University of Rajasthan
Jaipur

SYLLABUS

M.Sc.
(BOTANY)

2015-2016 (I & II SEMESTER)
2016-2017 (III & IV SEMESTER)
UNIVERSITY OF RAJASTHAN
JAIPUR

M. Sc. BOTANY

SYLLABUS SEMESTER SCHEME

2015-2017

M. Sc. Botany Semester Scheme 2015-17
- M.Sc. (Botany) semester scheme will be spread over two academic years consisting of four semesters, two semesters each in M.Sc. Previous (Semester I and Semester II) and M.Sc. Final (Semester III and Semester IV). The course in all the four semesters shall be of 336 credits i.e., each semester of PG course shall offer 84 credits. The candidate is required to earn a minimum of 120 credits.
- In theory, 15 hrs of theory teaching will be equivalent to one credit.
- In practical, 45 hrs of laboratory work will be equivalent to 2 credits.
- Practical classes will be of 4 hours duration/day.
- Each semester will have continuous assessment which will include internal assessment in theory and practical by internal examination (50 marks) and overall performance assessed by seminar/oral examination- viva voce. Attendance/Classroom participation/Quiz/Home Assignment etc. (30 marks) and the maximum marks will be 100.
- Studies tour during III semester shall be compulsory. Students are required to submit 10 herbarium sheets of plant collection made in the excursion. This will carry 10 marks to be allotted out of 15 marks assigned for records.

**FIRST-SEMESTER**

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<th>S. No.</th>
<th>SUBJECT CODE</th>
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<th>Course Category</th>
<th>Credit</th>
<th>Contact hours per week</th>
<th>EoSE duration (Hrs.)</th>
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<tr>
<td>1</td>
<td>BOT 101</td>
<td>Algae, Fungi and Bryophyta</td>
<td>CCC</td>
<td>4.5</td>
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<td>2</td>
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<td>BOT 104</td>
<td>Plant Ecology</td>
<td>CCC</td>
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<td>BOT 112</td>
<td>Practical-II (BOT 103, BOT 104)</td>
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1. EoSE: End of Semester Examination
### SECOND-SEMESTER

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<td>BOT 201</td>
<td>Genetics and Plant Breeding</td>
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<td>BOT 202</td>
<td>Pteridophyta, Gymnosperm and Paleobotany</td>
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<td>3.</td>
<td>BOT 203</td>
<td>Principles of Plant Pathology</td>
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<td>4.</td>
<td>BOT 204</td>
<td>Plant Physiology and Metabolism</td>
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<td>CCC</td>
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### THIRD-SEMESTER

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<td>BOT 302</td>
<td>Taxonomy of Angiosperms</td>
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<td>Plant Morphology and Developmental Anatomy</td>
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Asst. Registrar (Acad-I)
University of Rajshahi

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## FOURTH SEMESTER

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<td>BOT 401</td>
<td>Plant Reproductive Biology</td>
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<td>BOT 402</td>
<td>Plant Resource Utilization and Ethnobotany</td>
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<td>3.</td>
<td>BOT 403</td>
<td>Plant Biotechnology and Genetic Engineering</td>
<td>CCC</td>
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<td>Core Elective Courses A-F</td>
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5. BOT 411 Practical-I (BOT 401, BOT 402 & BOT 403)

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6. BOT 412 Practical-II (BOT 404)

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* Out of 6 elective papers. Candidates will be allotted one elective paper based on choice cum merit basis.

### Elective Core Courses:

Specialization Clusters

A. Advanced Plant Pathology  
B. Seed Science and Technology  
C. Ecosystem Ecology & Environmental Biology  
D. Advanced Plant Physiology  
E. Advanced Morphology & Morphogenesis  
F. Biosystematics or Angiosperm
Scheme of Examination

- Each theory paper shall carry 100 marks and will be of 3 hrs duration. Minimum passing marks shall be 30.

- The theory question paper will be divided into two parts A and B. Part A of question paper shall be compulsory and contain 10 (ten) very short answer type questions covering entire syllabus. Each carrying 2 (two) marks, with a total of 20 marks.

- Part B of question paper will have 4 questions having 100% internal choice. Each question will carry 20 marks, with a total of 80 marks.

- Each Practical examination will be of four six hour duration and involve laboratory experiments, exercises, and viva voce examination and record to the ratio of 75:25 (i.e., 15% for record and 10% for viva). Schedule hour during III semester shall be compulsory. Students are required to submit 10 herbarium sheets of plant collection made in the excursion. This will carry 10 marks to be allotted out of 15 marks assigned for records.

- Practical Examinations (BOT-311, 211 & 212) shall be of 100 marks each, BOT-311 & 411 shall be of 150 marks and BOT-312 & 412 shall be of 50 marks each.
BOT 101: ALGAE, FUNGI AND BRYOPHYTA

ALGAE (20 Hours)
• Algae in diversified habitats (terrestrial, freshwater and marine), thallus organization, cell ultra-structure, reproduction (vegetative asexual and sexual) classification of algae: based on pigments, cell wall composition, reserved food material and flagellation. Salient features of cyanophyta, chlorophyta, bacillariophyta, xanthophyta, pyrrhophyta, phaeophyta and rhodophyta with special reference to *Spirulina, Scytonema*, *Dunaliella, Pinnularia,Gonyaulax, Laminaria, Gelidium* and *Batrachospernum*.

(15 Hours)
• Economic importance of algae specially in industries, food, fodder, biofertilizers, Biofuels and algal bloom, isolation and culture of algae.

(5 Hours)

FUNGI (20 Hours)
• General characters, substrate relationship, cell ultra-structure, thallus organization, cell wall composition, nutrition (saprobic, biotrophic and symbiotic), reproduction (asexual and sexual).

(5 Hours)
• Heterothallism, heterokaryosis, Brachymeosis, paraseuxuality, sex hormones and recent trends in classification of fungi, phylogeny of fungi.

(5 Hours)
• General account of mastigomycota, zygomycota, ascomycota, basidiomycota and dueteromycota with special reference to *Rhizopus, Peronospora, Neurospora, Polyporus, Drechslera* and *Colletotrichum*.

(6 Hours)
• Economic importance of fungi in industries, medicines and as food, fungi as biocontrol agents, poisonous fungi, mycorhizae.

(4 Hours)

BRYOPHYTA (20 Hours)
• Distribution, Morphology, structure, reproduction and classification of bryophytes.

(4 Hours)
• General account of marchantiales, jungernmanniales, anthocerotales, sphagnales, funariales and polychaetales with special reference to *Plagiochaeta, Nototrichum, Sphagnum, Physcomitrella patens* and *Polytrichum*.

(6 Hours)
• Fossil Bryophytes, evolutionary trends in Bryophytes.

(3 Hours)
• Economic importance of Bryophyta

(3 Hours)
• Role of Bryophytes in plant succession.

(4 Hours)

Suggested Laboratory Exercises:

Morphological study of representative members of algae, fungi and bryophytes present in your locality in their natural habitat with special reference to
- **Algae**: Microcystis, spirullina, Scytonema, Ribularia, Dunella, Aulosira, Spirogyra, Pediasastrum, Hydrodictyon, Ulva, Pithophora, Stigeoclonium, Gelidium and Battrachospernum: Isolation and culture of algae.

- **Fungi**: Stemomites, Paronospora, Pythium, Albago, Rhizopus, Polobolus, Yeast, Emericel la, Chaetomium, Pleospora, Morchella, Melamsora, Phallus, Polyporus, Drechlera, Curvarulia, Phoma, Penicillium, Aspergillus, Colletotric hum, Fusarium and Alternaria;

- Isolation and culture of fungi using moistened blotters, PDA and Sabouraud’s Dextrose Agar media.

- **Bryophyta**: Plagiochasma, Pogonatum, Pellia, Notothylus, Andreaea and polytrichum

**Suggested Readings:**


**BOT 102: Cell Biology**

The **Dynamics of cell, shape and motility**: Structural organization of the plant cell, Cytoskeleton, microtubules and microfilaments, motor and flagellar movements.

**Cell wall, plasma membrane and plasmodesmata**: Structure and functions, biogenesis, growth models and functions, ion carriers, channels and pumps, receptors. Role in movement of
molecules and macromolecules across membranes, comparison with gap junctions.

(4)

Other Cellular organelles: Structure and functions of micro-bodies. Golgi apparatus, ribosomes, lysosome, endoplasmic reticulum.

Plant vacuole: Structure and function (6)

Chloroplast and mitochondria: Fine Structure and function of the organelles, their electron transport systems, import of nuclear encoded proteins, ATP synthases, structure, organization and function of mitochondrial and chloroplast genomes, mechanism of organelle gene expression, diversity and evolution of organelle genomes. (6)

Nucleus: Structure, nuclear envelope (karyotheca), nuclear pores, nuclear lamina, nucleolous and nuclear matrix.

Chromatin organization: Chromosome structure and packaging of DNA, nucleosome organization, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes, euchromatin and heterochromatin, specialized types of chromosomes, polytenic, lambrush. B-chromosomes, supernumerary chromosomes, molecular basis of chromosome pairing. (2)

Cell Cycle and Mechanics of cell division: Cell cycle control mechanisms -Negative and Positive intra & extra cellular controls. Role of cyclins & cyclin depended kinases (CDKs). Cytokinesis and cell plate formation; The events of m phase, CDK & cyclin B leading to Metaphase. The spindle assembly check points leading to Anaphase. DNA damage check point controlled by P 53 protein. Map & mitogen-activated protein kinase (MAPK) : Erk1 & Erk2, Ras (mitogen activated protein kinases). (6)

Mechanism at different stages of mitosis: Cohesins and condensins in chromosome segregation, Microtubules in spindle assembly, Structure of kinetochore, centrosome and its functions, Sister Chromatid separation. Cytokinesis actin & myosin in the generation of contractile ring, somatic metaphase. (5)

Meiosis- Significance, Chiasma formation- Synaptonemal complex, Recombination during meiosis- Recombination nodules. (2)

Apoptosis: Apoptosis (Programmed cell death): Mechanism of apoptosis, Apoptosis triggered by internal & external signals, Apoptosis inducing factors, cancer, oncogenesis & its mutations. (4)

Cell communication and Signal transduction: Overview of extra cellular signaling signal molecules- hormones, neurotransmitter proteins, environmental factors

Second messengers and their role in signal transduction - lipid and phosphatidyl inositol derived second messengers & Role of calcium as second messenger

Cell surface receptors in signal transduction: G-protein coupled receptor – structure and function, Ion channel receptors, Tyrosine kinase linked receptors. Receptors with intrinsic enzyme activity (RTK). (6)

Interaction and regulation of cell signaling pathways - bacterial and plant two component signaling system. bacterial chemotaxis and quorum sensing and Biofilm. (4)

Suggested Laboratory Exercises
1. EM study of cell organelles
2. Fluorescence staining with FDA for cell viability.
3. Cell wall staining with calcofluor white
4. Study of stages in cell cycle
5. Mitosis and Meiosis
6. Histochemical localization of protein, carbohydrate, fats, starch, lignin, nucleic acids
7. Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDH).
8. Isolation of chloroplast and study of its percentage intactness
9. Isolation of chloroplast and study of light reaction system.
10. Demonstration of SEM and TEM.
11. Karyotype analysis.
12. Polytenes, lambrush, B-chromosomes and sex chromosomes.
13. Preparation of Polytenes chromosome from *Chironomous* larva/Drosophila larva
15. Characteristics and behavior of B chromosomes using maize or any other appropriate material.
16. Any other practical based on theory syllabus.

Suggested readings:


**BOT 103: Microbiology**

**Introduction and classification:**

8 hrs.

**Microbial diversity:** Occurrence, salient features of following: Gram negative bacteria, spirochaetes, aerobic, anaerobic and microaerophilic bacteria, rickettsias and anoxigenic phototrophs, oxygeneric phototrophs, mycobacteria, actinomycetes, chlamydias, mycoplasma, archebacteria, methanogens, extremophiles, halophiles and thermophiles.

10 hrs.

**Microbial toxins:** Pathogenic types of toxins (exotoxin, endotoxin and enteroxin), non specific and specific defense mechanisms.

2 hrs.

**Morphology, ultra structure and cultivation of bacteria:** Morphology and ultra structure of bacteria, cytoplasmic inclusions, plasmids and endosporides. Anaerobic and aerobic culture media, growth curve, growth kinetics, batch, continuous culture, growth measurements and pure culture techniques.

10 hrs.

**Viruses:** Classification and nomenclature with cryptograms, properties and structure of viruses, life cycle and pathogenesis of following: RNA viruses-retero, rhabdo, hepatitis, swine flu; DNA viruses- Pox, herpes, measles; Plant viruses- cauliflower mosaic and turnip yellow mosaic.

8 hrs.

**Immunology:** General account of immunity, properties of antigens and antibodies, antibody structure and function, affinity and antibody specificity, monoclonal antibodies and their uses, antibody engineering, serology, vaccination and vaccines, interferon.

6 hrs.

**Microbial associations:** Symbiotic nitrogen fixation, symbrophy, bioluminescence, mycorrhiza, VAM fungi and plant growth promoting rhizobacteria (PGPR).
Application of microbiology : Agriculture and waste management; Food microbiology: specially in contamination and spoilage of food products, application of microbial enzymes in food industries; microbiology of fermented milk products and food preservation methods. Industrial microbiology: industrial production of alcohols, organic acids, amino acids, enzymes, antibiotics, minerals recovery.

Biodegradation, bioremediation and biodeterioration. Preliminary account of biofilms, biochips, biosensors and biosurfactants.

Suggested Laboratory Exercises
1. Preparation of culture media-liquid and solid media, enrichment, selective, preparation of slant, deep tube and plate culture.
2. Isolation of pure culture by pour plate, serial dilution and streak plate method.
3. Study of growth curve.
5. Sterilization methods.
7. Total counts (haemocytometer method), viable counts (plate count), WBC and RBC counts.
8. Methods of staining bacteria (simple staining, Gram’s staining, negative staining).
9. Endospore staining.
10. Fermentative production of ethyl alcohol by Yeast.
11. Extraction and detection of aflatoxin in infested foods.
14. To study spontaneous mutations by replica plating.
15. To study induced mutations in bacteria.
16. Antibiotic bioassay (gradient plate technique and disc method).
17. Testing of milk by MBRT, turbidity test for milk.
18. Qualitative estimation of Phosphorus and Calcium in milk.
19. Determination of most probable number (MPN).
20. Coliform test for milk water.
21. Isolation of microorganisms from air, water, soil and rhizosphere microflora.

Suggested readings:
BOT 104: Plant Ecology

Science of Ecology: Introduction to ecology, evolutionary ecology, ecological models:
Population: Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure, population growth. Competition and coexistence, intra-specific interactions, interspecific interactions, scramble and contest competition model, mutualism, commensalism and allelopathy, prey-predator interactions.

25 hours

Vegetation organization: Concepts of community and continuum, community coefficients, interspecific associations, ordination, species diversity and pattern diversity in community, concept of habitat and ecotone, ecological niche.

Vegetation development: Temporal changes (cyclic and non-cyclic), mechanism of ecological succession (delay floristic and initial floristic composition), succession models (facilitation, tolerance and inhibition models), Changes in ecosystem properties during succession, concept of climax.

20 hours

Ecosystems: Nature and size of ecosystem, components of an ecosystem (producers, consumers and decomposers), Grazing (grassland) and Detritus food chain in freshwater ecosystems, food webs. Ecological energetic: Solar radiation and energy takes at the earth's surface, energy flow models. Productivity of various ecosystems of the world and global biogeochemical cycles of carbon and nitrogen. Ecosystem Management: Homeostasis and cybernetics of ecosystem. Resilience of ecosystem. Restoration of degraded ecosystems. Ecology of plant invasion. Ecosystem services. 20 hours

25 hours

Suggested Readings


Suggested Laboratory Exercises

1. To determine minimum size and number of quadrat required for reliable estimate of biomass in grasslands.
2. To compare protected and unprotected grassland stands using community coefficients (similarity indices).
3. To estimate JVI of the species in a grassland woodland using quadrat method.
4. To determine gross and net phytoplankton productivity by light and dark bottle method.
To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.

To determine the water holding capacity of soils collected from different locations.

To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.

To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Winkler's method.

To estimate chlorophyll content in SO2 fumigated and unfumigated plants leaves.

To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.

To study environmental impact of a given developmental activity using checklist as a PFA method.

BOT 201: Genetics and Plant Breeding

Gene Structure and expression: Genetic fine structure, Operon concept, Introns and Exons, cis-trans test, fine structure analysis of eukaryotes, introns and their significance, Gene family.


Genetic recombination: Homologous and non-homologous recombinations; independent assortment and crossing over; molecular mechanism of recombination, Holiday junction, site-specific recombination, FLP, FRT and cre-lox recombination, role of Rec A and Rec BCD enzymes and other recombinations.

Mutation and types of DNA damage: Mutagens and their effects – Physical (Radiations) and Chemical (Base analogues, Intercalating agents, Alkylating agents and others). Types of mutation- Spontaneous and induced mutations, lethal, conditional; biochemical, loss and gain of function, base substitution, frameshift mutation, gene transfer, verses somatic mutation. Mutations induced by transposons.

Repair mechanisms of mutational DNA damages- Direct reversal of damages (Photoreactivation and Dealkylation), Excision Repair mechanisms (NER and BER), Post-replication repair mechanisms (Mismatch repair and Recombination repair), SOS repair, Inherited diseases and defects in DNA repair.

Chromosome mapping: Linkage map, mapping with genetic markers including RAPD, QTL, construction of molecular maps, restriction mapping- concept and technique, correlation of genetic and physical maps. mapping by using somatic cell hybrids.

Structural and numerical alterations in chromosomes : Origin, meiosis and breeding behaviour of duplication, deficiency, inversion and translocation heterozygotes. Origin, occurrence, production and meiosis of haploids, aneuploids and euploids; origin and production of autoploids; chromosome and chromatin segregation, allopolyploids types; genome constitution and analysis. Evolution of major crop plants, induction and characterization of trisomics and monosomics.

Molecular cytogenetics : Nuclear DNA content, C-value paradox, cot curve and its significance, multigene families and their evolution, in situ hybridization - concept and techniques, computer assisted chromosome analysis, chromosome microdissection and microcloning, flow cytometry and confocal microscopy in karyotype analysis. An idea about Proteomics, Genomics and Epigenomics.

Plant Breeding
Genetic system and breeding methods: Selection and breeding strategies for self-pollinated, cross-pollinated and clonally propagated crop plants, breeding for crop quality, biotic and abiotic stresses, gene pyramiding for multi-trait incorporation. Genetic control and manipulation of breeding systems including male sterility and apomixis.

Suggested Laboratory Exercises:
2. Linear differentiation of chromosomes through banding techniques, such as G-banding, C-banding and Q-banding.
3. Silver banding for staining nucleolus-organizing region, where 18S and 28S rRNA are transcribed.
4. Working out the effect of mono- and trisomy on plant phenotype.
5. Induction of polyploidy using colchicine.
6. Different applications of Colchicine.
7. Study of variations in plants due to numerical alterations in chromosomes.
8. Isolation of chlorophyll mutants following irradiation and treatment with chemical mutagens.
10. Flow cytometry and confocal microscopy
11. Any other practical based on theory syllabus.

Suggested Readings:

BOT 202: Pteridophytes, Gymnosperms and Paleobotany

**Pteridophytes:** Distribution, classification by International Committee of Botanical Nomenclature (ICBN), Economic importance of Pteridophytes.
General account of fossil Pteridophytes, Psilopsida, Lycopsidea, Sphenopsida and Pteropsida classes.
Morphology, anatomy, reproduction, classification, life history of: *Tmesipteris, Lycopodium, Gleichenia, Isoetes, Ophioglossum* and *Azolla*.
Origin and evolution of stele, heterospory and seed habit. **20 hrs**

**Gymnosperms:** Distribution, morphology, anatomy, reproduction; classification, life history and evolution. Cycadales (*Zamia*), Ginkgoales (*Ginkgo*), Coniferales (*Pinus, Taxus, Araucaria* and *Biota*), Welwitschiales (*Welwitschia*), Gnetales (*Gnetum*). **20 hrs**

**Paleobotany:** History of paleobotany, formation and types of fossils, techniques of study of fossils, Geological time scale. Brief account of Pteridospermales (*Lygopenteris, Medullosa, Caytonia* and *Glossopteris*). Brief account of Cycadeoidales (Cycadeoidea), Cordaitales (*Cordaites*).
Paleobotany and the evolution of vascular plants.
Applied aspects of paleobotany, use in coal and petroleum exploration. **20 hrs**

**Suggested Laboratory Exercises:**
Morphological and anatomical study of representative members of Pteridophytes and Gymnosperms in their natural habitat found in your locality with special reference to, *Lycopodium, Isoetes, Gleichenia, Ophioglossum* and *Azolla* in Pteridophytes, *Zamia, Ginkgo, Pinus, Taxus, Araucaria, Biota* and *Gnetum* in Gymnosperms.
Collection and study of fossils.

**Suggested Readings:**

**BOT 203: Principles of Plant Pathology**

- **Plant diseases:** Introduction and General Account of disease development History of plant pathology Nature and concept of Plant Disease and evolution of parasitism. Symptoms of Plant Diseases caused by plant pathogen. (13 Hrs)

- **Pathogenesis:** Biotic and Abiotic factors in pathogenesis, pathogen factors in disease development. Penetration, infection. Enzymes and Toxin in Plant Disease –Host specific and non-host specific toxin, Concept of Effectors. (15Hrs)

- **Disease Development:** Modes of infection, Mechanism of Penetration of Pathogens. Protective and defense mechanism in plants-Morphological and Biochemical(10Hrs)

- **Management of Plant disease:** Physical, Chemical and Biological Biopesticides, Plant Disease Clinics (12Hrs)

- **Symptomology, Identification and Control of Following Plant Diseases:** (20Hrs)
  - **Fungal diseases:**
    - Wheat - Flag smut, Karnal bunt.
    - Rust of Linseed
    - Tikka disease of Groundnut
  - **Bacterial diseases:**
    - Wheat: Tundu disease
    - Black rot of Crucifer
  - **Viral diseases:**
    - Cadang –Cadang disease of Coconut
    - Leaf Curl of Tomato
  - **Nematode disease:**
    - Root Knot of Brinjal.
    - Ear Cockle of Wheat
  - **Non-Parasitic Diseases**
    - Black Heart of Potato
    - Mango necrosis
Suggested Laboratory Exercises:
- Isolation of antibiotic resistant colonies by antibiotic disc method
- Gradient plate method.
- Hanging drop method.
- Grams stain for different bacteria.
- Negative staining technique of bacteria.
- Determination of growth curve of bacteria.
- Identification of fungal cultures.
- Isolation of microorganisms from soil.
- Study of following disease:
  1. Bacterial disease of groundnut
  2. Black rot of cucurbit
  3. Fusarium disease of wheat
  4. Leaf curl of Tomato
  5. Root knot of Brinjal
  6. Lar cockle of wheat
  7. Mango necrosis

Suggested Readings:

BOT 204: Plant Physiology and Metabolism

Biomolecules: General structure, classification, properties, distribution and functions of primary metabolites, carbohydrates, proteins, amino acids, lipids and secondary metabolites (flavonoids, alkaloids, steroids) and their role in plant defense mechanism. Ramachandran Plot for amino acids.  


**Bot 301: Molecular Biology**

**Genes and DNA**

Evidences of DNA and RNA as the genetic material for bacteria, virus and eukaryotes. Double helical structure of DNA, DNA supercoiling. Coding DNA, gene mutations, ORF, gene structure, Exons and Introns. Non-coding DNA & RNA. 05

**DNA replication, damage and repair**

Initiation, Elongation and Termination, Replicons, linear, circular and D-loops. DNA polymerases, helicase, and other enzymes and proteins used in replication, coordinating synthesis of the leading and lagging strands. Okazaki fragments, topoisomerase activity, causes of DNA damage and molecular mechanisms of repair - excision repair system in bacteria and eukaryotes, base excision, recombination repair systems and SOS. 10

**Transcription, post-transcriptional changes**

mRNA structure, prokaryotic and eukaryotic RNA polymerases. Transcriptional factors, promoter sequences, binding sites for RNA polymerase, transcription initiation, promoter
clearance and elongation, termination, attenuation and antitermination. Role of Enhancers, repressors, mediators and silencers, transcription inhibitors. RNA splicing and processing - capping, polyadenylation, splicing, splicesome, mRNA stability, group I introns and transesterification, ribozymes, RNA editing.

Translation

Gene regulation

DNA Cloning and Characterization
Restriction and other enzymes. Expression vectors, basic steps in gene cloning, genomic and c-DNA libraries, electrophoresis, blotting techniques (Southern, Northern and Western), gene sequencing methods (Sanger’s methods & Maxam Gilbert’s method), nick translation. DNA finger printing, PCR and RT-PCR, DNA microarrays. DNA-protein interaction (DNA footprinting, yeast two-hybrid system) & Cluster analysis.

Suggested Readings:


See the following Review Journals:
Annual Review of Plant Physiology and Molecular Biology.
Current Advances in Plant Sciences.
Trends in Plant Sciences.
Nature Reviews: Molecular and Cell Biology.
Current Biology.

Suggested laboratory Exercises
1. Isolation of nuclei and identification of histones by SDS-PAGE.
2. Isolation of plant DNA and its quantitation by a spectrophotometric method.
3. Isolation of DNA and preparation of 'cot' curve.
4. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
5. Isolation of RNA and quantitation by a spectrophotometric method.
6. Polymerase Chain reaction.
7. Southern blot analysis using a gene specific probe.
8. Determination of size of DNA by comparison with DNA Ladder electrophoretically.

BOT 302: Taxonomy of Angiosperms

(4 Hours)

(10 Hours)

(4 Hours)

Taxonomic tools and techniques: Herbarium: preparation, maintenance, utility, important national, international and local herbaria, serological, Molecular technique, GIS and Mapping biodiversity.
(10 Hours)
**Taxonomic evidences:** Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry and Genome analysis. *(10 Hours)*

**Classification:** Phenetic system: Phylogenetic- Cronquist, Dahlgren, Thorne and APG system with merits and demerits of these systems. *(6 Hours)*

**Salient features of the groups:** Polypetalaec, Gamopetalaec, Monochlamydaec and Monocotyledons including their important families. *(10 Hours)*

**Phylogeny of Angiosperm:** Ancestors of angiosperms with special reference to *Amborella*, time and place of origin of Angiosperms. Habit of Angiosperm, primitive living angiosperm, inter relationship among the major groups of Angiosperm. *(6 Hours)*

**Suggested Readings:**

Suggested Laboratory Exercises:

1. Description of a specimen from representative, locally available families.

List of Locally Available Families


2. Description of a species based on various specimens to study intraspecific variation: a collective exercise.

3. Description of various species of a genus, location of key characters and preparation of keys at generic level.

4. Location of key characters and use of keys at family level.

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

6. Training in using floras and herbaria for identification of specimens described in the class.

7. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.

8. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.

BOT 303: Plant Morphology and Developmental Anatomy

**Introduction:** Unique features of plant development, differences between animal and plant development.

**Seed germination and seedling growth:** Metabolism of proteins and mobilization of food reserves, tropisms during seed germination and seedling growth, hormonal control of seedling growth, gene expression, use of mutants in understanding seedling development.

**Shoot development:** Organization of the shoot apical meristem (SAM), cytological and molecular analysis of SAM, control of cell division and cell to cell communication, Stem cell in plants. Primary and Secondary tissue differentiation, control of tissue differentiation, especially xylem and phloem, secretory ducts and laticifers, wood development in relation to environmental factors.

**Leaf growth and differentiation:** Inception, phyllotaxy, control of leaf form (leaf meristems and other factors), differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll, kranz anatomy. Leaf traces and leaf gaps, transfer cells.
Root development: Organization of root apical meristem (RAM), vascular tissue differentiation, lateral roots, root hairs, root-microbe interactions.

Seed coat development: External and internal morphology of seed, seed appendages, ontogeny of seed coat in various families, mature structure, spermoderm patterns.

Suggested Readings:
   New York.

Suggested Laboratory/Field Exercises
1. Study of living shoot apices by dissections using plants such as Tabernaemontana, Albizia
2. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant. Examination of shoot apices in a monocotyledon in both T.S. and l.s. to show the origin and arrangement of leaf primordia.
3. Study of alternate and distichous, alternate and superposed, opposite and superposed, opposite and decussate leaf arrangement. Examination of rosette plants (Launaea, Mollugo, Raphanus, Hyoscyamus etc.) and induction of bolting under natural conditions as well as by GA treatment.
4. Microscopic examination of vertical sections of leaves such as Eucalyptus, Ficus, Mango, Nerium, maize, grass and wheat to understand the internal structure of leaf tissues and trichomes, glands etc. Also study the leaf anatomy C3 and C4 of plants.
5. Study of epidermal peels of leaves such as Coccinia, Tradescantia etc. to study the development and final structure of stomata and prepare stomatal index.
6. Study of types of stomata in plants belonging to different families.
7. Study of whole roots in monocots and dicots.
8. Examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives. (use maize, aerial roots of banyan etc.)
9. Study of lateral root development.
10. Study of leguminous roots with different types of nodules.
11. Study of primary and secondary tissue differentiation in roots and shoots.
12. Study of seed coat types— *Pisum, Cucurbita*, wheat.
13. Study of vascular tissues by clearing technique

**BOT: 304 A - Advanced Plant Pathology I**

**Plant Pathology: History & Scope:** Parasitism and disease development, Host-Parasite interaction, pathogenicity, (5 Hrs)

**Dispersal of plant pathogens**—Direct, Indirect and Biological Transmission (5 Hrs)

**Host Factors in Disease Development:** Inoculum Potential, Protective and defense mechanisms in plants. Phytoalexins, Genetics of plant disease. Phenomenon of resistance and susceptibility. Gene for gene hypothesis. (10 Hrs)

Alteration in plant physiological method due to plant pathogen interaction. (5 Hrs)

**Symptomology, Identification and Control of following plant diseases (35 Hrs)**

**Fungal Diseases:**
- Crucifers— *Alternaria* blight
- Paddy— Paddy blast
- Leaf roa and Foot rot of *Pani* (*Piper* beetle)
- Red rot of Sugarcane, Flax rust,

**Bacterial diseases**
- Brown rot of Potato,
- Blight of Rice,
- Crown Gall disease of stone fruits
- Angular leaf spot of Cotton.

**Phytoplasma Disease:**
- Little leaf of Brinjal,
- Sesame Phyllody.

**Plant Galls:** Classification, developmental anatomy, host-parasite interaction and physiology of Insect induced plant galls of Rajasthan. Economic significance of galls

**Plant Galls:** Galls of Pongamia, *Cordia, Prosopis* and *Salvadora*

**Nematology:** General account of nematode disease, Symptoms caused by nematodes. Methods used in Nematology. Control of plant parasitic nematodes, Inter relationship between nematode and other Plant pathogens

**Nematode Disease:** Molya disease of Wheat and Barley. Soybean Cyst nematode
Suggested practical :-

Histopathology of nematode infected roots
Study of following disease
- Red rot of Sugarcane
- Paddy Blast
- Flax rust,
- Crown Gall disease of stone fruits
- Angular leaf spot of Cotton.
- Little leaf of Brinjal,
- Sesame Phyllody,
- Galls of Pongamia, Cordia, Prosopis, Salvador
- Molya disease of wheat and Barley
- Soyabean cyst nematodes

Suggested Readings:

BOT 304 B: Seed Science and Technology -I

History of seed testing and its importance to agriculture, aims of seed testing. Seed- definition and its types. Sampling of seeds, purity analysis (physical and genetical), seed moisture content, germination test, rapid test of viability and evaluation, seedling evaluation, various methods of seed separation, cleaning, drying and Seed processing plant and its process.
Gross architecture of seed structure of angiosperms, identification and structure of seeds of important crop plants with special reference to Rajasthan (wheat, pearl millet, mustard, gram, pea. spices) and Identification of designated objectionable weeds at seed level.

Principles of seed production, seed production in self and cross pollinated crops; hybrid seed production. Production of foundation and certified seeds; synthetetic seed, terminator seed technology, Physiology of seed germination; seed and seedling vigour.

Seed storage methods, principles for safe seed storage, effects of storage, mycotoxins, Deterioration of seeds in storage by micro-organisms, insects and rodents; detoxification, control of seed deterioration.

Seed certification standards and quarantine regulations. International cooperations, International Seed Testing Association - Rules and recommendations, Certificates, other seed certificates; Indian Seeds Act and recent amendments, National and Regional Seed Corporations of India - their organisation, aims and functions, National and International Co-operation in Seed Pathology. Sanitary and phytosanitary (SPS) agreements of WTO.

List of suggested Practical exercises:

1. Structure of seeds of some crop plants (wheat, pearl millet, mustard, gram, and pea).
2. Preparation of inventory of designated objectionable weeds at seed level and identification.
3. Identification of seed coat cracking.
4. Study of physical purity of seed sample.
5. Study of seed germination, seedling abnormality and seedling index.
6. Determination of moisture content of seeds.
7. TZ test for seed viability.
10. Localization of starch, protein, lipids, tannins, phenols and lignin in seed sections.
11. Isolaton and identification of storage fungi.
12. Preparation of phytosanitary certificate etc. of seed lot.

Suggested Readings:


**BOT 304 C: Ecosystem Ecology**

**Grassland Ecosystems** - Characteristics of grasslands. stratification, grasslands and grazing, grasslands and drought, grassland and animal life. Grasslands types with special reference to Prairie and Savannah, Indian grasslands. 10 hours

**Freshwater Ecosystems** - Classification of Freshwater Habitats, Lentic: Lakes & Ponds; Temperature and Oxygen stratification. Zonation based on light penetration, Flora and fauna, Productivity classes of lakes, Marshes and Swamps, Bogs
Lotic: Springs, Streams and Rivers. 10 hours

**Marine and Estuarine Ecosystems** - Characteristics of marine environment: Salinity, Temperature and pressure, Zonation and Stratification, Tides. Estuarine ecosystem: Types of Estuaries, Flora and fauna, Estuarine productivity, Coral reef ecosystem, Mangrove ecosystem
10 hours

**Forest Ecosystems** - Stratification of the forest, Forest types - Boreal, Temperate and Tropical forests, Forest animal life 5 hours

**Urban Ecosystem** - Urban environment and Climatic conditions, additional physical complexes (modified surfaces including parking lots, roofs, and landscaping, buildings, transportation networks, infrastructure and public amenities), flora and fauna (human beings as largest macro
Implications of urbanization: problems of air pollutants, drinking water supply, floods, waste disposal.

5 hours


5 hours

Desert Ecosystem: Desert. Definition, classification (hot and cold), physiography, desert features, flora, fauna and water. Formation, topography, distribution and characteristics of world deserts. Thar desert: Sand dunes, types, origin and morphology of sand dunes. Vegetation types and plant communities, Biological production, conservation of flora and fauna, wild life. Succession in vegetation of western Rajasthan and coastal sand dunes, economic importance of desert plants (general economic plants, medicinal, famine food plants and crops). Saline Arid zones: Saline tracts of Rajasthan and plants of saline and zones (Halophytes). Economic and social considerations in the management of salt affected soils, afforestation in salt affected soils. Importance of halophytes. 15 hr

Suggested Readings

Suggested Laboratory Exercises
- Find out stomatal index of Xerophytes (Xerium, Calotropis, Zizyphus) growing in your locality.
- Study of trichomes of xerophytes (Zizyphus Lantana, Calotropis, Acacia) growing in your locality.
- Study spread of root system of a perennial species in the soil.
- Study ecological adaptations of halophytes in your nearby area.
- Seed Viability by T.C. method.
- Dormancy (seed) - A temporary in seeds.
- Soil moisture and temperature at different depths.
- Salinity of soil sample.
- Study of Canopy and Basal Cover of trees in your study area.
- Estimate primary productivity of a water body by light and dark bottle method.
- Mean leaf area of plant species or soil in your area by graph method.
- Relative humidity - Sand hygrometer.
- Light intensity by Luminometer.
- Mark hot and cold desert on map.
Proteins and Enzymes: Techniques of protein purification, protein sequencing and proteomics. Enzyme kinetics: Michaelis-Menten equation and significance of Km value. Negative and positive co-operativity, enzyme nomenclature and IC number. Catalytic mechanisms: Acid-Base catalysis, covalent catalysis, metal ion catalysis, electrostatic state binding, lysozyme as model enzyme for catalytic mechanism. Regulation of enzyme activity: feedback and allosteric regulation, active sites, enzymes, activators and inhibitors. 20Hrs

Nucleotides metabolism: Biosynthesis of Ribonucleotides and of Deoxy-ribonucleotides-salvage and de novo pathways, nucleotide degradation. 15Hrs

Vitamins: Water and fat-soluble vitamins, biochemical functions of thiamine, riboflavin, nicotinic acid, pantothenic acid, pyridoxine, biotin, folic acid, vitamin B12, ascorbic acid. Vitamin A and Vitamin D. 10Hrs

Secondary Metabolites: Detailed account of Coumarins, Lignins, Insecticides (pyrethrins and rotenoids). Tannins, Flavonoids, Alkaloids and Steroid. 15Hrs

Suggested Readings


Suggested Laboratory Exercise

1. Quantitative estimation of proteins in the given plant material by Lowry’s method.
2. Desalting of proteins by Gel Filtration chromatography using sephadex.
3. Isolation of casein from milk and its quantification.
4. Effect of ion and enzyme concentration on rate of reaction of enzyme. Ex.- Acid Phosphatase, Nitrate reductase.
5. Quantification of Vitamin C.
6. Extractor and identification of flavonoids and alkaloids through TLC.
7. Preliminary detection of flavonoids, alkaloids and steroids.

**BOT 304 E: ADVANCED MORPHOLOGY AND MORPHOGENESIS-I**

Floral anatomy and its role in explaining the morphology of the Stamen and Carpel, seed and pericarp and their taxonomic significance. 10

Anther-organization, relationship of anther tissues, ultrastructure aspects of microsporangogenesis, pollen sporoderm pattern, pollen analysis, pollen fertility and sterility, allergy due to pollen. Viability, storage and germination of pollen. 12

Embryo sac - basic types and their inter-relationships, ultrastructural aspects of embryosac development. Pollen-pistil interaction, cytomorphology of style and stigma, role of pollen ultrastructural studies on pollen tube growth in the pistil, chemo-topism, fertilization. 13

Endosperm - relationship of the major types of endosperm, cytology and role, in embryo development. 5

Embryo - Embryogenic laws. Major types of embryogenesis, cell lineages. Apomixis - types. agri-horticultural importance. 10

Embryological features of the following families: Santalaceae, Loranthaceae, Podostemaceae, Onagraceae, Cyperaceae, Fascaraceae, Boraginaceae, Campanulaceae and Tropeolaceae. 10

**Suggested Readings**


- Suggested practical field exercises:
- 1. Study of floral anatomy by cutting serial transverse sections.

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- 2. Study different types of placentation.
- 3. Transverse sections of different stages of developing anthers to see development of wall layers and sporogenesis.
- 4. Spermatogenesis studies of pollen grains
- 5. Make acetolysis preparations of pollen grains to study wall structure.
- 6. Pollen viability tests using different salt and sugar concentrations.
- 7. Endosperm development.
- 8. Stages in embryo development in plants like *Raphanus* and legumes etc.

**BOTANY BIOSYSTEMATICS OF ANGIOSPERMS-I**

Aims, components, and principles of taxonomy; Alpha and omega taxonomy, documentation and scope. **(4 Hours)**

Evolutionary taxonomic classifications with their merits and demerits; system of Hutchinson, Takhtajan, Cronquist, Dahlgren, Thorne, and APG. **(8 Hours)**

International and national botanical gardens, plant geography, Indian plant geographical regions. **(6 Hours)**

Taxonomic literature: Herbarium, flora, monograph, icons, index, library, manuals, taxonomic keys for plant identification. **(6 Hours)**

ICBN: Principles, rules, and recommendation, Nomenclature of hybrids and cultivars, concept of biomass. **(10 Hours)**

Biosystemic procedure in diagnosis, Cytology-chromosomes morphology and number, polyploidy, allopolyploidy, chromosome bands, G-C Bands, Histochromy - lipids, fats, sugar, ascorbic acid, tannins, phenols, proteins, Molecular systematics (RAPD, RFLP analysis). **(12 Hours)**

Biosystemic tools: phylogeny - pollen characters in detail related to taxonomy, embryology - embryological characters of taxonomic importance. **(8 Hours)**

Numerical Taxonomy: Principles, concepts, operational taxonomic units (OTU), data processing and taxonomic studies, taximetric methods for study of population variation and similarity, scoring, cluster analysis, cladistics and cladogram. **(6 Hours)**

**Suggested Readings:**


Suggested Laboratory Exercises:
1. Description of a minimum of five representative, locally available families.
2. List of Locally Available Families:
3. Description of various species of a genus, location of key characters and preparation of keys at generic level.
4. Location of key characters and use of keys at family level.
5. Field trips within and around the campus, compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.
6. Training in using floras and herbaria for identification of specimens described in the class.
7. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
8. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.
9. Molecular taxonomy

BIO 401: PLANT REPRODUCTIVE BIOLOGY

Reproduction: Vegetative options and sexual reproduction, flower development, genetics of floral organ differentiation, homeotic mutants in Arabidopsis and Antirrhinum, sex determination. 5

Male gametophyte: Structure of anthers, microsporogenesis, role of tapetum, pollen development and gene expression, male sterility, sperm dimorphism and hybrid seed production, pollen germination, pollen tube growth and guidance, pollen storage, pollen allergy, pollen embryos. 13

Female gametophyte: Ovule development, megasporogenesis, organization of the embryo sac, structure of the embryo sac cells. 5

Pollination, pollen-pistil interaction and fertilization: Floral characteristics, pollination mechanisms and vectors, structure of the pistil, pollen-stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects), double fertilization, in vitro fertilization. 13

Seed development and fruit growth: Endosperm development, embryogenesis, cell lineages during late embryo development, storage proteins of endosperm and embryo 6

Polyembryony, apomixis, embryo culture, dynamics of fruit growth, biochemistry and molecular biology of fruit maturation. 5

Latent life - dormancy: importance and types of dormancy, seed dormancy, overcoming seed dormancy, bud dormancy. 5

Senescence and programmed cell death (PCD): Basic concepts, types of cell death, PCD in the life cycle of plants, metabolic changes associated with senescence and its regulation, influence of hormones and environmental factors on senescence. 8

Suggested Readings
38
Suggested practical/Field exercises:
1. Study of microsporogenesis and gametogenesis in sections of anthers of different ages.
2. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, Cannabis sativa, Crotonloria, Tradescantia, Brassica, Petunia, Solanum melongena, etc.)
5. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
7. Study of ovules in cleared preparations, study of monosporic, bisporic and tetrusporic types of embryo sac development through examination of permanent, stained serial sections.
8. Field study of several types of flower with different pollination mechanisms.
9. Emasculation, bagging and hand pollination to study pollen germination.
10. Study of nuclear and cellular endosperm through dissections and staining.
11. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds.
12. Polyembryony in citrus, jamun (Syzygium cumini) etc. by dissections.
13. Biochemical estimation (qualitative and quantitative) of metabolites of seeds.

Suggested Readings (for Laboratory Exercises)

BOT 402: PLANT RESOURCE UTILIZATION & ETHNOBOTANY
1. Economic importance of microbes, with special reference to Bacteria and algae of your locality and found in extreme habitats (3 hrs)
2. Role of fungi in industries with reference to the production of alcohol, organic acids, antibiotics and enzymes. (3 hrs)
4. World centers of primary diversity of domesticated plants: The Indo-Burmese centre, plant introductions and secondary centers. (3 hrs)
5. Origin, evolution, botany, cultivation and uses of (i) Food, forage and fodder crops, (ii) ornamental plants, plants used in sericulture, as petro crops, in narcotics, as mastigatory, fumitories and fiber crops, (iii) medicinal and aromatic plants and (iv) vegetables, fruits,
spices condiments & oil-yielding crops \( (10 \text{ hrs}) \)

6. Important fire-wood and timber-yielding plants and non-wood forest products (NWFPs) such as bamboos and rattans. Raw materials for paper making, gums, tannins, dyes and resins. \( (5 \text{ hrs}) \)

7. Green revolution: Benefits and adverse consequences. Recent trends of research for meeting world food demands. Plants used as avenue trees for shade, pollution control and aesthetics. \( (4 \text{ hrs}) \)

8. Principles of conservation, extinctions, environmental status of plants based on International Union for Conservation of Nature (IUCN). \( (4 \text{ hrs}) \)

9. Strategies for conservation - \textit{in situ} conservation: International efforts and Indian initiatives, protected areas in India- sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs conservation of wild biodiversity. \( (7 \text{ hrs}) \)

10. Strategies for conservation - \textit{ex situ} conservation: Principles and practices, botanical gardens. Field gene banks, Seed banks, \textit{in vitro} repositories and cryobanks. \( (5 \text{ hrs}) \)

11. General account of the activities of Botanical Survey of India (BSI), National Bureau of plant Genetic Resources (NBPRG), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), and the Department of Biotechnology (DBT) for conservation and non formal conservation efforts. \( (5 \text{ hrs}) \)

12. Ethnobotany: Scope, Interdisciplinary approaches, ethnic groups of India, conservation practices of biodiversity, role of ethnobotany in national priorities, health care and development of cottage industries in India. \( (5 \text{ hrs}) \)

\textbf{Suggested Readings}

25. Nair, M.N.B. et al. (Eds.) 1988 Sustainable Management of Non-wood Forest Products. Faculty of Forestry, University of Putra Malaysia. 43004 PM Serdang, Selangor, Malaysia.

Suggested Laboratory Exercises

The Practical course is divided into three units: (1) Laboratory work, (2) Field survey and (3) Scientific visits.

Laboratory Work

1. Food crops: Wheat, rice, maize, chickpea (Bengal gram), potato, sweet potato, sugarcane. Morphology, anatomy, biochemical tests for stored food materials.
2. Forage fodder crops. Study of any five important crops of the locality (for example fodder sorghum, barley, berseem, khejari, Aeluropus.)
(b) Cordage fibres: contain fibres for stuffing: silk cotton or kapok

Morphology, anatomy (microscopic) study of whole fibres using suitable staining procedures.

4. Medicinal and aromatic plants: Depending on the geographical location of the college/university select five medicinal and aromatic plants each from a garden crop field (or from the wild if they are abundantly available).


Study of live or herbarium specimens or other visual materials, to become familiar with these resources.

5. Vegetable oils: Mustard, groundnut, soybean, coconut, sunflower, castor.

Morphology, microscopy, structure of the oil-yielding tissues, tests for oil and iodine number.

6. Gums, resins, tannins, dyes: Perform simple tests for gums and resins. Prepare a water extract of vegetable tannins (\textit{Acacia, Terminalia, Cinnamomum}, \textit{Cassia spp.}, \textit{Myroxylon}), and dyes (turmeric, indigo, \textit{Butea monosperma, Lawsonia inermis}) and perform tests to understand their chemical nature.

7. Firewood and timber yielding plants and NWF's

Field Surveys

a. Prepare a short list of 10 most important sources of firewood and timber in your locality. Give their local names, scientific names, and families to which they belong. Mention their properties.

b. Prepare an inventory of the bamboos and rattans of your area giving their scientific and local names and their various uses with appropriate illustrations.

c. A survey of a part of the town or city should be carried out by the entire class. In batches, individual students will select one avenue road and locate the trees planted on a graph paper. They will identify the trees, mention their size, canopy shape, blossoming and fruiting period and their status (healthy, diseased, infested, mutilated, misused or dying) and report whether or not the conditions in which they are surviving are satisfactory. The individual reports will be combined to prepare a larger map of the area which can be used for subsequent monitoring either by the next batch of students or teachers/local communities/NGOs or civic authorities. The purpose of exercise in item C above is to make the students aware of the kinds of trees and value in urban ecosystems and ecological services.

Scientific Visits

The students should be taken to one of the following:

i. A protected area (biosphere reserve, national park, or a sanctuary)

ii. A wetland

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Bot 403: PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING


Science and society: Public acceptance of genetically modified crops (Public concerns, current status of transgenic crops, regulation of GM crops, cisgenic crops and products). Introduction to Intellectual property, Biosafety guidelines, Environmental release of GMO's, Risk assessment, Risk management, 05

Introduction to bioinformatics (Definition, history, applications & scope): Biological databases and sequence analysis. BLAST and FASTA. Multiple sequence alignment, phylogenetic analysis and Bioinformatics in Drug Discovery. Bioinformatics in India, 05

Practicals:
1. Preparation of medium
2. Surface sterilization
3. Micropropagation technique
4. Organ culture
5. Cuttles propagation, embryogenesis, transfer of plants to soil
6. Anther culture: production of haploids
7. Preparation of synthetic seeds
8. Cytological examination of regenerates plants.
9. Isolation of protoplasts from various plant tissues and testing their viability
10. Agrobacterium culture, selection of transformants, reporter gene (GUS) assays
11. PCR and Gel electrophoresis
12. Techniques: Biolistics, Membrane Filtration, Cell Counting
13. Hairy root cultures
14. Induction and precursor feeding
15. Extraction of alkaloids and flavonoids from plant material and their separation using TLC
16. Isolation of plant DNA using CTAB method
17. BLAST
18. FASTA

Suggested Readings:

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Assist. Registrar (Acad-I)
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**BOT 404 (A): Advanced Plant Pathology II**

- **Plant Disease epidemiology and plant disease forecasting:** Computer simulation of epidemics, Methods used in Plant disease forecast, examples of Plant Disease forecasting System (10 Hrs)
- **Disease Control:**
  - Immunizing the host
  - Disease control by transgenics
  - Innovative methods of plant disease control—Pollen Management and Integrated Pest Management (15 Hrs)
- **Breeding for disease resistance:** Types of resistance—basal resistance, systemic resistance, acquired resistance, Gene for Gene concept, Production of disease resistant plants, Effectors (15 Hrs)
- **Molecular Plant Pathology:**
  - Molecular diagnosis, Identification of genes and specific molecules in disease development, Genetics of host pathogen interaction, Molecular mechanism of resistance and Biotechnological approaches for disease (15 Hrs)
- **Application of Biotechnology and Information technology** in Plant Pathology & Integrated Pest Management (5 Hrs)

**Suggested practicals:**
- Biochemistry—Altered plant physiology due to plant pathogen interaction
- Histochemistry of altered metabolites—Protein, lipids, starch, cellulose, peroxidases and polyphenol oxidase
- Virus detection through biological (indicator hosts and host range) and serological methods (ELISA, Immunodiffusion)
- Virus Indexing
- Methods of application of fungicides—seed and foliar application
- Bio-control of plant pathogens—dual culture technique
- Bioassay of fungicides—poisoned food technique, inhibition zone technique and slide germination technique

**Recommended Books:**
Introduction and importance of Seed Pathology in modern agriculture. History of Seed Pathology. Various methods for testing seed borne fungi, bacteria and viruses (Dry seed examination, seed washing test, incubation methods, cultural, biochemical, serological, nucleic acid based methods).  

Mechanism of seed infection and its types, environment influencing seed infection, infected/contaminated part of seed, morphology and anatomy of seeds in relation to invasion, location of inoculum of the pathogen in seed- seed coat and pericarp, endosperm and perisperm and embryo.  

Seed-borne diseases of some important crops with particular reference to the state of Rajasthan and India. Typical case of infection by: fungi (wheat- smuts and bunts, Sesame-charcoal rot; bacteria (Brassicas- black rot, cluster bean- bacterial blight); viruses (tomato mosaic virus, pea seed borne mosaic virus) and nematodes (wheat- car cockle, rice- white tip).  

Seed-borne inoculum, inoculum density and assessment of seed borne inoculum in relation to plant infection, epiphytotics due to seed borne inoculum, disease forecast based on infected seed samples, tolerance limits of seed borne pathogens.  

Transmission of seed borne disease: Systemic and non- systemic seed transmission, types of disease transmission, mode of establishment and course of disease from seed to seedling and plant, factors affecting seed transmission.
Management of seed-borne disease, principles of control, seed treatments (physical, chemical and biological), mechanism of action of seed treatments, major seed treatments for important seed borne pathogens and their methods of application.

List of suggested Practical exercises:
1. Dry seed examination of seed lots.
2. Isolation and identification of seed-borne mycoflora by standard blotter method.
3. Preparation of culture media (PDA and NA).
4. Plating seeds on PDA/NA for identification of seed borne fungi and bacteria.
5. Other methods of plating e.g. deep freezing; 2,4D- blotter method.
7. Study of any seed borne nematode disease.
8. Detection of bacterial and viral pathogens in seeds.
9. LOPAT tests for detection of seed- borne bacteria.
10. Nucleic acid based detection of seed borne pathogens.
11. Histopathology of infected seed samples.
12. Physical control of seed-borne pathogens.
13. Antibiotic/fungicidal assay against seed-borne pathogens
14. Biological control of seed borne pathogens.
15. Field visits: Crop fields, FCI. NSC, Seed testing Labs., quarantine station (e.g. NBPGR) etc.

Suggested Readings:

BOT 404 (C) : ENVIRONMENTAL BIOLOGY


12hr

Water Pollution: Eutrophication: Process and Control; Oil Pollution, Thermal Pollution, Heavy metal Pollution. Treatment. Disposal & Recycling of Wastewaters, drinking water standards, Minimum National Standards

10hr


08hr

Climate Issues: Greenhouse gases (CO\textsubscript{2}, CH\textsubscript{4}, N\textsubscript{2}O, CFCs: sources, trends and role) and consequence of greenhouse effects (CO\textsubscript{2} fertilization, global warming, sea level rise, Biodiversity erosion), Carbon footprints, Carbon sequestration, Applications of GIS and Remote Sensing technology in environmental studies, the future of planet earth.


Environmental concerns: Environment auditing, Ecological footprints, Environment Impact Assessment, Bioindicator and biomarkers of environmental health; Environmental economics, Ecopolitics and green policies; Ecolabel, Rain water harvesting, Orans, Indira Gandhi Canal and its ecological implication, water logging & salinity problems- The management alternatives.

Suggested Readings

Suggested Laboratory Exercises
- To estimate pH, EC and Secchi Disc transparency for polluted and unpolluted water bodies.
- To estimate Chemical Oxygen Demand of polluted water sample.
- To estimate Biological Oxygen Demand of polluted water sample.
- To estimate inorganic phosphorus content in water samples collected from polluted and unpolluted water bodies.
- To estimate Total hardness, calcium and magnesium content in water samples collected from polluted and unpolluted water bodies.
- To estimate chloride content in water samples collected from polluted and unpolluted water bodies.
- To estimate Total alkalinity in water samples collected from polluted and unpolluted water bodies.
- To determine diversity indices (Shannon-Wiener, concentration of dominance, species richness, equitability and β-diversity) for polluted and unpolluted water bodies.
- Chlorophyll content of plant species growing in polluted (along JLN Marg) and unpolluted habitat (Botany Department).

**BOT 404 (D) : Advanced Plant Physiology II**

**Signal transduction in plants:** Receptors and G-Proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity of protein kinases and phosphate, single transduction mechanism with special reference to Actin-cytoskeleton signal transduction, sugar induced signal transduction.  **20Hrs**

**Stress physiology:** Plant responses to biotic and abiotic stress resistance, plant defense mechanisms against water stress, salinity stress, metal toxicity, freezing, heat stress and oxidative stress.  **8Hrs**

**Photobiology:** Photoreceptors, Phytochrome: History, discovery, physiological properties, interaction between hormones and phytochromes, role of different phytochromes in plant development and flowering. Cryptochromes and Phototropins. Physiology of flowering: Photoperiodism and Vernalization. Biological clock, physiology of seed dormancy, senescence & Abscissions.  **10Hrs**

**Circadian rhythms in plants:** Nature of oscillator, rhythmic outputs, entertainments (inputs) and adaptive significance.  **2Hrs**

**Tools and Techniques:** Principles and application of Spectrophotometry, principle of chromatography: Partition chromatography, Thin layer chromatography, Column chromatography--ion exchange chromatography, gas liquid chromatography, high performance liquid chromatography, gel filtration, electrophoresis, ultra centrifugation (velocity and density gradient), ELISA and RIA.  **20Hrs**

**Suggested Readings**


Suggested Laboratory Exercises

1. Study of effect of PEG induced water stress on seed germination.
2. Effect of Red and Infrared light on seed germination and study of photo morphogenesis.
3. Hormonal regulation of leaves and petal senescence.
4. To study the rhythmic movements of plants.
5. Study of changes in starch and protein content during seed development.

BOT 404 E : ADVANCED MORPHOLOGY AND MORPHOGENESIS-II

Development and morphogenesis - Shoot apex the apical cell, meristem, the subcellular and biochemical structure of the meristem, the mechanism of primordium initiation, transition to flowering, growth and formation of organs. Experimental work on shoot apical meristem, meristem culture and virus free plants, histochemical studies on apical meristems. 14

The phenomenon of morphogenesis - Correlation, polarity, symmetry, differentiation, regeneration. 9

Morphogenetic factors - Physical, mechanical, chemical and genetic factors, molecular basis of morphogenesis in plants with special reference to work done in Arabidopsis. 8

Somatic embryogenesis - Survey of somatic embryogenesis in angiosperms, direct somatic embryogenesis and embryogenesis from callus and protoplasts, cytology, physiology and genesis of somatic embryogenesis, nutritional factors, hormonal factors and embryo rescue in wide hybridization, endosperm and ovary culture. Micropropagation advances and synthetic seeds. Cell plating technique and isolation of mutant cell lines, auxotrophic mutants. Mechanism involved in cell culture mutants. Suspension culture and growth studies. 16

Microtechniques. Collection, killing and fixation (FAA and glutaraldehyde) of plant material, dehydroxylation and embedding in paraffin and GMA, microtomy, (equipments and method) , conventional and histochemical staining procedures. Transmission and scanning electron microscopy for internal structure and morphological development of plant organs and tissues. 13

Suggested practical/Field exercises:

1. Study of organization of vegetative shoot apices
2. Study of organization of reproductive shoot apices.
3. Localization of different metabolites through histochemical techniques.
4. Study of polarity of egg and synergids in embryo sac through permanent slides.

5. *In vitro* tissue and organ culture using different media. Preparation of media.
6. Inoculation and somatic embryogenesis.
7. Micropropagation and endosperm culture.
8. Histological techniques:
   - Collection, killing and fixation
   - Dehydration
   - Infiltration
   - Embedding
   - Microtomy
   - Staining
9. Micromometing equipments:
   - Microtome
   - Spreading table
   - Oven
   - Ribbon box
   - Block holder
10. Demonstration of SEM and TEM
11. Micrometry

Suggested Readings:

Botany 404F: Biodynamics of Angiosperms-II

Herbarium Methods: Plant exploration, plant collection, pressing and drying, mounting, maintenance and importance of herbarium. Important national, international herbaria, concept of digital herbaria. (10 Hours)

Concept of Species: Speciation. Gradual and additive mechanism: species classification, concept of characters: analytic versus synthetic character, qualitative versus quantitative characters, good and bad characters. (10 Hours)

Concept of Population: Its significance, types of variation (developmental, environmental and genetic), variance analysis, isolating mechanism. (10 Hours)

Ecotypes: Origin and differentiation, taxonomic significance of ecotypes, vicarians. (6 Hours)

Experimental Taxonomy and Hybridization: Role of hybridization in evolution: amphidiploidy, breeding barriers, episitasis and pleiotropy. (10 Hours)

Biochemical Systematics: Methods and principles, systematic markers, PCR analysis, chemotaxonomy, seed proteins, technique of protein electrophoresis, chemical protein analysis procedures, genome analysis and nucleic acid hybridization. (14 Hours)

Suggested Readings:

Cockrell-Macmillan Ltd. London.
Ltd. London.
London.

Suggested Laboratory Exercises:
1. Flora writing
2. Synonymy
3. Taxometrics and cladistics
4. Molecular taxonomy