Plants Begin Life as an Embryo Within a Seed

Seeds are the result of sexual reproduction in plants. Once the egg is fertilized, it develops into an embryo. An embryo is the earliest stage of development for sexual-reproducing organisms. It contains cells that will eventually differentiate into specialized cells, forming tissue that develops into the roots, stems, and leaves. A seed has a protective outer layer called a seed coat and a food supply called endosperm. The seed coat protects the embryo until it begins to grow. The endosperm stores energy that will be used by the embryo to grow.
Seed Dispersal

Seeds may be dispersed or scattered from the parent plant in a variety of ways. Some plants rely on the wind, gravity, or water to scatter seeds. Others have developed specialized fruits that attract animals to eat them. Whatever the mechanism, the purpose for seed dispersal is to allow the embryo an opportunity to grow without competition from the parent plant for space, sunlight, water, and nutrients.

Seeds that are dispersed by wind and water are generally lightweight. This allows the seed to be carried by air currents or to float in water. Some trees, such as maples, have seeds encased in winglike structures that allow them to fly like a helicopter.

A more advanced mechanism for seed dispersal is through fruits. Plants that produce fruits rely on animals for seed dispersal. The fruit is often fragrant and provides nutrition for the animal. Once eaten, the seed passes through the digestive tract and is deposited away from the parent plant. Not all fruits are edible; some plants produce a fruit that is a burr. When an animal brushes up against a plant containing burrs, the spikes in the burr cling to the fur of the animal. As the animal moves, the burr eventually falls off and releases its seeds.

Seed Dormancy

Not all seeds begin to grow immediately upon landing in soil. They need just the right environmental conditions to be stimulated into growth. If these conditions are not present, the seed stays dormant.
Understanding Growth and Development

Seeds are able to survive for months or even years in a dormant state. This dormant state allows the new plant to grow under favorable conditions. Seeds end their period of dormancy when environmental conditions are ideal. Think about the environmental factors that are necessary for most seeds to grow. When you plant a seed, what actions do you take to ensure growth of a plant? More than likely, you plant it in soil during the spring or summer and make sure it receives light and water. When the soil temperature is right, the seed absorbs water, causing the endosperm to swell. As the seed swells, the seed coat breaks open. This process is called germination. During germination, the plant embryo emerges out of the seed coat and begins to grow into a seedling.

**Seed Germination**

When most seeds germinate, a tiny root tip breaks through the seed coat and grows downward into the soil. This first root is called the embryonic root, which eventually becomes the primary root for the plant. Soon, tiny root hairs begin to appear and push through spaces in the soil, absorbing water and minerals. Water and minerals are used by the seedling along with the endosperm for energy. Water activates enzymes inside the seed. The enzymes control chemical reactions that break down starches into sugars. Sugar absorbed by cells of the embryo is converted into ATP. Cells use ATP to grow and divide, forming new cells.

After the root emerges, the next part to emerge from the seed coat is the stem called the embryonic shoot. Cells in the shoot multiply and grow upward, eventually breaking through the surface of the soil. Soon after the shoot breaks through the surface of the soil, the first foliage leaves emerge from the shoot and begin to photosynthesize. Once photosynthesis begins, the plant is capable of making food energy for the rest of its life. The young plant, now called a seedling, has developed its three main organs, called roots, stems, and leaves.
Plant Growth Increases Length and Width of the Plant

A plant continues to grow throughout its life. It will grow in both length and diameter. Growth in length is called primary growth. Growth in diameter is called secondary growth.

Growth occurs from new cells being added to the plant through rapid cell division in tissue called meristems. Cells within the meristem are undifferentiated, thus they are the stem cells of the plant. As plant cells become differentiated, they are arranged into tissues. The tissues become further arranged into tissue systems; and then into the three main organs of the roots, stems, and leaves. Each organ contains all three tissue systems in various proportions. Once cells become differentiated, they usually do not divide again.

Primary Growth

Primary growth makes the roots grow downward and stems grow taller. In roots, meristem tissue is located near the tips of roots just behind the root cap; in stems, it is found at the tip or terminal bud. This zone of undifferentiated tissue is called the apical (ä-pick-ul) meristem. Cells divide through mitosis and form new cells within the apical meristem. These cells then grow longer and eventually become specialized into one of the tissue types. The region behind the apical meristem, where cells grow longer, is called the zone of elongation. Cells elongate in the root and push the root downward. In stems, cells elongate and push the stem upward.

Secondary Growth

Secondary growth increases the width of stems and roots. Adding tissue that increases width in roots and stems is necessary to provide more support and more vascular tissue to transport water and nutrients to the plant. Tissues created during primary growth are insufficient to sustain the needs of the plant. Secondary growth takes place in areas of stems and roots called lateral meristem, which is found in the outer layers of roots and stems.
Plants Have Three Main Tissue Systems

Dermal Tissue

Dermal tissue makes up the outer covering of the plant. Cells in the dermal tissue are called epidermal cells. Typically, the epidermal layer is one cell-layer thick. Epidermal tissue protects the plant from the outside environment similar to the way skin protects the body from the environment. It also helps prevent water loss and provides a barrier that blocks pathogens from entering the plant. Epidermal cells may have specialized functions depending on the location within the plant. For example, epidermal cells of some plants secrete a waxy substance called cuticle. The cuticle prevents water loss from the plant. The thicker the cuticle, the less water that is lost through evaporation. In roots, epidermal cells form tubular extensions that develop into the root hairs. Root hairs increase the surface area for absorption of water and minerals from the soil. In leaves, the epidermal layer contains small pores that allow for gas exchange.

Vascular Tissue

Vascular tissue is a complex tissue system made up of various types of cells. The vascular tissue system is responsible for transporting water and nutrients throughout the plant. The two major types of tissue within the vascular system are xylem and phloem. Cells within both xylem and phloem are elongated into tubes to allow for transport of material. **Xylem** tissue helps to provide support for the plant and transports water and dissolved nutrients from the roots upward to the other parts of the plant. **Phloem** tissue transports sugar made through photosynthesis to other parts of the plant.

The vascular tissue system also contains meristem tissue called the vascular cambium. Cells within the cambium divide by mitosis and differentiate into xylem or phloem. As cells are added from the vascular cambium, the plant increases in thickness and diameter.

Ground Tissue

The remaining tissue between the dermal tissue and vascular tissue is a system of ground tissue. Ground tissue makes up the bulk of the plant.
and is composed of several types of tissue. These tissues provide support for roots and stems giving them rigidity and strength. Ground tissues in leaves are packed with cells containing chloroplasts, which are responsible for photosynthesis in the plant.

**Discussion Questions:**

1. What is the advantage for seed dispersal mechanisms?
2. Why is seed dormancy important for survival of plant species?
3. Where are stem cells located in plants?
4. What is the difference between primary and secondary growth?
5. What are the three main organs of plants?
6. What two types of tissue make up the vascular tissue system?