

Questions

Q1.

Doctors sometimes prescribe beta-blockers for their patients.

Beta-blockers are a type of drug with antihypertensive properties.

Beta-blockers work by blocking the effects of a hormone called adrenaline.

Adrenaline is produced by the adrenal glands located on top of each kidney.

Adrenaline acts on the heart to cause changes in heart rate.

Deduce how adrenaline can cause a change in heart rate.

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(Total for question = 4 marks)

Q2.

The effect of being shown a cheeseburger on saliva production in a child was studied.

When the child was shown the cheeseburger, information would have been sent from the eye to the brain.

Describe the role of sodium ions in the functioning of a mammalian rod cell.

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(Total for question = 3 marks)

Q3.

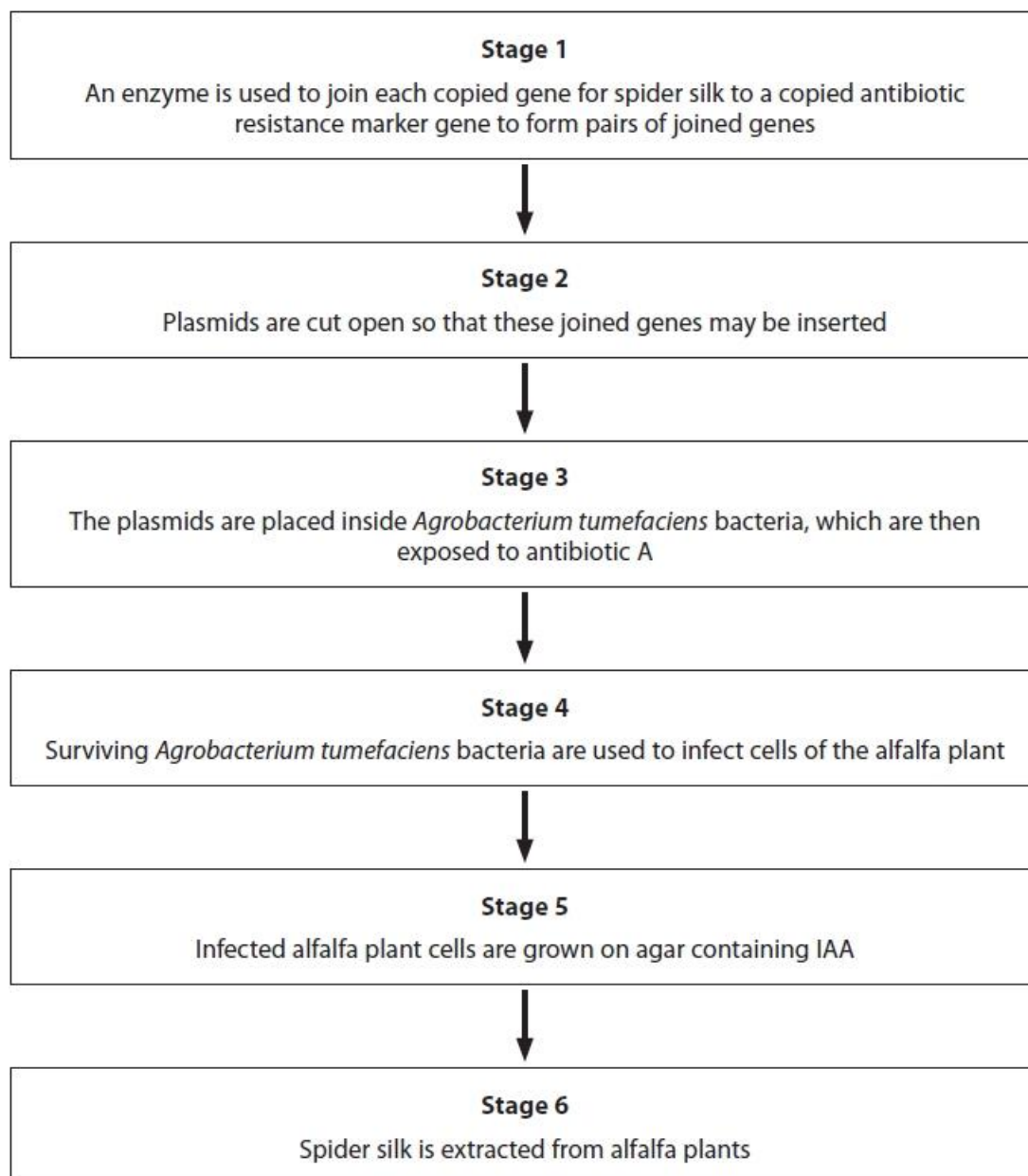
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Spider silk is a very strong and flexible natural fibre. It is of interest to humans as a possible fibre for protective clothing.

Scientists have genetically modified a range of organisms to produce spider silk, including goats and plants such as alfalfa.

A gene for spider silk is copied. A gene for resistance to antibiotic A is also copied.

The flow diagram shows some of the stages in genetically modifying alfalfa plants to produce spider silk using the copied genes.



(i) Explain how an enzyme is involved in joining the two different genes together in stage 1.

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(ii) Which one of the following enzymes can be used to cut open the plasmids in stage 2?

(1)

- A DNA polymerase
- B RNA ligase
- C RNA polymerase
- D restriction endonuclease

(iii) Explain why antibiotic A is used in stage 3.

(2)

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(iv) Give reasons why the infected alfalfa plant cells are grown on agar containing IAA in stage 5.

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(v) The table shows the mass of spider silk produced from the genetically modified alfalfa in stage 6. It also shows the mass of spider silk produced from the genetically modified goats.

Organism	Mass of spider silk produced per year
Alfalfa	218 kg per acre
Goat	10 kg per goat

A typical number of goats that can be kept on one acre of land is 12.
 Calculate the percentage increase in spider silk produced by the alfalfa plants compared with the goats.

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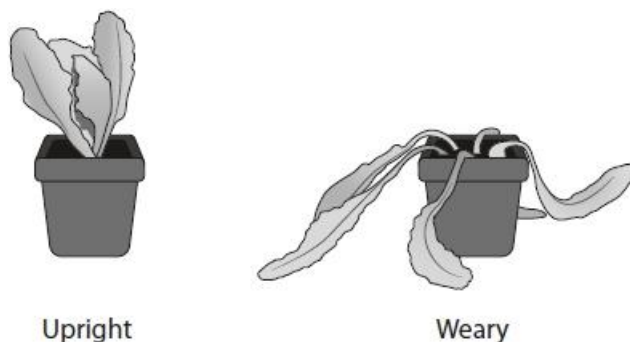
(Total for question = 11 marks)

Q4.

Lettuce plants usually grow upright. This is the 'upright' phenotype.

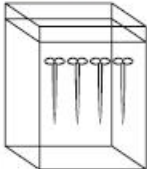
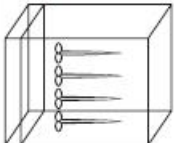
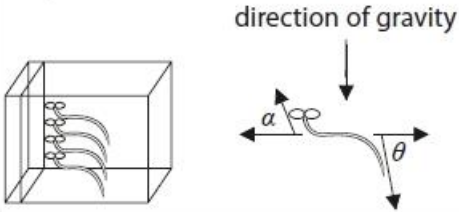
In one variety of lettuce the stem of the lettuce grows along the ground. This is the 'weary' phenotype.

These two phenotypes are shown in the diagram.



The effect of gravity on the growth of lettuce plants with either upright or weary phenotype was investigated.

The diagram shows the stages in this investigation.

<p>Stage A</p> 	<p>Lettuce plants were grown until their stems were 15 cm long.</p>
<p>Stage B</p> 	<p>The lettuce plants were then placed in complete darkness and rotated so that they were at 90° to the direction of gravity.</p>
<p>Stage C</p> 	<p>The curvatures of the stems (α) and roots (θ) were measured for the next 23 days.</p>

(i) Explain why the plants were placed in a box in complete darkness.

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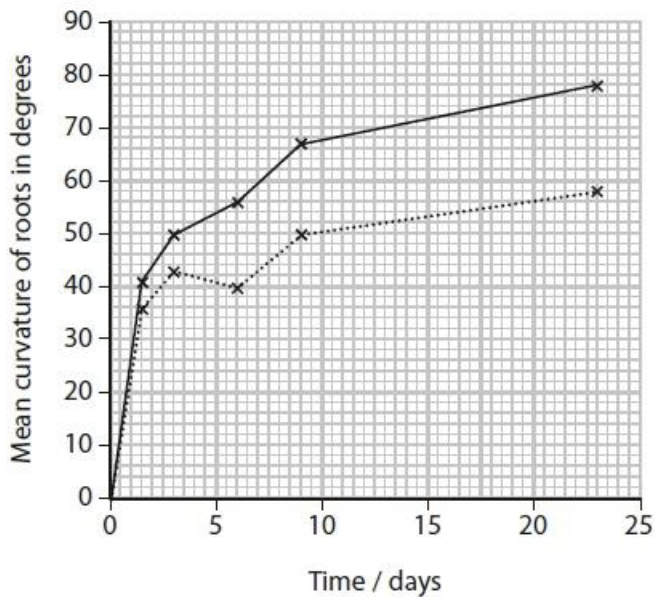
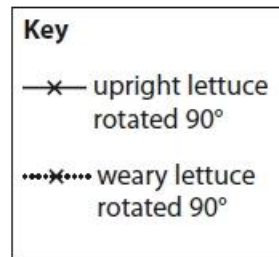
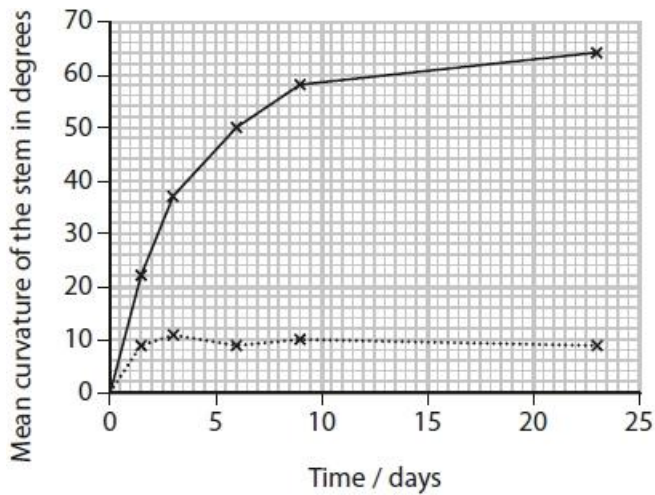
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(ii) The mean curvatures of the stems and the roots are shown in the graphs.



Calculate the difference in the mean rate of curvature of the stems and roots of the weary lettuce plants over 23 days.

(2)

Answer

(iii) Explain why the stems of weary lettuce do not respond to gravity.

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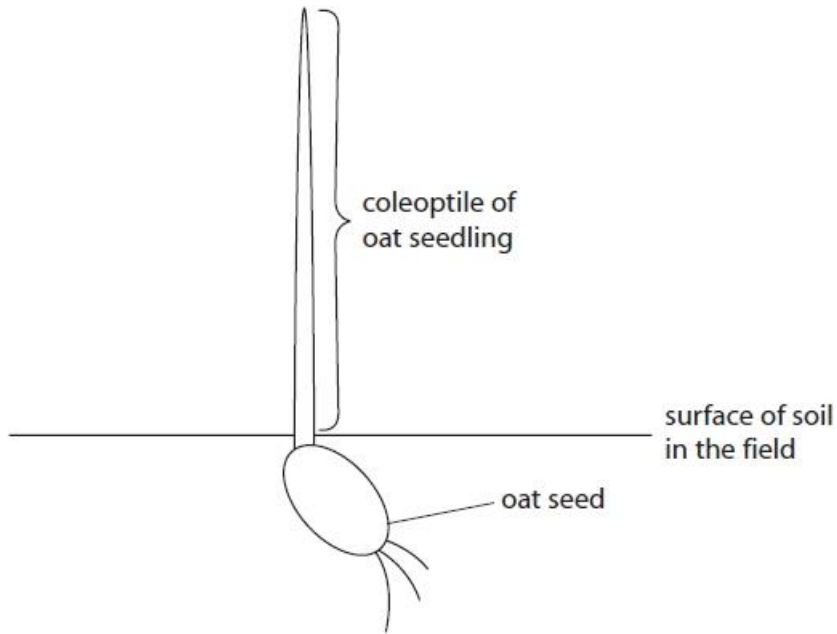
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(Total for question = 7 marks)

Q5.

Phytochromes and IAA (indole acetic acid) are important substances that bring about growth responses in plants.

The diagram shows an oat seedling in part of a field.



Cells in the tip of the oat coleoptile release IAA.

Explain how the IAA affects the growth of the coleoptile.

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(Total for question = 4 marks)

Q6.

Answer the questions with a cross in the boxes you think are correct . If you change your mind about an answer, put a line through the box and then mark your new answer with a cross .

Phytochromes and IAA (indole acetic acid) are important substances that bring about growth responses in plants.

Phytochrome is found in two different forms known as P_R (or P_{660}) and P_{FR} (or P_{730}).

(i) Which row correctly describes the effects of sunlight on phytochrome?

(1)

	Change in form of phytochrome	Speed of change
<input type="checkbox"/> A	P_{FR} to P_R	slow
<input checked="" type="checkbox"/> B	P_{FR} to P_R	rapid
<input type="checkbox"/> C	P_R to P_{FR}	slow
<input type="checkbox"/> D	P_R to P_{FR}	rapid

(ii) Phytochrome can be described as

(1)

- A a form of opsin
 B a photosensitive pigment
 C an isomer of retinal
 D a type of cytochrome

(iii) Give one example of a growth response of a plant that is affected by phytochrome.

(1)

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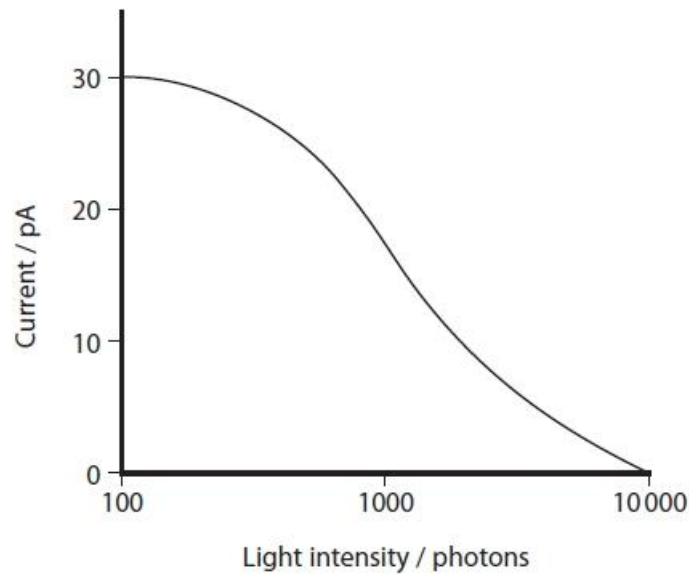
(Total for question = 3 marks)

Q7.

The retina of the human eye contains rod cells.
These cells detect light energy as photons.
The light energy is converted to a nerve impulse that is interpreted by the brain.

A current is produced by a rod cell when ions move through the cell surface membrane of a rod cell.

The graph shows the effect of increasing light intensity on the current produced by a rod cell.



Explain the effect of increasing light intensity on the current produced by a rod cell.

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(Total for question = 5 marks)

Q8.

Plants can respond to and use light.

The photograph shows a seedling starting to grow from a germinating seed.



Describe the role of IAA (auxin) in the phototropic response of plants.

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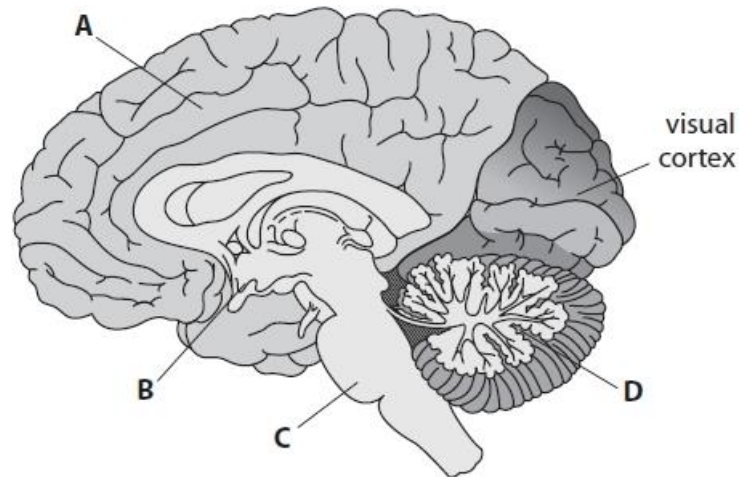
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(Total for question = 4 marks)

Q9.

Visual development requires exposure of the visual cortex to environmental signals during a critical period.

The diagram shows parts of the brain, including the visual cortex.



The visual cortex processes information received from the retina.

(i) The non-protein part of the light-absorbing pigment in the rod cells of the retina is called

(1)

- A IAA
- B opsin
- C retinal
- D rhodopsin

(ii) The part of the brain involved in interpreting the information processed in the visual cortex is

(1)

- A
- B
- C
- D

(iii) Explain how fMRI can be used to identify the part of the brain involved in interpreting information from the visual cortex.

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(Total for question = 5 marks)

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
	<p>An answer that makes reference to four of the following:</p> <ul style="list-style-type: none"> • adrenaline carried in the blood (1) • (acts on the) sinoatrial node (1) • increasing the frequency of impulses (produced by the SAN / that spread across the heart) (1) • increasing the rate at which the heart contracts 	<p>ALLOW increases the frequency of {action potentials / depolarisations} in the SAN</p> <p>ALLOW atria / ventricles</p> <p>ALLOW increasing heart rate</p>	(4)

Q2.

Question Number	Answer	Additional Guidance	Mark
	<p>A description that makes reference to three of the following:</p> <ul style="list-style-type: none"> • sodium ions are pumped out of the { rod cell / inner segment } (1) • (in the light / when stimulated) sodium ions do not move back into rod cell (1) • (in the dark / when not stimulated) sodium ions can move back into the { rod cell / outer segment } (1) • (in the light / when sodium ions do not move back in) the rod cell is hyperpolarised / (in the dark / when sodium ions can move back in) the rod cell is depolarised (1) 		(3)

Q3.

Question Number	Answer	Additional guidance	Mark
(i)	<p>An explanation that makes reference to three of the following:</p> <ul style="list-style-type: none"> • (DNA) ligase (joins the two genes) (1) • by joining phosphate to sugar / forming phosphodiester bonds (1) • by condensation reactions (1) • description of role of active site of enzyme (1) 		(3)

Question Number	Answer	Mark
(ii)	<p>The only correct answer is D restriction endonuclease</p> <p>A is not correct because DNA polymerase catalyses the formation of new DNA strands</p> <p>B is not correct because RNA ligase joins sections of RNA</p> <p>C is not correct because RNA polymerase catalyses the formation of pre-mRNA</p>	(1)

Question Number	Answer	Additional guidance	Mark
(iii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • so that only bacteria with the antibiotic resistance gene survive (1) • therefore, these bacteria will also have the gene for spider silk (1) 		(2)

Question Number	Answer	Additional guidance	Mark
(iv)	<p>An answer that makes reference to two of the following:</p> <ul style="list-style-type: none"> • IAA to cause cell elongation (1) • detail of how IAA affects plant cells (1) • to grow plants that produce spider silk (1) 	<p>ALLOW alters pH of cell wall / makes cellulose cellwall more plastic / effect on transcription</p> <p>ALLOW stimulates roots to grow</p>	(2)

Question Number	Answer	Additional guidance	Mark
(v)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> • mass per acre per year for goats (1) • correct calculation of difference in mass of spider silk produced (1) • correct percentage increase (1) 	<p>Example of calculation</p> $10 \times 12 = 120 \text{ (kg per acre per year)}$ $218 - 120 = 98 \text{ (kg per acre per year)}$ $81.66 / 81.7 / 82 \text{ (\%)}$ <p>Correct answer with no working gains fullmarks</p>	(3)

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • plants respond to light / plants show phototropic responses (1) • (therefore) light must be excluded in order to study the effects of gravity (1) • (putting plants in the dark) therefore prevents light having an effect (1) 	<p>ALLOW plant shoots grow towards light</p> <p>ALLOW 'geotropism' for 'effects of gravity'</p> <p>ALLOW to control light</p>	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> • correct values selected from the graphs (1) • correct calculation of mean rate of curvature with units (1) 	<p><u>Example of calculation</u></p> <p>58 and 9</p> $49 \div 23 = 2.1 \text{ \{degrees per day / } ^\circ \text{ day}^{-1} \}$ <p>ALLOW 2.13 degrees per day</p> <p>Correct answer without working gains full marks</p> <p>Correct value without units gains 1 mark</p>	(2)

Question Number	Answer	Additional guidance	Mark
(iii)	<p>An answer the makes reference to two of the following:</p> <ul style="list-style-type: none"> do not have allele conferring ability to respond to gravity / only have alleles that confer a lack of response to gravity (1) (so) do not produce {IAA / auxin} (1) (therefore) lack of stimulation of cell elongation on side of stem facing downwards (1) 	<p>ALLOW cells present in the stem fail to detect gravity</p> <p>ALLOW there is no auxin present</p>	(2)

Q5.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to four of the following:</p> <ul style="list-style-type: none"> IAA diffuses from the tip of the coleoptile (1) (therefore) can be taken up by cells in zone of elongation (1) which causes cells to elongate (1) details of action in zone of elongation (1) (therefore) causes the coleoptile to { grow towards the light / increase in height } (1) 	<p>e.g. leads to lowering of the pH in the cellulose cell wall</p> <p>ALLOW: positive phototropism IGNORE: bend for growth</p>	(4)

Q6.

Question Number	Answer	Mark
(i)	<p>The only correct answer is D – phytochrome change is P_R to P_{FR} and speed of change is rapid</p> <p>A is incorrect because phytochrome does not change from P_{FR} to P_R in light and the process is rapid</p> <p>B is incorrect because phytochrome does not change from P_{FR} to P_R in light</p> <p>C is incorrect because the conversion is not slow</p>	(1)

Question Number	Answer	Mark
(ii)	<p>The only correct answer is B – a photosensitive pigment</p> <p>A is incorrect because phytochrome is not a form of opsin</p> <p>C is incorrect because phytochrome is not an isomer of retinal</p> <p>D is incorrect because not a type of cytochrome</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An answer that makes reference to one of the following:</p> <ul style="list-style-type: none"> (seed) germination / flowering (1) 	ALLOW chlorophyll synthesis / leaf development / stops growth e.g. falling leaves	(1)

Q7.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> increasing light intensity decreases the current (1) because {rhodopsin is broken down / opsin is released} (1) therefore, more opsin binds to the channel proteins in the outer segment (1) sodium-gated voltage channels close (1) {reducing / stopping} the influx of sodium ions / making membrane impermeable to sodium ions (1) 	<p>ALLOW opsin binds to the cell surface membrane / sodium-gated voltage channels</p> <p>ALLOW Na⁺ channels / (non-specific) cation channels for sodium-gated voltage channels</p>	(5)

Q8.

Question number	Answer	Additional guidance	Mark
	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> (IAA) produced in the tip of the shoot (1) (IAA) accumulates on the dark side of the shoot (1) (IAA) stimulates cell elongation (1) causing the shoot to grow towards the light source (1) 	<p>ALLOW a diffusion gradient is established / IAA diffuses to the opposite side of the shoot</p> <p>ALLOW low concentrations of IAA inhibit cell elongation on the light side</p> <p>ALLOW plant</p> <p>ALLOW bend</p>	<p>Choose an item.</p> <p>(4)</p>

Q9.

Question Number	Answer	Mark
(i)	<p>C - retinal</p> <p><i>The only correct answer is C</i></p> <p>A is incorrect because IAA is auxin</p> <p>B is incorrect because opsin is the protein part and not the non-protein</p> <p>D is incorrect because rhodopsin is the pigment</p>	(1)

Question Number	Answer	Mark
(ii)	<p>A</p> <p><i>The only correct answer is A</i></p> <p>B is incorrect because it is the hypothalamus</p> <p>C is incorrect because it is the medulla oblongata</p> <p>D is incorrect because it is the cerebellum</p>	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	<p>An explanation that makes reference to the following:</p> <ul style="list-style-type: none"> • (fMRI) detects { blood flow / oxygen use } in the brain • increased brain activity results in increased { blood flow / demand for oxygen / aerobic respiration } in the area of activity • oxyhaemoglobin absorbs fewer radio waves / fMRI detects areas where less signal absorbed 	ALLOW signal reflected by oxyhaemoglobin	(3)