

Ecology

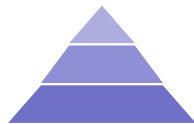
AP Biology ■ Unit 8

AP Biology



What we will cover

- 1 Responses to the environment
- 2 Energy flow
- 3 Population growth
- 4 Density factors
- 5 Community ecology
- 6 Biodiversity and disruptions





Responses to the environment

Organisms react to survive and keep **homeostasis** :

- **innate** (built in) vs learned behaviour
- a **tropism** : growth toward a cue (light, gravity)
- **signals** coordinate a group (the bee dance)

A lizard basks then shades to hold its temperature – behaviour protecting homeostasis.



Tropisms bend growth toward useful cues

Innate and learned behaviour

the principle	organisms sense and respond in ways that aid survival and reproduction
innate behaviour	inherited and present without experience – reflexes, fixed action patterns, taxis and kinesis
learned behaviour	acquired through experience – habituation, conditioning, imprinting
why innate persists	it is reliable and needs no learning time, which matters when the first mistake is fatal
why learning persists	it adapts to conditions too variable to be worth encoding genetically
communication	signals – chemical, visual, auditory, tactile – coordinate behaviour between individuals

Ask what the environment is like: **stable** environments favour innate responses, **variable** ones favour learning. That framing answers most behaviour questions.



Energy flow

Energy enters through **producers** and climbs the **trophic levels** .

- **consumers** eat others
- **decomposers** recycle nutrients

Only $\sim 10\%$ passes up each level – the **10% rule** – so food chains stay short.



Energy enters at producers; chains stay short

Worked example – the 10% rule up the chain

Producers capture 10,000 kcal. How much reaches the secondary consumers?

- primary consumers:
 $10\% \times 10,000 = 1,000 \text{ kcal}$
- secondary consumers:
 $10\% \times 1,000 = 100 \text{ kcal}$
- the other 90% at each step leaves as **heat**, waste and uneaten tissue

Each level keeps about a tenth. That is why food chains are **short** – after four or five levels there is not enough energy left to support another.

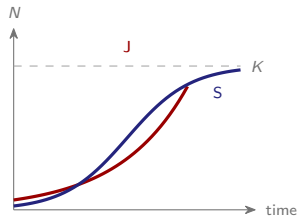


Population growth

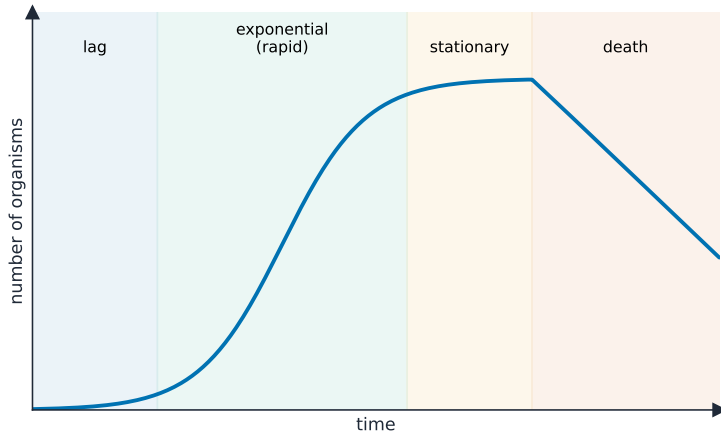
Two growth models:

- **exponential** : a J-curve, $\frac{dN}{dt} = rN$
- **logistic** : an S-curve, slowed by resources

Growth levels off at the **carrying capacity** K : $\frac{dN}{dt} = rN \frac{K - N}{K}$.



Population growth: lag



Population growth: lag, exponential, then levelling off at the carrying capacity

Worked example – the logistic growth rate

A population has $r_{\max} = 0.5 \text{ yr}^{-1}$, carrying capacity $K = 1000$, and current size $N = 400$. Find dN/dt .

- $\frac{dN}{dt} = r_{\max} N \frac{K - N}{K}$
- $= 0.5(400) \frac{1000 - 400}{1000}$
- $= 200 \times 0.6 = 120 \text{ yr}^{-1}$

Exponential growth

$r_{\max} N$ would give 200.

The $(K - N)/K$ term is what makes it **logistic** : it approaches zero as N approaches K .



Density factors

What limits a population splits by whether crowding matters:

- **Density-dependent** – competition, predation, disease
- **Density-independent** – floods, fire, frost



Crowding intensifies density-dependent limits

Together they make a population rise and fall around K rather than sitting still.



Community ecology

A **community** is all the species interacting in one area. **Symbiosis** sorts by who benefits:

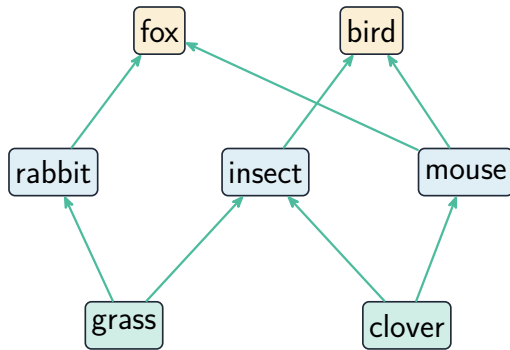
- **mutualism** : both win (+/+)
- **commensalism** : one wins (+/0)
- **parasitism** : one harmed (+/-)

A **keystone species** (sea otter) holds up the whole community.



Mutualism: both partners gain

A food web links several food chains together



A food web links several food chains together



Biodiversity and disruptions

Biodiversity makes an ecosystem stronger:

- more **stability** and recovery
- free **ecosystem services** (clean water, pollination)

Invasive species , **habitat** loss, and **climate change** ripple far through food webs.



Habitat loss ripples through food webs

Biodiversity, resilience and succession

biodiversity

the variety of life at three levels – **genes, species and ecosystems**

why it matters

higher diversity generally makes a community more **re-silient** to disturbance

the mechanism

varied species can fill the roles that lost ones held

ecological succession

the ordered change in a community over time after a disturbance

primary succession

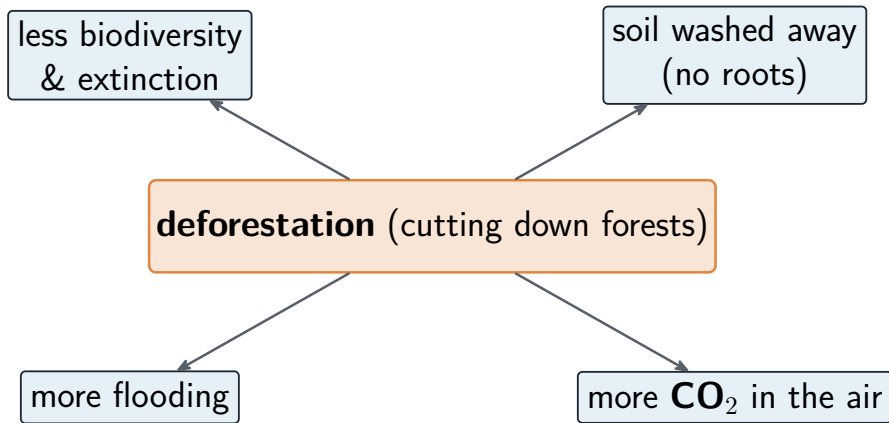
begins on **bare rock** with no soil – very slow

secondary succession

follows a disturbance that **leaves the soil**, so it is much faster

Resilience is the link between the two ideas: succession is how a community rebuilds, and diversity is what determines how well it does so.

Deforestation lowers biodiversity and causes erosion



Deforestation lowers biodiversity and causes erosion, flooding, and higher CO₂

Biodiversity



ecosystem
diversity



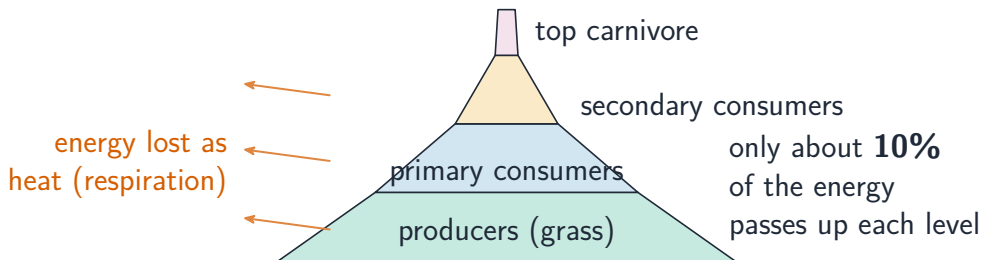
species
diversity



genetic diversity
(within a species)

Biodiversity at three levels: genetic, species, and habitat

Energy Flow Through Ecosystems



Only about 10% of the energy passes to the next trophic level

Exam tips

- Apply the **10% rule**: about 90% of energy is lost at each trophic level, so food chains are short.
- Distinguish **exponential** (J) from **logistic** (S) growth; the latter levels off at the **carrying capacity** ($\frac{dN}{dt} = r_{\max} N \frac{K-N}{K}$).
- Separate **density-dependent** (competition, disease, predation) from **density-independent** (weather) limiting factors.
- Name community interactions (competition, predation, symbiosis) and the effect of a **keystone species**.
- Explain how disturbing one species – especially a keystone or a whole trophic level – ripples through the ecosystem.



Unit 8 – key takeaways

1

Energy flow

producers up the trophic levels;
only $\sim 10\%$ passes on

2

Growth

J exponential vs S logistic; levels
off at K

3

Limits

density-dependent vs independent
factors around K

4

Community

symbiosis $+/+$, $+/0$, $+/-$; key-
stone species; biodiversity

Check yourself

- 1 About how much energy passes to the next trophic level?
- 2 Which growth curve is J-shaped?
- 3 Is a drought density-dependent or independent?
- 4 Name the symbiosis where both species benefit.



Answers 1. about 10% 2. exponential 3. density-independent 4. mutualism