Mark scheme

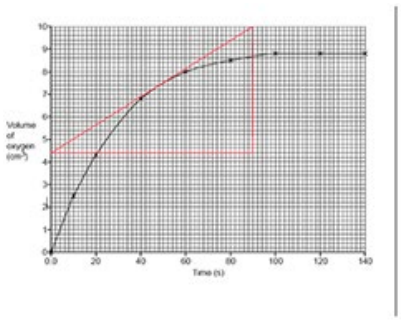
Question			Answer/Indicative content	Marks	Guidance
1	a	i	(because) hydrogen peroxide / H_2O_2 , is toxic / damages cells **OR** breakdown of hydrogen peroxide / H_2O_2 , minimises / prevents, damage (to cells) ✓ products of breakdown are, harmless / water and oxygen ✓	2	**ALLOW** damage to organelles / triggers apoptosis / damage to enzyme **ALLOW** prevents damage to organelles / prevents apoptosis / prevents damage to enzyme **ALLOW** H_2O and O_2 **Examiner's Comments** Most candidates understood that hydrogen peroxide is toxic or would damage cells or their components to gain one mark. However, only good responses offered further detail about the importance of the breakdown.
		ii	**FIRST CHECK ANSWER ON ANSWER LINE** **If answer = 3.7 ± 0.6 award 2 marks** ✓✓ drawn tangent at t = 30 s figures from tangent e.g. 170 (µg) ÷ 46 (s) **Unit =** µg s^{-1} ✓	3	*Max 2 if answer given to more than 3 significant figures* If answer incorrect **One mark for** tangent drawn with **straight** line that meets the curve at 30s and can be any length **OR** calculation showing difference in volume ÷ difference in time (from tangent / triangle) **ALLOW** µg / s **Examiner's Comments** Candidates who scored well on this question drew an appropriate tangent to the curve, and a range of answers were accepted to account for the variation in possible gradients.

					However, some candidates made the error of not calculating the rate using a tangent and, instead, took the readings of x and y and divided them or simply read off the value at 30 seconds. The mark for correct units was given regardless of the method used. **Assessment for learning** Calculating rate from curves on graphs using tangents is a mathematical skill included in this specification. Many candidates were just reading the value for hydrogen peroxide at 30s, so practice in use of tangents is to be encouraged. **OCR support** Maths skills handbook can be found to support candidates preparing for assessment. There is also extra support on maths skills in the 'Maths for Biology' resources.
	b	i	because they have many mitochondria ✓ catalase activity may be (too) low ✓ mutation in / less transcription of , catalase gene✓ (or) SOD activity may be (too) high ✓	max 2	**ALLOW** catalase may be inactive **ALLOW** low concentration of catalase **ALLOW** high concentration of SOD **Examiner's Comments** Many candidates understood

					that sperm cells would have many mitochondria to gain credit. However, only high achieving candidates gained further mark points by referring to the possibility of high concentrations of SOD or the presence of inactive catalase.
		ii	*Evidence to support* **1** as (H_2O_2) concentration increases motility (of treated sperm) decreases ✓ **2** as (H_2O_2) concentration increases cells with changes to (composition of) plasma membrane increase ✓ *Evidence that does not support* ***-max 2*** **3** correlation does not prove causation ✓ **4** sample size was (relatively) small / only 10 men ✓ **5** no statistical test has been performed ✓ **6** (sperm cell) samples , not representative / show bias ✓ **7** (some motility) error bars overlap ✓	max 3	**MP1 ALLOW** e.g. negative correlation between hydrogen peroxide concentration and motility **MP1 DO NOT ALLOW** normal sperm cells **MP2 ALLOW** e.g. positive correlation between concentration of hydrogen peroxide and cells with changes to plasma membrane **MP3 ALLOW** there may have been another cause of low motility **MP5 ALLOW** no correlation coefficient calculated / no Spearman's rank **MP6 ALLOW** samples from fertility clinic more likely to have abnormal sperm **MP6 ALLOW** *idea* of skewed results **Examiner's Comments** Candidates appear to be more familiar with the command word "evaluate" and there were many who structured their response with supporting points followed by points against the conclusion, along with comments on the methodology of the investigation. **Assessment for learning**

					Candidates should be encouraged to read graphs carefully noting the named variables on the x and y axes.
		iii	oxidises / reacts with / AW , fatty acids / phospholipids / cholesterol ✓ damages / denatures (named) , membrane proteins ✓ disrupts phospholipid bilayer ✓ causes membrane to be more permeable ✓	max 2	**ALLOW** changes the fluidity of the membrane **ALLOW** causes breaks / pores in membrane **Examiner's Comments** Most candidates achieved at least one mark for this question part. There were a number of alternative phrases allowed and candidates should be encouraged to refer to the phospholipid bilayer when answering questions on this topic, rather than the more general term 'membrane'.
			Total	**12**	
2		i	H_2O / water ✓ 2 / two ✓	2	**ALLOW** 1 mark for just H_2O / water **IGNORE** incorrect number e.g. 3 for **MP1** **Examiner's Comments** This question was generally well-answered. Most candidates knew that water was used for one mark and many correctly understood that two water molecules would be used in this hydrolysis reaction. Some candidates incorrectly suggested that three molecules of water were used, possibly because there were three glucose molecules. There were several

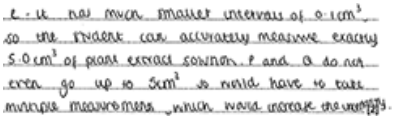
					'no responses' for this question and this may be because candidates simply did not notice it due to lack of an answer line.
		ii	(maltotriose is) complementary to the <u>active site</u> (of maltase / the enzyme) **OR** (maltotriose also) contains (α-1,4) glycosidic bonds **OR** (maltase / the enzyme) hydrolyses (α-1,4) glycosidic bonds ✓	1	**ALLOW** (maltotriose) can bind to or fit into <u>active site</u> (of maltase / the enzyme) **DO NOT ALLOW** beta / β **ALLOW** breaks down for hydrolyses **<u>Examiner's Comments</u>** This question part was also generally well-answered with the full range of marking points being given as correct responses. Incorrect responses often referred to maltotriose as a polysaccharide or did not include the appropriate scientific terminology for a mark to be given.
			Total	**3**	
3		i	unzips, (DNA) double helix / strands / molecule ✓ breaks hydrogen bonds between the , two strands /(nitrogenous/complementary/named) bases / base pairs ✓	2	**ALLOW** unwinds **ALLOW** described for MP1 e.g. 'creates 2 separate strands of DNA' **<u>Examiner's Comments</u>** Some candidates were given 2 marks and some were given 1, suggesting the action of helicase is well known. Unzipping/unwinding was nearly always seen, but the most common mistake was not making it clear that there were two strands being separated and/or linking this to the DNA double helix. Many candidates missed out the breaking of Hydrogen bonds for the second mark.

		ii	mutation / described ✓ change in DNA (base) sequence / order of bases changed ✓ description of types of mutation (e.g. substitution / addition / deletion / frameshift / idea of wrong complimentary base pairs being matched up (during DNA replication) etc.) ✓ e.g. exposure to (named) mutagen ✓	2 max	e.g. spontaneous / random change **ALLOW** wrong nucleotide / base inserted e.g A pairs with G not T **DO NOT ALLOW** direct ref to transcription / RNA bases / A pairing with U e.g. radiation, (named) carcinogens, (toxic) chemicals, sunlight, UV **Examiner's Comments** Most candidates were given 1 mark for correctly identifying mutations as a key term. Many candidates focused on incorrect complimentary base pairing but did not link this to the resulting DNA base sequence being different (i.e. suggesting that the base pairing was wrong but then not explaining that this leads to a different sequence of bases). A few candidates lost a mark by referring to transcription and RNA, possible due to not recognising the need to refer to DNA replication stated in the stem of the question.
			Total	**4**	
4	a		**FIRST CHECK ON ANSWER LINE** **If answer = 0.062, award 2 marks ✓ ✓** tangent drawn and is straight , meets the curve at 50s , can be any length **OR** difference/change/Δ in volume / Δy / dy , ÷ , difference/change/Δ in time / Δx / dx **OR** calculation showing , difference / change , in volume ÷ , difference	2	**DO NOT ALLOW** interpolation alone **ALLOW** range 0.057−0.063 **for 2 marks**  **Examiner's Comments**

			/ change , in time **OR** correct answer to incorrect sig fig e.g. 5.6 / 90 = 0.0622 cm^3 s^{-1} ✓		Some candidates were able to accurately draw a tangent and use it to calculate the rate of reaction at a point. More were given 1 mark for drawing a tangent and knowing how to use it. Some were not awarded marks by falling outside the tolerance range and drawing an inaccurate tangent line, but it was good to see so many showing their working out and annotating the graph as they still achieved 1 mark for this. Candidates who were not given any marks often merely read the graph as an interpolation or were able to draw a tangent but then did not use it, instead just using interpolation. **OCR support** Tangent should be 'even on both sides of the line of best fit', i.e. the entire curve should be visible. While aligning the ruler, make sure that in the vicinity of the point none of the line of the curve is covered by the ruler. The aim is to have the entire curve visible as the line is drawn, otherwise the tangent will not be accurate. Taken from the OCR AS and A Level Mathematical Skills Handbook.
	b		carry out the experiment at different concentrations of , hydrogen peroxide / substrate ✓ without inhibitor **AND** with inhibitor ✓	2 max	**ACCEPT** hydroxylamine for inhibitor **Examiner's Comments** Candidates that were given 2 marks described the practical

			rate (of reaction) with inhibitor (also) increases as the concentration of substrate increases **OR** (with inhibitor has) greater inhibition at lower concentrations of substrate / less inhibition at higher concentrations of substrate ✓		procedure and knew the expected results with competitive inhibitors. They described carrying out the experiment at different concentrations of substrate. The most common response that was given marks was where students understood the need to do an experiment 'with and without' the inhibitor to be able to see its effects. Many candidates did not realise that the original experiment did not do this, so they just stated that the experiment should be repeated. Most candidates described what a competitive inhibitor was and/or how they affect the rate of reaction and so were given no marks.
			Total	**4**	
5	a	i	induced fit ✓	1	**Examiner's Comments** This is a very straightforward question, but it has proved to be challenging. Less able candidates didn't recognise that the correct hypothesis is the induced fit hypothesis and many stated 'lock and key'. This might be due to the specific context of the question.
		ii	(changes to active site cause formation of) stronger bonds between chitin and chitinase ✓ bonds in chitin are, weakened / put under strain ✓ lower activation energy ✓	2 max	**Examiner's Comments** Some of the candidates who correctly identified the hypothesis as induced fit didn't score well here. A few candidates scored a mark for 'reducing the activation energy' but very few were able to explain how this was achieved. The majority of candidates restated parts of the question stem or described larger numbers of enzyme substrate complexes being formed.

	b	i	**FIRST CHECK ON ANSWER LINE** **If answer = 0.048 award 2 marks** 0.12 / 250 = 0.00048✓ x 100 ✓	2	**ALLOW** if 0.048 seen anywhere in answer space **Examiner's Comments** This question was well answered with the majority of candidates being able to calculate the correct percentage error. The most common error was to double the absolute uncertainty to 0.24 and end up with a value of 0.096%. Doubling the value of uncertainty is only used when a value is calculated by difference. **OCR support** OCR Maths skills handbook can support with teaching maths skills Maths for Biology website also has a range of resources for all mathematical skills.
		ii	*pipette R because…* (it has the) highest resolution ✓ (it has the) lowest , uncertainty / percentage error ✓ fewer, random / measurement , errors ✓ (larger volume therefore) fewer , uses / transfers / measurements , required ✓	2 max	No mark for selecting pipette R, but a maximum of 1 mark should be awarded if a different pipette is selected. **ALLOW** 'smallest gaps between graduations' **ALLOW** idea that measurement lines are closest together **IGNORE** best resolution **ALLOW ORA** if refer to both P & Q **ALLOW** improves accuracy **ALLOW ORA** if refer to both P & Q **ALLOW** can transfer 5cm3 in one go **Examiner's Comments** This question was not well

					answered and all alternatives were regularly seen in responses. Once a choice had been made most candidates were unable to explain the reasons for their choice coherently. Vague statements about ease of use or precision or accuracy were common. However, these terms were rarely used in the correct context to explain that having the smallest increments in its scale and containing a large enough volume meant that pipette R would reduce uncertainty the most. Highest resolution refers to the equipment with the smallest scale divisions (i.e., smallest division for P=0.25cm^3, Q=0.5 cm^3, R=0.1 cm^3). Exemplar 1  In this exemplar we see a fairly good response which scored one mark. The candidate has correctly identified pipette R as the best pipette to use. This correct identification did not gain a mark as the marks are given for the explanation. Mark point 1 was not given as the candidate has described the intervals on the scale as 'smaller' rather than the 'smallest' of the three. Mark point 5 was given as using P or Q multiple times is the reverse argument of pipette R needing to be used fewer times or only once. **OCR support**

					Many candidates appear to find the language of measurement very demanding. Support on uncertainty and the effect it has on measurements is available at: Language of measurement in context - Biology
			Total	**7**	
6		i	*idea of* changes protein production (inside cells) ✓ (some of these) proteins are secreted to affect, other cells / growth / embryo development ✓ increased protein synthesis requires more energy ✓ rate of respiration increases (to supply ATP) ✓	2 max	e.g. 'TET enzymes cause new proteins to be made in the cell' / proteins to be made at a higher rate / more proteins made **ALLOW** proteins are secreted to cause faster growth **DO NOT ALLOW** ref to excretion of proteins **Examiner's Comments** Many candidates correctly linked the activity of the TET enzyme to a change in protein production usually suggesting that protein production increased. However, few then linked the change in protein production to an increase in energy needs or an increase in respiration rate to provide that extra energy. Very few described the secretion of proteins from the cell that could then affect growth of the whole embryo or development. Less able candidates tended to rely on rephrasing or simply copying out parts of the question stem.
		ii	cofactor / coenzyme ✓	1	**IGNORE** 'activator' **Examiner's Comments** Many candidates knew that Vitamin C acted as a cofactor or coenzyme. Less able candidates called it a prosthetic group.

<table>
<tr>
<td></td><td></td><td>iii</td>
<td>
<table>
<tr><th rowspan="2">Enzyme</th><th colspan="2">Type of reaction catalysed</th></tr>
<tr><th>Intracellular</th><th>Extracellular</th></tr>
<tr><td>TET</td><td>✓</td><td></td></tr>
<tr><td>Catalase</td><td>✓</td><td></td></tr>
<tr><td>Trypsin</td><td></td><td>✓</td></tr>
</table>
✓
</td>
<td>1</td>
<td>IGNORE crosses

<u>Examiner's Comments</u>

Many candidates scored well in this question. A few seemed that they didn't understand the terms intracellular and extracellular. The most common error was thinking that catalase was an extracellular enzyme – possibly because it is often used in laboratory experiments investigating enzyme action.</td>
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<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
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<td>7</td><td></td><td></td>
<td>D ✓</td>
<td>1</td>
<td><u>Examiner's Comments</u>

Most candidates selected the correct response, D, but all other distractors were seen.

OCR support
OCR has a resource available to support candidates with the practical investigation and 'Language of measurement'.

Language of measurement in context - Biology</td>
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<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr>
<td>8</td><td></td><td></td>
<td>B ✓</td>
<td>1</td>
<td><u>Examiner's Comments</u>

Many candidates selected the correct response, B, but all other distracters were seen. Candidates should appreciate that any unit of rate must include a reference to time.</td>
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<tr><td></td><td></td><td></td><td>Total</td><td>1</td><td></td></tr>
<tr>
<td>9</td><td></td><td></td>
<td>A ✓</td>
<td>1
(AO2.1)</td>
<td><u>Examiner's Comments</u>

A large majority of candidates correctly chose option A. Option D was seen regularly, suggesting</td>
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</table>

					uncertainty about the definition of coenzyme.
			Total	**1**	
10	a	i	hydrogen peroxide concentration ✓	1 (AO3.3)	**IGNORE** conc. **Examiner's Comments** Most candidates got this right. Some missed out by writing 'a.u.', 'conc.', or even 'amount', rather than 'concentration'. A small but significant minority cited 'volume of gas produced', suggesting that some candidates are unsure of the difference between the independent and dependent variable. **OCR support** Language of measurement resource is excellent guidance to help students with the correct use of scientific terminology.
		ii	(mix with) distilled water ✓ ratio of 3 (water) : 2 (stock solution) ✓	2 (AO3.3)	**ALLOW** deionized water **ALLOW** any suggested volumes if proportion (3:2) is correct **IGNORE** units **IGNORE** any procedure with more than one step **Examiner's Comments** This question differentiated well. Most recognised that water needed to be added and most of these correctly stated 'distilled' water. Many candidates found it difficult to suggest an appropriate ratio and suggested a serial dilution process involving more than one step, often struggling to conceive of a dilution factor other than 1 in 2, 1 in 10 or 1 in 100. Two-step dilution techniques (e.g. 50:50 dilution to achieve 10

					a.u. then a second dilution to 8 a.u.) are not an accurate or appropriate way of making an 8 a.u. solution for use in an investigation. **Misconception** Many candidates were using the term 'serial dilution' and then suggesting a simple (often correct) proportional dilution, suggesting a misunderstanding to the term 'serial dilution'. **Assessment for learning** Giving candidates opportunities in lessons to practice a variety of dilution techniques, for example with blackcurrant cordial can be helpful. **OCR support** Help with generic practical techniques such as dilution can be found in the OCR Biology Practical Skills Handbook
		iii	easier to control surface area ✓ less chance of ethical objection (to use of animal material) ✓ AVP ✓	2 Max (AO3.4)	**ALLOW** lower risk of infection **ALLOW** more acceptable to vegetarians **ALLOW** e.g., less chance of violent frothing reaching delivery tube / slower reaction so easier to record accurately **IGNORE** cheaper **Examiner's Comments** Less than half of candidates achieved a mark here and less than 1 in 20 got both marks. The most common mark given was

					linked to potential ethical objections. Many candidates addressed the idea of surface area, e.g. by suggesting that it was easier to cut into shape, without using the term 'surface area', which is a key variable in rate of reaction investigations. A number of candidates noted that the question stem stated that liver has a higher catalase concentration than potatoes and would therefore produce a very rapid reaction. On this occasion, credit was given to candidates that suggested that this might be difficult to record accurate volumes. This was added in the Guidance column of the mark scheme as is not an ideal answer, since a simple adjustment (i.e., use a smaller mass of liver) would solve this problem. A few candidates suggested that, unlike potatoes, liver could not be bought in a shop, while a very small number of candidate thought that potato plants were not living organisms.
		iv	ensure there is no skin on / consistent potato variety ✓	1 (AO3.4)	**ALLOW** use potatoes that are the same age **IGNORE** drying / use same (part of) potato / measure mass **<u>Examiner's Comments</u>** Around a quarter of answers scored a mark in this question. Many candidates stated that the potato pieces should be patted dry, suggesting confusion with an osmosis investigation. Suggestions that the potato pieces come from the same potato (or part thereof) were not credited on this occasion as extracting 15 x 5 cm cylinders from the same potato is not feasible.

	b	i	**FIRST CHECK ON ANSWER LINE** **If answer = 2.3 award 2 marks** mean = 76.7 $\Sigma(x-\bar{x})^2$ = 10.67 ✓ correct answer to 1 decimal place ✓	2 (AO2.8)	**ALLOW** 1 mark for 2.3 to >1 decimal place. Check table for correct answer. **Examiner's Comments** Most candidates scored both marks here. Where that was not achieved, a single mark was often given, either for the correct answer to too many decimal places (i.e., 2.31 - the answer needing to be consistent with the other numbers in the table) or for getting as far as 10.67. Less than 1 in 5 candidates scored 0 marks. **OCR support** We have a range of resources available to support you and your students on maths skills focused on statistics: Maths for Biology resources Include tutorials and student activities for all the statistical skills that candidates need to know for the course. Statistics for Biologists Guidance for teachers on the statistical skills that candidates need to have. Mathematical skills Handbook Provides guidance on the statistical skills and explains how they can be used within a biology context.
		ii	standard deviations are low(er) at , low(er) concentration(s) / earlier times ✓ **ora** more repeatable at , (stated)	2 (AO3.4)	**ALLOW** AW for 'concentrations', e.g., a.u. **IGNORE** quoted standard deviations

			low(er) concentration(s) / (stated) earlier times ✓ **ora**		**ALLOW** less repeatable as time goes on **IGNORE** it is repeatable / not repeatable (must be comparative) **CREDIT** 'higher precision' as AW for 'more repeatable' **Examiner's Comments** Around a third of candidates scored both of the marks available for this question. One common mistake was to omit the word 'repeatability' or to use it in absolute, rather than comparative, terms (e.g. 'the results are repeatable'). Some candidates merely defined the terms without reference to the numbers in the table. **OCR support** Support on Language of measurement can be found on Teach Cambridge.
		iii	**FIRST CHECK ON ANSWER LINE** **If answer = 0.2 or 0.18 cm^3 s^{-1} award 2 marks** 5.3/30 **or** 5.3/0.5 ✓ ≤ 3 s.f. and correct units ✓	2 (AO2.8)	*Max 1 if no or incorrect unit given* **ALLOW 2 marks** if answer is 11 or 10.6 or 10 (cm^3 min^{-1}) or 0.177 (cm^3s^{-1}) **ALLOW** unit written as cm^3/min or cm^3/s **Examiner's Comments** Most candidates got both marks and 4 out of 5 achieved at least 1 mark. The second mark was often lost for incorrect units (e.g. 'secs' instead of 's' or 'cm^{-3} s^{-1}') or incorrect rounding ('0.176' was seen regularly).
		iv	**1** bung not airtight / some (gas) escaped ✓	2 Max (AO3.3)	**1 IGNORE** gas entering

			2 some , oxygen / gas , dissolved (in solution) ✓ **3** difficult to judge (volume at a set time) / AW , if rate of gas production is high / AW ✓ **4** gas other than oxygen collected ✓		**2** **ALLOW** some oxygen used in respiration **3** **ALLOW** e.g., measuring cylinder fills too quickly to measure accurately at 20 (a.u.) **4** **IGNORE** non-standard atmospheric gases **Examiner's Comments** Most candidates achieved at least 1 mark here, usually for a version of one of the first 2 marking points. Some candidates offered human error as a suggestion, which was not credited. A number of candidates suggested that oxygen might have been *used* in photosynthesis.
	c		**1** more frequent collisions at the start ✓ **ora** **2** substrate / H_2O_2 (collides with) , active site (of catalase) ✓ **3** rate of , product / oxygen , formation decreases (with time or substrate concentration) ✓ **4** substrate / H_2O_2 , concentration decreases (with time) ✓	3 Max (AO2.8)	**1** **ALLOW** (rate) depends on frequency of collisions / more collisions over first 30 s **2** **ALLOW** formation of ESC **3** **ALLOW** e.g., more oxygen produced per second at the beginning **4** **ALLOW** substrate concentration initially higher **4** **ALLOW** substrate concentration becomes limiting factor **4** **4 DO NOT CREDIT** enzyme concentration **DO NOT AWARD 1**, **3** or **4** for answers that do not address changes over time **Examiner's Comments**

					Most candidates achieved at least 1 mark here, usually for the guidance version of marking point 2. Marking points 3 and 4 were frequently seen but many candidates did not use the key term 'rate' or alternative words, or 'concentration' when referring to substrate. The first marking point was attempted less often and sometimes it was not always achieved. The reason was because candidates did not link collisions to the idea of frequency. Many candidates attempted to explain the changes in terms of decreasing *enzyme* availability (and so could not get marking point 4). Some candidates assumed that the y-axis showed the rate of reaction and didn't gain any marks other than marking point 2. A significant minority of candidates answered in terms of the differences between the three concentrations, which meant that large parts of their answer were irrelevant to the question.
			Total	**17**	
1 1		i	assists enzymes / AW ✓ without being permanently bound to enzymes / AW ✓ example of mechanism ✓	2 max (AO1.1)	e.g. 'activates enzymes' / 'helps enzyme (carry out its function)' e.g. 'temporarily attached to enzyme' e.g. 'reduces activation energy required for reaction' / 'involved with binding of substrate to active site' / 'allows substrate to bind more easily' / 'allows more ESCs to form' / 'binds to active site of enzyme' / 'changes structure of binding site' / 'helps transport reactant into active site' **Examiner's Comments**

					Most candidates scored 1 mark, usually for describing the mechanism of how a coenzyme might work, e.g. coenzyme attaching to the active site or making it easier for substrates to bind to the active site. Only a few candidates mentioned that coenzymes assisted enzymes without being permanently bound to them. A small number of candidates thought that they bind permanently to the enzymes which was not credited.
		ii	acts as inhibitor / reduces enzyme activity / enzyme activity is (always) lower in the presence of vitamin C / reduces amount of cAMP produced ✓ *idea of* (possibly) non-competitive because increasing ATP concentration does not allow enzyme activity to reach level without vitamin C ✓ *idea of* cannot decide whether it is competitive or noncompetitive because enzyme activity has not plateaued (at the ATP concentrations shown) ✓	2 max (AO3.1)	**ALLOW** 'without vitamin C enzyme activity is (always) higher' **ALLOW** 'non-competitive because V_{max} not reached' **Note** : if state 'it is a non-competitive inhibitor because increasing ATP concentration does not allow enzyme activity to reach level without vitamin C' = mp1 and 2 **Examiner's Comments** Most candidates were able to interpret the graph to state that vitamin C reduces the activity of adenyl cyclase or acts as an inhibitor. However, very few were able to explain that the shape of the curve with vitamin C present, indicates that it is a non-competitive inhibitor, or that as the enzyme activity had not plateaued you could not decide which type of inhibition was shown. **OCR support**

					Our teaching guide on 'Enzymes' offers an overview of key concepts and suggest classroom activities.
			Total	**4**	
12			A ✓	1 (AO1.1)	
			Total	**1**	
13	a	i	continuous **AND** there is an outlet for (continuous) collection of product ✓	1(AO3.1)	**ALLOW** (named) raw materials can be constantly added **Examiner's Comments** The vast majority correctly chose 'continuous' and all but a few of these supported this with a creditworthy explanation. Some chose batch but almost as many wrote 'aerobic' or 'alcohol' (fermentation).
		ii	temperature affects , rate of growth / enzyme activity ✓ (fungal) metabolic reactions generate heat ✓ to inhibit growth of pathogenic bacteria ✓	2 max(AO2.5)	**ALLOW** proteins could denature (at higher temperatures) **ALLOW** respiration is exothermic **Examiner's Comments** Most candidates achieved 1 mark here, usually for a version of the extra guidance for the first marking point. All three marking points were seen but rarely more than one in a single answer. Often candidates stated that heat was being produced but many such responses were vague about the source of this extra heat.
		iii	source of , nitrogen / N / amine / NH2 ✓ for (producing) amino acids / polypeptides / proteins ✓	2(AO2.5)	**IGNORE** nitrate / NH_3 **ALLOW** for (named) nucleic acids **Examiner's Comments**

					A little under half of candidates seemed to understand what was happening here but those who did usually achieved both marks. A significant minority of responses discussed the role of nitrates in the nitrogen cycle. Many responses vaguely suggested that ammonia might be used as a substrate for something, usually respiration. Some thought it killed unwanted microbes.
	b	i	pH below <u>optimum</u> ✓ (for) bacterial enzymes ✓	2(AO2.5)	**ALLOW** low(er) pH denatures (enzymes) **ALLOW** enzymes in (named) microorganisms **<u>Examiner's Comments</u>** Most candidates struggled to produce a creditworthy response to this with many answers merely stating that the lactic acid prevented microbial growth. Around a fifth of candidates gained at least 1 mark, most commonly for a version of the extra guidance for the first point; the second marking point was more rarely given marks and usually only in those responses that had already been given the first. A significant minority of responses suggested that the acidic conditions would promote the growth of bacteria and some suggested that the bacteria could metabolise the lactic acid in preference to lactose. A few responses discussed the *lac* operon.
		ii	*Product* amino acid(s) ✓ *Reaction* hydrolysis ✓	2(AO1.2)	**ALLOW** water added **<u>Examiner's Comments</u>** The vast majority of candidates

					gained both marks here. Of those that didn't, the reaction was more often correct than the product, for which 'whey' and even 'casein' itself were sometimes suggested.
			Total	**9**	
14			environmental ✓ stimuli ✓ apoptosis ✓ enzymes ✓ phagocytes / phagocytosis ✓	5(AO1.2)	**ALLOW** stress / factors **ALLOW** proteases / caspases **IGNORE** lysosomes **ALLOW** macrophages / endocytosis **Examiner's Comments** The majority of responses for the first three blank spaces were correct. Few responses were able to gain full marks. For each blank, the most common incorrect responses were 'hormonal' and 'conditions'. Nearly all candidates got this right, although spellings that were not phonetically similar were not given marks. Examples of these are: phagocytes, lysosomes and lysozyme, exocytosis, enzymes and vesicles.
			Total	**5**	
15			A ✓	1(AO2.5)	
			Total	**1**	
16		i	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer is 2.22 / 2.20 award 2 marks** $Q_{10} = \frac{R_2}{R_1}$ 200 / 90 = 2.22222	2 (AO3.1) (AO3.2)	**If answer incorrect then**: **ALLOW** 1 mark if answer not given to 3 sig. fig. e.g. 2.22222 **OR** **ALLOW** 1 mark if you see 200 and 90 or 91 as the two correct readings from Fig. 20.2 **DO NOT ALLOW** if 170 is also

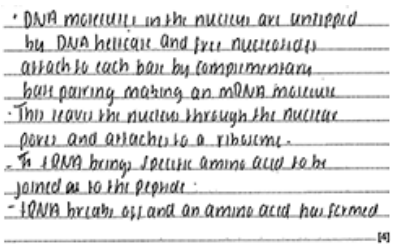
			correct values for O2 consumption at 23 °C **AND** 13 °C ✓ correct calculation of Q_{10} based on values from graph ✓		given as this is the incorrect reading for 18°C **Examiner's Comments** It was encouraging to see candidates calculating Q10 correctly. The rate of reaction doubles for a 10°C rise in temperature for enzyme-controlled reactions. Q10 = 2. Candidates were given 1 mark for reading the correct values of 200 and 90 from the graph then 200/90 = 2.22 was a straightforward calculation.
		ii	*Conclusion supported because…* **1** larger increase in O_2 consumption between 13 °C and 18 °C ✓ **2** *idea that* higher temperature / 23°C, may not be economic / ORA ✓ ***Max 3 marks from MPs 3 to 7**: Conclusion not supported because…* **3** greater O_2 consumption may indicate high metabolic rate (rather than growth rate) ✓ **4** greater O_2 consumption may result in, more food consumption / higher feeding costs ✓ **5** temperatures below 13 °C and above 23 °C not used / only three temperatures used ✓ **6** no indication of sample size used ✓ **7** *idea that* there is no evidence of, statistical tests / replicates / repeats / mean values obtained ✓	max 4 (AO3.1) (AO3.2)	**MP1 ALLOW** smaller increase between 18 °C and 23 °C **MP2 ALLOW** reference to e.g. extra heating costs **Examiner's Comments** Candidates should be encouraged to read the detail of the experiment and the results provided and be more critical of experimental methods that are presented to them. Some candidates were able to spot that only three temperatures had been used, and others that no statistical tests had been carried out. Some were able to suggest that warming to the highest temperature may not be economically sound; a question that is often asked in the context of photosynthesis and greenhouse temperatures. Candidates should be encouraged to give responses and critiques that both support and do not support the stated conclusion.
			Total	**6**	

17			**C**	1 (AO2.3)	
			Total	**1**	
18			**A**	1 (AO1.1)	**Examiner's Comments** This is an example of a multiple-choice question that asks candidates to identify the option that is **not** correct. Higher ability candidates understood that organisms living in hot environments would require enzymes that could control reactions at temperatures above 40°C and correctly identified option A as the only incorrect statement. It was evident that some candidates eliminated correct statements to produce a response.
			Total	**1**	
19	a		insulin is made from <u>two</u>, polypeptide chains / amino acid chains / primary structures ✓ chains joined by disulfide bonds (between, cysteine / CYS) ✓	2	**IGNORE** 'multiple chains' or 'more than one' **ALLOW** disulfide bridges **Examiner's Comments** The figure clearly shows two polypeptide chains, and the chains are joined by bonds between cysteine residues. Many candidates simply described what is meant by a quaternary structure as having 'more than one' or 'many' polypeptide chains. Many candidates also correctly stated that there were disulfide bonds between cysteine residues but did not point out that these were on separate chains and therefore joined the chains together. Only a minority of candidates were able to appreciate the detail

					provided in figure 21.1 and state correctly the two required features. **Assessment for learning** Candidates should read the question carefully. They should appreciate that the question refers to the insulin molecule in the figure rather than to a generalised protein with a quaternary structure. A reference to the figure is essential to gain marks.
	b	i	change in primary structure changes, tertiary structure / 3D shape ✓ (tertiary structure / 3D shape) no longer complementary (to shape of enzyme) ✓ less likely to be broken down by enzymes / enzyme-substrate complexes less likely to form ✓ change in solubility ✓	Max 1	**ALLOW** change in complementary shape **IGNORE** takes longer to be broken **ALLOW** can't be broken down easily / harder to break down **DO NOT ALLOW** can't be broken down by enzyme / ESC can't be formed **ALLOW** more or less **DO NOT ALLOW** ref to insulin glargine being insoluble **<u>Examiner's Comments</u>** The most able candidates were able to spot that there would be a change in the tertiary structure which would mean the molecule was no longer fully complementary in shape to the active site of the enzyme. However, this was often worded simply as 'the molecule is harder to break down'. This simplified mark point was accessed by many more candidates.

					Very few candidates were able to make the link between the change in primary structure and the resulting change in the tertiary structure. Many suggested that simply making the polypeptide longer meant there were more bonds to break and so this would take longer.
		ii	AAT / AAC ✓ is replaced by, GGT / GGC / GGA / GGG ✓	2	For two marks: **ALLOW** 1st A and 2nd A replaced by GG. **ALLOW** A replaced by G twice **ALLOW** 2 A's replaced by 2 G's For one mark: **ALLOW** A replaced by G **Examiner's Comments** Most candidates were able to extract the correct information from the table and gain full credit. The most common error was not making it clear that both adenine bases were replaced by guanine. A small number of candidates seemed to be unfamiliar with using DNA code data tables and referred to ASN (Asparagine) or GLY (Glycine) as the code or codon being altered; they were apparently unaware that these are just the accepted abbreviations for amino acids. Other candidates misread the question and used the code for arginine rather than the code for asparagine.
		iii	1. (modified gene undergoes) transcription (in nucleus)✓ 2. production of (modified) mRNA / described ✓ 3. mRNA, leaves nucleus / goes to ribosomes ✓	Max 4	**Examiner's Comments** Those candidates that read the question correctly often did very well, gaining 3 or 4 marks. Some excellent responses were seen

			4. translation at ribosome(s) ✓ 5. tRNA with specific amino acid binds its anticodon (to codon of mRNA) ✓ 6. (formation of) peptide bonds between amino acids ✓		with well-sequenced and detailed accounts. The majority of the candidates showed good knowledge and understanding of the production of mRNA followed by leaving the nucleus or going to the ribosomes. Less well known was the fact that the tRNA has a specific anticodon and brings a specific amino acid to the ribosome. The formation of peptide bonds was often missed out. Many of the more able candidates continued beyond the requirement of the question, (e.g., to the point where the polypeptide is made) and gave details of the transformations required to produce the quaternary structure of the protein. Many candidates did not use the terms ‘transcription’ and ‘translation’. Unfortunately, a relatively large number of candidates did not read the question with sufficient care. Having seen the references to genetic engineering they then gave an account of that process to describe how the gene could be modified to produce insulin glargine. Another common error was that candidates described DNA replication rather than transcription. **Exemplar 1**

					 • DNA molecule in the nucleus are unzipped by DNA helicase and free nucleotides attach to each base by complimentary base pairing making an mRNA molecule • This leaves the nucleus through the nuclear pores and attaches to a ribosome. • A tRNA brings specific amino acid to be joined on to the peptide. • tRNA breaks off and an amino acid has formed [4] Exemplar 1 shows a typical response that gives a clearly sequenced outline, but that could with more detail to gain full marks. This response was given 2 marks for production of mRNA and the mRNA leaving the nucleus. More marks could have been achieved if more detail of translation had been given. For example, stating that the tRNA has a specific anticodon that is complementary to the codon on the mRNA which ensures the specific amino acid is held in the correct position. Naming the peptide bond used to join the amino acids together would also gain credit.
			Total	**9**	
20			**A** ✓	1	**Examiner's Comments** Relatively few candidates gave the correct response (A). All other distractors were seen. Candidates must learn and understand these definitions. For this question candidates are required to have a good understanding of the Language of measurement as well as other maths skills such as standard deviation. Precise results are clustered together, while standard deviation gives an indication of how spread the data is around

					the mean and accuracy is a property of a single result. **OCR support** Definitions of these terms are provided in the Practical Skills Handbook available at: https:/www.ocr.org.uk/Images/294468-biology-practical-skills-handbook.pdf OCR has also produced a specific resource on 'Language of measurement' within a biology context: https:/www.ocr.org.uk/Images/577369-language-of-measurement-in-context-biology.docx
			Total	**1**	
21			**D** ✓	1	**Examiner's Comments** Only a minority of candidates chose the correct response (D). There was no obvious pattern to the incorrect answers which suggests this was a matter of guesswork for many candidates.
			Total	**1**	