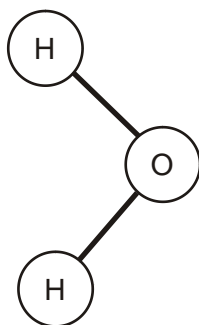


1. The figure below represents a water molecule.



Water molecules are polar. As a result, they attract each other.

Draw a second water molecule on the figure above.

Your drawing should show:

- the bond(s) between the two molecules
- the name of the bond
- the charges on each atom.

[Total 3 marks]

2. Ponds provide a very stable environment for aquatic organisms.

Three properties of water that contribute to this stability are as follows:

- the density of water decreases as the temperature falls below 4 °C so ice floats on the top of the pond
- it acts as a solvent for ions such as nitrates (NO_3^-)
- a large quantity of energy is required to raise the temperature of water by 1 °C.

Explain how these three properties help organisms survive in the pond.



In your answer you should make clear the links between the behaviour of the water molecules and the survival of the organisms.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Total 8 marks]

3. Water is important in many biological reactions.

Complete the table below by writing an appropriate term next to each description.

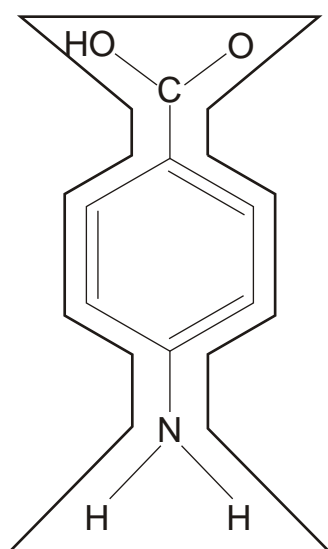
description	term
the type of reaction that occurs when water is added to break a bond in a molecule	
the phosphate group of a phospholipid that readily attracts water molecules	

[Total 2 marks]

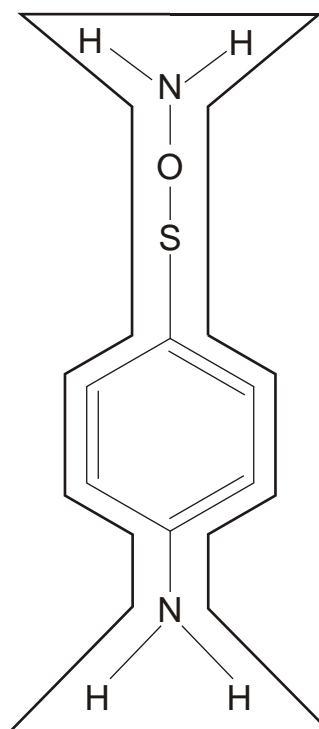
4. The enzyme DHPS is involved in the production of folic acid in bacteria.

- The substrate for DHPS is a molecule known as PABA.
- The enzyme DHPS is inhibited by the drug sulfonamide.

The figure below shows the structure of PABA and that of sulfonamide.

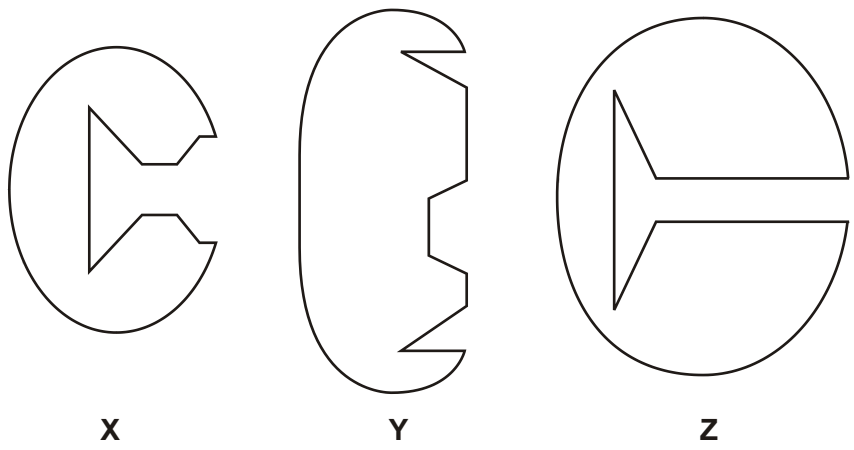


PABA



sulfonamide

(i) Diagrams **X**, **Y** and **Z** represent these enzyme molecules and their active sites.



State the letter, **X**, **Y** or **Z**, that most accurately represents the enzyme DHPS.

.....

[1]

(ii) Using the information in the figure above, explain why sulfonamide acts as a competitive inhibitor of DHPS.

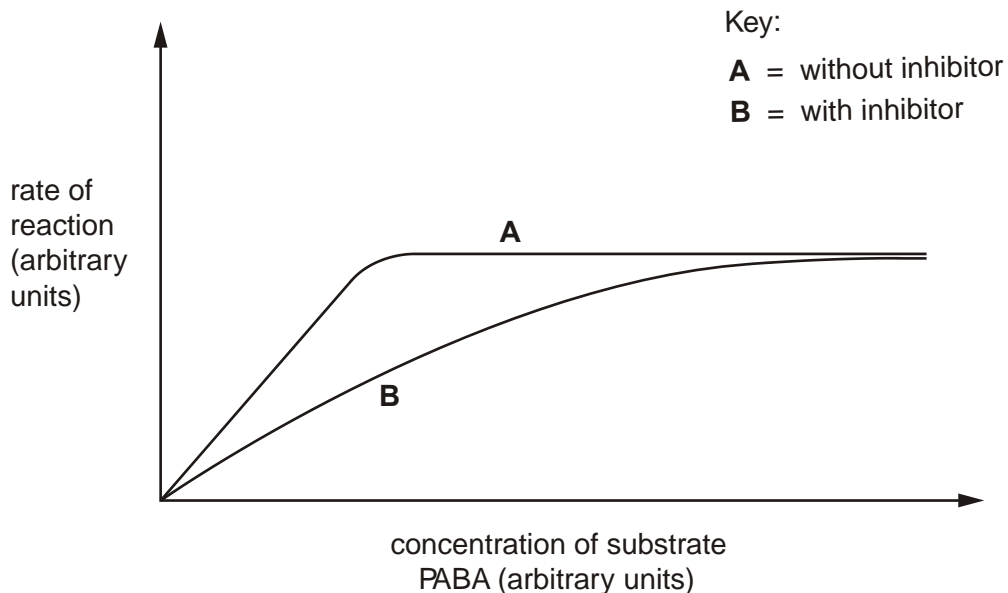
.....
.....
.....
.....
.....
.....
.....

[3]

[Total 4 marks]

5. The figure below shows the effect of increasing the concentration of the substrate (PABA) on the rate of reaction.

- Curve **A** shows the rate of reaction without the presence of the competitive inhibitor sulfonamide.
- Curve **B** shows the rate of reaction in the presence of the competitive inhibitor sulfonamide.



Explain the effect of increasing the concentration of substrate on the rate of reaction;

(i) without inhibitor,

.....
.....
.....
.....
.....
.....

(ii) with inhibitor.

.....

.....

.....

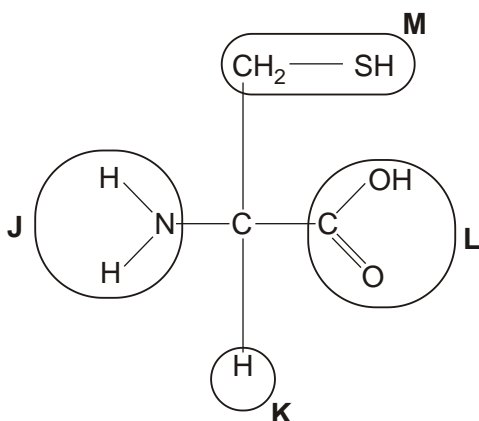
.....

.....

[2]

[Total 5 marks]

6. (a) Amino acids are the basic building blocks for proteins. The figure below shows the amino acid cysteine.



- (i) Complete the table by selecting the letter, **J**, **K**, **L** or **M**, that represents the following groups in cysteine.

group	letter
carboxyl	
R group	
amine group	

[3]

(ii) The primary structure of a protein consists of a chain of amino acids.

Describe how a second amino acid would bond to cysteine in forming the primary structure of a protein.

.....

.....

.....

.....

.....

.....

.....

.....

[3]

(b) Each amino acid has a different R group.

Describe how these R groups can interact to determine the **tertiary** structure of a protein.

.....

.....

.....

.....

.....

.....

.....

.....

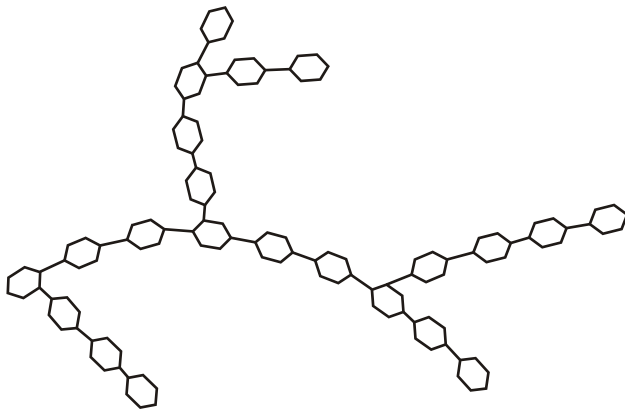
.....

.....

[4]

[Total 10 marks]

7. The figure below shows the structure of two polymers, glycogen and collagen, that are found in mammals.



glycogen



collagen

- (i) Complete the table below to give three **differences** between the **structure** of glycogen and collagen.

glycogen	collagen

(ii) Collagen is found in the ligaments which hold bones together at joints.

State **two** properties of collagen that make it suitable for this purpose.

1

2

[2]

[Total 5 marks]

8. DNA and RNA are nucleic acids.

(i) State the components of a **DNA** nucleotide.

.....
.....
.....
.....

[3]

(ii) Describe how the structure of RNA differs from that of DNA.

.....
.....
.....
.....

[2]

[Total 5 marks]

9. Before a cell divides, the DNA needs to be accurately replicated.

Describe how a DNA molecule is replicated.



In your answer you should make clear how the steps in the process are sequenced.

[Total 7 marks]

10. (i) State what a gene codes for.

.....
.....
.....

[1]

(ii) Suggest how changing the sequence of DNA nucleotides could affect the final product the DNA codes for.

.....
.....
.....
.....
.....

[2]

[Total 3 marks]

11. Complete the following passage by using the most appropriate terms from the list to fill the gaps.

Each term should not be used more than once.

anti-parallel

β -pleated sheet

covalent

double helix

hydrogen

parallel

polypeptide

ribose

sugar-phosphate

DNA is found in the nucleus. The molecule is twisted into a
 in which each of the strands are It
 has two backbones attached to one another by
 complementary bases. These bases pair in the centre of the molecule by means of
 bonds.

[Total 4 marks]

12. The table below shows the relative proportions of different DNA bases in four different organisms.

relative proportions of bases in DNA as a percentage				
organism	A	C	G	T
human	30.9	19.8	19.9	29.4
grasshopper	29.3	20.7	20.5	29.3
wheat	27.3	22.8	22.7	27.1
<i>E. coli</i>	24.7	25.7	26.0	23.6

(i) Describe the patterns shown by the data given in the table above.

.....
.....
.....
.....
.....
.....
.....
.....

[3]

(ii) Suggest how the data given in the table above might have been helpful to scientists in working out the structure of DNA.

.....
.....
.....
.....

[2]

[Total 5 marks]

13. DNA in the nucleus acts as a template for the production of RNA.

Complete the table below to show **three** ways in which the structure of DNA differs from that of RNA.

feature	DNA	RNA
number of strands		
bases present		
sugar present		

[Total 3 marks]

14. DNA codes for the structure of polypeptides.

State the role of messenger RNA (mRNA).

.....

.....

.....

.....

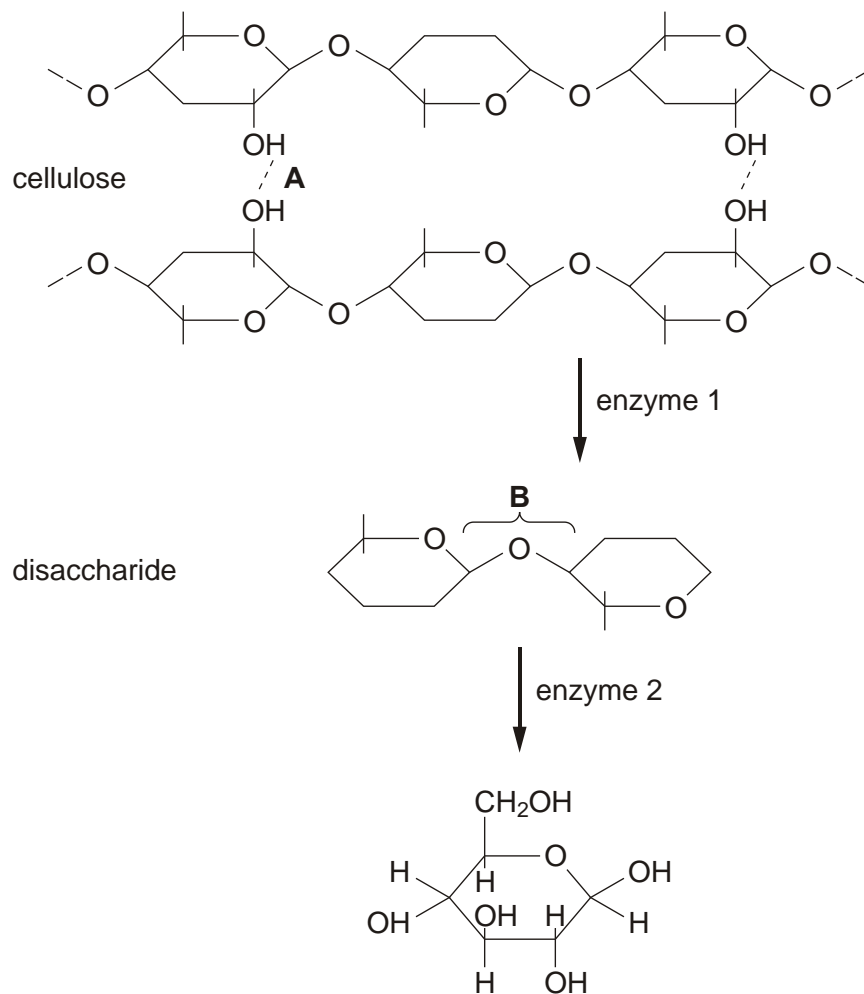
.....

[Total 2 marks]

15. In the search for new biofuels, research has been done into the digestion of wood waste by fungi.

The cellulase enzymes produced by the fungi break cellulose into sugars. These sugars can then be converted into ethanol, a biofuel.

The figure below shows the stages in this digestion process.



- (a) (i) Name bonds **A** and **B** shown in the figure.

A

B

(ii) State how bond **B** is broken in the digestion of the disaccharide.

.....
.....

[1]

(iii) Name the sugar that is the **final** product of this digestion process.

.....

[1]

(b) Explain why **different** enzymes are involved in each stage of the digestion process.

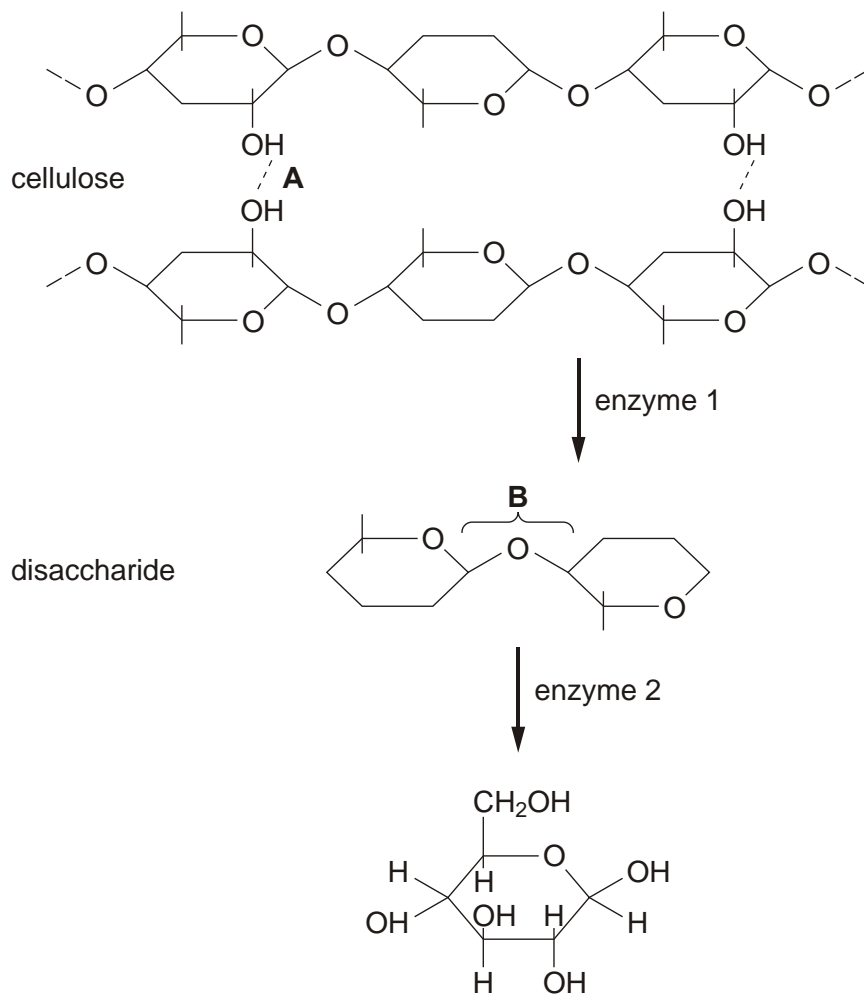
.....
.....
.....
.....
.....
.....
.....
.....

[3]

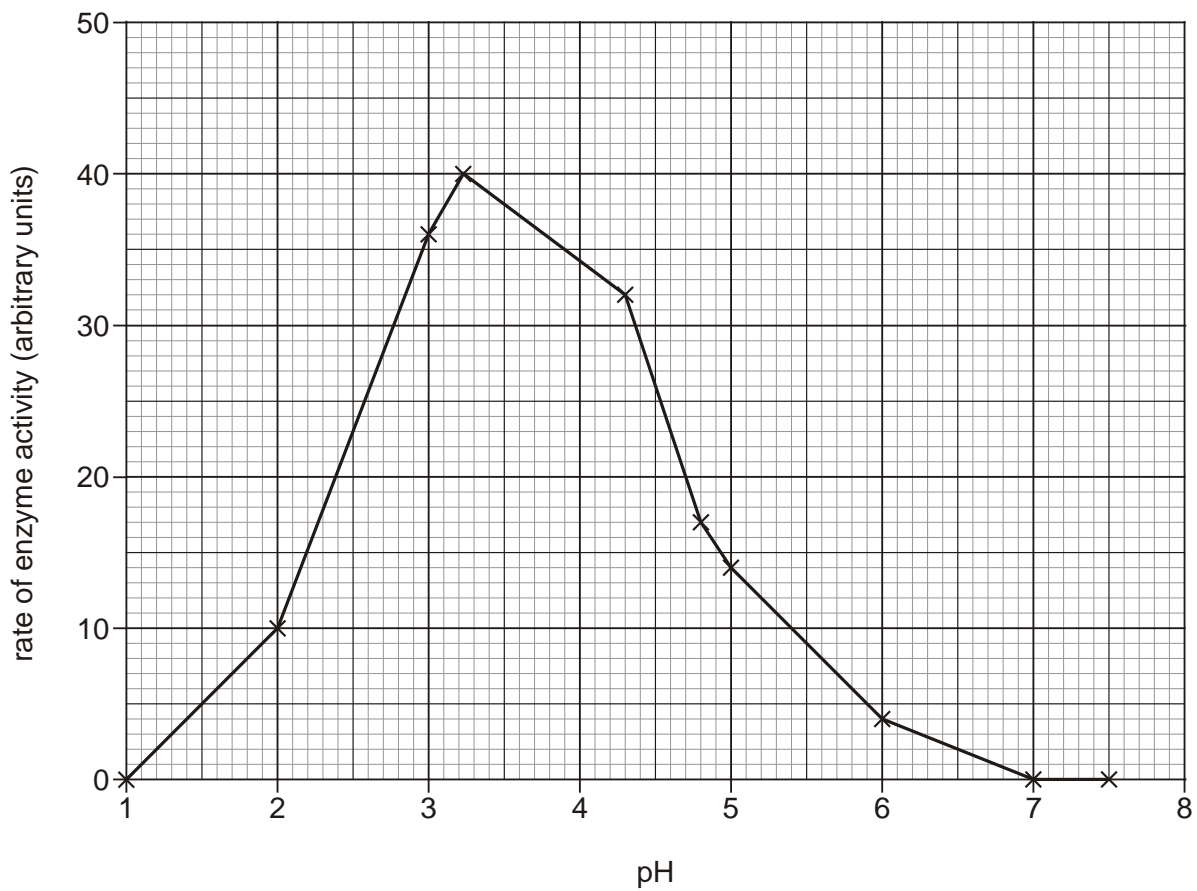
- (c) In the search for new biofuels, research has been done into the digestion of wood waste by fungi.

The cellulase enzymes produced by the fungi break cellulose into sugars. These sugars can then be converted into ethanol, a biofuel.

The figure below shows the stages in this digestion process.



The figure below shows the effect of changing pH on the rate of activity of **enzyme 2**.



(i) Explain why the activity of **enzyme 2** falls to zero at pH 7.

.....

.....

.....

.....

.....

.....

.....

(ii) State **two** factors that should have been controlled when investigating the effect of pH on the activity of **enzyme 2**.

1

2

[2]

[Total 12 marks]

16. The activity of an enzyme can be measured by testing for the concentration of its product at regular intervals.

Describe how the concentration of a reducing sugar can be measured using a colorimeter.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Total 6 marks]

17. Some species of Acacia tree produce gum arabic. Gum arabic is classed as a heteropolysaccharide. This means that it is made up of a number of different sugars.

Hydrolysis of gum arabic releases four different monosaccharides.

Describe what happens during the hydrolysis of a polysaccharide molecule.

.....

.....

.....

.....

.....

.....

[Total 2 marks]

18. Complete the table below, comparing gum arabic with some other polysaccharides.

	gum arabic	amylase	cellulose	glycogen
branched structure	yes		no	
heteropolysaccharide	yes		no	
found in animals/plants	plants		plants	
function in organism	healing cuts			energy store

[Total 4 marks]

19. *Acacia senegal* is a species of tree which is common in the drier parts of Africa. Cattle are allowed to graze on both its leaves and the fallen seed pods. The seed pods have relatively high protein content.

(i) Describe how you would test an extract of the seed pods for protein.

.....

.....

.....

.....

.....

.....

[2]

(ii) Describe how you could compare the **reducing sugar** content of the leaves with that of the seed pods.



In your answer you should make clear how the steps in the process are sequenced.

[8]

(iii) The **seeds** of *Acacia* species are sometimes eaten by people.

Suggest why it might be better for people living in areas where the tree grows to let their cattle feed on the trees and fallen seed pods and then obtain their nutrition from the cattle.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[3]
[Total 13 marks]

20. DNA and RNA are nucleic acids.

(i) Describe the structure of a DNA **nucleotide**.

In your answer you should spell the names of the molecules correctly.

You may use the space below to draw a diagram if it will help your description.

.....

.....

.....

.....

.....

.....

[3]

(ii) Describe how the two nucleotide chains in DNA are bonded together.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

[4]

[Total 7 marks]

21. State **three** ways in which the structure of DNA differs from that of RNA.

1

.....

2

.....

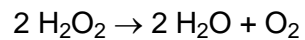
3

.....

[Total 3 marks]

22. The fungus, yeast, contains the enzyme catalase.

Catalase speeds up the decomposition of hydrogen peroxide, a toxic metabolic product, to oxygen and water.



A student decided to investigate the activity of catalase using the apparatus shown in Fig. 1.

The total volume of gas collected was recorded every 20 seconds.

The results are shown in Fig. 2.

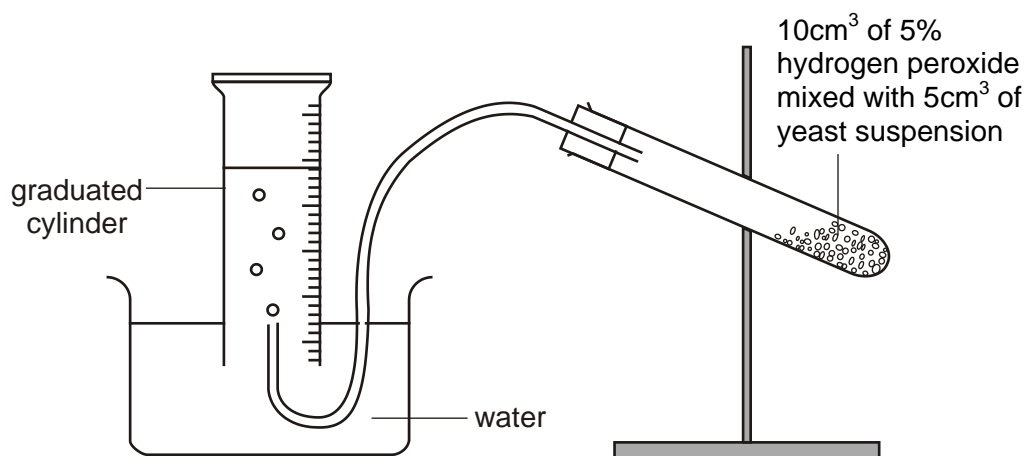


Fig. 1

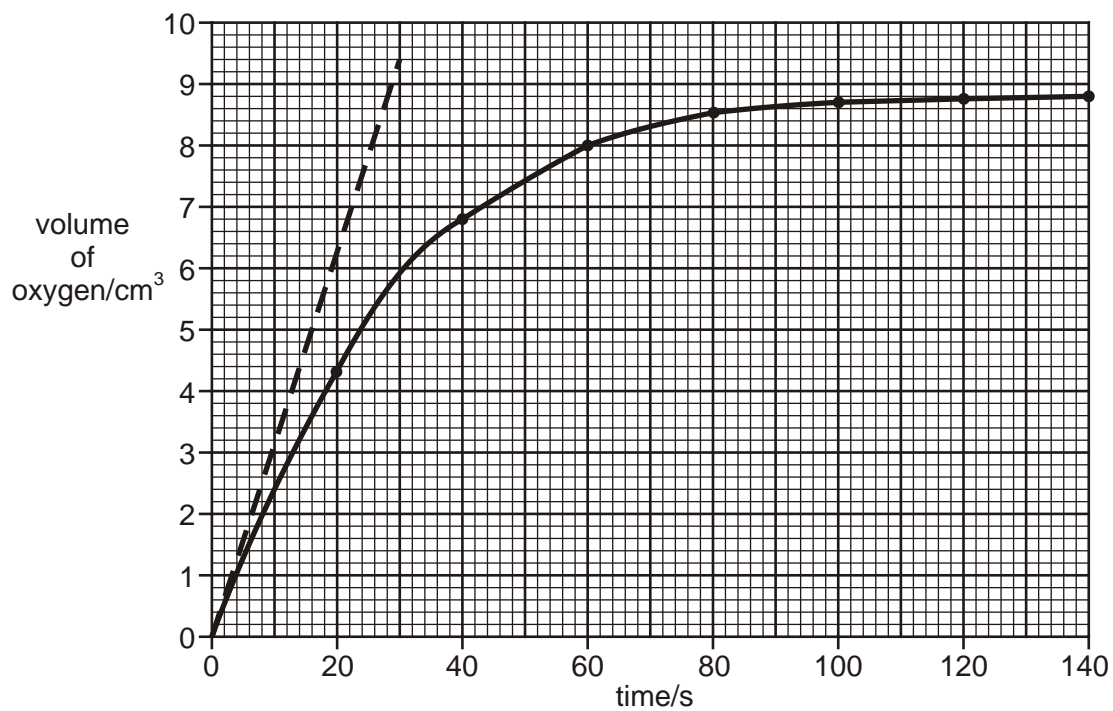


Fig. 2

The rate of decomposition can be calculated using the formula:

$$\text{rate of decomposition} = \frac{\text{volume of oxygen collected}}{\text{time taken for collection}}$$

- (a) Calculate the rate of decomposition over the first 30 seconds.

Show your working and give your answer in **cm³ min⁻¹**.

.....cm³ min⁻¹

- (b) The initial rate of decomposition is the rate measured within the first few seconds. Using the dashed line in Fig. 2, the initial rate of decomposition is calculated to be $19 \text{ cm}^3 \text{ min}^{-1}$.

Explain why the initial rate of reaction is greater than the rate you calculated in (a).

.....

.....

.....

.....

.....

.....

[3]

[Total 5 marks]

23. Fungi such as *Fusarium venenatum* are grown in huge batch cultures to manufacture protein for food products.

Explain why these cultures are often maintained at the optimum temperature for protein production and not at a temperature above the optimum.



In your answer you should make clear how the structure and activity of enzymes relates to the effects described.

[Total 8 marks]

24. 'Health – Milk' and 'Energy – Boost' are flavoured milk drinks.

The manufacturers make the following claims:

'HEALTH – MILK'
Flavoured with real fruit extract.
No added sugar.

'ENERGY – BOOST'
A delicious milk drink – packed full of
energy.
Convenient, quick and easy.

The two different flavoured milk drinks and a sample of fresh milk were all tested for the presence of some biological molecules.

The methods used and the results obtained are shown in the table below.

method used	colour change observed for		
	fresh milk	'Health – Milk'	'Energy – Boost'
a few drops of iodine solution added	remains yellow	remains yellow	remains yellow
5 cm ³ biuret solution added	blue to lilac	blue to lilac	blue to lilac
5 cm ³ Benedict's reagent added and solution boiled	blue to green	blue to green to yellow	blue to green to yellow to orange
<ul style="list-style-type: none"> sample that has been tested with Benedict's reagent is filtered the filtrate (solution) is boiled with 5 cm³ dilute acid, cooled and neutralised then 5 cm³ Benedict's reagent is added and the solution is boiled 	remains blue	blue to green to yellow to orange	blue to green to yellow to orange to red

(a) Using **only** the information in the table, state the biological molecules present in

(i) fresh milk;

.....

[2]

(ii) 'Health – Milk'.

.....

[3]

(b) What **differences** between 'Health – Milk' and 'Energy – Boost' are identified by the information in the table?

.....
.....
.....
.....

[2]

(c) Explain why the claims made by the manufacturer for 'Health – Milk' could be misleading.

.....
.....
.....
.....
.....
.....

[3]

(d) Suggest why it would **not** be appropriate to test milk for lipids using the emulsion test.

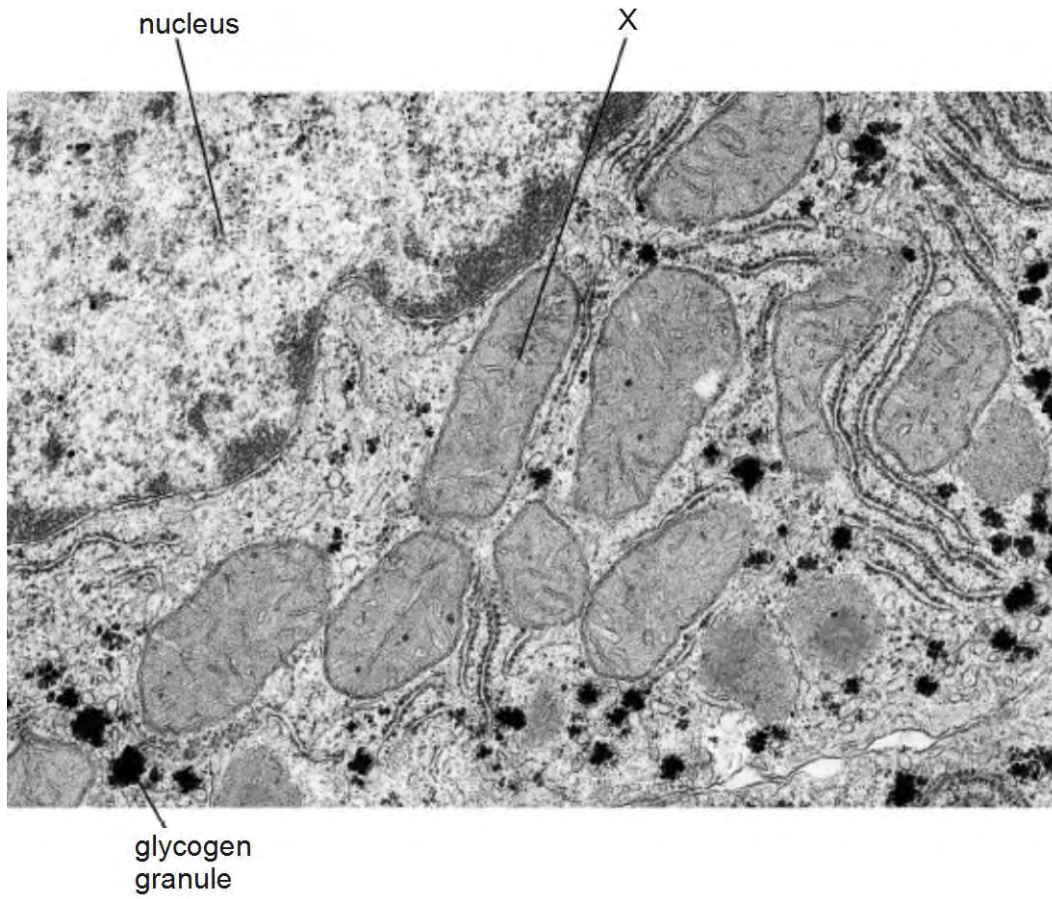
.....
.....

[1]

[Total 11 marks]

25. The diagram below is an electron micrograph of part of a cell from a human liver.

This cell is responsible for converting glucose in the body into glycogen for storage. The glycogen can be seen as granules in the cytoplasm.



(i) Describe the molecular structure of glycogen.

.....

.....

.....

.....

.....

.....

.....

.....

- (ii) Name the type of chemical reaction that takes place during the formation of glycogen.

.....

[1]

[Total 5 marks]

- 26.** The formation of glycogen is one of many enzyme-controlled reactions carried out by liver cells in humans. The liver is a very active organ and generates a lot of heat. The temperature must not be allowed to increase too much as it will affect the rate at which glucose is converted into glycogen.

- (i) Suggest the optimum temperature for these enzyme-controlled reactions.

.....

[1]

- (ii) A **significant** increase in temperature above the optimum has an effect on the rate of an enzyme-controlled reaction.

Explain why this is so.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

[4]

[Total 5 marks]

- 27.
- DNA is found in the nucleus of a cell.
 - During interphase DNA replicates.
 - DNA is involved in the transcription stage of protein synthesis.

The following statements, **A** to **H**, refer to events that may take place during:

- ◆ DNA replication **only**
- ◆ transcription **only**
- ◆ **both** DNA replication **and** transcription
- ◆ **neither** DNA replication **nor** transcription.

Complete the table by marking the appropriate boxes with a tick (✓) if the event takes place or a cross (✗) if it does not take place.

		DNA replication	transcription
A	Nucleotides line up along an exposed DNA strand.		
B	The whole of the double helix 'unzips'.		
C	Uracil pairs with adenine.		
D	A tRNA triplet pairs with an exposed codon.		
E	Both DNA polynucleotide chains act as templates.		
F	Adjacent nucleotides bond, forming a sugar-phosphate backbone.		
G	The original DNA molecule is unchanged after the process.		
H	Adenine pairs with thymine.		

[Total 8 marks]

28. In order to reproduce asexually, *Plasmodium* needs to obtain amino acids from red blood cells of its host.

Suggest how *Plasmodium* obtains amino acids from haemoglobin within red blood cells.

.....

.....

.....

.....

.....

.....

[Total 3 marks]

29. The table below shows six statements that apply to biochemical tests.

Complete the table to show which of these statements apply to the biochemical tests carried out on the substances listed.

Fill in each box using a tick (✓) to show that the statement applies or a cross (✗) if it does not. The first row has been completed for you.

substance	statement					
	use heat	use biuret reagent	use Benedict's reagent	boil with a dilute acid	a positive result is a blue-black colour	a positive result is an emulsion
lipid	✗	✗	✗	✗	✗	✓
protein						
starch						
reducing sugar						
non-reducing sugar						

[Total 4 marks]

30. A sucrose molecule is a carbohydrate molecule made by joining a glucose unit to a fructose unit.

(i) Name the bond that joins the units in a molecule of sucrose.

.....

[1]

(ii) Name the type of reaction that **breaks** this bond.

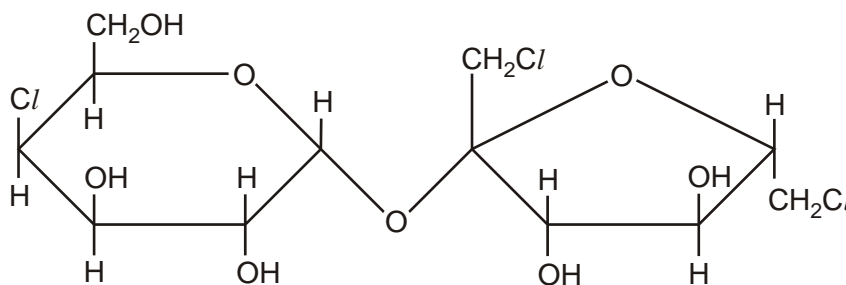
.....

[1]

[Total 2 marks]

31. Sucralose is a chemical that is similar in structure to sucrose. It has been made from sucrose by replacing three of the OH (hydroxyl) groups with Cl (chlorine) atoms.

The diagram below shows a molecule of sucralose.



The following claim is made for sucralose:

Sucralose has the same sweet taste as sucrose.

It cannot be digested by enzyme action in the human body and so it does not lead to weight increase.

Using the information in the diagram to help you, suggest why sucralose cannot be digested in the body.

.....

.....

.....

.....

.....

.....

.....

.....

[Total 4 marks]

32. In this question, one mark is available for the quality of spelling, punctuation and grammar.

The immense biodiversity of the oceans includes:

- corals that host symbiotic algae which die if the sea temperature rises by 1°C;
- animals like polar bears that use floating ice as a base for sea fishing expeditions;
- sessile animals like mussels that feed by filtering food particles from the water and reproduce by releasing gametes into the water;
- reef-building animals like corals that form hard calcium carbonate skeletons by extracting mineral ions such as Ca^{2+} from the water;
- seaweeds of different colours which occur in shallow water;
- animals like fish that hunt prey using well-developed visual skills;
- large animals such as the blue whale;
- physically delicate organisms like jellyfish that lose their shape in air.

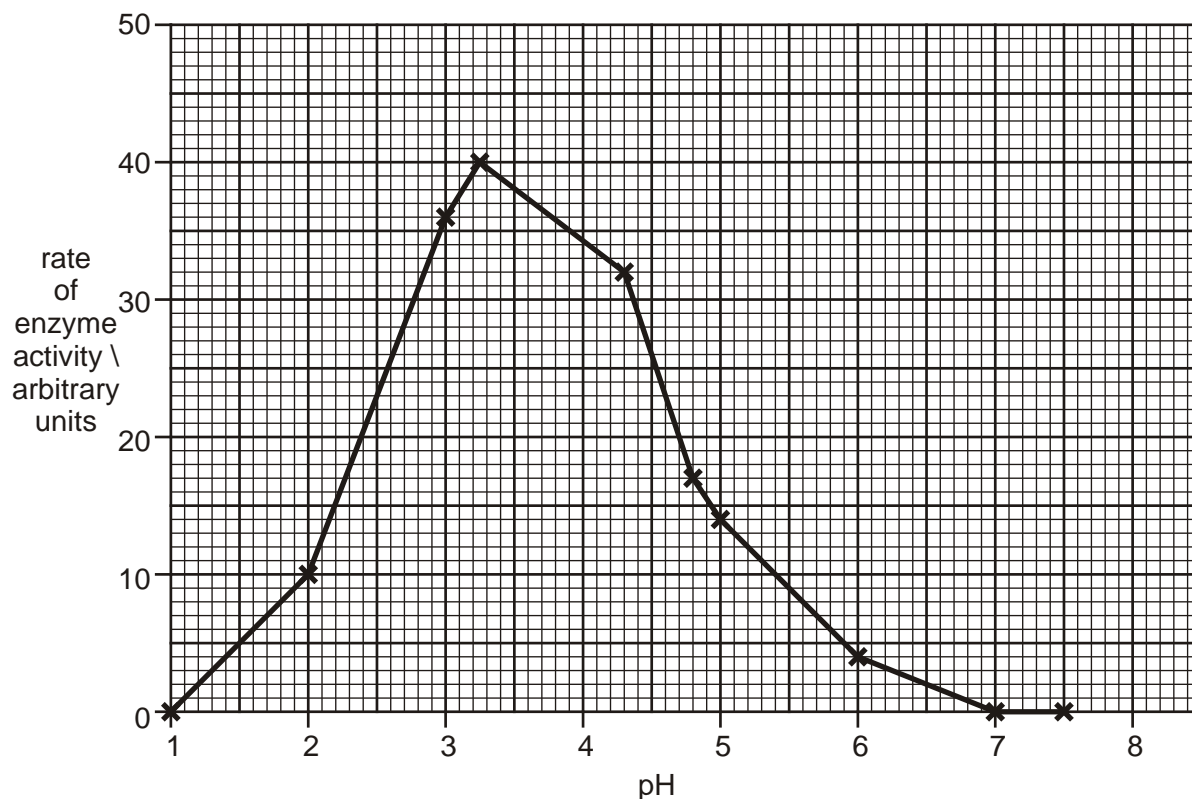
Using examples from the list above, describe **and** explain how the **properties** of water make it a suitable environment for these organisms.

[7]

Quality of Written Communication [1]

[Total 8 marks]

33. Two students carried out an investigation into the effect of pH on the activity of a lysosomal enzyme. Student **A** drew the graph shown in the diagram below.



- (i) A teacher asked two students to state the optimum pH for this enzyme. Student **A** gave the answer 'pH 3.25' but student **B** gave the answer 'somewhere between pH 3.0 and pH 4.3'. The teacher said that student **B** had given the better answer.

Explain why student **B**'s answer was better.

.....

.....

.....

.....

- (ii) Explain why this enzyme is not active at pH 7.

.....

.....

.....

.....

[2]

[Total 4 marks]

- 34.** In this question, one mark is available for the quality of spelling, punctuation and grammar.

Explain the effects of enzyme concentration, substrate concentration **and** competitive inhibitors on the rate of an enzyme-controlled reaction.

[9]

Quality of Written Communication [1]

[Total 10 marks]

- 35.** Read the following passage and then answer the questions that follow.

Human Factor VIII is a glycoprotein found in blood plasma. It is involved in blood clotting.

- 5 This glycoprotein contains 2332 amino acids linked into a single chain. This chain is folded and coiled into a secondary structure and then further folded. The chain forms six individual regions, each with its own function.

An artificial source of Factor VIII, created using genetic engineering, is now used to treat patients with haemophilia, a medical condition in which the blood clots more slowly than normal. The Factor VIII gene is first removed from the genome of human cells. It is then inserted into the genome of hamster cells.

- 10 Cancer cells or cells taken from an ovary are usually used to produce Factor VIII as these grow very well in industrial tanks. The Factor VIII that is produced is then removed from the tanks and purified before use in treating patients.

- (a) State what is meant by the term *glycoprotein* (line 1).

.....
.....

[1]

- (b) The secondary structure of a protein is identified by its shape.

- (i) Name a shape formed by **coiling** of the primary structure.

.....

[1]

- (ii) Name a shape formed by **folding** of the primary structure.

.....

[1]

- (c) State the name given to the level of structure formed by **further folding** of the secondary structure (line 4).

.....

[1]

[Total 4 marks]

36. Complete the following passage by using the most suitable word(s) in each of the blank spaces.

Water is essential for life. It makes up a high proportion of the cytoplasm in a cell. Many different compounds can dissolve in it and it is therefore described as an excellent

Water remains in the state over a wide range of environmental temperatures. As it cools below 4 °C it becomes less than warmer water. Ice floats on water, forming a layer that the water beneath with the result that large bodies of water rarely freeze entirely.

The bonds that form between water molecules are responsible for its high, which allows small insects such as pond skaters to move on its surface without sinking.

[Total 6 marks]

37. Cholesterol is a lipid which forms part of the structure of membranes of animal cells. It is absorbed from food and can also be synthesised by liver cells.

Cholesterol is transported by the blood with the help of specific transport proteins to which cholesterol molecules become reversibly attached. These complexes of lipid and protein are known as lipoproteins. There are three different types of lipoprotein transporting cholesterol in the blood. The concentration of cholesterol in blood can be measured, either as the total cholesterol, or as the amount carried by each of the different types of lipoprotein.

Explain why cholesterol must be carried in the blood by proteins while glucose does **not** need any transport protein.

.....

.....

.....

.....

[Total 2 marks]

38. The table below shows information about tests that identify three different types of biological molecule.

Complete the table to show the names of the types of molecule that are tested, the reagents used and the results obtained.

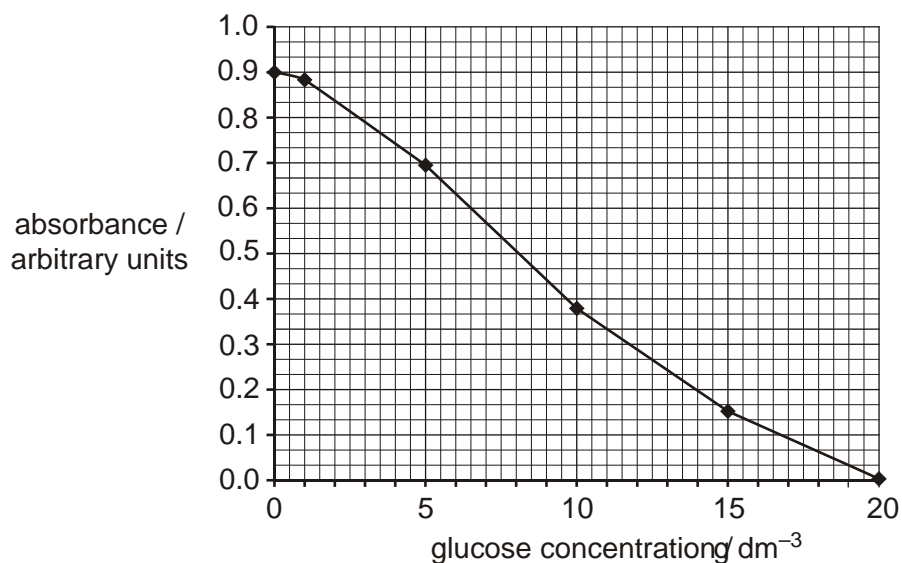
type of molecule tested	reagents used	positive result	negative result
protein	blue solution
.....	alcohol and water	white emulsion	clear liquid
starch	yellow solution

[Total 5 marks]

39. A student followed a procedure to find the concentration of reducing sugars in a fruit juice. The first part of the method used was as follows:

- A range of glucose solutions of different concentrations was made up, starting with a 20 g dm^{-3} glucose solution.
- Each solution was boiled with excess Benedict's solution.
- When there was no further change in colour, the liquid was cooled and filtered.
- The absorbance of the liquid was measured with a colorimeter. (A colorimeter measures the amount of light that is absorbed by a coloured solution.)

The student's results are shown in the diagram below.



- (i) State **two** precautions that the student should have taken during the procedure to ensure that the results give a valid comparison between the different glucose solutions.

1

.....

2

.....

- (ii) In the second part of the method, the student tested the fruit juice. The absorbance reading obtained was 0.60 arbitrary units.

Use the diagram above to determine the reducing sugar concentration of the fruit juice.

..... g dm⁻³

[1]

- (iii) This procedure does **not** test for non-reducing sugars, such as sucrose.

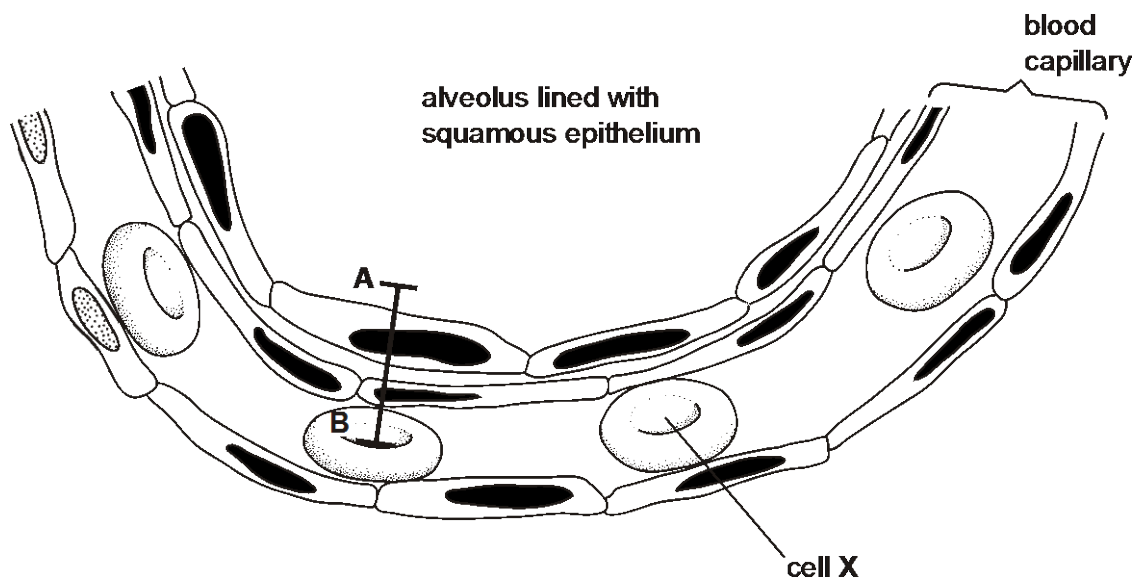
How should the procedure be altered to determine the concentration of **non-reducing sugar** in the fruit juice?

.....
.....
.....
.....
.....
.....

[2]

[Total 5 marks]

40. The diagram below is a drawing of an alveolus together with an associated blood capillary.



Oxygen diffuses from the alveolus into cell X. Cell X carries oxygen around the body in the blood stream.

(i) **Name** the compound inside cell **X** that combines with oxygen.

.....

[1]

(ii) **Name** the metal ion required for the formation of the compound in (i).

.....

[1]

[Total 2 marks]

41. An experiment was carried out in which the enzyme lipase was used to hydrolyse a triglyceride. The pH of the reaction mixture was recorded at regular intervals during the experiment. The results are shown in the table.

time / min	pH
0	7.0
2	6.2
4	5.6
6	5.1
8	4.7
10	4.6
12	4.6
14	4.6

- (i) State what is meant by the term *hydrolysis*.

.....
.....

[1]

(ii) Explain why the pH falls during the reaction.

.....

.....

.....

[2]

- (iii) After 14 minutes, the mixture was analysed and unreacted triglyceride was found to be present. No inhibitor was added to the reaction mixture.

Explain why the reaction had stopped after 10 minutes.

.....

.....

.....

.....

.....

[2]

[Total 5 marks]

42. Explain how a **non-competitive** inhibitor affects the rate of an enzyme-catalysed reaction.

.....

.....

.....

.....

.....

.....

.....

[Total 3 marks]

43. During research into the mechanism of DNA replication, bacteria were grown on a medium containing nitrogen isotopes. The nitrogen isotopes used were 'heavy' nitrogen, ^{15}N , and 'light' nitrogen, ^{14}N . After growth, the bacterial DNA was isolated from the cells and spun in a centrifuge. The DNA settled in the centrifuge tube at a position that corresponded to its density, indicating the proportion of the different types of DNA present in the sample.

Bacteria were grown for many generations in a medium containing only the 'heavy' isotope of nitrogen, ^{15}N . This resulted in all the DNA molecules containing only ^{15}N . The result after centrifugation is shown in Fig. 1.

These bacteria were then grown in a medium containing only 'light' nitrogen, ^{14}N . After allowing time for the DNA to replicate once, the DNA was analysed as before. The result is shown in Fig. 2.

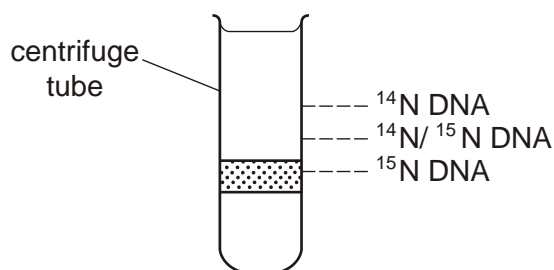


Fig. 1

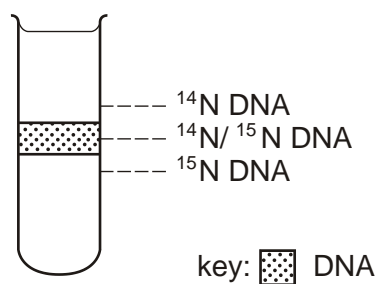


Fig. 2

(a) Explain how this information supports the semi-conservative hypothesis of DNA replication.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[4]

The bacteria were allowed to continue to grow in the 'light' nitrogen, ^{14}N , until the DNA had replicated once more. The DNA was analysed as before and the result is shown in Fig. 3.

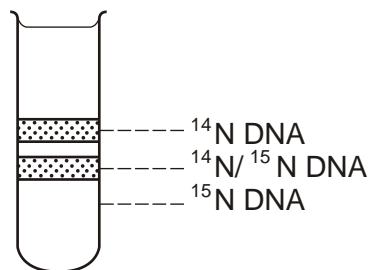


Fig. 3

Fig. 4 shows simple diagrams of DNA molecules, indicating the nitrogen content of each.

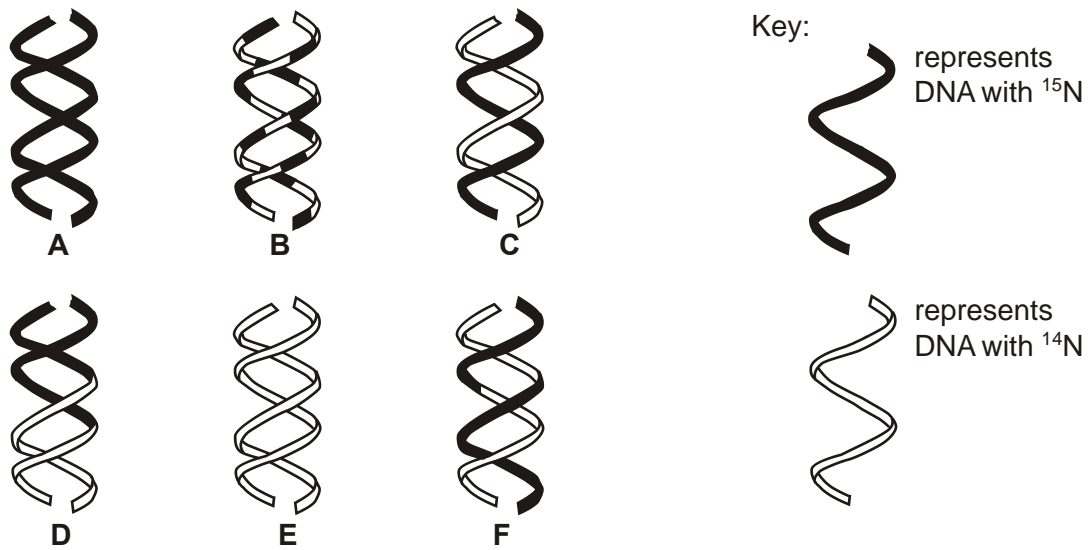


Fig. 4

(b) Select the letter or letters from Fig. 4 representing the bacterial DNA in Fig. 1, Fig. 2 and Fig. 3.

Fig. 1

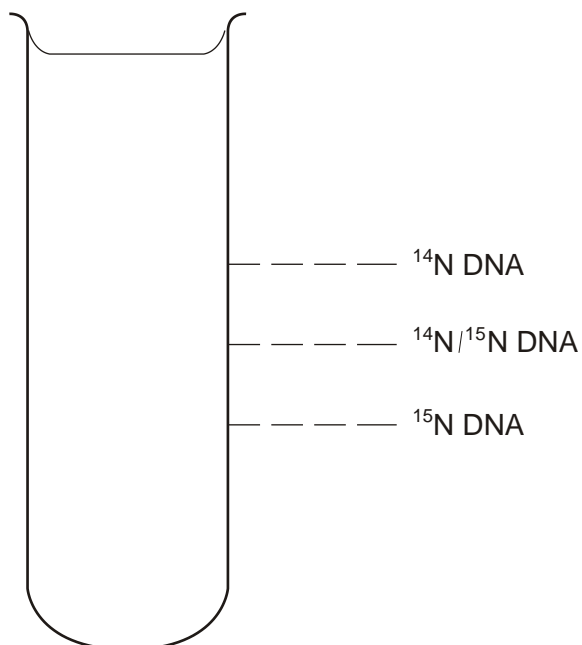
Fig. 2

Fig. 3

[3]

- (c) The bacteria were allowed to continue to grow in the 'light' nitrogen, ^{14}N , until the DNA had replicated once more. The DNA molecules were analysed as before.

Complete the diagram to indicate the expected results showing the composition of these DNA molecules.

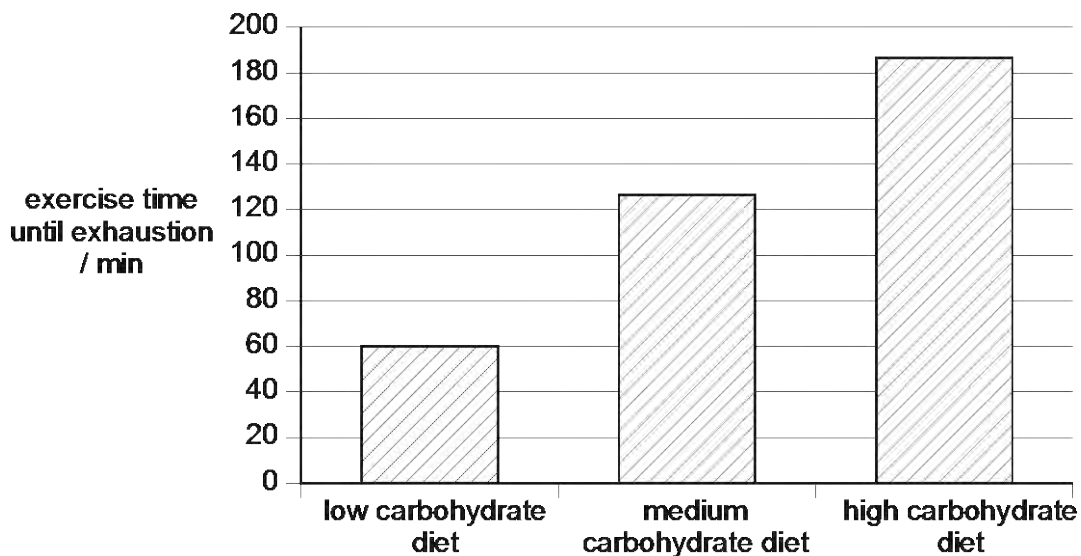


[2]

[Total 9 marks]

44. An investigation was carried out to determine the effects of increasing carbohydrate levels in the diet. Consuming extra carbohydrate is a technique called carbohydrate loading. It is often used by endurance athletes, such as long distance cyclists.

The diagram below shows the effect that different amounts of carbohydrate have on the length of time an athlete can continue exercising until exhausted.



Clyde Williams (1999) 'Does carbo-loading work?'
Biological Sciences Review vol. 12 No. 2

Using the evidence in the diagram, describe the effect of carbohydrate loading on an athlete's performance.

.....

.....

.....

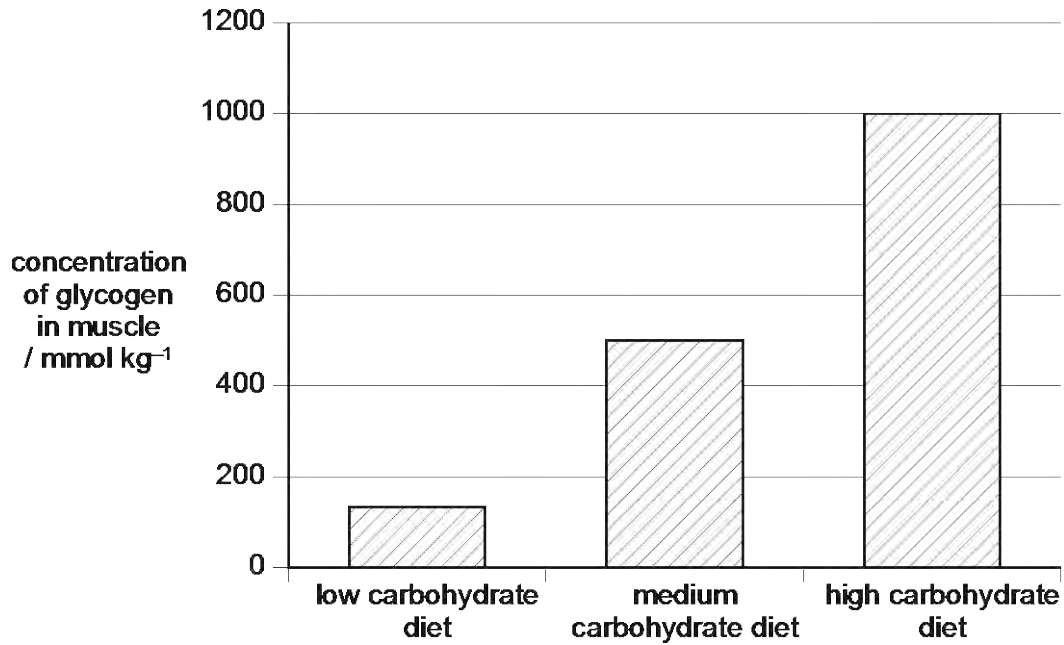
.....

.....

.....

[Total 3 marks]

45. The diagram below shows the effect that different amounts of carbohydrate have on the concentration of glycogen stored in the muscles.



Clyde Williams (1999) 'Does carbo-loading work?'
 Biological Sciences Review vol. 12 No. 2

Explain why a high concentration of glycogen in the muscles improves an athlete's performance in an endurance event.

.....

.....

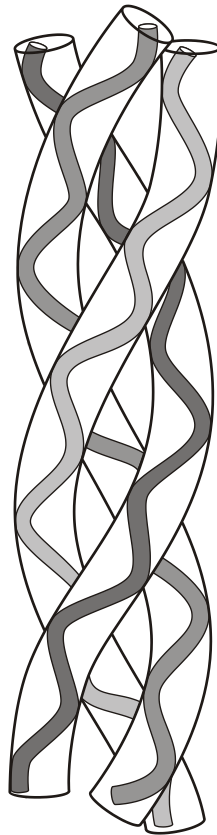
.....

.....

.....

[Total 2 marks]

46. The diagram below represents part of a collagen molecule.



- (i) Collagen is a protein made of three chains of amino acids, twisted together like a rope. State the name given to a chain of amino acids.

.....

[1]

- (ii) Name the amino acid that forms a high proportion of the collagen molecule.

.....

[1]

- (iii) Collagen has tremendous strength, having about one quarter of the tensile strength of mild steel. Using information given in the diagram to help you, explain how the structure of collagen contributes to its strength.

.....
.....
.....
.....
.....
.....

[2]
[Total 4 marks]

47. Complete the following passage by inserting the most appropriate terms in the spaces provided.

Cellulose and collagen are both fibrous molecules. Cellulose, a carbohydrate, is the main component of the in plants.
Cellulose is made of chains of many glucose molecules which are joined by 1,4 bonds. Each glucose molecule is rotated° relative to its neighbour, resulting in a chain. Adjacent chains are held to one another by bonds.

[Total 6 marks]

48. Deoxyribonucleic acid (DNA) is a polynucleotide.

(i) State how many different types of nucleotide are found in DNA.

.....

[1]

(ii) Name the components of **one** of these nucleotides.

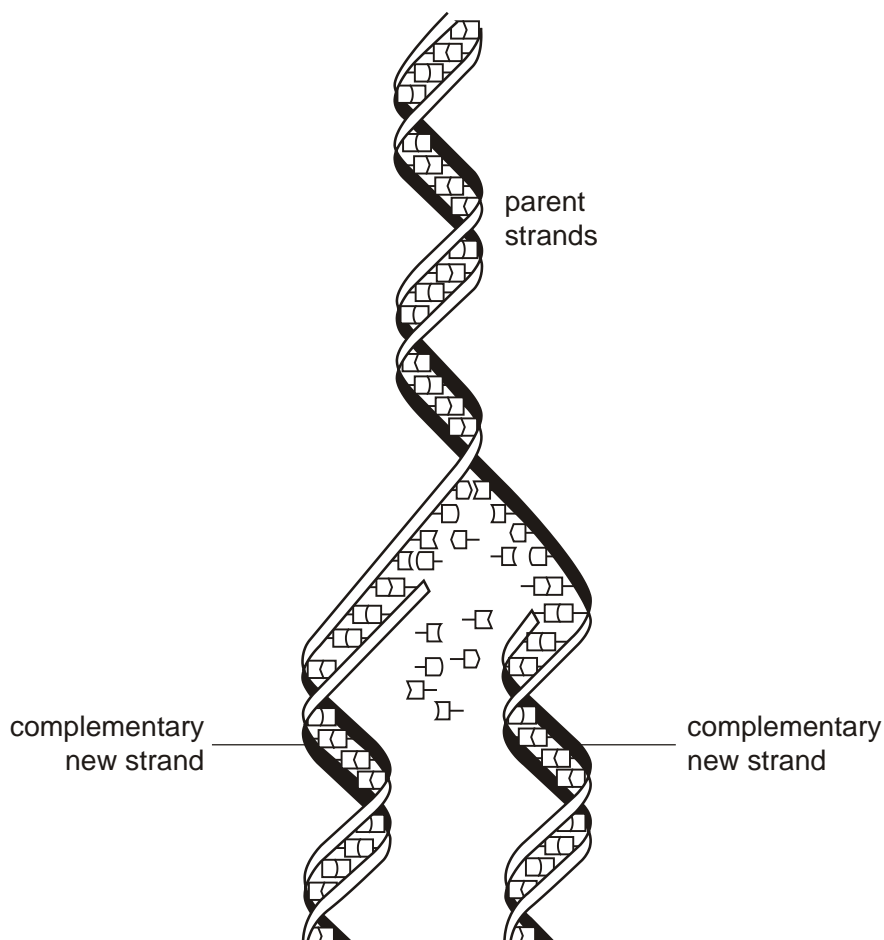
.....

.....

[3]

[Total 4 marks]

49. DNA replication is described as semi-conservative. Below is a diagram showing the replication of a DNA molecule.



Explain what is meant by the term *semi-conservative replication*.

.....

.....

.....

.....

[Total 3 marks]

50. Cyclo-oxidase (COX) is one of the enzymes needed in the formation of prostaglandins, compounds that are involved in causing fever, pain and inflammation. COX catalyses the conversion of arachidonate to prostaglandinH₂, as shown in Fig. 1.

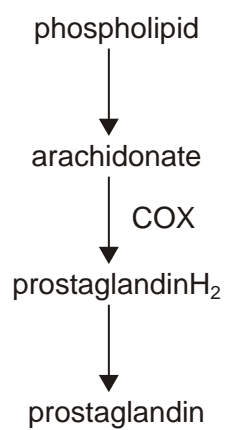


Fig. 1

The COX enzyme is found attached to the inner surface of the endoplasmic reticulum membrane. This is shown in Fig. 2.

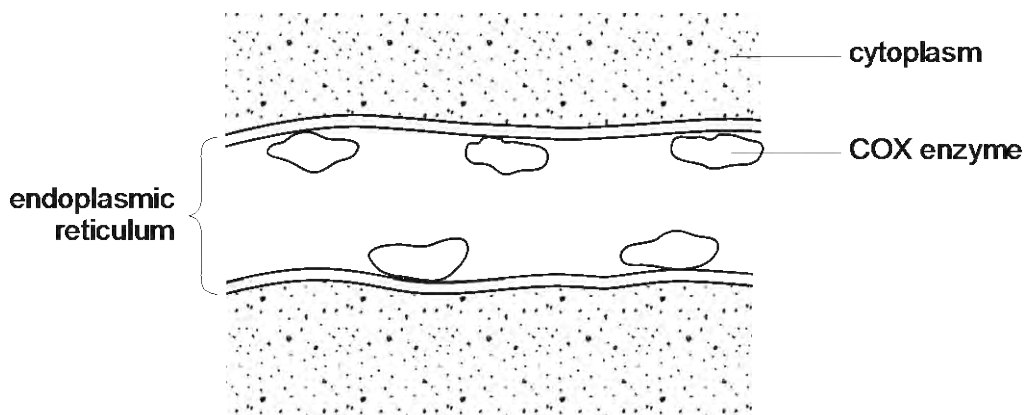


Fig. 2

- (a) Using the information given above, suggest why the COX enzyme is found attached to the inner surface of the endoplasmic reticulum.

.....

.....

.....

.....

.....

(b) Arachidonate reaches the active site of COX through a hydrophobic channel in the surface of the enzyme.

Ibuprofen and aspirin are drugs that inhibit the action of the COX enzyme.

- Ibuprofen enters and occupies the hydrophobic channel in the surface of the enzyme.
- Aspirin reacts with one of the R groups close to the active site of the enzyme.

Suggest how each drug inhibits the action of the COX enzyme.

ibuprofen

.....

.....

.....

.....

aspirin

.....

.....

.....

.....

(c) Describe the effect of **low** temperature, such as 5 °C, on enzyme action.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

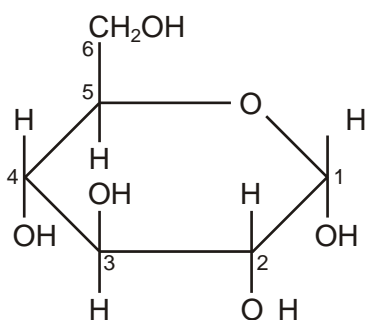
[4]

[Total 10 marks]

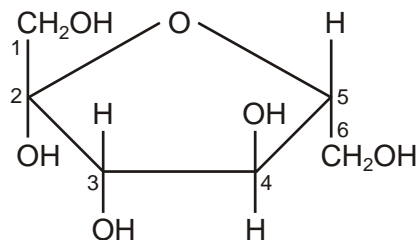
51. Glucose:

- is a carbohydrate
- is a hexose (six-carbon sugar)
- has the formula $C_6H_{12}O_6$
- has a six-membered ring structure.

The diagram below shows the molecular structures of two monosaccharide sugars, glucose and fructose.



glucose



fructose

State **one** way, **visible in the diagram above**, in which the structure of fructose is:
similar to glucose;

.....
.....

different from glucose.

.....
.....

[Total 2 marks]

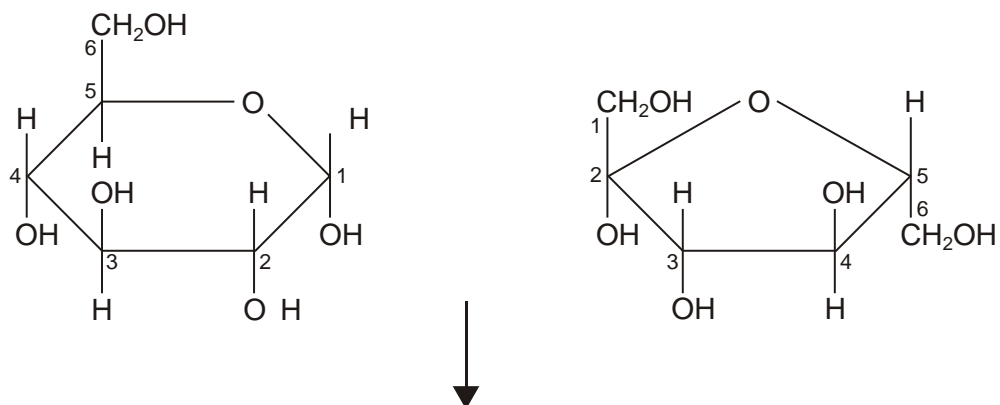
52. Maltose and sucrose are disaccharide sugars in which a bond joins two monosaccharide molecules. Sucrose is formed by the formation of a bond between carbon 1 of a glucose molecule and carbon 2 of a fructose molecule.

(i) Name the bond that joins the two molecules to form a disaccharide.

.....

[1]

- (ii) Complete the diagram below to show what happens when the glucose and fructose molecules join together.



[2]

[Total 3 marks]

53. (i) Describe the test that is used to indicate the presence of a reducing sugar, such as glucose, and state the observation that would be made if glucose was present.

description of test

.....
.....
.....
.....

observation if glucose is present

.....
.....

[3]

- (ii) No change is observed if sucrose, a non-reducing sugar, is tested for in this way. The bond between the glucose and fructose units must first be broken. The test for a reducing sugar can then be carried out.

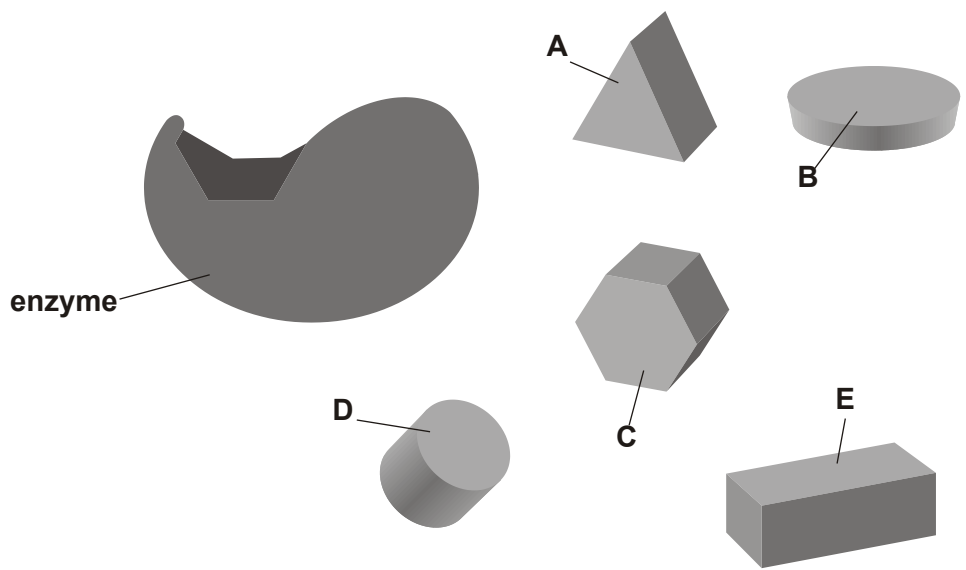
Describe how this bond can be broken chemically before carrying out the test for a reducing sugar.

.....
.....

[1]

[Total 4 marks]

54. The diagram below represents an enzyme and a number of other molecules.



(a) Label on the diagram the active site of the enzyme.

[1]

(b) Write the letter of the molecule that is most likely to be the substrate for this enzyme.

.....

[1]

(c) Use the information in the diagram to explain **enzyme specificity**.

.....
.....
.....
.....
.....
.....

[3]

- (d) One hypothesis of the mechanism of enzyme action is the 'lock and key' hypothesis. Another hypothesis, the 'induced fit' hypothesis, involves the enzyme changing shape slightly to allow the substrate to fit perfectly. The substrate also changes shape slightly.

Suggest how the **substrate** changing shape slightly will assist enzyme action.

.....
.....

[1]

[Total 6 marks]

- 55. *'Scientists have discovered that certain microorganisms can survive in the Antarctic, completely surrounded by ice.'*

Suggest how this discovery was useful in the development of certain biological washing powders.

.....
.....
.....
.....

[Total 2 marks]

56. In this question, one mark is available for the quality of written communication.

Some of the properties of water are listed below.

- boils at 100 °C
- freezes at 0 °C
- water below 4 °C is less dense than water above 4 °C
- excellent solvent
- much energy is required to raise the temperature of water
- much energy is required to change water into water vapour
- high surface tension and cohesion

Describe **and** explain the roles of water in living organisms **and** as an environment for living organisms.

You will gain credit for using information about the properties of water.

(Allow one and a half lined pages).

[9]

Quality of Written Communication [1]

[Total 10 marks]

57. DNA and RNA are nucleic acids.

State **two** ways in which the structure of DNA differs from that of RNA.

1

2

[Total 2 marks]

58. The DNA molecule is made of two chains of nucleotides, wound into a double helix.

(i) Describe the structure of a **DNA nucleotide**.

You may use the space below to draw a diagram if it will help your description.

.....
.....
.....
.....
.....
.....
.....
.....
.....

[3]

(ii) Describe how the two nucleotide chains in DNA are bonded together.

.....
.....
.....
.....
.....
.....

[3]

[Total 6 marks]

59. An enzyme, such as amylase, has a specific 3-dimensional shape.

Explain how DNA structure determines the specific shape of enzymes.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Total 4 marks]

60. Read the following passage carefully, then answer the questions below.

Rhizobium is a bacterium that is closely associated with the roots of certain plants known as legumes. These plants produce chemicals to attract the bacteria and extra root hairs are produced. The bacteria attach to the surface of the root hairs. Chemical links are formed between a complex
5 polysaccharide on the bacterial surface and lectin, a protein, formed by the plants. The bacteria penetrate the cell walls of the root hairs and enter the cells. The presence of the bacteria stimulates the cells of the root to divide, forming swellings known as nodules.

The bacteria produce an enzyme, nitrogenase, that is the catalyst for the
10 conversion of nitrogen gas to ammonia. The bacteria use carbon compounds manufactured by the plant to respire, making energy available for this conversion. The ammonia is then used to form amino acids. Nitrogenase only functions in low oxygen concentrations. The root cells produce a pigment, leghaemoglobin, that is very similar to haemoglobin. Leghaemoglobin absorbs
15 oxygen, leaving low concentrations in the nodules.

- (i) *Rhizobium* is a prokaryotic organism.

State **one** characteristic that is typical of prokaryotes, but not of eukaryotes.

.....
.....

[1]

- (ii) Lectin (line 5) and polysaccharides are compounds that are formed from small molecules joined together by chemical bonds.

Explain how the small molecules are joined together to form these compounds.

.....
.....
.....
.....

[3]

- (iii) Leghaemoglobin contains the same metal element as haemoglobin.

Name this metal element.

.....

[1]

- (iv) State the names of **two** proteins, **other than lectin**, mentioned in the passage.

1

2

[2]

- (v) Name the process that occurs in *Rhizobium* to convert nitrogen gas into ammonia.

.....

[1]

(vi) It has been suggested that oxygen is an inhibitor of nitrogenase.

Explain **one** way in which oxygen could act as an inhibitor.

.....
.....
.....
.....

[2]

[Total 10 marks]

61. State the word or phrase that best describes a region on the surface of an enzyme molecule where a substrate can bind.

.....

[Total 1 mark]

62. State the word or phrase that best describes the energy that must be provided for a chemical reaction to take place.

.....

[Total 1 mark]

63. State the word or phrase that best describes a length of DNA that codes for a particular polypeptide.

.....

[Total 1 mark]

64. A student was carrying out tests to determine which biological molecules were present in a food sample.

(a) (i) Describe a test that the student could carry out to discover whether this sample contained a lipid.

.....
.....
.....
.....

[2]

(ii) State what would be seen if a lipid was present.

.....

[1]

(b) Describe how the **structure** of a phospholipid differs from that of a triglyceride.

You may use the space below for a diagram to help your answer.

.....
.....
.....
.....
.....

[3]

(c) (i) Describe a test that the student could carry out to discover whether the food sample contained protein.

.....
.....
.....

[1]

(ii) State what would be seen if protein was present.

.....

[1]

[Total 8 marks]

65. Explain what is meant by the primary and secondary structure of a protein.

primary structure

.....
.....

secondary structure

.....
.....
.....
.....
.....

[Total 5 marks]

66. An important enzyme that is used in respiration is succinate dehydrogenase. Its substrate is succinate, which is converted into fumarate. Malonate acts as a **competitive** inhibitor, but does **not** bind permanently to the enzyme.

(a) Describe how malonate inhibits the enzyme. You may use the space below for a diagram to help your answer.

.....
.....
.....

[3]

(b) Explain what would happen to the reaction if the concentration of succinate was increased relative to the concentration of malonate.

.....
.....
.....
.....
.....
.....

[3]

[Total 6 marks]