Stability and tipping points

60 minutes • D4.2.1 to D4.2.4 • Chapters 1, 2, 3, 4 • The dry lab

What makes an ecosystem stable for millions of years, the Amazon as a possible tipping point, and sealed mesocosms as a model

BY THE END, STUDENTS 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

TIMING

0–5	5 min	**Do now: the oldest place**	
5–13	8 min	**Two old ecosystems**	
13–21	8 min	**Every Nest Gets Care**	
21–36	15 min	**Flying rivers**	
36–53	17 min	**Life in a sealed jar**	
53–60	7 min	**Exit**	
	60 min	**One lesson**	

STARTER

5 min

Do now: the oldest place

Show a photograph of the Daintree. “This forest is older than the dinosaurs’ extinction. What would it need to keep going that long?” Students list ideas. Keep them for the mnemonic.

ON THE BOARD, FROM THE GUIDE

Open the guide on the projector at each chapter (the links work in this PDF). Every figure plays from its own buttons, and the lesson's slides have the same figures, step by step, in the order of this plan.

01 Some ecosystems last for millions of years

CHAPTER 01 IN THE SLIDES

Tap the parts of the figure in turn: The canopy, Idiot fruit tree, Fossil pollen, Fog, The dunes, Welwitschia and Fog-basking beetle.

> **Predict box:** Why are very old, stable ecosystems such as the Daintree so rich in species found nowhere else? Hands up or mini whiteboards first.
>
> **Answer B: Lineages have had a very long time to diversify there, with no event that wiped them out**

02 Four things a stable ecosystem needs

CHAPTER 02 IN THE SLIDES

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. **Energy.** Sunlight is captured by the producers. Energy is lost as **heat** at every step, so it must be supplied all the time.
2. **Nutrients. Decomposers** break down dead leaves and bodies and release minerals, which roots take up again. Matter is recycled.
3. **Genetic diversity.** Members of each population differ, so some can survive a new disease or a change in conditions, and the population can adapt.
4. **Climate.** Temperature and rainfall stay within the range the species can **tolerate**. Every Nest Gets Care.

> **Predict box:** A forest is cut and the logs are taken away every 30 years. Which requirement for stability does this put at risk most directly? Hands up or mini whiteboards first.
>
> **Answer B: The recycling of nutrients, because the nutrients locked in the logs leave the forest and never return**

> **Remember it:** Every Nest Gets Care (Energy, Nutrients, Genetic diversity, Climate).

03 The forest that makes its own rain

CHAPTER 03 IN THE SLIDES

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. Moist air blows in from the **Atlantic** and forms clouds over the coast.
2. Rain falls on the forest. Trees take up the water and release it again by **transpiration**, and new clouds form further west.
3. The water is recycled several times across the continent. Blocked by the Andes, the moist air flows south as a **flying river**, bringing rain to southern Brazil.
4. Clear a large area and transpiration there stops. Less rain falls downwind, the dry season lengthens and the remaining forest dries out and burns.

Show the figure.

> **Predict box:** Nobody knows exactly how much forest the Amazon can lose before it tips. Why is this so hard to find out? Hands up or mini whiteboards first.
>
> **Answer B: There is only one Amazon, so models are all we have, and they depend on climate warming too**

04 An ecosystem in a bottle

CHAPTER 04 IN THE SLIDES

Tap the parts of the figure in turn: Mud and microbes, Pondweed, Snails, The seal, Light in and Heat out.

> **Predict box:** 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? Hands up or mini whiteboards first.
>
> **Answer B: The dark jar, because with no photosynthesis everything there uses oxygen and nothing makes it**

THE LESSON

8 min — Two old ecosystems

Chapter 1's figure: tap all six parts. Ask which parts are *evidence* of age and which are *adaptations* that long stability allowed. Then its predict box.

8 min — Every Nest Gets Care

Chapter 2's film through its four steps. Students sort their do-now ideas under the four requirements. The predict box on logging tests the nutrient cycle.

15 min — Flying rivers

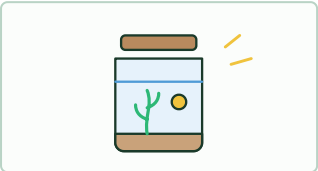
Chapter 3's film, then the tipping point graph. Stress the uncertainty band: the threshold is not known. Students do the two percentage change sums, then the Amazon worksheet from the deck if you use it.

17 min

Life in a sealed jar

Chapter 4's figure and predict box, then the dry lab in pairs: light, snails and pondweed. Each pair finds one stable jar and one that fails, and explains both in terms of oxygen. They then plan the jar they will seal for real.

ACTIVITIES



PRACTICAL

Seal a mesocosm

Groups seal a jar of pond water with a measured mass of pondweed, a set number of snails and a spoonful of pond mud, and vary one factor between jars (light, plant mass or snails). Measure dissolved oxygen with a probe or a colour kit every few days for two to four weeks. Check the animals daily and release them if stressed.

Needs: glass jars with lids, pond water and mud, pondweed, water snails, a dissolved oxygen probe or kit, a light source.

PLENARY

7 min

Exit

Why is a sealed jar a better model of ecosystem stability than an open tank? Two sentences, one about matter and one about energy.

WHAT STUDENTS GET WRONG

"A stable ecosystem never changes." Populations rise and fall in it all the time. Stability means it stays within limits and recovers after a disturbance.

"Energy is recycled in an ecosystem." Nutrients are recycled. Energy flows through and is lost as heat, so it must be supplied all the time.

"Percentage change divides by the new value." Always divide by the original value.

STRETCH AND SUPPORT

Support: a worked percentage change on the board with the formula boxed, before students try their own.

Stretch: the Amazon is also warming. How could warming and deforestation together lower the tipping point?

IN THE GUIDE

1 Some ecosystems last for millions of years
2 Four things a stable ecosystem needs
3 The forest that makes its own rain
4 An ecosystem in a bottle
Lab Dry lab: Life in a sealed jar
All The whole guide, with the figures that play
PPTX This lesson's slides, in the order of this plan

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on D4.2 at standard level each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?topics=D4.2&level=SL&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on D4.2, built from its key terms and ready to print
- A pub quiz with rounds on D4.2, to present or run with no projector
- An escape room built from the question bank on D4.2

ALREADY ON THE SITE FOR D4.2

- Quiz: Stability & Change
- Revision map: D4.2 Stability and change, to fill in
- Exam questions: D4.2 in the exam maker, a paper with its markscheme

CARD SETS ON SPLYCR

Open a set to host it as a class game, or make a copy to edit.

- D4.2 Stability and Change

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.