

pNATIONAL COLLEGE (AUTONOMOUS), TIRUCHIRAPPALLI - 620 001

Nationally Accredited at 'A' Level by NAAC



M. Sc. BOTANY
COURSE STRUCTURE UNDER C.B.C.S.

(Applicable to the candidates admitted from the academic year 2016-17 onwards)

Sem.	Course	Course Title	Instru. hours/ week	Cre- dit	Exam hr	Marks			Total
						Int.	External		
							W	O	
I	Core Course – CC1 P16BO1	Plant Diversity-I (Algae, Fungi and Bryophytes)	6	5	3	25	75		100
	Core Course – CC2 P16BO2	Plant Diversity-II (Pteridophytes, Gymnosperms and Paleobotany)	6	5	3	25	75		100
	Core Course - CC3 P16BO3	Microbiology, Plant Pathology and Immunology	6	5	3	25	75		100
	Core Course – CC4 P16BO4P	Practical-1 (Core Courses I, II & III)	6	5	3	25	70	5	100
	Elective – EC1 P16BO5E	Biofertilizers, Mushroom Technology and Vermicomposting	6	4	3	25	75		100
	Total			30	24				
II	Core Course – CC5 P16BO6	Anatomy and Embryology	6	5	3	25	75		100
	Core Course – CC6 P16BO7	Angiosperm Taxonomy and Morphogenesis	6	5	3	25	75		100
	Core Course – CC7 P16BO8	Ecology, Phytogeography and Conservation Biology	6	5	3	25	75		100
	Core Course – CC8 P16BO9P	Practical-2 (Core Courses V, VI & VII)	6	5	3	25	70	5	100
	Elective – EC2 P16BO10E	Industrial Microbiology	6	4	3	25	75		100
	Total			30	24				
III	Core Course – CC9 P16BO11	Cytogenetics and Plant Breeding	6	5	3	25	75		100
	Core Course – CC10 P16BO12	Plant Physiology, Biochemistry and Biophysics	6	5	3	25	75		100
	Core Course – CC11 P16BO13P	Practical-3 (Core Courses XI & X)	6	5	3	25	70	5	100
	Elective – EC3 P16BO14E	Genetic Engineering	6	4	3	25	75		100
	Elective- EC4 P16BO15E	Plant Tissue Culture	6	4	3	25	75		100
	Total			30	23				

IV	Core Course – CC12 P16BO16	Biotechnology	6	5	3	25	75		100
	Core Course – CC13 P16BO17	Research Methodology	6	5	3	25	75		100
	Elective – EC5 P16BO18E	Horticulture	6	4	3	25	75		100
	P16BOP19	Project Work	12	5		75	25		100
	Total		30	19					400
	Grand Total		120	90					1900

W: Written; O : Oral

There will be oral test for all Practical Examinations. The oral test will carry 5 marks in the external component.

**PLANT DIVERSITY I - P16B01
(ALGAE, FUNGI AND BRYOPHYTES)**

Semester : I

Instruction Hours/Week: 6

Core Course: 1

Credit: 5

Unit-I: ALGAE (Teaching - 1 h / week)

Major criteria used for Algal classification (Cell wall, pigments, reserve food materials and flagella). Classification of algae – Bold & Wynne (1979), Chapman and Chapman (1973) and Fritsch Comparative account on structure, reproduction, phylogeny and interrelationship of Chlorophyceae, Xanthophyceae, Bacillariophyceae, Phaeophyceae, Rhodophyceae and Myxophyceae.

Unit-II: ALGAE (Teaching - 1 hr/ week)

Ecology of Algae: Aquatic (Freshwater algae, marine algae), Terrestrial, aerophytic, cryptophytic and thermophytic algae. Soil algae and symbiotic associations.. Algal blooms- Algae as pollution indicators. Cultivation of fresh water and marine algae.

General trends in algae: Thallus variation, life cycle patterns, origin and evolution of sex in algae and economic importance of algae.

Unit-III: FUNGI (Teaching-1 hr/ week)

General features of fungi. General structure and organization of fungal hyphae. Classification of fungi (Alexopoulos and Mims, 1979). Structure, reproduction, life cycle and phylogeny of - Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.

Unit-IV: FUNGI (Teaching-2 hrs/ week)

Mode of nutrition and culture of fungi. Homothallism, heterothallism and parasexual cycle. Hormonal control in fungi.

Economic importance of fungi.

Fungal association: Mycorrhiza (ectomycorrhiza, endomycorrhiza). Lichen (General features, thallus organization and life cycle).

Unit-V: BRYOPHYTES (Teaching-1 h / week)

Salient features of bryophytes. Classification of Bryophytes (Reimer). Comparative study on the structure, reproduction and life cycle of Hepaticopsida, Anthocerotopsida and Bryopsida.

Origin of bryophytes. Evolution of gametophytes and sporophytes in bryophytes.. Economic uses of bryophytes.

References

Algae

- Bold, H. C. and Wynne, M. J. (1978). Introduction of Algae - Structure and Reproduction. Prentice Hall, New Jersey.
- Chapman, C.J. and Chapman, D.J. (1981). The Algae. 2nd ed. Macmillan, London.
- Darley, W. M. (1982). Algal Biology: A Physiological Approach. Blackwell Scientific Publications. Oxford, London.
- Fritsch, F. E. (1976). Structure and Reproduction of the Algae. Vol. I & II. Cambridge University Press, London.
- Ian Morris (1967). An Introduction to the Algae. Hutchinson University Library, London.

- Kumar, H. D. (1989). *Introductory Phycology*. East-West Press, Madras.
- Kumar, H. D. and Singh, H. N. (1982). *A Textbook of Algae*. East-West Press, Madras.
- Round, F. E. (1981). *The Ecology of Algae*. Cambridge University Press, London.
- Sharma, O. P. (1986). *Textbook of Algae*. Tata McGraw Hill, New Delhi.
- Smith, G. M. (1976). *Cryptogamic Botany*. Vol. I. Algae and Fungi. Tata McGraw Hill, New Delhi.
- Vashishta, B. R. *et al.* (2008). *Botany for Degree Students - Algae*. S. Chand and Co. Ltd., New Delhi.
- Venkataraman *et al.* (1974). *Algal Form and Function*. Today and Tomorrow Publishers, New Delhi.

Fungi

- Alexopoulos, C. J. and Mims, C. W. (1979). *Introductory Mycology*. Wiley Eastern Ltd., New York.
- Bessey, E. A. (1979). *Morphology and Taxonomy of Fungi*. Vikas Publishing House Pvt. Ltd., New Delhi.
- Bold, H. C. *et al.* (1980). *Morphology of Plants and Fungi*. Harper and Row Publishing Inc., New York.
- Burnet, J. H. (1971). *The Fundamentals of Mycology*. ELBS Publications, London.
- Mehrotra, R. S and Aneja, K. R. (1990). *An Introduction of Mycology*. Wiley Eastern Ltd., New Delhi.
- Sharma, P. D. (1987). *The Fungi*. Rastogi and Co., Meerut.
- Vashishta, B. R. and Sinha, A. K. (2007). *Botany for Degree Students - Fungi*. S. Chand and Co. Ltd., New Delhi.

Lichens

- Hale, M. E. Jr. (1983). *Biology of Lichens*. Edward Arnold, Maryland.

Bryophytes

- Cavers, F. (1911) *The Interrelationship of Bryophytes*. Cambridge, UK.
- Ingold, C. T. (1939). *Spore Discharge in Land Plants*. Oxford, UK.
- Kashyap, S.R. (1972). *The Liverworts of Western Himalayas and Punjab*. Plains I & II. Research Company Publications, New Delhi.
- Parihar, N. .S (1972). *An Introduction to Embryophyta-I: Bryophyta*. Central Book Depot, Allahabad.
- Prem Puri (1973). *Bryophytes: A Broad Perspective*. Atma Ram and Sons, New Delhi.
- Smith, G. M. (1971). *Cryptogamic Botany*. Vol. II. Bryophytes and Pteridophytes. Tata McGraw Hill, New Delhi.
- Vashishta, B. R. *et al.* (2008). *Botany for Degree Students: Bryophyta*. S. Chand and Co. Ltd., New Delhi.
- Watson, E. V. (1971). *The Structure and Life of Bryophytes*. B.I. Publications, New Delhi.

**PLANT BIODIVERSITY II – P16BO2
(PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)**

Semester : I

Core Course: 2

Instruction Hours/Week: 6

Credit: 5

Unit-I: PTERIDOPHYTES (Teaching - 1 h / week)

General features. Classification of Pteridophytes (Reimer, 1954). Range of morphology, structure, reproduction and evolution of gametophytes and sporophytes of the following orders: Rhyniales, Psilotales, Lycopodiales, Selaginellales, Isoetales, Calamitales and Equisetales.

Unit-II: PTERIDOPHYTES (Teaching - 2 hrs / week)

Range of morphology, structure, reproduction and evolution of gametophytes and sporophytes of the following orders: Ophioglossales, Marattiales, Osmundales, Filicales and Salviniales. Stelar evolution in pteridophytes, Heterospory and origin of seed habit. Structure, development and evolution of sorus in Filicales.

Unit-III: GYMNOSPERMS (Teaching - 1 h / week)

A general account of the characteristic features of Gymnosperms. Classification of Gymnosperms (Sporne, 1965). General structure and interrelationships of Pteridospermales, Bennetitales, Pentoxylales and Cordaitales.

Unit-IV: GYMNOSPERMS (Teaching - 1 h / week)

A general account on the distribution, morphology, anatomy, reproduction of Cycadales, Coniferales, Ginkgoales and Gnetales. Economic Importance of Gymnosperms.

Unit-V: PALEOBOTANY (Teaching - 1 h / week)

Concepts of Paleobotany, A general account on Geological Time Scale.

Fossil types: Compressions, incrustation, casts, molds, petrifications, coalballs and compactions. Paloclimates and fossil plants. Study of *Lepidodendron*, *Stigmaria*, *Lyginopteris* and *cordaites*. Age of fossils – radiocarbon dating. Role of fossil in oil exploration and coal excavation, Paleopalynology.

References

Pteridophytes

- Bower, F. O. (1939). *The Ferns* (Vol. I, II, III). Today and Tomorrow's Printers, New Delhi.
- Eames, A. J. (1936). *Morphology of Vascular Plants - Lower Groups*. Tata McGraw Hill, New Delhi.
- Ingold, C. T. (1939). *Spore Discharge in Land Plants*. Oxford, UK.
- Parihar, N. S. (1985). *The Biology and Morphology of Pteridophytes*. Central Book Depot, Allahabad.
- Rashid, A. (1986). *An Introduction to Pteridophyta*. Vani Educational Books, New Delhi.
- Sharma, O. P. (1990). *Text Book of Pteridophyta*. Macmillan India Ltd., India.
- Smith, G. M. (1971). *Cryptogamic Botany*. Vol. II. Bryophytes and Pteridophytes. Tata McGraw Hill, New Delhi.
- Sporne, K. R. (1972). *The Morphology of Pteridophytes*. B. I. Publications, Madras.

- Sundararajan, S. (2007). Introduction to Pteridophyta. New Age International Publishers, New Delhi.
- Vashishta, P. C. *et al.* (2008). Botany for Degree Students: Pteridophyta. S. Chand and Co. Ltd., New Delhi.

Gymnosperms

- Chamberlain, C. J. (1957). Gymnosperms Structure and Evolution. University Chicago Press, New York.
- Coulter, J. M. and Chamberlin, C. J. (1967). Morphology of Gymnosperms. Central Book Depot, Allahabad.
- Foster, A. S. and Gifford, E. M. (1965). Morphology and Evolution of Vascular Plants. W. H. Freeman & Co.
- Maheswari, P. and Vasil, V. 1960. Gnetum: A Monograph. CSIR Publication, New Delhi.
- Sporne, K. R. (1974). The Morphology of Gymnosperm. B.I. Publications, New Delhi.
- Vasishta, P. C. *et al.* (2006). Botany for Degree Students: Gymnosperms. S. Chand and Co. Ltd., New Delhi.

Paleobotany

- Nikias, K. J. (1981). Paleobotany, Paleoecology and Evolution. Praeger Publishers, USA.
- Seward, A. C. (1919). Fossil Plants. Vol. I, II, III and IV. Cambridge University Press, London.
- Seward, A. C. (1931). Plant Life through the Ages. Cambridge University Press, London.
- Shukla, A. C. and Mishra, S. P. (1982). Essentials of Paleobotany. 2nd ed. Vikas Publishing House Pvt. Ltd., New Delhi.

MICROBIOLOGY, PLANT PATHOLOGY AND IMMUNOLOGY – P16BO3

Semester : I

Core Course: 3

Instruction Hours/Week: 6

Credit: 5

Unit-I: MICROBIOLOGY (Teaching - 1 h / week)

Classification of microorganisms- Five kingdom system by Whittaker (1969) – Features of Prokaryote and Eukaryote. General features of Viruses. Classification (Harrison *et al.*,), characteristics, ultrastructure, isolation, purification, replication and transmission of viruses. Virions and prions.

Unit-II: MICROBIOLOGY (Teaching - 1 h / week)

Outline of Bergey's system of Bacterial classification (1984-1991). Study of Eubacteria, Archaeobacteria, Cyanobacteria and Actinomycetes. General account, ultrastructure, nutrition, growth, reproduction of bacteria. Isolation and culture of bacteria.

Unit-III: PLANT PATHOLOGY (Teaching - 1 h / week)

Plant pathology - causal factor and organisms responsible for plant diseases - methods of studying plant diseases -- common terminologies used in plant pathology, Epidemiology symptomology, Etiology, Epidemic disease, Control measures - Host parasite interactions - Mycotoxins - Aflatoxins.

Unit-IV: PLANT PATHOLOGY (Teaching - 1 h / week)

Common plant diseases of India (Cucumber mosaic, Synchytrium Anthracnose of mango, Wilt of Cotton, Downy mildew of grapes, White rust of Mustard, Damping off disease of mustard seedlings, Rust of wheat, Blast of paddy.

Unit-V: IMMUNOLOGY (Teaching - 2 hrs / week)

General account on immune systems and immunology - innate and acquired immunity - Antigen and antibody (types, structure and antigen-antibody interactions) - Detection of antibody (immunoelectrophoresis, ELISA and RIA) - Application of immunology in plant systems with special reference to immune cytochemistry.

References

Microbiology

- Carpenter, P. L. (1967). Microbiology. Saunders Co., Philadelphia, USA.
- Davis, B. D., Dulbecco, R., Eiser, H. N. and Grinsberg, H. S. (1980). Microbiology. Harper & Row, New York.
- Dubey, R. C. and Maheshwari, D. K. (2007). A Textbook of Microbiology. S. Chand and Co. Ltd., New Delhi.
- Edmond, P. (1978). Microbiology: An Environment Perspective. Macmillan & Co., New Delhi.
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- Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (1993). Microbiology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
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- Power and Dagainwala (1994). General Microbiology. Himalayan Publishing House, Bombay.
- Salle, A. J. (1974). Fundamental Principles of Bacteriology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Schegal, H. E. (1986). General Microbiology. Cambridge University, London.
- Sharma, P. D. (1992). Microbiology. Rastogi & Co., Meerut.
- Staley, J. T. *et al.* (1991). Bergey's Manual of Systematic Bacteriology. Vol. I to IV. Williams & Wilkins, London.
- Stanier, R. Y., Adelberg, E. A. and Ingram, J. L. (1978). General Microbiology. Mac Millan & Co., New Delhi.

Plant Pathology

- Bilgrami, K. S. and Dube, H. C. (1990). A Textbook of Modern Plant Pathology. Vikas Publishing House Pvt. Ltd., New Delhi.
- Butler, E. J. and Jones, S. G. (1949). Plant Pathology. Macmillan & Co., London.
- Cooper, J. I. (1995). Viruses and the Environment. 2nd ed. Chapman & Hall, London.
- Mehrota, R. S. (1994). Plant Pathology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Pandey, B. P. (1982). A Textbook of Plant Pathology, Pathogen and Plant Diseases. S. Chand and Co. Ltd., New Delhi.
- Rangaswamy, G. (1972). Diseases of Crop Plants in India. Prentice Hall of India Pvt. Ltd.
- Rangaswamy, G. and Soumini Rajagopalan. (1973). Bacterial Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
- Singh, R. S. (1990). Plant Diseases. 6th ed., Oxford & IBH, New Delhi.
- Smith, K. M. (1957). A Textbook of Plant Virus Diseases. Little Borwn & Co., Boston.
- Southey, J. F. (1965). Plant Nematology. Tech. Bull. No.7, Ministry of Agricultural, Fisheries and Food, Her Majesty's Stationery Office, London.
- Walker, J. C. (1952). Diseases of Vegetable Crops. McGraw Hill Book Co. Inc., New York.

Immunology

- Annadurai, B. (2008). A Textbook of Immunology and Immunotechnology. S. Chand and Co. Ltd., New Delhi.
- Kuby, J. (2000). Immunology. 4th ed. W. H. Freeman and Co., New York.
- Nandini Shetty. (2008). Immunology Introductory Textbook. New Age International Publishers, New Delhi.
- Wein and Stewart, J. (1997). Immunology, Churchill Livingston, New York.

PRACTICAL I - P16BO4P
(Covering Core Courses I, II & III)

Semester : I
Instruction Hours/Week: 6

Core Course: 4
Credit: 5

Algae

Anabaena, Spirulina, Nitella, Padina, Sargassum and Gracilaria.

Fungi

Pilobolus, Taphrina, Xylaria, Pleurotus and Lycoperdon

Lichens

Parmelia and Usnea

Bryophytes

Morphological and anatomical study of representative members of the following genera:

Lunularia, Targionia, Reboulia, and Funaria.

Pteridophytes

Study of the morphology and anatomy of the vegetative and reproductive parts of the following genera:

Isoetes, Angiopteris, Osmunda, Pteris, and Nephrolepis.

Gymnosperms

Study of the morphology and anatomy of vegetative and reproductive parts of the following genera:

Podocarpus, Cupressus and Ephedra

Paleobotany

Lepidodendron, Stigmaria, Lyginopteris and Cordaites

Microbiology

Isolation of microbes from soil food, fruits and vegetables - Gram's staining of Bacteria – Bacterial contamination of milk by methylene - blue reduction test

Plant Pathology

Study of the Rust of wheat, Blast of paddy, White rust of mustard, Cucumber mosaic.

BIOFERTILIZERS, MUSHROOM TECHNOLOGY & VERICOMPOSTING – P16B05E

Semester : I
Instruction Hours/Week: 6

Elective Course: 1
Credit: 4

Unit-I: BIOFERTILIZER (Teaching - 1 h / week)

Fertilizers types – synthetic and natural (organic).

Biofertilizers: Significance- Isolation and mass cultivation of Cyanobacteria (*Anabaena*) and *Azolla*.

Unit-II: BIOFERTILIZER (Teaching - 1 h / week)

Bacterial biofertilizers: A general account of bacterial biofertilizers. Isolation, inoculums preparation, maintenance and mass production of *Azospirillum*, *Azotobacter*, *Rhizobium* and *Phosphobacteria*.

Unit-III: BIOFERTILIZER (Teaching - 2 hrs / week)

Mycorrhizal fungi as biofertilizers: Introduction – Scope - General account of Ecto, Endo and Arbuscular mycorrhizae (AM). Methods of collection - wet sieving and decanting method and inoculum production. Culture of mycorrhizae in Modified Melin - Norkrans (MMN) agar medium - Isolation and method of inoculation of Arbuscular mycorrhizae (AM).

Unit-IV: MUSHROOM TECHNOLOGY (Teaching - 1 h / week)

Mushroom Technology - Introduction, History and Scope – edible and poisonous mushrooms - importance and nutritive value of edible mushrooms. Cultivation technology for Button mushroom (*Agaricus bisporus*), and Oyster mushroom (*Pleurotus sajorcaju*) - Harvest - Storage methods. Recipe for mushroom food products.

Unit-V: VERICOMPOSTING (Teaching - 1 h / week)

Classification of Composting, Composting Techniques - Windows - Aerated Static Pile - In-vessel - Pre and Post processing - Composting agent - Desired characteristics - Vermicomposition - Process of vermicomposting - Vermicompost as sustainable biofertilizer.

References

Biofertilizers

- Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co., New Delhi.
- Newton, W. E. *et al.* (1977). Recent Developments in Nitrogen Fixation. Academic Press, New York.
- Schwintzer, C. R. and Tjepkema, J. D. (1990). The Biology of *Frankia* and *Actinorhizal* Plants. Academic Press Inc., San Diego, USA.
- Stewart, W. D. P. and Gallon, J. R. (1980). Nitrogen Fixation. Academic Press, New York.
- Subba Rao, N. S. (1982). Advances in Agricultural Microbiology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

- Subba Rao, N. S. (2002). Soil Microbiology. 4th ed. Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Subba Rao, N. S. and Dommergues, Y. R. (1998). Microbial Interactions in Agriculture and Forestry. Vol. I, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Verma, A. (1999). Mycorrhiza. Springer Verlag, Berlin.
- Wallanda, T. *et al.* (1997). Mycorrhizae. Backley's Publishers, The Netherlands.

Mushroom Technology

- Alice, D., Muthusamy and Yesuraja, M. (1999). Mushroom Culture. Agricultural College, Research Institute Publications, Madurai.
- Marimuthu, T. *et al.* (1991). Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
- Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
- Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.
- Tripathi, D. P. (2005). Mushroom Cultivation. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Vermicomposting

- Benny Joseph (2005). Environment Studies. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Dubay, R. C. (2009). A Textbook of Biotechnology. S. Chand & Co. Ltd., New Delhi.
- Jogdand, S. N. (2003). Environmental Biotechnology. Himalaya Publishing House, New Delhi.

ANATOMY, AND EMBRYOLOGY – P16B06

Semester : II
Instruction Hours/Week: 6

Core Course: 5
Credit: 5

Unit-I: ANATOMY (Teaching - 2 hrs / week)

Development of plant body. Meristems - Theories of organisation of shoot apical meristem (SAM), and root apical meristem (RAM). Modern molecular concept on the development of SAM and RAM. Floral meristem.

Structure and diversification of simple tissues (Parenchyma, collenchymas and sclerenchyma) Brief outline on development, structure and function of primary root, stem and leaf of dicot and monocot.

Secretory cells and tissues. Brief account on epidermal tissue, stomatal types in monocotyledons and dicotyledons.

Unit-II: ANATOMY (Teaching - 1 h / week)

Cambium in dicotyledons: Origin and development of cambial tissues. Seasonal effects and activity. Factors affecting cambial activity. Cambial growth in wound, callus and graft tissues.

Cambium in monocotyledons: Anomalous cambial activity (abnormal position & behavior, accessory and extracellular formation)

Periderm (Cork Cambium): Extent, duration, morphology and function of periderm components (Phellogen, Phellem and Phelloderm). Factors affecting formation and activity of periderm

Unit-III: ANATOMY (Teaching - 1 h / week)

Secondary Xylem: Structure of Xylem components (tracheids, vessel elements, xylem fibres and xylem parenchyma). Phylogenetic trends in specialization of Xylem components.

Secondary Phloem: Structure of Phloem components (Sieve tube elements, companion cell, phloem fibres and phloem parenchyma). Phylogenetic trends in specialization of Phloem components..

Transfer cells: Occurrence, structure and functions

Annual rings: Growth and seasonal activity. Basic concepts of dendrochronology

Wood: Types of wood - ring and diffuse; sap and heart; soft and hard; tension and compression woods. Physical and chemical properties of wood. Wood defects and wood preservation. Economic uses of wood.

Unit-IV: EMBRYOLOGY (Teaching - 1 h / week)

Microsporangium: Structure and development of anther - wall layers, epidermis, endothecium, middle layer and tapetum. Sporogenous tissue: Microspore mother cell – structure and development of pollen grain – pollen wall layers

Megasporangium: Structure and type of ovules – megasporogenesis

Embryosac: Structure and types

Unit-V: EMBRYOLOGY (Teaching - 1 h / week)

Brief account on anther dehiscence and pollination –pollen incompatibility – methods to overcome pollen incompatibility - fertilization – outline on nature of stigma and style –

pollen germination, pollen tube growth and discharge of gametes – development of status embryo – dicot (Crucifer type) and monocot (Tritium type).

Endosperm : Types – nuclear, cellular, helobial and ruminant. Functions of Endosperm. Brief account on Polyembryony and Apomixis.

References

Anatomy

- Clowers, F. A. L. (1961). Apical Meristems. Blackwell Scientific Publication, Oxford.
- Cutter, E. G. (1978). Plant Anatomy. Edward Arnold Publishers Ltd., London.
- Easu, K. (1953). Plant Anatomy. John Wiley & Sons Inc., New York.
- Fahn, A. (1989). Plant Anatomy. Maxwell Pvt. Ltd., Singapore.
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- Pandey, B. P. (1989). Plant Anatomy. S. Chand and Co. Ltd., New Delhi.
- Singh, V., Pande, P. C. and Jain, D. K. (1987). Anatomy of Seed Plants. Rastogi Publications, Meerut.

Embryology

- Agarwal, S. B. (1990). Embryology of Angiosperms - a fundamental approach. Sahitya Bhawan, Agra.
- Bhojwani, S. S. and Bhatnagar, S. P. (1981). Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd., New Delhi.
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- Maheswari, P. (1963). An Introduction to Embryology of Angiosperms. International Society of Plant Morphologies, University of Delhi.
- Raghavan, V. (1976). Experimental Embryogenesis in Vascular Plants. Academic Press, London.

ANGIOSPERM TAXONOMY AND MORPHOGENESIS – P16B07

Semester : II
Instruction Hours/Week: 6

Core Course: 6
Credit: 5

Unit-I: TAXONOMY (Teaching - 1 h / week)

Introduction: History of classification - Carolus Linnaeus, Cronquist and Takhtajan, Biosystematics, Chemotaxonomy, Numerical Taxonomy and Molecular Taxonomy (DNA markers).

Unit-II: TAXONOMY (Teaching - 1 h / week)

International Code of Botanical Nomenclature - Typification, principles of priority and their limitations. Effective and valid publications - author citation, retention, choice and rejection of names. A general account on keys. Herbarium preparation and management. A brief account of B.S.I. and its role.

Unit-III: TAXONOMY (Teaching - 1 h / week)

Diagnostic characters of Menispermaceae, Caryophyllaceae, Rhamnaceae, Sapindaceae, Aizoaceae, Gentianaceae, Boraginaceae, Aristolochiaceae, Casuarinaceae, Commelinaceae.

Unit-IV: MORPHOGENESIS (Teaching - 1 h / week)

Definition - Morphogenesis and its relation to morphology. Turing's diffusion reaction theory - Morphogenetic factors - growth regulators - genetic and environment. Polarity. Molecular basis of morphogenesis - Cytosol and cytoskeleton, microtubules and microfilaments. Cellular level morphogenesis.

Unit-V: MORPHOGENESIS (Teaching - 2 hrs / week)

Nuclear-Cytoplasmic interaction - transplantation experiments in *Acetabularia*. Sach's and Errera's laws - Asymmetric divisions and their significance. Morphogenesis at tissue level - Differentiation, dedifferentiation and redifferentiation of vascular tissue *in vivo*, *in vitro* (eg.: wound healing process). Plant galls and their importance.

References

Taxonomy

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ECOLOGY, PHYTOGEOGRAPHY AND CONSERVATION BIOLOGY – P16B08

Semester : II

Core Course: 7

Instruction Hours/Week: 6

Credit: 5

Unit-I: ECOLOGY (Teaching - 1 h / week)

Concept and dynamics of ecosystem: Types of ecosystem, components, Food chain, Food web and energy flow. Trophic level, and ecological pyramids. Productivity and biogeochemical cycles (N, P, C, S). Ecological amplitude of a species and adaptation - Ecads, ecotypes, ecospecies. Raunkaier's Life Forms.

Unit-II: ECOLOGY (Teaching - 1 h / week)

forest Types conservation - energy resources - Non-renewable and renewable.

Environmental pollution - Air, water, soil, thermal and radiation. pollution Cumulative effect of pollution on global environment, Ozone depletion, Greenhouse effect and their consequences. Climatic factors. Ecological indicators.

Unit-III: PHYTOGEOGRAPHY (Teaching - 1 h / week)

Phytogeography: Range - Dispersal and migration barriers hypothesis, Continental drift hypothesis, Land - Bridges hypothesis, Age and Area hypothesis, Endemism. Introduction to Remote Sensing and its uses. Vegetation types of India.

Unit-IV: CONSERVATION BIOLOGY (Teaching - 1 h / week)

Conservation Biology - Introduction - Ecosystem and Species based approaches - Social approaches - Sacred groves - Chipko movement - Forest management, Biodiversity awareness programmes, Biodiversity Education Resources and Sustainable Development - Role of IUCN, UNESCO, WWF, ICSU in Conservation Programme, Biopyracy..

Unit-V: CONSERVATION BIOLOGY (Teaching - 2 hrs / week)

In situ conservation (Afforestation, Social Forestry, Agro Forestry, Botanical Gardens, Biosphere Reserves, National Parks, Sanctuaries, Sacred Groves and Sthalavrikshas) and *ex situ* conservation (Cryopreservation, Gene Banks, Seed Banks, Pollen Banks, Sperm Banks, DNA Banks, Tissue Culture and Biotechnological strategies) - Environmental Education, Environmental ethics.

References

Ecology

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Phytogeography

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Conservation Biology

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PRACTICAL II – P13BO9P
(Covering Core Courses V, VI & VII)

Semester : II
Instruction Hours/Week: 6

Core Course: 8
Credit: 5

Anatomy and Wood Science

- Dissection of shoot apex in *Hydrilla* and whole mount.
- Wood structure - TS, TLS and RLS - showing variations in vessel elements, fibres axial parenchyma and ray parenchyma.
- Identification of different types of stomata (Spotters)
- Anomalous secondary growth in *Nyctanthus* and *Aristolochia*.

Embryology

- Slides showing developmental stages of anther, embryosac and embryo.
- Study of different types of pollen grains.
- Study of endosperm types (Spotters)
- Dissection of Embryo - *Abelmoschus*, *Tridax*

Taxonomy

Study of the plants belonging to the following families:

- Menispermaceae
- Caryophyllaceae
- Rhamnaceae
- Sapindaceae
- Aizoaceae
- Gentianaceae
- Boraginaceae
- Aristolochiaceae
- Casuarinaceae
- Commelinaceae
- Identification of binomial of the plants with the help of Gamble Flora.
- ICBN problems to be worked out.
- Submission of **10 herbarium specimens** with field note book and tour report.
- The students should undertake as part of their course a tour and field study of vegetation under the guidance of the staff for three to five days within the state and neighbouring states. Students who have not undertaken the above activities shall forfeit the appropriate marks allotted for this purpose (10 marks) for practical examination.

Morphogenesis

- Superficial 'V' shaped wounding of young stem and studying the wound healing response in Dicot.
- Bisecting aerial root apices and studying their further behaviour.
- Study of one fungal gall (Club - Root of Cabbage) and insect gall (*Pongamia* leaf - gall)

Ecology

- Estimation of dissolved oxygen content in water samples.
- Estimation of chloride content in water samples.

Phytogeography and Conservative Biology

- Study of vegetation by Quadrat method.

INDUSTRIAL MICROBIOLOGY – P16BO10E

Semester : II
Instruction Hours/Week: 6

Elective Course: 2
Credit: 4

Unit-I (Teaching - 1 h / week)

General Introduction, history and development of industrial microbiology, scope of industrial microbiology. Microorganisms in industry - Sterilization - Preparation of media - Isolation and culture methods for microorganisms - Principles of storage of microbes at low temperature in Lyophilization.

Unit-II (Teaching - 2 hrs / week)

Principle of fermentation: factors involved in fermentation, differences between biochemical and chemical processes; biochemical reactions, operational consideration. Fermenter configuration and various types of fermentors; principle, design and operation characteristics of fermentors.

Unit-III (Teaching - 1 h / week)

Methylophils: Methanogens and methylophils, Mechanism of methane production - Economic importance of methylophils. Hydrogen fuel. Single Cell oil, Microbial leaching. Sulphur utilizing bacteria.

Unit-IV (Teaching - 1 h / week)

Microbial production of food; Microbial Single Cell Protein (SCP). Fermented dairy products, fermented meats, leavening of breads, alcoholic beverages - beer, distilled liquors and wines

Unit-V (Teaching - 1 h / week)

Production of pharmaceuticals: Human Proteins, Vaccines and Vitamins.

Antibiotics and their mode of action with reference to Penicillin, Streptomycin, and Erythromycin.

References

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CYTOGENETICS AND PLANT BREEDING – P16B011

Semester : III
Instruction Hours/Week: 6

Core Course: 9
Credit: 5

Unit-I: CELL BIOLOGY (Teaching - 1 h / week)

Structural organisation of Plasma membrane - Structure, models and functions - Ultrastructures of Chloroplast and Mitochondria, Chloroplast and Mitochondrial genomes - Structure and functions of Glyoxisomes, Peroxisomes and Lysosomes. Protein targeting in mitochondria.

Unit-II: CELL BIOLOGY (Teaching - 1 h / week)

Ultrastructure of Nucleus, structure and organisation of Chromosomes. DNA types - Replication methods and DNA repair mechanisms. RNA types and functions - Genetic code – Detailed account of Programmed cell death (PCD).

Unit-III: GENETICS (Teaching - 1 h / week)

Linkage and crossing over - Sex determination in plants - Sex limited and sex linked inheritance - Cytoplasmic inheritance - Male sterility and mechanism of inheritance, Application of cytoplasmic and genetic male sterilities.

Unit-IV: GENETICS (Teaching - 1 h / week)

Mutation - Biochemical basis, induction, mutagenic agents - Physical and chemical mutagens, reverse and suppressed mutations. Polyploidy - types, induction, role in plant breeding. Population genetics - Hardy and Weingberg Law.

Unit-V: PLANT BREEDING (Teaching - 2 hrs / week)

Plant breeding techniques - Breeding methods in self pollinated, cross pollinated, vegetatively propagated and apomictic plants. Inbreeding depression - Role of heterosis and hybrid vigour in plant breeding. Somaclonal variation in crop improvement.

References

Cell Biology

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Genetics

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Plant Breeding

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PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIOPHYSICS – P16BO12

Semester : III
Instruction Hours/Week: 6

Core Course: 10
Credit: 5

Unit-I: PLANT PHYSIOLOGY (Teaching - 2 hrs / week)

Water and its relation in plants: Properties of water - chemical potential and water potential and bulk movement of water.

Mineral nutrition in plants – Modern concepts of mineral salt absorption and its translocation - modern concepts of mineral salt absorption and translocation.

Stomata: Physiology – opening and closing mechanism

Photosynthesis: Light reactions – cyclic and noncyclic types – Emerson Enhancement Effect – Photophosphorylation. CO₂ fixation – C₃, C₄ and CAM types

Unit-II: PLANT PHYSIOLOGY (Teaching - 1 h / week)

Respiration: Glycolysis – Aerobic and anaerobic respiration-Kreb's cycle and Respiratory electron transport chain - Oxidative Phosphorylation – Cyanide resistant respiration Photorespiration – pathway and its significance

Mechanism of nitrogen fixation, Biological nitrogen fixation – nitrate uptake and assimilation.

Plant growth regulators: Structure, synthesis and mode of action of Auxin, Gibberellin, Cytokinin. Phytochrome and its role.

Stress physiology: Brief account on water and salt stress

Unit-III: BIOCHEMISTRY (Teaching - 1 h / week)

Carbohydrates: Classification, structure, properties and function carbohydrates

Protein: Classification, structure (primary, secondary, tertiary and quaternary), properties and function.

Enzyme: Classification, properties and mode of action. Enzyme kinetics – Km value and V_{max}, Michaelis menton concept.

Unit-IV: BIOCHEMISTRY (Teaching - 1 h / week)

Lipids: Classification, structure, properties, and function of lipids. Synthesis and degradation of fatty acids (α and β oxidation pathway)

Nucleic acids: Structure of DNA and RNA.

Secondary metabolites: Biosynthesis and function of terpenes, phenols, alkaloids, flavonoids.

Unit-V: BIOPHYSICS (Teaching - 1 h / week)

Bioenergetics: Scope and definition. Energy and work - entropy and enthalpy. Laws of thermodynamics. Redox potential, redox couples. ATP bioenergetics,

Photobiology: Dual nature of light, electromagnetic radiation, Energy states, Excitation De-excitation states – heat emission. light emission – fluorescence & phosphorescence.

Reference

Plant Physiology

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Plant Biochemistry

- Blonstein, A. B. and King, P. J. (1987). A Genetic Approach to Plant Biochemistry. Narosa, New Delhi.
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Biophysics

- Casey, E. J. (1962). Biophysics: Concepts and Mechanics. Van Nostrand Reinhold Co. and East-West Press, New Delhi.
- Lehninger, A. L. (1971). Bioenergetics: The Molecular Basis of Biological Energy Transformation. Addison Wiley.
- Salil Bose, S. (1982). Elementary Biophysics. Vijaya Printers, Madurai.

PRACTICAL III – P16BO13P
(Covering Core Courses IX & X)

Semester : III
Instruction Hours/Week: 6

Core Course: 11
Credit: 5

Cytogenetics and Plant Breeding

1. Squash and Smear techniques - Onion root tip and Rheo flower buds.
2. Identification of DNA using Schiff's Reagent/TBO/methyl green.
3. Emasculation, Crossing, Bagging
4. Working problems in population genetics

Demonstration using Charts / Models:

1. Regulations of gene expression
2. Isolation of plasmid from *E. coli*
3. Detection of a plasmid containing foreign DNA (Recombinant Ti plasmid)
4. Mapping a cloned gene on a cosmic vector

Plant Physiology

1. Determination of water potential by gravimetric and plasmolytic methods.
2. Determination of chlorophyll-a, chlorophyll-b, total chlorophyll by the Arnon's method, and determination of carotenoids.
3. Estimation of protein by Lowry's method (or) Bradford
4. Estimation of total phenols.
5. Estimation of total nitrogen

Biochemistry

1. Extraction and estimation of lipid
2. Determination of reducing sugars in (grapes) fruit
3. Separation of amino acids by paper chromatography
4. Extraction of amylase and determination of its activity
5. Determination of peroxidase activity.

Biophysics

pH meter, Spectrophotometer, Centrifuge, Electrophoretic apparatus

GENETIC ENGINEERING - P16B014E

Semester : III
Instruction Hours/Week: 6

Elective Course: 3
Credit: 4

Unit-I (Teaching - 1 h / week)

Genetic Engineering: Basic principles and scope. Gene cloning - Vectors in gene cloning – Ti Plasmids, Phagemids, Cosmids, Bacteriophages.

Unit-II (Teaching - 1 h / week)

Isolation, purification, restriction and ligation of DNA. Molecular mapping genome – Genetic and physical maps

Unit-III (Teaching - 1 h / week)

Direct gene transfer methods (Microinjection, Electroporation - Particle bombardment, lipofection nuclear transplantation) – Use of vector in gene transfer - *Agrobacterium* mediated gene transfer technique, selectable markers and reporters.

Unit-IV (Teaching - 2 hrs / week)

Principles and applications - DNA finger printing - PCR, RFLP, RAPD Techniques and Microarrays.

Unit-V (Teaching - 1 h / week)

Application of genetic engineering - Transgenic plants – Resistance to crop diseases – transgenic (*Bt* crops, GM crops) crops resistant to herbicide, drought and salt - advantages and disadvantages of transgenic crops - Terminator techniques

Reference

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PLANT TISSUE CULTURE – P16BO15E

Semester : III
Instruction Hours/Week: 6

Elective Course: 4
Credit: 4

Unit-I (Teaching - 1 h / week)

Introduction - History, Scope and Concepts of basic techniques in plant tissue culture. Laboratory requirements and organisation. Sterilization methods - Media preparation - Culture media (MS, Whites and Gamborg's media).

Unit-II (Teaching - 1 h / week)

Concept of Totipotency - Cellular totipotency, Cytological, cytochemical and vascular differentiations - Cell, tissue and organ culture - Tissue explants for culture - Paper, raft nurse technique, Plating method, Microchamber techniques, cell suspension cultures - Synchronization of suspension culture.

Unit-III (Teaching - 2 hrs / week)

Micropropagation: Introduction, protocol and application

Organogenesis: Protocol, factors affecting organogenesis. Role of growth regulators and other factors, somaclonal and gametoclonal variations.

Somatic embryogenesis - Process of somatic embryogenesis, factors affecting embryogenesis, synthetic seeds.

Unit-IV (Teaching - 1 h / week)

Haploid production: Anther and pollen culture technique – diploidisation. Method of production, significance and application of haploid.

Protoplast culture: Isolation of protoplasts (mechanical and enzymatic) - culture of protoplasts and viability. Protoplast fusion – spontaneous, mechanical and induced electroporation. Selection of somatic hybrids and cybrids.

Unit-V (Teaching - 1 h / week)

Production of secondary metabolites: Sources (callus, suspension and hairy root), cultural conditions, factors, and methodology.

Application of tissue culture in forestry, horticulture, agriculture and pharmaceutical industry.

References

- Bhojwani, S. S. and Razdan, M. K. (1983). Plant Tissue Culture: Theory and Practice. Elsevier Science Publishers, Netherlands.
- Dodds, J. H. and Roberts, I. W. (1985). Experiments in Plant Tissue Culture. Cambridge University Press, UK.
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BIOTECHNOLOGY – P16BO16

Semester : IV
Instruction Hours/Week: 6

Core Course: 12
Credit: 5

Unit-I (Teaching – 2hrs / week)

Basic techniques: introduction and scope of Biotechnology. Agarose gel electrophoresis - Transformation of *E. coli*.

Cloning strategies: Cloning genomic DNA - Genomic DNA libraries.

Cloning: Properties of cDNA libraries, preparation of cDNA for library construction, full-length cDNA cloning. Screening and selection of recombinant

Unit-II (Teaching - 1 h / week)

Anti-sense RNA technology - Flavr savr tomato and delay of fruit ripening, gene silencing, monoclonal antibodies and hybridoma technology. Gene therapy, Immunotoxin and recombinant vaccine.

Unit-III (Teaching - 1 h / week)

Basic principles of screening techniques - Dependent screening, screening by hybridization, probe design, chromosome walking, screening expression libraries - Immunological, Southern, Western, Northern blotting, DNA footprinting.

Unit-IV (Teaching - 1 h / week)

Basic DNA sequencing - Chain terminator sequencing, automated sequencing, Whole genome sequencing - Analysis of sequence data, DNA sequence databases and data base searches, site-directed mutagenesis.

Unit-V (Teaching - 1 h / week)

Enzyme Biotechnology - Isolation, purification, immobilization - Enzyme engineering - Engineering of Macromolecules - Protein engineering - Drug designing. Biosafety, ethical issues. Intellectual Property Right (IPR).

Reference

- Dubey, R. C. (2008). A Textbook of Biotechnology. S. Chand & Co. Ltd., New Delhi.
- Gupta, P. K. (1994). Elements of Biotechnology. Rastogi and Co., Meerut.
- Hammaond, J., McGarvey, P. and Yusibov, V. (2000). Plant Biotechnology. Springer Verlag.
- Primrose, S. B. (1994). Molecular Biotechnology. Blackwell Scientific Publishing, Oxford.
- Primrose, S. B., Twyman, R. M. and Old, R. W. (2001). Principles of Gene Manipulation. Blackwell Science, London.
- Sambrook, J., Fritsch, E. F. and Maiatis, T. (2000). Molecular Cloning: A Laboratory Manual. Spring Harbor Laboratory Press, New York.
- Satyanarayana, V. (2005). Biotechnology, Books and Allied (P) Ltd., Kolkata.
- Slater, A., Scotta, N. and Fowler, M. (2003). Plant Biotechnology. Oxford University Press, New Delhi.
- Singh, B. D. (1998). Biotechnology. Kalyani Publishers, New Delhi.

RESEARCH METHODOLOGY – P16BO17

Semester : IV
Instruction Hours/Week: 6

Core Course: 13
Credit: 5

Unit-I (Teaching - 1 h / week)

Choosing the problem for research - Review of Literature - Primary, Secondary and Tertiary sources - Bibliographs - Indexing and abstracting - Reporting the results of research in conference - Oral and Poster presentation.

Unit-II (Teaching - 1 h / week)

Planning and preparation of thesis - Research journals - National and International - Reprints - Proof correction - Full paper and Short Communication - Review Paper.

Unit-III (Teaching - 1 h / week)

Biostatistics - Scope - Collection - Tabulation and classification of data - Graphical diagrammatic representation - Mean, Median, Mode – Standard Deviation – Standard Error

Unit-IV (Teaching - 2 hrs / week)

Probability analysis - Test of significance - 't'-Test - Chi-square test - ANOVA Table - Correlation and its types

Unit-V (Teaching - 1 h / week)

Organisation of computer - CPU - Input and output devices - Memory (Internal and external) – General outline on MS Word, Excel and Power Point,) – Internet and its applications in research

References

- Balagurusamy, E. (1985). Programming in BASIC. 2nd ed. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Connor and Peter Woodford (1979). Writing Scientific Paper in English Pitman. Medical Publishing Co. Ltd., England.
- Dheenadayalu, R. (1987). Computer Science. Vol. I. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Gupta, S. P. (1990). Statistical Methods. S. Chand & Co. Ltd., New Delhi.
- Jayaraman, J. (1972). Techniques in Biology. Higginbothams Pvt. Ltd., Madras.
- Jayaraman, J. (1985). Laboratory Manual in Biochemistry. Wiley Eastern Ltd., New Delhi.
- Khan, I. A. and Khannum, A. (1994). Fundamentals of Biostatistics. Vikas Publishing, Hyderabad.
- Kothari, C. R. (1991). Research Methodology: Methods and Techniques. Wiley Eastern Ltd., New Delhi.
- Rastogi, V. B. (2006). Fundamentals of Biostatistics. Ane Book India, New Delhi.
- Sree Ramulu, V. S. (1988). Thesis Writing. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Zar, J. H. (1984). Biostatistics Analysis. Prentice Hall International, New Jersey.

HORTICULTURE - P13BO18E

Semester : IV
Instruction Hours/Week: 6

Elective Course: 5
Credit: 4

Unit-I (Teaching - 2 hrs / week)

Importance and scope of horticulture – classification of horticultural plants (vegetable, fruit, spices). Plant propagation methods - Cutting, layering, grafting, budding. Stock - scion relationship, growth regulators in horticulture

Unit-II (Teaching - 1 h / week)

Principles and methods of designing outdoor garden - Hedges, Edges, Fences, Trees, Topiary, Trophy, Climbers, Arches, cycads, ferns and palms - Lawn establishment and maintenance - Water garden – Rock garden .

Unit-III (Teaching - 1 h / week)

Indoor gardening - Foliage plants, flowering plants, roof and terrace plants, hanging basket. Bonsai – kinds and methods .

Floriculture - Cultivation of commercial flower crops - Rose, Jasmine and Chrysanthemum, Dry and wet flower decoration .

Unit-IV (Teaching - 1 h / week)

Classification of vegetables, cultivation of important vegetable - Tomato, potato, onion, brinjal, cabbage and snake guard. Model layout for a kitchen garden.

Unit-V (Teaching - 1 h / week)

Fruit crops - Induction of flowering, flower thinning, fruit setting, fruit development. Cultivation of important fruit crops - Mango, Grapes and Guava. Preservation of fruits. Cultivation of tree species - *Eucalyptus* and *Tectona* (Teak).

References

- Arora, J. S. (1992). Introductory Ornamental Horticulture. Kalyani Publishers, New Delhi.
- Edmond, J. B. *et al.* (1977). Fundamentals of Horticulture. Tata McGraw Hill Publishers Co. Ltd., New Delhi.
- George Acquaah. (2002). Horticulture Principles and Practices. 2nd ed. Pearson Education, Delhi.
- Kumar, N. (1987). Introduction to Horticulture., Rajalakshmi Publishers, Nagercoil.
- Manibushan Rao, K. (1991). Textbook of Horticulture. Macmillan Publishing Co., New York.
- Rao, K. M. (2000). Text Book of Horticulture. Macmillan India Ltd., New Delhi.

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PROJECT WORK - P16BOP19

Semester : IV
Instruction Hours/Week: 12

Project
Credit: 5

PROJECT WORK
(Dissertation 75 marks & Viva Voice – 25 Marks)
