



Surname _____

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Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

BIOLOGY

Paper 1

7402/1

Wednesday 7 June 2023

Afternoon

Time allowed: 2 hours

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]



JUN237402101

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MATERIALS

For this paper you must have:

- **a ruler with millimetre measurements**
- **a scientific calculator.**

INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions.**
- **You must answer the questions in the spaces provided. Do not write 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.**

DO NOT TURN OVER UNTIL TOLD TO DO SO



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

01.2

**Explain why viruses are described as acellular and non-living.
[2 marks]**

[Turn over]



0	1	.	3
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Give ONE reason why antibiotics are NOT effective against viruses. [1 mark]

5



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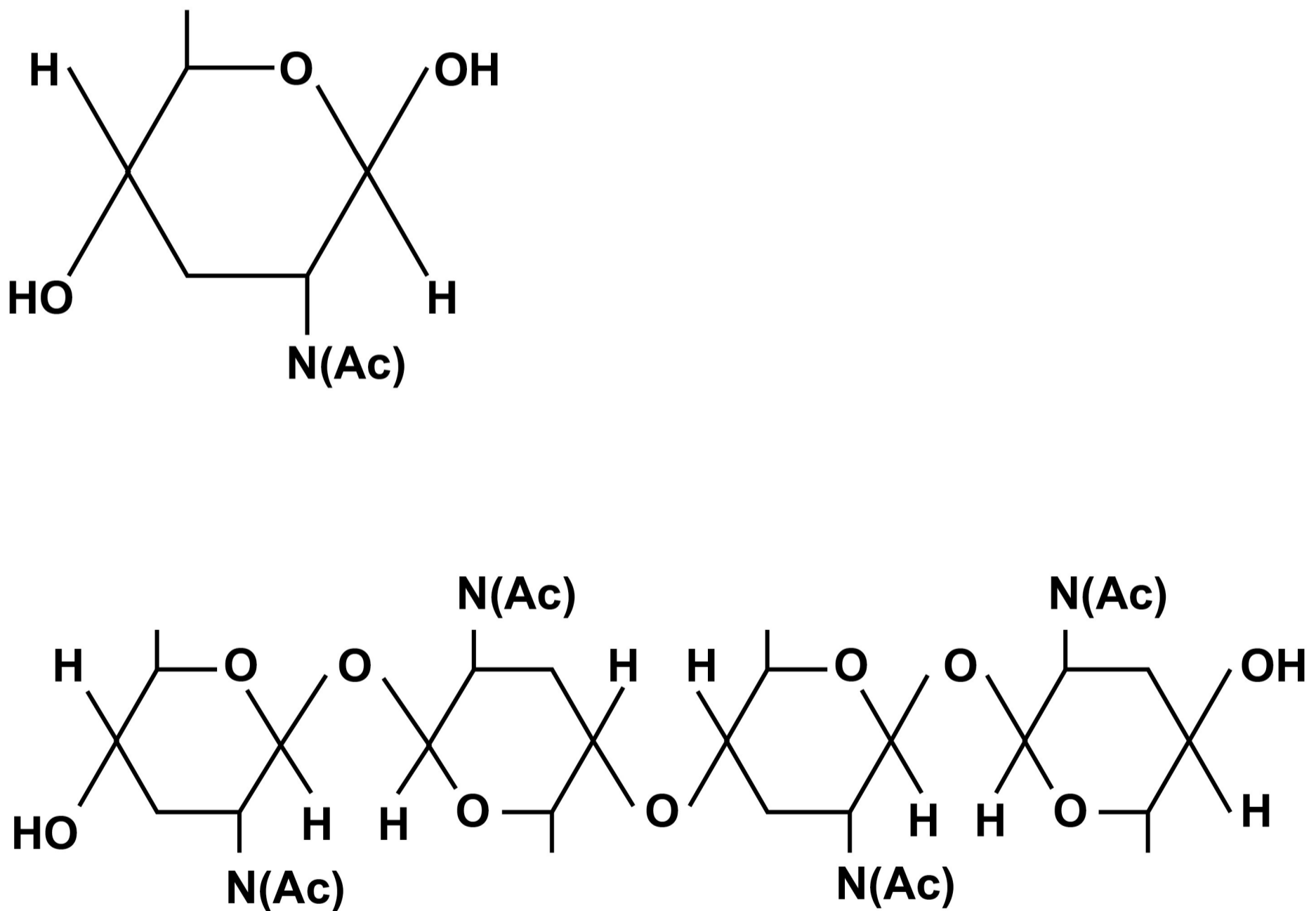


02.1

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 _____

2 _____

3 _____

[Turn over]



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

FIGURE 2, on the opposite page, shows a diagram of 'Plasmodium vivax', one of the species that can cause malaria.

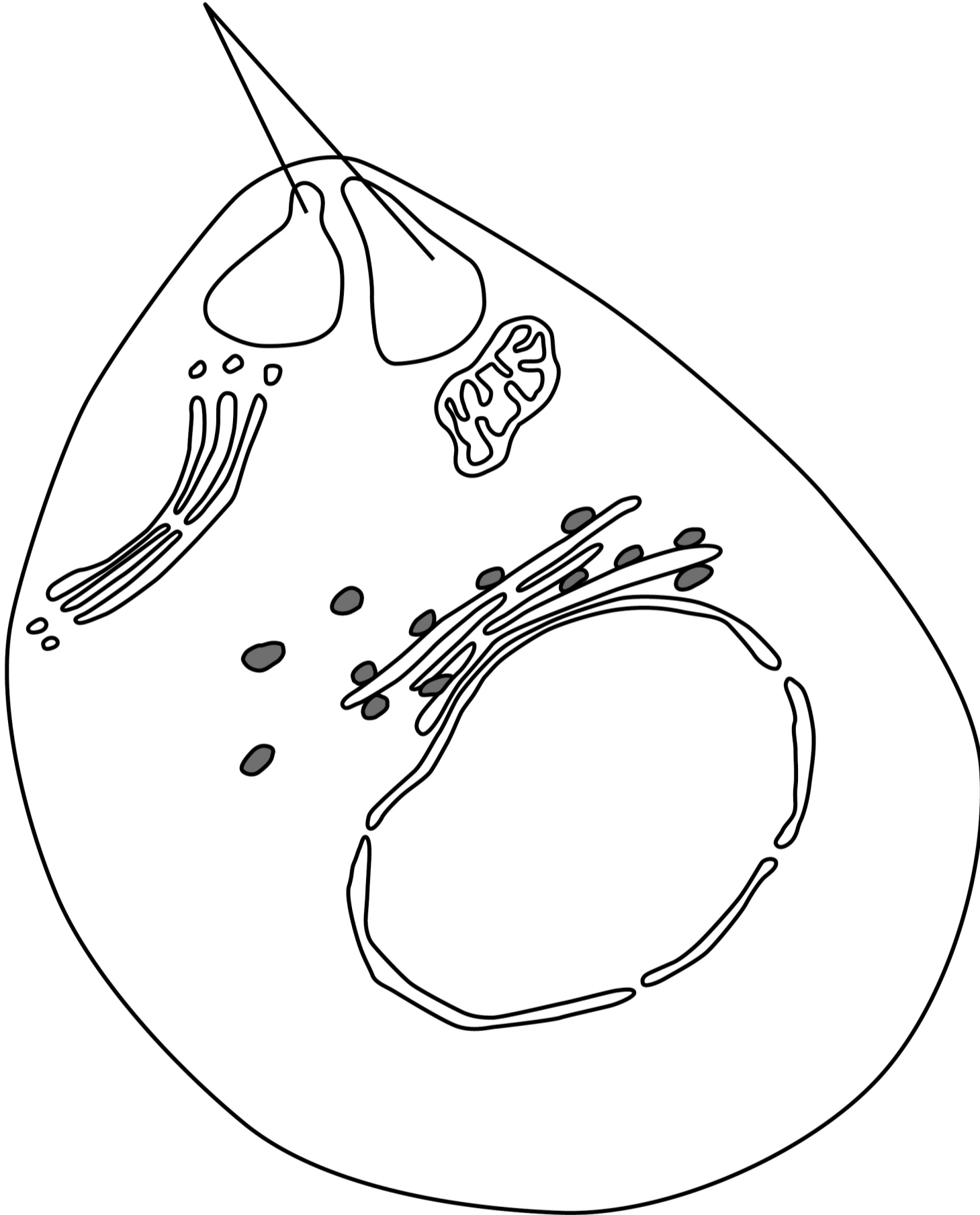
Other than the Golgi apparatus, name **ONE** structure in **FIGURE 2** which shows that 'P. vivax' is a eukaryote.

[1 mark]



FIGURE 2

Structures
containing enzymes
that allow '*P. vivax*'
to enter human cells



[Turn over]



03.2

Describe TWO functions of the Golgi apparatus in a eukaryotic cell. [2 marks]

1 _____

2 _____

'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, on page 16, shows a phylogenetic diagram of the evolution of these different strains.

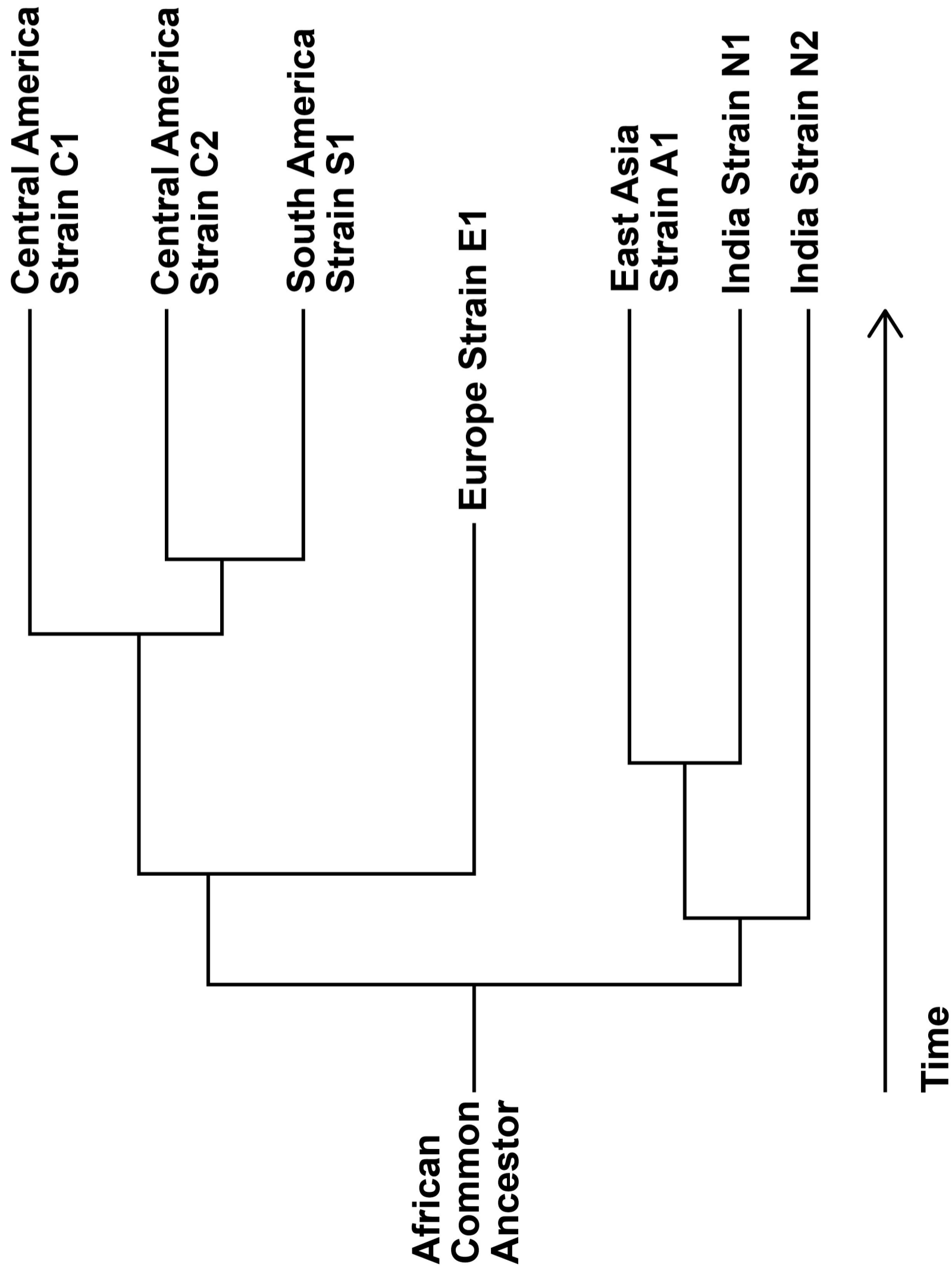
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1 6

FIGURE 3



**African
Common
Ancestor**

**Central America
Strain C1**

**Central America
Strain C2**

**South America
Strain S1**

Europe Strain E1

**East Asia
Strain A1**

India Strain N1

India Strain N2

Time



03.3

What does FIGURE 3 suggest is the order of human migration out of Africa? [1 mark]

Tick (✓) ONE box.

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

[Turn over]

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0	3	.	4
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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

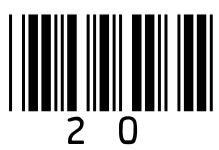
[Turn over]



03.5

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]



[Turn over]

9



[Turn over]



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, on page 26, shows the scientists' results.



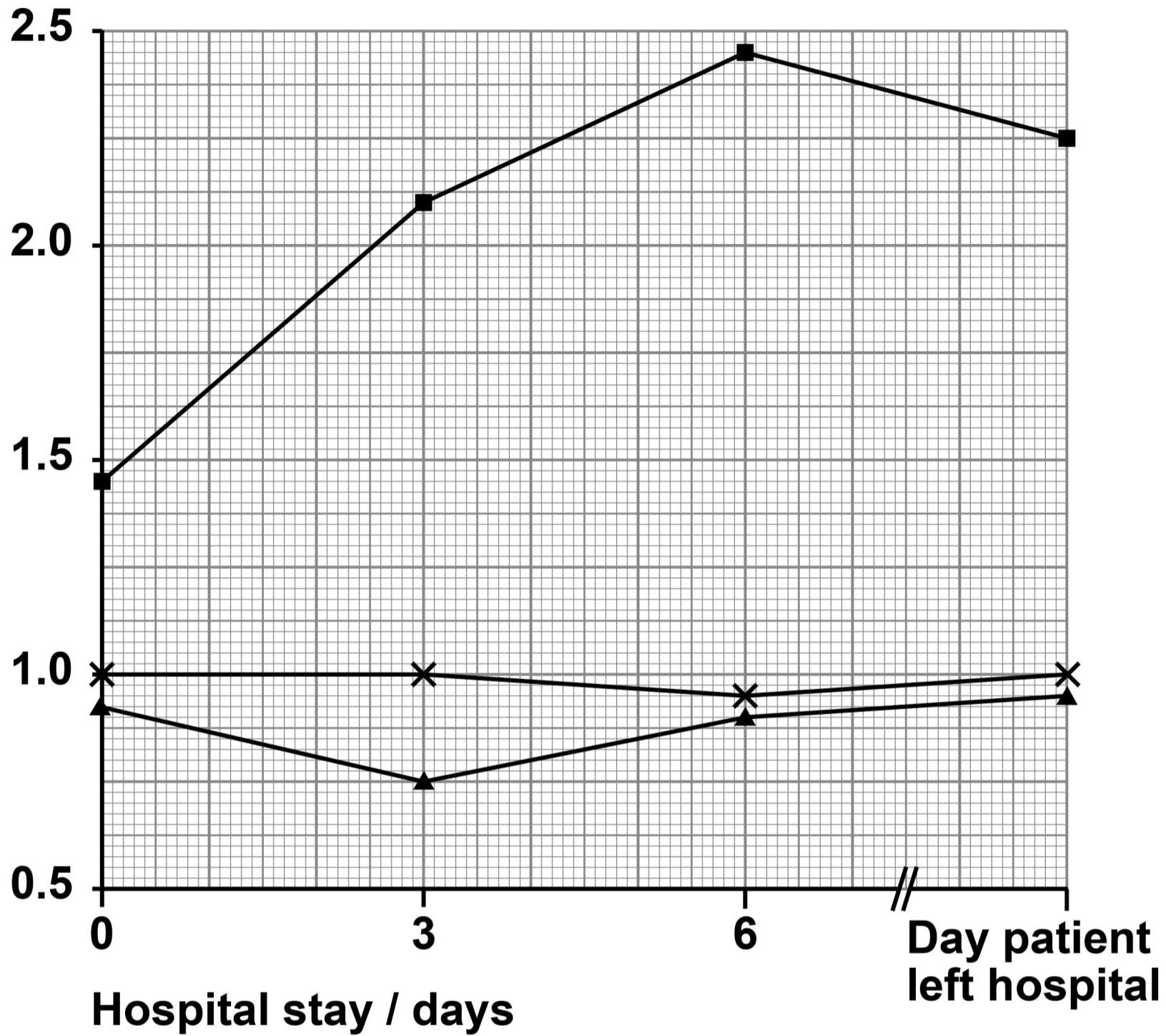
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FIGURE 4

Mean anti-toxin
antibody
concentration
/ arbitrary units

**KEY**

- Patients with 'C. difficile' infection but NO diarrhoea
- ×—× Patients without 'C. difficile' infection
- ▲—▲ Patients with 'C. difficile' infection and diarrhoea



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]**

[Turn over]

9



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 mm³ 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]**



[Turn over]



05.2

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 mm³ of cinnamon oil into the well.

Calculate the minimum depth of the well to allow the addition of 50 mm³ of cinnamon oil.

Use the following equation in your calculation:

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

Use 3.14 as the value for π .

Show your working. [2 marks]



Answer _____ mm

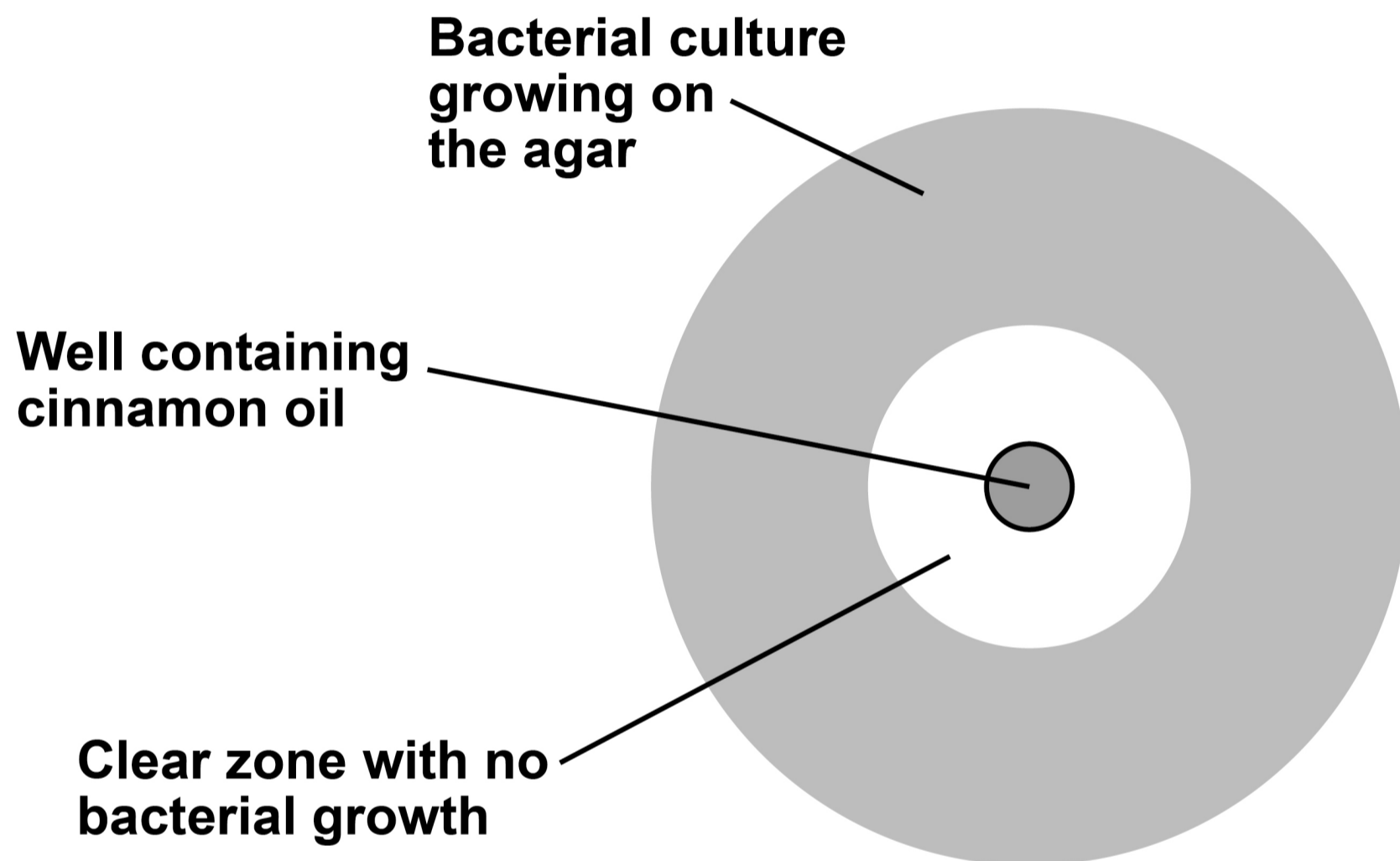
[Turn over]



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, on page 36, shows her results.

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[Turn over]



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



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, on the opposite page, to show the median and mean diameters. [1 mark]

[Turn over]



0 5 . 5

The mean \pm 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



0	6	.	1
---	---	---	---

Define genome and proteome. [2 marks]

Genome _____

Proteome _____

[Turn over]



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.

06.2

Consider the accuracy and limitations of the early classification of bacteria using the arrangement of flagella.
[3 marks]



[Turn over]



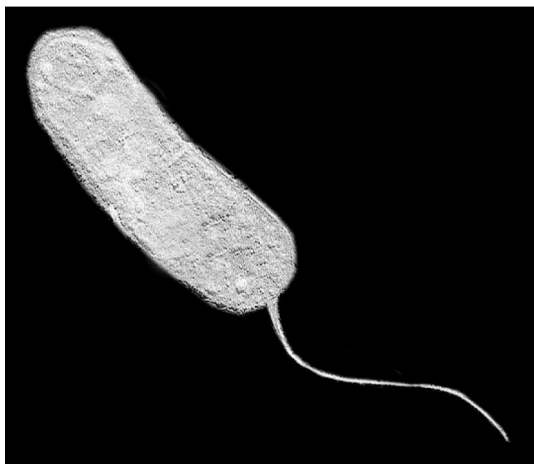
06.3

Suggest why several bacterial species have been renamed in recent years. [1 mark]

06.4

FIGURE 6 shows an image from an optical microscope of a single bacterial cell.

FIGURE 6



This bacterial cell is $2.3 \mu\text{m}$ long (excluding the flagellum).

Calculate the magnification of this image.

Show your working. [2 marks]

Magnification \times _____

[Turn over]

8



07.1

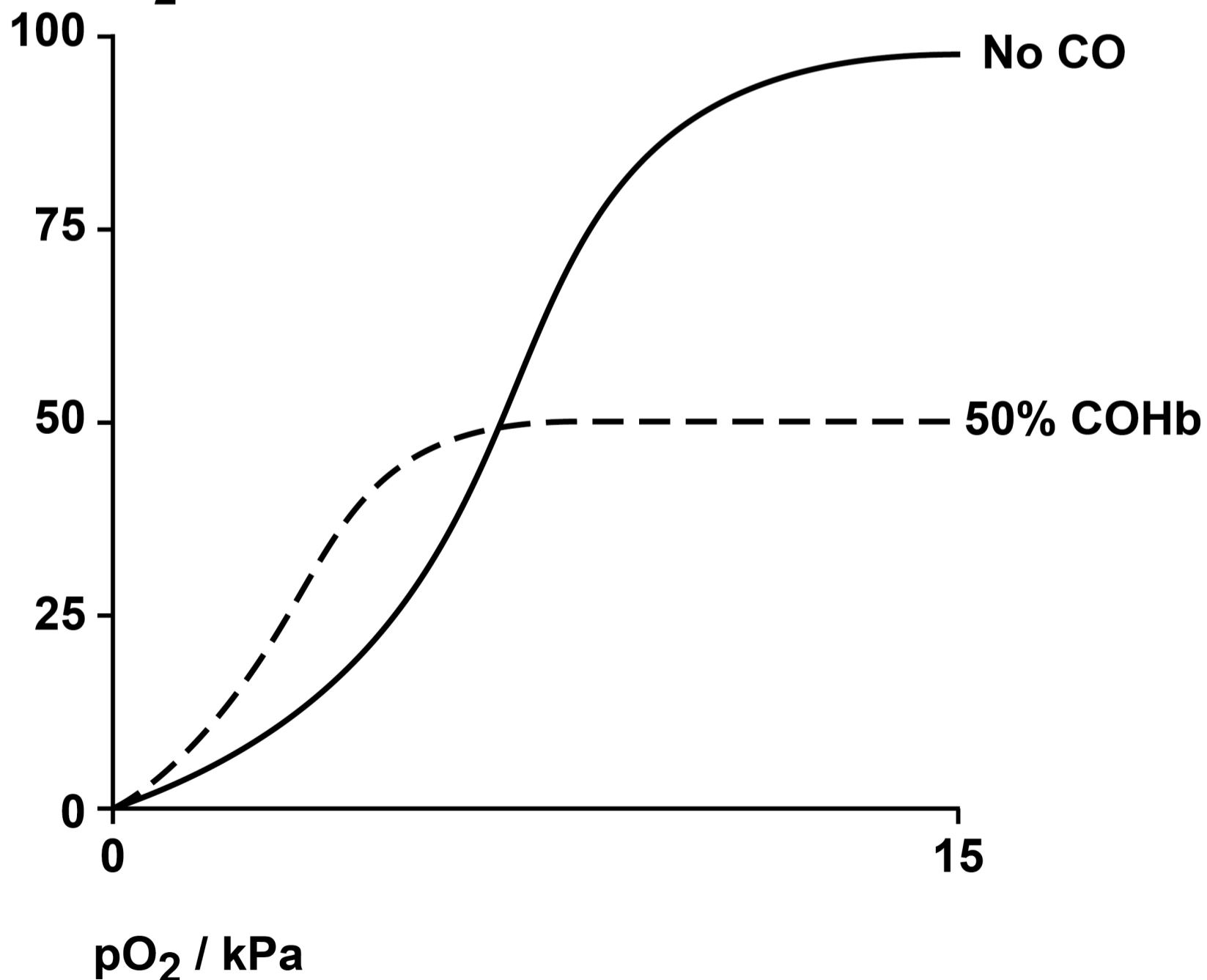
Carbon monoxide (CO) is released during incomplete combustion of fossil fuels.

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

Percentage
saturation
with O₂



07.2

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 $> 10 \text{ mg m}^{-3}$ CO for more than 8 hours
- air with $> 30 \text{ mg m}^{-3}$ 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]

[Turn over]



08.1

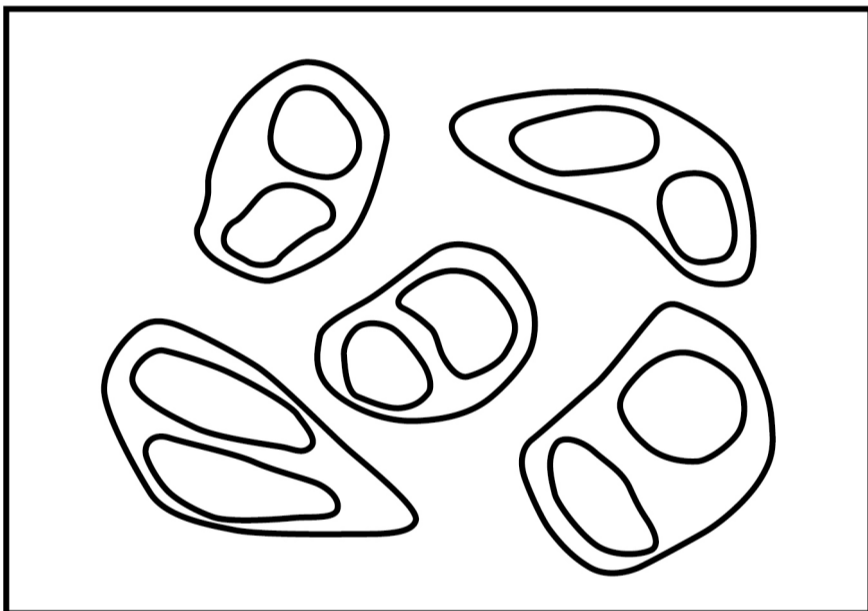
Scientists investigated a drug called MiTMAB as a treatment for cancer. MiTMAB inhibits cytokinesis.

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

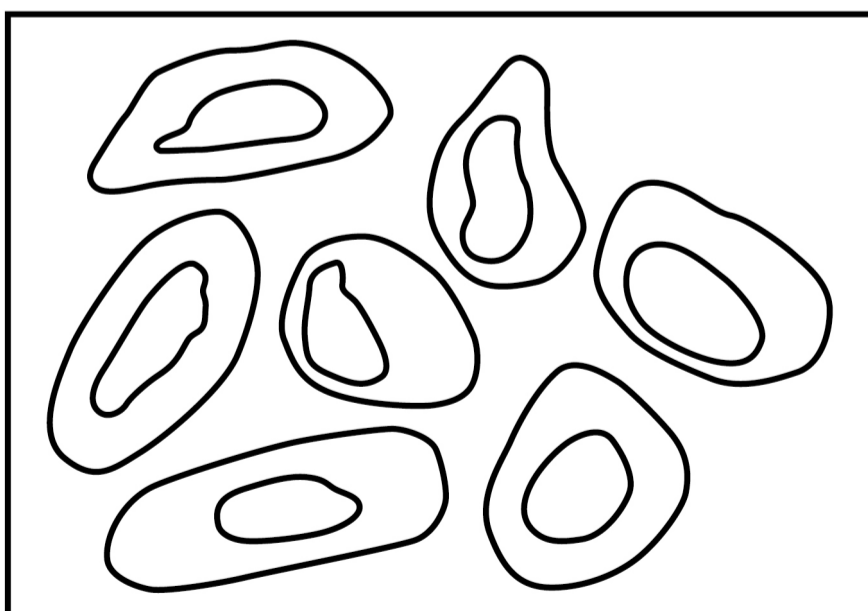
- sample treated with MiTMAB
- control sample.

FIGURE 8

A



B



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

Explain why. [2 marks]

[Turn over]



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[Turn over]



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.**

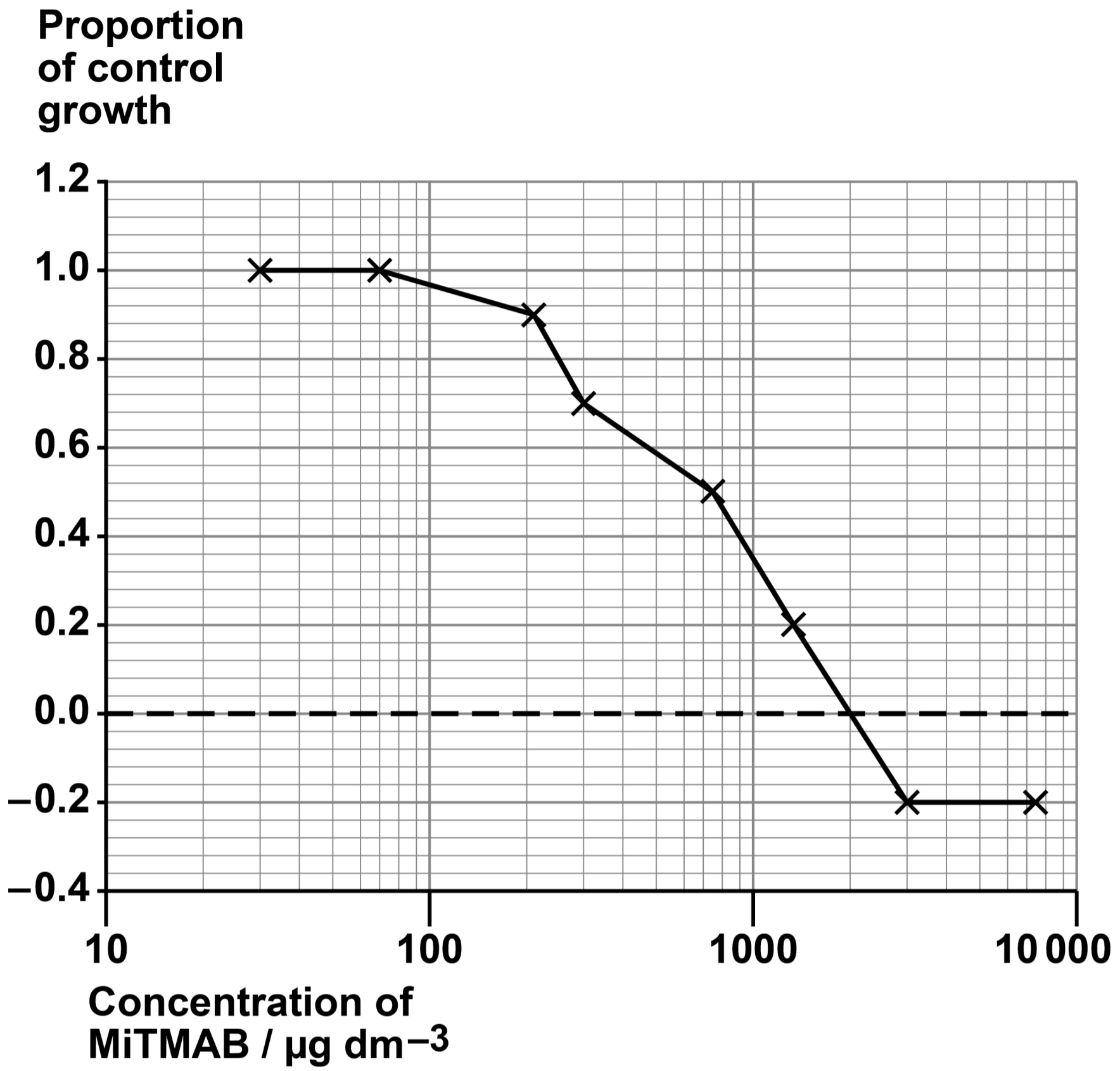
After 72 hours, the scientists measured the number of cells in each sample.

FIGURE 9, on the opposite page, 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



[Turn over]



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0	8	.	3
---	---	---	---

Use all the information given to explain the results shown in FIGURE 9, on page 53. [3 marks]

[Turn over]



0	8	.	4
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0.01 dm³ 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



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[Turn over]



09

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

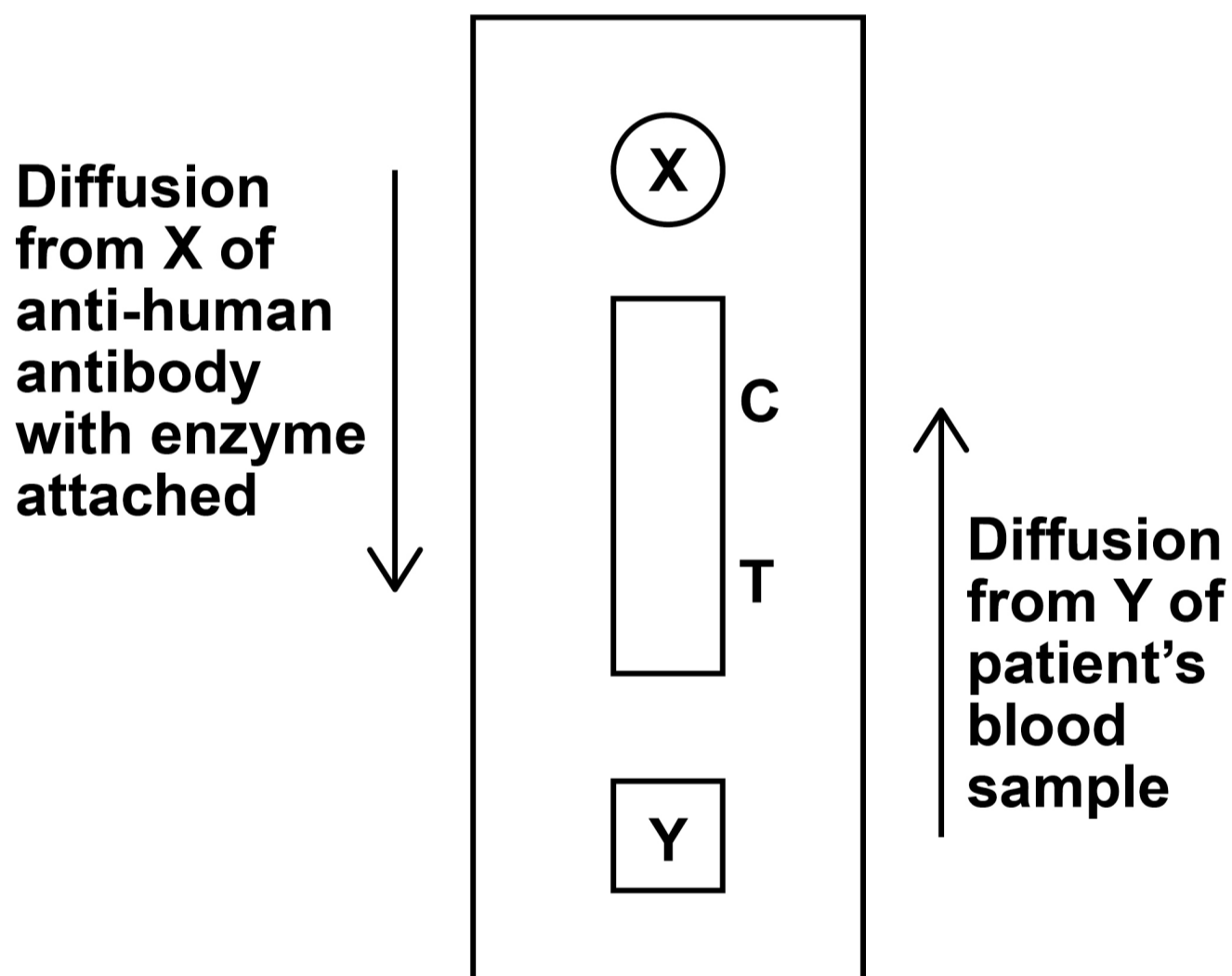
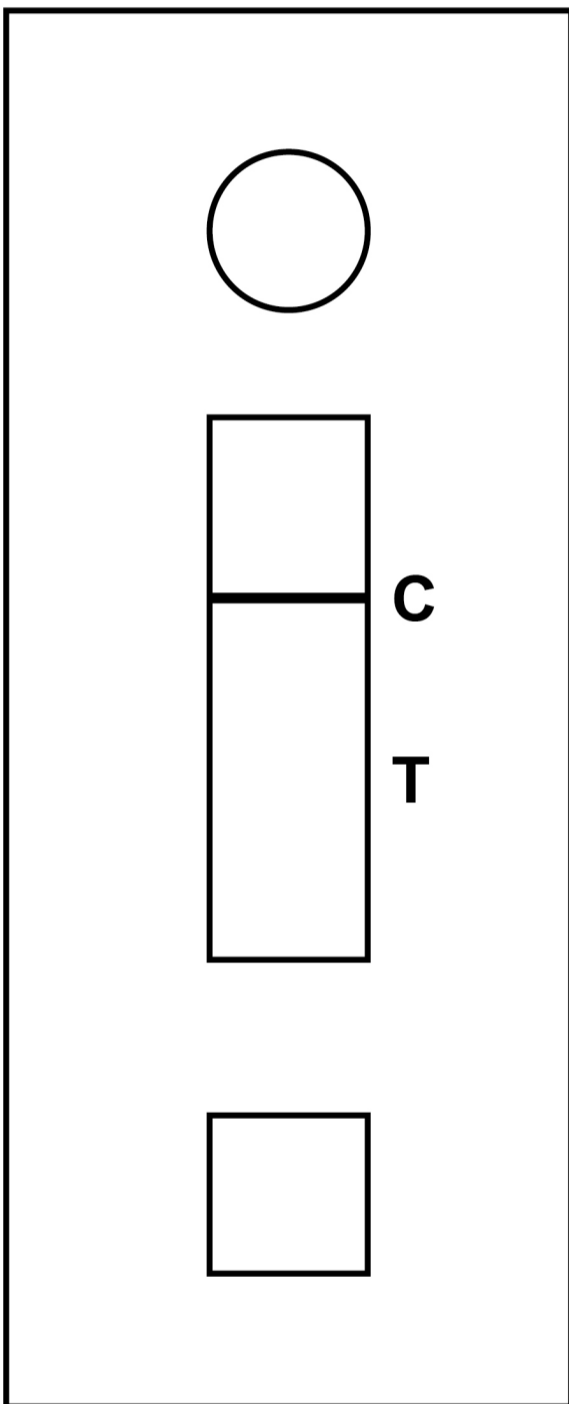


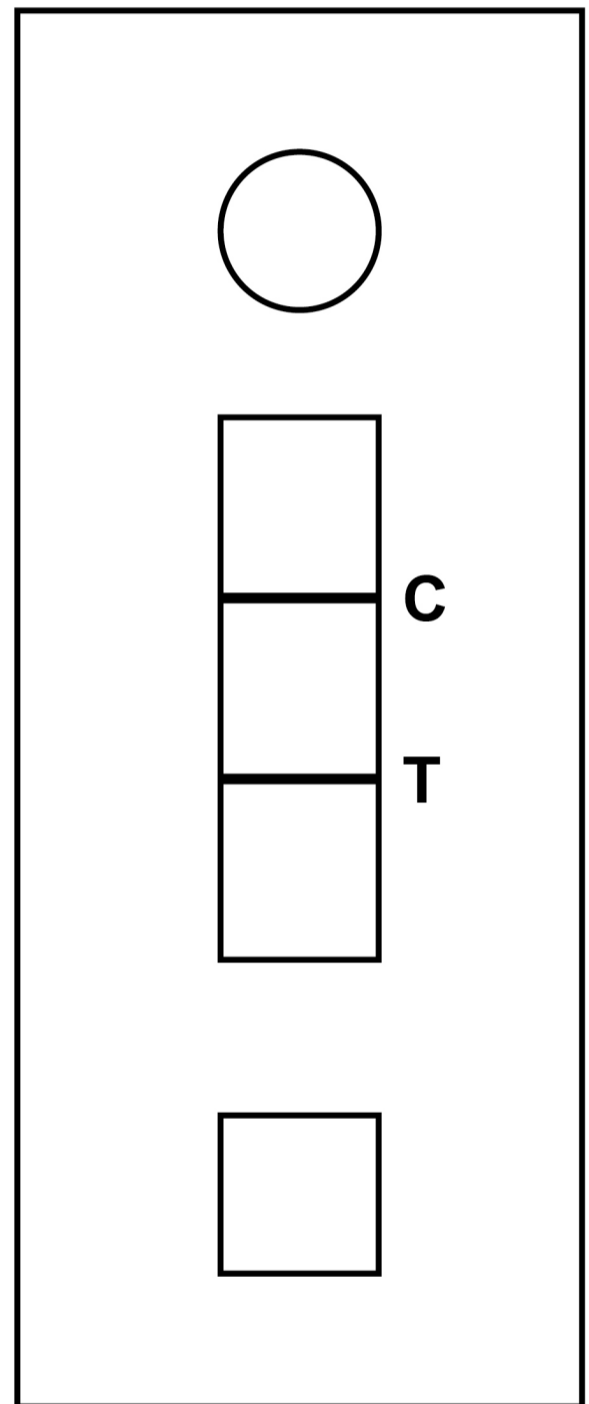
FIGURE 11 shows the negative and positive results that were produced 20 minutes after the use of the test shown in **FIGURE 10**.

FIGURE 11

Negative



Positive



[Turn over]



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.

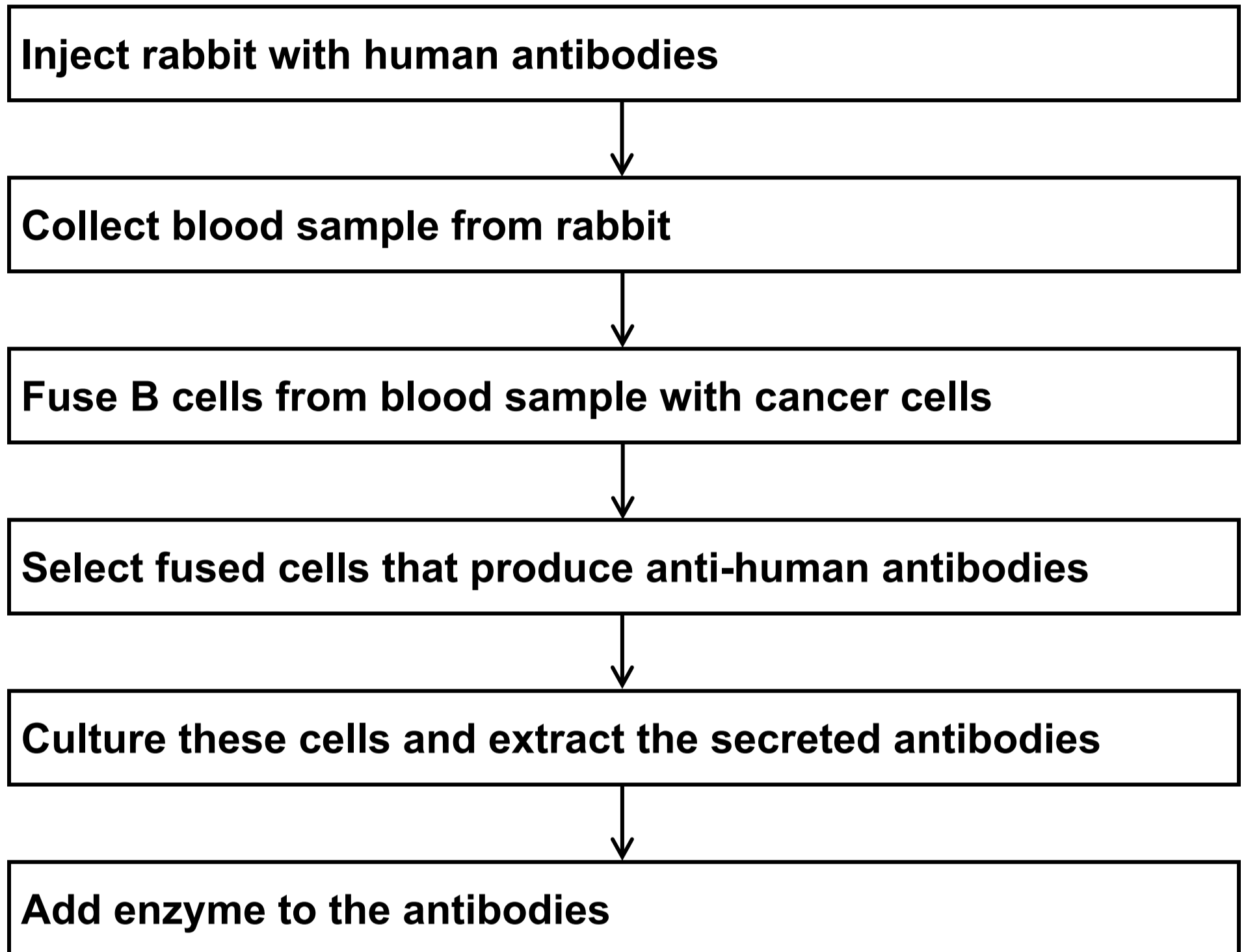
Suggest ONE reason why a line at C shows the test has worked. [1 mark]

[Turn over]



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

FIGURE 12



09.3

Suggest why the fused cells allow continuous production of monoclonal antibodies. [2 marks]

09.4

Evaluate the ethics of the production process shown in FIGURE 12. [1 mark]

[Turn over]





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 pages 58 and 59).**

The scientists’ results are shown in TABLE 3, on the opposite page.

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



6 5

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

[Turn over]



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]



6 7

[Turn over]



09.6

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]



[Turn over]



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