

Organisms and their environment

IGCSE Biology 0610 · Topic 19 revision notes

Everything from the 4 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Energy flow

2. Food chains, webs and pyramids

3. The carbon and nitrogen cycles

4. Populations

1 Energy flow

Syllabus 19.1

The **Sun is the principal source of energy input to biological systems**. Producers capture **light energy** in photosynthesis and store it as **chemical energy** in organic molecules such as glucose, starch and proteins. Chemical energy passes from organism to organism by feeding, but at every stage some is transferred to the environment, mainly as **heat** from respiration. Energy **flows** through an ecosystem in one direction; it is not recycled.

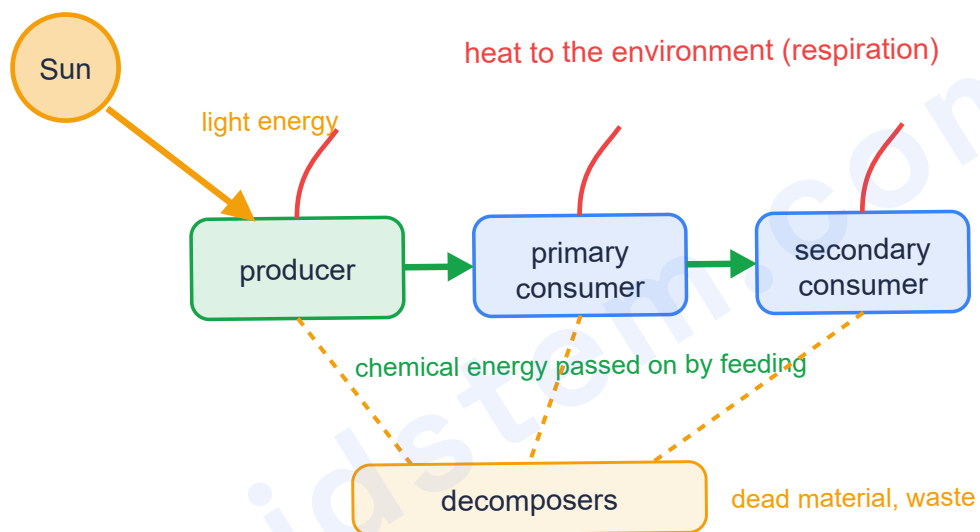


Fig. 1: light energy enters producers, chemical energy passes along the chain by feeding, and every level loses energy to the environment as heat

Flows, never cycles.

- ✓ **Source:** the Sun is the principal source of energy input to biological systems.
- ✓ **Forms:** light energy → chemical energy in organisms → heat in the environment.
- ✓ **Between organisms:** energy passes on by feeding, as chemical energy in food.
- ✓ **Words:** energy is transferred or lost to the environment, never made or used up.

Watch out!

Energy is never "used up" or "made". Say it is transferred from light to chemical energy, then to the environment as heat. And energy is not recycled: nutrients cycle, energy flows through.

Heat lost to the environment cannot be used by plants for photosynthesis. Only light energy can be captured, which is why the flow is one-way.

2 Food chains, webs and pyramids

Syllabus 19.2

A **food chain** shows the transfer of energy from one organism to the next, beginning with a **producer**; a **food web** is a network of interconnected food chains. A **trophic level** is an organism's position in a food chain, food web or ecological pyramid: producers, then primary, secondary, tertiary and quaternary consumers. Pyramids of numbers and biomass compare the levels. Extended: only a small fraction of the energy at one trophic level reaches the next, so food chains usually have fewer than five trophic levels.

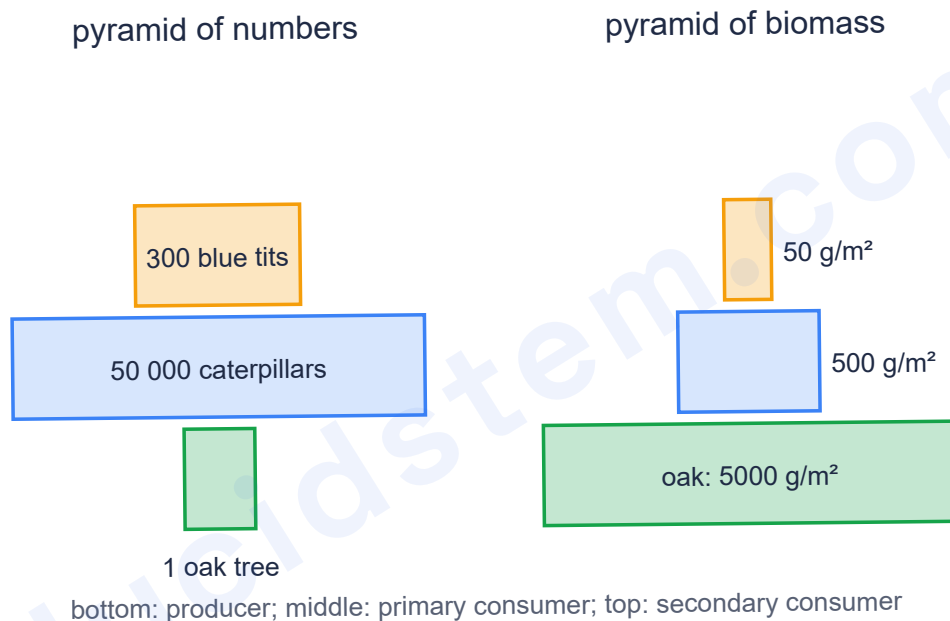


Fig. 1: the same oak tree food chain drawn as a pyramid of numbers (one large producer, so not a pyramid shape) and as a pyramid of biomass in g per m^2 (a true pyramid)

Level by level.

- ✓ **Arrows** show energy flow: from the organism eaten to the organism that eats it.
- ✓ **Trophic levels:** producer, primary, secondary, tertiary, quaternary consumer.
- ✓ **Biomass beats numbers** because it allows for size; (Extended) energy beats both because it allows for time.
- ✓ **Extended:** about 10% passes on; the rest is lost as heat from respiration, movement, faeces, urine and uneaten parts.

Watch out!

Arrows in a food chain show the direction of energy flow, so they point towards the eater: grass → rabbit means the rabbit eats the grass. Drawing them the other way loses the mark.

A pyramid of biomass is better than numbers, but it is still a snapshot at one moment. A fast-growing producer that is eaten quickly (such as plankton) can have a small standing biomass, so even biomass pyramids are occasionally inverted.

Energy is not lost "in" the food chain because animals are wasteful: most of it leaves as heat from respiration, which every organism must carry out to stay alive.

3 The carbon and nitrogen cycles

Syllabus 19.3

In the **carbon cycle**, **photosynthesis** removes carbon dioxide from the air; **feeding** passes carbon compounds along food chains; **respiration** by plants, animals and decomposers and **combustion** of fossil fuels return carbon dioxide to the air; dead material that does not decompose can form **fossil fuels** over millions of years. Extended: in the **nitrogen cycle** microorganisms carry out decomposition, nitrification, nitrogen fixation and denitrification, while plants absorb nitrate ions to make amino acids and proteins.

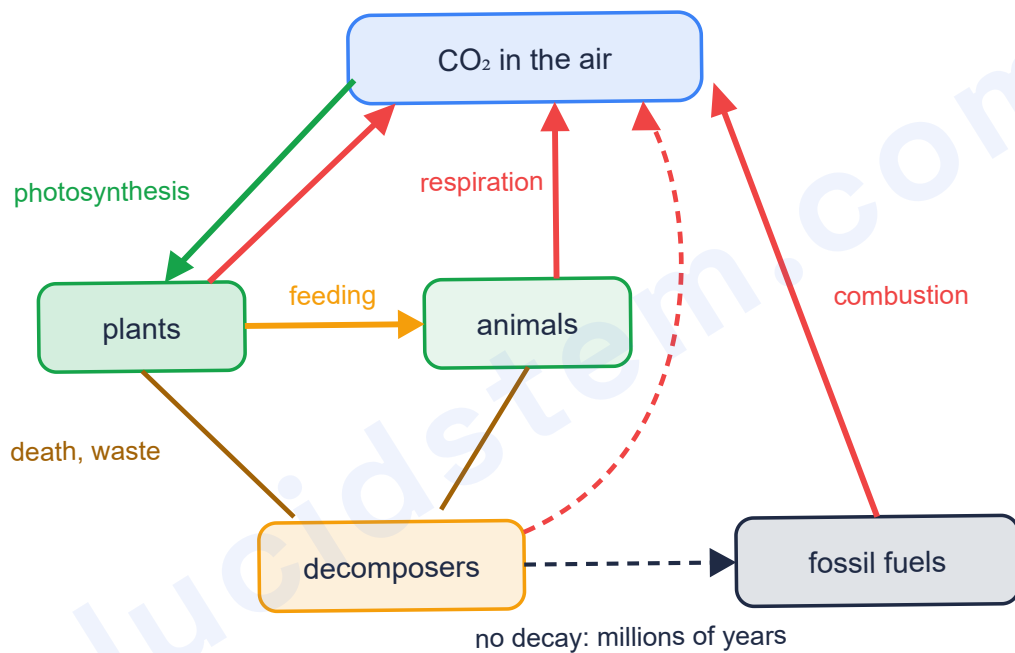


Fig. 1: the carbon cycle, limited to the six processes in the syllabus; red arrows return carbon dioxide to the air

In, along, back out.

- ✓ **Carbon out of the air:** photosynthesis only. **Back in:** respiration (all organisms) and combustion.
- ✓ **Decomposers** feed on dead material and waste, then respire; no oxygen means fossil fuels may form.
- ✓ **Extended, nitrogen:** fixation ($N_2 \rightarrow$ ammonium), decomposition (protein $\rightarrow$ ammonium), nitrification (ammonium $\rightarrow$ nitrate), denitrification (nitrate $\rightarrow N_2$).
- ✓ **Plants** absorb nitrate ions to make amino acids and proteins; animals deaminate excess amino acids to urea.

Watch out!

Plants respire all the time, day and night, as well as photosynthesising. Do not draw respiration arrows only from animals; plants and decomposers release carbon dioxide too.

Nitrification and nitrogen fixation are different processes. Fixation starts from nitrogen gas; nitrification starts from ammonium ions already in the soil.

Denitrification is the one that returns nitrogen gas to the air.

4 Populations

Syllabus 19.4

A **population** is a group of organisms of one species, living in the same area, at the same time. A **community** is all of the populations of different species in an ecosystem, and an **ecosystem** is a unit containing the community of organisms and their environment, interacting together. The rate of population growth depends on **food supply, competition, predation and disease**. In an environment with limited resources a population follows a **sigmoid curve** with lag, exponential (log), stationary and death phases.

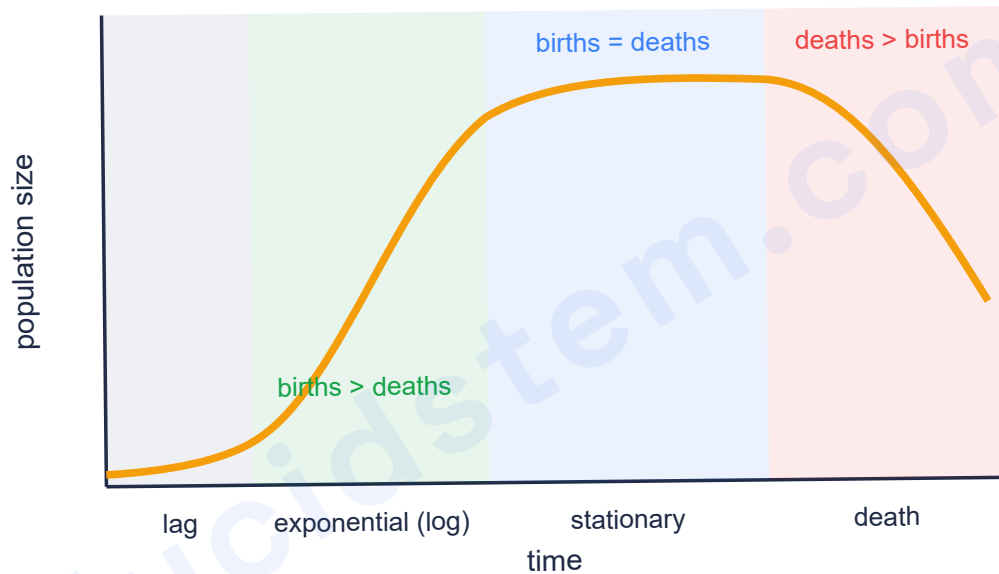


Fig. 1: the sigmoid growth curve of a population with limited resources, showing the four phases

Lag, log, level, fall.

- ✓ **Population:** one species, same area, same time. **Community:** all the populations. **Ecosystem:** community plus environment, interacting.
- ✓ **Growth rate** depends on food supply, competition, predation and disease.
- ✓ **Phases:** lag, exponential (log), stationary (births = deaths), death (deaths > births).
- ✓ **Extended:** name the limiting factor and link it to the birth and death rates.

Watch out!

In the stationary phase organisms are still being born and still dying. The population stays level because the two rates are *equal*, not because reproduction has stopped.

Do not say the population levels off "because it is full". Name the limiting factor (food, space, oxygen) and say that it makes the birth rate fall to equal the death rate.