Seed structure and Germination

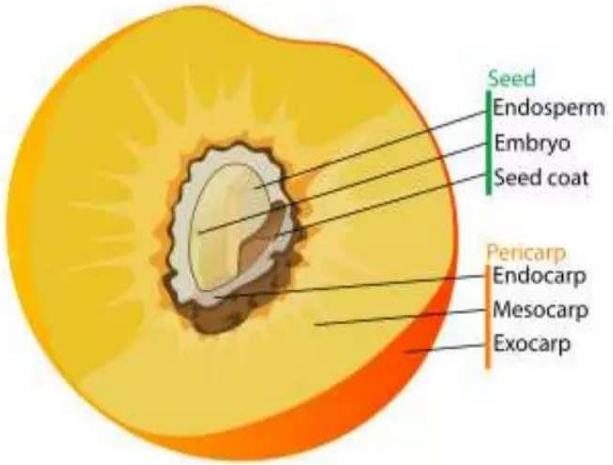
Jegatheeswari Karthik

Fruit

Is the enlarged ripened ovary.

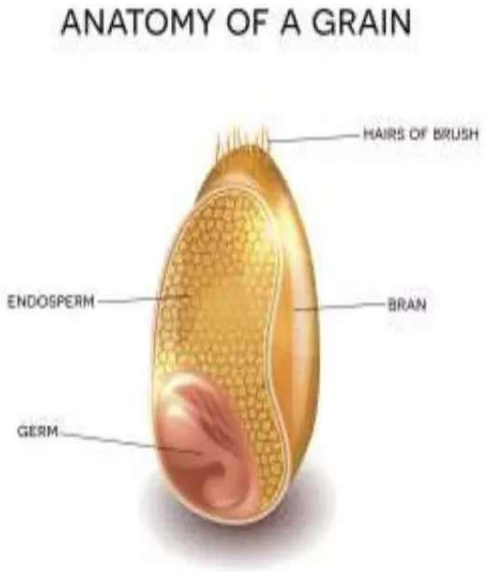
It protects the seed and helps in seed dispersal.

Eg. Mango, Pea pod



Grain

Is a fruit in which the fruit-wall and the seed coat are fused together to form a protective layer.



Seed

Is the ripened ovule.

It contains embryo which develops into a new plant.

Seed coat protects embryo.

Eg. Bean seed, Peas

Seed

Is the mature ovule after fertilization.

It contains embryo which develops into a new plant.

Embryo remains in an dormant state until exposed to favourable conditions when it germinates.

Seed contains food material for the nourishment of the embryo during germination.

Embryo can withstand temperature and drought.

Seed structure

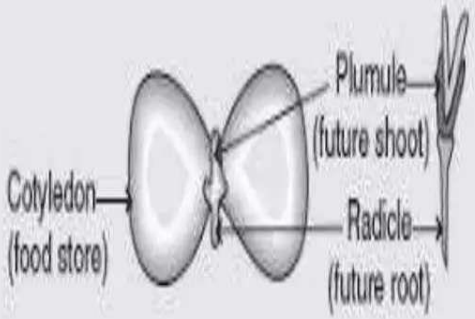
A seed is a fertilised, matured ovule of a flowering plant, containing an embryo. This tiny embryo enclosed within the seed devolves to form a new plant by the process of germination.

Plant embryo in seeds have structures called cotyledons.

A cotyledon is the central part of a seed embryo to which the plumule – the immature shoot, and the radicle – the immature roots, are attached.

Seed structure

(i)



(ii) (a) Radicle : Future root

(b) Plumule : Future stem,

(c) Cotyledon (food store).

Classification of seeds

Seeds are classified according to the number of cotyledons present in the embryo. If the embryo has one cotyledon (monocotyledon) it is a monocot plant, and if there are two cotyledons (dicotyledon), it is a dicot plant

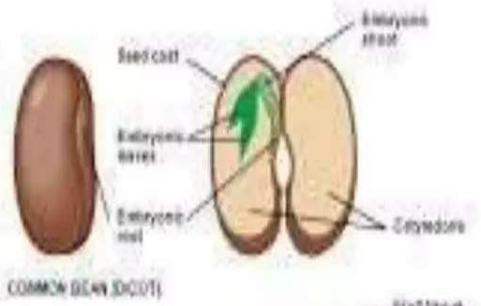
Example:

Monocot seeds – Maize, Wheat, etc.

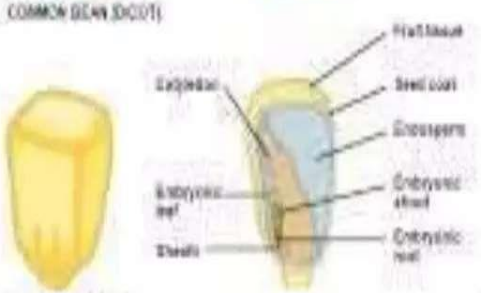
Dicot seeds – Pea, Gram, kidney Bean etc.

Monocot and Dicot

- Comparison between dicot and monocot seeds



COMMON BEAN (DICOT)



CORN (MONOCOT)

Size of seeds

Some are very small - Poppy seeds, Orchid seeds

Some are large - watermelon, pumpkin, mango

Few are largest - Coconut

Endosperm

- The **endosperm** is a tissue produced inside the seeds of most of the flowering plants following fertilization.
- It is triploid (meaning three chromosome sets per nucleus) in most species.
- It surrounds the embryo and provides nutrition in the form of starch, though it can also contain oils and protein.
- On the basis of endosperm, seeds are classified as

1. Albuminous
2. Exalbuminous

Albuminous and exalbuminous seed

- **Albuminous seeds** are the **seeds** which have food stored in the special nourishing tissue called as endosperm that remains persistent till maturity.
- **Exalbuminous seeds** are the **seeds** which have the stored food and the cotyledons in a special structure called as kernel. It does not remain until the embryo is mature.

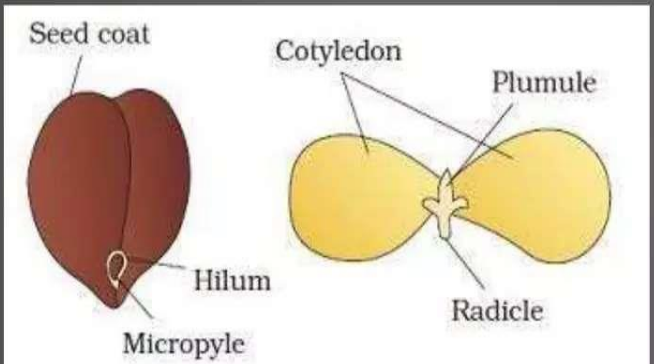


Figure 18. Structure of dicotyledonous seed

A bean (dicot) seed is normally kidney shaped, flat and has a notch on one side.

Dicots have two seed leaves inside the seed coat.

They are usually rounded and fat because they contain the endosperm to feed the embryo plant.

Dicot seed consists of the following parts:

Hilum, Micropyle, seed coat and Embryo

Seed structure

- Hilum:
- The hilum is the point where the seed is attached to the inner margin of the fruit.

- Micropyle:

- This is the opening through which the pollen tube enters the ovule. In the seed, the Micropyle imbibes water and softens the seed coats and allows the embryo to emerge. It allows diffusion of gases for respiration of the embryo.

Seed structure

- Seed coats:

In dicots, the seed coat is further divided into an outer coat, known as the testa, and inner coat, known as the tegmen.

The inner coat is thin, membranous and generally united with the testa.The seed coat is tough and waterproof. It covers and protects the embryo and the food supply.

Embryo

- The embryo is the baby plant, which emerges from the seed and germinates into a mature plant.
- The embryo consists of Cotyledons or seed leaves or nurse leaves.
- They are fleshy, green, leaf-like structures and provide nourishment to the growing embryo.
- It also consists of Radicle or future root of the plant.
- It is the first to emerge out of the Micropyle during germination and develops into a tap root in the bean plant.
- Plumule or the embryonic shoot system. It has a growing point covered by undeveloped, delicate tiny leaves. It is attached to the radicle by the hypocotyl.

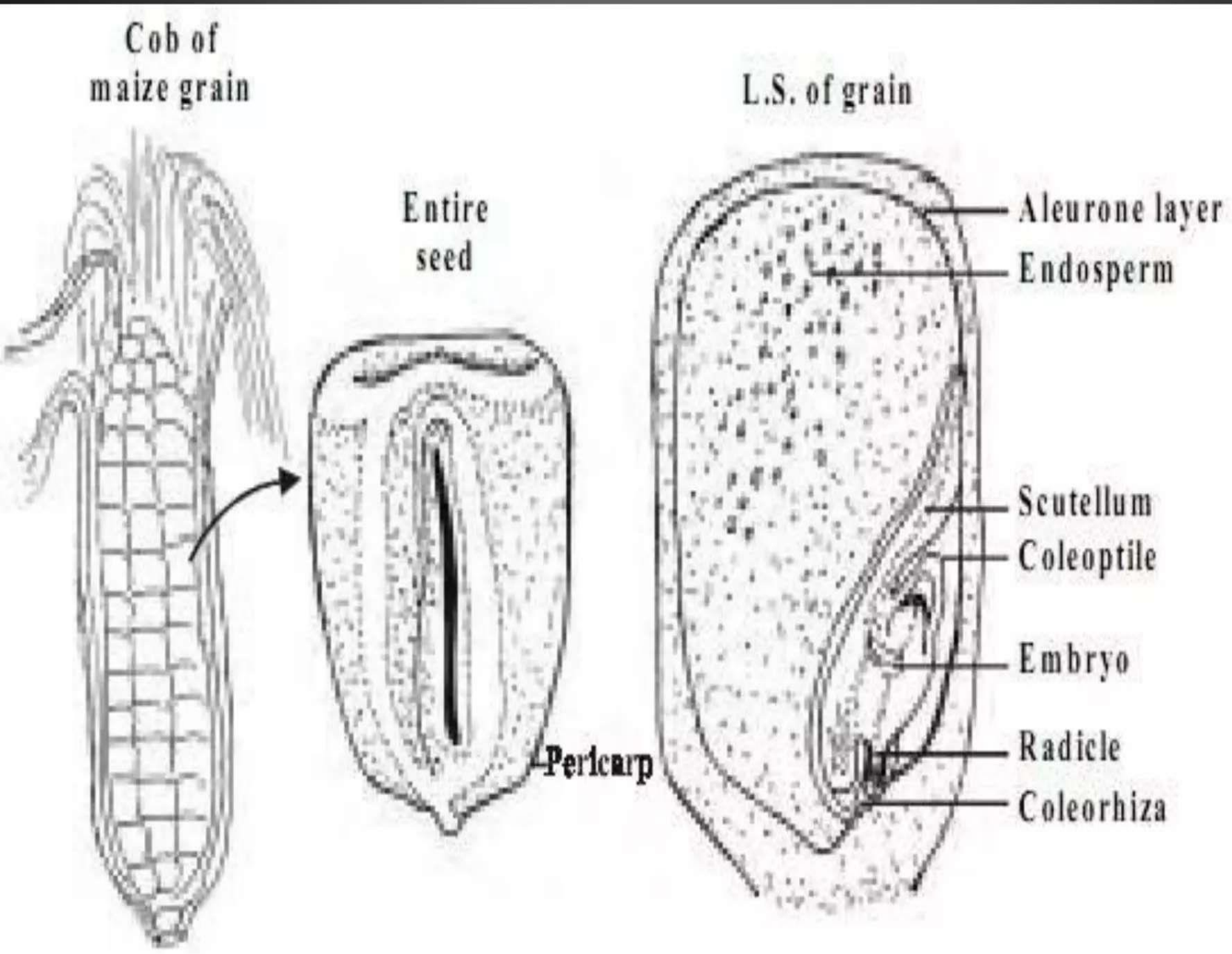
The structure of Monocot Seed:

The maize grain (monocot) is roughly oval in shape and normally flattened.

The lower narrower portion shows a white triangular region, which is the embryo.

The broader and more yellowish region is the endosperm.

Monocots have only one seed leaf inside the seed coat. It is often only a thin leaf because the endosperm to feed the new plant is not inside the seed leaf.


Cob of maize grain
Entire seed
L.S. of grain
Aleurone layer
Endosperm
Scutellum
Coleoptile
Embryo
Radicle
Coleorhiza
Pericarp

Parts of the maize seed

- Endosperm
- Most of the grain is occupied by the endosperm and is filled with reserved food.
- A thin epithelial layer separates it from the embryo.
- The outermost layer of the endosperm which is continuous with the fused seed coat and fruit wall is rich in protein and is called aleurone layer. The inner starchy endosperm is made of starch cells and a few lipid cells.

Embryo

It is seen below the endosperm. It is made of single cotyledon called scutellum and embryo axis with plumule and radicle.

It has special cells which secrete digestive enzymes to digest and absorb the nutrients in the endosperm to provide nourishment for the developing embryo.

Embryo

. Root cap protects the tip of the radicle. The radicle is surrounded by a protective sheath called coleorhiza.

Plumule is also protected by a covered sheath known as coleoptile.

Difference between Bean seed and Maize grain

BEAN 	MAIZE 
1. **Two** cotyledons.	**One** cotyledon (scutellum)
2. **No** endosperm.	**Large** endosperm present.
3. **Large** embryo.	**Small** embryo.
4. Plumule leaves **folded**.	Plumule leaves **rolled**.
5. Plumule **large**.	Plumule very **small**.
6. Hilum and micropyle **visible**.	Hilum and micropyle **not visible**.
7. Seed separately contained **in the fruit** called pod.	The seed wall and the fruit wall fused to form **a single grain** with no separate seed.

Germination

Germination is the development of a plant from a seed or spore under specific environmental conditions.

In other words, Seed germination is a process in which dormant embryo of seed resumes metabolic activities and grows to produce a seedling.

The most common example of germination is the sprouting of a seedling from a seed of an angiosperm or gymnosperm.

Types of Germination

There are 2 types of Germination, namely:

1. Epigeal Germination.
2. Hypogeal Germination.

Common processes

1. The seed soaks up water and the seed coat may burst.
2. The radicle elongates and forms the primary root. Root hairs make their appearance.
3. The plumule emerges after the radicle. Leaves appear before the food reserves get exhausted so that the small plant can start preparing food by photosynthesis.

Conditions necessary for Germination

- Water
- Suitable temperature
- Air

Water

- Water from the soil enters through micropyle
- Two main uses of water

1. Seed swell and seed coat ruptures. Elongated radicle come out and form the root system
2. Necessary for chemical reaction and for the enzymes to act upon the food stored in cotyledons

converted to dissolved form to be utilised by the growing embryo.

Suitable temperature

- Optimum temperature favourable for germination 25-35 degree Celsius.
- Very low temperature inhibits the growth of the embryo.
- Very high temperature destroys its delicate tissues.
- Seeds of tropical need a higher temperature for germination than those of temperate regions.

Oxygen

- Oxygen is needed for respiration.
- During germination, rapid cell division and cell growth will takes place.
- Energy is needed
- Energy is available by oxidation of food.

Seeds sown very deep in soil fail to germinate

- No proper supply of oxygen.
- Insufficient pushing force in the embryonic parts to break through the upper layers of soil.

Objective

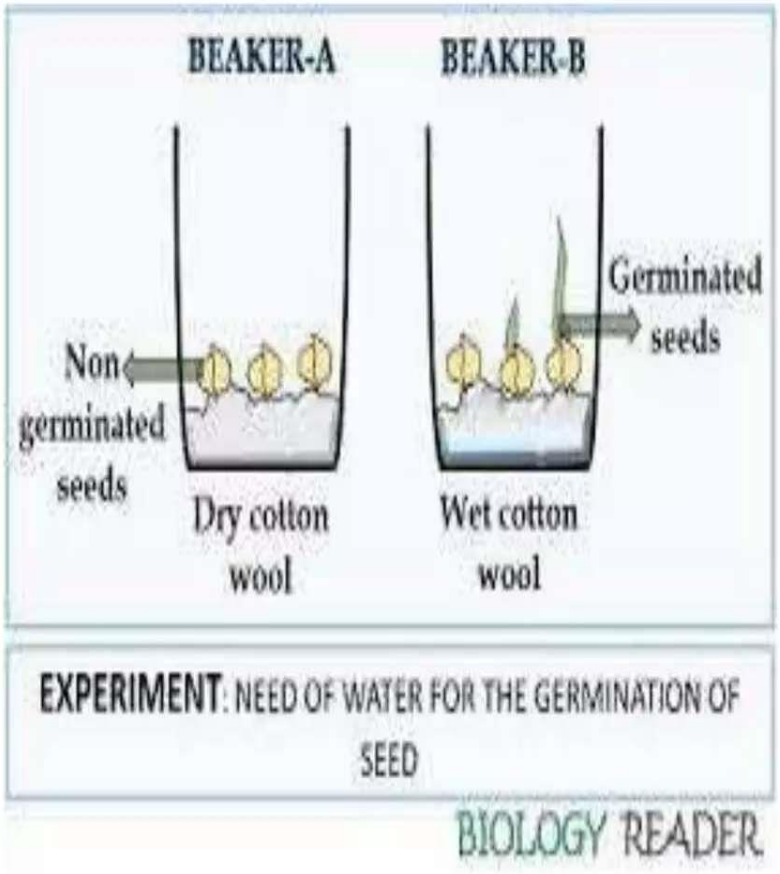
Why are you conducting the experiment; what are you trying to determine?

Students, write your response!

Experiment to show that water is necessary for germination

- Aim: To prove that water is necessary for germination.
- Apparatus: Two beakers marked A and B, seeds of Pea, water and cotton wool.
- Procedure: Take two beakers which are marked A and B respectively. In beaker place some pea seeds on a wet cotton wool and in beaker B place some pea seed on a dry cotton wool. Keep the beakers at room temperature.
- Observation: The seeds in beaker A germinate and in B do not germinate.
- Result: Water is necessary for germination.

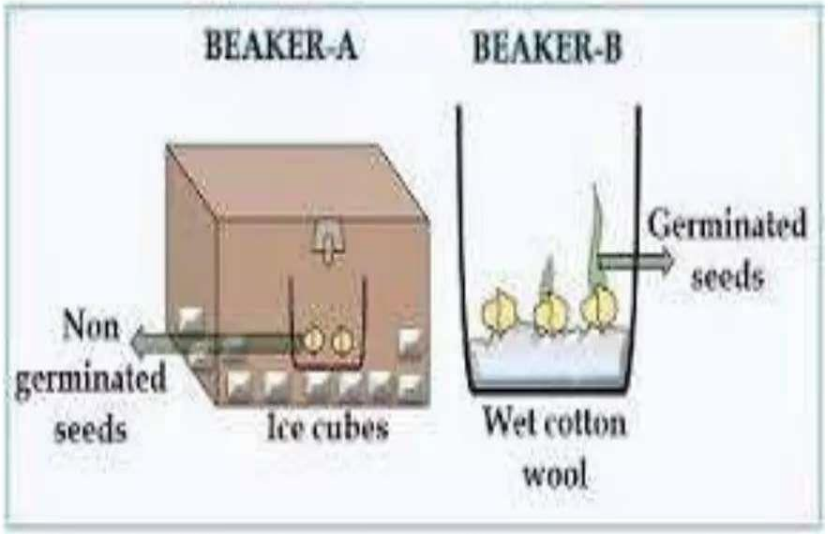
Experiment to show that water is necessary for germination



EXPERIMENT TO PROVE THAT SUITABLE TEMPERATURE IS NECESSARY FOR GERMINATION

- Aim: To prove that suitable temperature is necessary for germination.
- Apparatus: Two beakers marked A and B, seeds of pea, water and cotton wool.
- Procedure: Take two beakers marked A and B respectively. Place some pea seeds on cotton wool in both the beakers. Keep beaker A at room temperature and B in refrigerator.
- Observation: The seeds in beaker A germinate and in B do not germinate.
- Result: Suitable temperature is necessary for germination.

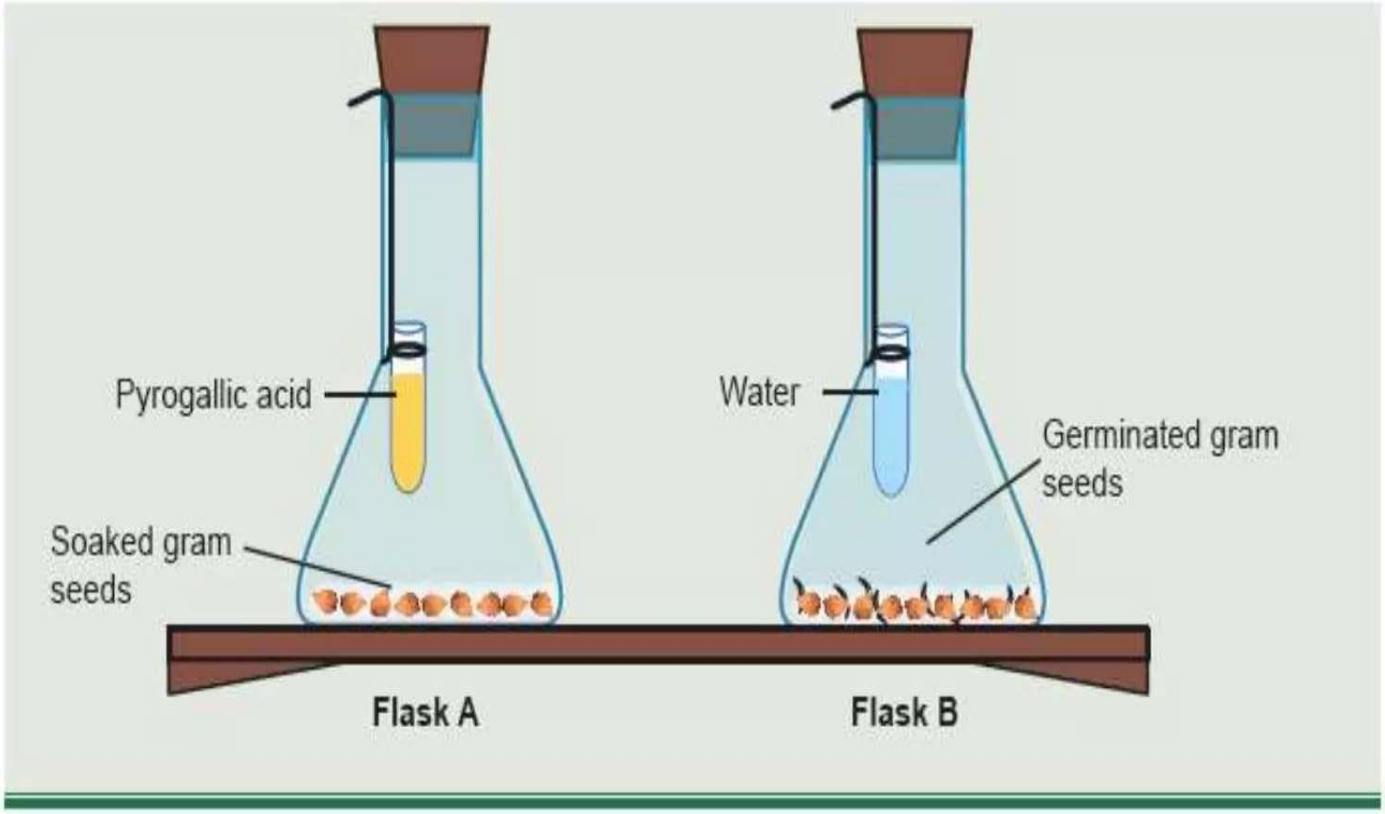
EXPERIMENT TO PROVE THAT SUITABLE TEMPERATURE IS NECESSARY FOR GERMINATION



EXPERIMENT TO PROVE OXYGEN IS NECESSARY FOR GERMINATION

- Aim: To prove that oxygen is necessary for germination.
- Apparatus: Two conical flask marked A and B, seeds of pea, water, cotton wool, pyrogallic acid, test tubes.
- Procedure: Take two conical flask with a cork and mark them A and B respectively. Place a wet cotton wool in each flask with some soaked Pea seeds. Pyrogallic acid absorbs oxygen so a test tube of in flask B in such a way that the chemical doesn't drop in the flask. In flask A hang a test tube of plain water.
- Observation: The seeds in flask A germinate because of presence of oxygen and seeds in flask B do not germinate because pyrogallic acid absorbs oxygen.
- Result: Oxygen is necessary for germination.

EXPERIMENT TO PROVE OXYGEN IS NECESSARY FOR GERMINATION



THREE BEAN SEED EXPERIMENT

- Aim: To prove that seed needs oxygen, water and temperature in equal proportions.
- Apparatus: A glass slide, a beaker, a thread and bean seeds.
- Procedure: Take a glass slide and tie three mature bean seeds at different position. Place the slide in the beaker containing water in such a way that the seed at top is above the water, the middle seed is at the water level and the third seed is submerged in water.
- Observation: The top seed does not germinate as it gets oxygen but no water. The middle seed germinates as it gets both oxygen and water. The bottom seeds do not germinate but shows emergence of tiny radical as it gets dissolved oxygen in water in small amount.

THREE BEAN SEED EXPERIMENT

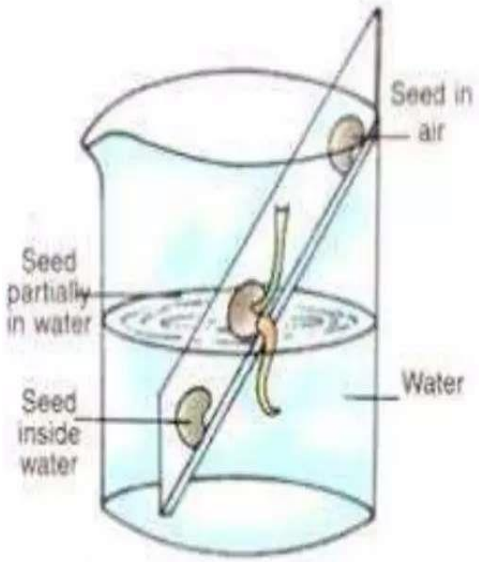


Fig. 3.4. Three bean seed experiment.

Observations

What did you observe during your experiment? Record relevant data here.

Students, write your response!

Types of germination

Hypocotyl

The portion of the embryonal axis which lies below the cotyledon in a dicot embryo is known as the hypocotyl.

It terminates with the radicle.

Epicotyl

The portion of the embryonal axis which lies above the cotyledon in a dicot embryo is known as the epicotyl.

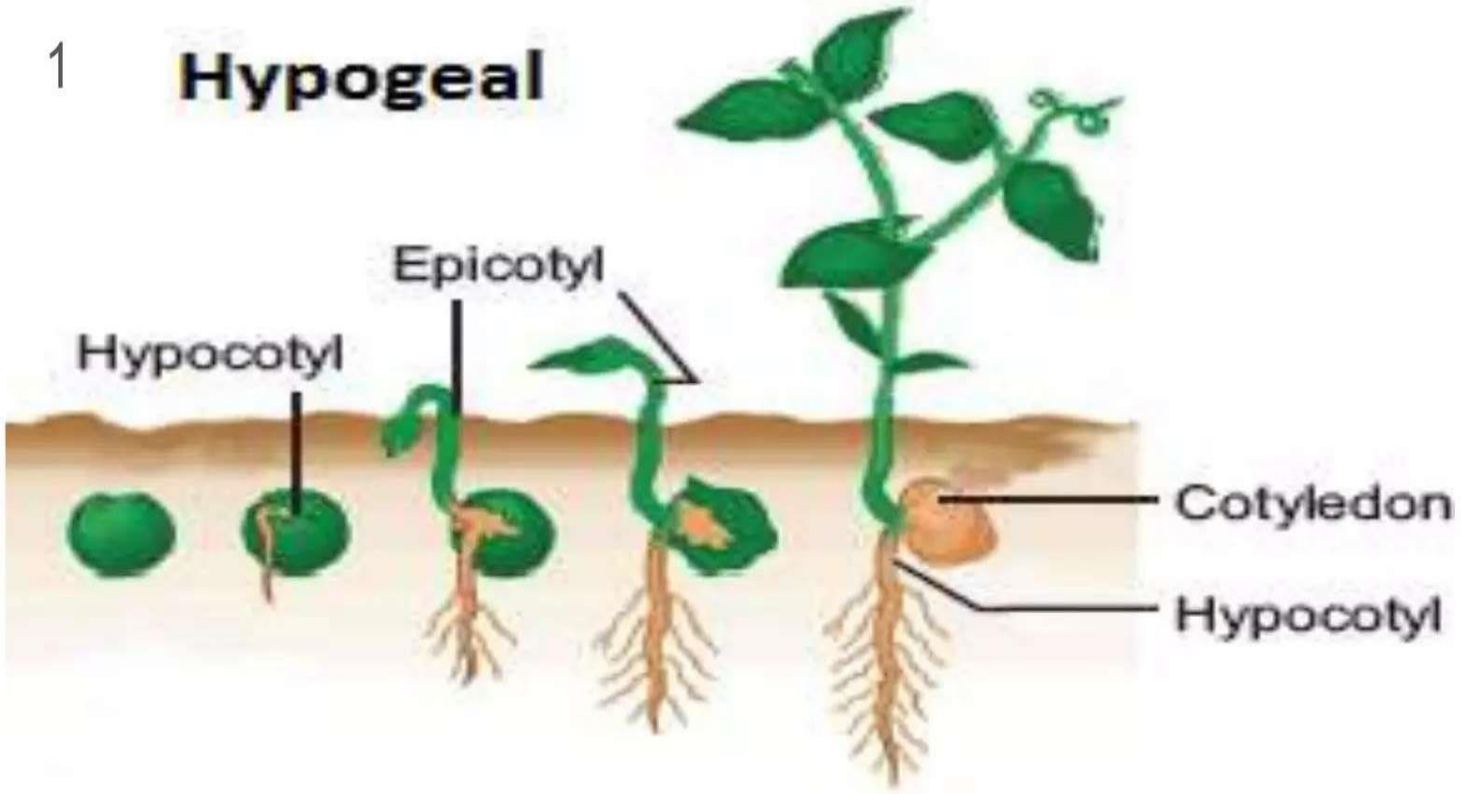
It terminates with the plumule.

Types of germination

- Both epicotyl and hypocotyl of a seed never elongate at the same time.
- If the epicotyl elongates, the cotyledons remain underground and the germination is called hypogeal. E.g. Pea and gram
- If the hypocotyl elongates, the cotyledons are pushed above the ground and the germination is called Epigeal . E.g Castor, Bean

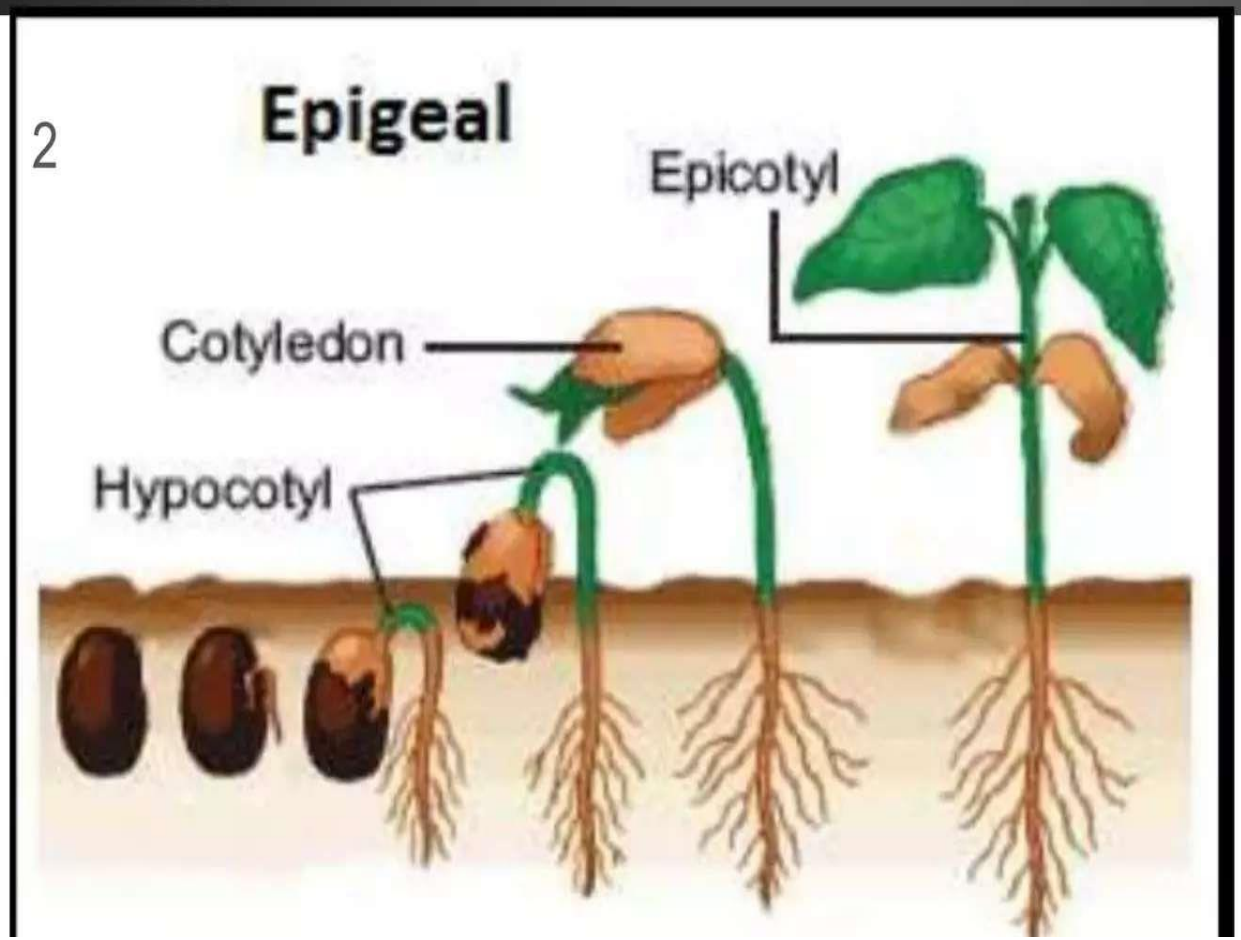
Hypogeal Germination

- 1 **Hypogeal**



Epigeal germination

- 2



Difference between Hypogeal and Epigeal germination

Hypogeal germination	Epigeal germination
Cotyledons remain underground	Cotyledons pushed above the ground
Epicotyl elongates faster	Hypocotyl elongates faster
Usually occurs in monocotyledonous seeds	Usually occurs in dicotyledonous seeds

A method to observe stages in germination

- TAKE A GLASS VESSEL
- FILTER PAPER OR ORDINARY WHITE PAPER IS LINED BESIDE THE INNER WALL
- PUT STEILIZED SAND
- PLACE SEEDS IN BETWEEN THE PAPER AND THE GLASS
- WHEN WATER IS ADDED TO THE SAND IN THE VESSEL, SEEDS WILL ABSORB
- WATER AND GERMINATE IN FEW DAYS.

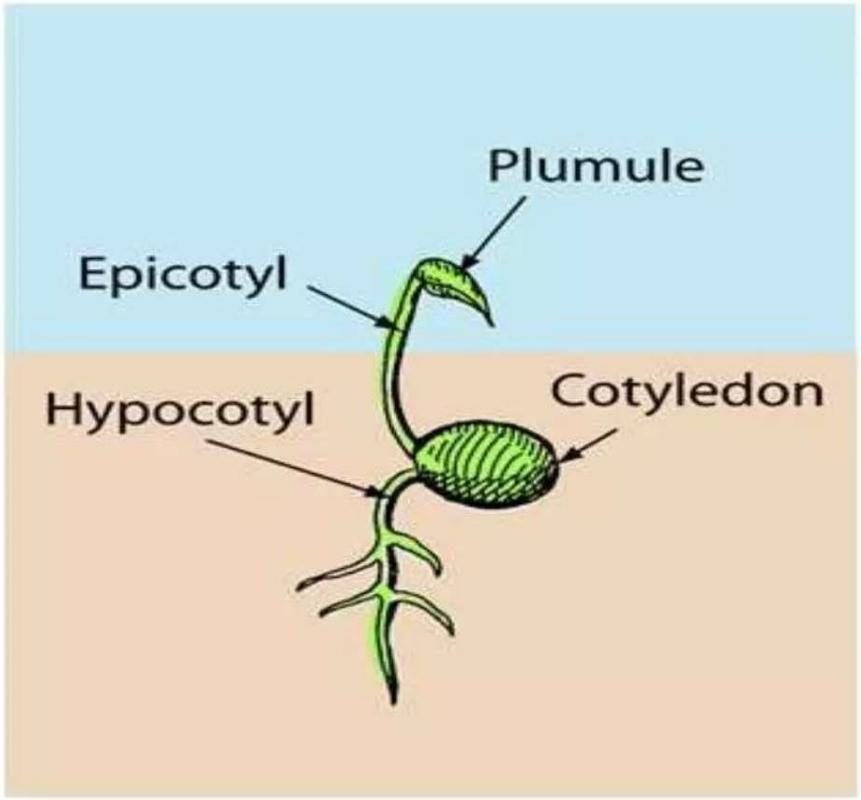
Germination in pea seed

1. The seed absorbs water and swells
2. The testa softens and bursts
3. Radicle emerges
4. Start to grow dowuwards and forms root system
5. Plumule grows upwards and forms the shoot system
6. In early stages of development plumule is arched
7. Cotyledons supply food till a seedling till sometime

Germination in pea seed

8. Once the seedling become independent they wither and shrivel up.
9. Cotyledons remain underground
10. This type of germination is Hypogeal
11. Hypo Means below. Geo means Earth

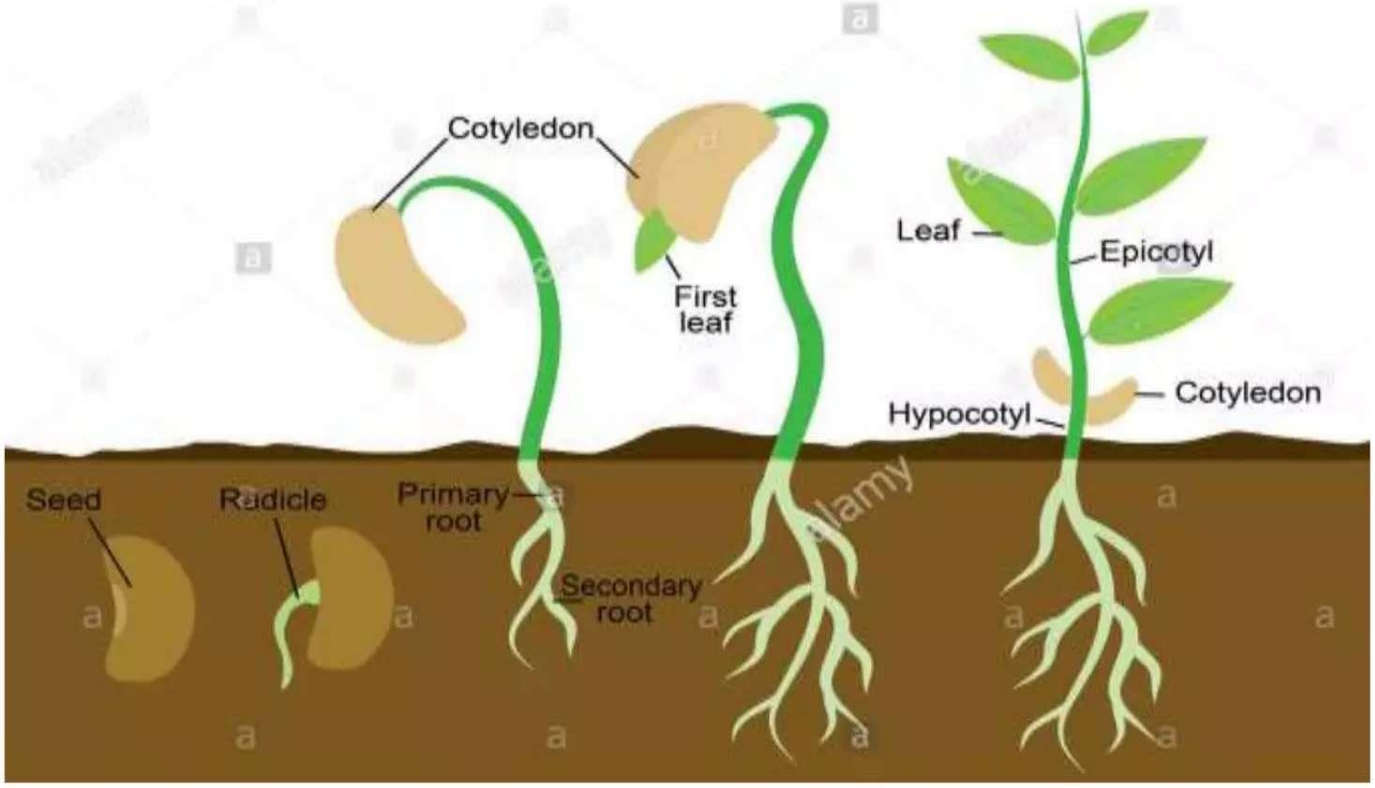
Hypogeal germination



Germination in bean seed

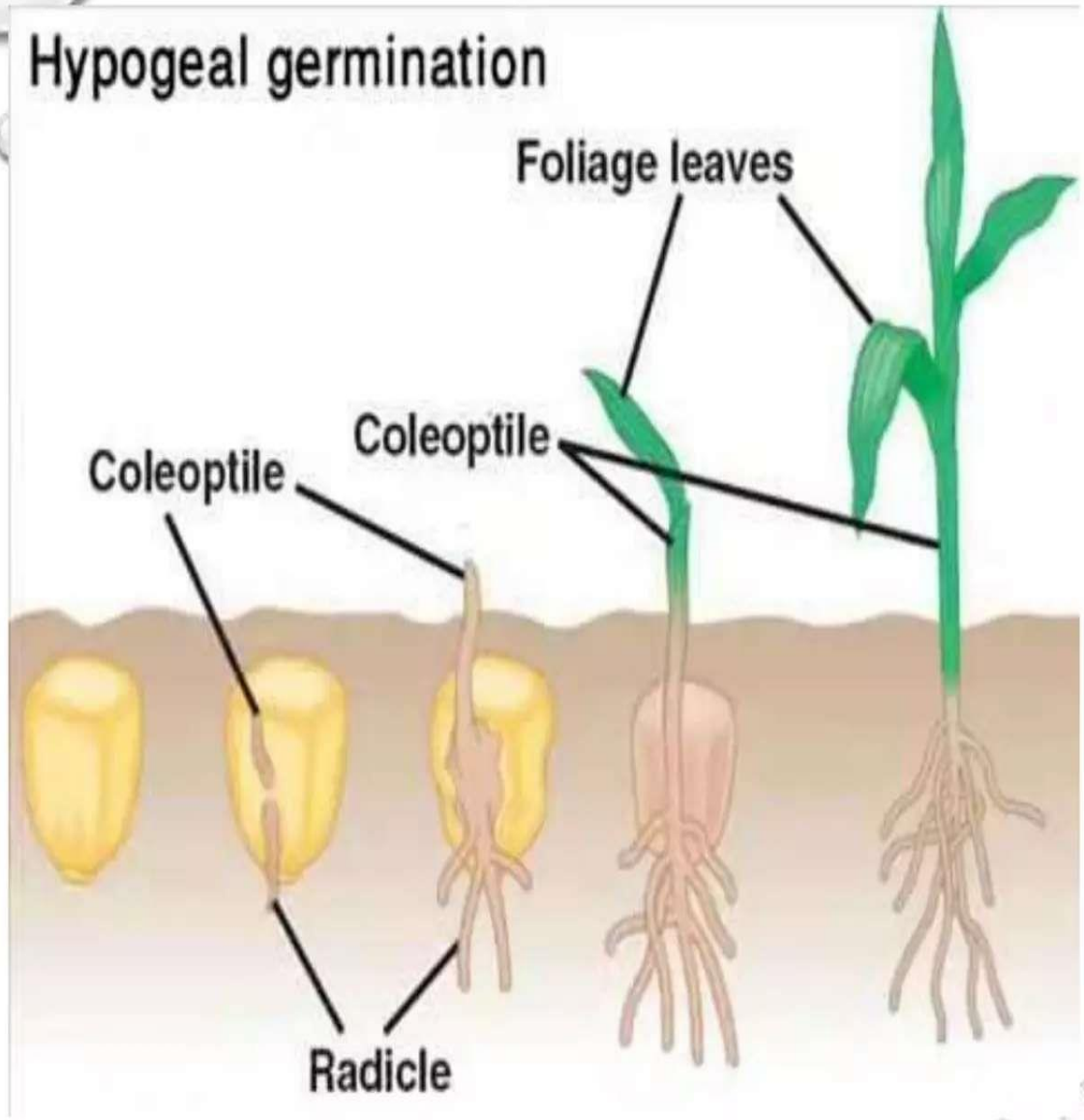
1. The seed absorbs water and swells
2. The radicle grows downwards to form the root system
3. The arched hypocotyl grows forming an arch above the soil
4. It straightens and brings the cotyledons above the soil
5. This is Epigeal germination
6. Epi Means above Geo means Earth
7. The cotyledons become the first green leaves and fall off once the foilage leaves grow.

BEAN SEEDS GERMINATION IN SOIL



Germination of maize grain

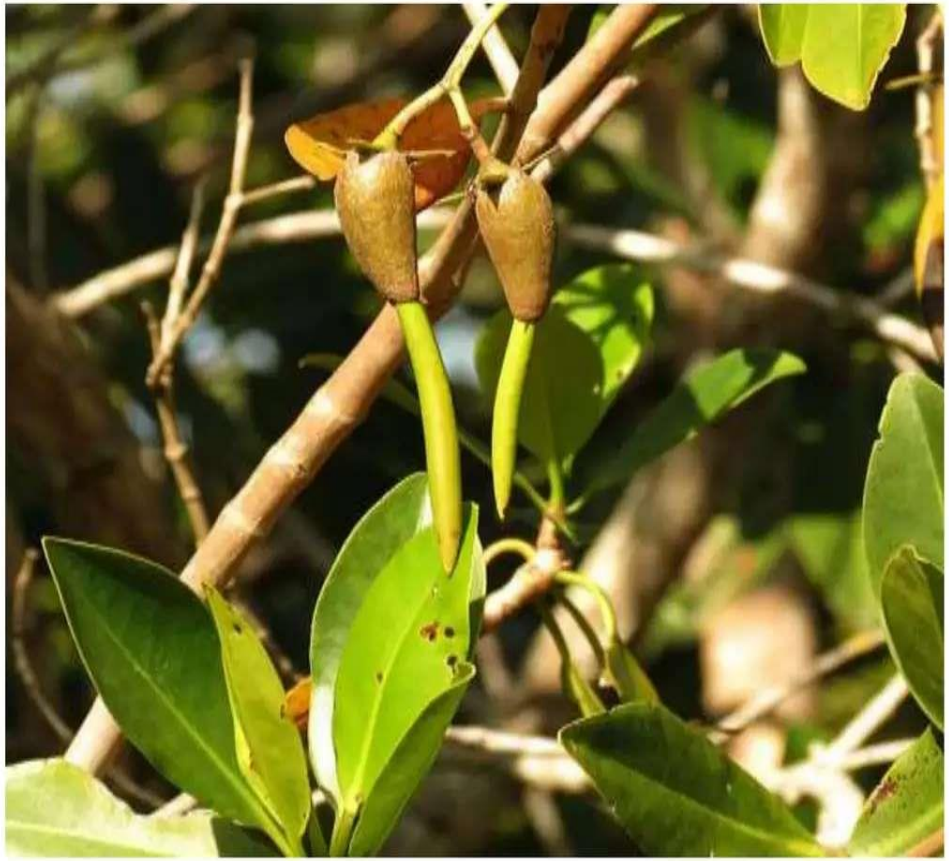
1. The grain imbibes water and swells
2. Radicle pierces through the protective root sheath.( ) And the fruit wall
3. It develops into a root system
4. It dies off soon
5. New roots starts to develop from the base of the stem
6. The plumule pierces through its protective sheath and straight upwards
7. Scutellum absorbs food from the endosperm till it is exhausted
8. The hypocotyl does not elongate


Hypogeal germination
Foliage leaves
Coleoptile
Coleoptile
Radicle

Viviparous germination

- Special type of germination
- Seed germinates inside the fruit while it is still attached to the parent plant
- This condition is called vivipary
- Mangrove plants like Rhizophora and Sonneratia will undergo viviparous germination

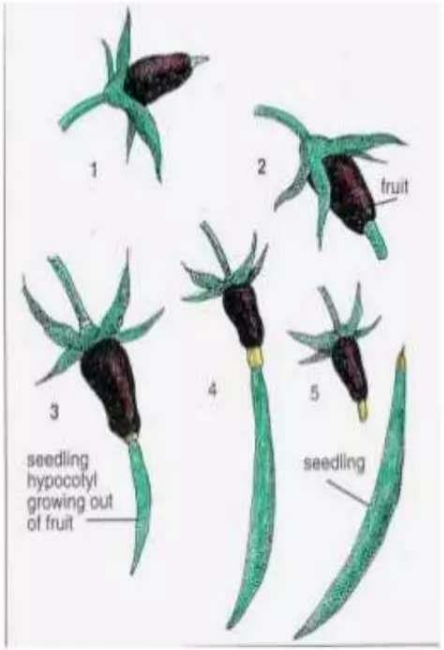
Viviparous germination in Rhizophora



Viviparous germination in Sonneratia

Mangrove in karnataka

Vivipary



Seedling

- Germination ends with the formation of seedling.
- A seedling is a very young plant that grows from a seed. When the moisture, light, and temperature conditions are correct, the seedling's development begins with seed germination and the formation of three main parts:

1. Radicle - Embryonic root
2. Hypocotyl - Embryonic shoot
3. Cotyledons - Seed leaves