Revision Notes on Sexual Reproduction in Flowering Plants

Flower

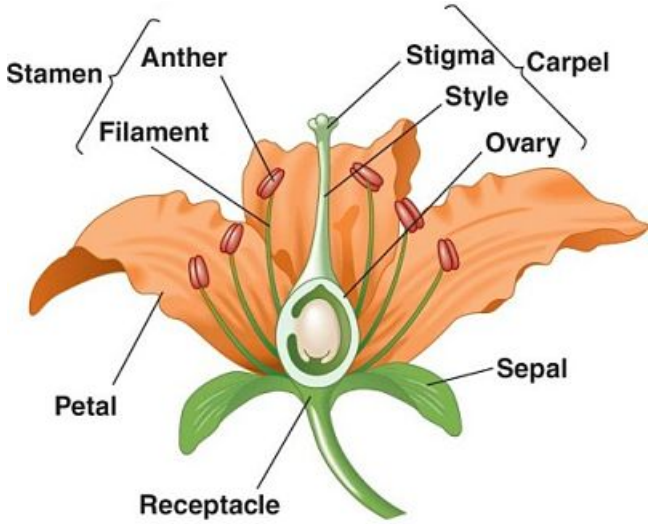
Flower is a modified stem which functions as a reproductive organ and produces ova and/or pollen

(1) Structure of the flower:

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.



(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.

(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.

(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.

(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.

(3) Functions of a flower

(i) Flowers are modifications of shoot to perform the function of sexual reproduction.

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

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

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

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

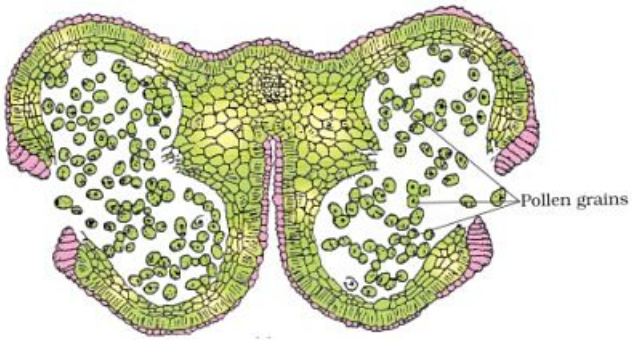
seeds.

Microsporogenesis

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

Microsporogenesis is well studied under following heads:

(1) Structure of anther:



The fertile portion of stamens is called anther. Each anther is usually made up of two lobes connected by a connective. In turn each anther lobe contains two pollen chambers placed longitudinally. Each pollen chamber represents a microsporangium and is filled with a large number of pollen grains or microspores.

The pollen sacs are surrounded by following 4 layers :

(i) Epidermis: This is the outermost single layered and protective. In Arceuthobium, cells of epidermis develop 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) Tarentum: This is the innermost layer of the wall. The cells are multinucleate (undergo endopolyploidy) and polyploid. Tapetal cells are nutritive.

(2) Development of anther and formation of microspores (Pollen grains):

(a) The young anther consists of homogenous mass of paranchymatous cells surrounded by epidermis. It soon becomes four lobed.

(b) In each of the four lobes, some of the hypodermal cells begin to act as archesporial initials.

(c) Each archesporial initial divides into an outer primary parietal cell and an inner primary sporogenous cell.

(d) The primary parietal cell divides to form 3-5 wall layers, i.e., endothecium, middle layers and tapetum.

(e) The primary sporogenous cells divide to produce a mass of sporogenous cells or microsporocytes.

(f) Each microspore mother cell divides meiotically to form four haploid microspores or pollen grains and remains arranged in tetrads.

(3) Development of male gametophyte (Microgametogenesis):

(a) Microspore or pollen grain is the first cell of male gametophyte (partially developed).

(b) 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). The inner intine is thin, delicate and is made of cellulose and pectose.

(4) Pre-pollination development:

(a) Microspores start germinating in situ (i.e. while enclosed inside the microsporangium or pollen sac) and are called precocious.

(b) Microspore nucleus divides mitotically to form a smaller generative cell lying next to spore wall and a much larger vegetative cell (or tube cell).

(c) 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.

(d) The callose layer then dissolves. The pollen grains are shed from the anther at this bicelled stage (rarely three celled).

(5) Post-pollination development:

(a) The liberated pollen grains are transferred to the receptive surface of the carpel (i.e., stigma) by the process called pollination.

(b) On the stigma, the pollen grain absorbs water and swells within a few minutes.

(c) The vegetative (or tube) cell enlarges and comes out through one of the apertures in the form of a pollen tube.

(d) 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.

(e) The vegetative and generative nuclei are carried by the pollen tube, the farmer lying at its tip.

(f) The generative cell divides to form two non-motile male gametes.

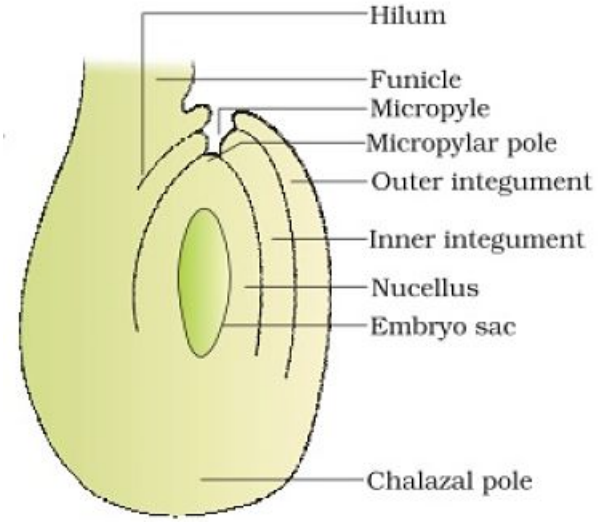
(g) The tube nucleus has no important function and may disintegrate.

Megasporogenesis

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

(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.



(2) 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.

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

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

Pollination

(1) The process of transfer of pollen grains from an anther to the stigma of the same flower or of different flower.

(2) It is of two types:

(i) 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.

(ii) 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.

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.

(2) Entry of pollen tube into ovule:

After reaching ovary, the pollen tube enters the ovule. Pollen tube may enter the ovule by any one of the following routes:

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

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

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

(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 enlarges 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.