OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL AS

BIOLOGY (9610)

Unit 2 Biological Systems and Disease

Monday 13 January 2025 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

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).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

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

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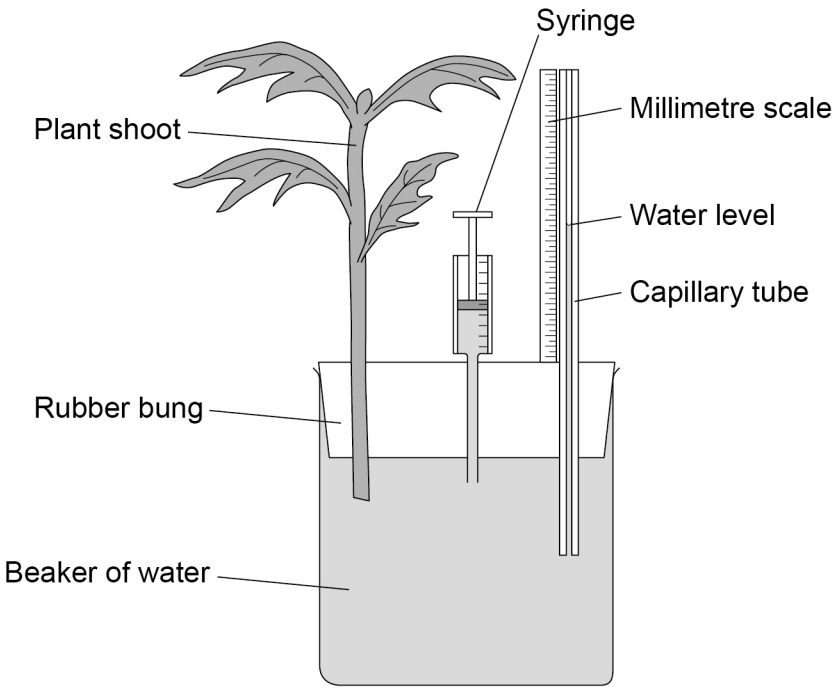
0 1 A student uses a potometer to investigate the rate of water uptake from two different plant species.

Figure 1 shows the potometer the student uses.

Figure 1



The student uses several practical techniques in the method to make sure that the results are as accurate as possible.

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0 1 . 1 Describe **three** practical techniques the student uses when setting up the potometer to make sure that the results are accurate.

Give the reason for each practical technique.

[6 marks]

1 _____

_____

_____

Reason _____

_____

_____

_____

2 _____

_____

_____

Reason _____

_____

_____

_____

_____

3 _____

_____

_____

Reason _____

_____

_____

_____

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0 1 . 2 Give the function of the syringe shown in **Figure 1**.

[1 mark]

The student records the results for the first plant shoot (species **A**).

The student repeats the investigation on a different day using a shoot from a different plant (species **B**).

The student calculates the rate of water uptake for species **A** and species **B**.

Table 1 shows the student's results.

Table 1

Time interval / min	**Rate of water uptake / mm^3 min^{-1}**	
	Species **A**	Species **B**
0–15	0.30	0.24
15–30	0.31	0.23
30–45	0.32	0.24
45–60	0.31	0.24

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0 1 . 3 Describe how the student calculates the rate of water uptake in $mm^3\ min^{-1}$ for each time interval.

[3 marks]

0 1 . 4 Suggest **two** reasons for the lower rate of water uptake by species **B**.

[2 marks]

1

2

12

Turn over for the next question

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0 2 Immunity is the ability of an organism to resist infection.

0 2 . 1 Define **active** and **passive** immunity.

[2 marks]

Active immunity _____

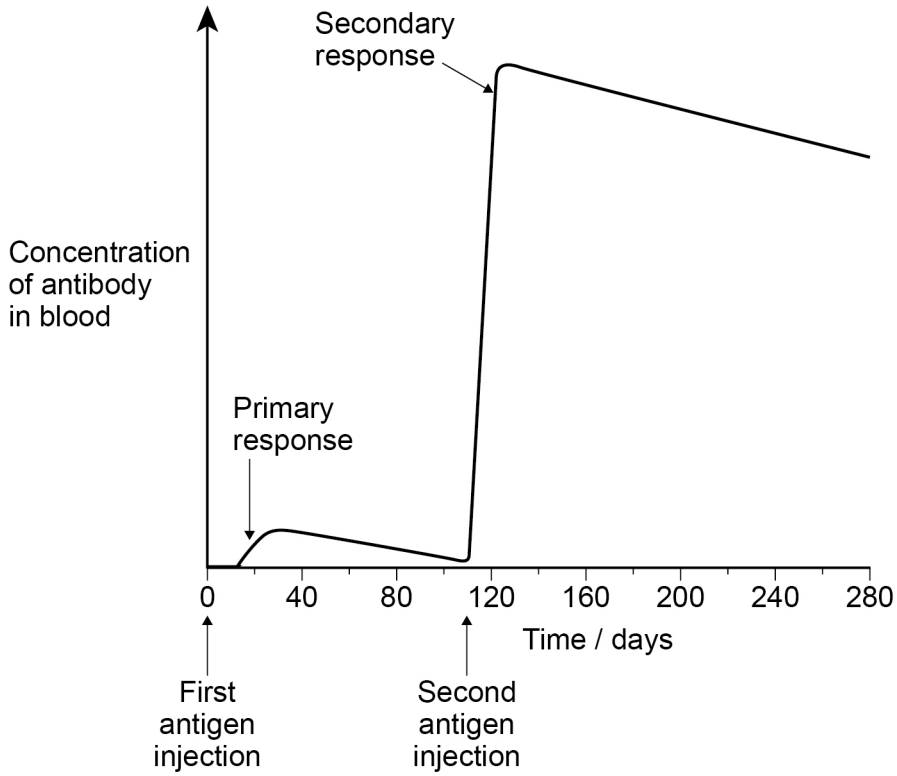
_____

Passive immunity _____

_____

Figure 2 shows the primary and secondary response to the injection of the same antigen as part of a vaccination programme.

Figure 2



0 2 . 2 Suggest a suitable unit of measurement for the 'concentration of antibody in blood' axis in **Figure 2**.

[1 mark]

_____

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0 2 . 3 Describe and explain **two** ways that the secondary response in **Figure 2** is different from the primary response.

[4 marks]

Difference 1 _____

_____

Explanation _____

_____

Difference 2 _____

_____

Explanation _____

_____

Question 2 continues on the next page

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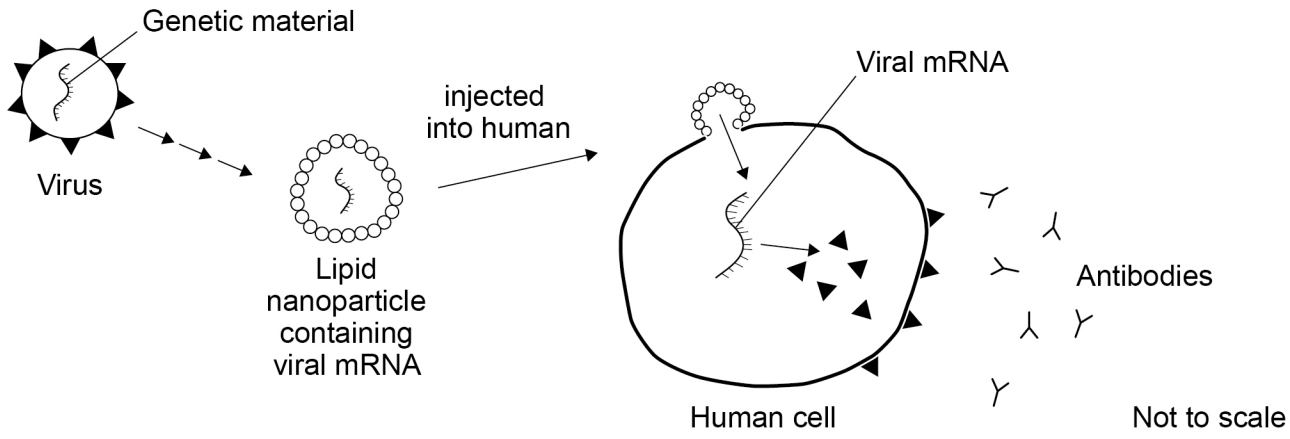
There are many different types of vaccine. One type of vaccine uses mRNA molecules within lipid nanoparticles.

A nanoparticle is a small particle between 1 to 100 nanometres in size.

Figure 3 shows an **outline** of the process of the production and use of the vaccine. Not all the stages are shown.

Figure 3



0 2 . 4 Suggest which part of the virus the mRNA is coding for.

[1 mark]

0 2 . 5 Suggest why the viral mRNA is put into a lipid nanoparticle.

[1 mark]

0 2 . 6 Name the type of human cell shown in **Figure 3**.

[1 mark]

10

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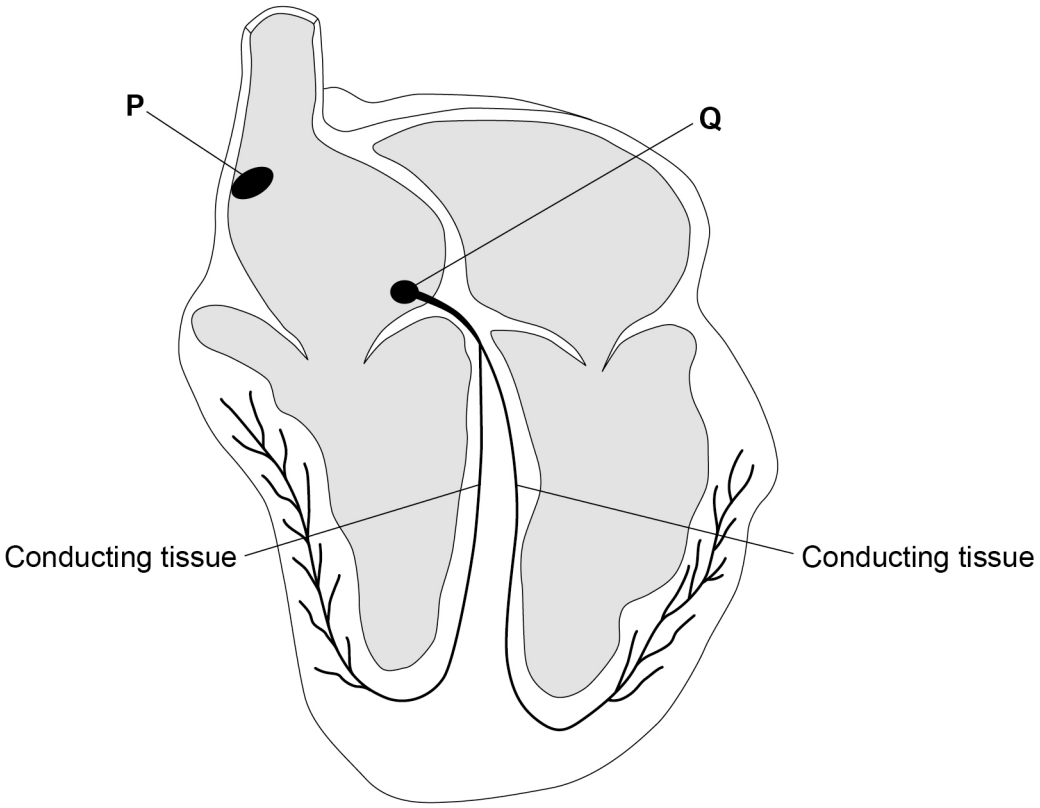
0 3 **Figure 4** shows some of the internal structures of the human heart.

Figure 4



Structure **P** starts the contraction of the heart muscle.

0 3 . 1 Name the chamber of the heart containing structure **P**.

[1 mark]

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The contraction of the heart muscle is delayed briefly at structure **Q** before the lower chambers contract.

0 3 . 2 Suggest why the delay at structure **Q** is important.

[1 mark]

0 3 . 3 Explain why it is important that the contraction of the lower chambers starts at the base of the heart.

[2 marks]

Question 3 continues on the next page

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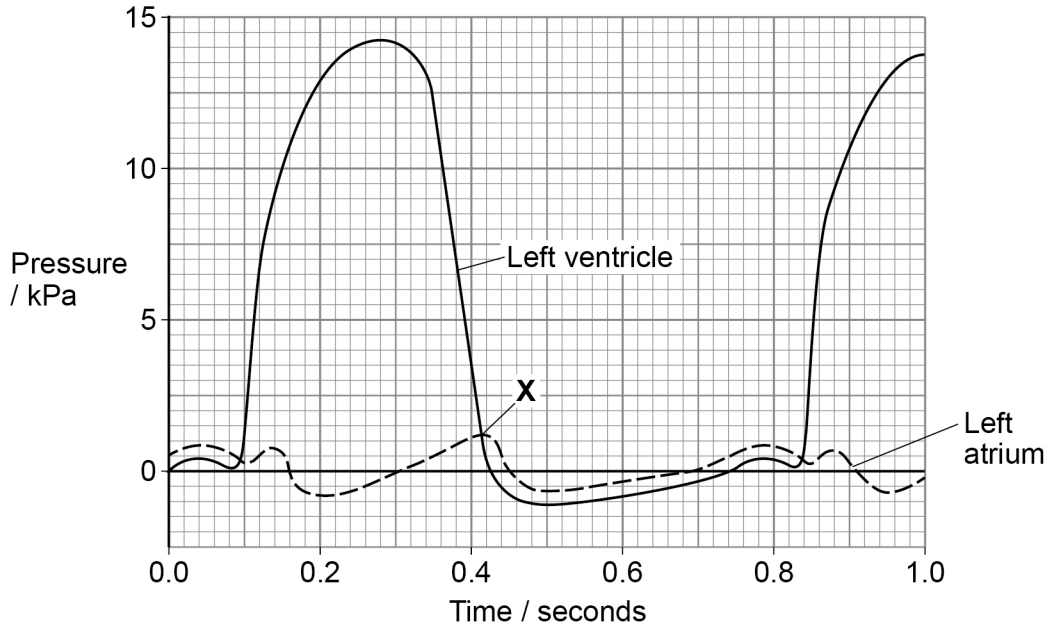
Figure 5 shows the pressure changes in the left side of the human heart.

Figure 5



0 3 . 4 Use **Figure 5** to calculate the heart rate in beats per minute (bpm).

[1 mark]

Heart rate _____ bpm

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0 3 . 5 The cardiac output was measured as 5.6 dm^3 min^{-1}

Use the equation for cardiac output to calculate the stroke volume for this individual in cm^3

[2 marks]

Stroke volume _____ cm^3

0 3 . 6 Describe **and** explain what is happening at point **X** on **Figure 5**.

Include the name of the **valve** involved in your answer.

[2 marks]

0 3 . 7 What causes the maximum pressure in the ventricle to be much **higher** than the maximum pressure in the atrium?

[2 marks]

11

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0 4 The human immunodeficiency virus (HIV) is a retrovirus containing the enzyme reverse transcriptase.

0 4 . 1 Explain why HIV needs reverse transcriptase to produce viral proteins.

[2 marks]

HIV binds to receptors on helper T-cells.

0 4 . 2 Describe the role of helper T-cells in defending the body against HIV.

[2 marks]

Question 4 continues on the next page

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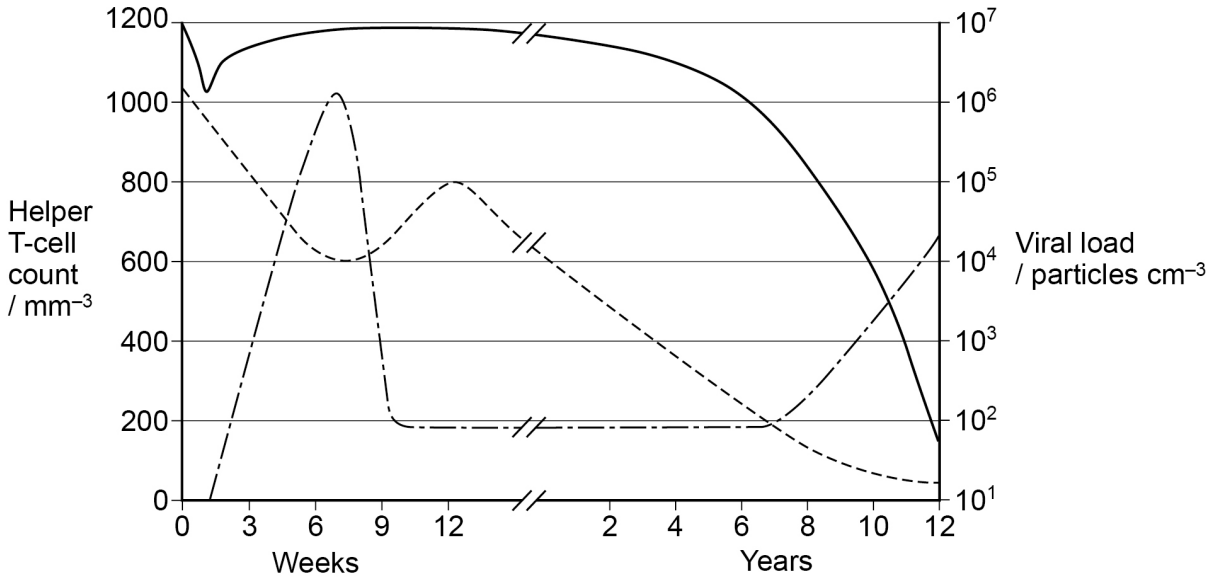
Figure 6 shows the stages of a typical untreated HIV infection.

Figure 6



Key

——— Patient 'wellness'

- - - - - - - Helper T-cell count

—·—·— Viral load

0 4 . 3 Describe the trend in the viral load between years 1 to 12 shown in **Figure 6**.

[1 mark]

Do not write outside the box

0 4 . 4 ‘Patient wellness’ is a measure of how well a patient is feeling.

Suggest a method scientists could have used to measure patient wellness **and** the reason why their measure of patient wellness might be inaccurate?

[2 marks]

Method for measuring patient wellness _____

_____

Reason for inaccuracy in measuring patient wellness _____

_____

_____

0 4 . 5 The viral load was 9.9×10^1 at the end of the first year and 3.5×10^4 at the end of 12 years.

Calculate the percentage change in the viral load.

Give your answers to the **nearest whole number**.

[2 marks]

Percentage change in the viral load = _____ %

0 4 . 6 Patients in the final stage (9–12 years) of untreated HIV are more likely to die from cancer and diseases caused by pathogens.

Use information in **Figure 6** to explain why untreated HIV patients are more likely to die from these diseases.

[2 marks]

_____

_____

_____

_____

_____

11

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0 5 Bacteria are prokaryotic cells. Prokaryotic cells and eukaryotic cells divide using different processes to produce new cells.

0 5 . 1 Name the type of cell division in prokaryotic cells and the type in eukaryotic cells.

[1 mark]

Prokaryotic cells _____

Eukaryotic cells _____

0 5 . 2 Give **two** ways that cell division in prokaryotic cells is different from cell division in eukaryotic cells.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 5 . 3 In a culture of bacteria, each cell can divide every 30 minutes.

The original number of cells in the population of bacteria is 1.15×10^5

Calculate the number of cells after 24 hours.

None of the bacterial cells die during this time.

Give your answer in standard form.

[2 marks]

Number of cells after 24 hours = _____

Do not write outside the box

A scientist investigates how effective an antibiotic called vancomycin is in killing a species of bacterium called *Staphylococcus aureus*.

The scientist:

- puts an equal volume of a culture of *S. aureus* into five containers
- adds the same volume of different concentrations of vancomycin solution to each of four of the containers
- adds the same volume of water instead of vancomycin solution to the fifth container
- keeps the containers at 35 °C for 3 hours
- estimates the number of living bacteria in each container.

Table 2 shows the scientist's results.

Table 2

Concentration of vancomycin / μg cm^{-3}	Estimated number of living bacteria remaining after 3 hours ($\times 10^6$)
0	100
5	57
10	48
50	37
100	36

0 5 . 4 Describe the results shown in **Table 2**.

[2 marks]

Question 5 continues on the next page

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0 5 . 5 Give **one** limitation of the method used in this investigation.

[1 mark]

Scientists discovered that some cells of *S. aureus* have a gene for resistance to the antibiotic vancomycin.

Scientists had previously identified this same resistance gene in a different species of bacterium called *Enterococcus faecalis*.

0 5 . 6 Describe how the resistance gene could have passed from *E. faecalis* to *S. aureus*.

[2 marks]

10

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0 6 Mutagens can cause damage to DNA.

Damage to the DNA in a cell activates a tumour suppressor gene to code for a protein called p53

The p53 protein activates another gene to produce a protein called p21

The p21 protein can either repair the DNA or stop the cell cycle.

0 6 . 1 Explain how a mutation in a tumour suppressor gene could cause cancer to develop.

Use your own knowledge and the information provided.

[3 marks]

Question 6 continues on the next page

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Chemotherapy drugs are used to treat cancer.

The drugs work by causing damage to the DNA in cancer cells.

This damage causes the cancer cells to die.

Chemotherapy drugs damage DNA most if they are given in the stage of the cell cycle where DNA replication occurs.

0 6 . 2 Name the stage of the cell cycle that a chemotherapy drug is likely to cause the **most** damage to DNA.

[1 mark]

Chemotherapy drugs can sometimes cause tumour cells to go into an inactive state called senescence.

Cells in senescence are alive but are no longer able to divide.

Scientists can identify the cells that are in senescence by adding ^{3}H-labelled thymine to a tissue section from a tumour.

^{3}H is a radioactive isotope of hydrogen.

0 6 . 3 Suggest how the use of ^{3}H-thymine could distinguish between cells in senescence and cells **not** in senescence.

[2 marks]

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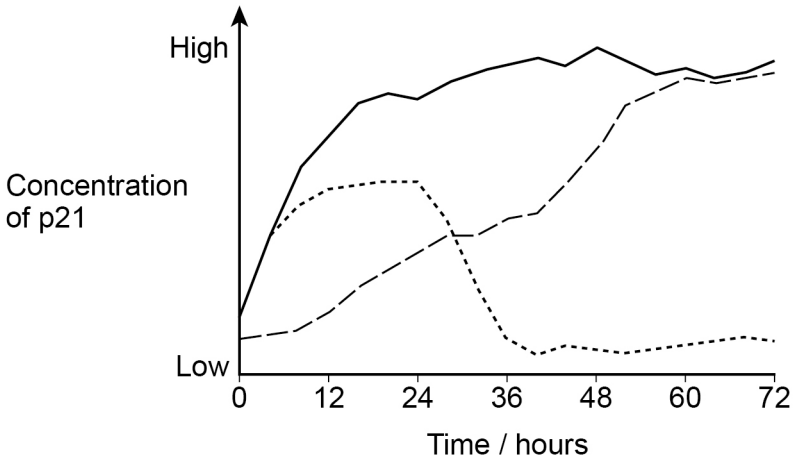
Scientists investigate the effect of a chemotherapy drug on the concentration of p21 in human lung cancer cells.

The scientists:

- isolate and culture a large number of lung cancer cells and divide them into two groups
- add the chemotherapy drug to the cancer cells in one group before the cells replicate their DNA
- add the chemotherapy drug to the cancer cells in the other group after the cells have replicated their DNA
- measure the concentration of the p21 protein in the cells from both groups at regular intervals for 72 hours
- analyse a large number of cells from each group to determine if they are in senescence.

Figure 7 shows the scientists' results.

Figure 7



Key

Chemotherapy drug added	**Condition of cells**
Group 1: Before cells replicate DNA	—— Cells in senescence
	------- Cells continue dividing
Group 2: After cells replicate DNA	— — — Cells in senescence

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0 6 . 4 A journalist states:

'This investigation shows that future chemotherapy treatments should happen before DNA replication. This would increase the chances of successful treatment of cancerous tumours.'

Evaluate the journalist's statement.

Use the information provided and **Figure 7**.

[5 marks]

11

Turn over for the next question

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0 7 Food is digested and absorbed in the human digestive system.

0 7 . 1 Describe how **proteins** are digested in humans.

Include the names of the enzymes involved **and** the locations of the enzymes in the digestive system.

[5 marks]

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0 7 . 2 Pathogens, including cholera bacteria, may also be ingested with food and water.

Describe how cholera bacteria cause severe dehydration.

[5 marks]

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