iBLaurel

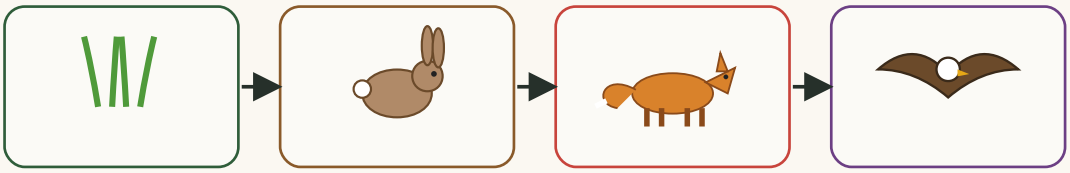
Specialist one-to-one Science, Maths & Economics tuition

AQA GCSE BIOLOGY · SPECIFICATION 4.7

Topic 7: Ecology

Complete revision & exam preparation guide — key points to memorise, clear diagrams, practice questions and full answers

Key-point notes | Memory hooks | Required practicals | Maths skills | Exam questions + answers



Producer
grass

Primary consumer
rabbit

Secondary consumer
fox

Tertiary consumer
eagle

Producers make their own food by photosynthesis, using light energy

Prepared by iBLaurel · Specialist one-to-one Science, Maths & Economics tuition
Suitable for Foundation and Higher tier · Combined Science (Trilogy) and Separate Biology

START HERE

Contents and how to use this guide

7.1 Ecosystems, competition and interdependence
7.2 Abiotic and biotic factors
7.3 Adaptations
7.4 Food chains and predator–prey cycles
7.5 Sampling with quadrats (RP)
7.6 Transects and percentage cover (RP)
7.7 The water cycle
7.8 The carbon cycle
7.9 Decay, compost and biogas (Bio)
7.10 Temperature and rate of decay (RP, Bio)
7.11 Environmental change (Bio, HT)
7.12 Biodiversity, population and waste
7.13 Land use, deforestation and peat bogs
7.14 Global warming
7.15 Maintaining biodiversity
7.16 Trophic levels (Bio)
7.17 Pyramids of biomass and transfer (Bio)
7.18 Food security and farming (Bio)
7.19 Biotechnology and food (Bio)
★ One-page memory sheet
✎ Summary questions
✓ Answers and mark scheme

How to use this guide

1. **Read** one section. Study the diagram and say the labels out loud.
2. **Learn the gold "Remember it" box** — short hooks that make facts stick.
3. **Cover and recall:** cover the page, write the key points and **equations** from memory, then check and correct in a different colour.
4. **Read the green "Exam tip" and red "Common mistake" boxes** — they show where marks are won and lost.
5. Finish with the **summary questions** (no notes), then mark them with the **answers**. Re-test the ones you got wrong 2–3 days later.

THE BIG IDEA OF TOPIC 7

Ecology is about how organisms **interact** with each other and with their **environment**. Living things **compete** and depend on each other; materials such as **carbon and water are recycled**; and **human activity** affects biodiversity, so we must manage it carefully. Energy and biomass flow along **food chains**, with most lost at each step.

Key boxes in this guide

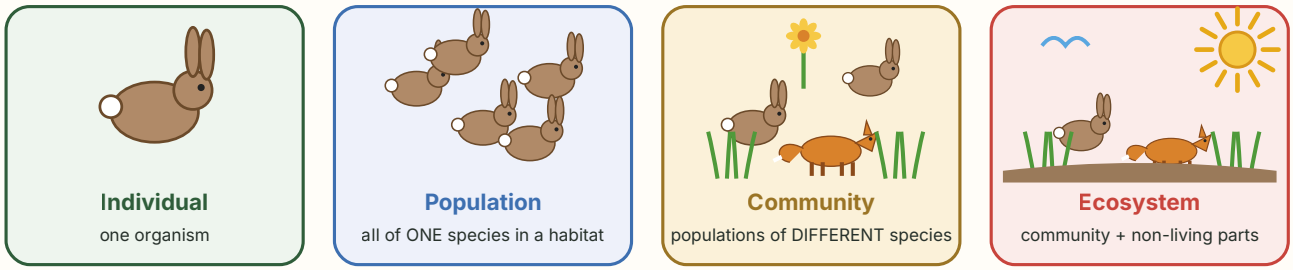
Box	What it means
Remember it	Memory hook, rhyme or shortcut to memorise
Exam tip	How to write the answer to get the marks
Common mistake	Errors examiners see every year
Maths skill	Calculations and graph skills you must be able to do
RP	AQA Required Practical — can be asked in the written exam
BIOLOGY ONLY	Only for Separate (Triple) Biology, not Combined Science
HIGHER TIER	Only examined on the Higher tier paper

PART A

Ecosystems and Sampling

7.1 Ecosystems, competition and interdependence

AQA 4.7.1.1



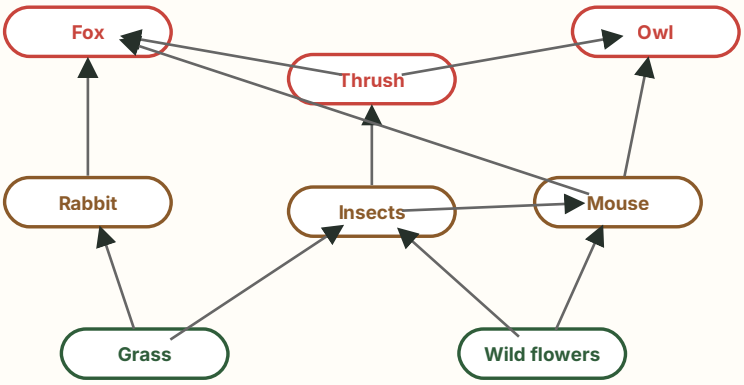
Levels of organisation in ecology

Word	Meaning
Habitat	The place where an organism lives
Population	All the organisms of **one species** living in a habitat
Community	The populations of **different species** living in a habitat
Abiotic factors	**Non-living** factors of the environment, e.g. temperature
Biotic factors	**Living** factors of the environment, e.g. food
Ecosystem	The interaction of a **community** of living organisms with the **non-living** parts of their environment

Competition

- **Plants** compete for **light, space, water** and **mineral ions** from the soil.
- **Animals** compete for **food, mates** and **territory**.
- Organisms compete with other species **and** with members of their own species.

Interdependence



Arrows show the direction of energy transfer

If insects die out: thrushes have less food → fewer thrushes; wild flowers may increase.

= INTERDEPENDENCE

Part of a food web

- Within a community each species **depends on other species** for food, shelter, pollination, seed dispersal etc. This is **interdependence**.

- If one species is removed, it can affect the whole community.
- A **stable community** is one where all the species and environmental factors are in **balance**, so population sizes stay **roughly constant** (e.g. tropical rainforests, ancient oak woodlands).

REMEMBER IT

Small to big: **"I Pick Carrots Every day"** → **I**ndividual, **P**opulation, **C**ommunity, **E**cosystem.
Plants compete for **"LSWM"** (light, space, water, minerals). Animals compete for **"FMT"** (food, mates, territory).

7.2 Abiotic and biotic factors

AQA 4.7.1.2–4.7.1.3

Abiotic (non-living) factors	Biotic (living) factors
Light intensity	Availability of **food**
Temperature	New **predators** arriving
Moisture levels	New **pathogens**
Soil pH and mineral content	One species **outcompeting** another, so numbers are too low to breed
Wind intensity and direction	
Carbon dioxide levels (for plants)	
Oxygen levels (for aquatic animals)	

- A change in any of these factors can change the **size of a population**, which then affects other populations that depend on it.
- Example (abiotic): less light → slower photosynthesis → slower plant growth → fewer plants → fewer herbivores.
- Example (biotic): grey squirrels **outcompete** red squirrels for food and shelter in the UK, so the red squirrel population has fallen.

REMEMBER IT

Abiotic = **A**bsent of life (non-living). **Bio**tic = **bio**logy, living.
Abiotic list: **"Lovely Teachers Make Students Work Calmly Outside"** → **L**ight, **T**emperature, **M**oisture, **S**oil, **W**ind, **C**O_2, **O**xygen.

7.3 Adaptations

AQA 4.7.1.4

- Organisms have features (**adaptations**) that let them **survive** in the conditions where they normally live.

Type	Meaning	Examples
Structural	Features of the **body structure**, e.g. shape or colour	Arctic fox: **white fur** (camouflage), small ears. Whales: thick **blubber** and a low SA:V ratio to keep heat. Camels: large SA:V ratio and thin fat layer to lose heat
Behavioural	The way an organism **behaves**	Swallows **migrate** to warmer places in winter; animals hunt at night in deserts
Functional	Processes **inside the body** (metabolism, reproduction)	Desert animals make very little sweat and small amounts of concentrated urine; brown bears **hibernate** (lower metabolism)

- **Extremophiles** are organisms that live in **extreme conditions** — very high **temperature**, high **pressure** or high **salt concentration**. E.g. bacteria living in deep-sea volcanic vents.

REMEMBER IT

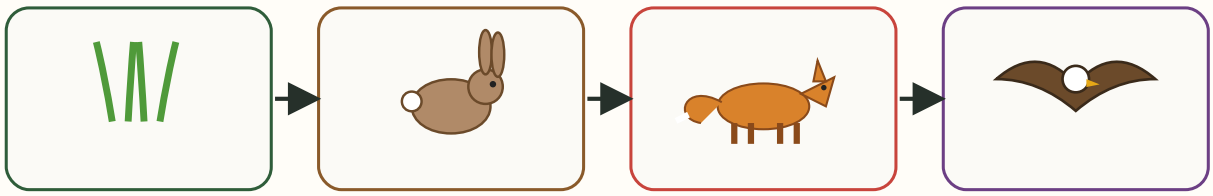
Adaptations: **"SBF"** → **S**tructural (what it **looks** like), **B**ehavioural (what it **does**), **F**unctional (what goes on **inside**).

EXAM TIP

Always link the feature to how it helps survival: "The polar bear has thick fur **so that** it is insulated and loses less heat in the cold." A feature alone earns only half the marks.

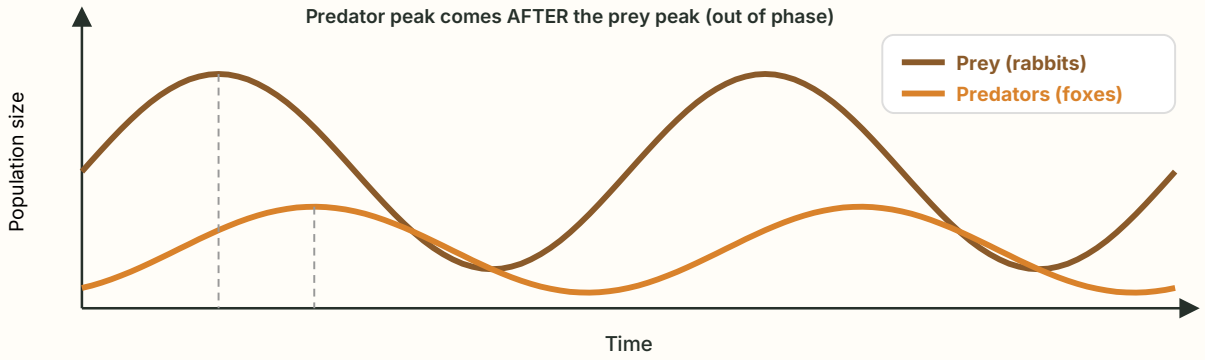
7.4 Food chains and predator–prey cycles

AQA 4.7.2.1



A food chain: arrows show the direction of energy (biomass) transfer

- Every food chain starts with a **producer** — usually a **green plant or alga** that makes glucose by **photosynthesis**.
- Producers make **biomass** (living material), which is passed along the chain when organisms eat each other.
- **Primary consumers** eat producers; **secondary consumers** eat primary consumers; **tertiary consumers** eat secondary consumers.
- Consumers that kill and eat other animals are **predators**; the animals they eat are **prey**.



Predator and prey populations rise and fall in cycles

1. More prey (rabbits) → more food for predators → **predator numbers rise**.
2. More predators eat more prey → **prey numbers fall**.
3. Less food for predators → **predator numbers fall** → prey recover, and the cycle repeats.

EXAM TIP

The cycles are **out of phase**: the predator peak comes **after** the prey peak, because it takes time for the predators to **reproduce** in response to more food.

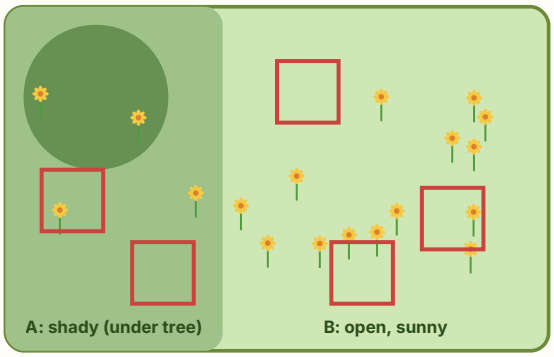
REMEMBER IT

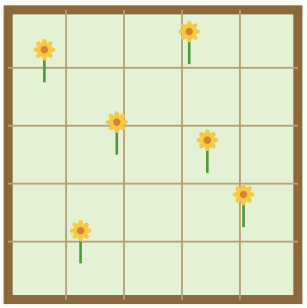
Arrows = **"is eaten by"** (energy flows in the direction of the arrow). Food chains start with the **P**roducer — "**P**lants **P**ower the chain."

7.5 Sampling with quadrats REQUIRED PRACTICAL

AQA 4.7.2.1

- Organisms are found in some places more than others because **environmental factors** vary (e.g. more daisies in the open than under trees, because there is more light).
- A **quadrat** is a square frame of known area, e.g. **1 m²**. It is used to study the distribution of **small organisms**.





1 m² quadrat — count the daisies inside

Place quadrats at RANDOM coordinates (random number generator)

Repeat many times, **find the MEAN**

Comparing the number of daisies in two areas using random quadrats

1. Place a 1 m² quadrat at a **random** point in the first sample area (e.g. divide the area into a grid and use a random number generator to pick coordinates).
2. **Count** all the organisms within the quadrat.
3. **Repeat** steps 1 and 2 many times (e.g. 10 quadrats).
4. Work out the **mean** number of organisms per quadrat.
5. Repeat steps 1–4 in the **second** sample area, and compare the two means.

MATHS SKILL — MEAN AND POPULATION SIZE

Mean = total number of organisms ÷ number of quadrats. Example: 18, 20, 22, 23, 23, 23, 25 daisies → 154 ÷ 7 = **22 daisies per quadrat**.

Population size = mean number per m² × total area (m²).
Example: 0.5 m² quadrats, mean 10.5 daisies → 21 per m². Field area 800 m² → 21 × 800 = **16 800 daisies**.

WHY RANDOM?

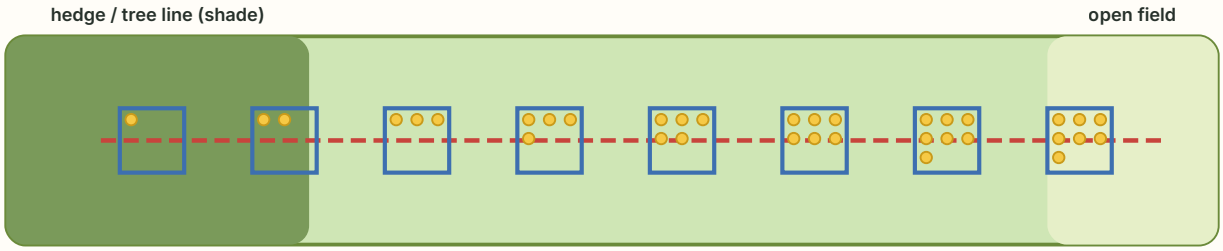
Placing quadrats **randomly** avoids **bias** (e.g. choosing spots with the most flowers), so the sample is **representative** of the whole area. More quadrats → a more reliable mean.

7.6 Transects and percentage cover

REQUIRED PRACTICAL

AQA 4.7.2.1

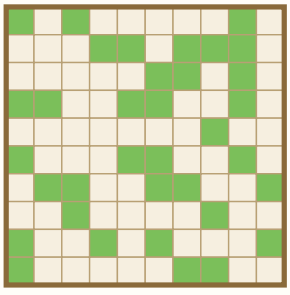
- A **transect** is a line used to study how the distribution of organisms **changes across an area** — e.g. from a hedge into the middle of a field.



A belt transect from shade into the open field

1. Mark out a line with a **tape measure** across the area you want to study.
2. Collect data along the line: count the organisms **touching** the line, or place **quadrats** at regular intervals (e.g. every 2 m).
3. Measure the abiotic factor at each point too (e.g. light intensity with a light meter), to see if it explains the pattern.

Percentage cover — when it is hard to count individual organisms (e.g. grass, moss), estimate the area of the quadrat they cover:



% cover = squares covered ÷ total squares × 100

= 35 ÷ 100 × 100 = 35%

Count a square if it is more than half covered

Estimating percentage cover with a gridded quadrat

REMEMBER IT

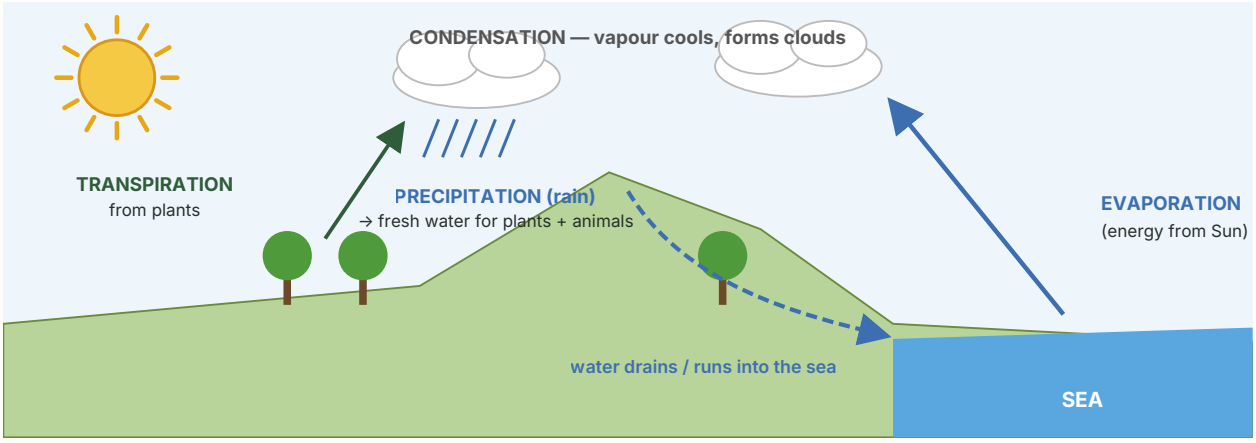
Quadrat = compare **two areas**.
Transect = see a **change along a line**.
Population = **mean per m² × area**.

PART B

Cycles, Decay and Environmental Change

7.7 The water cycle

AQA 4.7.2.2



The water cycle

1. Energy from the **Sun** makes water **evaporate** from the land and sea → water vapour. Plants also lose water vapour by **transpiration**.
2. Warm water vapour rises; it **cools and condenses** to form **clouds**.
3. Water falls as **precipitation** (usually rain) onto the land, providing **fresh water** for plants and animals.
4. It then **drains** into the sea, and the cycle starts again.

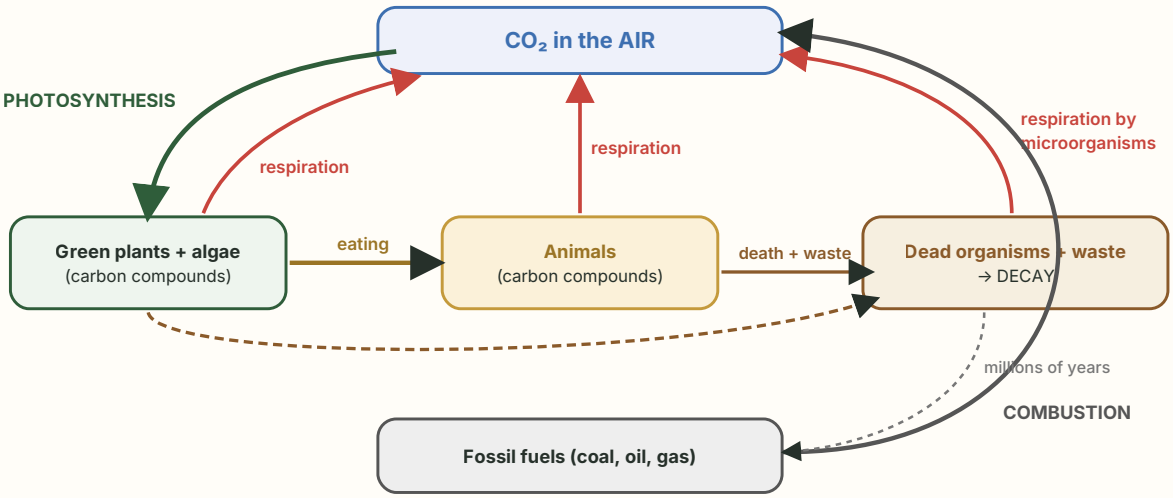
REMEMBER IT

Water cycle: **"Every Time Cats Purr, Dogs bark"** → **E**vaporation, **T**ranspiration, **C**ondensation, **P**recipitation, **D**rainage.

7.8 The carbon cycle

AQA 4.7.2.2

- Materials such as carbon are **recycled** to provide the building blocks for future organisms.
- **Microorganisms** decompose dead organisms and waste, returning **carbon** to the atmosphere as CO_2 and **mineral ions** to the soil.



The carbon cycle

Process	What happens to the carbon
Photosynthesis	**Removes** CO_2 from the air; carbon becomes glucose, then carbohydrates, fats and proteins in plants and algae
Eating	Carbon compounds pass to **animals** along the food chain
Respiration (plants, animals, microorganisms)	**Returns** CO_2 to the air
Death and decay	Detritus feeders and microorganisms feed on dead remains and waste, then respire → CO_2 returned
Combustion	Burning wood and **fossil fuels** releases CO_2 back into the air

REMEMBER IT

Only **ONE** process takes CO_2 **out** of the air: **photosynthesis**. Three put it **back**: **respiration, decay (microbes respiring), combustion**.

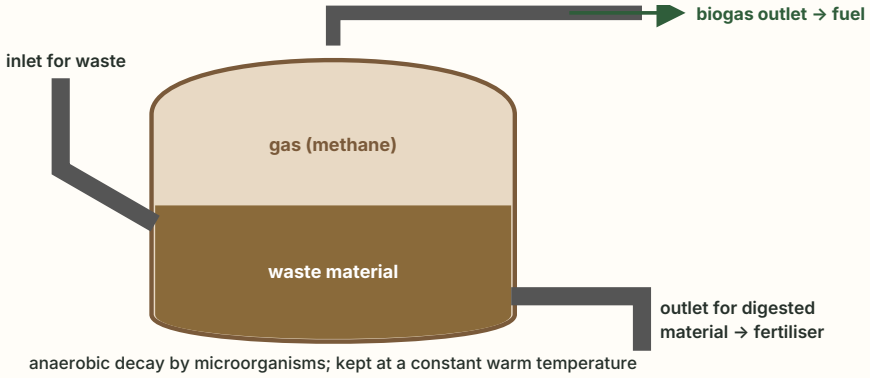
7.9 Decay, compost and biogas BIOLOGY ONLY

AQA 4.7.2.3

- **Microorganisms** (bacteria and fungi) and **detritus feeders** (e.g. worms) break down dead material and waste.
- Gardeners and farmers create the **ideal conditions for quick decay** to make **compost**, a natural fertiliser.

Factor	Effect on the rate of decay
Temperature	Warmer → faster (enzymes work faster). Too hot → enzymes and microorganisms are **denatured / killed**. Cold → slow
Oxygen	Many decomposers need oxygen to **respire**, so decay is faster with oxygen
Water	Faster in **moist** conditions — microorganisms need water for their reactions
Number of decomposers	More microorganisms and detritus feeders → faster decay

Biogas



A simple biogas generator

- **Anaerobic decay** (without oxygen) of plant and animal waste produces **methane gas** — the main part of **biogas**.
- Biogas is made in a **biogas generator** (digester) kept at a constant temperature, and is used as a **fuel** (heating, cooking, lighting, electricity).
- Biogas can't be stored as a liquid, so it must be **used straight away**. The leftover digested material is a **fertiliser**.
- **Batch** generators make biogas in small batches; **continuous** generators make it all the time.

REMEMBER IT

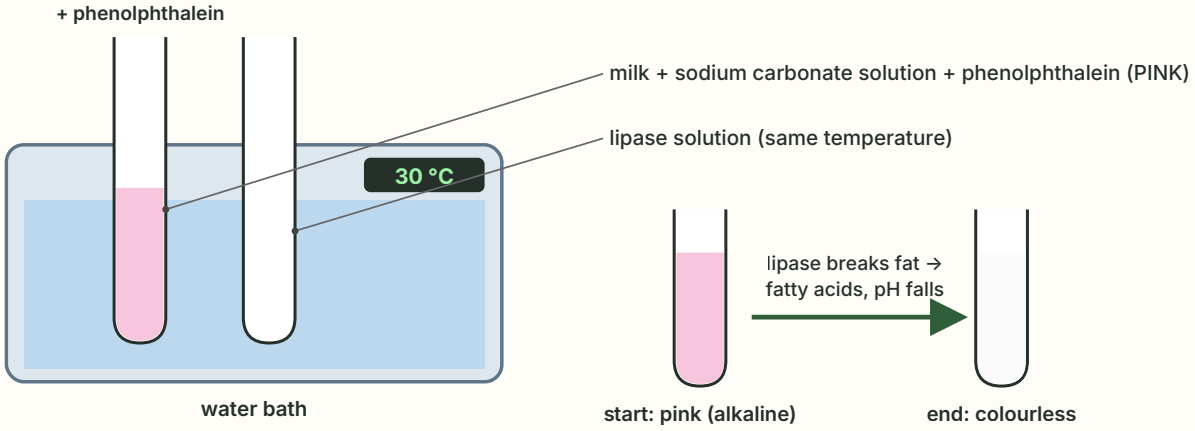
Fast decay needs **"WOW"** → **W**arm, **O**xygen, **W**et. Biogas = **anaerobic** → **methane**.

7.10 Temperature and the rate of decay REQUIRED PRACTICAL

AQA 4.7.2.3

BIOLOGY ONLY

Milk contains fat. The enzyme **lipase** breaks fat into **fatty acids**, so the pH falls. The indicator **phenolphthalein** is **pink** above pH 10 and turns **colourless** when the pH falls below about 8.3.



Investigating the effect of temperature on the decay of milk

1. Measure **5 cm³ of lipase** solution into a test tube.
2. Measure **5 cm³ of milk** into a second test tube; add **5 drops of phenolphthalein**.
3. Add **7 cm³ of sodium carbonate** solution to the milk tube to make it **alkaline** — it turns pink.
4. Put both tubes in a **water bath** at the chosen temperature (e.g. 30 °C) and let them reach that temperature.

5. Add **1 cm³ of lipase** to the milk tube with a calibrated pipette, stir, and **start the stopwatch**.
6. Stop the clock when the solution **loses its pink colour**; record the time.
7. Repeat at other temperatures (e.g. 10, 20, 40, 50 °C), three times each, and calculate the mean.

MATHS SKILL — RATE OF DECAY

Rate = 1000 ÷ time (unit: s^{-1}). Example: colour change took 280 s → rate = 1000 ÷ 280 = **3.6 s^{-1}** (2 s.f.).

EXAM TIP

Control variables: volume and concentration of milk, lipase and sodium carbonate; number of drops of indicator. Judging the exact end-point is **subjective** — compare against a white tile or a colour standard, or use a **pH probe**.

7.11 Environmental change and distribution

BIOLOGY ONLY

HIGHER TIER

AQA 4.7.2.4

- Environmental changes affect the **distribution** of species — where they are found. Changes can be **seasonal, geographic** or caused by **human interaction**.

Change	Example
Availability of water	The distribution of some animals and plants in the tropics changes between the **wet and dry seasons**; e.g. wildebeest **migrate** each year following the rainfall
Temperature	Some bird species are being found further **north** as average temperatures rise (e.g. European bee-eaters now seen in Britain and Germany)
Composition of atmospheric gases	Some **lichens** can't grow where there is **sulfur dioxide** pollution from industry — so lichens are used as **indicators** of air quality

REMEMBER IT

Distribution changes with **"WTG"** → **W**ater, **T**emperature, **G**ases.

PART C

Biodiversity and Human Impact

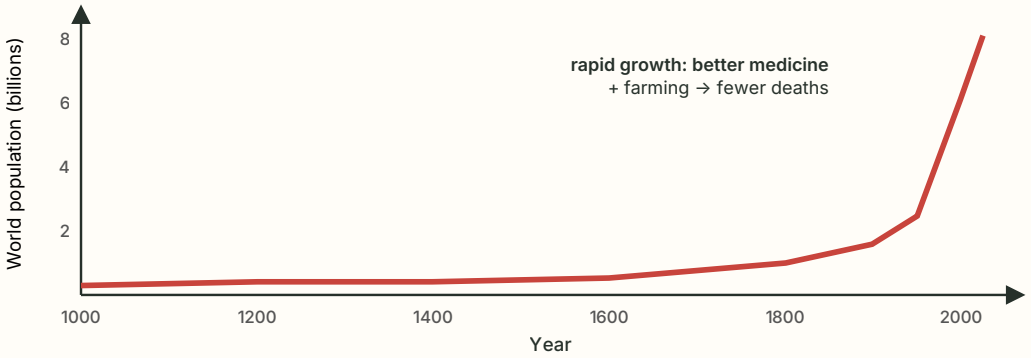
7.12 Biodiversity, population and waste

AQA 4.7.3.1–4.7.3.2

DEFINITION — LEARN IT

Biodiversity is the **variety of all the different species** of organisms on Earth, or within an ecosystem.

- **High biodiversity** ensures the **stability** of ecosystems, by reducing the dependence of one species on another for food, shelter and the maintenance of the physical environment.
- The future of the human species on Earth relies on us maintaining a good level of biodiversity.
- Many human activities are **reducing biodiversity**; only recently have measures been taken to try to stop this.



The human population has grown rapidly

- The **human population** is growing rapidly, and the **standard of living** is rising — so **more resources are used** and **more waste is produced**.
- Unless waste and chemicals are properly handled, more **pollution** is caused.

Where	Pollution
Water	**Sewage**, **fertiliser** or **toxic chemicals** washed into lakes, rivers and seas
Air	**Smoke** and **acidic gases** (e.g. sulfur dioxide → **acid rain**)
Land	**Landfill** waste and **toxic chemicals** (e.g. pesticides, herbicides, nuclear waste)

- Pollution **kills plants and animals**, which can **reduce biodiversity**.

REMEMBER IT

Pollution in **"WAL"** places → **W**ater, **A**ir, **L**and. More people + higher living standards = more resources + more waste.

7.13 Land use, deforestation and peat bogs

AQA 4.7.3.3–4.7.3.4

- Humans reduce the land available for other animals and plants by **building, quarrying, farming** and **dumping waste**.

Deforestation

- Large-scale deforestation in **tropical areas** has happened to provide land for **cattle** and **rice fields**, and to grow crops for **biofuels**.

Problem	Why
Less CO_2 taken in	Fewer trees → less CO_2 removed from the atmosphere by **photosynthesis**; trees also 'lock up' carbon in their wood
More CO_2 released	Trees are often **burnt** to clear land (combustion); microorganisms **decaying** the dead wood also release CO_2 by respiration
Less biodiversity	Forests contain a huge number of species; many lose their **habitat** and may become extinct

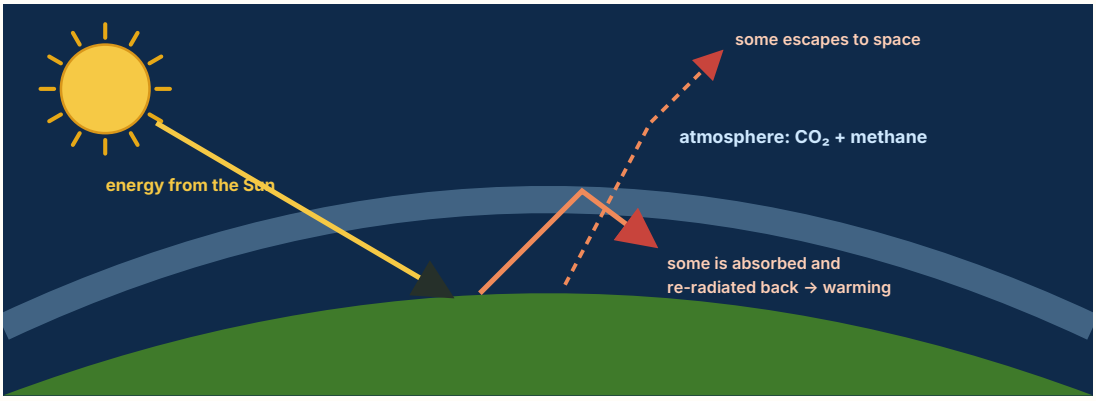
Destroying peat bogs

- Bogs are acidic and waterlogged, so dead plants **don't fully decay** (not enough oxygen) and build up as **peat** — a store of carbon.
- Peat bogs are drained for **farmland**, and peat is dug up to make **garden compost** or burnt as a **fuel**.
- This **reduces the area of the habitat** and so reduces **biodiversity**.
- When drained, microorganisms decay the peat (respiration), and when burnt it combusts — both **release CO_2**, adding to global warming.

> **REMEMBER IT**
> Deforestation = **"3 Bs"**: **B**urning (more CO_2), **B**reathing in less CO_2 (less photosynthesis), **B**iodiversity lost.
> Peat = **carbon store** → use peat-free compost.

7.14 Global warming

AQA 4.7.3.5



The greenhouse effect

- **Carbon dioxide** and **methane** in the atmosphere act like an insulating layer: they absorb most of the energy radiated by the Earth and re-radiate it back, keeping the Earth warm.
- Levels of these **greenhouse gases** are rising (burning fossil fuels, deforestation, cattle and rice farming produce methane), so the Earth is **heating up** — **global warming**.

Biological consequences of global warming:

Consequence	Why it happens
Loss of habitat	Low-lying areas are **flooded** by rising sea levels (seawater expands and ice melts)
Changes in the distribution of species	Species that need warmth spread into more areas; species that need cool conditions have smaller ranges
Changes in migration patterns	E.g. some birds migrate further north
Reduced biodiversity	Species unable to survive a change in the climate may become **extinct**

REMEMBER IT

Greenhouse gases: **CO_2 + methane (CH_4)**. Consequences: **"Hot Days Make Burnt toast"** → **H**abitat loss, **D**istribution change, **M**igration change, **B**iodiversity loss.

EXAM TIP

Most scientists agree that global warming is linked to human activity. When evaluating evidence, look at whether the data comes from **peer-reviewed** sources and how large the sample (time period) is.

7.15 Maintaining biodiversity

AQA 4.7.3.6

Scientists, governments and concerned citizens have set up programmes to **reduce the negative effects** of humans on ecosystems and biodiversity:

Programme	How it helps
Breeding programmes	Endangered species are bred in captivity so the species survives; individuals may later be released into the wild
Protecting rare habitats	Protecting and regenerating habitats such as mangroves, heathland and coral reefs protects the species that live there
Hedgerows and field margins	Reintroduced around fields where farmers grow only one crop → habitats for a wider variety of organisms
Reducing deforestation + CO_2 emissions	Some governments have introduced rules to reduce deforestation and emissions from businesses
Recycling	Recycling resources rather than dumping waste in **landfill** means less land is taken over

Conflicting pressures — maintaining biodiversity is not always simple:

- It **costs money** (e.g. paying farmers to keep hedgerows), which governments may want to spend elsewhere.
- It may cost people their **livelihood**, e.g. reducing deforestation may mean fewer jobs.
- Protecting species may conflict with **food security** — some species are pests that eat crops.
- **Development** (new housing, farmland) is important too, but uses up land.

REMEMBER IT

Ways to help: **"Big Penguins Hate Rainy Rivers"** → **B**reeding programmes, **P**rotect habitats, **H**edgerows, **R**educe deforestation, **R**ecycle.

PART D

Trophic Levels and Food Production

7.16 Trophic levels BIOLOGY ONLY

AQA 4.7.4.1

Trophic level	Organisms
Level 1	**Producers** — plants and algae that make their own food by photosynthesis
Level 2	**Primary consumers** — **herbivores** that eat plants and algae
Level 3	**Secondary consumers** — **carnivores** that eat herbivores
Level 4	**Tertiary consumers** — carnivores that eat other carnivores

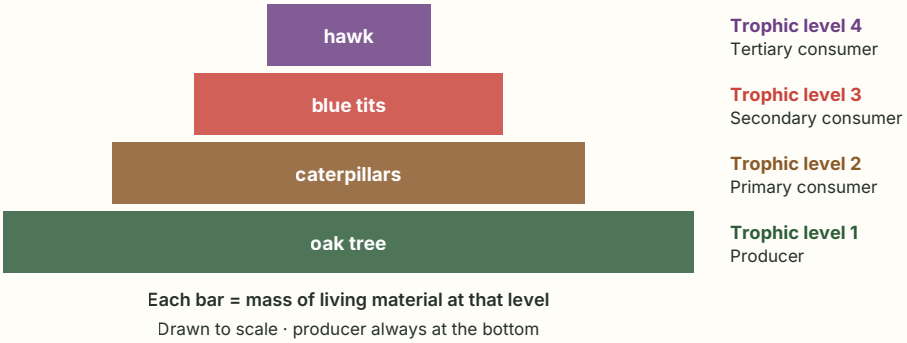
- **Apex predators** are carnivores with **no predators**, at the top of the food chain.
- **Decomposers** (bacteria and fungi) break down dead plant and animal matter by **secreting enzymes** into the environment. Small soluble food molecules then **diffuse** into the microorganism.

REMEMBER IT

Trophic = **feeding** level. Count from the **producer** = level 1. Herbivore = **herb**s (plants); carnivore = **carn**e (meat).

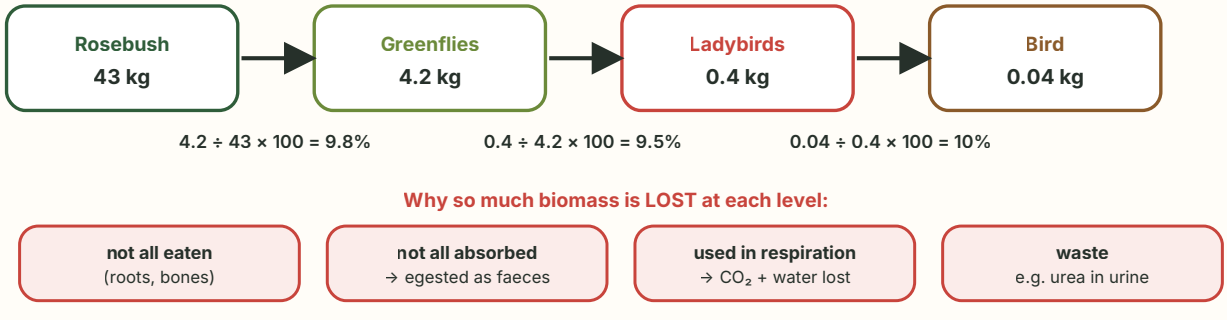
7.17 Pyramids of biomass and biomass transfer BIOLOGY ONLY

AQA 4.7.4.2–4.7.4.3



A pyramid of biomass

- A **pyramid of biomass** shows the **relative mass of living material** at each trophic level. The bottom bar is always the **producer**.
- It is (almost) always **pyramid-shaped**, because biomass is **lost** at each level. One oak tree has a big biomass, even though it is just one organism.
- Producers transfer only about **1%** of the light energy reaching them for photosynthesis.
- Only about **10%** of the biomass at each trophic level is transferred to the level above.



Biomass at each level and why so much is lost

MATHS SKILL — EFFICIENCY OF BIOMASS TRANSFER

Efficiency = biomass transferred to the next level ÷ biomass available at the previous level × 100

Example: 43 kg rosebush → 4.2 kg greenflies. Efficiency = 4.2 ÷ 43 × 100 = **9.8%**. Biomass lost = 43 − 4.2 = **38.8 kg**.

EXAM TIP

Because so much biomass is lost, food chains rarely have more than **4 or 5** trophic levels, and there are fewer organisms (less biomass) at higher levels. Draw pyramids **to scale** and **label each bar**.

7.18 Food security and farming BIOLOGY ONLY

AQA 4.7.5.1–4.7.5.3

DEFINITION — LEARN IT

Food security is having **enough food** to feed a population.

Biological factors that threaten food security:

- Increasing **birth rate** in some developing countries.
- Changing **diets** in developed countries mean scarce food resources are transported around the world.
- New **pests and pathogens** that affect farming.
- **Environmental changes** (e.g. drought, flooding) that affect food production, causing **famine**.
- The **cost** of agricultural inputs (seeds, fertiliser, machinery).
- **Conflicts** in some parts of the world that affect access to food or water.

Making food production more efficient

- **Factory farming**: limiting the movement of livestock and keeping them in **temperature-controlled** environments reduces energy transfer to the environment → more energy for **growth**, so more food from the same input.
- Some animals are fed **high-protein foods** to increase growth.
- But there are **ethical objections**: some people think it is cruel to keep animals in small, unnatural conditions; disease also spreads easily.

Sustainable fisheries

- **Fish stocks** in the oceans are **declining** because of overfishing. It is important to keep fish stocks at a level where breeding continues, or some species may disappear.
- **Fishing quotas** limit the number and size of fish that can be caught in certain areas.
- **Net size** — a bigger mesh size lets **younger fish** escape, so they can reach breeding age.

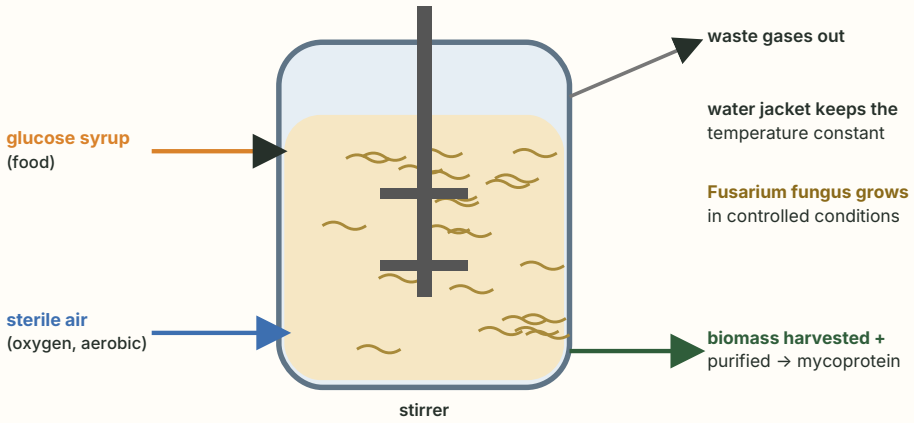
REMEMBER IT

Sustainable fishing: **"Quota + Mesh"**. Factory farming: **less movement + warm = less energy wasted**.

7.19 Biotechnology and food BIOLOGY ONLY

AQA 4.7.5.4

- Modern **biotechnology** techniques allow large quantities of microorganisms to be **cultured** for food.
- The fungus ***Fusarium*** is used to make **mycoprotein**, a protein-rich food suitable for **vegetarians** (meat substitutes).



Producing mycoprotein in a fermenter

- The fungus is grown on **glucose syrup** in **aerobic conditions**, in large fermenters with controlled conditions.
- The fungal **biomass** is harvested and **purified**.

Genetically modified (GM) organisms can also help with food security:

- A genetically modified bacterium produces **human insulin**; when grown in vats, the insulin is harvested and purified.
- GM crops can be made **resistant to pests**, or to grow better in **drought** conditions → bigger yields.
- GM crops can provide **more nutrients**, e.g. **'Golden Rice'** makes a chemical that the body turns into **vitamin A**.
- **But** some people argue that hunger is caused by poverty (people can't afford food), not a lack of food; others fear countries may become dependent on companies that sell GM seeds.

REMEMBER IT

Myco = fungus → **Fusarium** + glucose syrup + oxygen → mycoprotein (Quorn-type food).

★ LAST-MINUTE

One-page memory sheet

Topic	Must-know facts
Key words	Habitat, population (one species), community (many species), ecosystem (community + abiotic). Plants compete for light, space, water, minerals; animals for food, mates, territory. Interdependence; stable community.
Factors	Abiotic: light, temperature, moisture, soil pH/minerals, wind, CO_2, O_2 (aquatic). Biotic: food, predators, pathogens, competition.
Adaptations	Structural, behavioural, functional. Extremophiles: high temperature, pressure or salt.
Food chains	Producer → primary → secondary → tertiary consumer. Predator–prey cycles out of phase.
Quadrats + transects (RP)	Random quadrats, count, repeat, mean; compare two areas. Population = mean per m^2 × area. Transect: line + quadrats at intervals. % cover.
Water cycle	Evaporation + transpiration → condensation → precipitation → drainage to sea.
Carbon cycle	Photosynthesis removes CO_2; respiration, decay and combustion return it. Microorganisms return carbon and mineral ions.
Decay (Bio)	Faster when warm, moist, with oxygen, more decomposers. Compost. Anaerobic decay → methane → biogas generator.
Decay RP (Bio)	Milk + sodium carbonate + phenolphthalein (pink) + lipase in water bath; time to go colourless; rate = 1000/time.
Environmental change (Bio, HT)	Distribution changes with water availability, temperature, atmospheric gases (e.g. lichens and SO_2).
Biodiversity	Variety of species; high biodiversity = stable ecosystem. Population growth → more resources + waste → pollution of water, air, land.
Land use	Building, quarrying, farming, waste. Deforestation (cattle, rice, biofuels) → less photosynthesis, more CO_2, less biodiversity. Peat bogs → CO_2 + habitat loss.
Global warming	CO_2 + methane trap energy. Habitat loss (flooding), distribution changes, migration changes, reduced biodiversity.
Maintaining biodiversity	Breeding programmes, protect habitats, hedgerows/field margins, reduce deforestation + emissions, recycle. Conflicts: cost, jobs, food security, development.
Trophic levels (Bio)	1 producers, 2 herbivores, 3 carnivores, 4 top carnivores; apex predators; decomposers secrete enzymes.
Biomass (Bio)	Pyramid of biomass. ~1% of light used; ~10% passed on. Losses: not eaten, faeces, respiration, urine. Efficiency = next ÷ previous × 100.
Food (Bio)	Food security threats: birth rate, diets, pests, environment, cost, conflict. Factory farming; quotas + net size. Mycoprotein (Fusarium, glucose syrup, aerobic). GM crops, Golden Rice.

PRACTICE

Summary questions

Try every question **without notes**. Tick each one you get fully right; redo the rest in 2–3 days. Answers are in the next section. Questions marked **(Bio)** are for Separate Biology only; **(HT)** are Higher tier only.

Section A — Quick recall (1–2 marks each)

1. What is a habitat?
2. What is the difference between a population and a community?
3. What is an ecosystem?
4. Name three things that plants compete for.
5. Name three things that animals compete for.
6. What is interdependence?
7. What is a stable community?
8. Give four abiotic factors.
9. Give two biotic factors.
10. What are the three types of adaptation?
11. What is an extremophile?
12. What do food chains always start with?
13. Explain what happens to a predator population if its prey becomes more common.
14. Why should quadrats be placed randomly?
15. What is a transect used for?
16. Name the process by which water moves from leaves into the air.
17. What happens to water vapour when it cools?
18. Which process removes carbon dioxide from the atmosphere?
19. Give three processes that return carbon dioxide to the atmosphere.
20. (Bio) Give three factors that affect the rate of decay.
21. (Bio) What gas is produced by anaerobic decay and used in biogas?
22. (Bio) Why does phenolphthalein turn colourless in the decay practical?
23. (Bio, HT) Give one environmental change that can affect the distribution of organisms.
24. What is biodiversity?
25. Why is high biodiversity important?
26. Give one way humans pollute water.
27. Give two reasons why tropical forests are cut down.
28. Why does burning peat contribute to global warming?
29. Name two greenhouse gases.
30. Give two biological consequences of global warming.
31. Give two ways biodiversity can be maintained.
32. (Bio) Which trophic level contains the producers?
33. (Bio) What is an apex predator?

34. (Bio) What does each bar of a pyramid of biomass represent?
35. (Bio) Roughly what percentage of biomass is passed from one trophic level to the next?
36. (Bio) What is food security?
37. (Bio) Give two ways fish stocks can be kept at a sustainable level.
38. (Bio) Which organism is used to make mycoprotein?

Section B — Exam-style questions

39. Explain why removing one species from a food web can affect other species. [3 marks]
40. Describe two adaptations of a polar bear for living in the Arctic and explain how each helps it survive. [4 marks]
41. Explain why predator and prey population cycles are out of phase. [2 marks]
42. Describe how a student could estimate the number of buttercups in a field. [6 marks]
43. Describe how a student could investigate how the distribution of daisies changes from a hedge to the middle of a field. [4 marks]
44. Describe how carbon is recycled in an ecosystem. [6 marks]
45. (Bio) Explain why compost heaps decay faster in summer than in winter. [3 marks]
46. (Bio) Explain why a farmer might use a biogas generator. [3 marks]
47. (Bio) A student found the milk turned colourless after 120 s at 30 °C and after 400 s at 10 °C. Explain these results. [3 marks]
48. Explain how deforestation can contribute to global warming. [4 marks]
49. Explain why destroying peat bogs reduces biodiversity and increases carbon dioxide in the atmosphere. [4 marks]
50. Evaluate the use of programmes to maintain biodiversity, such as paying farmers to plant hedgerows. [6 marks]
51. (Bio) Explain why biomass is lost between trophic levels. [4 marks]
52. (Bio) Explain why factory farming can increase the efficiency of food production. Give one disadvantage. [3 marks]
53. (Bio) Describe how mycoprotein is produced. [3 marks]

Section C — Maths skills

54. A student counted 6, 9, 4, 7, 8 and 8 limpets in six quadrats. Calculate the mean. [1 mark]
55. 0.25 m^2 quadrats found a mean of 3 buttercups per quadrat. The field is 1200 m^2. Estimate the buttercup population. [2 marks]
56. In a quadrat with 100 squares, moss covered 37 squares. What is the percentage cover? [1 mark]
57. (Bio) The milk took 280 s to turn colourless. Calculate the rate of decay. Give your answer in s^{-1} to 2 s.f. [2 marks]
58. (Bio) Small fish have 995 kg of biomass; large fish have 110 kg. Calculate the efficiency of biomass transfer. [2 marks]
59. (Bio) A field of grass has 2500 kg of biomass. If 10% is transferred at each level, what biomass reaches the secondary consumers? [2 marks]
60. Atmospheric CO_2 rose from 280 ppm to 420 ppm. Calculate the percentage increase. [2 marks]

ANSWERS

Answers and mark scheme

Section A — Quick recall

1. **What is a habitat?**
   The place where an organism lives.
2. **What is the difference between a population and a community?**
   A population is all the organisms of one species in a habitat; a community is the populations of different species in a habitat.
3. **What is an ecosystem?**
   The interaction of a community of living organisms with the non-living (abiotic) parts of their environment.
4. **Name three things that plants compete for.**
   Light, space, water, mineral ions (any three).
5. **Name three things that animals compete for.**
   Food, mates, territory.
6. **What is interdependence?**
   When species in a community depend on each other for things like food, shelter, pollination and seed dispersal.
7. **What is a stable community?**
   One where all species and environmental factors are in balance, so population sizes stay roughly constant.
8. **Give four abiotic factors.**
   Light intensity, temperature, moisture, soil pH/minerals, wind, CO_2 level, O_2 level for aquatic animals (any four).
9. **Give two biotic factors.**
   Availability of food; new predators; new pathogens; competition (any two).
10. **What are the three types of adaptation?**
    Structural, behavioural and functional.
11. **What is an extremophile?**
    An organism that lives in extreme conditions, e.g. high temperature, pressure or salt concentration.
12. **What do food chains always start with?**
    A producer (a green plant or alga).
13. **Explain what happens to a predator population if its prey becomes more common.**
    It increases, because there is more food available (after a short delay).
14. **Why should quadrats be placed randomly?**
    To avoid bias, so the sample is representative.
15. **What is a transect used for?**
    To study how the distribution of organisms changes across an area.
16. **Name the process by which water moves from leaves into the air.**
    Transpiration.
17. **What happens to water vapour when it cools?**
    It condenses to form clouds.

18. **Which process removes carbon dioxide from the atmosphere?**
    Photosynthesis.
19. **Give three processes that return carbon dioxide to the atmosphere.**
    Respiration, decay (respiration by microorganisms), combustion.
20. **(Bio) Give three factors that affect the rate of decay.**
    Temperature, oxygen availability, water availability (also number of decomposers).
21. **(Bio) What gas is produced by anaerobic decay and used in biogas?**
    Methane.
22. **(Bio) Why does phenolphthalein turn colourless in the decay practical?**
    Lipase breaks fat in milk into fatty acids, so the pH falls below about 8.3.
23. **(Bio, HT) Give one environmental change that can affect the distribution of organisms.**
    Availability of water; temperature; composition of atmospheric gases (any one).
24. **What is biodiversity?**
    The variety of all the different species of organisms on Earth or within an ecosystem.
25. **Why is high biodiversity important?**
    It makes ecosystems stable, reducing dependence of one species on another.
26. **Give one way humans pollute water.**
    Sewage, fertilisers or toxic chemicals (any one).
27. **Give two reasons why tropical forests are cut down.**
    Land for cattle; land for rice fields; growing crops for biofuels (any two).
28. **Why does burning peat contribute to global warming?**
    Peat is a store of carbon; burning it releases CO_2.
29. **Name two greenhouse gases.**
    Carbon dioxide and methane.
30. **Give two biological consequences of global warming.**
    Loss of habitat from flooding; changes in species distribution; changes in migration; reduced biodiversity (any two).
31. **Give two ways biodiversity can be maintained.**
    Breeding programmes; protecting habitats; hedgerows and field margins; reducing deforestation; recycling (any two).
32. **(Bio) Which trophic level contains the producers?**
    Trophic level 1.
33. **(Bio) What is an apex predator?**
    A carnivore with no predators.
34. **(Bio) What does each bar of a pyramid of biomass represent?**
    The relative mass of living material at one trophic level.
35. **(Bio) Roughly what percentage of biomass is passed from one trophic level to the next?**
    About 10%.
36. **(Bio) What is food security?**
    Having enough food to feed a population.
37. **(Bio) Give two ways fish stocks can be kept at a sustainable level.**
    Fishing quotas; controlling net (mesh) size.
38. **(Bio) Which organism is used to make mycoprotein?**
    The fungus Fusarium.

Section B — Exam-style questions

39. **Explain why removing one species from a food web can affect other species.** [3]
    - Species are interdependent (1)
    - Animals that ate the removed species have less food, so their numbers may fall (1)
    - The species it ate may increase / its competitors may increase (1)

40. **Describe two adaptations of a polar bear for living in the Arctic and explain how each helps it survive.** [4]
    - Thick fur / layer of blubber (1) → insulation, reduces heat loss (1)
    - White fur (1) → camouflage, so it can sneak up on prey (1); or small ears / large body → low SA:V ratio, less heat loss

41. **Explain why predator and prey population cycles are out of phase.** [2]
    - When prey numbers increase, it takes time for predators to reproduce / for their numbers to respond (1)
    - So the predator peak comes after the prey peak (1)

42. **Describe how a student could estimate the number of buttercups in a field.** [6]
    - Divide the field into a grid; use a random number generator to choose coordinates
    - Place a quadrat (e.g. 1 m^2 or 0.25 m^2) at each point
    - Count the buttercups in each quadrat
    - Repeat for many quadrats (e.g. 10+)
    - Calculate the mean number per quadrat, then per m^2
    - Measure the area of the field and multiply: mean per m^2 × total area
    - *Level marking: clear, logical method with random sampling and the calculation for 5–6 marks.*

43. **Describe how a student could investigate how the distribution of daisies changes from a hedge to the middle of a field.** [4]
    - Lay a tape measure (transect) from the hedge into the field (1)
    - Place quadrats at regular intervals along the line, e.g. every 2 m (1)
    - Count daisies (or estimate % cover) in each quadrat (1)
    - Measure an abiotic factor (e.g. light intensity) at each quadrat; repeat with more transects (1)

44. **Describe how carbon is recycled in an ecosystem.** [6]
    - Plants and algae take in CO_2 by photosynthesis and make carbohydrates, fats and proteins
    - Animals eat plants, so carbon compounds pass along the food chain
    - Plants and animals respire, releasing CO_2
    - When organisms die or produce waste, microorganisms (and detritus feeders) decay them
    - Microorganisms respire, releasing CO_2 back into the atmosphere
    - Combustion of wood and fossil fuels also releases CO_2
    - *Level marking: a full sequence with correct processes for 5–6 marks.*

45. **(Bio) Explain why compost heaps decay faster in summer than in winter.** [3]
    - Temperature is higher in summer (1)
    - Enzymes in microorganisms work faster / microorganisms respire and reproduce faster (1)
    - so organic matter is broken down more quickly (1)

46. **(Bio) Explain why a farmer might use a biogas generator.** [3]
    - Animal/plant waste is decayed anaerobically by microorganisms to produce methane / biogas (1)
    - Biogas can be used as a fuel for heating/electricity, saving money (1)
    - The digested material can be used as fertiliser (1)

47. **(Bio) A student found the milk turned colourless after 120 s at 30 °C and after 400 s at 10 °C. Explain these results.** [3]
    - At 30 °C, the lipase enzyme works faster (more collisions/energy) (1)
    - so fat is broken down into fatty acids more quickly and the pH falls faster (1)
    - At 10 °C, enzymes work more slowly, so the colour change takes longer (1)

48. **Explain how deforestation can contribute to global warming.** [4]
    - Fewer trees, so less CO_2 removed from the atmosphere by photosynthesis (1)
    - Trees are often burnt to clear land, releasing CO_2 (1)
    - Microorganisms decay leftover wood and respire, releasing CO_2 (1)
    - More CO_2 in the atmosphere traps more energy → global warming (1)

49. **Explain why destroying peat bogs reduces biodiversity and increases carbon dioxide in the atmosphere.** [4]
    - Peat bogs are habitats for many species; destroying them removes the habitat (1) → fewer species / reduced biodiversity (1)
    - Peat is a store of carbon (1)
    - When drained it decays (microorganisms respire) or is burnt, releasing CO_2 (1)

50. **Evaluate the use of programmes to maintain biodiversity, such as paying farmers to plant hedgerows.** [6]
    - **For:** hedgerows and field margins provide habitats and food for more species; increase biodiversity; ecosystems more stable; may help pollinators and natural pest control
    - **Against:** costs money (government subsidies); less land for crops → lower food production; some species are pests to crops; farmers may lose income
    - **Conclusion:** justified judgement, e.g. benefits for long-term stability outweigh costs
    - *Level marking: balanced points + justified conclusion for 5–6 marks.*

51. **(Bio) Explain why biomass is lost between trophic levels.** [4]
    - Not all of an organism is eaten (e.g. bones, roots) (1)
    - Not all eaten material is absorbed — some is egested as faeces (1)
    - Much glucose is used in respiration, releasing energy, CO_2 and water (1)
    - Some is lost as waste, e.g. urea in urine (1)

52. **(Bio) Explain why factory farming can increase the efficiency of food production. Give one disadvantage.** [3]
    - Limiting movement and keeping animals warm means less energy is transferred to the environment / used in respiration (1)
    - so more energy/biomass is used for growth → more food from the same food input (1)
    - Disadvantage: ethical objections / disease spreads easily / animals kept in unnatural conditions (1)

53. **(Bio) Describe how mycoprotein is produced.** [3]
    - The fungus Fusarium is grown in large fermenters (1)
    - on glucose syrup in aerobic conditions (controlled temperature) (1)
    - The biomass is harvested and purified (1)

Section C — Maths skills

54. **A student counted 6, 9, 4, 7, 8 and 8 limpets in six quadrats. Calculate the mean.** [1]
(6 + 9 + 4 + 7 + 8 + 8) ÷ 6 = 42 ÷ 6 = **7 limpets per quadrat**

55. **0.25 m² quadrats found a mean of 3 buttercups per quadrat. The field is 1200 m². Estimate the buttercup population.** [2]
3 ÷ 0.25 = 12 per m² (1) → 12 × 1200 = **14 400 buttercups** (1)

56. **In a quadrat with 100 squares, moss covered 37 squares. What is the percentage cover?** [1]
37 ÷ 100 × 100 = **37%**

57. **(Bio) The milk took 280 s to turn colourless. Calculate the rate of decay. Give your answer in s^{-1} to 2 s.f.** [2]
1000 ÷ 280 = 3.57… (1) = **3.6 s^{-1}** (1)

58. **(Bio) Small fish have 995 kg of biomass; large fish have 110 kg. Calculate the efficiency of biomass transfer.** [2]
110 ÷ 995 × 100 (1) = **11%** (11.1%) (1)

59. **(Bio) A field of grass has 2500 kg of biomass. If 10% is transferred at each level, what biomass reaches the secondary consumers?** [2]
2500 × 0.1 = 250 kg (primary) (1) → 250 × 0.1 = **25 kg** (1)

60. **Atmospheric CO_2 rose from 280 ppm to 420 ppm. Calculate the percentage increase.** [2]
420 − 280 = 140 (1) → 140 ÷ 280 × 100 = **50%** (1)

FINAL EXAM ADVICE

Use the **key words** examiners look for: *ecosystem, community, population, interdependence, abiotic, biotic, adaptation, extremophile, producer, consumer, quadrat, transect, random sampling, mean, photosynthesis, respiration, combustion, decay, biodiversity, deforestation, greenhouse gas, trophic level, biomass, efficiency, food security, sustainable, mycoprotein*. In practical questions always mention **random sampling**, **repeats** and the **mean**.

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