Questions

Q1.

Auxins and cytokinins are plant growth regulators that control apical dominance and cell elongation.

Explain how auxins and cytokinins control the growth of lateral buds.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

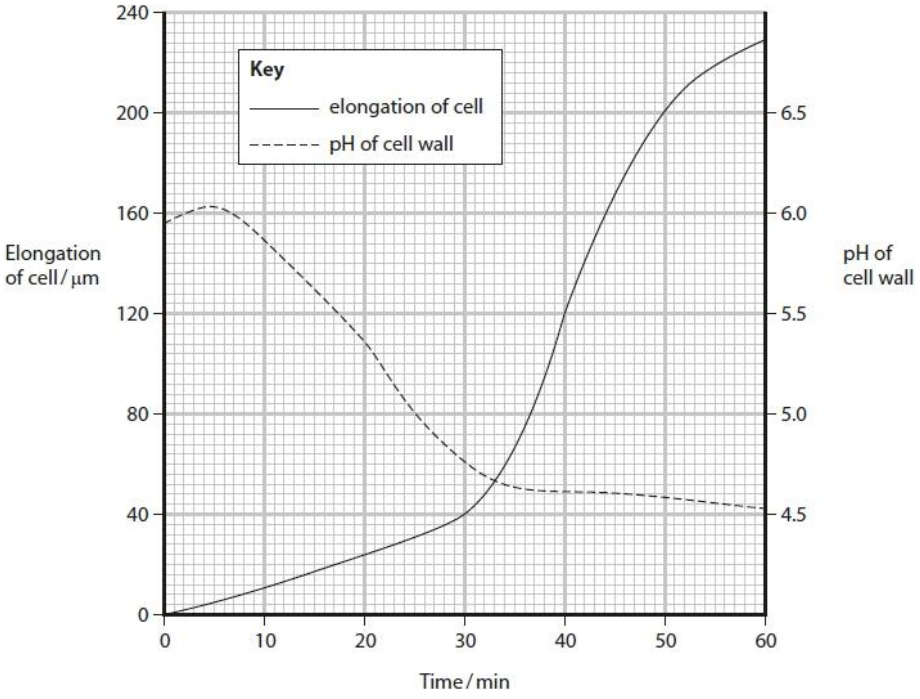
.....

(Total for question = 3 marks)

Q2.

Auxins and cytokinins are plant growth regulators that control apical dominance and cell elongation.
When auxin enters a cell, it causes hydrogen ions to be pumped out of the cell into the cell wall.
The effect of auxin on the pH of the cell wall and cell elongation was investigated. Auxin was added to plant cells. The pH of the cell wall and cell elongation were measured over a period of 60 minutes.

The results are shown in the graph.



(i) Calculate the maximum rate of elongation of the cell.

(2)

Answer .....

(ii) Expansin is a protein located in cell walls.

Expansin disrupts hydrogen bonds and ionic bonds of molecules in the cell wall.
Deduce a mechanism by which auxin and expansin cause cells to elongate.

(3)

.....

.....

.....

.....

.....

(Total for question = 5 marks)

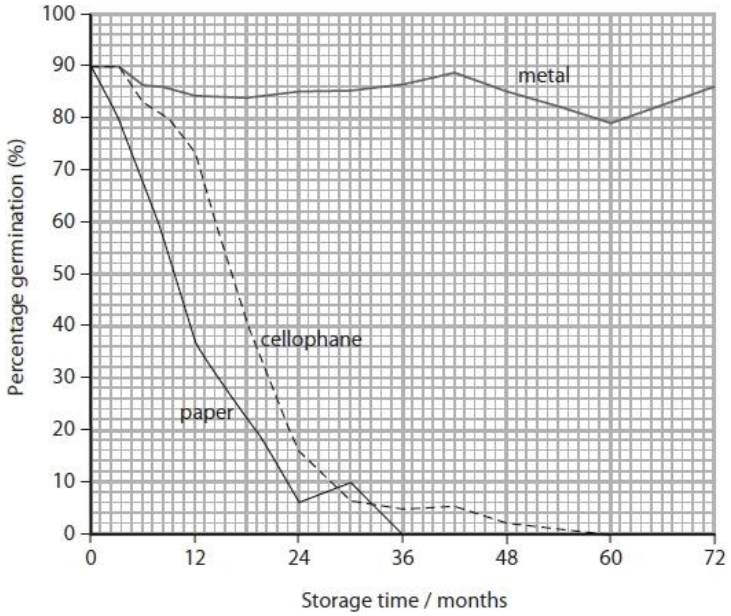
Q3.

Seed banks store seeds for future use. Seeds can be stored for a long time if the seeds are kept dry with a moisture content of less than 8%.

The seeds are stored in closed containers. The percentage germination of the seeds is measured to test their viability during storage.

At the Millennium Seed Bank, the seeds are stored in closed glass containers at 15% relative humidity at a temperature of –20°C.

The graph shows the percentage germination of seeds kept in three different closed containers: metal, cellophane and paper. They were kept for 72 months at a temperature of –20°C.



(a) Analyse the data to explain why seeds are stored in glass containers in the Millennium Seed Bank.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Each time the seeds are tested for viability, 50 seeds are used.

State why 50 seeds are used.

(1)

.....

.....

(c) Calculate the rate of change in viability of the seeds stored in a cellophane container for the first two years.

(2)

Answer .....

(d) Seeds from other parts of the world are stored in seed banks.

(i) Explain how the viability test would be different for these seeds from other parts of the world.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(ii) Explain why plants grown from these germinating seeds may not flower at the same time of year as they would have done in their country of origin.

(2)

.....

.....

.....

.....

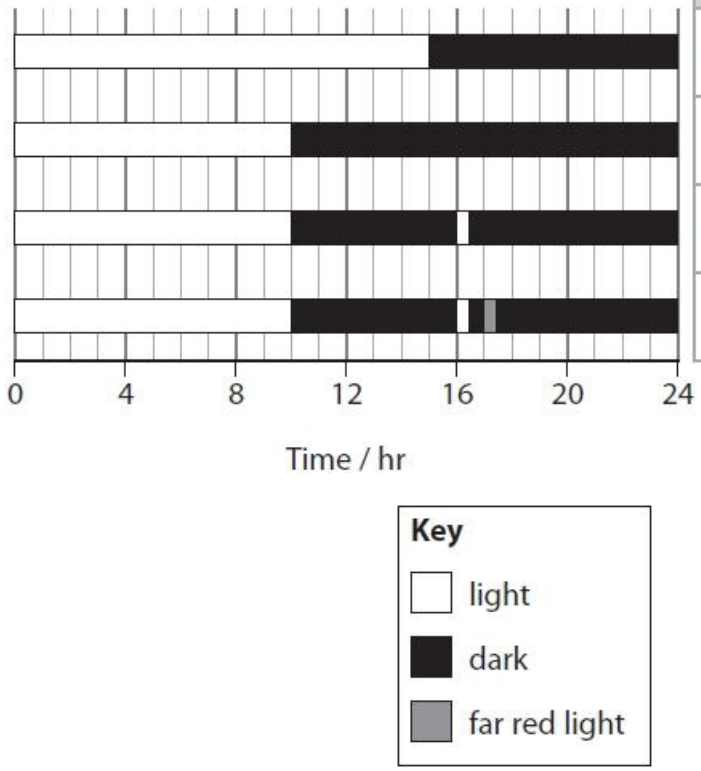
(Total for question = 12 marks)

Q4.

* The effect of day length on flowering in two species of plants, *Kalanchoe* and *Sedum*, was investigated.

The effect of different periods of light and darkness and the effects of exposure to far red light were investigated.

The diagram shows the results of this investigation.

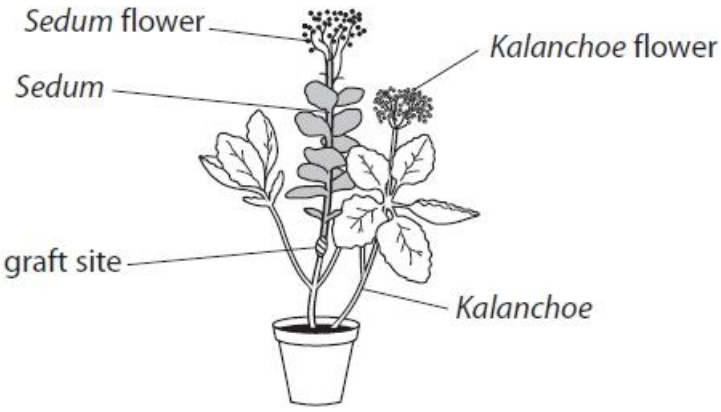


Kalanchoe	*Sedum*
no flowers	flowers
flowers	no flowers
no flowers	flowers
flowers	no flowers

In another investigation, a piece of *Sedum* was grafted onto the stem of a *Kalanchoe* plant.

This plant and graft were exposed to 10 hours of light followed by 14 hours of darkness.

The *Kalanchoe* and the *Sedum* graft both produced flowers, as shown in the diagram.



Analyse the data to explain the effects of different light periods and far red light on flowering in *Kalanchoe* and *Sedum*.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q5.

Chemical control in plants involves plant growth substances.

Which of the following effects are caused by auxin?

(1)

1 cell elongation
2 suppression of lateral bud growth
3 photomorphogenesis

- ☒ **A** 1 and 2
- ☒ **B** 1 and 3
- ☒ **C** 2 and 3
- ☒ **D** 1, 2 and 3

(Total for question = 1 mark)

Q6.

Gibberellin stimulates cells in the aleurone layer of cereal grains, such as barley, to produce the enzyme amylase.

Global warming may cause sea levels to rise and salty seawater to flood land used for growing crops.

A student read that salt (NaCl) inhibits gibberellin synthesis.

This could affect amylase production in cereal grains.

Devise an investigation to show the effect of salt concentration on amylase production in cereal grains.

(5)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q7.

Plant growth substances and phytochromes are chemicals that affect the growth of plants.

Phytochrome is involved in the germination of seeds.

The effect of red (R) light and far-red (FR) light on the germination of lettuce seeds was investigated.

A scientist exposed five groups of 50 seeds to red light for one minute.

The seeds were planted and the mean number that germinated was calculated.

Another five groups each of 50 seeds were then exposed to red light for one minute, followed by far-red light for four minutes.

These seeds were planted and the mean number that germinated was calculated.

The experiment was repeated with different combinations of red light and far-red light.

The results are shown in the table.

Sequence of red (R) and far-red (FR) light	Mean number of seeds that germinated	Standard deviation (SD)
R	45	±4
R, FR	5	±2
R, FR, R	45	±5
R, FR, R, FR	10	±4
R, FR, R, FR, R	40	±9

Analyse the data to comment on the effect of red (R) and far-red (FR) light on the germination of lettuce seeds.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 4 marks)

Q8.

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 ☒.

Plant growth substances and phytochromes are chemicals that affect the growth of plants.

(i) Which row of the table shows the concentrations required for the fastest growth of lateral buds?

		Auxin concentration	Cytokinin concentration
☒	**A**	high	high
☒	**B**	high	low
☒	**C**	low	high
☒	**D**	low	low

(ii) Some types of auxin affect the activity of cells in the same way as hormones such as oestrogen affect human cells.

These auxins pass through the cell membrane and affect the synthesis of enzymes.

Explain how these auxins affect the synthesis of enzymes.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 3 marks)

Q9.

Chemical control in plants is brought about by plant growth substances such as auxins.

Auxins cause elongation of cells.

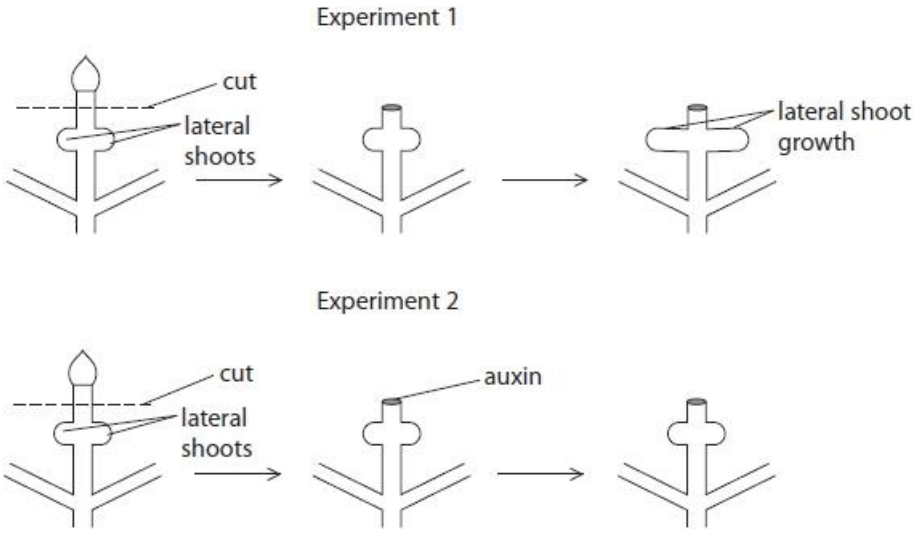
Auxins weaken the bonds between molecules found in cell walls. Molecules found in cell walls include cellulose and hemicellulose.

A scientist investigated apical dominance in plants.

In experiment 1, the shoot tips were cut off and the growth of lateral shoots assessed.

This was repeated in experiment 2, but auxin was placed over the cut end of the tips and the growth of lateral shoots was assessed.

The results are shown in the diagrams.



Explain how the interaction between auxins and cytokinins could have produced the results shown in the diagram.

(3)

.....

.....

.....

.....

.....

.....

.....

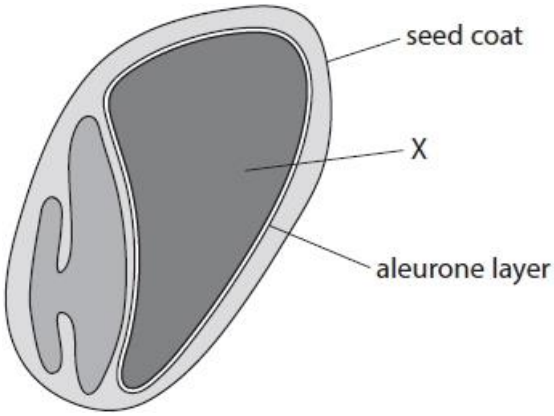
.....

(Total for question = 3 marks)

Q10.

Gibberellin stimulates cells in the aleurone layer of cereal grains, such as barley, to produce the enzyme amylase.

The diagram shows the location of the aleurone layer in a barley grain.



The part labelled X contains triploid cells.

Name the part labelled X.

(1)

.....

(Total for question = 1 mark)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three from: • auxin is released from the terminal bud (1) • and (diffuses down the stem) to inhibit cytokinin action / inhibit lateral shoot growth (1) • cytokinin stimulates lateral shoot growth (1) • and is produced from base of shoot (1)	Allow one mark for antagonistic effectif no MP1 or MP3?	3

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	• correct calculation of increase of elongation from graph from tangent (1) • increase in elongation divided by timetaken (1)	ecf for mp2 **Allow** answer between 9.5 and 12.8 μm min^{-1} one mark for correct answer with no units a correct answer gains full credit	2
(ii)	An answer that makes reference to three from: • as pH falls / at lower pH, elongation increases (1) • because expansin is activated by lower pH (1) • weakening (intermolecular) bonds between cellulose molecules / calcium pectate / hemicelluloses (1) • cell takes in water causing it to expand (1)	**Allow** converse for increase in pH forall MPs **Allow** low pH / hydrogen ions changeshape of expansin so it can weakencell walls	3

Q3.

Question Number	Answer	Additional Guidance	Mark
(a)	An explanation that makes reference to four of the following: • {seed viability / germination} high in metal containers (1) • glass containers have similar properties to metal containers (1) • because {metal / glass} containers keep {air / moisture} out (1) • therefore seed water content is kept below 8% (1) • can see through glass without removing lid (1)	**Accept** converse for paper / cellophane	(4)

Question Number	Answer	Additional Guidance	Mark
(b)	• to produce valid (measure of seed viability / results / data)	**Accept** allows identification of anomalous result **Do not accept** if in list	(1)

Question Number	Answer	Additional Guidance	Mark
(c)	• difference calculated • how many times better calculated with units	Example of calculation: 90 – 16 = 74 74 ÷ 2 = 37 % year^{-1} or 74 ÷ 24 = 3.08 % month^{-1} / 3.1 % month^{-1} / 3 % month^{-1}	(2)

Question Number	Answer	Additional Guidance	Mark
(d)(i)	An explanation that makes reference to the following: • {viability test / germination} requires similar conditions as the country (1) • because germination is affected by {temperature / pH / light intensity / wavelength / humidity / vernalisation} (1) • if correct conditions not used seeds would not germinate even if viable (1)	**Accept** other relevant abiotic factor	(3)

Question Number	Answer	Additional Guidance	Mark
(d)(ii)	An explanation that makes reference to the following: • because flowering is affected by {day length / photoperiod / light and dark period} (1) • because flowering involves {phytochrome / P_R / P_{FR}} (1)	**Accept** florigen	(2)

Q4.

Question Number	Indicative content
*	Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content Level 1 Descriptions (D) • Sedum flowers with long period of light / short period of dark • Kalanchoe flowers with short period of light / long period of dark • Kalanchoe is a short day plant / Sedum is a long day plant • light during dark period means Sedum flowers / Kalanchoe does not flower • light then far red during dark period means Sedum does not flower / Kalanchoe flowers Level 2 Phytochrome (P) • phytochrome converted between P_R and P_{FR} • light converts P_R to P_{FR} • dark converts P_{FR} to P_R • far red converts P_{FR} to P_R • far red converts P_{FR} to P_R rapidly • short light exposure during dark period converts P_R to P_{FR} • Sedum needs (high) P_{FR} / (low) P_R to flower / Kalanchoe needs (high) P_R / (low) P_{FR} to flower Level 3 Explanation (E) • experiment 2 Kalanchoe should flower • experiment 2 Sedum should not flower but does because Kalanchoe produces florigen / growth factor / diffusible substance / FT mRNA • florigen / growth factor is transported between the two plants • florigen / growth factor activates genes • florigen / growth factor triggers flowering in both plants

Level	Marks	
0	0	No awardable content
1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. **D only or P only**
2	3-4	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure. **2 D and 1 P or 1 E**
3	5-6	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **2 D, 2 P and 1E**

Q5.

Question Number	Answer	Mark
(i)	The only correct answer is A 1 and 2 *B is incorrect because photomorphogenesis is incorrect* *C is incorrect because photomorphogenesis is incorrect* *D is incorrect because photomorphogenesis is incorrect*	1

Q6.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to five of the following: • (soak grains in) range of at least five salt concentrations (1) • use {surface sterilised seeds / sterile agar / sterile Petri dishes} (1) • {wash / cut} grains and place onto starch agar (1) • leave for 24-48 hours (1) • add iodine (solution) (1) • measure {diameter/area} of clear zone (1)	Accept wash grains with bleach Accept leave {washed / cut} seed in starchy solution If alternative method used (grain in starch solution), accept use a colorimeter to measure absorbance	(5)

Q7.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to four of the following points: • **more** seeds germinate when last colour is red (1) • number of exposures to light makes no difference (1) • significant difference when last colours are different as standard deviations do not overlap (1) • red light converts P_R into P_{FR} / far red light converts P_{FR} into P_R (1) • {P_{FR} stimulates/ P_R inhibits} {germination / gibberellin release / activation of amylase / abscisic acid}	**Allow** converse for FR light **Accept** no significant difference when last colours are same as standard deviations overlap (1) **Accept** P725 or P730 for P_{FR} / P665 or P660 for P_R **Accept** high P_{FR} : low P_R ratio stimulates germination	**4 exp**

Q8.

Question Number	Answer	Additional Guidance	Mark
(i)	The only correct answer is: **C** low auxin, high cytokinin *A is incorrect as high auxin inhibits lateral shoots* *B is incorrect as high auxin inhibits lateral shoots* *D is incorrect as low cytokinin inhibits lateral shoots*		**1 comp**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following points: • auxin binds with {receptor / transcription factor} (inside cell / in cytoplasm / in nucleus) (1) • transcription factor becomes active / is activated (1) • transcription factor binds to {DNA / promoter} (1) • switches on / causes {transcription / production of RNA} (1)	**Accept** forms auxin-receptor complex **Accept** forms hormone-receptor complex **Do not accept** if receptor on cell membrane **Accept** transcription factor changes shape **Accept** auxin-receptor complex becomes a transcription factor **Accept** auxin-receptor complex binds to DNA / promoter (1)	**3 exp**

Q9.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • {removing tip / removing meristem / absence of auxin} results in lateral shoot growth (1) • because auxin inhibits lateral shoot growth (1) • cytokinin stimulates lateral bud growth (1) • auxin {represses / inhibits / is dominant over} cytokinin action (1)	**Accept** if auxin is higher than cytokinin, lateral shoot growth stops **Accept** if cytokinin is higher than auxin, lateral shoot growth occurs	**(3)**

Q10.

Question Number	Answer	Additional guidance	Mark
	endosperm		**(1)**