B.Sc. 1st year
BOTANY 2013

THEORY

<table>
<thead>
<tr>
<th>Course</th>
<th>Nomenclature</th>
<th>Number of Papers</th>
<th>Number of Periods per week</th>
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<tbody>
<tr>
<td>Paper I</td>
<td>Algae, Lichens and Bryophytes</td>
<td>1</td>
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<tr>
<td>Paper II</td>
<td>Mycology, Microbiology and Phytopathology</td>
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<td>2</td>
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<tr>
<td>Paper III</td>
<td>Palaeobotany, Pteridophytes and Gymnosperms</td>
<td>1</td>
<td>2</td>
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PRACTICAL COURSE 6 75 27

Duration of examination of each theory papers 3 hours
Duration of examination of practicals 5 hours

PAPER – I
ALGAE, LICHENS AND BRYOPHYTES

Unit 1: General characters, Classification and economic importance of Algae. Important features and life history of Chlorophyceae and Charophyceae. Structure and life cycle of Volvox, Oedogonium, Coleochaete and Chara.

Unit 2: Important features and life history of Xanthophyceae and Phaeophyceae. Structure and life cycle of Vaucheria, Ectocarpus and Sargassum.

Unit 3: Important Features and life history of Rhodophyceae. Lichens: Morphology and structure of the two components; biological, ecological and economic importance. Vegetative multiplication methods with special reference to Parmelia and Usnea.


Unit 5: Characters and classification of Anthocerotopsida and Bryopsida. Morphology and life history of Anthoceros and Sphagnum.

SUGGESTED LABORATORY EXERCISES
Algae: Microscopic preparation and study of following algal materials: *Volvoc*, *Oedogonium*, *Coleochaete*, *Vaucheria*, *Chara*, *Ectocarpus*, *Sargassum* and *Polysiphonia*

Lichens: Study of Lichens

Bryophytes: Study of external morphology and microscopic preparations of following Bryophytes: *Riccia*, *Marchantia*, *Plagiochasma*, *Anthoceros* and *Sphagnum*

SUGGESTED READINGS


PAPER – II

MYCOLOGY, MICROBIOLOGY AND PHYTOPATHOLOGY

Unit 1: General characters, Classification and economic importance of fungi. Important features and life history of Mastigomycotina–*Pythium* and *Albugo*; *Zygomycotina–Rhizopus*; *Ascomycotina–Saccharomyces*, *Aspergillus* and *Penicillium*.

Unit 2: Important features and life history of Basidiomycotina–*Puccinia*, *Agaricus* and wild Mushroom and *Ustilago*; Deuteromycotina–*Collectotrichum* and *Alternaria*.

Unit 3: Viruses: Chemical and physical nature; Structure, multiplication and transmission of plant viruses. Tobacco mosaic virus and yellow vein mosaic virus disease. General account of Viroids, AIDS and Prions.

Unit 4: Bacteria–Structure, nutrition, cell division, reproduction and economic importance. Biofilms and Quorum sensing in microbes. Cyanobacteria–Life history of *Nostoc* and *Oscillatoria*; Nitrogen fixation – by BGA (Blue green algae). General account and biology of Mycoplasma and Phytoplasma.
Unit 5: Causes and symptoms of plant diseases with special reference to green ear disease of Bajra, smut of wheat, citrus canker, little leaf of brinjal and root knot disease. A brief account of principles of plant protection.

SUGGESTED LABORATORY EXERCISES


Bacteria: Gram staining of bacteria. *Nostoc, Oscillatoria* and study of bacteriological specimens. Study of symptoms of following diseases: (specimen or photographs)

Green ear disease of bajra
Smut of wheat
Citrus canker
Rust of wheat
Little leaf of bringal
Root knot nematode.

SUGGESTED READINGS


PAPER – III
PALAEOBOTANY, PTERIDOPHYTES AND GYMNOSPERMS


Unit 2: Occurrence, Structure and life history of Lycopodium, Selaginella and Equisetum.


Unit 4: Characteristics of seed plants, evolution of the seed habit. General features of gymnosperms and their classification; evolution, diversity and economic importance of Gymnosperms. Cycas: Morphology of vegetative and reproductive parts, anatomy of root, stem and leaf; Reproduction and life cycle.

Unit 5: Pinus and Ephedra: Morphology of vegetative and reproductive parts, anatomy of root, stem and leaf, reproduction and life cycle.

SUGGESTED LABORATORY EXERCISES

Palaeobotany: Microscopic examination of slides of Rhynia.


Study of temporary single stained microscopic preparations of cone of Selaginella and T.S. of Sporophyll of Adiantum and sections of sporocarp of Marsilea.

Gymnosperms: Study of external morphology of plant parts of Cycas: young and old foliage leaf, scale leaf, bulbils, male cone, microsporophyll, megasporophyll and mature seed (if material is not available show photographs).

Microscopic temporary double stained preparations of rachis and leaflet of Cycas. Study of T.S. normal and Corolloid root by permanent slides.

Study of external morphology of plant parts of Pinus habit, long and dwarf shoot, male cone; female cone; winged seeds.

Microscopic temporary preparation of pollen grains (W.M.) of Pinus. Study through permanent slides T.S. stem: young and old; male/female cone of Pinus.
Study of habit and structure of whole male and female cone of *Ephedra*.

Microscopic preparation of male and female flowers of *Ephedra*.

**SUGGESTED READINGS**


# THEORY

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<tr>
<td>Paper II</td>
<td>Anatomy of Angiosperms, Economic Botany and Ethnobotany</td>
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<tr>
<td>Paper III</td>
<td>Cell Biology, Genetics, Plant Breeding and Evolution</td>
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<td>PRACTICAL COURSE</td>
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<td>6</td>
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Duration of examination of each theory papers: 3 hours
Duration of examination of practicals: 5 hours

## PAPER – I

**TAXONOMY AND EMBRYOLOGY OF ANGIOSPERMS**

**Unit 1:** Diversity in plant form in annuals, biennials and perennials, Canopy architecture in angiosperms: tree-origin, development, arrangement and diversity in size and shape, Flower-modified shoot, structure and development of flower, Inflorescence-types of Inflorescence.

**Unit 2:** Angiosperms: Origin and evolution. Some examples of primitive angiosperms. Angiosperm taxonomy; (Alpha-taxonomy, Omega-taxonomy, holotaxonomy) Taxonomic literature. Botanical nomenclature; principles and rules; taxonomic ranks, type concept, principle of priority. Classification of angiosperms; salient features of the systems proposed by Bentham and Hooker and Engler and Prantl.

**Unit 3:** Major contributions of cytology and molecular biology, phytochemistry and taximetrics to taxonomy. Diversity of flowering plants as illustrated by members of the families Ranunculaceae, Papaveraceae, Caryophyllaceae, Capparidaceae, Cucurbitaceae, Rutaceae and Apiaceae.
Unit 4: Diversity of flowering plants as illustrated by members of the families Asteraceae, Acanthaceae, Apocynaceae, Asclepiadaceae, Scrophulariaceae, Lamiaceae, Euphorbiaceae, Musaceae and Poaceae.

Unit 5: Embryology: Structure of anther and pistil. Development of the male and female gametophytes; pollen-pistil interactions, self incompatibility; Double fertilization; Development of endosperm and embryo; Brief account of experimental embryology. Basics of gene imprinting.

SUGGESTED LABORATORY EXERCISES
Field study of diversities found in leaf shapes, size, thickness and surface properties.

The following families are for detailed taxonomic studies:
1. Ranunculaceae: *Ranunculus, Delphinium*
2. Papareraeae: *Papaver, Argemone*
3. Caryophyllaceae: *Dianthus, Gypsophylla, Saponaria*
4. Capparidaceae: *Capparis, Cleome*
5. Rutaceae: *Murraya, Citrus*
6. Apiaceae: *Coriandrum, Foeniculum, Anethum*
7. Cucurbitaceae: *Luffa or any Cucurbit*
8. Asteraceae: *Helianthus, Calandula, Sonchus*
9. Acanthaceae: *Adhatoda, Barleria*
10. Apocynaceae: *Catharanthus, Thevetia, Nerium*
11. Asclepiadaceae: *Calotropis*
12. Scrophulariaceae: *Linaria, Antirrhinum*
13. Euphorbiaceae: *Euphorbia, Phyllanthus*
14. Lamiaceae: *Ocimum, Salvia*
15. Musaceae: *Musa*
16. Poaceae: *Avena, Triticum, Hordeum, Poa, Sorghum*

SUGGESTED READINGS
Bhandari, M.M. Flora of Indian Desert.


Maheshwari, J.K. Flora of Delhi, CSIR, New Delhi, 1963.


PAPER – II
ANATOMY OF ANGIOSPERMS, ECONOMIC BOTANY AND ETHNOBOTANY

Unit 1: Anatomy of Angiosperms: Concept of stem cell in plants. Root system; Root apical meristem; differentiation of primary and secondary tissues and their roles; structural modification for storage, respiration, reproduction and for interaction with microbes.

Unit 2: Shoot system: The shoot apical meristem and its histological organization; vascularization of primary shoot in monocotyledons and dicotyledons; cambium and its functions; formation of secondary xylem, a general account of wood structure in relation to conduction of water and minerals; characteristics of growth rings, sapwood and heart wood; secondary phloem-structure, function relationship; Periderm.

Unit 3: Abnormal secondary growth and Leaf: Abnormal secondary growth in stems due to abnormal origin and activity of cambium. Leaf: Internal structure in relation to photosynthesis and water loss; adaptations to water stress; senescence and abscission.

Unit 4: Economic Botany, Food plants: Rice, wheat, maize, potato, sugarcane. Fibers: Cotton and Jute. Vegetable oils: Groundnut, mustard and coconut,
General account of sources of firewood, timber and bamboos. Beverages: Tea and coffee; Rubber.


**SUGGESTED LABORATORY EXERCISES**


**ECONOMIC BOTANY:** Food plants: Study of morphology and structure. Simple microchemicals tests of the food storing tissues in rice, wheat, maize, potato and sugarcane. Microscopic examination of starch in these plants (except sugarcane)

Fibers: Study of cotton fiber, tests for cellulose. Vegetable oils: study of hand sections of Groundnut, Mustard and Coconut and staining of oils droplets by Sudan III and Sudan Black

Field visits: To study sources of firewood (10 plants), timber-yielding trees (10 trees) and bamboos. A list to be prepared mentioning special features

Medicinal Plants & Spices: Black pepper, cloves, cardamom describe them briefly. Study of 10 medicinal plants. Write their botanical and common names, parts used and diseases/disorders for which they are prescribed.

**Beverages & Rubber:** Coffee, Tea & Rubber

**ETHNOBOTANY:** Ethnobotanically important plants of Rajasthan (Abrus, Leptidenia and Calotropis)

**SUGGESTED READINGS**


Unit-4: Origin of Agriculture, Centers of origin of crop plants and centers of Diversity. Concepts of Centers and Non-center (Harlan Hypothesis) Principles of plant breeding- Domestication, Introduction, Selection, Clonal propagation, Hybridization, Mutation breeding; Breeding work done on wheat; Green revolution; Assessment and Consequences; Biodiversity and Conservation of germplasm.


SUGGESTED LABORATORY EXERCISES
CYTOLOGY
1. Study of cell structure from onion leaf peels
2. Comparative study of cell structure in onion cells and *Hydrilla*
3. Smear preparation of root tips for different stages in *Allium* root tip
4. Cytological examination special types of chromosomes (Slides)
5. Examination of electron micrographs of eukaryotic cells and cell organelles

GENETICS
1. Working out laws of inheritance using seed mixtures
2. Monohybrid, dihybrid and test crosses using seed samples

PLANT BREEDING
1. Demonstration of Emasculation techniques.

SUGGESTED READINGS


Gupta, P.K. A Textbook of cell and Molecular Biology, Rastogi Publications, Meerut, 1999


Miglani, G.S. Advanced Genetics, Narosa publishing Co., Inc., USA

Russel, P.J. Genetics. The Benjamin/ Cummings Publishing Co., Inc., USA

Shukla, R.S. and Chandel, P.S. Cytogenetics, Evolution and Plant Breeding, S.Chand & Co.Ltd., New Delhi


Sunstand, D.P. and Simmons, M.J. Principles of Genetics, John Wiley & Sons Inc., USA 2000
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<td>Plant Physiology and Biochemistry</td>
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<tr>
<td>Paper III</td>
<td>Plant Biotechnology and Molecular Biology</td>
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PRACTICAL COURSE: 6 75 27

Duration of examination of each theory papers 3 hours
Duration of examination of practicals 5 hours

PAPER – I
ECOLOGY AND ENVIRONMENTAL BIOLOGY

Unit 1: Plants and Environment: Atmosphere (gaseous composition), water (properties of water cycle), light (global radiation, phytosynthetically active radiation), temperature, soil (development, soil profiles, physico-chemical properties) and biota.

Morphological, anatomical and physiological responses of plants to water (hydrophytes and xerophytes) temperature (thermoperiodicity and vernalization), light (photoperiodism, heliophytes and sciophytes) and salinity

Unit 2: Population ecology: Concept and characters, growth curves, biotic potential, ecotypes and ecads. Seed: The significance, suspended animation; ecological adaptation and dispersal strategies

Community ecology and Succession: Community characteristics, frequency, density, cover, life forms and biological spectrum. Succession: concept, classification and examples (hydrosere & xerosere)
**Unit 3**: Ecosystems and Productivity: Ecosystem — Structure, abiotic & biotic components, food chain, food web, ecological pyramids, energy flow, biogeochemical cycles of carbon, nitrogen, phosphorus and Sulphur.

Productivity: Primary productivity, its measurements and factors affecting primary productivity


Phytogeography: Vegetation types of India — Forest and Grasslands. Biogeographical regions of India, Remote sensing: The basics and applications in ecological studies

**SUGGESTED LABORATORY EXERCISES**

1. To determine minimum number of quadrats required for reliable estimation of biomass in herbaceous vegetation
2. To study the frequency of herbaceous species and to compare the frequency distribution with Raunkaier’s Standard frequency diagram
3. To estimate Importance Value Index for herbaceous vegetation on the basis of relative frequency, relative density and relative biomass in protected and Gochar land
4. To measure the vegetation cover of grassland through point frame
5. To measure the above ground plant biomass in a natural field
6. To determine diversity indices (richness Simpson, Shannon-Weaver) in natural fields
7. To estimate bulk density and porosity of soil samples
8. To determine moisture contents, water holding capacity and texture of soil samples
9. To estimate qualitatively nitrate, phosphate and potassium in soil samples
10. To study the vegetation structure through profile diagram
11. To estimate transparency and pH of different water bodies
12. To measure dissolved oxygen content in polluted and unpolluted water samples
13. To estimate salinity, hardness, carbonates and bicarbonate in different water samples
14. To determine the percent leaf area injury of different leaf samples collected around polluted site
15. To estimate dust holding capacity of the leaves of different plant species
16. Plant adaptive modifications: Specimens/Slides:
   i) Succulents: *Opuntia, Euphorbia*
   ii) Salt secretion: *Atriplex, Chloris*
   iii) Salt accumulation: *Suaeda, Salsola, Zygophyllum*
   iv) Xerophytes: *Calligonum, Capparis, Leptadenia, Parkinsonia*
   v) Hydrophytes: *Eichhornia, Nymphaea, Hydrilla*

SUGGESTED READINGS
Sen, D.N. Environment and Plant Life in Indian Desert, Geobios International, Jodhpur, 1982
Sharma, P.D. Ecology and Environment, Rastogi Publications, Meerut 2002

PAPER – II
PLANT PHYSIOLOGY AND BIOCHEMISTRY

**Unit 1:** Plant-water relations: Importance of water to plant life; physical properties of water; diffusion and osmosis; absorption, transport of water and transpiration; physiology of stomata

Mineral nutrition: Essential macro- and micro-elements and their role, mineral uptake; deficiency and toxicity symptoms

Transport of organic substances: Mechanism of phloem transport; source-sink relationship; factors affecting translocation

**Unit 2:** Photosynthesis: Significance; historical aspects; photosynthetic pigments; action spectra and enhancement effects; concept of two
photosystems; Z-scheme; photophosphorylation; Calvin cycle; C4 pathway; CAM plants; photorespiration. Rubisco and its regulation.

**Unit 3:** Respiration: Aerobic and anaerobic respiration; Kreb’s cycle; electron transport mechanism (chemi – osmotic theory); redox potential; oxidative phosphorylation pentose phosphate pathway

Basics of enzymology: Discovery and nomenclature; characteristics of enzymes; concept of holoenzyme, apoenzyme, coenzyme and cofactors; regulation of enzyme activity; mechanism of action. Protein structures

**Unit 4:** Nitrogen and lipid metabolism: Biological Nitrogen fixation and metabolism. Importance of nitrate reductase and its regulation; ammonium assimilation. Structure and function of lipids; fatty acid biosynthesis; B-oxidation; saturated and unsaturated fatty acids; storage and mobilization of fatty acids

**Unit 5:** Growth and development: Definitions; phases of growth and development. Seed dormancy, seed germination. Photoperiodism, physiology of flowering; florigen concept. biological clocks vernalization. physiology of senescence, fruit ripening. Plant Hormones-auxins, gibberellins, cytokinins, abscisic acid and ethylene, history of their discovery. Physiological role and mode of action. Photomorphogenesis; phytochromes and cryptochromes.

**SUGGESTED LABORATORY EXERCISES**

1. To study the permeability of plasma membrane using different concentrations of organic solvents
2. To study the effect of temperature on permeability of plasma membrane
3. To prepare the standard curve of protein and determine the protein content in unknown samples
4. To study the enzyme activity of catalase and peroxidase as influenced by pH and temperature
5. Comparison of the rate of respiration of various plant parts
6. Separation of chloroplast pigments by solvent method
7. Determining the osmotic potential of *vacuolar sap* by plasmolytic method
8. Determining the water potential of *any tuber*
9. Separation of amino acids in a mixture by paper chromatography and their identification by comparison with standards
10. Bioassay of auxin, cytokinin, GA, ABA and ethylene using appropriate plant material
11. To study the regulation of stomatal movement using growth regulators, KCI and anti-transpirants
SUGGESTED READINGS


Lea, P.J. and Leegood, R.C. Plant Biochemistry and Molecular Biology, John Wiley & Sons, Chichester, England, 1999

Mohr, H. and Schopfer, P. Plant Physiology, Springer-Verlag, Berlin, Germany, 1995


Srivastava, H.S. Plant Physiology, Rastogi Publication, Meerut, 2001


SUGGESTED READINGS

(for Laboratory Exercises)

Amar Singh. Practical Plant Physiology, Kalyani Publishers, New Delhi, 1977


Nifa, A.J. and Ballou, D.P. Fundamental Laboratory Approaches for Biochemistry and Biotechnology, Fitzrierald Science Press, Inc., Maryland, USA, 1998


PAPER – III

PLANT BIOTECHONOLOGY AND MOLECULAR BIOLOGY

restriction enzymes, ligases, electrophoresis (Agarose and PAGE) and PCR. General introduction and applications of DNA finger printing, bioinformatics and NanoBiotechnology.

**Unit 2**: Bacterial and viral genome organization (with special reference to plasmids and phage). Genetic recombination in bacteria. Vectors for gene cloning: p-BR322, p-UC18, Cosmids, Phagemids, BAC, PAC, YAC and HAC; c-DNA libraries. Detection and screening of recombinant DNA.


**Unit 5**: Biotechnology and society: Development of transgenic crop plants against biotic and abiotic stresses. Genetically modified crops: Golden rice, Bt cotton and Bt brinjal (as a model system). Molecular marker assisted plant breeding. Plant Breeder’s Rights (PBR) and Intellectual Property Right (IPR) in current regime of WTO. Impact of GM crops on society and environment.

**SUGGESTED LABORATORY EXERCISES**

1. Demonstration of the technique of micropropagation by using different explants, e.g. auxiliary buds, shoot meristems
2. Demonstration of the techniques of anther culture
3. Isolation of protoplasts from different tissues using commercially available enzymes
4. Demonstration of root and shoot formation from the apical and basal portions of stem segments in liquid medium containing different hormones
5. Demonstrations/poster on GM Crops and related issues

**SUGGESTED READINGS**


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(for Laboratory Exercises)


Glick, B.R. and Thompson, J.E. Methods in Plant Molecular Biology and Biotechnology, CRC Press, Boca Raton, Florida, 1993