



SEXUAL REPRODUCTION IN FLOWERING PLANTS

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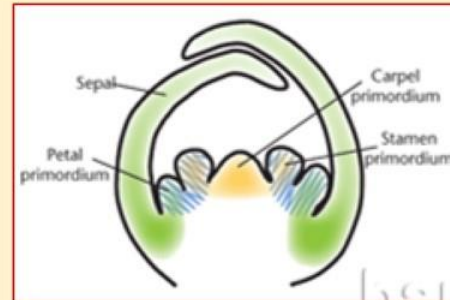
- ▶ All flowering plants (angiosperms) show sexual reproduction.
- ▶ **Flowers** are the sites of sexual reproduction.

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PRE-FERTILIZATION: STRUCTURES & EVENTS

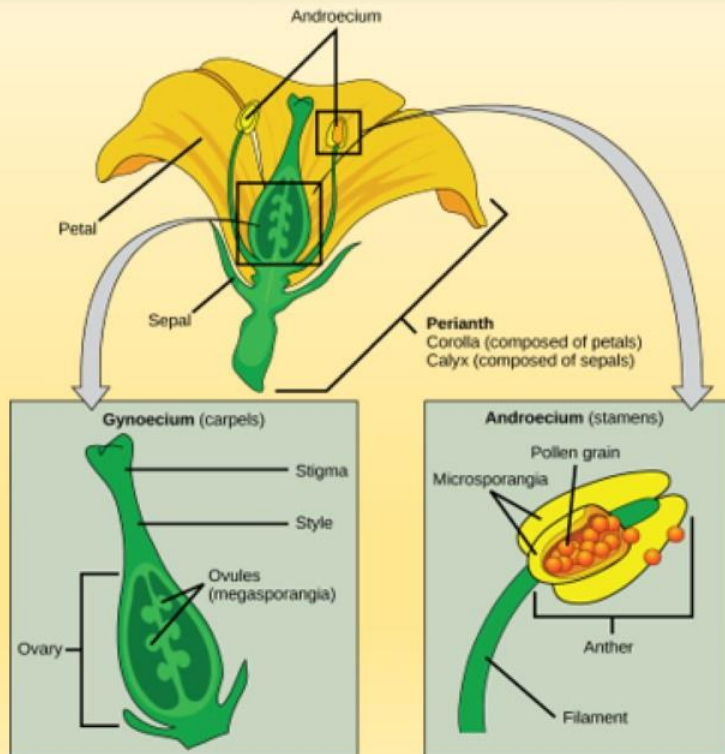


- ▶ Several hormonal and structural changes result in differentiation and development of the **floral primordium**.
- ▶ **Inflorescences** bear the **floral buds** and then the flowers.



PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER



A typical flower has 2 parts:

Androecium

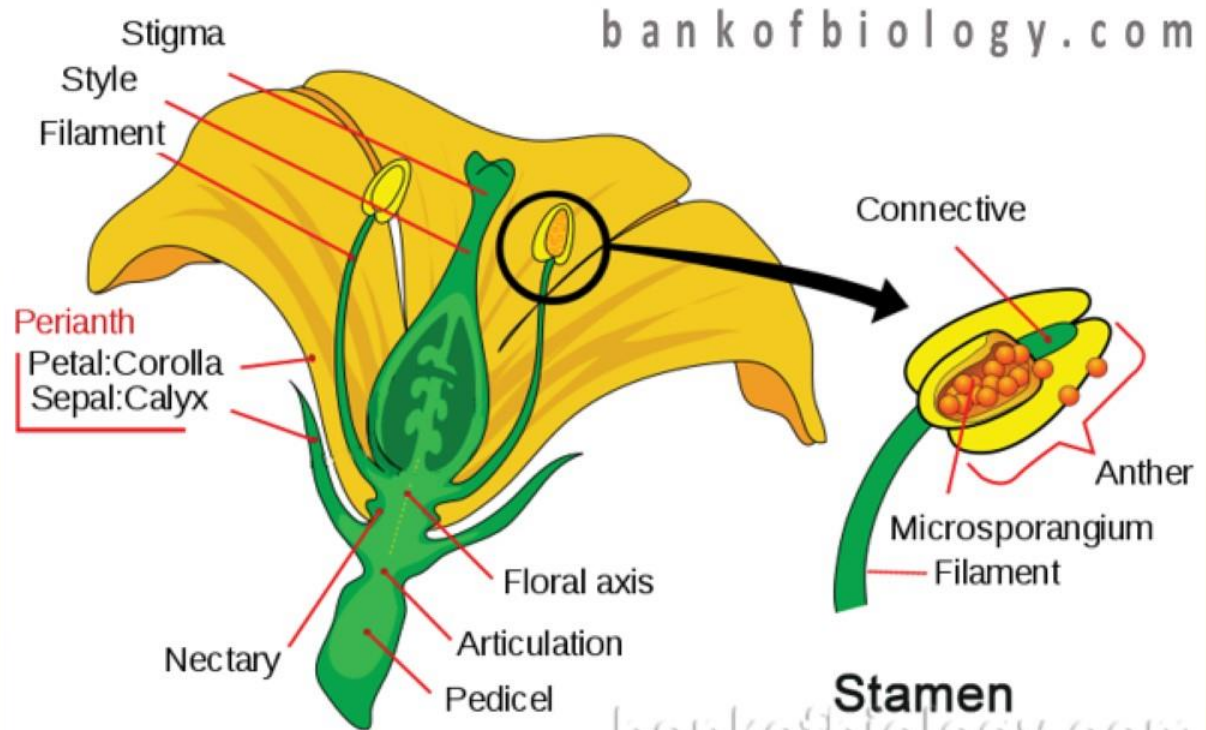
Gynoecium

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

1. Androecium

- ▶ It is the **male reproductive part** of the flower.
- ▶ It consists of a whorl of **stamens**. Their number and length are variable in different species.



PRE-FERTILIZATION: STRUCTURES & EVENTS

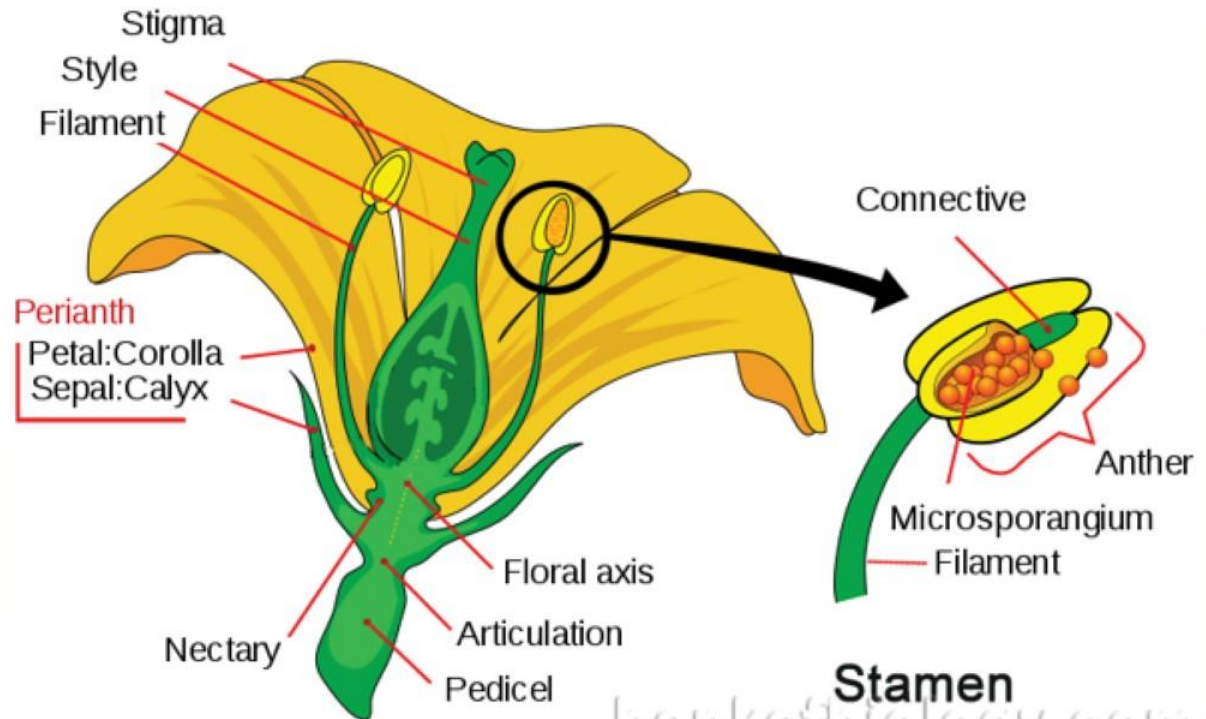
STRUCTURE OF A FLOWER

1. Androecium

Parts of a stamen

Filament

Anther



PRE-FERTILIZATION: STRUCTURES & EVENTS

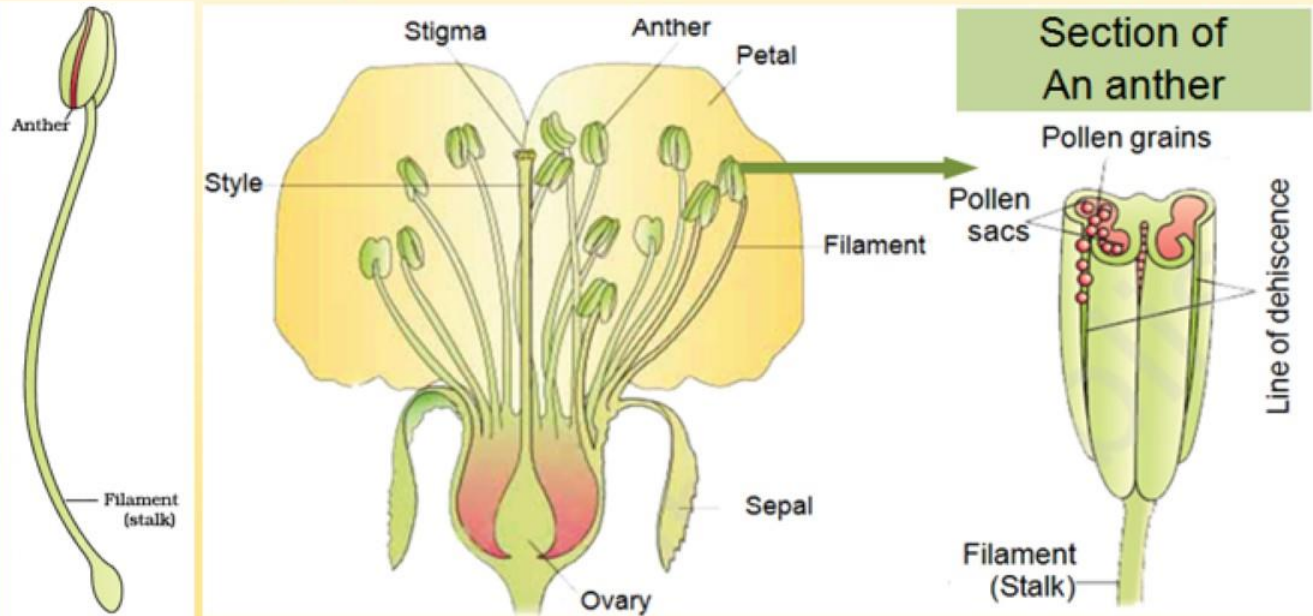
STRUCTURE OF A FLOWER

1. Androecium

Parts of a stamen

Filament

Anther



- Filament is long and slender stalk.
- Its proximal end is attached to the **thalamus** or the **petal** of flower.

PRE-FERTILIZATION: STRUCTURES & EVENTS

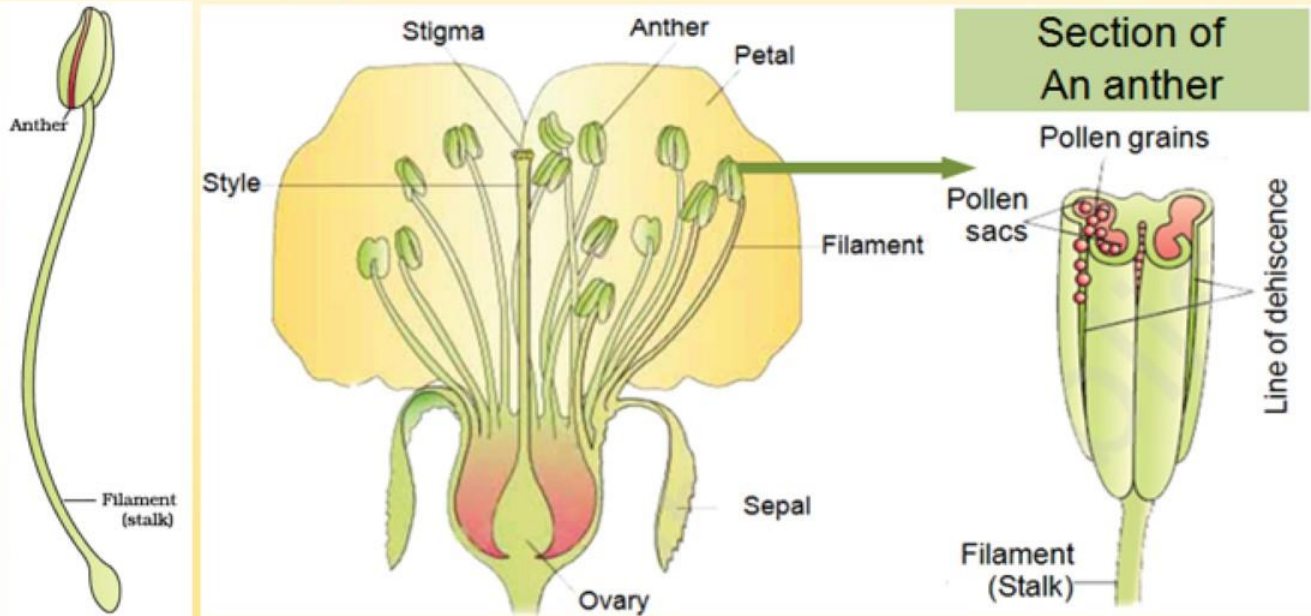
STRUCTURE OF A FLOWER

1. Androecium

Parts of a stamen

Filament

Anther



- Terminal and typically **bilobed**. Each lobe has **2 thecae (dithecous)**.
- Often a longitudinal groove runs lengthwise separating the theca.

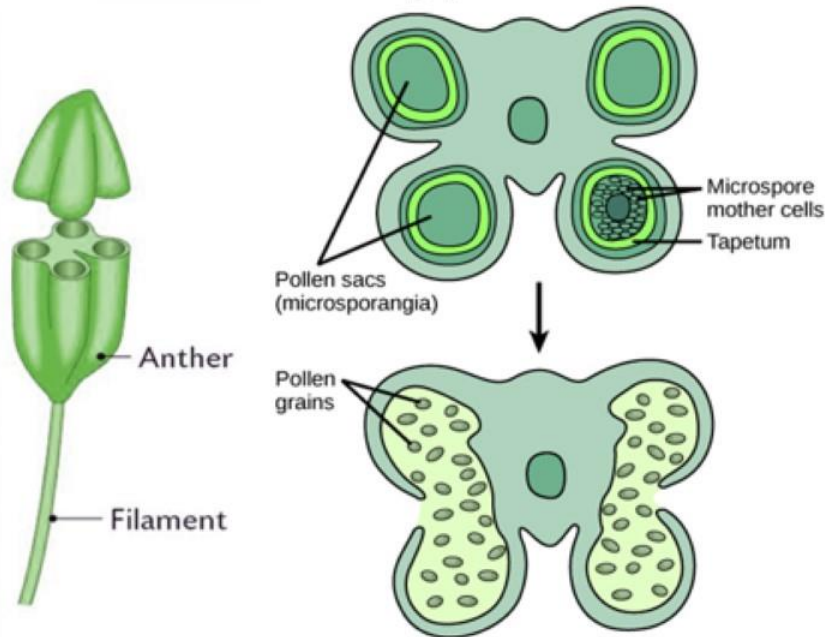
PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

1. Androecium

Transverse section of Anther

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- ▶ The anther is a tetragonal structure consisting of **four microsporangia** located at the corners (2 in each lobe).
- ▶ The microsporangia develop to **pollen sacs**. They extend longitudinally all through the length of an anther and are packed with pollen grains.

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PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

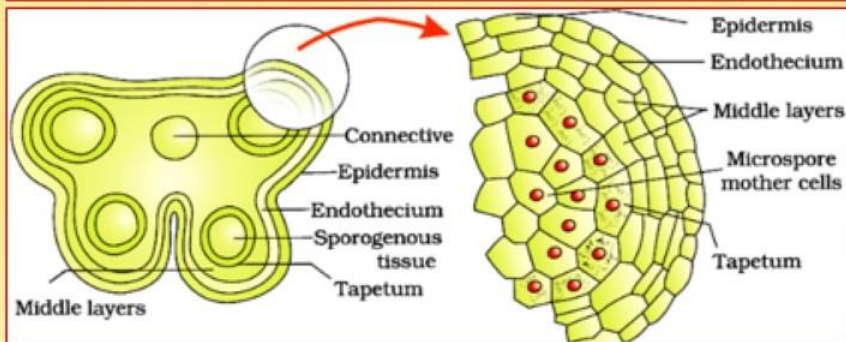
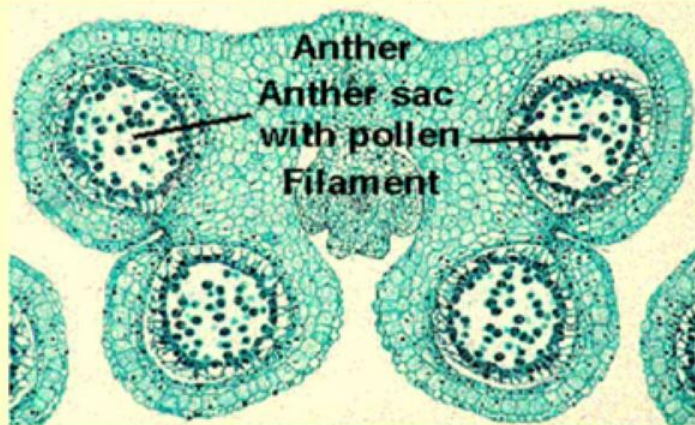
1. Androecium

Structure of Microsporangium

- ▶ A typical microsporangium is near circular in outline.
- ▶ It is surrounded by 4 wall layers:

- ❖ Epidermis
- ❖ Endothecium
- ❖ Middle layers
- ❖ Tapetum

- ▶ The outer 3 layers give protection and help in dehiscence of anther to release the pollen.



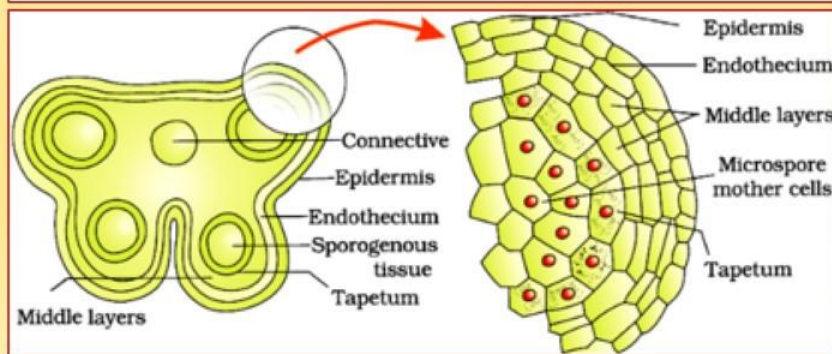
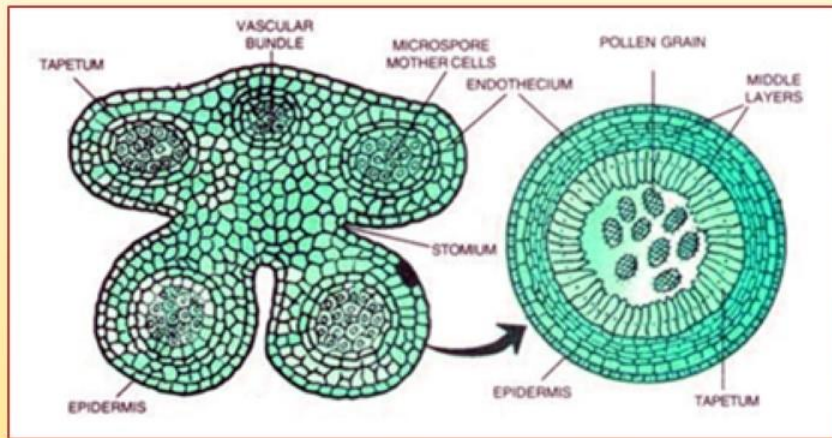
PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

1. Androecium

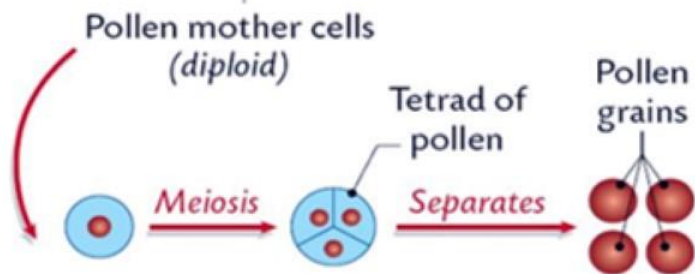
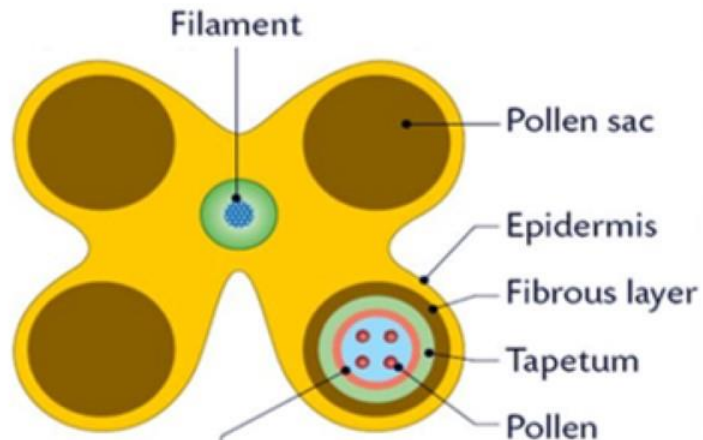
Structure of Microsporangium

- ▶ The **tapetum** (innermost layer) nourishes the developing pollen grains.
- ▶ Cells of the tapetum contain dense cytoplasm and generally have more than one nucleus.
- ▶ In young anther, each microsporangium has **sporogenous tissue** at centre. It consists of compactly arranged homogenous diploid cells (**sporogenous cells**).



PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER



1. Androecium

Microsporogenesis

- ▶ As the anther develops, each sporogenous cell (**microspore or pollen mother cell**) undergoes meiotic divisions to form microspore tetrads (microspores arranged in a cluster of four cells).
- ▶ The formation of microspores from a pollen mother cell (PMC) through meiosis is called **microsporogenesis**.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

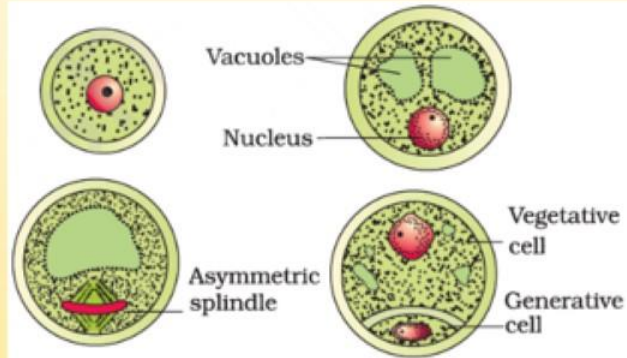
1. Androecium

Microsporogenesis

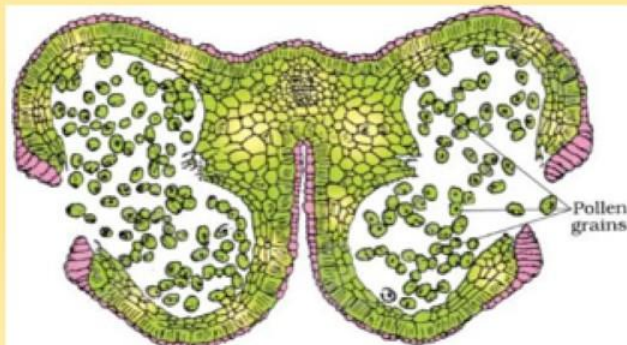
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- ▶ As the anthers mature and dehydrate, the microspores dissociate from each other and develop into **pollen grains**.
- ▶ Each microsporangium contains thousands of pollen grains. They are released with the dehiscence of anther.

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Stages of a microspore maturing into a pollen grain



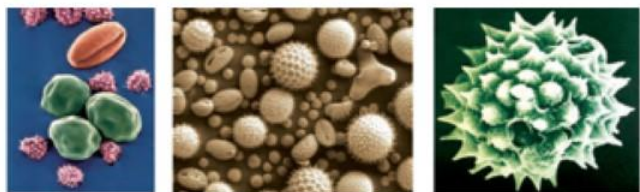
A mature dehiscing anther



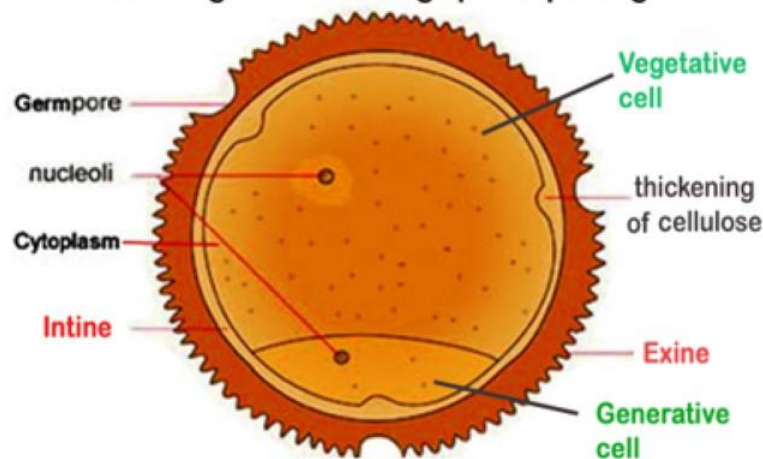
PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

1. Androecium



Scanning electron micrographs of pollen grains



A pollen grain

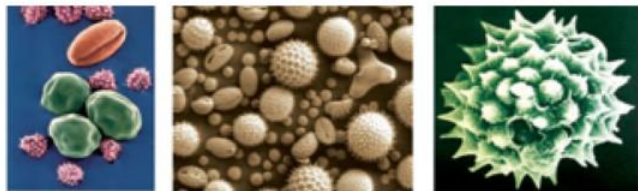
Pollen grain (male gametophyte)

- ▶ Generally spherical.
- ▶ 25–50 μm in diameter.
- ▶ Cytoplasm is surrounded by a plasma membrane.
- ▶ A pollen grain has a two-layered wall: **exine** and **intine**.

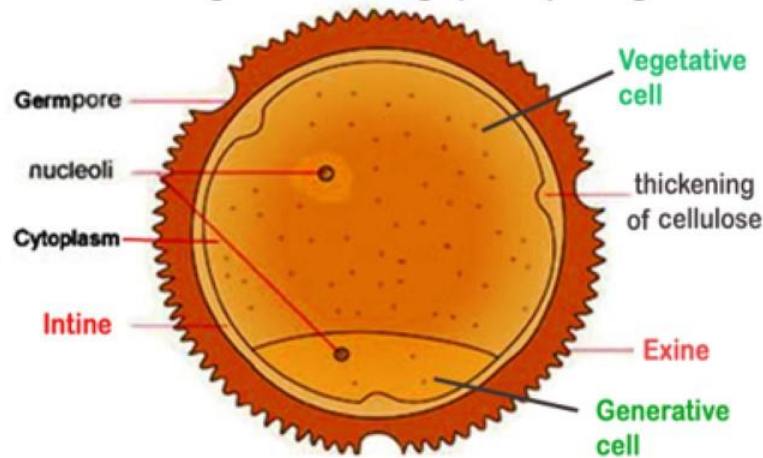
PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

1. Androecium



Scanning electron micrographs of pollen grains



A pollen grain

Pollen grain (male gametophyte)

Exine

- ▶ The hard outer layer made up of **sporopollenin** (highly resistant organic material). It can withstand high temperature and strong acids and alkali. Enzymes cannot degrade sporopollenin.
- ▶ Exine has apertures called **germ pores** where sporopollenin is absent.
- ▶ Pollen grains are preserved as fossils due to the presence of sporopollenin.
- ▶ Exine exhibits patterns and designs.

PRE-FERTILIZATION: STRUCTURES & EVENTS

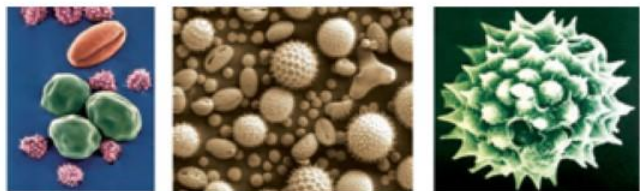
STRUCTURE OF A FLOWER

1. Androecium

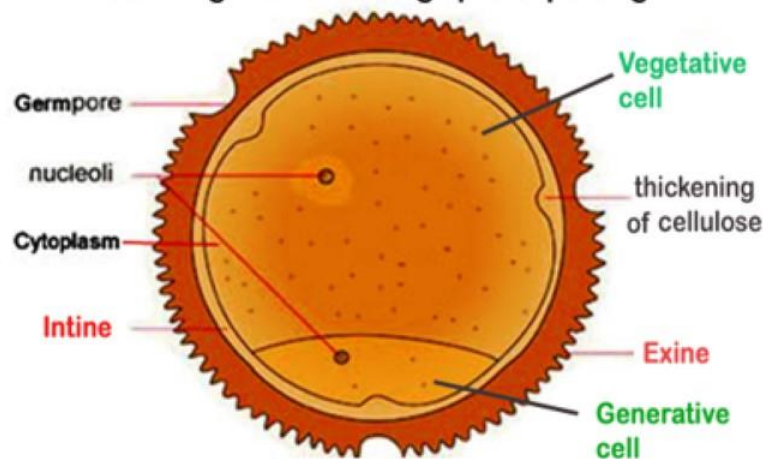
Pollen grain (male gametophyte)

Intine

- ▶ The inner wall.
- ▶ It is a thin and continuous layer made up of **cellulose** and **pectin**.



Scanning electron micrographs of pollen grains

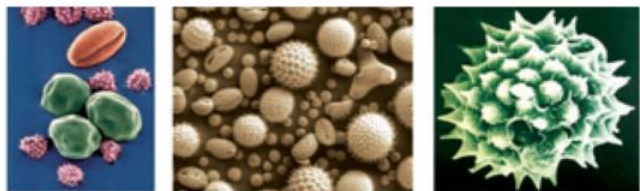


A pollen grain

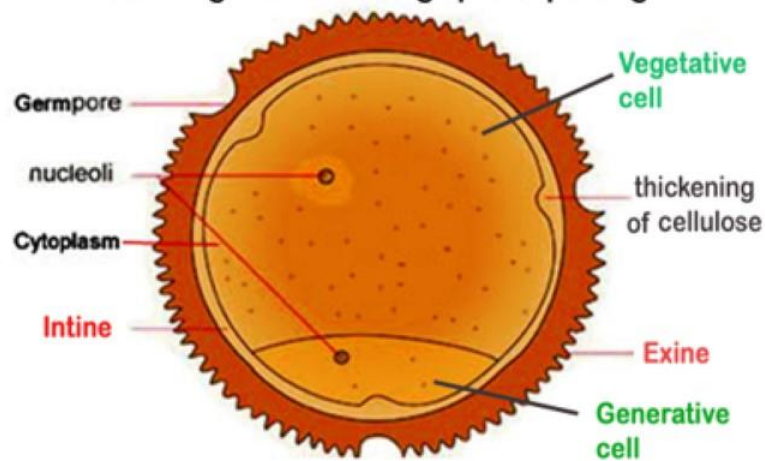
PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

1. Androecium



Scanning electron micrographs of pollen grains



A pollen grain

Pollen grain (male gametophyte)

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A matured pollen grain contains 2 cells:

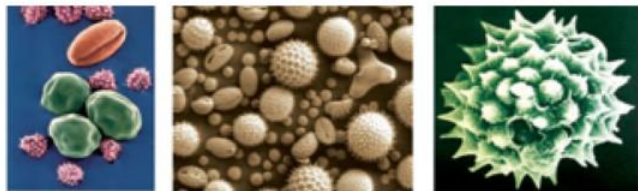
- ❖ **Vegetative cell:** It is bigger, has abundant food reserve and a large irregularly shaped nucleus.
- ❖ **Generative cell:** It is small and floats in the cytoplasm of the vegetative cell. It is spindle shaped with dense cytoplasm and a nucleus.

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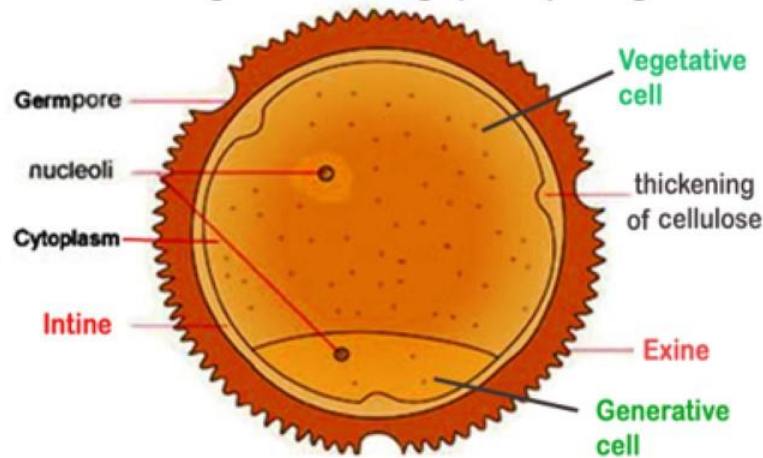
PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

1. Androecium



Scanning electron micrographs of pollen grains



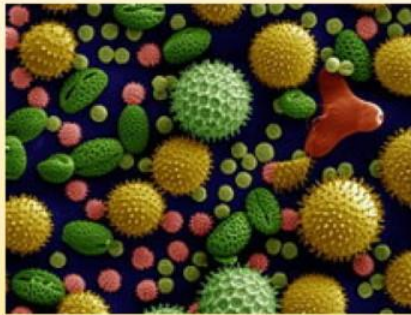
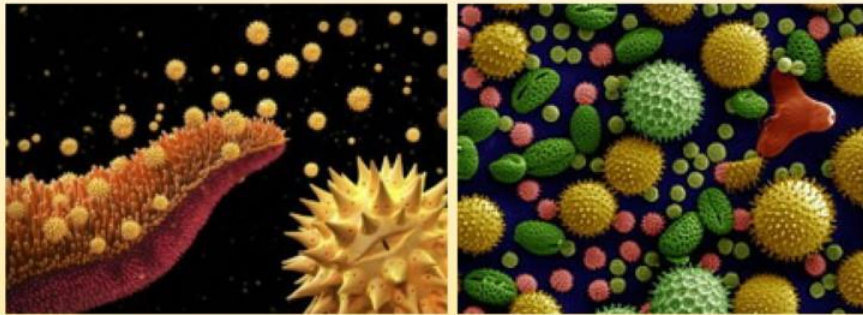
A pollen grain

Pollen grain (male gametophyte)

- ▶ Over 60% angiosperms shed their pollen grains at **2-celled stage**.
- ▶ In others, generative cell divides mitotically to give 2 male gametes. Thus pollen grains are shed at **3-celled stage**.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER



1. Androecium

Pollen grain (male gametophyte)

- ▶ The shed pollen grains have to land on the stigma before they lose viability.
- ▶ The viability period of pollen grains is variable. It depends on temperature and humidity.
- ▶ Viability of pollen grains of some cereals (rice, wheat etc.) is 30 minutes. Some members of Leguminosae, Rosaceae & Solanaceae have viability for months.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

1. Androecium

Economic importance of pollen grains



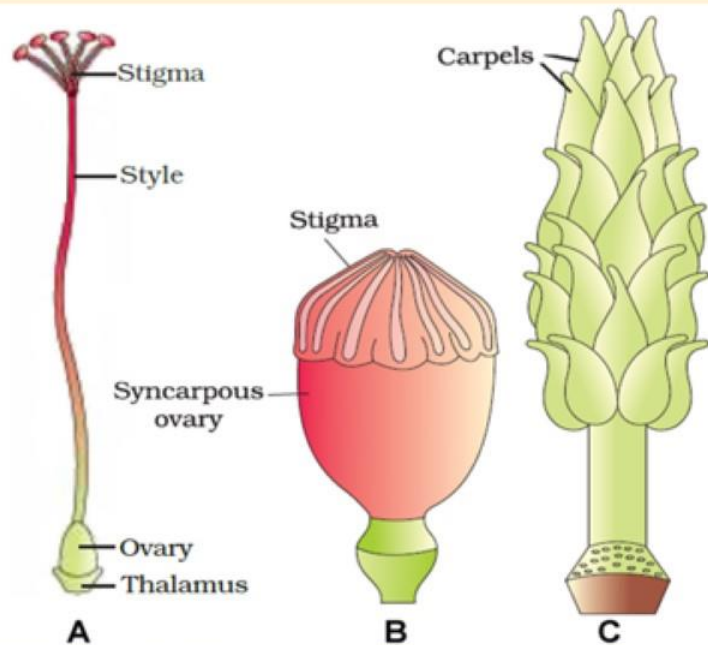
- These are **rich in nutrients**. Pollen tablets are used as food supplements. Pollen tablets & syrups increase performance of athletes and race horses.
- They are stored for years in **liquid nitrogen** (-196°C). They are used as **pollen banks** in crop breeding programmes.
- Pollen grains of some plants (e.g. *Parthenium* or carrot grass) are **allergic** for some people. It leads to chronic respiratory disorders – asthma, bronchitis, etc.



PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

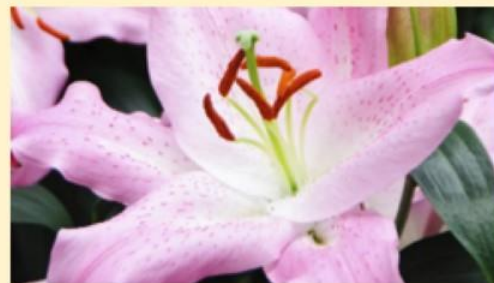
2. Gynoecium



A. *Hibiscus* pistil.

B. Multicarpellary, syncarpous pistil of *Papaver*.

C. Multicarpellary, apocarpous gynoecium of *Michelia*

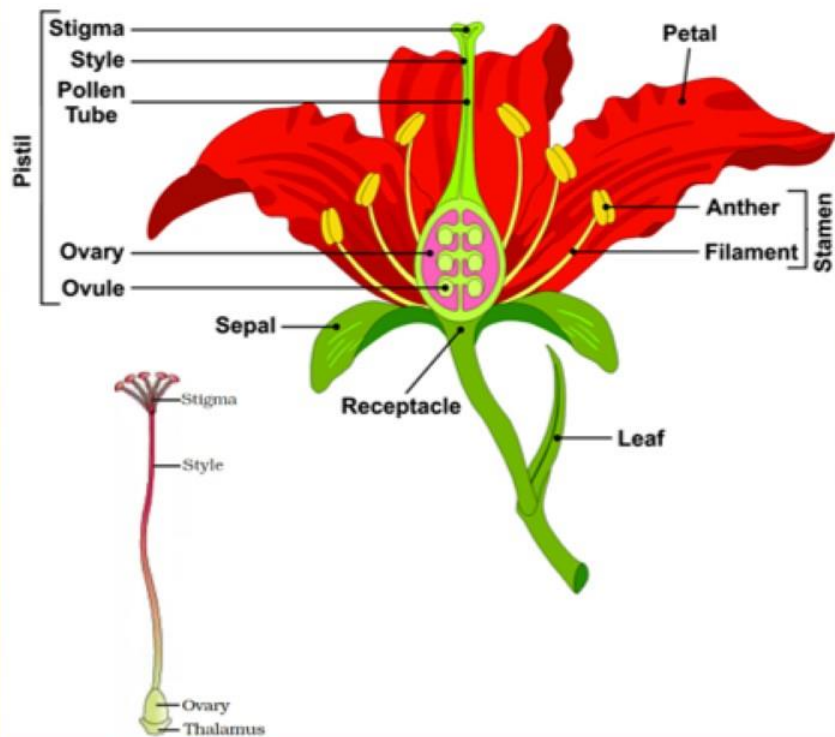


- ▶ Female reproductive part.
- ▶ It may have a single pistil (**monocarpellary**) or more than one pistil (**multicarpellary**).
- ▶ In multicarpellary, the pistils may be fused together (**syncarpous**) or free (**apocarpous**).

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

2. Gynoecium



Each pistil has three parts:

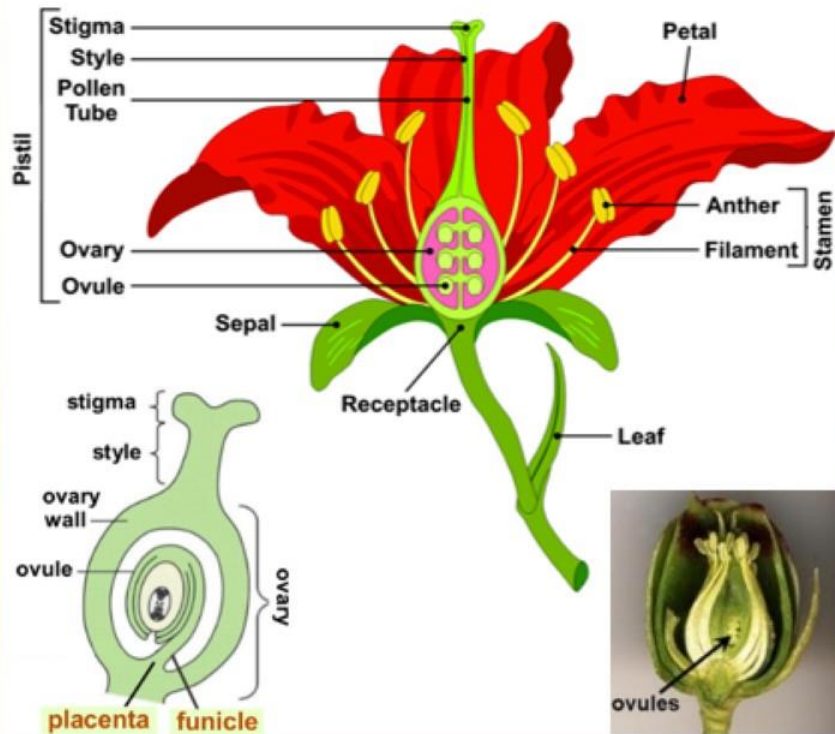
- ▶ **Stigma:** Landing platform for pollen grains.
- ▶ **Style:** Elongated slender part beneath the stigma.
- ▶ **Ovary:** Basal bulged part.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

2. Gynoecium

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▶ Inside the ovary is the **ovarian cavity (locule)** in which **placenta** is located.

▶ Arising from the placenta are the **ovules (megasporangia)**.

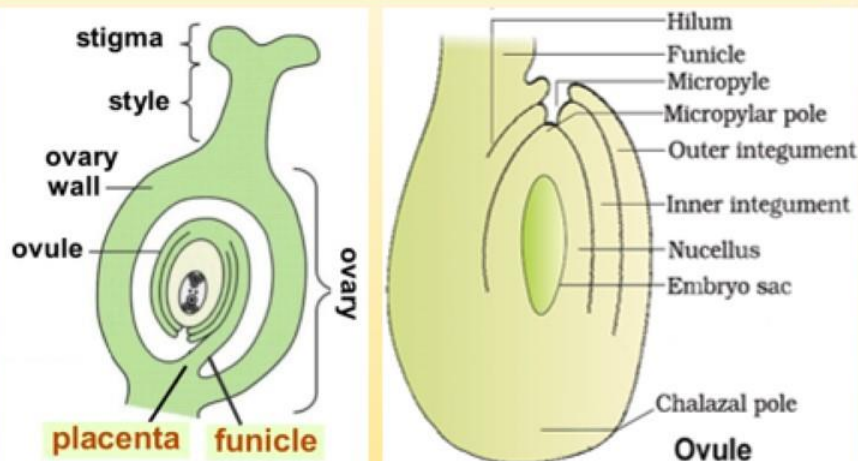
▶ The number of ovules in an ovary may be one (wheat, paddy, mango etc.) to many (papaya, water melon, orchids etc.).

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PRE-FERTILIZATION: STRUCTURES & EVENTS

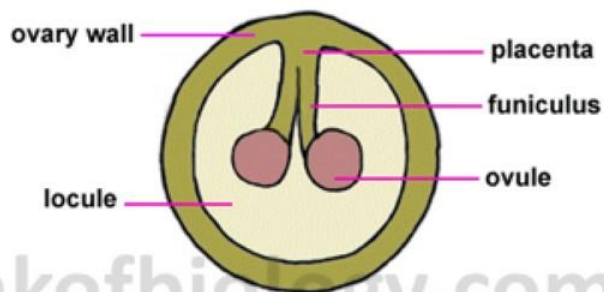
STRUCTURE OF A FLOWER

2. Gynoecium



Structure of Megasporangium (Ovule)

- ▶ Ovule is attached to the placenta by a stalk (**funicle**).
- ▶ Junction between the body of ovule and funicle is called **hilum**.
- ▶ Each ovule has 1 or 2 protective envelopes (**integuments**) except at the tip where a small opening (**micropyle**) is present.
- ▶ Opposite the micropylar end is the **chalaza** (basal part).

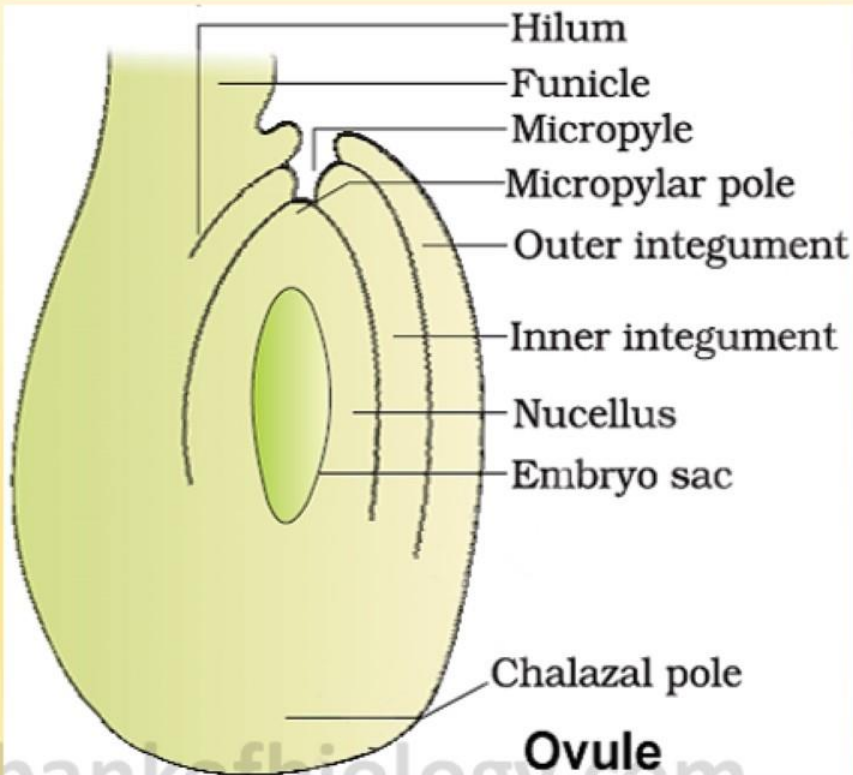


PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

2. Gynoecium

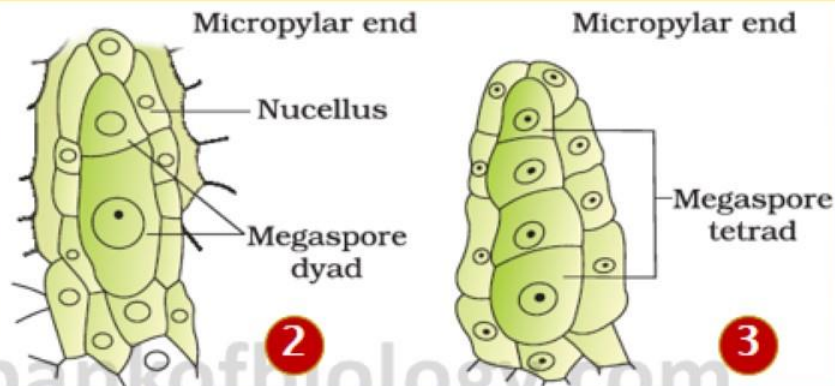
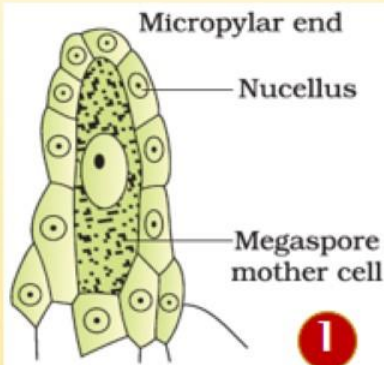
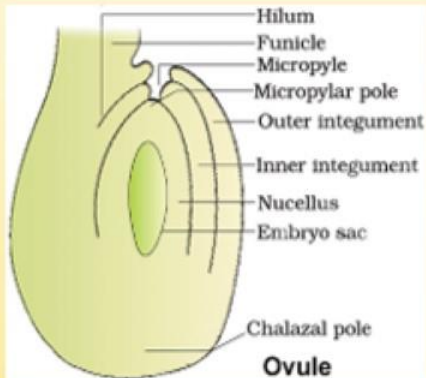
Structure of Megasporangium (Ovule)



- ▶ Enclosed within the integuments, there is a mass of cells called **nucellus**. Its cells contain reserve food materials.
- ▶ Inside the nucellus is the **embryo sac (female gametophyte)**.
- ▶ An ovule generally has a single embryo sac formed from a megaspore.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER



2. Gynoecium

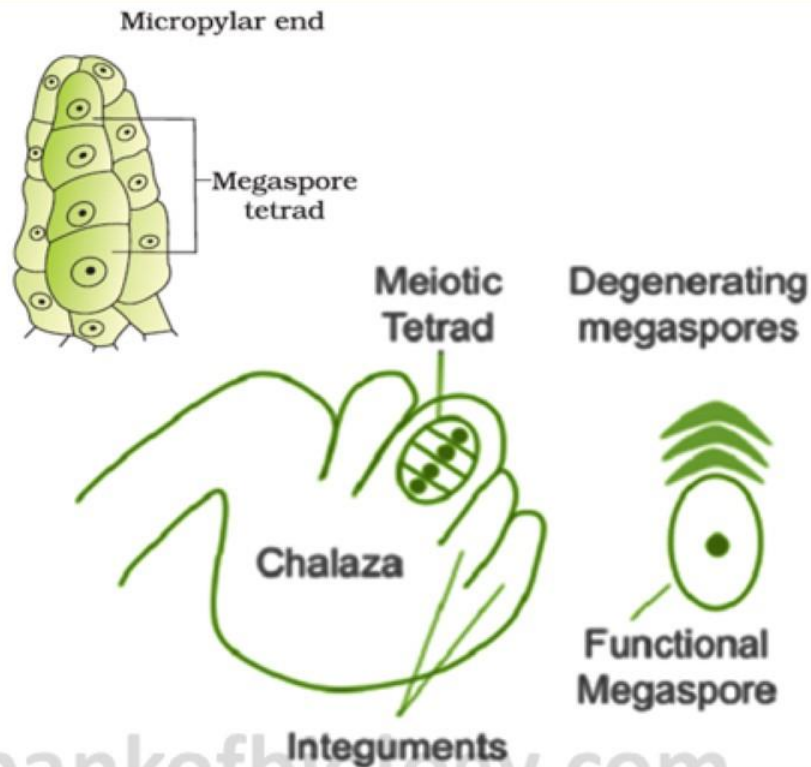
Megasporogenesis

- ▶ It is the formation of megaspores from **megaspore mother cell (MMC)**.
- ▶ Ovules generally differentiate a single MMC in the micropylar region of the nucellus.
- ▶ It is a large cell containing dense cytoplasm and a prominent nucleus.
- ▶ MMC undergoes meiosis to produce **4 megaspores**.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

2. Gynoecium



Formation of Female gametophyte (embryo sac)

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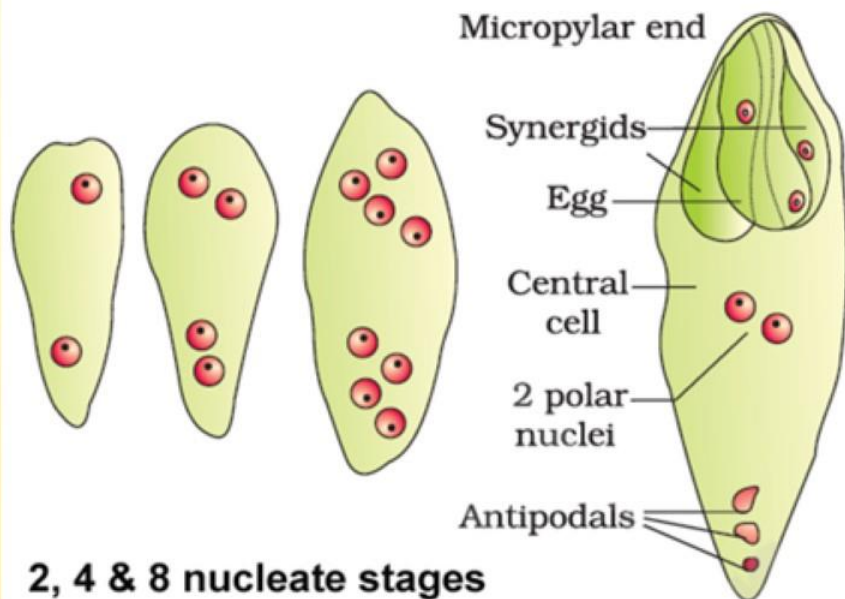
- ▶ In majority of flowering plants, one megaspore is functional while the other three degenerate.
- ▶ The **functional megaspore** develops into the **female gametophyte**.
- ▶ The embryo sac formation from a single megaspore is called **monosporic** development.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

2. Gynoecium

Formation of Female gametophyte (embryo sac)



2, 4 & 8 nucleate stages
embryo sac & a mature embryo sac

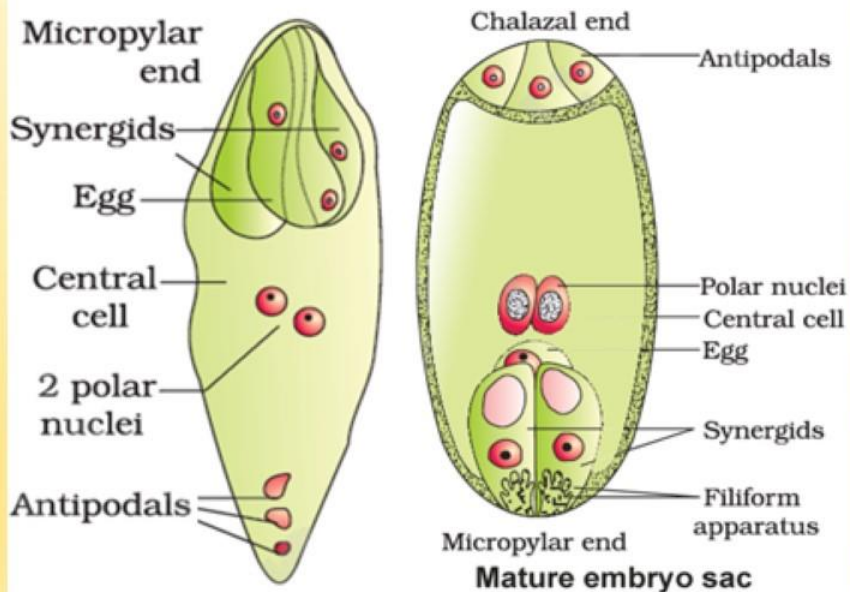
- ▶ The nucleus of functional megaspore divides mitotically to form 2 nuclei. They move to opposite poles, forming **2-nucleate** embryo sac.
- ▶ The nuclei again divide two times forming **4-nucleate** and **8-nucleate** stages of the embryo sac.
- ▶ These divisions are free nuclear, i.e. nuclear divisions are not followed immediately by cell wall formation.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

2. Gynoecium

Formation of Female gametophyte (embryo sac)



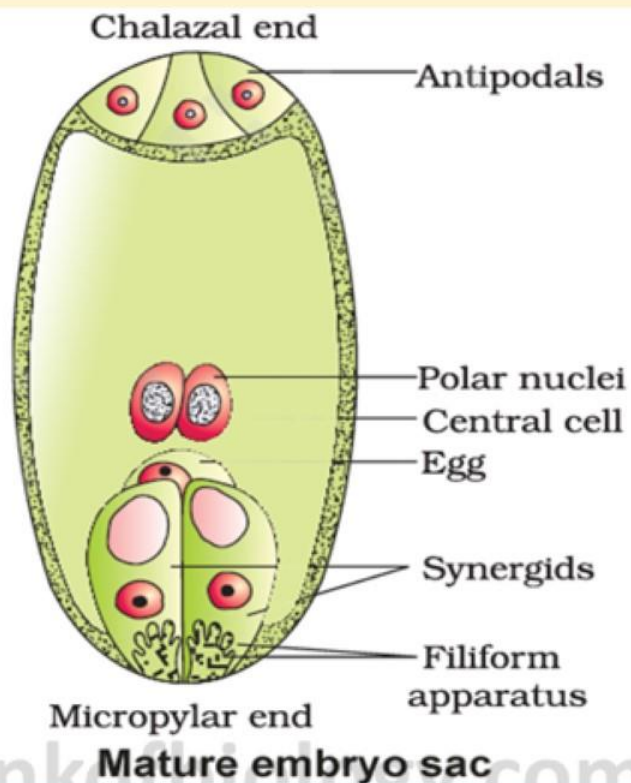
- ▶ After the 8-nucleate stage, cell walls are laid down leading to the organization of the typical **female gametophyte**.
- ▶ 6 of the 8 nuclei are surrounded by cell walls and organized into cells. Remaining 2 nuclei (polar nuclei) are situated below the egg apparatus in the large **central cell**.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

2. Gynoecium

Distribution of cells in the embryo sac



- ▶ A typical mature embryo sac is **8-nucleate** and **7-celled**.
- ▶ 3 cells are grouped at the **micropylar end** and form **egg apparatus**. It consists of 2 **synergids** and one **egg cell**.
- ▶ Synergids have special cellular thickenings at the **micropylar tip** called **filiform apparatus**. It helps to guide the pollen tubes into the synergid.
- ▶ 3 cells at the **chalazal end** are called the **antipodals**.
- ▶ The large **central cell** has two **polar nuclei**.

PRE-FERTILIZATION: STRUCTURES & EVENTS

STRUCTURE OF A FLOWER

2. Gynoecium

Formation of Female gametophyte (embryo sac): Overall

