Sexual Reproduction in Flowering Plants

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1. A Flower

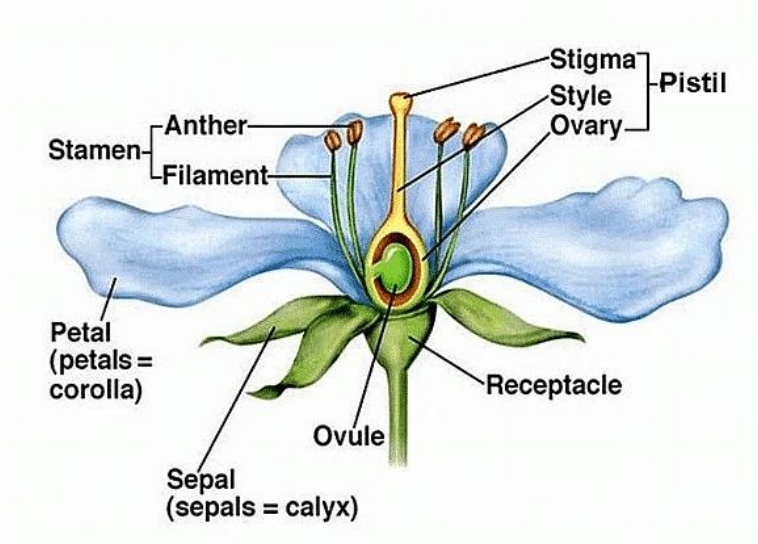
The flower is considered to be a modified shoot. 4 main parts of flower:

a) **Calyx:** It is the outermost whorl of the flower. A single unit of the **calyx** is called as **sepals**. The function of the calyx is protection in inner floral whorls when in bud condition.

b) **Corolla:** Flowers are the beautiful and attractive cause of **petals**. Many petals unite to form a **corolla**. The main function of the petal is to help in pollination by attracting insects.

c) **Androecium:** Male reproductive whorl of the flower is called androecium. A single unit of androecium is known as the **stamen**. A Stamen is made up of anther, connective and filament.

d) **Gynoecium:** Gynoecium or carpel is the female reproductive part of the flower. The gynoecium is sometimes referred to as **pistil**. It consists of three parts namely stigma, style and ovary.



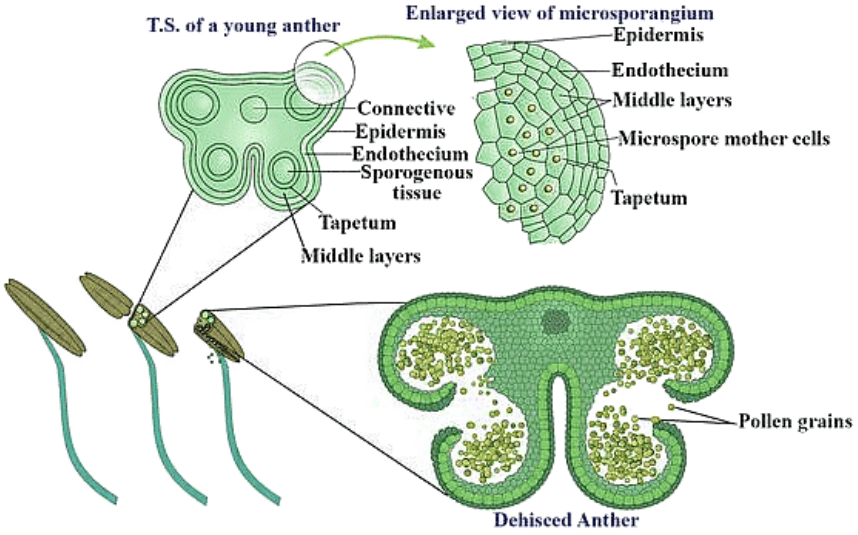
Parts of a Flower

2. Section of a Young Anther and a Dehisced Anther

Anther is bilobed containing 4 microsporangia in angiosperms so it is known as **dithecous anther**. Each microsporangium contains spores that produce male gametes.

It has following layers:

- The outermost layer is known as the **epidermis.**
- Inner to the epidermis is the layer of **endothecium**.
- Inner to endothecium, there are 2-3 cell **middle layers** that usually disintegrate during anther maturation.
- The innermost layer is known as **tapetum.**
- Inner to the tapetum are **the microspore mother cells** which give rise to pollen grains through **meiotic division.**

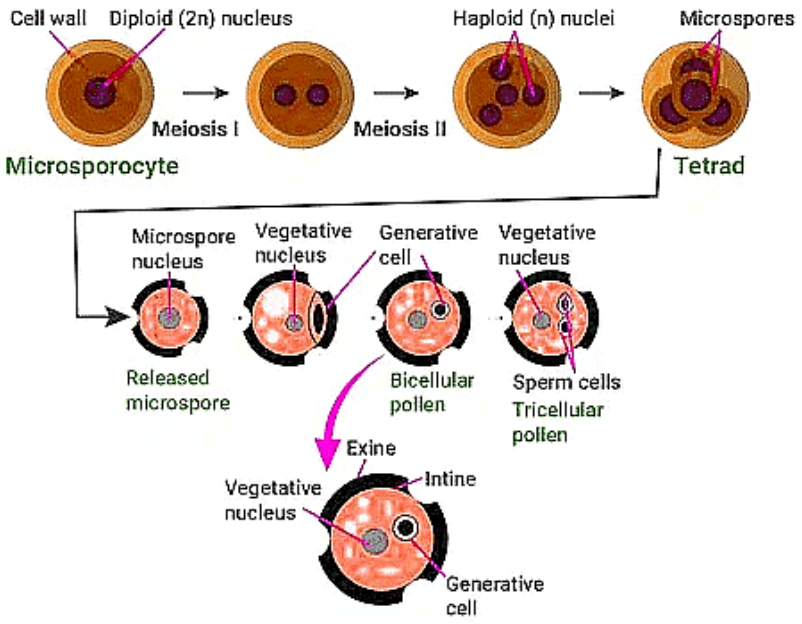


L.S of an Anther

3. Formation of a Pollen Grain (Microsporogenesis)

- The nucleus of each microspore mother cell undergoes **meiosis or reduction division** and gives rise to **four haploid nuclei.**
- This process is called **microsporogenesis.**
- The four nuclei are organised **tetrahedrally** and are shortly surrounded by cell walls.

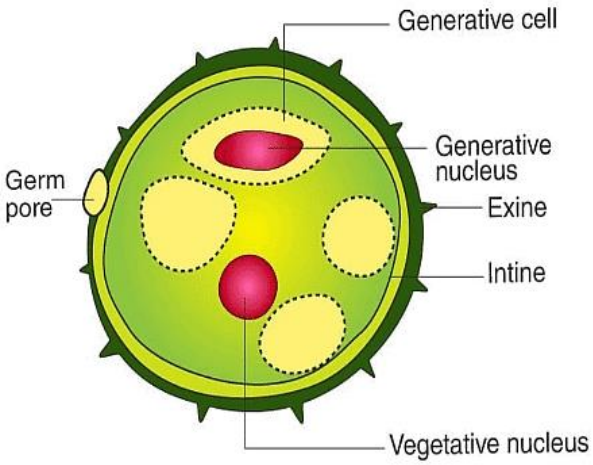
- These are now called **microspores or pollen grains.**



Process of Microsporogenesis

4. Structure Of Mature Pollen Grain

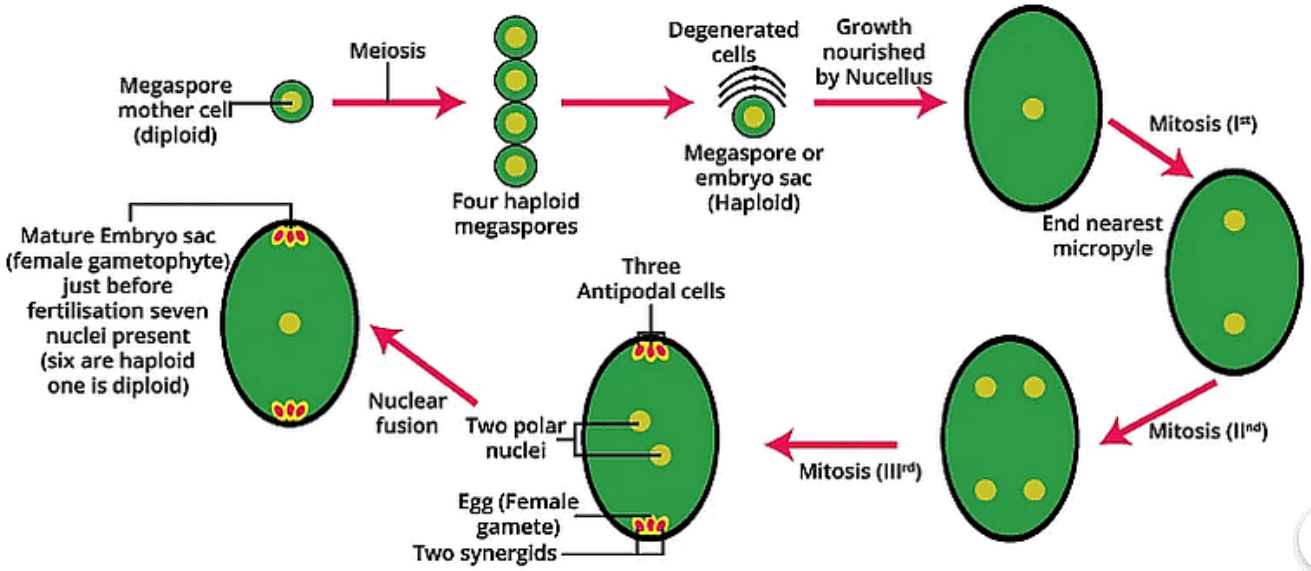
- The pollen grain is surrounded by two layers as: **exine** which forms the outer layer and **intine** which forms the inner layer.
- The **generative cell** divides to form the two male gametes.
- The **vegetative cell** is responsible for the providing nutrition.
- The **intine layer** comes out of the germ pore to form the pollen tube.



Structure of a Mature Pollen Grain

5. Formation of an Egg Cell (Megasporogenesis)

- The process of creating haploid megaspores from a diploid megaspore mother cell is known as **megasporogenesis.**
- A large diploid (2n) cell known as the **megaspore mother cell (MMC)** conducts **meiotic division** to produce **four haploid megaspores.** It also contains thick cytoplasm and a conspicuous nucleus.
- Only one of the four megaspores is viable, and the other three degenerate in the majority of blooming plants.
- The functioning megaspore develops, and as it does, its nucleus goes through mitosis and divides into eight haploid nuclei. **Megagametophyte or embryo-sac** are two names for the structure that results from megasporogenesis.

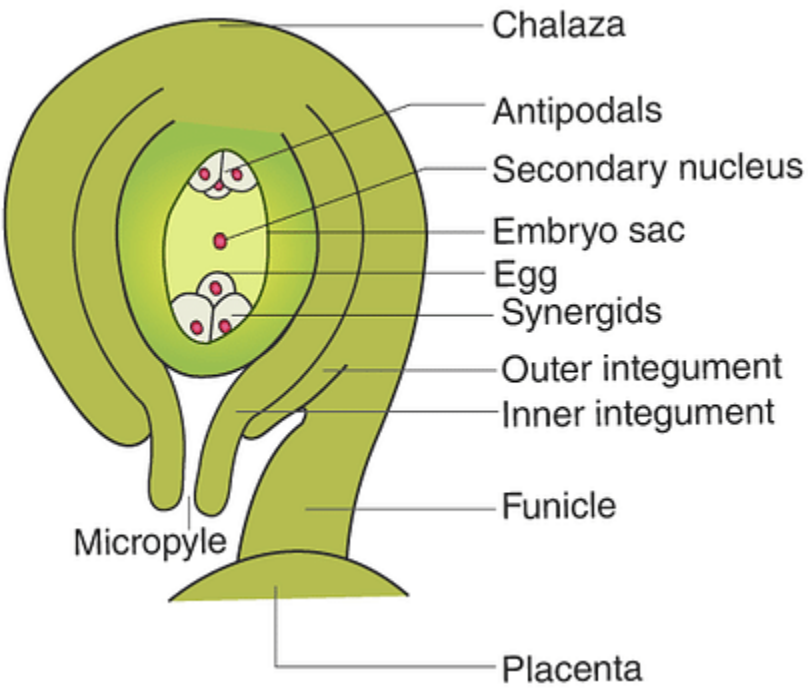


Process of Megasporogenesis

6. Structure of Anatropous Ovule

- This ovule is a **completely curved or inverted structure.**
- Here, the body of the ovule fuses with the **funicle.**
- The **micropyle** is found at the bottom.
- This type of ovule is seen in most **monocots and dicots.**

- The anatropous ovule is the **most common type** of ovule orientation.

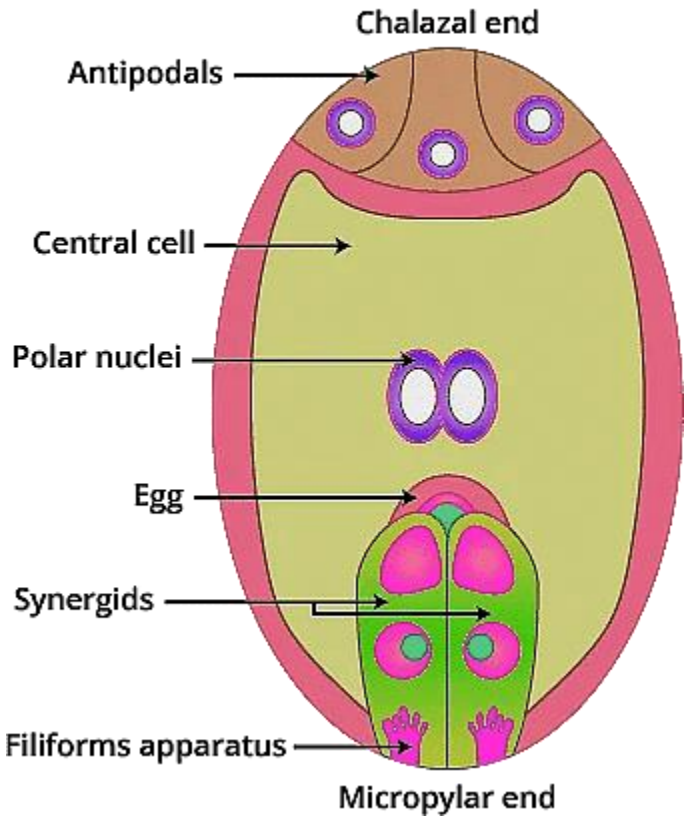


Structure of Anatropous Ovule

7. Embryo Sac

- Embryo Sac is the **female gametophyte** of a seed plant, consisting of a thin-walled sac within the nucellus which contains the egg nucleus and other nuclei that produce endosperm upon fertilisation.
- A typical mature embryo sac of Angiosperms is a **7-celled** and **8-nucleate** structure.
- **Micropylar end:** The micropyle is a small pore or opening in the outer covering of the ovule, typically located at one end (the micropylar end).
- **Egg Cell (or Ovum)** is situated close to the micropyle, which is the entry point for pollen tubes. The egg cell is the female gamete and fuses with a sperm cell during fertilization to form the zygote, which eventually develops into the embryo.
- **Synergids** are cells adjacent to the egg cell. They guide the pollen tube to the egg cell through chemical signaling, helping in the process of fertilization.

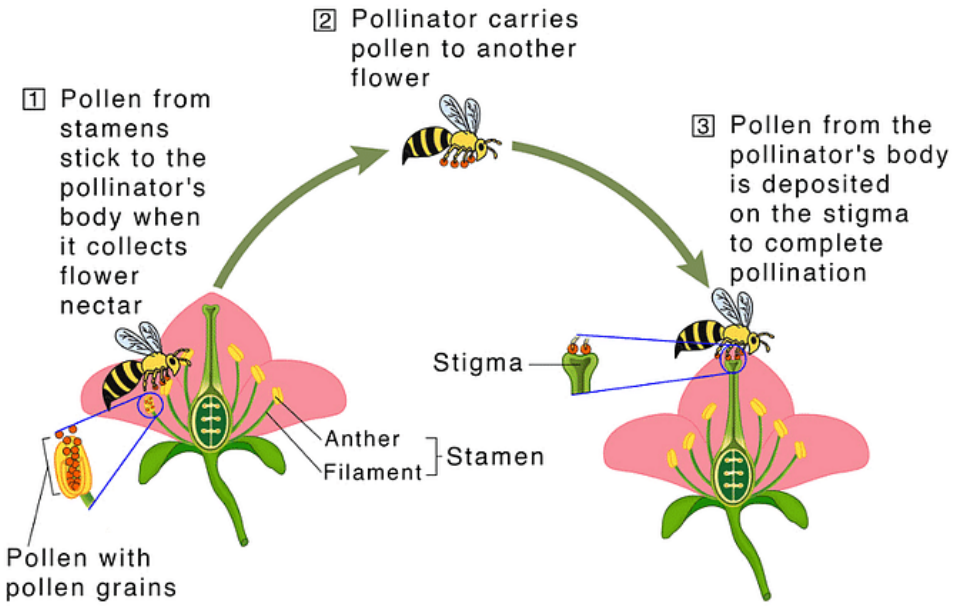
- **Central Cell** (or Central Nucleus) is positioned in the center of the embryo sac. It contains two nuclei, known as the polar nuclei, which are crucial for double fertilization during seed formation.
- **Polar Nuclei** (Polar Fusion Nuclei) are found within the central cell and are involved in double fertilization. The polar nuclei fuse with a sperm cell to form the endosperm, a nutrient-rich tissue that supports the developing embryo.
- **Chalaza** is the base of the embryo sac, located opposite the micropyle. It is a thickened region of tissue that connects the ovule to the ovary and helps anchor the embryo sac within the ovule.
- **Antipodal cells** are located at the opposite end from the micropyle.



Structure of Embryo Sac

8. Pollination

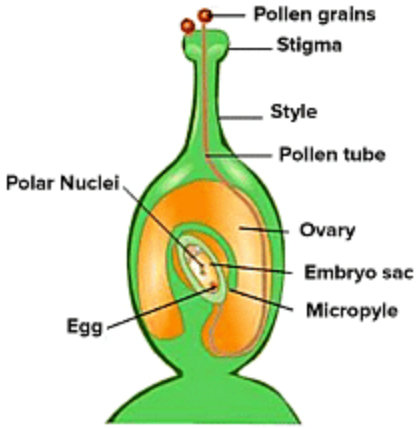
The process of pollination begins when the **pollen grains** from the respective flowers lands on the **stigma** and form a **pollen tube** with the style length, which connects both the stigma and ovary. After the completion of the pollen tube, the pollen grain starts transmitting sperm cells from the grain to the ovary.



Process of Pollination

9. Pollen Tube Formation

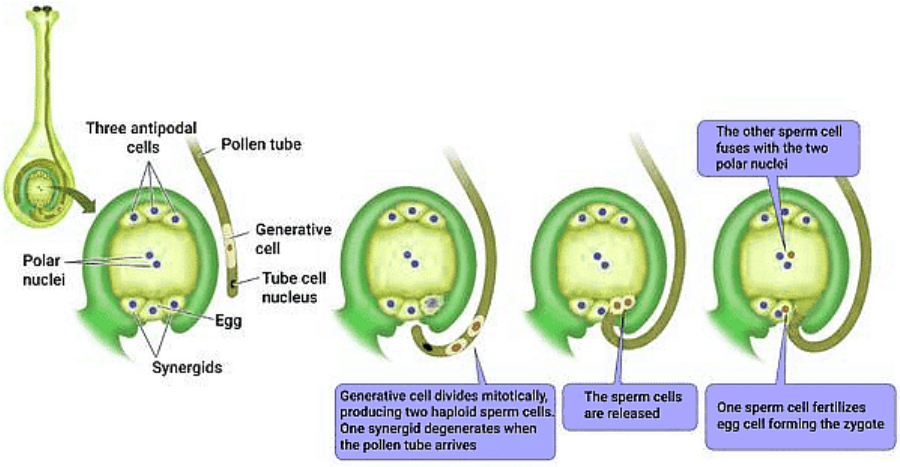
- The process of the landing of pollen on the stigma, **pollen tube growth**, and entry of germ cells in the ovule is the events covered in the germination of pollen grains.
- The pollen grains attach to the stigma with a sticky surface and germinate to produce a tube.
- This tube is known as the pollen tube.
- The pollen tube carries the male gametes through the style to the ovary.
- After reaching the ovary, the pollen tube enters the ovule through a pore called the **micropyle**.



Pollen Tube Formation

10. Double Fertilization

- Double fertilization is a chief trait of flowering plants.
- Double fertilization is a complex process where out of two sperm cells, one fuses with the egg cell and the other fuses with two polar nuclei which result in a **diploid (2n) zygote** and a **triploid (3n) primary endosperm nucleus (PEN)** respectively.
- Double fertilization provides stimulus to the plant resulting in the ovarian development to fruits and the development of ovules into the seed.

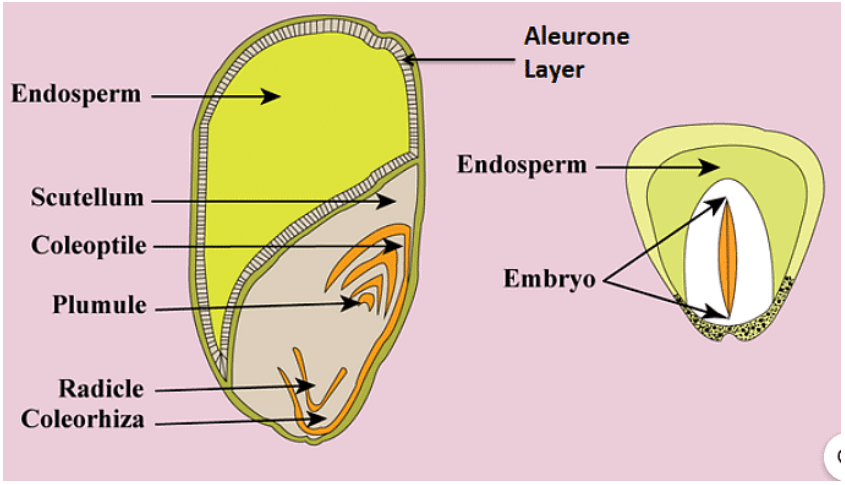


Process of Double Fertilization

11. Structure of Maize Seed

- **Seed Coat (Testa)** is the outermost layer of the seed, providing protection and serving as a barrier to the external environment. It helps prevent desiccation (drying out) and protects the embryo inside.
- **Pericarp** is the layer surrounding the seed coat, derived from the ovary wall. It provides additional protection and aids in seed dispersal.
- **Endosperm** is the tissue that surrounds and nourishes the embryo. In maize seeds, the endosperm is starchy and provides a source of energy and nutrients for the developing plant.
- **Embryo** is the young, undeveloped plant within the seed. It consists of several key parts:
  (a) Plumule: The embryonic shoot, which will give rise to the stem and leaves of the new plant.
  Coleoptile: A protective sheath covering the emerging shoot (plumule) of the embryo.

  (b) Radicle: The embryonic root, which will develop into the root system of the new plant.
  Coleorhiza: A protective sheath covering the emerging root (radicle) of the embryo.It helps the emerging root penetrate the soil during germination.
- **Scutellum** is a **specialized cotyledon** in maize that is absorptive and plays a role in the early nutrition of the developing embryo.



Structure of a Maize Seed

Diagram Based Previous Year Questions - NEET

Q 1: What is the function of the tapetum in the anther?

a) Production of pollen grains

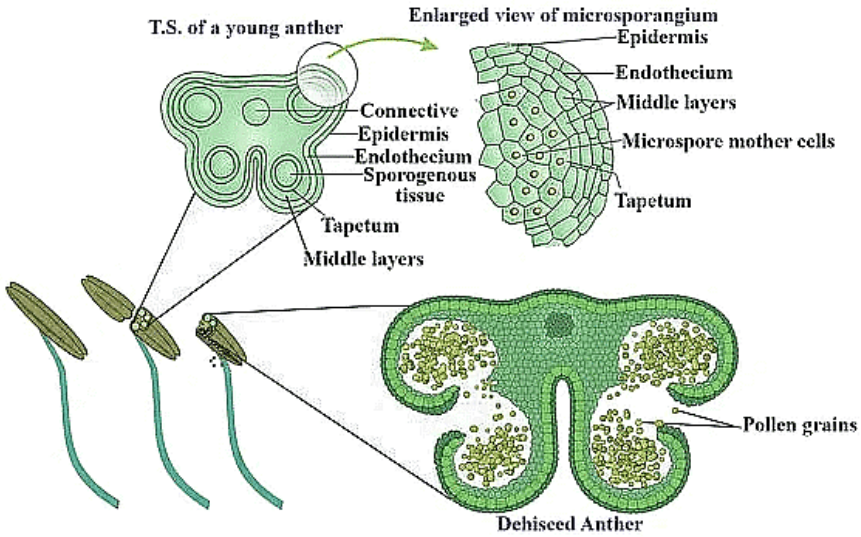
b) Protection of microspores

c) Nutrient supply to developing pollen grains

d) Attachment of the anther to the filament

Ans: c) Nutrient supply to developing pollen grains.

Solution.



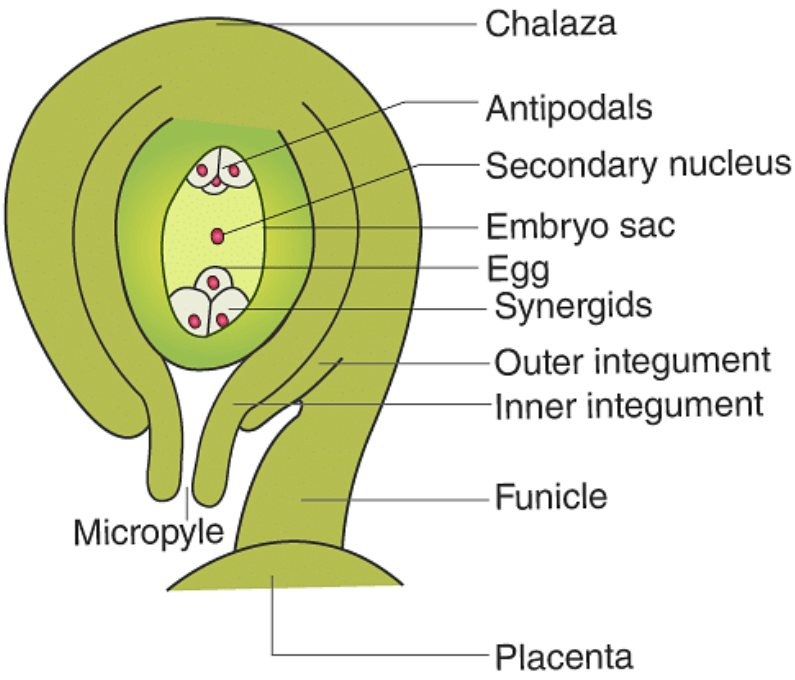
- The tapetum is a specialized layer of cells present within the anther of flowering plants.
- It surrounds the developing microsporangia, which are the pollen sacs within the anther.
- The tapetum has an important role in supporting the development of pollen grains.

Q 2: The region of the ovule where the integuments join is known as_____.

a) Micropyle

b) Hilum
c) Chalaza
d) Funicle
Ans: c) Chalaza

Solution.

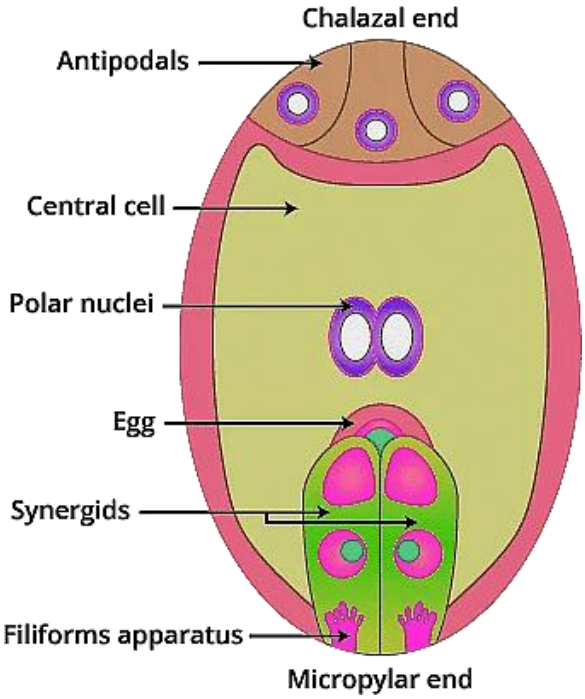


Structure of Anatropous Ovule

- The region of the ovule where the integuments join is known as the **chalaza**.
- The chalaza is **located** at the base of the ovule, **opposite the micropyle.**

Q7: A typical angiosperm embryo sac at maturity is:

(a) 7-nucleate and 7-celled
(b) 8-nucleate and 8-celled
(c) 8-nucleate and 7-celled
(d) 7-nucleate and 8-celled
Ans. c)
Solution.



Structure of Embryo Sac

- The mature embryo sac has **three cells** called **antipodals** at the chalazal end and **three cells** at micropylar end constituting the egg apparatus.
- **Each** of these **cells** consists **one nuclei**.
- The egg apparatus consists of **two synergids** and **one egg cell.**
- There is **one large central cell** present which consists of **two polar nuclei.**
- Hence embryo sac has **7 cells and 8 nuclei.**

Some Important Terms

- **Microsporogenesis:** The process of formation of microspores from a pollen mother cell (PMC) through meiosis is called microsporogenesis.
- **Pollen Grains:** As the anthers mature and dehydrate, the microspores dissociate from each other and develop into pollen grains. The pollen grains represent the male gametophytes.

- **Exine:** Pollen grains are generally spherical measuring about 25-50 micrometers in diameter. It has a prominent two-layered wall. The hard outer layer called the exine is made up of sporopollenin which is one of the most resistant organic material known.
- **Germ Pore:** Pollen grain exine has prominent apertures called germ pores where sporopollenin is absent.
- **Intine:** The inner wall of the pollen grain is called the intine.
- **Vegetative Cell:** When the pollen grain is mature it contains two cells, the vegetative cell and generative cell. The vegetative cell is bigger, has abundant food reserve and a large irregularly shaped nucleus.
- **Generative Cell:** The generative cell is small and floats in the cytoplasm of the vegetative cell.
- **Stigma, style & ovary:** The stigma serves as a landing platform for pollen grains. The style is the elongated slender part beneath the stigma. The basal bulged part of the pistil is the ovary.
- **Ovule:** The ovule is a small structure attached to the placenta by means of a stalk called funicle.
- **Integuments:** Each ovule has one or two protective envelopes called integuments.
- **Nucellus:** Enclosed within the integuments is a mass of cells called the nucellus.
- **Megasporogenesis:** The process of formation of megaspores from the megaspore mother cell is called megasporogenesis.
- **Antipodals:** Three cells are at the chalazal end and are called the antipodals.
- Pollination: Transfer of pollen grains (shed from the anther) to the stigma of a pistil is termed as pollination.
- **Autogamy:** In this type, pollination is achieved within the same flower. Transfer of pollen grains from the anther to the stigma of the same flower.

- **Chasmogamous flowers:** These are similar to flowers of other species with exposed anthers and stigma.
- **Cleistogamous flowers:** Cleistogamous flowers which do not open at all.
- **Geitonogamy:** Transfer of pollen grains from the anther to the stigma of another flower of the same plant.
- **Xenogamy:** Transfer of pollen grains from anther to the stigma of a different plant.
- **Emasculation:** If the female parent bears bisexual flowers, removal of anthers from the flower bud before the anther dehisces using a pair of forceps is necessary. This step is referred to as emasculation.
- **Bagging:** Emasculated flowers have to be covered with a bag of suitable size, generally made up of butter paper, to prevent contamination of its stigma with unwanted pollen. This process is called bagging.
- **Zygote:** Male gametes moves towards the egg cell and fuses with its nucleus thus completing the syngamy. This results in the formation of a diploid cell, the zygote.
- **Double Fertilisation:** Two types of fusions, syngamy and triple fusion take place in an embryo sac the phenomenon is termed double fertilisation.
- **Scutellum:** Embryos of monocotyledons possess only one cotyledon. In the grass family the cotyledon is called scutellum.
- **Non albuminous:** Non albuminous seeds have no residual endosperm as it is completely consumed during embryo development.
- **Albuminous seeds:** Albuminous seeds retain a part of endosperm as it is not completely used up during embryo development.
- **Pericarp:** The wall of the ovary develops into the wall of fruit called pericarp.
- **False fruits:** In most plants, by the time the fruit develops from the ovary, other floral parts degenerate and fall off. However, in a few species such as apple, strawberry, cashew, etc., the thalamus also contributes to fruit formation. Such fruits are called false fruits.

- **True Fruits:** Most fruits however develop only from the ovary and are called true fruits.
- **Parthenocarpic fruits:** In most of the species, fruits are the results of fertilisation, there are a few species in which fruits develop without fertilisation. Such fruits are called parthenocarpic fruits.
- **Apomixis:** A few flowering plants such as some species of Asteraceae and grasses, have evolved a special mechanism, to produce seeds without fertilisation, called apomixis.
- **Polyembryony:** Occurrence of more than one embryo in a seed is referred to as polyembryony.