Q.1.

5 Haemoglobin is a globular protein with quaternary structure.

Fig. 5.1 is a diagram of the haemoglobin molecule.

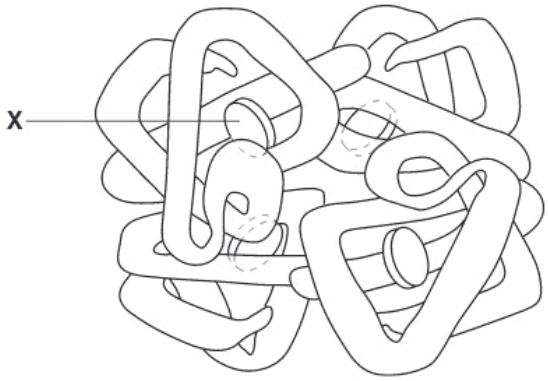


Fig. 5.1

(a) With reference to Fig. 5.1,

(i) name **X** and state its function;

.....

.....[2]

(ii) explain why haemoglobin is described as a *globular protein* with *quaternary structure*.

.....

.....

.....[2]

(b) Explain why people who have a deficiency of iron in their diet are often lacking in energy and feel tired.

.....

.....

.....

.....[3]

Q.2

3 **(a)** The table below includes statements about the roles of water
- in living organisms
- as an environment for living organisms.

Complete the table by indicating with a tick (✓) which **one** of the properties of water is responsible for each role.

You should put only **one** tick in each row.

roles of water	properties of water			
	high specific heat capacity	strong cohesive forces between water molecules	high heat of vaporization	solvent for polar molecules and ions
transport medium in blood plasma and phloem				
surface for small insects to walk on				
major component of sweat used in heat loss				
transpiration pull in xylem				
preventing wide variations in body temperature				

[5]

Q.3

(d) Starch grains in plant cells contain both amylose and amylopectin.

Explain how **both** of these substances are formed from glucose in plant cells.

.....

.....

.....

.....

.....

.....

.....

.....[4]

(e) State three functions of the water stored in the vacuoles of plant cells.

1. .....

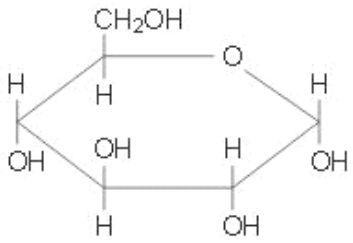
2. .....

3. .....[3]

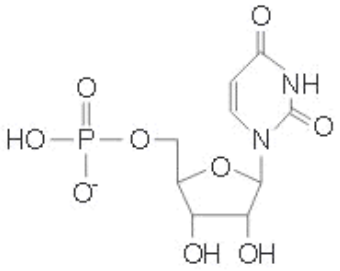
Q.4

3 Fig. 3.1 shows seven biological molecules, labelled **D** to **K**.

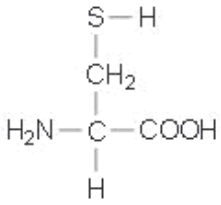
D



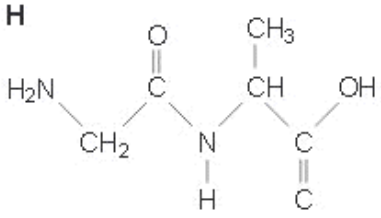
G



E



H



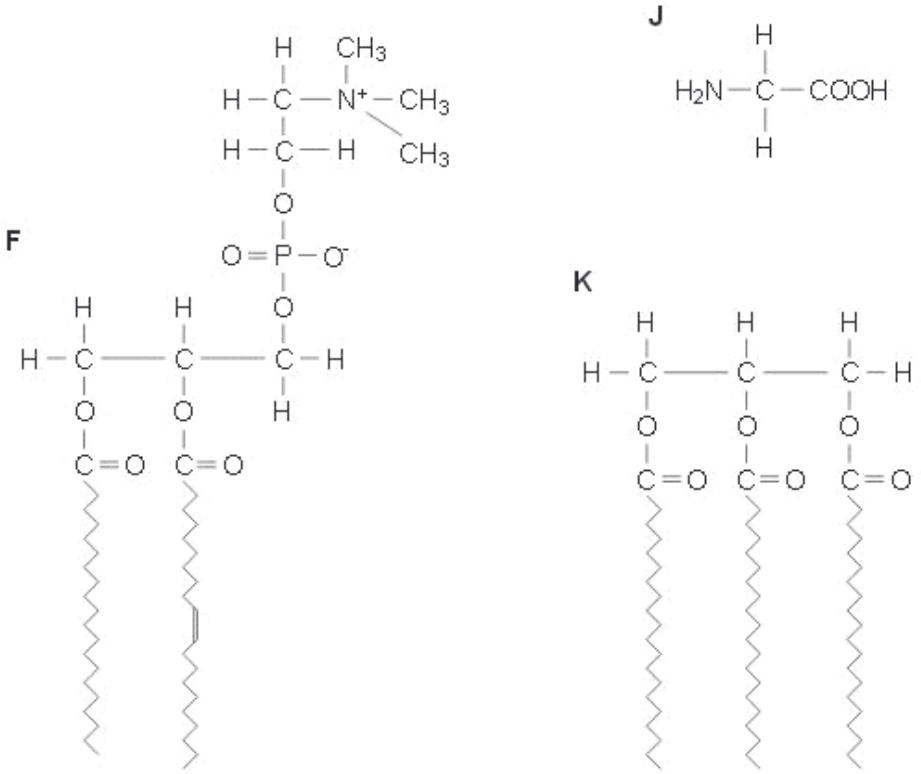


Fig. 3.1

(a) Table 3.1 contains statements about the biological molecules in Fig. 3.1.

Complete the table by selecting the biological molecule from Fig. 3.1 that matches each of the statements. Write the appropriate letter from Fig. 3.1 in the table. The first one has been done for you.

You may use each letter once, more than once or not at all.

Table 3.1

statement	letter
an amino acid that is a major constituent of collagen	**J**
a component of RNA	
a molecule that is polymerised to form glycogen	
a molecule with a peptide bond	
an important store of energy, insoluble in water	
a molecule with hydrophilic and hydrophobic regions	
an amino acid that forms disulfide (disulphide) bonds in proteins	

[6]

(b) Describe two ways in which the **structure** of DNA differs from the **structure** of collagen.

1 .....

.....

2 .....

..... [2]

[Total: 8]

Q.5

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

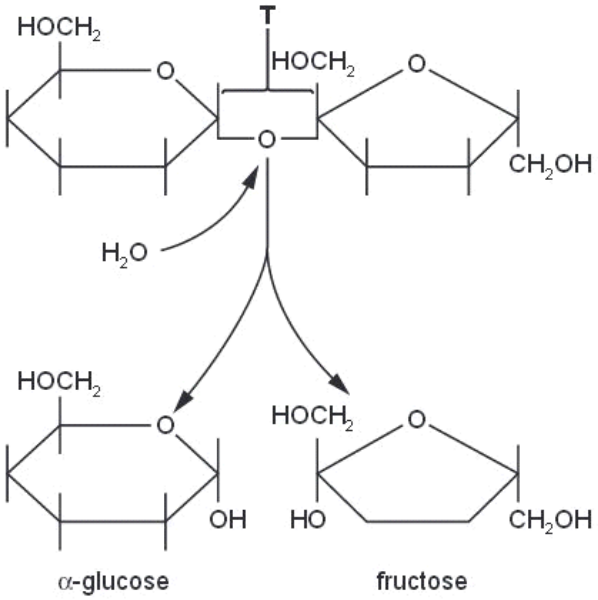


Fig. 1.1

(i) Name the bond indicated by **T**.

.....[1]

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

.....[1]

(iii) State two roles of water **within plant cells** other than taking part in breakdown reactions.

1. .....

2. .....[2]

(b) Enzymes are globular proteins.

State what is meant by the term *globular*.

.....

.....

.....

.....[2]

Q.6

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

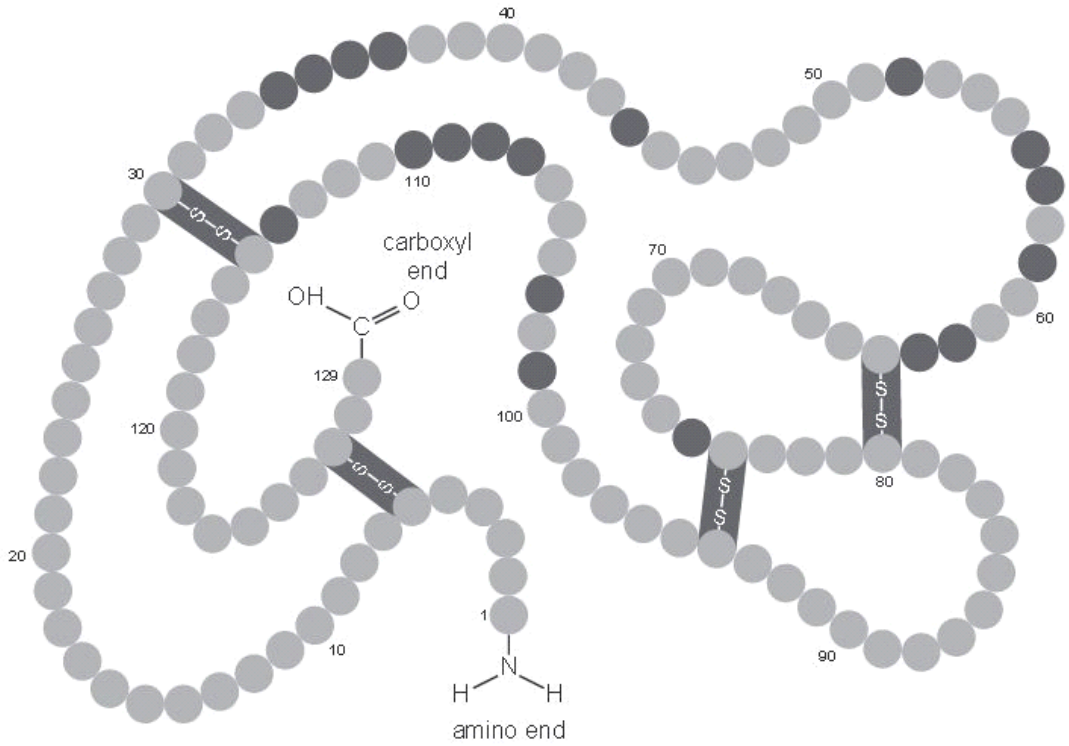


Fig. 4.1

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

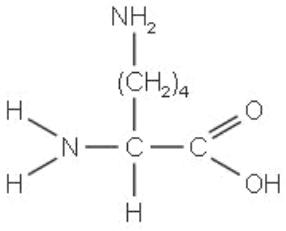
.....

.....

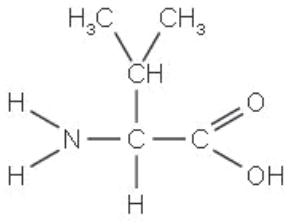
.....[1]

(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 .....

.....

.....

.....

.....

.....

.....[5]

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

.....

.....[1]

(c) Some people have a rare disease caused by a single change in the DNA nucleotide sequence of the gene coding for lysozyme. The change leads to the formation of an insoluble protein that has a different structure to the normal soluble lysozyme molecule.

Suggest how a change in the gene can lead to the differences observed between the normal lysozyme and the changed lysozyme.

.....

.....

.....

.....

.....

.....[3]

[Total: 13]

Q.7.

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

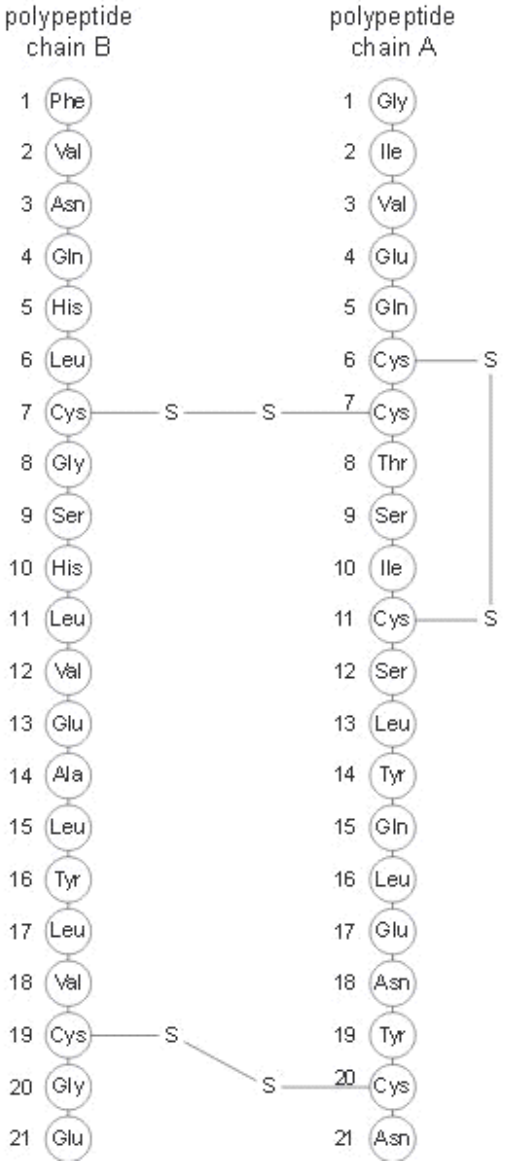


Fig. 3.1

(a) With reference to Fig. 3.1, state

(i) which two levels of protein structure are shown

1. .....

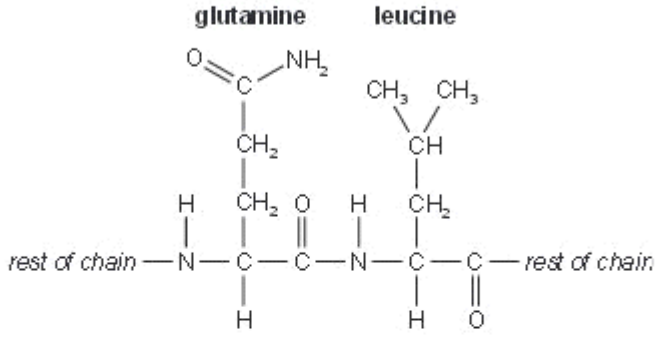
2. .....[2]

(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.



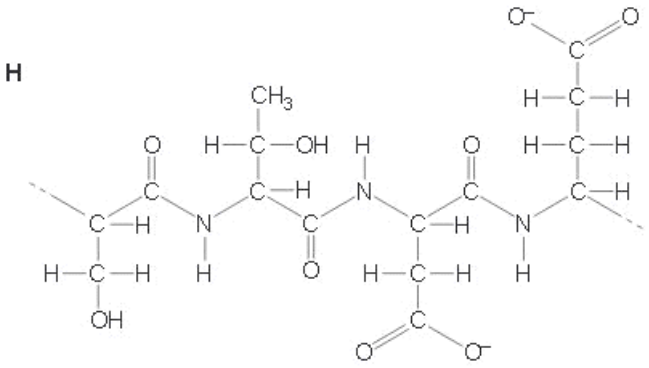
[3]

[Total: 6]

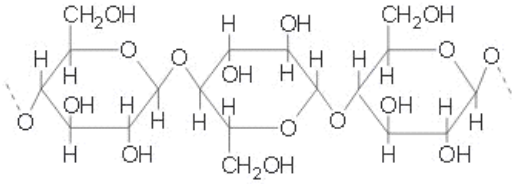
Q.8.

5 Fig. 5.1 shows five different biological molecules.

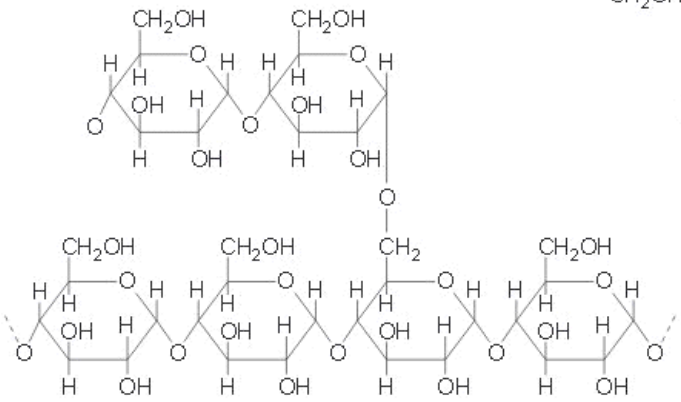
H



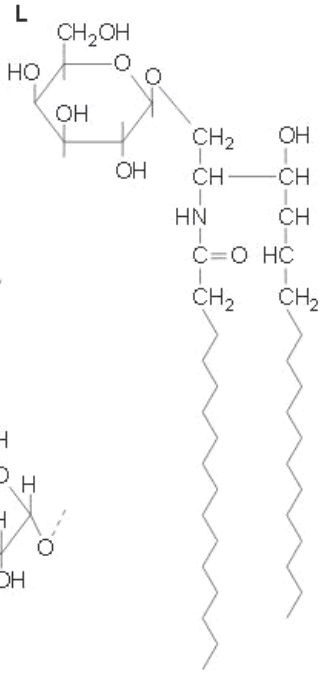
J



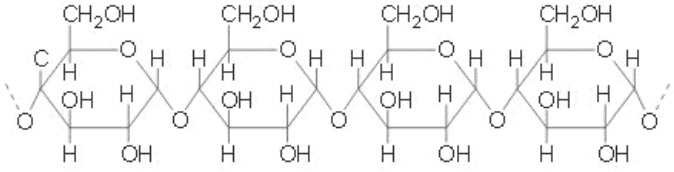
K



L



M



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]

Q.9.

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.

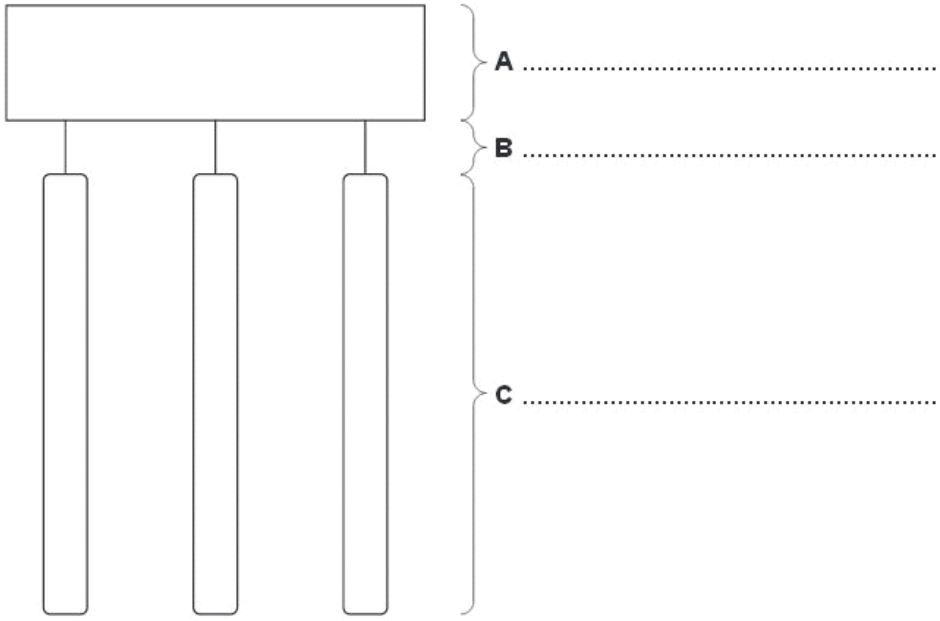


Fig. 5.1 [3]

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

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

.....

.....

.....[2]

(ii) Explain how a phospholipid is suited to its role in cell membranes.

.....

.....

.....

.....

.....

.....[3]

Q.10.

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.

(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

.....

.....

.....

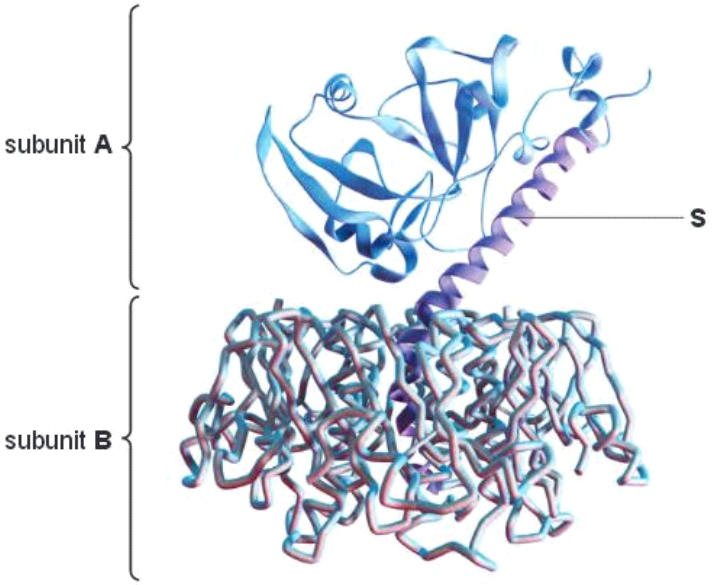
.....[3]

Q.11.

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.



(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]

Q.12

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]

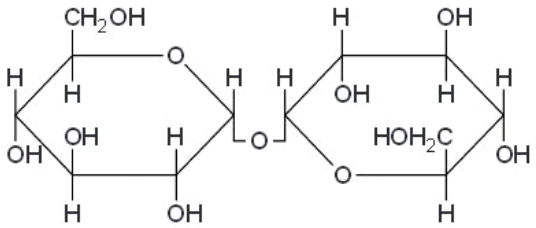
(b) Disaccharides are formed following synthesis from monosaccharides or as a result of polysaccharide hydrolysis.

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

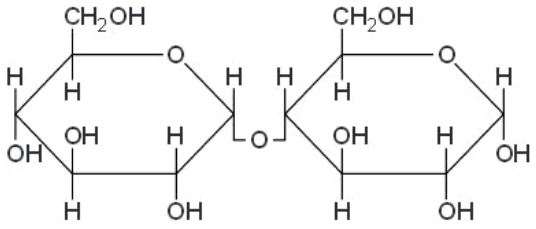
Identify the disaccharides, labelled **A** to **D**, using the information below.

- 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.

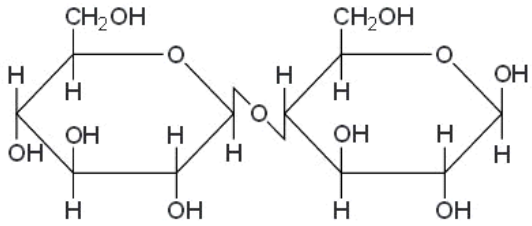
Write the name of the disaccharides in the spaces provided on Fig. 4.1.



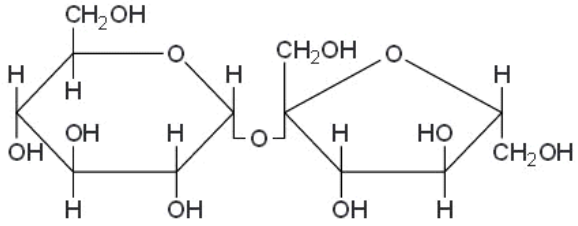
A .....



B .....



C .....



D .....

[3]

Fig. 4.1

Q.13.

2 Fig. 2.1 shows the reaction to form triglycerides.

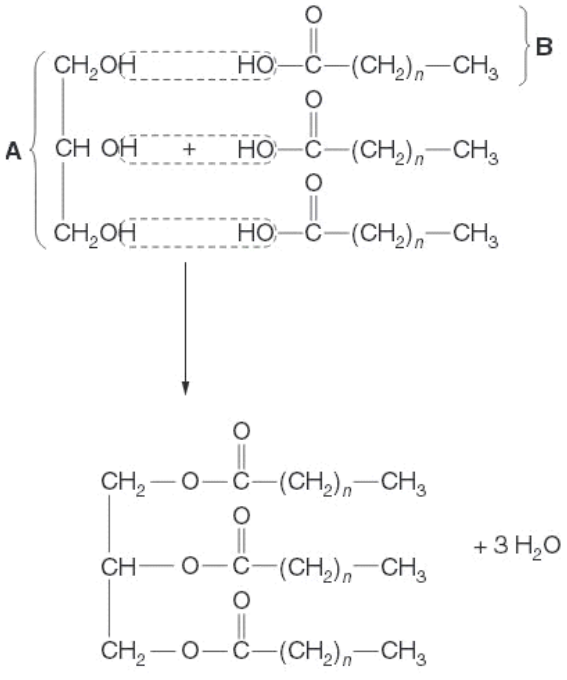


Fig. 2.1

(a) With reference to Fig. 2.1,

(i) name the molecules **A** and **B**;

A .....

B .....[2]

(ii) state the name of the reaction shown.

.....[1]

(b) Animals and plants store triglycerides as energy reserves.

Explain the advantages of storing triglycerides as energy reserves rather than carbohydrates, such as starch.

.....

.....

.....[2]

Overconsumption of fat in the diet may lead to obesity.

(c) State how it is determined whether a person is sufficiently overweight to be classed as obese.

.....

.....

.....[1]

(d) Outline two risks to health of being obese.

1. .....

2. .....[2]

[Total : 8]

Q.14

4 Starch, glycogen and cellulose are all polysaccharides. They are made from monomers that are joined by covalent bonds.

(a) Complete the table below to show which of the statements apply to each of the polysaccharides.

Fill in each box using a tick (✓) to show that the statement applies and a cross (✗) if it does not.

statement	starch	glycogen	cellulose
glycosidic bonds between monomers			
monomer is β glucose			
stored within chloroplasts			
stored in muscle cells			
exists in two forms – branched and unbranched chains			

[5]

A solution of the enzyme amylase was added to a solution of starch and kept at 25 °C. The starch was broken down by hydrolysis.

(b) Explain how you would determine the rate of hydrolysis.

.....

.....

.....

.....

.....

.....[4]

[Total: 9]

Q.15.

2 Fig. 2.1 shows a β glucose molecule.

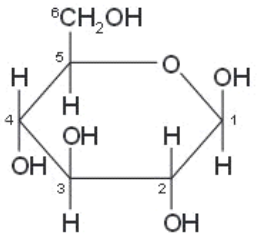


Fig. 2.1

(a) State how α **glucose** differs from β glucose as shown in Fig. 2.1.

.....[1]

(b) Fig. 2.2 shows a molecule of β glucose that is about to be added to the end of a growing chain of a polysaccharide.

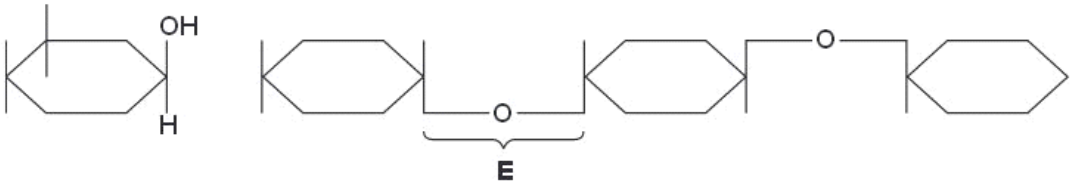


Fig. 2.2

(i) Name the bond **E**.

.....[1]

(ii) Use the diagram below to show how the β glucose molecule will attach to the end of the growing chain of the polysaccharide. You may annotate the diagram if you wish.

(iii) Name a polysaccharide that is formed entirely from β glucose molecules in the way shown in Fig. 2.2.

.....[1]

(c) A solution of starch was poured into six separate test-tubes, labelled **F** to **K**. The test-tubes were kept at 35 °C for 5 minutes and then treated as shown in Table 2.1. After a further 30 minutes the contents of the test-tubes were tested for the presence of reducing sugar.

Table 2.1

test-tubes	substances added after 5 minutes	presence or absence of reducing sugar after 30 minutes
F	distilled water	absent
G	amylase + boiled maltase	present
H	amylase + distilled water	present
I	boiled amylase + maltase	absent
J	amylase + maltase	present
K	maltase + distilled water	absent

Explain the results shown in Table 2.1.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total : 10]

Q.16

2 Phospholipids are components of cell surface membranes.

(a) Describe how phospholipid molecules are arranged in a cell surface membrane.

You may use the space below for a **simple annotated** diagram if you wish.

.....

.....

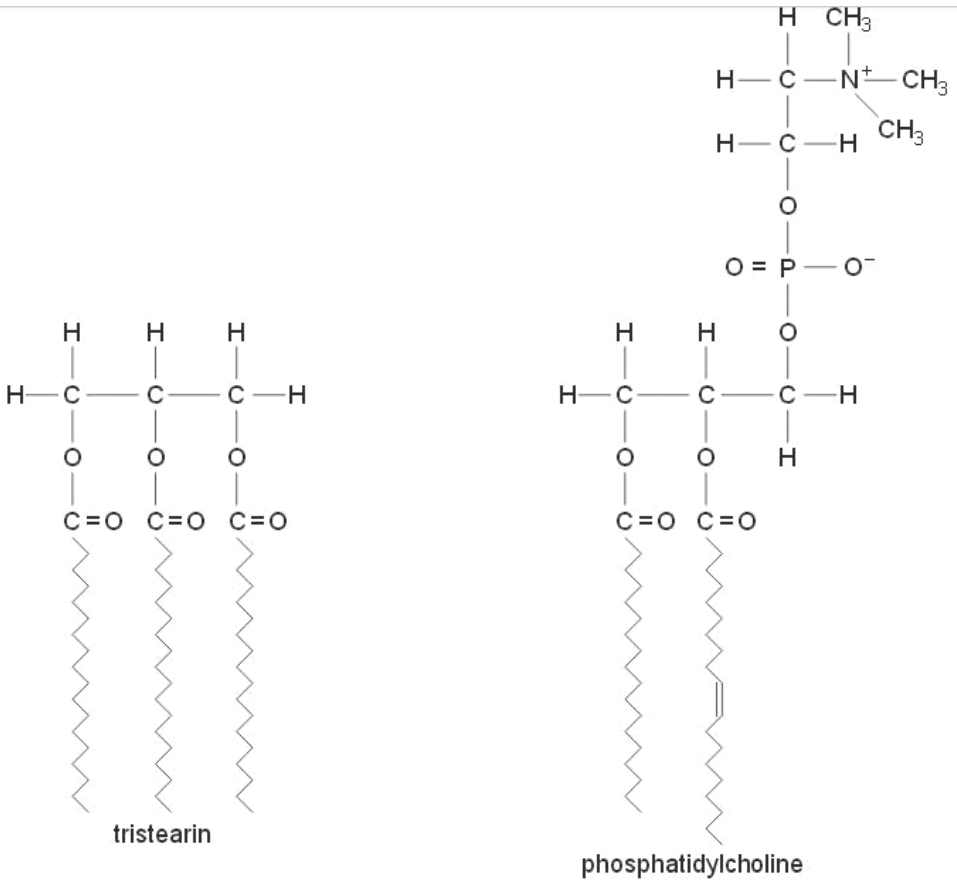
.....

.....

[2]

Fig. 2.1 shows the structure of the lipids:

- tristearin, which is a triglyceride;
- phosphatidylcholine, which is a phospholipid.



(b) State two ways, **visible in Fig. 2.1**, in which phosphatidylcholine differs from tristearin.

1. .....

.....

2. .....

.....[2]

(c) Explain how the structure of triglycerides, such as tristearin, makes them more suitable for energy storage than carbohydrates, such as glycogen.

.....

.....

.....

.....[2]

Q.17

6 Haemoglobin is a globular protein that shows quaternary structure. It is composed of two types of polypeptide, known as α and β globin.

(a) Explain how a globular protein differs from a fibrous protein, such as collagen.

.....

.....

.....

.....[2]

Fig. 6.1 shows part of the base sequence of the mRNA that codes for the first ten amino acids of β globin. Table 6.1 shows some of the codons and the amino acids for which they code.

GUG	CAC	CUG	ACU	CCU	GAG	GAG	AAG	UCU	GCC

Fig. 6.1

Table 6.1

amino acid	abbreviation	codons					
alanine	ala	GCA	GCC	GCG	GCU		
glutamic acid	glu	GAA	GAG				
histidine	his	CAC	CAU				
leucine	leu	UUA	UUG	CUA	CUC	CUG	CUU
lysine	lys	AAA	AAG				
proline	pro	CCA	CCC	CCG	CCU		
serine	ser	UCA	UCC	UCG	UCU	AGC	AGU
threonine	thr	ACA	ACC	ACG	ACU		
valine	val	GUA	GUC	GUG	GUU		

(b) Use the information in Table 6.1 to complete the sequence of amino acids at the beginning of β globin using the first three letters of each amino acid. Some of them have been done for you.

val	his				glu				ala

[2]

15

(c) β globin has a tertiary structure that consists of eight helices arranged to give a precise three-dimensional shape.

Describe how the precise three-dimensional shape of a polypeptide is maintained.

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 8]

Q.18

2 Scientists have developed a variety of ways to represent the three dimensional structure of proteins. Fig. 2.1 shows one way of representing the structure of the protein, haemoglobin.

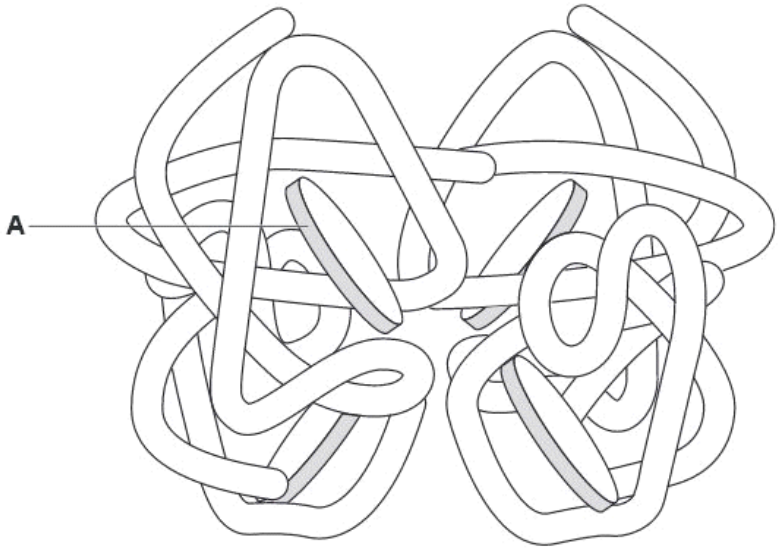


Fig. 2.1

(a) (i) Name **A** and state its role.

name .....

role .....

.....

.....[3]

(ii) With reference to Fig. 2.1, explain why a molecule of haemoglobin is said to show **both** tertiary structure and quaternary structure.

.....

.....

.....

.....

.....[2]

Q.19.

5 **(a)** Table 5.1 contains statements about four molecules.

Complete the table by indicating with a tick (✓) or a cross (✘) whether the statements apply to haemoglobin, DNA, phospholipids or antibodies.

You should put a tick or a cross in each box of the table.

Table 5.1

statement	haemoglobin	DNA	phospholipids	antibodies
contains iron				
contains phosphate				
able to replicate				
hydrogen bonds stabilise the molecule				
contains nitrogen				

[5]

(b) Water is sometimes described as providing an ideal environment for many organisms.

Explain how the hydrogen bonds between water molecules affect the properties of water and help to make water an ideal environment for many organisms.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 10]

Q.20.

2 Polysaccharides, such as glycogen, amylopectin and amylose, are formed by polymerisation of glucose. Fig. 2.1 shows part of a glycogen molecule.

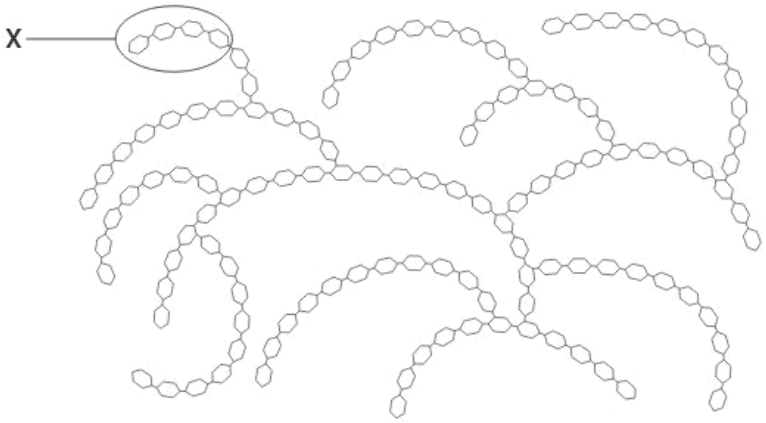


Fig. 2.1

(a) With reference to Fig. 2.1,

(i) describe how the **structure** of glycogen differs from the structure of amylose;

.....

.....

.....

.....

..... [2]

(ii) describe the advantages for organisms in storing polysaccharides, such as glycogen, rather than storing glucose.

.....

.....

.....

.....

.....

..... [3]

(b) Glycogen may be broken down to form glucose.

Fig. 2.2 shows region **X** from the glycogen molecule in Fig. 2.1 in more detail.

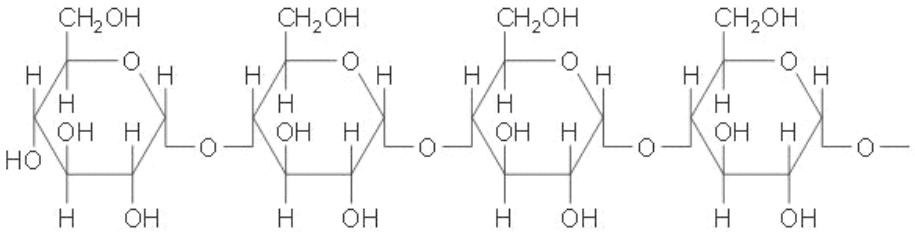


Fig. 2.2

Draw an annotated diagram in the space provided to explain how a glucose molecule is formed from the free end of the glycogen molecule shown in Fig. 2.2.

[3]

[Total: 8]

Q.21

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

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

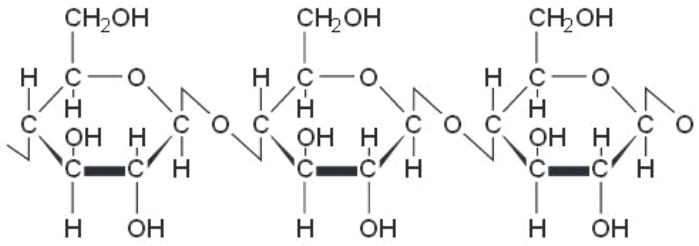


Fig. 5.1

(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]

Q.22.

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]

There are many different variants of haemoglobin. The sequence of bases in DNA that code for the first seven amino acids in two variants of the β-globin polypeptide are shown in Fig. 3.2.

The genetic dictionary for some of the amino acids is in Table 3.1.

Variant 1

1	2	3	4	5	6	7
CAC	GTG	GAC	TGA	GGA	CTC	CTC

Variant 2

1	2	3	4	5	6	7
CAC	GTG	GAC	TGA	GGA	CAC	CTC

Fig. 3.2

Table 3.1

amino acid	abbreviation	DNA triplets on the coding polynucleotide
valine	val	CAA, CAC, CAG, CAT
proline	pro	GGA, GGC, GGG, GGT
threonine	thr	TGA, TGC, TGG, TGT
histidine	his	GTA, GTG
glutamic acid	glu	CTC, CTT
leucine	leu	AAC, AAT, GAA, GAC, GAG, GAT

(b) Use the genetic dictionary to describe the similarities and differences between the two variants of haemoglobin.

.....

.....

.....

.....

.....

.....[3]

(c) Collagen is a fibrous protein found in many tissues in animals.

(i) State the function of collagen in the walls of arteries.

.....

.....[1]

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

.....

.....[1]

[Total: 9]

Q.23.

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

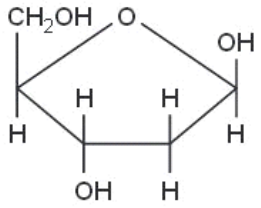


Fig. 4.1

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]

Q.24.

(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.

.....

.....

.....

.....

.....

.....

.....

.....[4]

Q.25.

(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]

(ii) State **one** role of magnesium ions within chloroplasts.

.....

..... [1]

Q.26

2 **(a)** Table 2.1 shows eight ions that are biologically important.

Table 2.1

ammonium (NH_4^+)	**A**
hydrogen (H^+)	**B**
hydrogen carbonate (HCO_3^-)	**C**
iron (Fe^{2+})	**D**
magnesium (Mg^{2+})	**E**
nitrate (NO_3^-)	**F**
phosphate (PO_4^{3-})	**G**
sulfate (SO_4^{2-})	**H**

Choose one ion to match each of the following statements. In each case write **one** letter from Table 2.1. You may use each letter (**A** to **H**) once, more than once or not at all.

(i) A component of polynucleotides.

.....[1]

(ii) Ion produced by enzyme activity inside red blood cells.

.....[1]

(iii) Ion used in the production of all amino acids in chloroplasts.

.....[1]

(iv) Ion that diffuses through carrier proteins with sucrose into companion cells in phloem tissue.

.....[1]

(v) Component of haem group in haemoglobin that binds oxygen.

.....[1]

Q.27.

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.

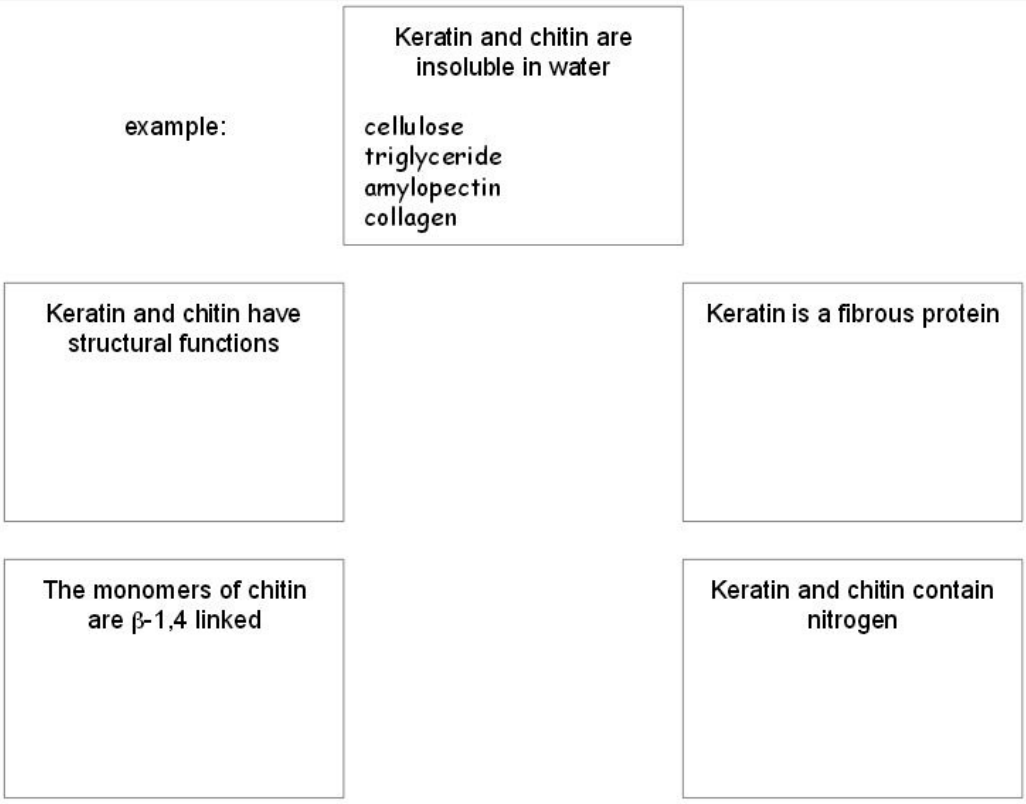


Fig. 2.1

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]

Q.28.

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

description

.....

.....

.....

.....

.....

explanation

.....

.....

.....

.....

..... **[4]**

Q.29.

(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.

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.....

.....

.....

.....

..... [3]

[Total: 8]