

Structured Questions: Paper 2

9.3 Growth in Plants

9.3.1 Plant Growth / 9.3.2 Plant Hormones / 9.3.3 Micropropagation

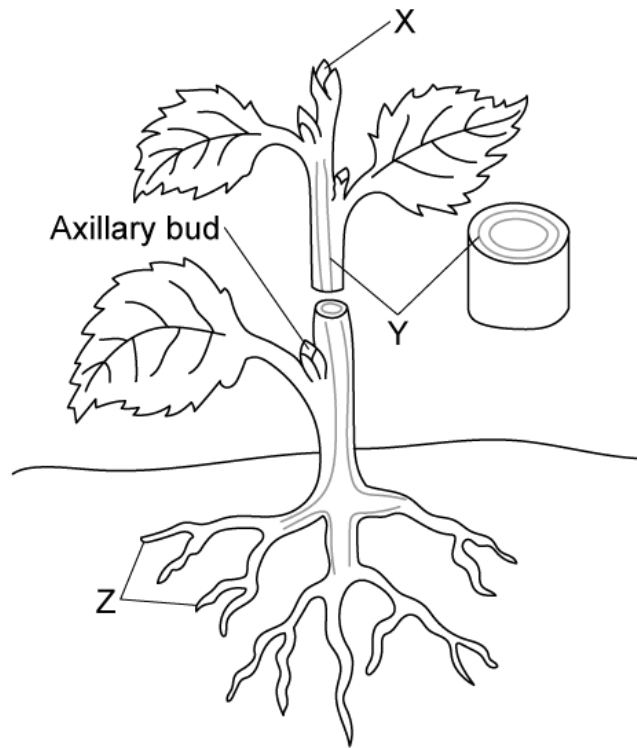
Easy (5 questions)	/42
Medium (5 questions)	/45
Hard (5 questions)	/62
Total Marks	/149

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Easy Questions

1 (a) The image below shows a representation of a growing plant.



Identify structures **X-Z** in the image above.

(3 marks)

(b) The cells in structures **X-Z** in part a) divide constantly.

(i) Identify the type of cell division taking place in structures **X-Z**.

[1]

(ii) Describe what happens to the daughter cells produced by the process named in part i).

[2]

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(3 marks)

(c) State **one** feature of the cells found in structures **X-Z** in the image in part a) **other** than the feature described in part b).

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(1 mark)

(d) The image in part a) shows the location of regions known as axillary buds.

Describe the effect of the following plant hormones on axillary buds:

(i) Auxin

[1]

(ii) Cytokinins

[1]

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(2 marks)

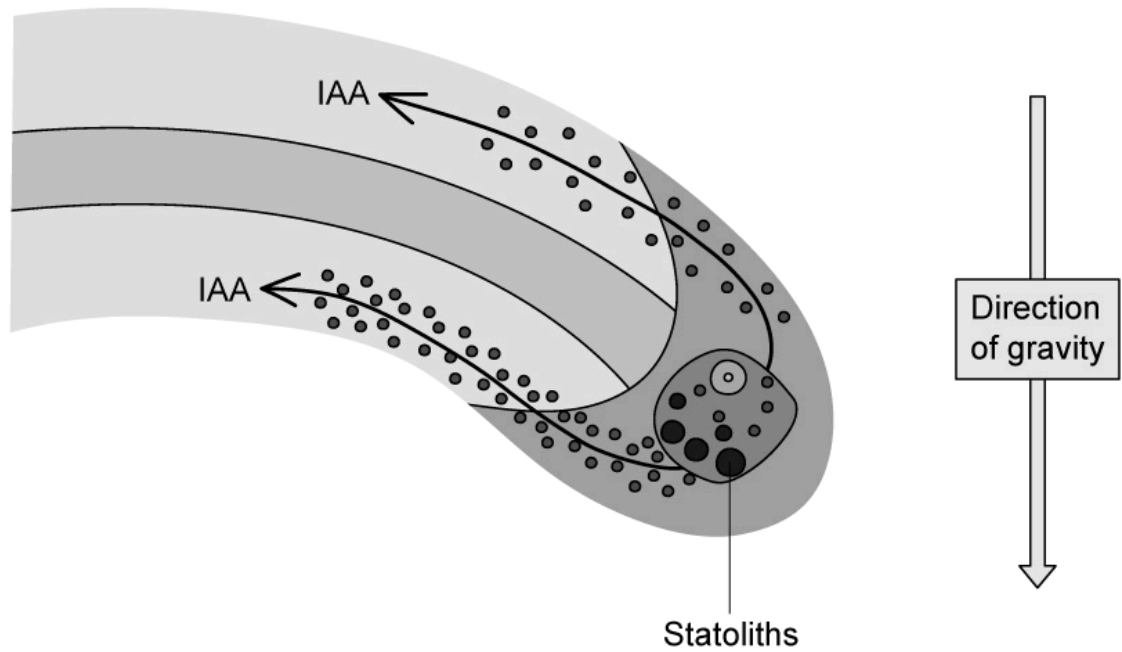
2 (a) State the meaning of the term **tropism**.

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(2 marks)

(b) The diagram below shows the events taking place during a tropism in a plant root.



Explain the role of statoliths in this type of tropism.

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(2 marks)

(c) **Other** than the role of statoliths, outline the events that cause the tropism shown in part b).

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(2 marks)

(d) (i) Identify **one** example of a tropism **other** than the tropism shown in part b).

[1]

(ii) Outline the benefit to the plant of the tropism identified in part i).

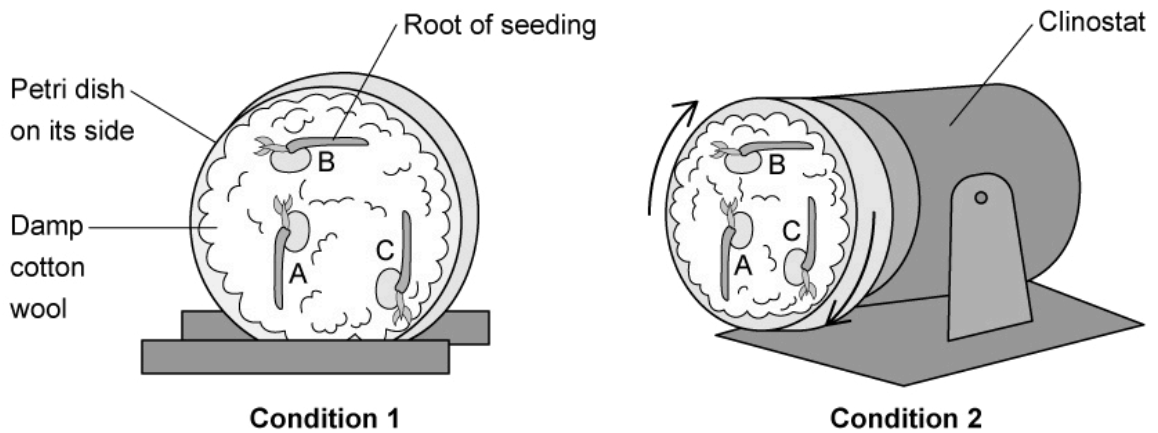
[2]

(3 marks)

3 (a) An investigation was carried out into the effects of gravity on seedling root growth. The experiment was set up as shown in the diagram below.

Note that:

- Both conditions 1 and 2 were set up in the dark.
- A clinostat is a piece of equipment that rotates slowly over time.



Suggest the purpose of the following:

(i) Setting up the experiment in the dark.

[1]

(ii) The damp cotton wool.

[1]

(iii) The clinostat in condition 2.

[1]

(3 marks)

(b) Identify a **quantitative** variable that the researcher could measure in the experiment shown in part a) to find out about the effect of gravity on the growth of seedling roots.

(1 mark)

(c) Sketch the results that you would expect for seedling B in the experiment in part a) in:

(i) Condition 1

[1]

(ii) Condition 2

[1]

(2 marks)

(d) Experiments such as that shown in part a) can be used to find out about the large-scale effects of different stimuli on plant growth, but cannot tell researchers anything about the underlying processes inside plant cells.

Outline how modern scientists can find out about the processes occurring inside plant cells.

(2 marks)

4 (a) Identify **one** feature of plant growth that makes plants suitable for micropropagation.

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(1 mark)

(b) State the reasons for each of the following stages of the micropropagation process:

(i) The explant is taken from meristematic tissue. [1]

(ii) The agar gel is sterilised. [1]

(iii) The agar gel contains 10 times more auxin than cytokinin. [1]

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(3 marks)

(c) Identify **three** advantages of using micropropagation in plant production.

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(3 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Outline the role of meristems in plant growth.

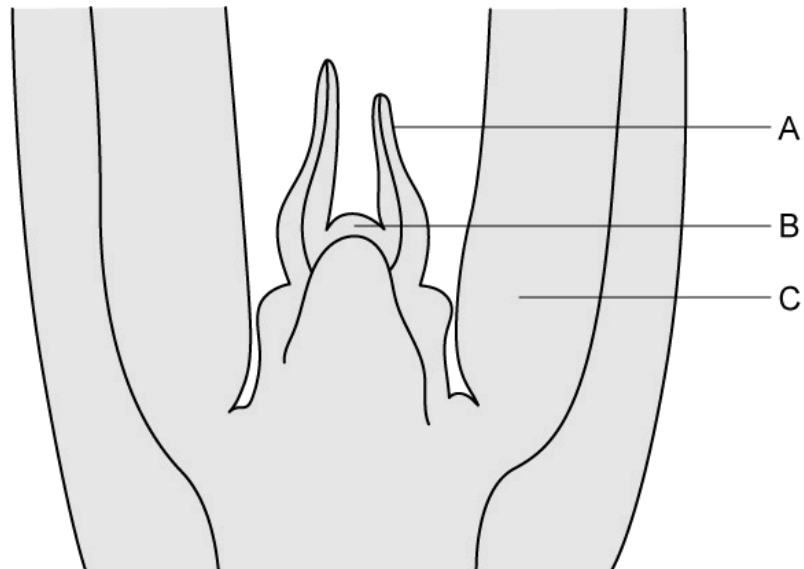
(6 marks)

(b) Outline the role of auxin in the shoot response to light.

(3 marks)

Medium Questions

1 (a) The image below shows the tip of a shoot.



Identify the structure labelled **B** in this image.

(1 mark)

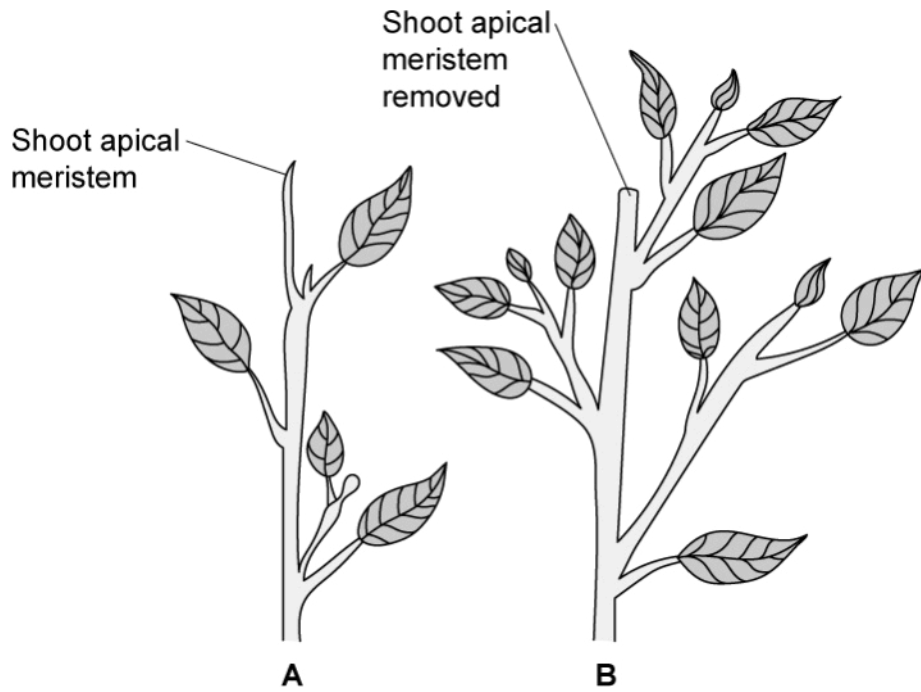
(b) Outline how structure **B** in part a) leads to the extension of the stem in a plant.

(2 marks)

(c) Describe the response the tip of the shoot would show if it received light from one side only.

(2 marks)

(d) The image below shows two plants that illustrate a specific pattern of growth.



Identify, with a reason, the pattern of growth observed in the two plants shown in the image above.

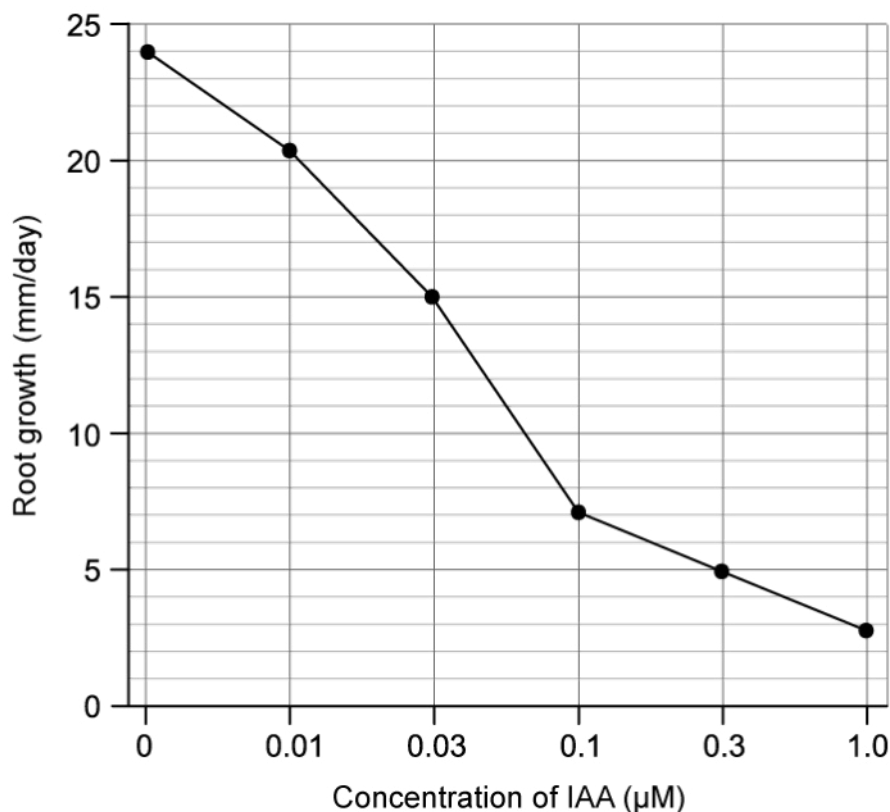
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(3 marks)

- 2 (a) Indole-3-acetic acid (IAA) is a common auxin that affects the growth of plants. An investigation was done to determine the effect of different concentrations of IAA on the growth of young roots. The results of this investigation are shown in the graph.



State the conclusion that can be drawn from these results.

.....
(1 mark)

- (b) Contrast the root growth observed at IAA concentrations of 0.03 µM and 0.3 µM.

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(2 marks)

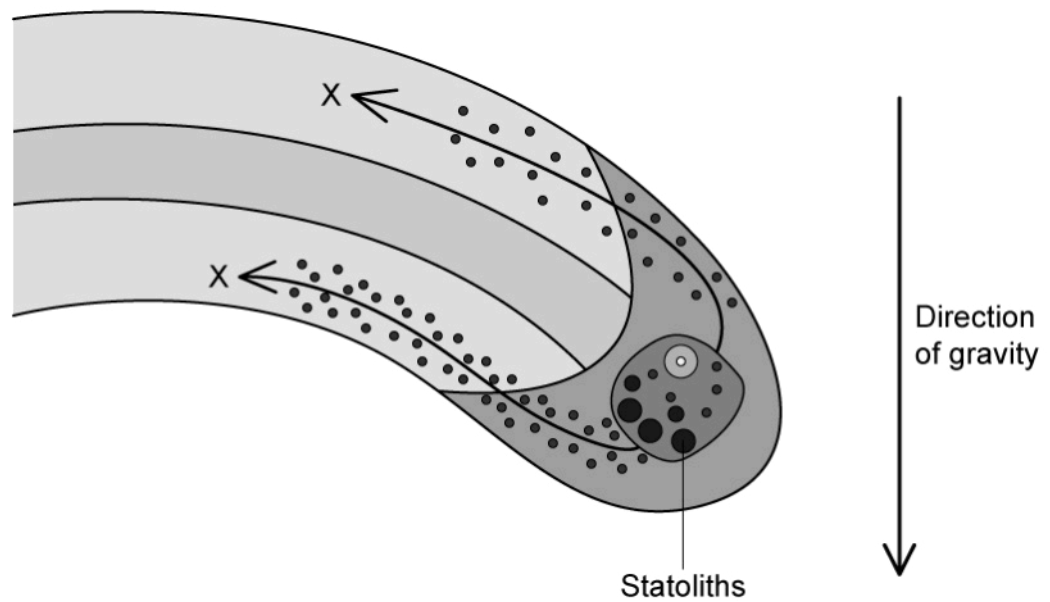
- (c) Calculate the rate of root growth per hour when roots are **not** exposed to IAA from the graph in part a).

(2 marks)

(d) Explain the importance of gravitropism in roots.

(2 marks)

- 3 (a)** The image below shows the tip of a root that was placed in a horizontal position, as well as the changes taking place inside the root.



State the function of statoliths in a root.

.....

.....

(2 marks)

- (b)** Identify the substance labelled **X** in the image in part a)

.....

(1 mark)

- (c)** Explain the link between the presence of statoliths and the distribution of substance **X** shown in the image in part a).

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(3 marks)

- (d) A group of students investigated the effect of removing the root tip on the gravitropic response of a radicle.

The students had two groups of plants, each containing five seedlings, that were germinated at the same time and under the same conditions. Group 1 had the end 2 mm of the root tip removed, while Group 2 was left intact. All ten seedlings were laid flat and the position of each root tip was marked on a sheet of paper that was placed beneath the seedlings. After five hours the new position of the root tips were marked on the paper and the angle of bending was measured. An upward-bending root was recorded as a negative value and a downward-bending root was recorded as a positive value.

The results are displayed in the table.

Plant seedling	Root bending / degrees	
	Group 1 (without root tip)	Group 2 (with root tip)
1	0	42
2	-3	39
3	0	37
4	0	40
5	-2	35
Mean	-1	39

Suggest an explanation for the results shown in the table above.

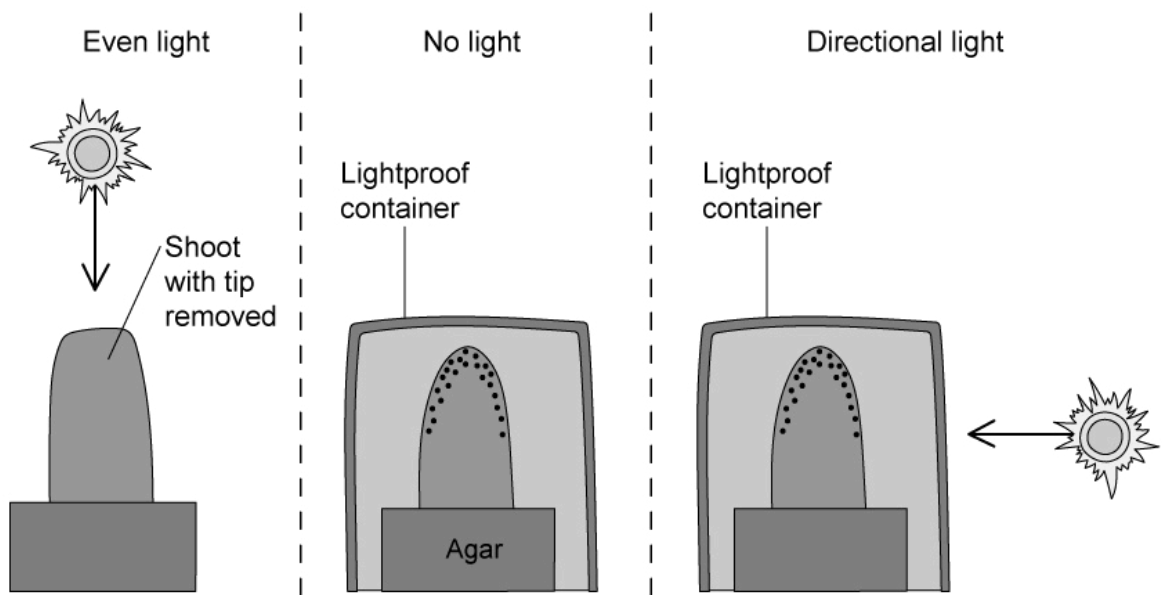
(2 marks)

4 (a) In an investigation to test the effect of auxin on shoot growth in seedlings, three different experiments were set up:

Group A = Shoot with the tip removed.

Group B = Shoot has been covered in a light proof container.

Group C = Shoot was grown under a directional light source.



Contrast the growth that would be seen in **group A** and **group B**.

(1 mark)

(b) Explain how directional light in **group C** from the experiment in part a) will affect gene expression in the shoot.

(3 marks)

(c) Explain how being unable to respond to light stimuli would lead to reduced growth in a plant.

(3 marks)

5 (a) *One mark is available for clarity of communication throughout this question.*

Describe the process of plant micropropagation.

(7 marks)

(b) Outline some of the commercial and environmental benefits of micropropagation.

(5 marks)

(c) Explain how microarrays are used in genomics to increase our understanding of plant hormones and their effect on gene expression.

(3 marks)

Hard Questions

- 1 (a) The microscope image below shows a cross section of part of a stem of a herbaceous (non-woody) plant.

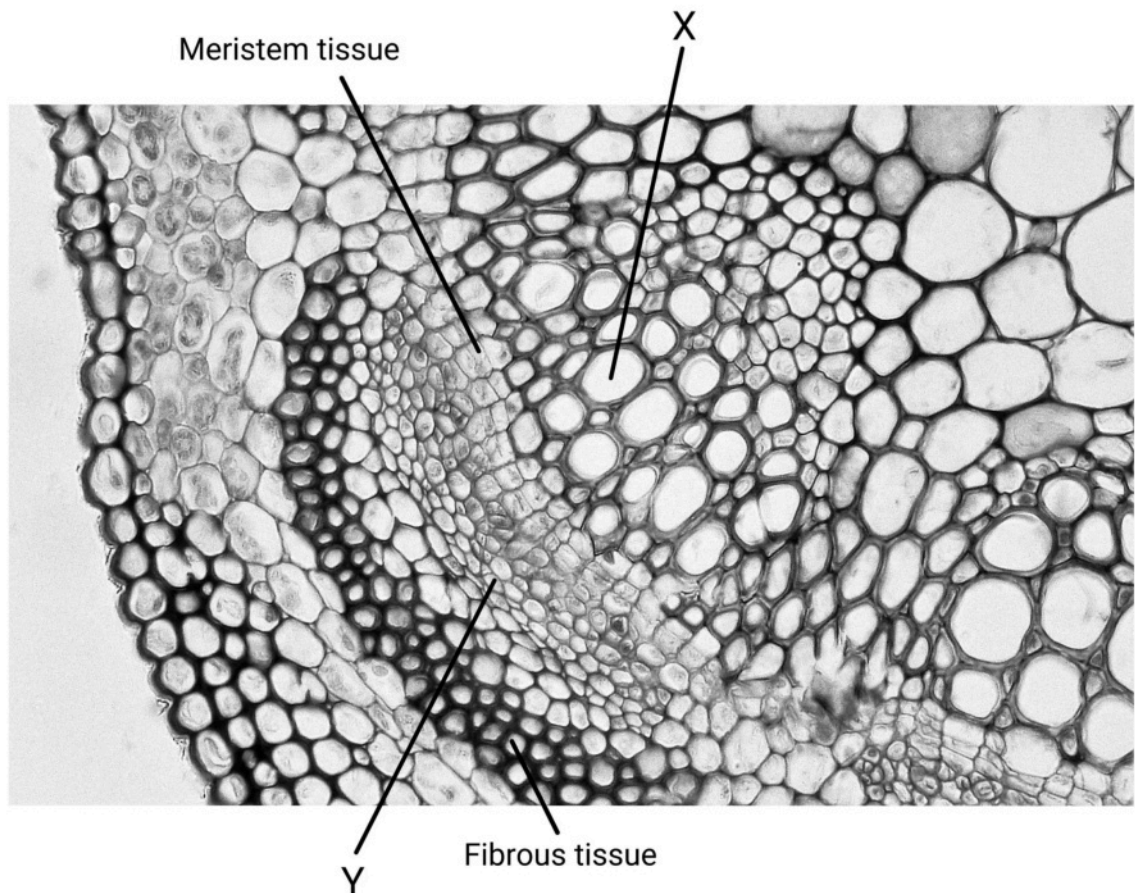


Image courtesy of Berkshire Community College Bioscience Image Library. Adapted and redistributed under a Creative Commons CC0 1.0 Universal Public Domain Dedication license under conditions found at <https://creativecommons.org/publicdomain/zero/1.0/deed.en>

Identify tissue types **X** and **Y** in the image.

(2 marks)

(b) The region of tissue between structures **X** and **Y** in the image in part a) is a type of meristem tissue.

(i) Identify the meristem tissue in part a).

[1]

(ii) State **two** roles of the meristem identified in part i).

[2]

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(3 marks)

(c) The fibrous tissue shown in the image in part a) is known as sclerenchyma tissue, and has an important structural role in plants. Other tissue types include parenchyma, sometimes known as pith, which is involved with photosynthesis and storage, and collenchyma, which also has a structural role.

Describe how this range of different tissue types can arise in plants. Avoid repetition of ideas covered in part b).

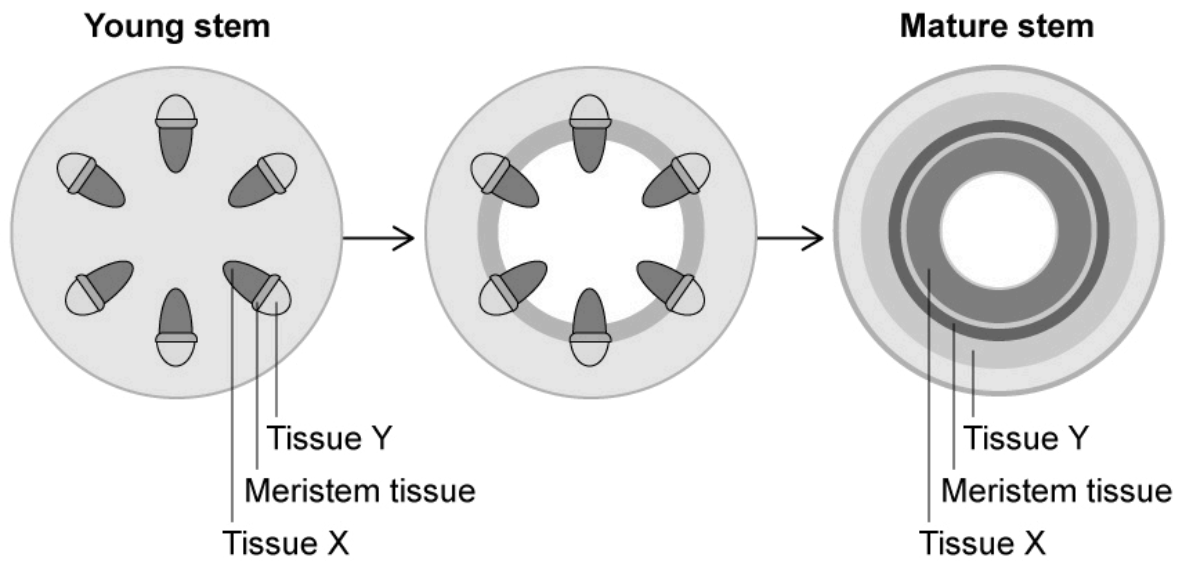
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(3 marks)

(d) The stem section shown in the image in part a) is taken from a young plant stem. The diagram below shows how the arrangement of tissue in a plant stem can change as the stem matures. Some of the tissues shown in part a) are also labelled below for comparison.



The change in tissue arrangement is in part triggered by increased expression of a gene known as HCA2, which codes for a transcription factor.

- (i) Suggest how increased expression of HCA2 might alter the distribution of tissue within the plant stem.

[3]

- (ii) Suggest how scientists could determine the expression levels of HCA2 at any given stage in a plant's life cycle.

[2]

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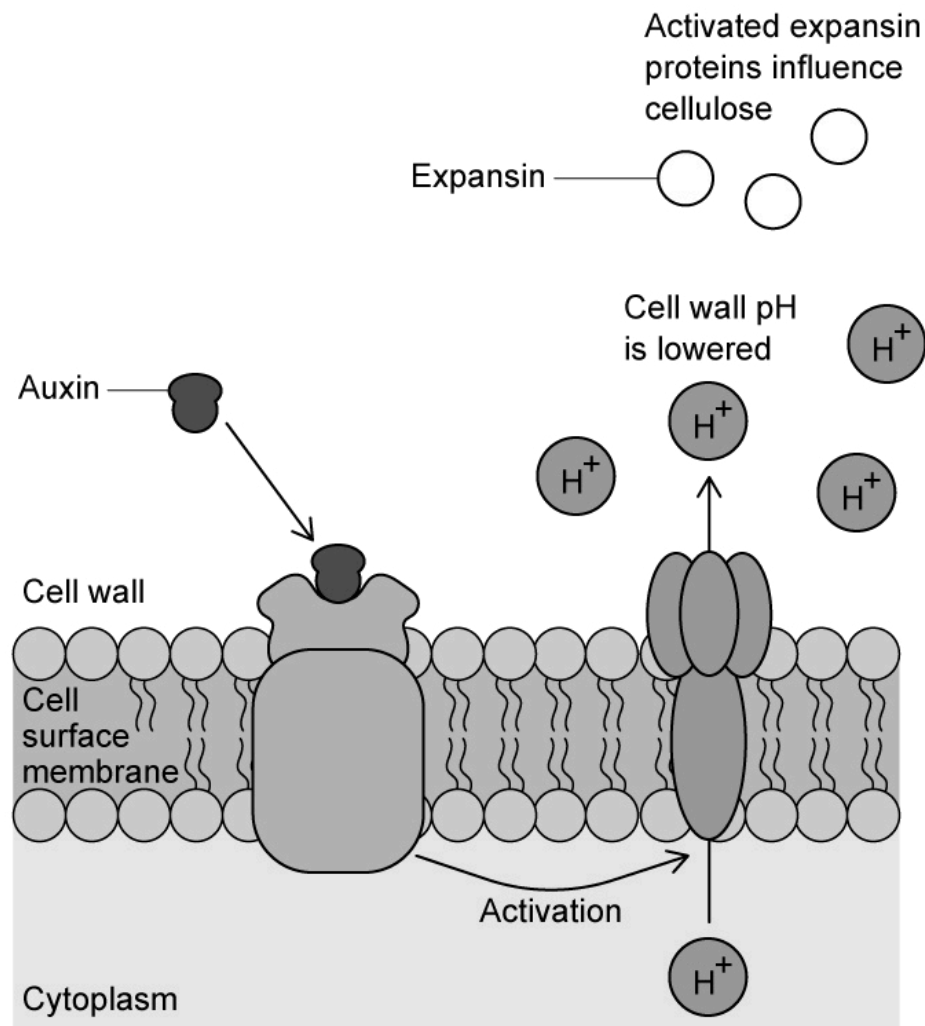
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(5 marks)

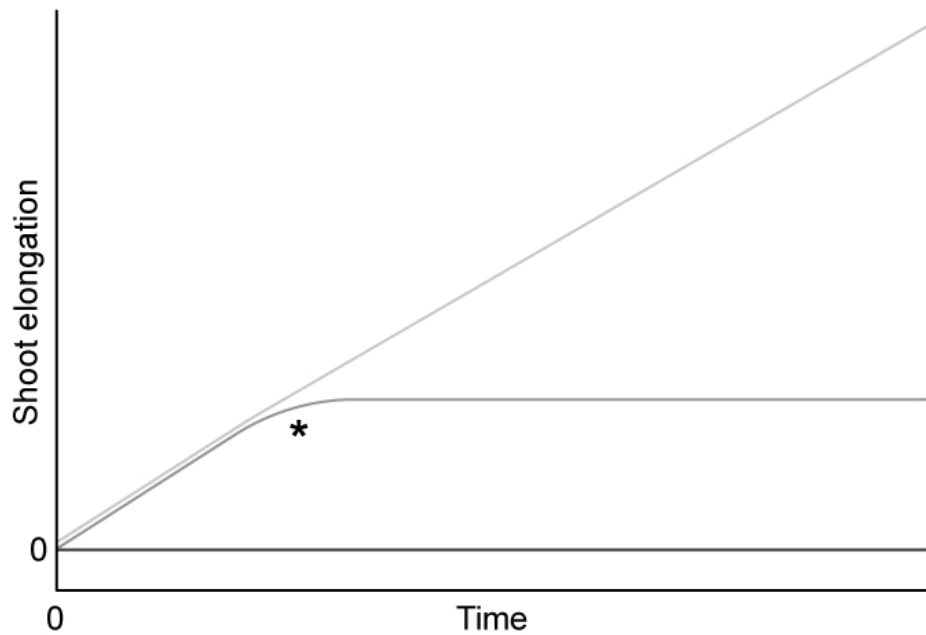
- 2 (a) The diagram below illustrates a theory of auxin action known as the acid growth hypothesis. In the acid growth hypothesis plant cell wall rigidity is reduced, allowing plant cells to expand and therefore elongate.



Suggest how activated expansin proteins could reduce the rigidity of plant cell walls.

(2 marks)

- (b) An investigation was carried out into the effect of a respiratory inhibitor on the elongation of wheat seedling shoots. The results of the study are shown in the graph below.



Key: — = Auxin only
 — = Auxin and respiratory inhibitor added at *
 — = Auxin and respiratory inhibitor

(i) Identify, with a reason, the condition that functions as an experimental control.

[2]

(ii) Use information provided in part a) to explain the results for the seedlings in the presence of auxin alone. Note that marks will not be awarded for content relating to the effect of expansins.

[3]

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(5 marks)

(c) Suggest an explanation for the effect of the respiratory inhibitor in the graph in part b).

(2 marks)

(d) It is thought that auxin activates proton transporters by increasing expression of a gene from a group of genes known as the *SAUR* genes.

(i) Identify **one other** gene where expression is thought to be influenced by auxin. Note that you do not need to name the gene itself.

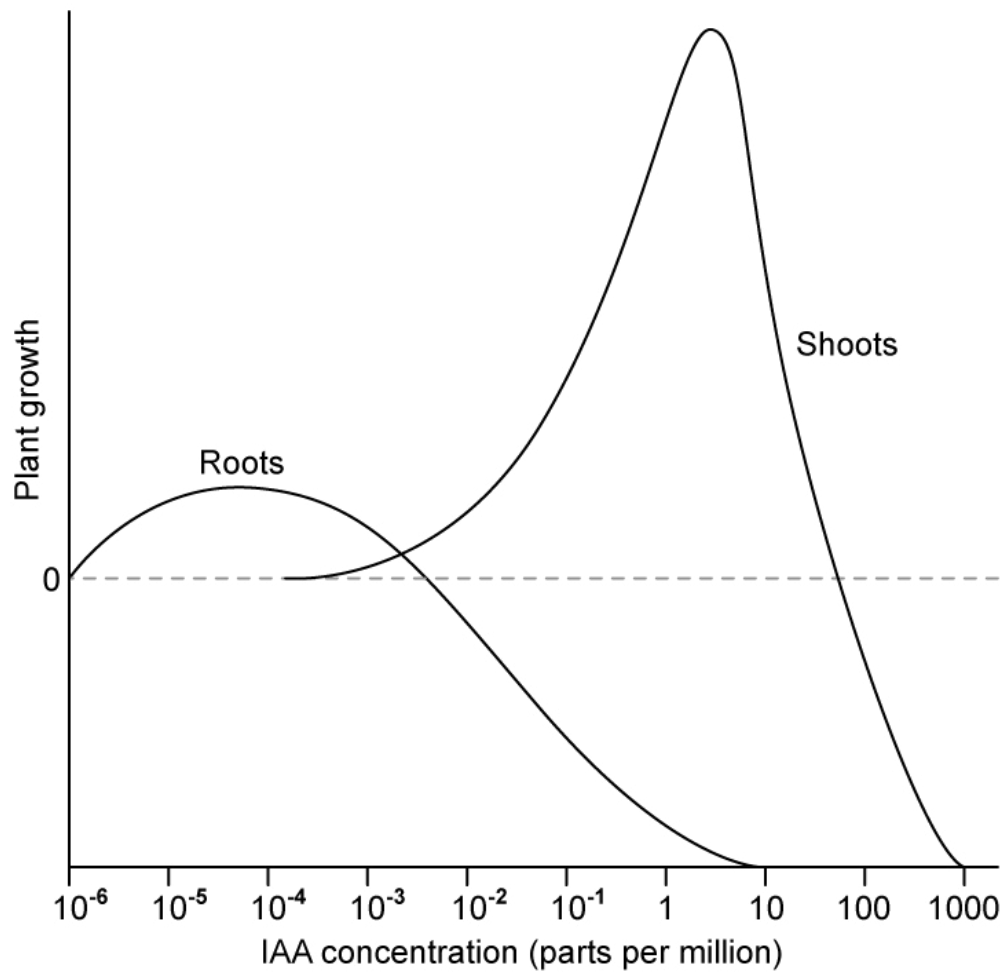
[1]

(ii) Outline the role of the proteins for which the gene identified in part i) codes.

[2]

(3 marks)

3 (a) The graph below shows the effect of increasing auxin concentration on the growth of plant roots and shoots. Note that auxin is also known as IAA.



Describe the effect of increasing auxin concentration on the growth of plant **shoots** shown in the graph.

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(3 marks)

(b) Use the graph in part a) to suggest a possible auxin concentration for the following parts of a plant. Note that your value readings should be given to the nearest accurate value on the scale provided.

(i) The shaded side of a shoot.

[1]

(ii) The lower side of a root.

[1]

(iii) The upper side of a root.

[1]

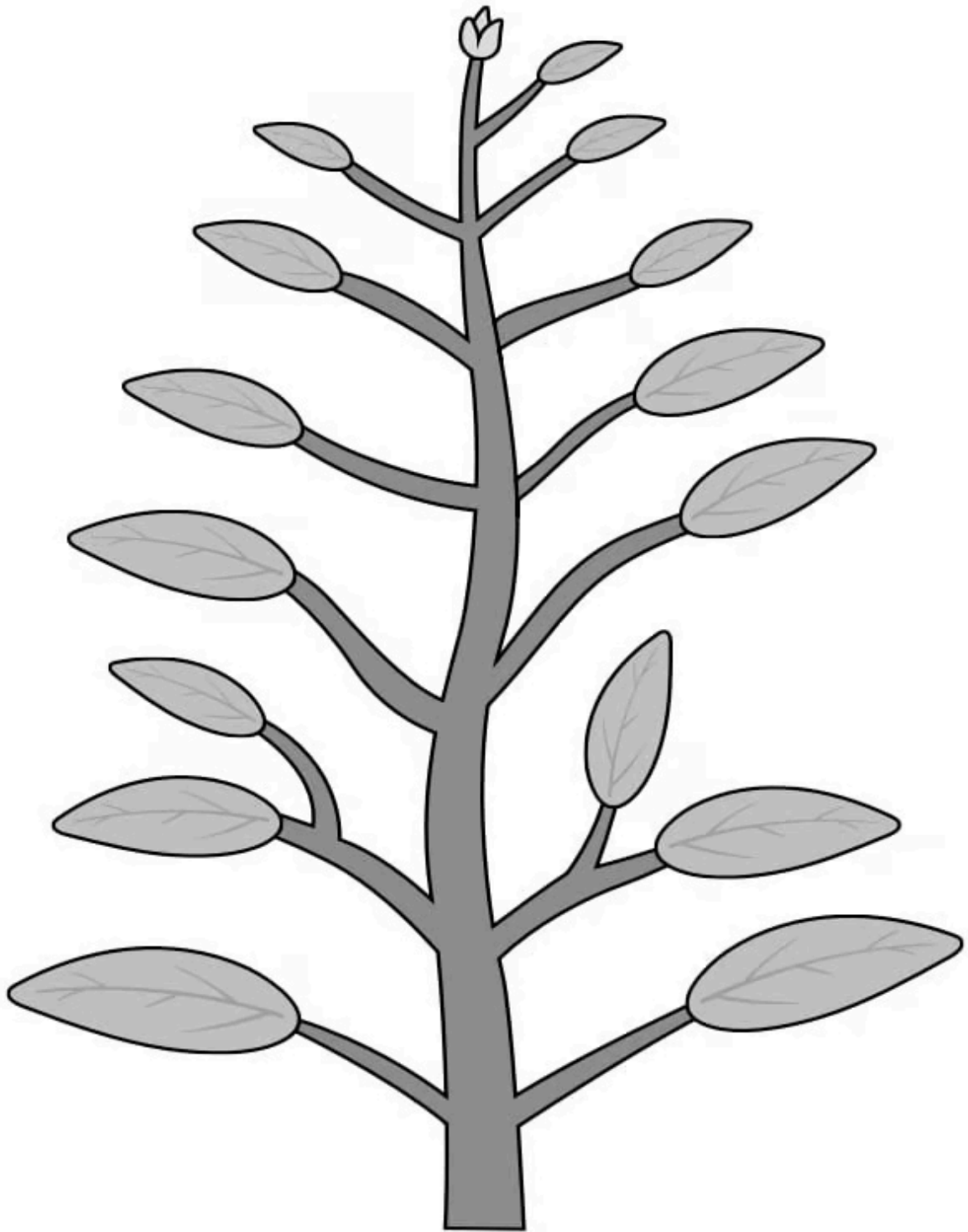
(3 marks)

(c) As implied by the questions in part b) there is often an auxin concentration gradient across a plant stem or root.

Explain how light falling on one side of a plant shoot can generate an auxin gradient across that shoot.

(3 marks)

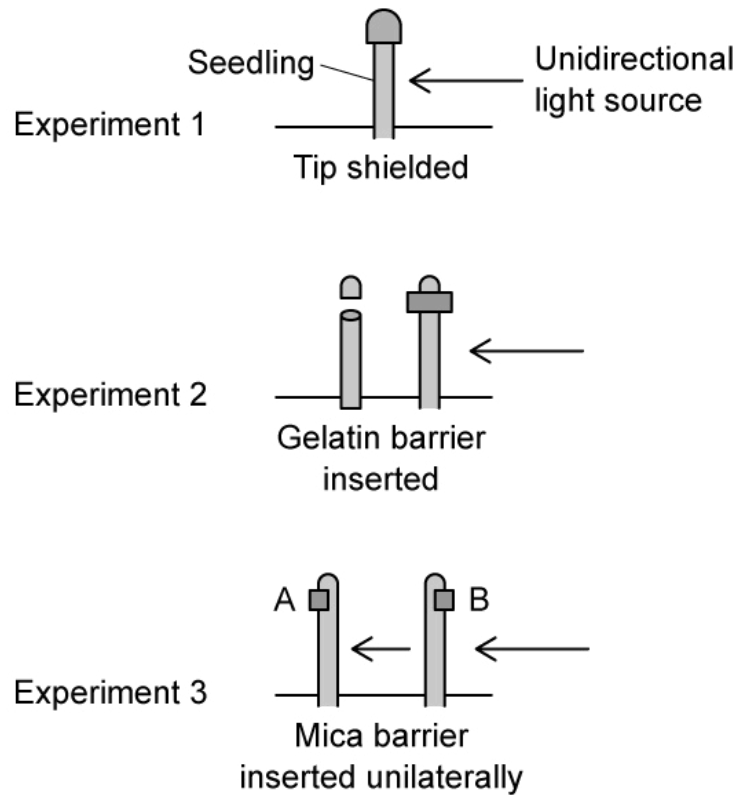
(d) In addition to regulating shoot and root elongation, auxin is involved with other aspects of plant growth. The image below shows the appearance of a plant that has been influenced by auxin.



Explain how auxin and any other relevant plant hormones can cause the plant appearance shown in the image.

(3 marks)

4 (a) Current knowledge of plant tropisms has been gained from multiple experiments carried out on plant seedlings. For example, early experiments showed that a plant growth influence (now known as auxin) was produced in the growing tip of seedlings. The image below illustrates three more experiments. Note that gelatin is a permeable material while mica is impermeable.



Identify **three** control variables that would be required to ensure valid results from all of the experiments shown.

(3 marks)

(b) Predict, with a reason, the seedling growth that would be seen in each of the following experiments shown in part a):

(i) Experiment 1

[1]

(ii) Experiment 2

[1]

(iii) Experiment 3A

[1]

(iv) Experiment 3B

[1]

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(4 marks)

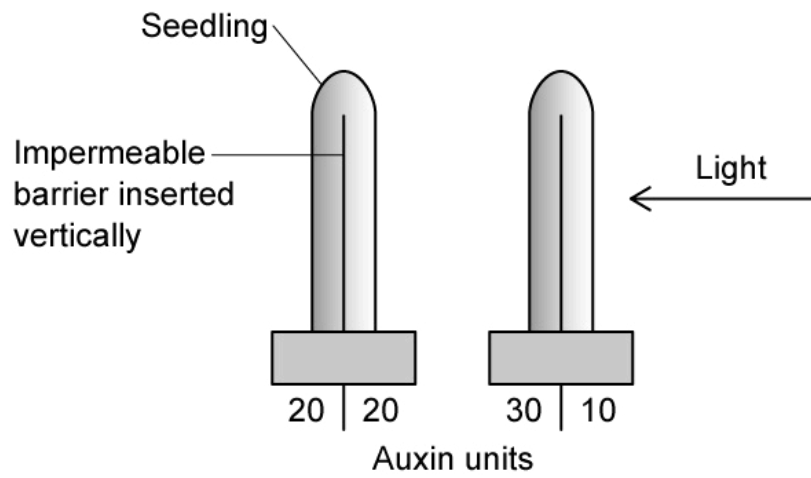
(c) State **two** possible conclusions about phototropism that can be drawn from the experiments shown in part a).

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(2 marks)

(d) A fourth experiment was set up as shown below.



(i) Predict the growth of the seedling in this experiment.

[1]

(ii) Identify **one** additional conclusion that can be drawn from this experiment that can **not** be drawn from experiments 1-3 in part a).

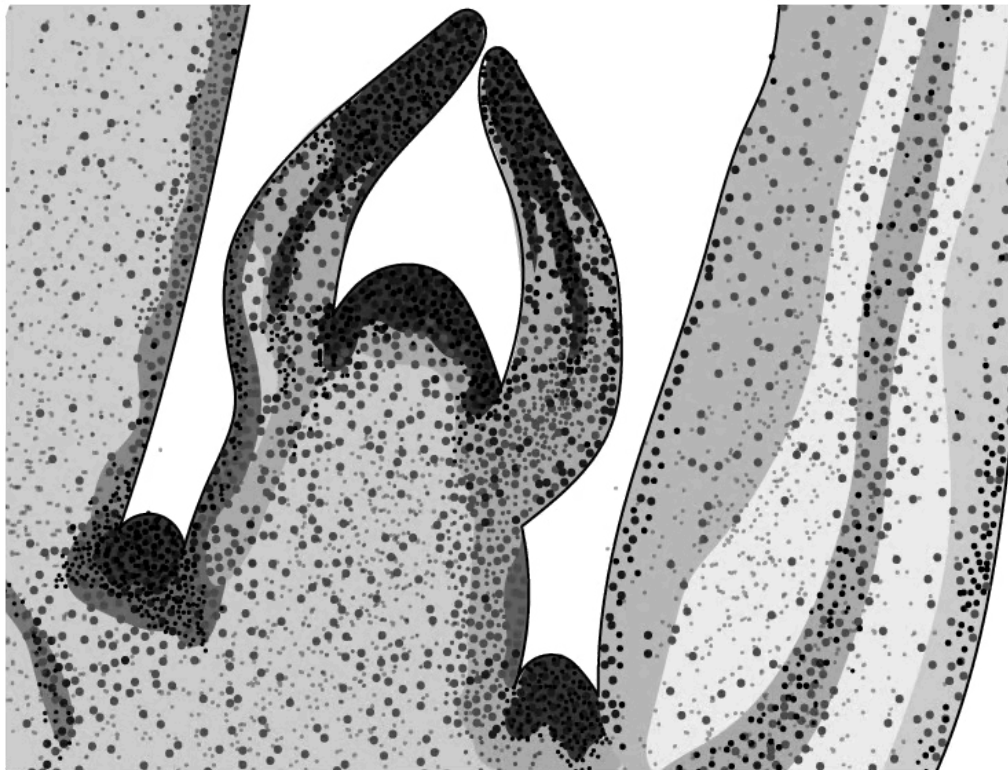
[1]

(2 marks)

5 (a) One mark is available for clarity of communication throughout this question.

The image below is a micrograph showing a cross-section through part of a plant. The areas of dark stain represent the presence of cell nuclei.

Annotate the micrograph below:



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(7 marks)

(b) Compare and contrast animal and plant hormones.

(7 marks)