

## Cellular Respiration

### Introduction

Respiration [process that occurs in all living cells] is the oxidization of food substances with the release of energy, which is stored as ATP. ATP, standing for adenosine triphosphate, is the short term energy storage form of all cells.

The uses of energy produced:

- ✚ Synthesis:
  - ➔ For formation of new substances for growth, development and repair.
- ✚ Transport:
  - ➔ For transport of material by active transport.
  - ➔ Movement of materials across cell membranes.
- ✚ Movement:
  - ➔ For contraction of muscles
- ✚ Electrochemical Activity:
  - ➔ For generation of nerve impulses
- ✚ Heat Production:
  - ➔ To maintain a constant body temperature in warm-blooded animals

There are two types of respiration:

- ✚ Aerobic Respiration
- ✚ Anaerobic Respiration
  - ➔ In yeast
  - ➔ In muscles [when necessary]

### Aerobic Respiration

Aerobic respiration is the breakdown of food substances in the presence of oxygen with the release of lots of energy stored in the form of ATP. One glucose molecule can produce 38 ATP worth of energy. This process takes place in the mitochondria.

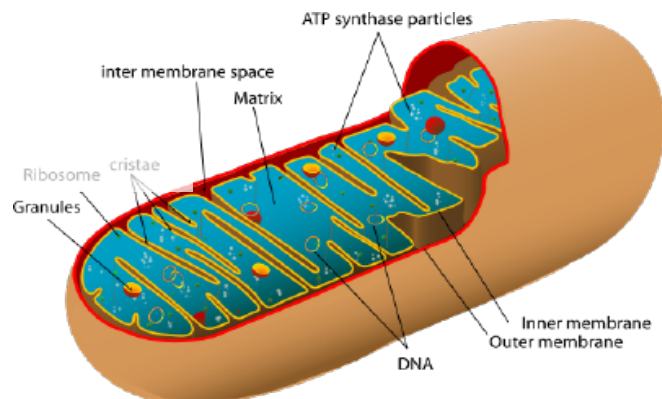
#### Overall Equation

Glucose + oxygen → carbon dioxide + water + lots of energy

#### Adenosine Triphosphate

ATP has adenosine, phosphate groups and ribose.

There is a high energy stored in the bonds between the 3 phosphate groups.



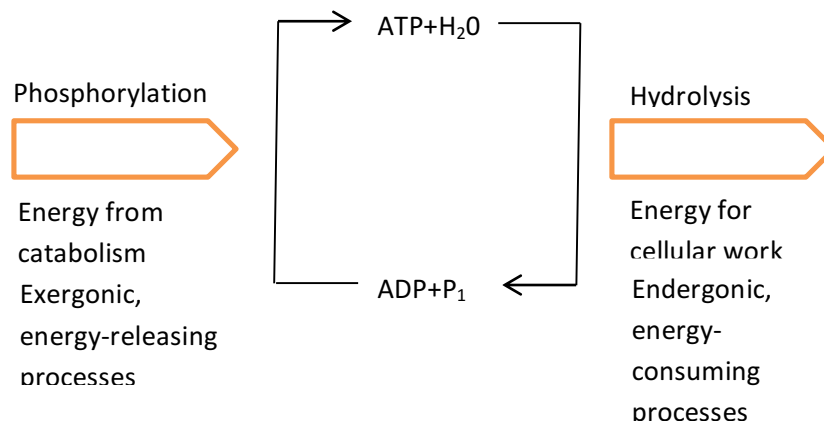
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### ADP-ATP Cycle:

Energy produced from respiration is used to phosphorylate [add a phosphate group] ADP to ATP. Energy is temporarily stored in bonds until required.

When required, ATP is hydrolysed to ADP and inorganic phosphate to produce energy for work:

- ✚ Active transport, building molecules, muscle contraction, transmission of nervous impulses.



- ✚ Adenosine triphosphate is formed through respiration and photosynthesis

### Anaerobic Respiration

Anaerobic Respiration is the breakdown of food substances in the absence of oxygen with the release of small amounts of energy. [about 19x less than aerobic respiration; 2ATP worth of energy].

Examples of things that undergo anaerobic respiration:

- ✚ Yeast
- ✚ Muscles [when necessary]

### Overall Equation

Glucose → carbon dioxide + ethanol + small amounts of energy

\*Ethanol: C<sub>2</sub>H<sub>5</sub>OH

### Anaerobic Respiration in Yeast

Yeast cells can respire aerobically or anaerobically [facultative anaerobes]. When yeast cells respire anaerobically, ethanol and carbon dioxide are produced. This process is also known as fermentation [of yeast]; it is used in wine making and bread making.

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### Anaerobic Respiration of Muscles

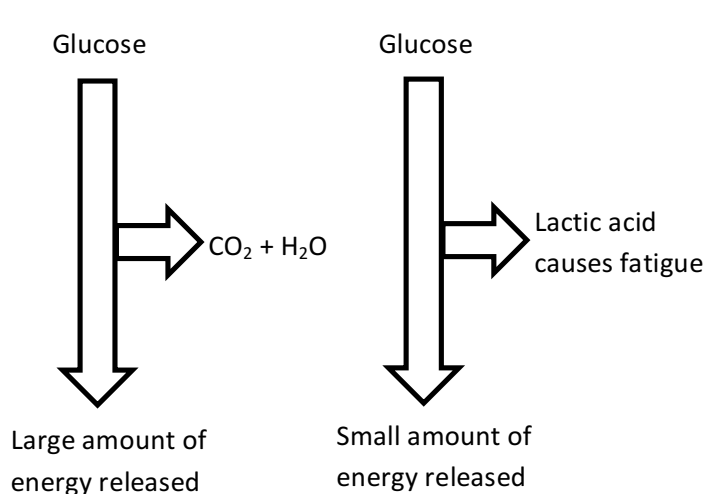
General Equation:

Glucose → Lactic acid + small amount of energy

\*Lactic acid →  $C_3H_{12}O_6$

Usually, muscles respire aerobically to produce large amounts of energy, carbon dioxide and water.

During muscular activity, insufficient oxygen is transported to the muscles. These muscles will then undergo anaerobic respiration to produce energy. The aerobic and anaerobic respiration of muscles will take place concurrently.



During anaerobic respiration, only the first stage of respiration occurs therefore only 2ATP produced per glucose molecule. Due to the accumulation of lactic acid in the muscles, the muscles will be fatigued after rigorous activity. After a period of rest, some of the lactic acid produced is transported to the liver and will be broken down

into energy. This energy will then be used to oxidise remaining lactic acid into energy. Once all lactic acid is used up, \*oxygen debt is said to be repaid.

\*Oxygen debt: During the period of rest immediately after vigorous exercise, oxygen debt occurs. It is also defined as the amount of oxygen required to oxidise the lactic acid produced in muscles during anaerobic respiration.

### Anaerobic vs. Aerobic Respiration

- ✚ Small amounts of energy are produced in anaerobic respiration.
- ✚ Waste product lactic acid and ethanol contain much unused energy.
- ✚ Lactic acid and ethanol are harmful to organisms if they accumulate

### Differences between Respiration and Photosynthesis

Respiration	Photosynthesis
Energy is liberated	Energy is stored in
Oxygen is used; carbon dioxide and water produced	Carbon dioxide and water are used; oxygen is given off
Catabolic process, breakdown of glucose	Anabolic process; glucose is formed
Occurs all the time	Occurs only cells with chlorophyll and in

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	presence of sunlight
Results in loss of dry mass	Results in gain of dry mass