

B.A./B.Sc. (Semester System) (12+3 System of Education) (*Semester System*)
(*FACULTY OF LIFE SCIENCES*)

KHALSA COLLEGE AMRITSAR
(AN AUTONOMOUS COLLEGE)

P.G. DEPARTMENT OF BOTANY

SYLLABUS

FOR

B.Sc. MEDICAL SEM I – SEM VI

Bachelors' SEM -III & IV (All streams) – EVS

BA Social Science SEM-III - EVS

Bachelor of Physiotherapy (2nd Year) – EVS

SESSION- 2016-2017

SEMESTER-I
BOTANY

Theory Paper IA	:	30 Marks
Theory Paper IB	:	30 Marks
Practical I (IA & IB)	:	20 Marks
Internal Assesement	:	20 Marks
Total	:	100 Marks

PAPER-I A: DIVERSITY OF MICROBES

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Algae: General characters, classification and economic importance, important features and life history of Chlorophyceae–*Volvox*, *Oedogonium*, *Coleochaete*, Xanthophyceae–*Vaucheria*; Phaeophyceae–*Ectocarpus*, *Sargassum*; Rhodophyceae–*Polysiphonia*.

Viruses, Bacteria and Fungi: General account of viruses and mycoplasma; bacteria–structure, nutrition, reproduction and economic importance; general account cyanobacteria. General characters, classification and economic importance of Fungi. Important features and life history of Mastigomycotina–*Pythium*, *Phytophthora*; Zygomycotina–*Mucor*, Ascomycotina–*Saccharomyces*, *Eurotium*, *Chaetomium*. *Peziza*; Basidiomycotina–*Puccinia*, *Agaricus*; Deuteromycotina–*Cercospora*. *Colletotrichum*; general account of Lichens.

Suggested Readings:

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. *Introductory Mycology* (4th Edition), Wiley - Blackwell, USA.
2. Dube, H.C., 2007, *A Textbook of Fungi, Bacteria and Viruses* (3rd edition), Scientific Publishers, India
3. Dube, H.C., 2012, *An Introduction to Fungi* (4th edition), Scientific Publishers., India.
4. James W. Brown. (2014). *Principles of Microbial Diversity*. ASM press, USA.
5. Ogunseitan, O. (2004). *Microbial Diversity: Form and function in Prokaryotes*. Wiley Publishers, USA.
6. Sharma, O.P., 2004, *Text Book of Thallophytes*. McGraw Hill Publishing Co., India.
7. Sharma, P.D., 2004, *The Fungi*, (2nd Edition) Rastogi Publication, India

PAPER–I B: DIVERSITY OF CRYPTOGAMS

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Bryophyta: Amphibians of plants kingdom displaying alternation of generations; structure, reproduction and classification of Hepaticopsida (e.g. *Marchantia*); Anthocerotopsida (e.g. *Anthoceros*), Bryopsida (e.g. *Funaria*).

Pteridophyta: The first vascular plant; important characteristics of Psilopsida, Lycopsida, Sphenopsida and Pteropsida; structure, reproduction in *Rhynia*, *Lycopodium* *Selaginella*. *Equisetum*, *Pteris* and *Marsilea*.

Suggested Readings:

1. Goffinet B. (2008). Bryophyte Biology. Cambridge University Press, UK.
2. Sambamurty, S.S. (2005). A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany. I K International Publishing House Pvt Ltd., India
3. Sharma, O.P. (2014). Bryophyta. Mc Graw Hill Education Pvt Ltd., India.

PRACTICALS–I (BASED ON PAPERS–I A AND I B)

Time: 3 Hrs.

Practical Hours: 4½ Hours/week

Marks: 20

Suggested Laboratory Exercises

Teachers may select plants/material available in their locality/institution.

1. Gram staining of bacteria.
2. Observation of disease symptoms in hosts infected by fungi, viruses and mycoplasma Section cutting of diseased material and identification of the pathogens as per the theory syllabus.
3. Study of the genera included under algae and fungi.
4. Study of morphology, reproductive structures and anatomy of the examples cited in theory under Bryophyta and Pteridophyta.

**SEMESTER-II
BOTANY**

Theory Paper IA	:	30 Marks
Theory Paper IB	:	30 Marks
Practical I (IA & IB)	:	20 Marks
Internal Assessment	:	20 Marks
Total	:	100 Marks

PAPER-II A: CELL BIOLOGY

Time: 3 Hrs.

Marks: 30

Theory Lectures: 3 Hours/Week

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Structure and Function of Nucleus; Ultrastructure; nuclear membrane; nucleolus.

Extranuclear Genome: Presence and function of mitochondrial and plastid DNA; plasmids.

Structure and Function of other Organelles: Golgi, ER, peroxisomes, Vacuoles.

Chromosome Organization: Morphology; centromere and telomere; chromosome alterations; deletions, duplications, translocations, inversions; variations in chromosome number, aneuploidy, polyploidy; sex chromosomes.

The Cell Envelopes: Plasma membrane; bilayer lipid structure; functions; the cell wall.

Suggested Readings:

1. Gupta, P.K. (2013). A Text–book of Cell and Molecular Biology (3rd edition). Rastogi Publications, Meerut, India
2. Johnson, A., Raff, L. and Walter, R. (2008). Molecular Biology of the Cell (5th Edition). Taylor and Francis Group, USA.
3. Karp, G. (2013). Cell and Molecular Biology: Concepts and Experiments (7th Edition). Wiley Publishers, USA.
4. Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology (2nd edition). Harper Collins College Publishers, New York, USA.
5. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P. Baltimore. D. and Darnell, J. (2008). Molecular Cell Biology, W.H. Freeman & Co., New York, USA.
6. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics (5th Edition). John Wiley and Sons Inc., U.S.A.

PAPER–II B: GENETICS

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

DNA the Genetic Material: DNA structure; replication; DNA–protein interaction; the nucleosome model; genetic code; satellite and repetitive DNA.

Cell Division: Mitosis; meiosis.

Genetic Inheritance: Mendelism; laws of segregation and independent assortment; linkage analysis; allelic and non–allelic interactions. **Gene expression:** Structure of gene; transfer of genetic information; transcription, translation, protein synthesis, tRNA; ribosomes; regulation of gene expression in prokaryotes and eukaryotes; proteins, 1D, 2D, and 3D structure.

Genetic Variations: Mutations, spontaneous and induced; transposable genetic elements; DNA, damage and repair.

Suggested Readings:

1. Brown, T.A. (2011). Genetics: A Molecular Approach (3rd Edition). BIOS Scientific Publishers, UK.
2. Fletcher, H., Hickey, I. and Winter, P. (2010). Instant Notes on Genetics (3rd edition) Taylor and Francis Group, USA.
3. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (2012). Principles of Genetics (8th Edition). Wiley Sons, USA.
4. Gupta, P.K. (1999). A Text–book of Cell and Molecular Biology, Rastogi Publications, Meerut, India.
5. Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.
6. Krebs, B. E., Goldstein, E.S. and Kilpatrick, S.T. (2011). Lewins Genes X. Jones and Bartlett Publishers, LLC, UK.
7. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P. Baltimore, D. and Darnell, J. (2000). Molecular Cell Biology, W.H. Freeman & Co., New York, USA.
8. Singh, B.D. (2007). Molecular Genetics. Kalyani Publishers, India.
9. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics (5th Edition). John Wiley and Sons Inc., U.S.A.

PRACTICAL–II (BASED ON PAPERS–II A AND II B)

Time: 3 Hrs.

Practical Hours: 4½ Hours/week

Marks: 20

Suggested Laboratory Exercises

Teachers may select plants/material available in their locality/institutions.

1. To study cell structure from onion leaf peels; demonstration of staining and mounting methods.
2. Comparative study of cell structure in onion cells, *Hydrilla* and *Spirogyra*. Study of cyclosis in *Tradescantia* Staminal Cells.
3. Study of plastids to examine pigment distribution in plants (e.g. *Cassia*, *Lycopersicon* and *Capsicum*).
4. Examination of electron micrographs of eukaryotic cells with special reference to organelles.
5. Study of electron micrographs of viruses, bacteria, cyanobacteria and eukaryotic cells for comparative cellular organization.
6. Examination of various stages of mitosis and meiosis using appropriate plant material (e.g. onion root tips, onion flower buds).
7. Preparation of karyotypes from dividing root tip cells and pollen grains.
8. Cytological examination of special types of chromosomes: bar body, lampbrush and polytene chromosomes.
9. Working out the laws of inheritance using seed mixtures.
10. Working out the mode of inheritance of linked genes from test cross and/or F2 data.

Suggested Readings

1. Fukui, K. and Nakayama, S. 1996. Plant Chromosomes; Laboratory Methods, CRC Press, Boca Raton, Florida.
2. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology; Structure and Function, Jones and Barlett Publishers, Boston, Massachusetts.
3. Harns, N. and Oparka, K.J. 1994. Plant Cell Biology, A Practical Approach. IRL Press, at Oxford University Press, Oxford, UK.
4. Sharma, A.K. and Sharma, A. 1999. Plant Chromosomes; Analysis. Manipulation and Engineering, Harwood Academic Publishers, Australia.

**SEMESTER-III
BOTANY**

Theory Paper IA	:	30 Marks
Theory Paper IB	:	30 Marks
Practical I (IA & IB)	:	20 Marks
Internal Assessment	:	20 Marks
Total	:	100 Marks

Paper- IIIA: DIVERSITY OF SEED PLANTS AND THEIR SYSTEMATICS-I

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Characteristics of seed plants; Evolution of the seed habit; Distinguishing features of angiosperms and gymnosperms.

General features of gymnosperms and their classification; Evolution and diversity of Gymnosperms including fossil and living gymnosperms; Geological time scale and fossilization. Morphology of vegetative and reproductive parts; Anatomy of root, Stem and leaf; Reproduction and life cycle of *Pinus*, *Cycas*, *Ephedra* and *Ginkgo*.

Angiosperms: Origin and evolution. Some examples of primitive angiosperms.

Suggested Readings:

1. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age International Limited, New Delhi.
2. Gifford, E.M. and Foster, A.S., 1988, Morphology and Evolution of Vascular Plants, W.H. Freeman & Company, New York.
3. Pellant, C. (1994). Fossils, Dragon's World, Great Britain
4. Sporne, K.R., 1965, The Morphology of Gymnosperms, Hutchinson & Co. (Publishers) Ltd., London.
5. Taylor, T. N., Taylor, E. L. and Krings, M. (2008). Paleobotany: The Biology and Evolution of Fossil Plants (2nd Edition). Elsevier Inc. Netherlands.

Paper- IIIB: DIVERSITY OF SEED PLANTS AND THEIR SYSTEMATICS-II

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Angiosperm taxonomy; Brief history, Aims and fundamental components (alpha-taxonomy, Omega-taxonomy, Holotaxonomy); Identification, keys. Taxonomic literature.

Botanical nomenclature: Taxonomic ranks; Type concept; Principle of priority. Major contribution of cytology, phytochemistry and taxinetrics to taxonomy.

Classification of angiosperms; Salient features of the systems proposed by Bentham and Hooker, Engler and Prantl.

Diversity of flowering plants as illustrated by members of the families Ranunculaceae, Brassicaceae, Rutaceae, Fabaceae, Apiaceae, Acanthaceae, Apocynaceae, Asclepiadaceae, Solanaceae, Lamiaceae. Chenopodiaceae, Euphorbiaceae, Liliaceae, Orchidaceae and Poaceae.

Suggested Readings:

1. Bendre, A. (2007). Practical Botany, Rastogi Publications, Meerut.
2. Davis, P.H. and Heywood, V.H., 1963, Principles of Angiosperm Taxonomy, Oliver and Boyd, London.
3. Gifford, E.M. and Foster, A.S., 1988, Morphology and Evolution of Vascular Plants, W.H. Freeman & Company, New York.
4. Jeffrey, C. 1982, An Introduction to Plant Taxonomy, Cambridge University Press, Cambridge, London.
5. Jones, S.B., Jr. and Luchsinger, A.E., 1986, Plant Systematics (2nd edition), McGraw-Hill Book Co., New York.
6. Radford, A.E., 1986, Fundamental of Plant Systematics, Harper and Row, New York.
7. Singh, G. 1999, Plant Systematics: Theory and Practice, Oxford and IBH Pvt. Ltd., New Delhi.
8. Sinha, S. (2012). Encyclopaedia on Morphology of Angiosperms, Oxford Book Company, Jaipur.

Botany Practicals - III (Based on Papers- IIIA and IIIB)

Time: 3 Hrs.

Practical Hours: 4½ Hours/week

Practical Marks: 20

Suggested Laboratory Exercises

Angiosperms

The following species are suitable for study. This list is only indicative. Teachers may select plants available in their locality.

Teachers may select plants/material available in their locality/institution.

1. Ranunculaceae : *Ranunculus, Delphinium*
2. Brassicaceae : *Brassica, Alyssum, Iberis, Coronopus.*
3. Malvaceae : *Hibiscus, Abutilon.*
4. Rutaceae : *Murraya, Citrus.*
5. Fabaceae : *Faboideae : Lathyrus, Cajanus, Melilotus, Trigonella, Caesalpinioideae : Cassia, Caeslpainia, Mimosoideae : Prosopis, Mimosa, Aeacia.*
6. Apiaceae : *Coriandrum. Foeniculum, Anethum.*
7. Acanthaceae : *Adhatoda, Peristrophe.*
8. Apocynaceae : *Vinca, Thevetia, Nerium.*
9. Asclepiadaceae : *Calotropis.*
10. Solanaceae : *Solanum, Withania, Datura.*
11. Euphorbiaceae : *Euphorbia, Phyllanthus.*
12. Lamiaceae : *Ocimum, Salvia.*
13. Chenopodiaceae : *Chenopodium, Beta.*
14. Liliaceae : *Asphodelus, Asparagus.*
15. Poaceae : *Avena, Triticum, Hordeum Poa, Sorghum.*

The Students should be made familiar with the use of identification keys including use of computers in taxonomy.

The teachers should prevent students from collecting plants from the wild and submitting them for the practical examination.

Instead, the student should be asked to prepare field reports.

Gymnosperms

Cycas (i) Habit, armour, of leaf bases on the stem (if specimen is not available show photography), very young leaf (circinate vernation) and old foliage leaves, sclae leaf, bulbils, male cone (specimen); Microsporophyll, megasporophyll mature seed. (ii) Study through permanent slides—normal root (T.S.), stem (T.S.) (if sections are not available show photographs), ovule (L.S.). (iii) Study through hand sections or dissections-coralloid root (T.S.), rachis (T.S.), leaflet (V.S.), microsporophyll (V.S.) pollen grains (W.M.).

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Pinus (i) Habit, long and dwarf shoot showing cataphylls and scale leaves, T.S. wood showing growth rings, male cone, 1st year, 2nd year and 3rd year female cones, winged seeds. (ii) Study through permanent slides-root (T.S.), female cone (L.S.) ovule (L.S.), embryo (W.M.) showing polycotyledonous condition. (iii) Study through hand sections or dissections-young stem (T.S.), old stem (wood) (T.L.S. and R.L.S.), needle (T.S. male cone (L.S.), male cone (T.S.), Pollen grains (W.M.).

Ephedra (i) Habit and structure of whole and female cones. (ii) Permanent slides-female cone (L.S.). (iii) Hand sections/dissections-node (L.S.), internode (T.S.), macerated stem to see vessel structure; epidermal peel mount of vegetative parts to study stomata, male cone (T.S. and L.S.), pollen grains.

SEMESTER – IV
BOTANY

Theory Paper IA	:	30 Marks
Theory Paper IB	:	30 Marks
Practical I (IA & IB)	:	20 Marks
Internal Assessment	:	20 Marks
Total	:	100 Marks

**Paper- IVA: STRUCTURE, DEVELOPMENT AND REPRODUCTION IN
FLOWERING PLANTS-I**

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

The basic body plan of a flowering plant-modular type of growth.

The Shoot System: The shoot apical meristem and its histological organization; meristematic and permanent tissue, formation of internodes, branching pattern; monopodial and sympodial growth; canopy architecture; 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; role of woody skeleton; secondary phloem-structure function relationships; periderm.

Diversity in plant form in annuals, biennials and perennials; trees-largest and longest-lived.

Leaf: Origin, development, arrangement and diversity in size and shape; internal structure in relation to photosynthesis and water loss; adaptations to water stress; senescence and abscission.

Suggested Readings:

1. Beck, C.B. (2010). *An Introduction to Plant Structure and Development: Plant anatomy for the Twenty First Century* (2nd Edition). Cambridge University Press, UK.
2. Cutler, D. F., Botha, T. and Stevenson, D. M. (2007). *Plant Anatomy: An Applied Approach*. Blackwell Publishing, Oxford, UK.
3. Dickison, W.C. (2000). *Integrative Plant Anatomy*. Academic Press, California, USA.
4. Mauseth, J.D., 1988, *Plant Anatomy*, The Benjamin/Cummings Publishing Company Inc., Menlo Park, California, USA.
5. Peau, K., 1977, *Anatomy of Seed Plants*, 3rd edition. John Wiley & Sons, New York.
6. Raven, P.H., Evert, R.F. and Eichhorn, S.E., 1999, *Biology of Plants*, 5th edition. W.H. Freeman and Co., Worth Publishers, New York.
7. Rudall, P. J. (2007). *Anatomy of Flowering Plants: An Introduction to Structure and Development* (3rd Edition). Cambridge University Press, UK.
8. Thomas, P., 2000, *Trees: Their Natural History*, Cambridge University Press, Cambridge.

**Paper- IVB: STRUCTURE, DEVELOPMENT AND REPRODUCTION IN
FLOWERING PLANTS-II
(THEORY)**

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

The Root System: The root apical meristem; differentiation of primary and secondary tissues and their roles; structural modification for storage, respiration, reproduction and for interaction with microbes.

Vegetative Reproduction: Various methods of vegetative propagation. Detailed study and types of grafting and budding, economic aspects.

Flower: A modified shoot; structure, development and varieties of flower; functions; structure of anther and pistil; the male and female gametophytes; types of pollination; attractions and reward for pollinators; (sucking and foraging types); pollen-pistil interaction self incompatibility; double fertilization: formation of seed endosperm and embryo : fruit development and maturation.

Significance of Seed: Suspended animation; ecological adaptation; unit of genetic recombination with reference to reshuffling of genes and replenishment; dispersal strategies.

Note for Teachers:

Wherever required, role of environment and hormones in plant development and reproduction should be emphasized.

Suggested Readings:

1. Bhojwani, S.S. and Bhatnagar, S.P. 2000, The Embryology of Angiosperms, 4th revised and enlarged edition. Vikas Publishing House, Delhi.
2. Hartmann, H.T. and Kestler, D.E., 1976, Plant Propagation: Principles and Practices, 3rd edition, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Mauseth, J.D., 1988, Plant Anatomy, The Benjamin/Cummings Publishing Company Inc., Menlo Park, California, USA.
4. Peau, K., 1977, Anatomy of Seed Plants, 3rd edition. John Wiley & Sons, New York.
5. Pegeri, K. and Vander Pijl 1979, The Principles of Pollination Biology, Pergamon Press, Oxford.
6. Raven, P.H., Evert, R.F. and Eichhorn, S.E., 1999, Biology of Plants, 5th edition. W.H. Freeman and Co., Worth Publishers, New York.

Botany Practicals - IV (Based on Papers- IVA and IVB)

Time: 3 Hrs.

Practical Hours: 4½ Hours/week

Practical Marks: 20

Suggested Laboratory Exercises

1. Study of any commonly occurring dicotyledonous plant (for example *Solanum nigrum* or Kalanchoe) to the body plan, organography and modular type of growth.
2. Life forms exhibited by flowering plants (by a visit to a forest or a garden, Study of tree-like habit in cycads, bamboo, banana, traveller's tree (*Revenala madagascariensis*) and Yucca and comparison with true trees as exemplified by conifers and dicotyledons.
3. L.S. Shoot tip to study the cytohistological zonation and origin of leaf primordia.
4. Monopodial and sympodial types of branching in stems (especially rhizomes).
5. Anatomy of primary and secondary growth in monocots and dicots using free hand razor technique (*Solanum*, *Boerhavia*, *Helianthus*, *Mirabilis*, *Nyctanthus*, *Draceana*, *Maize*) hand sections (or prepared slides). Structure of secondary phloem and xylem. Growth rings in wood, Microscopic study of wood in T.S., T.L.S. and R.L.S.
6. Field study of diversity in leaf shape, size, thickness, surface properties. Internal structure of leaf. Structure and development of stomata (using epidermal peels of leaf).
7. Anatomy of the root. Primary and secondary structure.
8. Examination of a wide range of flowers available in the locality and methods of their pollination.
9. Structure of anther, microsporogenesis (using slides) and pollen grains (using whole mounts). Pollen viability using *in vitro* pollen germination.
10. Structure of ovule and embryo sac development using serial sections from permanent slides.
11. Nuclear and cellular endosperm. Embryo development in monocots and dicots (using permanent slides/dissections).
12. Simple experiments to show vegetative propagation (leaf cuttings in *Bryophyllum*, *Sansevieria*, *Begonia*; stem cuttings in rose, *Salix*, money plant, Sugarcane and *Bougainvillea*).
13. Germination of non-dormant and dormant seeds.

Suggested Readings (for laboratory exercises):

1. Bhojwani, S.S. and Bhatnagar, P., 2000, The Embryology of Angiosperms (4th revised and enlarged edition), Vikas Publishing House, New Delhi.
2. Mauseth, J.D., 1988, Plant Anatomy, The Benjamin/Cumminas Publishing Co., Inc., Mehlo Park, California, USA.
3. Raven, P.H., Evert, R.F. and Eichhorn, S.E., 1992, Biology of Plants (5th Edition). Worth Publishers, New York.
4. Steeves, T.A. and Sussex, I.M., 1989, Patterns in Plant Development (2nd Edition). Cambridge University Press, Cambridge.

SEMESTER-V
BOTANY

Theory Paper IA	:	30 Marks
Theory Paper IB	:	30 Marks
Practical I (IA & IB)	:	20 Marks
Internal Assessment	:	20 Marks
Total	:	100 Marks

Paper - VA: PLANT PHYSIOLOGY

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Plant-Water Relation: Importance of water to plant life, physical properties of water, (imbibition) 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 (hydroponics).

Transport of Organic Substances: Mechanism of phloem transport, source-sink relationship, factors affecting translocation.

Photosynthesis: Significance, historical aspects, photosynthetic pigments, action and absorption spectra and enhancement effects, concept of two photosystems, z-scheme, photophosphorylation, Calvin, cycle, C4 pathway, CAM plants, photorespiration.

Growth and Development: Definitions, phases of growth and development, kinetics of growth, seed dormancy, seed germination and factors of their regulation, plant movements, the concept of photoperiodism, physiology of flowering, florigen concept, biological clocks, physiology of senescence, fruit ripening, plant hormones - auxins, gibberellins, cytokinins, abscissic acid and ethylene, history of their discovery, biosynthesis and mechanism of action, general account of salicylic acid, jasmonates and brassinosteroids, photomorphogenesis, phytochromes and cryptochromes, their discovery, physiological role and mechanism of action.

Suggested Readings:

1. Dennis, D.T., Turpin, D.H. Lefebvre, D.D. and Layzell (eds.) 1997. Plant Metabolism (2nd Edition). Longman, Essex, England.
2. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library, Springer-Verlag, New York, USA.
3. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology (4th Edition). John Wiley and Sons. U.S.A.
4. Mandavia, C., Patel, S. V., Mandavia, M. K., Golakiya, B. A. and Chovatia, V. P. (2009). Glimpses in Plant Physiology. International Book Distributing Co., Lucknow, India.
5. Mohr, H. and Schopfer, P. 1995. Plant Physiology. Springer-Verlag, Berlin, Germany.
6. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th Edition). Wadsworth Publishing Co., California, USA.
7. Taiz, L. and Zeiger, E. (2006). Plant Physiology (5th Edition). Sinauer Associates Inc. USA.

Paper - VB: BIOCHEMISTRY AND BIOTECHNOLOGY

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Basics of Enzymology: Discovery and nomenclature, characteristics of enzymes, concept of holoenzyme, apoenzyme, coenzymes and cofactors regulation of enzyme activity, mechanism of action.

Respiration : ATP-the biological energy currency, aerobic and anaerobic respiration, Krebs' cycle, electron transport mechanism (chemi-osmotic theory), redox potential, oxidative phosphorylation, pentose phosphate pathway.

Nitrogen and Lipid Metabolism: Biology of nitrogen fixation, importance of nitrate reductase and its regulation, ammonium assimilation, structure and function of lipids, fatty acid biosynthesis, β -oxidation, saturated and unsaturated fatty acids, storage and mobilization of fatty acids.

Genetic Engineering: Tools and techniques of recombinant DNA technology, cloning vectors, genomic and cDNA library, transposable elements, techniques of gene mapping and chromosome walking.

Biotechnology: Functional definition, basic aspects of plant tissue culture, cellular totipotency, differentiation and morphogenesis, biology of Agrobacterium, vectors for gene delivery and marker genes, salient achievements in crop biotechnology.

Suggested Readings:

1. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
2. Dennis, D.T., Turpin, D.H. Lefebvre, D.D. and Layzell (eds.) 1997. Plant Metabolism (2nd Edition). Longman, Essex, England.
3. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library, Springer-Verlag, New York, USA.
4. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
5. Lea, P.J. and Leegood, R.C. 1999. Plant Biochemistry and Molecular Biology. John Wiley & Sons, Chelichester, England.
6. Old, R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation, Blackwell Scientific Publishers, Oxford, UK.
7. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics (5th Edition). John Wiley and Sons Inc., U.S.A.
8. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
9. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, The Netherlands.

Botany Practicals – V (Based on Papers- VA and VB)

Time: 3 Hrs.

Practical Hours: 4½ Hours/week

Max. Marks: 20

Suggested Laboratory Exercises:

1. To study the permeability of plasma membrane using different concentrations of organic solvents.
2. To study the effects 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. Separation of chloroplast pigments by solvent method.
6. Determining the osmotic potential of vacuolar sap by plasmolytic method.
7. Determining the water potential of any tuber.
8. Separation of amino acids in a mixture by paper chromatography and their identification by comparison with standards.
9. Bioassay of auxin, cytokinin, GA, ABA and ethylene using appropriate plant material.
10. Demonstration of the technique of micropropagation by using different explants, e.g. axillary buds, shoot meristems.
11. Demonstration of the technique of another pollen culture.
12. Demonstrate the ascent of sap using a dye.
13. Demonstration of root and shoot formation from the apical and basal portion of stem segments in liquid medium containing different hormones.
14. Demonstrate the transpiration pull by mercury method.
15. Demonstration of osmosis by potato osmoscope.
16. Comparison of loss of water from two surfaces of leaf by CoCl_2 method/four leaf method.
17. Demonstration of imbibition by plaster of paris method.
18. Demonstration that O_2 is evolved during photosynthesis.
19. Separation of pigments by paper chromatography/TLC method.
20. Demonstration of phototropism movements.
21. Demonstration the measurements of growth by arc auxanometer.
22. Preparation of nutrient medium.
23. Sterilization of glassware and plant material.
24. Preparation of explant for aseptic manipulation.
25. Requirements for setting up the tissue culture laboratory.

Suggested Readings (For Laboratory Exercises)

1. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

B.A./B.Sc. (Semester System) (12+3 System of Education) (*Semester System*)
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2. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.
3. Dixon, R.A. (Ed.) 1987. Plant Cell Culture: A Practical Approach, IRL Press, Oxford.
4. Kochhar, S. L. and Gujral, S. K. (2012). Comprehensive Practical Plant Physiology. Macmillan Publishers India Ltd., Delhi.
5. Moore, T.C. 1974. Research Experiences in Plant Physiology: A Laboratory annual. Springer-Verlag. Berlin.
6. Plummer, D.T. (1996). An Introduction to Practical Biochemistry (3rd Edition). Tata McGraw-Hill Publishing Co. Ltd. New Delhi.
7. Roberts, J. and Tuckar, G.A. (Eds.) 2000. Plant Hormone Protocols. Human Press, New Jersey, USA.
8. Scott, R.P.W. 1995. Techniques and Practices of Chromotography. Marcel Dekker, Inc., New York.
9. Smith, R.H. 2000. Plant Tissue Culture: Techniques and Experiments. Academic Press, New York.
10. Wilson, K. and Goulding, K.H. (Eds.) 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.

**SEMESTER-VI
BOTANY**

Theory Paper IA	:	30 Marks
Theory Paper IB	:	30 Marks
Practical I (IA & IB)	:	20 Marks
Internal Assesement	:	20 Marks
Total	:	100 Marks

**Paper- VIA: ECOLOGY
(THEORY)**

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Plants and Environment: Atmosphere (gaseous compositions), water (properties of water cycle), light (global radiation, photosynthetically 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 verbalization), light (photoperiodism, heliophytes and sciophytes) and salinity.

Population Ecology: Growth curves, ecotypes, ecads.

Community Ecology: Community characteristics, absolute and relative frequency, density and dominance, basal area and importance value index (IVI), Whittaker's classification of biodiversity, indices of alpha, beta and gamma diversity, life forms, biological spectrum, ecological succession.

Ecosystem: Structure, abiotic and biotic components, food chain, food web, ecological pyramids, energy flow, biogeochemical cycles of carbon, nitrogen and phosphorus.

Biogeographical Regions of India

Vegetation types of India: Forests and grasslands

Landscape Ecology: Definition & concept, effect of patch size and shape on biodiversity, dynamics of land use.

Suggested Readings

1. Kocchar, S.L. 1998. Economic Botany in Tropics, 2nd edition, Macmillan India Ltd., New Delhi.
2. Kumar, H.D. (2011). Modern Concepts of Ecology. Vikas Publishing House, New Delhi.
3. Mackenzie, A. et al., 1999. Instant Notes in Ecology. Viva Book Pvt. Ltd., New Delhi.
4. Odum, E.P. and Barrett, G.W. (2012). Fundamentals of Ecology. Cengage Learning India Pvt. Ltd., New Delhi.
5. Sambarmurthy, A.V.S.S. and Subramanyam, N.S. 1989. A Textbook of Economic Botany, Wily Eastern Ltd., New Delhi.
6. Sharma, O.P. 1996. Hill's Economic Botany (Late Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
7. Sharma, P.D. (2013). Environmental Biology. Rastogi Publications, Meerut.
8. Simpson, B.B. and Conner-Ogozaly, M. 1986. Economic Botany-Plants in Our World. McGraw Hill, New York.

Paper- VIB: ECONOMIC BOTANY

Time: 3 Hrs.

Theory Lectures: 3 Hours/Week

Max. Marks: 30

Instructions for the Paper Setters:

There will be a total of nine questions and candidates will attempt five questions. Question No. 1 will be compulsory and will consist of six parts with equal distribution from the whole syllabus. Answer to each part should not exceed 3-4 lines. Each part will carry one mark (multiple choice/one-word answer type questions not to be set). The remaining eight questions will be set from equal distribution of the whole syllabus out of which candidates will be required to attempt any four questions. Each question will carry six marks. Answer to each question should not exceed four pages.

Food Plants: *Oryza sativa* (Rice), *Triticum aestivum* (Wheat), *Zea mays* (Maize), *Solanum tuberosum* (Potato), *Saccharum officinarum* (Sugarcane).

Fibres: *Gossypium hirsutum* (Cotton) and *Chorchorus capsularis* (Jute).

Vegetable Oils : *Arachis hypogea* (Groundnut), *Brassica campestris* (Mustard) and *Cocos nucifera* (Coconut).

General account of sources of firewood, timber and bamboos.

Spices : General account of *Piper nigrum* (Black pepper), *Eugenia caryophyllum* (Cloves), *Cinnamomum verum* (Cinnamomum), *Elettaria cardamomum* (cardamom), *Zingiber officinalis* (Ginger), *Curcuma longa* (Turmeric), *Coriandrum sativum* (Coriander), *Foeniculum vulgare* (Fennel) and *Mentha arvensis* (Mint).

Medicinal Plants: General account of *Terminalia chebula* (Harar), *Terminalia belerica* (Bahera), *Azadirachta indica* (Neem), *Phyllanthus emblica* (Amla), *Aconitum napellus* (Aconite), *Rauwolfia serpentina* (Sarpagandha), *Atropa belladonna* (Belladonna), *Datura stramonium* (Datura), *Withania somniferum* (Ashwagandha) and *Papaver somniferum* (Poppy).

Beverages: *Camellia sinensis* (Tea) and *Coffea arabica* (Coffee).

Rubber: Morphology of *Hevea brasiliensis* (Rubber), Processing and Uses.

Suggested Readings

1. Council of Scientific & Industrial Research 1986. The Useful Plants of India. Publications and Information Directorate. CSIR, New Delhi.
2. Das, K. 2010. Medicinal plants- Their importance in Pharmaceutical Sciences, Kalyani Publishers, New Delhi.
3. Kocchar, S.L. 2000. Economic Botany of the Tropics, Macmillan India Pvt. Ltd., New Delhi.

B.A./B.Sc. (Semester System) (12+3 System of Education) (*Semester System*)
(*FACULTY OF LIFE SCIENCES*)

4. Prinotel, D. and Hall, C.W. (Eds.) 1989. Food and Natural Resources. Academic Press, London, New York.
5. Reddy, K. et al. 2007. Advances in Medicinal plants, Universities Press, Hyderabad.
6. Sharma, O.P. 1996. Hill's Economic Botany. Tata McGraw Hill Co. Ltd., New Delhi.
7. Swaminathan, M.S. and Kocchar, S.L. (Eds) 1989. Plants and Society. Macmillan Publications Ltd., London.
8. Verma, V. 2009. Textbook of Economic Botany, ANE Books, New Delhi.

Botany Practicals - VI (Based on Papers- VIA and VIB)

Time: 3 Hrs.

Practical Hours: 4½ Hours/week

Max. Marks: 20

Suggested Laboratory Exercises

1. To determine minimum number of quadrats required for reliable estimate of biomass in grasslands through species-area curves.
2. To study the frequency of herbaceous species in grassland and to compare the frequency distribution with Raunkiaer's Standard Frequency Diagram.
3. To estimate Importance Value Index for grassland species on the basis of relative frequency, relative density and relative dominance in protected and grazed grassland.
4. To measure the vegetation cover of grassland through point frame method.
5. To measure the above ground plant biomass in a grassland.
6. To study the morphological anatomical features of hydrophyte (Hydrilla, Eichhornia) Xerophyte (Nerium, Calotropis).
7. To determine diversity indices (richness, Simpson, Shannon-Wiener) in grazed and protected grassland.
8. To estimate bulk density and porosity of grassland and woodland soils.
9. To determine moisture content and water holding capacity of grassland and woodland soil.
10. To study the vegetation structure through profile diagram.
11. To estimate transparency, pH and temperature of different water bodies.
12. To measure dissolved oxygen content in polluted and unpolluted water samples.
13. To estimate salinity of different water samples.
14. To determine the percent leaf area injury of different leaf samples collected around polluted sites.
15. To estimate dust-holding capacity of the leaves of different plant species.
16. **Food Plants:** Study of the morphology, structure and simple microchemical tests of the foods storing tissues rice, wheat, maize, potato and sugarcane. Microscopic examination of starch in these plants (excepting sugarcane).
17. **Fibres:** Study of cotton flowers, sectioning of the cotton ovules/developing seeds to trace the origin and development of cotton fibers. Microscopic study of cotton and test for cellulose. Sectioning and staining of jute stem to show the location and development of fibers. Microscopic structure. Tests for lignocelluloses.
18. **Vegetable Oils:** Study of hand sections of groundnut, mustard and coconut and staining of oil droplets by Sudan III and Sudan Black.

B.A./B.Sc. (Semester System) (12+3 System of Education) (*Semester System*)
(*FACULTY OF LIFE SCIENCES*)

19. **Field Visits:** To study sources of firewood (10 plants)/timberyielding trees (10 trees)/bamboos, list to be prepared mentioning special features, collection of plant based articles of common use.
20. **Spices:** Examine black pepper, cloves, cinnamon (hand sections) and opened of cardamom and describe them briefly.
21. Preparations of an illustrated inventory of 10 medicinal plants used in indigenous systems of medicine or allopathy: Write their botanical and common names parts used and diseases/disorders for which they are prescribed.
22. **Beverages:** Section boiled coffee beans and tea leaves to study the characteristic structural features.
23. Visit to in situ conservation site/Botanical Garden.

Suggested Readings (for laboratory exercises)

1. Council of Scientific & Industrial Research 1986. The Useful Plants of India. Publications and Information Directorate. CSIR, New Delhi.
2. Kocchar, S.L. 2000. Economic Botany of the Tropics, Macmillan India Pvt. Ltd., New Delhi.
3. Krebs, C.J. 1989. Ecological Methodology. Harper and Row, New York, USA.
4. Ludwig, J.A. and Reynolds, J.F. 1988. Statistical Ecology, Wiley, New York.
5. Moore, P.W. and Chapman, S.B. 1986. Methods in Plant Ecology, Blackwell Scientific Publications.
6. Prinotel, D. and Hall, C.W. (Eds.) 1989. Food and Natural Resources. Academic Press, London, New York.
7. Sharma, O.P. 1996. Hill's Economic Botany. Tata McGraw Hill Co. Ltd., New Delhi.
8. Swaminathan, M.S. and Kocchar, S.L. (Eds) 1989. Plants and Society. Macmillan Publications Ltd., London.