

AQA GCSE Combined Science: Trilogy — Biology

Topic 7

Ecology

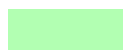
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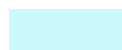
Revision notes for one topic, free to download.

These are the summary notes only. The full edition of this booklet also carries the worked examples, the required practicals and the formula sheets, with every topic in one place.

Colour Codes



Definitions



Diagrams



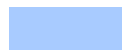
Notes and warnings



Mnemonics



Common confusions



Check yourself



Sub-topic headings

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Define Ecosystem

- the interaction of a community of living organisms (biotic) with the non-living (abiotic) parts of their environment.

Define Community

- all the populations of different species in a habitat.

Define Stable community

- one where all species and environmental factors are in balance, so population sizes stay fairly constant.

Define Biotic factor

- a living factor that can affect a community.

Define Extremophile

- an organism living in a very extreme environment (high temperature, pressure or salt).

Define Predator and prey

- consumers that kill and eat other animals, and the animals that are eaten.

Define Biodiversity

- the variety of all the different species of organisms on Earth or within an ecosystem.

Define Habitat

- the place where an organism lives.

Define Population

- all the organisms of one species in a habitat.

Define Interdependence

- species depend on each other for food, shelter, pollination and seed dispersal.

Define Abiotic factor

- a non-living factor that can affect a community.

Define Adaptation

- a feature enabling an organism to survive in the conditions in which it normally lives.

Define Producer

- a photosynthetic organism that synthesises molecules, making biomass for life on Earth.

Define Decomposing microorganism

- a microorganism that breaks down dead matter, returning carbon to the atmosphere as carbon dioxide and mineral ions to the soil.

7.1 Adaptations, interdependence and competition

7.1.1 Communities

Levels of organisation, smallest to largest: individual organism → population → community → ecosystem.

An **ecosystem** is the interaction of a community of living organisms (**biotic**) with the non-living (**abiotic**) parts of their environment. To survive and reproduce, organisms need materials from their surroundings and from the other living organisms there.

Competition. Organisms compete for resources in short supply:

ANALOGY

Interdependence is like interlocking cogs in a clock. Every cog is turned by the ones next to it, so pulling out one small cog — a single pollinating insect species, say — does not cost you "one cog's worth" of time. The whole clock stops.

DON'T MIX UP

population vs community

A **population** is all the members of **one species** in an area. A **community** is **all the populations** of all the species there. One species versus all of them — that is the whole difference.

SAY IT

Light, Temperature, Moisture, Soil, Wind, Gases

The seven abiotic factors, taking carbon dioxide for plants and oxygen for aquatic animals together as gases. All non-living — that is the test.

DON'T MIX UP

abiotic vs biotic

Abiotic — absent of life: light, temperature, moisture, soil pH and minerals, wind, gas levels. **Biotic** — anything to do with living things: food availability, predators, pathogens, competitors.

Group	Compete for
Plants	Light and space; water and mineral ions from the soil
Animals	Food, mates and territory

Interdependence. Each species depends on others for food, shelter, pollination, seed dispersal etc, so removing one can affect the whole community. A **stable community** is one where all species and environmental factors are in balance, so population sizes stay fairly constant — for example mature oak woodland.

SAY IT

Individual, Population, Community, Ecosystem

Smallest to largest. An **ecosystem** is the one that adds the non-living part — a community interacting with the abiotic environment.

CHECK YOURSELF

Cover the grey line before you answer.

1. Define an ecosystem.

The interaction of a community of living organisms with the non-living parts of their environment.

2. What do plants compete for, and what do animals compete for?

Plants: light, space, water and mineral ions. Animals: food, mates and territory.

3. What is a stable community?

One where all the species and environmental factors are in balance, so population sizes stay fairly constant.

CHECK YOURSELF

Cover the grey line before you answer.

1. Name five abiotic factors.

Light intensity; temperature; moisture levels; soil pH and mineral content; wind intensity and direction; carbon dioxide levels; oxygen levels for aquatic animals.

2. Explain in a chain how reduced light affects a community.

Less light → less photosynthesis → producers grow more slowly → fewer primary consumers can be supported → the effect passes up the food chain.

7.1.2 Abiotic factors

Abiotic (non-living) factors that can affect a community are:

- light intensity
- temperature
- moisture levels
- soil pH and mineral content
- wind intensity and direction
- carbon dioxide levels for plants
- oxygen levels for aquatic animals.

To explain how a change in an abiotic factor affects a community, argue in a chain: *factor changes* → *effect on one species* → *knock-on effect through the food chain*. Less light means less photosynthesis, so producers grow slowly and fewer primary consumers are supported.

DON'T MIX UP

a new predator vs a new pathogen

Both are biotic and both reduce a population, but by different routes — one eats the organism, the other infects it. Name which one you mean; “a new species arrives” is too vague to score.

7.1.4 Adaptations

Organisms have features (**adaptations**) enabling them to survive in the conditions in which they normally live. These may be:

7.1.3 Biotic factors

Biotic (living) factors that can affect a community are:

- availability of food
- new predators arriving
- new pathogens
- one species outcompeting another so the numbers are no longer sufficient to breed.

WATCH OUT

Disease is often wrongly called abiotic. A pathogen is living, so new pathogens are a **biotic** factor — as is food. The mineral ions in soil that plants need are abiotic.

CHECK YOURSELF

Cover the grey line before you answer.

1. Name four biotic factors.

Availability of food; new predators arriving; new pathogens; one species outcompeting another so its numbers fall too low to breed.

2. Why can one species outcompeting another cause local extinction?

Numbers fall until they are no longer sufficient to breed.

Type	Meaning	Example
Structural	Body shape or features	Small ears, thick fur of an Arctic fox reduce heat loss
Behavioural	How an organism acts	Migrating to avoid cold seasons
Functional	Body processes	Making very concentrated urine to conserve water in a desert

Organisms living in very extreme environments — high temperature, pressure or salt concentration — are called **extremophiles**. Bacteria living in deep sea vents are extremophiles.

DON'T MIX UP

behavioural vs functional

Behavioural is something the organism **does** — migrating, huddling. **Functional** is a process **inside** it — metabolic or reproductive, like a desert animal producing very concentrated urine.

SAY IT

Structural, Behavioural, Functional

The three kinds of adaptation: what the organism **looks like**, what it **does**, and what its **body chemistry** does — such as producing antivenom or controlling water loss.

CHECK YOURSELF

Cover the grey line before you answer.

1. Name the three types of adaptation.

Structural, behavioural and functional.

2. What is an extremophile?

An organism living in a very extreme environment — of high temperature, pressure or salt concentration — such as bacteria at deep sea vents.

7.2 Organisation of an ecosystem

7.2.1 Levels of organisation

Photosynthetic organisms are the **producers** of biomass for life on Earth. All food chains begin with a producer which synthesises molecules — usually a green plant or alga making glucose by photosynthesis.

producer → primary consumer → secondary consumer → tertiary consumer

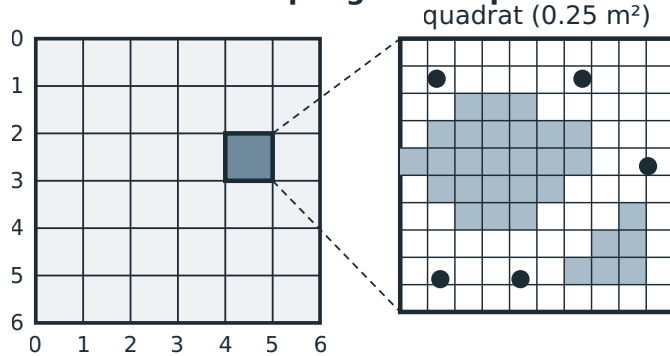
Consumers that kill and eat other animals are **predators**; those eaten are **prey**. In a stable community their numbers rise and fall in **cycles**: prey rise when predators are few, so predators increase, cutting prey numbers, so predators fall again. On a graph the predator peak comes **after** the prey peak, and prey are always more numerous.

Sampling. Ecologists use **quadrats** and **transects** to determine distribution and abundance.

- A **quadrat** is a square frame of known area, placed at **random** coordinates to sample abundance without bias.
- A **transect** is a line along which quadrats are placed at regular intervals, showing how distribution *changes* across a gradient (for example from a path into a field).

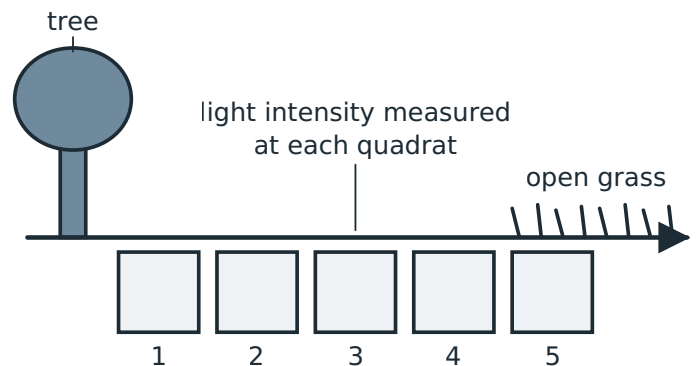
Sampling with quadrats and a transect

Random sampling with a quadrat



shaded squares = area covered by the plant
percentage cover = 30 of 100 squares = 30%
count = 5 snails (dots) in this quadrat
Repeat at several random coordinates and calculate the mean number per quadrat.

Belt transect from a tree to open grass



quadrat	1	2	3	4	5
light / lux	200	450	900	1500	2000
daisies	2	5	9	14	18

$$\text{estimated population size} = \text{mean number per quadrat} \times \frac{\text{total area of the habitat}}{\text{area of one quadrat}}$$

SAY IT

Producer, Primary, Secondary, Tertiary

Every food chain starts with a **producer** — a green plant or alga making glucose by photosynthesis. The numbers count consumers, not the producer.

CHECK YOURSELF

Cover the grey line before you answer.

- What does every food chain begin with, and why?
A producer — usually a green plant or alga — because it synthesises the molecules that all the other organisms depend on.
- Describe the predator–prey cycle.
Prey numbers rise when predators are few; more food means predators increase; more predators cut prey numbers; with less food, predators fall again.
- Why must a quadrat be placed at random coordinates?
So the sample is unbiased and representative of the whole area.

DON'T MIX UP

predator peak vs prey peak

On a predator–prey graph the **prey** peak always comes **first** and prey are always the **more numerous**. The predator curve follows it, slightly behind. Reading the two curves the wrong way round is the single commonest error on this topic.

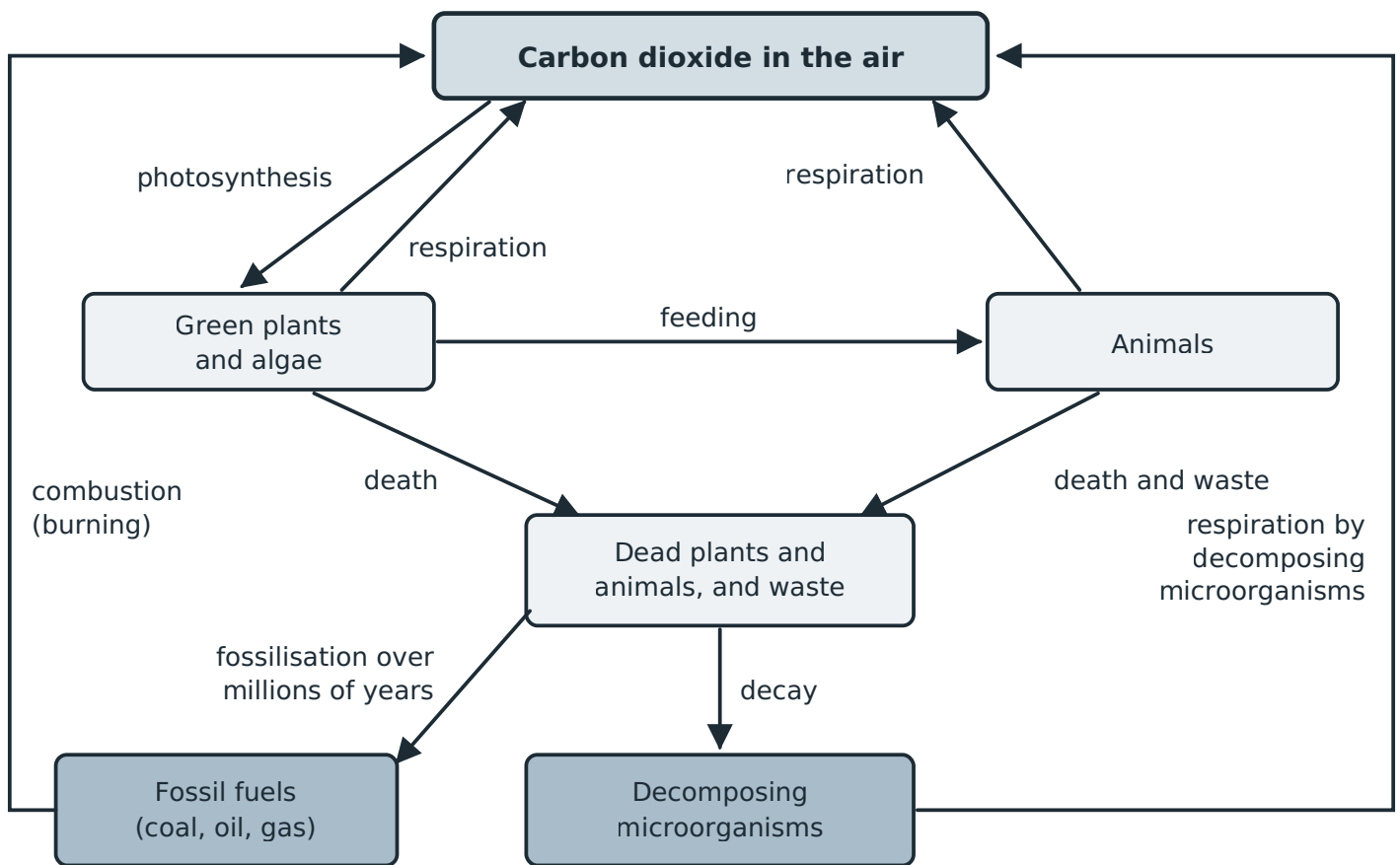
7.2.2 How materials are cycled

Many different materials cycle through the abiotic and biotic components of an ecosystem: all materials in the living world are recycled to provide the building blocks for future organisms.

The carbon cycle returns carbon from organisms to the atmosphere as carbon dioxide, to be used by plants in photosynthesis.

- Carbon dioxide is removed from the air by **photosynthesis** in plants and algae.
- Carbon passes along food chains when organisms are eaten.
- Carbon dioxide is returned to the air by **respiration** of plants, animals and decomposing microorganisms, and by **combustion** of fuels.

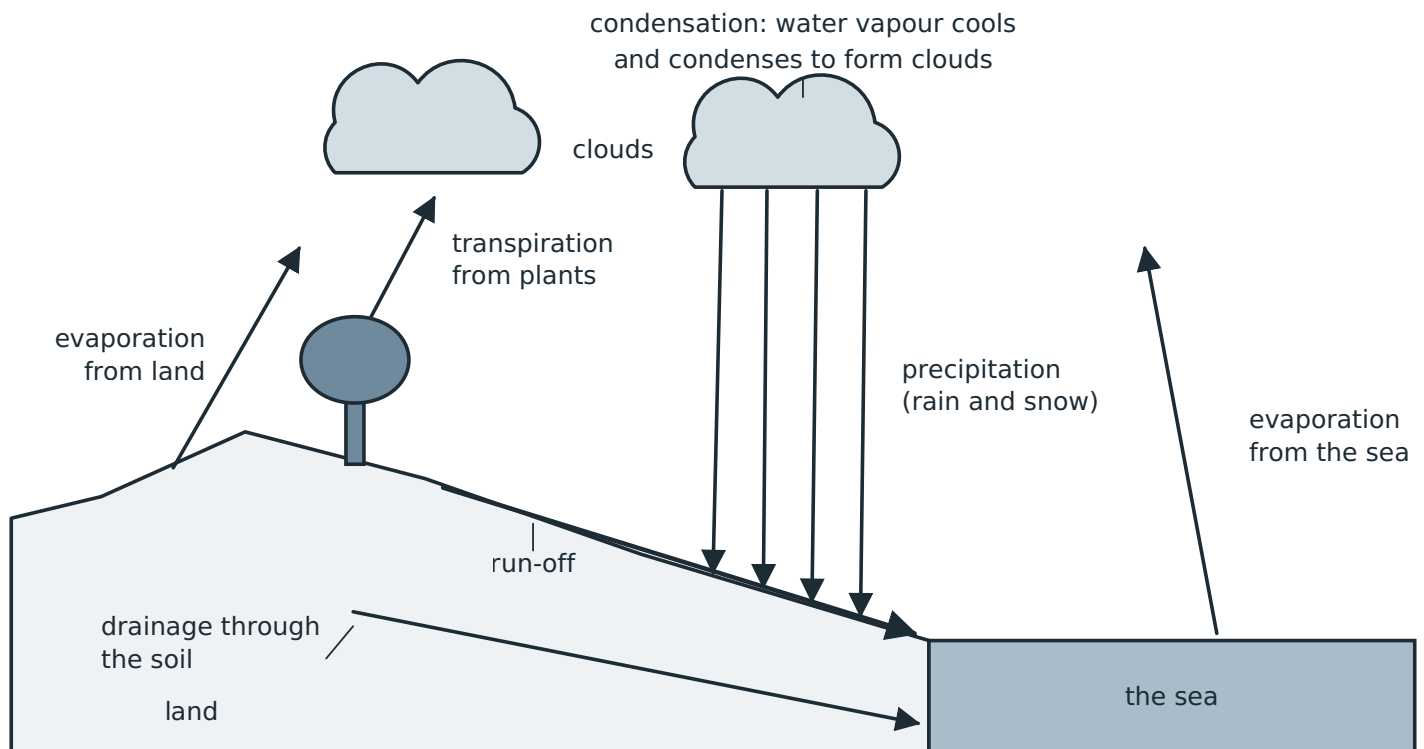
The carbon cycle



The water cycle provides fresh water for plants and animals on land before draining into the seas. Water is continuously **evaporated** and **precipitated**.

- Energy from the Sun evaporates water from seas, lakes and land; plants also lose water by transpiration.
- Water vapour rises, cools and condenses into clouds.
- Water falls as precipitation, providing fresh water on land, then drains through rivers back into the seas.

The water cycle



The water cycle provides fresh water for plants and animals on land before draining into the seas.

Role of microorganisms. They cycle materials through an ecosystem by returning carbon to the atmosphere as carbon dioxide and **mineral ions to the soil**, where plants take them up again.

SAY IT

Photosynthesis takes out, respiration and combustion put back

Carbon dioxide leaves the air by **photosynthesis** only. It returns by **respiration** of plants, animals and decomposers, and by **combustion**.

DON'T MIX UP

decay vs combustion

Both return carbon dioxide to the air, but **decay** is respiration by **microorganisms** breaking down dead material, and **combustion** is burning. A carbon-cycle diagram usually wants both arrows labelled separately.

NOTE

The spec states students are **not** expected to study the nitrogen cycle — carbon and water only.

ANALOGY

The carbon cycle is like canteen crockery: the same finite set of plates is served out (photosynthesis), passed down the queue (feeding), then washed and returned to the stack (respiration, decay, combustion). No new plates are made — burning fossil fuels just unlocks a cupboard shut for millions of years, so more are in circulation at once.

CHECK YOURSELF

Cover the grey line before you answer.

1. What is the only process that removes carbon dioxide from the air?

Photosynthesis in plants and algae.

2. Name three processes that return carbon dioxide to the air.

Respiration of plants and animals; respiration of decomposing microorganisms; combustion of fuels.

3. Describe how water is cycled.

Energy from the Sun evaporates water from seas, lakes and land, and plants lose it by transpiration; the vapour rises, cools and condenses into clouds; water falls as precipitation and drains back to the seas.

7.3 Biodiversity and the effect of human interaction on ecosystems

DON'T MIX UP

biodiversity — variety, not number

Biodiversity is the **variety of species**, not how many individuals there are. A field with a million individuals of one crop has very **low** biodiversity.

7.3.1 Biodiversity

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

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

7.3.2 Waste management

Rapid growth in the human population and a rising standard of living mean more resources are used and more waste produced. Unless waste and chemical materials are properly handled, more pollution is caused, and it can occur:

- **in water**, from sewage, fertiliser or toxic chemicals **in air**, from smoke and acidic gases
- **on land**, from landfill and toxic chemicals.

Pollution kills plants and animals, which reduces biodiversity.

CHECK YOURSELF

Cover the grey line before you answer.

1. Define biodiversity.

The variety of all the different species of organisms on Earth, or within an ecosystem.

2. Why does high biodiversity make an ecosystem more stable?

It reduces the dependence of one species on another for food, shelter and maintenance of the physical environment.

SAY IT

Water, Air, Land

Pollution in three places: **water** — sewage, fertiliser, toxic chemicals; **air** — smoke and acidic gases; **land** — landfill and toxic chemicals.

CHECK YOURSELF

Cover the grey line before you answer.

1. Why is more waste being produced?

Rapid growth in the human population and a rising standard of living mean more resources are used.

2. How does pollution reduce biodiversity?

It kills plants and animals, so fewer species survive in the ecosystem.

SAY IT

Build, Quarry, Farm, Dump

The four ways humans reduce the land available to other species.

DON'T MIX UP

the two reasons to conserve peat

Destroying a peat bog does **two** separate kinds of damage: it destroys a **habitat**, reducing biodiversity, and decay or burning of the peat **releases carbon dioxide**. An evaluation needs both, set against cheaper compost and more food production.

7.3.3 Land use

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

Peat bogs. Destroying peat bogs and other peat areas to produce garden compost reduces this habitat and so the variety of plant, animal and microorganism species living there (biodiversity). The decay or burning of the peat releases carbon dioxide into the atmosphere. The conflict to evaluate: cheap peat compost increases food production, but peat bogs must be conserved for biodiversity and to reduce carbon dioxide emissions.

CHECK YOURSELF

Cover the grey line before you answer.

1. Give the three reasons for large-scale deforestation in tropical areas.

To provide land for cattle and for rice fields, and to grow crops for biofuels.

2. Give three implications of deforestation.

Habitat loss and reduced biodiversity; less carbon dioxide removed by photosynthesis; carbon dioxide released when trees are burned or decay.

SAY IT

Habitat, Distribution, Migration, Biodiversity

The four biological consequences of global warming: habitat **lost** as low-lying land floods; species' **distribution** shifting polewards or uphill; **migration** patterns changing; and **biodiversity** falling where species cannot move or adapt fast enough.

CHECK YOURSELF

Cover the grey line before you answer.

1. Name four ways humans reduce the land available for other plants and animals.

Building, quarrying, farming and dumping waste.

2. Give the two environmental costs of destroying peat bogs.

Loss of habitat and so of biodiversity; and the release of carbon dioxide when the peat decays or is burned.

SAY IT

Cattle, Rice, Biofuels

The three reasons for large-scale tropical deforestation named by the specification.

DON'T MIX UP

the three consequences — do not stop at one

Deforestation does three things: **habitat loss** and so reduced biodiversity; **less carbon dioxide removed** by photosynthesis; and **carbon dioxide released** when the trees are burned or decay. Most answers give one and lose two marks.

7.3.4 Deforestation

Large-scale deforestation in tropical areas has occurred to:

- provide land for cattle and rice fields
- grow crops for biofuels.

Implications to use when evaluating: habitat loss and so reduced biodiversity, less carbon dioxide removed by photosynthesis, and carbon dioxide released when trees are burned or decay.

DON'T MIX UP

“scientists disagree” — what the uncertainty actually is

The **consensus** rests on systematic reviews of thousands of peer-reviewed papers. The uncertainty is in the **detail of the predictions**, because climate is a complex system with many interacting variables — not in whether it is happening.

CHECK YOURSELF

Cover the grey line before you answer.

1. Name two gases contributing to global warming.

Carbon dioxide and methane.

2. Give three biological consequences of global warming.

Loss of habitat as low-lying areas flood; changes in species distribution; changes in migration patterns; reduced biodiversity where species cannot adapt or migrate in time.

3. Why is the scientific consensus considered reliable?

It is based on systematic reviews of thousands of peer-reviewed publications.

7.3.6 Maintaining biodiversity

Programmes put in place by scientists and concerned citizens to reduce human damage to ecosystems and biodiversity include:

- breeding programmes for endangered species
- protection and regeneration of rare habitats
- reintroduction of field margins and hedgerows in agricultural areas where farmers grow only one type of crop
- reduction of deforestation and carbon dioxide emissions by some governments
- recycling resources rather than dumping waste in landfill.

Be ready to describe positive and negative human interactions, explain their impact on biodiversity and evaluate the **conflicting pressures** — cost, loss of farmland or jobs, and a growing population's demand for food and housing.

CHECK YOURSELF

Cover the grey line before you answer.

1. Name four programmes used to maintain biodiversity.

Breeding programmes for endangered species; protection and regeneration of rare habitats; reintroduction of field margins and hedgerows; reducing deforestation and carbon dioxide emissions; recycling resources instead of landfill.

2. Name three pressures that conflict with conservation.

Cost; loss of farmland or jobs; and a growing population's demand for food and housing.

7.3.5 Global warming

Levels of **carbon dioxide and methane** in the atmosphere are increasing and contribute to **global warming**. Biological consequences include:

- loss of habitat, for example low-lying areas flooded as ice melts and sea water expands
- changes in the **distribution** of species, migrating polewards or to higher ground as areas warm or dry
- changes in **migration patterns**, for example birds migrating earlier or further north
- reduced biodiversity if species cannot migrate or adapt fast enough and become extinct.

The scientific consensus on global warming is based on systematic reviews of thousands of peer reviewed publications. Evidence can still be uncertain or incomplete because climate is a complex system with many interacting variables.

SAY IT

Breed, Protect, Hedge, Reduce, Recycle

The five programmes: **breeding** endangered species; **protecting** and regenerating rare habitats; reintroducing field margins and **hedgerows**; **reducing** deforestation and carbon dioxide emissions; and **recycling** rather than using landfill.

DON'T MIX UP

describing vs evaluating

“Describe” wants the measure. “Evaluate” wants the conflicting pressures too — cost, loss of farmland or jobs, and a growing population's demand for food and housing — and then a justified conclusion.

7.4 Key ideas in biology

A small number of key ideas of universal application underpin the whole biology content of GCSE Combined Science: Trilogy.

- Life processes depend on molecules whose structure is related to their function.
- The fundamental units of living organisms are cells, which may be part of highly adapted structures including tissues, organs and organ systems, enabling living processes to be performed effectively.
- Living organisms may form populations of single species, communities of many species and ecosystems, interacting with each other, with the environment and with humans in many different ways.
- Living organisms are interdependent and show adaptations to their environment.
- Life on Earth is dependent on photosynthesis, in which green plants and algae trap light from the Sun to fix carbon dioxide and combine it with hydrogen from water to make organic compounds and oxygen.
- Organic compounds are used as fuels in cellular respiration to allow the other chemical reactions necessary for life.
- The chemicals in ecosystems are continually cycling through the natural world.
- The characteristics of a living organism are influenced by its genome and its interaction with the environment.
- Evolution occurs by a process of natural selection, and accounts both for biodiversity and for how organisms are all related to varying degrees.