

Enzymes

Mark Scheme 1

Level	International A Level
Subject	Biology
Exam Board	CIE
Topic	Enzymes
Sub Topic	Enzymes
Booklet	Theory
Paper Type	Mark Scheme 1

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) enzyme **A** uses 'lock and key' **and** enzyme **B** uses induced fit ;
A enzymes work by 'lock and key' and induced fit
 enzyme **A** / lock and key, (shape of) active site is complementary / AW, to
 (shape of) substrate (molecule) ;
 enzyme **B** / induced fit, has an active site that, moulds around / AW, the
 substrate ;

[3]

- (b) (i) 1 **P** is β -pleated sheet, **Q** is α -helix ;
accept if P and Q are identified by a description
 2 determined by, coiling / folding / sequence, of amino acids / polypeptide ;
A primary structure for sequence of amino acids
 3 stabilised / held / AW, by hydrogen bonds ;
 4 between C = O and H–N (of peptide bonds) ;
A carbonyl / carboxyl group, and, amine / amino group
 5 ref to, parallel / anti-parallel, nature of β -pleated sheet ;

[max 3]

- (ii) 1 catalyses reaction between carbon dioxide and water to form carbonic acid ;
A correct, formulae / equation
 2 very fast reaction ;
 3 in (cytoplasm of) red blood cell / erythrocyte ;
 4 (so there are) hydrogen ions / protons, and hydrogencarbonate ions ;
 5 hydrogen ions promotes oxyhaemoglobin dissociation / AW ;
 e.g. reduces affinity of haemoglobin for oxygen / (oxy)haemoglobin
 gives up oxygen more readily
 6 increases supply of oxygen to (respiring) tissues ;
 7 carbon dioxide is transported as hydrogencarbonate ions ;
 8 in the plasma ; **A** carbon dioxide diffuses from red blood cell to plasma
 9 AVP ; e.g.
 carbonic anhydrase catalyses reverse reaction in the lungs
 ref to hydrogencarbonate ions as buffer in plasma (as a
 consequence of reaction)
R buffering action of haemoglobin in red blood cells

[max 4]

[Total: 10]

2 (a) *description*

- 1 enzyme mixed with sodium alginate (solution) ;
- 2 placed in syringe ;
- 3 added drop by drop ;
- 4 to (solution of) calcium chloride ;
- 5 beads (with enzyme) formed ;
- 6 beads separated from calcium chloride ;
- 7 wash with water ;

advantages

- 8 (enzyme) can be re-used ;
- 9 product, uncontaminated / enzyme-free ;
- 10 (so) purification not needed / less downstream processing ;
- 11 reduces cost ;
- 12 works at higher temperature / thermostable ;
- 13 works in changed pH ;
- 14 reaction, can be fast(er) / have high(er) yield ;

[max 9]

(b) 1 glucose oxidase immobilised ;

- 2 stuck onto, pad / (dip)stick ;
- 3 dip stick lowered into, body fluid / blood / urine ;
- 4 oxidises glucose (in body fluid) ;
- 5 (changes glucose to) gluconic acid ; **A** gluconolactone
- 6 hydrogen peroxide produced ;
- 7 (peroxide) reacts with chromogen (on pad) ;
- 8 produces, colour / named colour ;
- 9 darkness of colour / range of colours, is proportional to concentration of glucose ;
- 10 AVP ; e.g. peroxidases catalyse reaction / ref. to importance of fixed time to observe colour change

[max 6]

[Total: 15]

- 3 (a) any one valid ;
 e.g.(first) appearance of (brown) color
 use of, colour standards/ colour charts
 use of colorimeter
 time-lapse photography/ video
- (b) *allow catechol for substrate throughout*
 rate of reaction 0 au, no substrate to act on / AW ;
- at substrate concentrations lower than 5mM*
 substrate (concentration) is limiting (factor in rate of reaction) ;
 presence of free active sites/ enzyme is in excess ;
 few collisions between enzyme and substrate ;
 rate increases with substrate concentration as more, active sites can be occupied/ E-S complexes can form ;
one data quote to support response
 V_{\max} reached/ rate becomes maximum, at 4.5–5 mM substrate concentration;
 rate constant/ levels out/ AW, from 4.5–5 mmol substrate concentration ;
- at substrate concentrations greater than 5 mM*
 enzyme (concentration) becomes limiting (factor) ;
 all active sites, saturated/ occupied ;
 (so) further increase in substrate concentration does not increase rate ; [max 5]
- (c) (i) curve always lower than that with no inhibitor ; *must be similar shape*
 curve reaches the maximum ; **A** curve heading to maximum [2]
- (ii) PHBA/ inhibitor, similar shape to, substrate/ catechol ;
 (so) binds to active site ;
 blocks access to substrate/ fewer (successful) enzyme-substrate collisions ;
 reduces rate of, reaction/ conversion of substrate to product ;
 AVP ;
 e.g. inhibitor has a greater effect on rate at lower substrate concentration
 V_{\max} reached at higher substrate concentrations
 inhibitor forms same interactions with R-groups in active site [max 2]
- (d) enzymes work in a limited pH range / either side of optimum pH rate decreases ;
 (acid so) presence of H^+ ions, partially denatures / denatures (some), enzymes ;
 further detail ; e.g. ref. to breaking ionic or hydrogen bonds
 change of active site shape means substrate can no longer fit ;
 AVP ; e.g. ref. to antioxidant effect of, lemon juice / citric acid / vitamin C [max 2]

[Total: 12]

4 (a) (i) hydrolysis / hydrolysing ; I catabolic / digestive R hydrolysis [1]

(ii) to stop the reaction ; R 'stop it working'
by denaturing, the enzyme / sucrase ; R incorrect context
A 'change shape of active site'
to make the Benedict's solution, react / AW ; [2]

(b) *description to max 2*

rate increases to a, maximum / plateau ; A 'levels off' / remains constant
idea that increase in rate slows ;
11.5 (arbitrary units / au) at 80 - 90, g dm⁻³ ; A range 11.4 – 11.6

explanation to max 4 – accept ora where appropriate

substrate concentration is limiting (factor) ;

(at low concentration) *may be given in terms of increasing concentration*
few collisions between enzyme and substrate ;
few, enzyme-substrate / E-S, complexes formed ;
active sites unoccupied ;

(at high concentration / >80 g dm⁻³)
enzyme concentration is limiting (factor) ;
A 'not enough enzyme for substrate to bind to'
maximum number of enzyme-substrate complexes formed ;
active sites , saturated / always occupied ; A ref to V_{max}

[max 5]

[Total: 8]

CHEMISTRY ONLINE
— TUITION —

- 5 (a) 1. (either feature) reduces water loss by, transpiration / evaporation ;
2. reduction in, number of stomata / surface area, (for, transpiration / evaporation) ;
3. rolling leaves traps moist air ;
4. idea of reduced, diffusion / water potential, gradient (between leaf and trapped air) ;
[3 max]

- (b) (i) cooked protein more digestible than raw protein ;
use of figures ; *accept any **named** comparison between cooked and raw* [2]

- (ii) *cooked*
1. cooking breaks cross-links (in kaffirin) ; **A** bonds
2. ref. to named bond ; e.g. hydrogen / ionic / disulphide / covalent
3. tertiary / 3D / quaternary, structure disrupted / AW ;
4. protease can now bind, more / easier, with polypeptides ;
5. enzyme-substrate complexes can form ;
6. so more protein is digested to amino acids ;
[3 max]

[Total: 8]

CHEMISTRY ONLINE
— TUITION —