A

AQA

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

BIOLOGY

Paper 3

7402/3

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]

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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 in SECTION A.**
- **Answer ONE question from SECTION B.**
- **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 78.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

SECTION A

Answer ALL questions in this section.

You are advised to spend no more than 1 hour and 15 minutes on this section.

0 1

Amino acids are used to make proteins. TABLE 1 shows the R groups of six different amino acids.

TABLE 1

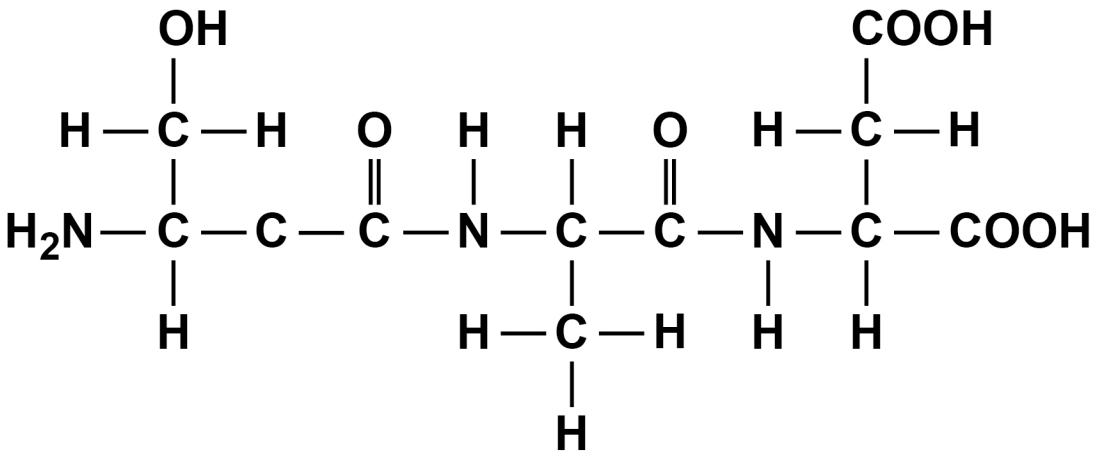
Amino acid	R group
Alanine	CH_3
Asparagine	CH_2CONH_2
Aspartic acid	CH_2COOH

Amino acid	R group
Glutamic acid	CH_2CH_2COOH
Glycine	H
Serine	CH_2OH

0 1 . 1

Use TABLE 1, on the opposite page, to identify the THREE different amino acids used to make the polypeptide shown in FIGURE 1. [2 marks]

FIGURE 1



Left amino acid _____

_____

Middle amino acid _____

_____

Right amino acid _____

_____

[Turn over]

90

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0 7

0 1 . 2

TABLE 2 shows three statements and names of four biological molecules.

Put a tick (✓) in each box where the statement is true for the biological molecule.
[3 marks]

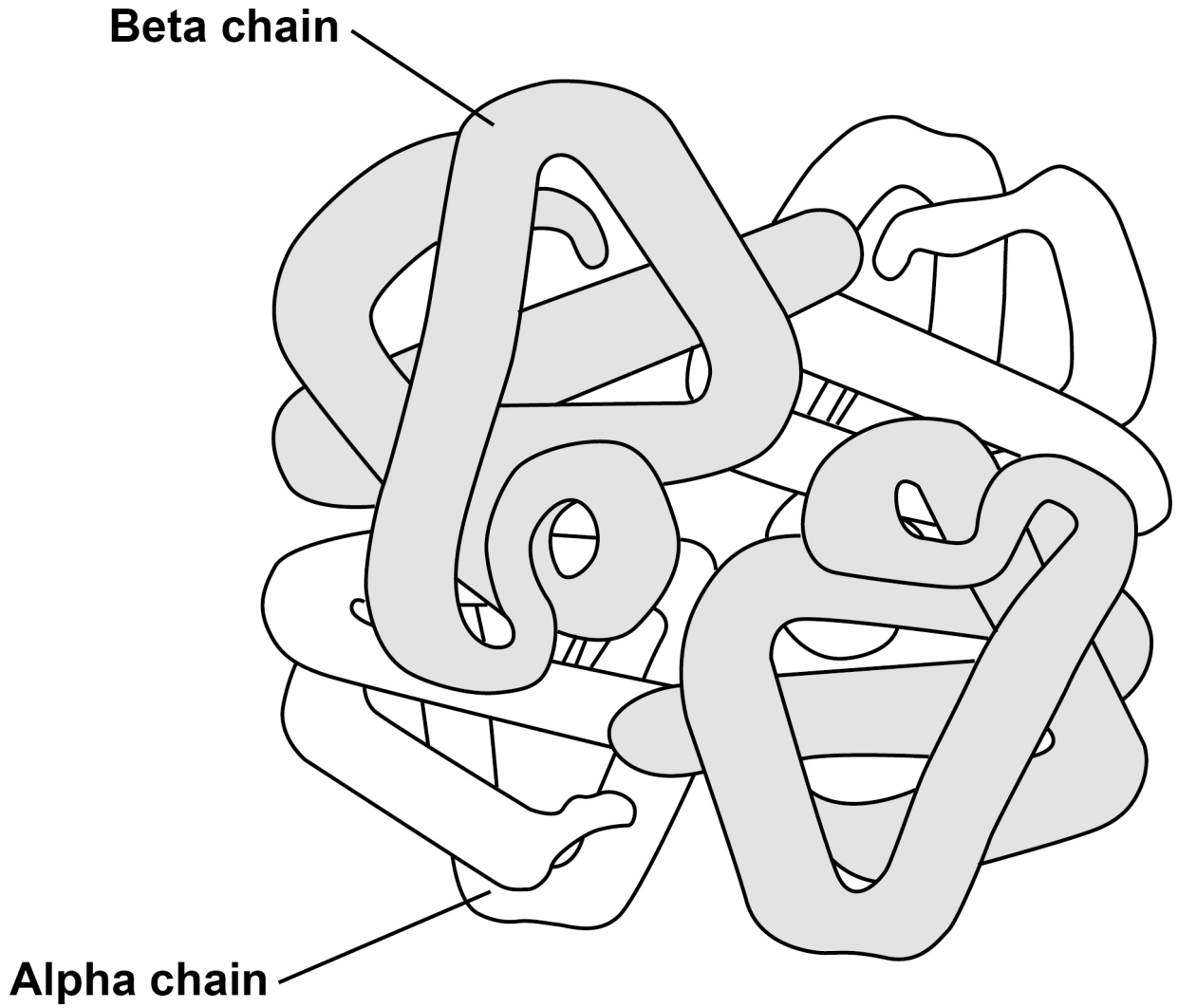
TABLE 2

Statement	DNA	ATP	Reverse transcriptase	Phospholipid
Contains peptide bonds				
Is formed using a condensation reaction				
Is a polymer				

[Turn over]

FIGURE 2 represents the structure of adult human haemoglobin.

FIGURE 2



0 1 . 3

The number of amino acids in the beta chains in FIGURE 2 is 3.546% greater than in the alpha chains. Each alpha chain contains 141 amino acids.

Calculate how many amino acids there are in total in the haemoglobin molecule shown in FIGURE 2. Give your answer to the nearest whole number. [2 marks]

Answer _____ amino acids

[Turn over]

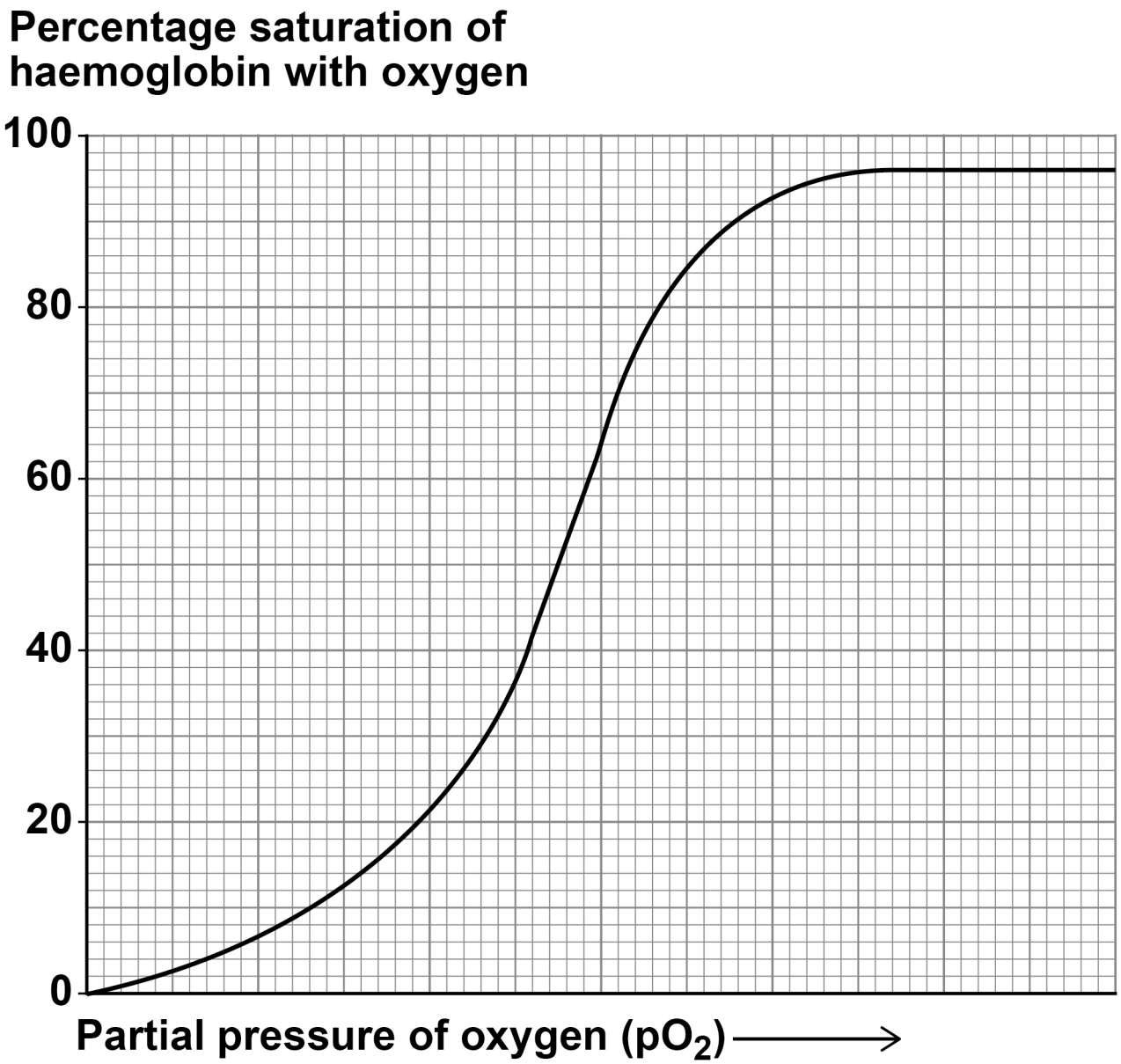
When a substance called BPG binds to haemoglobin, it reduces the affinity of haemoglobin for oxygen.

0 1 . 4

FIGURE 3, on the opposite page, shows an oxyhaemoglobin dissociation curve for haemoglobin in normal conditions.

Sketch a curve on FIGURE 3 to show the oxyhaemoglobin dissociation curve for haemoglobin when BPG binds to it. [1 mark]

FIGURE 3



[Turn over]

0 1 . 5

Suggest and explain when it would be an advantage to a human for BPG to bind to haemoglobin. [2 marks]

10

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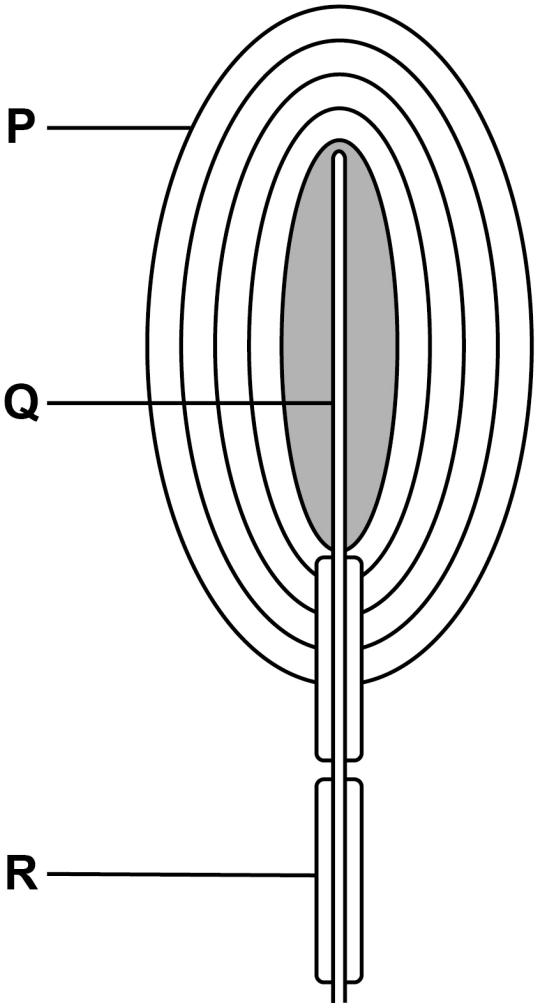
[Turn over]

0 2

FIGURE 4 shows a diagram of a Pacinian corpuscle.

FIGURE 4



0 2 . 1

Name the structures labelled P, Q and R shown in FIGURE 4, on the opposite page. [2 marks]

P _____

Q _____

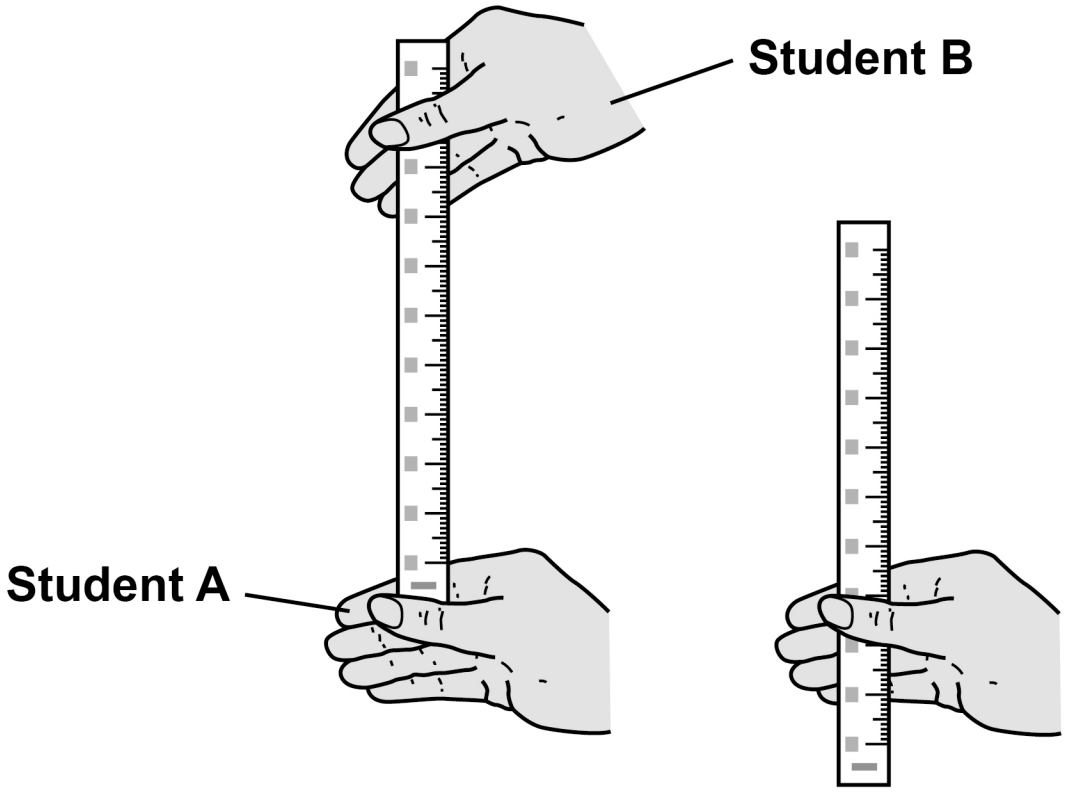
R _____

[Turn over]

Two students (A and B) investigated reaction time in response to touch.

- **Student A sat with her eyes shut and her forearm resting on a worktop so that her hand was over the edge.**
- **Student B held a ruler vertically between student A's thumb and first finger, with the ruler at 0 mm lightly touching student A's first finger.**
- **Student B released the ruler.**
- **As soon as student A felt the ruler fall, she closed her thumb and first finger to catch the ruler as shown in FIGURE 5.**
- **Student B measured the distance the ruler had fallen to the nearest mm**

FIGURE 5



The test was repeated three more times using the same hand to catch the ruler.

TABLE 3 shows student A's results.

TABLE 3

Trial	Distance the ruler has fallen / mm
1	79
2	97
3	10
4	94

The student was able to convert these distances into reaction times using TABLE 4.

TABLE 4

Distance the ruler fell / mm	Reaction time / ms
10	45
20	64
30	78
40	90
50	101
60	111
70	120
80	128
90	136

[Turn over]

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0 2 . 2

Calculate the percentage uncertainty in the measurement of TRIAL 1 in TABLE 3, on page 17.

Put a tick (✓) in the correct box below. [1 mark]

☐ **0.633%**

☐ **1.27%**

☐ **2.53%**

☐ **12.6%**

[Turn over]

0 2 . 3

In this investigation, it is not possible for a student to react in less than 45 ms

Suggest ONE explanation for the value recorded in TRIAL 3 in TABLE 3, on page 17. [1 mark]

0 2 . 4

Student A estimated that the length of the nerve pathway involved was 175 cm

Use TABLE 3 and TABLE 4, on page 17, to calculate the mean speed of nerve impulse transmission.

Do NOT use the value for TRIAL 3 in your calculation.
[2 marks]

Answer _____ **m s^{-1}**

[Turn over]

0 2 . 5

In response to touch, nerve impulses can be transmitted at speeds of 76.2 m s^{-1}

Suggest THREE reasons why, in this investigation, the estimated speed of student A's impulse transmission was less than 76.2 m s^{-1} [3 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

3 _____

_____

_____

_____

BLANK PAGE

[Turn over]

0 3

A student prepared a stained squash of cells from the root tips of garlic to calculate a mitotic index. He:

1. **cut the end 5 mm from 10 garlic roots**
2. **placed the root tips into a Petri dish containing 5 cm^3 of hydrochloric acid for 12 minutes**
3. **rinsed the root tips in distilled water**
4. **placed one of the root tips on a microscope slide and added toluidine blue stain**
5. **placed a coverslip onto the microscope slide, and gently pressed the coverslip downwards on the root tip**
6. **observed the root tip using an optical microscope.**

0 3 . 1

Suggest why the student soaked the root tips in hydrochloric acid in step 2. [2 marks]

[Turn over]

0 3 . 2

Pressing the coverslip downwards enabled the student to observe the stages of mitosis clearly.

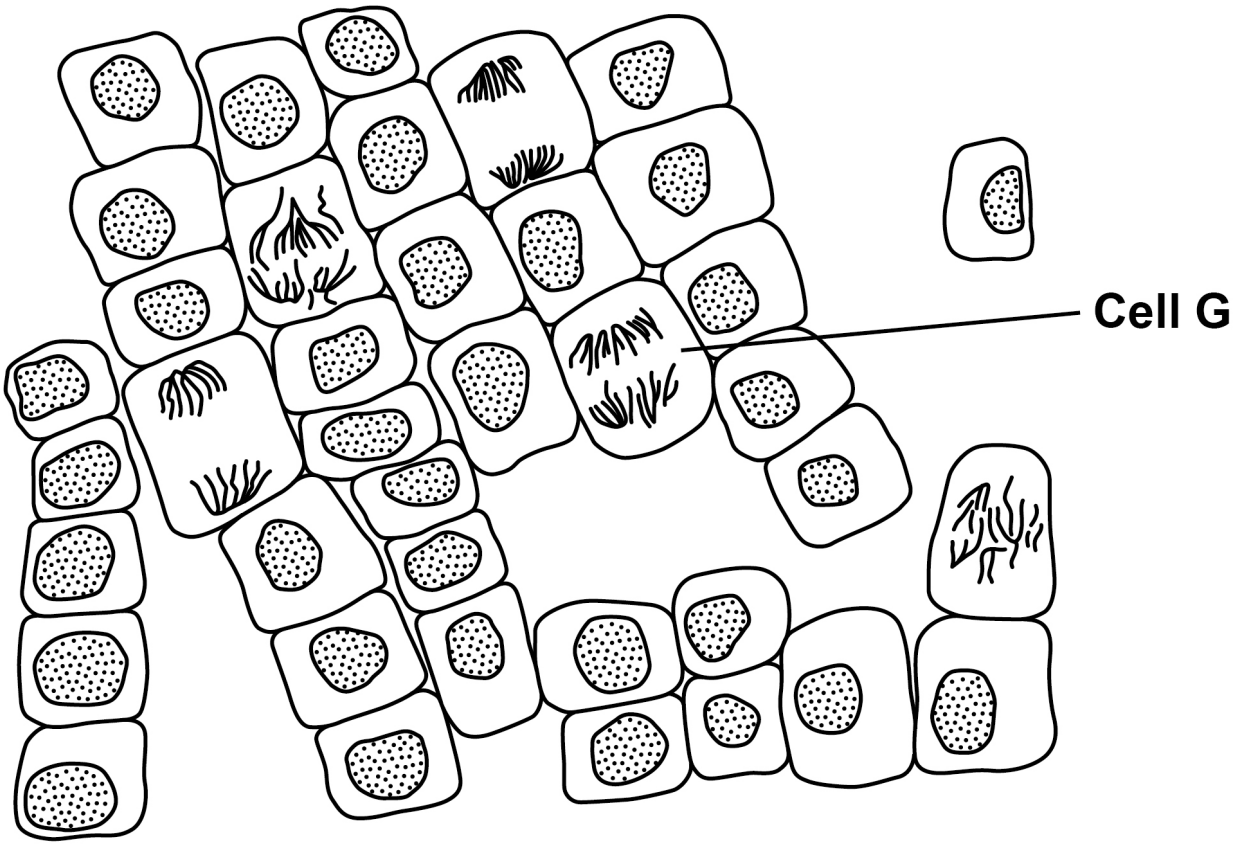
Explain why. [2 marks]

BLANK PAGE

[Turn over]

FIGURE 6 shows the student's drawing of one field of view.

FIGURE 6



0 3 . 3

Name the stage of mitosis shown in cell G. Explain the appearance of this cell. [2 marks]

Stage of mitosis _____

Explanation _____

_____

_____

_____

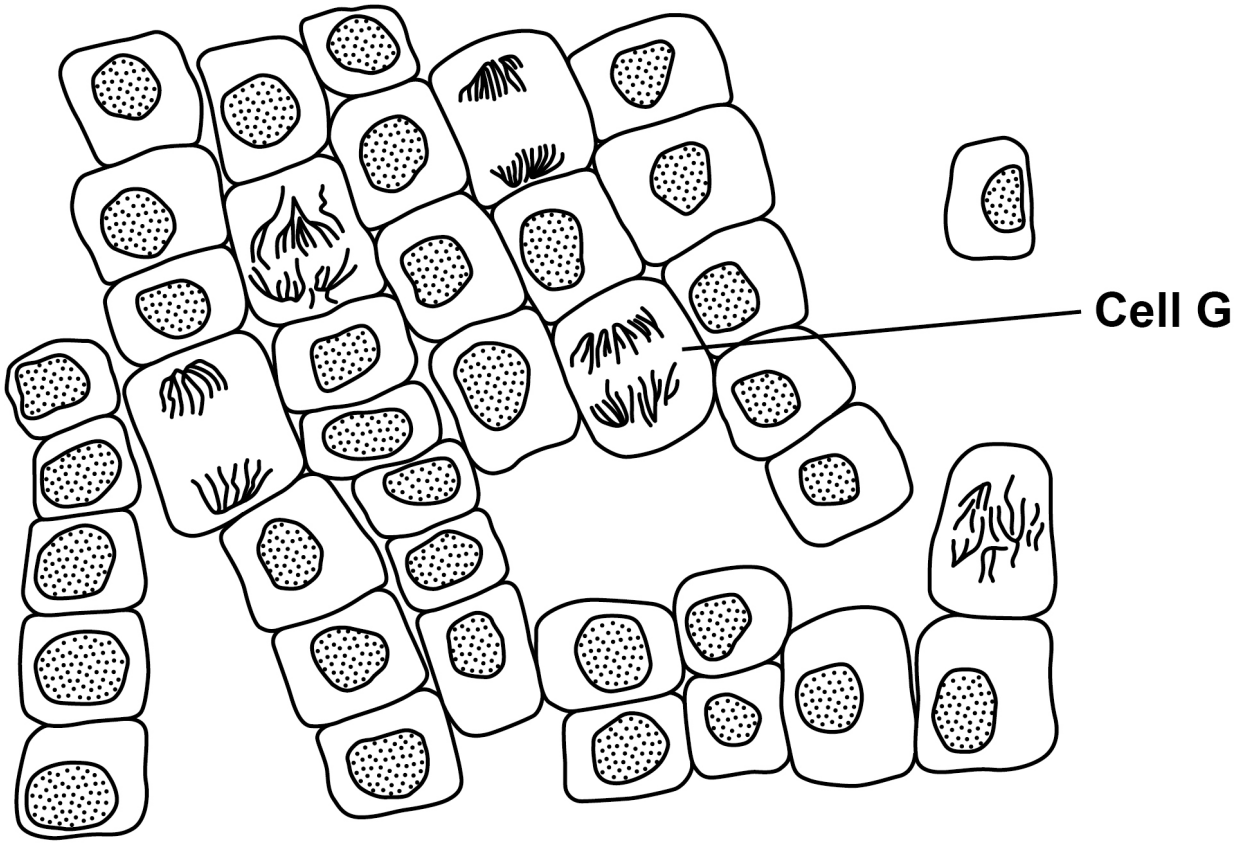
_____

_____

_____

[Turn over]

REPEAT OF FIGURE 6



0 3 . 4

Use FIGURE 6 to calculate a mitotic index for the cells in this field of view. [1 mark]

Mitotic index _____

0 3 . 5

Other students in the class followed the same method, but calculated different mitotic indices.

Apart from student errors, suggest TWO explanations why. [2 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

[Turn over]

9

0 4 . 1

Complete the following definitions. [2 marks]

The genome is _____

_____

_____

_____

The proteome is _____

_____

_____

_____

Recombinant DNA technology can involve the transfer of fragments of human DNA into bacteria. The bacteria are then used to produce human proteins.

0 4 . 2

Give TWO reasons why bacteria are able to use human DNA to produce human proteins. [2 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

[Turn over]

0 4 . 3

Suggest and explain ONE reason why bacteria might NOT be able to produce every human protein. [1 mark]

BLANK PAGE

[Turn over]

Antithrombin is a protein. Antithrombin prevents blood from clotting too much.

Some people have a deficiency of antithrombin in their blood, so they need to inject the protein.

Genetically modified goats are used to produce this protein. The human antithrombin gene is transferred into goat embryos. The adult goats then make human antithrombin protein.

FIGURE 7 shows an example of a DNA fragment that can be transferred into the cells of goats.

FIGURE 7

0 4 . 4

The enhancer stimulates region M.

Name regions M and N shown in FIGURE 7, on the opposite page. [2 marks]

Region M _____

Region N _____

0 4 . 5

Explain the purpose of the marker gene. [1 mark]

_____

_____

[Turn over]

0 4 . 6

The enhancer only stimulates region M in the milk-producing glands of a goat.

Suggest TWO explanations for the importance of the enhancer being included in the DNA fragment transferred. [2 marks]

1 _____

_____

_____

_____

_____

_____

2 _____

_____

_____

_____

_____

_____

_____

10

0 5

Scientists investigated the effect of full sun and shade on the rate of photosynthesis in a species of shade-tolerant tree.

To estimate the rate of photosynthesis, the scientists measured uptake of carbon dioxide by trees in a forest. They measured uptake of carbon dioxide during two parts of the day:

- **08.30 – 09.40 hours**
- **11.40 – 13.15 hours.**

FIGURE 8, on page 40, shows the scientists' results.

[Turn over]

FIGURE 8

FIGURE 8 is not reproduced here due to third-party copyright restrictions

0 5 . 1

Calculate the total uptake of carbon dioxide between 11.40 and 13.15 hours in trees exposed to full sun in a forest that is 12 000 m^2 in area.

Give your answer in standard form. Show your working. [3 marks]

Answer _____ **µmol**

[Turn over]

0 5 . 2

FIGURE 8, on page 40, shows there is a small difference in the mean uptake of carbon dioxide between 08.30 and 09.40 hours by trees in full sun and by trees in the shade. When the scientists performed a statistical test on these data, they calculated P > 0.5

State what this P value tells you about this difference.

Explain your answer using the words PROBABILITY and CHANCE. [2 marks]

0 5 . 3

In this species of tree, very high light intensities can inhibit the release of electrons from chlorophyll.

Suggest how this could explain the results shown in FIGURE 8, on page 40, for 11.40 to 13.15 hours.
[4 marks]

Tomato plants grow best in high light intensities. To increase the yield of tomato plants, a farmer uses LED lightbulbs to provide additional light.

The increase in dry mass (D) produced when using additional light can be calculated using this equation.

$$D = \frac{L}{0.4F}$$

Where

L = light used in photosynthesis

F = GPP to NPP conversion factor for tomato plants

TABLE 5 shows some of these values for LED lightbulbs.

TABLE 5

L / MJ m^{-2} h^{-1}	F / MJ kg^{-1}
2.87×10^{-2}	20

0 5 . 4

Use the equation and TABLE 5 to calculate the increase in dry mass produced when using LED lightbulbs.

Give your answer in standard form AND give the units.
[2 marks]

Answer _____ **Units** _____

[Turn over]

0 5 . 5

Mature leaves from slow-growing, shade-tolerant plants produce poisonous chemicals that are a defence against being eaten by herbivores.

Suggest how this benefits slow-growing, shade-tolerant plants. [2 marks]

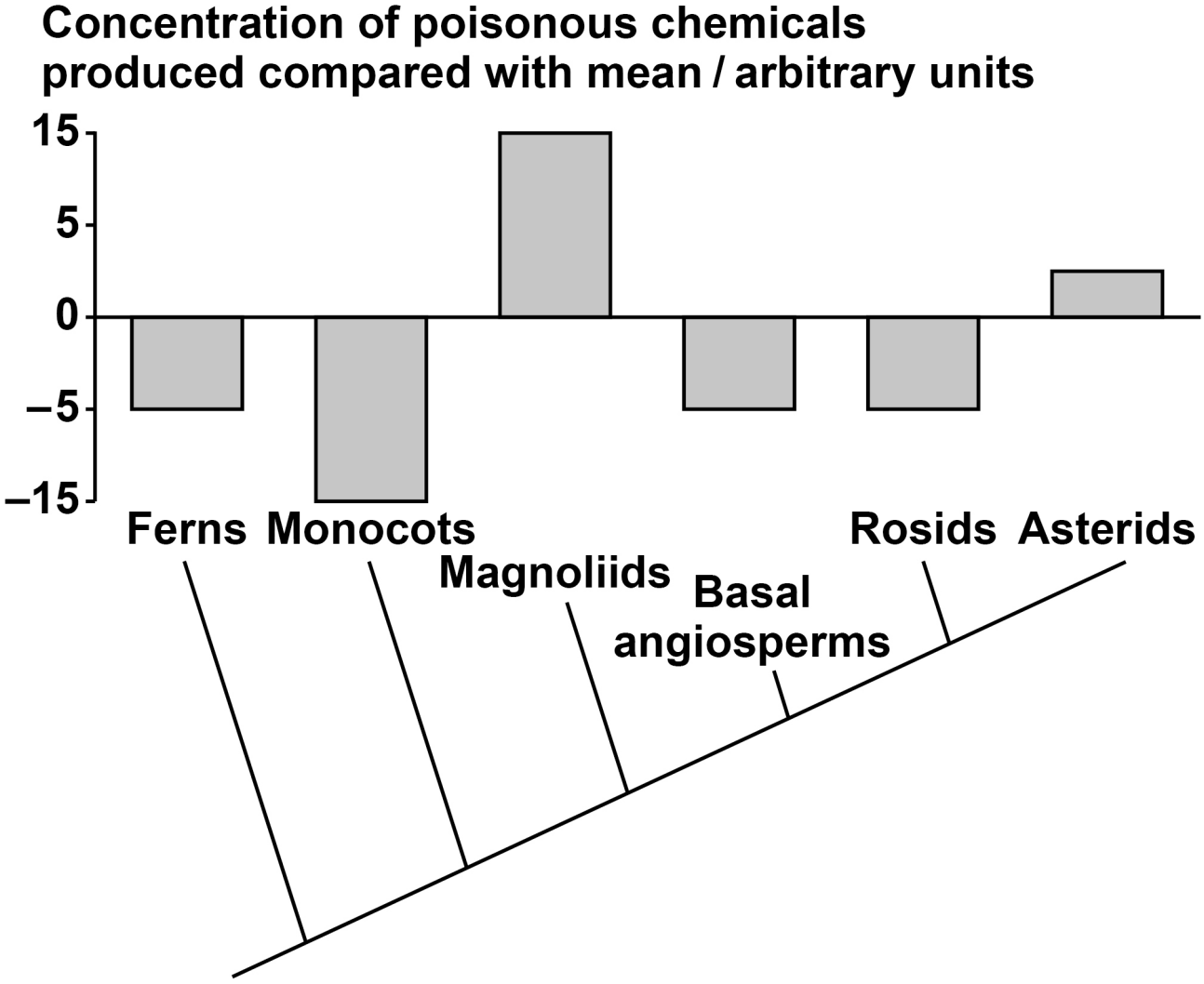
BLANK PAGE

[Turn over]

Scientists measured the concentration of poisonous chemicals produced by shade-tolerant plant species in six taxa. They compared this with the mean concentration of poisonous chemicals produced by all plants and the phylogenetic relationships between the six taxa.

FIGURE 9 shows the scientists' results.

FIGURE 9



0 5 . 6

A journalist published the following summary of these results.

‘The more recently a shade-tolerant plant species evolved, the greater the concentration of poisonous chemicals it produces.’

Do the data in FIGURE 9, on the opposite page, support this summary? Justify your answer. [2 marks]

15

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[Turn over]

SECTION B

Answer ONE question.

You are advised to spend no more than 45 minutes on this section.

0 6

Write an essay on ONE of the topics below.

EITHER

0 6 . 1

The uses and importance of ATP in organisms.
[25 marks]

OR

0 6 . 2

The importance of cycles in biology. [25 marks]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

[Turn over]

8 2

END OF QUESTIONS

25

Additional page, if required.
Write the question numbers in the left-hand margin.

Additional page, if required.
Write the question numbers in the left-hand margin.

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Question	Mark
1	
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6	
TOTAL	

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