How materials are cycled

4.7.2.2 · Biology · revision notes

Materials such as carbon and water are constantly recycled between living things and the non-living environment. Expect to name or explain the processes on carbon cycle and water cycle diagrams, and to explain how microorganisms return carbon dioxide to the air and mineral ions to the soil.

Key facts

- Photosynthesis removes CO_2 from the air
- Combustion of fossil fuels and wood releases CO_2
- Decomposers respire → CO_2 to the air; mineral ions → the soil
- Carbon cycle returns CO_2 for photosynthesis; water cycle supplies fresh water on land
- Respiration (by plants, animals and microorganisms) releases CO_2
- Feeding passes carbon compounds along food chains
- Water cycle: evaporation and transpiration → condensation → precipitation → drainage to the sea

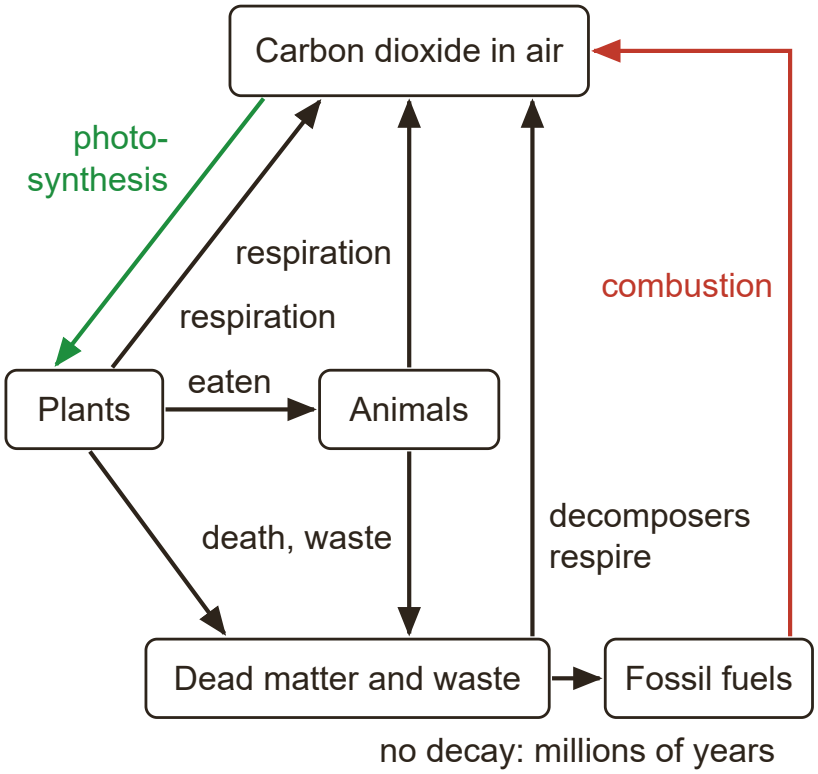
Notes

Why materials are cycled

- The materials that make up living things are used again and again: they are recycled to build new organisms.
- Many different materials, including carbon, water and mineral ions, cycle between the **biotic** (living) and **abiotic** (non-living) parts of an ecosystem.
- You do not need to learn the nitrogen cycle.

The carbon cycle

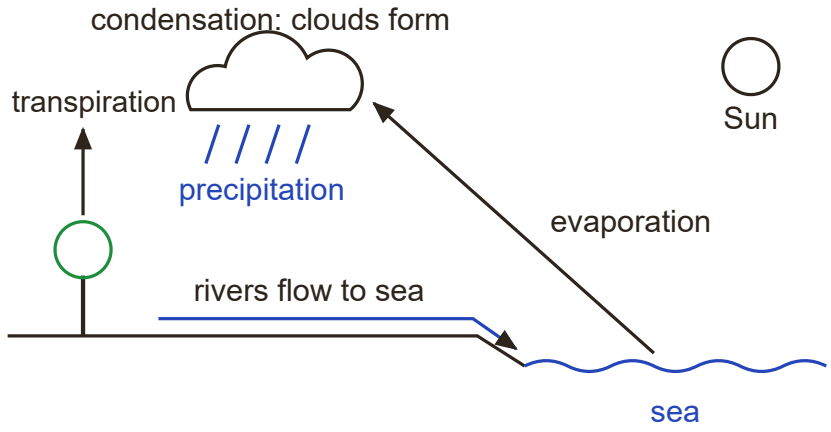
- **Photosynthesis**: plants and algae take in carbon dioxide and use it to make glucose and other carbon compounds.
- **Feeding**: carbon compounds pass along food chains when animals eat plants and other animals.
- **Respiration**: plants, animals and microorganisms all respire, releasing carbon dioxide into the air.
- **Decay**: when organisms die or produce waste, microorganisms such as bacteria and fungi (decomposers) break the material down. Their respiration releases carbon dioxide.
- **Combustion**: burning fossil fuels and wood releases carbon dioxide.
- Some dead material does not decay and, over millions of years, forms fossil fuels, which store carbon until they are burned.
- So the carbon cycle returns carbon from organisms to the atmosphere as carbon dioxide, which plants use again in photosynthesis.



The carbon cycle. Only photosynthesis (green) takes carbon dioxide out of the air.

The water cycle

- Energy from the Sun makes water **evaporate** from seas, lakes and land, and plants lose water vapour from their leaves by **transpiration**.
- Water vapour cools and **condenses** to form clouds.
- Water falls as **precipitation** (rain, snow or hail), providing fresh water for plants and animals on land.
- Water drains through the soil and flows in rivers back to the sea, and the cycle continues.



The water cycle is driven by energy from the Sun.

The role of microorganisms

- Decomposers return carbon to the atmosphere as carbon dioxide and return **mineral ions** to the soil, where plant roots can absorb them.
- Without decomposers, dead material would build up and the carbon and mineral ions in it would stay locked away.

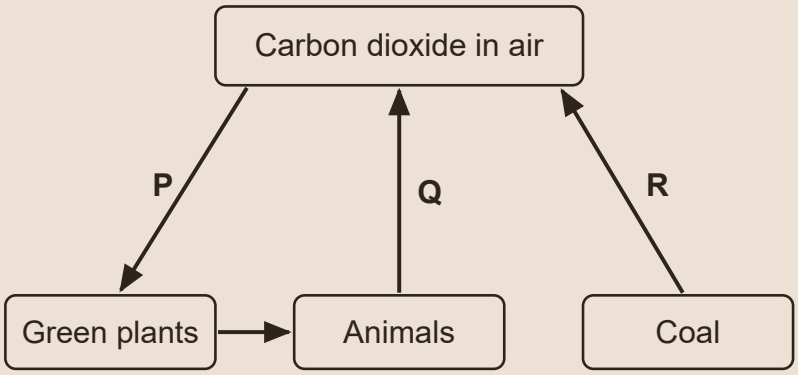
How to answer each type of question

Name a process on a carbon cycle diagram

1 mark each | **Grade 4**

1. Arrow from the air into plants: photosynthesis.
2. Arrow from living organisms or decomposers into the air: respiration.
3. Arrow from fossil fuels or wood into the air: combustion.
4. Arrow from plants to animals: feeding (eating).

Example. A carbon cycle diagram has three arrows labelled P, Q and R.



P goes from carbon dioxide in the air to green plants.
Q goes from animals to carbon dioxide in the air.
R goes from coal to carbon dioxide in the air.
Name processes P, Q and R.

Model answer.

P: photosynthesis	(1)
Q: respiration	(1)
R: combustion / burning	(1)

Describe the water cycle

3 to 4 marks | **Grade 5**

1. Start with evaporation from the sea (and transpiration from plants).
2. Water vapour condenses to form clouds.
3. Precipitation brings fresh water to the land.
4. Water drains through the soil and flows back to the sea.

Example. Describe how water from the sea can reach the roots of a plant growing on land. (4 marks)

Model answer. Water evaporates from the sea, heated by the Sun (1). The water vapour cools and condenses to form clouds (1). The water falls on the land as rain / precipitation (1). The rainwater soaks into the soil, where the roots can absorb it (1).

Explain the role of microorganisms in the carbon cycle 3 marks **Grade 5**

1. Say that microorganisms (decomposers) break down dead organisms and waste.
2. Say that they respire, releasing carbon dioxide into the air.
3. Say that plants can use this carbon dioxide for photosynthesis.
4. If asked about minerals, add that mineral ions are returned to the soil.

Example. Explain how carbon in the body of a dead rabbit can become part of a plant.

Model answer. Microorganisms / decomposers break down the rabbit's body (1). They respire, releasing carbon dioxide into the air (1). A plant takes in the carbon dioxide and uses it in photosynthesis to make glucose (1).

Explain why the carbon or water cycle is important 2 to 3 marks **Grade 7**

1. Carbon cycle: carbon dioxide is returned to the air, so plants can keep photosynthesising and making the biomass that food chains depend on.
2. Water cycle: fresh water is supplied on land for plants and animals.
3. Say what would happen without the cycle.

Example. Explain why the carbon cycle is important for animals as well as for plants. (3 marks)

Model answer. Respiration and decay return carbon dioxide to the air (1). Plants use this carbon dioxide in photosynthesis to make glucose and other carbon compounds / biomass (1). Animals get their carbon compounds by eating plants (or animals that ate plants), so without the cycle they would have no food (1).

Don’t lose marks

- Saying decomposers 'release carbon dioxide' without saying how. They release it by respiration.
- Thinking plants only photosynthesise. Plants respire all the time too, releasing carbon dioxide.
- Mixing up evaporation (liquid to vapour) and condensation (vapour to liquid).
- Writing that mineral ions go into the air. Decomposers return mineral ions to the soil and carbon dioxide to the air.

More tips

Memory tricks

- Only one process takes CO_2 out of the air: photosynthesis. Respiration (including by decomposers) and combustion put it back.
- Carbon moves by five processes: photosynthesis, feeding, respiration, decay and combustion.
- Water cycle order: Evaporate, Condense, Precipitate, Drain.

Exam technique

- On cycle diagrams, check the direction of each arrow before naming the process.
- Use precise names: photosynthesis, respiration, combustion, evaporation, transpiration, condensation, precipitation.
- In any answer about decomposers, include the word respiration.

What each grade needs

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

Grade 3

State that materials are recycled in ecosystems

Materials cycle through the living and non-living parts of an ecosystem, providing the building blocks for new organisms.

Grade 4

Name the processes in the water cycle

Evaporation, transpiration, condensation, precipitation, and water draining back into rivers and seas.

Grade 5

Name processes that add or remove carbon dioxide

Photosynthesis removes carbon dioxide from the air; respiration and combustion release it.

Grade 5

Explain the role of decomposers in cycling

Microorganisms break down dead matter and waste, respire and release carbon dioxide, and return mineral ions to the soil.

Grade 7

Explain why the carbon and water cycles matter

They return carbon dioxide for photosynthesis and supply fresh water on land, so organisms can grow and survive.

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