NAME _____ CLASS _____ DATE _____

IB BIOLOGY · C4.2

Transfers of energy and matter

Notes to fill in alongside the guide. Each numbered block matches a chapter of the guide, and of the lesson slides. Write in the gaps, answer the cues, annotate the figures, and sum up each section in your own words.

BY THE END YOU CAN

- [ ] Describe an ecosystem as an open system that energy and matter enter and leave, and a closed system as one only energy crosses C4.2.1
- [ ] Explain why sunlight sustains most ecosystems, and name ecosystems it does not C4.2.2
- [ ] Explain how chemical energy passes along a food chain as each consumer feeds C4.2.3
- [ ] Construct food chains and food webs, with arrows the way energy and biomass move C4.2.4
- [ ] Explain how decomposers get their energy from dead organisms, dead parts and faeces C4.2.5
- [ ] Describe autotrophs as making carbon compounds from inorganic substances with an external energy source C4.2.6
- [ ] Compare photoautotrophs, which use light, with chemoautotrophs such as iron-oxidising bacteria C4.2.7
- [ ] Describe heterotrophs as building their carbon compounds from those of other organisms C4.2.8
- [ ] Explain that autotrophs and heterotrophs both release energy by cell respiration C4.2.9
- [ ] Place organisms in trophic levels, including an organism that feeds at more than one C4.2.10
- [ ] Construct a pyramid of energy to scale from data for a real ecosystem C4.2.11
- [ ] Explain why less energy is available at each stage of a food chain C4.2.12
- [ ] Explain heat loss from respiration, in making ATP and in using it C4.2.13
- [ ] Explain why energy losses limit the number of trophic levels C4.2.14
- [ ] Describe primary production in g m^{-2} a year and compare biomes C4.2.15
- [ ] Explain why secondary production is lower than primary production C4.2.16
- [ ] Construct a carbon cycle diagram with photosynthesis, feeding and respiration C4.2.17
- [ ] Decide whether an ecosystem is a carbon sink or a carbon source C4.2.18
- [ ] Explain the release of carbon dioxide by combustion of biomass, peat, coal, oil and gas C4.2.19
- [ ] Analyse the yearly wiggle and the long rise of the Keeling curve C4.2.20
- [ ] Explain how respiration depends on photosynthesis for oxygen and photosynthesis on respiration for carbon dioxide C4.2.21
- [ ] Explain that every element living things use is recycled, with decomposers as the key C4.2.22

01 Light in, heat out

C4.2.1 C4.2.2

CUES

Predict: A student seals a jar with pond water, waterweed and snails and keeps it on a sunny windowsill. What must cross the glass for the jar to keep going for years?

NOTES

1 Draw a line round a wood, a pond or a stretch of seabed and call it an _____.

2 A system that both energy and matter can cross is an _____.

What is meant by ecosystem?

What is meant by open system?

What is meant by closed system?

3 Seal some soil, water, plants and small animals in a glass jar, a _____, and you have the nearest thing to a _____: light still shines in and heat still escapes through the glass, but no matter gets in or out.

4 For almost every ecosystem on Earth the energy starts as _____, caught by plants, algae and cyanobacteria in photosynthesis.

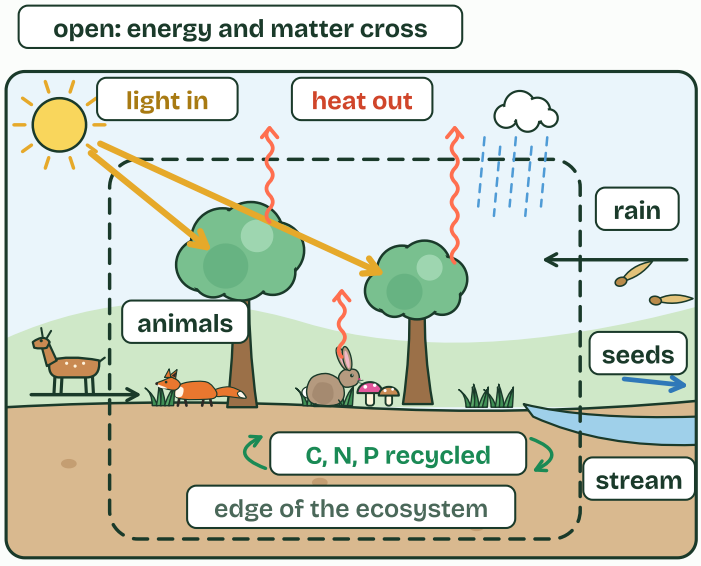
5 _____: energy and matter both cross the boundary. Most ecosystems are open.

6 _____: only energy crosses. A sealed mesocosm comes close.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as A wood: open and A sealed jar: closed. Note what changes each time.



SUMMARY

Sum up section 01 in two or three sentences of your own.

02 Make it or take it

C4.2.6 C4.2.7 C4.2.8 C4.2.9

CUES

Predict: Iron-oxidising bacteria live in a mine shaft with no light. What is the source of the carbon in their proteins?

What is meant by autotroph?

What is meant by heterotroph?

NOTES

1 An _____ makes them from simple inorganic substances: carbon dioxide, water, and ions such as nitrate and phosphate.

2 For a _____ (plants, algae, cyanobacteria) that source is light.

3 For a _____ it is an oxidation reaction: oxidising an inorganic substance releases energy.

4 A _____ takes its carbon compounds from other organisms.

5 It digests their proteins, polysaccharides and nucleic acids into small molecules, inside its gut (animals) or outside its cells (fungi and many bacteria), absorbs them and then _____ them: builds them into its own proteins, its own glycogen, its own DNA.

6 Whichever way it got them, every organism releases energy from carbon compounds the same way: by oxidising them in _____.

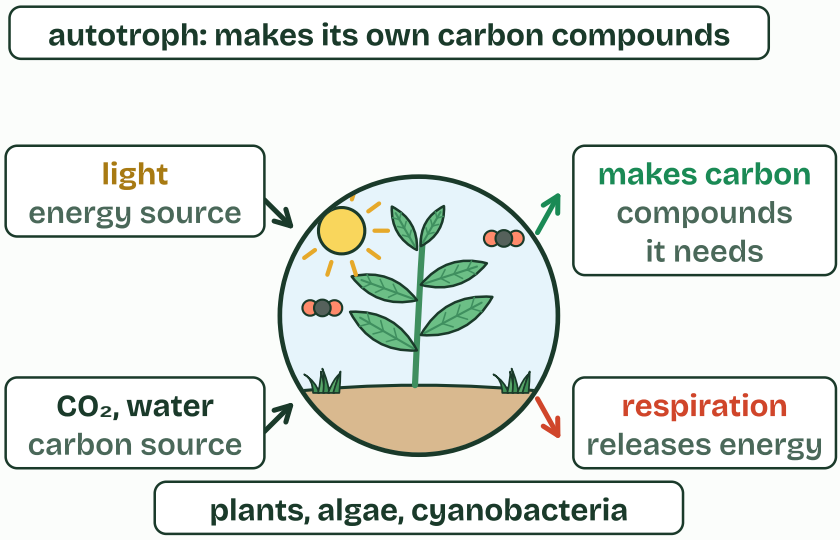
7 _____: inorganic carbon plus outside energy. Photo- uses light; chemo- uses oxidation of inorganic chemicals.

8 _____: carbon compounds from other organisms, digested and then assimilated.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Photoautotroph, Chemoautotroph and Heterotroph. Note what changes each time.



SPOT THE MISTAKE

What do students often get wrong about autotrophs as organisms that use external energy sources to synthesize carbon compounds from simple inorganic substances Use of light as the external energy source in photoautotrophs and oxidation reactions as the energy source in chemoautotrophs Heterotrophs as organisms that use carbon compounds obtained from other organisms to synthesize the carbon compounds that they require Release of energy in both autotrophs and heterotrophs by oxidation of carbon compounds in cell respiration? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 02 in two or three sentences of your own.

03 Who eats whom

C4.2.3 C4.2.4 C4.2.10

CUES

Predict: Build the woodland web below, then switch to Remove a species. Before you run it, predict: the sparrowhawk eats only blue tits. If the sparrowhawks are removed, what happens?

What is meant by food chain?

What is meant by trophic level?

What is meant by food web?

NOTES

1 A _____ shows that passing along: oak tree, caterpillar, blue tit, sparrowhawk.

2 Each place in a chain is a _____.

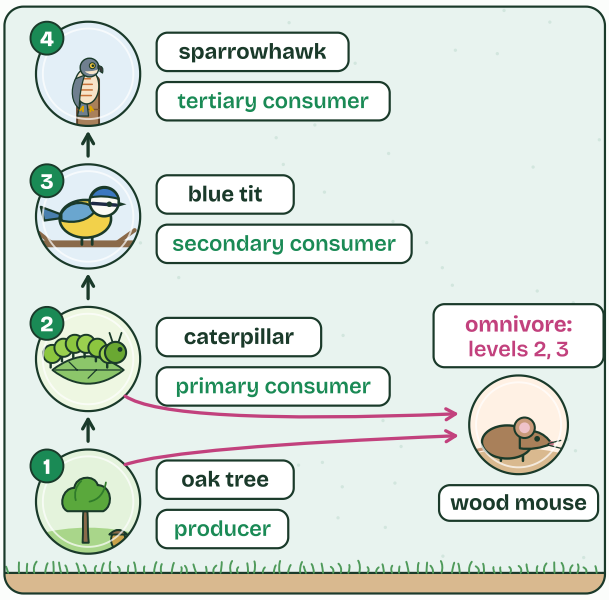
3 The _____ is first, then the _____ that eats it, the _____ that eats that, and the _____.

4 Real animals rarely eat one thing, so chains link up into a _____.

Your own notes

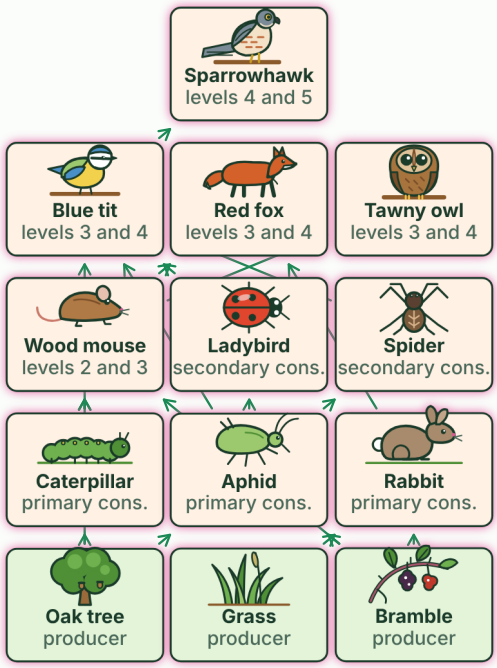
ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each: 1 is eaten by; 2 trophic level; 3 wood mouse.



ANNOTATE THE FIGURE

Label the key parts and add a note on what it shows.



SPOT THE MISTAKE

What do students often get wrong about flow of chemical energy through food chains Construction of food chains and food webs to represent feeding relationships in a community Classification of organisms into trophic levels? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 03 in two or three sentences of your own.

04 Nothing goes to waste

C4.2.5

CUES

Predict: A sheep eats grass, but much of the grass comes out again as faeces. Where does the energy in the faeces go next?

What is meant by decomposers?

NOTES

1 All of it is still made of carbon compounds, so it still holds chemical energy: a whole food supply for the _____.

2 There are two kinds. _____ such as earthworms, woodlice and millipedes eat dead matter, digest it inside their guts and leave it in smaller pieces. _____, most fungi and many bacteria, secrete enzymes onto the dead matter and absorb the small molecules the enzymes release: their digestion happens outside their cells.

3 _____ release carbon dioxide, heat and mineral ions.

4 An earthworm, a _____, eats it in pieces.

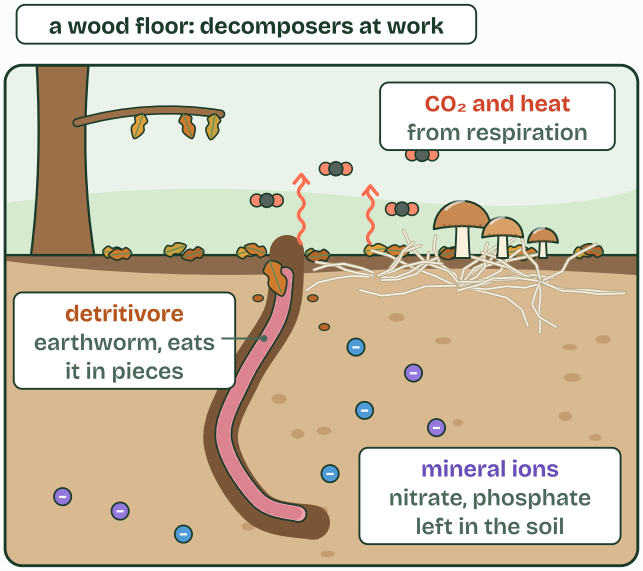
5 A fungus, a _____, secretes enzymes and digests it outside its cells.

6 Respiration releases _____ and _____; _____ are left in the soil.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each.



SUMMARY

Sum up section 04 in two or three sentences of your own.

05 Where the energy goes

C4.2.12 C4.2.13 C4.2.14

CUES

Predict: Turn the film's efficiency down from 10% to 5%. What happens to the owl?

NOTES

1 Rabbits eat grass holding _____ of chemical energy. Follow it.

2 About _____ is never absorbed: it leaves in _____, food for decomposers.

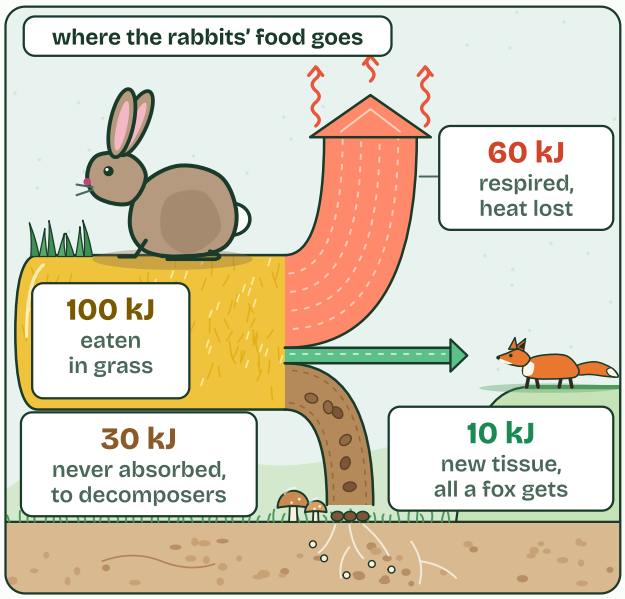
3 About _____ is used in _____ and released as _____, lost from the ecosystem.

4 Only about _____ ends up in new rabbit tissue: all a fox can get.

Your own notes

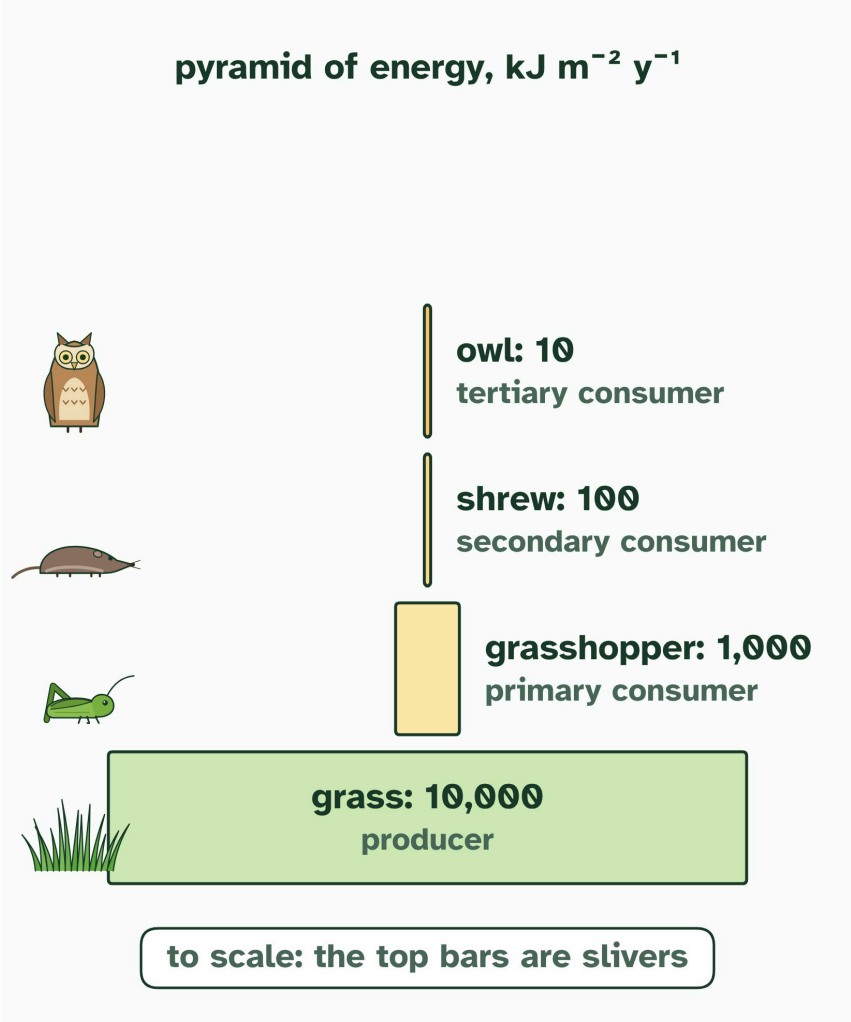
ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 100 kJ; 2 30 kJ, faeces; 3 60 kJ, respiration, heat; 4 10 kJ.



ANNOTATE THE FIGURE

Annotate this still from the animation (Watch it happen: energy down a food chain): what is happening, and why?



SPOT THE MISTAKE

What do students often get wrong about reductions in energy availability at each successive stage in food chains due to large energy losses between trophic levels Heat loss to the environment in both autotrophs and heterotrophs due to conversion of chemical energy to heat in cell respiration Restrictions on the number of trophic levels in ecosystems due to energy losses? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 05 in two or three sentences of your own.

06 Drawn to scale

C4.2.11

CUES

Predict: A pyramid of numbers for an oak wood can be upside down: one tree feeds thousands of caterpillars. Can a pyramid of energy ever be upside down?

What is meant by pyramid of energy?

NOTES

1 A _____ stacks the trophic levels from the producers up, each bar as wide as the energy passing through that level.

2 Working out each level as a percentage of the one below gives its _____ of transfer.

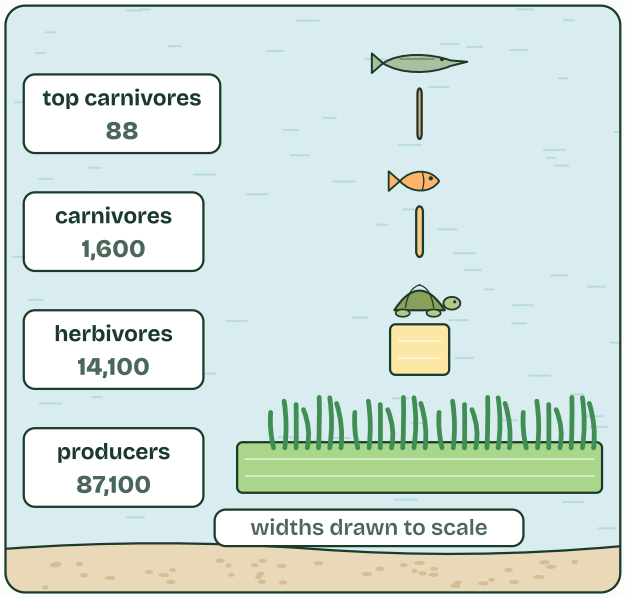
3 Units: _____.

4 The same data as a _____, to scale.

Your own notes

ANNOTATE THE FIGURE

Number the 2 steps on the figure and note what happens at each.



SUMMARY

Sum up section 06 in two or three sentences of your own.

07 What is left to grow

C4.2.15 C4.2.16

CUES

Predict: Why does a tropical rainforest have a much higher net primary production than the tundra?

What is meant by primary production?

What is meant by secondary production?

NOTES

1 _____ is the building up of carbon compounds in biomass by autotrophs.

2 All the carbon a plant fixes by photosynthesis is its _____ primary production.

3 It respires some of that straight away to stay alive, and what is left is its _____ primary production: new leaves, wood, roots, seeds.

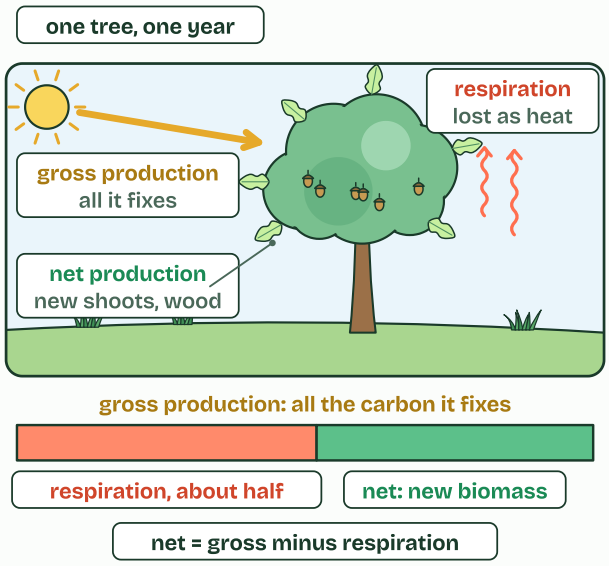
4 _____ is the same thing for heterotrophs: biomass they build as they grow and reproduce.

5 _____ is lower than primary production.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as One tree and Biomes compared. Note what changes each time.



SUMMARY

Sum up section 07 in two or three sentences of your own.

08 Round and round

C4.2.17 C4.2.18 C4.2.19

CUES

Predict: A peat bog is drained for farming. Air gets into the peat. What happens to the bog's carbon?

What is meant by carbon sink?

What is meant by carbon source?

NOTES

1 Energy flows through an ecosystem once; carbon goes round. _____ takes carbon dioxide from the air (or from water) and fixes it into carbon compounds. _____ passes those compounds to consumers, and death and egestion pass them to decomposers. _____, by producers, consumers and decomposers alike, turns them back into carbon dioxide.

2 If an ecosystem fixes more carbon by photosynthesis than it releases by respiration, it takes carbon dioxide out of the air: it is a _____.

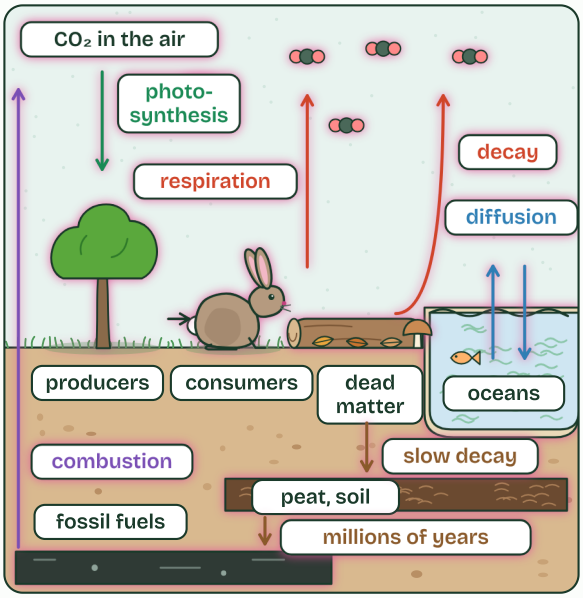
3 If respiration wins, it is a _____: a drained bog, or a forest after a fire.

4 Old sinks can be burned. _____ of wood and other biomass, peat, coal, oil and natural gas oxidises their carbon to carbon dioxide.

Your own notes

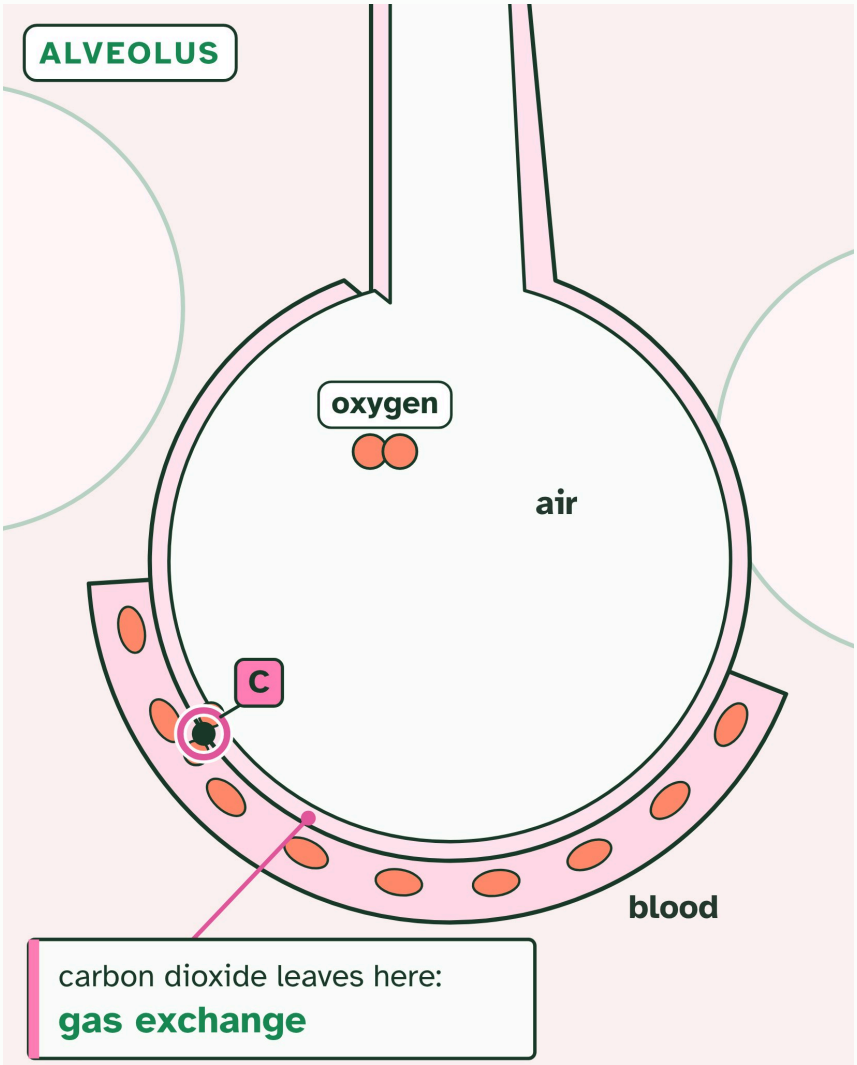
ANNOTATE THE FIGURE

Label the key parts and add a note on what it shows.



ANNOTATE THE FIGURE

Annotate this still from the animation (Follow one carbon atom): what is happening, and why?



SUMMARY

Sum up section 08 in two or three sentences of your own.

09 The Earth breathing

C4.2.20 C4.2.21 C4.2.22

CUES

Predict: A station in New Zealand, in the southern hemisphere, also measures carbon dioxide. What would you expect its wiggle to look like?

NOTES

1 The record has run every month since, and its graph is the _____.

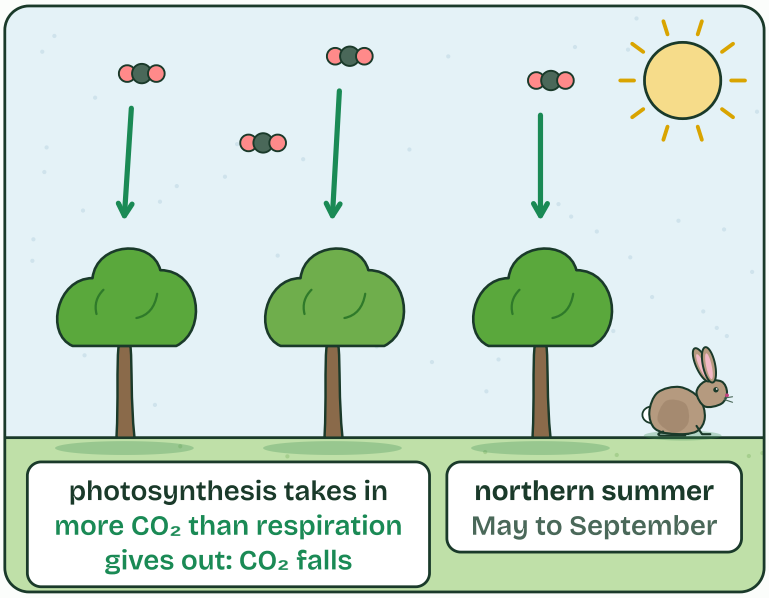
2 Wiggle: _____.

3 Rise: _____.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Northern summer and Northern winter. Note what changes each time.



SPOT THE MISTAKE

What do students often get wrong about analysis of the Keeling Curve in terms of photosynthesis, respiration and combustion Dependence of aerobic respiration on atmospheric oxygen produced by photosynthesis, and of photosynthesis on atmospheric carbon dioxide produced by respiration Recycling of all chemical elements required by living organisms in ecosystems? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 09 in two or three sentences of your own.

Check yourself

The check for this guide is online: a fresh paper of past-paper style questions from the exam bank on C4.2 each time, marked as you go, and saved to your Exam practice progress when you are signed in. Scan the code, or type the link.

biologybybradford.com/exam-maker/sit?topics=C4.2&level=SL&paper=quiz&marks=15&src=ep

How this was made. The course structure, the activities and the teaching choices come from my own classroom, my presentations and my years of teaching IB and AP Biology. I use Claude, an AI, to help write and build the interactive guides, lesson plans, slides and practice questions, and to draw the diagrams and code the interactives. I direct the work and review it against the IB and AP specifications before it goes live.