Hormones called auxins control plant growth.

A student investigated plant growth responses in roots.

This is the method used.

1. Grow three bean seeds until their roots are 1 cm long.

2. Attach the three bean seeds to moist cotton wool in a Petri dish.
   Each bean seed root should point in a different direction.

3. Fix the Petri dish vertically for 2 days in the dark.

**Figure 1** shows the results.

**Figure 1**

(a) Describe the direction of growth of the bean roots after 2 days.

Give one reason for this growth response.

Direction of root growth ________________________________________________

Reason ____________________________________________________________
___________________________________________________________________

(2)
(b) The student then noticed the shoots growing from the seeds.

He then:

1. put a light above the Petri dish but did not move the seeds
2. allowed the seeds to grow for 2 more days.

Predict the direction of growth of the bean **shoots** after 2 days.

Give **one** reason for your prediction.

Direction of root growth ________________________________

Reason ________________________________________________
(c) Ethene is a plant hormone. Ethene causes fruit to ripen.

Scientists measured the concentration of ethene found in fruit at different stages of ripeness.

**Figure 2** shows the results.

![Figure 2](image)

At which stage of ripeness is there most ethene?

Tick **one** box.

- Stage 1
- Stage 2
- Stage 3
- Stage 4
- Stage 5

(d) Suggest how the scientists can find out if the result for Stage 1 was an anomaly.

___________________________________________________________________
___________________________________________________________________

(1)
Gibberellins are a different type of plant hormone.

Farmers growing cotton plants in cold climates sometimes soak their seeds in a solution of gibberellins before planting the seeds.

Suggest an advantage of soaking seeds in a gibberellin solution in cold climates.
___________________________________________________________________
___________________________________________________________________

A student investigated growth in plants.

The student:

• planted a seed in damp soil in a plant pot
• put the plant pot in a dark cupboard.

The image below shows the result after 5 days.

(a) Draw a ring around the correct answer to complete each sentence.

(i) After the 5 days, the root had grown ___________.
    away from water.
in the direction of the force of gravity.
towards light.

(ii) After the 5 days, the shoot had grown ___________.
    against the force of gravity.
    away from light.
    towards water.
(b) After the plant had grown, the student put the plant pot by a window with lots of light.

The illustration below shows this.

(i) Complete the diagram below to show the appearance of the student's plant after 20 days by the window.

(ii) Explain the advantage to the plant of growing in the way that you have drawn in part (b)(i).

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(2)
(Total 5 marks)
A student investigated growth responses in plants.

The student grew a bean seed in a box filled with moist soil, as shown in Diagram A. After the seed had started to grow, the box was turned onto its side and placed in a dark room, as shown in Diagram B.

(a) Complete Diagram C to show what the root and shoot will look like three days later.

(b) Draw a ring around the correct answer to complete the sentence.

The results of the investigation show that the root is sensitive to
light.
moisture.
gravity.
(c) A hormone in the plant causes the growth responses.  
What is the name of this hormone?  
Tick (✓) one box.

Auxin

Statin

Steroid

(d) Gardeners can use some plant hormones as weed killers.  
(i) Give one different use of plant hormones by gardeners.

____________________________________________________________

____________________________________________________________

(ii) Selective weed killers only kill some plants in a garden.  
Killing weeds in a garden reduces competition between plants.  
Give three factors that plants compete for.

1. __________________________________________________________

2. __________________________________________________________

3. __________________________________________________________
Gardeners sometimes use weed killers to control the growth of plants.

(a) A gardener wanted to get rid of daisy plants growing in a lawn.

The gardener investigated the use of a weed killer.

The gardener:
• recorded the number of daisy plants growing in different 10 m\(^2\) areas of the lawn
• made solutions of the weed killer (each solution had a different concentration)
• put 5 dm\(^3\) of each solution on different 10 m\(^2\) areas of the lawn
• recorded the number of daisy plants growing in each area after 2 weeks.

The table shows the results.

<table>
<thead>
<tr>
<th>Concentration of weed killer in arbitrary units</th>
<th>Number of daisy plants per 10 m(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before using weed killer</td>
</tr>
<tr>
<td>0 (water)</td>
<td>8</td>
</tr>
<tr>
<td>20</td>
<td>6</td>
</tr>
<tr>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>60</td>
<td>5</td>
</tr>
<tr>
<td>80</td>
<td>4</td>
</tr>
<tr>
<td>100</td>
<td>8</td>
</tr>
</tbody>
</table>

(i) To make the investigation fair, the gardener controlled some variables.

Give one variable the gardener controlled in the investigation.

____________________________________________________________________________________
____________________________________________________________________________________  (1)

(ii) The gardener decided that the result for a concentration of 20 arbitrary units of weed killer was anomalous.

Suggest why the gardener decided this result was anomalous.

____________________________________________________________________________________
____________________________________________________________________________________  (1)
(iii) Why did the gardener put 0 arbitrary units of weed killer on one area of the lawn?

________________________________________________________________________

________________________________________________________________________

(1)

(iv) The gardener concluded that the best concentration of weed killer to use all over a lawn is 100 arbitrary units.

Suggest why the gardener cannot be sure about this conclusion.

________________________________________________________________________

________________________________________________________________________

(1)

(b) In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Plants respond to different environmental factors.

Describe how different environmental factors affect:
• the direction of growth of roots
• the direction of growth of shoots.

In your answer you should refer to the role of plant hormones.

Do not refer to the artificial use of plant hormones by gardeners or scientists.

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(6)

(Total 10 marks)
(a) When a seed starts to grow, the young root grows downwards towards gravity. The young shoot grows upwards, away from gravity.

(i) Name this type of plant response to gravity.

________________________________________________________________________

(ii) Give two reasons why it is useful for a young root to grow towards gravity.

1. ______________________________________________________________________

________________________________________________________________________

2. ______________________________________________________________________

________________________________________________________________________

(iii) The root grows towards gravity due to the unequal distribution of a substance in the root.

Draw a ring around the correct answer to complete the sentence.

This substance is

auxin.
chlorophyll.
sugar.
(b) The drawings show some apparatus and materials.

- Lamp
- Petri dishes
- Forceps
- 50 maize seedlings on damp cotton wool
- Supply of cardboard boxes with lids
- Ruler
- Scissors
In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Describe how the students could use some or all of the apparatus and materials shown in the drawings to investigate the growth response of maize seedlings to light shining from one side.

You should include a description of the results you would expect.

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(6)
(Total 10 marks)
Plant hormones are used in horticulture.

(a) Name one plant hormone.

___________________________________________________________________

(1)
(b) The diagram shows how new plants are produced using tissue culture.

(i) Tissue culture is a type of **asexual reproduction**.

Give the main features of **asexual reproduction**.

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Another method of producing new plants is by taking cuttings.

Suggest **one** advantage of using tissue culture and **not** using cuttings to produce plants.

______________________________________________________________

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(1)
(Total 5 marks)

Charles Darwin investigated tropisms in plants.

Some students did an investigation similar to Darwin’s investigation.

The students:

- grew seeds until short shoots had grown
- used black plastic to cover parts of some of the shoots
- put the shoots in light coming from one direction
- put boxes over the shoots to keep out other light.

The diagrams show how the investigation was set up.

Two days later the students took off the black plastic covers and looked at the shoots.
The diagrams show the results.

(a)  Give two variables that the students should control in this investigation.

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___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

(2)

(b)  Shoot A bent towards the light as it grew.

   Explain how.

___________________________________________________________________
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___________________________________________________________________
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(4)

(c)  What conclusions can be drawn from the results about:

   (i)  the detection of the light stimulus

   ________________________________________________________________
   ________________________________________________________________

   (1)
(ii) where in the shoot the response to the light takes place.

________________________________________________________________________

________________________________________________________________________

(1)
(Total 8 marks)
Mark schemes

1. (a) grown down
   allow longer
   towards gravity / gravitropism
   allow geotropism
   1

   (b) grow up
   towards the light
   allow phototropism
   1

   (c) 3
   1

   (d) repeat the experiment
   1

   (e) seeds germinate sooner so growing season is longer
   1

   [7]

2. (a) (i) in the direction of the force of gravity
   1

   (ii) against the force of gravity
   1

   (b) (i) diagram completed to show stem bending / leaning towards the window
   the bend / lean can be at / from any point above pot level
   ignore any leaves
   1

   (ii) more light (for leaves)
   ignore heat
   more photosynthesis / biomass / glucose
   ref to ‘more’ needed once only, eg ‘more light for photosynthesis’ = 2 marks
   if no other marks given allow 1 mark for ‘to get light for photosynthesis’
   1

   [5]
(a) diagram to show root growing down
   
   allow single lines or not attached or open ends for both marks
   
   all branches must go down

   diagram to show shoot growing up
   
   all branches must go up

(b) gravity

(c) Auxin

(d) (i) rooting / cuttings
   
   accept other suggestions, eg fruit set / ripening
   
   do not accept weed killers

(ii) any three from:

   - light
     
     ignore sun / energy

   - water / moisture

   - nutrients / ions / minerals
     
     accept one named mineral
     
     ignore nutrition / food

   - space / area
     
     ignore soil / land / territory / volume
     
     ignore reference to gases
(a) (i) any one from:

ignore references to same lawn / weather / soil, which are not given in the question.

- (same) (type of) weed killer
- (same) volume / 5dm$^3$ of solution used (on each area)
  
  allow amount of solution used
  do not allow amount / volume / concentration of weed killer
  do not allow number of daisy plants

- effect on daisies (not other weeds / plants)
- (same) area / 10m$^2$
- (same) time or (effect after) two weeks.

(ii) more (daisies) growing after use of weed killer or after two weeks

  allow it does not fit pattern (of other results)

(iii) any one from:

  ignore to see if it / water has an effect

  - as a control
  
  do not allow as a control variable

  - to compare (to the other areas)
  - to check other factor(s) are not affecting the results / daisies.

(iv) 80 (arbitrary units of weed killer) also killed all the daisies

  allow ref to possible experimental design flaws such as ‘only tested once’ or ‘not repeated’ or ‘different number of daisies in each area at first’

  allow idea that other weed species may not respond in the same way as daisies

  allow idea that 100 (units) may also kill wanted species / grass
Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking Guidance and apply a ‘best-fit’ approach to the marking.

0 marks
No relevant content.

Level 1 (1–2 marks)
Reference to at least one environmental factor plants respond to or at least one response or a named hormone

Level 2 (3–4 marks)
Reference to at least one environmental factor plants respond to and at least one associated response or reference to a named hormone and at least one associated response

Level 3 (5–6 marks)
Reference to at least one environmental factor plants respond to and at least one associated response and reference to a named hormone
Examples of biology points made in the response:

**environmental factors**
- light
  allow phototropism
- (direction of the force of) gravity
  allow gravi / geotropism
- moisture / water.
  allow hydrotropism

**effects on direction of growth**
- shoots grow upwards
- shoots grow towards light
- shoots grow against (the force of) gravity
- roots grow downwards
- roots grow towards moisture
- roots grow towards (the force of) gravity.
  allow reference to ‘positive’ and ‘negative’ in terms of tropisms as indicating direction of growth

**hormone**
- reference to auxin
  allow other named hormone(s)
- unequal distribution of hormone causes unequal growth (rates).
  allow higher concentration of hormone causes faster growth in shoots
  allow higher concentration of hormone causes slower growth in roots

(a) (i) gravitropism / geotropism
  not ‘…trop…him’
  ignore ‘positive’ or ‘negative’

(ii) any **two** from:
- anchorage
- takes in water
- takes in ions / minerals / salts / correct named example
  allow nutrients
do not accept food

(iii) auxin
(b) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a best-fit approach to the marking.

0 marks
No relevant content.

**Level 1 (1 – 2 marks)**
There is a basic description of a simple method involving seedlings and light.

**Level 2 (3 – 4 marks)**
There is a description of a method involving seedlings in 1-sided light, and a control, with a correct observation.

**Level 3 (5 – 6 marks)**
There is a description of a method involving groups of seedlings in 1-sided light, and in control conditions. It includes some correct measurements or observations.

**Examples of Biology points made in the response:**
- use of scissors to cut tips from some shoots / cut hole in box
- use of forceps for handling seedlings
- use of ruler to measure lengths of shoots at start and at end
- other factors controlled – eg temperature / water
- use of lamp + box re. one-sided lighting
- repetitions – each treatment ≥ 3 times
- control in total darkness / all-round light
- time taken = several hours to a few days
- sample results: tip exposed to 1-sided light→bend to light, tip removed→vertical, control→vertical

(a) auxin

*accept other named plant hormones*

(b) (i) any **three** from:

* no (fusion of) gametes / fertilisation
  *allow no meiosis** or **new cells only produced by mitosis*

* only one parent
  *allow not two parents*

* no mixing of *genetic* material

* no *genetic variation** or **genetically** identical offspring
  *allow clones*
(ii) more / many offspring / plants (produced from one parent plant)

*allow less damage to parent plant*

*ignore speed / cost*

(a) any **two** control variables for 1 mark each:

- age / size of shoots
- species or type of plant / seeds
- light intensity
  
  *accept amount of light / colour of light*
- (other) named condition eg temperature / water

(b) *ignore reference to phototropism*

- ref to auxin / hormone
  
  1
- unequal (lateral) distribution
  
  1
- more hormone on dark side
  
  1
- causes growth on dark side
  
  1

(c) (i) (detection) in tip / top / end

  1

(ii) (response) behind tip

  *allow at tip / end / top half*

  1