

Organisms & their Environment

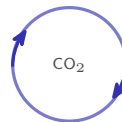
IGCSE Biology ■ Topic 19

IGCSE Biology



What we will cover

- 1 Energy flow & food chains
- 2 Food webs & feeding roles
- 3 Pyramids & energy loss
- 4 The carbon cycle
- 5 The nitrogen cycle
- 6 Populations

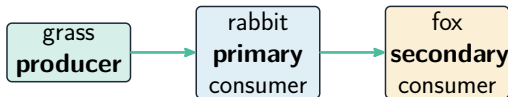


in and out

the carbon cycle



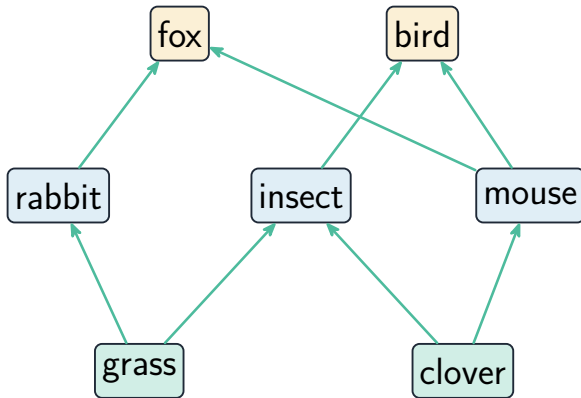
Energy flow and food chains



each arrow shows energy flowing to the next organism

- a **population** is a group of organisms of one **species** , living in the same area at the same time.
- a **community** is all the populations of different species in one place.
- an **ecosystem** is the community together with its **environment**, all interacting.

Food webs and feeding roles

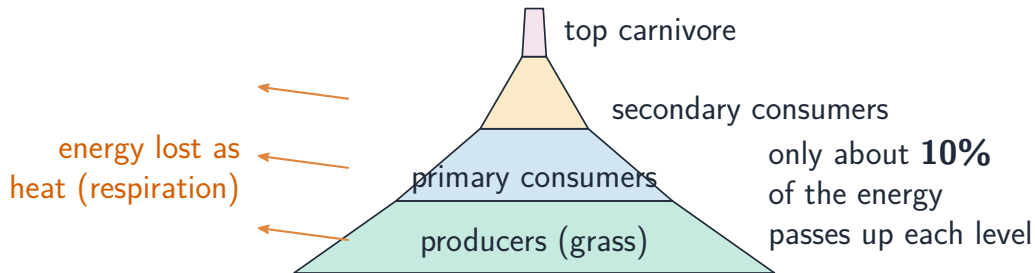


A **food chain** shows the transfer of energy from one organism to the next, starting with a producer.

Each arrow points in the direction the energy flows:
grass → rabbit → fox
A **food web** is many food chains linked together.

Pyramids and energy loss

Each **trophic level** passes only $\sim 10\%$ of its energy up, so levels shrink & chains are short. A **pyramid of numbers** counts organisms and can come out the wrong shape – one oak tree feeding many insects. A **pyramid of biomass** weighs them, which is usually the better picture. Eating crops directly wastes less than eating animals; humans harm webs by **overharvesting**.



Human impact

- **overharvesting** – taking too many of one species (such as overfishing), so its numbers crash.
- introducing a **foreign species** – a new species may have no predators and may crowd out native species.

Why eating plants feeds more people

Energy is lost

Only about 10% of the energy at one trophic level reaches the next – the rest goes in respiration, movement and undigested waste.

So a shorter chain feeds more

It is more energy-efficient for people to eat **crop plants** directly than to eat animals fed on those crops.

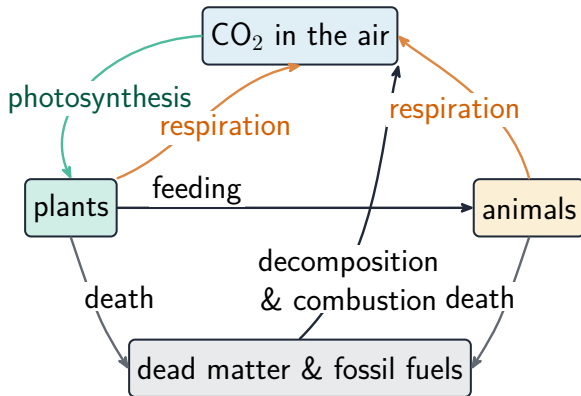
The carbon side

Photosynthesis removes **carbon dioxide** from the air; respiration, decay and combustion put it back.

“Energy is lost between levels” earns a mark only when you say *where* it went.



The carbon cycle



Carbon is **recycled**:

- **photosynthesis** removes CO₂
- over millions of years dead organisms form **fossil fuels**, which return that carbon when burned
- respiration & **combustion** return it
- **decomposition** & fossil fuels too

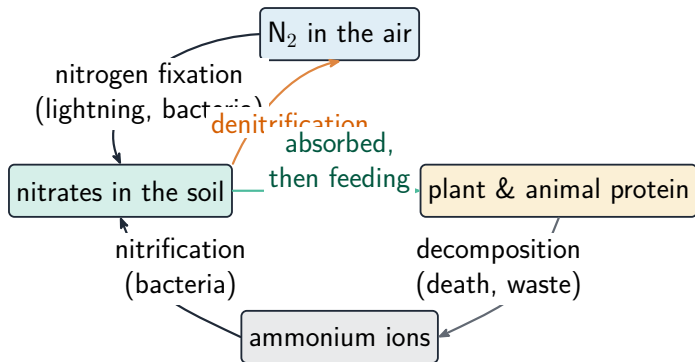
The nitrogen cycle

Microorganisms move nitrogen:

- **nitrogen fixation** – N_2 into compounds plants can use
- **nitrification** – ammonium to nitrate
- **denitrification** – nitrate back to N_2
- **deamination** in the liver, and decomposition, release nitrogen compounds again

Plants absorb nitrates for protein.

The nitrogen cycle, in detail



The nitrogen cycle: microorganisms move nitrogen between the air, soil and living things

Four steps, four kinds of bacteria

Nitrogen fixation

Bacteria in root nodules and in the soil turn atmospheric N_2 into ammonium ions – lightning does a little too.

Nitrification

Bacteria change ammonium ions into **nitrate ions**, the form roots can absorb.

Assimilation

Plants absorb nitrate ions to make **amino acids** and proteins; animals get theirs by feeding and **digestion**.

Decay and denitrification

Decomposers return nitrogen from dead matter as ammonium; denitrifying bacteria return N_2 to the air.

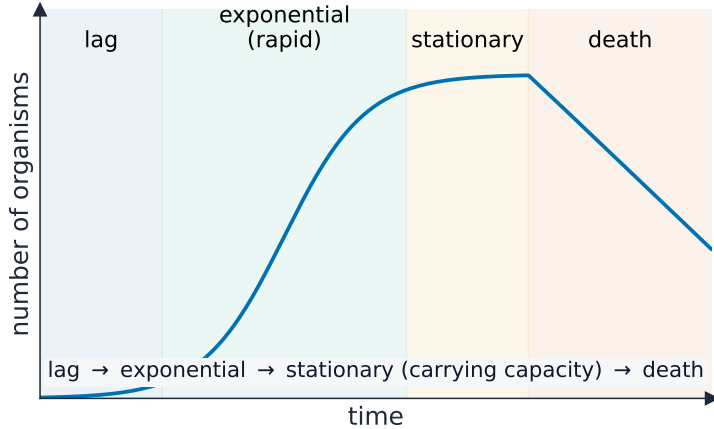
Name the bacteria *and* the ion at each step. “Bacteria change it” is the answer that scores nothing.



Populations

A **population** is one species in one area; a **community** is all of them; with the environment it is an **ecosystem** . Growth runs **lag** → exponential → stationary → death, and what sets each phase is the food supply, **competition** , **predation** and disease.

Populations, in detail



A **population** is one species in one area; a **community** is all of them; with the environment it is an **ecosystem**.

The four phases of a population curve

Lag phase

Slow growth: few individuals, and they are still adjusting to the conditions.

Exponential phase

The **exponential phase** : very fast growth, with plenty of food and space and few predators.

Stationary phase

Births balance deaths – the population sits at the carrying capacity of the habitat.

Death phase

Food runs out or waste builds up, and numbers fall.

Every phase is a statement about *limiting factors*, so name the factor that changed at each turn of the curve.

Populations, continued



A coral reef is a rich ecosystem supporting many interdependent species.

The nitrogen cycle, and the four phases of growth

the nitrogen cycle

recycles nitrogen for making **proteins** and **amino acids**

the microorganisms

nitrogen-fixing **bacteria** make ammonia; nitrifying bacteria make nitrites then nitrates; denitrifying bacteria return N_2 to the air

decomposers

release **ammonium ions** from dead matter and waste

lag phase

slow growth at first, while numbers are still small

log phase

rapid exponential growth, with resources plentiful

stationary phase

growth stops; births $\approx$ deaths – a **limiting factor** has taken hold

A **death phase** follows when waste accumulates or food runs out. Naming **which** limiting factor ended the log phase is the mark.

Food chains and food webs



A savanna ecosystem: organisms linked by feeding relationships.

Producers, consumers and decomposers

Consumers are named by their position: a **primary** consumer eats the producer; a **secondary** consumer eats the primary consumer.

Exam tips

- Energy enters from the Sun, flows one way along the chain, and is lost as heat at each step. Nutrients are recycled.
- Food chain starts with a producer; arrows show energy flow. Learn producer, consumer, herbivore, carnivore, decomposer.
- Only ~10% of energy passes up each trophic level, so chains are short and eating plants is more efficient.
- Carbon cycle: photosynthesis $\leftrightarrow$ respiration and combustion; nitrogen cycle (Supplement): fixation, nitrification, denitrification by microorganisms.
- Population: one species, one area, one time. Learn the four phases of the S-shaped growth curve.



Worked example – why food chains are short

Explain why a food chain rarely has more than four or five links.

- Only about 10% of the energy at one level reaches the next.
- The rest is lost as heat from respiration, in faeces, and in urine.
- Some parts are also not eaten (bones, roots).
- After a few links there is too little energy left to support another population.

Energy enters as sunlight and leaves as heat – it flows through, it does not cycle. Nutrients do cycle. That difference is worth marks.

Topic 19 – key takeaways

1

Energy

from the Sun; one way; lost as heat

2

Pyramids

only ~10% passes up each level

3

Cycles

carbon & nitrogen are recycled

4

Populations

lag, exponential, stationary, death

Check yourself

- 1 What does a food-chain arrow show?
- 2 Roughly how much energy passes up a level?
- 3 Which process removes CO_2 from the air?
- 4 What are the four phases of population growth?



Answers 1. the direction energy flows 2. about 10% 3. photosynthesis 4. lag, exponential, stationary, death