



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	
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8	
9	
10	
TOTAL	



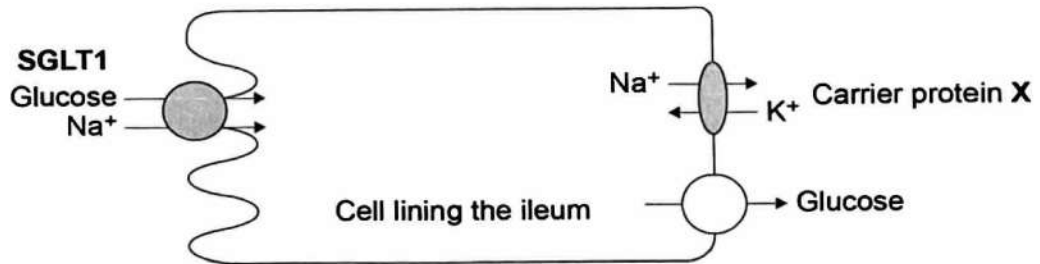
Answer all questions in the spaces provided.

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]

Converts ATP to ADP + P_i releasing energy. This energy allows active transport of ions.

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]

It creates a concentration gradient of Na^+ from the inside of the cell. Na^+ moves then in by facilitated diffusion, co-transporting glucose into the cell as Na^+ moves into cell along the concentration gradient.



0 1 . 3

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

[2 marks]

1 The folded membrane with microvilli provides a large surface area

2 Large number of mitochondria to make ATP to be used in active transport,

Question 1 continues on the next page

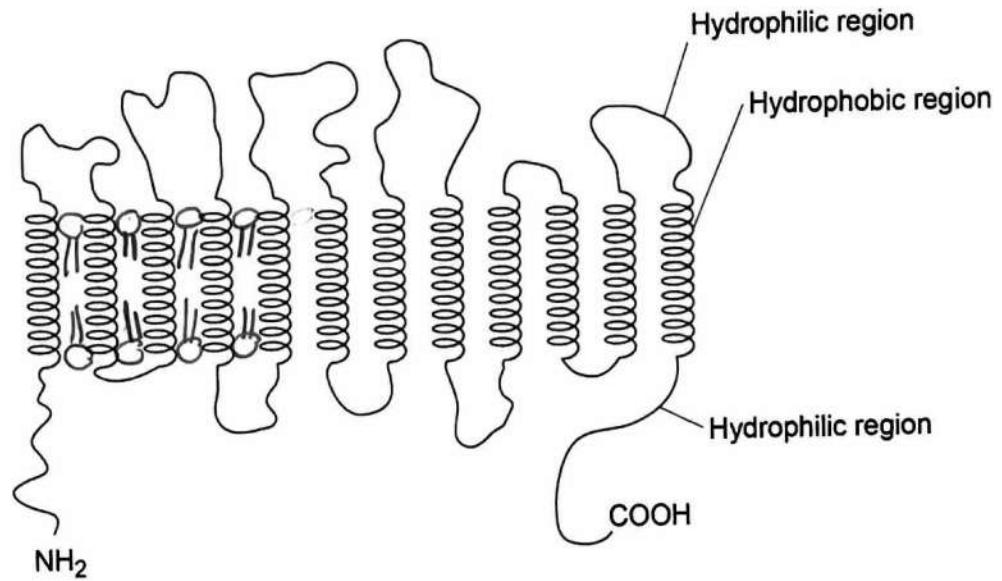
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Figure 2 is a diagram of one SGLT1 carrier protein.

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]



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0 1 . 5

Figure 2 shows the SGLT1 polypeptide with NH_2 at one end and COOH at the other end.

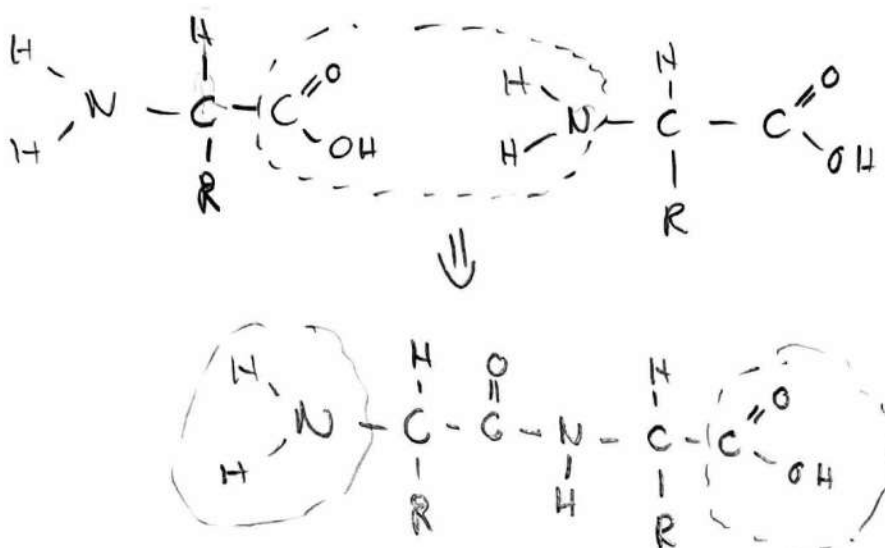
Describe how amino acids join to form a polypeptide so there is always NH_2 at one end and COOH at the other end.

You may use a diagram in your answer.

[2 marks]

NH_2 group joins with COOH group to form a peptide bond. Free COOH group on one end and NH_2 on the other end as all amino acids are oriented in the same direction

Space for diagram:



10

Turn over for the next question

Turn over ►



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]

Triglyceride decreases as they get broken down by lipases. They are broken down into fatty acids and glycerol, so fatty acid increases. This breaking down is done through a hydrolysis reaction which breaks the ester bonds between glycerol and fatty acid chains.



0 2 . 2

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

Explain why.

[2 marks]

To denature any lipase or other enzyme in the sample, so no further breakdown is taking place.

0 2 . 3

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

[3 marks]

They allow fatty acids to be ~~so~~ more soluble in water, so they can be transported to the cell lining. They contain fatty acids and bile salt. The fatty acids then can get absorbed by the cell through diffusion across the cell membrane.

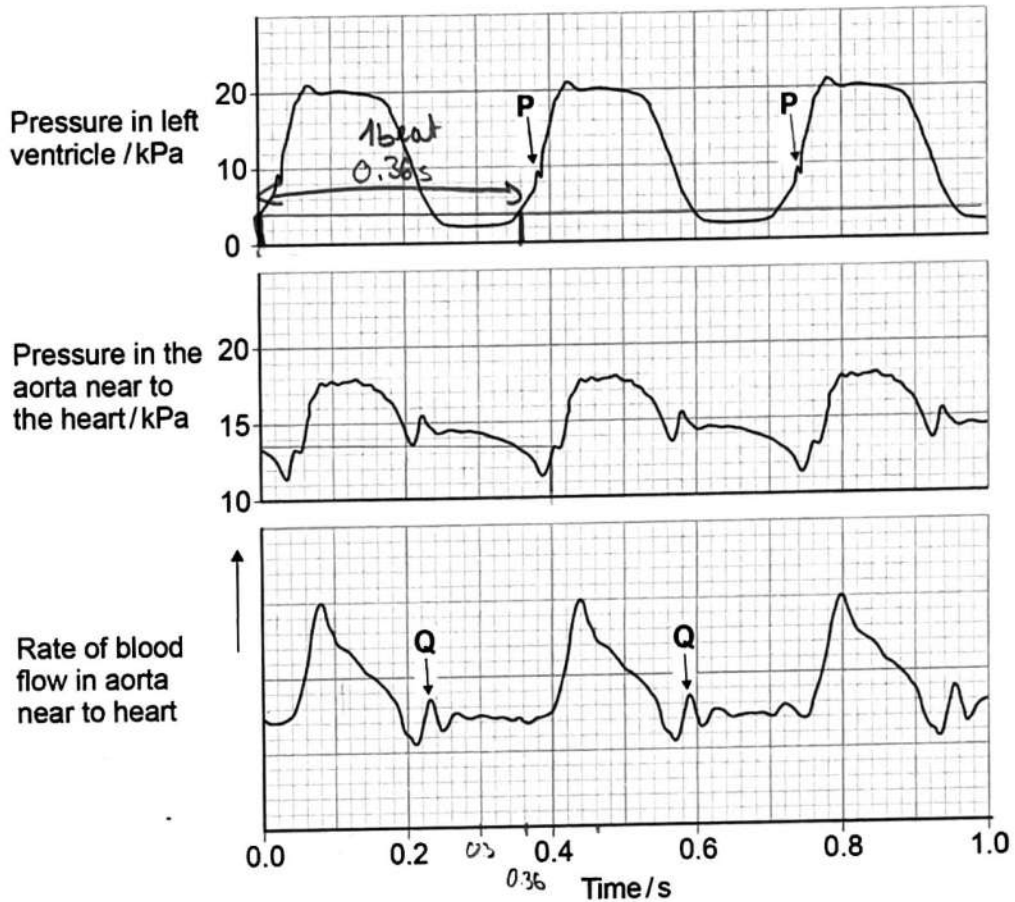


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0 3

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]

semi lunar valve is closed. As aorta pressure is 13 kPa while ventricle pressure is 9 kPa, so lower than in the aorta.



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]

The wall of the aorta has thick elastic tissue that recoils. This maintains a steady blood pressure.

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 The peaks indicated would be happening at the same time, as contractions happen at the same time.

Difference While peaks in the same time, they would be lower, as pressure is lower in the right ventricle.

0 3 . 4

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

[1 mark]

$$\div 0.36 \left(\begin{array}{l} 0.36 \text{ s} - 1 \text{ beat} \\ 1 \text{ s} - 2.777... \end{array} \right) 0.36$$

$$2.777... \times 60 = 166.666...$$

167 beats/min

Heart rate 167 beats minute⁻¹

7

Turn over ►



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 Temperature

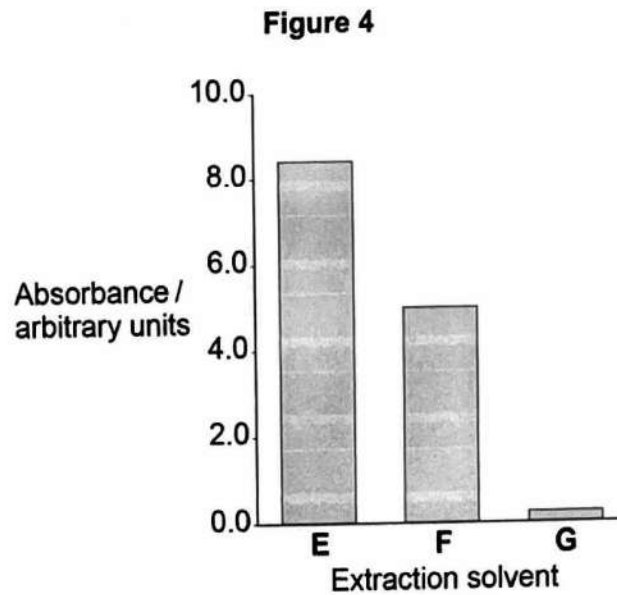
2 Concentration of ethanol



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**.



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

[4 marks]

High absorbance indicates higher amount of anthocyanin. This can only escape the cell if the cell membrane is damaged. So higher absorbance means higher level of damage. The more the membrane is damaged the more anthocyanin is released. E and F has most damage due to ethanol, which dissolves lipids in the phospholipid bilayer of the cell membrane. More damage in E as not only effect of ethanol, as stated above but effect of acid as well. Acid denatures the cell surface and embedded proteins in the cell membrane, making it more permeable.

Turn over ►



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]

Use a known concentration of the pigment at the start. Then do a series of serial dilutions on this known concentration. This will give them a colour scale they can compare their samples to, while they also know the concentration of each dilution. They can score their experimental values against this scale.

10



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0 5 . 1

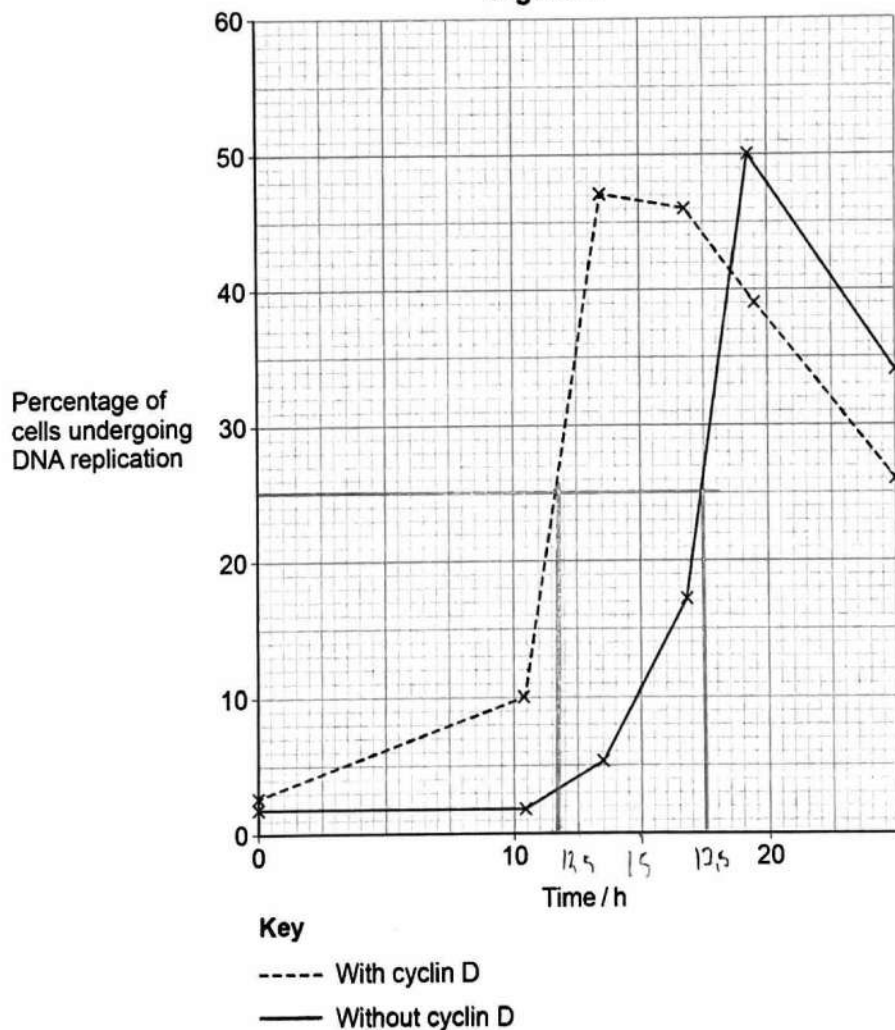
Describe the role of DNA polymerase in the semi-conservative replication of DNA.

[2 marks]

It joins free nucleotides together through a condensation reaction between the deoxyribose sugar and a phosphate group. Forming phosphodiester bonds inbetween.

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.

$17.50 - 11.75$

With cyclin D - 11.75h 5.75h

Without cyclin D - 17.50h

[2 marks]

$$\frac{5.75h}{17.50h} = 0.3285714\% \Rightarrow 32.9\%$$

Answer 32.9 %

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]

ATP gets hydrolysed releasing an inorganic phosphate, which gets attached to the enzyme.

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]

Cell begins to replicate the DNA sooner, shortening the interphase. This results in a faster rate of cell division, which can get out of control.

8

Turn over ►



06.1

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]

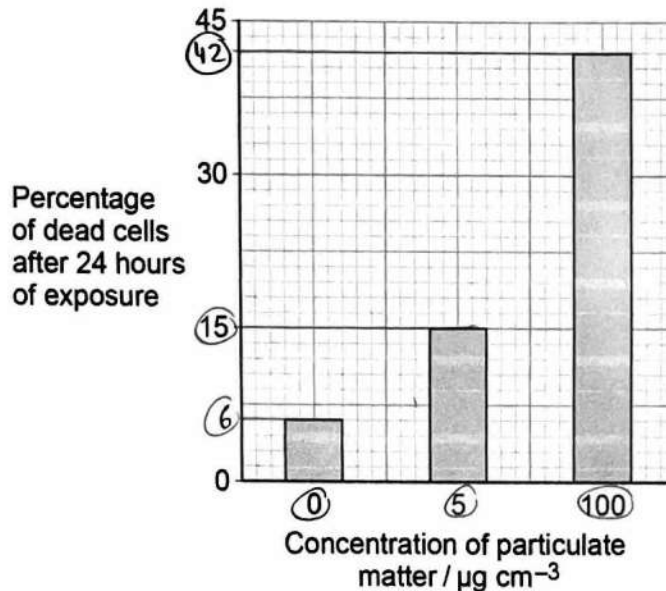
These cells provide the walls of the alveoli, so their death reduces the number of alveoli so reducing the gas exchange surface area. This increases the distance for diffusion, so reducing the efficiency of gas exchange in the lungs.



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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]

No, as increase from 0 to 5 $\mu\text{g cm}^{-3}$ is 9%, so if linear it should be 180% for increase from 0 to 100 $\mu\text{g cm}^{-3}$. But it is 42% which is much less.

Space for your calculations:

$$0 - 5 \mu\text{g means } 6 \rightarrow 15\% = 9\%$$

$$\text{is linear } \frac{100}{5} \times 9\% = 180\%$$

$$\text{but its } 42\%$$

5

Turn over ►



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07.1 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]

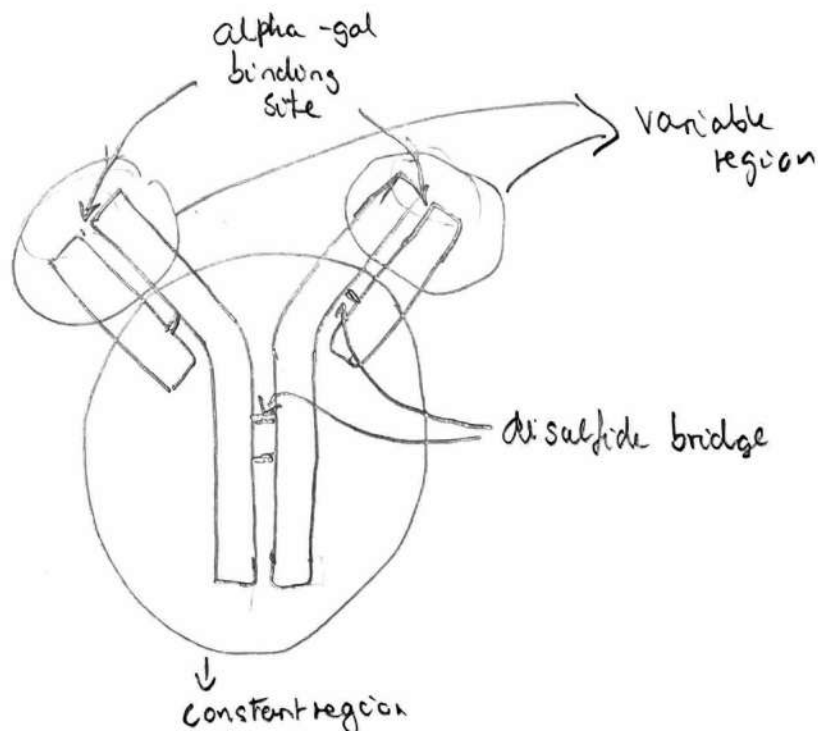
Formula $C_{12}H_{22}O_{11}$

Description Condensation reaction between the two molecules releases 2 hydrogen and 1 oxygen as H_2O (water).

07.2 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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07.3

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]

tick protein has similar shape to alpha-gal.
Antibody is complementary to both so both can
bind to it.

Question 7 continues on the next page

Turn over ►



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 Has no plasmid	Has plasmids
2 Has introns and exons	only has introns
3 Linear DNA	circular DNA

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]

DNA that doesn't code for the expression of a protein. It is found in between genes as introns.

Question 8 continues on the next page

Turn over ►



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

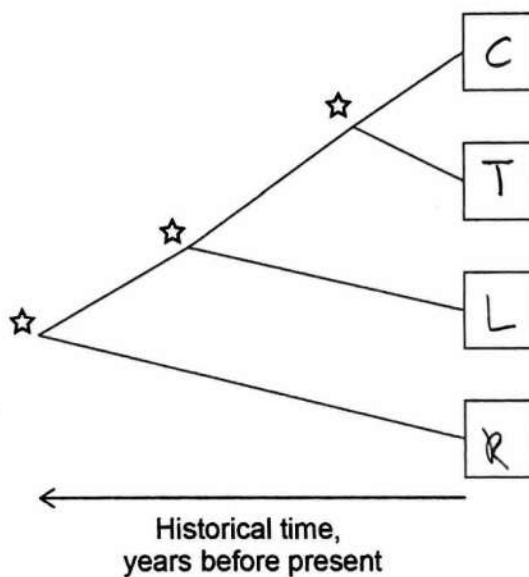
Species of sweet potato	Percentage similarity between non-coding multiple repeat base sequences			
	C	L	R	T
C		53.5	25.7	59.7
L	53.5		33.4	53.7
R	25.7	33.4		36.6
T	59.7	53.7	36.6	

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



Key

☆ Common ancestor of the species to the right



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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]

They show that members of the same species
are more similar to each other than to
other species. But, 66% still ~~suggest~~ suggests
suggests large variations within T population.

8

Turn over for the next question

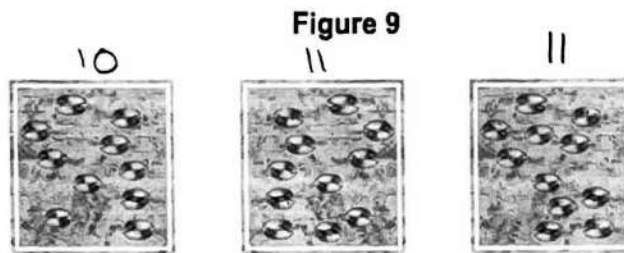
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0 9

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.

**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.

$$250 \mu\text{m} \times 250 \mu\text{m} \\ = 62500 \mu\text{m}^2$$

$$1 \text{mm}^2 = 1000000 \mu\text{m}^2$$

$$\frac{10 + 11 + 11}{3} = 10.666\dots$$

$$\frac{1000000}{62500} = 16$$

$$16 \times 10.666\dots = 170.6\dots$$

171

Stomatal density 171 per mm^2

[2 marks]

Question 9 continues on the next page

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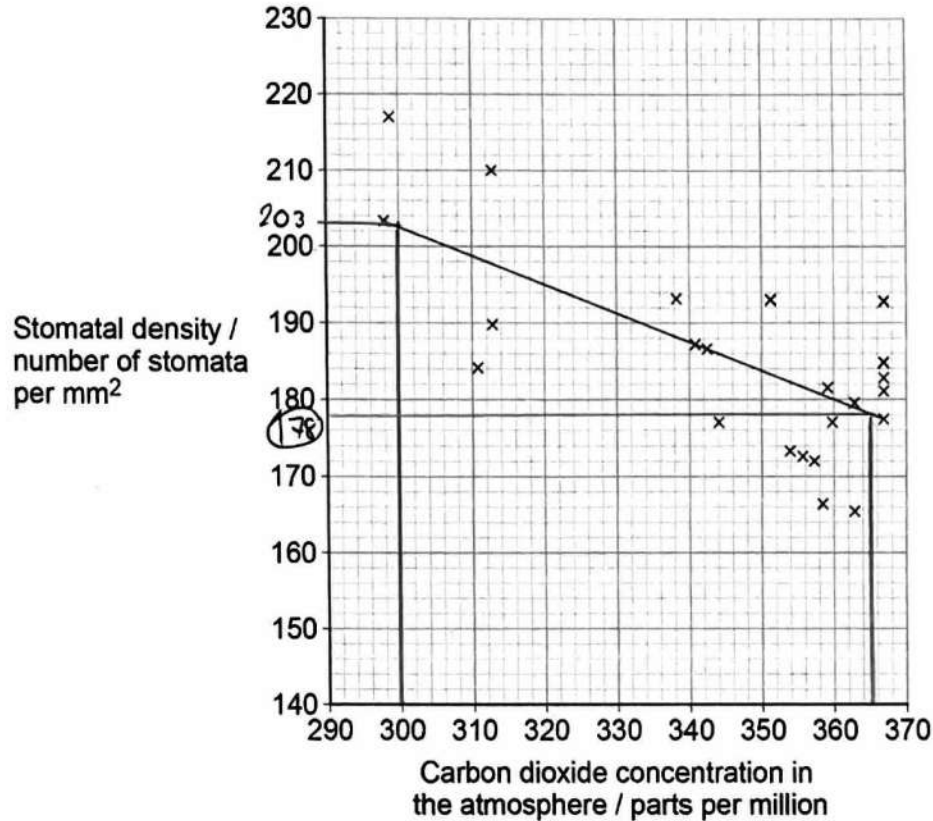


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The scientists used leaves from individual trees that had grown in different areas of the world in different years. Each tree had grown in an area and year with known carbon dioxide concentration.

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 There is no relationship between CO₂ concentration and stomata density.

Statistical test Correlation Coefficient.



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- 09.3 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.

$$203 - 178 = 25 \quad 90 \text{ years} \quad [2 \text{ marks}]$$

$$\frac{25}{90} = \underline{0.27}$$

Number of stomata per mm^2 per 10-year period 0.27

- 09.4 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]

Increase in CO_2 concentration shows a decrease in stomatal density. If there is fewer stomata there will be less ~~trans~~ transpiration.

This is because same amount of CO_2 can be absorbed with fewer number of stomata at high CO_2 concentration.

However there is no indication whether total stomata number is decreased, as size of leaf could have increased.

Also, trend may be limited by factors, so may not continue proportionally.

10

Turn over ►



1 0 . 1

Describe how mRNA is formed by transcription in eukaryotes.

[5 marks]

The double helix of the DNA is broken, by breaking of the hydrogen bonds between base pairs. Each strand then can be used ~~to~~ as a template. Free RNA nucleotides align along the template by complementary base pairing. C pairs with G, but A pairs with U (uracil) instead of T (Thymine).

RNA polymerase is then used to join up the free nucleotides into an RNA molecule with phosphodiester bonds.

This RNA needs to be spliced to remove introns to make mRNA molecule.



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

[6 marks]

Translation happens at the ribosomes. The mRNA contains the codon which is the base pairs read in a triplet code, while tRNA contains the anticodon complementary to the codon. tRNA has an amino acid attached to it as well bringing it with it to the ribosome when the codon is read. This amino acid joins the polypeptide with a peptide bond. This joining process requires energy from ATP to take place. Once the amino acid has attached to the polypeptide chain, it detaches from the tRNA and the tRNA detaches from the ribosome. The ribosome moves along the mRNA strand to "read" the next 3 bases as the next codon. Process repeats till whole mRNA is read or a stop codon is reached.

Question 10 continues on the next page

Turn over ►



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]

Change to the a base or base sequence of a chromosome, leading to a formation of a new allele.

It can sometimes have no effect as gene can be recessive so no significant change to phenotype of the individual. It could be a silent mutation, changing the base pair but not changing the actual amino acid it codes for, so no change to protein produced.

It can have a positive effect as new structure from change in amino acid sequence results in a protein more efficient in its function. This can increase an individual's success at survival and hence reproduction,

15

END OF QUESTIONS

