Mark scheme - Plant Responses

Question			Answer/Indicative content	Marks	Guidance
1			A ✓	1	
			Total	**1**	
2			D ✓	1	
			Total	**1**	
3			B ✓	1 (AO1.1)	**Examiner's Comments** Many candidates completed the gap fill here to aid their decision-making. It appeared, therefore, that the majority had come down to a final choice between options B and D. Candidates then needed to apply their knowledge of the involvement of auxin in phototropic responses to this new situation regarding the original scientific ideas about how it works. Option B is correct because if light shining on the upper side of the shoot '*destroyed*' auxin then there would be more auxin on the underside so it would bend towards the light, which does. If auxin was originally thought to be '*synthesised*' by light the stems would bend downwards because auxin would be accumulating in the upper surface i.e. upper surface cells would elongate. So option D cannot be the correct option.
			Total	**1**	
4			D ✓	**1**	**Examiner's Comments** The correct response, option **D**, was relatively straightforward but some candidates appeared challenged by the use of species' names within the text. A number of candidates put the number '1' in the answer box rather than the letter, **D**.
			Total	**1**	
5			B ✓	1 (AO2.5)	
			Total	**1**	

6			B ✓ **ALLOW** A	1 (AO2.5)	**Examiner's Comments** Knowledge of the functions of plant hormones caused problems for some candidates throughout this paper. Candidates that were aware of the effects of auxin and ethene in controlling leaf drop correctly gave option B as their response. While not a recognised role of gibberellins it is reported that there is some evidence of involvement in leaf senescence, it was therefore decided to also credit candidates who chose option A.
			Total	**1**	
7			example of chemical defence ✓ example of physical defence ✓	1 max (AO1.1)	e.g. (production of) pheromones / poisons / toxic compounds / named examples (phenols, tannins, alkaloids, Bt toxin) e.g. folding in response to touch / thorns / spines
			Total	**1**	
8			*idea that* minimum period of darkness required for flowering is between 6.5 and 8.5 hours (1) *idea that* cockleburs flower when day length / period of exposure to light decreases (1) *idea that* red light prevents flowering (1) *idea that* far red light reverses / resets the effect of red light (1) *idea that* far red light reduces the period of darkness required for flowering (1)	3	**ALLOW** red light has no effect on flowering
			Total	**3**	
9			Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The	**6**	

			indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. **The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met. **The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. **In summary:** • **The science content determines the level.** • **The communication statement determines the**		**Indicative scientific points may include…** *Supporting firm's claim (F):* • As the volume of Diatin increases the mass of seedless fruit (harvested) increases *Against firm's claim (A):* • no, scale / units / numerical value, on graph axes • labels of graph axes are the wrong way round • no, error bars / standard deviation / mean / (named) statistical test • should be percentage increase in mass • correlation is not evidence of causation • risk of bias / lack of objectivity (as company is selling product based on claims) • Zeatin is more productive (than Diatin) *Issues with validity (V):* • no method given • species / type of plant is not named

			mark within a level. **Level 3 (5–6 marks)** A statement in support of the claim **AND** a statement against the claim **AND** more than one comment on the validity of the claim **OR** A statement in support of the claim **AND** more than one statement against the claim **AND** a comment on the validity of the claim *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)** A statement in support of the claim **AND** a statement against the claim **AND** a comment on the validity of the claim **OR** A statement in support of the claim **AND** more than one statement against the claim **OR** A statement in support of the claim **AND** more than one comment on the validity of the claim **OR** A statement against the claim **AND** more than one comment on the validity of the claim *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.*		• no control variables given • concentration of hormone not specified • temperature control not specified • carbon dioxide concentration not specified • location not specified (e.g. could be outside vs greenhouse) • mineral availability / soil type, not specified • water availability not specified • light intensity not specified • presence of pollinators not specified • presence of, pests / weeds / pesticide / herbicide, not specified • no control group (to compare results) • no evidence of repeats • no consideration of the interaction with other hormones or processes **Examiner's Comments** Some candidates gave an excellent evaluation of the firm's claim, discussing bias and validity in great detail. A few candidates failed to achieve any marks despite offering an extended response. Such responses tended to discuss the merits of Diatin over Zeatin or Kinetin without criticising the rigour of the investigation. Some candidates, usually those gaining a Level 3 response, noticed that the axes were reversed in the question, with the independent variable on the y axis instead of the x axis. Candidates should be reminded to look critically at data and query points such as a lack of numerical data being presented and the potential lack of objectivity by the company. Candidates were better able to discuss issues with the validity of the experiment. Many spotted that no species or type of plant had been named and that no control variables were given. Some were also able to state that the concentration of the hormones had not been given. It is recommended that centres encourage candidates to practise responding to this style of questioning which draws on extended writing in a practical context.

			Level 1 (1–2 marks) A statement in support of the claim **AND** a statement against the claim **OR** A statement in support of the claim **and** a comment on the validity of the claim **OR** A statement against the claim **and** a comment on the validity of the claim **OR** More than one statement against the claim **OR** More than one comment on the validity of the claim *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.		
			Total	**6**	
10	a	i	***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall*	6 (AO2.3) (AO2.4) (AO3.1)	**Indicative scientific points may include (but are not limited to):** *AO2.3 and 2.4 Apply knowledge and understanding of scientific ideas and techniques in a practical context when handling qualitative and quantitative data.* *Descriptions:* Table 3.1: • light increases length and mass of both roots and stems • group A has less growth than group B Table 3.2: • stems grow towards the light (with a few exceptions)

			quality of the answer. Then, award the higher or lower mark within the level, according to the Communication Statement (shown in italics): ○ *award the higher mark where the Communication Statement has been met.* ○ *award the lower mark where aspects of the **Communication Statement** have been missed.* • *The science content determines the level.* • *The Communication Statement determines the mark within a level.* **Level 3 (5-6 marks)** Detailed description **and** linked explanation of results for **both** tables. *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)** Describes results for **both** tables with some explanation of at least **one** table. *There is a line of reasoning with some structure. The information presented is*		• (almost) half the roots grow away from light • some appear unaffected by light or grow towards light *AO3.1 Analyse scientific information to make judgements and reach conclusions* *Explanations:* Table 3.1: • more carbohydrates produced during photosynthesis • light may trigger growth and germination (through phytochromes) Table 3.2: • details of phototropism (e.g. auxins produced in shoot tip moves to side away from light / auxins cause more cell elongation on side away from light) • light allows photosynthesis • positive phototropism in stems • geotropism more important than phototropism in roots • (some) negative phototropism in roots • other reasons for varied data, e.g. conditions not natural / measurement error / shading of stems / stems heavier than roots so tips

			relevant and supported by some evidence. **Level 1 (1-2 marks)** Offers some description for both tables **or** describes and explains one table. *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.		
		ii	(unpaired) t-test ✓	1 (AO2.8)	**ALLOW** unrelated t-test **DO NOT ALLOW** paired/related, t-test
		iii	*idea of* comparing two means ✓	1 (AO3.3)	
		iv	8.10 is greater than 5.99 (at 2 degrees of freedom) ✓ (therefore) significant (difference) at (p =) 0.05 ✓ not significant at (p =)0.01 ✓ (indicates greater than 95% probability that) difference is not due to chance ✓ null hypothesis can be rejected (at p = 0.05) ✓	3 max (AO3.2)	**ALLOW ECF for mp2 ,4 and 5 if 9.49 or 11.07 value used from table for max 2 marks** **ALLOW** 'students chi-squared value greater than critical value for 2 degrees of freedom' **ALLOW** 'there is a significant difference between the observed and expected results' **ALLOW** 'less than 5% probability that difference is due to chance'
	b	i	auxin(s) / IAA ✓	1 (AO1.1)	**ALLOW** cytokinins
		ii	(soil/water) pH / species of plant / age of plant / size of	1 (AO3.3)	**IGNORE** carbon dioxide concentration / wind movement / humidity **ALLOW** pre-treatment of seeds

			plant / soil type / water availability ✓		
	c		amyloplasts are, dense / heavy ✓ binding of amyloplasts with ER releases Ca^{2+} /AW ✓ *idea that* Ca^{2+} stimulates growth (factors) ✓ the root grows to the side of the, amyloplasts / Ca^{2+} release ✓	2 max (AO3.2)	**ALLOW** amyloplasts fall in direction of gravity e.g. 'contact of amyloplasts with ER releases Ca^{2+}' **ALLOW** 'Ca^{2+} causes growth' **ALLOW** 'elongation' instead of 'growth' **Examiner's Comments** Most candidates suggested the t-test for **(a)(ii)** but far fewer could justify the choice of test for **(a)(iii)** (omitting the idea of comparing means). Candidates were good at using the tabulated data in **(a)(iv)** and linking this to the rejection of a null hypothesis. However, a significant number of candidates could not work out the correct number of degrees of freedom to use in the table. Surprisingly, few candidates were able to suggest the correct formulae of the ions for **(b)**. In **(d)**, most candidates correctly used the information in the diagrams of Fig 3.2 to help them answer the question, gaining full marks. **OCR support** Support with maths calculations and statistics can be found in the Mathematical skills handbook: https:/www.ocr.org.uk/Images/294471-biology-mathematical-skills-handbook.pdf As well as the Mathematical skills statistics booklet: https:/www.ocr.org.uk/Images/338621-mathematical-skills-statistics-booklet.doc And the Maths for biology section on the OCR website:

					https:/www.ocr.org.uk/subjects/science/maths-for-biology/index.aspx?id=biology-a-h020-h420-from-2015
			Total	**15**	
11			***Please refer to the marking instruction point 10 for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the lower mark where aspects of the Communication Statement have been missed.* • ***The science content***		

			determines the level. • ***The Communication Statement determines the mark within a level.***		
			Level 3 (5–6 marks) Includes detailed explanations for most of the observations, with clear links to the correct hormone treatment and including relevant biochemical details where appropriate. *There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.* **Level 2 (3–4 marks)** Includes explanations for some of the observations, with some links to the correct hormone treatment and / or including relevant biochemical details. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1–2 marks)** A limited number of observations included in the response, without clear links to the correct	6	**Indicative scientific points may include:** *shorter roots* high auxin concentrations / auxin in addition to the natural production inhibits root growth *taller* gibberellins promote stem elongation by stimulating cell elongation and division *growth timing* gibberellins promote seed germination by activating genes for amylase and protease enzymes, which break down food stores. *side branches* auxin maintains apical dominance and inhibits the growth of lateral shoots / branches. *delayed fruit and leaf fall* (a small addition of) auxin slows down fruit drop and leaf fall. Auxin inhibits abscission by preventing ethene production from increasing.

			hormone treatment and / or including only limited biochemical detail. *There is a logical structure to the answer. The explanation and use of scientific language, though basic, is clear.* **0 marks** No response or no response worthy of credit.		
			Total	**6**	
12			ethene (1)	1	
			Total	**1**	
13		i	(stimulates) cell, elongation / division	1	**IGNORE** ref to action outside the cell, or to unqualified "growth" etc.
		ii	*three from* **1** reduced / no, proton pumping / proton motive force / chemiosmosis (1) **2** photophosphorylation stops (1) **3** less / no, ATP produced (1) **4** less / no, reduced NADP produced (1) **5** no, Calvin cycle / carbon fixation / light independent stage (1) *plus* **6** no, TP / (hexose) sugars, made (1) **7** no respiratory substrate / respiration ceases (1)	5	**3** **ALLOW** cessation of vital process that needs ATP **IF** ATP mentioned but **IGNORE** respiration (as credited in mp 7).
			Total	**6**	
14			results suggest action of plant, hormone / growth factor ✓ (observations suggest) apical dominance ✓ (which is mediated by) IAA / auxin ✓	3 max	i.e. student statement refers only to effect on bonsai

<table>
<tr><td></td><td></td><td></td><td>idea that all plants / not just bonsai, will show apical dominance / will be affected by IAA / auxin ✓</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>3</td><td></td></tr>
<tr><td>15</td><td>a</td><td></td><td>1. (gibberellin is) a chemical messenger ✓
2. produced in one part of plant but has effects in another part / AW✓
3. affects activity / AW , of target , cells / tissues ✓
4. long-lasting / acts over long period of time ✓
5. wide-spread effect ✓</td><td>3 max
(AO1.2)(AO2.1)</td><td>IGNORE functions of gibberellin
ALLOW cell-signalling molecule

e.g. causes activity of target cells to be altered
e.g. causes response in target cells

<u>Examiner's Comments</u>

Good responses recognised the need to explain why gibberellin is classed as a hormone to achieve maximum marks. However, many candidates misunderstood the question and offered descriptions about how hormones work when they reach target cells or described the role of gibberellin in plants.</td></tr>
<tr><td></td><td>b</td><td>i</td><td>x (horizontal) axis labelled volume of gibberellin applied (x10^{-3} cm^3 kg^{-1} day^{-1})
AND
<i>y</i> (vertical) axis labelled <b>rate of internodal length increase (mm day^{-1}) ✓

linear scale on both axes
AND
at least 50% of area covered ✓</td><td>4 (AO3.2)</td><td>
<table>
<tr><th>Volume of gibberellin applied (10^{-3} cm^3 kg^{-1} day^{-1})</th><th>Rate of increase of internodal length (mm day^{-1})</th></tr>
<tr><td>0.0</td><td>1</td></tr>
<tr><td>0.2</td><td>1</td></tr>
<tr><td>0.4</td><td>2</td></tr>
<tr><td>0.6</td><td>4</td></tr>
<tr><td>0.9</td><td>22</td></tr>
<tr><td>1.2</td><td>47</td></tr>
<tr><td>1.4</td><td>48</td></tr>
<tr><td>1.8</td><td>49</td></tr>
<tr><td>1.9</td><td>50</td></tr>
<tr><td>2.0</td><td>50</td></tr>
</table>

IGNORE extrapolations

Units must be given for both axes
ALLOW solidus i.e. / for brackets ()
NOTE () or / should be seen at least once</td></tr>
</table>

			line graph **AND** points plotted accurately to ±1 small square ✓ suitable curved line of best fit drawn ✓		**NOTE** non-linear x axis data **ALLOW** one error in plotting **ALLOW ECF** if non-linear scale used **DO NOT ALLOW** ruled lines between points **Examiner's Comments** Candidates who had acquired skills in practical techniques with regards to presenting data often achieved all four marks here. However, there is still uncertainty among some candidates of how to draw a line of best fit or which variables to assign to the *x* and *y* axes. **OCR support** The mathematical Skills Handbook provides support on plotting graphs: https:/www.ocr.org.uk/Images/294471-biology-mathematical-skills-handbook.pdf
		ii	Any **one** from seed germination flowering in long-day plants cellular , transcription / translation prevents leaf abscission aids stomatal opening promotes fruit development promotes , activity of amylase / hydrolysis of starch ✓	1 max (AO1.2)	**Examiner's Comments** Many candidates gained credit here. Seed germination was the most commonly seen correct response.
			Total	**8**	
16				**6 max**	*Mark limitation, explanation and improvement as continuous prose within each numbered prompt.* *If marks come from more than one letter within either numbered prompt, award that which gives the highest mark* **IGNORE** reference to any other variables

			related to light (L) **L1** light intensity / brightness, is not, controlled / specified **OR** size of hole in box not specified ✓ **L2** different, light intensities / brightness, could lead to variation in, phototropism / bending ✓ **L3** *idea that* light intensity / brightness, stays the same ✓ ***related to selection of seedlings (S)*** **S1** no method for, selecting / AW, (20) seedlings ✓ **S2** could lead to biased results ✓ **S3** *idea of* random selection ✓ ***related to measuring bend of seedlings (B)*** **B1** degree of bending (of seedlings) not considered ✓ **B2** *idea of* a (reproducible) comparison is not possible		**ALLOW** wavelength / colour instead of intensity throughout (***L)*** *For L3 if statement not used other examples may include* e.g. use of, light meter / photo sensor e.g. use lamps of same bulb wattage e.g. use same distance from lamp e.g. use same, wavelength / coloured bulb *For S1* **IGNORE** only 20 seedlings selected *For S3* **ALLOW** count, all / more / 50, seedlings **ALLOW** reasonable method of selection e.g. photograph and allocate numbers e.g. mini grid then select random numbers *For B1* **ALLOW** bending judgement**,** not quantitative / is subjective *For B3* **ALLOW** descriptions of method e.g. use of protractor e.g. use a, standard / model (for comparison)

			OR could lead to biased results ✓ **B3** measure angle of bend ✓ ***related to replicates (R)*** **R1** experiment / trial, was not repeated ✓ **R2** cannot, calculate mean / identify anomalies / carry out statistical analysis ✓ **R3** repeat (experiment at least) twice **OR** carry out (at least) three trials ✓ ***related to size of dish (D)*** **D1** size of petri dish not, controlled / specified ✓ **D2** different sized dishes could affect, spacing of seeds / access to light ✓ **D3** specify, size / volume / diameter, of petri dish ✓		*For R2* **IGNORE** reference to, fair test / accuracy / reliability *For D3* **ALLOW** use the same sized dish **Examiner's Comments** **Q21(b)** proved challenging and candidates seemed to have had little preparation in analysing and redesigning experiments. The majority of marks awarded pertained to the control of light and selection of seedlings. Very few achieved maximum marks and Examiners commented on the fact that some candidates gave responses that included aspects of the experiment that had already been taken into account in the method provided.
			Total	**6**	