A-level
BIOLOGY
(7402/1)
Paper 1

Specimen 2014 Session Time allowed: 2 hours

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the bottom of this page.
- Answer **all** questions.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 91.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

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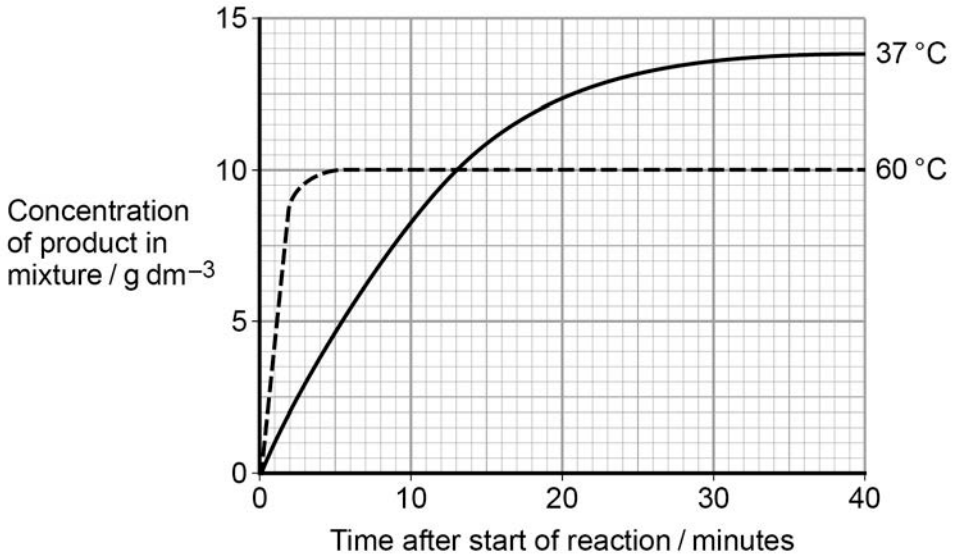
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Answer **all** questions in the spaces provided.

1 A technician investigated the effect of temperature on the rate of an enzyme-controlled reaction. At each temperature, he started the reaction using the same concentration of substrate.

Figure 1 shows his results.

Figure 1



0 1 . 1 Give **two** other factors the technician would have controlled.

[1 mark]

1 _____

2 _____

0 1 . 2 Draw a tangent on each curve to find the initial rates of reaction.
Use these values to calculate the ratio of the initial rates of reaction at 60 °C : 37 °C.
Show your working.

[2 marks]

Ratio = _____ :1

0 1 . 3 Explain the difference in the initial rate of reaction at 60 °C and 37 °C.

[2 marks]

0 1 . 4 Explain the difference in the rates of reaction at 60 °C and 37 °C between 20 and 40 minutes.

[4 marks]

[Extra space]

0 2 . 1 Describe how oxygen in the air reaches capillaries surrounding alveoli in the lungs. Details of breathing are **not** required.

[4 marks]

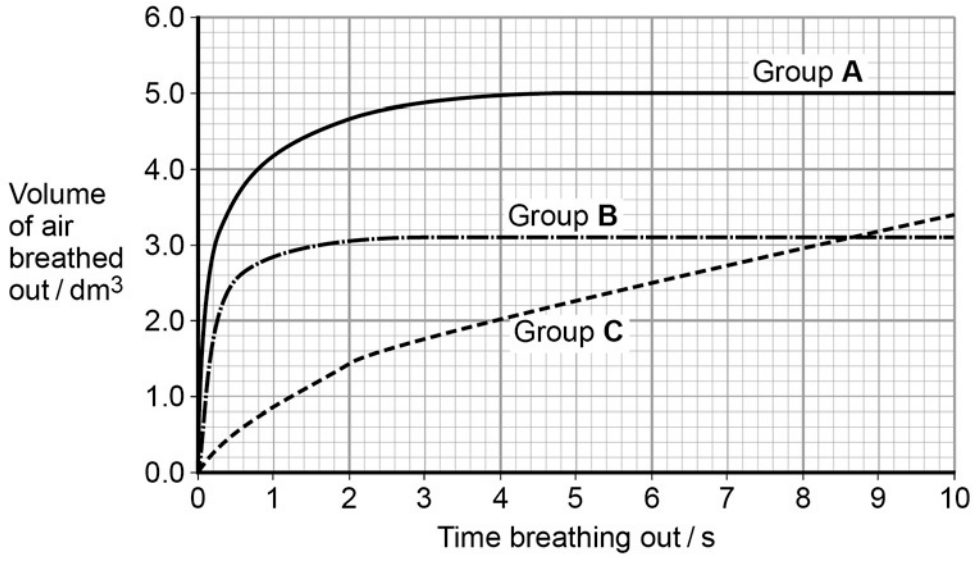
[Extra space]

Forced expiratory volume (FEV) is the greatest volume of air a person can breathe out in 1 second.

Forced vital capacity (FVC) is the greatest volume of air a person can breathe out in a single breath.

Figure 2 shows results for the volume of air breathed out by three groups of people, **A**, **B** and **C**. Group **A** had healthy lungs. Groups **B** and **C** had different lung conditions that affect breathing.

Figure 2



0 2 . 2 Calculate the percentage drop in FEV for group **C** compared with the healthy people.

[1 mark]

Answer = _____

0 2 . 3 Asthma affects bronchioles and reduces flow of air in and out of the lungs.
Fibrosis does not affect bronchioles; it reduces the volume of the lungs.

Which group, **B** or **C**, was the one containing people with fibrosis of their lungs?
Use the information provided and evidence from **Figure 2** to explain your answer.

[3 marks]

_____

_____

_____

_____

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_____

[Extra space] _____

_____

_____

3 Species richness and an index of diversity can be used to measure biodiversity within a community.

0 3 . 1 What is the difference between these two measures of biodiversity?

[1 mark]

Scientists investigated the biodiversity of butterflies in a rainforest. Their investigation lasted several months.

The scientists set one canopy trap and one understorey trap at five sites.

- The canopy traps were set among the leaves of the trees 16–27 m above ground level.
- The understorey traps were set under trees at 1.0–1.5 m above ground level.

The scientists recorded the number of each species of butterfly caught in the traps. **Table 1** summarises their results.

Table 1

Species of butterfly	**Mean number of butterflies**		**P value**
	In canopy	**In understorey**	
Prepona laertes	15	0	< 0.001
Archaeoprepona demophon	14	37	< 0.001
Zaretis itys	25	11	> 0.05
Memphis arachne	89	23	< 0.001
Memphis offa	21	3	< 0.001
Memphis xenocles	32	8	< 0.001

0 3 . 2 The traps in the canopy were set at 16–27 m above ground level. Suggest why there was such great variation in the height of the traps.

[1 mark]

0 3 . 3 By how many times is the species diversity in the canopy greater than in the understorey? Show your working.

Use the following formula to calculate species diversity.

$$d = \frac{N(N-1)}{\sum n\,(n-1)}$$

where N is the total number of organisms of all species and n is the total number of organisms of each species.

[3 marks]

Answer = _____

0 3 . 4 The scientists carried out a statistical test to see if the difference in the distribution of each species between the canopy and understorey was due to chance.
The P values obtained are shown in **Table 1**.

Explain what the results of these statistical tests show.

[3 marks]

_____

_____

_____

_____

_____

[Extra space] _____

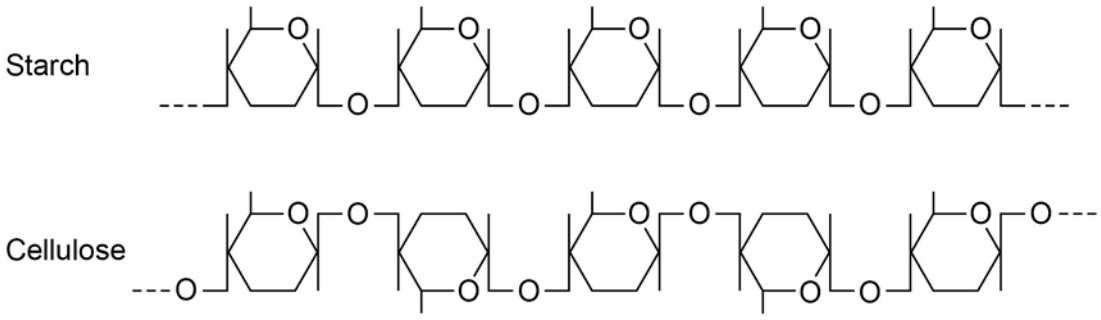
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4 Starch and cellulose are two important plant polysaccharides.

Figure 3 shows part of a starch molecule and part of a cellulose molecule.

Figure 3



0 4 . 1 Explain the difference in the structure of the starch molecule and the cellulose molecule shown in **Figure 3**.

[2 marks]

0 4 . 2 Starch molecules and cellulose molecules have different functions in plant cells. Each molecule is adapted for its function.

Explain **one** way in which starch molecules are adapted for their function in plant cells.

[2 marks]

0 4 . 3 Explain how cellulose molecules are adapted for their function in plant cells.

[3 marks]

[Extra space]

Turn over for the next question

0 5 . 1 Contrast the processes of facilitated diffusion and active transport.

[3 marks]

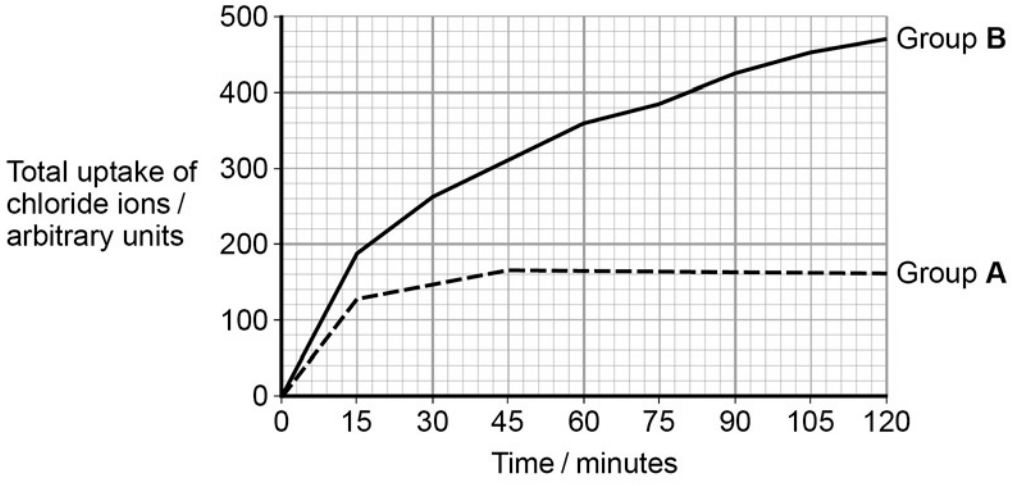
[Extra space]

Students investigated the uptake of chloride ions in barley plants. They divided the plants into two groups and placed their roots in solutions containing radioactive chloride ions.

- Group **A** plants had a substance that inhibited respiration added to the solution.
- Group **B** plants did not have the substance added to the solution.

The students calculated the total amount of chloride ions absorbed by the plants every 15 minutes. Their results are shown in **Figure 4**.

Figure 4



0 5 . 2 Calculate the ratio of the mean **rate** of uptake of chloride ions in the first hour to the **rate** of uptake of chloride ions in the second hour for group **B** plants.

[2 marks]

Ratio = _____ :1

0 5 . 3 Explain the results shown in **Figure 4**.

[4 marks]

[Extra space]

6 **Table 2** shows how a bird called the bluethroat (*Luscinia svecica*) is classified by biologists.

Table 2

Taxon	Name of taxon
Domain	Eukaryota
	Animalia
	Chordata
	Aves
	Passeriformes
	Muscicapidae
Genus	
Species	

0 6 . 1 Complete **Table 2** by filling the seven blank spaces with the correct terms.

[2 marks]

A group of scientists investigated genetic diversity in different species of bird. For each species, the scientists:

- collected feathers from a large number of birds
- extracted DNA from cells attached to each feather
- analysed the samples of DNA to find genetic diversity.

Table 3 summarises their results.

Table 3

Species of bird	Number of genes examined	Number of genes examined that showed genetic diversity
Willow flycatcher	708	197
House finch	269	80
Bluethroat	232	81

0 6 . 2 In this investigation, what is meant by **genetic diversity**?

[1 mark]

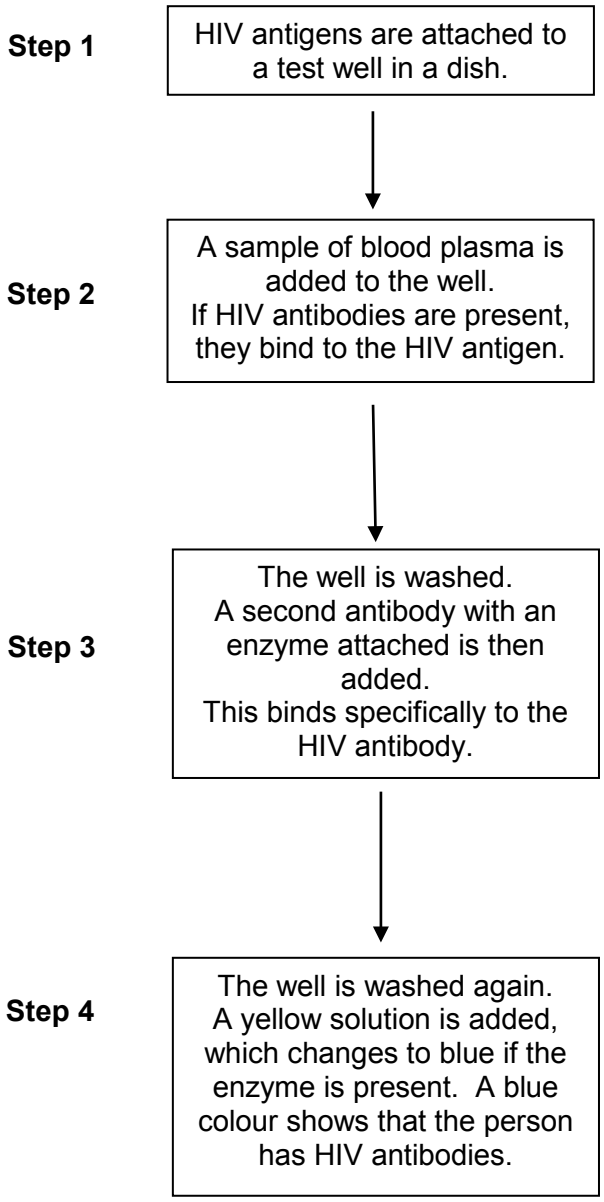
0 6 . 3 The scientists concluded that the bluethroat showed greater genetic diversity than the willow flycatcher. Explain why they reached this conclusion. Use calculations to support your answer.

[2 marks]

Turn over for the next question

7 **Figure 5** shows a test that has been developed to find out if a person has antibodies to the human immunodeficiency virus (HIV) antigen.

Figure 5



0 7 . 1 This test only detects the presence of HIV antibodies. Give **two** reasons why it cannot be used to find out if a person has AIDS.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 2 The solution will remain yellow if a person is **not** infected with HIV. Explain why.

[2 marks]

0 7 . 3 A mother who was infected with HIV gave birth to a baby. The baby tested positive using this test. This does not prove the baby is infected with HIV.
Explain why.

[2 marks]

0 7 . 4 A control well is set up every time this test is used. This is treated in exactly the same way as the test wells, except that blood plasma is replaced by a salt solution.

Use information from **Figure 5** to suggest **two** purposes of the control well.

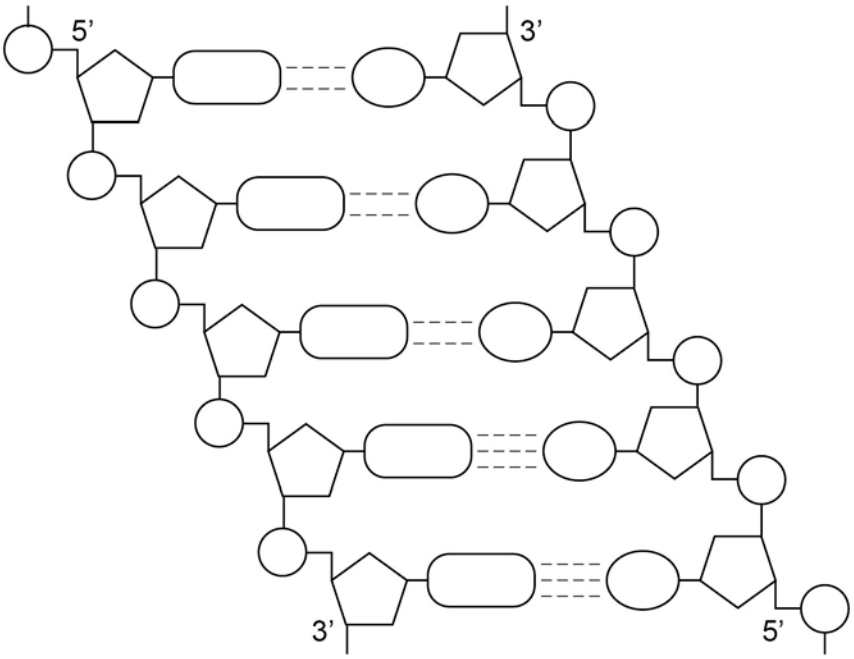
[2 marks]

1

2

8 **Figure 6** represents part of a DNA molecule.

Figure 6



0 8 . 1 Draw a box around a single nucleotide.

[1 mark]

Table 4 shows the percentage of bases in each of the strands of a DNA molecule.

Table 4

DNA strand	Percentage of each base			
	A	**C**	**G**	**T**
Strand **1**	16			
Strand **2**		21	34	

0 8 . 2 Complete **Table 4** by adding the missing values.

[2 marks]

0 8 . 3 During replication, the two DNA strands separate and each acts as a template for the production of a new strand. As new DNA strands are produced, nucleotides can only be added in the 5' to 3' direction.

Use **Figure 6** and your knowledge of enzyme action and DNA replication to explain why new nucleotides can only be added in a 5' to 3' direction.

[4 marks]

[Extra space]

Turn over for the next question

0 9 . 1 Describe the mass flow hypothesis for the mechanism of translocation in plants.

[4 marks]

[Extra space]

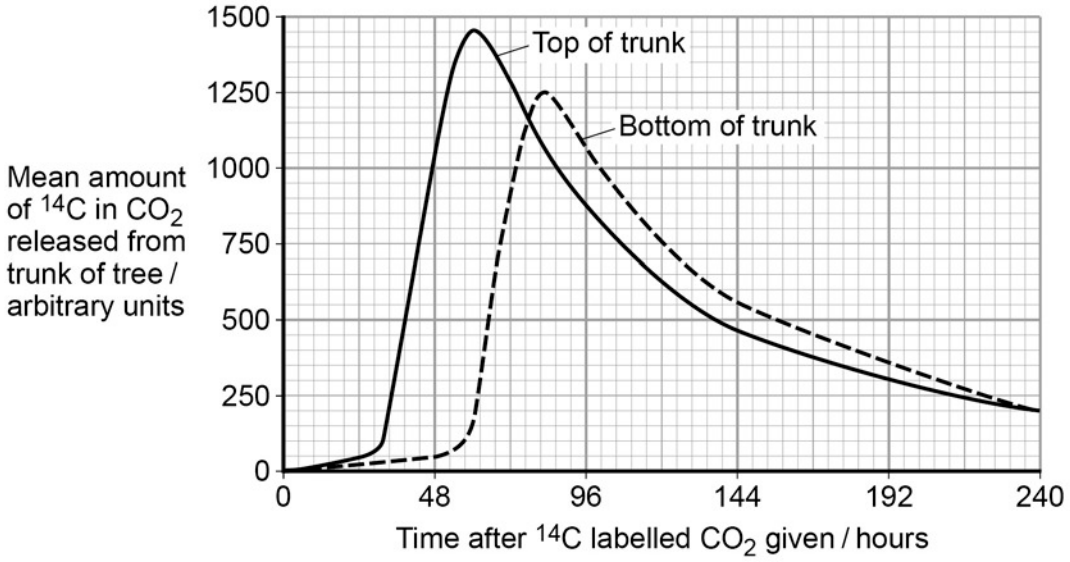
Scientists measured translocation in the phloem of trees. They used carbon dioxide labelled with radioactive ^{14}C.

They put a large, clear plastic bag over the leaves and branches of each tree and added $^{14}CO_2$. The main trunk of the tree was not in the plastic bag.

At regular intervals after adding the $^{14}CO_2$ to the bag, the scientists measured the amount of $^{14}CO_2$ released from the top and bottom of the main trunk of the tree. On the surface of the trunk of these trees, there are pores for gas exchange.

Figure 7 shows the scientists' results.

Figure 7



0 9 . 2 Name the process that produced the $^{14}CO_2$ released from the trunk.

[1 mark]

0 9 . 3 How long did it take the ^{14}C label to get from the top of the trunk to the bottom of the trunk? Explain how you reached your answer.

[2 marks]

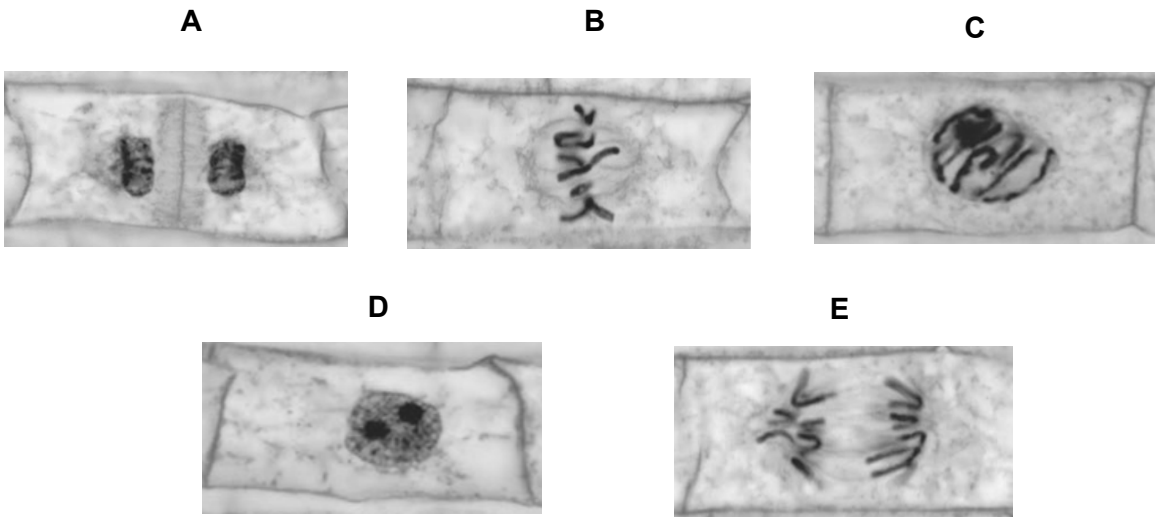
0 9 . 4 What other information is required in order to calculate the mean rate of movement of the ^{14}C down the trunk?

[1 mark]

Turn over for the next question

1 0 **Figure 8** shows some cells from an onion root tip at different stages of the cell cycle.

Figure 8



1 0 . 1 Place stages **A** to **E** in the correct order. Start with stage **D.**

[1 mark]

D

To obtain these images, the onion root tip was cut off, stained and put on a microscope slide. A cover slip was placed on top. The root tip was then firmly squashed and viewed under an optical microscope.

1 0 . 2 Complete **Table 5** to give **one** reason why each of these steps was necessary.

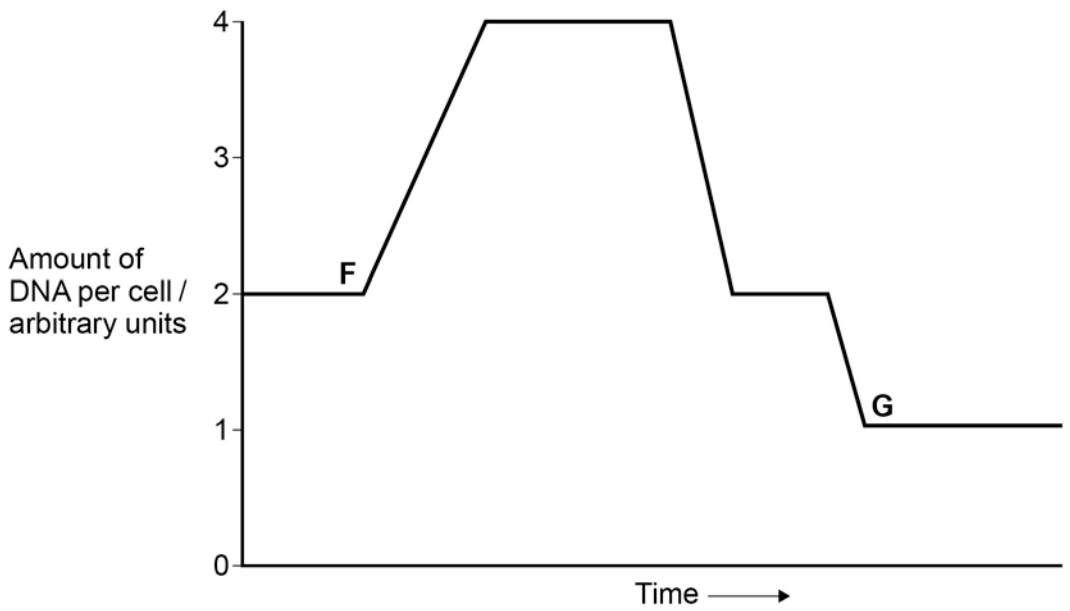
[2 marks]

Table 5

Step	Reason
Taking cells from the root tip	
Firmly squashing the root tip	

Figure 9 shows how the amount of DNA per cell changed during interphase and meiosis in an animal.

Figure 9



1 0 . 3 Explain how the behaviour of chromosomes causes these changes in the amount of DNA per cell between **F** and **G**.

[3 marks]

[Extra space]

1 0 . 4 What would happen to the amount of DNA per cell at fertilisation of cell **G**?

[1 mark]

1 1 . 1 Messenger RNA (mRNA) is used during translation to form polypeptides.
Describe how mRNA is produced in the nucleus of a cell.

[6 marks]

[Extra space]

1 1 . 2 Describe the structure of proteins.

[5 marks]

[Extra space]

Question 11 continues on the next page

1 1 . 3 Describe how proteins are digested in the human gut.

[4 marks]

[Extra space]

END OF QUESTIONS

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Figure 8: All images Ed Reschke/Oxford Scientific/Getty Images

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