5. Enzymes

5.1 Enzymes

Paper 3 and 4

Marking scheme

Q1.

(b)(i)	breaks down (AW) starch ; to (simple reducing) sugar(s) ;	**2**	
(b)(ii)	*any two from:* protein ; is a (biological) catalyst ; speeds up (chemical) reactions / is unchanged / is not used up ;	**2**	

Q2.

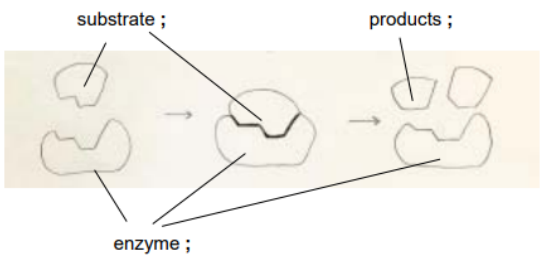
(a)	*box 2:* they are involved in all metabolic reactions ticked ; *box 3:* they are proteins ticked ;	**2**	
(b)(i)	9 ;	**1**	
(b)(ii)	any value within the range 4 to 7 inclusive ;	**1**	
(b)(iii)	any value within the range 0 to 4 **or** 10 to 12 inclusive ;	**1**	
(b)(iv)	*location:* stomach ; *action:* (catalyses the) breakdown of proteins (to amino acids) ;	**2**	
(b)(v)	*substrate:* starch ; *product:* (reducing or simple) sugar ;	**2**	
(c)	chemical ;	**1**	
(d)	temperature / AVP ;	**1**	

Q3.

(a)	(a substance that) increases the rate of reaction / speeds up the reaction ; and is not changed (by the reaction) ;	**2**	
(b)	proteins / amino acids ;	**1**	**A** peptides / polypeptides

(c)(i)	*any four from:* 1 the (rate of) activity of (both) enzymes increases then decreases (with increasing temperature) ; 2 both enzymes are active between 40 and 45 / 46 °C ; 3 enzyme **A** is active at lower temperatures / enzyme **B** is active at higher temperatures ; 4 the optimum temperature of **A** is lower than **B** ; ora 5 (enzyme) **A** is denatured at a lower temperature than **B** ; ora 6 correct data quote for either enzyme (to support any marking point) ; 7 correct temperature ranges for where enzyme **A and** enzyme **B** are active ;	**4**	MP7 enzyme **A** 0–44 / 45 / 46°C **and** enzyme **B** 39 / 40 / 41 – 89/90/91°C
(c)(ii)	active site ;	**1**	
(c)(iii)	pH / AVP ;	**1**	
(d)	*enzymes linked to:* are involved in all metabolic reactions ; are necessary to sustain life ; are used to make fruit juice ;	**3**	**R** each additional line

Q4.

(a)		**3**	one correct label needed for each MP
(b)	enzymes are proteins ; (that act as biological) catalysts / AW ;	**2**	
(c)(i)	lipase ;	**1**	**R** each additional circle
(c)(ii)	*any two from:* enzymes, digest / breakdown, stains / fats / proteins ; enzymes are specific **OR** idea of, one type removes protein and one removes fats / AW ; protein (stains/substrate) will not fit into the active site of lipase / AW **ora** ; enzyme and substrate have complementary shapes ;	**2**	
(d)(i)	35 (°C) ;	**1**	
(d)(ii)	63 / 64 / 65 / 66 (minutes) ;	**1**	
(d)(iii)	enzymes denature (described) ; change in shape of active site ;	**2**	

Q5.

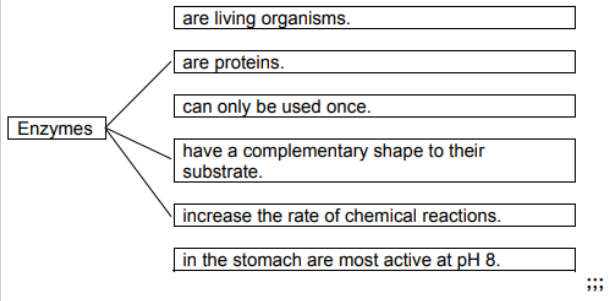
(a)	Enzymes are carbohydrates. are catalysts that slow down reactions and remain unchanged. are catalysts that speed up reactions and are changed. are catalysts that speed up reactions and remain unchanged. are lipids. are proteins. ;;	2	one mark for each correct line **R** each additional line
(b)	**S** ;	1	

(d)(i)	part of the alimentary canal / pH values / enzyme letter duodenum / 5.5 / **V** ileum / 8.0 / **X** mouth / 6.7 / **W** stomach / 1.5 / **U** ;;	2	one mark per two correct letters
(d)(ii)	colon / rectum / anus ;	1	

Q6.

(d)(i)	8 ;	1	
(d)(ii)	10 ;	1	
(d)(iii)	temperature / AVP ;	1	
(e)	it increases the rate of a (chemical) reaction ; and is not changed (by the reaction) ;	2	
(f)	carbon, hydrogen and oxygen circled ; nitrogen circled ;	2	

Q7.

(a)(i)	5.0 ; this is the pH where the largest volume of apple juice is produced / AW ;	**2**	
(a)(ii)	temperature / concentration OR volume OR amount of enzyme / surface area (of apple) / **AVP** ;	**1**	
(b)	 ;;;	**3**	one mark per correct line **R** each additional line

Q8.

(a)(i)	33 (°C) ;	**1**	**A** 32 / 34 (°C)
(a)(ii)	enzymes, destroyed / will not work / become inactive ;	**1**	**A** denatured **R** killed / die
(b)	pH ;	**1**	**A** enzyme / substrate, concentration **A** inhibitors

Q9.

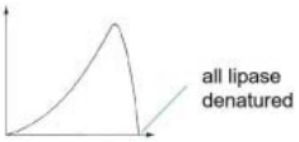
(c)(i)	(rate of reaction) increases **and** decreases / AW ; peak / optimum, at pH 8.1–8.7 / AW ; data quote for both axes with units ;	**2**	
(c)(ii)	temperature ; concentration of substrate ; concentration of enzyme ;	**1**	

Q10.

(a)(i)	*any three from:* *row 1* – lactase breaks down lactose into glucose (and galactose in milk) ; *row 2* – lactose-free milk has already been treated with lactase (so glucose is already present) ; *row 3* – sucrose, is not broken down / does not contain lactose / AW ; lactase is specific for breakdown of lactose / AW OR lactose only fits into active site of, lactase / enzyme ;	**3**	*accept simple sugar(s) for glucose throughout* MP2 **A** lactose already broken down to glucose MP3 **A** lactase cannot breakdown sucrose MP4 **A** 'lactose is only complementary to lactase'

(a)(ii)	*any four from:* 1 at optimum temperature maximum enzyme activity *or* rate of reaction OR outside the optimum / when cold / when hot, reduced, enzyme activity / rate of reaction ; 2 at optimum temperature maximum, successful collisions / enzyme-substrate complexes (ESCs) OR outside the optimum / when cold / when hot, fewer, successful collisions / enzyme-substrate complexes (ESCs) ; 3 as temperature increases kinetic energy increases / ora ; 4 ref to denaturation at, high temperatures / temperatures above optimum ; 5 (so) shape of active site changes ; 6 (so) lactase is no longer complementary to the lactose ; 7 AVP ; e.g. ref. to temperature as a standardised variable	**4**	**A** enzyme and substrate for lactase and lactose MP2 **A** binding of lactose to lactase for ESC MP3 **A** at high temperatures kinetic energy is high / at low temperatures kinetic energy is low

Q11.

(c)	line drawn showing that decrease after optimum is steeper than increase ; ***MP1** - line does not have to start at the origin or end at the x-axis* label line to point where line meets the *x*-axis **and** label indicating that all the lipase is denatured / AW ; ***MP2** – line must meet the x-axis*	**2**	
(d)	*any three from:* ref to specificity ; (only) substrate for lipase is fat (molecules) ; shape of active site is, not complementary to protein / complementary to fat ; protein cannot, fit into / bind to, active site / lipase / enzyme ; enzyme-substrate complexes cannot be formed ;	**3**	

Q12.

(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**	
(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**	

Q13.

(a)(i)	*any three from:* protease / trypsin / pepsin ; chemical) digestion ; (protein) digested to amino acids ; insoluble to soluble molecules ;	**3**	
(a)(ii)	*any four from:* enzymes have, a specific shape / complementary shape to substrate ; correct ref. to active site ; 30°C is optimum temperature ; above 50 °C (these) enzymes denature ; ref. to active site changing (shape) ; (below 30 °C,) less kinetic energy / lower frequency of effective collisions (between substrate and enzyme) ; **ora**	**4**	

Q14.

(f)(i)	*conclusions* **1** fungal extract contains amylase and pectinase ; **2** clear zone is where substrate has been, digested / broken down ; **3** extract has a higher concentration than 1% of amylase ; **4** extract has lower concentration than 1% of pectinase ; **5** extract has, higher concentration of / more, amylase than pectinase ; *evidence - can refer to what is in the wells (***A*** to ***D****)* **6** **D** / fungal extract, in both Petri dishes has clear zones (MP1) ; **7** no staining in clear zones shows that enzyme was active (MP2) ; **8** size of clear zone, **D** / with fungal extract, is bigger than **A** / amylase solution (MP3) ; **9** size of clear zone, **D** / with fungal extract, is smaller than **B** / pectinase solution (MP4) ; **10** clear zone in, **D** / with fungal extract, is larger in the plate containing starch than in the plate containing pectin (MP5) ; **11** enzymes, diffuse / move, through the agar ; **12** greater the clear area the greater, the activity / concentration, of the enzyme ; **13** no clearance / no breakdown / no change, with water ;	**5**	**MP3** ***ignore*** more effective *If awarding* ***MP3*** *and* ***MP4****, then award* ***MP1*** *as well; if awarding* ***MP5*** *also award* ***MP1*** **MP8** **A** more digested **MP9** **A** less digested
(f)(ii)	(same pattern but) smaller / no, clear zones ;	**1**	

Q15.

(a)	(substance) that increases the rate of (chemical) reactions ; not changed, during / by, the reaction ;	**2**	
(b)(i)	**T** ;	**1**	
(b)(ii)	(**T**) fits into / binds to, enzyme / active site ; active site has a complementary shape (to **T**) / active site and **T** are complementary ;	**2**	**A** **T** and enzyme form an, enzyme-substrate complex / ESC

Q16.

(a)	**A** substrate ; **B** active site ; **C** enzyme-substrate complex ; **D** product(s) ;	**4**	