Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level BIOLOGY

Paper 1

Thursday 4 June 2020 Morning Time allowed: 2 hours

Materials

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

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).
- 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.

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

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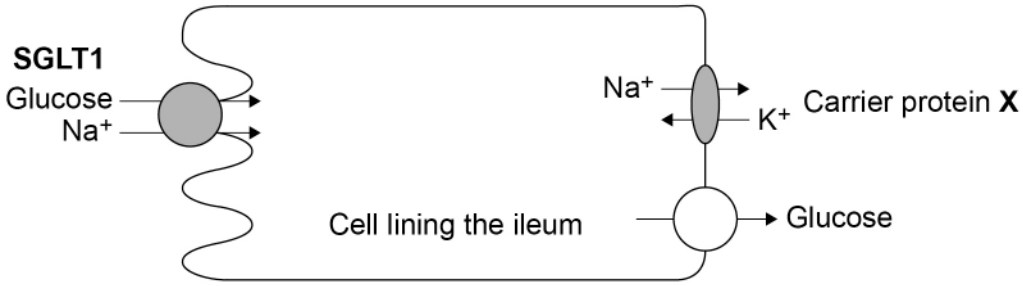
Answer **all** questions in the spaces provided.

0 1 **Figure 1** shows a cell from the lining of the ileum specialised for absorption of products of digestion.

SGLT1 is a carrier protein found in the cell-surface membrane of this cell, it transports glucose and sodium ions (Na^+) into the cell.

Figure 1



0 1 . 1 The action of the carrier protein **X** in **Figure 1** is linked to a membrane-bound ATP hydrolase enzyme.

Explain the function of this ATP hydrolase.

[2 marks]

0 1 . 2 The movement of Na^+ **out** of the cell allows the absorption of glucose **into** the cell lining the ileum.

Explain how.

[2 marks]

Do not write outside the box

0 1 . 3 Describe and explain **two** features you would expect to find in a cell specialised for absorption.

[2 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

Question 1 continues on the next page

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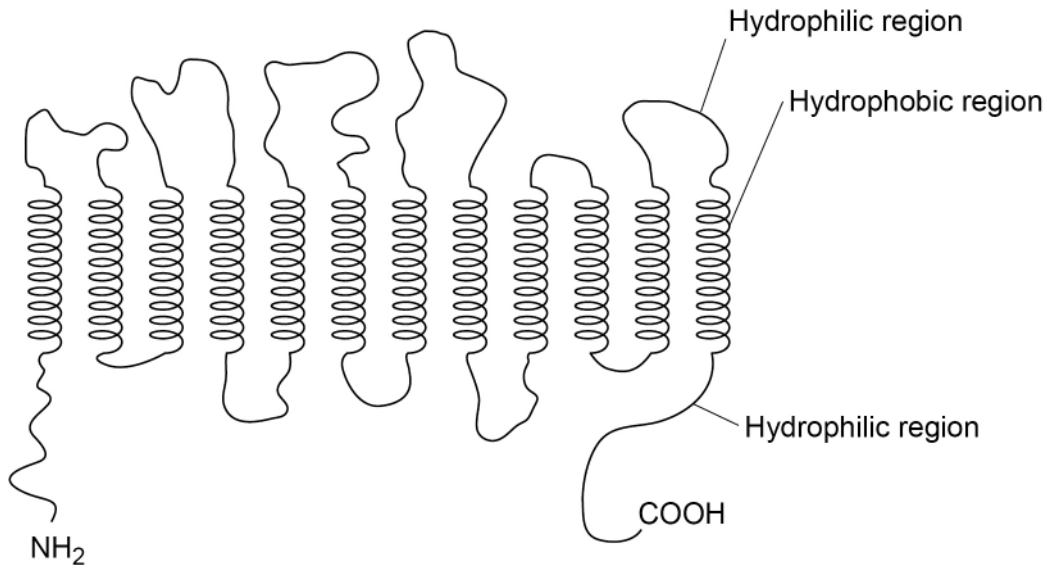
Figure 2 is a diagram of one SGLT1 carrier protein.

Figure 2



0 1 . 4 Draw phospholipids on **Figure 2** to show how the carrier protein, SGLT1, would fit into the cell-surface membrane.

Do **not** draw more than eight phospholipids.

[2 marks]

Do not write outside the box

0 1 . 5 **Figure 2** shows the SGLT1 polypeptide with NH_2 at one end and COOH at the other end.

Describe how amino acids join to form a polypeptide so there is always NH_2 at one end and COOH at the other end.

You may use a diagram in your answer.

[2 marks]

Space for diagram:

10

Turn over for the next question

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0 2 To study lipid digestion, a scientist placed a tube into the gut of a healthy 20-year-old man. The end of the tube passed through the stomach but did not reach as far as the ileum.

The scientist fed the man a meal containing triglycerides through the tube.
The scientist also used the tube to remove samples from the man's gut at intervals after the meal.

The scientist measured the type of lipid found in the samples. Some of her results are shown in **Table 1**.

Table 1

Sample	Time of collection after meal / min	Concentration of fatty acids / mg cm^{-3}	Concentration of triglycerides / mg cm^{-3}
A	45	2.7	0.6
B	75	3.3	0.0

0 2 . 1 Use your knowledge of lipid digestion to explain the differences in the results for samples **A** and **B** shown in **Table 1**.

You should assume that **no** absorption had occurred.

[3 marks]

Do not write outside the box

0 2 . 2 After collecting the samples, the scientist immediately heated them to 70 °C for 10 minutes.

Explain why.

[2 marks]

0 2 . 3 Describe the role of micelles in the absorption of fats into the cells lining the ileum.

[3 marks]

8

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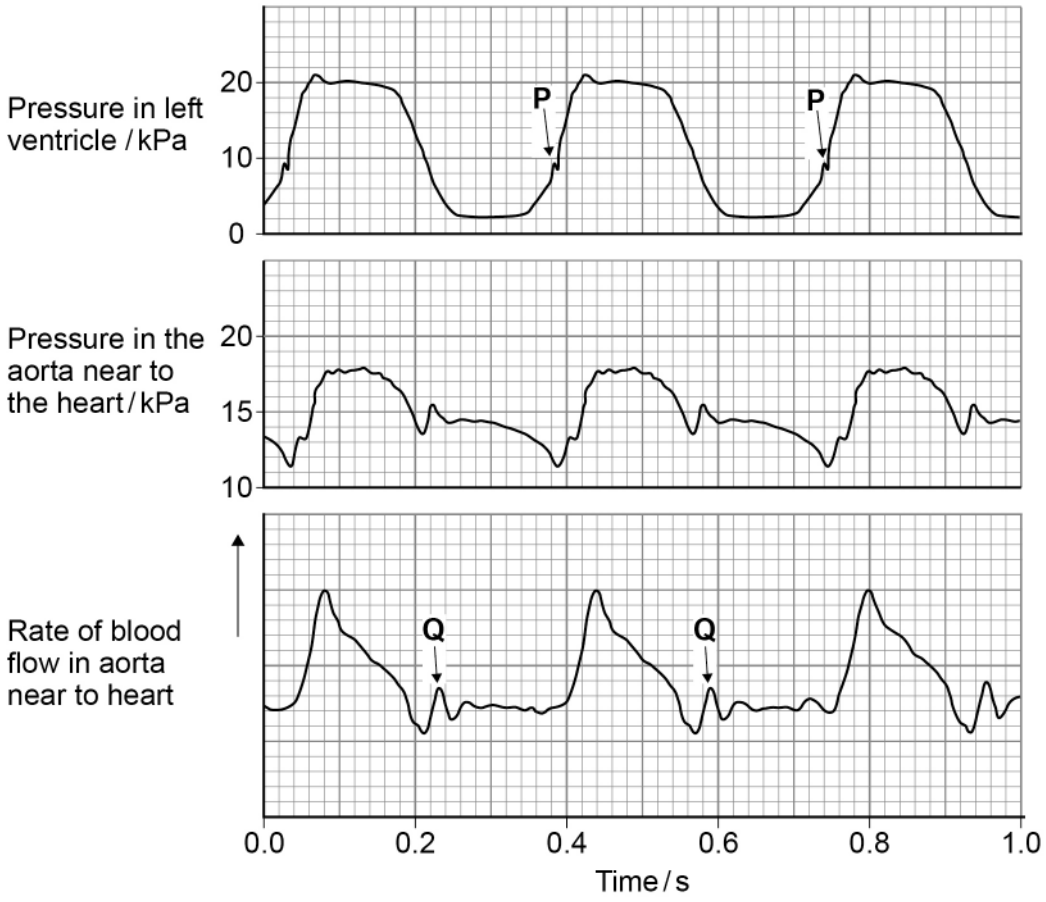
0 3 **Figure 3** shows pressure and blood flow during the cardiac cycle in a dog.

Figure 3



0 3 . 1 At **P** on **Figure 3**, the pressure in the left ventricle is increasing. At this time, the rate of blood flow has not yet started to increase in the aorta.

Use evidence from **Figure 3** to explain why.

[2 marks]

Do not write outside the box

0 3 . 2 At **Q** on **Figure 3** there is a small increase in pressure **and** in rate of blood flow in the aorta.

Explain how this happens **and** its importance.

[2 marks]

0 3 . 3 A student correctly plotted the right ventricle pressure on the same grid as the left ventricle pressure in **Figure 3**.

Describe **one** way in which the student's curve would be similar to and **one** way it would be different from the curve shown in **Figure 3**.

[2 marks]

Similarity

Difference

0 3 . 4 Use information from **Figure 3** to calculate the heart rate of this dog.

[1 mark]

Heart rate _____ beats minute^{-1}

7

Turn over ►

Do not write outside the box

0 4 Anthocyanins are coloured pigments found in the cell vacuole of some plant cells. Anthocyanins cannot move across undamaged cell membranes.

A student investigated how to extract anthocyanins from blueberries.

She mixed 10 g of crushed, fresh blueberries with 100 cm^3 of extraction solvent for 1 hour.

She investigated three different extraction solvents:

- **E** – Ethanol, water and acid
- **F** – Ethanol and water
- **G** – Water

0 4 . 1 When making up extraction solvent **E**, the student used a volume ratio of 70:30:1 ethanol:water:acid.

Tick (✓) **one** box that shows the most appropriate volumes she would use to make up 100 cm^3 of extraction solvent **E**.

[1 mark]

63.6 cm^3 ethanol, 27.3 cm^3 water, 9.1 cm^3 acid ☐

69.3 cm^3 ethanol, 29.7 cm^3 water, 1.0 cm^3 acid ☐

70.0 cm^3 ethanol, 30.0 cm^3 water, 1.0 cm^3 acid ☐

70.7 cm^3 ethanol, 30.3 cm^3 water, 1.0 cm^3 acid ☐

0 4 . 2 The student kept constant:

- the mass of fresh blueberries
- the volume of extraction solvent
- the time for the mixture to stand.

Name **two** other variables the student should have kept constant during this investigation.

[2 marks]

1 _____

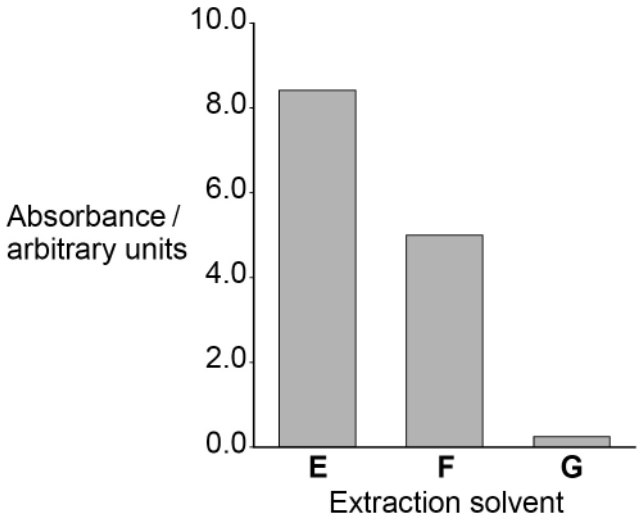
2 _____

Do not write outside the box

0 4 . 3 After 1 hour, the student filtered the samples.
She placed the filtrate in a colorimeter and measured the light absorbance.

Her results are shown in **Figure 4**.

Figure 4



Use your knowledge of membrane structure to explain the results in **Figure 4**.

[4 marks]

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0 4 . 4 A different student did this investigation. He did **not** have a colorimeter.

Describe a method this student could use to prepare colour standards and use them to give data for the total anthocyanin extracted.

[3 marks]

10

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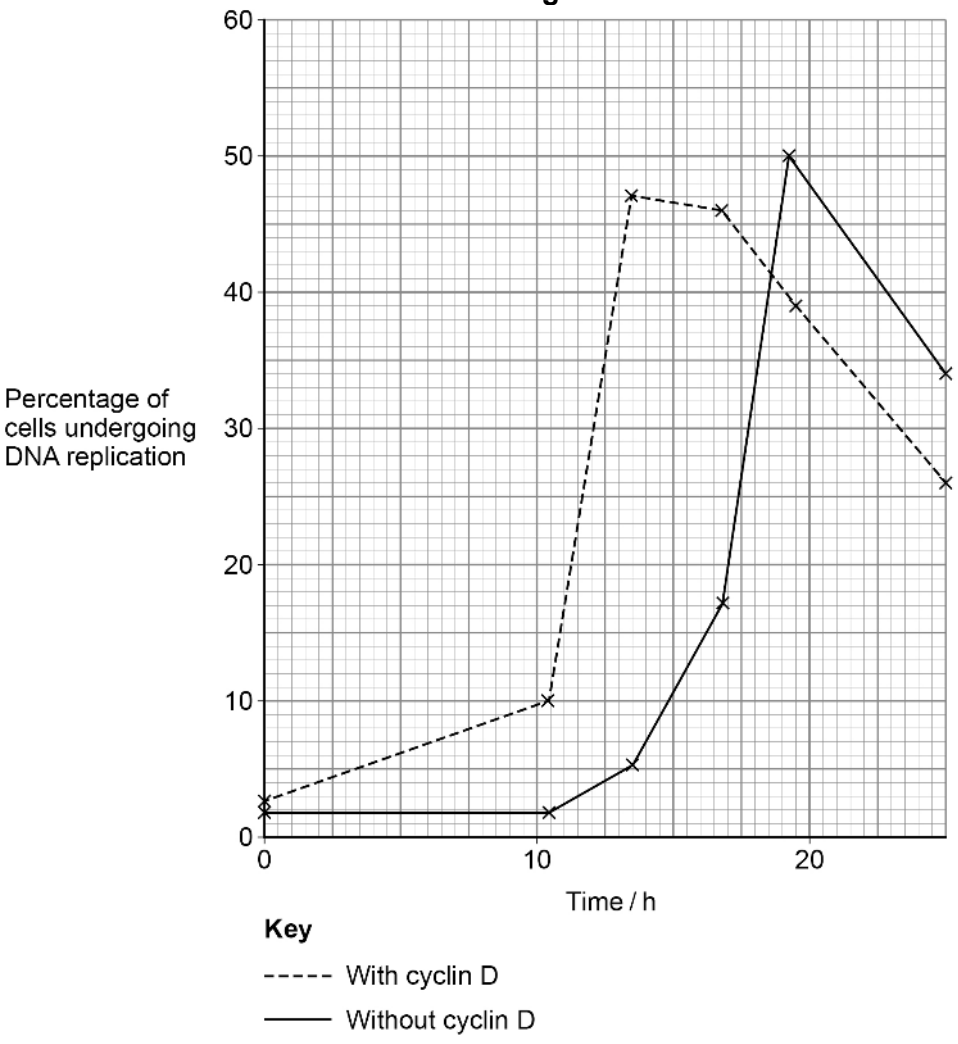
0 5 . 1 Describe the role of DNA polymerase in the semi-conservative replication of DNA.

[2 marks]

Figure 5 shows the percentage of rat cells undergoing DNA replication. Some cells contained a protein called cyclin D and some cells did not contain cyclin D. All cells were in early interphase at time 0

Figure 5



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0 5 . 2 It took less time for 25% of cells with cyclin D to be undergoing DNA replication than for 25% of cells without cyclin D.

Use **Figure 5** to calculate this time difference as a percentage decrease.

Show your working.

[2 marks]

Answer _____ %

0 5 . 3 Cyclin D stimulates the phosphorylation of DNA polymerase, which activates the DNA polymerase.

Describe how an enzyme can be phosphorylated.

[2 marks]

0 5 . 4 Some tumour cells contain higher than normal concentrations of cyclin D.

Use **Figure 5** to suggest why higher than normal concentrations of cyclin D could result in a tumour.

[2 marks]

8

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0 6 . 1 Particulate matter is solid particles and liquid particles suspended in air. Polluted air contains more particulate matter than clean air.

A high concentration of particulate matter results in the death of some alveolar epithelium cells. If alveolar epithelium cells die inside the human body they are replaced by non-specialised, thickened tissue.

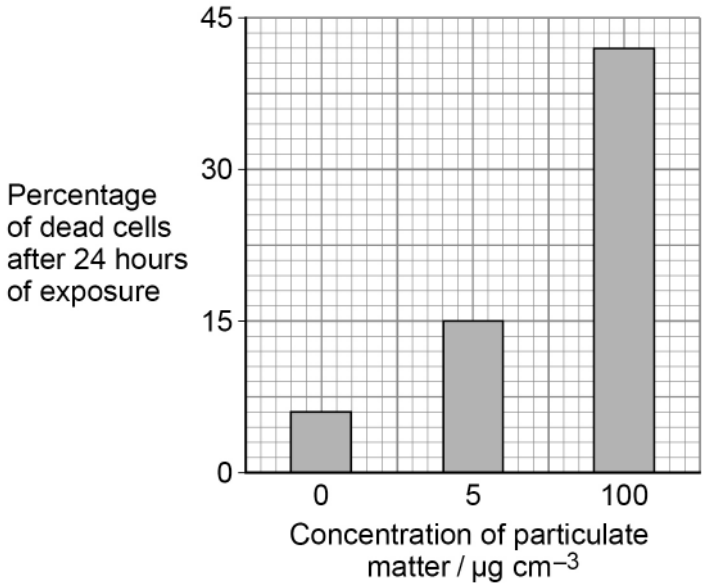
Explain why death of alveolar epithelium cells reduces gas exchange in human lungs.

[3 marks]

Do not write outside the box

Scientists grew alveolar epithelium cells and exposed the epithelium cells to different concentrations of particulate matter. They calculated the percentage of these alveolar epithelium cells that died after 24 hours of exposure to particulate matter. Their results are shown in **Figure 6**.

Figure 6



0 6 . 2 Do the data in **Figure 6** show a linear relationship between concentration of particulate matter and percentage of dead cells?

Use suitable calculations to justify your answer.

[2 marks]

Space for your calculations:

5

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0 7 . 1 Alpha-gal is a disaccharide found in red meat.

Alpha-gal is made of two galactose molecules. Galactose has the chemical formula $C_6H_{12}O_6$

Give the chemical formula for the disaccharide, alpha-gal, and describe how it is formed from two galactose molecules.

[2 marks]

Formula _____

Description _____

_____

_____

_____

_____

0 7 . 2 Some people eat red meat for many years without having any reaction, then have an allergic reaction to the alpha-gal in red meat.

An allergic reaction is caused by an immune response.

Draw a labelled diagram of an antibody **and** identify the specific alpha-gal binding site.

[3 marks]

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0 7 . 3 A tick is a small animal that bites humans and feeds on their blood. This results in proteins from the tick saliva entering the human body.

Scientists have suggested one hypothesis for the allergic reaction to alpha-gal in red meat. They think that an earlier immune response to a tick bite can cause a person to have an allergic reaction to alpha-gal in red meat.

Suggest how **one** antibody can be specific to tick protein and to alpha-gal.

[2 marks]

Question 7 continues on the next page

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0 7 . 4 Scientists took blood samples from one man over several weeks and measured the concentration of antibody in the man's blood. During this time, the man had two tick bites and had an allergic reaction to alpha-gal in red meat.

The scientists' results are shown in **Figure 7**.

Figure 7

This figure has been removed due to third-party copyright restrictions.

The scientists' hypothesis was that an earlier immune response to tick protein causes the allergic reaction.

Consider whether **Figure 7** supports this hypothesis.

[3 marks]

10

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0 8 . 1 Complete **Table 2** to show **three** differences between DNA in the nucleus of a plant cell and DNA in a prokaryotic cell.

[3 marks]

Table 2

DNA in the nucleus of a plant cell	DNA in a prokaryotic cell
1	
2	
3	

0 8 . 2 Scientists investigated the genetic diversity between several species of sweet potato. They studied non-coding multiple repeats of base sequences.

Define 'non-coding base sequences' and describe where the non-coding multiple repeats are positioned in the genome.

[2 marks]

Question 8 continues on the next page

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The percentage similarities in the non-coding multiple repeats of base sequences of four species of sweet potato are shown in **Table 3**.

Table 3

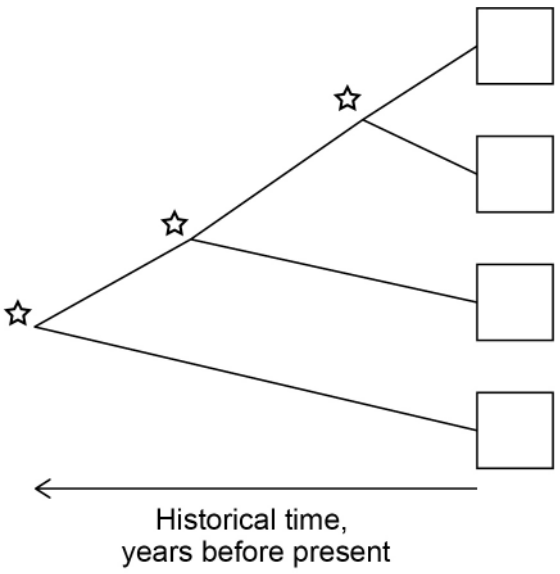
Species of sweet potato	Percentage similarity between non-coding multiple repeat base sequences			
	C	**L**	**R**	**T**
C		53.5	25.7	59.7
L	53.5		33.4	53.7
R	25.7	33.4		36.6
T	59.7	53.7	36.6	

0 8 . 3 Use the information in **Table 3** to complete the phylogenetic tree shown in **Figure 8**.

Write the letter that represents the correct species into each box.

[1 mark]

Figure 8



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0 8 . 4 The scientists studied five individuals from each species. Within the five individuals of **species T** they found a percentage similarity of 66%.

Use **Table 3** to evaluate how this information affects the validity of the phylogenetic tree.

[2 marks]

8

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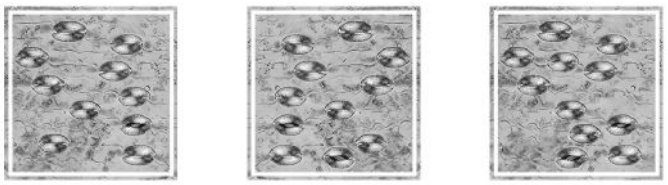
0 9 Scientists investigated stomatal density on leaves of one species of tree.

Figure 9 shows three examples of the square fields of view the scientists used to calculate a mean stomatal density.

Figure 9



Key

Stomata

White lines show the counting field for stomata (each edge of white square = 250 µm)

0 9 . 1 Calculate the mean stomatal density in the three fields of view in **Figure 9**.

Give your answer as number of stomata per mm^2

Show your working.

[2 marks]

Stomatal density _____ per mm^2

Question 9 continues on the next page

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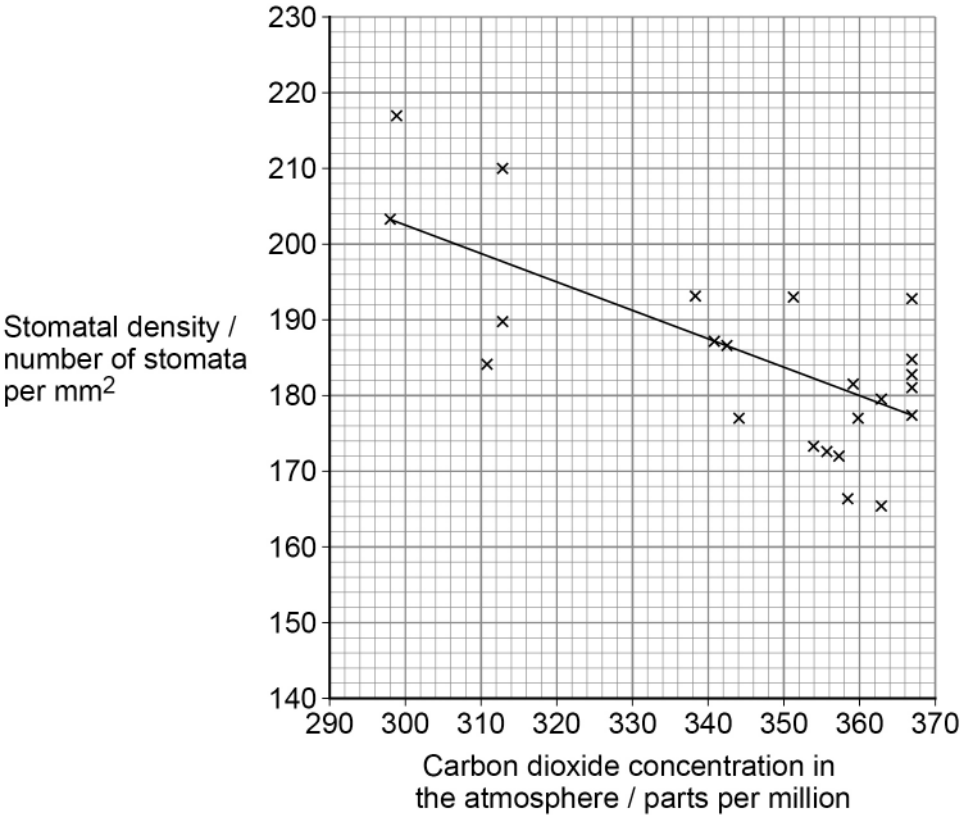
The scientists used leaves from individual trees that had grown in different areas of the world in different years. Each tree had grown in an area and year with known carbon dioxide concentration.

Their results are shown in **Figure 10**.

Figure 10



Key

Each plotted point represents mean stomatal density from 10 leaves from one tree

Line shows line of best fit, which shows a statistically significant change

0 9 . 2 Give a null hypothesis for this investigation **and** name a statistical test that would be appropriate to test your null hypothesis.

[2 marks]

Null hypothesis _____

_____

_____

Statistical test _____

Do not write outside the box

0 9 . 3 From 1910 to 2000, the carbon dioxide concentration in the atmosphere increased from 300 parts per million to 365 parts per million.

Use **Figure 10** to calculate the mean rate of change in stomatal density from 1910 to 2000.

Give your answer as number of stomata per mm^2 per 10-year period.

Show your working.

[2 marks]

Number of stomata per mm^2 per 10-year period _____

0 9 . 4 A journalist saw **Figure 10** and suggested that future increases in atmospheric carbon dioxide concentration could result in less transpiration.

Evaluate his suggestion.

[4 marks]

10

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1 0 . 1 Describe how mRNA is formed by transcription in eukaryotes.

[5 marks]

Do not write outside the box

1 0 . 2 Describe how a polypeptide is formed by translation of mRNA.

[6 marks]

Question 10 continues on the next page

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1 0 . 3 Define 'gene mutation' and explain how a gene mutation can have:

- no effect on an individual
- a positive effect on an individual.

[4 marks]

15

END OF QUESTIONS

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