Question			Answer	Mark	Guidance
1	(a)		(works) outside cells **;**	1	**ACCEPT** secreted / AW , from cells **ACCEPT** works in named extracellular environment e.g. digestive tract **IGNORE** doesn't work in cells
	(b)	(i)	time / time taken **;**	1	**Mark the first answer.** If the answer is correct and another answer is given that is incorrect or contradicts the original answer, then = **0 marks** **ACCEPT** 'how long it took …'

Question			Answer	Mark	Guidance
	(b)	(ii)		5 max	**ACCEPT** glucose / maltose for product throughout **ACCEPT** substrate for starch throughout
			linear part of the graph means…		
			1 more (successful) collisions with (amylase) active site (at increasing starch concentration) **; ora**		**1 ACCEPT** few(er) active sites occupied at low starch concentrations
			2 more ESC (at increasing starch concentration) **; ora**		**2 ACCEPT** ESC formed more easily
			3 so more product formation in a given time (at increasing starch concentration) **; ora**		**3 AWARD** only if linked to the context of marking points **1 or 2** e.g. **'**more product formation in a given time because of more collisions with the enzyme' gets mp3 but not mp1 because active site not mentioned **3 IGNORE *rate*** as this is a description of graph
			curve / plateau , means…		
			4 all / most , active sites (of amylase) are occupied **;**		**4 ACCEPT** all active sites are full of substrate
			5 enzyme / amylase , working , at / near, maximum rate / V_{max} **;**		**5 ACCEPT** enzyme at full capacity
			6 (so) further increase in starch concentration has no effect (on rate) **;**		**6** Must link to **4** or **5** **6 AWARD** only if mp 4 or 5 given **6 DO NOT CREDIT** rate decreases
			7 enzyme concentration , is / becomes , limiting factor **;**		**7 ACCEPT** the increasing part of the graph is because starch concentration is the limiting factor

Question			Answer	Mark	Guidance
	(b)	(iii)		3 max	The mark points refer to a constant pH preventing damage to the enzyme. **CREDIT** throughout the appropriate marking point for an answer that describes what would happen if the pH changed.
			1 (so) charges in active site do not change **; ora**		
			2 (so) hydrogen / ionic **,** bonds unaffected **; ora**		**2 DO NOT CREDIT** peptide / disulphide **,** bonds break **2 DO NOT CREDIT** in context of heat / vibration **2 IGNORE** hydrophobic / hydrophilic
			3 (so) tertiary structure / 3D shape / active site **,** unaltered **; ora**		**3 IGNORE** ref to denaturing active site **3 IGNORE** tertiary structure breaks **3 ACCEPT** tertiary structure affected **3** Cannot be inferred from mp5 – must be stated
			4 (so) enzyme / tertiary structure **,** does not <u>denature</u> **; ora**		**4 IGNORE** ref to denaturing active site **4 DO NOT CREDIT** kill / die
			5 (so) substrate , fits / is complementary shape to , <u>active site</u> **; ora**		**5 IGNORE** enters / binds with
			6 so the results are <u>valid</u> / as the <u>rate</u> (of reaction) will vary if pH varies / so that only one (independent) variable is changed ;		**6 IGNORE** fair test / reliable / accurate

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td></td><td>(b)</td><td>(iv)</td><td>temperature (of the reaction mixture) ;
enzyme / amylase , concentration ;

(total) volume of (reaction) solution ;

concentration of , cofactors / chloride ions / Cl^- ;</td><td>2 max</td><td>Mark the first answer on each prompt line. If the answer is correct and another answer is given that is incorrect or contradicts the original answer, then = 0 marks
DO NOT CREDIT substrate / starch , concentration (as this is the independent variable)

DO NOT CREDIT amount

ACCEPT volume of enzyme solution
DO NOT CREDIT amount

ACCEPT concentration of coenzymes

IGNORE time / agitation / inhibitors</td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>
<table>
<tr><th>Amylose</th><th>Cellulose</th></tr>
<tr><td>coiled</td><td>no coiling</td></tr>
<tr><td>(contains) α / alpha / A / a ,-glucose</td><td>(contains) β / beta / B / b , -glucose</td></tr>
<tr><td>α / alpha / A / a 1-4 glycosidic bonds</td><td>β / beta / B / b 1-4 glycosidic bonds</td></tr>
<tr><td>all , monomers / AW , in same orientation</td><td>alternate monomers at , 180° / AW , to each other</td></tr>
<tr><td>granular / not fibrous</td><td>fibrous / not granular</td></tr>
<tr><td>H bonds within molecule / no (H) bonds (between molecules)</td><td>(H) bonds between adjacent molecules</td></tr>
</table>
;
;
;
;
;
</td><td>3</td><td>Mark the first 3 responses
AWARD 1 mark for each correct row irrespective of boxes
Three correct rows of responses written within the same box can be awarded 3 points.

ACCEPT every second one is flipped

ACCEPT fibres / microfibrils / fibrils / macrofibrils
DO NOT CREDIT myofibrils
ACCEPT grains

ACCEPT ‘(cross)links’ as AW for ‘bonds’</td></tr>
</table>

Question			Answer	Mark	Guidance
	(c)	(ii)	(tensile) strength / strong **;** (H) bonds / links , can form (between adjacent fibrils) **;** insoluble **;**	2 max	**ACCEPT** mechanical strength **IGNORE** fibrous / rigid **ACCEPT** fibres / microfibrils / fibrils / macrofibrils **IGNORE** refs to bonding with water **IGNORE** ionic / myofibrils **ACCEPT** crosslinks **DO NOT CREDIT** peptide / covalent / glycosidic / disulfide etc
			Total	**17**	

Question			Answer	Mark	Guidance
2	(a)	(i)	udder size / milk production / meat production / growth rate / muscle (as proportion of body mass) ;	1	**ACCEPT** number of offspring per birth **IGNORE** unqualified references to size **IGNORE** references to , horns / placidity , unless the answer links this with more energy diverted to productivity
	(a)	(ii)	**1** artificial selection ; **2** (selection of) named desired feature (linked to productivity) ; **3** (cross)breed , selected / AW , cattle ; **4** (cross)breed, best / selected / AW, offspring ; **5** over (many) generations ;	4 max	**1 IGNORE** 'selective breeding' as mentioned in part (i) **2 ACCEPT** e.g. weigh them / measure them / see who produces the most milk / choose the biggest / udder size **2 IGNORE** select the best **2 CREDIT** marker assisted selection / progeny testing **2 DO NOT CREDIT** if clearly not in the context of selective breeding, e.g. change their diet to make them produce more milk' **3 ACCEPT** 'parents' as AW for 'cattle' **3 ACCEPT** 'reproduce / mate / interbreed' as AW for 'breed' **3 DO NOT CREDIT** inbreed **2&3** 'breed cattle with high milk productivity = 2 marls **4 IGNORE** 'crossbreed offspring' without qualification. Answer must imply some selection of offspring. **5 DO NOT CREDIT** few **5 ACCEPT** several
	(b)	(i)	(contains) all / each , of , nutrients / food groups ; in correct proportions / AW ;	2	**ACCEPT** a list of food groups that contains at least – protein, fat, carbohydrate, vitamins, minerals **IGNORE** components **ACCEPT** right amount of

Question			Answer	Mark	Guidance
	(b)	(ii)		3	**Mark the first answer on each prompt line.** If the answer is correct and another answer is given that is incorrect or contradicts the original answer, then = **0 marks**
			A glycerol **;**		**A IGNORE** molecule
			C <u>unsaturated</u> fatty acid **;**		**C ACCEPT** unsaturated hydrocarbon , tail / chain
			D <u>ester</u> , bond / link **;**		**D IGNORE** covalent

Question			Answer	Mark	Guidance
	(b)	(iii)	**1** contains **,** large amounts of energy / more energy than individual needs **;** **2** increased , fat / lipid , deposition / storage **;** **3** (associated with) obesity **;** **4** (lots of meat and dairy in diet could mean) lack of other (named) food groups / AW **;**	3 max	**1 ACCEPT** contains , too many calories / excess energy **1 ACCEPT** contains a lot of saturated fat **2 ACCEPT** in context of arteries and adipose tissue **2 ACCEPT** cholesterol / LDL as AW for fat **2 IGNORE** build up **3 IGNORE** CHD (as not malnutrition) **4 ACCEPT** nutrients as AW for food groups **4 IGNORE** unbalanced diet **4 IGNORE** fat / protein
	(c)		**1** reduces , water potential / Ψ , outside , microbial / bacterial / fungal , cells **;** **2** (microbes) lose water **and** cannot , reproduce / survive / carry out metabolic reactions / AW **;** **3** water moves by osmosis **;**	3	**1** Cannot be implied from references to water potential gradient **1 ACCEPT** reduces beef water potential **1 IGNORE** solute potential **1 IGNORE** viruses **2 ACCEPT** bacteria lose water and die **2 AWARD** only in context of microbes dehydrating **2 IGNORE** viruses **2 IGNORE** beef losing water so microbes cant reproduce **3 ACCEPT** in any correct water potential context
			Total	**16**	

Question			Expected Answer	Mark	Additional Guidance
3	(a)	(i)	blue-black / black / dark blue **;**	1	**ACCEPT** dark purple / purplish-blue **DO NOT CREDIT** blue or purple unqualified by darkness **ACCEPT** acceptable colour change
	(a)	(ii)		2	**CREDIT** marking points from clearly labelled diagram max 1 if incorrect charges are on atoms
		1	between oxygen and hydrogen (atoms) **;**		**1 DO NOT CREDIT** molecules / ions
		2	(between) electronegative / δ^-, and electropositive / δ^+ **;**		**2 DO NOT CREDIT** ions / + and – **2 ACCEPT** slight / partial (negative / positive), charge
	(a)	(iii)		2 max	**IGNORE** refs to denaturation
		1	hydrogen / H, bonds break **;**		
		2	helix, lost / unravels / AW **;**		**2 ACCEPT** spiral / coil
		3	iodine, released / no longer in complex / AW **;**		**3 ACCEPT** no longer contained in helix

Question			Expected Answer	Mark	Additional Guidance
	(b)	1	take samples at a range of times / AW **;**		
		B2	same volumes (of solutions) added / removed (each time) **;**		**B2** must be in context of Benedict's test rather than reaction mixture
		B3	heat with, Benedict's (solution) / $CuSO_4$ and NaOH **;**		**B3 DO NOT CREDIT** boil **/** warm **B3 DO NOT CREDIT** if Benedict's added to the mixture at the beginning
		B4	(use of) excess Benedict's **;**		
		B5	changes to, green / yellow / orange / brown / (brick) red **;**		
		C6	remove precipitate / obtain filtrate **;**		**C6 CREDIT** description of method e.g. filtering / centrifuging / decanting
		C7	colorimeter **;**		
		8	calibrate / zero, using, a blank / water / (unreacted) Benedict's **;**		**8 IGNORE** 'control'
		9	use (red / orange) filter **;**		**9 DO NOT CREDIT** if colour of filter is incorrect
		T10	reading of, transmission / absorbance **OR** mass of precipitate **;**		**T10 ACCEPT** 'measure how much light, does / does not, pass through'
		11	more transmission / less absorbance, of filtrate, **OR** greater mass ppt, = more maltose present **; ora**		**11** if unfiltered Benedict's / precipitate is **clearly indicated** as being present **in sample**, **ACCEPT** 'less transmission / more absorbance, = more maltose present' **11 DO NOT CREDIT** if precipitate is added to colorimeter
		12	using, standard / known, concentrations (of maltose) **;**		**12 CREDIT** 'serial dilutions'
		13	(obtain) calibration curve **;**		
		14	plot, transmission / absorbance / mass of ppt, against (reducing sugar) concentration **;**		
		15	use graph to read off concentration of maltose / AW **;**	**6 max**	
			QWC – correct sequence **;**	**1**	1 of mps **B2 to B5**, *then* mp **C6 or C7**, *then* mp **T10**

<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>
1 increases / greater / faster ;
2 reaction completed in / plateaus after / concentration is 100% after, 3.5 minutes ;
3 figures with units to support mp 1 ;
</td><td>2 max</td><td>
1 ACCEPT any time between 3.45 and 3.55 min.

3 two maltose concentrations (+ or – chloride) for a given time or two times (+ or – chloride) for given maltose concentration.
3 ACCEPT calculated difference
3 DO NOT CREDIT if ‘%’ and ‘min.’ not given
3 ACCEPT any concentration within ± 1 % and time within ± 0.05 min.
</td></tr>
<tr><td></td><td></td><td></td><td colspan="3">
<table>
<tr><th rowspan="2">Presence or absence of chloride ions</th><th colspan="9">The percentage concentration of maltose (%) present every half a minute</th></tr>
<tr><th>0.0 min</th><th>0.5 min</th><th>1.0 min</th><th>1.5 min</th><th>2.0 min</th><th>2.5 min</th><th>3.0 min</th><th>3.5 min</th><th>4.0 min</th></tr>
<tr><td>Chloride ions present</td><td>0</td><td>24</td><td>54</td><td>70</td><td>80</td><td>88</td><td>95</td><td>100</td><td>100</td></tr>
<tr><td>Chloride ions absent</td><td>0</td><td>12</td><td>20</td><td>29</td><td>36</td><td>40</td><td>45</td><td>48</td><td>50</td></tr>
<tr><td>Difference in maltose concentration When chloride ions are either present or absent</td><td>0</td><td>12</td><td>34</td><td>41</td><td>44</td><td>48</td><td>50</td><td>52</td><td>50</td></tr>
</table>
Allow a + /- 1% for any concentration of maltose and a +/- 2% for the difference in maltose concentrations
</td></tr>
<tr><td></td><td>(c)</td><td>(ii)</td><td>
1 (acts as a) cofactor ;
2 (Cl^-) binds to, enzyme / amylase / amylose / substrate ;
3 enzyme substrate complex / ESC, forms more, easily / quickly ;
</td><td>2 max</td><td>
1 IGNORE ‘coenzyme’

2 ACCEPT binds to, active site

3 ACCEPT description
</td></tr>
</table>

Question			Expected Answer	Mark	Additional Guidance
	(c)	(iii)			**Mark the first three answers only regardless of which line they are on** **DO NOT CREDIT** refs to, time
		1	temperature **;**		
		2	pH **;**		
		3	enzyme / amylase / chloride, <u>concentration</u> **;**		**3 IGNORE '**amount' or 'volume' **3 DO NOT CREDIT** 'concentration' unqualified
		4	substrate / starch / amylose, <u>concentration</u> **;**		**4 IGNORE '**amount' or 'volume' **4 DO NOT CREDIT** 'concentration' unqualified
		5	constant / regular, stirring **;**		
		6	(fixed) <u>volume</u> of solution (removed each time for sampling) **;**	**3 max**	
			Total	**19**	

Question			Expected Answer	Mark	Additional Guidance
4	(a)	(i)			**Mark the first response** but do not award the mark if a further answer is incorrect or contradictory **DO NOT CREDIT** refs to length as given in stem
		1	(m)RNA is single stranded / DNA is double stranded **;**		***1*** **ACCEPT** DNA is a double helix (as stranded is implied) **for this mp** **DO NOT CREDIT** DNA is a double *molecule*
		2	(m)RNA is non helical / DNA is helical **;**		***2*** **ACCEPT** (mRNA) not twisted / not coiled / not spiral / straight / ora
				1	
	(a)	(ii)			**Mark the first response to (a)(ii)** – but but do not award the mark if a further answer is incorrect or contradictory
		1	RNA contains ribose **and** DNA contains deoxyribose **;**		
		2	RNA contains, uracil / U, **and** DNA contains, thymine / T **;**		***2*** **DO NOT CREDIT** thyamine
		3	3 / more than 1, forms of RNA **;**		***3*** **ACCEPT** 'one form of DNA'
		4	RNA is, single stranded / non helical, **and** DNA is, double stranded / helical **;** *if not already* ***awarded*** *as answer in (i)*		
				1	
	(a)	(iii)	gene **;**		**IGNORE** allele / operon
				1	
	(a)	(iv)	too big to / does not, fit through pore (in nuclear envelope) **;**		**ACCEPT** 'too long to fit … pore'
				1	
	(a)	(v)	*idea that* only copies one, gene / section / part / AW, (of DNA) **;**		e.g. mRNA only codes for 1 protein
			idea that DNA comprises many, genes / alleles **;**		**DO NOT CREDIT** '1 DNA molecule contains *all* the genes' 'mRNA only codes for 1 protein but DNA codes for many proteins' = 2 marks
				2	

Question			Expected Answer	Mark	Additional Guidance
	(b)	(i)			
		1	non-competitive (inhibitor) ;		
		2	(α-amanitin / inhibitor / toxin) fits into, allosteric site / a place other than active site ;		
		3	active site changes, shape / configuration / conformation / structure ;		3 **ACCEPT** 'distortion of active site'
		4	substrate no longer, fits / complementary to, active site ;		*4* Mark to be awarded in context of active site (although need not be repeated if stated in mp 3) **IGNORE** ESC
				2 max	
	(b)	(ii)			
		1	inhibits production of mRNA / mRNA not produced ;		*1* **CREDIT** prevents transcription
		2	prevents protein synthesis / AW ;		*2* **CREDIT** translation
		3	e.g. of, specific named protein / (vital) process, that may be affected ;		*3* e.g. respiration / photosynthesis (as question refers to 'an organism') / haemoglobin / cytochrome C oxidase
				2 max	
	(c)	(i)	sequence / order, of amino acids ;		**IGNORE** number / organisation
				1	
	(c)	(ii)			**ALLOW** phonetic spelling
			A = ionic ;		
			B = hydrogen ;		
			C = disulfide (bond / bridge) ;		**DO NOT CREDIT** disulfate
				3	
	(d)	1	increased kinetic energy ;		*1* must contain the idea of more than normal
		2	(any part of protein molecule) vibrates ;		
		3	hydrophilic / hydrophobic / hydrogen / ionic, bonds / interactions, break ;		*3* **IGNORE** Van der Waals **DO NOT CREDIT** if disulfide / covalent / peptide bonds are included
		4	change in, 3D shape / conformation (of protein) ;		*4* **IGNORE** tertiary / structure (as in question) **IGNORE** refs to, active site / enzymes
		5	denatures ;		
				3 max	
			Total	**17**	