Early Development of the Plant Body

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Introduction: After fertilization plants go through a process of growth and development called **embryogenesis**. During this stage, a single-celled zygote develops into a multicellular sporophyte with recognizable morphological features of the mature plant. Except for the angiosperms, plant embryos are dependent on the gametophyte for nutrition. In the angiosperms, the gametophyte (the embryo sac) is destroyed by double fertilization, and another tissue, the **endosperm**, is formed. This tissue facilitates transfer of resources between sporophyte generations, and, in some angiosperms, serves as the food reserve for the young plant in the seed. An angiosperm seed contains an **embryo**, with or without endosperm, surrounded by a **seed coat** derived from the **integuments** of the ovule. In some angiosperms, such as the grasses, the function of the seed coat is taken over by the ovary wall itself, and what we call a grain is actually a fruit with an enclosed seed.

Most seeds enter a period of dormancy. For germination to occur all seeds require moisture and warmth. Some plant seeds are adapted to remain dormant for a number of years, or only when certain conditions occur (lettuce will only germinate in the light). As a rule, dormancy in crop plants such as bean, pea, and corn is easily broken as this trait has been selected for by humans for hundreds or thousands of years.

Embryogeny of *Capsella bursa-pastoris*

Early in development, the embryo becomes differentiated into two parts, the **suspensor** and the "**embryo proper**". The suspensor anchors the embryo in the ovule. The "embryo proper" develops into what we recognize as the immature sporophyte with root and shoot. During embryogenesis, in the "embryo proper", cells become differentiated into one of **three primary meristematic tissues: protoderm**, **procambium**, and **ground meristem**. These tissues are meristematic because cell division occurs in each. The protoderm matures into **dermal tissue**; the procambium, into **vascular tissue**, and the ground meristem, into the **ground tissue** of the mature plant. In the next lab topic we will study these three types of mature tissue in a mature plant organ.

We have images of four stages of embryo development:

The Globular Stage is the earliest stage. Note the **suspensor** with the huge basal cell at the micropyle end of the ovule. The "**embryo proper**" is globular in shape. A layer of **protoderm** can be discerned along the outside of its structure. The "empty" area away from the micropyle contains endosperm tissue which is not well preserved here.

The Heart-shaped Stage: As the embryo develops, two lobes form at the top of the "embryo proper" which are destined to become the two cotyledons (seed leaves). In the mature seed, these will fill the space now occupied by **endosperm** and will become the food storage tissue of the seed.

The Torpedo Stage: As the **cotyledons** develop they bend to fill the ovule. In this stage, the three primary meristematic tissues are clearly discernable. The polar ends of the shoot and root are clearly defined with a well developed root apical meristem. The central axis of the embryo is termed the **hypocotyl-root axis.**

The Mature Embryo: In the mature seed the space originally occupied by endosperm completely filled with the two cotyledons.

II. Seeds and Seedling Development. Typically the first structure to emerge from any seed is the **root.** This is adaptive in that it ensures the young plant a source of water, and anchors it in its environment. The first structure to actually emerge from the ground varies from plant to plant. In each case, it is adaptive for some structure to protect the emerging apical meristem of the shoot as it emerges.

IIa. Eudicoteledons Bean and Pea: At maturity both of these, seeds lack endosperm and each has two cotyledons which serve for food storage. An example of an eudicotyledon with endosperm, **is castor bean** (*Ricinus*) **.** In pea and bean, the cotyledons function to store food. They occupy most of the volume of seed. In these seeds, the region of the stem above the root and below the cotyledons is termed the **hypocotyl**. The region of the stem above the cotyledons and below the first foliage leaves is termed the **epicotyl.** Note the differences in the pattern of growth of these structures between pea an bean.

Bean Seeds and Seedlings

The bean seed has scar where the seed had attached to the fruit. This scar is termed the **hilum**.

Dissected bean seed with one cotyledon, first foliage leaves, epicotyl, hypocotyl, and root visible.

Labelled

6-day old seedling with a hooked hypocotyl pulling the cotyledons out of the substrate.

View of bean seedlings of a series of ages.

Pea Seeds and Seedlings

The pea seed also has scar where the seed had attached to the fruit called the **hilum**.

Dissected pea seed with one cotyledon, first foliage leaves, epicotyl, hypocotyl, and root visible.

6-day old seedling with a hooked epicotyle. The cotyledons remain in the substrate.

View of pea seedlings of a series of ages.

IIB. Grains and Seedlings of the Monocotyledon Corn.

All cereal grains are grasses. These includes rice, corn, wheat, rye, barley, and oats. Grass seeds all share certain distinctive characteristics. A grain is a type of fruit and is not just a seed. The **pericarp** constitutes the bran derived from grains. The seed itself is has a considerable store of **endosperm** tissue. The endosperm tissue, when separated from the bran and the **embryo** (the germ), can be processed into a fine flour such as the white flour of wheat. The embryos of grasses are all highly developed with a well defined seedling root (the **radical**) and a shoot apex consisting of numerous **leaf primordia** surrounding the apical meristem of the shoot called the **plumule**. Grasses are monocots and their embryos have one shield-like **cotyledon** also called a scutellum**.** Grass embryos all have a **coleoptile** and a **coleorhiza**. The coleoptile ensheathes the plumule and the coleorhiza ensheathes the radical.

Longitudinal section of a corn grain (fruit).

Detail of a corn embryo.

Germinating corn grain with coleoptile emerging from the substrate.

Series of corn seedling stages.

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