AQA GCSE Biology | 8461

SPECIFICATION POINT 4.7.5.4

Role of biotechnology

Past-paper questions

Tier	**Higher**
Question groups	**11**
Available paper years	**2008–2020**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

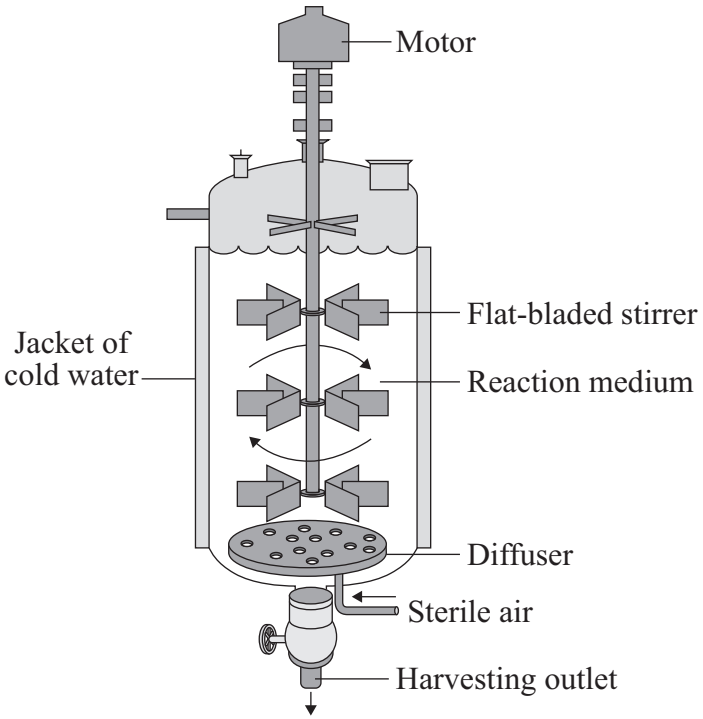
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.7.5.4 Role of biotechnology

Question 01

January 2008 | BLY3H | Original Q7 | Legacy

7 The diagram shows a fermenter. This fermenter was used to grow the fungus *Cephalosporium* which makes the antibiotic Cephalosporin C. The reaction medium contains a mixture of the sugars glucose and sucrose and a variety of mineral ions.



(a) (i) The stirrer continuously mixes the contents of the fermenter. Why is this important?

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(1 mark)

(ii) Explain why the fermenter is surrounded by a jacket of cold water.

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(2 marks)

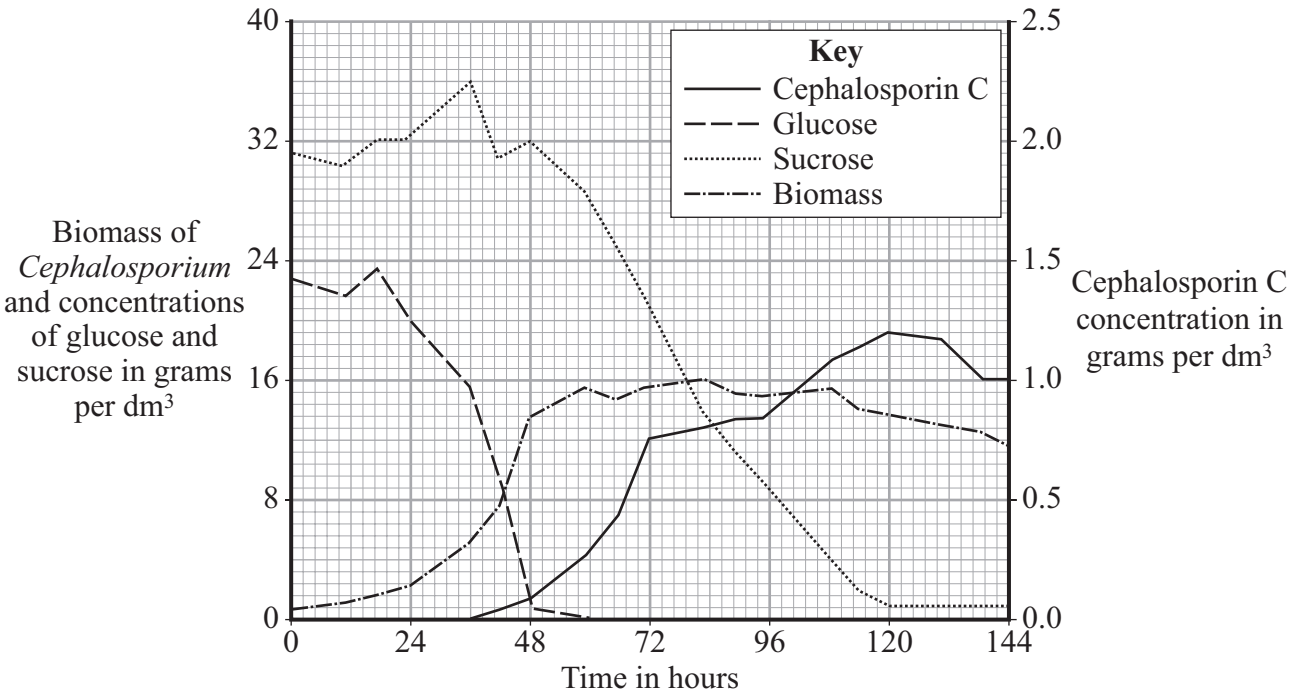
Question 7 continues on the next page

4.7.5.4 Role of biotechnology

Question 01 · continued

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(b) The graph shows changes in the concentrations of glucose, sucrose, Cephalosporin C and the biomass of *Cephalosporium* measured in the fermenter over 6 days.



(i) During which 6-hour time period is the antibiotic being produced at its maximum rate?

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(1 mark)

(ii) What evidence is there that *Cephalosporium* is able to use glucose more easily than sucrose?

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(1 mark)

4.7.5.4 Role of biotechnology

Question 01 · continued

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(iii) Describe and explain the relationship between glucose concentration, the biomass of *Cephalosporium* and the concentration of Cephalosporin C.

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(4 marks)

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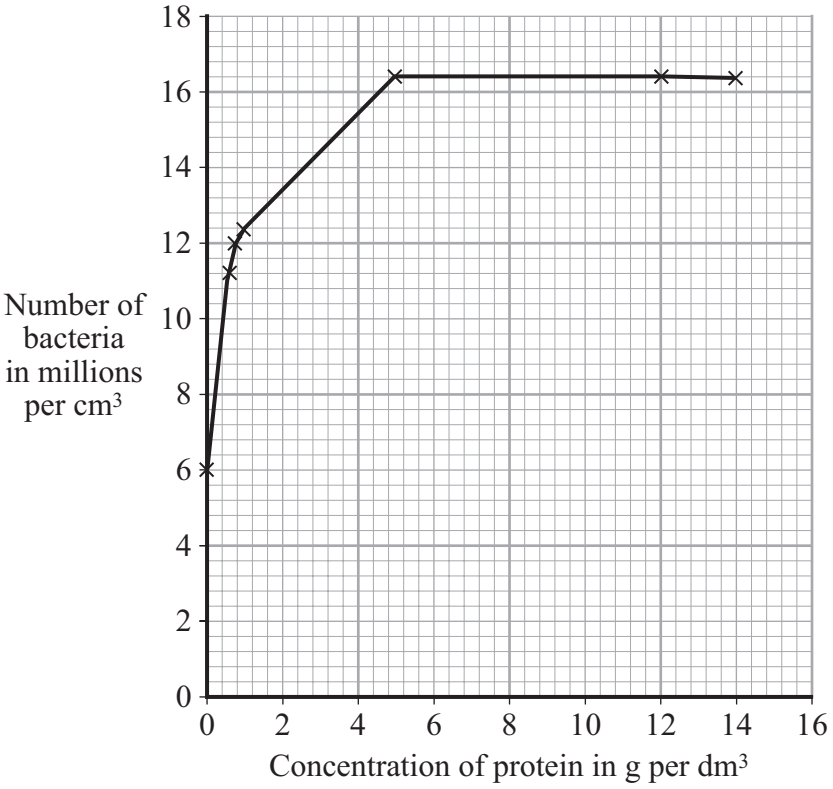
4.7.5.4 Role of biotechnology

Question 02

June 2008 | BLY3H | Original Q6 | Legacy

6 Microorganisms are grown in industrial fermenters. Before this is done, laboratory investigations are carried out to find the optimum growing conditions.

6 (a) The graph shows the effect of protein concentration on the growth of one species of bacterium after 12 hours in a broth culture.



4.7.5.4 Role of biotechnology

Question 02 · continued

for mark

6 (a) Describe and explain, as fully as you can, the effect of protein concentration on the number of bacteria.

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(5 marks)

6 (b) Bacteria of this species were grown in an industrial fermenter.

What concentration of protein would you recommend for use in the fermenter?

Explain the reasons for your answer.

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(3 marks)

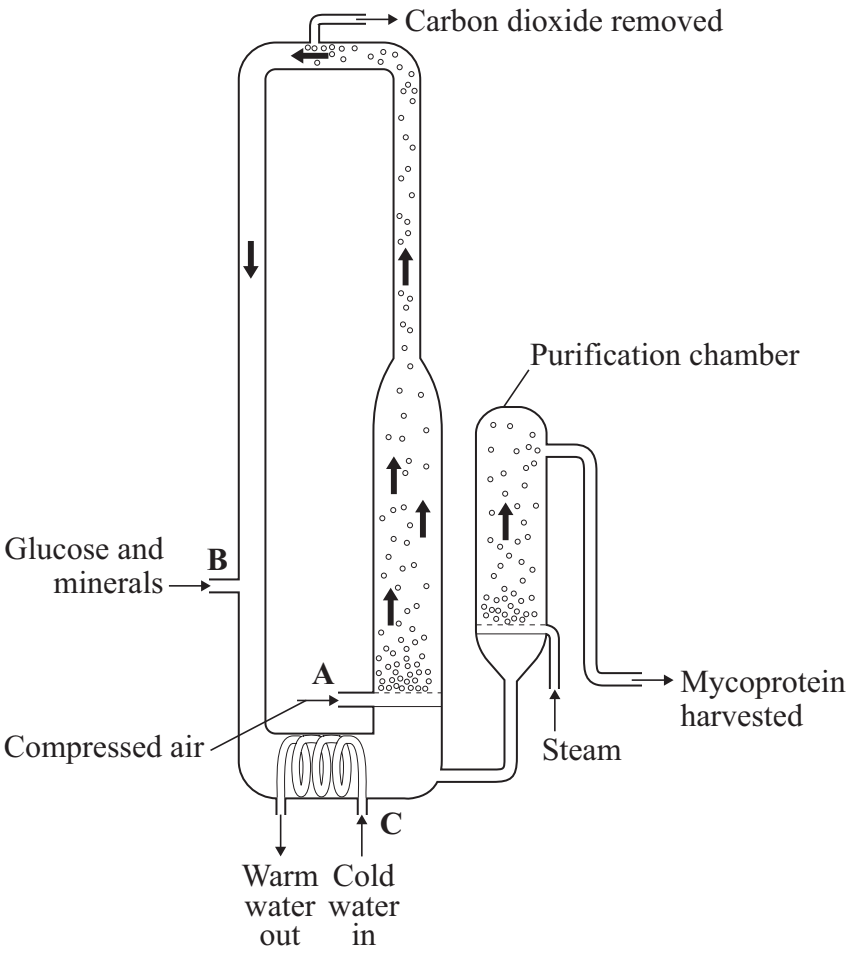
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4.7.5.4 Role of biotechnology

Question 03

June 2008 | BLY3H | Original Q7 | Legacy

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



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

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

1 .....

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2 .....

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(2 marks)

4.7.5.4 Role of biotechnology

Question 03 · continued

for mark

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

Explain why glucose is added.

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(1 mark)

7 (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.

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(1 mark)

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

7 (d) (i) Why is this important?

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(1 mark)

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

1 .....

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2 .....

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(2 marks)

Question 7 continues on the next page

4.7.5.4 Role of biotechnology

Question 03 · continued

for mark

7 (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.

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(4 marks)

11

4.7.5.4 Role of biotechnology

Question 04

June 2009 | BLY3H | Original Q6 | Legacy

6 Microorganisms are often used in the industrial production of useful substances.

The fungus, *Penicillium chrysogenum*, can be used to make an enzyme that digests the sugar sucrose. When it is growing in a medium containing sucrose, the fungus releases this enzyme into the surrounding solution.

6 (a) Explain why it is useful to the fungus to release the enzyme into the surrounding solution.

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(2 marks)

6 (b) Before setting up an industrial fermenter, laboratory-scale investigations are carried out to find the best conditions to use.

A manufacturer investigated the effect of changing several factors on the amount of enzyme produced by the fungus.

The results are shown in the table.

Condition	Concentration of enzyme produced in arbitrary units		
	24 hours	72 hours	120 hours
Amount of fungus added as %			
1	9.0	28.8	44.4
5	7.2	54.0	60.0
25	6.0	66.0	62.4
Aeration rate in arbitrary units			
0.5	9.0	36.0	45.8
1.0	7.2	54.0	60.0
2.0	10.8	43.2	52.8
Sucrose concentration at start as %			
4	7.2	54.0	60.0
8	3.0	29.7	48.3
12	0	54.0	21.6

4.7.5.4 Role of biotechnology

Question 04 · continued

for mark

The manufacturer decided to use the following conditions:

- amount of fungus = 5%
- aeration rate = 1.0 arbitrary units
- time = 72 hours.

Suggest an explanation for each of the following.

6 (b) (i) The manufacturer decided to add 5% fungus rather than 25%.

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(2 marks)

(Extra space) .....

6 (b) (ii) The concentration of enzyme produced at an aeration rate of 2.0 arbitrary units was less than the concentration at an aeration rate of 1.0 arbitrary units.

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(2 marks)

(Extra space) .....

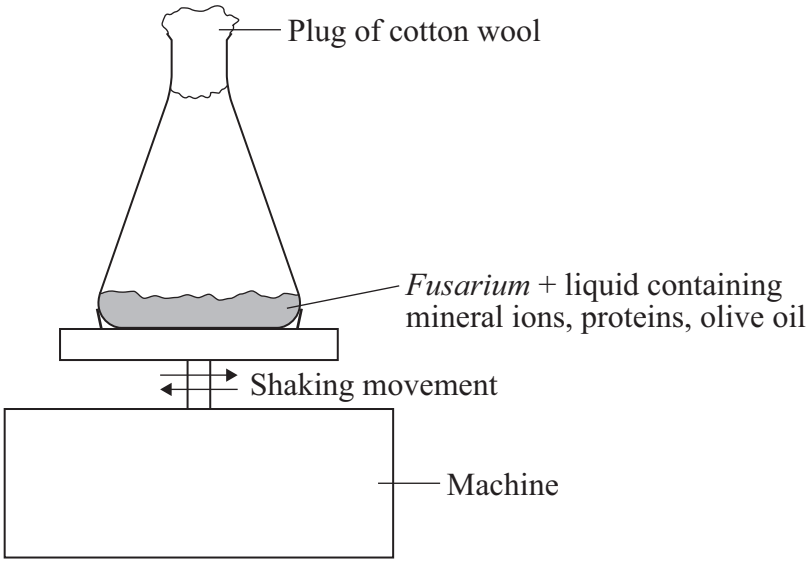
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4.7.5.4 Role of biotechnology

Question 05

7 Lipase is an enzyme used in biological detergents. It catalyses the digestion of fats and oils.

Scientists investigated the production of lipase by the fungus, *Fusarium*.
The scientists made up different liquids containing mineral ions, proteins and olive oil.
They mixed 90 cm^3 of one of these liquids with a *Fusarium* culture in a flask.
The flask was then shaken on a machine throughout the investigation, as shown in the diagram.



The scientists carried out two investigations.

- In each investigation, 10 cm^3 of a high concentration of *Fusarium* was used.
- In **Investigation 1**, they varied the concentration of protein.
- In **Investigation 2**, they varied the concentration of olive oil.
- In each investigation, they measured the amount of lipase produced in each flask over 72 hours.
- They repeated each investigation three times.

7 (a) (i) The shaking movement mixed the liquid and the *Fusarium*.

Suggest **one** further reason why the flasks were shaken throughout the investigations.

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(1 mark)

4.7.5.4 Role of biotechnology

Question 05 · continued

for mark

7 (a) (ii) The high concentration of *Fusarium* in each flask increased the rate of lipase production.

Suggest **one** other reason why a high concentration of *Fusarium* was used.

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(1 mark)

Question 7 continues on the next page

4.7.5.4 Role of biotechnology

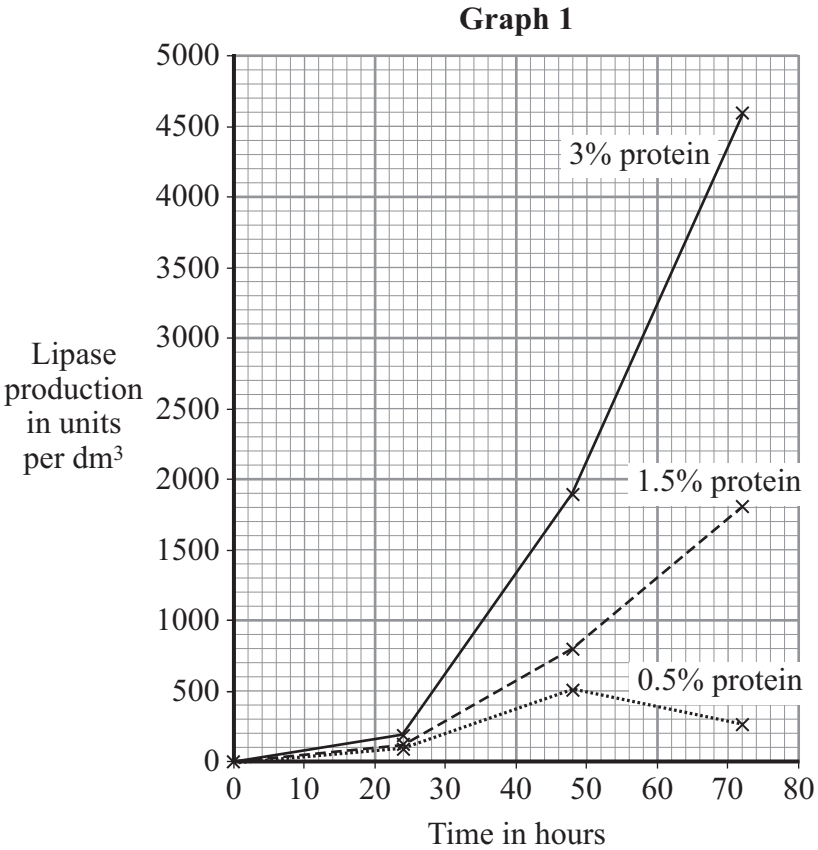
Question 05 · continued

for mark

7 (b) Graphs **1** and **2** show the results of the two investigations.

Graph 1 shows lipase production at three different concentrations of protein.

Graph 2 shows lipase production at three different concentrations of olive oil.

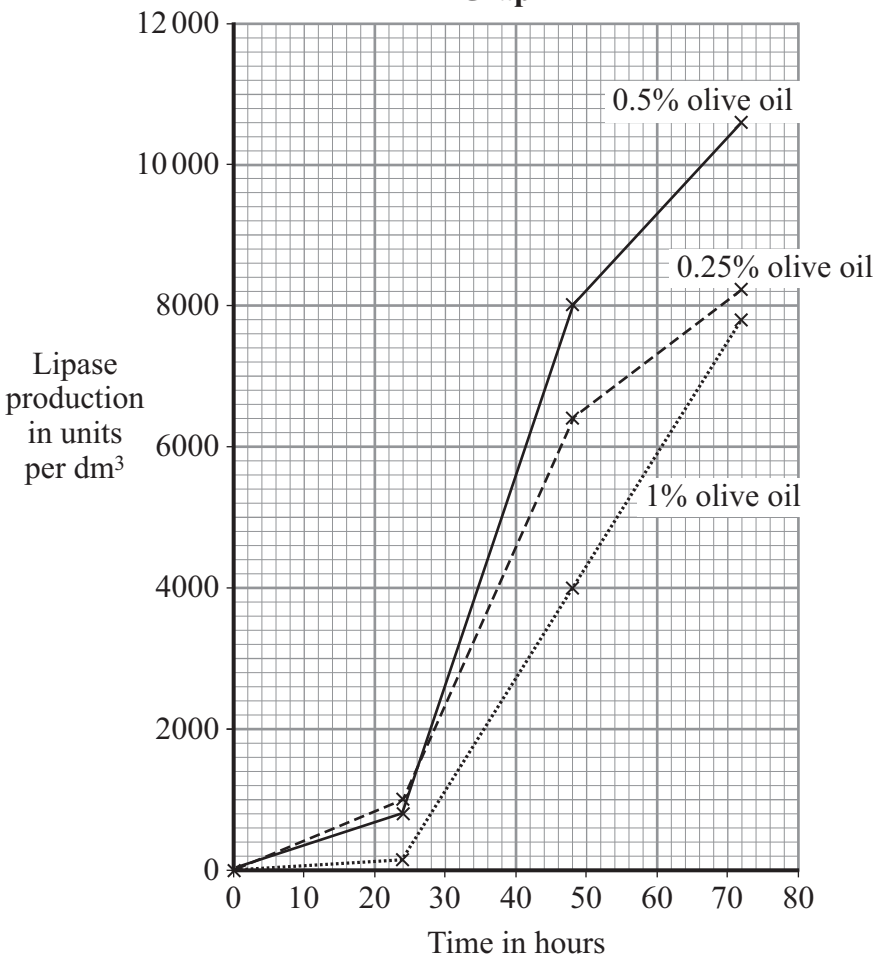


4.7.5.4 Role of biotechnology

Question 05 · continued

for mark

Graph 2



7 (b) (i) From **Graph 2**, calculate the maximum rate of lipase production per hour.

Show clearly how you work out your answer.

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Answer =.....units of lipase per dm^3 per hour
(2 marks)

Question 7 continues on the next page

Question 05 · continued

for mark

7 (b) (ii) Each point plotted on **Graphs 1** and **2** is the mean of three values.

The scientists published only the mean results in their scientific paper. They did not include the actual measured values.

Why would it have been better to have included the actual measured values?

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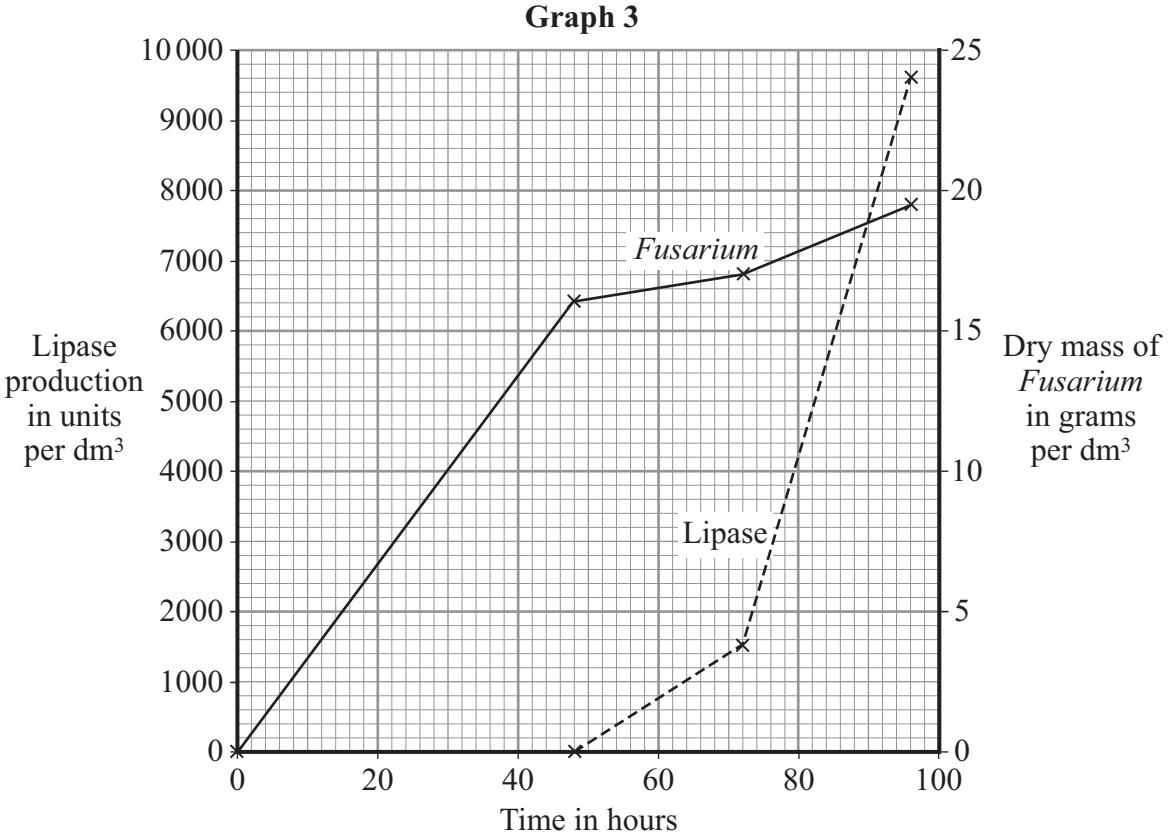
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(2 marks)

7 (c) The scientists then carried out **Investigation 3**.
They used the results of **Investigations 1** and **2** to provide optimum concentrations of protein and olive oil. They measured the dry mass of the *Fusarium* and the amount of lipase produced over 96 hours.

The results of **Investigation 3** are shown in **Graph 3**.

Graph 3



4.7.5.4 Role of biotechnology

Question 05 · continued

for mark

7 (c) (i) Use information from **Graph 3** to describe the relationship between the growth of *Fusarium* and the production of lipase.

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(2 marks)

7 (c) (ii) Suggest an explanation for this relationship.

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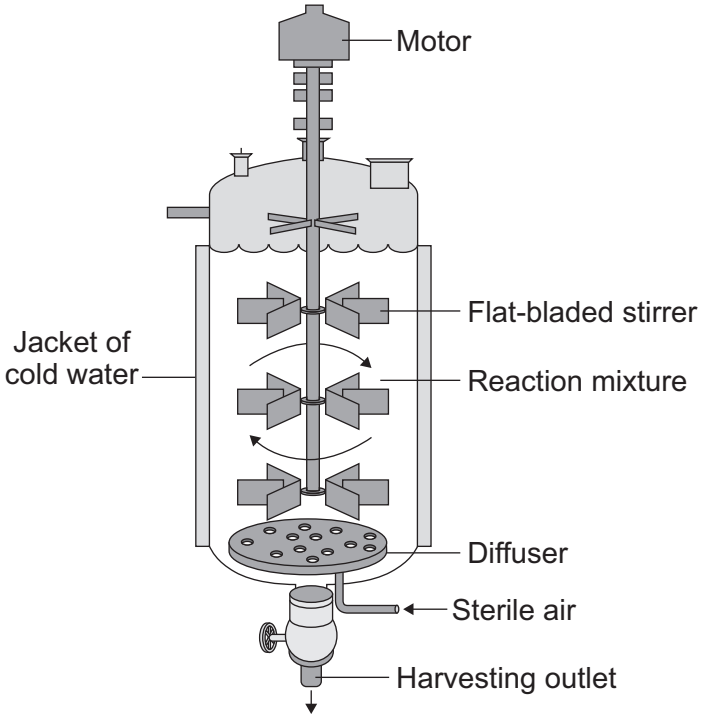
(2 marks)

10

4.7.5.4 Role of biotechnology

Question 06

6 The diagram shows a fermenter.
This fermenter can be used to grow a fungus which makes a protease enzyme.



6 (a) Explain, in detail, why the fermenter needs to be surrounded by a jacket of cold water.

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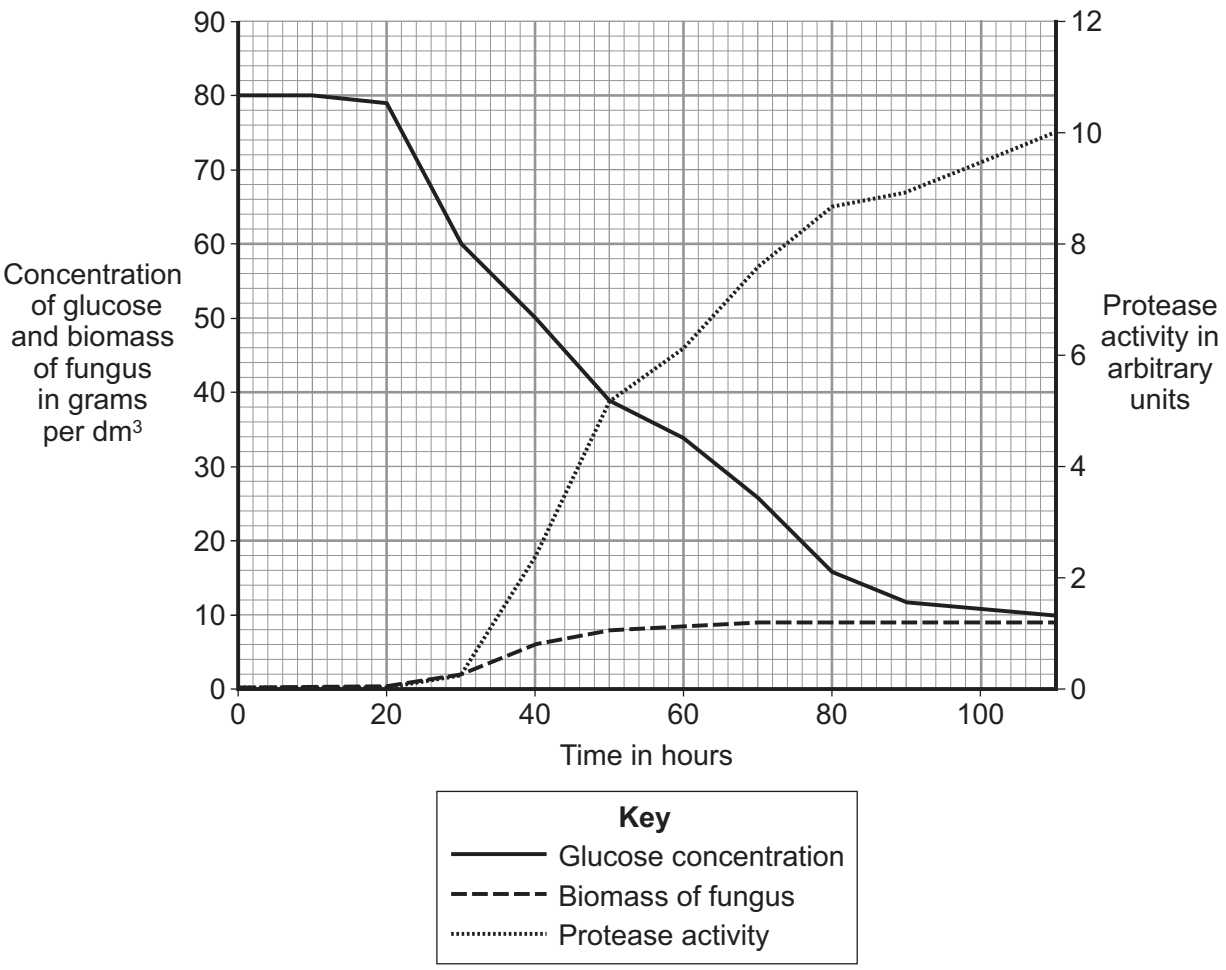
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(3 marks)

Question 6 continues on the next page

Question 06 · continued

6 (b) Scientists investigated the effect of glucose concentration on the growth of the fungus and on the production of the protease enzyme.
The graph shows the results when the glucose concentration in the fermenter at the start was 80 grams per dm^3.



There was no measurable amount of protease activity in the reaction mixture until after 20 hours.

Suggest an explanation for this.

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4.7.5.4 Role of biotechnology

Question 06 · continued

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(4 marks)

6 (c) The scientists repeated the investigation using 40 grams of glucose per dm^3 and using 60 grams of glucose per dm^3.

The table shows all of their results.

Concentration of glucose in grams per dm^3	Yield of fungus biomass in grams per gram of glucose consumed	Protease activity in arbitrary units per gram of glucose consumed	Protease activity in arbitrary units per gram of fungus biomass produced
40	0.09	0.83	8.93
60	0.11	0.22	1.92
80	0.13	0.14	1.11

The scientists plan to set up the fermenter for commercial production of the protease enzyme.

Which concentration of glucose should they use in the fermenter?

..... grams per dm^3

Explain, in detail, why you chose this concentration.

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(2 marks)

9

4.7.5.4 Role of biotechnology

Question 07

June 2011 | BLY3H | Original Q6 | Legacy

6 (a) In industry, microorganisms are grown in fermenters to make useful products.

Name **one** useful product that can be made using microorganisms grown in a fermenter.

.....

(1 mark)

6 (b) Scientists grew one species of bacterium in a fermenter.
The scientists added glucose and other nutrients to the culture medium in the fermenter.

To study the growth of the bacteria, the scientists removed a 1 cm^3 sample of the culture medium from the fermenter once every 5 hours. They added a measured volume of water to dilute the sample by a known amount.

The scientists used two different methods to find the number of bacteria in each sample.

Method A

The scientists:

- added 0.1 cm^3 of the diluted culture to a Petri dish
- poured molten agar into the Petri dish and swirled the dish to mix the contents
- placed the Petri dish in an incubator at 35 °C for 24 hours
- counted the number of colonies of bacteria that had grown in the Petri dish.

Method B

The scientists:

- put some of the diluted sample into a special counting chamber on a microscope
- counted the number of bacteria found in a small volume of the diluted culture.

6 (b) (i) In each method, the scientists diluted the samples that they removed from the fermenter.

Why did they need to do this?

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(1 mark)

4.7.5.4 Role of biotechnology

Question 07 · continued

6 (b) (ii) In **Method A**, the scientists counted colonies of bacteria that had grown in a Petri dish. Explain how counting colonies helped the scientists to find the number of bacteria in a sample.

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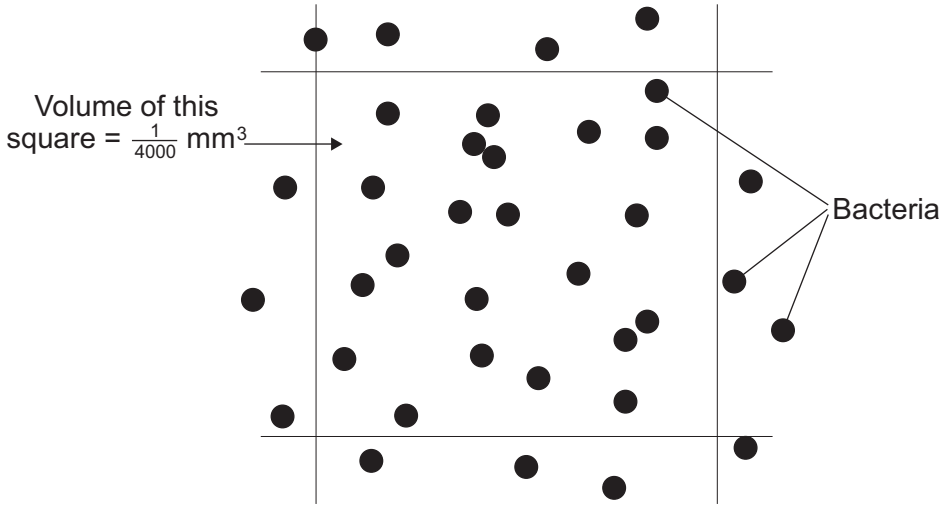
(2 marks)

6 (c) The scientists wanted to find the number of bacteria in a sample of culture medium by using **Method B**.

The sample of culture medium was diluted to $\frac{1}{100}$ of its original concentration.

The diluted sample was then placed in the counting chamber.

The diagram shows part of the counting chamber as seen under a microscope.



Complete the following calculations to find how many bacteria there were in 1 mm^3 of the undiluted sample of culture medium.

Use information from the diagram.

Number of bacteria in $\frac{1}{4000}$ mm^3 of **diluted** culture medium = ...

Number of bacteria in 1 mm^3 of **diluted** culture medium = ...

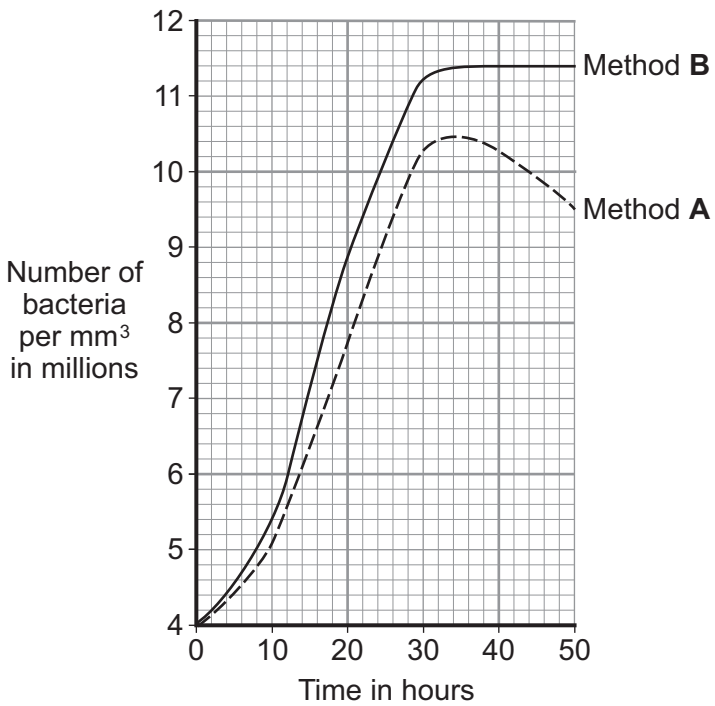
Number of bacteria in 1 mm^3 of **undiluted** culture medium = ...

(2 marks)

Question 6 continues on the next page

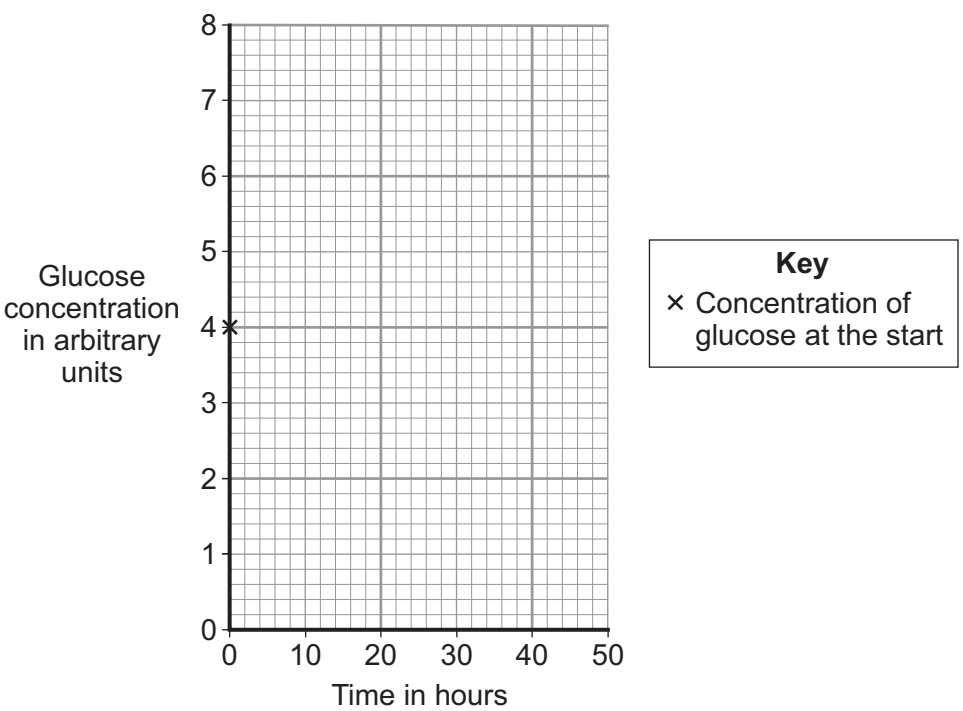
6 (d) The scientists grew the bacteria for 50 hours.
Graph 1 shows the scientists' results.

Graph 1



Graph 2 is not complete.
The concentration of glucose in the fermenter at the start of the investigation was 4 units.

Graph 2



4.7.5.4 Role of biotechnology

Question 07 · continued

6 (d) (i) **On Graph 2**, draw a line to show how the glucose concentration would change over the 50 hours of the investigation.

(2 marks)

6 (d) (ii) Explain the shape of the growth curve that was obtained using **Method A**.

Use information from your answer to part (d)(i).

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(3 marks)

6 (d) (iii) Why did **Method B** give higher values for the number of bacteria than **Method A**?

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(1 mark)

12

4.7.5.4 Role of biotechnology

Question 08

June 2014 | BL1HP | Original Q8 | Legacy

8 Read the information.

> Insects can be both useful and harmful to crop plants.
> Insects such as bees pollinate the flowers of some crop plants. Pollination is needed for successful sexual reproduction of crop plants.
> Some insects eat crops and other insects eat the insects that eat crops.
>
> Corn borers are insects that eat maize plants.
> A toxin produced by the bacterium *Bacillus thuringiensis* kills insects.
> Scientists grow *Bacillus thuringiensis* in large containers. The toxin is collected from the containers and is sprayed over maize crops to kill corn borers.
>
> A company has developed genetically modified (GM) maize plants. GM maize plants contain a gene from *Bacillus thuringiensis*. This gene changes the GM maize plants so that they produce the toxin.

8 (a) Describe how scientists can transfer the gene from *Bacillus thuringiensis* to maize plants.

[3 marks]

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4.7.5.4 Role of biotechnology

Question 08 · continued

8 (b) Would you advise farmers to grow GM maize plants?

Justify your answer by giving advantages and disadvantages of growing GM maize plants.

Use the information from the box and your own knowledge to help you.

[4 marks]

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4.7.5.4 Role of biotechnology

Question 09

June 2015 | BL3HP | Original Q1 | Legacy

1 The world population is increasing and the need for food is increasing.

Mycoprotein is a high-protein food made in fermenters using the organism *Fusarium*.

The process takes only a few weeks to produce a large amount of food.

1 (a) (i) What type of organism is *Fusarium*?

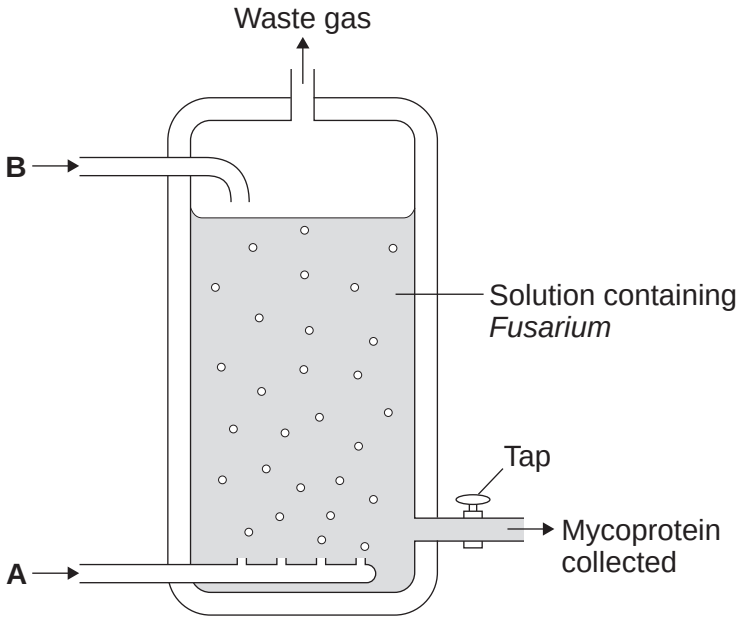
Draw a ring around the correct answer.

[1 mark]

bacterium **fungus** **virus**

Figure 1 shows a fermenter used in mycoprotein production.

Figure 1



1 (a) (ii) *Fusarium* makes mycoprotein. *Fusarium* respires aerobically.

Suggest which gas is added to the fermenter at point **A**.

[1 mark]

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4.7.5.4 Role of biotechnology

Question 09 · continued

1 (a) (iii) Another substance is added to the fermenter at point **B**. This substance is used in aerobic respiration.

Name this substance.

[1 mark]

.....

1 (b) People need to eat protein to grow and to be healthy.

Some people think that it would be an advantage to get more food from mycoprotein and less from farming animals.

Suggest **two** possible advantages of getting more food from mycoprotein.

[2 marks]

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2 .....

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5

4.7.5.4 Role of biotechnology

Question 10

June 2016 | BL3HP | Original Q9 | Legacy

9 **Figure 8** shows some information about 'stem cell burgers'.

Figure 8

The first laboratory burger has now been cooked

In July 2013 the first burger grown from cow stem cells was cooked.

Muscle stem cells from cows were grown into strands of beef in a laboratory. About 20 000 strands of beef were then made into a burger. The burger can be cooked and eaten by humans. This type of meat is called cultured meat.

The cultured meat is exactly the same as normal cow muscle tissue and the cells are not genetically modified.

9 (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.

[2 marks]

1 _____

_____

2 _____

_____

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

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

[2 marks]

1 _____

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2 _____

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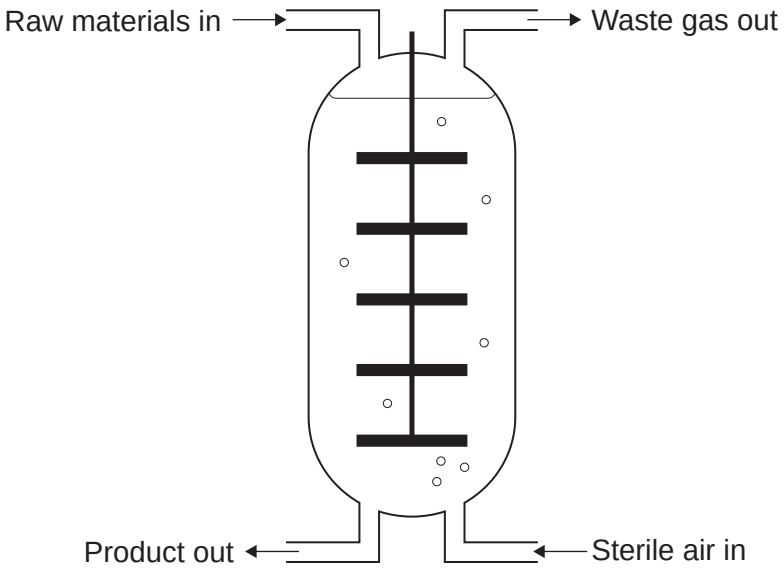
4.7.5.4 Role of biotechnology

Question 10 · continued

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

Figure 9 shows a fermenter used to produce mycoprotein.

Figure 9



Describe how mycoprotein is produced.

[4 marks]

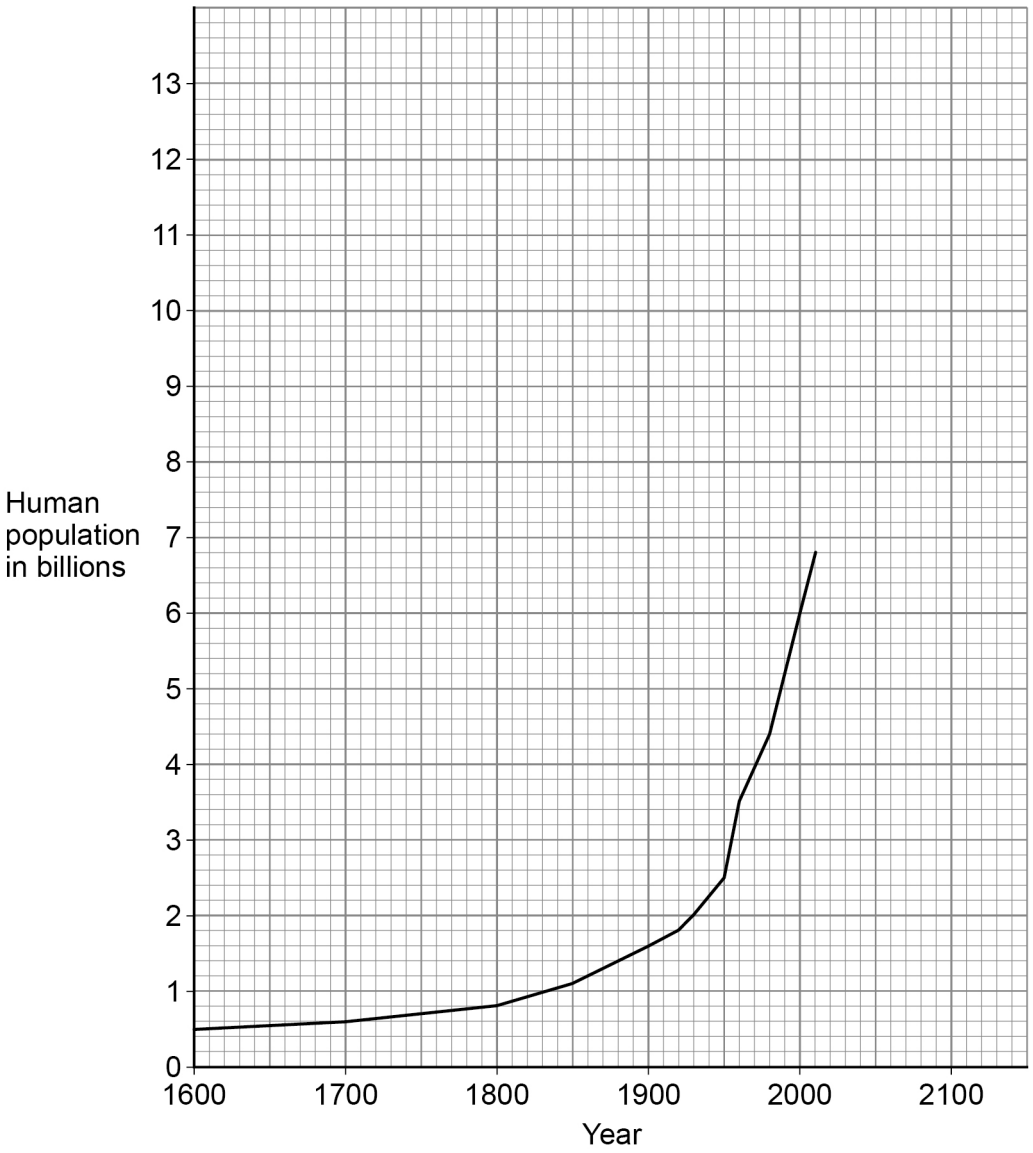
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4.7.5.4 Role of biotechnology

Question 11

0 2 **Figure 2** shows the human population from 1600 to 2010.

Figure 2



In 1900 the human population was 1.6 billion.

0 2 . 1 Calculate how many times greater the human population was in the year 2000 compared with the year 1900.

[2 marks]

Number of times greater = _____

4.7.5.4 Role of biotechnology

Question 11 · continued

0 2 . 2 In 1950 the human population was 2.5 billion.

Calculate the mean annual increase in the human population between 1900 and 1950.

[2 marks]

Mean annual increase = _____ billion per year

0 2 . 3 Predict the human population in 2050 if the current rate of population increase continues.

You should draw an extrapolation line on **Figure 2**.

[2 marks]

Predicted human population = _____

0 2 . 4 The increasing human population has caused a decline in fish stocks.

Describe how fishing quotas can help to return fish stocks to a sustainable level.

[2 marks]

Question 2 continues on the next page

4.7.5.4 Role of biotechnology

Question 11 · continued

0 2 . 5 Farming techniques have changed in recent years.

Describe:

- why more land is being used for farming
- how increased farming has decreased biodiversity.

[6 marks]

4.7.5.4 Role of biotechnology

Question 11 · continued

0 2 . 6 Genetic modification of crop plants can help meet the demands of the increasing human population.

Golden rice is a genetically modified (GM) crop.

What is the advantage of golden rice compared with non-GM rice?

[1 mark]

Tick (✓) **one** box.

Golden rice contains protein-rich mycoprotein ☐

Golden rice has improved nutritional value ☐

Golden rice produces human insulin ☐

0 2 . 7 Suggest **one** reason why some people are concerned about the use of golden rice.

[1 mark]

_____

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16