

Solutions

Each answer shows the steps, then the **result**.

2.1

- a decomposer gets its energy from **dead or waste organic material**
- for example a **bacterium** or a **fungus**

2.2

- primary consumer: the **rabbit** or the **grasshopper**
- secondary consumer: the **fox** or the **frog**

2.3

- the bottom bar is **very narrow** and the bar above it is **very wide**, so the pyramid is **inverted** at its base
- there is only **one** oak tree, but it supports thousands of aphids
- a pyramid of numbers counts organisms without taking their **size** into account

2.4

- biomass uses the **total dry mass** at each level, so the size of the organisms is taken into account
- so the pyramid comes out the right shape even when one huge producer supports many small consumers

2.5

- any **three** of: energy used in **respiration** and lost as **heat**; undigested food lost in **faeces**; **urea** lost in **urine**; parts **not eaten**, such as bones or roots

2.6

- eating the wheat directly means the energy passes through **one fewer transfer**
- at each transfer about **90%** of the energy is lost, in respiration, faeces and urine
- so about **ten times** as much of the field's energy reaches people, and more people can be fed

3.1 C

- a level can never pass on more energy than it received, so each bar must be smaller than the one below it
- **A** is inverted whenever one large producer feeds many small consumers; **B** is almost always a pyramid but is not guaranteed; **D** is wrong because **C** is guaranteed

3.2

(a)

- producer: **grass**
- the frog is a **secondary consumer**

(b)

- **grass** → **grasshopper** → **frog** → **hawk**
- arrows point from the organism eaten to the organism that eats it

(c)

- the number of foxes **falls**
- the rabbit is the fox's only food in this web, so the foxes have nothing else to eat

(d)

- grasshoppers and rabbits both eat grass, so with fewer rabbits there is **less competition** for grass

3.3

(a)

- four bars, with the **producers at the bottom** and each bar **above** the one before
- the bars drawn **to scale**, so that 20 000 is by far the widest and 11 is barely visible
- each bar labelled with its trophic level

(b)

- divide the energy reaching the primary consumers by the energy in the producers

$$\frac{1600}{20\,000} \times 100 = \mathbf{8\%}$$

(c)

- most of the producers' energy is **never eaten** – roots and dead leaves go to the decomposers
- of what is eaten, much is lost in **respiration** and given out as heat, and more is lost undigested in **faeces** and as urea in **urine**
- so only a small fraction is stored as new tissue and becomes available to the next level

(d)

- the tertiary consumers receive only **11 kJ** per square metre per year
- about a tenth of that, roughly **1 kJ**, would reach a fourth consumer level, which is far too little to support a population of animals

(e)

- people eating wheat are **primary consumers**, but people eating cattle are **secondary consumers**
- removing one transfer keeps about ten times as much of the field's energy, so more people can be fed from the same area

(f)

- the beetle eats grass, so it **competes** with the rabbits and grasshoppers for the same food

- their numbers are likely to **fall**, because less grass is available to them