Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____
I declare this is my own work.

A-level
BIOLOGY

Paper 1

Wednesday 7 June 2023 Afternoon Time allowed: 2 hours

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 91.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Do not write outside the box

Answer **all** questions in the spaces provided.

0 1 . 1 Give the **three** structural features found in **all** virus particles **and** describe the function of **one** of these features.

[2 marks]

1 _____

2 _____

3 _____

Function of **one** named feature _____

_____

_____

_____

0 1 . 2 Explain why viruses are described as acellular and non-living.

[2 marks]

_____

_____

_____

_____

_____

_____

0 1 . 3 Give **one** reason why antibiotics are **not** effective against viruses.

[1 mark]

_____

_____

_____

5

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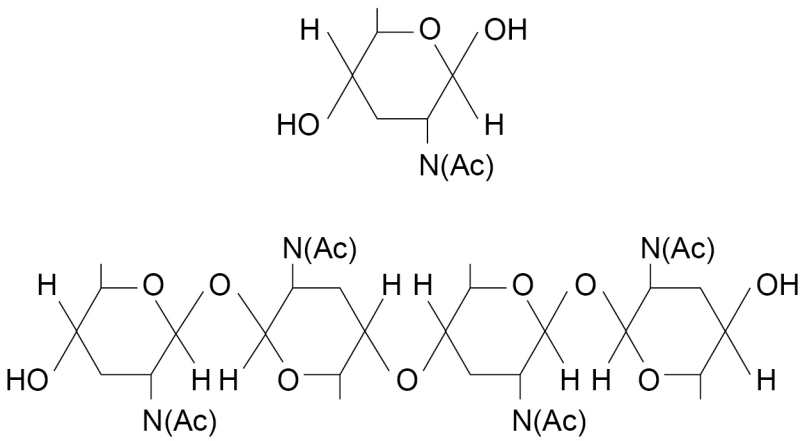
0 2 . 1 Chitin is a polysaccharide. The chitin monomer is a β-glucose molecule with one OH group replaced by an $NHCOCH_3$ group. $NHCOCH_3$ can be represented by N(Ac).

Figure 1 shows the monomer that forms chitin and the chitin polymer.

Figure 1



Chitin has a similar structure to cellulose.

Use **Figure 1** to describe **three** ways the structure of chitin is similar to the structure of cellulose.

[3 marks]

1 _____

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2 _____

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3 _____

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_____

Question 2 continues on the next page

Do not write outside the box

0 2 . 2 Chitin keeps the tracheae open in the tracheal system of gas exchange in an insect. Gas exchange does **not** occur in the tracheae.

Explain the importance of **one** adaptation of the gas exchange surface in the tracheal system of an insect.

[2 marks]

0 2 . 3 Lignin is a polymer found in the walls of xylem vessels in plants. Lignin keeps the xylem vessel open as a continuous tube.

Explain the importance of the xylem being kept open as a continuous tube.

[3 marks]

8

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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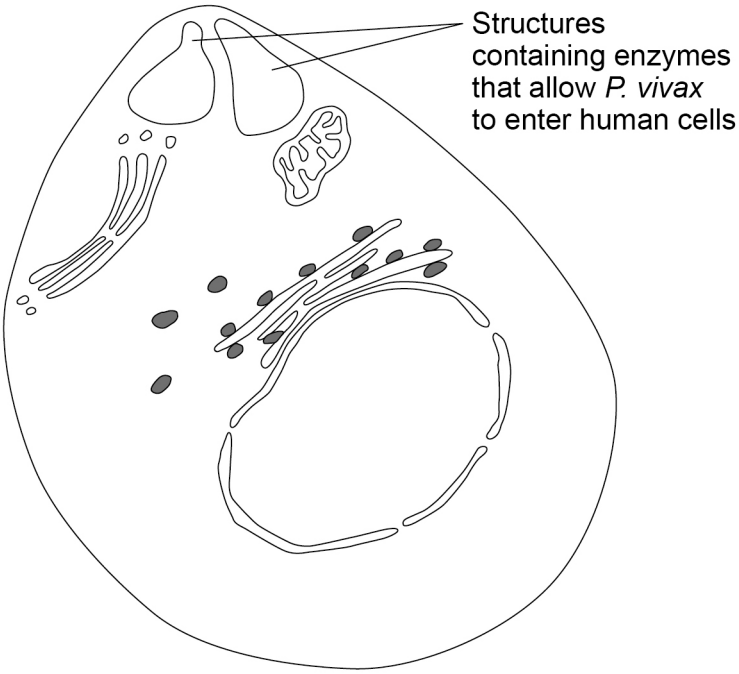
0 3 . 1 The human disease, malaria, is caused by infection with a single-celled eukaryotic organism.

Figure 2 shows a diagram of *Plasmodium vivax*, one of the species that can cause malaria.

Figure 2



Other than the Golgi apparatus, name **one** structure in **Figure 2** which shows that *P. vivax* is a eukaryote.

[1 mark]

_____

_____

0 3 . 2 Describe **two** functions of the Golgi apparatus in a eukaryotic cell.

[2 marks]

1 _____

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2 _____

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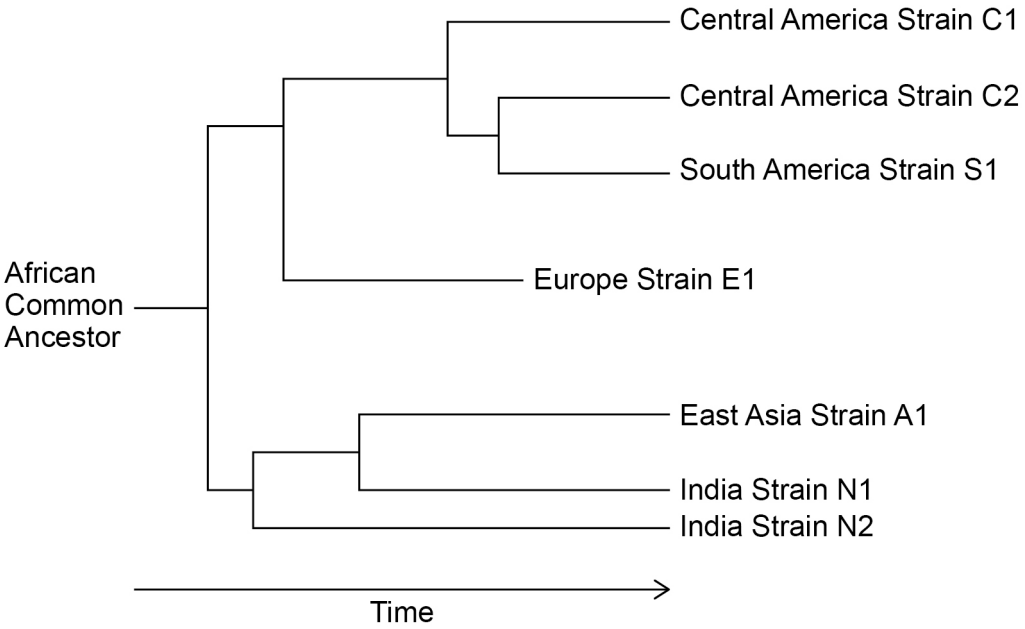
P. vivax evolved from a common ancestor in Africa. As humans migrated around the world, new strains of *P. vivax* evolved.

P. vivax is now extremely rare in Africa but there are several different strains of *P. vivax* in other parts of the world.

Figure 3 shows a phylogenetic diagram of the evolution of these different strains.

Figure 3



0 3 . 3 What does **Figure 3** suggest is the order of human migration out of Africa?

Tick (✓) **one** box.

[1 mark]

Europe, India, East Asia, Central America, South America ☐

India, East Asia, Europe, South America, Central America ☐

India, Europe, East Asia, Central America, South America ☐

South America, Central America, East Asia, Europe, India ☐

Question 3 continues on the next page

Do not write outside the box

0 3 . 4 There are an estimated 229 million cases of human malaria worldwide per year. 94% of these cases are found in Africa, but are not caused by *P. vivax*. *P. vivax* does cause 61% of the cases of human malaria outside Africa.

Use this information to calculate the number of cases worldwide caused by *P. vivax* each year.

[1 mark]

Answer _____ cases of malaria

0 3 . 5 In Africa today, most of the human population are resistant to malaria caused by *P. vivax*.

Use your knowledge of natural selection to explain why this resistance is so common in Africa.

[4 marks]

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9

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0 4 . 1 Some hospital patients suffer from diarrhoea caused by infection with the bacterium *Clostridium difficile*. The *C. difficile* bacteria release toxins. These toxins cause the diarrhoea.

The toxins damage the cells lining the ileum, causing them to lose their microvilli. The damage to the cells reduces the absorption of the products of digestion and reduces the absorption of water, resulting in diarrhoea.

Explain why the damage to the cells lining the ileum reduces absorption of the products of digestion **and** why this reduces absorption of water.

[3 marks]

Question 4 continues on the next page

Do not write outside the box

Not all patients in hospital with *C. difficile* develop diarrhoea.

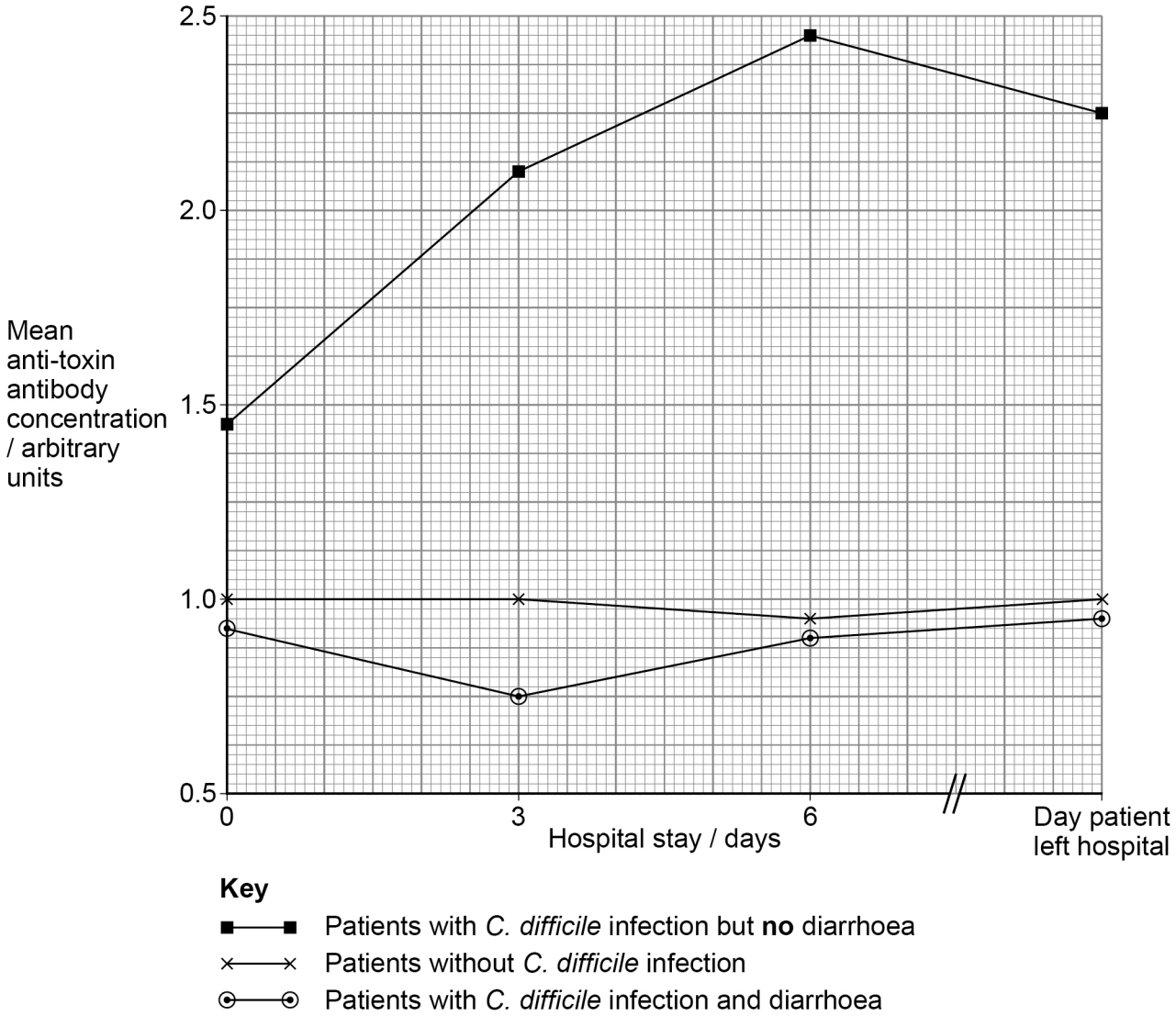
Scientists measured the anti-toxin antibody concentration in hospital patients with and without *C. difficile* infection.

They measured the anti-toxin antibody concentration **four** times:

- on admission to hospital (day 0)
- on day 3
- on day 6
- on the day the patient left the hospital.

Figure 4 shows the scientists' results.

Figure 4



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0 4 . 2 The scientists suggest that the anti-toxin antibody could be given to some patients as a form of passive immunity.

Use **Figure 4** to suggest how this passive immunity would work **and** which patients should be offered this anti-toxin antibody.

[3 marks]

0 4 . 3 To be used as passive immunity treatment, the anti-toxin antibody would be injected. If it was given by mouth, it would be digested.

Describe how the anti-toxin antibody would be digested.

[3 marks]

9

Turn over for the next question

Do not write outside the box

0 5 A student investigated the use of cinnamon oil as an antimicrobial substance. She investigated the effect of cinnamon oil on the growth of five different bacterial cultures grown on agar plates.

0 5 . 1 The student added 100 mm^3 of each bacterial culture from its glass bottle onto a separate agar plate. She spread each bacterial culture evenly over the agar using a spreader.

Describe the aseptic techniques she should use.

[3 marks]

Do not write outside the box

0 5 . 2 On each agar plate, the student cut a well (a hole) in the agar.

The well had a diameter of 6 mm. The student added 50 mm^3 of cinnamon oil into the well.

Calculate the minimum depth of the well to allow the addition of 50 mm^3 of cinnamon oil.
Use the following equation in your calculation:

$$\text{Volume of a cylinder} = \pi r^2 \times l$$

Use 3.14 as the value for π.

Show your working.

[2 marks]

Answer _____ mm

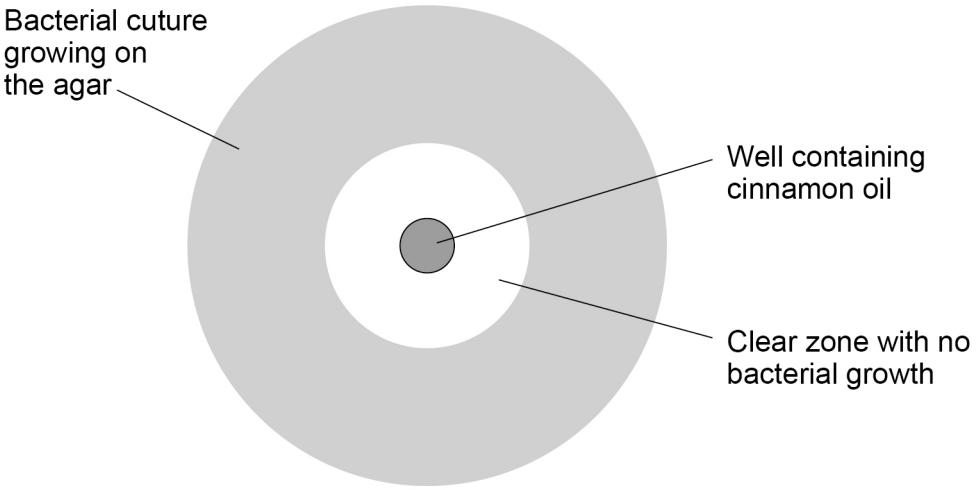
Question 5 continues on the next page

Do not write outside the box

The student kept the plates at 25 °C for 24 hours.

Figure 5 shows what one of her plates looked like after 24 hours.

Figure 5



The student measured the diameter of the clear zone with no bacterial growth around each well. She made these measurements to the nearest whole mm

Table 1 shows her results.

Table 1

Bacterial culture	**Diameter of clear zone / mm**		
	Cinnamon oil	Positive control	Negative control
Bacillus spp.	15	14	0
Staphylococcus aureus	20	17	0
Listeria monocytogenes	18	12	0
Escherichia coli	16	12	0
Klebsiella spp.	14	12	0
Median for all cultures			0
Mean for all cultures			0
Standard deviation for all cultures	2.4	2.2	0

Do not write outside the box

0 5 . 3 Suggest exactly what the student added to the wells to get the positive control **and** negative control results.

[2 marks]

0 5 . 4 Complete **Table 1** to show the median and mean diameters.

[1 mark]

0 5 . 5 The mean ± 2 standard deviations includes over 95% of the data.

Use this information to consider whether the standard deviations suggest the differences in means are likely to be due to chance.

Explain your answer, including at least **one** calculation.

[2 marks]

10

Turn over for the next question

Do not write outside the box

0 6 . 1 Define genome and proteome.

[2 marks]

Genome _____

_____

_____

Proteome _____

_____

_____

The classification system used in the early 20th century grouped different species of bacteria according to the position and shape of flagella on bacterial cells and by the number of flagella per cell. These were observed using an optical microscope.
Each species of bacterium has a characteristic cell shape and arrangement of flagella.
These characteristics may be shared with other species within a genus.
Flagella are fragile, difficult to stain and may extend from the cell at any angle.

0 6 . 2 Consider the accuracy and limitations of the early classification of bacteria using the arrangement of flagella.

[3 marks]

_____

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Do not write outside the box

0 6 . 3 Suggest why several bacterial species have been renamed in recent years.

[1 mark]

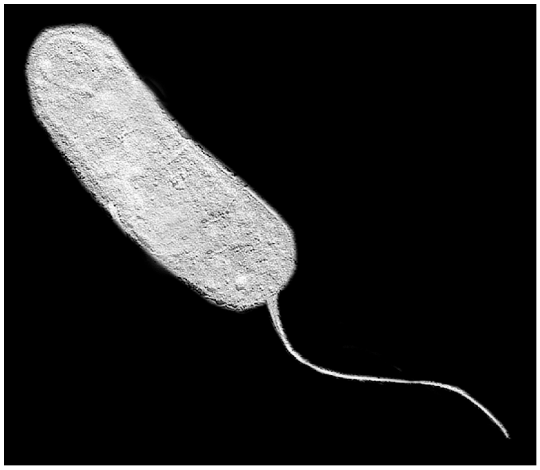
_____

_____

_____

0 6 . 4 **Figure 6** shows an image from an optical microscope of a single bacterial cell.

Figure 6



This bacterial cell is 2.3 μm long (excluding the flagellum).

Calculate the magnification of this image.

Show your working.

[2 marks]

Magnification × _____

8

Turn over for the next question

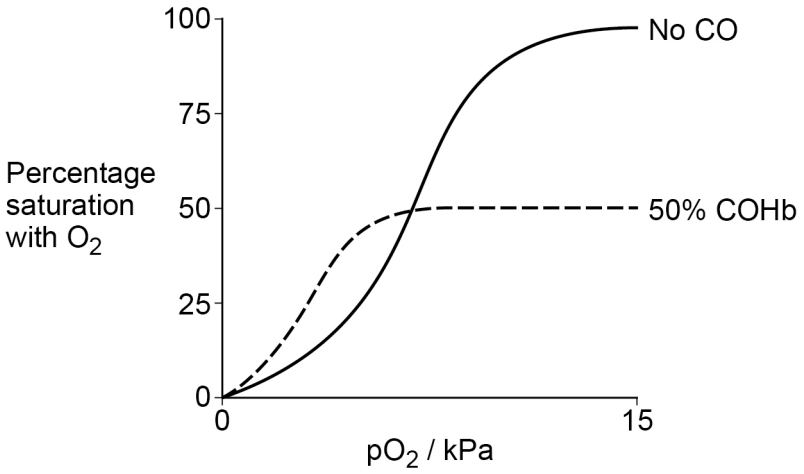
Do not write outside the box

0 7 . 1 Carbon monoxide (CO) is released during incomplete combustion of fossil fuels.

Figure 7 shows the dissociation curve for oxyhaemoglobin when:

- **not** exposed to CO
- exposed to CO such that 50% of the oxygen binding sites are occupied by CO (50% COHb).

Figure 7



Using **Figure 7**, what can you conclude about how exposure to CO affects the loading and unloading of oxygen by haemoglobin?

Explain your answer.

[3 marks]

Do not write outside the box

0 7 . 2 The World Health Organisation (WHO) suggests that to avoid long-term health effects, COHb concentrations should be kept below 2.5%.

WHO recommends that people should not be exposed to:

- air with > 10 mg m^{-3} CO for more than 8 hours
- air with > 30 mg m^{-3} CO for more than 1 hour.

Scientists have used a mathematical model to calculate the exposure to carbon monoxide that would result in 2.5% COHb in both adults and children.

Table 2 shows the scientists' results.

Table 2

Exposure duration at rest / hours	**CO concentration in the air / mg m^{-3} resulting in 2.5% COHb**	
	Child	Adult
1	31.2	40.2
8	9.6	10.6

The scientists suggest that the WHO recommendations for carbon monoxide concentrations resulting in 2.5% COHb should be reduced.

Evaluate the scientists' conclusion.

[3 marks]

6

Turn over for the next question

Do not write outside the box

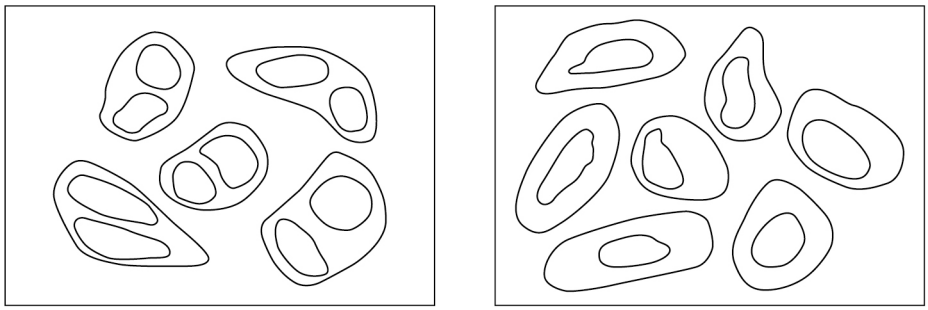
0 8 . 1 Scientists investigated a drug called MiTMAB as a treatment for cancer. MiTMAB inhibits cytokinesis.

Figure 8 shows drawings of cancer cells seen with an optical microscope from a:

- sample treated with MiTMAB
- control sample.

Figure 8

A **B**



The cells in drawing **A** can be identified as those treated with MiTMAB.

Explain why.

[2 marks]

Do not write outside the box

0 8 . 2 MiTMAB acts as a non-competitive inhibitor of an enzyme called dynamin.

Suggest how MiTMAB can cause dynamin to become inactive.

[3 marks]

Question 8 continues on the next page

Do not write outside the box

When active, dynamin has **two** functions:

- it stimulates cytokinesis
- it inhibits cell death.

The scientists treated actively growing cultures of cancer cells with MiTMAB.

They incubated:

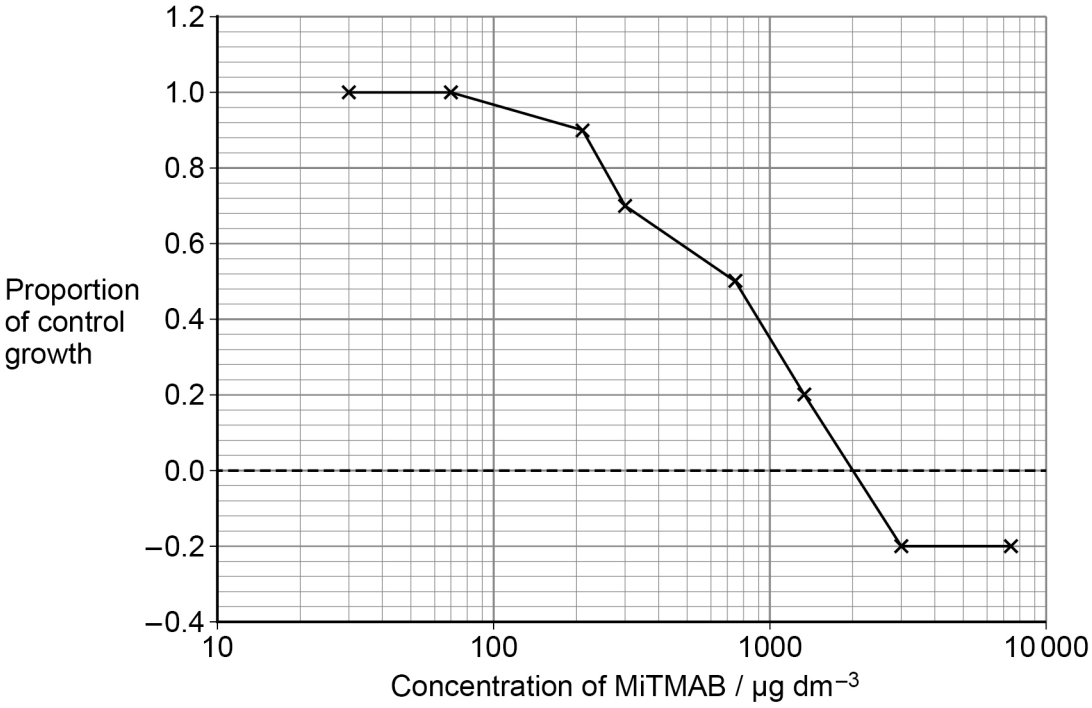
- one sample of 2500 cells without MiTMAB as a control
- eight samples, each with 2500 cells and a different concentration of MiTMAB.

After 72 hours, the scientists measured the number of cells in each sample.

Figure 9 shows the scientists' results.

A negative value for proportion of control growth means that fewer than 2500 cells were counted after 72 hours.

Figure 9



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0 8 . 3 Use all the information given to explain the results shown in **Figure 9**.

[3 marks]

0 8 . 4 0.01 dm^3 of MiTMAB solution was added to the treated cells.

Calculate the increase in mass of MiTMAB (in µg) added to the cells to reduce the cell growth from equal to the control to 0.0 of the control.

Show your working.

[2 marks]

Answer _____ µg

10

Turn over for the next question

Do not write outside the box

0 9 Dengue fever is a human disease caused by the dengue virus.

Scientists designed an ELISA test to detect antibodies to the dengue virus in a patient's blood sample.

Figure 10 shows a diagram of this test and some information about how it works.

Figure 10

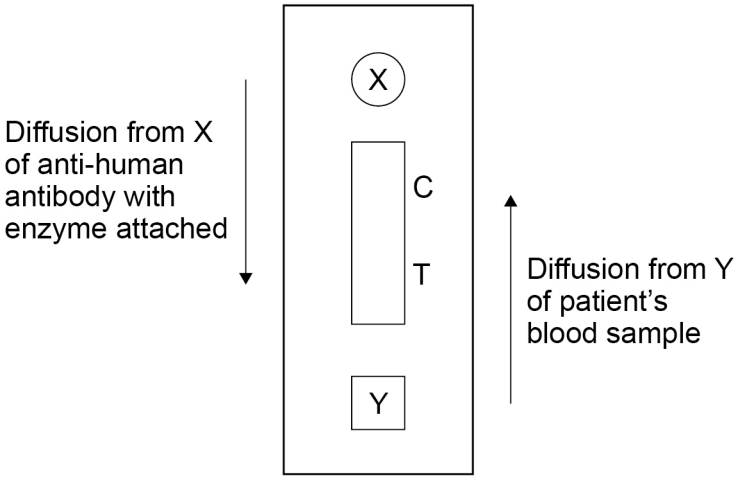
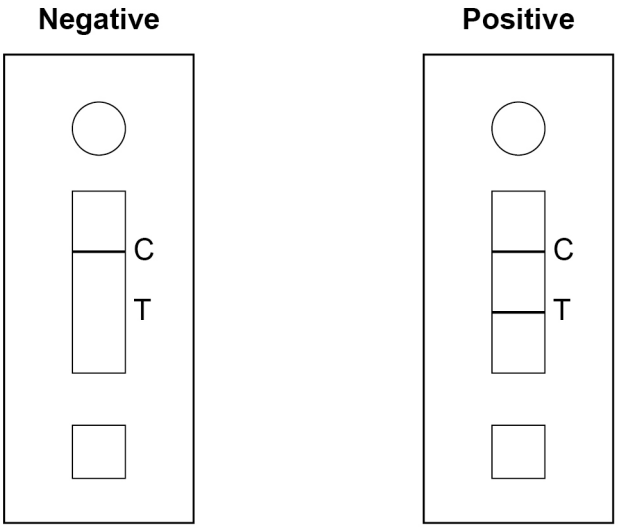


Figure 11 shows the negative and positive results that were produced 20 minutes after the use of the test shown in **Figure 10**.

Figure 11



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0 9 . 1 Suggest what is on the test at line **T** and explain what causes the line to appear in a positive test.

[2 marks]

0 9 . 2 A line at **C** shows that the test has worked.

Suggest **one** reason why a line at **C** shows the test has worked.

[1 mark]

Question 9 continues on the next page

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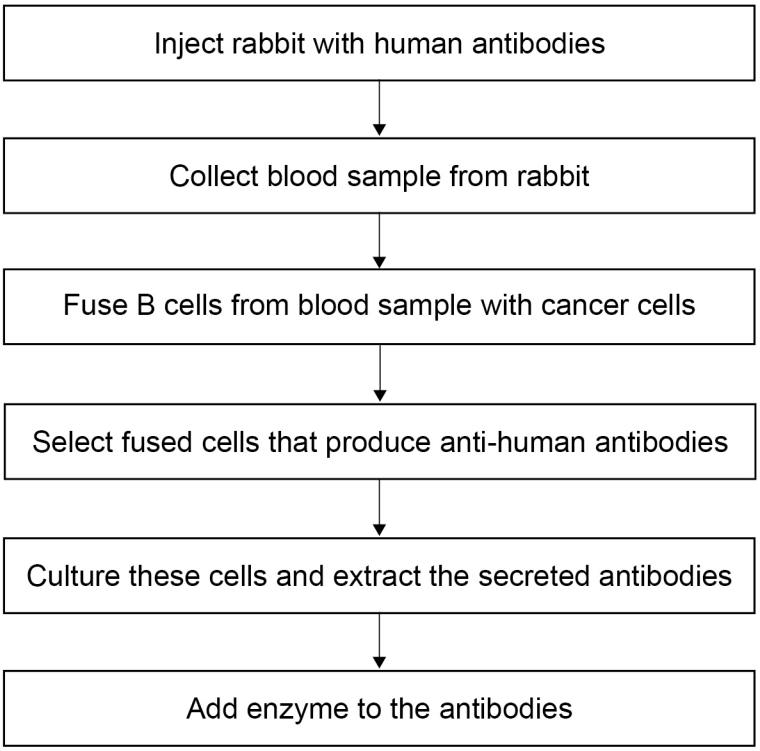
Figure 12 shows a flowchart of how the anti-human antibodies with enzyme attached are produced.

Figure 12



0 9 . 3 Suggest why the fused cells allow continuous production of monoclonal antibodies.

[2 marks]

0 9 . 4 Evaluate the ethics of the production process shown in **Figure 12**.

[1 mark]

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Question 9 continues on the next page

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ANSWER IN THE SPACES PROVIDED

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Early identification of dengue fever can be difficult as many other diseases produce the same symptoms. Early identification is important because people suffering with dengue fever can become ill very quickly and may need hospital treatment.

Scientists compared the effectiveness of three diagnostic tests for dengue fever.

- Laboratory-based test – a patient's blood sample is sent from the doctor's clinic to a laboratory for testing.
- Current test used in the doctor's clinic.
- New test to be used in the doctor's clinic – the ELISA test shown in **Figures 10** and **11** (on page 24).

The scientists' results are shown in **Table 3**.

A blood sample from each patient with confirmed dengue fever at each time after onset of symptoms was tested with all three diagnostic tests.

Table 3

Time after onset of symptoms / days	**Number of confirmed dengue fever patients tested**	**Number of positive results**		
		Laboratory-based test	Current test	New test
1–2	14	10	0	6
3–4	38	28	6	24
5–7	18	8	14	14

Do not write outside the box

0 9 . 5 The scientists recommend that the new test is used for the identification of dengue fever in all countries around the world.

Discuss this recommendation. Use all the information given.

[3 marks]

0 9 . 6 The dengue virus causes damage to capillaries so that blood proteins move out of the capillaries into the tissue fluid.

Explain how this would affect the return of tissue fluid into the capillaries.

[2 marks]

11

Turn over for the next question

Do not write outside the box

1 0 . 1 Describe how a quaternary protein is formed from its monomers.

Do not include the process of translation in your answer.

[5 marks]

Do not write outside the box

1 0 . 2 Describe the structure of DNA and the structure of a chromosome.

[6 marks]

Question 10 continues on the next page

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1 0 . 3 Mutation can result in an increase in genetic variation within a species.

Describe and explain the **other** processes that result in increases in genetic variation within a species.

[4 marks]

15

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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Question number	Additional page, if required. Write the question numbers in the left-hand margin.

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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Question number	Additional page, if required. Write the question numbers in the left-hand margin.

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