CHAPTER

2

Sexual Reproduction in Flowering Plants

Parts of flower

- All flowering plants show sexual reproduction.
- A complete flower consists of calyx, corolla, androecium and gynoecium.
- Androecium is the male reproductive structure that consists of a whorl of stamens.
- Gynoecium is the female reproductive structure that consists of a whorl of carples (pistils).
- Each pistil has three parts.
  - **Stigma:** Landing platform for pollen grains.
  - **Style:** Elongated slender part beneath the stigma.
  - **Ovary:** Basal bulged part of pistil, has ovarian cavity (locule). Placenta is located inside ovarian cavity.
- A typical stamen is composed of filament and anther.
  - **Filament:** It is a long slender stalk. The proximal end of the filament is attached to the thalamus or the petal of the flower.
  - **Anther** is terminal and generally bilobed structure and each lobe having two theca i.e., they are dithecous.
- The anther is a four-sided (tetragonal) structure consisting of four microsporangia located at the corners two in each lobe.
- The microsporangia develop further & become pollen sacs. They extend longitudinally all through the length of an anther and are packed with pollen grains.

Structure of Microsporangium

- A typical microsporangium near circular, which is generally surrounded by four wall layers.
- The outer 3 wall layers perform the function of protection and help in dehiscence of anther to release the pollen. The innermost wall layer tapetum nourishes the developing pollen grains.
- **Microsporogenesis** is a process of formation of microspores from PMC (Pollen Mother Cell).

Pollen Grain

- It represents the male gametophyte.
- It has prominent two layered wall-exine and intine.
- The outer layer exine is made up of sporopollenin and the intine is made up of pectin and cellulose.
- Pollen grains of many species causes severe allergies.
- Pollen grains are rich in nutrients.
- **Pollen variability:** depends on both temperature and humidity.
- Pollen of a large number of species can be stored for years in **liquid nitrogen (–196°C)** in pollen banks for crop breeding programmes.

Female Gametophyte/Embryo Sac

- Ovules generally differentiate a single megaspore mother cell (MMC) in micropylar region of nucellus.
- In majority of flowering plants, one megaspore remains functional and 3 degenerate. The functional megaspore develops in to the female gametophyte (embryo sac).
- The typical angiosperm embryo sac (female gametophyte) possess **8-nucleate and 7-celled** condition at maturity.

Pollination

- Pollination is the transfer of pollen grain from anther to the stigma of the same flower (self pollination) or of different flower (cross pollination) of the same species.
- Self pollination is of two types i.e, autogamy and geitonogomy.
- Autogamy can be promoted by cleistogamy.
- **Xenogomy** (cross pollination) is the only type of pollination which brings genetically different types of pollen grains on the stigma.
- **Geitonogamy** functionally similar to cross pollination and genetically it is similar to autogamy (self pollination).
- Wind and water are common abiotic pollinating agents.
- **Wind Pollination** requires **light, non-stickly pollen** so that they can be transported by wind currents. Well exposed stamens and large often **feathery stigma** to trap air borne pollen, single ovule in each ovary and numerous flowers in an inflorescence.
- In majority of aquatic plants like **water hyacinth** and **water lily**, flowers emerge above water & are pollinated by **insects or wind**.
- In most **water-pollinated** species, **pollen grains** are protected from wetting by a **mucilaginous covering**.
- **Insect-pollinating flowers** are **large, colourful, fragrant** and **rich in nectar**.
- Nectar & pollen grains are usual **floral rewards** for pollinators.

- In some species, floral rewards are in providing safe places to lay eggs, eg, *Amorphophallus*. A species of **moth and *Yucca*** cannot complete their life cycles without each other.

Outbreeding devices

- Flowering plants have developed many out breeding devices to discourage self pollination and to encourage cross pollination. For example:
  - Pollen release and stigma receptivity are not synchronised.
  - Anther and stigma are placed at different positions so that pollen cannot come in contact with stigma of the same flower.
  - **Self-incompatibility** is a genetic mechanism which prevents self-pollen from fertilizing the ovules by inhibiting pollen germination or pollen tube growth in the pistil.
  - Production of unisexual flowers.

Pollen-pistil Interaction

- Pollen-pistil interaction is a chemical-mediated dynamic process.
- Following compatible pollination, pollen tube grows through the tissues of the stigma and style, the contents of pollen grain move into pollen tube.
- The growing pollen tube carrying **two non-motile male gametes**, reaches the ovary, enters the ovule through micropyle & then enters one of the synergids through the filiform apparatus, which guides the entry of pollen tube.
- One male gamete fuses with egg cell and other with PEN.
- In **artificial hybridisation**, desired pollen are used for pollination and stigma is protected from contamination from unwanted pollen by emasculation and bagging.
- If female flowers are unisexual, there is no need of emasculation.

Double Fertilisation

- **Syngamy & triple fusion are together called double fertilisation**, an event unique to flowering plants.
- The central cell after triple fusion becomes primary endosperm cell (PEC) and develop into **endosperm**.

Endosperm

- Endosperm development precedes embryo development. As it is filled with reserve food materials and used by developing embryo.

Embryo

- **Embryo** develops at micropylar end of embryo sac where the zygote is situated.
- Early stages of embryo development (**Embryogeny**) are similar in both monocotyledons and dicotyledons.
- In dicots, the stages of embryo development are: proembryo → globular → heart-shaped → mature embryo.
- Embryos of monocot has only one cotyledon called **scutellum** Radicle or root cap is enclosed with undifferentiated sheath called **coleorhiza**. Epicotyl has shoot apex & a few leaf primordia enclosed in foliar structure **coleoptile**.

Seed

- In angiosperms, seed (fertilised ovule) is the final product of sexual reproduction, formed inside fruits. A seed typically consists of seed coats, cotyledon(s) & an embryo axis.
- Mature seeds may be **non-abuminous or ex-albuminous**, having no residual endosperm, which is consumed completely during embryo development (eg. Pea, groundnut). **Albuminous seeds** retain a part of endosperm (eg. Wheat, maize, barley, castor, coconut).
- In black pepper & beet, remnants of nucellus are also persistent, called **perisperm**.
- True fruits develop from ovary.
- In apple, strawberry, cashew, etc., thalamus also contributes to form fruit called **false fruit**.
- **Parthenocarpic fruit** develop without fertilisation eg., Banana.
- *Lupinus arcticus* seed germinated and flowered after estimated record 10,000 years of dormancy. *Phoenix dactytifera* (date palm) seed remained viable for 2000 years.

Apomixis and Polyembryony

- Some species of **Asteraceae & grasses** have evolved a special mechanism to produce seeds without fertilisation called apomixis.
- In ***Citrus* and mango**, nucellar cells protrude into embryo sac & develops into embryos, so each ovule contains many **embryos (polyembryony)**.