

Chapter 9: Respiration

Knowledge organiser

Cellular respiration

Cellular **respiration** is an **exothermic** reaction that occurs continuously in the **mitochondria** of living cells to supply the cells with energy.

The energy released during respiration is needed for all living processes, including

- chemical reactions to build larger molecules, for example, making proteins from amino acids
- muscle contraction for movement
- keeping warm.

Respiration in cells can take place aerobically (using oxygen) or anaerobically (without oxygen).

| Type of respiration | Oxygen required? | Relative amount of energy transferred |
|---------------------|------------------|---|
| aerobic | ✓ | complete oxidation of glucose – large amount of energy is released |
| anaerobic | ✗ | incomplete oxidation of glucose – much less energy is released per glucose molecule than in aerobic respiration |

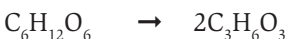
Aerobic respiration

glucose + oxygen → carbon dioxide + water



Anaerobic respiration in muscles

glucose → lactic acid



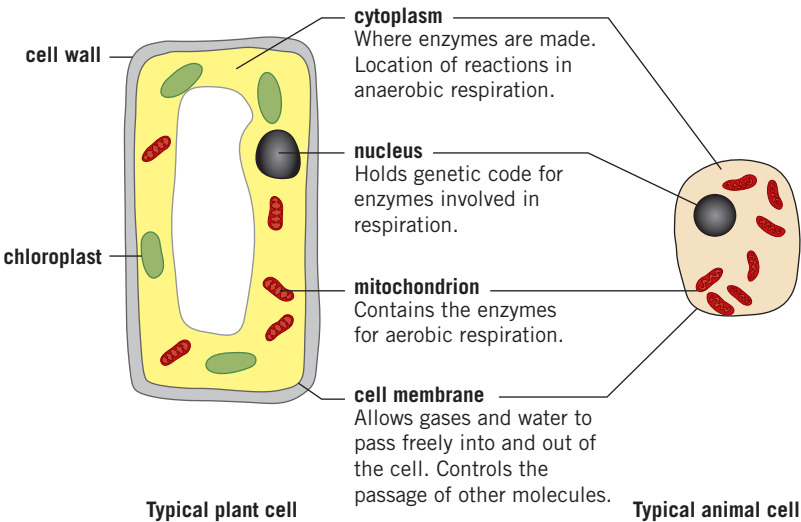
Fermentation

Anaerobic respiration in plant and yeast cells is represented by the equation

glucose → ethanol + carbon dioxide

Anaerobic respiration in yeast cells is called **fermentation**.

The products of fermentation are important in the manufacturing of bread and alcoholic drinks.



Key terms

Make sure you can write a definition for these key terms.

aerobic amino acids anaerobic carbohydrates cellulose exothermic fermentation
fatty acid glycerol glycogen lactic acid lipids metabolism mitochondria
oxidation oxygen debt proteins respiration starch

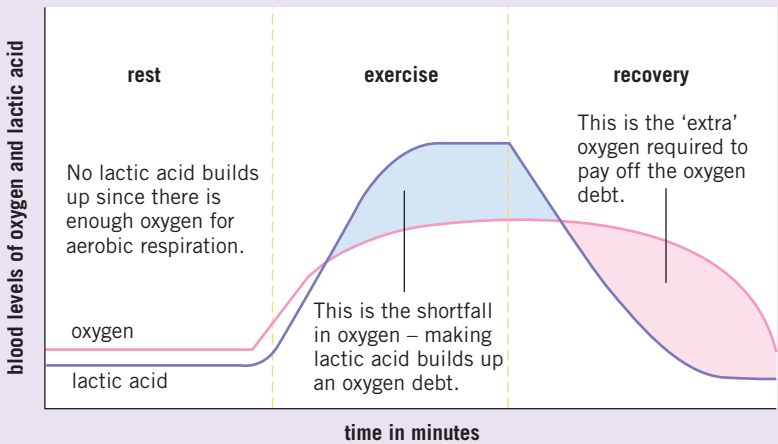
Response to exercise

During exercise the human body reacts to the increased demand for energy.

To supply the muscles with more oxygenated blood, heart rate, breathing rate, and breath volume all increase.

If insufficient oxygen is supplied, anaerobic respiration takes place instead, leading to the build-up of **lactic acid**.

During long periods of vigorous exercise, muscles become fatigued and stop contracting efficiently.



Oxygen debt (HT only)

After exercise, the lactic acid accumulated during anaerobic respiration needs to be removed.

Oxygen debt is the amount of oxygen needed to react with the lactic acid to remove it from cells.

Removal of lactic acid

lactic acid in the muscles
↓
transported to the liver in the blood
↓
lactic acid is converted back to glucose

Metabolism

Metabolism is the sum of all the reactions in a cell or the body.

The energy released by respiration in cells is used for the continual enzyme-controlled processes of metabolism that produce new molecules.

Metabolic processes include the synthesis and breakdown of:

Carbohydrates

- synthesis of larger carbohydrates from sugars (starch, glycogen, and cellulose)
- breakdown of glucose in respiration to release energy

Lipids

- synthesis of lipids from one molecule of glycerol and three molecules of fatty acid

Proteins

- synthesis of amino acids from glucose and nitrate ions
- amino acids used to form proteins
- excess proteins broken down to form urea for excretion

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Retrieval questions

Learn the answers to the questions below, then cover the answers column with a piece of paper and write as many as you can. Check and repeat.

B9 questions

Answers

| | | | |
|----|---|----------------|---|
| 1 | Define the term cellular respiration. | Put paper here | an exothermic reaction that occurs continuously in the mitochondria of living cells to release energy from glucose |
| 2 | What do organisms need energy for? | Put paper here | <ul style="list-style-type: none"> chemical reactions to build larger molecules muscle contraction for movement keeping warm |
| 3 | What is the difference between aerobic and anaerobic respiration? | Put paper here | aerobic respiration uses oxygen, anaerobic respiration does not |
| 4 | Write the word equation for aerobic respiration. | Put paper here | glucose + oxygen → carbon dioxide + water |
| 5 | Write the word equation for anaerobic respiration in muscles. | Put paper here | glucose → lactic acid |
| 6 | Write the balanced symbol equation for aerobic respiration. | Put paper here | $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ |
| 7 | Why does aerobic respiration release more energy per glucose molecule than anaerobic respiration? | Put paper here | oxidation of glucose is complete in aerobic respiration and incomplete in anaerobic respiration |
| 8 | What is anaerobic respiration in yeast cells called? | Put paper here | fermentation |
| 9 | Write the word equation for anaerobic respiration in plant and yeast cells. | Put paper here | glucose → ethanol + carbon dioxide |
| 10 | How does the body supply the muscles with more oxygenated blood during exercise? | Put paper here | heart rate, breathing rate, and breath volume increase |
| 11 | What substance builds up in the muscles during anaerobic respiration? | Put paper here | lactic acid |
| 12 | What happens to muscles during long periods of activity? | Put paper here | muscles become fatigued and stop contracting efficiently |
| 13 | What is oxygen debt? | Put paper here | amount of oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from cells |
| 14 | How is lactic acid removed from the body? | Put paper here | lactic acid in muscles → blood transports to the liver → lactic acid converted back to glucose |
| 15 | What is metabolism? | Put paper here | sum of all the reactions in a cell or the body |