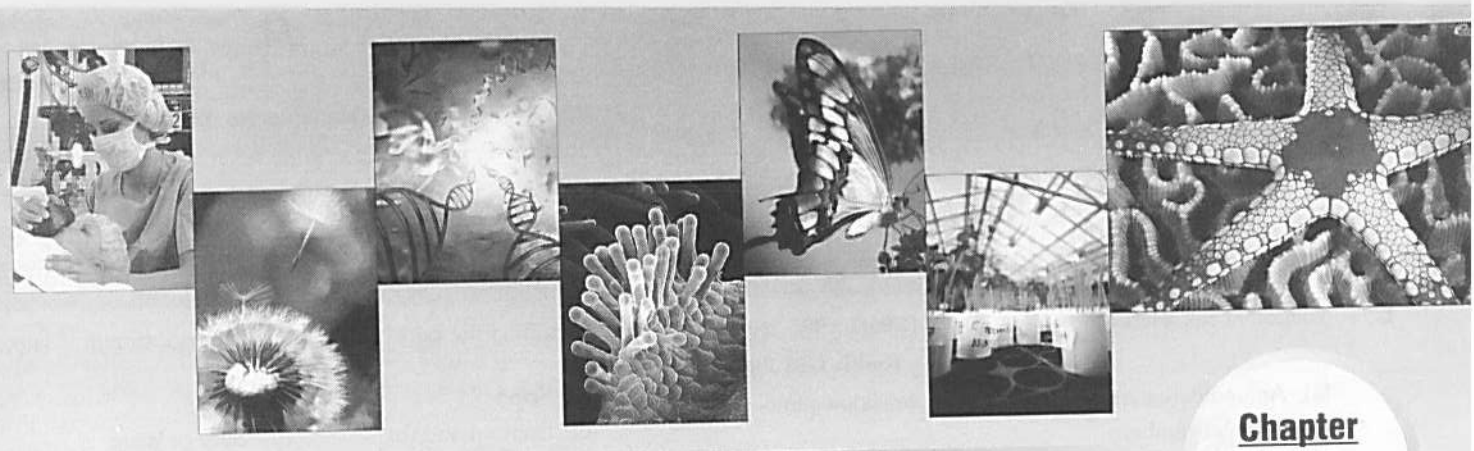


Chapter

6.2

Sexual Reproduction in Flowering Plants

Embryology is confined to study of embryo, *i.e.*, the branch dealing with study of events which lead to the development of embryo or study of events of life cycle of a plant is called Embryology. Prof. P. Maheshwari was the most important and founder Indian embryologist of international fame (father of Indian embryology).

His book 'An Introduction to Embryology of Angiosperms' is an important contribution in the field of embryology.

Sexual reproduction

Sexual reproduction in flowering plants involves transformation of diploid sporophytic cells into haploid gametophytic cells by *meiosis* and subsequent *fusion* of haploid gametes of opposite sex to form diploid zygote. The zygote then develops into an embryo which ultimately forms a diploid plant body. In flowering plants, all these steps of sexual reproduction occur within specialized reproductive organs, called the *flowers*.

(1) **Structure of the flower :** Morphologically flower is a modified shoot meant for sexual reproduction of the plant. Typically, it is a condensed branch in which internodes have become condensed, bringing nodes very close to one another, and the leaves are modified to form floral whorl that directly or indirectly participate in the process of reproduction.

The flower is commonly borne on short or long stalk called the *pedicel*. It has an upper swollen region known as *receptacle* (*thalamus or torus*).

(2) **Parts of a flower :** A typical angiospermic flower consists of four whorls of floral appendages attached on the receptacle : calyx, corolla, androecium and gynoecium. Of these, the two lower whorls (*i.e.*, calyx and corolla) are sterile and considered as nonessential, accessory or helping whorls. The two upper whorls (*i.e.*, androecium and gynoecium) are fertile and considered as essential or reproductive whorls.

(3) **Functions of a flower**

(i) Flowers are modifications of shoot to perform the function of sexual reproduction. The fertile leaves become microsporophylls (stamen) and megasporophylls (carpels) which bear anthers and ovules respectively. The anthers produce pollen grains and the ovules possess eggs.

(ii) Flowers of most of the angiosperms are shaped variously to help diverse modes of pollination.

(iii) Flowers provide seat for germination of pollen, development of pollen tube, formation of gametes and fertilization.

(iv) The ovary part of the carpel gets transformed into fruit and the ovules are transformed into seeds after fertilization.

(v) Some floral parts like calyx and various modifications in ovaries help in the dispersal of fruits and seeds.

Microsporogenesis

The process of the formation and differentiation of microspores (pollen grains) from microspore mother cells (MMC) by reductional division is called microsporogenesis.

Microsporogenesis is well studied under following heads :

(1) **Structure of anther :** The fertile portion of stamens is called anther. Each anther is usually made up of two lobes connected by a connective. In turn each anther lobe contains two pollen chambers placed longitudinally. Each pollen chamber represents a microsporangium and is filled with a large number of pollen grains or microspores. Parietal cells form wall of microsporangium. It consists of a layer of endothecium,1–3 middle layers and a layer of tapetum.

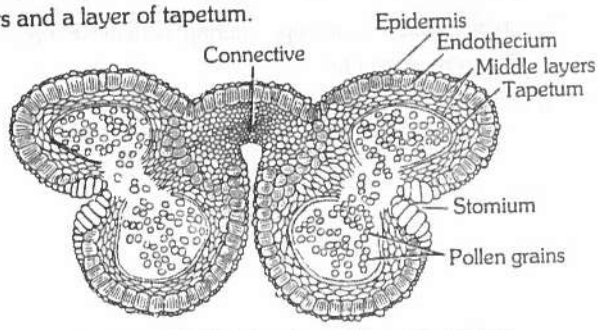


Fig : 6.2-1 T.S. of mature dithecous anther

The pollen sacs are surrounded by following 4 layers :

(i) **Epidermis :** This is the outermost single layered and protective covering. In *Arceuthobium*, cells of epidermis develops a fibrous thickening and the epidermis is designated as exothecium.

(ii) **Endothecium :** Inner to epidermis, there is a single layer of radially elongated cells. Cells of endothecium develop fibrous thickening (made up of cellulose with a little pectin and lignin) which help in the dehiscence of anther. In between these cells, a few cells without thickening are also present. These thin walled cells collectively form the ***stomium***.

(iii) **Middle layer :** Three to four layers of thin walled cells situated just below the endothecium are known as middle layers. Cells of this layer are ephemeral and degenerate to provide nourishment to growing microspore mother cells.

(iv) **Tapetum :** This is the innermost layer of the wall. The cells are multinucleate(undergo endopolyploidy) and polyploid. Tapetal cells are nutritive. Nutritional functions like producing enzymes, IAA and food materials.

In these cells the Ubisch bodies are present which help in the ornamentation of microspore walls. A compound sporopollenin is secreted in the exine of microspore wall. According to *Periasamy* and *Swamy* (1966), developmentally the tapetum has dual nature.

The tapetum is of two types

(a) Amoeboid or Periplasmodial tapetum

(b) Secretory or Glandular tapetum

(2) **Development of anther and formation of microspores (Pollen grains) :** The young anther consists of homogenous mass of parenchymatous cells surrounded by epidermis. It soon becomes four lobed. In each of the four lobes, some of the hypodermal cells begin to act as archesporial initials. Each archesporial initial divides into an outer primary parietal cell and an inner primary sporogenous cell. The primary parietal cell divides to form 3-5 wall layers, *i.e.*, endothecium, middle layers and tapetum. The primary sporogenous cells divide to produce a mass of sporogenous cells or microsporocytes.

Each microspore mother cell divides meiotically to form four haploid microspores or pollen grains and remains arranged in tetrads. The arrangement in the tetrads can be tetrahedral, isobilateral, linear, T-shaped and decussate.

Now the microspores are separated from tetrad. In *Drosera, Typha, Elodea, Hydrilla*, etc. all the four pollen grains do not separate and thus form compound pollen grains. In the members of the family Cyperaceae (*Cyprus*), out of 4 pollen in a tetrad, 3 degenerate and one remains alive. So one meiosis produces one pollen. Sometimes more than four pollens are produced from one microspore mother cell. It is called as *polyspory e.g.*, Cuscuta. In *Calotropis* (Asclepiadaceae) and some orchids all the pollen grains of an anther lobe form a typical structure called *pollinium*.

(3) **Development of male gametophyte (Microgametogenesis) :** Microspore or pollen grain is the first cell of male gametophyte (partially developed). It is unicellular and haploid. The shape varies from oval to polyhedral. The wall of the pollen grain is made of two layers.

The outer layer is called *exine*. It is made up of *sporopollenin* (derived from carotenoid). It is thick and ornamented Exine is differentiated into inner endexine and other ektexine. Ektexine is formed of 3 layers – (i) inner continuous foot layers (ii) middle discontinuous baculate layer and (iii) outer discontinuous tectum. At certain places, exine remains unthickened or missing and these places are known as *germ pores*. Sporopollenin is resistant to physical and biological decomposition. So pollen wall preserved for long periods in fossil deposits. The inner *intine* is thin, delicate and is made of *cellulose* and *pectose*.

In insect pollinated flowers, the exine of the pollen grain is covered with a yellowish, viscous and sticky substance called *pollenkitt*. This is perhaps the protective envelope which also sticks to the body of the insects and thus helps in pollination. It is chiefly made up of *lipids* and *carotenoids*. In monocots germ pores are absent and there is one germinal furrow. The development of male gametophyte from pollen grain is called microgametogenesis.

(4) **Pre-pollination development :** Microspores start germinating in situ (*i.e.*, while enclosed inside the microsporangium or pollen sac) and is called *precocious*. Microspores may be best defined as partially developed male gametophyte. Microspore nucleus divides mitotically to form a smaller generative cell lying next to spore wall and a much larger vegetative cell (or tube cell). A *callose layer* is deposited around the generative cell. The generative cell loses its contact with the wall of microspore and becomes free in the cytoplasm. The callose layer than dissolves. The pollen grains are shed from the anther at this bicelled stage (rarely three celled).

(5) **Post-pollination development :** The liberated pollen grains are transferred to the receptive surface of the carpel (*i.e.*, stigma) by the process called pollination. On the stigma, the pollen grain absorbs water and swells within a few minutes. It releases the wall-held recognition factors. These factors determine whether the pollen grain will germinate on the stigma or not. Subsequent to mutual recognition, the vegetative (or tube) cell enlarges and comes out through one of the apertures in the form of a pollen tube. The wall of pollen tube is the extension of intine. The tube secretes exogenous pectinases and other hydrolytic enzymes to create a passage for its entry. It absorbs nourishment from the transmitting tissue of the style. Gradually, the vegetative and generative nuclei are carried by the pollen tube, the former lying at its tip. The generative cell divides to form two non-motile male gametes. The tube nucleus has no important function and may disintegrate.

Megasporogenesis

The process of formation of megaspore from megaspore mother cell by meiotic division is known as megasporogenesis. This process takes place in ovule.

Megasporogenesis can be studied under following heads :

(1) **Structure of ovule (Megasporangium) :** Ovule is considered to be an integumented megasporangium. The ovule consists of the stalk and the body. The stalk is called *funicle*. One end of the funicle is attached to placenta and the other end to the body of the ovule. The point of attachment of funicle with the body is called *hilum*. Sometimes funicle gets fused with the body of the ovule one side and forms a ridge known as *raphe*. The body of the ovule shows two ends: the basal end, often called the *chalazal* end and the upper end is called *micropylar* end. The main body of the ovule is covered with one or two envelopes called integuments. These leave an opening at the top of the ovule called micropyle. The integuments enclose a large parenchymatous tissue known as nucellus. Generally till maturity whole of the nucellus is consumed in seeds but in some cases, a thin layer of nucellus is present in mature seeds, which is called perisperm (*i.e.*, Perisperm is remnant of nucellus)

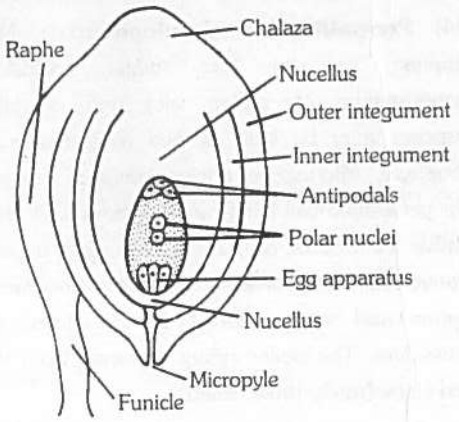


Fig : 6.2-2 Structure of ovule

In the centre of the nucellus is situated a female gametophyte known as *embryo sac*.

Following are the conditions seen in ovule in relation to integuments :

(i) **Unitegmic :** Ovule with a single integument, *e.g.*, synpetalous or gamopetalous dicotyledons.

(ii) **Bitegmic :** Ovule with two integuments as in polypetalous (Archichlamydeae) dicotyledons and monocotyledons.

(iii) **Aril :** This is a collar-like outgrowth from the base of the ovule and forms third integument. Aril is found in litchi, nutmeg, etc.

(iv) **Caruncle :** It is formed as an outgrowth of the outer integument in the micropylar region. Caruncle is common in the ovules of Euphorbiaceae. *e.g.*, Castor (*Ricinus*).

(v) **Ategmic :** In some parasites like *Loranthus, Viscum, Santalum* etc., there is no integument. Such an ovule is called ategmic.

(2) **Kinds of ovules :** Depending upon the shape and orientation, the ovules of angiosperms are classified into following types :

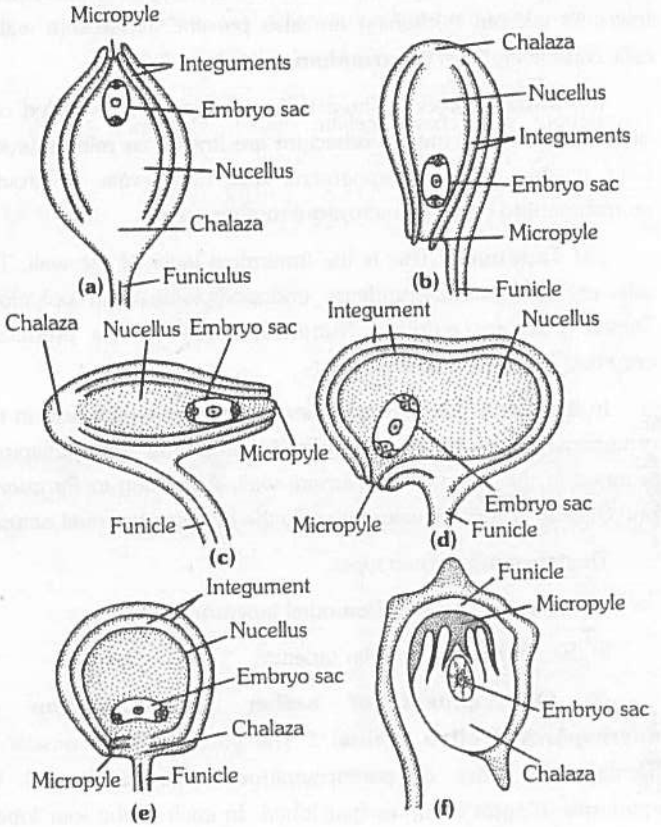


Fig : 6.2-3 Different forms of the ovule in longitudinal section (a) Orthotropous, (b) Anatropous, (c) Hemianatropous, (d) Campylotropous, (e) Amphitropous, (f) Circinotropous

(i) **Orthotropous or Atropus :** The micropyle, chalaza and funicle are in straight line. This is most primitive type of ovules. *e.g.*, Betel, *Piper, Polygonum*.

(ii) **Anatropous :** The body of the ovule is completely inverted (turn at 180° angle) so that micropyle and hilum come to lie very close to each other. *e.g.*, 82% of angiosperm families.

(iii) **Hemianatropous :** Ovule turns at 90° angle upon the funicle or body of ovule is at right angle to the funicle *e.g.*, *Ranunculus*.

(iv) **Campylotropous :** Ovule is circled more or less at right angle to funicle. Micropylar end is bent down slightly. *e.g.*, in members of *Leguminosae* and *Cruciferae, Capsella*.

(v) **Amphitropous :** Curvature of ovule is more and embryo sac becomes curved like horse shoe *e.g. Lemna, Poppy, Alisma*.

(vi) **Circinotropous :** The ovule is initially orthotropous but becomes anatropous due to unilateral growth of funicle. The growth continues till the ovule once again becomes orthotropous. As a result funicle completely surrounds the body of the ovule *e.g.*, *Opuntia* (prickly pear).

(3) **Formation of megaspore :** The ovule or the megasporangium develops as a small protuberance of the placental tissue. In the very young ovule a single hypodermal cell is differentiated as archesporium cell. The archesporial cell may directly function as megaspore mother cell (*tenuinucellate ovule*) or may divide periclinally to form an outer parietal cell and an inner sporogenous cell (*crassinucellate ovule*). The sporogenous cell directly behaves as megaspore mother cell (or megasporocyte). The diploid megaspore mother cell enlarges in size and divides by meiosis to form a linear tetrad of four haploid megaspores. Occasionally T-shaped or inverted T-shaped (⊥) tetrads are also formed. Megaspore is the first cell of female gametophyte.

Of the linear tetrad, three megaspores towards the micropyle degenerate. The lowermost, *i.e.*, the chalazal megaspore enlarges and remains functional. It later produces an embryo sac.

(4) **Development of female gametophyte (Megagametogenesis) :** The process of development of female gametophyte or embryo sac from megaspore is called megagametogenesis.

(i) **Monosporic type (Polygonum) :** In this type, only one megaspore situated towards chalazal end takes part in the development of embryo sac. The functional haploid megaspore enlarges in size and by means of three successive mitotic divisions, gives rise to an 8-nucleate embryo sac. Of these, four nuclei occur at micropylar end and the other four at the chalazal end. Three nuclei at the micropylar end form egg apparatus and the fourth migrates from the both pole to the centre and form polar nucleus.

A fully developed typical or polygonum type of embryo sac is large and oval structure consisting of seven cells and eight nuclei.

(a) **Egg apparatus :** This is a group of 3 cells situated at the micropylar end. The centrally located cell is called egg cell. On its sides are present two synergids. Egg cell has a large vacuole at its upper end and a prominent nucleus near its lower end. Synergids show a filiform apparatus attached to their upper wall. It is known to attract and guide the pollen tube. Each of the synergids has a vacuole at its lower end and the nucleus at its upper end.

(b) **Polar nuclei :** These are situated in the centre of the embryo sac representing a large binucleate central cell. Generally, both the polar nuclei fuse before fertilization and form a single diploid nucleus called secondary nucleus or definitive nucleus.

(c) **Antipodals :** The three cells situated at the chalazal end are called antipodals. They may take part in nourishing the embryo. For this, the antipodal cells often develop haustoria. These cells generally degenerate soon after fertilization *e.g.*, in *Sasa paniculata* (a bamboo), 300 antipodals are present.

- Polygonum type occurs in about 70% of angiosperms and is the common type.

(ii) **Bisporic type :** In this type two megaspore nuclei take part in embryo sac formation.

(iii) **Tetrasporic type :** This type of embryo sac develops from four megaspore nuclei.

Pollination

The process of transfer of pollen grains, from an anther to the stigma of the same flower or of different flower. This process of pollination occurs only in gymnosperms and angiosperms. It is of two types :

(1) **Self pollination :** This process involves the transfer of pollen grains from the anthers to the stigma of the same flower or of another flower borne by the same plant. It is of two types :

(i) **Autogamy :** It is a kind of pollination in which the pollen from the anthers of a flower are transferred to the stigma of the same flower.

(ii) **Geitonogamy :** It is a kind of pollination in which the pollen from the anthers of one flower are transferred to the stigma of another flower borne on the same plant. It usually occurs in plants which show monoecious condition (unisexual, male and female flowers are borne on the same plant). Geitonogamy involves two flowers but these belong to the same parent plant.

Merits

- Pollen grains are not wasted.
- The purity of the generation is maintained.

Demerits

- New and healthier varieties are not formed
- It results in weaker progeny, producing weaker seeds and plants.

Contrivances for self pollination : The major contrivances or adaptations which favours self pollination are :

(a) **Bisexuality :** Flowers should be bisexual or hermaphrodite.

(b) **Homogamy :** Anthers and stigma of the bisexual flowers of some plants mature at the same time. They are brought close to each other by growth, bending or folding to ensure self pollination. This condition is called homogamy. *e.g.*, *Mirabilis* (Four O, clock), *Catharanthus* (= *Vinca*), Potato, Sunflower, Wheat, Rice, etc.

(c) **Cleistogamy :** Some plants never open to ensure complete self-pollination. This condition is called cleistogamy, *e.g.*, *Commelina bengalensis*, *Oxalis*, *Viola*, etc. The cleistogamous flowers are bisexual small, inconspicious, colourless and do not secrete nectar.

(2) **Cross pollination :** Cross pollination involves the transfer of pollen grains from the flower of one plant to the stigma of the flower of another plant. It is also called *xenogamy*.

Merits

- Seeds are more and viable.
- Progenies are healthier.
- Adaptability is better.
- New varieties can be produced.

Demerits

- The process is not definite because plants depend on agencies.
- Large amount of pollen grains are wasted.

Contrivances for cross pollination : Nature favours cross pollination. All unisexual flowers and a large number of bisexual flowers are naturally cross pollinated.

The main contrivances ensuring cross pollination are as follows :

(i) **Diclincy or Unisexuality :** In unisexual flowers stamens and carpels are found in different flowers. Unisexuality can be of two types :

- **Monoecious plant :** When male and female flowers are borne on the same plant. *e.g.*, Maize, Cucurbits, Castor.
- **Dioecious plant :** When male and female flowers are borne on different plants. *e.g.*, *Carica papaya, Cannabis*.

(ii) **Dichogamy :** In bisexual flowers, when two sexes mature at different intervals and thus avoid self pollination is known as dichogamy. When stamens mature earlier than the stigma, it is known as *protandry* and the flowers are called protandrous *e.g.*, Coriander, Jasmine, Sunflower, Lady's finger, etc. When stigma matures earlier than the stamens, it is known as *protogyny* and the flowers are called protogynous. *e.g.*, Rose, Tobacco, Crucifers, etc.

(iii) **Heterostyly :** The plants of some species in which flowers are dimorphic. Thus facilitate cross pollination. Some of them possess a long style but short stamens and are known as *pin-eyed* while others have short style and long stamens. These are known as *thrum-eyed*. *e.g.*, *Oxalis*.

(iv) **Herkogamy :** In some bisexual flowers where the stigma and anthers mature at the same time, self pollination is avoided by some sort of barrier. The flowers show following contrivances :

- The male and female sex organs lie at some distance from each other.
- In some flowers corolla has peculiar forms which act as barrier in self pollination. *e.g.*, *Aristolochia*.
- In some other flowers, the pollens are held together to form pollinia which can only be carried away by insects. *e.g.*, Orchids and *Calotropis*.

(v) **Self sterility or Incompatibility :** When pollen grain of an anther do not germinate on the stigma of the same flower, then such flower is called self sterile or incompatible and this condition of flower is called self sterility, intraspecific incompatibility or self incompatibility. In these flowers cross pollination is the only means for fertilization and production of seeds.

Agents for cross pollination : Cross pollination involves external agents for the transfer of pollen grains of one flower to the stigma of another flower. There are two main groups of agents : (i) Abiotic agents like wind and water (ii) Biotic agents which include animals of different types such as insects, birds, bats, snails, etc.

(i) **Abiotic agents**

(a) **Anemophily :** When flowers are pollinated by *wind* agency, the phenomenon is known as anemophily. Anemophilous flowers are small and inconspicuous with long and versatile stamens. *e.g.*, Sugarcane, Maize, Wheat, Bamboo, Pinus, Papaya, Grasses, *Typha*, Datepalm, Coconut, Mulberry, Chenopodium, etc. This type of pollination mainly observed in Graminae.

(b) **Hydrophily :** When the pollination takes place through the agency of ***water***, it is known as hydrophily. All aquatic plants are not hydrophilous some are anemophilous *e.g.*, *Potamogeton, Myriophyllum* or Entomophilous *e.g.*, *Alisma*, Lotus. Hydrophily is of two types :

- **Hypohydrophily :** Plants which are pollinated inside the water *e.g.*, *Zostera, Ceratophyllum, Najas*, etc.
- **Epihydrophily :** Plants which are pollinated outside the water. *e.g.*, *Vallisneria* (Ribbon weed).

(ii) **Biotic agents**

(a) **Entomophily :** When pollination is brought about by the agency of *insects*, it is known as entomophily or insect pollination. About 80% pollination occurs by insects like moths, beetles, butterflies, wasp, etc. All the flowers pollinated by insects are brightly coloured, have a sweet smell and produce nectar. Entomophilous flowers produce a small amount of pollen which has a spinous and sticky exine due to presence of pollenkitt. The stigmas of such flowers are long rough and sticky. *Salvia* is excellent example of insect pollination is which pollination occurs by lever or turn pipe mechanism. Other examples of insect plants are *Yucca* (by *Tageticula* moth), Orchid *Ophrys speculum* (by *Colpa aurea* a hairy wasp), *Ficus* (by *Blastophaga*), etc. Yucca is pollinated by Pronuba (= Tegaticula) yuccasella which passes its larval stage inside the ripening ovary. The flower of orchid ophrys resemble in shape colour and odour to female wasp of colpa aurea (mimicry). The male wasps pollinate the flowers mistaking them as female (pseudocopulation).

(b) **Ornithophily :** When flowers are pollinated by *birds*, the phenomenon is known as ornithophily. The most common bird pollinators are Sun bird, Humming bird, Crow, Bulbul, Parrot, Mynah, etc. The birds visit a large variety of flowers such as *Bombax* (red silk cotton), *Erythrina* (Coral tree), *Callistemon* (Bottle brush), *Bignonia, Agave*, etc. Flowers are brightly coloured and produce plenty of nectar and large quantities of pollen. Humming bird pollinates while hovering over the flowers and sucking nectar. The bird can derive about half of its body weight of nectar in a single day. The nectar is chiefly made of sugars and provides a sweet drink to the bird.

(c) **Chiropterophily :** It is a mode of pollination performed by ***bats***. The flowers they visit are large, dull-coloured and have a strong scent. Chiropterophilous flowers produce abundant pollen grains. These flowers secrete more nectar than ornithophilous flowers and open at night emit a good fragrance. *e.g.*, *Kigelia pinnata* (Sausage tree), *Adansonia* (Baobab tree), *Bauhinia megalandra, Anthocephalus* (Kadam tree), etc.

(d) **Malacophily :** Pollination by *slugs and snails* is called malacophily. Land plants like *Chrysanthemum* and water plant like lemna shows malacophily. Arisaema (aroid; snake plant) is often visited by snails.

(e) **Myrmecophily :** Pollination by ants. *e.g.*, *Anemone nemarosa* (fruit).

Fertilization

The fusion of two dissimilar sexual reproductive units (gametes) is called fertilization. This process was discovered by Strasburger (1884).

(1) **Germination of pollen grain on stigma and growth of pollen tube :** Pollen grains reach the receptive stigma of the carpel by the act of pollination. Pollen grains, after getting attached to the stigma, absorb water and swell. Subsequent to mutual recognition and acceptance of pollen grains, the pollen grain germinates (*in vivo*) to produce a pollen tube which grows into stigma towards the ovarian cavity.

G.B. Amici (1824) discovered the pollen tube in *Portulaca oleracea*. Generally, only one pollen tube is produced by a pollen grain (*monosiphonous*). But some plants like members of Cucurbitaceae produce many pollen tubes (*polysiphonous*). The pollen tube contains a vegetative nucleus or tube nucleus and two male gametes. Later, the vegetative cell degenerates. The pollen tube now reaches the ovule after passing through the style.

(2) **Entry of pollen tube into ovule :** After reaching ovary, the pollen tube enters the ovule. Pollen tube may enter the ovule by any one of the following routes :

(i) **Porogamy :** When the pollen tube enters the ovule through micropyle, it is called porogamy. It is the most common type. *e.g.*, *Lily*.

(ii) **Chalazogamy :** The entry of pollen tube into the ovule from chalazal region is known as chalazogamy. Chalazogamy is less common. *e.g.*, *Casuarina*, *Juglans*, *Betula*, etc. It was first observed by ***Treub*** (1981) in *Casuarina*.

(iii) **Mesogamy :** The pollen tube enters the ovule through its middle part *i.e.*, through integument (*e.g.*, *Cucurbita*, *Populus*) or through funicle (*e.g.*, *Pistacia*).

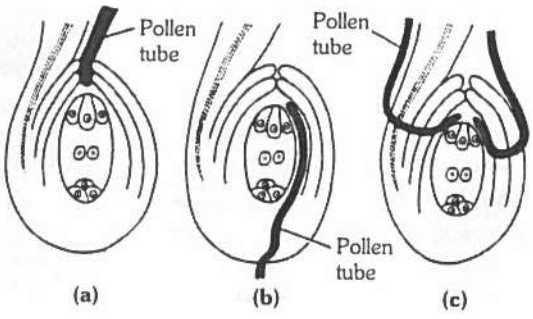


Fig : 6.2-4 Entry of pollen tube into the ovule
(a) Porogamy, (b) Chalazogamy, (c) Mesogamy

(3) **Entry of pollen tube into embryo sac :** The pollen tube enters the embryo sac only from the micropylar end irrespective of its mode of entry into the ovule. The pollen tube either passes between a synergid and the egg cell or enters into one of the synergids through filiform apparatus. The synergids direct the growth of pollen tube by secreting some chemical substances (chemotropic secretion). The tip of pollen tube enters into one synergid. The penetrated synergid starts degenerating. After penetration, the tip of pollen tube enlarge and ruptures releasing most of its contents including the two male gametes and the vegetative nucleus into the synergid.

(4) **Double fertilization :** The nuclei of both the male gametes are released in the embryo sac. One male gamete fuses with the egg to form the diploid zygote. The process is called syngamy or generative fertilization. This syngamy was discovered by Strasburger (1884).

The diploid zygote finally develops into embryo. The other male gamete fuses with the two polar nuclei (or secondary nucleus) to form the triploid primary endosperm nucleus. The process is called triple fusion or vegetative fertilization. These two acts of fertilizations constitute the process of double fertilization. The process was discovered by S.G. Nawaschin (1898) and Guignard in Lilium and *Fritillaria*. Double fertilization occurs in angiosperms only. Total number of nuclei involved in double fertilization is five, *i.e.*, 2 in syngamy + 3 in triple fusion.

Endosperm

Endosperm is the nutritive tissue for the developing embryo and also the seedling. In angiosperms, the endosperm develops from triploid ($3n$) primary endosperm nucleus which is formed as a result of vegetative fertilization, triple fusion or fusion of a male gamete with secondary nucleus of the central cell. In gymnosperms, endosperm is formed before fertilization and is always haploid.

(1) **Types of endosperm :** On the basis of development, endosperm are of three types :

(i) **Nuclear endosperm :** In the nuclear type of endosperm development, the primary endosperm nucleus divides by repeated mitotic free nuclear divisions without the formation of walls. It results in the formation of a large number of free nuclei in the central cell of the embryo sac. A big central vacuole develops in the embryo sac pushing all the nuclei to the peripheral cytoplasm. Finally cell wall formation takes place from the periphery of the embryo sac towards the centre leading to the formation of cellular endosperm tissue. In Coconut, the endosperm is multicellular in the outer part and free nuclear in the centre. Nuclear endosperm is the most common type of endosperm and mostly found in polypetalae. *e.g.*, *Cotton*, *Zeamays*, *Capsella* etc.

(ii) **Cellular endosperm :** In the cellular type of endosperm development, the first nuclear division of the primary endosperm nucleus is immediately followed by the wall formation. The first division results in the formation of two equal sized chambers : chalazal and micropylar chambers. The subsequent divisions are followed by regular cell wall formation. This type of endosperm formation is common in gamopetalae. *e.g.*, *Petunia*, *Datura*.

(iii) **Helobial endosperm :** In the helobial type of endosperm development, the endosperm is intermediate between cellular and nuclear types. The division of primary endosperm nucleus is followed by wall formation and as a result two chambers : micropylar and chalazal chambers, are formed. Generally the chalazal cell does not divide further and function as haustorium. Nucleus of the large micropylar cell divides by repeated free nuclear divisions and further development takes place in the same way as the nuclear endosperm. Helobial type of endosperm development is prevalent in monocotyledons. *e.g., Erumurus.*

(2) **Some terms related to endosperm**

(i) **Ruminate endosperm :** Mature endosperm with irregularity and unevenness in its surface is called ruminate endosperm. Rumination is caused by the activity of seed coat or by the endosperm itself. It is found in about 32 families of angiosperm. *e.g., Annonaceae, Palmae, Myristicaceae*, etc.

(ii) **Mosaic endosperm :** In some cases, the tissue of endosperm is not homogeneous but there are patches of different colours. Such type of endosperm is called mosaic endosperm and was observed by Webber (1990) in *Zea mays*. In maize endosperm, red and white patches appear irregularly distributed. In *Petunia* and Tomato, endosperm shows two types of tissues – some consisting of diploid cells and some triploid cells. These two types of cells intermix to form mosiac.

(iii) **Xenia :** The effect of pollen on endosperm is called xenia. This term was given by ***Focke*** (1881). *e.g., Maize.*

(iv) **Metaxenia :** The effect of pollen on somatic tissue lying outside the endosperm is known as metaxenia. Metaxenia term was given by the Swingle (1928). *e.g., Datepalm.*

Embryo

(1) **Development of embryo (Embryogeny) :** The zygote after a period of rest develops into embryo. The process of development of mature embryo from diploid zygote is called embryogenesis.

(i) **In dicotyledons :** The normal type of dicot embryo development has been studied in Shepherd's purse (Capsella bursapastoris) family Cruciferae. This is called as crucifer or onagrad type of embryo development. This development of embryo is endoscopic i.e., apex is downward or towards inside. The first division of zygote is transverse which produces a basal cell (cb) towards the micropyle and a terminal cell (ca) towards chalaza. The basal cell divides by transverse division and the terminal cell by a longitudinal division, so 4 celled T-shaped proembryo is produced. The two basal cells divide by transverse division and form 6-10 celled suspensor. The upper most cell of the suspensor is vasicular cell and lowest cell is called hypophysis which forms radicle and root cap.

The two apical cells first divide by longitudinal division (at right angle to first one) and then by transverse and periclinal division. So sixteen celled globular embryo is produced. Due to differentiation of cotyledons globular embryo becomes *heart shaped.*

Mature embryo in dicots consists of two lateral cotyledons, terminal plumule or stem tip and radicle or root tip.

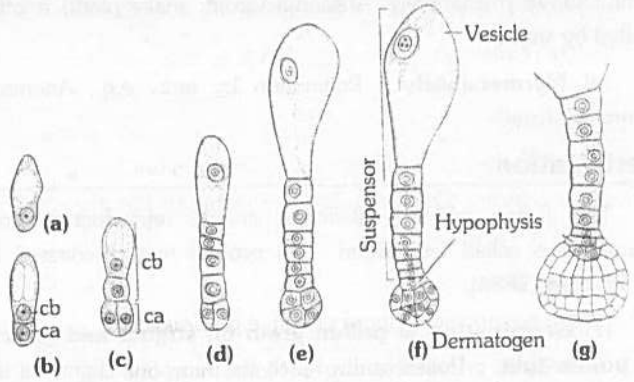


Fig : 6.2-5 Successive stages of the development of dicotyledonous embryo upto globular stage

(ii) **In monocotyledons :** The normal type of monocot embryo development has been studied in *Sagittaria sagittaefolia*. The early development of dicot and monocot embryos is similar upto globular stage. Later on differentiation starts. Suspensor is single celled and vascular. There is only one terminal cotyledon called scutellum (shield shaped). In grasses the second cotyledon is reduced called epiblast.

The *basal cell* (*cb*) divides by a transverse wall into two cells – *ci* and *m*. The cell *ci* divides once again to form *n* and *n'* cells. Of these *n'* is the outermost which develops into suspensor. The cell *n* forms parts of root cap the cell *m* contributes to the remaining part of root cap and a part of the radicle.

The *terminal cell* (*ca*) divides by two vertical walls, at right angles to one another. This results in the formation of a quadrant (*q*). Cells of the quadrant divide periclinally differentiating into the peripheral cells and the inner group of cells. The repeated divisions in both peripheral and central group of cells results in the formation of two regions –*l* and *l'*. Region *l* produces the lower part of cotyledon while upper part of cotyledon, hypocotyl and plumule are formed by *l'* region.

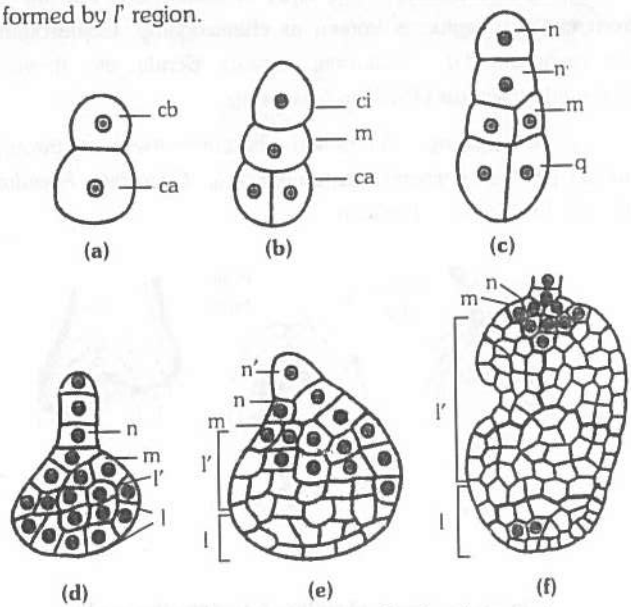


Fig : 6.2-6 Different stages in the development of monocotyledonous embryo

(2) **Polyembryony :** Occurrence of more than two embryo in the seed is known as polyembryony. It was discovered by *A.V. Leeuwenhock* (1719) in *Citrus*. It may be :

(i) **Cleavage polyembryony :** Due to cleavage of zygote or proembryo into two or more embryos and each split part develops into an embryo. This type of polyembryony is common in gymnosperms than in angiosperms. *Erythronium americanum, Nymphaea advena, Crotolaria,* etc., are some of the angiosperms showing cleavage polyembryony.

(ii) **Simple polyembryony :** Due to presence of more than one embryo sac and so oospore or egg. *e.g., Brassica.*

(iii) **Mixed polyembryony :** More than one pollen tube entering an ovule and fertilizing synergids (as in *Argemone maxicana*) and antipodal cell (as in *Ulmus americana*).

(iv) **Adventive polyembryony :** Diploid nucellus or integument cells form embryos *e.g., Citrus, Opuntia, Mangifera.*

If extra embryos develop from same embryo sac, it is called true polyembryony and if embryos develop elsewhere it is called false polyembryony. In *Balanophora*, an extra embryo develops from endosperm.

Parthenocarpy

The formation of fruits without fertilization is called parthenocarpy. Such fruits are either seedless or non-viable seeds. Parthenocarpy is of two types :

(1) **Natural parthenocarpy :** When seedless fruits are produced without any special treatment from the ovaries in the absence of pollination and fertilization, the phenomenon is called natural parthenocarpy. *e.g.*, Grapes, Banana, Pineapple, Vitis and Noval oranges.

(2) **Induced parthenocarpy :** When seedless fruits are produced by spraying the flowers with either water extract of pollen grains or growth promoting hormones such as Indole acetic acid (IAA), Naphthalene acetic acid (NAA), Gibberellic acid (GA), etc. the phenomenon is called induced parthenocarpy. *e.g.*, Tomato, Black berry, Fig, *Lemon, Apple, Orange, Pear.* etc.

Pomegranate lose its economic value if its fruits are produced by induced parthenocarpy.

Tips & Tricks

✍ In angiosperms apospory was first reported by Rosenberg (1907) in Hieracium.

✍ Rudolf Camerarius (1694) first described sexual reproduction in plants.

✍ Origin of pollen sac is eusporangiate while that of megaspore mother cell (embryo sac or megagametophyte) is leptosporangiate.

✍ Pollen grain of *Zoostera* is filamentous and without exine.

✍ Adansonia flowers bears 1500-2000 stamens.

✍ In *Aristolochia elegans* all types of pollen tetrads (tetrahedral, isobilateral, T-shaped, ⊥ shaped and decussate) are found.

✍ Edible pollens are produced in rose.

✍ Best temperature for growth of pollen tube is 20-30°C.

✍ Pollen tube secretes IAA, cytokinins and hydrolysing enzymes for separation of cells in case of solid styles.

✍ Ubisch discovered the role of tapetum in anthers of angiosperms.

✍ Size of pollen (i) Smallest-Myosotis, 2.5-3.5μm. (ii) Biggest Mirabilis, diameter 250μm (iii) Longest Zoostera - 2500μm.

✍ Onagard or Crucifer type of embryo development is endoscopic (*i.e.*, apex is downward or towards inside) in tracheophytes and exoscopic (towards outside or tip of archegonium) in bryophytes.

✍ Study of pollen grain is known as palynology.

✍ In maize the outermost layer of endosperm is rich in protein and constitutes the aleurone layer.

✍ Embryosac (polygonum type) was first studied by Strasburger.

✍ The pollination mechanism of *Calotropis* is referred as translator mechanism.

✍ Hay fever is allergic reaction to the presence of pollen in the air. Plants commonly causing hay fever are *Amaranthus, Chenopodium, Sorghum* and *Castor.*

✍ Inspite of being dicot *Cuscuta* lacks cotyledons.

✍ Erythrina is pollinated by crows as well as squirrels.

✍ The seed with double endosperm is found in Coconut (Cocus nucifera) (I) Liquid endosperm (ii) Cellular endosperm.

✍ Stony endosperm is present in Betel nut (Areca nut) and Date palm (Phoenix dactylifera).

✍ Largest embryo in monocots is found in coconut. Loranthus is a monocot with 2-6 cotyledons.

✍ *Cocus nucifera* is widely used in the preparation of culture medium as coconut milk.

✍ In *Rafflesia*, pollination is carried by carrion flies while the dispersal of seeds/fruits by elephant.

Ordinary Thinking

Objective Questions

Microsporogenesis

1. Which one of the following is resistant to enzyme action **[CBSE PMT 2008]**
(a) Pollen exine (b) Leaf cuticle
(c) Cork (d) Wood fibre

2. There are 10 flowers in one individual plant of *Crotalaria*. In each microsporangium of every stamen of all the flowers, there are 30 microspore mother cells. How many pollen grains are formed from that plant **[EAMCET 2009]**
(a) 4,000 (b) 10,000
(c) 24,000 (d) 48,000

3. Pollen grains of a plant whose $2n = 28$ are cultured to get callus by tissue culture method. What would be the number of chromosomes in the cells of the callus **[KCET 2009]**
(a) 28 (b) 21
(c) 14 (d) 56

4. Pollengrain develops from _____of anther **[MHCET 2015]**
(a) Epidermis (b) Endothecium
(c) Tapetum (d) Sporogenous tissue

5. Sporopollenin is chemically **[WB JEE 2009; BHU 2012]**
(a) Homopolysaccharide (b) Fatty substance
(c) Protein (d) Heteropolysaccharide

6. Which one of the following is surrounded by a callose wall **[CBSE PMT 2007]**
(a) Microspore mother cell (b) Male gamete
(c) Egg (d) Pollen grain

7. These processes are necessary for the complete development of male gametophyte from pollen mother cell **[BHU 1994; GUJCET 2007]**
(a) One meiotic and two mitotic division
(b) One meiotic cell division and one mitotic cell division
(c) Two meiotic cell division and one mitotic cell division
(d) Two mitotic cell division

8. Male gametes in angiosperms are formed by the division of **[MH CET 2001; MP PMT 2007; CBSE PMT 2007]**
(a) Microspore (b) Generative cell
(c) Vegetative cell (d) Microspore mother cell

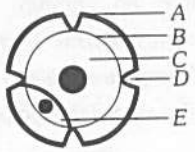
9. In the angiosperm ovule, central cell of the embryo sac, prior to the entry of pollen tube, contains **[KCET 2006]**
(a) A single haploid nucleus
(b) One diploid and one haploid nuclei
(c) Two haploid polar nuclei
(d) One diploid secondary nucleus

10. Pollen grains are formed in **[HPMT 2005]**
(a) Anther (b) Stigma
(c) Filament (d) Pollen sac

11. Male gametophyte in angiosperms produces **[AIPMT 2015]**
(a) Single sperm and a vegetative cell
(b) Single sperm and two vegetative cells
(c) Three sperms
(d) Two sperms and a vegetative cell

12. Rarely among angiosperms the pollen grains influenced the endosperm. This is called as **[CPMT 2004]**
(a) Metaxenia (b) Nemec phenomenon
(c) Xenia (d) Mesogamy

13. In the given diagram name the parts *A*, *B*, *C*, *D* and *E* **[KCET 2007]**



(a) *A* – germ pore, *B* – generative cell, *C* – intine, *D* – exine, *E* – vegetative cell
(b) *A* – germ pore, *B* – generative cell, *C* – exine, *D* – entine, *E* – vegetative cell
(c) *A* – intine, *B* – exine, *C* – germ pore, *D* – generative cell, *E* – vegetative cell
(d) *A* – exine, *B* – entine, *C* – vegetative cell, *D* – germ pore, *E* – generative cell

14. Exine of pollen grains is composed of **[MHCET 2003, 05; AIIMS 2003; MP PMT 2005, 09; KCET 2010; WB JEE 2010; J & K CET 2012]**
(a) Pectocellulose (b) Lignocellulose
(c) Sporopollenin (d) Pollenkitt

15. Meiosis can be observed in **[BVP 2003]**
(a) Spore mother cells (b) Microspores
(c) Megaspores (d) Tapetal cells

16. In angiosperm, all 4 microspores of tetrad are covered by a layer which is formed by **[CBSE PMT 2002]**
(a) Callose (b) Cellulose
(c) Sporopollenin (d) Pectocellulose

17. Pollinia is found in which of the following plant family **[AIIMS 2001]**
(a) Asteraceae (b) Myrtaceae
(c) Malvaceae (d) Asclepiadaceae

18. Haploids can be obtained from **[MHCET 2000; MP PMT 2006]**
(a) Pollen grains (b) Root apex
(c) Shoot apex (d) Embryo

19. An anther with two microsporangia is found in **[MP PMT 2007]**
(a) *Hibiscus* (b) Cucurbits
(c) Legumes (d) Corianders

20. The pollen grain is **[CBSE PMT 1993; RPMT 2002]**
(a) An immature male gametophyte
(b) A mature male gametophyte
(c) Partially developed male gametophyte
(d) Last stage of male gametophyte

21. How many meiotic divisions are necessary to produce 100 pollen grains **[AIIMS 1993; RPMT 1995; CBSE PMT 1995; AFMC 1999]**
(a) 100 (b) 25
(c) 50 (d) 20

22. Which part of the reproductive structure produces both enzymes and hormones **[AIIMS 1993]**
(a) Archegonium (b) Middle layer
(c) Tapetum (d) Endothecium

23. Which of the following statement about sporopollenin is false **[Kerala PMT 2010]**

(a) Exine is made up of sporopollenin

(b) Sporopollenin is one of the resistant organic materials

(c) Exine has apertures called germ pores where sporopollenin is present

(d) Sporopollenin can withstand high temperatures and strong acids

(e) No enzyme that degrades sporopollenin is so far known

24. Which one of the following statements is **not** true **[NEET (Phase-I) 2016]**

(a) Tapetum helps in the dehiscence of anther

(b) Exine of pollen grains is made up of sporopollenin

(c) Pollen grains of many species cause severe allergies

(d) Stored pollen in liquid nitrogen can be used in the crop breeding programmes

25. If there are 1280 microspores in a tetralocular anther, how many microspore mother cells will be there in its each pollen chamber **[MHCET 2015]**

(a) 80 (b) 160

(c) 240 (d) 1280

26. The function of innermost layer of pollen sac, tapetum is **[MHCET 2000, 02; BHU 2001; RPMT 2002; MP PMT 2005; DPMT 2006; CPMT 2009; AMU (Med.) 2012]**

(a) Dehiscence (b) Mechanical

(c) Protective (d) Nutritive

27. What is the function of germ pore **[CBSE PMT (Mains) 2012]**

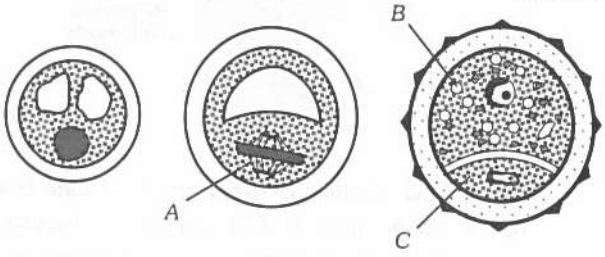
(a) Emergence of radicle

(b) Absorption of water for seed germination

(c) Initiation of pollen tube

(d) Release of male gametes

28. The given figure represents some stages in microgametogenesis. Identify A, B and C respectively **[NCERT]**



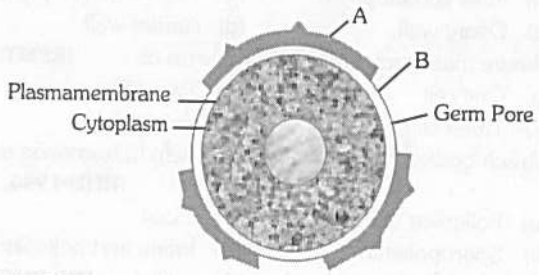
	A	B	C
(a)	Symmetric spindle	Vegetative cell	Generative cell
(b)	Symmetric spindle	Generative cell	Vegetative cell
(c)	Asymmetric spindle	Vegetative cell	Generative cell
(d)	Asymmetric spindle	Generative cell	Vegetative cell

29. Development and formation of pollen grains in anther of the stamen is known as

(a) Pollination (b) Fertilization

(c) Microsporogenesis (d) Megasporogenesis

30. In given figure A and B are respectively **[NCERT]**



(a) Epicarp and endocarp (b) Epidermis and endodermis

(c) Intine, exine (d) Exine, intine

31. In anther culture, the androgenic haploid plants are obtained from **[CBSE PMT 1990]**

(a) Young pollen grain (b) Connective tissue

(c) Anther tapetum (d) Anther wall

32. In monocots, male gametophyte is **[CBSE PMT 1990]**

(a) Microspore (b) Megaspore

(c) Tetrad (d) Nucellus

33. The odd one is **[CBSE PMT 1991; Odisha JEE 2011]**

(a) Micropyle (b) Embryo sac

(c) Nucellus (d) Pollen grain

34. In plants meiosis occurs in

(a) Anther (b) Root tip

(c) Cambium (d) Pollen grain

35. If you want to develop hybrid seeds within a bisexual flower which of the following parts need to be removed from the same flower **[WB JEE 2012]**

(a) Stigma (b) Ovary

(c) Anther (d) Oviduct

36. In anther culture, some diploid plants were reported with haploids. They have evolved from

(a) Prothallial cell of pollen grain

(b) Generative cell of pollen grain

(c) Cell of anther wall

(d) Exine of pollen grain

37. The anther wall consists of four wall layers where **[MP PMT 1993; CBSE PMT 1993; BVP 2003]**

(a) Endothecium lies inner to middle layers

(b) Tapetum lies just inner to endothecium

(c) Tapetum lies next to epidermis

(d) Middle layers lie between endothecium and tapetum

38. Study the following statements and select the correct option

A. Tapetum nourishes the developing pollen grains

B. Hilum represents the junction between ovule and funicle

C. In aquatic plants such as water hyacinth and water lily, pollination is by water

D. The primary endosperm nucleus is triploid **[Kerala PMT 2011; NEET 2013]**

(a) A and B are correct but C and D are incorrect

(b) A, B and D are correct but C is incorrect

(c) B, C and D are correct but A is incorrect

(d) A and D are correct but B and C are incorrect

(e) B and D are correct but A and C are incorrect

39. Which of the following wall layers of anther play a predominant role in its dehiscence **[DUMET 2010]**

(a) Epidermis (b) Endothecium

(c) Middle layers (d) Tapetum

40. Tapetum is a part of **[MP PMT 2000; CPMT 2009]**
(a) Male gametophyte (b) Female gametophyte
(c) Ovary wall (d) Anther wall

41. Mature male gametophyte is made up of **[RPMT 1995]**
(a) One cell (b) Two cells
(c) Three cells (d) Four cells

42. Ubisch bodies found in tapetal cell help in formation of **[BHU 1995, 2005]**
(a) Pollenkitt and pollinia (b) Exine
(c) Sporopollenin (d) Intine and pollenkitt

43. Germpore is the region where the exine is **[MP PMT 1995]**
(a) Thick (b) Uniform
(c) Thick and uniform (d) Absent

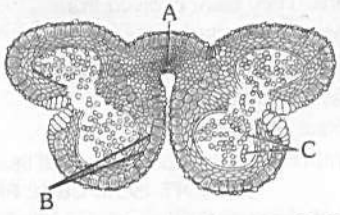
44. How many pollen grains are formed from 10 microspore mother cells by meiosis **[CBSE PMT 1996]**
(a) 80 (b) 40
(c) 20 (d) 10

45. In a young anther the four rows of cells which later produce pollen are called **[MP PMT 1999]**
(a) Antheridium (b) Archesporium
(c) Tapetum (d) Zoosporangium

46. If a sporangium is derived from a single cell, it is called **[BHU 2000]**
(a) Leptosporangiate (b) Eusporangiate
(c) Heterosporangiate (d) Homosporangiate

47. At the time of shedding the number of nuclei present in an angiosperm pollen grain is **[DUMET 2010]**
(a) One (b) One or two
(c) Two or three (d) Only two

48. The following is the diagram of T.S. of anther. Identify the parts labelled A, B and C **[KCET 2011]**

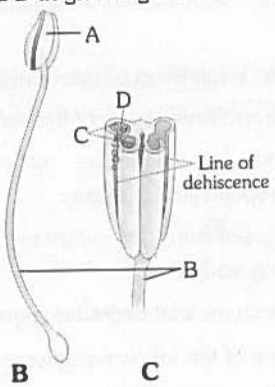


(a) A–Connective tissue, B–Endothecium, C–Pollen grain
(b) A–Endothecium, B–Connective tissue C–Pollen grain
(c) A–Pollen grain, B–Connective tissue, C–Endothecium
(d) A–Endothecium, B–Pollen grain, C–Connective tissue

49. Which of the following statement is **not** true about somatic embryogenesis **[NEET (Karnataka) 2013]**
(a) The pattern of development of a somatic embryo is comparable to that of a zygotic embryo
(b) Somatic embryos can develop from microspores
(c) Somatic embryo is induced usually by an auxin such as 2, 4-D
(d) A somatic embryo develops from a somatic cell

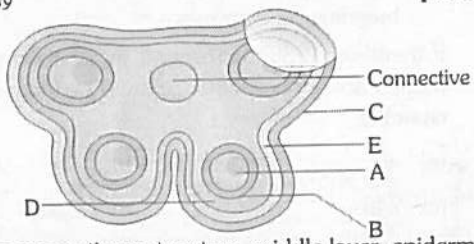
50. Which of the following statements is correct **[NEET (Karnataka) 2013]**
(a) Sporopollenin can be degraded by enzymes
(b) Sporopollenin is made up of inorganic materials
(c) Sporopollenin can withstand high temperatures as well as strong acids and alkalis
(d) Sporopollenin can withstand high temperatures but not strong acids

51. Identify A, B, C and D in given figure **[NCERT]**



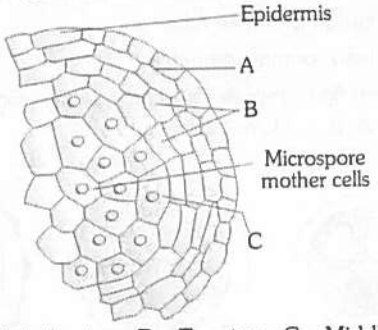
	A	B	C	D
(a)	Anther	Filament	Pollen sac	Pollen grains
(b)	Anther	Pedicel	Megasporangium	Pollen grains
(c)	Anther	Petiole	Megasporangium	Pollen grains
(d)	Anther	Petiole	Pollen sac	Magaspore

52. The given figure refers to a T.S. of anther. Identify A to E respectively **[NCERT]**



(a) Sporogenous tissue, tapetum, middle layer, epidermis, endothecium
(b) Sporogenous tissue, epidermis, middle layer, tapetum, endothecium
(c) Sporogenous tissue, epidermis, tapetum, middle layer, endothecium
(d) Sporogenous tissue, tapetum, epidermis, middle layer, endothecium

53. The given figure is an enlarged view of one microsporangium of a matured anther. identify A, B and C **[NCERT]**



(a) A - Endothecium, B – Tapetum, C – Middle layer
(b) A - Middle layer, B - Endothecium, C - Tapetum
(c) A - Tapetum, B - Middle layer, C - Endothecium
(d) A - Endothecium, B - Middle layer, C – Tapetum

Megasporogenesis

1. Which one of the following pairs of plant structures has haploid number of chromosomes **[CBSE PMT 1991, 2008]**
(a) Nucellus and antipodal cells
(b) Egg nucleus and secondary nucleus
(c) Megaspore mother cell and antipodal cells
(d) Egg cell and antipodal cells

2. What does the filiform apparatus do at the entrance into ovule **[CBSE PMT 2008]**

Or

Function of filiform apparatus is to **[CBSE PMT 2014]**

(a) It brings about opening of the pollen tube
(b) It guides pollen tube from a synergid to egg
(c) It helps in the entry of pollen tube into a synergid
(d) It prevents entry of more than one pollen tube into the embryo sac

3. Which one of the following statements is not true **[Kerala PMT 2009]**

(a) Pollen grains are released from anthers at 2-celled state
(b) Sporogenous cell directly behaves as the megaspore mother cell
(c) Megaspore divides twice to form an eight nucleate embryosac
(d) Egg and synergids always lie near the micropylar end of ovule
(e) Endosperm is triploid

4. The hilum and micropyle lie side by side very close to each other in **[CPMT 1993, 2009; Pb. PMT 2004]**

(a) Anatropous ovule (b) Campylotropous ovule
(c) Amphitropous ovule (d) Circinotropous ovule

5. Stalk with which ovules remain attached to placenta is called **[CPMT 1996; Odisha JEE 2005, 11]**

(a) Funicle (b) Raphe
(c) Hilum (d) Chalaza

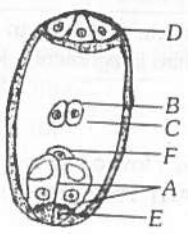
6. If the number of chromosomes in root cells is 14, what will be the number of chromosomes in synergids cells of an ovule of that parent **[MP PMT 2007; BHU 2012]**

(a) 7 (b) 14
(c) 21 (d) Incomplete information

7. The arrangement of the nuclei in a normal embryo sac in the dicot plants is **[NCERT; CBSE PMT 2006]**

(a) 2 + 3 + 3 (b) 3 + 3 + 2
(c) 2 + 4 + 2 (d) 3 + 2 + 3

8.



In the diagram given above, parts labelled as 'A', 'B', 'C', 'D', 'E' and 'F' are respectively identified as **[NCERT; Kerala PMT 2010]**

(a) Synergids, polar nuclei, central cell, antipodals, filiform apparatus and egg
(b) Polar nuclei, egg, antipodals, central cell, filiforms apparatus and synergids
(c) Egg, synergids, central cell, filiform aparatus, antipodals and polar nuclei
(d) Central cell, polar nuclei, filiform apparatus, antipodals, synergids and egg
(e) Filiform apparatus, polar nuclei, egg, antipodals, synergids and central cell

9. Which one of the most common embryo sac in flowering plant **[NCERT; MHCET 2004; Kerala PMT 2008; CPMT 2010; AIIMS 2013]**

(a) Monosporic, 8 nucleated and 7 celled
(b) Monosporic, 7 celled and 7 nucleated
(c) Bisporic, 8 nucleated and 7 celled
(d) Bisporic, 7 nucleated and 8 celled

10. An ovule which becomes curved so that the nucellus and embryo sac lie at right angles to the funicle is **[CBSE PMT 2004]**

(a) Anatropous (b) Orthotropous
(c) Hemitropous (d) Campylotropous

11. The hilum is a scar on the **[AIPMT (Cancelled) 2015]**

(a) Fruit, where it was attached to pedicel
(b) Fruit, where style was present
(c) Seed, where micropyle was present
(d) Seed, where funicle was attached

12. Caruncle is derived from **[Manipal MEE 1995; MP PMT 1996]**

(a) Cotyledons (b) Integument
(c) Peduncle (d) None of the above

13. Perisperm is **[AFMC 1993; CPMT 1995; MP PMT 1996; AIIMS 2009; AMU (Med.) 2010]**

(a) Degenerate part of synergids
(b) Peripheral part of endosperm
(c) Degenerate part of secondary nucleus
(d) Remnant of nucellus

14. Match the items in column I with those in column II and choose the correct answer

Column I	Column II
1. Funicle	A. Small opening of ovule
2. Integuments	B. Stalk of ovule
3. Chalaza	C Protective envelopes of ovule
4. Hilum	D. Junction part of ovule and stalk
5. Micropyle	E. Basal part of the ovule

[NCERT; Kerala PMT 2012]

(a) 1-B; 2-C; 3-E; 4-D; 5-A (b) 1-A; 2-C; 3-B; 4-D; 5-E
(c) 1-B; 2-C; 3-A; 4-D; 5-E (d) 1-B; 2-D; 3-E; 4-A; 5-C
(e) 1-C; 2-D; 3-E; 4-A; 5-B

15. When the ovule is curved and embryo sac becomes horse-shoe shaped, such an ovule is called **[CBSE PMT 2005; MP PMT 2010]**

(a) Amphitropous (b) Circinotropous
(c) Campylotropous (d) Orthotropous

16. Select the incorrect statement regarding angiosperm **[Odisha JEE 2010]**

(a) Megaspore is diploid
(b) Megaspore is the first cell of the female gametophyte
(c) The pollen grain is the first cell of the male gametophyte
(d) All of the above

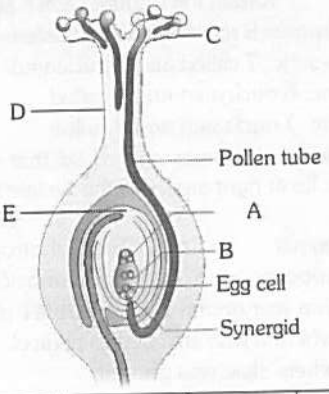
17. Embryo sac is **[CBSE PMT 1990; Pb. PMT 1999; MP PMT 2010; CPMT 2010]**

(a) Megasporangium (b) Megaspore
(c) Female gametophyte (d) Female gamete

18. Generally number of integuments in the ovule of angiosperms and gymnosperms is

(a) One and two (b) One and one
(c) Two and one (d) Two and two

19. Choose the right option in which all the alphabets A, B, C, D and E are correctly identified **[NCERT]**



	A	B	C	D	E
(a)	Antipodal cells	Secondary nuclei	Chalaza	Stigma	Style
(b)	Antipodal cells	Secondary nuclei	Stigma	Chalaza	Style
(c)	Antipodal cells	Secondary nuclei	Style	Stigma	Chalaza
(d)	Antipodal cells	Secondary nuclei	Stigma	Style	Chalaza

20. Tegmen develops from **[CBSE PMT 1990; AFMC 1993; MH CET 2006]**

(a) Outer integument (b) Inner integument
(c) Chalaza (d) Funicle

21. Crassinucellate ovule shows

(a) Absence of nucellus
(b) Well developed nucellus
(c) Partially developed nucellus
(d) Ill developed nucellus

22. Which of the following statements is **not** correct **[NEET (Phase-I) 2016]**

(a) Pollen grains of many species can germinate on the stigma of a flower, but only one pollen tube of the same species grows into the style
(b) Insects that consume pollen or nectar without bringing about pollination are called pollen/nectar robbers
(c) Pollen germination and pollen tube growth are regulated by chemical components of pollen interacting with those of the pistil
(d) Some reptiles have also been reported as pollinators in some plant species

23. The normal or Polygonum type of embryo sac is **[CPMT 1993; MP PMT 2013]**

(a) Bisporic eight nucleate
(b) Monosporic four nucleate
(c) Tetrasporic sixteen nucleate
(d) Monosporic eight nucleate

24. In angiosperms, functional megaspore develops into **[CBSE PMT (Mains) 2011]**

Or

The microscopic structure in flower that contains polar nuclei is

(a) Endosperm (b) Pollen sac
(c) Embryo sac (d) Ovule

25. The functional megaspore undergoes

(a) 2 meiotic divisions to form mature embryo sac
(b) 3 mitotic divisions to form mature embryo sac
(c) 2 mitotic divisions to form mature embryo sac
(d) 3 meiotic divisions to form mature embryo sac

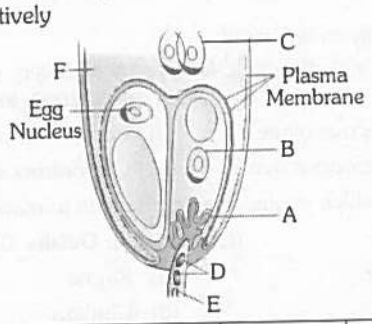
26. For the formation of tetrasporic embryosac, how many megaspore mother cells are required **[BHU 2003]**

(a) 1 (b) 2
(c) 3 (d) 4

27. Which of the following is not functionally analogous with others in the group **[CPMT 1993]**

(a) Archegonium (b) Oogonium
(c) Antheridium (d) Ovule

28. Examine the figure given below showing entry of pollen tube into embryo sac. Identify A, B, C, D, E and F respectively **[NCERT]**



	A	B	C	D	E	F
(a)	Obturator	Synergid	Polar nuclei	Male gemetes	Vegetative Nucleus	Central cell
(b)	Egg apparatus	Synergid	Polar nuclei	Male gametes	Vegetative Nucleus	Central cell
(c)	Filiform apparatus	Synergid	Polar nuclei	Vegetative Nucleus	Male gametes	Central cell
(d)	Filiform apparatus	Synergid	Polar nuclei	Male gametes	Vegetative Nucleus	Central cell

29. Collar like outgrowth arising from the base of ovule and forming a sort of third integument is known as **[JIPMER 2002]**

(a) Coma (b) Caruncle
(c) Aril (d) Operculum

30. Filiform apparatus is found in which part of angiosperms **[CPMT 1993, 95, 99; CBSE PMT (Pre.) 2011; AIPMT 2015]**

(a) Sperm (b) Antipodal
(c) Egg (d) Synergid

31. An orthotropous ovule is one in which micropyle and chalaza are **[CBSE PMT 1994; BHU 2008]**

(a) In straight line of funiculus
(b) Parallel to funiculus
(c) At right angles to funiculus
(d) Oblique to funiculus

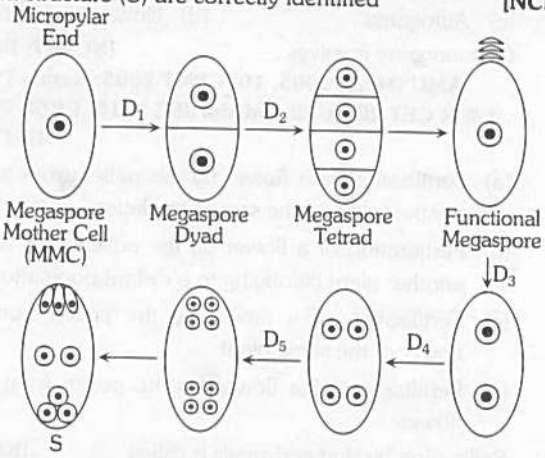
32. The ovule in pea are **[MP PMT 1996]**

Or

Ovule of *Capsella* is **[RPMT 1995]**

(a) Anatropous (b) Hemianatropous
(c) Campylotropous (d) Amphitropous

33. The given figure shows megasporogenesis and development of typical female gametophyte in angiosperms. Which of the following options is right in which all divisions (D_1 to D_5) and structure (S) are correctly identified **[NCERT]**



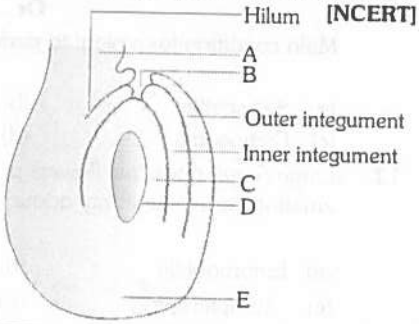
	D_1	D_2	D_3	D_4	D_5	S
(a)	Meiosis I	Meiosis II	Mitosis	Mitosis	Mitosis	Embryo
(b)	Meiosis I	Meiosis II	Mitosis	Mitosis	Mitosis	Microgame tophyte
(c)	Meiosis I	Meiosis II	Mitosis	Mitosis	Mitosis	Embryo sac
(d)	Mitosis	Meiosis	Mitosis	Mitosis	Mitosis	Embryo sac

34. In an embryo sac of a typical angiosperm, there are
(a) Egg, synergids and antipodals
(b) Egg, synergids, polar nuclei and antipodals
(c) Egg, synergids, central cell and polar nuclei
(d) Egg, synergids and secondary cell

35. Female gametophyte of angiospermic plants is represented by **[MP PMT 1994, 2000]**
(a) Oospore (b) Egg
(c) Carpel (d) Pollen grain

36. In *Capsella* meiosis takes place during **[RPMT 1995]**
(a) Development of pollen grains
(b) Development of egg
(c) Germination of zygote
(d) Development of embryo sac

37. A diagrammatic view of a typical anatropous ovule is given below. In which of the following option all five parts are correctly identified **[NCERT]**



	A	B	C	D	E
(a)	Funicle	Micropyle	Female gametophyte	Embryo sac	Chalaza
(b)	Placenta	Micropyle	Egg	Embryo sac	Chalaza
(c)	Raphe	Micropyle	Egg	Embryo sac	Chalaza
(d)	Funicle	Micropyle	Nucellus	Embryo sac	Chalaza

38. The formation of embryo sac is called **[CPMT 1998]**
(a) Megasporogenesis (b) Megagametogenesis
(c) Micro gametogenesis (d) None of these

39. Mature *Polygonum* type embryo sac has got **[NCERT; BHU 1999; MP PMT 1999, 2000, 06; MH CET 2005]**

Or

A normal angiosperm embryo sac at the final stage of development has **[DPMT 1992; CPMT 1993; MP PMT 1999; AMU (Med) 2009]**
(a) Seven cells and eight nuclei
(b) Seven nuclei and eight cells
(c) Eight cells and eight nuclei
(d) Seven cells and seven nuclei

40. If diploid chromosome number in a flowering plant is 12, then which one of the following will have only 6 chromosomes
(a) Endosperm (b) Leaf cells
(c) Cotyledons (d) Synergids

41. Egg apparatus of angiosperm consists of **[AFMC 1993, 2009; MHCET 2000; Odisha JEE 2010; DUMET 2010]**
(a) One egg cell and two synergids
(b) One egg cell 2 synergids 3 antipodals
(c) 3 antipodals only
(d) Secondary nucleus and egg cell

42. The point of attachment of funicle with chalazal end is called **[MP PMT 1996, 2001; MHCET 2003]**
(a) Placenta (b) Integument
(c) Nucellus (d) Hilum

43. The haploid cell which divides by mitosis to form embryosac is **[RPMT 2002]**
(a) Megaspore mother cell (b) Microspore mother cell
(c) Functional megaspore (d) Non-functional megaspore

44. What is the direction of micropyle in anatropous ovule **[CBSE PMT 2002]**
(a) Left (b) Right
(c) Upward (d) Inverted

45. Synergids of the polygonum type embryo sac are **[MHCET 2002; AMU (Med.) 2010]**
(a) Haploid (b) Diploid
(c) Triploid (d) Polyploid

46. Megasporangium is equivalent to **[NEET 2013]**
(a) Ovule (b) Embryo sac
(c) Fruit (d) Nucellus

47. Megaspores are produced from the megaspore mother cells after **[NEET (Karnataka) 2013]**
(a) Mitotic division (b) Formation of a thick wall
(c) Differentiation (d) Meiotic division

48. The ovule of an angiosperm is technically equivalent to **[NEET (Phase-II) 2016]**
(a) Megaspore (b) Megasporangium
(c) Megasporophyll (d) Megaspore mother cell

Pollination

1. Plants with ovaries having only one or a few ovules, are generally pollinated by **[CBSE PMT (Mains) 2012]**

Or

Flowers which have single ovule in the ovary and are packed into inflorescence are usually pollinated by **[NEET 2017]**
(a) Bees (b) Buttertlies
(c) Birds (d) Wind

2. Unisexuality of flowers prevents **[CBSE PMT 2008]**
(a) Geitonogamy, but not xenogamy
(b) Autogamy and geitonogamy
(c) Autogamy, but not geitonogamy
(d) Both geitonogamy and xenogamy

3. Choose the mis-matched option **[Kerala PMT 2008]**
(a) Wind – Cannabis – anemophily
(b) Water – Zoostera – hydrophily
(c) Insects – Salvia – entomophily
(d) Birds – Adansonia – ornithophily
(e) Bats – Kigelia – chiropterophily

4. One advantage of cleistogamy is **[DUMET 2009; NEET 2013]**
(a) It leads to greater genetic diversity
(b) Seed dispersal is more efficient and widespread
(c) Seed set is not dependent on pollinators
(d) Each visit of a pollinator results in transfer of hundreds of pollen grains

5. Which one of the following is an example of cleistogamy **[J & K CET 2008]**

Or

Even in absence of pollinating agents seed setting is assured in **[CBSE PMT (Pre.) 2012]**
(a) Sunflower (b) *Vallisneria*
(c) *Commelina* (d) *Calatropis*

6. Continued self pollination result in **[KCET 2015]**
(a) Formation of unisexual flowers
(b) Inbreeding depression
(c) Gametes loose vigour
(d) Self incompatibility

7. Match the entries in Column I with those of Column II and choose the correct answer

Column I		Column II	
A.	Cleistogamy	m.	Insect pollination
B.	Geitonogamy	n.	Bud pollination
C.	Entomophily	o.	Pollination between flowers in the same plant
D.	Xenogamy	p.	Wind pollination
		q.	Cross pollination

[DPMT 1992; KCET 2012]
(a) A – o; B – m; C – q; D – n (b) A – m; B – q; C – n; D – o
(c) A – n; B – o; C – m; D – q (d) A – q; B – p; C – o; D – n

8. Pollination occurs when a pollen grain **[DPMT 1993]**
(a) Matures and has three nuclei
(b) Lands on a stigma
(c) Releases its sperm nuclei
(d) Releases its pollen tube nucleus

9. Match the following

A. Zoophily	1. Pollination by birds
B. Ornithophily	2. Pollination by insects
C. Entomophily	3. Pollination by bats
D. Chiropterophily	4. Pollination by animals

[CPMT 1993, 98; MP PMT 2000; KCET 2004; MH CET 2005; HP PMT 2005; AMU (Med.) 2006; Kerala PMT 2006; WB JEE 2009]
(a) A – 3, B – 2, C – 1, D – 4 (b) A – 1, B – 2, C – 3, D – 4
(c) A – 4, B – 1, C – 2, D – 3 (d) A – 4, B – 2, C – 1, D – 3
(e) A – 4, B – 2, C – 3, D – 1

10. Pollination by wind is called **[KCET 2001; Manipal 2005; J & K CET 2010; CBSE PMT (Pre.) 2010]**
(a) Geitnogamy (b) Anemophily
(c) Autogamy (d) None of the above

11. Geitonogamy involves **[NCERT; BHU 1999; AMU (Med.) 2005, 10; CPMT 2005; Kerala PMT 2007; J & K CET 2010, 12; Odisha JEE 2010; CBSE PMT 2014; MH CET 2015]**
(a) Fertilization of a flower by the pollen from a flower of another plant in the same population
(b) Fertilization of a flower by the pollen from a flower of another plant belonging to a distant population
(c) Fertilization of a flower by the pollen from another flower of the same plant
(d) Fertilization of a flower by the pollen from the same flower

12. Pollination by slug and snails is called **[KCET 1994; AIIMS 1998; CBSE PMT 2002; Odisha JEE 2012]**
(a) Ornithophilous (b) Malacophilous
(c) Anemophilous (d) Chiropterophilous

13. Dichogamy which helps in cross pollination is a floral mechanism in which **[CPMT 2000]**
(a) Pollen sac and stigma are at different heights
(b) Anther and stigma mature at different times
(c) Structure of pollen sac and stigma functions as hurdles
(d) Pollen grain is unable to germinate on the stigma of the same flower

14. Correct definition of pollination is **[AFMC 1994]**
(a) Transfer of pollen grain from anther to stigma
(b) Germination of pollen grain
(c) Growth of pollen tube in ovule
(d) Visits of insects in flower

15. Which of the following is pollinated by water **[Kerala PMT 2010]**
(a) *Viola* (b) *Yucca*
(c) *Oxalis* (d) *Commelina*
(e) *Zostera*

16. Which prevents self pollination

Or

Main condition for a plant to perform cross pollination is **[BHU 2008]**
(a) Self sterility (b) Herkogamy
(c) Dichogamy (d) All of the above

17. Large Stout, nocturnal flowers producing copious nectar and emitting fermenting fruity odour, are the adaptations for **[MHCET 2015]**
(a) Entomophily (b) Ornithophily
(c) Chiropterophily (d) Anemophily

18. In plants, in nature, autogamy is avoided since the seeds produced **[JIPMER 1993]**
(a) Are fewer in number
(b) Do not germinate successfully
(c) Do not produce healthy plants
(d) All the above

19. Wind pollinated flowers are **[CBSE PMT (Pre.) 2010]**
(a) Small, producing nectar and dry pollen
(b) Small, brightly coloured, producing large number of pollen grains
(c) Small, producing large number of dry pollen grains
(d) Large producing abundant nectar and pollen

20. Wind pollination is common in **[NCERT; CBSE PMT (Pre.) 2011]**
(a) Orchids (b) Legumes
(c) Lilies (d) Grasses

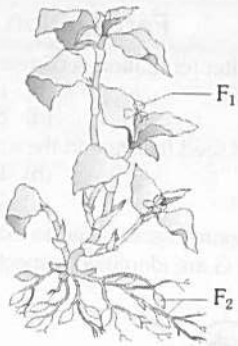
21. Pollination by water is seen in
(a) *Nelumbium* (b) *Vallisneria*
(c) *Eichornia* (d) *Nymphaea*

22. Which one of the following may require pollinators, but is genetically similar to autogamy **[AIPMT (Cancelled) 2015]**
(a) Xenogamy (b) Apogamy
(c) Cleistogamy (d) Geitonogamy

23. In sausage tree (*Kigelia africana*) the pollination takes place by **[BHU 1993]**
(a) Birds (b) Bats
(c) Wind (d) Insects

24. Part of the gynoecium which receives the pollen is called **[AIIMS 1992; MP PMT 2004]**
(a) Ovary (b) Ovule
(c) Style (d) Stigma

25. The diagram given below shows the plant of *Commelina* with two type of flowers (F_1 and F_2). The flowers are **[NCERT]**



(a) F1 - Chasmogamous , F2 - Cleistogamous
(b) F1 - Cryptogamous, F2 - Ovulate
(c) F1 - Neutral , F2 - Staminate
(d) F1 - Cleistogamous , F2 - Chasmogamous

26. Xenogamy is essentially a type of **[WB JEE 2012]**
(a) Cleistogamy (b) Allogamy
(c) Autogamy (d) Homogamy

27. A close relation between flower and pollinating agent is best exhibited by **[BHU 1994]**

Or

In which of the following pollination takes place by lever mechanism
(a) *Cocos* (b) *Salvia*
(c) *Yucca* (d) *Avena*

28. Pollination characteristically occurs in **[BHU 1994]**
(a) Angiosperms and fungi
(b) Angiosperms and gymnosperms
(c) Pteridophytes and angiosperms
(d) Bryophytes and angiosperms

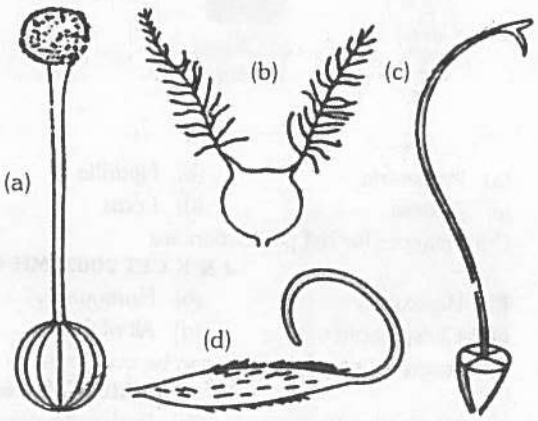
29. The transfer of pollen grain from the stamen to the stigma of the same flower is **[NCERT; JIPMER 1994; DUMET 2010]**

Or

The process where by a perfect flower is pollinated by its pollen is called **[NCERT]**
(a) Autogamy (b) Allogamy
(c) Geitonogamy (d) Xerogamy

30. Progeny produced as a result of cross pollination **[CMC Vellore 1994]**
(a) Shows high degree of variability and is evolutionary important
(b) Is sterile
(c) Has recessive characters
(d) Is homozygous with phenotypic uniformity

31. Which of the following type of gynoecium is associated by wind pollination



32. In *Salvia* pollination takes place by **[Kerala PMT 2006]**
(a) Animals (b) Water
(c) Air (d) Insects

33. Feathery stigma is present in **[BHU 1995]**
(a) Wheat (b) Pea
(c) Ceasalpinia (d) Datura

34. Which of the following are the important floral rewards to the animal pollinators **[AIPMT (Cancelled) 2015]**
(a) Nectar and pollen grains
(b) Floral fragrance and calcium crystals
(c) Protein pellicle and stigmatic exudates
(d) Colour and large size of flower

35. Anemophily is NOT observed in **[MHCET 2015]**
(a) Maize (b) Jowar
(c) Sugarcane (d) *Salvia*

36. Which type of pollen grains are found in insect pollinated flowers **[AFMC 2003]**
(a) Hygroscopic (b) Light and sticky
(c) Light and rough (d) Heavy and coloured

37. Cross pollination in crop plant is known as **[MP PMT 1998; BHU 2002]**
(a) Autogamy (b) Allogamy
(c) Cleistogamy (d) Chasmogamy

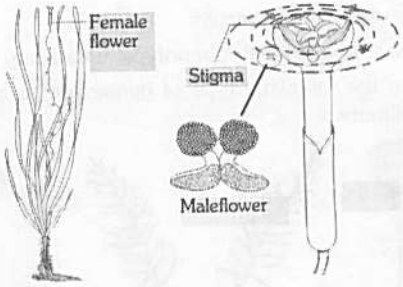
38. Flowers preventing self-pollination is called **[KCET 1998]**
(a) Dichogamy (b) Protandry
(c) Herkogamy (d) Protogyny

39. The mature stigma is either rough or sticky in **[RPMT 1997]**
(a) All types of flowers (b) Water pollinated flowers
(c) Wind pollinated flowers (d) All of these

40. The process of transfer of pollen grains from another to stigmatic surface of the flower with the help of water is called **[J & K CET 2005]**
(a) Anemophily (b) Zoophily
(c) Hydrophily (d) Ornithophily

41. Anemophilous pollination is mainly observed in **[CPMT 2000; CBSE PMT 2001]**
(a) Gramineae (b) Annonaceae
(c) Papilionaceae (d) Euphorbiaceae

42. The given diagram is showing hydrophily of **[NCERT]**



(a) *Vallisneria* (b) *Hydrilla*
(c) *Zostera* (d) *Lotus*

43. Contrivances for self pollination are **[NCERT; J & K CET 2002; MH CET 2006]**
(a) Bisexuality (b) Homogamy
(c) Cleistogamy (d) All of these

44. Intra-species incompatibility can be overcome by **[AIEEE Pharmacy 2003]**
(a) Wetting of the stigma (b) Bud-pollination
(c) Mixed-pollination (d) Intra-ovarian pollination

45. When anthers and stigma mature at the same time it is called **[MHCET 2003; AFMC 2005; Odisha JEE 2012]**
(a) Protandry (b) Homogamy
(c) Isogamy (d) Dichogamy

46. Both, autogamy and geitonogamy are prevented in **[NCERT; CBSE PMT (Pre.) 2012]**
(a) Papaya (b) Cucumber
(c) Castor (d) Maize

47. In which one of the following pollination is autogamous **[NCERT; CBSE PMT (Pre.) 2011; Kerala PMT 2012; NEET (Karnataka) 2013]**

Or

Pollination which occurs in closed flower is known as **[AFMC 1994; WB JEE 2016]**
(a) Cleistogamy (b) Geitonogamy
(c) Xenogamy (d) Chasmogamy

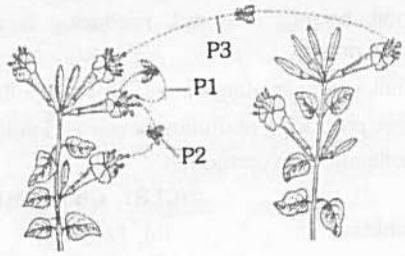
48. The pollination of two flowers on different plants is known as **[AIIMS 2010]**

Or

The type of pollination in which genetically different pollen grains are brought to stigma is **[AMU (Med.) 2012]**
(a) Xenogamy (b) Geitonogamy
(c) Cleistogamy (d) Dichogamy

49. Animal vectors are required for pollination in **[NEET (Karnataka) 2013]**
(a) Vallisneria (b) Mulbery
(c) Cucumber (d) Maize

50. The below figure shows 2 plants of the same species. Identify the types of pollination indicated as P1, P2 and P3 **[NCERT]**



	P1	P2	P3
(a)	Autogamy	Geitonogamy	Xenogamy
(b)	Geitonogamy	Allogamy	Autogamy
(c)	Allogamy	Chasmogamy	Cleistogamy
(d)	Autogamy	Xenogamy	Geitonogamy

51. Pollination in water hyacinth and water lily is brought about by the agency of **[NEET (Phase-II) 2016]**
(a) Bats (b) Water
(c) Insects or wind (d) Birds

52. A dioecious flowering plant prevents both **[NEET 2017]**
(a) Autogamy and xenogamy
(b) Autogamy and geitonogamy
(c) Geitonogamy and xenogamy
(d) Cleistogamy and xenogamy

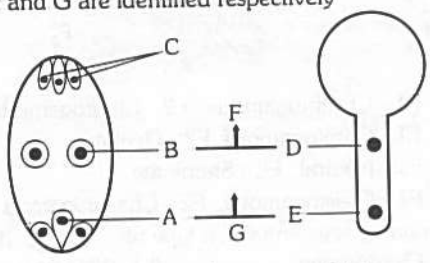
53. Attractants and rewards are required for **[NEET 2017]**
(a) Anemophily (b) Entomophily
(c) Hydrophily (d) Cleistogamy

Fertilization

1. The ovary after ferilization is converted into **[J & K CET 2008]**
(a) Embryo (b) Endosperm
(c) Fruit (d) Seed

2. Micropyle of seed facilitate in the entry of **[Odisha JEE 2009]**
(a) Air (b) Pollen grains
(c) CO_2 (d) Water

3. The given figure is associated to double fertilization. A, B, C, D, E, F and G are identified respectively **[NCERT]**



(a) Egg, Polar nuclei, Male gamete, Male gamete, Zygote and Primary endosperm nucleus (PEN)
(b) Egg, Male gamete, Male gamete, Polar nuclei, Primary endosperm nucleus (PEN) and Zygote
(c) Egg, Male gamete, Polar nuclei, Male gamete, Primary endosperm nucleus (PEN) and Zygote
(d) Egg, Polar nuclei, Male gamete, Male gamete, Primary endosperm nucleus (PEN) and Zygote

4. When the pollen tube enters through the micropyle, it is termed as **[Manipal MEE 1995; CPMT 1999; MHCET 2001, 05; MP PMT 2008; J & K CET 2008; Odisha JEE 2011]**
(a) Chalazogamy (b) Mesogamy
(c) Porogamy (d) None of the above

5. Female gametophyte of a typical dicot at the time of fertilization is **[CBSE PMT 1993; AIIMS 2000]**
(a) 8 celled (b) 7 celled
(c) 6 celled (d) 4 celled

6. Which one of the following events takes place after double fertilization **[Kerala PMT 2012]**
(a) The pollen grain germinates on the stigma
(b) The pollen tubes enter the embryo sac
(c) Two male gametes are discharged into the embryo sac
(d) The PEN (Primary Endosperm Nucleus) develops into endosperm
(e) The male gamete fuses with egg to form a zygote

7. Double fertilization was discovered by **[NCERT; CPMT 1993, 96, 99; RPMT 1995; MP PMT 1999; BHU 2003; Odisha JEE 2012]**
(a) Karl Schnarf (b) P. Maheshwari
(c) S.G. Nawaschin (d) B.G.L. Swamy

8. When pollen tube enters by integuments, then the process is called **[MHCET 2000, 06; MP PMT 2004, 12]**
(a) Mesogamy (b) Porogamy
(c) Chalazogamy (d) Pseudogamy

9. Double fertilization is a characteristic of **[CPMT 1993, 94; Bihar CECE 1995; BHU 1999, 2000, 08; Kerala CET 2003; MP PMT 2004; NEET 2017]**
(a) Gymnosperms (b) Bryophytes
(c) Angiosperms (d) Pteridophytes

10. Fertilization of egg takes place inside **[DPMT 1993]**
(a) Anther (b) Stigma
(c) Pollen tube (d) Embryo sac

11. Which of the following floral parts forms pericarp after fertilization **[MH CET 2007; MP PMT 2009; Odisha JEE 2011]**
(a) Nucellus (b) Outer integument
(c) Ovary wall (d) Inner integument

12. Which of the following is not true for double fertilization **[Bihar CECE 2005]**
(a) Discovered by Nawaschin
(b) Male gamete and secondary nucleus fused to form Endosperm nucleus
(c) Endosperm nucleus is diploid
(d) Endosperm provide nutrition to embryo

13. The nuclei of the sperm and egg fuse as a result of **[CBSE PMT 1990]**
(a) Base pair relation of DNA and RNA
(b) Formation of hydrogen bonds
(c) Mutual attraction caused by differences in electrical charges
(d) Attraction of protoplasts of egg and sperm

14. Number of nuclei taking part in double fertilization is **[NCERT; RPMT 1995; Kerala PMT 2004]**
(a) 2 (b) 3
(c) 4 (d) 5

15. Fusion of two dissimilar gametes is called **[DPMT 1993; AFMC 1996]**
(a) Fertilization (b) Pollination
(c) Self pollination (d) Self fertilization

16. A pollen tube grows down the style because **[CPMT 1993; AFMC 2002]**
(a) It helps in fertilization
(b) It takes nutrients from the style
(c) Filiform apparatus of synergids attracts the pollen tube
(d) Of chemical attraction

17. Double fertilization results in the production of **[J & K CET 2005]**
(a) Haploid nucleus (b) Diploid nucleus
(c) Triploid nucleus (d) Tetraploid nucleus

18. In a mature embryo sac the central cell is **[AMU (Med.) 2009]**
(a) Single nucleate (b) Binucleate
(c) Four nucleate (d) Eight nucleate

19. Which one of the following events in a botanical garden is never directly influenced by light **[CPMT 1993]**
(a) Flowering (b) Photosynthesis
(c) Transpiration (d) Fertilization

20. How much time is generally required/taken by the pine plant from pollination to fertilization **[MP PMT 1995]**
(a) Four months (b) Thirteen months
(c) Two years (d) Four years

21. The process of fusion between male nucleus and egg nucleus is called as **[CBSE PMT 1991; MP PMT 1995]**
(a) Syngamy (b) Triple fusion
(c) Double fertilization (d) Conjugation

22. Double fertilization was first discovered by Nawaschin (1898) in **[MP PMT 1997, 2003]**
(a) *Lilium* and *Fritillaria* (b) Mango and sugarcane
(c) Papaya and pea (d) *Brassica* and Candytuft

23. The phenomenon of syngamy (fertilization) in angiosperms was discovered by **[RPMT 1997; AFMC 2001]**
(a) Svedberg (b) Strasburger
(c) Nawaschin (d) Coulter and Chamberlin

24. Germination of pollen grain on the stigma is **[BVP 2003]**
(a) Autogamy (b) In vivo germination
(c) In vitro germination (d) None of these

25. In angiosperm, triple fusion is necessary for the formation of **[CBSE PMT 1996; Kerala PMT 2004]**
(a) Seed coat (b) Fruit wall
(c) Embryo (d) Endosperm

26. In an angiospermic plant, endosperm is formed due to fertilization of secondary nucleus but it is absent in some of the seeds *viz.* pea, bean, phaseolus (moong) etc. It is due to lack of **[MP PMT 1997]**
(a) Certain enzymes (b) Dicotyledonous hormone
(c) Growth hormone (d) None of the above

27. Growth of pollen tube towards embryo sac is **[AIIMS 2000; CPMT 2003]**
(a) Geotropism (b) Thigmotaxis
(c) Chemotaxis (d) Phototaxis

28. Through which route the pollen tube enters the ovule **[MP PMT 2001; J & K CET 2012]**
(a) Chalaza (b) Micropyle
(c) Funiculus (d) All of these

29. Through which cell of the embryo sac, does the pollen tube enter the embryo sac **[NCERT; AIIMS 2004; CPMT 2005; CBSE PMT 2005]**
(a) Egg cell (b) Central cell
(c) Persistant synergid (d) Degenerated synergid

30. Which of the following is without exception in angiosperms **[CBSE PMT 2002]**
(a) Secondary growth (b) Presence of vessels
(c) Double fertilization (d) Autotrophic nutrition

31. Pollen tube discharge its gametes in **[CPMT 2003; CBSE PMT 2003]**
(a) Synergids (b) Antipodals
(c) Central cell (d) None of these

32. The formation of embryo without fusion of gametes is termed, as **[MP PMT 2003]**
(a) Apospory (b) Isogamy
(c) Apogamy (d) Syngamy

33. Triple fusion in angiosperm is the fusion of second sperm with **[Odisha JEE 2004, 09]**
(a) Antipodal cell and one synergid cell
(b) Two antipodal cells
(c) Two synergid cells
(d) Two polar nuclei

34. After fertilization the outer integument forms **[MHCET 2004]**
(a) Testa (b) Tegmen
(c) Perisperm (d) Pericarp

35. Which one of the following statements is wrong **[CBSE PMT (Mains) 2012]**
(a) When pollen is shed at two-celled stage, double fertilization does not take place
(b) Vegetative cell is larger than generative cell
(c) Pollen grains in some plants remain viable for months
(d) Intine is made up of cellulose and pectin

Embryo and endosperm

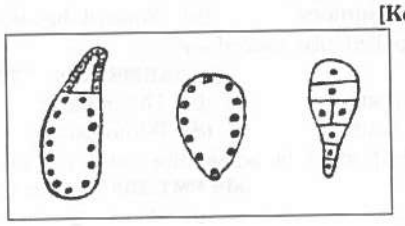
1. Endosperm is consumed by developing embryo in the seed of **[CBSE PMT 2008; AMU (Med.) 2009]**
(a) Pea (b) Maize
(c) Coconut (d) Castor

2. In the monocotyledonous seeds the endosperm is separated from the embryo by a distinct layer known as **[Kerala PMT 2008]**

Or

The outermost proteinaceous layer of endosperm of maize grain is called **[CPMT 1993; MH CET 2003; CPMT 2005]**
(a) Testa (b) Aleurone layer
(c) Tegmen (d) Scutellum
(e) Coleoptile

3. Select the correct order of endosperm types **[Kerala PMT 2008]**



(a) Cellular, helobial, free nuclear
(b) Cellular, free nuclear, helobial
(c) Helobial, free nuclear, cellular
(d) Free nuclear, cellular, helobial
(e) Free nuclear, helobial, cellular

4. Identify the wrong statements regarding post-fertilisation development **[Kerala PMT 2007]**
(a) The ovary wall develops into pericarp
(b) The outer integument of ovule develops into tegmen
(c) The fusion nucleus (triple nucleus) develops into endosperm
(d) The ovule develops into seed
(e) The ovary develops into fruit

5. Which of the following inspite of being dicot lacks cotyledons **[HP PMT 2005]**
(a) *Cuscuta* (b) *Pistia*
(c) *Dianthus* (d) *Ranunculus*

6. Which one is an example of triploid tissue **[CPMT 1993, 94]**
(a) Onion root
(b) Fern prothallus
(c) Maize and lily endosperm
(d) None of the above

7. The monocotyledonous seed (wheat grain) consists of one large and shield shaped cotyledon known as **[Kerala PMT 2010; AIPMT 2015]**
(a) Aleurone layer (b) Scutellum
(c) Coleoptile (d) Hilum
(e) Coleorhiza

8. Formation, growth and development of a new individual beginning from egg is known as **[MP PMT 1999]**
(a) Embryology (b) Cytology
(c) Genetics (d) Ethnobotany

9. The best example of polyembryony is **[DPMT 2004]**
(a) *Cocos* (b) Pea
(c) *Capsicum* (d) *Pinus*

10. Milky water of green coconut is **[Manipal MEE 1995; Kerala PMT 2004; RPMT 2006; Odisha JEE 2009; AIPMT 2015; NEET (Phase-I) 2016]**
(a) Liquid nucellus
(b) Liquid of female gametophyte
(c) Liquid endosperm / free nuclear endosperm
(d) Liquid embryo
(e) Liquid gametes

11. Nucellar embryo is **[AIIMS 1993; MP PMT 2013]**
(a) Apomictic embryo (b) Amphimictic haploid
(c) Adventitive embryony (d) Amphimictic diploid

12. The gymnospermic endosperms differs from an angiospermic endosperm because in gymnosperms it is **[MHCET 2015]**
(a) Haploid and developed from female gametophyte
(b) Diploid and developed from female gametophyte
(c) Triploid and developed after fertilization
(d) Triploid and developed before fertilization

13. Fusion product of polar nuclei and male gamete is **[RPMT 1995; AFMC 1999]**
(a) Triple fusion
(b) Primary endosperm nucleus
(c) Zygote
(d) Secondary nucleus

14. Nuclear endosperm has **[DPMT 2006]**

(a) Every nuclear division followed by wall formation

(b) Initially free-nuclear divisions followed by wall formation

(c) First division followed by wall formation and other free nuclear

(d) None of the above

15. Ruminate endosperm is commonly found in seeds of **[BHU 2006; CPMT 2010]**

(a) Cruciferae (b) Compositae

(c) Euphorbiaceae (d) Annonaceae (*Areca nut*)

16. Dicot embryo consists of **[DPMT 1993; AMU (Med.) 2010]**

(a) Radicle and plumule

(b) Radicle, plumule, cotyledons and sometimes endosperm

(c) Radicle, plumule, cotyledons and tegmen

(d) Radicle, plumule, cotyledons, tegmen and testa

17. Triploid plants can be obtained from culture of **[AIIMS 1993]**

(a) Pollen (b) Endosperm

(c) Ovule (d) Megaspore

18. The sequence of development of embryo sac is **[AIIMS 1993]**

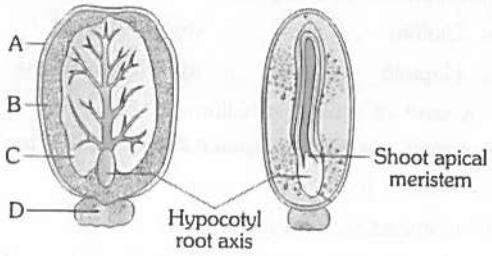
(a) Archesporium → megaspore mother cell → megaspore → embryo sac

(b) Archesporium → megaspore → megaspore mother cell → embryo sac

(c) Archesporium → megaspore → megasporophyte → embryo sac

(d) None of the above

19. The given figure are related to castor seeds. Identify A to D respectively **[NCERT]**



(a) Seed coat, endosperm cotyledon and caruncle

(b) Seed coat, cotyledon, endosperm and caruncle

(c) Seed coat, endosperm, caruncle and cotyledon

(d) Endosperm, seed coat, cotyledon and caruncle

20. If the number of chromosomes in endosperm of a dicot plant is 36, the root cells will contain **[Bihar CECE 1992]**

(a) 72 chromosomes (b) 28 chromosomes

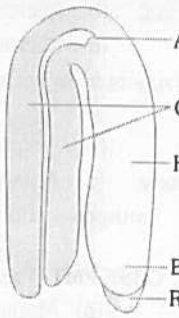
(c) 24 chromosomes (d) 48 chromosomes

21. Which of the following is a non-endospermic monocot seed

(a) Plumbago (b) Castor

(c) Linseed (d) Alisma

22. Study the given figure of a typical dicot embryo. Select the right option in which all the labelled parts as A, B and C are correctly matched with their respective functions **[NCERT]**



	A	B	C
(a)	Radicle, root system formation	Plumule, shoot system formation	Endosperm, food storage
(b)	Radicle, root system formation	Plumule, shoot system formation	Cotyledon, food storage
(c)	Plumule, shoot system formation	Radicle, root system formation	Cotyledon, food storage
(d)	Plumule, shoot system formation	Radicle, root system formation	Hypophysis, formation of radicle

23. In angiosperms endosperm is formed by **[MP PMT 1993, 94; CBSE PMT 1998; 2000; CPMT 2001; RPMT 2006]**

(a) Free nuclear divisions of megaspore

(b) Division of fused polar nuclei

(c) Division of fused polar nuclei and male gamete

(d) Division of fused synergids and male gamete

24. From which cells peripheral region of radicle is produced **[GUJCET 2007]**

(a) Vegetative cell (b) Hypophysis

(c) Apical octant (d) Micropylar octant

25. If an angiospermic male plant is diploid and female plant tetraploid, the ploidy level of endosperm will be **[CBSE PMT 1997]**

(a) Haploid (b) Triploid

(c) Tetraploid (d) Pentaploid

26. Endosperm in Angiosperm (Flowering Plants) is **[MP PMT 1994, 95 98, 99, 2001, 06; CPMT 2002; RPMT 2006; Odisha JEE 2008; J & K CET 2012]**

Or

The endosperm of Brassica is **[DPMT 1992]**

(a) Haploid (b) Diploid

(c) Triploid (d) Polyploid

27. Function of embryonal suspensor in angiosperms is to **[CPMT 2005]**

(a) Serve as channel for H_2O

(b) Push embryo deeper into endosperm

(c) Release growth hormones

(d) Transfer nutrients from parent sporophyte to young embryo

28. The embryo in sunflower has **[CBSE PMT 1998; BHU 2002]**

(a) No cotyledon (b) One cotyledon

(c) Two cotyledons (d) Many cotyledons

29. In agamospermy, the embryo sac is diploid because it is formed without meiosis. Such embryo sac may develop from **[CBSE PMT 1993; MP PMT 2003]**

(a) Megaspore mother cell (b) Microspore mother cell
(c) Megaspores (d) Microspores

30. When vegetative cell of zygote form embryo, it is called **[BHU 1995]**

(a) Apospory (b) Apomixis
(c) Diploid polyembryony (d) Adventive polyembryony

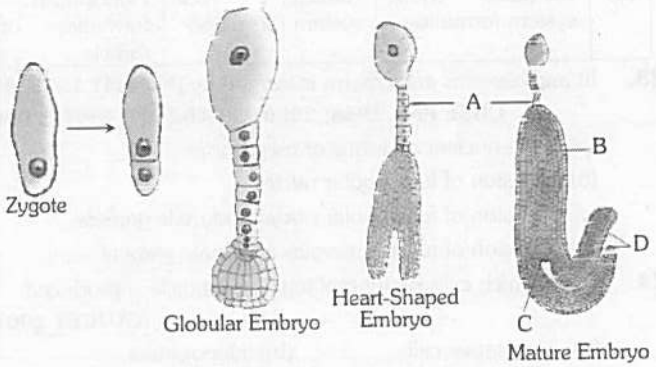
31. Presence of many embryos (Polyembryony) is a characteristic feature of **[CPMT 1994, 95, 98; CBSE PMT 1995; CBSE PMT (Pre.) 2011; BHU 2012]**

(a) *Citrus* (b) Mango
(c) Banana (d) None of these

32. The figure given below shows stages in embryogenesis in a typical dicot (*Capsella*). Identify structures A, B, C and D respectively **[NCERT]**

Or

Which option is correct for the region produced from the apical octant (b) and basal octant (d), in *Capsella* type of embryonic development **[GUJCET 2014]**



(a) Suspensor, Radicle, Plumule, Hypocotyls
(b) Suspensor, Plumule, Redicle, Cotyledons
(c) Hypophysis, Radicle, Plumule, Cotyledons
(d) Suspensor, Radicle, Plumule, Cotyledons

33. The coconut water and the edible part of coconut are equivalent to **[CBSE PMT (Pre.) 2012]**

Or

The morphological nature of the edible part of coconut is **[NEET 2017]**

(a) Endosperm (b) Endocarp
(c) Mesocarp (d) Embryo

34. Apomictic embryos in citrus arise from **[CBSE PMT (Pre.) 2010]**

(a) Diploid egg
(b) Synergids
(c) Maternal sporophytic tissue in ovule
(d) Antipodal cells

35. In angiosperms, the oospore on development produces **[CBSE PMT 1993; MH CET 2015]**

(a) Seed (b) Embryo
(c) Protonema (d) Endosperm

36. Ovule integument gets transformed into **[WB JEE 2011]**

Or

In coconut, black covering (thin layer) adherent to the kernel around the endosperm is

(a) Seed (b) Fruit wall
(c) Seed coat (d) Cotyledons

37. The endosperm in angiosperms develops from **[MP PMT 2002; BHU 2004]**

(a) Micropylar polar nucleus (b) Chalazal polar nucleus
(c) Secondary nucleus (d) Zygote

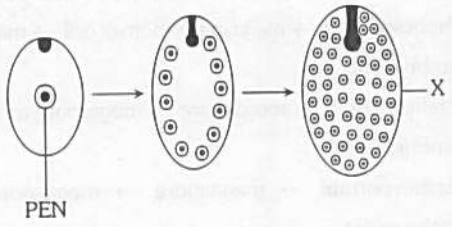
38. Xenia and metaxenia terms are related with **[AIIMS 2002]**

(a) Pollen culture (b) Only endosperm
(c) Xylem and phloem (d) Pollen and endosperm

39. Which of the following workers are related as ecologist, palaeobotanist and embryologist **[BHU 2003]**

(a) B. Sahni, R. Mishra, P. Maheshwari
(b) R. Mishra, B. Sahni, P. Maheshwari
(c) B. Sahni, P. Maheshwari, R. Mishra
(d) P. Maheshwari, R. Mishra, B. Sahni

40. In the following figure



X is **[NCERT]**

(a) Ruminate endosperm (b) Nuclear endosperm
(c) Helobial endosperm (d) Cellular endosperm

41. Endosperm of gymnosperm is **[Odisha JEE 2004]**

(a) Diploid (b) Tetraploid
(c) Haploid (d) None of these

42. In a seed of maize, scutellum is considered as cotyledon because it **[AIEEE Pharmacy 2004; NEET (Phase-I) 2016]**

(a) Protects the embryo
(b) Contains food for the embryo
(c) Absorbs food materials and supplies them to the embryo
(d) Converts itself into a monocot leaf

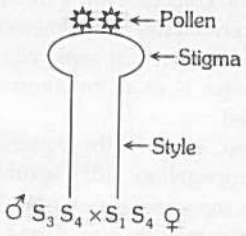
43. In which one of the following would you expect to find glyoxysomes **[AIIMS 2005]**

(a) Endosperm of wheat (b) Endosperm of castor
(c) Palisade cells in leaf (d) Root hairs

44. Perisperm differs from endosperm in **[NEET 2013]**

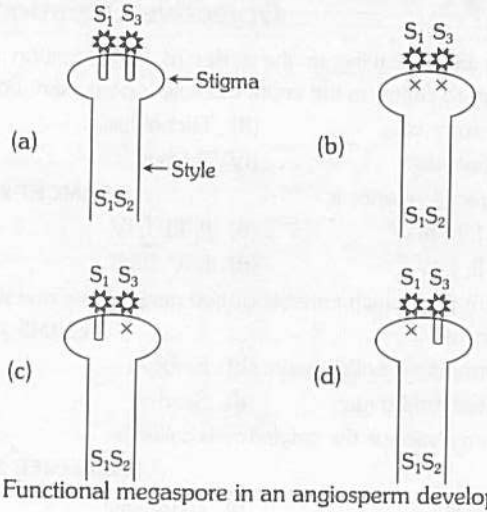
(a) Its formation by fusion of secondary nucleus with several sperms
(b) Being a haploid tissue
(c) Having no reserve food
(d) Being a diploid tissue

45. The given figure refers the self - incompatibility. The genotypes of embryo and endosperms are **[NCERT]**



	Embryo	Endosperm
(a)	$S_1 S_3, S_3 S_4$	$S_1 S_1 S_3, S_4 S_4 S_3$
(b)	$S_1 S_1$	$S_1 S_3 S_4$
(c)	$S_1 S_3, S_3 S_4$	$S_3 S_4 S_4$
(d)	$S_4 S_4$	$S_3 S_4 S_4, S_1 S_1 S_3$

46. Considering the genetic basis of self- incompatibility which of the following options is correct. Male plant is $S_1 S_3$ and female plant is $S_1 S_2$ **[NCERT]**



47. Functional megaspore in an angiosperm develops into **[NEET 2017]**

(a) Ovule (b) Endosperm
(c) Embryo sac (d) Embryo

Parthenocarpy

1. Seedless fruit in banana is produced because of **[Bihar CECE 2006; WB JEE 2009]**

(a) Asexual reproduction (b) Parthenogenesis
(c) Triploid (d) Cross pollination

2. Formation of fruits (Seed) without fertilization is known as or

Ovary $\xrightarrow{\text{No fertilization}}$ Fruit **[NCERT; CPMT 1993, 97, 98, 2009; MP PMT 1994; KCET 2000; Kerala CET 2002; AMU (Med.) 2005; HPMT 2005; RPMT 2006]**

Or

The process of embryo formation without fertilisation is known as **[J & K CET 2008]**

(a) Parthenocarpy (b) Parthenogenesis
(c) Polyembryony (d) Polygamy

3. Parthenogenesis is a term of **[Odisha JEE 2005]**

Or

Which one of the following generates new genetic combinations leading to variation **[NEET (Phase-II) 2016]**

(a) Sexual reproduction (b) Asexual reproduction
(c) Budding (d) Regeneration

4. An example of a naturally occurring parthenocarpic fruit is **[AIPMT 2015]**

(a) Guava (b) Mango
(c) Banana (d) Apple

5. Seedless grapes are produced due to **[Manipal 2005]**

Or

Seedless fruits in *Vitis* are formed due to **[EAMCET 1995; MHCET 2000]**

(a) Parthenocarpy (b) Crossing over
(c) Parthenogenesis (d) None of these

6. Which plant will lose its economic value, if its fruits are produced by induced parthenocarpy **[NCERT; CBSE PMT 1997; Pb. PMT 2004]**

(a) Grape (b) Pomegranate
(c) Orange (d) Banana

7. Which of the following is parthenocarpic fruits **[CPMT 1996]**

(a) Orange (b) Papaya
(c) Pomegranate (d) Apple

NCERT Exemplar Questions

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

(i) Androecium (ii) Carpel
(iii) Corolla (iv) Sepal
(a) (i) and (iv) (b) (iii) and (iv)
(c) (ii) and (iv) (d) (i) and (ii)

2. Embryo sac is to ovule as _____ is to an anther **[NCERT]**

(a) Stamen (b) Filament
(c) Pollen grain (d) Androecium

3. In a typical complete, bisexual and hypogynous flower the arrangement of floral whorls on the thalamus from the outermost to the innermost is **[NCERT]**

(a) Calyx, corolla, androecium and gynoecium
(b) Calyx, corolla, gynoecium and androecium
(c) Gynoecium, androecium, corolla and calyx
(d) Androecium, gynoecium, corolla and calyx

4. A dicotyledonous plant bears flowers but never produces fruits and seeds. The most probable cause for the above situation is **[NCERT]**

(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

5. The outermost and innermost wall layers of microsporangium in an anther are respectively **[NCERT]**

(a) Endothecium and tapetum
(b) Epidermis and endodermis
(c) Epidermis and middle layer
(d) Epidermis and tapetum

6. During microsporogenesis, meiosis occurs in **[NCERT]**

(a) Endothecium (b) Microspore mother cells
(c) Microspore tetrads (d) Pollen grains

7. From among the sets of term given below, identify those that are associated with the gynoecium **[NCERT]**
(a) Stigma, ovule, embryo sac, placenta
(b) Thalamus, pistil, style, ovule
(c) Ovule, ovary, embryo sac, tapetum
(d) Ovule, stamen, ovary, embryo sac

8. Starting from the innermost part, the correct sequence of parts in an ovule are **[NCERT]**
(a) Egg, nucellus, embryo sac, integument
(b) Egg, embryo sac, nucellus, integument
(c) Embryo sac, nucellus, integument, egg
(d) Egg, integument, embryo sac, nucellus

9. From the statements given below choose the option that are true for a typical female gametophyte of a flowering plant
(i) It is 8-nucleate and 7-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 **[NCERT]**
(a) (i) and (iv) (b) (ii) and (iii)
(c) (i) and (ii) (d) (ii) and (iv)

10. Autogamy can occur in a chasmogamous flower if **[NCERT]**
(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

11. Choose the correct statement from the following **[NCERT]**
(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

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 **[NCERT]**
(a) Insects (b) Water
(c) Wind (d) Animals

13. From among the situations given below, choose the one that prevents both autogamy and geitonogamy **[NCERT]**
(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

14. In a fertilised embryo sac, the haploid, diploid and triploid structures are **[NCERT]**
(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

15. In an embryo sac, the cells that degenerate after fertilisation are **[NCERT]**
(a) Synergids and primary endosperm cell
(b) Synergids and antipodals
(c) Antipodals and primary endosperm cell
(d) Egg and antipodals

16. While planning for an artificial hybridization programme involving dioecious plants, which of the following steps would not be relevant **[NCERT]**
(a) Bagging of female flower (b) Dusting of pollen on stigma
(c) Emasculation (d) Collection of pollen

17. In the embryos of a typical dicot and a grass, true homologous structures are **[NCERT]**
(a) Coleorhiza and coleoptile (b) Coleoptile and scutellum
(c) Cotyledons and scutellum (d) Hypocotyl and radicle

18. The phenomenon observed in some plants wherein parts of the sexual apparatus is used for forming embryos without fertilisation is called **[NCERT]**
(a) Parthenocarpy (b) Apomixis
(c) Vegetative propagation (d) Sexual reproduction

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 **[NCERT]**
(a) Haploid
(b) Diploid
(c) A few haploid and a few diploid
(d) With varying ploidy

Critical Thinking

Objective Questions

1. Arrange the following in the order of their location from periphery to centre in the entire dicotyledonous plant body
(I) Fusiform cells (II) Trichoblasts
(III) Collocytes (IV) Tyloses
The correct sequence is **[EAMCET 2009]**
(a) IV, I, II, III (b) II, III, I, IV
(c) III, II, I, IV (d) I, IV, III, II

2. The plant part which consists of two generations one within the other, is **[AIIMS 2008]**
(a) Germinated pollen grain (b) Embryo
(c) Unfertilized ovule (d) Seed

3. Embryo axis above the cotyledon is called as **[Odisha JEE 2009]**
(a) Epicotyl (b) Hypocotyl
(c) Funicle (d) Raphe

4. Secondary nucleus in the middle of an embryo sac of angiosperms is **[BHU 1999; AIEEE Pharmacy 2003]**
(a) Diploid (b) Triploid
(c) Tetraploid (d) Haploid

5. If the diploid number of an angiospermic plant is 24, the number of chromosomes in the pollen grain, endosperm and integument will be **[CPMT 2000; BHU 2008]**
(a) 12, 36, 12 (b) 12, 24, 36
(c) 12, 12, 36 (d) 12, 36, 24

6. What would be the number of chromosomes in the cell of the aleurone layer in a plant species with 8 chromosomes in its synergids **[CBSE PMT 2006]**
(a) 32 (b) 8
(c) 16 (d) 24

7. Which of the following four phases, in the post emergence life of an angiospermic plant, begins just after germination of seed and ends when the plant develops the capacity to reproduce **[KCET 1999]**
(a) Death (b) Ageing
(c) Maturity (d) Juvenility

8. Pick out wrong statement **[Kerala PMT 2010]**

(a) Double fertilization is unique to gymnosperms and monocotyledons

(b) *Sequoia*, a gymnosperm, is one of the tallest tree

(c) Phaeophyceae members possess chlorophyll a, c, carotenoids and xanthophylls

(d) Moss is a gametophyte which consists of two stages namely, protonema stage and leafy stage

(e) Evolutionarily, pteridophytes are the first terrestrial plants to possess xylem and phloem

9. Which of the following statements is correct for the pollen tube **[CBSE PMT 1993]**

(a) It shows chemotactic movement

(b) It shows only tip growth

(c) It is composed of three non-cellular zones

(d) It shows radial cytoplasmic streaming

10. Even after killing the generative cell with a laser beam, the pollen grain of a flowering plant germinates and produces normal pollen tube because **[JIPMER 1993]**

(a) Laser beam stimulates pollen germination and pollen tube growth

(b) The laser beam does not damage the region from which pollen tube emerges

(c) The contents of killed generative cell permit germination and pollen tube growth

(d) The vegetative cell has not been damaged

11. Which one of the following statements is not true **[AIPMT (Cancelled) 2015]**

(a) Pollen grains of some plants cause severe allergies and bronchial afflictions in some people

(b) The flowers pollinated by flies and bats secrete foul odour to attract them

(c) Honey is made by bees by digesting pollen collected from flowers

(d) Pollen grains are rich in nutrients, and they are used in the form of tablets and syrups

12. Double fertilization process means **[CBSE PMT 1991; CPMT 1994, 95; MP PMT 1997; BHU 1999; AIIMS 2005; AFMC 2006; AMU (Med.) 2010; WB JEE 2016]**

(a) Fusion of one male gamete nucleus with egg nucleus while fusion of other male gamete nucleus with secondary nucleus

(b) Fusion of male gamete nucleus with secondary nucleus

(c) Fusion of two polar nuclei with each other

(d) Fusion of male gamete nucleus with egg nucleus

13. Despite high level of heterozygosity, the progeny derived from seed of a cross pollinated plant was found to be completely uniform. One reason for this may the phenomenon of **[BHU 1994]**

(a) Parthenocarpy (b) Apomixis

(c) Induced mutation (d) Polyploidy

14. Sperm cells of angiosperms differ from the rest of the plant groups like gymnosperms by **[AFMC 1993]**

(a) In angiosperms the sperm cells are non-motile whereas in the others they are flagellate

(b) In angiosperms the sperm cells are produced in the pollen grain whereas in the rest they are produced in the antheridium

(c) In angiosperms and gymnosperms the sperm cells are non-motile whereas in the rest they are flagellated

(d) None of the above

15. When the pollen grains are not transferred from anthers to the stigma in flower due to the barrier or fence, it is referred or when some natural barrier exists between androecium and gynoecium to check self pollination, it is known as **[AIIMS 1993]**

(a) Heterostyly (b) Herkogamy

(c) Dichogamy (d) Cleistogamy

16. Which is the most logical sequence with reference to the life cycle of angiosperms **[DPMT 1993]**

(a) Germination, endosperm formation, seed dispersal, double fertilization

(b) Pollination, fertilization, seed formation, germination

(c) Cleavage, fertilization, grafting, fruit formation

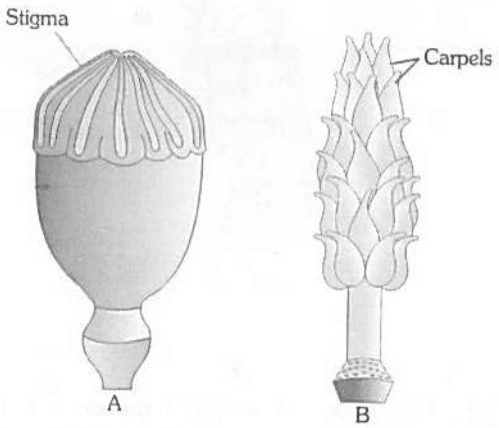
(d) Maturation, mitosis, differentiation, fertilization

17. Seed formation without fertilization in flowering plants involves the process of **[KCET 2015; NEET (Phase-I) 2016]**

(a) Polyembryony (b) Parthenocarpy

(c) Dormancy (d) Apomixis

18. The given figure A and B show female reproductive organs of *Papaver* and *Michelia* respectively **[NCERT]**



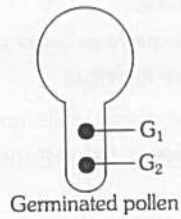
(a) A - Multicarpellary syncarpous pistil and B - Multicarpellary apocarpous pistil

(b) A - Multicarpellary apocarpous pistil B - Multicarpellary syncarpous pistil

(c) Both A and B are multicarpellary syncarpous pistils

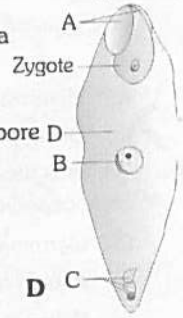
(d) Both A and B are multicarpellary apocarpous pistil

19. G_1 and G_2 are genetically identical because **[NCERT]**



(a) They are products of meiosis I
(b) They are products of amitosis
(c) They are products of meiosis
(d) They are products of mitosis

20. Identify the components labelled A, B, C and D in the given figure from the list I to VIII **[NCERT]**

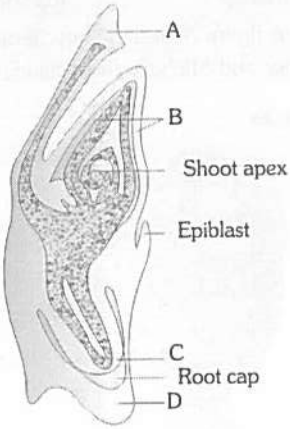


I. Micropyle
II. Chalaza
III. Central cell
IV. PEN
V. PEC
VI. Megaspore
VII. Degenerating synergid
VIII. Degenerating antipodal cell

The correct components are

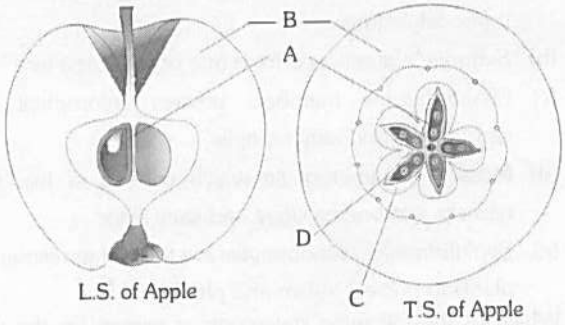
	A	B	C	D
(a)	I	VIII	II	III
(b)	II	VIII	III	I
(c)	VI	IV	VII	III
(d)	VI	IV	VII	V

21. Identify all the four parts A, B, C and D in the given diagram **[NCERT]**



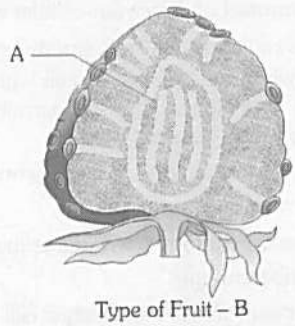
	A	B	C	D
(a)	Hypophysis	Coleoptile	Radicle	Coleorhiza
(b)	Hypophysis	Coleorhiza	Radicle	Coleoptile
(c)	Scutellum	Coleorhiza	Radicle	Coleoptile
(d)	Scutellum	Coleoptile	Radicle	Coleorhiza

22. Select the right option in which the edible part (A, B, C and D) shown in the figure is correctly identified **[NCERT]**



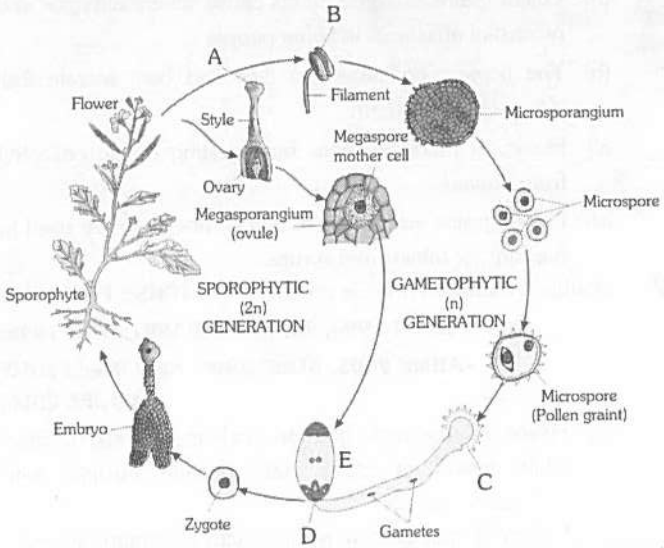
(a) D - Endocarp
(b) C= Epicarp + Mesocarp
(c) B-Thalamus
(d) A – Seed

23. In the given figure of strawberry fruit, identify A and B **[NCERT]**



(a) A - Mesocarp, B - Drupe
(b) A - Thalamus, B - Achene
(c) A - Thalamus, B - Pome
(d) A - Endocarp, B – Pome

24. See the following figure and identify A, B, C, D and E are respectively **[NCERT]**



(a) Stigma, Anther, Embryo sac, Egg and Female gametophyte
(b) Stigma, Anther, Male gametophyte, Fertilized egg and Female gametophyte
(c) Stigma, Anther, Female gametophyte, Egg and Male gametophyte
(d) Stigma, Anther, Male gametophyte, Egg and Female gametophyte

AR Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below :

(a) If both the assertion and the reason are true and the reason is a correct explanation of the assertion

(b) If both the assertion and reason are true but the reason is not a correct explanation of the assertion

(c) If the assertion is true but the reason is false

(d) If both the assertion and reason are false

(e) If the assertion is false but reason is true

1. Assertion : Angiospermic flowers perform the function of sexual reproduction.
Reason : The male and female reproductive structures are found in the flowers. **[AIIMS 1994]**

2. Assertion : Endosperm is a nutritive tissue and it is triploid.
Reason : Endosperm is formed by fusion of secondary nucleus to second male gamete. It is used by developing embryo. **[AIIMS 1998]**

3. Assertion : In hemianatropous ovule, the funicle lies parellel to body of ovule.
Reason : Here, body of ovule has rotated by 90°. **[AIIMS 1999]**

4. Assertion : Pollen grain reaches directly to the egg, which is seated deep in the ovarian cavity.
Reason : To effect fertilization, the pollen grains germinate on the stigma.

5. Assertion : The two cotyledons in seed are embryonic leaves.
Reason : The embryo contains radicle and plumule. **[AIIMS 2002]**

6. Assertion : The megaspore mother cell divides mitotically to produce four spores.
Reason : Megaspore mother cells are diploid and megaspore is haploid. **[AIIMS 2002, 13]**

7. Assertion : The embryo which is capable to germinate should have well-developed radicle plumule and one or two cotyledons.
Reason : In the Orobanchaceae and Orchidaceae the embryo never differentiates a true radicle, plumule and cotyledons, but can germinate.

8. Assertion : Chasmogamous flowers require pollinating agents.
Reason : Cleistogamous flowers do not expose their sex organs.

9. Assertion : Nuclear endosperm is formed by subsequent nuclear division without wall formation.
Reason : Coconut is an example of such endosperm, where the endosperm remains nuclear throughout the development of the fruit.

10. Assertion : 7–celled, 8 nucleate and monosporic embryosac is called *polygonum* type of embryo sac.
Reason : It was discovered by Hofmeister for the first time in *polygonum*. **[AIIMS 2007]**

11. Assertion : Tapetum helps in the liberation of microspores from tetrad.
Reason : Tapetum shows callose activity.

12. Assertion : Insects visit flowers to gather honey.
Reason : Attraction of flowers prevents the insects from damaging other parts of the plant. **[AIIMS 2004]**

13. Assertion : Proembryo stage is restricted to 2-celled stage.
Reason : It has one basal and one apical cell.

14. Assertion : Most common type of ovule is anatropous.
Reason : Anatropous ovule is horse – shoe shaped.

15. Assertion : Megaspore mother cell undergoes meiotic division.
Reason : All four megaspores form female gametophyte.

16. Assertion : The chalazal cells of the embryo sac is central cell.
Reason : They play nutritive role for embryo sac.

17. Assertion : The largest cell of the embryo sac is central cell.
Reason : It consists of a fused nuclei.

18. Assertion : Autogamy is pollination between two flowers on the same plant.
Reason : Xenogamy is pollination between two flowers on different plants.

19. Assertion : Cellular endosperm is formed by both nuclear division and wall formation.
Reason : It lacks haustoria.

Answers

Microsporogenesis

1	a	2	d	3	c	4	d	5	b
6	a	7	a	8	b	9	c	10	d
11	d	12	c	13	d	14	c	15	a
16	a	17	d	18	a	19	a	20	c
21	b	22	c	23	c	24	a	25	a
26	d	27	c	28	c	29	c	30	d
31	a	32	a	33	d	34	a	35	c
36	c	37	d	38	b	39	b	40	d
41	c	42	b	43	d	44	b	45	b
46	a	47	c	48	a	49	b	50	c
51	a	52	d	53	d				

Megasporogenesis

1	d	2	c	3	c	4	a	5	a
6	a	7	d	8	a	9	a	10	c
11	d	12	b	13	d	14	a	15	a
16	a	17	c	18	c	19	d	20	b
21	b	22	a	23	d	24	c	25	b
26	a	27	c	28	d	29	c	30	d
31	a	32	c	33	c	34	b	35	b
36	d	37	d	38	b	39	a	40	d
41	a	42	d	43	c	44	d	45	a
46	a	47	d	48	b				

Pollination

1	d	2	c	3	d	4	c	5	c
6	b	7	c	8	b	9	c	10	b
11	c	12	b	13	b	14	a	15	e
16	d	17	c	18	d	19	c	20	d
21	b	22	d	23	b	24	d	25	a
26	b	27	b	28	b	29	a	30	a
31	b	32	d	33	a	34	a	35	d
36	b	37	b	38	c	39	c	40	c
41	a	42	a	43	d	44	d	45	b
46	a	47	a	48	a	49	c	50	a
51	c	52	b	53	b				

Fertilization

1	c	2	d	3	d	4	c	5	b
6	d	7	c	8	a	9	c	10	d
11	c	12	c	13	d	14	d	15	a
16	c	17	c	18	b	19	d	20	b
21	a	22	a	23	b	24	b	25	d
26	d	27	c	28	d	29	d	30	c
31	a	32	c	33	d	34	a	35	a

Embryo and endosperm

1	a	2	b	3	c	4	b	5	a
6	c	7	b	8	a	9	d	10	c
11	c	12	a	13	b	14	b	15	d
16	b	17	b	18	a	19	a	20	c
21	d	22	c	23	c	24	b	25	d
26	c	27	b	28	c	29	a	30	d
31	a	32	d	33	a	34	c	35	b
36	c	37	c	38	d	39	b	40	b
41	c	42	c	43	b	44	d	45	a
46	d	47	c						

Parthenocarpy

1	b	2	a	3	a	4	c	5	a
6	b	7	b						

NCERT Exemplar Questions

1	c	2	c	3	a	4	d	5	d
6	b	7	a	8	b	9	c	10	c
11	a	12	c	13	b	14	a	15	b
16	c	17	c	18	b	19	b		

Critical Thinking Questions

1	b	2	d	3	a	4	a	5	d
6	d	7	d	8	a	9	a	10	d
11	c	12	a	13	b	14	d	15	b
16	b	17	d	18	a	19	d	20	d
21	d	22	c	23	b	24	d		

Assertion and Reason

1	a	2	a	3	e	4	e	5	b
6	e	7	b	8	b	9	c	10	c
11	a	12	d	13	e	14	c	15	c
16	b	17	b	18	e	19	c		

AS Answers and Solutions

Microsporogenesis

7. (a) During microsporogenesis, primary sporogenous cell gives rise to microspore mother cells or pollen mother cells. Each pollen mother cell on reduction division gives rise to 4 microspores or pollens which is the beginning of male gametophytic generation. The microspore undergoes only two mitotic divisions and thus fully developed male gametophyte is formed. It is 3-nucleated structure.

8. (b) Generative cell divides into two male gametes, if it has not divided already.

11. (d) Male gametophyte in angiosperm is 3-celled containing 2 male gametes (sperms) and vegetative cell.

12. (c) The transference of characters by a male gamete and its influence on endosperm is known as xenia.

13. (d) Pollen grains contain the male gametophyte produced by meiosis of microspore other cells that are located along the inner edge of the microsporangia. The outer part of the pollen is exine, which is composed of a complex polysaccharide, sporopollenin. Inner part is intine. the cell contains vegetative cell which develop into the pollen tube and germ pore and generative cell (degenerative) are also present.

14. (c) Exine is made up of sporopollenin (derived from carotenoid).

15. (a) Spore mother cells are diploid. These cells divide meiotically to form haploid spores. It may be micro/megaspores.

16. (a) It is outer most covering of tetrad microspores in microsporangium.

17. (d) In Asclepiadaceae family all microspores of a sporangium form a single body called pollinium.

18. (a) Haploids can be obtained by culturing pollen grains. Only pollen grains are haploids. Root apex, shoot apex and embryo are diploid.

20. (c) Pollen grain is partially developed male gametophyte because the rest of the development is completed on stigma when pollen grains start to germinate and produces pollen tube having two male nuclei.

21. (b) Four pollen grains are formed by one pollen mother cell by meiosis.

22. (c) Its chief function is the production of enzymes, and hormones (IAA) and secretion of nutrients for developing pollens.

32. (a) In monocots, male gametophyte is formed in pollen grain or microspore.

33. (d) Pollen grains are not part of ovule.

34. (a) Meiosis occurs in pollen mother cells of anther.

40. (d) The cells between middle layer and microsporogenous cells develop into tapetum. Tapetum plays an important role in pollen development by providing nutrition. It is a part of anther wall.

42. (b) Ubisch bodies secreted by tapetum help in external thickening of exine as these bodies get coated with sporopollenin.

46. (a) When the sporangium is derived from a single parent cell and the wall is one layered it is called leptosporangiate type.

Megasporogenesis

1. (d) Antipodal cells and egg cells are formed by megaspore and are haploid.

2. (c) Filiform apparatus, present in synergids, play an important role in guiding the pollen tube into the synergid.

4. (a) Ovule with funiculus lying close to micropyle is called anatropus. In camphylotropus and amphitropous funiculus micropyle make an angle of 120° and in atropous they fall in one line.

6. (a) 7; the number of chromosomes in root cells is $2n$ while it is n in synergids because it develops by reductional division.

12. (b) In *Asphodelus*, the outer integument is curved so that this curved structure is known as caruncle.

13. (d) After double fertilization the remnants of nucellus of ovule in mature seed is called perisperm.

17. (c) Female gametophyte embryo sac of ovule develops from megaspore.

18. (c) In angiosperms, two integuments are found in ovule while in gymnosperms only one integument is found.

25. (b) Embryo sac is made up of 8 nuclei which are formed by 3 simple divisions.

29. (c) Aril is a collar like outgrowth from the base of the ovule and forms third integument. It is present sometimes as in Litchi and *Asphodelus* or in the form of caruncle in *Ricinus* (Castor).

30. (d) Synergids show a filiform apparatus attached to their upper wall. It is known to attract and guide the pollen tube.

32. (c) In campylotropus the body of ovule is curved but the embryo sac is straight *e.g.*, *Capsella*, *Capparis*.

38. (b) The nucleus of megaspore undergoes divisions and give rise to embryo sac or female gametophyte, which is called megagametogenesis.

39. (a) A *Polygonum* type of embryo is 7 celled and 8 nucleate where these are 3 antipodals, 2 synergids, one egg cell and one secondary nucleus which is binucleated.

40. (d) Synergids are formed by megaspore which is a haploid structure. Thus synergids are haploid and possess 6 chromosomes.

41. (a) Egg apparatus of angiosperm is 3 celled. It has one egg cell and two synergids on either side of egg cell. 3 antiipodal are present on chalazal side. The secondary nucleus is binucleate, is present in the centre of embryo sac.

43. (c) After meiotic division four haploid megaspores are formed. Only one megaspore (haploid) divides mitotically to form embryo sac and other three disappear or disintegrates.

44. (d) When the funicle lies parallel to the body of the ovule and micropyle. The body of the ovule has rotated by 180°, the ovule is called anatropous.

45. (a) All cells in the ovule (integument, nucellus, funicle, hilum) are diploid ($2x$) but embryo sac (synergids, antipodal cells, egg cell) is haploid.

Pollination

1. (d) Wind pollinated flowers have generally single ovule in each ovary.

5. (c) In cleistogamy bisexual flowers never open therefore the pollengrains may only pollinate the stigma of the same flower *e.g.*, *commelina bengalenis* (day flower)

11. (c) Geitonogamy is the transfer for pollen grains from anthers of one flower to another flower of either the same plant or genetically similar plant or between two clones.

12. (b) Malacophily is cross pollination brought about by the agency of snails, slugs *e.g.*, *Arisaema* (cobra plant).

13. (b) Dichogamy is the maturation of anther and stigmas of a flower at different times, *e.g.*, sunflower.

16. (d) Self sterility, herkogamy and dichogamy are adaptation for cross pollination.

20. (d) Wind pollination is common in grasses and gymnosperms.

21. (b) *Vallisneria* is submerged, dioecius, fresh water plant. Hence pollinated in water.

22. (d) Geitonogamy is genetically self pollination but it requires pollinators.

23. (b) Chiropterophily is pollination by bats, *e.g.*, *Kigelia africana*. *Adansonia* etc.

27. (b) In Salvia (Sage plant), a member of family Labiatae, pollination occurs by bees and there is a special mechanism called 'Turn pipe mechanism' or Lever mechanism of pollination.

31. (b) Stigmas are exserted, sticky, hairy, feathery or branched to capture the pollen grains.

33. (a) Feathery stigma is characteristic of wind pollination.

38. (c) Herkogamy are mechanical devices that prevent self pollination and favour cross pollination even in homogamous flowers.

41. (a) Anemophilous plants bear small and inconspicuous flowers. The pollen grains are small, light, smooth and dry.

46. (a) Papaya is dioecious so that it prevents both Autogamy and geitonogamy (method of self pollination).

47. (a) Self pollination is favoured by cleistogamy.

48. (a) Xenogamy is the cross pollination between two flowers of different plants.

49. (c) Maize, mulberry → wind pollination

Vallisneria → Hydrophily.

Fertilization

4. (c) Porogamy is the most common way in angiosperms *e.g.*, Lily.

5. (b) In mature female gametophyte, 3 antipodal cells, 2 synergids, 1 egg and 1 diploid secondary nucleus are present.

7. (c) Double fertilization was discovered by Nawaschin, (1898) in *Fritillaria* and *Lilium*.

8. (a) In mesogamy pollen tube penetrates laterally through integuments (*Cucurbita*) and funiculus (*e.g.*, *Pistacia*).

9. (c) Because in gymnosperms, bryophytes and pteridophytes single fertilization is found.

10. (d) Because egg is the part of embryo sac.

12. (c) Endosperm is triploid ($3n$).

14. (d) 5 *i.e.*, 2 sperm nuclei, 2 pollen nuclei and one egg nucleus.

16. (c) Filiform apparatus of synergids secretes some chemical substance which is polysaccharide in nature which attract pollen tube.

21. (a) Syngamy is fusion of one of the two male gametes with egg to produce diploid zygote (oospore).

23. (b) In angiosperms, male gametes reach the female gamete with the help of pollen tube. (Strasburger, 1884).

24. (b) Germination of pollen grains completes on stigma *i.e.*, in vivo. It means in natural conditions or within the cell.

26. (d) Pea, bean and *Phaseolus* seeds are non-endospermic because endosperm is fully consumed during their embryo development. It is an advance character of angiosperm.

27. (c) Growth of pollen tube towards the embryo sac is chemotaxis because this movement is induced by chemicals like auxin hormone and carbohydrate.

28. (d) All three types can be route of the pollen tube enters in the ovule as chalazogamy mesogamy and porogamy.

29. (d) Synergids are short lived (one of them degenerated long before fertilization and second after entry of pollen tube into embryo sac).

30. (c) Double fertilization is found only in angiosperms. In which secondary nucleus form triploid cell and egg convert into diploid zygote. Triploid cell to form endosperm and diploid zygote to form embryo.

31. (a) The pollen tube releases two male gametes, which migrate towards the chalazal end of the degenerated synergid by an unknown mechanism. Gametes discharge at synergid cells.

32. (c) The formation of sporophyte from gametophytic cell without fertilization is called apogamy.

34. (a) After fertilization the outer integument forms testa, inner integument forms tegmen and ovary wall forms pericarp.

35. (a) In more than 60% angiospermic plants. Pollen grains release in 2-celled stage.

Embryo and Endosperm

2. (b) In maize the outermost layer of endosperm is rich in protein and constitutes the aleurone layer.

6. (c) Because maize and lily are angiosperm plants, in which endosperm is formed by fusion of one diploid polar nucleus and haploid male gamete, thus this tissue is triploid.

9. (d) In *Pinus*, both cleavage and simple polyembryony is present.

10. (c) In *Cocos nucifera* (coconut) milky endosperm is found in which many nuclei, vitamins and growth hormone *e.g.*, cytokinins, auxin, AG and induced cytokinin is found.

13. (b) Primary endosperm nucleus is triploid structure which forms endosperm.

14. (b) During the development of **nuclear endosperm**, the primary endosperm nucleus divides repeatedly without wall formation i.e., produce large number of free nuclei. The multinucleate cytoplasm undergo cleavage and gives rise to multicellular tissue e.g., Maize, Wheat, Rice, Sunflower. etc.

15. (d) The endosperm that shows irregular or uneven surface contour is called ruminate endosperm. Ruminate or convoluted endosperm occurs in Areca (Batelnut) and Passiflora.

20. (c) Endosperm (result of triple fusion) $= 3n = 36$

$$n = \frac{36}{3} = 12$$

No. of chromosome in root cells is $2n = 24$ (sporophytic).

28. (c) Since sunflower is a dicotyledonous plant, so the number of cotyledons in sunflower will be two.

29. (a) In *Agamospermy* megaspore mother cells no meiosis persists so all the megaspores remain diploid and later on they develop in diploid embryo sacs.

30. (d) Growth of diploid nuclear or integument cells into embryos (adventive polyembryony) *e.g.*, Mango.

31. (a) In angiosperms, citrus have two or more than two embryos in one seed. It is called polyembryony.

32. (d) The anterior octant occurs towards the chalazal end. It is called apical octant or chalazal octant. The shoot apex or plumule epicotyl and two cotyledons of embryo will develop from this octant. The posterior octant occurs towards the micropylar end. It is called basal octant or micropylar octant. The hypocotyls and the central region of radical of the embryo will develop from this octant.

35. (b) Embryogeny is the development of mature embryo from zygote or oospore.

37. (c) Secondary nucleus forms endosperm in angiosperms. After double fertilization secondary nucleus become triploid and this triploid cell forms endosperm.

38. (d) Xenia means direct effect of the pollen grains on the seeds and fruits, outside the embryo. Metaxenia is the effect of pollen grain on the testa and fruit wall. Maize is the classical example of xenia and date palm is an example of metaxenia.

41. (c) Endosperm in gymnosperm is formed before fertilization and is always haploid.

Parthenocarpy

1. (b) Banana is natural parthenocarpy fruit formed without fertilization of ova.

2. (a) When seedless fruits (noble varieties) are produced by the removal of pollination the process is known as parthenocarpy.

3. (a) Development of the individual from single gamete without fertilization is called parthenogenesis.

5. (a) Stimulative parthenocarpy occurs with stimulus of pollination *e.g.*, grapes.

6. (b) In pomegranate, succulent testa is the edible part. Parthenocarpy will make the fruit seedless and thus useless.

Critical Thinking Questions

4. (a) Secondary nucleus of an embryo sac of angiosperms is diploid because two nucleus comes from each pole to the middle and they becomes fuse.

5. (d) 12, 36, 24; because pollen grains are haploid while endosperm has triploid chromosome number and integument is diploid in nature.

7. (d) Juvenility is the first stage of plant just after germination of seed when it is soft and filamentous.

9. (a) The movement of pollen tube towards embryosac though style is chemotactic as it secrets pectinases and other hydrolytic enzymes to create a passage for its entry into style.

13. (b) Because apomixis is a abnormal kind of sexual reproduction in which egg or other cells associated with egg (synergids, antipodals etc) develop into embryo without fertilization and with or without meiosis.

Assertion and Reason

1. (a) Angiospermic flowers possess male and female sex organs and perform the sexual reproduction.

2. (a) In angiosperm, triploid endosperm is formed by fusion of secondary nucleus and second male gamete. This tissue is used by developing embryo.

3. (e) When funicle lies at right angle to body of ovule and micropyle, the ovule is called hemianatropous or body of ovule has rotated by 90°.

4. (e) In angiosperms the female gametophyte is seated deep in the ovarian cavity, quite away from the stigma. The pollen (male gametophyte) is normally held at the stigma. In seed plants the male gametes are brought to the egg containing female gametophyte by a pollen tube. A pollen grain does not pass down the stigma. Only its pollen tube does so.

5. (b) In angiosperms, cotyledons are embryonic leaves. Embryo also has radicle and plumule which gives rise to root and shoot respectively.

6. (e) The megaspore mother cell is diploid. This divides by meiotic division and produce four haploid megaspores.

7. (b) Irrespective of its mode of development a mature embryo generally possesses an embryonic root (radicle) an embryonic shoot (plumule) and one or two cotyledons. However, some groups of plants are characterised by the presence of reduced embryos, lacking the differentiation of these organs, for example, the plants of Balanophoraceae, Orchidaceae, Orobanchaceae.

8. (b) The majority of angiosperms bear chasmogamous flowers, which means the flowers expose their mature anthers and stigma to the pollinating agents. There is another group of plants which set seeds without exposing their sex organs. Such flowers are called cleistogamous and the phenomenon cleistogamy.

9. (c) In nuclear type of endosperm the division of the primary endosperm nucleus and a few subsequent nuclear division are not accompanied by wall formation. So numerous nuclei are freely suspended in its sap. In coconut, the primary endosperm nucleus undergoes a number of free nuclear divisions. When the fruit is about 50 *mm* long before the embryo sac gets filled with a clear fluid in which float numerous nuclei of various sizes. At a later stage (about 100 *mm* long fruit) the suspension shows in addition to free nuclei, several cells each enclosing variable number of nuclei. Gradually these cells and free nuclei start setting at the periphery of the cavity and layers of cellular endosperm start appearing. This forms the coconut meat. In mature coconuts the liquid endosperm becomes milky and it does not contain free nuclei or cell.

10. (c) Embryo sac is the female gametophyte of angiosperms. It was observed by Hofmeister first time. Polygonum type of embryo sac is most simple, most primitive and normal, type of embryo sac. It is 7 celled, 8– nucleate and monosporic embryo sac. It was discovered for the first time in Polygonum by Strasburger.

11. (a) Mepham and Lane have demonstrated that in *Tradescantia bracteata* the plasmodial cytoplasm derived from the tapetum has callose activity. Shortly before callose degradation starts the cytoplasm of tapetal cells show certain vesicles which are probably associated with callose activity. This suggests that sporophytic tissue, presumably tapteum, is involved in the synthesis of callose enzyme for the release of microspores in a tetrad by degrading the callose wall.

12. (d) Insect visit flowers to get nectar. The attraction of flower in plants is not to diverge the insect from damaging other part, but to bring about pollination (*i.e.*, transfer of pollen to the stigma).

13. (e) From the 2-celled stage until the initiation of organs the embryo is commonly called proembryo. In the majority of angiosperms the zygote divides transversely, resulting in small apical cell towards the interior of the embryo sac and a large basal cell.

14. (c) The ovules where micropyle comes to lie close to the funiculus due to unilateral growth of the ovule are called anatropous. This is the most common type of ovule in angiosperms where the curvature of the ovule also affects the nucellus so that the later becomes horse shoe-shaped. The ovule is called amphitropous.

15. (c) One hypodermal nucellar cell of the micropylar region differentiates into the sporogenous cell. It forms a diploid megaspore mother cell or megasporocyte. The megaspore mother cells undergo meiosis and forms a row of four haploid megaspores. Only the chalazal megaspore remains functional megaspore enlarges and gives rise to female gametophyte, also called embryo sac.

16. (b) The three chalazal cells of the embryo sac are called antipodal cells. They are the vegetative cells of the embryo sac which may degenerate soon or take part in absorbing nourishment from the surrounding nucellar cells. Internally they are connected with the central cell by means of plasmodesmata.

17. (b) The central cell is the largest cell of the embryo sac. It has a highly vacuolate cytoplasm which is rich in reserve food and golgi bodies. In the middle the cell contains two polar nuclei which have large nucleoli. The polar nuclei fuse to form a single diploid secondary or fusion nucleus.

18. (e) Based on the destination of pollen grains, two types of pollination are recognised. When pollen grains are transferred from an anther to the stigma of the same flower the process is called self pollination or autogamy. Cross-pollination is further classified depending on whether the pollination has occurred between two flowers on the same plant (geitonogamy) or between two flowers on different plants (xenogamy).

19. (c) The cellular endosperm is characterized by the absence of free nuclear stage. The division of the primary endosperm nucleus and a few subsequent nuclear division are followed regularly by wall formation. The occurrence of haustoria is a common feature of this type of endosperm the haustoria may be micropylar or chalazal. Occasionally, both types of haustoria are present in the same plant.

Sexual Reproduction in Flowering Plants

SET Self Evaluation Test

1. Feathery stigma is called **[Odisha JEE 2010]**
(a) Spur (b) Stylopodium
(c) Plumose (d) Calyculus

2. Two rigid pointed hook-like structures are present in
(a) *Martynia* (b) *Cleome*
(c) *Xanthium* (d) *Achyranthes*

3. Most resistant biological material is **[CPMT 1999; JIPMEER 2001; MP PMT 2006]**

Or

An organic substance that can withstand environmental extremes and cannot be degraded by any enzyme is **[NCERT; CBSE PMT (Pre.) 2012]**
(a) Ligin (b) Cellulose
(c) Suberin (d) Sporopolenin

4. Which of the following plant product is the hardest **[BHU 2006]**
(a) Lignin (b) Cutin
(c) Suberin (d) Sporopollenin

5. If position of ovary is below sepals petals and stamens, the flower is called **[Odisha JEE 2005]**
(a) Epigynous (b) Perigynous
(c) Mesogynous (d) Metagynous

6. The arrangement of the ovules on the placenta developed from the central axis of the ovary is called **[J & K CET 2005]**
(a) Parietal placentation (b) Axile placentation
(c) Basal placentation (d) Marginal placentation

7. Who is author of book "Introduction to the Embryology" of Angiosperms **[HP PMT 2005]**
(a) Maheshwari (b) Birbal Sahni
(c) T.S. Mahabale (d) J.S. Singh

8. Which of these is not essential for allogamy **[Manipal 2005]**
(a) Self sterility (b) Dichogamy
(c) Heterogamy (d) None of these

9. Siphonogamy in angiosperm means **[MHCET 2002]**
(a) Tube like male gametes
(b) Motile male gametes
(c) Male gametes produced in a tube
(d) Male gametes are carried in a tube

10. Plasmogamy refers to **[AIIMS 1994]**
(a) The fusion of two haploid hyphae with simultaneous nuclear fusion
(b) The fusion of two haploid hyphae without simultaneous nuclear fusion
(c) Fusion of egg cell with sperm
(d) Fusion of sperm with polar nuclei

11. A plant raised from a single germinating pollen grain under cultural conditions is called a **[MP PMT 1994]**
(a) Haploid plant (b) Diploid plant
(c) Tetraploid plant (d) Polyploid plant

12. Match the following ovular structure with post fertilization structure and select the correct alternative

(A) Ovule	1. Endosperm
(B) Funiculus	2. Aril
(C) Nucellus	3. Seed
(D) Polar nuclei	4. Perisperm

Codes **[AIIMS 2007]**

	A	B	C	D
(a)	2	3	4	1
(b)	2	3	1	4
(c)	3	2	4	1
(d)	3	2	1	4

13. Heteroblastic means
(a) Development of male and female structures on the same plant
(b) Development of male and female structures on different plants
(c) Vegetative and reproductive growth in different seasons
(d) Vegetative structure of young and old plants is different

14. In angiosperms, microsporogenesis and megasporogenesis **[AIPMT 2015]**
(a) Form gametes without further divisions
(b) Involve meiosis
(c) Occur in ovule
(d) Occur in anther

15. Environmental biotic factor that helps in pollination is **[MHCET 2015]**
(a) Air (b) Water
(c) Wind (d) Insects

AS Answers and Solutions

1	c	2	a	3	d	4	d	5	a
6	b	7	a	8	d	9	d	10	c
11	a	12	c	13	d	14	b	15	d

2. (a) Fruits of *Martynia* have hard hair and spine or hooks which help them to cling to the fur of birds and animals and are carried to distant places.

3. (d) Sporopollenin is fatty substance present in pollen wall and provides resistance against extremes conditions like high temperature, Acid, bases.

4. (d) Sporopollenin is a polymer, tougher than lignin but with similar properties, composed cheifly of carotenoids makes spores and pollen grains of plants resistant to biodegradation. It is the hardest plant product.

5. (a) When calyx and corolla arise from upper side of ovary it is called epigyny, Ovary is inferior and flower is epigynous.

9. (d) In seed plants fertilization is called Siphonogamy because the male gametes are brought to the egg containing female gametophyte by a pollen tube.

11. (a) Guha and Maheshwari reported culture of androgenic haploids of *Datura innoxia*.

14. (b) Each microspore mother cell of anther undergoes meiosis to form microspore tetrad while megaspore mother cell of ovule undergoes meiosis to form megaspore tetrad.

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