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

1 Responses

Responses to the environment

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

- **innate** 先天的 (built in) vs learned behaviour
- a **tropism** 向性: growth toward a cue (light, gravity)
- **signals** 信号 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.

2 Energy flow

Energy flow

Energy enters through **producers** 生产者 and climbs the **trophic levels** 营养级.

- **consumers** 消费者 eat others
- **decomposers** 分解者 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:
  $10\% \times 10{,}000 = 1{,}000$ kcal
- secondary consumers:
  $10\% \times 1{,}000 = 100$ 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.

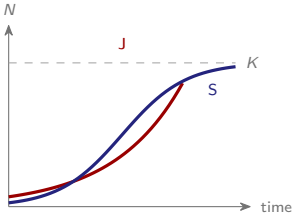
3 Population growth

Population growth

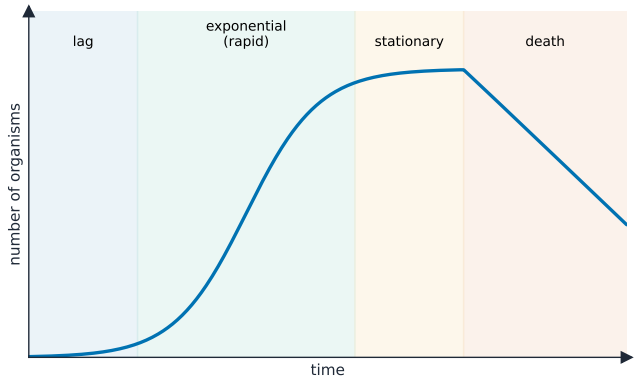
Two growth models:

- **exponential** 指数增长: a J-curve, $\frac{dN}{dt} = rN$
- **logistic** 逻辑斯谛增长: an S-curve, slowed by resources

> Growth levels off at the **carrying capacity** 承载力 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 $r_{\max} = 0.5$ yr^{-1}, carrying capacity $K = 1000$, and current size $N = 400$. Find dN/dt.

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

Exponential growth 指数增长 $r_{\max} N$ would give 200. The $(K - N)/K$ term is what makes it **logistic** 逻辑斯蒂增长: it approaches zero as N approaches K.

4 Density

Density factors

What limits a population splits by whether crowding matters:

- **Density-dependent 密度制约** – competition, predation, disease
- **Density-independent 非密度制约** – floods, fire, frost

Crowding intensifies density-dependent limits

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

5 Community

Community ecology

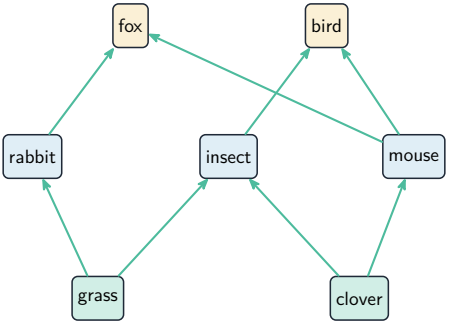
A **community** 群落 is all the species interacting in one area. **Symbiosis** 共生 sorts by who benefits:

- **mutualism** 互利共生: both win $(+/+)$
- **commensalism** 偏利共生: one wins $(+/0)$
- **parasitism** 寄生: one harmed $(+/-)$

A **keystone species** 关键种 (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

6 Biodiversity

Biodiversity and disruptions

Biodiversity 生物多样性 makes an ecosystem stronger:

- more **stability** 稳定性 and recovery
- free **ecosystem services** 生态系统服务 (clean water, pollination)

Invasive species 入侵物种, **habitat** 栖息地 loss, and **climate change** 气候变化 ripple far through food webs.

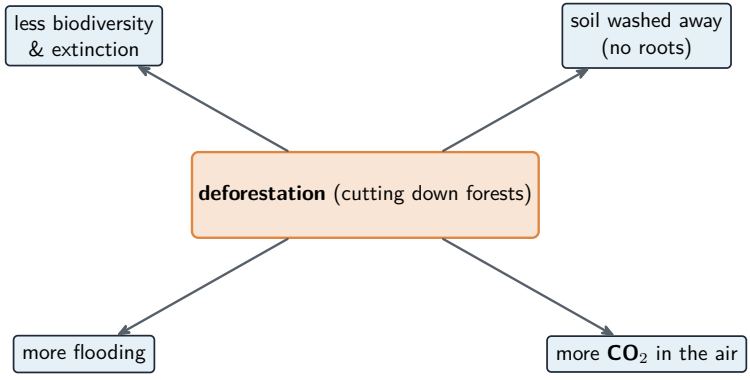
Habitat loss ripples through food webs

Biodiversity, resilience and succession

biodiversity 生物多样性	the variety of life at three levels – genes, species and ecosystems
why it matters	higher diversity generally makes a community more **resilient 有韧性的** to disturbance
the mechanism	varied species can fill the roles that lost ones held
ecological succession 生态演替	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

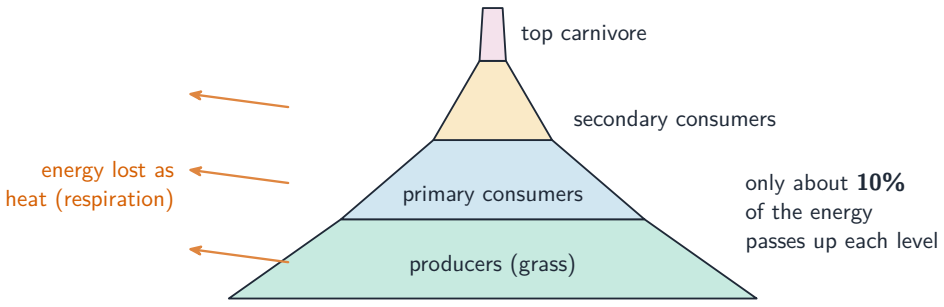


Deforestation lowers biodiversity and causes erosion, flooding, and higher CO2

Biodiversity

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.

7 Recap

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 $+/+, +/0, +/-$; keystone 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