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## **A2 Biology OCR**

### **Unit F215: Control, genomes and environment**

#### **Module 4.1 Plant responses**

## **Notes & Questions**

**Explain why plants need to respond to their environment in terms of the need to avoid predation and abiotic stress.**

- Plant carryout a number of responses to their environment to ensure their survival, such as avoiding pollutants, deterring herbivores, maximising light absorbance etc.
- Plants need to be sensitive to a range of stimuli such as light, gravity and chemicals etc
- As plants are multicellular they need to be able to carryout cell signalling to be able to coordinate these responses
- Plants have hormones, chemical messengers that have target sites/tissues.
- Hormones can be referred to as growth factors
- Hormones can move around the plant by
  - Active transport
  - Diffusion
  - Mass flow in the xylem and phloem

**Define the term *tropism*.**

- **Tropism**
  - A directional growth response in which the direction of the response is determined by the direction of the external stimulus
  - **Positive tropism**
    - A growth response towards the stimulus
  - **Negative tropism**
    - A growth response away from the stimulus
  - **Phototropism**
    - A growth response to light
    - Shoots +ve / Roots -ve
  - **Chemotropism**
    - A growth response to chemicals
    - E.g pollen tube
  - **Geotropism**
    - A growth response to gravity
    - Shoots -ve / Roots +ve
  - **Thigmotropism**
    - A growth response to touch
    - E.g climbing Ivy
- **Nasties**
  - A non-directional growth response to
  - Thigmonasty response is seen by *Mimosa pudica*

## Describe how plant hormones are used commercially.

- **Auxin**

- What does it do?
  - Involved in cell elongation
  - Inhibits leaf abscission
  - Inhibits growth of side shoots
- What are its commercial uses
  - Taking cuttings – found in rooting powder which encourages root formation
  - Seedless fruit – can cause fruit to form regardless of fertilisation
  - Herbicides – rapid growth leads to the plant unable to support itself under its own weight and collapses, breaking the stem = death

- **Gibberellins**

- What does it do?
  - Seed germination
  - Stem growth
- What are its commercial uses
  - Fruit production – improves apples shape & increases yield
  - Brewing – rapid seed germination of barley = malt
  - Sugar production – increases the stem length of sugar cane. This is where the sugar is produced = increases sugar production.
  - Plant breeding – Speeds up the aging of conifers to reach reproductive age earlier

- **Cytokinins**

- What does it do?
  - Cell division
- What are its commercial uses
  - Prevents yellowing of cut lettuce leaves
  - Tissues cultures – help promote root and shoot growth by cell division

- **Ethene**

- What does it do?
  - Fruit ripening
- What are its commercial uses
  - Preventing fruit ripening

- **Abscisic acid**

- What does it do?
  - Inhibits seed germination
  - Inhibits growth
  - Causes stomatal closure when water availability is low
- What are its commercial uses
  - Seed storage

**Explain how plant responses to environmental changes are coordinated by hormones, with reference to responding to changes in light direction.**

- **What Auxin does**

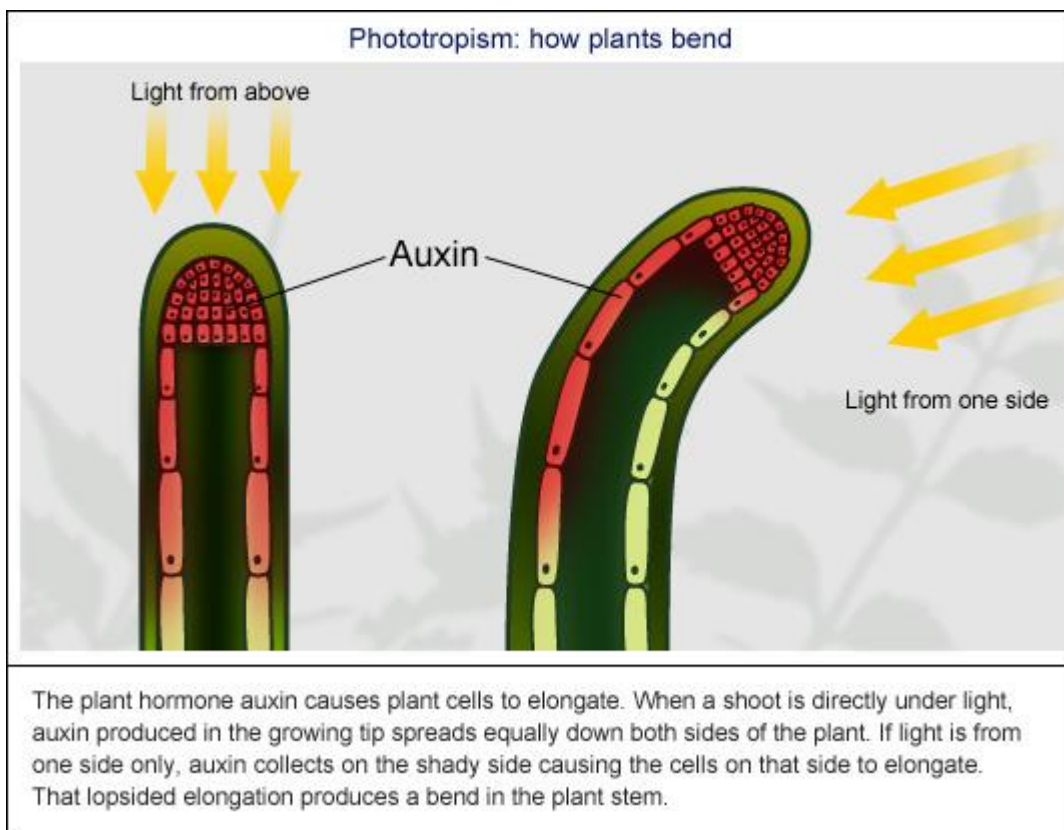
- Auxin activates **ATPase** (an enzyme in cell membranes)
- ATPase pumps  $H^+$  into the cellulose cell wall
- The build up of  $H^+$  decreases the pH of the cellulose cell wall to the optimum pH of the enzyme **Expanase**
- Expanase breaks the glycosidic bonds between the beta-glucose molecules
- The plant cell can take in more water and become turgid
- This stretches the cell.

- **Phototropism**

- Positive phototropism in shoots (shoot bends towards light source)
- Cells on the shaded side of the stem elongate faster and to more of a degree than the illuminated side

- **How?**

- 2 enzymes have been identified **Phototropin 1** and **Phototropin 2**
- Blue light = increases Phototropin's activity
- Therefore there is more Phototropin on the illuminated side and less on the shaded side of the shoot. This creates a gradient and distributes auxin

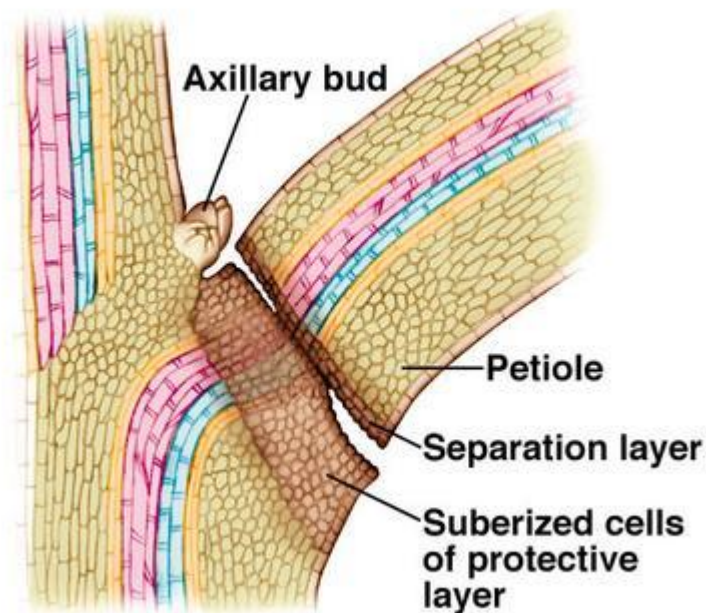


### Outline the role of hormones in leaf loss in deciduous plants.

- **Senescing (leaf ages, turns brown and dies) occurs in deciduous trees and leads to abscission (leaf drop)**
- **How does it happen?**
  - Cytokinins are found in the leaf
  - They act as a nutrient sink in the leaf preventing senescence
  - If Cytokinin levels in the leaf drop then nutrients levels in the leaf drop
  - This starts a chain reaction
    - Decrease cytokinins = senescence
    - Senescence decreases auxin levels in the leaf
    - Decrease in auxin = increase in ethane
    - The abscission zone shown in the diagram below is sensitive to ethane
    - The increase in ethane will increase cellulase activity and digests the cellulose cell walls at the abscission zone.

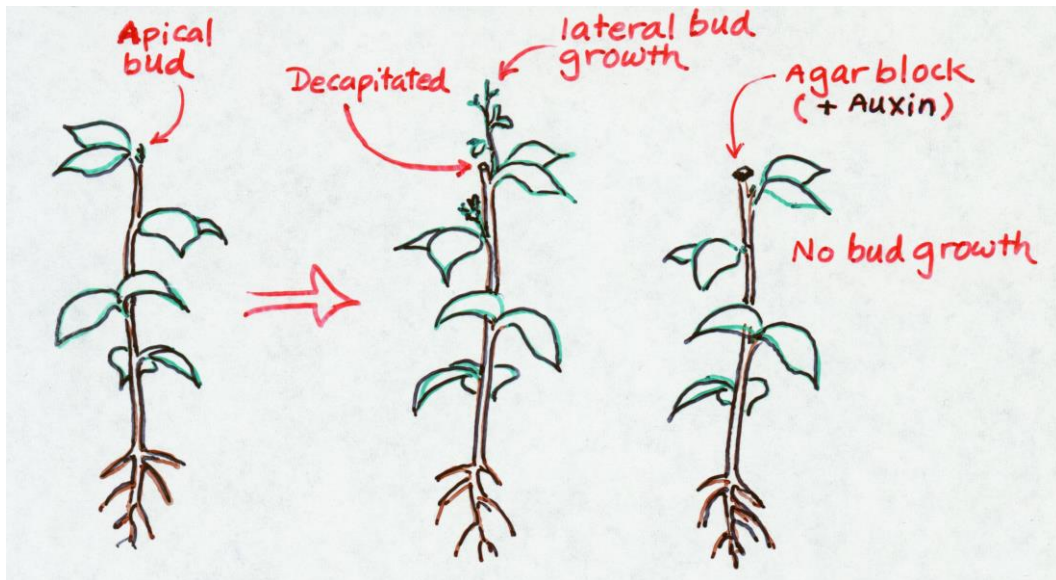
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### Leaf Abscission Zone



**Evaluate the experimental evidence for the role of auxins in the control of apical dominance and gibberellin in the control of stem elongation.**

- **Auxin & apical dominance**
- **Theory Auxin inhibits lateral buds**
- Evidence 1
  - Remove growing tip and lateral buds grow as auxin levels drop
  - Add paste containing auxin to cut end and lateral buds did not grow



- Weakness in evidence
  - Upon exposure to oxygen cells at the cut end of the stem could have produced a hormone that promoted lateral bud growth
- Evidence 2
  - Auxin transport inhibitor was placed below the growing tip and the lateral buds did not grow
- Weakness in evidence
  - It could just be a coincidence that auxin concentrations inhibit growth
  - Could there be more variables?
- Further Evidence
  - Scientists now believe that there are 2 other hormones involved
    - Abscisic acid - Inhibits bud growth
      - High auxin concentrations = High Abscisic acid levels
      - Remove tip = decrease auxin = decrease abscisic acid
    - Cytokinins – promotes bud growth
      - Auxin acts as a sink for cytokinins
      - Auxin at tip = cell division at tip = apical dominance
      - Remove tip = auxin spreads more evenly throughout plant and so too do cytokinins = cell division at lateral buds.

- **Gibberellin and stem elongation**

- **Investigation**

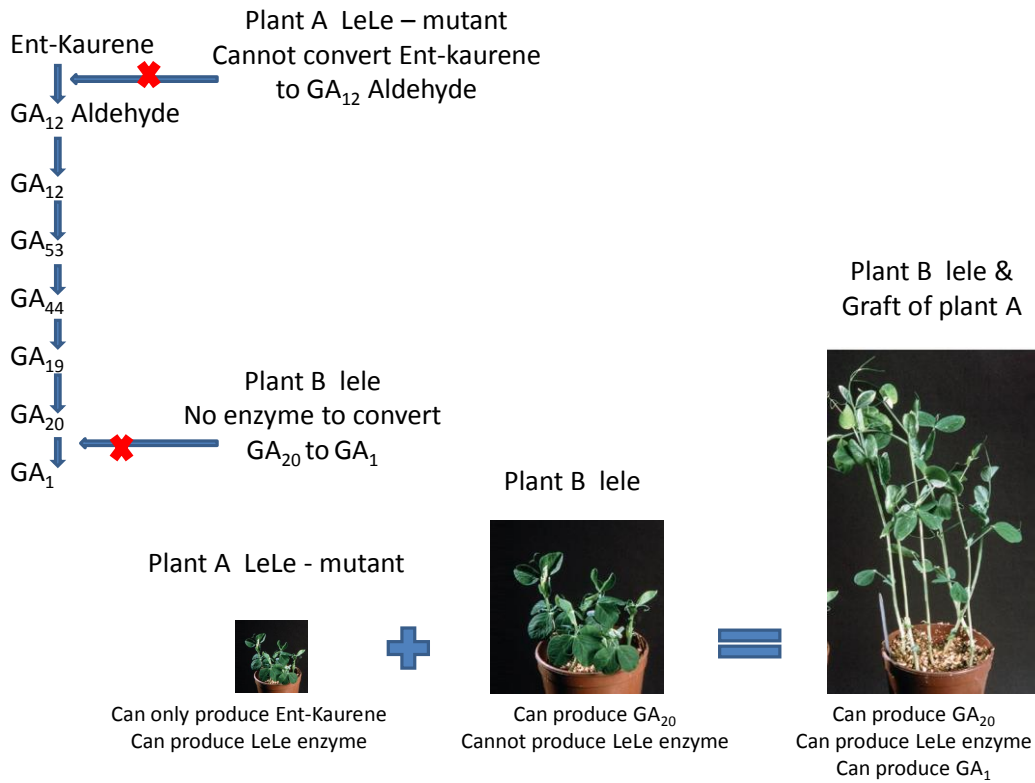
- Investigating a plant disease (fungal) which caused plants to grow tall isolated Gibberellic acid ( $GA_3$ ) as the cause.

- **Challenge**

- Just because  $GA_3$  can cause stem elongation in this case does not mean it does so naturally with gibberellic acids found in plants.

- **Further Investigation**

- LeLe genotype = Enzyme which converts  $GA_{20}$  into  $GA_1$ .
- lele genotype = No enzyme is produced so  $GA_{20}$  is final compound
- $GA_1$  causes stem elongation in plants.



# Questions

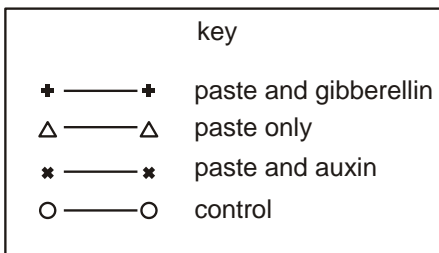
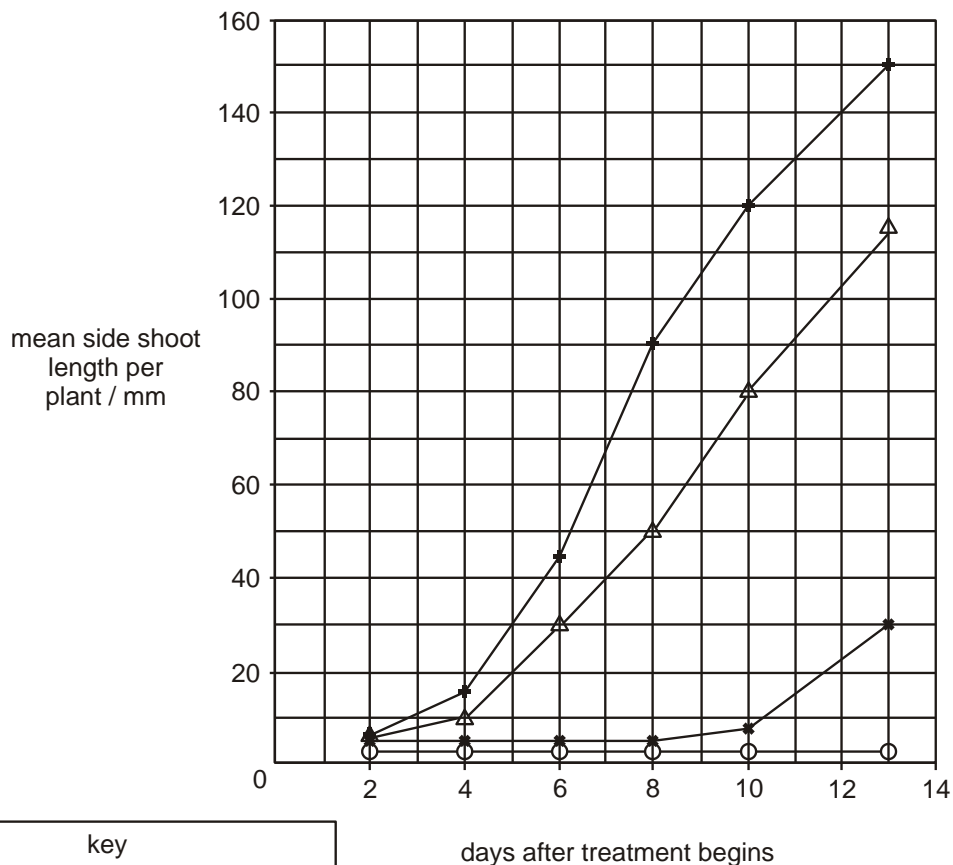
1

An investigation was carried out into the effects of two plant growth substances, gibberellins and auxins, on apical dominance. The terminal (apical) buds of a number of pea plants were removed and discarded. The tops of each of the remaining shoots were given one of the following treatments:

- Coated with a paste containing gibberellin.
- Coated with a paste containing auxin (IAA).
- Coated with a paste without any plant growth substance.

In addition, a control group of plants did not have their terminal buds removed and were not coated with paste.

The growth of the side shoots was measured at regular time intervals and a mean value calculated. The results are shown in the figure below.





(a) Explain why the side shoots grow when the terminal buds are removed.

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.....  
.....  
.....  
.....  
.....

[3]

(b) Side shoots show greater growth when paste containing gibberellin is applied than when paste without any plant growth substance is applied.

Calculate the percentage increase in growth due to gibberellin in 8 day old seedlings compared to seedlings with paste only. Show your working.

Answer = .....%

[2]

(c) Using data from the figure above describe **and** explain the effect of auxin (IAA) on the growth of side shoots.

.....  
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[3]

[Total 8 marks]

2

An experiment was carried out to investigate the effect of gibberellins on stem elongation in both wild type and dwarf varieties of *Brassica campestris*. Plants from both varieties were germinated and grown under controlled laboratory conditions. Stem measurements were taken on day 12 after planting, and then on five more occasions, as indicated in the table below. Stems were measured from the point at which they join the seed to the apical meristem. The plants were divided into four groups as follows:

- wild type variety treated with a gibberellin solution
- dwarf variety treated with gibberellin solution
- wild type variety treated with water (control)
- dwarf variety treated with water (control).

The stem lengths were measured and the mean values are shown in the table.

age of plants / days	mean length of stem / mm			
	plants treated with gibberellin		plants treated with water	
	wild type	dwarf	wild type	dwarf
12	25.58	1.27	30.04	0.78
13	52.19	2.50	53.42	1.21
15	65.33	4.46	72.49	2.69
18	96.87	10.63	93.97	4.15
20	97.19	21.55	100.81	6.79
23	104.71	35.44	108.78	8.48

From Russell and Sunday <http://www.sfu.ca/~msr/Papers/BISC/brassica.html>

(a) (i) Suggest how the dwarf variety may have arisen.

.....

.....

.....

[2]

(ii) State **two** environmental factors that would need to be controlled during this experiment.

1 .....

2 .....

[2]

- (b) With reference to the table, describe the effect of the gibberellin solution on stem elongation in both the wild type and dwarf varieties.

*wild type*

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.....  
.....  
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*dwarf*

.....  
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.....  
.....  
.....

[5]

- (c) Explain the different effects of the gibberellin solution on stem elongation in these two varieties.

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.....  
.....

[2]

[Total: 11 marks]

3

Plants must respond to changes in both their external and internal environments.  
Communication in plants is achieved by using a number of plant growth regulators.

List **three** stimuli that plants respond to.

- 1 .....
- 2 .....
- 3 .....

[Total 3 marks]

4

Flowering plants have chemical communication systems.

(i) Outline the nature of chemical communication within flowering plants.

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[2]

(ii) Explain why plants need such a communication system.

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.....  
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[2]

[Total 4 marks]

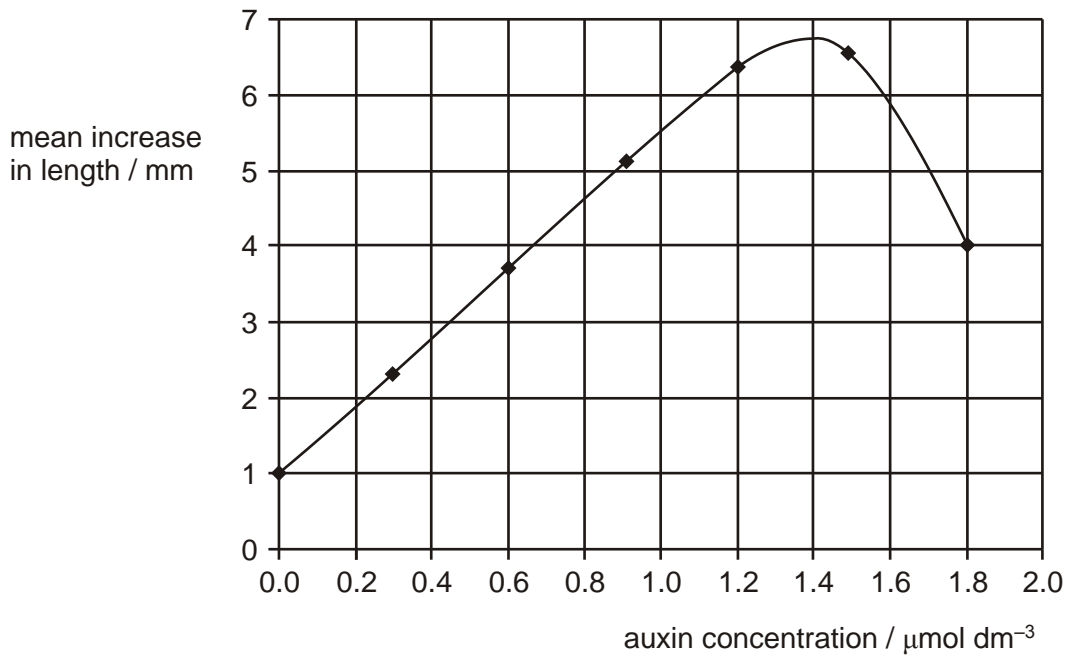
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Sections of young, growing stems were cut from just below the terminal buds of several similar plants of the same species. Each section was 5 mm long.

The stem sections were placed in Petri dishes containing different solutions of auxin, with ten sections in each dish.

After 12 hours, the sections were removed from the Petri dishes and measured.

The figure below shows the mean **increase** in length of the sections in each dish, plotted against the concentration of auxin in the solution in the dish.



(a) (i) Using the figure above, describe the relationship between the concentration of auxin in the solutions in the Petri dishes and the mean increase in length of the stem sections.

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[3]

(ii) List **three** variables which should have been controlled in the investigation.

1 .....

2 .....

3 .....

[3]

(b) Suggest **two** ways in which auxin might have caused the change in growth of the stems as shown in the figure above.

1 .....

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2 .....

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[2]

(c) State **two** ways in which the control of plant growth by growth substances differs from the control of blood sugar concentration by mammalian hormones.

1 .....

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2 .....

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[2]

[Total 10 marks]