Welcome

to

Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (UP)

Lecture Topic

Development of Seed

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DEVELOPMENT OF SEED

Development of seed: In this chapter, we will learn about the seed, its structure, its development, development of rice seed and the development of seed habit.

Seed: A seed is an embryonic plant that has a protective coat around it. Seed development is a stage in the reproduction of spermatophytes (seed plants), such as gymnosperms and angiosperms. After pollen fertilization and some growth within the mother plant, the mature ovule produces seeds. The zygote produces the embryo, while the integuments of the ovule produce the seed coat.

Seed development in Angiosperms: Angiosperm (flowering plant) seeds are made up of three genetically separate components:

1. The embryo generated from the zygote,
2. The typically triploid endosperm, and
3. The seed coat made up of tissue derived from the ovule's maternal tissue.

- The formation of the primary endosperm and the zygote in angiosperms begins with double fertilization, which involves the fusing of two male gametes with the egg cell and the central cell to generate the primary endosperm and zygote. Until the roots have developed following germination, this tissue becomes the food for the newborn plant.

Ovule: The ovules grow into seeds after fertilization. The ovule is made up of several components:

- At the pericarp, the funicle (funiculus, funiculi) or seed stalk connects the ovule to the placenta and thus the ovary or fruit wall.
- The nucellus is the major part of the ovule where the megagametophyte develops, as well as the remains of the megasporangium.
- The micropyle is a small pore or opening in the apex of the ovule's integument where the pollen tube normally enters during the fertilization process.
- The chalaza connects the integument and nucellus at the base of the ovule, opposite the micropyle.

Embryo: The embryo's basic components are:

1. The embryonic axis is linked to the cotyledons, or seed leaves. There could be one (Monocotyledons) or two (Monocotyledons) (Dicotyledons).
2. The epicotyl is the embryonic axis above the cotyledon's attachment point.
3. The plumule, the epicotyl's tip, has a feathery look due to the presence of immature leaf primordia at the apex, and when germination occurs, it will become the stem.
4. The stem-root transition zone is formed by the hypocotyl, an embryonic axis connecting the epicotyl and the radicle below the point of attachment of the cotyledons.
5. The radicle, which is the hypocotyl's basal tip, develops into the major root.

Seed coat: The integuments of the growing ovule undergo significant alterations, most commonly a decrease and disarray, but occasionally a thickening. The two integuments or outer layers of cells of the ovule, which arise from tissue from the mother plant, form the seed coat, with the inner integument forming the tegmen and the outer integument forming the testa. When the seed coat is made up of only one layer, it is called the testa; however, not all testae are homologous from one species to the next.

Seed development in Gymnosperms:

The ovules and thus the seeds are exposed in gymnosperms, which do not have ovaries. Their nomenclature is based on this – naked seeded plants. The seed is not developed by double fertilization when two sperm cells are transported from the pollen, but one sperm nucleus connects with the egg nucleus and the other sperm is not utilized. One zygote is sometimes aborted or absorbed during early development after each sperm fertilizes an egg cell.

Development of rice seed: Plant development begins with the fertilization of an egg cell with a sperm nucleus to form a zygote (fertilized egg). Plant development progresses toward maturity through a variety of stages that are identifiable based on landmark events, beginning with the first zygotic division. The production of male and female gametes, which fertilize to produce a zygote, is the ultimate stage of development. The embryonic, vegetative, and reproductive phases of plant development are typically divided into three parts.

Development of seed habit:

- The character of spermatophytes is seed, which is an ovule generated following fertilization. Seed habit refers to the adaptation of heterospory as well as the preservation and germination of a single megaspore within a megasporangium. It is generally thought to be the most advanced and successful mode of sexual reproduction used by terrestrial plants.

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.

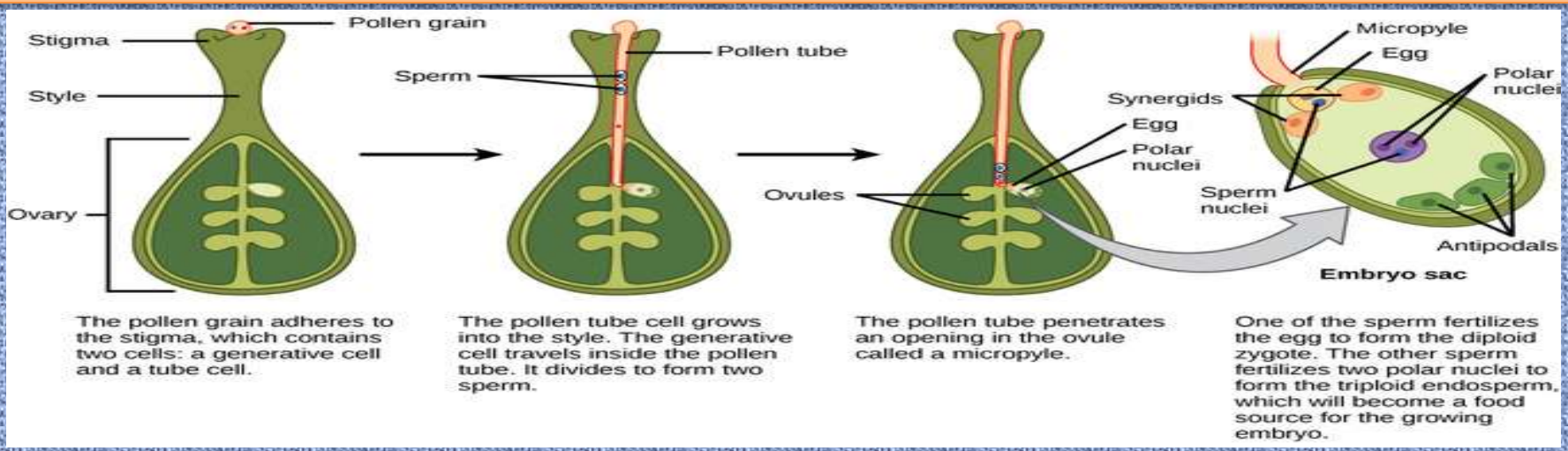

Figure 1: Double fertilization: In angiosperms, one sperm fertilizes the egg to form the 2n zygote, while the other sperm fuses with two polar nuclei to form the 3n endosperm. This is called a double fertilization.

- 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.

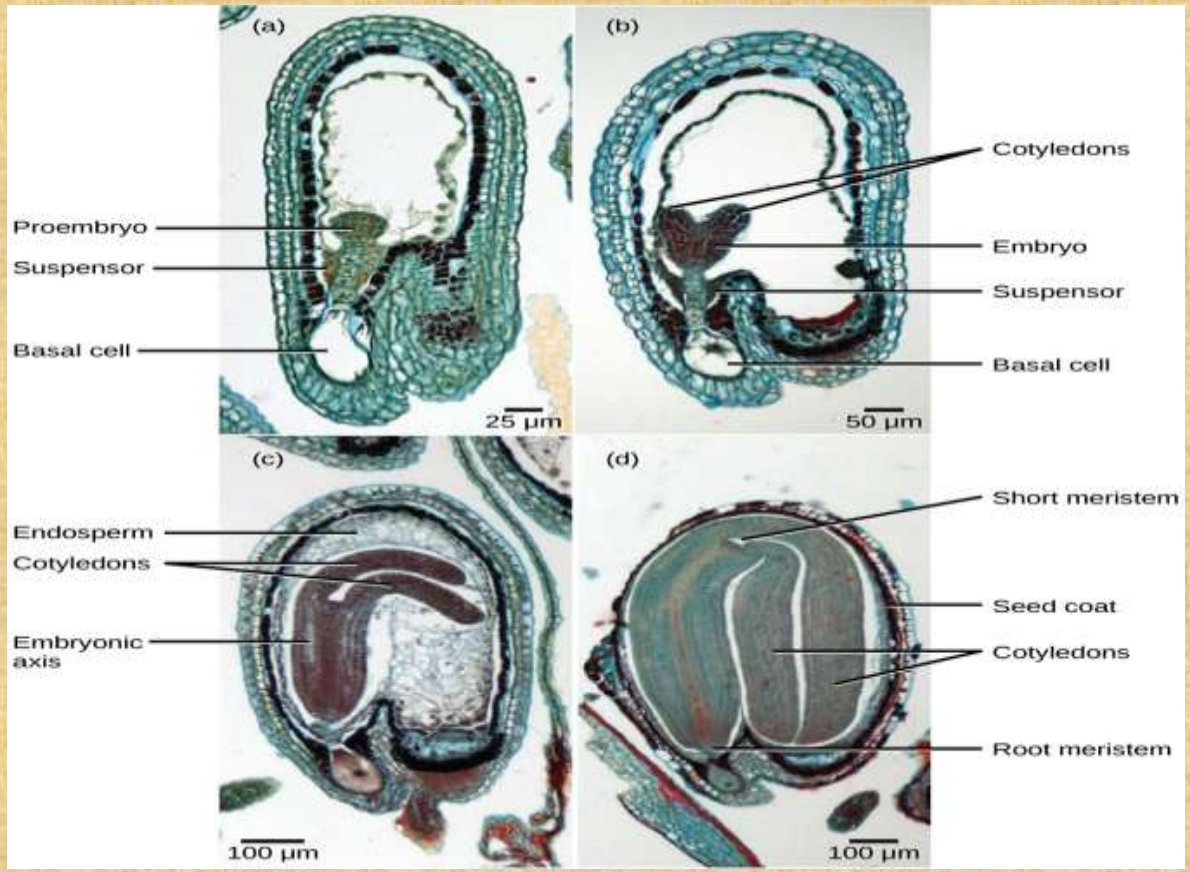

Figure 2: Embryo development: Shown are the stages of embryo development in the ovule of a shepherd's purse (Capsella bursa). After fertilization, the zygote divides to form an upper terminal cell and a lower basal cell. (a) In the first stage of development, the terminal cell divides, forming a globular 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.

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


THANK YOU