1. Water is the main component of blood plasma.

State **two** properties of water in blood plasma and explain their significance.

Property _____

Significance _____

_____

Property _____

Significance _____

[4]

2(a). Different models can be used to investigate factors that affect the rate of diffusion of molecules into and out of cells.

Beetroot cells are a useful model for investigating the effect on diffusion rates of changes to plasma membranes. These cells contain the pigment betalain and the diffusion of betalain out of the cells can be measured using a colorimeter.

Fig. 23.1 is a simplified diagram of an intact beetroot cell.

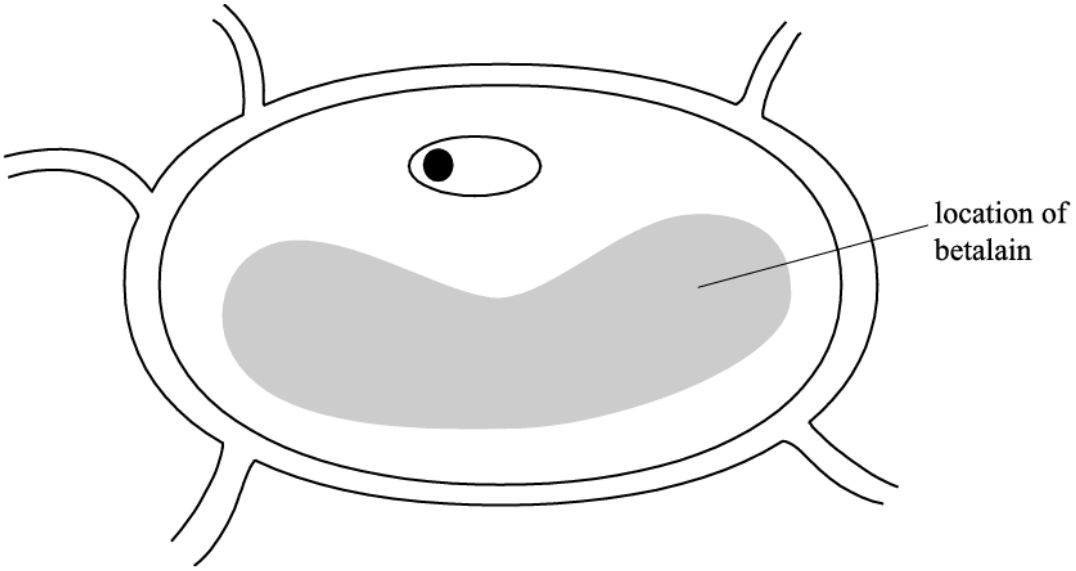


Fig. 23.1

Describe the diffusion of betalain out of a beetroot cell under normal conditions.

---

[3]

(b). Alternatively, a model cell can be made using visking tubing. A group of students investigated the effect of temperature on the rate of diffusion using visking tubing as a model cell as shown in **Fig. 23.2.**

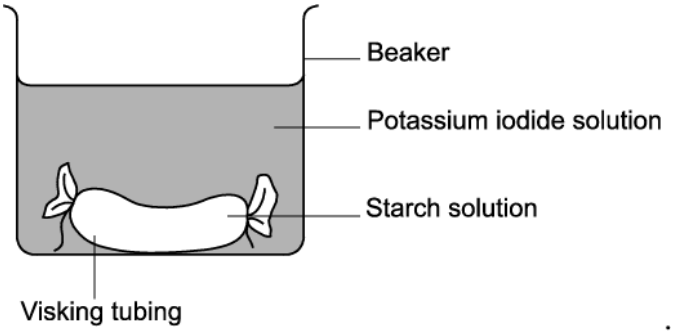


Fig. 23.2

This is the method they used:

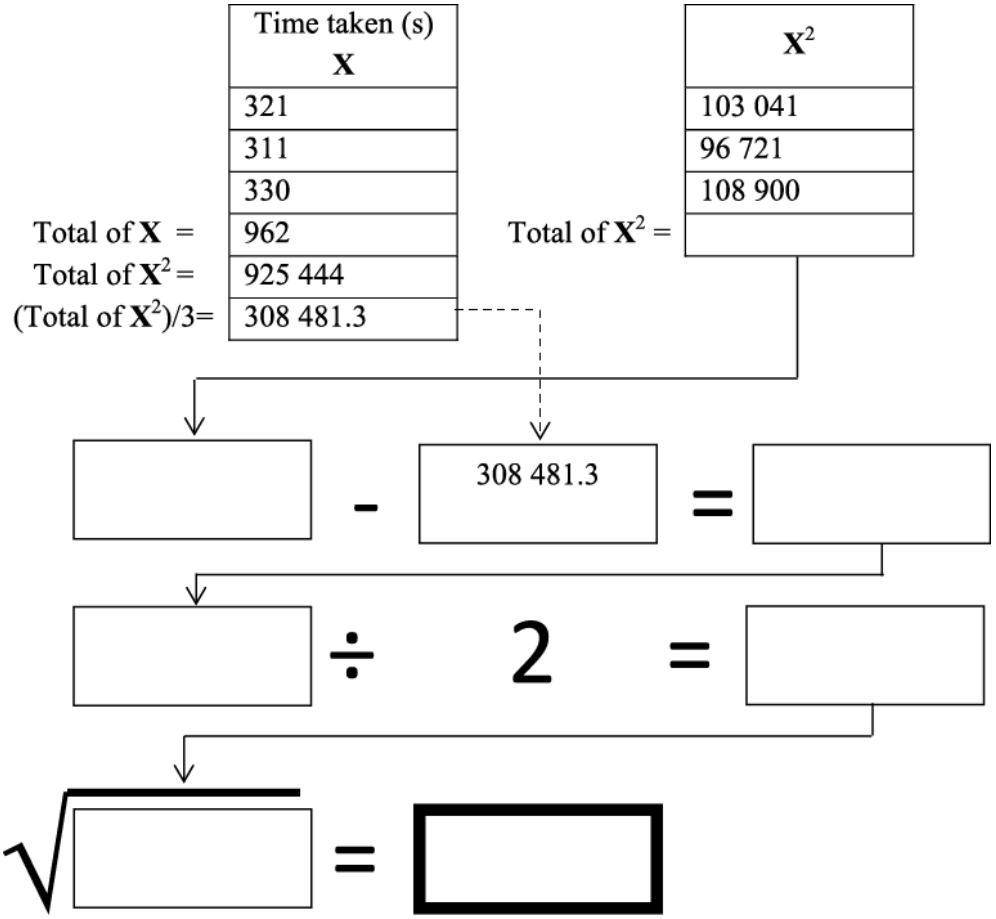
- take a piece of visking tubing approximately 6 cm in length
- tie a knot in one end of the tubing
- half fill the tubing with starch solution
- tie a knot in the other end
- blot dry the outside of the tubing
- place the 'model cell' into a potassium iodide solution at 20°C
- time how long it takes for potassium iodide to diffuse into the model cell and turn it blue-black in colour
- complete the procedure a total of three times and calculate a mean
- repeat the experiment at temperatures of 25 °C, 30 °C, 35 °C and 40 °C.

Table 23.1 shows their results.

Temperature (°C)	Time taken to turn blue-black in colour (s)				Standard deviation
	Repeat 1	Repeat 2	Repeat 3	Mean	
20	545	522	498	521.7	23.50
25	477	451	446	458.0	16.64
30	421	427	448	432.0	14.18
35	378	361	358	365.7	10.79
40	321	311	330	320.7	

Table 23.1

Complete the flowchart below to calculate the standard deviation at 40°C **and** comment on the precision of results over the temperature range tested.



---

[4]

(c). State **two** limitations to the experiment and explain how each could be improved.

Limitation ---

Improvement ---

Limitation ---

Improvement ---

---

[4]

3. Proteins in blood plasma affect the formation of tissue fluid.

(i) How could you confirm the presence of protein in a sample of blood plasma?

---[2]

(ii) The formation of tissue fluid depends on both the hydrostatic pressure (HP) of the blood and the oncotic pressure (OP) provided by the presence of plasma proteins and other substances.

Fig. 23.2 is a diagram showing some of the pressures in and around a capillary that result in the formation of tissue fluid.

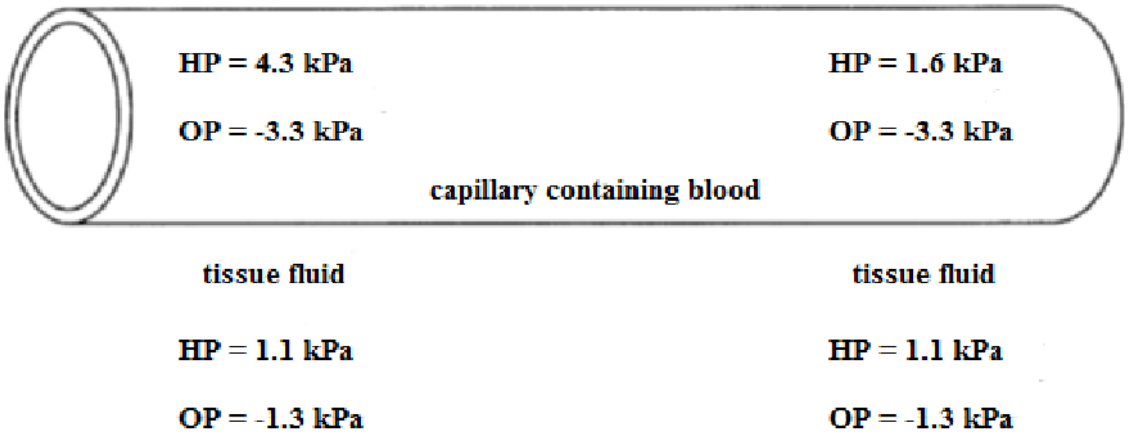


Fig. 23.2

The **effective** blood pressure can be calculated as follows:

(OP + HP of blood) – (OP + HP of tissue fluid)

Calculate the effective blood pressure at the **arterial** end of the capillary shown in Fig. 23.2.
Show the steps in your calculation.

Answer _____ kPa **[2]**

4(a). A student was asked to find the concentration of glucose in a sports drink. The student was given a method to follow.

The student was given distilled water and a standard solution of 1 mol dm^{-3} of glucose. The student was told to prepare a range of concentrations. The final volume of each concentration was 20 cm^3.

(i) Complete the table to show how **20 cm^3** of a concentration of 0.3 mol dm^{-3} could be made using the standard solution.

Solution	Concentration (mol dm^{-3})	Volume of 1 mol dm^{-3} glucose(cm^3)	Volume of distilled water (cm^3)
A	0.1		
B	0.3	_____	_____
C	0.5		
D	0.7		
E	0.9		

[2]

- The student was told to put 2 cm^3 of each solution into five test tubes labelled **A** to **E**.
- 3 cm^3 of a test reagent was added to each tube.
- The tubes were placed in a water bath for five minutes.

Name the reagent used **and** suggest a temperature for the water bath.

Reagent _____

Water bath temperature _____

[2]

(b). The student was reminded to cool the test tubes and carry out **two** additional procedures before reading the absorbance of the fluid within each tube in a colorimeter.

(i) State the additional procedure that the student had to perform **on the contents of tubes A to E** before reading the absorbance.

---

[1]

(ii) State the additional procedure the student had to perform **on the colorimeter** before reading the absorbance.

---

[1]

(c). The readings were used to plot a calibration curve for absorbance against glucose concentration.

The student then carried out **the same procedure** on a sample of the sports drink.

A value of 0.45 mol dm^{-3} was obtained for the sports drink from the calibration curve.

The student concluded that the sports drink contained 0.45 mol dm^{-3} glucose.

Suggest one reason why this conclusion was **not** valid.

---

[1]

5(a). **Table 2.1** shows some components which can be found in phloem sap.

Component	Concentration (mg cm^{-3})
Sucrose	80–160
Protein	1.45–2.20
Amino acids	5.20
Phosphate ions	0.35–0.55
Potassium ions	2.30–4.40

Table 2.1

Explain what is meant by the term *organic molecule* using an example from **Table 2.1**.

---

[2]

(b). A student tested a sample of phloem sap by placing the sample in a test tube and carrying out a Benedict's test. The result of the Benedict's test was negative.

(i) Describe the appearance of the test tube when a negative result is obtained in a Benedict's test.

---

[1]

(ii) The student observed that, following the Benedict's test, the tube appeared cloudy. Using your knowledge of the Benedict's test and the information in **Table 2.1**, suggest why the tube content appeared cloudy after the test.

---

[2]

6. Glycogen granules are not always present in liver cells as glycogen can be broken down to release glucose for metabolism.

Fig. 3.2 shows some of the stages in the breakdown of glycogen in liver cells.

The white, grey and black circles in Fig. 3.2 all represent alpha glucose molecules.

- **Enzyme 1** in Fig. 3.2 breaks bonds labelled **P**.
- The debranching enzyme transfers the remaining alpha glucose molecules from the branch to the main part of the molecule.
- **Enzyme 2** breaks bond **Q**.
- **Enzyme 1** then continues breaking bonds until the next branch is reached.

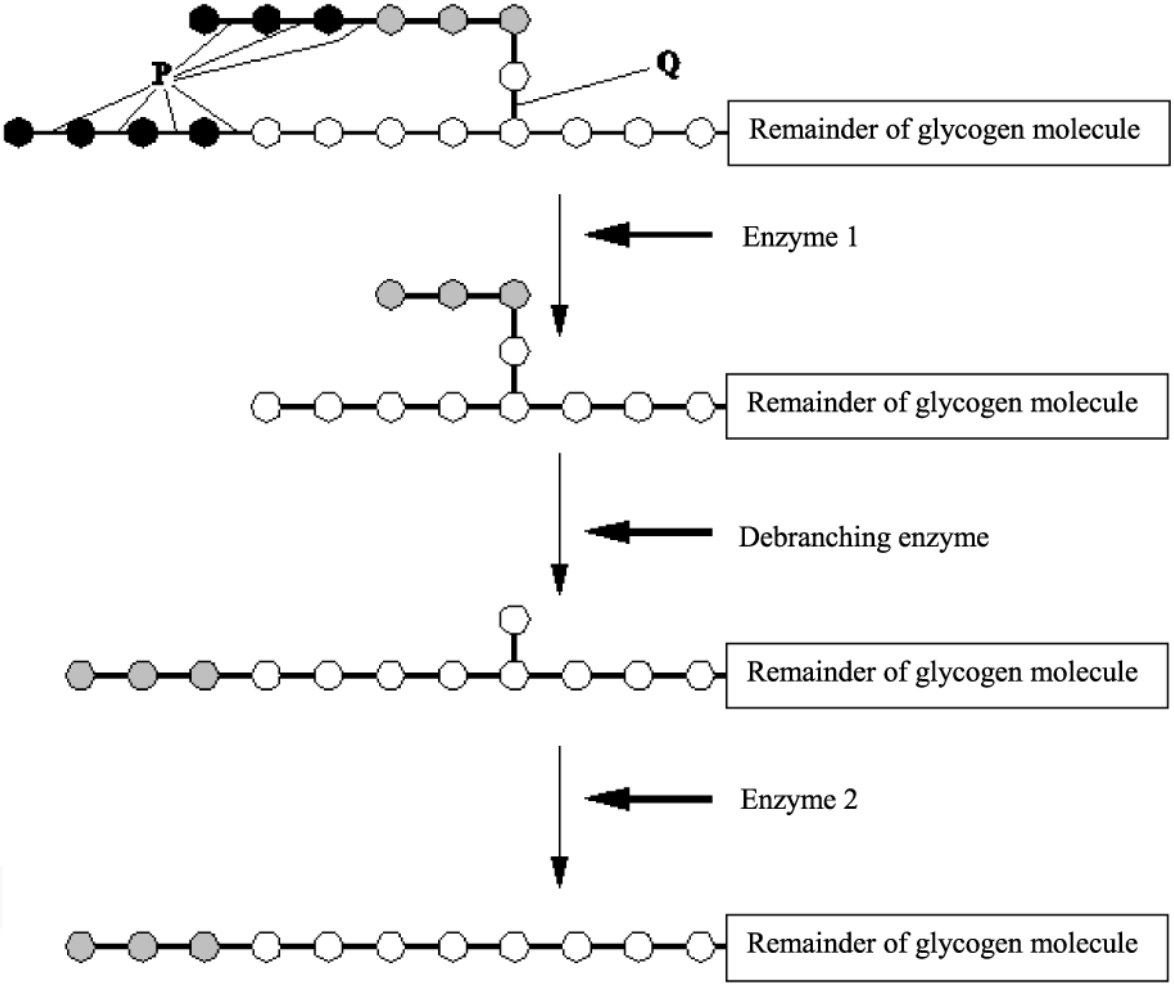


Fig. 3.2

(i) What types of covalent bond are represented by the letters **P** and **Q** in Fig. 3.2?

P

Q

---

[2]

(ii) Name the type of reaction that **forms** these bonds in glycogen **synthesis**.

---

[1]

(iii) In Cori's disease, the debranching enzyme in liver cells does not function.

Suggest how the microscopic appearance of liver cells in a person with Cori's disease would differ from the cell shown in Fig. 3.1. Explain your suggestion.

---

[2]

7(a). A group of students were investigating the effect of varying sodium chloride concentration on a suspension of mammalian erythrocytes (red blood cells) by observing haemolysis.

When haemolysis occurs, the contents of the erythrocytes are released and the suspension will become clear.

Fig. 21 shows the appearance of the suspensions at the end of the investigation.

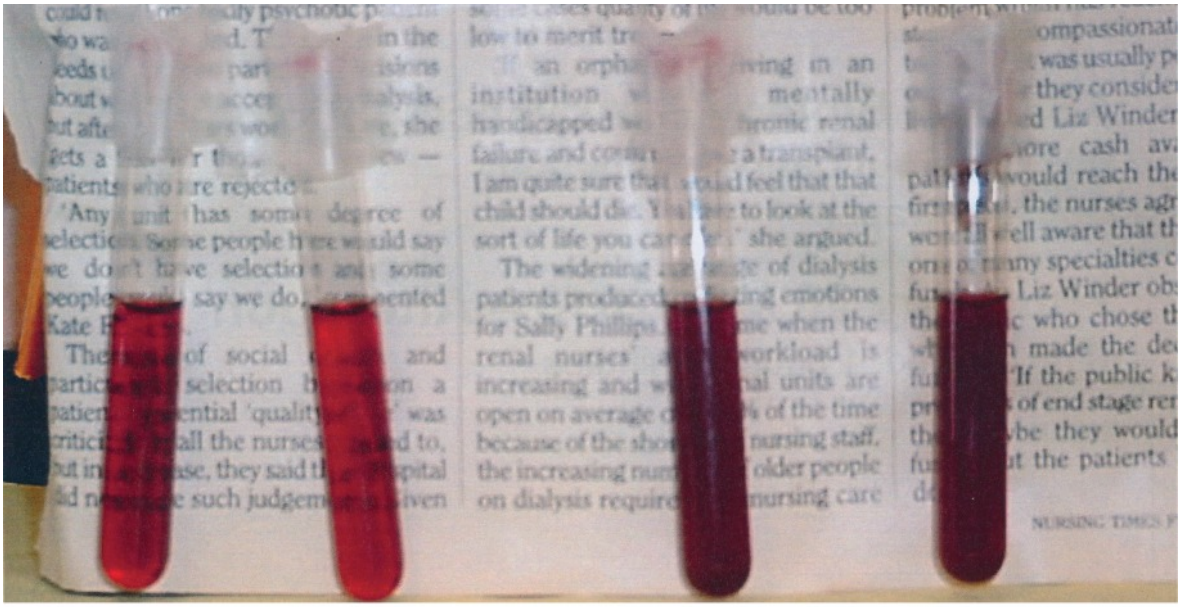


Fig. 21

Using Fig. 21, **explain** the results for the suspension in test tube **B**.

---

[2]

(b). The students waited for 15 minutes after adding the erythrocyte suspensions to the sodium chloride solutions before recording their observations.

Explain why.

---

[1]

(c). The students repeated the experiment using a colorimeter to measure the absorbance of each erythrocyte suspension after 15 minutes.

Table 21.1 below shows the data obtained.

Concentration of sodium chloride (mol dm^{-3})	Absorbance (a.u.)
0.00	0.00
0.05	0.01
0.10	0.08
0.15	0.70
0.20	0.73
0.25	0.75
0.30	0.75

Table 21.1

Compare the type of data obtained using these two methods **and** suggest the advantages of using the colorimeter.

---[3]

(d). The students decided to repeat the experiment using the colorimeter once more, but this time they used glucose instead of sodium chloride.

Table 21.2 shows the results obtained for glucose.

Concentration of glucose (mol dm^{-3})	Absorbance (a.u.)
0.00	0.00
0.05	0.03
0.10	0.10
0.15	0.18
0.20	0.19
0.25	
0.30	0.78

Table 21.2

(i) Compare the results for concentrations of glucose **and** sodium chloride between 0.05 and 0.20 mol dm^{-3}.

---

[2]

(ii) The students forgot to take the measurement for absorbance at 0.25 mol dm^{-3} glucose concentration.

Suggest how the missing data could affect the conclusions made about haemolysis in this investigation.

---

[1]

8(a). A group of students were investigating the protein content of a sports drink used by athletes.

Describe a method the students could use to confirm the presence of protein in the sports drink.

---

[2]

(b). The students added a protease enzyme to the sports drink to produce a solution containing amino acids.

Name the **type** of reaction catalysed by the protease enzyme.

---

[1]

(c). The students then separated the amino acids in the solution using chromatography.

Fig. 2 shows the chromatogram obtained by the students.

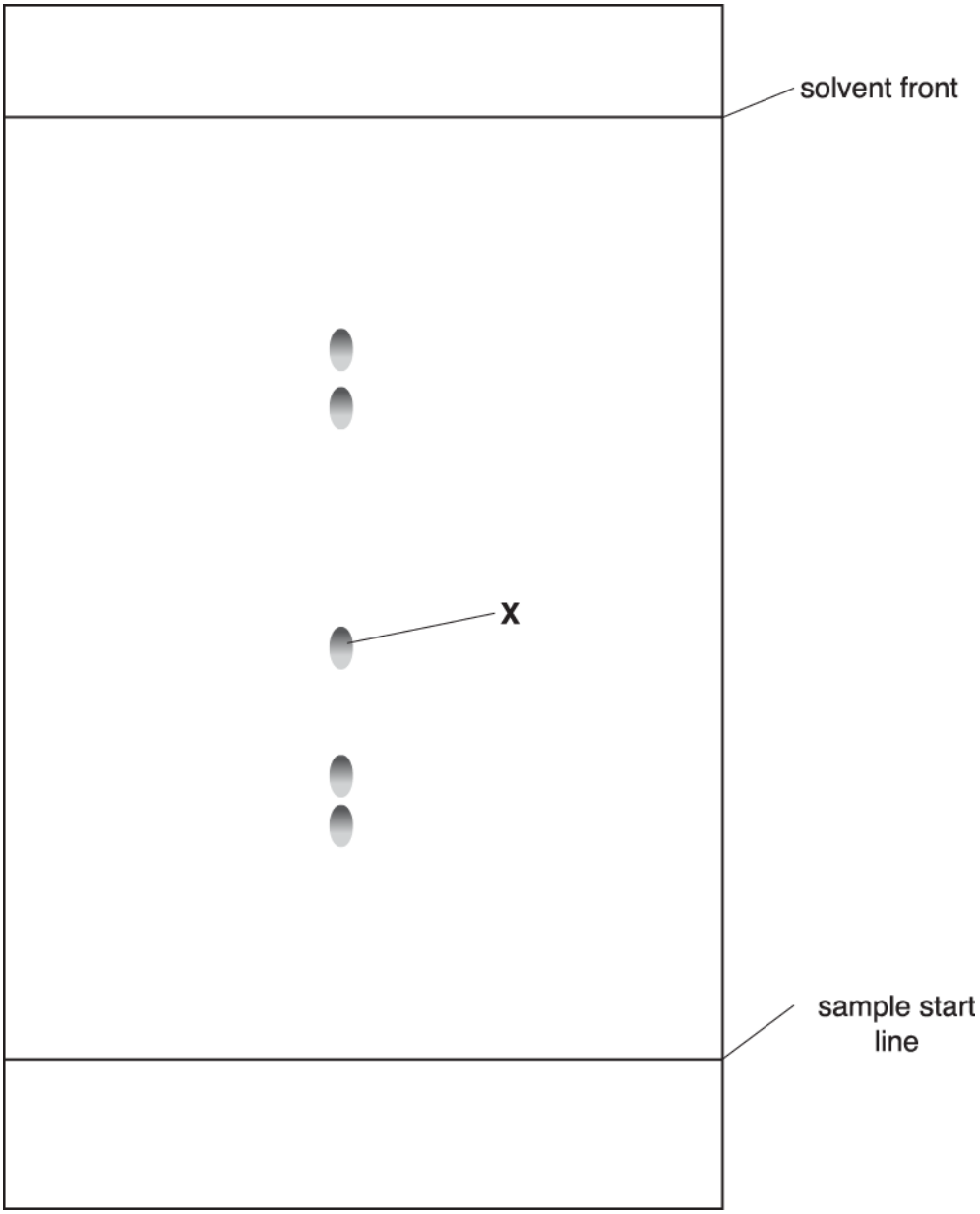


Fig. 2

Table 2 shows Rf values for six amino acids.

Amino acid	Rf value
asparagine	0.24
aspartic acid	0.29
isoleucine	0.73
phenylalanine	0.68

tryptophan	0.66
tyrosine	0.44

Table 2

(i) Using Fig. 2, which of the amino acids named in Table 2 could be **X**?

Show working to support your answer.

X =_____ **[3]**

(ii) The students were concerned that they may not be able to distinguish between the amino acids phenylalanine and tryptophan on their chromatogram.

Using the information in Table 2, suggest **one** way the procedure could be modified to determine whether both phenylalanine and tryptophan were present.

Give a reason(s) for your suggestion.

_____

_____

_____

_____ **[2]**

9. A full blood count (FBC) is a screening test that can be used to monitor health. The FBC includes a count of the number of each type of leucocyte in a cubic decimetre (dm^3) of blood.

Fig. 1.1 shows the result of a leucocyte count for a healthy adult.

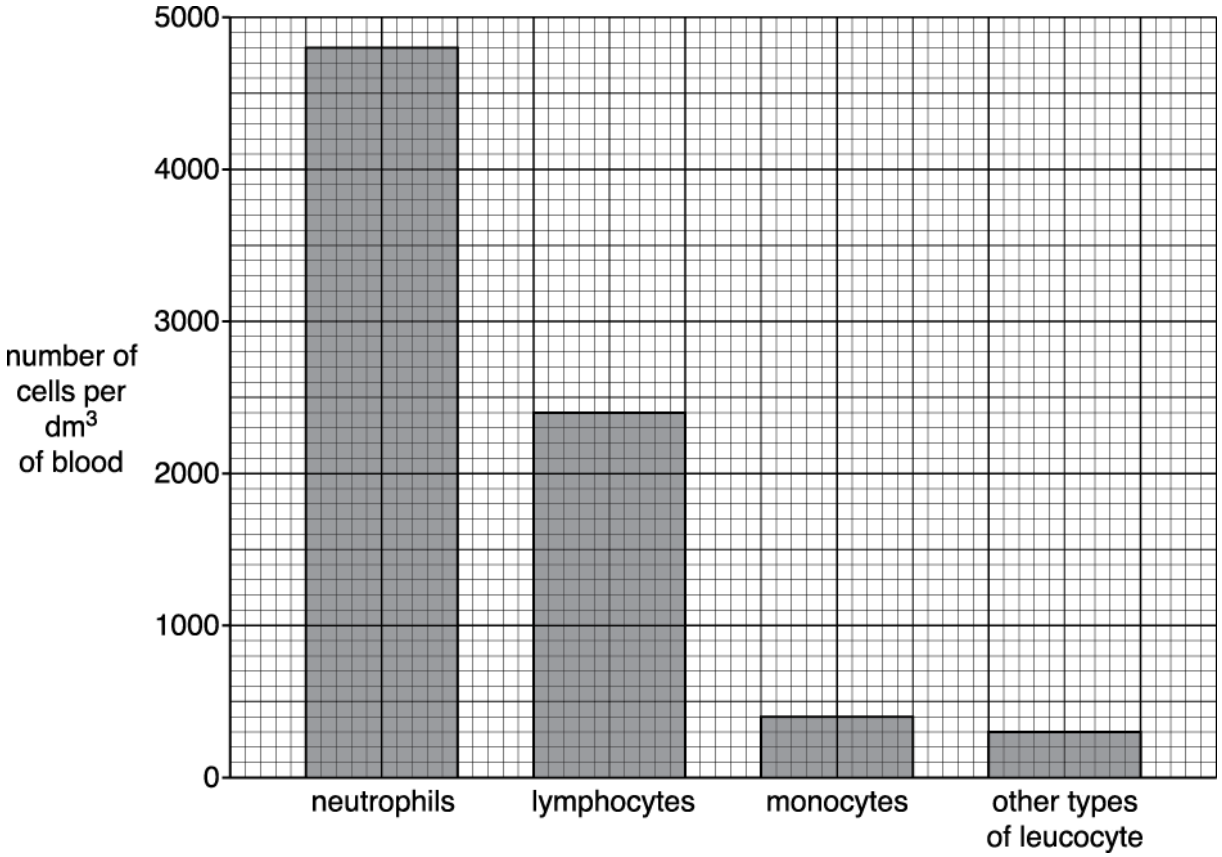


Fig. 1.1

(i) Using Fig. 1.1, calculate the percentage of lymphocytes in the total leucocyte count for this adult.

Show your working. Give your answer to **one** decimal place.

Answer = _____ % **[2]**

(ii) The result of a FBC for another adult showed more than 50% of the leucocyte count to be lymphocytes.

Suggest **one** reason for the difference in the result for this adult compared with the result for the healthy adult shown in Fig. 1.1.

---

[1]

(iii) As well as being found in blood plasma, leucocytes may also be present in other body fluids, such as lymph.

Name **one** other component of **blood plasma** that is present in lymph.

---

[1]

10. Glycogen is a biological molecule found in heart muscle cells.

Glycogen is insoluble, which means it can be stored without affecting the water potential of cells.

(i) What type of biological molecule is glycogen?

---

[1]

(ii) Other than insolubility, state and explain **one** other feature of the glycogen molecule that enables it to be used as a storage molecule.

Feature _____

Explanation _____

---

[2]

11(a). During the formation of glycogen in the liver, large numbers of glucose molecules are joined together to form polysaccharide chains.

(i) Describe the reaction in which glucose molecules are joined together to form the polysaccharide chains.

---

[3]

(ii) The formation of glycogen in liver cells is catalysed by glycogen synthase.

Suggest how the structure of glycogen synthase enables it to function as an enzyme in the formation of glycogen.

---

[3]

(b). Glycogen molecules stored in the liver are branched.

Glycogen storage disease type IV occurs when the liver is unable to catalyse the addition of branches of glucose molecules. People with this disease may develop liver damage over time.

Suggest why this disease may result in liver damage.

---

[1]

12. Box jellyfish are extremely poisonous to humans.

The venom of the box jellyfish produces changes in cell membranes that result in high concentrations of potassium ions in blood plasma. This may lead to the death of cells.

(i) Suggest why the venom of the box jellyfish causes the concentration of potassium ions in blood plasma to increase.

---

[2]

(ii) Explain how the **loss** of potassium ions from the cell may lead to **cell death**.

---

[2]

13. People with diabetes can use biosensors to monitor their blood glucose concentration.

(i) Explain why it is important for diabetics to monitor their blood glucose concentration.

---

[2]

(ii) Complete the following passage by inserting the **most appropriate word** into each gap to explain how a biosensor works.

A person's blood is placed on a test strip on the biosensor. The test strip contains a molecule called glucose . This molecule is an that converts glucose in the blood into .

An electrode detects the small electric current generated by this chemical reaction. The current is converted by a into a digital reading of the person's blood glucose concentration.

[4]

14(a). A student was investigating the effect of sucrose concentration on plasmolysis in onion cells using the following procedure.

- Five Petri dishes were labelled **A** to **E**.
- Six drops of 0.2 mol dm^{-3} sucrose solution and two drops of differential stain were added to Petri dish **A**.
- A sample of epidermal tissue from an onion was placed in Petri dish **A**.
- The tissue sample was then removed immediately, placed on a microscope slide and viewed using light microscope.
- The numbers of plasmolysed **and** unplasmolysed cells were counted.
- This was repeated for Petri dishes **B** to **E** using different concentrations of sucrose solution as shown in Table 6.

(i) What is the purpose of the differential stain in **this** investigation?

---

[1]

(ii) The student made the following statement:

'The water potential of the onion cells changes when the cells are stained with the differential stain.'

---

[1]

(iii) Identify **two** sources of error in the procedure used **and** suggest an improvement for each.

error

---

improvement

---

error

---

improvement

---

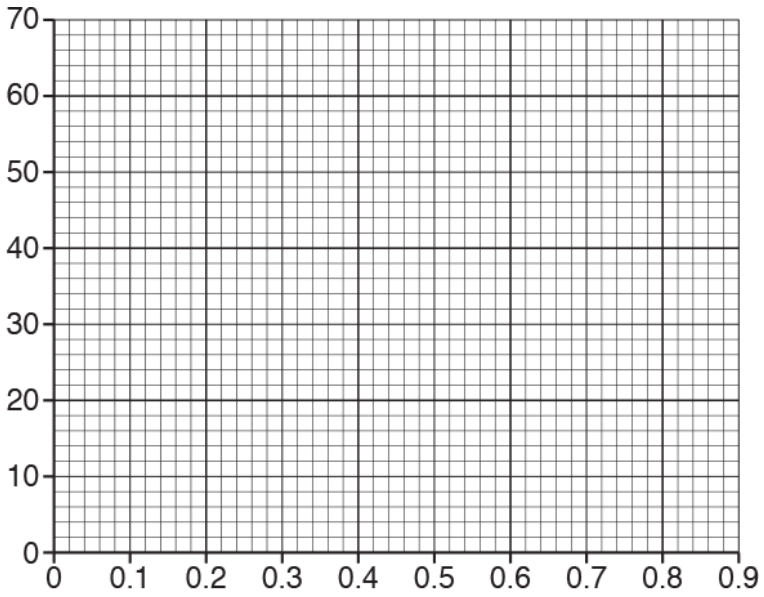
[4]

(b). The results of the student's investigation are shown in Table 6.

Petri dish	Sucrose concentration (mol dm^{-3})	Number of plasmolysed cells	Number of unplasmolysed cells	Percentage of plasmolysed cells (%)
A	0.2	30	168	18
B	0.3	46	162	28
C	0.5	62	148	42
D	0.7	73	124	59
E	0.8	68	104	65

Table 6

(i) Using the data in Table 6, complete an appropriate graph on the grid provided.



[3]

(ii) Using your graph plotted in **(b) (i)**, state the sucrose concentration at which 50% of the onion cells are plasmolysed.

---

[1]

15(a). Glucose is produced by plants during photosynthesis. It can be combined with fructose to form the disaccharide sucrose, which can then be transported to other tissues inside the plant.

Fig. 5 is a diagram of glucose and fructose.

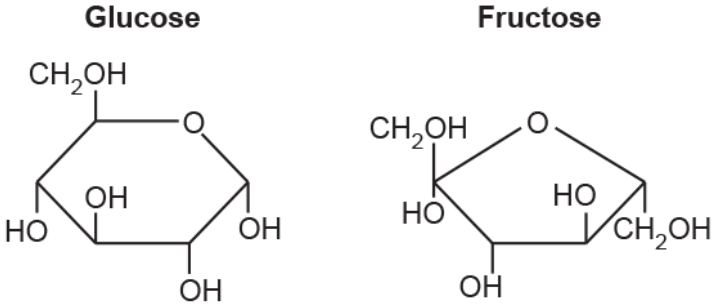


Fig. 5

Using the information in Fig. 5, draw a diagram of a sucrose molecule in the space below.

[2]

(b). A student used the following procedure to test different organs from a tomato plant for the presence of sucrose.

1. Remove a leaf from the tomato plant and after dipping it into boiling water grind it using a mortar and pestle.
2. Add water to the ground up leaf and filter the mixture.
3. Pour a small sample of the filtrate into a test tube and add dilute hydrochloric acid.
4. Place the test tube into a water bath.
5. Remove the test tube from the water bath and add sodium hydrogen carbonate.
6. Add Benedict's reagent and then place the test tube back into the water bath.
7. Record the colour of the contents of the test tube.
8. Repeat steps 1 to 7 with stem and root samples taken from the same tomato plant.

Table 5 shows the observations recorded by the student.

Plant organ being tested	**Observations**
Leaf	Blue-green
Stem	Green-orange
Root	Blue-green

Table 5

(i) The student made the following statement:

My observations support the theory of translocation.

Using the information in Table 5 and your knowledge of translocation discuss the validity of this statement.

---

[4]

(ii) State **three** modifications to the procedure that would allow the observations in Table 5 to be reproducible.

1 ---

---

2 ---

---

3 ---

---

[3]

(c). The presence of starch in seeds can be detected using iodine-KI reagent.

When tested with iodine-KI reagent, dry seeds showed a high concentration of starch but after the seeds had been soaked in water for seven days they tested negative for the presence of starch.

Explain why the seeds tested negative for starch after being soaked in water.

---

[3]

16(a) Water is an important biological molecule.

.

The table below shows some of the properties of water and their importance to living organisms.

Complete the table using the most appropriate term(s) or sentence(s).

Property of water	Importance to living organisms
....	allows chemical reactions to take place inside cells
has a high latent heat of vaporisation	....
....	allows a continuous column of water to move through xylem vessels without breaking
has a high specific heat capacity	....

[4]

(b). Water also lays an important role in the reactions involved in the formation and breakdown of macromolecules in the human body.

Fig. 23.1 shows the formation and breakdown of one type of macromolecule.

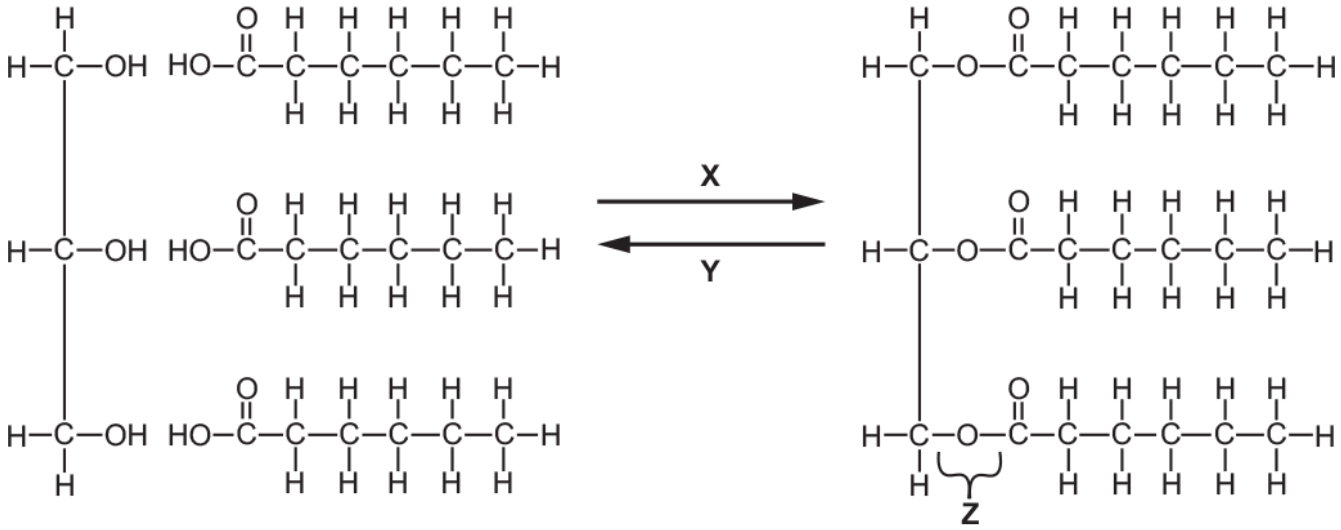


Fig. 23.1

(i) Name the types of reaction taking place at **X** and **Y**.

Reaction **X** .....

Reaction **Y** ..... [1]

(ii) Name **both** products of reaction **X**.

.....[1]

(iii) Name the bond labelled **Z**.

.....[1]

17. Ruminants such as cows are used extensively in food production.

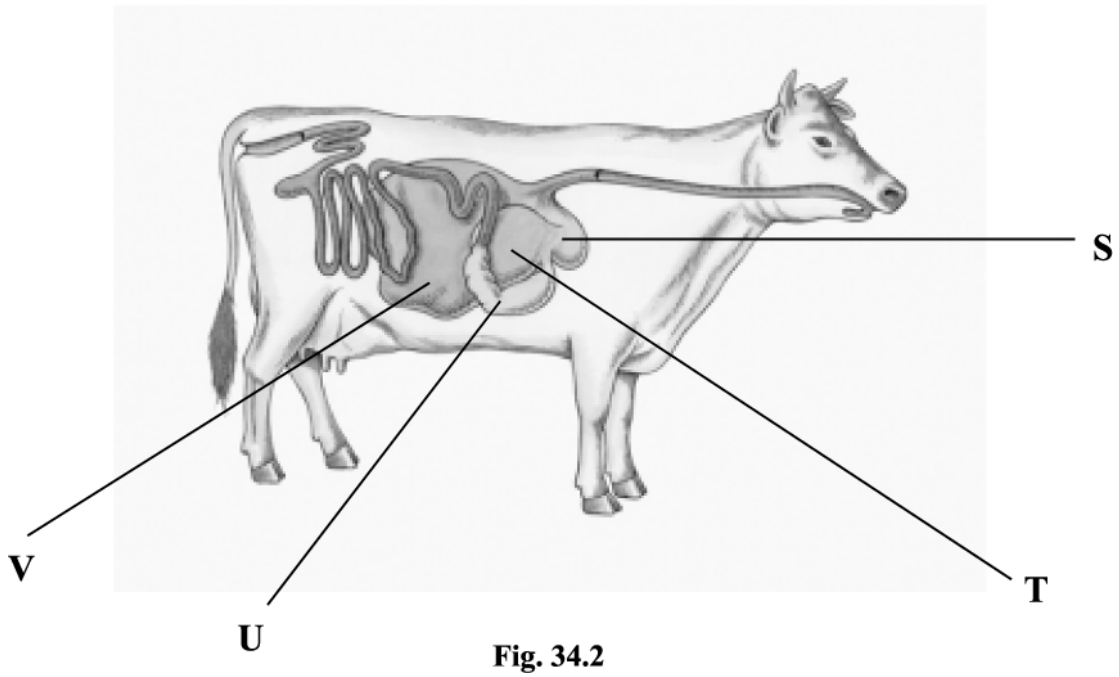


Fig. 34.2

(i) Complete the following table about the parts of the cow's digestive system labelled in Fig. 34.2.

Description	Name	Letter
Secretes hydrochloric acid and protease enzymes.		
Allows the cow to regurgitate material back up to the mouth for further chewing.		

[2]

(ii) Both cows and humans need a range of amino acids to make their own proteins.

- Amino acids which have to be present in the diet are called essential amino acids.
- Unlike humans, essential amino acids do **not** need to be present in the diet of cows.

Explain how cows obtain their essential amino acids.

---

[2]

(iii) Amino acids which have been absorbed but which are **not** required for protein synthesis cannot be stored.

State what happens in liver cells to the amino acids which are not required for protein synthesis.

---

[1]

18. One mechanism for controlling gene expression in cells uses small, double stranded pieces of RNA known as siRNA.

1 siRNA molecules are introduced into the cell.
2 The siRNA molecules are combined with a protein complex called the RNA induced silencing complex (**RISC**) and one of the siRNA strands is destroyed.
3 The other strand remains bound to RISC and acts as a guide. RISC is now said to be activated.
4 This strand binds to complementary sequences on messenger RNA molecules in the cytoplasm causing them to be destroyed.

Fig. 36.1 shows the sequence of events for this mechanism.

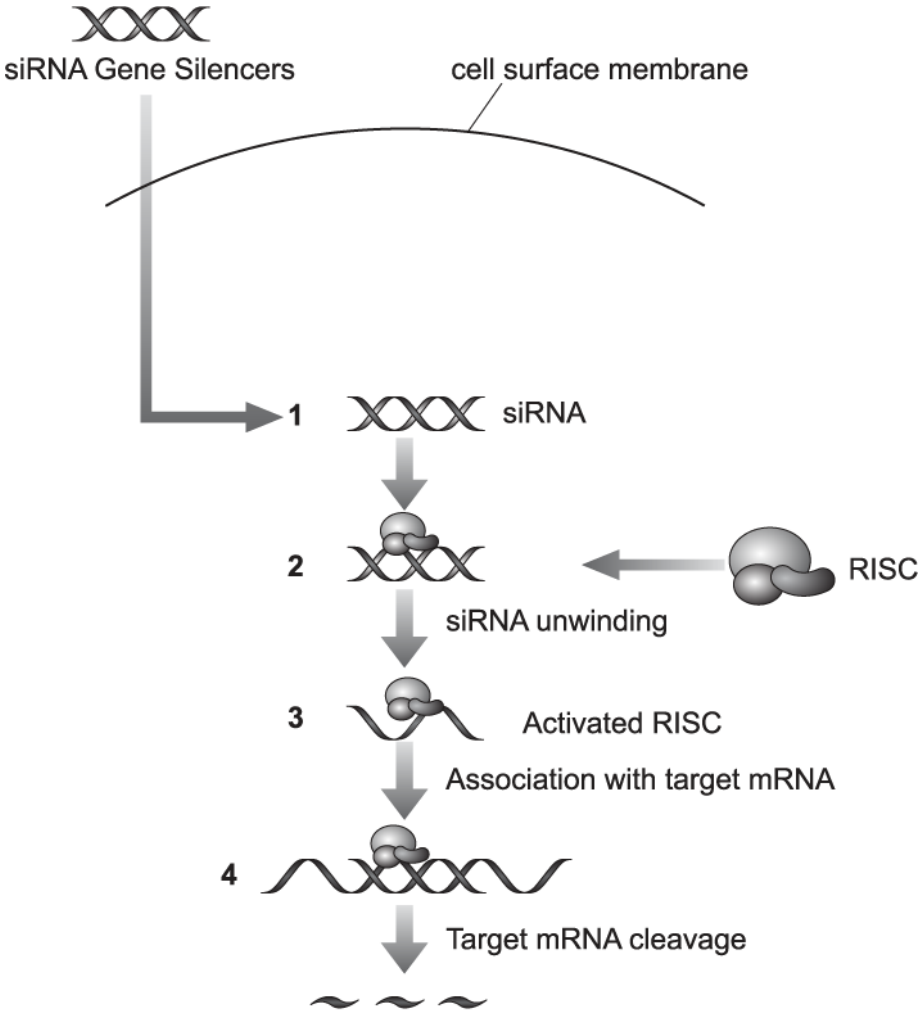


Fig. 36.1

(i) An RNA strand on an activated **RISC** has the following sequence.

ACGGGAAGGGCCCGAGCACGGA

On the line above, write out the sequence that activated **RISC** would bind to on the mRNA molecule.

[1]

(ii) What type of reaction is carried out by activated **RISC** on the bonds in the mRNA molecule?

---

[1]

(iii) Clinical trialling is being carried out on the use of siRNA as an anti-viral therapy for the treatment of Hepatitis C infections.

Suggest how siRNA could prevent the spread of a virus within a person infected by the Hepatitis C virus.

---

[3]

19. * Aspirin (2–*O*–acetylsalicylic acid) is a drug commonly used in medicine.

Ingestion of more than 500 mg kg^{-1} of aspirin causes severe and possibly fatal toxicity.

Once in the body aspirin is gradually broken down in the liver into salicylic acid.

Salicylic acid is excreted through the kidney and leaves the body in the urine.

Estimates of the amount of aspirin remaining in the body can be made by determining the amount of salicylic acid in the urine. Salicylic acid reacts with a solution of iron(III) chloride to give a purple–coloured substance.

Write a <u>method</u> to determine the concentration of salicylic acid in a sample of urine.

Your method must be based on the assumption that you are provided with the following:

- a solution of 100 mg dm^{-3} salicylic acid
- a 1% solution of iron(III) chloride
- a colorimeter
- school or college laboratory resources.

---

[9]

20. This question is based on the Advance Notice article **CATALASE**.

Fig. 1.2 summarises the glyoxylate cycle in peroxisomes. This cycle converts fatty acids to carbohydrates. The glyoxylate cycle is a modification of the Krebs cycle.

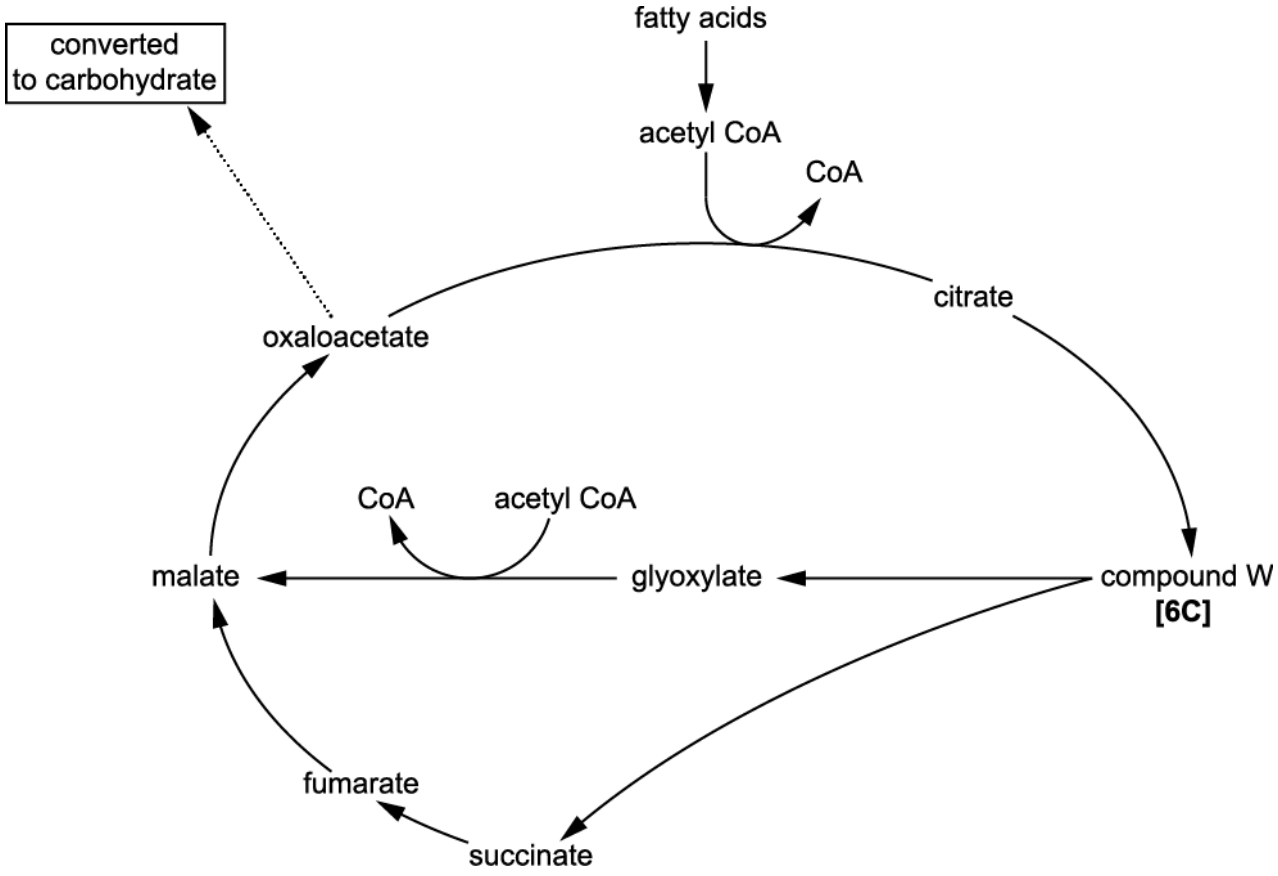


Fig. 1.2

Identify the following from the information given in Fig. 1.2:

(i) a 6-carbon compound other than compound **W**

---------- [1]

(ii) the number of carbons present in glyoxylate

---------- [1]

(iii) a 4-carbon compound other than oxaloacetate

---------- [1]

(iv) In the **Krebs cycle**, the conversion of compound **W** to succinate results in the production of an excretory product.

Give the name of this product.

_____ [1]

21. Haemoglobin is contained in erythrocytes. While studying oxygen transport, a student investigated the water potential of erythrocytes. They wrote the following description in their laboratory notebook:

I placed a drop of blood on a microscope slide and covered it with a coverslip, then added a drop of distilled water on one side of the coverslip. I immediately observed the slide under high power. I repeated the procedure with sodium chloride solutions of two different concentrations to find the one that caused plasmolysis to occur.

(i) Explain why the term 'plasmolysis' is used incorrectly in this student's description.

---

[1]

(ii) State **two** ways in which the experimental procedure described by the student could be improved.

improvement 1 ---

---

improvement 2 ---

---

[2]

22. Water is a polar molecule. Molecules of water are attracted to each other.

Fig. 36.1 shows the structure of a water molecule.

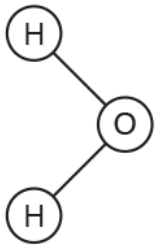


Fig. 36.1

Draw a **second** water molecule on Fig. 36.1, in the position it might take up beside the first water molecule.

Your drawing should show:

- the bond(s) between the two molecules
- the name of each bond
- the charges on each atom.

[Answer on Fig. 36.1] **[3]**

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			*Property*: solvent (1) *Significance*: transport polar chemicals (1) *Property*: high specific heat capacity (1) *Significance*: maintenance of stable temperature (1)	4	ALLOW description of high specific heat capacity
			Total	4	
2	a		down a concentration gradient / AW, between vacuole and, surroundings / AW (1) across tonoplast **and** cell surface membrane (1) through the cell wall (1)	3	ACCEPT a description e.g. ref. to a high concentration in the vacuole compared to outside the beetroot cell
	b		9.51 (1) results at 40 °C are the most precise and results at 20 °C are least precise (1) precision increases as temperature increases (1) quotes data to support either statement (1)	4	
	c		*Any 2 limitations and improvements up to maximum 4 marks* approximate length of visking tubing (1) exactly 6 cm length of visking tubing (1) half fill the model cell (1) use exact volume of liquid (1) blot dry the outside of the tubing (1) thoroughly dry the tubing (1) concentration of, potassium iodide solution / starch solution not stated (1) use the same / known concentrations for each repeat / temperature (1)	4	Improvement must be linked to limitation
			Total	11	
3		i	add biuret solution / carry out biuret test (1) protein present if a, purple / lilac / mauve, colour seen (1) OR use, multistix / protein test strip (1) protein present if colour seen matches chart (1)	2	

Question			Answer/Indicative content	Marks	Guidance
		ii	1.2 (1) (1)	2	**Correct answer** = 2 marks If answer incorrect award 1 mark for: –1.5kPa (correct calculation but wrong data used) **OR** 4.3 – 3.3 (correct blood values used but tissue fluid values not used or used incorrectly)
			Total	**4**	
4	a	i	(glucose volume) 6 (1) (water volume) 14 (1)	2	If answer incorrect **ALLOW 1 mark** for glucose volume 3 **AND** water volume 7
		ii	(reagent) - Benedict's (solution) (1) (temperature) - above 70 °C (1)	2	**ALLOW** 'boiling' or any value greater than 70 given with correct units **IGNORE** temperature figures without units
	b	i	filter solutions **or** centrifuge	1	
		ii	*idea of* zeroing colorimeter **or** select correct filter (orange / red / wavelength) (1)	1	**ALLOW** a description **ALLOW** any wavelengths in range 570–750 nm
	c		*idea that* Benedict's test is, for reducing sugars / not specific to glucose	1	**ALLOW** error carried forward from (a) (ii) if the reagent was incorrectly named
			Total	**7**	

Question			Answer/Indicative content	Marks	Guidance
5	a		*idea of* a molecule containing mainly carbon and a number of other elements (1) sucrose / protein / amino acids, used as illustration (1)	2	Examples of other elements could include hydrogen, nitrogen, sulphur
	b	i	(solution remains) blue	1	
		ii	**Any 2 from:** precipitate is produced (1) copper oxide is insoluble (1) high temperatures / boiling, required in the Benedict's test (1) boiling / high temperatures, denature the protein in the phloem sap (1)	2	
			Total	**5**	
6		i	(both are) glycosidic (1) **P** – (alpha) 1,4 **and Q**- (alpha) 1,6 (1)	2	*Examples of how to award the marks,* **P** glycosidic, **Q** glycosidic = 1 mark **P** glycosidic, **Q** peptide = 0 marks **P** 1-4, **Q** 1-6 = 1 mark **P** 1-4 glycosidic, **Q** 1-6 glycosidic = 2 marks **P** 1-6 glycosidic, **Q** 1-4 glycosidic = 1 mark
		ii	condensation (1)	1	
		iii	*Appearance – idea that:* granules appear smaller **OR** (some) granules permanently present **OR** more granules (1) *Explanation-idea that:* some / AW of glycogen molecule remains **OR** short branches still left on the molecule **OR** molecules still synthesised but not broken down (1)	2	Explanation must correspond to the appearance
			Total	**5**	

Question			Answer/Indicative content	Marks	Guidance
7	a		cell surface / plasma, membranes have been disrupted ✓ (because) water has entered the cells by osmosis ✓ (because) water potential of the sodium chloride solution is higher ✓	2 max	ACCEPT description of osmosis e.g. by moving from higher to lower water potential CREDIT ORA IGNORE water concentration Examiner's Comments This question addressed AO3 with a practical theme aimed at assessing the ability of candidates to apply practical experience to a situation involving the osmosis of erythrocytes. A coloured insert was supplied to candidates to provide visual results and context for the question parts. Centres are encouraged to allow candidates to undertake the practical components of the specification where possible as it is important that candidates continue to appreciate the procedures detailed in the specification. As Centres become more familiar with the new specification, it is hoped that candidates will become more confident in applying their knowledge in a practical-based context. A significant number of candidates failed to grasp the concept of this osmosis practical. Test tube B, on the insert, showed that haemolysis had taken place (described in the question stem) and candidates were required to explain how water had entered the cells by osmosis which caused the plasma membranes to rupture. Candidates who realised this generally gained both marking points, but many responses were too vague to gain credit or simply stated that haemolysis had occurred without offering an explanation.

Question			Answer/Indicative content	Marks	Guidance
	b		gives time for haemolysis to occur (in the solution) OR *idea that* gives time for water potential to equilibrate between solution and cytoplasm / AW OR osmosis may be slow depending on water potential gradient ✓	1	DO NOT ACCEPT allows time for reaction to occur ACCEPT time for osmosis OR to reach equilibrium Examiner's Comments This question addressed AO3 with a practical theme aimed at assessing the ability of candidates to apply practical experience to a situation involving the osmosis of erythrocytes. A coloured insert was supplied to candidates to provide visual results and context for the question parts. Centres are encouraged to allow candidates to undertake the practical components of the specification where possible as it is important that candidates continue to appreciate the procedures detailed in the specification. As Centres become more familiar with the new specification, it is hoped that candidates will become more confident in applying their knowledge in a practical-based context. The most common correct response in was that 'it gave time for haemolysis to occur'. A common misconception among candidates was that a reaction was involved in this process which could not be credited.

Question			Answer/Indicative content	Marks	Guidance
	c		colorimeter gives quantitative results ✓ observing haemolysis is qualitative / AW ✓ *advantages of colorimeter* takes away human subjective judgement on haemolysis / AW ✓ allows calibration to give concentration at which cells are isotonic with sodium chloride solution / AW ✓	3 max	ACCEPT colorimeter gives data with numbers OR allows (numerical) data to be plotted on a graph Examiner's Comments This question addressed AO3 with a practical theme aimed at assessing the ability of candidates to apply practical experience to a situation involving the osmosis of erythrocytes. A coloured insert was supplied to candidates to provide visual results and context for the question parts. Centres are encouraged to allow candidates to undertake the practical components of the specification where possible as it is important that candidates continue to appreciate the procedures detailed in the specification. As Centres become more familiar with the new specification, it is hoped that candidates will become more confident in applying their knowledge in a practical-based context. The most common correct response was generally well answered with many candidates confidently referring to 'quantitative' and 'qualitative' in their responses, demonstrating knowledge of the use of a colorimeter.
	d	i	*idea that* absorbance in both solutions is similar up to 0.10 moldm^{-3} ✓ for both solutions as concentration increases absorbance increases ✓ *idea that* sodium chloride has higher absorbance at concentrations of, 0.15 / 0.20 moldm^{-3} ✓ in 0.05 and 0.10 moldm^{-3} for both solutes haemolysis has occurred ✓ in sodium chloride solution no haemolysis occurs above 0.15 moldm^{-3} OR in glucose haemolysis occurs at concentrations between 0.05 and 0.20 moldm^{-3} ✓	2 max	

Question			Answer/Indicative content	Marks	Guidance
			comparative figures with units given at least once ✓		MUST be linked to another mark point e.g. for *sodium chloride at concentration of 0.15 moldm^{-3} the absorbance of 0.70 a.u. is higher than glucose which is only 0.18* gets mps 3 and 6 Examiner's Comments This question addressed AO3 with a practical theme aimed at assessing the ability of candidates to apply practical experience to a situation involving the osmosis of erythrocytes. A coloured insert was supplied to candidates to provide visual results and context for the question parts. Centres are encouraged to allow candidates to undertake the practical components of the specification where possible as it is important that candidates continue to appreciate the procedures detailed in the specification. As Centres become more familiar with the new specification, it is hoped that candidates will become more confident in applying their knowledge in a practical-based context. Candidates achieved marks by describing the differences in absorbance as concentration increased, with few candidates opting to suggest what was happening with regards to haemolysis. Some candidates considered that the changes in absorbance were either 'quicker' or 'slower' which was incorrect. Centres are advised to encourage candidates to practice looking at graphs or tables of data and making comparative statements to describe the relationships or conclusions drawn from the data. This is where candidates could pick up what are relatively easy marks for a straight forward description or comparison.

Question			Answer/Indicative content	Marks	Guidance
		ii	*idea that* the critical point for determining the concentration of solute at which haemolysis occurs is between 0.20 moldm^{-3} and 0.30 moldm^{-3} / AW ✓	1	***look for idea that*** absorbance shows that at 0.20 moldm^{-3} haemolysis occurs but at 0.30 moldm^{-3} there is no haemolysis so 0.25 moldm^{-3} could go either way e.g. they could conclude that haemolysis occurs at the wrong concentration such as 0.30 but it could have happened at 0.25 moldm^{-3} the haemolysis could have occurred earlier at 0.25 rather than 0.30 moldm^{-3} IGNORE ref to anomalous result Examiner's Comments This question addressed AO3 with a practical theme aimed at assessing the ability of candidates to apply practical experience to a situation involving the osmosis of erythrocytes. A coloured insert was supplied to candidates to provide visual results and context for the question parts. Centres are encouraged to allow candidates to undertake the practical components of the specification where possible as it is important that candidates continue to appreciate the procedures detailed in the specification. As Centres become more familiar with the new specification, it is hoped that candidates will become more confident in applying their knowledge in a practical-based context. Candidates achieved marks proved challenging. Stronger candidates understood the idea that the missing data was important to be able to determine the point (concentration) at which haemolysis occurred.
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
8	a		add, biuret solution ✓ observe a colour change (from blue) to lilac ✓	2	ACCEPT add, NaOH **and** copper sulphate solution ACCEPT purple, mauve for end colour
	b		hydrolysis ✓	1	
	c				Examiner's Comments Many candidates incorrectly wrote about repeating the test or doing them on separate papers as a reference for (ii). Quite a few candidates suggested using a different solvent but found it hard to justify this and get the second mark.
		i	distance travelled by amino acid = 52 – 58mm **and** distance travelled by solvent front = 125 – 127mm ✓ 0.42 – 0.46 calculated ✓	2	Examiner's Comments Many candidates scored highly in (i) and correctly got all three mark points. The candidates that didn't had tended to guess from the rf values and spots that the answer was tyrosine and did not get the mark point for the calculation.
		ii	tyrosine ✓	1	
		iii	use longer chromatography paper ✓ *idea of* longer paper gives better resolution ✓	2	CREDIT alternative methods suitably justified e.g. two–way chromatography / different solvent
			Total	8	

Question			Answer/Indicative content	Marks	Guidance
9		i	30.4 (%);;	2	If incorrect answer given allow 1 mark for: answer not given to 1 decimal place e.g. 30% or 30.37% **OR** incorrect rounding (30.3) **OR** a number divided by 7900 **ECF** if total cell number is incorrect **Examiner's Comments** The calculation proved very accessible with most candidates gaining full marks. The most common mistake was incorrect rounding or misreading the figures from the graph.
		ii	(so) patient may , have / be recovering from , an infection **OR** autoimmune disease **OR** blood cancer;	1	**CREDIT** a correct reference to pathogens or disease **DO NOT CREDIT** reference to patient being unwell **CREDIT** reference to an allergic response **CREDIT named** blood cancer e.g. leukaemia
		iii	Any **one** from: electrolytes or **named** dissolved ion(s) e.g. sodium ion; **named** dissolved nutrient(s) e.g. glucose, amino acids; water; AVP;	1 max	**IGNORE** oxygen (as this is mostly transported in combination with haemoglobin rather than in plasma) **CREDIT** correct symbol e.g. Na+ e.g. carbon dioxide, urea, antibodies, protein, fibrinogen, hormones **Examiner's Comments** (ii) and (iii) were both answered well with references to electrolytes or ions being the commonest answers in (iii).
			Total	**4**	

Question			Answer/Indicative content	Marks	Guidance
10		i	polysaccharide / carbohydrate / polymer / macromolecule;	1	Examiner's Comments Part (i) was answered well but only more able candidates could describe and, more importantly, explain how glycogen was adapted to its role as a storage molecule.
		ii	compact; so lots of , glucose / glycogen , can be stored in a small space; OR branched molecule; so lots of end points for, quick / AW, release of glucose;	2 max	*feature must be linked to correct property* Allow 1 mark max for correct feature **or** correct property if not linked
			Total	3	

Question			Answer/Indicative content	Marks	Guidance
11	a	i	condensation reaction / removal of water molecule; glycosidic links formed; (α)1-4 links;	3	CREDIT correctly annotated diagram Examiner's Comments This question included more biochemical aspects by linking polysaccharide formation with enzyme structure within the context of liver function. The AO2 'suggest' style questions were, as in previous sessions, a good discriminator across the ability range with this part needing application of knowledge about the effects of glycogen and glucose within cells. For **(i)**, most candidates could correctly identify the type of reaction with some going onto name the glycosidic bond for two marks. Stronger candidates extended their responses further by offering the correct type of glycosidic bond thereby gaining maximum marks.
		ii	(enzymes are) globular proteins; (enzymes have) tertiary structure / specific 3D shape; (enzymes have) active site which has <u>complementary</u> shape to substrate;	3	ACCEPT active site is complementary to glycogen or glucose or UDP-glucose Examiner's Comments This question included more biochemical aspects by linking polysaccharide formation with enzyme structure within the context of liver function. The AO2 'suggest' style questions were, as in previous sessions, a good discriminator across the ability range with this part needing application of knowledge about the effects of glycogen and glucose within cells. The question then moved onto enzyme structure for **(ii)** and whilst there were some good responses for marking points two and three, very few candidates gained maximum marks. Some candidates failed to notice that the question referred to the enzyme, glycogen synthase and modelled their responses around the structure of glycogen.

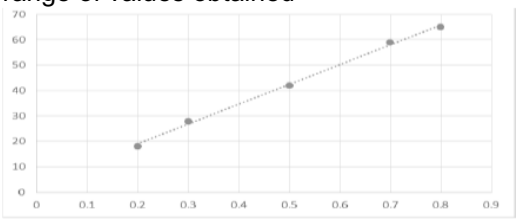
Question			Answer/Indicative content	Marks	Guidance
	b		*idea that* the glycogen deposited is, in long chains / not branched, so not compact (which damages liver cells); *idea that* glucose, is in excess / remains in cells, so lowers water potential (which damages liver cells);	1 max	
			Total	7	

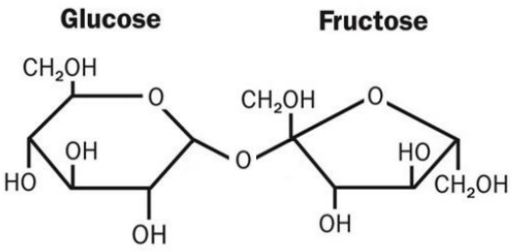
Question			Answer/Indicative content	Marks	Guidance
12		i	(venom) increases permeability / AW (of cell membrane); (so) potassium ions diffuse out of cell; AVP;;	2 max	ACCEPT well-reasoned argument e.g. sodium-potassium pumps may stop working (so) no active transport of potassium ions Examiner's Comments Despite two challenging AO2 style questions in **(i)** and **(ii)**, there were still few 'no response' questions at the end of the paper suggesting that candidates had managed their time effectively during the examination. The question assessed the ability of candidates to demonstrate application of their knowledge and understanding of electrolytes, water potential and ECG interpretation in the context of conditions that would affect potassium ion concentration. In **(i)** was challenging for weaker candidates who struggled to link the reference to cell membranes in the question stem with the possibility of disruption to the mechanism of potassium ion transport across the membrane. There were, however, some good responses gaining credit for AVPs, for example, some reasoned that the potassium ion channels could be blocked by the toxin so that there would be no facilitated diffusion.

Question			Answer/Indicative content	Marks	Guidance
		ii	(loss of potassium ions) increases water potential inside the cell; water leaves cell by osmosis; cell, crenates / shrivels; *idea that* cell metabolism is affected;	2 max	CREDIT ORA Examiner's Comments Despite two challenging AO2 style questions in **(i)** and **(ii)**, there were still few 'no response' questions at the end of the paper suggesting that candidates had managed their time effectively during the examination. The question assessed the ability of candidates to demonstrate application of their knowledge and understanding of electrolytes, water potential and ECG interpretation in the context of conditions that would affect potassium ion concentration. The responses to **(ii)** showed that this concept was well understood and candidates could discuss the consequence of altering osmotic balance.
			Total	4	

Question			Answer/Indicative content	Marks	Guidance
13		i	*idea that* you can, check / see / know, if glucose concentrations are too, high / low; (if untreated) high blood glucose may cause named condition; (if untreated) low blood glucose may cause, faint / coma / death; so the person can adjust their insulin dose / carbohydrate intake (if necessary);	2	ACCEPT to check levels are within limits DO NOT CREDIT 'to ensure' ACCEPT to detect hypoglycemia / hyperglycemia e.g. blindness / foot amputation / nerve damage / kidney failure / high blood pressure / heart disease / strokes / chronic infections / shortening of life Examiner's Comments This question also mainly addressed AO3 but had some elements of AO1 and AO2 Candidates failed to appreciate the difference between checking to see if blood glucose was too high or too low (which was what was required), and ensuring it didn't get too high or too low(which is what they were saying, implying a control mechanism) . Some candidates were not specific about the direction of blood glucose concentration (too high / too low) and the correct consequence. A good analogy would be that a thermometer tells you what the temperature is so you know if it is changing, but the water bath keeps it constant. There were too many 'water bath' answers, and not enough 'thermometer' answers.
		ii	oxidase / dehydrogenase; enzyme; gluconolactone; transducer;	4	Examiner's Comments This question also mainly addressed AO3 but had some elements of AO1 and AO2 Most candidates gained a mark for 'enzyme, and several for 'oxidase' or 'dehydrogenase'. Gluconolactone was often incorrectly spelled. Very few candidates identified the transducer.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
14	a	i	*idea that* the cell (surface membrane)/ tonoplast , can be seen ✓ plasmolysed cells can be seen ✓	Max 1	Examiner' Comments n this question, candidates were asked about the method used in an investigation into the water potential of onion cells and then had to analyse the results obtained. Many candidates suggested that the differential stain made the cells easier to see for Q6(a)(i) without any mention of plasmolysed or unplasmolysed (or tonoplast). Candidates should be taught that very vague answers like this rarely score marks
		ii	the student is correct AND idea that the water potential of the cells decreases / dye is soluble in the cytoplasm ✓	1	Examiner' Comments The common mistake in Q6(a)(ii) was to simply state that water potential decreases without saying inside the cell, another type of answer that is much too vague.
		iii	Error immediately remove ✓ Improvement immersion time should be, longer / stated ✓ Error drops (of solution)✓ Improvement idea that should be flooded to ensure full coverage ✓	Max 4	Examiner's Comments Candidates often suggested an improvement as the error in part Q6(a)(iii).

Question			Answer/Indicative content	Marks	Guidance
	b	i	all points plotted correctly ✓ sucrose concentration, mol dm^{-3}, on x axis AND percentage of plasmolysed cells,%, on y axis ✓ line of best fit drawn ✓	3	ALLOW+/– half small square DO NOT CREDIT if line extends beyond range of values obtained  **Examiner's Comments** Candidates often missed the units in Q6(b)(i). There were not many plotting errors but few unusual non-linear scales on the axis. The line of best fit often extended beyond the plots. Candidates should be reminded that they should not automatically extrapolate beyond the point on graph.
		ii	0.6 mol dm^{-3} ✓	1	ALLOW ECF DO NOT CREDIT if more than two decimal places **Examiner' Comments** Candidates often accurately stated the answer to Q6(b)(ii) but did not include the units.
			Total	10	

Question			Answer/Indicative content	Marks	Guidance
15	a		*drawn as a diagram* glycosidic bond between two molecules shown by oxygen atom ✓ bond drawn between correct carbon atoms ✓	2	 Examiner's Comments Most candidates correctly identified the carbons, but a large number didn't know how to draw a glyosidic bond with an oxygen bridge.
	b	i	*Support statement* (blue-green) result in leaf shows little sucrose present OR (green-orange) result in stem shows (greater) concentration of sucrose present ✓ (so) supports loading of sucrose into phloem , from source / as it is produced ✓ (blue-green) result in root shows sucrose is used by , roots / sinks ✓ (so) supports starch formation/use in respiration *Do not support statement* *idea that* (Benedict's) test does not distinguish between reducing and non-reducing sugars ✓ the blue-green result for , leaf / root , extract could be interpreted as a negative test ✓	max 4	ALLOW sucrose is converted to starch in roots ALLOW does not distinguish between glucose and sucrose ALLOW reducing sugar / glucose , could be causing positive result Examiner's Comments Most candidates had a good understanding of translocation but many did not demonstrate understanding of the colour changes seen in a Benedict's test. A number of candidates thought that water caused the colour changes.

Question			Answer/Indicative content	Marks	Guidance
		ii	**Any three from:** same temperature of water bath ✓ (equal) volume of Benedict's / test solutions ✓ excess sodium hydrogen carbonate needed ✓ same time left in water bath ✓ use method for obtaining quantitative results ✓	3	**ALLOW** boiling water bath **ALLOW** must be added until mixture stops fizzing e.g. filter precipitate and weigh e.g. use colorimeter
	c		starch , hydrolysed / broken down into , sugars / glucose / maltose ✓ enzyme / amylase ✓ germination ✓	3	<u>Examiner's Comments</u> Some candidates thought that starch moved out of the seeds down a concentration gradient into the water or that water moving in by osmosis diluted the starch to such a degree that the test would be negative.
			Total	12	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>16</td><td>a</td><td></td><td>
<table>
<tr><th>Property of water</th><th>Importance to living organism</th></tr>
<tr><td>is a solvent ✓</td><td>allows chemical reactions to take place inside cells</td></tr>
<tr><td>has a high latent heat of vaporisation</td><td>cooling effect by evaporation of, water / sweat ✓</td></tr>
<tr><td>cohesion ✓</td><td>allows a continuous column of water to move through xylem vessels without breaking</td></tr>
<tr><td>has a high specific heat capacity</td><td>prevents internal temperature changing quickly / AW
OR
temperature of aquatic environments remains stable /
AW ✓</td></tr>
</table>
</td><td>4</td><td>ONE mark per row.

ALLOW dissolves , polar molecules / ions

IGNORE adhesion

ALLOW helps maintain stable body temperature

<u>Examiner's Comments</u>

This was generally well answered with candidates across the ability range being credited. Responses for the importance of a high latent heat of vaporisation often lacked detail and did not gain credit. Good detailed responses that gained credit stated how evaporation of water through sweating could cool the body down.</td></tr>
<tr><td></td><td>b</td><td>i</td><td>X condensation
AND
Y hydrolysis ✓</td><td>1</td><td>BOTH required for one mark</td></tr>
<tr><td></td><td></td><td>ii</td><td>triglyceride AND (three) water ✓</td><td>1</td><td>BOTH required for one mark</td></tr>
<tr><td></td><td></td><td>iii</td><td>ester ✓</td><td>1</td><td>IGNORE covalent

<u>Examiner's Comments</u>

There were many good responses across the ability range for these biochemical questions in parts (b)(i), (ii) and (iii). In (b)(ii) some responses omitted water as a possible product and as both products were required for the response these did not gain credit.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>7</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>17</td><td></td><td>i</td><td><table><tr><th>Description</th><th>Name</th><th>Letter</th></tr><tr><td></td><td>Abomasum</td><td>U</td></tr><tr><td></td><td>Reticulum</td><td>S</td></tr></table></td><td>2</td><td>One mark for each correct row

ALLOW rumen and V</td></tr>
<tr><td></td><td></td><td>ii</td><td>idea that microbes in rumen are a protein source

(microbial protein) hydrolysed into amino acids by protease enzymes</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td>iii</td><td>(amino acids are) deaminated / AW</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
<tr><td>18</td><td></td><td>i</td><td>ACGGGAAGGGCCCGAGCACGGA
UGCCCUUCCCGGGCUCGUGCCU</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td>ii</td><td>hydrolysis</td><td>1</td><td>IGNORE ‘cleavage’</td></tr>
<tr><td></td><td></td><td>iii</td><td>Any 3 from:
(activated) RISC, cleaves / AW, viral mRNA
no viral proteins made
no, viral particles / AW, assembled
idea that no new cells are infected</td><td>3</td><td>

IGNORE ‘virus cannot spread’ as this is given in the question</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
19			*** Level 3 (7–9 marks)** Details of apparatus and a method to produce reliable data are provided to include the use of a dilution series to construct a standard curve. Most variables are identified, and the method states how most variables are controlled. *There is a well–developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (4–6 marks)** The apparatus and a method to provide reliable results are provided although some details may be missing. There is an outline of standard curve construction. Some variables are identified and the method states how some variables are controlled. *There is a line of reasoning presented with some structure. The information presented is in the most–part relevant and supported by some evidence.* **Level 1 (1–3 marks)** Apparatus and an outline method are suggested to provide some results but information, such as standard curve construction, may be missing. Some variables are omitted. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	9	**Indicative scientific points could include:** **Apparatus & method:** • cuvettes, test tubes • apparatus for volume measurement (pipettes, syringes) • distilled / deionised water • selection of appropriate filter (on colorimeter) • reference to zero or blank • details of quantitative preparation of dilution series (for salicylic acid) to include volumes and final concentration • standard curve construction • method of testing urine and obtaining a reading. **Variables:** • (curve) independent variable = dilution • dependent variable = colorimeter reading • correct units included • control variables e.g. filters (colorimeter), volumes, time, temperature. **Reliability:** • repeats (for dilutions and urine reading) • reference to quantitative processing of data e.g. calculation of means • reference to use of error bars on standard curve. **Risk Assessment:** • potential chemical hazards & control • potential electrical hazards & control • potential microbial hazards (urine) & control.
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
20		i	citrate ✓	1	
		ii	2 ✓	1	
		iii	malate / fumarate / succinate ✓	1	
		iv	carbon dioxide ✓	1	ALLOW CO_2
			Total	4	
21		i	(plasmolysis) occurs in plant cells / erythrocyte is not a plant cell ✓	1	Examiner's Comments Approximately 40% of candidates achieved the mark for **(b)(i)**. A lot of candidates stated the correct term but did not state the relevance of the actual term used.
		ii	allow time for equilibration before observation OR observe immediately and after 10 – 15 min ✓ use more concentrations ✓ count cells using, haemocytometer measure (diameter of) cells using, scale / graticule ✓	2	ALLOW other valid improvements Examiner's Comments For **(b)(ii)** the majority of candidates achieved mp2. Many candidates discussed slowly increasing the magnification or a better method for spreading the blood across the slide. Candidates did not appreciate that the improvement should be pertinent to observing osmotic effects. Candidates should focus on the relevance of the procedure, i.e. the student is trying to compare the solutions to 'find the one that caused' an osmotic effect, thus counting or measuring cells is the focus not how to apply the sample in the first place. A few candidates referred to adding a dye to visualise again without appreciating the osmotic relevance and thus the leakage of any dye from the cell.
			Total	3	

Question			Answer/Indicative content	Marks	Guidance
22			bond between any H and any O on separate molecules ✓ labelled hydrogen bond / H bond ✓ (delta/δ) + charges on H atoms AND (delta/δ) – charges on O atoms ✓	3	ALLOW charges on a single water molecule Examiner's Comments Many candidates were able to gain full marks in this question although it was noted that many drawings showed more than one extra water molecule. This was not penalised on this occasion, but candidates should read instructions carefully, particularly when in bold type.
			Total	3	