

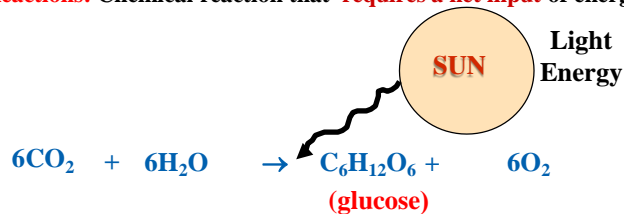
ENERGY AND THE CELL

Cells transform energy as they perform work

- **Energy is the capacity to do work and cause change**
 - **There are two kinds of energy**
 - A. **Kinetic energy is the energy of motion**, Heat and light energy are examples
 - B. **Potential energy is energy that an object possesses as a result of its position**, includes energy stored in chemical bonds

Two Types of Energy Reactions:

1- Endergonic Reactions: Chemical reaction that **requires a net input** of energy. Example: Photosynthesis.



2- Exergonic Reactions: Chemical reactions that **releases energy**.

Example: Cellular Respiration.



Metabolic Reactions of Cells

What is Metabolism?

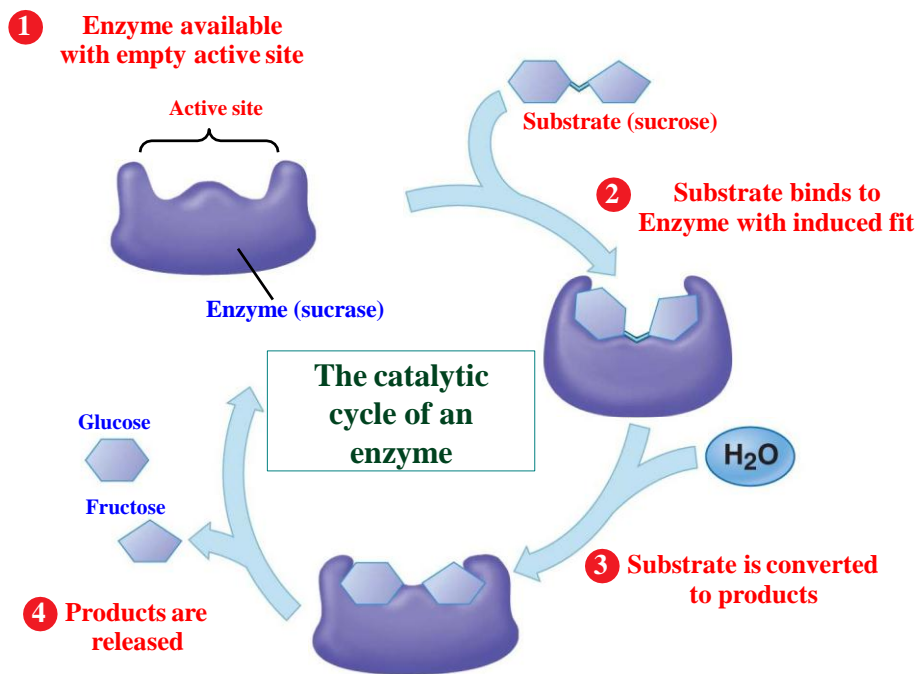
- The sum total of the chemical activities of all cells.
- *Two Types of Metabolism:*
 - 1) **Anabolic Pathways.** Metabolic reactions, which **consume energy** (endergonic), to **build** complicated molecules from simpler compounds.
 - 2) **Catabolic Pathways.** Metabolic reactions which **release energy** (exergonic) by **breaking down** complex molecules in simpler compounds
- A cell does three main types of cellular work
 - **Chemical work** — driving endergonic reactions
 - **Transport work** — pumping substances across membranes
 - **Mechanical work** — beating of cilia
- To accomplish work, a cell must **manage its energy resources**, and it does so by **energy coupling** — the use of **exergonic** processes to drive an **endergonic** one

Cellular Energy - ATP

- **ATP, adenosine triphosphate, is the energy currency of cells.**
 - **ATP is the immediate** source of energy that **powers most forms of cellular work.**
 - It is composed of **adenine** (a nitrogenous base), **ribose** (a five-carbon sugar), and **three phosphate groups.**
- Hydrolysis of ATP releases energy by transferring its third phosphate from ATP to some other molecule
 - The transfer is called **phosphorylation**

Enzymes speed up the cell's chemical reactions:

- The cell uses **catalysis** to drive (speed up) biological reactions
 - **Catalysis** is accomplished by **enzymes**, which are proteins that function as biological catalysts
- **Enzyme increases speed of a chemical reaction** without being consumed
 - Each enzyme is specific; has a particular target molecule called the **substrate**



How Cells Harvest Chemical Energy

Harvest chemical energy (ATP)

- Energy is necessary for **life processes**. These include growth, transport, manufacture, movement, reproduction, and others.
- Energy that supports life on Earth is captured from **sun rays** reaching Earth through plant, algae, protist, and bacterial photosynthesis.
- All of our cells harvest chemical energy (**ATP**) from our food by a process called **cellular respiration**

Photosynthesis and cellular respiration provide energy for life

- Energy in sunlight is used in **photosynthesis** to make glucose from CO_2 and H_2O with release of O_2
- Other organisms use the O_2 and energy in sugar and release CO_2 and H_2O (**cellular respiration**)
- Together, these **two processes** are responsible for the majority of life on Earth

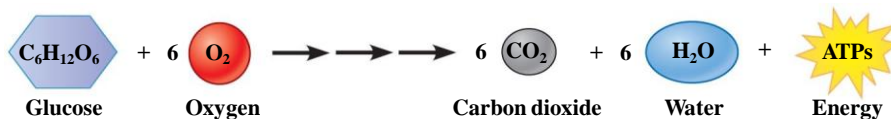
INTRODUCTION TO CELLULAR RESPIRATION

Breathing supplies oxygen to our cells for use in cellular respiration and removes carbon dioxide

- **Breathing and cellular respiration are closely related**
 - **Breathing** is necessary for exchange of CO_2 produced during cellular respiration with atmospheric O_2
 - **Cellular respiration** uses O_2 to help harvest energy from glucose and produces CO_2 , H_2O and ATP in the process

Cellular respiration Stores energy in ATP molecules

- Cellular respiration is an **exergonic** process that transfers energy stored in glucose bonds to **ATP**
 - Cellular respiration produces **38 ATP** molecules from each **glucose** molecule
 - Other foods (protein and lipid) can be used as a source of energy as well



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Summary equation for cellular respiration

Stages of Aerobic Cellular Respiration

What are the Stages of Cellular Respiration?

1. **Glycolysis** occurs in the **Cytoplasm**
2. **The Krebs Cycle** or **citric acid cycle** occurs in **the mitochondria matrix**
3. **Oxidation phosphorylation** occurs in **the mitochondria**.

What is Glycolysis:

Glycolysis begins respiration by breaking glucose, a six-carbon molecule, into two molecules of a three-carbon compound called **pyruvate**

What is citric acid cycle:

The citric acid cycle breaks down **pyruvate** into **carbon dioxide** and supplies the electrons for stage three.

What is oxidative phosphorylation:

At this stage, electrons are shuttled through the electron transport chain, as a result, ATP is generated through this stage.

INTERCONNECTIONS BETWEEN MOLECULAR BREAKDOWN AND SYNTHESIS

How do cells extract energy in chemical bonds in organic molecules

- Although glucose is considered to be the primary source of sugar for respiration and fermentation, there are actually three sources of molecules for generation of ATP

1- **Carbohydrates**(disaccharides)

2- **Proteins** (after conversion to amino acids)

3- **Fats**

Catabolism of Various Food Molecules:

- Other organic molecules used for fuel.
- **Fats:** glycerols and fatty acids both oxidized as fuel
- **Proteins:** amino acids undergo **deamination**. Carbon skeletons converted to intermediates of aerobic respiration