



Chapter 20.3

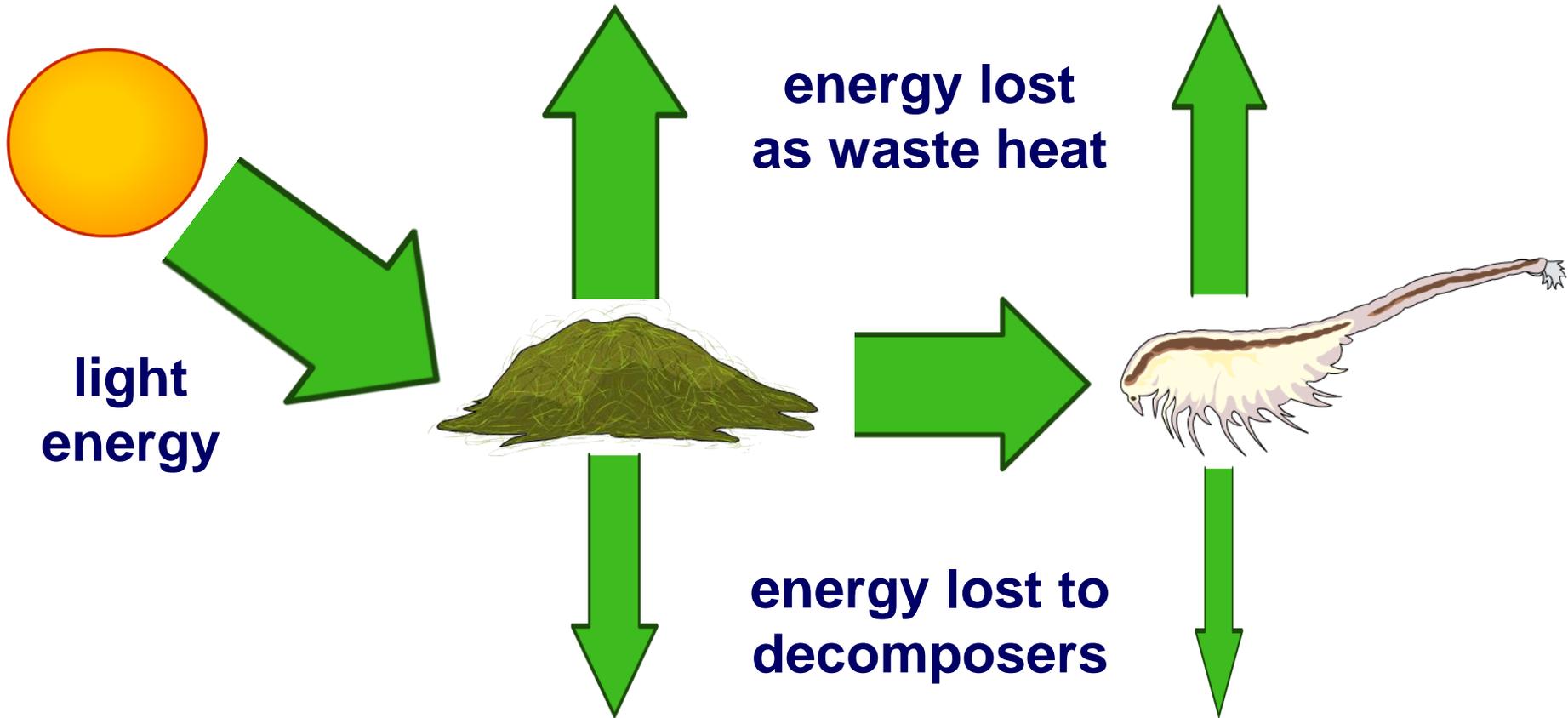
NUTRIENT CYCLES





How does energy flow in an ecosystem?

Shrimps obtain food and oxygen from tiny algae in the water.



The algae use solar energy to build food molecules.
Where do their carbon dioxide and minerals come from?



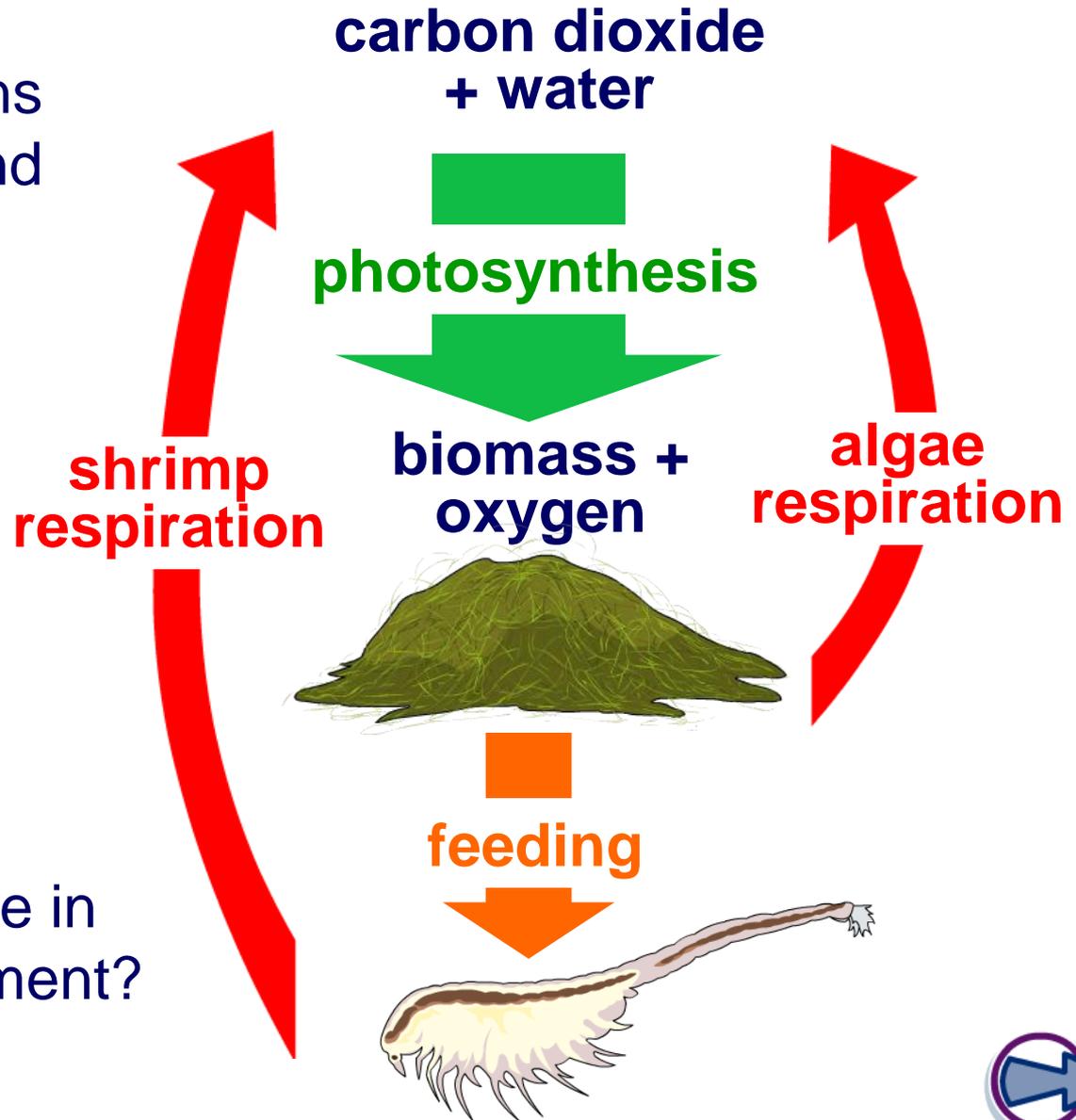


How are carbon dioxide and oxygen balanced?

What is the link between the equations for photosynthesis and respiration?

One is the exact reverse of the other, so carbon dioxide and oxygen are continually recycled.

Could humans survive in an enclosed environment?





How much algae would a human need?



In the 1960s, Russian scientists investigated how much plant life would be needed to provide oxygen for humans to live in an enclosed space.

A three-man crew lived in a sealed research facility for six months. Eight bath-sized tanks of algae per person were required to keep oxygen supplies stable.

However, this was not a completely closed system:

- the scientists took food in with them instead of eating algae
- their urine and faeces were dried and stored away.





Is the Earth an ecosphere?

The record for keeping an ecosphere working is eight years because the shrimps will die eventually.

This occurs because important minerals get locked up in deposits.

Like an ecosphere, the Earth is a closed system, with sunlight as the only input. Nutrients are stored in living material but return to the system as dead material or waste faeces.



How are essential nutrients released from the dead biomass?





Can human-sized biospheres be made?



If humans colonize Mars and the Moon, completely self-sufficient human biospheres will be needed.

In the 1990s, eight volunteers stayed inside **Biosphere 2** for two years.

This glass-roofed building is designed to imitate the biosphere of Earth. It is large enough to grow crops and has specialist waste recycling.



Adam Hart-Davis / Science Photo Library

The volunteers grew their own food but had to cheat by adding extra oxygen. What could have used up the oxygen?





Increased respiration?

The designers of Biosphere 2 wanted the crops to grow well, so they added compost and plenty of micro-organisms to the soil.



Conditions in the biosphere were warm and moist, which is perfect for micro-organisms, and so their populations boomed.

Why did that use up oxygen?

Micro-organisms respire when they decompose food. This process uses oxygen and releases carbon dioxide.

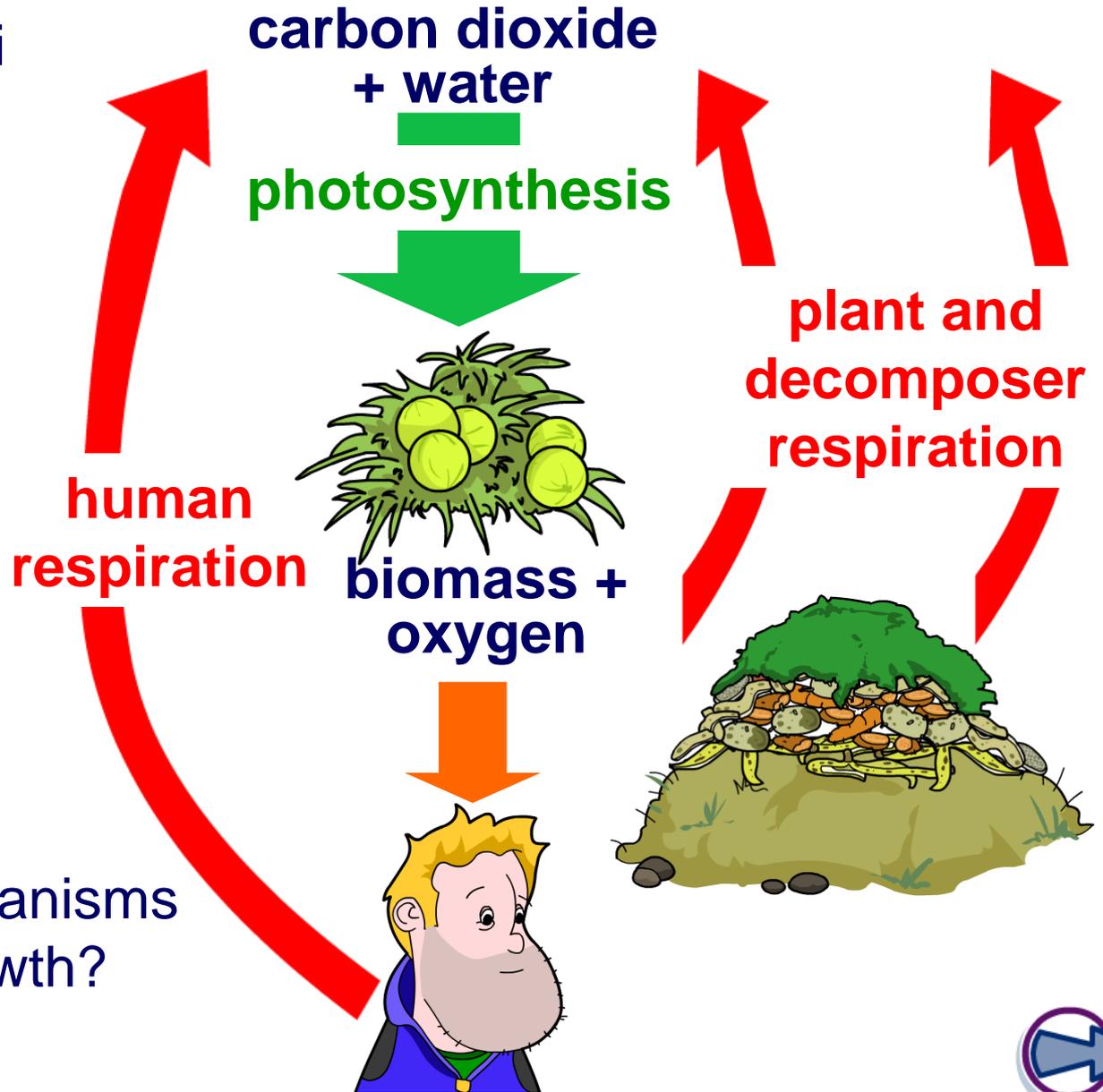


Do microbes use up oxygen?

Bacteria and fungi use oxygen when they break down organic material, leaving less for humans.

Plants grow well in soil containing certain types of micro-organisms.

How do micro-organisms improve plant growth?





Complete each statement about interdependence

Respiration by plants and animals produces...

Photosynthesis by plants produces...

Respiration by micro-organisms produces...

?

?

?

...oxygen and glucose, and uses carbon dioxide.

...carbon dioxide and uses oxygen in some species.

...carbon dioxide and uses oxygen.

?

C

solve

↶

Decay and Recycling

Contents

Interdependence

Decomposers

The nitrogen cycle

The carbon cycle

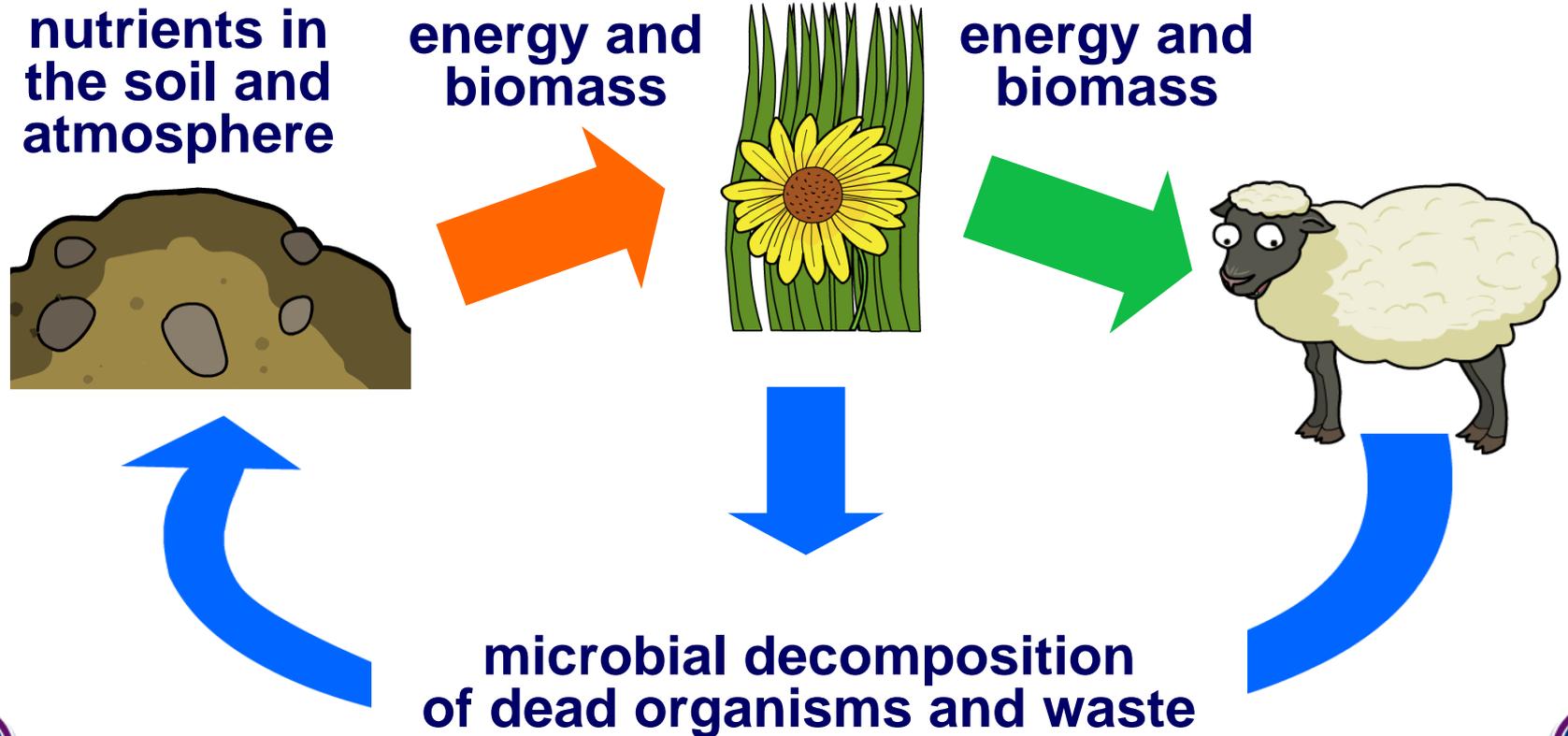
Summary activities





What happens to nutrients?

Throughout an ecosystem, energy is constantly lost by wasted heat. In contrast, nutrients are constantly recycled through the **carbon cycle** and the **nitrogen cycle**.





What is decay?

In all ecosystems, dead organisms and waste material are broken down by bacteria and fungi called **decomposers**.

This process is **decay** or **decomposition**, and it releases nutrients back into the environment ready to be reused by other organisms.

Some food chains have decaying matter as the first stage.



Under what conditions will decay occur the fastest?

A warm, moist, oxygen-rich environment is the most favourable for decay to occur.





What is a detritivore?

Detritus is dead and decaying matter, such as dead leaves.

A **detritivore** is an organism that feeds on detritus. The detritus may already be partially decomposed by fungi or bacteria. Earthworms, maggots and woodlice are detritivores.

By gaining minerals from the decaying matter, detritivores reintroduce essential nutrients back into food chains.





What is a saprotroph?



A **saprotroph** is an organism that gains nutrients from dead organic matter. This is usually the first stage of decay.

Saprotrophs produce enzymes that break down dead matter. They can then absorb the released nutrients.

Bacteria and fungi feed saprotrophically. What would happen if they didn't exist?





Complete these sentences about decomposers

1. A decomposer is an organism that breaks down dead matter, releasing essential _____ .

2. Dead and decaying matter is also called _____ .

3. Organisms that eat decaying matter are called _____ . Organisms that feed in this way include _____ .



bacteria

detritus

algae

earthworms

nutrients

detritivores

enzymes

saprotrophs



hide

solve





Complete these sentences about decomposers

4. Some decomposers release _____ to break down dead matter. These organisms are called _____.

5. Organisms that feed saprotrophically include _____ and fungi.



bacteria

detritus

algae

earthworms

nutrients

detritivores

enzymes

saprotrophs

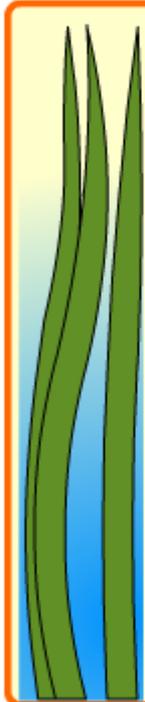


hide

solve



How much plant matter is decomposed in different habitats?



The amount of plant biomass decomposed is different in aquatic and terrestrial habitats.

Click on a habitat below to find out more.



aquatic

terrestrial





Why is food decay harmful?

Eating decaying food can cause food poisoning, which leads to vomiting, diarrhoea and, in extreme cases, death.

It is not always possible to see the early stages of decay, which is why food has 'best before' dates.

Placing fresh food, such as vegetables, in a refrigerator decreases the speed of bacterial growth and helps food last longer.

What other methods are used to preserve food?

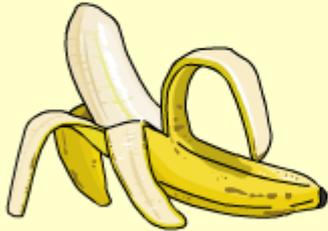




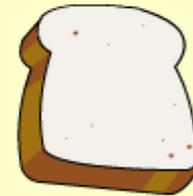
What methods are used to preserve food?



Keeping food edible for longer is very important to humans because it ensures a constant supply of food, and allows food to be transported for many miles.



Click on the buttons below to find out about the methods used to keep food safe for longer.



canning

freezing

drying

adding
salt or
sugar

adding
vinegar





Match food preservation methods to how they work

adding salt

removes water to stop bacterial growth

adding vinegar

denatures bacterial enzymes

adding sugar

puts bacteria into suspended animation

freezing

kills bacteria and prevents contamination

canning

used to draw water out of savoury food

drying

used to draw water out of sweet food



solve

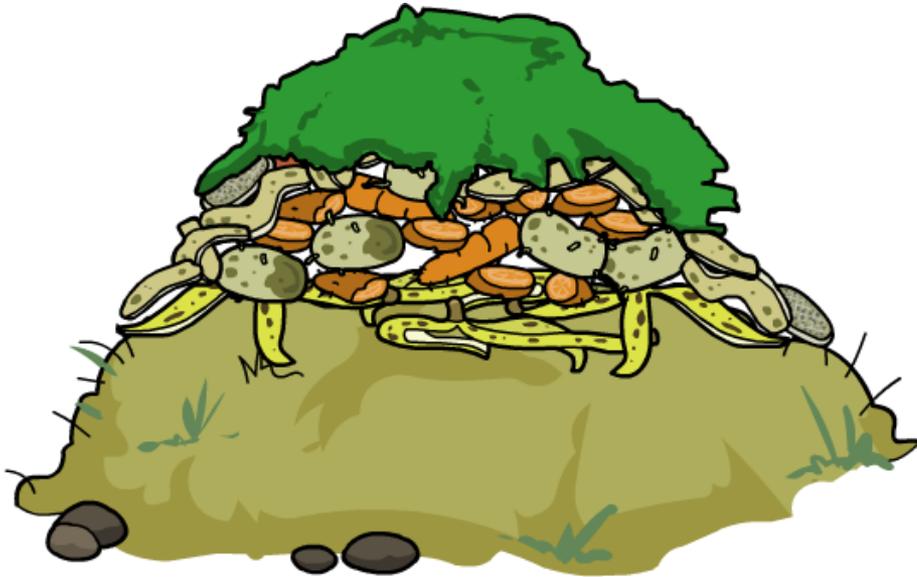




How do humans use micro-organisms?



The average person in the UK creates just over half a tonne of waste a year. How are micro-organisms used to break some of this down?



- Decomposers break down plant waste to make compost.
- Micro-organisms are used in sewage plants to break down human waste.
- Biodegradable plastics are broken down by micro-organisms.





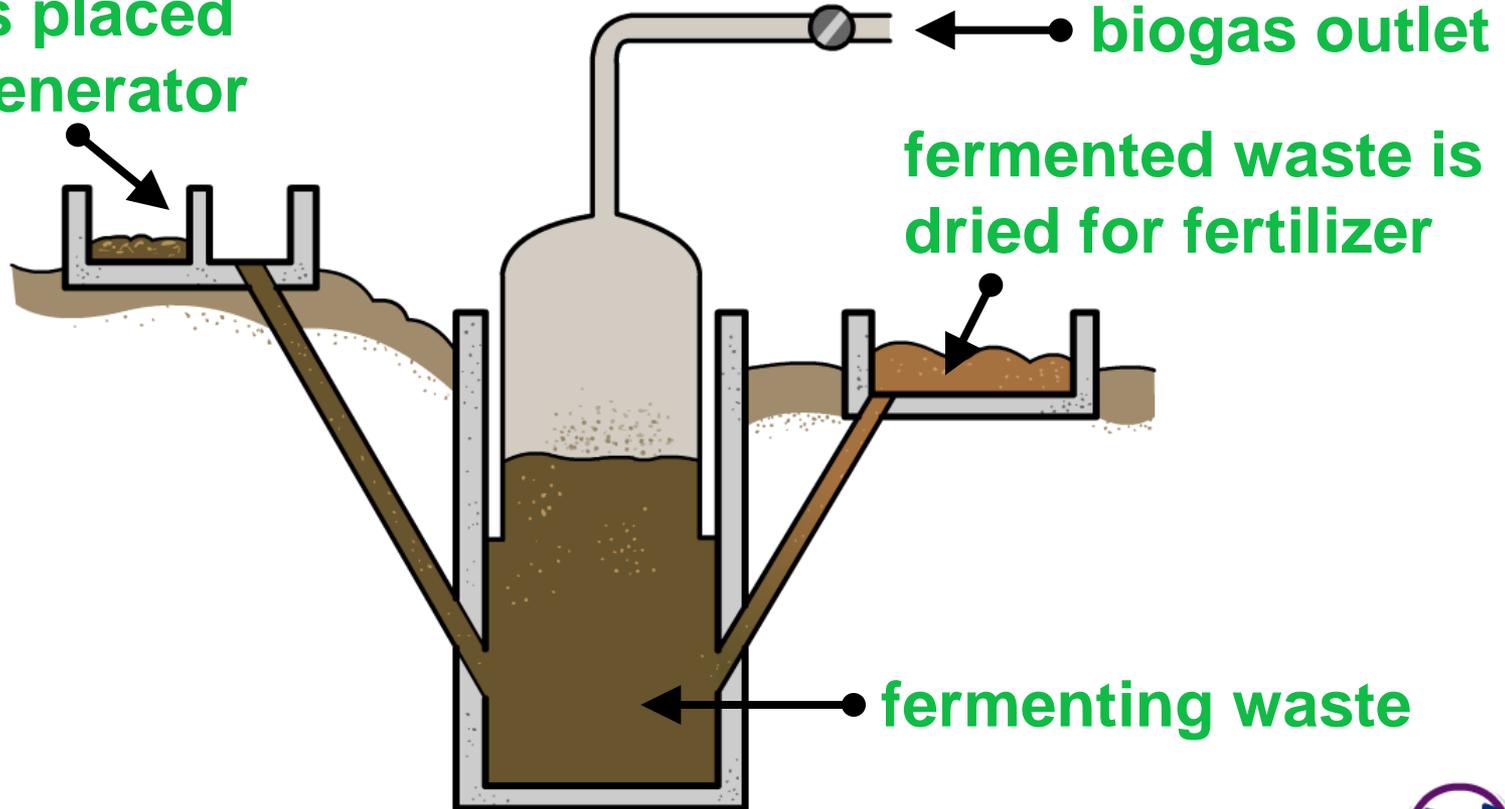
How can decay help to make fuel?



Some bacteria ferment organic material to create methane.

This naturally occurs at landfill sites, but it can also take place in specialized **biogas** generators to create fuel.

waste is placed
in the generator



fermented waste is
dried for fertilizer

fermenting waste



Decay and Recycling

Contents

Interdependence

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The nitrogen cycle

The carbon cycle

Summary activities



Why is nitrogen so important?

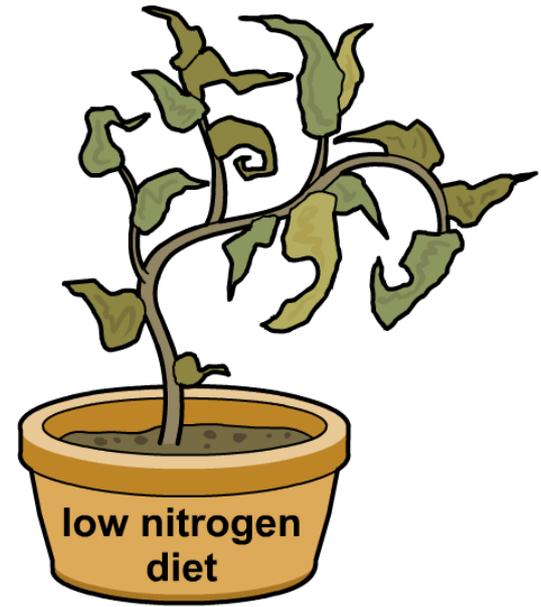
Nitrogen is essential for growth because it is used by plants and animals to make proteins.

Nitrogen makes up about 78% of the atmosphere. However, nitrogen deficiency is the most common cause of poor plant growth.

Why are plants unable to use the nitrogen straight from the air?

Nitrogen gas (N_2) is unreactive and is not easily converted into other compounds. Most plants can only take up nitrogen in the form of ammonia or nitrate.

How is atmospheric nitrogen changed into a useable form?





What is the nitrogen cycle?



The nitrogen cycle

Click "play" to find out how nitrogen is recycled through the environment.

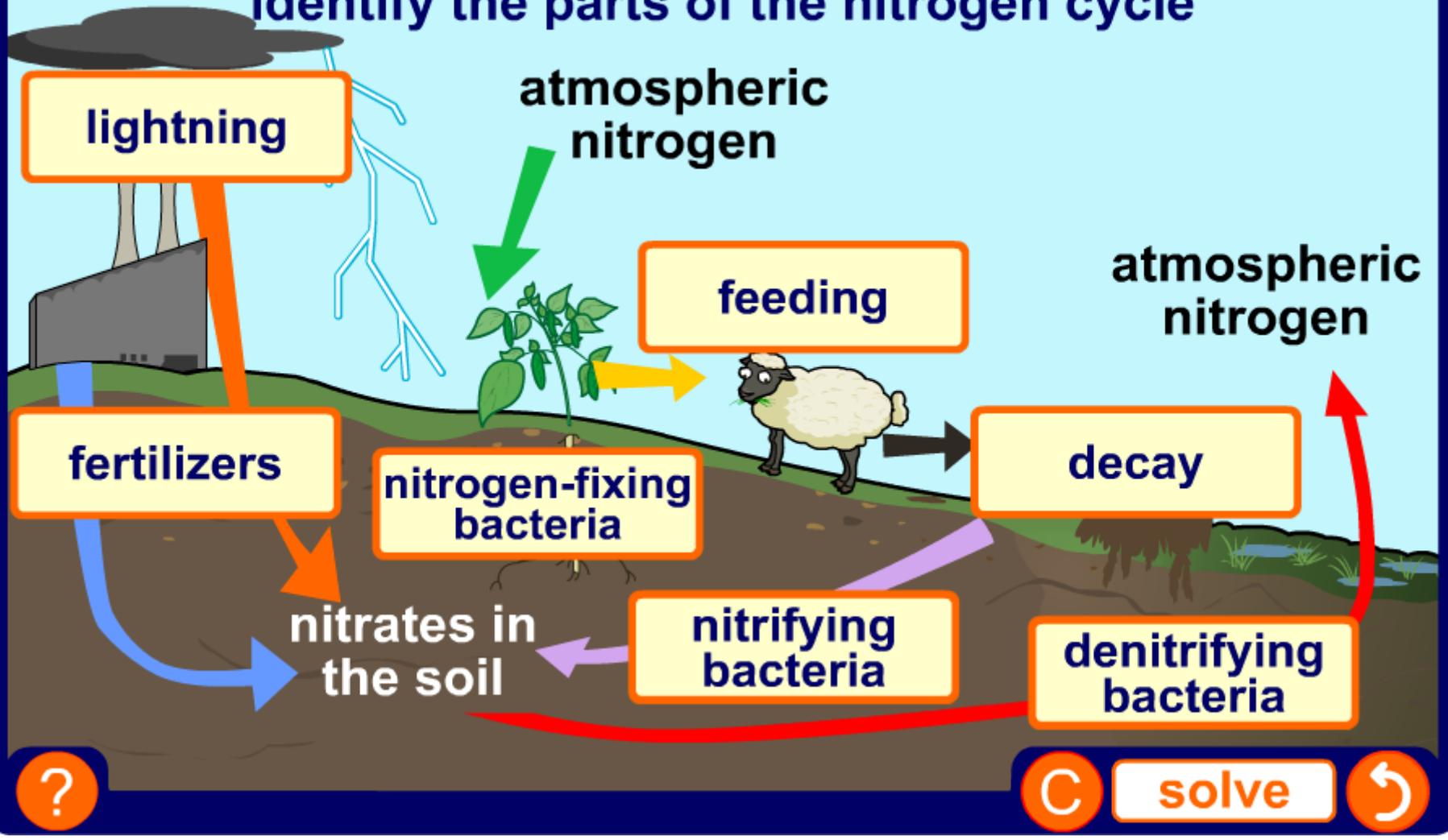




Labelling the nitrogen cycle



Identify the parts of the nitrogen cycle



solve





Match the components of the nitrogen cycle to their role

lightning strikes

live in the root of legumes and fix nitrogen

nitrifying bacteria

convert ammonia compounds to nitrates

denitrifying bacteria

convert atmospheric nitrogen to nitrates

nitrogen-fixing bacteria

break down waste and dead matter

decomposers

convert nitrates into nitrogen



solve



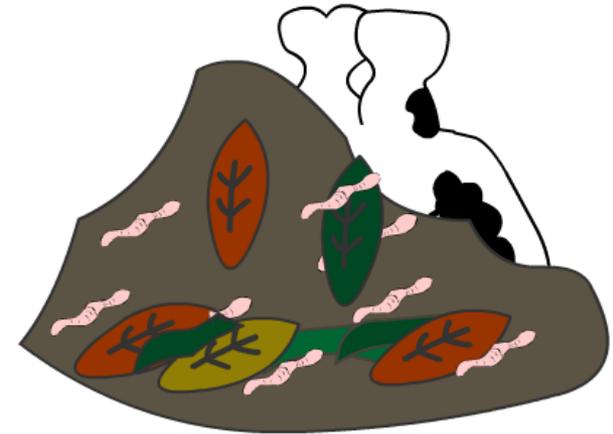


How are nitrates produced?

Nitrates are important because they are a form of nitrogen that plants can absorb. Nitrogen is used to make protein, and is passed from plants to animals along food chains.

What processes add nitrates to the soil?

- Decomposers release ammonium compounds from waste (such as urine) and dead matter. Nitrifying bacteria then convert the ammonium compounds into nitrates.
- Some nitrogen compounds form during lightning strikes and are washed into the soil by rain water. Lightning provides the high level of energy required for nitrogen to react and form compounds.



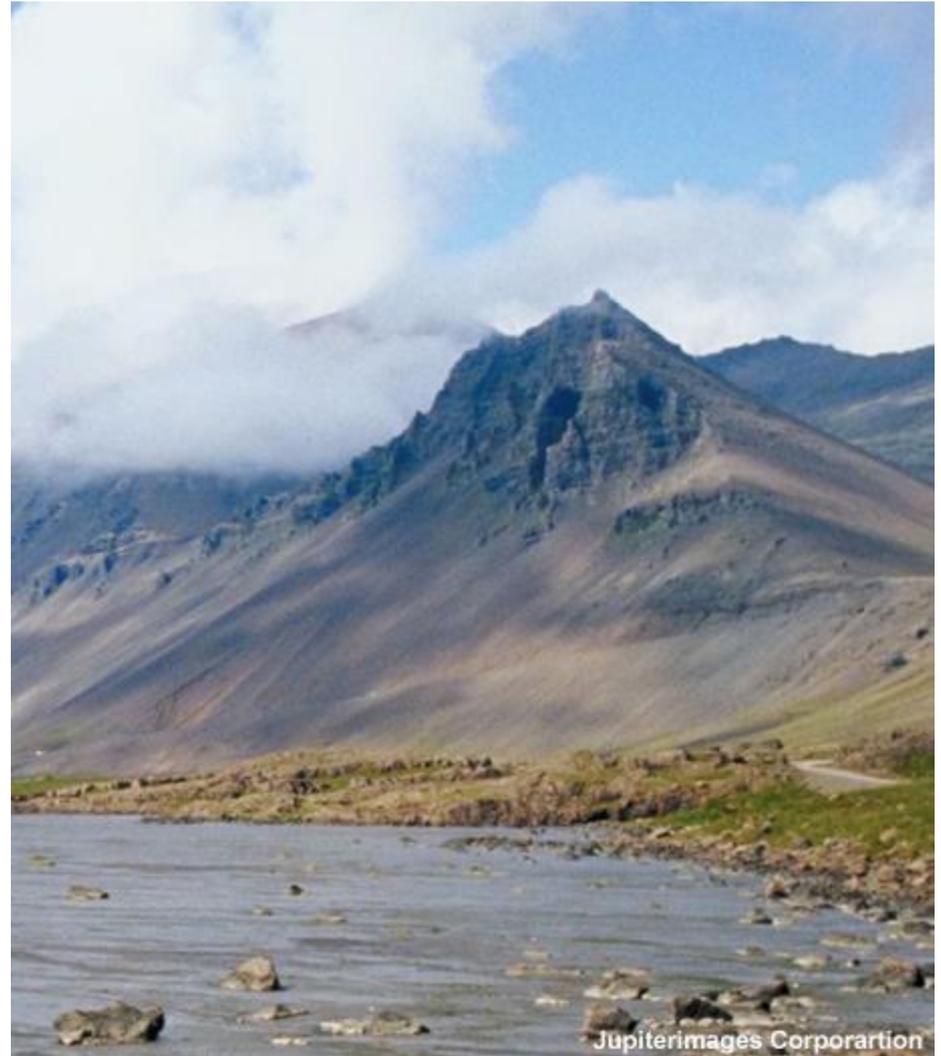


Can plants add nitrogen to the soil?

This rugged place is in Iceland. Deforestation by the original settlers and high levels of volcanic activity have left much of the country as bare lava or sand; an environment in which few plants grow.

In the 1960s, the country began to manage its soil, and dropped millions of lupin seeds from the air.

Why might lupins survive where nothing else grows?



Jupiterimages Corporation



What are legumes?



Most plants need nitrates from the soil because the nitrogen in air is too unreactive. These plants rely on the presence of nitrifying bacteria in the soil or artificial fertilizers.



By contrast, lupins and other **legumes**, such as clover and peas, are self-sufficient.

Nitrogen-fixing bacteria living in the root nodules of legumes convert nitrogen gas into nitrates, improving the fertility of poor-quality soils.





How can nitrates be added to soil?



Nitrates are vital for plant growth, but levels in the soil are gradually depleted as crops grow.

What methods can farmers use to increase soil nitrate levels?



- Modern, intensive farming uses artificial fertilizers. These are made by the **Haber process**. However, run-off into nearby rivers and lakes can cause **eutrophication**.
- Organic farming uses manure – a natural fertilizer. Crop rotation, a system that varies the crops planted each season, is also used to maintain soil fertility.





How do these processes affect soil nitrate levels?

increases nitrates

add nitrifying bacteria ✓

add animal manure ✓

add decomposers ✓

expose to lightning ✓

decreases nitrates

expose to heavy rain ✓

grow fast-growing crops ✓

add denitrifying bacteria ✓

Well done! ✕



solve



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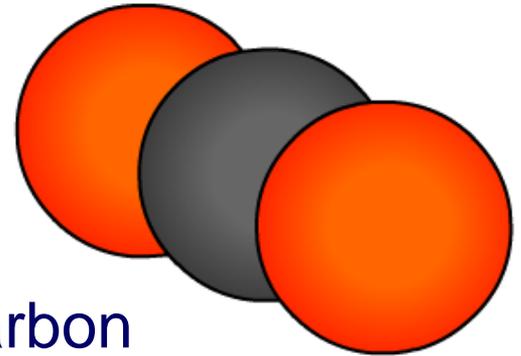




Why is carbon important?

Proteins, fats and sugar all contain **carbon**. Life without carbon would be very different and might be impossible.

Carbon is present in the atmosphere as **carbon dioxide**.



Plants use carbon dioxide during photosynthesis to produce sugars. The carbon is then transferred to animals along food chains.

What happens to the carbon in organisms when they die?

- As dead matter decomposes, carbon is released back into the atmosphere in the form of carbon dioxide.
- The carbon from dead organisms can also form fossil fuels and sedimentary rocks such as limestone. These are **long-term carbon stores**.



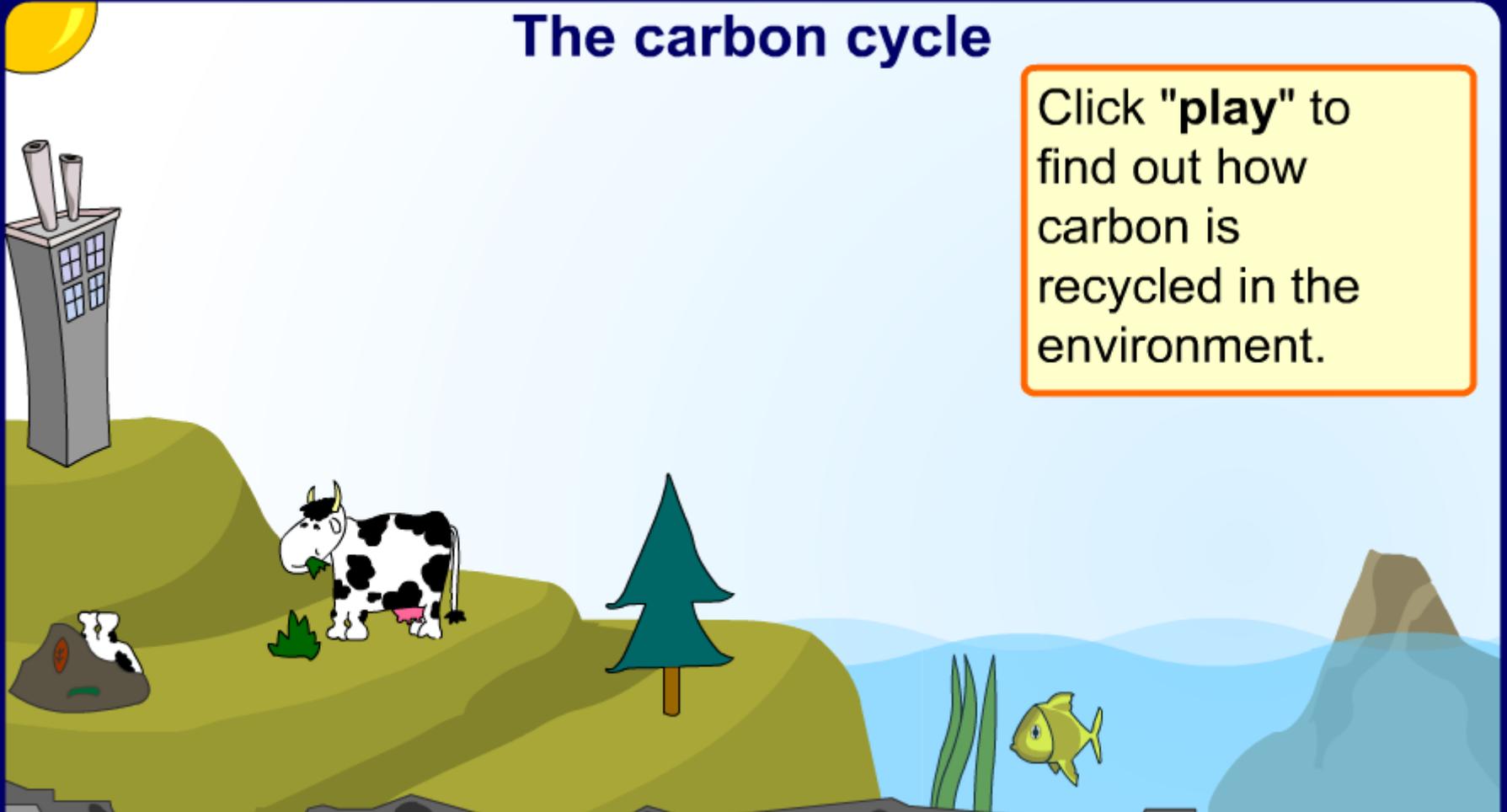


What is the carbon cycle?



The carbon cycle

Click "play" to find out how carbon is recycled in the environment.

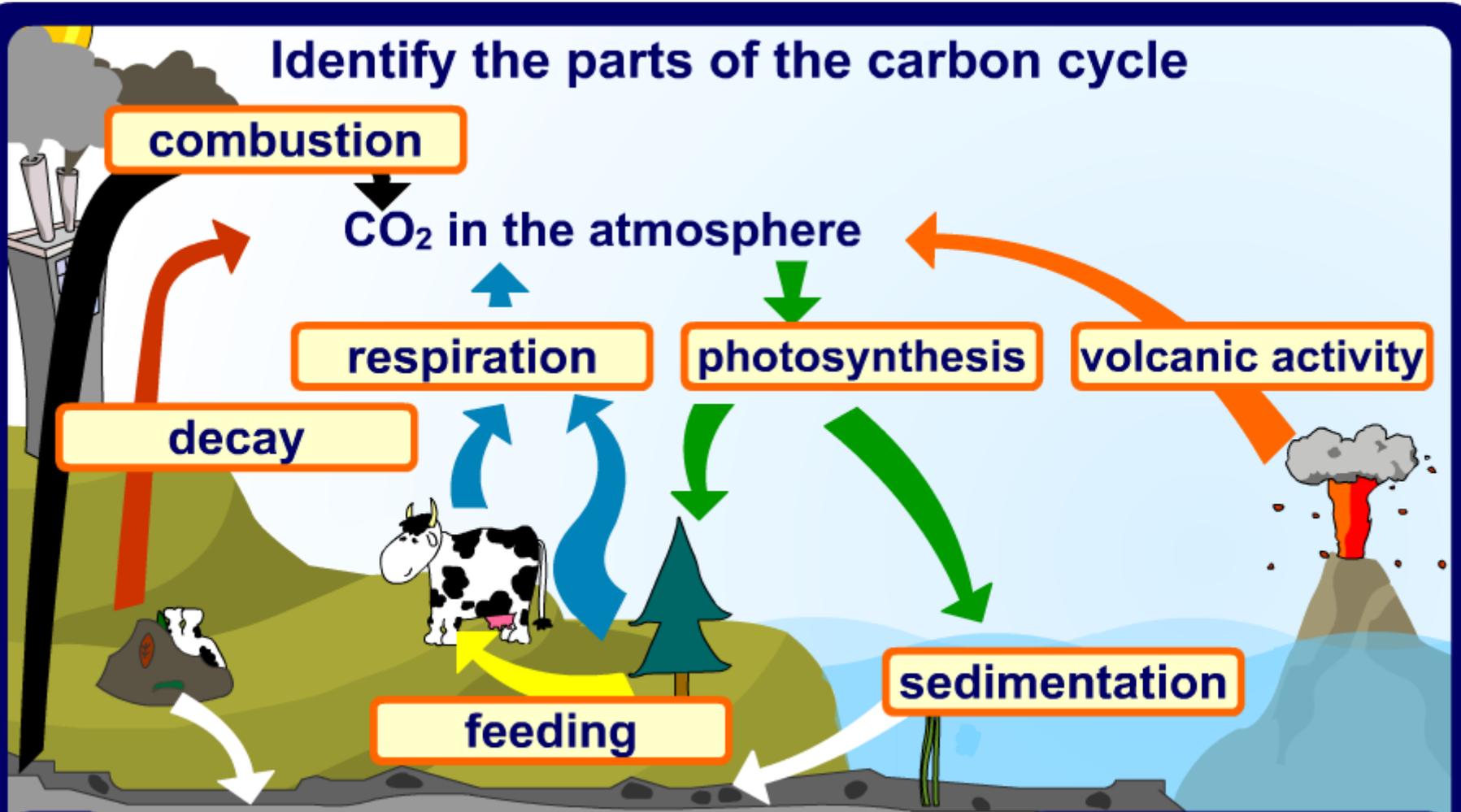




Labelling the carbon cycle



Identify the parts of the carbon cycle



solve





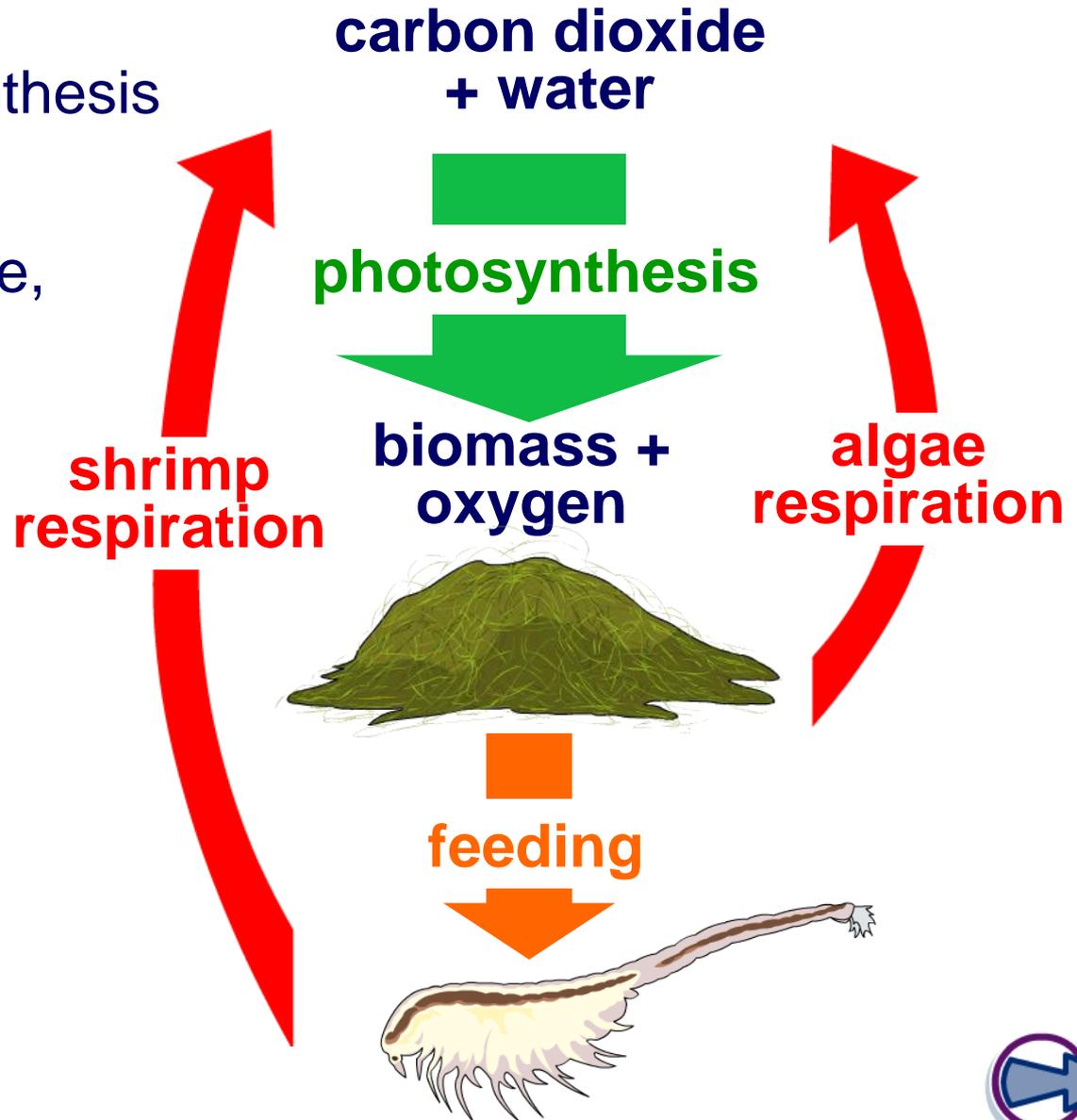
How is carbon recycled?



Carbon is constantly recycled by photosynthesis and respiration.

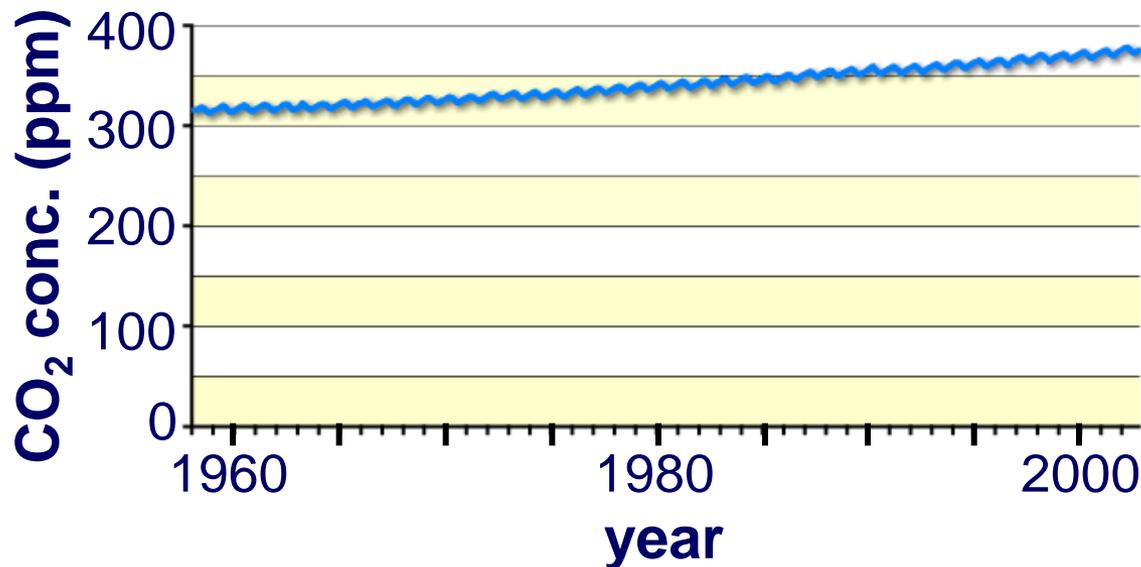
In a sealed ecosphere, carbon dioxide concentrations fluctuate but the mean level does not change.

How are carbon dioxide levels changing in the atmosphere of the Earth?



Are carbon dioxide levels rising?

Although the total amount of carbon in the environment is fixed, carbon dioxide levels are constantly fluctuating.



Currently, the general trend shows an increasing level of carbon dioxide. Why might this be happening?

Many scientists believe that human activity, such as burning fossil fuels and making cement from limestone, is responsible for increasing carbon dioxide levels. What environmental problems might this cause?





Carbon: true or false?



Are these statements about carbon true or false?

1.	Carbon dioxide makes up 78 % of the atmosphere.	
2.	Plants give out carbon dioxide when they respire.	
3.	Photosynthesis converts water and carbon dioxide into oxygen and sugar.	
4.	Coal and oil do not contain carbon.	
5.	Carbon dioxide is stored during the manufacture of cement.	
6.	Limestone is a long-term carbon store.	

true

false



solve



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Contents

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- **carbon cycle** – The process by which carbon is continuously recycled in the environment.
- **detritus** – Dead or decaying organic matter.
- **detritivore** – An animal, such as an earthworm or maggot, that feeds on waste and dead matter.
- **denitrifying bacteria** – Soil bacteria that convert nitrates into nitrogen gas.
- **fertilizer** – A chemical added to soil to provide essential mineral salts supporting plant growth.





- **legume** – A group of plant species that contain nitrogen-fixing bacteria in their roots and can therefore make their own nitrates.
- **nitrifying bacteria** – Soil bacteria that convert ammonium ions from protein decomposition into nitrates.
- **nitrogen cycle** – The process by which nitrogen is continuously recycled in the environment.
- **nitrogen-fixing bacteria** – Bacteria that live in the roots of legumes and convert nitrogen gas into nitrates.
- **saprotroph** – An organism that feeds by breaking down dead organic matter.





How quickly can you unscramble
anagrams of words about

d e c a y

a n d

r e c y c l i n g ?

start





How good are you at decomposing this quiz on decay and recycling?



start

