

Enzymes

Question Paper 3

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Enzymes
Sub Topic	Enzymes
Booklet	Theory
Paper Type	Question Paper 3

Time Allowed : 54 minutes

Score : / 45

Percentage : /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

- 1 Some bacteria that are found in soils contain the enzyme urease.

Urease catalyses the hydrolysis of urea to form ammonia and carbon dioxide:



Some fertilisers added to soils to help crop growth contain urea. Although some crop plants can absorb ammonium ions, most obtain their source of nitrogen as nitrate ions.

- (a) Describe how urea from fertilisers becomes available to plants as nitrate ions.

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.....[3]

The activity of urease can be measured by following the increase in pH as ammonia is produced in the reaction. A student was provided with urease extracted from bacteria and solutions of urea and two chemical inhibitors, thiourea and lead nitrate. The student prepared six reaction mixtures (1 to 6) as shown in Table 5.1 in order to investigate the effect of the two chemical inhibitors on the activity of urease.

Table 5.1

reaction mixture	urea	water	thiourea	lead nitrate	urease	boiled urease
1	✓	✓	✗	✗	✓	✗
2	✓	✗	✓	✗	✓	✗
3	✓	✗	✗	✓	✓	✗
4	✓	✓	✗	✗	✗	✗
5	✗	✓	✓	✗	✓	✗
6	✓	✓	✗	✗	✗	✓

Key ✓ = present in reaction mixture ✗ = absent from reaction mixture

The student recorded an increase in pH in reaction mixtures 1 and 2. The reaction was faster in 1 than in 2. The pH in the other reaction mixtures did not change.

(b) The student made some conclusions about the results from the test-tubes. Match the statements to the reaction mixtures, **1** to **6**. You may use the numbers once, more than once or not at all.

(i) ‘No reaction took place because urease was denatured.’ [1]

(ii) ‘There was no reaction because there was no substrate for urease.’ [1]

(iii) ‘The reaction did not occur because there was an inhibitor present.’ [1]

Thiourea has a molecular structure that is very similar to that of urea. The student designed an experiment to find out whether thiourea is a competitive inhibitor. The student set up several reaction mixtures like **1** using increasing concentrations of urea. The student determined the initial rate of the reaction for urease at each concentration of urea. The results are shown in Fig. 5.1.

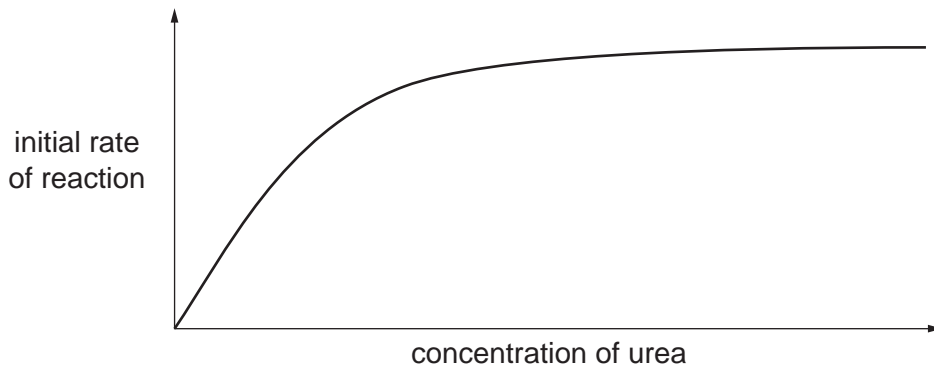


Fig. 5.1

The student then repeated the experiment using the same concentrations of urea. However, the student added the same volume and concentration of a thiourea solution to each test-tube in place of the water.

(c) Sketch a curve on Fig. 5.1 to show the results that the student would expect if thiourea acts as a competitive inhibitor of urease. [2]

(d) Explain why it is important to determine the **initial** rate of reaction when investigating the effect of a competitive inhibitor on an enzyme.

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..... [2]

[Total: 10]

2 The following statements apply to the effects of drugs on the body.

- S acts as a stimulant
- T increases the heart rate
- U acts as a painkiller
- V if taken in excess, may lead to cirrhosis
- W mimics natural neurotransmitter chemicals in the nervous system
- X leads to constriction of peripheral blood vessels
- Y acts as a depressant
- Z raises blood pressure

(a) Complete the table by putting **two** letters in each column of the table. Choose letters for the statements that most closely match each of the four drugs.

You may use each letter once, more than once or not at all.

alcohol	caffeine	nicotine	heroin
.....

[4]

(b) Explain the term *drug tolerance*.

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.....[2]

(c) Some medicinal drugs act as non-competitive inhibitors of enzymes.

Explain how a non-competitive inhibitor acts on an enzyme to prevent it catalysing a reaction.

You may use an annotated diagram to illustrate your answer if you wish.

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[3]

[Total : 9]

- 3 Fig. 4.1 is a computer-generated image of the enzyme hexokinase binding with its substrate, glucose. The product of the enzyme-catalysed reaction is glucose-6-phosphate.

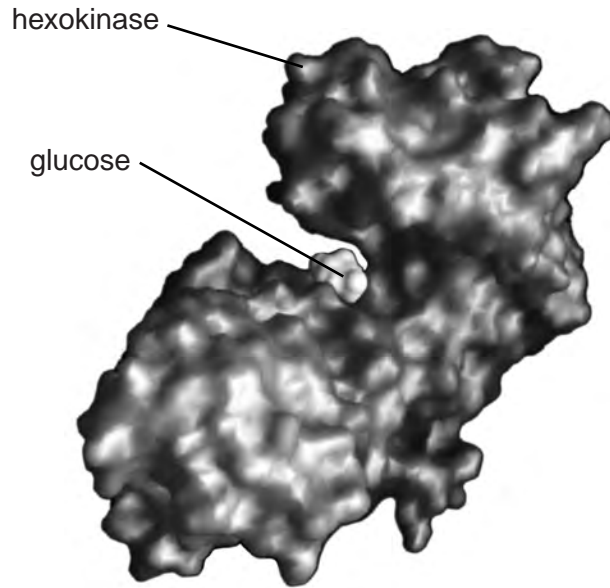


Fig. 4.1

- (a) Hexokinase binds with glucose using the induced fit mechanism. Describe how an enzyme-substrate complex forms by this mechanism.

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- (b) Suggest how enzymes which use the induced fit mechanism can be less affected by competitive inhibitors than those which use the lock and key mechanism.

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- (c) When a solution of the enzyme hexokinase is heated to 45 °C for 10 minutes, the quantity of product formed decreases by 50% compared to a sample kept between 30 °C and 40 °C.

Explain this result.

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Glucose can enter cells by active transport or facilitated diffusion.

Glucose-6-phosphate is a charged, polar molecule and cannot move out of cells.

- (d) (i) State two **differences** between active transport and facilitated diffusion.

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2.
..... [2]

- (ii) Suggest why glucose-6-phosphate cannot move out of cells.

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..... [2]

[Total: 12]

- 4 (a) Table 2.1 shows eight ions that are biologically important.

Table 2.1

ammonium (NH_4^+)	A
hydrogen (H^+)	B
hydrogen carbonate (HCO_3^-)	C
iron (Fe^{2+})	D
magnesium (Mg^{2+})	E
nitrate (NO_3^-)	F
phosphate (PO_4^{3-})	G
sulfate (SO_4^{2-})	H

Choose one ion to match each of the following statements. In each case write **one** letter from Table 2.1. You may use each letter (**A** to **H**) once, more than once or not at all.

- (i) A component of polynucleotides.

..... [1]

- (ii) Ion produced by enzyme activity inside red blood cells.

..... [1]

- (iii) Ion used in the production of all amino acids in chloroplasts.

..... [1]

- (iv) Ion that diffuses through carrier proteins with sucrose into companion cells in phloem tissue.

..... [1]

- (v) Component of haem group in haemoglobin that binds oxygen.

..... [1]

