Al-Mustaqbal University

College of Science

General biology-Botany

Professions Theoretical Lecture 7

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**Plant Growth and Development**

**Plant Growth and Development** refer to the processes by which a plant increases in size, matures, and undergoes various stages of differentiation, leading to the formation of various structures like roots, stems, leaves, flowers, and fruits. These processes are regulated by both genetic factors and environmental stimuli.

Here’s an overview of the key concepts involved in plant growth and development:

### ****Growth****

Growth refers to the irreversible increase in the size or mass of a plant. It occurs through cell division and cell enlargement.

**Types of Growth:**

1. **Primary Growth**: This is the elongation of the plant, which occurs at the **apical meristems** (found at the tips of roots and shoots). It leads to an increase in length.
2. **Secondary Growth**: This type of growth results in an increase in the girth (diameter) of stems and roots. It occurs in **lateral meristems**, particularly the **vascular cambium** and **cork cambium**. This is typical of woody plants.

**Processes Involved in Growth:**

1. **Cell Division**: Occurs in meristems and produces new cells.
2. **Cell Elongation**: After cell division, cells elongate, increasing the size of the plant.
3. **Cell Differentiation**: Cells differentiate into specific types (e.g., xylem, phloem, epidermis) to perform specialized functions.

### ****Hormonal Regulation of Growth****

Plant growth and development are largely regulated by plant hormones (also called **phytohormones**). These hormones control various aspects of plant growth, including elongation, division, and differentiation.

**Plant Hormones:**

1. **Auxins**: Promote cell elongation and are involved in phototropism (growth toward light) and gravitropism (growth in response to gravity). Auxins are also critical in root development.
2. **Cytokinins**: Promote cell division and are involved in the growth of lateral buds, delaying leaf senescence, and stimulating shoot formation.
3. **Gibberellins**: Promote stem elongation and seed germination. They are also involved in flowering and fruit development.
4. **Abscisic Acid (ABA)**: Inhibits growth and promotes the closing of stomata to prevent water loss. It also plays a role in seed dormancy.
5. **Ethylene**: Regulates fruit ripening, leaf abscission (shedding), and responses to stress such as flooding or wounding.

### ****Development****

Plant development refers to the process by which a plant grows and forms its specialized tissues, organs, and structures (like flowers, seeds, and fruits). It involves complex hormonal regulation and interactions with the environment.

**Stages of Plant Development:**

1. **Germination**: The process where a seed develops into a seedling. It involves the absorption of water (imbibition), followed by the growth of the embryo root (radicle) and shoot (plumule).
2. **Vegetative Growth**: During this stage, the plant focuses on increasing its size, producing leaves, stems, and roots. The plant is building up resources for reproduction.
3. **Reproductive Growth**: At this stage, the plant shifts to the formation of flowers, seeds, and fruits. This stage involves processes like pollination, fertilization, and seed production.
4. **Senescence**: This is the aging process of the plant, during which cells break down, and the plant eventually dies. Senescence is marked by the yellowing of leaves and the cessation of growth and reproduction.

### ****Environmental Factors Affecting Growth and Development****

In addition to hormones, external factors also play a significant role in a plant’s growth and development:

1. **Light**: Light is essential for photosynthesis and influences plant growth. Plants can exhibit **phototropism** (growth toward light) and **photoperiodism** (response to light duration), affecting flowering and other processes.
2. **Temperature**: Affects enzyme activity and metabolic rates. Most plants have an optimal temperature range for growth, and extreme temperatures can slow down or stop development.
3. **Water**: Water is crucial for cellular functions, photosynthesis, and nutrient transport. Insufficient water can lead to drought stress, while too much water can cause root rot.
4. **Gravity**: Plants can sense gravity through gravitropism, where roots grow downward (positive gravitropism) and stems grow upward (negative gravitropism).
5. **Nutrients**: Essential nutrients like nitrogen, phosphorus, and potassium are required for various metabolic processes, including growth, protein synthesis, and energy production.
6. **Mechanical Stimuli**: Plants can respond to touch (thigmotropism) and wind (thigmomorphogenesis), adjusting their growth patterns accordingly.

### ****Morphogenesis****

Morphogenesis is the process by which cells, tissues, and organs develop their specific shape and structure. It involves cell division, elongation, and differentiation, guided by genetic and hormonal signals.

1. **Organogenesis**: The process by which specific organs (roots, leaves, flowers) are formed.
2. **Tissue Differentiation**: Cells within a developing organ differentiate into various types of tissues (e.g., epidermal, vascular, and ground tissues).

### ****Tropisms****

Tropisms are directional growth responses to environmental stimuli:

1. **Phototropism**: Growth response to light. Shoots usually grow toward light (positive phototropism), and roots typically grow away from light (negative phototropism).
2. **Gravitropism**: Growth response to gravity. Roots grow downward (positive gravitropism), while stems grow upward (negative gravitropism).
3. **Thigmotropism**: Growth response to touch or mechanical stimuli (e.g., climbing plants that wrap around structures).

### ****Seed Development and Germination****

The seed is the embryo of the plant, surrounded by a seed coat. Seed development involves fertilization, zygote formation, and the growth of the embryo. After the seed matures, it enters a dormant state until it encounters favorable conditions (moisture, temperature, light) for **germination**.

**Stages of Germination:**

1. **Imbibition**: Absorption of water by the seed, causing it to swell.
2. **Activation of Enzymes**: Water activates enzymes that break down stored food in the seed, providing energy for growth.
3. **Radicle Emergence**: The embryo's root (radicle) breaks through the seed coat and begins to grow downward into the soil.
4. **Plumule Emergence**: The shoot (plumule) grows upward toward the light.