

WJEC (Wales) Biology A-level
Topic 1.4: Enzymes
Questions by Topic - Mark
Scheme

1.	Question	Marking details	Marks Available
1	(a)	(i) Activation energy;	1
		(ii) Line starting and finishing at the same point but with a lower activation energy;	1
	(b)	The <u>active site</u> (of succinate dehydrogenase) has a <u>specific shape</u> ; Succinate has a <u>complementary</u> shape; (and therefore) {fits/ binds/ bonds to} into the active site; NOT attaches	Max 2
	(c)	(i) I The concentration of succinate/ substrate;	1
		II As the concentration of the {succinate/substrate} increases {the rate of reaction/production of fumarate increases};	1
		(ii) The concentration of succinate dehydrogenase/ enzyme; all of its active sites are occupied (at any given moment);	2
	(d)	(i) Malonate has a similar {shape/structure} to {succinate/ substrate} / malonate has a complementary {shape/structure} the active site; NOT same shape Malonate {binds/ competes} to the active site; Prevents succinate binding / fewer enzyme-substrate complexes are formed; (MP3 must be in context of competitive inhibition)	3
		(ii) Curve rising at a lower rate and plateaus at the max rate at a higher concentration; Accept max rate may not be reached	1
		Question 1 Total	[12]

2.

(a)	$\frac{5.8}{0.5}$ 11.6 cm ³ min ⁻¹ ; (allow: 5.8/30 x 60) correct answer + units =2; correct answer - units =1; incorrect answer, correct working = 1	2
(b)	Maximum/higher concentration of substrate; all active sites occupied; (not: ref. unoccupied at start)	2
(c) (i)	increase in rate from 20 - 100°C/up to 100°C; fall from 100 - 130°C; increase in kinetic energy; molecules move faster; (not: more) More successful collisions/more enzyme-substrate complexes formed; up to optimum; (not: 100°C unqualified) above optimum increased vibrations; hydrogen bonds break; Loss/change of <u>shape</u> of active site; (not: ref. enzyme) denature;	6 max
(ii)	enzymes have different optimum temperatures/ human amylase has optimum of 37°C, bacterial 100°C; human amylase denatures at a lower temperature;	1 1
		(Total 12 marks)

3.

Question			Marking details	Marks Available
3	(a)	(i)	Lock and key;	1
		(ii)	Theory 1/ induced fit;	1
	(b)		Enzyme substrate complex; NOT ESC/ ES complex	1
	(c)		Lower the <u>activation</u> energy/eq;	1
	(d)		Enzyme/ active site is unchanged/can be re-used; NOT active sites are a specific shape unqualified	1
	(e)		Temperature (not heat); pH; NOT acidity Enzyme concentration; Substrate concentration; NOT amount	3
	(f)		Intracellular: inside the <u>cell</u> + Extracellular:outside the <u>cell</u> ; NOT inside body	1
Question 3 total				[9]

4.	Question	Marking details	Marks Available
4	(a)	Any two from <u>Product</u> not contaminated with enzyme; Enzyme can be re-used/ small quantity of enzyme required; Can {withstand/tolerate} a <u>wider</u> range of pH; Can be used in a continuous process;	Max 2
	(b)	Increases (contact) time between enzymes and substrate/ more time for pectinase to digest {apple pulp/pectin}; More <u>successful</u> collisions/more enzyme substrate complexes formed; NOT ESC	2
	(c) (i)	<u>40°C to 60°C</u> {decrease in/less} (volume of) juice extracted; NOT less juice extracted above 40 °C Above 60 °C no juice extracted; Between 40 °C and 60 °C enzymes are denaturing/ above 60°C they are denatured; <u>Hydrogen</u> bonds break; {Tertiary structure deformed / active site changes shape} {Substrate can no longer fit/ fewer enzyme substrate complexes formed};	Max 4
	(ii)	(Free enzymes) can move; Increased chance of <u>successful</u> collision / more enzyme substrate complexes formed;	2
	(iii)	(Increased juice extracted with membrane bound enzymes) because membrane bound enzymes are {more accessible/OWTTE} to substrate; (Enzymes immobilised inside bead) substrate has to {diffuse/pass} into bead;	2

Question 4 Total [12]

5.

Question			Marking details	Marks Available
5	(a)		Produced by cells / is a protein; speed up (the rate of a) reaction (without being used or changed themselves) ; NOT activation energy	2
	(b)	(i)	<u>all</u> (three) enzymes {have high activity / are working well};	1
		(ii)	blood;	1
		(iii)	1. enzymes are <u>specific</u> ; 2. each {stain / protein} has a different <u>shape</u> / different <u>shaped</u> substrates; NOT structure alone 3. would not fit one <u>active site</u> / three <u>different active sites</u> are needed;	Max 2
		(iv)	1. (at this temperature) <u>all</u> (three) enzymes {non-functional / denatured / no activity}; 2. due to breaking of <u>hydrogen</u> bonds; Allow H bonds REJECT listing of all bonds 3. active site deforms; 4. {prevents / no} { enzyme-substrate complexes forming / successful collisions}; REJECT: less enzyme-substrate complexes	4

	(c)	(i)	<p>Any 4 from</p> <ol style="list-style-type: none"> 1. (Isoleucine) has a similar {shape / structure} to threonine / complementary to the active site of {enzyme 1 / threonine deaminase}; NOT same shape 2. Less enzyme substrate complexes formed/ more enzyme inhibitor complexes formed / fewer successful collisions; NOT no enzyme substrate complexes 3. Less threonine is converted / reaction decreases; NOT no threonine (ecf) 4. So (concentration) of {isoleucine/product} decreases / less product; 5. {increasing concentration of threonine / more threonine added} reduces effect of {inhibitor / isoleucine}; 	Max 4
		(ii)	<p>prevents {build up /overproduction} of {end product / isoleucine / harmful concentrations} / (pathway) stops when {sufficient / enough} product is made / regulating the production of {isoleucine / product} / stops isoleucine reaching toxic levels;</p>	1
			Question 5 total	[15]

6.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)		Activation energy	1			1		
		(ii)		Curve drawn with a lower activation energy under existing curve – energy state at beginning and end must be the same.	1			1		
	(b)			{Alcohol dehydrogenase/ enzyme} has a <u>specific</u> {shaped active site/ tertiary structure/ OWTTE} (1) {Ethanol/ substrate} has a <u>complementary</u> (shape) (1) (The two fit together) to form an <u>enzyme-substrate complex</u> (1)	3			3		
	(c)	(i)		Any answer between 0.57 - 0.63 = 2 marks If incorrect award 1 mark for sight of : attempted calculation of gradient		2		2	2	
		(ii)		1. P: the rate of reaction is higher as the concentration of {ethanol/ substrate} is high (1) 2. The concentration of {alcohol dehydrogenase/ enzyme} is limiting the rate of reaction; (1) 3. Q: the rate of reaction is lower the concentration of {ethanol/ substrate} decreases(1) 4. The concentration of {ethanol/ substrate} becomes the limiting factor. (1)		2	2	4		
6	(d)			1. Ethanol and ethylene glycol must have a similar structure / Ethanol and ethylene glycol must both be complementary to the shape of the active site of {alcohol dehydrogenase/ the enzyme} (1) 2. ethanol acts as a competitive inhibitor (1) 3. When ethanol binds to the active site it prevents ethylene glycol from attaching (1) 4. Fewer enzyme-substrate complexes form (1) 5. Which reduces the rate of production of {glycoaldehyde/ product} (1)		3	2	5		
				Question 6 total	5	7	4	16	2	

7.

Question				Marking details	S	Marks Available					
						AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)		F B D All 3 ✓ =2, 2 ✓ = 1;		2			2		
	(b)	(i)		ATP can be regenerated quickly/More ATP for <u>muscle contraction</u> (1) Not: more energy produced			1		1		
		(ii)		lock and key <u>active site</u> shape already 'fixed'/ 'perfectly complementary' (1) (3D) active site changes shape when substrate binds/OWTTE (1)		2			2		
	(c)	(i)		intra act within a cell + extra outside a cell (1)		1			1		
				Question 7 total		5	1	0	6	0	0