1. Proteins are important biological molecules.

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]

2. Triglycerides consist of glycerol combined with three fatty acids.

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

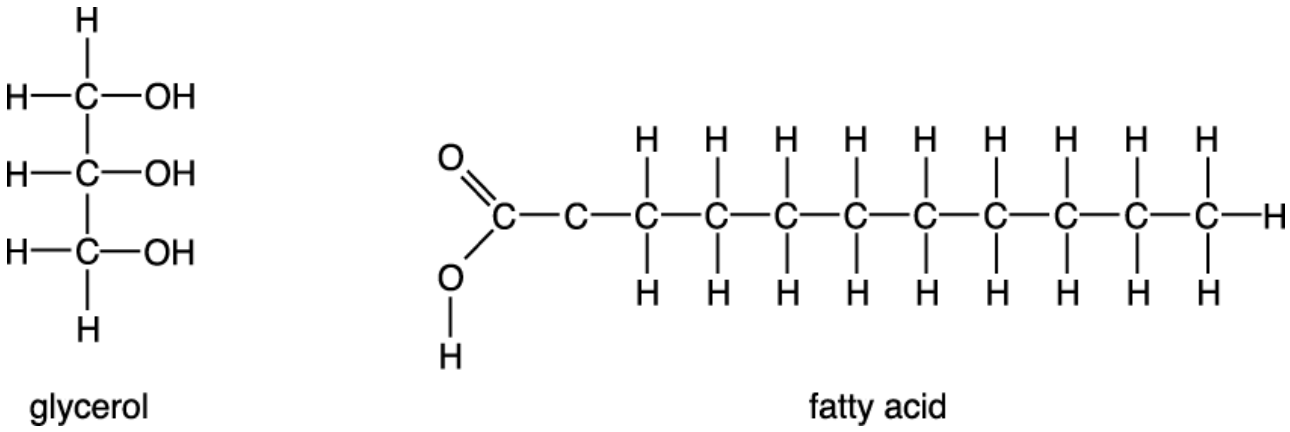


Fig. 18

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]

3. 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]

4. Cellulose is another 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

ii. [3]

iii. Which properties of cellulose make it suitable for forming cell walls?

[2]

5. In cells, glucose can exist as α-glucose or as β-glucose.

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

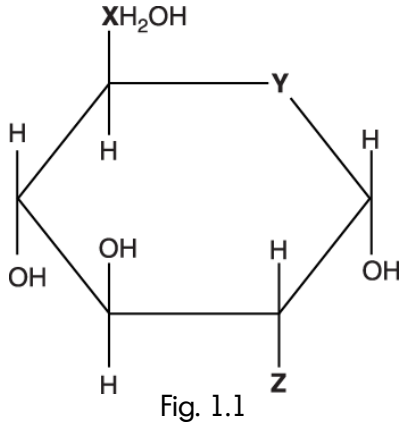


Fig. 1.1

i. Fig. 1.1 In the figure, some atoms or groups have been replaced by the letters **X**, **Y** and **Z**.

Identify the correct atom or group that has been replaced by each letter.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. 1.1the figure above would be different if it represented a molecule of **β-glucose.**

---

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]

6. 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]

7. 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]**

8. 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]

9. 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]

10. Lactose is a reducing sugar.

Benedict's reagent can be used to detect the presence of lactose in a solution. A colorimeter can be used to measure the concentration of lactose.

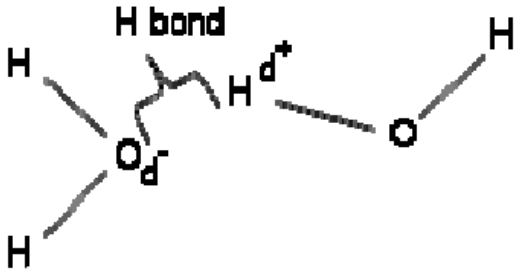
The colorimeter first needs to be calibrated.

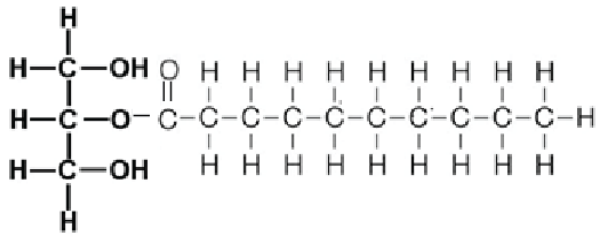
Describe how a method that uses Benedict's reagent and a colorimeter could be calibrated to measure the concentration of lactose in an unknown sample.

[4]

END OF QUESTION paper

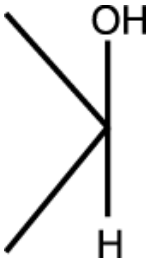
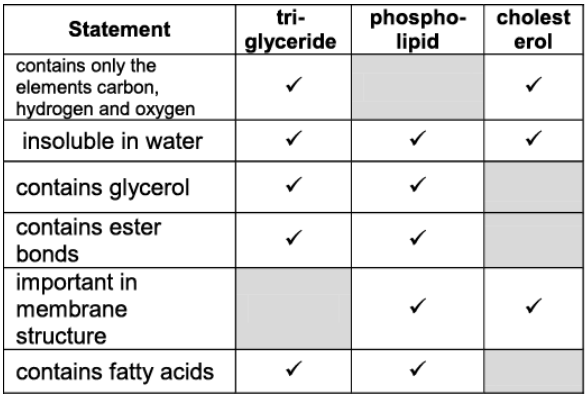
Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1		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.
		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 /	3 max	**1ACCEPT** reactions can happen in water **1 ACCEPT** supports metabolic reactions

			(named) gas / food; 6. able to dilute toxic substances;		**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	**6**	
2		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	
			Total	**4**	
3			**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;	6	**G2 ACCEPT** (glycogen) phosphorylase / transferase / (α1-6) glucosidase / amylase **S1 IGNORE** many glucose monomers

			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; **QWC** – *linking structure to function*1 A mark and 1 B mark;	1	**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 **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.
			Total	**7**	
4		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.

			<table><tr><th>Amylose</th><th>Cellulose</th></tr><tr><td>coiled</td><td>no coiling</td></tr><tr><td>(contains) α / alpha / A / a ,-glucose</td><td>(contains) β / beta / B / b , -glucose</td></tr><tr><td>α / alpha / A / a 1-4 glycosidic bonds</td><td>β / beta / B / b 1-4 glycosidic bonds</td></tr><tr><td>all , monomers / AW , in same orientation</td><td>alternate monomers at , 180° / AW , to each other</td></tr><tr><td>granular / not fibrous</td><td>fibrous / not granular</td></tr><tr><td>H bonds within molecule / no (H) bonds (between molecules)</td><td>(H) bonds between adjacent molecules</td></tr></table>		**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.
	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**	
5	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.
		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.
			Total	**7**	
6				6	**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.
			Total	**6**	
7		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**	
8		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.
			Total	**4**	
9			*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	*7* max	**G1 IGNORE** round / globular **G5 ACCEPT** (named) enzyme / hormone / antibody / channel / carrier **G5 IGNORE** metabolic / transport **H1 ACCEPT** references to buffering

			(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** havestructural role; **C1** collagen has high proportion of glycine, so chains can lie close together / AW; **C2** collagen forms, crosslinks / covalent bonds,between molecules; **C3** crosslinks / ends of molecules, are staggered to avoid, weak points / AW; **C4** collagen forms part of, tendon / cartilage / ligament / bone / connective tissue / bronchi / bronchioles / trachea / skin; **QWC** - use of haemoglobin and collagen as examples	1	**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 **C2 ACCEPT** (micro / macro) fibrils / fibres, as AW for molecules **C3 ACCEPT** (micro / macro) fibrils / fibres, as AW for molecules **C4 IGNORE** blood vessel / artery / vein, wall **C4 IGNORE** lips **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'. • 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**	
10			**1** zero the colorimeter / set to zero **2** using blank **3** use red filter **4** use known concentrations (of lactose) **5** (produce) serial / series, dilutions **6** construct calibration curve **7** test unknown sample (using the same method) **8** use / read from, graph / calibration curve, to determine (unknown) concentration	**4 max**	**ALLOW** calibrate to zero **3 ALLOW** red light / orange filter **4 ALLOW** a list of stated concentrations **5 ALLOW** clear description **6 ALLOW** plot concentration against, transmission / absorbance **8** Cannot be assumed from mp 6 **Examiner's Comments** This question differentiated well between candidates. Candidates should be familiar with this type of practical from the practical endorsement (PAG 5), and most ought to have carried out a similar practical activity. A large proportion of candidates began their answers with detailed

					descriptions of various aspects of the Benedict's test that were not relevant to the calibration process but then went on to score marks with relevant descriptions of the calibration procedure. Some focused on describing a Benedict's test or explaining the principle which they were not asked to do, and so did not receive much, if any, credit. All of the marking points were seen but serial dilutions were less commonly suggested despite these being a feature of OCR's PAG activities. It is worth noting that in order to construct a calibration curve, more than one known concentration needs to be used. Centres are reminded that the practical components of the syllabus are integral to students being able to apply their theoretical learning; performing these practical activities will enable candidates to relate to these elements when tested in the examinations.
			Total	**4**	