

# Enzymes

## Mark Scheme 7

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Enzymes
Sub Topic	Enzymes
Booklet	Theory
Paper Type	Mark Scheme 7

Time Allowed : 64 minutes

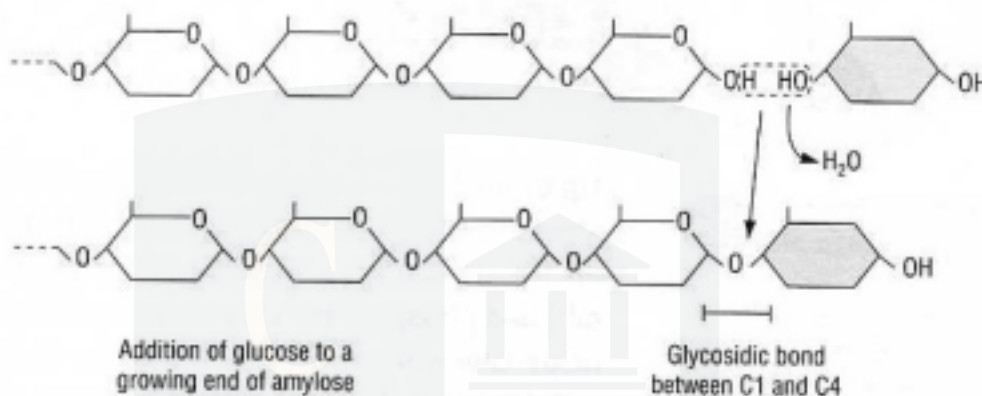
Score : / 53

Percentage : /100

Grade Boundaries:

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

- 1 (a) (i)  $-H$  and  $-OH$  indicated ; **A**  $-OH$  on end of amylose and  $-H$  on alpha glucose  
 water eliminated / condensation ; **A** dehydration  
 oxygen bridge / glycosidic bond, drawn between C1 and C4 ;



*If the whole glucose molecule and/or the end of the amylose molecule has not been drawn, then only award mp3 if C1 and C4 are indicated in some way, e.g. by numbering them or putting in the hydrogens.* [3]

- (ii) (1,4 / 1,6) glycosidic ; **A** glucosidic **A** phonetic spelling of glycosidic [1]

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(b)

feature	a	glycogen	cellulose
type of glucose	$\alpha$ -glucose	$\alpha$ -glucose	$\beta$ -glucose ;
branched or unbranched molecule	unbranched		unbranched / not branched ;
role in organisms	energy storage	energy storage	structural / (component of) cell walls / tensile strength / dietary fibre / roughage ; I support

[3]

- (c) (i) *maltase and maltose must be correctly referenced*  
*ignore references to reversible/irreversible*

(ascorbate) binds to / fits into / enters active site ;  
complementary (shape) to active site ;  
so substrate / maltose, cannot enter / cannot bind ;

**A** no / few, ES complex

**A** prevents formation of ES complexes

**A** ascorbate forms enzyme inhibitor complex

competes with substrate / competitive inhibition ;  
slows the (rate of), digestion / hydrolysis / breakdown, of maltose ;  
**R** 'stops the reaction'  
**R** if in context of starch

*alternative answer if candidates assume ascorbate is an enzyme:*

ascorbate, breaks down / digests / hydrolyses, maltase ;

**A** ascorbate destroys the active site of maltase

so no enzymes to digest maltose ;

slows / stops, reaction / digestion / hydrolysis / breakdown, of maltose ;

[max 3]

- (ii) inhibits / slows down / prevents, breakdown / (catalysing) hydrolysis / digestion, of maltose (to glucose) ;  
**I** starch

less glucose is absorbed / passes across membranes / enters blood ;

[2]

[Total: 12]

- 2 (a) glycosidic ; **A** glucosidic [1]
- (b) **A** = trehalose ;  
**B** = maltose ;  
**C** = cellobiose ;  
**D** = sucrose ; [max 3]
- (c) *idea of separation / barrier / AW, from surroundings / external environment ;*  
2 regulates / controls / AW, entry / exit, substances / named substances ;  
3 enables recognition of self (antigens) / cell recognition / avoids cell destruction / act as antigens / AW ;  
4 allows binding of / receptors for, hormones / signal molecules / neurotransmitters / antigens ;  
5 cell to cell adhesion ;  
6 location for enzymes / multi-enzyme systems / enzyme pathways ;  
7 AVP ; e.g. idea of flexibility (for some cells, ref. glycoproteins / glycolipids, form H bonds with water for stability [max 3]
- (d) (i) 1 active site has, specific / particular, shape ;  
2 complementary to substrate ; **A** substrate fits into active site  
3 ref. to (some enzymes) induced fit mechanism ; **A** described  
4 formation of enzyme-substrate complex ; AW  
5 lowering, activation energy /  $E_a$  ; **A** detail of how activation energy lowered e.g substrates held close together for bond formation facilitates transfer of electrons places strain on bond(s) to be broken [max 3]
- (ii) 1 loss of tertiary structure / hydrogen bonds broken / ionic bonds broken ; **R** if include disulfide or peptide bonds  
2 changes shape / substrate unable to fit, active site; **A** enzyme changes shape so alters active site  
3 loss of / AW, globular structure ;  
4 hydrophobic groups to outside of molecule ;  
5 hydrophilic groups no longer interact with water / AW ; [max 2]

(e) *penalise once for no units*

- 1 with no cryoprotectant, enzyme (remains), inactive / AW ;  
**A** at 0 mmol of cryoprotectant, 0% (of maximum) activity
- 2 for both, increasing concentration increases % (enzyme) activity recovered ;  
**A** comparative data quote with ref. to increase *need units*
- 3 trehalose, steeper curve / AW, up to 10 mmol (cryoprotectant) ; ora **R** rapid
- 4 at all concentrations (below 90 mmol), trehalose has higher percentage of (maximum enzyme) activity
- 5 comparative data quote to support either mps 3 or 4 ;  
*for mp 3* trehalose from 0 to 80% and glycerol from 0 to 10%
- 6 both cryoprotectants can produce, 100% / maximum, (enzyme, activity / recovery) ;
- 7 trehalose produces, 100% (enzyme) activity / full (enzyme) recovery at,  
lower concentrations than glycerol / 30 mmol  
compared to, 90-100 (mmol) ; *this is also mp 6*
- 8 trehalose more effective than glycerol (up to 90 – 95 mmol cryoprotectant) ;  
**A** trehalose is a better cryoprotectant (than glycerol)

[max 4]

**[Total: 16]**

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- 3 (a)  $W^R$  = allele for warfarin resistance  
 $W^S$  = allele for warfarin susceptibility

parental phenotypes		resistant male		resistant female	
parental genotypes		$W^R W^S$		$W^R W^S$	
gametes	$W^R$	$W^S$	$W^R$	$W^S$	;
offspring genotypes	$W^R W^R$	$W^R W^S$	$W^R W^S$	$W^S W^S$	;
offspring phenotypes	resistant	resistant	resistant		

[3]

- (b) not enough Vitamin K found (in the wild) / require too much Vitamin K;

[1]

- (c) competitive / reversible;

as the concentration of inhibitor increases, the rate of the (inhibited) reaction decreases

or

as dose of warfarin increases, the rate at which blood clots decreases; or

[2]

- (d) 1. different, codon / triplet;  
 2. stop codon;  
 3. different amino acid;  
 4. different, primary / secondary / tertiary / 3D, structure;  
 5. shortened, polypeptide / protein;  
 6. change in function of protein;

[3 max]

[Total: 9]

- 4 (a) diffusion / diffuses ;  
down concentration gradient / from high concentration to low concentration / from high to low partial pressure ;  
description of pathway ;  
*two of the following*  
cell (surface) membrane of (respiring) cell, tissue fluid, (pore in) capillary wall / endothelium / endothelial cell, basement membrane / plasma [max 2]

- (b) *assume answer refers to Y unless told that it refers to X*  
less pressure ; **A** low pressure  
less oxygen ; **A** deoxygenated  
less glucose ; *only accept more glucose if identified as liver*  
fewer / more, amino acids / fatty acids ;  
less water / lower water potential / lower solute potential / higher osmotic pressure / higher concentration of solutes *and / or* rbc's ;  
**A** 'blood is more concentrated'  
fewer ions ;  
more of **named** cell product ; e.g. insulin / glucagon / albumen / AW  
  
(more), urea / excretory waste ; waste unqualified [max 3]

- (c) carbonic anhydrase ; [1]

- (ii) (catalyses very) fast / AW, reaction ;  
(carbon dioxide as) hydrogen carbonate ions / bicarbonate ions ;  
diffuse / move / leaves, out of the (red blood) cell ;  
in(to) the plasma ; **R** 'into blood'  
(so that) blood can transport more than could be transported as carbon dioxide (in solution) / 80 – 90% CO<sub>2</sub> transported this way ;  
*idea that*  
reaction maintains concentration gradient for CO<sub>2</sub> from, tissues / tissue fluid, to blood ;  
if carbon dioxide transported then pH would decrease ;  
(therefore) maintains pH / prevents pH decreasing / acts as a buffer ; [max 3]

(d) (i) 55 (%) **A** 54 - 56 (%),  
32 (%) **A** 31 / 31.5 (%);

[1]

(ii) hydrogen ions / protons ; **A**  $H^+$

*either*

react *or* combine with haemoglobin / form haemoglobinic acid / form HHb ;

**A** 'picks up' / absorb

*or*

carbon dioxide combines with haemoglobin / forms carboxyhaemoglobin ;

(so) stimulate haemoglobin to release more oxygen (in areas of low  $pO_2$ ) ;

ref. to, allosteric effect / change in tertiary *or* quaternary structure *or* shape ;

**A** conformational change

*either*

haemoglobin has a higher affinity for hydrogen ions than oxygen = 2 marks

*or*

haemoglobin has a higher affinity for carbon dioxide than oxygen = 2 marks

[max 2]

(iii) Bohr (effect / shift) ;

[1]

(iv) 1 carbon dioxide influences percentage saturation of haemoglobin with oxygen / AW ;

2 tissues / cells, with high rate of (aerobic) respiration ;

3 high demand for oxygen ;

4 haemoglobin / blood, releases more oxygen ; **R** faster

5 than it would in absence of carbon dioxide ;

6 at same partial pressure of oxygen ;

[max 3]

**[Total: 16]**

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