

Department of Botany
Maharshi Dayanand University, Rohtak
Credit Matrix for M.Sc. Programme w.e.f. 2015-16

Semester	Hard Core	Soft core	Open elective	Foundation	Practical/ Dissertation/ seminar	Total
I	20	--	--	--	10	30
II	16	4	2--	2--	10	34
III	16	4	--	--	10+2	32
IV	8	--	--	--	20	28
						124

INSTRUCTION FOR THE STUDENTS

- **Hard Core (C):** There are core course in every semester. These courses are to be compulsory studied by a student as a core requirement to complete the requirement of programme in a said discipline of study.
- **Soft Core Elective (E):** Soft core is a course which can be chosen from a pool of papers. It will be supportive to the discipline of study & mandatory as per course curriculum.
- **Foundation Course (F):** The foundation course is based upon the content that leads to knowledge enhancement. It is mandatory as per course curriculum.
- **Interdisciplinary Course/open elective (OE):** open elective course may be from an unrelated discipline. It is interdisciplinary/open Elective & mandatory as per course curriculum.

Choice Based Credit System (CBCS)
Scheme of Examination
M.Sc. Botany (1st Semester)

Code No.	Nomenclature of the Paper	Type of paper	No. of Credits	Hours	Max. Marks	Internal assessment	Total marks
BOT 101 C	Cell and Molecular Biology	Hard Core	4	4	80	20	100
BOT 102 C	Virology, Bacteriology and Mycology	Hard Core	4	4	80	20	100
BOT 103 C	Cryptogamic Botany	Hard Core	4	4	80	20	100
BOT 104 C	Plant Anatomy and Diversity of Gymnosperms	Hard Core	4	4	80	20	100
BOT 105 C	Tools and Techniques	Hard Core	4	4	80	20	100
BOT 106	Lab Course-I (BOT 101C-BOT 105C)	Practical	10	40	150	--	150
Total Marks: 650							

**Choice Based Credit System (CBCS)
Scheme of Examination
M.Sc. Botany (2nd Semester)**

Code No.	Nomenclature of the Paper	Type of paper	No. of Credits	Hours	Max. Marks	Internal assessment	Total marks
BOT 201 C	Taxonomy of Angiosperms	Hard Core	4	4	80	20	100
BOT 202 C	Plant Development	Hard Core	4	4	80	20	100
BOT 203 C	Plant Biochemistry and Metabolism	Hard Core	4	4	80	20	100
BOT 204 SC 1	Plant Tissue Culture	Soft Core	4	4	80	20	100
BOT 205 SC 2	Plant Breeding and Cytogenetics	Soft Core	4	4	80	20	100
BOT 206 OE	Plant Resource Utilization	Open elective	2	2	40	10	50
BOT 207 F	Biostatistics	Foundation	2	2	40	10	50
BOT 208	Lab Course-II (BOT 201-BOT 204)	Practical	10	32	150	--	150
Total Marks: 750							

**Choice Based Credit System (CBCS)
Scheme of Examination
M.Sc. Botany (3rd Semester)**

Code No.	Nomenclature of the Paper	Type of paper	No. of Credits	Hours	Max. Marks	Internal assessment	Total marks
BOT 301 C	Plant Physiology	Hard Core	4	4	80	20	100
BOT 302 C	Plant Ecology	Hard Core	4	4	80	20	100
BOT 303 C	Plant Biotechnology	Hard Core	4	4	80	20	100
BOT 304 C	Plant Reproduction	Hard Core	4	4	80	20	100
BOT 305 SC 1	Plant Pathology	Soft Core	4	4	80	20	100
BOT 306 SC 2	Computer Applications	Soft Core	4	4	80	20	100
BOT 307 SC3	Evolutionary and Economic Botany	Soft Core	4	4	80	20	100
BOT 308	Lab Course-III (BOT 301-BOT 305)	Practical	10	40	150	--	150
BOT 309	Seminar		2	4	50	-	50
Total Marks: 700							

*Only one paper out of three soft core papers will be offered

Choice Based Credit System (CBCS)
Scheme of Examination
M.Sc. Botany (4th Semester)

Code No.	Nomenclature of the Paper	Type of paper	No. of Credits	Hours	Max. Marks	Internal assessment	Total marks
BOT 401 C	Plant Genetics	Hard Core	4	4	80	20	100
BOT 402 C	Biodiversity Conservation	Hard Core	4	4	80	20	100
BOT 403 D	Dissertation		20	40	300	--	300
Total Marks: 500							
Grand Total of all the four Semesters: 2600							

M. Sc. Botany (Semester-I)
Paper Code: BOT 101C
Title of the paper: Plant cell and Molecular Biology

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT –I

Cell And Cell wall---Ultrastructure of prokaryotic & eukaryotic cells. Structure organisation & function of plant cell wall. **Membrane structure and function** -Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Cellular communication -Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

UNIT –II

Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility). Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle). Mechanism of programmed cell death.

UNIT –III

Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA). (Operon, unique and repetitive DNA. Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons.

RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

UNIT –IV

Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).

Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

Suggested Laboratory Exercises

1. Separation of membrane and demonstration of permeability.
2. Isolation and demonstration of mitochondria activity.
3. Isolation of chloroplast and demonstration of chloroplast activity.
4. Histochemical localization of nucleus and nucleolus.
5. Isolation and quantification of RNA.
6. Isolation and quantification of DNA.
7. Isolation and quantification of Proteins.
8. To study chromosomal banding pattern.
9. To determine the T_m of given sample of RNA and DNA.
10. Separation of proteins through electrophoresis.

REFERENCE BOOKS

1. Brown and Berke: **Text Book of Cytology**, Blackstains Sons & Co.
2. Brachet and Mirsky (ed.): **The Cell**, Academic Press, Vols. 16.
3. Darlington, C.D. : **Recent Advances in Cytology**, Blackstains Sons & Co.
4. Lewin, B. 2000. **Genes VII**, Oxford University Press, USA.
5. DeRobertis, E.D.P. and De Robertis, E.M.F. 2001. **Cell and Molecular Biology**, Lippincott Williams & Wilkins, Bombay.
6. Sharma, A.K. and Sharma, A. 1980. **Chromosome Techniques**. Theory and Practice, Butterworth.
7. Stebbins, J.L. **Chromosomal Evolution in Higher Plants**, Edward Arnold Publ., London.
8. Roy, S.C. and Kumar, K.D.C. 1977. **Cell Biology**, New Central Book Agency, Calcutta.
9. Wolfe, S.L. 1993. **Molecular and Cellular Biology**, Wordsworth Publ. Co., California, USA.

M. Sc. Botany (Semester-1)

Paper Code: BOT 102C

Title of Paper: Virology, Bacteriology and Mycology

Max. Marks: 80

Internal Assessment:

20

Time: 3 hrs.

Note:

1. Nine questions will be set in all.
2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Viruses: Characteristics and ultrastructure of virions; chemical nature, replication, transmission and economic importance of viruses. Phytoplasma: General characteristics and role in causing plant diseases.

UNIT-II

Archaeobacteria and eubacteria: General account; ultrastructure, nutrition and reproduction; economic importance.

Cyanobacteria: Salient features and biological importance.

UNIT-III

Mycology: General characters of fungi, their significance to human, Organization of thallus, cell wall composition, nutrition (saprobic, biotrophic, symbiotic), reproduction, kinds of spores.

Fungal classification: Ainsworth, 1973; Alexopoulos *et.al.*, 1996; general account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.

UNIT-IV

Heterokaryosis, heterothallism, parasexuality, sex hormones, mycorrhizae and predaceous fungi; Lichens: structure, reproduction and economic importance.

Importance of fungi in different microbiological and Biotechnological processes; role of fungi in industry (Alcohol), medicine (Antibiotics and steroids) and food (edible mushrooms).

Suggested Laboratory Exercises

1. Morphological study of some Cyanobacteria, Bacteria and Fungi.
2. Preparation of media for Fungus and Bacteria culture.
3. Preparation of different stains of bacteria.
4. To demonstrate Gram's staining of bacteria.
5. Identification of fungal cultures: *Rhizopus*, *Mucor*, *Aspergillus*, *Penicillium*, *Emericella*, *Chaetomium*, *Drechslera*, *Curvularia*, *Fusarium*, *Phoma*, *Colletotrichum*, *Graphium*.
6. Study of permanent slides of Bacteria and Fungi.

Suggested readings:

Calton, A. 1958. Introduction to Bacteria. McGraw-Hill Book Co., NY.

Tortora, G.J., Funke, B.R. and Case, C.L. 2001. Microbiology: An Introduction. Addison Wesley Longman, New York.

Brock Biology of Microorganisms: by Madigan, Mortinko and Parker (2000), Prentice Hall.

Microbiology: by Prescott, L.M., Harley, J.P. and Klein, D.A. (1992). WCB Publishers.

Introductory Mycology: by Alexopoulos, C.J. Mims, C.W. and Blackwell, M. (1996). John Wiley & Sons.

An Introduction to Fungi: by Webster, J. (1985). Cambridge Univ. Press.

Introduction to Plant Viruses: by Mandahav, C.L. (1978). Chand & Co., New Delhi.

Agrios, G.N. 1997. Plant Pathology. Academic Press, London.

Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology.

John Wiley & Sons, Inc.

Mehrotra, R.S. and Aneja, R.S. 1998. An introduction to Mycology. New Age Intermediate Press.

Webster, J. 1985. Introduction to Fungi. Cambridge University Press.

M. Sc. Botany (Semester-I)

Paper Code: BOT 103 C

Title of Paper: Cryptogamic Botany

Max. Marks: 80

Internal Assessment:

20

Time: 3 hrs.

Note:

1. Nine questions will be set in all.
2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Phycology: Algae in diversified habitats (terrestrial, freshwater, marine); thallus organization; cell ultra structure; reproduction (vegetative, asexual and sexual).
Classification of algae; criteria for classification; pigments, reserve food and flagella.

UNIT-II

Salient features of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta.

Algal blooms; algal biofertilizers; Economic importance of algae as food, feed, in medicine and industry.

UNIT-III

Bryophyta: Morphology, structure, reproduction and life history; distribution; economic and ecological importance.

Classification of bryophytes; general account of Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales

UNIT-IV

Pteridophyta: General characteristics, morphology, anatomy, reproduction and classification of Pteridophytes.

Evolution of stele and stelar system; heterospory and origin of seed habit; general account of fossil pteridophyta; introduction to Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

Suggested Laboratory Exercises

1. Morphological study of representative members of Algae, Bryophytes and Pteridophytes.

Algae: *Volvox*, *Hydrodictyon*, *Cladophora*, *Coleochaete*, *Oedogonium*, *Zygonema*, *Spirogyra*, *Chara*, *Vaucheria*, *Pinularia*, *Ectocarpus*, *Fucus*, *Sargassum*, *Polysiphonia*, *Batrachospermum*, *Oscillatoria*, *Nostoc*, *Scytonema*, *Euglena*, *Peridinium*.

Bryophytes: *Marchantia*, *Anthoceros*, *Funaria*, *Polytrichum*, *Pellia*, *Porella*, *Sphagnum*.

Pteridophytes: *Lycopodium*, *Selaginella*, *Psilotum*, *Equisetum*, *Adiantum*, *Marsilea*, *Azolla*, *Pteris*, *Ophioglossum*, *Dryopteris*, *Nephrolepis*.

2. To study permanent slides of Algae, Bryophytes and Pteridophytes.

3. Collection and submission of locally available Cryptogamic plant species.

Reference Books

- Bold, H.C. and Wynne, M.J. 1978. Introduction to the Algae. Prentice-Hall of India,
- Puri, P. 1980. **Bryophytes**. Atma Ram & Sons, New Delhi.
- Morris, I. 1986. **An Introduction to the Algae**. Cambridge University Press, U.K.
- Round, F.E. 1986. **The Biology of Algae**. Cambridge University Press, U.K.
- Kumar, H.D. 1988. **Introductory Phycology**. Affiliated EastWest Press Ltd., New Delhi.
- Sporne, K.R. 1991. **The Morphology of Pteridophytes**. B.I. Publ. Pvt. Ltd.
- Parihar, N.S. 1991. **Bryophytes**. Central Book Depot, Allahabad.
- Parihar, N.S. 1996. **The Biology and Morphology of Pteridophytes**. Central Book Depot, Allahabad.

M. Sc. Botany (Semester-I)

Paper Code: BOT 104C

Title of Paper: Plant Anatomy and Diversity of Gymnosperms

Max. Marks: 80

Internal Assessment:

20

Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Plant tissue system, tissue types and functions. Meristems, their classification, functions, organization of root and shoot apices. Structure of xylem and phloem. Anatomy of dicot and monocot stem, root, leaves and wood. Transition from root to stem. Primary and secondary growth, anomalous structure and abnormal secondary growth in stems. Application of anatomy in systematic, archaeology and climate change studies.

UNIT-II

Introduction to gymnosperms, general characters, life cycle, diversity and origin and classification of gymnosperms. Evolution of gymnosperms. Distribution of gymnosperms in India. Economic and ecological importance of gymnosperms.

UNIT-III

Paleobotany: fossils, types of rocks, types of fossils and fossilization. Techniques for study of fossils. Notable paleobotanists of India. General account of the few fossil gymnosperm families (Lyginopteridaceae, Medullosaceae, Glossopteridaceae and Caytoniaceae) and orders (Cycadeoidales, Pentoxylales and Cordaitales).

UNIT-IV

Comparative account of the morphology, anatomy and reproduction in the following orders: Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales.

Suggested Laboratory Exercises

1. Study of various meristems and plant tissues by permanent and temporary slides.
2. Identification of plant organs on the basis of anatomy
3. Study of anatomy of root, stem and leaves by double staining method
4. Comparative study of anatomy of vegetative and reproductive parts of *Cycas*, *Pinus*, *Ginkgo*, *Cedrus*, *Aracaria*, *Cryptomeria*, *Ephedra*, *Gnetum* and *Taxus*.
5. To study permanent slide of various Gymnosperms

Suggested readings:

1. Biswas, C. and Johri, B.M. 1999. The Gymnosperms. Narosa Publishing House, New Delhi.
2. Chamberlain, C.J. 1955. Gymnosperms. Structure and Evolution.
3. Chamberlain, C.J. 2000. Gymnosperms. C B S Publishers and Distributors, New Delhi.
4. Sporne, K.R. 1986. Morphology of Gymnosperms. Hutchinson University Press.
5. Vashishta, P.C. 1999. Gymnosperms, S. Chand & Company Ltd. New Delhi.
6. David F. Cutler *et. al.* 2007. Plant Anatomy: An Applied Approach, Wiley-Blackwell.
7. William C. Dickison 2000. Integrative Plant Anatomy, Academic Press.

M. Sc. Botany (Semester-I)
Paper Code: BOT 105 C
Title of Paper: Tools and Techniques

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 which will be objective covering the entire syllabus, will be compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, scanning and transmission electron microscopes.
Fixation and staining; cytophotometry and flow cytometry.

UNIT-II

Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC).
Electrophoresis and centrifugation: Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).

UNIT-III

Molecular biology techniques: southern, northern and western blotting techniques, polymerase chain reaction (PCR), ELISA.
Methods for measuring nucleic acid and protein interactions; DNA fingerprinting; Molecular markers (RFLP, AFLP, RAPD).

UNIT-IV

Spectroscopy: Fluorescence, UV, visible, NMR and ESR spectroscopy; X-ray diffraction.
Tracer Biology: Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography.

Suggested Laboratory Exercises

1. Demonstration of working of different types of microscopes.
2. Demonstration of Chromatography i.e. TLC, HPLC, GC.
3. To demonstrate the separation of proteins with the help of electrophoresis.
4. To study various molecular biology techniques i.e. PCR, ELISA.
5. To demonstrate the use of spectrophotometer.
6. Purification of protein by column chromatography.
7. Visit of various laboratories in the university, preparation and submission of report.
8. Principles of Calorimetry, Spectrophotometry and Fluorimetry.

M. Sc. Botany (Semester-II)
Paper Code: BOT 201C
Title of Paper: Taxonomy of Angiosperms

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Origin and evolution of angiosperms; general principles of angiosperm phylogeny, evolutionary trends in angiosperms, ecads and ecotypes; speciation; various species concepts, adaptive radiation, adaptive modifications; concept of taxonomic characters; character weighting; taxonomic hierarchy and different taxonomic categories

UNIT-II

Principles of taxonomy, characters considered before plant identification; identification keys, computer aided identification, floral formula and floral diagram. Salient features of the International Code of Botanical Nomenclature (ICBN); some important rules of nomenclature; brief idea about phylocode as a new system of nomenclature

UNIT-III

Systems of angiosperm classification: Phenetic versus phylogenetic systems; cladistics in taxonomy; Relative merits and demerits of major systems of classification. Taxonomic evidence: Morphology, anatomy, palynology, embryology, cytology; Modern trends in plant taxonomy: Numerical taxonomy, Chemotaxonomy, molecular taxonomy.

UNIT-IV

Herbarium and botanical garden: purpose of modern herbarium, techniques of herbarium preparation, description of flowering plants in different types of herbaria, major Indian herbaria and botanical gardens, importance of herbarium and botanical gardens in botanical research; Relevance of taxonomy to conservation, sustainable utilization of bio-resources and ecosystem research.

Suggested Laboratory Exercises

1. Description of a specimen from representative, locally available families such as Apiaceae, Asclepiadaceae, Asteraceae, Apocynaceae, Brassicaceae, Chenopodiaceae, Convolvulaceae, Cryophyllaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Liliaceae, Malvaceae, Myrtaceae, Poaceae, Ranunculaceae, Rosaceae, Rubiaceae, Solanaceae, Verbenaceae etc.
2. Location of key characters and use of keys at family level.
3. Description of various species of a genus, location of key characters and preparation of keys at generic level.

4. Preparation of herbarium of locally available wild plants.
5. Training in using floras and herbarium for identification of specimens described in class.
6. Field trips / excursion, compilation of field notes and preparation of herbarium specimens of wild plants.

Reference Books

- Davis, P.H. and Heywood, V.M. 1973. **Principles of Angiosperm Taxonomy**. Robert E. Kereiger Publ. New York.
- Grant, W.F. 1984. **Plant Biosystematics**. Academic Press, London.
- Heywood, V.H. and Moore, D.M. 1984. **Current Concepts in Plant Taxonomy**. Academic Press. London.
- Radford, A.E. 1986. **Fundamentals of Plant Systematics**, Harper & Row Publ. USA.
- Stace, C.A. 1989. **Plant Taxonomy and Biosystematics** (2nd ed.) Edward Arnold Ltd. London.
- Takhtajan, A.L. 1997. **Diversity and Classification of Flowering Plants**. Columbia Univ. Press, New York.
- Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. **Plant Systematics for 21st Century**. Portland Press Ltd. London
- Singh, G. 2005. **Plant Systematics: Theory and Practices** (2nd Ed.) Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi
- Sambamurty, A.V.S.S. 2005. **Taxonomy of Angiosperms**. I.K. International Pvt. Ltd., New Delhi.
- Naik, V.N. 2006. **Taxonomy of Angiosperms**. Tata McGraw Hill Education Pvt. Ltd. New Delhi.
- Sharma, O.P. 2009. **Plant Taxonomy**. Tata McGraw Hill Education Pvt. Ltd. New Delhi.
- Verma, B.K. 2011. **Introduction to Taxonomy of Angiosperms**. PHI Learning Pvt. Ltd. New Delhi

M. Sc. Botany (Semester-II)
Paper Code: BOT 202 C
Title of Paper: Plant Development

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

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

Shoot Development: Organization of shoot apical meristem (SAM); Cytological and molecular analysis of SAM; cell to cell communication, secretory ducts and laticifers.

UNIT-II

Root Development: Organization of root apical meristem (RAM); cell fate and lineages, lateral roots; root hairs; root-microbe interactions.

UNIT-III

Leaf growth and differentiation: Determination; phyllotaxy; differentiation of epidermis (with special reference to trichomes) and mesophyll.

Flower Development: Vegetative options and sexual reproduction, Genetics of floral organ differentiation; Homeotic mutants in *Arabidopsis* and *Antirrhinum*.

UNIT - IV

Seed development, Physiological and Biochemical aspects, seed germination and seedling growth: mobilization of food reserves; tropisms; hormonal control of seedling growth; use of mutants in understanding seedling development.

Suggested Laboratory Exercises:

- 1.) Effect of gravity, unilateral light and plant growth regulators on the growth of young seedlings.
- 2.) Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla*.
- 3.) Study of cytohistological zonation in the shoot apical meristem(SAM) in sectioned and double-stained permanent slides of a suitable plant such as *Coleus*, *Kalanchoe*, *Tobacco*. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
- 4.) Study of alternate and distichous; alternate and superposed; opposite and superposed; opposite and decussate leaf arrangement. Examination of rosette plants (*Launaea*, *Mullugo*, *Raphanus*, *Hyoscyanus*, etc.) and induction of bolting under natural conditions as well as by GA treatment.

- 5.) Microscopic examination of vertical sections of leaves such as *Cannabis*, *Nicotiana*, *Nerium*, *Zea mays* and *Triticum* to understand the internal structure of leaf tissues and trichomes, glands, etc. Also study the C3 and C4 leaf anatomy of plants.
- 6.) Study of epidermal peels of leaves such as *Coccinia*, *Gaillardia*, *Tradescantia*, *Notonea*, etc. To study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.
- 7.) Study of whole roots in monocots and dicots. 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, *Pistia*, *Jussiaea*, etc.). Origin of lateral roots. Study of leguminous roots with different types of nodules.
- 8.) Study of permanent tissues.

Suggested readings:

- Burgess, J. 1985. **An Introduction to Plant Cell Development**, Cambridge University Press, Oxford.
- Fosket, D.E. 1994. **Plant Growth and Development – A Molecular approach**, Academic Press, Oxford.
- Lyndon, R.F. 1990. **Plant Development – The Cellular basis**, Unwin Hyman, London.
- Raghavan, V. 1999. **Developmental Biology of Flowering Plants**, SpringerVerlag, New York.
- Steeve, T.A. and Sussex, I.M. **Patterns in Plant Development** (2nd Ed.), Cambridge University Press, Cambridge.
- Leyser, O. and Day, S. 2003. **Mechanism of Plant Development**. Blackwell Publishing Co.
- Murphy, T.M. and Thompson, W.F. 1988. **Molecular plant development**. Prentice Hall, New Jersey.
- Atwell, B.J., Kriederussan, P.E. and Jumbull, C.G.N. (Eds.), 1999. **Plant in action: Adaptation in nature, Performance in cultivation**, MacMillan Education, Sydney.
- Bewley, J.D. and Black, M. 1994. **Seeds: Physiology of Development and Germination**, Plenum Press, New York.
- Fahn, A. 1982. **Plant Anatomy** (3rd Ed.), Pergamon Press, Oxford.
- Fosket, D.E. 1994. **Plant Growth and Development – A Molecular approach**, Academic Press, Oxford.
- Lyndon, R.F. 1990. **Plant Development – The Cellular basis**, Unwin Hyman, London.
- Raghavan, V. 1999. **Developmental Biology of Flowering Plants**, SpringerVerlag, New York.
- Steeve, T.A. and Sussex, I.M. **Patterns in Plant Development** (2nd Ed.), Cambridge University Press, Cambridge.

M. Sc. Botany (Semester-II)
Paper Code: BOT 203 C
Title of Paper: Plant Biochemistry and Metabolism

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

Note:

1. Nine questions will be set in all.
2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

Unit-I

Principles of Biochemistry: Structure of atom, molecules, forces stabilizing macromolecules, weak bonds and covalent bonds, buffers and pKa values.

Fundamentals of enzymology: General aspects, nature of enzyme catalysis, enzyme kinetics, enzyme regulation and inhibition, isozymes, vitamins and cofactors.

Unit-II

Bioenergetics: Principles of thermodynamics, free energy, chemical and redox , potential, structure and function of ATP.

Photobiology and Photosynthesis: Nature of light, photoreceptors and photosynthetic pigments, light harvesting complexes, PSI and PSII, photooxidation of water, photophosphorylation and photoinhibition. RubisCo – structure & function, CO₂ assimilation in C₃ and C₄ plants, CAM pathway, biosynthesis of starch and sucrose, bacterial photosynthesis.

Unit-III

Carbohydrates: Structure and classification. Metabolism of carbohydrates: Glycolysis, Pentose Phosphate Pathway, gluconeogenesis, TCA, glyoxylate cycle (C₂), electron transport and oxidative phosphorylation, alternative oxidase. Photorespiration versus dark respiration.

Lipids: Composition, structure and classification. Biosynthesis and oxidation of structural and storage lipids.

Unit-IV

Proteins: Composition, classification and structure. Conformation of proteins: Ramachandran plot, secondary, tertiary and quaternary structure, domains, motifs and folds. Amino acid biosynthesis and catabolism. Introduction to Proteomics, protein – protein interactions and practical applications of proteomics.

Nitrogen fixation and N & S metabolism: Overview, biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation. Sulfate uptake, transport and assimilation.

Suggested References:

1. Campbell, M.K. 1999. Biochemistry. Saunders College Publishing, New York.

2. Conn, E.E. and Stumpf P.K. et al., 1999. Biochemistry. John Wiley and Sons. New Delhi.
3. David T. Dennis and David H. Trurpin (Eds.) 1993. Plant Physiology. Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.
4. Fisher J. et. al., 1999. Instant notes in Chemistry for Biologists. Viva Books Pvt. Ltd. New Delhi.
5. Goodwin and mercer 1996. Introduction to plant Biochemistry. CBS Publishers and Distributors, New Delhi.
6. Hames, B.D. et al., 1999. Instant notes in Biochemistry. Viva books Pvt. Ltd. New Delhi.
7. Harborne, J.B. 1999. Plant Biochemistry. Chapman & Hall, New Delhi.
8. Jain, J.L. 2000. Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
9. Plummer, D.T. 1996. An Introduction to practical Biochemistry. McGraw Hill
10. Satyanarayana, U. 1999. Biochemistry. Books and Allied (P) Ltd. Calcutta.
11. Wilson and Goulding. 1992. Biologists Guide to Principles and Techniques of Practical Biochemistry.

Suggested List of Practicals:

1. Preparation of buffers.
2. Preparation of standard solutions of BSA, Glucose, Catechol.
3. Extraction and estimation of soluble proteins by Bradford method.
4. Estimation of reducing sugars.
5. Separation of pigments by paper chromatography.
6. Isolation, assay and determination of specific activity of plant enzymes of germination, growth and fruit ripening, viz amylase, lipase, protease, peroxidase, polyphenol oxidase.
7. Ammonium sulphate precipitation – dialysis and kinetics of anyone of the above enzyme.
8. Isolation and quantification of plant lipids.
9. Isolation of chloroplast from fresh leaves and estimation of chlorophyll proteins.
10. Chlorophyll survey of five plants. Quantification, absorption spectra of chlorophyll and carotenoids using different solvents.
11. Hill activity by DCPIP/ ferricyanide reduction.
12. Extraction and estimation of total phenols.
13. Determination of antioxidants in plant tissues – ascorbic acid, tocopherol, β – carotene.

M. Sc. Botany (Semester-II)
Paper Code: BOT 204 SC1
Title of Paper: Plant Tissue Culture

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

Unit-I

Plant Tissue Culture: General introduction, History and Scope and basic concepts ,laboratory Organization; media preparation and sterilization techniques, Nutrition of plant tissues- Growth limiting Factor, Concept of cellular differentiation and totipotency, Types of culture, Embryo and Endosperm culture, Induction and maintenance of Callus and suspension Cultures

Unit-II

Fundamental aspect of Morphogenesis, Study of differentiation through Organogenesis and Embryogenesis, Somatic embryogenesis, Zygotic vs. Somatic embryogenesis, micropropagation advances and encapsulation of somatic embryo & shoot tip for artificial seeds and its applications, In vitro production of haploids, techniques and utility, Haploid for breeding and selection of mutants

Unit-III

Protoplast isolation, fusion, culture, hybrid selection and regeneration possibilities with special reference to crop plants, Limitations of protoplast research, Somatic hybridization and selection mechanism for hybrids and cybrids, cell line selection through callus/ suspension culture for the production of stress resistant plants, their application in crop improvement

Unit-IV

Somaclonal & gametoclonal variations, Large scale clonally propagation of plants, Cryopreservation and germplasm storage, embryo/endosperm culture, Applications of plant tissue culture in Forestry, Ornamental Plants, Disease free plants and in the production of secondary metabolites/natural products.

References

1. Bajaj, Y.P.S. 1986. Biotechnology in agriculture and forestry Vol.2 Crops.Springer Verlag
2. Dodds.J.H and L.W. Roberth.1985. Experiments in plant tissue culture. Cambridge University Press.
3. Vasil,I.K and T.A.Thorpe.1994. Plant Cell and Tissue Culture. Kluwer Academic Press.
4. Owen and Pen, 1996.? Transgenic plants-a production system for industrial and pharmaceutical proteins, Wiley

Plant Biotechnology-I

Suggested laboratory exercises

1. Preparation of germination medium
2. Inoculation of seeds on germination medium
3. Determination of fresh and dry weight of *in vitro* seedling
4. Preparation of culture medium (MS/B5 medium)
5. Culture of explants on MS medium
6. Establishment and maintenance of callus & suspension culture
7. Organogenesis and Somatic embryogenesis using appropriate explants
8. Multiple shoots induction & calli regeneration
9. Raising of haploids by tissue culture
10. Protoplast isolation from various tissues and testing their viability
11. Demonstration of fusion technique

M. Sc. Botany (Semester-II)

Paper Code: BOT 205 SC2

Title of Paper: Plant Breeding and Cytogenetics

Max. Marks: 80

Internal Assessment:

20

Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Plant Breeding: Principles of plant breeding; Important conventional methods of breeding self, cross pollinated and vegetatively propagated crops.

Non-conventional methods of plant breeding; evolution of major crops (wheat, maize, mustard).

UNIT-II

Origin, occurrence, production, meiosis and breeding behavior of haploids, aneuploids, euploids, autopolyploids and allopolyploids; induction and characterization of trisomics and monosomics.

Molecular Cytogenetics: C- value paradox; Cot curve and its significance; multigene families and their evolution.

UNIT-III

Alien gene transfer through chromosome manipulation: Transfer of whole genome, examples from wheat, *Arachis* and *Brassica*; transfer of individual chromosomes and chromosome segments.

Methods for detecting alien chromatin; Production, characterization and utility of alien addition and substitution lines.

UNIT-IV

Genetic basis of inbreeding and heterosis; exploitation of hybrid vigour. Immunotechniques; *In-situ* hybridization- concept and techniques; FISH, GISH; computer assisted chromosome analysis

Suggested Laboratory Exercises

1. Characteristics and behavior of B chromosome using maize or other appropriate material.
2. Induction of polyploidy using colchicines.
3. Different methods of applications of colchicines.
4. Mitotic and meiotic behavior of chromosomes in polyploidy plants

5. Effect of polyploidy on phenotype, pollen, seed fertility and fruit setting.
6. Isolation of chlorophyll mutants.
7. Orcein / Feulgen staining of the salivary gland chromosomes of *Chironomas* and / or *Drosophilla*.
8. Linear differentiation of chromosomes through G-banding / C- banding / Q- banding.
9. Study different stages of mitosis in root tips of *Allium* species.
10. Study meiotic behaviour of chromosomes in Anthers of *Allium* sp. or *Tradescantia*.
11. Isolation of DNA/ RNA from suitable plant material.
12. Quantitative estimation of DNA by diphenylamine method.

M. Sc. Botany (Semester-II)

Paper Code: BOT 206 OE

Title of Paper: Plant resource utilization

Max. Marks: 40

Internal Assessment:

10

Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Origin of Agriculture, World Centres of Primary diversity of domesticated plants: The Indo-Burma Centre, Plant Introductions and Secondary Centres. Origin, Distribution, Types, Botany, Cultivation, Harvesting and uses of Wheat and Rice.

History, Botany, Breeding, Cultivation and uses of following fruits and vegetables: Mango, Apple, Banana, Potato, Alliums, Cabbage, Spinach and Tomato

UNIT-II

General Account of the Spices: Ginger, Turmeric, Cinnamon, Clove, Umbelliferous spices and Peppers.

Beverage Plants: Source and general account of Tea and Coffee.

Legumes: Origin, Botany, Cultivation and uses of Pigeon pea, Chick pea, Cluster bean, French bean etc.

Medicinal Plants: Plants as sources of drugs, parts used, composition and uses.

UNIT-III

Gums: Important commercial gums and their uses.

Tannins and Dyes: Sources and their uses.

Vegetable Oils and Fats: Distinction between fatty and essential oils. Drying (Soyabean and linseed), nondrying (Groundnut and Mustard oil) and Semi drying (cottonseed and Sunflower oil) oils and their uses.

Fibres: Classification, uses, type of fibres - Soft fibres, Hard fibres, Surface fibres, Brush fibres and Braiding fibres.

UNIT-IV

Wood and its Uses: Soft woods and hard woods, wood as fuel, construction material
Unexploited plants of potential economic value; plants as a source of renewable
energy. Genetic Resources and their conservation.

SUGGESTED READINGS

1. Anonymous. *National Gene Bank: Indian Heritage on Plant Genetic resources* (Booklet). National Bureau of Plant Genetic Resource, New Delhi. 1997.
2. Cobby, L.S. and W.M. Steels. *An Introduction to the Botany of Tropical Crop Plants.3rd Ed.* The English Language Book Society and Longman, London. 1979.
3. Bole, P.V. and Y. Vaghani. *Field Guide to Common Indian Trees.* Oxford University Press, Mumbai. 1991.
4. Chandel, K.P.S., G. Shukla and N. Sharma. *Biodiversity in Medicinal and Aromatic Plants in India: Conservation and Utilization.* National Bureau of Plant Genetic Resources, New Delhi. 1996.
5. Conway, G. and V.W.Rattan. *The Doubly Green Revolution. Food for all in the 21st Century.* Cornell Univ. Press. 1999.
6. Dastur, J.F. *Medicinal Plants of India and Pakistan.*3rd Ed. Meyerbooks. 1985.
7. Hill, A.F. *Economic Botany.* McGraw Hill Book Co. Inc., New York. 1986.
8. Kirtikar, K.R. & D.D. Basu. *Indian Medicinal Plants.* Vols. I & II. 2nd Ed. Lalit Mohan Basu, Allahabad. 1953.
9. Kochhar, S.L. *Economic Botany of the Tropics.*2nd Ed. MacMillan India Ltd., Delhi.
10. Leonard, W.H. & J.H. Martin. *Cereal Crops.* MacMillan Co., New York, USA. 824 pp. 1963.

M. Sc. Botany (Semester-II)

Paper Code: BOT 207 F

Title of Paper: Biostatistics

Max. Marks: 40

Internal Assessment:

10

Time: 3 hrs.

Note:

1. Nine questions will be set in all.
2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Biostatistics: Graphical representation of data; Analysis of variation; Analysis of frequencies; Measures of central tendency; coefficient of variation.

UNIT-2

Correlation and regression; Hypothesis testing; Experimental design and sampling theories.

UNIT-3

Probabilities theory; t- test, F- test and χ^2 - test; Probability distributions and their properties.

UNIT-4

Non-parametric test: Sign test; Run & Median test; Wilcoxon Signed Rank Mann-whitney test; Kruskal Wallis test.

Suggested Laboratory Exercises-

1. Numerical problems on mean, median and mode.
2. Calculation of standard deviation and coefficient of variation
3. Applications of t and chi- square tests in real life examples.

Suggested Books-

Statics , Probabilty and Game Theory; papers in honor of David Blackwell by David Blackwell, at. al.-IMS,1996.

Introducation to Probability Theory and Statics for Linguistics by Marcus Kracht-UCLA-2005.

M. Sc. Botany (Semester-III)

Paper Code: BOT 301 C

Title of Paper: Plant Physiology

Max. Marks: 80

**Internal Assessment:
20**

Time: 3 hrs.

Note:

1. Nine questions will be set in all.
2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

Unit I

Water: Structure, properties and movement, osmosensors. Water absorption and conduction. Loss of water from plants, stomatal physiology. Beneficial nutrient elements, their functions and deficiency symptoms. Toxic effects of minerals. Antagonistic and synergistic relationship amongst ions. Nutrient uptake by roots. Root microbe interactions for nutrient uptake. Comparison of xylem and phloem transport, molecular mechanism of phloem loading and unloading, passive or active solute transport.

Unit II

Signal transduction: Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, Ca⁺² - calmodulin cascade. Regulation of signaling pathways.

Diversity in protein kinases and phosphatases, specific signaling mechanisms-two component system in plants. Physiology of flowering: History, discovery, properties and molecular structure of phytochromes and cryptochromes. Photoperiodism, photoinduction and endogenous rhythms.

Unit III

Promoters and inhibitors of plant growth. Structure, bioassay, transport, storage, physiological role and mechanism of action of auxins, gibberellins and cytokinins. Peptide hormones in plants. Structure and function of ABA, ethylene, ascorbic acid, brassinosteoroids, polyamines (putrescine, spermidine, spermine and cadavarin), jasmonic acid and salicylic acid.

Unit IV

Stress physiology: Type of stresses. Plant responses and mechanism of tolerance of biotic and abiotic stress. Water, temperature, salt, heavy metal and oxidative stress. Effect of air pollutants SO₂ and O₃ and elevated CO₂ on plants. Hypersensitive reaction and systemic acquired resistance. Role of phytoalexins and phenyl propanoid pathway in plants. Secondary plant metabolites: role of terpenes, phenols and nitrogenous compounds, allelopathy.

Suggested Laboratory Exercises:

1. Demonstration of stomatal activity from suitable plant material.
2. To study plant responses to red and far-red light.
3. Bioassay of auxin, cytokinin and gibberellins.
4. Effect of plant hormones on growth.
5. To study the effect of plant hormones on enzymatic activity.
6. To study the effect of salt and water stress on seed germination and plant growth in terms of metabolites.

Suggested Readings:

1. Brett, C.T. and Waldron, K.K. 1996. Physiology and Biochemistry of Plant Cell Walls, Chapman and Hall London.
2. Conn, E.E. and Stumpf P.K. et al., 1999. Biochemistry. John Wiley and Sons. New Delhi.
3. Daphne. J. Osborne, Micheal. B. Jackson. 1989. Cell separation in plants physiology, Biochemistry and Molecular Biology. Springer – Verlag. Berlin.
4. David T. Dennis and David H. Trurpin (Eds.) 1993. Plant Physiology, Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.
5. Devlin and Witham, 1997. Plant Physiology. CBS Publishers and Distributors, New Delhi.
6. Fitter, A.H. and Hay R.K.M. 1987. Environmental physiology of plants. Academic Press.
7. Hall, D.O. and Rao, K.K. 1999. Photosynthesis. Cambridge University Press.
8. Hatch, M.D. et. al., 1971. Photosynthesis and Photorespiration.
9. Hess, D. 1975. Plant physiology. Narosa Publishing House, New Delhi
10. Jain, J.L. 2000 Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
11. Lincoln Taiz and Eduardo Zeiger, 1991. Plant Physiology. The Benjamin/Cummings publishing Company, Inc.
12. Noggle and Fritz, 1999. Introductory Plant physiology. Prentice hall, London.

13. Salisbury, F.B. and Ross. C. 2000, Plant physiology. John Wiley & Sons, New Delhi.
14. Strafford, G.A. 1979 Essentials of Plant Physiology. Heinemann Publishing Co. New York.
15. Wilkins, M.B. (Ed) 1984. Advanced Plant Physiology, Pitman Publishing Co. New York.
16. William G. Hopkins, 1999. Introduction to Plant Physiology. John Wiley & Sons. Inc. New York.

M. Sc. Botany (Semester-III)
Paper Code: BOT 302 C
Title of Paper: Plant Ecology

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

Note:

1. Nine questions will be set in all.
2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT 1

Environment: Physical environment; biotic environment; biotic and abiotic interactions; climate and soil pattern of world.

Habitat ecology: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement and major habitat types of the subcontinent.

UNIT II

Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *k* selection); age structured populations.

Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis; Mechanisms of litter fall decomposition and climatic factors associated with decomposition.

UNIT III

Community ecology: Nature of communities; community structure and attributes; analysis of communities (analytical and synthetic characters); levels of species diversity and its measurement; edges and ecotones.

Ecological succession: Types; mechanisms; changes involved in succession; concept of climax; models of succession, Ecological adaptations.

UNIT IV

Ecosystem ecology: Structure and function; energy flow and biogeochemical cycles; primary production and methods of measurement, global pattern and controlling factors; ecosystem restoration,

Biomes: Distribution, climatic and edaphic, floral and faunal characteristics of major terrestrial biome.

Suggested Laboratory Exercises

1. To study the physical characteristics (temperature, colour and texture) of soil.
2. To determine water holding capacity of soils collected from different locations.
3. To determine pH and conductivity of soils collected from different locations.
4. Chemical testing of soil for phosphorus, potassium and nitrate.
5. To determine percentage organic carbon and organic matter in the soils of crop land, grassland and forest.
6. To determine the pH and conductivity of water samples collected from different locations.
7. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples.
8. To record the abiotic components i.e. pH, temperature, turbidity and light intensity of water in a pond ecosystem.
9. To determine the minimum size of the quadrat by species- area curve.
10. To study the community by quadrat method by determining frequency, density and abundance of different species present in the community.
11. Determination of species diversity index and importance value index of local vegetation.
12. To compare protected and unprotected grasslands using community coefficients (similarity index).
13. To study the species composition of an area for analyzing biological spectrum and comparison with Raunkiaer's normal biological spectrum.
14. To survey and study the ecological adaptations of locally available hydrophytes and xerophytes.
15. Field visit of any protected area and to discuss causes and impacts of biodiversity loss.

Reference Books

- Begon, M. Harper, J.L. and Townsend, C.R. 1996. **Ecology**. Blackwell Science, Cambridge, USA.
- Campman, J.L. and Reiss, M.J. 1998. **Ecology**. Principles and Applications, Cambridge University Press, U.K.
- Ludwig, J. and Reynolds, J.F. 1998. **Statistical Ecology**. John Wiley & Sons.
- Ambasht, R.S. and Ambasht, N.K. 1999. **A text book of Ecology**. CBS Publ. & Distr. New Delhi.
- Sharma, P.D. 2001. **Ecology and Environment**, Rastogi Publications, Meerut.
- Odum, E.P. and Barrett, G.W. 2005. **Fundamentals of Ecology** (5th Ed.) Brooks/Cengage Learning India Pvt. Ltd., New Delhi.
- Kormondy, E.J. 2008. **Concepts of Ecology**. Prentice Hall of India., New Delhi.
- Subrahmanyam, N.S. and Sambamurty, A.V.S.S. 2008. **Ecology** (2nd Ed.) Narosa Publishing House, New Delhi
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. **Ecology, Environment and Resource Conservation**, Anamaya Publishers, New Delhi.

- Stiling, P. 2009. **Ecology: Theory and Applications** (4th Ed.). PHI Learning Pvt. Ltd. New Delhi.
- Rana, S.V.S. 2009. **Essentials of Ecology and Environmental Sciences** (4th Ed.) PHI Learning Pvt. Ltd. New Delhi.

M. Sc. Botany (Semester-III)
Paper Code: BOT 303 C
Title of Paper: Plant Biotechnology

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

Note:

1. Nine questions will be set in all.
2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

Unit-I

Tools of Genetic engineering - Enzymes, Cloning vectors (Plasmids, Bacteriophages, Cosmids, Phagemids, Shuttle vectors, transposons vectors, artificial chromosomes as vector and eukaryotic vectors) Construction of genomic library, and cDNA library, Staggered cleavage, addition of oligopolymer tailing, blunt end ligation, Polymerase Chain Reaction (PCR) Principles, technique and modifications, Gene cloning Vs PCR, application, Applications of PCR.

Unit-II

DNA synthesis and gene sequencing, Aims, strategies for the development of transgenic - Transformation vectors, Promoters from heterologous sources and its utility, Terminators, Markers and Reporter genes, *Agrobacterium* mediated gene transfer, Molecular genetics of T-DNA transfer from *Agrobacterium* to plants, Direct gene transfer methods, Comparison of vector – mediated & vector free methods, Gene tagging in transgenic plants, Uses of transgenes for herbicide Salinity and drought tolerance

Unit-III

Chloroplast and Mitochondrial Transformation, Mechanism and Genetics of nitrogen fixation, *nif* & *nod* gene cluster, Fermentation Technology, Genetic improvement of industrial microbes & N₂ fixer, Biofertilizer, Nutritional quality improvement - Golden rice and other development

Unit-IV

Molecular markers for introgression of useful traits in plants, Genomics and Proteomics: Genome project, Microarray, protein profiling and its significance, Applications of G.E. to Health, Industry & Agriculture, including gene therapy, IPR and regulatory requirements

References

1. Foster and Twell. (1997). Plant gene isolation: Principles and Practice
2. Owen and Pen (1997). Transgenic plants : (a production system for industrial and pharmaceutical proteins)
3. Kung and Wu (1993). Transgenic Plants: Vols 1&2
4. Potrykus and Spangenberg 1995. Gene Transfer to Plants
5. Brown.T.A. 1995. Gene Cloning an Introduction. (3rd edition). Chapman Hall, 2-6 Bunday Row, U.K.
6. Rissler and Mellon 1996. Ecological risks of transgenic crops
7. Old and Primrose (1984). Principles of gene manipulation. Blackwell

Plant Biotechnology-II

Suggested laboratory exercises

1. Growth characteristics of bacteria using planting & turbidimetric methods
2. Isolation of plasmids from bacteria by alkaline lysis and its quantification spectrophotometrically
3. Co-cultivation of plant material with *Agrobacterium* and study GUS activity histochemically
4. Isolation of DNA from suitable plant material
5. Spectrophotometer demonstration of DNA/RNA
6. Study of PCR

M. Sc. Botany (Semester-III)
Paper Code: BOT 304 C
Title of Paper: Plant Reproduction

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Male gametophyte: Structure of anther; microsporogenesis; role of tapetum; pollen development and gene expression; male sterility, sperm dimorphism; pollen germination; pollen tube growth and guidance, pollen storage; pollen allergy.

UNIT-II

Female gametophyte: Ovule development; megasporogenesis; organization of embryo sac; structure and functions of embryo sac cells.

Pollination: Floral characteristics, mechanisms and vectors.

Pollen-pistil interaction and fertilization: structure of the pistil; pollen stigma interactions, Self incompatibility- SSI and GSI (cytological, biochemical and molecular aspects); Double fertilization; *in-vitro* fertilization.

UNIT-III

Seed Development: Endosperm development during early maturation and desiccation stages; embryogenesis- ultrastructure and nuclear cytology. Storage proteins of endosperms and embryo; Polyembryony; Apomixis; Embryo culture.

UNIT-IV

Fruit Growth: Dynamics of fruit growth; Biochemistry and molecular biology of fruit maturation.

Dormancy: Importance and types of dormancy; seed dormancy; methods of overcoming seed dormancy.

Suggested Laboratory Exercises

1. Study of microsporogenesis and gametogenesis in sections of anthers.
2. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa*, *Tradescantia*, *Crotolaria*, *Brassica*, *Petunia*, *Solanum melongena*, etc.).
3. Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface cultures.
4. Estimating percentage and average pollen tube length *in vitro*.
5. Role of transcription and translation inhibitors on pollen germination and pollen tube growth.
6. Pollen storage, pollen –pistil interaction, self incompatibility, *in vitro* pollination.
7. Study of ovules in cleared preparations; study of monosporic, bisporic and tetrasporic type of embryosac development through examination of permanent, stained serial sections.
8. Field study of several types of flowers with different pollination mechanisms (wind pollination, thrips pollination, bee/butterfly pollination, bird pollination).
9. Emasculation, bagging and hand pollination to study pollen germination, seed set and fruit development using self compatible and obligate out crossing systems. study of cleistogamous flowers and their adaptations.
10. Study of nuclear and cellular endosperm through permanent slides.
11. Isolation of zygotic globular, heart shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun, etc. by dissections.
12. Study of seed dormancy and methods to break dormancy.

Suggested readings

1. Bhojwani, S.S. and Bhatnagar, S.P. 2000 **The embryology of Angiosperms. (4th revised and enlarged edition), Vikas publishing house, New Delhi.**
2. Maheswari, P. **An Introduction to Embryology of Angiosperms**, 1950.
3. Shivanna, K.R. and Johri, B.M. **The Angiosperm Pollen: structure and Function**, Wiley Eastern Ltd., Publications, 1989.
4. Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. **Comparative Embryology of Angiosperms**, Vol. I & II, SpringerVerlag publication.
5. Bhojwani, S.S. and Bhatnagar, S.P. 1999. **The Embryology of Angiosperms**. Vikas publishing House, New Delhi.

6. Raghwan, V. 1997. Developmental biology of flowering plants. Springer-Verlag, New York.
7. Salisbury, F.B. and Ross, C.W. 1992. Plant physiology (4th edn.). Wadsworth publishing, Belmont, California.
8. Shivanna, K.R. and Sawhney, V.K. 1997. Pollen biotechnology for crop production and improvement. Cambridge University press, Cambridge.

M.Sc Botany Semester (111)
Paper Code: BOT SC1
Title of Paper: Plant Pathology

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Fundamentals of plant pathology: History of plant pathology; Various levels of parasitism; Classification of plant diseases.

Pathogenesis: Penetration and entry of plant pathogens; development inside host tissue.

UNIT-II

Agents of plant diseases: General characteristics and symptoms caused by- agents of infectious diseases (fungi, bacteria, mycoplasma, virus and nematodes) and Agents of non-infectious diseases (air pollution, chemicals, minerals excesses, temperature).

Enzymes and toxins in plant diseases.

UNIT-III

Plant Diseases: Casual organisms, symptoms and management of –

- a. Downy mildew of grapes
- b. Karnal bunt of wheat
- c. Smut of Bajra
- d. Late and early blight of potato

Plant Diseases: Casual organisms, symptoms and management of –

- e. Yellow vein mosaic of Bhindi
- f. Tikka diseases of groundnut
- g. Bacterial blight of paddy
- h. Black rust of wheat
- i. Sandal spike.

UNIT-IV

Defense Mechanism in plants: Structural, Induced and Biochemical defense mechanisms; Hypersensitivity reaction.

Detoxification of pathogen toxin; Application of molecular biology in diseases control strategies. Plant quarantine.

Suggested Laboratory Exercises

- A). to study the symptoms and diagnostic features of causal organisms of the following plant diseases.

1. Downy mildew of grapes
 2. Karnal bunt of wheat
 3. Smut of bajra
 4. Late and early blight of potato
 5. Yellow vein mosaic of Bhindi
 6. Tikka disease of groundnut
 7. Bacterial blight of paddy
 8. Black rust of wheat
 9. Sandal spike
- B). Collection and submission of plant diseases samples.

M. Sc. Botany (Semester-III)
Paper Code: BOT 306 SC 2
Title of Paper: Computer Applications

Max. Marks: 40
Internal Assessment:
10
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Computers: Components and functions; generations of computer; input and output devices; types of memory; file manager; internet and its applications.

UNIT-II

Operating system and its evolution; system and application software; internal and external commands of DOS, UNIX, WIN 98/2000/XP; Office applications including MS-Word, MS-Excel, MS-Powerpoint.

UNIT-III

Bioinformatics: Introduction and uses of bioinformatics tools –

- a. BLAST
- b. FASTA
- c. Multiple sequence alignment- CLUSTAL-W
- d. MEDLINE & PubMed

UNIT-IV

Retrieving and installing a programme (Tree Tool); Searching Science Citation Index & current content; Accessing full text Journal.

Suggested Laboratory Exercises

Working knowledge of Microsoft Windows.
Demonstration of on-line data-base search.
Similarity searching using BLAST/FASTA.
Demonstration to access full text journals.

Suggested Book-

Introduction to Embedded Systems ;2011 by E.A.Lee and S.A.Seshia.

M. Sc. Botany (Semester-III)

Paper Code: BOT 307 SC 3
Title of Paper: Evolutionary and Economic Botany

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Evolutionary Biology: Origin of life (including aspects of prebiotic environment and molecular evolution); Concept of evolution; Theories of organic evolution; Mechanisms of speciation.

Hardyweineberg genetic equilibrium, genetic polymorphism and selection; origin and evolution of economically important microbes and plants.

UNIT-II

Origin of agriculture: World centers of primary diversity of domesticated plants; Plant introduction; Secondary centers of origin.

Plant as a source of renewable energy; Innovations for meeting world food demands.

UNIT-III

Botany, cultivation and uses of –

- a. Food, forage and fodder crops (cereals, pulses, vegetables and fruits)
- b. Fiber yielding plants

Botany, cultivation and uses of-

- c. Medicinal plants
- d. Aromatic plants
- e. Oil yielding plants

UNIT-IV

Important fire-wood, timber-yielding plants and Non-wood forest products (NWFPs) such as- Bamboos, rattans, raw materials for paper-making, gums, tannins, dyes and resins.

Plants used as avenue trees for shade, pollution control and aesthetics.

Suggested Laboratory Exercises

The practical course is divided into three units:

- i) Laboratory Work
- ii) Field Survey
- iii) Scientific visits
- i) Laboratory Work

Food Crops: Wheat, Rice, Maize, Potato, Chickpea(Bengal gram), Sugarcane.
Morphology, anatomy, microchemical tests for stored food materials.

Fodder Crops:Sorghum, Bajra, Berseem, Guar, Oat.

Plant Fibres: Cotton, Jute, Sun hemp, Coir.

Medicinal and Aromatic Plants: Study of live or herbarium specimens or other visual materials to become familiar with following plants:

Papaver somniferum, Atropa belladonna, Catharanthus roseus, Adhatoda zeylanica, Allium sativum, Rauwolfia serpentina, Withania somnifera, Phyllanthus niruri, Andrographis paniculata, Aloe barbadensis, Mentha arvensis, Ricinus communis, Abutilon indicum, Datura sp., Artemisia sp., Pedalium murex, Ocimum sanctum, Vetiveria zizanioides, Cymbopogon maritimi.

Gums, Resins, Tannins, Dyes: *Acacia, Terminalia, Tea, Turmeric, Bixa orellana, Indigo, Butea monosperma, Lawsonia inermis.*

ii) Field Survey

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

iii) Scientific visits

Students should be taken to any protected area, a recognized botanical garden or museum (such as FRI, BSI, NBRI), to a CSIR laboratory doing research on plants and their utilization and an ICAR research institute or a field station dealing with crops.

Suggested readings:

Swaminathan, M.N. & Jain, R.S. **Biodiversity: Implications for global security**, Macmillan, 1982.

CSIR 1986. **The Useful Plants in India.**

Kothari, 1987. **Understanding biodiversity, life sustainability and equity**, Orient Longman.

Sharma, O.P. 1996. **Hills Economic Botany.**

Thakur, R.S. *et al.*, **Major Medicinal Plants.**

Kocchar, S.L. 1998. **Economic Botany of Tropics.**

Richard B. Primack. 1993. **Essentials of Conservation Biology.**

Heywood, V.H. & Watson, R.T. 1995. **Global Biodiversity Assessment.**

Peter B. Kaufman *et al.*, 1999. **Natural Products from Plants.**

Negi, S.S. 1993. **Biodiversity and its Conservation in India.**

M. Sc. Botany (Semester-IV)
Paper Code: BOT 401 C
Title of Paper: Plant Genetics

Max. Marks: 80
Internal Assessment:
20
Time: 3 hrs.

- Note:**
1. Nine questions will be set in all.
 2. Question No.1 which will be objective covering the entire syllabus, will be compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Cytology: Chromosome structure and packaging of DNA; molecular organization of centromere and telomere; euchromatin and heterochromatin.

Karyotype analysis; banding patterns; karyotype evolution; specialized types of chromosomes: polytene, lampbrush, B-chromosomes and sex chromosomes.

UNIT-II

Structural and numerical alterations in chromosomes: Mutations, mutagens and their molecular mechanisms of occurrence; Site directed mutagenesis; DNA repair mechanisms; Transposable elements; DNA methylation.

Origin, meiosis and breeding behavior of deficiency, duplication, inversion and translocations in chromosomes; Robertsonian and B-A translocations.

UNIT-III

Mapping of bacteriophage genome; genetic recombination in phage; genetic transformation, conjugation and transduction in bacteria.

Genetic fine structure; cis-trans test; Heterochromatization; Dosage compensation and mechanism of sex determination.

UNIT-IV

Genetic recombination and mapping: Recombination; independent assortment and crossing over; molecular mechanisms of recombination; role of RecA and RecBCD enzymes; site-specific recombination.

Chromosome mapping; linkage groups; physical mapping; construction of molecular maps; correlation of genetic and physical maps; somatic cell genetics- an alternative approach to gene mapping.

Suggested readings:

1. Russel P.J., 1998. Genetics (5th ed.). The Benjamin/Cummings Publishing Co., Inc. USA.
2. Snustad, D.P. and Simmons, M.J., 2000. Principles of Genetics (2nd ed.) John Wiley and Sons, Inc. USA.
3. Strickberger, M.W., 2008. Genetics, Phi Learning.
4. Atherly, A.G., Girton, J.R. and McDonald, J.F., 1999. The Science of Genetics. Saunders College Publishing, Frot Worth, U.S.A.
5. Hartk, D.L. and Jones, E.W., 1998. Genetics: Principles and Analysis (4th ed.). Jones and Bartlett Publishers, Massachusetts, U.S.A.
6. Lodish, H., Berk, A., Zipursky, S.L., Matudaria, P., Baltimoe, D. and Darnell, J. 2000. Molecular, Cell Biology, W.H. Freeman and Co., New York, USA.
7. Miesfeld, R. 1999. Applied molecular genetics. John Wiley and Sons, Inc. USA.
8. Ringo, J., 2004. Fundamental Genetics. Cambridge University Press.
9. Brooker, R., 2008. Genetics: Analysis and Principles. McGraw-Hill Science.
10. Hartwell, L., 2010. Genetics: From Genes to Genomes. McGraw-Hill Science.
11. Elrod, S., 2010. Schaum's outline of Genetics (5th ed.). McGraw-Hill Science.
12. Lewin, B., Elliot, S. G., Krebs J. E. and Kilpatrick, S.T., 2009. Lewins Gene X. Jones and Bartlett Publishers.

M. Sc. Botany (Semester-IV)

Paper Code: BOT 402 C

Title of Paper: Biodiversity Conservation

Max. Marks: 80

Internal Assessment:

20

Time: 3 hrs.

Note:

1. Nine questions will be set in all.
2. Question No.1 will be compulsory. It will be objective type covering the entire syllabus. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt Question 1 and four more selecting one from each section.

UNIT-I

Biodiversity: concept; national & global status; endemism, speciation and extinction; levels of biodiversity, hotspots and hottest hotspots; study of Indian biodiversity hot spot, significance of biodiversity; local plant diversity and its socio-economic importance, causes of biodiversity depletion, ICUN categories of threat; Red Data Books.

UNIT-II

Principles of conservation, major approaches to management, Biodiversity Conservation strategies, Protected areas in India - Wildlife sanctuaries; National parks; Biosphere reserves; Wetlands and Ramsar convention, Role of botanical gardens, seed banks, *in-vitro* repositories and cryobanks in biodiversity conservation.

UNIT-III

Plant explorations; invasions and introductions; National Bureau of Plant Genetic Resources (NBPGR), Convention of Biological Diversity (CBD), Indian initiatives in biodiversity conservation, National Biodiversity Authority (NBA), Importance of Ethnobotany in Indian context; Farmers' Rights and Intellectual Property Rights.

UNIT-IV

Phytogeography and forest types of India - Ecological and economic importance of forests, afforestation, deforestation and social forestry; endangered plants, endemism, invasive species; desertification and wasteland reclamation, energy plantations; Effects of global warming, climatic change and stratospheric ozone depletion on plant diversity.

Reference Books

- Odum, E.P. and Barrett, G.W. 2005. **Fundamentals of Ecology** (5th Ed.) Brooks/Cengage Learning India Pvt. Ltd., New Delhi.
- Kormondy, E.J. 2008. **Concepts of Ecology**. Prentice Hall of India., New Delhi.
- Subrahmanyam, N.S. and Sambamurty, A.V.S.S. 2008. **Ecology** (2nd Ed.) Narosa Publishing House, New Delhi
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2008. **Ecology, Environment and Resource Conservation**, Anamaya Publishers, New Delhi.
- Stiling, P. 2009. **Ecology: Theory and Applications** (4th Ed.). PHI Learning Pvt. Ltd. New Delhi.
- Rana, S.V.S. 2009. **Essentials of Ecology and Environmental Sciences** (4th Ed.) PHI Learning Pvt. Ltd. New Delhi.