Control and coordination

4.5.4.1 · Homeostasis and response · revision notes

How auxin makes shoots and roots grow towards or away from light and gravity, what gibberellins and ethene do (Higher tier), and the required practical on seedling growth. Expect 'explain why the shoot bends' questions, planning questions and results analysis. This subtopic is in GCSE Biology only.

Key facts

- Phototropism = growth response to light; gravitropism (geotropism) = growth response to gravity
- Unequal distribution of auxin → unequal growth → bending
- Roots: auxin inhibits cell elongation
- Grade 7+ only Gibberellins: initiate seed germination
- Shoots: towards light, against gravity. Roots: in the direction of gravity
- Shoots: auxin stimulates cell elongation
- Light from one side → auxin moves to the shaded side → shaded side grows faster → bends towards light
- Grade 7+ only Ethene: cell division and fruit ripening

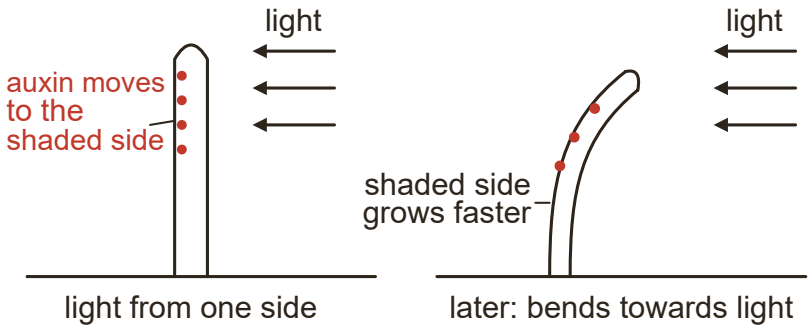
Notes

Plant hormones and tropisms

- Plants produce **hormones** to coordinate and control growth, and their responses to **light** (**phototropism**) and **gravity** (**gravitropism**, also called geotropism).
- Shoots grow **towards light** and **against gravity**. Roots grow **in the direction of gravity** (downwards).
- This helps shoots absorb more light for photosynthesis, so more glucose is made, and helps roots anchor the plant and reach water and mineral ions.
- **Unequal distributions of auxin** cause unequal growth rates in roots and shoots, so they bend.

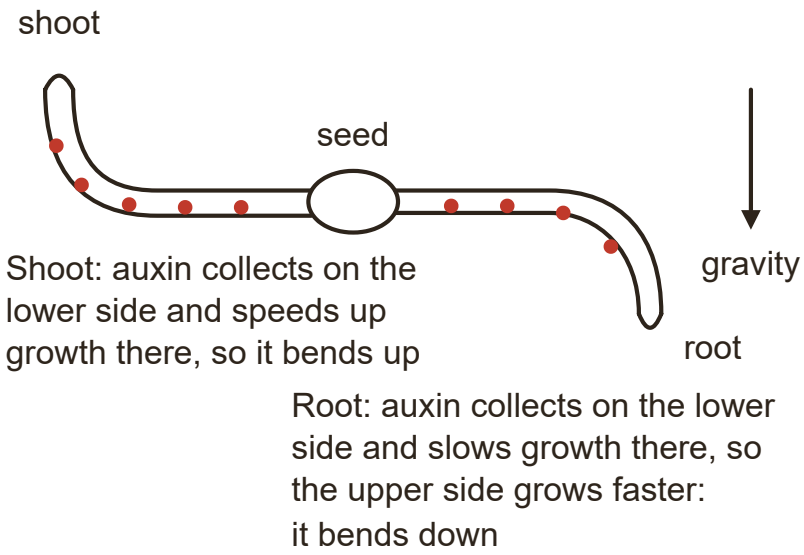
How auxin works

- Auxin is made in the tip of a shoot or root and moves into the region just behind the tip.
- In **shoots**, auxin **stimulates cell elongation**. In **roots**, a high concentration of auxin **inhibits** cell elongation.
- **Light from one side**: auxin moves to the **shaded side** of the shoot. Cells there elongate faster, so the shoot bends **towards the light**.



Phototropism: auxin on the shaded side makes those cells elongate more.

- **Shoot lying on its side**: auxin collects on the **lower side**. Cells there elongate faster, so the shoot bends **upwards**.
- **Root lying on its side**: auxin collects on the **lower side**, where it inhibits growth. The upper side grows faster, so the root bends **downwards**.



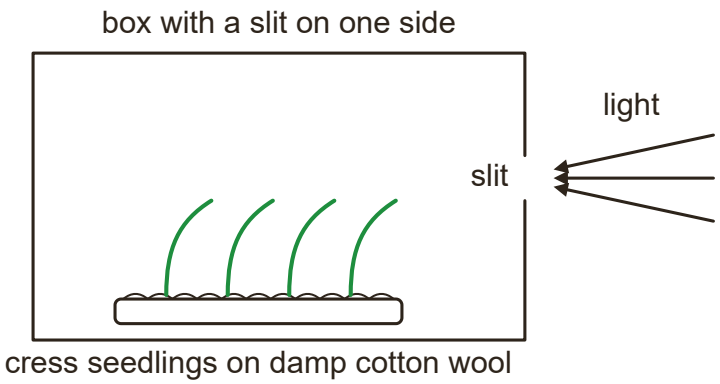
Gravitropism: the same auxin distribution makes shoots bend up and roots bend down.

Other plant hormones Grade 7+ only

- **Gibberellins** are important in **initiating seed germination**.
- **Ethene** (a gas) controls **cell division** and the **ripening of fruits**.

Required practical: seedling growth

- Germinate the same number of seeds, such as cress, on damp cotton wool in each Petri dish.
- Light: put one dish in a box with a slit so light comes from one side, one in all-round light and one in the dark.



Light from one side: the seedlings grow towards the slit.

- Gravity: fix germinating seeds to damp cotton wool and turn the dish on its side, keeping it in the dark so light does not affect the result.
- Measure the length of each seedling with a ruler every day for several days and calculate a mean for each dish.
- Record results as **both** length measurements and careful, **labelled biological drawings** that show the direction of growth.
- Control the type of seed, temperature and volume of water.

How to answer each type of question

Explain why a shoot bends towards light

3 marks **Grade 6**

1. Say where auxin goes: the shaded side.
2. Say what auxin does in shoots: stimulates cell elongation.
3. Say which side grows faster and which way the shoot bends.

Example. A seedling is left on a windowsill so that light reaches it from one side only. After two days, the shoot has bent towards the window.
Explain why.

Model answer. Auxin moves to the shaded side of the shoot (1). Auxin stimulates cell elongation, so cells on the shaded side grow longer (1). The shaded side grows faster than the lit side, so the shoot bends towards the light (1).

Explain the response of a root to gravity

3 marks | Grade 7

1. Say that auxin collects on the lower side.
2. Say that in roots auxin inhibits cell elongation.
3. So the upper side grows faster and the root bends downwards.

Example. A germinating bean is placed on its side. After a day, its root has started to grow downwards.
Explain how auxin causes this.

Model answer. Auxin collects on the lower side of the root (1). In roots, auxin inhibits cell elongation, so the lower side grows more slowly (1). The upper side grows faster, so the root bends downwards (1).

6-mark: plan the seedling investigation

6 marks | Grade 5

1. Describe the set-up for each condition, including a comparison (control) dish.
2. Name the control variables.
3. Say what you measure (length, with a ruler), when, and what you observe (direction of growth).
4. Say how you would process the results, e.g. a mean length for each dish.

Example. Describe how you could investigate the effect of light from one direction on the growth of newly germinated cress seedlings.

Model answer.

Indicative content: place the same number of cress seeds on damp cotton wool in three Petri dishes; let them germinate; put one dish in a box with a slit so light enters from one side, one in all-round light and one in the dark; keep the temperature and the volume of water added the same for each dish; after several days measure the length of each seedling with a ruler; calculate a mean length for each dish; record the direction in which the seedlings grow, with careful, labelled biological drawings; compare the dishes.
Level 3 (5 to 6 marks): a detailed, logical method that would give valid results, including control variables and both measurements and observations.
Level 2 (3 to 4 marks): a method with some detail but missing key steps or controls.
Level 1 (1 to 2 marks): simple statements, e.g. 'shine a light on some seedlings'.

Recall other plant hormones

1 mark each | Grade 7

1. Germination: gibberellins.
2. Fruit ripening and cell division: ethene.

Example. Name the plant hormone that:
(a) initiates seed germination
(b) controls the ripening of fruits.

Model answer.

(a) Gibberellins / gibberellin (1)
(b) Ethene (1)

Don’t lose marks

- Saying light kills the auxin or the cells on the lit side. Say auxin moves to (builds up on) the shaded side.
- Saying auxin makes shoot cells 'divide'. Say it makes cells elongate (grow longer).
- Forgetting that auxin has the opposite effect in roots.
- Explaining why bending is useful (to photosynthesise) when the question asks how it happens.
- In the practical, only measuring length. Also make labelled drawings that show the direction of growth.

More tips

Memory tricks

- Auxin in shoots: 'grow'. Auxin in roots: 'slow'.
- Auxin hides from light: it gathers on the dark side, which grows longer, so the shoot bends towards the light.
- Photo = light, gravi = gravity, tropism = a growth response.
- Gibberellins get seeds going; ethene gets fruit ripe.

Exam technique

- Use the three-step chain: where auxin goes → its effect on cell elongation → which side grows faster and which way it bends.
- Always say whether you mean a shoot or a root: auxin has opposite effects in each.
- In practical questions, name specific control variables (seed type, temperature, volume of water) and say exactly what you would measure.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Define phototropism and gravitropism**
Phototropism is a growth response to light; gravitropism (geotropism) is a growth response to gravity.

Grade 4 — **Describe how shoots and roots respond**
Shoots grow towards light and against gravity; roots grow downwards, in the direction of gravity.

Grade 5 — **Describe the seedling growth practical**

Grow seedlings with light from one side, or on their side, and record both lengths and direction of growth.

Grade 6

Explain phototropism using auxin

Auxin moves to the shaded side, where cells elongate faster, so the shoot bends towards the light.

Grade 7

Explain gravitropism in shoots and roots

Auxin collects on the lower side: it speeds up growth in shoots but slows it in roots.

Grade 7

State the roles of gibberellins and ethene

Gibberellins initiate seed germination; ethene controls cell division and the ripening of fruit.

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