OXFORD

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I declare this is my own work.

INTERNATIONAL AS

BIOLOGY (9610)

Unit 2 Biological Systems and Disease

Wednesday 11 January 2023 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	
8	
TOTAL	

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

0 1 Gene mutations are changes in the base sequence of DNA.

Table 1 shows some amino acids and the DNA triplets that code for them.

Table 1

Amino acid	DNA triplets
Arg	AGA, AGG, CGT, CGC, CGA, CGG
Gly	GGT, GGC, GGA, GGG
Leu	TTA, TTG, CTT, CTC, CTA, CTG
Ser	AGT, AGC, TCT, TCC, TCA, TCG
Trp	TGG
Tyr	TAT, TAC

Table 2 shows:

- the original DNA base sequence for part of a gene that codes for an enzyme
- the effects of two different mutations on the DNA base sequence of this gene.

Table 2

Original DNA base sequence	A	G	C	C	G	G	C	T	G	T	A	C
Mutation **1** DNA base sequence	A	G	C	C	G	G	C	T	C	T	A	C
Mutation **2** DNA base sequence	A	G	C	G	G	G	C	T	G	T	A	C

Use the information shown in **Table 1** and **Table 2** to answer the following questions.

0 1 . 1 Give the sequence of amino acids coded for by the original DNA base sequence.

[1 mark]

_____

Do not write outside the box

0 1 . 2 Mutation **1** shows that the genetic code is degenerate.

Explain how.

[2 marks]

0 1 . 3 Explain how mutation **2** may produce a non-functional enzyme.

[3 marks]

6

Turn over for the next question

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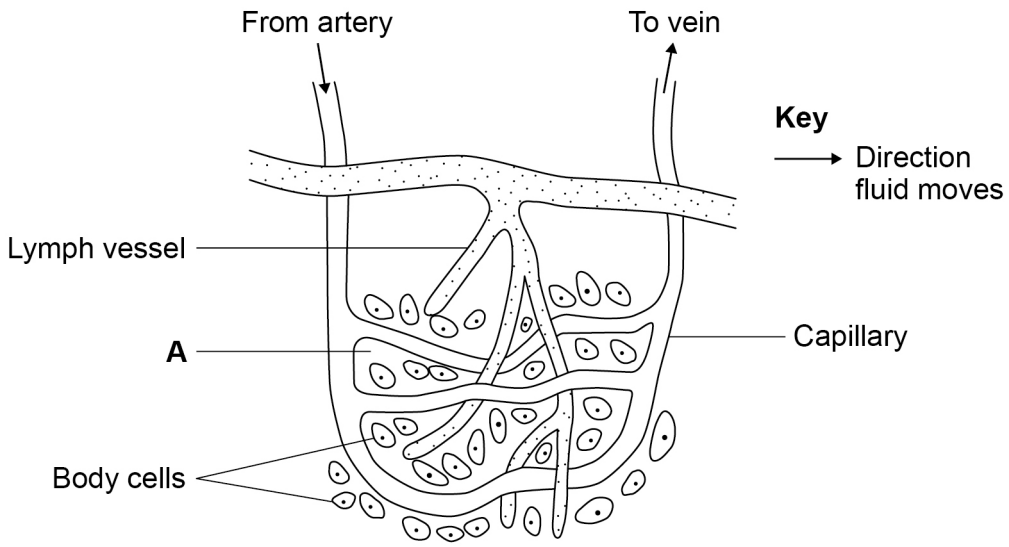
0 2 **Figure 1** shows the arrangement of some blood vessels and lymph vessels.

Figure 1



0 2 . 1 Name the fluid found at position **A** shown in **Figure 1**.

[1 mark]

_____

0 2 . 2 The blood in the capillary consists of cells suspended in a fluid.

Name this fluid.

[1 mark]

_____

0 2 . 3 Give **one** function of the lymph vessels.

[1 mark]

_____

_____

_____

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0 2 . 4 Explain how **two** structural features of capillaries allow efficient exchange of substances.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 2 . 5 When a mosquito bites a person, some swelling can develop around the bite.

This swelling is caused by a chemical called histamine. Histamine changes the permeability of capillary walls so that large molecules can pass through.

Explain how this change in the permeability of capillary walls causes swelling.

[3 marks]

_____

_____

_____

_____

_____

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_____

_____

8

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0 3 Pathogens cause disease. When pathogens enter the body, they stimulate an immune response.

0 3 . 1 Give **two** ways that pathogens can cause disease.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 3 . 2 Describe how a pathogen is killed by phagocytosis.

[3 marks]

_____

_____

_____

_____

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_____

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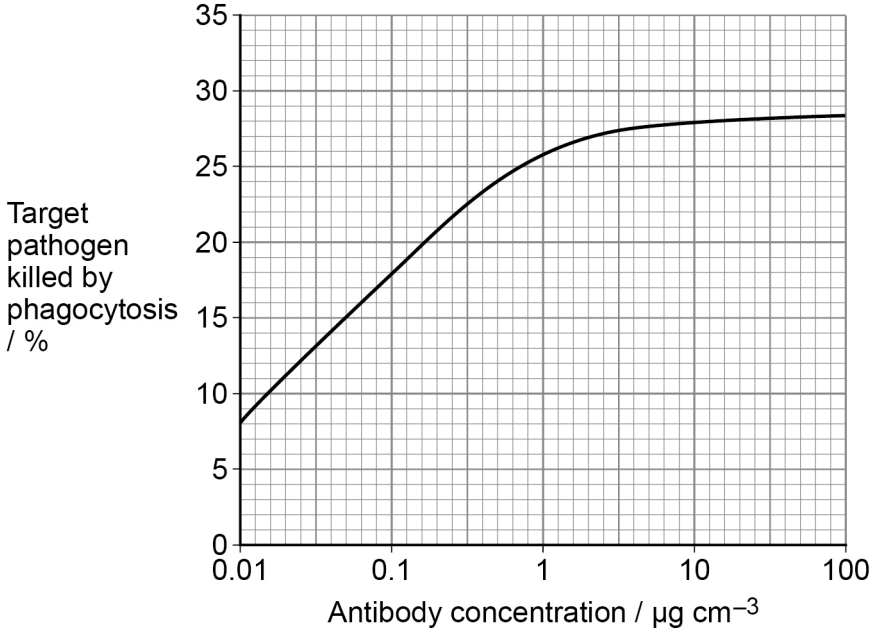
Figure 2 shows the relationship between the concentration of one type of antibody and the percentage of a target pathogen killed by phagocytosis.

Figure 2



0 3 . 3 Explain the relationship shown in **Figure 2** between antibody concentrations 0.01 and 1 μg cm^{-3} and the percentage of target pathogens killed by phagocytosis.

[2 marks]

0 3 . 4 Explain why an antibody is only effective against a specific pathogen.

[2 marks]

9

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0 4 A group of students investigate the number of cells that are dividing at different distances from the end of a root tip.

Each student:

- cuts a 10 mm length from the tip of an onion root
- puts the cut piece in a watch glass
- covers the piece of root tip with one drop of toluidine blue stain
- puts the piece of root tip on a microscope slide
- puts a coverslip on top of the root tip and presses down firmly without moving the cover slip sideways
- uses a light microscope to record the number of cells that are dividing at different distances from the end of the root tip.

0 4 . 1 Explain why the students press down firmly on the cover slip but do not move the cover slip sideways.

[2 marks]

0 4 . 2 Give the reason why the students add a stain to the pieces of root tip.

[1 mark]

In this investigation, toluidine blue stain is used instead of a more traditionally used stain called acetic orcein.

0 4 . 3 Suggest **one** reason why the students use toluidine blue stain instead of acetic orcein.

[1 mark]

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Each student calculates the mitotic index at five distances from the tip of the onion root.

The students use the formula:

$$\text{Mitotic index} = \frac{\text{Number of cells dividing by mitosis}}{\text{Total number of cells viewed}} \times 100$$

0 4 . 4 One student counts a total of 138 cells when viewing a root tissue sample. The student calculates a mitotic index of 10.1%

Calculate the number of dividing cells the student counted.

[1 mark]

Number of dividing cells = _____

Question 4 continues on the next page

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Each student calculates the mitotic index at five distances from the tip of the onion root.

Table 3 shows the students' results.

Table 3

Distance from root tip / mm	**Mitotic index / %**					
	Student					**Mean ± SD**
	1	2	3	4	5	
1	10.1	10.9	11.5	10.6	9.9	10.6 ± 0.6
3	3.2	2.8	1.8	3.1	2.3	2.6 ± 0.6
5	2.1	1.6	1.2	0.0	1.4	1.3 ± 0.8
7	0.0	0.8	0.0	0.0	1.0	0.4 ± 0.5

0 4 . 5 Describe what the standard deviations show about the results of this investigation.

Use data from **Table 3**.

[2 marks]

One student states:

"There is a higher chance of seeing some cells in metaphase if tissue is examined as near to the root tip as possible."

0 4 . 6 Explain how the results in **Table 3** support the student's statement.

[2 marks]

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0 4 . 7 At distances of 1 mm, 3 mm and 5 mm, the values for the mitotic index differed between the five students.

Suggest **three** possible causes for these differences in the value of the mitotic index.

[3 marks]

1 _____

_____

_____

2 _____

_____

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3 _____

_____

_____

12

Turn over for the next question

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0 5 Scientists investigate the digestion of two lipid emulsions with different droplet sizes in human volunteers.

The scientists:

- tell 8 healthy volunteers not to eat any food for 12 hours before the start of the investigation
- prepare an emulsion containing small lipid droplets
- give each volunteer 500 cm^3 of the small lipid droplet emulsion through a tube directly into the duodenum
- measure the concentration of chylomicrons in the blood of each volunteer at intervals for 7 hours
- repeat the investigation 1 week later but with an emulsion containing large lipid droplets.

0 5 . 1 Chylomicrons contain large amounts of triglycerides.

Name **one** other component of a chylomicron

[1 mark]

_____

0 5 . 2 Give the reason for:

[2 marks]

selecting healthy volunteers

_____

_____

_____

volunteers not eating any food for 12 hours before the start of the investigation.

_____

_____

_____

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Table 4 shows information about the two sizes of lipid droplets.

Table 4

Size of lipid droplets	Mean diameter of droplets / μm	Mean volume of droplets / μm^3	Mean surface area of droplets / μm^2
Small	1.4	1.4	6.2
Large	9.8	492.6	

0 5 . 3 The mean surface area to volume ratio (SA:V) of the small lipid droplets is 4.4:1

Calculate the mean SA:V of the large lipid droplets.

Use information from **Table 4** and the formula for surface area of a droplet.

[2 marks]

$A = 4\pi r^2$

A = surface area
r = radius
π = 3.14

Mean SA:V of large lipid droplets = _____:1

Question 5 continues on the next page

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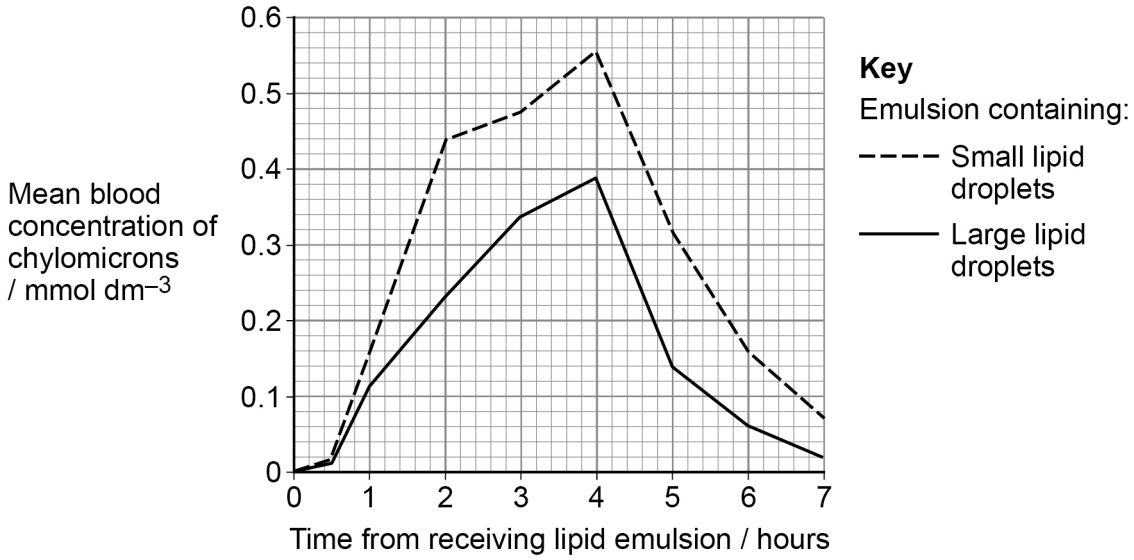
Figure 3 shows the mean concentration of chylomicrons in the volunteers' blood over 7 hours.

Figure 3



Food supplements are often given to patients with disorders of the digestive system.

The scientists concluded that the results of this investigation suggest that food supplements containing emulsions with small lipid droplets would help patients with problems digesting and absorbing lipids.

0 5 . 4 Describe how the results in **Figure 3** support the scientists' conclusion.

[1 mark]

0 5 . 5 Explain why emulsions with small lipid droplets are easier to digest and absorb.

[2 marks]

8

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0 6 The human immunodeficiency virus (HIV) causes a disease called acquired immune deficiency syndrome (AIDS).

0 6 . 1 Complete **Table 5** by giving the name of the HIV component that matches the description.

[2 marks]

Table 5

Description	Name of component
A protein layer that surrounds RNA and some enzymes	
Outer surface formed from the cell-surface membrane of cells infected with HIV	

Question 6 continues on the next page

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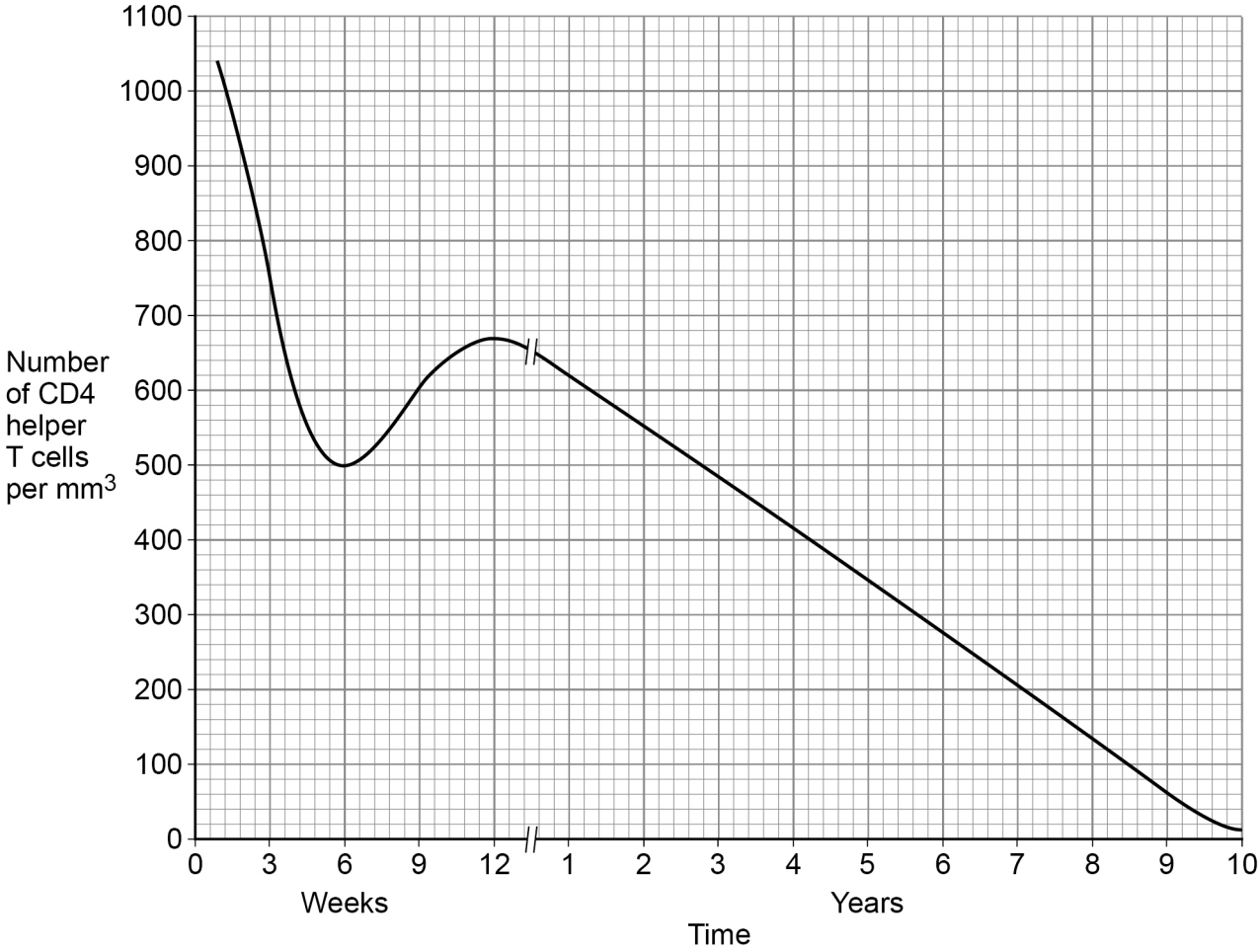
Figure 4 shows how the number of CD4 helper T cells in the blood of a person infected with HIV changes with time.

Figure 4



0 6 . 2 This person started to develop many secondary infections about 8 years after first becoming infected with HIV.

Explain why, using information from **Figure 4**.

[3 marks]

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To assess the stage of a patient's HIV infection, doctors can use a measurement called the CD4 percentage (CD4%). This is the percentage of cells in the immune system that are CD4 helper T cells.

0 6 . 3 A patient with HIV has a CD4% of 15% and a CD4 helper T cell count of 197 cells per mm^3 of blood.

The patient starts a new treatment and the CD4% increases to 35%

Calculate the increase in CD4 helper T cells, if the total number of cells in the immune system remains constant.

[2 marks]

Increase in CD4 helper T cells = _____ cells per mm^3 of blood

Question 6 continues on the next page

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0 6 . 4 Antiretroviral drugs have increased the life expectancy of HIV patients.

One type of antiretroviral drug inhibits the HIV enzyme integrase and stops HIV DNA from integrating into the host cell DNA.

Name **one** other HIV enzyme that could be inhibited by an antiretroviral drug.

Explain how inhibition of this enzyme affects the replication of HIV.

[3 marks]

Name of enzyme

_____

How replication is affected

_____

_____

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10

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0 7 Scientists investigate the behaviour of a species of aphid (*Rhopalosiphum padi*). The aphid carries a plant pathogen called barley yellow dwarf virus (BYDV).

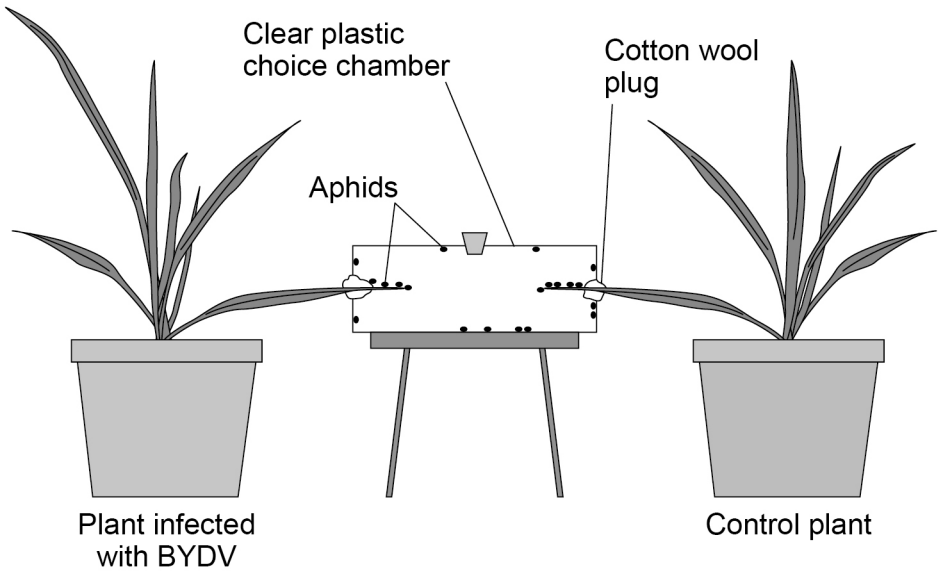
The scientists:

1. put a choice chamber (a clear plastic container), as shown in **Figure 5**, into a temperature-controlled and light-controlled room
2. insert one leaf of a plant infected with BYDV into one side of the choice chamber
3. insert one leaf of a plant not infected with BYDV (control plant) into the choice chamber on the opposite side
4. release 50 aphids carrying BYDV (infective aphids) into the choice chamber
5. record the number of infective aphids in the choice chamber found on the BYDV-infected plant leaf and on the control plant leaf after 72 hours
6. repeat steps 1 to 5 five more times with new plants each time and with 50 infective aphids each time.

To complete the investigation, the scientists repeat steps 1 to 6, but in these experiments use aphids **not** carrying BYDV (non-infective aphids).

Figure 5 shows a diagram of how the experiment is set up.

Figure 5



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0 7 . 1 Give **three** variables that the scientists should control in this investigation that are not mentioned in the method.

[3 marks]

1 _____

_____

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2 _____

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3 _____

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_____

0 7 . 2 Describe how aphids feed on a plant leaf.

[2 marks]

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_____

_____

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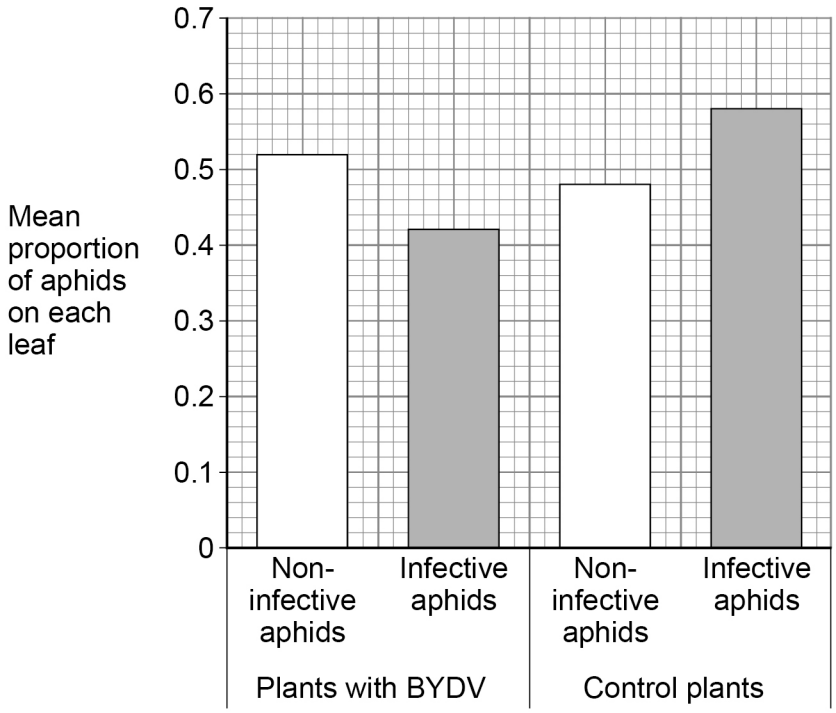
Figure 6 shows the scientists' results.

Figure 6



0 7 . 3 The scientists used a chi-squared test to analyse the results for each group of plants.

Give the reason why they used this statistical test.

[1 mark]

0 7 . 4 The result of the chi-squared test for both groups of plants was the same at $P < 0.0001$

Explain what this means when applied to this investigation.

In your answer, use the words probability **and** chance.

[2 marks]

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0 7 . 5 The scientists concluded that:

'The behaviour of the aphids in this investigation provides evidence for an increase of pathogen transmission in agriculture.'

Use **Figure 6** and the information provided to evaluate the scientists' conclusion.

[4 marks]

12

Turn over for the next question

Do not write outside the box

0 8 . 1 Explain how the heart maintains a one-way flow of blood from the left atrium to the aorta.

In your answer, include the role of cardiac muscle and the heart valves.

[5 marks]

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0 8 . 2 Explain how atheroma formation may cause myocardial infarction.

[5 marks]

10

END OF QUESTIONS

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