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Oxford Cambridge and RSA

Friday 20 May 2022 – Afternoon

AS Level Biology A

H020/01 Breadth in biology

Time allowed: 1 hour 30 minutes

You can use:
- a ruler (cm/mm)
- a scientific or graphical calculator

Please write clearly in black ink. **Do not write in the barcodes.**

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

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

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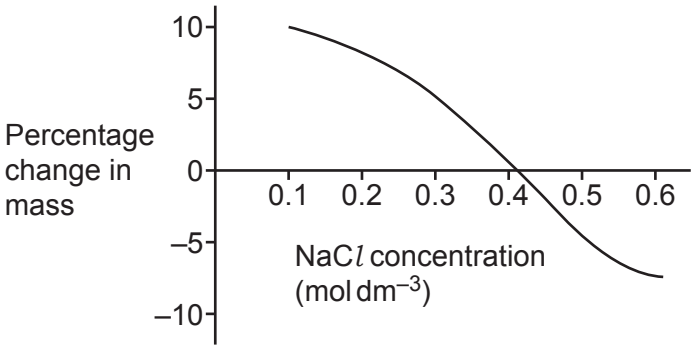
SECTION A

You should spend a maximum of 25 minutes on this section.

Write your answer for each question in the box provided.

Answer **all** the questions.

1 The graph below shows the results of an osmosis experiment investigating the effect of changing the concentration of sodium chloride (NaC*l*) on mass of potatoes.



Which concentration of NaC*l* causes equal movement of water into and out of the potato?

A 0.36 mol dm^{-3}

B 0.40 mol dm^{-3}

C 0.42 mol dm^{-3}

D 0.62 mol dm^{-3}

Your answer ☐ **[1]**

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2 The reaction between carbon dioxide and water forms carbonic acid. This reaction is catalysed by the enzyme carbonic anhydrase. To catalyse this reaction, carbonic anhydrase needs a cofactor that attaches to its active site as a prosthetic group.

What is the correct cofactor for carbonic anhydrase?

A Ca^{2+}

B Cl^{-}

C H^{+}

D Zn^{2+}

Your answer ☐ **[1]**

3 The table shows the numbers of different species of invertebrates found in four different areas in a woodland.

Area	Invertebrate species			
	Woodlice	**Spiders**	**Beetles**	**Millipedes**
A	15	20	1	0
B	2	7	6	7
C	25	1	7	3
D	8	0	2	17

Which row shows the area that has the greatest species richness **and** greatest species evenness?

Your answer ☐ **[1]**

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4 The table shows the chemical symbols for some inorganic ions involved in biological processes.

	Ammonium ion	**Calcium ion**	**Nitrate ion**
A	NH_4^+	Ca^+	NO_2^-
B	NH_4^-	Ca^{2+}	NO_3^-
C	NH_4^+	Ca^{2+}	NO_3^-
D	NH_4^+	Ca^{2+}	NO_2^-

Which row gives the correct chemical symbols for all of these inorganic ions?

Your answer ☐ **[1]**

5 Researchers have calculated that the probability of bacterial DNA having a mutation is 1/333 in a single division.

A gene has DNA that codes for amino acids and is called coding DNA. The rest of the DNA in a genome has base sequences that do not code for amino acids and is called non-coding DNA.

Bacterial genome studies have shown that the average proportion of a bacterial genome that has non-coding DNA is 3/25.

What is the probability of a dividing bacterium having a mutation in a gene that codes for a protein in a single division?

A 1/2775

B 22/8325

C 1024/8325

D 7351/8325

Your answer ☐ **[1]**

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6 Restriction endonucleases are a group of enzymes that carry out hydrolysis reactions that cut long DNA molecules into shorter lengths.

Which of the options describes how restriction endonucleases carry out hydrolysis reactions on a DNA molecule?

A They break the glycosidic bond between a ribose and a phosphate group.

B They break the hydrogen bonds between nitrogenous bases.

C They break the phosphodiester bond between a deoxyribose and a phosphate group.

D They break the phosphodiester bond between a ribose and a phosphate group.

Your answer ☐ **[1]**

7 A student carried out an investigation to see the effect of changing the concentration of the enzyme maltase. They used two different maltase concentrations (concentration **P** and **Q**) to break down the disaccharide maltose for 10 minutes. The student carried out the reducing sugar test and recorded the percentage absorbance of each solution using a colorimeter.

Their results are shown in the table.

Absorbance (arbitrary units)	
Maltase concentration P	**Maltase concentration Q**
0.235	0.452
0.253	0.523
0.436	0.541
0.258	0.361
0.224	0.256
0.236	0.236

Which statistical test would be used to determine if there was a significant difference between the mean glucose concentration produced by maltase concentration **P** and maltase concentration **Q**?

A Chi-squared test

B Spearman's rank correlation coefficient

C *t*-test – paired

D *t*-test – unpaired

Your answer ☐ **[1]**

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8 International trade in parts of the rhinoceros including rhino horn has been illegal since 1977.

Which organisation regulates this trade?

A CBD

B CITES

C CSS

D IUCN

Your answer ☐ **[1]**

9 The following passage has four key terms missing, which are names of molecules involved in protein synthesis.

The enzyme .....**1**..... joins nucleotides together to make a copy of the gene. This makes the molecule .....**2**..... , which leaves through the nuclear pore to bind to an organelle that is made of protein and .....**3**..... . The amino acids are assembled here when .....**4**..... brings the specific amino acid to be joined to the polypeptide.

Which row gives the correct names of these missing molecules?

	1	2	3	4
A	DNA polymerase	(t)RNA	(m)RNA	(r)RNA
B	RNA polymerase	(m)RNA	(r)RNA	(t)RNA
C	RNA polymerase	(m)RNA	(t)RNA	(r)RNA
D	RNA polymerase	(r)RNA	(t)RNA	(m)RNA

Your answer ☐ **[1]**

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10 *Victoria cruziana* is a tropical species of flowering plant, native to South America. Its leaves have stomata only on their upper surface and contain a large amount of aerenchyma tissue, which contains air spaces.

Which group of plants does *Victoria cruziana* belong to?

A Epiphytes

B Halophytes

C Hydrophytes

D Xerophytes

Your answer ☐ **[1]**

11 The temperature coefficient (Q_{10}) for catalase is recorded in a data book as 1.15.

A student carries out an experiment to test if this Q_{10} value is correct and collects data with a high level of precision and accuracy.

Which row shows the correct definition of both precision and accuracy for their data?

	Precision	**Accuracy**
A	results have a small standard deviation	mean result is close to 1.15
B	results have a small standard deviation	repeated readings close together
C	results recorded to a high number of decimal places	mean result is close to 1.15
D	results recorded to a high number of decimal places	repeated readings close together

Your answer ☐ **[1]**

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12 The table shows the dimensions of a dividing ball of cells and their surface area to volume ratios.

Number of divisions	Number of cells	Radius (mm)	Surface area (mm^2)	Volume (mm^3)	Surface area to volume ratio
0	1	0.5	3.14	0.52	6 : 1
3	8	1.0	12.57	4.19	3 : 1
5	32	1.5	28.27	14.14	2 : 1
6	64	2.0	50.27	33.51	

What is the best estimate of the surface area to volume ratio after the cell has divided six times?

A 7 : 4

B 3 : 2

C 5 : 4

D 1 : 1

Your answer ☐ **[1]**

13 Cells in the leaves of plants synthesise amino acids.

Which of the statements explains why plants need a vascular system to support amino acid synthesis?

A To transport amino acids to the roots using xylem tissue

B To transport nitrates to the leaves using phloem tissue

C To transport nitrates to the leaves using xylem tissue

D To transport sucrose to the leaves using phloem tissue

Your answer ☐ **[1]**

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14 Fick's Law describes the relationship between the rate of diffusion and factors that affect this rate.

This can be simplified as the equation:

$$\text{Rate of diffusion } \alpha \frac{\text{surface area} \times \text{concentration gradient}}{\text{thickness of surface}}$$

Inhalation of asbestos dust can cause a thickening of the alveolus wall.

Which option shows the change in the rate of diffusion if the alveolus wall increases from a thickness of 2.0 μm to 2.5 μm?

A Decreases by 20%

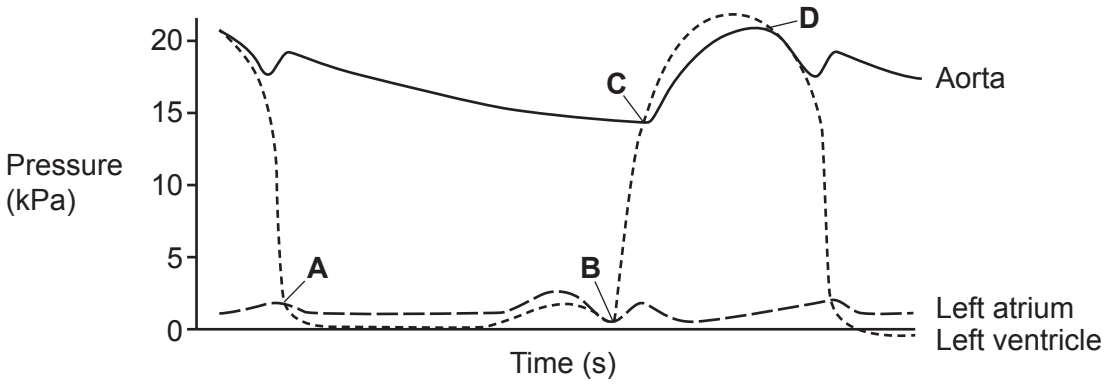
B Decreases by 50%

C Increases by 20%

D Increases by 50%

Your answer ☐ **[1]**

15 The diagram shows the changes in pressure in the left atrium, left ventricle and aorta in a single cardiac cycle.



Which letter shows the point at which the semilunar valve opens?

Your answer ☐ **[1]**

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16 Diseases can be caused by many different types of pathogen.

Which row matches the disease to the correct pathogen?

	Fungus	Protoctist	Virus
A	black sigatoka	tomato late blight	influenza
B	black sigatoka	tomato late blight	ring rot
C	tomato late blight	black sigatoka	influenza
D	tomato late blight	black sigatoka	ring rot

Your answer ☐ **[1]**

17 Which option describes the correct process of blood clotting?

A Platelets convert into insoluble fibrin to trap erythrocytes.

B The insoluble plasma protein fibrinogen converts into soluble fibrin to trap erythrocytes.

C The soluble plasma protein fibrinogen converts into insoluble fibrin to trap erythrocytes.

D The soluble plasma protein fibrinogen converts into soluble fibrin to trap erythrocytes.

Your answer ☐ **[1]**

18 A student is studying three unicellular organisms: the bacterium *Escherichia coli*, the protoctist *Euglena gracilis* and the fungus *Saccharomyces cerevisiae*.

Which feature is common to all three unicellular organisms?

A Cell wall

B Mitochondria

C Nucleus

D Ribosomes

Your answer ☐ **[1]**

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19 Convalescent plasma immunity is one method used to treat patients infected with Ebola virus disease (EVD). In this method, blood plasma is taken from a person who has recovered from EVD and is injected into the patient with the EVD infection.

Which of the options describes this form of immunity?

A Artificial active immunity

B Artificial passive immunity

C Natural active immunity

D Natural passive immunity

Your answer ☐ **[1]**

20 An enzyme hydrolyses a phospholipid molecule to release a fatty acid.

What is the name of the bond that is broken in this hydrolysis reaction?

A Ester

B Glycosidic

C Peptide

D Phosphodiester

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

21 Human insulin is a globular protein with a quaternary structure. One insulin molecule has 51 amino acids.

Fig. 21.1 shows the sequence of amino acids in one molecule of human insulin.

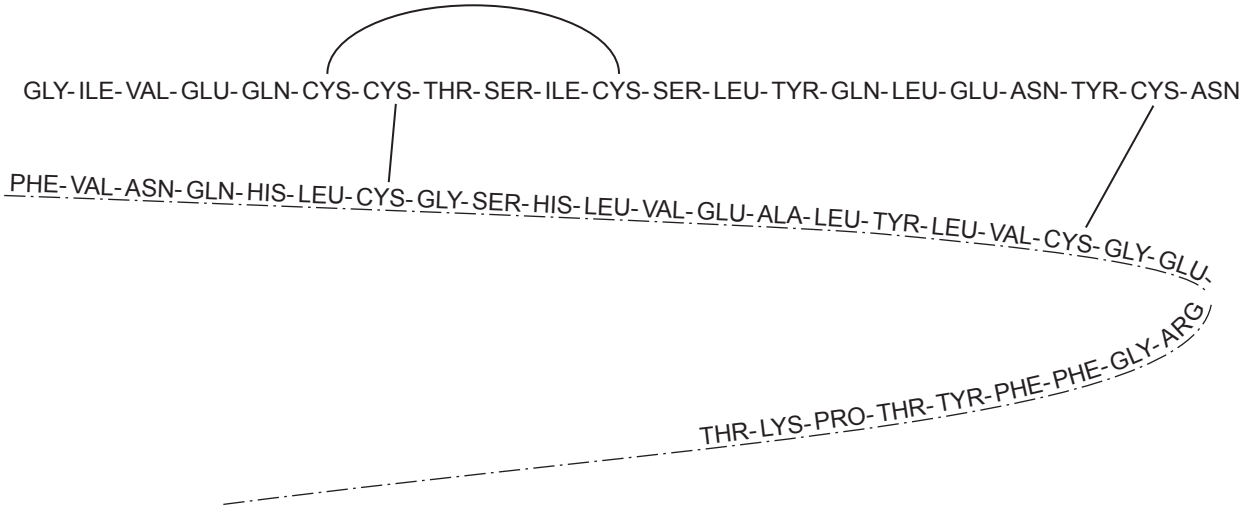


Fig. 21.1

(a) The amino acid cysteine is abbreviated to 'CYS' in **Fig. 21.1**. The side chain (R group) found in cysteine is shown in **Fig. 21.2**.

Complete **Fig. 21.2** to show the structure of the amino acid cysteine.

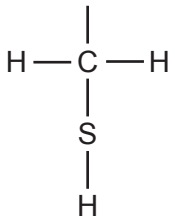


Fig. 21.2

[3]

(b) Explain how **Fig. 21.1** shows that insulin has a quaternary structure.

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.....

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..... **[2]**

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(c) Insulin is a hormone that regulates blood glucose concentration. People with type 1 diabetes need to inject insulin, to reduce their blood glucose concentration, as they are unable to produce their own insulin.

Diabetics need to inject insulin before every meal as insulin has a short half-life. Enzymes in the liver cells break down insulin, which removes it from the blood.

Insulin glargine is a modified version of human insulin that lasts much longer in the blood.

Fig. 21.3 shows the sequence of amino acids in one molecule of human glargine with the modifications in **bold**.

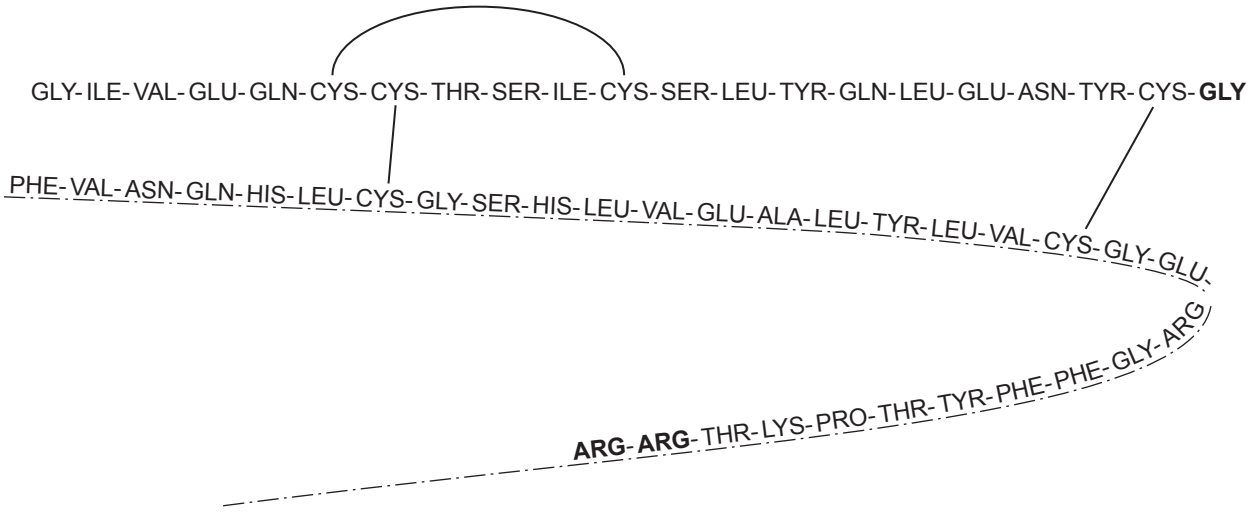


Fig. 21.3

(i) Suggest why insulin glargine is long-lasting.

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..... **[1]**

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The table shows some of the DNA triplet codes for amino acids.

1st base of DNA triplet	2nd base of DNA triplet								3rd base of DNA triplet
	T		C		A		G		
A	ATT	(ILE) Isoleucine	ACT	(THR) Threonine	AAT	(ASN) Asparagine	AGT	(SER) Serine	T
	ATC		ACC		AAC		AGC		C
	ATA		ACA		AAA	(LYS) Lysine	AGA	(ARG) Arginine	A
	ATG	(MET) Methionine	ACG		AAG		AGG		G
G	GTT	(VAL) Valine	GCT	(ALA) Alanine	GAT	(ASP) Aspartic acid	GGT	(GLY) Glycine	T
	GTC		GCC		GAC		GGC		C
	GTA		GCA		GAA	(GLU) Glutamic acid	GGA		A
	GTG		GCG		GAG		GGG		G

In order to produce insulin glargine, the human insulin gene is modified by genetic engineering. This is a process which can change the genetic code of the gene. The genetic code of DNA triplet 21 is changed so that the amino acid it codes for is glycine instead of asparagine.

(ii) With reference to the table, predict how the genetic code of DNA triplet 21 is changed so that it codes for the amino acid glycine instead of the amino acid asparagine.

.....

..... **[2]**

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(iii) The modified polypeptides that form insulin glargine are made inside cells.

The process of making the modified polypeptides that form insulin glargine involves several steps. The process starts with the modified gene for insulin glargine.

Outline the steps involved in the process of making the modified polypeptides that form insulin glargine, starting with the gene for insulin glargine until when the modified polypeptides are made.

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..... **[4]**

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22 A student gives a definition of one level of biodiversity as:

The number of different alleles for all the genes in a population.

(a) Name **and** define **two** other levels of biodiversity.

Name .....

Definition .....

.....

Name .....

Definition .....

.....

[2]

(b) During the 20th Century, there was a very large decrease in the size of wild populations of the cheetah, *Acinonyx jubatus*. This decrease was largely due to hunting. Recent research shows that wild populations of the cheetah have a very low number of polymorphic genes.

There are 17 863 gene loci in the genome of the cheetah and now only 10% of these gene loci are polymorphic in wild populations.

Scientists investigated the genetic biodiversity of cheetah populations in European zoos. They sampled 256 gene loci and found 18 gene loci to be polymorphic.

(i) Calculate the proportion of polymorphic gene loci in the European zoo population.

Proportion = ... **[2]**

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(ii) A second group of scientists carried out a separate investigation to calculate the proportion of polymorphic gene loci of cheetahs in European zoos and found that their results were different. These new results were accepted as being accurate.

Suggest **two** reasons why the calculated proportion of polymorphic gene loci in the European zoo population of cheetahs might have been less accurate in the investigation carried out by the first group of scientists.

1 .....

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2 .....

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[2]

(iii) Suggest **and** explain reasons why, in the 21st Century, only 10% of the gene loci are polymorphic in wild populations of cheetah.

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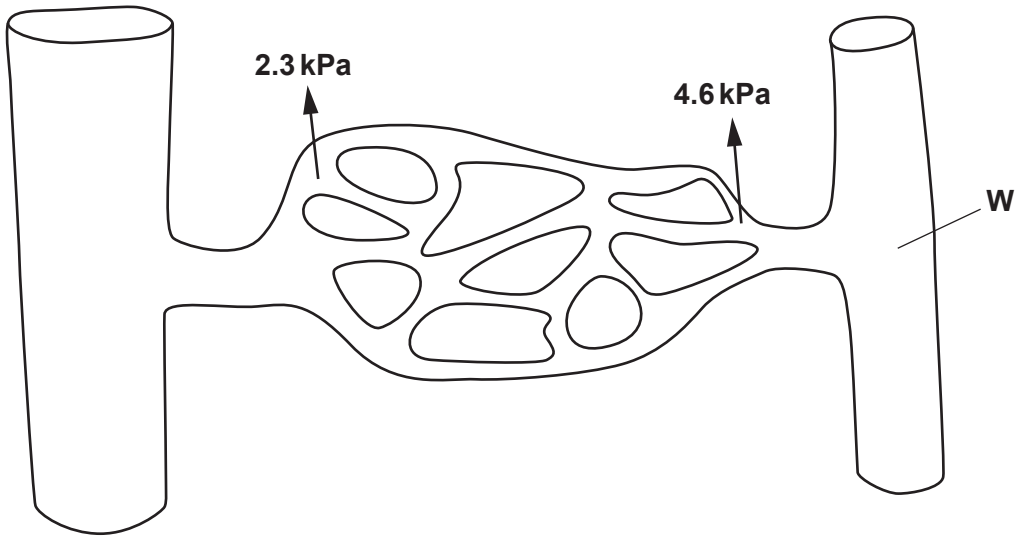
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..... **[3]**

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23 The diagram shows the change in hydrostatic pressure across a capillary network in muscle tissue.



(a) (i) **On the diagram**, draw an arrow to show the direction of movement of blood through the capillary network. **[1]**

(ii) **On the diagram**, draw an arrow to show the direction in which oncotic pressure is acting **and** suggest a value for oncotic pressure.

Write the value for oncotic pressure next to the arrow. **[2]**

(iii) Name the structure labelled **W**.

..... **[1]**

(b) Describe how oncotic pressure is established.

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..... **[3]**

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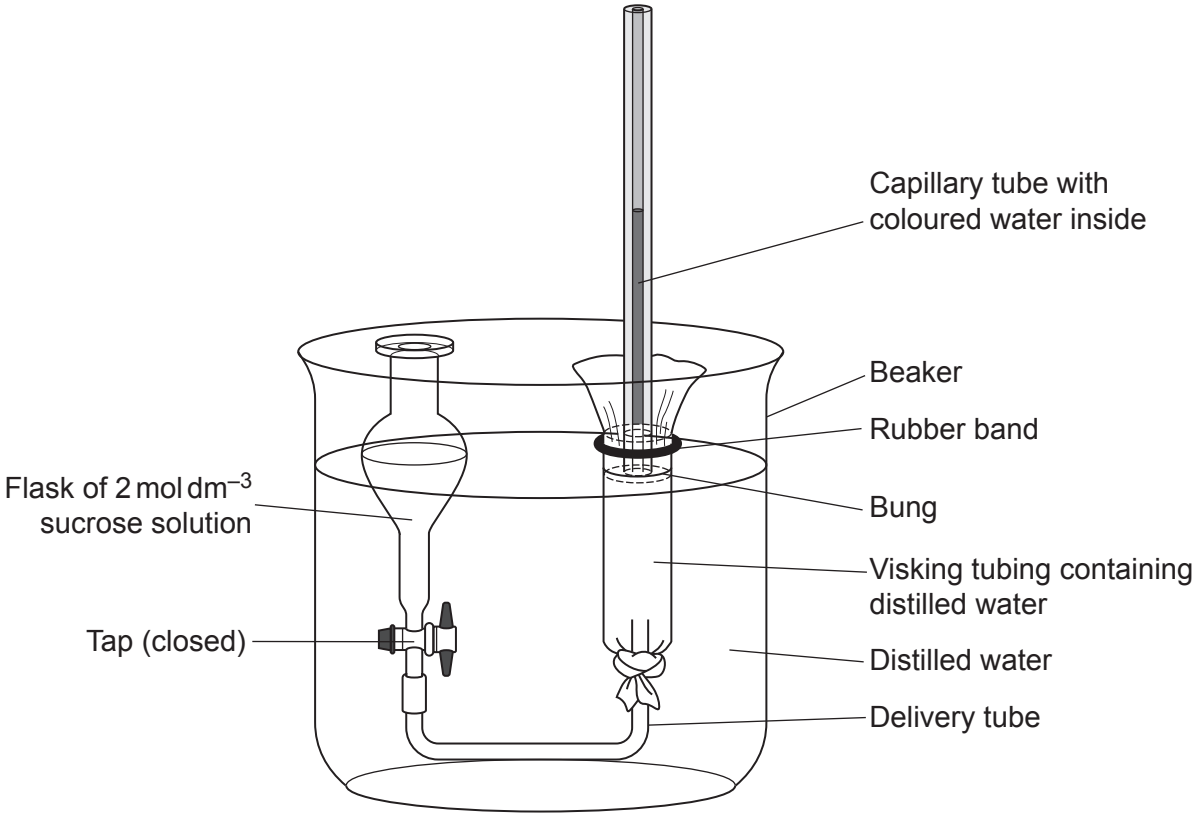
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24 A student is investigating how sucrose is loaded into phloem sieve tubes by companion cells, using a model of phloem tissue.

To create the model, the student added distilled water to a bag made from Visking tubing (an artificial partially permeable membrane). They inserted a capillary tube into one end of the Visking tubing and connected the other end to a flask containing 2 mol dm^{-3} sucrose solution.

They placed the Visking tubing and connected flask into a beaker of distilled water, as shown in the diagram.



The capillary tube, the flask and the beaker of distilled water represent plant tissues involved in the active loading of sucrose. The Visking tubing represents the cell surface membrane of the phloem sieve tube.

The student opens the tap on the flask and the level of the coloured water in the capillary remains the same. After a few minutes, the water level in the capillary tube starts to rise. The tap is then closed after 5 minutes.

(a) (i) Describe what happens inside the model, immediately after the tap on the flask is opened.

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..... **[1]**

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(ii) Explain why the water level in the capillary tube starts to rise after a few minutes.

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..... **[2]**

(iii) With reference to the diagram, name the plant cells or tissues that are represented by:

The capillary tube

.....

The beaker of distilled water

.....

The flask

.....

[3]

(b) The student measured the increase in the level of the coloured liquid in the capillary tube after 2 minutes. It had risen by 8 mm. The capillary tube has a diameter of 1 mm.

Calculate the rate of osmosis as the volume of water moved per second.

Use the formula: Volume of cylinder = $\pi r^2 l$

Rate of osmosis = ... $mm^3 s^{-1}$ **[2]**

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25 **(a)** Water molecules are transported in the stem of a sunflower. Water molecules are polar and are therefore attracted to each other.

(i) Draw **two** water molecules **and** label the bond between the two molecules.

[3]

(ii) Explain how the properties of water are related to the transport role of water in a stem.

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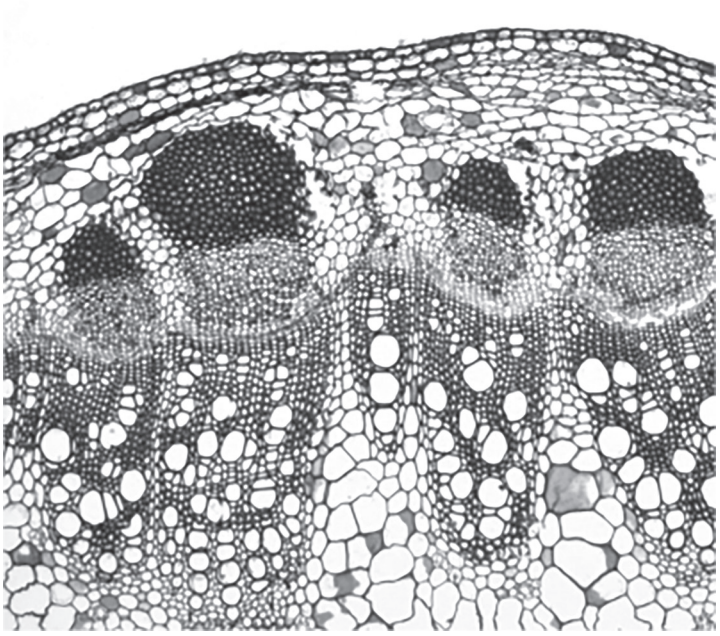
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..... **[3]**

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(b) The photomicrograph is of a transverse section of a stem of a sunflower, *Helianthus annuus*.



(i) **On the photomicrograph**, label the location of meristem tissue. **[2]**

(ii) Name the type of microscope used to produce the photomicrograph **and** explain the reasons for your choice.

Name of microscope .....

Reasons for your choice .....

.....

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..... **[3]**

(c) Explain the role of meristem tissue in a stem.

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..... **[2]**

(d) Name **one** potential use of stem cells in medicine.

.....

..... **[1]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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