

## Mark scheme

Question	Answer/Indicative content	Marks	Guidance
1 a i	directional growth in response to a stimulus ✓	1	<p><b>ALLOW</b> grows towards / away from a stimulus  <b>DO NOT ALLOW</b> 'growth' unqualified – it must have the sense of being directional</p> <p><b><u>Examiner's Comments</u></b></p> <p>This meaning of the term tropism proved challenging for many candidates to describe. Most responses lacked the idea of the fact that it is a directional or growth response. Some candidates gave an example of a tropism which was not awarded a mark.</p> <p> <b>Assessment for learning</b></p> <p>As stated in previous reports, definitions and meanings of scientific terms are an important part of the specification and candidates should be encouraged to learn these in full.</p>
	ii phototropism / geotropism / hydrotropism / thigmotropism / chemotropism ✓	1	<p><b>ALLOW</b> any correct plant tropism  <b>ALLOW</b> gravitropism  <b>DO NOT ALLOW</b> 'trop<del>h</del>ism'</p> <p><b><u>Examiner's Comments</u></b></p> <p>Generally well-answered with phototropism and geotropism the most used examples.</p>
	iii <i>abiotic stress</i> : drought / lack of water ✓ <i>response</i> : closing stomata / leaf drop / wilting ✓  <b>OR</b> <i>abiotic stress</i> : freezing / cold or low temperatures ✓ <i>response</i> : closing stomata /	2	<p><b>For two marks</b> correct response linked to abiotic stress  <b>ALLOW one mark</b> for a correct abiotic stress factor with incorrect response  <b>DO NOT ALLOW</b> grazing / herbivory or other examples of biotic stress.  <b>IGNORE</b> ref to hormones</p> <p><b><u>Examiner's Comments</u></b></p> <p>Most candidates showed knowledge of plant responses and this was generally well-answered. The most common error was where candidates had misread the question</p>

		<p>leaf drop / wilting / production of anti-freeze chemicals ✓</p> <p><b>OR</b>  <i>abiotic stress</i>: high temperature ✓  <i>response</i>: closing stomata / opening stomata / wilting ✓</p> <p><b>OR</b>  <i>abiotic stress</i>: low light levels / short day length ✓  <i>response</i>: closing stomata / abscission / leaf fall / etiolation ✓</p> <p><b>OR</b>  <i>abiotic stress</i>: high wind (speeds) ✓  <i>response</i>: closing stomata / wilting ✓</p>		<p>and provided an example of a biotic stress such as predation.</p>
b	i	<p>by enclosing the (donor / recipient) plant in (airtight plastic) bag ✓</p>	1	<p><b>ALLOW</b> container / AW for bag  <b>ALLOW</b> e.g. glass jar to cover the aerial parts e.g. cover that prevents interaction between aerial parts  <b>IGNORE</b> separate the plants in containers alone as the answer must imply separating aerial parts</p> <p><b><u>Examiner's Comments</u></b></p> <p>Candidates found this question challenging. Higher ability candidates were able to suggest that a solution to this problem would be to separate the aerial parts of the plant from one another while still allowing communication through the roots. Common incorrect responses involved separating the different plants e.g. in separate rooms or greenhouses.</p>
	ii	<p><b>Level 3 (5–6 marks)</b>  An evaluation that includes statements for supporting evidence <b>AND</b> statements for non-supporting evidence <b>AND</b> includes general statement about quality of data</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p>	6	<p><b>Loss of mark for communication statement if incorrect science e.g. muddled group comparisons</b>  <b>Group 1 = leaves / small mesh bag / no hyphae</b>  <b>Group 2 = no leaves / small mesh bag / no hyphae</b>  <b>Group 3 = leaves / large mesh bag / hyphae</b>  <b>Group 4 = no leaves / large mesh bag / hyphae</b>  <b>Assume points relate to PPO activity</b></p> <p><b>Indicative scientific points may include:</b></p>

	<p><b>Level 2 (3–4 marks)</b> An evaluation that includes statements for supporting evidence <b>OR</b> statements for non-supporting evidence <b>AND</b> includes general statement about quality of data <b>OR</b> An evaluation that includes a statement for supporting evidence <b>AND</b> a statement for non-supporting <b>AND</b> includes general statement about quality of data</p> <p><i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 1 (1–2 marks)</b> An evaluation that includes a statement for supporting evidence <b>OR</b> a statement for non-supporting evidence <b>OR</b> includes a general statement about quality of data</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p><b>0 mark</b> <i>No response or no response worthy of credit.</i></p>		<p><b>Supporting evidence</b></p> <ul style="list-style-type: none"> <li>• defoliation increased (PPO) activity</li> <li>• non defoliation did not increase (PPO) activity as much</li> <li>• group 2 bigger increase than 1 / group 4 bigger increase than 3</li> <li>• bigger increase with large-mesh bag / hyphae involved</li> <li>• groups 2 and 4 had large increase / groups 1 and 3 had small increase</li> <li>• group 1 had smallest increase</li> <li>• group 1 SDs overlap</li> <li>• group 4 had largest increase</li> <li>• calculation of comparative difference in increase</li> <li>• group 1 activity only increased by 11% and group 2 increased by 213%</li> <li>• group 3 increased by 83% and group 4 increased by 544%</li> </ul> <p><b>Non-supporting evidence</b></p> <ul style="list-style-type: none"> <li>• increase in all groups</li> <li>• plants not defoliated also showed increase</li> <li>• groups 1 and 3 still increased even though they didn't have leaves removed</li> <li>• increase in activity even when leaves are not removed from donor plant</li> <li>• some transmission by mycorrhizae regardless of whether donor leaves removed or not</li> <li>• increase even with small-mesh bag / no hyphae involved</li> <li>• increase in even when hyphae cannot grow between plants</li> <li>• some transmission by means other than mycorrhizae / hyphae</li> </ul> <p><b>Quality of data -general statements</b> <i>Good quality because</i></p> <ul style="list-style-type: none"> <li>• SD calculated</li> <li>• low spread of results about the mean</li> <li>• small standard deviations compared to size of mean</li> <li>• increases (in activity) could be significant</li> </ul> <p><i>Poor quality because</i></p>
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- no control for effect of mesh bag
- sample size relatively small
- may not be representative of mature trees / trees growing in the wild
- no statistical test
- only two species used / different species for donor and recipient
- raw data not shown – possible anomalies were included

### **Examiner's Comments**

Having data to evaluate two conclusions for two variables (i.e. experimental treatments) proved challenging for many candidates. Good Level 3 responses provided three clear and logical sections often titled: supporting evidence, non-supporting evidence and validity. Most candidates were able to produce a meaningful comparison between all or some of the groups but finding two non-supporting statements proved more challenging and often limited candidates to Level 2. Lower level responses interpreted or repeated the data without clearly stating whether it supported the conclusions or not and were unable to identify trends. Some candidates had difficulty expressing themselves clearly and precisely enough for the point they were making to be understood. The most confusing answers tried to compare too many groups at once and conflated the effect of leaf removal and blocking hyphae. Better responses clearly separated comments about the two conclusions. Not very successful responses gave opinions without the support of data.

Overall, candidates could extract supporting evidence from the data but were less likely to provide non supporting evidence. Some focused only on a criticism of the validity of the scientists' data limiting themselves to Level 1.

Exemplar 3

				<p>SUPPORT: There is a much larger increase in volume of pheromones produced after 72 hours when mesh bag allowed hyaline communication. 98 are increase compared to 34 an increase of 50% (more than double). suggests hyaline are responsible for some form of pheromone signalling. Higher amounts of PEO produced when stems removed compared to when stems remain. supports your theory stems leads to a chemical digests.</p> <p>AGAINST: correlation by causation. No statistical tests done. Hypothesis may not be 'myristic acid hyaline' could be another factor causing observed degree response. Removing whole stems is not representative of an insect attack. Mean PEO acting increases even when no stems removed and also slightly increases when hyaline cannot be used as communication.</p> <p>WEAKNESS: Sample size too small. Control variables and methodology unknown. Scientists share too large standard deviation from apr error and only 24g so not precise. 72 hours not long enough. Repeats needed. Graphs should be drawn.</p>	
			<b>Total</b>	<b>11</b>	The exemplar shows a clear Level 3 response with sections titled by the candidate to help them structure their response.
2		<p>involuntary  <b>AND</b> does not use, the cerebrum / somatic nervous system <b>or</b> coordinated by the medulla (oblongata) /AW <b>or</b> does not use , decision-making /AW ✓</p> <p>reflex / fast (response)  <b>AND</b> involves, (only) three (named) neurones / few neurones <b>or</b> coordinated by , brainstem / medulla (oblongata) ✓</p>		<p>2  (AO3.1)  (AO3.2)</p>	<p><b>ALLOW</b> autonomic  <b>IGNORE</b> automatic / unconscious</p> <p>e.g. 'involves the medulla (oblongata)'  e.g. 'does not require conscious thought / happens without thinking about it'</p> <p><b>IGNORE</b> 'involves minimal number of neurones'  <b>ALLOW</b> '(only) involves, two / few, synapses'  <b>ALLOW</b> 'passes through , brainstem / medulla'  <b>IGNORE</b> 'spinal / cranial'</p> <p>'it is involuntary and fast because it involves the medulla (oblongata)' = 2 marks</p> <p><b><u>Examiner's Comments</u></b></p> <p>This was intended to be a challenging question. Many candidates understood that the response was involuntary or a reflex but found it difficult to explain why. Some seemed to have little knowledge on neural pathways and reflexes in general, believing that this was not a reflex as it involved the brain, or that it was an automatic response. Higher scoring candidates could identify it as an involuntary reflex response and linked this to being controlled by the medulla oblongata or only involving a few neurones.</p>
			<b>Total</b>	<b>2</b>	

3			B ✓	1 (AO2.7)	
			<b>Total</b>	<b>1</b>	
4	a	i	<p>placed vertically so that , roots grow downwards / shoots grow upwards ✓</p> <p>in dark so that light does not affect , results / growth <b>OR</b> in dark to prevent phototropism ✓</p>	2 (AO2.7)	<p><b>DO NOT ALLOW</b> tropism / trophic <b>ALLOW</b> roots are positively geotropic / shoots are negatively geotropic <b>ALLOW</b> gravitropic for geotropic <b>ALLOW</b> roots grow towards gravity / shoots grow away from gravity</p> <p><b>ALLOW</b> absence of light / darkness , is a control variable</p> <p><b>Examiner's Comments</b></p> <p>Good responses showed good knowledge of phototropism and geotropism in formulating their response. Some candidates did not refer to keeping the seeds either vertically or in the dark and should be advised that if there are two conditions in a question, they should be clear which they are discussing in their responses. Most candidates were able to relate the requirement to keeping the dish in the dark to avoid phototropism, but fewer were able to explain the need for the vertical dish. In some instances where candidates came close to the mark, they had recognised that it was related to geotropism but did not relate this to the action of the root or shoot.</p> <p> <b>Misconception</b></p> <p>A common misconception included the idea that placing the dish vertically would stop the effects of geotropism. Candidates should be aware that geotropism is still occurring but and the placement of the dish allows growth of shoots and roots in different directions to help measurement.</p>
		ii	<p>act as a control ✓</p> <p>determine , results / growth , without , auxin / IAA ✓</p> <p>compare , results / growth , with and without, auxin / IAA ✓</p>	max 2 (AO3.4)	<p><b>DO NOT ALLOW</b> control variable</p> <p><b>ALLOW</b> e.g. shows growth without auxin</p> <p><b>ALLOW</b> percentage , increase / decrease for % change</p>

		<p>allow calculation of percentage , change / stimulation / inhibition ✓</p>		<p><b><u>Examiner's Comments</u></b></p> <p>Most candidates were able to identify this as a 'control experiment' but few gained an additional mark. Some candidates incorrectly used the term control 'variable' and should be advised of the difference between a 'control experiment' and a 'control variable'.</p> <p> <b>Assessment for learning</b></p> <p>It is important to make a clear comparison between what is happening in the control experiment to the outcome of the experiment and then also consider how the data might be analysed and processed. This emphasises the important of practical based activities throughout the course that address such ideas.</p>
b		<p><b>FIRST CHECK THE ANSWER ON ANSWER LINE</b>  <b>if answer = 19 (%) award 2 marks</b></p> <p>change in length = <math>16.5 - 13.9 = 2.6</math> ✓</p> <p>percentage change = <math>[2.6 \div 13.9] \times 100</math> <b>OR</b> <math>[16.5 - 13.9] \div 13.9 \times 100</math> <b>OR</b> 18.7 ✓</p> <p>19 (%) to 2 sig. figs. ✓</p>	<p>2 (AO2.8)</p>	<p>If answer incorrect check for MP1 or MP2</p> <p><b>max 1 mark</b> if answer not to 2 sig. figs. e.g. 18.7 / 19.0 / 18.71 / 18.705.....</p> <p><b><u>Examiner's Comments</u></b></p> <p>Candidates who were able to calculate percentage change achieved full marks for this question. A common error was to divide the difference in lengths by the final length resulting in the incorrect answer of 16%. Some candidates performed the correct calculation but lost 1 mark for not giving their response to the 2 significant figures stated in the question. Candidates should be reminded that the instruction to show their working is to help them gain marks in the event of an incorrect final response and should be encouraged to show the full steps that they have carried out.</p> <p> <b>OCR support</b></p> <p><a href="#">Maths for Biology resources</a> include a range of support on all mathematical skills required for A level Biology.  The <a href="#">maths skills handbook</a> also includes</p>

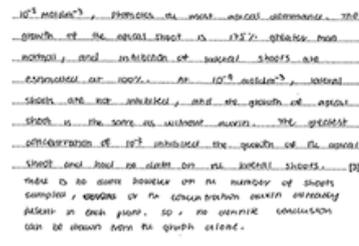
				<p>guidance on all the areas of mathematics that candidates need to have.</p> <p> <b>Assessment for learning</b></p> <p>Candidates should be reminded that the instruction to show their working is to help them gain marks in the event of an incorrect final response and should be encouraged to show the full steps that they have carried out.</p>																													
c	i	<p><b>MP1</b> = correct axis labels and appropriate correct scale <b>and</b> plotted points should occupy at least 50% ✓</p> <p><b>MP2</b> 16 plots mostly correct for <b>both</b> roots and shoots ✓</p> <p><b>MP3</b> appropriate lines for roots and shoots ✓</p> <p><b>MP4</b> appropriate key for root and shoot lines correctly labelled ✓</p>	<p>4 (AO2.8)</p>	<p>Should be a line graph Bar chart max 2 for <b>MP1</b> and <b>MP4</b> if correct</p> <p><b>MP1 ALLOW</b> x axis in middle or at bottom / y axis in middle or left-aligned <b>MP1</b> x axis = concentration of IAA (ppm) and y axis = % change in length <b>MP1 DO NOT ALLOW</b> incorrect scale on x axis...decreasing size i.e. <math>10^2</math> to <math>10^{-5}</math></p> <table border="1"> <thead> <tr> <th rowspan="2">Concentration of IAA (ppm)</th> <th colspan="2">% change in length</th> </tr> <tr> <th>Root</th> <th>Shoot</th> </tr> </thead> <tbody> <tr> <td><math>1 \times 10^2</math></td> <td>-100</td> <td>0</td> </tr> <tr> <td><math>1 \times 10^1</math></td> <td>-100</td> <td>+200</td> </tr> <tr> <td><math>1 \times 10^0</math></td> <td>-75</td> <td>+140</td> </tr> <tr> <td><math>1 \times 10^{-1}</math></td> <td>-45</td> <td>+70</td> </tr> <tr> <td><math>1 \times 10^{-2}</math></td> <td>+25</td> <td>+30</td> </tr> <tr> <td><math>1 \times 10^{-3}</math></td> <td>+65</td> <td>+10</td> </tr> <tr> <td><math>1 \times 10^{-4}</math></td> <td>+70</td> <td>0</td> </tr> <tr> <td><math>1 \times 10^{-5}</math></td> <td>+55</td> <td>0</td> </tr> </tbody> </table> <p><b>MP2</b> look at overall shapes for guidance <b>No MP2</b> if any plots missing</p> <p><b>MP3 DO NOT ALLOW</b> double lines, lines missing the plot points by more than 1 square or extrapolation</p> <p><b>ECF MP3</b> if plots wrong or missing e.g. if only root data plotted allow a correct line</p> <p><b><u>Examiner's Comments</u></b></p>	Concentration of IAA (ppm)	% change in length		Root	Shoot	$1 \times 10^2$	-100	0	$1 \times 10^1$	-100	+200	$1 \times 10^0$	-75	+140	$1 \times 10^{-1}$	-45	+70	$1 \times 10^{-2}$	+25	+30	$1 \times 10^{-3}$	+65	+10	$1 \times 10^{-4}$	+70	0	$1 \times 10^{-5}$	+55	0
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				<p>Good responses gave dependent and independent variables on correct axes with appropriate scales and went on to plot data for both roots and shoots, which were clearly identified by a key. However, some candidates reversed the independent and dependent variable axes, others forgot to add units or chose difficult scales that made it hard for them to plot. Some candidates did not complete appropriate lines or extrapolated lines. A common error was plotting the <math>1 \times 10^2</math> zero value for the shoot but not including it in the line drawn.</p> <p> <b>Assessment for learning</b></p> <p>Plotting graphs is an invaluable skill included in this specification. Practice identifying dependent and independent variables for datasets and plotting a graph using appropriate scales is a recommended activity.</p> <p> <b>OCR support</b></p> <p><a href="#">Maths skills handbook</a> can be used to support candidates preparing for assessment.</p>
	ii	<p>keep , (some) stock / undiluted , solution to use for , <math>100 / 10^2</math>, ppm ✓</p> <p>use serial dilution ✓</p> <p><math>1\text{cm}^3</math> of , stock / <math>100\text{ppm} / 10^2</math>, solution and add <math>9\text{cm}^3</math> of (distilled) water (to get <math>10\text{ppm}</math>) ✓</p> <p>repeat this procedure with each previously diluted solution ✓</p>	max 2 (AO3.3)	<p><b>MUST</b> be clear statement not implied</p> <p><b>ALLOW</b> other stated volumes to give 1 in 10</p> <p><b>ALLOW</b> annotated drawing for MPs 3 and 4</p> <p><b><u>Examiner's Comments</u></b></p> <p>This question was generally well answered. Most candidates included the correct term 'serial dilution' in their response. A common error was to state the use of equal volumes of distilled water and solution, rather than using the figures provided in the question to give a 9 :1 (water : solution) ratio.</p>
	iii	<p>use , new / clean , syringe / pipette for , measuring volumes / each transfer ✓</p> <p>ensure (adequate) mixing at each step / AW ✓</p>	2 (AO3.3)	<p><b>Mark as continuous prose</b></p> <p><b>ALLOW</b> other suitable apparatus for measuring volume</p> <p><b>ALLOW</b> separate / different for clean / new</p> <p><b>IGNORE</b> rinsing</p> <p><b><u>Examiner's Comments</u></b></p>

				<p>Generally, only higher achieving candidates scored 2 marks for this question. It is important to make sure that practical work and the understanding of the processes carried out are discussed using correct scientific terminology.</p> <p> <b>OCR support</b></p> <p><a href="#">Practical skills handbook</a> can be used to support candidates preparing for assessment.</p>	
		iv	because each interval is a factor of 10 / AW ✓	1 (AO2.4)	<b>DO NOT ALLOW</b> e.g. change by 10 each time
			<b>Total</b>	<b>15</b>	
5		i	<p>more adenylyl cyclase ✓</p> <p>on, cell surface / plasma, membranes ✓</p> <p>more, cAMP / second messenger, produced ✓</p> <p><i>idea of</i> adrenaline has greater effect on heart cells ✓</p> <p><i>idea of</i> improved contraction of, cardiac muscle / heart ✓</p>	2 max(AO2.5)	<p><b>ALLOW</b> more, adenylyl / adenylylate, cyclase / enzyme</p> <p>e.g. increases responsiveness to, adrenaline / noradrenaline</p> <p>e.g. greater heart rate / increased contraction</p> <p><b>IGNORE</b> 'improved heart function' alone as in question stem</p> <p><b>IGNORE</b> 'heart pumps blood more efficiently'</p> <p><b><u>Examiner's Comments</u></b></p> <p>There were a range of responses for this question; and many candidates did not score any marks as they only described what adenylyl cyclase and cAMP do, rather than what happens to their levels when the genes are expressed. The most commonly scored marks were for <b>increased</b> adenylyl cyclase and <b>increased</b> cAMP, followed by improved heart contraction. Almost no examples of greater effect of adrenaline or the idea of adenylyl cyclase being found on cell surface membranes were seen. Some achieved a mark for increased heart contraction, but many just repeated 'improved heart function' or stated that it could increase or decrease contractions, which gained no marks. Very few answers mentioned adrenaline, and those that did described it as the fight or flight hormone.</p>
		ii	virus / viral vector ✓ liposome ✓	1 max(AO1.2)	<p><b>ALLOW</b> plasmid / yeast artificial chromosome / YAC</p> <p><b>IGNORE</b> 'injection' unqualified</p>

					<p><b><u>Examiner's Comments</u></b></p> <p>Generally, this question was poorly answered. Few candidates were able to identify a method of inserting the gene during gene therapy. Those that did access the mark here said that you should use a virus or plasmid, with a few mentioning liposomes. Common incorrect answers included: somatic cell nuclear transfer, somatic cell gene therapy, injection (unqualified), vector (unqualified) and genetic engineering/restriction enzymes.</p>
		iii	<p><i>idea of to share knowledge (with other scientists) ✓</i></p> <p><i>idea of to allow validation of new knowledge ✓</i></p>	1 max(AO2.1)	<p>e.g. allow others to repeat the procedure / others can compare results with their own</p> <p><b>IGNORE</b> 'peer review with other scientists' / 'to prevent bias' unqualified</p> <p>e.g. to ensure the integrity of scientific results / check if results are reproducible / to evaluate the results</p> <p><b><u>Examiner's Comments</u></b></p> <p>A large majority of candidates obtained the mark here. While a wide variety of responses were given, most candidates were able to get across the idea that publishing data was to allow other scientists to see the information, compare the results, or check the validity/reproducibility. Those candidates whose responses were given no marks suffered from lack of detail, mentioning just peer review, or describing what is included in a journal. Some wrote about the idea of sharing results with the public, not understanding that these are specialist journals.</p>
			<b>Total</b>	<b>4</b>	
6	a	i	$10^{-5}$ (mol dm <sup>-3</sup> )	1(AO2.8)	<p><b>ALLOW</b> answers in range <math>9 \times 10^{-6}</math> to <math>1 \times 10^{-5}</math> (mol dm<sup>-3</sup>)</p> <p><b><u>Examiner's Comments</u></b></p> <p>Most candidates gave the correct answer, but some did not read the x scale correctly giving incorrect standard form notations in their responses such as <math>10^{-5.2}</math>. A few candidates confused the key and put the value apical shoots were inhibited instead or gave an intermediate value.</p>

	ii	repeat measurements (for that concentration) ✓	1(AO2.7)	<p><b>IGNORE</b> 'repeat the experiment' unqualified</p> <p><b>Examiner's Comments</b></p> <p>Successful candidates appreciated the importance of using all the information given in this question and gained the mark by stating that the experiment should be repeated at <math>10^{-6}</math> mol dm<sup>-3</sup> of auxin. Less successful responses omitted reference to the required concentration of auxin, simply stating 'repeat the experiment', or referred to using a statistical test which would identify but not correct an anomaly.</p>
	iii	<p><i>Apical shoots</i></p> <p>at high(er) auxin concentrations / from <math>10^{-9}</math> ( to <math>10^{-4}</math> mol dm<sup>-3</sup>), apical growth / apical dominance is, stimulated / increased ✓</p> <p>(apical shoot growth) peaks at <math>10^{-5}</math> (mol dm<sup>-3</sup>) ✓</p> <p><i>Idea of very high concentrations of auxin inhibit apical (shoot) growth</i> ✓</p> <p><i>lateral shoots</i></p> <p>at low(er) auxin concentrations / from <math>10^{-11}</math> ( to <math>10^{-7}</math> mol dm<sup>-3</sup>), lateral (shoot) growth is, stimulated / increased ✓</p> <p>at high(er) auxin concentrations / above <math>3 \times 10^{-7}</math> (mol dm<sup>-3</sup>), lateral (shoot) growth is inhibited ✓</p>	3 max(AO3.1)	<p><b>IGNORE</b> units throughout</p> <p><b>ALLOW</b> any value within this range.</p> <p><b>IGNORE</b> 'as auxin concentration increases apical growth increases' <b>without ref</b> to 'high / higher auxin concentration' <b>or</b> correct data quote</p> <p>e.g. apical (shoot) growth is inhibited at <math>10^{-3}</math> (mol dm<sup>-3</sup>)</p> <p><b>ALLOW</b> any value within this range.</p> <p>'at high auxin concentrations, apical dominance is greatest and lateral shoot growth is inhibited' = 2 marks (mp1 and 5)</p> <p><b>Examiner's Comments</b></p> <p>Successful responses described the conclusions that could be drawn from the data clearly referring to auxin concentrations and relating these to stimulation or inhibition of apical and lateral growth. There were many good answers here, showing that graph interpretation is a highly achieved skill among many candidates. Not quoting data or making reference to high/low concentrations of auxin or if the effect on growth was affecting apical or lateral shoots were the most common errors. Where fewer than 3 marks were given, many focused on the effects of auxin on growth of either apical shoots or lateral shoots. The most successful responses embedded data from the graph in their responses to support their ideas. Those candidates who did not score any marks on this question did not understand the graph</p>

				<p>axes and often thought that <math>10^{-9}</math> mol dm<sup>-3</sup> was a higher auxin concentration than <math>10^{-6}</math> mol dm<sup>-3</sup>. A few candidates did not refer to the graph at all and gave a general description about the role of apical dominance.</p> <p>Exemplar 1</p>  <p>This exemplar clearly shows how conclusions can be drawn using data quotes from the graph to gain maximum marks. It gets the second mark point for describing how apical dominance peaks at <math>10^{-5}</math> mol dm<sup>-3</sup> and also the last marking point for saying that at the same concentration the growth of lateral shoots is inhibited. It also gets the third mark point later in the response for saying that at a concentration of <math>10^{-3}</math> apical shoot growth is inhibited.</p> <p> <b>OCR support</b></p> <p>Advice on using a logarithmic graph scale for maths skill M2.5 can be found on page 43 of the Biology mathematical skills handbook on this page:  <a href="https://www.ocr.org.uk/qualifications/as-and-a-level/biology-a-h020-h420-from-2015/planning-and-teaching/">https://www.ocr.org.uk/qualifications/as-and-a-level/biology-a-h020-h420-from-2015/planning-and-teaching/</a>  A tutorial, quiz sheet and teacher answers on the use of logarithmic scales are available here under M2.5:  <a href="https://www.ocr.org.uk/subjects/science/maths-for-biology/algebra/">https://www.ocr.org.uk/subjects/science/maths-for-biology/algebra/</a></p>
b	i	mm h <sup>-1</sup> or cm h <sup>-1</sup> or mm d <sup>-1</sup> or cm d <sup>-1</sup>	1(AO3.3)	<p><b>ALLOW</b> 'day' for 'd' 'hour' for 'h'</p> <p><b>DO NOT ALLOW</b> s / secs/ seconds /min / minutes</p> <p><b>ALLOW</b> '/' for <sup>-1</sup></p> <p><b>IGNORE</b> 'per'</p> <p><b>DO NOT ALLOW</b> use of both <sup>-1</sup> and '/'</p>

				<p>together</p> <p><b><u>Examiner's Comments</u></b></p> <p>Many candidates did not identify the units were required for <u>rate</u> of stem elongation rather than <u>length</u> of stem elongation and thus gave units appropriate for measured distances only (mm, cm, etc). A good proportion also gave incorrect answers referring to concentration (e.g. mol dm<sup>3</sup>). Of those who were suggesting a measurement for the rate of stem elongation, errors included using min or s as the unit of time (not a suitable measurement for growing plants) or combining two conventions such as using a slash and <sup>-1</sup> after the time term.</p>
	ii	<p><b><i>In summary:</i></b></p> <p><i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i></p> <p><i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, <b>Level 1, Level 2 or Level 3</b>, best describes the overall quality of the answer.</i></p> <p><i>Then, award the higher or lower mark within the level, according to the <b>Communication Statement</b> (shown in italics):</i></p> <ul style="list-style-type: none"> <li>•</li> <li>○ award the higher mark where the Communication Statement has been met.</li> <li>○ award the lower mark where aspects of the Communication Statement</li> </ul>	6(AO3.3)(AO3.4)	<p><b>Indicative scientific points may include (but are not limited to):</b></p> <p><i>AO3: To develop and refine practical design and procedures</i></p> <p><i>Experimental method</i></p> <p>Validity</p> <ul style="list-style-type: none"> <li>• Details of sample sizes and repeats</li> <li>• Details of group design (e.g. two groups: one without additional gibberellin, or several groups receiving different gibberellin concentrations, plus a control group)</li> <li>• Details of gibberellin application</li> </ul> <p>Variables</p> <ul style="list-style-type: none"> <li>• Details of control variables (e.g. plant/seedling size, water availability, light, temperature)</li> <li>• Details of the independent variable (varying gibberellin concentrations)</li> <li>• Details of the measurement of the dependent variable (measurement of stem length)</li> </ul> <p>Statistical analysis</p> <ul style="list-style-type: none"> <li>• Idea of identifying anomalies</li> <li>• Mean calculations</li> <li>• Standard deviation</li> <li>• Statistical testing (e.g. t-test if two groups are used, or Spearman's</li> </ul>

have been missed

- **The science content determines the level.**
- **The Communication Statement determines the mark within a level.**

### Level 3 (5–6 marks)

Comprehensive outline of a valid experimental method, including details of all three types of variable, **and** statistical analysis for the investigation.

*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*

### Level 2 (3–4 marks)

The answer contains detailed reference to variables **and** statistical analysis for the investigation.

*There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.*

### Level 1 (1–2 marks)

The answer contains brief reference to a variable **or** statistical analysis for the investigation.

*The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear*

### 0 marks

No response or no response worthy of credit.

rank/Pearson correlation test if a range of concentrations are used)

### Examiner's Comments

Many candidates answered this question in depth and detail, including all the required variables, validity and reference to statistical tests. Examples of concentrations of gibberellin were included together with specific and appropriate sample sizes and control variables. Most candidates could identify at least two of the variables - the independent variable and at least one control variable. Some candidates did not gain marks through lack of precision in describing how to measure the dependent variable, stem elongation, referring to 'measuring growth' or 'measure the plant' rather than measuring the length of the stem. Validity was sometimes not considered at all. If it was, there was reference to a control group with no gibberellin and a suitable sample size to allow repeats. Most candidates were able to refer to the use of a statistical test but the understanding of the purpose of these tests was often inadequate and candidates lost marks by referring to a statistical test which was not appropriate to the data that their experiment would generate. The most frequently quoted test was the *t*-test which was usually not appropriate to the candidate's experimental design, when using a range of gibberellin concentrations for example.

### Exemplar 2

*The student should use at least 30 individuals, three for each concentration, these individuals should be clones of each other. The student should then make the gibberellin concentration solutions of  $10^{-7}$ ,  $10^{-6}$ ,  $10^{-5}$ ,  $10^{-4}$ ,  $10^{-3}$ ,  $10^{-2}$ ,  $10^{-1}$ ,  $10^0$ ,  $10^1$ ,  $10^2$ ,  $10^3$ ,  $10^4$ ,  $10^5$ ,  $10^6$ ,  $10^7$  and then a control. The student should apply the measure the starting length of the stem, then apply the concentration solution, after the student should leave the plants for 72 hr, in the same place, same room, making sure that all seeds have the same light intensity and soil conditions, and measure the final lengths. They should then calculate the change in length and calculate a mean average for each concentration. A graph should be plotted of mean change in stem length against gibberellin concentration. The standard deviation of each value should be calculated and represented on the graph. This allows it to be seen easily if there is a statistical difference between the values.*

This response clearly contains detailed

				reference to variables (use of different gibberellin concentrations as the independent variable, measuring shoot length as dependent variable and using cloned plants, same light intensity and soil conditions as control variables). It has an outline of a valid experimental method (3 plants per gibberellin concentration, use of a control group) but lacks the use of a statistical test to analyse the results, i.e., use of Spearman's rank or Pearson correlation test. It does use means and standard deviation to do some statistical analysis and so meets the criteria for L2 – 4 marks.
	c	<p>ethene , promotes / AW , fruit ripening ✓</p> <p>concentration of ethene / stage of apple development , needs to be known ✓</p> <p><i>idea that</i> use of ethene to ripen fruit (normally) needs controlled conditions ✓</p> <p>ethene is a gas <b>AND</b> <i>idea that</i> it will not be effective outside ✓</p> <p>ethene promotes fruit dropping (therefore apples may fall to the ground and be damaged) ✓</p>	3 max(AO3.2)	<p><b>ALLOW</b> ethene promotes fruit maturing</p> <p><b>ALLOW</b> using too much ethene may make the apples too ripe / ethene will affect different fruits at different rates (due to varying stages of development or time of year used)</p> <p>e.g. ethene is usually applied at a particular temperature</p> <p>e.g. ethene should be applied in closed conditions</p> <p>e.g. ethene should be released gradually</p> <p>e.g. ethene gas would diffuse away in the air and not land on the fruit</p> <p><b>IGNORE</b> ' spraying a gas would be ineffective'</p> <p><b>ALLOW</b> ethene promotes (fruit) abscission</p> <p><b>IGNORE</b> leaf abscission</p> <p><b><u>Examiner's Comments</u></b></p> <p>Most candidates got at least 1 mark, knowing that ethene encouraged fruit ripening, many also knew that it also encouraged fruit drop. The most successful candidates recognised that there were 3 marks available and so extended their answers often suggesting that the concentration of ethene or the stage of maturity of the fruit needed to be known or that the fruit should be picked before being sprayed. Few candidates stated that ethene was a gas and so many were not able to gain marks for reference to its effectiveness outside.</p>
		<b>Total</b>	<b>15</b>	
7	i	cortisol / glucocorticoids, regulate carbohydrate	2 (AO2.1)	<b>ALLOW</b> helps regulate availability of glucose <b>or</b> ref to gluconeogenesis <b>or</b> glycogenolysis

		<p>metabolism ✓</p> <p>lack of, aldosterone / mineralocorticoids, cause, low blood pressure / salt craving, as regulate ion concentration ✓</p>		<p><b>IGNORE</b> aldosterone</p> <p><b>ALLOW</b> for ions either sodium ions <b>or</b> Na<sup>+</sup> <b>or</b> potassium ions <b>or</b> K<sup>+</sup></p> <p><b>DO NOT ALLOW</b> cortisol</p> <p><b><u>Examiner's Comments</u></b></p> <p>Most candidates found this question challenging. Some candidates did link cortisol to the regulation of metabolism but omitted to say that it is specifically 'carbohydrate' metabolism. Other candidates correctly attributed low blood pressure to the absence of aldosterone but did not develop their answer to link this to regulation of ion concentration, or just talked about salts rather than ions. Less successful responses confused the effects of each hormone, or attributed them both to each symptom or effect, e.g. cortisol and aldosterone are responsible for low blood pressure.</p>
	ii	<p><b>any three from:</b></p> <p>ACTH only affects (adrenal) cortex ✓</p> <p>adrenaline is produced by the (adrenal) medulla ✓</p> <p>adrenaline is responsible for, response to danger / flight or fight response ✓</p> <p>response to danger / flight or fight response, is also, mediated by / AW, (autonomic/sympathetic) nervous system ✓</p>	3 (AO2.1)	<p><b>ALLOW</b> ACTH does not affect medulla</p> <p><b>DO NOT ALLOW</b> parasympathetic</p> <p><b><u>Examiner's Comments</u></b></p> <p>This question was generally answered well, and most candidates were able to gain 1 or 2 marks. Many responses included the idea that adrenaline was produced by the adrenal medulla, and linked the fact that adrenaline was responsible for the fight or flight response. Several candidates made reference to the sympathetic nervous system but did not develop their answer to include that it is also responsible for the flight or fight response.</p>
		<b>Total</b>	<b>5</b>	

8	a	<table border="1" data-bbox="220 203 608 584"> <thead> <tr> <th></th> <th>skeletal</th> <th>cardiac</th> <th>involuntary</th> </tr> </thead> <tbody> <tr> <td>contraction speed is slow</td> <td></td> <td></td> <td>✓</td> </tr> <tr> <td>fibres are multinucleated</td> <td>✓</td> <td></td> <td>✓</td> </tr> <tr> <td>fibres are branched and interconnected</td> <td></td> <td>✓</td> <td>✓</td> </tr> <tr> <td>under conscious control</td> <td>✓</td> <td></td> <td>✓</td> </tr> </tbody> </table>		skeletal	cardiac	involuntary	contraction speed is slow			✓	fibres are multinucleated	✓		✓	fibres are branched and interconnected		✓	✓	under conscious control	✓		✓	3 (AO1.1)	<p><b>IGNORE</b> use of crosses / hybrid ticks</p> <p><b>DO NOT ALLOW</b> more than 1 tick per row</p> <p><b>Examiner's Comments</b></p> <p>Many candidates identified the correct options for the rows in the table and correctly entered ticks rather than a combination of ticks and crosses in their tables. Some responses did not gain marks as more than one tick per row had been entered. Most candidates knew that skeletal muscle was under conscious control, but several thought that cardiac fibres were multinucleate and that skeletal fibres were branched and interconnected.</p>
	skeletal	cardiac	involuntary																					
contraction speed is slow			✓																					
fibres are multinucleated	✓		✓																					
fibres are branched and interconnected		✓	✓																					
under conscious control	✓		✓																					
	b	i	3 (AO1.1)	<p><b>Mark first three answers even if on same line</b></p> <p><b>ALLOW</b> correct proteins in any order</p> <p><b>Examiner's Comments</b></p> <p>Most candidates gained at least one mark for including 'actin' as one of the proteins in the filament labelled <b>Z</b> on <b>Fig. 19.1</b>. Many also incorrectly included 'myosin'. Other incorrect answers given included a range of key terms related to muscles or proteins, e.g., sarcoplasm, collagen, keratin and myofibril.</p>																				
		ii	2 (AO2.7)	<p><b>ALLOW</b> dark <b>or</b> A band for X</p> <p><b>IGNORE</b> actin</p> <p><b>ALLOW</b> light <b>or</b> I band for band Y</p> <p><b>IGNORE</b> ref to H zone <b>or</b> M line <b>or</b> Z line</p> <p><b>Examiner's Comments</b></p> <p>This question was answered well by the majority of candidates, although some candidates confused myosin with actin. less successful responses just stated that the difference was due to them having different proteins but didn't develop the response any further.</p>																				
		iii	max 3 (AO2.7) (AO3.2)	<p><b>ALLOW</b> band Y (as labelled on diagram)</p> <p><b>ALLOW</b> band X (as labelled on diagram)</p> <p><b>ALLOW</b> Z lines closer together</p> <p><b>Examiner's Comments</b></p>																				

		<p>H zone becomes smaller ✓</p> <p>there is greater overlap between actin and myosin (filaments) ✓</p>		<p>Candidates who linked their responses to evidence that could be seen in the micrographs usually scored well, with correct reference made to the H- zone, I band and A band. However, many candidates simply described the sliding filament mode of muscle contraction in great detail with very little or no reference to the image provided in <b>Fig. 19.2</b>.</p>
c		<p><b>Any two from:</b></p> <p>ATP, is required to, break cross-bridges / detach myosin from actin ✓</p> <p>actin and myosin (filaments) remain cross-linked / AW ✓</p> <p>prevents relaxation of muscle / muscle stays contracted ✓</p>	<p>2 (AO2.5)</p>	<p><b>ALLOW</b> e.g. ATP is needed to break the links between myosin and actin so they remain attached = 2 marks</p> <p><b><u>Examiner's Comments</u></b></p> <p>Good responses described how ATP was required for breaking the cross-bridges between the actin and myosin, so the myosin could not detach if ATP was lacking, and the muscle would stay contracted. However, several candidates stated that ATP was required to move the myosin head back to its original position or that it was required to form the cross-bridges, and so the muscle would not contract. Some candidates only described ATP as the energy currency of a cell, and so a lack of ATP would prevent muscle contraction as there is less energy available.</p> <p> <b>Misconception</b></p> <p>The role of ATP in muscle contraction is commonly misunderstood with many candidates thinking that it is needed to attach myosin heads to the actin-binding site.</p>
d		<p><b><i>In summary:</i></b> <i>Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)</i></p> <p><i>Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors, <b>Level 1, Level 2 or Level 3</b>, best describes the overall quality of the answer.</i></p>	<p>6 (AO1.2) (AO2.5)</p>	<p><b>Indicative points include</b></p> <p><i>Sources of ATP</i></p> <ul style="list-style-type: none"> <li>• Free ATP in muscle cells / sarcoplasm</li> <li>• ATP formed from creatine phosphate or phosphocreatine</li> <li>• runs out in a few seconds / quickly</li> </ul> <p><i>Aerobic respiration stated</i></p> <ul style="list-style-type: none"> <li>• occurs if oxygen available</li> <li>• oxidative phosphorylation</li> <li>• greater yield of ATP</li> </ul>

	<p><i>Then, award the higher or lower mark within the level, according to the <b>Communication Statement</b> (shown in italics):</i></p> <p><i>award the higher mark where the</i></p> <ul style="list-style-type: none"> <li>○ <i>Communication Statement has been met.</i></li> </ul> <p><i>award the lower mark where aspects of the</i></p> <ul style="list-style-type: none"> <li>○ <i>Communication Statement have been missed.</i></li> </ul> <ul style="list-style-type: none"> <li>• <b>The science content determines the level.</b></li> <li>• <b>The Communication Statement determines the mark within a level.</b></li> </ul> <p><b>Level 3 (5–6 marks)</b></p> <p>A description of source of ATP during strenuous exercise <b>AND</b> detail of both aerobic <b>AND</b> anaerobic respiration</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p><b>Level 2 (3–4 marks)</b></p> <p>A description of source of ATP during strenuous exercise <b>AND either</b> detail of aerobic <b>OR</b> anaerobic respiration. <b>OR</b> A description that includes detail of aerobic <b>AND</b> anaerobic respiration</p> <p><i>There is a line of reasoning presented with some</i></p>		<ul style="list-style-type: none"> <li>• delivery of O<sub>2</sub> to tissues does not meet demand</li> <li>• O<sub>2</sub> is limited during strenuous exercise</li> </ul> <p><i>Anaerobic respiration stated</i></p> <ul style="list-style-type: none"> <li>• needed during strenuous exercise</li> <li>• anaerobic only involves glycolysis</li> <li>• ATP formed by substrate level phosphorylation</li> <li>• net yield of 2 ATP / smaller yield of ATP</li> <li>• NAD regenerated so glycolysis can continue</li> <li>• cannot continue indefinitely due to lactic acid build-up</li> </ul> <p><b><u>Examiner's Comments</u></b></p> <p>Many candidates gave good descriptions of aerobic, anaerobic respiration and the formation of ATP using creatine phosphate, briefly describing and comparing the main points of each ATP source as required by this LoR style question. However, several candidates frequently included a lot of unnecessary detail about aerobic respiration and wrote at length describing the biochemical details, which would be time-consuming. As with Question 17*, many candidates used extra pages to provide their response. Some candidates left out reference to aerobic respiration completely, possibly due to the reference to strenuous exercise in the question and went straight to discussing the role of anaerobic respiration and sometimes creatine phosphate.</p>
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		<p><i>structure. The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 1 (1–2 marks)</b></p> <p>A description of a source of ATP for muscle contraction <b>OR</b> detail of aerobic <b>OR</b> anaerobic respiration.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p><b>0 marks</b></p> <p><i>No response or no response worthy of credit.</i></p>		
		<b>Total</b>	<b>19</b>	
9		<b>D</b>	1 (AO2.6)	<p><b><u>Examiner's Comments</u></b></p> <p>This question is an example of a statement-style multiple-choice question. Candidates needed to use the information in the diagram of an electromyogram (EMG) and their knowledge to process information in the three statements about muscle fatigue. Many candidates understood that lactic acid in muscles would cause fatigue and identified statement 1 as being correct. Those who were then able to apply their knowledge of the specification to the EMG deduced that frequency does not change and amplitude decreases, thereby realising that statements 2 and 3 were incorrect giving option D as the only correct response.</p>
		<b>Total</b>	<b>1</b>	