EXAM PAPERS PRACTICE

Proteins and enzymes 3

Level: AQA AS 7401
Subject: Biology
Exam Board: Suitable for all boards
Topic: Proteins and enzymes 3
Type: Questionnaire

To be used by all students preparing for AQA AS Biology 7401 foundation or higher tier but also suitable for students of other boards.

1 Uric acid is produced in the body. One of the reactions involved in the production of uric acid is catalysed by xanthine oxidase.

$$\text{xanthine} \xrightarrow{\text{xanthine oxidase}} \text{uric acid}$$

(a) A sample of xanthine oxidase was tested by mixing with biuret reagent. Describe and explain the result of this test.

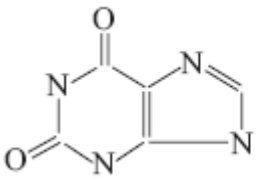
(2)

(b) Explain why xanthine oxidase is able to catalyse this reaction but it is not able to catalyse other reactions.

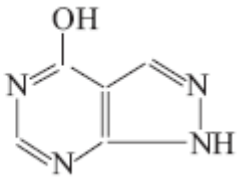
(2)

(c) Gout is a painful condition caused by uric acid crystals in the joints. It is often treated with a drug that inhibits xanthine oxidase. The diagram shows a molecule of xanthine and a molecule of this drug.

Xanthine



Drug used to treat gout



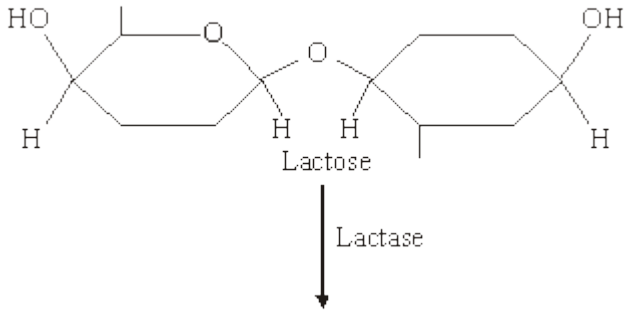
Use the diagram to explain why this drug is effective in the treatment of gout.

(3)

(Total 7 marks)

2 Lactose is a disaccharide found in milk. In the human small intestine, the enzyme lactase catalyses the hydrolysis of lactose to the monosaccharides, galactose and glucose. These monosaccharides are then absorbed into the blood.

SComplete the diagram to show the hydrolysis of lactose to galactose and glucose.



(Total 2 marks)

3 The box jellyfish produces a poison (venom) which enters the blood when a person is stung. A person who has been stung can be treated with an injection of antivenom. This antivenom is produced by injecting small amounts of venom from box jellyfish into sheep, then extracting antibodies from the sheeps' blood. These antibodies are then injected into the person who has been stung.

(a) If a sheep is injected with the box jellyfish venom on more than one occasion a higher yield of antivenom is obtained. Explain why.

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_____

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(2)

(b) Injecting antivenom does not give a person lasting protection against the venom of box jellyfish. Explain why.

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(2)

(c) Suggest **one** possible problem in injecting people with antivenom made in this way.

_____

_____

(1)

(Total 5 marks)

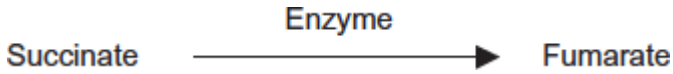
4 (a) The table contains statements about three stages of respiration.

Complete the table with a tick if the statement in the first column is true for each stage of respiration in an animal.

	Glycolysis	Link reaction	Krebs cycle
Occurs in mitochondria			
Carbon dioxide produced			
NAD is reduced			

(3)

(b) The following reaction occurs in the Krebs cycle.



A scientist investigated the effect of the enzyme inhibitor malonate on this reaction. The structure of malonate is very similar to the structure of succinate. The scientist added malonate and the respiratory substrate, pyruvate, to a suspension of isolated mitochondria. She also bubbled oxygen through the suspension.

(i) Explain why the scientist did not use glucose as the respiratory substrate for these isolated mitochondria.

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_____

_____

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_____

(2)

(ii) Explain how malonate inhibits the formation of fumarate from succinate.

_____

_____

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(2)

(iii) The scientist measured the uptake of oxygen by the mitochondria during the investigation. The uptake of oxygen decreased when malonate was added. Explain why.

_____

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(2)

(Total 9 marks)

5 (a) Name the monosaccharides of which the following disaccharides are composed.

(i) Sucrose

monosaccharides_____and_____

(1)

(ii) Lactose

monosaccharides_____and_____

(1)

(b) Amylase and maltase are involved in the digestion of starch in the small intestine.

Complete the table by identifying where these enzymes are produced and the product of the reaction they catalyse.

Name of enzyme	**Where the enzyme is produced**	**Product of the reaction catalysed by the enzyme**
Amylase		
Maltase		

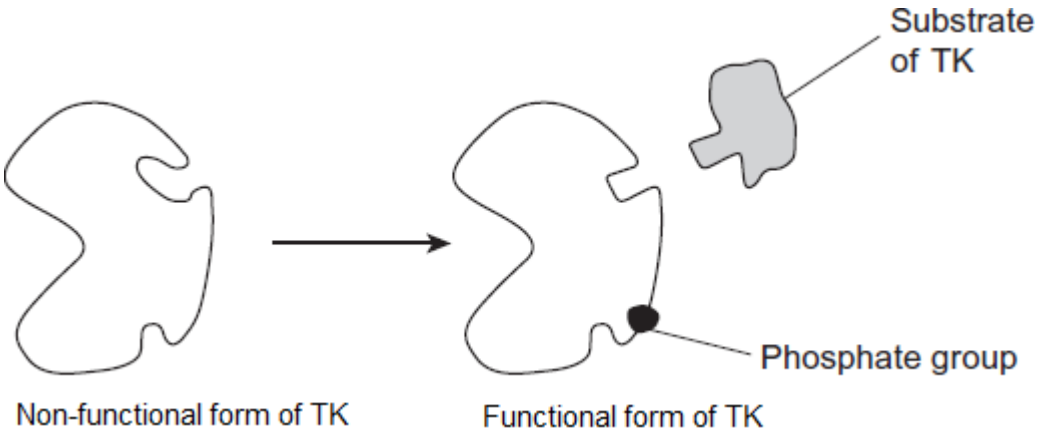
(2)

(Total 4 marks)

6 The enzyme tyrosine kinase (TK) is found in human cells. TK can exist in a non-functional and a functional form. The functional form of TK is only produced when a phosphate group is added to TK.

This is shown in **Figure 1.**

Figure 1



(a) Addition of a phosphate group to the non-functional form of TK leads to production of the functional form of TK.

Explain how.

_____

_____

_____

_____

_____

(2)

(b) The binding of the functional form of TK to its substrate leads to cell division. Chronic myeloid leukaemia is a cancer caused by a faulty form of TK. Cancer involves uncontrolled cell division.

Figure 2 shows the faulty form of TK.

Figure 2

Faulty form of TK

Suggest how faulty TK leads to chronic myeloid leukaemia.

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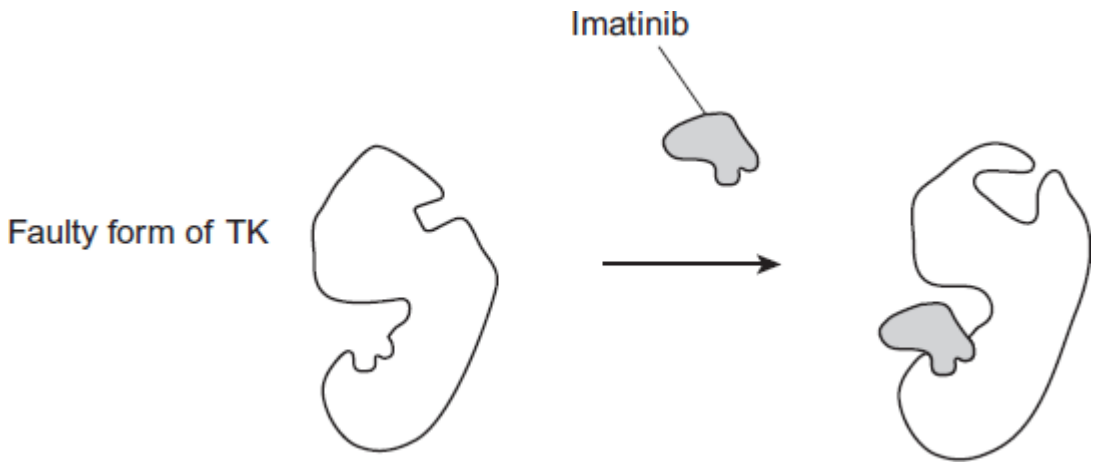
(2)

(c) Imatinib is a drug used to treat chronic myeloid leukaemia. **Figure 3** shows how imatinib inhibits faulty TK.

Figure 3



Using all of the information, describe how imatinib stops the development of chronic myeloid leukaemia.

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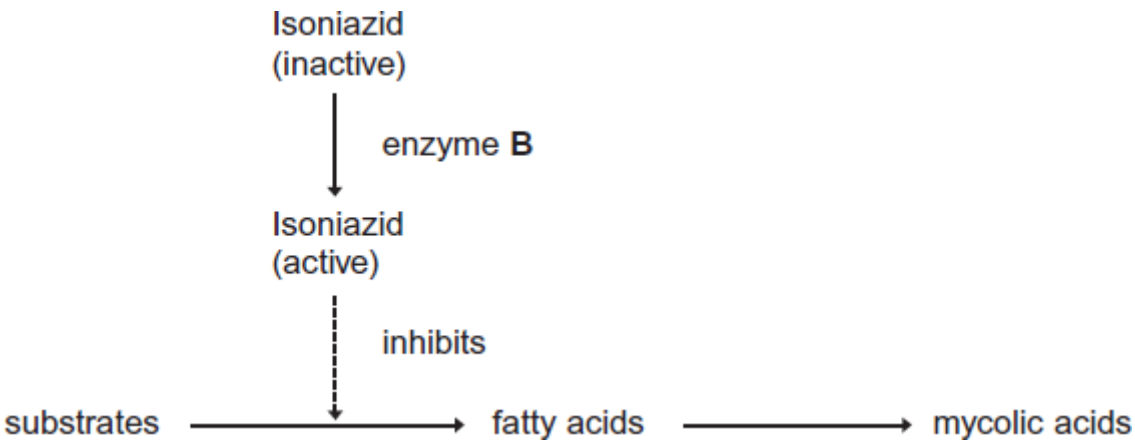
(2)

(Total 6 marks)

7 Mycolic acids are substances that form part of the cell wall of the bacterium that causes tuberculosis. Mycolic acids are made from fatty acids. Isoniazid is an antibioticthat is used to treat tuberculosis. The diagram shows how this antibiotic inhibits the production of mycolic acids in this bacterium.



(a) Treatment with isoniazid leads to the osmotic lysis of this bacterium. Use information in the diagram to suggest how.

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_____

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_____

(2)

(b) Human cells also produce fatty acids. Isoniazid does not affect the production of these fatty acids.

Use information in the diagram to suggest **one** reason why isoniazid does **not** affect the production of fatty acids in human cells.

_____

_____

_____

(1)

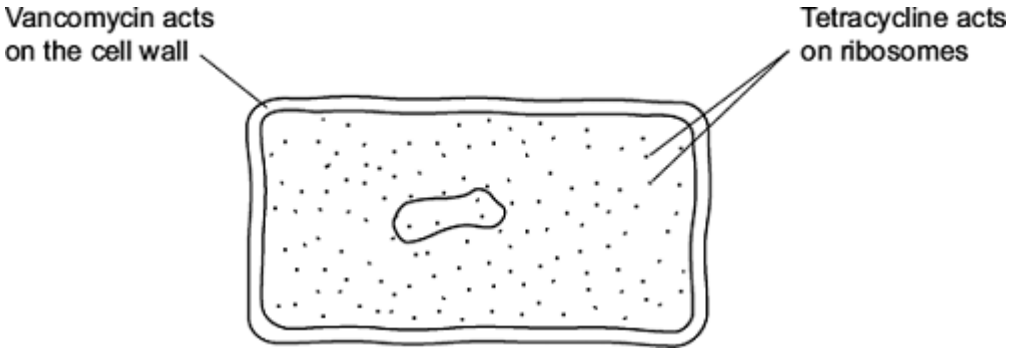
(c) A mutation in the gene coding for enzyme **B** could lead to the production of a non-functional enzyme. Explain how.

(Extra space)

(3)

(Total 6 marks)

8 The diagram shows the structure of a bacterium and the sites of action of two antibiotics.



(a) (i) Use information in the diagram to explain why vancomycin does **not** affect human cells.

(1)

(ii) Use information in the diagram to explain how tetracycline prevents bacterial growth.

(1)

(b) Frequent treatment with vancomycin can result in resistant strains of bacteria. Explain how.

(Extra space)

(2)

(Total 4 marks)

9 The equation shows the breakdown of lactose by the enzyme lactase.

Lactose + water $\xrightarrow{\text{lactase}}$ galactose + monosaccharide **X**

(a) (i) Name the type of reaction catalysed by the enzyme lactase.

(1)

(ii) Name monosaccharide **X**.

(1)

(b) (i) Describe how you would use a biochemical test to show that a reducing sugar is present.

(2)

(ii) Lactose, galactose and monosaccharide **X** are all reducing sugars.
After the lactose has been broken down there is a higher concentration of reducing sugar. Explain why.

_____

(1)

(c) A high concentration of galactose slows down the breakdown of lactose by lactase.
Use your knowledge of competitive inhibition to suggest why.

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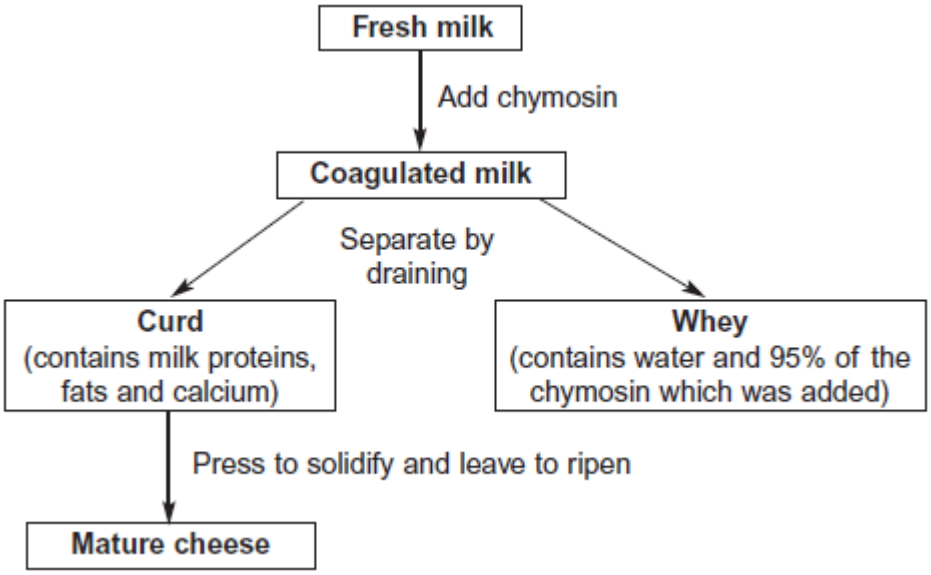
(2)

(Total 7 marks)

10 The figure below summarises the way in which cheese is made.



(a) A student carried out a biuret test on a sample of whey. The sample turned purple. Use the flowchart to explain why.

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(2)

(b) The percentage of protein in mature cheese is greater than the percentage of protein in coagulated milk. Use the flow chart to explain why.

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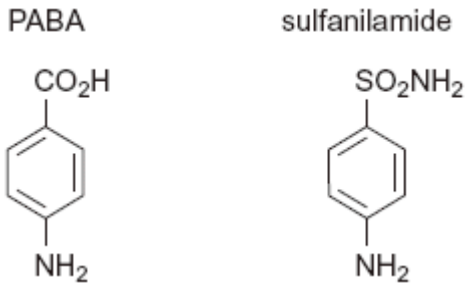
(1)

(Total 3 marks)

11 Folic acid is a substance required by bacteria for cell growth. Bacteria produce folic acid by the following reaction.

The diagram shows the structure of a molecule of PABA. It also shows the structure of a molecule of a drug called sulfanilamide, which can be used to treat bacterial infections. Sulfanilamide prevents bacteria producing folic acid.



Use the diagram and your knowledge of enzymes to explain how sulphanilamide prevents bacteria producing folic acid.

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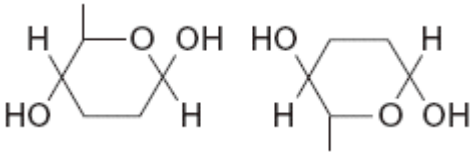
(Total 3 marks)

12 (a) The table shows some substances found in cells. Complete the table to show the properties of these substances. Put a tick in the box if the statement is correct.

Statement	Substance			
	Starch	Glycogen	Deoxyribose	DNA helicase
Substance contains only the elements carbon, hydrogen and oxygen				
Substance is made from amino acid monomers				
Substance is found in both animal cells and plant cells				

(4)

(b) The diagram shows two molecules of β-glucose.



On the diagram, draw a box around the atoms that are removed when the two β-glucose molecules are joined by condensation.

(2)

(c) (i) Hydrogen bonds are important in cellulose molecules. Explain why.

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(2)

(ii) A starch molecule has a spiral shape. Explain why this shape is important to its function in cells.

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(1)

(Total 9 marks)

13 Gangliosides are lipids found in the cell surface membranes of nerve cells. Hexosaminidase is an enzyme present in blood that breaks down gangliosides. If gangliosides are not broken down, they damage nerve cells.

(a) Hexosaminidase only breaks down gangliosides. It does not break down other lipids.

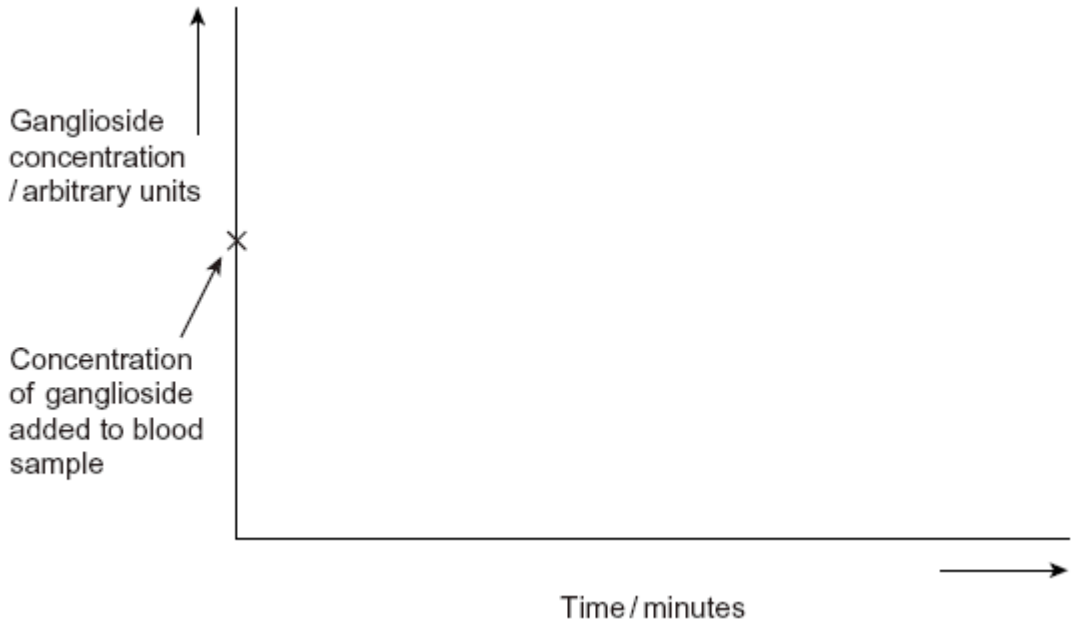
Explain why this enzyme only breaks down gangliosides.

(3)

(b) Hexosaminidase is found in the blood of healthy people. People with Tay Sachs disease do not have this enzyme in their blood.

Doctors confirm Tay Sachs disease by using a blood test. The technician carrying out the test adds a solution containing a high concentration of gangliosides to a sample of blood from the person being tested. The technician then measures the concentration of gangliosides in the person's blood at regular intervals.

(i) Complete the graph below by sketching a curve to show the results you would expect for a person with Tay Sachs disease. Label this curve **T**.



(1)

(ii) Sketch a curve on the same graph to show the results you would expect for a healthy person who does **not** have Tay Sachs disease. Label this curve **H**.

(1)

(c) Scientists are trying to find a way to give the missing enzyme to people with Tay Sachs disease. Suggest why they cannot give the enzyme as a tablet that is swallowed.

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(2)

(Total 7 marks)

14 Nitrogenase catalyses the reduction of nitrogen during nitrogen fixation. The reaction requires 16 molecules of ATP for each molecule of nitrogen that is reduced.

(a) Nitrogen gas is the usual substrate for this enzyme. Name the product.

_____

(1)

(b) Nitrogenase also catalyses reactions involving other substances. Explain what this suggests about the shapes of the molecules of these other substances.

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(2)

(c) (i) *Azotobacter* is a nitrogen-fixing bacterium. It produces the enzyme nitrogenase. The enzyme only works in the absence of oxygen.

Azotobacter has a very high rate of aerobic respiration compared with bacteria that do not fix nitrogen. Suggest **two** advantages of the very high rate of aerobic respiration.

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(2)

(ii) If scientists could transfer the gene that codes for nitrogenase to cereal plants, these cereal plants would be able to fix nitrogen. However, the scientists would expect these genetically engineered cereal plants to grow more slowly than cereal plants that get their nitrogen from fertiliser. Explain why they would grow more slowly.

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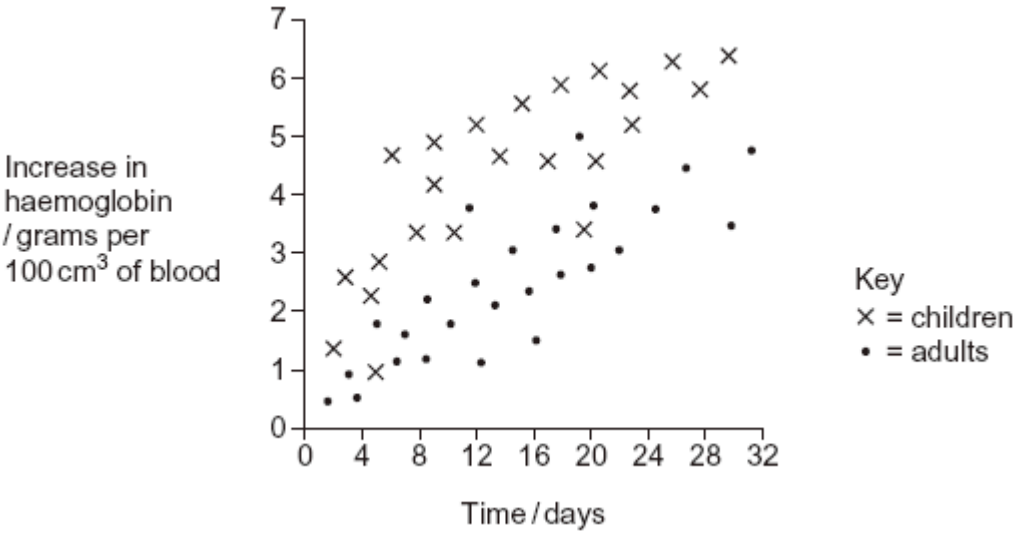
(2)

(Total 7 marks)

15 (a) Haemoglobin contains iron. One type of anaemia is caused by a lack of iron. This type of anaemia can be treated by taking tablets containing iron. A number of patients were given a daily dose of 120 mg of iron. **Figure 1** shows the effect of this treatment on the increase in the concentration of haemoglobin in their red blood cells.

Figure 1



(i) Give **one** difference in the response of adults and children to this treatment.

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_____

(1)

(ii) You could use the graph to predict the effect of this treatment on the increase in haemoglobin content of an adult after 40 days. Explain how.

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_____

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_____

(2)

(iii) Haemoglobin has a quaternary structure. Explain what is meant by a quaternary structure.

_____

_____

(1)

(b) (i) Pernicious anaemia is another type of anaemia. One method of identifying pernicious anaemia is to measure the diameter of the red blood cells in a sample of blood that has been diluted with an isotonic salt solution. Explain why an isotonic salt solution is used to dilute the blood sample.

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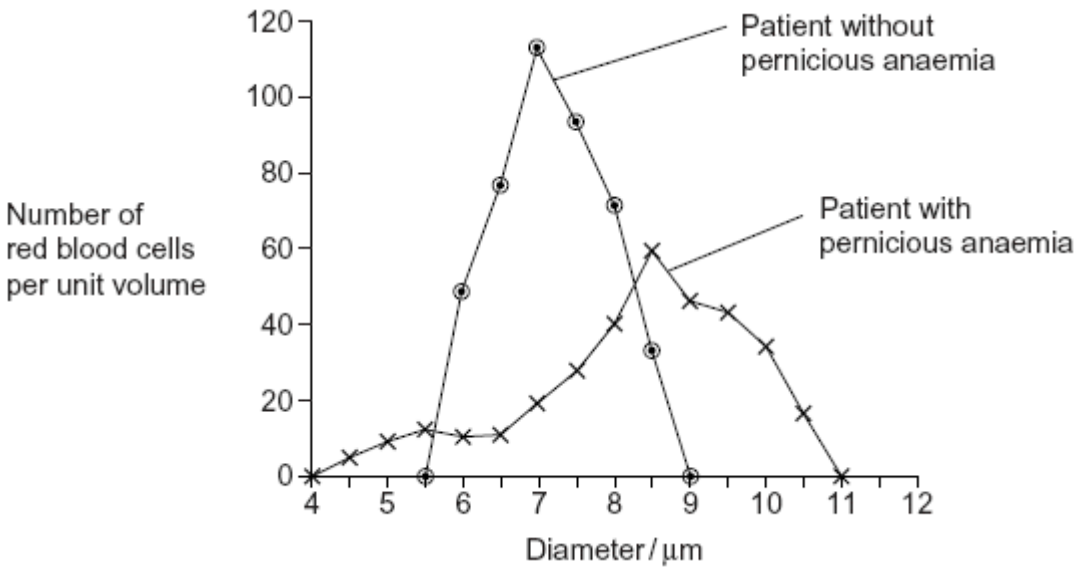
(3)

(ii) A technician compared the red blood cells in two blood samples of equal volume. One sample was from a patient with pernicious anaemia, the other was from a patient who did not have pernicious anaemia. **Figure 2** shows some of the results she obtained.

Figure 2



Describe **two** differences between the blood samples.

1. _____

_____

2. _____

_____

(2)

(Total 9 marks)

16 (a) (i) The equation shows the reaction catalysed by the enzyme lactase. Complete this equation.

Lactase + _____ ⟶ Glucose + _____

(2)

(ii) Name the type of chemical reaction shown in this equation.

_____

(1)

(b) Lactase is an enzyme. Lactose is a reducing sugar.

(i) Describe how you could use the biuret test to distinguish a solution of the enzyme, lactase from a solution of lactose.

_____

_____

(1)

(ii) Explain the result you would expect with the enzyme.

_____

_____

(1)

(Total 5 marks)

17 A glucose biosensor is an instrument used to measure glucose concentration. It contains an enzyme called glucose oxidase.

(a) A glucose biosensor detects only glucose. Use your knowledge of the way in which enzymes work to explain why.

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_____

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_____

(3)

(b) It is better to use a biosensor than the Benedict's test to measure the concentration of glucose in a sample of blood. Suggest **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(c) (i) Diabetes mellitus is a disease that can lead to an increase in blood glucose concentration. Some diabetics need insulin injections. Insulin is a protein so it cannot be taken orally. Suggest why insulin cannot be taken orally.

_____

_____

_____

(1)

(ii) A drug company produced a new type of insulin. Scientists from the company carried out a trial in which they gave this new type of insulin to rats. They reported that the results of this trial on rats were positive. A newspaper stated that diabetics would benefit from this new drug. Suggest **two** reasons why this statement should be viewed with caution.

1. _____

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2. _____

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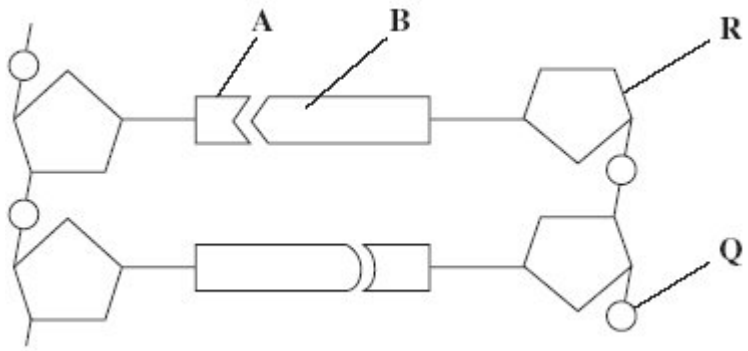
(2)

(Total 8 marks)

18 **Figure 1** shows a short section of a DNA molecule.

Figure 1



(a) Name parts **R** and **Q**.

(i) **R** _____

(ii) **Q** _____

(2)

(b) Name the bonds that join **A** and **B**.

_____

(1)

(c) Ribonuclease is an enzyme. It is 127 amino acids long.

What is the minimum number of DNA bases needed to code for ribonuclease?

☐

(1)

(d) **Figure 2** shows the sequence of DNA bases coding for seven amino acids in the enzyme ribonuclease.

Figure 2

G T T T A C T A C T C T T C T T C T T T A

The number of each type of amino acid coded for by this sequence of DNA bases is shown in the table.

Amino acid	Number present
Arg	3
Met	2
Gln	1
Asn	1

Use the table and **Figure 2** to work out the sequence of amino acids in this part of the enzyme. Write your answer in the boxes below.

Gln						

(1)

(e) Explain how a change in a sequence of DNA bases could result in a non-functional enzyme.

_____

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_____

_____

_____

(3)

(Total 8 marks)

19 (a) Sucrose, maltose and lactose are disaccharides.

(i) Sucrase is an enzyme. It hydrolyses sucrose during digestion. Name the products of this reaction.

_____ and _____

(2)

(ii) Sucrase does **not** hydrolyse lactose. Use your knowledge of the way in which enzymes work to explain why.

_____

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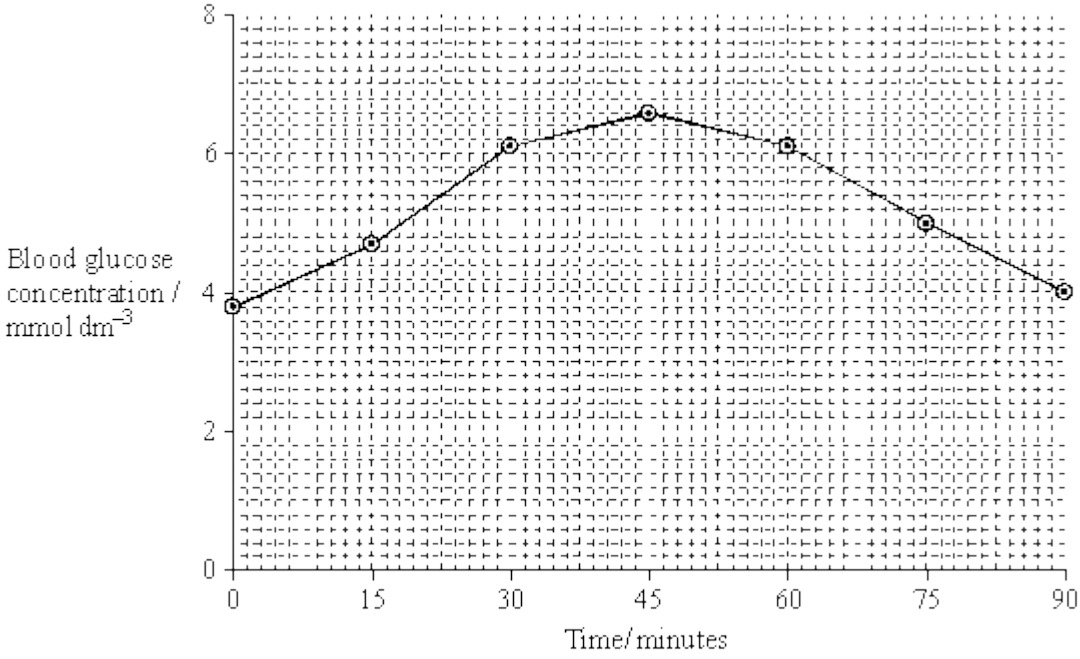
(2)

(b) A woman was given a solution of sucrose to drink. Her blood glucose concentration was measured over the next 90 minutes. The results are shown on the graph.



(i) Describe how the woman's blood glucose concentration changed in the period shown in the graph.

_____

_____

_____

_____

(2)

(ii) Explain the results shown on the graph.

_____

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(2)

(Total 8 marks)

20 Some enymes digest protein. They hydrolyse the peptide bonds between amino acids. The extent to which a protein is digested is called the degree of hydrolysis (DH). The DH value may be calculated from the equation:

$$DH = \frac{100 \times \text{Number of peptide bonds hydrolysed}}{\text{Total number of peptide bonds present}}$$

(a) (i) A protein molecule contains 151 amino acids. What is the total number of peptide bonds in this molecule?

_____

(1)

(ii) A molecule of this protein is digested. The DH value of the digested protein is 18. Calculate the number of peptide bonds that have been hydrolysed.

Answer _____

(1)

(b) What would be the DH value of a protein if it were completely hydrolysed to amino acids? Explain how you arrived at your answer.

DH value _____

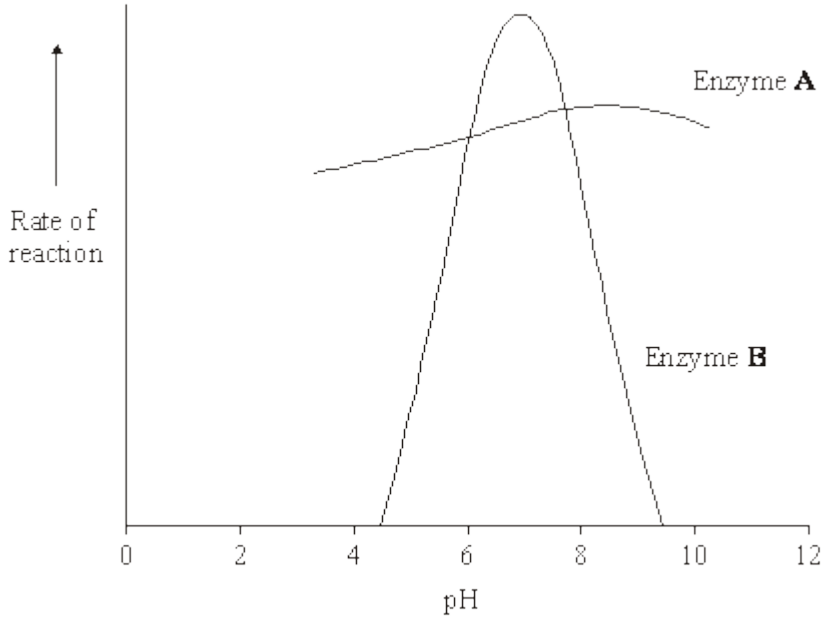
Explanation _____

_____

_____

(2)

Enzymes **A** and **B** digest protein. The graph shows the effect of pH on the rates of reaction of these enzymes.



(c) Pepsin is a protein-digesting enzyme found in the stomach. It has an optimum pH of 2 and is fully denatured at pH 6. Sketch a curve on the graph to show the effect of pH on the rate of reaction of pepsin.

(1)

(d) Explain why the rate of reaction of enzyme **B** is low at pH 5.

(3)

(e) Enzyme **A** is present in some washing powders used for cleaning clothes. Use the graph to suggest why enzyme **A** would be of more use in washing clothes than enzyme **B**.

(1)

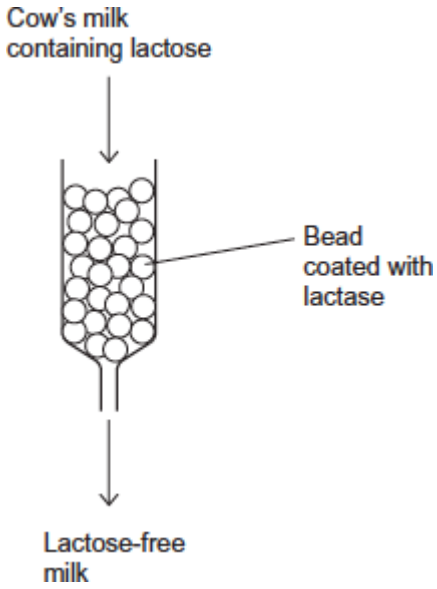
(f) Use your knowledge of protein structure to explain why enzymes are specific and may be affected by non-competitive inhibitors.

(6)

(Total 15 marks)

21 Cow's milk contains the sugar lactose. Many cats are unable to digest cow's milk because they are lactose intolerant.

Cow's milk can be made suitable for these cats by treating it with the enzyme lactase to hydrolyse lactose. This makes the cow's milk lactose-free. Beads are coated with lactase and placed in a tube, as shown in the diagram below. Cow's milk flows over the beads and the lactose is hydrolysed.



(a) Attaching lactase to the beads is a more efficient use of lactase than adding the lactase directly to cow's milk.

Suggest **three** reasons why it is more efficient to attach lactase to the beads.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(b) Monosaccharides and disaccharides taste sweet.
The lactose-free milk made after hydrolysis with lactase tastes sweeter than the cow's milk containing lactose.
Suggest why.

(2)

(Total 5 marks)

22 A principle of homeostasis is the maintenance of a constant internal environment. An increase in the concentration of carbon dioxide would change the internal environment and blood pH.
Explain the importance of maintaining a constant blood pH.

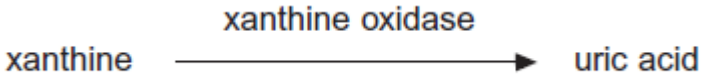
[Extra space]

(Total 3 marks)

23 (a) An enzyme catalyses only one reaction. Explain why.

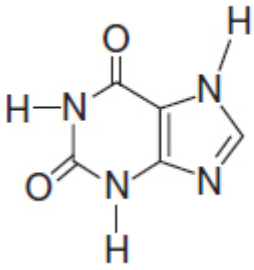
(2)

(b) Gout is a disease caused by the build-up of uric acid crystals in joints. Uric acid is produced from xanthine in a reaction catalysed by the enzyme xanthine oxidase.

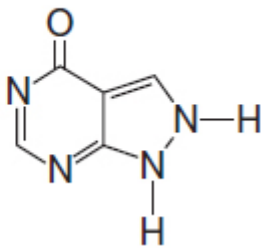


Allopurinol is a drug used to treat gout. The diagram shows the structures of xanthine and allopurinol.

Xanthine



Allopurinal



Use this information to suggest how allopurinol can be used to treat gout.

(Extra space)

(3)

(Total 5 marks)