

Feeding relationships

Revision notes · Trophic levels, food chains and webs, pyramids of number, biomass and energy, and why only about 10% of energy passes to the next level.

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** is not in the Double Award and is only examined on Paper 2.

Feeding relationships Spec 4.6–4.9

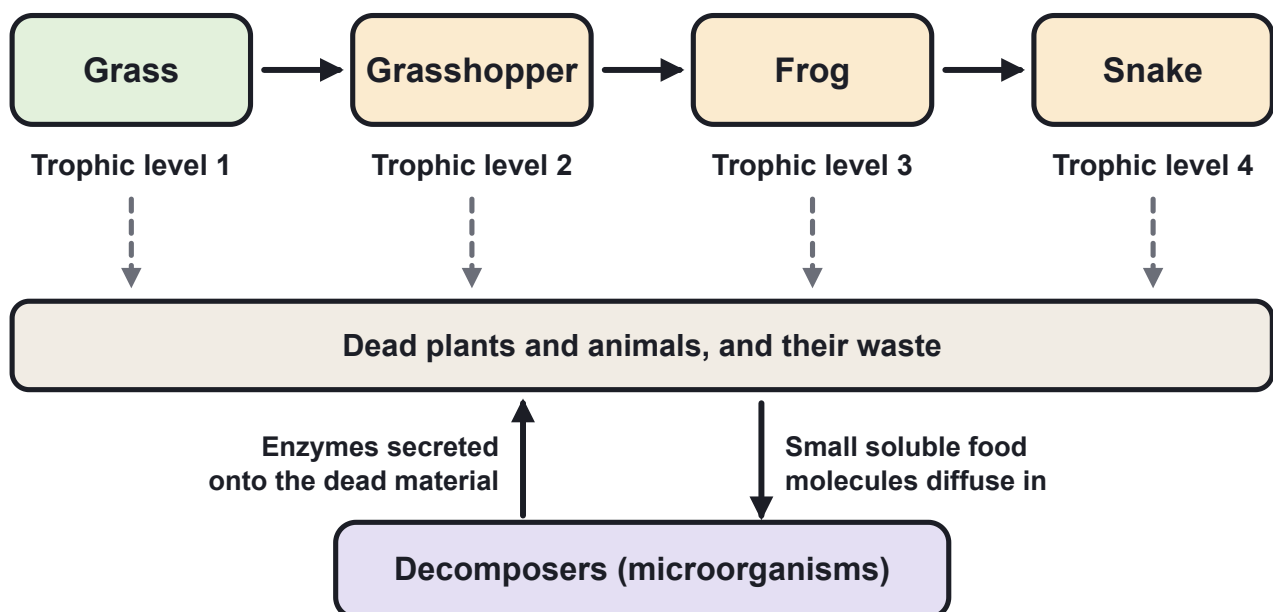
Trophic levels Spec 4.6

A **trophic level** is the position of an organism in a food chain. Trophic levels are numbered, starting at level 1 with the producers. Further levels are numbered according to how far the organism is along the food chain.

Trophic level	Organisms	Name
Level 1	Plants and algae make their own food	Producers
Level 2	Herbivores eat the producers	Primary consumers
Level 3	Carnivores that eat herbivores	Secondary consumers
Level 4	Carnivores that eat other carnivores	Tertiary consumers

Decomposers

Decomposers break down dead plant and animal matter and waste by secreting enzymes into the environment. Small soluble food molecules then diffuse into the microorganism. Decomposers are bacteria and fungi.



Every trophic level ends up as dead material or waste. Decomposers **secrete enzymes** onto it, then the small soluble molecules diffuse in.

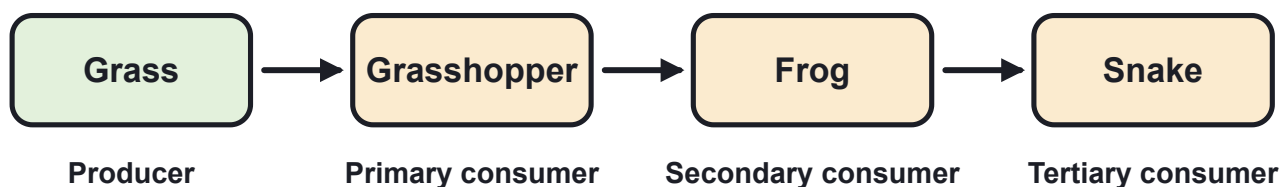
Exam tip: Decomposers secrete enzymes outside their bodies, onto the dead material. They do not take in the dead material and then digest it.

Food chains and food webs Spec 4.7

Feeding relationships in a community can be shown by **food chains**. All food chains begin with a **producer**, usually a green plant or alga that makes glucose by photosynthesis. The arrows show the direction in which food, and so energy and substances, pass.

Feeding levels in a food chain		
Name	What it does	Example
Producer	Makes glucose by photosynthesis	Grass
Primary consumer	Eats the producer	Grasshopper
Secondary consumer	Eats the primary consumer	Frog
Tertiary consumer	Eats the secondary consumer	Snake

Consumers that kill and eat other animals are **predators**, and those eaten are **prey**.

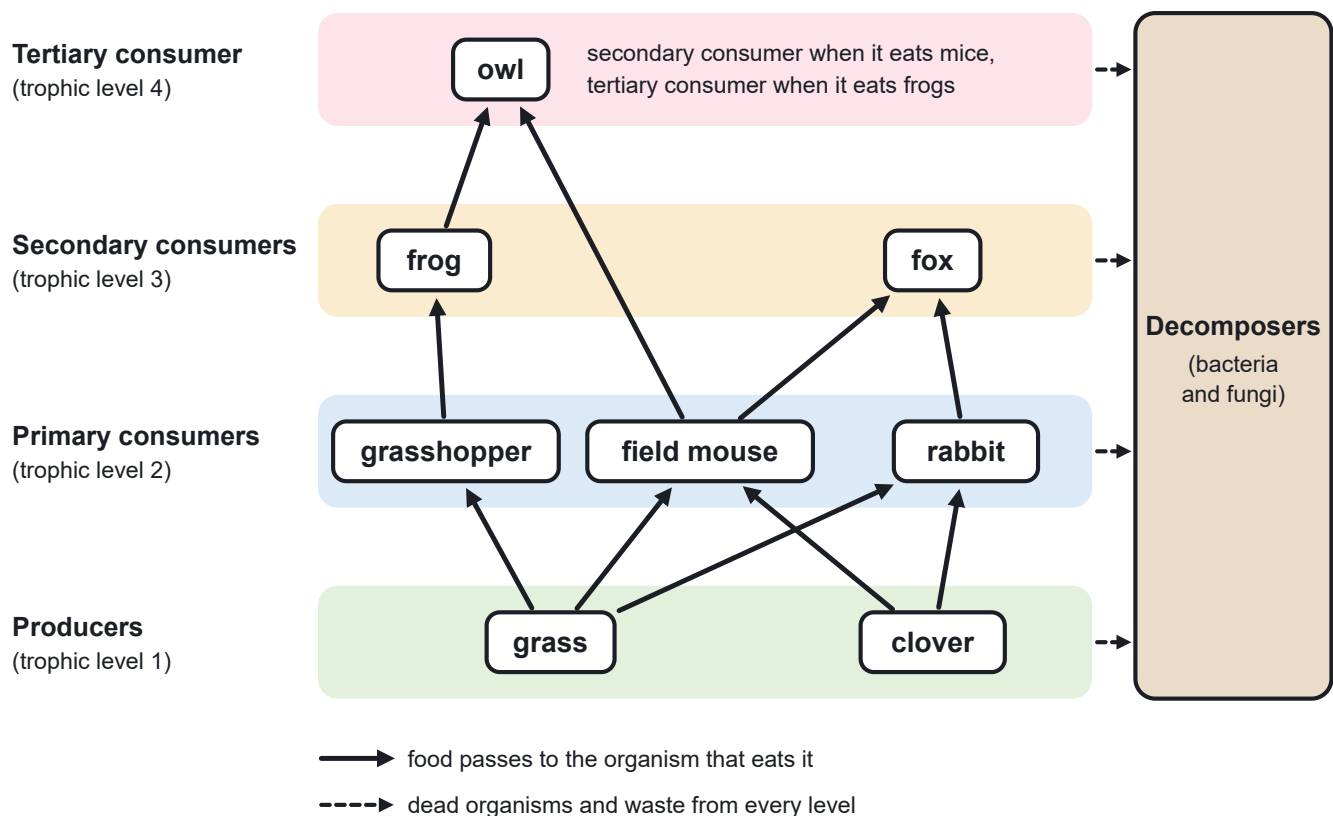


The arrows show the direction the food goes: **from the food to the animal that eats it**.

Food webs

Most organisms eat more than one type of food, and are eaten by more than one type of predator. A **food web** shows how all the food chains in a habitat are linked together. In a food web an organism can be at more than one trophic level. For example, an owl that eats mice and also eats shrews that have eaten beetles is both a secondary and a tertiary consumer.

Because the food chains are linked, a change in the population of one organism can affect many others. If one prey species dies out, its predators may eat more of another prey species, whose numbers then fall.



The owl feeds at **two trophic levels**: a secondary consumer when it eats mice and a tertiary consumer when it eats frogs.

Common mistake: Arrows in a food chain or web point from the food to the animal that eats it. Grass → rabbit means the rabbit eats the grass.

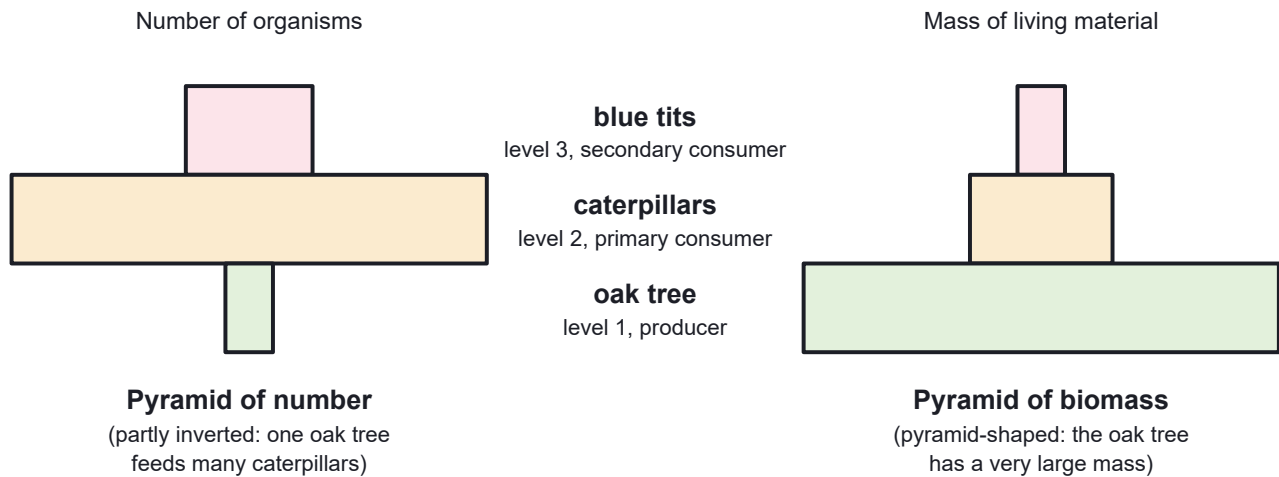
Pyramids of number, biomass and energy Spec 4.7

Pyramids use bars to compare the trophic levels in a food chain, with trophic level 1 at the bottom. There are three types.

Types of ecological pyramid		
Pyramid	What each bar shows	Shape
Pyramid of number	The number of organisms at each trophic level	Often a pyramid, but can be inverted
Pyramid of biomass	The mass of living material at each trophic level	Almost always narrows at each level
Pyramid of energy transfer	The amount of energy transferred to each trophic level, for example in kJ per m ² per year	Always narrows at each level

Pyramids of number

A pyramid of number counts the organisms but ignores their size. Where one large producer supports many small consumers, such as one oak tree supporting thousands of caterpillars, the bottom bar is narrower than the bar above it, so the pyramid is not pyramid-shaped. It is partly or fully **inverted**. Parasites can do the same: one fox may carry hundreds of fleas. A pyramid of biomass for the same chain is pyramid-shaped, because the oak tree has a very large mass.



The same food chain: the **pyramid of number is inverted**, but the pyramid of biomass is pyramid-shaped.

Pyramids of biomass

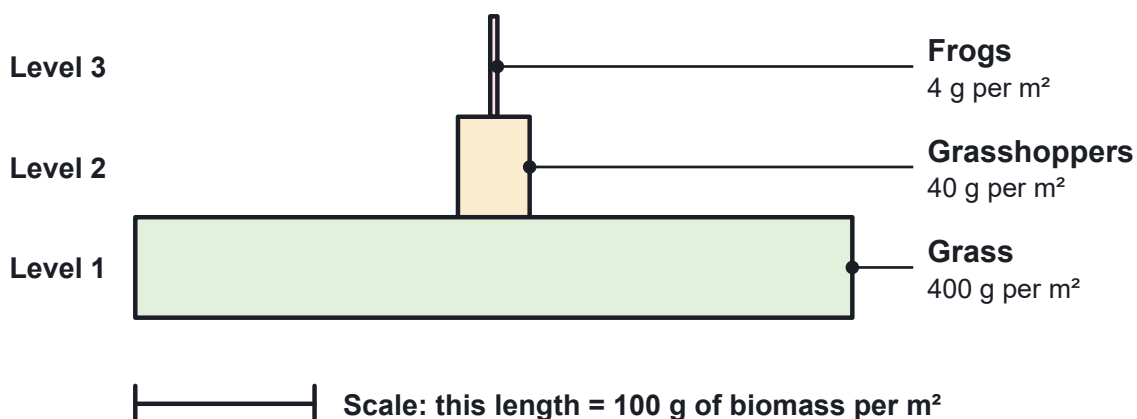
Each bar shows the mass of living material at that trophic level, and it almost always gets narrower at each higher level. To draw one, choose a scale so the length of each bar is proportional to its biomass, put trophic level 1 at the bottom and centre the bars on a vertical line.

Drawing a pyramid to scale

A food chain has biomass of 400 g per m² of grass, 40 g per m² of grasshoppers and 4 g per m² of frogs. Describe how to construct the pyramid using a scale of 1 mm = 4 g.

1. Grass: $400 \div 4 = 100$ mm long, at the bottom.
2. Grasshoppers: $40 \div 4 = 10$ mm long, above the grass.
3. Frogs: $4 \div 4 = 1$ mm long, at the top.

Answer: Three centred bars of 100 mm, 10 mm and 1 mm, with grass at the bottom and frogs at the top.



The pyramid from the worked example, drawn to scale. Each bar is about **10%** of the one below it.

Pyramids of energy transfer

A pyramid of energy transfer shows how much energy is transferred to each trophic level in a given time. It is always pyramid-shaped, because energy is lost at every step, so each level receives less than the one below.

Exam tip: Pyramids of number are often inverted. Pyramids of energy transfer never are. If a question shows a pyramid that is not pyramid-shaped, it is most likely a pyramid of number.

Energy transfer and the 10% rule Spec 4.8, 4.9

Producers absorb only a small part of the light energy that reaches them. The energy stored in their biomass is passed along the food chain, together with the substances (such as carbon compounds) that make up the biomass, when each organism is eaten by the next.

Energy is not passed on completely. Only about **10%** of the energy is transferred from one trophic level to the next. The rest is lost, for these reasons:

- not all of the organism is eaten (for example bones, roots or hair), and some of what is eaten is not digested and is lost in faeces;
- energy is released by **respiration** and transferred to the surroundings as heat;
- energy is used for movement and for keeping warm in mammals and birds;
- energy is lost in waste such as urine.

percentage of energy transferred = energy transferred to the next level ÷ energy available at the previous level × 100

Percentage of energy transferred

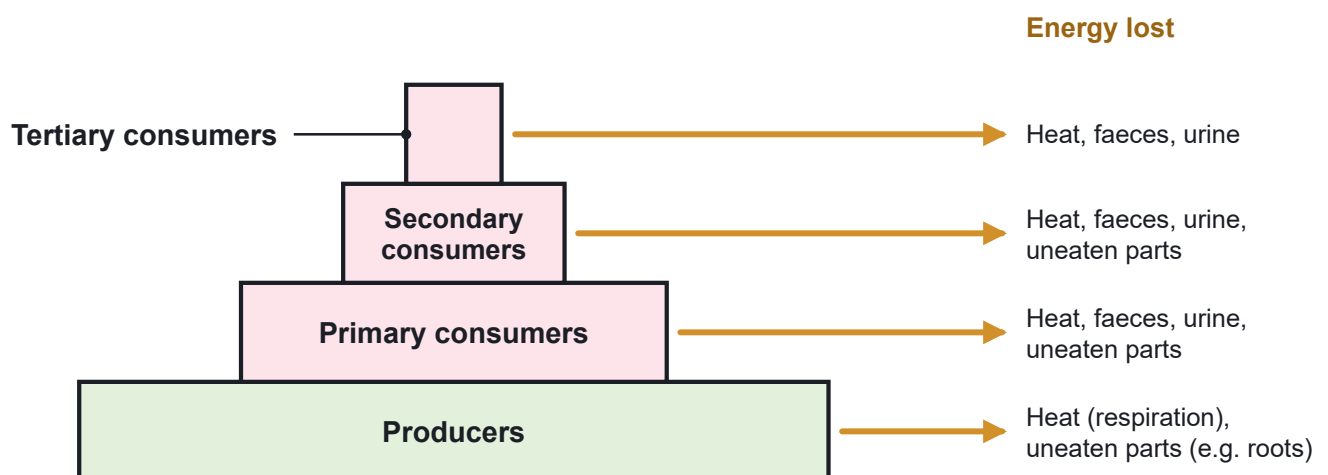
The grass in a field stores 20 000 kJ of energy. The rabbits that eat the grass gain 1800 kJ. Calculate the percentage of energy transferred from the grass to the rabbits.

1. Energy transferred = 1800 kJ.
2. Energy available = 20 000 kJ.
3. Percentage = $1800 \div 20\,000 \times 100 = 9\%$.

Answer: 9%

This has two effects. Less energy and biomass is available at each higher trophic level, so pyramids of biomass and energy narrow at each level. Food chains are **limited in length**, usually to four or five trophic levels, because there is too little energy left to support more.

Exam tip: Do not say that energy is used up. Say that it is transferred to the surroundings as heat, or to less useful forms, or lost in waste.



A pyramid of biomass (not drawn to scale) gets narrower at each trophic level because energy is **lost to the surroundings** at every level.

Quick check

- 1 . What number trophic level are producers?
- 2 . Name the organisms that break down dead material.
- 3 . What do the arrows in a food chain show?
- 4 . What percentage of energy is transferred to the next trophic level?
- 5 . Why are food chains limited in length?

Quick check answers

Feeding relationships

1. Level 1.
2. Decomposers.
3. The direction food and energy pass, from the food to the organism that eats it.
4. About 10%.
5. Too little energy is left to support more trophic levels.