Biological Molecules - Carbohydrates

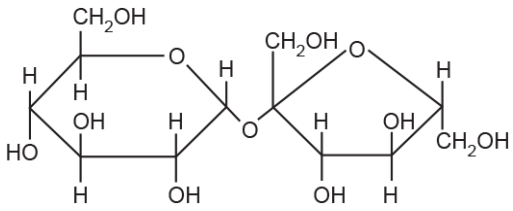
1. Sucrase is the enzyme that breaks down sucrose.

Which of the bonds, **A** to **D**, is broken by sucrase?

A alpha glycosidic
B beta glycosidic
C ester
D peptide

Your answer ☐ **[1]**

2. The molecule below is the disaccharide sucrose.



Which row, **A** to **D**, shows the type of reaction that occurs in the breakdown of sucrose and the monosaccharides produced by the reaction?

	Type of reaction	Monosaccharides	
A	condensation	α glucose	α glucose
B	condensation	α glucose	fructose
C	hydrolysis	α glucose	α glucose
D	hydrolysis	α glucose	fructose

Your answer ☐ **[1]**

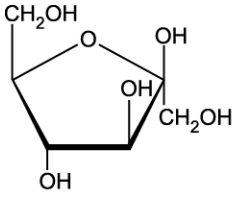
3. Which of the processes, **A** to **D**, describes the formation of cellulose?

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

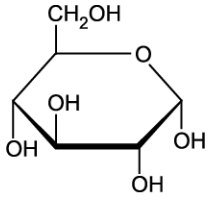
Your answer ☐

[1]

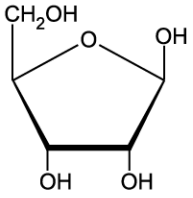
4. Which of the molecules, **A** to **D**, is a pentose sugar?



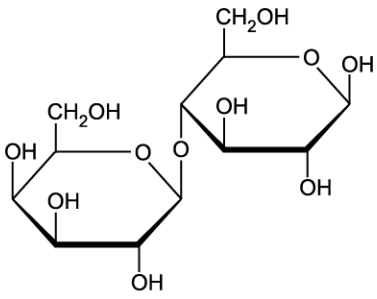
A



B



C



D

Your answer ☐

[1]

5. Which of the statements, **A** to **D**, about amylopectin is correct?

A it contains 1-4 and 1-6 glycosidic bonds between α-glucose monomers
B it is an unbranched chain of α-glucose monomers
C it contains α 1-4 and β 1-6 glycosidic bonds
D it is made up of β-glucose monomers and is uncoiled

Your answer ☐ **[1]**

6. The following are a series of organic molecules and the chemical processes that occur to convert them into different molecules.

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

A nucleic acid $\xrightarrow{\text{hydrolysis}}$ nucleotide $\xrightarrow{\text{hydrolysis}}$ polynucleotide

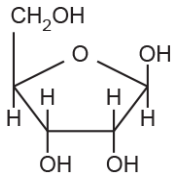
B α-glucose $\xrightarrow{\text{condensation}}$ amylopectin $\xrightarrow{\text{hydrolysis}}$ α-glucose

C amino acid $\xrightarrow{\text{condensation}}$ dipeptide $\xrightarrow{\text{hydrolysis}}$ polypeptide

D β-glucose $\xrightarrow{\text{condensation}}$ cellulose $\xrightarrow{\text{condensation}}$ maltose

Your answer ☐ **[1]**

7. The structure of a biological molecule is shown below.



Which of the following options, **A** to **D**, correctly describes the molecule?

A hexose monosaccharide glucose
B hexose monosaccharide ribose
C pentose monosaccharide glucose
D pentose monosaccharide ribose

Your answer ☐ **[1]**

8. Which of the following ions, **A** to **D**, is required for the hydrolysis of starch by an enzyme?

A Cl^-
B K^+
C Na^+
D Zn^{2+}

Your answer ☐ **[1]**

9. The table below shows four biological molecules and their component elements.

Which of the rows, **A** to **D**, correctly identifies the elements in each molecule?

	sucrose	**cholesterol**	**insulin**	**ATP**
A	C, H, O	C, H, O, N	C, H, O, N, S	C, H, O, N, P
B	C, H, O, N	C, H, O	C, H, O, N, S	C, H, O, N, S
C	C, H, O	C, H, O	C, H, O, N, S	C, H, O, N, P
D	C, H, O	C, H, O	C, H, O, N, P	C, H, O, N, P

Your answer ☐ **[1]**

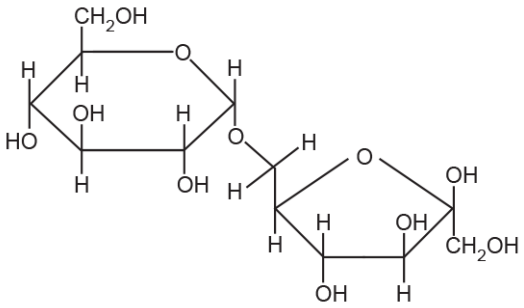
10. The hydroxyl (-OH) group of carbohydrates is polar and makes the molecule soluble in water. The greater the number of free hydroxyl groups as a proportion of the number of carbon atoms, the more soluble the carbohydrate.

Which of the rows, **A** to **D**, lists the carbohydrates in order of most soluble to least soluble?

	Most soluble	⟷		**Least soluble**
A	glucose	ribose	amylose	amylopectin
B	amylose	amylopectin	glycogen	ribose
C	glucose	ribose	amylopectin	amylose
D	ribose	amylose	glucose	amylopectin

Your answer ☐ **[1]**

11. The image below shows isomaltulose, a disaccharide formed from α-glucose and fructose.



Name the bond that holds the α-glucose and the fructose together

A 1,6-glycosidic bond
B phosphodiester bond
C ester bond
D 1,4-glycosidic bond

Your answer ☐ **[1]**

12. Which of the options, **A to D**, is a correct statement about polysaccharides of glucose?

A Cellulose microfibrils are formed by hydrogen bonding between adjacent chains of α-glucose molecules bonded with 1,4-glycosidic bonds.

B Amylose is a straight chain of α-glucose monomers bound by 1,6-glycosidic bonds to allow for dense packing.

C Glycogen has a high proportion of 1,6-glycosidic bonds to produce a highly branched molecule for rapid release of α-glucose.

D Amylopectin has a mixture of 1,4-glycosidic and 1,6-glycosidic bonds between β-glucose molecules for rapid release of energy.

Your answer ☐ **[1]**

13. A group of students was given a 1% solution of an unknown digestive enzyme.

They were also given three tubes containing an identical mixture of foods.

The students carried out a different biochemical test on each tube before and after adding the unknown enzyme. Their results are shown in the table below.

	Colour before	**Colour after**
Biuret test	purple	purple
Iodine test	blue / black	yellow / orange
Benedict's test	brick red	brick red

Name the type of enzyme the students used.

A protease
B carbohydrase
C lipase
D lipase

Your answer ☐ **[1]**

14. 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]

15. 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]

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.

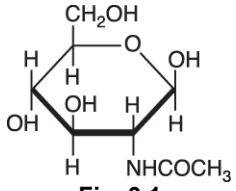


Fig. 3.1

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]

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]

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.

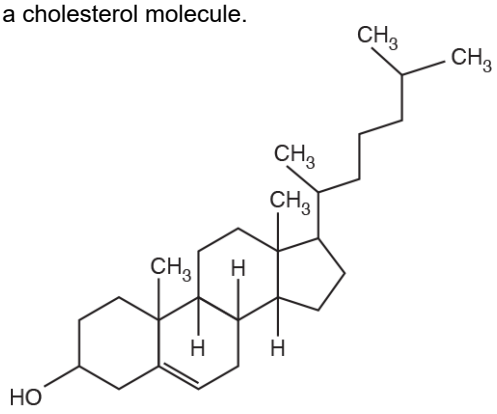


Fig. 6

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]

19. Many multicellular organisms need to be able to convert monosaccharides into polysaccharides and back again.

Mammals convert the monosaccharide glucose into a highly branched polysaccharide called glycogen, which gets stored in liver cells.

Explain why mammals store glycogen instead of glucose.

[3]

20(a). Fig. 20 shows the disaccharide lactose, which is found in milk.

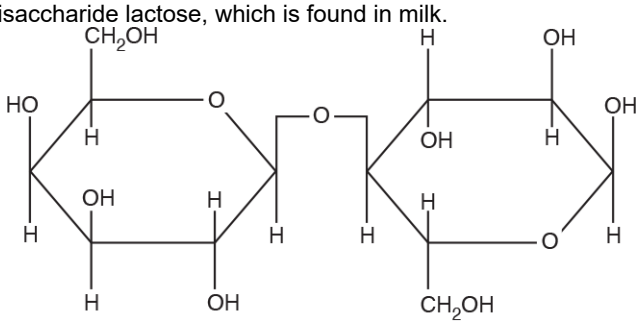


Fig. 20

Another disaccharide is maltose. Maltose and lactose both contain the same number of atoms of each element, C, H and O.

i. State two **other** structural similarities between lactose and maltose.
1

2

[2]

ii. Complete the table below to identify differences between the structures of lactose and maltose. The first one has been completed for you.

Lactose	Maltose
one glucose monomer and one galactose monomer	both monomers are glucose

[3]

(b). One of the monomers of lactose is galactose.
The bacterium *E. coli* usually uses glucose as a respiratory substrate.
Under certain circumstances, *E. coli* is able to use galactose as a respiratory substrate by breaking down lactose into glucose and galactose and then using both glucose and galactose as respiratory substrates.

i. Explain how the structure of galactose allows it to be used as a respiratory substrate.

[3]

ii. *E. coli* usually grows in conditions where the extracellular concentration of lactose is low. In such conditions lactose does not easily cross the bacterial cell surface membrane.

Suggest and explain why lactose is unable to cross membranes.

[2]

iii. In order for lactose to enter the cytoplasm of *E. coli* a protein is required.
The *E. coli* living in the digestive system of young mammals are more likely to contain this protein than *E. coli* living in the digestive system of old mammals.

Suggest an explanation for this observation.

[2]

21.

Plant cell walls are made of cellulose. Cellulose is a polymer of β-glucose.

Give **three** properties of cellulose that make it suitable as the basis of plant cell walls.

1
2
3

[3]

22. Chitin is a polysaccharide found in insects. It is used to form the hard outer casing of their bodies.

Fig. 19.2 shows the chemical structure of chitin.

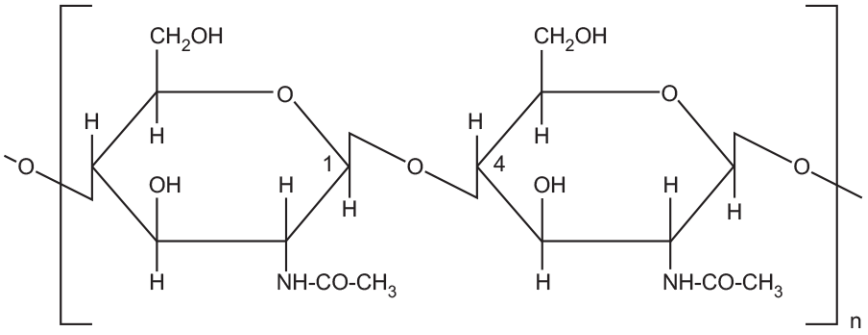


Fig. 19.2

Using information from Fig. 19.2, state **two** similarities and **two** differences between the structures of chitin and glycogen.

Similarity 1

Similarity 2

Difference 1

Difference 2

[4]

23(a). The information below is about carbohydrates.

- Glucose is a monomer of polysaccharides such as glycogen and starch.
- Glucose is an important source of energy in animals and is transported in the circulatory system.
- Glycogen is an energy storage molecule found in many animals.
- Starch is an energy storage molecule found in many plants.
- Amylopectin is one of the two polysaccharides that constitute the molecular structure of starch.

i. State **one** property of glucose that allows it to be easily transported in animals.

[1]

ii. Explain how the structure of glycogen differs from that of amylopectin to make it better suited as an energy store in animals.

[3]

iii. **Fig. 1.1** shows the molecular structure of beta glucose.

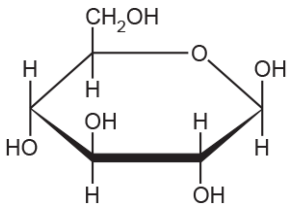


Fig. 1.1

Describe how the structure of alpha glucose would be different from the molecule shown in **Fig. 1.1**.

[1]

(b). Fig. 1.2 shows the start of the ring structure of ribose.

Complete the diagram to show the position of the carbon atoms. There is no need to include the −H and −OH groups. **[1]**

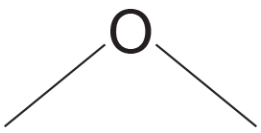
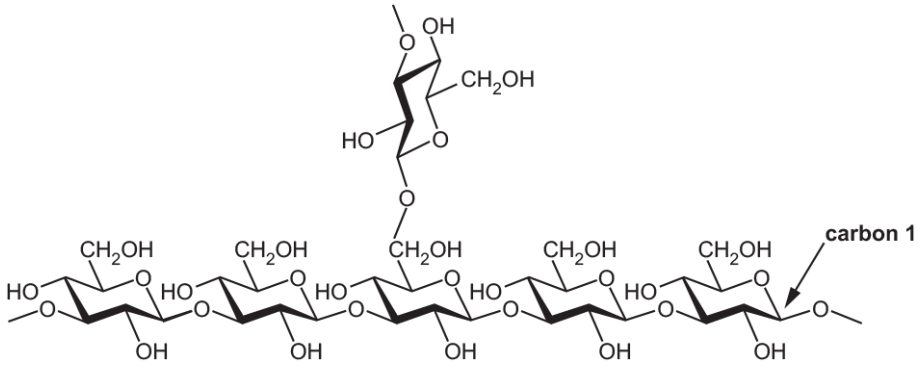


Fig. 1.2

24. Callose is a polysaccharide produced by plants.

Callose is formed from β-glucose monomers.

The figure below shows a section of callose.



Describe the differences between the structures of callose and cellulose.

_____

_____

_____

_____

_____ **[2]**

25. Amylose is formed from the glucose molecules produced in photosynthesis. **Table 5.1** shows three statements about amylose, which may be true or false.

Complete **Table 5.1** by writing either 'True' or 'False' in the empty boxes provided.

Statement	True or False?
Amylose is soluble	
Amylose is branched	
Amylose is formed by condensation reactions	

Table 5.1 **[1]**