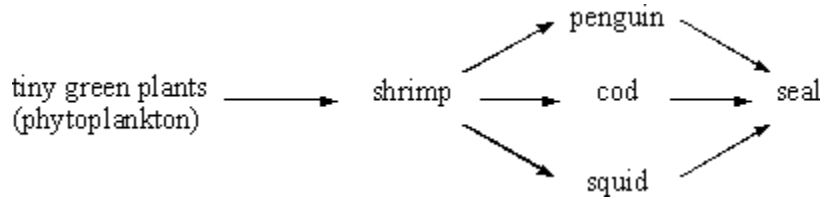


1 Scientists have found the following food web in the cold Antarctic Ocean.



(a) Humans are removing large numbers of the cod.

Some scientists argue that this could lead to a decrease in the numbers of squid and penguins.

Others argue that the numbers of squid and penguins will stay the same.

Carefully explain each argument.

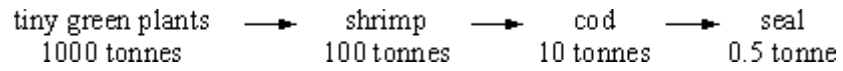
Why they might decrease.

(1)

Why they might stay the same.

(2)

- (b) The following information is about the biomass of the organisms in one of the food chains in the web.



Draw and label a pyramid of biomass for this chain.

(2)

- (c) Explain, as fully as you can, why the conversion of shrimp biomass into cod biomass is more efficient than that of cod biomass into seal biomass in the cold Antarctic Ocean.

(3)

- (d) Boats from many countries fish the Antarctic Ocean. The cod are being overfished. If the numbers of cod are to increase, the population must be carefully managed.

- (i) Suggest **two** control measures which would prevent a further drop in numbers,

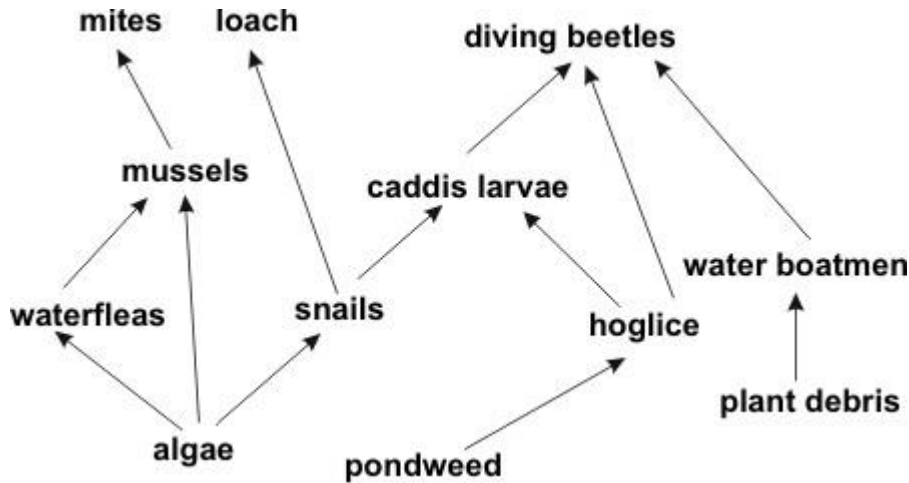
(2)

(ii) Suggest why **one** of your control measures would be difficult to put into practice.

(1)
(Total 11 marks)

2

The diagram below shows a food web for some of the organisms which live in a pond.



(a) (i) Name **one** secondary consumer in this food web.

(1)

(ii) The algae are small green plants.

Give **three** conditions needed by green plants to produce sugars.

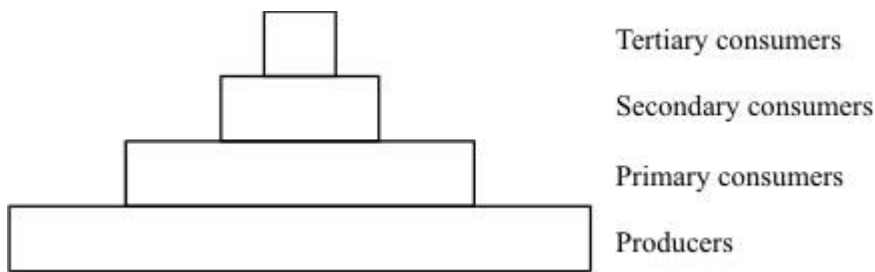
1. _____

2. _____

3. _____

(3)

(b) This is a pyramid of biomass for the organisms in the aquarium.



Some of the biomass of the producers is **not** transferred to the tertiary consumers.

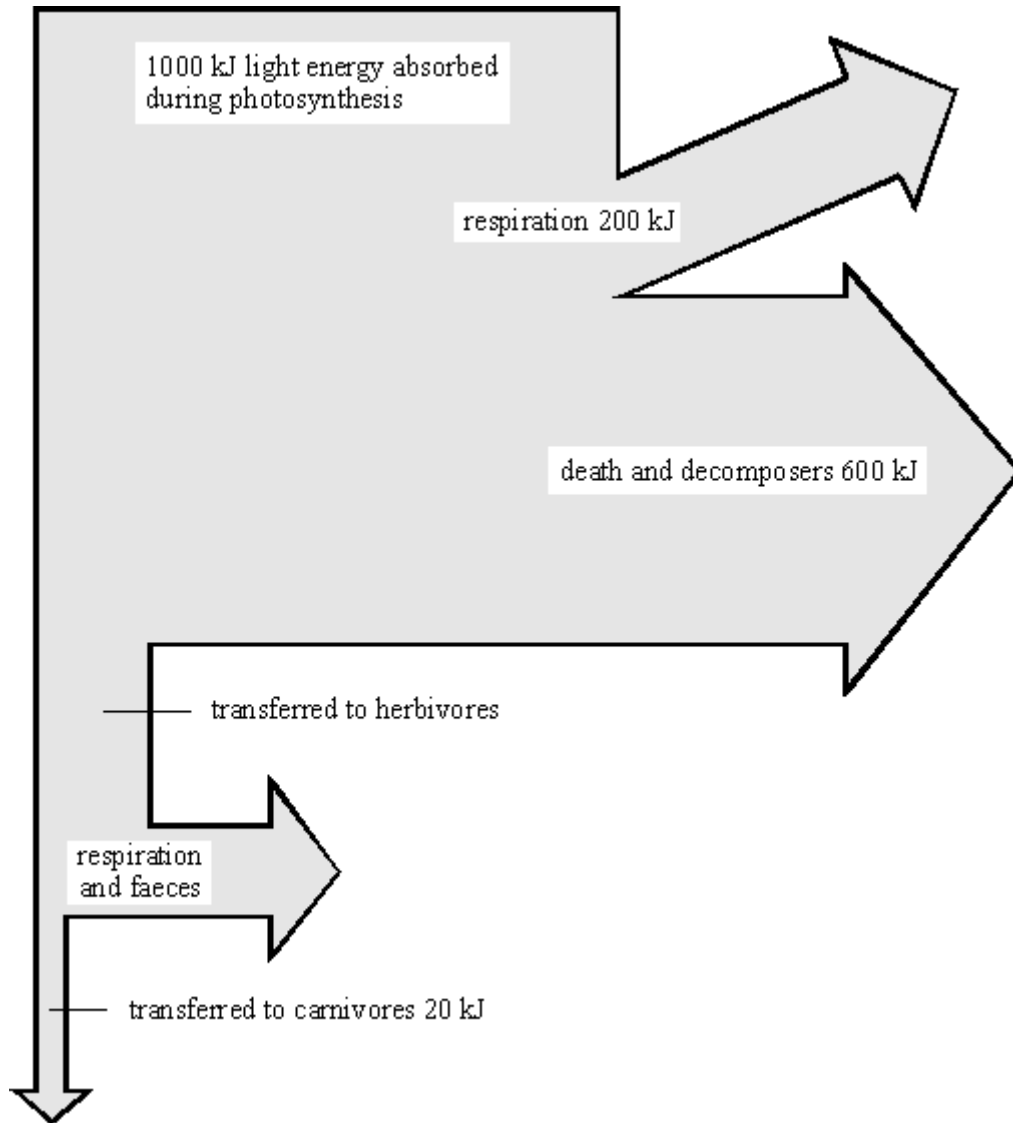
Explain, as fully as you can, what happens to this biomass.

(6)

(Total 10 marks)

3

- (a) The diagram shows what happens to each 1000 kJ of light energy absorbed by plants growing in a meadow.



Use the information from the diagram to calculate:

- (i) how much energy was transferred to herbivores;

_____ kJ

(1)

- (ii) the percentage of the energy absorbed during photosynthesis that was eventually transferred to carnivores. Show your working.

_____ %

(2)

- (b) The table gives the energy output from some agricultural food chains.

FOOD CHAIN	ENERGY AVAILABLE TO HUMANS FROM FOOD CHAIN (kJ PER HECTARE OF CROP)
cereal crop \Rightarrow humans	800 000
cereal crop \Rightarrow pigs \Rightarrow humans	90 000
cereal crop \Rightarrow cattle \Rightarrow humans	30 000

Explain why the food chain *cereal crop* \Rightarrow *humans* gives far more energy than the other two food chains.

(3)

- (c) The amounts of energy available to humans from the food chain
cereal crop \Rightarrow *pigs* \Rightarrow *humans*
can be increased by changing the conditions in which the pigs are kept.

Give **two** changes in conditions which would increase the amount of energy available. In each case explain why changing the condition would increase the available energy.

Change of condition 1 _____

Explanation _____

Change of condition 2 _____

Explanation _____

(4)
(Total 10 marks)

- (b) A scientist estimated the total amount of energy flow through each level of the pyramid per year.

The results were:

Energy absorbed by oak trees 4 600 000 kJ per m² per year

Energy in sugar produced by trees 44 000 kJ per m² peryear

Energy transferred to primary consumers 2 920 kJ per m² per year

Energy transferred to secondary consumers 700 kJ per m² per year

- (i) Calculate the percentage of the energy absorbed by the trees that is transferred to sugar by photosynthesis. Show your working.

Answer _____%

(2)

- (ii) Suggest **two** reasons why a large proportion of the energy is not transferred to sugar.

1. _____

2. _____

(2)

- (iii) Give **three** reasons why some of the energy in the primary consumers is not passed on to the secondary consumers.

1. _____

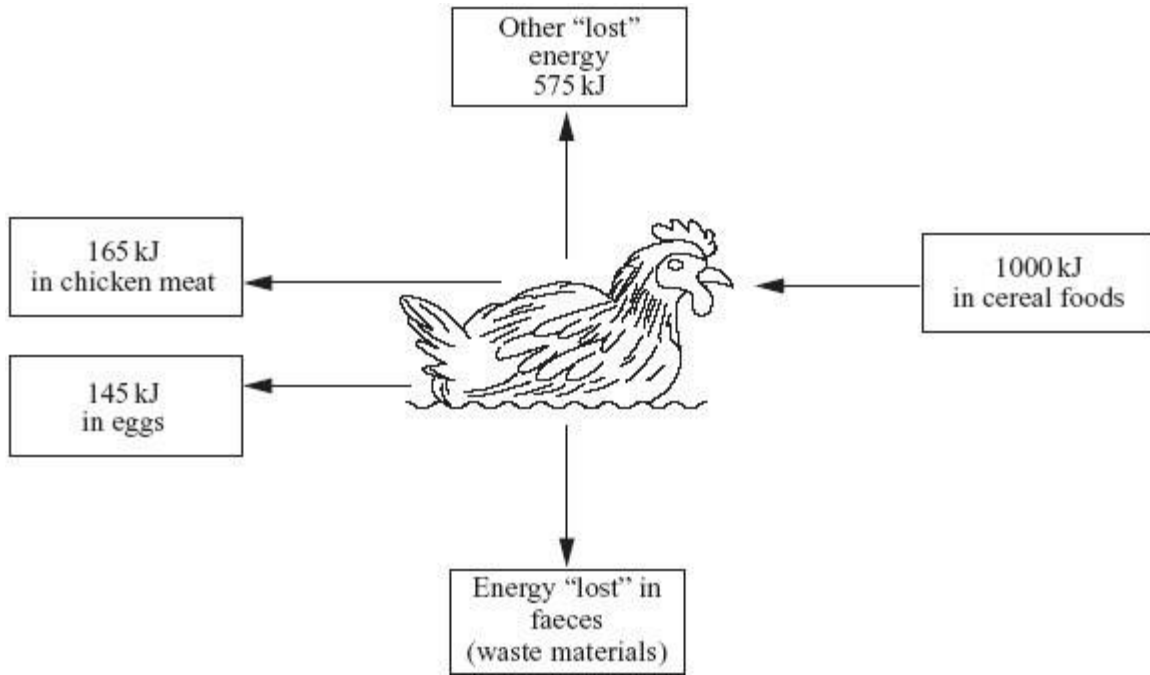
2. _____

3. _____

(3)

(Total 9 marks)

- 6 Chickens are kept as farm animals to produce food. Free-range chickens are allowed to feed in a large space outside. The diagram shows how energy supplied in food to a free-range chicken is transferred.



- (a) Calculate the amount of energy “lost” in faeces.

Energy “lost” = _____ kJ

(1)

- (b) Some farmers use the battery method. They keep large numbers of chickens in a small indoor space. The food yield from these chickens is higher than that from free-range chickens. Explain why, as fully as you can.

(4)

(Total 5 marks)

7 The information in the table compares two farms. Both are the same size, on similar land, close to one another and both are equally well managed.

Name of farm	Activity	Energy value of food for humans produced in one year	Number of people whose energy requirements can be met by this food
Greenbank Farm	Grows food for humans	3285 million kJ	720
Oaktree Farm	Grows food for animals on the farm which become food for humans	365 million kJ	80

(a) Use this information to work out the average daily human energy requirement in kilojoules (kJ) per day.

Energy requirement = _____ kJ/day

(2)

(b) The figures show that farms like Greenbank Farm can be nine times more efficient at meeting human food energy requirements than farms such as Oaktree Farm.

(i) The food chain for Greenbank Farm is:

vegetation → humans

What is the food chain for Oaktree Farm?

(1)

(ii) Explain why Greenbank Farm is much more efficient at meeting human food energy requirements.

(3)

- (c) The human population has been increasing rapidly throughout this century. It is now about 6 billion and is still growing. What does the information in this question suggest about likely changes in the human diet which may need to occur during the coming century? Explain your answer.

(4)
(Total 10 marks)

8 Compare the efficiency of these two food chains.

Food chain **A** grain → humans

Food chain **B** grain → bullocks → humans

In your answer, make **full use** of the following data.

Food	Consumer	Percentage of available energy transferred as useful energy
Grain	Human	9%
Grain	Bullock	12%
Bullock	Human	10%

One kilogram of grain has 80 000 kJ of available energy.

(Total 4 marks)

Mark schemes

- 1 (a) Decrease: seals will eat more squid and penguins
for 1 mark

1

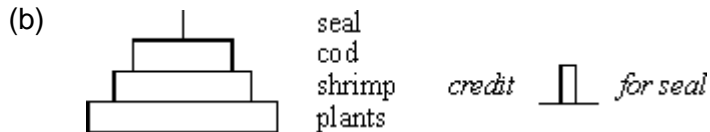
Stay the same:

- more shrimp/food for squid and penguins

ideas that

- increase in squid and penguins balances the extra eaten by seals
- seals find other prey (allow start to eat shrimps)
any two for one mark each

2



allow



- correct shape (doesn't need to be to scale)
- correctly with organisms

*(if wholly correct but inverted then credit 1 mark)
each for 1 mark*

2

- (c)
- seals are mammals
 - *idea that* seals have (to maintain) a constant body temperature
[allow warm blooded]
 - heat losses to cold seas
 - more of food eaten used to replace heat loss

*(credit use of figures i.e. 95% loss compared to 90%
or 5% efficient compared to 10%
or 20 : 1 conversion ratio compared to 10 : 1
with 1 mark)*

any three for 1 mark each

3

- (d) (i) *ideas that*
- reduce number of fishing boats allowed
 - breed in captivity and then release
 - agree quotas [not an unqualified 'ban']
 - avoid breeding areas
 - avoid breeding seasons
 - increase size of net mesh/don't catch small fish
 - limit catches of shrimps
 - cull seals
- any two for 1 mark each*
[allow any other reasonable answer]

2

- (ii)
- breeding areas closer to some countries than others
 - difficult to police/easy to cheat/'poach'
 - difficult to agree quotas
 - some countries eat more fish than others
 - best weather for fishing maybe in breeding seasons
 - fisherman/trawlers need employment
 - big demand for cod
- any one for 1 mark*
[allow any other sensible response]

1

[11]

2

- (a) (i) e.g. mussels/caddis loach
for 1 mark
- (ii) 3 of:
 carbon dioxide
 water
 chlorophyll/chloroplasts
 light
- any 3 for 1 mark each*

1

3

- (b) 6 of e.g.
 some plant/animal material not digested by consumers passes out with faeces
 respiration releases energy used in movement lost as heat
 some 'lower' organisms die energy transferred to decomposers/detritivores
 thence to environment

any 6 for 1 mark each

6

[10]

3

- (a) (i) 200 kJ

for 1 mark

1

- (ii) 2

gains 2 marks

(if answer incorrect, $20 / 1000 \times 100$ gains 1 mark)

2

- (b) *ideas that*
 energy lost by animal (pig / cattle) / extra stage / extra trophic level
 in waste materials e.g.
 in muscular activity / movement
 in keeping body temperature higher than surroundings / lost as heat

any three for 1 mark each

references to respiration regarded as neutral

3

- (c) *ideas that*
 controlling (high) temperature of surroundings / keeping indoors / insulating
 reduces energy transferred from animal as heat / animal uses body heat to maintain
 temperature restricting movement (e.g. caging or keeping in darkness)
 reduces muscular contraction / muscular activity

each for 1 mark

*accept respiration as explanation once only if neither explanation
 point has received credit*

reject give more food / different food

4

[10]

4 any **five** from:

- the amount of energy (in the biomass of organisms) is reduced at each successive stage in a food chain
- all of prey organism is not consumed
- energy is 'lost' as the organisms' waste materials
- energy is transferred / lost during respiration
- energy is transferred / lost as movement (kinetic energy)
- energy is transferred / lost as heat (thermal energy)
- energy is transferred / lost to the surroundings
- the only energy transferred to a higher level is that which the organisms have used in growing

statements about energy flow the wrong way are neutral

[5]

5 (a) levels in correct order
sizes correct

for 1 mark each

2

(b) (i) working
0.96% (correct answer = 2)

for 1 mark each

2

(ii) 2 of e.g.
heat up leaves
absorbed by non-photosynthetic parts
transmitted through leaves

any 2 for 1 mark each

2

(iii) 3 of e.g.
respiration of primary consumers
movement of p.c.
waste from p.c.
repair/growth of p.c.; heat losses to
surroundings

any 3 for 1 mark each

3

[9]

6 (a) 115

1

- (b) any **four** from
 less energy lost / used
 as heat lost to the atmosphere
 since warm indoors

accept temperature controlled

(less energy lost) in movement

since movement restricted

more growth / eggs

*accept prevents loss of body mass **or** gets fatter / weight gain*

4

[5]

7

- (a) 12 500

*incorrect numerical answer but clear evidence of correct working
 e.g. 365 million ÷ 365 ÷ 80 **or** 3285 million ÷ 365 ÷ 720 credit with
 (1)*

2

- (b) (i) vegetation
 → (farm) animals → humans

*accept any correct variation on this theme
 e.g. grass → lambs → humans*

1

- (ii) any **three** linked points from

* less links in the food chain

***or** only one link in the food chain*

* energy 'wasted' **or** 'lost' **or**
 'used' at each link

* energy 'wasted' **or** 'lost' in (the
 process of) respiration

* energy 'used' to maintain body
 temperature

* energy 'used' by the animals in
 movement

3

- (c) people will eat more/greater proportion
 of food from plants

*accept people will eat less/smaller proportion of food from animals
 do not credit 'everyone will stop eating meat'*

1

any **three** linked points from

these marks are independent of the 'prediction' mark

do not credit 'food from plants will become less expensive'

- * meat will become more expensive
- * only a limited area of land available on the planet (for food production **or** otherwise)
- * more people means less land available for food production because some used for housing etc.
- * land will become more expensive
- * land will have to be used more efficiently

***or** more people will go hungry*

***or** people will (each) eat less*

- * livestock farmers will try to improve efficiency
- * (leading to) growth of 'factory farming'
- * demand for food will rise (total)

3

[10]

8

(food chain) A gives 7 200 kJ
(of useful energy)

***or** 7.2 MJ*

***or** 7 200 000 J*

unit essential in each case

1

(food chain) B gives 960 kJ (of useful energy)

***or** 0.96 MJ*

***or** 960 000 J*

unit essential in each case

*credit 1 mark if **both** are numerically correct but unit omitted*

1

same comparison made in **each** case
e.g. for each kilogram of grain

***or** refers to more stages in food chain
results in less efficiency*

1

(so) (food chain) A is 7.5 times more efficient than (food chain) B

or for every unit of useful energy given

to a person by B, A gives $7\frac{1}{2}$ units

or food chain B is only 13(.3)% as
efficient as food chain A

or makes a correct comparison
in percentage terms

1

[4]