Reproductive Biology of Angiosperms (BHCC11)Core Course - (CC) Credit:6 UPC: 32161501

Course Objective(2-3)

To have knowledge of the flowering and fruiting, reproduction process, role of pollinators, ovule and seed development.

Course Learning Outcomes

Student would have an understanding of

- 1. Induction of flowering and molecular and genetic aspects of flower development.
- 2. Anther structure, pollen development, dispersal and pollination
- 3. Ovule, embryo sac development and fertilization,
- 4. Endosperm development and its importance
- 5. Alternative pathways of reproduction and their importance

6. Student would be able to apply this knowledge for conservation of pollinators and fruit development

Unit 1: Introduction

History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison, H.Y. Mohan Ram) and scope of Reproductive Biology.

Unit 2: Anther

Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance; Polyspory

Unit 3: Pollen biology

Micro-gametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system (no details but table to be included); Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Unique features: Pseudomonads, polyads, massulae, pollinia, pollen embryo sacs.

Unit 4: Ovule

Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of Polygonum, Allium and Fritillaria type); Organization and ultrastructure of mature embryo sac; Female germ unit.

Unit 5: Pollination and fertilization

Mechanism of anther dehiscence, Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; structure of pollen tube; double fertilization.

Unit 6: Self incompatibility

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Recognition and rejection reaction, Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intra-ovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization (in brief with examples); in vitro fertilization.

Unit 7: Endosperm

Types (2 examples each), development, structure and functions.

(8 lectures)

(4 lectures)

(6 lectures)

(9 lectures)

(7 lectures)

(2 lectures)

(4 lectures)

Unit 8: Embryo

Six types of Embryogeny (no details); General pattern of development of dicot and monocot embryo; Suspensor: Ultrastructure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features: Embryo development in *Paeonia*.

Unit 9: Seed

Structure, importance and dispersal mechanisms (Adaptations – Autochory, Anemochory, Hydrochory, Zoochory with 2 examples each).

Units 10: Polyembryony and apomixes

Introduction; Classification (given by Bhojwani and Bhatnagar); Causes and applications.

Unit 11: Germline transformation

Transformation of male gametes (MAGELITR method) and egg cell through pollen tube pathway method (irradiated pollen, DNA application on cut end), floral dip method. (Methods of gene transfer not to be taught.)

Practical

1. Anther: Wall layers including tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representations.

2. Pollen grains: Fresh pollen showing ornamentation and aperture, psuedomonads, polyads, pollinia, massulae (slides/photographs, fresh material), ultrastructure of pollen wall (micrograph); Pollen viability: Tetrazolium test; Pollen germination: Calculation of percentage germination in different media using hanging drop and or sitting drop method; Study of pollen cytology of 2-celled and 3-celled pollen using DNA flurochormes or acetocarmine stain.

3. Ovule: Types: anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).

4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus, central cell, antipodals.

5. Intra-ovarian pollination; Test tube pollination through photographs.

6. Endosperm: Dissection of young seeds for endosperm with free-nuclear haustoria.

7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of young seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

8.Pollination and Seed dispersal mechanisms (through photographs / specimens)

References

1. Bhojwani, S.S., Bhatnagar, S.P. (2011). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publishing House. (Chapter 1 for Unit 1, Chapters 3 to 15 for unit 2-10, Chapter 17 for Unit 11)

2. Johri, B.M. (1984). Embryology of Angiosperms. Netherlands: Springer-Verlag. (Chapters 3, 4 for Unit 4, Chapter 6 for Unit 5, Chapter 7, 8 for Unit 7-8; Chapter 12 for Unit 9)

3. Raghavan, V. (2000). Developmental Biology of Flowering plants. Netherlands: Springer (Chapter 13 for Unit 8)

4. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. New Delhi, Delhi: Oxford

(6 lectures)

(4 lectures)

(4 lectures)

(6 lectures)

and IBH Publishing Co. Pvt. Ltd. (Chapters 1, 2, 3, 4 for Unit 2-3; Chapter 7 for unit 5, Chapter 9 for Unit 6)

Additional Resources

1. Moza M. K., Bhatnagar A.K. (2007). Plant reproductive biology studies crucial for conservation. Current Science 92:1907. (For Unit 1)

2. Bhat V, Dwivedi K.K., Khurana P, Sopory S. (2005). Apomixis: an enigma with potential applications. Current Science 89: 1879-1893. (For Unit 10).

3. Mohanty D, Chandra A, Tandon R. (2016). Germline transformation for crop improvement. In: Raina S. N., Rama Rao S, Rajpal V. R. (Eds.). Molecular Breeding for Sustainable Crop Improvement (Vol 2). Switzerland: Spring International Publishing AG, Cham, (Chapter14: pp 343-395 for Unit 11).

4. Resch T, Touraev A. (2011). Pollen Transformation Technologies. In: Plant Transformation Technologies. C. Neal Stewart Jr, Alisher Touraev, Vitaly Citovsky, Tzvi Tzfira (Eds). Blackwell Publishing limited. (Chapter 5 for Unit 11)

Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded and students are encouraged to refer to and read the latest research papers in the fields/topics covered.

When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.

Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained.

Week 1: Unit I Week 2: Unit II Week 3: Unit III Week 4: Unit III Week 5: Unit IV Week 6: Unit V Week 7: Unit VI Week 8: Unit VII Week 9: Unit VIII Week 10: Mid semester Exam Week 11: Mid Semester Break Week 12: Unit VIII Week 13: Unit IX Week 14: Unit X Week 15: Unit XI

Assessment Methods

<u>Theory</u>: The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test