NAME _____ CLASS _____ DATE _____

IB BIOLOGY · C4.1

Populations and communities

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 a population as an interacting, interbreeding group of one species in an area C4.1.1
- [ ] Explain why populations are estimated by random sampling, and what sampling error is C4.1.2
- [ ] Estimate a population of a sessile organism with random quadrats, and read its standard deviation C4.1.3
- [ ] Estimate a population of a motile organism with the Lincoln index, and state its assumptions C4.1.4
- [ ] Define carrying capacity and name resources that limit it C4.1.5
- [ ] Explain negative feedback by density-dependent factors, and contrast density-independent ones C4.1.6
- [ ] Explain the phases of a population growth curve, and test the exponential phase on a log scale C4.1.7
- [ ] Model the sigmoid curve with data from a growing population such as yeast C4.1.8
- [ ] Compare competition and cooperation within a species, with real examples C4.1.9
- [ ] Describe a community as all the interacting populations in an area C4.1.10
- [ ] Give an example of herbivory, predation, competition, mutualism, parasitism and pathogenicity C4.1.11
- [ ] Explain the benefits to both partners in root nodules, orchid mycorrhizae and coral zooxanthellae C4.1.12
- [ ] Explain how an invasive species can outcompete endemic species for resources C4.1.13
- [ ] Describe experiments and observations that test for interspecific competition C4.1.14
- [ ] Use a chi-squared test for association between two species C4.1.15
- [ ] Explain predator-prey cycles as density-dependent control, with a real case C4.1.16
- [ ] Distinguish top-down from bottom-up control of populations C4.1.17
- [ ] Describe allelopathy and the secretion of antibiotics, with an example of each C4.1.18

01 Who counts as one population?

C4.1.1 C4.1.2

CUES

Predict: A student estimates the daisies on a field by placing quadrats wherever daisies look thickest. What will the estimate be?

What is meant by population?

What is meant by random?

NOTES

1 A _____ is a group of organisms of one species living in one area, close enough to interact and, normally, to breed with each other.

2 So they take a _____ and scale it up to an estimate.

3 The sample must be _____: every individual, or every spot, must have the same chance of being picked.

4 Even a random sample gives an estimate that differs a little from the true size; that difference is the _____.

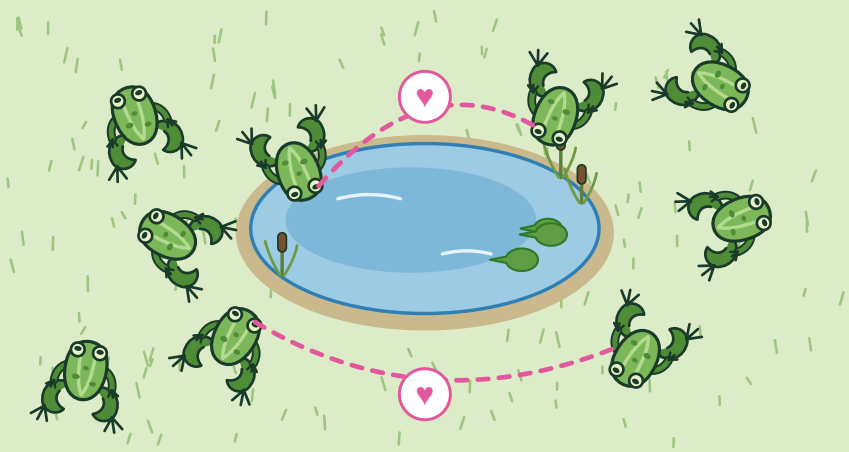
5 _____: one species, one area, interbreeding.

6 Estimate from a _____ sample; counting all is rarely possible.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as One pond and Two ponds and a road. Note what changes each time.



one population: any two can meet and breed

SUMMARY

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

02 Throw the square

C4.1.3

CUES

Predict: In the bench below, throw 20 random quadrats, then switch to By eye and place 10 yourself. What do you expect?

What is meant by quadrat?

NOTES

1 A _____ is a square frame, often 1 m on each side.

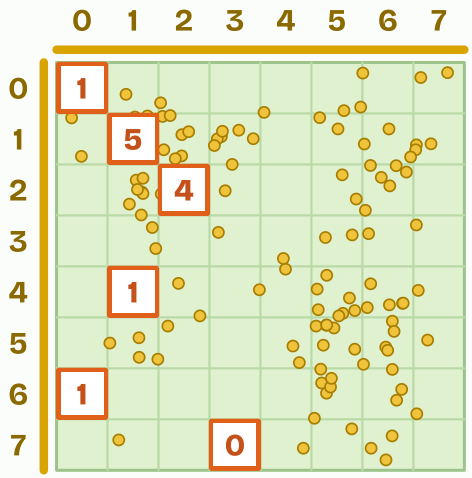
2 It suits _____ organisms, ones that stay put: plants, and animals such as barnacles and limpets on a rock.

3 Work out the _____ of the counts too (a calculator or spreadsheet does it).

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each.



a meadow 8 m × 8 m: 64 m²

random coordinates

(0, 6) (1, 4)
(3, 7) (0, 0)
(2, 2) (1, 1)

buttercups in each

1, 1, 0, 1, 4, 5

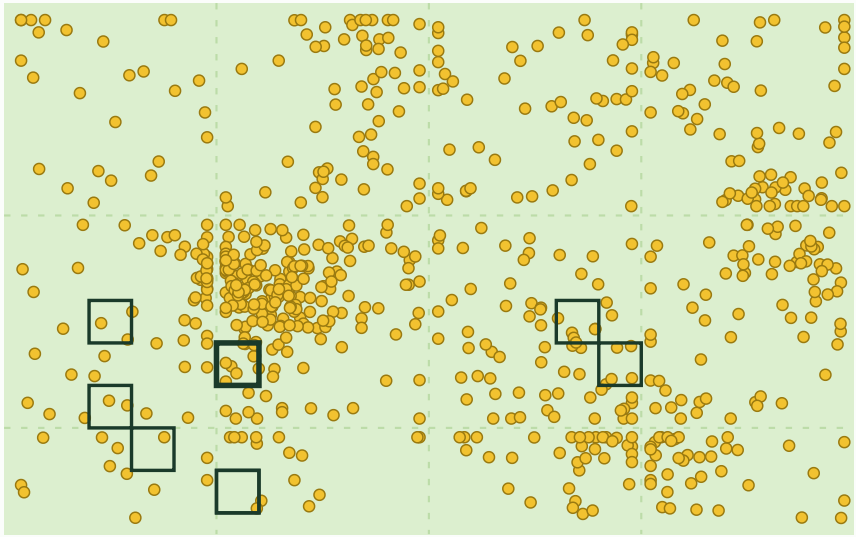
mean = 2.0 per m²

× 64 m² ≈ 128

real number: 120

ANNOTATE THE FIGURE

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



SUMMARY

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

03 Mark them, catch them again

C4.1.4

CUES

Predict: In the bench, choose Marks wear off and run it. Some marked woodlice lose their paint before the recapture. What happens to the estimate?

What is meant by lincoln index?

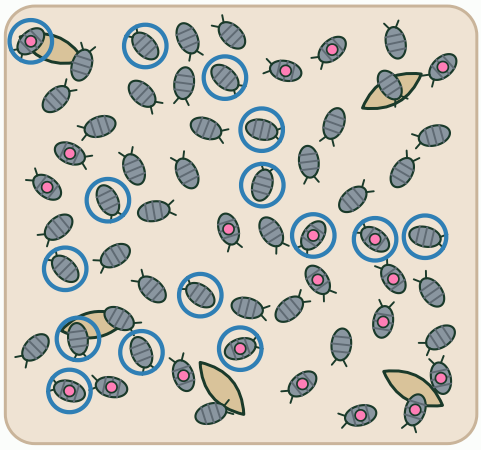
NOTES

1. For these _____ organisms ecologists use capture, mark, release and recapture.
2. If the marked animals have mixed in evenly, the share of marked ones in the second catch, R ÷ N, should match the share in the whole population, M ÷ population. That gives the _____:
3. It only works if its _____ hold: marks do not wear off or make animals easier to spot; marked and unmarked animals are equally likely to be caught; they mix fully between the samples; and no births, deaths or migration change the population in between.
4. For motile animals: _____.
5. Catch a first sample, _____ = 20, and mark each one with a dot of paint.
6. Catch again: _____ = 15 in the second catch, _____ = 5 of them marked.

Your own notes

ANNOTATE THE FIGURE

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



woodlice under the leaf litter

second catch
N = 15

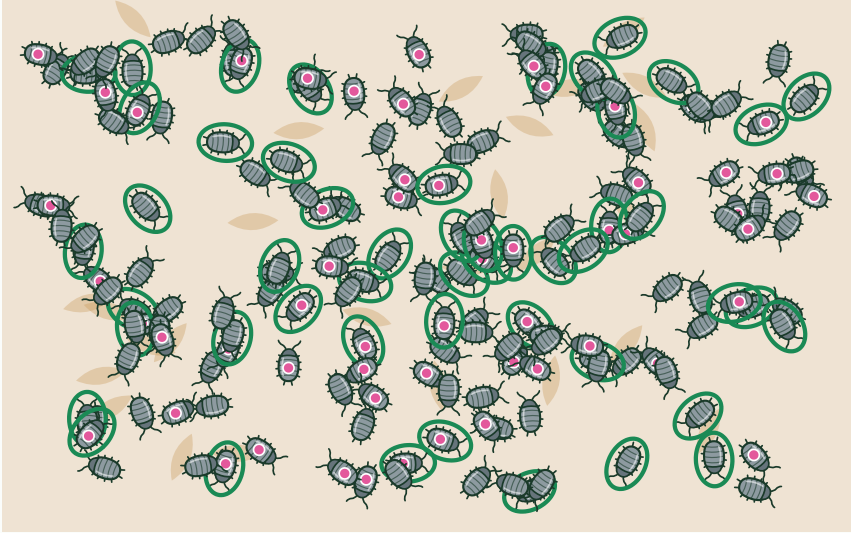
marked in it
R = 5

population ≈
M × N ÷ R
= 20 × 15 ÷ 5
= 60

the real number: 60

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 Room for so many

C4.1.5 C4.1.6 C4.1.7 C4.1.8

CUES

Predict: In the population growth bench (the Dry lab), you double the sugar in the flask. What happens?

What is meant by carrying capacity?

What is meant by density-dependent factors?

NOTES

1 The _____ (K) is the largest population an environment can support long term.

2 Individuals then _____ for it.

3 Some factors hit harder the more crowded the population is. These _____ include competition for resources, predators (more prey makes hunting easier) and pathogens and pests, which spread faster between crowded hosts.

4 They act as _____: above K, births fall and deaths rise and the population drops; below K the reverse, and it climbs. _____ factors, such as a flood, a frost or a fire, kill a share of the population whatever its size, and can knock it away from K, but they do not push it back.

5 A population introduced into a new area with plenty of resources grows along a _____ (S-shaped) curve with three phases:

6 To test whether growth really is exponential, plot the numbers on a _____ against time on an ordinary scale: exponential growth is then a straight line.

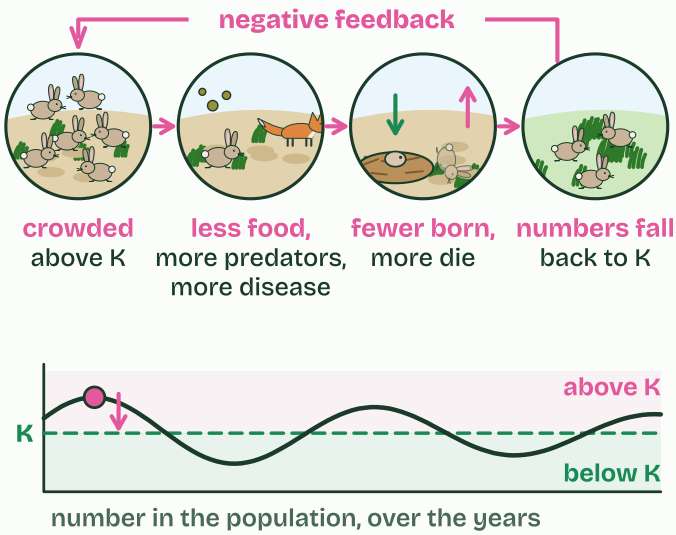
7 _____: the most an environment supports, set by limited resources.

8 _____ (competition, predation, disease) give negative feedback towards K.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Above K and Below K. Note what changes each time.



SPOT THE MISTAKE

What do students often get wrong about carrying capacity and competition for limited resources Negative feedback control of population size by density-dependent factors Population growth curves Modelling of the sigmoid population growth curve? 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 Rivals and allies

C4.1.9

CUES

Predict: Why is competition usually fiercer within a species than between two different species?

NOTES

1 Members of one species need exactly the same things, so when something is in short supply they compete for it more fiercely than with any other species. _____ can be for food, water, light, territory, nest sites or mates.

2 Members of a species also _____, when working together gains each one more than it costs.

3 Competition within a species:

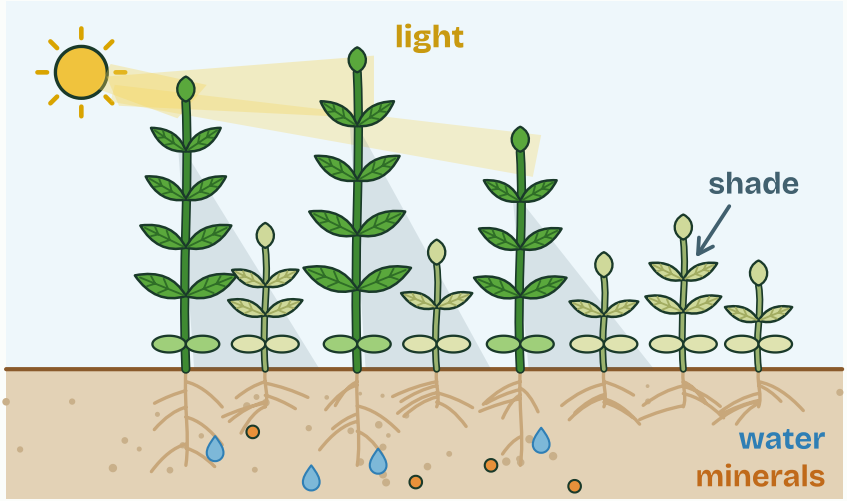
_____.

4 Cooperation: _____.

Your own notes

ANNOTATE THE FIGURE

The figure shows it as Competition and Cooperation. Note what changes each time.



seedlings of one species compete for light, water and minerals: the tallest shade the rest

SUMMARY

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

06 Six ways to get along

C4.1.10 C4.1.11 C4.1.12

CUES

Predict: Sea water warms and corals expel their zooxanthellae ("bleaching"). Why do bleached corals often die?

What is meant by community?

What is meant by mutualism?

NOTES

1 A _____ is every population living in an area together: the plants, animals, fungi and bacteria, all interacting.

2 In _____ both species benefit:

3 _____: all the populations in an area.

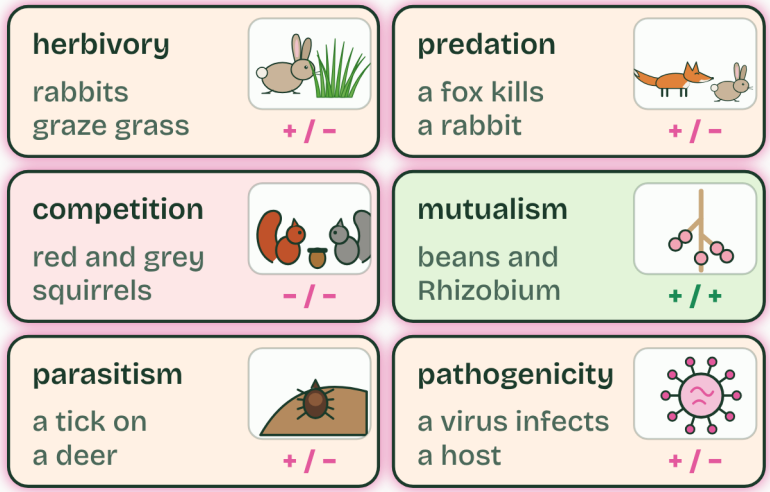
4 Herbivory, predation, parasitism, pathogenicity (+/–); competition (–/–); _____ (+/+).

5 _____ examples: legume nodules, orchid mycorrhizae, coral zooxanthellae.

Your own notes

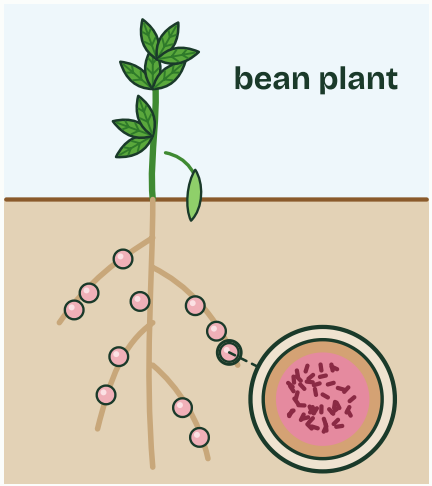
ANNOTATE THE FIGURE

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



ANNOTATE THE FIGURE

The figure shows it as Root nodules, Orchid mycorrhiza and Coral zooxanthellae. Note what changes each time.



the plant gives
sugars from photosynthesis

Rhizobium gives
ammonium: nitrogen fixed from the air

SUMMARY

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

07 Newcomers and tests

C4.1.13 C4.1.14

CUES

Predict: In Connell's experiment, what was the purpose of leaving some plots with Balanus untouched?

What is meant by invasive species?

NOTES

1 An _____ species is native to a place.

2 An _____ has been brought in from elsewhere, spreads, and harms what was there.

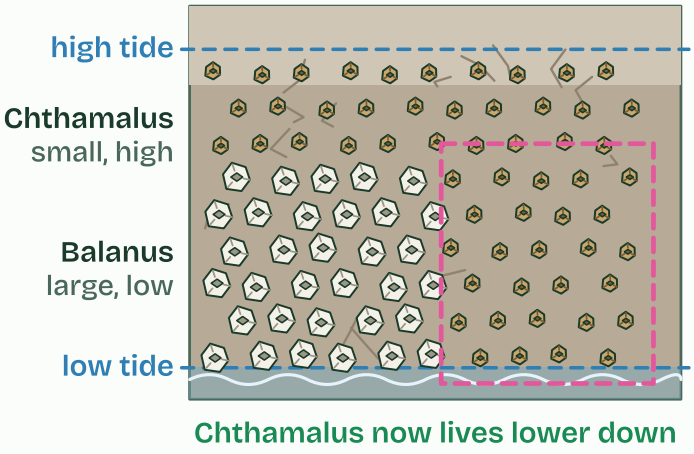
3 If one species does better when another is absent, competition is _____, but something else, such as a different predator or a difference in the soil, might explain it.

4 _____ often win by taking a shared resource more efficiently.

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each: 1 Chthamalus, Balanus; 2 Balanus; 3 Chthamalus.



SUMMARY

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

08 Together, apart, or chance?

C4.1.15

CUES

Predict: On the Hillside in the bench, heather and creeping buttercup are found together in fewer quadrats than expected, and $\chi^2 = 11.2$. What should you conclude?

What is meant by chi-squared test?

NOTES

1 If they grow together more often than chance predicts, there is a _____: perhaps they need the same conditions, or one helps the other.

2 If they occur together less often, a _____: perhaps they need different conditions, or they compete.

3 The _____ tells you whether the difference from chance is big enough to be real.

4 $\chi^2 > 3.84$ (1 df, p = 0.05): _____.

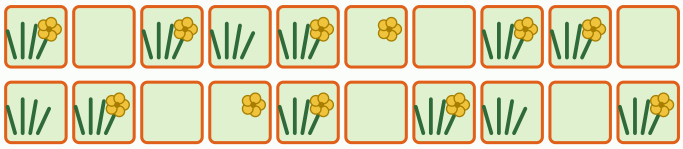
5 The _____ counts go in a 2 × 2 table.

6 The _____ counts come from the totals. $\chi^2 = 4.85$, above 3.84: the two grow together more than chance predicts.

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each.



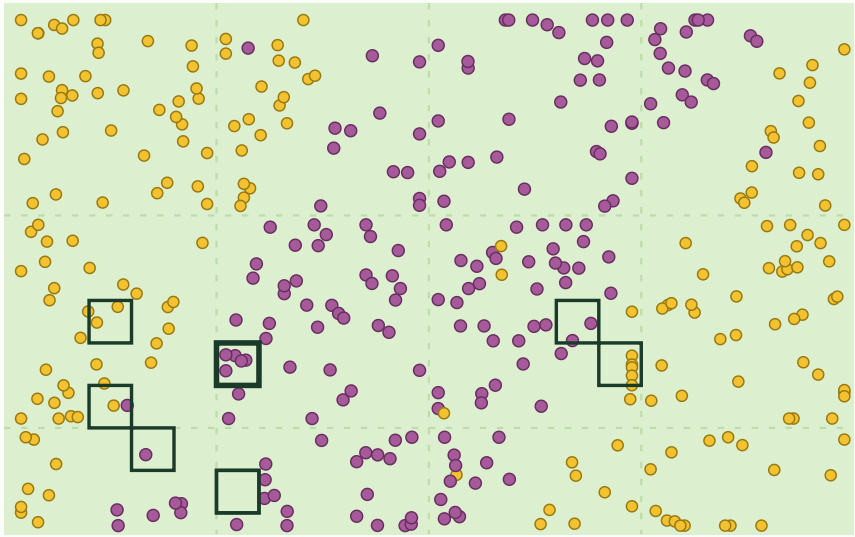
soft rush creeping buttercup

	buttercup	no buttercup
rush	9 (6.6)	3 (5.4)
no rush	2 (4.4)	6 (3.6)
total	11	9

$\chi^2 = 4.85 > 3.84$: a significant positive association

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 use of the chi-squared test for association between two species? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

09 Held in check

C4.1.16 C4.1.17 C4.1.18

CUES

Predict: In the film, choose Lynx trapped out. What happens to the hares after year 20?

What is meant by top-down control?

What is meant by bottom-up control?

What is meant by allelopathy?

NOTES

1 Predation is _____: the more hares there are, the more are eaten, which pulls their numbers back.

2 A population can be held back from above or from below.

_____ comes from predators;

_____ comes from the food, nutrients and producers below.

3 In _____ a plant releases substances that stop others growing near it: black walnut trees release juglone from their roots, leaves and nut husks, and many plants wilt and die near them.

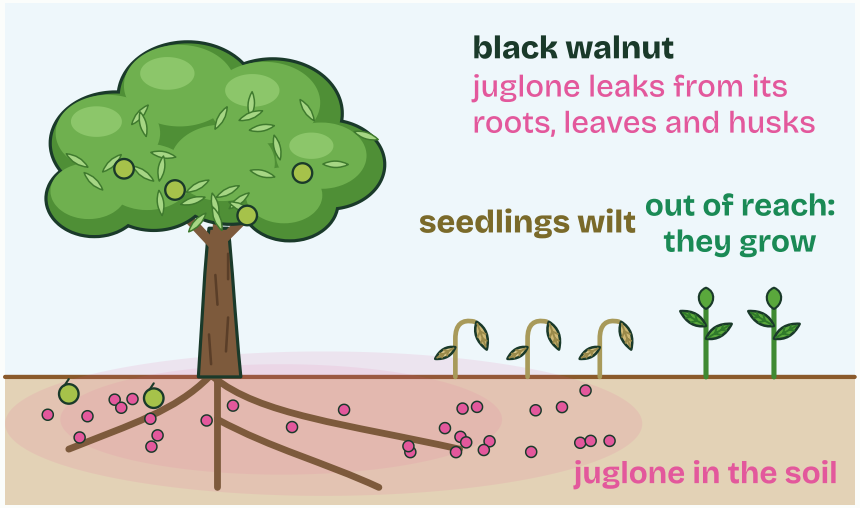
4 Microorganisms secrete _____: the mould *Penicillium* secretes penicillin, which kills bacteria competing with it for the same food.

5 _____ (black walnut, juglone) and antibiotics (Penicillium, penicillin) deter competitors.

Your own notes

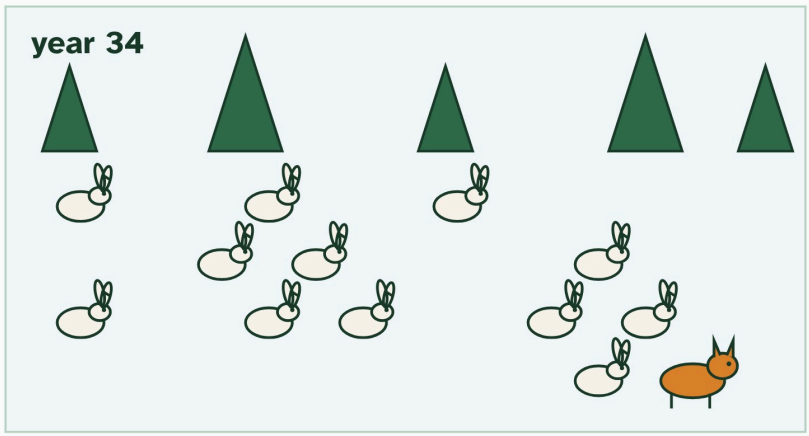
ANNOTATE THE FIGURE

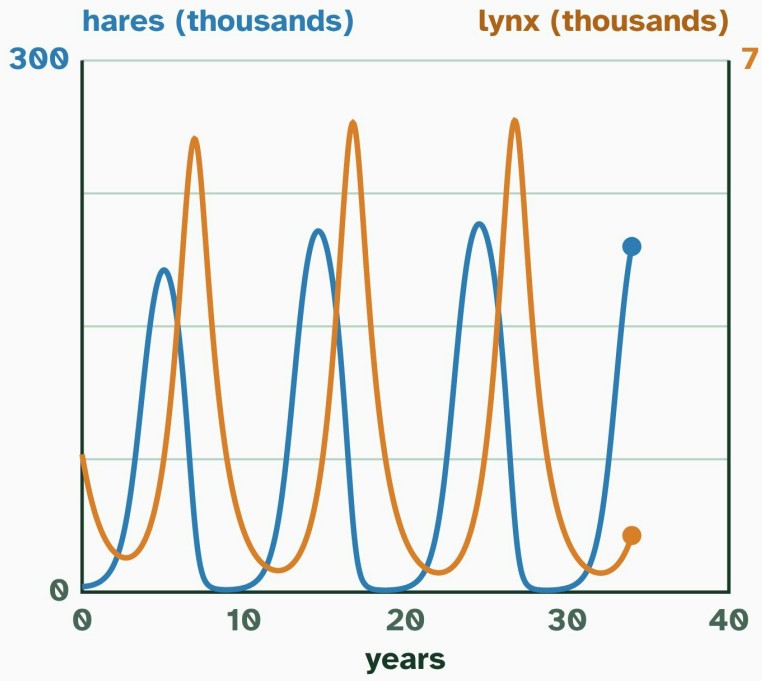
The figure shows it as Black walnut and Penicillium. Note what changes each time.



ANNOTATE THE FIGURE

Annotate this still from the animation (Watch it happen: lynx and hares): what is happening, and why?





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 C4.1 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=C4.1&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.