Chapter – 1

SEXUAL REPRODUCTION IN FLOWERING PLANTS

Structure of microsporangium:

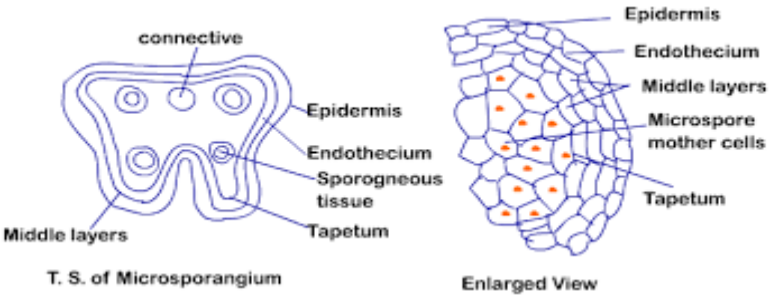
Each **microsporangium** surrounded by four wall layers

- **Epidermis** – Outermost layer provide protection.
- **Endothecium:**

  contains radially elongated, compactly arranged hygroscopic cells which helps in the protection and dehiscence of anther.
- **Middle layer** – multilayered and provide protection.
- **Tapetum.**

  The innermost layer is **tapetum** which is multinucleated, with dense cytoplasm; it nourishes the developing pollen grains.

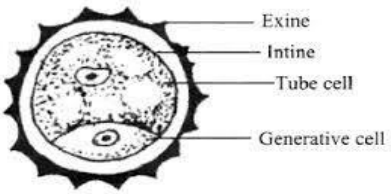
  The centers of each microsporangium contain homogenous cells called **sporogenous tissues.**



T. S. of Microsporangium — Enlarged View

Pollen grain:

- Pollen grain represents the **male gametophytes**.
- It is spherical and measuring about 25-50 micrometer in diameter.
- It is covered by **two layers**.
- The hard outer layer called the **exine** is made up of **sporopollenin,** which is the most resistant organic material. It can withstand high temperature and strong acids and alkali. No enzyme can degrade sporopollenin.



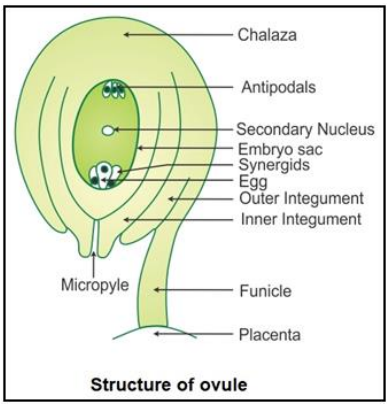
Pollen grain (Sectional view)

- The exine has prominent apertures called **germ pore** where sporopollenin is absent.
- The inner wall of pollen grain is called **intine.** It is thin and continuous layer made up of **cellulose** and **pectin**.
- On maturity, the pollen grain contains two cells, the **vegetative cell** and **generative cell**.
- The vegetative cell is bigger, has abundant food reserve and a large irregularly shaped nucleus.
- The generative cell is small and floats in the cytoplasm of vegetative cell.
- In 60% of angiosperms, pollen grains are shed at this **2-celled stage**.
- In others the generative cell divides mitotically to form two male gametes and pollen grain are usually shed **3-celled stage.**

The Megasporangium (Ovule):

- Ovule is a small structure attached to the placenta of locule with a stalk called **funicle.**
- The body of the ovule fused with the funicle in the region called **hilum.**
- **Hilum** is the junction between the funicle and ovule.
- Each ovule has one or two protective envelops called **integuments**.

- Integument covered the ovule except an opening at the tip called **micropyle**.
- Opposite of the micropylar end, is the **chalaza**, representing the basal part of the ovule.



Structure of ovule

Megasporogenesis:

- The process of formation of **megaspores** from the **megaspore mother cell (MMC)** is called **megasporogenesis.**
- In the center of the ovule there is a mass of tissue called **nucellus**.
- Cells of nucellus have abundant reserve food materials.
- One cell of the nucellus towards micropylar end differentiated into **megaspore mother cell** (MMC).
- It is a large **diploid cell,** dense **cytoplasm** with **prominent nucleus.**
- The MMC undergo **meiotic** division resulting four haploid **megaspores**.

Female gametophyte:

- Out of four megaspores, one megaspore is functional and other three degenerates.
- The functional **megaspore** developed into the **female gametophyte.**
- Female gametophyte is known as the **embryo sac**.
- Development of embryo sac from a single megaspore is called as **monosporic development**.
- The nucleus of the functional megaspore divided by **mitotic division** to form **two nuclei** which move to the opposite poles, **2-nucleated embryo sac**.
- Two successive mitotic division leads to formation of **4-nucleate** and later **8-nucleate** stages of the embryo sac.
- All mitotic divisions are free nuclear type; **karyokinesis** is not followed by **cytokinesis.**
- Six of the eight nuclei are surrounded by cell walls and organized into cells.
- Three cells are grouped together at the micropylar end, constitute the **egg apparatus.**
- The egg apparatus, in turn consists of two **synergids** and one **egg cell**.
- Synergids have special **filiform apparatus**, which play an important role in guiding the entry of pollen tube into the synergids.
- Three cells arranged towards chalazal end are called **antipodal** cells.
- The large **central cell** has two **polar nuclei.**
- A typical angiosperm embryo sac at maturity is **8- nucleated** and **7-celled.**

Pollination:

- Transfer of pollen grains from the anther to the stigma of a pistil is termed as pollination.
- Both male and female gametes are non-motile.

Kinds of pollination:

1. **Autogamy:**
   Pollination within same flower.
   In open and exposed anthers and stigma autogamy is rare.

Viola, Oxalis **and** ***Commelina*** produce two types of flowers:

- **Chasmogamous**: Flowers with exposed anther and stigma.
- **Cleistogamous**: Flowers with enclosed anther and stigma.

2. **Geitonogamy:**
   Pollination between two flowers of the same plant.
   Pollinating agents helps to effect pollination.
   Genetically similar to the autogamy.
3. **Xenogamy:**
   Transfer of pollen grains from the anther to the stigma of different plant.
   It is commonly called as cross-pollination.
   It brings genetically different pollen to stigma.

Agents of pollination:

Plant use **abiotic agents (**wind and water) and **biotic agents (**animals) for pollination.
Majority of plants use biotic agents for pollination.

Adaptations for Anemophily (Pollinating agent is wind) **:-**.

- Plants produces enormous amount of pollen.
- Flowers with well exposed stamens.
- Large feathery stigma to trap air-borne pollen grains.
- Most wind pollinated flowers contain single ovule in one ovary and numerous flowers packed into an inflorescence e.g. corn cob.
- Pollen grains are light and non-sticky.

Adaptations for Hydrophily (Pollination by abiotic agent like water**) :-**

This type of pollination is very rare, about 30 genera, mostly monocot.
Vallisneria, Hydrilla* and *Zostera are the common example for Hydrophily.
All aquatic plants doesn't show Hydrophily.

- in ***Vallisneria p***ollen grains released into the surface of water and carried to the stigma by air current.
- In **sea grass** the flowers remains **submerged.**
- Pollen grains are **long, ribbon** like and carried passively inside the water
- Pollen grains are protected from wetting by **mucilaginous covering.**

Adaptations for Pollination by animals

Bees are the dominant biotic agents for pollination.

- Insect pollinating flowers are very large, colorful, fragrant and rich in nectar.
- Small flowers present in cluster to make them conspicuous.
- Flower pollinated by flies and beetles secrete foul odour.
- Nectar and pollen grains are the usual floral rewards for insects.
- In some species, flower provide floral rewards by providing safe places to lay eggs: e.g. ***Amorphophallus.***

A species of **moth** and ***Yucca*** plant cannot complete their life cycle without each other.
The moth deposits its eggs in the locule of the ovary and the flower in turn get pollinated by the moth.
Many insects may consume pollen or nectar without bring about pollination. Such floral visitors are referred as **pollen/nectar robbers.**

Artificial hybridization:

One of the major approaches of crop improvement programme.
Only desired pollen grain used for pollination.
Stigma is protected from contamination (from unwanted pollen grain).
Removal of anthers from the flower bud before the anther dehisces is called **emasculation.**

Emasculated flowers covered by bag generally made up of butter paper, to prevent contamination. This step is called **bagging.**

Pollen grains collected from desired male parent are dusted after the stigma of emasculated flower attain receptivity. This step is called **artificial pollination.**

After artificial pollination female flower is **rebagged.**

Double fertilization:

After entering one of the synergids, the pollen tube releases two male gametes into the cytoplasm of the synergids.

Syngamy: One of the male gamete fused with egg cell, to form a diploid **zygote.**

Triple fusion: Two polar nuclei of central cell fused to form a diploid **secondary nucleus**.

The second male gamete fused with the secondary nucleus to form a triploid **primary endosperm nucleus (PEN).**

Since **syngamy and triple fusion** take place in the embryo sac, the phenomenon is termed as **double fertilization**.

The central cell after triple fusion becomes **primary endosperm cell** and developed into the **endosperm.**

The zygote developed into an embryo.

Embryo:

Zygote formed and placed at the micropylar end of the embryo sac.

Zygote starts its development only after some amount of endosperm formed.

Embryo development takes place in following stages:

- **Proembryo**
- **Globular embryo**
- **Heart embryo**
- **Matured embryo**

Dicot embryo:

- A typical dicotyledonous **embryo** consists of an **embryonal axis** and two **cotyledons.**
- Embryonal axis above the cotyledon is the **epicotyls.**
- Terminal part of the epicotyls is the **plumule** (gives rise to the shoot).
- Embryonal axis below the cotyledon is the **hypocotyl.**
- The terminal part of the hypocotyl is called the **radicle** gives rise to the root system).
- The root tip is covered by the **root cap.**

Monocot embryo:

- Possesses only one cotyledon
- Single large **cotyledon** is called **Scutellum.**
- Scutellum situated towards one side of the embryonal axis.
- Radicle and the root cap enclosed by a sheath called **Coleorhiza.**
- The portion of the embryonal axis above level of attachment of scutellum is called **Epicotyls.**
- Epicotyl has the shoot apex or plumule enclosed by hollow foliar structure called **Coleoptile.**

Fruit developed from the ovary is called t**rue fruit.**

In apple, strawberry, cashew, the thalamus contributes in the fruit formation and such fruits are called **False fruit**.

Fruit developed without fertilization is called **parthenocarpic fruits.**

Eg :- Pineapple, banana, cucumber, grape, watermelon, orange, grapefruit, pear.