Lesson 5: Germination

In order for a viable seed to germinate, certain environmental conditions must be met. This lesson will discuss what seeds are, how they germinate, and how emergence differs between a monocot seed and a dicot seed.

Seeds

A seed is a young embryonic (living organism in an early stage of development) plant in a dormant or resting stage. Each seed contains a supply of food and one or more seed coats. Seeds come in many sizes, shapes, and colors. Seeds can be planted to produce another plant or eaten as foods like popcorn, peanuts, or cooked beans. Regardless of the shape or color, all seeds contain three basic parts: an embryo, a food supply, and an ovary wall (seed coat).

The seed is alive even though it is in a dormant stage. Proper care of seeds during dormancy is vital. Improper storage conditions such as extreme moisture, heat, or cold may damage the seed and cause it to die. In order for a seed to germinate, it must be a viable (capable of living or growing) seed.

Germination

A seed must germinate in order for the young plant to begin to grow and develop. Germination of a viable seed occurs when a seed has been exposed to certain environmental conditions that stimulate the process. Favorable temperature, sufficient moisture, and air (specifically oxygen) are three environmental conditions necessary for germination. However, due to differences in plants, the degree to which these environmental conditions are required will vary. Some ornamental bedding plants require light to begin the germination process. However, light will inhibit germination of most agronomic crops.

Seed germination involves several steps. The first step in germination is absorption of water by the seed. Seeds will generally absorb 35% to 100% of their weight in water. Absorption of water causes the seed coat to swell. When penetration of water and swelling of the seed occurs, the seed's proteins are activated.

The second step of activating the seed's proteins involves the activation of the seed's enzyme system. Increased enzyme activity in the seed stimulates the growth of the embryo. The embryo's rapid growth requires more moisture and oxygen.

Emergence of the root structure from the seed is the third step. The new root anchors the seed in the soil and absorbs moisture for continued growth.

The fourth step in the germination process is the emergence of the shoot from the seed. Because the seed has a limited supply of food, the plant must soon begin producing its own food. The shoot of the embryo will push its way up through the soil into the sunlight.

Once the shoot has emerged from the soil, the last step can take place. The last step is the formation of leaves and the production of food through photosynthesis. The plant begins to grow and develop after the process of germination has been completed.

Monocot Seeds

Monocot and dicot seeds require three environmental conditions for germination. However, when comparing seeds of monocots and dicots, the parts and functions are different.

The monocot seed consists of a seed coat, endosperm, and embryo. The embryo contains the cotyledon, epicotyl, hypocotyl, and radicle. See Figure 5.1 for parts.

Each part of a monocot seed has a unique purpose. The seed coat is the tissue surrounding the embryo, which protects the inner parts. The endosperm is a source of starch or energy (food) for the miniature plant until germination is complete. After germination, the plant produces its own food through photosynthesis.

The embryo is a miniature plant within the seed structure. The embryo contains the cotyledon (scutelum), which breaks down the starch in the endosperm to provide food for the embryo. The epicotyl is the shoot above the cotyledon. This part grows above the ground. The hypocotyl is the part of

Figure 5.1 – Monocot Seed (Corn)

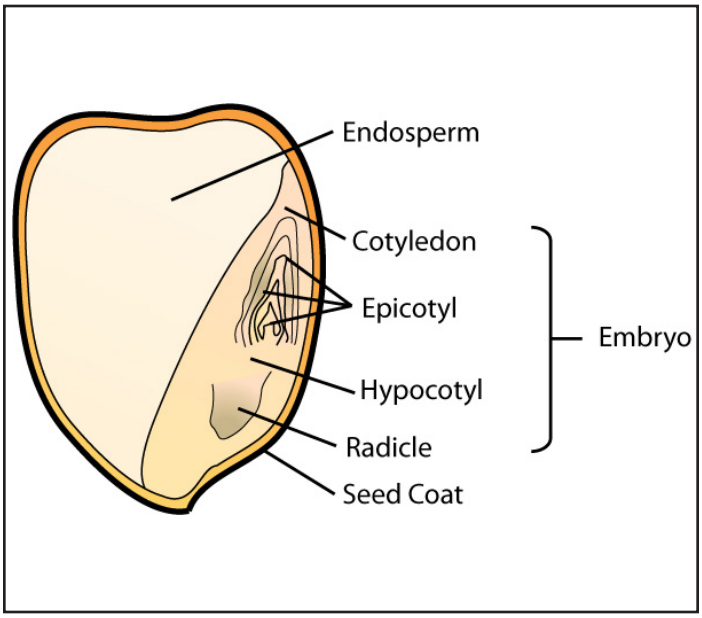
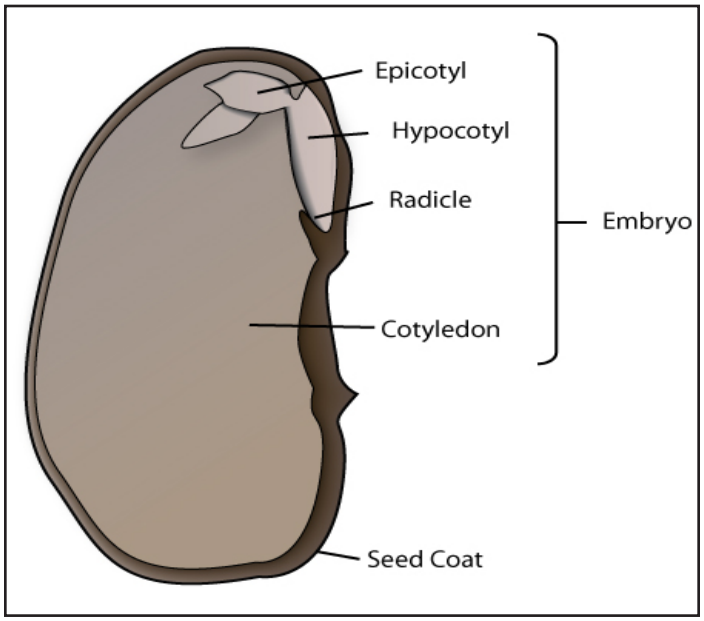


Figure 5.2 – Dicot Seed (Bean)



the stem below the cotyledon. The radicle develops into the primary root of the plant. The radicle absorbs water during germination. The radicle dies after other permanent roots have formed.

Dicot Seeds

Figure 5.2 is an example of a dicot seed. The parts of the dicot seed consist of the seed coat and the embryo. The embryo contains two cotyledons, the epicotyl, the radicle, and the hypocotyl. The purpose of the seed coat is to protect the embryo during the dormant stage. The two cotyledons store food during dormancy. The epicotyl forms into the first true leaves, shoot, and everything above the cotyledons. The hypocotyl is the first true stem between the root and first node of the stem. As the hypocotyl straightens upright, it pulls the cotyledons up out of the ground. The radicle forms the root system.

Germination and Emergence

During the germination process, tender parts of the young plant emerge from the soil. Emergence of the young plant is vital to begin photosynthesis. The emergence process of the young monocot plant is quite different than that of the dicot plant.

Germination and emergence of a monocot seed starts with the swelling of the seed due to absorption of water. Moisture stimulates enzyme activity and the seed coat ruptures. The radicle is the first part of the miniature plant to emerge from the seed. During the next step, the epicotyl grows out of the seed and starts pushing its way up through the soil towards the sunlight.

After the epicotyl emerges, new leaves form and food production begins through photosynthesis. A new root system forms above the first internode just beneath the soil surface. The temporary root system ceases to function and dies.

The process of germination and epigeal emergence, which occurs in most dicot seeds, also begins with the seed swelling and rupturing due to the absorption of water. The hypocotyl is the first part to grow out of the seed. The hypocotyl begins to elongate and forms an arch that breaks the soil surface. Once the hypocotyl reaches light, elongation ceases, The hypocotyl then straightens up and pulls the cotyledons out of the soil. Once the cotyledons have been exposed to light, they turn green and begin to manufacture food. When new leaves develop, the cotyledons dry up and fall off. The radicle extends downward into the soil to form roots during germination.

Figure 5.3 – Germination and Emergence of a Monocot Seed (Corn)

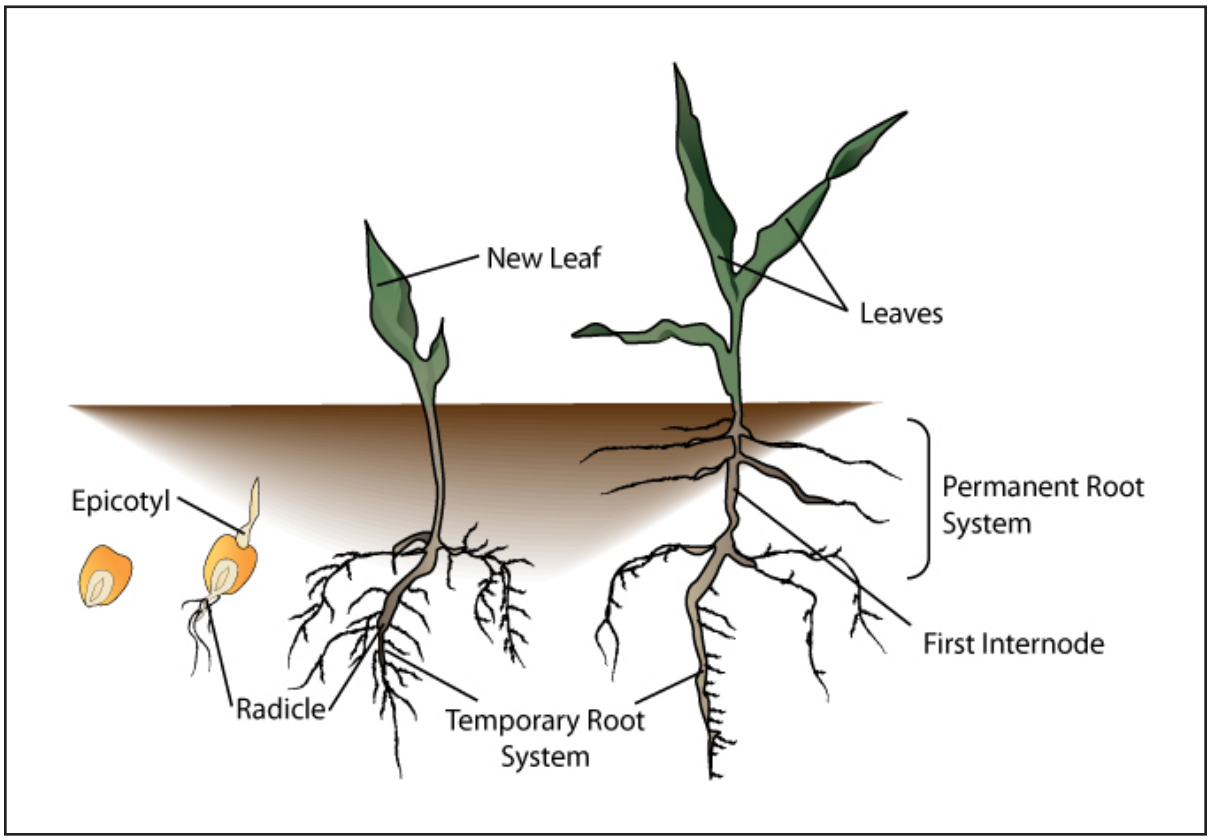
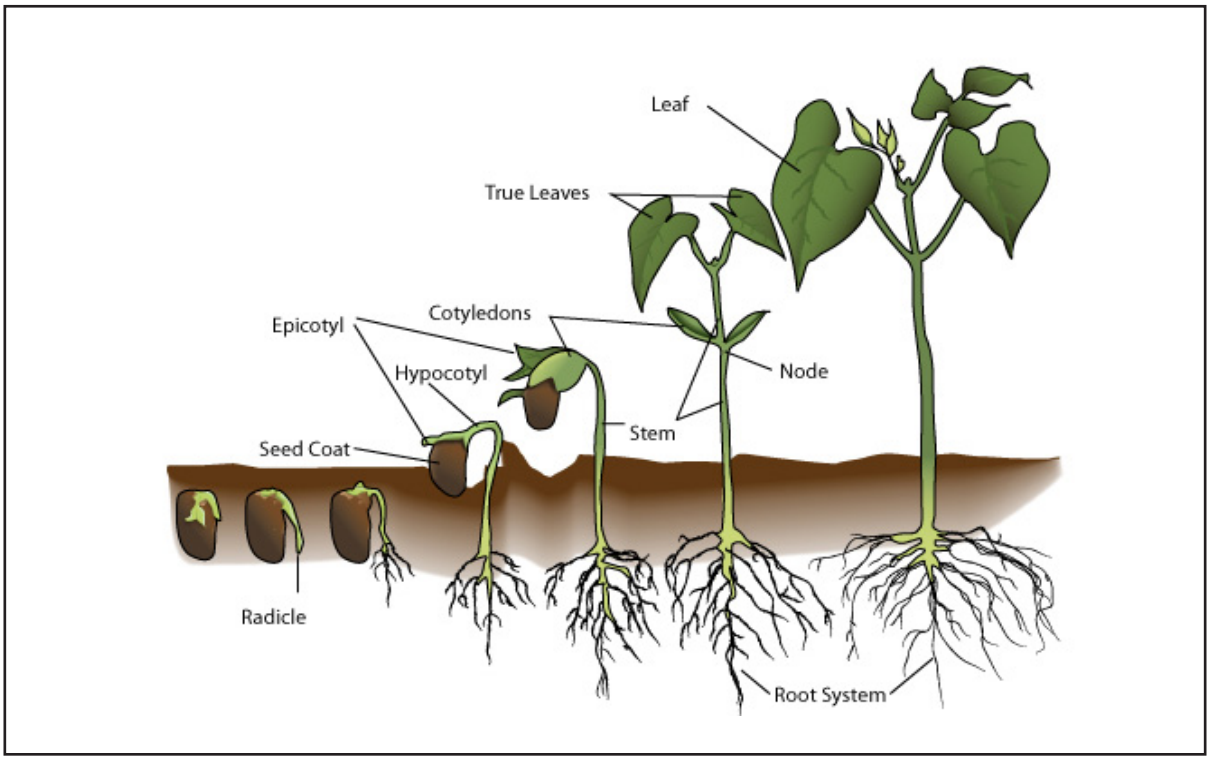


Figure 5.4 – Germination and Emergence of a Dicot Seed (Bean)



Summary

Seeds are the beginning of a plant's life cycle. Seeds are also an important food source throughout the world. Knowing the parts and functions of seeds, and the factors that affect germination and emergence are important to develop an understanding of how plants grow. In both monocot and dicot seeds, each part of the seed performs functions that are vital in the process of germination.

Credits

Bishop, D.D., S.R. Chapman, and L.P. Carter. *Working in Plant Science*. New York: McGraw-Hill, 1978.

Walton, P.D. *Principles and Practices of Plant Science*. NJ: Prentice-Hall, 1988.

Wells, J.A., and J. Anderson. *Greenhouse Operation and Management*. University of Missouri-Columbia: Instructional Materials Laboratory, 1990.