NAME _____ CLASS _____ DATE _____

IB BIOLOGY · D4.2

Stability and 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

- [ ] Give evidence that some ecosystems, such as the Daintree rainforest and the Namib Desert, have stayed stable for millions of years D4.2.1
- [ ] Explain the four requirements for a stable ecosystem: energy, nutrient recycling, genetic diversity and a climate within tolerance D4.2.2
- [ ] Explain why deforestation could tip the Amazon rainforest into savanna, and calculate percentage change in forest area D4.2.3
- [ ] Design and evaluate a sealed mesocosm to investigate the effect of a variable on ecosystem stability D4.2.4
- [ ] Explain the disproportionate effect of a keystone species, such as the sea otter, on its community D4.2.5
- [ ] Assess whether harvesting a resource is sustainable, using the Brazil nut and Atlantic cod D4.2.6
- [ ] Outline the factors that decide whether farming is sustainable D4.2.7
- [ ] Explain how leached fertilizer causes eutrophication and raises the biochemical oxygen demand D4.2.8
- [ ] Explain how DDT and mercury biomagnify up a food chain D4.2.9
- [ ] Describe the effects of macroplastic and microplastic on marine life, and how research changed what people do D4.2.10
- [ ] Describe how rewilding restores natural processes, with Hinewai Reserve as the example D4.2.11
- [ ] Explain how abiotic and biotic changes trigger ecological succession D4.2.12
- [ ] Describe the changes during primary succession, from bare rock to forest D4.2.13
- [ ] Explain cyclical succession, with the heather cycle as the example D4.2.14
- [ ] Explain climax communities and how grazing and drainage arrest succession D4.2.15

01 Some ecosystems last for millions of years D4.2.1

CUES

Predict: Why are very old, stable ecosystems such as the Daintree so rich in species found nowhere else?

What is meant by ecosystem stability?

NOTES

1 Both are examples of _____: the same community, with the same processes running, over a very long time.

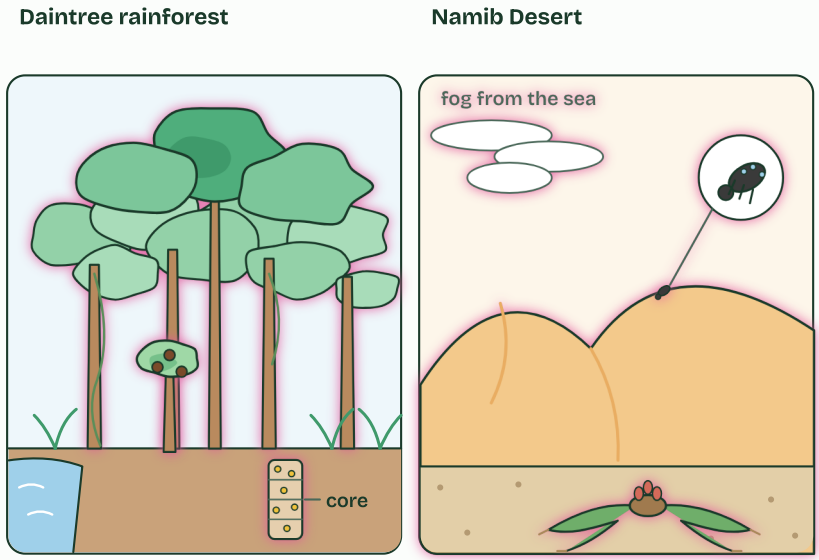
2 A stable ecosystem keeps the same _____ and the same _____ over long periods.

3 _____ for long-term stability: fossils such as pollen, the age of the landforms, and ancient lineages still living there.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: the canopy, idiot fruit tree, fossil pollen, fog, the dunes, welwitschia, fog-basking beetle.



SUMMARY

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

02 Four things a stable ecosystem needs

D4.2.2

CUES

Predict: A forest is cut and the logs are taken away every 30 years. Which requirement for stability does this put at risk most directly?

What is meant by saprotrophs?

NOTES

1 **The recycling of nutrients.** Unlike energy, matter is not supplied from outside: the same carbon, nitrogen and phosphorus atoms go round and round. _____ and other decomposers break down dead matter and release the nutrients for producers to take up again.

2 **Energy.** Sunlight is captured by the producers. Energy is lost as _____ at every step, so it must be supplied all the time.

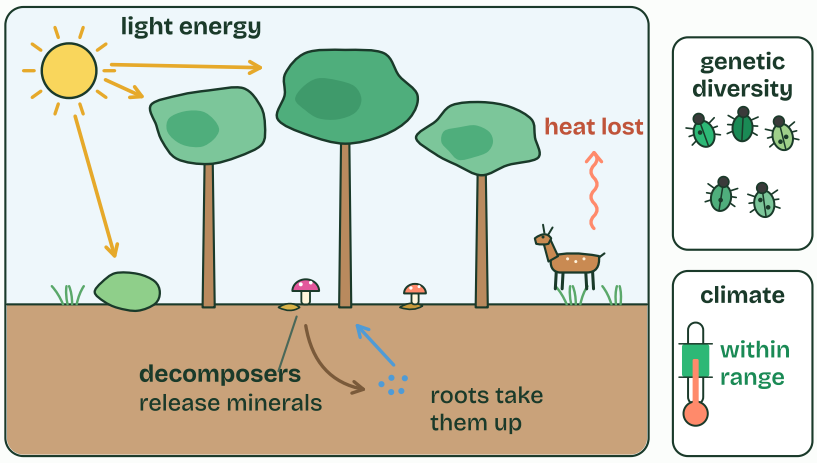
3 **Nutrients.** _____ break down dead leaves and bodies and release minerals, which roots take up again. Matter is recycled.

4 **Climate.** Temperature and rainfall stay within the range the species can _____. Every Nest Gets Care.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 Energy., heat; 2 Nutrients., Decomposers; 3 Genetic diversity.; 4 Climate., tolerate.



REMEMBER IT

The four requirements for stability

E Every	N Nest	G Gets	C Care
E	N	G	C

SUMMARY

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

03 The forest that makes its own rain

D4.2.3

CUES

Predict: Nobody knows exactly how much forest the Amazon can lose before it tips. Why is this so hard to find out?

What is meant by transpiration?

What is meant by flying rivers?

What is meant by tipping point?

NOTES

1 The trees take the water up through their roots and release most of it again as water vapour by _____.

2 The moist air flows on in streams that Brazilian scientists call _____.

3 It would then die back into dry savanna, even where no one cuts it. That threshold is a _____.

4 Moist air blows in from the _____ and forms clouds over the coast.

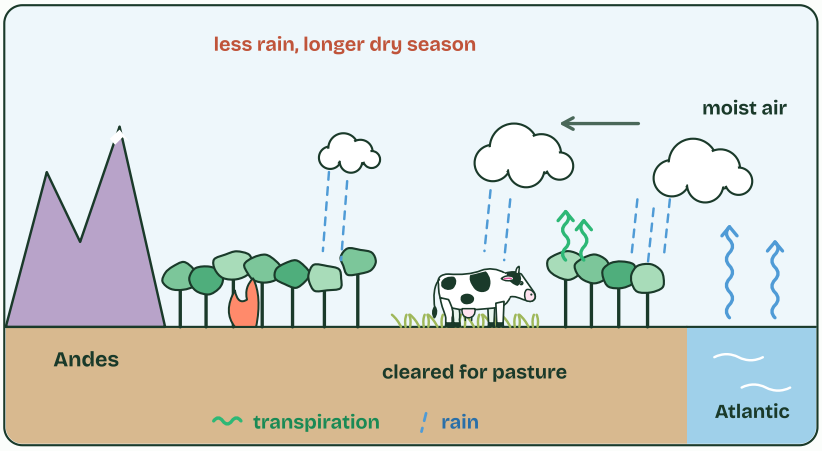
5 Rain falls on the forest. Trees take up the water and release it again by _____, and new clouds form further west.

6 The water is recycled several times across the continent. Blocked by the Andes, the moist air flows south as a _____, bringing rain to southern Brazil.

Your own notes

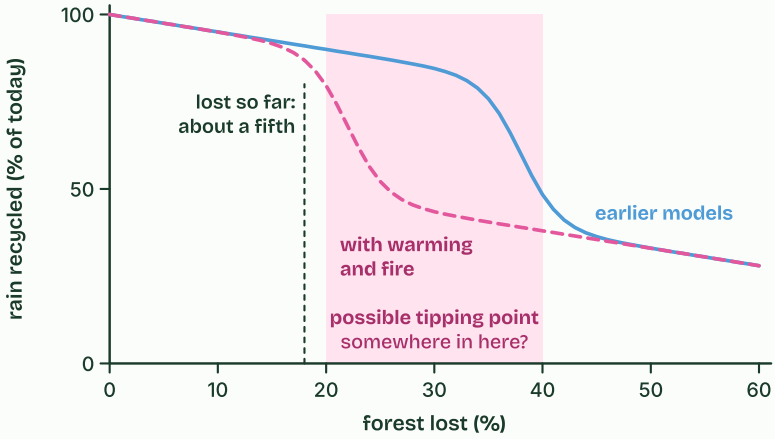
ANNOTATE THE FIGURE

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



ANNOTATE THE FIGURE

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



SUMMARY

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

04 An ecosystem in a bottle

D4.2.4

CUES

Predict: A student seals four jars with pondweed and snails and keeps one in the dark. Which jar would you expect the snails to die in first, and why?

What is meant by mesocosm?

What is meant by closed system?

NOTES

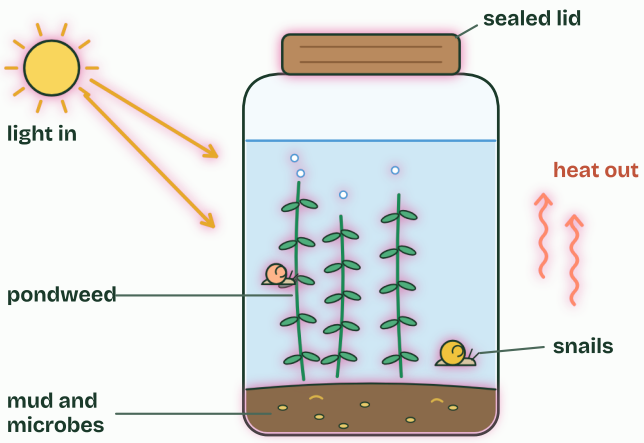
1 A bottle like this is a _____, a model ecosystem that can be controlled and repeated.

2 A sealed vessel is a _____.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: mud and microbes, pondweed, snails, the seal, light in, heat out.



SPOT THE MISTAKE

What do students often get wrong about use of a model to investigate the effect of variables on ecosystem stability? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

05 Pull out one stone and the arch falls

D4.2.5

CUES

Predict: A seaweed is the most common organism in a rock pool. Removing it changes little. Removing a rare whelk, a predator, changes almost everything. Which is the keystone species?

What is meant by keystone species?

What is meant by urchin barren?

NOTES

1 Paine called the sea star a _____, after the wedge-shaped stone at the top of an arch, which holds the others in place.

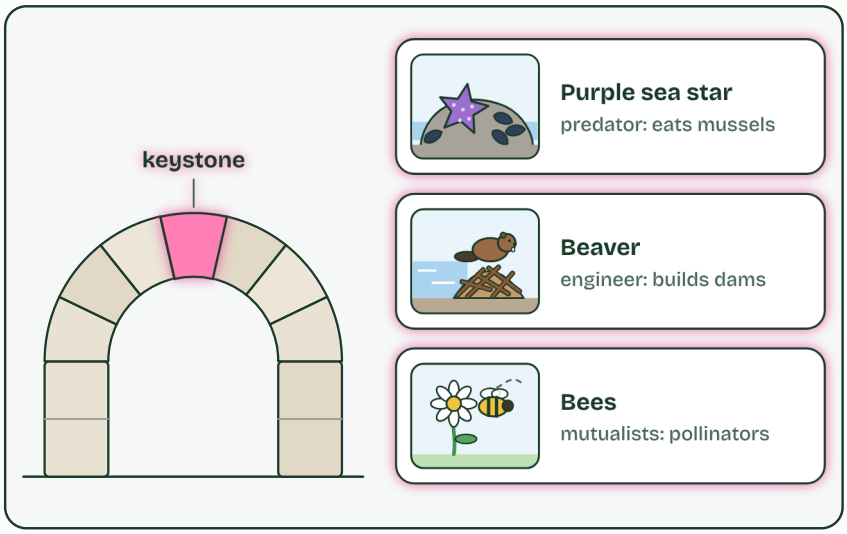
2 What matters is that its effect is _____: far bigger than its numbers would suggest.

3 Without otters to eat them, sea urchins multiplied and grazed the giant kelp down to bare rock, leaving an _____.

Your own notes

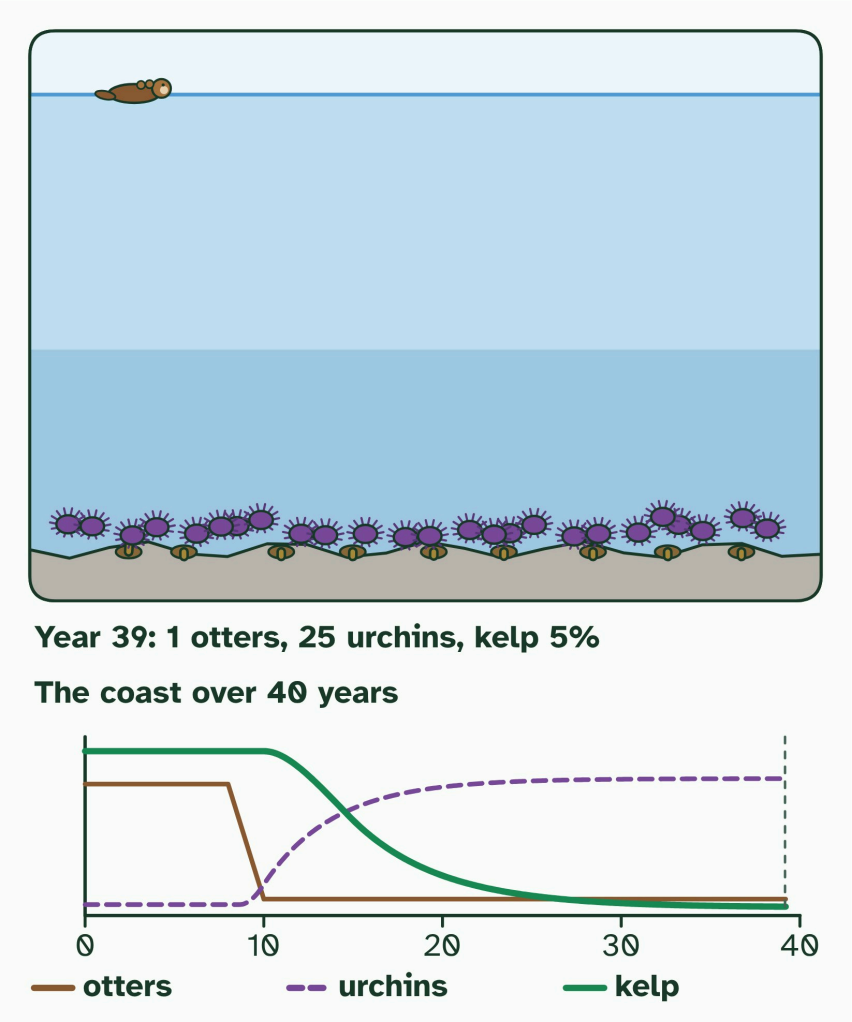
ANNOTATE THE FIGURE

Label each part and say what it does: the keystone, purple sea star, beaver, bees.



ANNOTATE THE FIGURE

Annotate this still from the animation (Otters, urchins and kelp): what is happening, and why?



SUMMARY

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

06 Take no more than grows back

D4.2.6

CUES

Predict: Fishing boats keep catching the same tonnage of cod each year, but they need more and more days at sea to do it, and the fish landed are smaller. What does this suggest?

What is meant by renewable resources?

What is meant by sustainable?

What is meant by maximum sustainable yield?

NOTES

1 Fish, timber and wild nuts are _____: the population that provides them reproduces and grows.

2 Harvesting is _____ when the rate of harvesting is lower than the rate of replacement.

3 The largest catch that can be taken every year without the population falling is the _____ (MSY).

4 A population grows in an _____, levelling off at the _____ (K) set by food and space.

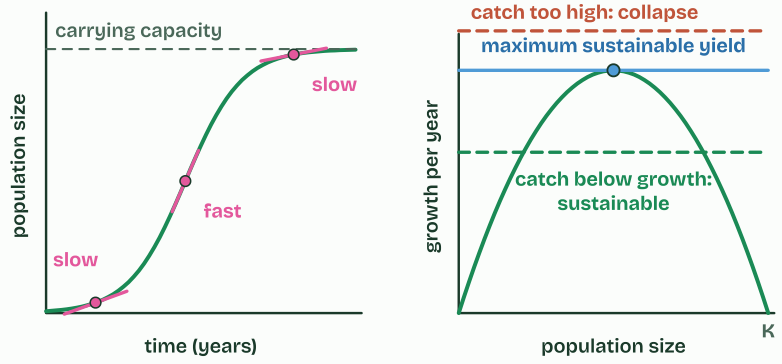
5 It grows _____ at middle sizes: a small population has few parents, and a crowded one is held back by competition.

6 The most that can be taken every year, for ever, is the growth at the peak: the _____, with the population kept at about _____.

Your own notes

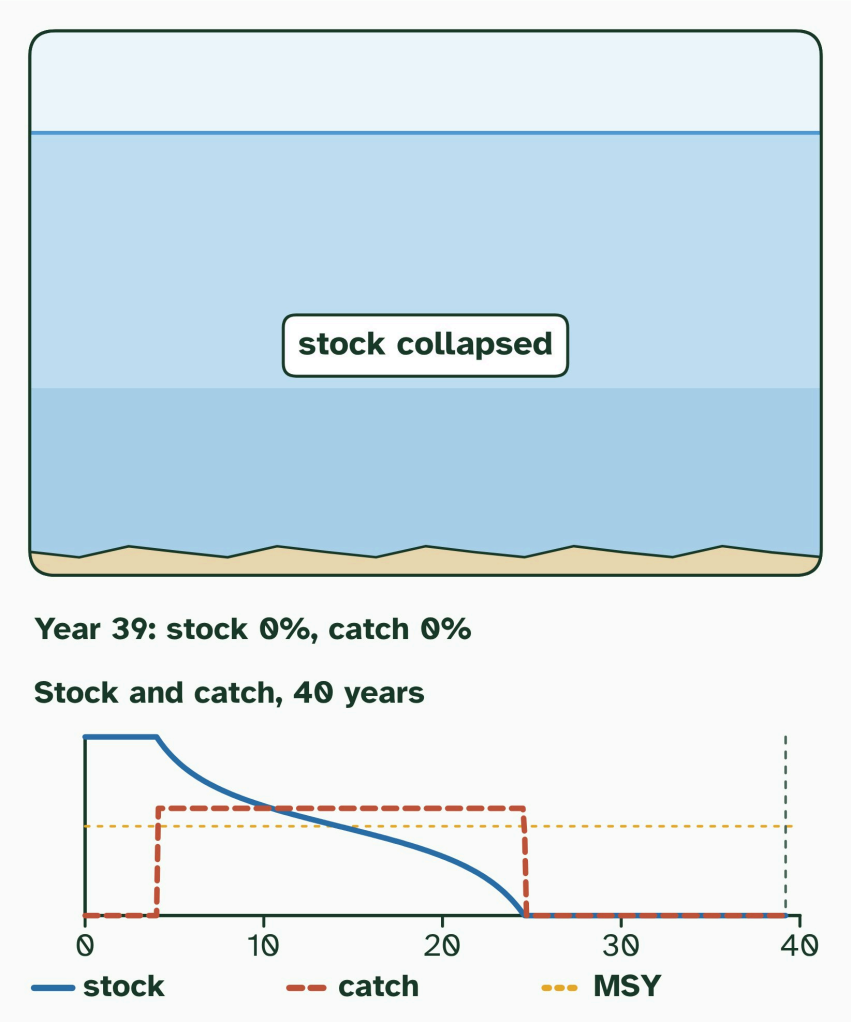
ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 S curve, carrying capacity; 2 fastest; 3 maximum sustainable yield, half of K; 4 collapses.



ANNOTATE THE FIGURE

Annotate this still from the animation (Fishing a cod stock): what is happening, and why?



SUMMARY

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

07 Can a farm keep going for ever?

D4.2.7

CUES

Predict: A farmer grows clover in a field for one year in four, then ploughs it in before planting wheat. Which problem does this mainly reduce?

What is meant by integrated pest management?

NOTES

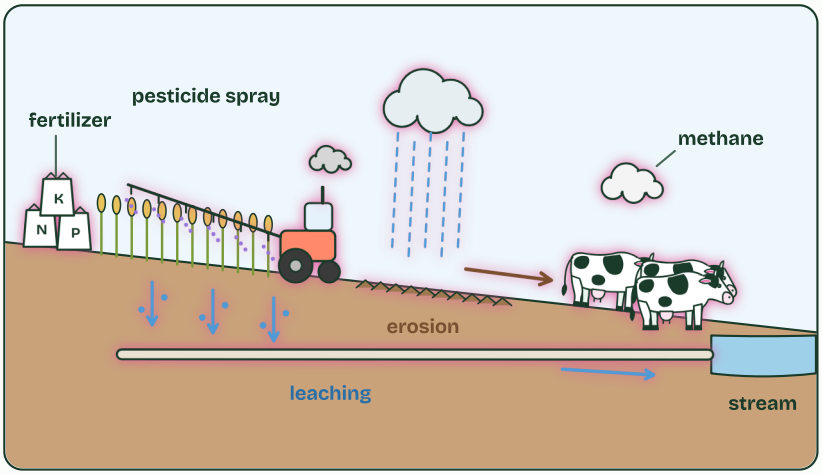
1 **Pollution by agrochemicals.** Pesticides and herbicides can kill species other than the targets, such as pollinators and the predators of pests, and some persist and build up in food chains (chapter 9).

_____ uses them only when needed.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: inputs, agrochemicals, soil erosion, leaching, carbon footprint.



REMEMBER IT

Five factors for sustainable farming

E	L	I	P	C
Every	Lazy	Ivy	Poisons	Crops
E	L	I	P	C

SUMMARY

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

08 Too much of a good thing

D4.2.8

CUES

Predict: A river below a farm has a high nitrate level and a high BOD. Why does adding nitrate, which is not organic matter, raise the BOD?

What is meant by eutrophication?

What is meant by biochemical oxygen demand?

NOTES

1 The enrichment of water with nutrients is _____.

2 The demand for oxygen from decomposers is measured as the _____ (BOD).

3 Rain _____ nitrate and phosphate from the fertilized field into the lake.

4 The nutrients were limiting the algae. Now they multiply into an _____ at the surface.

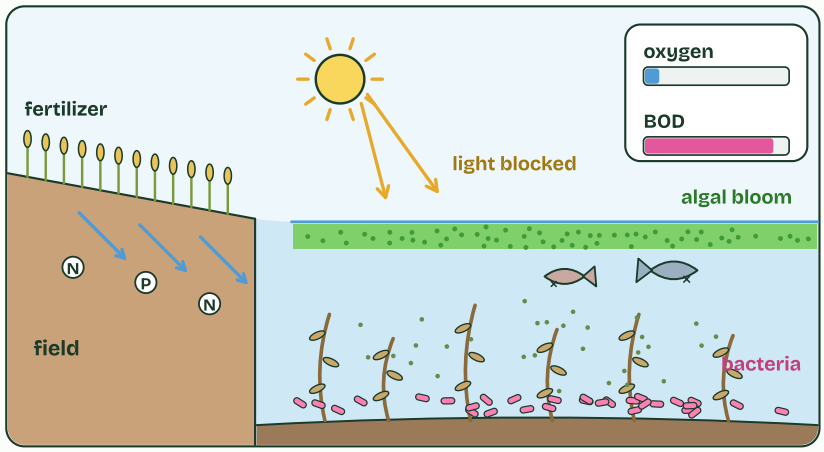
5 The bloom _____, so the plants on the lake bed cannot photosynthesize and die.

6 The short-lived algae _____ and sink, adding to the dead plant matter.

Your own notes

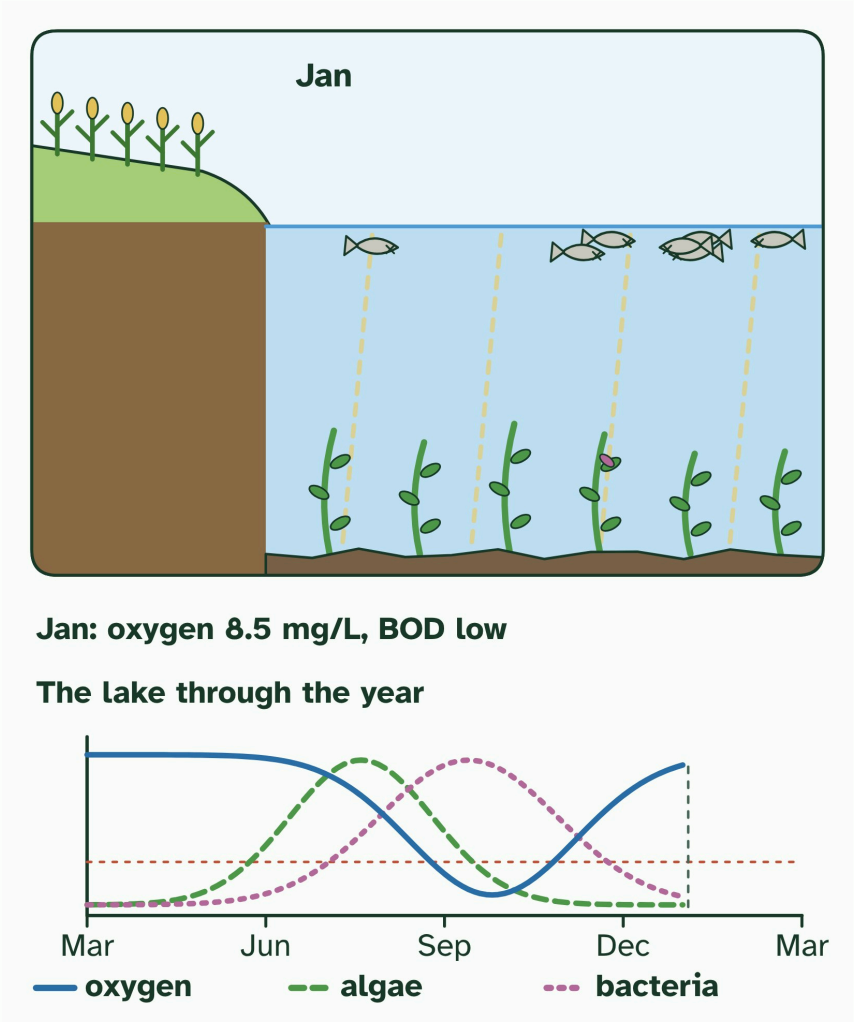
ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each: 1 leaches; 2 algal bloom; 3 blocks the light; 4 die; 5 bacteria, biochemical oxygen demand; 6 fish die.



ANNOTATE THE FIGURE

Annotate this still from the animation (A lake below a farm): what is happening, and why?



REMEMBER IT

The steps of eutrophication

L	A	L	D	D	D
Little	Algae	Love	Dirty	Dark	Ditches
L	A	L	D	D	D

SUMMARY

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

09 A pesticide that climbs the food chain

D4.2.9

CUES

Predict: Why do top predators carry the highest concentration of DDT, even though they eat far less food in total than the plankton do?

What is meant by bioaccumulation?

What is meant by biomagnification?

NOTES

1 Whatever an animal takes in stays in its fat for the rest of its life. This build-up within one organism is _____.

2 At each trophic level the concentration rises, because most of the biomass eaten is used in respiration while the DDT stays. This rise in concentration up a food chain is _____.

3 _____ biomagnifies in the same way.

4 DDT in the water is barely measurable, but _____ absorb it and keep it in their fat: _____.

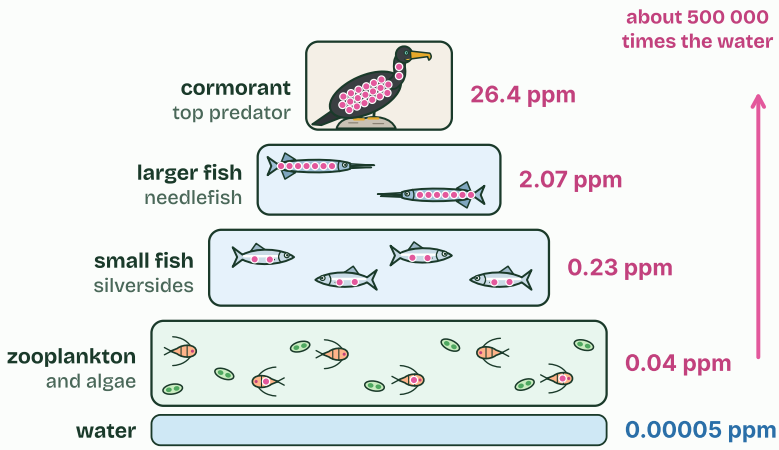
5 Each small fish eats many plankton. Most of their biomass is respired, but their DDT stays, so it is more _____ in the fish.

6 The _____, a cormorant, carries the highest concentration of all.

Your own notes

ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each.



SUMMARY

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

10 Plastic that never goes away

D4.2.10

CUES

Predict: Why does breaking macroplastic into microplastic not solve the problem?

What is meant by biodegradable?

What is meant by macroplastic?

What is meant by microplastic?

NOTES

1 No decomposer has the enzymes to digest most plastics, so they are not _____.

2 _____ is the debris you can see, such as bags, bottles, nets and bottle caps.

3 _____ is debris smaller than about 5 mm (sources differ on the cut-off).

4 Plastics are _____ because they are not biodegradable.

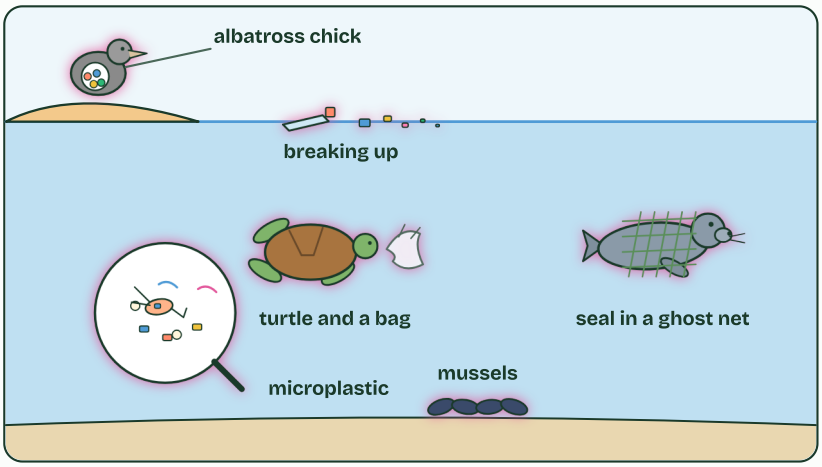
5 _____: entanglement and blocked guts, as in turtles, seals and albatross chicks.

6 _____: eaten by plankton and filter feeders, and carries toxins up food chains.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: laysan albatross chicks, persistent, sea turtle, ghost nets, microplastic, filter feeders.



SUMMARY

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

11 Let the land heal itself

D4.2.11

CUES

Predict: At Hinewai, why does leaving the invasive gorse alone speed up the return of native forest, rather than slowing it?

What is meant by rewilding?

What is meant by nurse crop?

NOTES

1 Most conservation protects what is left. _____ goes further: it restores the processes that make an ecosystem work and then lets them run with as little human interference as possible.

2 _____ on Banks Peninsula, in the South Island of New Zealand, is more than a thousand hectares of former sheep farm.

3 Since 1987, the botanist Hugh Wilson has managed it on a different principle: _____.

4 The gorse is left alone. It acts as a _____, sheltering native seedlings from wind, frost and browsing animals.

5 Rewilding restores _____, then lets them run.

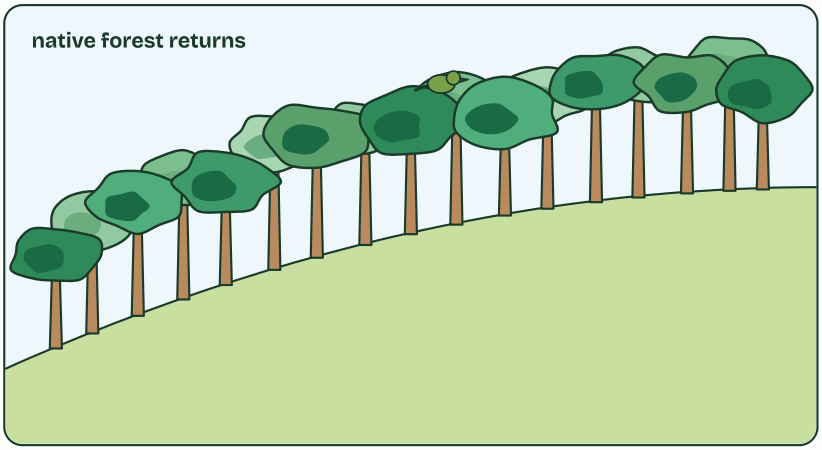
6 Methods: reintroduce _____, reconnect habitats, and _____.

7 _____: gorse left as a nurse crop, browsers excluded, native forest returning since 1987.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 1987., gorse; 2 left alone, nurse crop; 3 overtop; 4 native forest.



SUMMARY

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

12 Communities that change in order

D4.2.12 HL

CUES

Predict: A forest fire burns a wood to the ground. A new lava flow covers another. Which will be forest again first, and why?

What is meant by ecological succession?

What is meant by seral stage?

What is meant by primary succession?

What is meant by secondary succession?

NOTES

1 Over years to centuries one community replaces another in a fairly predictable sequence, called _____.

2 Each community in the sequence is a _____.

3 _____ are changes to the non-living environment.

4 _____ are changes to the living community.

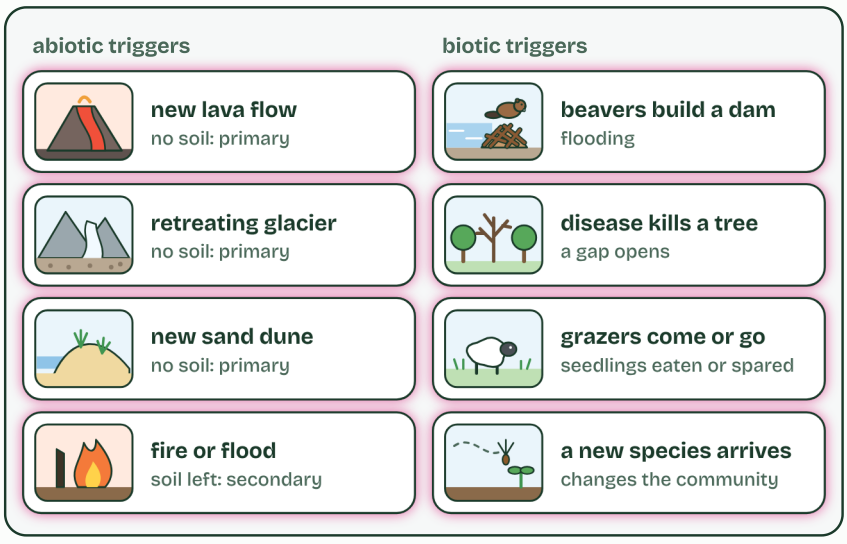
5 Where succession begins on ground with no soil, it is _____.

6 Where a disturbance removes the community but leaves the soil, as after a fire or when a field is abandoned, it is _____, which is faster because the soil, seeds and roots are already there.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: lava, a retreating glacier, a new sand dune, fire, flood or storm, beavers, disease, grazing animals, a new arrival.



SUMMARY

Sum up section 12 in two or three sentences of your own.

13 From bare rock to forest

D4.2.13 HL

CUES

Predict: Why does soil depth increase as succession goes on?

What is meant by pioneer species?

NOTES

1 The first colonizers are _____: cyanobacteria, lichens and mosses that can grip bare rock and survive drought and cold.

2 _____: from mats of lichen to tall trees.

3 _____: more and bigger plants capture more light energy.

4 _____: more kinds of plants give more habitats and food for animals.

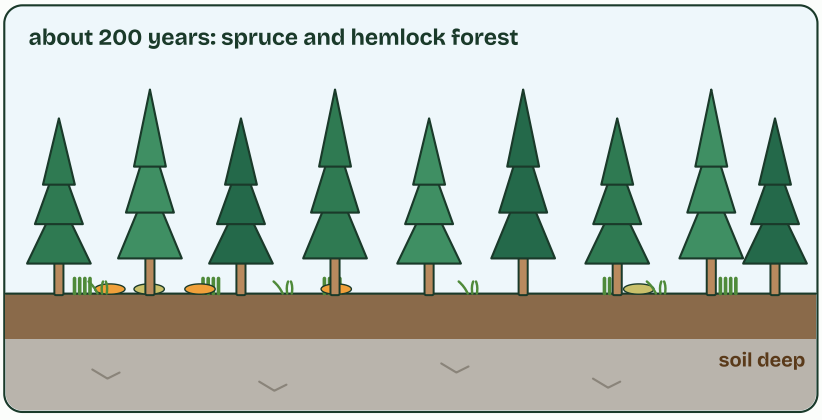
5 _____: more producers and consumers, with more links between them.

6 _____: a deeper soil, more dead matter and more decomposers, so more nutrients cycle faster.

Your own notes

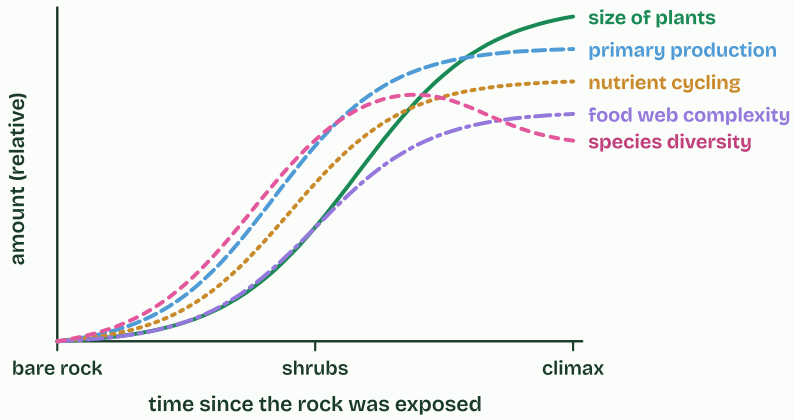
ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each.



ANNOTATE THE FIGURE

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



REMEMBER IT

What increases in primary succession

S Slowly	P Plants	S Spread	F Feeding	N Nature
S	P	S	F	N

SUMMARY

Sum up section 13 in two or three sentences of your own.

14 A succession that goes round in a circle

D4.2.14 HL

CUES

Predict: A heather moor has patches at all four phases. Why does the moor still look much the same from year to year?

What is meant by cyclical succession?

NOTES

1 In some ecosystems it is a loop instead: a series of communities replace each other and then the first one comes back. This is _____.

2 In the _____ phase a seedling grows among grasses, mosses and lichens.

3 In the _____ phase it forms a dense dome that shades out almost everything beneath.

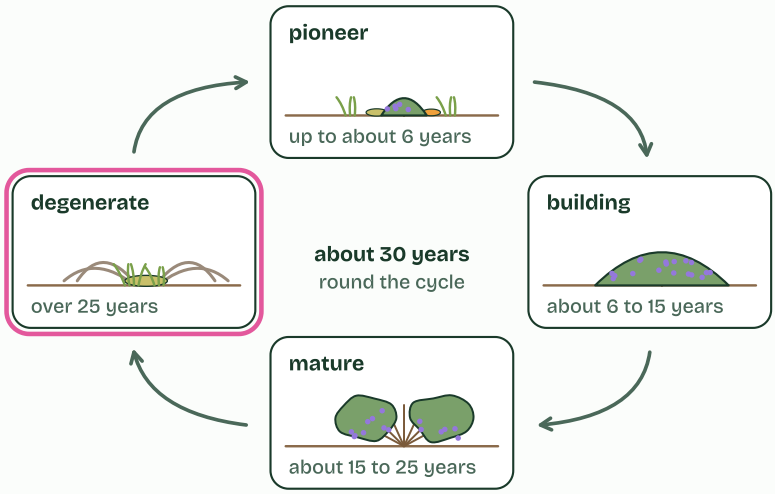
4 In the _____ phase the centre of the bush begins to open up.

5 In the _____ phase the old stems die and fall outwards, leaving a gap where lichens, mosses and grasses grow again, and then a new heather seedling starts the cycle.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 Pioneer.; 2 Building.; 3 Mature.; 4 Degenerate..



SUMMARY

Sum up section 14 in two or three sentences of your own.

15 Where succession stops

D4.2.15 HL

CUES

Predict: A sheep farm on a hillside in lowland Britain is abandoned. What would you expect to grow there after a hundred years?

What is meant by climax community?

What is meant by arrested succession?

NOTES

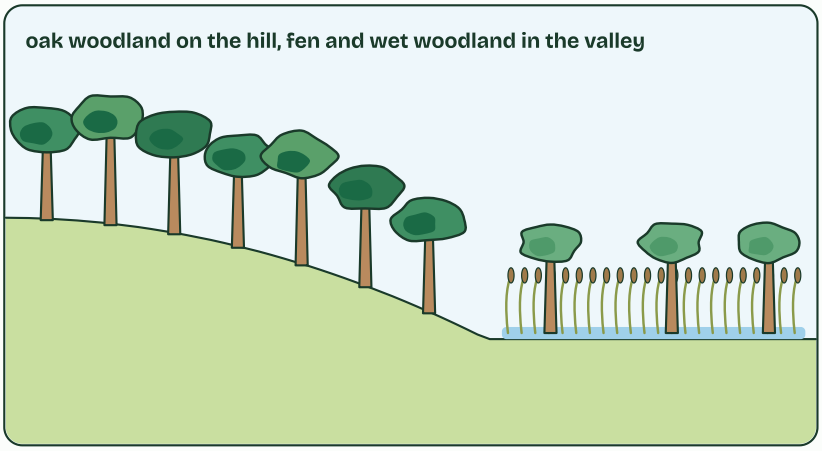
1 Succession tends towards a _____: the community that is stable under the climate and soil of that place.

2 People often stop succession before it gets there. This is _____, and the community it leaves is sometimes called a plagioclimax.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Left alone, Grazed by sheep and Valley drained. Note what changes each time.



SUMMARY

Sum up section 15 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 D4.2 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=D4.2&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.