Answer **all** the questions.

1. Which inorganic ion can act as a cofactor for amylase?

A OH^-
B PO_4^{3-}
C Cl^-
D HCO_3^-

Your answer ☐

[1]

2. After being mixed with iodine, which of the following would show a blue / black colour?

A potato tuber cells
B erythrocytes
C sieve tube elements
D neutrophils

Your answer ☐

[1]

3. Fig. 5.1 shows part of a conjugated protein that is a respiratory pigment in muscle cells.

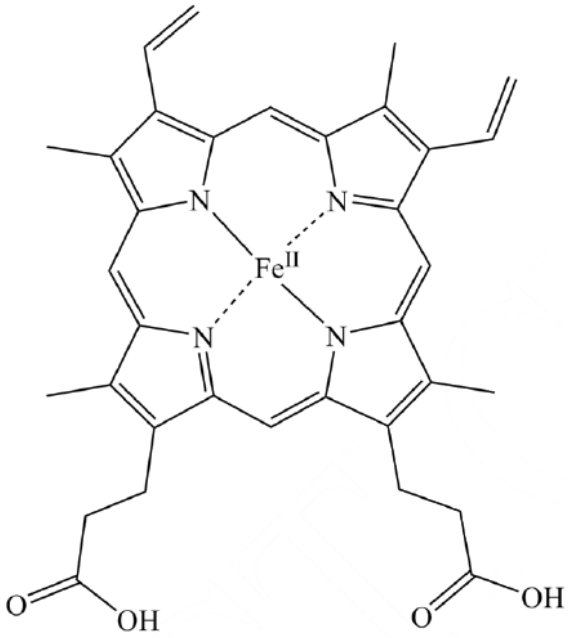


Fig. 5.1

Which part of the molecule does Fig 5.1 represent?

A prosthetic group
B disulfide bond
C quaternary structure
D polypeptide

Your answer ☐

[1]

4. A student tested a range of solutions of known concentrations of reducing sugar using Benedict's solution and colorimetry. Fig. 14.1 shows the calibration curve drawn by the student.

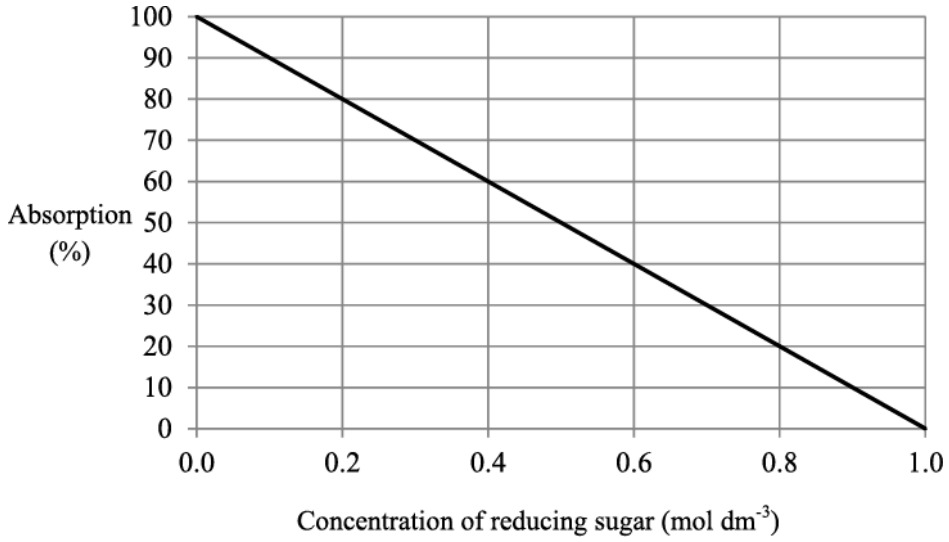


Fig. 14.1

The student then tested four solutions of **unknown** concentrations of reducing sugar. Table 14.1 shows the results:

Solution	**P**	**Q**	**R**	**S**
Absorption (%)	60	40	70	100

Table 14.1

Select the option that gives the correct sequence of reducing sugar concentrations from **highest** to **lowest**.

A **S**, **R**, **P**, **Q**
B **Q**, **R**, **P**, **S**
C **S**, **P**, **R**, **Q**
D **Q**, **P**, **R**, **S**

Your answer ☐

[1]

5. The walls of blood vessels contain a polymer called collagen.

Name the type of monomer from which collagen is made and explain how two such monomers are joined together.

Name ----------

Joined together by ----------

---

[3]

6(a). A thin-layer chromatography procedure was carried out on an extract of leaf cells that contained chlorophyll and other pigments.

Liquid extract from the leaf cells was dried thoroughly.

The extract was then mixed with an organic solvent and placed onto a thin-layer chromatography plate suspended in organic solvent.

Fig. 24.1 shows the results of the procedure.

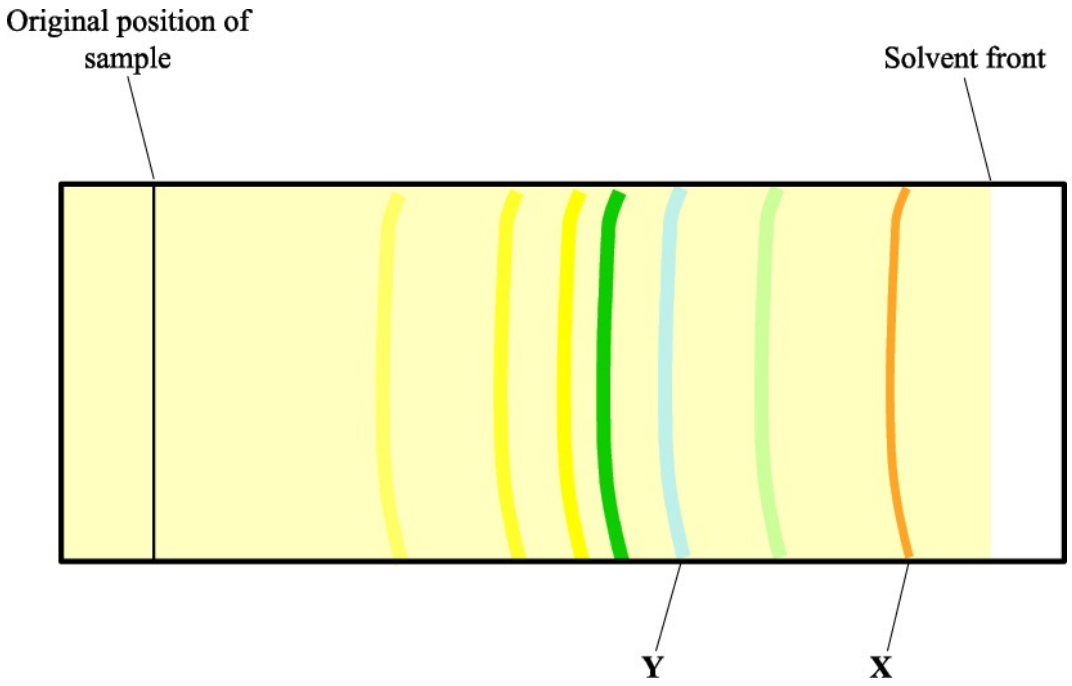


Fig. 24.1

Table 24.1 shows the typical *Rf* values for various pigments present in plants.

Pigment	**Colour**	***Rf* value**
Carotene	yellow-orange	0.91
Pheophytin a	grey	0.75
Chlorophyll a	blue green	0.63
Chlorophyll b	green	0.58

Table 24.1

(i) Name the organelle that is likely to have yielded most of the pigments present in the leaf extract.

[1]

(ii) Suggest why it was important that the leaf extract was dried thoroughly before mixing with the organic solvent.

[1]

(b).

(i) Calculate the *Rf* value for pigment **Y** on Fig. 24.1.

Answer _____ **[1]**

(ii) The student concluded that in Fig. 24.1 pigment **Y** was probably chlorophyll a.

How well do the results support the student's conclusion? Support your answer with reference to Fig 24.1 and Table 24.1.

[3]

7. Zinc ions are necessary for the enzyme carbonic anhydrase to work.

Which statement correctly describes the nature and function of zinc ions in their interaction with carbonic anhydrase?

A inorganic ions and coenzymes
B vitamins and prosthetic groups
C inorganic ions and prosthetic groups
D vitamins and coenzymes

Your answer ☐

[1]

8. Which of the following formulae of fatty acids represents a saturated fatty acid?

Statement 1: Palmitic acid, $C_{15}H_{31}COOH$
Statement 2: Oleic acid, $C_{17}H_{33}COOH$
Statement 3: Linoleic acid, $C_{17}H_{31}COOH$

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐

[1]

9. **Fig. 22.1** shows a transverse section of the stem of a typical pondweed viewed using a × 10 objective lens. Part of a graticule is shown below the stem. The markings on the graticule are 0.1 mm apart.

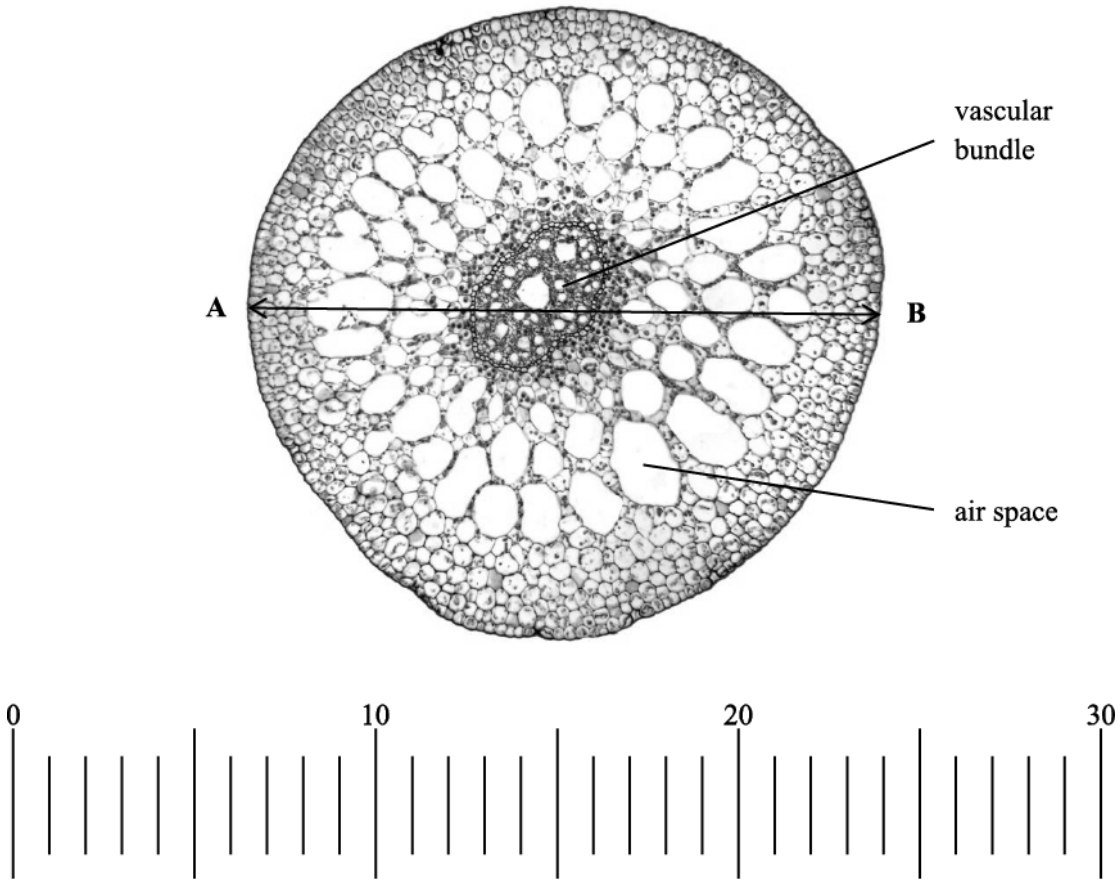


Fig. 22.1

(i) Measure the width of the stem between points **A** and **B**.
Give your answer to the nearest 0.1 mm.

Answer _____ **[1]**

(ii) Calculate the magnification of the image in **Fig. 22.1**.

Answer _____ **[2]**

(iii) The thin stem and thin cell walls do not provide much support for the leaf. Suggest how the leaf is supported.

---

[2]

10. An unknown solution of a single sugar was tested. The results were recorded in **Table 9.1**.

Colours observed after testing	
Benedict's test for reducing sugars	**Benedict's test for non-reducing sugars**
blue	brick red

Table 9.1

Identify the unknown sugar.

A fructose
B lactose
C sucrose
D glucose

Your answer ☐

[1]

11. One of the main functions of the liver cells is the formation of urea by the ornithine cycle, an outline of which is shown in **Fig. 17.2**.

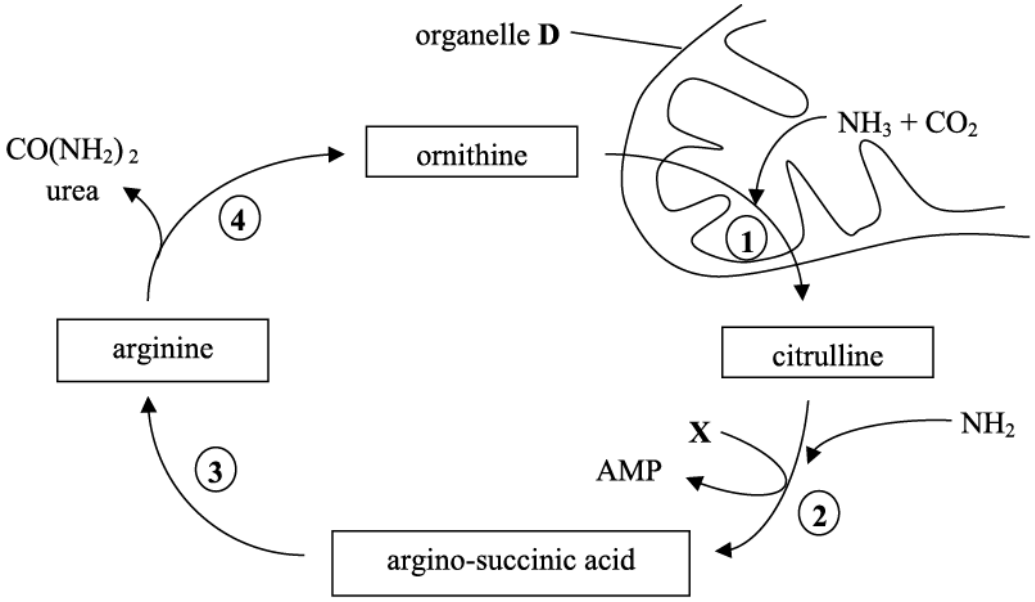


Fig. 17.2

(i) Step **1** of the cycle takes place in the organelle represented by **D**.

Identify organelle **D**.

[1]

(ii) During the cycle ornithine moves into organelle **D** and citrulline moves out of the organelle.

Suggest the method by which these molecules move into and out of the organelle during the cycle. Give reasons for your choice.

[2]

(iii) How has the ammonia that is used in step **1** been formed?

[1]

(iv) Identify the compound labelled **X** in **Fig. 17.2**.

[1]

12(a). Following their formation, assimilates are transported throughout the plant by translocation in phloem.

Phloem sap mainly consists of carbohydrate in the form of sucrose, but also contains other solutes.

(i) Suggest why it is beneficial to the plant for the carbohydrate to be transferred throughout the plant in the form of sucrose rather than as an alternative carbohydrate.

[2]

(ii) How is transport in the phloem similar to and different from transport in the xylem?

Similar

Different

[2]

(b). **Fig. 19.2** is a diagram of a potato plant. Potatoes are tubers which are underground storage organs.

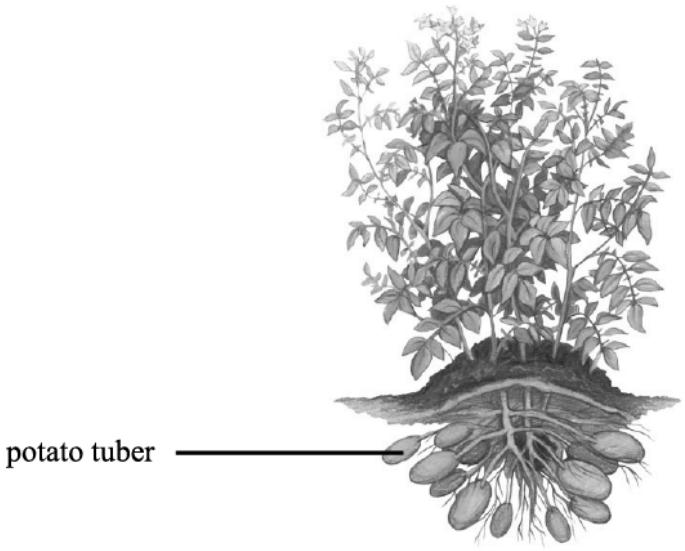


Fig. 19.2

Actively growing tissues have a high demand for carbohydrates. This means that a lot of phloem sap is directed to these tissues and requires sucrose to be unloaded in large amounts.

In an investigation, potato plants were modified by having a gene for invertase inserted into their DNA so that the gene for invertase would be expressed in the tubers. Invertase is responsible for catalysing the hydrolysis of the disaccharide sucrose.

A trial experiment was carried out to compare the properties of the modified plants with those that had not been modified. After harvesting, the tubers of three of each type of plant were compared. The results are shown in **Table 19.1**.

	Modified	**Not modified**
Mean number of tubers per plant	2.2	5.3
Mean mass per tuber (g)	49.7	16.8
Mean sucrose concentration (mg g^{-1} tuber mass)	1.4	13.7
Mean glucose concentration (mg g^{-1} tuber mass)	36.3 ± 3.5	1.9 ± 0.3
Invertase activity (arbitrary units)	62.1	1

Table 19.1

(i) Name the bond that is hydrolysed by invertase.

---

[1]

(ii) The potato tubers contain monosaccharides.

Compare the concentration of monosaccharides in the modified tubers with those that were not modified.

---

[2]

(iii) In the modified plants, the unloading of sucrose is increased in the tubers compared with those that were not modified.

The transport of sucrose to the tubers was also increased in the modified plants.

Using the data and the information given, deduce a possible mechanism to account for the increased unloading and transport of sucrose in the modified plants.

---

[4]

(iv) The trial experiment compared the properties of modified potato plants with those that were not modified.

Analyse the data and draw conclusions about the yield of the tubers of modified plants compared with those tubers from plants which had not been modified.

---

[3]

13. A student mixed an unknown substance with water and ethanol. A white suspension formed in the tube.

Which of the explanations, **A** to **D**, is correct?

A lipid is present

B non-reducing sugar is present

C protein is present

D reducing sugar is present

Your answer ☐

[1]

14. *Heliamphora*, shown in Fig. 18.1, is a genus of carnivorous plant. Its leaves are adapted to form water-filled traps for insects. The insects are attracted by nectar, then fall into the traps and drown. The plants digest the insects and absorb the mineral ions produced. This allows *Heliamphora* to survive in soils with low mineral content.

Fig. 18.1

Four pigments, A, B, C and D, were extracted from a *Heliamphora* plant. Thin layer chromatography (TLC) was carried out on the pigments. The results of the TLC are shown in Fig. 18.3.

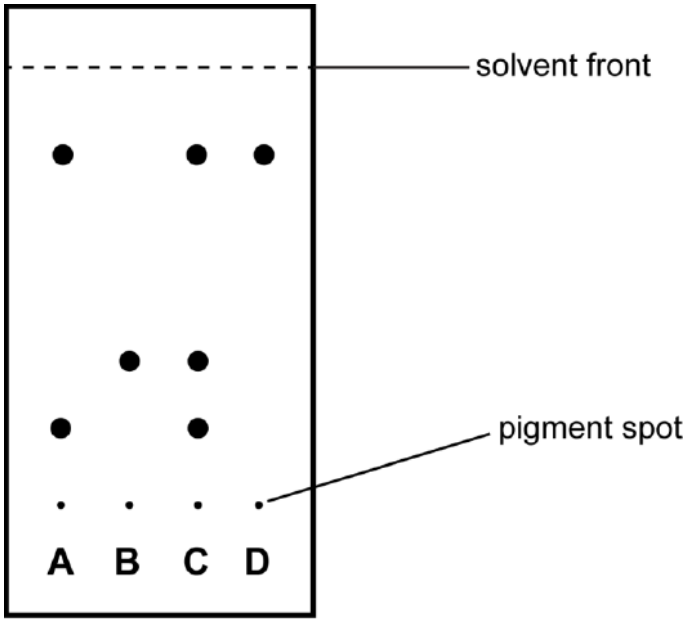


Fig. 18.3

(i) Using Fig. 18.3, what can you conclude about the composition of pigments **A** to **D**?

_____

_____

_____

_____

_____

_____

_____

_____

_____ **[3]**

(ii) Calculate the Rf value of pigment **B**. Give your answer to **two significant figures**.

Show your working.

Answer = _____ **[2]**

15. Sodium ions and glucose are both reabsorbed into the blood from proximal convoluted tubules (PCTs) in the kidney.

(i) A student designed an experiment to investigate the effect of temperature on the rate of glucose diffusion through dialysis tubing.

State **two** factors that would need to be controlled in this experiment.

1

2

---

[2]

(ii) Describe the structural difference between alpha and beta glucose molecules.

---

[1]

(iii) Sulthiame is a drug that inhibits the enzyme carbonic anhydrase.

Fig. 2.2 shows the role of carbonic anhydrase in the PCT of the kidney.

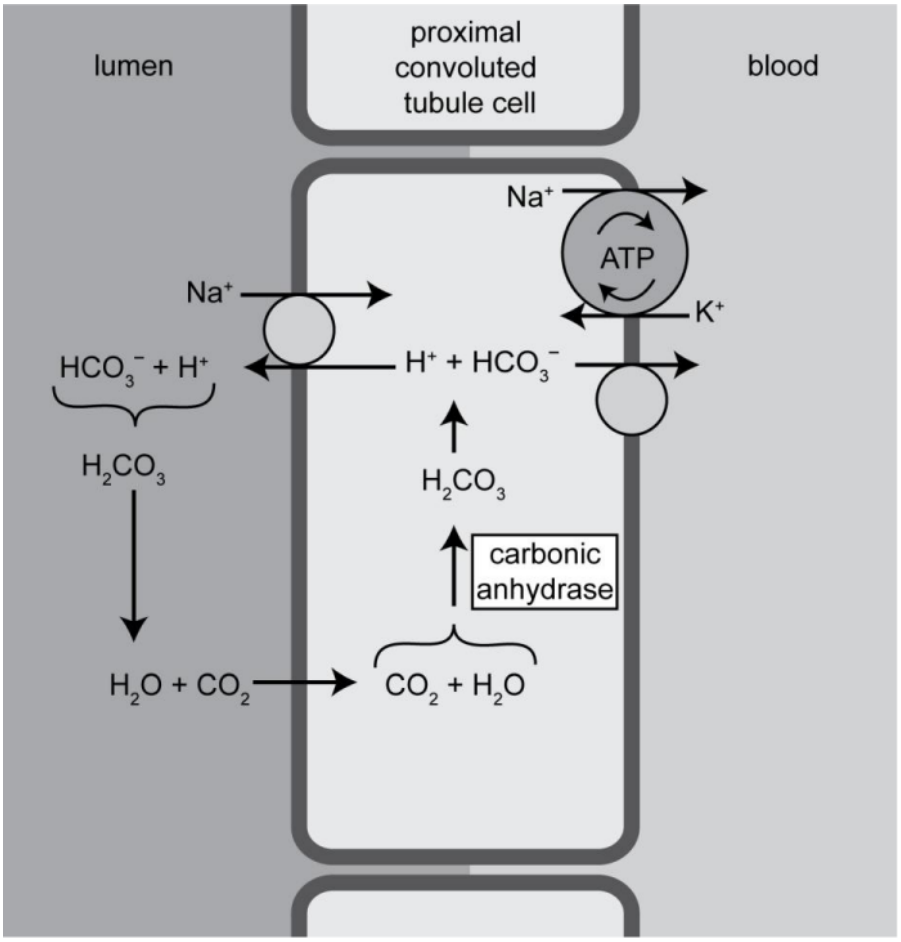


Fig. 2.2

Using the information in Fig. 2.2, what can you conclude about the likely effect of sulthiame on the reabsorption of sodium ions in the PCT?

---

[3]

16(a). Milk contains lactose. Lactose cannot be absorbed in the small intestine. The intestinal cells of mammalian infants produce lactase, an enzyme that splits lactose into glucose and galactose. These monosaccharides can pass into the blood.

Fig. 18.1 shows a molecule of the disaccharide lactose and the products of its breakdown in digestion.

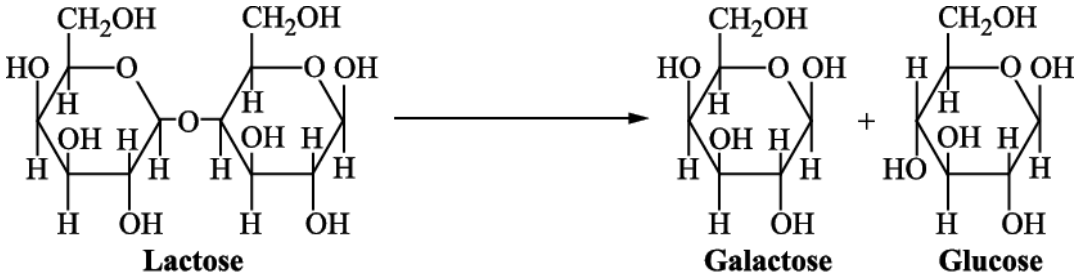


Fig. 18.1

(i) Suggest why galactose and glucose cannot pass through the plasma membrane into intestinal cells by simple diffusion through the phospholipid bi-layer.

[1]

(ii) What two substances are required to break the glycosidic bond in lactose?

1

2

[1]

(b). A gene codes for the production of lactase. This gene is normally switched off after an infant moves to adult food. Almost all adult mammals are unable to digest lactose. They are said to be **lactose intolerant.** Humans are an exception.

Most humans have a genetic mutation that prevents the shutdown of lactase production.

State what structural detail of a polypeptide is altered by gene mutations.

[1]

17. Valine, citrulline, hydroxyproline and glutamic acid are amino acids that are normally found in considerable amounts in urine. Following certain diets can result in a change in the amino acids present in the urine of some people.

Plan a method to compare the amino acids present in the urine of a person who has been following one of these diets with that of a person who has not.

[3]

18. Amylase activity is increased in the presence of chloride ions.

State the name given to any inorganic ion that increases the activity of an enzyme.

[1]

19(a). * Describe how the structure of llama hamoglobin is likely to be different from that of camel haemoglobin with reference to the four levels of protein structure.

[6]

(b). Haemoglobin is a protein that carries oxygen in the blood of all mammals. The structure of haemoglobin can vary slightly between species.

Fig. 4.1 shows a llama, a relative of the camel.

Fig. 4.1

- Llamas live at high altitudes and camels live at low altitudes.
- At high altitudes the partial pressure of oxygen is low.
- Llama and camel haemoglobin consists of 2 α subunits and 2 β subunits.
- Each subunit contains a haem group and is able to bind to one molecule of oxygen.

- In the β subunits, one amino acid present in camel haemoglobin has been replaced by a different amino acid in llama haemoglobin.

Fig. 4.2 shows dissociation curves for llama haemoglobin and camel haemoglobin.

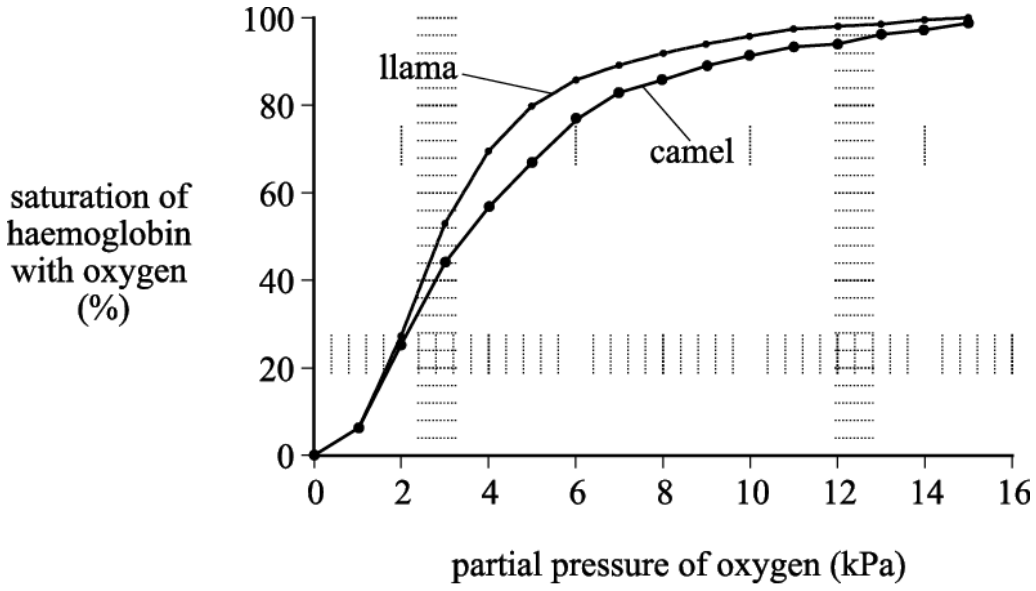


Fig. 4.2

(i) State the partial pressure of oxygen that results in a saturation of 50% in llama haemoglobin.

Answer_____ **[1]**

(ii) Explain why it is important for the survival of the llama that the llama haemoglobin dissociation curve is to the left of the camel haemoglobin dissociation curve.

---

[2]

(c). Collagen is a fibrous protein.

State three **properties** of a fibrous protein that are different from those of a globular protein.

1

2

3

[3]

(d). A vet is concerned that a llama is unwell. The vet suspects there may be haemoglobin in the urine of the llama.

Explain how the vet could confirm this suspicion.

[2]

20(a). Triglycerides, phospholipids and proteins are important biological molecules.

Triglycerides are found in a variety of foods, such as milk, and are an important part of a human diet. They are digested and absorbed in the small intestine. Bile salts present in the small intestine speed up the digestion of triglycerides.

An investigation was carried out into the breakdown of triglycerides in milk using the enzyme lipase.

Tube A contained a solution of bile salts.
Tube B contained an equivalent volume of water.

Both tubes also contained:

- full fat milk
- phenolphthalein indicator
- sodium carbonate solution (to ensure an alkaline pH to start with).

Phenophthalein is an indicator that is pink in alkaline solutions. When the pH drops below 8.3 the indicator turns colourless.

Lipase solution was added last and immediately after this the tubes were mixed thoroughly.

After mixing, the solutions were pink. The tubes were then kept in a water bath at 35°C and the time taken for the solutions to turn from pink to white was recorded using a stopwatch.

The experiment was replicated three times and the results are shown in Table 4.1.

	Time for pink colour to disappear (s)				
Tube	**Replicate 1**	**Replicate 2**	**Replicate 3**	**Mean**	**Standard deviation**
A (bile salts)	324	362	298	328.0	32.2
B (water)	725	699	824	749.3	

Table 4.1

Explain why phenolphthalein indicator was able to detect the breakdown of triglycerides.

---

[2]

(b).

(i) Use the formula to calculate the standard deviation for Tube **B**.

$$s = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}$$

Where,
x is the values measured
$\bar{x}$ is the mean
n is the number of replicates

Answer_____ s **[2]**

(ii) Standard deviation is a measure of the spread of results.

All significant variables were controlled during the investigation.

Identify a limitation to the experimental procedure that caused a high standard deviation and suggest an improvement to the method that could reduce this spread of results.

Limitation

Improvement

---

[2]

(c). Triglycerides contain three elements.

(i) **M** and **N** are formulae for two macromolecules,

$C_{55}H_{98}O_6$ **M** $C_{18}H_{30}O_{16}$ **N**

Which of the formulae, **M** or **N**, corresponds to a triglyceride?
Explain your answer.

Formula _ _ _ _ _

Because

---

[1]

(ii) Phospholipid molecules are similar to triglycerides but they also contain the element phosphorus as part of a phosphate group.

Explain how the structure of phospholipids allows them to form the bilayer of a plasma membrane.

---

[3]

21. Which of the rows, **A** to **D**, correctly describes the properties of the named proteins?

Row	Collagen	Insulin	Elastin	Haemoglobin
A	fibrous protein which is flexible but does not stretch	globular protein with specific, fixed shape	fibrous protein which recoils after being deformed	globular protein which cannot change shape
B	fibrous protein which is flexible but does not stretch	globular protein with specific, fixed shape	fibrous protein which recoils after being deformed	globular protein which can change shape
C	fibrous protein which recoils after being deformed	globular protein with specific, fixed shape	fibrous protein which is flexible but does not stretch	globular protein which can change shape
D	fibrous protein which is flexible but does not stretch	globular protein which can change shape	fibrous protein which recoils after being deformed	globular protein with specific, fixed shape

Your answer ☐

[1]

22. Water has many important roles in living organisms.

(i) State the name of the bond that holds water molecules together.

---

[1]

(ii) DNA is one of many substances which will dissolve in water. Explain why water is a good solvent.

---

[2]

(iii) A student studied the pack of 'plant food' supplied with some cut flowers. The list of ions included hydrogen and sodium.

Suggest what roles these may play in helping the cut flowers to last longer.

hydrogen

---

sodium

---

[2]

23(a). Botulism is a condition resulting from the action of botulinum toxin. The main symptom of botulism is skeletal muscle weakness, which can be fatal.

(i) Botulinum toxin is produced by the anaerobic bacterium *Clostridium botulinum.*
What information does the word 'anaerobic' suggest about the bacterium?

---

[1]

(ii) The toxin is initially produced as a large single polypeptide that has low potency.
After the toxin has been acted upon by a protease, two chains are produced which remain connected by a disulfide bond. In this form it is far more toxic.

Describe the action of the protease when it acts on the toxin.

---

[1]

(b). A mouse assay, using 99 mice, was used to determine the median lethal dose of the the toxin.

(i) Suggest what is meant by the term *median lethal dose.*

---

[1]

(ii) The median lethal dose of the toxin is in the range of 5 – 50 ng kg^{-1} body mass, depending on the toxin type and the method of introduction into the body.

Calculate the probable lethal dose of the **least toxic** botulinum toxin for an individual with a body mass of 85 kg.

Show your working and give your answer in µg.

Answer_____ µg **[2]**

(iii) The toxin acts primarily at the cholinergic nerve terminals of stimulatory motor neurones. Part of the molecule binds irreversibly to specific receptors on the presynaptic membrane. The toxin–receptor complex is then taken into the cytoplasm of the neurone where the disulfide bond is broken, releasing the section of the molecule which acts to block the release of the neurotransmitter.

Explain why botulism can be fatal.

---

[2]

24. Most termites eat only dead vegetable material, so their principle food source is cellulose. Cellulose is a polymer.

State the name of the monomer in cellulose.

---

[1]

25. Carbohydrates, such as starch, are made from monosaccharides joined together.

Which of the bonds, **A** to **D**, joins monosaccharides together?

A ester
B glycosidic
C peptide
D phosphodiester

Your answer

[1]

26. Some inorganic ions have roles in enzyme-controlled reactions.

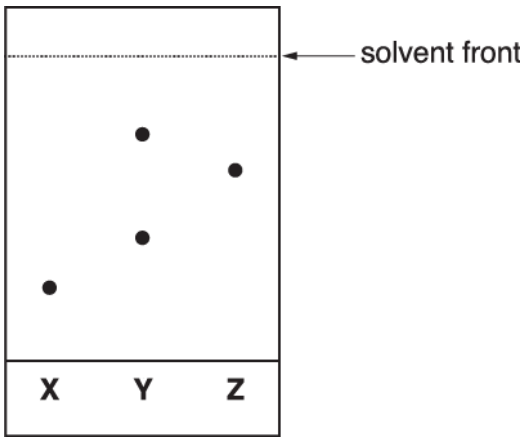
Which of the rows, **A** to **D**, in the table below is correct?

	Role of ion	
	Cofactor for amylase	**Prosthetic group for carbonic anhydrase**
A	Zn^{2+}	Cl^-
B	Zn^+	Cl^-
C	Cl^{2-}	Zn^+
D	Cl^-	Zn^{2+}

Your answer

[1]

27. A student investigates some solutions, **X**, **Y** and **Z**, using paper chromatography.
The results are shown below.



Which of the following options, **A** to **D**, is the Rf value of **Z**?

A 0.63
B 1.6
C 0.85
D 0.25

Your answer

[1]

28. A DNA molecule contains polynucleotide strands.

(i) Individual nucleotides are joined together to make a polynucleotide strand.

What type of chemical reaction takes place when two nucleotides in a single polynucleotide strand are joined together?

[1]

(ii) Name the chemical released when the bond is formed between the two nucleotides.

[1]

(iii) A DNA molecule contains two polynucleotide chains.

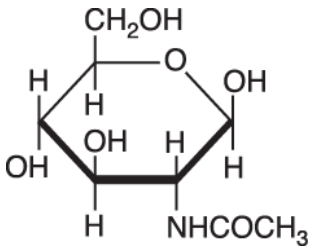
Describe how these two chains are held together.

[3]

29. Polymers are important molecules that have structural and functional roles in organisms.

Chitin is a polymer that is found in insects, where it forms a major part of the structure of the exoskeleton.

- Chitin is a macromolecule that is similar to a polysaccharide.
- Chitin is composed of molecules of N-acetylglucosamine, the structure of which is shown in the figure below.
- The monomers of N-acetylglucosamine join by 1–4 glycosidic bonds to form the chitin molecule.



(i) How does the composition of N-acetylglucosamine differ from the composition of a monosaccharide sugar?

---

[1]

(ii) Which monosaccharide sugar does N-acetylglucosamine most closely resemble?

---

[2]

(iii) Using your knowledge of the formation of structural polysaccharides, describe the formation of the chitin molecule from its monomer and predict its structure.

---

[4]

30(a). Lipase is an enzyme that catalyses the breakdown of lipids.

An investigation was carried out to see the effect of temperature on the activity of a lipase.

- 5 cm^3 of an alkaline solution of lipid was poured into a test tube.
- The test tube was placed into a water bath maintained at 20 °C and left to equilibrate.
- A few drops of an indicator were added to the wells of a white spotting tile. The indicator is pink above pH values of 8.3 and turns colourless at pH values below 8.3.
- Once the lipid solution had equilibrated, 1 cm^3 of 0.5% lipase solution at the same temperature was then added to the test tube.
- For five minutes, at 30 second intervals, the solution was stirred and a few drops were removed from the test tube and placed in a well on the white spotting tile.
- The time was recorded when the solution and indicator did not remain pink.
- The procedure was repeated four more times at 20 °C and then again at a further six temperatures.

The results are shown in Table 4.1 below.

Temperature (°C)	**Time when solution did not remain pink**				
	Replicate 1	**Replicate 2**	**Replicate 3**	**Replicate 4**	**Replicate 5**
20	210	270	240	300	270
25	90	120	210	180	120
30	60	60	90	90	60
35	60	60	60	90	60
40	210	120	210	180	210
45	240	300	300	–	270
50	–	–	–	–	–

Table 4.1

(i) Why is pH **not** a controlled variable in this investigation?

---**[1]**

(ii) Identify **one** variable that has been controlled in this procedure.

---**[1]**

(iii) Identify **one** variable, other than pH, that has **not** been controlled in this procedure.

---

[1]

(iv) The procedure required the solution to be stirred and then drops of solution to be placed on a white spotting tile.

Suggest why this procedure was followed rather than simply adding indicator to the test tube, stirring the solution and looking for the colour change in the test tube.

---

[1]

(v) What can be concluded from the results in Table 4.1 about the optimum temperature for lipase activity?

---

[1]

(vi) Describe **two different** ways in which the procedure could be modified to obtain a more accurate value for the optimum temperature for lipase activity.

1

2

---

[4]

(b). There are two models for the mechanism of enzyme action. Outline how changes in temperature can affect these mechanisms of lipase action.

[6]

31(a). In cells, glucose can exist as α-glucose or as β-glucose.

Fig. 1.1 The figure represents the structural formula of a molecule of α-glucose.

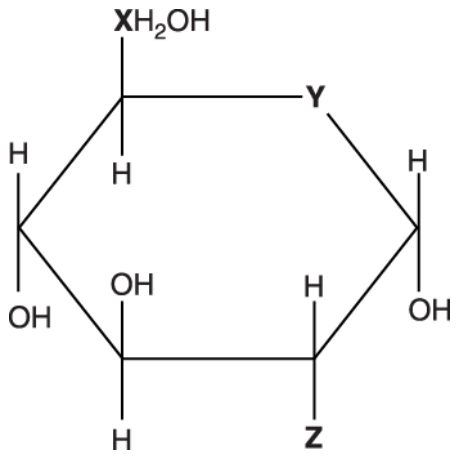


Fig. 1.1

(i) Fig. 1.1 In , some atoms or groups have been replaced by the letters **X**, **Y** and **Z**.

Identify the correct atom or group that has been replaced by each letter.

X

Y

Z

---

[3]

(ii) Describe how the structure drawn in Fig. 1.1 above would be different if it represented a molecule of β **-glucose**.

_____

_____ **[2]**

(iii) Two α-glucose molecules can be joined to form a disaccharide molecule.

State the **precise** name of the covalent bond that forms between the two glucose molecules and the name of the disaccharide that is formed.

bond _____

disaccharide _____

[2]

(b). Glucose, glycogen and amylose are carbohydrates.

- Glycogen and amylose are used for energy storage.
- Glycogen is found in animals.
- Amylose is found in plants.

Describe how the structure of glycogen allows it to perform its function **and** explain the advantage to animals of using glycogen as an energy store.

In your answer you should make clear the links between structure and function.

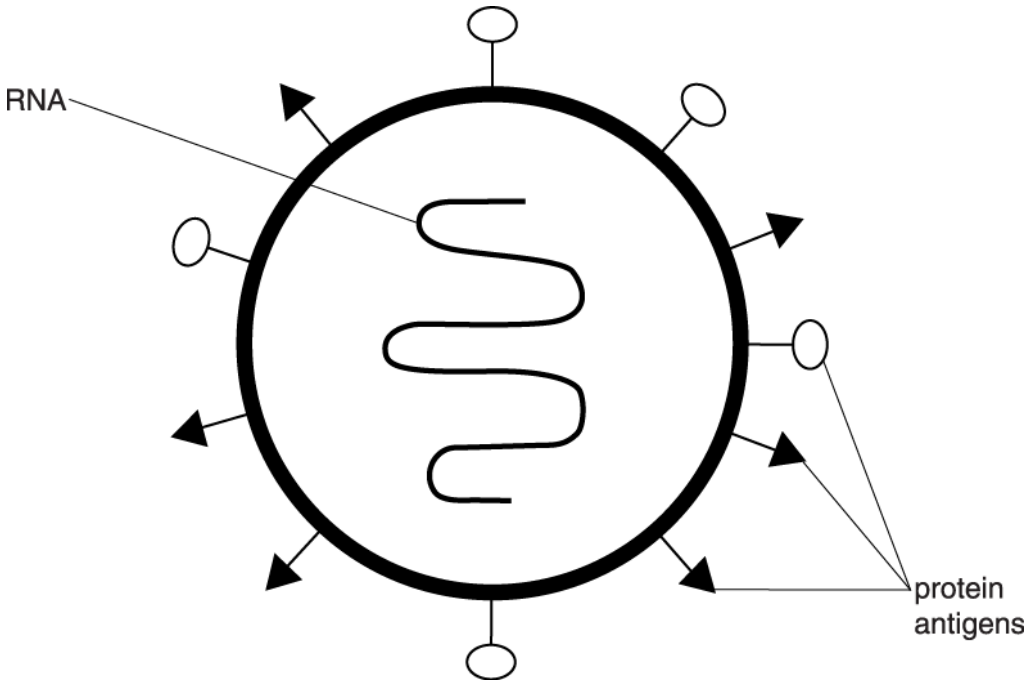
[7]

(c). Complete the following statements about proteins using the most appropriate terms.

- The secondary structure of a protein may contain many regions folded in zig-zag patterns known as _____ _____.
- The secondary structure of a protein is determined by the arrangement of _____ bonds, which stabilise the structure.
- The _____ structure of collagen is described as a left-handed helix because of the direction in which the polypeptide twists.
- Polypeptides known as alpha (α) and beta (β) _____ form part of the _____ _____ structure of haemoglobin.

[5]

32. This figure represents an influenza virus. Various protein antigens are attached to the outer surface of the virus.



When a virus infects a human host, it causes the host's cells to produce many new copies of the virus.

(i) The influenza vaccination must be given each year because there are frequent mutations in the RNA of the virus.

The antigens on the surface of the virus are made of protein.

The virus uses the organelles and enzymes in the host's cells to produce new copies of itself.

Suggest the role of the viral RNA in the production of viral proteins.

---

[2]

(ii) Explain why a mutation in the viral RNA leads to a change in the 3-D shape of the protein antigens.

---

[3]

(iii) The head teacher of a school decided to offer teachers free influenza vaccinations every year.

Suggest why the head teacher thought this would be a good use of the school's money.

---

[1]

33. Enzymes are important molecules in living organisms.

(i) A student decided to use the biuret test to detect the presence of enzyme in a solution.

Outline the procedure the student should follow in order to detect the presence of enzyme in a solution using the biuret test.

---

[2]

(ii) State why the structure of enzyme molecules allows them to be detected **in solution** using the biuret test.

---

[1]

34.

The R group in the amino acid alanine is CH_3.

Describe the structure of the amino acid alanine.

[4]

35. This question is about genetic control and selective breeding.

Fill the gaps in the following passage using the most appropriate term: Much of the _____ in cells contains sequences called genes.

Many genes code for _____ that fold to make enzymes. Often, enzymes are kept in an inactive form until needed. These enzymes may then be activated by cAMP, which involves changes in their _____.

[3]

36. Pepsin is an enzyme that digests protein foods in the mammalian stomach.

Protein molecules are made from chains of amino acids.

(i) Name the covalent bond between two adjacent amino acids in a chain of amino acids.

---

[1]

(ii) Name the type of reaction involved in breaking this bond **and** describe what happens in this reaction.

---

[2]

37. Erythrocytes contain haemoglobin, which is a globular protein.

Blood vessel walls contain collagen, which is a fibrous protein.

Describe the differences between globular and fibrous proteins using haemoglobin and collagen as examples.

In your answer you should refer to collagen and haemoglobin.

[8]

38(a). Lipids are a group of fatty or waxy compounds.

Triglyceride, phospholipid and cholesterol are examples of lipid compounds that are important in living organisms.

Table 7.1 lists a number of statements that could apply to these compounds.

Complete the table by indicating with a tick (✓) which of the compounds applies to each statement.

You may use more than one tick in a row.

Statement	Triglyceride	Phospholipid	Cholesterol
Contains only the elements carbon, hydrogen and oxygen			
Insoluble in water			
Contains glycerol			
Contains ester bonds			
Important in membrane structure			
Contains fatty acids			

Table 7.1

[6]

(b). Describe how to do the emulsion test for lipids and how a positive result would be identified.

---

[2]

(c). Lipids form an essential part of a balanced diet. Some food, such as mycoprotein, is produced by microorganisms.

How might the **lipid** content of mycoprotein differ from food that comes from animals?

[2]

39. Cellulose is a polysaccharide that is present in some living organisms.

(i) Complete the following table to show **three** other differences in the **structures** of starch (amylose) and cellulose molecules.

Amylose	Cellulose
coiled	no coiling

[3]

(ii) Which properties of cellulose make it suitable for forming cell walls?

---

[2]

40(a). Proteins are important biological molecules.

Protein structure can be represented at four levels: primary, secondary, tertiary and quaternary.

Below is a set of features that may be used when describing the structure of a protein such as haemoglobin.

Features	Letter
hydrogen bonds	**A**
peptide bonds	**B**
α and β subunits	**C**
the sequence of amino acids	**D**
the initial folding of the polypeptide chain	**E**
the overall 3D shape	**F**
ionic bonds	**G**

(i) Select the letters of the features that describe the primary level of protein structure.

---

[1]

(ii) Select the letter or letters of the feature(s) found in the secondary level of protein structure that are **not** present in the primary structure.

---

[1]

(iii) Select the letter or letters of the feature(s) that are found in the tertiary level of protein structure that are **not** present in the primary and secondary structures.

---

[1]

(iv) Select the letter or letters of the feature(s) found only in the quaternary level of protein structure.

---

[1]

(b). Hydrogen bonds also form between water molecules.

(i) Describe the formation of a hydrogen bond between two molecules of water and explain why water can form these bonds.

---

[3]

(ii) Hydrogen bonds allow water to act as a solvent.

Why is the ability of water to act as a solvent important for the survival of organisms?

---

[3]

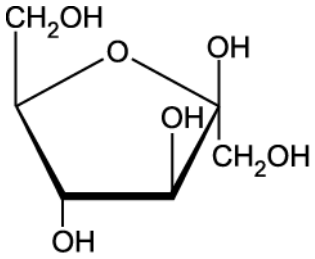
41. Which of the processes, **A** to **D**, describes the formation of cellulose?

A condensation polymerisation of amino acid molecules
B condensation polymerisation of β-glucose molecules
C hydrolysis polymerisation of α-glucose molecules
D hydrolysis polymerisation of deoxyribose molecules

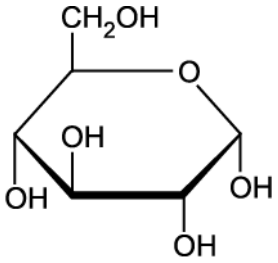
Your answer

[1]

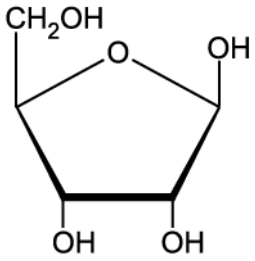
42. Which of the molecules, **A** to **D**, is a pentose sugar?



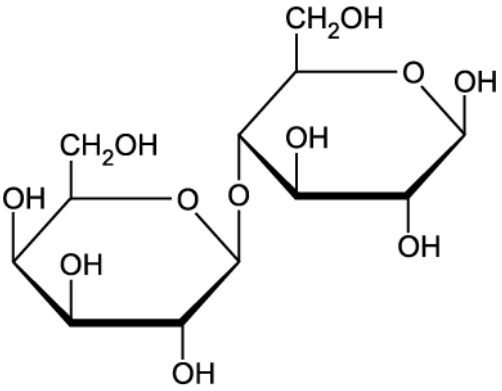
A



B



C



D

Your answer

[1]

43. Root vegetables require sulfate ions (SO_4^{2-}) in order to grow to a normal size. The plant uses the sulfur atoms to synthesise biological molecules during growth.

Sulfur atoms are required for the synthesis of which type of biological molecule?

[1]

44(a). Triglycerides consist of glycerol combined with three fatty acids.

Fig. 18 shows a glycerol molecule and a fatty acid molecule.

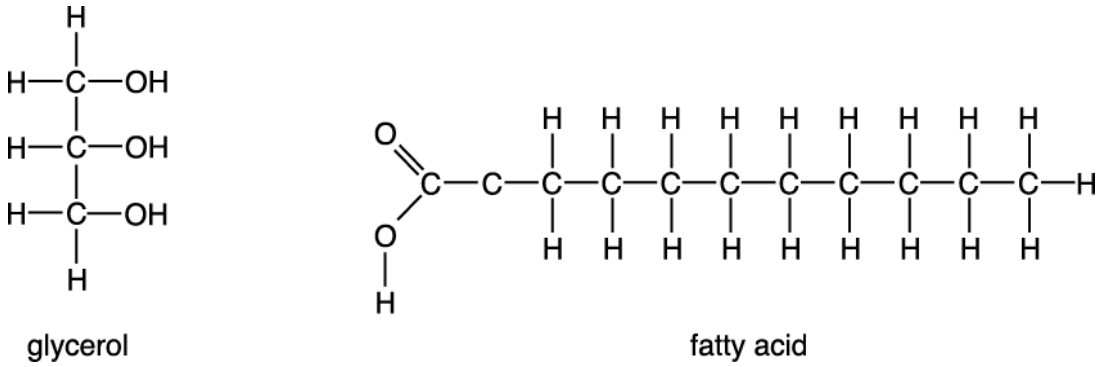


Fig. 18

(i) In the space below draw a monoglyceride molecule.

[2]

(ii) Name the bond formed between the glycerol and the fatty acid.

---

[1]

(iii) Name the other molecule formed when this bond is made.

---

[1]

(b). Energy can be stored in living organisms in the form of carbohydrates or lipids.

Name the carbohydrate molecules used to store energy in plants and animals.

plants ____

animals ____

[1]

(c). *Describe and explain how the structure and properties of different carbohydrate and lipid molecules suit them to their role as energy storage molecules in plants and animals.

____

____

____

____

____

____

____

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____ **[9]**

45. A student attempted to measure the concentration of sucrose in the leaves of a holly bush, *Ilex aquifolium*, using the following method:

- A leaf was removed from the bush and ground with a pestle and mortar.
- The resulting mixture was filtered and 1 cm^3 of the leaf filtrate was placed in a boiling tube.
- 1 cm^3 of a known concentration of Benedict's solution was added to the boiling tube.
- The boiling tube was gently heated for five minutes.
- The solution was filtered to remove the precipitate.
- The transmission of light through the solution was measured using a calibrated colorimeter.
- A blue filter was used.
- The percentage transmission was converted to a sucrose concentration using a calibration curve for known sucrose concentrations.

Explain why the student's method is invalid.

---

[4]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			C	1	
			Total	**1**	
2			A	1	
			Total	**1**	
3			A	1	
			Total	**1**	
4			D	1	
			Total	**1**	
5			*Name* amino acid (1) *Joined by* peptide, bond / link (1) between amine group and carboxyl group (of different amino acid) (1) condensation / water is produced (1)	3	**ALLOW** amino group
			Total	**3**	
6	a	i	chloroplast	1	
		ii	*idea that* presence of water may have altered the RF	1	**ALLOW** too diluted
	b	i	*Rf* is 0.61	1	**ALLOW** 0.60 or 0.62 **DO NOT ALLOW** 0.6
		ii	*does not support because* calculated *Rf* is not 0.63 (1) *supports because* within range of experimental variability (1) other *Rf* values appear to be slightly low (1) correct ranking position on chromatogram (1) colour is blue / green (1)	3	
			Total	**6**	
7			C	1	
			Total	**1**	
8			D	1	

Question			Answer/Indicative content	Marks	Guidance
			Total	**1**	
9		i	1.7 mm (1)	1	
		ii	× 50 (1)(1)		**ALLOW** 1 mark for correct working e.g. 80 / 1.6 **ALLOW** answer in the range of 48–51
		iii	air spaces give buoyancy (1) supported by (surrounding) water (1)	2	
			Total	**5**	
10			C	1	
			Total	**1**	
11		i	mitochondrion	1	**ALLOW** mitochondria.
		ii	*either* facilitated diffusion (1) conversion of ornithine into citrulline creates concentration gradients **or** (molecules are not lipid soluble so) require protein channels to cross membrane (1) ***or*** active transport (1) ornithine and citrulline need to be moved into and out of **D** more quickly than would be met by diffusion (1)	2	
		iii	deamination / removal of NH_2 group from amino acid (1)	1	
		iv	ATP (1)	1	
			Total	**5**	

Question			Answer/Indicative content	Marks	Guidance
12	a	i	sucrose is soluble so can be transported in sap (1) but metabolically (relatively) inactive so no, used / removed, during transport (1)	2	
		ii	*similar – one of* solutes carried in solution in both (1) both carry mineral salts (1) both use, mass flow / generated hydrostatic pressure (1) *different – one of* transport in phloem can take place in different directions **and** transport in xylem only takes place up the plant (1) phloem carries carbohydrates **and** xylem does not (1) phloem transport uses living cells **and** xylem does not (1) xylem uses, capillary action / cohesion and adhesion, **and** phloem does not (1)	2	
	b	i	glycosidic	1	
		ii	*two from* 19 × greater in modified (1) 1811% increase in modified compared with unmodified (1) standard deviation indicates greater spread of data for modified (1)	2	
		iii	*two from* sucrose unloaded at sinks and invertase converts sucrose into, glucose / monosaccharide (1) increases sucrose concentration gradient between phloem and sink (1) causes increased unloading of sucrose from phloem (1) *two from* increases solute gradient between source and sink (1) removal of water from phloem increases pressure gradient between source and sink (1) contributes to increased movement in phloem (1)	4	

Question			Answer/Indicative content	Marks	Guidance
		iv	modified produce fewer **and** larger tubers (1) **ora** modified produce greater mass of tuber (1) **ora** 109.34 g for modified **and** 89.04 g for not modified (1)	3	
			Total	**14**	
13			A	1	
			Total	**1**	
14		i	pigment A contains 2, components / molecules (1) pigments B and D contain 1, component / molecule (1) pigment C contains 3, components / molecules (1) *idea that* pigments A and C share 2, components / molecules (1) *idea that* pigments A and D **OR** pigments B and C **OR** pigments C and D share 1, component / molecule (1) all pigments are soluble (in liquid phase) (1)	3	
		ii	0.35 ± 0.01 (1)(1)	2	**ALLOW** 1 mark for evidence of 19 ÷ 55 1 mark maximum for incorrect s.f.
			Total	**5**	
15		i	initial / AW, glucose concentration (on both sides on the membrane) (1) volume of solution (1) length / diameter, of dialysis tubing (1) type / brand, of dialysis tubing (1)	2	
		ii	*alpha glucose* H above ring / OH below ring, on, carbon 1 / C1 **ORA** (1)	1	**ALLOW** a suitable annotated diagram
		iii	*(less reabsorption because)* *idea of* fewer H^+ ions in PCT cells (1) less / no, co-transport / facilitated diffusion, of Na^+ ions, into cells / from lumen (1) less / no, active transport of Na^+ ions into, blood (1)	3	
			Total	**6**	

Question			Answer/Indicative content	Marks	Guidance
16	a	i	too large / not fat soluble	1	**IGNORE** 'no channels'
		ii	water / H_2O, **and**, lactase / enzyme	1	**Mark the first two answers.** If they are correct and any other word is written that is incorrect or contradicts the correct answer then **0 marks.** **DO NOT ALLOW** H_2O with incorrect case or subscript **IGNORE** refs to pH, buffers, hydrocarbonate etc.
	b		sequence / order, of amino acids	1	**ALLOW** primary structure.
			Total	**3**	
17			*three from* (paper) chromatography (1) Set, blots / AW, of the two (urine) samples (1) separate / AW, with (aqueous / hydrophilic) solvent (1) (use a) stain / ninhydrin to visualise the spots (1) compare patterns (of separated components / colours) (1)	3	Max 2 marks if chromatography is not mentioned. **IGNORE** further detail of blot placement. The idea of overall pattern is wanted here, not just "compare colours, streaks" etc.
			Total	**3**	
18			cofactor	1	**IGNORE** coenzyme.
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
19	a		**Level 3 (5–6 marks)** Describes differences and similarities of llama and camel haemoglobin at all four levels of protein structure with correct reference to bonding. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes differences and similarities of llama and camel haemoglobin in some levels of protein structure with some reference to bonding. *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 (1–2 marks)** Describes a difference or similarity of llama and camel haemoglobin at a level of protein structure. *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.	6	**Indicative scientific points include:** • difference in primary structure • different amino acid / polypeptide sequence • one amino acid changed. • amino acid change could cause change to secondary structure • initial coiling or folding of polypeptide chain • α-helix • β-pleated sheet • hydrogen bonding. • amino acid change could cause change to tertiary structure • further coiling of secondary structure • ionic bonding • disulphide bonds • hydrophilic / hydrophobic bonds • 3D shape. • amino acid change has not changed quaternary structure • alpha and beta subunits still able to form haemoglobin in both camel and llama.
	b	i	2.8 (kPa)	1	**ALLOW** answer in the range of 2.8–3.0 kPa
		ii	(llama) haemoglobin needs higher affinity for oxygen (1) (so) can pick up oxygen at lower partial pressure (of oxygen) (1)	2	
	c		insoluble (1) strong / AW (1) unreactive / AW (1)	3	 **IGNORE** flexible.

Question			Answer/Indicative content	Marks	Guidance
	d		*two from* add biuret / NaOH and $CuSO_4$, solution / reagent to urine (1) observe colour change (from blue to purple) (1) compare with, control / blank (urine containing no protein) (1)	2	**IGNORE** biuret test unqualified.
			Total	**14**	
20	a		breakdown product is (fatty) acid (1) pH falls as more breakdown occurs / AW (1)	2	
	b	i	66.0 (1) (1)	2	**ALLOW** 1 mark for 66 or any answer between 65.9 and 66.
		ii	*limitation* *idea that* end point is subjective / difficult to judge (1) *improvement* use of pH meter (1)	2	**ALLOW** other valid limitations e.g. fat separates to top of solution **ALLOW** other valid improvements e.g. keep mixing throughout experiment
	c	i	*formula* **M** (no mark) *because* high ratio of hydrogen to oxygen / **N** has (approximately) 2 H to 1 O (1)	1	
		ii	hydrophilic head and hydrophobic tails (1) hydrophobic part / tails, repelled / AW, by water (1) head / hydrophilic part, forms H bonds with water (1) *idea that* medium outside / inside plasma membrane is aqueous (1) *idea that* hydrophobic nature of tails results in their facing towards each other (1)	3	
			Total	**10**	
21			B	1	
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
22		i	hydrogen	1	
		ii	molecules are polar (1) (polarity) enables (water) molecules to, attract / bind to, solute molecules (1)	2	
		iii	hydrogen ions used to affect / regulate pH (1) sodium ions used to regulate water potential (1)	2	
			Total	**5**	
23	a	i	it (only) respires in the absence of oxygen	1	Must imply that the absence of oxygen is the preferred / essential condition. e.g. 'can respire in the absence of oxygen' does not really imply this, as this statement also applies to aerobic organisms.
		ii	it hydrolyses a peptide bond between two amino acids (residues) which are joined by a disulfide bond	1	
	b	i	amount that is required to kill the 50^{th} mouse when they are arranged in order of lethal dose	1	
		ii	4.25 (μg) (1)(1)	2	**ALLOW** 1 mark for correct working using, least lethal dose is 50 ng kg^{-1} 50 × 85 = 4250 ng /1000 = 4.25 μg
		iii	*two from* intercostal muscles are / diaphragm muscle is, weakened / paralysed (1) *idea that* ventilation and oxygenation of blood is, reduced / compromised (1) cells / (named) organ(s), cannot, obtain oxygen for respiration / carry out aerobic respiration (1)	2	
			Total	**7**	
24			β / beta glucose	1	
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
25			B	1	**Examiner's Comments** This was a straightforward question that candidates should have been able to answer by recalling the fact. This was answered correctlyby a high proportion of candidates.
			Total	**1**	
26			D	1	**Examiner's Comments** This question was also straightforward as the material is a clear learning outcome. While many had the ions the wrong way round, the correct choice for the charge of the ions defeated a significant number of candidates.
			Total	**1**	
27			A	1	**Examiner's Comments** This was one of the questions that would have advantaged those candidates who had carried out relevant practical work. Many candidates were able to successfully measure the distances and perform the calculation correctly.
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
28		i	condensation ☐	1	*If additional incorrect answer given, then 0 marks* **ACCEPT** esterification **Examiner's Comments** Most candidates identified the correct reaction involved and stated that the chemical released was water. Esterification also gained credit for some candidates. A minority of candidates wrongly answered hydrolysis, with hydrogen given off.
		ii	water ☐	1	*If additional incorrect answer given, then 0 marks* **ACCEPT** H_2O (correct formula only) **Examiner's Comments** Most candidates identified the correct reaction involved and stated that the chemical released was water. Esterification also gained credit for some candidates. A minority of candidates wrongly answered hydrolysis, with hydrogen given off.

Question			Answer/Indicative content	Marks	Guidance
		iii	1 phosphodiester bonds in, backbone / described ☐ 2 hydrogen / H, bonds / bonding (between chains / bases) ☐ 3 purine to pyrimidine / A to T **and** C to G ☐ 4 ref to correct number of bonds between base pairs (A-T & C-G) ☐	max 3	**IGNORE** antiparallel 1 **ACCEPT** covalent bond in backbone 2 **DO NOT CREDIT** if other bond mentioned to connect between the two chains **DO NOT CREDIT** H^+ bonds **IGNORE** strength of bond 3 **DO NOT CREDIT** thiamine / cysteine / adenosine **Note:** 'Two bonds between A and T and three bonds between C and G' **= 2 marks (mp 3 and mp 4)** 'Two hydrogen bonds between A and T and three hydrogen bonds between C and G' **= 3 marks (mp 2, mp 3 and mp 4)** **Examiner's Comments** Generally this was a well answered question with candidates recalling correctly the base pairs and the relevant number of hydrogen bonds between the pairs. Fewer candidates were able to describe the correct location of the phosphodiester bond in the sugar-phosphate backbone. A few candidates were unsure of DNA structure, incorrectly identifying them as polypeptides and then going on to list the bonds found in protein structure.
			Total	**5**	

Question			Answer/Indicative content	Marks	Guidance
29		i	it contains, N / nitrogen **or** monosaccharide does not contain nitrogen □	1	**CREDIT** any correct ref to the nitrogen-containing group in Fig. 3.1 $NHCOCH_3$ **ACCEPT** 'OH is replaced with $NHCOCH_3$' **or** '$NHCOCH_3$ is replaced with OH' **ACCEPT** ref to H not being twice C / 15 H instead of 12 / 8 C instead of 6 **ACCEPT** has no OH on carbon 2 **ACCEPT** 'monosaccharide **only** contains C, H & O' **DO NOT CREDIT** 'it has a nitrogen molecule' **Examiner's Comments** Candidates' understanding of biochemistry was generally good. The mechanism of a condensation reaction was well known, although some candidates confused glycosidic and peptide bonds. The presence of the N in various forms was generally recognised.
		ii	beta / β □ glucose □	2	**IGNORE** alpha /**α** **DO NOT CREDIT** B / b / beta pleated sheet **Examiner's Comments** Many candidates correctly suggested beta glucose, although some failed to specify the type of glucose or incorrectly suggested alpha. If using the symbol for beta, rather than writing it in full, it should be stressed to candidates that the symbol must be unambiguous and clearly distinguishable from the letter B. Consequently, β needed to have a clear 'tail' so as not to be confused with B. (B or b were not acceptable answers because of the potential confusion with protein structure.)

Question			Answer/Indicative content	Marks	Guidance
		iii	*four from* 1 (in chitin glycosidic bond(s) formed by) condensation ☐ 2 (molecule of) H_2O / water, produced / released ☐ 3 alternate monomers are, upside-down / flipped / rotated through 180° ☐ 4 because of the position of the, OH / H, on carbon 1 ☐ 5 forms a, straight / linear / unbranched, chain / molecule / polymer ☐ 6 similar to cellulose ☐	4	**IGNORE** ref to 1-4 linkage & glycosidic (as given in Q) **ACCEPT** shown on a diagram 3 **ACCEPT** sugars / units / residues / molecules **DO NOT CREDIT** glucose 4 Must be a clear statement **ACCEPT** the 2 OH groups cannot, line up / bond 5 **IGNORE** ref to branching **IGNORE** ref to polysaccharide 6 **ACCEPT** ref to H bonds crosslinking between, molecules / chains **Examiner's Comments** Many candidates gained 2 out of the 4 possible marks. These tended to be the mark points for condensation reaction and the water released. There were some excellent answers from candidates who applied their scientific knowledge and explained fully how chitin could be formed to gain all 4 marks. The need to 'flip' alternate monomers was recognised but few managed to clearly explain why this was necessary. The similarity to cellulose was identified but some were unable to distinguish between the monomer and polymer, stating that chitin molecules are joined to each other by glycosidic bonds. Weaker answers strayed into descriptions of alpha helixes and beta pleated sheets.
			Total	**7**	

Question			Answer/Indicative content	Marks	Guidance
30	a	i	*one from* pH / it, is, the dependent variable / being measured ☐ (pH changes as) fatty acids are produced ☐	1	**ACCEPT** pH (change) indicates the rate of the reaction if pH were controlled there would be no, colour change / end point indicated because the pH (change) shows that the, reaction is happening / lipid is being broken down **IGNORE** we are investigating pH / pH is being investigated **Examiner's Comments** A significant proportion of candidates gave 'stock' answers and did not interpret the information given to realise that pH change is a component of the dependent variable due to the production of fatty acids when lipase digests lipid and therefore indicates when the reaction has taken place.

Question			Answer/Indicative content	Marks	Guidance
		ii	volume of, alkaline / (alkaline) lipid / substrate, solution **or** concentration of, lipase / enzyme, solution **or** volume of, lipase / enzyme, solution **or** temperature **or** time / intervals, between testing of samples □	1	**Mark 1st answer** **IGNORE** amount **IGNORE** 5 cm^3 - this is how the variable was controlled 'volume of 5 cm^3 of alkaline solution' = 1 mark '5 cm^3 of alkaline solution' = 0 marks **IGNORE** 0.5 % - this is how the variable was controlled 'concentration of 0.5% enzyme solution' = 1 mark '0.5% enzyme solution' = 0 marks **IGNORE** 1 cm^3 - this is how the variable was controlled 'volume of 1 cm^3 of lipase solution' = 1 mark '1 cm^3 of lipase solution' = 0 marks **IGNORE** 20°C - this is how the variable was controlled 'a temperature of 20°C' = 1 mark 'keep it at 20°C' = 0 marks **IGNORE** 30 seconds - this is how the variable was controlled 'the times the samples were taken were at intervals of 30 seconds' = 1 mark 'samples taken every 30 seconds' = 0 marks **Examiner's Comments** There were five controlled variables for candidates to select from,but answers commonly lacked an important detail, such as the word 'solution' or a clear description of how the variable was quantified such as volume. Students should be encouraged to replace the imprecise term 'amount' with a more precise descriptor of measurement when talking or writing about experimental variables.

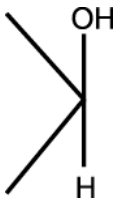
Question			Answer/Indicative content	Marks	Guidance
		iii	concentration of, alkaline / (alkaline) lipid / substrate, solution **or** volume of indicator (added) **or** number of drops of indicator (added) **or** volume of, sample / mixture / solution (removed) **or** number of drops of, sample / mixture / solution (removed) ☐	1	**Mark 1st answer** **IGNORE** amount **IGNORE** size / volume, of drops **Examiner's Comments** A surprisingly large number of answers stated that temperature was uncontrolled, although the question states that the first run of repeats occurred at 20°C and subsequently at six other temperatures (all of which are listed in the independent variable column in Table 4.1). Correct answers focused on the volume or number of drops of indicator added or sample of reaction mixture solution removed.
		iv	*one from* (looking at, a small volume / against a white background) makes it easier to see the colour change ☐ the indicator (if added to test tube) might affect the progress of the enzyme reaction ☐ better temperature control as test tube not taken in and out of water bath ☐ AVP ☐	1	**ACCEPT** provides a contrasting background to see the colour **ACCEPT ora** e.g. harder to see colour change in the test tube **Examiner's Comments** Many candidates realised the value of a white tile in perceiving a colour change more easily as it provided a contrast.
		v	(the optimum temperature) is between 30°C and 35°C ☐	1	**Must give a range** °C must be stated once **IGNORE** 35°C alone / 'around 35°C' **Examiner's Comments** Most candidates picked a single temperature (35°C) and did not realise that with intervals of 5°C between tests there is a possibility that the true optimum lies to one side of this figure. The correct range was 30°C-35°C based on comparing the data for 30°C and 40°C. Marks were not given on this and the next question if units were omitted.

Question			Answer/Indicative content	Marks	Guidance
		vi		4	**Mark the first 2 suggestions seen.** **B mark must relate to the appropriate A mark point**
			1A use more intermediate temperature values □		1A e.g. test, every 2°C / at 1°C intervals use temperatures less than 5°C apart
			1B in the 30°C - 35°C range □		1B **CREDIT** a range of 25°C - 40°C Units must be given once
			_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _		**Note:** 'test a range of temperatures between 30°C and 35°C' 'carry out more experiments between 30°C and 35°C' = 2 marks (mps 1 & 2)
			2A take samples at more frequent intervals (than 30 seconds) □		2A **ACCEPT** sample more regularly
			2B e.g. every 15 seconds □		2B time interval must be experimentally workable, so should be from 10 and less than 30 seconds. **Note:** 'take samples every 15 seconds' = 2 marks (mps 3&4) 'take samples every 5 seconds' = 1 mark (mp 3 only)
			_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _		
			3A use of colorimeter □		
			3B colour change would be less, subjective / biased □		3B obtain a numerical value **Examiner's Comments** Very few candidates scored full or many marks on this task. Candidates needed to focus on the word 'accurate' and consider ways of measurement that would allow the true optimum temperature to be pin-pointed more truly. Refining the temperature range to include smaller temperature intervals in the suspected optimum range, or sampling more often to identify the end point time more closely were the most frequent good suggestions. A few candidates mentioned the use of
			_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _		
			4A use of pH, meter / probe / sensor □		
			4B obtain a numerical value □		

Question			Answer/Indicative content	Marks	Guidance
					more sophisticated equipment such as a colorimeter to detect the end point time, or a pH probe to measure the dependent variable without the need for a subjective colour judgement.
	b		**Level 3 (5–6 marks)** • Provides a description of the 2 mechanisms of enzyme action • Provides a description of the ways in which high and low temperature affects the reactants and active site. *There is a well-developed line of reasoning which is clear and logically structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.* Awarding at this Level = L3 & 5 ticks □ □ □ □ □ Communication = □ or □ **Level 2 (3–4 marks)** • Describes 1 or both of the mechanisms of enzyme action • Describes some ways in which temperature affects the reactants and / or active site. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* Awarding at this Level = L2 & 3 ticks □ □ □ Communication = □ or □ – **Level 1 (1–2 marks)**	6	***In summary:*** *Read through the whole answer. (**Be prepared to recognise and credit unexpected approaches where they show relevance.**) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, **Level 1**, **Level 2** or **Level 3**, **best describes the overall quality of the answer**.* *Then, award the higher or lower mark within the level, according to the **Communication Statement** (shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.*** **Use the green dot in the margin to indicate places where good scientific points are made about the 2 models of enzyme action.** **Use a highlight square in the margin to indicate places where good scientific points are made about the effect of temperature.** **Indicative scientific points may include but are not limited to:** *enzyme action* **1** enzyme-substrate complex formed **2** enzyme-product complex formed

Question	Answer/Indicative content	Marks	Guidance
	• **either** Describes some aspects of the mechanism of enzyme action **or** Describes an effect of temperature *The information is communicated with some structure but may include a small amount of irrelevant material and some inappropriate use of scientific language.* Awarding at this Level = L1 & 1 tick □ Communication = □ or □ – **0 marks** No response or no response worthy of credit.		**3** product(s) leave the active site **4** lock and key = shape of substrate and enzyme's active site are complementary and so enzyme is specific **5** induced fit = enzyme active site changes shape to accommodate substrate once substrate binds *effect of temperature* *reactants* **6** increase in temperature increases kinetic energy of molecules **7** results in more successful collisions **8** more enzyme-substrate complexes form **9** decrease in temperature reduces kinetic energy of molecules **10** results in fewer successful collisions **11** fewer enzyme-substrate complexes form *active site* **12** enzymes have an optimum temperature **13** (small) increase in temperature affects the bonds involved in tertiary structure **14** change in shape of active site **15** prevents substrate binding to active site **16** high temperature results in denaturing **17** effects of high temperature are irreversible **18** effects of low temperature are reversible **Examiner's Comments** Most candidates achieved a level two response. Descriptions of what is meant by the lock and key model and the induced fit model were mostly good, as was description of the events that lead to denaturing of enzyme structure at high temperatures. Level three responses also described reaction kinetics at low temperatures. Errors included the belief that enzymes denature at low temperatures. The question referred to temperature change and this was frequently repeated in the answer without stating whether the information was linked

Question			Answer/Indicative content	Marks	Guidance
					to a raising or lowering of temperature. Given the difference in the effect of low and high temperatures on enzyme structure and action, this needed to be clear.
			Total	**15**	

Question			Answer/Indicative content	Marks	Guidance
31	a	i	X: C / carbon; Y: O / oxygen; Z: OH / hydroxyl (group);	3	**Mark the first answer.** If the answer is correct and an additional element or group is given = **0 marks.** For example X = C or CH_2 = 0 marks **Y DO NOT CREDIT** O_2 **Z IGNORE** hydroxy / hydroxide **Z IGNORE** OH^- **Examiner's Comments** was generally answered well. The most common error was describing Z as hydroxide.
		ii	OH and H groups reversed / AW (on single C atom); on, C_1 / right hand C atom / AW;	2	*Max 1 if any other change is described / shown*. **CREDIT** a correct diagram **ACCEPT** right hand part of molecule only **IGNORE** parts of molecule labelled X, Y and Z **IGNORE** C number if it contradicts an otherwise correct answer  = 2 marks **Examiner's Comments** was also well answered by the majority of candidates. If the maximum 2 marks were not achieved, it tended to be for reversing OH and H on C4 instead of, or in addition to, on C1.

Question			Answer/Indicative content	Marks	Guidance
		iii	(α / alpha / a / A) 1–4 glycosidic; maltose;	2	**ACCEPT** glycosidic 1,4 **IGNORE** covalent **Examiner's Comments** Despite the question emphasising the term 'precise' to naming of the bond, very many candidates stated 'glycosidic' but failed to include the '1–4' detail. Most candidates correctly gave maltose for the name of the disaccharide although sucrose was occasionally seen, along with a variety of incorrect molecules.
	b		**G1** (contains α–) glucose which is, a respiratory substrate / used in respiration; **G2** (glycogen) can be, broken down / hydrolysed / digested, by enzymes; **S1** polymer / polysaccharide / macromolecule / large molecule / long chains; **S2** insoluble; **S3** does not affect, water potential / Ψ; **C** (compact so) energy dense / large amount of energy in small volume; **B1** (also) 1–6 glycosidic bonds (at branches); **B2** branched; **B3** multiple sites / greater surface area / AW, for, breakdown / (named) enzyme activity; **B4** quickly, broken down / glucose can be removed quickly; **A1** animals / feature of animal's lifestyle, require, rapid / AW, energy / ATP, release; **A2** animals have high(er) metabolic rate;	6	**G2 ACCEPT** (glycogen) phosphorylase / transferase / (α1-6) glucosidase / amylase **S1 IGNORE** many glucose monomers **S3 IGNORE** refs to osmosis **C ACCEPT** dense so can store a lot of energy **C ACCEPT** space / mass, as AW for volume **B4 IGNORE** easily **B4 IGNORE** energy release for this marking point **A1 ACCEPT** 'they' as AW for 'animal' **A1** must be a direct statement related to an animal's lifestyle, e.g. exercise / muscle contraction / (animal) movement

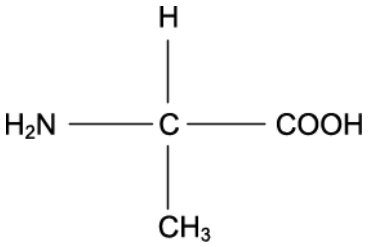
Question			Answer/Indicative content	Marks	Guidance
			QWC – *linking structure to function* 1 A mark and 1 B mark;	1	**AWARD** if, e.g. **A1** and **B2** are given **Examiner's Comments** Many candidates made a reasonable attempt at this extended answer question although very few gained the maximum 7 marks. The QWC was rarely awarded as this required engagement with the context of the question and discussion of why animals might benefit from faster breakdown of an energy store. Most of the marking points were regularly seen, apart from the 'A' marks. Well-prepared candidates tended to achieve more marks than poorly prepared candidates but what really differentiated responses was the number of mistakes. Some candidates made so many errors with basic biochemistry that, where they had written something that on its own might be creditworthy, they could not be awarded a mark because it was associated with something clearly incorrect. For example, a candidate might have stated that the structure is branched, and thus potentially gain marking point B2; however, if they stated that it is branched because it contains amylopectin (or even amylose) then B2 could not be awarded at that point. The rather imprecise term 'easy' was used by many candidates, which on this occasion did not attract any credit, unlike more precise references to speed.

Question			Answer/Indicative content	Marks	Guidance
	c		beta– / β- / B / b, pleat(ed sheet) / fold; hydrogen / H; secondary; subunits / chains; quaternary;	5	 **DO NOT CREDIT** H^+ / H_2 **ACCEPT** 2° **IGNORE** tertiary / fibrous **ACCEPT** globins **IGNORE** strands / units / peptides **ACCEPT** 4° **IGNORE** globular **Examiner's Comments** Few candidates scored full marks for this question. The most common incorrect answer was to describe the left-handed twisting of the polypeptide chain as an aspect of tertiary, rather than secondary, structure. Collagen has an atypical structure that many candidates find confusing and textbooks often do little to clarify.
			Total	**19**	

Question			Answer/Indicative content	Marks	Guidance
32		i	viral RNA, acts as, host cell / m, RNA; RNA, carries, code / sequence (for viral protein); (to) ribosomes;	2 max	**ACCEPT** RNA / DNA, produced from viral RNA **DO NOT CREDIT** tRNA **ACCEPT** RNA is, translated into / used as a template to produce, (viral) protein (or description) **ACCEPT** RNA codes for (viral) protein **DO NOT CREDIT** tRNA **ACCEPT** as a standalone mark **Examiner's Comments** This question presented a challenge both to the candidates and examiners. Candidates often could not express the difference between viral RNA and host mRNA and many candidates thought that, contrary to the diagram provided, the virus contained DNA. Thus both host DNA and the supposed viral DNA became entangled. Examiners then had to unravel which RNA and DNA was being referred to by the candidates. A little less than half of candidates described RNA as carrying the code for protein, often viral protein, a slightly larger number identified ribosomes as the ultimate destination of RNA. A smaller number correctly suggested a specific role for the viral RNA.

Question			Answer/Indicative content	Marks	Guidance
		ii	altered base sequence (of viral RNA) means, altered, primary structure / (sequence of) amino acids; R-groups / disulphide bonds / hydrogen bonds / ionic bonds, interact differently; tertiary structure is determined by, bonds / R-groups / secondary structure / primary structure / sequence of amino acids; 3-D shape is tertiary structure;	3 max	**ACCEPT** if a nucleotide (in RNA) is different the amino acid (in the protein) is different **ACCEPT** changed as AW for interact differently **ACCEPT** implication that 3D is tertiary structure **Examiner's Comments** The first marking point was not awarded often because most candidates failed to mention the link between base sequences and amino acid sequences. Close to half the candidates realised that an alteration in primary or secondary structure would lead to an altered tertiary structure and a similar number linked this to 3D shape. Less than a quarter of candidates gained the second marking point – usually for reference to bonds rather than R-groups.
		iii	money would be saved / education improved / fewer sick days / reduced spread (of virus) / good example of health practice / few teachers will have immunity (to current strain);	1	**IGNORE** so they don't get the flu without further qualification **IGNORE** because they are at risk of infection **Examiner's Comments** was fairly easy achieved by most candidates.
			Total	**6**	

Question			Answer/Indicative content	Marks	Guidance
33		i	add / AW, biuret solution / biuret reagent / biuret mixture / NaOH and $CuSO_4$; observe colour;	2	**IGNORE** 'biuret' unqualified **DO NOT CREDIT** heat / warm / neutralise / put in water bath **ACCEPT** see if it goes, lilac / purple / mauve / violet **DO NOT CREDIT** if incorrect colour change described **DO NOT CREDIT** precipitate **Examiner's Comments** This question blended familiar recall, that suited candidates who had spent time learning the specification, with some AO3 questions that many candidates found challenging. was generally done well. Candidates had learnt how to carry out a Biuret's test. Where candidates lost marks it was for failing to recognise that the key addition was Biuret *solution*, not just 'Biuret'. Some candidates mentioned heating and received no credit.
		ii	(enzymes are) globular, proteins / polypeptide; hydrophilic / water soluble, (R-)groups on outside (of enzyme);	1 max	**Examiner's Comments** This question blended familiar recall, that suited candidates who had spent time learning the specification, with some AO3 questions that many candidates found challenging. This mark was rarely awarded. The words 'in solution' were emboldened in the question in an attempt to get candidates to link enzyme structure to solubility. Few candidates appeared to recognise which aspect of knowledge they were being asked to apply.
			Total	**3**	

Question			Answer/Indicative content	Marks	Guidance
34				4	**CREDIT** displayed formulae for groups throughout
			1 central, C / carbon (atom);		**1 DO NOT CREDIT** if joined to another group by an incorrect bond
			2 NH_2 / amine (group);		**2 ACCEPT** amino group / HNH
			3 COOH / carboxyl (group) opposite amine group;		**3 ACCEPT** carboxylic (acid) group **3 DO NOT CREDIT** if single bond drawn between C and O
			4 CH_3 / methyl (group), opposite, hydrogen / H;		 **= 4 marks**
					If diagram is correct, **IGNORE** contradictory prose. If diagram is incorrect, **DO NOT AWARD** mark for correct prose
					Examiner's Comments most candidates drew an accurate diagram and gained all 4 marks. The most common mistakes were only having a single bond for the C=O in the carboxyl group, writing COH for the carboxyl group, or having 3 Hs in the amine group.
			Total	**4**	

Question			Answer/Indicative content	Marks	Guidance
35			DNA; polypeptide(s); tertiary, structure / shape;	3	**Mark the first answer.** If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** chromosomes **IGNORE** protein **ACCEPT** 3D, shape / structure **IGNORE** active site **Examiner's Comments** Examiners were surprised by the number of candidates who failed to score well on this question. Often chromosomes and genetic material were given as the incorrect answers to DNA for the first 'fill in the blank'. Many answers named proteins instead of polypeptides for the second, which gained no credit. Lack of detail such as just mentioning shape and not extending their answer to tertiary structure/shape or 3D structure/shape meant that many candidates did not gain this mark for the third blank.
			Total	**3**	

Question			Answer/Indicative content	Marks	Guidance
36		i	peptide (bond / link);	1	**DO NOT CREDIT** dipeptide **Examiner's Comments** The vast majority of candidates got this mark; of those who did not 'polypeptide', 'dipeptide' and 'hydrogen' were the most common responses.
		ii	hydrolysis; water / H_2O, is, added / used / needed;	2	**IGNORE** name of bond **CREDIT** OH and H put back on amino acids **ACCEPT** (broken down) with water **Examiner's Comments** This was also a high scoring question with over three-quarters of candidates getting both marks. Some described condensation in some detail, for no marks or mixed up hydrolysis and condensation and got one mark only.
			Total	**3**	

Question	Answer/Indicative content	Marks	Guidance
37	*Globular* **G1** ball (shaped) / spherical / AW; **G2** hydrophilic / (R-)groups / regions, on outside (of 3-D structure) / hydrophobic (R-)groups on inside; **G3** form H-bonds with water; **G4** soluble; **G5** example of globular protein (other than haemoglobin); **H1** haemoglobin, carries / transports, / oxygen / carbon dioxide; **H2** haemoglobin contains, prosthetic group / haem / Fe^{2+} / iron ion (to allow oxygen to be carried); **H3** (polypeptide chains within) haemoglobin have tertiary structure (in a ball shape); **F1** *Fibrous* linear / long (chain); **F2** (chains can) form (H) bonds with adjacent, chains (within a molecule); **F3** insoluble / few hydrophilic groups; **F4** strong / provide strength; **F5** have structural role; **C1** collagen has high proportion of glycine, so chains can lie close together / AW;	7 max	**G1 IGNORE** round / globular **G5 ACCEPT** (named) enzyme / hormone / antibody / channel / carrier **G5 IGNORE** metabolic / transport **H1 ACCEPT** references to buffering **H2 IGNORE** Fe^{3+} **H3 ACCEPT** haemoglobin has tertiary structure **F1 ACCEPT** straight / rope-like **F1 IGNORE** strand **F2 IGNORE** fibre / fibril **F2 ACCEPT** 'strand' as AW for 'chain' for **F2** only **F2 ACCEPT** crosslink as AW for bond for **F2** only **F2 DO NOT CREDIT** molecule as 'AW' for 'chain' **F2 IGNORE** attractions / (named) covalent bonds **F4 IGNORE** flexible / inelastic / withstands pressure

Question	Answer/Indicative content	Marks	Guidance
	C2 collagen forms, crosslinks / covalent bonds, between molecules;		**C2 ACCEPT** (micro / macro) fibrils / fibres, as AW for molecules
	C3 crosslinks / ends of molecules, are staggered to avoid, weak points / AW;		**C3 ACCEPT** (micro / macro) fibrils / fibres, as AW for molecules
	C4 collagen forms part of, tendon / cartilage / ligament / bone / connective tissue / bronchi / bronchioles / trachea / skin;		**C4 IGNORE** blood vessel / artery / vein, wall **C4 IGNORE** lips
	QWC - use of haemoglobin and collagen as examples	1	**AWARD** if any H mark **and** any C mark are awarded **Examiner's Comments** This question differentiated well between candidates and many scored highly. Observations on each marking point were as follows: • G1: Some candidates described the shape of globular proteins as 'round' and were not credited. • G2: Some referred to hydrophobic and hydrophilic 'interactions' rather than parts of the molecule. • G3: Almost nobody mentioned forming H-bonds with water. • G4 and F3: These were very commonly awarded but a few candidates got the solubility the wrong way round. • G5: This was only seen occasionally with enzymes being the most common suggestion. • H1: This was regularly given but some candidates just mentioned 'binding' to oxygen, rather than transporting or carrying it. • H2: This was frequently given but some responses just mentioned 'iron'. • H3: This was rarely given. Candidates often discussed primary, secondary, tertiary and quaternary structures for both proteins. • F1: This was given often for both 'long' and 'rope like'.

Question			Answer/Indicative content	Marks	Guidance
					• F2 and C2: F2 was easier, and given slightly more often, but it was clear that many candidates had not learned the specific nature of the bonds within collagen. • F4 and F5: Around half of candidates got both of got these marks. • C1: Many candidates acknowledged that glycine formed a high proportion of the structure, but failed to link this to the chains being able to lie closely together. • C3: This was attempted by a minority of candidates but with regard to strength rather than avoiding weak points. • C4: Many candidates just repeated what was in the question, giving blood vessels as an example. Of those that were awarded the mark, 'tendons' was most frequent, followed by 'bone' and 'skin'. • QWC: This was often awarded and where it wasn't it was usually for want of a C mark. Many candidates stated that haemoglobin was made of α and β glucose. It is worth noting that such errors as this usually result in fewer marks for candidates. On this occasion the mark scheme was more forgiving.
			Total	**8**	

<table>
<tr><th colspan="2">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>38</td><td>a</td><td></td><td>
<table>
<tr><th>Statement</th><th>tri-glyceride</th><th>phospho-lipid</th><th>cholesterol</th></tr>
<tr><td>contains only the elements carbon, hydrogen and oxygen</td><td>✓</td><td></td><td>✓</td></tr>
<tr><td>insoluble in water</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>contains glycerol</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>contains ester bonds</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>important in membrane structure</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>contains fatty acids</td><td>✓</td><td>✓</td><td></td></tr>
</table>
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;
</td><td>6</td><td>AWARD one mark per correct row
ACCEPT use of an unambiguous symbol other than a tick (e.g. Y)
DO NOT CREDIT if there is any ambiguity in the symbol used

Examiner's Comments

This question discriminated well between candidates and the range of marks varied a lot. Most candidates understood the role of phospholipids and cholesterol in membranes but few seemed aware of the constituent elements and many thought that phospholipids were soluble in water.</td></tr>
<tr><td></td><td>b</td><td></td><td>mix with / add, ethanol / alcohol, and water;

(goes) cloudy;</td><td>2</td><td>DO NOT CREDIT reference to any incorrect biochemical test

ACCEPT milky / white (emulsion)
DO NOT CREDIT precipitate

Examiner's Comments

Most candidates got at least one mark and many scored 2. Some candidates thought the white or cloudy colour was a precipitate and so could not access the second mark. Some descriptions of incorrect biochemical tests were seen.</td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
	c		less (overall, lipid / fat); less / no, <u>saturated</u> (fat / lipid / fatty acids); more <u>unsatutared</u> (fat / lipid / fatty acids);	2 max	Cannot be inferred from marking points 2 and 3 **ACCEPT** no / less, cholesterol **ACCEPT** meat has more **ACCEPT** meat has more **ACCEPT** meat has less "Higher ratio of unsaturated to saturated“ = 2 marks (mp 2 and 3) **Examiner's Comments** Most candidates scored one mark either for writing that there was less fat in mycoprotein or for discussing saturation. Many candidates failed to discuss both ideas so only a minority were awarded two marks. A significant number of candidates simply stated that mycoprotein contains unsaturated fat, without then making a comparison with animal protein, and so could not be awarded the mark.
			Total	**10**	

Question			Answer/Indicative content	Marks	Guidance
39		i		3	**Mark the first 3 responses** **AWARD** 1 mark for each correct row irrespective of boxes Three correct rows of responses written within the same box can be awarded 3 points.

Amylose	Cellulose	
coiled	*no coiling*	
(contains) α / alpha / A / a ,-glucose	(contains) β / beta / B / b , -glucose	;
α / alpha / A / a 1-4 glycosidic bonds	β / beta / B / b 1-4 glycosidic bonds	;
all , monomers / AW , in same orientation	alternate monomers at , 180° / AW , to each other	;
granular / not fibrous	fibrous / not granular	;
H bonds within molecule / no (H) bonds (between molecules)	(H) bonds between adjacent molecules	;

ACCEPT every second one is flipped

ACCEPT fibres / microfibrils / fibrils / macrofibrils
DO NOT CREDIT myofibrils
ACCEPT grains

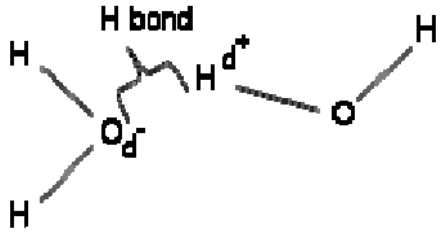
ACCEPT '(cross)links' as AW for 'bonds'

Examiner's Comments

This question was not answered well. Most candidates gained 1 or 2 marks, usually for identifying α- and β-glucose as subunits, the fibrous nature of cellulose or the arrangement of hydrogen bonding. Few got full marks. A significant minority used terms associated with protein structure and gained no credit. Similarly, many candidates gave differences relating to function rather than structure and gained no credit. A large number of candidates answered as if one of the molecules they were describing was glycogen, as reference to 1-6 bonds and branches was often seen. Candidates who did not compare like with like within a given row were not credited, nor were responses that were written in a 4th or 5th row.

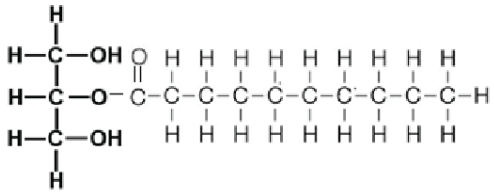
Question			Answer/Indicative content	Marks	Guidance
		ii	(tensile) strength / strong; (H) bonds / links, can form (between adjacent fibrils); insoluble;	2 max	**ACCEPT** mechanical strength **IGNORE** fibrous / rigid **ACCEPT** fibres / microfibrils / fibrils / macrofibrils **IGNORE** refs to bonding with water **IGNORE** ionic / myofibrils **ACCEPT** crosslinks **DO NOT CREDIT** peptide / covalent / glycosidic / disulfide etc **Examiner's Comments** Many gained 2 marks here for 'strong' and 'insoluble'. Those that attempted to describe binding between molecules sometimes failed to provide enough detail or were not given the mark because of incorrect or contradictory science. A significant number of candidates discussed the permeability of the cell wall and gained no credit.
			Total	**5**	

Question			Answer/Indicative content	Marks	Guidance
40	a	i	*primary* B **and** D;	1	**DO NOT CREDIT** if another letter is shown
		ii	*secondary* A **and** E;	1	**DO NOT CREDIT** if another letter is shown
		iii	*teritory* F **and** G;	1	**DO NOT CREDIT** if another letter is shown
		iv	*quaternary* C;	1	**DO NOT CREDIT** if another letter is shown **Examiner's Comments** The ability to apply knowledge of the fundamental aspects of protein structure was required for this question but many candidates were clearly uncomfortable with the topic. Part (i) was the part most frequently answered correctly. Only a minority answered (ii) - (iv) correctly and very few scored all 4 marks. A number of responses contained only one letter, when, for parts (i)-(iii), two were required. The most common response to part (iv) was F.

Question			Answer/Indicative content	Marks	Guidance
	b	i	1 between O and H (of adjacent molecules); 2 between, electropositive / δ^+ / delta$^+$ (H), and, electronegative / δ^- / delta$^-$ (O); 3 water molecule, is polar / has charge separation;	3	**1 DO NOT CREDIT** O/H molecules **2 ACCEPT** slightly, positive / negative **2 IGNORE** oxygen is negative / hydrogen is positive **2 DO NOT CREDIT** ions **AWARD** mp **1** and **2** for diagram below, i.e. H bond can be drawn as dotted or dashed or labelled, but **IGNORE** solid line **DO NOT AWARD** mark if diagram contradicts text  **3 ACCEPT** electrons pulled closer to oxygen atom / water is a dipole **3 IGNORE** electronegative / electropositive **3 IGNORE** oxygen is negative / hydrogen is positive **3 DO NOT CREDIT** ions **Examiner's Comments** This question was well answered. Candidates frequently used the space available to draw a diagram which was usually accurately drawn and gained 2 marks. Many candidates then gained the third mark for stating the polar nature of the water molecule. Candidates who referred to oxygen or hydrogen as molecules or ions were not awarded one or more of the marking points.

Question			Answer/Indicative content	Marks	Guidance
		ii	1 medium for (metabolic) reactions; 2 (because) allows (named) ionic compound(s) to separate; 3 transport; 4 **two** named transport, systems / media **OR** one example of a transport, medium / system, with a named example of what is transported; 5 (organisms can) absorb / take in, (named) minerals / ions / (named) gas / food; 6 able to dilute toxic substances;	3 max	**1 ACCEPT** reactions can happen in water **1 ACCEPT** supports metabolic reactions **4 IGNORE** nutrients **5 ACCEPT** apoplast / sap / blood / symplast / vacuolar pathway / blood / lymph / xylem / phloem / tissue fluid / CSF **5 IGNORE** nutrients / substances **5 IGNORE** get / obtain **IGNORE** refs to osmosis **Examiner's Comments** Most responses were awarded 1 or 2 marks. Reference to transport was the most commonly seen correct response. Marks were also awarded frequently for mention that water is a medium for reactions (processes was not sufficient) or giving examples of transport systems and what is carried in them. Many responses discussed the idea of absorption but used words such as 'get' or 'obtain' or 'nutrients', which were not precise enough. It was common for answers to imply that uptake of minerals was a feature of aquatic organisms only. Further detail of reaction facilitation was rarely seen and dilution of toxic substances was equally rare. A significant minority of responses did not focus on the word 'solvent' in the question and discussed other properties of water for no credit. Some responses described the *process* of dissolution despite the question asking about *importance*.
			Total	**10**	

Question			Answer/Indicative content	Marks	Guidance
41			B ☐	1	
			Total	**1**	
42			C ☐	1	
			Total	**1**	
43			protein / polypeptide ☐	1	**ALLOW** cysteine **IGNORE** (other named) amino acids
			Total	**1**	

Question			Answer/Indicative content	Marks	Guidance
44	a	i	single bond between oxygen on glycerol and carbon on fatty acid ☐ double bonded oxygen on first carbon of the fatty acid ☐	2	**ALLOW** on any of the glycerol carbons **ALLOW** any number of carbons in chain 
		ii	ester☐	1	
		iii	water☐	1	
	b		starch **AND** glycogen☐	1	**ALLOW** amylose , amylopectin

Question			Answer/Indicative content	Marks	Guidance
	c		***Please refer to the marking instructions on page 3 of this mark scheme for guidance on how to mark this question. In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.) Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then award the higher, middle or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the middle mark where aspects of the Communication Statement are missing.* • *award the lower mark where the Communication Statement has not been met.* • ***science content determines the level.*** • ***Communication Statement determines the mark within a level.***		

Question			Answer/Indicative content	Marks	Guidance
			Level 3 (7–9 marks) A good range of structural details and properties are provided including reference to fats and carbohydrates in both plants and animals. Explanations are provided for each structural comment. *The explanations are clearly linked to the structure of the molecules and the use of scientific terminology is at an appropriate level. All the information presented is relevant and forms a continuous narrative.* **Level 2 (4–6 marks)** Some structural details and properties are provided including reference to molecules in both plants and animals. Explanations are provided for each structural comment. *The explanations are clearly linked to the structure of the molecules but may not fully explain how the structure suits the role and use of scientific terminology may not always be appropriate. The information presented is mostly relevant.* **Level 1 (1–3 marks)** A limited number of structural details are provided. The explanations do not clearly show how the molecules are suited to their role. *There is a logical structure to the answer. The explanations, though basic, are clear.* 0 marks No response or no response worthy of credit	Max 9	**Indicative scientific points may include: Structures (S), Properties (P) and Explanations (E):** Carbohydrates: S1. Polymers of glucose E1. Glucose can be used in respiration to release energy S2. Large molecules P2. Insoluble E2. Do not affect water potential of cell S3. 1–4 glycosidic bonds E3. Easy to make and break to release glucose / monomers S4. Coiled shape / compact E4. Take up less space in cell S5. Amylose unbranched / amylopectin with few branches E5. No need for rapid release of monomers in plants S6. Glycogen more branched E6. Allows more rapid release of monomers in animals Lipids (**ACCEPT** lipids or fats): S7. Fats have more carbon-carbon bonds / carbon-hydrogen bonds P7. Fats are energy rich / contain more energy per molecule E7. More energy stored in less space P8. Fats are insoluble E8. Do not affect water potential of cell S9. Fatty acids are long carbon chains E9. Can be broken down to release two carbon / acetyl groups (which enter Krebs cycle) S10. Animal fats saturated / harder E10. Have role in protection / insulation as well as energy storage.
			Total	**14**	

Question			Answer/Indicative content	Marks	Guidance
45			*idea that* more than one leaf should be tested ☐ in case the leaf used was atypical ☐ sucrose is a non-reducing sugar ☐ if method is intended to measure sucrose then boiling with HCl in necessary s other sugars / glucose, also present in leaf ☐ chlorophyll / other pigments, in leaf ☐ green / colour, of pigments will interfere with colorimetry results ☐ blue filter is the wrong type of filter / should have used red filter ☐	4 max	
			Total	**4**	