Mark scheme

Enzymes

Biology 0610 · Questions from Paper 3, Paper 4 and Paper 6

Total marks

97

MARKS FOR EACH QUESTION

1	2	3	4	5	6	7	8	9	10	Total
5	10	11	11	11	6	12	10	10	11	**97**

Question 1 [5]

1	**(a)** made of protein; functions as a biological catalyst / speeds up chemical reactions in organisms; [2]		A – not used up in reaction
	(b) lactase could be coagulated / denatured in stomach; because of very low / acidic pH; as it normally works in alkaline conditions in small intestine; protease in stomach may digest it; any three – 1 mark each [3] **[Total: 5]**		

Question 2 [10]

2	**(a)**	protein ; catalysts ; speed up ;	[3]	
	(b) (i)	(ph) 7.5 ;	[1]	**A** 7.3 – 7.7
	(ii)	4 (min) ;	[1]	**A** 3.9 – 4.1
	(iii)	hydrochloric acid / stomach, has a low pH / pH ⩽ 4 ; (amylase) enzyme, is denatured / destroyed / will not function / AW ; (amylase) enzyme in saliva works best in neutral / ph 7.5 ;	[max 2]	**R** 'kills enzyme' ecf from graph reading
	(iv)	amylase ; salivary glands / pancreas / small intestine ;	[2]	
	(c)	temperature ;	[1] **[Total: 10]**	**A** presence of an inhibitor / heat

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Question 3 [11]

3(a)(i)	40 (minutes) ;	1	
3(a)(ii)	*idea that* 40°C gives the shortest time for stain removal ;	1	
3(a)(iii)	Washing powder B is active over a greater range of temperatures than washing powder A. : Washing powders **A** and **B** do **not** work at 50 °C. : Washing powders **A** and **B** have the same activity at 37 °C. : ✓ ; Washing powder **A** can remove the stain in 15 minutes. : Washing powder **A** is more effective at lower temperatures than washing powder **B**. : ✓ ;	2	**R** each additional tick
3(b)	pH / AVP ;	1	
3(c)	(a substance that) increases the rate of a chemical reaction / AW ; and is not changed permanently by the reaction / not used up in the reaction ;	2	
3(d)	substrate – **V** ; enzyme – **Z** ;	2	
3(e)	fat / oil / lipid ; (→) fatty acids ;	2	

Question 4 [11]

4 **(a)** 1 made of protein;

2 are (biological) catalysts;

3 that speed up chemical reactions;

4 not changed by chemical reaction

any three – 1 mark each [3]

(b) **(i)** completion of curve; [1]

(ii) 55 (°C) if point to point curve; (+/- half square)
check against candidate's graph if free hand curve; [1]

(iii) 24 or 25 or check value from candidate's graph; (+/- half square) [1]

(iv) rise in temperature increases the rate of reaction / ORA;

(rise) above optimum temperature / 55 °C rate falls; [2]

(v) <u>15 °C sample –</u>

1 at optimum / higher temperature enzyme active;

2 reaction occurs / starch digested;

<u>75 °C sample –</u>

3 no reaction at optimum temp;

4 enzyme destroyed / denatured (by 75 °C);

any three – 1 mark each [max 3]

[Total: 11]

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Question 5 [11]

5	**(a)**	(lemon juice is) **acid**(ic);	[1]	
	(b)	no colour change / less colour change in dish 2 ;	Max [1]	
	(c) (I)	lemon juice is acidic ; denature enzyme ; browning does not happen ;	[3]	
	(ii)	*Method:* put apples in high or very low temperature ; *Result:* no or less colour change / not or less brown ; *Explanation:* high temperatures denature enzymes OR cold temperatures inactivate enzymes / stops enzyme activity ;	[3]	
	(d) (I)	*Comparative colour change* cut surface goes darker brown / greater colour change ; *Speed of reaction* cut surface turns brown more quickly ;	[2]	
	(ii)	cells separated **and** contents remain intact	[1]	
			[Total: 11]	

Question 6 [6]

6	*total of six from:* **1** *independent variable* at least two pH values **,** tested / stated ; **2** *dependent variable* time for iodine solution to stay yellow-brown / time for disappearance of starch/colour of iodine (solution) after a set period of time ; **3, 4 + 5** *variables kept constant* ;;; • concentration of amylase / enzyme (solution) • volume of amylase / enzyme (solution) • temperature • volume of starch (suspension) • concentration of starch (suspension) • sampling interval time, stated / described • buffer / pH (solution) volume • iodine concentration / volume / number of drops **6 & 7** *method* ;; • equilibration (both solutions in the water bath before mixing) • take samples • use of, spotting / white, tile • use of buffer **8** repeat investigation twice more / at least two replicates ; **9** relevant safety precaution ;	**6**	

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Question 7 [12]

7(a)	1 enzymes are proteins; 2 enzymes can be reused / are unchanged in a reaction; 3 enzymes are specific; 4 (enzymes are) catalyst / speeds up reaction; 5 lowers (activation) energy needed for the reaction; 6 successful collisions; 7 enzyme-substrate complex / ESC; 8 active site; 9 (enzyme and substrate) complementary shape / AW; 10 ref. to optimum, temperature / pH; 11 too much heat results in denatured enzymes; 12 too little kinetic energy / heat, less (successful) reactions; 13 incorrect pH results in denatured enzymes; 14 (substrate) is pectin / cell wall; 15 results / product, is clear juice; 16 mass / cheaper / more (volume) / yield, juice production;	**6**	**R** cellulose
7(b)	read at eye level / avoid error of parallax; read bottom of meniscus; place measuring cylinder on a level / flat, surface; remove funnel / ensure all drops have fallen to the bottom;	**2**	**A** parallel / horizontal to meniscus
7(c)(i)	19 ÷ 10 **or** 17.5 ÷ 10; 2 (cm^3 per min);	**2**	
7(c)(ii)	**A** / 0.5 (cm^3 cubes); large(st) surface area (to volume);	**2**	**A** smallest cubes
		Total: 12	

Question 8 [10]

8(a)(i)	Fungus / Fungi ;	**1**	
8(a)(ii)	aerobic respiration ;	**1**	
8(b)	*any two from:* ref. to specificity (of enyme) ; shape of active site is complementary to, substrate / sucrose ; for, substrate / sucrose, to bind / fit, enzyme / sucrase / active site ;	**2**	
8(c)	*total of six from:* *max. four for description:* 1 sucrase / enzyme, is active between pH2 and pH12 ; 2 activity, increases and decreases / reaches a peak ; 3 peak / maximum or 100% activity, at pH 6 ; 4 steeper increase between pH 5–6 / steeper decrease in activity between pH 9–10 ; 5 minimum / 10%, activity at pH 12 ; 6 more activity in, acidic conditions / low pH, than, alkaline conditions / high pH ; *explanation:* 7 (change in) pH affects the shape of, sucrase / active site / enzyme ; 8 at pH 6, most enzyme-substrate complexes form / AW ; 9 at, low / high / extremes of, pH, enzyme is (partially) denatured ; 10 ref to substrate molecules can no longer bind with enzyme (at low / high / extreme pH, so activity decreases) ; 11 AVP ;	**6**	

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Question 9 [10]

9(a)	*any five from:* 1 enzyme activity reaches, peaks / increases and decreases (for **L** / **M**) ; 2 maximum (area digested) / peaks, is pH 2 for **L** and pH 10 for **M** ; 3 **L** has steepest increase in activity between pH 1 and 2 / **M** has most gradual increase from pH 3 to pH 10 / as pH increases / AW ; 4 **L** has higher activity than **M** at their optimum pHs / AW ; ora 5 **L** and **M** are active, between pH 3 and pH 5 ; 6 **L** has no activity, from / at pH 5 (and onwards) OR **M** has no activity, before / at, pH 3 ; 7 **M** is active for a wider pH range (in this investigation than **L**) ; ora 8 no change in activity between pH 7 and 8 for **M** ; 9 data quote with correct units that includes ref to pH and area where the enzyme is active ;	**5**	MP6 **A** denatured for no enzyme activity MP9 examples: • at pH 2 **L** digests 160 mm^2 of jelly • at pH 10 **M** digests 140 mm^2 of jelly • at pH, 7 / 8 **M** digests 80 mm^2 of jelly
9(b)	*any three from:* no jelly is broken down / enzyme has no activity ; enzyme / **M** / active site, is denatured ; enzyme / **M** / active site, has changed shape ; active site, does not fit / does not bind / is not complementary to, the substrate / protein in jelly ;	**3**	
9(c)	*enzyme **L***: pepsin ; *location:* stomach ;	**2**	

Question 10 [11]

10(a)	increases the rate of a (chemical) reaction ; (and is) not changed (during the reaction) / AW ;	**2**	
10(b)(i)	*any six from:* **1** amylase breaks down starch ; **2** iodine (solution) turns blue-black in the presence of starch ; *idea that at 0 °C / at the start* **3** least, starch break down / enzyme activity / amylase activity ; **4** fewest, successful collisions / enzyme substrate-complexes formed ; **5** *idea that* particles do not have sufficient (kinetic) energy ; *idea as temperature increases* **6** the kinetic energy (of particles) increases ; **7** (starch and amylase) collide more, frequently / successfully or more enzyme-substrate complexes form ; **8** faster break down of starch ; **9** 40 °C is the optimum temperature ;	**6**	
10(b)(ii)	*any two from:* *ref to* specificity ; *idea that* protease has a different shaped active site (to amylase) / starch and the active site (of protease) are not complementary ; unable to bind / unable to form an enzyme-substrate complex ;	**2**	
10(c)	pH / **AVP** ;	**1**	

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