KRISHNAGAR ACADEMY

# BIOLOGY

# GERMINATION

CHAPTER -6

## GERMINATION OF SEEDS

Seeds contain an inactive or dormant embryo in the resting stage. During dormancy, the embryo looks dead but it is living and performs all the life activities, though at a much slower rate. It utilises food, respires, consumes oxygen, and gives out carbon dioxide along with some heat. This is the reason why dry seeds get spoiled in the absence of proper aeration.

The embryo becomes active and starts growing when the seeds are provided with suitable or favourable conditions. The changes that take place in the seeds from the time of their growth till the formation of seedlings are collectively called **germination**. In other words, germination is the process of the formation of the seedling from an embryo.

Let us first understand the conditions which are necessary for the germination of seeds.

## CONDITIONS NECESSARY FOR GERMINATION OF SEEDS

Certain conditions which are essential for germination of seeds are as follows:

### External Conditions

#### *Water*

All seeds require water for germination and to develop into seedlings. In natural conditions, seeds obtain water from the moist soil. Even if we keep dry seeds on moist cotton or wrapped in a moist cloth, they start germinating after a few days. The seeds absorb water through the seed coat, especially through micropyle. Why do seeds need water?

Dry seeds perform their physiological activities at a very slow rate. With the absorption of water, their *activities become vigorous*. As a result of water absorption, the *seed swells and the seed coat ruptures, releasing the embryo*. Initially, the radicle comes out which forms the root system. It is followed by the plumule which forms the shoot system. The absorbed water dissolves the food stored in the cotyledons and *makes it diffusible* enabling the developing embryo to *utilise the food material*.

## *Temperature*

Different seeds require different range of temperatures for germination. The seeds can germinate between the temperature range of 0 °C to 50 °C. However, *the optimum range of temperature for seed germination is 25 °C to 35 °C*. Very high and very low temperatures are not suitable for seed germination. High temperature can destroy the tissues of the embryos and kill them. Low temperature makes the embryo inactive and slows down its physiological activities considerably.

### *Oxygen*

Seed germination is a *process of vigorous activities* during which the meristematic cells divide and grow. The whole process *requires a lot of energy* which is obtained by the process of respiration. Seeds require oxygen for carrying out respiration and thus, they *cannot germinate in an oxygen-free environment.*

## Internal Conditions

### *Growth Regulators*

All seeds require proper **nutrition** and certain **growth regulators** for germination. These are present in the cotyledons or endosperm of the seeds. The healthy seeds with proper nutrients and growth regulators germinate easily while others don't.

### *Viability*

The embryo in a seed has to be in a viable condition to develop further. Sometimes the embryo undergoes a period of low activity or rest during which it does not grow, even if kept in suitable environmental conditions.

# Seed Dormancy

Sometimes, viable seeds of many plants do not germinate immediately even if provided with suitable conditions. This condition is known as **dormancy**. It may be because of

- very high or low temperature.
- impermeability of the seed coat to oxygen or water.
- hard seed coat.
- imperfectly developed (immature) embryo.
- presence of certain chemicals.

## TYPES OF GERMINATION

The steps during germination of a healthy and viable seed are as follows:

- Seed *imbibes water* from the moist soil through its permeable seed coat and micropyle.
- It *swells and bursts*.
- The *embryo comes out* through the micropyle.
- First structure to emerge is the future root, known as **radicle** *which anchors the seed* in the soil.
- This is followed by the growth of future stem known as **plumule**.
- Plumule can be formed in two different ways:

  (*a*) **Elongation of epicotyl;** the portion of the embryonal axis between the point

of attachment of the cotyledons and the plumule.

(*b*) **Elongation of hypocotyl;** the region of the embryonal axis between the point of attachment of the cotyledons and the radicle.

Based on this, the process of germination can be categorised into two types:

### Hypogeal Germination

In hypogeal germination, the **epicotyl** *elongates first* and the plumule is pushed out of the soil, while the cotyledons and other parts remain under the soil. Hypogeal germination is observed in pea, gram, maize and coconut.

### Epigeal Germination

In this type of germination, the **hypocotyl** *grows first*. As a result, the cotyledons and other parts of the seed are pulled out of the soil above the ground. This is observed in castor, bean and onion.

Let us take some examples to understand the concept of hypogeal and epigeal germination.

## EXAMPLES OF HYPOGEAL GERMINATION

### Maize Grain (A Monocot Seed)

- The grain *imbibes water* from the moist soil and swells.
- The radicle and plumule grow from the seeds.
- The radicle *ruptures the root sheath* (coleorhiza) and *grows downwards*.
- It forms the primary root which soon dies.
- The plumule comes out *piercing the shoot sheath* (coleoptile) and *grows upwards*.
- It develops leaves forming the shoot system.
- New roots called **adventitious roots** develop from the seeds producing a fibrous root system.
- During the entire period, the cotyledon remains below the ground and supplies food material to the growing embryo.
- When the food store is exhausted, cotyledon withers and falls off.

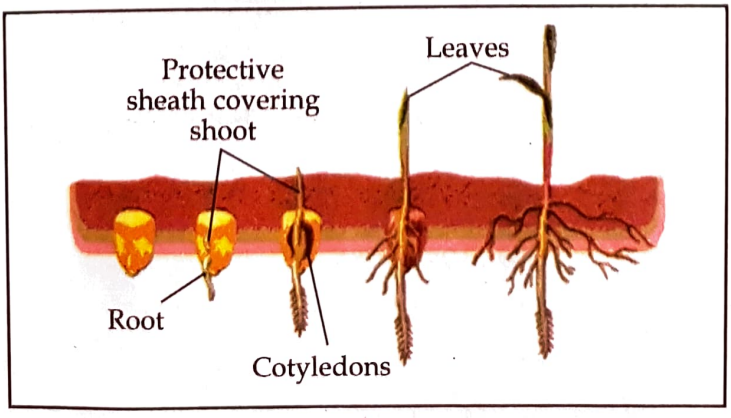



**Fig. 6.8:** Hypogeal germination in a maize grain

# EXAMPLES OF EPIGEAL GERMINATION

## Bean Seed (A Dicot Seed)

The bean seed germinates by the initial growth of hypocotyl, followed by that of epicotyl.

- Like all the other seeds, the bean seed also *absorbs water and swells up*.
- The radicle grows downwards piercing the seed coat, and forms the *root system*.
- The arched *hypocotyl straightens* and grows upwards.

- The growing hypocotyl forms a hook-like structure, which comes out of the soil and pulls the cotyledons in the ruptured seed coat above the soil.
- The cotyledons open, become green and function like green leaves.
- The *plumule* comes out of the cotyledons and grows into a shoot.
- As the foliage develops on the shoot, the cotyledon leaves wither and fall off.

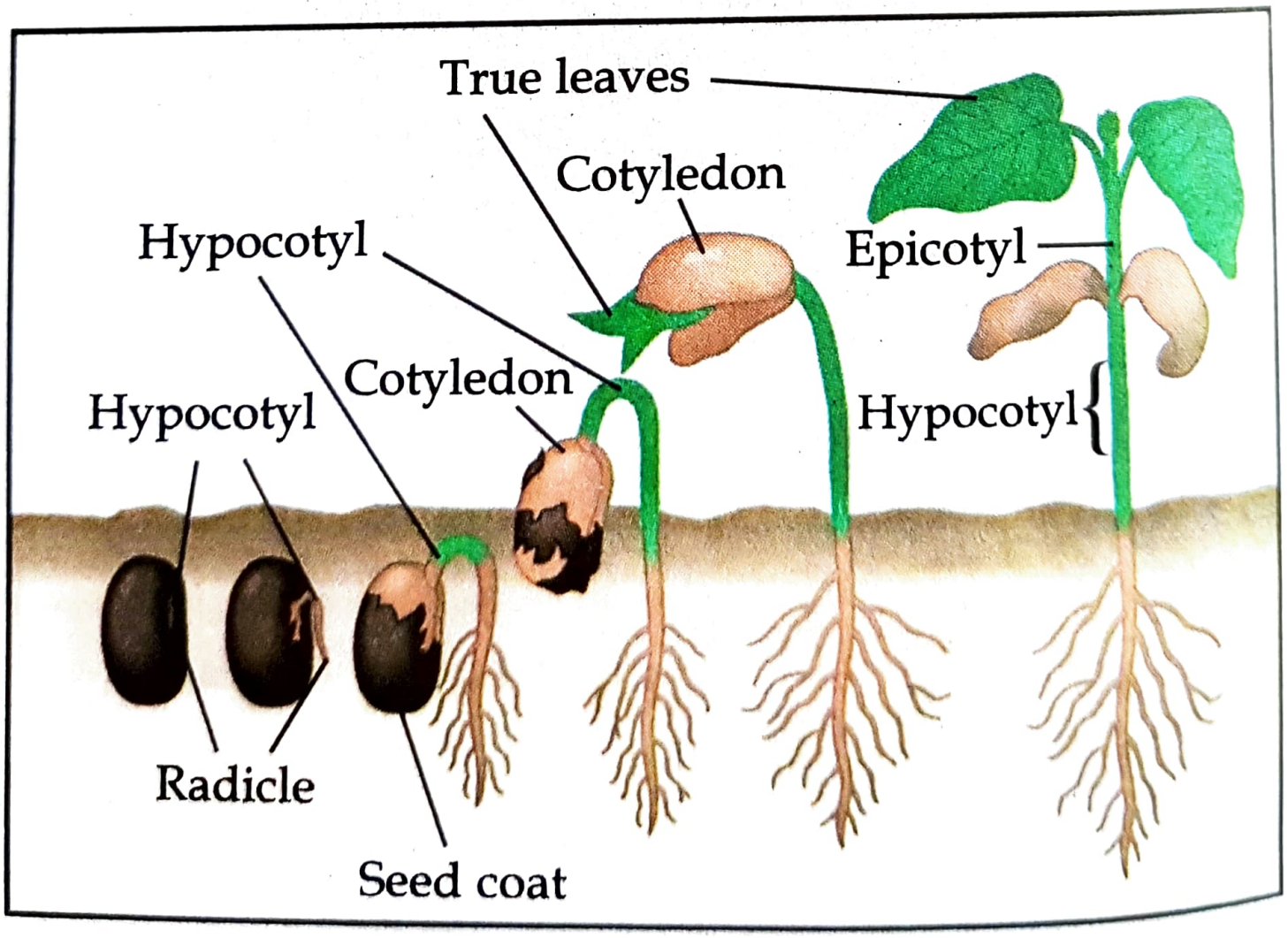
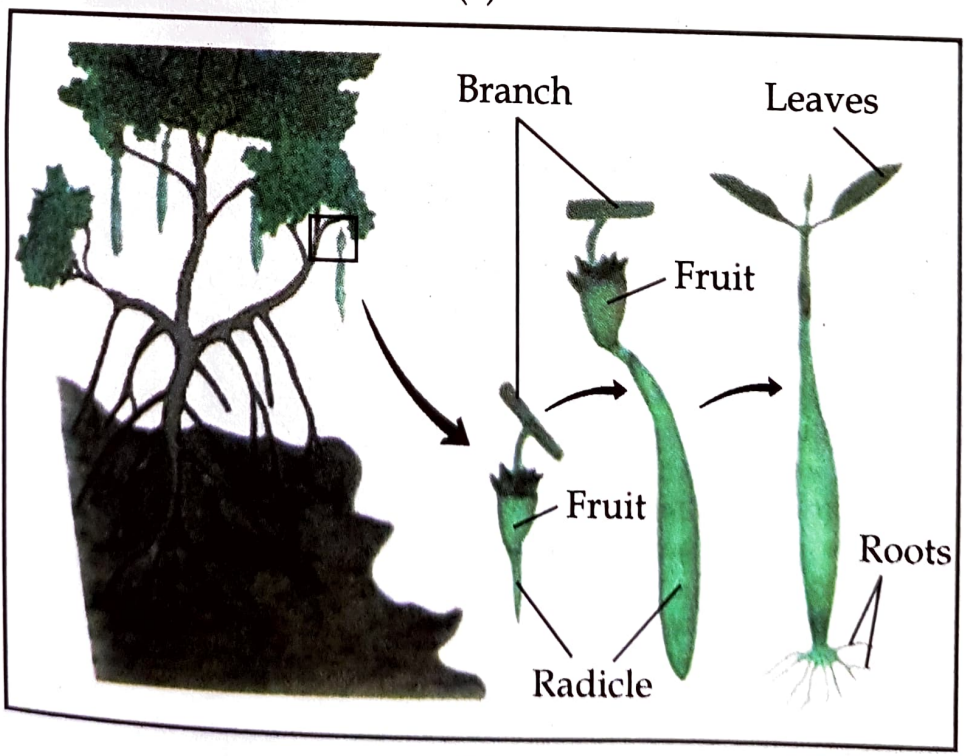



**Fig. 6.10:** Epigeal germination in a bean seed

## VIVIPAROUS GERMINATION

The seeds of mangrove plants (plants growing in marshy regions) such as *Rhizophora* and *Sonneratia*, germinate inside the fruit when it is still attached to the parent plant. This is called **viviparous germination** or **vivipary**. After germination, due to increase in the weight, the

(*a*)




(*b*)

**Fig. 6.11:** (*a*) Vivipary in a mangrove plant (*b*) Viviparous germination in mangrove plants

seedlings are dropped down into the mud or water. They develop lateral roots which help them to fix and gradually grow into a new plant.

Whichever type of germination may occur in a seed, the result is the formation of a seedling. A seedling is fixed in the soil *via* the root system and has a shoot system with foliage. The roots absorb water and minerals from the soil and transport them to the whole plant. The leaves manufacture food by the process of photosynthesis, which is translocated to other parts of the plants. Gradually, the seedling develops into a mature plant.

Why is water essential for seed germination?

What is the optimum range of temperature for seed germination?

Why do embryos sometimes undergo a period of rest?

What will happen if a seed is kept in an environment with very less amount of oxygen?

1. What happens to a seed when kept in moist conditions?
2. Differentiate between
   (*a*) Epicotyl and hypocotyl
   (*b*) Epigeal germination and hypogeal germination.
3. Name **any two** seeds which show hypogeal germination.
4. What is the function of cotyledon leaves in a bean seed?
5. Fill in the blanks with suitable words:
   (*a*) Seeds imbibe water through _____.
   (*b*) Maize root is covered by a sheath called _____.
   (*c*) Bean seeds exhibit _____ germination while pea seeds show _____ germination.