

Al-Mustaqbal University

College of Science

General biology-Botany

Professions Theoretical Lecture 10

Prof. Dr. Dhurgham Ali Al-Sultany

2024-2025

**plant Physiology**

Plant physiology is the branch of biology that deals with the study of the functions and processes occurring within plants. It covers how plants grow, develop, and interact with their environment. The study of plant physiology helps us understand how plants respond to various internal and external stimuli, and it is crucial for applications in agriculture, horticulture, environmental science, and biotechnology.

### Concepts in Plant Physiology:

#### 1. ****Photosynthesis****

* **Definition**: Photosynthesis is the process by which plants use sunlight, carbon dioxide, and water to produce glucose (a form of sugar) and oxygen.
* **Equation**:

**6CO2+6H2O+light energy→(C6H12O6+6O26CO\_2 + 6H\_2O + light \, energy \rightarrow C\_6H\_{12}O\_6 + 6O\_26CO2​+6H2​O+lightenergy)→C6​H12​O6​+6O2**​

* **Components**:
  1. **Chloroplasts**: Organelles that contain chlorophyll, which absorbs sunlight.
  2. **Light-dependent reactions**: These take place in the thylakoid membranes of the chloroplasts, where sunlight is converted into ATP and NADPH.
  3. **Calvin Cycle (Light-independent reactions)**: Occurs in the stroma of chloroplasts where ATP and NADPH are used to fix carbon dioxide into glucose.

#### 2. ****Respiration****

* **Definition**: Cellular respiration is the process by which plants break down glucose to release energy in the form of ATP.
* **Types**:
  1. **Aerobic Respiration**: Occurs in the presence of oxygen, producing carbon dioxide, water, and ATP.
  2. **Anaerobic Respiration**: Occurs in the absence of oxygen, yielding less ATP and producing byproducts like ethanol or lactic acid.
* **Stages**:
  1. **Glycolysis**: The breakdown of glucose into pyruvate, which takes place in the cytoplasm.
  2. **Citric Acid Cycle**: Occurs in the mitochondria, producing ATP and electron carriers.
  3. **Electron Transport Chain**: The final step in mitochondria, where the majority of ATP is generated.

#### 3. ****Water and Nutrient Transport****

* **Xylem**: Vascular tissue responsible for transporting water and minerals from the roots to the leaves.
* **Phloem**: Vascular tissue that transports sugars (produced in the leaves) and other organic compounds to other parts of the plant.
* **Transpiration**: The evaporation of water from the stomata in leaves, which creates a negative pressure that draws water from the roots through the xylem.

#### 4. ****Growth and Development****

* **Meristems**: Areas of active cell division, allowing for growth. Types of meristems include:
  1. **Apical Meristems**: Located at the tips of roots and shoots, responsible for primary growth (growth in length).
  2. **Lateral Meristems**: Responsible for secondary growth (growth in girth or thickness), found in woody plants.
* **Plant Hormones**:
  1. **Auxins**: Promote cell elongation, particularly in response to light (phototropism).
  2. **Cytokinins**: Stimulate cell division and influence the growth of lateral buds.
  3. **Gibberellins**: Promote seed germination and stem elongation.
  4. **Abscisic Acid**: Inhibits growth and helps plants respond to stress (such as drought).
  5. **Ethylene**: A gas that influences fruit ripening and leaf shedding.

#### 5. ****Stomatal Regulation****

* **Stomata**: Small openings on the surface of leaves that facilitate gas exchange (CO₂ in, O₂ out) and transpiration.
* **Guard Cells**: Control the opening and closing of stomata based on environmental conditions like light, humidity, and water availability.

#### 6. ****Mineral Nutrition****

* Plants require various essential nutrients for growth:
  + **Macronutrients**: Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), and Sulfur (S).
  + **Micronutrients**: Iron (Fe), Manganese (Mn), Zinc (Zn), Copper (Cu), Molybdenum (Mo), and Boron (B).
* Nutrients are absorbed by roots from the soil through processes like diffusion and active transport.

#### 7. ****Reproduction****

* **Sexual Reproduction**: Involves the fusion of male (pollen) and female (ovule) gametes, leading to the formation of seeds. This process occurs in flowers for angiosperms (flowering plants) and cones in gymnosperms (like conifers).
* **Asexual Reproduction**: Plants can reproduce without seeds via vegetative methods like runners (strawberries), rhizomes (ginger), or cloning (cuttings).

#### 8. ****Plant Stress Responses****

* **Abiotic Stress**: Environmental factors such as drought, heat, cold, and soil salinity can affect plant health.
  + **Drought Tolerance**: Some plants have adapted to survive in dry conditions by closing stomata to reduce water loss.
* **Biotic Stress**: Caused by living organisms like pathogens (fungi, bacteria) and herbivores (insects, animals).
  + **Defense Mechanisms**: Plants may produce chemical signals such as jasmonic acid and salicylic acid to protect themselves or attract predators of herbivores.

#### 9. ****Allelopathy****

* Some plants release chemicals into the soil or air that inhibit the growth of nearby plants. This can reduce competition for resources.

**10. Photoperiodism**

* **Definition**: The response of plants to the length of day and night, influencing processes like flowering and seed germination.
* **Types of Plants**:
  1. **Short-day plants**: Flower when days are shorter than a critical length.
  2. **Long-day plants**: Flower when days are longer than a critical length.
  3. **Day-neutral plants**: Flower regardless of day length.

**11. Environmental Adaptations**

* **Desert Plants**: Adaptations like thick, waxy cuticles, deep root systems, and modified leaves (spines) help conserve water in arid environments.
* **Salt Tolerant Plants**: Some plants can survive in saline environments by excreting excess salt or storing it in vacuoles.

**12. Tropisms**

* **Phototropism**: The growth of plants toward light. It is regulated by the plant hormone auxin.
* **Gravitropism**: The growth response to gravity. Roots show positive gravitropism (grow downward), and stems show negative gravitropism (grow upward).
* **Thigmotropism**: Growth in response to touch, as seen in climbing plants like vines.