# Auxins, phototropism and geotropism

Lesson plan and teacher's notes · Form 2 Biology · 1 period of 40 minutes

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| **School** | (write school name) | **Teacher** | (write name) |
| **Date** | (date) | **Class** | Form 2 |
| **Subject** | Biology | **Enrolment** | Boys ___ Girls ___ Total ___ |
| **Time** | 40 minutes | **Topic** | Auxins, phototropism and geotropism |

Learners say what a stimulus and a response are in plants, describe how light makes shoots bend towards it (phototropism), describe how gravity makes roots grow down and shoots grow up (geotropism), explain the role of auxin in shoots and in roots, and plan a simple experiment on light and gravity. Examples come from a potted plant near a classroom window at Kapoche school and seedlings grown in boxes.

## Specific outcomes

By the end of the lesson, learners should be able to:

1. Say what a stimulus and a response are in plants
2. Describe how light makes shoots bend towards it (phototropism)
3. Describe how gravity makes roots grow down and shoots grow up (geotropism)
4. Explain the role of auxin in shoots and in roots
5. Plan a simple experiment on the effects of light and gravity

## Prior knowledge

- Plants have shoots and roots
- Living things respond to changes around them
- Measuring length with a ruler

## Teaching and learning materials

- a potted plant near a window
- seedlings and cardboard boxes with a small opening
- moist containers or trays
- rulers
- chalk and board

## References

Ministry of Education (CDC) Form 2 Biology syllabus and module; 25Schools learners' note: Auxins, phototropism and geotropism.

## Lesson development

| Stage and time | Teacher activities | Learner activities |
|---|---|---|
| **Introduction 5 min** | Show or describe a plant near a classroom window with its shoot bent towards the light. Ask why it bends and tell learners that plants cannot move but they respond to their surroundings. | Suggest reasons and copy the title and key words. |
| **Development: stimulus, response and auxin 8 min** | Define stimulus, response, hormone, auxin and elongation. Explain that in shoots auxin stimulates cells to elongate, while in roots a higher concentration inhibits elongation. | Copy the definitions and the two statements about auxin. |
| **Development: light and phototropism 10 min** | Explain that the side of the shoot in the shade has more auxin, so its cells elongate more and the shoot bends towards the light. Describe the experiment with seedlings A, B and C. | Draw a bending shoot and mark the side with more auxin. |
| **Development: gravity and geotropism 12 min** | Show how auxin moves to the lower side when a seedling lies on its side. Explain why the shoot bends up and the root bends down. Work the data example on the best concentration for roots and shoots. | Draw a horizontal seedling, mark the lower side, and give the best concentration for each organ. |
| **Conclusion 5 min** | Ask how learners would plan an experiment on the effects of light and gravity. Set the homework. | Answer orally and copy the homework. |

## Teacher's content notes

Read these before the lesson. They are what you need to know, not what to copy onto the board.

### Stimulus, response and auxin

Plants adapt to changing conditions in their environment. A stimulus is a change such as light or gravity. The plant responds by growing in a certain direction. Chemical substances called hormones coordinate these growth responses. The hormone that does this in shoots and roots is auxin. Auxin works differently in different organs. In shoots, auxin stimulates cells to elongate. In roots, a higher concentration of auxin inhibits cell elongation. Elongation is growth of cells in length.

### Light and phototropism

Phototropism is growth of a plant part in response to light. A plant near a window has its shoot bending towards the light. This is because the side of the shoot in the shade has more auxin, so its cells elongate more than the cells on the lit side. The shoot therefore bends towards the light. Shoots grown in darkness become long, pale and weak. You can test this by growing seedlings in three ways: seedling A where it gets light evenly,

seedling B in a cardboard box with a small opening on one side, and seedling C in a sealed box covered with foil. After 3 to 5 days, measure the shoot length a

### Gravity and geotropism

Geotropism is growth of a plant part in response to gravity. When a seedling lies on its side, gravity causes auxin to move towards the lower side of the organ. In the shoot, the lower side has more auxin and grows faster, so the shoot bends upwards. In the root, the high auxin on the lower side inhibits elongation, so the upper side grows faster and the root bends downwards. To investigate, germinate seeds, place seedlings horizontally in a moist container, keep one still and put another on a slowly rotating turntable if you have one, and measure the angle of the shoots and roots over several

### Reading data on auxin

Look at the data: at 1 unit of auxin the root growth rate is high and the shoot growth rate is moderate. At 3 units the shoot growth rate is very high and the root growth rate is low. Find the highest growth rate in the root column: high, at 1 unit. Find the highest growth rate in the shoot column: very high, at 3 units. So the best concentration for roots is 1 unit and for shoots is 3 units.

## Questions to ask during the lesson

| Question | Expected answer |
|---|---|
| A teacher shows a plant near a classroom window whose shoot is bending towards the light, and asks about the words stimulus and response. (a) What is a stimulus. (b) Name the stimulus here. (c) What is the response of the shoot. | (a) A change in the surroundings, such as light or gravity, that a plant responds to. (b) Light. (c) The shoot grows bending towards the light. |
| A learner reads that a plant hormone controls growth in shoots and roots. (a) Name the hormone. (b) What does it do in a shoot. (c) What does a high concentration do in a root. | (a) Auxin. (b) It stimulates cells to elongate. (c) It inhibits cell elongation. |
| A teacher grows seedlings in a dark cupboard at a school in Luangwa to compare them with seedlings in the light. (a) What do shoots grown in darkness look like. (b) What is phototropism. (c) Which side of a shoot near a window has more auxin. | (a) Long, pale and weak. (b) Growth of a plant part in response to light. (c) The side in the shade. |
| A seedling lies on its side in a moist container for several days. (a) Name the response of roots to gravity. (b) Which way do the roots grow. (c) Which way do the shoots grow. | (a) Geotropism. (b) Downwards. (c) Upwards. |

## Worked examples for the board

### Example 1: reading the data on auxin

Look at the data: at 1 unit of auxin the root growth rate is high and the shoot growth rate is moderate. At 3 units the shoot growth rate is very high and the root growth rate is low.

Find the highest growth rate in the root column: high, at 1 unit. Find the highest growth rate in the shoot column: very high, at 3 units. So the best concentration for roots is 1 unit and for shoots is 3 units.

**Example 2: a shoot near a window**

A plant near a window has its shoot bending towards the light. The side of the shoot in the shade has more auxin, so its cells elongate more than the cells on the lit side. The shoot therefore bends towards the light.

**Example 3: a seedling on its side**

Gravity causes auxin to move towards the lower side. In the shoot, the lower side has more auxin and grows faster, so the shoot bends upwards. In the root, the high auxin on the lower side inhibits elongation, so the upper side grows faster and the root bends downwards.

## Board plan

Write the title and key words. Left: a shoot bending towards a window with the shaded side marked. Centre: a horizontal seedling with the lower side marked. Right: a table of auxin in shoots and roots.

| Organ | What auxin does | Result in the note |
|---|---|---|
| Shoot | Stimulates cells to elongate | Lower side grows faster, so the shoot bends upwards |
| Root | A higher concentration inhibits cell elongation | Upper side grows faster, so the root bends downwards |
| Shoot near a window | The shaded side has more auxin | The shoot bends towards the light |

The effect of auxin in shoots and roots

## Mistakes to expect

| Learners often think | Put it right |
|---|---|
| The lit side of a shoot has more auxin. | The side of the shoot in the shade has more auxin, so its cells elongate more and the shoot bends towards the light. |
| Auxin has the same effect in shoots and roots. | Auxin works differently in different organs. In shoots it stimulates cells to elongate. In roots a higher concentration inhibits cell elongation. |
| Shoots grown in darkness are short and green. | Shoots grown in darkness become long, pale and weak. |
| Roots grow down because they are heavy. | Gravity makes auxin move to the lower side. The high auxin there inhibits elongation, so the upper side grows faster and the root bends downwards. |

## Differentiation

### Learners who struggle

Give learners a drawing of a horizontal seedling with the lower and upper sides labelled, and let them write which side has more auxin and which side grows faster in the root and in the shoot.

### Learners who finish early

Ask learners who finish early to plan how they would test the effect of gravity using one still seedling and one on a slowly rotating turntable, and what they would measure.

### Hearing or visual impairment

For learners with visual impairment, let them feel a seedling that has been bent and a pale, long seedling from darkness, and describe the diagrams aloud. For learners with hearing impairment, write each key word on the board and draw the arrows showing the direction of bending.

### No projector, no printing

Use a seedling in a cup near a window, and a box with a small opening cut in one side. Draw the diagrams on the board.

### If time is short

Teach stimulus, response and auxin, then explain phototropism with the shoot near a window. Leave geotropism and the data example for the next lesson.

## Evaluation

| Question or task | A correct answer shows |
|---|---|
| A potted plant stands near a window in a classroom at Kapoche school and its shoot bends towards the window. (a) What is the stimulus. (b) On which side of the shoot is there more auxin. (c) Explain why this makes the shoot bend towards the window. | (a) Light. (b) The side in the shade, away from the window. (c) The cells on the shaded side elongate more than those on the lit side, so the shoot bends towards the light. |
| A seed lands on its side in the soil at a school in Luangwa, and after some days the root grows down and the shoot grows up. (a) Name the stimulus. (b) Explain why the shoot bends upwards. (c) Explain why the root bends downwards. | (a) Gravity. (b) Auxin moves to the lower side, which grows faster in the shoot. (c) The high auxin on the lower side inhibits elongation in the root, so the upper side grows faster and the root bends downwards. |
| A learner in Lusaka reads a table in which at 1 unit of auxin the root growth rate is high and the shoot growth rate is moderate, and at 3 units the shoot growth rate is very high and the root growth rate is low. (a) Which concentration is best for the root. (b) Which is best for the shoot. (c) Say how you found each. | (a) 1 unit. (b) 3 units. (c) Find the highest growth rate in each column. |

**Homework**

A girl in a village grows three seedlings: A where it gets light evenly, B in a cardboard box with a small opening on one side and C in a sealed box covered with foil. (a) What would you measure after 3 to 5 days. (b) Which seedling should be long, pale and weak. (c) Which seedling should bend towards the opening.

## Extra practice with answers

| Question | Answer |
|---|---|
| 1. A potted plant stands near a window in a classroom at Kapoche school and its shoot bends towards the window. (a) What is the stimulus. (b) On which side of the shoot is there more auxin. (c) Explain why this makes the shoot bend towards the window. | (a) Light. (b) The side in the shade. (c) The cells there elongate more than those on the lit side, so the shoot bends towards the light. |
| 2. A teacher grows seedling A in even light, seedling B in a box with a small opening on one side and seedling C in a sealed box covered with foil. (a) Which seedling gets light evenly. (b) Which seedling is in total darkness. (c) What would you measure after 3 to 5 days. | (a) Seedling A. (b) Seedling C. (c) The shoot length and the angle of bending. |
| 3. A seedling placed horizontally in a moist container at a school in Luangwa shows both shoot and root growth after some days. (a) Where does auxin move because of gravity. (b) What happens to the shoot. (c) What happens to the root. | (a) Towards the lower side of the organ. (b) The lower side grows faster, so the shoot bends upwards. (c) The high auxin inhibits elongation on the lower side, so the upper side grows faster and the root bends downwards. |
| 4. A learner sees a table in which a root grows fastest at 1 unit of auxin and a shoot grows fastest at 3 units. (a) What is the best concentration for the root. (b) What is the best concentration for the shoot. (c) Say what a higher concentration of auxin does in a root. | (a) 1 unit. (b) 3 units. (c) It inhibits cell elongation. |

## Answers to the learners' check-yourself questions

1. What is auxin?
   **A plant hormone that coordinates growth responses.**
2. What does auxin do in a shoot?
   **It stimulates cells to elongate.**
3. What does a high auxin concentration do in a root?
   **It inhibits cell elongation.**
4. What do shoots grown in darkness look like?
   **Long, pale and weak.**

5. Name the response of roots to gravity.
   **Geotropism; the roots grow downwards.**
6. A potted plant stands near a window in a classroom at Kapoche school and its shoot bends towards the window. (a) What is the stimulus? (b) On which side of the shoot is there more auxin? (c) Explain why this makes the shoot bend towards the window.
   **(a) Light. (b) The shaded side, away from the window. (c) Auxin stimulates elongation, so the shaded cells grow longer than the lit cells and the shoot bends towards the light.**
7. A bean seedling is laid on its side in a moist container for five days. (a) Which way does the root bend and which way does the shoot bend? (b) Say where the auxin collects. (c) Explain why the root and the shoot respond differently.
   **(a) The root bends down and the shoot bends up. (b) On the lower side of both. (c) In the shoot more auxin stimulates growth on the lower side, but in the root the high auxin inhibits elongation, so the upper side grows faster.**

## Teacher's reflection

What went well:

What I will change next time:

Learners who need follow-up: