

How oxygen increased

4.9.1.3 · Chemistry of the atmosphere · revision notes

How algae and then plants produced the oxygen in today's atmosphere by photosynthesis, and how this allowed animals to evolve. Expect the word equation for photosynthesis, the key dates, and 'describe' or 'explain' questions, sometimes as part of a 6-mark answer on how the atmosphere has changed.

Key facts

- Photosynthesis: carbon dioxide + water → glucose + oxygen (light needed)
- Over the next billion years: plants evolved and oxygen gradually increased
- Photosynthesis adds O₂ AND removes CO₂
- Algae first produced oxygen about 2.7 billion years ago
- Enough oxygen → animals could evolve
- Oxygen today: about 20% of the atmosphere

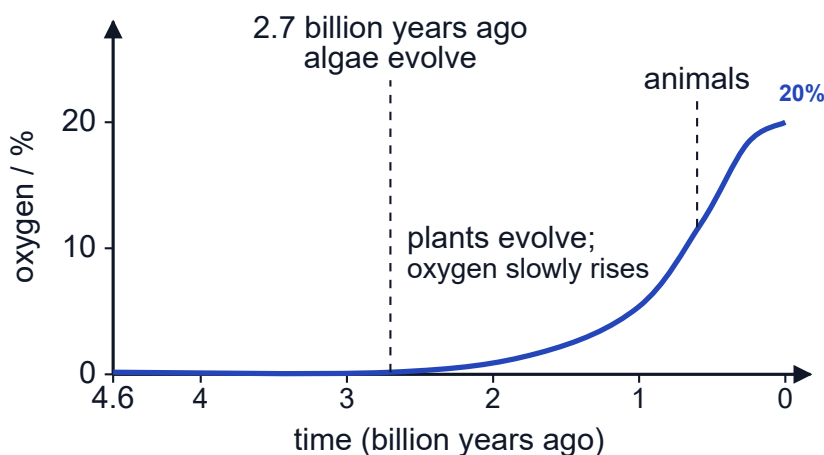
Notes

Photosynthesis made the oxygen

- The oxygen in today's atmosphere was produced by **algae and plants** through **photosynthesis**.
- Word equation: **carbon dioxide + water** → **glucose + oxygen**. Light is needed, so write 'light' above the arrow.
- Photosynthesis **adds oxygen** to the atmosphere and **removes carbon dioxide** from it at the same time.

The timeline

- The early atmosphere had **little or no oxygen**.
- **Algae** first produced oxygen about **2.7 billion years ago**. Soon after this, oxygen appeared in the atmosphere.
- Over the **next billion years, plants evolved** and the percentage of oxygen **gradually increased**.
- Eventually the percentage of oxygen was high enough for **animals to evolve**. Animals need oxygen for respiration.



Sketch, not to scale: photosynthesis slowly raised oxygen to about 20%.

- Today oxygen is about 20% of the atmosphere, and the proportions of the gases have been much the same for about 200 million years.

Putting it in order

- Volcanoes release mainly carbon dioxide → algae evolve and photosynthesise → oxygen appears in the atmosphere → plants evolve → oxygen gradually increases → animals evolve.
- The increase was very slow: it took hundreds of millions of years.
- The dates are estimates, worked out from evidence in very old rocks and fossils.

How to answer each type of question

Complete the word equation for photosynthesis

1 to 2 marks

Grade 4

1. Reactants: carbon dioxide and water. Products: glucose and oxygen.
2. Use names, not formulae, when the question asks for a word equation.

Example. Complete the word equation for photosynthesis.

carbon dioxide + _____ → glucose + _____

Model answer. water (1)

oxygen (1)

Don't lose marks

- ✗ Saying plants produced the first oxygen. Algae came first, about 2.7 billion years ago; plants evolved later.
- ✗ Saying the oxygen came from volcanoes. The volcanic early atmosphere had little or no oxygen.
- ✗ Writing the photosynthesis equation the wrong way round (that is respiration).
- ✗ Adding 'energy' as a product of photosynthesis. Light energy is taken in, so write 'light' above the arrow.
- ✗ Mixing up billion and million: algae about 2.7 billion years ago, today's proportions for about 200 million years.

More tips

Memory tricks

- Order of life: A-P-A, Algae, then Plants, then Animals.
- Balance photosynthesis with 'six, six, one, six'.
- Photosynthesis is the reverse of respiration: swap the two sides of the word equation.
- One process, two effects: photosynthesis puts O₂ in and takes CO₂ out.

Exam technique

- In 'describe how oxygen increased' answers, give the organisms, the process and the time scale.
- If asked for a word equation, don't write formulae; if asked for a balanced symbol equation, don't write words.
- In 6-mark questions on the history of the atmosphere, link each change to its cause, e.g. 'oxygen increased because algae and plants photosynthesised'.

What each grade needs

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

Grade 3

Name the process that produced the oxygen

Photosynthesis by algae and plants produced the oxygen that is now in the atmosphere.

Grade 4

Write the word equation for photosynthesis

carbon dioxide + water → glucose + oxygen, with light as the energy source.

Grade 5

State when algae first produced oxygen

Algae first produced oxygen about 2.7 billion years ago, and oxygen appeared in the atmosphere soon after.

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