2

Sexual Reproduction in Flowering Plants

Multiple Choice Questions (MCQs)

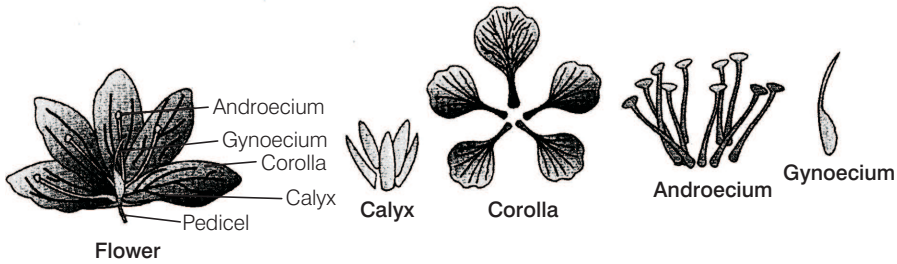
Q. 1 Among the terms listed below, those that of are not technically correct names for a floral whorl are

(i) androecium (ii) carpel

(iii) corolla (iv) sepal

(a) (i) and (iv) (b) (iii) and (iv) (c) (ii) and (iv) (d) (i) and (ii)

Ans. *(c)* All the four whorls of the plant with their relative position in flower can be indicated through following diagram.



Sepals collectively form a whorl, called as **calyx** while technically the carpel is known as gynoecium. The floral whorls formed by petals and stamens are called as **corolla** and **androecium** respectively.

Q. 2 Embryo sac is to ovule as ..... is to an anther.

(a) stamen (b) filament

(c) pollen grain (d) androecium

Thinking Process

It is the ovule within which a single Megaspore Mother Cell (MMC) differentiate into four megaspores. Out of these, only one megaspore, i.e., functional, develops into ***embryo sac*** *(female gametophyte) and the other three degenerate.*

Ans. *(c)* The pollen grains represent the male gametophytes. As the anthers mature and dehydrate, the microspores dissociate from each other and develop into pollen grains.

So, **embryo sac** is to **ovule** as **pollen grains** is to an **anther**.

Q. 3 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

Ans. *(a)* In a typical complete, bisexual and hypogynous flower the arrangement of floral whorls *on the thalamus from the outermost to the innermost is*

(i) The calyx, a whorl of sepals (outermost).
(ii) The corolla, a whorl of petals (inside the calyx).
(iii) The androecium, a whorl of stamens (inside the corolla).
(iv) The gynoecium, a whorl of pistils (in the centre of the flower forming inner most whorl).

Q. 4 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

Thinking Process

Fertilisation of both male and female gametes is essential for the formation of fruit and seed. Usually, the male gamete constitute the motile structure while female gamete is large and non-motile.

Ans. *(d)* In dioecious plants, the unisexual male flower is staminate, *i.e.,* bearing stamens only, while the female is pistillate or bearing pistils only. For the production of fruits and seeds fertilisation must take place, which is possible only in the presence of both male and female flowers.

When the plant is dioecious, it will give rise to the following situations

(i) If the plant is dioecious and bears only pistillate flowers, fertilisation can take place with the help of pollinators.
(ii) If the plant is dioecious and bears only staminate flowers, fertilisation can't take place, because female gamete is non-motile which can't reach the male gamete in order to fuse with it.

When the plant is monoecious (*i.e.,* carryins both stamen and pistill together, it may lead to self-fertilisation and production of seed.

Q. 5 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

Ans. *(d)* A typical microsporangium is generally surrounded by four-wall layers, *i.e*., the epidermis, (outermost protective layer), endothecium, (middle fibraus layers) and the tapetum (innermost nutritive layer).

Q. 6 During microsporogenesis, meiosis occurs in

(a) endothecium (b) microspore mother cells
(c) microspore tetrads (d) pollen grains

Ans. ***(b)*** As the anther develops, the microspore mother cells of the sporogenous tissue undergoes meiotic divisions to form microspore tetrads. The microspore tetrad after dehydration is separated into pollen grains.

Endothecium is the layer present between epidermis and middle layer, it is formed by columner cells.

Q. 7 From among the sets of terms given below, identify those that are associated with the gynoecium.

(a) Stigma, ovule, embryo sac, placenta (b) Thalamus, pistil, style, ovule
(c) Ovule, ovary, embryo sac, **tapetum** (d) Ovule, stamen, ovary, embryo sac

Ans. ***(a)*** The gynoecium represents the female reproductive part of the flower and consists of pistil. Each pistil has three parts, *i.e.*, **stigma, style** and **ovary.** Inside the ovarian cavity, the **placenta** is located.

Arising from the placenta there are the megasporangia, commonly called **ovules.** The functional megaspore undergoing the meiotic division develops into the female gametophyte or **embryo sac**.

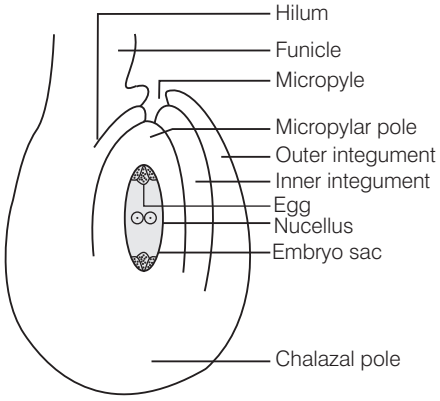
In option 'b' thalamus is not a part of gynoecium. Thalamus is the part of flower which form the base on which all the floral whorls rest upon, it is not associated with gynoecium. In option 'c' tapetum is not a part of gynoecuim.

Tapetum is the inner most nutritive layer of microsporangium and in option 'd' stamen is not a part of gynoecium. **Stamen** is male reproductive part (androecium) of plant. Therefore, the other options are wrong.

Q. 8 Starting from the innermost part, the correct sequence of parts in an ovule are

(a) egg, nucellus, embryo sac, integument
(b) egg, embryo sac, nucellus, integument
(c) embryo sac, nucellus, integument, egg
(d) egg, integument, embryo sac, nucellus

Ans. ***(b)*** Starting from the innermost part, the correct sequence of parts in an ovule is egg, embryo sac, nucellus, integument. *This sequence can be seen in following*



A diagrammatic view of an ovule

Q. 9 From the statements given below choose the option that are true for a typical female gametophyte of.

(i) It is eight-nucleate and seven-celled at maturity.

(ii) It is free-nuclear during the development.

(iii) It is situated inside the integument, but outside the nucellus.

(iv) It has an egg apparatus situated at the chalazal end.

(a) (i) and (iv) (b) (ii) and (iii)

(c) (i) and (ii) (d) (ii) and (iv)

Ans. ***(c)*** The female gametophyte or embryo sac is located inside the nucellus, enclosed within the integuments. In a majority of flowering plants, one of the megaspore is functional while the other three degenerate. Three repeated mitotic divisions of the functional megaspore results in the formation of **seven-celled** or **eight-nucleate** embryo sac.

Six of the eight nuclei are organised at the two poles. Three cells grouped at micropylar end forms **egg-apparatus** and 3 at the **chalazal end** forms **antipodal cells**. The large central cell at the centre has two polar nuclei.

The meiotic divisions in the formation of embryo sac are strictly free nuclear, that is nuclear divisions are not followed immediately by cell-wall formation. Gametophyte is situated at micropylar end not at chalazal end.

Q. 10 Autogamy can occur in a chasmogamous flower if

(a) pollen matures before maturity of ovule

(b) ovules mature before maturity of pollen

(c) both pollen and ovules mature simultaneously

(d) both anther and stigma are of equal lengths

Ans. ***(c)*** Autogamy is a method of self-pollination in which the stigma of a flower receive pollens from the anther of same flower. For autogamy both sex organs of a chasmogamous flower should mature at the same time.

As chasmogamous flowers open at maturity, pollen release and stigma receptivity should be synchronised for the process of autogamy.

In such flowers, the length of anther and stigma plays secondary role in autogamy. *e.g.,* in case of protandry (pollens mature early) and protogyny (stigma matures early) leads to cross-pollination.

Q. 11 Choose the correct statement from the following.

(a) Cleistogamous flowers always exhibit autogamy.

(b) Chasmogamous flowers always exhibit geitonogamy.

(c) Cleistogamous flowers exhibit both autogamy and geitonogamy.

(d) Chasmogamous flowers never exhibit autogamy.

Thinking Process

Chasmogamous flowers are flowers with exposed anthers and stigma and cleistogamous flowers are flowers, which do not open at all.

Ans. ***(a)*** The pollination that occurs in opened flowers is called chasmogamy. It is the most common type of pollination in all types of flowers. Chasmogamy is of two types *i.e.*, **self-pollination** (autogamy) and **cross-pollination.** Cross-pollination is of two types *i.e.*, **geitonogamy** and **xenogamy.**

So, we can say that chasmogamous flowers exhibit both autogamy (self-pollination) and allogamy (cross-pollination). While, in cleistogamous flower, the anthers and stigma lie close to each other with in the closed flowers.

When anthers dehisces in the flower buds, pollen grains come in contact with the stigma for effective pollination. Thus, these flowers are invariably autogamous as there is no chance of cross-pollen landing on the stigma.

Q. 12 A particular species of plant produces light, non-sticky pollen in large numbers and its stigmas are long and feathery. These modifications facilitate pollination by

(a) insects (b) water (c) wind (d) animals

Ans. ***(c)*** Plants use two abiotic (wind and water) and one biotic (animals) agent to achieve pollination. Majority of plants use biotic agents for pollination.

Pollination by wind is more common amongst abiotic pollination. Wind pollination requires the light and non-sticky pollen grains so that, they can be transported in wind currents.

They often possess well-exposed stamens (so that the pollens are easily dispersed into wind currents) and large often-feathery stigma to easily trap air-borne pollen grains. Wind pollination is common in grasses.

These types of pollens are not pollinated by means of other three options

(i) Pollination by water (hydrophily) is quite rare in flowering plants but accuss in aquatic plants.

(ii) Zoophihy is pollination through the agency of animals.

(iii) Entomophily is the most common type of zoophily through the agency of insects.

Q. 13 From among the situations given below, choose the one that prevents both autogamy and geitonogamy.

(a) Monoecious plant bearing unisexual flowers.

(b) Dioecious plant bearing only male or female flowers.

(c) Monoecious plant with bisexual flowers.

(d) Dioecious plant with bisexual flowers.

Ans. ***(b)*** Autogamy is a method of self-pollination in which the transfer of pollen grains from anther to stigma of the same flower takes place. While geitonogamy, is the transfer of pollen grains from anther to stigma of another flower of the same plant.

In the above condition, dioecious plants (bearing only male or female flowers) prevent both autogamy and geitonogamy. Geitonogamy is ecologically cross- pollination which is supposed to be equivalent to self-pollination because all flowers on a plant are genetically identical.

Q. 14 In a fertilised embryo sac, the haploid, diploid and triploid structure are

(a) synergid, zygote and primary endosperm nucleus

(b) synergid, antipodal and polar nuclei

(c) antipodal, synergid and primary endosperm nucleus

(d) synergid, polar nuclei and zygote

Ans. ***(a)*** (i) Synergid—haploid

(ii) Polar nuclei—haploid

(iii) Antipodal—haploid

(iv) Zygote—diploid

Since, all these cells three cells (synergid, polar nuclei and antipodals are) formed by mitosis from the functional megaspore, they are haploid (*n*).

Egg cell fertilises with the male gamete to form a diploid zygote.

(v) Primary Endosperm Nucleus (PEN).

Diploid secondary nucleus fertilises with a haploid male gamete to form a triploid PEN.

Q. 15 In an embryo sac, the cells that degenerate after fertilisation are

(a) synergids and primary endosperm cell
(b) synergids and antipodals
(c) antipodals and primary endosperm cell
(d) egg and antipodals

Ans. ***(b)*** In unfertilised embryo sac, the antipodals and synergids are distinctly present at chalazal end and micropylar end respectively While, in fertilised embryo sac antipodals and synergids gradually degenerate after the formation of zygote.

(*Also, refer to Q.* 14).

Q. 16 While planning for an artificial hybridisation programme involving dioecious plants, which of the following steps would not be relevant?

(a) Bagging of female flower
(b) Dusting of pollen on stigma
(c) Emasculation
(d) Collection of pollen

Thinking Process

Artificial hybridisation is human peformed crossing of two different plants having complementary good traits in order to obtain an overall superior variety. Two precautionary measures in artificial hybridisatian are emasculation and bagging.

Dioecious plants have the male and female reproductive organs borne on separate individuals of the same species.

Ans. ***(c)*** If the female parent produces unisexual flowers, there is no need for emasculation. The female flower buds are bagged before the flowers open.

When the stigma becomes receptive, pollination is carried out using the desired pollen and the flower rebagged. This protects them from contamination by unwanted pollen grains.

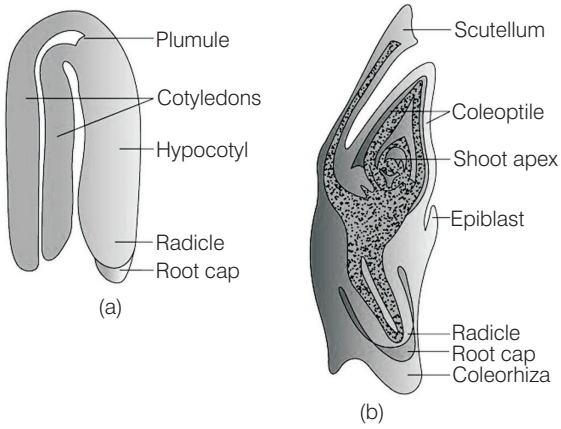
Note *If the female parent bears bisexual flowers, removal of anthers from the flower bud before the anther dehisces is necessary. This is called* ***emasculation.***

Q. 17 In the embryos of a typical dicot and a grass, true homologous structures are

(a) coleorrhiza and coleoptile
(b) coleoptile and scutellum
(c) cotyledons and scutellum
(d) hypocotyl and radicle

Ans. ***(c)*** A typical dicotyledonous embryo consists of two cotyledons.

While, embryos of monocotyledons possess only one cotyledon and it is called **scutellum** (in grass) .



(a) A typical dicot embryo
(b) LS of an embryo of grass

Q. 18 The phenomenon observed in some plants where in parts of the sexual apparatus is used for forming embryos without fertilisation is called

(a) parthenocarpy (b) apomixis
(c) vegetative propagation (d) sexual reproduction

Ans. ***(b)*** Apomixis is the phenomenon of formation of seeds without fertilisation. These embryos are genetically identical to the parental plant.

Other options are not correct because parthenocarpy and apomixis are different phenomenon. Parthenocarpy is the formation of fruits without fertilisation and hence the fruits are seedless. *e.g.,* banana.

(i) Vegetative propagatian or reproduction is a form of asexual reproduction in plants, in which new organisms arise without production of seeds or spores.

(ii) Sexual reproduction involves formation of the male and female gametes, either by the same individual or by different individuals of the opposite sex. These gametes fuse of form the zygote which develops to form the new organism.

Q. 19 In a flower, if the megaspore mother cell forms megaspores without undergoing meiosis and if one of the megaspores develops into an embryo sac, its nuclei would be

(a) haploid (b) diploid
(c) a few haploid and a few diploid (d) with varying ploidy

Thinking Process

Replacement of the normal sexual reproduction without fertilisation is called apomixis (Gk, apo- with out mixis-mixing). It does not involve meiosis.

Ans. ***(b)*** In some species, the diploid egg cell is formed without reduction division and develops into an embryo without fertilisation.

It is an asexual reproduction which occurs in the absence of pollinators or in extreme environments. In some species like citrus plants, nucellar cells surrounding the embryo sac start dividing and develops into embryos.

It occurs in the megaspore mother cell without undergoing meiosis, and produces diploid embryo sac through mitotic divisions. It helps in the preservation of desirable characters for indefinite period.

Thus, it can be concluded that apomictic species produce diploid cells. Haploid cells will be formed during sexual reproduction when cell will undergo meiosis and option 'c' and 'd' is not shown by megaspore mother cell.

Q. 20 The phenomenon wherein, the ovary develops into a fruit without fertilisation is called

(a) parthenocarpy (b) apomixis

(c) asexual reproduction (d) sexual reproduction

Ans. ***(a)*** Parthenocarpy (Gk. *parthenos*-virgin; *karpos*-fruit) is the formation of seed less fruits without fertilisation. The fruits developed from unfertilised ovary are called parthenocarpic fruits. *Other options are incorrect because*

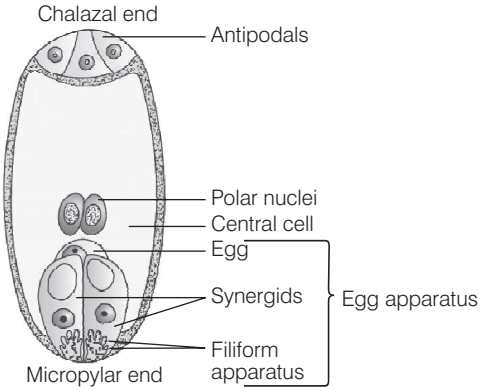
(i) In asexual reproduction, a single individual (parent) is capable of producing off spring.

(ii) For apomixis and sexual reproduction.
(*Also, refer to Q.* 18)

Very Short Answer Type Questions

Q. 1 Name the component cells of the 'egg-apparatus' in an embryo sac.

Ans. The component cells of the 'egg-apparatus' in an embryo sac include, two synergids, one egg cell and the filiform apparatus.



A diagrammatic representation of the mature embryo sac

Q. 2 Name the part of gynoecium that determines the compatible nature of pollen grain.

Thinking Process

Stigma is a part of pistil. So, somewhere it is also mentioned as the part of gynoecium that determines the compatible nature of pollen grain.

Ans. The pistil has the ability to recognise, the pollen, whether it is of the right type (compatible) or of the wrong type (incompatible). If it is of the right type, the pistil accepts the pollen and promotes post-pollination events that lead to fertilisation. If the pollen is of wrong type, the pistil rejects the pollen.

The ability of the pistil to recognise the pollen is followed by its acceptance or rejection. It is the result of a continuous dialogue between pollen grain and the pistil mediated by chemical components of the pollen interacting with those of the pistils.

Q. 3 Name the common function that cotyledons and nucellus perform.

Ans. *The common functions that cotyledons and nucellus perform are as follows*

(i) Storage of reserve food material.

(ii) **Nourishment** Cotyledons nourishes embryo and nucellus nourishes embryo sac.

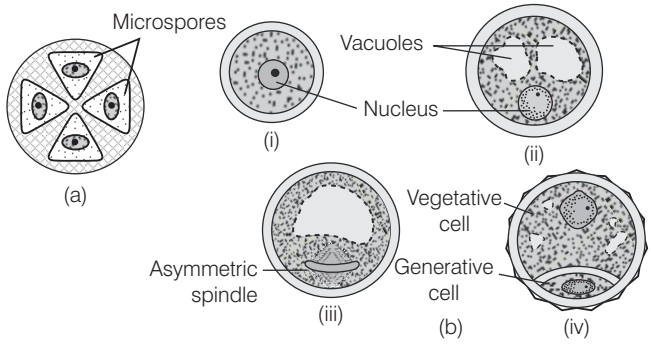
Q. 4 Complete the following flow chart

Pollen mother cell → Pollen tetrad → Pollen grain < Vegetative cell / .....

Ans. Pollen mother cell → Pollen tetrad → Pollen grain < (i) Vegetative cell / (ii) Generative cell

The process of formation of microspores from a Pollen Mother Cell (PMC) through meiosis is called microsporogenesis. The microspores, as they are formed, are arranged in a cluster of four cells *i.e.*, the **microspore tetrad**.

As the anthers mature and dehydrate, the microspores dissociate from each other and develop into **pollen grains** (male gametophyte). When the pollens mature, it contains two cells the **vegetative cell** (bigger) and **generative cell** (smaller).



Microsporogenesis : (a) A microspore tetrad

(b) A microspore maturing into a pollen grain

Q. 5 Indicate the stages where meiosis and mitosis occur (1, 2 or 3) in the flow chart.

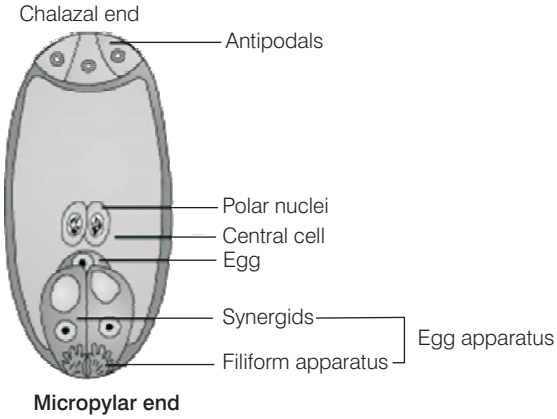
Megaspore mother cell $\xrightarrow{1}$ Megaspores $\xrightarrow{2}$ Embryo sac $\xrightarrow{3}$ Egg

Ans. Megaspore mother cell ($2n$) $\xrightarrow{\text{Meiosis}}$ Megaspores $\xrightarrow{\text{Mitosis}}$ Embryo sac (n) $\xrightarrow{\text{Meiosis}}$ Egg.

The diploid Megaspore Mother Cell (MMC) undergo meiosis and forms a linear tetrad of four haploid megaspores. Three mitotic divisions, inside the functional (one) megaspore form the embryo sac (eight haploid nuclei), while the other three megaspores degenerate.

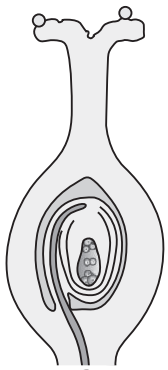
The embryo sac is a seven-celled and eight nucleated structure. Three **micropylar**, Three **chalazal** and one **central**. The three micropylar cells are collectively known as egg-apparatus, which, consists of two **synergids** and one egg cell.

While three chalazal cell form antipodal cell. The central cell is in the form of two nucleated cell till the fertilisation occurs and called as polar nuclei.



A diagrammatic representation of the mature embryo sac

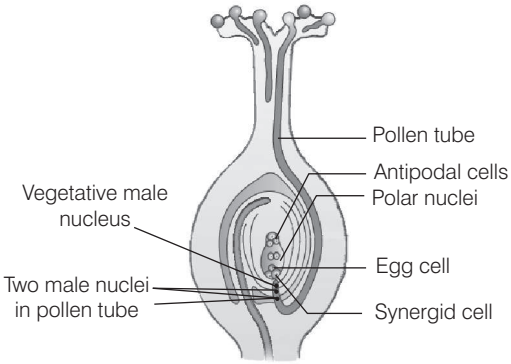
Q. 6 In the diagram given below, show the path of a pollen tube from the pollen on the stigma into the embryo sac. Name the components of egg apparatus.



Ans. Following compatible pollination, the pollen grain germinates on the stigma to produce a pollen tube through one of the germ pores. The contents of the pollen grain (2 mole nuclei) move into the pollen tube. Pollen tube grows through the tissues of the stigma and reaches the ovary.

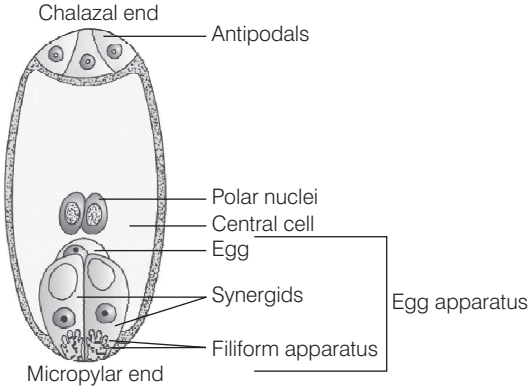
After reaching the ovary, pollen tube, enters the ovule through the micropyle and then enters the embryo sac by passing into one of the synergids through the filiform apparatus. It leads to the degeneration of that synergid.

The pollen tube breaks to release its contents (2 male nuclei). Out of the two male gametes one fuses with egg and the other fuses with central cell and fertilise.



Longitudinal section of a flower showing path of pollen tube growth

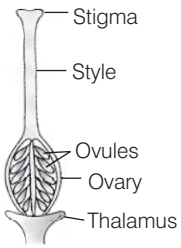
The component cells of the egg-apparatus in an embryo sac include, two synergids, one egg cell and the filiform apparatus.



A diagrammatic representation of the mature embryo sac

Q. 7 Name the parts of pistil which develop into fruit and seeds.

Ans. Pistil is the female reproductive organ that receives pollen to fertilise the egg located in ovary. A pistil has three parts, *i.e.*, **stigma** (receives pollen), which grows down through **style** to **ovary.** Ovary contains ovules, which contain an egg. The ovary develops into the fruit and ovule develops into a seeds.



Parts of a pistil

Q. 8 In case of polyembryony, if an embryo develops from the synergid and another from the nucellus which is haploid and which is diploid?

Thinking Process

Presence of more than one embryo in a seed is called ***polyembryony.*** *e.g., lemon, groundnut, etc.*

Ans. Embryo developed from the synergid is haploid as the ploidy of the synergid is haploid. Embryo developed from the nucellus is diploid as the ploidy of the nucellus is diploid.

Q. 9 Can an unfertilised, apomictic embryo sac give rise to a diploid embryo? If yes, then how?

Ans. *Yes*, if megaspore develops into embryo sac without meiotic division egg will be diploid. Diploid egg develops into embryo by mitotic divisions.

Note *Apomixis is a form of asexual reproduction to produce seeds without fertilisation.*

Q. 10 Which are the three cells found in a pollen grain when it is shed at the three celled stage?

Ans. In over 60% of angiosperms, pollen grains are shed at the two cell further stage (vegetative cell and generative cell). In the remaining species, the generative cell divides mitotically to give rise to the two male gametes before pollen grains are shed at the (three-celled stage (are vegetative cell and two male gametes).

Q. 11 What is self-incompatibility?

Ans. It is a genetic mechanism which prevents self-pollen from fertilising the ovules by inhibiting pollen germination or pollen tube growth in the pistil.

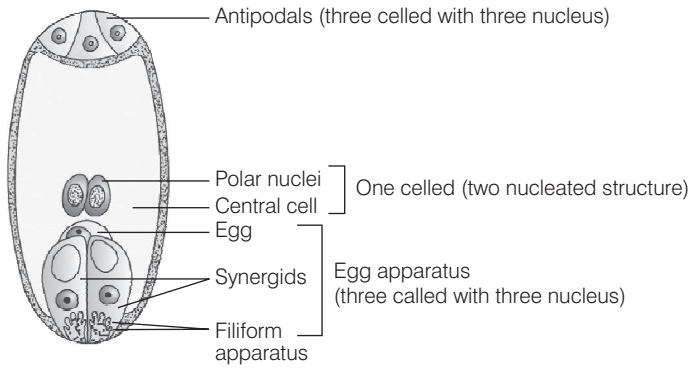
Q. 12 Name the type of pollination in self-incompatible plants.

Ans. In self-incompatible plants, (while self-pollination is incompatible) cross-pollination is occurs.

Note *Self-incompatibility is a genetic mechanism which prevents self-pollen from fertilising the ovules by inhibiting pollen germination or pollen tube growth in the pistil.*

Q. 13 Draw the diagram of a mature embryo sac and show its eight-nucleate, seven-celled nature. Show the following parts-antipodals, synergids, egg, central cell, polar nuclei.

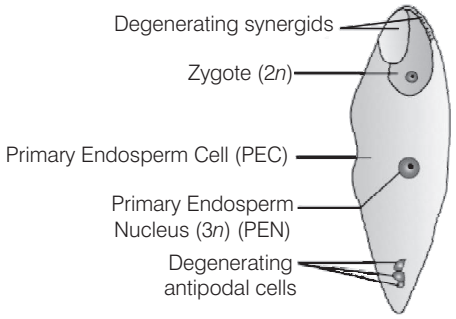
Ans.



A mature embryo sac (seven celled with eight nucleated structure)

Q. 14 Which is the triploid tissue in a fertilised ovule? How is the triploid condition achieved?

Ans. Endosperm is the triploid tissue. It results from triple fusion involving union of one male gamete and two haploid polar nuclei.



Fertilised embryo sac showing Primary endosperm nucleus (3*n*)

Q. 15 Are pollination and fertilisation necessary in apomixis? Give reasons.

Thinking Process

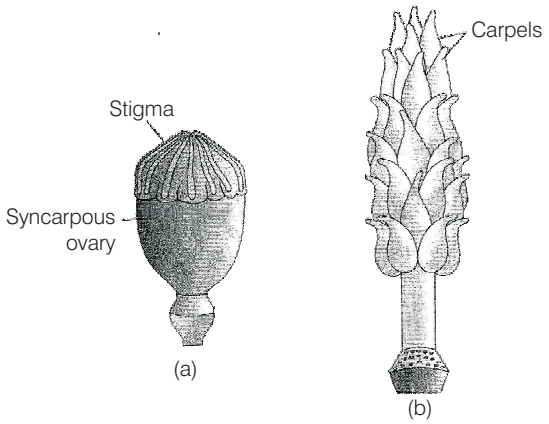
The phenomenon of asexual reproduction that mimics sexual reproduction by formation of seed without fertilisation is called apomixis.

Ans. Pollination and fertilisation are not necessary for apomixis. *The reasons in support of this are given below*

(i) Embryo sac can develop from megaspore without reduction division the egg is diploid and develops into embryo.

(ii) Embryo sac can also develop from diploid nucellus cells in which case egg is diploid that develop into embryo parthogenetically.

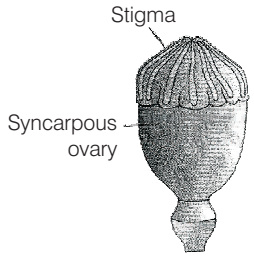
Q. 16 Identify the type of carpel with the help of diagrams given below



Thinking Process

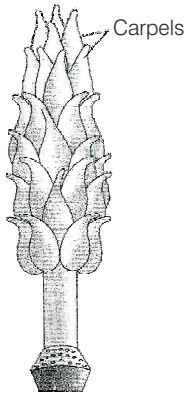
The gynoecium represents the female reproductive part of the flower and may consist of a single pistil (monocarpellary) or many pistils (multicarpellary).

Ans. **(a)** If a gynoecium has multiple carpels fused into a single structure, it is syncarpous. In this given diagram, the type of carpel is syncarpous (*e.g.,* poppy).



Multicarpellary, syncarpous pistil of *Papaver*

(b) If a gynoecium has multiple carpels in free form, it is apocarpous. In this given diagram, the type of carpel is apocarpous. (*e.g.,* michelia*)*



A multicarpellary, apocarpous gynoecium of michelia

Q. 17 How is pollination carried out in water plants?

Ans. (a) In many aquatic plants with emergent flowers, pollination occurs by wind and insects.

(b) In water plants if pollination occurs below the surface of water is called hypohydrophilly, *e.g., Ceratophyllum.*

(c) In water plants if pollination takes place over the surface of water is called epihydrophily, *e.g., Vallisneria spiralis*.

Q. 18 What is the function of the two male gametes produced by each pollen grain in angiosperms.

Thinking Process

Mature pollen grain contains two cells, the vegetative cell and generative cell. Generative cell is the generation cell that divides mitotically to give rise to the two male gametes .

Ans. One male gamete unites with egg forming embryo.This process is called fertilisation or syngamy.

Another male gamete unite with two polar nuclei resulting in the formation of endosperm triple fusion.

Short Answer Type Questions

Q. 1 List three strategies that a bisexual chasmogamous flower can evolve to prevent self-pollination (autogamy).

Thinking Process

Majority of flowering plants produce hermaphrodite flowers and pollen grains are likely to come in contact with the stigma of the same flower. This self-pollination result in inbreeding depression. Flowering plants have evolved many devices to discourage self- pollination.

Ans. A bisexual chasmogamous flower can evolve the following (three) strategies to prevent self-pollination (autogamy).

(a) **Dichogamy** In this mechanism, pollen release and stigma receptivity are not synchronised. In sunflower, the pollen is released before the stigma becomes receptive (protandry). In *Datura*, *Solanum*, the stigma becomes receptive much before the release of pollen (protogyny) leads to cross-pollination.

(b) **Herkogamy** The male and female sex organs are placed at different positions or in different directions is called Herkogamy. In these plants, the pollen cannot came in contact with the stigma of the same flower. It has undergone cross pollination, *e.g., Hibiscus, Gloriosa*.

(c) **Self-sterility** It is a genetic mechanism which prevents the self-pollen from fertilising the ovules by inhibiting pollen germination or pollen tube growth in the pistil, *e.g.,* Abotilon.

Note *Another device to prevent self-pollination is the production of unisexual flowers, but this is not beneficial as above mentioned strategies. It prevents autogamy but not geitonogamy in monoecious plants such as castor and maize.*

Q. 2 Given below are the events that are observed in an artificial hybridisation programme. Arrange them in the correct sequential order in which they are followed in the hybridisation programme (a) Re-bagging (b) Selection of parents (c) Bagging (d) Dusting the pollen on stigma (e) Emasculation (f) Collection of pollen from male parent.

Thinking Process

One of the major approaches of crop improvement programme is 'Artificial hybridisation'. In such crossing experiments it is important to make sure that only the desired pollen grains are used for pollination and the stigma is protected from contamination (from unwanted pollen).

Ans. *The correct sequential order of artificial hybridisatian is as following*

(a) Selection of parents.

(b) Emasculation (removal of anthers from the flower bud before the anther dehisces).

(c) Bagging (process to cover the emasculated flower with a bag made up of butter paper).

(d) Collection of pollen from other male plant.

(e) Dusting of pollen on stigma.

(f) Re-bagging

Note *If the female parent produces unisexual flowers, there is no need of emasculation.*

Q. 3 Vivipary automatically limits the number of offsprings in a litter. How?

Ans. Vivipary is defined as the seed germination, while the fruit is still attached to the mother plant. Plants which grow in marshy places are called **Mangroves.** In these plants when seeds fall on marshy places, they cannot germinate, because of high salinity and more water conditions.

So, in those plants, seeds germinate when they are still attached to the mother plant. Litter is the off spring at one birth of animal usually 3-8 in number.

Vivipary automatically limits the number of offspring in litter due to the reason that limited number of egg or ovum are produced and fertilised during reproductive cycle of female.

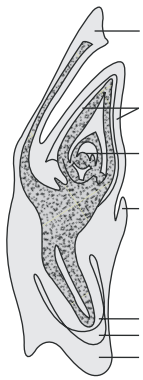
Q. 4 Does self-incompatibility impose any restrictions on autogamy? Give reasons and suggest the method of pollination in such plants.

Ans. Self-incompatibility imposes restrictions on autogamy. *The season far this may be as* Majority of flowering plants produce hermaphrodite flowers and when pollens grains comes in contact with the stigma of the same flower to continue self-pollination.

Such type of continued self-pollination result in inbreeding depression. That's why flowering plants have developed many devices to discourage self-pollination and to encourage cross-pollination. One of the major way to prevent self-pollination is self-sterility.

Self-sterility in some bisexual flowers, if the pollen grains fall on the stigma of the same flower, germination does not occur. But the same pollen grains germinate when they fall on the stigma of other flowers of the same species. It is a genetic mechanism to prevent self pollination.

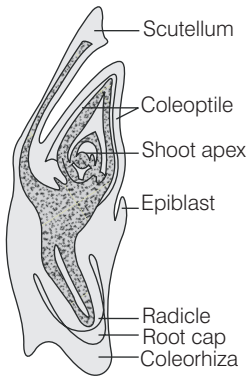
Q. 5 In the given diagram, write the names of parts shown with lines.



Ans. Embryos of monocotyledons possess only one cotyledon. In the grass family the cotyledon is called **scutellum** that is situated towards one side (lateral) of the embryonal axis.

At its lower end, the embryonal axis has the radical and root cap enclosed in an undifferentiated sheat called coleorrhiza. The portion of the embryonal axis above the level of attachment of scutellum is the epicotyl.

Epicotyl has a shoot apex and a few leaf primordia enclosed in a hollow foliar structure, the coleoptile.



LS of an manocot embryo of grass

Q. 6 What is polyembryony and how can it be commercially exploited?

Ans. Polyembryony is the occurrence of more than one embryo in a seed. In many citrus and mango varieties, some of the nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and develop into embryos. In such species, each ovule contains many embryos.

Polyembryony plays a main role in plant breeding and horticulture. The plantlets obtained from these embryos are virus free and has more vigour. Hybrid varieties of several food and vegetable crops are being extensively cultivated and these hybrid cultivars possess high productiviy.

Q. 7 Are parthenocarpy and apomixis different phenomena? Discuss their benefits.

Ans. *Yes*, parthenocarpy and apomixis are different phenomenon.

Importance of Parthenocarpy

(i) The fruit production without fertilisation of the ovary is called **parthenocarpy.** This phenomenon is applied for the commercial production of seedless fruits. *e.g.,* banana, grapes.

(ii) This is more useful far the juice industries.

Importance of Apomixis

(i) During apomixis, chromosomal segregation and recombination does not occur. So, characters are stable for several generations.

(ii) It simplifies commercial hybridised production because isolation is not necessary to produce F_1 or maintain parental generation.

(iii) Adventive embryony is being used in the production of uniform root-stock and virus free varieties.

Q. 8 Why does the zygote begin to divide only after the division of Primary Endosperm Cell (PEC)?

Thinking Process

The zygote needs nourishment to develop.

Ans. The primary endosperm cell divides repeatedly and forms a triploid endosperm tissue. The cells of this tissue are filled with reserve food materials and are used for nutrition of the developing embryo.

Embryo develops at the micropylar end of the embryo sac where zygote is situated. Most zygotes divide only after certain amount of endosperm is formed. This is an adaptation to provide assured nutrition to the developing embryo.

Q. 9 The generative cell of a two celled pollen divides in the pollen tube, but not in a three-celled pollen. Give reasons.

Thinking Process

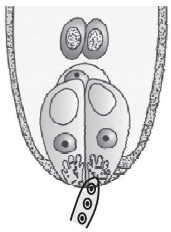
Pollen grain at maturity, divides and produce two unequal cells. The large cell is vegetative cells, has abundant food reserve and cantains a large irregular nucleus. The smaller cell is generative cell and floats in the cytoplasm of vegetative cell, which is spindle shaped with dense cytoplasm and a nucleus.

Ans. In over 60 % of angiosperms, pollen grains are shed at this 2-celled stage tube cell or vegetative cell generative cell. In the remaining species, the generative cell divides mitotically to give rise to the two male gametes before pollen grains are shed tubecell or vegetative cell two male gamete 3-celled stage.

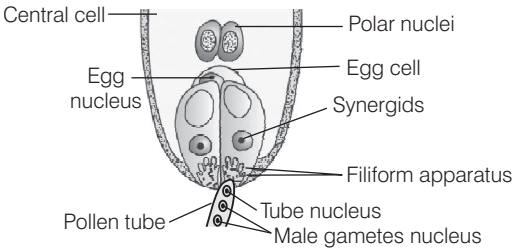
In 3 celled stage, the pollen grains further germinate on the stigma to produce pollen tube through ane of the germ pores. The contents of the pollen grains move into the tube pollen tube grows through the tissues of the stigma and style and reaches to ovary.

Inplants, when pollen grain are shed at 2 celled stage the generative cell divides and form two male gametes during the growth of the pollen tube in the stigma.

Q. 10 In the figure given below label the following parts-male gametes, egg cell, polar nuclei, synergid and pollen tube



Ans. *The following are the parts of this figure*



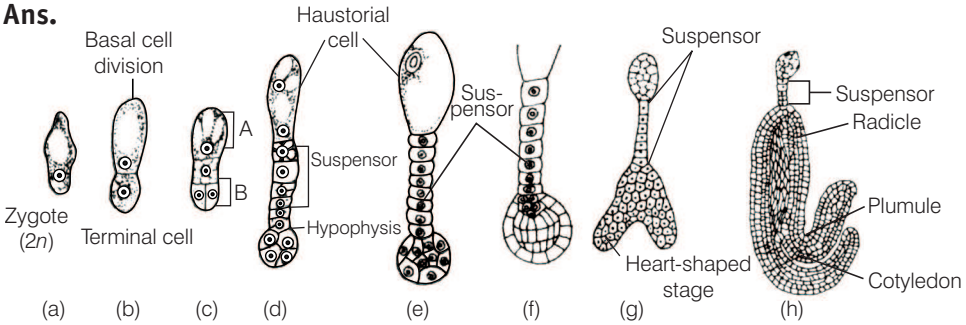
Long Answer Type Questions

Q. 1 Starting with the zygote, draw the diagrams of the different stages of embryo development in a dicot.

Thinking Process

The zygote gives rise to the proembryo and subsequently to the globular, heart-shaped and mature embryo

Ans.



Stage in the developemnt of a dicot embryo

Note *The early stages of embryogeny (embryo development) in both monocotyledons and dicotyledons are similar. In case of monocotyledonous embryo a single cotyledon is present.*

Q. 2 What are the possible types of pollinations in chasmogamous flowers. Give reasons.

Thinking Process

The pollination that occurs in open flowers is called ***chasmogamy.*** *It is the most common type of pollination in all types of flowers.*

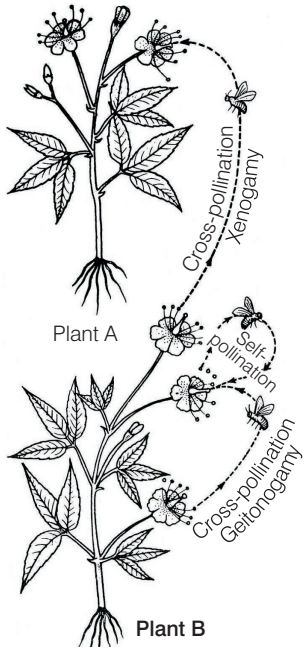
Ans. There are two types of pollinations (chasmogamy) in chasmogamous flowers, *i.e.*, self--pollination and cross-pollination.

(a) **Self-pollination**(Autogamy) The transfer of pollen grains from anther to stigma of the same flower is called **self-pollination.** It is found in both cleistogamous and chasmogamous flowers.

(b) **Cross-pollination** (Allogamy) The transfer of pollen grains from anther to stigma of another flower is called a **cross-pollination.** *It is of two types*

(i) **Geitonogamy** It is the transfer of pollen grains from anther to the stigma of another flower of the same plant. It is functionally a type of cross-pollination involving a pollinating agent, genetically. It is similar to autogamy.

(ii) **Xenogamy** The transfer of pollen grains from the flower of one plant to the stigma of another plant. This is the only type of pollination, which brings genetically different types of pollen grains to the stigma.



Showing self-pollination and cross-pollination

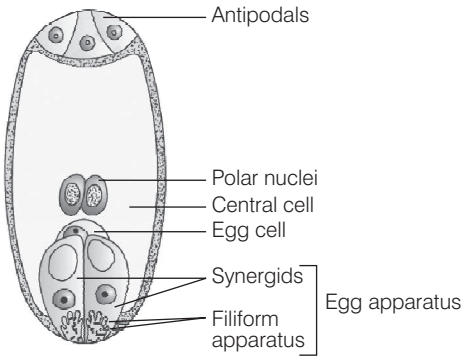
Q. 3 With a neat, labelled diagram, describe the parts of a mature angiosperm embryo sac. Mention the role of synergids.

Thinking Process

Megaspore is the mother cell for the development of female gametophyte (embryo sac). The nucleus of the functional megaspore divides mitotically to form two nuclei, which moves to the opposite poles forming two nucleus embryo sacs.

Two more mitotic nuclear divisions occur in two nuclei, resulting in the formation of eight-nucleate embryo sac.

Ans. After the 8-nucleate stage, cell walls are laid down leading to the organisation of the typical female gametophyte or embryo sac.



A mature embryo sac of angiosperm

Six of the eight nuclei are surrounded by cell walls and organised into cells. Three cells present towards the micropylar end grouped together, constitute the egg apparatus. The egg apparatus, in turn consists of two synergids and one egg cell.

Three cells of the chalazal end are called the antipodals. The large central cell is formed by the fusion of 2-polar nuclei. Thus, a typical angiospermic embryo sac, at maturity consists of eight nuclei and seven cells. This embryo sac is formed from, the single megaspore, so it is called 'monosporic embryo sac.

Role of Synergids

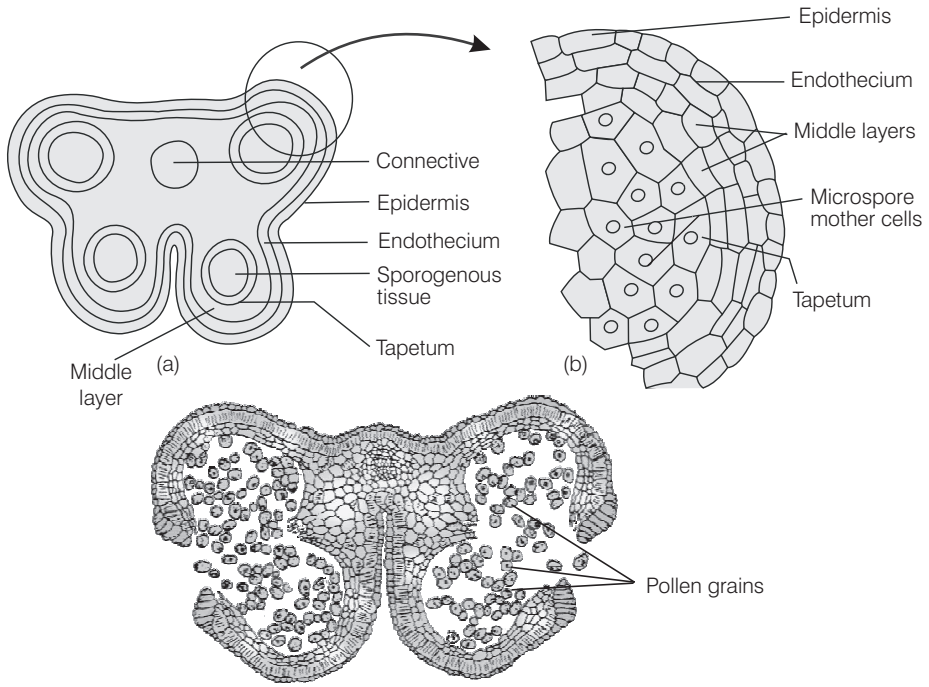
The synergids have special cellular thickenings at the micropylar tip called filiform apparatus, which play an important role in guiding the pollen tubes into the synergid.

Q. 4 Draw the diagram of a microsporangium and label its wall layers. Write briefly about the wall layers?

Thinking Process

A typical angiospermic anther is bilobed with each lobe having two theca. The anther is a four sided structure consisting of four microsporangia located at the corners, two in each lobe.

Ans. *The diagram representation of a microsporangium is shown below*



(a) Transverse section of a young anther (b) Enlarged view of one microsporangium showing wall layers (c) Mature dehisced anther showing pollen grain

In a transverse section, a typical microsporangium is circular in outline and is surrounded by four wall layers.

(a) **Epidermis** The epidermis is the outermost protective layer. It is composed of tangentially flattened cells. The cells are closely fitted and have thick walls which is helpful in the dehiscence of anther.

(b) **Endothecium** It is present below the epidermis and expands radically with fibrous thickenings, at maturity these cells loose water, at contract and help in dehiscence of pollen sac.

(c) **Wall Layers** It is present between well marked endothecium and tapetum. These are thin walled layers, arranged in one to five layers, which also help in dehiscence of anther.

(d) **Tapetum** It is the innermost wall layer with large cells, thin cell walls, abundant cytoplasm and have more than one nuclei. Tapetum is a nutritive tissue which nourishes the developing pollen grains.

The centre of the microsporangium consists of sporogenous tissue, which undergoes meiotic divisions to form microspore tetrads. This process is known as microsporogenesis.

Q. 5 Embryo sacs of some apomictic species appear normal, but contain diploid cells. Suggest a suitable explanation for the condition.

Ans. Replacement of the normal sexual reproduction by asexual reproduction without fertilisation is called apomixis. *e.g.,* replacement of the flower by bulbils and replacement of the seed by a plant.

Apomitically produced offsprings are genetically identical to the parent plant. In flowering plants, apomixis is used in a restricted sense to mean angiosperm, *i.e.*, asexual reproduction through seeds.

In some plant species it is common, *e.g.,* Asteraceae, Poaceae. In some species, the diploid egg cell is formed without reduction division and develops into embryo without fertilisation. It is an asexual reproduction in the absence of pollinators such as in extreme environments.

In some species like citrus, some of the nucellar cells surrounding the embryo sac start dividing and develop into embryo. It occurs in the megaspore mother cell does not undergo meiosis, thus produces diploid embryo sac through mitotic divisions.

Thus, it explains that, embryo sacs of some apomictic species appear normal, but produce diploid cells.