IGCSE BIOLOGY • EXERCISE SHEET

19.1 Energy flow

Name: _____ Class: _____ Date: _____ **Total: 26 marks**

KEY WORDS energy 能量 • trophic levels 营养级 • energy flow 能量流动 • respiration 呼吸作用 • excretory products 排泄物

Objective

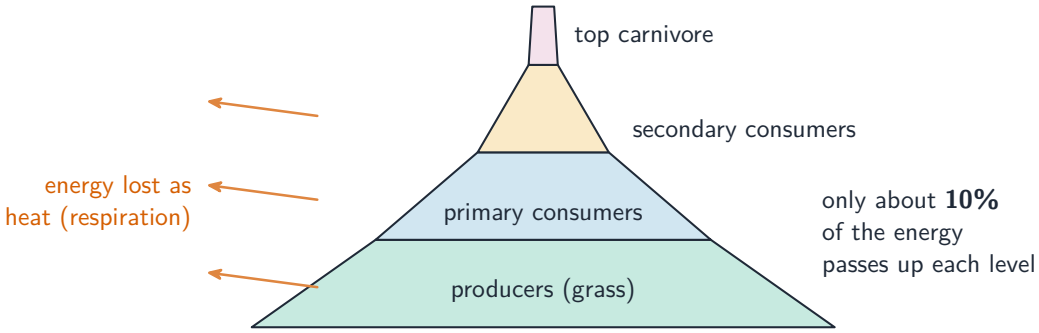
Build the skills to answer exam questions on **energy flow** 能量流动 — the Sun as the source, **trophic levels** 营养级, energy loss, and pyramids.

You must be able to:

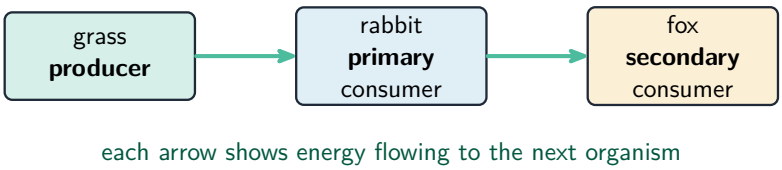
- describe how energy enters and flows through a food chain
- explain why only ~10% of energy passes up each level
- interpret pyramids of numbers, biomass and energy

1 Worked examples

Energy loss



Energy enters from the Sun, flows one way, and is lost as heat at each level (~10% passes up)



Energy flows along a food chain

- the rest is lost as heat (respiration), in movement and in waste.

- so chains have fewer than ~5 levels; eating plants directly wastes less energy.

■ Where the energy comes from, and where it goes

Almost all energy in an ecosystem starts as **light energy from the Sun**, captured by producers in **photosynthesis** 光合作用 and stored as chemical energy in glucose. That is why producers are always the first trophic level.

The losses at each transfer, which the exam wants named:

- **respiration** 呼吸作用 — the largest loss, released as **heat** to the surroundings;
- **undigested material** passed out in **faeces** 粪便;
- **excretory products** 排泄物 such as urea, which still contain chemical energy;
- parts of the organism that are **not eaten** — bones, roots, fur.

About **10%** of the energy at one level is passed on. That single figure explains three separate exam answers: why a pyramid of biomass narrows upwards, why food chains rarely exceed four or five levels, and why feeding people on crops supports more people than feeding them on meat — a shorter chain wastes fewer transfers.

Worked example. Producers hold 150 000 kJ; the primary consumers hold 14 000 kJ; the secondary consumers hold 1 200 kJ. Find the efficiency of each transfer.

1. Producers → primary: $\dfrac{14\,000}{150\,000} \times 100 = 9.3\%$.
2. Primary → secondary: $\dfrac{1\,200}{14\,000} \times 100 = 8.6\%$.
3. Both are close to the usual 10%, and the small difference is normal variation in how much is respired and excreted.

△ Always divide by the level **below**, and give the unit as a percentage. Dividing the wrong way round gives a number over 100, which should tell you at once that the calculation is upside down.

2 Practice

2.1 State the main source of energy for almost all food chains. [1]

2.2 State the form in which most energy is lost at each trophic level. [1]

2.3 Name three ways in which energy is lost between one trophic level and the next. [3]

2.4 Explain why a pyramid of biomass is usually narrower at the top. [2]

2.5 Explain why feeding a population on crops supports more people than feeding it on beef. [2]

3 Exam-style questions

3.1 Roughly what percentage of energy passes from one trophic level to the next? [1]

A	B
C	D

A 1%
B 10%
C 50%
D 90%

3.2 Energy is lost along a food chain.

(a) Explain why food chains usually have fewer than five trophic levels. [2]

(b) Explain why it is more efficient for people to eat crop plants than meat. [2]

3.3 A grassland food chain is: grass → cattle → humans. The grass contains 2 400 000 kJ, the cattle 180 000 kJ and the humans 9 000 kJ.

(a) Calculate the percentage of energy transferred from the grass to the cattle. [2]

(b) Calculate the percentage of energy transferred from the cattle to the humans. [2]

(c) Explain why so much energy is lost at each transfer, naming three losses. [3]

(d) Suggest, with a reason, how the same area of grassland could support more people. [3]

(e) Explain why this food chain could not support a fourth trophic level. [2]