## Concept 7.5
## Cellular respiration coverts energy in food to energy in ATP.

### Structure of Mitochondria:

- An **envelope** of two membranes with a space between the outer and inner membranes.

- The highly folded inner membrane encloses an thick fluid called the **matrix**.

- Many **enzymes and other molecules** involved in cellular respiration are built into the inner membrane.

### A Road Map for Cellular Respiration:

A cell's metabolism consists of a series of reactions and is referred to as a metabolic pathway.

The three main stages are the -

1. **Glycolysis**
2. **Krebs cycle**
3. **Electron transport chain / ATP synthase**

### Stage 1: Glycolysis

- Takes place outside the mitochondria in the cytoplasm of the cell.

- glycolysis means "splitting of sugar"

**Steps:**

1. Glucose 6 carbon sugar

2. 2 ATP Initial investment of energy

3. Split glucose into 2 three-carbon molecules each with one phosphate group.

4. Each group transfers electrons and hydrogen ions to a molecule of NAD+ to form NADH.

5. Four new ATP molecules are produced along with 2 pyruvic acid molecules.
( A net gain of 2 ATP molecules)

**Stage 2 : The Krebs Cycle**

The Krebs cycle finishes the breakdown of pyruvic acid molecules to carbon dioxide.

The enzymes for the Krebs cycle are dissolved in the fluid matrix within a mitochondrion's inner membrane.

Note: The pyruvic acid molecules produced during glycolysis do not take part in the Krebs cycle. Instead, after diffusing into the mitochondrion, each three-carbon pyruvic acid molecule loses a molecule of carbon dioxide. The resulting molecule is then converted to a two-carbon compound called **acetyl coenzyme A**, or **acetyl CoA** which then enters the Krebs cycle.

Steps:

1. acetyl CoA joins a four-carbon acceptor
2. produces 2 CO and one ATP / acetyl CoA
3. NADH and FADH trap most of the energy
4. four-carbon acceptor has been regenerated

For one glucose molecule the Krebs cycle turns twice and produces 4 CO and 2 ATP molecules.

**Stage 3: Electron Transport Chain and ATP Synthase Action.**

The final stage of cellular respiration occurs in the inner membranes of mitochondria.

This stage has two parts:

1. an electron transport chain
2. and ATP production by ATP synthase

Steps:

1. NADH transfers electrons from the original glucose molecule to an electron transport chain.
2. Electron transport chain releases energy that is used to pump H ions across the inner membrane.
3. Oxygen and electrons combine with hydrogen ions, forming water.
4. The H ions flow back through an ATP synthase, causing it to spin.
5. The ATP synthase generates ATP from ADP

This process can generate up to 34 ATP molecules per original glucose molecule.

## Adding Up the ATP Molecules:

The result of cellular respiration is to generate ATP for cellular work. A cell can convert the energy of one glucose molecule to ad many as 38 molecules of ATP.

**Glycolysis** produces 4 ATP
- input of 2 ATP
net gain **2 ATP**

**Krebs cycle** **2 ATP** one for each pyruvic acid

**ATP synthase** **34 ATP**

Notice most of the 38 molecules of ATP are produced after glycolysis and requires oxygen. Without oxygen, most of your cells would be unable to produce much ATP. As a result, you cannot survive for long without a fresh supply of oxygen.