SEXUAL REPRODUCTION IN FLOWERING PLANTS

1. Sexual Reproduction

It is a process of development of new organisms due to the fusion of male and female gametes. It occurs through flowers in plants. Such plants are called **angiospermic** or **flowering plants**.

2. Flower

It is the site of sexual reproduction in flowering plants. A typical flower consists of four whorls of floral appendages, attached on the receptacle, i.e.

A. **Calyx** is the outermost protective whorl of flower, which is usually green in colour.

B. **Corolla** is the second whorl of flower. It contains petals which are brightly coloured and are fragrant. This makes flowers attractive which helps in pollination.

C. **Androecium** is the male whorl which consists of stamens. Each stamen consists of anther, filament and a connective.

D. **Gynoecium** is the female whorl which consists of carpel or pistil. It contains three parts, i.e. stigma, style and ovary.

3.Pre-Fertilisation Events

These include the development of male and female gametophyte.

A. **Male Reproductive** Part It consists of a stamen, microsporangium and a pollen grain.

(i) A typical stamen has two main parts, i.e. an anther and a long slender structure called filament. Anther is a bilobed structure with each lobe having two theca. Thus, it has four microsporangia which develop and become pollen sacs that contain pollen grains. Ploidy level of pollen mother cell is diploid.

(ii) **Structure of Microsporangium** Transversely, a microsporangium appears circular in outline. It is generally surrounded by four layers, i.e. the epidermis, endothecium, middle layer and tapetum (nourishing tissue).

(iii) **Pollen grains** are known as male gametophytes. Each pollen grain has a two-layered wall, i.e. sporoderm. The outer layer is hard and known as exine. It is

made up of sporopollenin. The inner layer is thin, called as intine. It is composed of cellulose and pectin.

- **Microsporogenesis** The formation of microspores from a pollen mother cell through the meiosis is called microsporogenesis. Pollen grains are released by dehiscence of an anther.
- These microspores later develop into microgametophytes or matured pollen grains. This process is known as microgametogenesis. Each pollen grain has two cells, i.e. generative cell and vegetative cell. The vegetative cell is large and irregular in shape. It has abundant reserve food. The generative cell is small, spindle-shaped and floats in cytoplasm of the vegetative cell.

B. Female Reproductive Part It consists of pistil, megasporangium (ovule) and embryo sac.

(i) **Pistil** is the female reproductive unit of a flower. The main parts of a pistil are stigma, style and ovary. Stigma is meant to receive pollen grains, style is the slender part below the stigma and the basal swollen part of style is called ovary.

(ii) **Ovule** (megasporangium) is attached to the placenta by a stalk called funicle. Hilum is the junction between ovule and funicle. Each ovule contains two protective envelops, called integuments.

Micropyle is present at the tip while chalaza lies opposite to the micropylar end representing the basal part of the nucellus. Nucellus has food reserves.

(iii) Megasporogenesis It is the process of formation of megaspores (4) from megaspore mother cell by meiotic division.

- Only one of the 4 megaspores is functional which develops into female gametophyte or embryo sac. This is called monosporic development, while the other three degenerate in most of the angiosperms.
- Embryo sac or female gametophyte is formed when the nucleus of functional megaspore divides mitotically to form two nuclei, which move to the opposite poles and form 2-nucleate embryo sac, which then results into the formation of 4-nucleate and later 8-nucleate stage. This event is known as megagametogenesis.
- The mature embryo sac contains 7- cells and 8-nuclei (polygonum type). The 6 out of 8- nuclei get surrounded by cell wall and are organised into cells. Three cells present towards the micropylar end, grouped together

constitute the egg apparatus, i.e. two synergids and one egg cell. The 3-cells of the chalazal end are called antipodals.

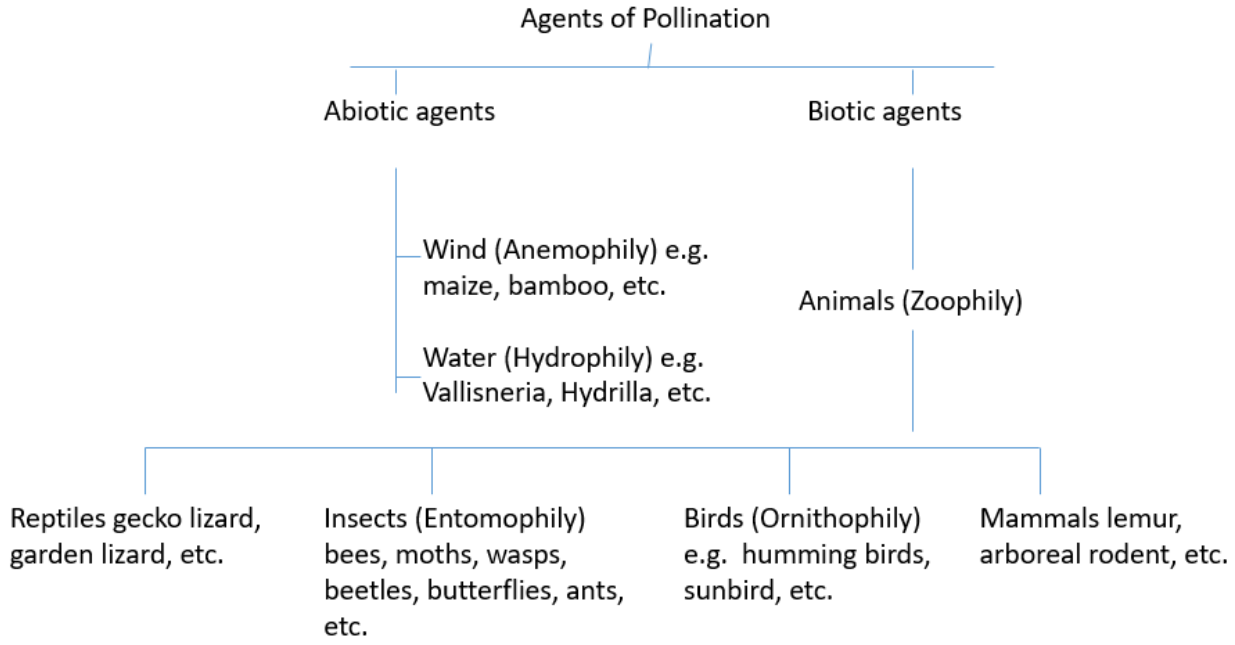
4.Pollination

Transfer of pollen grains from anther to stigma is called pollination. Stamen and other whorls fall down after pollination. Pollination is of two types

A. Self-Pollination When pollen grains reach to the stigma of the same flower (autogamy) or to the stigma of the another flower of the same plant, (geitonogamy), it is known as self-pollination. It is found in both unisexual and bisexual flowers. Adaptations for self-pollination are homogamy and cleistogamy.

B. Cross-Pollination or Allogamy (Xenogamy) In this pollination, pollen grains of one plant reach to the stigma of flower of another plant of the same species. It involves two plants of the same species to produce seeds. Unisexuality, dichogamy, self-sterility, heterostyly, dioecy and herkogamy are the specific adaptations in flowering parts to prevent self-pollination. These are also known as outbreeding devices. Pollen grains require some agencies to reach to the stigma.

These agencies are grouped as follows



5. Pollen-Pistil Interaction

It is an essential step in fertilisation of angiosperms because it determines the compatability and incompatability of pollen and pistil. It generally includes the events from the deposition of pollen on the stigma till the pollen tube enters ovule. This pollen-pistil interaction comprises of three stages

(i) Recognition of compatible pollen

(ii) Growth of a pollen tube

(iii) Entry of pollen tube into the ovule.

6. Artificial Hybridisation

It is the crossing of different species to generate a progeny by combining desirable characters which are present in commercially superior varieties. It is used for crop improvement programmes. This process involves

(i) Emasculation It refers to anther removal before its dehiscence.

(ii) Bagging and covering emasculated flower in a bag to prevent its contamination by unwanted pollen grains.

7. Fertilisation

It occurs just after pollination. Fusion of male and female gametes is called fertilisation. Pollen tube enters in ovary and after fertilisation embryo is formed.

8. Double-Fertilisation

It was discovered by SG Nawaschin in Fritillaria and Lilium plants in 1898. In this, one of the male gametes fuses with egg cell and forms diploid zygote. This is called syngamy. The other male gamete fuses with polar nuclei and forms 3n (triploid) Primary Endosperm Nucleus (PEN), so this is called triple fusion. This is the specific feature of angiosperms.

9. Post-Fertilisation Events

The major post-fertilisation events include development of endosperm and embryo, maturation of ovules into seeds and ovary into fruit. These events take place soon after double- fertilisation.

Endosperm development is of three types, i.e. nuclear type, cellular type and helobial type. Out of these, nuclear type is the most common one in which the PEN undergoes repeated mitotic divisions without cytokinesis. At this stage, endosperm is called free endosperm **nucleus.**

Development of an embryo takes place at the micropylar end of the embryo sac. The zygote development gives rise to proembryo and later globular, heart-shaped and mature embryo. Embryos are of two types, i.e. dicot embryo which consists of two cotyledons and monocot embryo which consists of only one cotyledon (called scutellum) e.g. rice, maize, etc.

10. Development of Seed and Fruit Formation

After fertilisation, ovary converts into fruit. The wall of ovary develops into pericarp, a fleshy part of fruits. It has three layers, i.e. epicarp, mesocarp and endocarp. Ovule converts into seed which consists of seed coat, cotyledon and embryonal axis. The seed coat contains two layers, i.e. outer called testa (hard) and inner called tegmen.

Types of fruits are as follows

A. False fruits are derived from ovary along with thalamus or other accessory floral parts, e.g. apple, cashewnut, strawberry, etc.

B. True fruits are derived from ovary of flower, e.g. mango and tomato.

C. Parthenocarpic Fruit When development of fruit in plants occurs without pollination and fertilisation, it is called parthenocarpy. As a result of this process, seedless fruits are developed like grapes, banana, pineapple, papaya, lemon, etc.

11. Significance of Seed and Fruit Formation

Seeds are basis of agriculture and can be stored for long period of time. Fruits protect seed from mechanical injury. They provide food to animals who act as pollinating agents.

12. Methods of Specific Types of Seed Development

A. **Apomixis** Sometimes embryo and sporophyte develop without fusion of male and female gametes or without gametophyte. This is called apomixis.

B. **Polyembryony** The process of developing more than one embryo in one seed is called polyembryony. It occurs as a result of presence of more than one embryo sac in the ovule or due to fusion with cell other than egg cell.