PLANT EMBRYOLOGY

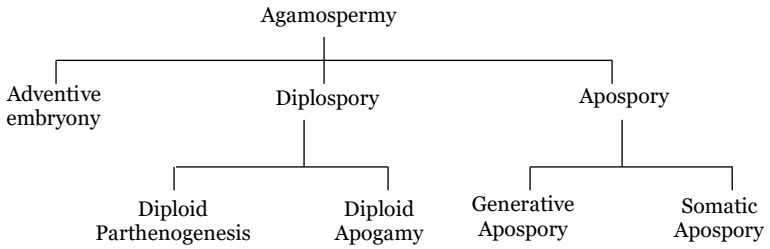
Reproduction is the process of formation of new individuals from pre-existing ones. It is the means of multiplication and perpetuation of the species because the older individuals of each species undergo senescene and die. There are two basic types of reproduction : Asexual and Sexual

5.1 ASEXUAL REPRODUCTION

The methods of reproduction which do not involve meiosis and fertilization are known as apomixis or asexual reproduction. Only mitotic divisions are involved in these methods, resulting into the formation of offsprings which are genetically similar to the parent plant.

Asexual reproduction is of following two types :

(1) **Agamospermy :** Agamospermy is a kind of plant apomixis in which the embryos and seeds are formed by asexual reproductive methods without involving meiotic gametogenesis and sexual fusion of gametes. It occurs widely in ferns and the flowering plants. There are three different types of agamospermy :



(i) **Adventive embryony :** Formation of embryo directly from the diploid sporophytic cells (nucellus or integument) of ovule is called adventive embryony. Such embryos are formed without involving meiosis and sexual fusion, *e.g.*, *Citrus*, *Opuntia*, etc. In *Citrus*, a seed may possess upto 40 embryos (one normal and rest adventive).

(ii) **Diplospory :** In this case, the archesporium differentiates but megaspore mother cell directly gives rise to an unreduced (*i.e.*, without meiosis) embryo sac. It may produce two types of embryos :

(a) **Diploid parthenogenesis :** Embryo develops from unfertilized diploid egg.

(b) **Diploid apogamy :** Embryo develops from any diploid cell of embryo sac except egg.

(iii) **Apospory :** It is the formation of complete embryo sac from the sporophytic cell without meiosis so that the gametophyte remains diploid. Apospory may be of two types :

(a) **Somatic apospory :** Embryo sac is formed from somatic cell.

(b) **Generative apospory :** Embryo sac is formed from archesporium without meiosis.

(2) **Vegetative propagation :** Regeneration or Formation of a new individual from any vegetative part of the body is called vegetative reproduction or vegetative propagation. The lower plants reproduce vegetatively through budding, fission, fragmentation, gemmae, resting buds, spores, etc. Among flowering plants, every part of the body such as roots, stem, leaves and buds take part in

vegetative propagation. It is very common mode of reproduction and it may be natural vegetative propagation or artificial vegetative propagation.

(i) **Natural methods of vegetative propagation :** In natural vegetative propagation, a portion gets deattached from the body of mother plant and it grows into a new individual plant under suitable conditions. Different plant parts are variously modified for vegetative propagation. Some of these are given below.

(a) **Vegetative propagation by stems :** The modified stems like bulbs, runners, rhizomes, corms, tubers, offsets, etc., help the plant to multiply under favourable conditions.

- **Bulb** : It is a modified shoot that has a very short stem and apical and axillary buds. Some of these grow to form shoots. *e.g.* Onion, Tulip, Lilies, Garlic, etc.
- **Runners :** These are creeping modified stems which produce adventitious roots at nodes. Each node gives rise to aerial shoot which becomes a new plant *e.g.* Doob grass (*Cynodon*), Wood sorrel (*Oxalis*), Indian pennywort (*Centella*), etc.
- **Rhizomes :** These are underground, horizontally growing stems. They have distinct nodes, internodes and axillary buds. The branches grow from the buds which later separate to form new individuals. *e.g.* Ginger, Turmeric, *Typha*, Lotus, *Saccharum*, Canna, etc.
- **Corms :** Corms are highly condensed and specialized underground stems which bear many buds. They perennate the unfavourable conditions and produce new plants under favourable conditions. *e.g.* Saffron (*Crocus*), *Gladiolus, Colocasia*, Banana, etc.
- **Tubers :** Tubers are the modification of underground stem tip having several eyes or buds. Each eye grows into new plants. *e.g.* Potato.
- **Offsets :** They are one internode long runners which develop tuft of leaves at the apex *e.g.* Water lettuce (*Pistia*), Water hyacinth (*Eichhornia*), etc.
- **Stolons :** They are arched runners with cross over small obstacles and develop small plantlets at their nodes. *e.g.* Strawberry, Vallisneria, etc.

(b) **Vegetative propagation by roots :** The roots of some woody plants produce shoots which grow into new plants; *e.g.*, *Murraya*, Lebbeck tree (*Albizzia*), Sisham (*Dalbergia sisso*), etc. Modified tuberous roots of Sweet potato, Asparagus, Dahlia, Tapioca, Tinospora, etc. develop buds and each of which form a new plant.

(c) **Vegetative propagation by leaves :** The leaves generally do not help in vegetative propagation. However, in *Bryophyllum pinnatum* and *B. daigremontianum*, develop along the leaf margins which on deattachment produce independent plants. In elephant ear plant (*Begonia*) also, leaf buds are produced from petiole and veins throughout the surface of the leaf.

(d) **Vegetative propagation by reproductive parts :** Flowers are primarily associated with sexual reproduction. But in *Globba*, American aloe (*Agave*), Onion (*Allium cepa*), etc. special multicellular structures, called *bulbils*, occur on the inflorescence. These are the modifications of flowers. Bulbils grow into new plants when shed from the mother plant.

(ii) **Artificial methods of vegetative propagation :** Several methods of vegetative propagation are man made and developed by plant growers and horticulturists for commercial production of crops. They are called artificial methods. In this method a portion is separated from the body of the plant and then it is grown independently. The potato tubers are organs of natural vegetative propagation but are also used artificially. This is useful commercially because the new individuals produced maintain the desirable characters of the parents. A population of these genetically identical plants obtained from an individual is called a ***clone***. Some of the artificial methods are given below :

(a) **Cuttings :** The small piece of any plant organ (stem, root or leaf) use for propagation is called cutting. Leaf cuttings are used to propagate *Sansevieria*, *Begonia, Bryophyllum, Glocinia* and *Kalanchoe*. Root cuttings are used to propagate *Citron* and *Tamarind*. Stem cuttings are most commonly used for artificial propagation. When cuttings (about 20-30 *cm.* long pieces of stem) from such plants are put into the moist soil, they develop adventitious roots and buds at the base which develops into new plants. Sometimes roots are not easily produced in the cuttings and hence, they are treated with rooting hormone (IBA). Factors such as age of the parent plant, length and diameter of the cutting, season and the type of plants are taken into consideration for the propagation of particular species. Grapes, Sugarcane, Rose, *Bougainvillea*, Carnation, Coleus, Duranta, etc. are propagated by stem cuttings.

(b) **Layering :** In this method, roots are artificially induced on the stem branches while it is still attached to the parent plant for propagation. There are two common types of layering :

- **Mound layering :** In this technique a lower branch of stem is bent and covered in such a way that the tip of the branch remains above the ground. After a few days, the covered part of the stem produces adventitious roots. At this stage the branch is cut off from the parent plant and it grows into a new plant. This method is commonly employed for propagating Strawberry, Jasmine, Grape vine, Raspberry, etc.
- **Air layering (Gootee) :** This is employed in plants with thick branches which can not be easily bent. In this method, part of the stem is girdled (*i.e.*, a ring of bark is removed) or slit at an upward angle. This part is covered with moist moss or cotton and enclosed in a polythene bag to prevent drying. The wrapped portion is called ***gootee***. The roots appear after some time and at that stage the branch is cut and planted. It grows into a new individual. This method is used in vegetative propagation of Litchi, Pomegranate, Orange, Lemon, Guava, *Bougainvillia*, etc.

(c) **Grafting :** A new variety is produced by joining parts of two different plants is called grafting. The rooted shoot of one plant, called ***stock***, is joined with a piece of shoot of another plant known as ***scion***. The root stock is generally derived from a plant resistant to diseases and efficient in water and mineral absorption. The scion is a stem cutting from a superior quality plant. The grafting ends of both, stock and scion are cut obliquely and then placed over one another in such a way that the cambia of two come in close contact. The two pieces are firmly held together by tape, rubber tubing, etc. This results in fusion of cambia and formation of new vascular tissue. Grafting is generally done between the related varieties or species. This method has been practised for many economically useful plants, such as Rose, Mango, Apple, Pear, Guava, Citrus, Rubber etc. There are various methods of grafting

like tongue or whip grafting, wedge grafting and crown grafting. Besides these a technique, called bud grafting, in which only a single bud along with a small portion of bark having intact cambium instead of a scion is employed for propagation.

(d) **Propagation by plant tissue culture or Micropropagation :** This method includes propagation of plants by culturing the cells, tissues and organs called ***tissue culture***. Small pieces of plant organs or tissues are grown aseptically in a suitable nutrient medium. Initially it results in the formation of undifferentiated mass of cells called ***callus***. Which later differentiates to produce a large number of plantlets. These plantlets are then transferred to separate pots or nursery beds to obtain a large number of plants. Tissue culture technique is useful in obtaining virus free plants, homozygous diploids and in commercial micropropagation of Orchids, Carnation, *Gladiolus*, *Chrysanthemum* and other Ornamental plants. This method is also employed for quick multiplication of plants.

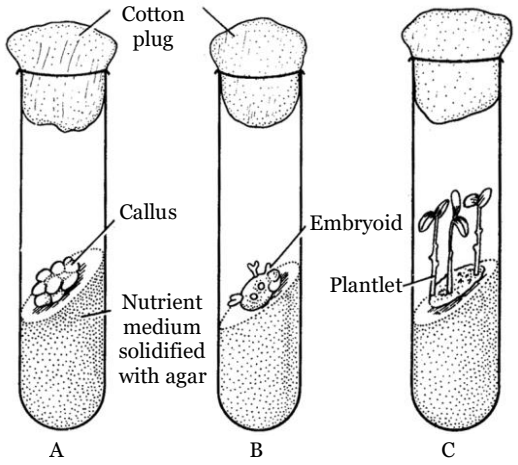


Fig : Micropropagation : A. Culture tube with tissue, B. Organised callus, C. Plantlets developed

Important tips

- **Grafting** is not possible in monocots as they do not bear cambium.
- Slip is a small piece or plantlets which can be separated and used for propagation.
- Tissue culture technique was first thought of by **Haberlandt** (1902) and **Hanning** (1908) but successful attempt was made by **White** (1932) in case of tomato root.
- **Steward** (1964) gave the concept of cellular totipotency.
- **Guha** and **Maheshwari** (1964) developed haploid culture or pollen grain culture.
- **Skoog** and **Miller** (1957) found that morphogenesis or differentiation in callus depends on two hormones–auxin (favours root formation) and cytokinin (favours shoot formation).
- Somatic hybridization or protoplast fusion was first reported by **Harrie** and **Matkins**.
- **Winkler** (1934) introduced the term apomixis.
- Graft hybrid is a chimera shoot formed by an adventitious bud formed at the junction of stock and scion. First reported in 1644 as Bizzaria orange (half orange half cistron) in Italy.
- In angiosperms apospory was first reported by **Rosenberg** (1907) in Hieracium.
- The ability of mature cells to develop new individual in vitro is called **cellular totipotency**. Vascular cambium show totipotency which cuts secondary xylem and secondary phloem.
- The formation of sporophyte directly from gametophyte without gamete formation and fusion is called **apogamy**.
- Walking fern propagates through leaf tip.

5.2 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.

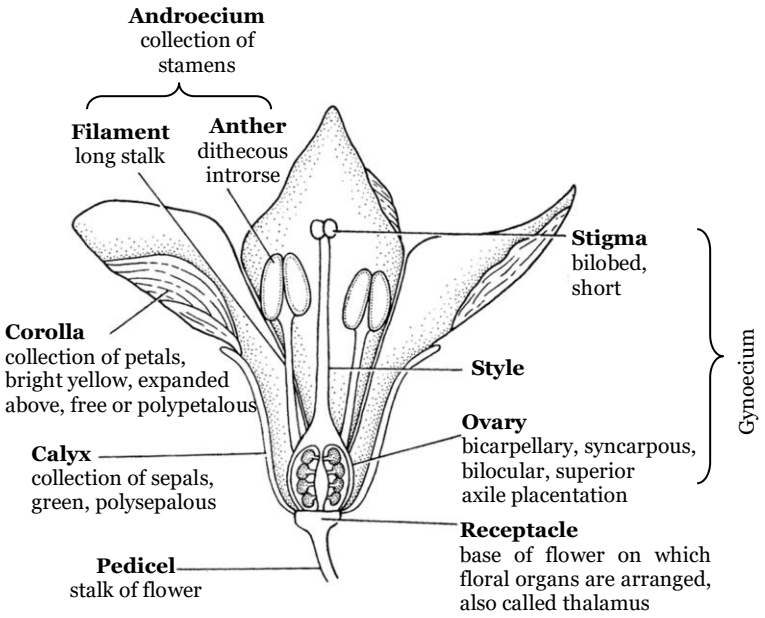


Fig : L.S. of a typical flower

(i) **Calyx :** It is the outermost whorl of the flower. It is composed of leaf like green sepals. The sepals are essentially green in colour but in some cases they are coloured like petals. Such a condition of calyx is called ***petaloid***. Sepals enclose the bud and protect the delicate part within. They prevent rapid transpiration from the inner parts of the flower.

(ii) **Corolla :** This is the second whorl of the flower and consists of a number of petals. Petals are generally brightly coloured and sometimes fragrant which make the flower to become attractive. Petals usually attract the insect pollinators and helps in pollination. The petals and sepals together form the floral envelope (*perianth*)**.**

(iii) **Androecium :** It is the third whorl of flower and is the male reproductive organ consisting of ***stamens***. Each stamen is made of filament and anther. The filament supports anther at its tip. Usually anthers are bilobed and contain four microsporangia (or pollen sacs), but sometimes they have only one lobe and two microsporangia. The portion of stamen which connects the anther and the filament is known as connective.

(iv) **Gynoecium :** This is the last and the fourth whorl of flower and is the female reproductive organ of the flower. It occupies the central position on the receptacle and composed of ovary, style and stigma and the component parts are called ***carpels***. Ovary encloses the ovules. Stigma is the receptive spots which lodges the pollen grains. Style is the connection between stigma and ovary.

(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.

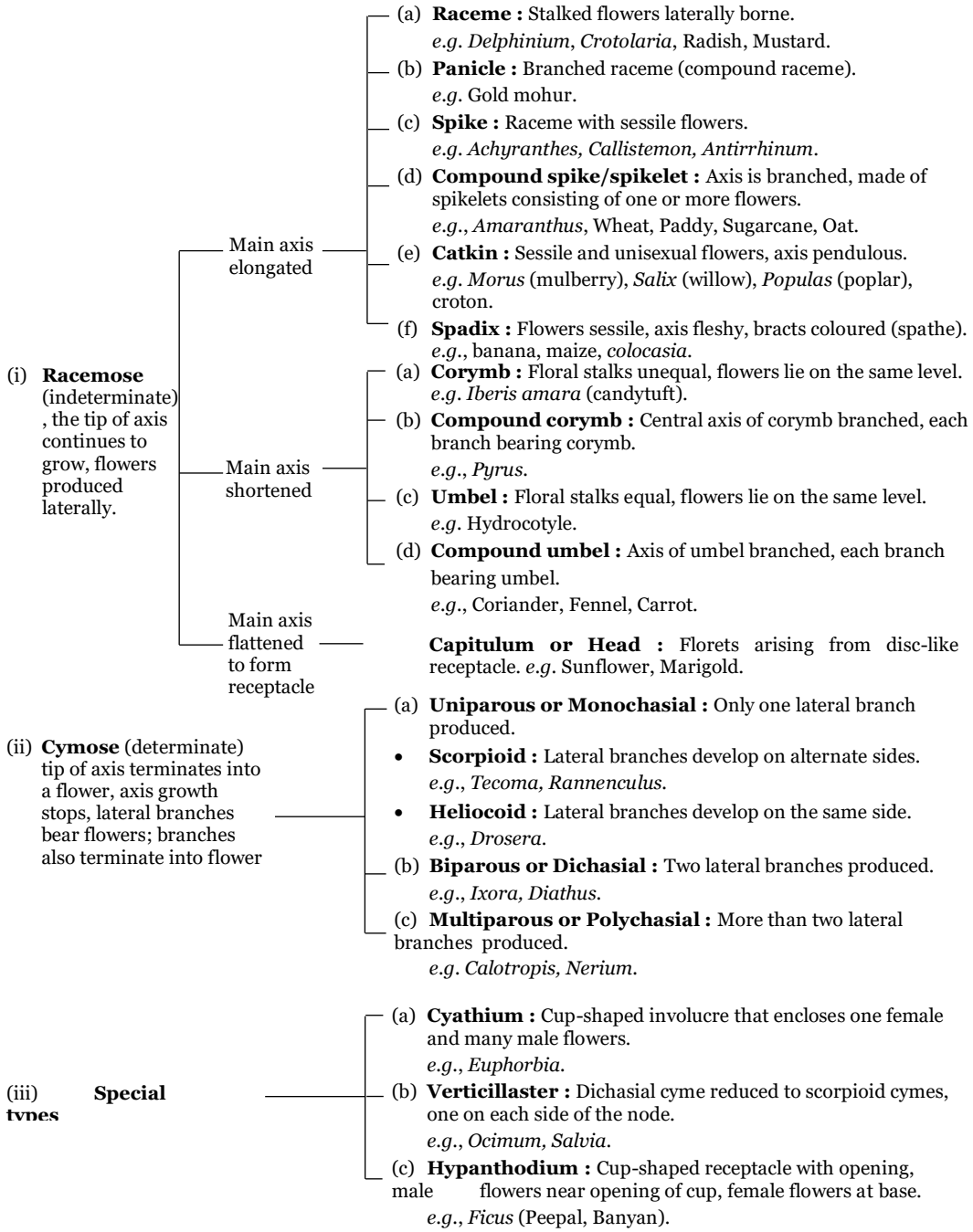
(iii) Flowers provide seat for germination of pollen, development of pollen tube, formation of gametes and fertilization.

(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.

(4) **Inflorescence :** The flowers are arranged in some definite manner on the plant in each species of the flowering plants. The mode of arrangement of flowers on a specialised branch on top of the plant which bears flowers is called inflorescence. The axis of the inflorescence is called ***peduncle***.

Depending upon the arrangement of flowers, inflorescence is classified as follows :



(5) **Relative position of floral organs on thalamus :** Depending upon the form of thalamus and the position of floral whorls with respect to the ovary, the flowers are of the following three types :

(i) **Hypogyny :** In this case the thalamus is convex-like and ovary occupies the highest position on it. The outer three whorls, *viz.* sepals, petals and stamens and inserted one above the other but below the ovary. Since the ovary lies above the other parts, it is described as superior and the rest of the floral whorls as inferior. A flower having hypogyny is called hypogynous. *e.g.* China rose, Brinjal, Mustard, etc.

(ii) **Perigyny :** In some cases, the receptacle or the thalamus forms a swallow or deep cup-shaped structure around the ovary. The pistil is attached at the centre of the concave thalamus. The sepals, petals and stamens are attached at the margins of the thalamus, the flowers are said to be perigynous and ovary is superior. Different type of flowers show different degrees of perigyny. *e.g.* Rose, Pea, Bean, Prunus, etc.

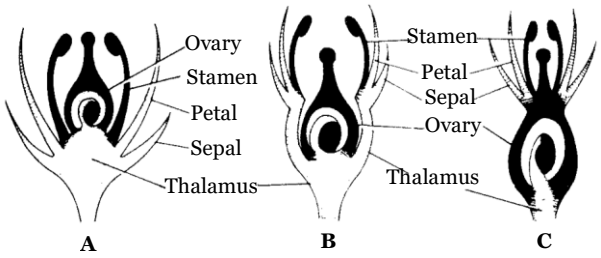


Fig : Insertion of Floral parts on thalamus

(iii) **Epigyny :** In this condition the margin of thalamus grows further upward completely enclosing the ovary and getting fused with it and bear the sepals, petals and stamens above the ovary. The ovary in such cases is said to be inferior and the rest of the floral members superior. *e.g.* Apple, Sunflower, Cucumber, Guava, etc.

(6) **Placentation :** The ovary contains one or more ovules, which later become seeds. The ovule bearing regions of the carpel is called ***placenta***. The arrangement of placentae and ovules within the ovary is called placentation. The placenta is the cushion-like structure to which the ovules are attached inside the cavity of the placenta, placentation is of the following types :

(i) **Marginal :** In this type of placentation, the ovary is simple, unilocular and the ovules are arranged along the margin of the unilocular ovary. The placenta develops along the ventral suture of the ovary. *e.g.* Pea, Gram, Goldmohur, etc.

(ii) **Axile :** It is found in a compound ovary which is two or more chambered, usually as many as the number of carpels *e.g. Petunia* and *Asphodelus*. The placentae bearing the ovules develop from the central column or axis which is formed by the fusion of margins of carpels. In certain cases the number of chambers (loculi) increases due to the false septum formation. *e.g.* Datura, Tomato, etc.

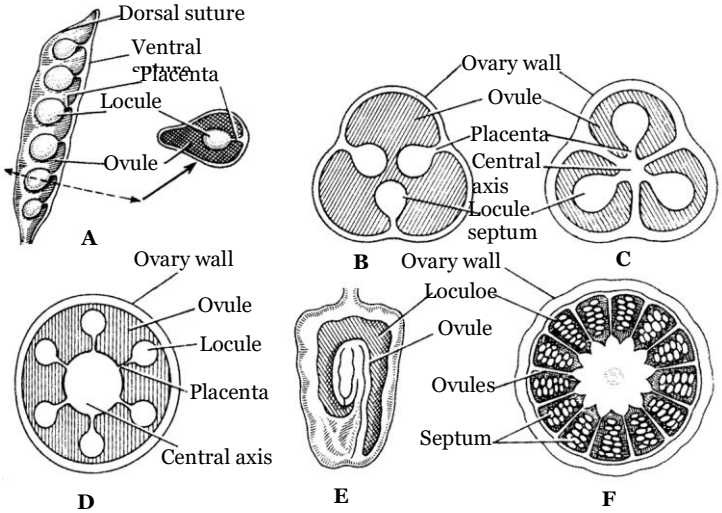


Fig : Different types of placentations A. Marginal; B. Parietal; C. Axile; D. Central; E. Basal; F.

(iii) **Free central :** In this free central placentation, the gynoecium is polycarpellary and syncarpous. The ovary in early stages is multilocular, but soon the septa break down leaving it as a unilocular structure. *e.g. Dianthus, Slience, Primula*, etc.

(iv) **Parietal :** In parietal placentation, the ovary is usually one-chambered but in some cases it becomes bilocular due to the formation of false septum, *e.g. Brassica compestris* (Sarson). The placentae bearing the ovules develop on the inner wall of the ovary at places where the margins of two adjoining carpels meet. The number of placentae corresponds to the number of fused carpels. *e.g.* Poppy, Mustard, Cactus, etc.

(v) **Basal :** In this type of placentation, ovary is bicarpellary, syncarpous and unilocular and a single ovule is borne at the base of ovary. *e.g.* Marigold, Sunflower, etc.

(vi) **Superficial :** The ovary is multicarpellary, syncarpous, and large number of loculi without specific order *e.g.* Waterlily (*Nymphea*).

(7) **Symmetry of the flower :** The number, shape, size and arrangement of floral parts (*i.e.* calyx, corolla, androecium and gynoecium) in a flower determines its symmetry. On the basis of symmetry, flowers can be of following three types :

(i) **Actinomorphic or Regular flowers :** Such flowers can be divided by vertical plane into two equal and similar halves. *e.g.* Mustard, *Hibiscus*, Brinjal, etc.

(ii) **Zygomorphic or Irregular flowers :** These flowers can be divided into two equal halves only along one median longitudinal plane. *e.g.* Pea, *Iberis, Ocimum*, etc.

(iii) **Asymmetrical flowers :** These flowers cannot be divided into two equal halves along any vertical plane. *e.g. Canna*, *Maranta*.

5.3 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***.

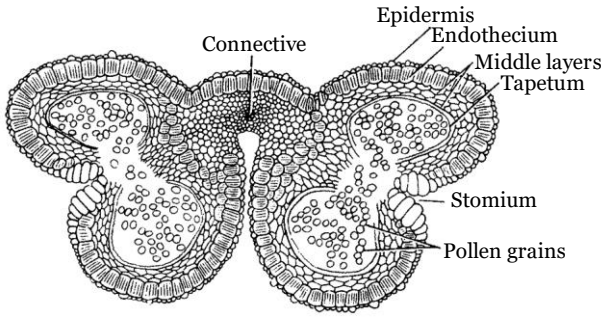


Fig : T.S. of mature dithecous

A typical anther consist of four microsporangia (tetrasporangiate) and such anthers is called ***dithecous*** *e.g.* mostly plants. In members of Malvaceae anthers are reniform or kidney shaped and consist of two microspoangia (bisporangiate), such anthers is called ***monothecous***. In the smallest parasitic angiosperm, *Arceuthobium minutissimum*, anthers consist of only one microsporangium (monosporangiate).

The pollen sacs are surrounded by following 4 layers :

(i) **Epidermis :** This is the outermost single layered and protective. 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 thick 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.

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 :** In young condition cell wall of tapetal cells breaks, so protoplast of these cells become free between microspore mother cell and form mass of tapetal periplasmodium. *e.g. Alisma, Typha, Tradescantia*.

(b) **Secretory or Glandular tapetum :** This is the most common type of tapetum which remains *insitu* as such throughout. The tapetal cells secretes nourishment that passes into sporogenous cells. This tapetum attains its maximum development at the stage of pollen tetrads and then degenerates.

(2) **Development of anther and formation of microspores (Pollen grains) :** The young anther consists of homogenous mass of paranchymatous 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 of pollen grains in a tetrad is affected by cytokinesis during meiosis. It is of two types :

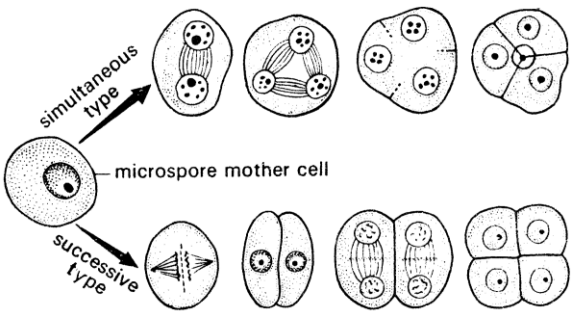


Fig : Microsporogenesis and two types of cytokinesis

(i) **Simultaneous type :** The cytokinesis occurs simultaneously at the end of meiosis II to form tetrahedral tetrad. Here wall formation is centripetal. It is common in dicotyledons.

(ii) **Successive type :** The cytokinesis occurs twice *i.e.* each of the two nuclear division is followed by wall formation to form an isobilateral tetrad. Here the wall formation is centrifugal. It is found in monocotyledons.

Besides tetrahedral and isobilateral tetrads, other types of tetrads are linear (*e.g. Halophila*), T-shaped (*e.g. Aristolochia, Butomopsis*) and decussate (*e.g. Magnolia*).

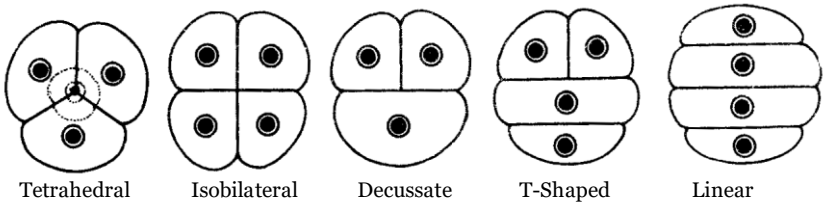


Fig : Different types of microspore tetrads

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. 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 starts 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 farmer 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.

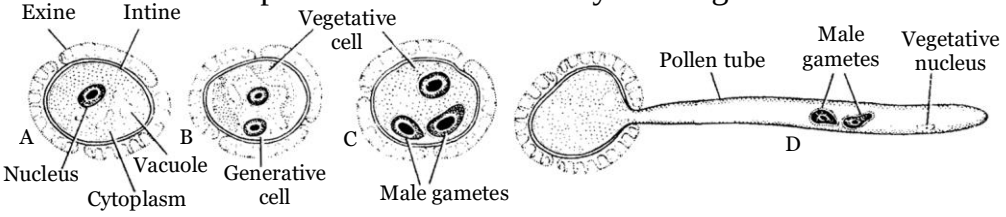


Fig : Different stages of microgametogenesis

5.4 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 :** 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***.

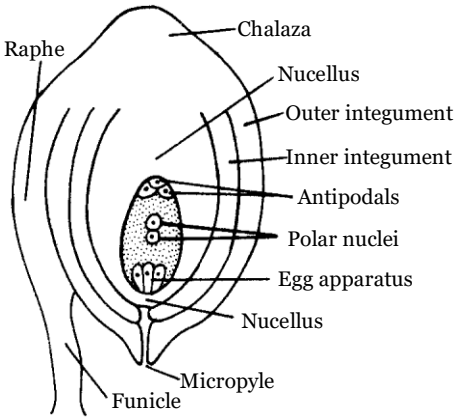


Fig. : Structure of

The residual part of nucellus in the mature seed is called ***perisperm***. 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.*, sympetalous 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 :

(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^{o} 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 *Leguminaceae* and *Cruciferae*.

(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).

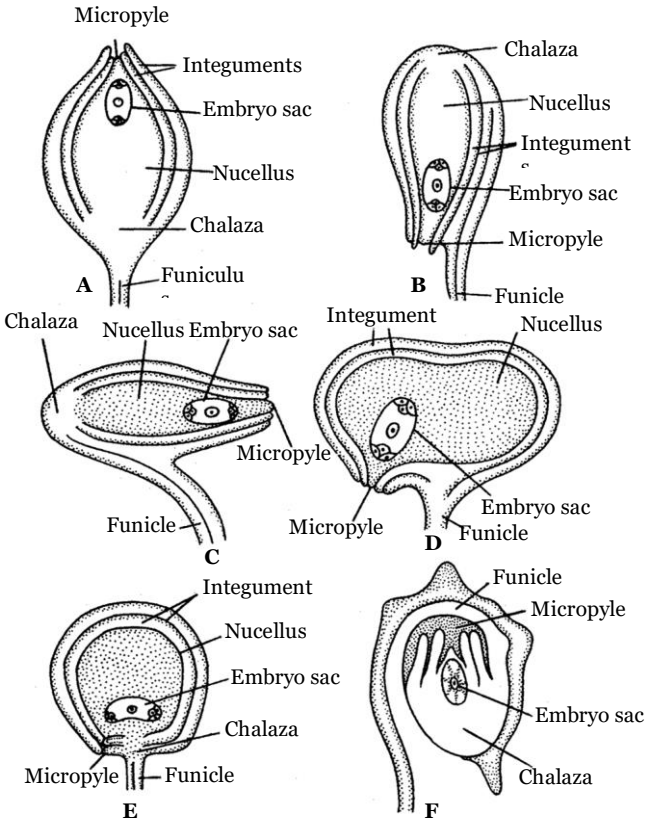


Fig : Different forms of the ovule in longitudinal section.
A, orthotropous; B, anatropous; C, hemianatropous; D, campylotropous; E, amphitropous; F

(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 nucleus :

(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. These cells generally degenerate soon after fertilization.

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

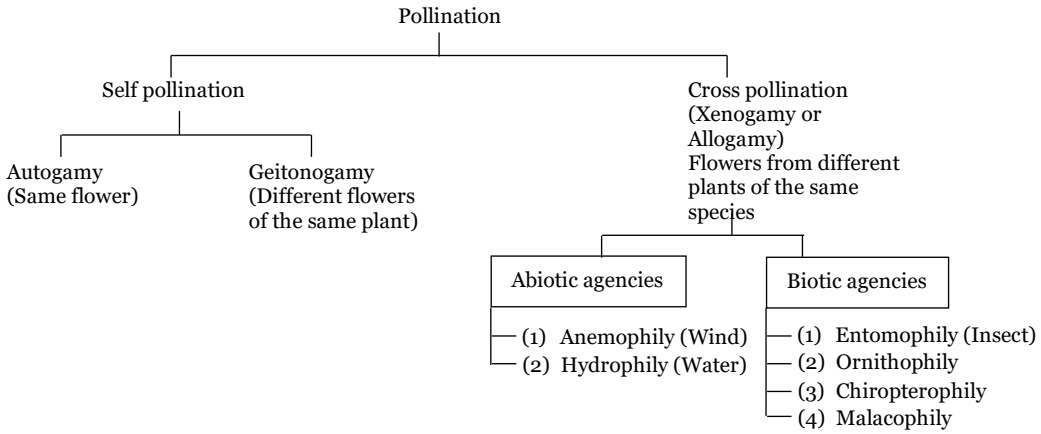
(ii) **Bisporic type :** In this type two megaspore nuclei take part in embryo sac formation.

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

5.5 POLLINATION

The process of transfer of pollen grains, from an anther to the stigma of the same flower or of different flower. It is of two types :

(1) Self pollination (2) Cross pollination



(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 an 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 hermophrodite.

(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 incompatibility 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.

(3) **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. Wind pollinated flowers produce very large amount of pollen grains to compensate the wastage. Pollen grains of such plants are small, light, dry, and smooth. The female flowers have large feathery or brush like stigmas to catch the pollen grains. 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, bettles, 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. The insects visit the flower for nectar, edible pollen grain and shelter. Bees obtain both nectar and pollen grains from the flowers and have basket for collecting pollen. *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 *Blastophega*), etc.

(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 nector 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.

5.6 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 in 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 :

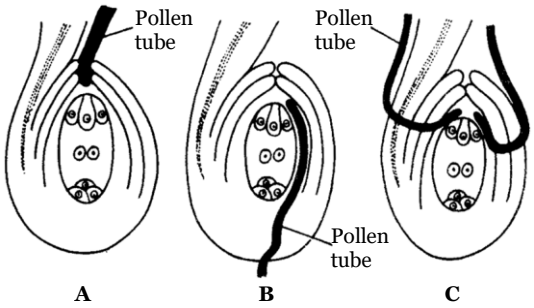


Fig : Entry of pollen tube in to the ovule
A. Porogamy; B. Chalazogamy; C

(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*).

(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* ***Frittillaria***. Double fertilization occurs in angiosperms only.

5.7 ENDOSPERM

Endosperm is the nutritive tissue for the developing embryo and also the seedling. In angiosperms, the endosperm develops from triploid (3*n*) 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.

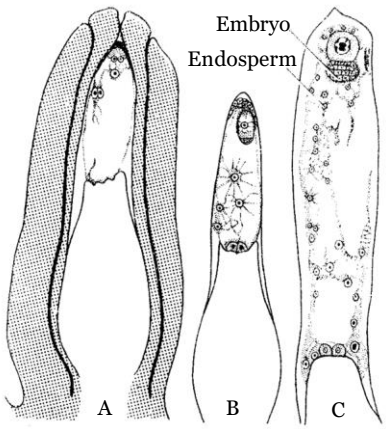


Fig : Different stages in the development of nuclear type of endosperm

(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.

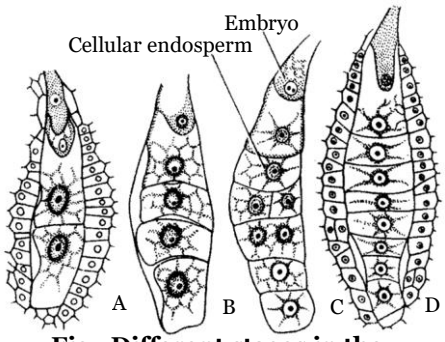


Fig : Different stages in the development of cellular type of

(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*.

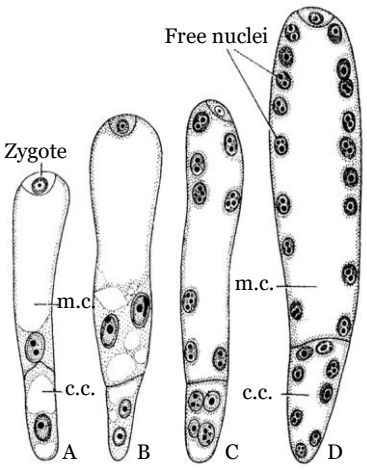


Fig : Different stages in the development of helobial type of endosperm (cc= chalazal chamber, mc= micropylar chamber)

(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 of somatic tissue lying outside the endosperm is known as metaxenia. Metaxenia term given by the swingle (1928). *e.g. Datepalm*.

5.8 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 ***Shephered 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.

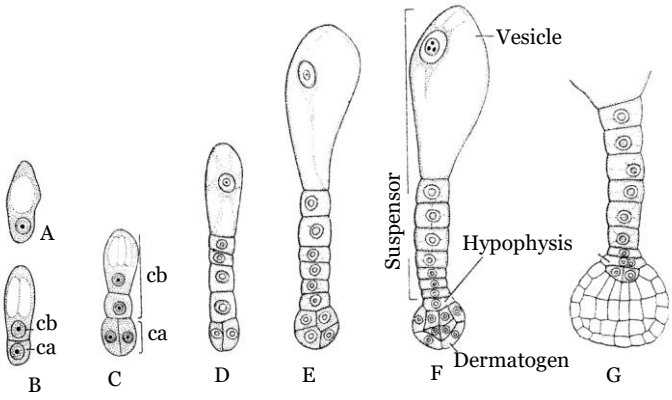


Fig : Successive stages of the development of dicotyledonous embryo up to globular stage

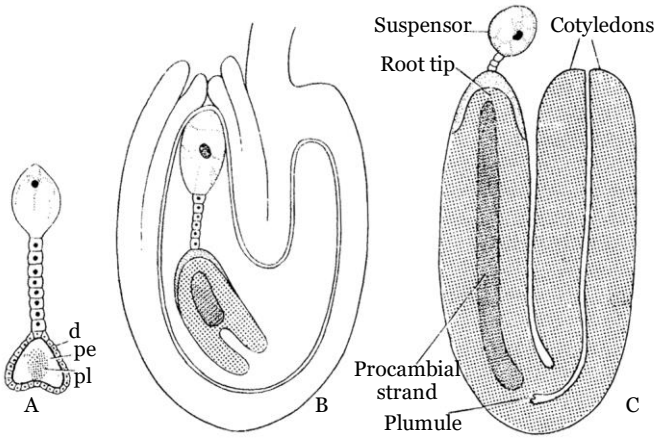


Fig : Development of globular embryo into mature

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.

(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***.

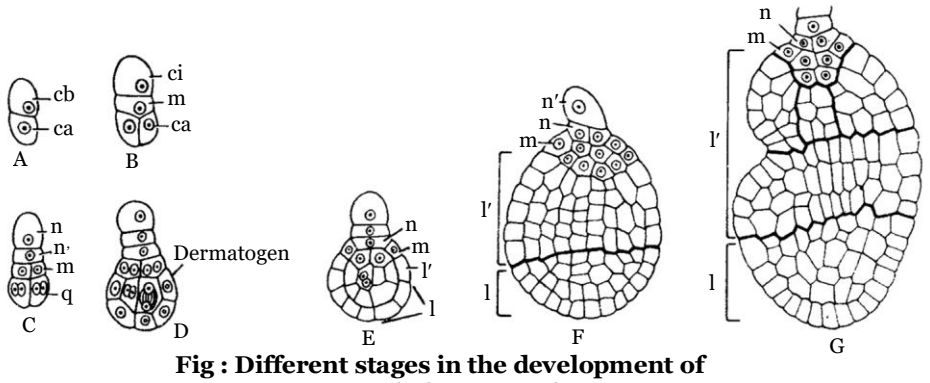


Fig : Different stages in the development of monocotyledonous embryo

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.

(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, Crotalaria,* 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.

5.9 Seed

(1) **Development of seed :** The fertilized ovule forms seed. The ovule increases greatly in size. The integuments dry up. The outer one becomes hard or leathery and forms the outer seed coat or testa while the inner one, if persist, forms the tegmen.

The nucellus is generally used up during the development of embryo but in some cases it remains outside the endosperm in the form of a thin layer, called ***perisperm***. The endosperm may persist or completely digested during embryogenesis.

A scar is usually visible on one side of the outer seed coat. It is known as *hilum* and marks the point of attachment to the stalk. With these changes, the ovule changes into seed and enters a period of dormancy while the ovary ripens into a fruit.

Dicotyledonous seeds

Exalbuminous : *Gram, Pea, Bean, Mustard, Mango, Groundnut*, etc.

Albuminous : *Castor, Poppy, Artabotrys, Custard apple* (*Ananas*) etc.

Monocotyledonous seeds

Exalbuminous : *Orchids, Alisma, Najas, Pothos, Amorphophallus, Vallisneria,* etc.

Albuminous : *Cereals, Millets, Palms, Lilies,* etc.

The seeds are of following types :

(i) **Non-endospermic or Exalbuminous seeds :** In exalbuminous seeds endosperm is completely consumed by the developing embryo, and the mature seeds are without endosperm.

The food is stored in cotyledons.

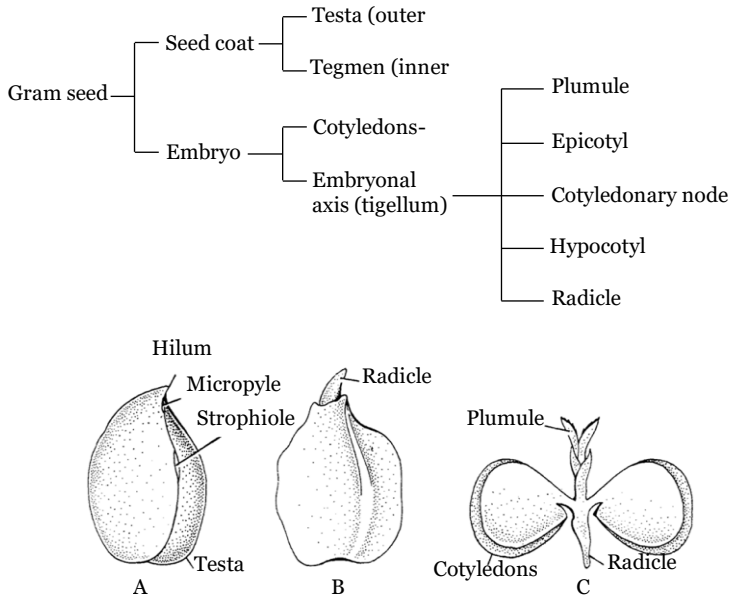
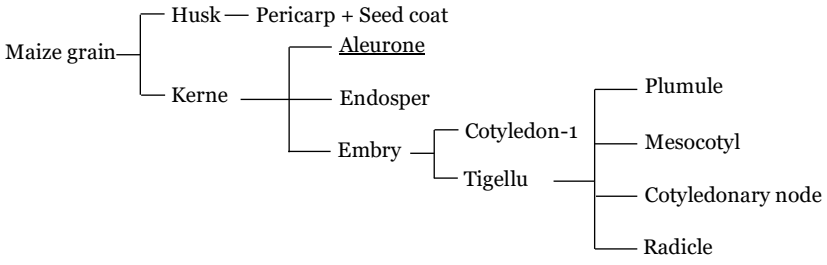


Fig : Structure of gram seed

(ii) **Endospermic or Albuminous seed :** In albuminous seeds, embryo not consumed all endosperm. So it persists in the mature seed. In these seeds food stored in endosperm. In monocot seed the membranous covering of:

- Radicle is called coleorrhiza.
- Plumule is called coleoptile.



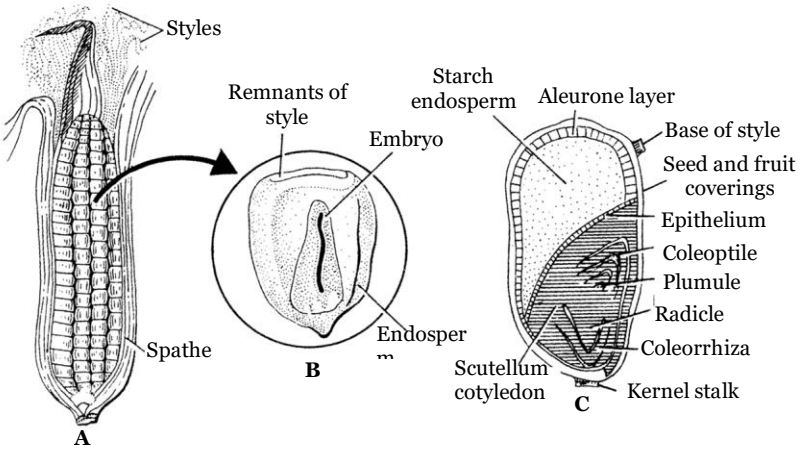


Fig : Structure of maize grain (A) Entire seed; (B) Grain in L. S.

(2) **Germination of seeds :** The process by which the dormant embryo of the seed resumes active growth and grows into a new plant is known as germination.

(3) **Types of seed germination**

(i) **Epigeal germination :** In this type of germination, the cotyledons come above the surface of the soil into the air and light due to the rapid growth and elongation of the hypocotyl. The cotyledons turn green and make food for a plant. The food in them is utilized by the growing stem. They finally dry up and fall off and seedling becomes an independent plant. Germination of seeds of Bean, Gourd, Castor, Cotton, etc. is of epigeal nature.

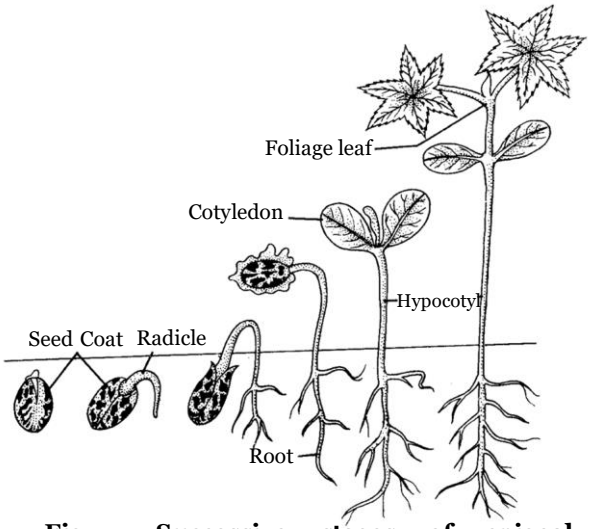


Fig : Successive stages of epigeal germination of dicotyledonous and albuminous seed of castor

(ii) **Hypogeal germination :** In this type of germination, the cotyledons remain in the soil or just above the surface. In this case epicotyl elongates pushing the plumule upwards. The cotyledons do not turn green and gradually dry up and fall off. Common examples of hypogeal germination are the seeds of *Pea, Mango, Groundnut,* etc.

(iii) **Viviparous germination :** This is a special type of germination found in mangrove plants. These plants are found in marshy lands and on sea coasts. In viviparous germination seeds inside the fruit germinate while still attached to the parent plant and nourished by it. The embryo grows not only out of the seed but also out of the fruit and projects from it in the form of a green seedling displaying root and hypocotyl. Due to its increasing weight the seedlings separate from the parent tree and falls into the mud or water and soon develops lateral roots. Vivipary is seen in *Rhizophora* and *Sonneratia.*

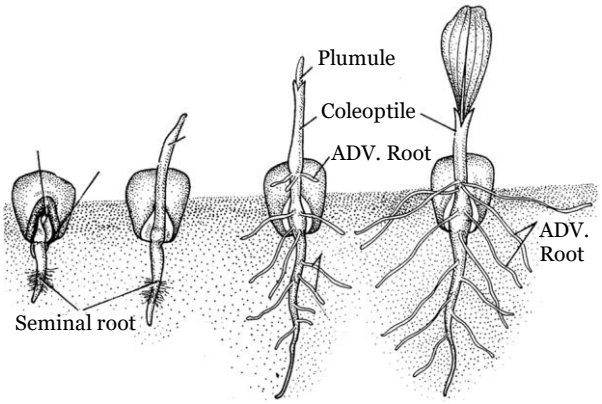


Fig : Stages of germination of maize (hypogeal germination)

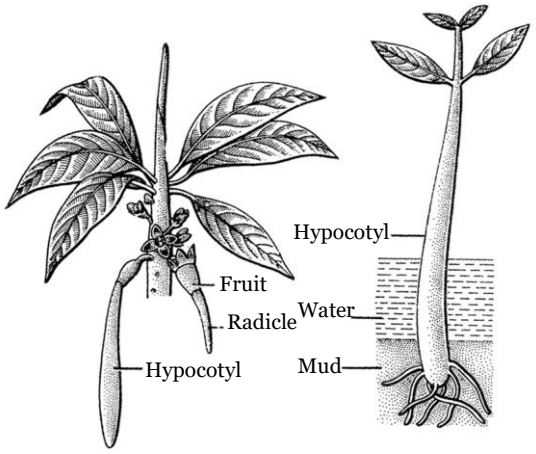


Fig : Vivipary (A) Twig of Rhizophora showing viviparous germination; (B) Seedling growing in mud

(4) **Factors for seed germination**

(i) **External factors :** *Water, oxygen, suitable temperature*.

(ii) **Internal factors :** *Foods* and *growth regulators*, completion of rest period, viability.

(5) **Seed dormancy :** In several plants seeds germinate as soon as they have undergone maturation and provided proper conditions for germination. *e.g. seeds* of *Bean, Pea, Maize* etc. In some plants seeds are incapable of germination because of some inhibitory factors. Such seeds are unable to germinate even under suitable conditions. This is called seed dormancy.

(i) **Causes of seed dormancy :** The seed dormancy may be due to many causes some of which are as follows :

(a) Impermeability of seed coats to oxygen. *e.g. Xanthium*.

(b) Impermeability of seed coats to water. *e.g., Chenopodium* and many *leguminous seeds*.

(c) Seed coat is mechanically hard, thus resisting the growth of embryo. *e.g. Mustard, Capsella, Amaranthus*.

(d) Presence of rudimantary or immature embryo. *e.g., Ginkgo biloba* (a gymnosperm).

(e) Some plants produce such chemical compounds that inhibit the germination of their own seeds. *e.g. Tomato,* (possesses inhibitor ferulic acid).

(ii) **Overcoming of seed dormancy :** Seed dormancy is overcomed naturally by several means. It can also be broken down artificially.

(a) **Mechanical scarification :** Seed coat is weakened by use of abrasives like and by making scratches.

(b) **Chemical scarification :** Seed coat weakening is done by acid treatments.

- Alternating high and low temperature treatment.
- Low temperature treatment.
- Exposure to light.
- Providing high pressure.

- Alcohol washing of seeds so as to remove inhibitors in seed coat etc.
- Soaking of seeds in some chemicals like ***thiourea*** and ***KNO_3*** etc.

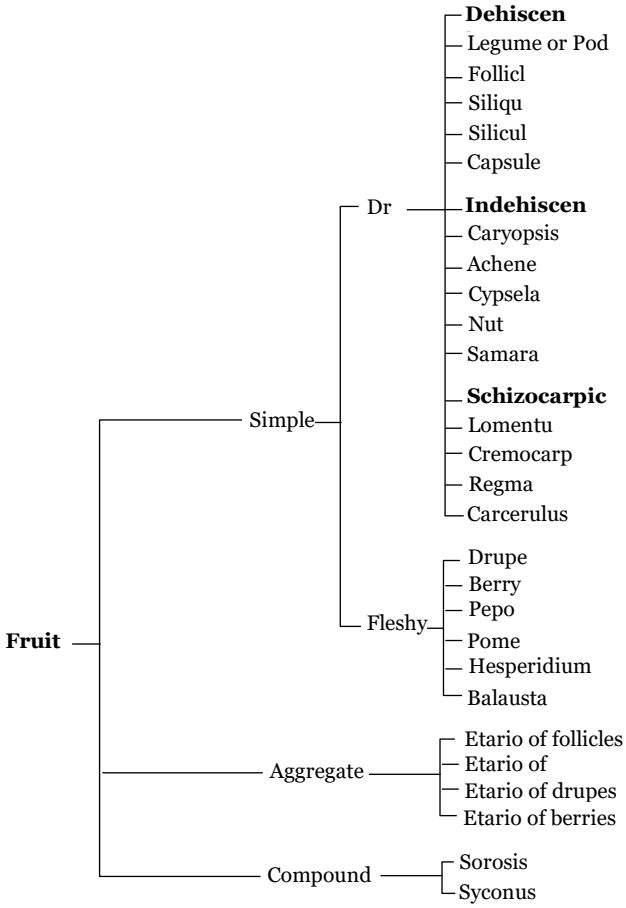
5.10 Fruit

(1) **Formation of fruit :** Fruit is defined as fertilized ovary. The ovary develops into fruit. The ovary wall at maturity forms the wall of the fruit, which is known as ***pericarp***. Sometimes, other parts of flower such as tepals, (*e.g.*, *Morus*), bracts (*e.g.*, *Ananas*) or thalamus (*e.g.*, *Pyrus*) are also involved in the formation of fruit and such fruits are called ***false fruits*** or ***pseudocarps***.

The fate of various parts of the ovary during the formation of fruits is summarized below :

Ovary	–	**Fruits**
Ovary wall	–	Pericarp
Ovule	–	Seed
Funiculus	–	Stalk of the seed
Hilum	–	Hilum
Nucellus	–	Perisperm (when present)
Micropyle	–	Micropyle
Outer integument	–	Testa } Seed coat
Inner integument	–	Tegmen } Seed coat
Embryo sac		
Synergids	–	} Degenerate
Antipodals	–	} Degenerate
Egg cell	–	Embryo
Secondary nucleus	–	Endosperm

(2) **Types of fruits**



They are classified into three groups : Simple, aggregate and multiple or compound fruit.

Simple fruits : They are formed from mono-or polycarpellary but syncarpous ovary. They may be dry or fleshy.

(i) **Simple dry fruits** have thin, hard and dry, pericarp. They are of three kinds :

(a) Ehiscent or Capsular (b) Achenial or Indehiscent (c) Schizocarpic

(a) **Dehiscent fruit :** These fruits are dry, many seeded and split open at maturity. They are of following types :

- **Legume or Pod :** It is characteristic of the family leguminosae; developed from monocarpellary unilocular superior ovary with marginal placentation. It can open or dehisces by both ventral and dorsal sutures. *e.g.,* in *Cicer arietinum* (Gram); *Pisum sativum* (Pea) and *Phaseolus mungo* (Black gram).
- **Follicle :** It is very much resembles the legume but on ripening it opens generally along the ventral suture. *e.g. Calotropis, Larkspur,* etc.
- **Siliqua :** The fruit is developed from bicarpellary, syncarpous and superior ovary which bears ovules on two parietal placenta. The ovary is unilocular but later becomes bilocular due to the development of a false partition wall called ***replum***. It dehisces from the base towards the apex by both the sutures *e.g.* in *Brassica* (Mustard) and is characteristic of the family Cruciferae.

- **Silicula :** It is flattened and short in length from siliqua type, found in *Iberis* (Candytuft) and *Capsella bursa* (Shepherd's purse).
- **Capsule :** It is mono or polycarpellary, dry dehiscent, many seeded fruit which developes from a superior or inferior ovary. It dehisces in almost all the ways *i.e.*, longitudinal and transverse, along both the sutures. Majority of capsules show longitudinal-dehiscence which again are of different types :

Loculicidal : Lines of dehiscence appear along the dorsal sutures, *e.g. Gossypium herbacium* (Cotton) and *Abelmoschus esculentus* (Lady's finger).

Septicidal : Lines of dehiscence appear along the ventral sutures or septations of the ovaries *e.g.* in *Viola* (Pansy), *Linseed* (Linum).

Septifragel : Lines of dehiscence along irregular lines, but the seeds remain attached to the placenta, as in *Datura stramonium* (Thorn apple).

(b) **Achenial or Indehiscent fruits :** These fruits do not burst at maturity but the seeds are liberated only by the decaying of the pericarp. These are of following types :

- **Achene :** It is small, dry one seeded fruit which develops from a superior or inferior monocarpellary ovary. In this type, the pericarp is tough but thin and free from the seed coat, *e.g.* in *Mirabilis* (four o'clock plant) and *Clematis*. Some times achenes occur in a group from apocarpus ovary where carpels are many *e.g.* in *Nelumbium* (Lotus).
- **Caryopsis :** It is very small, dry and one seeded fruit which develops from a superior monocarpellary ovary. Here the pericarp is closely fused with seed coat. It is the characteristic of family graminae, *e.g.*, in *Oryza sativa* (Paddy), *Triticum aestivum* (Wheat) and *Zea mays* (Maize).
- **Cypsela :** It is dry, one seeded fruit which develops from an inferior , bicarpellary ovary. Here the pericarp is free from seed coat but the thalamus is fused with pericarp. The fruit is provided with a crown of hairs at the top called ***pappus*** *e.g.* in *Helianthus annuus* (Sun flower), *Tridax*, *Cosmos*, *Sonchus*, etc.
- **Nut or Glans :** It is dry, one seeded fruit which develops from a superior, bi or polycarpellary ovary having a hard pericarp, free from seed coat *e.g.* in *Areca catechu* (Betalnut), *Anacardium occidentale* (Cashewnut) and *Trapa natans* (Water chestnut). Here the thalamus and sometimes the cotyledons of true fruit are also edible.
- **Samara :** It is dry, one or two seeded fruit, develops from a single mono-or bicarpellary ovary. The pericarp is free from test a and produces a wing like outgrowth which helps in the dispersal of seeds *e.g.* in *Hiptage* and *Elm.*

(c) **Schizocarpic or Splitting fruits :** These resemble both (achenial) indehiscent fruits as well as capsular fruits having many seeds. However, they break into one seeded segments known as ***mericarps***. By splitting usually the mericarps are indehiscent but in *Ricinus* (Castor) they are dehiscent. The important schizocarpic fruits are :

- **Lomentum :** It is a dry, many seeded fruits which develops from a monocarpellary, superior, unilocular ovary with marginal placentation. The fruit arises just like a legume but when ripened it becomes partitioned between seeds into single seeded mericarps *e.g.* in *Acacia arabica* (gum tree), *Mimosa* (touch me not) and *Dalbergia sisoo* (India red wood tree).
- **Cremocarp :** It is a dry fruit, develops from bicarpellary, syncarpous, bilocular ovary. The fruit when mature breaks into single seeded mericarps which remain attached to the top of the central axis called *carpophore, e.g.* in *Daucus carota* (Carrot); *Foeniculum vulgare* (fennel).
- **Regma :** It develops from tri-or penta-carpellary superior syncarpous ovary. The locules are many as the carpels known as ***Cocci*** (sing. Coccus), attached to carpophore and separate by splitting *e.g. Euphorbia, Geranium* and *Ricinus*.
- **Carcerulus :** It is a dry fruit, develops from bi or polycarpellary syncarpous, multilocular superior ovary with axile placentation. Many single seeded, mericarps are formed by splitting and formation of false septa. *e.g. Ocimum sanctum* (Sacred basil), *Althaea rosea*.

(ii) **Simple fleshy fruit :** The fruits are simple, but the pericarp is fleshy and edible. It is differentited into three layers epicarp, mesocarp and endocarp. Fleshy fruits are of following types :

(a) **Drupe :** It is a fleshy fruit formed from mono-or poly carpellary superior ovary, where one or more ovules may developes into seeds. Here the epicarp is thin and leathery. The mesocarp is thick, fleshy, juicy and edible in *Mangifera* (Mango) and fibrous in *Cocos* (Coconut). The endocarp is hard and stony in both the cases. In Cocos, pericarp is not edible. The portion inner to endocarp is the liquid endosperm which is edible.

(b) **Berry :** It is usually many seeded fleshy fruit develops from polycarpellary, syncarpous, superior ovary. Rarely it is single seeded as in *Borassus* (Palm). Here the epicarp remains as the skin of the fruit. The mesocarp and endocarp are fused together to form the pulp of the fruit. *e.g.* Brinjal, Tomato, Banana, etc.

(c) **Pepo :** It is a special type of berry. Here the epicarp and thalamus form the outer ring of the fruit. The mesocarp, endocarp and placentae are fused to form pulp which is edible; seeds are many. Common examples are *Cucurbita maxima* (Sweet gourd); *Cucumis sativa* (Cucurbit).

(d) **Pome :** The fruit develops from inferior, pentacarpel ovary. The fruit is covered by the fleshy thalamus, which is fused with the pericarp and edible. The outer part again encloses the inner stiff and membranous portion enclosing the seeds; common example is *Pyrus indica* (Apple).

(e) **Hesperidium :** It is another type of berry; it develops from a polycarpellary, syncarpous, superior ovary with many seeds. Here the outer skin is thick and leathery that represents the epicarp, which contains oil glands. The fibrous portion fused with epicarp is the mesocarp. The endocarp consists of many chambers with juicy glands. Common examples are *Citrus medica* (Lemon) and *Citrus sinensis* (Sweet orange).

(f) **Balausta :** This is many chambered, many seeded fruit developing from a multicarpellary, syncarpous but inferior ovary. The pericarp of balausta is leathery or tough. The carpels are arranged in

two rows. Carlyx is persistent. The seeds have succulent seed coat (testa) which form the edible part; *e.g. Punica granatum* (Pomegranate).

Aggregate fruits : The aggregate fruits are formed from polycarpellary, apocarpous ovary. Each ripened is called ***fruitlet*** *or* ***etaerio*** *e.g.* the *lotus, rose* fruit and strawberry are a collection of achenes; *raspberry,* a collection of drupes and custard apple is a collection of berries.

(3) **Composite or compound fruits :** Multiple fruit develops from entire inflorescence called sorosis or syconus.

(i) **Sorosis :** Develops from spike or spadix inflorescence *e.g.* Pineapple, Jackfruit, Mulberry, etc.

(ii) **Syconus :** Develops from hypanthodium inflorescence *e.g. Ficus carica.* (banyan).

5.11 Dispersal of fruits and seeds

(1) **Dispersal by wind (Anemochory) :** The wind is probably the most important agency of seed dispersal in nature. The fruits and seeds show following devices which help in dispersal by wind.

(i) **Light weight and minute seeds :** Seeds of some plants (*e.g.* Orchids) are sufficiently light and minute in size to be easily carried away to great distances by air currents.

(ii) **Winged seeds and fruits :** Some seeds (*e.g.* Oroxylon, Cinchona, Moringa) or fruits (Acer, Hiptage, Terminalia, Dipterocarpus) develop one or more thin membranous wings to ensure their dispersal by wind.

(iii) **Parachute mechanism :** In members of the family Asteraceae (Compositae) *e.g., Taraxacum, Sonchus,* sepals are modified into tufts of hairs called ***pappus***. The pappus is persistent and hence found attached to even small, single seeded fruits. It acts like a parachute that allows the wind to carry them to great distances. Seeds of many nasty weeds are also dispersed by this method.

(iv) **Censer mechanism :** In *Antirrhinum* (dog flower), *Aristolochia, Papaver* (poppy), *Argemone mexicana* (Prickly poppy), *Nigella* (love-in-a-mist), etc. the fruit is a capsule. At maturity it ruptures but the seeds do not come out. However, when the capsule is shaken violently by the wind, the seeds are scattered in all directions. In this process all the seeds do not escape together.

(v) **Rolling mechanism :** In some species, like *Amaranthus albus, Chenopodium album*, etc., plants dry out after bearing fruits and seeds**.** Eventually the entire plant breaks off at the base of the stem due to the force of wind and rolls over the ground, shedding the seeds all along the way. Such rolling plants are collectively known as ***tumble weeds***.

(vi) **Hairs :** In cotton, hairs are the outgrowth from the seed coat and occur all along its surface.

(vii) **Persistant styles :** *Clematis, Naravilia, Geranium* etc. have persistent and feathery styles which help the fruit to be easily carried by wind.

(viii) **Balloon like appendages :** In plants like *Cordiospermum* and *Nicandra* fruits develop balloon like appendages which make the fruits light to be easily carried by wind.

(2) **Dispersal by water (Hydrochory) :** Fruits and seeds, specialized for dispersal by water, generally develop some kind of floating devices and a protective covering which makes them water resistant. *e.g.* fibrous mesocarp in *Coconut*, spongy thalamus in *Lotus*.

(3) **Dispersal by animals (Zoochory) :** Fruit and seeds dispersed by animals can be divided into following three categories on the basis of their adaptive features :

(i) **Hooked fruits and seeds :** The surface of many fruits is covered with hooks (*e.g.*, *Xanthium*, *Urena*), barbs (*e.g.*, *Andropogon*), spines (*e.g.*, *Tribulus*), bristles (*e.g.*, *Pupalia*), or stiff hairs (*e.g.*, *Aristida*), by means of which they adhere to the body of animals or clothes of human beings and they are carried unwarily from one place to another.

(ii) **Sticky fruits and seeds :** Some fruits like those of *Boerhaavia*, *Cleome*, and *Plumbago* have sticky glands by which they adhere to the fur of grazing animals and are thus dispersed. Seeds of *Viscum* (mistletoe), *Loranthus*, etc. have a viscid layer which adhere to the beak of the bird which eat them.

(iii) **Edible fruits :** Human beings, birds, squirrels, bats, etc. are of great help in the dispersal of edible fruits from one place to another.

(4) **Dispersal by explosive or Spring like mechanism (Autochory) :** A less common method of seed dispersal is by means of explosive fruits. Such fruits open with force and scatter the seeds in all directions. *e.g.* Balsam fruit (*Impatiers*), *Oxalis*, night jasmine (*Nyctanthus*), castor (*Ricinus*), camel's foot climber (*Bauhinia vahlii*).

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

(i) **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 and Noval oranges.

(ii) **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.

Important tips

- **P. Maheshwari** is the greatest embryologist of India.
- **Rudolf Camerarius** (1694) first describe sexual reproduction in plants.
- The study of pollen grain is called **palynology**.
- Origin of pollen sac is eusporangiate while that of megaspore mother cell (embryo sac or megagametophyte) is leptosporangiate.
- The male gamete are non-motile and amoeboid.
- Pollen grain of **Zoostera** is filamentous and without exine.
- The exine is made up of sporopollenin which is derived from carotenoids.
- **Adansonia** Flowers bears 1500-2000 stamens.

- In Aristolochia elagans all types of pollen tetrads (tetrahedral, isobilateral, T-shaped, ⊥ shaped and decussate) are found.
- The pollen tube was first observed by **G.B. Amici** (1824) in Portulaca.
- Edible pollens are produced in rose.
- Best temperature for growth of pollen tube is 20-30^{o} 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, 2.5-3.5 μm.(ii) **Biggest** Mirabilis, diamter 250 μm (iii) **Longest** Zoostera - 2500 μm.
- **Anthesis** is development or opening of flower bud.
- A fully developed normal type embryo sac is 8-nucleate and 7-celled structure.
- **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.
- Most common type of ovule is **anatropous** (82% of total).
- Embryo sac (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.
- Double fertilization first studied by **Nawaschin** (1898) in Fritillaria and Lilium. It was confirmed by Guignard (1899).
- Erythrina is pollinated by crows as well as squirrels.
- The study of seed is called **spermology**.
- 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 fruit and seed** is found in Lodoicea maldivica (double Coconut). The fresh weight of seed is about 6 Kg.
- **Smallest seed** Orchid (light and dry).
- Analytical study of flower and its floral parts is called as **Anthology**.
- Angiosperms differ from gymnosperms in having fruit.
- **Largest flower** in the world is Rafflesia arnoldi and **smallest flower** is Wolffia microscopia.
- The term parthenocarpy was introduced by **Noll** (1902).
- A flower is said to be **complete** when all the four whorls are present and **incomplete** when any one of them is absent.

ASSIGNMENT

A SEXUAL REPRODUCTION

Basic Level

1. A clone is a group of individuals obtained through
(a) Self pollination (b) Hybridization
(c) Vegetative propagation (d) Cross pollination

2. Vegetative reproduction by layering is found in
(a) Jasmine (b) Mango (c) Rose (d) All of these

3. To get haploid callus, one can culture
(a) Embryo (b) Leaf tissue (c) Stigma (d) Pollen grain

4. The formation of embryo without fusion of gametes is termed, as
(a) Apospory (b) Isogamy (c) Apogamy (d) Syngamy

5. In anther culture, the androgenic haploid plants are obtained from
(a) Young pollen grain (b) Connective tissue (c) Anther tapetum (d) Anther wall

6. Plants identical to mother plants can be had obtained from
(a) Seeds (b) Stem cutting (c) Both (a) and (b) (d) None of these

7. Reproducing new plants by cells instead of seeds is known as
(a) Biofertilizer (b) Mutation (c) Tissue culture (d) Antibiotics

8. The reason of formation of embryoid from pollen grain in a tissue culture medium is
(a) Organogenesis (b) Double fertilization (c) Test tube culture (d) Cellular totipotency

9. A plant raised from a single germinating pollen grain under cultural conditions is called a
(a) Haploid plant (b) Diploid plant (c) Tetraploid plant (d) Polyploid plant

10. Among the following which one is not a method of vegetative propagation
(a) Budding (b) Layering (c) Sowing (d) Tissue culture

11. The development of gametophyte from the vegetative parts of the sporophyte without the intervention of spores is called
(a) Parthenocarpy (b) Parthenogenesis (c) Apogamy (d) Apospory

12. Which of the following is used for tissue culture which is free from virus
(a) Complete plant (b) Root of plant (c) Shoot of plant (d) Shoot apex

13. The plant material which is widely used in the preparation of culture medium is
(a) *Cycas revoluta* (b) *Cocos nucifera* (c) *Pinus longifolia* (d) *Borassus flabellifer*

14. Nucellar embryo is
(a) Apomictic embryo (b) Amphimictic haploid
(c) Apomictic diploid (d) Amphimictic diploid

15. The parthenogenesis refers to a fruit
(a) With seeds after pollination (b) Without seed after pollination
(c) With viable seed after fertilization (d) With viable seed without fertilization

16. Individuals of a clone have
(a) Same age (b) Same height
(c) Same genome (d) Same number of leaves

17. The technique of obtaining large number of plantlets by tissue culture method is called
(a) Micropropagation (b) Macropropagation (c) Plantlet culture (d) Organ culture

18. The development of a sporophyte without fertilization from the vegetative cells of the gametophyte is called
(a) Zygospory (b) Aplanospory (c) Apospory (d) Apogamy

19. One of the following is not a method of asexual reproduction
(a) Cutting (b) Grafting (c) Budding (d) Conjugation

20. In grafting; scion is always younger than stock. This scion is used for getting
(a) Hybrid (b) Root system (c) New shoot (d) New plant

21. Which of the following propagates through leaf-tip
(a) *Marchantia* (b) Moss (c) Walking fern (d) Sprout-leaf plant

22. A population of organisms genetically similar obtained from the same individual by vegetative propagation is known as
(a) Offspring (b) Clone (c) Stocks (d) Scions

23. In tissue culture for the first time roots in tomato were developed by
(a) Knop (b) P.R. White (c) Went (d) Hildebrandt

24. Callus is
(a) Material that heals injury in phloem (b) Undifferentiated mass of cells
(c) Tissue developed in the region of wound (d) All the above

25. Explant is
(a) A small part of plant for tissue culture (b) Exploited part of plant
(c) Harvested plant (d) Uprooted part for transplantation

26. Potatoes are cultivated by
(a) Seeds (b) Foliar buds (c) Buds on tubers (d) Cuttings of roots

27. Ginger is multiplied vegetatively by
(a) Rhizome (b) Tuber (c) Stem (d) Bud

28. Scion is the term used in relation to
(a) Embryology (b) Grafting (c) Agamospermy (d) Emasculation

29. Which of the following plant cells will show totipotency
(a) Sieve tube (b) Xylem vessels (c) Meristem (d) Cork cells

30. Bulbils occurs in
(a) *Cycas* (b) *Agave* (c) *Dioscorea* (d) All the above

31. Development of haploid plants from pollen is
(a) Parthenocarpy (b) Emasculation
(c) Androgenesis (d) Somatic hybridization

32. Mango and Guava are propagated through
(a) Tissue culture (b) Grafting (c) Stem cuttings (d) Layering

33. Adventive embryony is found in
(a) *Triticum* (b) *Chorchorus* (c) *Citrus* (d) *Carthamus*

34. A piece of Potato tuber will form a new plant if it has
(a) Branches (b) Stored food (c) Roots (d) Scales/eyes

35. Roots are used in vegetative propagation of
(a) *Ginger* (b) *Chrysanthemum* (c) Sweet Potato (d) Potato

36. Girdling cannot be performed in Sugarcane because its
(a) Vascular bundles are scattered (b)Phloem is internal to xylem
(c) Sugarcane plants are delicate (d)Inability to bear injury

37. Stem cuttings are commonly used in propagation of
(a) Mango (b) Cotton (c) Rose (d) Banana

38. Grafting is not possible in monocots as they
(a) Lack cambium (b) Are herbacous
(c) Have scattered vascular bundles (d) Have parallel venation

39. A quicker regeneration of grass leaves shall occur by
(a) Cutting (b) Grazing (c) Irrigation (d) Clipping

40. Stem cutting are employed in the propagation of
(a) Banana (b) Mango (c) Sugarcane (d) Cotton

41. Parthenogenesis is found in
(a) Litchi (b) Grape (c) Apple (d) Mango

Advance Level

42. Totipotent cell refers to
(a) An undifferentiated cells capable of developing into complete embryo
(b) An undifferentiated cell capable of developing into an organ
(c) An undifferentiated cell capable of developing into a system or entire plant
(d) Cells which lack the capability of differentiating into an organ or system

43. After culturing the anther of a plant, a few diploid plants were found along with haploid plants. The diploid plants could have arisen from
(a) Generative cell of pollen (b) Cells of anther wall (c) Vegetative cells of pollen (d) Exine of pollen wall

44. 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
(a) Parthenocarpy (b) Apomixis (c) Induced mutation (d) Polyploidy

45. By tissue culture, indefinite number of plants from a small amount of parental tissue can be obtained. This technique is of great economic importance as

(a) New species can be generated

(b) Through somaclonal variation, a large number of variants can be isolated

(c) It is a useful method to multiply genetically uniform population of elite species

(d) Homozygous diploids can be obtained

46. In agamospermy, the embryo sac is diploid because it is formed without meiosis. Such embryo sac may develop from

(a)Megaspore mother cell (b)Microspore mother cell

(c) Megaspores (d)Microspores

47. In vegetative propagation by tubers, which of following remains constant though generations

(a) Morphology (b) Vigour only

(c) Vigour and morphology only (d) Morphology**,** vigour and disease resistance

48. Development of shoot and root in tissue culture is determined by

(a) Cytokinin and auxin ratio (b) Enzymes

(c) Temperature (d) Plant nutrients

49. An introduced cell in tissue culture is made to divide and form callus by

(a) Adjusting ratio of auxin and cytokinin

(b) Keeping inoculated vessel at desired temperature

(c) Enriching medium with minerals and agar (d) Transferring plants to pots

50. First step in protoplasm fusion is

(a) Collection of somatic cell (b)Selection and isolation of somatic cells

(c) Isolation of protoplasts (d)Hybridisation

51. Heaping of earth around base of stem in Potato is meant for

(a) Preventing exposure of roots (b)Providing extra support to delicate stem

(c) Inducing development of more auxiliary shoots

(d)Making more water available

MICROSPOROGENESIS

Basic Level

52. The pollen grain is

(a) An immature male gametophyte (b) A mature male gametophyte

(c) Partially developed male gametophyte (d) Last stage of male gametophyte

53. Microsporogenesis is synonym for

(a) Spermatogenesis (b) Development of pollen

(c) Development of male gametophyte (d) Development of female gametophyte

54. The anther wall consists of four wall layers where

(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

55. In angiosperm, all 4 microspores of tetrad are covered by a layer which is formed by
(a) Callose (b) Cellulose (c) Sporopollenin (d) Pectocellulose

56. In a flowering plant the largest number of haploid cells occur in
(a) Ovule (b) Microsporangia (c) Root tip (d) Cambium

57. Mature male gametophyte is made up of
(a) One cell (b) Two cells (c) Three cells (d) Four cells

58. Endothecium and tapetum in anther are derived from
(a) Primary sporogenous layer (b) Primary parietal layer (c) Both (a) and (b)

59. Occurrence of more than four spores from a spore mother cell is called
(a) Polyspermy (b) Polyspory (c) Polyembryony (d) Polysiphony

60. Pollen grains are able to withstand extremes of temperature and dessication because their exine is compound of
(a) Cutin (b) Suberin (c) Sporopollenin (d) Callose

61. In a pollen grain, larger nucleus is
(a) Generative nucleus (b) Tube nucleus (c) Vegetative nucleus (d) Both (b) and (c)

62. Development and formation of pollen grains in anther of the stamen is known as
(a) Pollination (b) Fertilization (c) Microsporogenesis (d) Megasporogenesis

63. Tapetum is a part of
(a) Male gametophyte (b) Female gametophyte (c) Ovary wall (d) Anther wall

64. The function of innermost layer of pollen sac, tapetum is
(a) Dehiscence (b) Mechanical (c) Protective (d) Nutritive

65. Which part of the reproductive structure produces both enzymes and hormones
(a) Archegonium (b) Middle layer (c) Tapetum (d) Endothecium

66. In monocots, male gametophyte is
(a) Microspore (b) Megaspore (c) Tetrad (d) Nucellus

67. How many pollen grains are formed from 10 microspore mother cells by meiosis
(a) 80 (b) 40 (c) 20 (d) 10

68. How many meiotic divisions are necessary to produce 100 pollen grains
(a) 100 (b) 25 (c) 50 (d) 20

69. Germpore is the region where the exine is
(a) Thick (b) Uniform (c) Thick and Uniform (d) Absent

70. How many microspore mother cells will give rise to 256 microspores after reduction division
(a) 512 (b) 128 (c) 64 (d) 96

71. Meiosis can be observed in
(a) Spore mother cells (b) Microspores (c) Megaspores (d) Tapetal cells

72. Ubisch bodies found in tapetal cell help in formation of
(a) Pollen kitt and sporopollinin (b) Exine
(c) Sporopollenin (d) Intine and pollen kitt

73. Translator are found in
(a) *Calotropis* flower (b) *Hibiscus* (c) *Vinca* flower (d) *Leucas*

74. Pollinia is found in which of the following plant family
(a) Asteraceae (b) Myrtaceae (c) Malvaceae (d) Asclepiadaceae

75. In an young anther the four rows of cells which later produce pollen are called
(a) Antheridium (b) Archesporium (c) Tapetum (d) Zoosporangium

76. In plants meiosis occurs in
(a) Anther (b) Root tip (c) Cambium (d) Pollen grain

77. Angiosperms shed their pollen generally at ..... celled stage
(a) One (b) Two (c) Three (d) Four

78. In flowering plants archesporium gives rise to
(a) Wall of sporangium (b) Both wall and sporogenous cells
(c) Wall and tapetum (d) Tapetum and sporogenous cells

79. In flowering plants, the male gametes are formed by
(a) Generative cell (b) Uninucleate microspore
(c)Vegetative cell (d) Pollen tube

80. Palynology is connected with the study of
(a) Pollen grains (b) Palms (c) Flowers (d) Fruits

81. Number of prothallial cells present in male gametophyte of flowering plant is
(a) Three (b) Two (c) One (d) Zero

82. Pollen kitt is formed from
(a) Endothecium (b) Middle layers (c) Microspore mother cell (d)Tapetum

83. Microspore mother cell has 40 chromosomes. Each of its microspore shall have chromosomes
(a) 40 (b) 20 (c) 10 (d) 80

84. How many pollen mother cells will form 1000 pollen grains
(a) 200 (b) 250 (c) 300 (d) 100

85. An anther with 4 microsporocytes shall produce ..... pollen grains
(a) 24 (b) 8 (c) 12 (d) 16

86. Sporogenesis is
(a) Development and formation of spores (b) Production of mitospores
(c) Production of meiospores (d) Formation of zygote and embryo

87. When the filament runs along the back of anther, it is called
(a) Adnate (b) Versatile (c) Longitudinal (d) Syngenecious

88. Middle layer of anther wall is formed by secondary outer parietal layer in
(a) Dicots (b) Monocots (c) Both (a) and (b) (d) None of the above

89. Pollinia are sac like structures
(a) Which secrete yellow substance called pollen kit
(b) Which are found in megasporangia
(c) In which anther lobes are present (d) In which pollen grains are present in mass

90. Which organ of the plant plays dominant role in the life cycle

(a) Stem (b) Root (c) Flower (d) Leaves

91. If the developing microspore mother cells draw nourishment by contacting the tapetal cells, the type of tapetum is called

(a) Plasmodial tapetum (b) Secretory tapetum (c) Amoeboid tapetum (d) Endothelium

92. Anther is generally composed of

(a) One sporangium (b) Two sporangium (c) Three sporangium (d) Four sporangium

93. Meiosis is best observed in dividing

(a) Cells of apical meristem (b) Cells of lateral meristem

(c) Microspores and anther wall (d) Microsporocytes

94. Genotypically the pollen grain produced by an anther belong to

(a) One type (b) Two types (c) Many types (d) All the above

95. Male gametophyte of angiosperms is reduced to

(a) One cell (b) Two cells (c) Three cells (d) Four cells

Advance Level

96. Even after killing the generative cell with a laser beam, the pollen grain of a flowering plant germinates and produces normal pollen tube because

(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

97. In flowering plants, a mature 'male gametophyte' is derived from a 'pollen mother cell' by

(a) Three mitotic divisions (b) One meiotic and two mitotic divisions

(c) Two meiotic divisions (d) A single meiotic division

98. The tapetal nuclei in anthers of many angiosperm flower are

(a) Mostly aneuploid (b) Mostly polyploid

(c) Mostly haploid (d) Not having complete haploid genome

99. In order to check the purity of honey and its source pollen grains are being studied in a sample of honey. Such a study is called as

(a) Aeropalynology (b) Palynology (c) Melittopalynology (d) Iatropalynology

100. Pollen grains are non green due to

(a) Absence of plastids (b) Degeneration of plastids

(c) Conversions of plastids into chromoplasts (d) Attraction of vectors

MEGASPOROGENESIS

Basic Level

101. The ovule of angiosperms might be evolved from
(a) Megagametangium (b) Integumented megasporangium
(c) Megasporangium (d) Microgametangium

102. In angiosperms, the functional megaspore of a linear tetrad is the
(a) First nearest to the micropyle (b) Second from micropyle
(c) Third from micropyle (d) Fourth from micropyle

103. The normal or *Polygonum* type of embryo sac is
(a) Bisporic eight nucleate (b) Monosporic four nucleate
(c) Tetrasporic sixteen nucleate (d) Monosporic eight nucleate

104. The microscopic structure in flower that contains polar nuclei is
(a) Only gametophyte (b) Pollen tube (c) Embryo sac (d) None of the above

105. Collar like outgrowth arising from the base of ovule and forming a sort of third integument is known as
(a) Coma (b) Caruncle (c) Aril (d) Operculum

106. Egg apparatus comprises of
(a) Egg (b) Egg and synergids (c) Egg and antipodals (d) Egg and polar nuclei

107. 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

108. Female gametophyte of angiospermic plants is represented by
(a) Oospore (b) Egg (c) Carpel (d) Pollen grain

109. Mature embryo sac contains or A normal angiosperm embryo sac at the final stage of development has
(a) 4 cells (b) 3 cells (c) 7 cells (d) 8 cells

110. The point where funicle joins with ovule is known as
(a) Chalaza (b) Hilum (c) Integument (d) Micropyle

111. Mature *Polygonum* type embryo sac has got
(a) Seven cells and eight nuclei (b) Seven nuclei and eight cells
(c) Eight cells and eight nuclei (d) Seven cells and seven nuclei

112. The formation of embryo sac is called
(a) Megasporogenesis (b) Megagametogenesis (c) Microgametogenesis (d)None of these

113. For pollinated ovary which is correct
(a) Accessory cells are diploid (b) Antipodal cells are haploid(c)Egg cell is diploid

114. Which of the following pairs of plant parts are both haploid
(a) Antipodal cells and egg cells (b) Nucellus and primary endosperm nucleus
(c) Nucellus and antipodal cells (d) Antipodal cells and megaspore mother cells

115. Embryo sac is

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

116. Filiform apparatus is found in

(a) Synergids (b) Antipodals (c) Secondary nucleus (d) Egg cell

117. Micropyle allows

(a) Pollen tube to penetrate in the ovule at the time of fertilization

(b) Activity of germination of pollen grains

(c) A pore in pollen grain

(d) The growing up of pollen grain

118. Secondary nucleus in the middle of an embryo sac of angiosperms is

(a) Diploid (b) Triploid (c) Tetraploid (d) Haploid

119. The haploid cell which divides by mitosis to form embryo sac is

(a) Megaspore mother cell (b) Microspore mother cell (c) Functional megaspore (d) Non-functional megaspore

120. Caruncle is derived from

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

121. In angiosperms embryo sac is developed from

(a) Megaspore mother cell (b)Secondary nucleus

(c)Endothecium (d)Microspore mother cell

122. Numerous ovules are present in the ovary of the plants belonging to the family

(a) Gramineae (b) Compositae (c) Leguminosae (d) Solanaceae

123. Crassinucellate ovule shows

(a) Absence of nucellus (b)Well developed nucellus

(c) Partially developed nucellus (d) Poorly developed nucellus

124. The primary endosperm nucleus in *Polygonum* type of embryosac is

(a) Haploid (b) Diploid (c) Triploid (d) Tetraploid

125. 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

126. For the formation of tetrasporic embryo sac, how many megaspore mother cells are required

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

127. The odd one is

(a) Micropyle (b) Embryo sac (c) Nucellus (d) Pollen grain

128. What is the direction of micropyle in anatropous ovule

(a) Left (b) Right (c) Upward (d) Inverted

129. The ovule in pea are

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

130. An orthotropous ovule is one in which micropyle and chalaza are

(a) In straight line of funiculus (b) Parallel to funiculus

(c) At right angles to funiculus (d) Oblique to funiculus

131. Ovule of *Capsella* is

(a) Orthotropus (b) Anatropus (c) Campylotropus (d) Amphitropus

132. In anatropous ovule, the micropyle is

(a) In straight line with funicle (b) At right angle with funicle

(c) At 45° with funicle (d) Side by side with funicle

133. The stalk of the ovule is called

(a) Pedicle (b) Petiole (c) Funicle (d) Hilum

134. Embryo sac is monosporic, when it develops from

(a) Two functional megaspores of archegonium

(b) Three megaspores of a megaspore tetrad

(c) One of the four megaspores of a megaspore mother cell

(d) The megaspore mother cell where cytokinesis does not take place

135. Group of megaspores in angrosperm is arranged

(a) Linearly (b) Deccensately (c) Tetrahedrally (d) Isobilaterally

136. 8-nucleate embryo sac is

(a) Monosporic (b) Bisporic (c) Tetrasporic (d) All the above

137. In *capsella* embryo sac is

(a) Haploid (b) Diploid (c) Triploid (d) Polyploid

138. Meiotic divisions in an ovule occur in

(a) Megaspore mother cell (b)Megaspore (c) Nucellus (d) Archesporium

139. *Polygonum* type embryosac has ..... antipodal cells

(a) 2 (b) 3 (c) 4 (d) 5

140. Which haploid cell forms embryo sac

(a) Functional megaspore (b)Microspore mother cell

(c) Megaspore mother cell (d)None of the above

141. An ovule which becomes curved so that the nucellus and embryo sac lie at right angles to the funicle is

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

142. Ovule is curved and the embryo sac is horseshoe shaped micropyle, chalaza and funicle occur near one another. The ovule is

(a) Camylotropous (b) Amphitropous (c) Orthotropous (d) Anatropous

143. Ovule is inverted with body fused to funicle, micropyle lying close to hilum and facing the placenta. It is

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

144. Number of chromosomes in root cell is 14. What will be the number in synergid

(a) 14 (b) 21 (c) 7 (d) 28

Advance Level

145. 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

146. The sequence of development of embryo sac is

(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

147. In *Capsella* meiosis takes place during

(a) Development of pollen grains (b)Development of egg

(c) Germination of zygote (d)Development of ovule

148. Generally archesporium in an ovule is

(a) Single celled and hypodermal in origin

(b) Single celled and lies in the centre of the ovule

(c) Single called and terminal in origin (d) Many celled and lie in the centre

149. The number of nuclei migrating from each of the micropylar quartet and chalazal quartet to the centre of the normal embryo sac is

(a) One (b) Two (c) Four (d) Number not fixed

150. The most appropriate definition of an ovule/seed in terms of homologous structures is that it is

(a) Integumented indehiscent sporangium having a single spore

(b) Integumented gynosporangium

(c) Integumented indehiscent megasporangium with a single megaspore

(d) Integumented bud containing an egg

POLLINATION

Basic Level

151. Correct definition of pollination is
(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

152. The transfer of pollen grain from the stamen to the stigma of the same flower is
(a) Autogamy (b) Allogamy (c) Geitonogamy (d) Xerogamy

153. Pollination characteristically occurs in
(a) Angiosperms and fungi (b) Angiosperms and gymnosperms
(c) Pteridophytes and angiosperms (d) Bryophytes and angiosperms

154. Self pollination means
(a) Occurrence of male and female sex organs in the same flower
(b) Germination of pollens within the anther
(c) Transference of pollens from anther to the stigma within the same flower
(d) Transference of pollens from one flower to another on the same plant

155. Germination of pollen grain on the stigma is
(a) Autogamy (b) In vivo germination (c) In vitro germination (d) None of these

156. The pollination which occurs within the flower
(a) Herkogamy (b) Cleistogamy (c) Dichogamy (d) Dicliny

157. Part of the gynoecium which receives the pollen is called
(a) Ovary (b) Ovule (c) Style (d) Stigma

158. Pollination occurs when a pollen grain
(a) Matures and has three nuclei (b) Lands on a stigma
(c) Releases its sperm nuclei (d) Releases its pollen tube nucleus

159. Cross pollination in crop plant is known as
(a) Autogamy (b) Allogamy (c) Cleistogamy (d) Chasmogamy

160. The allogamy is best favoured by
(a) Homogamy (b) Cleistogamy (c) Dicliny (d) All of the above

161. The pollination by the birds is called
(a) Ornithophily (b) Chiropterophily (c) Entomophily (d) Malacophily

162. Pollination by insects is called
(a) Entomophily (b) Chiropterophily (c) Anemophilly (d) Zoophilly

163. Pollination by slug and snails is called
(a) Ornithophilous (b) Malacophilous (c) Anemophilous (d) Chiropterophilous

164. Malacophily is the name given to pollination by
(a) Bat (b) Birds (c) Snails (d) Insects

165. Pollination which occurs in closed flower is known as
(a) Allogamy (b) Cleistogamy (c) Dicliny (d) Protogyny

166. Chiropterophily is the process of pollination by
(a) Water (b) Bat (c) Insect (d) Bird

167. When pollen grains of a flower pollinate the stigma of another flower of the same plant, its is called
(a) Dichogamy (b) Herkogamy (c) Geitonogamy (d) Autogamy

168. Pollination by wind is called
(a) Geitonogamy (b) Anemophily (c) Autogamy (d) None of the above

169. In bisexual flowers when the gynoecium matures earlier than the androecium, it is called
(a) Protandry (b) Protogyny (c) Heterogamy (d) Autogamy

170. In which type of flowers, stigma is rough and sticky
(a) Insect pollinated (b) Wind pollinated (c) Water pollinated (d) All the above

171. Fragrant flowers with well developed nectaries are adapted for
(a) Anemophily (b) Hydrophily (c) Entomophily (d) None of these

172. Anemophilous flower have
(a) Sessile stigma (b) Small, smooth stigma
(c) Coloured flower (d) Large feathery stigma

173. Anemophilous pollination is mainly observed in
(a) Graminae (b) Annonaceae (c) Papilionaceae (d) Euphorbiaceae

174. The mature stigma is either rough or sticky in
(a) All types of flowers (b)Water pollinated flower
(c)Wind pollinated flowers (d)Insect pollinated flowers

175. Contrivances for self pollination are
(a) Bisexuality (b) Homogamy (c) Cleistogamy (d) All of these

176. Pollination in *Vallisneria* is
(a) Hydrophilous (b) Ornithophilous (c) Entomophilous (d) Malacophilous

177. In sausage tree (*Kigelia pinnata*) the pollination takes place by
(a) Birds (b) Bats (c) Wind (d) Insects

178. The insect *Blastophage grossorum* is associated with the pollination of
(a) Mango (b) Paddy (c) Beans (d) Ficus

179. Feathery stigma is present in
(a) Wheat (b) Pea (c) Ceasalpinia (d) Datura

180. Which prevents self pollination
(a) Self sterility (b) Herkogamy (c) Dichogamy (d) All of the above

181. Which of the following has both male and female sex organs in the same flower
(a) Date palm (b) Nut meg (c) *Hibiscus* (d) *Cucurbita*

182. In which of the following pollination takes place by lever mechanism
(a) *Salvia* (b) *Ficus* (c) *Antirhinum* (d) *Ocimum*

183. A close relation between flower and pollinating agent is best exhibited by
(a) *Cocos* (b) *Salvia* (c) *Yucca* (d) Both (b) and (c)

184. Pollen kitt is present in

(a) Anemophilous flowers (b)Entomophilous flowers

(c) Ornithophilous flowers (d)Hydrophilous flowers

185. Which one of the following normally have cross pollination but are adapted for self pollination

(a) Musturd (b) China rose (c) Sunflower (d) Wheat

186. Long silky hair coming out of the cob of maize are

(a) Meant for fruit dispersal (b) Meant for attracting insects

(c) Meant for protecting insects (d) Long styles and stigma

187. Some flowers possess pleasant odour and attractive colours for

(a) Entomophily (b) Hydrophily (c) Anemophily (d) All of the above

188. Bees are important to agriculture as they

(a) Produce wax (b) Perform pollination (c) Prevent pollination (d) Produce honey

189. Cross pollinatiom is preferred over self pollination because it

(a) Produces better offspring (b) Forms new varieties

(c) Induces parthenogenesis (d) Is economical

190. Pollination in Lotus is carried out by

(a) Wind (b) Water (c) Insects (d) All of the above

191. *Gloriosa superba* exhibits

(a) Heterostyly (b) Self sterility (c) Herkogamy (d) Cleistogamy

192. Flowers remain closed in

(a) Decliny (b) Chasmogamy (c) Dichogamy (d) None of the above

193. Geitonogamy is found in

(a) *Sorghum* (b) *Erythrina* (c) *Hydrilla* (d) Maize

194. Heterozygosity is produced following

(a) Xenogamy (b) Geitonogamy (c) Autogamy (d) Cleistogamy

195. Continuous self pollination in a species develops

(a) Strong offsprings (b) Weak offsprings (c) New varieties (d) Seedless fruits

196. Moth pollinated flowers have

(a) Inconspicuous petals with abundant pollen (b) Conspicuous coloured petals

(c) Coloured petals and nectaries (d) White scented petals and nectaries

197. In which characters air pollinated flowers differ from insect pollinated ones

(a) Due to small parianth and sticky pollen

(b) Small coloured parianth and heavy pollen grains

(c) Coloured parianth and large pollen grains

(d) Without parianth and light pollen grains

198. Protandry is

(a) Maturation of stigma earlier than anthers of the same flower

(b) Maturation of anthers and stigma at the same time

(c) Maturation of anthers earlier than stigma of the same flower

(d) Pollination of the stigma by the anther of the same flower

199. A typical example of cross pollination is

(a) Wheat (b) Tomato (c) Potato (d) Maize

Advance Level

200. Dichogamy which helps in cross pollination is a floral mechanism in which

(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

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

(a) Heterostyly (b) Herkogamy (c) Dichogamy (d) Cleistogamy

202. Progeny produced as a result of cross pollination

(a) Shows high degree of variability and is evolutionary important

(b) Is sterile

(c) Has recessive characters

(d) Is homozygous with phenotypic uniformity

203. In plants, in nature, autogamy is avoided since the seeds produced

(a) Are fewer in number (b)Do not germinate successfully

(c) Do not produce healthy plants (d)All of the above

204. Intra-species incompatibility can be overcome by

(a) Wetting of the stigma (b)Bud-pollination

(c) Mixed-pollination (d)Intra-ovarian pollination

205. Bisexual cleistogamous flowers

(a) Never open in life (b) Open only in daytime

(c) Open only during nights (d) Always remain open

206. An interesting modification of flower shape for insect pollination occurs in some orchids in which a male insect mistakes the pattern on the orchid flower for the female of his species and tries to copulate with it, thereby pollinating the flower. This phenomenon is called

(a) Pseudoparthenocarpy (b)Mimicry (c) Pseudopollination (d) Pseudocopulation

FERTILIZATION

Basic Level

207. Fertilization in angiosperms is the
(a) Fusion of two similar spores (b) Fusion of two dissimilar flowers
(c) Union of stamens of unequal length (d) Fusion of two dissimilar gametes

208. The phenomenon of syngamy (fertilization) in angiosperms was discovered by
(a) Svedberg (b) Strasburger
(c) Nawaschin (d) Coulter and Chamberlin

209. The process of fusion between male nucleus and egg nucleus is called
(a) Syngamy (b) Triple fusion (c) Double fertilization (d) Conjugation

210. Fusion product of polar nuclei and male gamete is
(a) Triple fusion (b) Primary endosperm nucleus
(c) Zygote (d) Secondary nucleus

211. Double fertilization was first discovered by Nawaschin (1898) in
(a) *Lillium* and *Frittillaria* (b)Mango and sugarcane
(c)Papaya and pea (d)*Brassica* and candytuft

212. The role of double fertilization in angiosperm is to produce
(a) Endosperms (b) Integuments (c) Cotyledons (d) Endocarp

213. Double fertilization is characteristic of
(a) Gymnosperms (b) Bryophytes (c) Angiosperms (d) Pteridophytes

214. Which of the following is without exception in angiosperms
(a) Secondary growth (b) Presence of vessels (c) Double fertilization (d) Autotrophic nutrition

215. Double fertilization was discovered by
(a) Karl Schnarf (b) P. Maheshwari (c) S.G. Nawaschin (d) B.G.L. Swamy

216. Fertilization of egg takes place inside
(a) Anther (b) Stigma (c) Pollen tube (d) Embryo sac

217. Triple fusion in *Capsella* is affected by
(a) Fusion of male gamete with egg (b) Fusion of male gamate with synergids
(c) Fusion of male gamete with nucellar cell
(d) Fusion of male gamete with secondary nucleus

218. Female gametophyte of a typical dicot at the time of fertilization is
(a) 8 celled (b) 7 celled (c) 6 celled (d) 4 celled

219. In which one of the following plants water is not necessary for the act of fertilization
(a) *Vallisneria* (b) *Pisum sativum* (c) Moss (d) Fern

220. Number of nuclei taking part in double fertilization is
(a) 2 (b) 3 (c) 4 (d) 5

221. Pollen tube at the time of entering embryo sac has
(a) Four gametes (b) Three male gametes
(c) Two male gametes (d) One gametic nucleus

222. In angiosperm, triple fusion is necessary for the formation of
(a) Seed coat (b) Fruit wall (c) Embryo (d) Endosperm

223. Which of the following statement is correct for the pollen tube
(a) It shows chemotropism movement (b) It shows only tip growth
(c) It is composed of three non-cellular zones (d) It shows radial cytoplasmic streaming

224. Pollen tube discharge its gametes in
(a) Synergids (b) Antipodals (c) Central cells (d) None of these

225. Growth of pollen tube towards embryo sac is
(a) Geotropism (b) Thigmotaxis (c) Chemotropism (d) Phototaxis

226. When pollen tube enters by integuments, then the process is called
(a) Mesogamy (b) Porogamy (c) Chalazogamy (d) Pseudogamy

227. When pollen tube enters through the funiculus or the base of the ovule, it is called as
(a) Chalazogamy (b) Mesogamy (c) Isogamy (d) Porogamy

228. Through which route the pollen tube enters the ovule
(a) Chalaza (b) Micropyle (c) Funiculus (d) All of these

229. When the pollen tube enters through the micropyle, it is termed as
(a) Chalazogamy (b) Mesogamy (c) Porogamy (d) None of the above

230. By double fertilization is formed
(a) Endosperm (b) Megaspore (c) Seed (d) Fruit

231. The area where pollen tube is produced in
(a) Stigmatic papillae (b) Ovule (c) Carpel (d) Stamen

232. Chromosome number in a flowering plant can be
(a) Haploid**,** diploid and polyploid (b) Haploid and diploid
(c) Only diploid (d) Only haploid

233. In gymnosperms and angiosperms male gametes are carried by pollen tube it is
(a) Porogamy (b) Chalazogamy (c) Siphonogamy (d) Mesogamy

234. In *Casuarina* fertilisation takes place through
(a) Mesogamy (b) Porogamy (c) Chalazogamy (d) Apogamy

235. External water is not required for fertilization of
(a) Pteriodophytes (b) Bryophytes (c) Thallophytes (d) Spermatophytes

Advance Level

236. After penetrating stigmatic and styler tissues, the pollen tube ususally grow down towards the egg because

(a) The egg cell attracts the pollen tube as they have dissimilar electric charge

(b) The filiform apparatus of synergids is believed to attract the pollen tube

(c) It has no other passage to follow

(d) It grows under control of nucleus

237. Plasmogamy refers to

(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

238. Double fertilization process means

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

(b) Fusion of one male gamete nucleus with secondary nucleus

(c) Fusion of two polar nuclei with each other

(d) Fusion of male gamete nucleus with egg nucleus

239. Oogamous sexual reproduction signifies

(a) Fusion of similar motile gametes (b) Fusion of dissimilar motile gametes

(c) Fusion of a motile and a non-motile gamete (d) Fusion of similar non-motile gametes

240. Which one of the following events in a botanical garden is never directly influenced by light

(a) Flowering (b) Photosynthesis (c) Transpiration (d) Fertilization

241. A pollen tube grows down the style because

(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

242. The nuclei of the sperm and egg fuse as a result of

(a) Base of 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

243. A self fertilizing trihybrid plant forms

(a) 8 different gametes and 16 different zygote (b) 8 different gametes and 32 different zygote

(c) 8 different gametes and 64 different zygote (d) 4 different gametes and 16 different zygote

EMBRYO AND ENDOSPERM

Basic Level

244. In angiosperms, the oospore on development produces
(a) Seed (b) Embryo (c) Protonema (d) Endosperm

245. The endosperm in angiosperms develops from
(a) Micropylar polar nucleus (b) Chalazal polar nucleus
(c) Secondary nucleus (d) Zygote

246. The endosperm in angiosperms is formed
(a) After fertilization (b) Before fertilization
(c) Along with fertilization (d) Before pollen discharge

247. Endospermic nucleus is usually

Or

Endosperms of higher plants are mainly
(a) Haploid (b) Diploid (c) Triploid (d) Tetraploid

248. Triploid plants can be obtained from culture of
(a) Pollen (b) Endosperm (c) Ovule (d) Megaspore

249. The embryo in sunflower has
(a) No cotyledon (b) One cotyledon (c) Two cotyledons (d) Many cotyledons

250. Proteinaceous endosperm of maize is called
(a) Apophysis (b) Scutellum (c) Aleurone layer (d) None of the above

251. The outermost layer of endosperm of maize grain is called
(a) Epidermis (b) Tunica (c) Aleurone (d) Pericarp

252. The endosperm of *Brassica* is
(a) Haploid (b) Diploid (c) Triploid (d) Tetraploid

253. In angiosperms, free nuclear divisions occurs during
(a) Gamete formation (b) Embryo formation (c) Endosperm formation (d) Flower formation

254. Ruminate endosperm is commonly found in seeds of
(a) Cruciferae (b) Compositae
(c) Euphorbiaceae (d) Annonaceae (Areca nut)

255. Xenia and metaxenia terms are related with
(a) Pollen culture (b) Only endosperm
(c) Xylem and phloem (d) Pollen and endosperm

256. Which one is an example of triploid tissue
(a) Onion root (b) Fern prothallus
(c) Maize and lily endosperm (d) None of the above

257. Fats is present in large quantities in the tissues of which of the following
(a) Cotton fibre (b) Tuber of potato (c) Coconut endosperm (d) Embryo of pea

258. Milky water of green coconut is

(a) Liquid nucellus (b) Liquid of female gametophyte

(c) Liquid endosperm (d) Liquid chalaza

259. Suspensor performs the function of

(a) Absorption of food (b) Pushing embryo to nutrition zone

(c) Formation of secondary embryos (d) All above

260. Multinucleate condition is present in

(a) Quiescent centre (b) Maize

(c) Meristematic tissue (d) Liquid endosperm of coconut

261. Ruminate endosperm is present in

(a) Coconut (b) Myristica (jaiphel) (c) Walnut (d) Tradescantia

262. Endosperm of gymnosperm is

(a) Haploid (b) Diploid (c) Triploid (d) Quadriploid

263. Suspensor is a part of

(a) Developing embryo (b) Mature embryo (c) Germinated embryo (d) Endosperm

264. Endosperm formation is supressed in

(a) Liliaceae (b) Cyperaceae

(c) Orchidaceae and podostemonaceae (d) Gramineae

265. Free nuclear division occurs in

(a) Flower (b) Gametes (c) Endosperm (d) Fruit

266. At what stage of endosperm development, you will observe nuclear or cellular type of endospern

(a) When divisions starts in embryo (b)When embryo is heart-shaped

(c) Mature stage of endosperm

(d)Just after division of primary endosperm nucleus

267. Total number of meiotic division required for forming 100 zygotes/100 grains of wheat is

(a) 100 (b) 75 (c) 125 (d) 50

268. The great plant embryologist of India is

(a) Iyengar (b) Kashyap (c) Maheshwari (d) De Bary

269. Number of chromosomes is 12 in megaspore mother cell. What shall be their number in endosperm

(a) 18 (b) 36 (c) 12 (d) 24

270. When vegetative cell of zygote form embryo, it is called

(a) Apospory (b) Apomixis

(c) Diploid polyembryony (d) Adventive polyembryony

271. Polyembryony commonly occurs in

(a) Citrus (b) Turmeric (c) Tomato (d) Potato

272. Zygote of *Capsella bursa* divides by

(a) Longitudinal division (b)Equal transverse division

(c) Unequal transverse division (d)Oblique divisions

Advance Level

273. Dicot embryo consists of

(a) Radicle and plumule

(b) Radicle, plumule, cotyledons and sometimes endosperm

(c) Radicle, plumule, cotyledons and tegmen

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

274. In angiosperms endosperm is formed by

(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

275. 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

(a) Certain enzymes (b) Dicotyledonous hormone (c)Growth hormone (d) None of the above

276. The endosperm found in angiospermic seed is different from that of gymnosperms in the sense that, in the former

(a) It is formed before fertilization while in the latter it is formed after fertilization

(b) It is formed after fertilization while in the latter it is formed before fertilization

(c) It is cellular while in the latter it is nuclear

(d) It is nutritive while in the latter it is protective

277. If an angiospermic male plant is diploid and female plant tetraploid, the ploidy level of endosperm will be

(a) Haploid (b) Triploid (c) Tetraploid (d) Pentaploid

278. Pollen grain of tetraploid plant brings about fertilization in a diploid plant. The endosperm of seed will be

(a) 2*n* (b) 3*n* (c) 4*n* (d) 5*n*

279. When a diploid female plant is crossed with a tetraploid male, the ploidy of endosperm cells in the resulting seed is

(a) Diploidy (b) Triploidy (c) Tetraploidy (d) Pentaploidy

280. The cell '*ca*' of 2-celled proembryo divides transversely, whereas the cell '*cb*' does not divide at all. Even if the suspensor is formed that too develops from the cell '*ca*' or its derivatives which confirms to

(a) Onagrad type (b) Asterad type (c) Caryoplyllad type (d) Chenopodiad type

281. A homogamous tall pistillate plant (TT) is crossed with homogamous dwarf staminate plant (tt). What is the genotype of endosperm

(a) TTT (b) TTt (c) Ttt (d) ttt

282. In endosperm of *Triticum*, *Zea mays* and *Pinus* the level of ploidy is

(a) Diploid both (b) Haploid both

(c) Diploid and triploid respectively (d) Triploid and haploid respectively

SEEDS AND FRUITS

Basic Level

283. Seeds of the orchids are

(a) Large and heavy (b) Light and dry (c) Minute and sticky (d) None of these

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

(a) Mesocarp (b) Endocarp (c) Seed coat (d) None of these

285. The megasporangium of the angiosperms on maturation gives rise to

(a) A fruit (b) Seed (c) An embryo (d) Cotyledons

286. Seeds are called products of sexual reproduction because they

(a) Give rise to new plant (b)Are formed by fusion of gametes

(c) Can be stored for longer time (d)Are formed by fusion of pollen tubes

287. After fertilization, the seed coats of seed develop from

(a) Integuments (b) Embryo sac (c) Chalaza (d) Ovule

288. Upon fertilization the ovule develops into seed, which structure develops from a carpel

(a) Testa (b) Tegmen (c) Pericarp (d) Perisperm

289. Tegmen develops from

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

290. The embryonic axis of the seed is the

(a) Plumule (b) Tigellum (c) Radicle (d) Coleoptile

291. Micropyle in seed helps in the entry of

(a) Pollen tube (b) Water (c) Male gamete (d) None of these

292. In the cereals, the cotyledon is called

(a) Coleorrhiza (b) Pericarp (c) Scutellum (d) None of these

293. Number of meiotic divisions required to produce 400 seeds of pea would be

(a) 400 (b) 800 (c) 600 (d) 500

294. Non-essential for seed germination is

(a) Light (b) Water (c) Air (d) Temperature

295. The plant whose seeds are known to have longest viability period is

(a) *Nelumbo nucifera* (lotus) (b) *Triticum vulgare* (wheat)

(c) *Zizyphus jujuba* (ber) (d) *Carica papaya* (papaya)

296. Fruits in Asteraceae are generally dispersed by
(a) Water (b) Insects (c) Wind (d) Birds

297. Parachute mechanism is found in
(a) Cruciferae (b) Compositae (c) Solanaceae (d) None of these

298. Which one of the following is an endospermic seed
(a) Pea (b) Bean (c) Gram (d) Castor

299. In which of the following plants, cotyledons form the first pair of leaves
(a) Maize (b) Castor (c) Rice (d) Bean

300. Seed develop from
(a) Ovules (b) Ovaries (c) Anthers (d) Pistils

301. Maize grain is considered as
(a) Spore (b) Endosperm (c) Ovule (d) Fruit

302. In non-endospermic seeds, food is stored in
(a) Seed coat (b) Endosperm (c) Cotyledons (d) Ovule

303. Which of the following is a non-endospermic monocot seed
(a) Plumbago (b) Castor (c) Linseed (d) Alisma

304. Vivipary means
(a) Fruits are not formed (b) Germination of seed on mother plant
(c) Formation of fruits directly by embryo (d) Production of fruitless plant

305. In which of the following the seed germinates and still attached with the main plant
(a) Mango (b) *Rhizophora* (c) Neem (d) Coconut

306. Formation of fruits without fertilization is known as or Ovary $\xrightarrow{\text{No fertilization}}$ Fruit
(a) Parthenocarpy (b) Parthenogenesis (c) Polyembryony (d) Polygamy

307. Seedless fruits in *Vitis* are formed due to
(a) Sterility (b) Double fertlization (c) Syngamy (d) Parthenocarpy

308. An example of a naturally occurring parthenocarpic fruit is
(a) Guava (b) Mango (c) Banana (d) Apple

309. Which plant will lose its economic value, if its fruits are produced by induced parthenocarpy
(a) Grape (b) Pomegranate (c) Orange (d) Banana

310. Which of the following is parthenocarpic fruits
(a) Orange (b) Papaya (c) Pomegranate (d) Apple

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

312. Edible part of mango is
(a) Epicarp (b) Mesocarp (c) Endocarp (d) Receptacle

313. In parthenocarpy the seed factor is formed from
(a) Seed coat (b) Any cell of embryo sac (c)Haploid egg cell (d) None of the above

314. Coleorrhiza is a cap like covering over

(a) Plumule in a dicot (b) The radicle in a monocot

(c)Radicle in dicot (d) Plumule in a monocot

315. Removal of seed coat in dormant seeds, by mechanical methods is called

(a) Separation (b) Vernalization (c) Emasculation (d) Scarification

316. Edible part in litchi is

(a) Pericarp (b) Mesocarp (c) Endosperm (d) Fleshy aril

Advance Level

317. The plant part which consists of two generations one with in the other is

(a) Germinated pollen grain (b) Embryo

(c) Unfertilized ovule (d) Seed

318. If testa is removed from water soaked gram seed, the remaining structure is

(a) Full mature embryo (b) Cotyledons with endosperm and pericarp

(c) Cotyledons filled with starch (d) None of the above

319. A seed coat ruptures because of

(a) Massive glycolysis in the endosperm and cotyledons

(b) Massive entry of water

(c) Differentiation of cotyledons

(d) Sudden increase in cell division

320. In seeds characterised by hypogeal germination, cotyledons generally do not become green because

(a) They lack plastids (b) They remain below the soil

(c) They abscise very rarely (d) They contain inhibitors

321. Monocarpic plant means

(a) Which produces single seed in its life (b) Which flowers only once in its life

(c) Which produces single fruit in its life (d) Which has only carpel

MISCELLANEOUS

Basic Level

322. Fromation, growth and development of a new individual beginning from egg is known as

(a) Embryology (b) Cytology (c) Genetics (d) Ethnobotany

323. Which is the most logical sequence with reference to the life cycle of angiosperms

(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

324. Which of the following workers are related as ecologist, palaeobotanist and embryologist
(a)B. Sahni, R. Mishra, P. Maheshwari (b**)R.** Mishr**a, B.** Sahn**i, P.** Maheshwar**i**
(c) B. Sahni, P. Maheshwari, R. Mishra (d) P. Maheshwari, B. Sahni, R. Mishra

325. Genetically identical progeny is produced when an individual
(a) Practices self-fertilization (b)Produces identical gametes
(c) Practices reproduction (d) Practices in breeding without meiosis

326. When gynoecium is present at the top most position of the thalamus, the flower is known as
(a) Inferior (b) Epigynous (c) Perigynous (d) Hypogynous

327. 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
(a) Death (b) Ageing (c) Maturity (d) Juvenility

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

329. Flower is considered as a modified shoot because
(a) In some flowers thallamus is elongated and shows distinct nodes and internodes
(b) Flowers aggregate to form inflorescence
(c) Epicalyx is present in some flowers
(d) Essential whorl is present in the centre

330. Angiosperms differ from Gymnosperms in having
(a) Fruit (b) Seed
(c) Ovule (d) Well developed leaves

331. Sperm cells of angiosperms differ from the rest of the plant groups like gymnosperms by
(a) In angiosperms the sperms 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

332. Term *perianth* is used when
(a) Androecium and gynoecium are similar (b) Calyx and corolla are similar
(c) Calyx and androecium are similar (d) Corolla and androecium are similar

333. The axis present between androecium and gynoecium is called
(a) Androphore (b) Gynophore (c) Anthophore (d) Gynandrophore

334. Formation of a sporophyte from gametophyte and *vice versa* is termed as
(a) Sexual reproduction (b) Asexual reproduction (c) Alternation of generation(d) Transformation

335. 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

336. If the diploid number of an angiospermic plant is 24, the number of chromosomes in the pollen grain, endosperm and integument will be
(a) 12, 36, 12 (b) 12, 24, 36 (c) 12, 12, 36 (d) 12**,** 36**,** 24

337. If a sporangium is derived from a single cell, it is called
(a) Leptosporangiate (b) Eusporangiate (c) Heterosporangiate (d) Homosporangiate

338. Epicalyx represents
(a) Involucre (b)An additional whorl of calyx
(c) A whorl of bracteoles (d)A whorl of bracts

339. Empty glumes are
(a) Petals (b) Bracts (c) Stamens (d) Carpels

340. Largest flower in the world is that of the largest known flower is
(a) Lotus (b) *Rafflesia arnoldi* (c) Giant cactus (d) Sunflower

341. Smallest flower is of
(a) *Nelumbo nucifera* (b) *Wolffia microscopica* (c) *Rafflesia arnoldi* (d) *Carica papaya*

342. Which of the following is not functionally analogous with others in the group
(a) Archegonium (b) Oogonium (c) Antheridium (d) Ovule

343. How much time is generally required/taken by the pine plant from pollination to fertilization
(a) Four months (b) Thirteen months (c) Two years (d) Four years

344. Which of the following is correct statement
(a) Gametes are dilpoid (b) Spores are invariably haploid
(c) Spores and gametes are invariably haploid (d) Gametes are invariably haploid

345. In the life cycle of the seed plants, the dominant generation is a
(a) Haploid (b) Diploid (c) Triploid (d) Any of these

346. In the monocot flower, the non-essential parts are termed
(a) Calyx (b) Corolla (c) Perianth (d) Epicalyx

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

348. If the number of chromosomes in endosperm of a dicot plant is 36, the root cells will contain
(a) 72 chromosomes (b) 28 chromosomes (c) 24 chromosomes (d) 48 chromosomes

349. Which type of propagation is better for the plant
(a) By seeds (b) By tubers (c) By bulbs (d) By rhizome

350. A major application of embryo culture is in
(a) Clonal propagation (b) Induction of somaclonal variations
(c) Overcoming hybridisation barriers (d) Production of embryoids

351. The structure in flower that is homologous to the prothallus of a fern is the
(a) Ovary (b) Embryo (c) Spore (d) Anther

352. Meiotic spore formation in plants results in
(a) Restoring haploid condition (b) Mixing hybrid traits of both parents
(c) New genetic recombinations (d) All the above

353. Axenic cultures are best defined as
(a) Cell cultures (b) Cell cultures free of micro-organisms
(c) Cell cultures free of other living organism (d) Cell cultures of insectivorous plants

354. Sexual reproduciton of flowering plants was discovered by
(a) Camerarius (b) Nawaschin (c) Strasburger (d) Maheshwari

355. F.C.Steward is associated with
(a) Molecular biology (b) Genetics (c) Tissue culture (d) Immunology

356. Night blooming flowers are generally
(a) Light weight (b) Scented (c) Brightly coloured (d) Bloom in clusters

357. Sexual reproduction leads to
(a) Recombination (b) Parthenogenesis (c) Apomixis (d) Polyploid

358. Anthesis is a phenomenon which refers to
(a) Development of anther (b) Openign of flower bud (c) Reception of pollen by stigma (d) Formation of pollen

359. Chromosome number in pollen grains is 6. What shall be its number in leaf tip cells
(a) 6 (b) 12 (c) 24 (d) 3

360. In *Bougainvillea*, the coloured floral structures are
(a) Petaloid bracts (b) Petals (c) Coloured epicalyx (d) Coloured calyx

361. A normal plant suddenly begins multiplying parthenogenetically. The number of chromosomes of the second viable generation as compared to the parent will be
(a) Same (b) One half (c) One fourth (d) Double

362. Odd sepal is enlarged and leaf-like in
(a) Rose (b) *Smilax* (c) *Mussaenda* (d) *Bougainvillea*

ANSWER

ASSIGNMENT (BASIC & ADVANCE LEVEL)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
c	a	d	c	a	b	c	d	a	c	d	d	b	c	b	c	a	d	d	c
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
c	b	b	b	a	c	a	b	c	b	c	b	c	d	c	a	c	a	d	c
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
c	c	b	b	c	a	d	a	a	b	c	c	c	d	a	b	c	b	b	c
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
d	c	d	d	c	a	b	b	d	c	a	a	a	d	b	a	b	b	a	a
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
d	d	b	b	d	a	a	c	d	c	b	d	d	c	b	d	b	b	c	c
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
b	d	d	c	c	b	b	b	c	b	a	b	b	a	c	a	a	a	c	b
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
a	d	b	c	c	d	d	d	a	a	c	d	c	c	a	d	a	a	b	a
141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
c	b	c	c	b	a	d	a	a	c	a	a	b	c	b	b	d	b	b	c
161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
a	a	b	c	b	b	c	b	b	b	c	d	a	c	d	a	b	d	a	d
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
c	a	d	b	c	d	a	b	a	c	c	d	d	a	b	d	d	c	d	b
201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220
b	a	d	d	a	b	d	b	a	b	a	a	c	c	c	d	d	b	b	d
221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
c	d	a	a	c	a	b	d	c	a	a	a	c	c	d	b	c	a	c	d
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260
d	d	c	b	c	c	c	b	c	c	c	c	c	d	d	c	c	c	b	d
261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280
b	a	c	c	c	d	c	c	a	d	a	c	b	c	d	b	d	c	c	a

281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
c	d	b	c	b	b	a	c	b	b	b	c	d	a	a	c	b	d	b	a
301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320
d	c	d	b	b	a	d	c	b	b	d	b	c	b	d	d	d	a	b	a
321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340
b	a	b	b	b	d	d	d	a	a	d	b	b	c	d	d	a	c	b	b
341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
b	c	b	c	b	c	a	c	a	c	c	d	c	a	c	b	a	b	b	a
361	362																		
a	c																		

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