NAME _____ CLASS _____ DATE _____

IB BIOLOGY · D4.3

Climate change

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

- [ ] Explain how human emissions of carbon dioxide and methane cause climate change, and tell correlation from causation in the ice core record D4.3.1
- [ ] Describe five positive feedback cycles that speed up global warming D4.3.2
- [ ] Explain how a boreal forest can flip from storing carbon to losing it, as an example of a tipping point D4.3.3
- [ ] Explain how melting landfast ice and sea ice threaten emperor penguins and walruses D4.3.4
- [ ] Explain how warmer surface water reduces nutrient upwelling and primary production in the sea D4.3.5
- [ ] Describe poleward and upslope range shifts, using birds in New Guinea and North American trees D4.3.6
- [ ] Distinguish ocean acidification from coral bleaching, and explain how they threaten coral reefs D4.3.7
- [ ] Evaluate afforestation, forest regeneration and peat restoration as ways to sequester carbon D4.3.8
- [ ] Explain how photoperiod and temperature cue the timing of biological events D4.3.9
- [ ] Explain how climate change breaks the synchrony between linked species, with reindeer and great tits D4.3.10
- [ ] Explain why warmer years give spruce bark beetles more generations in a year D4.3.11
- [ ] Explain how changing snow cover has changed the colour of tawny owls in Finland by natural selection D4.3.12

01 The blanket we keep thickening

D4.3.1

CUES

Predict: Ice cores from Antarctica show that over 800 000 years, temperature and carbon dioxide rose and fell together. What does this correlation show on its own?

What is meant by greenhouse gases?

What is meant by greenhouse effect?

NOTES

1 The warm surface gives the energy off again as infrared, and some of that infrared is absorbed by _____, which re-emit it in every direction, some of it back down.

2 That is the _____, and without it the Earth would average about −18 °C instead of about 15 °C.

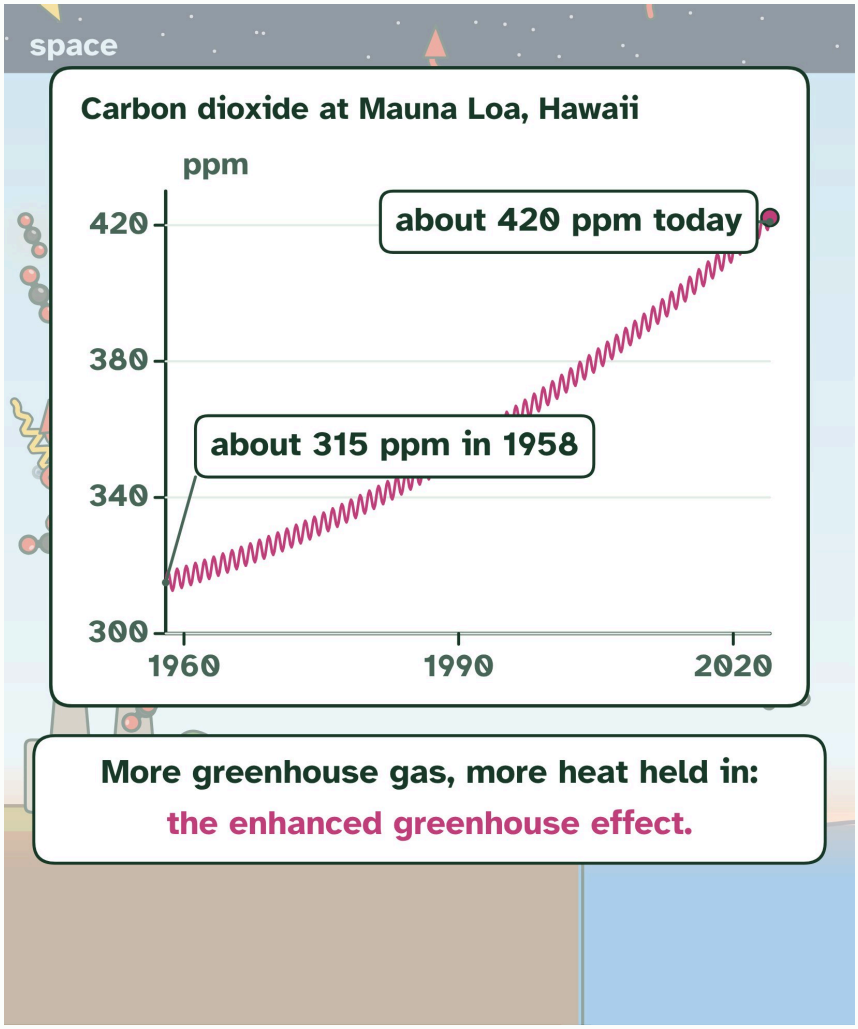
3 Climate change is the trouble we have made by adding to it. _____ carbon dioxide comes mostly from burning coal, oil and gas, with more from clearing and burning forests and from making cement.

Your own notes

What is meant by anthropogenic?

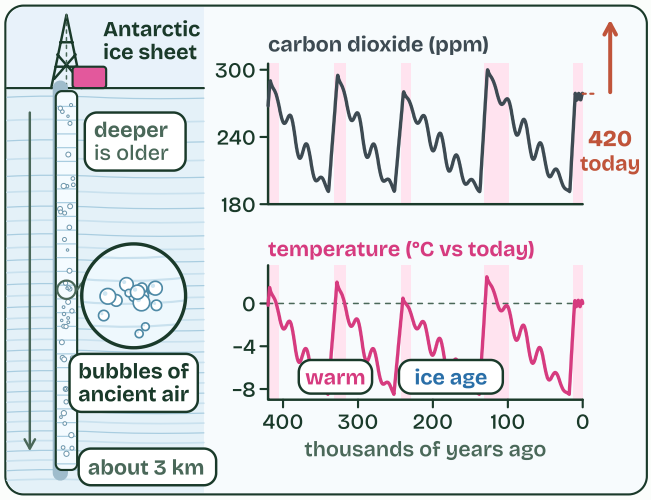
ANNOTATE THE FIGURE

Annotate this still from the animation (Trapping the heat): what is happening, and why?



ANNOTATE THE FIGURE

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



REMEMBER IT

Where the extra methane comes from

C Cows	R Rarely	L Leave	G Gas
C	R	L	G

SUMMARY

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

02 Warming that makes more warming

D4.3.2

CUES

Predict: Why is the thawing of permafrost a positive feedback, not a negative one?

What is meant by positive feedback?

What is meant by albedo?

What is meant by permafrost?

NOTES

1 A _____ cycle is one where a change sets off effects that make the same change bigger.

2 **Loss of snow and ice.** Snow and ice reflect most of the sunlight that hits them (a high _____).

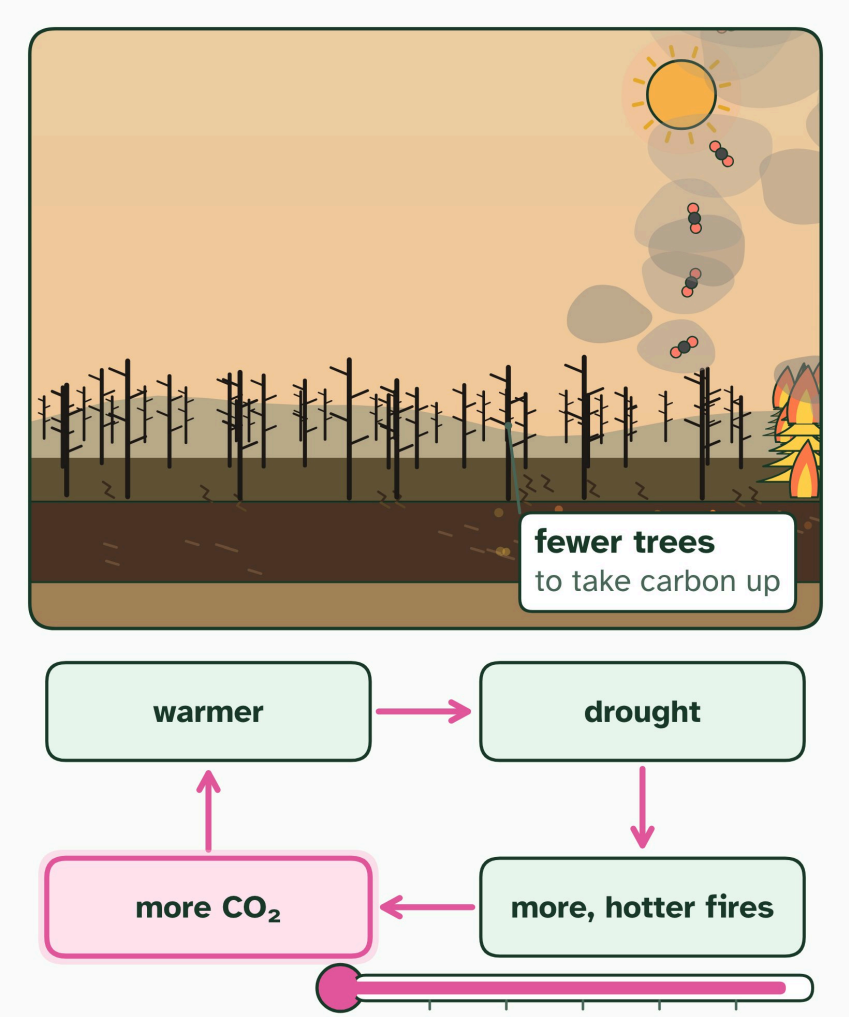
3 **Peat and permafrost.** Peat is plant matter that never decomposed because it was waterlogged; _____ holds the remains of plants frozen for thousands of years.

4 Warmer and drier, both start to decompose and release carbon dioxide, and thawing, waterlogged permafrost releases _____.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Warming that feeds itself): what is happening, and why?



REMEMBER IT

The five feedback loops

I	O	P	P	F
Icy	Oceans	Push	Polar	Fires
I	O	P	P	F

SUMMARY

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

03 When a forest stops storing carbon

D4.3.3

CUES

Predict: Fires have always burned in the taiga. Why does legacy carbon combustion matter so much?

What is meant by taiga?

What is meant by legacy carbon combustion?

What is meant by tipping point?

NOTES

1 The _____, or boreal forest, runs in a belt across Canada, Alaska, Scandinavia and Siberia.

2 Drought stress cuts photosynthesis, so _____, and stands of trees turn brown and die back, called _____.

3 Burning that old store is called _____.

4 That is a _____: the forest now speeds up the warming that tipped it.

5 Warmer temperatures and less winter snow: more _____.

6 Drought: less _____, forest _____.

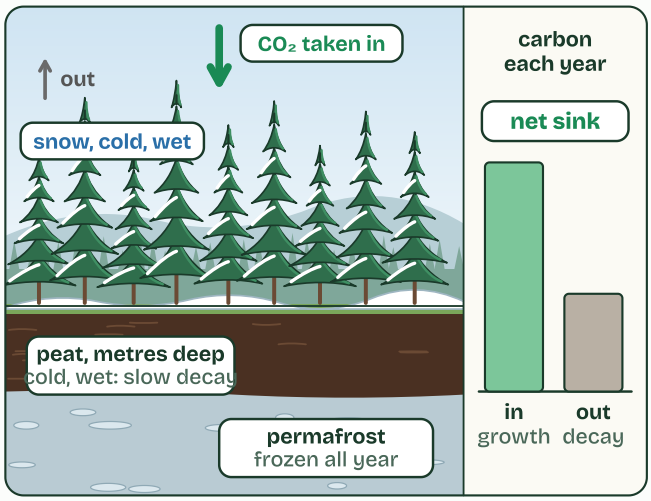
7 More frequent, more intense _____: _____.

8 Net carbon _____ flips to net carbon _____: a tipping point.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Storing carbon and After the tipping point. Note what changes each time.



SUMMARY

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

04 Standing on ice that leaves early

D4.3.4

CUES

Predict: Why does an early break-up of landfast ice harm emperor penguins, even if the ice forms again the next winter?

What is meant by landfast ice?

What is meant by sea ice?

NOTES

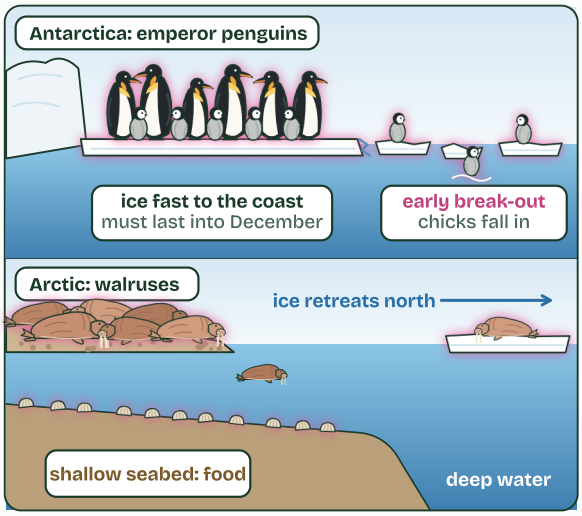
1 Emperor penguins (*Aptenodytes forsteri*) breed in the depth of the Antarctic winter, on _____: sea ice frozen fast to the coast.

2 In the Arctic, walruses (*Odobenus rosmarus*) feed on clams and worms on the shallow seabed and rest on floating _____ between dives.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: landfast ice, emperor penguins, early break-out, walruses on land, sea ice, food on the seabed.



SUMMARY

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

05 When the deep water stops rising

D4.3.5

CUES

Predict: Why does warm surface water reduce primary production in the sea, when warmth usually speeds photosynthesis up?

What is meant by upwelling?

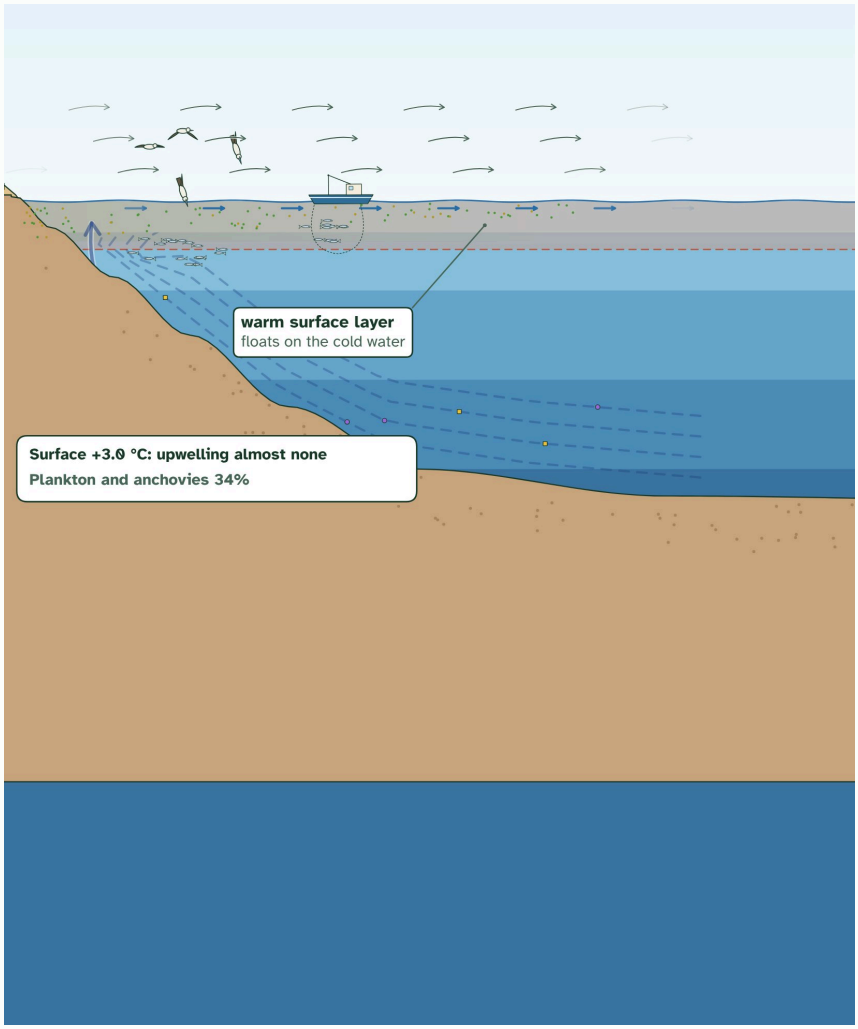
NOTES

1. This _____ feeds the phytoplankton, and with them some of the richest fisheries in the world: anchovies off Peru, sardines off California and South Africa.
2. The layers stop mixing (the water becomes _____), and winds have to work harder to bring deep water up.
3. With fewer nutrients, _____, and less energy flows up the food chain to fish, seabirds and mammals.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Wind, upwelling and anchovies): what is happening, and why?



SUMMARY

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

06 Moving uphill to stay cool

D4.3.6

CUES

Predict: A bird lives only near the top of a mountain in New Guinea. Why is it more at risk from warming than a bird that lives halfway up?

What is meant by range shift?

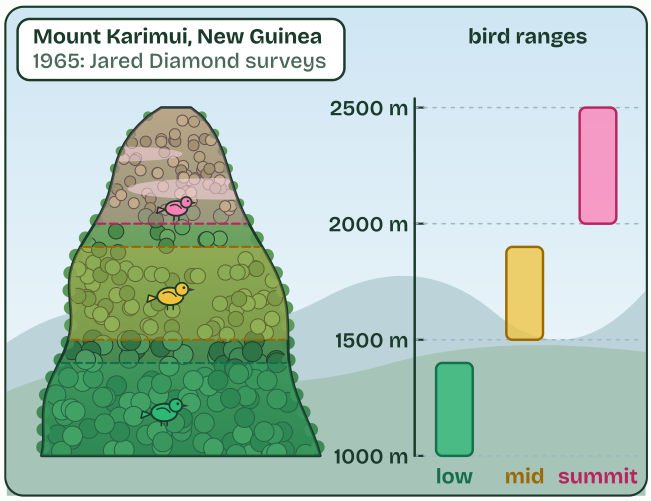
NOTES

1 A species spreads where its new range opens and dies out where its old one closes. That is a _____.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as 1965 and 2012. Note what changes each time.



SUMMARY

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

07 Two threats to a reef

D4.3.7

CUES

Predict: Which change causes coral bleaching?

What is meant by zooxanthellae?

NOTES

1 Inside the cells of each polyp live photosynthetic algae, _____, which give the coral most of its food in return for shelter and the coral's waste nutrients.

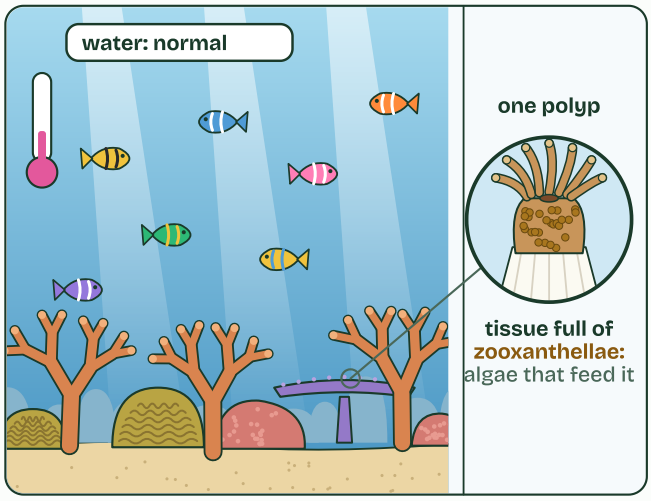
2 Corals need carbonate ions to build their skeletons, so with fewer of them, _____: skeletons grow more slowly and are weaker.

3 The fish and invertebrates that depended on its shelter go, and the reef ecosystem _____.

Your own notes

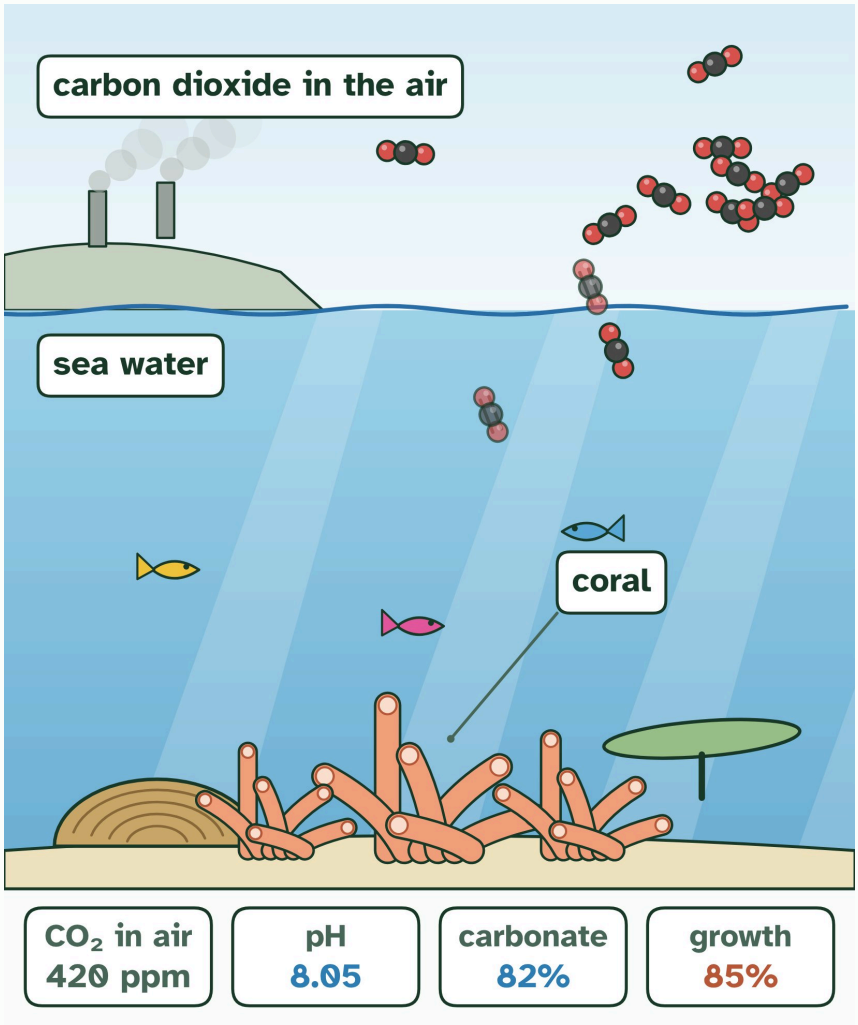
ANNOTATE THE FIGURE

The figure shows it as Healthy, Bleached and Dead. Note what changes each time.



ANNOTATE THE FIGURE

Annotate this still from the animation (Ocean acidification and coral): what is happening, and why?



SUMMARY

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

08 Putting carbon back in the ground

D4.3.8

CUES

Predict: Scientists still argue whether plantations or native forests are better for carbon. Why can't a quick measurement settle it?

What is meant by carbon sequestration?

NOTES

1 _____ takes carbon dioxide out of the air and locks it away.

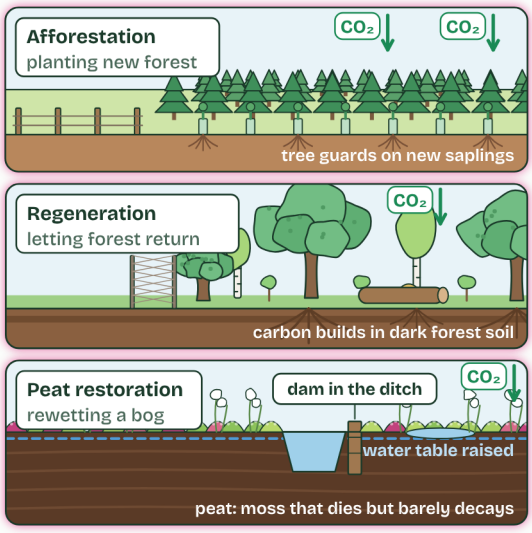
2 _____ is planting trees where there has been no forest for a long time. _____ is letting a forest grow back, or helping it to, where it was cleared or burnt.

3 _____ means raising the water table again in a drained bog, often by blocking the drainage ditches.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: afforestation, forest regeneration, peat restoration.



SUMMARY

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

09 Reading the calendar of nature

D4.3.9 HL

CUES

Predict: Which cue would let a tree burst its buds earlier in a warm spring, and later in a cold one?

What is meant by phenology?

NOTES

1 _____ is the study of when things happen in nature: when buds burst and leaves fall, when plants flower, when birds arrive, nest and leave.

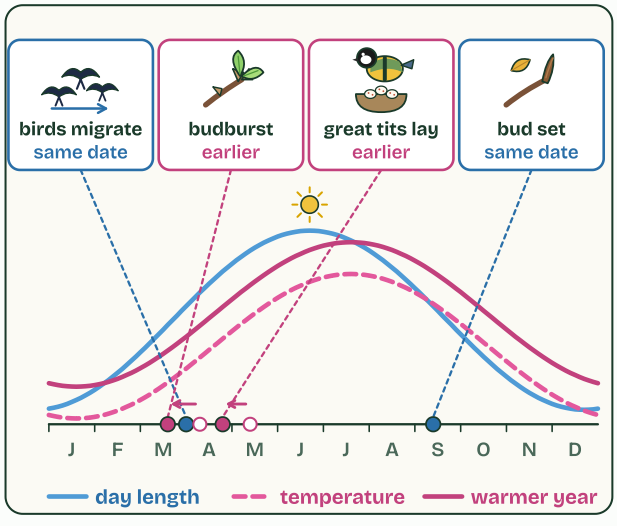
2 Organisms time these events by cues from the environment. _____, the length of the day, is the same on a given date every year, so it is a reliable calendar. _____ varies from year to year, but it tracks the season as it actually arrives.

3 Many deciduous trees need a run of warm days to set off _____ in spring, while _____ in autumn, when they stop growing and form winter buds, is often triggered by shortening days.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 Two cues.; 2 Cued by warmth.; 3 Cued by day length.; 4 A warmer year..



SUMMARY

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

10 Arriving after the feast

D4.3.10 HL

CUES

Predict: Great tits in Wytham Woods now lay about two weeks earlier than in the 1960s. What does this suggest?

What is meant by phenological mismatch?

NOTES

1 As it warms, the temperature-cued events move earlier and the photoperiod-cued ones do not, and the two drift apart: a _____.

2 Temperature cue: _____.

3 Photoperiod cue: _____.

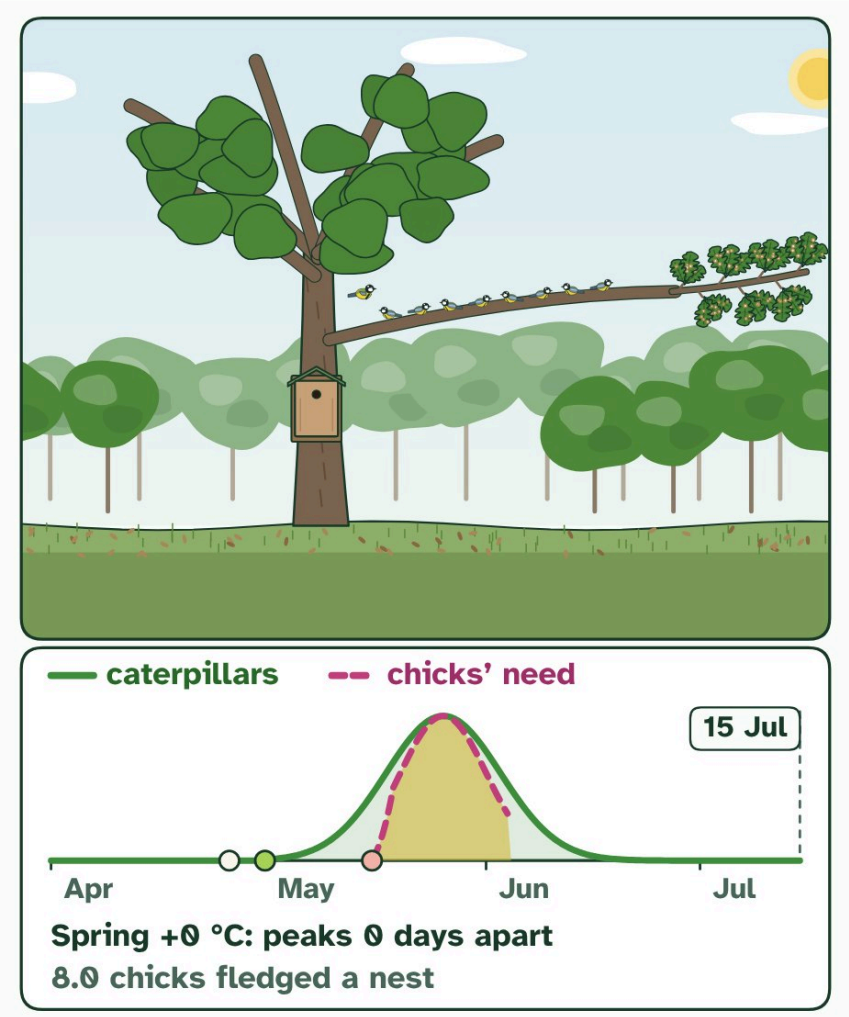
4 Two linked populations on different cues fall out of _____.

5 Examples: chickweed and _____ in Greenland; caterpillars and _____ in European oak woods.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Great tits and the caterpillar peak): what is happening, and why?



SUMMARY

Sum up section 10 in two or three sentences of your own.

11 A third generation of beetles

D4.3.11 HL

CUES

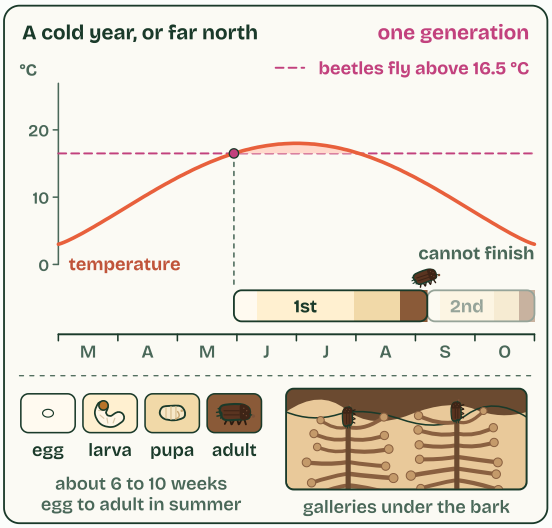
Predict: Why does a warmer year allow more generations of bark beetles?

NOTES

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Cold year, Warm year and Hot year. Note what changes each time.



SUMMARY

Sum up section 11 in two or three sentences of your own.

12 Grey owls, brown owls and snow

D4.3.12 HL

CUES

Predict: Why is the rise in brown tawny owls an example of evolution, and not just a change in the owls' plumage?

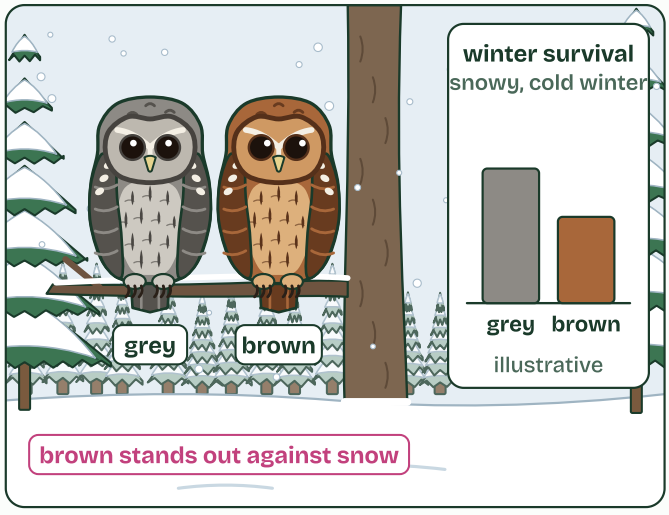
NOTES

1 A change in the frequency of an inherited variant in a population is _____, and here climate change has driven it by changing the _____ of each colour.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Snowy winter, Mild winter and Over 50 years. Note what changes each time.



SUMMARY

Sum up section 12 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 D4.3 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=D4.3&level=HL&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.