**UNIT 2: PLANT BIOLOGY**

**CHAPTER 10: PLANT REPRODUCTION, GROWTH, AND RESPONSE**

**LEARNING OUTCOMES**

**10.1 Sexual Reproduction in Flowering Plants**

1. Describe the alternation-of-generations life cycle including the role of the sporophyte and gametophyte generations.

2. Identify the reproductive parts of a flower and describe the function of each part.

3. Diagram and describe the development of male and female gametophytes and the development of the sporophyte of flowering plants.

**10.2 Growth and Development**

1. Recognize the developmental steps of a eudicot embryo and compare the function of its cotyledons to that of a cotyledon in monocots.

2. Identify different types of fruits.

3. Label seed structure and describe germination and dispersal.

**10.3 Asexual Reproduction in Plants**

1. Identify the asexual methods of reproduction in plants.

2. Describe how tissue culture can be used to clone plants with desirable traits.

**10.4 Control of Growth and Responses**

1. Explain the importance of plant hormones.

2. Identify the types of plant hormones and describe their function.

3. Recognize how plants respond to stimuli.

**LECTURE OUTLINE**

**10.1 Sexual Reproduction in Flowering Plants**

Plants have evolved at a two-stage life cycle, called an **alternation of generations**, composed of diploid (2n) **sporophyte** stage and a haploid (n) **gametophyte** stage.

 **Alternation of Generations in Flowering Plants**

In flowering plants, the sporophyte is dominant and it is the generation that bears flowers. A **flower** is a reproductive structure that produces **microspores** and **megaspores**.

 **Adaptation to a Land Environment**

The life cycle of flowering plants is adapted to a land existence because all stages of the life cycle are protected from drying out.

**Flowers**Flowers occur only in angiosperms. The basic floral structures are **sepals**, **petals**, **stamens**, and **carpels**. Depending on the structures present, a flower can be complete or incomplete and perfect (bisexual) or imperfect (single sex).

 **Life Cycle of Flowering Plants**

 The sporophyte produces haploid spores by meiosis. The haploid spores grow and develop into haploid gametophytes, which produce gametes by mitotic division.

 **Development of Male Gametophyte**

Microspores are produced in the anthers of flowers. The **pollen grain** is an immature male gametophyte. After mitotic division produces two sperm, the pollen grain is a mature male gametophyte.

 **Development of Female Gametophyte**

The ovary contains the megaspore mother cell, which through both meiosis and mitosis develops into the *female gametophyte*.

**Pollination and Fertilization**

 **Pollination** is the transfer of pollen from an anther to the stigma of a carpel. Self-pollination occurs if the pollen is from the same plant, and cross-pollination occurs if the pollen is from a different plant of the same species. Angiosperms have adaptations to foster cross-pollination.

**10.2 Growth and Development**

 **Development of the Eudicot Embryo**

Within a seed, the zygote undergoes development to become an embryo. The root-shoot axis is established in the globular stage when the zygote becomes an embryo. Further development produces the radicle, hypocotyl, epicotyl, and **cotyledons**.

 **Monocot versus Eudicot Embryos**

Monocots have only one cotyledon, which store the nutrient molecules that the embryo uses. Eudicots have two.

 **Fruit Types and Seed Dispersal**

A fruit is derived from an ovary and sometimes other flower parts. It protects and helps disperse offspring. Fruits can be simple or compound, dry or fleshy, and so on.

 **Dispersal of Seeds**

For plants to be widely distributed, their seeds must be dispersed from the parent plant. Plants have various means of ensuring that dispersal takes place.

 **Germination of Seeds**

With the right environmental conditions, seeds **germinate**, or begin to grow so that a seedling appears. Germination requires regulation by both inhibitors and stimulators.

 **Eudicot versus Monocot Seed Germination**

In eudicots, the cotyledons that have absorbed the endosperm supply nutrients to the embryo and seedling. In monocots, the endosperm is the food-storage tissue, and the single cotyledon has no storage role.

**10.3 Asexual Reproduction in Plants**

Asexual reproduction produces genetically identical offspring from a single parent.

**Asexual Reproduction from Stems, Roots, and Cuttings**

Because plants contain nondifferentiated meristem tissue, they routinely reproduce asexually by vegetative propagation.

 **Propagation of Plants in Tissue Culture**

 **Tissue culture** is the growth of a tissue in an artificial liquid or solid culture medium. Plant cells are **totipotent**, which means that individual plant cells can develop into an entire plant.

**10.4 Control of Growth and Responses**

Plants respond to environmental stimuli such as light, gravity, and seasonal changes. These responses require hormones.

 **Plant Hormones**

Plant **hormones** are small, organic molecules that serve as chemical signals between cells and tissues in plants and regulate growth. Commonly recognized hormone groups are the auxins, gibberellins, cytokinins, abscisic acid, ethylenes, and brassinosteroids.

 **Auxins**

The most common naturally occurring **auxin** is indoleacetic acid.

 **Effects of Auxin**

Auxin is present in the apical meristem of a plant shoot where it causes the shoot to grow from the top, a phenomenon called **apical dominance**.

 **How Auxins Work**

In unidirectional light, auxin moves to the shady side. It binds to receptors and activates an ATP-driven pump that transports hydrogen ions out of the cell. This weakens the cell wall and water enters the cell, causing it to elongate and bend. The plant bends toward the light—phototropism.

 **Gibberellins**

 **Gibberellins** are growth-promoting hormones that bring about elongation of the cells.

 **Effects of Gibberellins**

When gibberellins are applied externally to plants, they grow taller through stem elongation.

 **Cytokinins**

 **Cytokinins** encourage cell division.

 **Effects of Cytokinins**

Because cytokinins promote cell division, applying them can prevent the senescence (aging) of leaves.

 **Abscisic Acid**

 **Abscisic acid** was once thought to function in **abscission**, the dropping of leaves, fruits, and flowers from a plant. However, it is no longer believed to be involved in abscission.

 **Effects of Abscisic Acid**

Abscisic acid is sometimes called the stress hormone because it initiates and maintains seed and bud dormancy and brings about the closure of stomata when a plant is under water stress.

 **Ethylene**

 **Ethylene** is a gas that works with other hormones to bring about certain effects.

 **Effects of Ethylene**

Ethylene is involved in abscission.

**Brassinosteroids**

These compounds function in plant growth and development of the plant, specifically in the specialization of the vascular tissue. They also help with the plant’s response to stress, such as cold or drought conditions.

**Plant Responses to Environmental Stimuli**

Environmental signals determine the seasonality of growth, reproduction, and dormancy in plants.Plant responses are strongly influenced by such environmental stimuli as light, day length, gravity, and touch.

 **Plant Tropisms**

Plant growth toward or away from a directional stimulus is called a **tropism**. Tropisms are due to differential growth.

 **Flowering**

Flowering occurs according to the **photoperiod**, which is the ratio of the length of day to the length of night over a 24-hour period. Plants can be divided into **short-day plants**, **long-day plants**, and **day-neutral plants**.

 **Phytochrome and Plant Flowering**

 **Phytochrome** is a blue-green leaf pigment that allows plants to detect photoperiods.

 **Other Functions of Phytochrome**

Other functions of phytochrome include indicating to seeds that sunlight is present and conditions are favorable for germination.

**LECTURE ENRICHMENT IDEAS**

1. Have students dissect a monocot flower. Have them draw and label the various parts of the flower. A lily is a larger monocot flower with easily differentiated parts.

2. Bring in a variety of fruits and have students discuss whether they are looking at simple fruits, compound fruits, multiple fruits, dry fruits, fleshy fruits, accessory fruits, legumes, and so on. Good fruits include apples, raspberries, pineapples, beans, corn, and peanuts.

3. Have students read the Science in Your Life—Ecology “The Coevolution of Plants and Their Pollinators” before coming to class. Discuss the answers to the discussion questions at the end of the reading.

4. Allow students to germinate seeds in the classroom. Choose both monocot and eudicot seeds so students can compare and contrast germination in these two types. Many seeds will germinate between wet layers of paper towels if they are kept warm.

5. Have students read the Science in Your Life—Health “Are Genetically Engineered Foods Safe?” before coming to class. Discuss the answers to the discussion questions at the end of the reading.

**ESSAY QUESTIONS WITH ANSWERS**

1. What is the difference between fertilization and pollination in flowering plants?

*Answer: Fertilization takes place in the ovary when one of two sperm nuclei from the generative nucleus in the pollen tube combines with the egg forming a zygote. Pollination, on the other hand, occurs when pollen attaches to the stigma of the ovary due to transfer by the wind, insects, birds, or bats.*

2. What is meant by double fertilization in flowering plants?

*Answer: Fertilization in flowering plants takes place in the ovary when one of two sperm nuclei from the generative nucleus fertilizes the egg to form a zygote, and the second sperm nucleus unites with the two polar nuclei to form the 3n endosperm nucleus.*

3. Why would all plants not be short-day plants? Why would plants develop a variety of responses to environmental seasonal changes?

*Answer: Pollinators are a limited resource. Variation reduces competition for pollinators among flower species. Also, this is linked to other adaptations in seed durability and dormancy. Each difference is beneficial if it distances the plant from competition with others.*