

Respiration in Plants

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Introduction

- **Breathing is essential to life.**
 - But why is it so important? What exactly happens when we breathe? Do all living organisms — including plants and microorganisms — breathe? If they do, how does this process occur?
- All living organisms require energy to perform a variety of life processes, including:
 - Absorption of nutrients
 - Transport of substances
 - Movement
 - Growth and reproduction
 - Even the process of breathing itself
- This **energy is derived from food**. But this raises further questions:
 - How is energy extracted from food?
 - Do all types of food provide the same amount of energy?
 - Do plants and microorganisms "eat" in the same way animals do?
- Although these questions may seem different, they are all connected through a fundamental biological process called **respiration**.

Source of Energy: Food and Photosynthesis

Food as a Source of Energy

- Living organisms release energy by **oxidizing macromolecules** such as:
 - Carbohydrates
 - Fats
 - Proteins
- These macromolecules are collectively referred to as **food**.
- The energy obtained from food is used to carry out all essential life processes, including growth, repair, transport, movement, and reproduction.

How Do Plants Get Their Food?

- **Green plants** and **cyanobacteria** are autotrophs — organisms that can synthesize their own food.

- They use sunlight to perform photosynthesis, a process in which:
 - Light energy is converted into chemical energy.
 - This energy is stored in the form of **carbohydrates** such as:
 - Glucose
 - Sucrose
 - Starch

Do All Parts of a Plant Photosynthesise?

- **No**, not all parts of a plant can perform photosynthesis.
- Only those cells that contain **chloroplasts** — mainly found in the **green parts** of the plant (like leaves) — are capable of photosynthesis.
- Other plant parts such as:
 - Roots
 - Stems
 - Flowers
 - Fruits
- Do not photosynthesise and must **receive food** (in the form of sugars) produced by the green parts of the plant.

What About Animals and Microorganisms?

- **Animals** are **heterotrophic**, meaning they cannot produce their own food. They obtain food:
 - Directly from plants (herbivores), or
 - Indirectly by consuming other animals (carnivores)
- **Saprophytes**, such as **fungi** and certain bacteria, feed on dead and decaying organic matter.
- Despite the different methods of obtaining food, it is important to understand that:
 - All food and energy used in respiration by living organisms ultimately comes from photosynthesis.

What is Respiration?

- **Respiration** is the oxidative breakdown of complex food molecules (like glucose) to release energy.
- This process occurs in a stepwise manner, controlled by **enzymes**, ensuring that:
 - Energy is not released all at once
 - Energy is trapped in the form of ATP (Adenosine Triphosphate)

Types and Site of Respiration

Cellular Respiration

- Occurs in all living cells
- In **eukaryotic cells**, it takes place in:
 - The cytoplasm (initial steps)
 - The mitochondria (further breakdown for energy)

Oxidation of Food

- Respiration involves the oxidation of carbon-carbon (C–C) bonds in food molecules.
- This process releases **energy**, which is captured as **ATP**.

Respiratory Substrates

- **Carbohydrates** (like glucose) are the most common respiratory substrates.
- Under certain conditions, fats, proteins, and organic acids may also be used as energy sources by some plants.

ATP – The Energy Currency of the Cell

Step-wise Energy Release

- During respiration, energy is not released all at once.
- Instead, it is released through a series of slow, enzyme-controlled reactions.
- This controlled breakdown ensures efficient capture of energy.

Energy Trapping

- The energy released during respiration is not used directly by the cell.
- It is trapped and stored as chemical energy in the form of **ATP (Adenosine Triphosphate)**.

Utilization of ATP

- **ATP is broken down** wherever and whenever energy is needed.
- It powers a variety of essential cellular activities, such as:
 - Biosynthesis of macromolecules
 - Active transport across membranes
 - Mechanical work, such as movement (e.g., cilia, muscle contraction)

Role of ATP

- ATP acts as a **universal energy carrier** in all cells.
- It stores energy temporarily and releases it on demand for various biological processes.

Additional Role of Respiration

- In addition to energy production, respiration also generates carbon skeletons (metabolic intermediates).

- These intermediates serve as **precursors for the biosynthesis** of essential cellular components such as:
 - Proteins
 - Nucleic acids
 - Lipids
 - Other vital biomolecules

Do Plants Breathe?

Do Plants Require Oxygen?

- Yes, plants require **oxygen (O₂)** for **cellular respiration**.
- They also release carbon dioxide (CO₂) as a by-product.
- However, plants do not have specialized respiratory organs like animals.

How Do Plants Exchange Gases?

- Plants use the following structures for gas exchange:
 - **Stomata** (primarily in leaves)
 - **Lenticels** (in stems and woody parts)

Why Don't Plants Need Specialized Respiratory Organs?

1. Localized Gas Exchange

- Each part of the plant manages its **own gas exchange needs**.
- There is minimal gas transport between plant parts.

2. Lower Demand for Gas Exchange

- Plant cells have lower respiratory rates than animal cells.
- **Leaves** manage their own gas exchange, especially during photosynthesis, when O₂ is produced internally.

3. Short Diffusion Distance

- Even in large plants, gases only need to diffuse short distances.
- Most **living cells** are located **near the surface**, allowing easier access to gases.

4. Adapted Internal Structure

- In **stems**, living cells are in thin layers just beneath the bark.
- These layers are aerated via lenticels.
- Dead inner tissues provide mechanical support, not respiration.
- **Loose packing of parenchyma cells** in leaves, stems, and roots creates air spaces, forming an interconnected network for gas movement.

Respiration and Energy Production

- **Glucose** is broken down in the presence of oxygen to release:
 - Carbon dioxide (CO₂)
 - Water (H₂O)



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