

Photosynthetic reaction

4.4.1.1 · Bioenergetics · revision notes

Photosynthesis is the reaction in which plants and algae use energy transferred by light to make glucose from carbon dioxide and water. Expect recall of the word equation and the chemical formulae, 'explain why photosynthesis is endothermic', and questions that link the reaction to leaves, starch tests or gas exchange.

Key facts

- carbon dioxide + water → glucose + oxygen (light above the arrow)
- Takes place in chloroplasts; chlorophyll absorbs the light
- Carbon dioxide enters the leaf by diffusion through the stomata
- Starch test: iodine solution turns from orange-brown to blue-black
- $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$ (recognise these formulae)
- Endothermic: energy is transferred from the environment to the chloroplasts by light
- Water is absorbed by root hair cells and carried in the xylem

Notes

The reaction

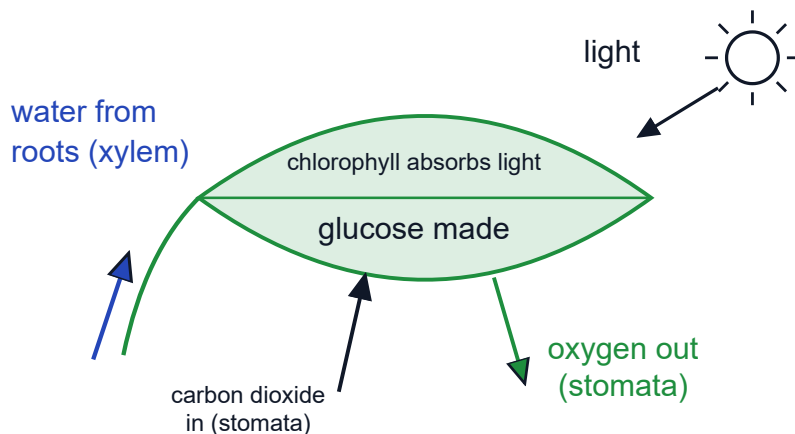
- Photosynthesis takes place in the **chloroplasts** of plant cells and algae.
- **Chlorophyll**, the green pigment inside chloroplasts, absorbs the light.
- Word equation: **carbon dioxide + water → glucose + oxygen** (write 'light' above the arrow).
- You need to recognise the formulae: CO_2 (carbon dioxide), H_2O (water), $\text{C}_6\text{H}_{12}\text{O}_6$ (glucose) and O_2 (oxygen).

Why photosynthesis is endothermic

- An **endothermic** reaction takes in energy from its surroundings.
- In photosynthesis, energy is transferred **from the environment to the chloroplasts by light**.
- This energy ends up in the chemical energy store of the glucose. The plant, and the animals that eat it, can later transfer it by respiration.
- Because they make glucose in this way, plants and algae are producers: they make the biomass that almost every food chain depends on.

Where the substances come from and go

- Carbon dioxide diffuses from the air into the leaf through the **stomata**.
- Water is absorbed from the soil by root hair cells and carried up to the leaves in the **xylem**.
- Oxygen diffuses out of the leaf through the stomata, or is used by the plant's own cells for respiration.
- Glucose is used by the plant straight away or turned into other substances, such as starch for storage.



What a leaf takes in and gives out while it photosynthesises.

How to answer each type of question

Recall: complete the equation or give a formula

1 to 3 marks

Grade 3

- Learn the word equation as a sentence: carbon dioxide and water make glucose and oxygen.
- Use names in a word equation and formulae only when a formula is asked for.
- Check the formula carefully: glucose is $C_6H_{12}O_6$, not $C_6H_{12}O_2$.

Example. (a) Complete the word equation for photosynthesis.

..... + water → + oxygen

(b) Give the chemical formula of water.

Model answer. (a) carbon dioxide (1); glucose (1)

(b) H_2O (1)

Explain why photosynthesis is endothermic

2 marks

Grade 5

- Say that energy is taken in from the environment (surroundings).
- Say how it gets there: it is transferred to the chloroplasts by light.

Example. A student wrote: 'Photosynthesis gives out energy to the plant.'

The student is wrong. Explain why photosynthesis is described as an endothermic reaction.

Model answer. Energy is taken in / transferred from the environment (1) to the chloroplasts by light (1).

Don't lose marks

- ✗ Writing that photosynthesis happens 'in the chlorophyll'. It happens in the chloroplasts; chlorophyll is the pigment that absorbs light.
- ✗ Writing light as a reactant on the left of the equation. Light is not a substance: it transfers the energy, so write it above the arrow.
- ✗ Calling photosynthesis exothermic, or saying it 'makes energy'. Energy is never made: it is transferred to the chloroplasts by light.
- ✗ Saying plants get their food from the soil. Plants make their own glucose; the soil supplies only water and mineral ions.
- ✗ Saying plants photosynthesise instead of respiring. Plants respire all the time, day and night, and photosynthesise only when there is light.

More tips

Memory tricks

- Endo = in: in photosynthesis energy goes in, carried by light.
- Chloroplast and chlorophyll both start with 'chloro' (green): the chloroplast is the organelle, chlorophyll is the green pigment inside it.
- Glucose formula pattern: 6 carbon, 12 hydrogen, 6 oxygen (6-12-6).
- Respiration is photosynthesis in reverse: swap the two sides of the word equation to get glucose + oxygen → carbon dioxide + water.
- Check the balanced equation by counting atoms: 6 C, 12 H and 18 O on each side.

Exam technique

- For 'endothermic' questions, use both key phrases: 'energy transferred from the environment' and 'to the chloroplasts by light'.
- Write 'carbon dioxide' in full rather than a half-remembered formula. If you do use formulae, check every subscript.
- In experiments with starch tests or indicators, write the whole chain: light → photosynthesis → glucose made (and carbon dioxide used) → the result you see.
- If a question asks for a word equation, give names only; do not mix names and formulae.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Write the word equation for photosynthesis

carbon dioxide + water → glucose + oxygen, with light written above the arrow.

Grade 3

State where photosynthesis takes place

In the chloroplasts of plant and algal cells, where chlorophyll absorbs light.

Grade 4

Recognise the formulae of the four substances

Carbon dioxide is CO₂, water is H₂O, glucose is C₆H₁₂O₆ and oxygen is O₂.

Grade 5

Explain why photosynthesis is endothermic

Energy is transferred from the environment to the chloroplasts by light, so the reaction takes in energy.

Grade 5

State where the reactants come from

Carbon dioxide diffuses into the leaf from the air through the stomata; water is absorbed by the roots and carried up in the xylem.

