Cambridge International AS & A Level

BIOLOGY (9700) PAPER 2

Past Paper Questions By Topic
+ Answer Scheme

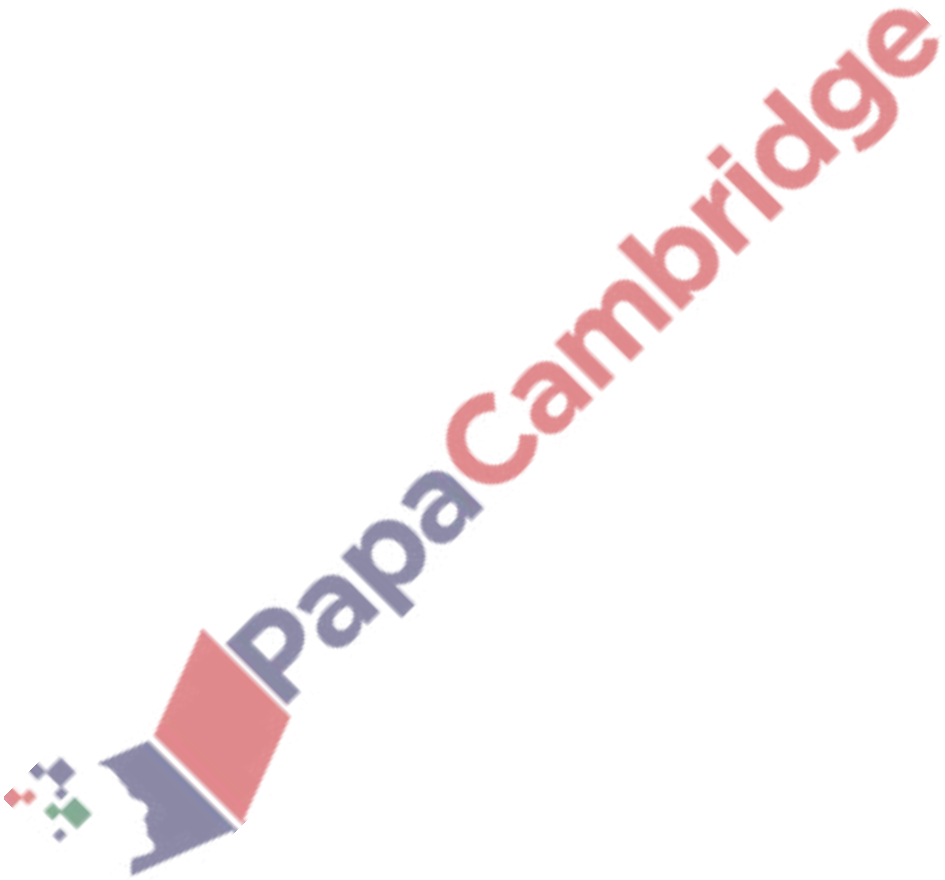
2015 - 2020

Complete Syllabus

PapaCambridge

Chapter 3

Enzymes



3.1 Mode of action of enzymes

13. 9700_w20_qp_21 Q: 2

(a) Fig. 2.1 shows the molecular structure of a triglyceride molecule.

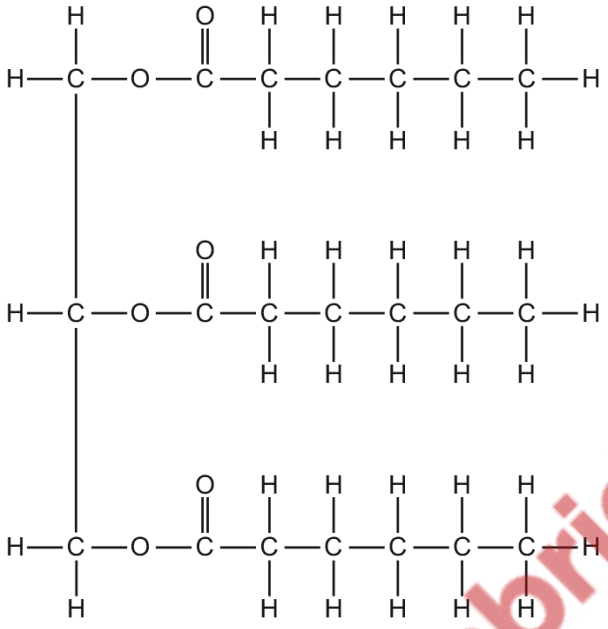


Fig. 2.1

(i) Draw a circle around an ester bond shown in Fig. 2.1. [1]

(ii) Name the type of reaction used to produce a triglyceride from its components.

State the number of water molecules produced during this reaction.

type of reaction .....

number of water molecules produced .....

[2]

(b) Lipases are enzymes that digest triglycerides in the lumen of the human intestine. These enzymes are released by exocytosis from intestinal epithelial cells.

(i) Underline **all** the terms from the list that are used to describe these lipases.

macromolecule **extracellular enzyme** **fibrous protein** **polysaccharide**

[1]

Scientists have found that treating milk with lipase can improve its taste.

The scientists carried out an experiment to determine the effect of lipase activity on the triglycerides found in milk.

- Lipase was immobilised in alginate beads.
- The pH of a known volume of milk was adjusted to pH 8 by adding an alkali.
- The beads were then mixed with this milk in a beaker.
- The pH of the reaction mixture was recorded over a period of 24 hours.

The results are shown in Fig. 2.2.

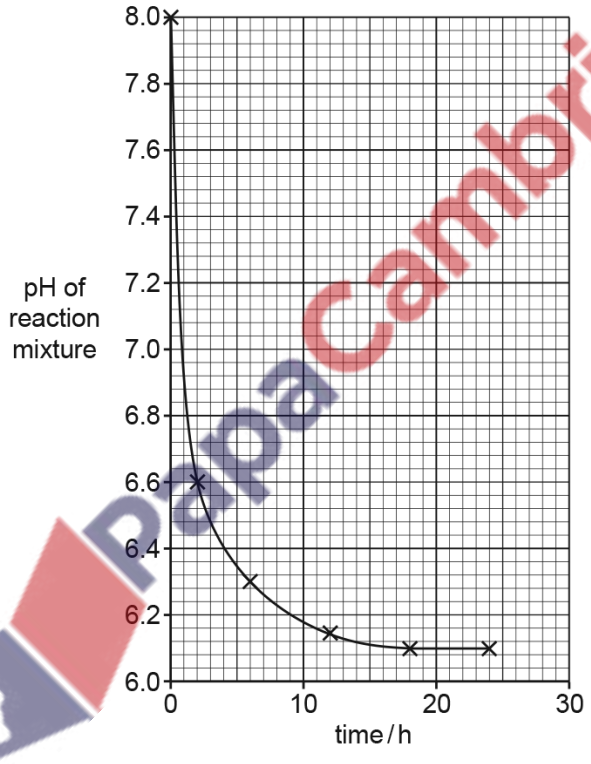


Fig. 2.2

Fig. 2.2 shows that the pH decreases steeply and then, after 18 hours, remains constant.

(ii) Calculate the time taken for the pH to decrease from pH 6.6 to pH 6.3.

time taken = ... h [1]

(iii) Explain the results shown in Fig. 2.2.

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(iv) The scientists repeated the experiment using a higher concentration of lipase. All other variables remained constant.

Predict how an increase in the concentration of the lipase would affect the results of the experiment.

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[Total: 11]

14. 9700_s18_qp_23 Q: 2

Adipose tissue, which is composed of cells known as adipocytes, stores large quantities of triglycerides and functions as an energy storage tissue.

Fig. 2.1 is a photomicrograph of adipose tissue.

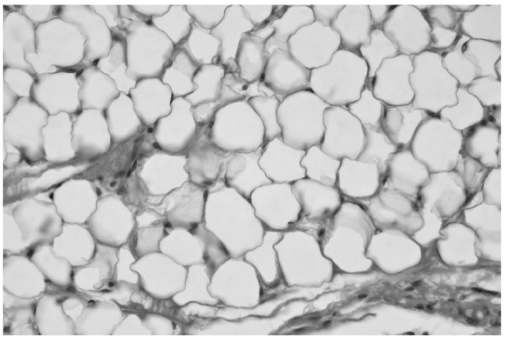

Fig. 2.1

(a) Adipocytes can be very large in size compared to other body cells. This is due to a large lipid droplet within the cell.

The largest adipocyte in Fig. 2.1 has a mean diameter of 35 μm. A person with good eyesight can see cells of 0.05 mm or greater diameter without a magnifying glass or any other optical aid.

State whether the person can see this adipocyte without any optical aid. Show your working to justify your answer.

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.....[1]

(b) Only some of the organelles within the adipocyte can be seen using a high quality light microscope set at the highest magnification.

Organelles such as rough endoplasmic reticulum, smooth endoplasmic reticulum and ribosomes are only visible using an electron microscope.

Explain why these organelles are **not** visible using a light microscope.

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(c) Adipocytes synthesise triglyceride lipase (ATGL), an enzyme that catalyses the formation or breakdown of triglycerides, as shown in Fig. 2.1.

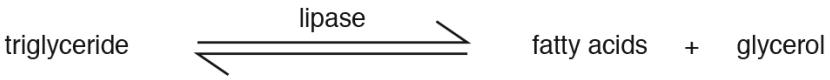

Fig. 2.1

The balance between triglyceride formation and breakdown is controlled by hormones. Fig. 2.2 is a summary of events occurring in an adipocyte when glycogen energy stores have been used up.

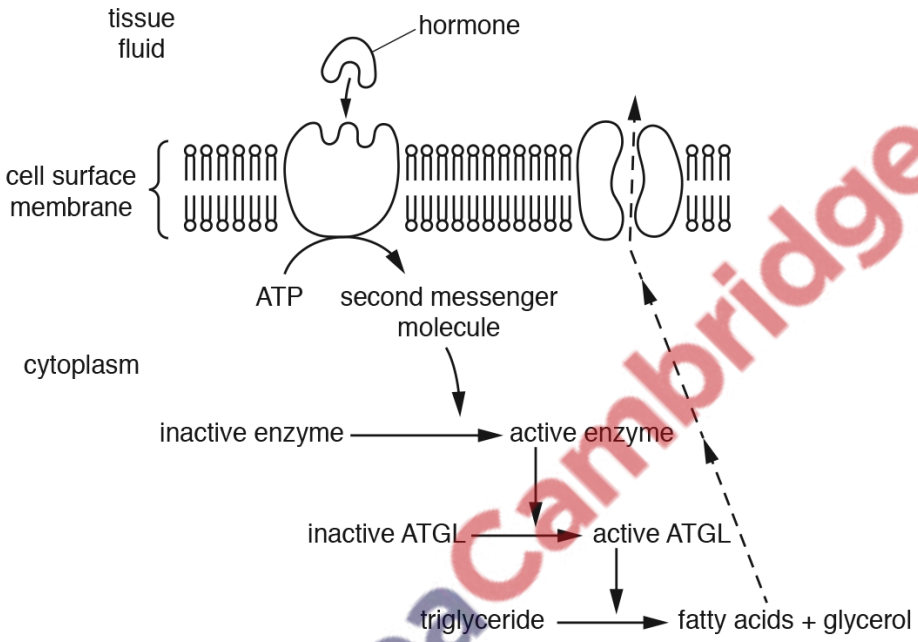

Fig. 2.2

(i) Name the type of bond broken by active ATGL to produce fatty acids and glycerol.

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(ii) Name **and** outline the process by which the fatty acids shown in Fig. 2.2 exit the cell.

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(iii) Fig. 2.2 is an example of cell signalling within the body.

With reference to Fig. 2.2, outline the process of cell signalling.

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(d) The fatty acids released from adipocytes are transported in blood plasma and are taken up by cells.

Although most cell types can metabolise fatty acids to synthesise ATP in the presence of oxygen, red blood cells **cannot** do this.

Suggest why red blood cells **cannot** metabolise fatty acids to synthesise ATP.

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.....[1]

[Total: 12]

3.2 Factors that affect enzyme action

15. 9700_m20_qp_22 Q: 2

Phosphatidate phosphatase (PAP) enzymes have an important role in lipid metabolism.

The reaction catalysed by PAP is shown in Fig. 2.1.

Fig. 2.1

Experiments were carried out to investigate the activity of PAP extracted from the cotyledons (seed leaves) of bitter gourd, *Momordica charantia*.

(a) There are two types of PAP enzymes:

- PAP1 enzymes need magnesium ions (Mg^{2+}) in the active site to function
- PAP2 enzymes do not need Mg^{2+}.

The effect of different concentrations of Mg^{2+} on the activity of PAP extracted from *M. charantia* was investigated.

The results are shown in Fig. 2.2.

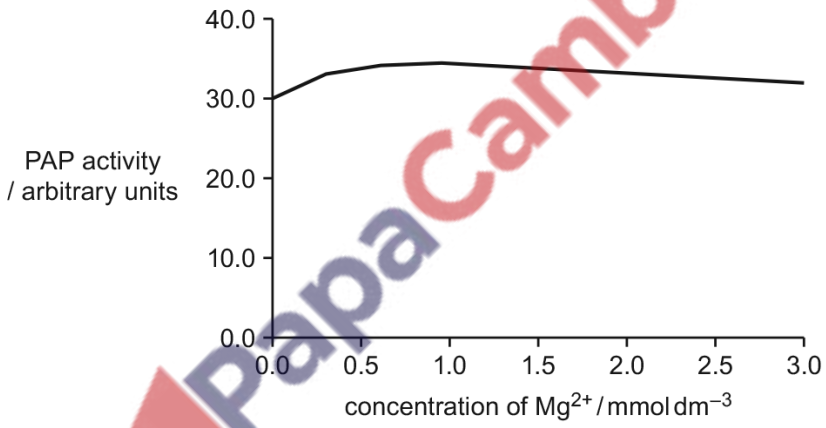

Fig. 2.2

Explain, with reference to Fig. 2.2, whether the PAP extracted from *M. charantia* is a PAP1 enzyme or a PAP2 enzyme.

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..... [2]

(b) Fig. 2.3 shows the effect of increasing phosphatidate concentration on the activity of PAP extracted from *M. charantia*.

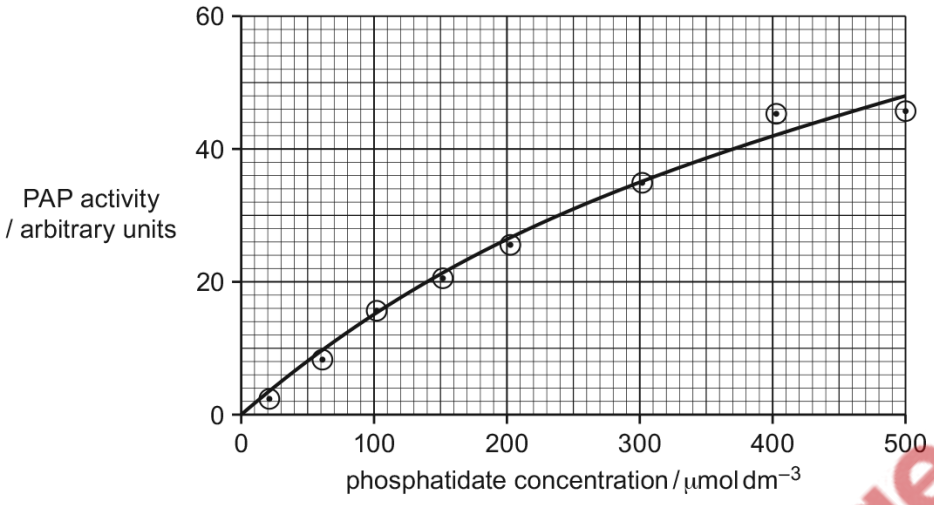

Fig. 2.3

With reference to Fig. 2.3, describe **and** explain the effect of increasing phosphatidate concentration on the activity of PAP.

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(c) The diglycerides formed as a result of the action of PAP can be used to synthesise triglycerides and membrane phospholipids.

(i) Explain how the structure of a triglyceride is suited to its function as an energy storage molecule.

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..... [2]

(ii) Explain why phospholipids are able to form a bilayer in cell membranes.

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[Total: 10]

16. 9700_s20_qp_21 Q: 3

The enzyme glucose 6-phosphate dehydrogenase (G6PD) is composed of two identical polypeptide chains.

(a) Students investigated the activity of two forms of G6PD, **J** and **K**, at different concentrations of substrate. **K** is a form of the enzyme that results from a mutation that changes one amino acid in the polypeptide.

The results are shown in Fig. 3.1.

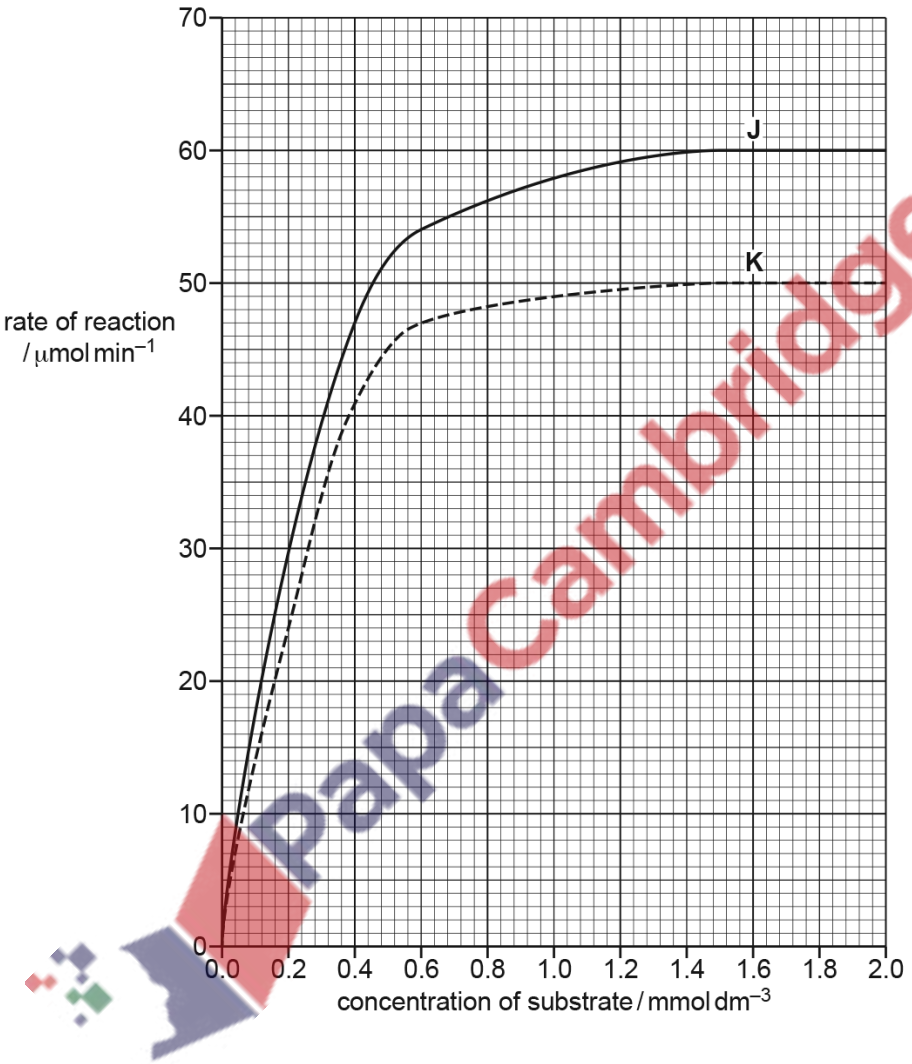

Fig. 3.1

(i) Use Fig. 3.1 to complete Table 3.1 by stating:

- the V_{max} and the K_m for enzymes **J** and **K**
- the units for V_{max} and K_m.

Table 3.1

	V_{max} /	K_m /
J		
K		

[3]

(ii) With reference to Fig. 3.1 and Table 3.1, describe the effect of the mutation on the activity of G6PD **and** suggest an explanation for this effect.

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..... [4]

(b) In certain conditions, G6PD may also exist as four identical polypeptide chains rather than two identical polypeptide chains.

Explain why both of these types of G6PD have all four levels of protein structure.

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..... [2]

[Total: 9]

17. 9700_s20_qp_23 Q: 4

Saccharomyces cerevisiae is a unicellular fungus that is important in the brewing and baking industries.

Fig. 4.1 is a diagram of a transmission electron micrograph of *S. cerevisiae*.

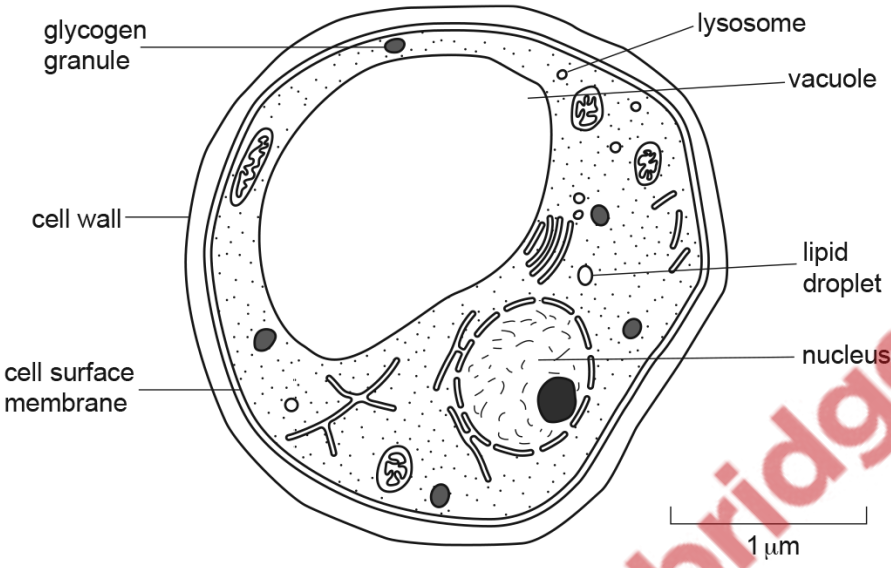

Fig. 4.1

(a) A student was asked to calculate the magnification of the image shown in Fig. 4.1.

The student began by measuring the length of the scale bar in millimetres using a millimetre ruler.

State what the student should do next to obtain the correct answer.

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..... [1]

(b) One function of the lipid droplets shown in Fig. 4.1 is to store triglycerides.

The triglycerides in a lipid droplet are surrounded by a single layer (monolayer) of phospholipids.

Suggest **and** explain why phospholipids, rather than triglycerides, are used for the outer monolayer of the lipid droplet.

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..... [2]

(c) The lysosomes and vacuole of *S. cerevisiae* contain acid hydrolases (hydrolytic enzymes) that function in an acid pH.

Explain why lysosomes need hydrolases to carry out their function.

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..... [1]

(d) A disaccharide, trehalose, is a reserve store of energy for *S. cerevisiae* when glycogen stores decrease. The monomer of glycogen and trehalose is α-glucose.

(i) Complete Fig. 4.2 to show the ring structure of **one** α-glucose molecule.

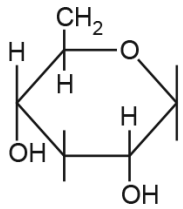

Fig. 4.2

[2]

(ii) A student carried out tests on a solution of trehalose and correctly concluded that trehalose is a **non-reducing** sugar.

Outline the procedure carried out by the student **and** state the results that were obtained.

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..... [3]

(e) The hydrolysis of trehalose is catalysed by two different enzymes produced by *S. cerevisiae*, regulatory trehalase and non-regulatory trehalase.

A study was carried out to compare regulatory trehalase and non-regulatory trehalase extracted from *S. cerevisiae*.

The results of the study showed that:

- regulatory trehalase had a higher K_m value (Michaelis-Menten constant) than non-regulatory trehalase
- the optimum pH of regulatory trehalase was pH 7.0–7.8
- the optimum pH of non-regulatory trehalase was pH 4.5–5.0.

(i) Explain what is meant by a higher K_m value.

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..... [2]

(ii) Regulatory trehalase is found only in the cytosol, the fluid part of the cytoplasm.

Non-regulatory trehalase has been found on the external surface of the cell surface membrane and inside the cell.

State the location inside the cell where non-regulatory trehalase is likely to be found **and** explain the reason for your answer.

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..... [2]

(iii) Explain whether both types of trehalase, regulatory and non-regulatory, can be described as intracellular enzymes.

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..... [1]

(f) *Saccharomyces boulardii* is a strain of *S. cerevisiae*. It has been researched for its possible health benefits for some gut diseases.

Researchers investigating trehalase extracted from *S. boulardii* concluded that only one type of trehalase was present in the extract.

Fig. 4.3 shows the effect of pH on the activity of the trehalase extracted from *S. boulardii*.

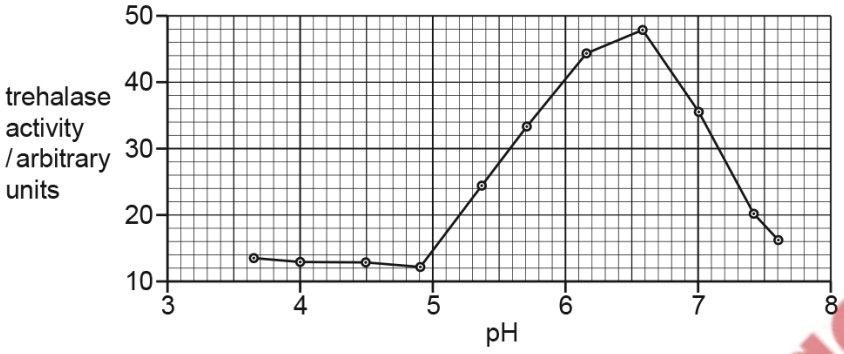

Fig. 4.3

With reference to Fig. 4.3 and to the two different types of trehalase enzyme produced by *S. cerevisiae*, state **and** explain what can be deduced about the type of trehalase present in *S. boulardii*.

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[Total: 17]

18. 9700_w20_qp_22 Q: 5

Sucrose phosphorylase is an enzyme found in some species of bacteria. One function of this enzyme is for the production of compounds that help to protect the cell from harmful osmotic changes in the external environment.

Fig. 5.1 shows the reversible reaction that takes place within the bacterial cell.

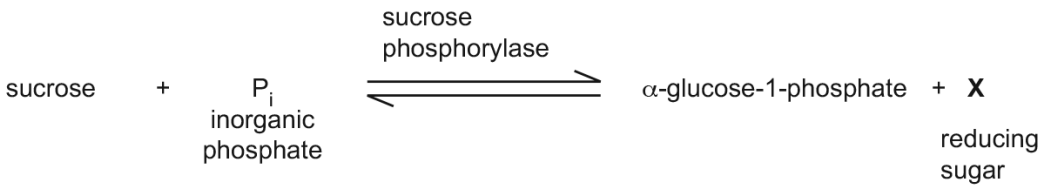

Fig. 5.1

(a) Name reducing sugar **X** in Fig. 5.1.

..... [1]

(b) In the absence of sucrose phosphorylase as a catalyst, the reaction shown in Fig. 5.1 would take too long to occur to allow the bacterial cell to function efficiently.

Explain why the reaction shown in Fig. 5.1 proceeds at a much faster rate in the presence of the enzyme.

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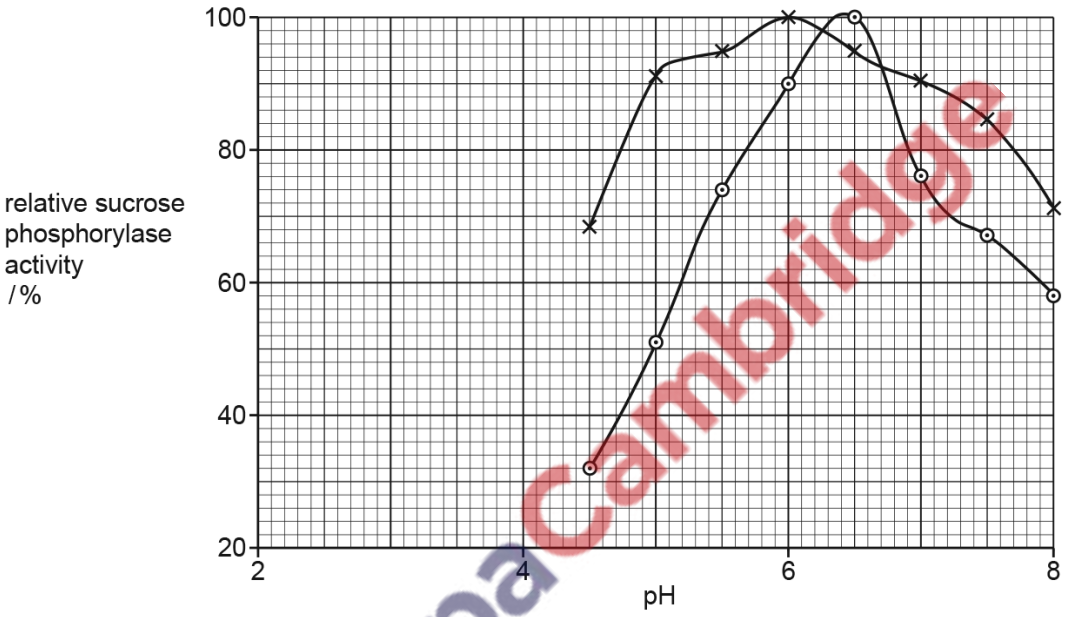
..... [2]

(c) An enzyme that catalyses a reaction of commercial interest needs to be investigated to see if it is suitable for use in industry.
For example:

- immobilised enzymes may be used as they have a longer shelf-life than the enzyme free in solution
- many industrial reactions are carried out at higher temperatures to minimise contamination of products by microorganisms.

Fig. 5.2 shows the results of an investigation to compare the activity of sucrose phosphorylase free in solution (free enzyme) with immobilised sucrose phosphorylase (immobilised enzyme) at different pHs.

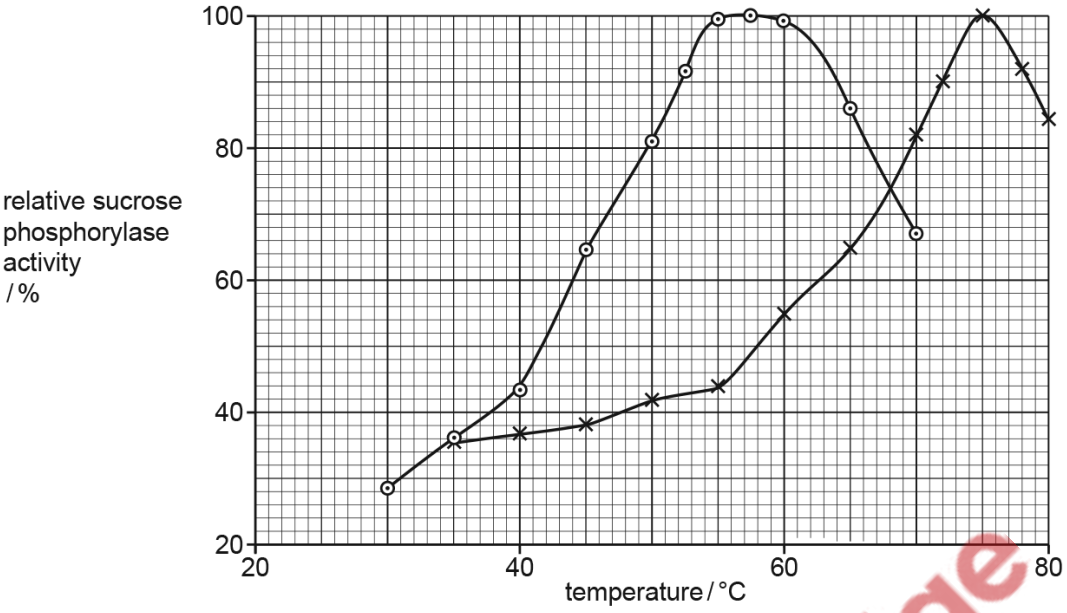
Fig. 5.3 shows the activity of the free enzyme and immobilised enzyme at different temperatures.



Key

⊙ free enzyme
× immobilised enzyme

Fig. 5.2



Key

⊙ free enzyme

× immobilised enzyme

Fig. 5.3

With reference to the results shown in Fig. 5.2 and Fig. 5.3, discuss which sucrose phosphorylase enzyme, free or immobilised, is better for use in industrial reactions.

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[Total: 7]

19. 9700_s19_qp_21 Q: 3

Neutrase® is an enzyme that is used to hydrolyse proteins in solution. When the enzyme is mixed with a 2% protein solution the reaction mixture changes from white to colourless.

A student carried out an experiment to find the effect of copper sulfate and potassium sulfate on the activity of Neutrase®.

The student made four reaction mixtures in test-tubes **A** to **D**. Test-tubes **A** to **C** contained equal volumes of protein solution and 0.1 cm^3 of solutions of copper sulfate or potassium sulfate. Test-tube **D** contained the same volume of protein solution and 0.1 cm^3 of water.

0.5 cm^3 of a 1% Neutrase® solution was added to test-tube **A** and immediately placed into a colorimeter. The colorimeter was used to measure the intensity of light that is absorbed by the solution (absorbance) over 100 seconds. The procedure was repeated with the other reaction mixtures, **B**, **C** and **D**.

The results are shown in Fig. 3.1.

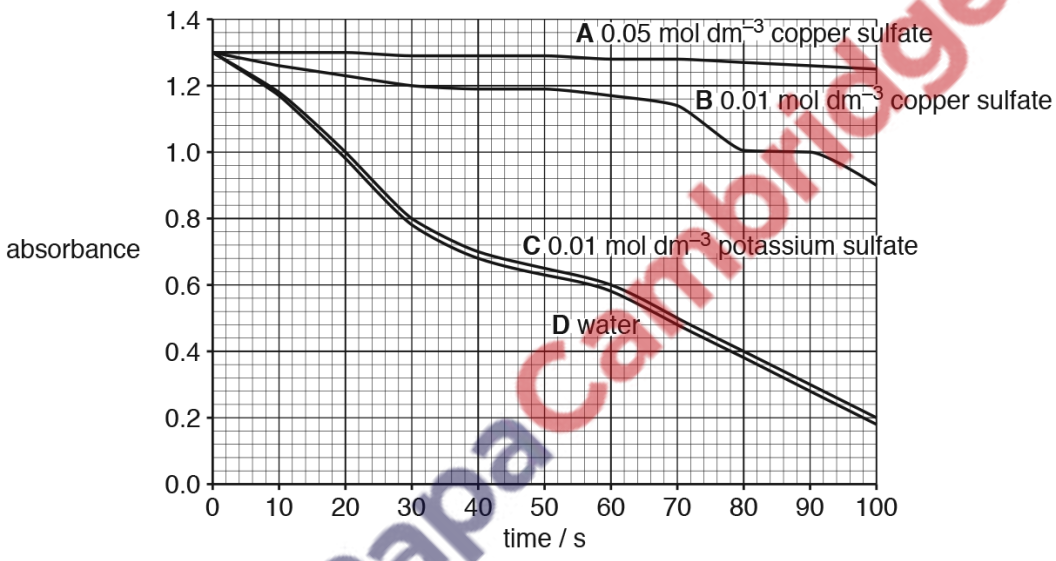

Fig. 3.1

(a) (i) Suggest **and** explain why measuring the absorbance of the reaction mixture over 100 s is a suitable method for determining the activity of Neutrase®.

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..... [2]

(ii) With reference to Fig. 3.1:

- describe the effects of copper sulfate solution and potassium sulfate solution on the activity of Neutrase®
- suggest explanations for the effects that you have described.

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(b) Neutrase® can be immobilised in alginate. Immobilised Neutrase® is used in the food industry to produce foods with high nutritional content.

Explain the advantages of using immobilised enzymes, such as Neutrase®, compared with using the same enzymes free in solution.

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[Total: 9]

20. 9700_s19_qp_22 Q: 6

Catalase is an enzyme that catalyses the breakdown of hydrogen peroxide, which is a waste product of cell metabolism.

The reaction catalysed by catalase is shown in Fig. 6.1.

$$2H_2O_2 \xrightarrow{\text{catalase}} 2H_2O + O_2$$

Fig. 6.1

(a) A student carried out two experiments to investigate the progress of the reaction shown in Fig. 6.1. Potato tissue was used as the source of the enzyme.

Six pieces of potato were cut, each measuring 20 mm × 10 mm × 10 mm.

In the first experiment, hydrogen peroxide solution was added to three of the pieces of potato tissue and the progress of the reaction was measured.

Fig. 6.2 shows how the first experiment was set up.

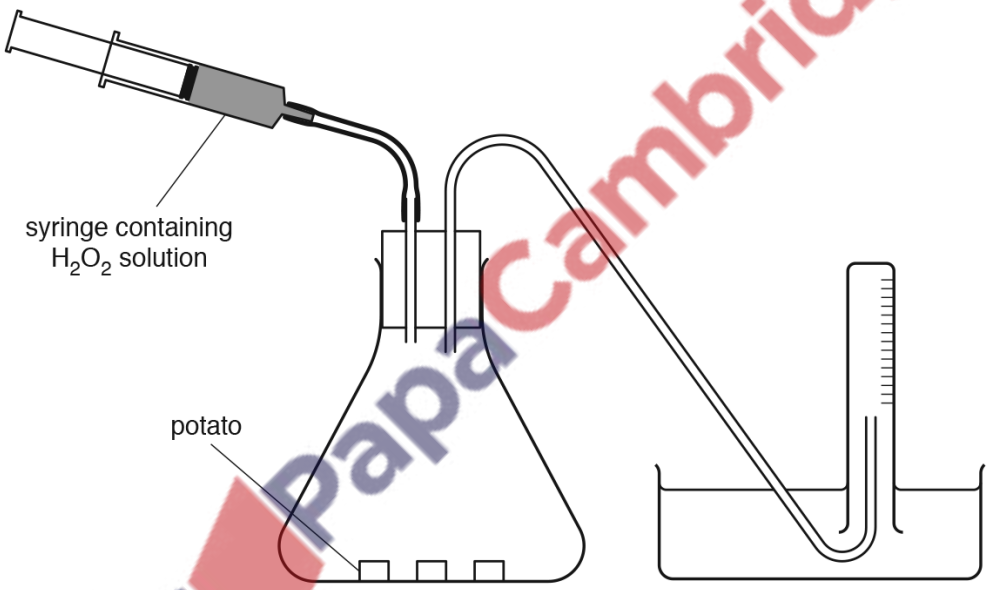

Fig. 6.2

(i) Suggest how the progress of the reaction could be measured.

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(ii) In the second experiment, the student cut each of the three remaining pieces of potato to obtain six pieces, each measuring 10 mm × 10 mm × 10 mm.

Using exactly the same conditions, the student measured the progress of the reaction and obtained different results to the first experiment.

Explain why the results of the second experiment were different from the results of the first experiment.

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(b) The student then investigated the effect of temperature on the activity of catalase.

On Fig. 6.3, sketch a curve to show how temperature affects the activity of an enzyme such as catalase.

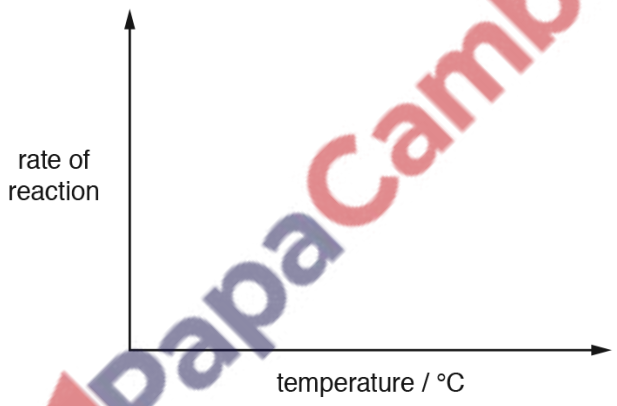

Fig. 6.3

[1]

[Total: 5]

21. 9700_m18_qp_22 Q: 3

The unicellular fungus *Kluyveromyces lactis* is found in dairy products. It is a safe microorganism to culture for the extraction of the enzyme lactase. Lactase catalyses the breakdown of lactose, a sugar found in milk.

The reaction catalysed by lactase is summarised in Fig. 3.1.

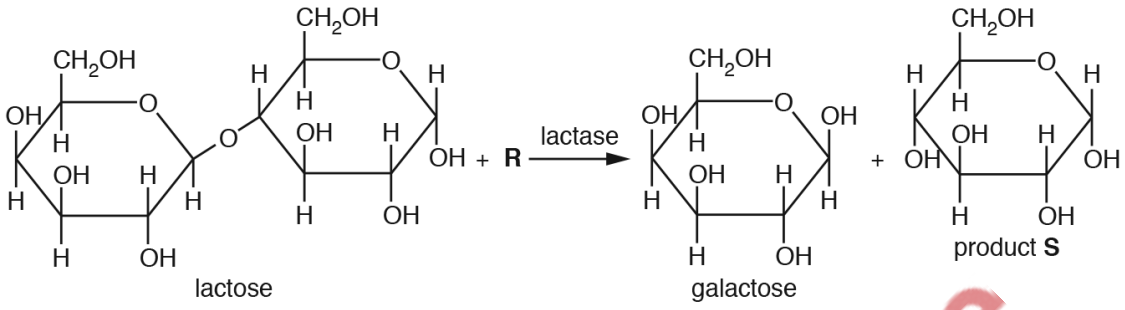

Fig. 3.1

(a) Describe the reaction that is catalysed by lactase. Use Fig. 3.1 to help you.

In your answer, identify **R** and product **S**.

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(b) On a commercial scale, immobilised lactase can be used to produce lactose-free milk.

One of the products of the reaction shown in Fig. 3.1 acts as an inhibitor of lactase. This is an example of product inhibition.

(i) Suggest why product inhibition is useful in *K. lactis* when lactase is acting as an intracellular enzyme, but can be a disadvantage when extracted lactase is used free in solution for the production of lactose-free milk.

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(ii) Suggest how using immobilised lactase in a commercial application helps to reduce the problem of product inhibition.

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(iii) The first large-scale production of lactose-free milk with an immobilised enzyme used lactase trapped in cellulose triacetate fibres.

Suggest **one** feature of cellulose triacetate that makes it useful as an immobilising material.

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..... [1]

(c) For a commercial application using an enzyme, the progress of the enzyme-catalysed reaction needs to be studied.

Outline how the progress of an enzyme-catalysed reaction can be investigated experimentally.

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..... [3]

[Total: 11]

22. 9700_s18_qp_21 Q: 3

Researchers isolated a sucrase enzyme from the bacterium *Bacillus subtilis*. They immobilised the enzyme in alginate beads.

The researchers investigated the effects of temperature on the activity of the immobilised sucrase compared with the activity of the same enzyme free in solution.

The results are shown in Fig. 3.1.

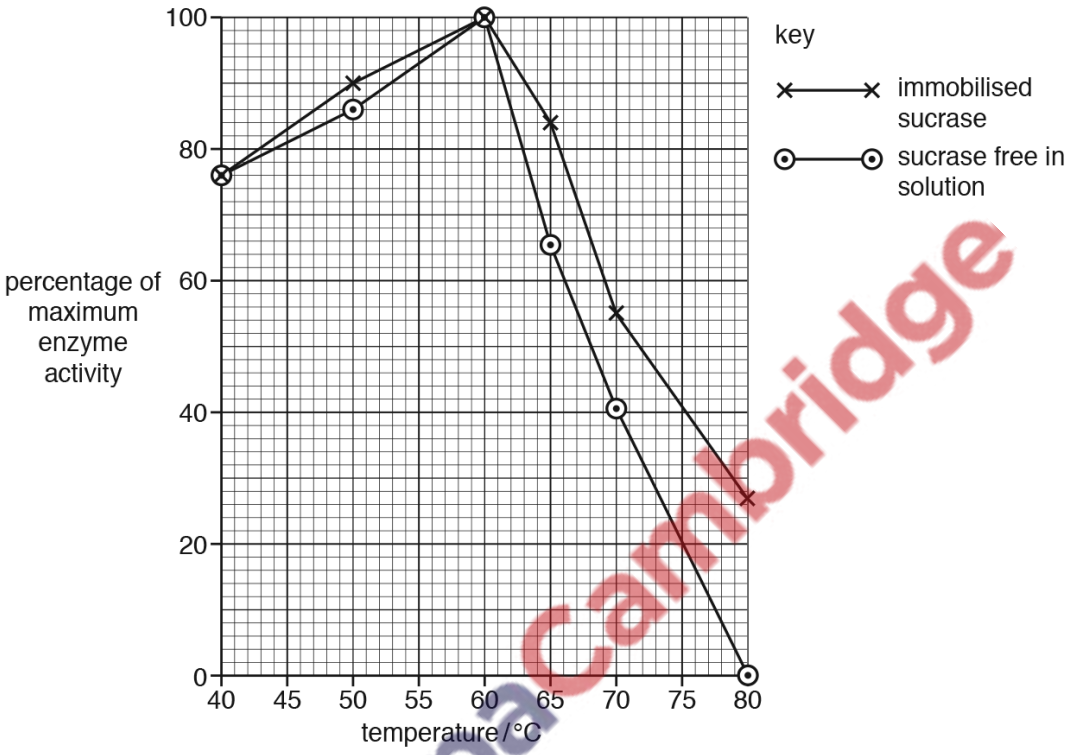

Fig. 3.1

(a) With reference to Fig. 3.1, **compare** the effects of temperature on the activity of immobilised sucrase with the activity of sucrase free in solution.

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.....[4]

The researchers also investigated the effects of pH on the activity of the immobilised sucrase compared with its activity free in solution.

The results are shown in Fig. 3.2.

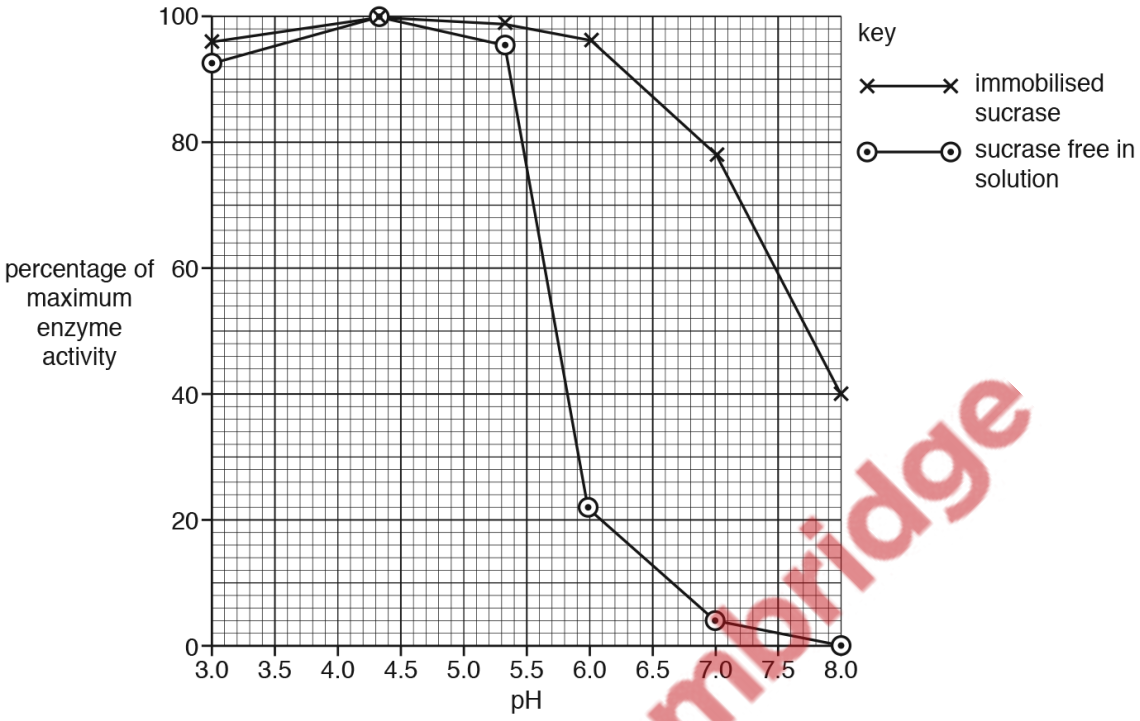

Fig. 3.2

(b) Fig. 3.2 shows that immobilised sucrase remains active over a wider range of pH compared with sucrase free in solution.

Suggest reasons for the higher activity of immobilised sucrase over the range of pH between 5.5 and 8.0.

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.....[2]

(c) State **one** variable that the researchers should keep constant in **both** investigations **and** explain your answer in terms of enzyme action.

variable .....

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explanation .....

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.....[2]

(d) There are many advantages of using immobilised enzymes in industry.

Suggest **two** advantages of using immobilised enzymes in industry **other than** remaining active over a greater range of pH.

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.....[2]

[Total: 10]

23. 9700_s18_qp_23 Q: 5

The fig tree, *Ficus carica*, and the papaya tree, *Carica papaya*, produce a milky-looking fluid known as latex. The latex is released when plant tissue is wounded and it is thought to act as a defence against attack by herbivorous insects or parasitic worms.

Latex is a complex mixture of substances and the exact composition of the mixture depends on the plant species. A group of enzymes that hydrolyse proteins, known as cysteine proteases, are commonly found in latex.

Ficin, found in *F. carica*, and papain, found in *C. papaya*, are both cysteine protease enzymes. These enzymes have been extracted and purified for use commercially.

(a) An investigation was carried out to compare the effect of temperature on the activity of ficin and papain.

The results are shown in Fig. 5.1.

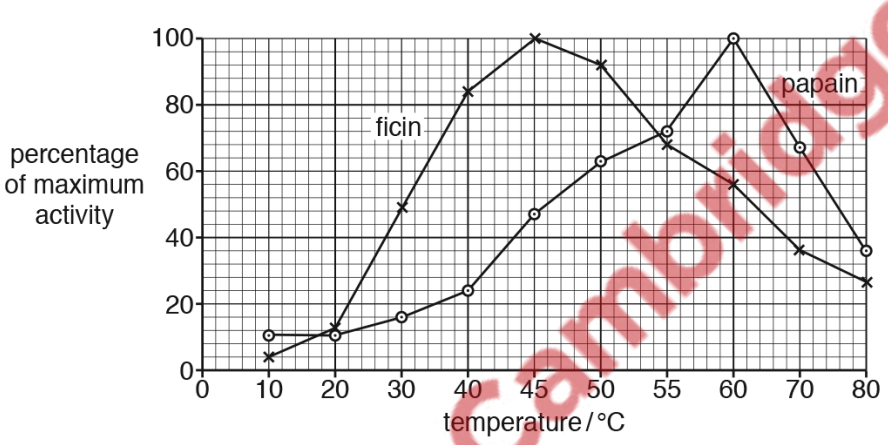

Fig. 5.1

(i) With reference to Fig. 5.1, describe the differences between the activity of papain compared to the activity of ficin between 20 °C and 80 °C.

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.....[3]

(ii) Ficin and papain have been shown to be effective in the digestion of parasitic nematodes (roundworms).

With reference to Fig. 5.1, explain which enzyme you would select to use in an oral medication for the treatment of human intestinal parasitic nematodes.

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.....[1]

(b) One commercial use of the enzyme ficin is the production of Fab fragments (antigen binding regions) of mouse IgG antibodies for use in immunological studies. The process uses immobilised ficin to cleave (cut) the antibodies in the hinge region.

Suggest **one** practical advantage of using immobilised ficin for this process, rather than ficin free in solution.

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.....[1]

(c) *Streptococcus pyogenes* is a bacterium that can cause a range of diseases in humans.

S. pyogenes synthesises streptopain, a cysteine protease that hydrolyses structural proteins in human connective tissue.

(i) Streptopain is secreted to the outside of the cell.

State the term given to an enzyme that is produced by a cell and is then secreted to the outside, where it has its action.

.....[1]

(ii) Suggest **one** example of a structural protein in connective tissue that can be hydrolysed by streptopain.

.....[1]

[Total: 7]

24. 9700_w18_qp_21 Q: 2

Fig. 2.1 shows the disaccharide lactose, which is found in milk.

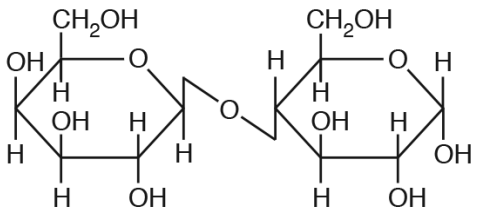

Fig. 2.1

(a) Name the type of bond that joins the two monosaccharides in lactose.

..... [1]

(b) The enzyme lactase catalyses the breakage of the bond between the two monosaccharides in lactose.

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

..... [1]

(ii) Some people do not produce the enzyme lactase, so cannot digest lactose.

The presence of lactose in the lumen of the intestine reduces the volume of water absorbed into the blood, resulting in diarrhoea.

Suggest why the presence of lactose in the intestine reduces the volume of water absorbed.

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..... [2]

(c) Enzymes, such as lactase, are often immobilised for use in the food industry.

A scientist carried out an investigation to determine the effects of temperature on the activity of lactase when it was immobilised and when it was free in solution.

The scientist produced alginate beads containing lactase for use in this investigation. The beads varied in size. The scientist selected small beads for the investigation and put them into a glass column.

(i) Suggest the advantage of using small beads rather than large beads.

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..... [2]

(ii) Fig. 2.2 shows the results of the investigation to determine the effects of temperature on the activity of lactase when it was immobilised, **I**, and when it was free in solution, **F**.

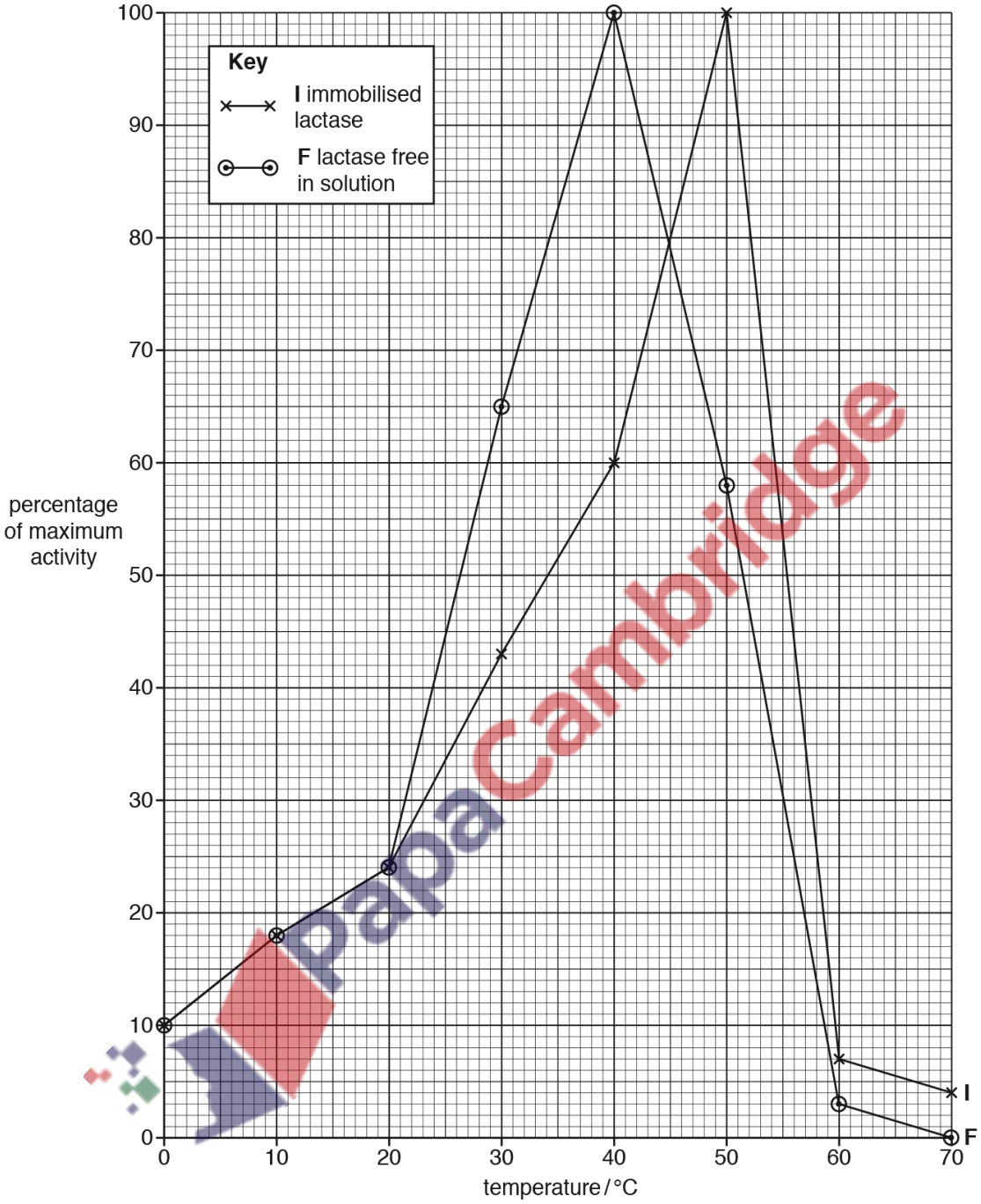

Fig. 2.2

With reference to Fig. 2.2, compare the effect of temperature on the activity of immobilised lactase, **I**, and lactase free in solution, **F**.

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..... [3]

[Total: 9]

25. 9700_s17_qp_21 Q: 2

Phosphatases are enzymes that catalyse the removal of phosphate groups from organic compounds.

Some students investigated the effect of substrate concentration on the rate of the reaction catalysed by an acid phosphatase (enzyme **A**). The results are shown in Fig. 2.1.

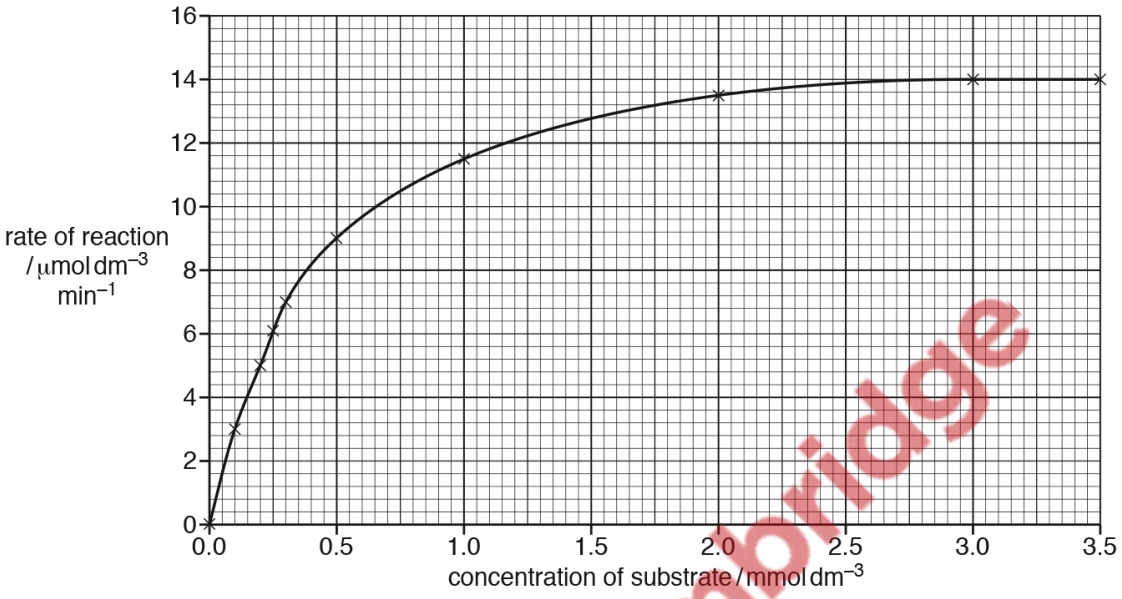

Fig. 2.1

(a) The students used Fig. 2.1 to derive the Michaelis-Menten constant (K_m) for enzyme **A** as 0.3 mmol dm^{-3}.

Explain how they derived K_m.

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.....[2]

(b) The students investigated a different phosphatase enzyme (enzyme **B**) and found the value of K_m to be higher than 0.3 mmol dm^{-3}.

Explain the difference between the values of K_m for these two phosphatase enzymes.

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.....[2]

(c) The students repeated their investigation on enzyme **A** with a competitive inhibitor.

They used the same concentrations of substrate as before, but added a competitive inhibitor to each reaction mixture.

They used the same concentration of the inhibitor in each reaction mixture.

The students found that V_{max} was the same as before, but K_m was higher than 0.3 mmol dm^{-3}.

Explain how the addition of the competitive inhibitor results in the same value for V_{max} but a higher value for K_m.

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.....[4]

[Total: 8]

26. 9700_s17_qp_22 Q: 2

Lipase is an enzyme with many commercial uses. Some species of bacteria are of great interest as they produce large quantities of lipase.

(a) Complete Fig. 2.1 to show the hydrolysis of triglyceride by lipase.

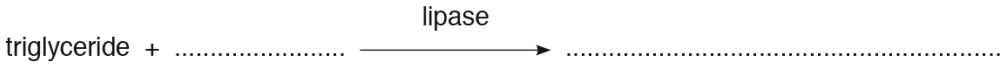

Fig. 2.1

[2]

Researchers carried out investigations into lipase extracted from a bacterium found in hot springs.

(b) To measure the activity of the bacterial lipase during their investigations, the researchers used a method based on the biological test for triglycerides.

Outline a biological test that could be carried out to show the presence of triglyceride in a liquid mixture **and** describe the positive result for this test.

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.....[3]

(c) The researchers investigated the effect of pH values between pH2.0 and pH10.5 on the activity of bacterial lipase in hydrolysing triglyceride at a temperature of 37 °C.

The results are shown in Fig. 2.2.

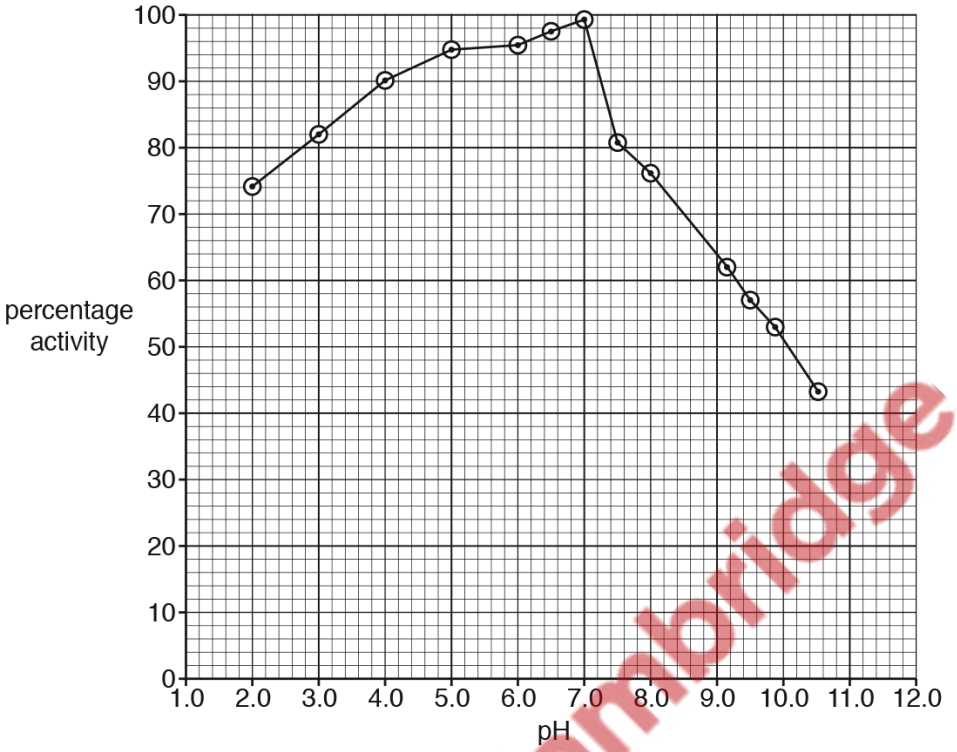

Fig. 2.2

With reference to Fig. 2.2, describe the effect of pH on the activity of bacterial lipase.

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.....[4]

(d) A separate investigation into the effect of pH on the same bacterial lipase compared the enzyme free in solution with the enzyme immobilised by physical attachment to a stable polymer.

At a temperature of 37 °C, the optimum pH of the enzyme free in solution was the same as that shown in Fig. 2.2. The optimum pH of the immobilised enzyme was measured as pH 4.

(i) Suggest **one** reason to explain why the enzyme free in solution has a different optimum pH compared to the immobilised enzyme.

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.....[1]

(ii) Suggest **one** advantage of immobilising the extracted lipase for commercial use.

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.....[1]

[Total: 11]

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27. 9700_s16_qp_22 Q: 1

Statements **A** to **E** are about the structure and functioning of enzymes.

State the correct term to match each of the statements **A** to **E**.

A The energy level, lowered by enzyme action, that needs to be overcome by reactants in order for products to be formed.

.....

B The mechanism of enzyme action that relies on the active site being partially flexible and changing shape in order to bind the substrate.

.....

C The term to describe a protein, such as an enzyme, with a tertiary or quaternary structure that results in an approximately spherical shape.

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D The term for enzymes that function outside cells.

.....

E The concentration of substrate that enables an enzyme to achieve half the maximum rate of reaction.

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[5]

[Total: 5]

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28. 9700_s16_qp_23 Q: 2

Trypsin is a protease enzyme found in the digestive system.

Fig. 2.1 shows how the substrate concentration affects the rate of reaction of trypsin.

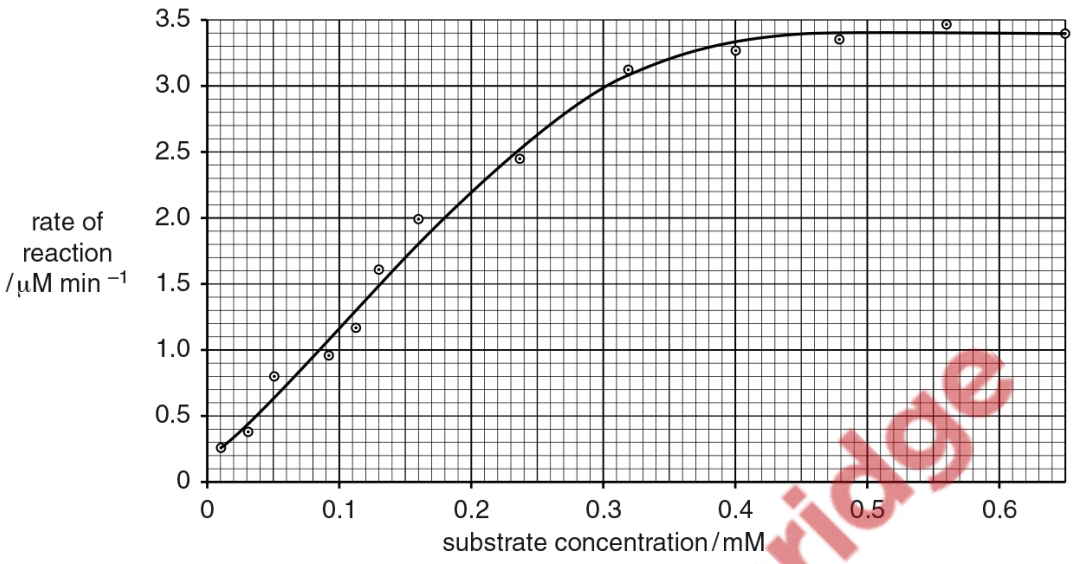

Fig. 2.1

(a) Use Fig. 2.1 to:

(i) determine V_{max} for trypsin

.....[1]

(ii) calculate K_m for trypsin.

Show your working.

.....[2]

(b) Describe **and** explain the shape of the curve in Fig. 2.1.

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.....[4]

(c) Trypsin is composed of one polypeptide chain of 223 amino acids.

The active site of trypsin contains three amino acids which catalyse a hydrolysis reaction. These three amino acids occupy the following positions in the primary structure of trypsin:

- histidine, position 57
- aspartate, position 102
- serine, position 195.

(i) In the functioning enzyme, these three amino acids are close together in the active site.

Explain how the structure of the protein makes this possible.

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.....[3]

(ii) When trypsin acts on a substrate, another substance is required as a reactant.

Name this other substance.

.....[1]

[Total: 11]

29. 9700_w16_qp_21 Q: 3

Fig. 3.1 shows the structure of the enzyme lysozyme.

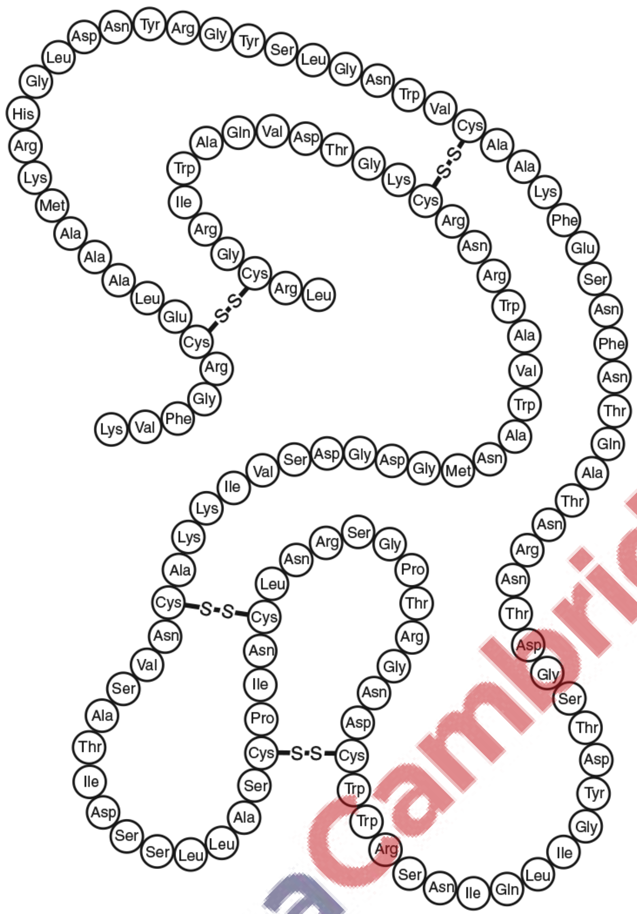

Fig. 3.1

(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]

(b) Lysozyme hydrolyses the β-1,4 glycosidic bonds present in compounds found in bacterial cell walls.

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

.....

.....[1]

(ii) Suggest the type of biological molecule which is the substrate for lysozyme.

.....[1]

(iii) Lysozyme uses the induced fit mechanism.

Explain the mode of action of an enzyme that uses the induced fit mechanism.

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.....[4]

(c) In human tears and saliva, lysozyme acts as an extracellular enzyme.

State what is meant by the term *extracellular*.

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.....[1]

(d) Fig. 3.2 shows the results of an investigation into the effect of substrate concentration on the rate of reaction catalysed by lysozyme.

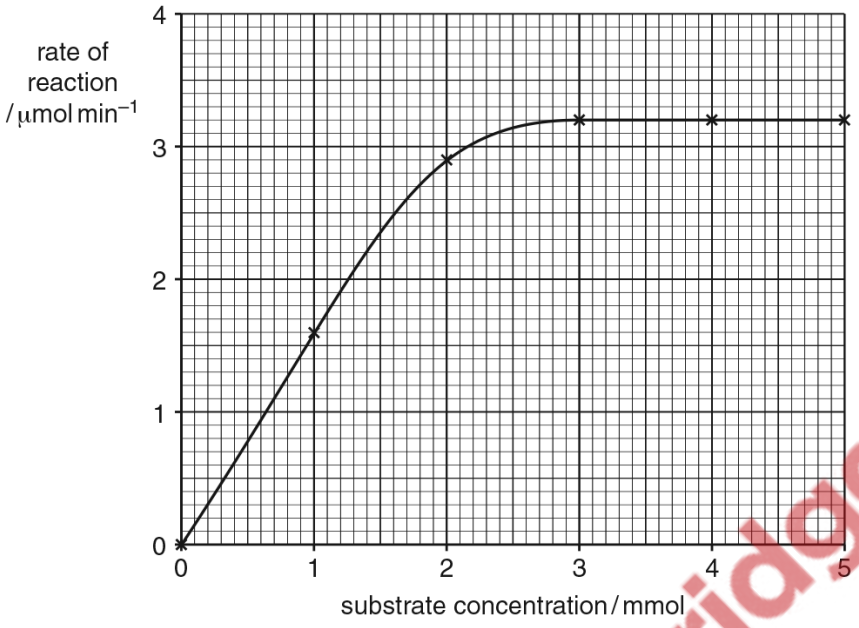


Fig. 3.2

Use Fig. 3.2 to:

(i) state the lowest substrate concentration to give the maximum rate of reaction, V_{max}

.....[1]

(ii) determine the Michaelis-Menten constant, K_m.

K_m = ...[1]

(e) The investigation was repeated in the presence of a competitive inhibitor of lysozyme.

Draw a curve **on Fig. 3.2** to show the expected results. [2]

[Total: 13]

30. 9700_s15_qp_22 Q: 4

Many microorganisms can digest cellulose by using a group of enzymes collectively known as cellulases. Cellobiose is the disaccharide produced during cellulose digestion.

The cellulase known as β-glucosidase completes the digestion of cellulose by hydrolysing the cellobiose molecule to produce two β-glucose molecules.

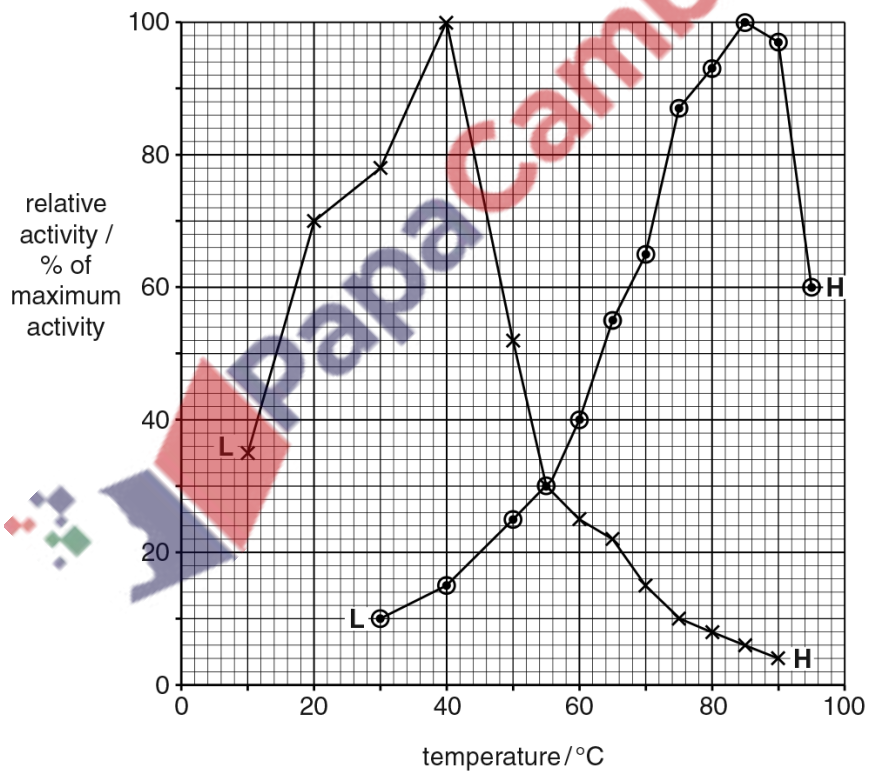
(a) Draw the ring structure of one β-glucose molecule in the space provided.

[2]

(b) β-glucosidase was extracted from two different bacteria, *Agrobacterium tumefaciens* and *Thermotoga maritima*.

Fig. 4.1 shows the results of an investigation into the effect of temperature between 0 °C and 100 °C, on the activity of each enzyme.

- **L** represents the lowest temperature at which activity of each enzyme was detected.
- **H** represents the highest temperature at which activity of each enzyme was detected.



Key

× enzyme **A** (extracted from *A. tumefaciens*)

⊙ enzyme **T** (extracted from *T. maritima*)

Fig. 4.1

(i) With reference to Fig. 4.1, describe the **differences** in the results for the two enzymes, **A** and **T**.

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.....[4]

(ii) Both enzyme **A** and enzyme **T** act on cellobiose. They have a similar, but not identical, primary structure.

Suggest how similarities **and** differences in the primary structure of the two enzymes could help to explain the results obtained in the investigation.

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.....[4]

[Total: 10]