Semester – X (AY 2020-21)

Reproductive and Developmental Biology of Plants

Assessment	
Maximum marks	100
Continuous Internal Assessment (CIA)	25
Mid Semester Exam (MSE)	25
End Semester Exam (ESE)	50
Passing Marks	50

Course objectives

To acquaint the students about the mechanisms of development and reproduction in plants. The course will enable students to know about the different reproductive structures of plants and their role in biological processes.

Unit 1: Development of vegetative parts

Plant growth kinetics and patterns of growth; Seedling growth - photomorphogenesis and hormonal control.

Shoot development – organization, determinate and indeterminate growth, lineage decisions, tissue differentiation, developmental patterning of shoot apical meristem (SAM); Regulation, and cytological and molecular analysis of cell fate in SAM.

Leaf development - Determination; Phyllotaxy; Control of leaf forms; Differentiation of epidermis - stomatal development and types, trichome development and types, mesophyll development.

Root development – Organization, fate determination, lineage decisions and developmental patterning of root apical meristem (RAM); Vascular tissue differentiation; Development of lateral roots, root hair and quiescent centre.

Unit 2: Development of floral development

Floral evocation and development of floral meristem ABC model, Sex determination mechanisms; Regulation of floral architecture and diversification; Physiological, environmental and molecular control of flowering; Floral organs meristem identity genes in *Arabidopsis* and *Antirrhinum* MADS-box genes.

Male gametophyte – Development of androecium and the genes involved; Molecular basis of microsporogenesis and microgametogenesis

Female gametophyte –Development of gynoecium and the genes involved; Molecular basis of megasporogenesis and megagametogenesis.

Unit 3: Pollination and post-pollination developments

Plant-pollinator interactions; pollen load; pollinator and pollination efficiency; physicochemical aspects of pollination; pollen: ovule ratio.

Genetic and molecular control of pollen-pistil interaction; Chemical and molecular signalling for pollen tube guidance; Molecular basis of double fertilization.

Molecular mechanism and genes involved in seed development; Molecular basis of embryogenesis in dicots and monocots.

Unit 4: Developmental perspectives on apomixis

Origin and maintenance of natural and induced apomixis; Types and significance; Embryological and molecular studies in apomixis; Nucellar and integumentary embryos; Polyembryony – types, significance and developmental patterns.

Unit 5: Deviations in plant development

Male sterility - mechanism of action; meiotic abnormalities; pollen viability; Cytological, biochemical and molecular aspects of pollen tube rejection reaction and sexual incompatibility.

In vitro fertilization (IVF) - origin; techniques and achievements; fruit and ovule abortion in relation to resource allocation; sibling competition in plants

Suggested readings:

1. Maheshwari, P., 2020. An Introduction to the Embryology of Angiosperms. Alpha Editions
2. Barrett, S.C.H., 2008. *Major Evolutionary Transitions in Flowering Plant Reproduction.* University of Chicago Press.
3. Faegri, K. and Van der Pijl, L., 1979. *The Principles of Pollination Ecology*. Pergamon Press, Oxford.
4. Harder, L.D. and Barrett, S.C.H., 2006. *Ecology and Evolution of Flower*. Oxford University Press.
5. O'Neill, S.D. and Roberts, J.A., 2002. *Plant Reproduction*. Sheffield Academic Press.

6. Raghavan, V., 1997. *Molecular Embryology of Flowering Plants*. Cambridge University Press.
7. Raghavan, V., 2000. *Developmental Biology of Flowering Plants*. Springer Verlag, New York.
8. Scott, R.J. and Stead, A.D., 2008. Molecular and Cellular Aspects of Plant Reproduction. *Society for Experimental Biology*, Seminar Series 55.
9. Shivanna, K.R. and Johri, B.M., 1985. *The Angiosperm Pollen: Structure and Function*. Wiley Eastern.
10. Shivanna, K.R., 2003. *Pollen Biology and Biotechnology*. Science Publishers, Enfie.d, New Hamsphire, U.S.A.
11. Shivanna, K.R. and Rangaswamy, N.S., 1992. *Pollen Biology: A Laboratory Manual*. Springer Verlag, Berlin.
12. Datte, Y., Dumas, C. and Gallais, A., 1992. *Reproductive Biology and Plant Breeding Biologie de la Reproduction et Amélioration des Plantes*. Springer Verlag.
13. Lyndon, R.F., 1990. *Plant Development: The Cellular Basis*. Unnin Hyman, London.
14. Hojsgaard Diego, Hörandl Elvira 2019. The Rise of Apomixis in Natural Plant Populations, Frontiers in Plant Science (10): 358
15. Wheeler, M.J., Franklin-Tong, V.E. and Franklin, F.C.H., 2001. The molecular and genetic basis of pollen–pistil interactions. *New Phytologist*, *151*(3). pp.565-584.
16. Beck, C., 2010. An Introduction to Plant Structure and Development. Cambridge University Press, 465pp.
17. Koltunow, A.M. and Grossniklaus, U., 2003. Apomixis: a developmental perspective. *Annual review of plant biology*, *54*(1). pp.547-574.
18. Steeves, T.A. and Sussex, I.M., 1989. Patterns in plant development. Cambridge University Press, 405pp.
19. Richards, A.J., 2003. Apomixis in flowering plants: an overview. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, *358*(1434). pp.1085-1093.
20. Whitelam, G.C. and Halliday, K.J., 2007. Light and Plant Development. Blackwell Publishing Ltd, 350pp.
21. Meyer, P. (Ed.) 2005. Plant Epigenetic. Blackwell Publishing Ltd. 281pp.
22. Leyser, O. and Day, S., 2003. Mechanism in Plant Development. Blackwell Publishing Ltd. 241pp.
23. Timmermans, M., 2010. Plant Development. Academic Press, 480pp.
24. Howell, S.J., 1998. Molecular Genetics of Plant Development. Cambridge University Press, 365pp.
25. Davies, P.J. (ed.) 2010. Plant Hormones: Biosynthesis, Signal Transduction, Action. Springer, Netherlands, 802pp.
26. Karp, J.G., 2007. Cell and Molecular Biology. John Wiley & Sons, USA.

27. Buchanan, B.B., Gruissem, W. and Jones, R.L., 2015. Biochemistry and Molecular Biology of Plants. Wiley Publisher, 1264pp.

28. Research and review articles on relevant topics.

Course Title: Reproductive and Developmental Biology of Plants Lab

Assessment	
Max. Marks	50
Continuous Internal Assessment (CIA)	25
End Semester Exam (ESE)	25
Passing Marks	25

1. Demonstration of developmental aspects of reproduction using normal and mutant Arabidopsis phenotypes.
2. Demonstration of the stages of pollen and ovule development in the wild and mutant plants using permanent slides; electron micrograph and available phenotypes.
3. Pollen *in vitro* germination methods: Sitting drop culture; suspension culture; surface culture and pollen viability tests.
4. To study the pollen mitosis.
5. Assessment of stigma receptivity by localizing peroxidases, non-specific esterases and phosphatases.
6. Assessment of floral rewards: quantitative and qualitative analysis of nectar and pollen.
7. To localize pollen tubes with aniline blue fluorescence method.
8. To study the different aspects of pollen-pistil interaction and post fertilization stage with the help of permanent slides and electron micrographs.
9. To isolate the embryo sacs and visualization of post-fertilization stages via fluorescence and confocal microscope.
10. To study of use of DNA fluorochromes to localize nuclei during pollen and ovule development.
11. To study the post-fertilization stage with the help of permanent slides and electron micrographs.

12. To induce somatic embryos using a suitable plant material.
13. To study the tissue systems, meristem, vascular and cork cambium.
14. To study the internal structure of root, stem and leaf (dicot and monocot), advanced secondary growth in dicot stem and root.
15. To study the origin of lateral roots.