IB BIOLOGY | D4.2 | SL AND HL

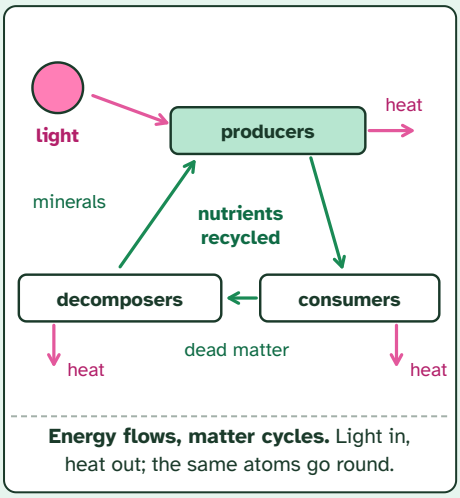
REVISION ON TWO PAGES

Ecosystems that *last*

What keeps them stable, and how people tip them. What to know, draw and say.

THE ONE IDEA

An ecosystem stays stable while energy flows in, nutrients cycle and its species can cope. People can push it past that.



Energy flows, matter cycles. Light in, heat out; the same atoms go round.

D4.2.1, D4.2.2 START HERE

What keeps an ecosystem *stable*

- **Stability:** the **same community and processes** carry on for a very long time. Populations still rise and fall, but stay within limits.
- **Evidence:** the **Daintree** rainforest has lasted over 100 million years, the **Namib** desert at least 55 million. Fossil pollen, the age of the rocks and ancient lineages show it.
- A stable ecosystem needs **all four** things below. Lose any one and it starts to change.

THE FOUR REQUIREMENTS

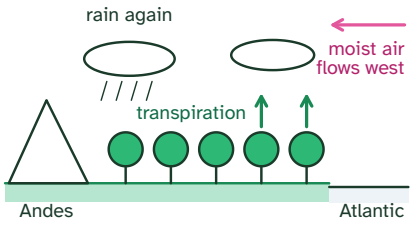
Every Nest Gets Care

E Energy a constant supply, almost always sunlight	**N** Nutrients recycled by decomposers	**G** Genetic diversity variation, so populations can adapt	**C** Climate temperature and rainfall within tolerance

D4.2.3

The Amazon: a *tipping point*

- Trees **transpire** vast amounts of water vapour. It **cools** the land, and moist air flows carry it west to fall as rain.
- **Deforestation** cuts transpiration: less rain, longer dry seasons. Below a **minimum area** the forest could die back to savanna.
- That area is **uncertain**: estimates range from about 20% to 40% loss.



Skill: % change = (new – original) ÷ original × 100. 4.0 to 3.3 million km² is **–17.5%**.

D4.2.4

A model in a *jar*

- A **mesocosm** is a small model ecosystem that can be controlled and repeated, to test one variable.
- Aquatic or microbial ones work better than terrestrial ones. Care for any animals under IB guidelines.
- **Example:** a sealed jar of pondweed, snails and pond-mud microbes can stay balanced for months.

Sealed glass vessel better
No matter enters or leaves, so nutrients must be recycled inside. **Energy still crosses**: light in, heat out.

Open tank weaker
Matter can enter and leave, so the model is not a closed system.

D4.2.5

Keystone species

- A keystone species has a **disproportionate effect** on community structure for its numbers. Remove it and the **ecosystem can collapse**.
- **Sea otters** eat sea urchins, which graze kelp. Without otters, urchins strip the kelp forest and the species living in it go.
- **Paine:** sea stars removed, mussels took over the rock.
- A keystone can be a predator, an ecosystem engineer or a mutualist.

15 species with sea stars	**8** once they were removed

D4.2.6

Harvesting *sustainably*

- Sustainable when the **rate of harvesting is lower than the rate of replacement**.
- **Assess it by** monitoring population size, age structure and catch per unit effort.

Brazil nut a plant on land
Gathered from wild trees. Where gathering was heavy, **few young trees** were found: no replacement.

Atlantic cod a sea fish
Grand Banks trawlers took far more than replacement. The stock **collapsed in 1992**.

D4.2.7

Can a *farm* last?

- A farm is a simplified ecosystem: every harvest carries minerals away. Its sustainability depends on five factors.
- **Inputs:** nitrogen fertiliser is made with fossil fuel; phosphate is mined from rock that will run out.
- **Fixes:** cover crops and contour ploughing against erosion; fertiliser little and often; legumes and manure for nitrogen.

FIVE FACTORS

Every Lazy Ivy Poisons Crops

E Erosion of soil	**L** Leaching nutrients	**I** Inputs fertiliser	**P** Pollution chemicals	**C** Carbon footprint

D4.2.8 IN ORDER: LITTLE ALGAE LOVE DIRTY DARK DITCHES

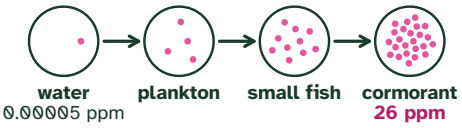
Eutrophication from leaching

LITTLE	ALGAE	LOVE	DIRTY	DARK	DITCHES
Leaching Fertiliser washes in	**Algal bloom** Algae multiply	**Light blocked** Plants below die	**Death** Algae die too	**Decomposers** Bacteria: BOD rises	**Deoxygenation** Fish die

D4.2.9

Biomagnification

- **DDT** and **mercury** are taken in faster than they are broken down or excreted: they **bioaccumulate**.
- Most prey biomass is respired, but the toxin stays: **concentration rises at each trophic level**.
- DDT thinned the eggshells of birds of prey; mercury harms the nervous system.



D4.2.10

Plastic in the *oceans*

- Plastics are **not biodegradable**: decomposers cannot digest most of them, so they persist.
- **NOS:** media coverage of research shifted public opinion, driving action.

Macroplastic visible
Entangles, blocks guts: turtles, seals, **Laysan albatross** chicks on Midway.

Microplastic under about 5 mm
Eaten by plankton and filter feeders; carries toxins up food chains.

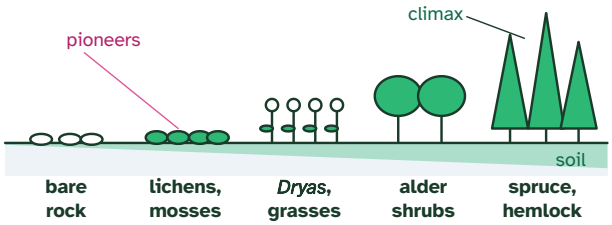
D4.2.11

Rewilding

- Restores **natural processes**: bring back **apex predators** and keystone species, reconnect habitats over large areas, minimise human impact.
- **Hinewai Reserve**, New Zealand: browsers kept out, **gorse left as a nurse crop**; native trees overtop it.
- **Yellowstone:** grey wolves returned in 1995; riverside trees grew back in places.

D4.2.12, D4.2.13 HIGHER LEVEL: GLACIER BAY, ALASKA

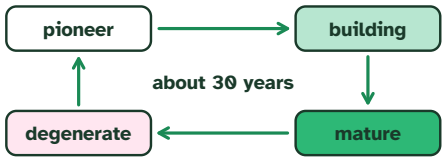
Succession and its *causes*



- Triggered by **abiotic** (glacier retreat, fire) or **biotic** (new species, disease) change. **Primary:** no soil at first; **pioneers** make it.
- Five things **increase**: plant size, primary production, species diversity, food web complexity, nutrient cycling (*Slowly Plants Spread Feeding Nature*).

D4.2.14, D4.2.15 HIGHER LEVEL

Cycles, climax and arrest



- **Cyclical:** heather (*Calluna vulgaris*; either name scores) patches cycle out of step: the moor stays the same.
- Succession tends to a **climax community**. **Arrested succession**: livestock graze tree seedlings; drained wetlands stay farmland.

WATCH OUT

Six mistakes that *cost marks*

- ✕ **Stable is not unchanging.** Populations still rise and fall, but stay within limits.
- ✕ **Keystones need not be common.** Effect, not numbers.
- ✕ **A sealed jar still gets energy.** Light enters and heat leaves; only matter is sealed in.
- ✕ **Nitrate does not use up oxygen.** Bacteria decomposing the dead algae do: that is the BOD.
- ✕ **Microplastic is still plastic.** Breaking plastic up does not make it biodegradable.
- ✕ **Divide by the original area.** Not by the area left.

COVER THE SHEET

Can you *answer these?*

1. State the four requirements for stability.
2. Explain why the Amazon may have a tipping point.
3. Explain why a sealed mesocosm is the better model.
4. Outline why sea otters are a keystone species.
5. Outline how harvesting and farming can be sustainable.
6. Explain how leaching raises the BOD of a lake.
7. Explain why DDT is highest in top predators.
8. Outline two effects of plastic on marine life.
9. Outline how Hinewai Reserve was rewilded.
10. Outline primary and arrested succession. HL

IN THE EXAM

Answer eutrophication, the Amazon and biomagnification as chains: every link in order, each **naming its mechanism** (transpiration, BOD, respiration).

GO FURTHER

Films, a sealed-jar dry lab and a marked Check are in the full guide online.