# Lesson Element

# Plant growth hormones

## Instructions and answers for teachers

These instructions cover the learner activity section which can be found on [page 8](#_Lesson_Element). This Lesson Element supports OCR GCSE (9–1) Gateway Science Biology A and the Twenty First Century Science Biology B qualifications.

**When distributing the activity section to the learners either as a printed copy or as a Word file you will need to remove the teacher instructions section.**

### Mapping to specification level (Learning outcomes)

**GCSE (9–1) Gateway Science Biology A/Combined Science A**

### B3.2g Explain how plant hormones are important in the control and coordination of plant growth and development, with reference to the role of auxins in phototropisms and gravitropisms

B3.2h Describe some of the variety of effects of plant hormones, relating to auxins, gibberellins and ethane

**GCSE (9–1) Twenty First Century Science Biology B/Combined Science B**

B4.4.1 a explain how plant hormones are important in the control and coordination of plant growth and development, with reference to the role of auxins in phototropisms and gravitropisms

B4.4.1 b describe practical investigations into the role of auxin in phototropism

### Introduction

### Prior knowledge

Learners will have learnt about hormones involved in human reproduction and the menstrual cycle and in the body as examples of negative feedback earlier in the topic. They must now look at the effect of hormones on plants.

This lesson element would be ideal as the first lesson on this area of the specification, introducing the role of auxins in phototropism and gravitropism. Learners would then be required to move on to learning about the effects of gibberellins and ethane and the commercial uses for plant hormones in subsequent lessons.

### Common learner misconceptions

* A number of learners will not realise that plant have hormones. They think only animals have hormones.
* Some learners will think that you must plant a seed the correct way up for the shoot to grow upwards and the roots to grow down.
* Some learners will have difficulty understanding that auxin has opposite effects on cells in the shoot compared with the root.

This lesson element addresses all of these misconceptions.

### Teacher preparation

Teachers may want to ask their lab technician to plant some cress, radish, mustard or other relatively fast growing seeds in some compost 7 - 10 days in advance of the lesson and keep them somewhere where they have a light source from one side only. This shows learners positive phototropism in shoots.

If you don't have time for this, an internet search will give you a number of images to show learners instead.

Practical equipment and seeds will be needed for the gravitropism and phototropism practical. The teacher notes can be found on the SAPS website: <http://www.saps.org.uk/secondary/teaching-resources/1239-tackling-tropisms-gravitropism-and-phototropism>

Worksheets will need to be photocopied, 1 per learner.

### Task 1 – Starter

Learners work in pairs to answer the questions:

1. What is a hormone?
2. Give some examples of hormones and their responses.

Examples: Oestrogen causes an egg to be released from the ovary, insulin and glucagon control blood sugar levels, ADH controls reabsorption of water in the kidney, adrenaline triggers the body's fight or flight response, auxin (rooting powder) encourages root growth etc.

Expect a number of examples for human hormones but fewer, if any examples of plant hormones. Highlight to learners that plants do have hormones and that is what they will be learning more about this lesson.

Ask learner pairs to write down what they think plants may need hormones to do.

Discuss their answers.

Learners add this information to the relevant section of their worksheet.

**Hormone – Definition**

|  |
| --- |
| *A substance (chemical messenger) that is secreted in one part of an organism and travels to a target organ or tissue to bring about a response.* |

|  |  |  |
| --- | --- | --- |
| **Examples of plant responses to hormones:**  *Root & shoot growth*  *Flower and leaf fall*  *Bud development*  *Fruit formation & ripening*  *Germination of seeds*  *Flowering time*  *etc.* |  | A plant shows **positive** **phototropism** as it grows  light.  *root*  *shoot*  *towards*  A plant shows **negative** **phototropism** as it grows light.  *away from* |

### Task 2 – Phototropism role play

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Show learners the seeds that have been grown with a light source from one side only (or an image of this). Ask learners what has happened and why this is beneficial to the plant.

Using two volunteers, explain to the class that one will be a plant and the other a light source. Ask the 'plant' to stick post-its/stickers randomly over the top half of their body, these stickers are molecules of auxin. Give the 'light source' a torch and ask them to shine from straight above the 'plant'. Explain to learners that in this situation, the auxin is evenly spread therefore all cells in the shoot grow at an even rate, so growth is straight up.

Now ask the 'light source' to shine onto one side of the 'plant'. The 'plant' now moves their stickers to the side of their body away from the 'light source'. Explain that auxin causes cells in shoots to grow and as the cells away from the light grow much faster now there is more auxin present, it causes that side to elongate and the plant bends towards the light. The learner should do this by stretching up the far side of their body and leaning towards the 'light source'.

Introduce the term **PHOTOTROPISM**.

This is a quick and simple demonstration that learners are far more likely to remember than using just images of auxin concentration in plant shoots.

Learners draw a cartoon strip to show the effect of auxin and phototropism on shoot growth on their worksheet.

Draw a cartoon strip to show how auxin affects **phototropism** in a shoot:

|  |  |  |
| --- | --- | --- |
| Auxin is evenly distributed at the tip so all parts of the tip grow evenly, therefore straight**Diagram** | Auxin accumulates on the side of the tip away from the light source | Auxin cause the cells on the side away from the light to elongate faster, so the shoot bends towards the light |
| **Explanation**  *Auxin is evenly distributed at the tip so all parts of the tip grow evenly, therefore straight* | *Auxin accumulates on the side of the tip away from the light source* | *Auxin cause the cells on the side away from the light to elongate faster, so the shoot bends towards the light* |

### Task 3 – Phototropism experiment results

Learners use the information on their worksheet to predict what will happen to the growth of the shoot in the four experiments shown.

Auxins are found only in the tip of the shoot. Use this knowledge to draw how each of the following tips would look if left to grow for a few days.

Explain each result.

|  |  |
| --- | --- |
| *Shoot with light coming from the right* | The shoot bends towards the light because auxin has accumulated on the side away from the light, causing the cells to elongate faster and resulting in the shoot bending. |
| *The shoot bends towards the light because auxin has accumulated on the side away from the light, causing the cells to elongate faster and resulting in the shoot bending.* |
| *shoot covered with a foil cap with light coming from the right* | The shoot grows straight up as the foil prevents the tip of the shoot and the auxin from detecting the light, so auxin stays evenly spread. |
| *The shoot grows straight up as the foil prevents the tip of the shoot and the auxin from detecting the light, so auxin stays evenly spread.* |
| *shoot with the tip removed, with light coming from the right* | The shoot grows very little if at all as there is no auxin left in the shoot causing the cells to grow. |
| *The shoot grows very little if at all as there is no auxin left in the shoot causing the cells to grow.* |
| *shoot with impermeable mica sheet in the tip, with light coming from the right* | The shoot grows straight up as the auxin is evenly spread due to the mica preventing the movement of it from one side to the other. |
| *The shoot grows straight up as the auxin is evenly spread due to the mica preventing the movement of it from one side to the other.* |

### Task 4 – Gravitropism practical

Learners sow some seeds onto damp cotton wool in petri dishes, place one on a flat surface and stick one vertically to the wall. Instructions and teacher notes can be found on the SAPS website: <http://www.saps.org.uk/secondary/teaching-resources/1239-tackling-tropisms-gravitropism-and-phototropism>

Learners should be able to see gravitropism occurring in approximately one week and add sketches and conclusions to the relevant section of their worksheet then.

Alternatively if time is short, an internet search will provide numerous images of gravitropism in roots and shoots of a plant.

For both sets of seeds, draw and describe your observations:

|  |  |
| --- | --- |
| **Seeds grown on a flat surface:** | **Seeds grown on a vertical surface:** |
| Plant show **positive gravitropism** as they grow in the  direction that gravity acts.  *roots*  *same*  *opposite*  *shoots*  Plant show **negative gravitropism** as they grow in the  direction from gravity. | |

Use a coloured pencil to shade in the areas of the root and shoot where auxin will accumulate causing them to bend:

|  |
| --- |
| root coloured to show where auxin will accumulate |

Explain the effect of auxin on the cells in the root:

*In the root, auxin inhibits the elongation of cells, so the cells on the underside of the root grow much more slowly than the one on the top side, causing the root to bend downwards.*

How is this different to its effect in the shoot?

*It has the opposite effect in the shoot. In the shoot it elongates cells.*

### Task 5 – Gravitropism theory

Show learners a short clip of gravitropism in a root and a shoot: <https://www.youtube.com/watch?v=mYZXax8V_L0>

Discuss what is happening in the clip and introduce the term **GRAVITROPISM**. Learners complete the DARTS activity on their worksheet.

Ask learners to use their knowledge of auxin distribution in the shoot to shade in where they think auxin will accumulate, causing the shoot to bend upwards.

Now explain that auxin has the opposite effect on cells in the root as it inhibits growth/elongation. Using this information ask learners to shade in the area of the root where they think auxin will accumulate causing it to bend downwards.

### Task 6 – Plenary

Hand out a large piece of paper and two different coloured pens to each pair of learners. Learner 1 writes a key fact they have learnt about plant hormones on the paper. Learner 2 checks it is correct and writes a different fact underneath. This continues backwards and forwards until one learner in the pair cannot think of another factor for 3 minutes timed by the teacher. The idea is not only to beat your partner by having the last fact on the sheet, but to be the pair who have more facts than the other pairs in the class.

### Extension task

Learners could use the SAPS website: <http://www.saps.org.uk/secondary/teaching-resources/185-learner-sheet-8-the-response-of-seedlings-to-light-phototropism-experiment>

to plan an experiment to determine the effect of different coloured light on the growth of shoots.

Learners may also be interested to find out how astronauts grow their own veg in space under zero gravity: <https://www.youtube.com/watch?v=SgpU08WJm0c>

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## Learner Activity

### Task 1 – Starter

|  |
| --- |
| **Hormone – Definition** |

|  |  |  |
| --- | --- | --- |
| **Examples of plant responses to hormones:** |  | A plant shows **positive** **phototropism** as it grows  light.  A plant shows **negative** **phototropism** as it grows light. |

### Task 2 – Phototropism role play

|  |  |  |
| --- | --- | --- |
| **Diagram** |  |  |
| **Explanation** |  |  |

### Task 3 – Phototropism experiment results

|  |  |
| --- | --- |
| *Shoot with light coming from the right* | **Drawing** |
| **Explanation** |
| *shoot covered with a foil cap with light coming from the right* |  |
| *.* |
| *shoot with the tip removed, with light coming from the right* |  |
|  |
| *shoot with impermeable mica sheet in the tip, with light coming from the right* |  |
|  |

### Task 4 – Gravitropism practical

|  |  |
| --- | --- |
| **Seeds grown on a flat surface:** | **Seeds grown on a vertical surface:** |
| Plant show **positive gravitropism** as they grow in the  direction that gravity acts.  Plant show **negative gravitropism** as they grow in the  direction from gravity. | |

Use a coloured pencil to shade in the areas of the root and shoot where auxin will accumulate causing them to bend:

|  |
| --- |
| root |

Explain the effect of auxin on the cells in the root:

How is this different to its effect in the shoot?