S.Y.B.sc Botany CBCS Pattern

SEM IV,PAPER I (2020-2021)

BO241 PLANT ANATOMY & EMBRYOLOGY 2 CREDITS

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Credit II Plant Embryology
Chapter 7 Microsporangium & Male Gametophyte.

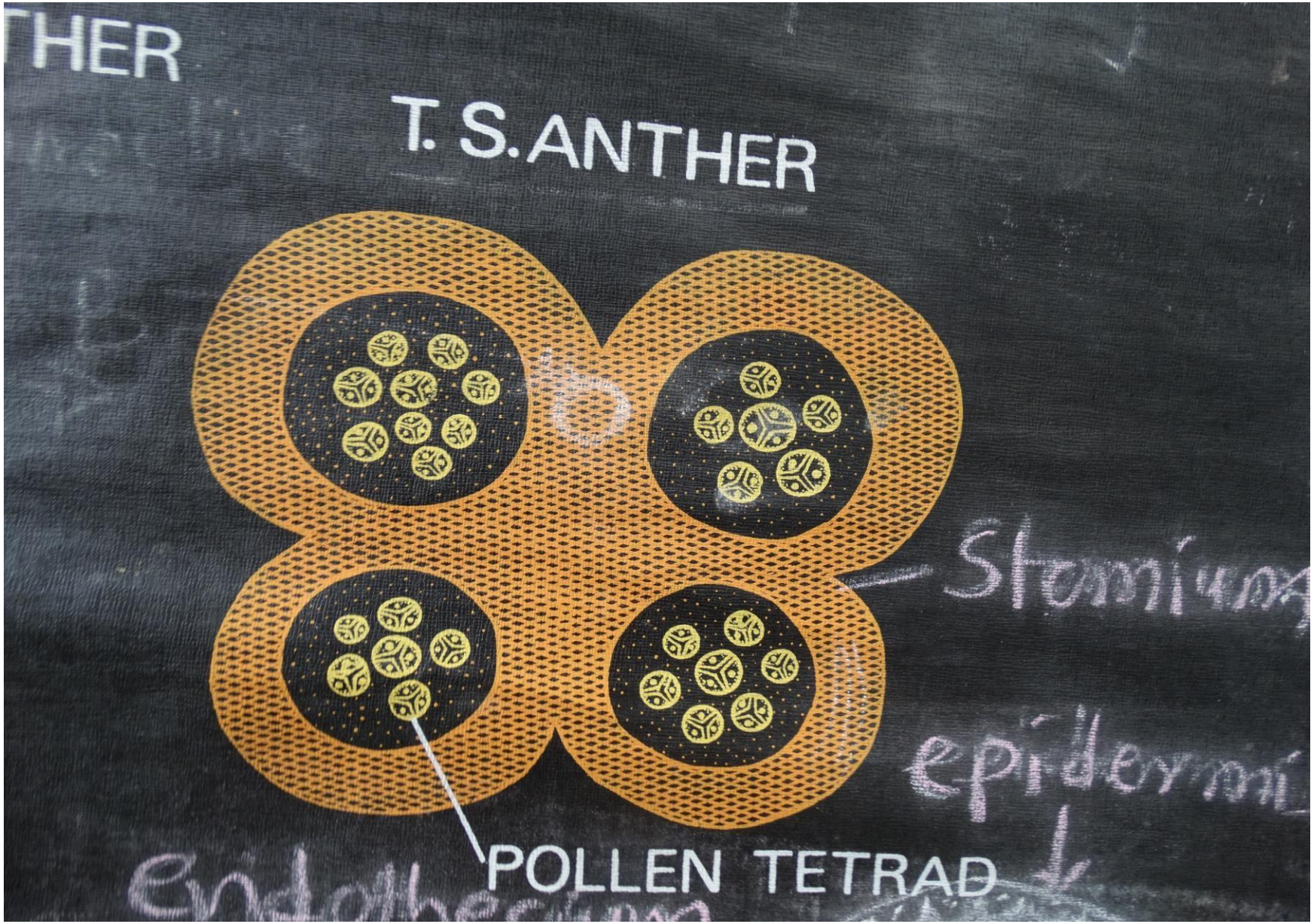
A stamen are also called as microsporophyll is an essential whorl of a flower, which produces the pollengrains / microspores in their microsporangia.

A stamen consist basal / proximal long or short stalk called filament and upper / distal part called anther lobes.

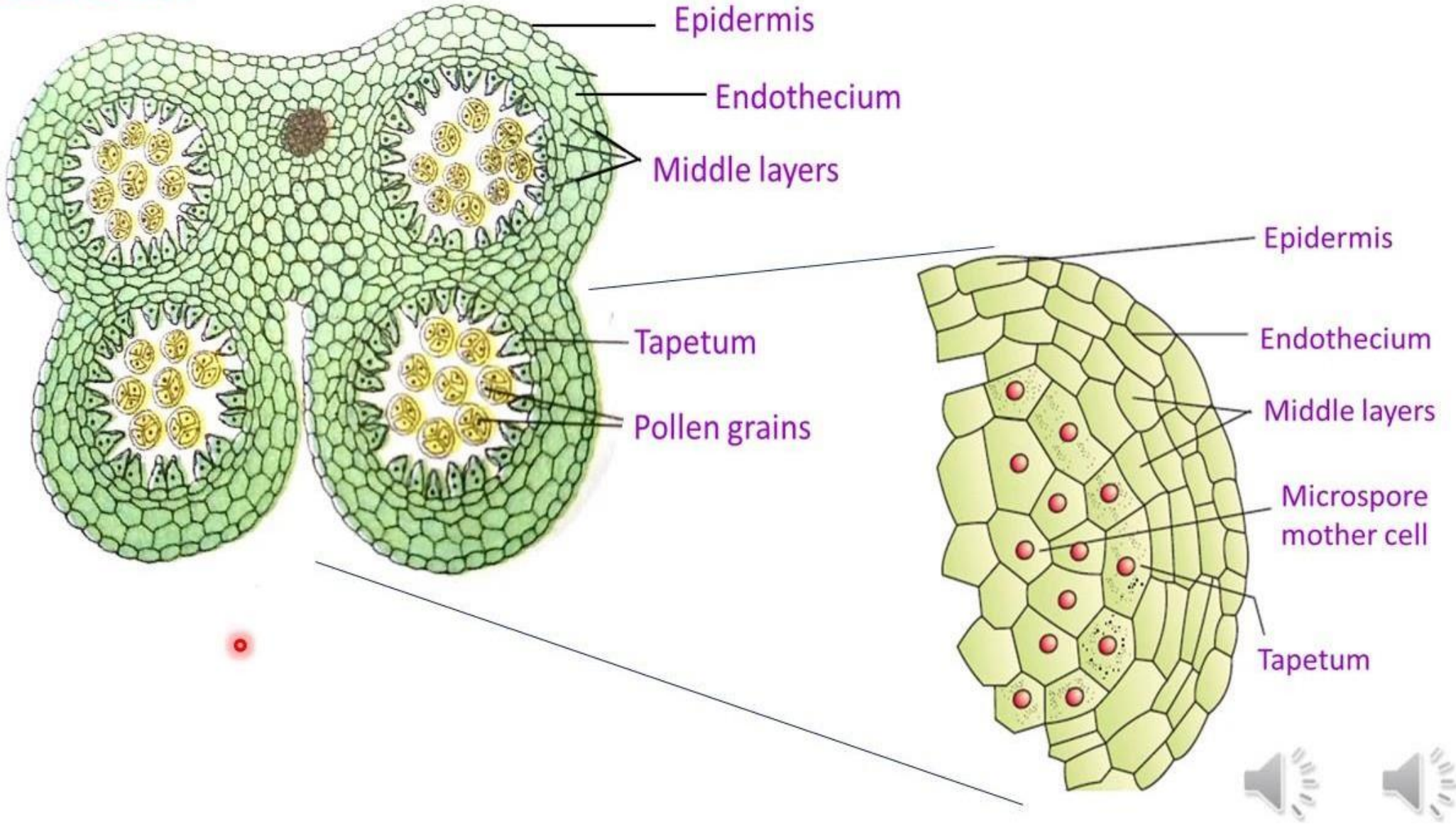
Anther lobes are joined by a strip of sterile tissue called connective. It posseses a vascular strand.

Each anther lobe has two elongated chambers / pollen sacs/ microsprangia.

Thus, in all there are 4 microsporangia. As a result of meiosis, in microspore mother cells, large no. of microspores are produce inside the microsporangia.


THER
T. S. ANTHER
POLLEN TETRAD

T. S. of anther


Epidermis
Endothecium
Middle layers
Tapetum
Pollen grains
Epidermis
Endothecium
Middle layers
Microspore mother cell
Tapetum


tuca
Salvia

Structure of tetra sporangiate anther: (4 lobed)

T.S. of mature anther consists of outermost layer, epidermis followed by a layer of endothecium (hypodermis), 2 to 3 middle layers and tapetum.

1.Epidermis: Outermost, cells are greatly stretched and flattened. Function- Protection.

2.Endothecium: Found just below the epidermis. Cells are radially elongated. Function- protection and retension of anther in proper condition. It provides mechanical strength to the lobes. It ruptures during dehiscence of the lobes.

3.Middle layers: They are ephemeral and become flattened and get crushed before meiosis in pollen mother cells.

4.Tapetum: Innermost layer of antherwall, made up of single layer of cells consisting dense cytoplasm and distinct nuclei. It completely surrounds the sporogenous tissue and is of considerable physiological significance. Tapetum is a nutritive tissue. At maturity, the tapetal cells get disorganized to form a nourishing fluid.

Based on this behavior i.e. the manner of nourishing the sporogenous tissue, the tapetum is of two types-

Amoeboid tapetum:

(Invasive / Periplasmodium)-

Walls of tapetal cells breakdown. It remain intact and wonder inside the locules. Protoplast of many cells unite to form a continuous mass, called periplasmodium.

It closely invests the pollen mother cells. The movement of protoplast into the locule may take place during meiotic prophase / tetrad stage.

E.g. *Tradescantia, Typha.*

Secretory tapetum:

Tapetal cells undergo marked changes as M.M.C. undergo divisions. When meiosis ends, tapetal cells start loosing contact with each other. In cytoplasm, a large no. of vacuoles appears and nuclei starts showing signs of degeneration. Finally, they get absorbed, when microspores begin to separate from each other.

This type of tapetum, in which cells remain' in situ' at their original position is called ' glandular / secretary tapetum. E.g. *Hibiscus, Ocimum, Mirabelis.*

2. Sporogenous tissue:

Is present in the locules of the anther and surrounded by tapetal tissue. It posses P.M.C. / M.M.C. Each divides by meiotic division and produces aggregate of 4 pollen grains / microspores called pollen tetrads.

Stages : P.M.C undergo meiosis I and II. Meiosis I is a reduction division where diploid parent nucleus divides into two haploid nuclei.

Meiosis II is a normal mitosis, where each haploid (n) nucleus divides into haploid nuclei. Hence, single 2n parent nucleus get divides into 4 haploid nuclei.

So, Meiosis I includes- Prophase (Leptotene, zygotene, pachytene, diplotene, dikinesis. Meiosis II consists meta-I, ana-I, telo-I, pro-II, meta-II, ana-II telo-II followed by cytokinesis.

Cytokinesis- Is a process of formation of partition walls between 4 haploid microspores to form microspore tetrads.

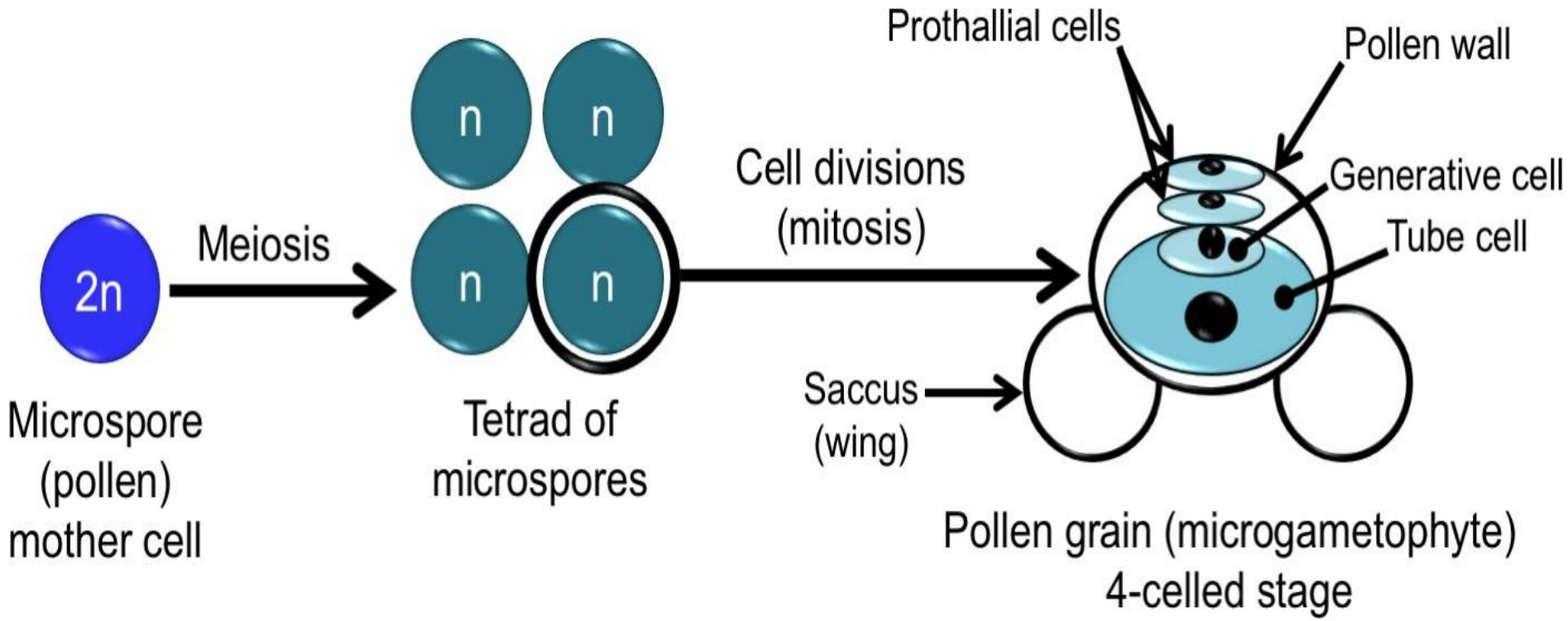
Wall formation is of two types.

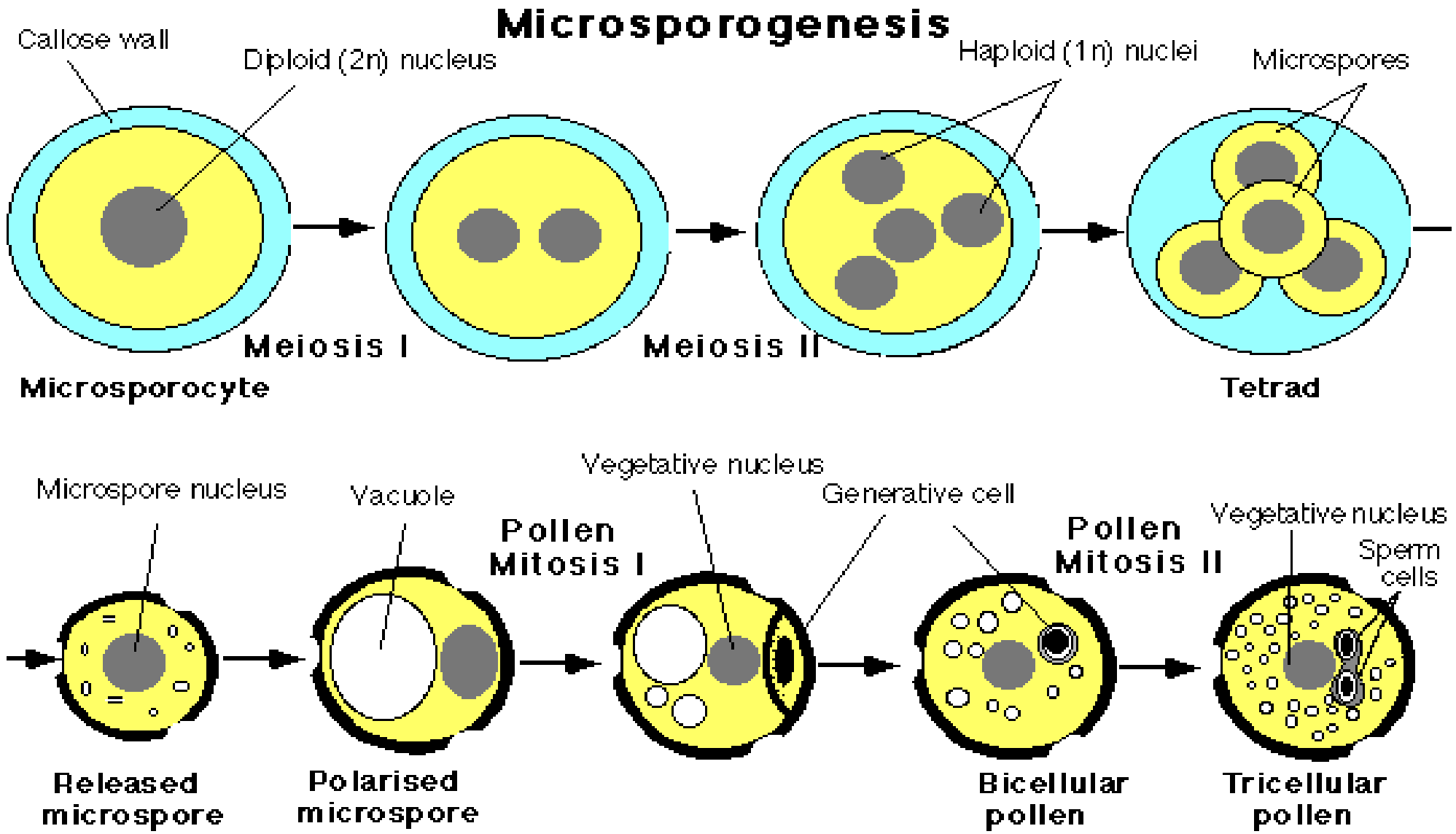
1. Successive- Occur in monocots called isobilateral tetrads.
2. Simultaneous- Occur in dicots called isobilateral and other types.

Types of microspore tetrads-

1. Tetrahedral tetrads: MMC divides into 4 microspores by simultaneously formed cellwalls into two vertical planes right angles to each other.

Microsporogenesis:





2.Isobilateral tetrad: First wall formation is vertical and second transverse.

3.Linear tetrad : First division is transverse, each daughter cell further divides by transverse division in same plane so that all 4 microspores remain arranged in single row.

4.‘T’ shaped tetrad :MMC divides by a transverse division to form upper and lower cell. Upper cell divides vertically and lower by transverse division. Thus, 4 microspores get arranged in ‘T’ shaped tetrad.

5.Decussate tetrad: Nucleus of mmc divides twice and produces 4 haploid nuclei, which lie in 4 directions.

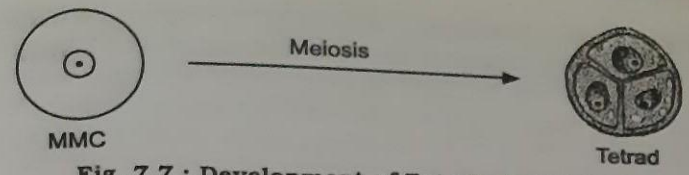


Fig. 7.7 : Development of Tetrahedral Tetrad

ii) Isobilateral Tetrad : Here spherical microspore mother cell divides by two cell walls formed successively during which plane of first cell wall formation is vertical while plane of second cell wall formation is transverse. Thus, microspore tetrad possesses upper two microspores and lower two microspores. (Fig. 7.8)

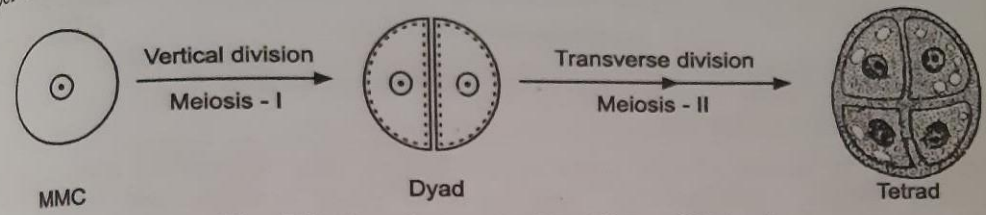


Fig. 7.8 : Development of Isobilateral Tetrad

iii) Linear Tetrad : In this case, microspore mother cell divides by transverse division to form two daughter cells. Each daughter cell further divides by transverse division in same plane, so that four microspores remain arranged in a single row. (Fig. 7.9)

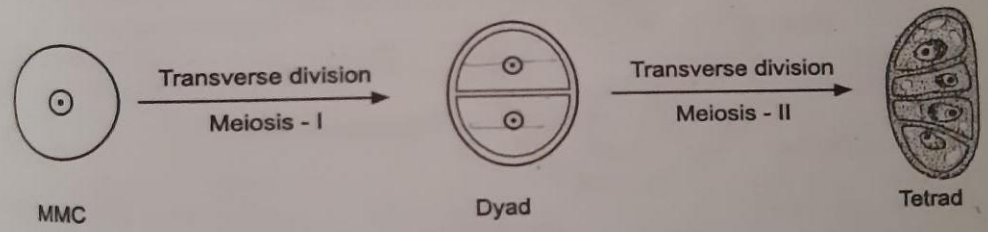


Fig. 7.9 : Development of Linear Tetrad

iv) T. Shape Tetrad : In this case, microspore mother cell firstly divides by a transverse division to form upper cell and lower cell. Further lower daughter cell divides by transverse division and upper daughter cell divides by vertical division thus four microspores get arranged in T-shape tetrad. (Fig. 7.10)

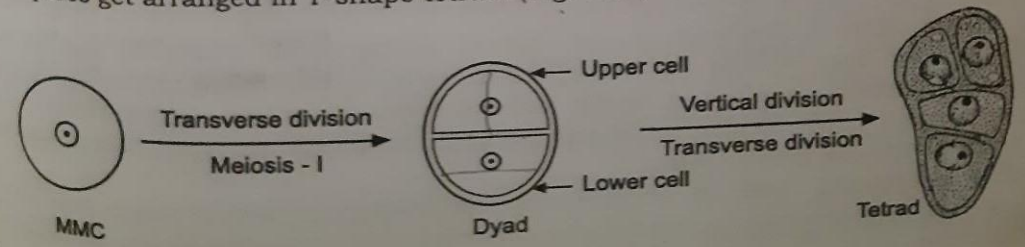
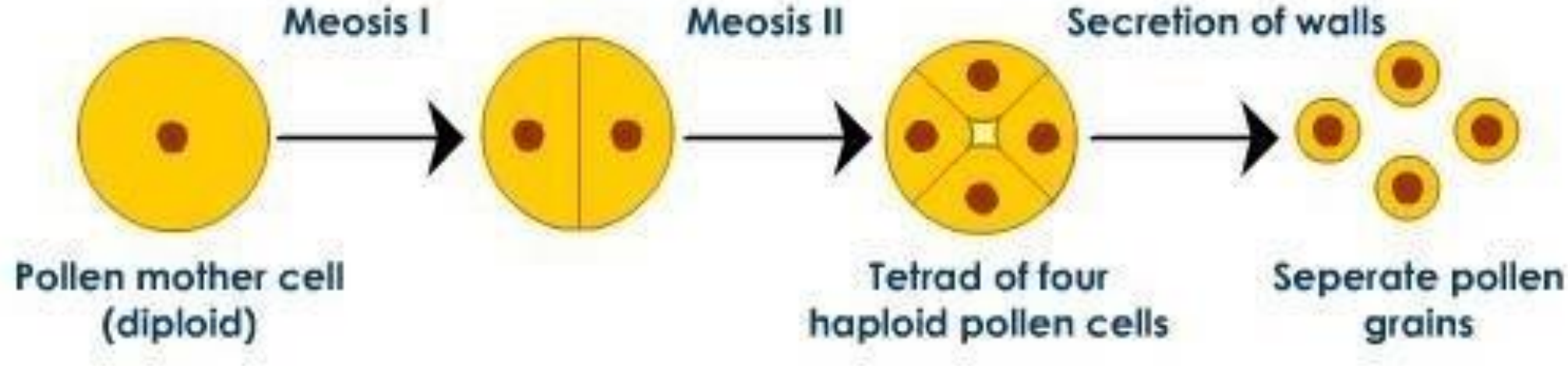
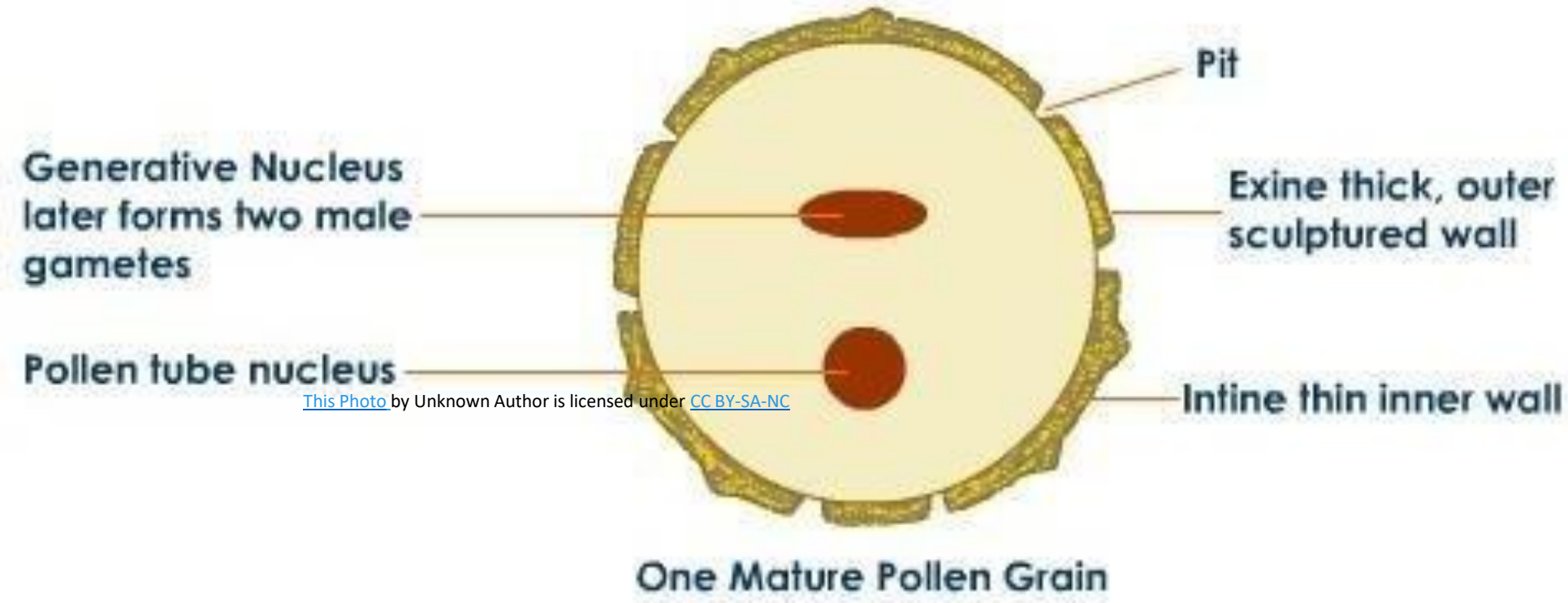


Fig. 7.10 : Development of T-shape Tetrad





Microsporangium: Fertilization:

It is union of male and female gamete. For the act of fertilization, pollen i.e. male gametophyte should come in contact with carpel. (part consist an ovum inside the embryo sac) it is achieved due to pollination.

Pollination: Is a mechanism of the deposition of pollen from anther to stigma of same flower or another flower of the same species.

Two methods of pollination are-

1. Self pollination-

a. Autogamy- Same flower

b. Geitnogamy- Different flowers of same plant.

2.Cross pollination / Allogamy / Xenogamy- Flowers of different plants of same species.

Hybridization / Induced (Artificial)- When pollination take place between two flowers borne on two different plants of allied species / genera.

Cross pollination requires external agents, which are of two types

1. Biotic / Animate i.e. Zoophily: Animal mediated
a. Entomophily- Pollination by insects
b. Ornithophily- birds
c. Cheiropterophily- bats
d. Malacophily- snails
2. Abiotic / Inanimate (agents, other than animals)
a. Anemophily- by wind
b. Hydrophily- by water

- In angiosperms, a special landing place for visiting pollen grains is present called stigma. When pollen grains are discharged from anthers they shows considerable resistance to the environmental conditions up to fertilization.
- Definition: The process by which there is fusion of male and female gametes is called sexual reproduction/ fertilization. It results in the formation of an embryo, in most of the plants. However, in angiosperms, double fertilization takes place for the development of endosperm.

Germination of pollen grains:

- Pollen grains usually germinate on the stigma of same species. In case of foreign pollen grains stigma produce poisonous substance or may become dry. The time required for the germination of pollen grains varies from plant to plant.
- *Sorghum vulgare* and Zea mays = 5 min., *Saccharum officinarum* within a minute, *Beta vulgaris* = 2 hours, *Carrya elliptica* = 2 days
- Pollen germination results in the formation of pollen tube. It is produced from intine and comes out through germ pore. Most of the pollen grains are monosiphonous (siphon =tube), however pollens of Malvaceae and Cucurbitaceae are poisonous. Sometimes some pollen tubes shows ramifications (branching) e.g. *Acacia*

Growth of pollen tube:

- After the tube has emerged from the pollen grains, it goes downward towards the ovary and ovules. The length of the pollen tube depends upon the length of style. It is very short, if the stigma is sessile, while it is very long, if style is very long.
- In Zea mays, about 50 cm pollen tube is recorded and it is called as ‘silk’

- On the basis of presence and absence of ‘transmitting tissue”Hanf’ classified stles into 3 types:
- 1. Open style: Where there is wide styler canal and inner epidermis helps in the nutrition and conduction of pollen tube. E.g. Family Papaveraceae
- 2. Half- closed style: In this type, canal is surrounded by rudimentary transmitting tissue. It is about 2 to 3 layered and made up of glandular cell. E.g. Cactaceae
- 3. Closed style: In this case, open channel is absent instead of which a solid core of elongated cells rich in protoplast is present. E.g. *Datura*

Rate of growth of pollen tube:

- Is usually affected by a. Environmental factors b. Compatibility
- a. Environmental factors: Temperature plays vital role.

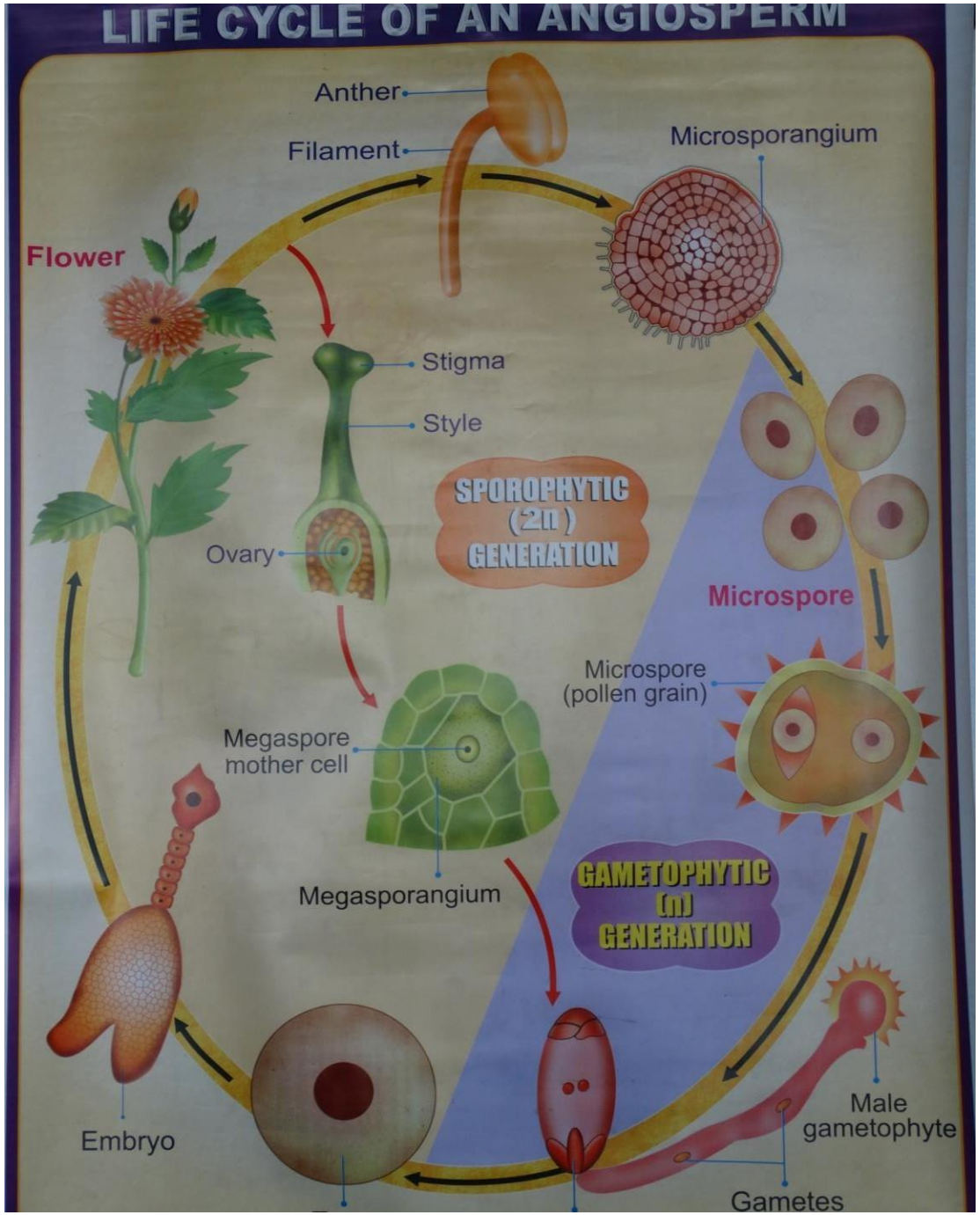
  In crocus, in warm moist air and bright sunshine the pollen tubes can be seen in micropyle within 24 hours. But in dry and cool weather, they take twice or thrice this time. In tomato plant, the max. growth of pollen tube occurs at 21 ^{0}C, and gradually gets reduced at higher and lower temp.

- b. Compatibility: In compatible species rate is rapid.
- Entry of pollen tube and discharge of pollen tube content:

Pollen tube enter inside the ovule by 3 different methods.

- 1. Porogamy: When pollen tube enters in ovule directly enters through micropyle. E.g. Most of angiosperms.
- 2. Chalazogamy: When pollen tube enters in ovule through chalazal end E.g. *Casurina*
- 3. Mesogamy: When pollen tube enters in ovule directlyenters through funiculus or integuents. E.g. Cucurbita

- Finally pollen tube enters inside the ovule near egg apparatus. The tip of pollen tube bursts and 2 sperms get released inside the embryo sac.


LIFE CYCLE OF AN ANGIOSPERM
Anther
Filament
Microsporangium
Flower
Stigma
Style
SPOROPHYTIC (2n) GENERATION
Ovary
Microspore
Microspore (pollen grain)
Megaspore mother cell
Megasporangium
GAMETOPHYTIC (n) GENERATION
Male gametophyte
Embryo
Gametes