

MICROSPOROGENESIS

EMBRYOLOGY OF ANGIOSPERMS

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AP in Botany

Sex organs and Development

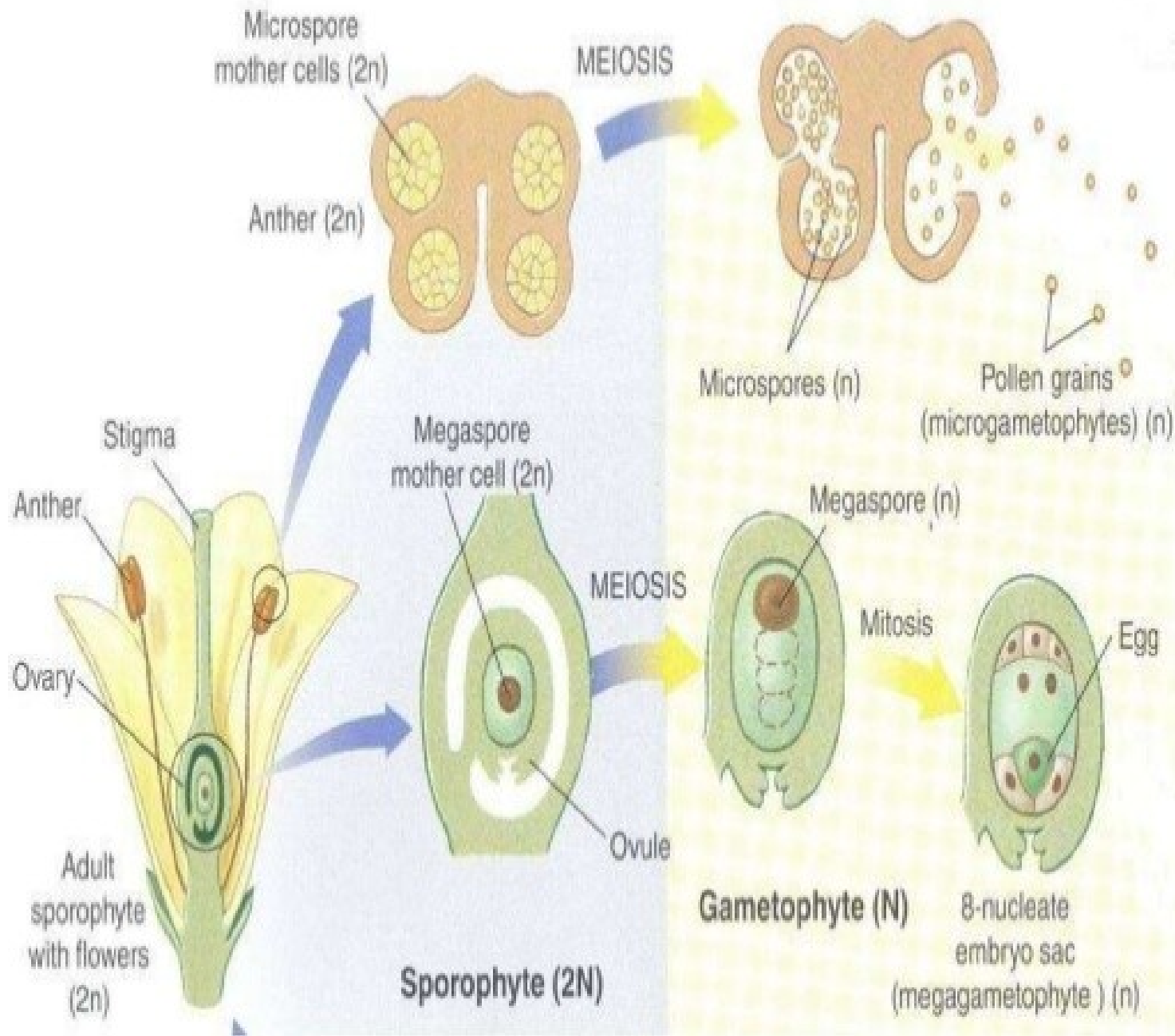
Any adult angiosperm plants are diploid **sporophytes**.

They produce haploid spores by meiosis.

This is called **sporogenesis**.

Spores are of two kinds namely **microspores** (male spores or pollen grains) and **megaspores** (female spores).

The formation of microspores is called **microsporogenesis** while formation of megaspores is called **megasporogenesis**.



Microsporogenesis

Megasporogenesis

Microsporogenesis

The formation of **microspores** or **pollen grains** inside the **microsporangia** or (**pollen sacs**) of seed plants.

A diploid cell in the microsporangium, called a **microsporocyte** or a **pollen mother cell**, which undergoes meiosis division and gives rise to four haploid **microspores** (**pollen grains**).

Each microspore then develops into a pollen grain (the microgametophyte).

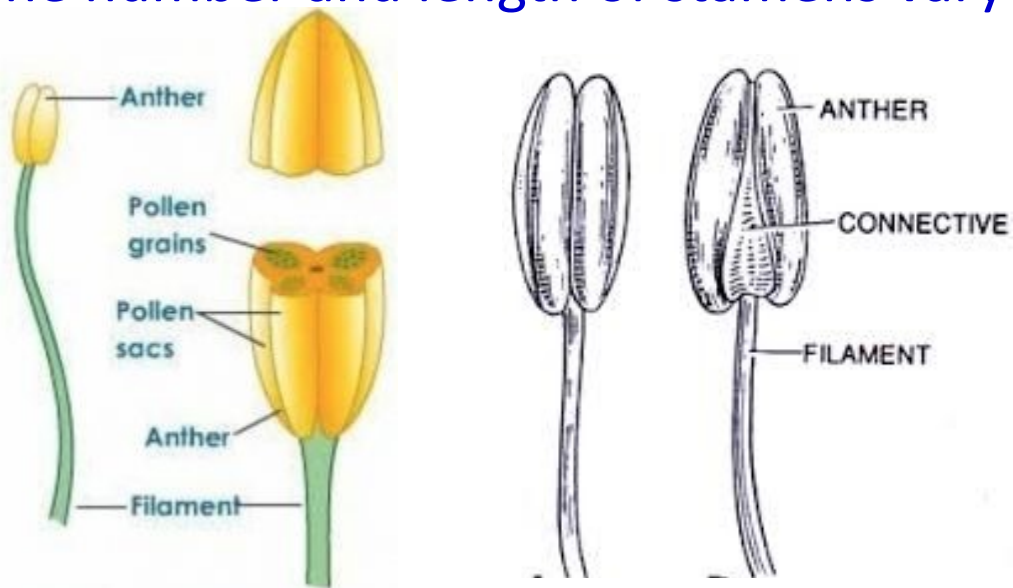
Structure of Stamen, Anther, Pollen Sac and Pollen Grain in Plants!

(a) The Stamen:

Stamen in a flower consists of two parts, the long narrow stalk like filament and upper broader knob-like bi-lobed anther.

The proximal end of the filament is attached to the thalamus or petal of the flower.

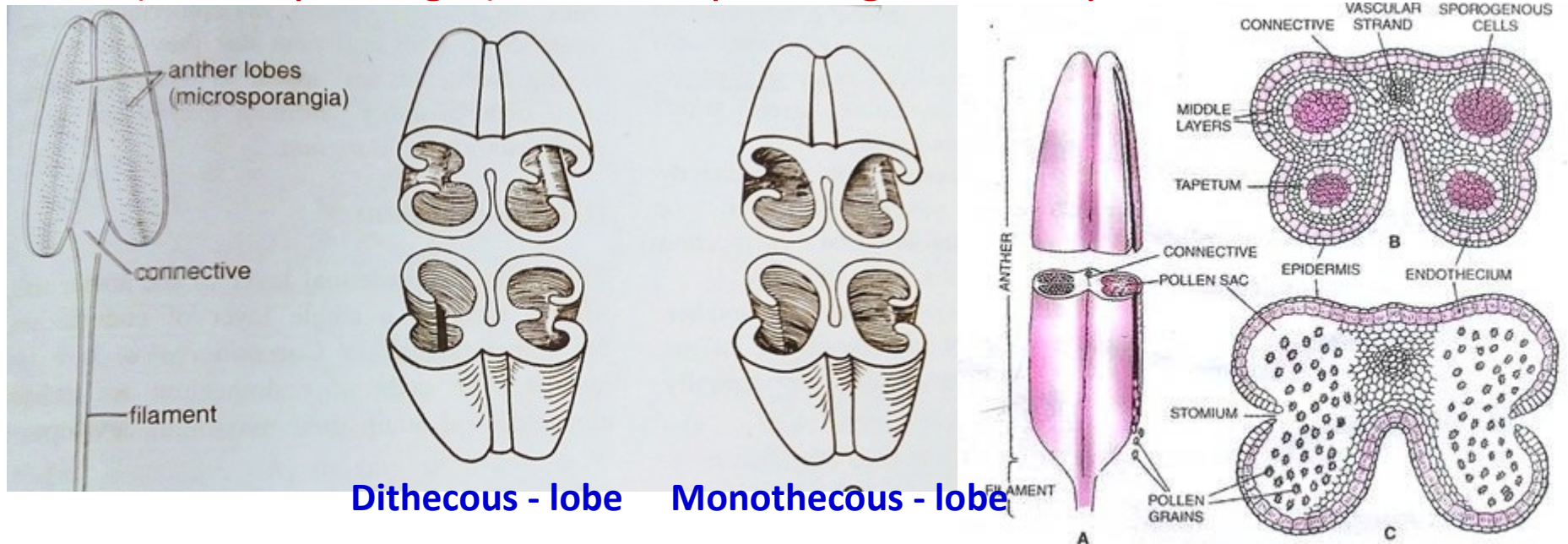
The number and length of stamens vary in different species.



(b) Structure of anther:

A normal **bithecous** or **dithecous** anther is made up of two **anther lobes**, which are connected by a strip of sterile part called **connective**.

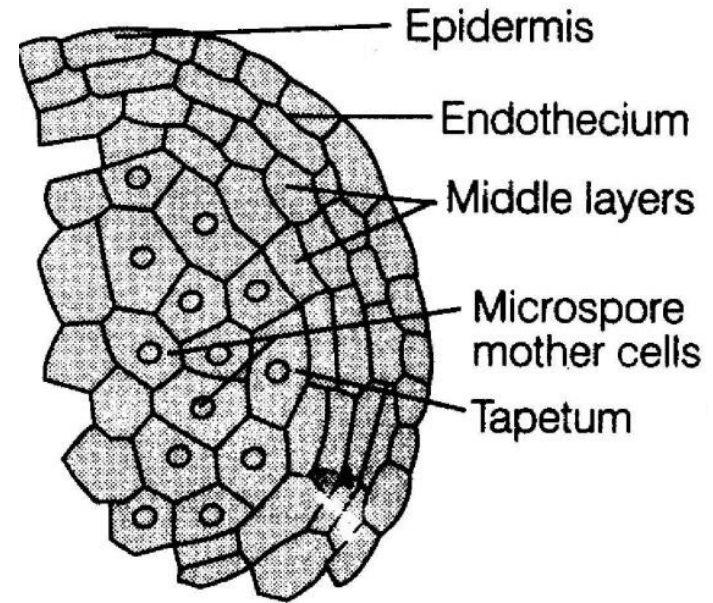
Two anther lobes contain four elongated cavities or pollen sacs (microsporangia) in which pollen grains are produced.



Structure Of Anther

A microsporangium is circular and which surrounded by 4 layers.

1. Epidermis
2. Endothecium
3. Middle layers
4. Tapetum.



Outermost layers are protective the pollen and pollen mother cell which are help in dehiscence of anther to release pollen grains.

(c) Structure of microsporangium (pollen sac):

Cross section of young anther reveals that presence of outermost single layer **epidermis**.

Below the epidermis layer is called **endothecium** or fibrous layer.

Stomium is present at the junctions of two pollen sacs for releasing pollen grains.

Below the endothecium, there are 1-3 **middle layers** which are parenchyma cells.

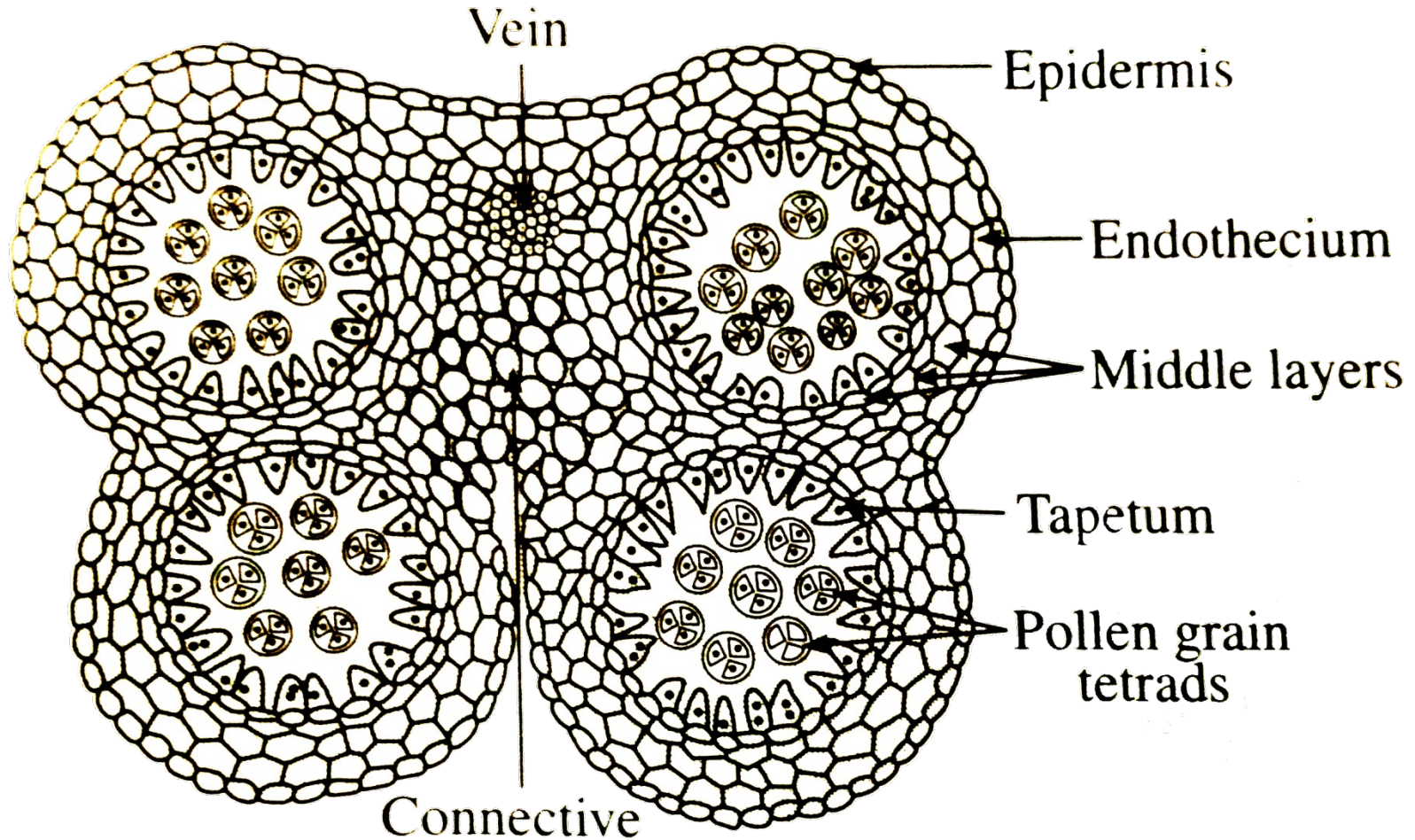
The cells of innermost wall layer are radially elongated and rich in protoplasmic layer as called **Tapetum**.

The tapetum forms the **nutritive tissue nourishing** the developing microspores (pollen grains).

The cells of tapetum may be multinucleate or may have large polyploid nucleus.

The tapetal cells provide nourishment to young microspore mother cells either by forming a plasmodium (amoeboid or invasive type) or through diffusion (parietal or secretory type).

Mature Anther - T.S



Development of anther and microsporogenesis:

Young anther has a mass of meristematic homogeneous cells covered by a single outer meristematic layered as **epidermis**.

A mass of hypodermal cells become large sized, radially elongated and prominent at the four corners of the young anther.

These cells are called **Archeporial cells**.

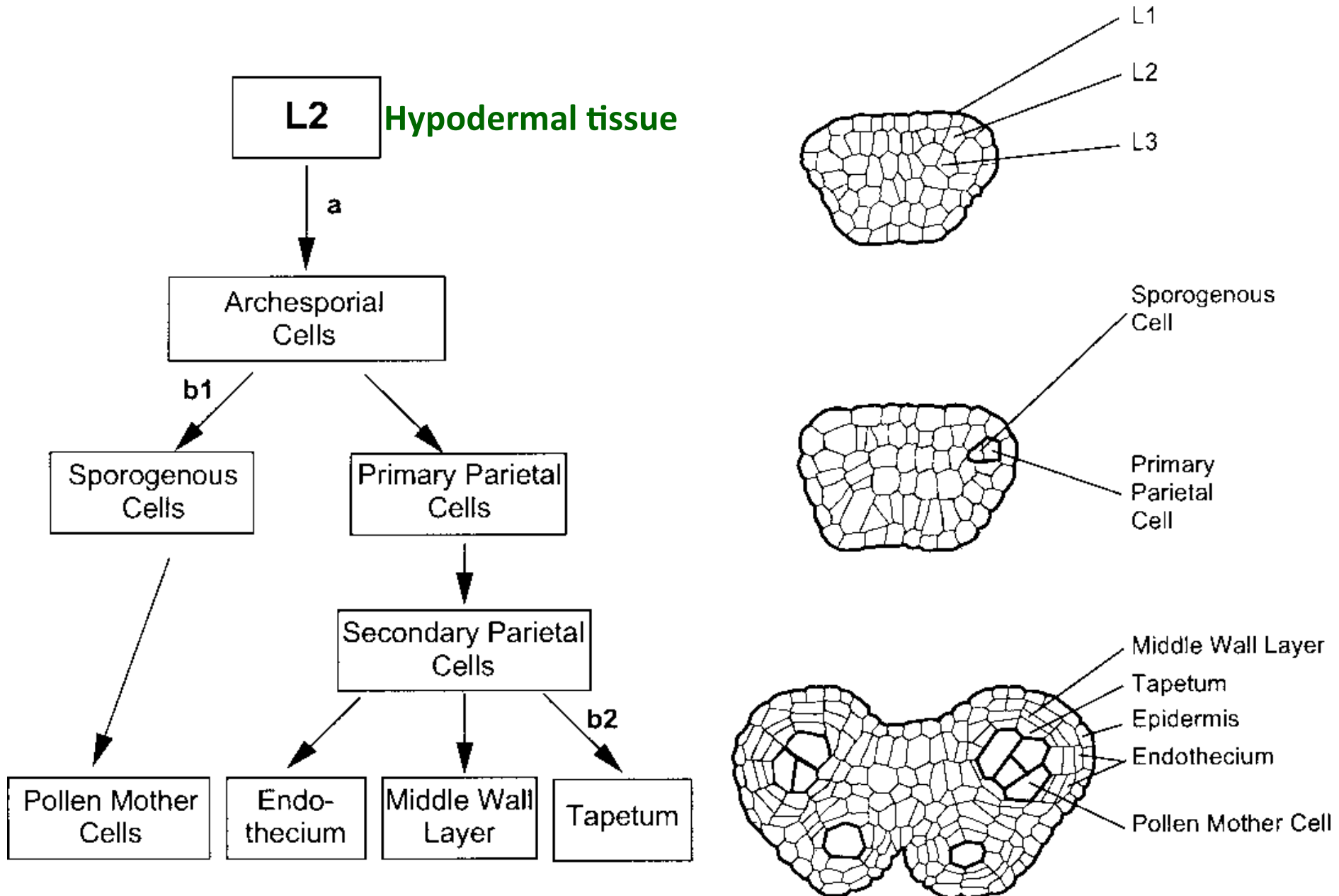
Archeporial cells divide by periclinal division to form **two layers cells**

Outer - primary parietal layer (PPL)

Inner - primary sporogenous layer (PSL)

Cells of the PPL divide by many anticlinal and periclinal divisions to form a multilayered (2-5 layers) anther wall.

Development of microsporangium and microspores :



Epidermis: outermost layer, single layer of flattened cells.

Endothecium: Inner to epidermis, single layered, radially elongated cells, which has thin layered area called **stomium** which helps in dehiscence of the anthers.

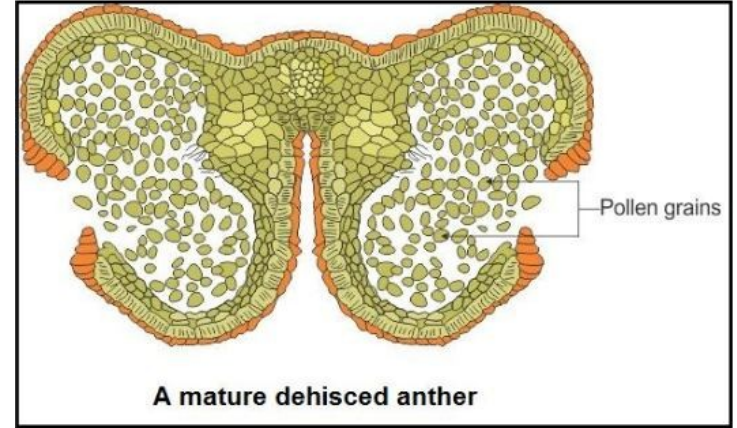
Middle layers: 2-3 layers of flattened 3 cells inner to endothecium.

Tapetum: Innermost layer, single layer of cells with dense cytoplasm and prominent nuclei, provides nutrition to developing microspores.

It is of two types – **Amoeboid type** and **Secretory type**.

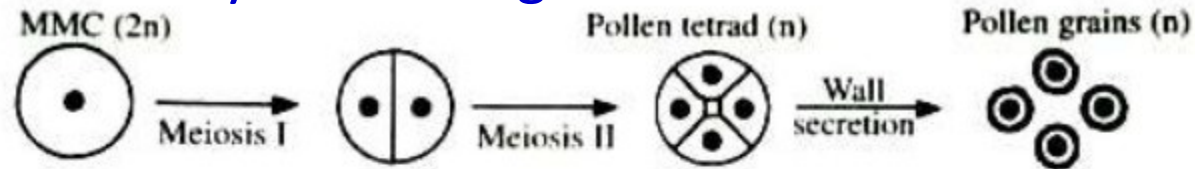
Cells of the PSL divide by mitosis and form a mass of diploid sporogenous tissue which forms Microspore mother cells or Pollen mother cells (MMC / PMC).

They are loosely arranged when mature.



MMC's divide by meiosis to form haploid microspores or pollen grains. They are arranged as

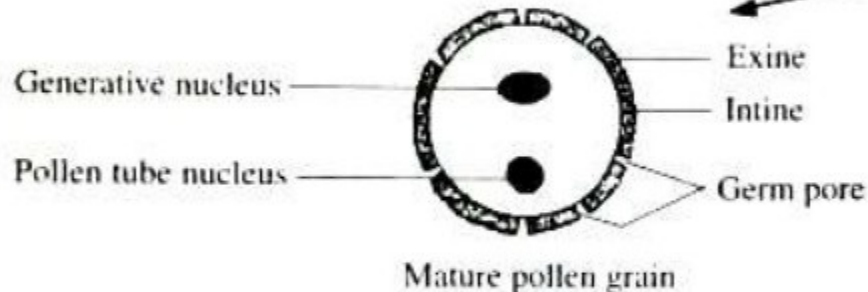
tetrads (group of four).



Tetrad formation is of two types:

❖ Successive type

❖ Simultaneous type



Successive type: Each nuclear division followed by cell wall formation.

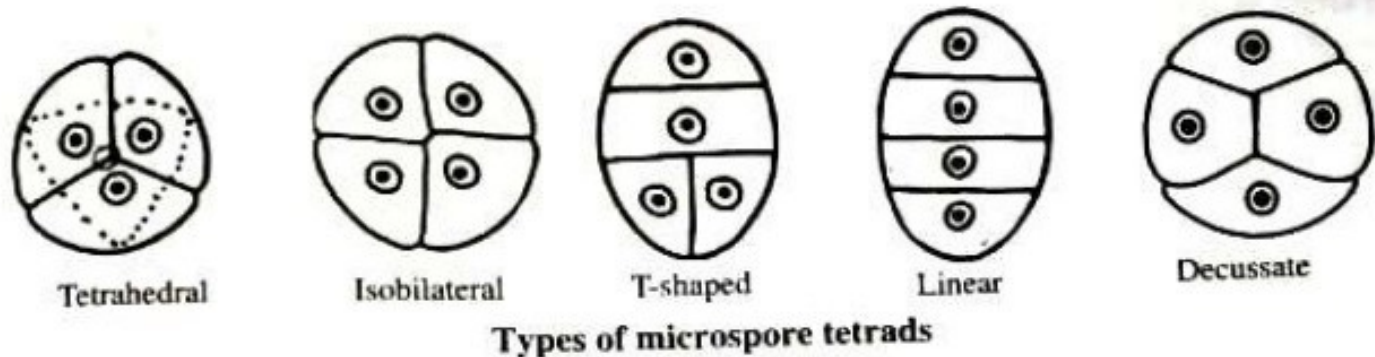
Four cells arranged in iso-bilateral manner.

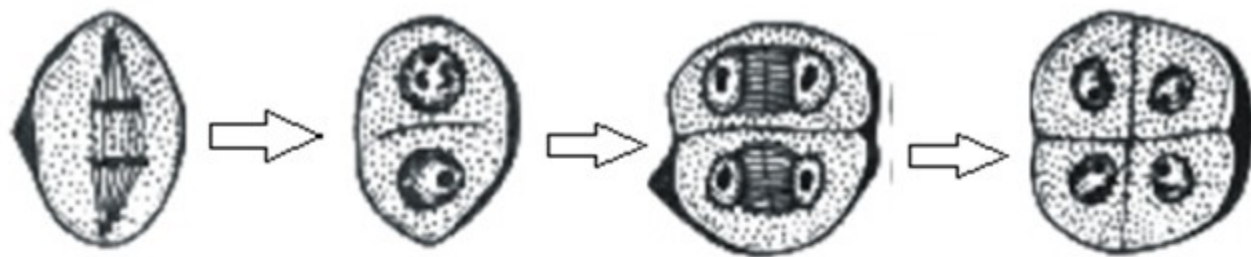
Simultaneous type: Nucleus of PMC divides twice to form four haploid nuclei.

Cell wall forms simultaneously between four nuclei resulting in tetrads.

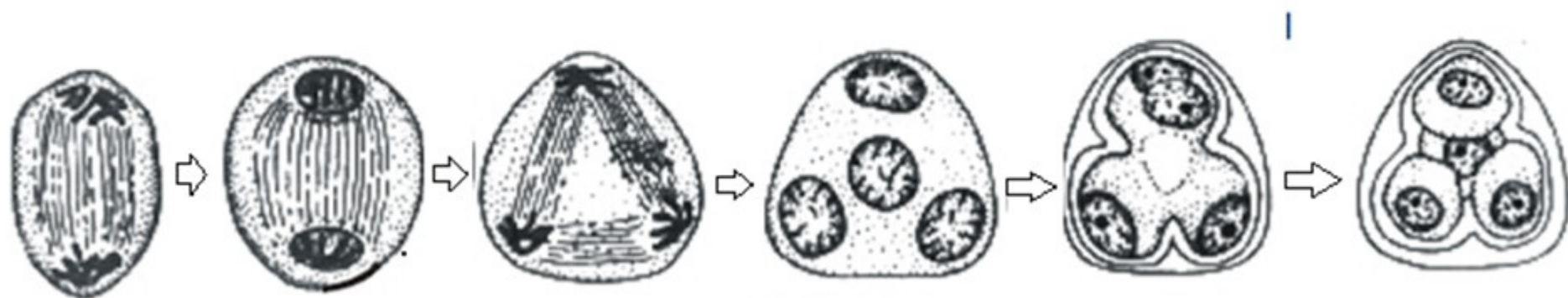
Cells of the tetrad completely separate from each other and develop into mature pollen grains.

These microspores germinate and produce the male gametophyte.





Various stages during successive type of cytokinesis during microsporogenesis



Various stages during simultaneous type of cytokinesis during microsporogenesis

Mature pollen grains

A mature pollen grain is a haploid, spherical structure, covered by two concentric walls.

The outer wall is called **exine** and the inner wall is called **intine**.

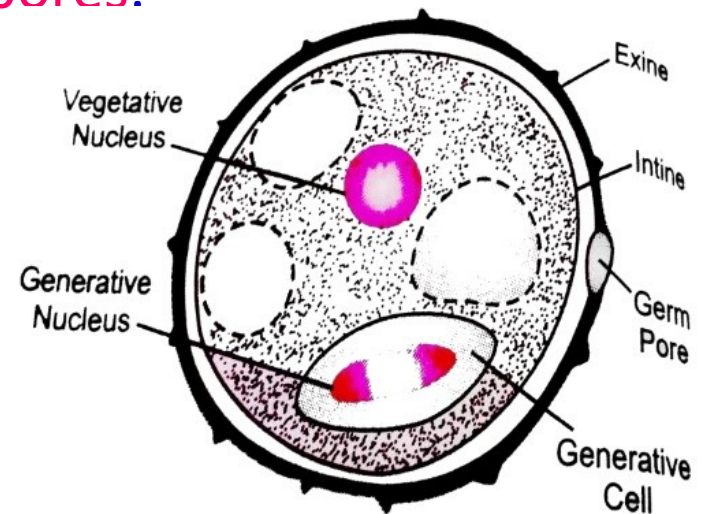
The exine may be **sculptured, spiny** or **warty**.

Exine has one or more thin **circular germ pores**.

Exine is divided into two layer:

- ❖ **outer layer is called exo-exine.**
- ❖ **inner layer is called endo-exine.**

Exine is multilayered and have biological material as called **sporopollenin**, which is related to **cutin** and **suberin**.



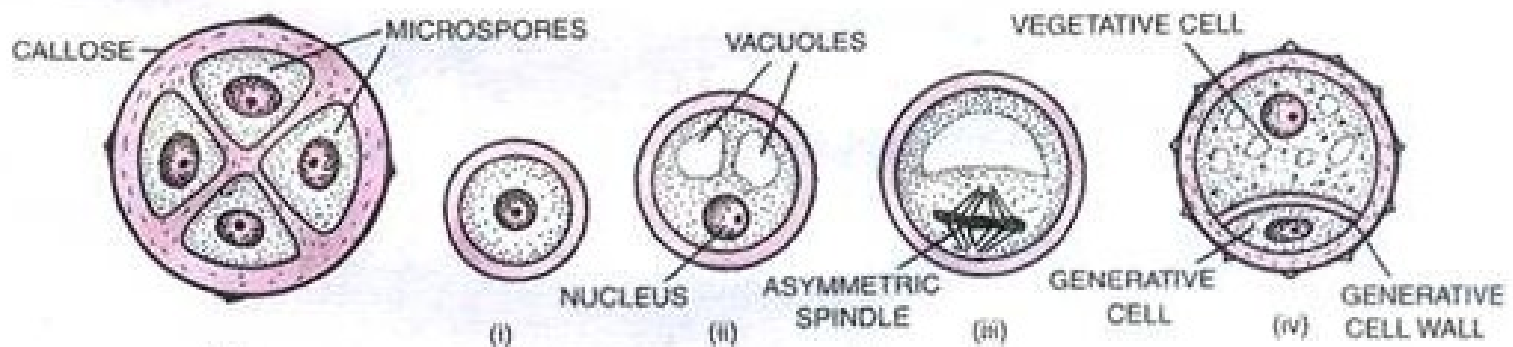
Structure and Development of Male gametophyte:

Male gametophyte (MG) is the haploid structure formed by pollen grains or microspore and it produces the male gametes or antherozoides.

Formation of MG from pollen grains occurs as follows:

Preparation: The nucleus of the pollen grain migrates from centre to periphery and its cytoplasm becomes highly polarized.

Formation of vegetative and generative cells: The migrated pollen nucleus divides mitotically to form two unequal cells.



The larger cell is called **vegetative** cell and smaller, spindle shaped cell is the **generative cell**.

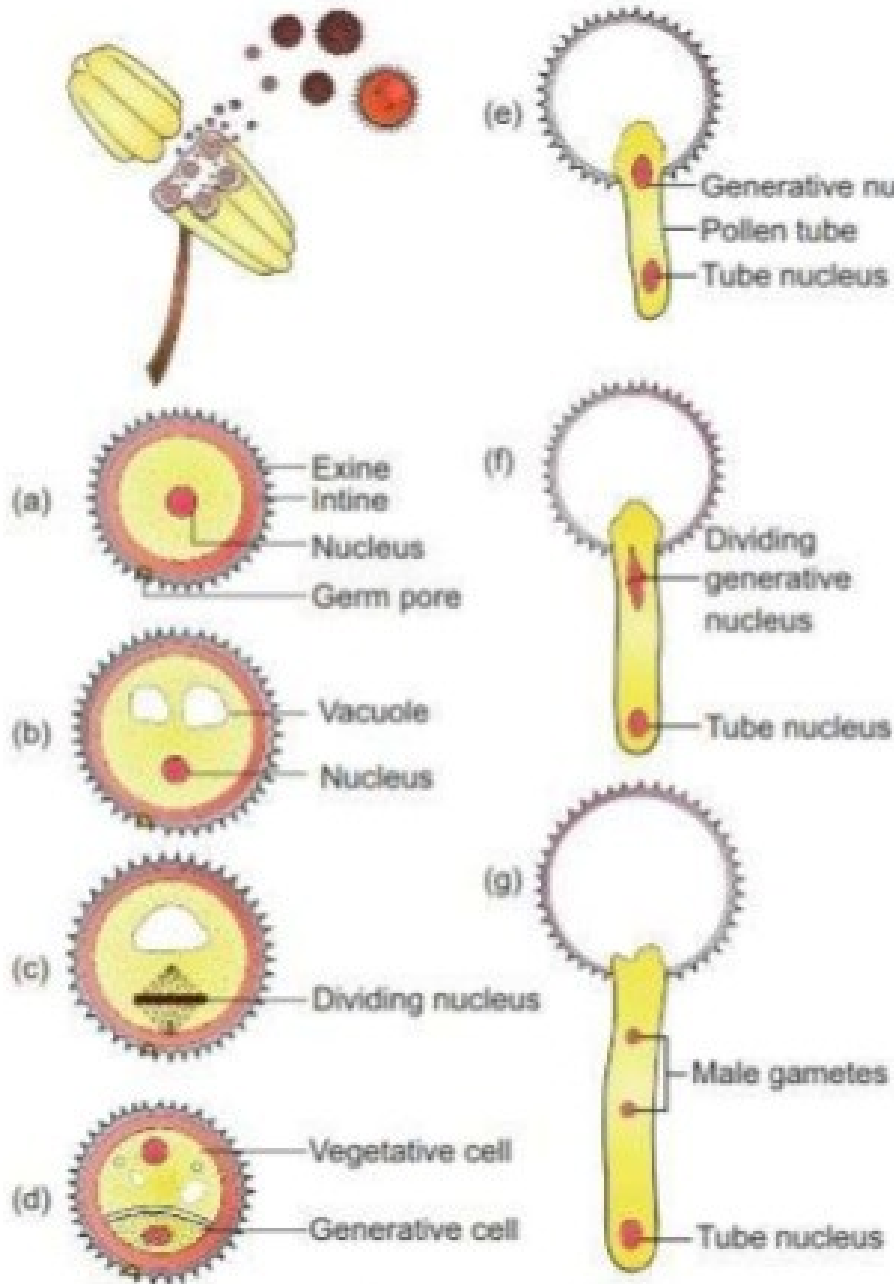
Later, the generative cell floats within the cytoplasm .

This is 2-celled MG.

Formation of Male gametes: The generative cell divides by mitosis forming two male cells which give rise to two non-motile male gametes or antherozoides (2 sperm cell).

This is 3-celled MG (**1 vegetative cell + 2 sperm cells**).

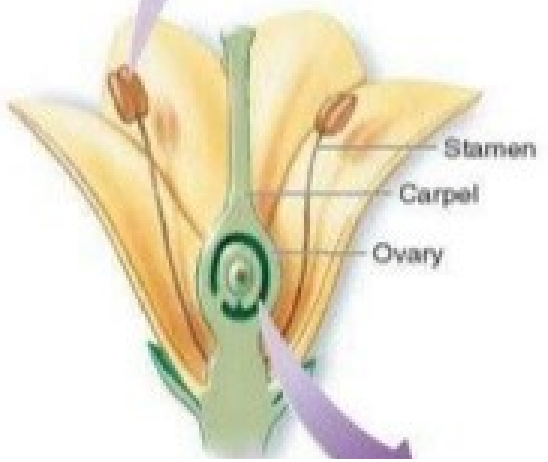
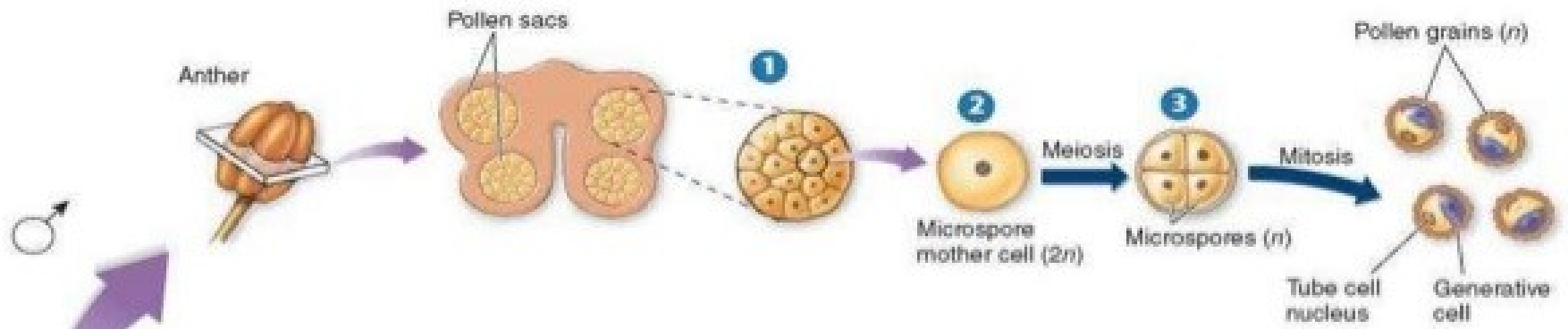
Pollen tube formation: Pollens are shed from the anther and deposited on the stigma (pollination), at the 3-celled stage.



On the stigma, pollen grains germinate forming a narrow tube called **pollen tube**.

The pollen tube grows **down** through the style.

The **male gametes** and the **vegetative nucleus** along with the cytoplasm is transferred to the pollen tube and is carried at its growing tip.



Thank You