REPRODUCTION

Germination of seed

Learning outcomes

Students will be able to:

1. describe the structure of seed (monocot and dicot);
2. distinguish between epigeal and hypogeal germination;
3. describe the conditions necessary for germination of seeds.

Structure of a monocot seed

A seed (mature ovule) is a miniature plant with a protective cover in a suspended state of development.
Most seeds contain a built-in food supply called endosperm (orchid is an exception). The endosperm can be made up of proteins, carbohydrates or fats.

Seed coat – from the wall of the embryo sack (mother tissue)
Endosperm – food supply containing 3 sets of chromosomes (2 from the mother and 1 from the father
Embryo – immature plant
Cotyledon – seed leaf
Plumule – shoot
Radicle – root

Structure of dicot seed

Seed coat – from embryo sack wall and endosperm tissue (During development, the endosperm stops dividing and is absorbed into the embryonic tissues.)
Embryo – immature plant
Cotyledon – food storing seed leaf
Plumule – shoot
Hypocotyl – stem
Radicle – root

Epigeal germination

In epigeous (or epigeal) germination, the hypocotyl elongates and forms a hook, pulling rather than pushing the cotyledons and apical meristem through the soil. Once it reaches the surface, it straightens and pulls the cotyledons and shoot tip of the growing seedlings into the air. Beans, tamarind, and papaya are examples of plants that germinate this way.[2]

Hypogeal germination

Another way of germination is hypogeous (or hypogeal), where the epicotyl elongates and forms the hook.
In this type of germination, the cotyledons stay underground where they eventually decompose.
Peas, for example, germinate this way.[2]

Conditions necessary for germination

Germination is the growth of an embryonic plant contained within a seed; it results in the formation of the seedling. The seed of a higher plant is a small package produced in a fruit or cone after the union of male and female sex cells. All fully developed seeds contain an embryo and, in most plant species some store food reserves, wrapped in a seed coat. Some plants produce varying number of seeds that lack embryos; these are called empty seeds[1] and never germinate. Most seeds go through a period of quiescence where there is no active growth; during this time the seed can be safely transported to a new location and/or survive adverse climate conditions until circumstances are favourable for growth. Quiescent seeds are ripe seeds that do not germinate because they are subject to external

environmental conditions that prevent the initiation of metabolic processes and cell growth. Under favourable conditions, the seed begins to germinate and the embryonic tissues resume growth, developing towards a seedling.

Water - is required for germination. Mature seeds are often extremely dry and need to take in significant amounts of water, relative to the dry weight of the seed, before cellular metabolism and growth can resume. Most seeds need enough water to moisten the seeds but not enough to soak them. The uptake of water by seeds is called imbibition, which leads to the swelling and the breaking of the seed coat. When seeds are formed, most plants store a food reserve with the seed, such as starch, proteins, or oils. This food reserve provides nourishment to the growing embryo.

When the seed imbibes water, hydrolytic enzymes are activated which break down these stored food resources into metabolically useful chemicals.[2] After the seedling emerges from the seed coat and starts growing roots and leaves, the seedling's food reserves are typically exhausted; at this point photosynthesis provides the energy needed for continued growth and the seedling now requires a continuous supply of water, nutrients and light.

Oxygen - is required by the germinating seed for metabolism.[3] Oxygen is used in aerobic respiration, the main source of the seedling's energy until it grows leaves.[2] Oxygen is an atmospheric gas that is found in soil pore spaces; if a seed is buried too deeply within the soil or the soil is waterlogged, the seed can be oxygen starved. Some seeds have impermeable seed coats that prevent oxygen from entering the seed, causing a type of physical dormancy which is broken when the seed coat is worn away enough to allow gas exchange and water uptake from the environment.

Temperature - affects cellular metabolic and growth rates. Seeds from different species and even seeds from the same plant germinate over a wide range of temperatures. Seeds often have a temperature range within which they will germinate, and they will not do so above or below this range. Many seeds germinate at temperatures slightly above room-temperature 60-75° F (16-24° C), while others germinate just above freezing and others germinate only in response to alternations in temperature between warm and cool. Some seeds germinate when the soil is cool 28-40° F (-2 - 4° C), and some when the soil is warm 76-90 °F (24-32° C). Some seeds require exposure to cold temperatures (vernalization) to break dormancy. Seeds in a dormant state will not germinate even if conditions are favourable. Seeds that are dependent on temperature to end dormancy have a type of physiological dormancy.

For example, seeds requiring cold or winter are inhibited from germinating until they take in water in the fall and experience cooler temperatures. Four degrees Celsius is cool enough to end dormancy for most cool dormant seeds, but some groups, especially within the family Ranunculaceae and others, need conditions cooler than -5° C. Some seeds will only germinate after hot temperatures during a forest fire which cracks their seed coats; this is a type of physical dormancy.

Light or darkness - can be an environmental trigger for germination and is a type of physiological dormancy. Most seeds are not affected by light or darkness, but many seeds, including species found in forest settings, will not germinate until an opening in the canopy allows sufficient light for growth of the seedling.[2]

Multiple Choice Questions

1. The process in which a plant emerges from a seed or spore is called

A. germination.
B. fertilization.
C. budding.
D. gametogenesis.

2. The type of germination in which the cotyledons stay underground is known as

A. epigeal germination.
B. hypogeal germination.
C. monocot germination.
D. dicot germination.

3. The uptake of water by seeds, which leads to the swelling and the breaking of the seed coat is called

A. respiration.
B. imbibition.
C. photosynthesis.
D. vapourization.