A

AQA

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

# A-level

# BIOLOGY

## Paper 1

## 7402/1

**Thursday 6 June 2019 Morning**

**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]**

JUN197402101

**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.**
- **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**

**Describe how a NON-COMPETITIVE inhibitor can reduce the rate of an enzyme-controlled reaction. [3 marks]**

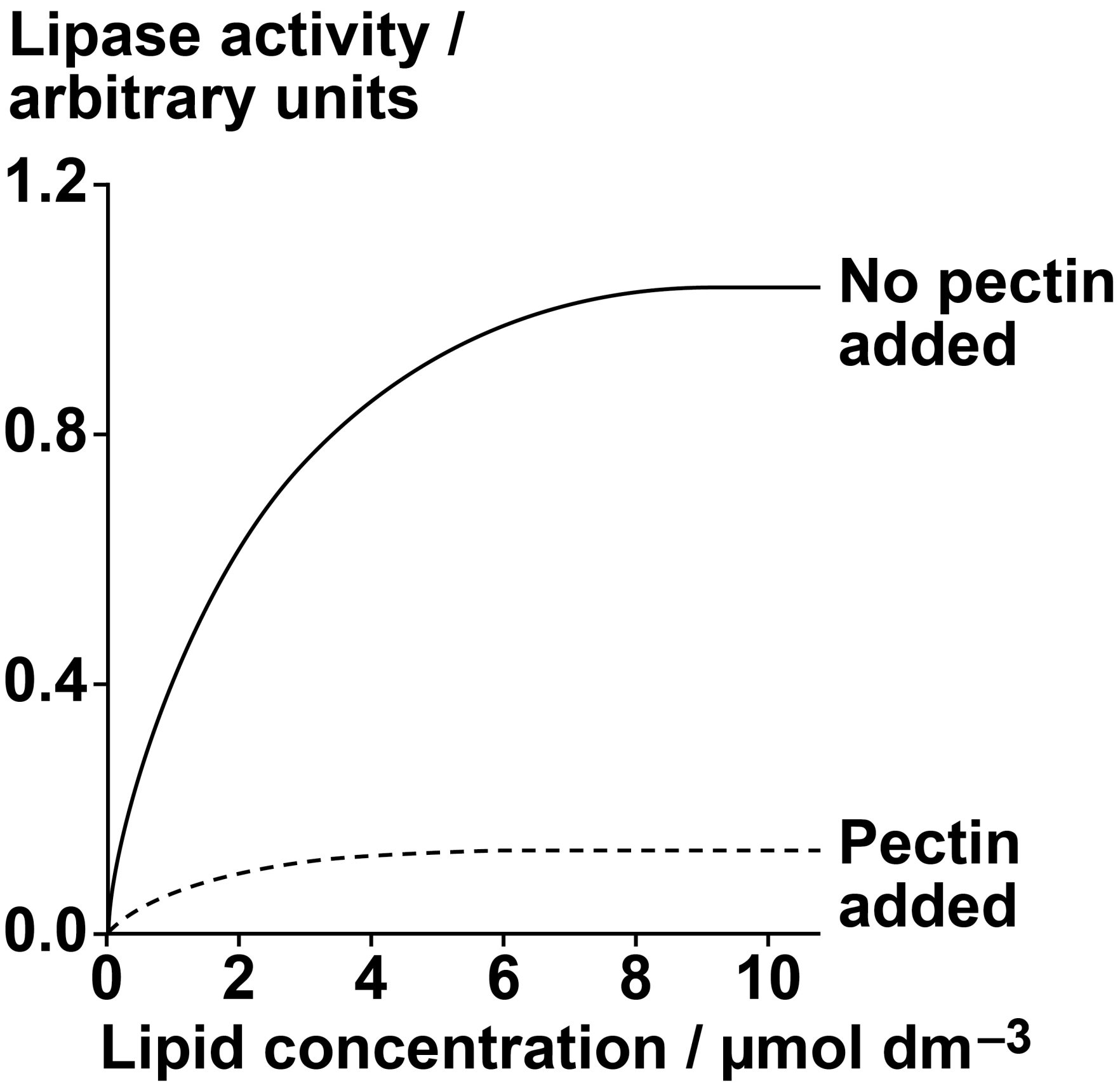
[Turn over]

**Pectin is a substance found in some fruit and vegetables.**

**A scientist investigated the effect of pectin on the hydrolysis of lipids by a lipase enzyme.**

**His results are shown in FIGURE 1, on the opposite page.**

FIGURE 1




[Turn over]

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**0 1 . 2**

**The scientist concluded that pectin is a non-competitive inhibitor of the lipase enzyme.**

**Use FIGURE 1, on page 7, to explain why the scientist concluded that pectin is a NON-COMPETITIVE inhibitor.**
**[1 mark]**

**The scientist also found that pectin stops the action of bile salts. He prepared two suspensions:**

- **suspension A – lipid and bile salts**
- **suspension B – lipid, bile salts and pectin.**

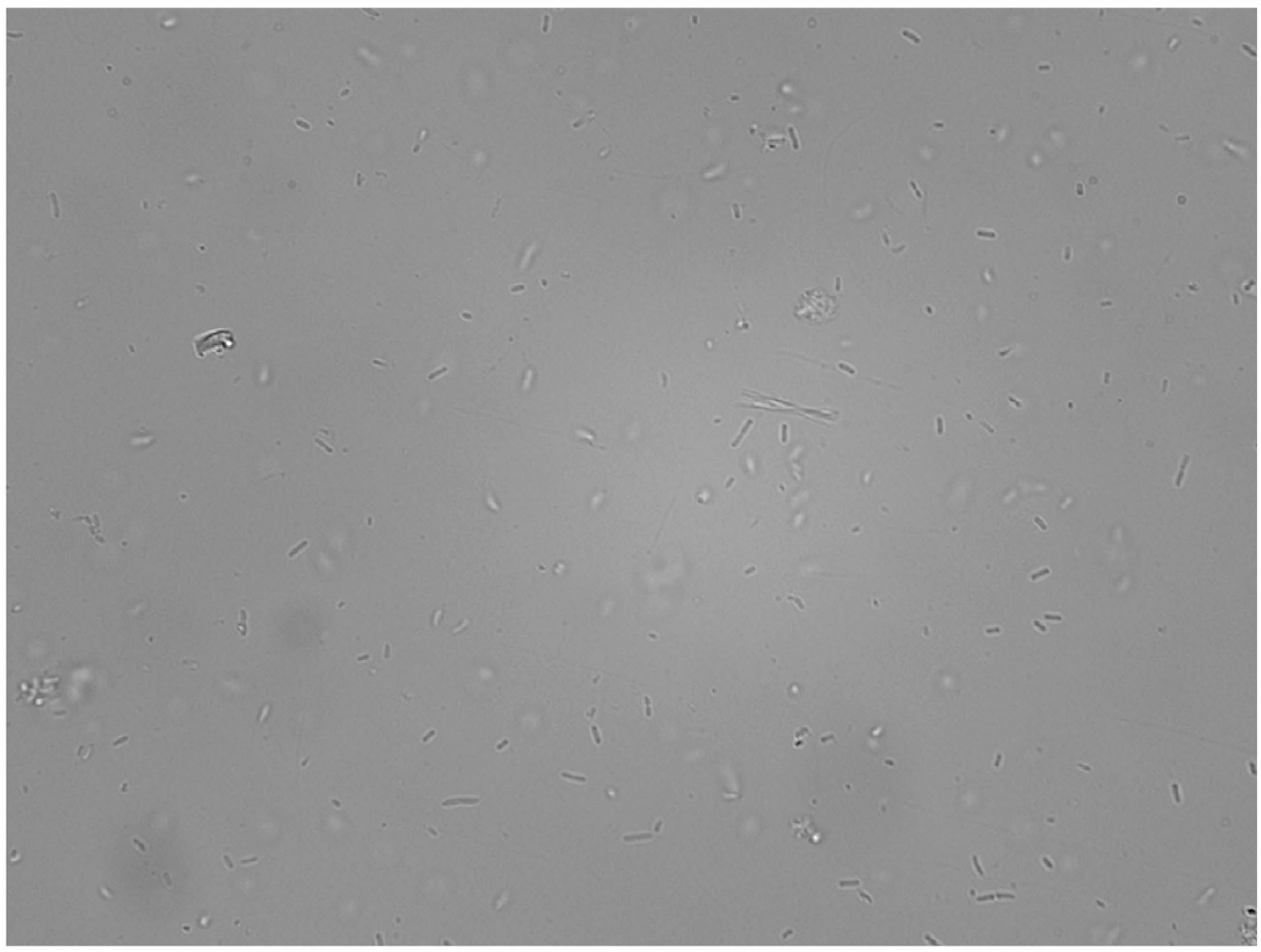
**He did NOT add lipase to either suspension.**

**He observed samples from the suspensions using an optical microscope.**

**FIGURE 2, on the opposite page, shows what he saw in a typical sample from each suspension.**

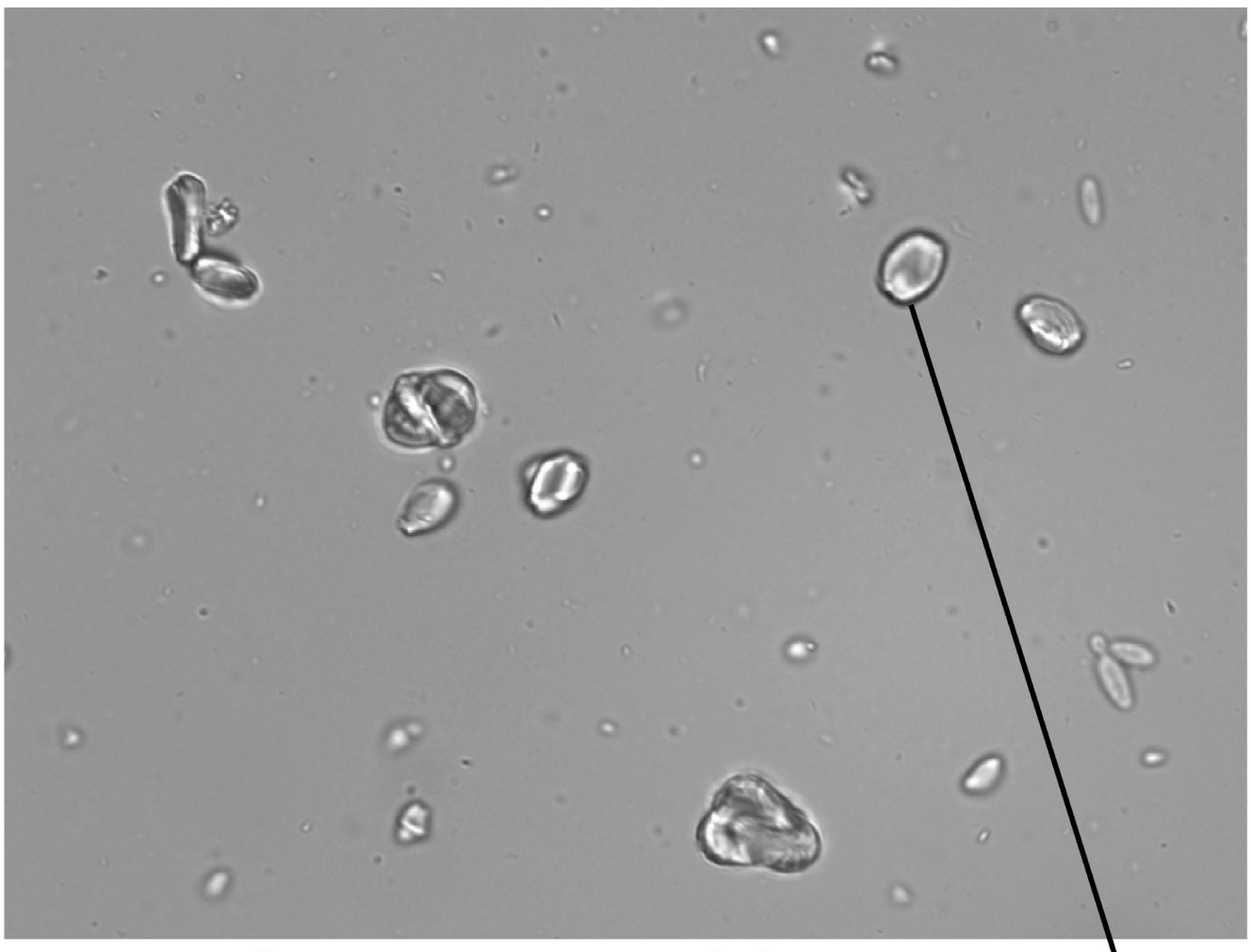
# FIGURE 2

## Suspension A



Magnification × 500

## Suspension B




Magnification × 500

**0 1 . 3**

**Calculate the maximum length of the large lipid droplet marked X in FIGURE 2, on page 11.**

**Using a ruler with millimetre intervals always includes an uncertainty in the measurement. Use the uncertainty in your measurement to determine the uncertainty of your calculated maximum length.**

**You can assume there is no uncertainty in the magnification. [2 marks]**

**Maximum length = _____ µm**

**Uncertainty of your calculated maximum length = _____ µm**

**[Turn over]**

**0 1 . 4**

**No large lipid droplets are visible with the optical microscope in the samples from suspension A.**

**Explain why. [2 marks]**

**8**

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[Turn over]

**0 2 . 1**

**TABLE 1 shows cell wall components in plants, algae, fungi and prokaryotes.**

**Complete TABLE 1, on the opposite page, by putting a tick (✓) where a cell wall component is present.**
**[3 marks]**

**TABLE 1**

| Cell wall component | Plants | Algae | Fungi | Prokaryotes |
|---|---|---|---|---|
| Cellulose | | | | |
| Murein | | | | |
| Chitin | | | | |



[Turn over]

**Cell walls make up much of the fibre that people eat.**

**Scientists investigated the relationship between the mass of fibre people ate each day and their risk of cardiovascular disease (CVD).**

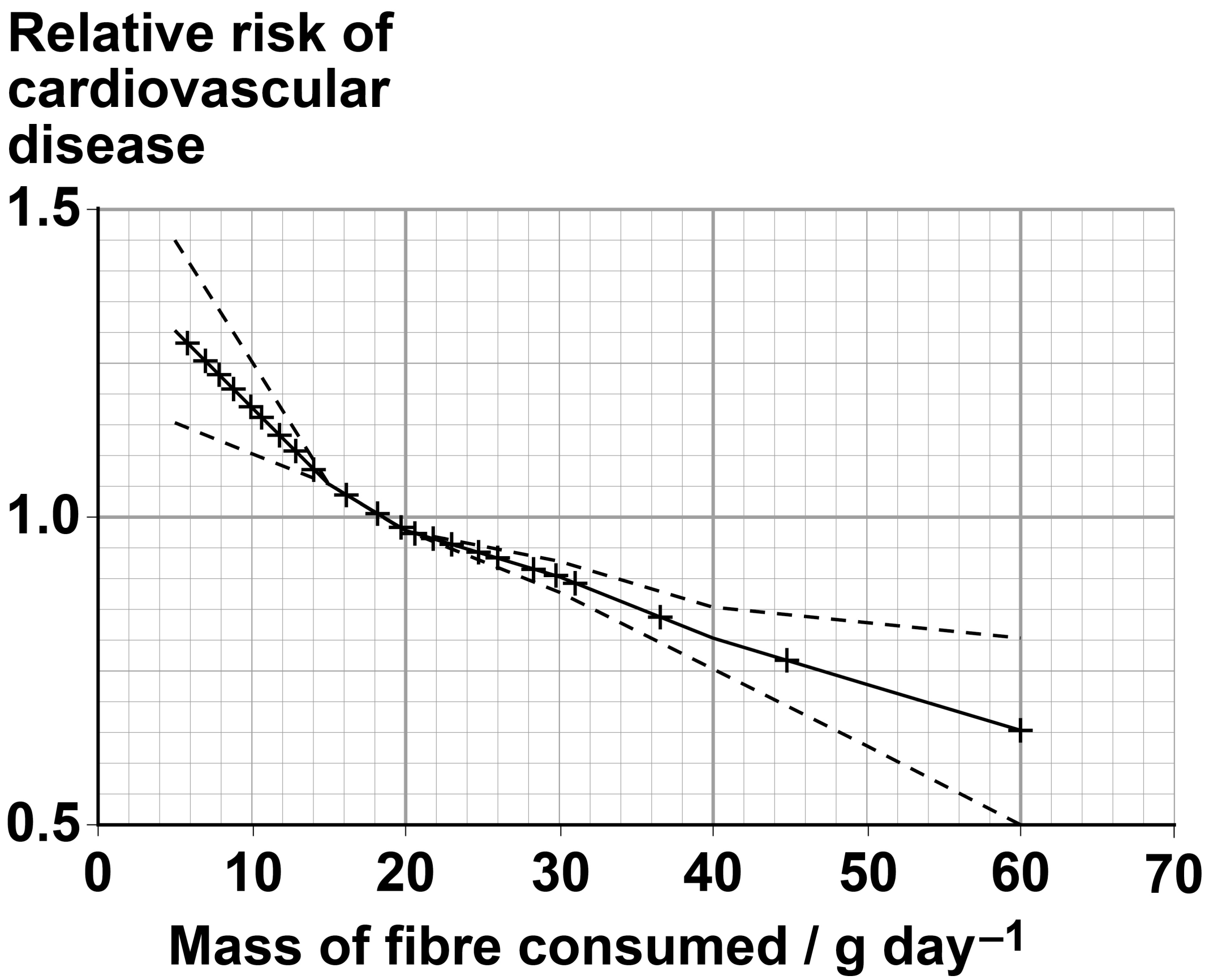
**They gathered data from a large sample of people and used this to calculate a relative risk.**

- **A relative risk of 1 means there is no difference in risk between the sample and the whole population.**
- **A relative risk of < 1 means CVD is less likely to occur in the sample than in the whole population.**
- **A relative risk of > 1 means CVD is more likely to occur in the sample than in the whole population.**

**Their results are shown in FIGURE 3, on pages 20 and 21. A value of ± 2 standard deviations from the mean includes over 95% of the data.**

**[Turn over]**

FIGURE 3


Relative risk of cardiovascular disease
1.5
1.0
0.5
0
10
20
30
40
50
60
70
Mass of fibre consumed / g day−1

**KEY**

—— **Mean relative risk**

- - - - **Line of best fit showing ± 2 standard deviations from the mean**

**Each ‘+’ plotted point represents 1000 people**

**[Turn over]**

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**0 2 . 2**

**A student concluded from FIGURE 3, on pages 20 and 21, that eating an extra 10 g of fibre per day would significantly lower his risk of cardiovascular disease.**

**Evaluate his conclusion. [4 marks]**

[Turn over]

**0 2 . 3**

**The scientists estimated the mean mass of fibre eaten per day using a food frequency questionnaire (FFQ).**

**The FFQ asks each person how often they have eaten many types of food over the past year.**

**An alternative method to calculate fibre eaten is for a nurse to ask each person detailed questions about what they have eaten in the last 24 hours.**

**Suggest ONE advantage of using the FFQ method and ONE disadvantage of using the FFQ method compared with the alternative method. [2 marks]**

**Advantage** _____

_____

_____

_____

**Disadvantage** _____

[Turn over]

9

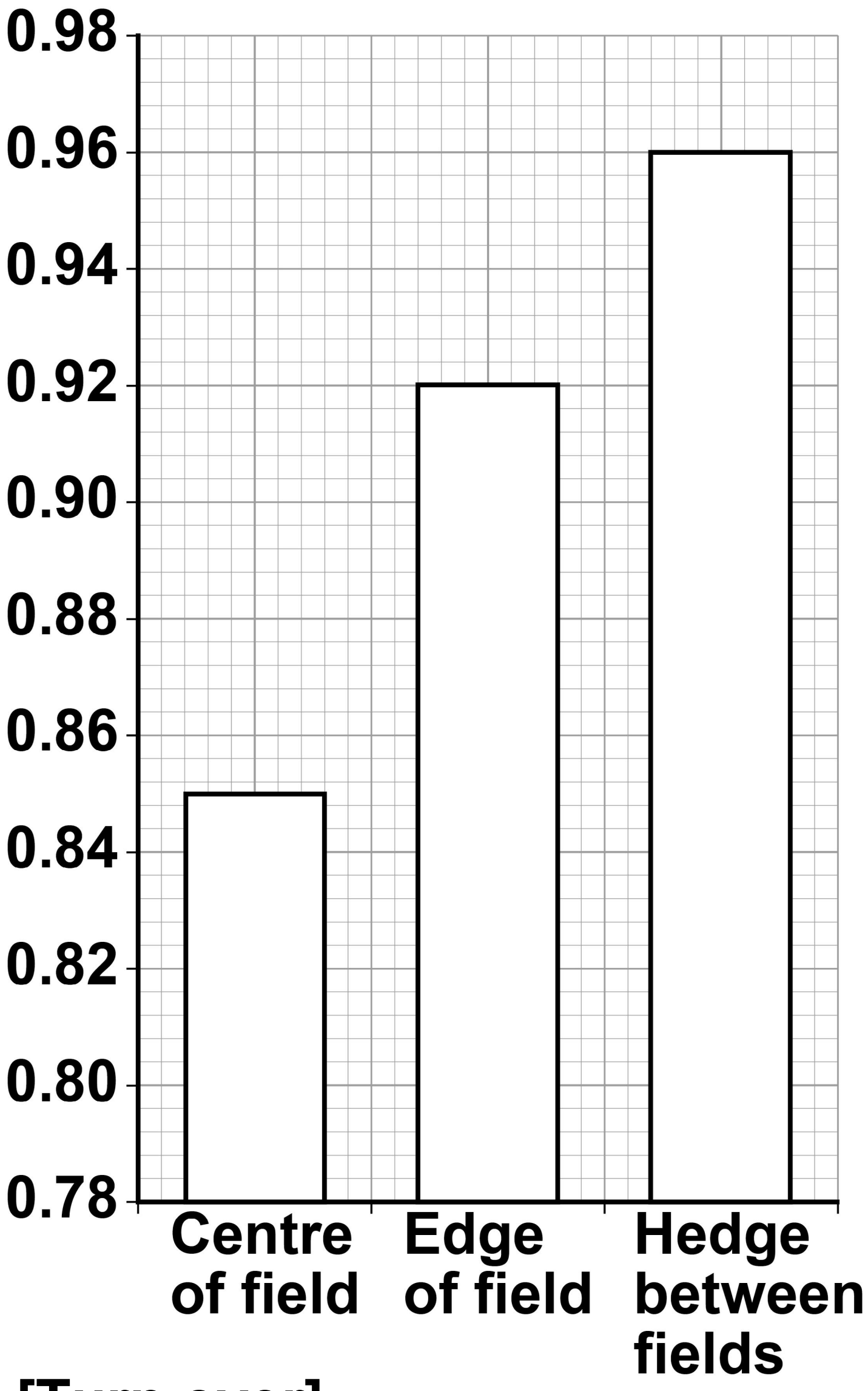
**0 3**

**A group of students investigated biodiversity of different areas of farmland. They collected data in each of these habitats:**

- **the centre of a field**
- **the edge of a field**
- **a hedge between fields.**

**Their results are shown in FIGURE 4, on the opposite page.**

# FIGURE 4




[Turn over]

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**0 3 . 1**

**What data would the students need to collect to calculate their index of diversity in each habitat?**

**Do NOT include apparatus used for species sampling in your answer.**

**[1 mark]**

# BLANK PAGE

**0 3 . 2**

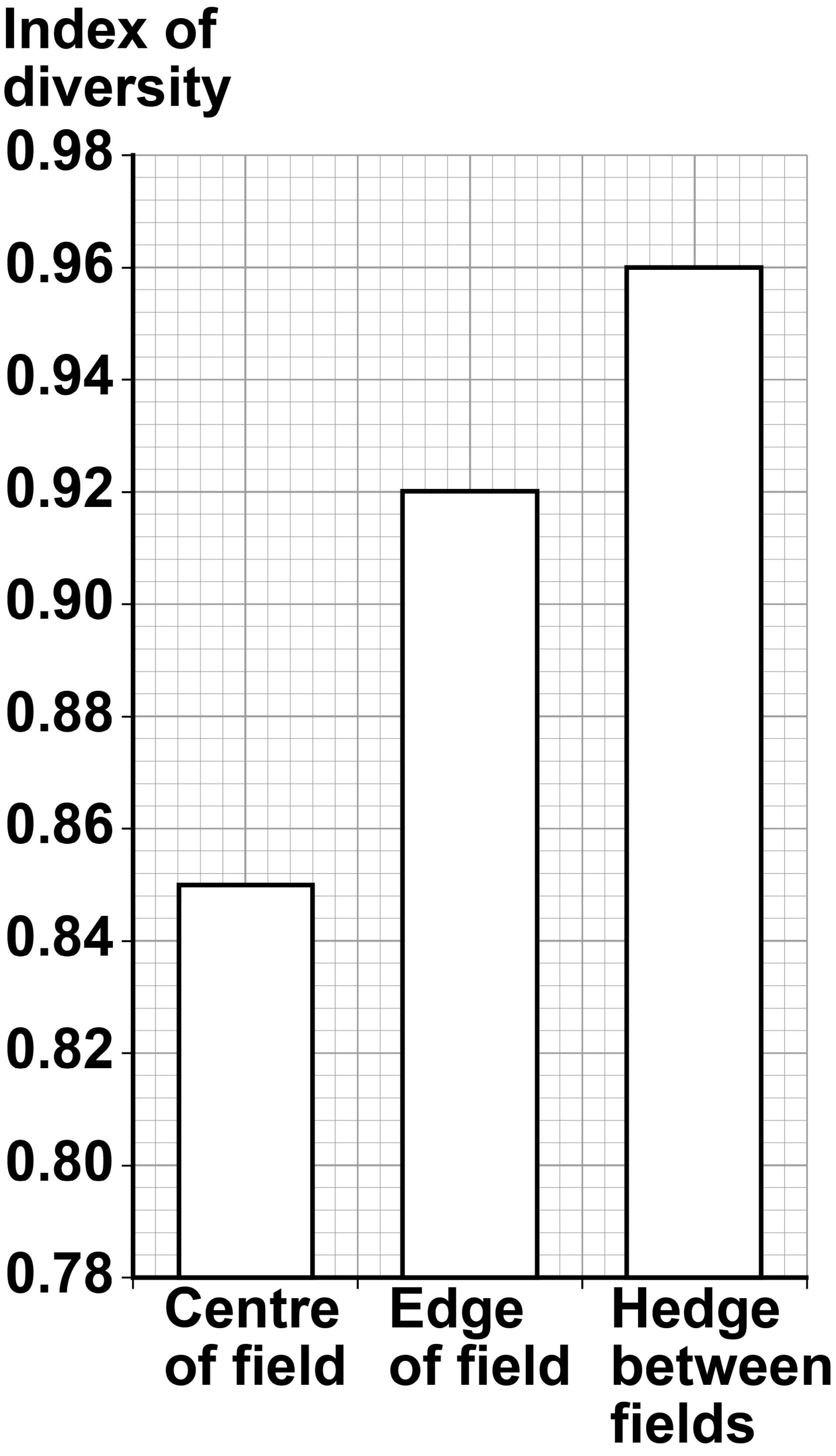
**Give TWO ways the students would have ensured their index of diversity was representative of each habitat. [2 marks]**

**1**

**2**

**[Turn over]**

# Repeat of FIGURE 4



**0 3 . 3**

**Modern farming techniques have led to larger fields and the removal of hedges between fields.**

**Use FIGURE 4 to suggest why biodiversity decreases when farmers use larger fields. [1 mark]**

**0 3 . 4**

**Farmers are now being encouraged to replant hedges on their land.**

**Suggest and explain ONE advantage and ONE disadvantage to a farmer of replanting hedges on her farmland.**

**[2 marks]**

**Advantage** _____

_____

_____

_____

_____

_____

**Disadvantage** _____

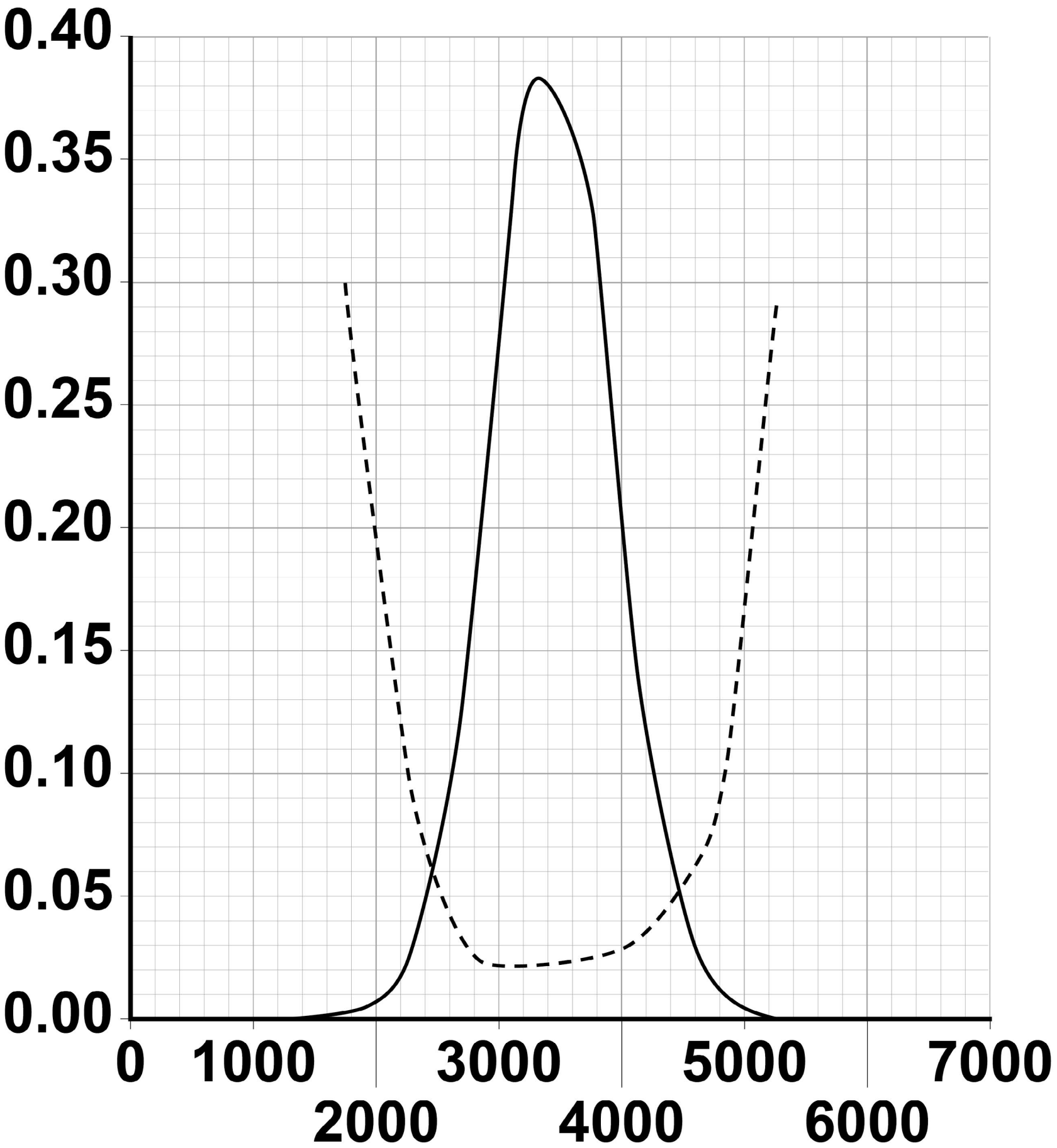
_____

_____

[Turn over]

6

# FIGURE 5


Population frequency
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
1000
2000
3000
4000
5000
6000
7000
Mass at birth / g
KEY
—— Mass at birth
---- Transfer to special care unit

**0 4**

**Scientists collected data on 800 000 human births. The data showed the mass of each baby at birth and whether the baby needed to be transferred to a special care unit for very ill babies. Their results are shown in FIGURE 5.**

**0 4 . 1**

**Use FIGURE 5 to explain how human mass at birth is affected by stabilising selection. [3 marks]**

[Turn over]

**0 4 . 2**

**The scientists studied the effect of one form, *KIR2DS1*, of the human *KIR* gene on mass at birth.**

**In the following passage the numbered spaces can be filled with biological terms.**

***KIR2DS1* is an ____(1)____ of the *KIR* gene, found at a ____(2)____ on chromosome 19. *KIR2DS1* is 14 021 bases long and is ____(3)____ into mRNA that is 1101 bases long. This mRNA is then ____(4)____ into a polypeptide 304 amino acids long. The polypeptide is then modified in the organelle, ____(5)____ before forming its functional ____(6)____ protein structure.**

**Write the correct biological term beside each number below, that matches the space in the passage. [3 marks]**

**(1)** _____

**(2)** _____

**(3)** _____

**(4)** _____

**(5)** _____

**(6)** _____

**0 4 . 3**

**The scientists studied 1500 more births. They recorded the mass at birth of each baby and the nature of the *KIR* gene in the mother's genome.**

**Some of their results are shown in TABLE 2, on the opposite page.**

**TABLE 2**

| Presence or absence of *KIR2DS1* in mother's genome | Number of babies with mass at birth: | |
|---|---|---|
| | between 2500 g and 4500 g | above 4500 g |
| Present | 389 | 148 |
| Absent | 606 | 173 |

**The scientists used a statistical test to test the following null hypothesis:**

**'The presence of *KIR2DS1* in the mother's genome does NOT affect the frequency of births above 4500 g'**

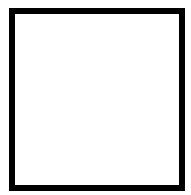
**[Turn over]**

# BLANK PAGE

**Tick (✓) ONE box that gives the name of the statistical test that the scientists should use with the data in TABLE 2, on page 45, to test this null hypothesis.**
**[1 mark]**

☐ **Chi-squared**

☐ **Correlation coefficient**



**Student's t-test**

**[Turn over]**

**0 4 . 4**

**The scientists calculated a P value of 0.03 when testing their null hypothesis.**

**What can you conclude from this result? Explain your answer. [3 marks]**

10

**0 5 . 1**

**Describe the structure of the human immunodeficiency virus (HIV). [4 marks]**

[Turn over]

**Some people infected with HIV do not develop AIDS. These people are called HIV controllers.**

**Scientists measured the number of HIV particles (the viral load) and the number of one type of T helper cell (CD4 cells) in the blood of a group of HIV controllers and also in a group of HIV positive patients who had symptoms of AIDS.**

**The median values and the range of their results are shown in TABLE 3, on the opposite page.**

**TABLE 3**

| HIV status of people | Median viral load / virus particles per $cm^3$ of blood (range) | Median number of CD4 cells per $mm^3$ of blood (range) |
|---|---|---|
| HIV controllers | 212 (<50 to 609) | 693 (529 to 887) |
| HIV positive people with AIDS symptoms | 66 274 (30 206 to 306 163) | 248 (107 to 365) |



[Turn over]

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**0 5 . 2**

**A test sample of 500 $mm^3$ of blood is taken from an HIV controller to determine the viral load.**

**Tick (✓) ONE box that shows the number of virus particles that would be present in a test sample of blood taken from an HIV controller with the median viral load. [1 mark]**

☐ **106 000**

☐ **10 600**

☐ **1060**

☐ **106**

**[Turn over]**

**0 5 . 3**

**Use the data in TABLE 3, on page 53, and your knowledge of the immune response to suggest why HIV controllers do not develop symptoms of AIDS. [3 marks]**

[Turn over]

8

5 7

**0 6**

**Scientists investigated the cell cycle in heart cells taken from mice 6 days before their birth and then at 4, 14 and 21 days after their birth.**

**Their results are shown in TABLE 4.**

**Age 0 days = day of birth.**

**TABLE 4**

| Age / days | Percentage of heart cells undergoing mitosis | Percentage of heart cells undergoing DNA replication |
|---|---|---|
| – 6 | 13.9 | 8.5 |
| 4 | 8.5 | 2.6 |
| 14 | 1.6 | 0.2 |
| 21 | 0.6 | 0.0 |

**0 6 . 1**

**Describe and explain the data in TABLE 4. [2 marks]**

The scientists determined the percentage of heart cells undergoing DNA replication by using a chemical called BrdU. Cells use BrdU instead of nucleotides containing thymine during DNA replication.

**0 6 . 2**

Describe how BrdU would be incorporated into new DNA during semi-conservative replication. [5 marks]

[Turn over]

**0 6 . 3**

**Cells with BrdU in their DNA are detected using an anti-BrdU antibody with an enzyme attached.**

**Use your knowledge of the ELISA test to suggest and explain how the scientists identified the cells that have BrdU in their DNA. [3 marks]**

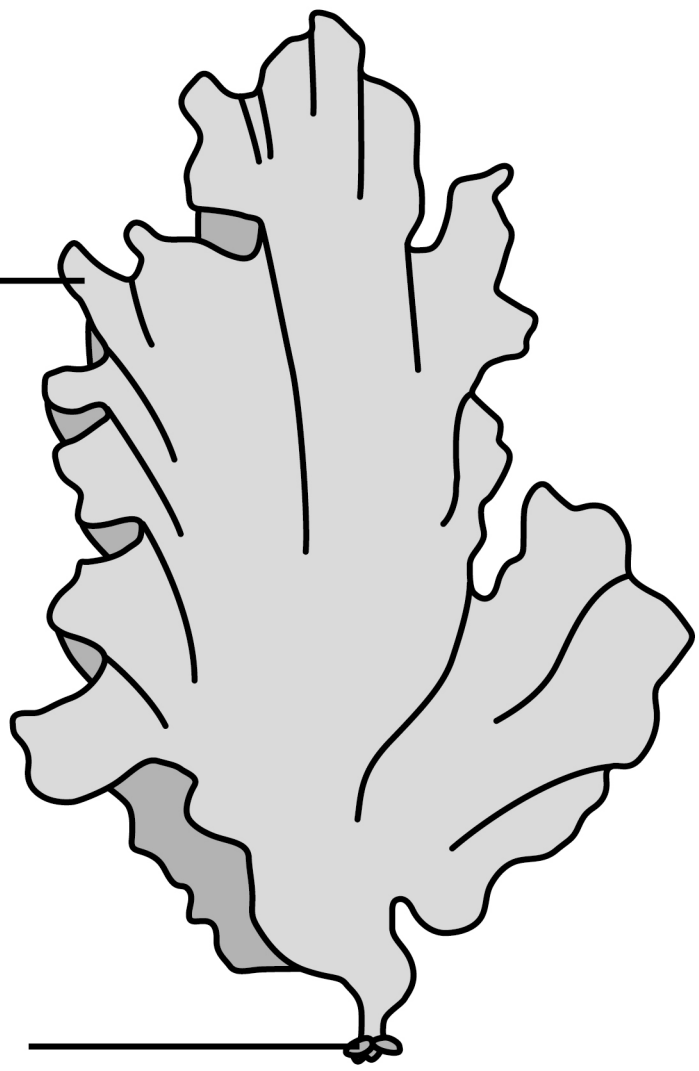
**0 7**

**‘Ulva lactuca’ is an alga that lives on rocks on the seashore. It is regularly covered by seawater.**

**FIGURE 6 shows a diagram of one ‘Ulva lactuca’ alga.**

**FIGURE 6**

**‘Ulva lactuca’**



**Thallus – the green, leaf-like part of the alga**

**Holdfast – attaches the alga to the rock**

**0 7 . 1**

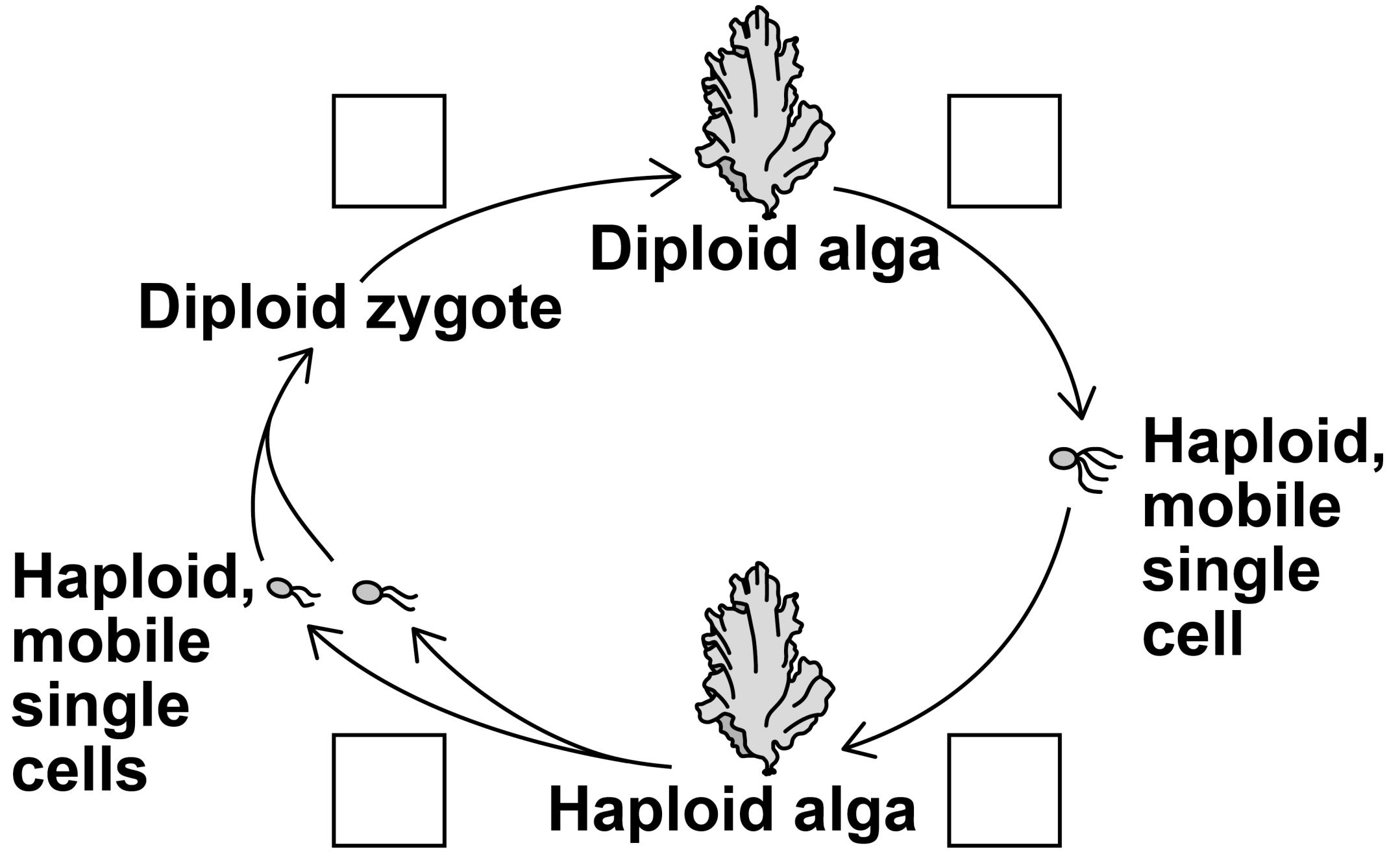
**Unlike plants, ‘Ulva lactuca’ does not have xylem tissue.**

**Suggest how ‘Ulva lactuca’ is able to survive without xylem tissue. [1 mark]**

‘Ulva lactuca’ has a haploid and a diploid form.

FIGURE 7 shows the life cycle of ‘Ulva lactuca’.

FIGURE 7



**0 7 . 2**

**On FIGURE 7 complete each box with an appropriate letter to show the type of cell division happening between each stage in the life cycle. Use 'T' to represent mitosis and 'E' to represent meiosis.**
**[2 marks]**

**0 7 . 3**

**‘Ulva prolifera’ also produces haploid, mobile single cells that can fuse to form a zygote.**

**Suggest and explain ONE reason why successful reproduction between ‘Ulva prolifera’ and ‘Ulva lactuca’ does NOT happen. [2 marks]**

[Turn over]

**0 8**

**The water potential of leaf cells is affected by the water content of the soil.**

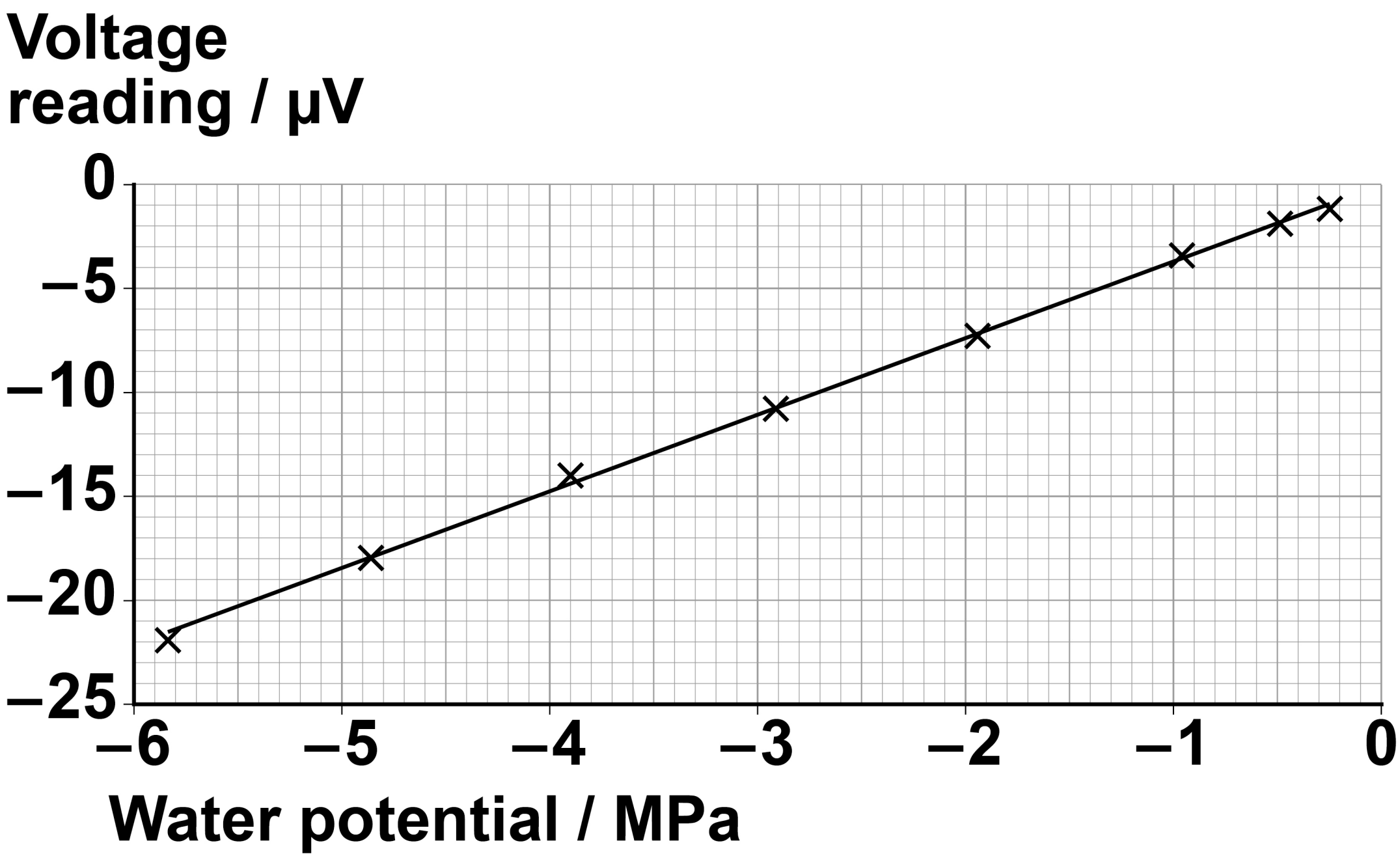
**Scientists grew sunflower plants. They supplied different plants with different volumes of water.**

**After two days, they determined the water potential in the leaf cells by using an instrument that gave a voltage reading.**

**The scientists generated a calibration curve to convert the voltage readings to water potential.**

**FIGURE 8, on the opposite page, shows their calibration curve.**

## FIGURE 8




[Turn over]

**0 8 . 1**

**The scientists needed solutions of known water potential to generate their calibration curve.**

**TABLE 5, on the opposite page, shows how to make a sodium chloride solution with a water potential of −1.95 MPa**

**Complete TABLE 5 by giving all headings, units and volumes required to make 20 $cm^3$ of this sodium chloride solution. [2 marks]**

**TABLE 5**

| Water potential / MPa | Concentration of sodium chloride solution / mol $dm^{-3}$ | Volume of 1 mol $dm^{-3}$ sodium chloride solution / _____ | _____ / _____ |
|---|---|---|---|
| –1.95 | 0.04 | _____ | _____ |

**[Turn over]**

**TABLE 6 shows some of the concentrations of sodium chloride solution the scientists used and the water potential of each solution.**

**TABLE 6**

| Concentration of sodium chloride solution / mol $dm^{-3}$ | Water potential / MPa |
|---|---|
| 0.04 | −1.95 |
| 0.10 | −4.87 |
| 0.12 | −5.84 |

**0 8 . 2**

**There is a linear relationship between the water potential and the concentration of sodium chloride solution.**

**Use the data in TABLE 6 to calculate the concentration of sodium chloride solution with a water potential of −3.41 MPa [2 marks]**

**Answer = _____ mol $dm^{-3}$**

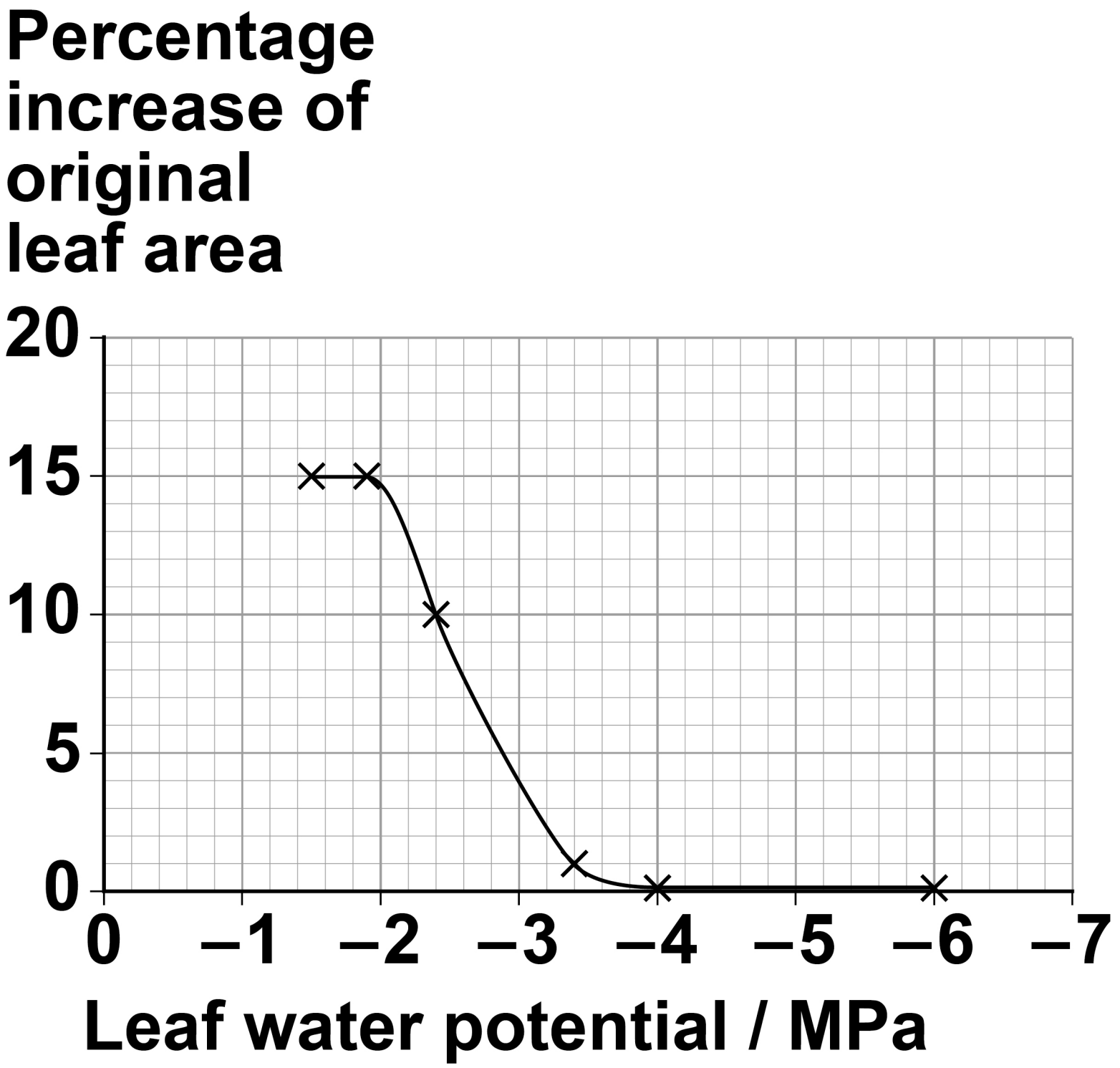
**[Turn over]**

**In addition to determining the water potential in the leaf cells, the scientists measured the growth of the leaves.**

**They recorded leaf growth as a percentage increase of the original leaf area.**

**Their results are shown in FIGURE 9.**

**FIGURE 9**



**0 8 . 3**

**One leaf with an original area of 60 $cm^2$ gave a voltage reading of –7 µV**

**Use FIGURE 8, on page 71, and FIGURE 9, opposite, to calculate by how much this leaf increased in area.**
**Give your answer in $cm^2$ [2 marks]**

**Answer = _____ $cm^2$**

**[Turn over]**

**0 8 . 4**

**Sunflowers are not xerophytic plants. The scientists repeated the experiment with xerophytic plants.**

**Suggest and explain ONE way the leaf growth of xerophytic plants would be different from the leaf growth of sunflowers in FIGURE 9, on page 76. [2 marks]**

**0 8 . 5**

**Use your knowledge of gas exchange in leaves to explain why plants grown in soil with very little water grow only slowly. [2 marks]**

**0 9**

**A scientist investigated the affinity for oxygen of horse haemoglobin and mouse haemoglobin.**

**Some of their results are shown in TABLE 7, on the opposite page.**

**TABLE 7**

| Animal | Partial pressure of oxygen when haemoglobin is 50% saturated / kPa | Partial pressure of oxygen when haemoglobin is 25% saturated / kPa | Body mass of one animal / g |
|---|---|---|---|
| Horse | 3.2 | 1.9 | 550 000 |
| Mouse | 6.5 | 3.3 | 23 |

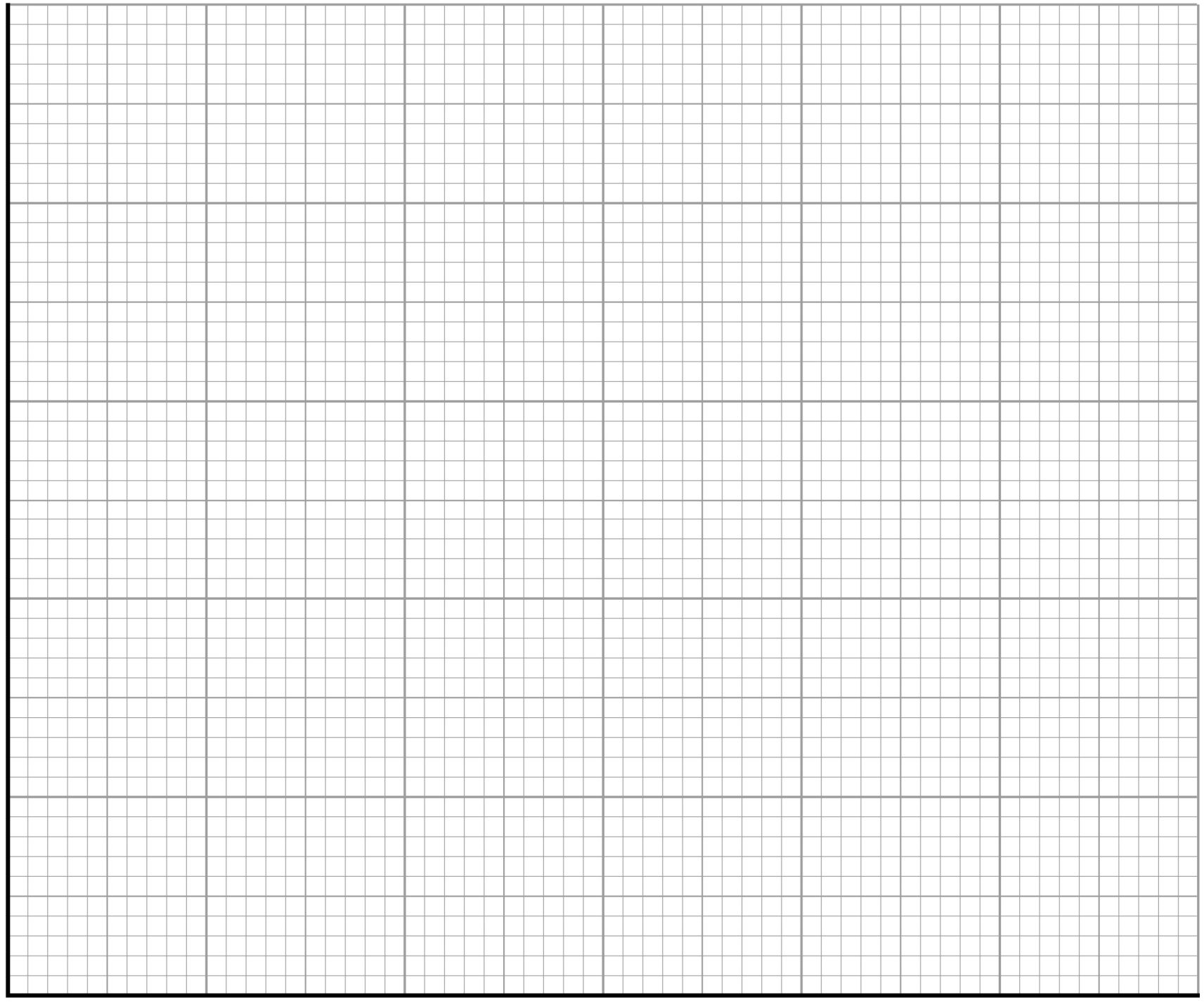


**[Turn over]**

0 9 . 1

**On the opposite page, plot the haemoglobin saturation data from TABLE 7, on page 81, and use these points to sketch the full oxyhaemoglobin dissociation curves for a horse and a mouse. [3 marks]**

# Percentage of saturation of oxyhaemoglobin



# Partial pressure of oxygen / kPa



**[Turn over]**

0 9 . 2

**The following equation can be used to estimate the metabolic rate of an animal.**

**Metabolic rate = $63 \times BM^{-0.27}$**

**BM = body mass in grams**

**Use this equation to calculate how many times faster the metabolic rate of a mouse is than the metabolic rate of a horse. [2 marks]**

Answer = ∞ times faster

[Turn over]

## Repeat of TABLE 7

| Animal | Partial pressure of oxygen when haemoglobin is 50% saturated / kPa | Partial pressure of oxygen when haemoglobin is 25% saturated / kPa | Body mass of one animal / g |
|---|---|---|---|
| Horse | 3.2 | 1.9 | 550 000 |
| Mouse | 6.5 | 3.3 | 23 |

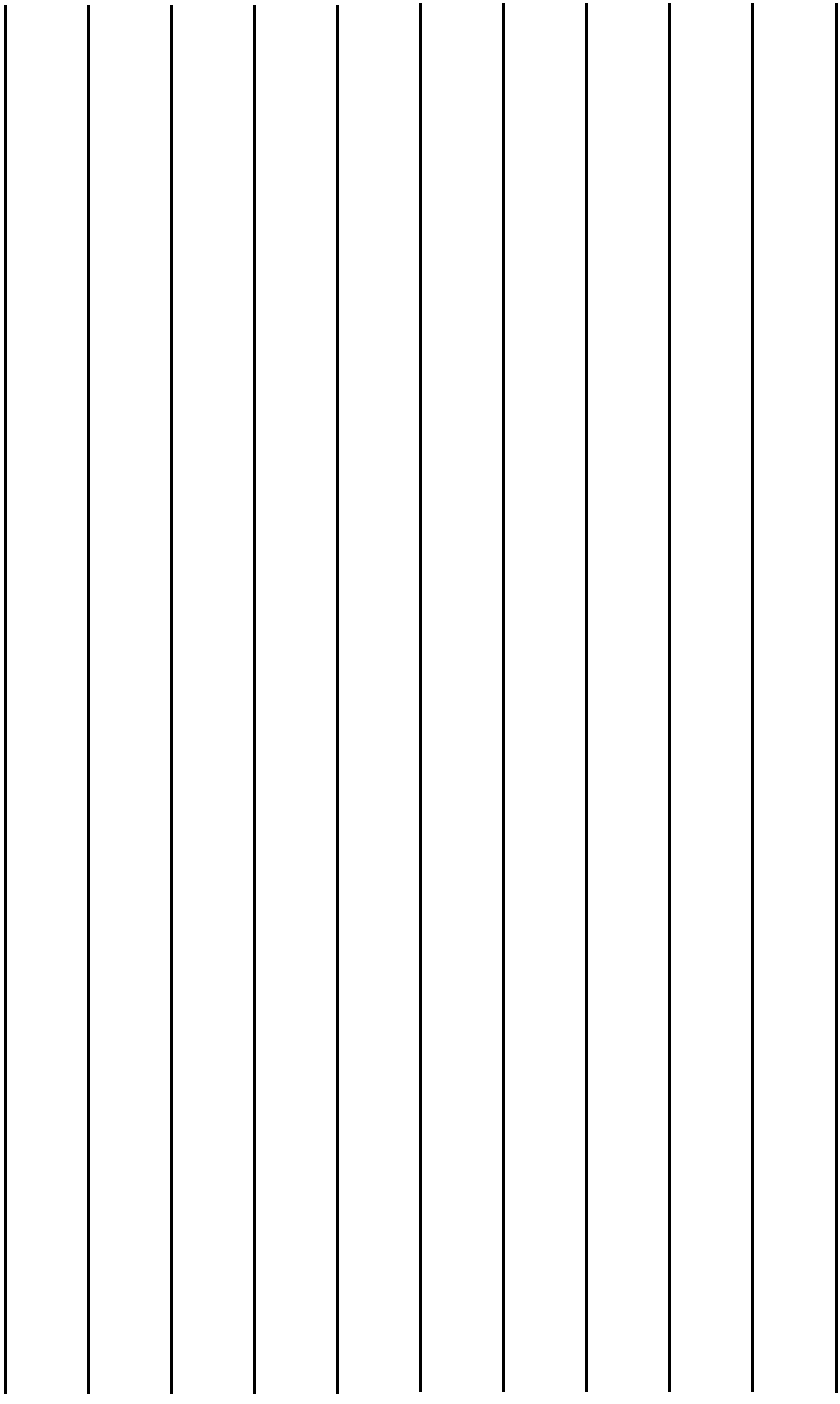
**0 9 . 3**

**The data in TABLE 7, on the opposite page, show differences between the oxyhaemoglobin dissociation curve for a mouse and the oxyhaemoglobin dissociation curve for a horse.**

**Suggest how these differences allow the mouse to have a higher metabolic rate than the horse. [2 marks]**



[Turn over]



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# [Turn over]

**0 9 . 4**

**Mammals such as a mouse and a horse are able to maintain a constant body temperature.**

**Use your knowledge of surface area to volume ratio to explain the higher metabolic rate of a mouse compared to a horse. [3 marks]**

[Turn over]

10

**1 0 . 1**

**Explain FIVE properties that make water important for organisms. [5 marks]**

[Turn over]

# 94

**1 0 . 2**

**Describe the biochemical tests you would use to confirm the presence of lipid, non-reducing sugar and amylase in a sample. [5 marks]**

[Turn over]

**1 0 . 3**

**Describe the chemical reactions involved in the conversion of polymers to monomers and monomers to polymers.**

**Give TWO named examples of polymers and their associated monomers to illustrate your answer. [5 marks]**

[Turn over]

END OF QUESTIONS

15

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