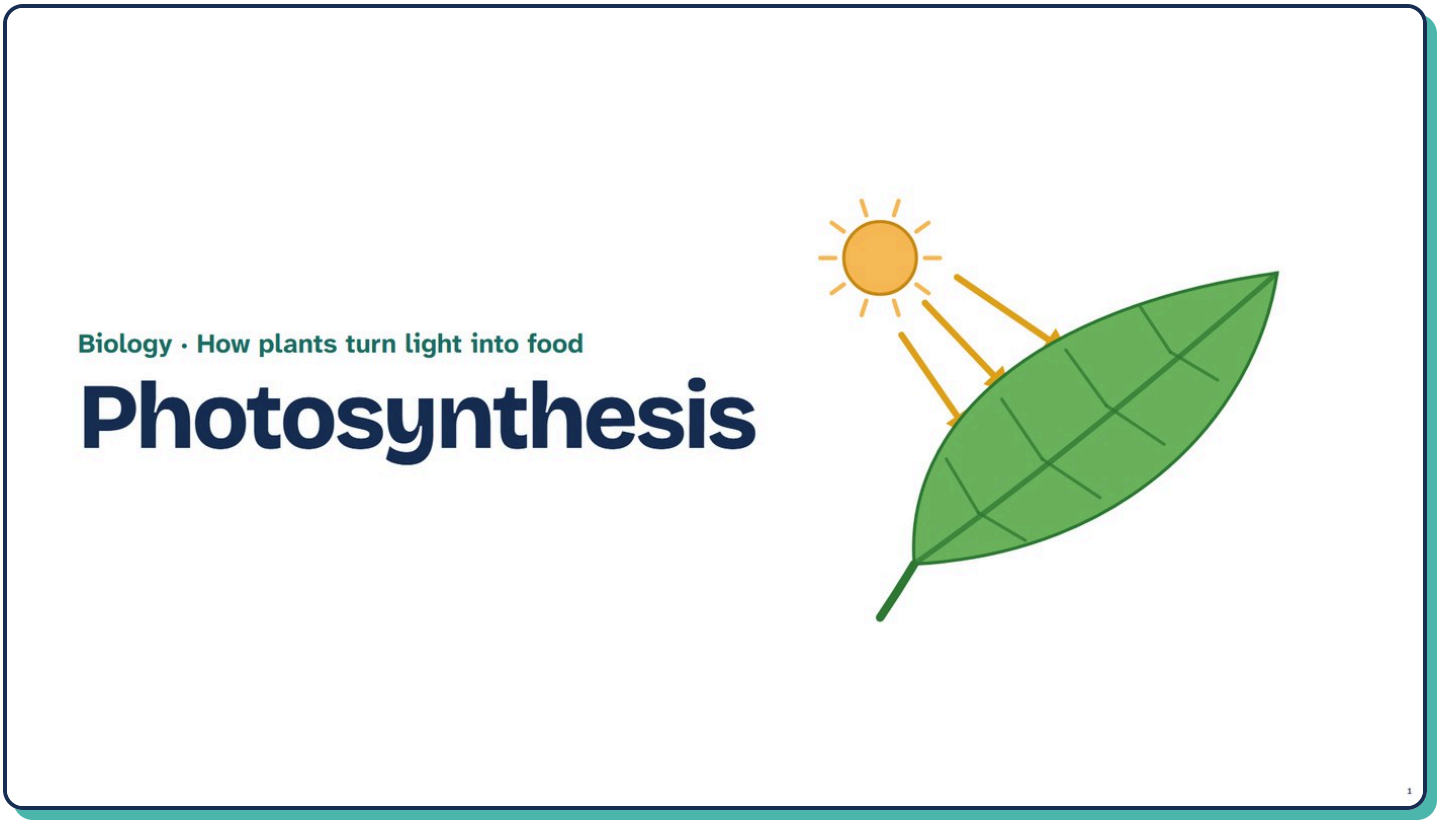

Photosynthesis

Teacher notes

Open with a puzzle: a seed weighing a fraction of a gram grows into a tree weighing tonnes. Where did all that mass come from? Take guesses (soil, water, sunlight, air) and write them on the board. Come back to the answers at the end of the lesson.

Ask the class

A seed weighing less than a gram grows into a tree weighing tonnes. Where do you think all that mass comes from?

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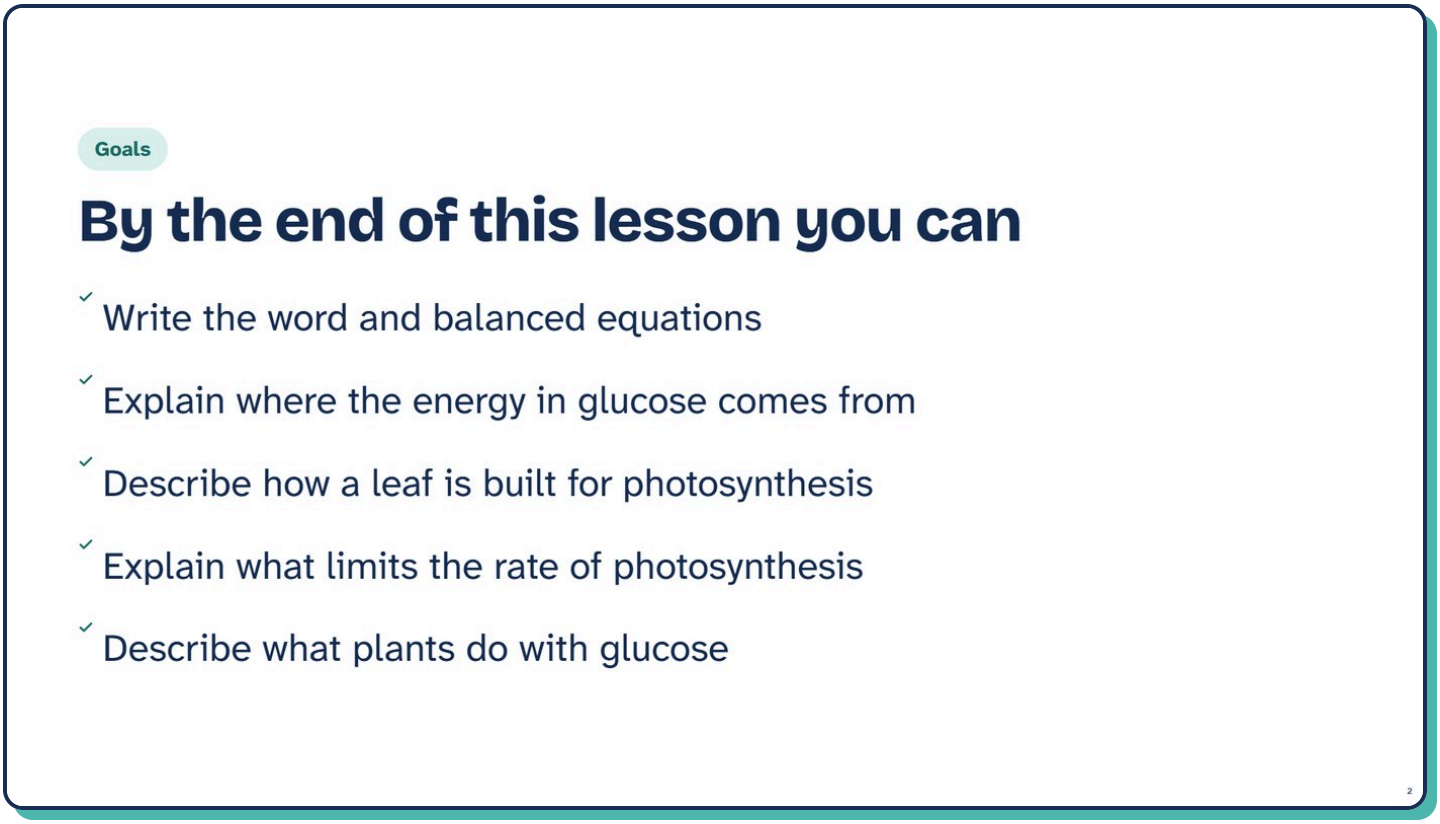
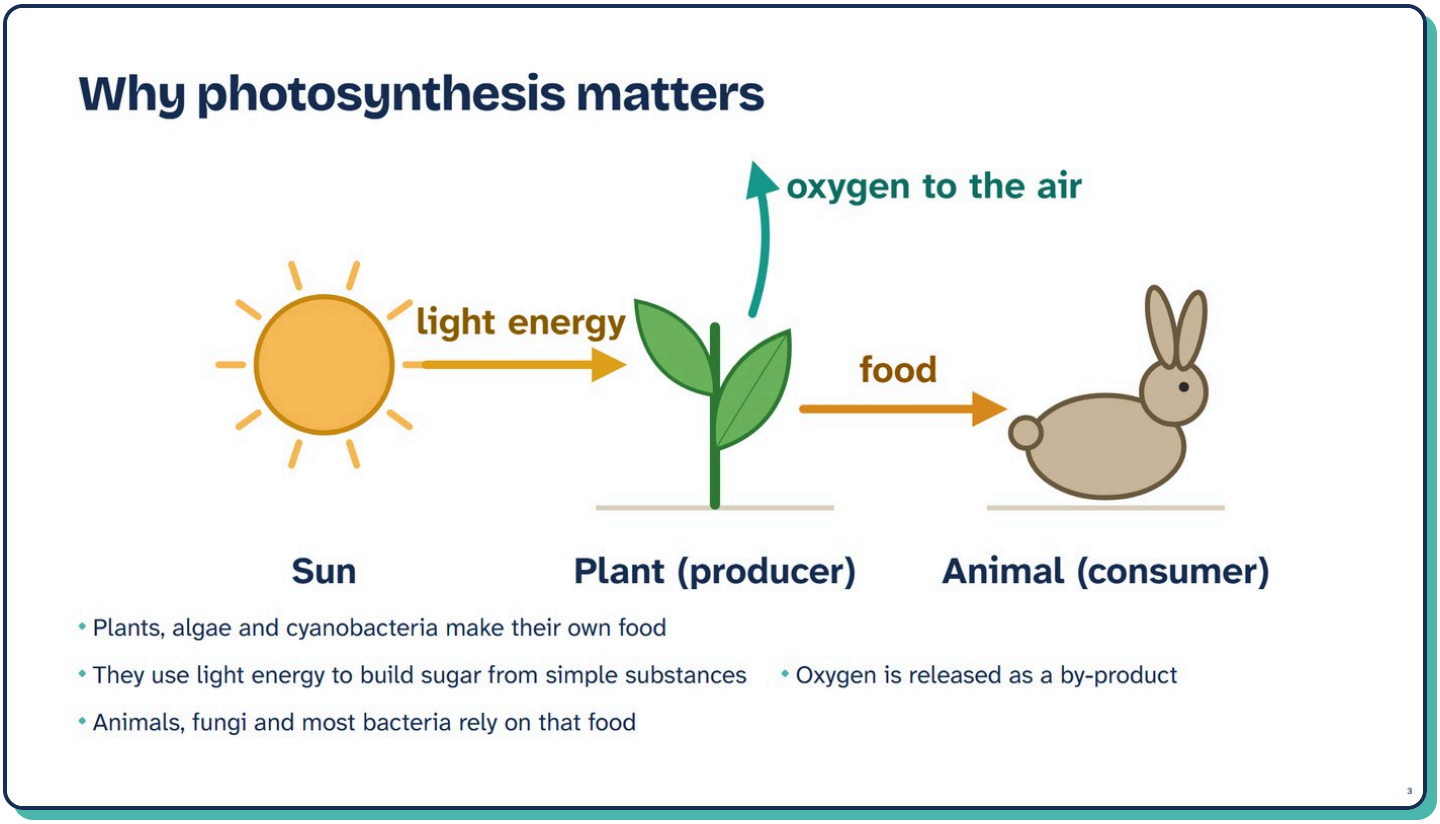


By the end of this lesson you can

Teacher notes

Read the objectives aloud. Tell students that the five-question quiz at the end checks one objective each, so they should make a note under each heading as you go.



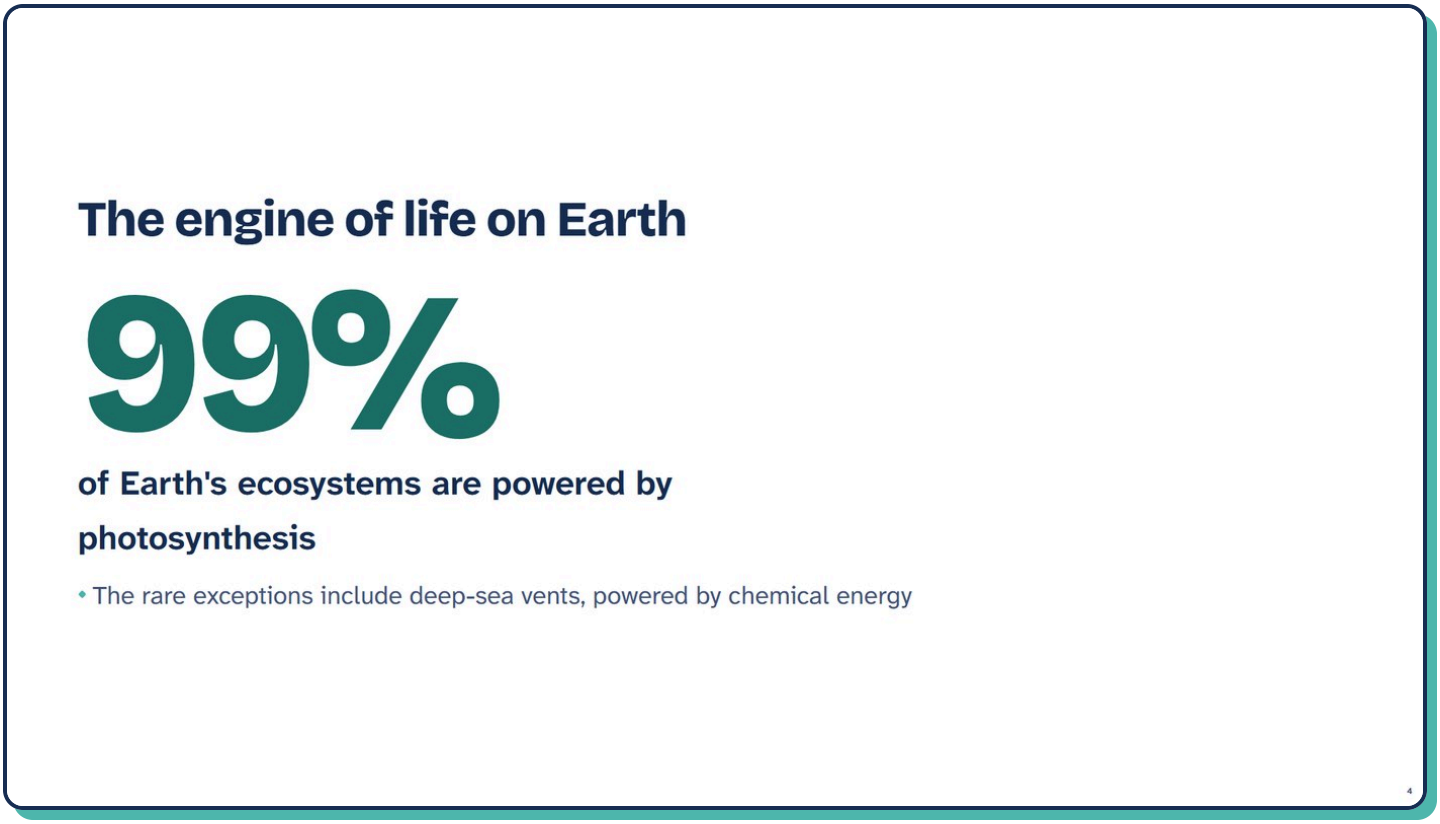
Why photosynthesis matters

Teacher notes

Introduce the terms producer and consumer if your class has not met them. Organisms that make food using light are called photoautotrophs; organisms that must eat food made by others are heterotrophs. Every food chain students know starts with a photosynthesiser.

Ask the class

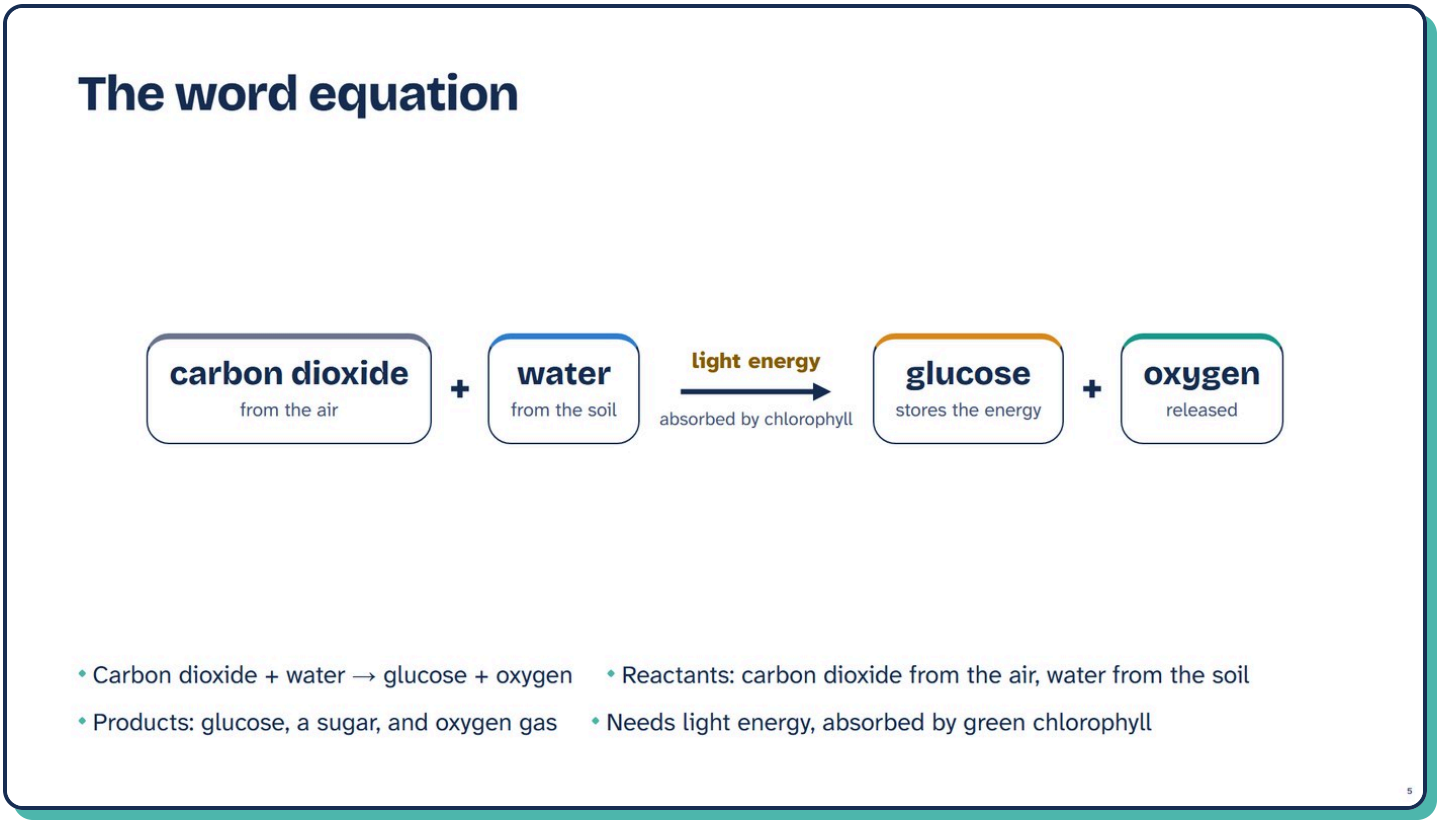
Trace your breakfast back to a plant. Can you find a food that does not start with photosynthesis?



The engine of life on Earth

Teacher notes

The 99 per cent figure comes from the OpenStax Biology textbook. Ask students to trace their breakfast back to a plant: milk comes from a cow that ate grass, bread comes from wheat. Every route ends at photosynthesis.



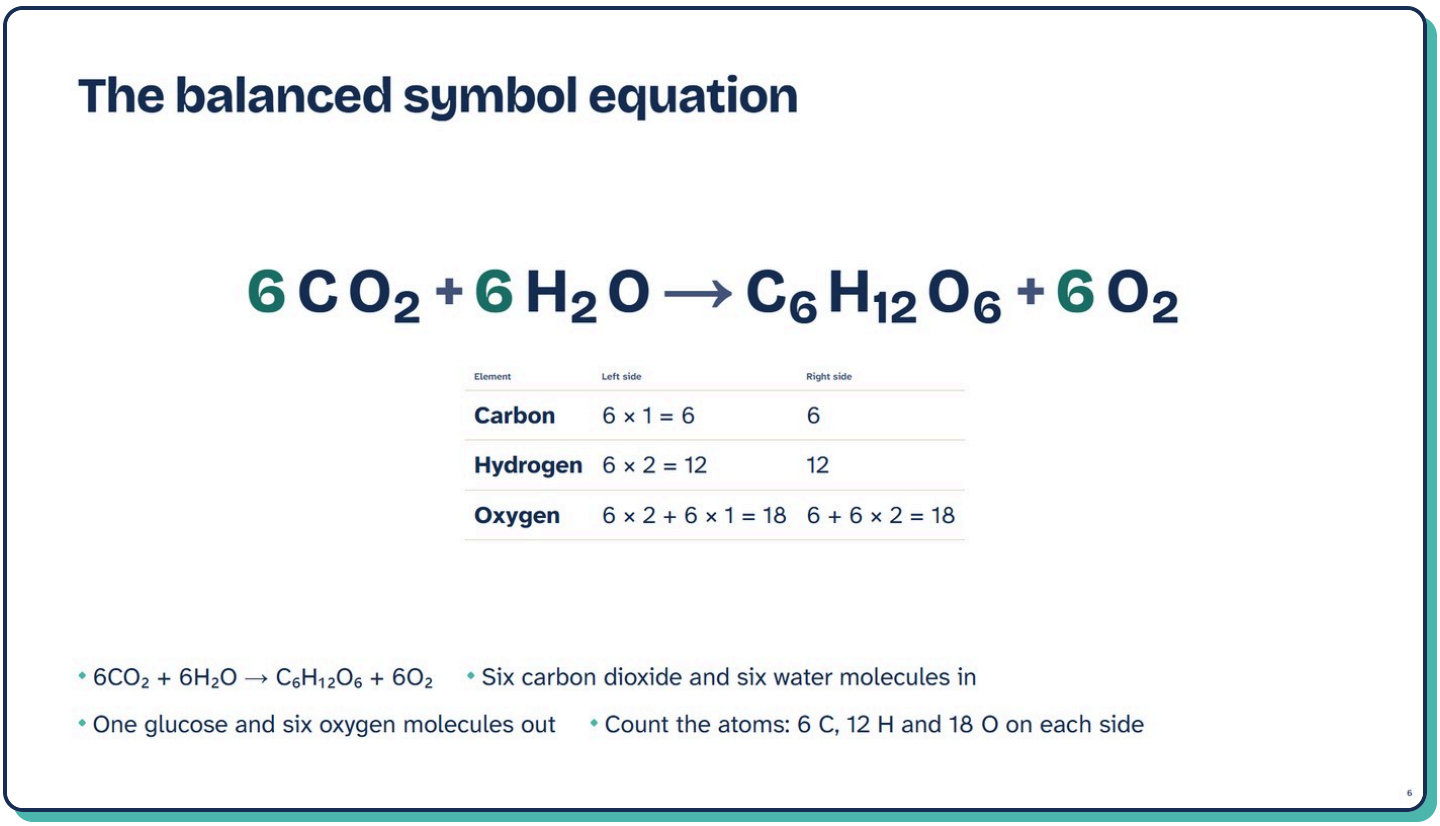
The word equation

Teacher notes

Write the equation on the board with 'light' and 'chlorophyll' above the arrow. Stress that light is not a reactant: it is the energy source. Energy is taken in from light and stored as chemical energy in glucose, which is why the plant can later release it by respiration.

Ask the class

Why do we write light above the arrow instead of adding it to the reactants?



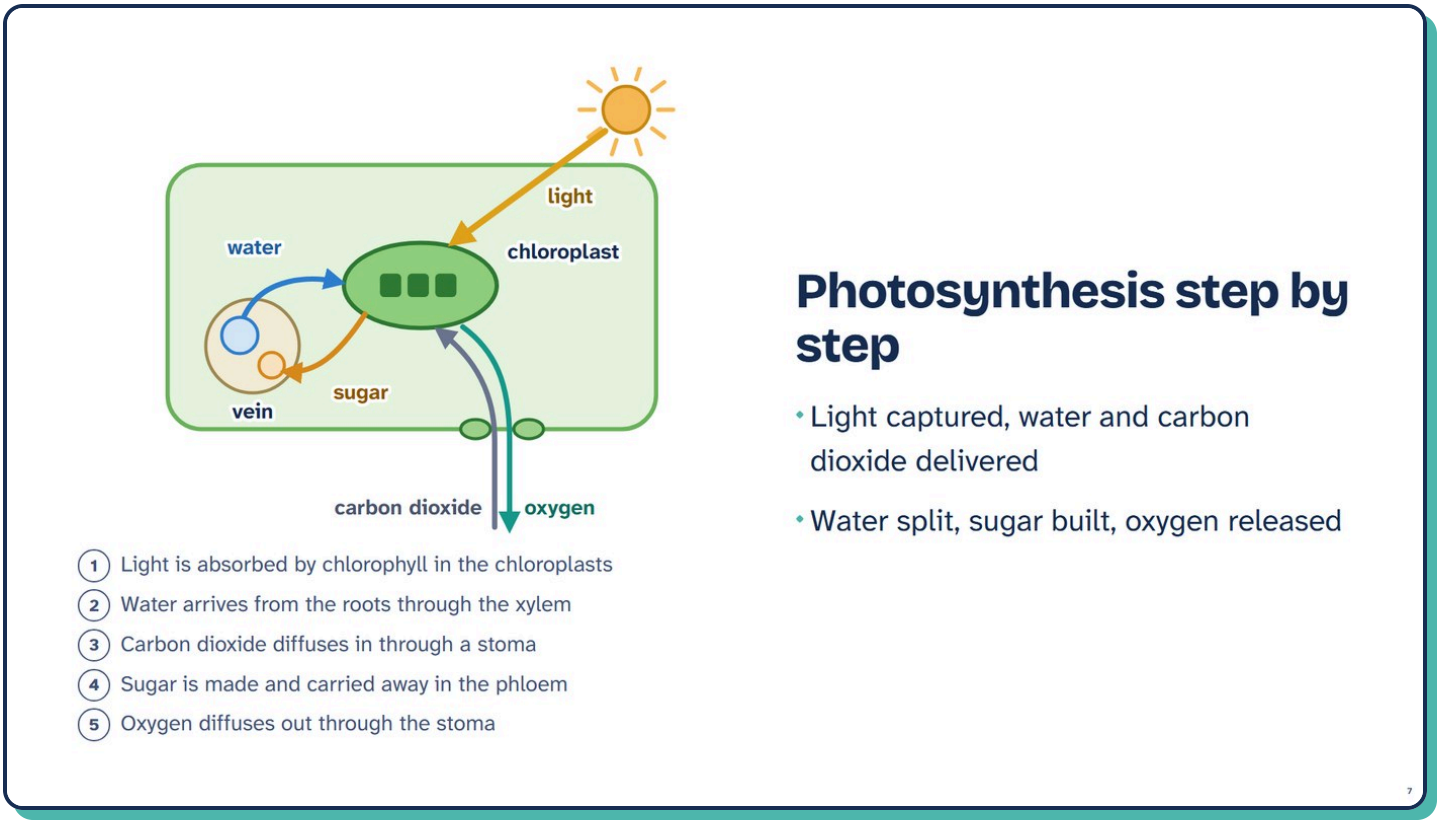
The balanced symbol equation

Teacher notes

For younger or less confident groups, the word equation may be enough; this slide is for students working towards GCSE or IGCSE level. Ask students to check the atom count themselves. Carbon: 6 on each side. Hydrogen: 12 on each side. Oxygen: 12 + 6 = 18 on the left, 6 + 12 = 18 on the right.

Ask the class

The left side has 18 oxygen atoms. Where does each of them end up on the right?



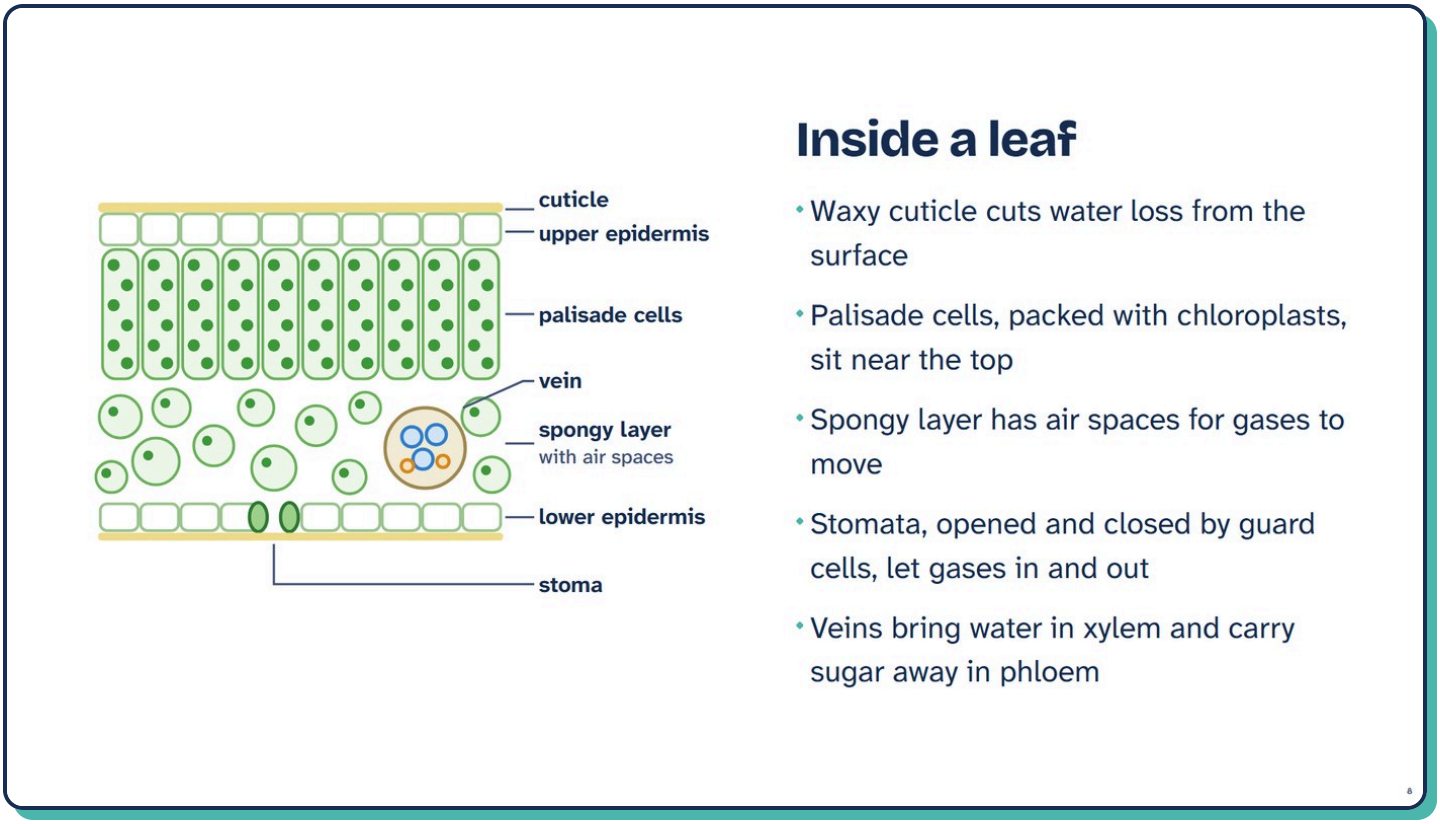
Photosynthesis step by step

Teacher notes

Walk through the poster from top to bottom. Older students can follow the two stages; younger students only need the inputs and outputs. Point out that the oxygen released comes from the water molecules, not from the carbon dioxide.

Ask the class

Light arrives at the top of the leaf, but most carbon dioxide enters at the bottom. How do the two meet in the same cells?



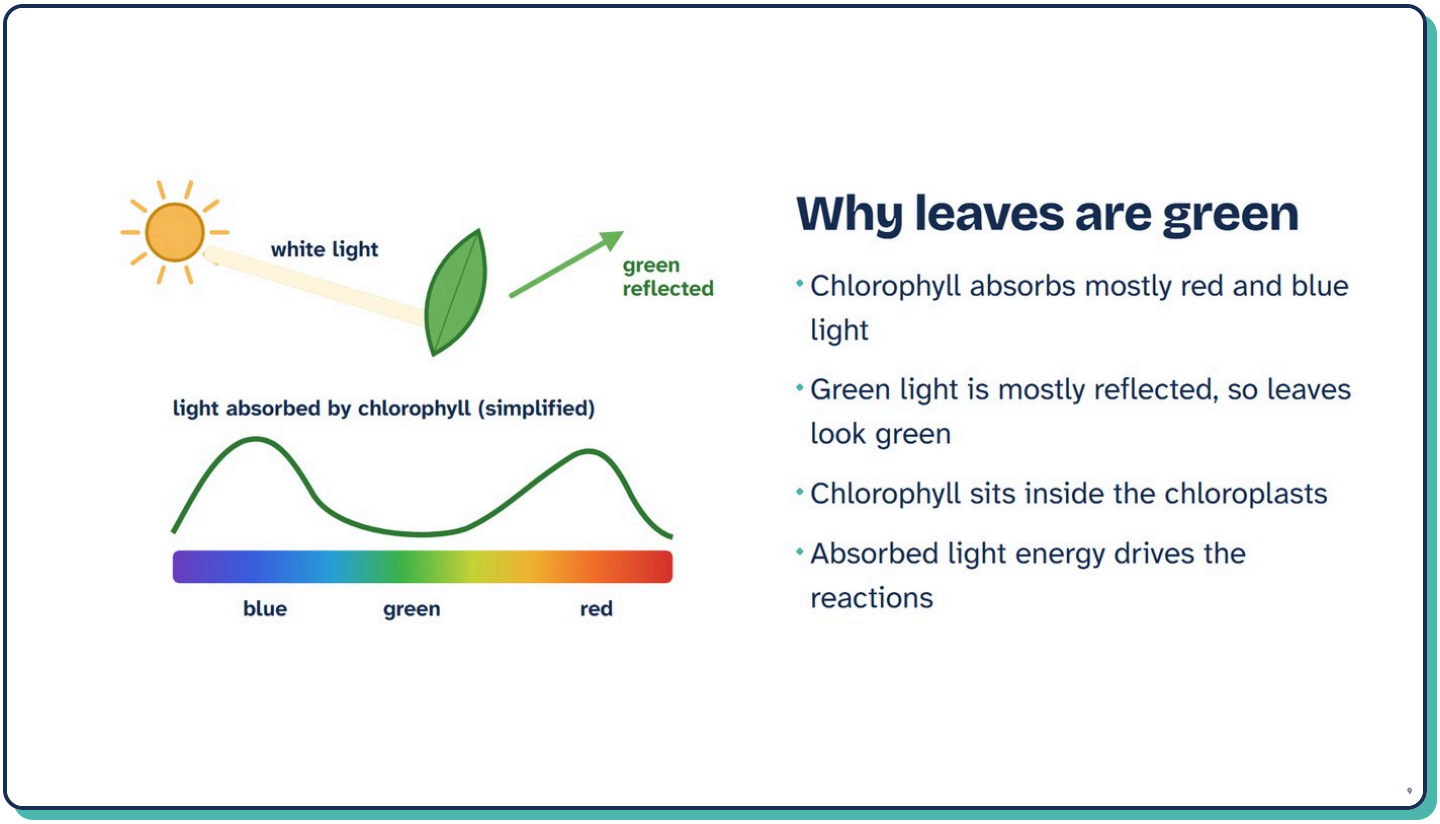
Inside a leaf

Teacher notes

Sketch a leaf cross-section on the board as you go, or project a microscope image. Ask: why are palisade cells at the top? (That is where the most light arrives.) Why are most stomata on the underside? (It helps reduce water loss.) A broad, flat leaf gives a large surface to catch light.

Ask the class

Most stomata are on the underside of the leaf. Suggest how that helps the plant.



Why leaves are green

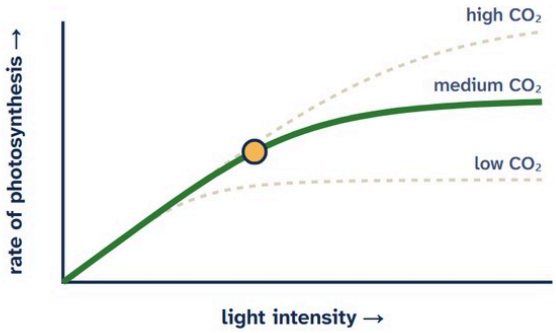
Teacher notes

A common wrong answer is that plants use green light most. Ask: if leaves reflect green light into our eyes, can they be using much of it? Link back to the chloroplasts in the cells lesson.

Ask the class

If a plant were lit only by green light, what would you predict about its rate of photosynthesis?

What limits the rate?



Simplified model: it shows the shapes of the graphs, not measured values. The best temperature differs from plant to plant.

- Light intensity: more light, faster rate, until it levels off
- Carbon dioxide: more carbon dioxide, faster rate, until it levels off
- Temperature: enzymes speed up when warmer, but too hot damages them
- Water: short of water, stomata close and carbon dioxide is cut off

10

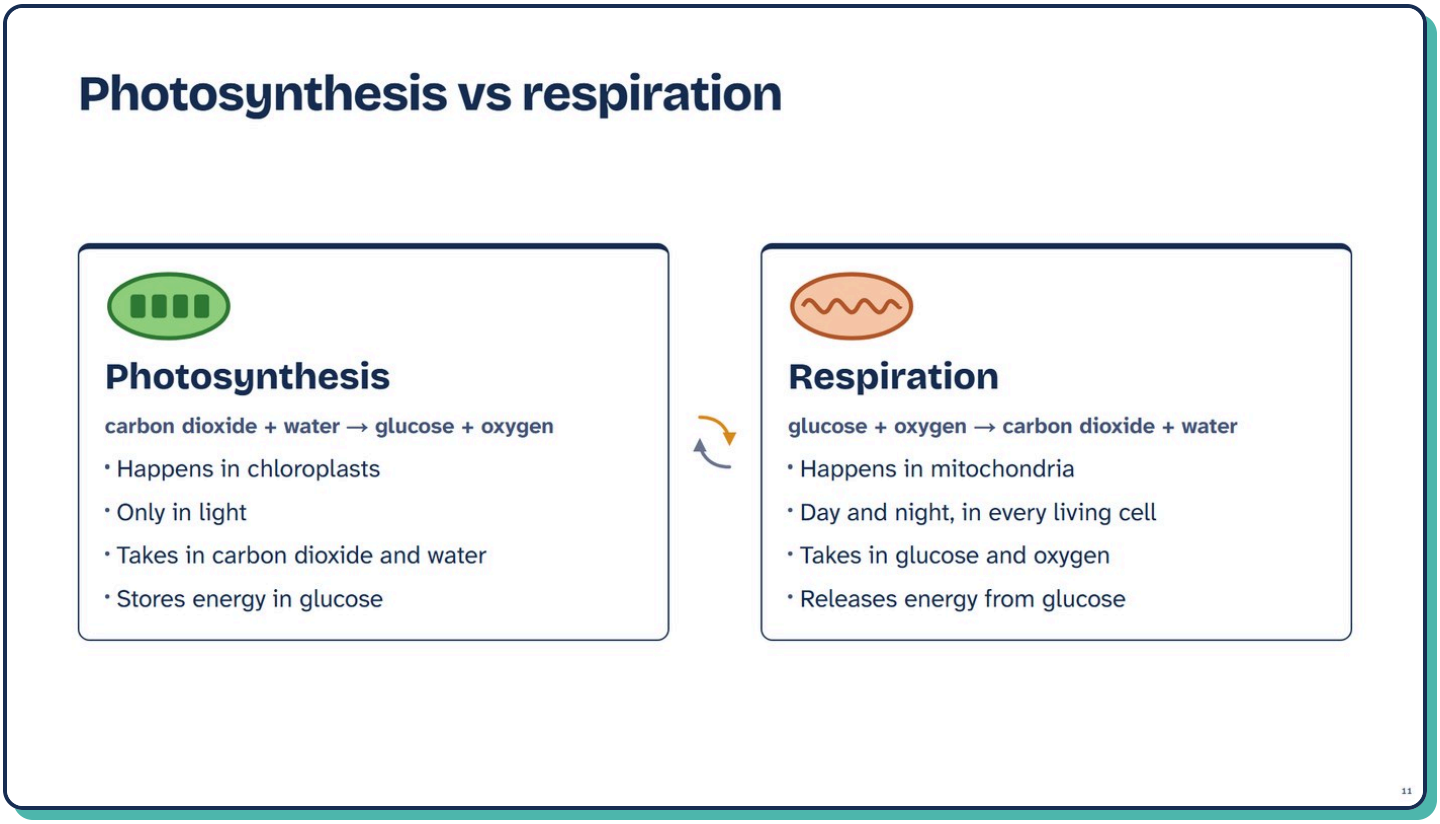
What limits the rate?

Teacher notes

Define a limiting factor: whichever factor is in shortest supply holds the rate back, so raising another factor makes no difference. Sketch the graphs: light and carbon dioxide rise and then plateau; temperature rises to an optimum and then falls steeply as enzymes are damaged.

Ask the class

On the graph, where is light the limiting factor, and where is it not? How can you tell?



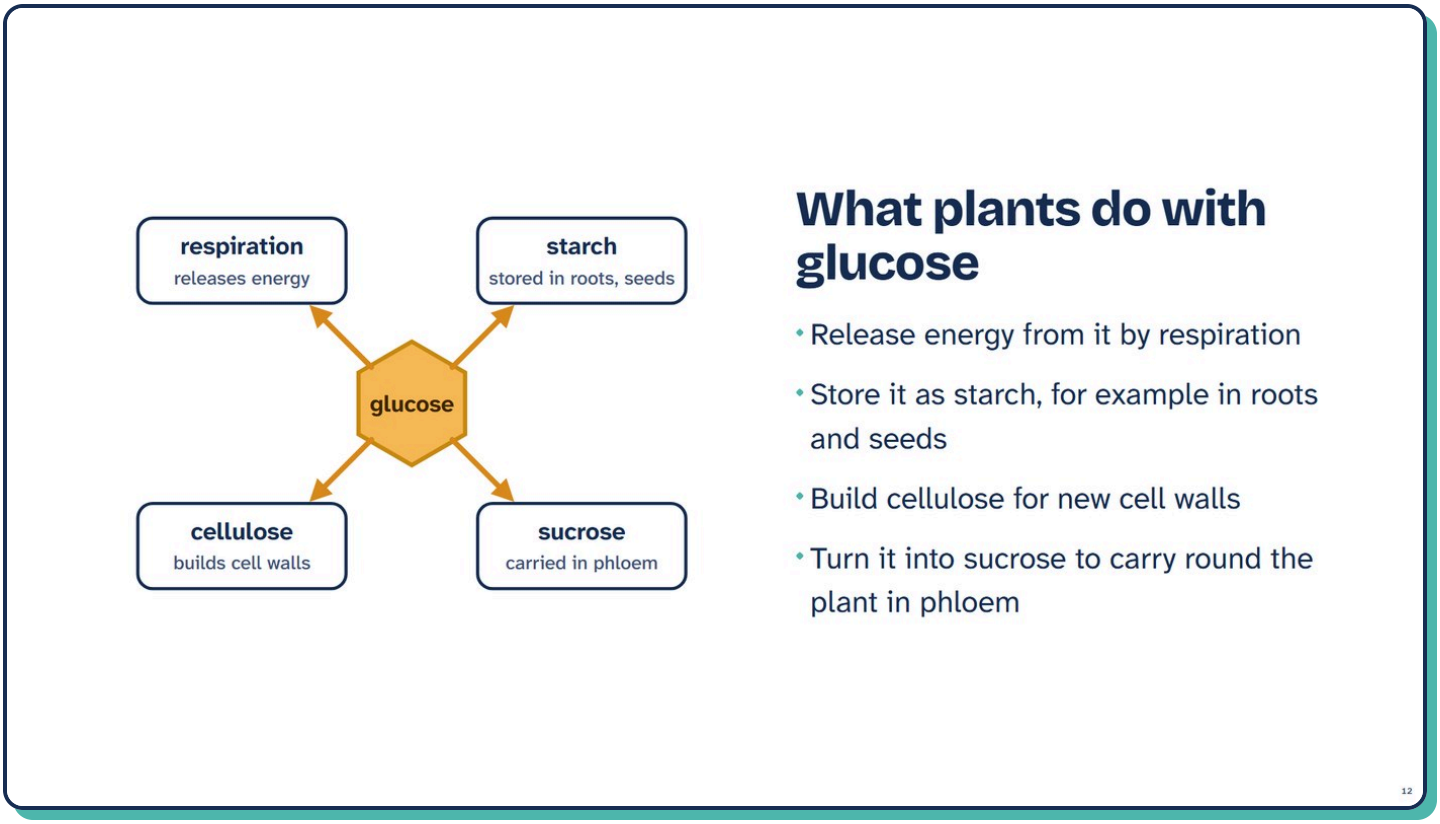
Photosynthesis vs respiration

Teacher notes

This is the most important comparison in the lesson. Plants do both: in bright light they photosynthesise faster than they respire, so overall they take in carbon dioxide; in the dark they only respire. The products of one process are the reactants of the other.

Ask the class

At night a plant gives out carbon dioxide. Why?



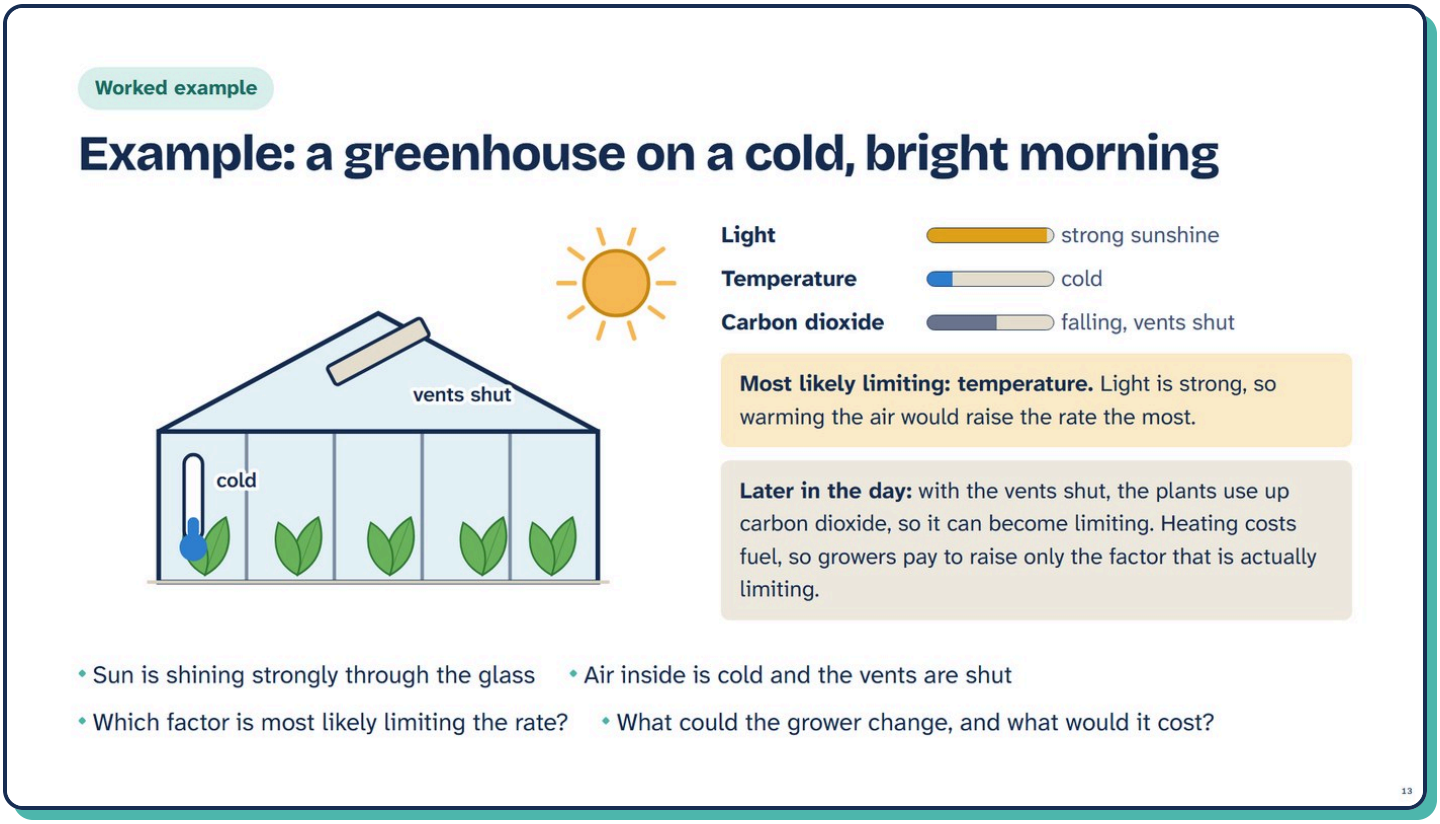
What plants do with glucose

Teacher notes

Plants turn spare glucose into starch for storage, for example in roots and seeds, and build cellulose from glucose for cell walls. Sucrose is the main sugar moved from leaves to roots, seeds and fruits. Ask students which of these uses they have eaten today: potatoes and rice are starch stores.

Ask the class

Potatoes and seeds store starch rather than glucose. What advantage could that give the plant?



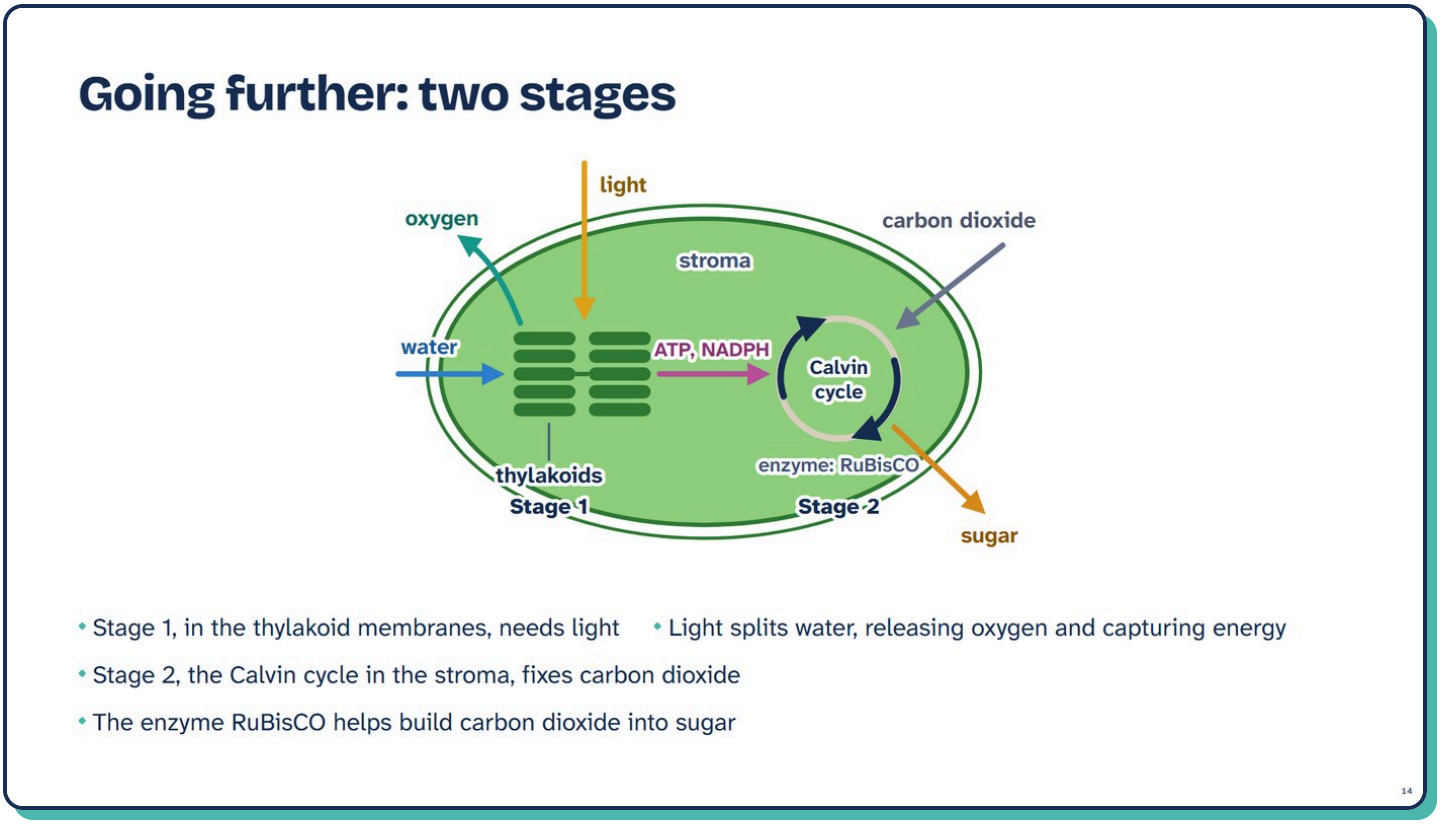
Example: a greenhouse on a cold, bright morning

Teacher notes

Give students two minutes in pairs. With bright light, temperature is the most likely limiting factor in the early morning, so warming the greenhouse would help most. Later in the day, with vents shut, carbon dioxide may become limiting instead. Discuss the trade-off: heating costs money, so growers only pay to raise the factor that is actually limiting.

Ask the class

A paraffin heater warms the air and also gives off carbon dioxide. Why might a grower choose one?



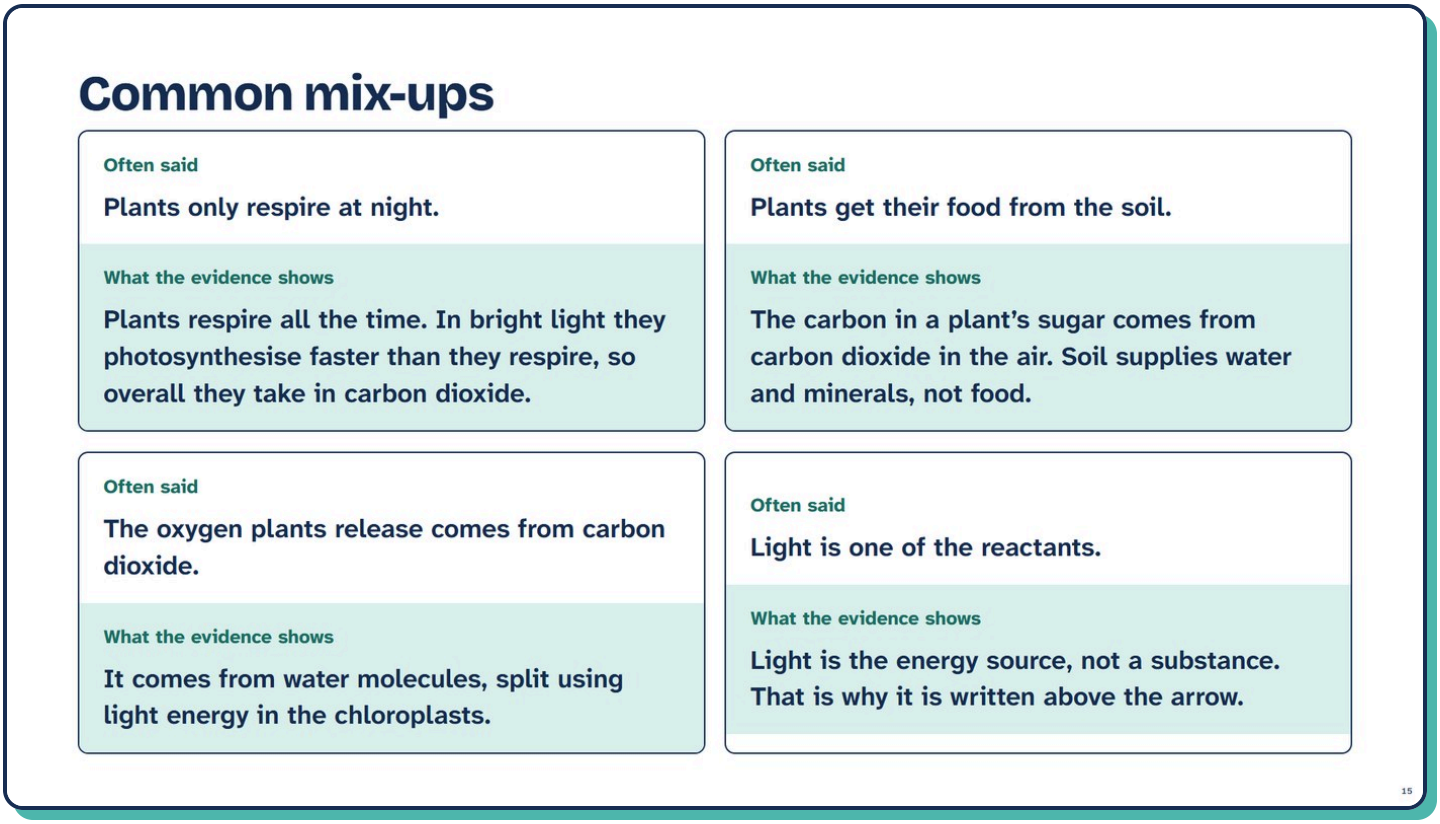
Going further: two stages

Teacher notes

This slide is extension for ages 15–16 or for fast finishers; skip it with younger groups. Stage 2 does not use light directly but depends on the energy carriers ATP and NADPH made in stage 1, so it soon stops in the dark.

Ask the class

Stage 2 does not use light directly, so why does it stop soon after the lights go off?



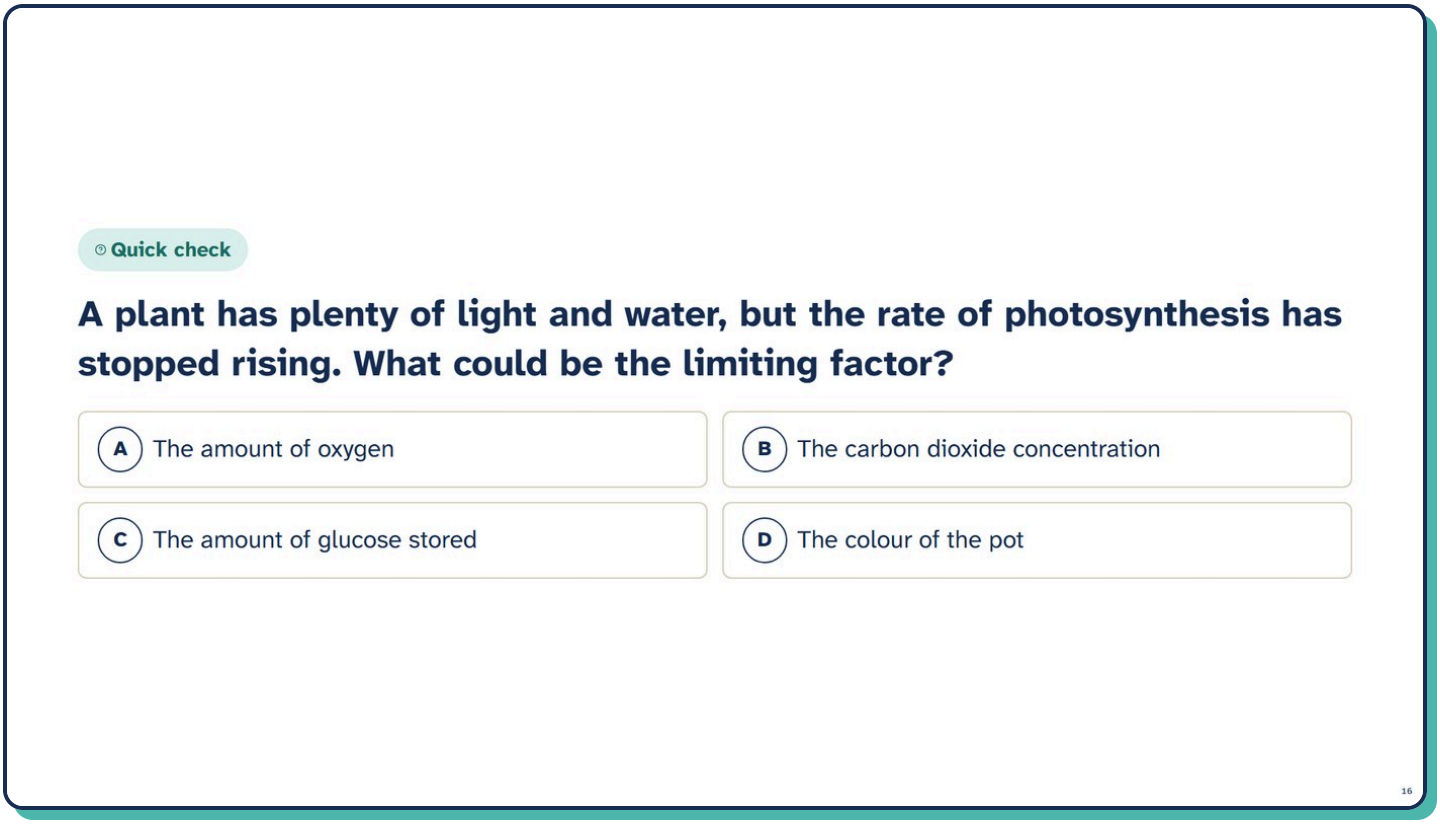
Common mix-ups

Teacher notes

Return to the opening puzzle: the carbon in a tree's wood and leaves comes from carbon dioxide taken in from the air. Soil supplies water and minerals, not food. Ask students to vote true or false on each statement before you reveal it.

Ask the class

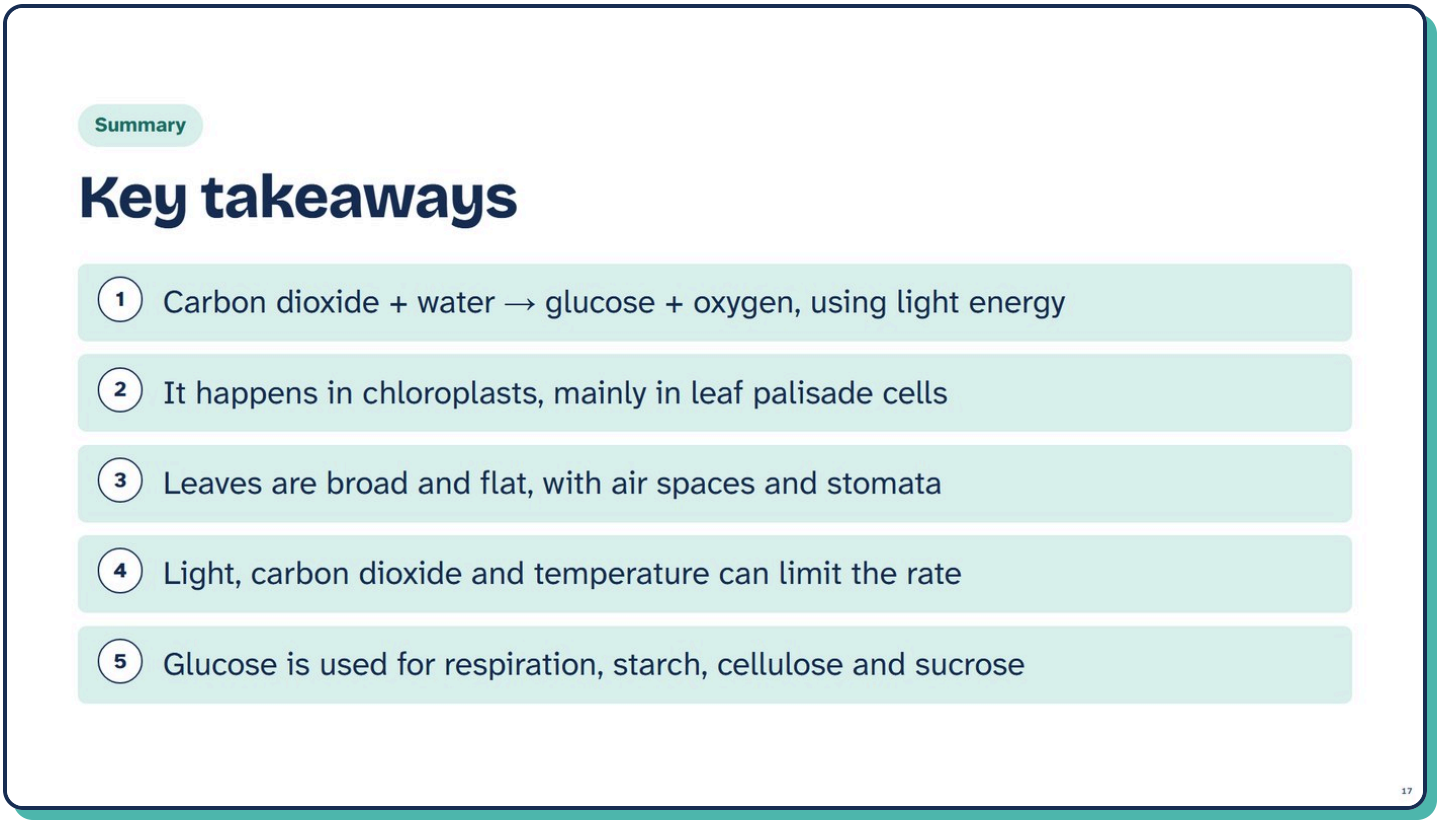
Vote true or false on each front before you turn it. Which one surprised the class most?



Quick check

Teacher notes

Answer: carbon dioxide concentration (temperature would also be a fair answer if it were offered). Oxygen is a product, not a reactant, so adding it does not speed photosynthesis up.



Key takeaways

Teacher notes

Go back to the guesses from the opening puzzle and ask students to correct them. Then move to the five-question quiz on the page. Homework idea: draw and annotate a leaf cross-section, explaining how each part helps photosynthesis.

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