IGCSE BIOLOGY 0610 · CHAPTER 14 NOTES · ~30 MIN READ

Ecology & human influences

How energy flows through food chains and webs, how pyramids and the carbon and nitrogen cycles work, why populations level off, and how farming, deforestation and pollution threaten biodiversity and what conservation can do.

Food chains & webs | Energy pyramids | Carbon & nitrogen cycles | Populations | Food supply | Pollution | Conservation

AS
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No tag = **Core** (everyone) EXTENDED Extended only highlight = comes up again and again

Test yourself at the end

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IN 30 SECONDS

- **Energy** comes from the **Sun**, is captured by **producers** and is passed along **food chains**. About **90% is lost** at each step, so food chains are short. **Carbon** and **nitrogen** are recycled by **photosynthesis, feeding, respiration and decay**.
- A **population** grows in an **S-shaped curve** and levels off when **food, competition, predation and disease** limit it. Farmers raise yields with **machinery, fertilisers, pesticides and selective breeding**.
- **Deforestation, pollution and habitat loss** reduce **biodiversity**. **Sustainable use** and **conservation** protect forests, fish stocks and **endangered species**.

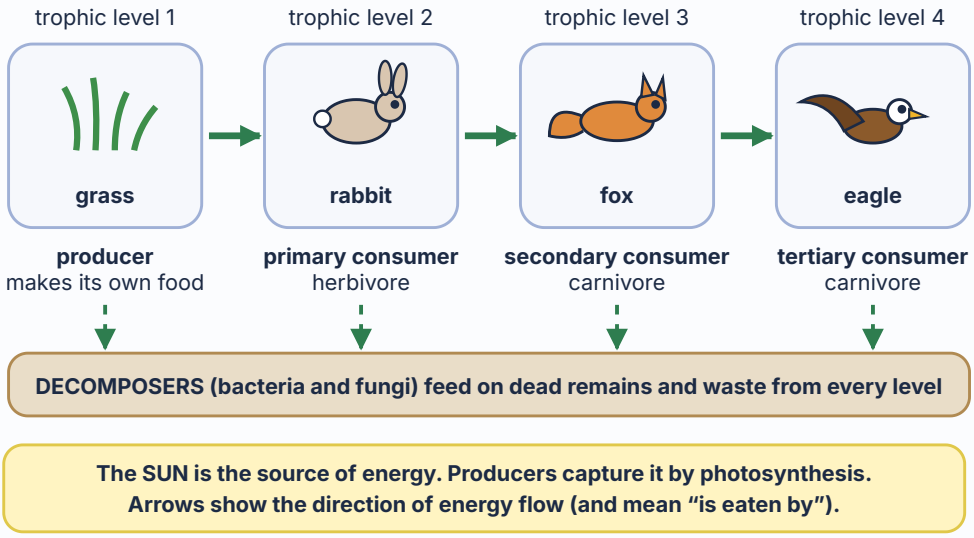
BY THE END YOU CAN

- Describe energy flow, food chains and food webs, and use the terms producer, consumer, herbivore, carnivore, decomposer and trophic level.
- Draw and interpret pyramids of numbers and biomass.
- Describe the carbon cycle.
- Define population, community and ecosystem, and describe the factors that limit population growth and the sigmoid growth curve.
- Describe how food production is increased, and the advantages and disadvantages of monocultures and intensive livestock production.
- Define biodiversity, and describe the causes of habitat destruction and the effects of deforestation.
- Describe the pollution caused by sewage, fertiliser, plastics, methane and carbon dioxide, and the greenhouse effect.
- Describe sustainable resources and the conservation of forests, fish stocks and endangered species.
- Interpret pyramids of energy and explain energy loss, why food chains are short, and why crops are more energy efficient than livestock. EXT
- Describe the nitrogen cycle and the roles of microorganisms in it. EXT
- Explain the phases of the sigmoid growth curve using limiting factors. EXT
- Describe the steps of eutrophication. EXT
- Explain the reasons for conservation, how AI and IVF help captive breeding, and the risks of a small population. EXT

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1 Energy flow in ecosystems

Food chains



Energy flows from the Sun, to a producer, then along the consumers. Decomposers feed on the remains from every level.

Food chain — a diagram showing the **transfer of energy** from one organism to the next, **beginning with a producer**.

Producer — an organism that **makes its own organic nutrients**, usually using **energy from sunlight**, through **photosynthesis**.

Consumer — an organism that gets its **energy by feeding on other organisms**.

Herbivore — an animal that gets its **energy by eating plants**.

Carnivore — an animal that gets its **energy by eating other animals**.

Decomposer — an organism that gets its **energy from dead or waste organic matter**.

Trophic level — the **position of an organism** in a food chain, food web or pyramid.

- The **Sun** is the **principal source of energy** for almost all ecosystems. Producers **capture** it by **photosynthesis** (plant nutrition) and store it in **chemical compounds**.
- Energy is **passed on when one organism eats another**. At every step some energy is **lost to the environment as heat** (respiration).
- **Trophic levels:** producer (**level 1**), **primary consumer** (level 2, eats the producer), **secondary consumer** (level 3, eats the primary consumer), **tertiary consumer** (level 4), **quaternary consumer** (level 5).

COMMON MISTAKE

"The arrow points to the thing that gets eaten." **No.** The arrow shows the **flow of energy**, so it points **towards the eater**: grass → rabbit, never rabbit → grass.

MEMORY TRICK

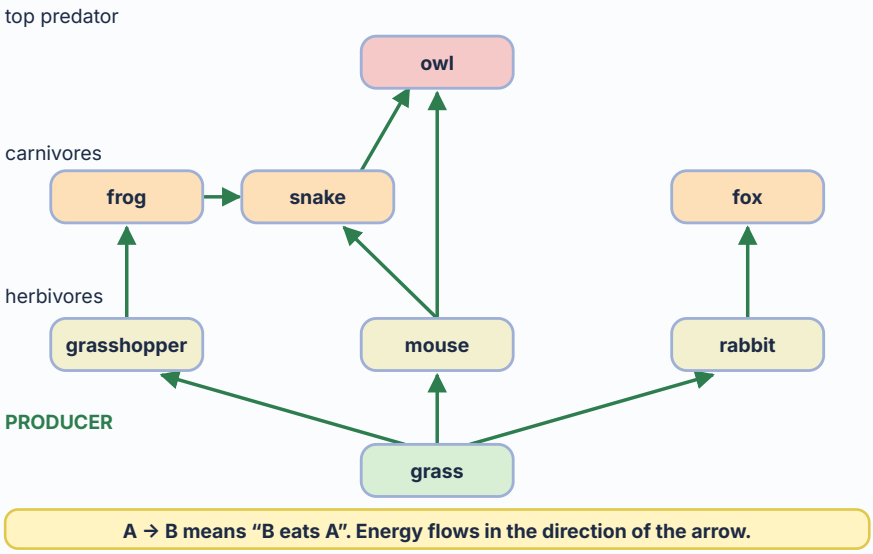
Read each arrow as "**is eaten by**": **grass → rabbit** means the grass **is eaten by** the rabbit.

WORKED EXAMPLE

In the food chain grass → grasshopper → frog → snake → eagle, name the producer and each consumer.

1. the chain **starts with the producer**: **grass** (trophic level 1)
2. **grasshopper** eats grass = **primary consumer** (level 2, a herbivore)
3. **frog** = **secondary consumer** (level 3)
4. **snake** = **tertiary consumer** (level 4)
5. **eagle = quaternary consumer (level 5). The frog, snake and eagle are carnivores.**

Food webs



Most animals eat more than one thing, so food chains join up into a food web.

Food web — a **network of interconnected food chains** showing the **energy flow** through part of an ecosystem.

- In the web, **mouse → owl** and **mouse → snake → owl** are two chains that **share organisms**. The **owl** is a **secondary consumer** in one chain and a **tertiary consumer** in the other.
- Webs show that **changing one population affects many others**, because the organisms are **linked**.

WORKED EXAMPLE

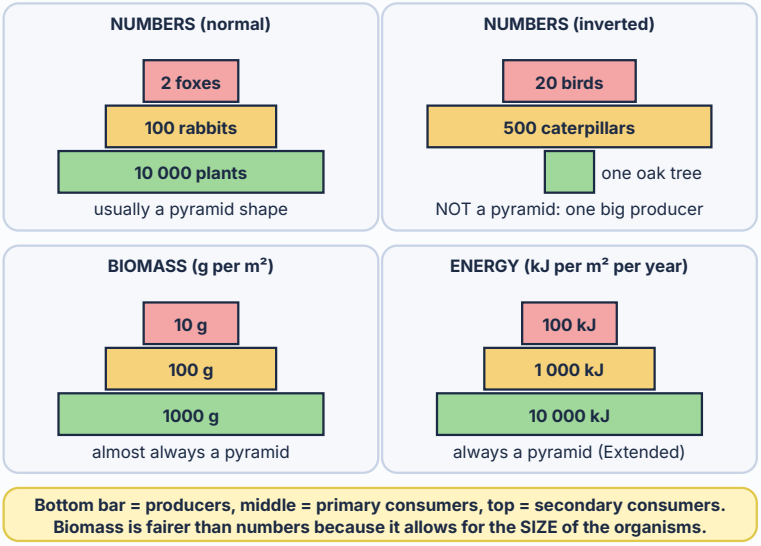
Using the food web, predict two effects if a disease kills all the frogs.

1. frogs eat **grasshoppers**, so grasshoppers are **no longer eaten by frogs**
2. so the **grasshopper population increases**, and they **eat more grass**, so the amount of **grass falls**
3. **frogs are also food for snakes: snakes lose a food source, so they eat more mice and the mouse population falls (or the snake population falls)**

EXAM TIP

For "what happens if..." questions, **follow the arrows one step at a time: fewer predators → more prey → more of the prey's food eaten → less of that food**. Always say **whether numbers increase or decrease**.

Pyramids of numbers and biomass



A pyramid has one bar for each trophic level, with the producers at the bottom. The bars show numbers, biomass or energy.

- A **pyramid of numbers** shows the **number of organisms** at each trophic level. A **pyramid of biomass** shows the **mass of living material** (dry mass) at each level.
- **To draw one:** the **producers** go at the **bottom**; make each bar's **length** match the **numbers or mass** on a **scale**; **centre** the bars; **label** every level.
- A pyramid of **numbers** is **not always a pyramid**. **One large oak tree** feeds **hundreds of insects**, so the bottom bar is **narrow**. A pyramid of **biomass** is **fairer** because it allows for the **size** of the organisms, so it is almost always pyramid-shaped.
- A pyramid of **energy** EXT is **always** pyramid-shaped (see below).

COMMON MISTAKE

Drawing a pyramid of numbers with every bar the **same width**, or putting the **top predator at the bottom**. Bars must be **drawn to scale** and the **producers go at the base**.

WORKED EXAMPLE

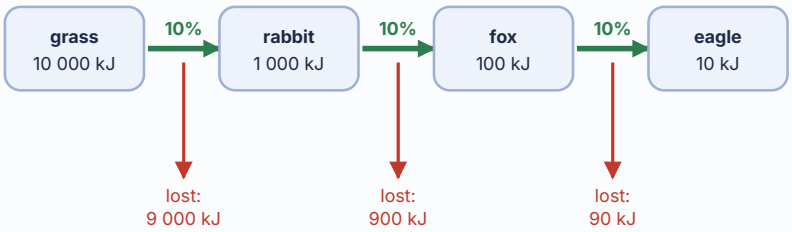
An oak tree (1) supports 3000 aphids, which are eaten by 50 ladybirds, which are eaten by 1 bird. Describe the pyramid of numbers and explain its shape.

1. bars from the bottom: **1 tree, 3000 aphids, 50 ladybirds, 1 bird**
2. the **aphid bar is the widest** and the **tree bar is a very narrow bar**
3. so it is **not a normal pyramid shape**
4. one **very large producer** supports **many small consumers**
5. **a pyramid of biomass would be a normal pyramid, because the tree has a huge mass**

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Energy loss between trophic levels

EXTENDED



WHERE DOES THE LOST ENERGY GO?

- released as HEAT by respiration
- used for MOVEMENT
- passed out as undigested waste (faeces)
- in parts that are NOT EATEN (bones, roots)

Only about 10% of the energy passes to the next level, so food chains rarely have more than 4 or 5 levels. Eating crops (level 2) gives people MORE energy than eating cattle that ate the crops (level 3): crops are more efficient.

EXT Only about 10% of the energy passes to the next level. The rest is lost to the environment.

- EXT Only about **10%** of the energy in one trophic level **passes to the next**. The rest is **lost**, as **heat from respiration**, in **movement**, in **waste (faeces and urine)** and in parts that are **not eaten** (bones, roots) or **not digested**.
- EXT **Why food chains are short:** after four or five steps there is **too little energy left** to support another level, so food chains **rarely have more than five trophic levels**.
- EXT **Why crops are more efficient than livestock:** people who **eat crops** take energy from the **second** trophic level. If the crop is **fed to animals** first, **about 90% is lost** before people eat the meat. **The same field feeds more people** when it grows crops.

$$\%\ \text{efficiency} = \frac{\text{energy passed to the next level}}{\text{energy in the previous level}} \times 100$$

both energies in the **same units**

WORKED EXAMPLE

A producer level holds 20 000 kJ. If 10% is passed on at every step, how much energy reaches the secondary consumers?

1. primary consumers: 20 000 × 10% = **2 000 kJ**
2. secondary consumers: 2 000 × 10% = **200 kJ**
3. **so 99% of the original energy (19 800 kJ) has been lost on the way**

WORKED EXAMPLE

A cow eats grass containing 50 000 kJ and stores 5 000 kJ in its body. Find the percentage efficiency of the transfer.

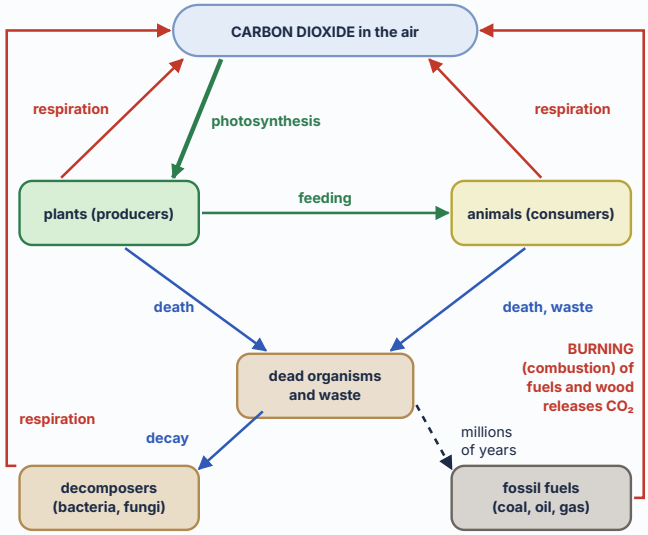
1. efficiency = energy passed on ÷ energy available × 100
2. = 5 000 ÷ 50 000 × 100
3. **= 10%**

WORKED EXAMPLE

A field of wheat holds 100 000 kJ of food energy. Compare the energy people get if they eat the wheat with the energy if the wheat is fed to cattle and people eat the beef (10% efficiency).

1. eating the wheat: up to **100 000 kJ** is available to people
2. via cattle: 100 000 × 10% = **10 000 kJ** in the beef
3. **so eating the crop gives about 10 times more energy from the same field**

The carbon cycle



Carbon dioxide is taken in by photosynthesis and returned by respiration, decay and burning.

- **Plants** take **carbon dioxide** from the air for **photosynthesis** and build **carbon compounds** (sugars, starch, proteins, fats). **Animals** get carbon compounds by **feeding**.
- **All living things release CO_2 by respiration** (respiration): plants, animals **and** decomposers.
- When organisms **die** (and when animals produce **waste**), **decomposers** (bacteria and fungi) **break the material down** and release **CO_2** by respiration.
- Over **millions of years** buried dead organisms can form **fossil fuels** (coal, oil and natural gas). **Burning** (**combustion**) fossil fuels and wood **returns CO_2 to the air**.

Process	What happens to carbon	Effect on CO_2 in the air
photosynthesis	CO_2 is built into sugars and other compounds	**removes** CO_2
feeding	carbon compounds pass from one organism to the next	no change
respiration	carbon compounds are broken down	**adds** CO_2
decomposition	dead remains and waste are broken down by decomposers	**adds** CO_2
fossilisation	carbon is locked away in coal, oil and gas	**removes** carbon from the cycle
combustion	fuels and wood are burnt	**adds** CO_2

MEMORY TRICK

Photosynthesis **P**ulls CO_2 in. **R**espiration, **R**ot (decay) and **R**oasting (burning) **R**eturn it to the air.

COMMON MISTAKE

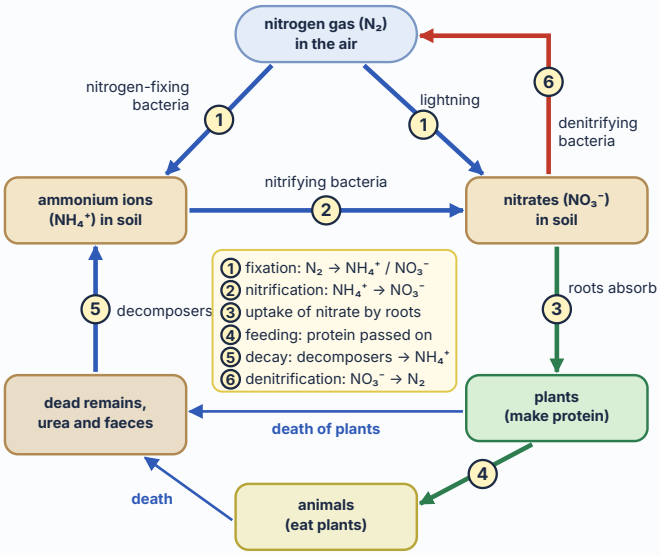
"Plants only take in CO_2, and animals only give it out." **Plants also respire** all the time, so they give out CO_2 too. In the light they take in **more** than they give out.

EXAM TIP

Carbon moves **between organisms in compounds** (sugars, proteins, fats) but **through the air as CO_2**. Name the **process** on every arrow in a carbon-cycle answer.

The nitrogen cycle

EXTENDED



EXT Bacteria in the soil change nitrogen between gas, ammonium and nitrate. Plants take up nitrates and build protein.

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- EXT **About 78% of the air is nitrogen gas (N_2)**, but plants and animals **cannot use it directly**. Plants take up **nitrates** from the soil and use them to make **amino acids and proteins**. Animals get protein by **eating plants** (or other animals).
- EXT **Nitrogen fixation: nitrogen-fixing bacteria** turn N_2 into **nitrogen compounds** (ammonium or nitrates). Some live in **root nodules** of **legumes** (peas, beans, clover) and some in the **soil**. **Lightning** also fixes some nitrogen.
- EXT **Decay: decomposers** break down **dead remains, urea and faeces**, releasing **ammonium ions**.
- EXT **Nitrification: nitrifying bacteria** change **ammonium ions into nitrates**.
- EXT **Denitrification: denitrifying bacteria** change **nitrates back into N_2**. This happens in **waterlogged soil** with **little oxygen**, and it **lowers soil fertility**.

Microorganism	Its role in the nitrogen cycle
decomposers (bacteria and fungi)	break down dead remains, urea and faeces into **ammonium ions**
nitrifying bacteria	change **ammonium ions** into **nitrates**
nitrogen-fixing bacteria	change **nitrogen gas** into **nitrogen compounds**
denitrifying bacteria	change **nitrates** into **nitrogen gas**

EXAM TIP

Farmers **rotate crops** and grow **legumes** such as clover or peas, because the bacteria in their **root nodules add nitrogen compounds** to the soil. This **reduces the fertiliser** needed for the next crop.

MEMORY TRICK

FIX puts nitrogen **IN** (gas to compounds). **NITRIFY** makes **nitrates**. **DENITRIFY** takes nitrates **out** to the air.

2 Populations and communities

Population, community and ecosystem

Population — a **group of organisms of one species**, living in the **same area** at the **same time**.

Community — **all the populations** of **different species** living in the **same area** (ecosystem).

Ecosystem — a **unit containing the community of organisms** and their **environment**, interacting together. Examples: a **pond**, a **rainforest**, a **decomposing log**.

MEMORY TRICK

Population = ONE species. Community = MANY species. Ecosystem = community + the non-living environment.

WORKED EXAMPLE

Which term describes (a) all the frogs in a pond, (b) all the living organisms in the pond, (c) the pond including its water, mud and sunlight?

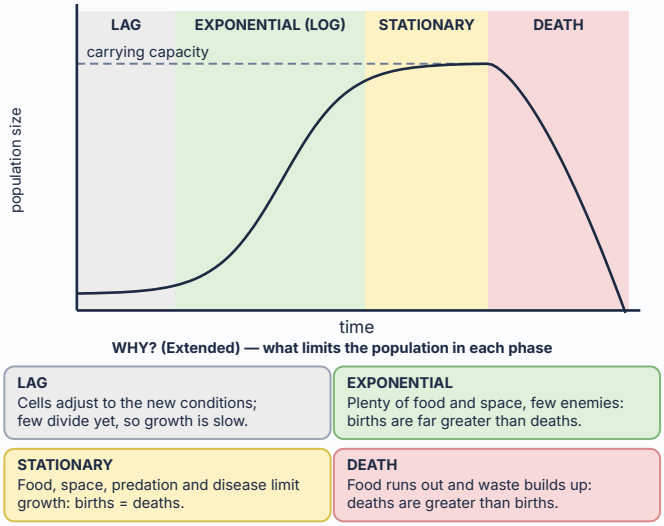
1. (a) frogs are **one species** in one place = a **population**
2. (b) many species living together = a **community**
3. **(c) living organisms and their non-living environment = an ecosystem**

What limits population growth

- A population **grows** when **births are greater than deaths**. It stops growing when **limiting factors** act.

Limiting factor	How it limits the population
food	too little food: animals **starve** and **fewer young** are born
competition	organisms **compete** for limited food, space, light (plants) or mates, so some **die or fail to breed**
predation	**predators** kill and eat their prey, so **prey numbers fall**
disease	**pathogens** spread quickly in a **crowded** population and **kill** individuals

The sigmoid growth curve



A population in a new environment grows in four phases: lag, exponential (log), stationary and death.

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- **Lag phase: slow growth**, because there are **few individuals** to reproduce (and the cells are adjusting to the new conditions).
- **Exponential (log) phase: rapid growth**, as the number **doubles at regular intervals**.
- **Stationary phase:** the population **stays level**. **Births equal deaths.**
- **Death phase:** the population **falls**, because **deaths are greater than births**. This happens with microorganisms in a **closed container**, for example a fermenter.
- EXT **Why?** In the **exponential phase** there is **plenty of food and space** and **few predators or diseases**, so **births far exceed deaths**. In the **stationary phase limiting factors** (food, competition, predation and disease) **balance** births and deaths. In the **death phase food runs out** and **waste products build up**.
- EXT The **sigmoid (S-shaped)** curve is the **lag, exponential and stationary** parts together.

WORKED EXAMPLE

A culture starts with 100 bacteria that divide every 20 minutes. How many bacteria are there after 2 hours of exponential growth?

1. 2 hours = 120 minutes
2. 120 ÷ 20 = **6 doublings**
3. $100 \times 2^6 = 100 \times 64 =$ **6 400 bacteria**
4. **in a real culture growth would slow down before this, as food runs out**

EXAM TIP

Do **not** say "nothing happens" in the stationary phase. **Births and deaths are still happening**, but they are **equal**, so the **total stays level**.

3 Human influences on ecosystems

Increasing food production

Method	How it raises yield	A possible problem
machinery	ploughing, sowing and harvesting are **faster** over **larger areas**	uses **fuel** (CO_2), costs money, removing **hedges** destroys habitats
fertilisers	add **nitrates and other minerals**, so plants **grow faster**	**run-off pollutes** rivers (see eutrophication)
insecticides	**kill insect pests** that eat the crop	also kill **useful insects** such as **pollinators** and can **build up in food chains**
herbicides	**kill weeds** that compete for light, water and minerals	**fewer wild plants**, so less food for insects and birds
selective breeding	crops and animals with **higher yield** and **disease resistance**	**less variation**, so one disease may harm the whole crop

- Selective breeding and genetic modification are two ways to improve the **crop plants and animals themselves**.

Monocultures

- **Monoculture:** growing **one crop** (for example wheat) over a **very large area**, year after year.

Advantages	Disadvantages
higher yield from the **best variety**	**pests and diseases spread quickly** because every plant is the same
cheaper: machines can plant and harvest the whole field at once	the crop uses the **same minerals every year**, so more **fertiliser** is needed
all the crop **ripens together**	**fewer habitats and food sources**, so **lower biodiversity**

Intensive livestock production

- **Intensive livestock production:** keeping **large numbers of animals** (hens, pigs, cattle) **indoors** in a **small space**, with **controlled feeding**.

Advantages	Disadvantages
more meat, eggs and milk from a small area, so food is **cheaper**	**animal welfare** problems: crowded, stressed and **unable to move** naturally
animals **lose less energy** as heat and movement, so **more food energy** goes into **growth**	**disease spreads quickly**, so **antibiotics** are used and can lead to **resistance**
easier to **control feeding** and **health**	**waste** pollutes water and animals release **methane**; large amounts of **feed** are needed

Biodiversity and habitat destruction

Biodiversity — the **number of different species** living in an area.

- **Habitat destruction** happens because of **land use** (houses, roads, farmland), **extraction of resources** (logging, mining, quarrying, drilling) and **pollution**.
- Destroying a habitat **removes the species that live there**, **breaks food webs** and **lowers biodiversity**. A species that loses its **food** or **shelter** can become **endangered** or **extinct**.

Deforestation



1 More CO_2, global warming
Fewer trees absorb CO_2 in photosynthesis. Burning or rotting wood releases more CO_2. The greenhouse effect gets stronger.

2 Soil erosion and flooding
No roots to bind the soil, so rain washes it away: nutrients are lost, rivers fill with silt and flood more easily.

3 Less rainfall
Fewer leaves means less transpiration, so less water vapour enters the air and less rain falls: the climate gets drier.

4 Loss of biodiversity
Habitats and food sources are destroyed. Food webs break down and some species become endangered or extinct.

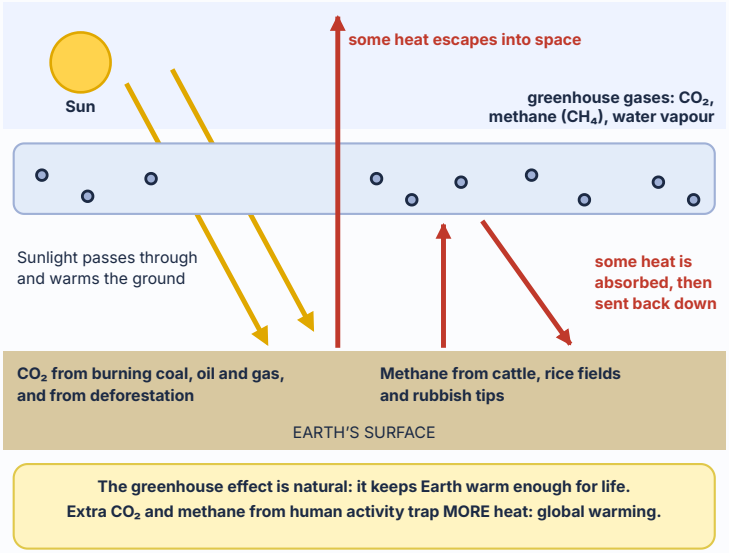
Cutting down forests removes habitats, soil, rainfall and a store of carbon.

- **Why forests are cleared: timber**, **farmland** (crops and cattle), **roads and buildings** and **mining**.
- **Loss of biodiversity and extinction:** the **animals and plants** that lived in the forest **lose their habitat and food**.
- **Soil erosion and flooding: roots no longer hold the soil**. Rain **washes it away**, taking **nutrients**, so the land becomes **less fertile** and rivers **silt up** and **flood**.
- **More carbon dioxide:** there are **fewer trees to remove CO_2** by **photosynthesis**, and **burning or rotting trees** releases CO_2 (plant nutrition).
- **Less rainfall** (an extra effect): **fewer leaves** means **less transpiration**, so **less water vapour** enters the air.

Pollution

Pollutant	Source	Effect
untreated sewage	released into **rivers and seas**	feeds **bacteria** that use up **oxygen**, so fish die. It also spreads **disease-causing microorganisms**
excess fertiliser	**run-off** from fields	**nitrates and phosphates** cause **eutrophication**
plastics	**litter** and rubbish dumped in the sea	animals **swallow** them or get **tangled**; they **do not rot** and break into **microplastics** that enter food chains
methane	**cattle**, **rice fields**, **rubbish tips**	a **greenhouse gas**
carbon dioxide	**burning fossil fuels** and **forests**	a **greenhouse gas**

The greenhouse effect and global warming



Greenhouse gases trap some of the heat given out by the ground. More gas means more heat is trapped.

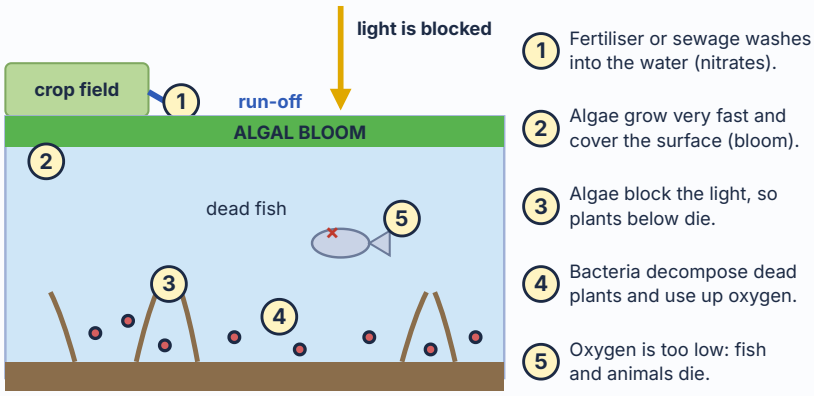
- The ground **absorbs sunlight** and **gives out heat**. **Greenhouse gases** (CO_2, methane, water vapour) **absorb some of this heat** and **send it back**, which **warms the Earth**. This **natural greenhouse effect** makes life possible.
- Human activity adds **extra CO_2 and methane**, so **more heat is trapped**: the **enhanced greenhouse effect**, which causes **global warming** and **climate change**.
- **Possible effects: melting ice** and **rising sea levels** (coastal flooding), **changing rainfall**, **more extreme weather**, and **habitats lost**, so some species become **extinct**.

COMMON MISTAKE

"Global warming is caused by the **hole in the ozone layer**." **No.** These are **different problems**. Global warming is caused by **extra greenhouse gases**.

Eutrophication

EXTENDED



EUTROPHICATION = too many nutrients in the water.
Fertiliser run-off → algal bloom → plants die → bacteria use up O_2 → animals die.

EXT Extra nutrients cause an algal bloom. When the plants die, bacteria use up the oxygen and animals suffocate.

Eutrophication — EXT the **enrichment of water by nutrients** (nitrates and phosphates) from fertiliser or sewage, leading to **loss of oxygen** and **death of animals**.

- EXT **The five steps:** (1) **fertiliser or sewage** washes into the water, (2) **algae grow rapidly** and cover the surface (an **algal bloom**), (3) the algae **block the light**, so **plants below die**, (4) **bacteria decompose** the dead plants and algae and **use up the oxygen** in respiration, (5) **fish and other animals die** from **lack of oxygen**.
- EXT **Reduce it:** use **less fertiliser**, **do not spread it before heavy rain**, and **treat sewage** before it is released.

COMMON MISTAKE

"The fertiliser **poisons** the fish." **No.** The fish die from **lack of oxygen**. It is the **bacteria** (not the algae) that use up the oxygen.

EXAM TIP

Write eutrophication answers as a **chain with "so" and "because"**: nutrients → algae grow → light blocked → plants die → bacteria respire → oxygen falls → fish die.

4 Conservation

Sustainable resources

Sustainable resource — a resource that is **produced as rapidly as it is removed** from the environment, so that it is **not likely to run out**.

- **Examples: timber** from a forest where **trees are replanted** as fast as they are cut, and **fish** caught at a rate that lets the **stocks recover**.
- **Fossil fuels** are **not sustainable**: they take **millions of years** to form.

Conserving forests and fish stocks

Resource	Methods of conservation
forests	**replant** trees; cut only **some trees (selective logging)**; **protect** areas as **national parks**; **educate** people; make and **enforce laws**
fish stocks	**fishing quotas** (limits on the catch); **larger net mesh** so young fish escape; **closed seasons** while fish breed; **no-fishing zones**; **monitor** the stocks

Endangered species

- **Causes of endangerment and extinction: climate change**, **habitat loss**, **hunting**, **pollution** and **introduced species** (which compete with, eat or infect the native species).
- **Methods of conservation: monitor and protect** species and their habitats (for example in **nature reserves**), **educate** people, **captive breeding** programmes (in zoos), and **seed banks** that store seeds of rare plants.
- EXT **Why conserve?** To **protect vulnerable ecosystems** and **food webs** (losing one species affects others), to **keep biodiversity** and its **genetic resources** (future medicines and crops), for **tourism and income**, and for **ethical reasons**: we should not cause **extinction**.
- EXT **Artificial insemination (AI)** places **sperm from a male** into a female, so animals in **different zoos** can breed without being moved. **IVF** fertilises **eggs outside the body**, and the embryos are placed in a female. Both help to **increase numbers** and **add genetic variety**.
- EXT **Risks of a small population: less genetic variation**, so it **adapts poorly** to change; **inbreeding** (two harmful recessive alleles are more likely to meet), which lowers **fertility and survival**; one **disease** or disaster could **wipe out** the whole population.

EXAM TIP

Conservation answers score best when they give a **reason** as well as the method: "**Seed banks store seeds** so that **if the plant becomes extinct in the wild, it can be grown again**."

5 Test yourself

Test yourself — cover the answers first

QUICK CHECK

1. Define a food chain.
2. What is the main source of energy for most ecosystems?
3. Define a producer.
4. What is a decomposer?
5. In which direction does an arrow in a food chain point?
6. What is a trophic level?
7. Which trophic level do herbivores occupy?
8. Why can a pyramid of numbers be inverted?
9. Name two processes that add CO_2 to the air.
10. Which process removes CO_2 from the air?
11. Define population.
12. Define ecosystem.
13. Name two factors that limit population growth.
14. What happens in the stationary phase of a growth curve?
15. Give one advantage and one disadvantage of a monoculture.
16. Define biodiversity.
17. Name two effects of deforestation.
18. Name two greenhouse gases.
19. What is a sustainable resource?
20. Name two methods of conserving fish stocks.
21. What is a seed bank for?
22. EXT Roughly what percentage of energy passes to the next trophic level?
23. EXT Why are crops more energy efficient than livestock?
24. EXT What do denitrifying bacteria do?
25. EXT Which bacteria change ammonium ions into nitrates?
26. EXT Why do farmers grow clover or peas in a crop rotation?
27. EXT What causes the death phase in a closed culture?
28. EXT Which organisms use up the oxygen during eutrophication?
29. EXT What is the difference between AI and IVF?

EXAM-STYLE

30. Describe the roles of the Sun and of producers in a food chain. [3]
31. Draw a food chain with four organisms and label a producer and a secondary consumer. [3]
32. Describe how carbon in the air becomes part of an animal and returns to the air. [4]
33. Describe the sigmoid growth curve of a population. [4]
34. Describe the advantages and disadvantages of growing crops as a monoculture. [4]
35. Describe the effects of deforestation. [4]
36. Explain how increasing the amount of methane and carbon dioxide leads to global warming. [3]

37. Describe how conservation of a fish stock can be achieved. [3]
38. EXT Explain why food chains rarely have more than five trophic levels. [3]
39. EXT Explain why more people can be fed from a field growing wheat than from the same field used to feed cattle. [3]
40. EXT Describe the nitrogen cycle, including the roles of bacteria. [5]
41. EXT Explain why a population stops growing and levels off. [4]
42. EXT Explain how the use of fertiliser on a field can lead to the death of fish in a nearby river. [5]
43. EXT Explain why it is important to conserve endangered species, and why small populations are at risk. [5]

Aiza Ma'am

Show answers

1. a diagram showing the transfer of energy from one organism to the next, beginning with a producer
2. the Sun
3. an organism that makes its own organic nutrients, usually using energy from sunlight, through photosynthesis
4. an organism that gets its energy from dead or waste organic matter
5. towards the organism that eats (the direction of energy flow)
6. the position of an organism in a food chain, food web or pyramid
7. the second (primary consumers)
8. one large producer (such as a tree) supports many small consumers
9. respiration, decomposition, combustion
10. photosynthesis
11. a group of organisms of one species living in the same area at the same time
12. a unit containing the community of organisms and their environment interacting together
13. food, competition, predation, disease
14. the population stays level because births equal deaths
15. easy to plant and harvest or higher yield; pests and diseases spread quickly or lower biodiversity
16. the number of different species living in an area
17. loss of biodiversity, soil erosion, flooding, more carbon dioxide
18. carbon dioxide and methane
19. one produced as rapidly as it is removed, so it is not likely to run out
20. quotas, larger net mesh, closed seasons, no-fishing zones
21. storing seeds of rare plants so they can be grown again
22. about 10%
23. people eating crops take energy from the second trophic level, so less energy is lost than when the crop is fed to animals first
24. change nitrates into nitrogen gas
25. nitrifying bacteria
26. bacteria in their root nodules fix nitrogen, which adds nitrogen compounds to the soil
27. food runs out and waste builds up, so deaths exceed births
28. bacteria decomposing the dead plants and algae
29. AI places sperm into a female; IVF fertilises eggs outside the body
30. the Sun is the source of energy
    producers capture the energy by photosynthesis
    the energy is stored in chemical compounds and passed to consumers when they are eaten
31. starts with a producer, for example grass → grasshopper → frog → snake
    arrows point towards the organism that eats
    grass labelled producer and frog labelled secondary consumer

32. plants take in CO_2 by photosynthesis
carbon is built into carbohydrates and other compounds
the animal eats the plant
CO_2 is returned by respiration (or decomposition after death)

33. slow growth at first (lag)
then rapid exponential growth
then levels off in the stationary phase
may fall in the death phase

34. advantages: easy to plant and harvest with machines, cheaper
high yield from the best variety
disadvantages: pests and diseases spread quickly
lowers biodiversity or uses up the same minerals, needing more fertiliser

35. loss of habitats, so extinction and lower biodiversity
soil erosion because roots no longer hold the soil
flooding
more CO_2 in the air because fewer trees photosynthesise

36. they are greenhouse gases
they absorb heat given out by the Earth and send it back (trap heat)
so more heat stays in the atmosphere and the Earth warms up

37. set quotas to limit the catch
use nets with larger mesh so young fish escape
close fishing in breeding seasons or create no-fishing zones
monitor the fish population

38. only about 10% of the energy passes to the next level
the rest is lost as heat, in waste and in parts not eaten
so there is too little energy left to support another level

39. people eating wheat take energy from the second trophic level
if cattle eat the wheat, about 90% of the energy is lost in the cattle
so less food energy reaches people as beef

40. nitrogen-fixing bacteria change nitrogen gas into nitrogen compounds
decomposers change dead remains and urea into ammonium ions
nitrifying bacteria change ammonium into nitrates
plants take up nitrates to make protein which animals eat
denitrifying bacteria change nitrates back into nitrogen gas

41. limiting factors act
food runs short or there is competition for food and space
predation and disease increase
so deaths equal births and the population stays level

42. fertiliser is washed into the river
nitrates cause algae to grow rapidly (algal bloom)
algae block the light so plants die
bacteria decompose the dead material and use up oxygen
fish die from lack of oxygen

43. keeps biodiversity and protects food webs
genetic resources for medicines and crops (or tourism, ethics)
small populations have less genetic variation
inbreeding increases harmful recessive alleles
a disease could wipe out the whole population

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