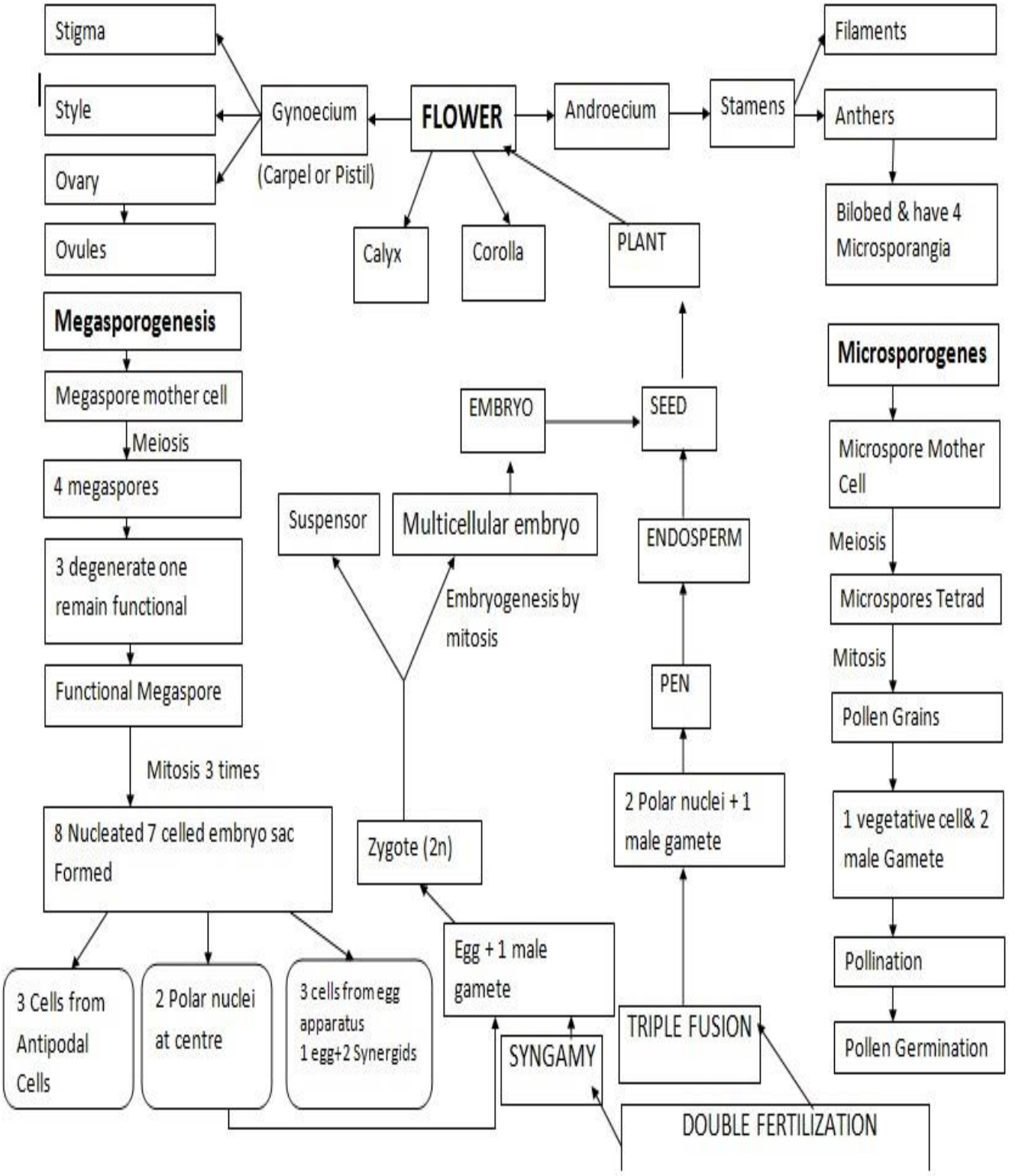
CHAPTER 2

TEACHING HOURS -10

SEXUAL REPRODUCTION IN FLOWERING PLANTS

WEIGHTAGE OF MARKS - 08



ONE MARK QUESTIONS

1. **What does the flower symbolize?**
   Flowers are the objects of aesthetic, ornamental, social, religious & cultural value. They have always been used as symbols for conveying human feelings such as love, affection, happiness, grief, mourning etc.,

2. **Name any one ornamental flower cultivated in homes and gardens.**
   (Write any one)

Carnation
Anthurium
Blue star
Cockcomb
Chrysanthemum

3. **Name any one flower used in social and cultural celebration.**
   (Write any one)

Jasmine
Rose
Aster
Marigold
Zarbara

4. **Name the tallest flower.**
   Amorphophallus (6ft height)

5. **An anther with malfunctioning Tapetum often fails to produce viable male gametophytes. Why?**
   The malfunctioning Tapetum does not nourish the developing pollen grains. Thus fails to produce viable male gametophytes.

6. **Name the first cell of male gametophytic generation in flowering plants**
   Microspore or pollen grain is the first cell of gametophytic generation.

7. **How are pollen grains preserved?**
   The pollen grains are preserved in liquid nitrogen at -196^0C, which are used as pollen banks in crop breeding programs.

8. **What is palynology?**
   It is the study of pollen grains.

9. **Give an example for a plant that causes pollen allergy.**
   Parthenium.

10. **Name the cells found at the chalazal end of embryo sac.**
    Antipodals.

11. What is meant by monosporic development of female gametophyte?

The method of embryo sac formation from a single haploid functional megaspore is called monosporic development.

12. Name the component cells of the egg apparatus in embryo sac.

Egg apparatus has two synergids and an egg cell.

13. Name the diploid nucleus of the mature embryo sac.

Secondary nucleus of the central cell

14. The meiocyte of rice has 24 chromosomes. How many chromosomes are present in its endosperm?

The endosperm will have 36 chromosomes.

15. Name the type of pollination in self-incompatible plants.

Cross pollination.

16. How does Yucca and Pronuba moth depend on each other?

The Pronuba moth deposits its eggs in the locule of the ovary of Yucca and the flower in turn get pollinated by the moth. The larvae of moth come out of the eggs as the seed starts developing.

17. What are pollen robbers or nectar robbers?

The floral visitors or insects that consume pollen and nectar without bringing about pollination are called pollen robbers.

18. Why do corn cobs have long tassels?

The long tassels of corn cobs are the style and stigma which help to trap the pollen grains carried by wind.

19. How do pollen grains of water pollinated plants like vallisneria protect themselves?

In water pollinated species like vallisneria, pollen grains are protected from wetting by a mucilaginous covering.

20. How does pollination occur in aquatic plants like water hyacinth & water lily?

In water hyacinth and water lily, the flowers emerge above the level of water and are pollinated by insects or wind as in most of the land plants.

21. How is it possible in oxalis and viola plant to produce assured seed sets even in the absence of pollinators?

Oxalis and Viola plants produce cleistogamaous flowers in which anther and stigma lie close to each other that favors self pollination and lead to assured seed sets.

22. Name the part of gynoecium that determines the compatible nature of pollen grain.

Stigma.

23. Which cell forms the kernel of coconut?

A triploid primary endosperm cell of embryo sac.

24. How does the kernel and coconut water differ?

The kernel of coconut is cellular endosperm while coconut water is free nuclear endosperm.

25. Name the common function that cotyledon and nucellus perform.

Nourishment.

26. What are the components of embryo of a seed?

Embryo of a seed has cotyledons and embryonic axis with plumule and radical.

27. Name the fruits containing thousands of tiny seeds.

Orchid fruits and the fruits of parasitic species such as orobanche and striga.

TWO MARKS QUESTIONS

1. Name the parts of an angiosperm flower in which development of male and female gametophyte takes place.

The development of male gametophyte takes place in the microsporangium (pollen chamber) of anther.

The development of female gametophyte (embryo sac) takes place in the mega sporangium(ovule) of ovary.

2. Explain the role of Endothecium.

- Endothecium provides protection to pollen grains
- These cells are hygroscopic. When they lose water, they contract and cause dehiscence of anther for the release of pollen grains.

3. Arrange the following terms in the correct developmental sequence: pollen grain, Sporogenous tissue, Microspore tetrad, Pollen mother cell, Male gametes.

Sporogenous tissue → Pollen mother cell → microspore tetrad → pollen grain → male gamete

4. Identify the type of carpel in the following diagrams b and c.

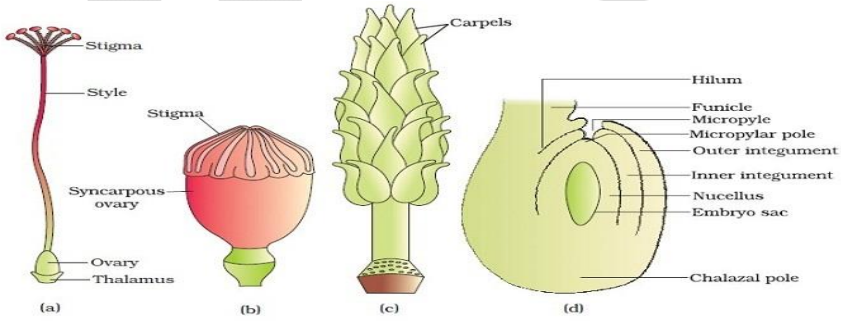


Figure 7. (a) A dissected flower of *Hibiscus* showing pistil (other floral parts have been removed); (b) Multicarpellary, syncarpous pistil of *Papaver*; (c) A multicarpellary, apocarpous gynoecium of *Michelia*; (d) A diagrammatic view of a typical anatropous ovule

b) It is multicarpellary, syncarpous pistil of Papaver

c) It is multicarpellary, apocarpous pistil of Michelia

5. Papavar and Michelia both have multicarpellary ovaries. How do they differ from each other?

The papavar ovary is syncarpous, whereas Michelia ovary is apocarpous.

6. Name the cells that undergo meiosis in a bisexual flower

Microspore mother cell to produce haploid microspores (pollen grains)

Megaspore mother cell to produce haploid megaspore (embryo sac)

7. What is filiform apparatus? What is its significance?

The synergids have special cellular thickenings at the micropilar end called filiform apparatus. It plays an important role in guiding pollen tube into embryo sac through synergid.

8. Name the male and female gametophytes of angiosperms.

Male gametophyte is microspore or pollen grain. Female gametophyte is embryo sac.

9. Mention the advantage and disadvantage of cleistogamaous flowers.

Cleistogamous flowers undergo autogamy so there is an assured seed set but the continued self pollination leads to inbreeding depression.

10. What is perisperm? Give examples.

The remnants of persistent nucellus in a seed are called perisperm.

Eg: Nymphaea, Black pepper and beetroot.

11. Why do you think the zygote is dormant for some time in a fertilized ovule?

The zygote remains dormant for some time in a fertilized ovule and divides only after certain amount of endosperm is formed from PEN, because the zygote requires reserve food materials of endosperm for the nutrition of the developing embryo.

12. Why does the zygote begin to divide only after the division of primary endosperm cell?

The zygote needs nourishment during its development as the mature, fertilized embryo sac offers little nourishment to the zygote. So, the primary endosperm cell divides and generates the endosperm tissue which nourishes the zygote. Hence the zygote always divides after the division primary endosperm cell.

13. Differentiate between the following.

Hypocotyl	**Epicotyl**
The cylindrical portion of the embryonic axis below the level of cotyledon is called hypocotyl that terminates in radical.	The portion of the embryonic axis above the level of cotyledon is called epicotyl that terminates in plumule.
Coleoptile	**Coleorhiza**
In monocot seeds, plumule is covered by a protective sheath called coleoptiles.	In monocot seeds, radical and root cap are covered by a protective sheath called coleorhizae.
Integument	**Testa**
The protective envelop of the ovule is called integument.	The outer protective seed layer is called testa.
Perisperm	**Pericarp**
The remnants of persistent nucellus in a seed are called perisperm.	The wall of ripened ovary or fruit is called pericarp.

14. What are false fruits? Give example.

The fruits developed from the floral parts other than the ovary are called false fruits. Eg: Apple, Strawberry, cashew, etc. In these fruits, the thalamus forms into the edible part.

15. What are parthenocarpic fruits? Give example.

The fruits developed from unfertilized ovary are called parthenocarpic fruits. They are seedless fruits. It can be induced by the application of growth harmones. Eg: Banana, grape, etc.

16. Why apple is called a false fruit? Which part of the flower forms the fruit?

The fruits developed from the parts other than the ovary are called false fruits. Apple is called so because the thalamus forms the edible part of the apple.

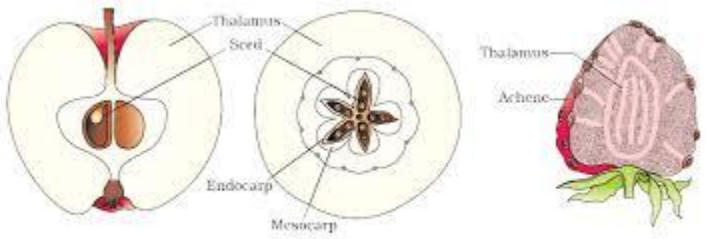


Figure 2.15 (b) False fruits of apple and strawberry

17. If one can induce parthenocarpy through the application of growth substances, which fruit would you select to use parthenocarpy and why?

Parthenocarpy can be induced in banana, grapes and guava to obtain seedless fruits.

18. Are pollination and fertilization necessary in apomixes? Give reasons.

Pollination and fertilization are not necessary because in apomicts, the embryos develop directly develop from the cells of nucellus, integument or megaspore mother cell.

19. Embryo sacs of some apomictic species appear normal but contain diploid cells. Why?

It is true that many apomicts possess normal looking embryo sacs. The only possibility of the embryo sac possessing diploid cells is due to failure of meiotic division of megaspore mother cell. The MMC undergo mitosis instead of meiosis to produce all diploid cells.

20. Can an unfertilized, apomictic embryo sac give rise to a diploid embryo? If yes, How?

Yes. If the embryo develops from the cells of nucellus or integument as they are diploid.

21. Name the mechanism responsible for the formation of seed without fertilization in angiosperms. Give an example.

Apomixis Eg: grasses and members of asteraceae.

22. Are parthenocarpy and apomixis different phenomenon?

Parthenocarpy and apomixis are different phenomena. Parthenocarpy is the formation of fruits without fertilization and hence the fruits are seedless. Whereas, apomixis is the phenomenon of formation of seeds without fertilization. These embryos are genetically identical to the parental plant.

23. In case of Polyembryony, if an embryo develops from synergid, and another from the nucellus, which is haploid and which is diploid?

Synergid embryo is haploid and Nucellar embryo is diploid.

THREE MARKS QUESTIONS

1. Explain the role of Tapetum in the formation of pollen grain.

During microsporogenesis, the Tapetum performs the following functions:

- It transports nutrients to developing pollen grains.
- It secretes enzymes (callase) and hormones.
- It produces ubisch bodies which are coated with sporopollenin to cause thickening of exine.
- Secretes oil coating over pollen grains called pollen kit. It protects the pollen from UV radiations and attracts insects.
- Secretes special protein to recognize compatibility

2. What is the importance of pollen grains?

- Pollen grains of many species cause severe allergies and bronchial afflictions leading to chronic respiratory disorders like asthma, bronchitis etc.,
- They are rich in nutrients. So the pollen tablets and syrups are used as food supplements.
- Consumption of pollen grains may increase the performance of athletes & race horses.

3. Write a note on viability of pollen grains.

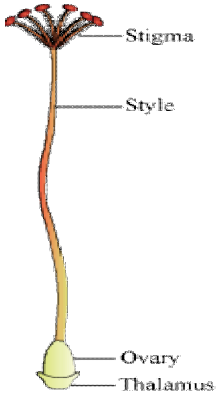
- Viability of pollen grains depends on the prevailing temperature and humidity
- In some cereals like rice and wheat, pollen grains lose viability within 30minutes of their release
- The pollen grains of some members of Rosaceae, Leguminaceae and Solanaceae can be preserved in liquid nitrogen at -196^{0}C, for many years and used as pollen banks in crop breeding programs.

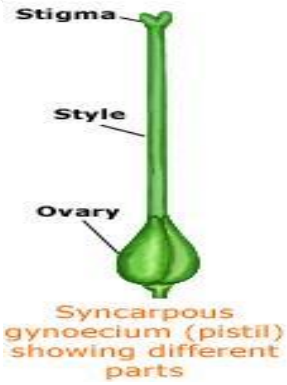
4. Describe the structure of gynoecium or pistil with a neat labelled diagram.

Pistil is a female reproductive structure of flower. It has one or more units called carpels. Carpels are also called megasporophylls. Each carpel has a basal swollen ovary, a long stalk called style that terminates in stigma.

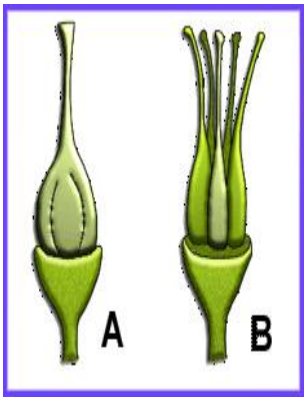
The pistil with one carpel is called monocarpellary and with many carpels is called multicarpellary pistil.

If the carpels are fused, the condition is called syncarpous, and if the carpels are free, the condition is called apocarpous.

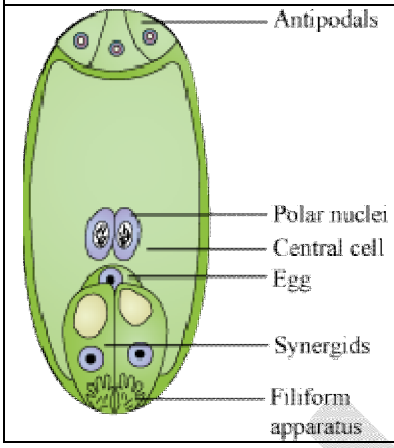
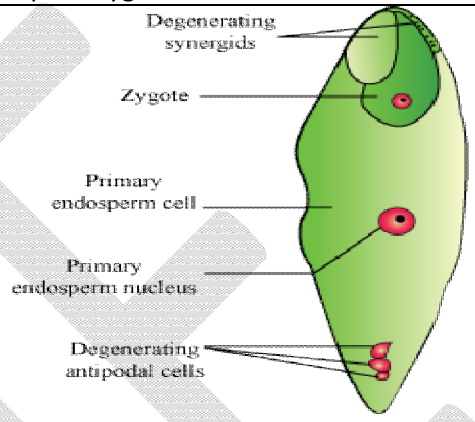




Syncarpous gynoecium (pistil) showing different parts



5. What are the differences between a matured unfertilized embryo sac and a fertilized embryo sac?

Unfertilized embryo sac	Fertilized embryo sac
All the cells are haploid	Zygote is diploid, PEN is triploid and other cells are haploid
Antipodals and synergids are distinctly present	Antipodals and synergids gradually degenerate
The haploid polar nuclei may fuse to form a diploid secondary nucleus	Diploid secondary nucleus fertilizes with a haploid male gamete to form a triploid PEN
Egg cell is haploid	Egg cell fertilizes with the male gamete to form a diploid zygote
	

6. What are chasmogamous flowers? Can cross pollination occur in cleistogamous flowers? Give reasons.

Chasmagamous flowers open at maturity and expose their anthers and stigma.

Cross pollination does not occur in cleistogamous flowers as they do not bloom or bloom after self pollination. They are autogamous. Eg: Viola, Oxalis and Commelina

7. What are the characters of insect pollinated flowers (entamophilous flowers)?

The insect pollinated flowers are

- Large
- Colourful
- Showy
- fragrant
- rich in nectar
- provide reward in the form of nectar and pollen
- safe place to lay eggs
- some flowers produce foul odour to attract flies and beetles
- pollen grains are sticky

8. What are the characters of wind pollinated flowers (anemophilous flowers)? Give example.

- Pollen grains are light and non-sticky.
- Stigma is large & feathery to trap pollen grains.
- They have single ovule in each ovary and numerous flowers packed into an inflorescence. Eg: corn cob & grasses.

9. What are the characters of water pollinated (hydrophilous) flowers?Give examples

- Pollen grains are long and ribbon like
- Pollen grains are protected from wetting by mucilaginous covering
  Eg: vallisneria, hydrilla, marine sea grasses like zostera

10. Explain the mechanism of pollination in water plants like vallisneria and sea grass (Zostera).

In vallisneria, the female flowers reach the surface of water by the long stalk and the male flowers are released onto the surface of water. They are carried by water currents and some of them eventually contact with female flowers and its stigma to bring about pollination.

In sea grass, female flowers remain submerged in water and the pollen grains are released inside the water. Pollen grains are long, ribbon like and they are carried passively inside the water; some of them reach the stigma and achieve pollination.

11. Write a note on pollen – pistil interaction.

All the events from pollen deposition on the stigma until the entry of the pollen tube into the ovule are together called pollen-pistil interaction. It is a dynamic process involving pollen recognition by stigma/pistil for compatible pollen by accepting them and if incompatible rejecting them.

- The pistil has the ability to recognize the compatible or incompatible pollen
- If the pollen is compatible, the pistil accepts the pollen and promotes post pollination events that leads to fertilization
- This pollen – pistil interaction is governed by chemical components of pollen and pistil

12. What is self-incompatibility? Does it impose any restrictions on autogamy? Give reasons and suggest the method of pollination in such plants.

In some plants, when mature pollen grain falls on the receptive stigma of the same flower, it fails to bring about self-pollination. It is called self-incompatibility. Eg: Potato, Tobacco, Petunia.

It imposes restrictions on autogamy. These plants undergo only cross pollination.

13. What is artificial hybridization? How is it achieved? What is its significance?

It is a process of transferring desired pollen grains onto the stigma by preventing contamination from unwanted pollen to obtain improved crop varieties.

It is achieved by:

- **Emasculation:** The technique of removal of anthers from a bisexual floral bud before their dehiscence using a pair of forceps or scissors is called emasculation.
- **Bagging:** The process of covering of emasculated flowers with a bag made of butter paper to prevent the contamination of stigma from unwanted pollen is called bagging.

Then the matured pollen grains collected from the anther are dusted onto stigma. Then the flowers are rebagged and the fruits are allowed to develop. Plant breeders employ this technique in artificial hybridization technique to perform crossing experiments and also to produce commercially superior varieties of plants.

14. What is meant by emasculation? When and why does a plant breeder employ this technique?

The technique of removal of anthers from the floral bud before their dehiscence using a pair of forceps or scissors is called emasculation.

Plant breeders employ this technique in artificial hybridization technique to perform crossing experiments and also to produce commercially superior varieties of plants.

15. What is bagging technique? How is it useful in a plant breeding programme?

The process of covering of emasculated flowers with a bag made of butter paper to prevent the contamination of stigma from unwanted pollen is called bagging.

- It is used to carry out cross breeding by desired pollen for crop improvement programmes.
- It is used in the production of commercially superior hybrid varieties.

16. What is triple fusion? Where does it take place? Name the nuclei involved in the triple fusion.

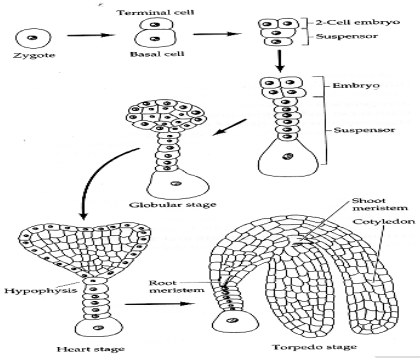
The fusion of one haploid male gamete with two haploid polar nuclei or one diploid secondary nucleus to produce a triploid endosperm nucleus in the embryo sac is called triple fusion.

It occurs in the central cell of embryo sac.

The nuclei involved in triple fusion are one nucleus from male gamete and two polar nuclei.

17. Explain the development of embryo in angiosperms.

The process of development of embryo from zygote is called embryogenesis. The embryo develops from a diploid zygote located at the micropylar region of embryo sac. The zygote development takes place after the formation of certain amount of endosperm from PEN as it requires nourishment. The zygote divides mitotically to form pro embryo and subsequently into the globular, heart shaped and mature embryo. The mature embryo has cotyledon/s and an embryonic axis with plumule and radicle.



18. Write a note on viability of seeds.

- In a few species the seeds loose viability within few months.
- The seeds of large number of species live for several years.
- The oldest viable seed is that of lupine, Lupinus arcticus excavated from Arctic tundra. The seed germinated and flowered after an estimated record of 10000 years of dormancy.
- The recent record of 2000 years old viable seed is of the date palm, Phoenix dactylifera discovered during the archeological excavation at King Herod's palace near 'The Dead Sea'.

19. What are the advantages of seeds?

- The reproductive processes like pollination and fertilization are independent of water. So the seed formation is more dependable.
- Seeds have better adoptive strategies for dispersal to new habitats and help the species to colonize in other areas.
- As they have sufficient food reserves, young seedlings are nourished until they are capable of photosynthesis on their own. The hard seed coats provide protection to the young embryo.
- As they are the products of sexual reproduction, they generate new genetic combinations leading to variations.
- Seeds are used as food by animals.

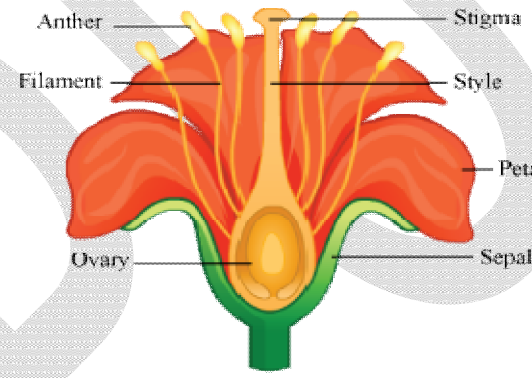
20. What is a fruit? Mention the types with example.

Fruit is a matured ripened fertilized or unfertilized ovary. It has a fruit wall called pericarp enclosing the seeds.
The types are:
a) Fleshy fruits: Pericarp is fleshy. Eg- Orange, mango, guava etc.
b) Dry fruits: Pericarp is dry. Eg- Groundnut, mustard etc.

FIVE MARKS QUESTIONS

1. Describe the LS of a typical flower with a neat labelled diagram.

Flower is a modified condensed shoot for sexual reproduction. The stalk of flower is called pedicel. The upper swollen part of pedicel is called Thalamus. The modified leaves as floral whorls are arranged on the thalamus.



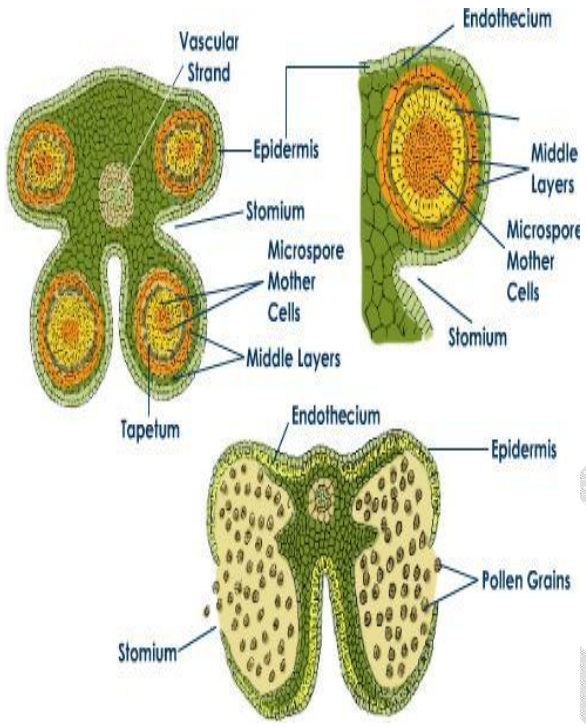
They are

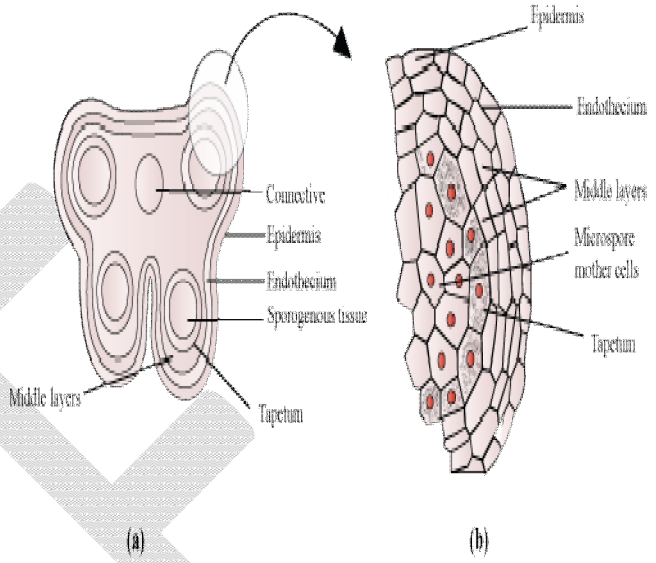
- Calyx – units called sepals (for protection)
- Corolla – units called petals (to attract pollinators)
- Androecium – units called stamens (microsporophylls to produce microspores in their microsporangia)
- Gynoecium/pistil – units called carpels (megasporophylls to produce megaspores in their Mega sporangia/ovules)

2. Explain the T.S of mature dithecous anther lobe with a neat labelled diagram.

The androecium is a male reproductive whorl of flower composed of units called stamens. The stamen has a long narrow slender stalk called filament and a knob like bilobed anther.

The bilobed anther (dithecous) is made up of two anther lobes connected by a sterile connective. It has four microsporangia (pollen chambers). So it is called tetrasporangiate anther lobe. Each microsporangium has a sporogenous tissue surrounded by an anther wall made up of four wall layers. These wall layers are produced from primary parietal cells derived from archesporial cells.





The four layers of anther wall are:

a) Epidermis: It is outer single layer of flattened cells which provides protection.

b) Endothecium: It is present below the epidermis. It is a single layer of radially elongated cells with fibrous thickenings. These cells are hygroscopic. When they lose water, they contract and cause dehiscence of anther for the release of pollen grains.

c) Middle layer of cells: These are two to three layers of cells present between Endothecium and Tapetum. They store food materials.

d) Tapetum: It is the innermost layer of anther wall containing the cells with rich cytoplasm and nuclei. It

- Nourishes pollen grains
- Forms pollen wall
- Secretes callase enzyme
- Secretes oil coating over pollen grains called pollen kit. It protects the pollen from UV radiations and attracts insects.

The Sporogenous cells produce diploid microspore mother cells. These diploid mother cells undergo meiosis to produce microspore tetrad. Each cell of tetrad separates to form microspore or pollen grain.

3. Explain the process of microsporogenesis (or) Explain the development of male gametophyte (pollen grain) in flowering plants.

The process of formation of microspores or pollen grains or male gametophytes from pollen mother cell through meiosis in the pollen chambers (micro sporangia) of anther is called microsporogenesis.

The primary hypodermal cells of young anther called archesporial cells differentiate into primary parietal cells and primary Sporogenous cells. The primary parietal cells produce 4 layers of anther wall namely Epidermis, Endothecium, middle layer of cells & Tapetum. Sporogenous cells develop into microspore mother cells (MMC) or pollen mother cells (PMC). The diploid MMC undergoes meiosis to produce a haploid microspore tetrad held

together by callose. Each haploid microspore separates from microspore tetrad by callase enzyme secreted by tapetum layer.

Microspore or pollen grain is the first cell of gametophytic generation. As it produces the male gametes, it is called male gametophyte. As the microspores develop within the microsporangium, it is called precocious germination.

MICROSPOROGENESIS

ARCHESPORIAL CELL

↓

SPOROGENOUS CELLS

↓ **MITOSIS**

MICROSPORE MOTHER CELL

↓ **MEIOSIS**

MICROSPORE TETRAD

↓

MICROSPORE (POLLEN GRAIN)

4. Explain the development and structure of male gametophyte or pollen grain or microspore.

Development of male gametophyte: Microspore is the first cell of gametophytic generation. The nucleus of the microspore migrates from center to periphery and divides to produce a large vegetative cell (tube cell) and a small generative cell. Temporary callose wall is laid between the two cells. It dissolves by callase enzyme and the nucleus of generative cell floats in the cytoplasm of tube cell. This two celled pollen grain is ready to liberate from pollen sac.

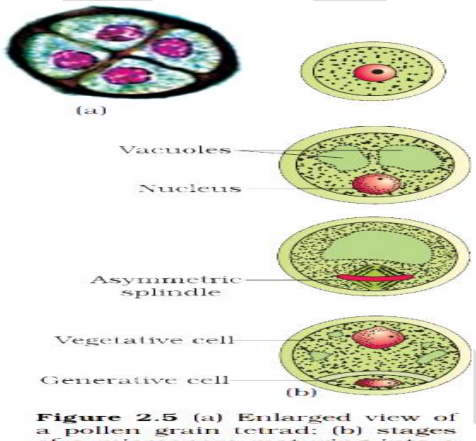
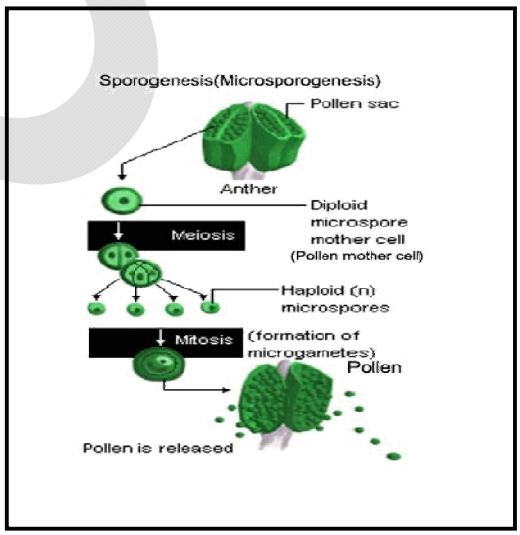
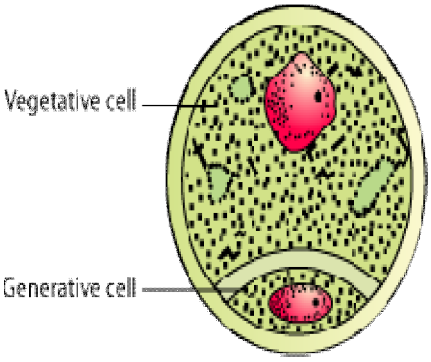


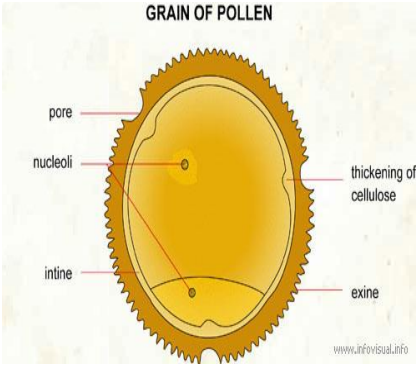
Figure 2.5 (a) Enlarged view of a pollen grain tetrad: (b) stages of a microspore maturing into a pollen grain



Structure of pollen grain:

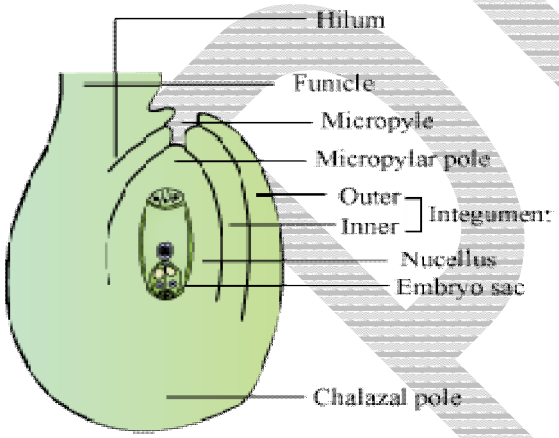
- It is spherical, oval, ellipsoidal & triangular in shape and 25-50 micrometer in diameter
- It has two layered wall namely outer exine & inner intine.
- Exine is hard, made up of sporopollenin. Sporopollenin is the most resistant organic material that can withstand high temperature, strong acids, alkalis & enzymes. It has prominent apertures called germ pores where sporopollenin is absent. Pollens can be well preserved as fossils because of the presence of sporopollenin.

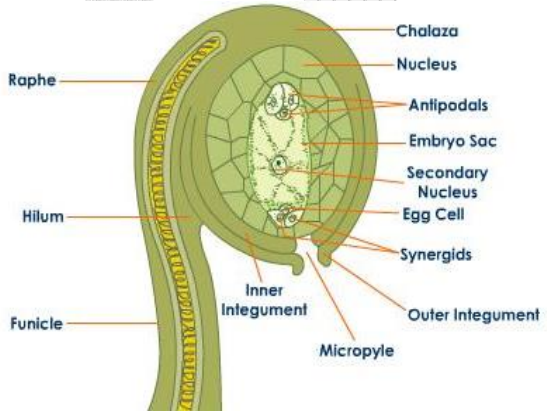




- The intine is thin continuous layer made up of cellulose and pectin.
- It is two or three celled. One vegetative cell and one generative cell / two gametic cells.
- The vegetative cell is large with abundant food reserve (starch & unsaturated oils) and large irregularly shaped nucleus.
- The generative cell is small and floats in the cytoplasm of vegetative cell. It is spindle shaped with dense cytoplasm and nucleus.
- Usually the pollen grain is shed at two cell stage in 60% of the angiosperms. In the remaining species, the generative cell divides mitotically and a three celled pollen grain is shed.
-

5. Describe the structure of an anatropous ovule or megasporangium with a neat labelled diagram.





The ovule is a small structure attached to the placenta by means of a stalk called funicle. The body of the ovule fuses with funicle in the region called hilum. The ovule has one or two protective envelopes called Integuments. These encircle the ovule except at the tip where a small opening called micropyle is organized. The chalaza is present opposite to the micropylar end representing the basal part of the ovule. The integuments enclose a mass of cells with reserved food called nucellus. Nucellus encloses the embryo sac or female gametophyte.

OR

Ovule (megasporangium) has

- Funicle – stalk of ovule
- Hilum – body of ovule that attaches to funicle
- Raphe – a ridge formed by funicle
- Integuments – covering of nucellus

- Nucellus – a mass of thin walled parenchymetous tissue that covers embryo sac
- Embryo sac – seven celled, eight nucleated female gametophyte
- Chalaza – basal portion of the ovule from where integuments arise
- Micropyle – a small opening left at the apex of integuments

6. Explain the process of megasporogenesis and megagametogenesis (the development of female gametophyte) (embryosac).

Megasporogenesis: The process of formation of megaspore from megaspore mother cell by the process of meiosis is called megasporogenesis.

The process of megasporogenesis occurs in megasporangia (ovules) present inside the ovary. Each ovule has outer integuments enclosing the nutritive tissue called nucellus. Some cells of nucellus develop into diploid **archesporial cells**. The archesporial cells undergo periclinal divisions to form outer parietal layer which adds cells to sporogenous mass during division and inner sporogenous cell that develop into **megaspore mother cell** (MMC).

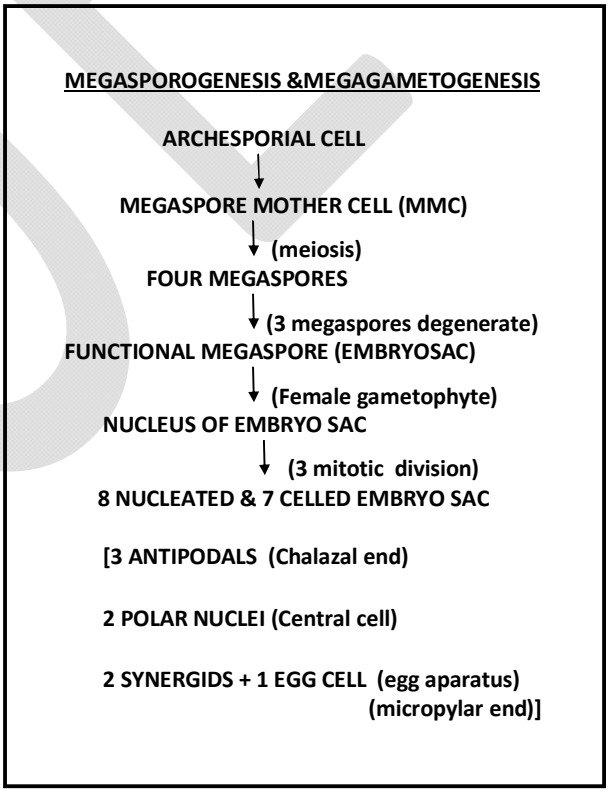
The MMC divides by meiosis to produce a linear tetrad of haploid **megaspores.** Out of 4 megaspores usually the upper three degenerate and the lowermost towards micropylar region enlarges to become a functional megaspore called **embryosac**. (This type of development is called **monosporic development**)

Megagametogenesis: It is the process of formation of egg cell from a functional megaspore (embryo sac)

The nucleus of embryo sac divides mitotically to form two nuclei which move to opposite poles. Two more successive mitotic divisions occur in each nucleus resulting in eight nucleate stage.

- Three nuclei in **chalazal** end are surrounded by cell wall and organized to form three **antipodal cells.**
- Two nuclei from each pole move to the centre to form polar nuclei present in a large **central cell**
- Three nuclei in the **micropyla**r end are surrounded by cell wall and organize into three celled **egg apparatus**. It consists of two synergids and an egg cell.

So the mature embryo sac is **eight nucleated and seven celled**.



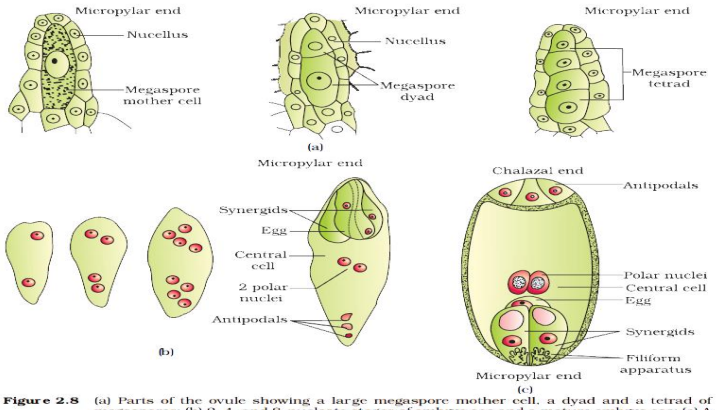


Figure 2.8 (a) Parts of the ovule showing a large megaspore mother cell, a dyad and a tetrad of megaspores; (b) 2, 4, and 8-nucleate stages of embryo sac and a mature embryo sac; (c) A diagrammatic representation of the mature embryo sac.

7. Differentiate between microsporogenesis and megasporogenesis. Which type of cell division occurs during these events? Name the structures formed at the end of these events.

Microsporogenesis	Megasporogenesis
1) The process of formation of microspores from microspore mother cell through meiosis is called microsporogenesis.	1) The process of formation of megaspores from megaspore mother cell through meiosis is called megasporogenesis.
2) It occurs inside the microsporangium of anther.	2) It occurs in nucellus of ovule.
3) Many microspore mother cells are differentiated.	3) Only one megaspore mother cell is differentiated.
4) Microspore mother cell produces tetrad of microspores.	4) Megaspore mother cell produces a linear tetrad of megaspores.
5) All the four cells of microspore tetrad are functional.	5) Three megaspores degenerate and only one megaspore becomes functional and develops into embryo sac (female gametophyte)

Meiosis occurs during these events.

Microspore and megaspore are the cells produced at the end of these two events.

8. What is pollination? Explain the types and factors favouring self pollination.

Pollination is the transfer of pollen grains from anther to receptive stigma of same or another flower.

The types are

I. Autogamy: It is the transfer of pollen grains from anther to stigma of the flowers of the same plant.

a) Homogamy – It is the transfer of pollen grains from anther to the stigma of the same flower

b) Geitonogamy: It is the transfer of pollen grain from anther of one flower to the stigma of another flower of the same plant.

Autogamy is favored when

- Synchronisation in the release of pollen and stigma receptivity
- The flowers are bisexual
- Anther and stigma of a flower attain maturation at the same time
- Cleistogamy : The flowers do not bloom. Eg: Oxalis, Viola (common pansy) commelina
- The anther and stigma lie close to one another

II. Allogamy or cross pollination: The transfer of pollen from anther of one flower to stigma of another flower of another plant is called allogamy.

Xenogamy: The transfer of pollen grains for anther of one flower to stigma of another flower of a different plant. It results in genetic recombination.

9. Mention the types of pollination based on the respective pollinating agents

TYPES OF POLLINATION	I ABIOTIC AGENTS
a) Anemophily	Pollination by wind
b) Hydrophily	Pollination by water
	II BIOTIC AGENTS
c) Zoophily	Pollination by animals (lemurs, rodents, gecko, garden lizard)
d)Ornithophily	Pollination by birds (sun bird, humming bird)
e) Entamophily	Pollination by insects (bees, beetles, wasps, moths)
f) Malacophily	Pollination by snails
g) Myrmacophily	Pollination by ants
f) Chiropterophily	Pollination by bats

10. What are outbreeding devices? Explain.

The outbreeding devices are the devices or mechanisms to prevent self pollination and favor cross pollination to overcome the problem of inbreeding depression (caused due to continuous self pollination). These are also called contrivances for cross pollination. The factors favoring cross pollination are

- Unisexual flowers or dioecious plants or dicliny
- Male and female flowers are present in different plants which prevents homogamy and geitonogamy
  Eg: Papaya
- In monoecious plants like castor and maize homogamy is prevented but not geitonogamy
- Chasmogamous flowers: the flowers with exposed anther and stigma to facilitate pollination
- Dichogamy: The bisexual flowers in which male and female reproductive parts mature at different times, so prevents self pollination and favors cross pollination
  a) Protandry: Flower in which anther mature earlier to stigma to prevent self pollination.
  Eg: sunflower, cotton
  b)Protogyny : Flower in which stigma matures earlier to anther to prevent self pollination
  Eg: Mirabilis jalapa
- Pollen release and stigma receptivity are not synchronized due to dichogamy (protandry and protogyny)
- Herkogamy: It is flower in which there are physical barrier between anther and stigma
  Eg: calotropis
- Heterostyles: The flower with different length of styles and stamens that prevents self pollination
  Eg: Prim rose, Oxalis
- Self sterility or self incompatibility: The pollen grains do not germinate on stigma of same flower due to mutual inhibition. In this the genetic mechanism prevents the pollen germination on stigma
  Eg: Potato, Tobacco, Petunia.
- Suppression of one sex: In bisexual flower stamen or carpel is completely suppressed and become sterile

11. Explain the post pollination events or double fertilization process in angiosperms.

The pollen grains usually shed at two celled stage namely vegetative cell and generative cell. Further the generative cell divides to produce two haploid male gametes in pollen tube. In some plants, the pollen grains shed at three celled stage where pollen tube carries two male gametes from the beginning.

After pollination, the compatible pollen grain germinates on stigma by obtaining nourishment from stigmatic tissue. The vegetative cell or tube cell germinates into pollen tube through the style called siphonogamy. Then the pollen tube enters the embryo sac through different regions of ovule. They are

- Chalazogamy – pollen tube enters through chalaza
- Mesogamy - pollen tube enters laterally through integuments
- Porogamy – pollen tube enters through micropyle

Normally the pollen tube enters through micropyle into the embryosac through synergids. Synergids have filiform apparatus that guide the entry of the pollen tube into embryo sac. The tip of the pollen tube ruptures to release two haploid male gametes into embryosac.

One haploid male gamete fertilizes with the diploid secondary nucleus of central cell to form a triploid primary endosperm cell. This process is called **triple fusion**. The other haploid male gamete fertilizes with the haploid egg cell to form a diploid zygote.

Double fertilization: In the above process one haploid male gamete fertilizes with a diploid secondary nucleus to form a triploid primary endosperm nucleus and the other haploid male gamete fertilizes with the haploid egg cell to form a diploid zygote (syngamy). Hence is called double fertilization.

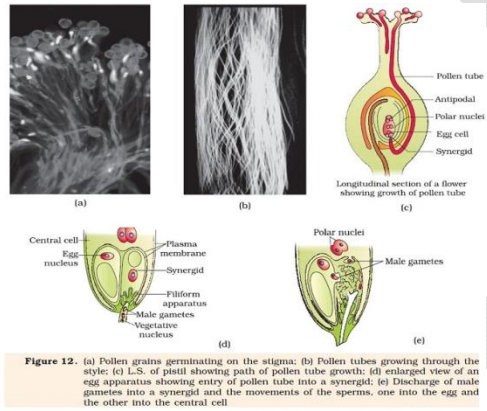
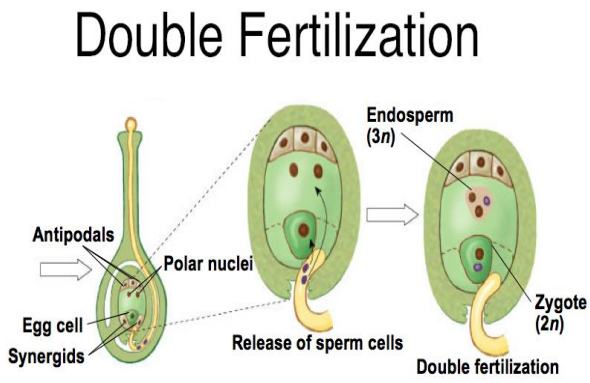


Figure 12. (a) Pollen grains germinating on the stigma; (b) Pollen tubes growing through the style; (c) L.S. of pistil showing path of pollen tube growth; (d) enlarged view of an egg apparatus showing entry of pollen tube into a synergid; (e) Discharge of male gametes into a synergid and the movements of the sperms, one into the egg and the other into the central cell



12. Write the post fertilization events that occur in angiosperm flower.

The post fertilization events are

- Antipodals and synergids disappear
- Sepals, petals and stamens wither off
- Ovules develop into seeds
- Integuments form the seed coats namely testa and tegmen
- Primary endosperm cell develops into endosperm that provides nourishment for developing embryo
- Zygote develops into embryo
- Ovary develops into fruits

Changes occur in flowering plants:

Sepal	Fall off
Petal	Fall off
Stamen	Fall off
Zygote	Embryo
Primary endosperm nucleus	Endosperm (3 N)
Synergid	Disintegrate

Antipodals	Disintegrate
Ovary	Fruit
Ovule	Seed
Ovary wall	Pericarp (epicarp + mesocarp + endocarp)
Integument	Seed coat (testa + tegmen)

13. Explain the development of endosperms in angiosperms.

The endosperm is developed from triploid primary endosperm nucleus (PEN). It precedes embryo development from zygote. During this process the triploid PEN divides mitotically to produce endosperm tissue filled with food materials. It is used for nourishing developing embryo.

There are two types of endosperm development

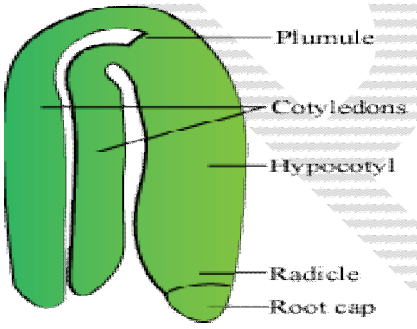
- **Free nuclear endosperm development**: The PEN undergoes successive nuclear division to give rise to free nuclei. This does not involve the cell wall formation. Eg: coconut water
- **Cellular endosperm development:** The PEN undergoes successive nuclear division followed by the cell wall formation. Eg: White kernel of coconut

During the embryonic development, the embryo may completely consume the endosperm before the seed matures. This results in **non endospermic seeds or exalbuminous seeds**. Eg: pea, ground nut, bean, etc.

The embryo may not utilize the endosperm completely and some amount of endosperm persists in the matured seeds. This results in the formation of **endospermic seeds or albuminous seeds.** Eg: castor, maize.

14. Explain the structure of a typical dicot embryo with a labelled diagram.

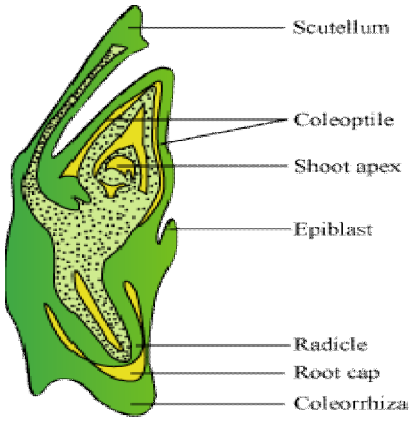
A typical dicot embryo consists of an embryonic axis and two cotyledons. The portion of the embryonic axis above the cotyledons is called epicotyl, which terminates with the plumule (embryonic shoot). The cylindrical portion below the level of cotyledons is called hypocotyl, which terminates at its lower end in the radicle (embryonic root). The root tip is covered by root cap



.

15. Explain the structure of a typical monocot embryo with a labelled diagram.

The monocot embryo possesses only one cotyledon called scutellum, which is situated towards one side of the embryonic axis. The embryonic axis has the radicle and root cap enclosed in an undifferentiated sheath called coleorrhiza. The portion of the embryonic axis above the level of attachment of scutellum is the epicotyl. Epicotyl has a shoot apex and a few leaf primordial enclosed in a hollow foliar structure called coleoptile.



16. Draw a VS of maize grain and LS of an albuminous seed.

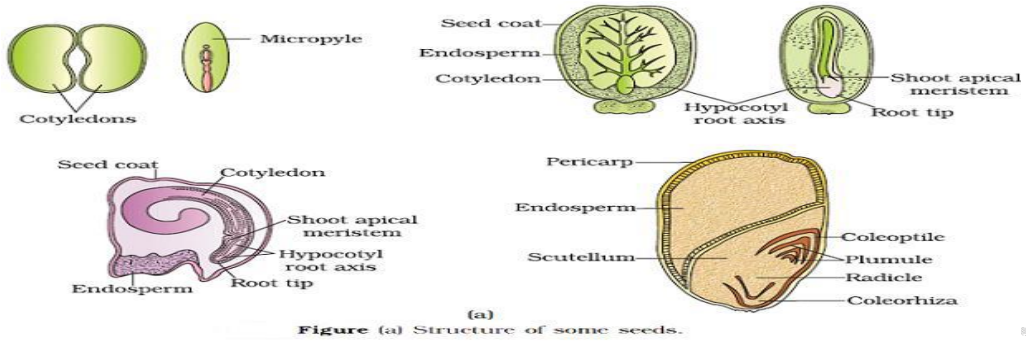


Figure (a) Structure of some seeds.

17. What is a seed? Explain the structure and types of seeds.

Seed is a matured fertilized ovule. It has seed coats, cotyledon/s and an embryo. Cotyledon is thick and swollen due to storage of food reserves. There are two types of seeds:

- **Albuminous seeds**: Have endosperm. Eg: Wheat, maize, barley, castor, sunflower etc.,
- **Exalbuminous seeds**: Do not have endosperm. Eg: Pea, groundnut etc.,

The black pepper and beet seeds have remnants of nucellus in their seeds called **perisperm**. The micropyle remains a pore that facilitates the entry of water and oxygen into the seed during germination.
As the seed matures, it loses 10 – 15 % of moisture by mass and metabolic activities of the embryo slows down. This inactive state is called **dormancy**. During favorable conditions like the availability of adequate moisture, oxygen & suitable temperature induces the germination of seeds.

18. What is Apomixis (Agamospermy)? How do they develop? What is its importance?

The development of seeds without involving meiosis and fertilization is called apomixis. It is a kind of asexual reproduction that mimics sexual reproduction.

Apomictic embryos develop from:

- Haploid gametophytes (Apogamy)
- Diploid megaspores (Apospory)
- Diploid Nucellar cell and integument cells (Adventative embryony)

The advantages of apomixis are:

- The segregation of characters does not take place in the seeds of apomictic hybrids. This helps in conserving desired traits of hybrids. Hence extensively used in agriculture and horticulture.
- Reduced cost of hybrid production.
- Accelerated breeding.
- Maintain hybrid vigour.
- Free from diseases.
- Nucellar seedlings of citrus provide better clones.

19. What is Polyembryony? How do they develop? How can it be commercially exploited?

Polyembryony is the occurrence of more than one embryo in a seed.

Polyembryos develop from:

Å Diploid egg cells
Å Haploid egg cells (Parthenogenesis)
Å Secondary nucleus (Parthenogamy)
Å Megaspores (Diplospory)
Å Synergids & Antipodals
Å Nucellar cells & Integument cells (Citrus, Mango) (Adventative embryony)
Å Cleavage Polyembryony (Gymnosperms, Nicotiana)

All these embryos can be isolated and cultured in artificial medium under aseptic conditions in vitro. Through micropropagation, many plants can be raised from one seed.