Biological Molecules – AS 9700 November 2023

1. Nov/2023/Paper_ 9700/11/No.8

The test for non-reducing sugars requires a second Benedict's test to be carried out.

Which set of steps is the correct method for carrying out the non-reducing sugar test **before** carrying out the second Benedict's test?

A Perform the Benedict's test, which gives a negative result.
Warm gently with dilute hydrochloric acid.
Neutralise with sodium hydrogencarbonate.

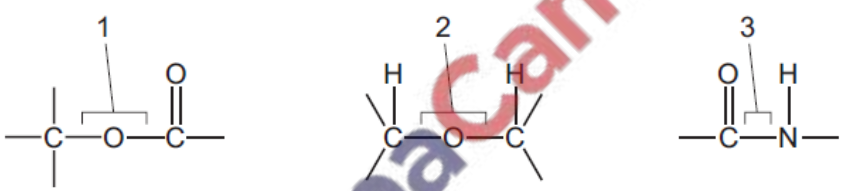
B Perform the Benedict's test, with the colour of the solution remaining red.
Boil with dilute hydrochloric acid.
Neutralise with sodium hydrogencarbonate.

C Perform the Benedict's test, with the colour of the solution remaining blue.
Boil with dilute hydrochloric acid.
Neutralise with sodium hydrogencarbonate.

D Perform the Benedict's test, which gives a negative result.
Neutralise with sodium hydrogencarbonate.
Warm gently with dilute hydrochloric acid.

2. Nov/2023/Paper_ 9700/11/No.9

The diagrams show three types of covalent bonds.



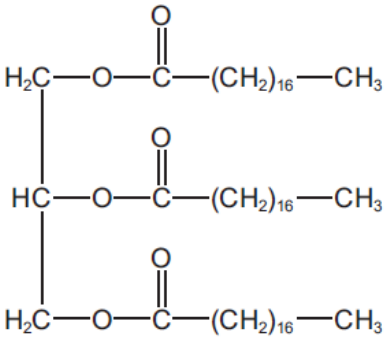
Which bonds will be found in glycolipids and glycoproteins?

	bond 1	bond 2	bond 3
A	glycolipids only	glycolipids and glycoproteins	glycoproteins only
B	glycolipids and glycoproteins	glycolipids only	glycoproteins only
C	glycoproteins only	glycolipids only	glycolipids and glycoproteins
D	glycoproteins only	glycolipids and glycoproteins	glycolipids only

3. Nov/2023/Paper_ 9700/11/No.10

Which molecules would be found in an oil (liquid) more than in a fat (solid)?

1



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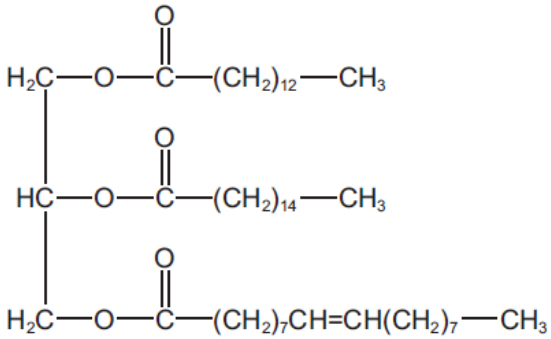

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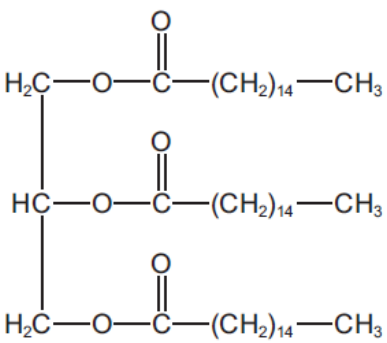

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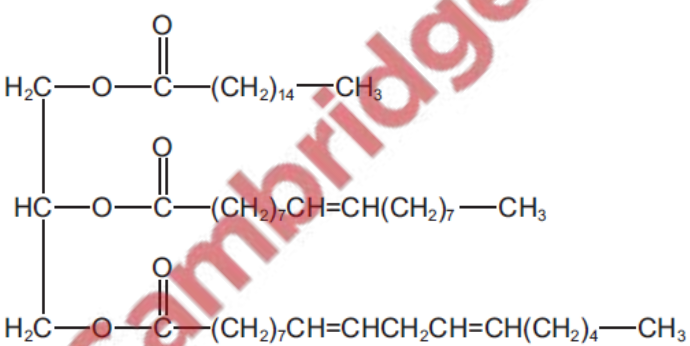


A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

4. Nov/2023/Paper_ 9700/11/No.11

Which row about the bonding found in the primary, secondary, tertiary and quaternary structure of proteins is correct?

	primary	secondary	tertiary	quaternary
A	covalent	covalent	ionic and disulfide only	hydrogen and hydrophobic interactions only
B	covalent	hydrogen	hydrogen, ionic, covalent and hydrophobic interactions	hydrogen, ionic, covalent and hydrophobic interactions
C	peptide	covalent	hydrogen, ionic, disulfide and hydrophobic interactions	hydrogen, ionic and disulfide
D	peptide	hydrogen	ionic and disulfide only	ionic and disulfide only

5. Nov/2023/Paper_ 9700/11/No.12

The specific heat capacity of different substances is shown.

substance	specific heat capacity / $J\,g^{-1}\,°C$
air	1.0
hydrogen gas	14.3
water (liquid)	4.2
water (steam)	2.1

Which statement is correct?

A Air is a more stable environment than water because it is more resistant to changes in temperature.

B It takes more energy to raise the temperature of hydrogen gas than it does to raise the temperature of water.

C A specific heat capacity of $4.2\,J\,g^{-1}\,°C$ means that it takes 4.2 J of energy to vaporise 1.0 g of liquid water.

D There are more hydrogen bonds between water molecules in a gas than between water molecules in a liquid.

6. Nov/2023/Paper_ 9700/12/No.8

A student carried out the Benedict's test on four different concentrations of glucose solution and then recorded the time taken for the first appearance of a colour change (the end-point).

The student found it difficult to identify the first appearance of a colour change and consistently timed each solution for two seconds after the colour change first appeared. This introduced a source of error into the experiment.

Which statements about this error are correct?

1 The effect of the error will be reduced if the student performs three repeats at each concentration of glucose.

2 The error will prevent the student from identifying which solution has the highest concentration of glucose.

3 The error is systematic as the student consistently timed each solution for two seconds after the end-point.

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

7. Nov/2023/Paper_ 9700/12/No.9

Which statements about amylopectin and glycogen are correct?

1 Amylopectin and glycogen contain 1-4 glycosidic bonds.

2 Amylopectin contains β-glucose.

3 Glycogen contains more 1-6 branches than amylopectin.

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

8. Nov/2023/Paper_ 9700/12/No.10

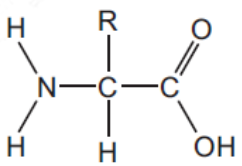
How many statements about fatty acids are correct?

- Fatty acids are either saturated or unsaturated.
- Fatty acids always have at least two double bonds.
- Long chains of fatty acids are very good energy stores.
- Fatty acids are insoluble in water and do not affect the water potential of the cell.

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

9. Nov/2023/Paper_ 9700/12/No.11

The diagram represents an amino acid.



R represents a variable side chain.

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

A CH_3

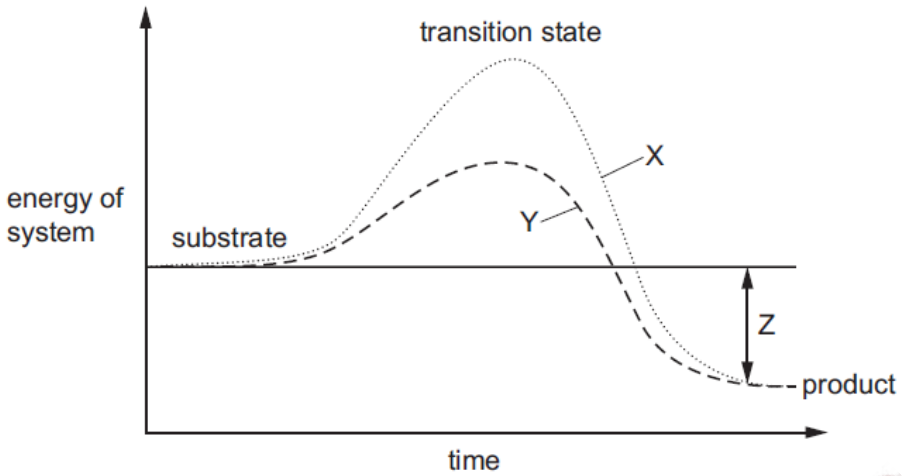
B $CH_2CH_2SCH_3$

C CH_2CONH_2

D $HOCH_2CH(OH)CH_2OH$

10. Nov/2023/Paper_ 9700/12/No.12

The graph shows the effect of an enzyme on a reaction.

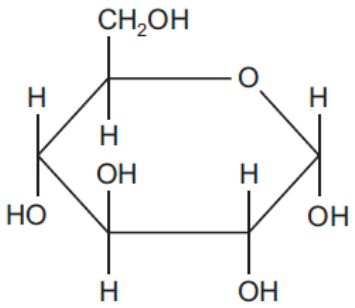


Which row identifies X, Y and Z?

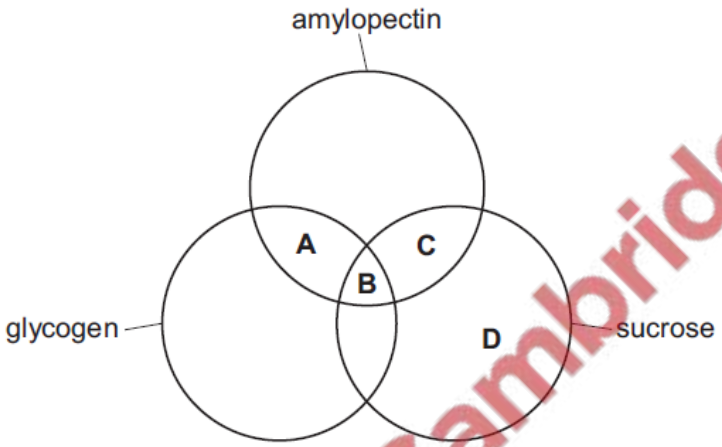
	X	Y	Z
A	catalysed reaction	uncatalysed reaction	energy lost by product
B	catalysed reaction	uncatalysed reaction	overall energy lost during reaction
C	uncatalysed reaction	catalysed reaction	energy gained by product
D	uncatalysed reaction	catalysed reaction	overall energy released during reaction

11. Nov/2023/Paper_ 9700/13/No.9

The diagram shows the structure of a monomer.



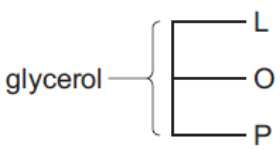
Which molecules contain this monomer?



12. Nov/2023/Paper_ 9700/13/No.10

A triglyceride consists of glycerol and three different fatty acids: linoleic acid (L), oleic acid (O) and palmitic acid (P).

The diagram shows one possible arrangement of the fatty acids L, O and P in the molecule.



What is the total number of different arrangements of the fatty acids in this triglyceride?

A 3 **B** 4 **C** 5 **D** 9

13. Nov/2023/Paper_ 9700/13/No.11

Which statement about phospholipid molecules is correct?

A They contain one saturated fatty acid and two unsaturated fatty acids.

B They contain three phosphodiester bonds.

C They contain hydrophobic regions and hydrophilic regions.

D They contain a hydrophobic phosphate group that is soluble in water.

14. Nov/2023/Paper_ 9700/13/No.12

Hydrogen bonding explains many of the properties of water, including the high latent heat of vaporisation and high specific heat capacity.

For which processes in plants is hydrogen bonding in water important on hot sunny days?

1 preventing denaturation of enzymes in leaves

2 reducing water loss by evaporation

3 allowing leaves to cool down quickly at night

4 holding the column of water in xylem vessels together

A 1, 2, 3 and 4

B 1, 2 and 4 only

C 1, 3 and 4 only

D 2 and 3 only

15. Nov/2023/Paper_ 9700/13/No.13

Which feature of cellulose molecules contributes to the function of plant cell walls?

A Adjacent cellulose molecules are linked by glycosidic bonds.

B Branched chains of β-glucose molecules are linked by hydrogen bonds.

C Molecules of α-glucose are linked by 1-6 glycosidic bonds.

D Unbranched chains of β-glucose are linked by hydrogen bonds.

16. Nov/2023/Paper_ 9700/22/No.2

Keratin is the structural protein in feathers of birds. Keratin polypeptides are composed of a high proportion of cysteine amino acids, which have sulfur-containing R groups.

Keratin polypeptides form filaments. The two main types of keratin in feathers are α-keratin, which consists of many α-helices, and β-keratin, consisting of many β-pleated sheets.

(a) Keratin can be classified as α-keratin or β-keratin based on a study of protein structure.

Suggest the level of protein structure used to classify a protein as α-keratin or β-keratin.

..... [1]

(b) Protease enzymes hydrolyse proteins. Many proteases are able to hydrolyse more than one type of protein.

Suggest why it is possible for a protease to act on different types of protein.

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..... [1]

(c) Proteases known as keratinases vary in the extent to which they can hydrolyse keratin.

Feathers are not easily degraded (broken down) because keratin is a very stable protein.

Suggest features of keratin structure that contribute to its stability.

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..... [3]

Keratinases are used to degrade the large quantities of waste feathers from chickens and turkeys that are processed in the food industry. The products of feather degradation can be used in animal feed.

Scientists investigated whether three different keratinases, K12, A22 and P3, were suitable as industrial enzymes. These enzymes were extracted from three different soil bacteria.

The effects of temperature and pH on the activity of each keratinase were investigated.

The results are shown in Fig. 2.1 and Fig. 2.2.

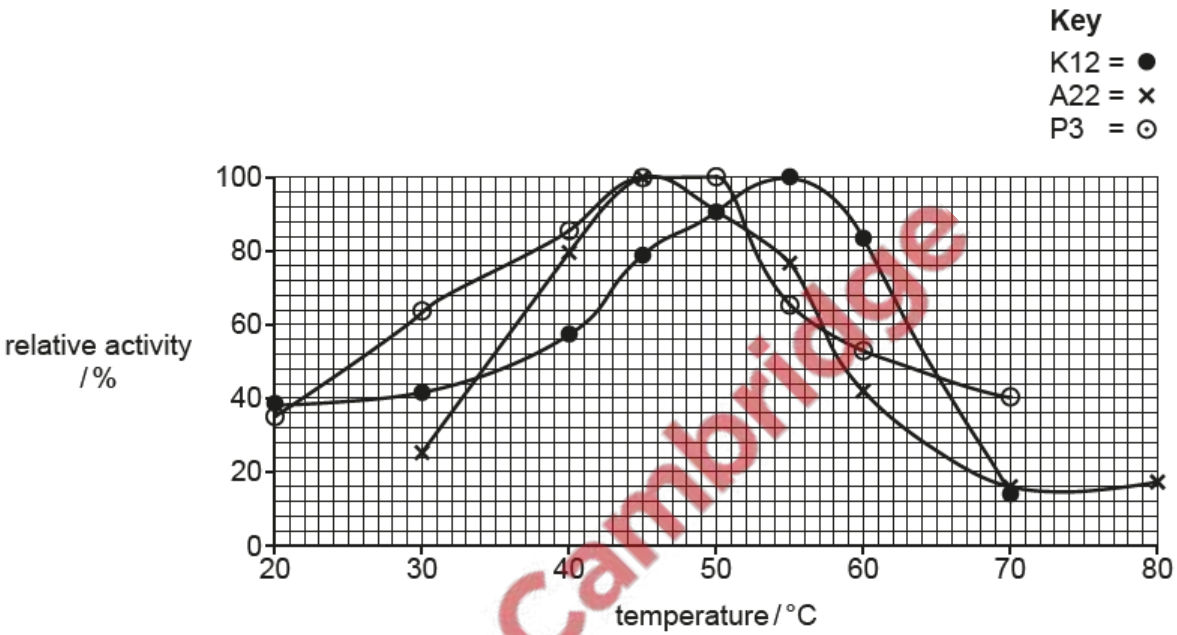

Fig. 2.1

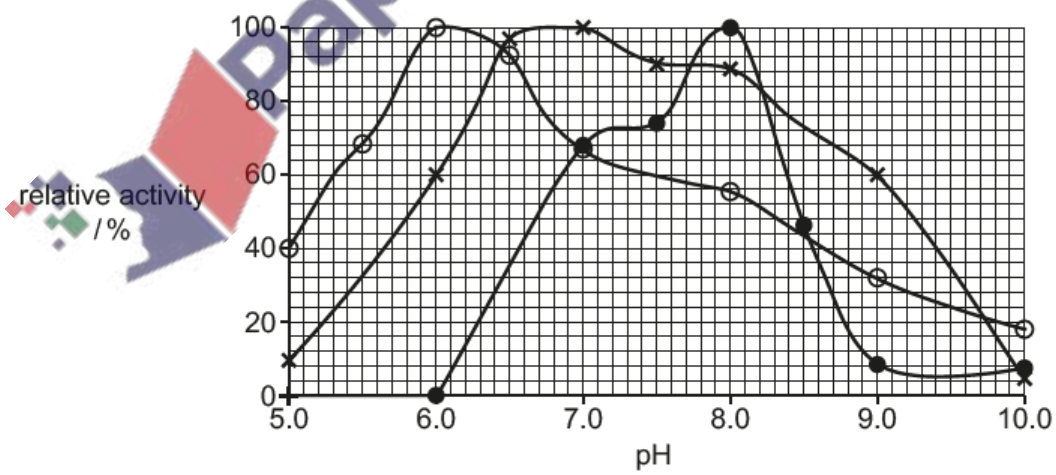

Fig. 2.2

(d) To degrade feather waste from industry, it is an advantage to use keratinases that show at least 60% relative activity in conditions where temperature and pH can vary widely.

Table 2.1 shows, for each keratinase, the working range of temperature and pH where at least 60% relative activity is obtained.

Use Fig. 2.1 and Fig. 2.2 to complete Table 2.1 **and** use the completed table to:

- name the keratinase that has the widest working range of temperature
- name the keratinase that has the widest working range of pH.

Table 2.1

keratinase	temperature range with at least 60% relative activity / °C	pH range with at least 60% relative activity
K12	41–63	
A22		6.0–9.0
P3	29–56	5.3–7.5

Keratinase with a relative activity of at least 60% that has:

- the widest working range of temperature .....
- the widest working range of pH .....

[4]

(e) Some detergents contain proteases to remove stains from clothes. These enzymes have a high relative activity in alkaline conditions.

The scientists reported that K12 and A22 could be suitable for use in the detergent industry.

With reference to Fig. 2.1 and Fig. 2.2, discuss the advantages **and** disadvantages of using K12 and A22 in the detergent industry.

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..... [3]

[Total: 12]

17. Nov/2023/Paper_ 9700/23/No.2

Glucose is used in the synthesis of amylose. Glucose is first converted to glucose 1-phosphate (G 1-P).

Starch phosphorylase is an intracellular enzyme that can catalyse the synthesis of amylose from G 1-P, which is the substrate for the reaction:

$$(\text{glucose 1-phosphate})n \longrightarrow \text{amylose} + (\text{phosphate ions})n$$

n = a large number

Students used a colorimeter to investigate the progress of the reaction.

The students made a reaction mixture containing 0.01 mol dm^{-3} G 1-P in a buffer solution at pH 6.0. A very small quantity of amylose was added to initiate the reaction.

A solution of starch phosphorylase was added to the reaction mixture and samples were taken at 1-minute intervals. Each sample was added to a dilute iodine solution, stirred and then poured into a cuvette. The absorbance of each solution was recorded.

The results of the investigation are shown in Fig. 2.1.

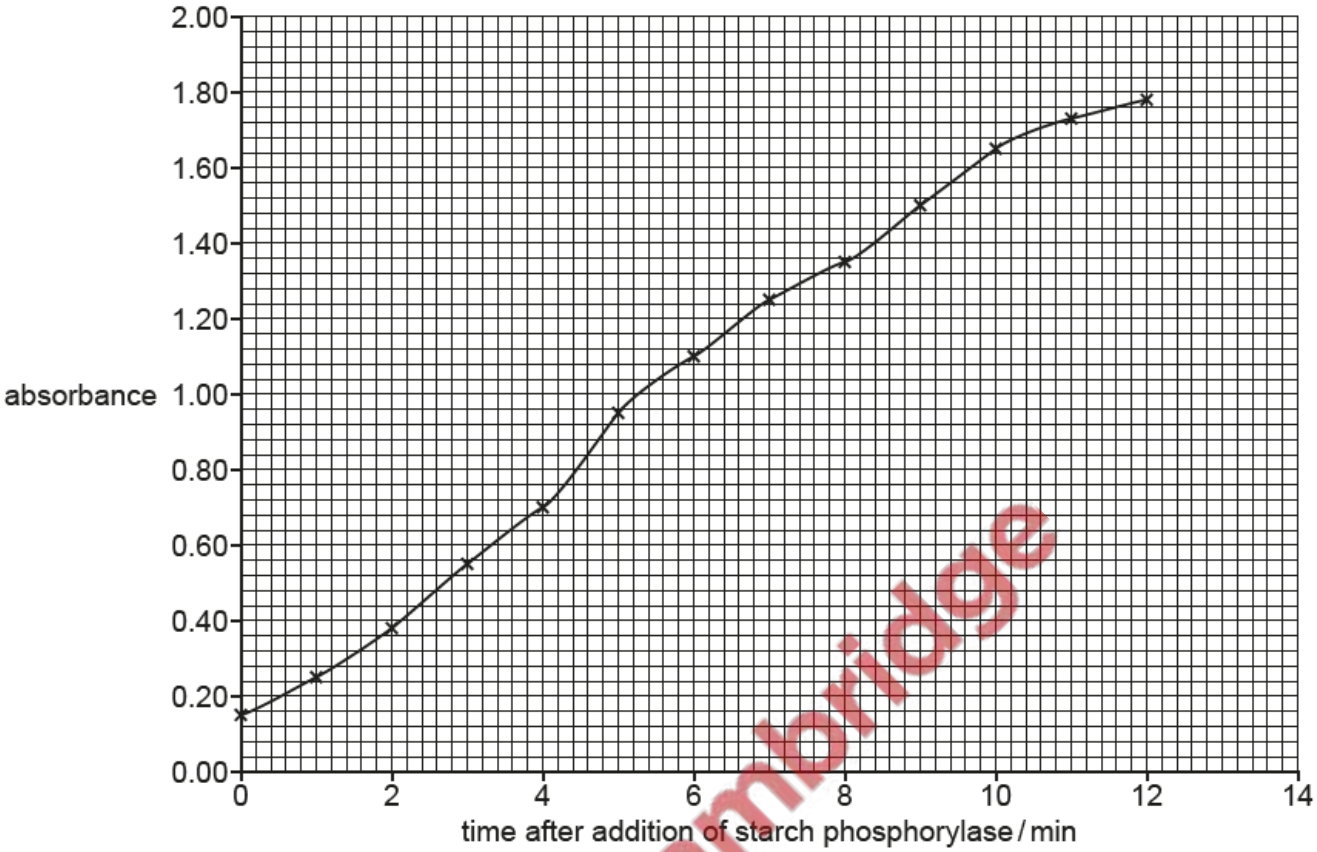

Fig. 2.1

(a) (i) Explain why the absorbance increases, as shown in Fig. 2.1.

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..... [1]

(ii) The students took their final sample at 12 minutes.

Predict the results for absorbance if the students had continued to take samples for a further 10 minutes. Explain your answer.

prediction .....

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explanation .....

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[2]

(iii) State an advantage of using a colorimeter in determining the progress of the reaction.

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..... [1]

(b) The reaction catalysed by starch phosphorylase occurs at the ends of amylose molecules.

Describe the sequence of events that occurs when starch phosphorylase catalyses the addition of a molecule of glucose to the end of an amylose molecule.

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[Total: 8]

18. Nov/2023/Paper_ 9700/23/No.3

Haemoglobin is a complex protein molecule made of four separate subunits, as shown in Fig. 3.1.

Fig. 3.1

(a) (i) The shading represents the two different polypeptides that form a molecule of haemoglobin.

State the names of the **two** different polypeptides.

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..... [1]

(ii) Identify the structure labelled **P** in Fig. 3.1.

..... [1]

(iii) Fig. 3.1 shows some of the levels of protein structure.

State the level of protein structure that is **not** shown in Fig. 3.1.

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..... [1]

(b) Haemoglobin is involved in the transport of carbon dioxide.

Molecules of carbon dioxide enter red blood cells as the cells travel in capillaries through muscle tissue. Some of these molecules are converted to carbonic acid.

Explain how haemoglobin is involved in the transport of carbon dioxide molecules that are **not** converted to carbonic acid.

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..... [3]

(c) When haemoglobin associates (binds) with oxygen it forms oxyhaemoglobin.

State the precise site in the mammalian body where haemoglobin molecules bind with oxygen.

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..... [1]

(d) The compound 2,3-diphosphoglycerate (2,3-DPG) is produced in red blood cells. 2,3-DPG binds to haemoglobin and stabilises it.

Fig. 3.2 shows oxygen dissociation curves when red blood cells have high and low concentrations of 2,3-DPG.

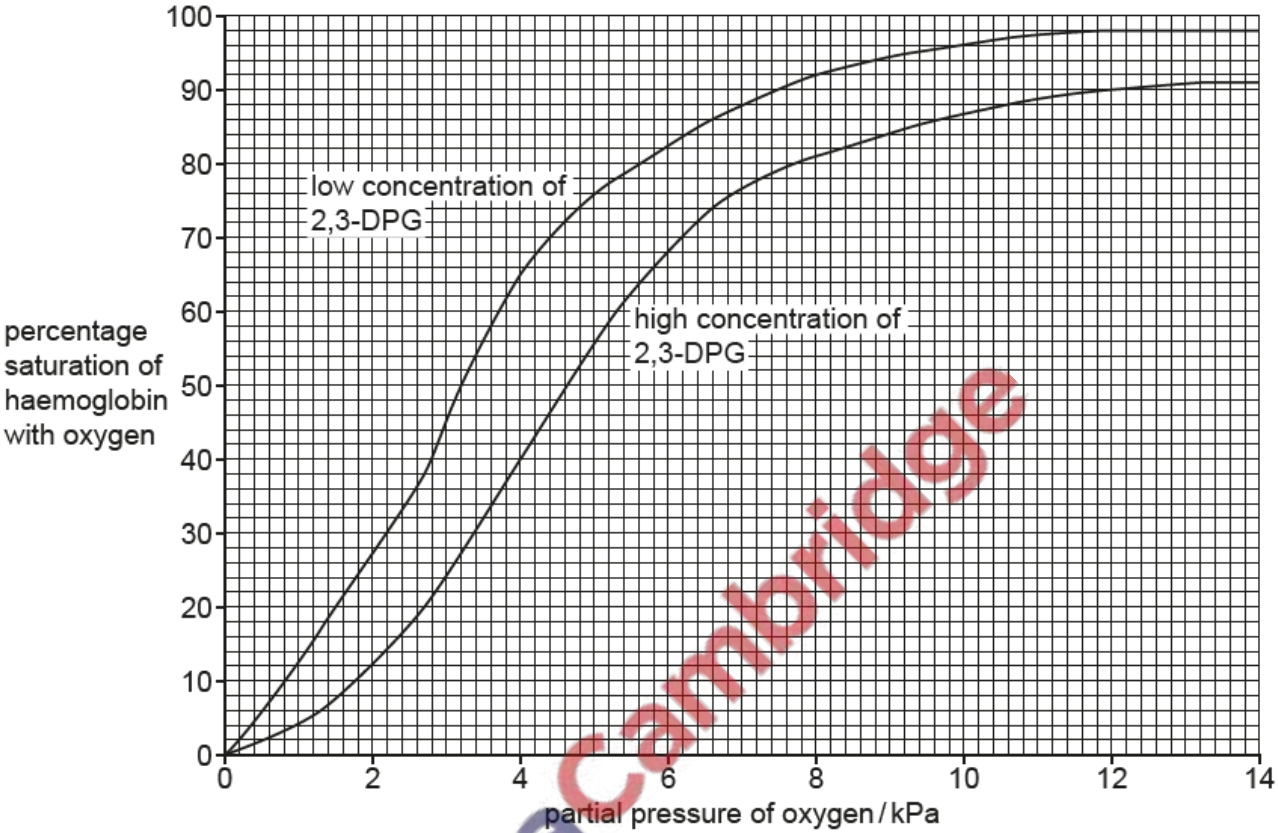

Fig. 3.2

P_{50} is the partial pressure of oxygen when haemoglobin is 50% saturated. The P_{50} is used to compare the affinity of haemoglobin for oxygen under different conditions.

(i) Use the information in Fig. 3.2 to describe the effect of an increase in the concentration of 2,3-DPG on the oxygen dissociation curve.

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..... [2]

(ii) Blood is stored in blood banks for use in hospitals during operations.

The concentration of 2,3-DPG in red blood cells decreases when blood is stored in a blood bank.

State **and** explain the effect that the use of blood taken from a blood bank has on the supply of oxygen to the tissues of a person during an operation.

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..... [2]

[Total: 11]