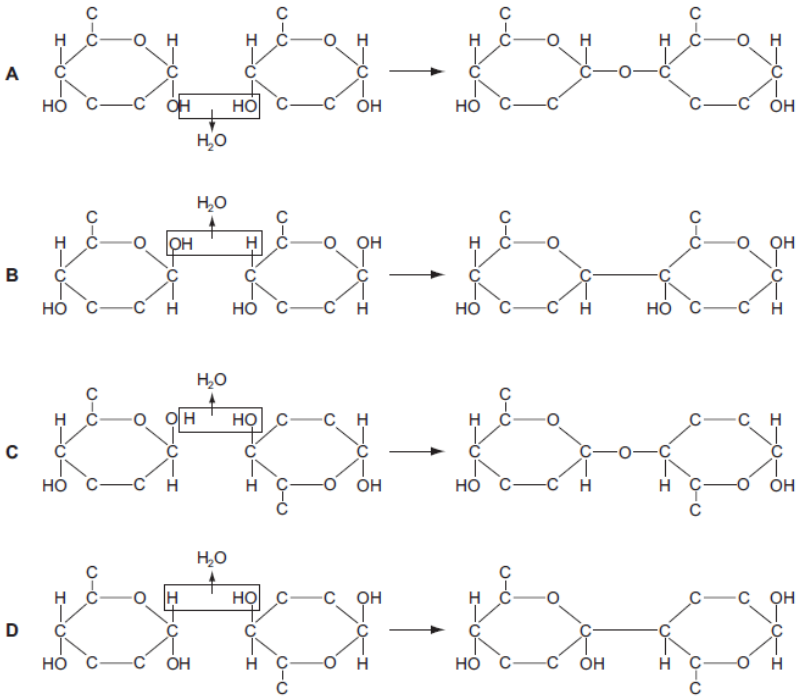
Name:_____ Period:_____

Problem Set: Biochemistry

Complete the following questions on your own. When you are done and your answers have been checked for completion, you may check your work for accuracy using Ms. Paxson's key. This assignment is due Wednesday, September 5 and is worth 30 points.

1. Which diagram shows the reaction that occurs to link two monomers that form cellulose?



2. Which bonds will be broken when a molecule of glycogen is hydrolysed?

1 α-1, 4

2 β-1, 4

3 α-1, 6

4 β-1, 6

A 1 and 3 only **B** 2 and 4 only **C** 1, 2 and 3 only **D** 2, 3 and 4 only

3. Collagen is a macromolecule with three polypeptides lying closely side by side in the form of a triple helix.

Every third amino acid in each polypeptide has the shortest possible R-group or side chain (– H) to allow close packing of the polypeptides.

Which is the amino acid?

A glucose

B glycerol

C glycine

D guanine

4. Which property of water makes it most suitable for transport in eukaryotic organisms?

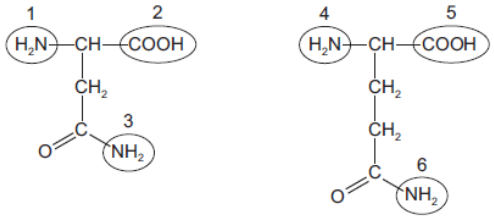
A density

B ionisation

C latent heat of vaporisation

D solvent properties

5. The diagrams show the structures of two amino acids, each of which has two amine ($-NH_2$) groups.



A peptide bond is formed between the two amino acids.

Which groups form the peptide bond?

A 1 and 4 **B** 1 and 5 **C** 2 and 6 **D** 3 and 5

6. Each list, 1, 2 and 3, shows some substances found in animal tissues.

1 glucose, cholesterol, triglycerides, water.

2 glycogen, antibodies, adenine, phospholipids.

3 haemoglobin, carbon dioxide, mRNA, monosaccharides.

Which shows one or more substances that contain nitrogen atoms?

A 1, 2 and 3

B 1 and 2 only

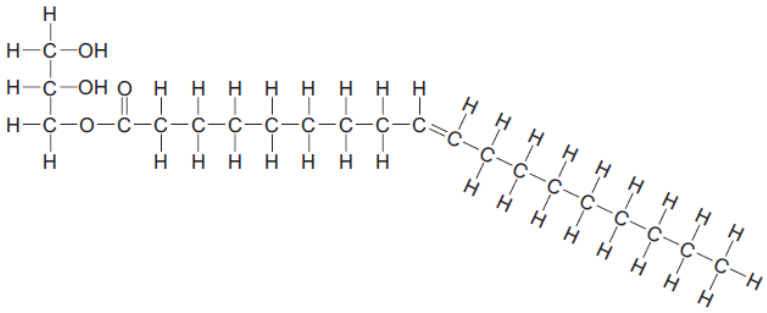
C 1 and 3 only

D 2 and 3 only

7. Which combination of procedures would **not** be used in a food test?

	use heat	use biuret reagent	use Benedict's reagent	boil with dilute acid
A	✓		✓	
B	✓	✓		
C	✓		✓	✓
D		✓		

8. The diagram shows a triglyceride molecule that has been partially hydrolysed.



What will be the products of the total hydrolysis of the molecule shown?

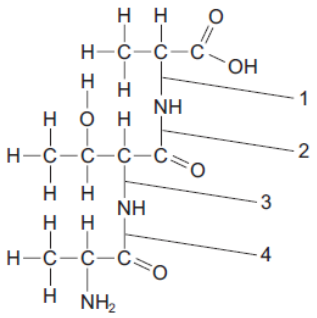
A a molecule of glycerol and a saturated fatty acid molecule only

B a molecule of glycerol and an unsaturated fatty acid molecule only

C a molecule of water, a molecule of glycerol and a saturated fatty acid molecule

D a molecule of water, a molecule of glycerol and an unsaturated fatty acid molecule

9. The diagram shows a tripeptide molecule.



At which two points will hydrolysis occur to release three amino acids?

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 2 and 4

10. Which statement is true for cellulose, but **not** true for protein?

A It is found in cell surface membranes.

B It is synthesised from identical sub-units.

C It is used as an energy source.

D It may be a structural component.

11. Which features of collagen result in it having high tensile strength?

1 covalent bonds form between adjacent molecules

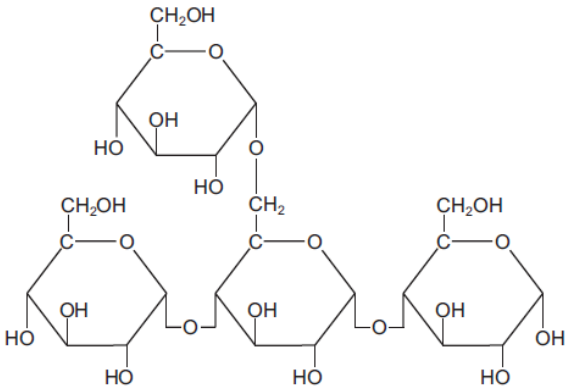
2 each three-stranded molecule is held together by hydrogen bonds

3 every third amino acid in the polypeptide is small

4 the primary structure is held together by peptide bonds

A 1 and 2 **B** 1, 2 and 3 **C** 1, 3 and 4 **D** 2, 3 and 4

12. The diagram shows a carbohydrate molecule.



Of which polymers could this be a part?

A amylopectin and cellulose

B amylose and starch

C glycogen and amylose

D starch and glycogen

13. Two disaccharides are maltose and sucrose. Maltose is formed from two molecules of glucose, whilst sucrose is formed from fructose and glucose.

Which row shows the molecular formulae of the two disaccharides?

	maltose	sucrose
A	$C_{12}H_{22}O_{11}$	$C_{12}H_{22}O_{11}$
B	$C_{12}H_{22}O_{11}$	$C_{12}H_{24}O_{12}$
C	$C_{12}H_{24}O_{12}$	$C_{12}H_{22}O_{11}$
D	$C_{12}H_{24}O_{12}$	$C_{12}H_{24}O_{12}$

14. Which is the strongest type of bonding found in proteins?

A disulfide bonds

B hydrogen bonds

C hydrophobic interactions

D ionic bonds

15. Solutions of biological molecules are tested for sugars. The table shows the colours of the solutions after testing.

Which may contain reducing sugars?

solution	heated with Benedict's solution	boiled with hydrochloric acid, neutralised, then heated with Benedict's solution
1	blue	yellow
2	green	orange
3	orange	red

A 1, 2 and 3 **B** 1 and 3 only **C** 2 and 3 only **D** 1 only

16. Four students, 1, 2, 3 and 4, each carried out the reducing sugar test and the non-reducing sugar test on a sucrose solution.

Which observations demonstrate that they carried out the correct tests?

student	observations for reducing sugar test	observations for non-reducing sugar test
1	no colour change	changed colour
2	no colour change	red
3	blue	changed colour
4	blue	red

A 2 only

B 3 only

C 4 only

D 1, 2, 3 and 4

17. Which of the bonds will be last to break as the temperature of an enzyme is increased?

A covalent

B hydrogen

C hydrophobic interactions

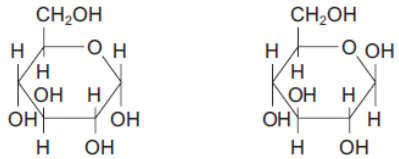
D ionic

18. Which row is correct for each of the molecules?

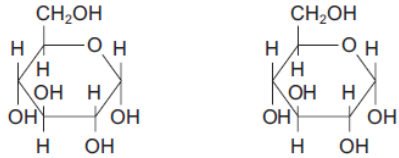
	β-glucose	collagen	haemoglobin	sucrose
A	hexose sugar with a molecular formula $C_6H_{12}O_6$	structural function, found in tendons and blood vessel walls	contains the elements carbon, hydrogen, iron, nitrogen and sulfur	formed by releasing a molecule of water in a hydrolysis reaction
B	repeating monomer of the polysaccharide, cellulose	a molecule consists of three polypeptide chains, each containing a prosthetic group	each non-protein haem group contains a central iron ion	composed of two monosaccharides linked by a glycosidic bond
C	monomer of the 1,6 glycosidic branches of the polysaccharide, glycogen	molecules lie parallel to each other, with cross-links and staggered ends	has two identical α chains and two identical β chains	formed by condensation of two identical monosaccharides
D	in its ring structure, the hydroxyl group of carbon atom 1 is above the plane of the ring	polypeptide chains interact to produce a fibrous protein	has all four levels of protein structure and at least four types of bond	digestion yields glucose and fructose in equal proportions

19. Which pair of monosaccharides form sucrose?

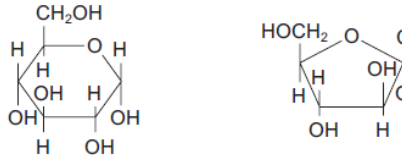
A



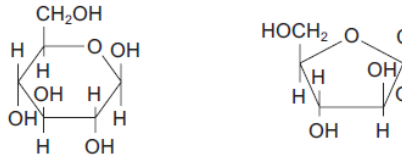
B



C



D



20. Which statement about triglycerides is correct?

A They are made up of three fatty acids combined with glycogen.

B They are more saturated with hydrogen compared with phospholipids.

C They form a bilayer in the membranes of cells.

D They have a lower ratio of oxygen to carbon compared with carbohydrates.

21. Which molecules contain C=O bonds?

1 amino acids

2 fatty acids

3 glycerol

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

22. Which of the statements about polysaccharides can be used to describe both amylose and glycogen?

1 contains 1,4 glycosidic bonds

2 contains 1,6 glycosidic bonds

3 polymer of α–glucose

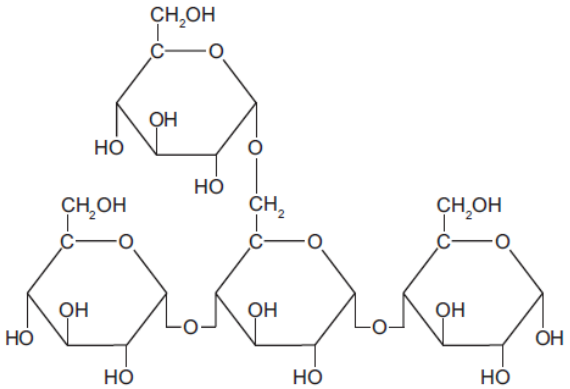
A 1 only

B 1 and 3 only

C 2 and 3 only

D 1, 2 and 3

23. The diagram shows part of a carbohydrate molecule.



If all the 1,4 glycosidic bonds in this molecule are hydrolysed, how many water molecules will be used and how many separate glucose molecules will be produced?

	number of water molecules used	number of glucose molecules produced
A	1	1
B	2	2
C	3	3
D	4	4

24. A peptide bond is formed between atoms of which two elements?

A carbon and carbon

B carbon and hydrogen

C carbon and nitrogen

D hydrogen and nitrogen

25. Which features affect the tensile strength of collagen?

1 the helical structure of collagen chains

2 the small R group of the amino acids in collagen

3 the insoluble nature of collagen

4 the covalent bonds between collagen molecules

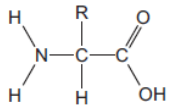
A 1, 2, 3 and 4

B 1 and 3 only

C 1, 2 and 4 only

D 2, 3 and 4 only

26. An amino acid can be represented as



where R represents a variable side chain.

Which is **not** a possible side chain?

A CH_3

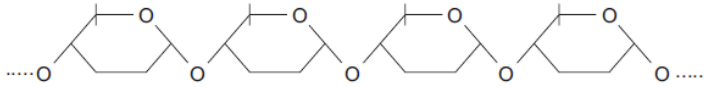
B $CH_2CH_2SCH_3$

C CH_2CONH_2

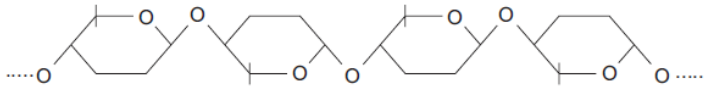
D $HOCH_2CH(OH)CH_2OH$

27. Which diagram shows part of a structural polysaccharide?

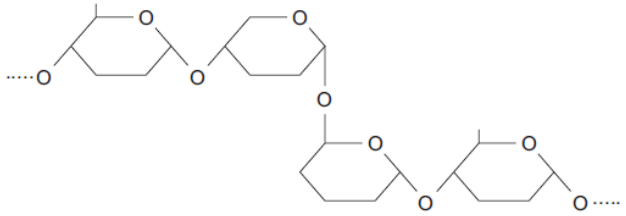
A



B



C



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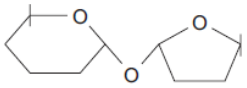


28. Which type of molecule contains disulphide bonds and which contains glycosidic bonds?

	disulphide bonds	glycosidic bonds
A	glycoprotein	polysaccharide
B	nucleic acid	glycoprotein
C	polysaccharide	nucleic acid
D	protein	triglyceride

29. Which substances contain carbon, hydrogen, oxygen and nitrogen?

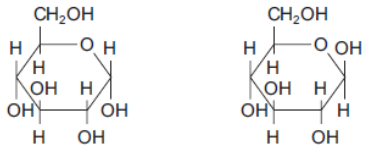
1 amylopectin
2 collagen
3 deoxyribonucleic acid

A 2 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

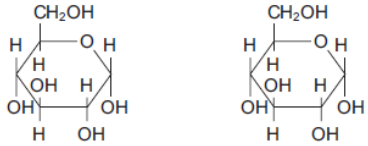
30. Sucrose is a disaccharide formed from two hexose sugars, α-glucose (alpha-glucose) and fructose.

Which pair of monosaccharide structures will be formed when sucrose is hydrolysed?

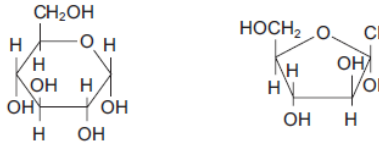
A



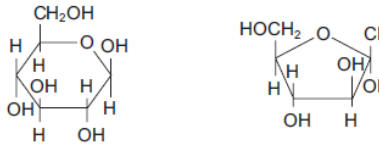
B



C



D



31. A number of different types of bonds maintain the structure of proteins. These include disulphide, hydrogen and ionic bonds, as well as hydrophobic interactions. Some of these are stronger than others.

Which are the strongest?

A disulphide bonds
B hydrogen bonds
C hydrophobic interactions
D ionic bonds

32. Haemoglobin is a globular protein consisting of four polypeptide chains – 2 alpha chains and 2 beta chains. In normal individuals, in the DNA which codes for each beta chain, the sixth triplet has a code for glutamic acid.

In individuals with sickle cell anaemia this base triplet changes and codes for valine.

What aspect of the haemoglobin molecule does this mutation change?

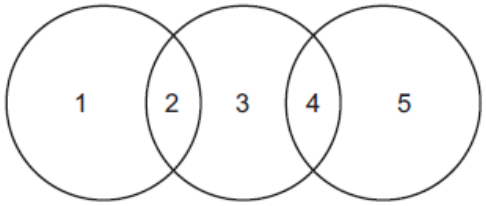
A the iron content
B the primary structure
C the quaternary structure
D the secondary structure

33. Which correctly matches the functional and structural features of cellulose, collagen, glycogen or triglyceride?

		function	structure		
			fibrous	molecule held together by hydrogen bonds	branched chains
A	cellulose triglyceride	support energy source	✓ ✗	✓ ✗	✗ ✗
B	collagen cellulose	strengthening support	✓ ✓	✓ ✗	✗ ✓
C	collagen glycogen	strengthening storage	✓ ✗	✓ ✗	✓ ✓
D	glycogen triglyceride	storage energy source	✗ ✗	✓ ✓	✓ ✗

key ✓ = true ✗ = false

34. The diagram shows the relationship between the levels of protein structure and bonds.



Which row is correct?

	1	2	3	4	5
A	primary	peptide	secondary	ionic	tertiary
B	secondary	hydrogen	tertiary	peptide	primary
C	tertiary	ionic	primary	peptide	quaternary
D	quaternary	ionic	tertiary	ionic	secondary

35. How many molecules of oxygen are bound to one molecule of haemoglobin, when it is fully saturated with oxygen?

A 1 B 2 C 4 D 8

36. **(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.

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..... [5]

[Total: 10]

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

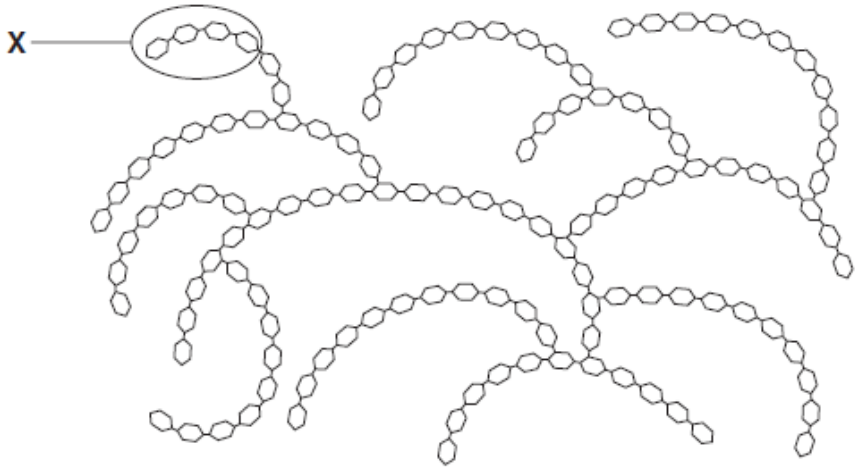

Fig. 2.1

(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.

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.....

..... [3]

37. continued…

(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.

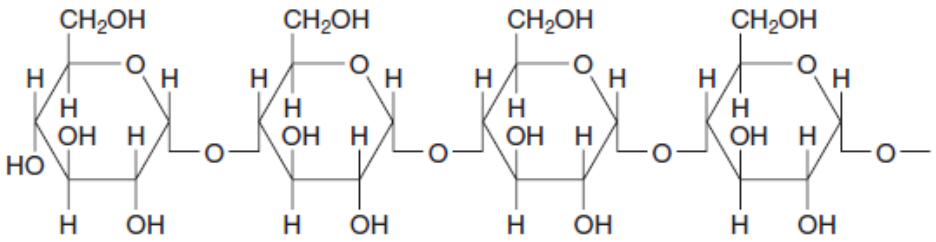

Fig. 2.2

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]

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

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

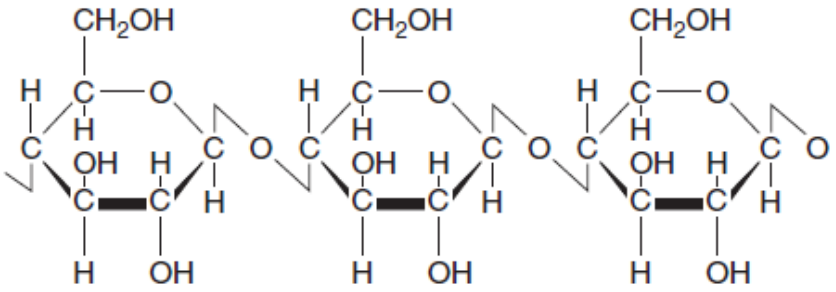

Fig. 5.1

(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]

38. continued…

Plant cell walls consist of cellulose that is embedded in a matrix of compounds, such as pectins and proteins.

Cell wall material is synthesised inside the cell and transported to the cell surface membrane as shown in the drawing made from an electron micrograph in Fig. 5.2.

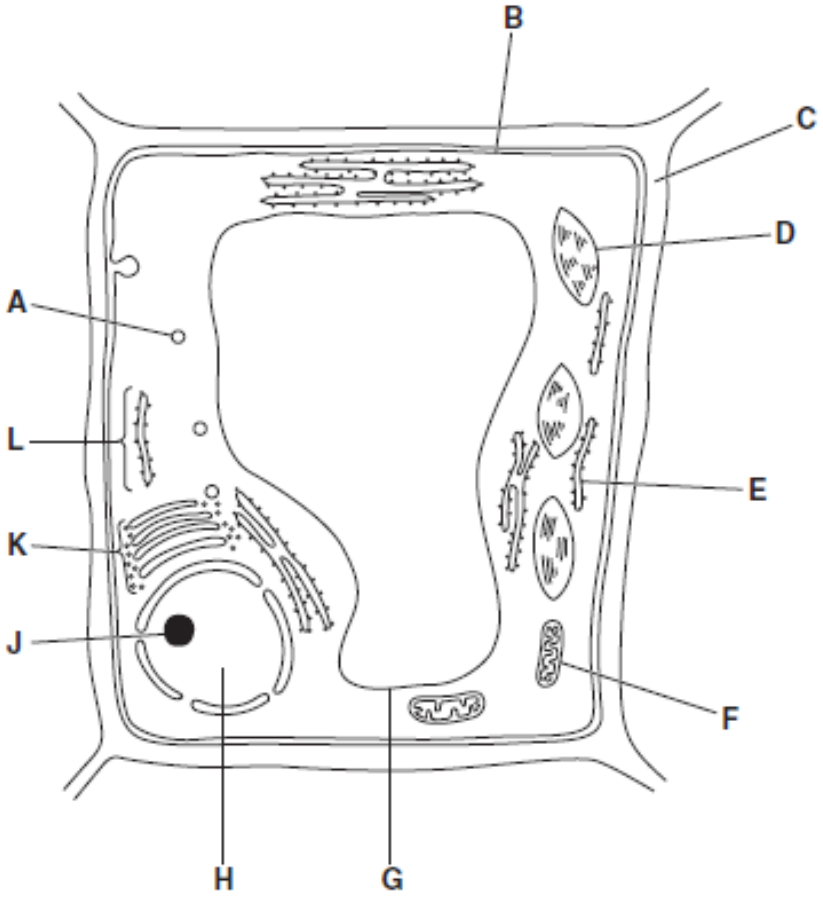

Fig. 5.2

(c) Locate the parts of the cell labelled in Fig. 5.2 which apply to each of the following statements. You must only give one letter in each case. You may use each letter once, more than once or not at all. The first answer has been completed for you.

statement	letter from Fig. 5.2
organelle that contains DNA	**H**
transports cell wall material to the cell surface membrane	
site of transcription	
site of ribosome synthesis	
site of photosynthesis	

[4]

38. continued…

(d) Enzymes known as expansins are found in the matrix of cell walls to help the growth of cells.

Use the information in Fig. 5.2 to describe how proteins made by the ribosomes reach the matrix of the cell wall.

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.....[3]

[Total: 11]

39. In the space below, prepare the space to compare glycogen, amylopectin, cellulose, and amylose.

40. Fig. 3.1 shows the structure of the enzyme lysozyme.

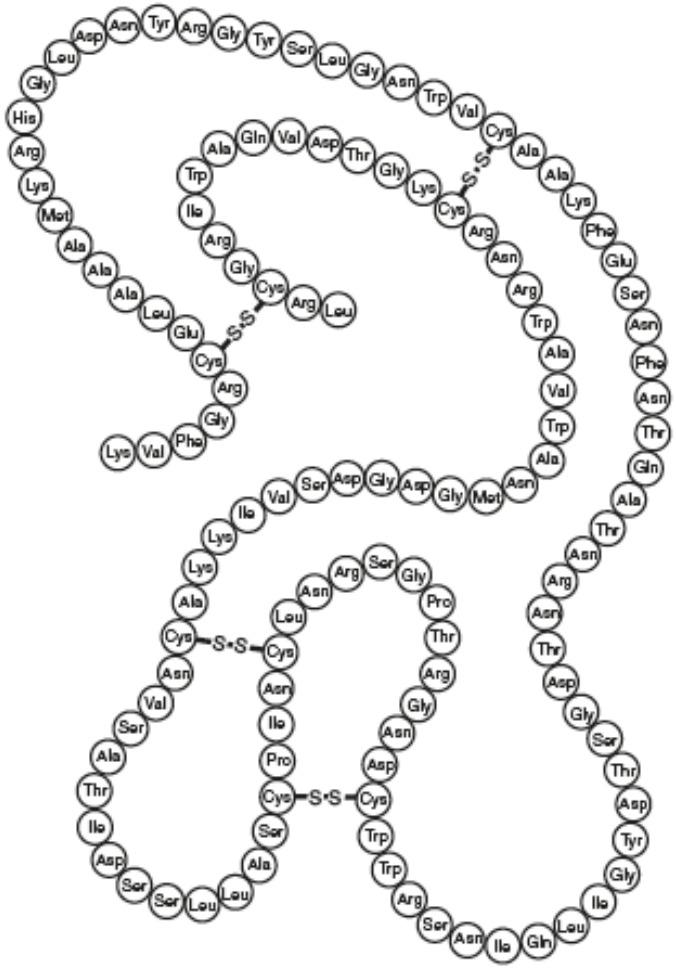

Fig. 3.1

(a) **(i)** Name the **two** types of covalent bond in the structure in Fig. 3.1.

.....[1]

(ii) The primary structure of lysozyme is shown in Fig. 3.1.

Explain the meaning of the term *primary structure*.

.....

.....

.....[1]

41. 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.

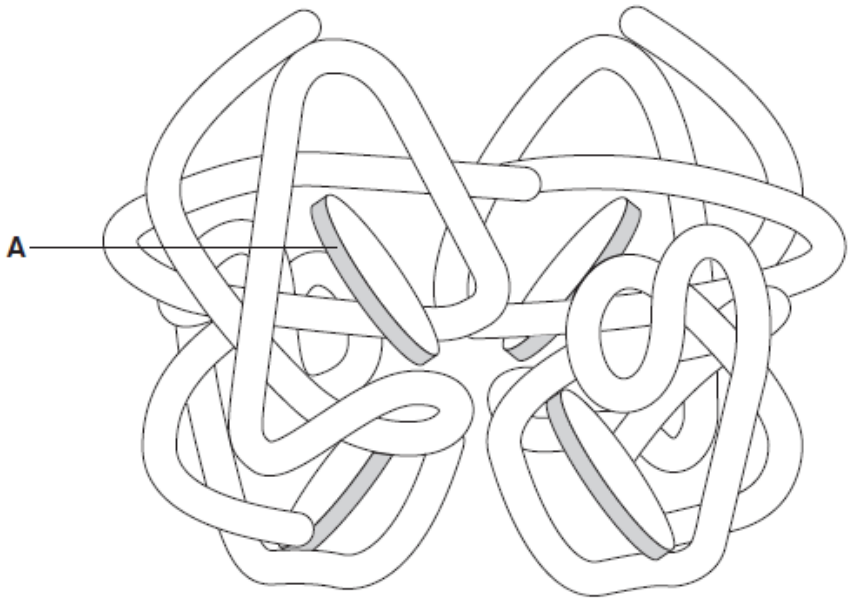

Fig. 2.1

(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]

42. 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.

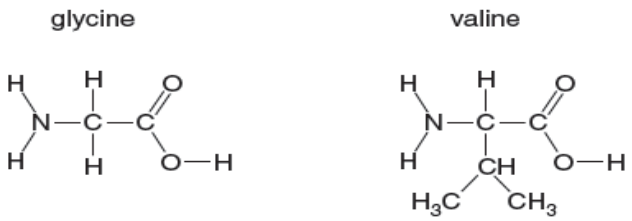

Fig. 3.1

[4]

43. Statements **A** to **E** relate to biological molecules.

For each statement, identify the most appropriate term that matches the description.

A The molecule formed from a condensation reaction between fructose and glucose.

.....

B The name of the bond broken when two amino acids are separated by hydrolysis.

.....

C The unbranched polymer consisting only of β-glucose molecules.

.....

D The reagent used to test for the presence of proteins.

.....

E The molecule produced, in addition to fatty acids, when a triglyceride is hydrolysed.

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[5]

[Total: 5]

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

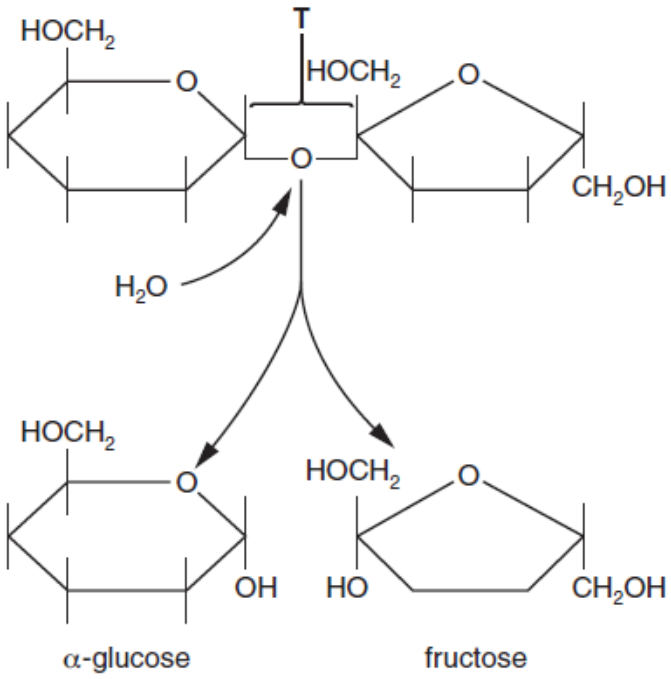

Fig. 1.1

(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]

45. One of the enzymes involved in glycogen synthesis is glycogen synthase. The monomer of the glycogen polymer is α-glucose.

(a) **(i)** Draw the ring form of α-glucose in the space provided.

[2]

(ii) Glycogen synthase catalyses the formation of a covalent bond between two α-glucose molecules during glycogen synthesis.

Name the type of bond formed.

.....[1]

(iii) Glycogen branching enzyme is another enzyme that is required for glycogen synthesis.

Suggest why glycogen branching enzyme is needed in addition to glycogen synthase.

.....

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.....

.....[1]

In the space below, draw a Beta glucose molecule to compare to the molecule above.