6.3 Seed structure and growth

In the life cycle of every plant there is a point when the balance of physiological processes shifts from vegetative growth to the development of reproductive structures. It is at this point that seed development really begins.

A **seed** can be defined as the out product of the union of male and female organs of plant flowers which is responsible for the survival of its species. In other words, a seed is an embryo, a living organism embedded in supporting or food storage tissue. In nature, seeds perform the following three functions.

1. Seeds serve as the source of plant *multiplication* because a seed can produce a plant which is in turn capable of producing many seeds and hence many plants.
2. Seeds serve as a means by which the plants can *survive adverse conditions*. The seed protects and sustains life; it is a highly organized fortress, well stocked with special supplies of food against unfavourable conditions.
3. Seeds give plants the *ability to move* in space, either by means of their special structures, or by natural forces of dispersal such as wind, water, insects, birds, and other animals.

6.3.1 Seed morphology

Basically a seed is made up of the embryo, the endosperm, and protective coverings consisting of the seed coat or testa and in some cases accessory structures (glumes, bracts, spines, and hairs). The testa has a conspicuous marking (**hilum**) on its surface which indicates the place of attachment of the seed in the fruit. At one end of the hilum in the testa is a small opening known as the **micropyle**. Seeds may have two layers of protective covering—the **testa** (outer layer) and **tegmen** (inner layer). In most seeds these are fused together. The function of these layers is to protect the embryo against drying out, mechanical injuries, and attack by insects, fungi, and bacteria. In most seeds, the outer coat is hard and durable and the inner one is thin and membranous.

In maize and other grains the main food reserves are stored as **endosperm**, while in beans they are stored in two cotyledons which later serve as photosynthetic organs for the young seedlings. Seeds which have endosperm are called endospermic, while those with no endosperm are called non-endospermic (Fig. 6.1).

The embryo is made up of a **hypocotyl**, a **plumule**, and one or two **cotyledons**. The hypocotyl is a very short axis with the **radicle** at its lower

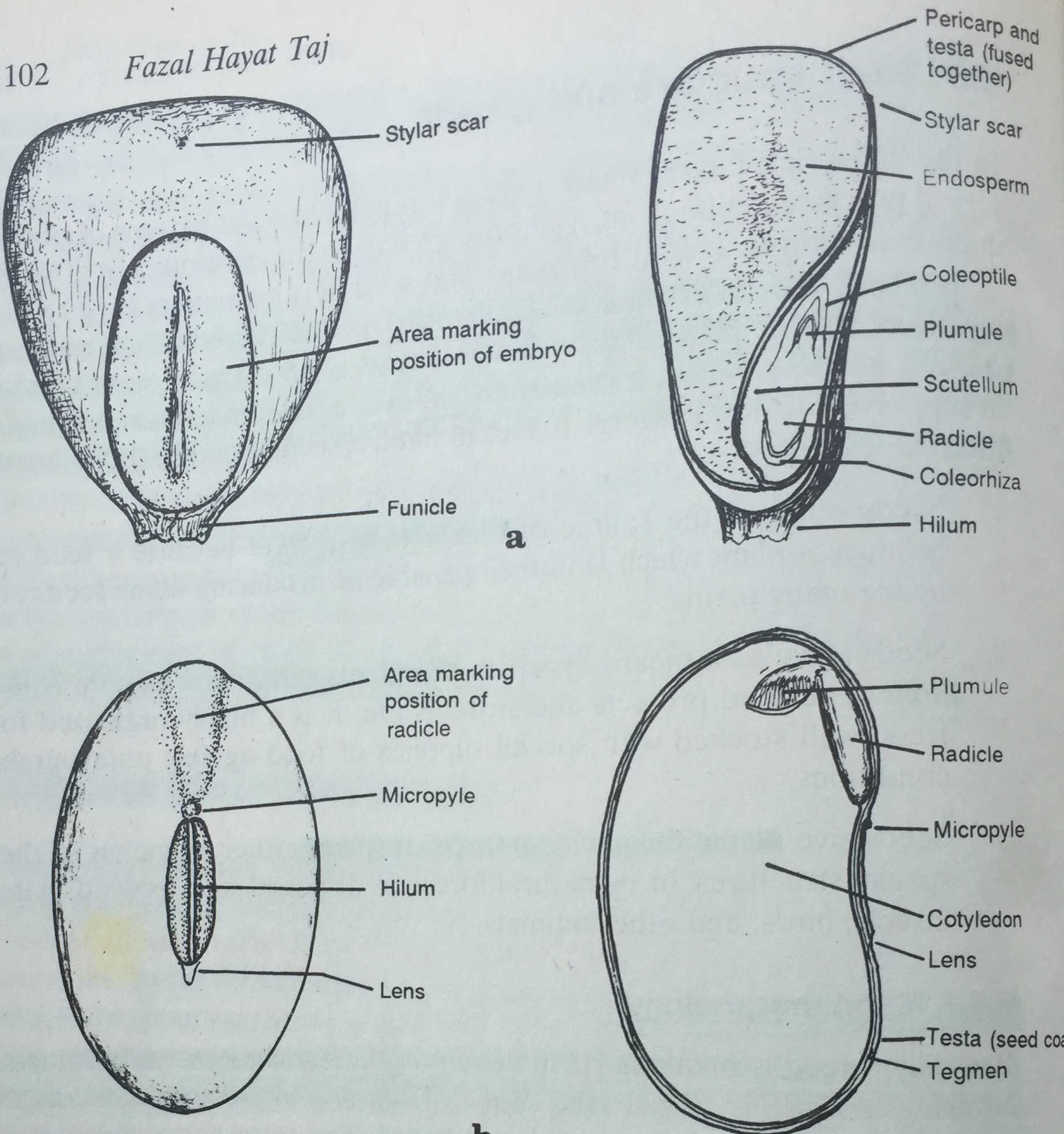

Figure 6.1 Structure of maize (a) and bean (b) seed.

end and the plumule at the upper end. The radicle develops into the root, whereas the plumule produces the leafy stem. The epicotyl is that part of the plumule (stem) which is just above the point of attachment of the cotyledons, whereas the hypocotyl is below the cotyledons. The plumule, radicle, and hypocotyl together form the embryonic axis. Seeds which have two cotyledons are called **dicotyledonous** (dicots), while those which have a single cotyledon are known as **monocotyledonous** (monocots).

Monocotyledonous and dicotyledonous seeds can be differentiated in the following ways.

	Monocot seeds	Dicot seeds
1.	Have one cotyledon.	Have two cotyledons.
2.	Testa fused with pericarp in one-seeded fruit.	Testa free from pericarp.

	Monocot seeds	Dicot seeds
3.	Usually endospermic.	Usually non-endospermic (except castor seed).
4.	Germination usually hypogeal, except in onion.	Germination usually epigeal, except in some dicots such as pea, gram.
5.	Primary root soon disappears and is replaced by adventitious roots arising from the base of the stem.	Primary root develops from the radicle and persists through the life of the plant.

6.3.2 Germination

To the seed analyst, **germination** is 'the emergence and development from the seed embryo of those essential structures which, for the kind of seed provided, indicate the ability to produce a normal plant under favourable conditions' (Grabe 1970:1126). Not all germinating seeds produce normal seedlings; the percentage of germination is expressed on the basis of normal seedlings only. Seeds present two modes of germination based on the behaviour of the cotyledons or storage organs.

1. Epigeal germination. (*epi* 'above' and *geos* 'earth'). The cotyledons come out above the soil surface and generally turn green and act as first foliage leaves (Fig. 6.2-top). This type of germination is characteristic of groundnut, bean, cotton, sunflower, and castor seeds.

2. Hypogeal germination. (*hypo* 'beneath' and *geos* 'earth'). The cotyledon(s) do not come above the soil surface (Fig 6.2-bottom). This type of germination is found in gram, chickpea, pea, maize, wheat, and barley.

Conditions necessary for germination. The essential conditions for germination are (1) water, (2) air, (3) temperature, and (4) light.

WATER. Water is a basic requirement for germination. The absorption of water softens the seed coat, causes the embryo to swell, initiates enzymatic action, and bursts open the softened seed coat. Water makes the seed coat permeable to gaseous exchange and renders the insoluble food substances soluble by the action of enzymes. Water carries the soluble substances (solutions) to the growing points of the embryo.

AIR. Air is composed of about 20% oxygen, 0.03% carbon dioxide, and about 80% nitrogen. Access of oxygen to seeds is essential, because respiration (involving the absorption of oxygen and release of CO_2) is always very active in germinating seeds. Seeds sown near the soil surface get plenty of oxygen, in contrast to deep-sown ones. In waterlogged soils there is a lack of oxygen and seeds fail to germinate.