

LESSON SLIDES

Photosynthesis

Biology · How plants turn light into food

By the end of this lesson you can

- 🎯 Write the word and balanced equations
- 🎯 Explain where the energy in glucose comes from
- 🎯 Describe how a leaf is built for photosynthesis
- 🎯 Explain what limits the rate of photosynthesis
- 🎯 Describe what plants do with glucose

Why photosynthesis matters

- Plants, algae and cyanobacteria make their own food
- They use light energy to build sugar from simple substances
- Oxygen is released as a by-product
- Animals, fungi and most bacteria rely on that food

The engine of life on Earth

99%

of Earth's ecosystems are powered by
photosynthesis

- The rare exceptions include deep-sea vents, powered by chemical energy

The word equation

- Carbon dioxide + water → glucose + oxygen
- Reactants: carbon dioxide from the air, water from the soil
- Products: glucose, a sugar, and oxygen gas
- Needs light energy, absorbed by green chlorophyll

The balanced symbol equation

- $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$
- Six carbon dioxide and six water molecules in
- One glucose and six oxygen molecules out
- Count the atoms: 6 C, 12 H and 18 O on each side

Photosynthesis step by step

- Light captured, water and carbon dioxide delivered
- Water split, sugar built, oxygen released

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How Photosynthesis Works

Plants turn light, water and carbon dioxide into sugar and release the oxygen we breathe.

1

Light is captured

Chlorophyll in the chloroplasts absorbs mostly red and blue light and reflects green, which is why most leaves look green.

2

Water arrives from the roots

Roots absorb water from the soil. It travels up through the xylem to the cells of the leaf.

3

Carbon dioxide enters

CO₂ from the air diffuses into the leaf through tiny pores called stomata, found mostly on the underside of leaves.

4

Water is split

In the thylakoid membranes, light energy splits water. Oxygen is released and the energy is stored in ATP and NADPH.

5

Sugar is built

In the stroma, the Calvin cycle uses ATP and NADPH to fix CO₂ into sugar. The enzyme RuBisCO does the fixing.

6

Energy is used or stored

Glucose powers growth and respiration, or is stored as starch. Oxygen leaves the leaf through the stomata.



The overall equation

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

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Inside a leaf

- Waxy cuticle cuts water loss from the surface
- Palisade cells, packed with chloroplasts, sit near the top
- Spongy layer has air spaces for gases to move
- Stomata, opened and closed by guard cells, let gases in and out
- Veins bring water in xylem and carry sugar away in phloem

Why leaves are green

- Chlorophyll absorbs mostly red and blue light
- Green light is mostly reflected, so leaves look green
- Chlorophyll sits inside the chloroplasts
- Absorbed light energy drives the reactions

What limits the rate?

- 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

Photosynthesis vs respiration

Photosynthesis

- Happens in chloroplasts
- Only in light
- Takes in carbon dioxide and water
- Stores energy in glucose

Respiration

- Happens in mitochondria
- Day and night, in every living cell
- Takes in glucose and oxygen
- Releases energy from glucose

What plants do with glucose

- Release energy from it by respiration
- Store it as starch, for example in roots and seeds
- Build cellulose for new cell walls
- Turn it into sucrose to carry round the plant in phloem

 Example

Example: a greenhouse on a cold, bright morning

- 1** Sun is shining strongly through the glass
- 2** Air inside is cold and the vents are shut
- 3** Which factor is most likely limiting the rate?
- 4** What could the grower change, and what would it cost?

Going further: two stages

- Stage 1, in the thylakoid membranes, needs light
- Light splits water, releasing oxygen and capturing energy
- Stage 2, the Calvin cycle in the stroma, fixes carbon dioxide
- The enzyme RuBisCO helps build carbon dioxide into sugar

Common mix-ups

- Plants respire all the time, not only at night
- The carbon in sugar comes from the air, not the soil
- The oxygen released comes from water
- Light is an energy source, not a reactant

 Quick check

A plant has plenty of light and water, but the rate of photosynthesis has stopped rising. What could be the limiting factor?

A The amount of oxygen

B The carbon dioxide concentration

C The amount of glucose stored

D The colour of the pot

Key takeaways

- ✔ Carbon dioxide + water → glucose + oxygen, using light energy
- ✔ It happens in chloroplasts, mainly in leaf palisade cells
- ✔ Leaves are broad and flat, with air spaces and stomata
- ✔ Light, carbon dioxide and temperature can limit the rate
- ✔ Glucose is used for respiration, starch, cellulose and sucrose