A

AQA

**Surname** _____

**Forename(s)** _____

**Centre Number** _____

**Candidate Number** _____

**Candidate Signature** _____

**I declare this is my own work.**

# AS

# BIOLOGY

**Paper 1**

# 7401/1

**Monday 15 May 2023** **Morning**

**Time allowed: 1 hour 30 minutes**

**At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.**

**[Turn over]**

JUN237401101

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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 75.**

**DO NOT TURN OVER UNTIL TOLD TO DO SO**

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

**0 1 . 1**

**Describe the primary structure of all proteins. [2 marks]**

**0 1 . 2**

**This question is about the genetic code.**

**Define UNIVERSAL, NON-OVERLAPPING and DEGENERATE. [3 marks]**

**Universal** _____

_____

_____

_____

**Non-overlapping** _____

_____

_____

_____

**Degenerate** _____

_____

_____

_____

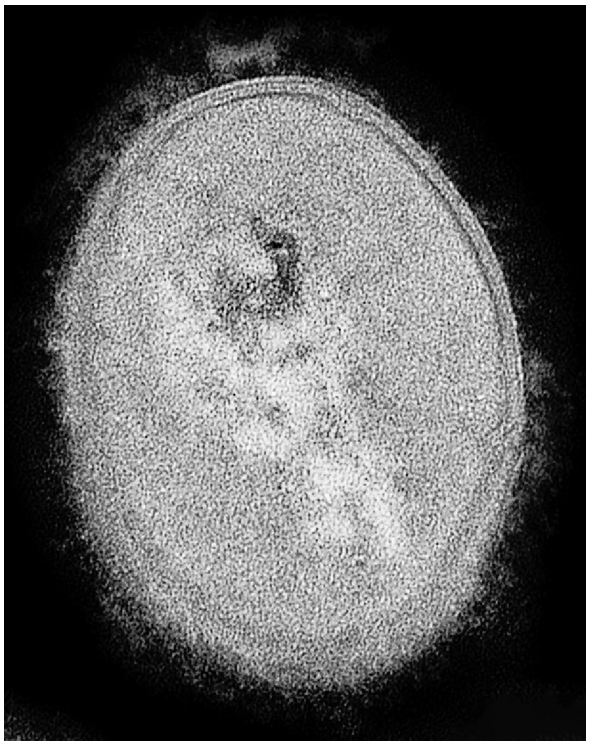
**[Turn over]**

**5**

**0 2**

**FIGURE 1 shows a transmission electron microscope (TEM) image of a 'Streptococcus' bacterium.**

**FIGURE 1**



**0 2 . 1**

**Describe how the appearance of the area containing DNA in a TEM image of a eukaryotic cell would differ from that shown in FIGURE 1. [2 marks]**

0 2 . 2

**Describe ONE difference between the structure of DNA in a prokaryotic cell and in a eukaryotic cell. [1 mark]**

**0 2 . 3**

**‘Streptococcus’ bacteria can infect the lungs when air is breathed in and cause lung disease.**

**Describe the mechanism of breathing that causes air to enter the lungs. [3 marks]**

**0 2 . 4**

**Some strains of 'Streptococcus' bacteria are more likely to cause lung disease than other strains.**

**Strains that do not cause lung disease are quickly destroyed by phagocytes. Phagocytes are stimulated when they bind to murein on 'Streptococcus' bacteria.**

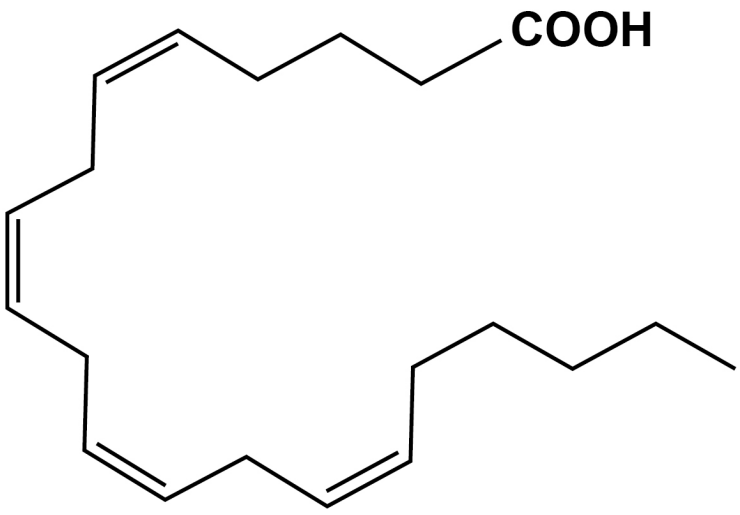
**Each strain of 'Streptococcus' bacteria has a capsule of different thickness from the others.**

**Suggest how 'Streptococcus' bacteria with a thicker capsule are more likely to survive AND so cause lung disease. [2 marks]**

**0 3 . 1**

**FIGURE 2 shows a fatty acid that contains 20 carbon atoms and four double bonds.**

**FIGURE 2**




**On FIGURE 2, draw a box around the R group of the fatty acid. [1 mark]**

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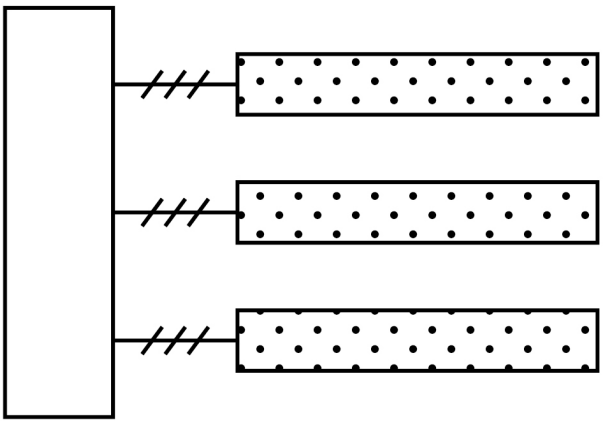
**[Turn over]**

**0 3 . 2**

**FIGURE 3 shows a triglyceride.**

**FIGURE 3**



**KEY**

**Glycerol**

**Ester bond**

**Fatty acid**

**Describe TWO differences between the structure of the triglyceride shown in FIGURE 3 and a phospholipid.**
**[2 marks]**

**1** _____

_____

_____

2 _____

_____

_____

[Turn over]

**0 3 . 3**

**Explain why phospholipids can form a bilayer but triglycerides cannot. [3 marks]**

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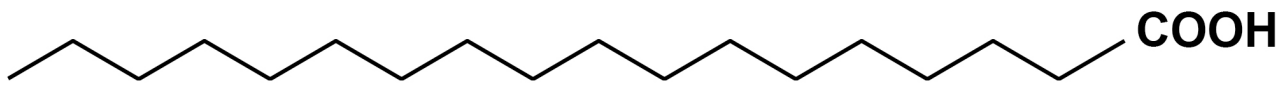
**[Turn over]**

**0 3 . 4**

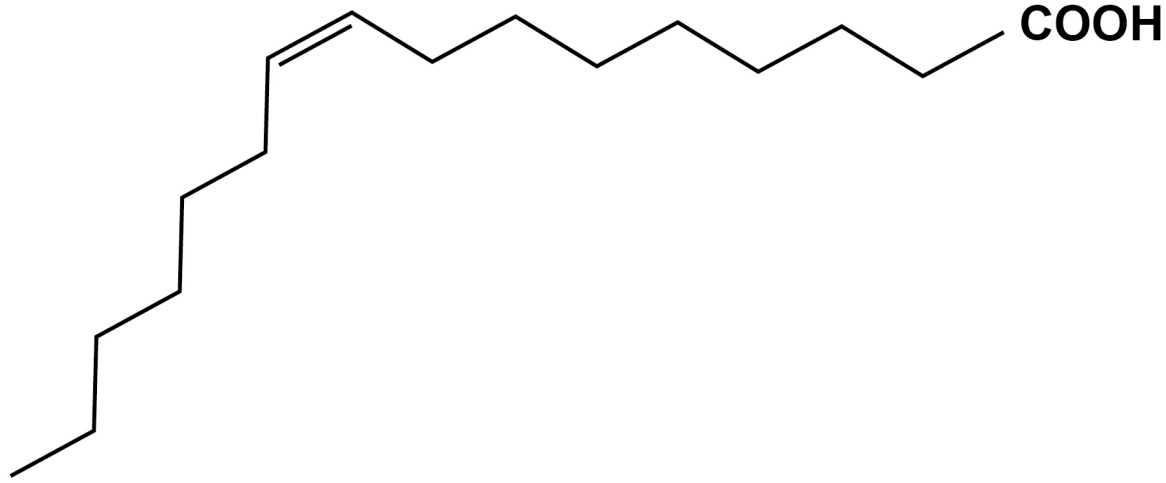
**FIGURE 4 shows two fatty acids, A and B.**

**FIGURE 4**

**A**




**B**




**Scientists fed rats a diet with added fish oil for 4 months.**

**They obtained samples of red blood cells from the rats before starting this diet (0 months) and after 4 months on this diet.**

**For each red blood cell sample, they separated the cell-surface membranes and measured:**

- **the percentage of phospholipids containing each of the fatty acids A and B**
- **the fluidity of the membrane.**

**TABLE 1, on page 18, shows the scientists' results.**

**[Turn over]**

**TABLE 1**

| Time sample of red blood cells obtained / months | Mean percentage of phospholipids containing fatty acid A | Mean percentage of phospholipids containing fatty acid B | Mean fluidity of the membrane / arbitrary units |
|---|---|---|---|
| 0 | 19.8 | 1.7 | 31 |
| 4 | 11.7 | 9.0 | 97 |

**Suggest why the fluidity of the membrane was higher after 4 months.**

**Use all the information provided in the question.**
**[3 marks]**

[Turn over]

9

**0 4**

**Scientists investigated the activation of T lymphocytes.**

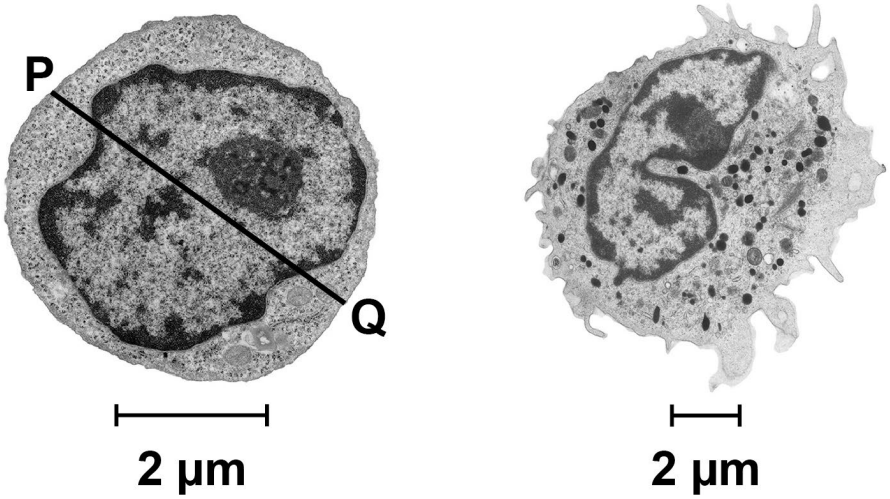
**The scientists studied two types of cell:**

- **naïve T cells, which are T cells that have not yet been in contact with a foreign antigen**
- **activated helper T cells, which are T cells that have been activated by a foreign antigen.**

**FIGURE 5 shows electron microscope images of the two types of cell.**

**FIGURE 5**

**NAÏVE T CELL** **ACTIVATED HELPER T CELL**




**The activated helper T cell has a volume of 463 µm$^3$**

**0 4 . 1**

**Calculate the volume of the naïve T cell shown in FIGURE 5.**

**Then calculate how many times larger the activated helper T cell volume is compared with the naïve T cell volume.**

**Assume the cell is spherical.**

**Use line PQ to measure the diameter of the naïve T cell.**

**Volume of a sphere = $\frac{4}{3}\pi r^3$ where $\pi$ is 3.14**

**Show your working. [3 marks]**

**Volume of naïve T cell _____ $\mu m^3$**

**Number of times larger the activated helper T cell volume is compared with the naïve T cell volume**

_____

**0 4 . 2**

**State ONE feature that shows the images in FIGURE 5, on page 20, were taken with an electron microscope and NOT an optical microscope.**

**Explain your answer. [2 marks]**

**0 4 . 3**

**State ONE role of a helper T cell. [1 mark]**

**0 4 . 4**

**The rate of translation is increased in T cells activated by antigens.**

**Describe the role of tRNA in translation. [2 marks]**

**8**

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**[Turn over]**

**0 5**

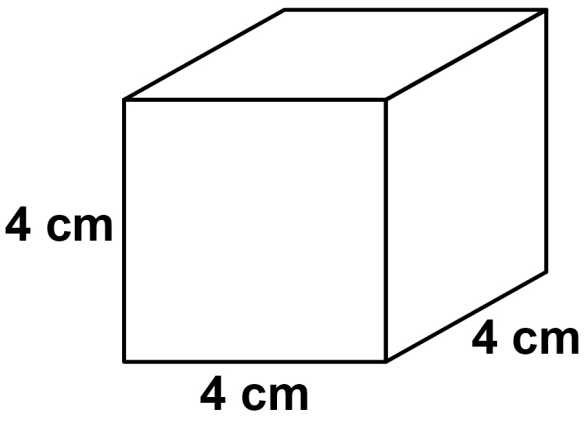
**A student investigated the effect of changing surface area on the rate of diffusion of a solution into the centre of agar blocks.**

**She used agar coloured by an indicator. The indicator is pink at pH > 8 and colourless at pH 8 and pH < 8**

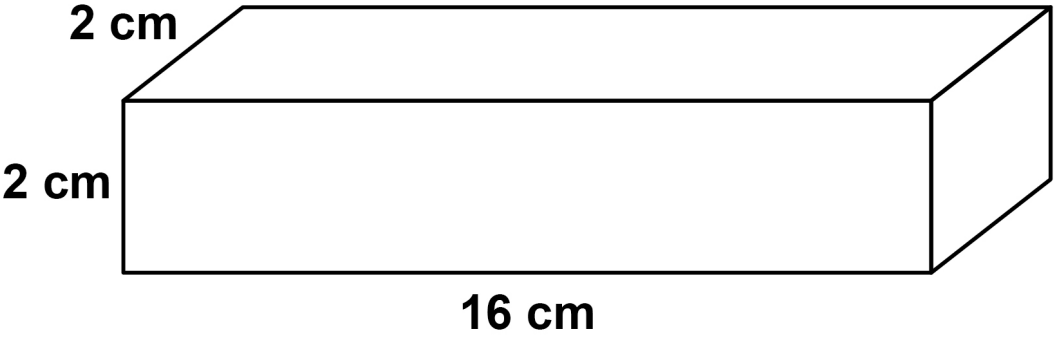
**She cut blocks in different shapes as shown in FIGURE 6.**

**FIGURE 6**

**C**




**D**



**0 5 . 1**

**Complete TABLE 2 to show the surface area and the surface area to volume ratio for the two shapes.**
**[2 marks]**

**TABLE 2**

| Shape | Surface area / $cm^2$ | Volume / $cm^3$ | Surface area to volume ratio |
|---|---|---|---|
| C | _____ | 64 | _____ : 1 |
| D | _____ | 64 | _____ : 1 |

**[Turn over]**

**0 5 . 2**

**The student put the blocks into an acidic solution.**

**The acidic solution caused the blocks to gradually turn from pink to colourless.**

**She recorded the time taken for the blocks to turn completely colourless. She repeated this three times.**

**TABLE 3 shows the student's results.**

**TABLE 3**

| Shape | Time for block to turn colourless / s | | | | Mean time for block to turn colourless / s |
|---|---|---|---|---|---|
| | Block 1 | Block 2 | Block 3 | Block 4 | |
| C | 3490 | 1200 | 3540 | 3530 | _____ |
| D | 1680 | 1500 | 1590 | 1610 | 1595 |

**After collecting the data, the student noticed that shape C, block 2 was damaged.**

**Calculate the mean for shape C. [1 mark]**

**0 5 . 3**

**Suggest what the student should have done when she saw that shape C, block 2 was damaged. [1 mark]**

**0 5 . 4**

**State THREE variables the student controlled in order to obtain valid results. [2 marks]**

**1** _____

**2** _____

**3** _____

**[Turn over]**

**0 5 . 5**

**Describe how gas exchange occurs in single-celled organisms AND explain why this method cannot be used by large, multicellular organisms. [3 marks]**

**0 6**

**The human papilloma virus contains a double-stranded DNA genome.**

**0 6 . 1**

**Which components are found in a human papilloma virus? [1 mark]**

**Tick (✓) ONE box.**

- ☐ **Capsid and attachment protein**
- ☐ **Capsid, attachment protein and reverse transcriptase**
- ☐ **Capsule and attachment protein**
- ☐ **Cell-surface membrane and attachment protein**

**[Turn over]**

**0 6 . 2**

**The DNA-replication enzymes of a human cell make copies of the human papilloma virus genome.**

**Name TWO enzymes that are involved in replicating the DNA of the human papilloma virus and describe their roles in the replication process. [3 marks]**

**Name of enzyme 1** _____

**Role of enzyme 1** _____

_____

_____

_____

**Name of enzyme 2** _____

**Role of enzyme 2** _____

_____

_____

_____

**0 6 . 3**

**Human papilloma virus infects cells that are no longer dividing. The human papilloma virus genome contains genes that code for proteins that cause human cells to restart their cell cycles.**

**Human papilloma virus infection can cause cancer.**

**Explain why. [1 mark]**

**0 6 . 4**

**Human papilloma virus (HPV) is transmitted through sexual contact.**

**More than 95% of cervical cancers (which only affect females) are due to HPV infection. HPV infection of other tissues increases the risk of cancer but this is rare compared with cervical infection.**

**A vaccine is available that is over 80% effective at preventing HPV infection, if given before the person has been exposed to HPV. There is evidence of herd immunity when more than 50% of the population have been vaccinated.**

**Evaluate whether 10- to 12-year-old boys should be given the HPV vaccine. [4 marks]**

9

[Turn over]

**0 7**

**Scientists investigated biodiversity in prokaryote communities found in soil.**

**The scientists:**

- **took soil samples from fields that had been managed for 20 years with two different farming methods**
- **sequenced all the DNA that coded for prokaryotic ribosomal RNA in the soil samples**
- **compared these base sequences to give a measure of species richness and an index of diversity for the prokaryote community**
- **recorded the total prokaryotic biomass and the mass of stored carbon for each soil sample**
- **obtained the mean wheat yield from the fields.**

**TABLE 4, on page 38, shows the scientists' results.**

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**[Turn over]**

**TABLE 4**

| DATA COLLECTED | FARMING METHOD 1 | FARMING METHOD 2 |
|---|---|---|
| Mean species richness (± 2 × standard deviation) | 517 (± 17) | 560 (± 24) |
| Mean index of diversity (± 2 × standard deviation) | 0.251 (± 0.011) | 0.230 (± 0.014) |
| Mean total prokaryotic biomass / kg $m^{-3}$ | 0.24 | 0.40 |
| Mean carbon stored in soil organisms / µg $g^{-1}$ | 203 | 342 |
| Mean wheat yield / g $m^{-2}$ | 451 | 377 |

**The mean ± 2 × standard deviation includes 95% of the data.**

**0 7 . 1**

**Using the standard deviation data from TABLE 4, describe the differences in prokaryotic biodiversity found in the soil with these two farming methods.**

**In your answer, give the definitions of SPECIES RICHNESS and INDEX OF DIVERSITY. [4 marks]**

**[Turn over]**

**0 7 . 2**

**Genetic diversity in soil species was traditionally inferred by making observations after growing prokaryotes on agar plates.**

**However, it is estimated that less than 10% of prokaryotes found in soil will grow if spread on an agar plate in a laboratory.**

**In recent years, our knowledge of prokaryotic biodiversity in the soil has increased.**

**Suggest why. [2 marks]**

## REPEAT OF TABLE 4

| DATA COLLECTED | FARMING METHOD 1 | FARMING METHOD 2 |
|---|---|---|
| Mean species richness (± 2 × standard deviation) | 517 (± 17) | 560 (± 24) |
| Mean index of diversity (± 2 × standard deviation) | 0.251 (± 0.011) | 0.230 (± 0.014) |
| Mean total prokaryotic biomass / kg $m^{-3}$ | 0.24 | 0.40 |
| Mean carbon stored in soil organisms / µg $g^{-1}$ | 203 | 342 |
| Mean wheat yield / g $m^{-2}$ | 451 | 377 |

**The mean ± 2 × standard deviation includes 95% of the data.**

**0 7 . 3**

**Evaluate the balance between conservation and farming for these two farming methods.**

**Use the information provided in TABLE 4, on the opposite page. [2 marks]**

**8**

**[Turn over]**

**0 8 . 1**

**A student prepared a plant root to observe cells undergoing mitosis.**

**He put the root in a small bottle of hydrochloric acid in a 40 °C water bath.**

**Why did he put the plant root in acid? [1 mark]**

**0 8 . 2**

**State TWO precautions required when working with hydrochloric acid. [2 marks]**

**1** _____

_____

_____

_____

**2** _____

_____

_____

_____

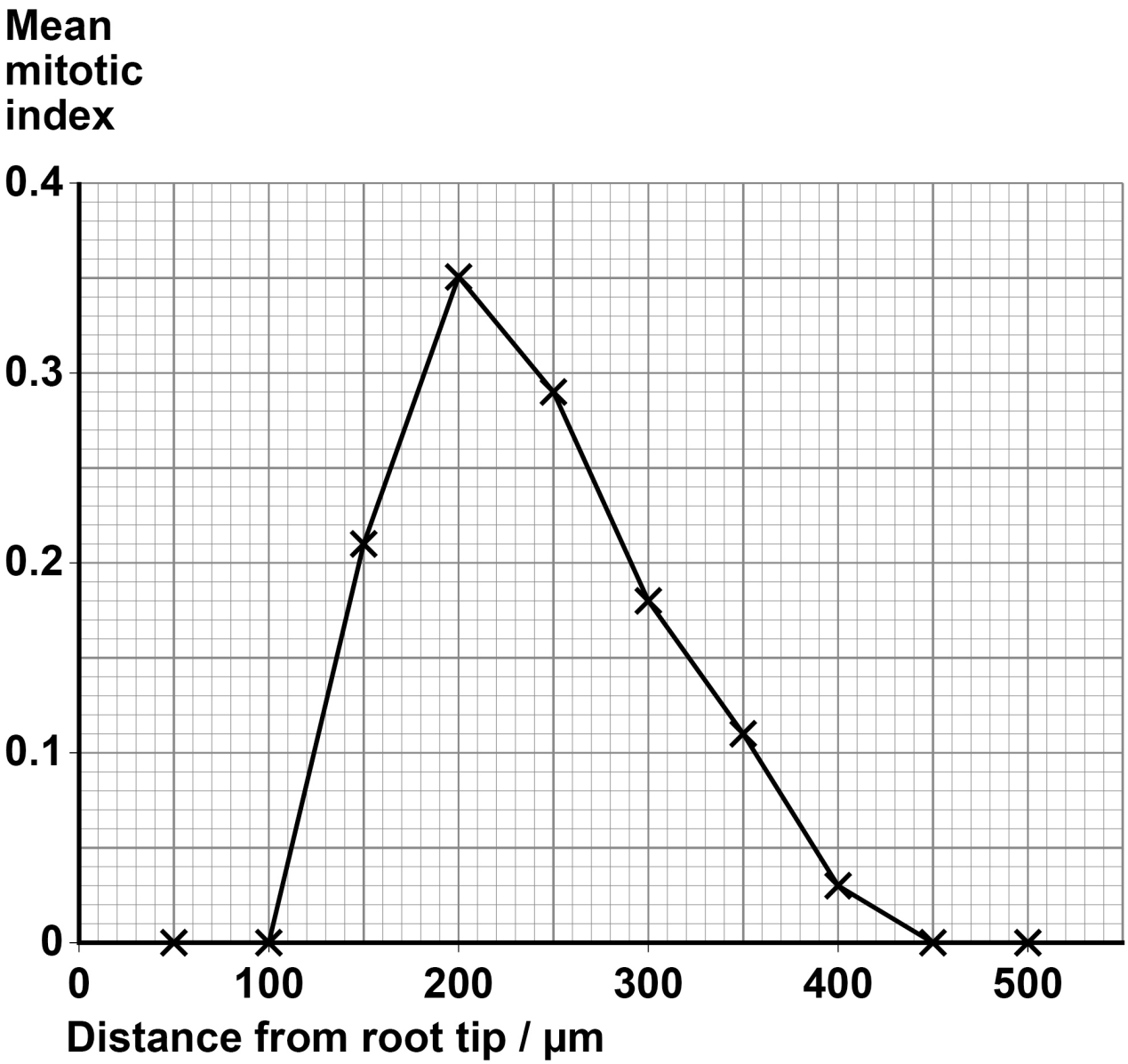
**[Turn over]**

**0 8 . 3**

**Scientists determined the mean mitotic index at 50 µm intervals away from the root tip in 10 young plant roots.**

**FIGURE 7 shows the scientists' results.**

**FIGURE 7**



**State the null hypothesis for this investigation.**

**Name the statistical test needed to determine whether the difference between the mean mitotic index at 200 μm and at 300 μm is significant. [2 marks]**

**Null hypothesis** _____

_____

_____

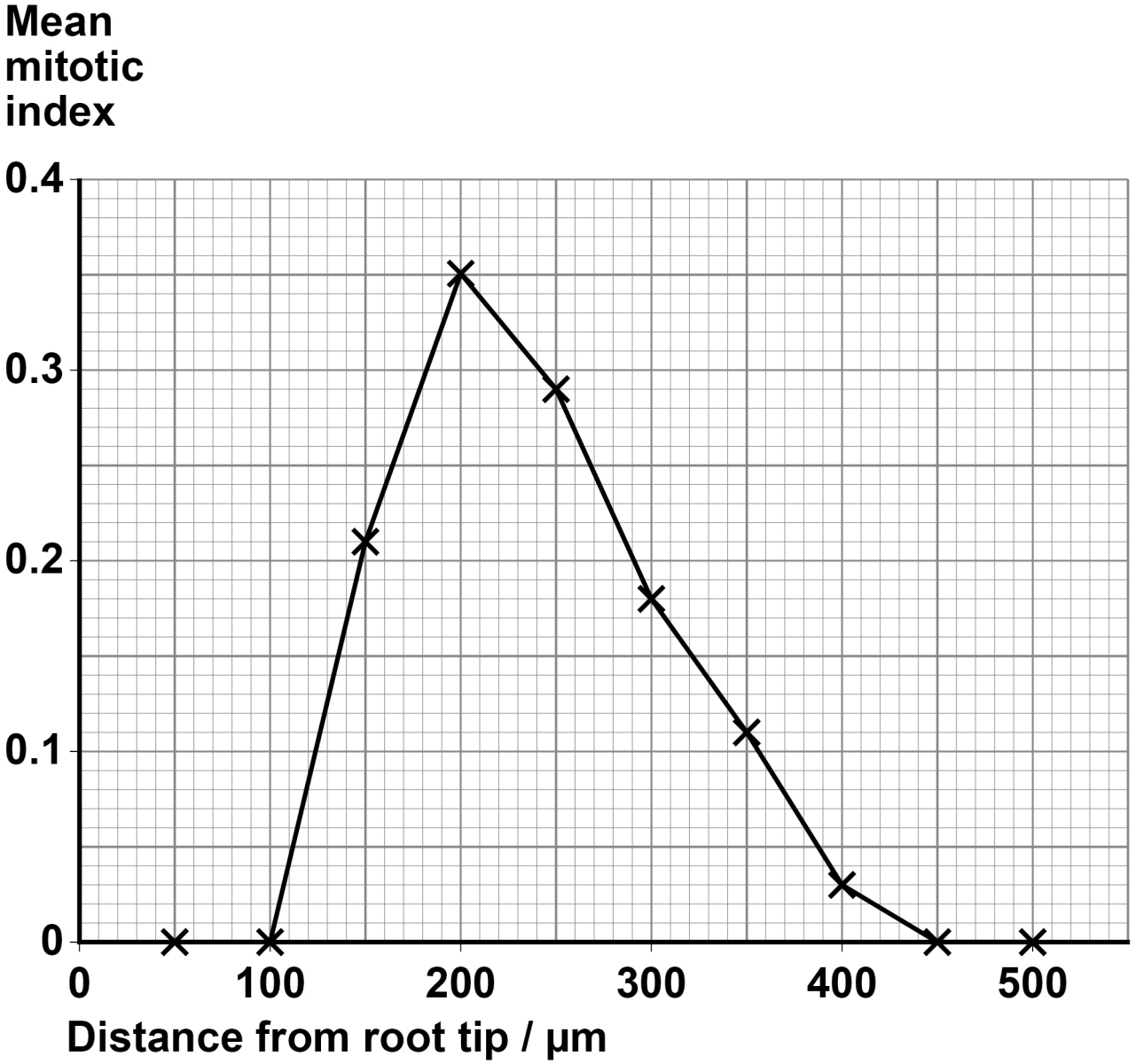
_____

**Statistical test** _____

_____

**[Turn over]**

## REPEAT OF FIGURE 7



**0 8 . 4**

**The scientists recorded these measurements from the tissue located at 200 µm from the root tip.**

**Area of field of view = 0.2 $mm^2$**
**Mean area of one cell = 3495 $\mu m^2$**

**Use this information and FIGURE 7, on the opposite page, to calculate the number of cells undergoing mitosis in this location.**

**Assume there are no spaces between the cells.**

**Show your working. [2 marks]**

_____ **cells**

**[Turn over]**

**0 8 . 5**

**Another student compares the mitotic index in the roots of two different species.**

**Give TWO considerations within her method to ensure this comparison is valid. [2 marks]**

**1** _____

_____

_____

_____

**2** _____

_____

_____

_____

**9**

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**[Turn over]**

**0 9**

**Read the following passage.**

**Carbohydrates are moved by mass transport in plants and in mammals. This movement is caused by a pressure gradient inside the transport vessels.**

**Plants transport most of their carbohydrate as sucrose. The phloem has sucrose-transport proteins in the cell-surface membrane. Potato plants with fewer sucrose-transport proteins produce fewer potatoes and accumulate sugars in their leaves.**

**Mammals do not have sucrose-transport proteins in their cell-surface membranes. They do have many monosaccharide-transport proteins in cell-surface membranes. These transport proteins allow monosaccharides through by facilitated diffusion.**

**Mammalian cells can change the number of glucose-transport proteins in their cell-surface membranes. The glucose-transport proteins are stored in internal membranes, then moved to the cell-surface membrane when they are needed. During exercise, there is a significant increase in glucose uptake by muscle cells.**

**Use the information in the passage and your own knowledge to answer the following questions.**

**0 9 . 1**

**Explain how sucrose-transport proteins in leaf cells enable the production of a pressure gradient in the phloem. [3 marks]**

**0 9 . 2**

**Potato plants with fewer sucrose-transport proteins produce fewer potatoes and accumulate sugars in their leaves (lines 6 to 9).**

**Explain why. [2 marks]**

**0 9 . 3**

**During exercise, there is a significant increase in the glucose uptake by muscle cells (lines 21 and 22).**

**Give two reasons why glucose uptake by muscle cells increases significantly during exercise.**

**Explain your answers. [4 marks]**

**1** _____

_____

_____

_____

_____

_____

_____

_____

_____

**2** _____

_____

[Turn over]

**0 9 . 4**

**Which statement correctly describes the structure of both a sucrose-transport protein and a glucose-transport protein? [1 mark]**

**Tick (✓) ONE box.**

☐ **The secondary structure is held by disulfide bridges. The tertiary structure allows the protein to be positioned on the inner surface of the cell membrane.**

☐ **The secondary structure is held by disulfide bridges. The tertiary structure allows the protein to be positioned spanning the whole cell membrane.**

☐ **The secondary structure is held by hydrogen bonds. The tertiary structure allows the protein to be positioned on the outer surface of the cell membrane.**

☐ **The secondary structure is held by hydrogen bonds. The tertiary structure allows the protein to be positioned spanning the whole cell membrane.**

**10**

**END OF QUESTIONS**

**Additional page, if required.**

**Write the question numbers in the left-hand margin.**

**Additional page, if required.**

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**Additional page, if required.**

**Write the question numbers in the left-hand margin.**

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