32.2D: Double Fertilization in Plants

Angiosperms undergo two fertilization events where a zygote and endosperm are both formed.

Learning Objectives

- Describe the process of double fertilization in plants

Key Points

- Double fertilization involves two sperm cells; one fertilizes the egg cell to form the zygote, while the other fuses with the two polar nuclei that form the endosperm.
- After fertilization, the fertilized ovule forms the seed while the tissues of the ovary become the fruit.
- In the first stage of embryonic development, the zygote divides to form two cells; one will develop into a suspensor, while the other gives rise to a proembryo.
- In the second stage of embryonic development (in eudicots), the developing embryo has a heart shape due to the presence of cotyledons.
- As the embryo grows, it begins to bend as it fills the seed; at this point, the seed is ready for dispersal.

Key Terms

- **double fertilization**: a complex fertilization mechanism that has evolved in flowering plants; involves the joining of a female gametophyte with two male gametes (sperm)
- **suspensor**: found in plant zygotes in angiosperms; connects the endosperm to the embryo and provides a route for nutrition from the mother plant to the growing embryo
• proembryo: a cluster of cells in the ovule of a fertilized flowering plant that has not yet formed into an embryo

Double Fertilization

After pollen is deposited on the stigma, it must germinate and grow through the style to reach the ovule. The microspores, or the pollen, contain two cells: the pollen tube cell and the generative cell. The pollen tube cell grows into a pollen tube through which the generative cell travels. The germination of the pollen tube requires water, oxygen, and certain chemical signals. As it travels through the style to reach the embryo sac, the pollen tube’s growth is supported by the tissues of the style. During this process, if the generative cell has not already split into two cells, it now divides to form two sperm cells. The pollen tube is guided by the chemicals secreted by the synergids present in the embryo sac; it enters the ovule sac through the micropyle. Of the two sperm cells, one sperm fertilizes the egg cell, forming a diploid zygote; the other sperm fuses with the two polar nuclei, forming a triploid cell that develops into the endosperm. Together, these two fertilization events in angiosperms are known as double fertilization. After fertilization is complete, no other sperm can enter. The fertilized ovule forms the seed, whereas the tissues of the ovary become the fruit, usually enveloping the seed.

Figure \(\PageIndex{1}\): Double fertilization: In angiosperms, one sperm fertilizes the egg to form the 2n zygote, while the other sperm fuses with two polar nuclei to form the 3n endosperm. This is called a double fertilization.

After fertilization, embryonic development begins. The zygote divides to form two cells: the upper cell (terminal cell) and the lower cell (basal cell). The division of the basal cell gives rise to the suspensor, which eventually makes connection with the maternal tissue. The suspensor provides a route for nutrition to be transported from the mother plant to the growing embryo. The terminal cell also divides, giving rise to a globular-shaped proembryo. In dicots (eudicots), the developing embryo has a heart shape due to the presence of the two rudimentary cotyledons. In non-endospermic dicots, such as Capsella bursa, the endosperm develops initially, but is then digested. In this case, the food reserves are moved into the two cotyledons. As the embryo and cotyledons enlarge, they become crowded inside the developing seed and are forced to bend. Ultimately, the embryo and cotyledons fill the seed, at which point, the seed is ready for dispersal. Embryonic development is suspended after some time; growth resumes only when the seed germinates. The developing seedling will rely on the food reserves stored in the cotyledons until the first set of leaves begin photosynthesis.
Figure 1: **Embryo development**: Shown are the stages of embryo development in the ovule of a shepherd's purse (*Capsella bursa*). After fertilization, the zygote divides to form an upper terminal cell and a lower basal cell. (a) In the first stage of development, the terminal cell divides, forming a globular pro-embryo. The basal cell also divides, giving rise to the suspensor. (b) In the second stage, the developing embryo has a heart shape due to the presence of cotyledons. (c) In the third stage, the growing embryo is crowded and begins to bend. (d) Eventually, it completely fills the seed.