

**DAV UNIVERSITY, JALANDHAR**

**DAV UNIVERSITY JALANDHAR**



**Course Scheme**

**For**

**Botany (Other Branches)**

**(Program ID-4)**

**1<sup>st</sup> TO 6<sup>th</sup> SEMESTER**

**Syllabi Applicable For Admissions in 2014**

## **DAV UNIVERSITY, JALANDHAR**

### **Instruction for candidates (Theory Paper)**

- The question paper for end-semester examination will have a weightage of 25%. It will consist of 100 objective questions of equal marks. All questions will be compulsory.
- Two preannounced test will be conducted having a weightage of 25% each. Each preannounced test will consist of 20 objective type, 5 short questions/problems on the UGC-NET (objective type) pattern as well as one long answer type question. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt all question. Choice will be given only in long answer type. The question paper is expected to contain problems to the extent of 40% of total marks.
- Four objective/MCQ type surprise test will be taken. Two best out of four objective/MCQ type surprise test will be considered towards final each of 12.5% weightage to the final. Each surprise test will include 20-25 questions.
- The books indicated as text-book(s) are suggestive However, any other book may be followed.

\* Wherever specific instructions are required these are given at the starting of that particular subject/paper

### **Instruction for candidates (Practical Paper)**

- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test.

# DAV UNIVERSITY, JALANDHAR

**Paper: Plant Biology I (Plant Anatomy and Development)**

**Code: Theory: BOT151; Practical: BOT152**

L	T	P	Credits	Marks	Minimum marks
4	0	0	3	75	30

## UNIT I

**Tissues:** (a) Epidermal: stomata, trichomes, nectaries, hydathodes; Transfer cells  
(b) Fundamental: parenchyma, collenchyma, and sclerenchyma; distribution of mechanical tissue. **(10 Lecture)**

## UNIT-II

**Tissue Systems:** (c) Vascular: Xylem (general structure of primary and secondary xylem cell types); Phloem (cell types, primary phloem, and secondary phloem). **(8 Lecture)**

**Organization of higher plant body:** The root and shoot systems; Variation in habit and longevity; Environmental influences; Modifications of root, stem and leaf. **(5 Lecture)**

## UNIT-III

**The Root:** primary and secondary state of growth; Monocot and Dicot root. **(6 Lecture)**

**The Stem:** Primary and secondary state of growth; Monocot and Dicot stem. **(6 Lecture)**

**Leaf:** Basic structure and development of monocot and dicot leaves. **(4 Lecture)**

**Phyllotaxy and venation.** **(2 Lectures)**

## UNIT-IV

**Respiration:** ATP: the biological energy currency; Aerobic and anaerobic respiration; Krebs' cycle; Mechanism of electron transport; Oxydative phosphorylation; Pentose Phosphate Pathway. **(3 Lectures)**

**Photosynthesis:** Introduction, history and significance; Photosynthetic pigments; Action and absorption spectra; Concepts of two photosystems; Z-scheme; Photophosphorylation; Calvin cycle; C4 pathway; CAM plants; Photorespiration. **(5 Lectures)**

# DAV UNIVERSITY, JALANDHAR

**Course Title: Plant Biology I (Plant Anatomy and Development)Lab**

**Course code: BOT152**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Marks</b>	<b>Minimum marks</b>
0	0	2	1	25	10

1. Anatomy of monocot (wheat, maize) and dicot (gram, sunflower) roots using hand sections and permanent slides.
2. Anatomy of monocot (wheat, maize) and dicot (gram, sunflower) stem using hand sections and permanent slides.
3. Anatomy of monocot (wheat, maize) and dicot (gram, sunflower) leaf using hand sections and permanent slides.
4. Study of wood anatomy (TLS of *Dalbergia* and *Pinus*).

## **Reference Books**

1. Esau, K. *Anatomy of Seed Plants*. John Wiley & Sons: New York, 1977.
2. Fahn, A. *Plant Anatomy*. Pergamon Press: Oxford, 1990.
3. Metcalfe, C.R., and Chalk, L. *Anatomy of Dicotyledons*. Clarendon Press: Oxford, 1950.
4. Jane, F.W. *The Structure of Wood*. Adam. & Charles Black: London, 1970.

# DAV UNIVERSITY, JALANDHAR

**Paper: Plant Biology II (Reproduction and Utilization of Plants)**

**Code: Theory: BOT153; Practical: BOT154**

L	T	P	Credits	Marks	Minimum marks
4	0	0	3	75	30

## UNIT-II

**Flower:** Structure, Flower as modified shoot; evolution, variations, genetic control of floral organs; Functions of flower; Inflorescence types. **(2 Lecture)**

**Stamen:** Morphology, evolutionary trends, structure and development of anther tapetum; Microsporogenesis, structure and development of male gametophyte; Pollen structure. **(5 Lecture)**

## UNIT-II

**Carpel:** Morphology, evolutionary trends; Structure, development and type of ovules; placentation; Archegonium; Megasporogenesis and embryo sac ontogenies; gene function and organization. **(7 Lecture)**

**Pollination:** Types of pollination; pollen transfer mechanisms. **(2 Lecture)**

## UNIT-III

Concept of centers of origin, their importance with reference to Vavilov's work **(1 Lecture)**

Botanical name, family, part used and uses of the following:

Food: Wheat, Rice, maize

Fruits: Mango, lemon, grapes.

Spices: Fennel, saffron, clove, turmeric ginger. **(2 Lecture)**

## UNIT-IV

Botanical name, family, part used and uses of the following:

Beverages: Tea, coffee and cocoa.

Oils: groundnut, coconut, linseed and mustard.

Medicine: Cinchona, Digitalis, Rauwolfia, Papaver and Cannabis.

Timber yielding plants

Fiber yielding plants

Gums & resins

Wax and tannin yielding plants **(8 Lecture)**

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**Course title: Plant Biology II (Reproduction and Utilization of Plants) Lab**

**Course Code:BOT154**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Marks</b>	<b>Minimum marks</b>
0	0	2	1	25	10

1. Study of basic structure of different flowers
2. Studies of stamens and carpels of different flowers.
3. Morphological studies based on theoretical parts.
4. Preparation of 20 most important sources of spices and medicines. Give their local names, scientific names and families to which they belong. Mention their properties.

## **Reference Books**

1. Kocchar, S.L. *Economic Botany of the Tropics*, 2<sup>nd</sup> edition. Macmillan India Ltd.: Delhi, 1998.
2. Kohli, R., Arya, K.S., Singh, H.P. and Dhillon, H.S. *Tree Directory of Chandigarh*, Lovedale Educational: New Delhi, 1994.
3. Thakur, R.S., Puri, H.S. and Husain, A. *Major Medicinal Plants of India*. Central Institute of Medicinal and Anomastic Plants: Lucknow, 1989.

# DAV UNIVERSITY, JALANDHAR

**Paper: GENERAL BOTANY**

**Code: BOT155; BOT156**

(FOR NON-MEDICAL (B.Sc. Agriculture) STUDENTS ONLY)

## SECTION- I

Classification of Plant kingdom. (1 Lecture)  
General outline of life history of Angiosperms. (1 Lecture)

## SECTION -II

Morphology of Root, Stem and Leaf. (3 Lectures)  
Seed structure of Gram and Maize. (2 Lectures)  
Seed Germination. (1 Lecture)

## SECTION- III

Structure of Flower, Floral formula and Floral Diagram. (2 Lectures)  
Inflorescence- different types. (3 Lectures)  
Pollination- Types and Agencies. (1 Lectures)  
Fruit – Types, Dispersal of Fruit and Seed. (4 Lectures)

## SECTION- IV

Anatomy- Tissue types. (3 Lectures)  
Difference between monocot and dicot root, stem and leaf. (2 Lectures)  
Families- General characters of Solanaceae, Malvaceae, Cruciferae, Graminae, Compositae. (5 Lectures)

### Practicals

Form and function of Root, Stem & Leaf and modifications.  
Different types of inflorescence.  
Representative of families included in theory.

### **Reference Books**

1. Bhatia K.N., and Widge, R., *Introduction of Botany*, Trueman Publishers: Jalandhar, 2010.
2. Dutta, C. *Text Book of Botany*. Oxford University Press: New Delhi, 2000.
3. Vidyarthi, S. *Text Book of Botany*. S. Chand and Company: New Delhi, 2002.

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## Introduction to Biology

Introduction to concepts of biology; Themes in the study of biology; A closer look at ecosystem; A closer look at cell; The process of Science; Biology and everyday life

Evolutionary history of biological diversity; Early earth and the origin of life; Major events in the history of life; Mechanism of Macroevolution; Phylogeny and the tree of life

Classifying the diversity of life; Kingdoms of Life –Prokaryotes, Eukaryotes, Archaea

Darwinian view of life and origin of species; Darwin's theory of evolution; The evolution of populations; Concepts of species; Mechanism of speciation

Genetic approach to Biology; Patterns of inheritance and question of biology; Variation on Mendel's Law; The molecular basis of genetic information; The flow of genetic information from DNA to RNA to protein; Genetic Variation; Methodologies used to study genes and gene activities; Developmental noise; Detecting macromolecules of genetics; Model organisms for the genetic analysis; Distinction between Phenotype and Genotype.

Chemistry of life; The constituents of matter; Structure of an atom; The energy level of electron; The formation and function of molecules depend on chemical bonding between atoms; Chemical reaction make or break chemical bonds.

Water and life; The water molecule is polar; Properties of water; Ionization of water

Carbon and life; Organic chemistry-the study of carbon compounds; What makes carbon special? Properties of organic compounds.

Structure and function of biomolecules; Most macromolecules are Polymers; Carbohydrates act as fuel and building materials; Lipids are group of hydrophobic molecules; Protein have diverse structures and functions; Nucleic acids store and transmit hereditary information

### Practicals

1. To learn a) use of microscope b) principles of fixation and staining.
2. Preparation of Normal, molar and standard solutions, phosphate buffers, serial dilutions
3. Use of micropipettes
4. Separation of A) amino acids B) chloroplast pigments by paper chromatography.
5. To perform gram staining of bacteria.
6. To study the cytochemical distribution of nucleic acids and mucopolysaccharides with in cells/tissues from permanent slides.
7. To perform quantitative estimation of protein using the Lowry's method. Determine the concentration of the unknown sample using the standard curve plotted.



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## Reference Books

1. Campbell, N.A., and Reece, J.B. *Biology*. 8<sup>th</sup> edition. Pearson Benjamin Cummings: San Francisco, 2008.
2. Griffiths, A.J.F. et al. *Introduction to Genetic Analysis*. 9<sup>th</sup> edition, W.H. Freeman & Co.: NewYork, 2008.
3. Raven, P.H et al. *Biology*. 7<sup>th</sup> edition Tata McGraw Hill Publications: New Delhi, 2006.

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## PLANT RESOURCE UTILIZATION

Origin of Cultivated Plants; Concept of centers of origin, their importance with reference to Vavilov's work; examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

Wheat and Rice, Role of dwarf varieties in green revolution; brief account of millets and pseudocereals.

Fruits: Mango, Citrus, Papaya.

Sugars and starches: Ratooning and nobilization of sugarcane, products and by products of sugarcane industry; Potato (Tuber anatomy and propagation methods) and comparative account with cassava.

Spices: Listing of important spices, their family and part used; with special reference to fennel, saffron, clove, turmeric and all spices; common adulterants of spices.

Beverages: Tea, coffee and cocoa, their processing and some common adulterants.

Oils and Fats: General description with details of groundnut, coconut, linseed and Brassica spp. and their use related health implications.

Essential Oils: General account and comparison with fatty oils.

Natural Rubber: Para Rubber, tapping and processing, Various substitutes of Para Rubber.

Drug Yielding Plants: Therapeutic and habit forming drugs with special reference to Cinchona, Digitalis, Rauwolfia, Papaver and Cannabis.

Masticatories and Fumitories

Tobacco and Health hazards.

Timber plants: General account with special reference to teak and pine.

Fibres: Classification based on the origin of fibres, Tetraploid cotton and Jute.

## PRACTICALS

Study of the following through habit sketches temporary preparations permanent slides photographs specimens products microchemical tests etc. to bring out the economic importance:

Cereals: Wheat, Rice, Millets and Pseudo cereals;

Legumes: Soyabean, groundnut and gram,

Fruits: mango, citrus and papaya;

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Sugars and starches: sugarcane, potato, cassava;

Spices: black pepper, coriander, fennel;

Beverages: tea, coffee, cocoa;

Oils and Fats: Coconut, mustard and linseed

Essential-oil yielding plants: Rosa, Cymbopogon, Vetiveria, Santalum and Eucalyptus; Fiber-yielding plants: Gossypium, Corchorus, jute.

Woods: Tectona, Pinus,

Rubber: Hevea brasiliensis;

Drug yielding plants: Cinchona, Digitalis, Rauwolfia, Papaver, Cannabis;

Fumitory plants: Tobacco

Each student should submit a theoretical project on any one of the topic pertaining to the course content. Some of the suggested topics for this purpose are: Biofuels; Biocides; Newer drug plants;

### Reference Books

1. Chrispeels, M.J., and Sadava, D. *Plants, Food and People*. W.H. Freeman & Co.: San Francisco, 1977.
2. Chrispeels, M.J. and Sadava, D.E. *Plants, Genes and Agriculture*. Jones & Bartlett Publishers: USA, 1994.
3. Harlan, J.R. *Crops and Man*. 2<sup>nd</sup> edition. Madison W.D. American Society of Agronomy, 1992.
4. Kochhar, S.L. *Economic Botany in Tropic*. Macmillan Publishers Ltd.: New Delhi, 2009.
5. Slater, A., Scott, N.W., and Fowler, M.R. *Plant Biotechnology: The Genetic Manipulation of Plants*, Oxford University Press, 2008.
6. Swaminathan, M.S., and Kochhar, S.L. *Plants and Society*. Macmillan Publishers Ltd.: New Delhi, 1989.
7. Wickens, G.E. *Economic Botany: Principles and Practices*, Springer. Kluwer Publishers, The Netherlands, 2004.

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## Plant Anatomy, Applied Botany & Cytogenetics

Meristems: Characteristics of meristems, classification, apical meristem, theories of apical meristem.

Tissue systems (including vascular elements)

The Root: General anatomical characteristics, dicot and monocot root anatomy, secondary growth in dicot root.

The Stem: Anatomy of dicot and monocot stem, secondary growth.

Tissue Culture: Basic techniques, achievements, practical applications of tissue culture, organ culture, somatic hybridization, and their role in crop improvement.

Utilization of Plants: Elementary knowledge of some of economically important plants used as source of :

- (a) Food : Wheat, rice, potato, sugarcane.
- (b) Timber : Tectona, Dalbergia, Shorea, Cedrus.
- (c) Fibres : Cotton, Jute, Coir.
- (d) Beverages : Tea, Coffee.
- (e) Spices : Ginger, Turmeric, Coriander.
- (f) Medicinal Plants: Ephedra, Cinchona, Atropa, Digitalis, Rauwolfia.

Cell Division: Mitosis and meiosis, bioenergetics and cell division.

DNA the Genetic Material: DNA structure, replication and genetic code.

Genetic Inheritance: Mendelism; Laws of segregation and independent assortment; allelic and non-allelic interactions.

Chromosomes: Physical and chemical structure; Dupraw's model and nucleosomes.

Linkage, linear arrangement of genes and genetic maps.

Structural Changes in Chromosomes: Deficiencies, duplications, inversions, translocations and their significance.

Numerical Changes in Chromosomes: Aneuploidy and polypoidy, their implications.

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## Practicals

Practicals will pertain to the syllabus of the theory paper.

## Reference Books

1. Bhatia, K.N. and Sharma, K.K. *A Treatise on Plant Ecology*, Pradeep Publishers, Jalandhar, 1989.
2. Butcher, D.N. and Ingram, D.S. *Plant Tissue Culture*. Edward Arnold Ltd., U.K., 1976.
3. Esau, K. *Vascular Differentiation in Plants*, Holb. Rinebant and Winston, New York, 1965.
4. Fahn, A. *Plant Anatomy*, Pergamon Press: Oxford, 1990.
5. Gupta, P.K. *Genetics*. Rastogi Publications: Meerut, 1995.
6. Kochhar, S.L. *Economic Botany in the Tropics*, Macmillan India Ltd.: Madras, 1981.
7. Mehrotra, R.S. *Plant Pathology*. Tata McGraw Hill: New Delhi, 1986.
8. Odum, E.P. *Fundamentals of Ecology*. Saunders Toppan, USA, 1974.
9. Sherry, R.M. *Plant for Man*. 2<sup>nd</sup> edition. Englewood Cliffs, New Jersey, Prentice – Hall, 1972,
10. Street, H.B. *Tissue Culture in Plant Science*. Academic Press: London, 1974.
11. Swanson, C.L., and Welisten, P.L. *The Cell*. 4<sup>th</sup> edition. Prentice Hall: New York, 1977.
12. Swanson, C.P. *Cytology and Cytogenetics*. Prentice Hall, 1957.

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## PLANT DEVELOPMENT AND ANATOMY

**Plant Sporophyte:** A bipolar structure; Onset of polarity; Cytodifferentiation and organogenesis during embryonic development; physiological and genetic aspects.

Introduction and scope of Plant Anatomy

Applications in systematics, forensics and pharmacognosy.

**Tissues and Cell Walls:** Classification and structure of tissues; cytodifferentiation of tracheary elements and sieve elements; pits and plasmodesmata; wall ingrowths and transfer cells; adcrustation and incrustation; ergastic substances.

**Stem:** Organization of shoot apex (apical cell theory, histogen theory, tunica corpus theory, plastochrone); shoot chimeras; types of vascular bundles; primary phloem and primary xylem; terminal, lateral and adventitious buds; primary thickening meristem.

**Leaf:** Development of leaf, histology of C3 and C4 leaves; stomatal complex and diversity of stomata, scale leaves.

**Root:** Organization of root apex (apical cell theory, histogen theory, korper-kappe theory); quiescent centre; root cap; primary root tissue: rhizodermis, cortex, endodermis, exodermis, metacutinization, lateral root apices; secondary growth in roots.

**Vascular Cambium:** Structure and function; concept of cambial zone; cambial derivatives; seasonal activity of cambium and unusual cambial activity.

**Secondary Growth:** Axially and radially oriented xylary and phloic elements, cyclic aspects, juvenile adult and reaction woods; sap wood and heart wood; Phloem as a dynamic tissue.

Hydathodes, salt glands, nectaries; cavities, lithocysts and laticifers.

## PRACTICALS

1. Familiarization with techniques: double staining, maceration, peel mount, clearing.
2. Study of anatomical details through permanent slides/temporary stain mounts/macerations/
3. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
4. Root: monocot, dicot, origin of lateral roots; secondary growth; anomalous root structure.
5. Stem: monocot, dicot - primary and secondary growth; periderm; lenticel; abnormal secondary growth in dicots and monocots;
6. Leaf: isobilateral, dorsiventral; venation patterns.
7. Adaptive Anatomy: xerophytes, hydrophytes, parasites and epiphytes.
8. Secretory tissues: ducts and cavities, lithocytes and laticifers.

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## Reference Books

1. Dickinson, W.C. *Integrative Plant Anatomy*. Harcourt Academic Press: USA, 2000.
2. Fahn, A. *Plant Anatomy*. Pergmon Press: USA and UK, 1974.
3. Mauseth, J.D. *Plant Anatomy*. The Benjamin/Cummings Publisher: USA, 1988.
4. Esau, K. *Anatomy of Seed Plants*. Wiley & Sons Publishers: NewYork, 1977.
5. Taiz, L., and Zeiger, E. *Plant Physiology*. 4<sup>th</sup> edition. Sinauer Associates, Inc. Sunderland, 2006.

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## Plant Metabolism & Biochemistry

**Enzymes:** Historical background, classification, nomenclature and importance of enzymes; role of enzymes as catalysts; physiochemical and biological properties; concept of holoenzymes; coenzyme; apoenzyme and prosthetic groups; mechanism and kinetics of enzyme action; enzyme inhibitors; isoenzymes; allosteric enzymes; industrial aspects of enzymology.

**Carbon Assimilation:** Role of chlorophylls and accessory pigments; antennae molecules and active center molecules; evidences for two photosystems; reduction of NADP; photophosphorylation; reduction of CO<sub>2</sub> into glucose; Benson and Calvin cycle; Hatch and Slack pathway; Crassulacean acid metabolism; energetics of CO<sub>2</sub> reduction; factors affecting CO<sub>2</sub> reduction.

**Carbohydrate Metabolism:** Structure, properties and importance of mono-, di- and polysaccharides; Synthesis of di - (sucrose) and polysaccharides (starch and cellulose).

**Carbon Oxidation:** Glycolysis, anaerobic conversion of pyruvate into ethanol or lactate, energy balance, reversibility and inhibition of glycolysis, Pasteur effect, oxidative decarboxylation of pyruvate into acetyl CoA, TCA cycle, oxidative phosphorylation, oxidation of RuBP (photorespiration), factors affecting oxidative processes, regulation of TCA cycle, role of glyoxalate cycle.

**Nitrogen and Protein Metabolism:** Biological nitrogen fixation and nitrogen cycle, Catabolism of amino acids, ammonia assimilation, transamination, deamination, structure and general properties of amino acids and proteins

**Lipid Metabolism:** Structure, properties, classification and functional significance of fatty acids, triglycerides and steroids; Synthesis and breakdown, formation of glycerides; oxidation of fatty acids, beta oxidation; energy balance.

## PRACTICALS

1. Detection of the presence of plant enzymes amylase, catalase, nitrate reductase urease (in vivo) in various sources.
2. To study properties (thermolability, proteinaceous nature and specificity) of any one of the enzymes (catalase/urease).
3. To study the effect of various factors (concentration, temperature, pH, inhibitor) on the activity of catalase enzyme.
4. Demonstration of dye reduction by isolated chloroplasts.
5. Study the effect of different factors on O<sub>2</sub> evolution during photosynthesis and demonstrate the Law of limiting factors.
6. Chemical separation of chloroplast pigments and determination of their absorption spectra.



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7. To extract anthocyanin pigments and study the effect of pH on their absorption spectra.
8. Study of the rate of aerobic respiration and respiratory quotient in different plant parts/materials.
9. Identification tests for carbohydrates (Fehling's test, Benedicts test) and proteins (Ninhydrin test, Xanthoproteic test).
10. Preparation of standard curve for estimation of proteins and determination of total proteins in plant tissue extracts for example of control and GA3 treated embryo-less wheat grains.
11. Separation and identification of amino acids by thin layer chromatography.

### Reference Books

1. Conn, E.E., Stumpf, P.K. and Bruening, G. *Outlines of Biochemistry*, 4<sup>th</sup> edition, John Wiley and Sons Inc.: NewYork, 2006.
2. Buchanan, B., Gruissem, W., and Jones, R. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Biologists, 2000.
3. Elliot. *Biochemistry and Molecular Biology*. Oxford Publishers, 2009.
4. Nelson, D.L., and Cox, M.M. Lehninger. *Principles of Biochemistry*, 4<sup>th</sup> edition,.WH Freeman and Company: New York, 2004.
5. Taiz, L., and Zeiger, E. *Plant Physiology*. 4<sup>th</sup> edition. Sinauer Associates Inc. Publishers, Massachusetts, USA, 2006.
6. Dennis, D.T., Layzell, D.B., Lefebvre, D.D. and Turpin, D.H. *Plant Metabolism*. Addison Wesley Longman, 1997.
7. Hopkins, W.G., and Huner, P.A. *Introduction to Plant Physiology*. John Wiley and Sons: NewYork, 2008.
8. Kaul, R.P. *Plant Metabolism*. Swastik Publishers and Distributors: India, 2009.
9. Salisbury, F.B., and Ross, C.W. *Plant Physiology*. Wadsworth Publishing Co. Ltd., 1991.

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## Paper: Embryology of Angiosperms

Historical perspective of the development of our knowledge of embryology.

**Microsporogenesis:** Structure and function of walls layers, ultra – structural changes in tapetum and meiocytes during microsporogenesis, role of callose, role of tapetum in pollen development, anther culture and haploid plants.

**Pollen:** Pollen mitosis, division of generative cell, cell heterogeneity in sperms, pollen fertility and sterility, pollen storage, viability and germination.

**Ovule:** Ontogeny; types of evolution, reduction, nutrition, post pollination changes, ovule culture.

**Megasporogenesis:** Subcellular profiles of archesporial and megaspore mother cells, megaspore tetrad, dyad and coenomegaspore (Polarity of nuclei) determination of functional megaspore/ dyad.

**Embryo sac types:** Ultrastructure of components, synergid and antipodal haustoria, nutrition of embryo sac.

**Pollination:** Ultrastructural and histochemical details of style and stigma, self and interspecific incompatibility, significance of pollen-pistil interaction, role of pollen pistil interaction, role of pollen wall proteins and stigma surface proteins, barriers to fertilization, methods of over coming incompatibilities, intra-ovarian pollination, in-vitro pollination.

**Fertilization:** Heterospermy, differential behaviour of male gametes, discharge and movement of sperms, syngamy and triple fusion, post fertilization, metabolic and structural changes in embryo sac.

**Endosperm:** Types, ultrastructure, cellularization in nuclear endosperm, endosperm haustoria, their extension and persistence, function, storage, metabolites, endosperm culture.

**Embryo:** Polarization of zygote, embryogenic types, histology and organogenesis of dicot embryos, organless (undifferentiated) embryos, delayed differentiation of embryo, structure, cytology and function of suspensor, physiological and morphogenetical relationship of endosperm and embryo.

**Polyembryony:** Types, genetic and somatic, pollen embryos.

**Apomixis:** Diplospory, apospory, parthenogenetic development of embryo, pseudogamous and autogamous development of endosperm, importance.

**Seed:** Growth and development, seed appendages.

### Practicals

1. Study of basic structure of different flowers.
2. Study of pollen grains and various pollen agglutinations.

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3. Study of various developmental stages; microsporogenesis, megasporogenesis and embryo development.

### Reference Books

1. Bhojwani, S.S., and Bhatnagar, S.P. *The Embryology of Angiosperms*. Vikas Publishing House Pvt. Ltd.: Delhi, 2003.
2. Eames, A.J. *Morphology of the Angiosperms*. Tata McGraw Hill Publishing Co. Ltd.: Bombay, 1961.
3. Johri. B.M. *The Embryology of Angiosperms*. McGraw Hill Publishing Co. Ltd.: Bombay, 1980.
4. Maheshwari, P. *An Introduction to the Embryology of Angiosperms*. Tata McGraw Hill Publishing Company Ltd.: Bombay, 1980.