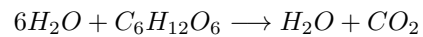


Respiration

Introduction

- **External Respiration** is how organisms exchange gases with their environment
- **Internal Respiration** is the controlled release of energy from food
- Controlled by enzymes
 - lets energy get released slowly
- Energy stored by ATP (Adenosine Triphosphate)



Aerobic Respiration

- **Aerobic Respiration** is the release of energy from food **using oxygen**
- Energy is stored as ATP
- Aerobic respiration is relatively efficient
- It's a 2 stage process

Stage 1 (Glycolysis)

- Anaerobic stage (doesn't require oxygen)
- Releases only a small amount of energy
- Takes place in the cytosol
- Involves splitting glucose (six-carbon sugar) into three-carbon molecules
 - Small amount of energy released (ATP)
- Produces pyruvic acid, which can be turned into pyruvate
-

Stage 2

Summary

- Aerobic process
- Large amount of energy released
 - Efficient
- Takes place in the mitochondria
- Involves breaking down 3-carbon molecules into CO₂ and H₂O

Main Events

- Pyruvic acid enters a mitochondrion
 - Loses a CO₂ molecule to form a 2-carbon molecule
 - * **Acetyl coenzyme A**

- Pyruvic acid also loses 2 high-energy electrons and a proton (H^+)
 - These combine with NAD^+ to form NADH

Anaerobic Respiration

- **Anaerobic Respiration** is the release of energy from food without the use of oxygen
 - AKA **Fermentation**
- Stage 1 process only
- Takes place in the cytosol
- Small amount of energy released
- Many forms of anaerobic respiration
 - They all break glucose down into 3-carbon molecules
 - 3-carbon molecules are broken down into different end products
 - * No additional energy released
- Two common forms of anaerobic respiration
 - Lactic acid fermentation (often called anaerobic respiration)
 - Alcohol fermentation

Lactic Acid Fermentation

- Occurs in some bacteria and fungi (anaerobes) and also in human muscle when it is low on oxygen
- 3-carbon molecules are converted into lactic acid
- Lactic acid fermentation causes a build up of lactic acid, causing cramp
- When we rest, lactic acid is broken down in the liver
- Glucose \gg **2 lactic acid** + small amount of energy

Alcohol Fermentation

- Takes place in some bacteria and fungi (e.g. yeast) and in plants when low on oxygen
- 3-carbon molecule converted into **ethanol and CO_2**
- Ethanol is a high energy product
- Glucose \gg **2 ethanol + 2 carbon dioxide** + small amount of energy

Micro-Organisms in industrial fermentation

- **Biotechnology** is the use of living things to manufacture useful products or to carry out useful reactions

Production Method

- Micro-organisms are placed in a container along with suitable substrates to react
 - The container is called a **bioreactor**
- Contents are mixed

- This produces foam
 - Foam breaker removes foam
- Oxygen is pumped into the liquid so the reactions happen better

Bioprocessing with immobilised cells

- Traditionally, micro-organisms are mixed in with ingredients
 - They have to be separated and thrown out after the reaction
 - * Very costly
- Nowadays,, microorganisms are **immobilised**

Detailed Study of Respiration