

Feeding Relationships and Energy Flow

Mark Scheme



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1. Feeding relationships are the vital links between species in an ecosystem, showing the pathways by which energy and nutrients flow from one organism to another.

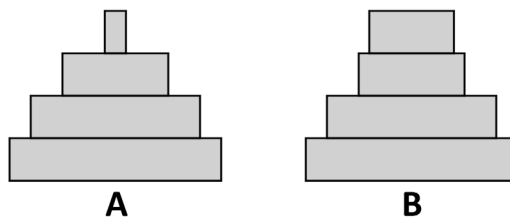
- a) Biomass is lost between different trophic levels in a food web.
One reason for this is the release of undigested food from the body.
Which term is used to describe this release?

C – is the only correct answer.

1 mark

Total: 1 mark

- b) The diagram shows pyramids of biomass for two food webs, A and B.



Which statement explains the difference between the two pyramids?

C – is the only correct answer.

1 mark

Total: 1 mark

- c) Which term describes an organism that makes its own food, usually using light energy?

C – is the only correct answer.

1 mark

Total: 1 mark

- d) In the food chain: Grass → Rabbit → Fox → Eagle
What is the trophic level of the Fox?

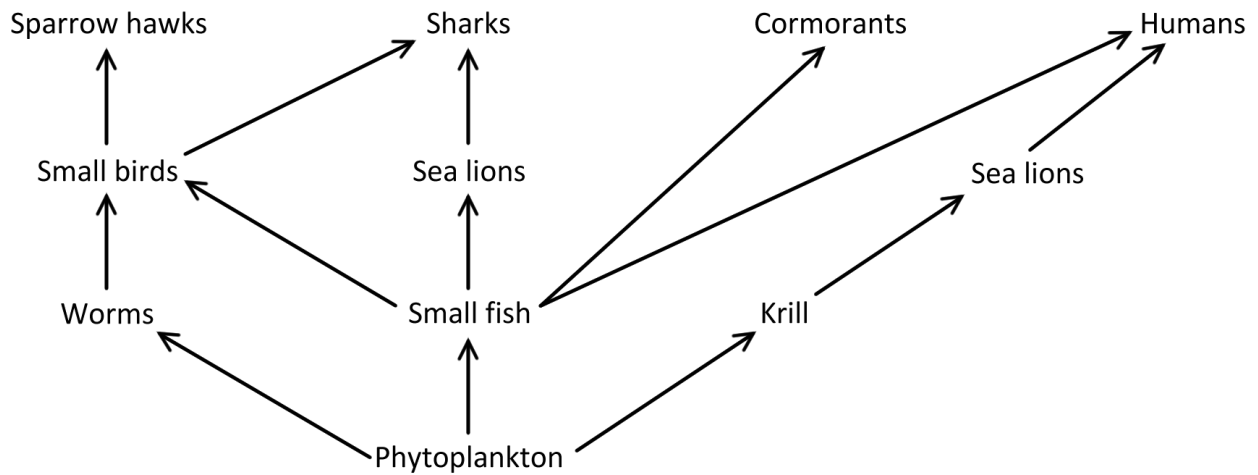
A – is the only correct answer.

1 mark

Total: 1 mark

(Total for Question 1 is 4 marks)

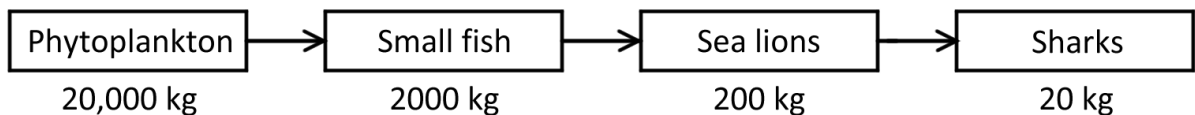
2. Look at the food web below.



a) Name **two** animals from the food web that are secondary consumers.

Any two from:	
• Small birds.	
• Sea lions.	
• Sharks.	
• Cormorants.	
	Total: 2 marks

b) The figure below shows the biomass at each stage in one of the food chains from the food web.



Calculate the total percentage of biomass **lost** from the start of this food chain (Phytoplankton) to the end of this food chain (Sharks).

Show your working.

Correct calculation of biomass lost: $20,000 - 20 = 19,980$ (kg)	1 mark
Correct substitution into percentage formula: $(19,980 / 20,000) \times 100$	1 mark
Correct final answer: 99.9 (%)	1 mark
	Total: 3 marks

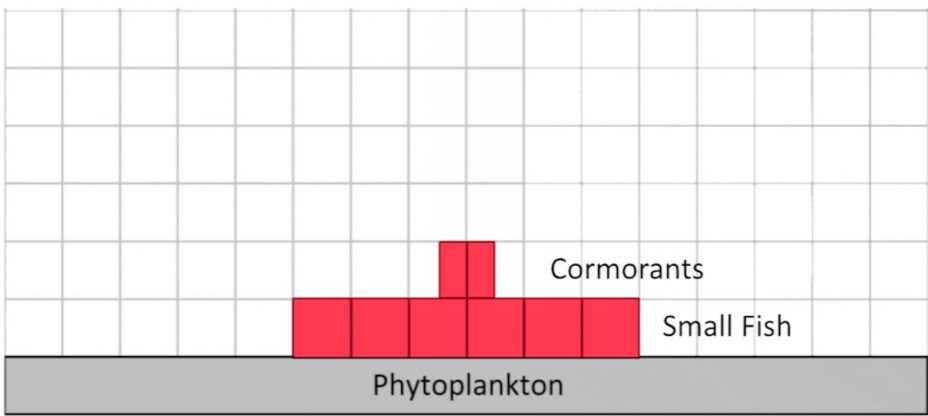
c) Calculate the percentage efficiency of biomass transfer from the Small Fish to the Sea Lions.

Show your working.

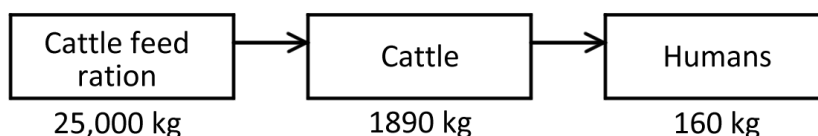
$(200 \div 2,000) \times 100$	1 mark
10 (%)	1 mark
	Total: 2 marks

- d) A pyramid of biomass shows the relative amount of biomass at each level of a food chain. For the food chain: **Phytoplankton** → **Small fish** → **Cormorants**, the producer (phytoplankton) is shown at the base of the pyramid on the grid.

Continue building this pyramid of biomass by drawing appropriately scaled and labelled bars for the small fish and then the cormorants in their correct trophic positions."

		
Two additional bars drawn on top of the producer.		1 mark
Bars are correctly labelled (Small fish and Cormorants) and are progressively narrower.		1 mark
Bars are centred on the bar below.		1 mark
		Total: 3 marks

- e) The figure below shows the flow of biomass through a different food chain.



- f) Calculate the percentage efficiency of transfer of biomass between the cattle food crop and humans.

$(160 \div 25,000) \times 100$	1 mark
0.64 (%)	1 mark
	Total: 2 marks

- g) State **two** ways that biomass is lost from the above food chain.

Any two from:	
Not all parts of the organism are eaten (e.g. bones/roots).	1 mark
Lost as waste products / not all food is absorbed (e.g. faeces/egestion).	1 mark
Used in respiration / for movement / to maintain body temperature.	1 mark
Lost through excretion (e.g. urea/urine).	1 mark
	Total: 2 marks

(Total for Question 2 is 14 marks)

3. A scientist estimated the biomass of various desert communities, categorizing organisms into four groups based on their food web roles in the table below. Detritivores, one such group, are defined as animals that eat dead organic material.

Types of Organisms	Biomass in g/m ²
Producers	840
Herbivores	420
Detritivores	210
Carnivores	105

- a) Using the data in the table above, calculate the percentage of biomass that is lost between the producer level and the carnivore level. Show your working.

Biomass lost = $840 - 105 = 735$	1 mark
$(735 \div 840) \times 100 = 87.5$	1 mark
	Total: 2 marks

- b) Explain why food chains are usually short and have fewer than five trophic levels.

An explanation to include any two of the following:	
A large amount of biomass / energy is lost at each trophic level.	1 mark
(Due to e.g.) respiration / movement / waste materials / not all parts being eaten.	1 mark
(Therefore) there is insufficient energy / biomass left to support organisms at higher trophic levels.	1 mark
	Total: 2 marks

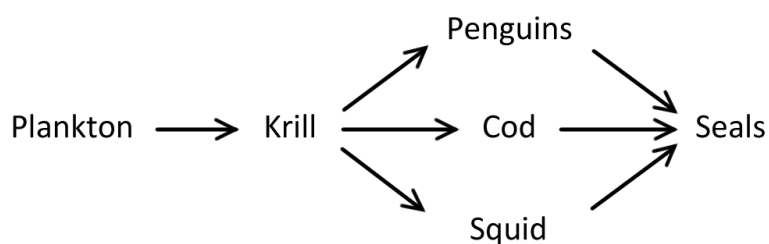
- c) A food chain consists of one large oak tree, 2,000 caterpillars that eat its leaves, and 10 birds that eat the caterpillars.

Explain why a pyramid of numbers is a poor way to represent this food chain, and why a pyramid of biomass would be better.

An explanation to include any two of the following:	
A pyramid of numbers would not be a pyramid shape / would be inverted at the base.	1 mark
Because one producer (the tree) supports a large number of primary consumers.	1 mark
A pyramid of biomass takes the size/mass of the organisms into account.	1 mark
(So) it would be the correct pyramid shape, as the biomass of the tree is greater than the biomass of the caterpillars.	1 mark
	Total: 2 marks

(Total for Question 3 is 6 marks)

4. The figure below shows part of a food chain for a marine habitat.



a) State which trophic level the cod is in.

Secondary consumer or Third trophic level.	1 mark
	Total: 1 mark

b) Each year humans fish large number of cod out of the Atlantic ocean.

Explain why the removal of large numbers of cod could lead to an **increase** in the numbers of squid and penguins.

There is) less competition (between cod, squid and penguins) for food / krill.	1 mark
Therefore) more food is available for the squid and penguins, so their populations can increase / they are more likely to survive and reproduce.	1 mark
	Total: 2 marks

c) The total energy stored in the plankton at the start of the food web is 800 000 kJ.

Scientists have estimated that, due to energy losses at each trophic level, only 0.02% of the original energy from the plankton is transferred to the seals.

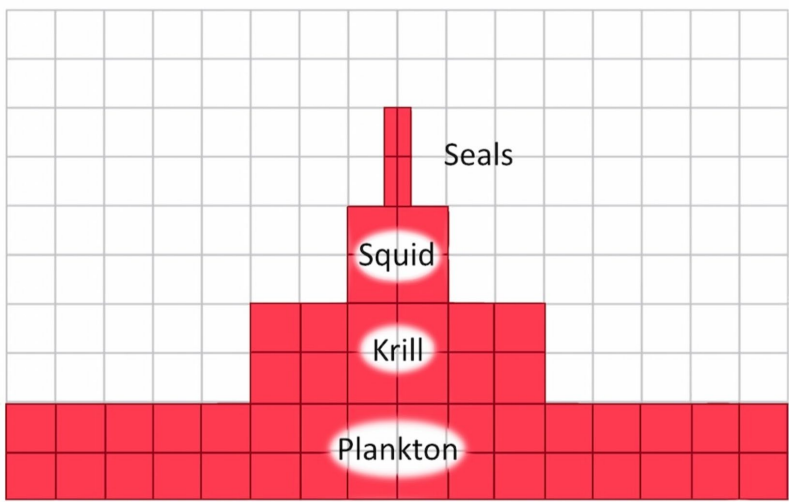
Calculate the amount of energy that is transferred to the seals.

$(800\,000 \div 100) \times 0.02$ or $0.0002 \times 800\,000$	1 mark
= 160	1 mark
kJ	1 mark
	Total: 3 marks

d) The table below shows information about the biomass of some of the organisms in one part of the food web above.

Types of Organism	Number of Organisms
Plankton	500 000
Krill	20 000
Squid	400
Seals	10

- i. Use the data in the table to draw a pyramid of numbers for this food chain on the graph paper below.
- ii. Label each trophic level of your pyramid with the correct organism.

		
Pyramid drawn with 4 bars of decreasing width, with Plankton at the base.		1 mark
All 4 bars are correctly labelled in order (bottom to top): Plankton, Krill, Squid, Seals.		3 mark
		Total: 4 marks

- e) Scientists estimate that only about 10% of the energy stored in the plankton is transferred to the krill.

Explain why so much energy is lost between the plankton and the krill.

An explanation to include any three of the following:	
Energy is transferred/lost to the surroundings as heat.	1 mark
Energy is used by the organisms for respiration / life processes.	1 mark
Not all of the plankton is eaten by the krill.	1 mark
Not all of the plankton that is eaten is digested / some is lost as waste (faeces/egestion).	1 mark
	Total: 3 marks

(Total for Question 4 is 13 marks)

5. The figure below shows a food web for a wooded grassland habitat.

Describe and explain the likely effects of the decrease in caterpillars on the other organisms in this food web. In your answer, you should refer to ideas about food availability and competition.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple statements are made about the effect on at least one other organism. The explanation is limited, with minimal or no effective use of the terms food availability or competition. The answer may be a list of simple consequences with little or no explanation.
Level 2	3 - 4	The description and explanation identify some correct effects on other organisms. There is a clear attempt to use the concepts of food availability and/or competition, but the links may be less detailed or not fully developed.
Level 3	5 - 6	A detailed and coherent description and explanation is provided, covering a range of organisms in the food web. The explanation correctly links the decrease in caterpillars to clear effects on other populations, consistently and correctly using the concepts of food availability and competition.

Indicative content:	
Effects on Blue tits and Sparrowhawks: The Blue tit population is likely to decrease. This is because their food availability has been reduced (as they eat caterpillars). This may lead to starvation or failure to reproduce. The Sparrowhawk population is also likely to decrease. This is because there will be fewer Blue tits available as food. Effects involving competition: Blue tits will eat more aphids. This will increase competition between Blue tits and Ladybirds for aphids. This increased competition could cause the Ladybird population to decrease due to less food being available for them. Effects on producers and other primary consumers: The Oak tree population/biomass may increase. This is because there is less predation from caterpillars. With less competition from caterpillars for oak leaves, the Squirrel and Aphid populations might increase. An increase in the Squirrel population could lead to an increase in the Fox population due to greater food availability. A top-level answer should describe a chain of effects, for example: a decrease in caterpillars reduces the food available for blue tits, causing their population to fall. This in turn reduces the food available for sparrowhawks, causing their population to fall. The answer should also discuss competition, for example: the decrease in caterpillars causes blue tits to eat more aphids, increasing competition with ladybirds.	
	Total: 6 marks

(Total for Question 5 is 6 marks)

6. A group of students investigated the feeding relationships in a woodland ecosystem. They focused on one food chain from the wider food web:

Oak Tree → Caterpillars → Blue Tits → Sparrowhawk

The students counted the number of organisms in their study area.

Their results are shown in the table below.

Types of Organism	Number of Organisms
Oak tree	1
Caterpillars	8000
Blue tits	40
Sparrowhawk	2

- a) On the graph paper below, draw a labelled **pyramid of numbers** for this food chain.

	
Four bars drawn, stacked and centred.	1 mark
Bars are correctly labelled in the correct order (Oak Tree at the base, then Caterpillars, Blue tits, Sparrowhawk).	1 mark
Correct non-pyramid shape, with a narrow base, a very wide second bar, and then two progressively narrower bars.	1 mark
	Total: 3 marks

- b) Explain why the pyramid of numbers you have drawn is not a typical pyramid shape.

The producer / the Oak Tree is a single, very large organism.	1 mark
This one large tree has a large biomass and can feed / support a very large number of much smaller organisms (the caterpillars).	1 mark
	Total: 2 marks

To investigate the biomass of the caterpillars, the students collected all the caterpillars from 5 different, similar-sized branches of the oak tree. The mass of caterpillars on each branch is shown below.

Caterpillars	1	2	3	4	5
Mass (g)	1.4	1.6	1.5	1.4	1.6

- c) Calculate the mean mass of caterpillars found per branch.

$(1.4 + 1.6 + 1.5 + 1.4 + 1.6) \div 5$ or $7.5 \div 5$	1 mark
1.5 (g)	1 mark
	Total: 2 marks

- d) Scientists calculated the energy transfer along this food chain.

They found that the chemical energy stored in the **oak tree leaves** available to the food chain was **4,000,000 kJ**.

The total energy that was finally incorporated into the biomass of the **sparrowhawks** was only **20 kJ**.

Calculate the **percentage efficiency** of the energy transfer from the oak tree to the sparrowhawk.

Give your answer to 2 significant figures.

$(20 \div 4\,000\,000) \times 100$	1 mark
0.0005	1 mark
0.00050 (to 2 significant figures)	1 mark
	Total: 3 marks

(Total for Question 6 is 10 marks)