2 – Foundations in Biology

(2.2. Biological Molecules)

Total Mark – 20

Question: 1

16. 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 Fig. 3.1the figure below.
- The monomers of N-acetylglucosamine join by 1–4 glycosidic bonds to form the chitin molecule.

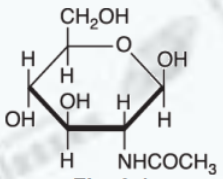

Fig. 3.1

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]

16		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.)

		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	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	

Question: 2

17(a). 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]

(b). *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.

[9]

17	a		starch **AND** glycogen✓	1	**ALLOW** amylose , amylopectin

	b		***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.*	•	

			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.	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

				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.*		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
				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		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	**10**	

Question: 3

18. Glucose and cholesterol are both molecules transported in the bloodstream that may need monitoring in people with different medical conditions.

Fig. 6 represents the structure of a cholesterol molecule.

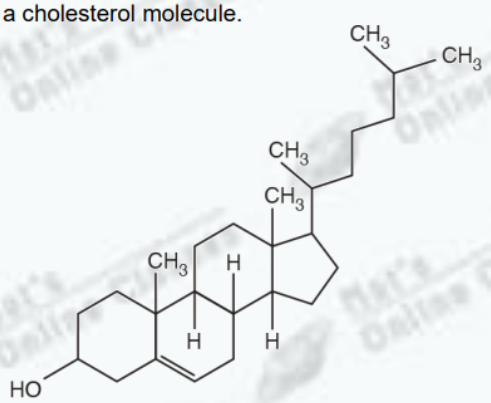

Fig. 6

i. State **two** ways in which the molecular structure of cholesterol is similar to the molecular structure of glucose.

[2]

ii. Glucose is an important biological molecule required by cells for cellular respiration.

State the physical property of glucose that allows it to be easily transported in the bloodstream.

[1]

18		i		**2 max**	**Mark the first 2 answers** **IGNORE** properties e.g. solubility **IGNORE** ref to hexagons / rings **IGNORE** hydrocarbon

				both contain, C / carbon (atoms) **and** H / hydrogen (atoms) ✓ contain, O / oxygen (atoms) ✓ have, OH / hydroxyl / hydroxide (groups) ✓		**DO NOT ACCEPT** hexose **DO NOT ACCEPT** ions **DO NOT ACCEPT** molecules / groups **DO NOT ACCEPT** molecules / groups **ACCEPT** alcohol group **DO NOT ACCEPT** molecules **Examiner's Comments** Poor exam technique meant that some answers did not focus on cholesterol's *similarities* with glucose but simply described features shown on the cholesterol molecule. Ideally points should have begun with 'both', as in 'both contain carbon and hydrogen' or 'both include hydroxyl groups'. Elementary flaws in candidates' understanding of chemistry lost marks when atoms, elements or organic groups like the hydroxyl group were referred to as 'molecules'. Incorrect lines of thought took candidates to discussions of hexose, glycosidic bonds and branched and unbranched polysaccharide structures

		ii	(glucose is) soluble (in water) ✓	1	**ACCEPT** polar / dissolves (in water) **Examiner's Comments** The correct answer was very commonly given. Sometimes the wording was that glucose is polar or able to dissolve in water or plasma. A few candidates stated that glucose was insoluble and some simply wrote the one word 'solubility' without stating how this concept applied to glucose. Some, referring back to a question on paper 1, described it as small and compact rather than homing in on its solubility.
			Total	3	