Chapter 7: Respiration in Plants

7.1 Introduction to Respiration

Respiration is a biochemical process through which living organisms, including plants, break down glucose to release energy in the form of **ATP** (adenosine triphosphate). This energy is required for all cellular functions, including growth, repair, and maintenance. Respiration in plants occurs in all living cells, and it is essential for the production of energy that sustains plant life. Unlike photosynthesis, respiration occurs continuously, both day and night.

7.2 Types of Respiration

There are two main types of respiration in plants:

1. **Aerobic Respiration**: This type of respiration occurs in the presence of oxygen and produces a large amount of ATP. In this process, glucose is completely oxidized to release energy, carbon dioxide, and water.

2. **Anaerobic Respiration**: This occurs in the absence of oxygen. It is less efficient and produces smaller amounts of ATP. The byproducts of anaerobic respiration are typically alcohol (in yeast) or lactic acid (in animals).

Both forms of respiration are crucial depending on the environmental conditions and the availability of oxygen.

7.3 Phases of Respiration

Respiration consists of several phases that lead to the complete breakdown of glucose and the release of energy.

Glycolysis

Glycolysis is the first step in the breakdown of glucose and occurs in the cytoplasm. In this process, one molecule of glucose (6-carbon) is broken down into two molecules of pyruvate (3-carbon), releasing a small amount of ATP and NADH (a carrier of electrons).

Electron Transport System (ETS) and Oxidative Phosphorylation

The **Electron Transport System** occurs in the mitochondria, where electrons from NADH and FADH2 are transferred through protein complexes in the inner mitochondrial membrane. This

creates a proton gradient, which drives the production of ATP in a process known as **oxidative phosphorylation**.

- **Oxidative Phosphorylation Steps**: Electrons move through the electron transport chain, and the energy released is used to pump protons across the membrane. Protons flow back through ATP synthase, generating ATP.

Tricarboxylic Acid Cycle (Citric Acid Cycle or Krebs Cycle)

The Krebs cycle occurs in the mitochondria and is responsible for the complete oxidation of acetyl-CoA (produced from pyruvate) into carbon dioxide. This cycle also produces high-energy compounds such as NADH and FADH2, which are used in the electron transport chain for further ATP production.

Pyruvate Oxidation (Link Reaction)

In the link reaction, pyruvate is converted into acetyl-CoA, which enters the Krebs cycle. This reaction occurs in the mitochondria and releases carbon dioxide as a byproduct.

7.4 Phases of Respiration: Fermentation

Fermentation is an anaerobic process that occurs when oxygen is not available. It allows cells to continue producing ATP in the absence of oxygen but is less efficient than aerobic respiration.

Types of Fermentation

1. **Lactic Acid Fermentation**: Occurs in muscle cells and certain bacteria, resulting in the production of lactic acid.

2. **Alcohol Fermentation**: Occurs in yeast and some bacteria, producing ethanol and carbon dioxide as byproducts.

3. **Acetic Acid Fermentation**: Involves bacteria that produce acetic acid (vinegar) from sugars.

4. **Butyric Acid Fermentation**: Occurs in some bacteria, producing butyric acid.

Advantages of Fermentation

While fermentation produces much less ATP compared to aerobic respiration, it allows plants and microorganisms to survive in anaerobic conditions and continue to generate some energy in the absence of oxygen.

7.5 Respiration in Plants

Respiration in plants happens in all parts of the plant, including roots, stems, and leaves. The process is similar to respiration in animals, where glucose is broken down to release energy.

- **Do Plants Breathe?**: Yes, plants undergo respiration continuously, using oxygen and releasing carbon dioxide. Though plants also perform photosynthesis, they do not "breathe" in the same sense as animals because they perform both processes simultaneously.

- **Respiration in Roots**: Roots are constantly consuming oxygen and releasing carbon dioxide. In soil, where oxygen may be less available, respiration is critical for energy production.

- **Respiration in Stems**: Stems carry out respiration, although this process is less significant than in the leaves and roots.

- **Respiration in Leaves**: Leaves also respire, particularly at night when photosynthesis does not occur. They consume oxygen and release carbon dioxide during cellular respiration.

7.6 Respiration and Photosynthesis

Photosynthesis and **respiration** are complementary processes.

- **Photosynthesis**: Involves plants using light energy, carbon dioxide, and water to produce glucose and oxygen.

- **Respiration**: Uses oxygen and glucose to release energy, producing carbon dioxide and water as byproducts.

These processes are interconnected: the products of photosynthesis (oxygen and glucose) are used in respiration, while the products of respiration (carbon dioxide and water) are used in photosynthesis, creating a continuous cycle.