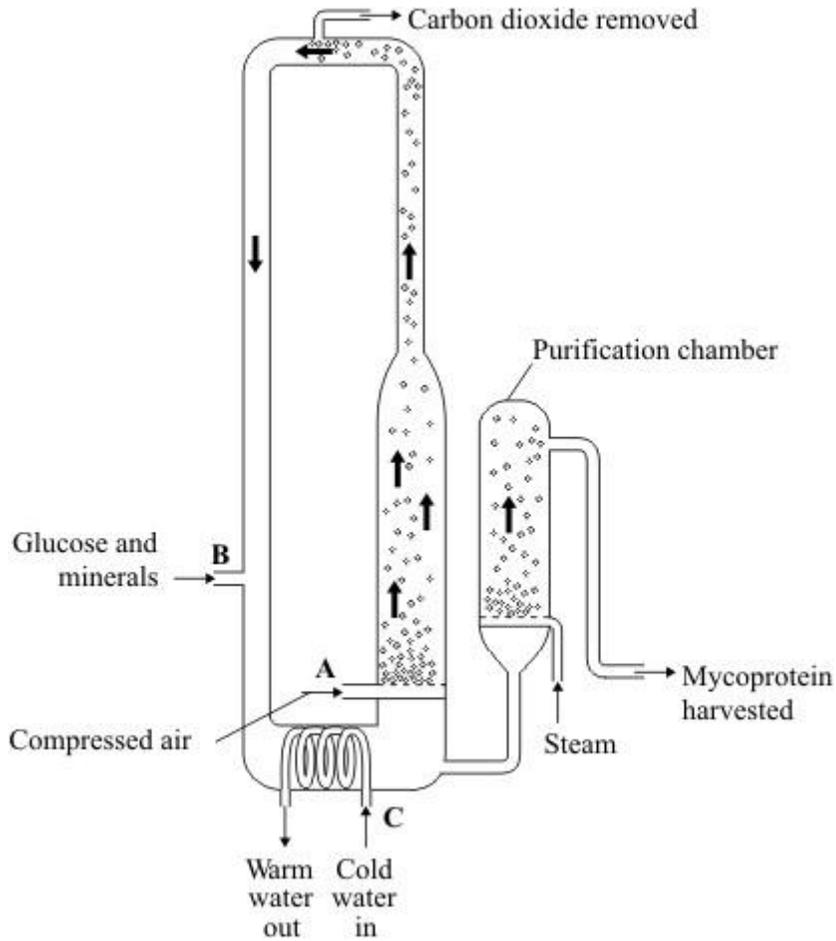


- 1 The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium* which is used to make mycoprotein.



- (a) Bubbles of air enter the fermenter at **A**.

Give **two** functions of the air bubbles.

1. _____

2. _____

(2)

- (b) Glucose is added to the fermenter at **B**.

Explain why glucose is added.

(1)

- (c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at **C**.

Explain what causes the fermenter to heat up.

(1)

- (d) It is important to prevent microorganisms other than *Fusarium* from growing in the fermenter.

- (i) Why is this important?

(1)

- (ii) Suggest **two** ways in which contamination of the fermenter by microorganisms could be prevented.

1. _____

2. _____

(2)

- (e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

A diet book states that mycoprotein is the best source of amino acids for the human diet.

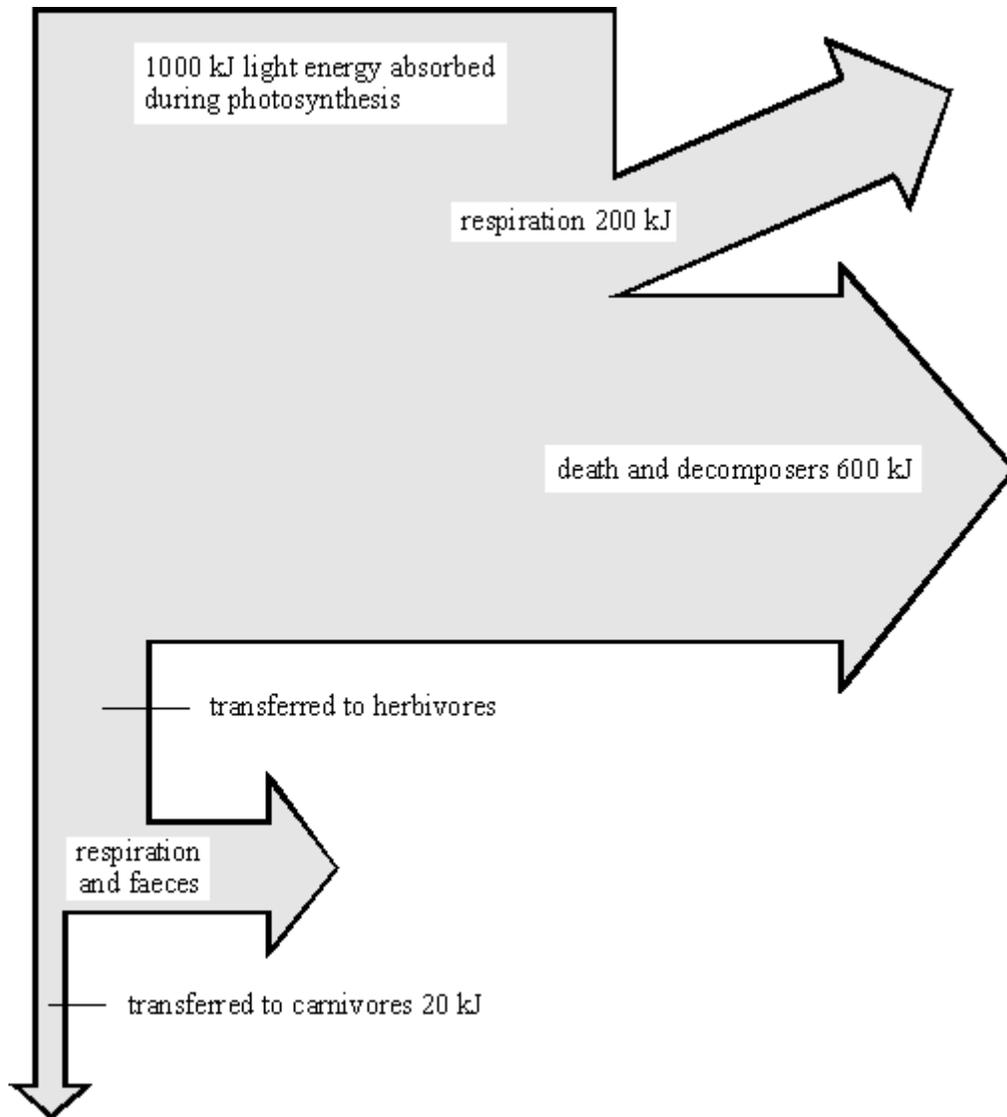
Evaluate this statement.

Remember to include a conclusion in your evaluation.

(4)
(Total 11 marks)

2

(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 ⇒ *pigs* ⇒ *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 _____

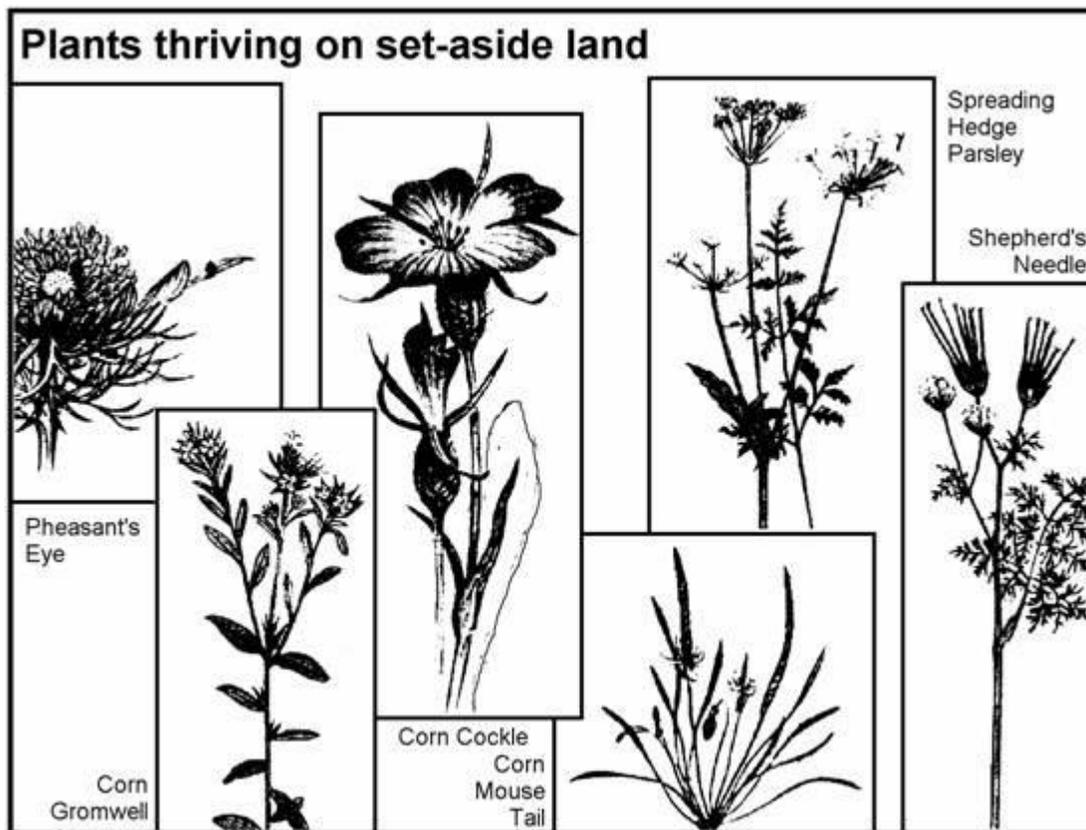
Change of condition 2 _____

Explanation _____

(4)

(Total 10 marks)

3



The drawings and text for this question are based on an article from The Independent newspaper.

Some of Britain's rarest wild flowers are likely to make a come-back thanks to an EC set-aside regime in which 15 per cent of arable land has been taken out of production.

As a result of this set-aside, shepherd's needle, pheasant's eye, corn gromwell, corn cockle, spreading hedge parsley and corn mouse tail are now thriving once again. They were once common in and around cereal fields and were even regarded as weeds, but were swept to near extinction by the intensification of agriculture after the Second World War. Their small, pale flowers are hardly seen. These plants cannot compete in fields where modern cereal crops are cultivated. Nor, however, do they flourish in semi-natural or wild habitats where nature is left to its own devices. They need farmland which is lightly tilled and cut once a year.

Dr Nick Sotherton, lowland research manager with the Game Conservancy Council, says that these species will flourish under the new rotational set-aside regime, in which farmers are compensated for taking land out of production in an attempt to end crop surpluses.

EC agriculture ministers are meeting to decide how much land should be used for rotational set-aside – in which a field is taken out of production for just one year before being replanted – and how much should be set-aside permanently. The ultimate set-aside is a wood, and Britain is seeking a forestry option.

The Game Conservancy Council says that the rotational scheme can benefit ground nesting birds as well as rare flowers that will not be helped by longer-term set-aside. But Richard Knight of the Wildlife Advisory Group, says "Non-rotational is better because it gives flora and fauna a chance to get well established".

"Intensification of agriculture" has led to the creation of artificial ecosystems.

- (a) Explain how the creation of artificial ecosystems may have led to the near-extinction of the plants seen in the picture above.

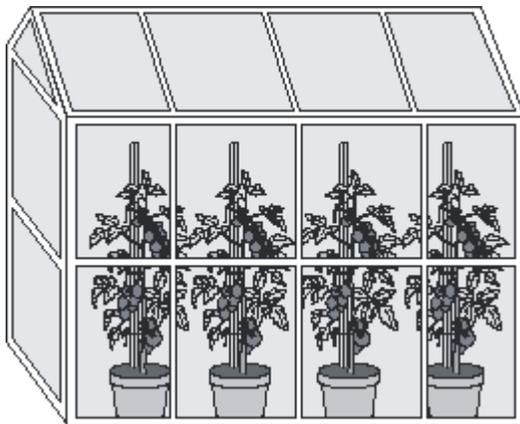
(4)

(b) What would you recommend to ministers meeting to decide a policy involving rotational set-aside and permanent set-aside? Explain the reasons for your answer.

(4)
(Total 8 marks)

4

In this country most tomatoes are grown in greenhouses.



(a) Suggest **one** way in which a grower could increase the yield of tomatoes from plants growing in his greenhouse.

(1)

(b) Large supermarkets often import tomatoes from overseas.

(i) Suggest **two** reasons why a supermarket might decide to import tomatoes rather than buy them from British growers.

1. _____

2. _____

(2)

- (ii) Importing tomatoes may be more damaging to the environment than selling tomatoes grown in this country.

Explain why.

(2)
(Total 5 marks)

5

Food security is when a population has enough food to stay healthy.

Lack of food security is a global problem.

One way to maintain food security is to increase the efficiency of food production.

The diagram below shows how some pigs are farmed using intensive methods.



© Ingram Publishing/Thinkstock

- (a) Some people think the farming methods shown in the diagram above are unethical.

Suggest **two** other possible disadvantages of intensive farming methods.

1. _____

2. _____

(2)

(c) A newspaper reported that:

'Food security is a serious problem in remote communities in Canada. This is because Aboriginal communities are eating fewer traditional foods.'

One traditional food eaten by Aboriginal communities in Canada is seal.

Look at the table below

Year	Number of seals caught in thousands
2004	362
2005	316
2006	348
2007	224
2008	215
2009	91
2010	67

Calculate the percentage (%) decrease in the number of seals caught from 2004 to 2010.

Decrease in seals = _____%

(2)

(d) The conclusion in the newspaper might **not** be correct.

Suggest **two** reasons why.

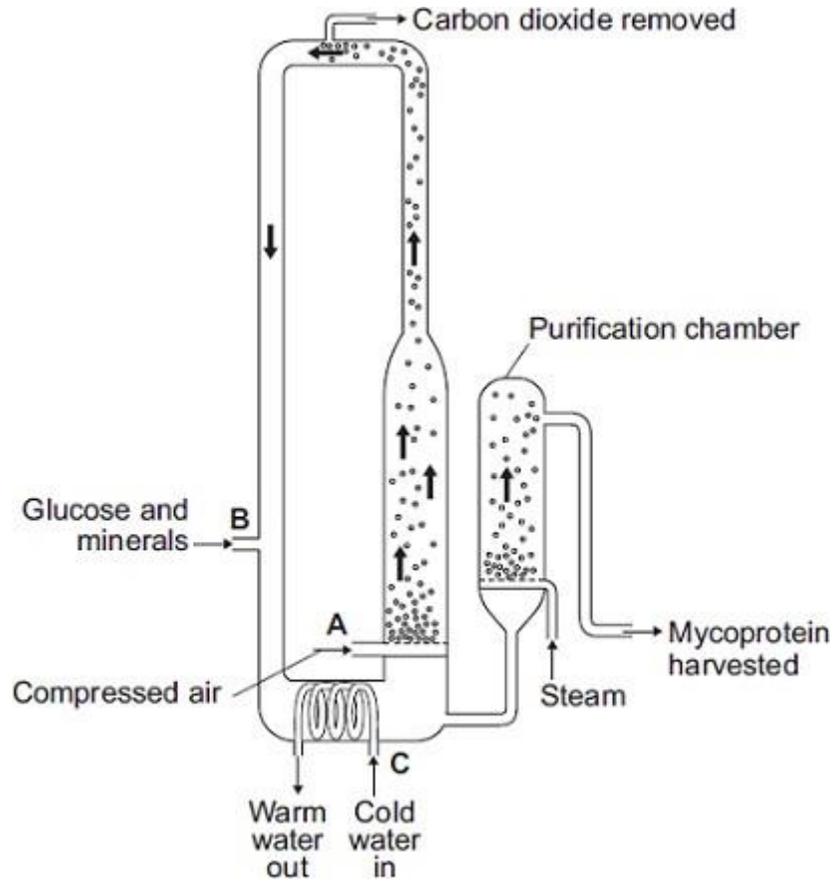
1. _____

2. _____

(2)

(Total 10 marks)

- 6 The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium*.
Fusarium is used to make mycoprotein.



- (a) Bubbles of air enter the fermenter at A.

Give **two** functions of the air bubbles.

1. _____

2. _____

(2)

- (b) Why is glucose added to the fermenter?

(1)

- (c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at **C**.

Name the process that causes the fermenter to heat up.

(1)

- (d) It is important to prevent microorganisms other than *Fusarium* growing in the fermenter.

- (i) Why is this important?

(1)

- (ii) Suggest **one** way in which contamination of the fermenter by microorganisms could be prevented.

(1)

- (e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

- (a) (i) Some scientists think using cultured meat instead of traditionally-produced meat will help reduce global warming.

Suggest **two** reasons why using cultured meat may slow down the rate of global warming.

1. _____

2. _____

(2)

- (ii) Suggest **two** other possible advantages of producing cultured meat instead of farmed meat.

Do **not** refer to cost in your answer.

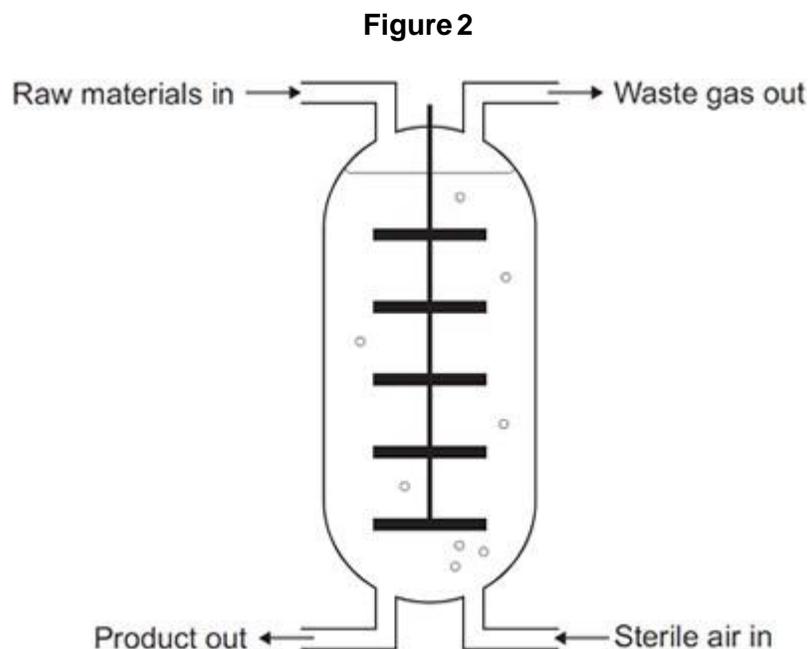
1. _____

2. _____

(2)

- (b) Mycoprotein is one type of food that is mass-produced.

Figure 2 shows a fermenter used to produce mycoprotein.



Mark schemes

- 1 (a) circulation / mixing / described 1
- or**
- temperature maintenance
- supply oxygen
- do **not** allow oxygen for anaerobic respiration*
- or**
- for aerobic conditions
- or**
- for faster respiration 1
- (b) any **one** from:
- energy supply / fuel
or use in respiration
*do **not** allow just food / growth*
ignore reference to aerobic / anaerobic
 - material for growth
or to make mycoprotein 1
- (c) (heat / energy) from respiration
- allow exothermic reactions*
- allow description eg breakdown of glucose / catabolism*
- ignore metabolism*
- ignore aerobic / anaerobic* 1
- (d) (i) any **one** from:
- compete (with Fusarium) for food / oxygen
or reduce yield of Fusarium
 - make toxic waste products
or they might cause disease / pathogenic
or harmful to people / Fusarium
*do **not** allow harmful unqualified* 1

(ii) any **two** from:

- steam / heat treat / sterilise fermenter (before use)
not just clean
allow sterilisation unqualified for 1 mark
- steam / heat treat / sterilise glucose / minerals / nutrients / water (before use)
not just use pure glucose
- filter / sterilise air intake
- check there are no leaks

2

(e) any **three** from:

- beef is best **or** beef is better than mycoprotein(*)
- mycoprotein mainly better than wheat(*)
- more phenylalanine in wheat than in mycoprotein(*)
allow equivalent numerical statements()*
- but no information given on other amino acids / costs / foods

3

overall conclusion:

statement is incorrect

or

it would be the best source for vegetarians

or

for given amino acids, beef is the best source

or

three foods provide insufficient data to draw a valid conclusion

1

[11]

2

(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]

3

- (a) 4 of:
 intensification due to need to improve efficiency of energy transfer;
 has led to developing fast growing crop varieties;
 native plants cannot compete with these;
 for e.g. light/water/minerals;
 effect of herbicides;
 pesticides killing pollinating insects
each for 1 mark

4

- (b) recommend a variety of measures; (can be implied)
 because rotational will allow these species to continue;
 permanent will allow others;
 leading to conservation of a wide range of species
each for 1 mark

4

[8]

4

(a) any **one** from:

- increase / give light
- increase temperature / make warmer

award marks if the method by which these could be done is given
eg leave lights on all night **or** use a heater

- increase / give CO₂
- add fertiliser / nutrients / minerals / named
allow nitrogen
ignore 'food'

1

(b) (i) any **two** from:

- cheaper
allow grow faster / more grown
- better quality / flavour
ignore size
- available all year
accept converse if clear that answer refers to use of British tomatoes
allow 'Fair Trade'

2

(ii) any **two** from:

- greater distance **or** more food miles **or** more transport
- idea of more needed only once
- transport needs (more) energy / fuel
 - reference to eg greenhouse effect / global warming / pollution / CO₂ release / carbon footprint
ignore ozone

2

[5]

5

(a) any **two** from:

- diseases spread more rapidly
- antibiotics can build up in the food chain
or
over use of antibiotics
- increased use of fossil fuels (to heat the barn)

2

- (b) **Level 2 (3–4 marks):**
Clear statements made identifying the farming methods which are linked to relevant explanations of how this increases the efficiency of food production.

Level 1 (1–2 marks):

Simple statements made identifying the farming methods used, but no attempt to link to explanations of how this increases the efficiency of food production.

0 marks:

No relevant content.

Indicative content

statements:

- kept inside or in a temperature controlled environment
- kept enclosed or in a restricted environment

explanations:

- less energy / heat is lost in controlling body temperature
- less energy required for movement
- so more energy is available for growth
- less energy / heat is transferred to the environment

4

- (c) $(362 - 67 = 295) / 362 \times 100$

1

81 / 81.49 / 81.5

allow 81 / 81.49 / 81.5 with no working shown for 2 marks

1

- (d) aboriginal people can eat other foods (so they may not be in food insecurity)

1

we do not know if other (traditional) food sources have declined

1

[10]

6

- (a) circulating / mixing / described **or** temperature maintenance

1

supply oxygen

or for aerobic conditions

or for faster respiration

*do **not** allow oxygen for anaerobic respiration*

1

- (b) energy supply / fuel / use in respiration

*do **not** allow just food / growth*

ignore reference to aerobic / anaerobic

or material for growth / to make mycoprotein

1

(c) respiration

allow exothermic reaction

allow catabolism

ignore metabolism

ignore aerobic / anaerobic

1

(d) (i) any **one** from:

- compete (with *Fusarium*) for food / oxygen **or** reduce yield of *Fusarium*
- make toxic waste products or they might cause disease / pathogenic **or** harmful to people / to *Fusarium*
*do **not** allow harmful unqualified*

1

(ii) steam / heat treat / sterilise fermenter (before use)

***not** just clean*

or

steam / heat treat / sterilise

glucose / minerals / nutrients / water (before use)

or

filter / sterilise air intake

or

check there are no leaks

*allow sterilisation unqualified **not** just use pure glucose*

1

(e) any **three** from:

- beef is best or beef is better than mycoprotein
- mycoprotein mainly better than wheat
- more phenylalanine in wheat than in mycoprotein
allow equivalent numerical statements
- but no information given on other amino acids / costs / foods

3

overall conclusion:

statement is incorrect because

either

it would be the best source for vegetarians

or

for given amino acids, beef is the best source

or

three foods provide insufficient data to draw a valid conclusion

1

[10]

7	(a) (i) fewer cows	1
	<p>any one from:</p> <ul style="list-style-type: none"> • less methane <p style="padding-left: 20px;"><i>do not allow CH⁴</i></p> <ul style="list-style-type: none"> • less CO₂ in the atmosphere because of less deforestation or less plants consumed. <p style="padding-left: 20px;"><i>allow less CO₂ released into the atmosphere because less fuel used e.g. to heat cowsheds or to transport meat</i></p> <p style="padding-left: 20px;"><i>do not allow CO²</i></p>	1
	<p>(ii) any two from:</p> <ul style="list-style-type: none"> • could be mass produced to feed an increasing population • disease free meat • no / low fat • no harm to animals or less intensive farming <p style="padding-left: 20px;"><i>allow (may be) suitable for vegetarians</i></p> <ul style="list-style-type: none"> • antibiotic free meat • more land available for farming crops <p style="padding-left: 20px;"><i>allow no energy loss along a food chain</i></p>	2
	(b) fungus / Fusarium	1
	with <u>glucose</u> (syrup)	1
	in aerobic conditions or in presence of oxygen	
	<i>ignore air</i>	1
	mycoprotein is harvested / purified	
	<i>allow ammonia added (as source of nitrogen)</i>	
	<i>ignore stirring / mixing and temperature</i>	1

[8]