Transfer of biomass

4.7.4.3 · Ecology · revision notes

Only a small fraction of the biomass at one trophic level passes to the next. You need to explain where the rest is lost, calculate the efficiency of biomass transfers, and explain how this limits the number of organisms at higher trophic levels. This subtopic is in GCSE Biology only, not Combined Science.

Key facts

- Producers transfer about 1% of incident light energy for photosynthesis
- Efficiency = biomass at higher level ÷ biomass at lower level × 100
- Much of the absorbed glucose is used in respiration
- About 10% of biomass passes to the next trophic level
- Losses: parts not eaten; faeces (egestion); CO_2 and water (respiration); urea and water (urine)
- Less biomass higher up → fewer organisms and short food chains

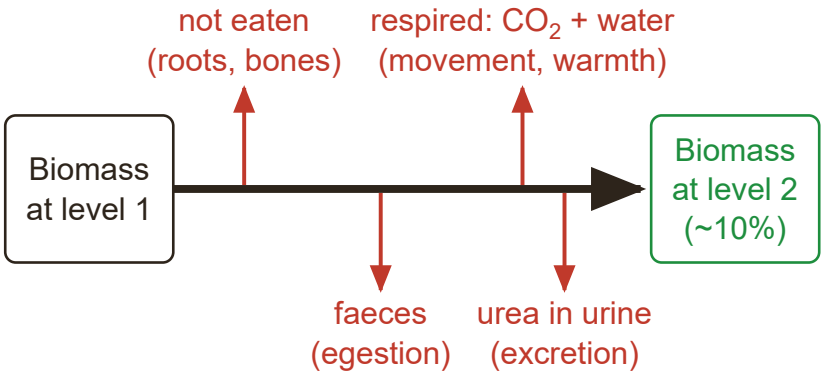
Notes

How much is transferred

- Of the light energy falling on producers (mostly plants and algae), only about **1%** is transferred for photosynthesis.
- On average, only about **10%** of the biomass in one trophic level ends up in the level above.

Where the biomass goes

- Not all of an organism is eaten, e.g. roots, bones or fur may be left.
- Some of the food eaten is never absorbed and leaves the body as **faeces** (**egestion**).
- Some of what is absorbed is lost as waste: **carbon dioxide and water** from **respiration**, and **urea and water** in **urine** (excretion).
- Much of the absorbed glucose is respired to release energy, e.g. for movement and, in mammals and birds, to keep warm, so it never becomes new biomass.



Most biomass is lost (red) before it reaches the next trophic level.

Calculating efficiency

- Efficiency of transfer (%) = (biomass transferred to the higher level ÷ biomass at the lower level) × 100.
- Example: producers 3500 g/m², primary consumers 280 g/m². Efficiency = 280 ÷ 3500 × 100 = 8%.
- As a fraction of the mass: 280/3500 = 2/25.

Consequences

- Less biomass is available at each higher trophic level, so fewer organisms can be supported there.
- This is why pyramids of biomass get narrower going up, and why food chains rarely have more than four or five trophic levels.
- Eating plants rather than animals means fewer transfers, so less biomass is lost along the way.

How to answer each type of question

Explain how biomass is lost between trophic levels 3 to 4 marks **Grade 5**

1. Give separate ways: not all eaten; egested as faeces; lost in respiration (carbon dioxide and water); excreted (urea and water in urine).
2. Say that respiration uses much of the absorbed glucose, releasing energy that is not stored as biomass.

Example. Only a small percentage of the biomass of the grass a cow eats becomes biomass in the cow.
Explain why. (3 marks)

Model answer. Some of the grass is not absorbed and is egested in faeces (1). Much of the absorbed glucose is used in respiration, and the carbon dioxide and water produced are lost (1). Some is lost as urea (and water) in urine (1). Also credit: energy released in respiration is used for movement or to keep warm.

Calculate the efficiency of biomass transfer 2 marks **Grade 5**

1. Identify the biomass at the lower level (available) and at the higher level (transferred).
2. Divide the higher-level biomass by the lower-level biomass.
3. Multiply by 100 and give the % sign, or give a fraction if asked.

Example. The biomass of algae in a lake is 850 g/m². The biomass of the small fish that eat the algae is 68 g/m².
Calculate the efficiency of biomass transfer from the algae to the small fish.

Model answer.

68 ÷ 850 × 100 (1)
= 8% (1)

Use the 10% figure in a calculation

2 marks | Grade 4

1. If told to assume 10%, multiply by 0.1 for each step up the food chain.
2. Check that the answer gets smaller at each level.

Example. The producers in a field have a biomass of 5000 g/m². Assuming that 10% of the biomass is transferred at each trophic level, estimate the biomass of the secondary consumers.

Model answer.

Primary consumers: 5000 × 0.1 = 500 g/m² (1)

Secondary consumers: 500 × 0.1 = 50 g/m² (1)

Explain why there are fewer organisms at higher trophic levels

2 to 3 marks | Grade 7

1. Say that biomass is lost at each level (only about 10% is passed on).
2. So less biomass is available at each higher level.
3. So fewer organisms can be supported, and food chains are short.

Example. Explain why there are far fewer top predators, such as eagles, than small herbivores in an ecosystem. (3 marks)

Model answer. Biomass is lost at each trophic level, e.g. through respiration and waste (1). So only a small fraction (about 10%) is passed on, and much less biomass is available at each higher level (1). So there is only enough food to support a small number of top predators (1).

Don’t lose marks

- Dividing the lower level by the higher level, giving an answer over 100%.
- Saying biomass is 'used up as energy'. Say glucose is used in respiration and the carbon dioxide and water produced are lost.
- Confusing egestion (faeces: material that was never absorbed) with excretion (urine: waste made by the body, such as urea).
- Using 1% for transfers between animals. The 1% is the light energy used by producers; about 10% applies to biomass between levels.

More tips

Memory tricks

- '1 and 10': about 1% of the light energy is used by producers; about 10% of biomass is passed up each level.
- Efficiency sense check: the answer must be less than 100%, and is usually around 10%.
- Losses, FRUN: Faeces, Respiration, Urine, Not eaten.

Exam technique

- Show the division and the × 100 in your working; each step can earn a mark.
- Give each way biomass is lost as a separate point, with its process (egestion, respiration, excretion).
- Round efficiencies sensibly, e.g. to 2 or 3 significant figures, unless the question tells you otherwise.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 4

State the typical transfer percentages

Producers transfer about 1% of the incident light energy for photosynthesis; about 10% of biomass passes to the next level.

Grade 5

Describe how biomass is lost between levels

Parts not eaten, egestion in faeces, carbon dioxide and water from respiration, and urea and water in urine.

Grade 5

Calculate the efficiency of biomass transfer

Efficiency = biomass at the higher level ÷ biomass at the lower level × 100.

Grade 5

Explain why respiration causes large biomass losses

Much of the absorbed glucose is respired to release energy for movement and keeping warm, so it never becomes new biomass.

Grade 7

Explain why higher levels have fewer organisms

Less biomass is available at each higher level, so fewer organisms can be supported.

Grade 7

Explain why food chains are short

After a few transfers too little biomass is left to support another trophic level.

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