S.Y.B.Sc. Botany CBCS Pattern

BO 241: Plant Anatomy and Embryology

Credit-II Plant Embryology

Chap – 8 Microsporangium and male gametophyte

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By

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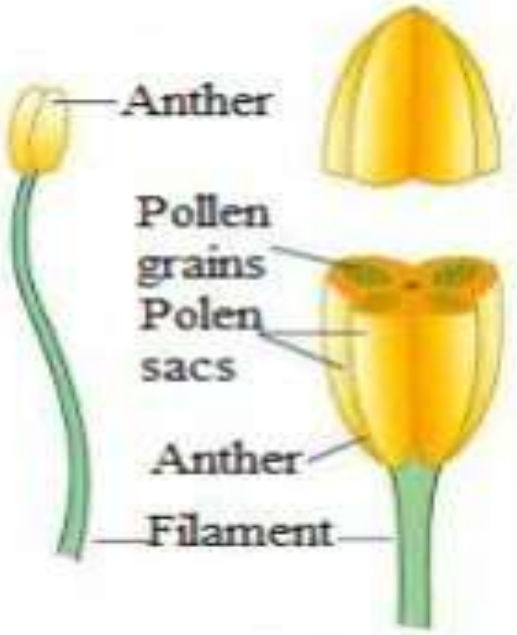
Learning Objects

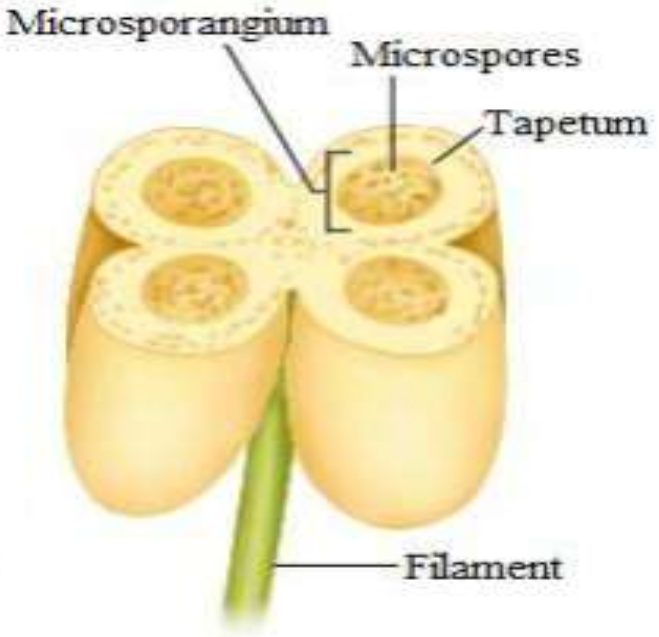
- 8.1 Structure of tetrasporangiate anther
- 8.2 Types of tapetum
- 8.3 Sporogenous tissue
- 8.4 Microsporogenesis: process and its types
- 8.5 Types of microspore tetrad
- 8.6 Male gametophyte: structure and development of male gametophyte

8.1 Structure of tetrasporangiate anther

- **Introduction:**
- During the Angiosperm life cycle, the sporophyte produces two types of spores, microspores and megaspores. These spores give rise to male gametophytes and female gametophyte, respectively. The Angiosperm gametophyte develops within sporophytic tissues that constitute the sexual organs of the flower. The male gametophyte, also referred to as the pollen grain or microgametophyte, develops within the stamen‟s anther and is composed of two sperm cells encased within a vegetative cell
- The male spores or microspores are developed by meiosis within the microsporangium (pollen sac)
- The process of development of the spore is termed as sporogenesis. When it is microspore (pollen), it is termed as microsporogenesis.

- STRUCTURE OF ANTHER
- The fertile portion of stamen is called anther. Actually the stamen is a slender organ and consists of the proximal sterile part, the filament (stalk) bearing at its distal end a fertile part, the anther.
- A typical anther has two anther lobes connected by a connective and each anther lobe has two pollen chambers (microsporangia/pollen sacs). Pollen grains (microspores), which contribute the male gametes, are present in each microsporangium or we can say are formed within an



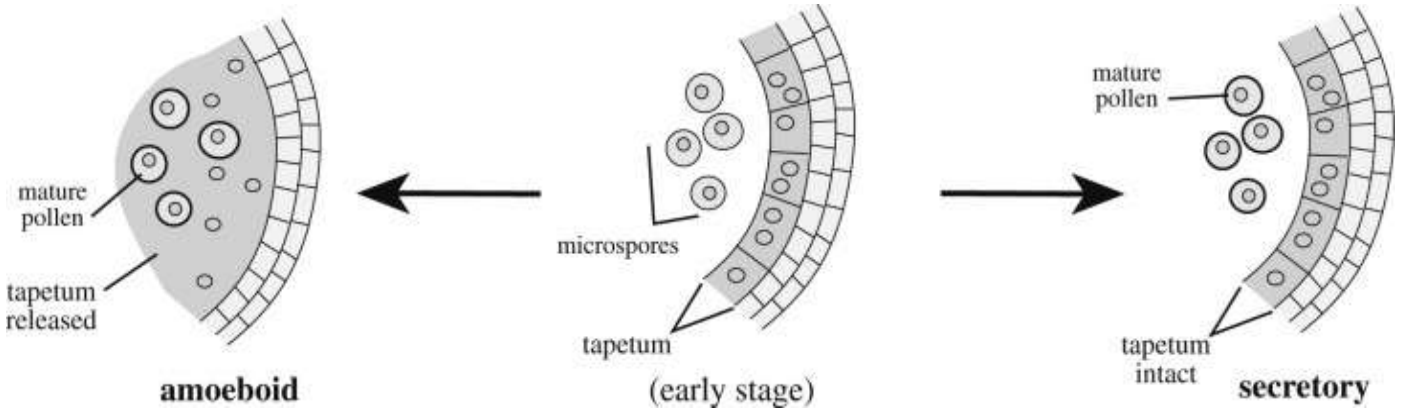


- A typical anther is a bilobed, dithecous structure with two microsporangia in each lobe. Therefore, an anther is a tetrasporangiate structure with four microsporangia.
- The non-sporangial tissue that joins the two anther lobes is known as the connective. A single vascular strand is embedded in the connective.
- In each lobe the two microsporangia are separated by a strip of sterile tissue, the intersporangial septum.
- A microsporangium or future pollen sac is a cylindrical sac which appears circular in transverse section. It consists of two parts, outer wall and central homogeneous mass of sporogenous tissue. Microsporangial wall/Pollen sac wall has four types of layers:
- 1. Epidermis (common anther covering)
- 2. Endothecium
- 3. 2-3 middle layers and

- (i) Epidermis : This is the outermost single layered and protective. In Arceuthobium, cells of epidermis develops a fibrous thickening and the epidermis is designated as exothecium.
- (ii) Endothecium : Inner to epidermis, there is a single layer of radially elongated cells. Cells of endothecium develop fibrous thickening (made up of cellulose with a little pectin and lignin) which help in the dehiscence of anther. In between these cells, a few cells without thickening are also present. These thick walled cells collectively form the stomium.
- (iii) Middle layer : Three to four layers of thin walled cells situated just below the endothecium are known as middle layers. Cells of this layer are ephemeral and degenerate to provide nourishment to growing microspore mother cells.

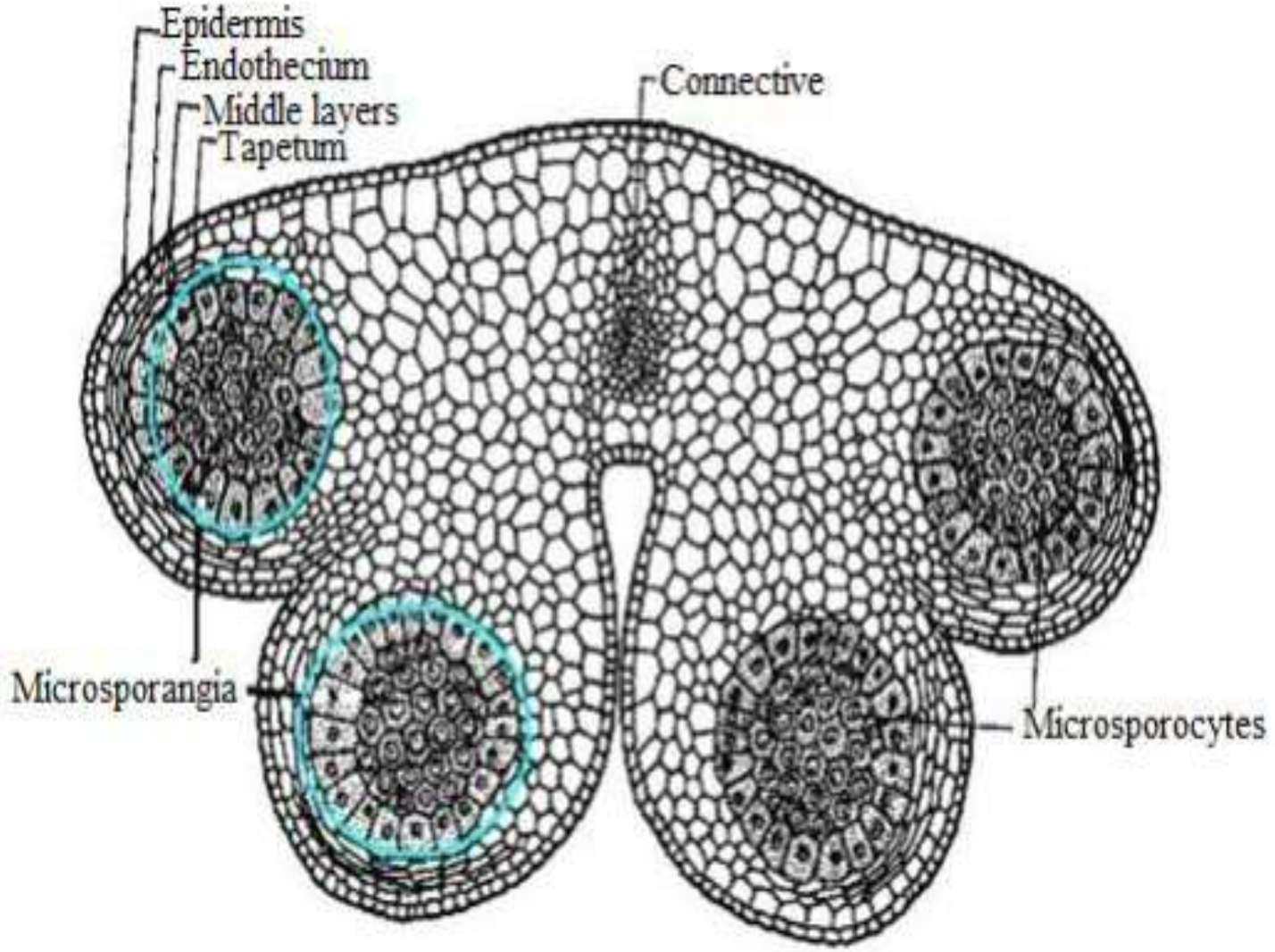
- **Tapetum** is the innermost layer of the anther wall characterized by the presence of dense cytoplasm and prominent nuclei. Tapetum is of considerable physiological significance.It attains its maximum development at the tetrad stage of microsporogenesis. It is a nutritive tissue nourishing the developing microspores, all the food material to the sporogenous tissue must pass through it.
- There are two basic types of tapetum:
- Amoeboid or invasive or periplasmodial or syncytial tapetum
- Secretory or glandular or parietal or non-syncytial tapetum
- **(i) Amoeboid or Invasive or Periplasmodial Tapetum**
- The tapetum is characterized by an early breakdown of the inner and radial wall of its cells.The protoplast masses moves into anther cavity followed by fusion of protoplast to form periplasmodial tapetum.Amoeboid tapetum is common in the monocots Eg. Alisma, Arum, Amoeboid tapetum is also present in most members of the dicot family Asteraceae ,e.g.Tradescantia, Typha, Helianthus.

- **(ii) Secretory or Parietal or Glandular Tapetum**
- Secretory tapetum is common in dicots. The tapetal cells remain in their original position throughout the microspore development.This tapetum is more common among angiosperms.A characteristic feature of the secretory tapetum is the presence of sporopollenin granules/bodies termed orbicules.
- The orbicules are known to transport sporopollenin between the tapetum and the developing pollen exine.

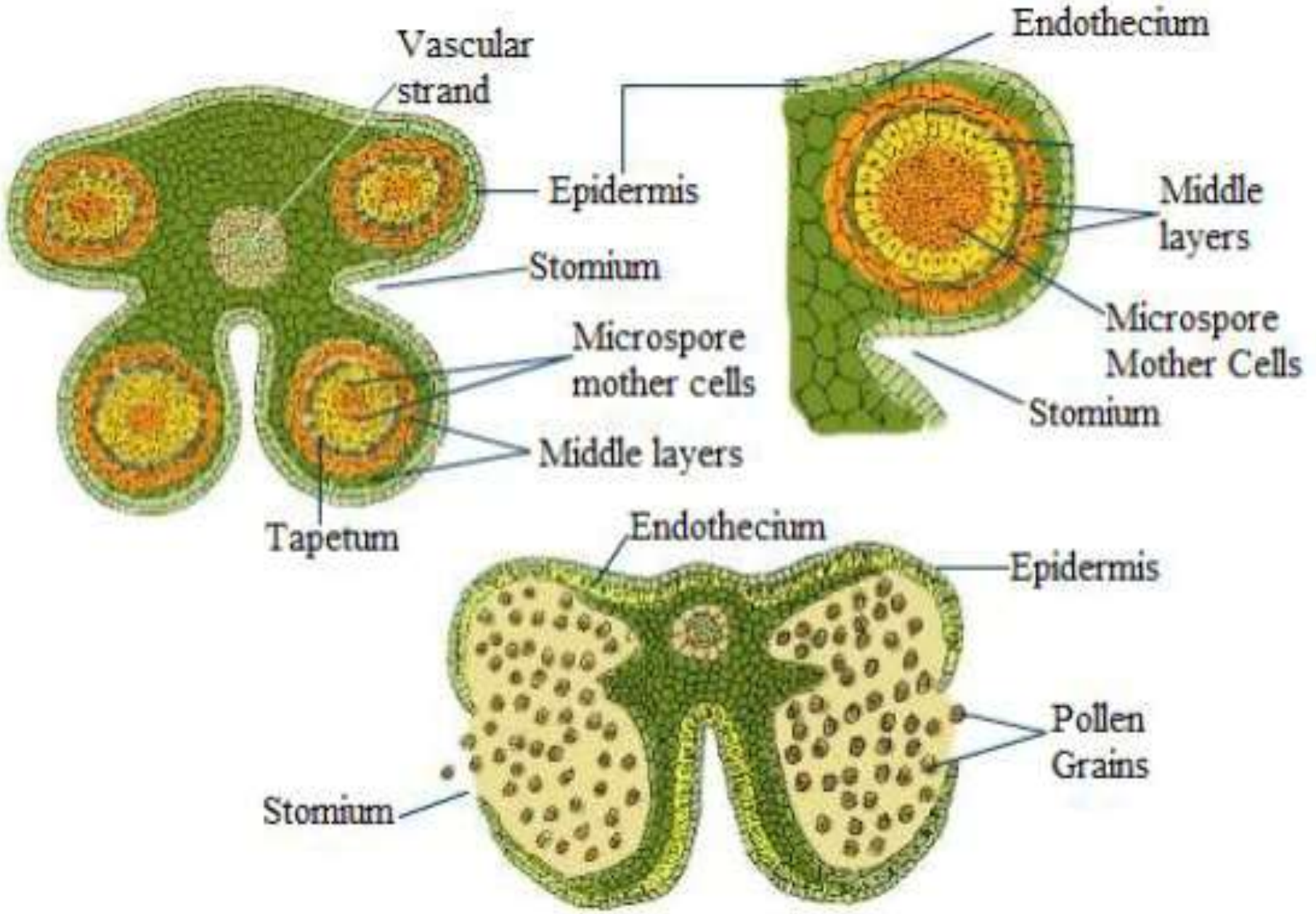


- **Sporogenous tissue**
- The sporogenous cells may directly functions as microspore mother cells (MMCs) or pollen mother cells or they may undergo few mitotic divisions to add up to their number before entering meiosis. Although all the sporogenous cells in the anther are potentially capable of giving rise to microspores, some of them frequently degenerate and absorbed by other cells.
- . In members of Malvaceae anthers are reniform or kidney shaped and consist of two microspoangia (bisporangiate), such anthers is called monothecous.

Transverse section of a tetrasporangiate anther showing various tissues



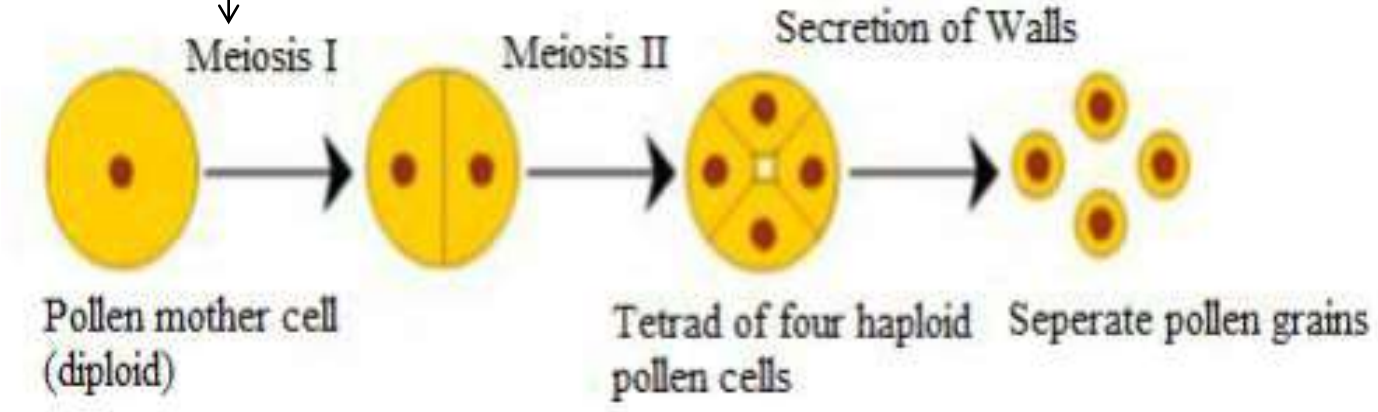
T.S. of tetrasporangiate anther; B. Enlarged view of one microsporangium showing four
wall layers; C.T.S. of a mature dehisced anther

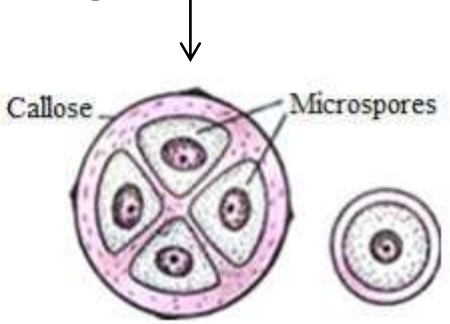


MICROSPOROGENESIS

- The process of development of the microspore (pollen) is termed as **microsporogenesis.** During microsporogenesis the nucleus of each microspore mother cell or pollen mother cell (2n) undergo meiosis or reduction division, giving rise to four haploid (possessing „n‟ number of chromosomes) microspores. At the end of meiosis four haploid microspores are enclosed in a common callose wall. The individual spore lacks a wall of its own and it is a callose partition which separates spores from each other. Aggregates of four microspores are called as microspore tetrads. Later on each spore forms its own wall

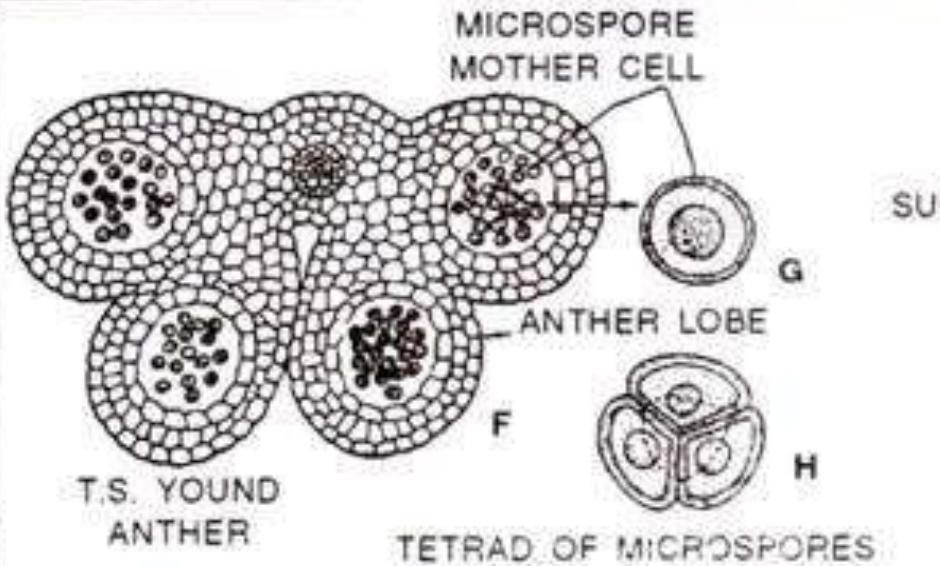
- **Microsporogenesis** **Microspores showing callose wall**





Types of Microsporogenesis

- Microsporogenesis is the process in which each micropore mother cell divides meiotically to form four haploid microspores or pollen grains. The arrangement of pollen grain in a tetrad is affected by cytokinesis during meiosis. It is of following types:
- **Simultaneous type**: In simultaneous type, the cytokinesis occurs only at the end of meiosis II. This results in the production of four cells by cell wall formation between the four nuclei. The resultant tetrad shows tetrahedral arrangement and is common in dicotyledons.
- **Successive type:** In this type, cytokinesis occurs twice – once at the end of meiosis I, forming two cells and then again at the end of meiosis II to form four cells. A dyad stage is thus observed which consists of two cells embedded within the pollen mother cell wall and separated by a callose wall. The resultant tetrad shows isobilateral arrangement and is found in monocotyledons.
- These two types of cytokinesis result in different tetrad morphologies. Tetrads obtained through successive cytokinesis can be tetragonal, decussate, T-shaped, Z-shaped and linear, whereas tetrads resulting from simultaneous cytokinesis can be tetrahedral, rhomboidal, tetragonal and decussate.



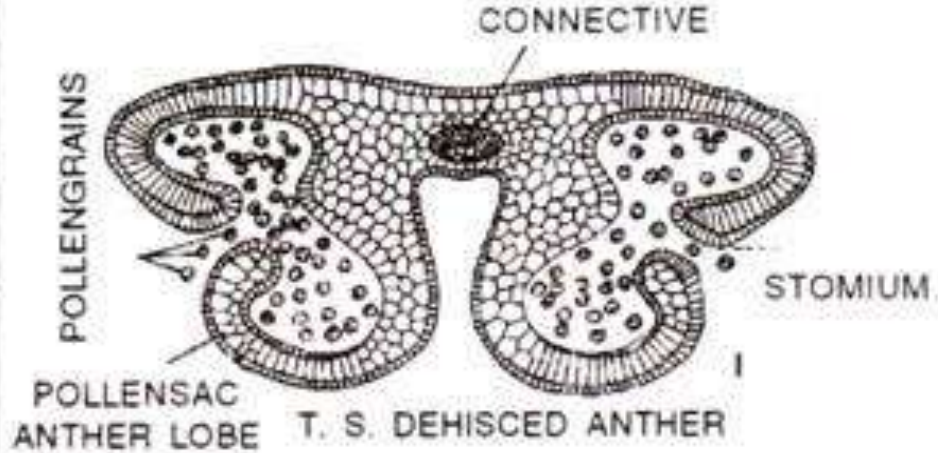


Figure 10.22. Development of pollen-grains (microspores) and dehiscence of anther.

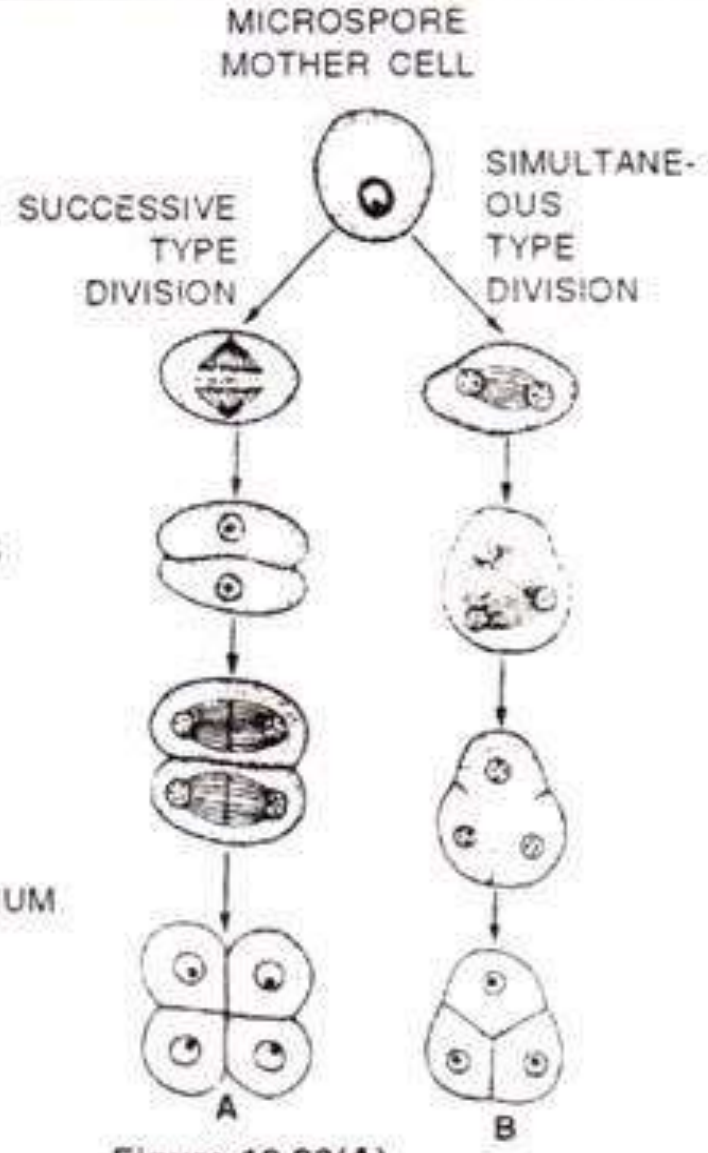


Figure 10.23(A). Microsporogenesis—**A**. Successive type in monocotyledonous plants. **B**. Simultaneous type in dicotyledonous plants.

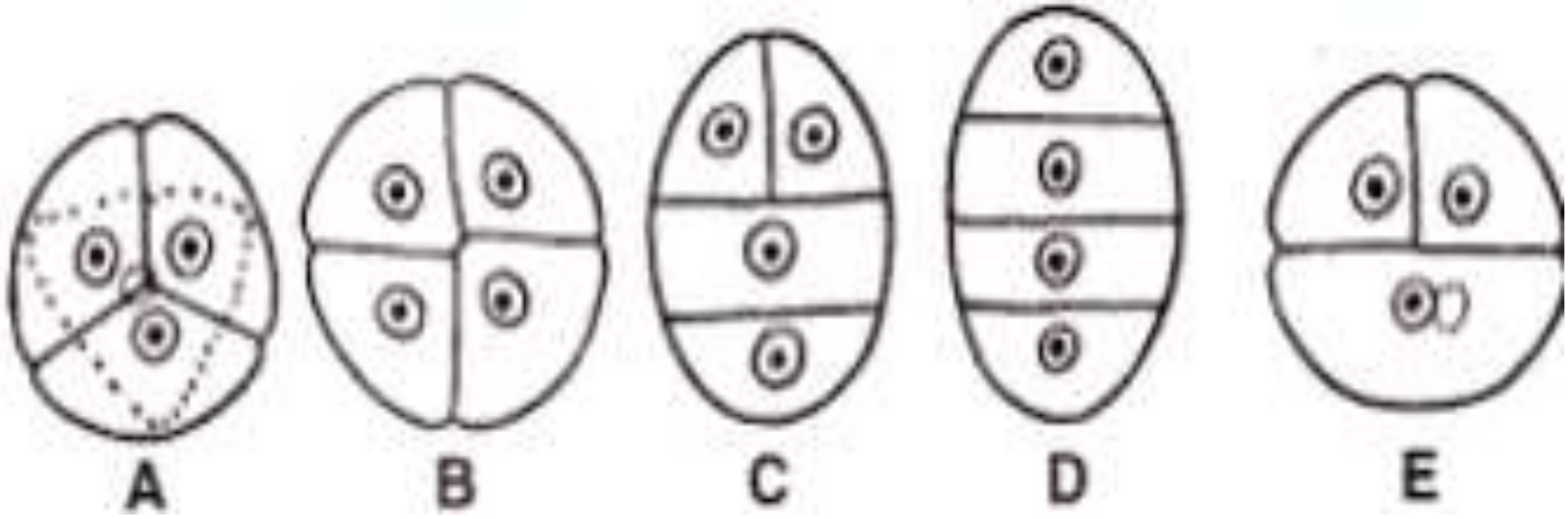
Figure 10.23(B). Different types of microspore tetrads.

Types of Tetrad

- On the basis of arrangement of spores, tetrads are classified into various types. Usually the arrangement of microspores in a tetrad is tetrahedral or isobilateral. However, other arrangements i.e. decussate, linear and T-shaped tetrads are also found.
- **Tetrahedral:** This type of tetrad is very common among dicots. The four microspores are arranged like a quadrant of a sphere so when see from an angle, only three microspores are visible and fourth lies at the back.
- **Isobilateral:** This type of tetrad is very common among monocots. The four microspores are arranged at four corners of a square in one plane.
- **T-shaped:** Out of the four microspores, two lies perpendicular to the others, so that the tetrad has the shape of “T”. Example: as in Aristolochia and Butomopsis .

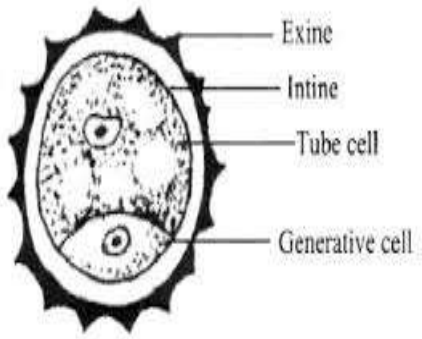
- Linear: The four microspores aligned linearly as a result of transverse division in mother cell. Example: In some genera of the Asclepiadaceae and in the genus Halophila of the Hydrocharitaceae . Atriplex and many other plants.
- **Decussate**: A decussate arrangement of the cells has been recorded in Magnolia (Farr, 1918),

- **In Aristolochia elegans all the five types of tetrad have been reported.**
- **Fig.: Arrangement of microspores/pollen grains, A. Tetrahedral; B.**



Male gametophyte: Structure

- Microspore or the pollen grains is the first cell of male gametophyte. It is unicellular and haploid and its shape varies from oval to polyhedral. Inside each anther, there are several thousands of pollen grains.
- The wall or covering of pollen grain is called sporoderm. It is made of two layers. The outer layer is called exine. It is thick and ornamented. The exine is made of fatty substance called sporopollenin. It is biologically the most resistant substance and can withstand high temperature and strong acids and alkali.
- In insect pollinated flowers, the exine of the pollen grain is covered with a yellowish viscous and sticky substance called **pollenkitt**. This is a protective envelop which sticks to the body of the insect and helps in pollination
- The inner layer, called intine, is thin and uniform. It is made of pecto-cellulose. At the time of pollen germination, intine comes



Pollen grain (Sectional view)

Development of male gametophyte (Pollen grain)

- In the process of formation of male gametophyte from a pollen grain or microspore, the nucleus of a pollen grain divides **mitotically** to form a vegetative nucleus (tube nucleus) and a generative nucleus.
- The generative nucleus gets surrounded by cytoplasm to become generative cell. At this stage, pollen grain is two celled – a large vegetative cell and a small lenticular generative cell. The pollen grain may be discharged from the anther at this stage (two-celled stage). However, in some plants, generative cell divides further to give rise to two male gametes before the pollen grains are shed. These pollen grains are thus, three-celled at the time of shedding.
- The liberated pollen grain germinates on the stigma and produces a pollen tube. The pollen tube is covered by intine. It secretes pectinases and other hydrolytic enzymes to create a passage for it in the style. The pollen tube absorbs nourishment from the cells of the style for its growth. The tube nucleus descends to the tip of the pollen tube. The generative cell also passes into it and divides inside the pollen tube to form two male gametes.

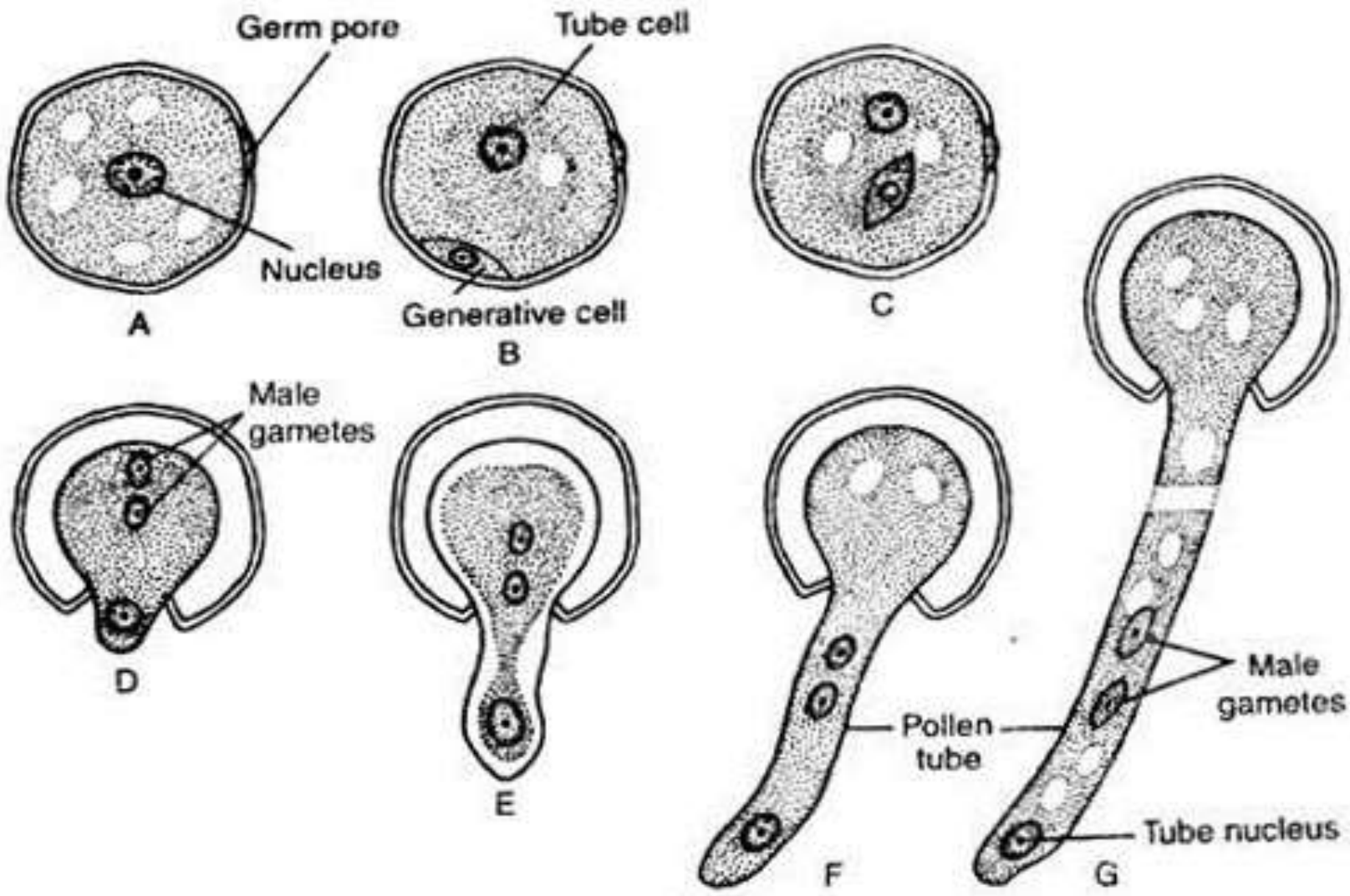
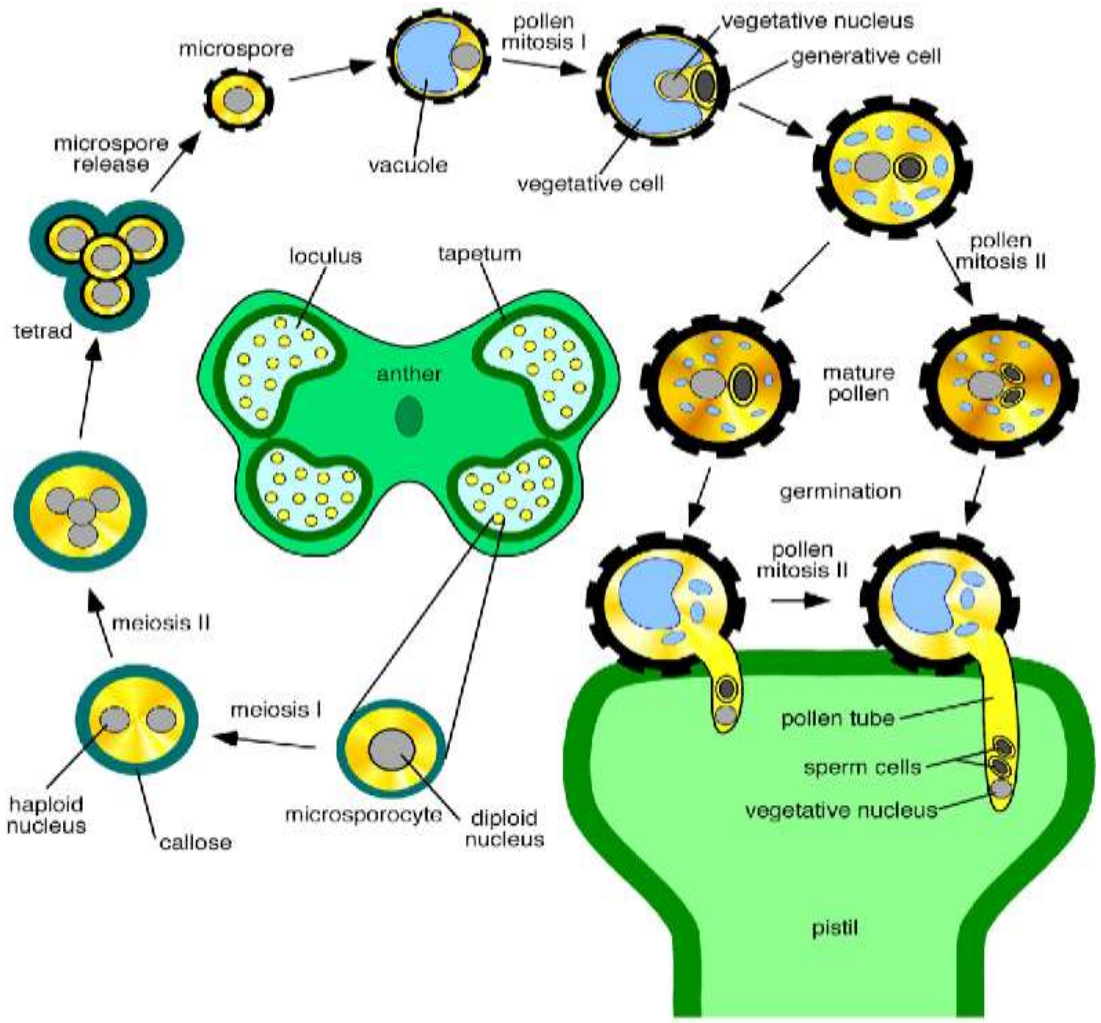


Fig. 3.5 : A-G. Germination of the pollen grain and development of the male gametes

Schematic diagram illustrating pollen development.



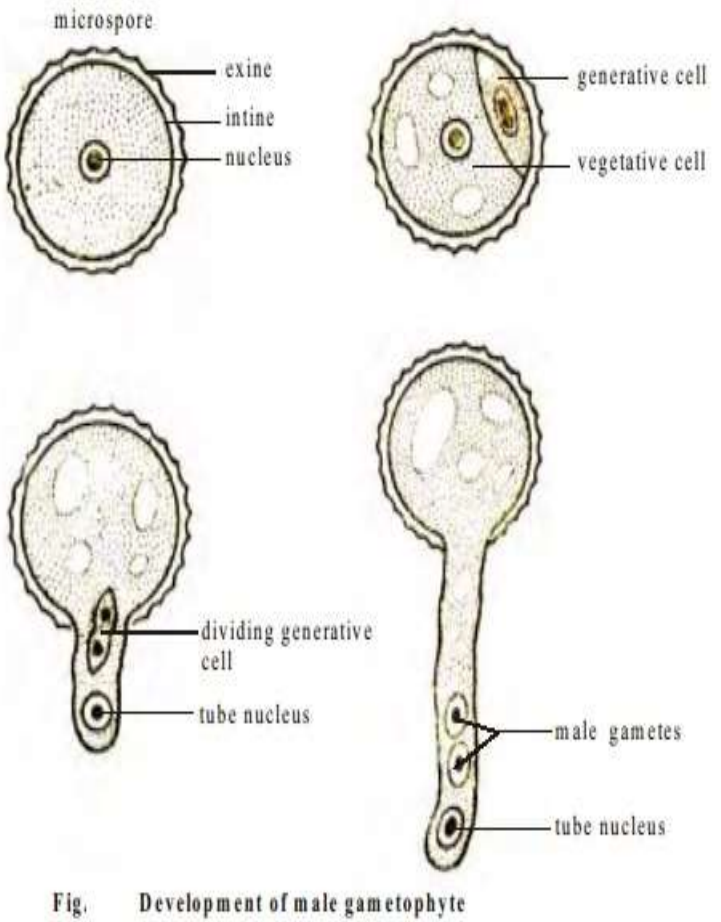


Fig. Development of male gametophyte

Reference

- https://www.shivajicollege.ac.in/sPanel/uploads/econtent/fb9eab7dd7141815e1aa03335a19f941.pdf
- https://surprisetest.com/e/neet-reproduction-6_Types_Or_Tapetum
- https://studyadda.com/current-affairs/neet/microsporogenesis/17580
- https://qforquestions.com/describe-process-microsporogenesis-angiosperms/