**Types of Pollination:**

The transfer of pollen grains from the opened anther of the stamen to the receptive stigma of the carpel/pistil is called pollination. Each pollen grain grows and provides two male gametes for fertilisation of an ovule.

Depending upon the source of pollen grain, pollination is of three types:

1. Autogamy (Self-pollination):

It is the kind of pollination in which the pollen from the anthers of a flower is transferred to the stigma of the same flower, e.g., wheat, rice, pea, etc.

Autogamy is further classified as:

(i) Cleistogamy In some plants, flowers never open up and the anthers dehisce inside these closed flowers to ensure pollination. Thus, cleistogamous flowers are invariably autogamous as there is no chance of cross-pollination. These flowers produce assured seed sets even in the absence of pollinators, e.g., Oxalis, Viola, etc.

(ii) Homogamy In this method, both the anthers and the stigma mature at the same time, e.g., Mirabilis.

2. Geitonogamy:

It is a kind of pollination where the pollen grains from the anther of the flower are transferred to the stigma of another flower borne on the same plant but at different branches. It usually occurs in plants, which show monoecious condition, e.g., Cucurbita.

3. Xeno-gamy (Cross-Pollination):

It involves the transfer of pollen grains from the flower of one plant to the stigma of the flower of another plant. This is the only type of pollination which brings genetically different types of pollen grains to the stigma during pollination, e.g., papaya, maize, etc.

**Agents of Pollination**

Adaptations for Wind Pollination:

Wind pollination is also termed as anemophily and takes place through the wind.

i. Flowers are small, colourless, inconspicuous, nectar less and become arranged as inflorescence.

ii. The anthers are well exposed for the easy dispersal of pollen grains.

iii. Pollen grains are small, light, dry, dusty, non-sticky and sometimes even winged.

iv. The stigmas are large, hairy and feathery or branched to catch the air borne pollen grains.

v. Examples of wind pollinated flowers are grass, sugarcane, bamboo and coconut, etc.

Adaptations for Water Pollination:

Water pollination is also termed as hydrophily and mode of pollination is water. It is quite rare in flowering plants and is limited to about 30 genera, mostly monocotyledons.

i. It is very common in plant groups such as algae, bryophytes and pteridophytes. Flowers are small, colourless, inconspicuous, odourless and nectar-less and pollen grains and stigmas are generally unwettable.

ii. The stigmas are long and sticky, e.g., Vallisneria, Hydrilla and Zostera.

iii. Not all aquatic plants use water for pollination. In a majority of aquatic plants, the flowers emerge above the level of water and are pollinated by insects or winds as in land plants, e.g., water hyacinth and lily.

iv. In Vallisneria, the female flower reach the surface of water by the long stalk and pollen grains are released on to the surface of water. They are then carried by the passive water currents.

v. In most of the water pollinated species, pollen grains are protected by mucilaginous covering.

Adaptations for Insect Pollination:

Inject pollination in also termed as entomophily.

Insect-pollinated flowers are large, colourful, fragrant and rich in nectar.

i. A number of flowers are clustered into an inflorescence to make them conspicuous.

ii. Flowers have nectar glands and are highly fragrant to attract insects.

iii. The surface of pollen grains is sticky due to exine layer and stigma is sticky due to mucilaginous layer.

iv. Nectar and pollen grains are floral rewards for the insect pollinators.

v. In some species, floral rewards are to provide safe place to lay eggs, e.g., for the tallest flower of Amorphophallus (about 6 feet in height).

vi. In plant Yucca, moth and the plant, cannot complete their life cycles without each other. The moth deposits its eggs in the locule of the ovary and the flower, in turn plant gets pollinated by the moth. The larvae of the moth come out of the eggs as the seeds start developing.

**Double Fertilization**

In plants, reproduction is attained by fertilization; more precisely double fertilization.

Double Fertilization Definition

“Double fertilization is a complex process which involves the fusion of one female gametophyte with two male gametes.

Double fertilization is a chief trait of flowering plants. In the phenomena, one female gamete unites with two male gametes. One of the male gametes fertilizes the egg resulting in the formation of a zygote and the other unites with 2 polar nuclei for the formation of an endosperm.

Double fertilization provides stimulus to the plant resulting in the ovarian development to fruits and development of ovules into the seed. When the haploid male gametes and female gametes fuse, the diploid state of the plant is restored.

Double Fertilization in Angiosperms

Angiosperms are flower-bearing plants and are the most diverse group of terrestrial plants. The flowers form the reproductive part of angiosperms with separate male and female reproductive organs. Each contains gametes – sperm and egg cells, respectively.

Pollination helps the pollen grains to reach stigma via style. The two sperm cells enter the ovule-synergid cell. This proceeds to fertilization.

In angiosperms, fertilization results in two structures, namely, zygote and endosperm, hence the name “double fertilization.”

Double fertilization is a complex process where out of two sperm cells, one fuses with the egg cell and the other fuses with two polar nuclei which result in a diploid (2n) zygote and a triploid (3n) primary endosperm nucleus (PEN) respectively.

Since endosperm is a product of the fusion of three haploid nuclei, it is called triple fusion. Eventually, the primary endosperm nucleus develops into the primary endosperm cell (PEC) and then into the endosperm.

The zygote becomes an embryo after numerous cell divisions

**Development of Embryo in Angiosperms**

Once fertilization is completed, embryonic development starts and no more sperms can enter the ovary. The fertilized ovule develops into a seed, and ovary tissues develop a fleshy fruit which encloses the seed.

After fertilization, the zygote divides into the upper terminal cell and lower basal cell. The basal cell develops into suspensor, which helps in the transport of nutrients to the growing embryo. The terminal cell develops into pro-embryo.

Following are the different stages involved in the development of an embryo.

Stages of Embryonic Development In Angiosperms

* In the first stage of development, the terminal cell divides forming a globular pro-embryo. The basal cell also divides, into a suspensor.
* The developing embryo attains a heart shape due to the presence of cotyledons.
* The growing embryo gets crowded and begins to bend.
* The embryo fills the seed completely.

Significance of Double Fertilization:

* Two products are obtained as a result of double fertilization.
* There are chances of polyembryony, and the plant has better chances of survival.
* Double fertilization gives rise to an endosperm that provides nourishment to the developing embryo.
* It increases the viability of the seeds of angiosperms.
* It utilizes both the male gametes produced by the pollen grains.

**Embryo in Plants**

The embryo develops from the zygote at the micropylar end of the embryo sac. It is formed as a result of syngamy when a male gamete fuses with the egg cell. The embryo is present in the seed and is made up of the embryonal axis, cotyledons (one or two). Radicle and plumule are present at the two ends of the embryonal axis.

The zygote produced after fertilization must undergo various cellular divisions and differentiations to become a mature embryo.

Dicot Embryo

A dicot embryo contains two cotyledons and an embryonal axis. Epicotyl is the portion above the cotyledons in the embryonal axis and terminates in the stem tip known as plumule. Hypocotyl is the lower end of the embryonal axis terminating in the root tip or radicle. The root cap covers the radicle.

Monocot Embryo

The monocot embryo possesses only one cotyledon. In grasses, the cotyledon is known as scutellum and present on the lateral side of the embryonal axis. Epicotyl has a shoot apex enclosed in coleoptile and the root cap is enclosed in an undifferentiated sheath known as coleorhiza.

The mature embryo of dicotyledons is globular and heart-shaped. It consists of two cotyledons. Monocotyledons possess only one cotyledon.

Seed Dispersal

Types of Seed Dispersal

As we walk around the garden, we come across the different types of new seedlings, and small plants with tender leaves and stem arising from the soil. Have you ever wondered, how these new plants grow and how seeds are dispersed? Here in this article, let us learn in brief about the seeds and how they are dispersed.

What is a Seed

Seeds are the unit of the reproduction of a flowering plant that is capable to develop into a single plant. In some species of plant, like walnuts, groundnuts, and chickpeas, seeds are also used as sources of food.

A fully grown and developed seed has three primary parts: the embryo, endosperm, and seed coat. The plumule is present in the seed embryo, which develops into a new plant.

What is Seed Dispersal

Seed Dispersal is an adaptive mechanism in all seed-bearing plants, participating in the movement or transport of seeds away from their parent plant to ensure the germination and survival of some of the seeds to adult plants. There are many vectors to transport the seed from one place to another.

Types of Seed Dispersal

There are different ways in which seeds from its parent plant is dispersed. These include:

**Seed Dispersal by Wind**

The wind is the natural and fundamental means of seed dispersal in the plant kingdom. This process of dispersal is mainly seen in those plants which bear very light seeds. The seeds of the orchid plant, dandelions, swan plants, cottonwood tree, hornbeam, ash, cattail, puya, willow herb, are all examples of plants whose seed are dispersed by the wind.

**Seed Dispersal by Water**

In this method of seed dispersal, seeds float away from their parent plant. These are mainly seen in those plant which lives in water or nearby the water bodies like beaches, lakes, ponds etc. Coconut, palm, mangroves, water lily, water mint, are a few examples of plants whose seed are dispersed by the water.

**Seed Dispersal by Animal and Birds**

There are different ways in which animals and birds disperse the seeds.

Few animals and birds are attracted to bright colourful fruits. They eat the entire fruit and only the juicy part is digested by their system and the seed are excreted out in the form of their dropping, which forms into new plants. Blackberry, cherry, tomato and apple seeds are dispersed in this way.

A few species of squirrels collect nuts from different plants like acorns and bury them under the soil as they store food for the winter season and often forget the place where they have previously buried them and the seeds grow into new trees.

There are a few plants which bear seeds with hooks. Burdock plant is an example of this type of plant species. The seed of these plants catches on the fur of animals and are carried away to different places, far from their parent plants.

Dates, rambutan, sea grapes, sea holly, tamarind, raspberry, sunflower, tomatoes are a few examples of plants whose seeds are dispersed by animals and birds.

**Seed Dispersal by Gravity**

Gravity is a force of attraction that exists among all the objects in the universe.

As the fruits from the tree fall on the ground due to the force of attraction, they sometimes roll down to some smaller distance, get buried in the soil after a few days and germinate into a new plant.

In certain cases, fruits which do not have very hard seed coat may crack and open after falling down from a height, which leads to a better dispersion of seeds.

In some cases, the fallen fruit is carried by other agents like water, wind, birds or animal and helps in the dispersion of seeds.

Apples, Commelina, canna, coconuts, calabash, passion fruit are a few examples of plants whose seeds are dispersed by Gravity – A force of attraction.

**Seed Dispersal by Explosions**

Explosions in fruits literally refer to bursting with all its energy. In this case, as the fruits get ripened, it shoots out its seeds into the external environment. This type of seed dispersal is mainly seen in those plants having pods.

Okra, Lupins, gorse, and broom are a few examples of plants whose seeds are dispersed by Explosions. Pea and bean plants also have pods and the seeds burst out when they ripen and pod has dried.

**Structure of a Seed**

Seeds of different plants may vary in many ways, but the basic anatomy remains the same. A typical seed consists of the following parts:

Tesla: It is the outer coat of the seed that protects the embryonic plant.

Micropyle: It is a tiny pore in the testa that lies on the opposite of the tip of the radicle. It permits water to enter the embryo before active germination.

Hilum: Is a scar left by the stalk which attached the ovule to the ovary wall before it became a seed.

Cotyledon: In some plants, this contains high quantities of starch and will provide a source of food for the developing embryo prior to germination, in other plants this role is performed by an endosperm. In monocotyledons, there is just one cotyledon whereas in dicotyledons there are two. Depending on the type of germination (epigeous or hypogeous) the cotyledons may remain below ground or be pulled above ground.

Radicle: This is the embryonic root which will develop into the primary root of the plant. It is usually the first part of the embryo to push its way out of the seed during germination.

Plumule: This is the embryonic shoot. It appears as a bud which will give rise to the shoot and the remaining structures in the plant.

Endosperm: In many plants, a separate part for storage of starch develops and this is called the endosperm. It is seen in maize and wheat.

