Biological Molecules

(Past Year Topical Questions 2010-2015)

May/June 2010 (21)

1 **(a)** Fig. 1.1 shows the breakdown of a molecule of sucrose.

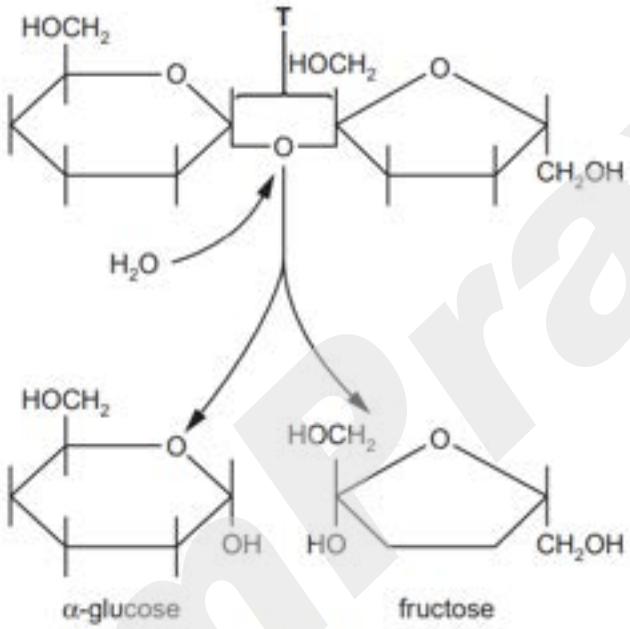


Fig. 1.1

(i) Name the bond indicated by T.

.....[1]

(ii) State the name given to this type of reaction in which water is involved.

.....[1]

(b) Enzymes are globular proteins.

State what is meant by the term *globular*.

.....

.....

.....

.....[2]

May/June 2010 (22)

4 Fig. 4.1 shows the primary structure of a lysozyme molecule, an enzyme found in tears, saliva and in lysosomes.

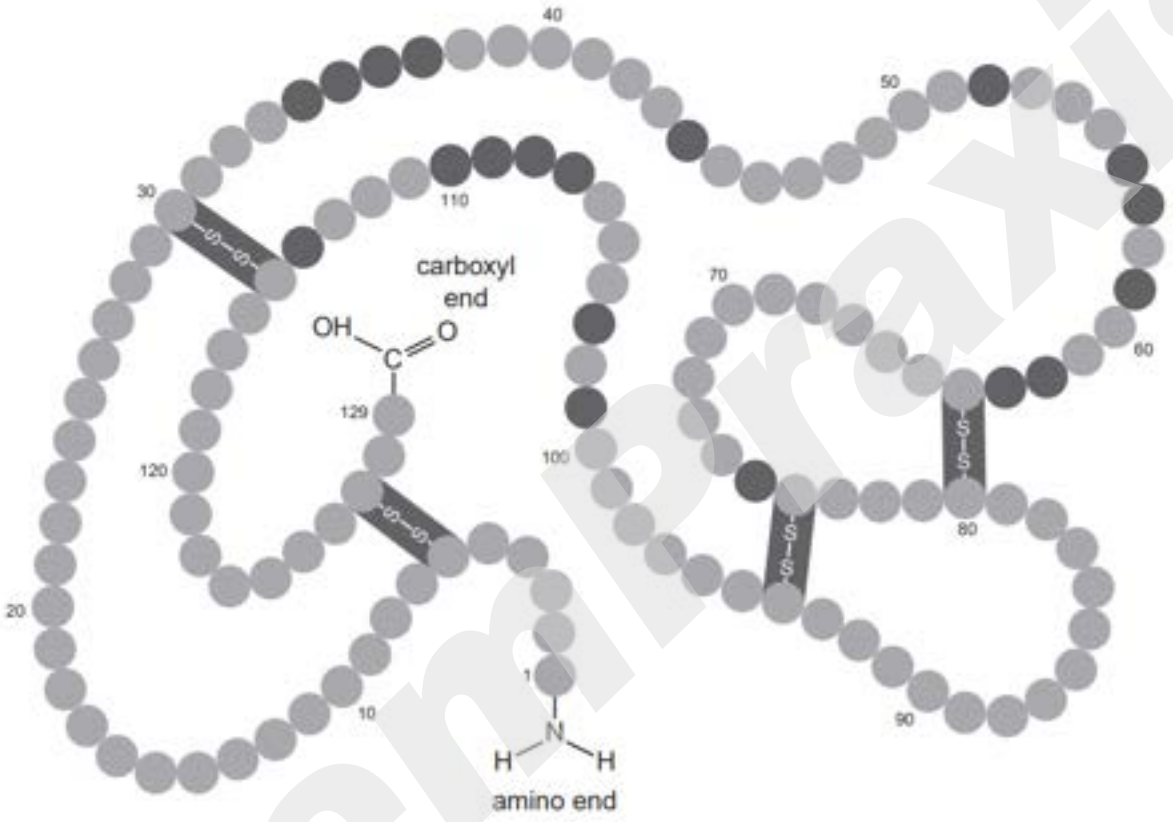


Fig. 4.1

(a) (i) Explain what is meant by the term *primary structure*.

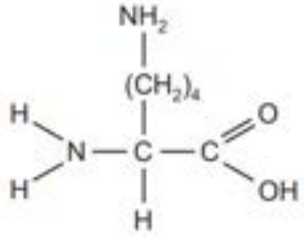
.....

.....

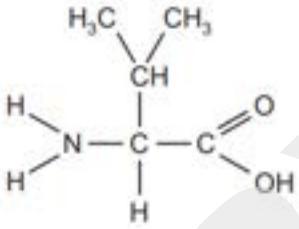
.....[1]

(ii) The molecular structure of the first two amino acids of lysozyme, lysine and valine, is shown below.

Use the space to show how these amino acids become linked in a condensation reaction.



lysine



valine

[3]

(b) Proteins, such as the enzyme lysozyme, have a secondary structure and a tertiary structure.

(i) Describe the secondary and tertiary structure of an enzymatic protein, such as lysozyme.

secondary .....

.....

.....

.....

tertiary .....

.....

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.....

.....[5]

(ii) State why it is important for enzymes, such as lysozyme, to possess a tertiary structure.

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.....[1]

May/June 2010 (23)

3 The amino acid sequence of the protein hormone insulin is shown in Fig. 3.1.

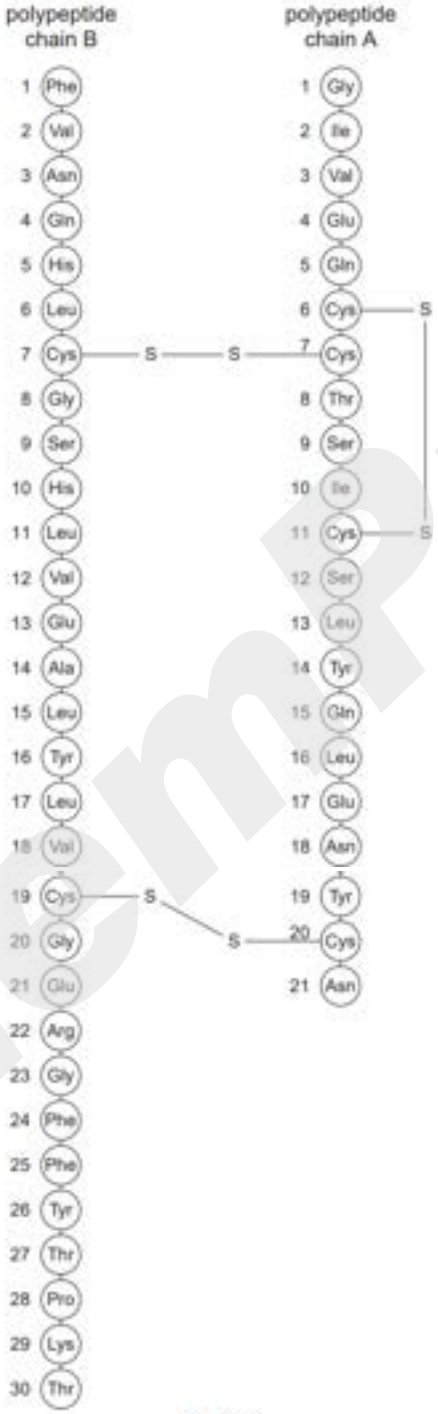


Fig. 3.1

(a) With reference to Fig. 3.1, state

(i) which two levels of protein structure are shown

1. .....

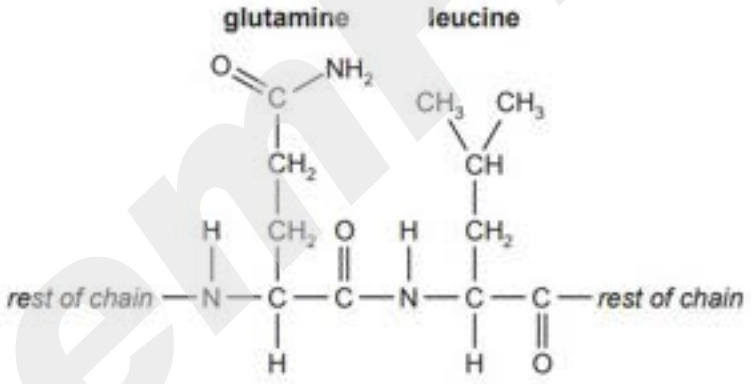
2. .....[2]

(ii) the name of the structures responsible for holding the two polypeptide chains together.

.....[1]

(b) Many people with diabetes need to take regular injections of insulin. Insulin in the form shown in Fig. 3.1 cannot be taken by mouth as it would be hydrolysed by proteases in the gut.

In the space below, draw a diagram to show how the peptide bond between glutamine 15 and leucine 16 in polypeptide chain A could be hydrolysed and show the products of the hydrolysis.



[3]

Oct/Nov 2010 (21)

5 **(a)** Cellulose is a polysaccharide.

Fig. 5.1 shows three sub-units from a molecule of cellulose.

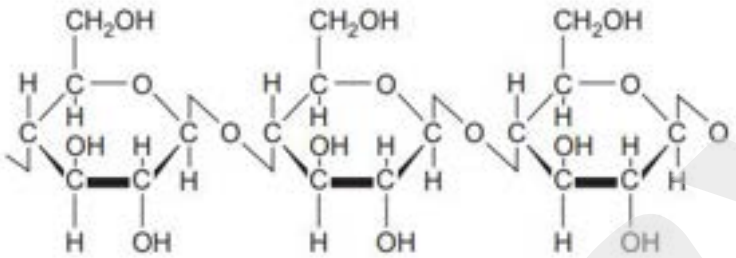


Fig. 5.1

(i) Name the sub-unit molecule of cellulose.

.....[1]

(ii) Name the bonds that attach the sub-unit molecules together within cellulose.

.....[1]

(b) Cellulose has high mechanical strength which makes it suitable for the cell walls of plants.

Explain how cellulose has such a high mechanical strength making it suitable for the cell walls of plants.

.....

.....

.....

.....[2]

Oct/Nov 2010 (22)

3 **(a)** Enzymes are globular proteins that catalyse metabolic reactions.

Describe the features of globular proteins.

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.....

.....

.....

.....

..... [3]

5 State the term that applies to each of the descriptions **(a)** to **(e)**.

(a) Storage polysaccharide in animals made of chains of 1,4 linked α-glucose with 1,6 linkages forming branches.

..... [1]

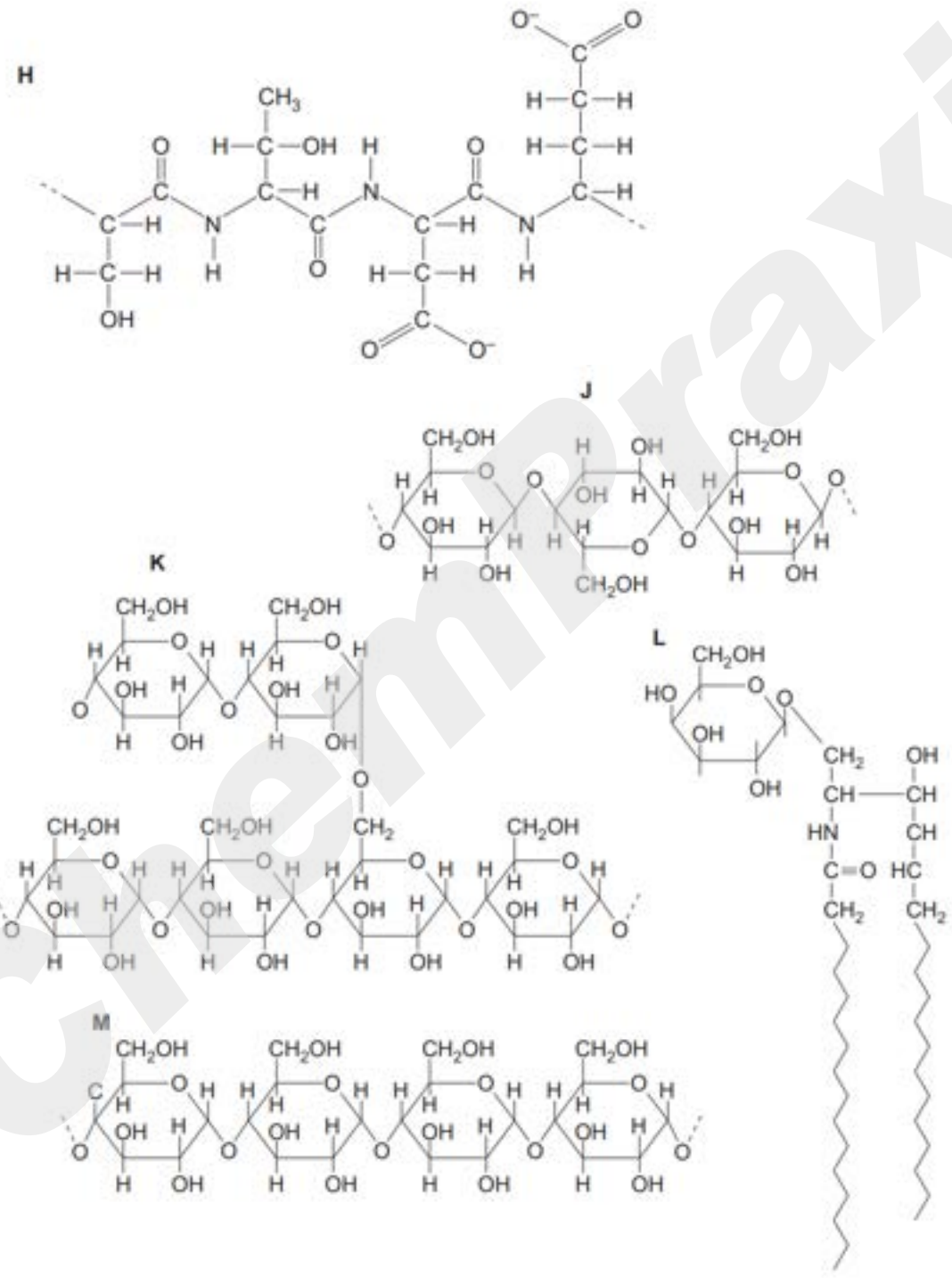
Oct/Nov 2010 (23)/Q3

(a) **(i)** State the names of the products of the hydrolysis of sucrose.

.....[1]

May/June 2011 (21)

5 Fig. 5.1 shows five different biological molecules.



Complete Table 5.1 by indicating which molecule matches each statement.

You may use each letter (**H** to **M**) once, more than once or not at all.

You should write only one letter in each box.

Table 5.1

statement	letter
contains peptide bonds	
part of the molecule forms the hydrophobic part of cell membranes	
contains 1-4 and 1-6 glycosidic bonds	
forms the primary structure of a protein	
used for energy storage in plants	
forms a helical structure	
the sub-unit molecule is β-glucose	

[Total: 7]

May/June 2011 (22)

5 **(a)** Fig. 5.1 represents a molecule of a triglyceride.

Name the components **A** and **C** and name the bond **B**.

Write your answers on the dotted lines provided in Fig. 5.1.

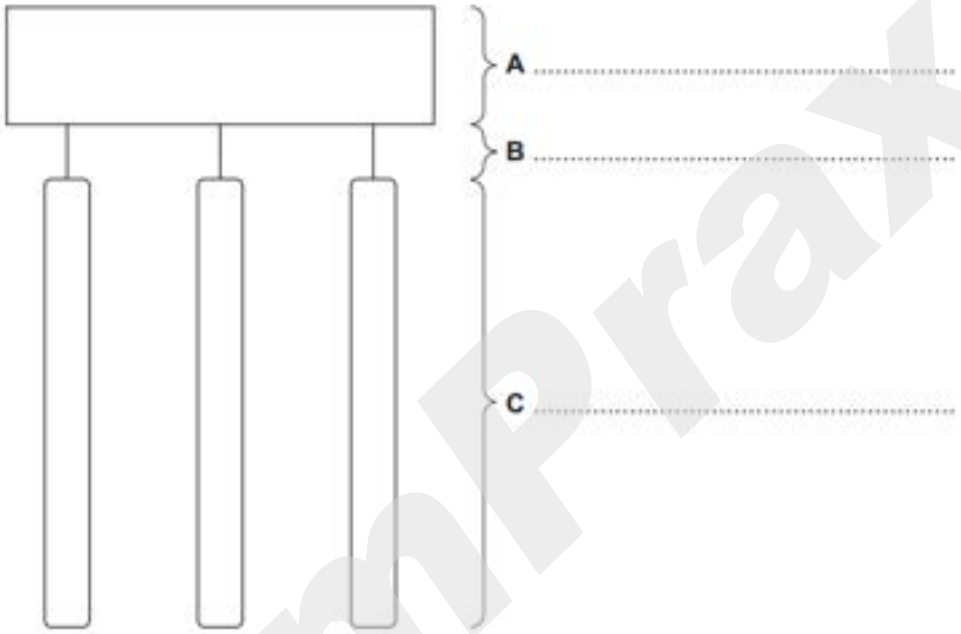


Fig. 5.1 [3]

(b) A phospholipid is sometimes described as a modified triglyceride.

(i) State how the structure of a phospholipid differs from a triglyceride.

.....

.....

..... [2]

Oct/Nov 2011 (21)

3 Fig. 3.1 shows a molecule of haemoglobin.

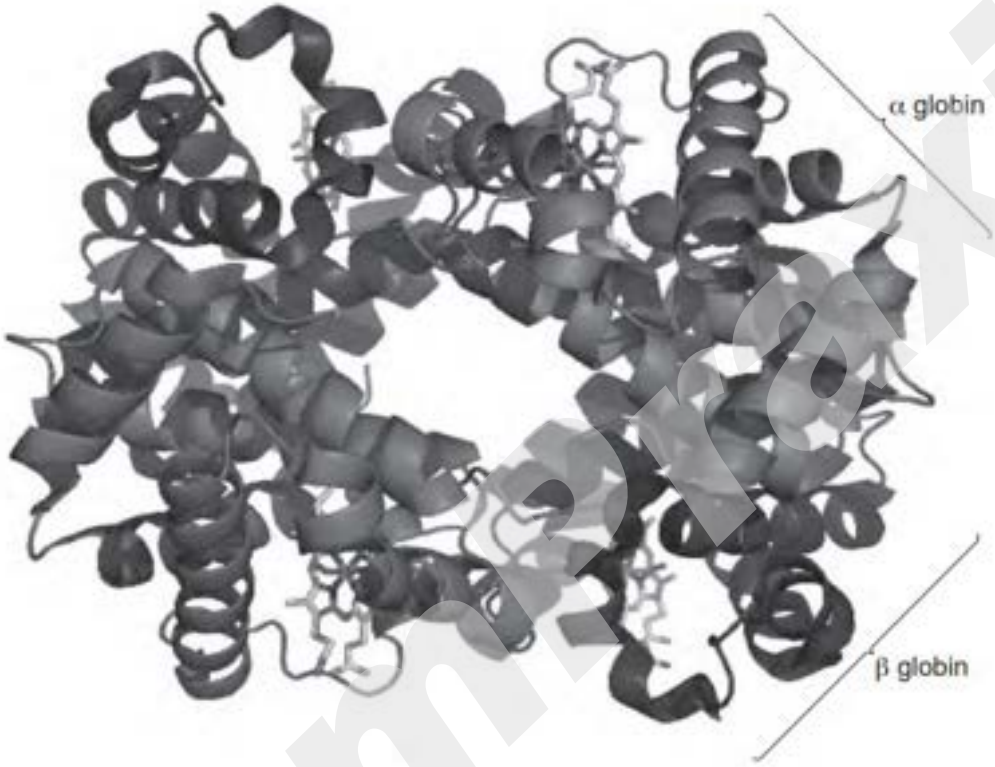


Fig. 3.1

(a) Explain how a molecule of haemoglobin shows the four levels of organisation of protein molecules.

primary structure .....

.....

.....

secondary structure .....

.....

.....

tertiary structure .....

.....

.....

quaternary structure .....

.....

.....[4]

(ii) State **one** way in which the **structure** of collagen differs from the structure of haemoglobin.

.....

.....[1]

Oct/Nov 2011 (22)

4 **(a)** Fig. 4.1 shows the structure of deoxyribose sugar.

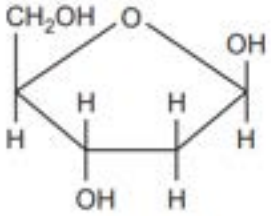


Fig. 4.1

State the differences between the structure of deoxyribose shown in Fig. 4.1 and the ring structure of α-glucose.

You may use the space below to help you in your answer.

.....

.....

.....

.....

[3]

(b) Match the biological macromolecule with the type of bond that is formed when the molecule is synthesised. Choose from the list below.

amylose **cellulose** **triglyceride** **protein** **amylopectin** **mRNA**

type of bond(s)	biological macromolecule
β, 1-4 glycosidic	
α, 1-4 glycosidic **and** α, 1-6 glycosidic	
phosphodiester	
peptide	

[4]

Oct/Nov 2011 (23)/Q1

(d) *E. carotovora* causes a disease in carrot and potato plants.

The bacteria release an enzyme called pectinase which hydrolyses the polysaccharide pectin. Pectin helps plant cells to attach to each other.

(i) Name the type of chemical bond which will be hydrolysed by pectinase.

..... [1]

May/June 2012 (21)

4 Penicillin is an antibiotic that interferes with the synthesis of cell walls in bacteria. Even before penicillin became widely available in the 1940s, the enzyme penicillinase which breaks down penicillin had been isolated. This enzyme is now found in many bacteria and gives them resistance to penicillin.

Fig. 4.1 is a ribbon model of the structure of the enzyme penicillinase. The arrow indicates the active site of the enzyme.

Fig. 4.1

(b) With reference to Fig. 4.1, identify the aspects of protein structure that are shown and those that are **not** shown.

aspects of protein structure shown

.....

.....

.....

.....

aspects of protein structure not shown

.....

.....

.....

..... [3]

May/June 2012 (22)

(c) Describe how a peptide bond is formed between two amino acids during polypeptide production.

You may use the space below to help with your answer.

.....

.....

.....

..... [3]

May/June 2013 (23)

3 Cholera is a disease caused by the bacterium *Vibrio cholerae*. The disease symptoms are caused by a toxin, produced by the bacterium, interacting with proteins in the cell surface membranes of epithelial cells in the human intestine.

The cholera toxin is a protein and is composed of two subunits, **A** and **B**. Subunit **A** is made from one polypeptide and subunit **B** is made from five identical polypeptides.

Fig. 3.1 shows the structure of the cholera toxin.

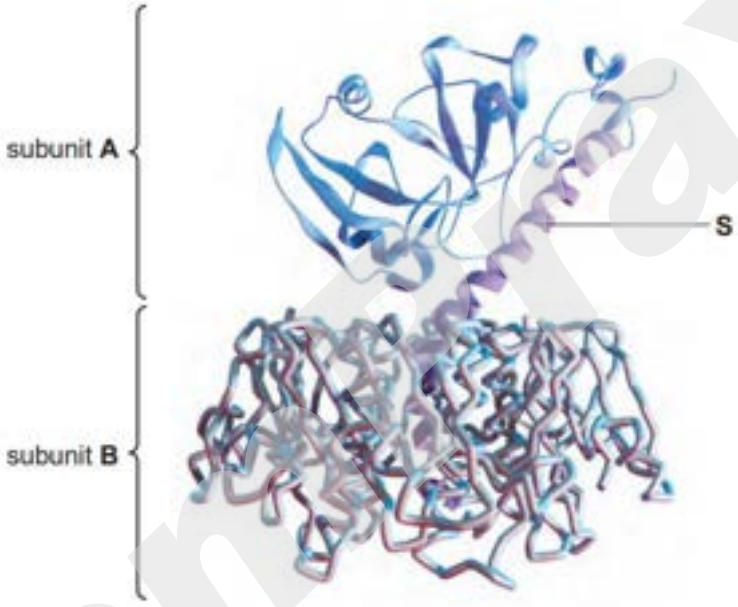


Fig. 3.1

(a) Name:

(i) the level of structure that is only shown by a protein that has more than one polypeptide chain

.....[1]

(ii) the part labelled **S**.

.....[1]

Oct/Nov 2012 (21)

1 Fig. 1.1 is a drawing made from an electron micrograph of a mammalian liver cell.

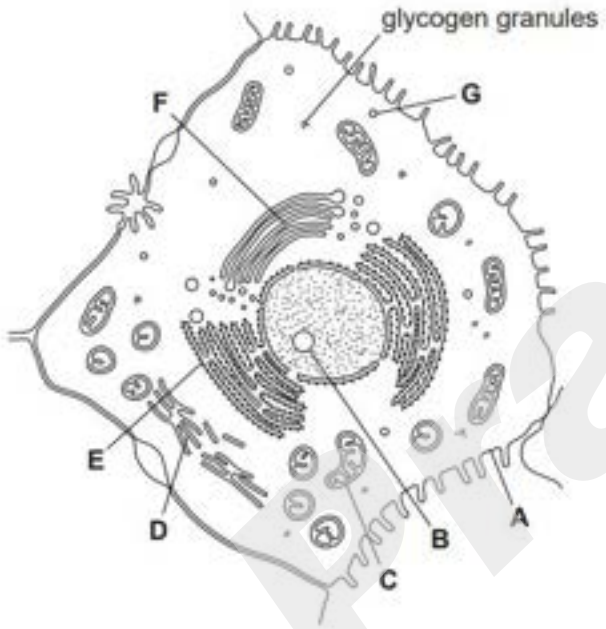


Fig. 1.1

(b) As shown in Fig. 1.1, liver cells contain many storage granules of glycogen.

Describe the molecular structure of glycogen **and** explain how this structure makes it suitable for storage.

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..... [4]

Oct/Nov 2012 (22)/Q1

(d) In Fig. 1.1, starch granules are visible within the chloroplasts. Starch is the most common storage compound of plants. It is composed of amylopectin and amylose.

(i) Describe the structural differences between amylopectin and amylose.

.....

.....

.....

.....

..... [2]

May/June 2013 (22)

4 Polysaccharides are synthesised by condensation reactions between monosaccharide or disaccharide subunits (monomers).

(a) Name the type of bond formed when polysaccharides are synthesised.

..... [1]

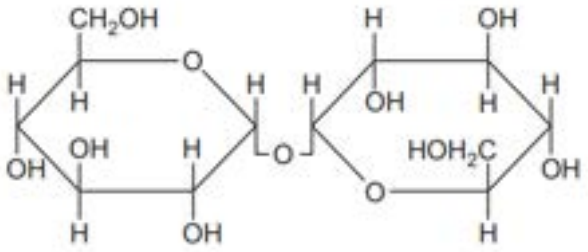
(b) Disaccharides are formed following synthesis from monosaccharides or as a result of polysaccharide hydrolysis.

Cellobiose, maltose, sucrose and trehalose are four different disaccharides found in nature. Fig. 4.1 shows the molecular structure of these disaccharides.

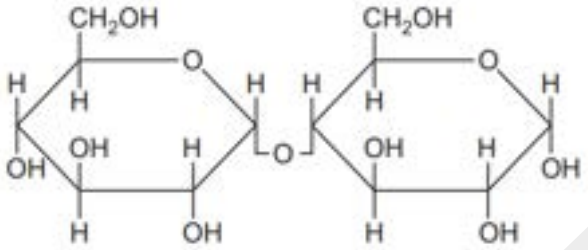
Identify the disaccharides, labelled **A** to **D**, using the information below.

- The disaccharide cellobiose is formed from the hydrolysis of the polysaccharide cellulose.
- When cellobiose is hydrolysed, two **β-glucose** molecules are produced.
- One of the disaccharides is sucrose.
- Trehalose is a disaccharide that is synthesised from two **α-glucose** molecules.
- The disaccharide maltose is formed from the hydrolysis of amylose, a component of starch.

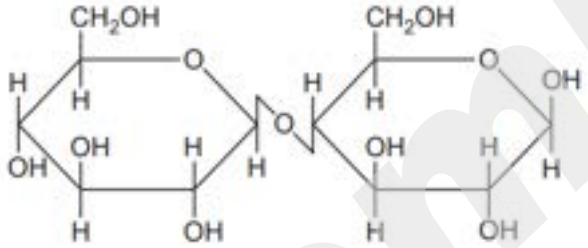
Write the name of the disaccharides in the spaces provided on Fig. 4.1.



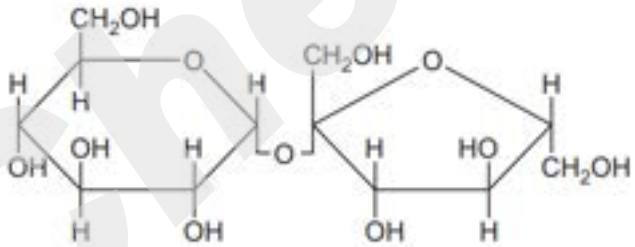
A .....



B .....



C .....



D .....

[3]

Fig. 4.1

May/June 2013 (23)/Q5

A protein, mitosis-promoting factor (MPF), has been identified in cells. MPF is a globular protein made from two polypeptide chains.

(b) Place a tick (✓) in the box next to the type, or types, of protein structure shown by MPF.

primary ☐

secondary ☐

tertiary ☐

quaternary ☐

[1]

Oct/Nov 2013 (22)

2 Keratin and chitin are two important biological molecules. Keratin is found in hair, fur and skin. Chitin is a modified polysaccharide found in a number of different organisms, for example in fungal cell walls and the hard outer skeletons of insects.

(a) Features of chitin and keratin are shown in the boxes in Fig. 2.1.

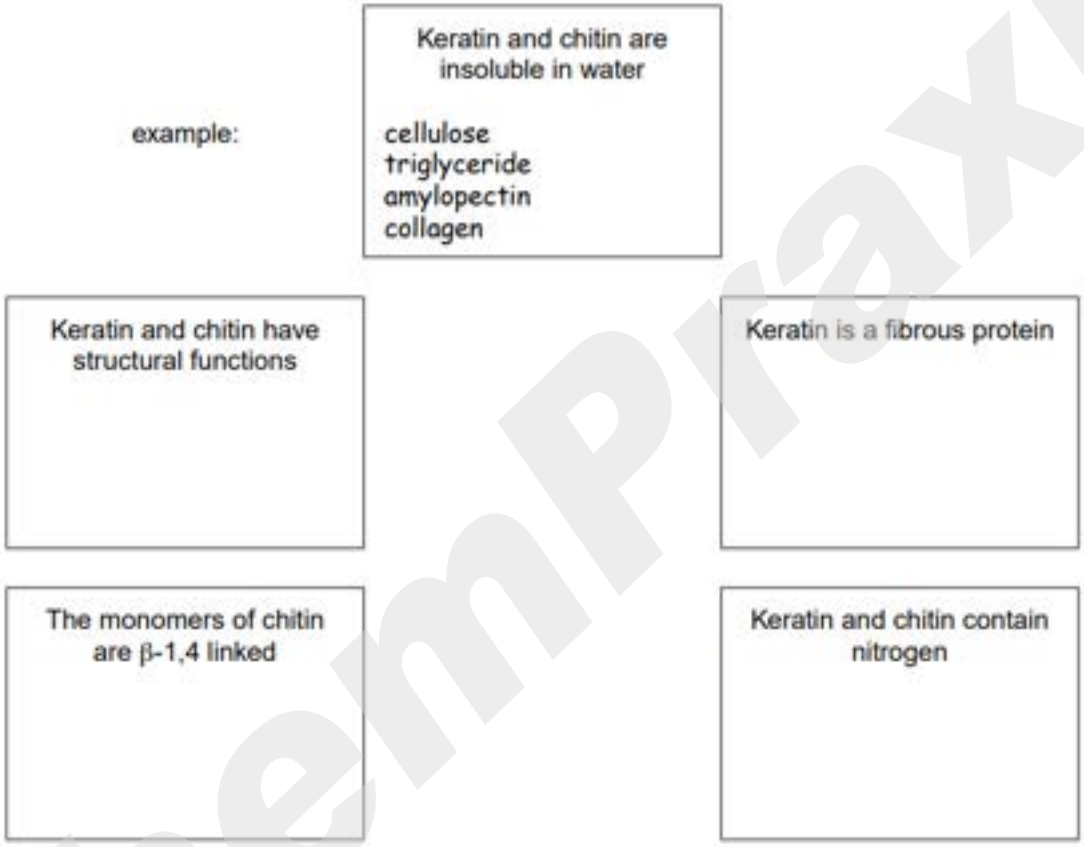


Fig. 2.1

Write, in each box, the biological molecules from the list below that have the same feature.

Each box may contain one, or more than one, biological molecule. The first box has been completed as an example.

amylopectin
cellulose
collagen
haemoglobin
mRNA
triglyceride

[5]

Oct/Nov 2013 (23)

5 **(a)** Describe the structure of a cellulose molecule **and** explain how cellulose is a suitable material for the cell walls of plants.

description

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.....

.....

.....

.....

explanation

.....

.....

.....

.....

..... [4]

May/June 2014 (21)

3 Starch is composed of two polysaccharides, amylose and amylopectin.

Fig. 3.1 shows a molecule of α-glucose before being added to the end of a molecule of amylose.

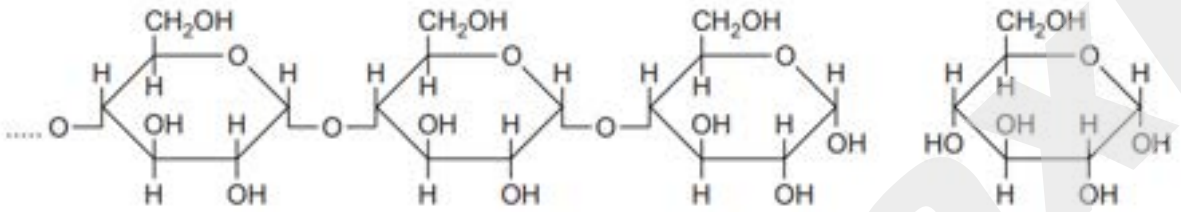


Fig. 3.1

(a) (i) Complete Fig. 3.1 to show how a molecule of α-glucose is added to the amylose. [3]

(ii) Name the bond that forms between glucose molecules in polysaccharides, such as amylose.

.....[1]

(b) Glycogen and cellulose are two other polysaccharides.

Complete Table 3.1 to compare glycogen and cellulose with amylose.

Table 3.1

feature	amylose	glycogen	cellulose
monomer	α-glucose		
branched or unbranched molecule	unbranched		
role in organisms	energy storage		

[3]

May/June 2014 (22)/Q5

(d) Papain is a globular protein with a tertiary structure but no quaternary structure.

(i) State how many polypeptides there are in a molecule of papain.

.....[1]

(ii) Explain how the tertiary structure of the protein results in papain being globular.

.....

.....

.....

.....[2]

May/June 2014 (23)

1 Fig. 1.1 shows the structures of four biological molecules **A**, **B**, **C** and **D**.

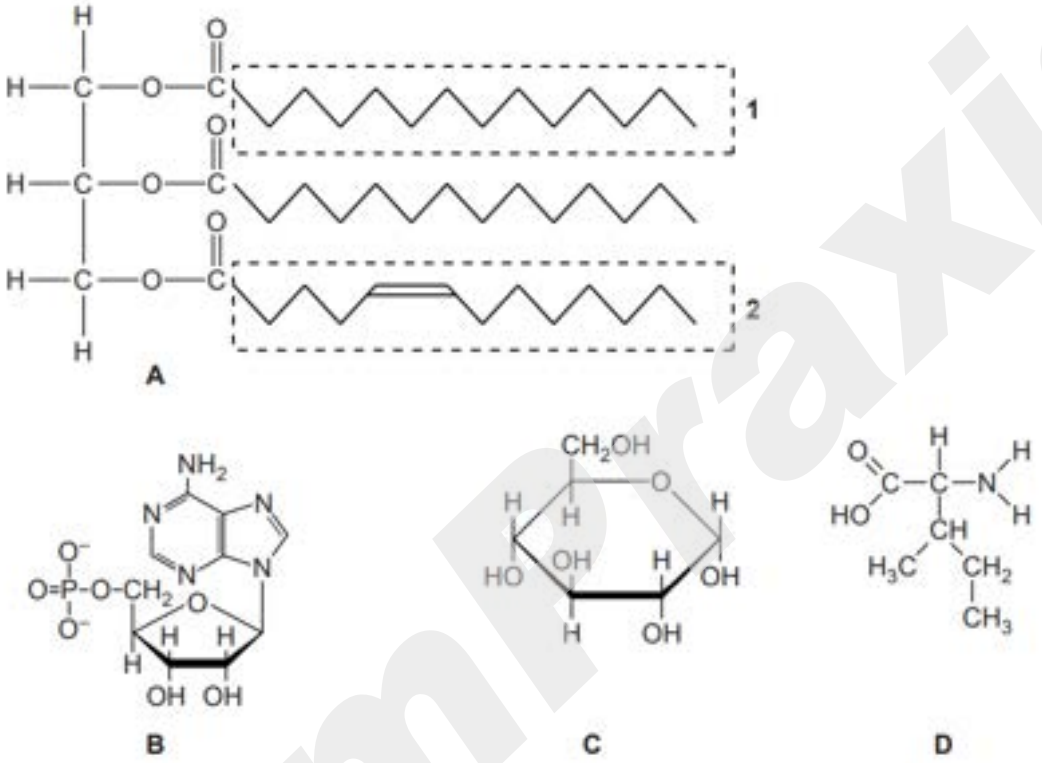


Fig. 1.1

(a) Give the letter, **A** to D, of the molecule in Fig. 1.1 which:

(i) is a nucleotide .....

(ii) can form peptide bonds .....

(iii) contains ester bonds. ..... [3]

(b) Some of the molecules in Fig. 1.1 can form polymers.

(i) Name a polymer which can be formed only from many molecules of **C**.

..... [1]

(ii) State one way, visible in Fig. 1.1, in which the part labelled **1** of molecule **A** differs from the part labelled **2**.

.....

.....

.....[1]

(iii) Molecule **D** can form macromolecules with other similar monomers.

These macromolecules have three dimensional shapes held in place by interactions or bonds other than those between adjacent monomers.

Name two of these interactions or bonds.

1. .....

2. .....

[2]

Oct/Nov 2014 (21)

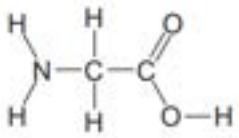
3 There are many types of amino acids, but only twenty that are polymerised to make polypeptides and proteins in animals.

(a) Name the type of chemical reaction that occurs when two amino acids form a dipeptide.

.....[1]

(b) Fig. 3.1 shows two amino acids, glycine and valine. Use the space below to make a drawing to show what happens when these two molecules join together to form a dipeptide.

glycine



valine

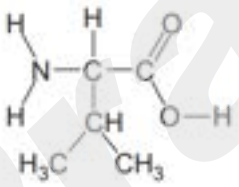


Fig. 3.1

[4]

Oct/Nov 2014 (22)/Q3

(b) Fig. 3.1 is a diagram that highlights the tertiary and quaternary structure of a haemoglobin molecule.

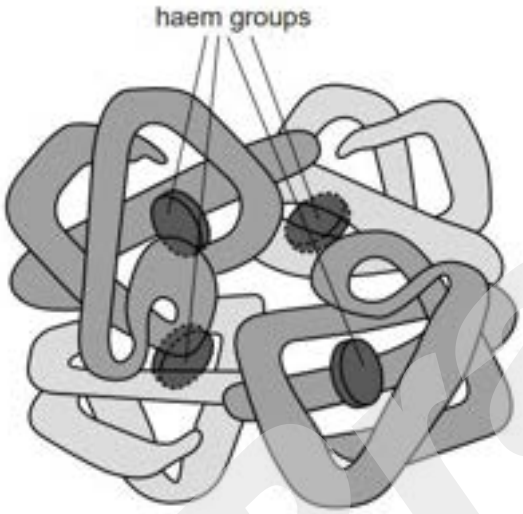


Fig. 3.1

Explain how the tertiary and quaternary levels of protein structure of the haemoglobin molecule contribute to its role in the transport of oxygen.

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.....

.....

.....

.....

.....

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.....

.....

..... [4]

May/June 2015 (21)/Q4

(b) Carbonic anhydrase is an enzyme that is found in blood, liver and kidneys. Fig. 4.2 shows a molecular model of this enzyme.

Fig. **4.2**

(i) With reference to Fig. 4.2 and the parts labelled **P** and **Q**, explain the term *secondary structure*.

.....

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.....

.....

.....[3]

5 Fig. 5.1 shows a diagram of the molecular structures of tristearin (a triglyceride) and phosphatidylcholine (a phospholipid).

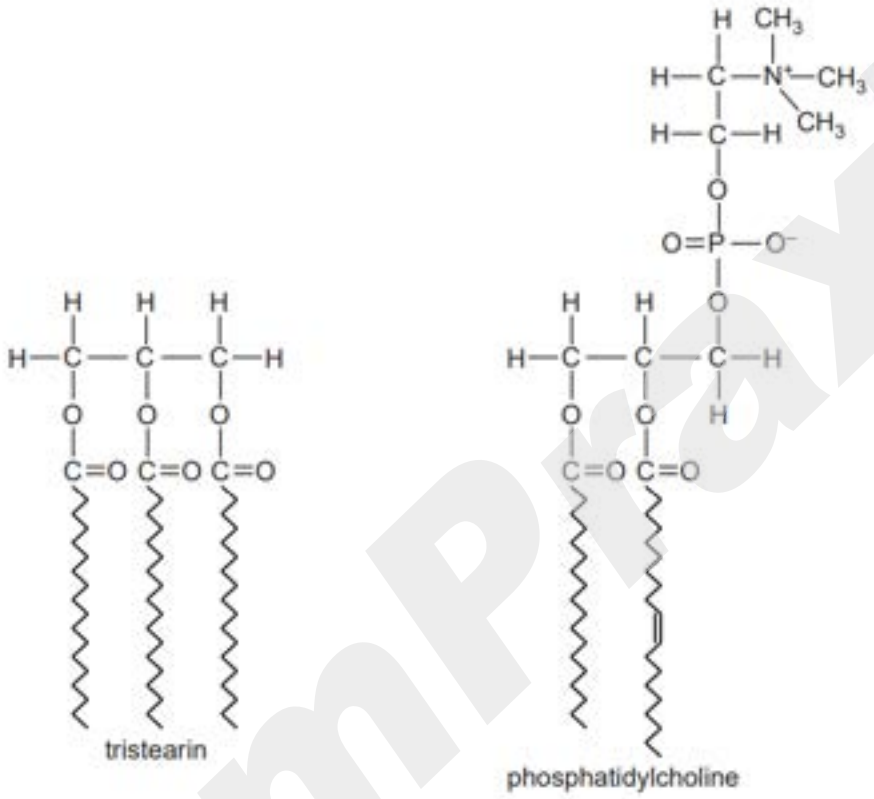

Fig. 5.1

(a) Table 5.1 shows a structural difference between the two molecules shown in Fig. 5.1.

Complete Table 5.1 with two further structural differences **other than** in numbers of different types of atoms.

Table 5.1

structural feature	tristearin	phosphatidylcholine
length of fatty acid chains	all the same length	different lengths

[2]

(c) Water has many significant roles to play in cells and living organisms.

Complete Table 5.2 below by stating the property of water that allows each of the following to take place.

Table 5.2

role of water	property of water
solvent for glucose and ions	
movement in xylem	
helps to decrease body temperature in mammals	

[3]

May/June 2015 (22)

4 Many microorganisms can digest cellulose by using a group of enzymes collectively known as cellulases. Cellobiose is the disaccharide produced during cellulose digestion.

The cellulase known as β-glucosidase completes the digestion of cellulose by hydrolysing the cellobiose molecule to produce two β-glucose molecules.

(a) Draw the ring structure of one β-glucose molecule in the space provided.

[2]

Oct/Nov 2015 (21)

2 Fig. 2.1 is a diagram of the structure of a protein channel for ions in a cell surface membrane.

Fig. 2.1a shows the channel when open and Fig. 2.1b shows the same channel when closed.

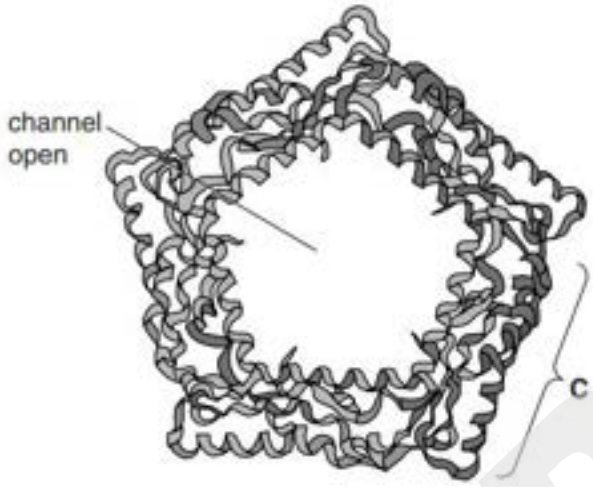

Fig. 2.1a

Fig. 2.1 b

(b) The channel protein in Fig. 2.1 is made from five identical polypeptide chains.

(i) Name the level of protein structure which is present when five polypeptide chains form the protein.

..... [1]

(ii) The part labelled **C** in Fig. 2.1 is another level of protein structure.

Name this level.

..... [1]

Oct/Nov 2015 (23)

4 Glycogen is a highly branched polysaccharide molecule that is stored in the liver, kidney and muscles of mammals.

Fig. 4.1 shows a small part of a molecule of glycogen.

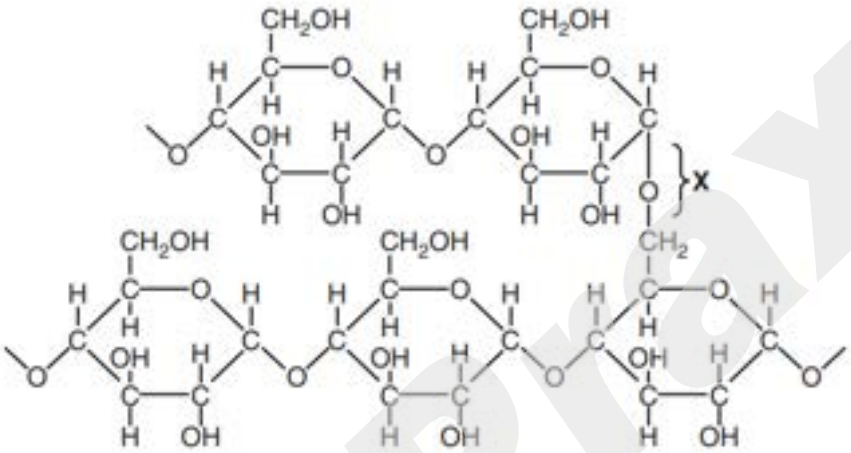

Fig. 4.1

(a) (i) Name the bond at **X**.

..... [1]

(ii) State the advantages for a mammal of having a storage molecule that is highly branched.

.....

.....

.....

.....

.....

.....

..... [2]

(iii) State two ways in which the structure of cellulose differs from the structure of glycogen.

1. .....

.....

2. .....

..... [2]