



Sem-ester	Course	Course Title	Ins. hr/ week	Cre- dit	Exam hr	Marks		Total
						Int.	Ext.	
<b>I</b>	Core Course I (CC)	Plant Biodiversity I (Algae, Fungi, Lichens and Bryophytes)	6	5	3	25	75	100
	Core Course II (CC)	Plant Biodiversity II (Pteridophytes, Gymnosperms and Paleobotany)	6	5	3	25	75	100
	Core Course III (CC)	Microbiology, Plant Pathology and Immunology	6	4	3	25	75	100
	Core Course IV (CC)	Biofertilizers and Mushroom Technology	6	4	3	25	75	100
	Core Practical I (CP)	Plant Biodiversity I & II, Microbiology, Plant Pathology and Immunology & Biofertilizers and Mushroom Technology (P)	6	4	3	40	60	100
	<b>Total</b>			<b>30</b>	<b>22</b>			
<b>II</b>	Core Course V (CC)	Anatomy, Embryology and Morphogenesis	6	5	3	25	75	100
	Core Course VI (CC)	Angiosperm Taxonomy, Ecology and Conservation	6	5	3	25	75	100
	Core Practical II (CP)	Anatomy, Embryology and Morphogenesis & Angiosperm Taxonomy, Ecology and Conservation (P)	6	4	3	40	60	100
	Elective Course I (EC)	Forestry and Wood Science	6	4	3	25	75	100
	Elective Course II (EC)	Industrial Microbiology	6	4	3	25	75	100
	<b>Total</b>			<b>30</b>	<b>22</b>			
<b>III</b>	Core Course VII (CC)	Cell Biology, Genetics and Plant Breeding	6	5	3	25	75	100
	Core Course VIII (CC)	Plant Physiology, Biochemistry and Biophysics	6	5	3	25	75	100
	Core Practical III (CP)	Cell Biology, Genetics and Plant Breeding & Plant Physiology, Biochemistry and Biophysics (P)	6	4	3	40	60	100
	Elective Course III (EC)	Genetic Engineering and Biotechnology	6	4	3	25	75	100
	Elective Course IV (EC)	Horticulture and Landscaping	6	4	3	25	75	100
	<b>Total</b>			<b>30</b>	<b>22</b>			
<b>IV</b>	Core Course IX (CC)	Plant Tissue Culture	6	5	3	25	75	100
	Core Course X (CC)	Research Methodology	6	5	3	25	75	100
	Core Practical IV (CP)	Plant Tissue Culture & Research Methodology (P)	6	4	3	40	60	100
	Elective Course V (EC)	Food Preservation and Processing	6	4	3	25	75	100
	Project Work	Project Work	6	6	–	-	-	100
	<b>Total</b>			<b>30</b>	<b>24</b>			
<b>Grand Total</b>			<b>120</b>	<b>90</b>				<b>2000</b>

## **ELECTIVE COURSES**

The Botany Department offers the following Elective Courses for P.G. Botany students:

- EC-I : Forestry and Wood Science (Semester II)
- EC-II : Industrial Microbiology (Semester II)
- EC-III: Genetic Engineering and Biotechnology (Semester III)
- EC-IV: Horticulture and Landscaping (Semester III)
- EC-V : Food Preservation and Processing (Semester IV)

Core Paper	-	10
Core Practical	-	4
Elective	-	5
Project	-	1

### **Note:**

1. Theory	Internal	25 marks	External	75 marks
2. Practical	”	40 marks	”	60 marks

3. Separate passing minimum is prescribed for Internal and External

- a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks)
- b) The passing minimum for University Examinations shall be 40% out of 75 marks (i.e. 30 marks)
- c) The passing minimum not less than 50% in the aggregate.

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## **CORE COURSE I**

### **PLANT BIODIVERSITY I (ALGAE, FUNGI, LICHENS AND BRYOPHYTES)**

#### **Objectives:**

This paper provides information pertaining to classification, structure, function and economic importance of Algae, Fungi, Lichens and Bryophytes.

#### **Unit I: ALGAE**

General trends and criteria for Algal classification (Bold and Wynne, 1978). Salient features of major classes: Prochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Phaeophyta and Rhodophyta. Ultrastructure of Prokaryotic and Eukaryotic algal cells and their components - cell wall, protoplasm, flagella, eye spots, chloroplast, pyrenoid, nucleus, pigments and reserve foods. Economic importance of algae - Food and feed - Single cell protein - Industrial products (Agar-Agar, Carrageenan, Iodine, Vitamins) - in Medicine and Diatomaceous earth.

#### **Unit II: ALGAE**

Range of thallus structure, origin and evolution of sex in algae, phylogeny and interrelationships of algae. Lifecycle patterns in algae and alternation of generations, Fossil algae.

Ecology of Algae: Freshwater algae, marine algae, soil algae, symbiotic algae and parasitic algae. Algae as pollution indicators, algal blooms, algicides culture and cultivation of fresh water and marine algae - Knop's solution and Chu-10 medium (1972).

#### **Unit III: FUNGI**

General features, occurrence and distribution. Mode of nutrition in fungi, culture of fungi. Classification of fungi (Alexopoulos and Mims, 1979), recent trends in the classification of fungi. General characters of major classes: Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Thallus organization, cell structure and fruit bodies. Phylogeny and interrelationships of major groups of fungi. Economic importance of fungi, in medicine and in industries.

#### **Unit IV: FUNGI**

Homothallism and Heterothallism in fungi. Homokaryon and Heterokaryon, Hormonal control in sex organ development in fungi. Physiological specialization and physiological races in fungi. Reproduction, life cycle types, parasexual cycles, reduction in sexuality in fungi. Spore dispersal mechanisms and fungal genetics, Fossil fungi.

**LICHENS:** General features, classification (Miller, 1984), Distribution, thallus organisation, vegetative and sexual reproduction, lichens as indicators of pollution and economic importance.

### **Unit V: BRYOPHYTES**

General features, distribution, classification (Watson, 1955), General characters of major groups. Marchantiales, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales. Range of vegetative structure, Evolution of gametophytes and sporophytes. Reproduction - Vegetative and sexual, spore dispersal mechanisms in bryophytes, spore germination patterns in bryophytes. Ecological and economic importance of bryophytes. Origin and interrelationships, Fossil bryophytes.

### **REFERENCES**

#### **ALGAE**

1. Bold, H.C. and Wynne, M.J. (1978). *Introduction of Algae - Structure and Reproduction*. Prentice Hall, New Jersey.
2. Chapman, C.J. and Chapman, D.J. (1981). *The Algae* (2<sup>nd</sup> ed.). Macmillan, London.
3. Darley, W.M. (1982). *Algal Biology: A Physiological Approach*. Blackwell Scientific Publications. Oxford, London.
4. Fritsch, F.E. (1976). *Structure and Reproduction of the Algae Vols. I & II*. Cambridge University Press, London.
5. Ian Morris (1967). *An Introduction to the Algae*. Hutchinson University Library, London.
6. Kumar, H.D. (1989). *Introductory Phycology*. East-West Press, Madras.
7. Kumar, H.D. and Singh, H.N. (1982). *A Textbook of Algae*. East-West Press, Madras.
8. Lee, R.E. (2008). *Phycology* (4<sup>th</sup> Edition). Cambridge University Press, New Delhi.
9. Round, F.E. (1981). *The Ecology of Algae*. Cambridge University Press, London.
10. Sharma, O.P. (1986). *Textbook of Algae*. Tata McGraw Hill Co., New Delhi.
11. Smith, G.M. (1976). *Cryptogamic Botany Vol. I. Algae and Fungi*. Tata McGraw Hill, New Delhi.
12. Van Den Hoek, C., Mann, D.G. and Jahns, H.M. (1995). *Algae (An Introduction to Phycology)*. Cambridge University Press India Pvt. Ltd., New Delhi.
13. Vashishta, B.R. *et al.* (2008). *Botany for Degree Students – Algae*. S. Chand and Co. Ltd., New Delhi.
14. Venkataraman *et al.* (1974). *Algal Form and Function*. Today and Tomorrow Publishers, New Delhi.

#### **FUNGI**

1. Alexopoulos, C.J. and Mims, C.W. (1979). *Introductory Mycology*. Wiley Eastern Ltd., New York.

2. Bessey, E.A. (1979). *Morphology and Taxonomy of Fungi*. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Bold, H.C. *et al.* (1980). *Morphology of Plants and Fungi*. Harper and Row Publishing Inc., New York.
4. Burnet, J.H. (1971). *The Fundamentals of Mycology*. ELBS Publications, London.
5. Mehrotra, R.S and Aneja, K.R. (1990). *An Introduction of Mycology*. Wiley Eastern Ltd., New Delhi.
6. Ringo, J. (2004). *Fundamental Genetics*. Cambridge University Press, United Kingdom.
7. Sharma, P.D. (1987). *The Fungi*. Rastogi and Co., Meerut.
8. 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**

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

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## **CORE COURSE II**

### **PLANT BIODIVERSITY II (PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY)**

#### **Objectives:**

This paper provides information pertaining to classification, structure, function and economic importance of Pteridophytes, Gymnosperms and Paleobotany.

#### **Unit I : PTERIDOPHYTES**

General features and origin of Pteridophytes. 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**

Range of morphology, structure, reproduction and evolution of gametophytes and sporophytes of the following orders: Ophioglossales, Marattiales, Osmundales, Filicales and Salviniales. Stellar evolution in pteridophytes, Heterospory and origin of seed habit. Structure, development and evolution of sorus in Filicales. Phyletic slide, spore germination patterns. Economic importance of Pteridophytes.

#### **Unit III : GYMNOSPERMS**

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

#### **Unit IV : GYMNOSPERMS**

A general account on the distribution, morphology, anatomy, reproduction and phylogeny of Cycadales, Coniferales, Ginkgoales, Ephedrales, Welwitschiales and Gnetales. Economic importance of Gymnosperms.

#### **Unit V : PALEOBOTANY**

Concepts of Paleobotany, A general account on Geological Time Scale. Techniques for paleobotanical study.

Fossil types: Compressions, incrustation, casts, molds, petrifications, coalballs and compactions. Age determination and methods of study of fossils. Systematic and Nomenclature of fossil plants. Paloclimates and fossil plants. Role of fossil in oil exploration and coal excavation, Paleopalynology.

## REFERENCES

### PTERIDOPHYTES

1. Bower, F.O. (1939). *The Ferns Vols. I - III*. Today and Tomorrow's Printers, New Delhi.
2. Eames, A.J. (1936). *Morphology of Vascular Plants - Lower Groups*. Tata McGraw Hill, New Delhi.
3. Ingold, C.T. (1939). *Spore Discharge in Land Plants*. Oxford University Press, Oxford, UK.
4. Parihar, N.S. (1985). *The Biology and Morphology of Pteridophytes*. Central Book Depot, Allahabad.
5. Rashid, A. (1986). *An Introduction to Pteridophyta*. Vani Educational Books, New Delhi.
6. Sharma, O.P. (1990). *Textbook of Pteridophyta*. Macmillan India Ltd., India.
7. Smith, G.M. (1971). *Cryptogamic Botany Vol. II Bryophytes and Pteridophytes*. Tata McGraw Hill, New Delhi.
8. Sporne, K.R. (1972). *The Morphology of Pteridophytes*. B. I. Publications, Madras.
9. Sundararajan, S. (2007). *Introduction to Pteridophyta*. New Age International Publishers, New Delhi.
10. Vashishta, P.C. *et al.* (2008). *Botany for Degree Students: Pteridophyta*. S. Chand & Co. Ltd., New Delhi.

### GYMNOSPERMS

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

### PALEOBOTANY

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

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## **CORE COURSE III**

### **MICROBIOLOGY, PLANT PATHOLOGY AND IMMUNOLOGY**

#### **Objectives:**

This paper helps

1. To understand the structure, biology, nutrition and reproduction of virus and bacteria
2. Give information on pathogen causing diseases in plants and then mode of action
3. To provide information on immunology.

#### **MICROBIOLOGY**

##### **Unit I**

Scope, branches of Microbiology. Whittaker's five kingdom concept (1969). Prokaryotic and Eukaryotic microbes. General features of virus, classification, ultrastructure, replication, economic importance, Virions and Prions, Phytoplasma (including Mycoplasma).

##### **Unit II**

Bergey's system of Bacterial classification (1984-1991) – Eubacteria, Archaeobacteria, Cyanobacteria and Actinomycetes - General account, ultrastructure, nutrition, growth and reproduction. Bacterial culture techniques and Economic importance.

#### **PLANT PATHOLOGY**

##### **Unit III**

Organisms and causal factors responsible for plant diseases – Methods of studying plant diseases. Koch's postulates. Plant-microbe interactions – mutualism, Mycoparasitism, Antagonism, Commensalism. Defense mechanism in plants. Integrated disease management.

##### **Unit IV**

Common Plant Diseases – Tobacco mosaic, Cucumber mosaic, Little leaf disease of Brinjal, Citrus canker, Rice blight, Tikka disease of groundnut, Wilt of cotton, White rust of Mustard, Rust of Wheat, Root Knot of tomato, Red rot of sugarcane.



## **IMMUNOLOGY**

### **Unit V**

General account of immune systems – innate and acquired immunity – Antigen and antibody (types, structure and interactions). Detection of antibody (immuno electrophoresis, ELISA and RIA). Immunohistochemistry – Major and minor Blood groups – ABO and Rh incompatibility.

### **REFERENCES:**

1. Annadurai, B. (2008). *A Textbook of Immunology and Immunotechnology*. S. Chand & Co. Ltd., New Delhi.
2. Bilgrami, K.S. and Dube, H.C. (1990). *A Textbook of Modern Plant Pathology*. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Carpenter, P.L. (1987). *Microbiology*. Saunders Co., Philadelphia, USA.
4. Dubey, R.C. and Maheshwari, D.K. (2007). *A Textbook of Microbiology*. S. Chand & Co. Ltd., New Delhi.
5. Kuby, J. (2000). *Immunology* (4<sup>th</sup> ed.). W.H. Freeman and Co., New York.
6. Mehrota, R.S. (1994). *Plant Pathology*. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
7. Nandini Shetty (2008). *Immunology - Introductory Textbook*. New Age International Publishers, New Delhi.
8. Pandey, B.P. (1982). *A Textbook of Plant pathology, Pathogen and Plant Diseases*. S. Chand and Co. Ltd., New Delhi.
9. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R. (1993). *Microbiology*. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
10. Power and Dagainwala (1994). *General Microbiology*. Himalayan Publishing House Bombay.
11. Rangaswamy, G. (1972). *Diseases of Crop Plants in India*. Prentice Hall of India Pvt. Ltd., New Jersey.
12. Schlegel, H.G. (1993). *General Microbiology* (7<sup>th</sup> Edition). Cambridge University Press, United Kingdom.
13. Singh, R.S. (1990). *Plant diseases* (6<sup>th</sup> ed.). Oxford & IBH, New Delhi.
14. Staley, J.T. *et al.*, (1991). *Bergey's manual of Systematic Bacteriology Vols. I– IV*. Williams & Wilkins, London.

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## CORE COURSE IV

### BIOFERTILIZERS AND MUSHROOM TECHNOLOGY

#### Objectives:

This paper helps

1. To understand the structure, biology, nutrition and reproduction of virus and bacteria
2. To give information on pathogen causing diseases in plants and then mode of action
3. To provide information on immunology.

#### BIOFERTILIZERS

##### Unit I

Biofertilizers: Introduction, scope and general account. Cyanobacterial biofertilizers –organism, medium (BG11), isolation (nitrogen fixing), mass cultivation, career material, field inoculation. Mass cultivation of *Azolla*. Symbiotic association of Cyanobacteria.

##### Unit II

Bacterial Biofertilizers: Isolation – *Azotobacter* – Ashby's mannitol agar, *Azospirillum* – Semisolid medium – (Bulow and Dobereiner, 1975). *Rhizobium* – Yeast Extract Mannitol Agar medium – Culture characteristics. Mass production of *Azospirillum*, *Azotobacter* and *Phosphobacteria*. Phosphate solubilization and mobilization – *Azospirillum*, *Azotobacter*, *Frankia*, *Phosphobacteria* and *Rhizobium*.

##### Unit III

Mycorrhiza: Scope and general account of Ecto, Endo and Arbuscular mycorrhizae (AM). Isolation and inoculation techniques. Legume-AM interaction – National and Regional Biofertilizers production and Development Centres. Methods of collection, wet sieving, and decanting method and inoculums production. Culture of mycorrhizae in Modified Melin – Norkrans (MMN) agar medium.

#### Mushroom Technology

##### Unit IV

Mushroom Technology: Introduction and Scope. Edible and Poisonous mushrooms. Structure, Formation and Development of Basidiocarp – *Agaricus*. Importance and nutritive value of edible mushrooms. Isolation and culture of spores, culture media preparation. Production of mother spawn, Multiplication of spawn – Inoculation Technique – Cultivation technology – Substrates, composting technology, bed, polythene bag preparation,

spawning – casing – cropping – mushroom production – Harvest – Storage methods and Marketing.

## **Unit V**

Cultivation of Button mushroom (*Agaricus bisporus*), Milky mushroom (*Calocybe indica*), Oyster mushroom (*Pleurotus sajor-caju*) and Paddy straw mushroom (*Volvariella volvacea*). Food Preparation – Soup, cutlet, vegetable curry, samosa, omlette and pickle. Mushroom Research Centres in India.

### **REFERENCES:**

1. Alice, D., Muthusamy and Yesuraja, M. (1999). *Mushroom Culture*. Agricultural College, Research Institute Publications, Madurai.
2. Dubey, R.C. (2008). *A Textbook of Biotechnology*. S. Chand & Co. Ltd., New Delhi.
3. Marimuthu, T. *et al.* (1991). *Oyster Mushroom, Development of Plant Pathology*. Tamil Nadu Agricultural University, Coimbatore.
4. Newton, W.E. *et al.* (1977). *Recent Developments in Nitrogen Fixation*. Academic Press, New York.
5. Nita Bhal (2000). *Handbook on Mushrooms Vols. I & II* (2<sup>nd</sup> ed.). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Pathak, V.N. and Yadav, N. (1988). *Mushroom Production and Processing Technology*. Agrobios, Jodhpur.
7. Schwintzer, C.R. and Tjepkema, J.D. (1990). *The Biology of Frankia and Actinorhizal Plants*. Academic Press Inc., San Diego, USA.
8. Subba Rao, N.S. (1982). *Advances in Agricultural Microbiology*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Subba Rao, N.S. (2002). *Soil Microbiology* (4<sup>th</sup> ed.) *Soil Microorganisms and Plant Growth*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
10. Tewari Pankaj Kapoor, S.C. (1988). *Mushroom Cultivation*. Mittal Publications, New Delhi.
11. Tripathi, D.P. (2005). *Mushroom Cultivation*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Verma, A. (1999). *Mycorrhiza*. Springer Verlag, Berlin.

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## **CORE PRACTICAL I**

### **PLANT BIODIVERSITY – I & II, MICROBIOLOGY, PLANT PATHOLOGY AND IMMUNOLOGY & BIOFERTILIZERS AND MUSHROOM TECHNOLOGY (P)**

#### **ALGAE**

*Gleocapsa, Spirulina, Anabaena, Volvox, Spirogyra, Ulothrix, Acetabularia, Nitella, Vaucheria, Cyclotella* and *Navicula (Diatoms), Padina, Sargassum, Gelidium* and *Gracilaria*

#### **FUNGI**

*Pythium, Pilobolus, Taphrina, Xylaria, Pluerotus, Lycoperdon, Cercospora, Fusarium* and *Colletotrichum*

#### **LICHENS**

*Parmelia* and *Usnea*

#### **BRYOPHYTES**

Morphological and anatomical study of representative members of the following genera: *Marchantia, Lunularia, Targionia, Reboulia, Porella* and *Polytrichum*

#### **PTERIDOPHYTES**

Study of morphology and anatomy of the vegetative and reproductive parts of the following genera: *Isoetes, Lycopodium, Angiopteris, Osmunda, Gleichenia, Pteris, Nephrolepis* and *Azolla*

#### **GYMNOSPERMS**

Study of morphology and anatomy of the vegetative and reproductive parts of the following genera: *Araucaria, Podocarpus, Ginkgo* and *Ephedra*

#### **PALEOBOTANY**

*Lepidodendron, Stigmaria, Calamostachys, Lyginopteris, Lagenostoma* and *Cordaites*

#### **MICROBIOLOGY**

Isolation of microbes from soil – Serial dilution and Plating – Gram's staining of bacteria found in milk, curd, root – nodule – Effect of different antibodies on bacterial growth (antibiotic sensitivity)

## **PLANT PATHOLOGY**

Study of the following diseases:

Rust of wheat, Wilt of cotton, White rust of mustard – Citrus canker, Rice blight – Tobacco mosaic, Cucumber mosaic, Little leaf of brinjal, Tikka diseases of ground nut, Root knot of tomato.

## **IMMUNOLOGY**

Blood group determination (Demonstration)

## **BIOFERTILIZERS**

Isolation, identification of *Rhizobium*, VAM, *Azospirillum*

## **MUSHROOM TECHNOLOGY**

Preparation of culture, Spawn production, Cultivation Techniques.

### **Note:**

Duly certified record notebooks should be submitted for all the practical examinations and those who do not submit, need not be permitted to the concerned practical examination.

## **EVALUATION FOR CORE COURSE – V**

### ➤ **Internal** (40 marks)

▪ Practical skill	: 10
▪ Submission of observation note books	: 10
▪ Practical assessment by test	: 10
▪ Submission of 10 permanent slide of hand/microtome section	: 10
<b>Total</b>	<b>: 40</b>

### ➤ **External** (60 marks)

▪ Practical Examination	: 50
▪ Record	: 10
<b>Total</b>	<b>: 60</b>

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## **CORE COURSE V**

### **ANATOMY, EMBRYOLOGY AND MORPHOGENESIS**

#### **Objectives:**

1. To inculcate the basics of tissues and anatomical features of plants.
2. To impart the knowledge about the various aspects of morphogenesis.
3. To understand the key aspects of embryology of angiosperms

#### **Unit I: ANATOMY**

General account and theories of organization of apical meristems of shoot apex and root apex, quiescent centre. Structural diversity and phylogenetic trends of specialization of xylem and phloem. Cambium - origin - cellular structure, cell division, storied and non-storied types. Cambium in budding and grafting - wound healing role. Trichomes, periderm and lenticels.

#### **Unit II: ANATOMY**

Anatomical characteristics and vascular differentiation in primary and secondary structure of root and stem in Dicot and Monocot. Origin of lateral roots – Root - stem transition - Anatomy of Dicot and Monocot leaves. Anatomy of nodes and petioles. Leaf abscission, stomatal types, vascularization of flower and seedling.

#### **Unit III: EMBRYOLOGY**

Microsporangium - Microsporogenesis, Microspores - arrangement - morphology - ultrastructure - Microgametogenesis - Nemece phenomenon – pollen - stigma - Incompatibility - Methods to overcome incompatibility - Megasporangium - Megagametogenesis - Female gametophyte – Monosporic, Bisporic, Tetrasporic and special types - Nutrition of embryo sac and fertilization

#### **Unit IV: EMBRYOLOGY**

Endosperm - Types - Endosperm haustoria - Cytology and physiology of endosperms, functions of endosperms - Embryo development in Dicot and Monocot, Nutrition of embryo - Polyembryony - Causes, Apomixis - Causes, Apospory - Their role in plant improvement programmes and seed development.

#### **Unit V: MORPHOGENESIS**

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 - Nuclear transplantation experiments with *Acetabularia* - Sach's and Error's laws - Asymmetric

divisions and their significance. Morphogenesis at tissue level - Differentiation, dedifferentiation and redifferentiation of vascular tissue *in vivo*, *in vitro* and in wounds.

## REFERENCES

### ANATOMY

1. Clowers, F.A.L. (1961). *Apical Meristems*. Blackwell Scientific Publications, Oxford.
2. Cutter, E.G. (1978). *Plant Anatomy*. Edward Arnold Publishers Ltd., London.
3. Easu, K. (1953). *Plant Anatomy*. John Wiley & Sons Inc., New York.
4. Fahn, A. (1989). *Plant Anatomy*. Maxwell Pvt. Ltd., Singapore.
5. Metcalfe and Chalk (1950). *Anatomy of the Dicotyledons and Monocotyledons*. Vols. I & II. Clarendon Press, Oxford, UK.
6. Pandey, B.P. (1989). *Plant Anatomy*. S. Chand & Co. Ltd., New Delhi.
7. Singh, V., Pande, P.C. and Jain, D.K. (1987). *Anatomy of Seed Plants*. Rastogi Publications, Meerut.

### EMBRYOLOGY

1. Agarwal, S.B. (1990). *Embryology of Angiosperms – a fundamental approach*. Sahitya Bhawan, Agra.
2. Bhojwani, S.S. and Bhatnagar, S.P. (1981). *Embryology of Angiosperms*. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Dwivedi, J.N. (1998). *Embryology of Angiosperms*. Rastogi and Co., Meerut.
4. Maheswari, P. (1963). *An Introduction to Embryology of Angiosperms*. International Society of Plant Morphologies, University of Delhi.
5. Raghavan, V. (1976). *Experimental Embryogenesis in Vascular Plants*. Academic Press, London.

### MORPHOGENESIS

1. Bard, J. (1990). *Morphogenesis*. Cambridge University Press, London.
2. Bonner, J.T. (1965). *Morphogenesis*. Oxford & IBH Publications, Bombay.
3. Brouder, L.W. (1986). *Development Order: A Comprehensive Treatise Vol.2. The Cellular Basis of Morphogenesis*. Plenum Press, New York.
4. Bryant, J.A. and Francis, D. (1985). *The Cell Division Cycle in Plants*. Cambridge University Press, London.
5. Burgess, J. (1985). *An Introduction to Plant Cell Development*. Cambridge University Press, London.
6. Ebert, J.D. *et al.* (1970). *Interacting Systems in Development*. Holt, Reinhart & Win Inc., New York.
7. Murphy, T. M. and Thompson, W. F. (1988). *Molecular Plant Development*. Prentice Hall of India Pvt. Ltd., New Jersey.

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## CORE COURSE VI

### ANGIOSPERM TAXONOMY, ECOLOGY AND CONSERVATION

#### Objectives:

This paper covers all the aspects pertaining to

1. Different systems of classification of Angiosperms, taxonomic literature, botanical nomenclature
2. Preparation of description of plant species, herbarium techniques and interpretation of allied disciplines and molecular taxonomy to resolve the disputes in modern taxonomy
3. Systematic treatment, diagnostic features, characters and economic importance of selected families in Angiosperms
4. Components, dynamics, trophic level and biogeochemical cycles in different ecosystems and their conservation by *in situ* and *ex situ* methods

#### Unit I

Plant Taxonomy: Objectives, types of botanical classifications; Linnaeus, Bentham and Hooker, Engler & Prantl and Hutchinson, Takhtajan system, Cronquist system, Dahlgrens system, APG III classification. Floras, revisions and monographs. Construction of taxonomic keys --indented and bracketed. International Code of Botanical Nomenclature: type concept, principle of priority, valid publication and starting points of nomenclature.

#### Unit II

Phytography. Field and Herbarium Techniques; Important herbaria and botanic gardens in India. Modern trends in taxonomy. Anatomy, palynology and embryology in relation to taxonomy. Cytotaxonomy, Biosystematics, Taxometrics, Cladistics, Chemotaxonomy, Serotaxonomy, Numerical Taxonomy, Biosystematics, Molecular Taxonomy applications of RAPD, RFLP, ISSR, SSR, ITS, and QTL, DNA barcoding.

#### Unit III

Menispermaceae, Polygalaceae, Caryophyllaceae, Portulacaceae, Rhamnaceae, Sapindaceae, Fabaceae (Papilionoideae, Caesalpinioideae, Mimosoideae), Lythraceae, Passifloraceae, Aizoaceae

#### Unit IV

Sapotaceae, Oleaceae, Gentianaceae, Boraginaceae, Scrophulariaceae, Pedaliaceae, Aristolochiaceae, Loranthaceae, Casuarinaceae, Orchidaceae, Commelinaceae, Cyperaceae



## Unit V

Concept and dynamics of ecosystem: Types of ecosystem, components, Food chain, Food web and energy flow - Trophic level, ecological pyramids. Productivity and biogeochemical cycles (N, P, C, S). *In situ*- Protected Areas; Biosphere Reserves, National Parks, Tiger Reserves, Wildlife Sanctuaries. *Ex situ* – selection of superior germplasms. Field gene bank, botanic garden, experimental garden, introduction, reintroduction and *in vitro* conservation of threatened plants.

## References

1. Bell, A.D. (1991). *Plant form*. Oxford University Press, Oxford.
2. Benson, E.E. (1999). *Plant Conservation Biotechnology*. Taylor and Francis Ltd., United Kingdom.
3. Benson, L.D. (1962). *Plant Taxonomy: Methods and Principles*. Ronald Press, New York.
4. Bilgrami, K.S. and Dogra, J.V. (1990). *Phytochemistry and Plant Taxonomy*. CBS Publishers, New Delhi.
5. Chopra, G.L. (1974). *Angiosperms*. Jowhar Offset Press, Delhi, India.
6. Cronquist, A. (1981). *An Integrated System of Classification of Flowering Plants*. Columbia University Press, New York.
7. Davis, P.H. and Heywood, V.M. (1963). *Principles of Angiosperm Taxonomy*. Oliver & Boyd, Edinburgh.
8. Durbin, R., Eddy, S., Krogh, A. and Mitchison, G. (1998). *Biological sequence analysis*. Cambridge University Press, United Kingdom.
9. Erdtman, G. (1986). *Pollen Morphology and Plant Taxonomy: Angiosperms An Introduction to Palynology*. E.J.Brill, Leiden, Netherlands.
10. Gary, K.M. and Carroll, R.C. 1994. *Principles of Conservation Biology* Sinauer Associates, Inc., Massachusetts.
11. Groombridge, B. (1992). *Global Biodiversity- Status of the Earth's Living Resources*. Chapman & Hall, London.
12. Heywood, V.H. (1967). *Plant Taxonomy*. Edward Arnold Ltd., Great Britain.
13. IUCN (1992). *Conserving Biological Diversity in Managed Tropical Forests*. IUCN, Gland Switzerland and Cambridge.
14. Jain, S.K. and Rao, R.R. (1977). *A handbook of Field and Herbarium methods*. Today and Tomorrow Printers and Publishers, New Delhi.
15. Jones, S.B. and Luchsinger, A.E. (1987). *Plant Systematics* (2<sup>nd</sup> ed.). McGraw-Hill Book Company. New York.
16. Judd W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue. (2002). *Plant Systematics - A Phylogenetic Approach*. Sinauer Associates, Sunderland, MA.
17. Krishnamurthy, K.V. (2003). *An advanced text book on Biodiversity*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
18. Lawrence, G.H.M. (1973). *Taxonomy of Vascular Plants*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
19. Mabberley, D.J. (2008). *Mabberley's Plant Book: A portable dictionary of plants, their classification and uses* (3<sup>rd</sup> ed.). Cambridge University Press, London.

20. McNeely, J.A., Harrison, J. and Dingwall (1994). *Protecting Nature: Regional Reviews of Protected Areas*. IUCN, Gland, Switzerland and Cambridge.
21. McNeely, J.A., Miller, K.R., Reid, W.V., Mittermeier, R.A. and Werner, T.B. (1990). *Conserving the World's Biological Diversity*. IUCN, Gland, Switzerland; WRI, CI, WWF- US and the World Bank, Washington, D.C.
22. Minelli, A. (1993). *Biological Systematics: The State of the Art*. Chapman & Hall, London.
23. Mitra, J.N. (1988). *An Introduction to Systematic Botany and Ecology*. The World Press Pvt. Ltd., Calcutta.
24. Naik, V.K. (1984). *Taxonomy of Angiosperms*. Tata McGraw-Hill publishing Co. Ltd., New Delhi.
25. Pandey, B.P. (1995). *Angiosperms*. S. Chand & Co. Ltd., New Delhi.
26. Poore, D. and Sayer, J. (1991). *The Management of Tropical Moist Forest Lands: Ecological Guidelines*. Second Edition. IUCN, Gland, Switzerland and Cambridge.
27. Quicke, D.L.J. (1993). *Principles and Techniques of Contemporary Taxonomy*. Blackie Academic & Professional (An imprint of Chapman & Hall.), London.
28. Radford, A.E., Dickinson, W.C., Massey, J.R. and Bell, C.R. (1974). *Vascular Plant Systematics*. Harper & Row, New York.
29. Sayer, J. (1991). *Rainforest Buffer Zones*. IUCN, Gland, Switzerland and Cambridge.
30. Simpson, M. G. (2010). *Plant Systematics* (2<sup>nd</sup> ed.). Elsevier Inc., San Diego.
31. Singh, G. (1999). *Plant Systematics – Theory and Practice*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
32. Sivarajan, V.V. (1991). *Introduction to the Principles of Plant Taxonomy*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
33. Stace, C.A. (1989). *Plant Taxonomy and Biosystematics* (2<sup>nd</sup> ed.). Edward Arnold, London.
34. Stuessy, T.F. (1990). *Plant taxonomy - the systematic evaluation of comparative data*. Columbia Univ. Press, Columbia.
35. Subramanyam, N.S. (1995). *Modern Plant Taxonomy*. Vikas Publishing House Pvt. Ltd., New Delhi.
36. Takhtajan, A. (1981). *Flowering Plants: Origin and Dispersal*. Bishen Singh Mahendra Pal Singh, Dehradun.
37. UNEP (1995). *Global Biodiversity Assessment*. Cambridge University Press, London.
38. Virchow, D. (1998). *Conservation of Genetic Resources*. Springer-Verlag, Berlin.
39. Whitmore, T.C. and Sayer, J.A. (1992). *Tropical Deforestation and Species Extinction*. Chapman & Hall, London.
40. Wiley, E.O. (1981). *Phylogenetics: The Theory and Practice of Phylogenetic Systematics*. John Wiley & Sons, New York.
41. Willis, J.C. (1973). *A Dictionary of the Flowering Plants & Ferns* (8<sup>th</sup> ed.). (revised by H.K. Airy Shaw). Cambridge University Press, London.

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## CORE PRACTICAL II

### ANATOMY, EMBRYOLOGY AND MORPHOGENESIS & ANGIOSPERM TAXONOMY, ECOLOGY AND CONSERVATION (P)

#### ANATOMY AND EMBRYOLOGY

**ANATOMY:** Preparation of Transverse sections of the following plant parts to observe and record the internal structure. Monocot and Dicot stem, and leaf (Primary structure), normal secondary thickening in dicot stem and root. Anomalous secondary thickening in *Dracaena*, *Nyctanthes* and *Boerhaavia* stems. Nodal anatomy—uni- & trilacunar.

**EMBRYOLOGY:** T.S. of anther (young and mature) at various stages of development. Pollen types L.S. of ovule, Types of ovules – orthotropous and Anatropous. Embryogenesis, Embryo Dissection.

#### TAXONOMY

Study of the plants belonging to the following families:

Menispermaceae, Polygalaceae, Caryophyllaceae, Portulacaceae,  
Rhamnaceae, Sapindaceae, Fabaceae (Papilionoideae, Caesalpinioideae,  
Mimosoideae), Lythraceae, Passifloraceae, Aizoaceae, Sapotaceae, Oleaceae,  
Gentianaceae, Boraginaceae, Scrophulariaceae, Pedaliaceae,  
Aristolochiaceae, Loranthaceae, Casuarinaceae, Orchidaceae,  
Commelinaceae, Cyperaceae.

- Identification of binomial of the plants with the help of Gamble Flora.
- ICBN problems to be worked out.
- Submission of 30 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.

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**ELECTIVE COURSE I**  
**FORESTRY AND WOOD SCIENCE**

**Objectives:**

1. To prepare students for careers in the forest services and wood products industry.
2. To educate students to provide technical expertise to the wood industries.

**Unit I**

World and Indian forest scenario; Forest types of India; Forest influences and protection; Rare and endangered species; Conservation strategies; Exotics and its significance; Silvicultural principles and practices; Genetic Engineering and its application in forestry; Remote sensing and GIS in forestry.

**Unit II**

Forest Resources and utilization; Forest products; Forest laws and policies, people and Forest; Social and community forestry; Forest industries; Role of social forestry in cottage industry; Role of forestry in Indian economy. Biomass conversion strategies - energy plantations.

**Unit III**

Nature and properties of wood: physical, chemical, mechanical and anatomy of wood. Durability of wood. Monocot and dicot wood; pycnoxylic and manoxylic wood; dendrochronology; Wood seasoning and preservation; Defects and abnormalities of wood; types of commercial wood species of India.

**Unit IV**

Wood deterioration- fungi, insects and other agents; Wood protection- Practical methods for preserving and protection, Chemical processing of wood.

**Unit V**

Composite wood: adhesives-manufacture, properties, uses, manufacture and uses of plywood, fiber boards and particle boards. Present status of composite wood, paper and rayon industries. Present position of supply of raw material to industries and wood substitution.

**BOOKS**

1. Bowyer, J.L., Shmulsky, R. and Haygreen, J.G. (2007). *Forest Products and Wood Science: An Introduction*. Wiley-Blackwell, Oxford.
2. De Vere Burton L. (2000). *Introduction to Forestry Science*. Delmar Publishers, New York.
3. Franz F.P. Kollmann and Wilfred A. Jr. Cote. (2012). *Principles of Wood Science and Technology: I Solid Wood*. Springer-verlag, Berlin.

**REFERENCES**

1. Jha, L.K. (1996). *Forestry for Rural Development*. APH Publishing Corporation, New Delhi.
2. Negi, S.S. (1994). *India's Forests, Forestry and Wildlife*. Indus Publishing Co., New Delhi.

**Note:** No Practical for this paper.

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**ELECTIVE COURSE II**  
**INDUSTRIAL MICROBIOLOGY**

**Objectives:**

1. Understand the importance of microbes, basics of a sterilization, fermenter design and types
2. Study the avenues of exploiting microbes in bioconversion technology
3. Study the industrial production and product recovery in fermentation

**Unit I**

Introduction, history and development of industrial microbiology, scope of industrial microbiology. Microorganisms in industry - sterilization - preparation of media - isolation methods for microorganisms - culture and preservation and stability. Principles of storage of microbes at low temperature in liquid nitrogen, preparation of inoculum.

**Unit II**

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

**Unit III**

Methylophils: methanogens and methylophils, mechanism of methane production - Economic importance of methylophils. Hydrogen fuel. Microbial leaching. Sulphur utilizing bacteria, sulphate reduction pathway - use of nucleotides as nitrogen source for growth of certain microorganisms (pathway of nucleic acid breakdown).

**Unit IV**

Microbial production of food; microbial single cell protein (SCP). Fermented dairy products, fermented meats, leavening of breads, alcoholic beverages - beer, distilled liquors and wines, vinegar; fermented vegetables, pickles, olives and soy sauce.

**Unit V**

Production of pharmaceuticals: antibiotics, steroids, human proteins, vaccines and vitamins, enzymes. antibiotics and their mode of action with reference to penicillin, streptomycin, erythromycin, cephalosporin and griseofulvin.

## BOOKS

1. Davis, B.D., Dulbecco, R., Eiser, H.N. and Grinsberh, H.S. (1980). *Microbiology*. Harber Row, New York.
2. Davis, R.W., Bostein, D. and Roth, J.R. (1980). *Advanced Bacterial Genetics*. Cold Spring, Henbor, New York.
3. Ketchum, P.A. (1988). *Microbiology: Concepts and Application*. John Wiley & Sons Inc., New York.
4. Moat, A.G. and Foster, J.W. (1988). *Microbial Physiology*. John Wiley & Sons Inc., New York.
5. Patel, A.H. (1999). *Industrial Microbiology*. Macmillan India Ltd., New Delhi.
6. Pelczar, M.H. and Cahn, E.C.S. (1993). *Microbiology*. Tata-McGraw Hill Publishing Co. Ltd., New Delhi.
7. Power and Daginawala (1994). *General Microbiology*. Himalayan Publishing House, New Delhi.
8. Ringo, J. (2004). *Fundamental Genetics*. Cambridge University Press, United Kingdom.
9. Salle, A.J. (1974). *Fundamental Principles of Bacteriology*. Tata-McGraw Hill Publishing Co. Ltd., New Delhi.
10. Schlegel, H.G. (1993). *General Microbiology (7<sup>th</sup> Edition)*. Cambridge University Press, United Kingdom.
11. Starr, M.P. (1981). *The Prokaryotes: A Handbook on Habitat, Isolation and Identification of Bacteria, Vols. I & II*. Springer Verlag, Berlin.
12. Trevan, M.D. (1987). *Biotechnology: The Biological Principles*. Tata-McGraw Hill Publishing Co. Ltd., New Delhi.
13. Trevan, K. (1991). *Biotechnology*. Wiley Eastern Ltd., New Delhi.

**Note:** No Practical for this paper.

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## **CORE COURSE VII**

### **CELL BIOLOGY, GENETICS AND PLANT BREEDING**

#### **Objectives:**

This paper imparts knowledge on

1. Structure, organization, function, interrelationships of cell membrane and cell organelles and cell communication systems
2. Cell growth and cell division
3. Mendelian and non-Mendelian genetics and linkage and crossing over
4. Genes and genetic variations
5. Plant breeding methods and role of molecular markers in plant breeding

#### **Unit I : CELL BIOLOGY**

Structural organization and composition of cell membrane carbohydrates, proteins and lipids. Membrane functions. Structure, function and interrelationships of mitochondria, chloroplast, peroxisomes and glyoxysomes. Genetic systems in mitochondria and chloroplast. Cell communication: general principles, Signaling molecules. Receptors: Cell surface receptors – ion-channel linked receptors, G-protein coupled receptors.

#### **Unit II : CELL BIOLOGY**

Cell growth and division - Phases of cell cycle, cell cycle control and regulation systems; extracellular and intracellular signals. Cyclins and Cyclin-dependent kinases. Regulation of plant cell cycle. Programmed cell death – molecular mechanism and control. Cytoskeleton; structure, assembly, disassembly and regulation of filaments involved – actin filaments (microfilaments), microtubules, and intermediate filaments.

#### **Unit III : GENETICS**

Mendelism – basic principles (brief study). Non-Mendelian inheritance: cytoplasmic inheritance - cytoplasmic and genetic male sterilities and applications. Sex determination in animals and plants.

Linkage and Crossing over - Stern's hypothesis, Creighton and McClintock's experiments, single cross over, multiple cross over, two-point cross, three-point cross, map distances, gene order, interference and co-efficient of coincidence.

#### **Unit IV : GENETICS**

Gene pool, allele and genotype frequency. Hardy-Weinberg law and its applications, estimation of allele and genotype frequency of dominant genes, codominant genes, sex-linked genes and multiple alleles. Genetic equilibrium, genetic polymorphism. Factors altering allelic frequencies

(mutation, genetic drift - bottle neck effect and founder effect, migration, selection, non-random mating and inbreeding coefficient).

## **Unit V : PLANT BREEDING**

Genetic variability and its role in plant breeding - Breeding methods in self-pollinated, cross pollinated, vegetatively propagated and apomictic plants. Inbreeding depression - Role of heterosis in plant breeding. Somaclonal variations in crop improvement. RFLP and SNP in plant breeding.

### **REFERENCES:**

1. Ajay Paul (2007). *Text book of Cell and Molecular biology*. Books and Allied (P) Ltd., Kolkata
2. Allard, R.W. (1995). *Principles of Plant Breeding*. John Wiley and Sons, Inc., India.
3. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2002). *Molecular biology of the cell* (IV Edn). Garland Science, Taylor and Francis group, New York.
4. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991). *Principles of Genetics* (III Edn). John Wiley and Sons Inc., India.
5. Gerald Karp (2008). *Cell and Molecular biology: Concepts and experiments* (V Edn). John Wiley & Sons, India.
6. Ghahal, G.S. and Gosal, S.S. (2002). *Principles and procedures of Plant Breeding*. Narosa Publishing House, New Delhi.
7. Ringo, J. (2004). *Fundamental Genetics*. Cambridge University Press, United Kingdom.
8. Robert J Brooker (2009). *Genetics: Analysis and principles* (III Edn). McGraw Hill, New Delhi.
9. Sharma, J.R. (1994). *Principles and practices of Plant Breeding*. Tata McGraw-Hill Publishers Company Ltd., New Delhi.
10. Singh, B.D. (1996). *Plant Breeding: Principles and methods*. Kalyani Publications, Chennai.
11. Snustad, D.P. and Simmons M.J. (2010). *Principles of genetics* (V Edn). John Wiley and Sons, India.
12. Strickberger (2005). *Genetics* (III Edn). Prentice Hall of India Pvt. Ltd., New Jersey.
13. Wayne M Becker, Lewis J Kleinsmith, Jeff Hardin (2007). *The world of the cell* (VI Edn). Pearson.

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## **CORE COURSE VIII**

### **PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIOPHYSICS**

#### **Objectives:**

Students can understand

1. Plant-water relationship, translocation of water and minerals, photosynthesis, respiration and transfer of energy
2. Nitrogen metabolism, plant growth hormones, flowering, dormancy and senescence, stress
3. Chemistry of carbohydrates, proteins, enzymes and lipids
4. Nucleic acids, vitamins and secondary metabolites
5. Bioenergetics, laws of Thermodynamics and photobiology

#### **PLANT PHYSIOLOGY**

##### **Unit I**

Water relations of plants – Structure and Physicochemical properties of water, chemical potential and water potential in the plant, bulk movement of water, soil-plant atmosphere continuum, stomatal physiology and regulation.

Modern concepts of mineral salt absorption and translocation. Photosynthesis: Photophysical and photochemical phase; Light reactions; sequence of photosynthetic pathway - Electron Transport Chain, Photophosphorylation. Pathways of CO<sub>2</sub> fixation. Respiration: Photorespiration and dark respiration. Cycles of respiration, Oxidative Phosphorylation, Gluconeogenesis.

##### **Unit II**

Mechanism of nitrogen fixation, Nitrogen uptake and assimilation. Biosynthesis, storage, breakdown, transport, physiological effects, and mechanism of action of plant growth hormones, elicitors. Phytochrome and hormones in movements and flowering. Physiology of Dormancy break. Senescence and aging. Effect of water and salt stress on crop production.

##### **Unit III**

Structure of atoms, molecules and chemical bonds. pH and buffers. Chemistry of biological molecule: Carbohydrates: Classification, structure of mono, di, oligo and polysaccharides. Protein: Classification, structure and composition of amino acids. Enzymes: Classification, mode of action, km value, coenzymes, isoenzymes. Lipids: Classification, structure and properties of acyl lipids and phosphates.

## Unit IV

Nucleic acids: DNA and RNA structure - Watson and Crick model; A, B and Z forms of DNA - RNA secondary structure. Vitamins – general characters – classification – structure and properties – fat soluble and water soluble vitamins. Secondary metabolites: Classification, biosynthesis, and functions of terpenoids, alkaloids, phenolics, flavonoids, coumarins.

## Unit V

Bioenergetics, Energy and work. Laws of Thermodynamics. Energy transductions in biological systems. Redox potential, Redox couples, ATP bioenergetics, Order of reactions. Photobiology: Dual nature of light, characteristics of solar radiation, solar energy - Efficiency of atoms - Absorption spectra in molecules, energy states, De-excitation.

## REFERENCES:

### PLANT PHYSIOLOGY AND BIOCHEMISTRY:

1. Haynie, D.T. (2008). *Biological Thermodynamics* (2<sup>nd</sup> Edition). Cambridge University Press India Pvt. Ltd., New Delhi.
2. Hess, D. (2012). *Plant Physiology: Molecular, Biochemical, and Physiological Fundamentals of Metabolism and development*. Springer Science & Business Media, New York.
3. Jain, V.K. (2007). *Fundamentals of Plant Physiology*. S. Chand & Co. Ltd., New Delhi.
4. Jeremy M Berg, John L Tymoczko, Lubert Stryer, Gregory J Gatto Jr. (2007). *Biochemistry*. W H Freeman and company, New York.
5. Michael M Cox, David L Nelson (2008). *Lehninger Principles of Biochemistry* (V Edn). W H. Freeman and company, New York.
6. Robert K Murray, David A Bender, Kathleen M Botham, Peter J Kennelly, Victor W Rodwell, P Anthony Weil (2009). *Harper's Illustrated Biochemistry* (27<sup>th</sup> ed.). McGraw Hill, New Delhi.
7. Salisbury, F.B. and Ross, C.W. (1992). *Plant Physiology*. Wadsworth Publishing Company, Belmont, California, USA.
8. Taiz, L. and Zeiger, E. (2010). *Plant Physiology*. Sinauer Associates, India.
9. Verma, S.K. (1999). *Plant Physiology*. S. Chand & Co., New Delhi.

### BIOPHYSICS:

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

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## **CORE PRACTICAL III**

### **CELL BIOLOGY, GENETICS AND PLANT BREEDING & PLANT PHYSIOLOGY, BIOCHEMISTRY AND BIOPHYSICS (P)**

#### **CELL BIOLOGY, GENETICS AND PLANT BREEDING**

1. Workout problems related to linkage, crossing over and gene mapping, human pedigree analysis.
2. Workout problems in population genetics - gene and genotype frequency, Hardy Weinberg equilibrium.
3. Hybridization techniques in self and cross pollinated plants
4. Visit a plant breeding station to familiarize with breeding programmes. Submit a report of the visit.

#### **PLANT PHYSIOLOGY**

1. Measurement of water potential by gravimetric method.
2. Measurement of Photosynthesis - Hill Reaction.
3. Estimation of total chlorophyll and study of absorption pattern of chlorophyll solution.
4. Survey of C<sub>4</sub> plants and CAM plants.
5. Separation of photosynthetic pigments by TLC/paper chromatography and calculating the R<sub>f</sub> value
6. Determination of nitrate reductase activity.
7. Extraction and estimation of leghaemoglobin from root nodules.
8. Estimation of proline in plant tissues under various abiotic stresses.
9. Estimation of phenol in plant tissues affected by biotic stress.
10. Determination of peroxidase activity in plant tissues affected by biotic/abiotic stresses.
11. Estimation of free amino acids in senescing leaves to understand the source to sink transformation phenomenon.

#### **BIOCHEMISTRY AND BIOPHYSICS**

1. Preparation of molal, molar, normal and percentage solutions and their dilutions.
2. Estimation of proteins by Lowry's method
3. Protein profile (SDS-PAGE).in plants under stress.
4. Extraction and estimation of lipid
5. Determination of reducing sugars in (grapes) fruit
6. Separation and identification of amino acids by chromatography
7. Extraction of amylase and determination of its activity
8. Determination of km-value, V-max, Michael's constant for amylase

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## **ELECTIVE COURSE III**

### **GENETIC ENGINEERING AND BIOTECHNOLOGY**

#### **Objectives:**

This paper provides an understanding of basic techniques of genetic manipulation, plasmids and phase vectors, cloning, screening and sequencing strategies of genomic DNA,

#### **Unit I: BASIC TECHNIQUES OF GENETIC MANIPULATION**

Basic techniques: Agarose gel electrophoresis, nucleic acid blotting, transformation of *E. coli*, polymerase chain reaction. Cutting and joining DNA molecules: Restriction enzymes, joining DNA molecules with DNA ligases, adaptors, homopolymer tailing, joining DNA molecules without DNA ligases.

#### **Unit II: PLASMIDS AND PHASE VECTORS**

pBR322, Ti-plasmid Bacteriophage  $\lambda$ , single standard DNA vectors – phage M<sub>13</sub>, cosmids, Phagemids BAC, YAC, Expression vectors, Shuttle vectors.

#### **Unit III: CLONING**

Cloning strategies: Cloning genomic DNA – Genomic DNA libraries, PCR as an alternative to genomic cloning. Cloning – Properties cDNA libraries, preparation of cDNA for library construction, full-length cDNA cloning.

#### **Unit IV: SCREENING STRATEGIES**

Sequence – dependent screening, screening by hybridization, probe design, chromosome walking, screening expression libraries – immunological, south-western, north-western blotting, RAPD, RFLP, DNA foot printing.

#### **Unit V: SEQUENCING STRATEGIES**

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. Gene transfer to plants: *Agrobacterium* mediated transformation, direct DNA transformation – Protoplast transformation, particle bombardment, electroporation and microinjection.

#### **REFERENCES**

1. Dubey, R. C. (2008). *A Textbook of Biotechnology*. S. Chand & Co. Ltd., New Delhi.
2. Durbin, R., Eddy, S., Krogh, A. and Mitchison, G. (1998). *Biological sequence analysis*. Cambridge University Press, United Kingdom.
3. Gupta, P. K. (1994). *Elements of Biotechnology*. Rastogi and Co., Meerut.

4. Hammaond, J., McGarvey, P. and Yusibov, V. (2000). *Plant Biotechnology*. Springer Verlag, Berlin.
5. Primrose, S. B. (1994). *Molecular Biotechnology*. Blackwell Scientific Publishing, Oxford.
6. Primrose, S. B., Twyman, R. M. and Old, R. W. (2001). *Principles of Gene Manipulation*. Blackwell Science, London.
7. Sambrook, J., Fritsch, E. F. and Maiatis, T. (2000). *Molecular Cloning: A Laboratory Manual*. Spring Harbor Laboratory Press, New York.
8. Satyanarayana, V. (2005). *Biotechnology*. Books and Allied (P) Ltd., Kolkata.
9. Singh, B. D. (1998). *Biotechnology*. Kalyani Publishers, New Delhi.
10. Slater, A., Scotta, N. and Fowler, M. (2003). *Plant Biotechnology*. Oxford University Press, Oxford.
11. Smith, J.E. (2009). *Biotechnology* (5<sup>th</sup> Edition). Cambridge University Press India Pvt. Ltd., New Delhi.
12. Xiong, J. (2006). *Essential Bioinformatics*. Cambridge University Press, New Delhi.

**Note:** No Practical for this paper.

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**ELECTIVE COURSE IV**  
**HORTICULTURE AND LANDSCAPING**

**Objectives:**

To enable the students

1. To understand the main principles and importance of horticulture
2. To develop skill in horticulture techniques
3. To know the various methods of plant propagation
4. To develop potential for self-employment

**Unit I**

Importance of scope of horticulture – Divisions of horticulture – Climate, soil and nutritional needs – Water irrigation – Plant propagation method – Cutting, layering, grafting, budding. Stock – scion relationship, micropropagation by induction of rooting. Glass houses and green houses

**Unit II**

Principles and methods of designing outdoor garden – hedges, edges, fences, trees, climbers, rockeries, arches, terrace garden – Lawn making and maintenance – Water garden – cultivation of water plants-common water plants. Layout for a model college garden.

**Unit III**

Indoor gardening – Foliage plants, flowering plants, hanging basket, Bonsai plants – Training, watering and pruning. Floriculture – Cultivation of commercial flower crops – Rose, Jasmine and Chrysanthemum, Flower decoration – Dry and wet decoration.

**Unit IV**

Classification of vegetables, cultivation of important vegetable – Tomato, potato, brinjal, onion, cabbage and snake guard. Layout for a model kitchen garden.

**Unit V**

Fruit crops – Induction of flowering, flower thinning, fruit setting, fruit development. Cultivation of important fruit crops - Mango, Grapes, Sapota and Guava. Cultivation of tree species – Eucalyptus and Teak.

**REFERENCES**

1. Arora, J.S. (1992). *Introductory Ornamental Horticulture*. Kalyani Publishers, New Delhi.
2. Edmond, J.B. *et al.* (1977). *Fundamentals of Horticulture*. Tata-McGraw Hill Publishers Co. Ltd., New Delhi.
3. George Acquaah. (2002). *Horticulture Principles and Practices* (2nd ed.). Pearson Education, New Delhi.
4. Kumar, N. (1987). *Introduction to Horticulture*. Rajalakshmi Publishers, Nagercoil.
5. Manibushan Rao, K. (1991). *Textbook of Horticulture*. Macmillan Publishing Co., New York.
6. Rao, K.M. (2000). *Textbook of Horticulture*. Macmillan India Ltd., New Delhi.
7. *Note: No Practical for this paper*

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## **CORE COURSE IX**

### **PLANT TISSUE CULTURE**

#### **Objectives:**

1. To inculcate the basics of plant tissue culture
2. To impart the knowledge about the various aspects of tissue culture and their applications

#### **Unit I**

Introduction - history, scope and concepts of basic techniques in plant tissue culture. Laboratory requirements and organisation. Sterilization-filter, heat and chemical. Media preparation - inorganic nutrients, organic supplements, carbon source, gelling agents, growth regulators and composition of important culture media (MS, White,s and Gamborg's media).

#### **Unit II**

Cell, tissue and organ culture - Isolation of single cells, selection and types of cells, tissue explants and organs for culture - paper, raft nurse technique, plating method, microchamber techniques, cell suspension cultures - batch, continuous, chemostat culture - synchronization of suspension culture, cellular totipotency, cytological, cytochemical and vascular differentiations - totipotency of epidermal and crown – gall cells.

#### **Unit III**

Micropropagation - clonal propagation of elite germplasm, factors affecting morphogenesis and proliferation rate, technical problems in micropropagation. Organogenesis - formation of shoots and roots - role of growth regulators and other factors, somaclonal and gametoclonal variations. Somatic embryogenesis - Process of somatic embryogenesis, structure, stages of embryo development, factors affecting embryogenesis, synthetic seeds.

#### **Unit IV**

Haploid production - androgenesis, gynogenesis - techniques of anther culture – segmentation pattern in microspore - isolated pollen culture - plantlets from haploids - diploidisation - factors influencing androgenesis, haploidy through gynogenesis, haploid mutants, utilization of haploids in plant breeding. *In vitro* pollination - ovule and ovary culture, importance, techniques overcoming incompatibility barriers, embryo rescue. Protoplast culture: Isolation of protoplasts - mechanical and enzymatic sources, culture of protoplasts, viability. Protoplastfusion - spontaneous, mechanical, induced electrofusion, selection of somatic hybrids, cybrids, importance.

## Unit V

*In vitro* production of secondary metabolites - classification of secondary metabolites, biosynthetic pathways, cell suspension cultures, immobilized cell cultures and biotransformation, elicitors and hairy root culture. Cryopreservation and gene bank - Modes of preservation, preparation of materials for deep freezing, cryoprotectors, storage strategies, assessment of successful cryopreservation, application and limitations. Application of tissue culture in forestry, horticulture, agriculture and pharmaceutical industry, transgenic plants.

## REFERENCES

1. Bhojwani, S.S. and Razdan, M.K. (1983). *Plant Tissue Culture: Theory and Practice*. Elsevier Science Publishers, Netherlands.
2. Dodds, J.H. and Roberts, I.W. (1985). *Experiments in Plant Tissue Culture*. Cambridge University Press, UK.
3. Fowler, M.W. (1986). *Industrial Application of Plant Cell Culture*. In: Yeoman, M. M. (ed.). *Plant Cell Culture Technology*. Blackwell, Oxford, London.
4. Hammond, J., McGarvey, P. and Yusibov, V. (2000). *Plant Biotechnology*. Springer Verlag, New York.
5. Johri, B.M. (1982). *Experimental Embryology of Vascular Plants*. Narosa Publishing House, New Delhi.
6. Kalyan Kumar, De (1992). *An Introduction to Plant Tissue Culture*. New Central Book Agency, Calcutta.
7. Ramawat, K.G. (2000). *Plant Biotechnology*. S. Chand and Co. Ltd., New Delhi.
8. Razdan, M.K. (2004). *Introduction to Plant Tissue Culture* (2<sup>nd</sup> ed.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
9. Reinert, J. and Bajaj, Y.P.S. (1977). *Plant Cell Tissue and Organ Culture: A Laboratory Manual*. Narosa Publishing House, New Delhi.
10. Vasil, I.K. (1986). *Cell Culture and somatic Cell Genetics of Plants* (3 Volumes). Academic Press Inc.

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## **CORE COURSE X**

### **RESEARCH METHODOLOGY**

#### **Objectives:**

To enable the students

1. To know principles involved in microscopy, chromatography, spectroscopy and electrophoresis method
2. To make the students apply statistical principles to biological studies
3. To make the students understand the problem selection, project design and thesis writing

#### **Unit I**

Microscopy – Principles and applications of light, dark field, phase contrast, fluorescence, polarization, scanning and transmission microscopy – Fixation and staining of materials for electron microscopy.

#### **Unit II**

Chromatography – Principles and applications of partition-adsorption – Ion Exchange – Affinity – Gel filtration – TLC–GLC, HPLC, GCMS-Spectroscopy – Colorimeter, UV-Visible Spectrophotometer – Flame photometer – Atomic absorption spectrophotometer, NMR.

#### **Unit III**

Electrophoresis – Native PAGE, SDS PAGE, Two dimensional Electrophoresis and Agarose – Radio isotopes – Half-life Tracer techniques, autoradiography – scintillation and GM counter.

#### **Unit IV**

Scope of biostatistics – Classification of data-graphical and diagrammatical representation – mean, median, mode-Standard Deviation – Standard Error – Test of significance – ‘t’-Test – Chi-square test – ANOVA – Simple Correlation – Regression.

#### **Unit V**

Thesis writing – Research design-choosing the problem for research – Review of literature – Primary, secondary and tertiary sources, Bibliography – Indexing and abstracting – Reporting the results of research in conference – Oral presentation – Poster presentation – Planning and preparing a thesis, Preparing article for publication, Proof correction, citation index and impact factor

## REFERENCES

1. Balagurusamy, E. (1985). *Programming in BASIC* (2<sup>nd</sup> ed.). Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. Connor and Peter Woodford (1979). *Writing Scientific Paper in English Pitman*. Medical Publishing Co. Ltd., England.
3. Dheenadayalu, R. (1987). *Computer Science* (Vol. I). Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4. Gupta, S.P. (1990). *Statistical Methods*. S. Chand & Co. Ltd., New Delhi.
5. Gurumani, N., (2006). *Research methodology for Biological Sciences*. MJP Publishers, Triplicane, Chennai.
6. Jayaraman, J. (1972). *Techniques in Biology*. Higginbothams Pvt. Ltd., Madras.
7. Jayaraman, J. (1985). *Laboratory Manual in Biochemistry*. Wiley Eastern Ltd., New Delhi.
8. Khan, I.A. and Khannum, A. (1994). *Fundamentals of Biostatistics*. Vikas Publishing, Hyderabad.
9. Kothari, C.R. (1991). *Research Methodology: Methods and Techniques*. Wiley Eastern Ltd., New Delhi.
10. Rastogi, V.B. (2006). *Fundamentals of Biostatistics*. Ane Book India, New Delhi.
11. Sree Ramulu, V.S. (1988). *Thesis Writing*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Zar, J.H. (1984). *Biostatistics Analysis*. Prentice Hall International, New Jersey.

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## **CORE PRACTICAL IV**

### **PLANT TISSUE CULTURE & RESEARCH METHODOLOGY (P)**

#### **RESEARCH METHODOLOGY**

1. Sampling by Random Number Table
2. Data Collection
3. Classification of Data: Discrete, continuous and cumulative.
4. Statistical diagrams: Histogram, Frequency curve, Bar chart and Ogive curve
5. Measures of Central Values: Mean, Median and Mode
6. Measures of Dispersion: Range, Mean Deviation and Standard Deviation.
7. Exercises with Tests of Significance
8. Preparation of Index cards
9. Preparation of Bibliography
10. Proof correction
11. Exercises in the calculation of Citation Index.
12. Determination of Impact Factor of Author, Article and Journal.
13. Identification of instruments/their parts and their applications

#### **PLANT TISSUE CULTURE**

1. Media preparation-MS, Whites and Gamborg's
2. Sterilization of Ex-plant and inoculation (shoot tip, nodal, leaf)
3. Callus induction
4. Micropropagation
5. Protoplast isolation (Mechanical and enzymatic)
6. Synthetic seed production

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## **ELECTIVE COURSE V**

### **FOOD PRESERVATION AND PROCESSING**

#### **Objectives:**

1. To understand the salient features of food preservation and processing.
2. To study the preservation and processing of day to day products by using food additives

#### **Unit I**

Food Preservation: principles and methods – perishable, semi-perishable and non-perishable foods – methods of preservation – temporary preservation – asepsis, low temperature, antiseptics, pasteurization, electromagnetic radiation – permanent preservation – sterilization processing by heat, effect of acidification and antiseptics.

#### **Unit II**

Preservation by salting, preservation by sugar syrup – preservation by concentration – preparation of jam jelly – role of pectin in jam – preservation by chemicals: benzoic acid, parabenzene, sulphur-di-oxide, sulphites, nitrites diethylpyrocarbonates (DEPC), hydrogen peroxide, chlorine and CO<sub>2</sub>.

#### **Unit III**

Processing methods: wet heating method by cookers. Microwave heating; processing of fruits and fruit products – canning fruits; preparation of fruit juices: squashes and cordials. Preservation by antibiotics and irradiation.

#### **Unit IV**

Vegetable and vegetable products –Canning of vegetables and pickles. Baked products: Classification of wheat – hard wheat, soft wheat, durum wheat, flour preparation, baking formulation, processing. Milk and milk products: butter, ghee, lassi, unfermented milk products, condensed milk, cheese, ice-cream and milk powder.

#### **Unit V**

Food additives: definitions, preservatives, antioxidants – colouring agents, emulsifier, stabilizers and thickening, bleaching and maturing agents, clarifying agents, anti- foaming agents, function of additives. Food adulteration – adulterants and simple detection techniques; food grades – standards, laws and regulations.

#### **References**

1. Adams, M.R. and Moss, M.O. (1996). *Food Microbiology*. New Age International Pvt. Ltd. Publishers, New Delhi.

2. Frazier, W.C. and Westhoff, D.C. (1988). *Food Microbiology* (3<sup>rd</sup> ed.). Tata-McGraw Hill Publishing Co. Ltd., New Delhi.
3. Giridharilal, Siddappa, G.S. and Tandon, G.L. (1990). *Preservation of Fruits and Vegetables*. CFTRI, Mysore.
4. Lal, B., Siddappa, G.B. and Tandon, G.N. (1967). *Preservation of Fruits and Vegetables*. ICAR Publications, New Delhi.
5. Manorajan Kalia and Sangita Sood (1992). *Food Preservation and Processing*. Department of Food Science and Nutrition, College of Home Science. Himachal Pradesh Agricultural University, Palampur.
6. Ranganna, S. (1986). *Handbook of Analysis and Quantity Control for Fruit, Vegetable Products*. CFTRI, Mysore.

**Note:** No Practical for this paper.

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