DP Biology – C3.1 (HL extension)

How plants respond and grow

- What do nerves and hormones each do to coordinate body systems?
- How does feedback help to control body systems?

HL statements C3.1.17–23 (plants). Textbook pp. 509–517.



Image: an orchid on a windowsill, leaning towards the light. Tangopaso, CC BY-SA 3.0.

Objectives for each class

Class	Statements	By the end of the class, you can...
1	C3.1.17–18	Observe and measure tropic responses, and explain positive phototropism
2	C3.1.19–20	Describe phytohormones, and explain how auxin efflux carriers set up gradients
3	C3.1.21	Explain how auxin makes cells elongate, and how this causes bending
4	C3.1.22	Explain how auxin and cytokinin coordinate root and shoot growth
5	C3.1.23	Explain positive feedback between ethylene and fruit ripening

Observing tropic responses

C3.1.17

- A **tropism** is directional growth in response to a directional stimulus
- Grow cress or oat seedlings in the dark, then light them from one side only
- Record **qualitative** data: draw the seedlings every few hours
- Record **quantitative** data: measure the angle of curvature with a protractor
- Controls: seedlings lit from above, and seedlings kept in the dark



A houseplant curving towards a window. Tangopaso, CC BY-SA 3.0.

Fair test

Same species, age, compost, water and temperature; same light intensity and distance. Measure many seedlings and find the mean angle.

Recording the results

Time / h	Lit from one side	Lit from above	Dark
0	0	0	0
4	12	1	0
8	28	2	1
12	41	1	0
24	58	2	1

Invented example: mean angle of curvature / degrees, 20 seedlings each.

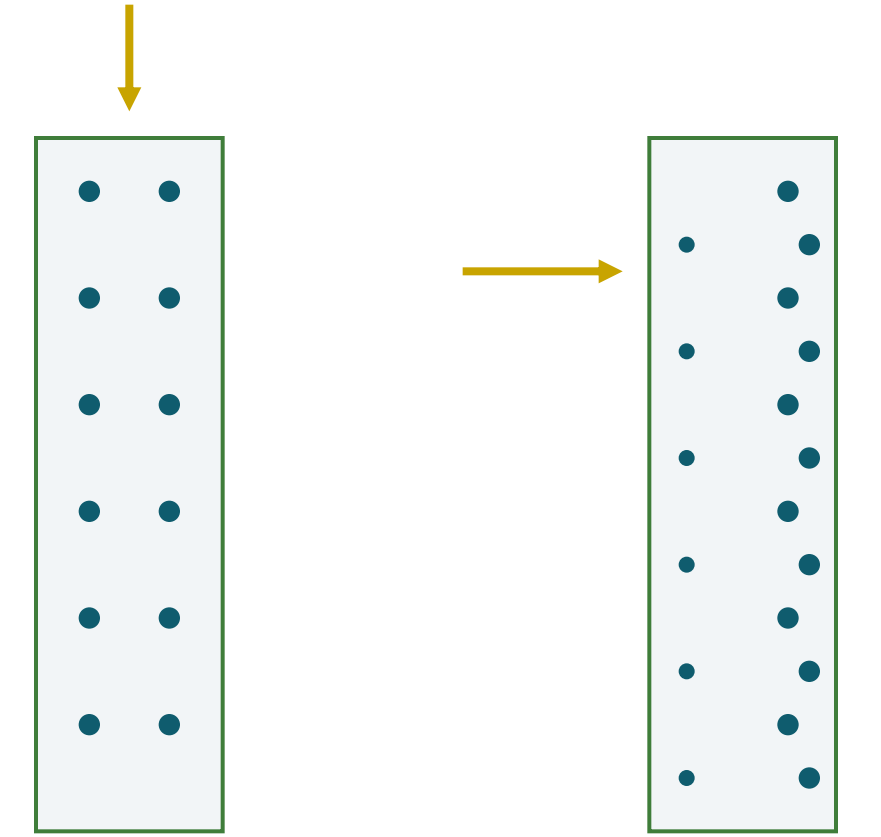
Try it

Plot these results. Describe the trend for one-sided light, and explain why the other two groups are needed.

Safety and ethics

Seedlings are easy to grow and dispose of; wash hands after handling compost.

Positive phototropism



Dots: auxin. Simplified shoot tips, before bending.

- Light from one side is detected by **phototropin** receptors near the shoot tip
- Auxin is moved to the **shaded** side
- Cells on the shaded side elongate more
- The shoot bends **towards** the light: positive phototropism
- Leaves then get more light for photosynthesis

Phytohormones

C3.1.19

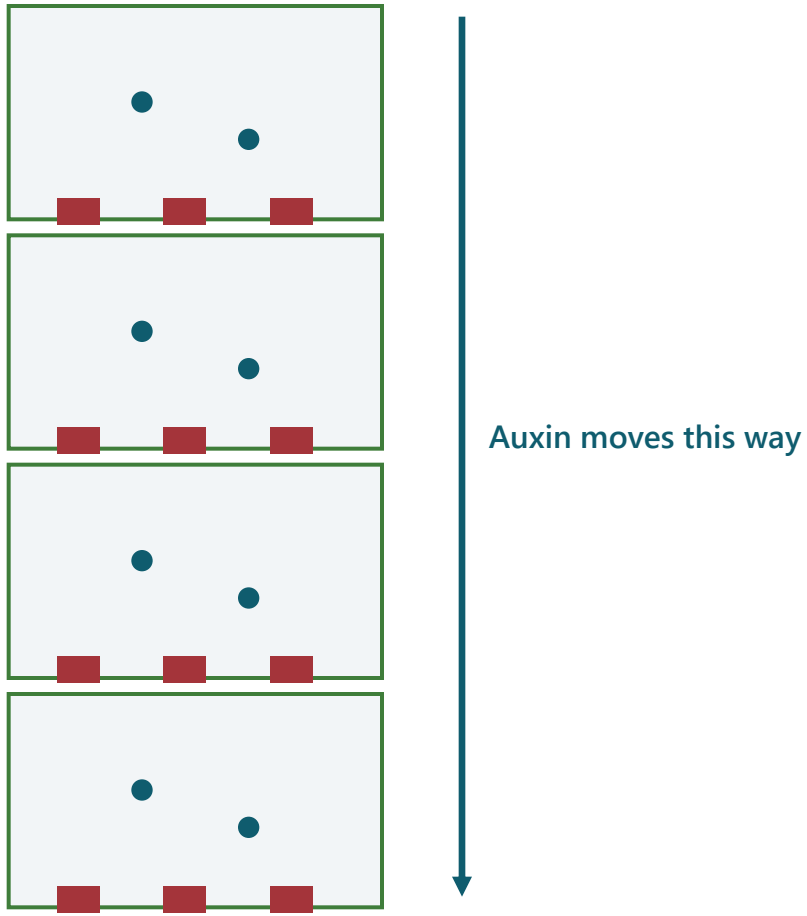
Phytohormone	Example of its effects
Auxin	Cell elongation; tropisms; apical dominance; root formation
Cytokinin	Cell division; growth of side buds
Gibberellin	Stem elongation; seed germination
Ethylene	Fruit ripening; leaf fall
Abscisic acid	Stomatal closure in drought; seed dormancy
Jasmonic acid	Defence against insects; closing of a Venus flytrap

Key idea

Plants use many signalling chemicals, often together, and each can have several effects.

Auxin efflux carriers

C3.1.20

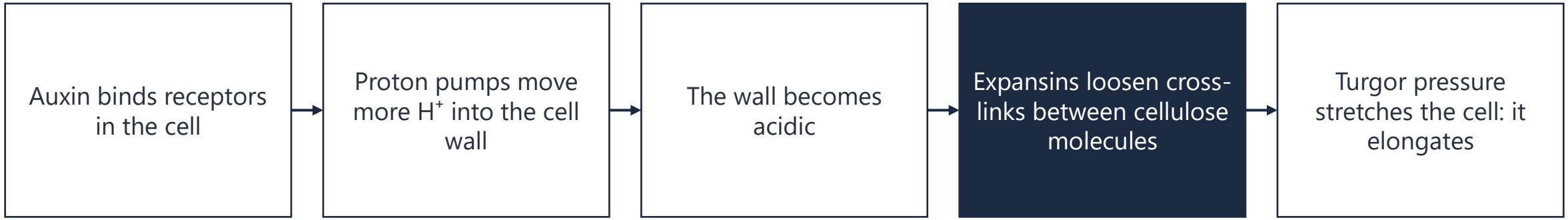


Red: efflux carriers, all on the same side of each cell. Dots: auxin.

- Auxin enters cells easily, by diffusion, but cannot diffuse out
- It leaves only through **auxin efflux carriers** (PIN proteins) in the plasma membrane, using energy
- Each cell puts its carriers on one side
- If neighbouring cells all use the same side, auxin is passed from cell to cell in one direction
- Auxin builds up where it is needed: a **concentration gradient**

How auxin makes cells grow

C3.1.21



Phototropism explained

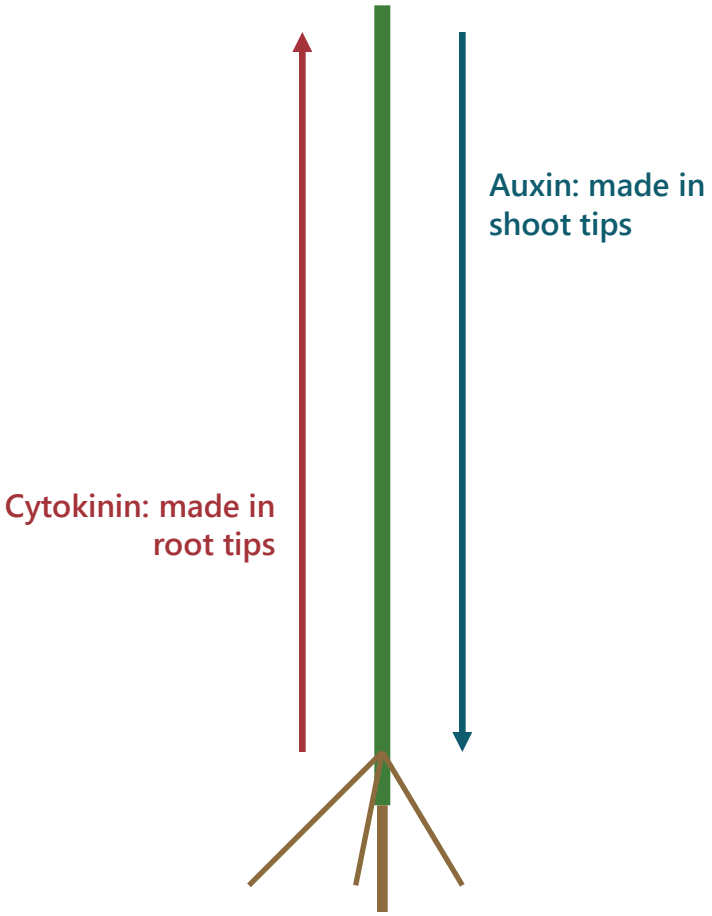
More auxin on the shaded side means more H^+ pumped into the walls there, so those cells elongate faster than cells on the lit side. The difference in growth rate bends the shoot.

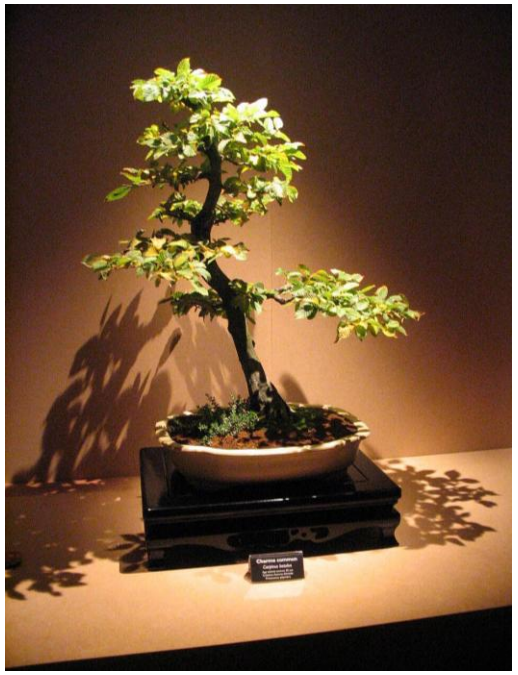
Concentration matters

The concentrations of auxin that speed up growth in shoots can slow growth in roots. The same hormone can have opposite effects in different tissues.

Auxin and cytokinin work together

C3.1.22





Bonsai: pruning shapes growth. Dake, CC BY-SA 2.5.

- Shoot tips make auxin, which travels down to the roots
- Root tips make cytokinin, which travels up to the shoots
- Auxin from the tip stops side buds growing: **apical dominance**
- Cytokinin promotes side buds; the balance decides

Why it matters

A large root system sends more cytokinin up, supporting more shoot growth; a large shoot sends more auxin down. Root and shoot growth stay in proportion.

Ethylene and ripening

C3.1.23



Tomatoes ripening on the plant. Naposia, CC BY-SA 3.0.

- Ripening: starch to sugars, softer flesh, colour change, scent
- Ethylene stimulates ripening, and ripening makes more ethylene: **positive feedback**
- Ethylene diffuses to nearby fruit, so they ripen too

Ripening fruit makes ethylene gas → Ethylene stimulates ripening → Ripening increases ethylene production

Why positive feedback helps

C3.1.23

Benefit to the plant

Ripening is fast and all the fruits ripen at the same time. Animals are attracted to a whole crop of ripe fruit at once and disperse many seeds.

Uses

Bananas are picked green, shipped cold, then ripened with ethylene in ripening rooms. Ethylene absorbers in packaging slow ripening. One rotten apple can ripen a whole barrel.

Compare

Positive feedback also controls childbirth (D3.1) and quorum sensing (C2.1). In each case a fast, complete change is useful.

Check that you can explain

1. How to observe and measure tropic responses in seedlings
2. How shoots grow towards light from one side
3. Examples of phytohormones and their effects
4. How auxin efflux carriers set up concentration gradients
5. How auxin causes cell elongation (acid growth)
6. How auxin and cytokinin coordinate root and shoot growth
7. Why positive feedback in ripening is useful

Exit activity: 5 minutes

On your own and without notes. Hand this in as you leave.

1. Define positive phototropism.
2. Explain how auxin causes cells to elongate.
3. Explain why fruits on a plant ripen at the same time.

Image credits

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Bonsai IMG 6426.jpg – Dake – CC BY-SA 2.5

Ripening tomatoes.jpg – Naposia – CC BY-SA 3.0

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