Lecture-5 Seeds Germination

POST-FERTILISATION : STRUCTURES AND EVENTS

2. Embryo

Embryo develops at the micropylar end of the embryo sac where the zygote is situated. Most zygotes divide only after certain amount of endosperm is formed. This is an adaptation to provide assured nutrition to the developing embryo. Though the seeds differ greatly, the early stages of embryo development (embryogeny) are similar in both monocotyledons and dicotyledons. Figure 2.13 depicts the stages of embryogeny in a dicotyledonous embryo. The zygote gives rise to the proembryo and subsequently to the globular, heart-shaped and mature embryo.

A typical dicotyledonous embryo (Figure 2.14a), consists of an embryonal axis and two cotyledons. The portion of embryonal axis above the level of cotyledons is the epicotyl, which terminates with the plumule or stem tip. The cylindrical portion below the level of cotyledons is hypocotyl that terminates at its lower end in the radicle or root tip. The root tip is covered with a root cap.

Embryos of monocotyledons (Figure 2.14 b) possess only one cotyledon. In the grass family the cotyledon is called scutellum that is situated towards one side (lateral) of the embryonal axis. At its lower end, the embryonal axis has the radical and root cap enclosed in an undifferentiated sheath called coleorrhiza. The portion of the embryonal axis above the level

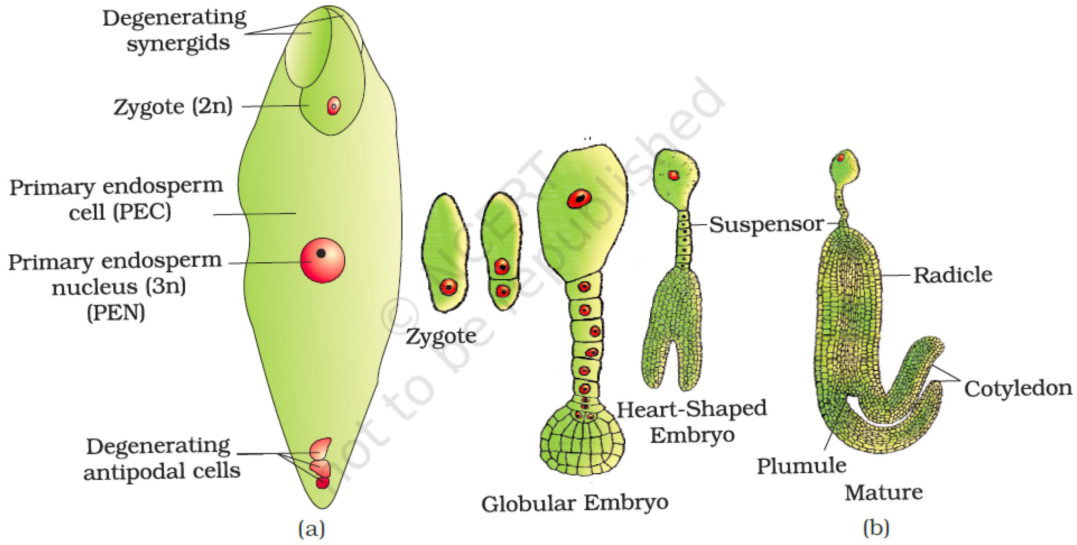


Figure 2.13 (a) Fertilised embryo sac showing zygote and Primary Endosperm Nucleus (PEN); (b) Stages in embryo development in a dicot [shown in reduced size as compared to (a)]

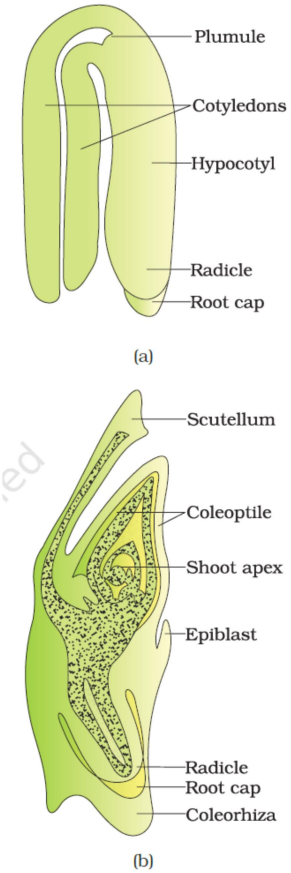


Figure 2.14 (a) A typical dicot embryo; (b) L.S. of an embryo of grass

Development of embryo

(i) The zygote divides into two cells, the upper cell (embryonal cell) and; lower cell (suspensor cell). (Fig 19.10)

(ii) The lower cell divides and forms the suspensor.

(iii) The suspensor pushes the developing embryo into the endosperm to get food.

(iv) The embryonal cell divides several times and finally gets differentiated into radicle, plumule and cotyledon.

(v) The integuments become hardened and thus form the seed coat which protects the seed.

(vi) Thus, a seed may be dicotyledonous with two cotyledons (pea) or monocotyledonous with one cotyledon (wheat, rice).

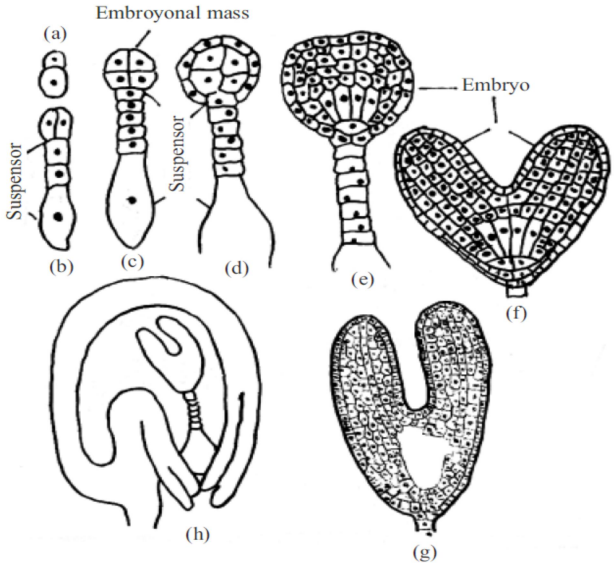
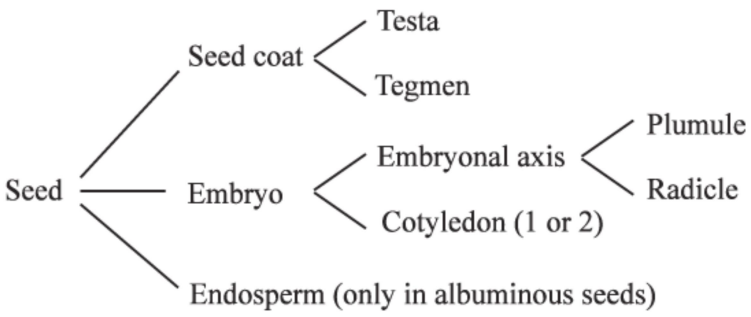


Fig. 19.10 Development of embryo, A-H

seed

The seed is defined as a **ripened ovule.**



•A seed is a sporophyte embryo with its own food supply in a protective coat

•Seed plants (gymnosperms and angiosperms) retain their spores

Seed

Seed is the final product of sexual reproduction and on maturity, it becomes relatively dry. The metabolic activity of the embryo slows down and in majority of cases the embryo enters into a phase of inactivity called dormancy or in some cases if favorable conditions are available they germinate. Dormancy helps the plants to survive under unfavorable conditions and ensures its germination only under favorable conditions.

Importance of Seed

1. It contains embryo which develops into a new plant.

2. The seed coat protects the embryo against dehydration and mechanical damage.

3. Seeds can be stored and transported from one place to another

Germination

A flowering plant begins its life cycle as a seed. Seeds need special conditions to germinate, or begin to grow. Spring provides seeds with the right conditions to grow. Therefore, the life cycle of a flowering plant begins in spring. In spring, there is more sunlight and temperatures are warmer. Seeds need just the right amount of light from the sun, nutrients from the soil, and water in order to grow.

Once the seed germinates, or sprouts, it grows and develops into a young plant with roots, a stem, and leaves. The first leaves unfold to allow photosynthesis to begin. Photosynthesis is the process by which plants make their own food, as well as oxygen. Plants use sunlight and water to make food in the form of glucose, a type of sugar.

In the warmth of spring and summer, plants continue to grow. The young plant is called a seedling. Gradually, a plant's stem will grow taller and true leaves will emerge. Once the plant matures, or become an adult plant, flowers appear.

In order for a flowering plant to reproduce, or produce seeds that will make new flowering plants, it must be pollinated. Pollination is when pollen from one flower mixes with the pollen of another flower so that the plant can make seeds. But

how is pollen transferred from one place to another? In other words, how does pollination occur?

Flowering plants need pollinators to help them with pollination. Pollinators are insects, birds, and other animals that are attracted to the shape, fragrance, or color of a flower. Without pollinators, most flowering plants would not produce seeds and fruit

There are many types of pollinators, such as birds and small mammals, but insects are the number-one pollinators of flowering plants. The flowers of a flowering plant are designed to attract various pollinators, especially insects. The shape, fragrance, and color of the flower, as well as the sweet-tasting nectar contained within the flower itself, attract many different kinds of insects. As insects move from flower to flower, the sticky substance called pollen clings to their bodies and is transferred, not only within a flower, but from flower to flower.

Honeybees are the most common pollinators. They carry out more pollination

than any other insect. Some scientists think that bees are attracted to bright blue and violet-colored flowers, whereas butterflies like fragrant yellow, pink, red, and orange flowers. Butterflies also like wide petals so that they can settle on them while they drink the sweet nectar.

Birds are important pollinators, too, especially of wildflowers. For example, hummingbirds have perfectly designed beaks that can reach the nectar inside long, tubular-shaped flowers. There are more than $2{,}000$ different kinds of birds in the world that feed on nectar. Birds have a poor sense of smell and help to

pollinate unscented flowering plants because they are attracted by the color and shape of the flowers.

A variety of small mammals pollinate flowering plants. Mice, shrews, and rats—

even tree-dwelling animals such as lemurs and small monkeys—can help to transfer pollen. People also help the pollination process. Often, when people are working in their flower gardens, the sticky pollen is accidently carried from flower to flower.

For some plants, pollination does not just occur during the daytime. Some

scented flowers attract nighttime pollinators such as bats and moths.

Although ninety percent of flowering plants are pollinated by animals, especially

insects, the wind and even water can play a part, too. Pollen is carried by the wind. Flowering plants that live in water, such as lilies, can be pollinated as the water carries the pollen from one plant to another.

Once pollen has been transferred and reaches the new plant, the flower produces seeds. The next part of the process is called seed dispersal. This is the process of carrying the seeds away from the parent plant so that the flowering plant life

cycle can begin all over again.

Just like pollination, there are various ways that seeds can be dispersed, or

spread apart in different directions. Many flowering plant seeds are carried away from the parent plant by the wind. As the wind blows, the seeds are carried up

into the air. Some flowering plants have pods, or capsules, that explode, sending forth a burst of tiny seeds into the air. Other flowering plants drop their seeds into rivers and streams, and the seeds are carried along to their new home.

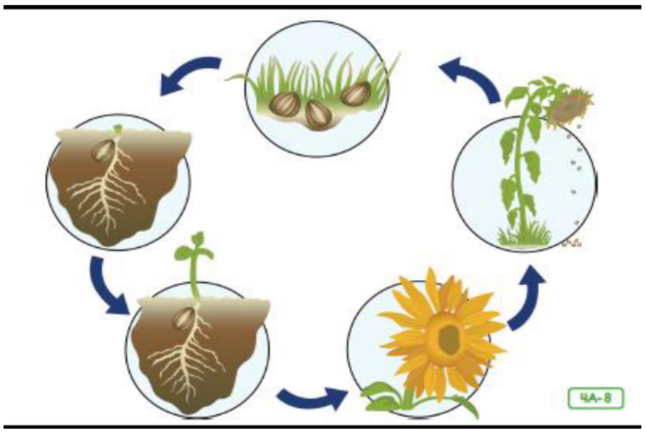
Sometimes animals carry seeds from place to place without knowing it. Some seeds contained within a protective casing can attach themselves to the fur of passing animals. The protective casing will eventually fall off the animal and rest in the soil,ready to begin the life cycle process.

Some seeds are contained within a fruit that animals like to eat. Animals either spit the seeds out, or they eat them, and the seeds reach the earth in the animal droppings that are left behind. Once on the ground, they rest in the soil until the germination process can begin again the following spring

Seed to seed

All of this is happening around us in spring, summer, and early autumn. The potential for new life is being created as flowering plants are pollinated and seeds are dispersed. Across the world,the life cycle of flowering plants is renewed, or happens again,each year.

Germination : Embryo lies dormant in the seeds, but when the seed receives the favourable signals and the inputs from the environment (moisture, suitable temperature and oxygen) are available, they germinate. Germination is the process by which the embryo grows and establishes itself as a seedling.



The Process of Seed Germination:

The activation of metabolic machinery of seed embryo is the first and foremost step to initiate the seed germination process Thus, seed germination is the process of reactivation of the metabolic activity of the seed embryo, resulting in the emergence of radical (root) and plumule (shoot), thus leading to the production of a seedling or a young plant. Seed germination is a very complex process as it involves many biochemical, physiological and morphological changes within a seed. For germination to be initiated, three conditions must be fulfilled First, the seed must be viable i.e the embryo should be alive and capable of germination. Second, the seed should be non-dormant i.e there should not be any dormancy or any chemical barrier for germination Third, the environmental conditions like

moisture, temperature, air (O2) and light must be available in appropriate amount. If all these conditions are fulfilled, the quiescent embryo in the seed will resume growth, thus initiating the process of germination. In the early stages of growth, the embryo draws nutrients from the stored food material in the cotyledons or the endosperm of Later, new shoot/leaves are developed, which produce their own photosynthetic system

Stages of seed germination:

The process of seed germination involves several consecutive but overlapping events like

i. absorption of water

ii. initiation of cell enlargement and division

iii. increased enzymatic activity

iv. food translocation to growing embryo

v. increase in respiration and assimilation

vi. increase in cell division and enlargement and

vii. differentiation of cells into tissue and organs of a seedling

The sequence of these events is not specific and one event may overlap the other.However, the entire process of germination can be divided into following different stages:

1) Activation or awakening stage: a) Water absorption: Early seed germination begins with the imbibition of water by the seed. Water is absorbed by the process of imbibition and osmosis by the dry seeds, which

softens the seed coat and other coverings and causes hydration of the protoplasm. After imbibition of water, the seed swells and seed coverings rupture, which helps protoplasm in resuming metabolic activity with the activation of enzymes. During hydration phase, the seed coat acts as a limiting factor and its rupture increase water uptake. Water enters the seed through micropyler pore and hilum. In general, water absorption is very rapid initially but it slows down slowly and steadily. b) Synthesis and activation of enzymes: After hydration, enzyme activity begins very quickly. Activation of enzymes is partly from reactivation of stored enzymes and partly by the synthesis of the enzymes during germination initiation process. The hydrolytic enzymes convert complex food material into simpler forms, which can be readily translocated and absorbed by the embryo. The oxidative enzymes are involved in respiration and releasing the energy for cell division and growth.

c) Cell elongation: Hydration, and synthesis and activation of enzymes help in the elongation of cells, which results in the emergence of radicle. Emergence of radicle is the first visible symptom of germination, which results from the elongation of cells rather than from the cell division. It is observed that under fabvourable conditions, the emergence of radicle may take place within a few hours as in non-dormant seeds or a few days after seed sowing. The emergence of radicle is considered as the end of stage 1 i.e. activation or awakening stage

2.Translocation stage: Food materials like fats, carbohydrates or proteins are stored in the endosperm or in the cotyledons. These compounds are converted into simpler forms and are translocated to the growing points of the embryo. The process of conversion of different speces differs with the type of food material reserved in the seed. For example, fat and oils are

converted enzymatically to first to fatty acids and then to sugars. Storage proteins are first converted to amino acids and then to nitrogen, which are essential to growing seedlings. Starch present in many seeds as an energy source, is converted to simple sugars. All these conversions are regulated by metabolic activity of specific enzymes in a proper sequence.

3. Seedling growth stage: In this stage, the development of the seedling plant takes place from continued cell division in different growing points of the embryo, which is subsequently followed by the expansion of the seedling structures. The cell division is growing point and subsequent cell elongations are two independent processes taking place in a seedling. As the germination proceeds, the structure of seedling soon becomes evident.

Steps of germination

 Imbibition of water through the micropyle, and by the seed coat.

 Seed swells up as it gets hydrated.

 Enzyme activity converts the reserve seed food into soluble forms (glucose, amino acid, fatty acids)

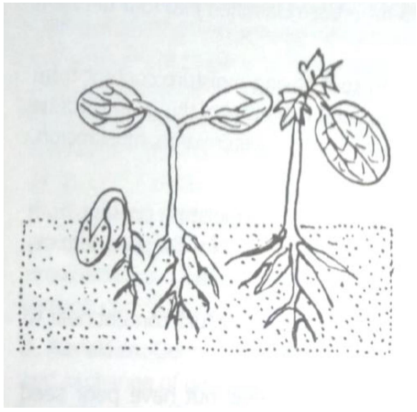
 The seed coat bursts and radicle emerges (grows into root) and then the plumule grows and develops into shoots

Types of seed germination:

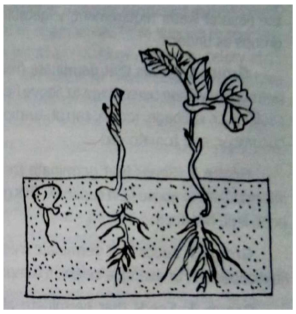
The radicle, the growing point of root emerges from the base of the embryo axis and the plumule, the growing point of shoot is at the upper end of embryo axis, above the cotyledons. The section of seedling stem above the cotyledons is called as epicotyl and below the cotyledons is called as hypocotyl

Two types of germination are commonly found in cultivated plants

1. Epigeal germination: Seed germination in dicots in which the cotyledons the soil surface. In this type, the hypocotyl elongates and raises the come above cotyledons above the ground surface, it is called as epigeous or epigeal germination. This type of germination is very common in beans, gourds, castor, .tamarind and onion etc



1. Hypogeal germination: Seed germination in dicots in which the cotyledons remain below the soil surface. In this type, the epicotyl elongates and the hypocotyl does not raise the cotyledons above ground, which is called as hypogeous or hypogeal germination. This type of germination is common in mango, custard apple, pea, and maize etc.



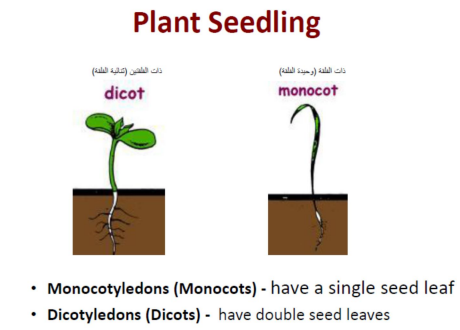
1. Seed: A seed is a ripened ovule, which consists of an embryo and stored food supply surrounded by protected seed coverings.

2. Embryo: A miniature plant within a seed, produces by the union of male and female gamete.

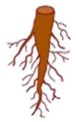
3. Germinate: To being to grow.

4. Germination: The process in which seed embryo starts growing, which leads to the development of seedling.

5.Dicots: Plants having two cotyledons in their seeds .

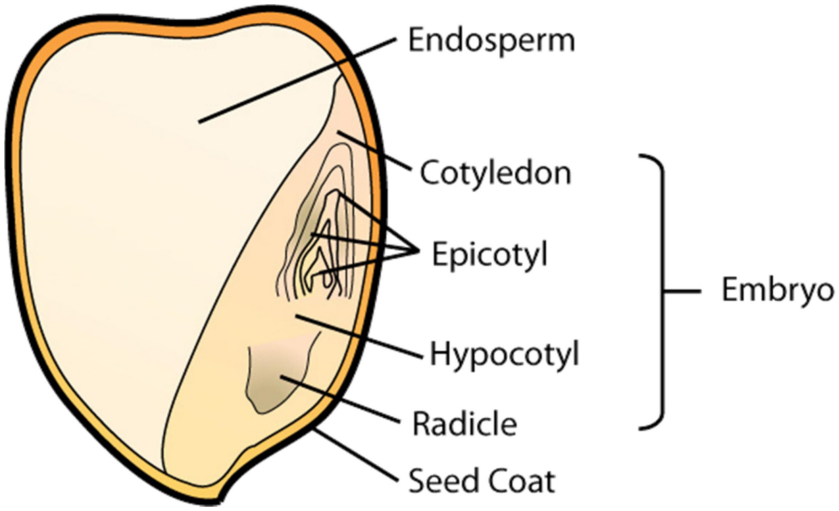


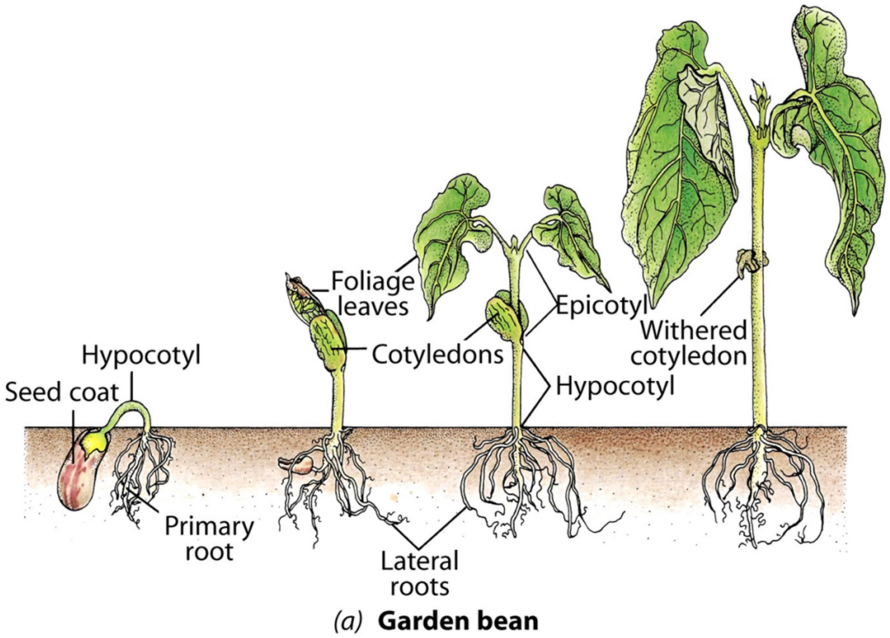
Monocots vs. Dicots

	Seed	Root	Vascular	Leaf	Flower
Monocot					
	One cotyledon	Fibrous roots	Scattered	Parallel veins	Multiples of 3
Dicot					
	Two cotyledon	Tap roots	Ringed	Net-like veins	4 or 5

Cotyledon

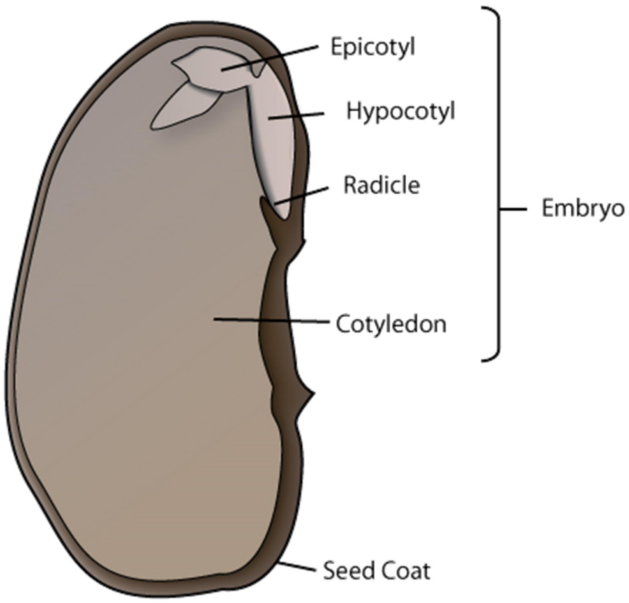
Parts of a Monocot Seed

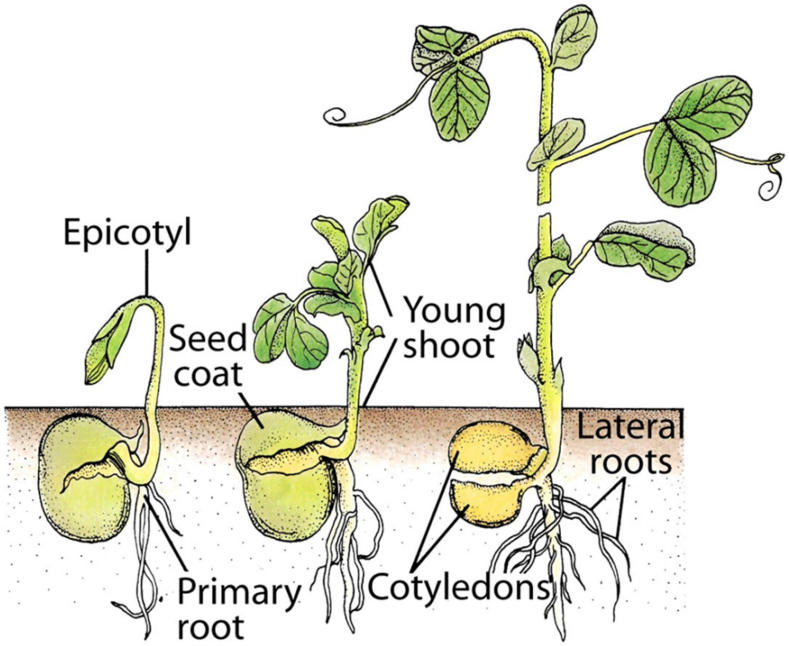




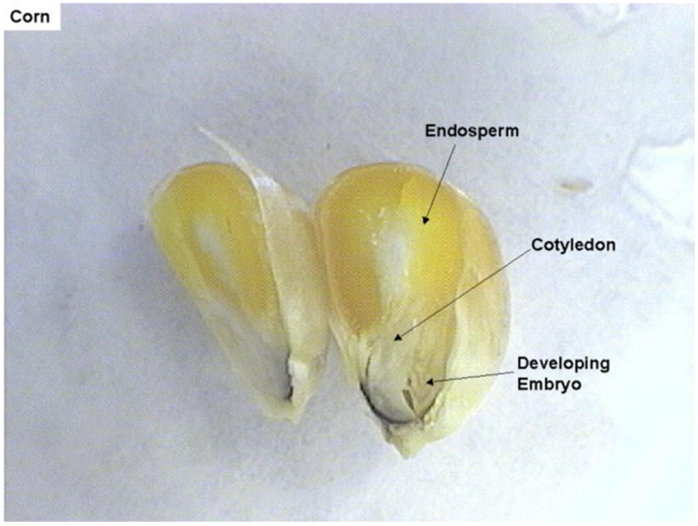
(a) **Garden bean**

Parts of a Dicot Seed



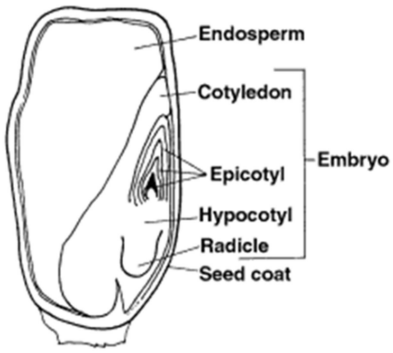

Epicotyl
Seed coat
Young shoot
Lateral roots
Primary root
Cotyledons

(c) **Pea**


Corn
Endosperm
Cotyledon
Developing Embryo

4parts of the embryo

1) Cotyledon
2) Epicotyl – "stem"
3) Hypocotyl – "growing point"
4) Radicle – "root"



Moncot (corn)

Steps of Germination

1) Seed absorbs water
2) Seed coat breaks open
3) Radicle Emerges & forms roots
4) Epicotyl breaks through soil
5) Cotyledon(s) open
6) Leaves form & photosynthesis starts