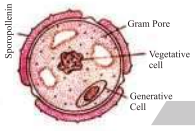
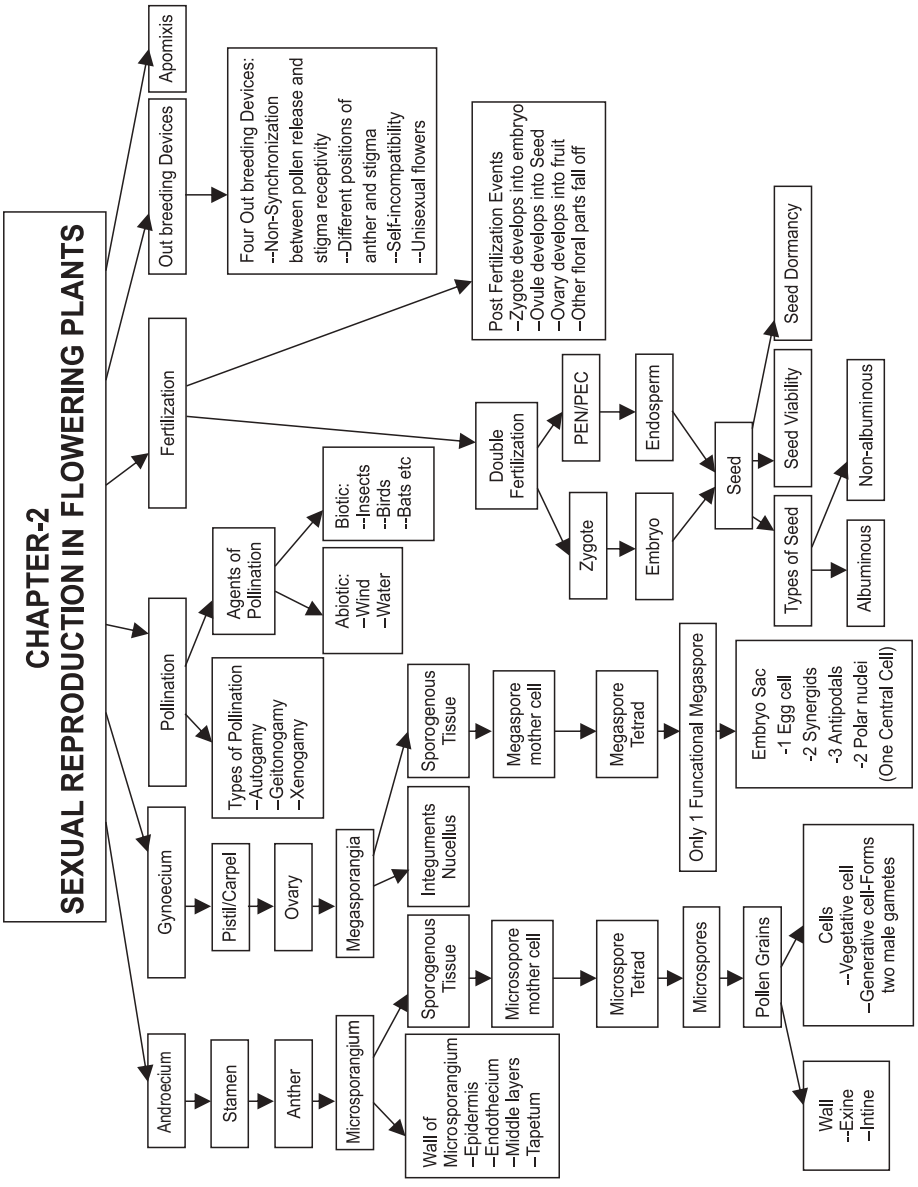


Chapter - 1

Sexual Reproduction in Flowering Plants



Autogamy : When pollen grains of a flower are transferred from anther to stigma of the same flower.

Coleorhiza : A protective sheath of radicle in monocot seed.

Coleoptile : A protective sheath of plumule in monocot seed.

Perisperm : It is diploid persistent nucellus e.g. Black pepper, beet.

Nucellus : Multicellular tissue in the centre of ovule in which embryo sac is present.

Viability of Seed : Ability of seed to retain the power of germination.

Structure of Microsporangium (Pollen Sac)		
Sequence of layers	**Name of Layer**	**Function**
Outermost layers	Epidermis	Protection
Second layer	Endothecium	Protection
2-4 layers of Cells	Middle layer	Protection
Innermost layer	Tapetum multinucleate DENSE cytoplasm	Nourishment of developing microspores (pollen grains)

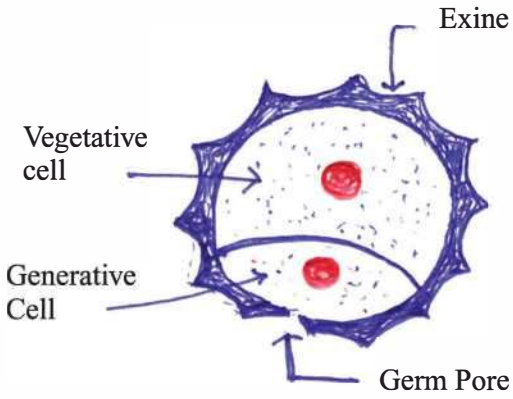
Microsporogenesis : Process of formation of microspores from a pollen mother cells.

Sporogenous tissue--> Microspore mother cell-MMC--> Microspore tetrad --> 4 Microspores --> 4 Pollen grains

[Diploid] [Diploid] [Haploid] [Haploid] [Haploid]

Pollen Grain (Male Gametophyte)		
Layers and Contents	**Name of Layers**	**Composition and Roles**
Outer wall	Exine	Thick, hard, made of sporopollenin Due to sporopollenin, pollen grains found preserved in fossils
Inner wall	Intine	Thin, made of cellulose and pectin. It emerges out as pollen tube.
Large cell	Vegetative cell	Forms a pollen tube to deliver male gametes to embryo sac
Smaller cell	Generative cell	Forms sperm cells or male gametes

Sporogenous Issue : Compactly arranged homogenous cells called as sporogenous tissue



Structure of Pollen Grain

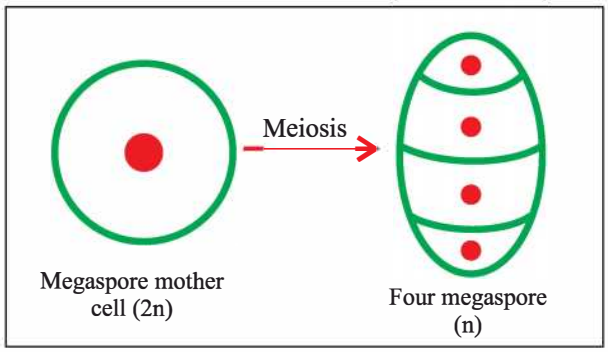
Sporopollenin is one of the most resistant organic substance. It is not affected by high temperature, strong acids or alkali. No enzyme can degrade it.

Pollen Products : Pollen grains are rich in carbohydrates, proteins and unsaturated fats. Their consumption is believed to increase performance of athlete and horses. They are used in the form of tablets and syrups.

Pollen Viability : Pollens of wheat and rice remain viable for 30 minutes. eg Pollen of some members of Rosaceae, Leguminoseae and solanaceae plant may remain viable for several months. Pollens can be cryopreserved in liquid Nitrogen (— 196°C) in pollen banks.

Pollen of carrot grass (*Parthenium*), *Chenopodium, Amaranthus* etc. may cause pollen allergy.

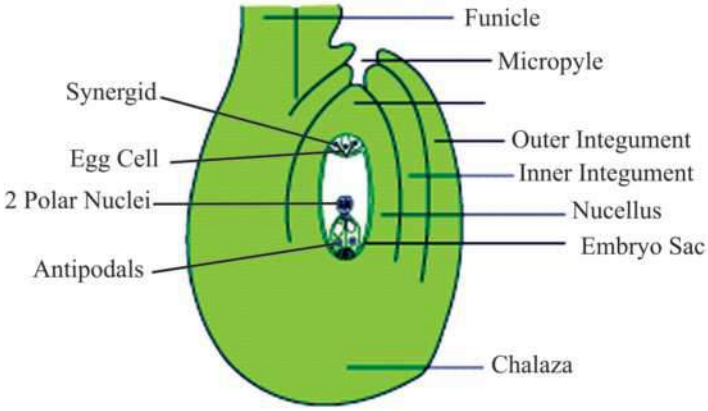
Megasporogensis : Process of formation of haploid megaspores from megaspore mother cells



Megasporangium (Ovule) :

- The ovule is a small structure which is attached to the placenta by means of a stalk called funicle.

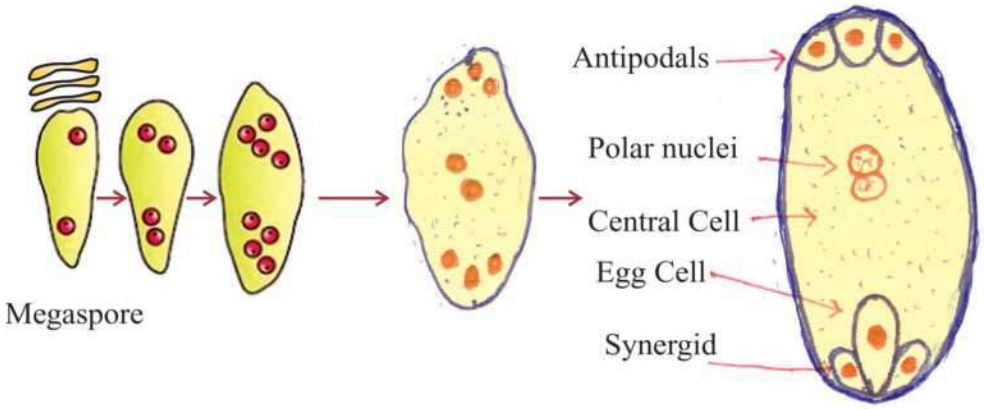
- The point of attachment of the body of the ovule to the funicle is known as hilum. The main body of the ovule is composed of parenchymatous cells known as nucellus.
- Each ovule has one or two protective integument, which encircle the ovule except at the tip having small opening called micropyle.
- Opposite to micropylar end is chalazal end
  Generally a single embryosac or female gametophyte located in nucellus.
- Cells of nucellus have abundant reserve food material and provide nourishment to the developing embryo.



Female gametophyte (embryo sac) : In a majority of flowering plant out of four megaspores one of the megaspore is functional while other three degenerate, (monosporic development)

- The functional megaspore develops in embryo sac.
- The nucleus of the functional megaspore (n) undergoes three successive mitotic cell division which results the formation of eight nucleated stage of embryo sac (free nuclear division).
- The cell wall formation starts at eight nucleated stages. Three cells are grouped together at micropylar end to form the egg apparatus (2 synergids + 1 egg cell).
- Three cells are grouped at chalazal end they are, called antipodal cells.
- The remaining 2 nuclei are polar nuclei move to the centre of embryo sac, called central cell.

  Thus, typical angiospermic embryo sac at maturity is 8 nucleate and 7 celled.



Development of Embryo Sac

TYPES OF POLLINATION		
Autogamy	**Definition**	**Special Feature**
	Transfer of pollen grain from the anther to the stigma of the same flower.	Self Pollination
Geitonogamy	Transfer of pollen grains from the anther to the stigma of another flower of the same plant.	It is functionally cross-pollination involving a pollination agent and genetically it is similar to autogamy since the pollen grains come from the same plant.
Xenogamy	Transfer of pollen grains from anther to the stigma of a different plant.	Cross Pollination

Agents of Pollination: Biotic and Abiotic agents help in pollination.

(a) Biotic Agents- Bees, flies, butterflies, wasps, moths, ants, birds, rodents, reptiles, and some primates.

(b) Abiotic Agents-Wind and water.

Types of Flowers : In some plants like Commelina, Oxalis and Viola have two types of flowers:

1. Chasmogamous Flower"

Flower remains open after maturity, both self pollination and cross pollination both can occur in the flower.

2. Cleistogamous Flower: Flower remain closed throughout their life, so, only self pollination (autogamy) occurs in such flowers.These flowers produce assured seed set even in the absence of pollinators

Out breeding Devices: Flowering plants have developed many devices called out breeding devices to discourage self pollination and to encourage cross-pollination. As continued, Self pollination leads to inbreeding depression . The types are:

(i) Non synchronization of pollen release and stigma receptivity
(ii) Position of anthers and stigma in such a way that pollen cannot come in contact of stigma of same flower.
(iii) Self-incompatibilty
(iv) Production of Unisexual flowers

Pollen—pistil interaction :

- The pistil has the ability to recognise the pollen grain, whether it is right type (Compatible) or of the wrong type (incompatible).
- If it is compatible then the pistil accepts the pollen grains.
- The pollen grains germinate on stigma to produce pollen tubes. The contents of the generative cell (or the two male gametes in those species whose pollen is liberated in the three celled stage), move into the pollen tube.
- Pollen tube grows through the tissue of stigma and style by secreting enzyme and enters the ovule, through micropyle via one of the synergid. Filiform apparatus guides the entry of pollen tube.

Double Fertilisation : The pollen tube releases two male gamete into the cytoplasm of synergid. One male gamete move towards egg cell and other male gamete towards the central cell.

- Syngamy : One male gamete + Egg cell → Zygote (2n)
- Triple Fusion : Second male gamete + 2 polar nuclei → PEN (3n)
- Since two types of fusion takes place in embryo sac, hence it is called as double fertilisation.

Post Fertilisation Events :

(i) Endosperm and embryo development

(ii) Maturation of ovule & ovary

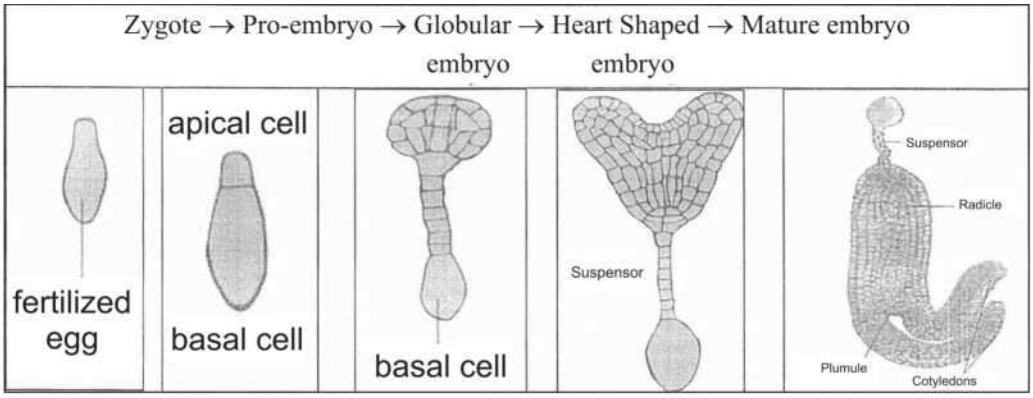
Fate of Floral Parts

Ovary (2n)	→	Fruit
Ovary Wall (2n)	→	Pericarp
Ovule (2n)	→	Seed
Outer Integument (2n)	→	Testa
Inner integument (2n)	→	Tegmen
Zygote (2n)	→	Embryo
Primary Endosperm Cell (3n)	→	Endosperm
Sepals (2n)	→	Fall down
Petals (2n)	→	Fall down
Stamens (2n)	→	Wither away
Stigma, style (2n)	→	Wither away
Nucellus	→	Consumed/may be present as Perisperm
Synergids (n)		Degenerate
Antipodal Cells (n)		Degenerate

Development of Endosperm: The primary endosperm cell (PEC) in embryo sac divide again and again, and form triploid endosperm. The cells of endosperm are filled with reserve food material which is used for nourishment of the embryo during its development and also for the young seedling at the time of germination.

PEN $\xrightarrow{\text{nuclear division}}$ Free Nuclear endosperm (e.g coconut water) $\xrightarrow{\text{Cellwall formation}}$ Cellular endosperm (e.g white kernel of coconut)

Development of Embryo: Embryo formation start after certain amount of endosperm is formed Following are the stages in development of a dicotyledonous embryo



Dicot Embryo : A typical dicot embryo consist of an embryonal axis and two cotyledons. The portion of embryonal axis above the level of cotyledons is the epicotyl and the portion below the level of cotyledons is hypocotyl.

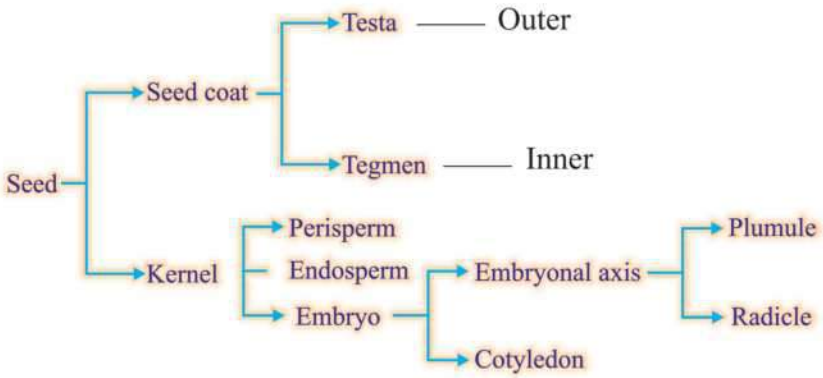
Monocot Embryo : Monocot (Rice, Maize etc.) has one cotyledon called Scutellum. The embryonal axis has the radicle and root cap enclosed by a sheath called Coleorrhiza.

The upper end (epicotyle) has plumule which is covered by hollow foliar structure called the coleoptile.

Polyembryony : Occurrence of more than one embryo in a seed, is known as polyembryony e.g. Orange, lemon, onion, mango, ground nut. It may be due to presence of more than one egg cell in the embryo sac or more than one embryo sac in the ovule.

Reasons of polyembryony : It is due to fertilisation of more than one egg cell in an ovule. The condition develop when an embryo sac contains more than one egg cell or ovule contain more than one embryo sac.

Seed : After fertilisation ovule mature into seed.



Non albuminous seed : Those seeds in which no residual endosperm is found because it is completely consumed during development of the embryo.
eg. pea, gram, ground nut.

Albuminous Seed : Those seeds, which retain a part of the endosperm because endosperm is not completely consumed by developing embryo.
eg. maize, wheat, sunflower, castor

Seed Dispersal : Seeds are dispersed to new habitat through agent like water, wind and animals.

Apomixis : Apomixis is a form of asexual reproduction that mimics sexual reproduction where seeds are formed without fertilisation.

Advantages of Apomictic Seed :

- No segregation of characters in hybrid progeny
- These seeds can be used to grow crop year after year
- These are economical as hybrid seed are not used to grow crops year after year.

Parthenocarpic fruits : The fruits which are formed (developed) without fertilisation are known as parthenocarpic fruit. Such fruits are seedless eg. Banana.

This phenomenon of development of fruit without fertilisation is known as parthenocarpy.

Questions

VSA **(1 Marks)**

1. Give the scientific name of a plant which came to India as a contaminant with imported wheat and causes pollen allergy.
2. Which characteristic of water pollinated species of pollen grains protect them from water?
3. Why are pollen grains produced in enormous quantity in maize ?
4. In some species of Asteraceae and grasses, seeds are formed without fusion of gametes. Mention the scientific term for such of reproduction.
5. If the diploid number of chromosomes in an angiospermic plant is 16. Mention number of chromosomes in the endosperm and antipodal cell.
6. Among the terms listed below, those that are not technically correct names for a floral whorl are:
   (i) Androecium (ii) Carpel (iii) Corolla (iv) Sepal
   (a) (i) and (iv)
   (b) (iii) and (iv)
   (c) (ii) and (iv)
   (d) (i) and (ii)
7. Embryo sac is to ovule as..... is to an anther
   (a) Stamen
   (b) Filament
   (c) Pollen grain
   (d) Androecium
8. In a typical complete, bisexual and hypogynous flower, the arrangement of floral whorls on the thalamus from the outermost to the innermost is
   (a) Calyx, corolla, androecium and gynoecium
   (b) Calyx, corolla, gynoecium and androecium
   (c) Gynoecium, androecium, corolla and calyx
   (d) Androecium, gynoecium, corolla and calyx

9. A dicotyledonous plant bears flowers but never produces fruits and seeds. The most probable cause for the above situation is
   (a) Plant is dioecious and bears only pistillate flowers
   (b) Plant is dioecious and bears both pistillate and staminate flowers
   (c) Plant is monoecious
   (d) Plant is dioecious and bears only staminate flowers
10. The outermost and innermost wall layers of microsporangium in an anther are respectively
   (a) Endothecium and tapetum
   (b) Epidermis and endodermis
   (c) Epidermis and middle layer
   (d) Epidermis and tapetum
11. **Assertion:** More than one embryo may also occur in a seed.
   Reason: It may be due to presence of more than one egg cell in the embryo sac or more than one sac in the ovule.
   (a) Both assertion and reason are true, and reason is the correct explanation of assertion.
   (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
   (c) Assertion is true but reason is false.
   (d) Both assertion and reason are false.
12. **Assertion:** Apomixis is a form of asexual reproduction that mimics sexual reproduction where seeds are formed without fertilisation.
   Reason: Apomictic seeds cannot be used to grow crop year after year.
   (a) Both assertion and reason are true, and reason is the correct explanation of assertion.
   (b) Both assertion and reason are true, but reason is not the correct explanation of assertion.
   (c) Assertion is true but reason is false
   (d) Both assertion and reason are false.

SA-I **(2 Marks)**

13. Fruits generally develops from ovary, but in few species thalamus contributes to fruit formation.
    Name the two categoris of fruits and give one example of each.
14. Among the animals, insects particularly bees are the domiant pollinating agents. List any four characteristic features of the insect pollinated flower.
15. Differentiate between geintonogamy and xenogamy.
16. In the given figure I of a dicot embryo, label the parts (A) and (B) and give their function.

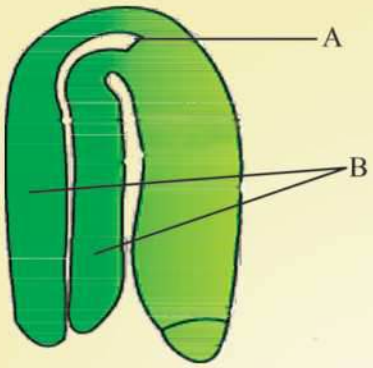


Figure 1

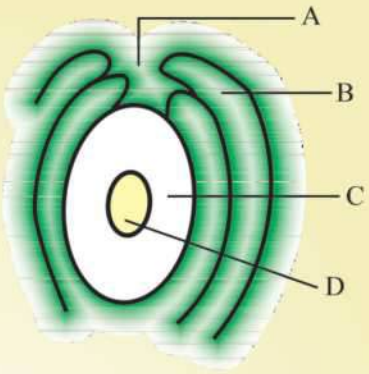
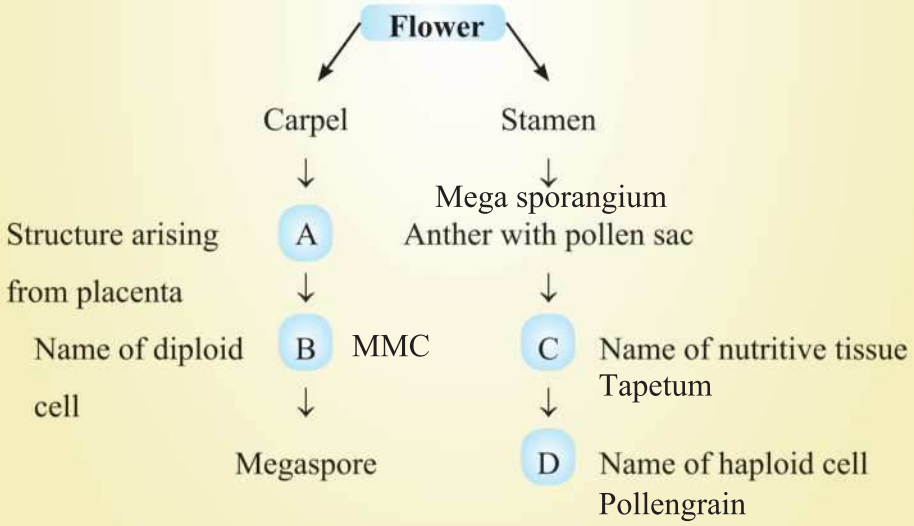


Figure 2

17. Name the parts A, B, C and D of the anatropous ovule (Figure 2) given above.

18. Given below is an incomplete flow chart showing formation of gamete in angiospermic plant. Observe the flow chart carefully and fill in the blank A, B, C and D.



19. Even though each pollen grain has two male gametes. Why are at least 10 pollen grains and not 5 pollen grains required to fertilise 10 ovules present in a particular carpel ?

SA-II **(3 Marks)**

20. Continued self pollination lead to inbreeding depression. List three devices, which flowering plant have developed to discourage self pollination ?

21. Differentiate between microsporogenesis and megasporogenesis. What type of cell division occurs during these events ? Name the structure formed at the end of these two events.

LA **(5 Marks)**

22. (a) Draw the embryo sac of a flowering plant and label the parts :
    (i) Which guides the entry of pollen tube ?
    (ii) Which develops into endosperm ?
    (iii) Which fuses with male gamete to form zygote ?
    (b) What will be the fate of antipodal cells after fertilisation ?
    (c) Name the cell that develops into embryo Sac. How many embryo sacs are formed from one megaspore mother cell?

Case Based Questions

23. Observe the given fruit and answer the questions

(a) How the above fruit get formed? Write term used for such development.
(b) Write one advantage & one disadvantage of such fruits
(c) Weather the development of given fruit is natural? Explain.
(d) Give an example of a fruit develop in same manner naturally.

24. A flower of tomato plant following the process of sexual reproduction produces 120 seeds. Based on the above information answer the following questions:

(a) How many pollen grains and ovules involved?

(b) How many microspore mother cells & megaspore mother cells involved in formation of male & female gametophytes?

(c) How many meiotic divisions involved in formation of 120 seeds?

(d) How many male gametes participated in fertilization process?

25. Aman visited a nursery, where he observed many of the flowers of floweringplants were covered with butter paper as shown in picture. He asked for his queriesto his biology teacher. What answers you expect for the following questions:

(a) Name the process shown in the picture? Write its advantage.

(b) In bisexual flowers which additional process is required before covering flowes?

(c) How the above steps followed by the gardener are helpful in developing plants?

(d) In which plant the above steps were followed by Mendel to explain the inheritance?

Answers

VSA **(1 Mark)**

1. *Parthenium hysterophorus* (carrot grass)
2. Presence of mucilagenous covering
3. To ensure pollination because Maize is pollinated by wind.
4. Apomixis
5. 24 Chromosomes in endosperm and 8 chromosomes in antipodal cells.

Answer of Multiple-Choice Question :

6. (c) 7. (c) 8. (a) 9. (d) 10. (d) 11. (b) 12. (c)

Answer of Assertion-Reason Question :

11.(a) 12. (c)

SA-I (2 Marks)

6. Two categories of fruits are :
   (i) True fruits *e.g.*, Mango
   (ii) False fruit *e.g.*, Apple

7. (i) Flowers are large
   (ii) Colourful petals of flowers
   (iii) Presence of fragnance
   (iv) Rich in nectar

15.

Geitonogamy	Xenogamy
1. Transfer of pollen grains from the anther to stigma of another flower of the same plant.	Transfer of Pollen grains from anther to Stigma of different plant.
2. Does not provide opportunity for genetic recombination.	Provide opportunity for genetic recombinations

16. A = Plumule — To form shoot system
B = Cotyledons — Storage of food

17. A = Micropyle, B = Outer integument, C = Nucellus, D = Embryo sac

18. A = Ovule/megasporangium, C = Tapetum
B = Megaspore mother cell, D = Pollen grains

19. Because only one male gamete is involved is syngamy, *i.e.*, fusion of male gamete with egg cell.

SA-II (3 Marks)

20. (a) Release of pollen and stigma receptivity is not synchronised in some species
   (b) Anther and stigma are at different position/heights in some plants
   (c) Self-incompatibility (a genetic mechanism).

21. • Microsporogenesis–Process of formation of microspore from a Pollen mother cell.

- Megasporogenesis–Process of formation of megaspore from megaspore mother cell.
- Meiotic division in both.

Microsporogenesis results in the formation of pollen grain while megasporogenesis results in the formation of megaspore.

LA

22.(a) Refer to figure 2.8(c) page 26 NCERT book.

(i) Filliform apparatus (ii) Central cell (iii) Egg cell

(b) They degenerate after fertilization.

(c) Functional megaspore, one megaspore develops to form one embryo sac.

23. (a) Without fertilisation, parthenocarpy

(b) Advantage: seedless fruits easy to eat/no need of pollinators Disadvantage: no seeds available for dispersal/ new variations do not occur/induced parthenocarpy leaves the impact of chemicals

(c) No, it is induced by chemicals

(d) Banana.

24. (a) Pollen grains – 120, ovules – 120

(b) Microspore mother cells – 30, Megaspore mother cells – 120

(c) Meiotic divisions = $120 \times \frac{1}{4} + 120 = 150$ divisions

(d) Male gametes involved – $2 \times 120 = 240$.

25. (a) Bagging, prevent pollination with unwanted pollens

(b) Emasculation-removal of anthers/stamen at bud stage.

(c) Enable to develop plants with desirable characters/leads to controlled pollination.

(d) In sweet pea (*Pisum sativum*)