Reproduction in Plants

Asexual Reproduction in Plants

We know that all organisms produce offsprings of their own kind. The process by which parents give rise to new individuals is known as **reproduction**. Plants also reproduce like all other organisms. **What parts of plants are involved in reproduction?**

Vegetative and reproductive parts of plants

Vegetative parts of plants are those which do not participate in the process of reproduction. The plant parts which give rise to new plants are known as **reproductive parts**. The given table lists the various vegetative and reproductive parts of plants.

Vegetative part	Reproductive part
Stem	Flower
Root	
Leaf	

The flower is the reproductive part of a plant. It has either or both the male and female parts.

How does a plant reproduce?

There are **two** types of reproduction in plants.

- **Asexual reproduction** is the process by which a plant gives rise to a new plant without producing seeds or spores.

- **Sexual reproduction** is the process by which a plant gives rise to a new plant by producing seeds. When a plant reaches a certain period of its growth, it starts bearing flowers. The flowers then give rise to fruits, which contain seeds. When animals eat these seeds, they discard them, which later germinate to give rise to a new plant.

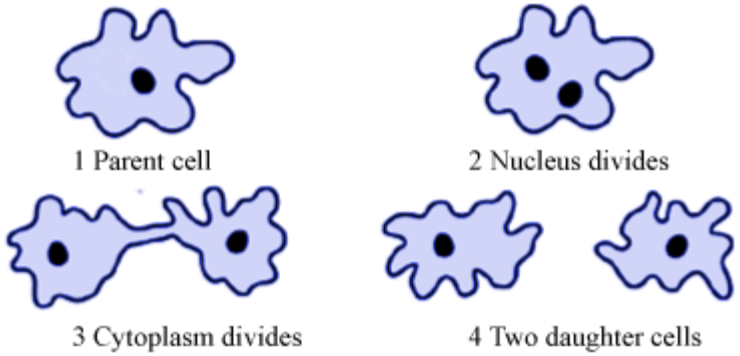
  Let us now study how plants reproduce through asexual reproduction.

  Asexual reproduction takes place by the following methods:

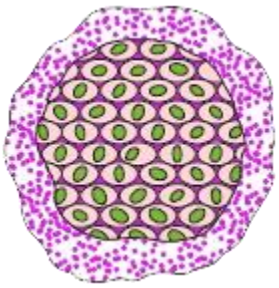
- Binary fission
- Budding
- Fragmentation
- Spore formation
- Vegetative propagation

Binary fission

In binary fission, the single cell divides into halves. A few organisms that divide by binary fission are bacteria and *Amoeba*. In this process, the nucleus of *Amoeba* first divides to form two daughter nuclei. Later the body of *Amoeba* splits into two halves, each half receiving its own nucleus. This leads to the formation of the two daughter cells.



Multiple fission: In multiple fission, a single cell divides into many daughter cells simultaneously. Examples: *Plasmodium*, *Chlorella*, etc



Budding

It involves the formation of a new individual from a protrusion called the **bud**. It is very common in plants and in yeasts. In yeast; the cells divide rapidly at a specific site and develop as an outgrowth called a **bud**. These buds, while attached to the parent cell, develop into small individuals. When this individual becomes large enough, it detaches itself from the parent body to exist as an independent individual.

How do they reproduce so fast? Let us study what is their mode of reproduction.

Do you want to observe baby yeasts?

Add a pinch of yeast powder to a container filled with water. Now, add a spoonful of sugar and shake the mixture to dissolve the sugar. Keep the container in a warm place. After an hour, take a drop from the liquid and place it on a clean glass slide. Observe the glass slide under the microscope. You will notice bud formation in yeast.

Fragmentation

It is a form of asexual reproduction in which an entirely new organism is formed from a fragment of the parent. It occurs in multicellular organisms, whose body organisation is fairly simple such as annelids, starfish, fungi, lichens, and some algae such as *Spirogyra*. The filaments of *Spirogyra*, upon maturation, break into small pieces or fragments, which grow into new individuals.

Spore formation

What are spores?

Spores are a type of reproductive structures produced asexually. Spores are covered with a hard protective coat.

What are the advantages of reproducing through spore formation?

- Spores can withstand unfavourable conditions such as high temperature and low humidity. This property of the spores makes them survive for a longer period of time.
- Spores are light in weight, which helps them to travel in the air. This is the reason for the spoilage of food kept in close proximity.

How do spores give rise to a new organism? Under favourable conditions, a spore germinates and develops into a new organism. Spore formation also occurs in plants such as moss and ferns.

Vegetative Propagation

The development of a new plant from the vegetative part of a plant like stem, root or leaf is known as vegetative propagation.

Vegetative propagation is further divided into

- Natural propagation
- Artificial propagation

Natural propagation

From underground stem: A potato plant has an underground stem known as the tuber. It has many buds called eyes. A vegetative bud consists of a short stem, around which immature overlapping leaves are present in a folded state. A bud can give rise to a new plant through asexual reproduction.

Let us perform an activity to investigate whether a bud can give rise to a whole plant.

Take a fresh potato and observe the scars present on it with the help of a magnifying glass. You will observe that there are buds present in the scars. Now, cut a piece from the potato having a scar, and keep it in soil. Water the piece everyday. After a few days, you will find a new plant coming out of the cut piece of the potato. Thus, buds can produce new plants through vegetative reproduction.

Rhizome: The underground stem of ginger is known as the rhizome which is capable of giving rise to a new plant. Corm is the underground stem as found in *Gladiolus.* It can also be used for vegetative propagation.

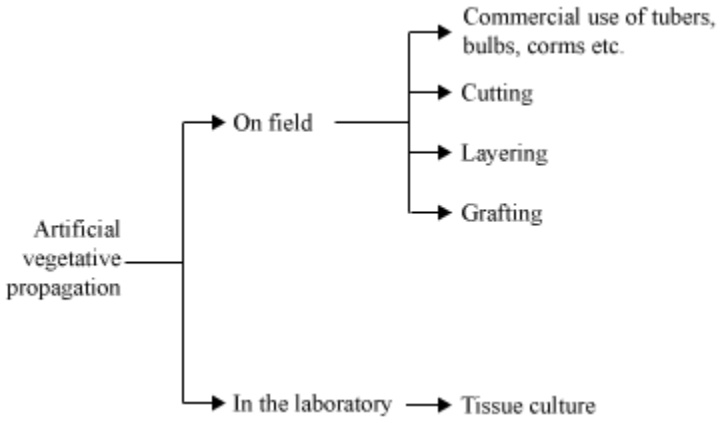
Through leaves: Leaves perform the function of photosynthesis. However, they can take part in asexual reproduction as well. In some plants, leaves can give rise to a new plant asexually. For example, the leaves of the plant ***Bryophyllum*** contain buds on its margins. These buds give rise to a new plant through asexual reproduction.

From aerial stem:

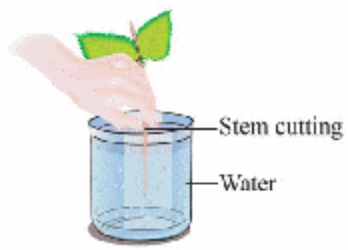
In certain plants, a slender stem arises from the base of the plant and touches the soil, it develops roots and buds at the point of contact with the soil and gives rise to new plants. When the new plant is old enough the stem connecting it to the parent plant withers away.

Artificial Vegetative Propagation

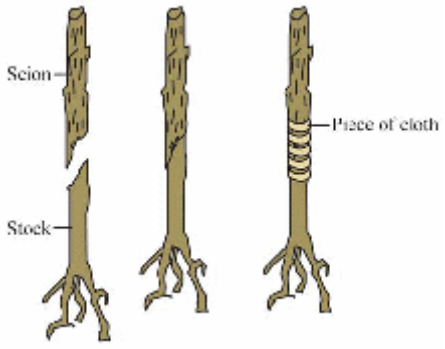
This process is used commercially for improving the yield, quality, and disease resistance in plants and their products.



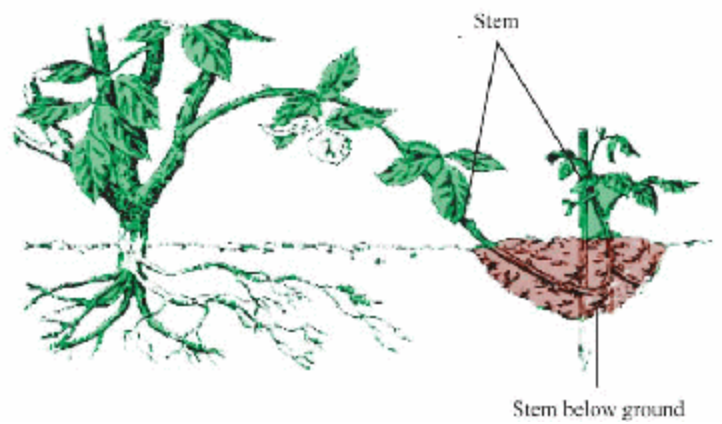
- **Cuttings:** It refers to the formation of a complete plant from regenerated pieces of roots, stems etc. For example, roses, sugarcane, money plant etc.



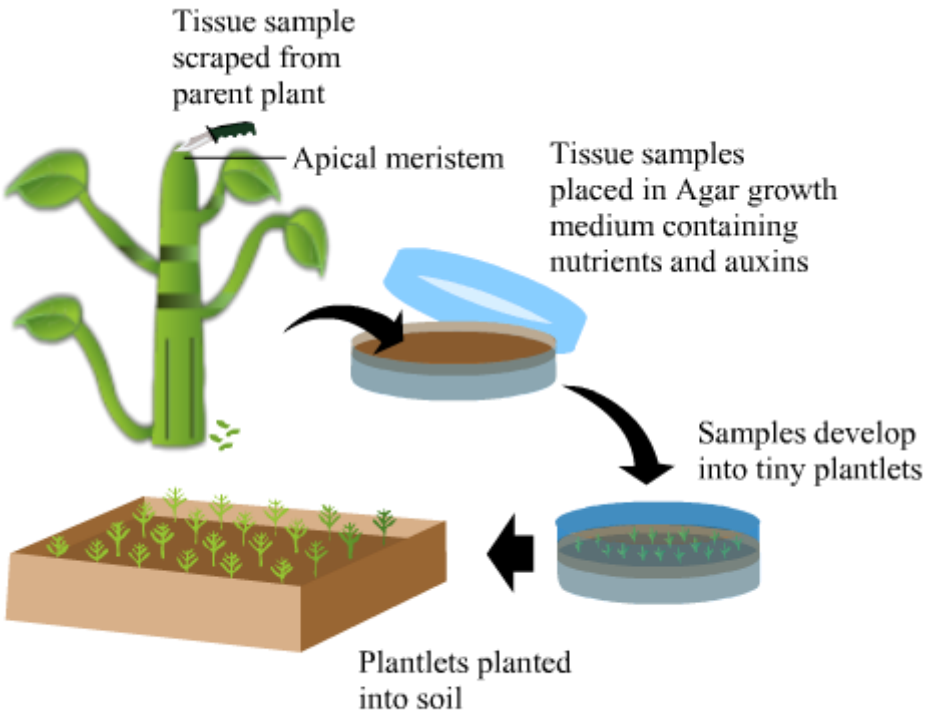
- **Grafting:** In this method, a stem cutting from the desired plant (scion) is inserted in a rooted plant (stock), which is resistant to diseases. Then, they are bound firmly with tape or cloth so that they have vascular continuity. For example, rose, mango, citrus etc.



- **Layering:** In this method, the branch of a plant is bent and covered with moist soil called mound. After a few days, roots arise from the underground portion; it separates from the parent plant and grows independently. For example, jasmine, strawberry, *Bougainvillea* etc.



- **Tissue Culture:** In this method, cells or tissues are taken from a plant under sterile conditions. The technique is developed on the basis of the principle that plant cells have the capacity to grow into plants of their own kind. Then, these cells or tissues are kept in dishes containing culture medium, they grow into an undifferentiated mass of tissue known as the **callus**, the callus is then transferred to another medium which induces the formation of plantlets. These plantlets can then be transferred into pots and grown into new plants. The nutrient medium consists of sucrose, inorganic salts, vitamins, amino acids and growth regulators like auxins, cytokinins etc. in a proper contaminant free environment. All these activities of tissue culture are carried out in well equipped laboratories maintaining aseptic conditions all throughout the process. Separate rooms are there to carry out various tissue culture processes such as nutrient preparation room, culture rooms, etc.
- This method of producing plants is also known as **micropropagation**. Plants produced using this technique are genetically identical to the parent plant. It is a quick method to produce large number of plants in a short period. This method is used for the propagation of *Chrysanthemum*, *Asparagus* and orchids.



Tissue Culture

Applications of Tissue Culture: It produces progeny, which is identical to the parent. Hence, useful characteristics of the parent are not lost.

• Large number of disease resistant and high yielding varieties of plants are obtained using this technique in a short period of time.

• Techniques of recombinant DNA technology can be combined with tissue culture to produce new plant varieties. For example: large number of transgenic higher plants have been produced by transferring nitrogen fixing gene from bacteria to higher plants.

• Large number of plants can be grown in limited time and space.

Advantages of Vegetative Propagation

Plants produced through asexual reproduction or vegetative propagation

- take less time to grow, and bear fruits and flowers earlier than plants produced through sexual reproduction
- are exact copies of the parent plant, thus retain all the desirable characters of the parent plant

Disadvantages of Vegetative Propagation

- Since all the plants grown through vegetative propagation are identical, they are prone to get affected simultaneously in case a disease is spread in the farm. This can result in big loss to the cultivator.
- Since daughter plants are identical to the parent plant, they are likely to carry the undesirable characters of the parent as well.
- In vegetative propagation, most of the daughter plants tend to grow in a restricted area, which leads to competition for resources among them.

Reproductive Parts of the Flower

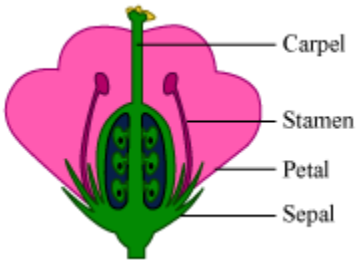
The flower is the reproductive organ of plants, which bears both male and female parts.

What are the male and female parts in a flower called? Do all flowers contain both male and female parts?

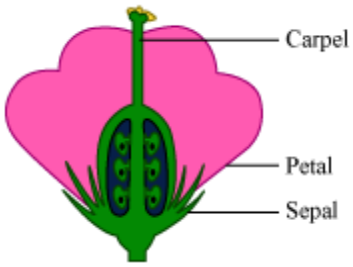
The male reproductive structure of a flower is known as the androecium whereas the female reproductive part is called the gynoecium. The androecium consists of a collection of stamens and gynoecium consists of a collection of pistils.

A complete flower four reproductive parts which are carpel, stamen, petal and sepal. However, not all the flowers contain both male and female reproductive parts. Incomplete flowers lack one or more main parts.

On the basis of the presence or absence of the reproductive parts, incomplete flowers can be of two types: **Bisexual and Unisexual**

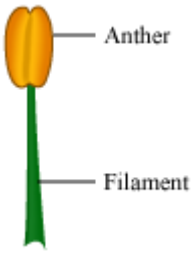
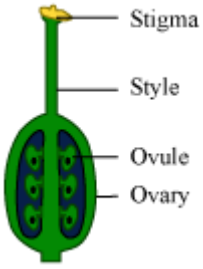


- **Bisexual flowers:** If both the stamen and carpel are present in a flower, then it is called a **bisexual flower**. Lily, rose, *Hibiscus*, Gulmohur (*Delonix regia*), etc. are some examples of bisexual flowers. A bisexual flower may or may not have sepals or petals.



- **Unisexual flowers:** If either the stamen or carpel is present in a flower, then it is called a **unisexual flower**. Corn, Marijuana, papaya, etc. are some examples of unisexual flowers.

Structure of a stamen and pistil

Stamen	Pistil
	
The stamen consists of an anther and a filament. The anther contains pollen grains and produces the male gametes.	The pistil consists of the stigma, style, and ovary. An ovary contains ovules. The female gamete or egg is produced inside the ovule.

How does the male and female gamete give rise to a new plant?

During the process of sexual reproduction, the male and female gamete i.e. the pollen grain and egg fuse to form a zygote, which later develops to form a new plant.

Dissect a flower!

Take a China rose or *Hibiscus* flower and separate its reproductive parts. Study the structure of the reproductive parts. Is the flower unisexual or bisexual?

The flower is bisexual, as both male and female reproductive parts are present in it.

Formation of Fruits and Seeds

Formation of Fruits and Seeds

We know that plants produce fruits.

When and why do plants produce fruits? Let us explore.

Seeds are present inside fruits. **Have you wondered why? Why do plants produce seeds inside the fruits?**

After fertilization i.e. after the fusion of male (pollen) and female (ovule) gametes:

- The **ovary gives rise to the fruit,** while the other structures of the flower fall down. **Thus, the fruit is a ripened ovary.**
- The **ovules present inside the ovary develop into a seed**. Seeds contain an embryo, which is protected by the seed coat.

Therefore, seeds when sown in the ground can give rise to new plants because they contain an embryo.

Seeds are present inside the fruit for protection. When fruits fall on the ground, seeds are protected and can grow into new plants. The fruit provides nourishment to the seeds.

A fruitful observation!

Visit a nearby market and observe different types of fruits available there. Observe the difference in the shape and size of fruits. Cut some fruits and observe the structures of the seed.

Do all seeds have a similar structure?

Do you know that seed of double coconut is the largest seed in the world?

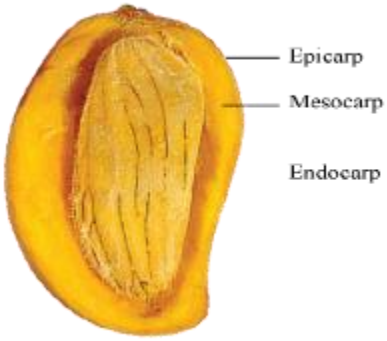
Fruit

A fruit consists of two portions − pericarp and seed.

Pericarp − Pericarp is the part that develops from the wall of the ovary. Pericarp may be thick or thin. It consists of three portions:

- Epicarp − The outer and leathery part of the fruit is called epicarp. It is usually not eaten.
- Mesocarp − It constitutes the sweet, fleshy part that is usually eaten by us.
- Endocarp − It is the innermost hard layer that contains the seed. You all must have noticed a white seed present inside the thin endocarp of an unripe mango.

The nature and presence of the three parts may vary for different fruits. In fact, in some plants, pericarp is not at all differentiated into three parts.



Functions of a fruit

- It protects the seeds from animals and harsh weather conditions.
- It helps in seed dispersal. We will learn more about seed dispersal later in this chapter.
- It stores food material.

Seed

Seeds are the mature ovules. Seeds vary greatly in their appearance and form.

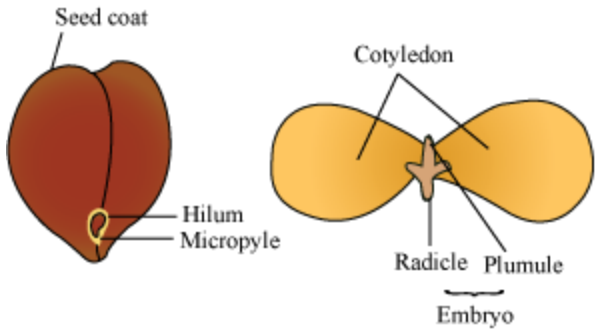
The outer part of the seed is called the **seed coat**. It is a hard outer covering consisting of two layers: outer exposed, hard layer, called **testa**, and inner thin, membranous layer, called **tegmen**. The purpose of seed coat is to protect the seed

from insects or bacteria and from any physical damage.
On the lower end of the concave side of seed is a scar, called **hilum**. It actually represents the place where seed was attached to the ovary wall. Just above the hilum is a small pore, called **micropyle**. It helps in absorption of water during seed germination and in exchanging gases through diffusion.

On removing the seed coat, we will observe the following parts:

- **Cotyledons** − Cotyledons may be one or two depending upon whether the seed is monocot or dicot.

- **Axis** − Axis is a short, curved structure to which cotyledons are attached. Axis consists of two parts, one of which develops into **plumule (future shoot)** and the other one develops into **radicle (future root)**.



Under proper conditions, seed germinates to form new plants.

The seeds that we use as a part of staple food diet can be distinguished into pulses, millets, cereals and grains

- **Pulses**- They are primarily seeds occurring in variable sizes and colours inside a type of fruit called pod. All pulses, like black gram, pea, lentil belong to the pea family- Leguminosae. They are rich source of proteins.

  India is the largest producer and consumer of pulses.

- **Grains**- They are small, hard dry seeds with or without the fruit wall attached. Variety of grasses belonging to the family Poaeceae produce grains. Most of the grains are generally cereals like maize, rice, wheat, etc.

  Maize, rice, wheat, barley, oats and sorghum are the common grains that account for more than 85% of the total grain production in the world.

- **Millets-** They are coarse grains with high protein content but smaller seeds. For example jowar, bajra and ragi etc.
    - Seed Dispersal
    - A plant produces many seeds. Seeds fall on the ground from plants and give rise to new plants.
    - Imagine if all seeds growing into plants grow under the parent plant. **Do you think all plants will be able to obtain enough nutrition, water, and sunlight? Will there be sufficient space left for all plants?**
    - **OR**
    - **Do we find the same kind of plants in the same region?**
    - **No.** To avoid competition, a plant develops different mechanisms to move the seeds away from the parent plant. Therefore,we can find the same types of plants growing at different places.
    - **Let us understand the mechanism in plants for seed dispersal.**
    - Seeds are dispersed to far off places to reduce competition among plants for sunlight, water, minerals, and space.
    - **The process of seed dispersal takes place by:**
    - **(I) Wind**: Some seeds are carried to far-away places by wind. The seeds which are carried by wind can have **winged seeds** like in drumstick and maple. They can have light seeds like in grasses, or can have hairy seeds like in aak.

Seed of drumstick Seed of maple Seed of sunflower Seed of madar

    - **(II) Water**: Some seeds are dispersed via water. These fruits or seeds usually develop floating ability in the form of spongy or fibrous outer coat as in coconut.

    - **(III) Animals**: Some seeds are dispersed with the help of animals. The seeds dispersed by animals have spine or hook-like structures to get attached to the body of the animal, for e.g. *Xanthium.*

    - **(IV)** Other methods of seed dispersal involve sudden bursting of the fruit with a jerk, which results in the scattering of seeds to new places, sometimes a long way from the parent plant. For example, this process occurs in fruits of castor and balsam.
    - **Seed! Seed! Seed!**
    - Make a list of five fruit bearing plants, and find out the agents through which their seeds are dispersed. **Are all seeds similar in structure despite of having a different dispersal mechanism?**

- Pollination and Fertilization
- Pollen grain and egg are male and female gametes respectively. **How does the pollen grain reach the ovule to fertilize the egg?**
- Pollen consists of a tough protective coat, which prevents it from drying. Pollen grains are light and are easily carried away by the wind. In some plants, insects sit on flowers and carry the pollen on their bodies.
- Therefore, various agencies such as wind, insects, water, etc. carry the pollen to the stigma of the flower. **The process of transfer of the pollen from the anther to the stigma is known as pollination**. Pollination is of two types. Let us study what these types are.

Agents of Pollination

Plants use air, water (abiotic agents), and animals (biotic agents) for pollination.

Pollination by wind

- It is the most common form of abiotic pollination.
- Plants, which are wind-pollinated, possess well-exposed stamens and large, feathery stigma.
- Pollens should be light and non-sticky to be carried easily by winds.
- Wind-pollinated flowers often have single ovule in the ovary and numerous flowers packed in an inflorescence.
- It is common in grasses.
- They neither possess any smell nor nectar.

Pollination by water

- It is rare in flowering plants, except for some aquatic plants such as *Vallisneria* and *Hydrilla*.
- In most water-pollinated plants, the pollen grains are long, ribbon-like, and are protected from wetting by mucilaginous covering.
- In a majority of water plants such as water hyacinth and water lily, flowers emerge above the water level and are pollinated by insects.

Pollination by insects

- Majority of flowering plants use butterflies, bees, wasps, etc. for pollination.
- Most of the insect-pollinated flowers are large, colourful, fragrant, and contain nectar to attract the animal pollinators. These are called floral rewards.

- Floral reward can be in the form of providing safe places to lay eggs. (example: the tallest flower, *Amorphophallus*)
- The pollen grains are sticky and get stuck to the body of the pollinator.
- Certain animals such as birds, squirrels, bats, etc. also act as pollinators.

Artificial Pollination

- It is a practice adopted by plant breeders to pollinate a given flower artificially or manually.
- It is done to obtain new crop varieties with desirable characters.
- In this, the anthers of a desirable plant are first removed at a very young and the flower is completely covered by plastic bags to avoid any unwanted pollen to settle on stigma through cross pollination.
- Once the flower gets mature, it is pollinated with the pollen from the desired plant variety.

Which process takes place after pollination?

After pollination, **fertilization** takes place.

The process of fusion of the male and female gamete is known as fertilization.

Let us study how fertilization takes place in plants.

After the pollen grain reaches the stigma, pollen tube grows and reaches the ovary passing through the style. Male cell travels down the pollen tube and fuses with the egg cell in the ovule. This fusion is known as fertilisation.

After fertilisation, the ovary of the fruit develops into the fruit and ovules develop into the seeds.

The fruits developed from a ripened ovary fall under various categories:

- Fleshy fruits: Developed from an ovary with fleshy walls. Examples include papaya, tomato, etc.
- Dry fruits: Developed from an ovary with dry walls. Examples include pea, maize, etc.
- False fruits: Fruits in which the fleshy part that we eat develops from thalamus (present at the base of the flower) and not the ovary. The ovary remains at a small region at the centre around the seeds. Examples include apple, pear, etc.

Some interesting facts:

Do you know why flowers are brightly coloured and strongly scented? This is because the colour and fragrance of flowers attract insects for pollination.
Honey bees help in pollination in a large number of plants.
Some flowers look like an insect to attract other insects for pollination.
Some plants are pollinated by bats.

Seed Germination

Germination is the process during which seed reserves present in the seed are broken down and the embryo starts to grow.

During germination, the seed absorbs water. Germination is irreversible i.e. once begun; the seed cannot be brought back to dormant state,

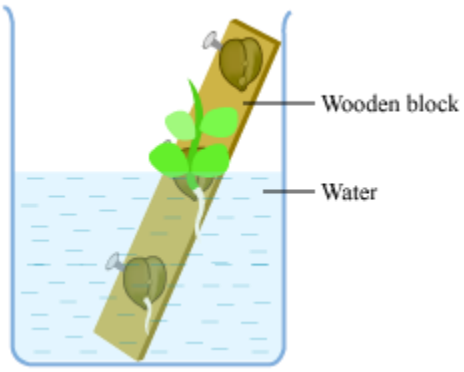
Seeds which do not germinate even after provided with all the conditions necessary for germination are called **dormant seeds** and the phenomenon is termed as **dormancy**.

Let us study what happens during germination

When a seed is germinating, the portion above the cotyledon that forms future shoots is called plumule and the portion below the cotyledon that forms the future roots is called radicle.

Conditions Necessary for Germination

Activity 1



- As shown in the figure, take a beaker with water and place it in, a glass slide with three bean seeds tied to it.
- The slide should be kept in such a way that the upper seed is completely out of water, lower seed is completely submerged in water and the middle seed is half submerged in water.
- The beaker is placed in warm temperature (25° C − 30° C) for few days.

Result

- Seed at top − Does not germinate
- Seed at middle − Germinates
- Seed at bottom − Does not germinates

Inference

- Seed at top gets only oxygen and no water. So it does not germinate.
- Seed at middle receives both oxygen and water. So it germinates.
- Seed at bottom gets only water and no oxygen. So it does not germinate.

Activity 2

- Take two petridishes with moist cotton placed in it.
- Place a few soaked seeds in both petridishes.

- Place the first petridish in refrigerator (4°C) and the second one at room temperature (30°C).
- Leave the petridishes for few days.

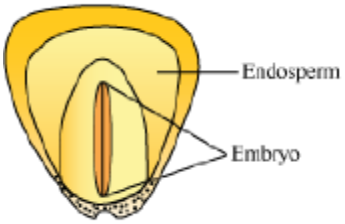
Result

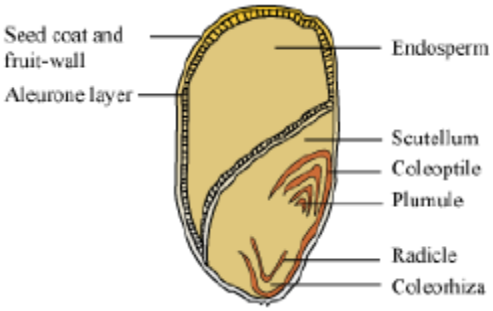
- No germination was seen in the petridish kept in refrigerator while the seed present in the petridish kept at room temperature germinates.

Inference

- Suitable temperature is necessary for germination.

Structure of Monocot Seed





- In seeds of cereals, seed coat is membranous and fused to the fruit wall.
- Generally, monocot seeds are endospermous. Endosperm is bulky and stores food.
- Aleurone layer - proteinous layer that separates embryo from outer covering of endosperm
- Embryo is situated in a groove in endosperm. Embryo consists of
- cotyledon known as scutellum
- embryonal axis (consisting of plumule and radical)
- Plumule is enclosed in a sheath called coleoptile and radical in coleorrhiza.

So what does you concluded about the necessary conditions for seed germination?

Seeds require water, suitable temperature, and oxygen for germination. Let us see how these factors affect germination one by one.

Water

- Helps in rupture of seed coat by swelling the seed, so as to allow the elongated radicle to come out during germination
- Necessary for various biochemical reactions occurring within the seed

Suitable Temperature

- Moderately warm temperature (25ºC - 35°C) is suitable for germination of most of the seeds.
- Very low or high temperature can destroy the delicate tissues of the seed.

Oxygen

- Necessary for providing energy (through respiration) required for rapid cell division and cell growth

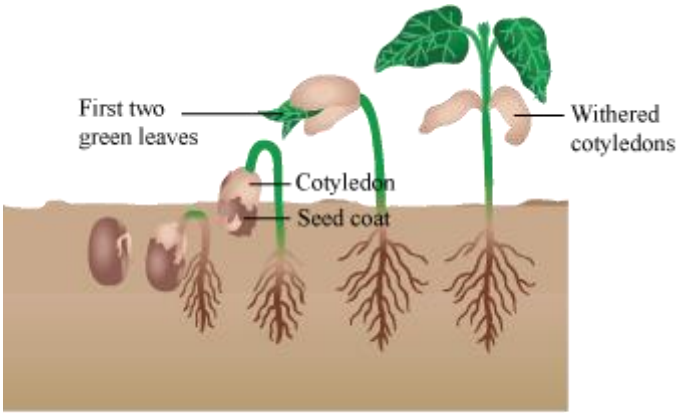
Types of Germination

There are two types of germination patterns depending upon the behaviour of cotyledons during germination.

- Epigeal germination
- Hypogeal germination

Epigeal Germination

When the cotyledons are lifted above the ground as a result of rapid elongation of hypocotyls e.g. seeds of bean, castor, cotton, etc germinate in this manner.

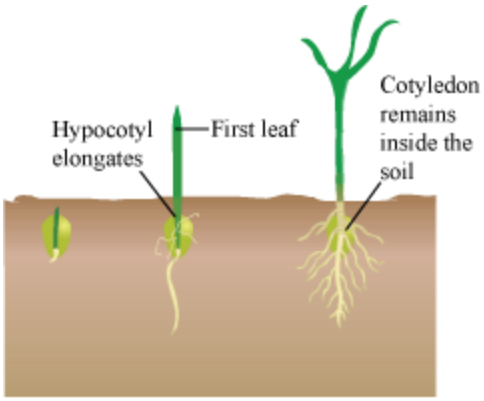


Epigeal germination in a bean seed

Hypogeal Germination

When the epicotyls elongates quickly and pushes the plumule up, and cotyledons are left on the ground only, the germination is hypogeal.

e.g. Gram, pea, maize, etc germinate in this manner.



Hypogeal germination in a maize grain

Viviparous Germination

A special mode of germination in which seed starts germinating inside the fruit while it is still attached to the parent plant. Once germinated, the seedling is dropped into the soil where it fixes itself by developing roots.

Seedling: A very young plant that grows from a seed after germination. It consists of roots, that fix it in the soil and absorb water and minerals, and small young leaves which manufacture food for it.