

B4: Bioenergetics

AQA · GCSE Biology · Revision Notes
Specification reference: 4.4

Note: Sections marked ★ HIGHER TIER ONLY are for Higher tier students only. Foundation tier students should focus on the unmarked sections.

4.4.1 Photosynthesis

4.4.1.1 The Photosynthesis Reaction

Photosynthesis is the process by which plants (and algae) make their own food using light energy. It occurs in the chloroplasts, which contain chlorophyll.

Word equation: carbon dioxide + water → glucose + oxygen

Symbol equation: $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ (requires light energy)

Exam Tip: Learn both the word equation and symbol equation. The arrow means "produces" and light is required above the arrow.

4.4.1.2 Rate of Photosynthesis and Limiting Factors

The rate of photosynthesis is controlled by limiting factors — the one in shortest supply limits the rate.

- **Light intensity** — more light = faster photosynthesis (up to a point). Measured using a lamp and counting oxygen bubbles produced.
- **Carbon dioxide concentration** — more CO₂ = faster rate (up to a point).
- **Temperature** — higher temp = faster rate (up to the optimum, ~25°C for most plants). Too hot = enzymes denature.
- **Water** — needed as a reactant; shortage slows photosynthesis.
- **Chlorophyll** — needed to absorb light energy.

Required Practical 5: Investigating the effect of light intensity on the rate of photosynthesis using pondweed (counting bubbles or measuring volume of O₂).

4.4.1.3 Uses of Glucose in Plants

- Respiration — releases energy for the plant.
- Converted to starch for storage.
- Converted to cellulose for cell walls.
- Converted to sucrose for transport in phloem.
- Used to make amino acids (with nitrogen from soil) for proteins.
- Converted to fats/oils for energy storage in seeds.

4.4.2 Respiration

4.4.2.1 Aerobic Respiration

Aerobic respiration releases energy from glucose using oxygen. It occurs in the mitochondria.

Word equation: glucose + oxygen → carbon dioxide + water

Symbol equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Energy released is used for: movement (muscle contraction), maintaining body temperature, active transport, building molecules.

Exam Tip: Aerobic respiration is the reverse of photosynthesis in terms of reactants and products — but they happen in different places and for different purposes!

4.4.2.1 Anaerobic Respiration

Anaerobic respiration occurs when oxygen is not available. It releases much less energy than aerobic respiration.

- **In animals and bacteria:** glucose → lactic acid (+ small amount of energy).
- **In yeast and plants:** glucose → ethanol + carbon dioxide (+ small amount of energy). This is called **fermentation**.

During exercise, when muscles run short of oxygen they respire anaerobically producing lactic acid. This causes fatigue and pain. After exercise, extra oxygen is needed to break down lactic acid — this is the **oxygen debt**.

Key Terms

Fermentation: Anaerobic respiration in yeast producing ethanol and CO₂ — used in brewing and bread-making

Oxygen debt: Extra oxygen needed after anaerobic exercise to break down lactic acid

4.4.2.2 Response to Exercise

- Heart rate increases — delivers more oxygen and glucose to muscles.
- Breathing rate and depth increase — takes in more O₂, removes more CO₂.
- Blood vessels in muscles widen (vasodilation) — increases blood flow.

★ HIGHER TIER ONLY — Metabolism

- Metabolism is the sum of all chemical reactions in the body.
- Metabolic rate is the speed at which these reactions occur.
- Metabolic rate is affected by: age, sex, amount of muscle, physical activity, and body size.