

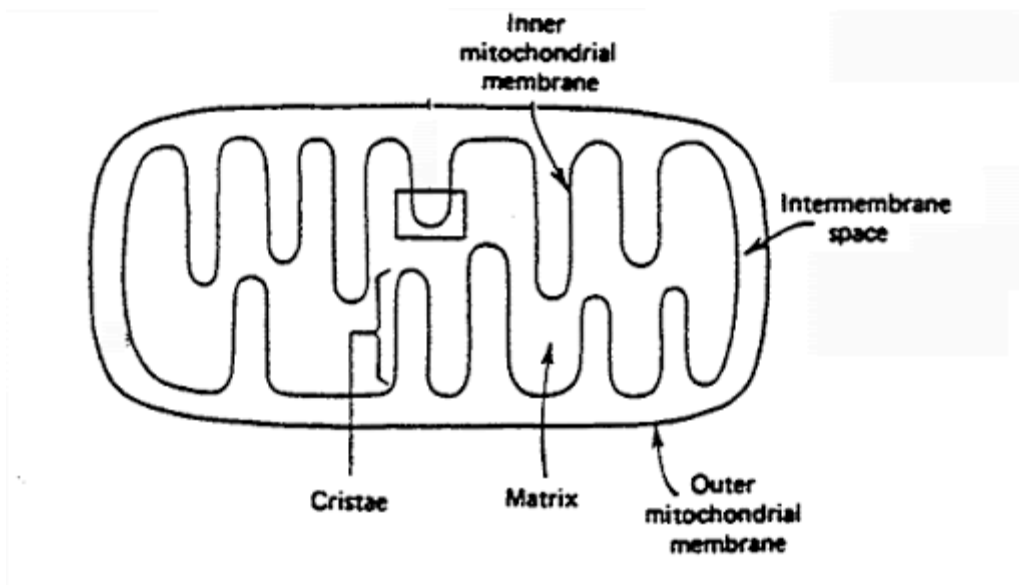
## Grade 11 Life Sciences

### Cellular respiration:

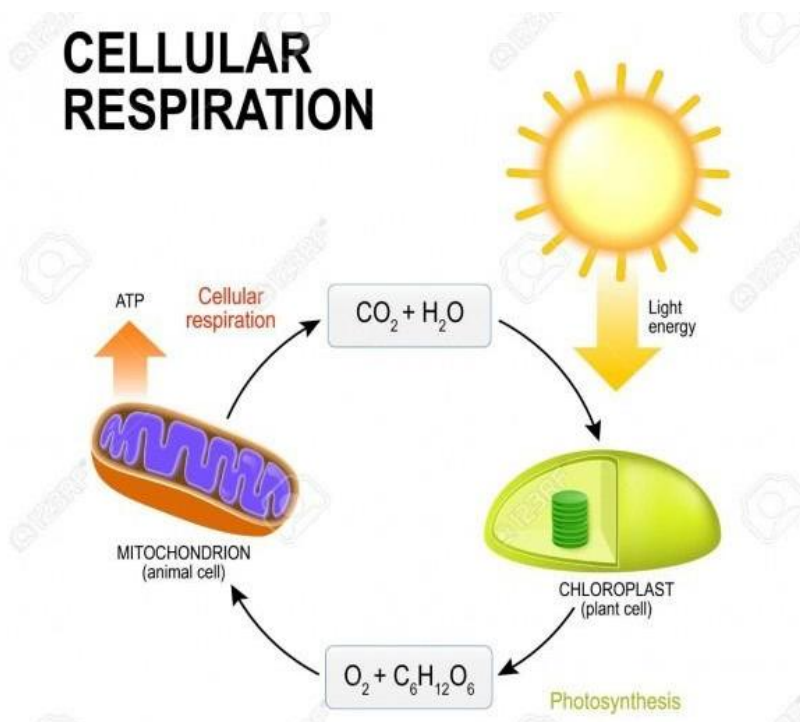
**Respiration** is the biochemical process in which the cells of an organism obtain energy by combining oxygen and glucose, resulting in the release of carbon dioxide, water, and energy (ATP).

The mitochondria is the site of aerobic cellular respiration in cells.

Diagram of a mitochondrion



## CELLULAR RESPIRATION



Life processes that require energy:

- Breathing
- Growth (cell division)
- Movement
- Active transport
- Maintaining a constant body temperature

Energy is the ability to do work. The energy can take a wide variety of forms - heat (thermal), light (radiant), mechanical, electrical, chemical, and nuclear energy.

There are two types of energy - stored (potential) energy and working (kinetic) energy.

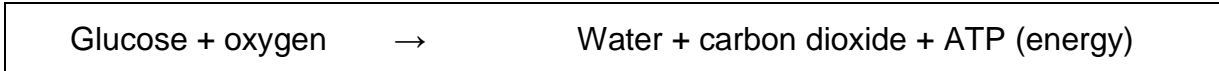
For example, the food you eat contains chemical energy, and your body stores this energy until you release it when you work or play.

### **Aerobic Cellular Respiration**

Aerobic respiration is respiration in the presence of oxygen.

Cellular respiration occurs in all plant and animal cells, providing the cells with energy necessary to carry out life processes. The purpose of cellular respiration is to break down glucose to release the stored chemical potential energy.

Aerobic respiration can be written as the following word equation:



Aerobic cellular respiration is made up of 3 stages:

1. Glycolysis
2. Krebs's cycle
3. Oxidative phosphorylation

## 1. Glycolysis

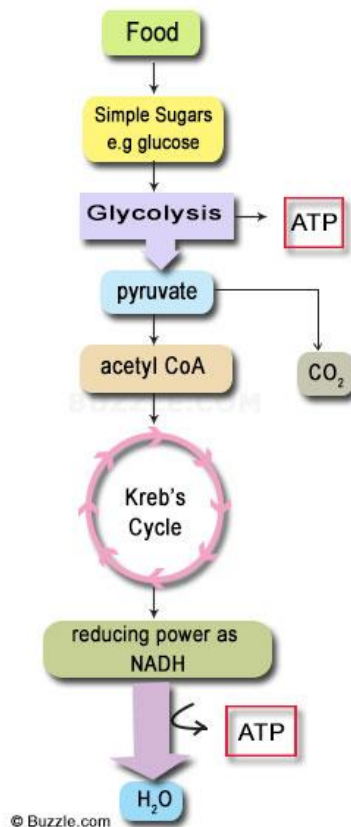
- Occurs in the cytoplasm of the cell.
- Glucose is broken down to pyruvic acid.
- Energy rich H (hydrogen) atoms are given and move to the mitochondria to be used during oxidative phosphorylation.
- 2 ATP molecules are produced.

## 2. Krebs cycle

- Occurs in the mitochondria.
- Pyruvic acid (from Glycolysis) is broken down into carbon dioxide and energy rich hydrogen atoms.
- The carbon dioxide will be transported in the blood to the lungs and is exhaled during breathing.

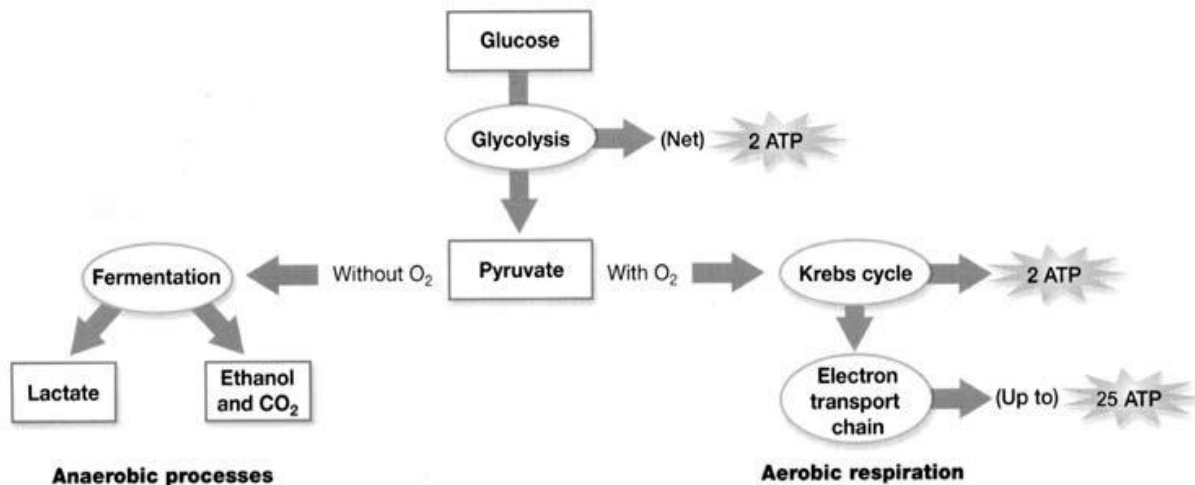
## 3. Oxidative Phosphorylation

- Occurs in the mitochondria.
- The energy from the energy rich hydrogen carriers is used to make ATP.
- The H combines with oxygen to make water. This water is either exhaled as water vapour or is excreted by the kidneys as part of the urine.



## Anaerobic respiration

Respiration without oxygen. As shown in the figure below, the first major step in producing ATP is **glycolysis**. What happens next depends on whether or not oxygen is available. When oxygen is available, cells can use the Krebs cycle (citric acid cycle) and the electron transport chain to make up to ATP molecules. This is called aerobic respiration.



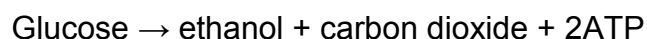
### **Production of ATP**

(Figure revised from Johnson and Raven, 2004, Biology, Holt Rinehart and Winston, p. 110)

When oxygen is **not** available, cells go through **anaerobic cellular respiration**. In plant cells pyruvic acid from glycolysis is converted to ethanol and carbon dioxide in a process called fermentation. Glycolysis plus anaerobic fermentation yields much less ATP per glucose molecule than aerobic respiration, but this process is very useful when O<sub>2</sub> is not available.

When animal cells do not supply oxygen at a rate which is needed for aerobic cellular respiration to occur, the cells too switch to anaerobic respiration where lactic acid is formed, as glucose is incompletely broken down.

The process of alcoholic fermentation is represented as follows:



The process of lactic acid fermentation is represented as follows:



The main differences between aerobic and anaerobic respiration are:

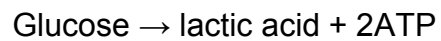
	Aerobic Respiration	Anaerobic Respiration
Raw Materials Required	Glucose and Oxygen	Glucose
Products	Carbon dioxide and water	Ethanol and carbon dioxide or lactic acid
Amount of Energy	More ATP	Less ATP

The word equation for anaerobic respiration, both in animal and plant cells:

Plant Cells



Animal Cells



Anaerobic respiration in the industry:

- Production of beer
- Production of wine
- Baking bread
- Making cheese