CHAPTER-2

SEXUAL REPRODUCTION IN FLOWERING PLANTS

Let's start our chapter with Flower.

Question in mind- What is Flower?
Answer-The sexual reproductive part of angiosperms plants is called flower. It develops after the completion of vegetative phase.

Question in mind- What are the parts of flower?
Answer-Parts of flower are-

- In a flower, four different sets of floral members are attached to a central axis called **thalamus.**
- The outermost and the first accessory whorls (cluster) are of sepals and is called **calyx.**
- The second accessory whorls of petals is called **corolla**.
- Next to the corolla, is the male reproductive whorl of stamens called **androecium.**

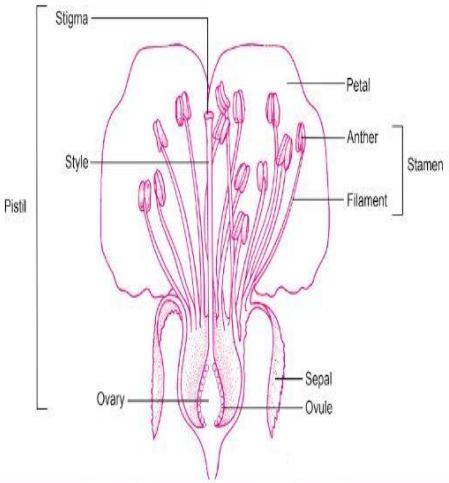


Fig. 2.1 A diagrammatic representation of L.S. of a flower

- The female reproductive whorl is of carpels and is called **gynoecium or pistil**.

Question in mind- What are the functions of floral members?
Answer-Functions of Floral members are-
CALYX-Its main function is to product the flower in bud condition. It is smaller than the petals in size. When green, it is photosynthetic in nature. When coloured, it attractes insects for pollination.
COROLLA-It provides color and scent to attract pollinators. Sometimes the base of corolla bears some secretory glands and secretes nector. They also provide protection to the plant.
ANDROECIUM- Its main function is the production of microspores that are pollen grains containing male gametes with in the anther lobe.
GYNOECIUM-The function of gynoecium is the production of megaspores, fruits and seeds.

Now let's discuss the MALE REPRODUCTIVE UNIT of flower

Question in mind- What is male reproductive unit of flower?
Answer-Stamen is the male reproductive unit and consists of the following two parts:

I. A long and slender stalk (stem like structure) called **filament** which may be joined or free.
II. A bilobed terminal structure called **anther**.

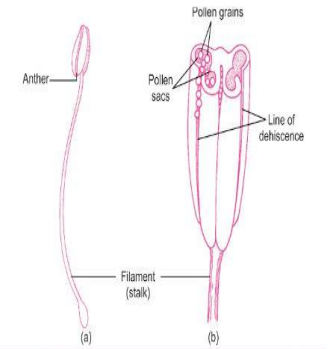


Fig. 2.2 (a) A typical stamen; (b) Transverse section of an anther

Question in mind-What is structure of anther?
Answer-It is composed of two anther sacs or lobes separated by a tissue called **connective tissue.** The anther is bilobed and each lobe or sac consists of two theca separated by a septum.

The anther is tetragonal (four sided) structure, consisting of **microsporangia** (plural of microsporanngium), two in each of the lobes. Microsporangia develop further and get transformed into pollen sacs.

Now let's discuss about MICROSPORANGIUM.

Question in mind- What is Structure of Microsporangium?
Answer-A typical microsporangium appears circular and is surrounded by four walls.

1. **Epiderms:-**It is the outermost single layer of cell which is protective in nature.
2. **Enothecium:-**It is the second with thick cells, help in dehiscence (brusting) and is protective in nature.
3. **Middle layer:-**It is third layer composed of 1-3 layers of cells, helps dehiscence and is protective in nature.
4. **Taptetum:-**It is the fourth and innermost layer of cell with dense cytoplasm and many nuclei. It provides nourishment to the developing pollen grains.
5. The centre of each microsporangium is filled with closely arranged similar cells called **sporogenous cells.**.

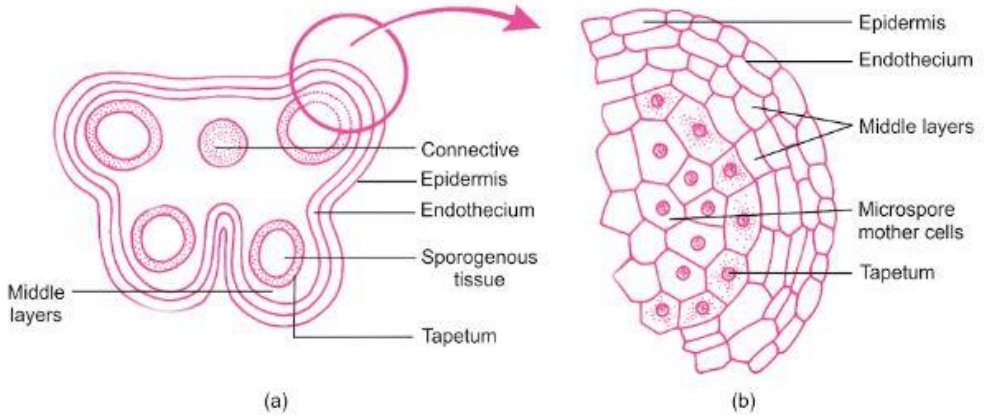


Fig. 2.3 (a) Transverse section of a young anther;
(b) Enlarged view of one microsporangium showing wall layers

We have studied about the male reproductive unit of flower; now let's discuss the formation of gamates from it, so our next topic is MICROSPORONGENESIS

Question in mind-What is Microsporogenesis?
Answer-The process of formation of microspore from a pollen mother cell by meiosis is called microsporongenesis.

Question in mind- How microsporogeneis occur?
Answer-Each cell of the sporogenous tissue in a microsporangium act as a pollen mother cell (PMC) or microspore mother cell. PMC undergoes meiotic division to form cluster of four cells called microspore tetrad. On maturity the anther dehydrates and the microspores separate from each other to form **pollen grains.**

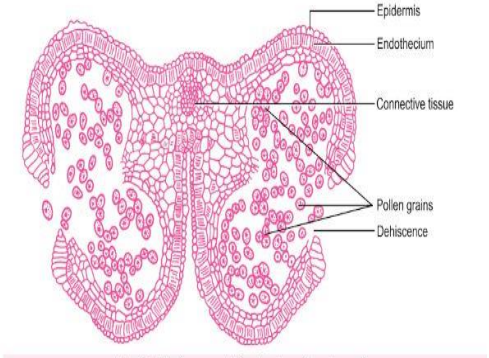


Fig. 2.4 T.S. of mature dehisced anther with pollen grains

Now let's discuss about Pollen Grains.

Question in mind- What is Pollen grain and how it is formed?
Answer-- They devlop from PMC by meiotic division. They represent the male gametophyte.

Question in mind-What is structure of Pollen grain?
Answer-Pollen grains are generally spherical in structure. They posses two prominent layers walls- outer **exine** and inner is **intine.**

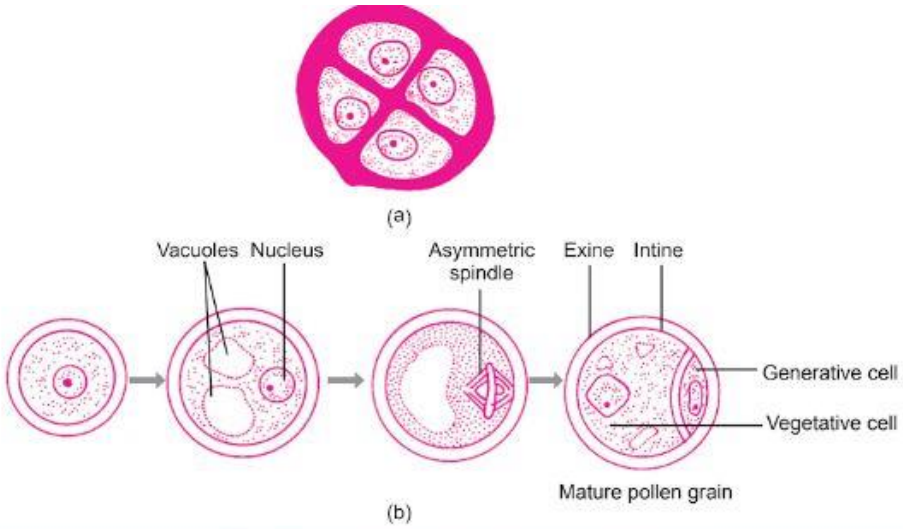


Fig. 2.5 (a) Enlarged view of a pollen grain tetrad; (b) Stages of a microspore maturing into a pollen grain

Question in mind-From which material these layers are formed?
Answer-The exine is a hard layer made of **sporopollenin** which is one of the most resistant organic materials present in nature.The inner thin layer of intine is made up of **cellulose and pectin**. The exine has an aperture where sporopollenin is absent, called **germpore**.

Question in mind- How pollen grains get mature?
Answer- The newly differentiated pollen grain has a central nucleaus and dense cytoplasm. The protoplast mitoticaly divide into two unequal cells-bigger **vegetative cells** which is rich food reserve and smaller spindle shaped **generative cell** with a dense cytoplasm and nucleaus. This is called **two celled stage.**In majority angiosperms, pollens are released in these two celled stage.
Whereas in the other species, the generative cell divides into two male gamates and thus pollen is said to being **3 celled stages**.

Question in mind-What are the Importances of pollen grains?
Answer- Importances of pollen grains are-

1. They contain male gametes for sexual reproduction.
2. These are nutrient rich and thus are taken as food supplements.
3. Pollens can be stored for years in liquid nitrogen at -196 degree celcius, to be used later in crop breeding programmers.

Now let's discuss the FEMALE REPRODUCTIVE UNIT.

Question in mind- What is femal reproductive unit of flower?
Answer-The **pistil or gynoecium** represents the female reproductive unit of a flower

Special terms-
The gynoecium may have single pistil (called **monocarpellary**), more than two pistils (called **multicarpellary**), fused pistils (called **syncarpous**) or free pistils (called apocarpous).

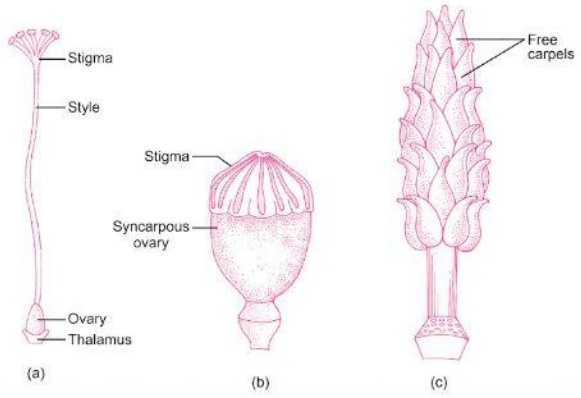


Fig. 2.6 (a) Pistil of *Hibiscus*; (b) Multicarpellary, syncarpous pistil of *Papaver*; (c) A multicarpellary, apocarpous gynoecium of *Michelia*

Question in mind- What is structure of Pistil or Gynoecium?
Answer-A pistil has following three major parts:

S.NO.	PARTS	FUNCTIONS
(1)	Stigma	It receives the pollen grains. It has sticky surface and pollen grains get stuck to it during pollination.
(2)	Style	It is elongated slender part beneath the stigma, that's connects the stigma with ovary.It holds the stigma to receive the pollen grains.Through style, the pollen tube grows and reaches the ovule.
(3)	Ovary	It is the basal swollen part of pistil that contains ovules and eggs.

Special terms-
Inside the ovary there is a compartment called **ovarian cavity** or locule separated by septum. Placenta is the tissue in ovarian cavity from where **ovule or megasporangium arises**.

Now let's see the STRUCTURE OF MEGASPORANGIUM (Ovule)

Question in mind- What is the structure of megasporangium?
Answer- Structure of megasporansium (Ovule)

- The ovule is attached to the placenta by means of a stalk (stem like structure) called **funicle**.
- The junction between an ovule and a funicle is called **helium**.
- The ovule is surrounded by one or two protective multicellular **integuments.**
- Integument encircles the ovule entirely except at the tip, resulting in a small opening called **micropyle.**
- The basal part of an ovule opposite to micropyle is called **chalaza.**

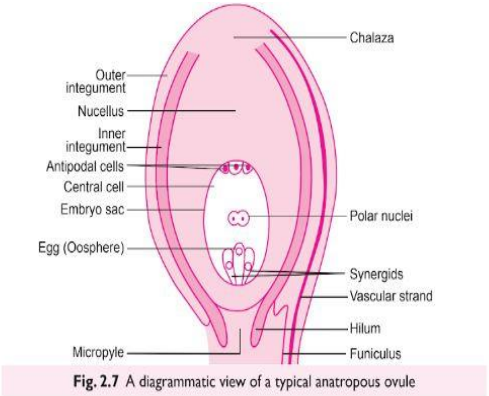


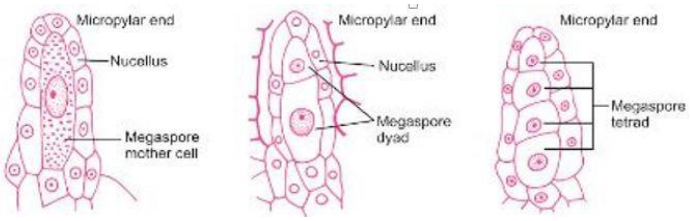
Fig. 2.7 A diagrammatic view of a typical anatropous ovule

- The cells with high or abundant reserve food material enclosed, with in integuments is called **nucellus.**
- The female gametophyte located witin a nucellus is called an embryo sac.

Now let's discuss the formation of female gamates, female gamate formation ocuur by MEGASPOROGENESIS

Question in mind- What is Megasporogenesis?
Answer-The process of formation of haploid megaspores from the diploid megaspore mother cell (MMC) is called megasporogenesis.

Question in mind-How megasporogenesis occur?
Answer-In the micropilar region, the nucellus contains cells (with dense cytoplasm and prominent nucleus) which is differentiated into a single megaspore mother cell (MMC).Megaspore mother cell is diploid and undergoes meiosis.MMC first divides transversally into two cells called dyad.These two cells again divides transversally as a result, a linear row of four haploid cells is produced which is called **megaspore tetrad or linear tetrad.**Out of these 4 megaspore, **only one remains functional** while the others three degenerate.

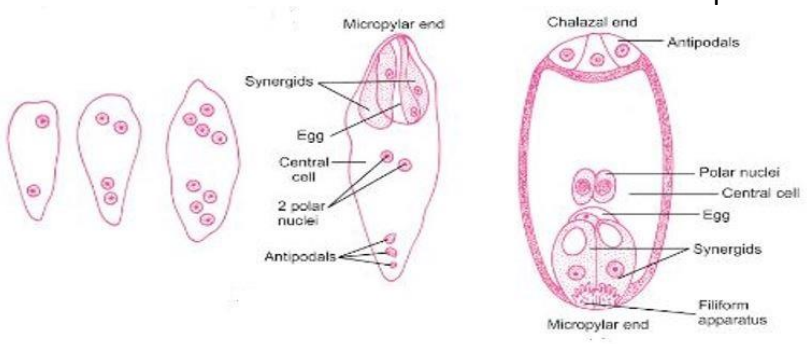


That one functional megaspores develops into the female gametophyte or **embryo sac.**This is called monosporic development.

Now we have to discuss how one functional megaspore develops into embryo sac. (MEGAGAMETOGENESIS)

Quuestion in mind- What is megagametogenesis?
Answer-The formation of female gametophyte (embryo sac) is called **megagametogenesis**.

Question in mind-How megagametogenesis occur?
Answer-Megaspore is the first cell of the female gametophyte.The megaspore increases in size and its nucleaus divides mietotically into two nuclei which move apart to opposite pole.Thus, a 2 nucleate embryo sac is formed.The two daughter nuclei undergo another mitotic division giving rise to the 4 nucleated stages.The third mitotic division gives rise to **8 nucleate 7 celled embryo sac**. Six of the eight nuclei are surrounded by cell walls and organised into cells .The central cell contains 2 nuclei known as polar nuclei.



The 3 nuclei at the micropilar region form the egg apparatus.In the egg apparatus, **the middle cell is the largest & is called oosphere/egg/ovum**, while other two cells are called

synergids. The synergids have special cellular thickenings at the micropylar tip called filiform apparatus, which play an important role in guiding the pollen tubes into the synergid.
The 3 nuclei at the chalazal end are surrounded by cytoplasm and cellular wall.These cells are called antipodal cells.

Now we have to transfer the gamtes for fertilization and it is done by Pollination. So let's see the Pollination in detail.

Question in mind-What is Pollination?
Answer –The transfer of pollen grains from anther and their deposition over stigma of the pistil is termed as pollination.

Question in mind –What are the different types of pollination?
Answer-Depending upon sources of pollen grains, pollination is of three types-
Autogamy- the transfer of pollen grains is from anther to stigma of the same flower e.g pea, rice, wheat etc. it is self pollination.
Geitonogamy-the transfer of pollen grains is from anther of one flowerto the stigma of another flower of same plant.e.g, cucurbita.
Xenogamy/Allogamy- the transfer of pollen grains from anther to the stigma of a different plant.e.g, papaya.

Now let's have a look on CONTRIVANCES OR DEVICES FOR SELF-POLLINATION

Question in mind-What are the Contrivances or Devices for self- pollination (Autogamy)?
Answer-Self pollination can be done by -

1. **Cleistogamous flower: -** these are bisexual closed flowers which never open at all and the anthers dehisce inside these closed flower. e.g., Commelina
2. **Homogamy: -** It is the condition of the maturity of anther and stigma at same time, e.g., Catharanthus (Vinca).
3. Close association between anther and stigma , e.g., Mirablis

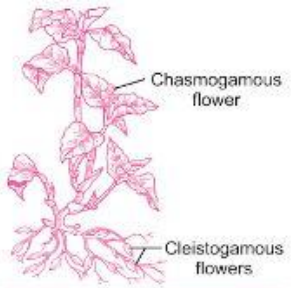
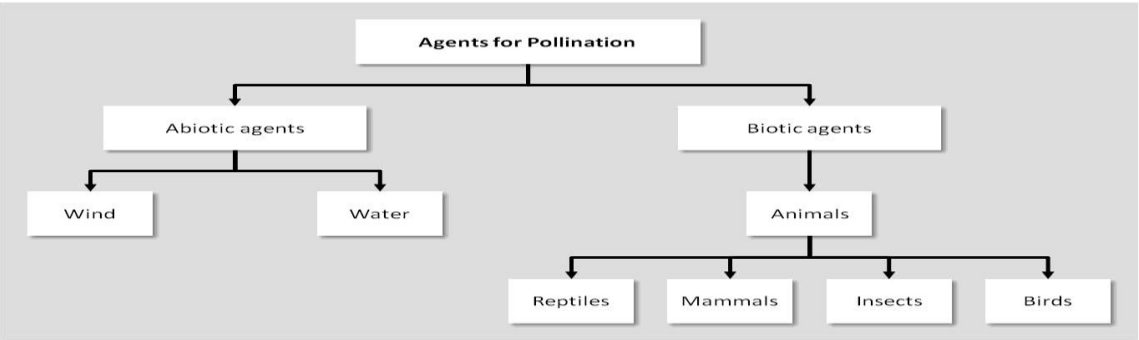


Fig. 2.9 Chasmogamous and cleistogamous flowers

Question in mind- What are Contrivances or Devices for cross- Pollination
Answer-Cross pollination can be done by-

1. **Unisexuality**: Male and female flowers are present on different plants.
2. **Dichogamy**: The condition in which the stamens and stigma of a bisexual flower mature at different times.
3. **Protandry**: This is the condition where anthers mature earlier than the stigma and release pollen.
4. **Protogyny**: This is the condition where the stigma matures earlier than the anther.
5. **Self-sterility or self-incompatibility**: It is a genetic mechanism that prevents self-pollination.
6. **Chasmogamous flowers**: These are open flowers with exposed stamens and stigma which facilitate cross-pollination.

Agents of Pollination-



Now let's talk about some Adaptions for Pollination, like for water pollination, wind pollination and Insect Pollination.

Question in mind –What are adaptations for water pollination (Hydrophily)?

Answer-The form of pollination in which pollen are distributed by water is called hydrophily.It is very common in algae, bryophytes, pteridophtyes and some angiosperms. **E.g, Vallisneria and Hydrilla** are submerged freshwater hydrophytes in which hydrophily is observed. Pollen grains are protected from wetting by the presence of a **mucilaginous covering.**

There are many examples for Hydrophily-

1. In sea-grasses,female flowers are submerged in water to receive pollen grains for pollination inside water.Pollen are long ,needle-like and are carried passively by water.
2. Zostera is marine angiosperm in which hydrophily is observed.
3. In Vallinsneria, the female flower stalk is coiled to reach the water surface to receive the pollen grains carried by water currents.

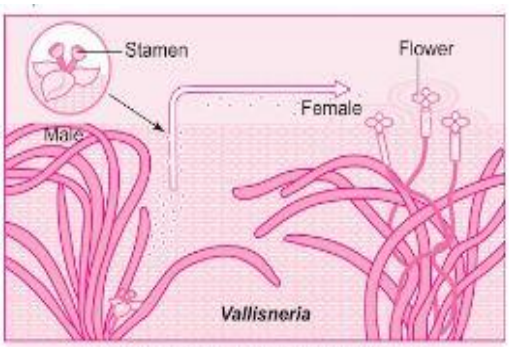


Fig. 2.10 Pollination by water in *Vallisneria*

Question in mind– What are the Adaptations for Wind Pollination (Anemophily)?

Answer- The form of pollination in which wind distributes the pollens is called Anemophily.

1. Pollen grains are light in weight, non-sticky, dry and winged.
2. Stamens are well-exposed for easy dispersal of pollen grains in the wind.
3. The stigma is sticky, large and feathery to trap pollen grains floating in the air.
4. Numerous flowers are packed together to form inflorescence.

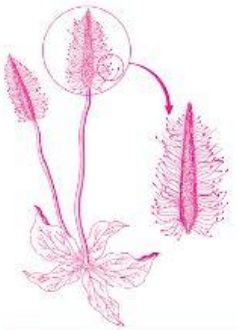


Fig. 2.11 A wind-pollinated plant showing compact inflorescence and well-exposed stamens


Fig. 2.12 Insect pollination

Question in mind- What are the adaptation for insect pollination (Entomophily)?

Answer-The form of pollination in which insects distribute pollens is called Entomophily.

1. Flowers are large, sticky and brightly coloured.
2. They have honey and nectar glands, which are highly fragrant to attract insects.
3. The pollen grain surface is sticky due to mucilaginous secretion.
4. The flowers offer floral rewards like nectar and pollen grains for pollination to insects.
5. In some species, floral rewards provide safe place to lay eggs, e.g., Amorphophallus.
6. The flower sometimes secrete foul odour to attract like flies and beetles.

After the pollination, the pollen grain attached to stigma, now what happens next, now there is interaction between pollen grain and pistil. So let's discuss it in detail. (Polen-Pistal Interaction)

Question in mind – What is the pollen-pistal Interaction?

Answer- All the events from pollen deposition on the stigma until the entry of the pollen tubes into the ovule are together called pollen-pistil interactions.

Question in mind- How pollen-pistal interaction occurs?

Answer- It is a dynamic process in which compatible pollen is recoginsed. Incompatible pollen or sterile pollens are rejected by the pistils and do not allow the growth of pollen tube.Compatible pollens are encouraged by pistil for growth and development of pollen tubes.The pollen tube grows through stigma and style to reach the ovary. It then enters the ovule through micropyle and reaches the synergids, guided by filiform apparatus.

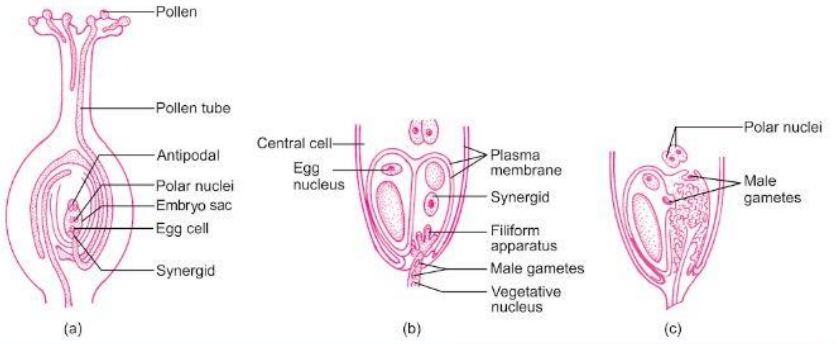


Fig. 2.13 (a) L.S. of pistil showing path of pollen tube growth;
(b) Enlarged view of an egg apparatus showing entry of pollen tube into a synergid;
(c) Discharge of male gametes into a synergid and the movements of the sperms, one into the egg and the other into the central cell

Our next topic is ARTIFICIAL HYBRIDISATION, let's discuss it in detail.

Question in mind-What is artificial hybridization and how it is done?

Answer- It is commonly used technique in plant breeding programmes to obtain desirable characters.

It is done in following steps -

1. Anthers are removed from the bisexual flowers using forceps.This is emasculation and is done before the anther dehiscence.
2. The emasculated flower is covered with a paper bag to prevent contamination from unwanted pollens. This is called bagging.
3. On attaining maturity, mature pollens from desirable plant are dusted on stigma of bagged flower and rebagged for fruit development.

Now we have seen the gamates formation and transfer of gamates (Pre- fertilization) now let's discuss Fertilization in plants.Our next topic is **DOUBLE FERTILISATION/TRIPLE FUSION**

DOUBLE FERTILISATION/TRIPLE FUSION

Question in mind-Why we are saying it Double fertilization/ triple fussion?
Answer-On reaching synergids, pollen tube releases the two male gametes into cytoplasm of synergids.

- One of the male gamete fuses with egg nucleus to form a diploid cell **zygote.** This event is called syngamy.Other male gamete fuses with polar nuclei at the centre to produce a triploid primary endosperm nucleus (PEN). This is termed as **Triple fusion.**
- As syngamy and triple fusion take place simultaneously in the embryo sac, it is termed as **double fertilisation.**
- The central cell after TRIPLE fusion forms primary endosperm cell (PEC) which later develops into endosperm. The zygote later develops into an embryo.

Now after fertlisation let's talk about **POST-FERTILISATION EVENTS**

Question in mind-What are posts –fertilisation events after double fertlisation?
Answer-The following events after double fertilisation are collectively called post fertilisation events:

1. Development of endosperm from primary endosperm nucleus(PEN)
2. Development of embryo from zygote.
3. Development of seeds from ovule.
4. Development of fruit from ovary.

Let's discuss each of them in detail-

1. ENDOSPERM DEVELOPMENT-"Endosperm develops first followed by an embryo.

Question in mind- How Endosperm develops?
Answer-"Endosperm develops from PEN. "The PEN undergoes successive nuclear divisions to give rise to free nuclei and this stage of endosperm development is called free nuclear endosperm."Subsequently, cell wall is formed and endosperm becomes cellular."This division is followed by cytokinesis and thus endosperm becomes cellular. It is now called cellular endosperm.

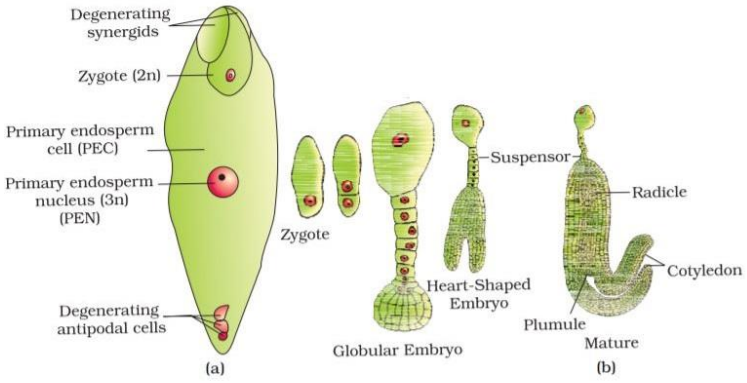
Question in mind-What are the functions of endosperm?
Answer-Functions of endosperm are:-

1. The cells of endosperm tissue are triploid and filled with reserve food material to nourish the developing embryo.
2. The water of tender coconut is free-nuclear endosperm and white kernel in the outer part is the multi cellular endosperm.
3. The endosperm may be completely consumed by the developing embryo, e.g. pea, beans, or it may persist in mature seed, eg, coconut.

2. EMBRYO DEVELOPMENT –

Question in mind-How embryo is develop?
Answer-Emryo develops from zygote at the micropylar end of embryo sac. The nutrition for development is provided by endosperm. The zygote divides to form proembryo. The

different stages of the developing proembryo are globular and heart shaped embryo, which finally forms mature embryo.



(a) Fertilised embryo sac showing zygote and Primary Endosperm Nucleus (PEN); (b) Stages in embryo development in a dicot [shown in reduced size as compared to (a)]

Let's see the structure of **Embryo of Dicot and Moncot Plants**.

Question in mind-What is the Structure of Dicot Embryo?

Answer- A typical dicotylednous emryo consists of-

1. An embryonal axis and two cotyledons.
2. The portion of embryonal axis above the level of cotyledon is called **epicotyl**, which develops into plumule or baby shoot
3. The cylindrical portion below the level of cotyledon is the **hypocotyl**, which develops into radicle or root tip.
4. The root tip is often covered with a root cap. Mango, Apple, radish, rose, actually, are some dicot plants.

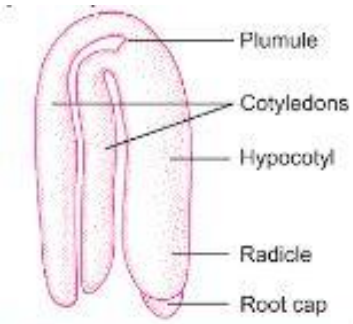


Fig. 2.15 A typical dicot embryo

Question in mind-What is the structure of moncot embryo?

Answer-A typical MONOCOTYLEDNOUS embryo consists of -

1. One cotyledon
2. The cotyledon us situated on one side (Lateral) of the embryonal axis and is called **scutellum.**
3. The radical and root cap are situated at the lower end of embryonal axis in an undifferentiated sheats called **coleorhiza.**
4. Shoot apex and few leaves primordial are enclosed in hollow follior in apicotyl region. Structure in apicotyl region called **coleoptile.**
5. The portion of the embryonal axis above the level of attachment of scutellum is called **epicotyl.**Grass, banana, bamboo palm, etc are some monocoat plants.

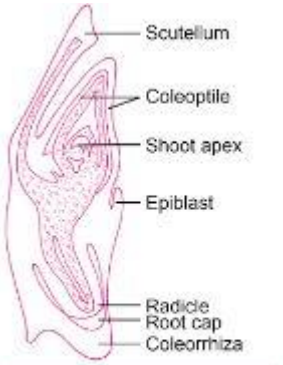


Fig. 2.16 L.S. of an embryo of grass (monocot)

3. SEED

Question in mind-What is Seed?

Answer-Seed is fertile ovule which is the final product of sexual reproduction.

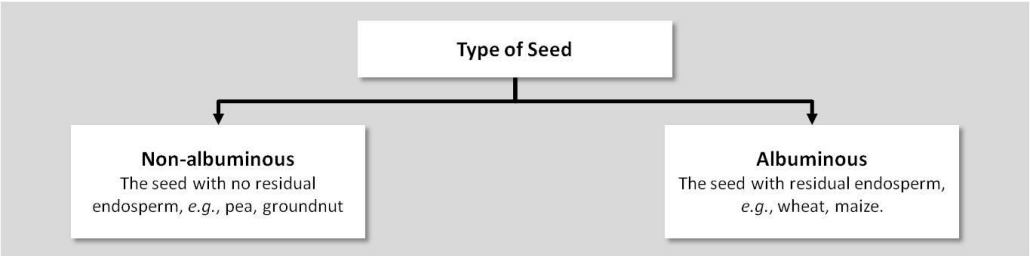
Question in mind-What a seed consist of?

Answer-It consists of the following:

1. **Seed coat(s):** 1-2 in number, having an opening called **micropyle.** Outer integument forms outer seed coat (testa) and inner integument forms inner seed coat (tegmen). The hard seed coat (testa+tegment) provide protection against injury.
2. **Cotyledons**: 1-2 in number and rich in reserve food material.
3. **Embryonal axis**

Question in mind-What are the types of seeds?

Answer-



Special term-

"Sometimes in the seeds, nucellus residual are present this is called **perisperm** e.g, in black pepper."With maturity, the water content of seed decreases and finally enters a state of inactivity called dormancy.

Question in mind-What are the advantages of seed?

Answer-Advantages of seeds are-

- Seeds posses better adaptive strategies to form a new colony.
- The reserve food of seed support the growth of seedling till they become nutritionally independent.
- They provide genetic recombination and variation as they are the products, of sexual reproduction.
- Seeds are stored to be consumed throughout the year to overcome the drought and natural calamities.
- Depending upon the mobility of seeds, they are used to raise crop in favourable season.

4. FRUIT

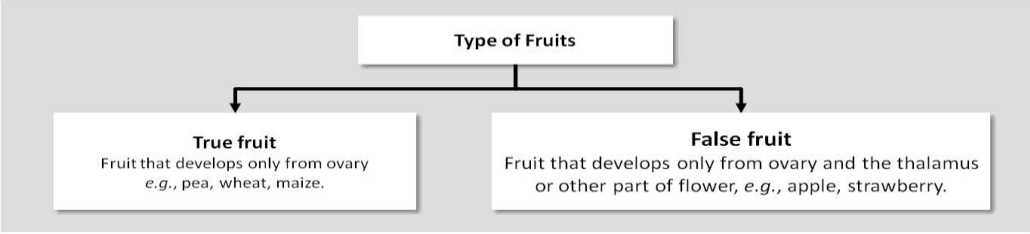
"The ovary matures to form **fruit** and the ovariam wall develops into the wall of fruit called **pericarp.**

"Fruits can be:

- Fruits can be **fleshy** e.g Orange, mango, etc.
- **Dry** e,g mustard or groundnutetc.

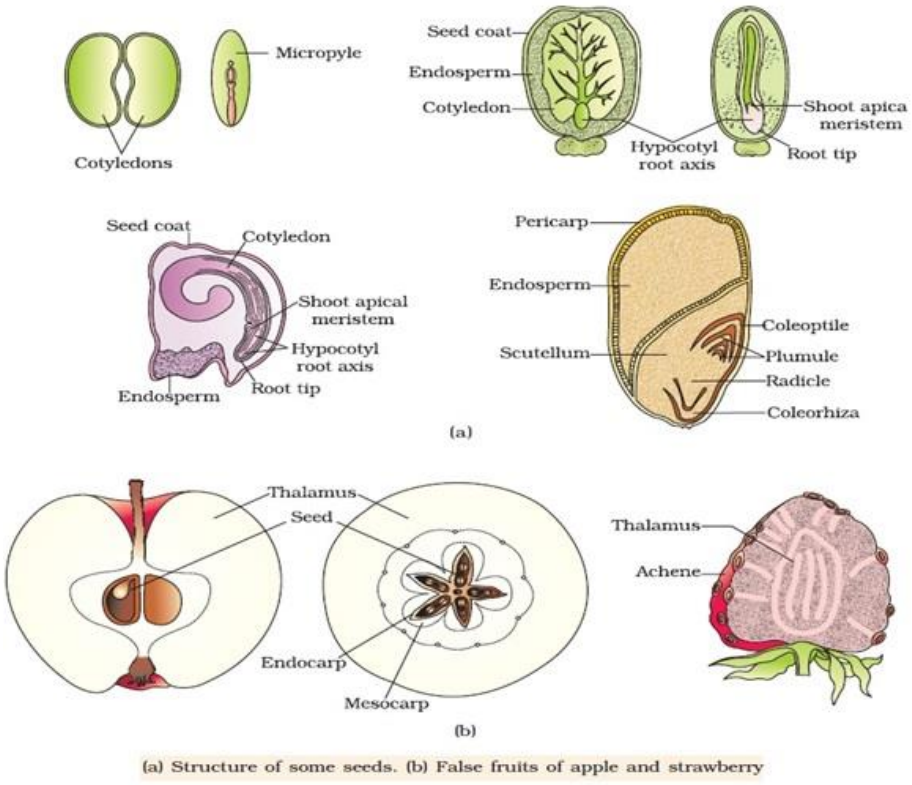
Question in mind-What are the types of fruits?

Answer-



Our next topicis **PERTHANOCARPIC FRUIT**

Question in mind-What are Parthanocarpic fruits?
Answer-Fruits that are formed without fertilisation are called **Perthanocarpic fruits**, e.g banana. Perthanocarpy can also be induced artificially by growth hormones.



(a) Structure of some seeds. (b) False fruits of apple and strawberry

Our next topic is **Special Mechansims of Reproduction**

First method is **APOMIXIS**

Question in mind-What is Apomixis?
Answer-The phenomena of asexual reproduction that initiates (start) sexual reproduction by formation of seed without fertilisation is called apomixes or agamospermy.

Question in mind-How apomiotic seeds are formed?
Answer-"Ways of development of apomiotic seeds:

a. A diploid egg is formed without reduction division and develops into embryo without fertilisation.
b. Some cells of nucellus, which are diploid in nature, start dividing and without fertilisation develop into embryo .eg-citrus fruit and mango.

Our next method is **POLYEMBRYONY**

Question in mind-What is Polyembryony?
Answer-The occurrence of more than one embryo in a seed is called polyembryony eg-orange.
Question in mind-How polyembryonic seeds are formed?
Answer-Ways of forming polyembryonic seeds;

a. Development of cells like synergids, cells of nucellus, cells of integuments, into embryo.

b. Formation of more than one embryo sac in an ovule.
c. Formation of more than one one egg in an embryo sac.

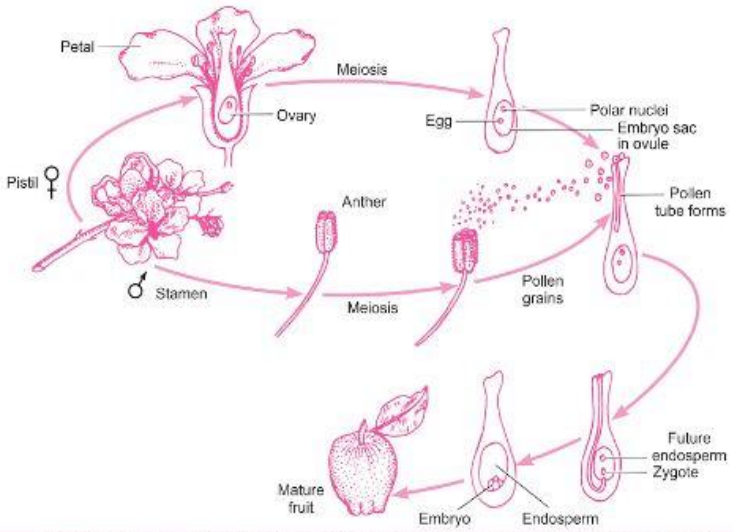


Fig. 2.19 Summary of fruit formation that includes germination of a seed, vegetative growth and the production of flowers that eventually bear fruit, which contains seeds

Frequently Asked CBSE Board Questions

Question from Male Reproductive Unit

Q. 1. Why angiosperm anthers are called dithecous? Describe the structure of its microsporangium.

Ans. The anthers of angosperms are called dithecous because they are bilobed and each lobe of anther has two theca.
Microsporangium is surrounded by four wall layers named as epidermis, endothecium, middle layer and tapetum. In young anther, a group of compactly arranged homogenous cells called sporogenous tissue occupies the centre of each microsporangium which produces microspores or pollen grains.

Q. 2. Name the organic materials the exine and intine of angiosperm pollen grains are made up of. Explain the role of exine.

Ans. Exine is made up of sporopollenin and intine is made up of cellulose and pectin.
Exine is the most resistant organic material which can stand high temperature, acidic and alkali environment.

Q. 3. Draw a diagram of a male gametophyte of angiosperm. Label any four parts. Why sporopollenin is considered the most resistant organic material?

Ans.

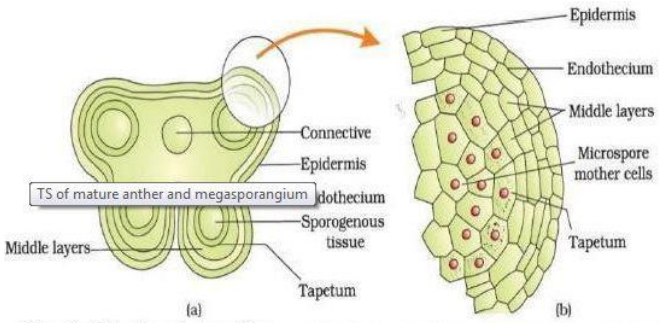


Fig. A: TS of mature anther B : Enlarge view of megasporangium.

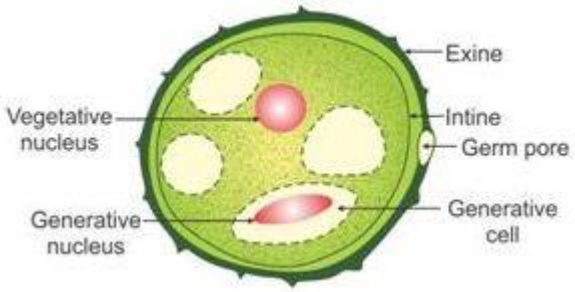
Sporopollenin is considered the most resistant organic material because it can with stand high temperatures and action of strong acids and alkalis. Also it cannot be degraded by any enzyme.

Q. 4. Write the cellular contents carried by the pollen tube. How does the pollen tube gain its entry into the embryo sac?

Ans. Pollen tube carries two male gametes. Pollen tube, after reaching the ovary, enters the ovule through the micropyle and then enters one of the synergids through the filiform apparatus which guides the entry of pollen tube into egg cell.

Q. 5. Draw a labelled diagram of the sectional view of a mature pollen grain in angiosperms.
Explain the functions of its different parts.

Ans. Pollen grain-

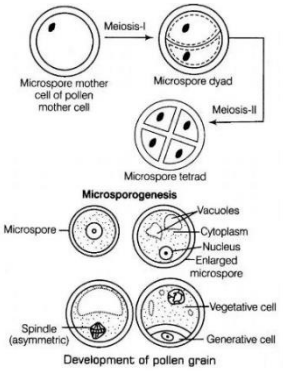


Functions:

a. Pollen grains are generally spherical with a prominent two-layered wall. The hard outer layer is called exine made up of sporopollenin, which is a resistant organic material.
b. Exine can withstand high temperature, strong acids and alkali, thus provide protection
c. It has prominent aperture called germ pore, through which pollen tube comes out.
d. Vegetative cell has abundant food reserve.
e. Generative cell divides mitotically giving rise to two male gametes, before pollen grains are shed (3-celled stage).

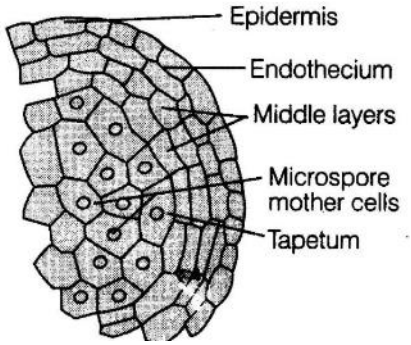
Q. 6. How does the pollen mother cell develop into a mature pollen grain? Illustrate the stages with labelled diagrams.

Ans. Pollen mother cells undergo meiosis to form a microspore tetrad (microspores arranged in a cluster of four cells) by the process called microsporogenesis.
— The microspores dissociate from each other and develop into pollen grains.
—The protoplast (pollen grain) then divides mitotically to form two unequal cells
— The bigger vegetative cell and smaller generative cell.



Q. 7. (a) Draw a diagram of an enlarged view of T.S. of one microsporangium of an angiosperm and label the following parts:
(i) Tapetum **(ii) Middle layer**
(iii) Endothecium **(iv) Microspore mother cells**
(b) Mention the characteristic features and function of tapetum.

Ans. (a) (Structure of Microsporangium)



(b) Tapetum is the innermost wall layer of the microsporangium. It nourishes the developing pollen grains. Cells of the tapetum possess dense cytoplasm and generally have more than one nucleus.

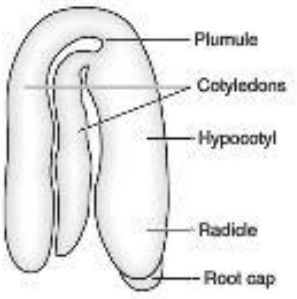
Question from Female Reproductive Unit

Q. 1. (a) Trace the development of megaspore mother cell up to the formation of a mature embryo sac in a flowering plant.
(b) Draw a labelled diagram of the structure of mature dicot embryo.

Ans. (a) The formation of female gametophyte (embryo sac) is called **megagametogenesis**.

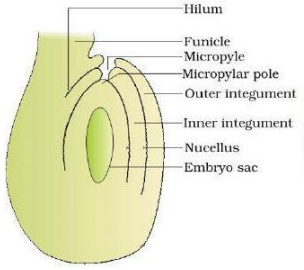
- Megaspore is the first cell of the female gametophyte.
- The megaspore increases in size and its nucleaus divides mietotically into two nuclei which move apart to opposite pole.Thus, a 2 nucleate embryo sac is formed.
- The two daughter nuclei undergo another mitotic division giving rise to the 4 nucleated stages.
- The third mitotic gives rise to 8 nucleate 7 celled embryo sac.
- The central sac contains 2 nuclei known as polar nuclei.
- The 3 nuclei at the micropilar region from the egg apparatus.
- In the egg apparatus, the middle cell is the largest & is called oosphere/egg/ovum, while other two naked cells adjoining the other cells are called synergids.
- The 3 nuclei at the chalazal end are surrounded by cytoplasm and cellular wall.These cells are called antipodal cells.

(b) (Structure of Dicotyledonous Embryo)



Q. 2. Draw a diagram of L.S. of an anatropous ovule of an angiosperm and label the following parts.
(i) Nucellus **(ii) Integument**
(iii) Antipodal cells **(iv) Secondary nucleus.**

Ans.

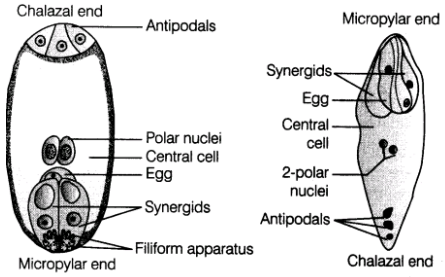


Q. 3. Name all the haploid cells present in an unfertilised mature embryo sac of a flowering plant. Write the total number of cells in it.

Ans. The haploid cells are: egg cell, synergids, and antipodals. There are 7 cells in total.

Q. 4. (a) Draw a labelled diagram of a mature embryo sac.
(b) Why does a pollen grain possess two male gametes? Explain.

Ans. (a) Embryo sac-



(b) Pollen grains possess two male gametes as it is required for double fertilisation in most angiosperms. Out of two male gametes, one male gamete moves towards egg cell and fuses with its nucleus to form a diploid cell called zygote and another male gamete fuses with two polar nuclei (secondary nuclei if they are already fused) to produce a triploid primary endosperm nucleus (PEN).

Q. 5. List the components of the embryo sac and mention their fate on fertilisation.

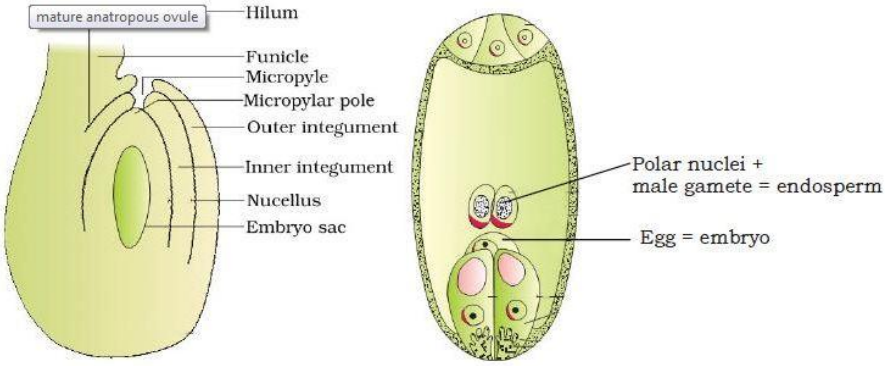
Ans. Components of embryo sac:-
2 polar nuclei, 1 egg cell, 2 synergids and 3 antipodal cells.
After positive pollen—pistil interaction, the pollen tube develops and enters the ovule through synergids guided by filiform apparatus. One of the male gamete fertilises the female gamete to form diploid zygote. The other male gamete fuses with the secondary nucleus (polar nuclei if they are already fused) to form a triploid primary endosperm nucleus (PEN) that develops into endosperm. The three antipodals at chalazal end and synergids at micropylar end start degenerating.

Q.6. (a) Draw a diagrammatic sectional view of a mature anatropous ovule and label the following parts in it:

a. **That develops into seed coat.**
b. **That develops into an embryo after fertilisation.**
c. **That develops into an endosperm in an albuminous seed.**
d. **Through which the pollen tube gains entry into the embryo sac.**
e. **That attaches the ovule to the placenta.**

(b)Describe the characteristic features of wind pollinated flowers.

Ans. (a)



(b) **Characteristic features of wind pollinated flowers are:-**

(i) Pollen grains are light in weight, non-sticky, dry and winged.

(ii) Well-exposed stamens for easy dispersal of pollen grains in the wind.

(iii) The stigma is sticky, large and feathery to trap pollen grains floating in the air.

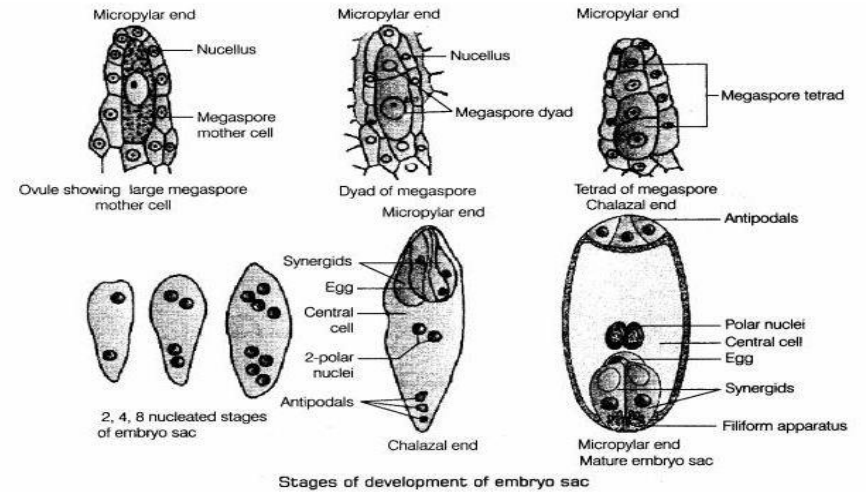
(iv) Numerous flowers are packed together to form inflorescence.

Q. 7. Explain with the help of a diagram the development of a mature embryo sac from a megaspore mother cell in angiosperm.

OR

How does the megaspore mother cell develop into 7-celled, 8 nucleate embryo sac in an angiosperm? Draw a labelled diagram of a mature embryo sac.

Ans. The megaspore mother cell (MMC) undergoes meiosis and forms a linear tetrad of 4 haploid megaspores.The process of meiotic formation of haploid megaspores from diploid megaspore mother cell is called megasporogenesis.



Development of Female Gametophyte-

The functional megaspore is the first cell of the female gametophyte.The cell enlarges and undergoes three free nuclear mitotic divisions. The first division produces two nucleated embryo sac. These two nuclei divide twice forming four nucleate and then eight nucleate structures.

One nucleus from each side moves to the middle of the embryo sac. They are called polar nuclei.

The remaining three nuclei form cells at the two ends, three celled egg apparatus at the micropylar end and three antipodal cells at the chalazal end.The middle binucleate structure organises itself into a central cell.
The female gametophyte in angiosperms is called the embryo sac. It is a 7-celled and 8-nucleated structure.

Question from Pollination

Q. 1. What is geitonogamy? Give its one similarity to autogamy and xenogamy.

Ans. Geitonogamy is a type of pollination in which pollen grains of a flower are transferred to the stigma of another flower of the same plant.
Similarity to autogamy: Geitonogamy is genetically similar to autogamy in the respect that pollen grains are transferred to stigma of the flower, but on the same plant so both are genetically similar whereas autogamy occurs in bisexual flower.
Similarity to xenogamy: Geitonogamy is similar to xenogamy in the respect that pollen grains are transferred to stigma of different flower.

Q. 2. Enumerate any six adaptive floral diaracteristics of a wind pollinated plant.

OR

How does the study of different parts of a flower help in identifying in wind as its pollinating agent?

Ans. Six adaptive floral characteristics of a wind pollinated plant are:

I. The flowers are small and inconspicuous (not clearly visible).
II. The pollen grains are light and non-sticky so that they can be easily transported by wind.
III. They have well-exposed stamens so that pollens get easily dispersed.
IV. They often have feathery stigma to catch the pollens grains.
V. The pollen grains are dry and unwettable to prevent pollens from gaining moisture from air.
VI. The pistil usually has single ovule in each ovary.

Q. 3. Make a list of any three outbreeding devices that flowering plants have developed and explain how they help to encourage cross-pollination.

Ans. (i) Time of pollen release and stigma receptivity is different (not synchronised). This prevents self pollination.
(ii) Anther and stigma are placed at different positions, so the pollend cannot come in contact with the stigma of the same flower.
(iii) Self incompatibility, which is a genetic mechanism (to prevent the pollen germination on the stigma of the same flower).

Q. 4. Geitonogamous flowering plants are genetically autogamous but functionally cross-pollinated. Justify.

Ans. Geitonogamous flowers are genetically autogamous because both male and female gamates are of same plant. They are functionally cross-pollinated because the pollen from one flower is transferred to the stigma of a different flower.

Q. 5. How does the Mediterranean orchid Ophrys ensures its pollination by bees?

Ans. The petals of the Ophnys resemble the female of a bee species in size, colour and odour. Male bee mistakes the Ophrys for female bee and tries to copulate. Few

pollen grains adhered to the body of the male bee and fall over stigma of the flower there by leading to pollination showing sexual action.

Q. 6. State the significance of pollination. List any four differences between wind pollinated and animal pollinated flowers.

Ans. Pollination is the phenomena of transfer of pollen grains from anthers to the stigma of a pistil. Pollination is required for the beginning of fertilisation.

S.No.	Wind pollinated flowers	Animal pollinated flowers
(i)	This kind of flower is pollinated by abiotic pollinating agent.	This kind of flower is pollinated by biotic pollinating agent.
(ii)	They are small and inconspicuous.	They are large, colourful, fragrant and rich in nectar.
(iii)	The pollen grains are dry, light and non-sticky so that they can be easily transported by wind.	The pollen gains are generally sticky in animal pollinated flowers.
(iv)	The flowers are often clustered so as to carry out pollination.	The flowers are grouped to become more conspicuous(clearly visible)

Q. 7. (i) Write the characteristic features of anther, pollen and stigma of wind pollinated flowers.

(ii) How do flowers reward their insect pollinators? Explain.

Ans, (i) The characteristics are:

a. Pollen grains are light in weight, non- sticky, dry and winged.
b. Well-exposed stamens for easy dispersal of pollen grains in the wind.
c. The stigma is sticky, large, and feathery to trap pollen grains in air.

(ii) Insect pollinators are rewarded in following ways:

The flowers offer floral reward like nectar and pollen grain. In some species floral reward provides safe place to lay eggs.

Q. 8. (a) Mention any four strategies adopted by flowering plants to prevent self-pollination.

(b) Why geitonogamy also referred to as genetical autogamy?

Ans. Self -POLLINATION can be prevented by exhibiting

a. **Unisexuality**: Male and female flowers are present on different plants.
b. **Dichogamy**: The condition in which the stamens and stigma of a bisexual flower mature at different times.
c. **Protandry**: This is the condition where anthers mature earlier than the stigma and release pollen.
d. **Protogyny**: This is the condition where the stigma matures earlier than the anther.
e. **Self-sterility or self-incompatibility**: It is a genetic mechanism that prevents self-pollination.
f. **Chasmogamous flowers**: These are open flowers with exposed stamens and stigma which facilitate cross-pollination.

(b) Geitonogamy is the transfer of pollen grains from the anther to the stigma of another flower of the same plant. Although geitonogamy is functionally cross-

pollination involving a pollinating agent, genetically it is similar to autogamy, since the pollen grains come from the same plant.

Q. 9. (a) Mention the similarity between autogamy and geitonogamy.
(b) How does geitonogamy differ from xenogamy?

Ans. (a) In both cases pollen grains come from the same plant. So are genetically similar.
(b) In geitonogamy pollen grains are transferred from the anther to the stigma of another flower, of the same plant whereas in xenogamy pollen grains are transferred from the anther, to the stigma of a different flower.

Q. 10. (a) How does cleistogamy ensure autogamy?
(b) State one advantage and one disadvantage of cleistogamy to the plant.

Ans. (a) Cleistogamous flowers do not open. Therefore, the pollens have to land on the stigma of the same flower. This ensures autogamy.
(b)Advantage: Self-pollination is assured/thus ensuring seed formation.
Disadvantage: Least variations observed and it leads to inbreeding depression.

Q. 11. Explain the steps that ensure cross pollination in an autogamous flower.

Ans. A bisexual flower is emasculated at unopened stage to prevent self-pollination in the flower and it is bagged after emasculation to prevent contact of unwanted pollen grain with the stigma of the flower. Artificial pollination is then performed when the stigma is ready and the flower is rebagged.

Q. 12. (a) Explain the characteristic features of wind pollinated flowers. How are insect pollinated flowers different from them?
(b) Explain the mutually rewarding relationship between Yucca plant and a species of moth.

Ans. (a) Wind pollinated flowers have light-weight, non-sticky, dry and winged pollens. The well- exposed stamens help in easy dispersal of pollen grains. The stigma is sticky, large and feathery to trap pollen grains floating in the air. Numerous flowers are packed together to form inflorescence.
Insect pollinated flowers are large, sticky and brightly coloured with honey and nectar glands to attract insects. They are highly fragrant and the stigma is sticky.

(b) Both Yucca plant and the moth cannot complete their life cycles without each other. The moth deposits its eggs in the locule of the ovary and the flower in turn, gets pollinated by the moth. The larvae of the moth come out of the eggs as the seeds start developing.

Q.13. Explain any two devices by which autogamy is prevented in flowering plants.

Ans. (i) Male and female flowers are present on different plants.
(ii) The stamens and stigma of a bisexual flower mature at different times. Anthers mature earlier than the stigma and release pollens. The stigma matures earlier than the anther.
(iii) Flowers are self-sterile or self-incompatible.
(iv) Chasmogamous flowers are present with exposed stamens and stigma which facilitate cross- pollination.

Q. 14. Differentiate between geitonogamy and xenogamy in plants. Which one between the two will lead to inbreeding depression and why?

Ans.

S.No.	Geitonogamy	Xenogamy
(i)	It is transfer of pollen grains from the anther to the stigma of another flower of same plant.	It is transfer of pollen grains from the anther to the stigma of a different plant
(ii)	The pollen grains are genetically similar to the plant.	The pollen grains are genetically different from the plant.

Geitonogamy will lead to inbreeding depression because the pollen grains are genetically similar, which results in inbreeding, continued inbreeding will thus reduce fertility and productivity.

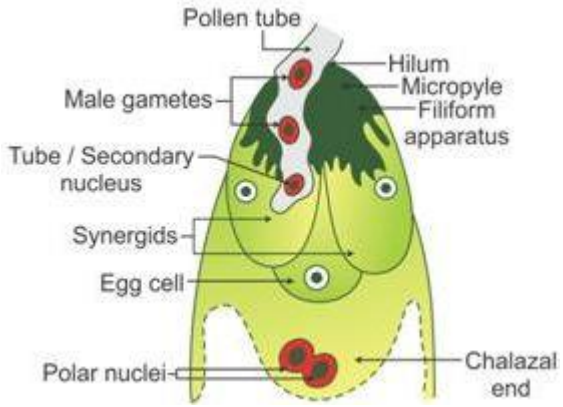
Q. 15. The flower of brinjal is referred to as chasmogamous while that of beans is cleistogamous. How are they different from each other?

Ans. Brinjal has chasmogamous flowers as they are open with exposed stamen and stigma. Such flowers exhibit cross-pollination as well as self-pollination. On the other hand, beans have cleistogamous flowers as they never open at all, even at maturity. They also exhibit self-pollination.

Question from Pollen-Pistal interaction

Q. 1. Draw a longitudinal section of a post-pollinated pistil showing entry of pollen tube into a mature embryo sac. Label filiform apparatus, chalazal end, hilum, antipodals, male gametes and secondary nucleus.

Ans.



Q. 2. Explain any three advantages the seeds offer to angiosperms.

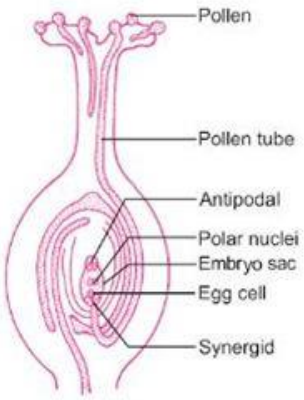
Ans. (i) Since reproductive process such as pollination and fertilisation are independent of water, seed formation is more dependable.
(ii) Seeds have better adaptive strategies for dispersal to new habitats and help the species to colonise in other areas.
(iii) As they have sufficient food reserves young seedlings are nourished until they are capable of photosynthesis on their own.
(iv) The hard seed coat provides protection to the young embryo.
(v) Being products of sexual reproduction, they generate new genetic combinations or variations.

Q. 3. (a) Write the changes a fertilised ovule undergoes within the ovary in an angiosperm plant.
(b) Draw a L.S. of a pistil showing pollen tube entering the embryo-sac in an angiosperm and label any six parts other than stigma, style and ovary

Ans. (a) In a fertilised ovule, following changes occur:

1. Zygote changes into embryo
2. integument develops into the seed coat
3. synergids and antipodals degenerate
4. Ovule changes to form the seed.

(b)



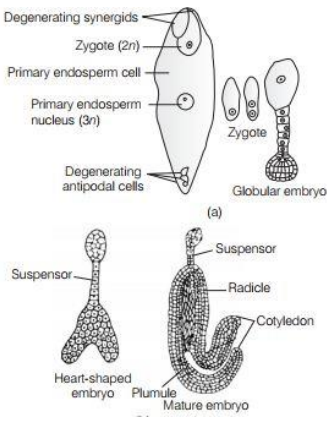
Q. 4. Pistil of a flower does not accept pollen from any plant other than from its own kind. How does it happen? Explain.

Ans. The pistil has the ability to recognise pollen, whether it is of right type (compatible) or of the wrong type (incompatible). It is mediated by chemical components of the pollen interacting with those of the pistil.

Question from Embryo Development

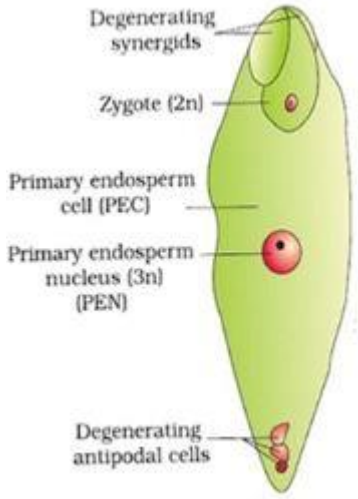
Q. 1. (a) Why does endosperm development precede embryo development in angiosperm seeds?
State the role of endosperm in mature albuminous seeds.
(b) Describe with the help of three labelled diagrams the different embryonic stages that include mature embryo of dicot plants.

Ans. (a) Endosperm development precides embryo development because endosperm provides nutrition to the developing embryo. It is an adaptation to provide assured nutrition to the developing embryo.
The endosperm provides nutrition during seed germination.
(b) The zygote (in the embryo sac) divides to give rise to pro embryo and subsequently to the globular, heart shaped and mature embryo as shown in the diagram.



Q. 2. (a) Draw a schematic labelled diagram of a fertilised embryo sac of an angiosperm.
(b) Describe the stages in embryo development in a dicot plant.

Ans. (a)



(b) Development of a dicot embryo (i) Embryo formation starts after a certain amount of endosperm is formed. (ii) Zygote divides by mitosis to form a proembryo. (iii) Formation of globular and heart-shaped embryo occurs, which finally becomes horse shoe-shaped forms a mature embryo.

Q. 3. Mention the reasons for difference in ploidy of zygote and primary endosperm nucleus in an angiosperm.

OR

In angiosperms, zygote is diploid while primary endosperm cell is triploid. Explain

Ans. A zygote is formed by the fusion of haploid male gamete with the haploid egg to form a diploid cell; whereas, primary endosperm nucleus (PEN) is formed by the fusion of haploid male gamete with two haploid polar nuclei, forming a triploid nucleus.

Q. 5. (a) Describe the endosperm development in coconut.
(b) Why tender coconut considered a healthy source of nutrition?
(c) How are pea seeds different from castor seeds with respect to endosperm?

Ans. (a) The primary endosperm nucleus (PEN) undergoes successive nuclear divisions to give rise to free nuclei. Subsequently, cell wall is formed towards the periphery and endosperm becomes cellular, leaving free nuclear endosperm in the central part. This division is followed by cytokinesis and thus endosperm becomes cellular and is called cellular endosperm.
(b) Because it is reserve food material.
(c) In peas, the endosperm is used up and there is no endosperm present in the mature seed. In castor, the endosperm remains intact in the mature seed.

Q. 6. Differentiate between perisperm and endosperm giving one example of each.

Ans.

S.No.	Perisperm	Endosperm
(i)	It is persistent nucellus.	It is the nutritive tissue for embryo.
(ii)	It is diploid.	It is triploid.
(iii)	Example: black pepper, beet.	Example: maize, rice, wheat, castor.

Questions from Fruit

Q. 1. Write two differences between parthenogenesis and parthenocarpy in plants.

Ans.

S.No.	Parthenogenesis	Parthenocarpy
(i) (ii)	It is the phenomenon in which the unfertilised ovum develops into a seed/ individual. It may result in haploid individual, e.g., drones of honey bee.	It is the phenomenon of formation of a fruit without fetilisation. Usually seeds are not produced and hence nonew individual is formed. It give rise to seedlessfruits, e.g., pineapple, banana..

Q. 2. What is pericarp? Mention its functions.

Ans. The wall of the ovary that develops into wall of the fruit is called pericarp.
Functions:
(i) Protects the seed till its maturity.
(ii) Helps in dispersal.

Q. 3. Banana is a parthenocarpic fruit whereas oranges show polyembryony. How are they different from each other with respect to seeds?

Ans. Banana develops from an ovary without fertilisation having non-viable seeds so it is called parthenocarpic fruit. An orange contain seeds with more than one embryo thus, it show polyembryony.

Q. 4. Why an apple is called a false fruit and a banana a parthenocarpic fruit? Explain.

Ans. In normal conditions, the fruit develops from the ovary. However, in apple the thalamus also contributes to fruit formation. That is why it is called a false fruit. Banana is called a parthenocarpic fruit because it develops without fertilisation and is thus seedless.

Question from Double Fertilization/Triple Fusion

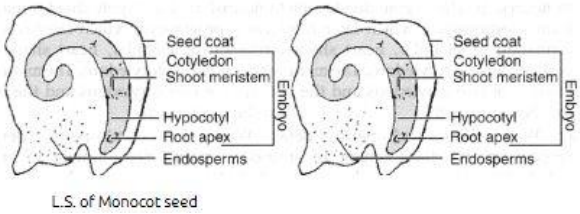
Q. 1. Explain the phenomenon of double fertilisation.

Ans. Double fertilisation includes syngamy where one of the male gametes fuses with egg cell to form zygote and triple fusion which includes fusion of second male gamete with two polar nuclei.

Q. 2. (a) Why is fertilisation in an angiosperm referred to as double fertilisation? Mention the ploidy of the cells involved.
(b) Draw a neat labelled sketch of L.S of an endospermous monocot seed.

Ans. (a) Fusion of haploid egg cell with one haploid male gamete to form diploid zygote is called syngamy.
Fusion of two (diploid) polar nuclei with the other haploid male gamete to form triploid primary endosperm nucleus is called triple fusion.

(b)



L.S. of Monocot seed

Q. 3. Fertilisation is essential for production of seed, but in some angiosperms, seeds develop without fertilisation.
(i) Give an example of an angiosperm that produces seeds without fertilisation. Name the process.
(ii) Explain the two ways by which seeds develop without fertilisation.

Ans. (i) In the members of family Asteraceae, seeds develop without fertilisation. This process is called apomixis.
(ii) Ways by which seeds develop without fertilisation are:
(a) In some species, the diploid (2n) egg cell is formed without reduction division and develops into embryo without fertilisation.
(b) In many varieties of Citrus and mango fruits, some of the nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and then develop into embryos.

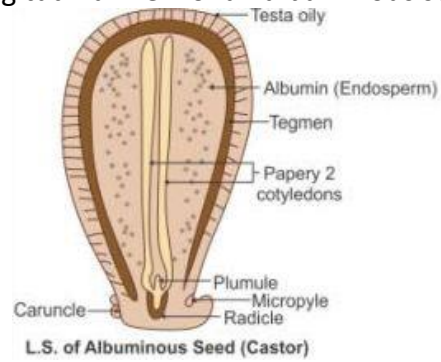
Q. 4. Where does triple fusion take place in a flowering plant? Why is it so called? Mention its significance.

Ans. Triple fusion involves fusion of one male gamete and two polar nuclei (or secondary nucleus; if the two have already fused) in the central cell of embryo sac. Three nuclei are involved in triple fusion, i.e., one male nucleus and two polar nuclei in the central cell, therefore, the process is termed triple fusion

Question from Seed

Q. 1. (a) Draw a labelled long-sectional view of albuminous 'seed'.
(b) How are seeds advantageous to flowering plants?

Ans. (a) Longitudinal view of an albuminous seed



L.S. of Albuminous Seed (Castor)

(b) Seeds contain food to nourish the embryo during germination and possess better adaptive strategies for dispersal to new habitats. These are formed by sexual reproduction with new variations and better genetic combinations. So, the seeds advantageous to flowering plants.

Q. 2. Differentiate between albuminous and non-albuminous seeds, giving one example of each.

Ans. Albuminous seeds have residual endosperm in them. For example, maize.

Non-albuminous seeds do not have any residual endosperm. For example, pea.

Q. 3. (a) Explain the different ways apomictic seeds can develop. Give an example of each.
(b) Mention one advantage of apomictic seeds to farmers.

Ans. (a) (i) Diploid egg cell is formed without reduction division and develops into embryo without fertilisation, e.g., Asteraceae/grasses.
(ii) In citrus/mango, some of the diploid nucellar cells surrounding the embryo sac start dividing, protrude into embryo sac and develop into a embryo.
(b) No segregation of character in hybrid seeds, economically beneficial and desired varieties are cultivated.

Q. 4. Name the product of fertilisation that forms the kernel of coconut. How does the kernel differ from coconut water?

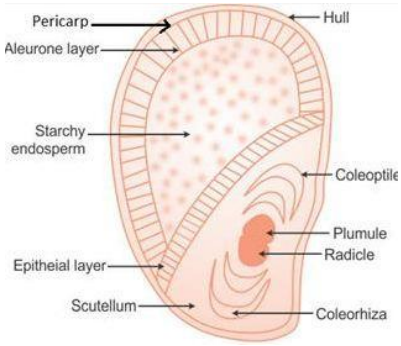
Ans. Endosperm forms the kernel of coconut.
The coconut water is free-nuclear endosperm whereas kernel is cellular endosperm.

Q. 5. Explain any two ways by which apomictic seeds get developed.

Ans. Ways by which apomictic seeds develop:
(i) A diploid egg is formed without reduction division which develops into embryo without fertilisation. (ii) Some cells of the nucellus, which are diploid in nature, start dividing and without fertilisation develop into embryo.

Q. 6. Draw a vertical section of a maize grain and label (i) pericarp, (ii) scutellum, (iii) coleoptile and (iv) radicle.

Ans.



Q. 7. Some angiosperm seeds are said to be 'albuminous', whereas few others are said to have a perisperm. Explain each with the help of an example.

Ans. Albuminous seeds are those which retain a part of endosperm as it is not completely used up during embryo development. For example, in wheat and maize. In some seeds remnants of nucellus are also persistant. This residual, persistant nucellus is the perisperm. For example, in black pepper and beet.

Questions Artifical Hybridisation

Q. 1. Ond day Shubham took his friend Ramesh to his grandfather's orchard. They ate various fruits growing there. In an area they saw that some flowers are covered with butter paper and tied. They started wondering why it has been done. They ask the caretaker about the same. He then explains to them the technique of artificial hybridisation.

i. **Why is artificial hybridisation done?**
ii. **Why are flowers covered with butter paper?**
iii. **What values are exhibited by the caretaker?**

Ans. (i) Artifical hybridisation is done to improve the quality of fruits and crops.
(ii) The flowers are covered so that it does not get pollinated by pollens in the air. Only the selected pollens having the desired characters are used to pollinate the covered flowers manually.
(iii) The caretaker has exhibited knowledge, awareness and scientific temperament.

Q. 2. Why should a bisexual flower be emasculated and bagged prior to artificial pollination?

Ans. A bisexual flower is emasculated to prevent self-pollination in the flower and it is bagged after emasculation to prevent contact of unwanted pollen grain with the stigma of the flower.

Questions Related to Chapter

Q. 1. Explain the function of each of the following:
(a) Coleorhiza
(b) Germ pores

Ans. (a) Protects the radical of (monocot) embryo.
(b) Allow germination of pollen grain/formation of pollen tubes.

Q. 2. If you squeeze a seed of orange you might observe many embryos of different sizes? How is it possible? Explain.

Ans. In orange, the nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and develop into a number of embryos of different sizes.

Q. 3. Mention the function of each of the following:
(a) Tassels of corn cob.
(b) Tapetum in the microsporangium.

Ans. (a) These are the stigma and style which wave in the wind to trap pollen grains.
(b) Provides nourishment to the developing pollen grains.