

FACULTY OF SCIENCE
B. Sc. I Year
Subject: BOTANY
Paper - I
Microbial Diversity, Cryptogams and Gymnosperms

Unit - I: Evolution of Life and Diversity of Microbes

1. Origin and evolution of Life - an outline.
2. Viruses: Structure, replication and transmission; plant diseases caused by viruses and their control.
3. Bacteria: Structure, nutrition, reproduction and economic importance. An outline of Plant diseases of important crop plants caused by bacteria and their control.
4. Brief account of Archaeobacteria, Chlamydia, Actinomycetes and Mycoplasma.
5. Cyanobacteria : Cell structure, thallus organisation and their prospecting (uses) - Biofertilizers. Structure and life history of *Oscillatoria*, *Nostoc* and *Anabaena*.

Unit - II: Algae and Fungi

6. Algae: General account, thallus organisation, structure, reproduction, classification and economic importance.
7. Structure, reproduction, life history and systematic position of *Oedogonium*, *Coleochaete*, *Chara*, *Ectocarpus* and *Polysiphonia*.
8. Fungi: General characters, classification and economic importance.
9. Structure, reproduction and life history of *Albugo*, *Saccharomyces*, *Penicillium*, *Puccinia*, *Alternaria*. General account of plant diseases caused by Fungi and their control.
10. Lichens: Structure and reproduction; ecological and economic importance.

Unit -III: Bryophyta and Pteridophyta

11. Bryophytes: General characters, classification and alternation of generations.
12. Structure, reproduction, life history and systematic position of *Marchantia*, *Anthoceros* and *Polytrichum*. Evolution of Sporophyte in Bryophytes.
13. Pteridophytes: General characters, classification, alternation of generations and evolution of sporophyte.
14. Structure, reproduction, life history and systematic position of *Rhynia*, *Lycopodium*, *Equisetum* and *Marsilea*.
15. Evolution of stele, heterospory and seed habit in Pteridophytes.

Unit - IV: Gymnosperms and Palaeobotany

16. Gymnosperms: General characters, structure, reproduction and classification.
17. Morphology of vegetative and reproductive parts, systemic position, life history of *Pinus* and *Gnetum*
18. Distribution and economic importance; endangered Gymnosperms.
19. Paleobotany: Introduction, Fossils and fossilization; Geological time scale; Importance of fossils.
20. Bennettitales: General account

Suggested Readings:

1. Alexopolus, J. and W.M. Charles. 1988. Introduction to Mycology. Wiley Eastern, New Delhi.
2. Mckane, L. and K. Judy. 1996. Microbiology - Essentials and Applications. McGraw Hill, New York.
3. Pandey, B.P. 2001. College Botany, Vol. I: Algae, Fungi, Lichens, Bacteria, Viruses, Plant Pathology, Industrial Microbiology and Bryophyta. S. Chand & Company Ltd, New Delhi.
4. Pandey, B.P. 2006. College Botany, Vol. II: Pteridophyta, Gymnosperms and Paleobotany. S. Chand & Company Ltd, New Delhi.
5. Pandey, B.P. 2007. Botany for Degree Students: Diversity of Microbes, Cryptogams, Cell Biology and Genetics. S. Chand & Company, New Delhi.
6. Sambamurthy, A.V.S.S. 2006. A Textbook of Plant Pathology. I.K. International Pvt. Ltd., New Delhi.
7. Sambamurthy, A.V.S.S. 2006. A Textbook of Algae. I.K. International Pvt. Ltd., New Delhi.
8. Sharma, O.P. 1992. Textbook of Thallophyta. McGraw Hill Publishing Co., New Delhi.
9. Sporne, K.R. 1965. Morphology of Gymnosperms. Hutchinson Co., Ltd., London.
10. Thakur, A.K. and S.K. Bassi. 2008. A Textbook of Botany: Diversity of Microbes and Cryptogams. S. Chand & Company Ltd. New Delhi.
11. Vashishta, P.C., A.K. Sinha and Anil Kumar. 2006. Botany - Pteridophyta (Vascular Cryptogams). S. Chand & Company Ltd, New Delhi.
12. Vashishta, B.R. A.K. Sinha and V.P. Singh. 2008. Botany for Degree Students: Algae. S. Chand & Company Ltd, New Delhi.
13. Vashishta, P.C., A.K. Singha and Anil Kumar. 2006. Botany for Degree Students: Gymnosperms. S. Chand & Company Ltd, New Delhi.
14. Vashishta, B.R. 1990. Botany for Degree Students: Fungi, S. Chand & Company Ltd, New Delhi.
15. Watson, E.V. 1974. The structure and life of Bryophytes, B.I. Publications, New Delhi.

Practical – I: Microbial Diversity, Cryptogams and Gymnosperms

1. Knowledge of equipment used in Microbiology: Spirit lamp, Inoculation loop, Hot air oven, Autoclave / Pressure, Laminar cooker / Inoculation chamber, Incubator, etc.
2. Preparation of solid and liquid media for culturing of microbes (Demonstration)
3. Study of viruses and bacteria using electron micrographs (photographs)
4. Gram staining of Bacteria
5. Study of symptoms of plant diseases caused by viruses, bacteria
Viruses: Tobacco mosaic virus, Bunchy top of banana, Yellow vein clearing of bhendi, Leaf curl of papaya
Bacteria: Citrus canker, Leaf blight of rice, Angular leaf spot of cotton
6. Vegetative and reproductive structures of the following taxa:
Algae: *Oscillatoria*, *Nostoc*, *Anabena*, *Volvox*, *Oedogonium*, *Coleochaete*, *Ectocarpus* and *Polysiphonia*.
Fungi: *Albugo*, *Saccharomyces*, *Penicillium*, *Puccinia* and *Alternaria*
7. Section cutting of diseased material infected by Fungi and identification of pathogens as per theory syllabus.
8. Lichens: Different types of thalli and their external morphology
9. Morphology (vegetative and reproductive structures) and anatomy of the following taxa:
Bryophytes: *Marchantia*, *Anthoceros* and *Polytrichum*
Pteridophytes: *Lycopodium*, *Equisetum* and *Marsilea*.
Gymnosperms: *Pinus* and *Gnetum*.
10. Fossil forms using permanent slides / photographs: *Rhynia* and *Cycadeoidea*.
11. Study of symptoms of plant diseases caused by Fungi and Mycoplasma: Tikka disease of Groundnut, Late blight of Potato, Ergot of Bajra, Whip smut of Sugarcane, Wheat rust, Brown spot of Rice, Rice (Paddy) blast, Head smut of Sorghum, Little leaf of Brinjal
12. Enumeration and examination of important microbial, fungal and algal products: Biofertilizers, protein capsules, antibiotics, mushrooms, SCP, Agar-agar etc.
13. Field visits to places of algal / microbial / fungal interest (e.g. Mushroom cultivation, water bodies).

FACULTY OF SCIENCE
B. Sc. II Year
Subject: BOTANY
PAPER - II

Anatomy, Embryology, Taxonomy and Medicinal Botany

Unit - I: Anatomy

1. **Meristems:** Types, histological organization of shoot and root apices and theories.
2. **Tissues and Tissue Systems:** Simple and complex
3. **Leaf:** Ontogeny, diversity of internal structure; Stomata and epidermal outgrowths.
4. **Stem and root:** Vascular cambium - Formation and function. Anomalous Secondary growth - Stem-*Achyranthes*, *Boerhavia*, *Bignonia*, *Dracaena*; Root- *Beta vulgaris*
5. **Wood structure:** General account. Study of local timbers - Teak (*Tectona grandis*), Rosewood, (*Dalbergia latifolia*), Red sanders, (*Pterocarpus santalinus*), Nalamaddi, (*Terminalia tomentosa* (T. *alata*), and Neem (*Azadirachta indica*)

Unit - II: Embryology

6. Introduction to Embryology.

Anther structure, Microsporogenesis and development of male gametophyte.
7. Ovule structure and types; Megasporogenesis; types and development of female gametophyte.
8. Pollination - Types; Pollen - pistil interaction. Fertilization.
9. Endosperm - Development and types. Embryo - development and types;

Polyembryony and Apomixis - an outline
10. Palynology: Principles and applications

Unit - III: Taxonomy

11. Introduction: Principles of Plant Systematics, Systematics vs Taxonomy, Types of classification: Artificial, Natural and Phylogenetic
12. Systems of classification: Salient features and comparative account of Bentham & Hooker and Engler & Prantl. An introduction to Angiosperm Phylogeny Group (APG)
13. Current concepts in Angiosperm Taxonomy: Embryology in relation to taxonomy, Cytotaxonomy, Chemotaxonomy and Numerical Taxonomy.

14. Nomenclature and Taxonomic resources: An introduction to ICBN, Vienna code - a brief account. Herbarium: concept, techniques and applications.

15. Systematic study and economic importance of plants belonging to the following families:

Annonaceae, Capparaceae, Rutaceae, Fabaceae (Faboideae/papilionoideae, Caesalpinioideae, Mimosoideae), Cucurbitaceae, Apiaceae, Asteraceae. Asclepiadaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Orchidaceae and Poaceae

Unit- IV: Medicinal Botany

16. Ethnomedicine: Scope, interdisciplinary nature, distinction of Ethnomedicine from Folklore medicine. Outlines of Ayurveda, Sidda, Unani and Homeopathic systems of traditional medicine. Role of AYUSH, NMPB, CIMAP and CDRI.

17. Plants in primary health care: Common medicinal plants - Tippateega (*Tinospora cordifolia*), tulasi (*Ocimum sanctum*), Pippallu (*Piper longum*), Karaka (*Terminalia chebula*), Kalabanda (*Aloe vera*), Turmeric (*Curcuma longa*).

18. Traditional medicine vs Modern medicine: Study of select plant examples used in traditional medicine as resource (active principles, structure, usage and pharmacological action) of modern medicine : Aswagandha (*Withania somnifera*), Sarpagandha (*Rauvolfia serpentina*), Nelausiri (*Phyllanthus amarus*), Amla (*Phyllanthus emblica*) and Brahmi (*Bacopa monnieri*).

19. Pharmacognosy: Introduction and scope, Adulteration of plant crude drugs and methods of identification - some examples. Indian Pharmacopoeia.

20. Plant crude drugs: Types, methods of collection, processing and storage practices, Evaluation of crude drugs.

Suggested Readings:

1. Bhattacharya et. al 2007 . A text book of Palynology, Central, New Delhi.
2. Bhojwani, S.S. and S.P. Bhatnagar, 2000. The Embryology of Angiosperms (4th Ed.), Vikas Publishing House, Delhi.
3. Davis, P.H. and V.H. Heywood. 1963, Principles of Angiosperm Taxonomy. Oliver and Boyd, London.
5. Esau, K. 1971. Anatomy of Seed Plants. John Wiley and Son, USA.
6. Heywood, V.H. 1965. Plant Taxonomy, ELBS, London
7. Heywood, V.H. and D.M. Moore (Eds). 1984. Current Concepts in Plant Taxonomy. Academic Press, London
8. Jain, S.K. and V. Mudgal. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun.
9. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge, London.
10. Johri, B.M. 1984. Embryology of Angiosperms. Springer-Verlag, Berlin.
11. Joshi, S.G. 2000. Medicinal Plants. Oxford and IBH, New Delhi.
12. Kapil, R.P. 1986. Pollination biology. Inter India Publishers, New Delhi.
13. Kokate, C. and Gokeale - Pharmacognosy - Nirali Prakashan, New Delhi.
14. Lad, V. 1984. Ayurveda ó The Science of Self-healing. Motilal Banarasi Dass, New Delhi.
15. Lewis, W.H. and M.P.F. Elwin Lewis. 1976. Medical Botany, Plants Affecting Man's Health. A Wiley Inter Science Publication, John Wiley and Sons, New York.
16. Maheswari, P. 1971. An Introduction to Embryology of Angiosperms. McGraw Hill Book Co., London.
17. Pandey, B.P. 2007. Botany for Degree Students : Diversity of Seed Plants and their Systematics, Structure, Development and Reproduction in Flowering Plants. S. Chand & Company Ltd., New Delhi.
18. Rastogi, R.R. and B.N. Mehrotra. 1993. Compendium of Indian Medicinal Plants. Vol. I & II. CSIR, Publication and Information Directorate, New Delhi.
19. Sivarjan, V.V. and I. Balasubramanian. 1994. Ayurvedic Drugs and their Plant Sources. Oxford and IBH, New Delhi.
20. Stace, C.A. 1989. Plant Taxonomy and Biostatistics (2nd Ed.). Edward Arnold, London
21. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford and IBH, New Delhi.

Practical - II: Anatomy, Embryology, Taxonomy and Medicinal Botany

(Total Hours of Laboratory Exercises: 90 @ 3 h/Week in 30 sessions)

Suggested Laboratory Exercises:

1. Demonstration of double staining technique
2. Tissue organization in root and shoot apices using permanent slides
3. Preparation of double staining slides

Primary structure: Root - *Cicer*, *Canna*; Stem - *Tridax*, *Sorghum*

Secondary structure: Root - *Tridax* sp.; Stem - *Pongamia*

Anomalous secondary structure: Examples as given in theory syllabus
4. Stomatal types using epidermal peels
5. Microscopic study of wood in T.S., T.L.S. and R.L.S
6. Structure of anther and microsporogenesis using permanent slides
7. Structure of pollen grains using whole mounts (*Catharanthus*, *Hibiscus*, *Acacia*, Grass)
8. Pollen viability test using in-vitro germination (*Catharanthus*)
9. Study of ovule types and developmental stages of Embryo sac.
10. Structure of endosperm (nuclear and cellular); Developmental stages of dicot and monocot Embryos using permanent slides
11. Isolation and mounting of embryo (using *Cymopsis* /*Senna* /*Crotalaria*)
12. Systematic study of locally available plants belonging to the families prescribed in theory Syllabus (minimum of one plant representative for each family)
13. Demonstration of herbarium techniques
14. Local field visits to study the vegetation and flora
15. Detailed morphological and anatomical study of medicinally important part(s) of locally available plants (a minimum 10 plants) used in traditional medicine
16. Field visits to identify and collect ethno medicinal plants used by local tribes/folklore
17. Preparation and submission of 25 herbarium specimens for evaluation during the practical examination

FACULTY OF SCIENCE

B. Sc. III Year

Subject: BOTANY

Paper- III:

Cell Biology, Genetics, Ecology and Biodiversity

Unit-I: Cell Biology

1. Plant cell envelopes: Ultra structure of cell wall, molecular organization of cell membranes.
2. Nucleus- Ultrastructure, Nucleic acids - Structures and replication of DNA; Types and functions of RNA.
3. Chromosomes: Morphology, organization of DNA in a chromosome. Euchromatin and Heterochromatin, Karyotype.
4. Special types of chromosomes: Lampbrush, polytene and B - chromosomes.
5. Cell division: Cell cycle and its regulation; mitoses, meiosis, and their significance.

Unit- II: Genetics

6. Mendelism: Laws of inheritance. Genetic interactions - Epistasis, Complementary, Supplementary and inhibitory genes.
7. Linkage and crossing over: A brief account, construction of genetic maps - 2 point and 3 point test cross data.
8. Mutations: Chromosomal aberrations - structural and numerical changes; Gene mutations, transposable elements.
9. Gene Expression: Organization of gene, transcription, translation, mechanism and regulation of gene expression in prokaryotes (Lac and Trp Operons).
10. Extra nuclear genome: Mitochondrial and plastid DNA, Plasmids.

Unit-III: Ecology

11. Concept and components of Ecosystem. Energy flow, food chains, food webs, ecological pyramids, biogeochemical cycles – Carbon, Nitrogen, Phosphorus.
12. Plants and environment: Ecological factors Climatic (light and temperature), edaphic and biotic. Ecological adaptations of plants.
13. Population ecology: Natality, Mortality, growth curves, ecotypes. ecads.
14. Community ecology: Frequency, density, cover life forms, biological spectrum, Ecological succession (Hydrosere, Xerosere).
15. Production ecology: Concepts of productivity, GPP.NPP, CR (Community -- Respiration) and secondary production, P/R ration and Ecosystems.

Unit - IV: Biodiversity and Conservation

16. Biodiversity: Concepts, Convention on Biodiversity - Earth Summit. Types of biodiversity.
17. Level, threats and value of Biodiversity.
18. Hot spots of India - Endemism. North Eastern Himalayas, Western Ghats.
19. Agro-biodiversity: Vavilov centres of crop plants.
20. Principles of conservation: IUCN threat - categories, RED data book- Threatened & endangered plants of India. Role of organizations in the Conservation of Biodiversity - IUCN, UNEP, WWF, NBPGR.

Suggested Readings:

1. Bharucha, E. 2005. Textbook of Environmental Studies for Undergraduate Courses. Universities Press (India) Private Limited, Hyderabad.
2. Fukui, K. and S. Nakayama. 1996. Plant Chromosomes: Laboratory Methods. CRC Press, Boca Raton, Florida.
3. Harris, N. and K.J. Oparka. 1994. Plant Cell Biology: A Practical Approach. IRL Press at University Press. Oxford. UK.
4. Khitoliya, R.K. 2007. Environmental Pollution - Management and Control for Sustainable Development. S. Chand & Company Ltd., New Delhi.
5. Kormondy, E. 1989. Concepts of Ecology (3rd Ed.). Printice Hall of India, New Delhi.
6. Kothari, A. 1997. Understanding Biodiversity: Life, Sustainability and Equity: Tracts for the Times. 11. Orient Longman Ltd., New Delhi.
7. Michael, S. 1996. Ecology. Oxford University Press London.
8. Mishra. D.D. 2008. Fundamental Concepts in Environmental Studies. S. Chand & Company Ltd., New Delhi.
9. Odum, E.P. 1983. Basics of Ecology. Saunderson's International Students Edition, Philadelphia.
10. Pandey. B.P. 2007. Botany for Degree Students: Diversity of Microbes, Prokaryotes, Cell Biology and Genetics. S. Chand & Company Ltd., New Delhi.
11. Sharma P.D. 1989. Elements of Ecology. Rastogi Publications, Meerut.
12. Sharma, A.K. and A. Sharma. 1999. Plant Chromosomes: Analysis, manipulation and Engineering. Harwood Academic Publishers, Australia.
13. Shukla, R.S. and P.S. Chandel. 2007. Cytogenetics, Evolution, Biostatistics and Plant Breeding. S. Chand & Company Ltd., New Delhi.
14. Singh, H.R. 2005. Environmental Biology. S. Chand & Company Ltd., New Delhi.
15. Snustad, D.P. and M.J. Simmons. 2000. Principles of Genetics. John Wiley & Sons, Inc., USA.
16. Strickberger, M.W. 1990. Genetics (3rd Ed). Macmillan Publishing Company.
17. Verma, P.S. and V.K. Agrawal. 2004. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company., New Delhi.
18. Verma, P.S. and V.K. Agrawal. 2006. Genetics. S. Chand & Company., New Delhi.

Practical - III: Cell Biology, Genetics, Ecology and Biodiversity

1. Demonstration of cytochemical methods: Fixation of plant material and nuclear staining for mitotic and meiotic studies.
2. Study of various stages of mitosis using cytological preparations of onion root tips.
3. Study of various stages of meiosis using cytological preparation of onion flower buds
4. Karyotype study using cytological preparation of dividing root tip cells of onion/photographs/permanent slides
5. Solving genetic problems related to monohybrid, dihybrid ratio and interaction of genes (Minimum of six problems in each topic).
6. Construction of linkage maps; two point test cross
7. Knowledge of ecological instruments: Working principles and applications of Hygrometer, rain gauge, anemometer, altimeter, light meter, wet and dry bulb thermometer (with the help of Equipment/ diagrams/ photographs)
8. Demonstration of soil texture (composition of clay, sand silt etc.) and pH.
9. Study of morphological and anatomical characteristics of plant communities using locally available plant species:
Hydrophytes (*Eichhornia*, *Hydrilla*, *Pistia*, *Nymphaea*, *Vallisneria*)
Xerophytes (*Asparagus*, *Opuntia*, *Euphorbia antiquorum*)
Halophytes (*Rhizophora*, *Avicenia*)
10. Detailed study on macro flora of a local fresh water body
11. Estimation of carbonates and bicarbonates in the given sample
11. Minimum of two field visits to local areas of ecological/ conservation of biodiversity
Importance (Sacred grove/ Reserved Forest / Botanical garden/Zoo park, Lakes etc.)

FACULTY OF SCIENCE

B. Sc. III Year

Subject: BOTANY

Paper - IV:

Physiology, Tissue Culture, Biotechnology, Seed Technology and Horticulture

Unit - I: Physiology (Part A)

1. Water Relations: Importance of water to plant life, physical properties of water, diffusion, imbibitions, osmosis; water, osmotic and pressure potentials; absorption, transport of water, ascent of sap; transpiration; Stomatal structure and movements.
2. Mineral Nutrition: Essential macro and micro mineral nutrients and their role; symptoms of mineral deficiency; absorption of mineral ions; passive and active processes.
3. Enzymes: Nomenclature, characteristics, mechanism and regulation of enzyme action, enzyme kinetics, factors regulating enzyme action.
4. Photosynthesis: Photosynthetic pigments, absorption and action spectra; Red drop and Emerson enhancement effect; concept of two photosystems; mechanism of photosynthetic electron transport and evolution of oxygen; photophosphorylation; Carbon assimilation pathways: C3, C4 and CAM; photorespiration.
5. Translocation of organic substance: Mechanism of phloem transport; source-sink relationships.

Unit - II: Physiology (Part - B)

6. Respiration: Aerobic and Anaerobic; Glycolysis, Krebs's cycle; electron transport system, mechanism of oxidative phosphorylation, pentose phosphate pathway.
7. Nitrogen Metabolism: Biological nitrogen fixation, nitrate reduction, ammonia assimilation, amino acid synthesis and protein synthesis.
8. Growth and Development: Definition, phases and kinetics of growth. Physiological Effects of phytohormones- auxins, gibberellins, cytokinins, ABA, ethylene and brassinosteroids.
9. Physiology of flowering and photoperiodism, role of phytochrome in flowering.

Unit - III: Tissue Culture and Biotechnology

10. Tissue culture: Introduction, sterilization procedures, culture media - composition and preparation; explants.
11. Callus culture; cell and protoplast culture. Somatic hybrids and cybrids.
12. Applications of tissue culture: Production of pathogen free plants and somaclonal variants, production of stress resistance plants, secondary metabolites and synthetic seeds.
13. Biotechnology: Introduction, history and scope.

14. rDNA technology: Vectors and gene cloning and transgenic plants.

Unit - IV: Seed Technology and Horticulture

15. Seed: Structure and types. Seed dormancy; causes and methods of breaking dormancy.

16. Seed storage: Seed banks, factors affecting seed viability, genetic erosion. Seed production technology; seed testing and certification.

17. Horticulture techniques: Introduction, Cultivation of ornamental and vegetable Crops, Bonsai and landscaping.

18. Floriculture: Introduction. Importance of green house, polyhouse, mist chamber, shade nets; Micro irrigation systems. Floriculture potential and its trade in India.

19. Vegetative Propagation of plants: Stem, root and leaf cuttings. Layering and bud grafting. Role of plant growth regulators in horticulture.

Suggested Readings:

1. Adams, C.R., K.M. Banford and M.P. Early. 1993. Principles of Horticulture. Butterworth Heineman Ltd., London.

2. Agarwal, P.K. 1993. Hand Book of Seed Technology. Dept. of Agriculture and Cooperation. National Seed Corporation Ltd., New Delhi.

3. Balasubramanian, D., C.F.A. Bryce, K. Dharmalingam, J. Green and K. Jayaraman. 2004. Biotechnology. Universities Press (India) Private Ltd., Hyderabad.

4. Bedell. Y.E. Seed Science and Technology. Indian Forest Species. Allied Publishers Ltd., New Delhi.

5. Channarayappa. 2007. Molecular Biotechnology ñ Principles and Practices. Universities Press (India) Private Ltd., Hyderabad.

6. Chawala, H.S. 2002. Introduction to Plant Biotechnology. Oxford & IBH Publising Company, New Delhi.

7. Dubey, R.C. 2001. A Textbook of Biotechnology, S. Chand & Company Ltd., New Delhi.

8. Edmond, J.B., T.L. Senn, F.S. Adreus and R.J. Halfacre. 1977. Fundamentals of Horticulture (4th Ed.). Tata McGraw-Hill, New Delhi.

9. Gorer, R. 1978. The Growth of Gardens. Faber and Faber Ltd., London

10. Hartman, H.T. And D.E. Kestler. 1976. Plant Propagation: Principles and practices. Prentice & Hall of India, New Delhi.

11. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons Inc., New York, USA.

12. Jain, J.L., S. Jain and Nitin Jain. 2008. Fundamentals of Biochemistry. S. Chand & Company Ltd., New Delhi.

13. Jha, T.B. and B. Ghosh. 2005. Plant Tissue Culture ñ Basic and Applied. Universities Press (India) Private Ltd., Hyderabad.
14. Janick Jules. 1979. Horticulture Science. (3rd Ed).W.H. Freeman and Co., San Francisco, USA.
15. Lewin, B. 1994. Genes V. Oxford University Press, Oxford.
16. Lewin, B. 2002. Genes VII. Oxford University Press, Oxford. 17. Pandey, B.P. 2007. Botany for Degree Students: Plant Physiology, Biochemistry, Biotechnology, Ecology and Utilization of Plants. S. Chand & Company Ltd., New Delhi.
18. Ramawat, K.G. 2008. Plant Biotechnology. S. Chand & Company Ltd., New Delhi.
19. Rao, K.M. 1991. A Text Book of Horticulture. Mc Millan India Ltd., New Delhi.
20. Salisbury, F.B. and C.W. Ross. 1992. Plant Physiology. 4th edn. (India Edition) Wordsworth, Thomson Learning Inc., USA.
21. Taiz, L. and E. Zeiger. 1998. Plant Physiology (2nd Ed.). Sinauer Associates, Inc., Publishers, Massachusetts, USA.
22. Tiwari, G.N., R.K. Goal. Green House Technology ñ Fundamentals, Design, Modelling and Application.Narosa Publishing House, New Delhi.
23. Tunwar, N.S. and S.V. Singh. 1988. Indian Minimum Seed Certification Standards. The Central Seed Certification Board, Govt. of India, New Delhi.

Practical - IV: Physiology, Tissue Culture, Biotechnology, Seed Technology and Horticulture

1. Determination of osmotic potential of vacuolar sap by plasmolytic method using leaves of *Rhoeo / Tradescantia*.
2. Determination of rate of transpiration using cobalt chloride method.
3. Determination of stomatal frequency using leaf epidermal peelings/impressions
4. Determination of catalase activity using potato tubers by titration method.
5. Separation of chloroplast pigments using paper chromatography technique.
6. Estimation of protein by biuret method.
7. Isolation and Estimation of DNA
8. Testing of seed viability using 2, 3, 5 - triphenyl tetrazolium chloride (TTC).
9. Demonstration of seed dressing using fungicide to control diseases.
10. Demonstration of seed dressing using biofertiliser (*Rhizobium*) to enrich nutrient supply.
11. Study on tools/equipment used in horticulture: Rake, Hoe, Spade, Trowel, Digger, Pick-axe, Shade net, Glass house, Mist chamber
12. Demonstration vegetative plant propagation: Rooting of cutting-Leaf and stem: layering: stem, bud and wedge grafting
13. Study of the application of plant growth regulator (IBA) for rooting of cuttings using Ornamental plants.
14. Knowledge of instruments and facilities used in plant tissue culture using equipment/photographs. Preparation of plant tissue culture medium.
15. Demonstration of Micropropagation using explants like axillary buds and shoot meristems (inoculation of explants).
16. Study of biotechnology products: samples of Antibiotics, Vaccines, Bio-fertilizers, Single Cell Protein, Cosmetics, photographs of transgenic plants, Multiple shoots, and Artificial/Synthetic seeds
17. Study visits to places of horticultural and biotechnological interest-Commercial nurseries/Botanical gardens; Biotechnology R&D laboratories/Industries.