



Plant Environment Abiotic Factors:

Oxygen and Its Impact on Plants

Sixth lecture

**Assist. professor
Dr. Rabah Salim Shareef**

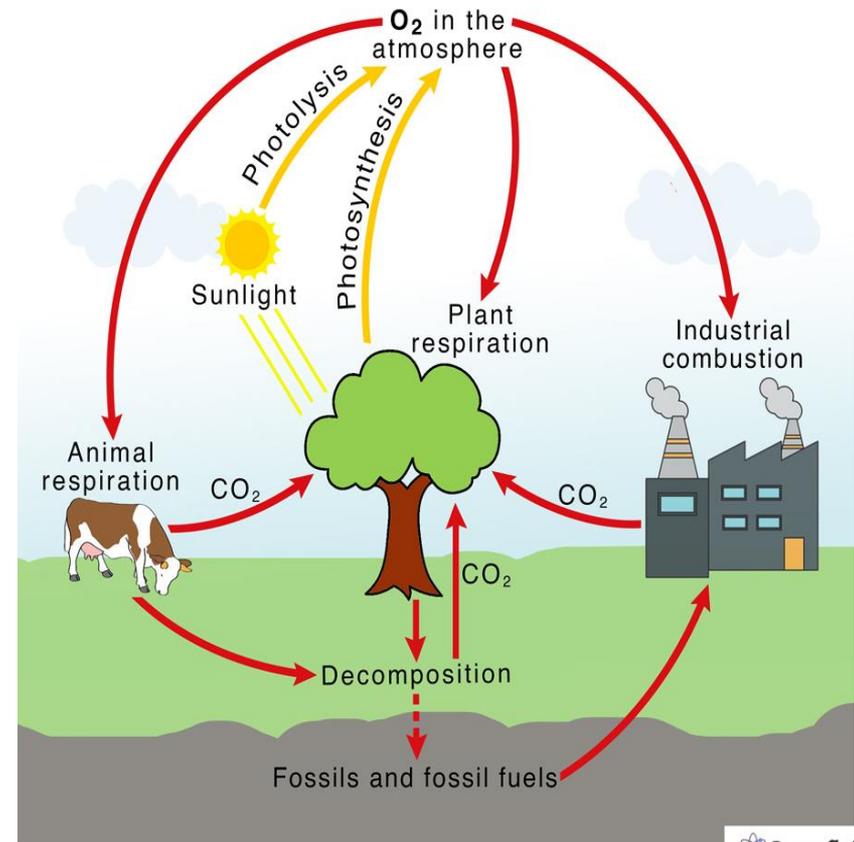


Plant Environment Abiotic Factors:

Introduction

This lecture will explore the different ways oxygen impacts plants, focusing on its role in respiration, stress responses, and interactions with other environmental factors.

Oxygen Cycle





Plant Environment Abiotic Factors:

Introduction

The role of oxygen (O_2) in the life cycle of plants is often overshadowed by the importance of carbon dioxide (CO_2) and sunlight in photosynthesis. However, oxygen is a critical component in several physiological processes that affect plant growth, development, and survival.



Plant Environment

Abiotic Factors:

1. Oxygen in Plant Respiration

A. Cellular Respiration Overview

- Plants, like all aerobic organisms, require oxygen for cellular respiration.
- **Equation:** $\text{Glucose} + \text{Oxygen} \rightarrow \text{Carbon Dioxide} + \text{Water} + \text{Energy (ATP)}$.
- Respiration in plants provides the energy needed for growth, reproduction, and other metabolic activities.



Plant Environment

Abiotic Factors:

1. Oxygen in Plant Respiration

B. Types of Respiration

- **Aerobic Respiration:** Occurs when oxygen is available, producing a high yield of ATP (energy).
- **Anaerobic Respiration:** In the absence of oxygen, plants can switch to anaerobic pathways (such as fermentation), but these processes are less efficient, producing less energy and leading to by-products like ethanol or lactic acid.
- **Impact on Plant Health:** Lack of oxygen, such as in waterlogged soils, can severely limit respiration and reduce plant vigor.



Plant Environment

Abiotic Factors:

1. Oxygen in Plant Respiration

C. Oxygen and Root Function

- Roots rely on oxygen to carry out respiration. Without adequate oxygen in the soil, root growth is stop, leading to poor nutrient uptake and overall plant health.
- **Waterlogging and Hypoxia:** In flooded conditions, soil oxygen becomes depleted, leading to hypoxic conditions (low oxygen), which can cause root damage and even plant death.



Plant Environment Abiotic Factors:

2. Oxygen and Photosynthesis

A. The Oxygen- Carbon Dioxide Cycle

- ❖ **Photosynthesis Equation:** Carbon dioxide + Water + Light Energy → Glucose + Oxygen.
- ❖ **Role of Oxygen:** While oxygen is a by-product of photosynthesis, its presence is not directly involved in the reaction, but it is essential for maintaining gas exchange in plants.
- ❖ **Stomatal Function:** Stomata, the tiny pores in leaves, enhance the exchange of gases. Oxygen exits through these pores, and CO₂ enters for photosynthesis.



Plant Environment Abiotic Factors:

2. Oxygen and Photosynthesis

B. Oxygen Toxicity in Plants

- ❖ Though oxygen is vital for respiration, too much oxygen can have harmful effects. **Reactive oxygen species (ROS)** can be produced, especially in stressed conditions such as high light, drought, or pollution.
- ❖ **ROS and Oxidative Stress:** ROS include molecules like superoxide radicals, hydrogen peroxide, and hydroxyl radicals, which can damage cell membranes, proteins, and DNA, leading to oxidative stress and inhibiting growth.



Plant Environment Abiotic Factors:

3. Oxygen and Plant Stress Responses

A. Hypoxia and Anoxia

1. Hypoxia: Oxygen deficiency that can occur in soil under waterlogged conditions.

2. Anoxia: Complete absence of oxygen, which can occur in extreme cases (e.g., flooding).

Impact on Plants:

- Hypoxic conditions affect root metabolism, causing an energy deficit.
- Plants may switch to anaerobic metabolism to survive, but this is a less efficient energy process, leading to stunted growth and lower survival rates.



Plant Environment Abiotic Factors:

3. Oxygen and Plant Stress Responses

Adaptive Responses:

- ❑ Plants can modify their root architecture (e.g., aerenchyma formation) to adapt to low-oxygen conditions.
- ❑ Some species have evolved to tolerate low-oxygen environments, like rice (*Oryza sativa*), which can grow in flooded soils.



Plant Environment Abiotic Factors:

3. Oxygen and Plant Stress Responses

B. Oxidative Stress and Antioxidant Defense

- ✓ Under stress, excess oxygen in the form of ROS can accumulate and damage cellular structures.
- ✓ **Antioxidants in Plants:** Plants have evolved a variety of antioxidant systems to neutralize ROS, including enzymes like superoxide dismutase (SOD), catalase (CAT), and peroxidases.

The superoxide dismutase enzyme (SOD) which converts superoxide radicals into hydrogen peroxide and oxygen. Then the enzyme catalase (CAT) converts hydrogen peroxide into water and oxygen.



Plant Environment Abiotic Factors:

4. Oxygen and Plant Growth in the Environment

A. Oxygen Availability and Soil Health

- Oxygen levels in the soil are influenced by factors like soil texture, moisture levels, and microbial activity.
- **Well-Aerated Soil:** Supports proper root development and efficient nutrient uptake.
- **Poorly Aerated Soil:** Can lead to root rot, reduced nutrient uptake, and overall plant stress.



Plant Environment Abiotic Factors:

Thanks for listening