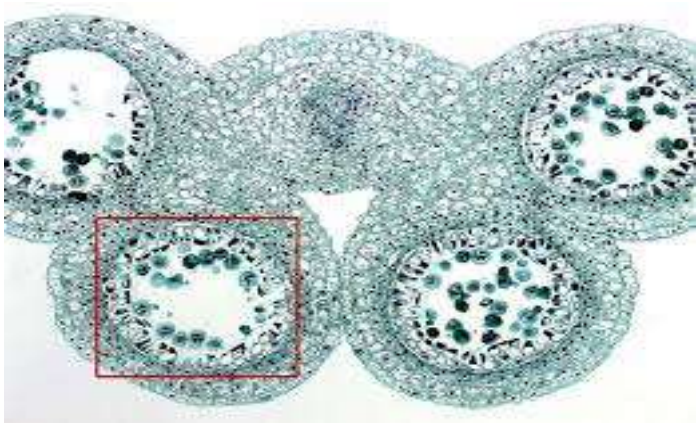
MICROSPORANGIUM, MICROSPOROGENESIS AND MALE GAMETOPHYTE



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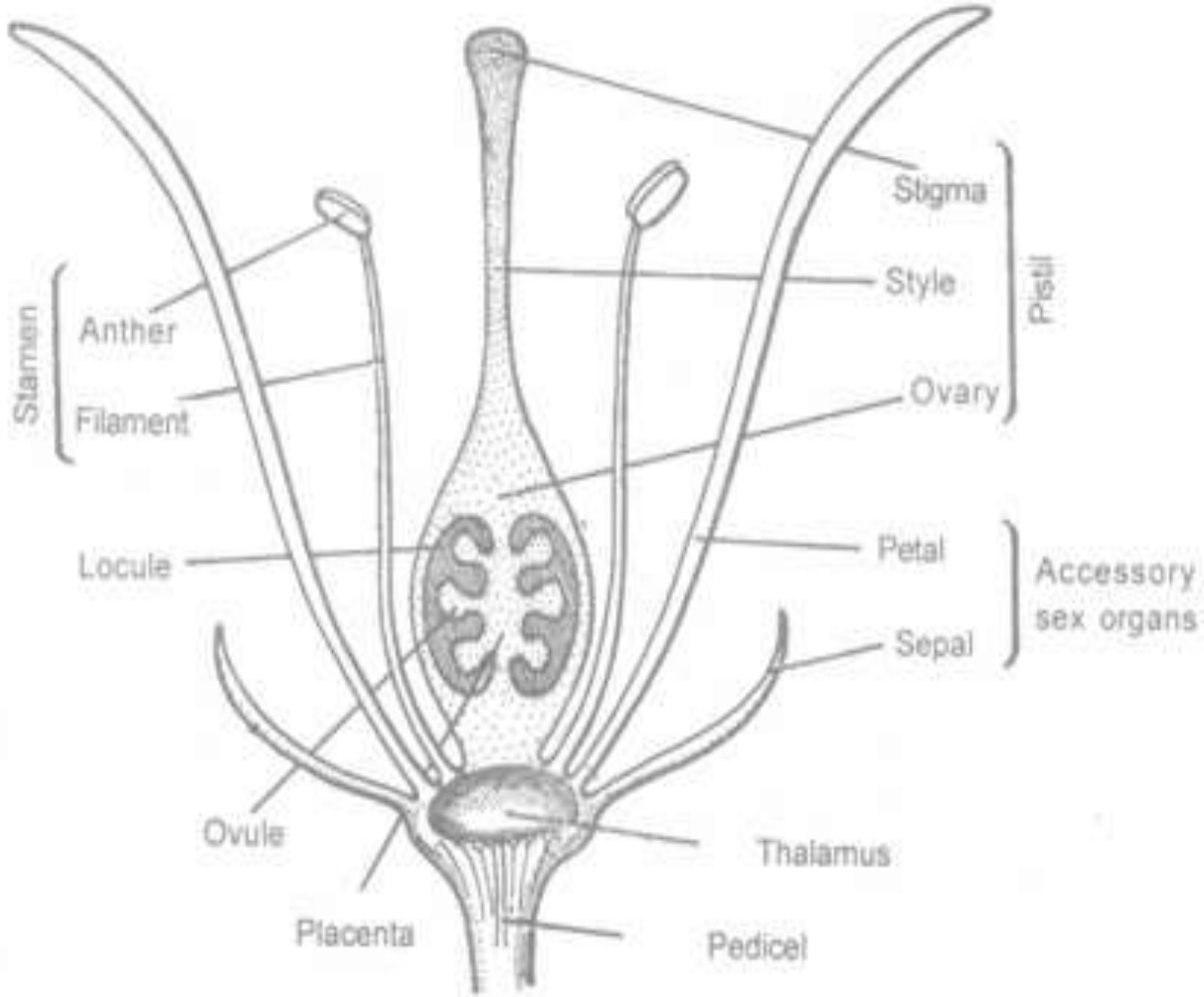
For B.Sc. Part II (Subs) Students

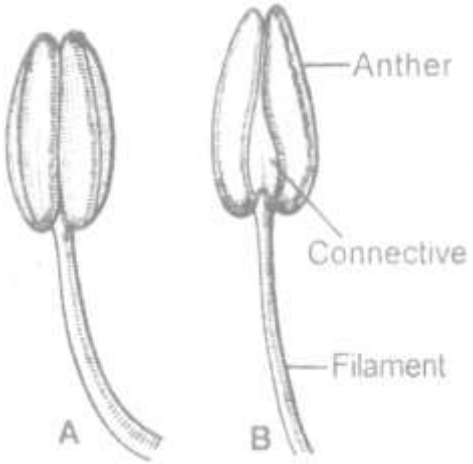
Lecture No.12



STRUCTURE OF FLOWER

Male reproductive part of flower is called **androecium** and their unit is called **stamen**.

Stamen is also known as microsporophyll.



Stamen

A typical stamens has three parts

Anther: Anther is the upper fertile part which is the bilobed structure.

Connective: Median sterile part of the anther is known as connective. Which joins the lobes . Each lobe of the mature anther has two pollen sacs .

Filament: a long, thin structure is called filament which joins the stamen to the thalamus.

Anther and Microsporogenesis

- A complete anther has four microsporangia – Tetra-sporangiate or dithecous .
- In some plants has a single lobe with two microsporangia or monothecous.

  (Example- *Hibiscus*, *Moringa* , Family Malvaceae).
- Rarely anther has only one lobe with a single microsporangia unisporangiate (Example- *Arceuthobium*).

- The development of anther in origin is eusporangiate type i.e. it is developed from more than one archesporial cells.
- T. S of anther shows the following structure

(A) Parietal layers or wall layers of anther

(B) Pollen chambers or microsporangia having sporogenous tissue or archaesporial cell

Parietal layers or wall layers of anther

From outside to inner side following layers are present in wall of anther

i) Epidermis: It is the outermost layer of anther. It is single celled thick and continuous layer but not archesporial in origin . It forms the outermost protective layer.

ii) Endothecium:

Endothecium is present below the epidermis. It is single called thick layer.

- During the maturation of anther, various changes take place in different walls of cell of endothecium.
- The outer wall of these cells remains thin walled, but inner walls and radial walls become think due to thickening of **α- cellulose fibers.**
- Callose bands are also present along the radial walls. At some places callose bands and fibrous thickening are absent. These place are called **stomium.** The dehiscence of anther takes place only from these places.
- Endothecium becomes hygroscopic nature due to presence of fibrous thickening. So it helps in dehiscence of anther.
- In family Hydrocharitaceae, fibrous thickening are absent

(iii) Middle layer :-

➢Middle layer is consist of parenchymatous cells.

➢This layer is one to three celled thick structure. Food is stored by parenchymatous cell in this layer.

➢ Middle layer is ephemeral in nature and absent in a mature anther.

✓ In *Holoptelia* plant 3 to 4 celled think middle layer is present.

✓ In Najadaceae & Lemnaceae families middle layer is absent.

✓ In *Wolffia* middle layer is also absent.

iv) Tapetum:

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

➢The cells of the tapetum initially diploid but they become polyploidy due to endomitosis.

➢ Tapetum absorbs food from the middle layer and provide nutrition to the microspore mother cells or microspores.).

- The cells of tapetum secrete hormones and enzymes.
- The tapetum layer disappears in the mature anther.
- In *Nicodia* and *Costum* plants, tapetum is multilayered.

Tapetum is of two types

1. Ameboid type / Invasive tapetum/ Periplasmodial tapetum
2. Glandular / Secretary tapetum

1. Ameboid type / Invasive tapetum/ Periplasmodial tapetum

It is found in primitive Angiosperm. Such type of tapetum absorb all foods from the middle layer. So middle layer immediately degenerates. In the beginning , all food materials stored by tapetum. Tapetal cells convert absorbed food into special food granules called protoplast bodies. The innermost layer of tapetum dissolve and release its protoplast into the cavity of the microsporangium. Now inside the pollen sace protoplast bodies are known as periplasmodium**.** Microspore mother cells are surrounded by periplasmodium and provides nourishment to the developing microspores.

- This type of tapetum provide nutrition to the microspores after degeneration

2. Glandular / Secretary tapetum

It is developed type of tapetum. It is not degenerates quickly. It absorbs nutrients from the middle layer and secreted into the cavity of the micro sporangia (Pollen sacs) and does not store it e.g. Usually it is found in most of Flowering plants .

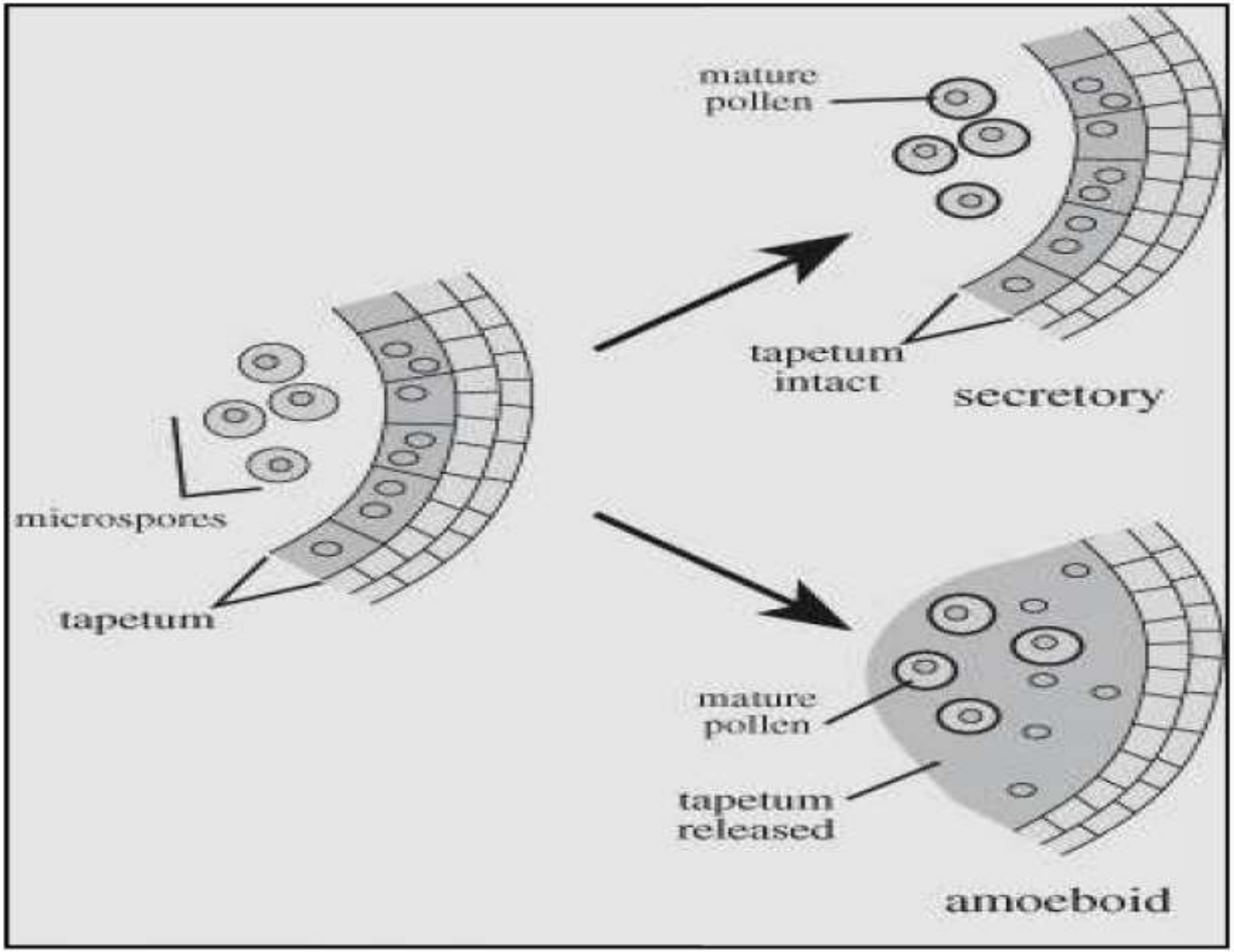
- It secretes both enzymes and substances of harmonal nature.

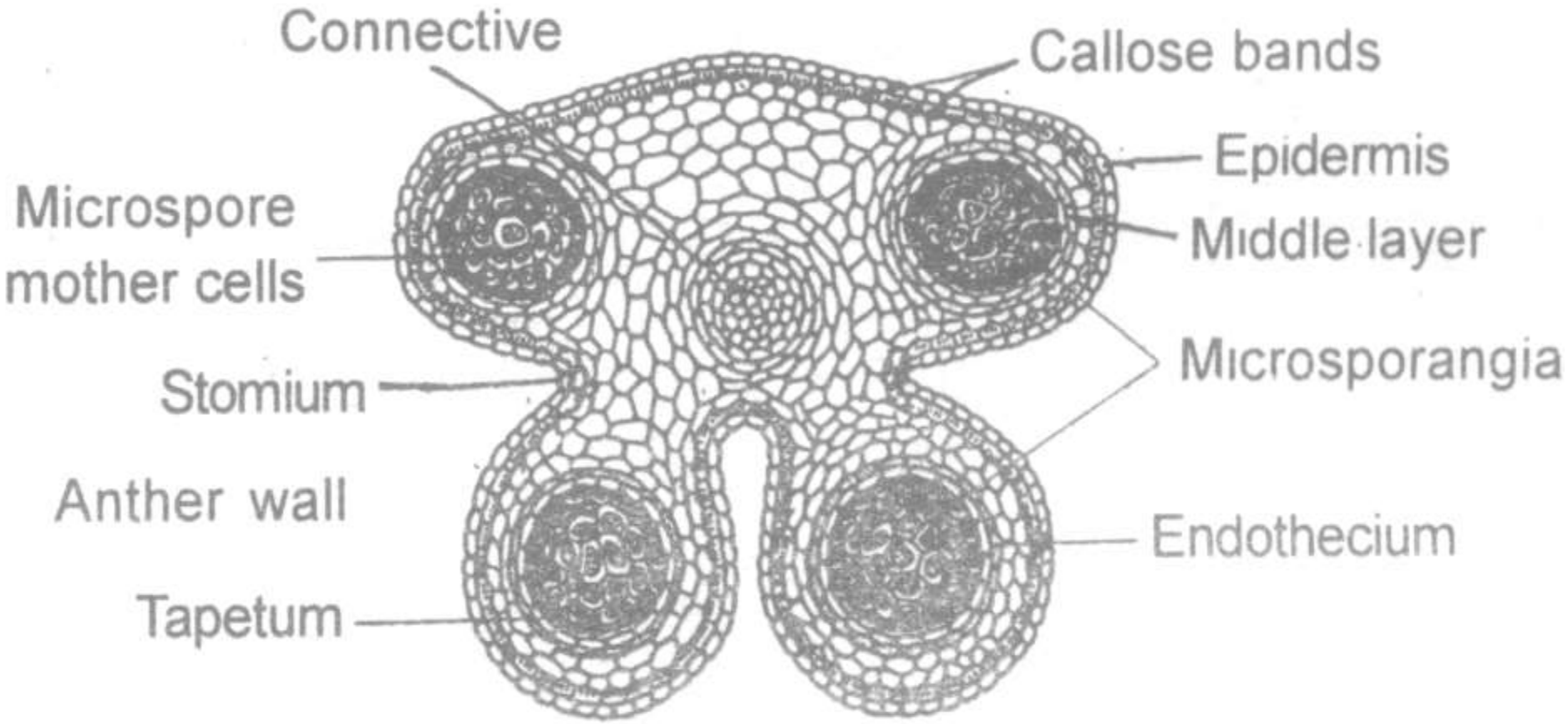
Before degeneration of cells of tapetum, they form special granules called **Pro ubisch bodies** in cytoplasm. Pro ubisch bodies transfer between cell wall and cell membrane of Tapetal cells.

Here they are surrounded by sporopollenin. Now they are called Ubisch bodies or orbicules. At last tapetum degenerates and ubisch bodies released into pollen sacs.

Generally , sporopollenin participates in the formation of other covering (Exine) of Pollen Grains.

- Tapetum helps in transfer of food, storage of food, formation of sporopollenin and pollenkitt materials.


mature
pollen
tapetum
intact
secretory
microspores
tapetum
mature
pollen
tapetum
released
amoeboid

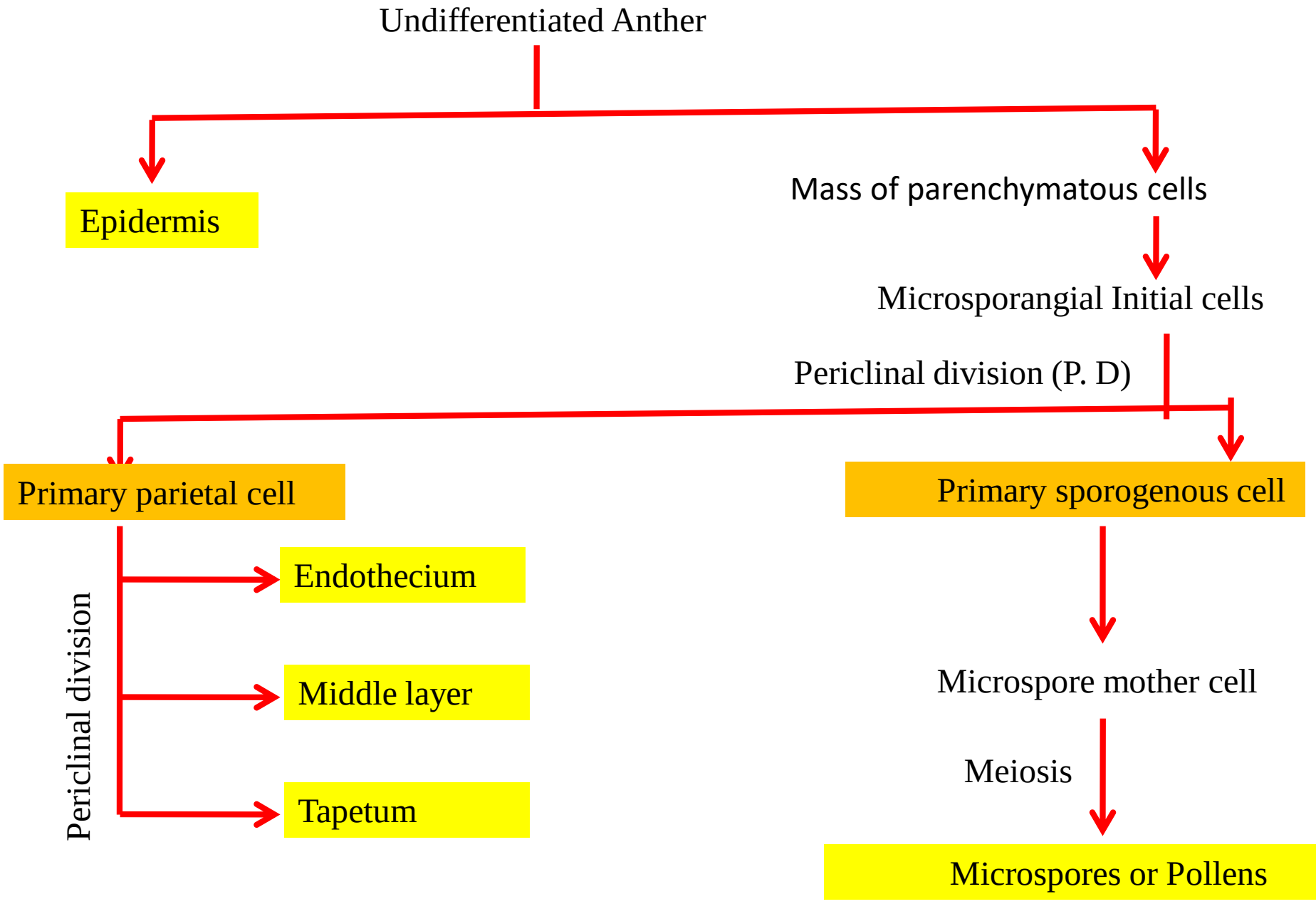


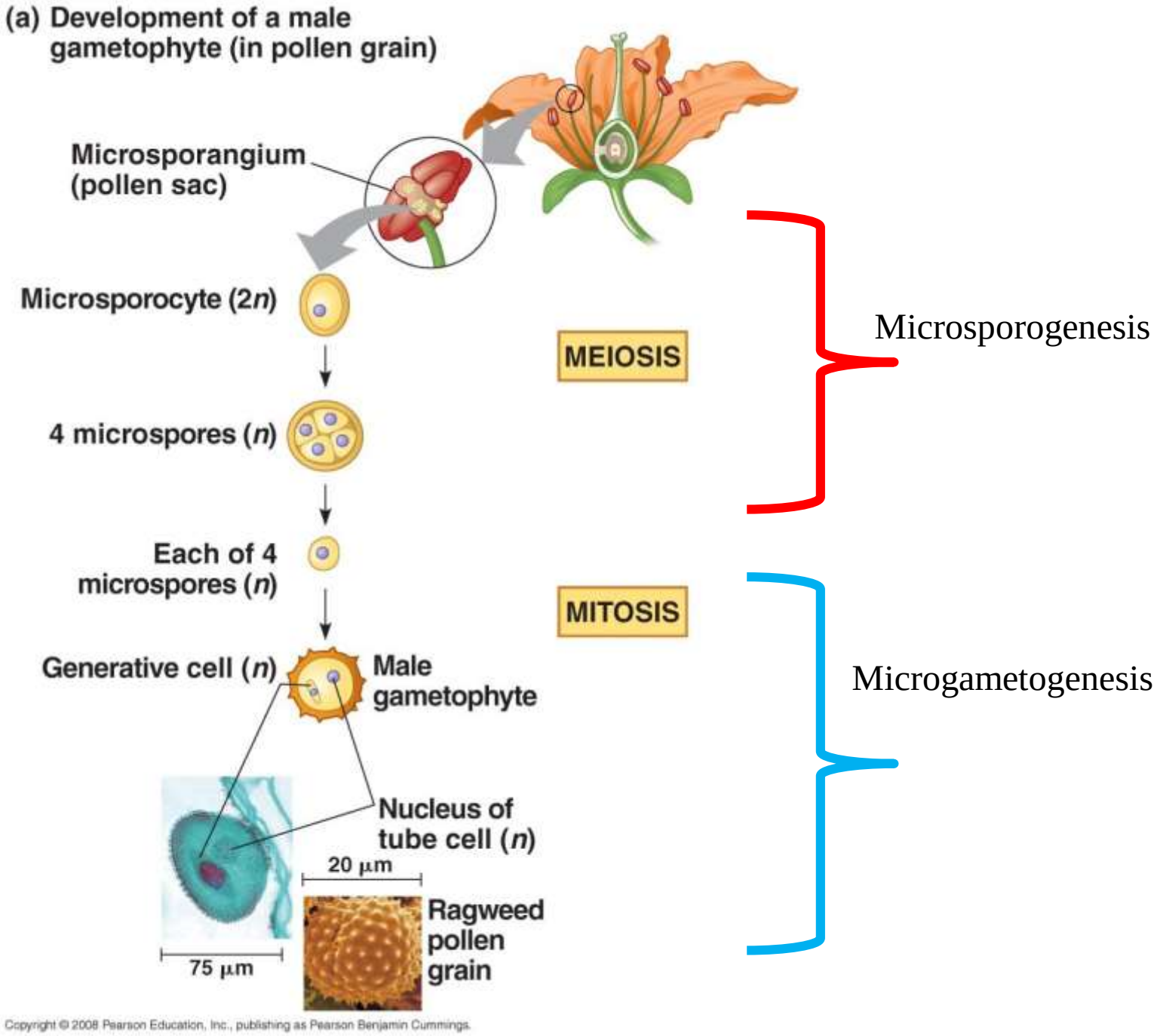
T.S. of anther, showing four microsporangia and anther walls

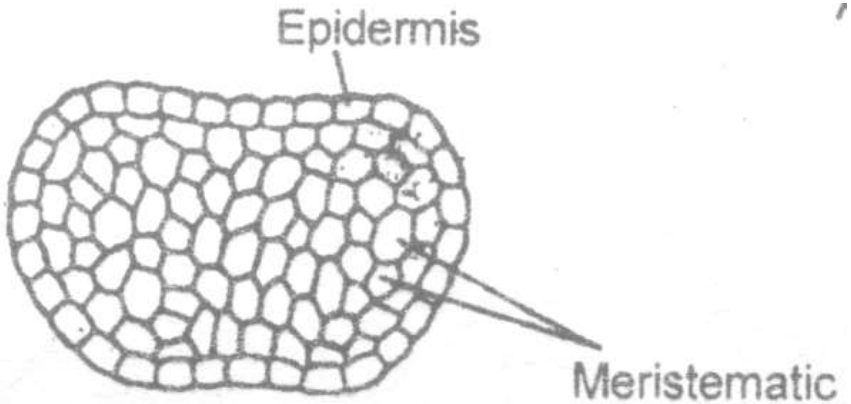
MICROSPOROGENESIS:

Primary sporogenous cell gives rise to microspore mother cells . Each microspore mother cell on reduction division give rise to four microspores or pollens and this formation of microspores or pollens is called microsporogenesis.

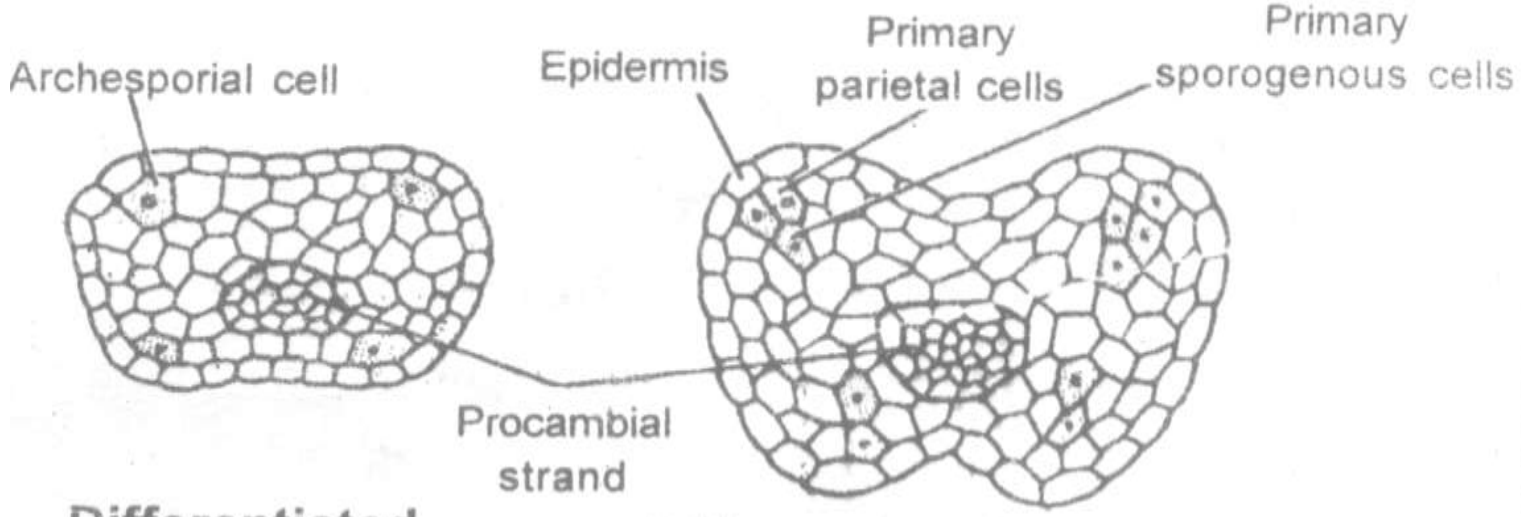
- Young anther has a mass of meristematic homogeneous cells covered by a single layer epidermis. It becomes four lobed and each lobe forms a microsporangium with microspores or pollen grains.
- First of all vascular tissue are formed in middle region simultaneously four cells located just below the epidermis in vertical rows in the region of hypodermis at the four corners are become large has visible nucleus with dense cytoplasm. Due to this reason they are different from the rest of the cells. These cells are called archesporial cells.
- Archaesporial cells divide periclinally to form primary parietal cells below the epidermis and primary sporogenous cells towards the centre. Both of the cells usually undergo further division to form complete structure of anther except epidermis.


Undifferentiated Anther
Epidermis
Mass of parenchymatous cells
Microsporangial Initial cells
Periclinal division (P. D)
Primary parietal cell
Primary sporogenous cell
Endothecium
Middle layer
Tapetum
Periclinal division
Microspore mother cell
Meiosis
Microspores or Pollens





T. S. of young anther



Differentiated archesporial cells

Differentiated primary parietal cells and primary microsporogenous cells

➢ Primary parietal cells undergo further periclinal and anticlinal division to form a series of 3-5 layers making the walls of the anther

➢ Out of them outer most layer of anther is formed just below the epidermis by primary parietal cells is called endothecium or fibrous layer. The endothecium is followed by 1-3 celled thick layer is termed middle layer. The innermost layer of the anther which surrounds pollen sacs, is called tapetum. Later the Tapetal cells play a significant role during the meiotic cell division in microsporogenous cells and in pollen development

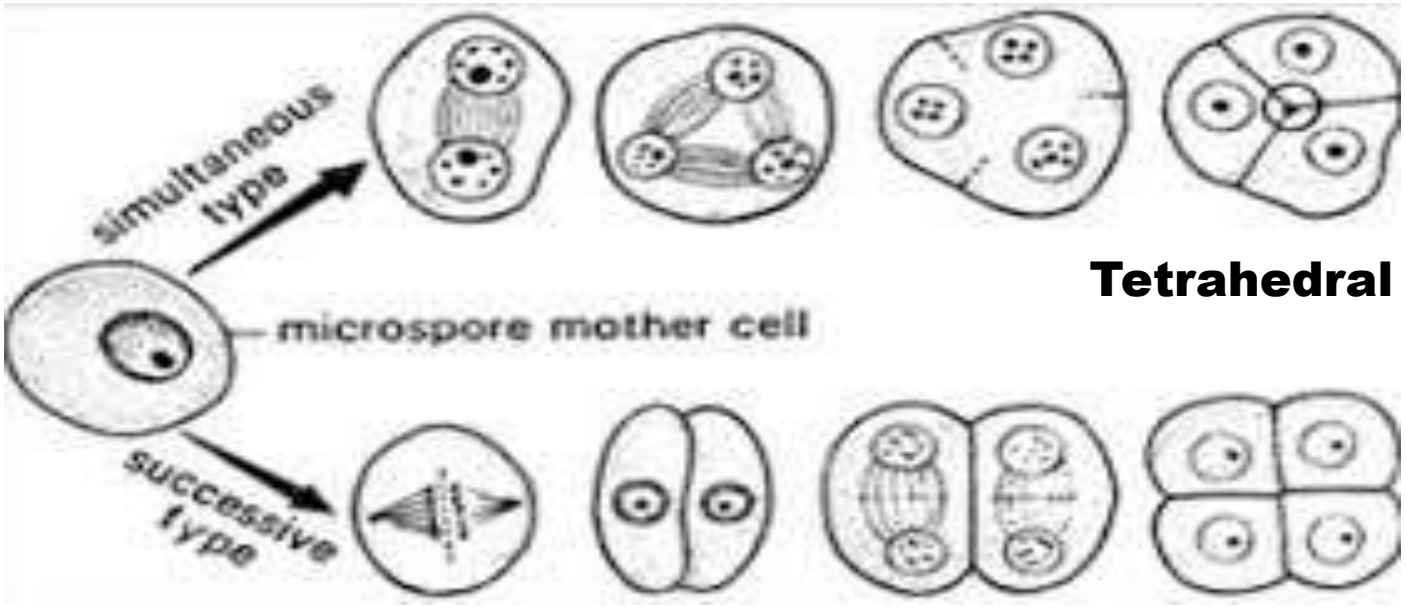
➢ The primary sporogenous cells divide twice or more then two by mitotic division to form sporogenous cells and later sporogenous differentiated into microspore mother cells during the formation of wall of pollen sac.

➢ Each microspore mother cell divide to form four haploid microspore or pollen grain by meiotic division or reduction division .

- During this period spherical bodies are formed inside the Tapetal cells before their disintegration. These spherical bodies are known as Ubisch-body. Ubisch body is made up of a complex substance called sporopollenin. It is the polymer of carotenoids.
- After the formation of ubisch body, the tapetum layer degenerates. Ubisch bodies participate in the formation of exine of the microspores inside the pollen sacs. Now thick walled microspores are called pollen grains.
- At the initial stage all four microspores are attached together with the help of callose layer. This group of microspores is called tetrad. After some time, this callose layer dissolve by callase enzyme. Which is secreted by tapetum.

During meiotic division of microspore mother cell , the wall formation may be of two types

1. **Successive type:** This type of cytokinesis is common in monocots. Here both meiosis -I and meiosis –II nuclear divisions are followed by wall formation that leads to formation of isobilateral tetrad.
2. **Simultaneous type:** This type of cytokinesis is common in dicots. Here I nuclear division is not followed by wall formation and wall formation occurs after mieosis –II nuclear division leads to formation of tetrahedral tetrad



Besides tetrahedral and isobilateral pollen tetrad some other types are

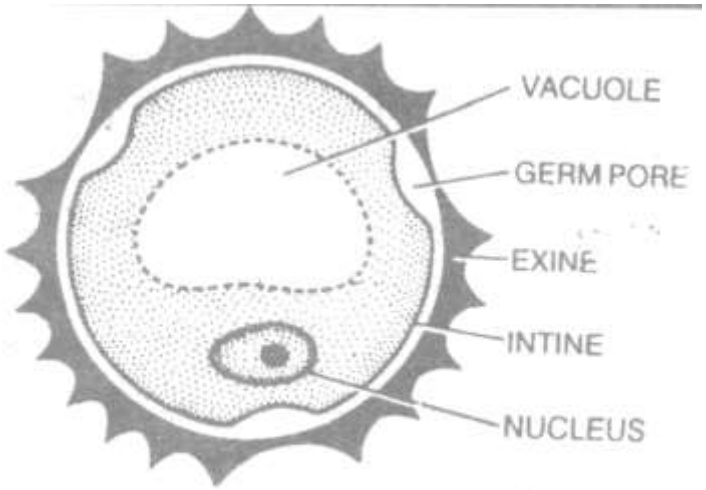
✓Linear tetrad

✓T- shaped tetrad

✓Decussate tetrad

Development of male gametophyte or Microgametogenesis

- Microspore or pollen is the beginning of male gametophyte generation.
- Development of male gametophyte is uniform in all angiosperms.



STRUCTUREOF POLLENGRAINS

➢ Here microspore undergoes only two mitotic division and thus fully developed male gametophyte in angiosperms is very very simple and reduced i.e. Only 3-nucleated structure

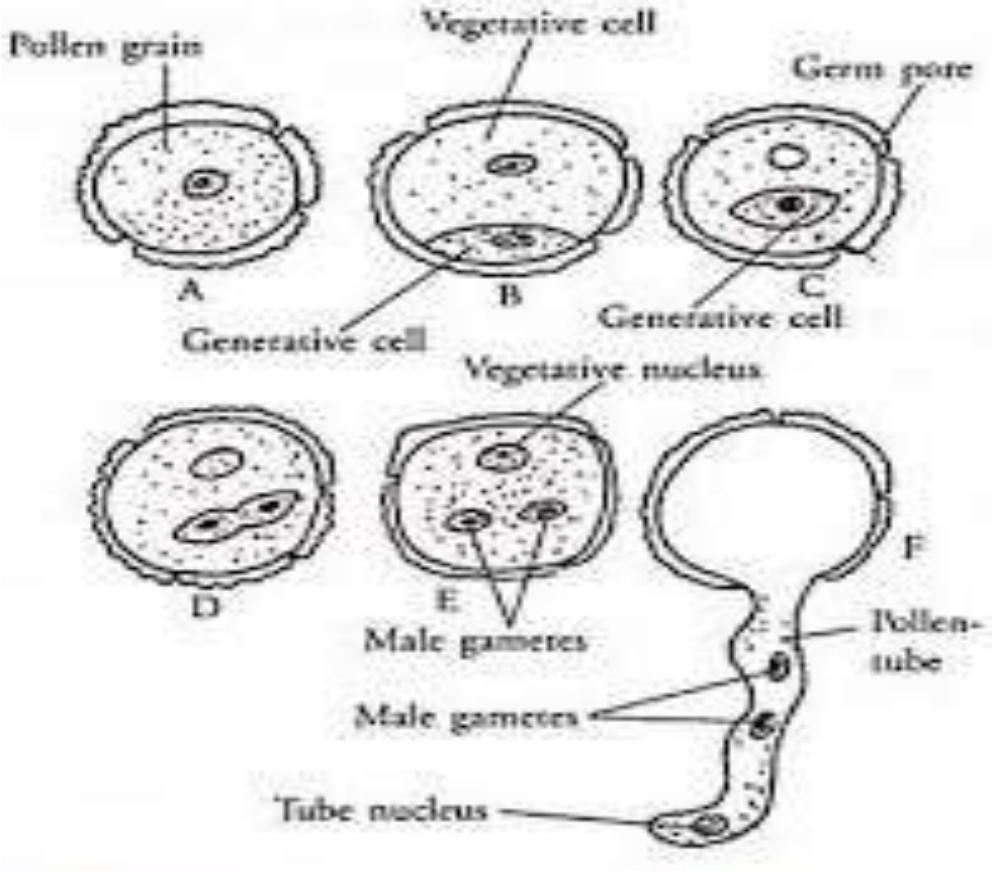


Fig: Stages in Development of male gametophyte

➢ In tropical plants the microspore nucleus divides immediately without any resting period but in temperate plants (colder region plants) there is resting period from few days to several weeks

➢ In the beginning of the process, only nucleus of pollen divided by unequal mitotic division resulting two unequal size of nucleus are formed. Small nucleus present near the wall is called generative nucleus and large nucleus present inside the cytoplasm is called Tube or Vegetative nucleus.

➢ Larger cell in which large nucleus is present known as Vegetative cell and smaller cell in which small nucleus is present, called generative cell.

➢Now pollen grains come in bicelled and binucleated stage. In Angiosperms pollination of pollen grains take place in bicelled and binucleated stage.

➢This stage of pollen grain is called immature or partially developed male gametophyte

- Rest of the further development of pollen grain [Immature male gametophyte] takes place on the stigma of Carpel after pollination. Pollens absorb moisture and sugar content from the stigma. Due to this volume of internal contents of cytoplasm increased. It exerts pressure on the both outer layers. Because of this pressure intine comes out through any one germpore in the form of tube like structure called pollen tube
- Inside the pollen tube, generative cell divides mitotically and to form a two non motile male gametes. Now male gametophyte comes in three celled structure in which one vegetative cell and two male gametes are present. This three celled stage represents the mature male gametophyte of angiosperm

Thank You !!