DEPARTMENT OF BOTANY				*CLASS: I M.Sc. Botany*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
I	Major Core 3	21P1BMC3	Plant Anatomy, Embryology and Morphogenesis	4	5	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	✓
Skill oriented	✓		Entrepreneurship oriented	

Objectives

1. To gain knowledge on the structure and functional development of plant cells and tissues.
2. To differentiate the normal and anomalous secondary growth in Dicots and Monocots.
3. To understand the formation and development of embryo and their applications for crop improvement.
4. To understand the critical steps in the differentiation of tissues and organs.

UNIT	CONTENT	CLO	K LEVEL	HOURS
1	**Plant Anatomy:** Meristems – characters, classification and theories – Apical cell theory, shoot apical meristem (SAM), root organization – root apical meristem (RAM). Secondary structure of dicot stem and root. Identification of common timbers - Heart wood and sap wood-strength, ability, grains, texture and defects. Anomalous secondary growth in Dicots and Monocots (Boerhaavia, Bougainvilla, Amaranthus, Mirabilis and Dracaena).	**1**	**Up to K4**	**15**
2	**Embryology of Angiosperms:** Development of microspores and megaspores – types and factors involved. Development of micro gametophyte – pollen wall development - vegetative and generative cells; pollen viability test. Development of megagametophyte – structure and types of ovule. Development of monosporic, biosporic and tetrasporic types of embryosac and their cellular organization. Endosperm – Origin, types, structure, development. Haustorial endosperms	**2**	**Up to K4**	**15**
3	Pollen-Pistil interaction and fertilization, types of stigma and style events on stigmatic surface, pollen tube growth, guidance and entry into ovule and embryo sac. Double fertilization – significance. Incompatibility – interspecific – homomorphic and heteromorphic, Causes and methods to overcome incompatibility. Classification of embryo development in Dicots and Monocots. Polyembryony – causes – Apomixis, Apospory. Their role in crop improvement programmes and seed development. Biochemical and physical factors in fruit development. Parthenocarpy. Prospects and significance of embryo, pollen and endosperm culture.	**3**	**Up to K4**	**15**

4	**Morphogenesis:** Concept of morphogenesis as a package of development; components – cell division, division planes, their importance; Cytoskeleton, pre-prophase band in orienting karyokinesis and cell plate. Origin, Structure, development and ontogeny of xylem and phloem. Role of sucrose in Vascular tissue differentiation. Vascular Cambium – Types, divisions, arrangement and seasonal activity, factors affecting cambial activity.	**4**	**Up to K4**	**15**
5	Leaf ontogeny – initiation, apical, intercalary, marginal and adaxial growth, plate meristem and development of vascular tissues, plastochronic index, zone of foliar inhibition in apices. Transfer cells – Structure, development and functions. Classical concept of flower; Floral anatomy and its role in classification, ABC model of ontogeny of flower. Plant galls - types, structure and development. Role of polarity in cell differentiation and symmetry (Polarity in cuttings, unicellular coenocytes, eggs and spores).	**5**	**Up to K4**	**15**

Books for study

1. Agarwal, S. B. 1990 Embryology of Angiosperms - a fundamental approach. Sahitya Bhawan, Agra.
2. Clowers, F. A. L. 1961 Apical Meristems. Blackwell Scientific Publication, Oxford.
3. Bhojwani S. S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd., New Delhi
4. Cutler, D.F. 1978, Applied plant Anatomy, Orient Longman Publishers, New Delhi
5. Dwivedi, J. N. 1998 Embryology of Angiosperms. Rastogi and Co., Meerut.
6. Easu, K. 1953 Plant Anatomy. John Wiley & Sons Inc., New York.
7. Easu, 1987. The Anatomy of seed plants. Wiley Eastern Ltd., New Delhi
8. Fahn, A. 1989 Plant Anatomy,Pergamon press, Oxford, New York.
9. Fosket, D.E. 1994. Plant Growth and Development – a molecular approach. Academic Press.
10. Johri, B.M. 1984 Embryology and Angiosperms. Springer Verlag. Berlin

Books for reference

1. Maheshwari, P. 2015. An Introduction to the Embryology of Angiosperms, Scholar Select Publishers.
2. Metcalfe and Chalk 1950 Anatomy of the Dicotyledons and Monocotyledons. Vol. I and II. Clarendon Press, Oxford, UK.
3. Pandey , A.K., 1997. Introduction to Embryology. CBS Publishers and Distributors , New Delhi
4. Pandey, B. P. 1989 Plant Anatomy. S. Chand and Co. Ltd., New Delhi.
5. Pandey, S.N. and Chadha , A. 2000. Embryology. Vikas Publishing House Pvt. Ltd., , New Delhi
6. Paula J. Rudall, 2007. Anatomy of Flowering Plants: An Introduction to Structure and Development (3rd Edition), Cambridge University Press.
7. Ray F. Evert, 2006. Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function, and Development. John Wiley & Sons.
8. Shivanna, K. R. 2003 . Pollen Biology and Biotechnology. Oxford and IBH publishing house, New Delhi.
9. Singh, V., Pande, P. C. and Jain, D. K. 1987 Anatomy of Seed Plants. Rastogi Publications, Meerut. Embryology

Rationale for Nature of the Course:
Enumerating the sources and quality of fibres and timbers
Visiting the crop improvement centers to acquaint with the modern techniques

Activities having direct bearing on Skill development / Employability / Entrepreneurship
Observation of internal morphology of different habits of angiosperms adopting hand and microtome sectioning of different dimensions(T.S, RLS and TLS), differential staining, tissue maceration and permanent slide preparations.
Analyzing the fibre and timber quality of the plants of interests
Undertstanding and applications of conventional crop improvement techniques

Pedagogy:
Chalk and Talk, PPT, Group Discussion, Seminar, Interaction, Problem Solving, Quiz, Virtual Labs & Learning Management System (CANVAS).

Course Learning Outcomes:

CLOs	CLO Statement	Knowledge Level
Students will be able to know, understand, apply, and analyse		
CLO -1	the characteristics and classifications of meristems, theories on apical meristems, secondary and anomalous secondary structures of stem and root	Up to K4
CLO -2	The micro and megasporogenesis; development of male gametophyte, ontogeny of types of embryosac and endosperms	Up to K4
CLO -3	The pollen pistil interactions, double fertilization, classification of embryo development and polyembryony	Up to K4
CLO -4	the components of morphogenesis like cell division, cytoskeleton, cambial activity and xylem and phloem differentiation	Up to K4
CLO -5	the development of leaf, flower and galls; and role of polarity in plant developement	Up to K4

Mapping Programme Specific Outcomes with Course Outcome:

	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CLO-1	1	2	3	1	2
CLO-2	2	1	3	2	2
CLO-3	3	3	3	3	3
CLO-4	3	3	1	2	3
CLO-5	3	3	2	3	3

Lesson plan

Unit	Description	Hours	Mode
I	Meristems – characters, classification and theories – Apical cell theory, shoot apical meristem (SAM), root organization – root apical meristem (RAM). Secondary structure of dicot stem and root. Identification of common timbers - Heart wood and sap wood-strength, ability, grains, texture and defects. Anomalous secondary growth in Dicots and Monocots (Boerhaavia, Bougainvilla, Amaranthus, Mirabilis and Dracaena).	5 5 5	Chalk and talk PPT, LMS Quiz, Video lectures and Group discussion
II	Development of microspores and megaspores – types and factors involved. Development of micro gametophyte – pollen wall development - vegetative and generative cells; pollen viability test. Development of megagametophyte – structure and types of ovule. Development of monosporic, biosporic and tetrasporic types of embryosac and their cellular organization. Endosperm – Origin, types, structure, development. Haustorial endosperms.	5 5 5	Chalk and talk PPT, LMS Quiz, Video lectures and Group discussion
III	Pollen-Pistil interaction and fertilization, types of stigma and style events on stigmatic surface, pollen tube growth, guidance and entry into ovule and embryo sac. Double fertilization – significance. Incompatibility – interspecific – homomorphic and heteromorphic, Causes and methods to overcome incompatibility. Classification of embryo development in Dicots and Monocots. Polyembryony – causes – Apomixis, Apospory. Their role in crop improvement programmes and seed development. Biochemical and physical factors in fruit development. Parthenocarpy. Prospects and significance of embryo, pollen and endosperm culture.	5 5 5	Chalk and talk PPT, LMS Quiz, Video lectures and Group discussion
IV	**Morphogenesis:** Concept of morphogenesis as a package of development; components – cell division, division planes, their importance; Cytoskeleton, pre-prophase band in orienting karyokinesis and cell plate. Origin, Structure, development and ontogeny of xylem and phloem. Role of sucrose in Vascular tissue differentiation. Vascular Cambium – Types, divisions, arrangement and seasonal activity, factors affecting cambial activity.	8 4 3	Chalk and talk PPT, LMS Quiz, Video lectures and Group discussion

V	Leaf ontogeny – initiation, apical, intercalary, marginal and adaxial growth, plate meristem and development of vascular tissues, plastochronic index, zone of foliar inhibition in apices. Transfer cells – Structure, development and functions. Classical concept of flower; Floral anatomy and its role in classification, ABC model of ontogeny of flower. Plant galls - types, structure and development. Role of polarity in cell differentiation and symmetry (Polarity in cuttings, unicellular coenocytes, eggs and spores).	4 3 3 5	Chalk and talk PPT, LMS Quiz, Video lectures and Group discussion

Course Designer: Dr. S. Karuppusamy, Assistant Professor

PG Botany BluePrint

Test	10 marks	As per table below
Assignment	5 marks	K4
Seminar	5 marks	K4
Quiz	5 marks	K4

Learning Outcome Based Education (LOBE) & Assessment
Formative – Blue Print
Articulation Mapping-K Levels with Courses Learning Outcomes (CLOs)

Units	**CLOs**	**K- Level**	**Section A**		**Section B (Either/or Choice)**	**Section C (Open Choice)**
			Short Answers			
			No. of Questions	**K- Level**		
1	CLO x	Up to K3	2	K2,K3	2 (K3&K3)	2 (K2,K3)
2	CLO y	Up to K4	3	K2, K2, K3	2 (K4&K4)	1 (K3/K4)
No. of Questions to be asked			5		4	3
No. of Questions to be answered			5		2	2
Marks for each question			2		5	10
Total Marks for each section			10		10	20

Learning Outcome Based Education (LOBE) & Assessment
Summative Examination – Blue Print
Articulation Mapping-K Levels with Courses Learning Outcomes (CLOs)

Units	CLOs	K- Level	Section A		Section B		Section C (Either/or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K- Level	No. of Questions	K- Level		
1	CLO 1	Up to K2	2	K1 & K1	1	K1	2 (K1&K1)	1 (K2)
2	CLO 2	Up to K3	2	K2 & K3	1	K1	2 (K2&K2)	1 (K3)
3	CLO 3	Up to K4	2	K2 & K3	1	K2	2 (K3&K3)	1 (K3)
4	CLO 4	Up to K4	2	K3 & K4	1	K2	2 (K4&K4)	1 (K4)
5	CLO 5	Up to K4	2	K3 & K4	1	K3	2 (K4&K4)	1 (K4)
No. of Questions to be asked			10			5	10	5
No. of Questions to be answered			10			5	5	3
Marks for each question			1			2	5	10
Total Marks for each section			10			10	25	30

Distribution of Section- wise marks with K Levels in the summative examinations

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (Either/or)	Section D (Open Choice)	Total Marks	% of Marks without choice	Consolidated
K1	2	4	10	-	**16**	13.33	**35%**
K2	2	4	10	10	**26**	21.66	
K3	4	2	10	20	**36**	30.00	**30%**
K4	2	-	20	20	**42**	35.00	**35%**
Total Marks	10	10	50	50	**120**	100.00	**100%**