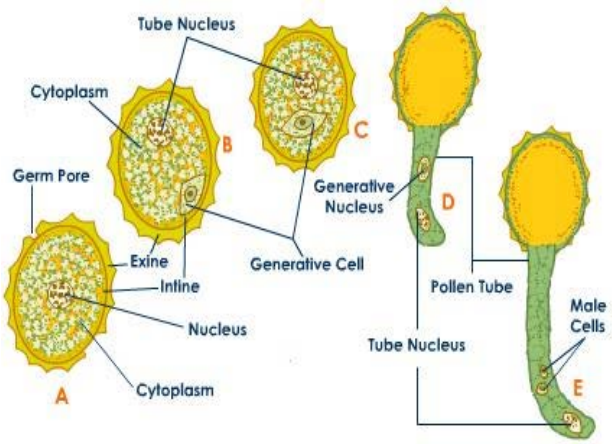
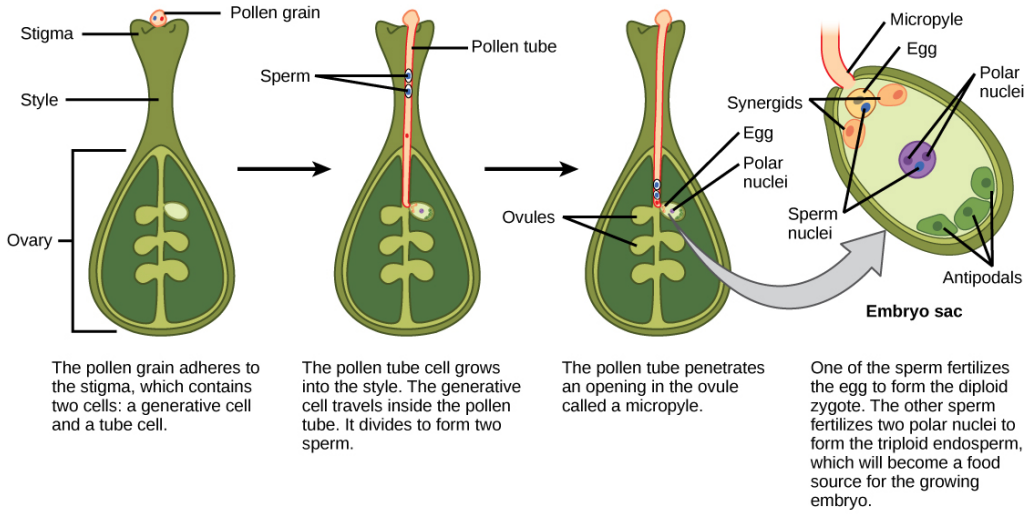
Lecture 3: Fertilization in Flowering Plants

Fertilization is defined as the fusion of haploid gametes to initiate the development of a new diploid organism.



After pollen is deposited on the stigma, it must germinate and grow through the style to reach the ovule. The microspores, or the pollen, contain two cells: the pollen tube cell and the generative cell. The pollen tube cell grows into a pollen tube through which the generative cell travels. The germination of the pollen tube requires water, oxygen, and certain chemical signals. As it travels through the style to reach the embryo sac, the pollen tube growth is supported by the tissues of the style. In the meantime, if the generative cell has not already split into two cells, it now divides to form two sperm cells. The pollen tube is guided by the chemicals secreted by the synergids present in the embryo sac, and it enters the ovule sac through the micropyle. Of the two sperm cells, one sperm fertilizes the egg cell, forming a diploid zygote. This process is called **syngamy** or **true fertilization**. The other sperm fuses with the two polar nuclei, forming a triploid cell called the **primary endosperm nucleus** that develops into the **endosperm**. The process of nuclear fusion is called **triple fusion**. The entire phenomenon of fertilization involves the fusion of the egg and one of the male gametes, along with the union of the second male gamete with the secondary nucleus or the polar nuclei is called as **double fertilization**.

After fertilization is complete, no other sperm can enter. The fertilized ovule forms the seed, whereas the tissues of the ovary become the fruit, usually enveloping the seed.



Asexual reproduction

A form of reproduction that does not involve meiosis, ploidy reduction or fertilization, and the offspring is a clone of the parent organism; as there will be no changes of the genetic material. Asexual reproduction needs only one parent, unlike sexual reproduction, which needs two parents. Since there is only one parent, there is no fusion of gametes and no mixing of genetic information. As a result, the offspring are genetically identical to the parent and to each other.

Examples of asexual reproduction are:

1. Budding 2. Vegetative reproduction 3. Spore formation
4. Fragmentation 5. Parthenogenesis 6. Apomixes and nuclear embryonic

Methods of Asexual (Vegetative) Reproduction:

1. **Reproduction by using any part of plant**, to produce a new plant having similar genotypes as its source (from mother plant). The parts of the plant can be bulbs of onion and tubers of potatoes…etc.

2. **Reproduction by apomixes**: This involved the embryo formation without the gamete union (male & female gametes) or establish from unreduced cells (2n). There are many methods for apomixes to happen:

    1) **Parthenogenesis**: When the embryo sac reduced haploid plant (n), mostly this plant is weak because it is sterile, this kind found in some horticultural crops, it does not produce seeds (seedless) such as banana and pineapple, usually can spray the IAA, NAA on the pistils of the flowers to encourage this as in Tomato and Watermelon.

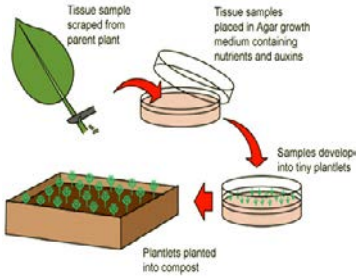
IAA being the natural auxin is present in abundance in plants but NAA is the synthetically made auxin in the labs.

    a) **Adventitious embryonic:** The embryo produced from growth of the cells surrounding the ovary from integuments or ovary wall with the existence of haploid embryo sac.

    b) **Apospory:** it is similar to Adventitious embryonic, but no existence for haploid embryo sac (diplo spore).

    c) **Development of megaspore mother cell:** Directly or indirectly to embryo sac by normal mitosis division or modified which prevent of reduction the chromosomes number by meiosis division without fertilization.

3. **Reproduction by Tissue and Cell culture:** It is stated as a method to unlimited asexual reproduction for desirable genotypes.



Pollination:

In angiosperms, **pollination** is defined as the placement or transfer of pollen grains which produce the male gametes from the anther to the stigma then the ovules which bear the female gametes of the same flower or another flower. Or the transference and deposition of pollen grains from the anther to the stigmatic surface of the flower is called pollination.

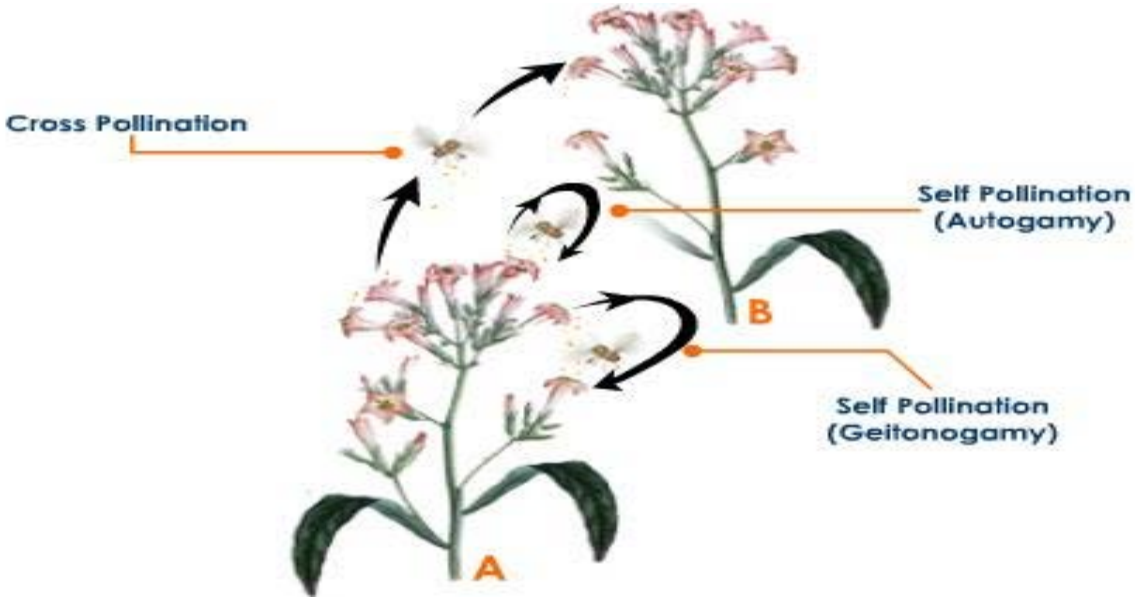
Significance of Pollination:

The breeding method is determinates by pollination method of the crops. Pollination leads to fertilization, resulting in the production of seeds and fruits, thus ensuring continuity of life.

Classification of plants according to pollination method

The economical plants which have sexual reproduction according the common pollination method divided into three groups:

- Self-Pollination
- Partial Cross Pollination
- Cross Pollination



Self-Pollination (Autogamous)

Self-pollination occurs when the pollen from the anther is deposited on the stigma of the same flower, or another flower on the same plant. It occurs in flowers where the stamen and carpel mature at the same time, and are positioned so that the pollen can land on the flower's stigma. The cross pollination is less than 1% and sometimes reach to 10%. Such as in the Fabaceae plant family e.g., beans.

Partial cross pollination: The cross pollination between 10%-49% and the self-pollination exceed 50%. Such as in tomatoes.

Cross Pollination or (Allogamous):

Cross-pollination is the transfer of pollen from the anther of one flower to the stigma of another flower on a different individual of the same species. It is also known as allogamy or exogamy. Cross pollination requires the help of abiotic or biotic agencies such as wind, water, insects, birds, bats, snails and other animals. The cross pollination exceeds 50% sometime its limitation, the cross pollination exceeds to 90%. Such as in strawberries

Factors affecting self- pollination

Self-pollinating (autogamy) known as the move of pollen grain transferred from the anther to the stigma herself (in the same flower) , but according to plant breeders self-pollination includes the transfer of pollen grain to the stigma of any flower on the same plant. The case known as (geitonogamy) or any flowers of any plants in the vegetative line itself. Because the plants have homozygous genotypes. Usually, self-pollinated case is more developed than cross pollinated. Self-pollination happens when the flower includes stamens and pistil together, that known as bisexuality and the stamens and pistil became mature at the same time

known as (Homogamy). The self-pollination rare is complete, in which, mostly the cross pollination occurs about 10%.

Mechanisms promoting self-pollination

The various mechanisms that promote self-pollination are generally more efficient than those promoting cross –pollination: These mechanisms are listed below:

1. Cleistogamy**.** In this case, flowers do not open at all. This ensures complete self-pollination since foreign pollen cannot reach the stigma of a closed flower. Cleistogamy occurs in some varieties of wheat, oats, and barley and in a number of other grasses. Such as in Viola flower as well.

2. In some species, the flowers open, but only after pollination has taken place. This occurs in many cereals, such as, wheat, barley, rice and oats. Since the flower open, some cross-pollination may occur.

3. In crops like tomato the stigmas are closely surrounded by anthers. Pollination generally occurs after the flowers open, but the position of anthers in relation to stigmas ensures self-pollination.

4. In some species, flowers open but the stamens and the stigma are hidden by other floral organs. In several legumes, e.g., pea and Soybean the stamens and the stigma are enclosed by the two petals forming a keel.

5. In a few species, stigmas become receptive and elongate through stamen columns. This ensures predominant self –pollination.