Topic 5: Homeostasis and response

AQA GCSE Biology 8461 · spec 4.5 · sheets 5.1–5.4

Homeostasis and response: keeping conditions steady

- describe how control systems use **receptors**, **coordination centres** and **effectors**;
- explain how the nervous system and reflex arcs work, and measure reaction time;
- (biology only) describe the brain and the eye, and how body temperature is controlled;

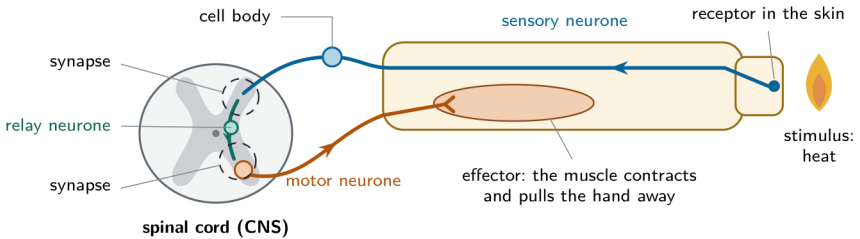
Homeostasis and response: keeping conditions steady (2)

- explain how hormones control blood glucose, water balance and the menstrual cycle, and how fertility can be controlled;
- (biology only) explain how plant hormones control growth, and their uses.

Control systems and the nervous system

- **receptors** , which detect changes, called **stimuli** ;
- **coordination centres** , such as the brain, the **spinal cord** and the **pancreas** , which receive and process the information;
- **effectors** , muscles or glands, which bring about responses that restore the best conditions.

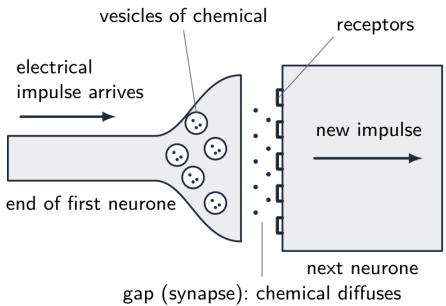
Figure: Control systems and the nervous system



arrows: direction of the impulses; the conscious part of the brain is not involved

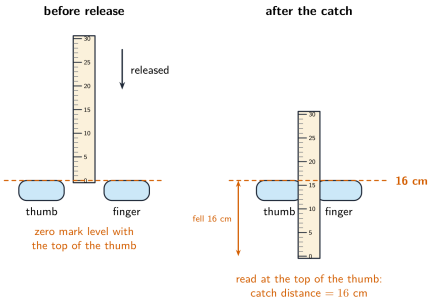
- Spinal withdrawal reflex: impulses pass from the receptor to the effector through the **spinal cord**; the conscious part of the brain is not involved.
- Match each part of the diagram to the text.

Figure: Control systems and the nervous system (2)



- A chemical crosses the gap and triggers a new electrical impulse in the next **neurone**.
- Match each part of the diagram to the text.

Figure: Control systems and the nervous system (3)

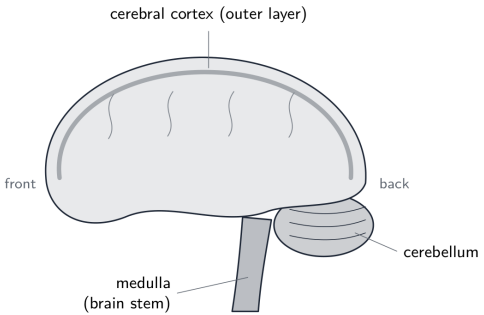


- The zero mark starts at thumb level; catch distance is read at the thumb.
- Match each part of the diagram to the text.

The brain (biology only)

- the **cerebral cortex** : consciousness, intelligence, memory and language;
- the **cerebellum** : balance and muscle coordination;
- the **medulla** : unconscious activities such as the heartbeat and breathing.

Figure: The brain (biology only)



- The brain from the side: **cerebral cortex**, **cerebellum** and **medulla**
- Match each part of the diagram to the text.

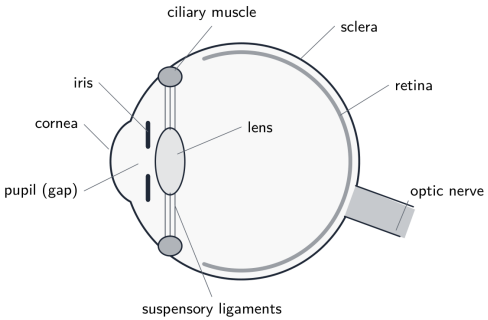
The eye (biology only)

- The **retina** contains receptor cells sensitive to light intensity and colour.
- The **optic nerve** carries impulses from the **retina** to the brain.
- The **sclera** is the tough white outer layer.

The eye (biology only) (2)

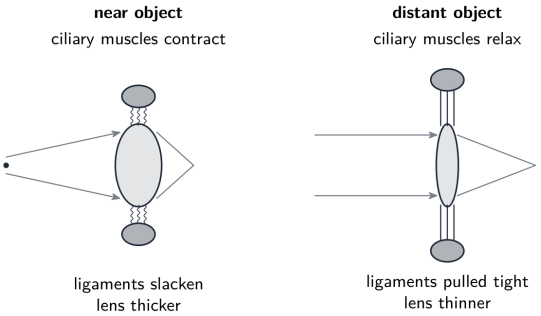
- The **cornea** is the transparent front, which refracts light into the eye.
- The **iris** controls the size of the **pupil** , the hole that lets light in.
- Ciliary muscles and suspensory ligaments change the shape of the **lens** .

Figure: The eye (biology only)



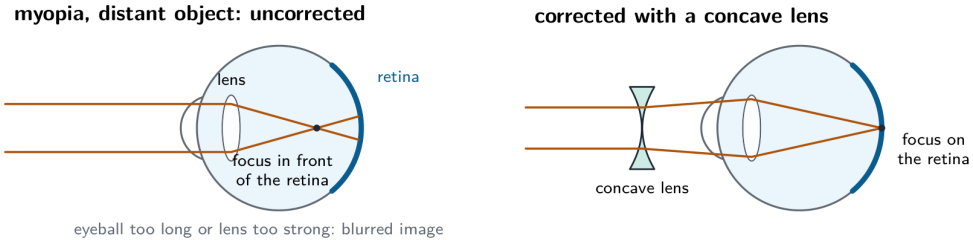
- Eye section: the **pupil** is an opening; ligaments connect ciliary muscles to the **lens**.
- Match each part of the diagram to the text.

Figure: The eye (biology only) (2)



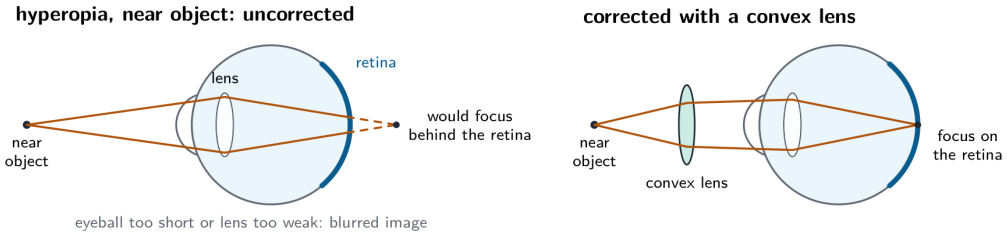
- Near and distant focusing: muscle contraction changes ligament tension and **lens** shape.
- Match each part of the diagram to the text.

Figure: The eye (biology only) (3)



- **Myopia**: light from a distant object focuses in front of the **retina**; a **concave lens** corrects it
- Match each part of the diagram to the text.

Figure: The eye (biology only) (4)



- **Hyperopia**: light from a near object would focus behind the **retina**; a **convex lens** corrects it
- Match each part of the diagram to the text.

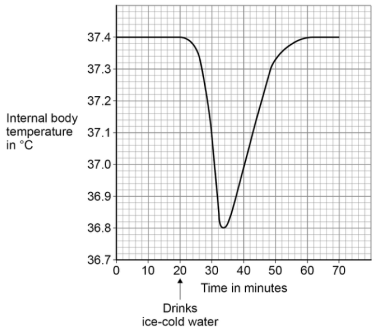
Controlling body temperature (biology only)

- the blood vessels supplying the skin capillaries widen (**vasodilation**), so more blood flows near the surface and more energy is transferred to the surroundings;
- **sweat glands** release more **sweat** , which transfers energy away from the skin as it evaporates.
- the blood vessels supplying the skin capillaries narrow (**vasoconstriction**), so less blood flows near the surface and less energy is lost;

Controlling body temperature (biology only) (2)

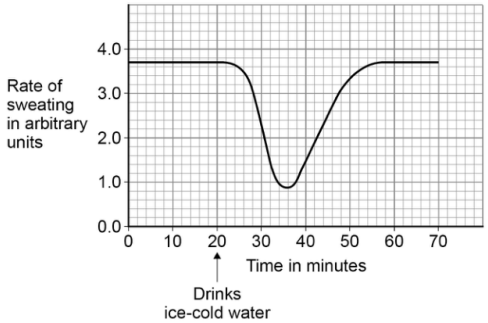
- sweating stops;
- skeletal muscles contract and relax rapidly (shivering), and the extra respiration releases energy that warms the body.

Figure: Controlling body temperature (biology only)



- Core body temperature before and after drinking ice-cold water at 20 minutes (AQA GCSE Biology Paper 2H, June 2021, Figure 5)
- Read the axes and units first.

Figure: Controlling body temperature (biology only) (2)

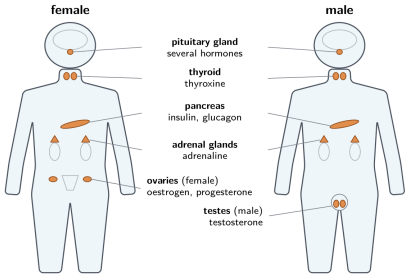


- Rate of sweating before and after drinking ice-cold water (AQA GCSE Biology Paper 2H, June 2021, Figure 6)
- Read the axes and units first.

Hormones and blood glucose

- If it is too high, the **pancreas** releases **insulin** . **Insulin** makes glucose move from the blood into cells. In the **liver** and muscles, extra glucose is turned into **glycogen** for storage. Blood glucose falls.
- (HT) If it is too low, the pancreas releases **glucagon** . Glucagon makes the liver turn glycogen back into glucose and release it into the blood. Blood glucose rises.

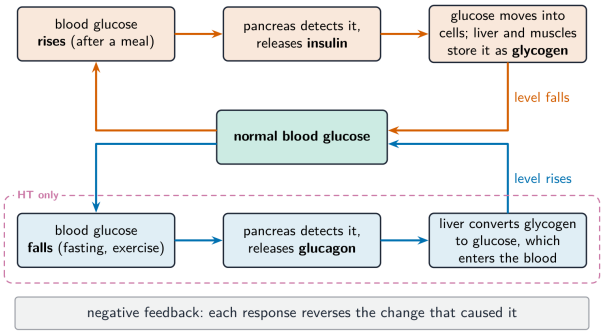
Figure: Hormones and blood glucose



schematic positions, not to scale; kidneys drawn faintly below the adrenal glands

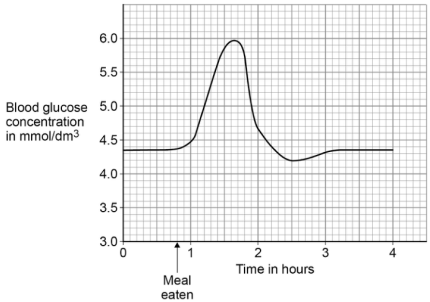
- Where the endocrine glands are, in a female and a male body
- Match each part of the diagram to the text.

Figure: Hormones and blood glucose (2)



- **Insulin** lowers high blood glucose; the HT **glucagon** branch raises low blood glucose.
- Match each part of the diagram to the text.

Figure: Hormones and blood glucose (3)

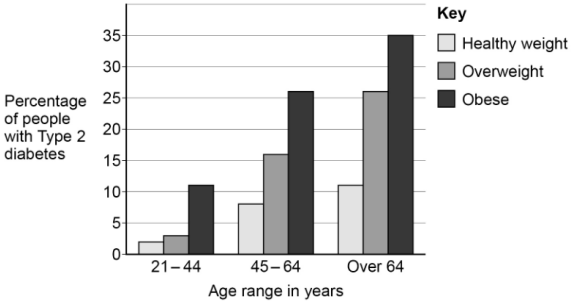


- Blood glucose concentration for four hours after a meal (AQA GCSE Biology Paper 2H, June 2022, Figure 2)
- Match each part of the diagram to the text.

Diabetes

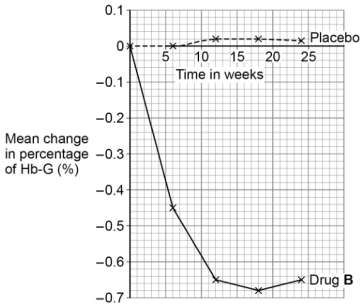
- **Worked example 4.** Person C has a blood glucose concentration of 9.56 mmol/dm^3 (normal mean 4.51) and an **insulin** level of 24.32 arbitrary units (normal mean 14.83).
- Both are higher than normal.
- High glucose despite plenty of insulin suggests that C's cells are not responding to insulin, so C might have **Type 2 diabetes**.
- Further tests would be needed to be sure.

Figure: Diabetes



- Percentage of people with **Type 2 diabetes** by age and weight category (AQA GCSE Biology Paper 2H, June 2025, Figure 10)
- Match each part of the diagram to the text.

Figure: Diabetes (2)

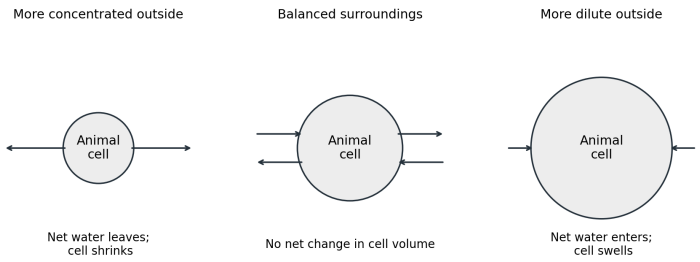


- Change in Hb-G for drug B and a placebo over 24 weeks (AQA GCSE Biology Paper 2H, June 2025, Figure 11)
- Read the axes and units first.

Water and nitrogen balance (biology only)

- **Why water balance matters.** If the fluid around cells becomes more concentrated than the cytoplasm, the cells lose water by osmosis and shrink; if it becomes more dilute, they gain water and swell.
- Either way, they stop working properly.
- Water leaves the body from the lungs in exhaled air, from the skin in **sweat** (with ions and a little **urea**), and from the kidneys in urine.
- We cannot control the losses from the lungs and skin, so the kidneys adjust the volume and concentration of urine.

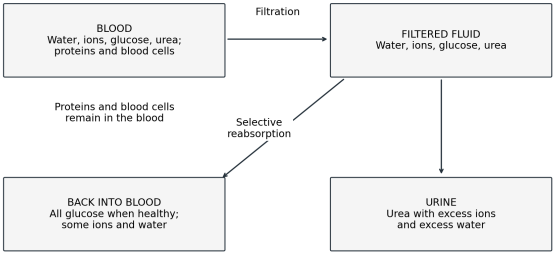
Figure: Water and nitrogen balance (biology only)



Arrows show net movement, except the balanced case: water moves both ways.

- Animal-cell volume responds to net osmotic water movement.
- Match each part of the diagram to the text.

Figure: Water and nitrogen balance (biology only) (2)



Functional process, not anatomy.

- Functional **filtration** and **selective reabsorption**, not anatomical structures.
- Match each part of the diagram to the text.

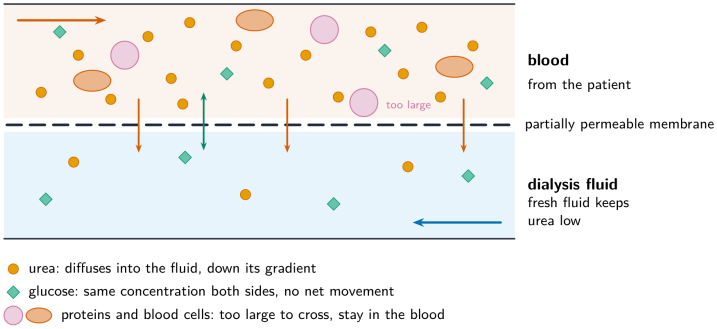
Figure: Water and nitrogen balance (biology only) (3)

Table 2

Concentration of ADH in the blood in nanograms/dm^3	Concentration of dissolved substances in urine in arbitrary units	Rate of urine production in cm^3/minute
0.0	50	20.0
1.25	700	8.8
2.50	980	3.9
3.75	1110	1.8
5.00	1170	0.9

- **ADH** concentration, urine concentration and urine production rate before and after drinking water (AQA GCSE Biology Paper 2H, June 2023, Table 2)
- Match each part of the diagram to the text.

Figure: Water and nitrogen balance (biology only) (4)



- A **urea** gradient, matched glucose concentrations and a partially permeable membrane.
- Match each part of the diagram to the text.

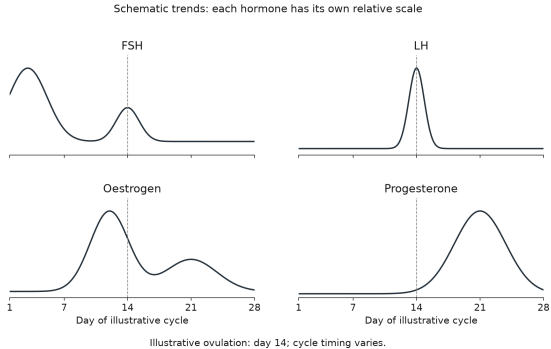
Hormones in human reproduction

- During puberty, reproductive hormones cause secondary sexual characteristics to develop. **Oestrogen** , made by the **ovaries**, is the main female reproductive **hormone**; eggs begin to mature, and about every 28 days one is released by **ovulation** . **Testosterone** , made by the **testes**, is the main male reproductive hormone and stimulates sperm production.
- **The menstrual cycle.**

Hormones in human reproduction (2)

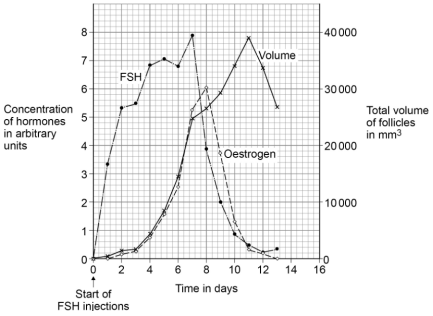
- **How the hormones interact (HT). FSH** makes an egg mature and stimulates the ovary to produce **oestrogen**.
- Oestrogen inhibits FSH and, at high levels, stimulates a surge of LH, which causes **ovulation** on about day 14.

Figure: Hormones in human reproduction



- The four hormones of the menstrual cycle, each on its own scale; **ovulation** happens at about day 14
- Match each part of the diagram to the text.

Figure: Hormones in human reproduction (2)



- **Hormone** concentration (left axis) and total follicle volume (right axis) after daily **FSH** injections (AQA GCSE Biology Paper 2H, June 2023, Figure 12)
- Read the axes and units first.

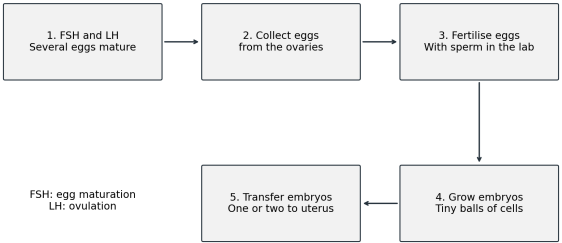
Controlling fertility

- barrier methods, such as **condoms** and **diaphragms**, stop sperm reaching an egg;
- spermicides kill or disable sperm;
- intrauterine devices (coils) prevent the implantation of an embryo or release a **hormone**;

Controlling fertility (2)

- surgical sterilisation is permanent;
- avoiding sex at the time when an egg may be in the oviduct is the least reliable.

Figure: Controlling fertility



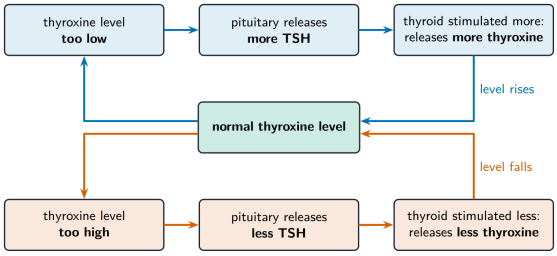
Fertilisation happens in the laboratory; embryos are transferred.

- IVF stages from **hormone** treatment to embryo transfer.
- Match each part of the diagram to the text.

Adrenaline and thyroxine (HT)

- **Adrenaline** is made by the **adrenal glands** in times of fear or stress.
- It increases the heart rate, which delivers more oxygen and glucose to the brain and muscles, preparing the body for "fight or flight".
- **Thyroxine** is made by the **thyroid** gland.
- It increases the basal metabolic rate, the speed of the chemical reactions in the body, and is important for growth and development.

Figure: Adrenaline and thyroxine (HT)



- The pituitary's TSH stimulates the **thyroid**; each response opposes the change, so thyroxine returns to normal.
- Match each part of the diagram to the text.

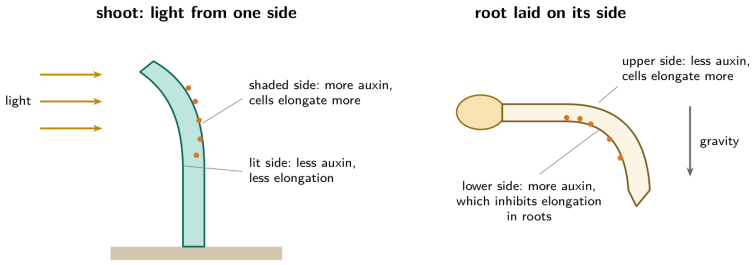
Plant hormones (biology only)

- In a shoot lit from one side, **auxin** collects on the shaded side. Auxin makes shoot cells elongate (grow longer), so the shaded side grows faster and the shoot bends towards the light.
- In a root lying on its side, auxin collects on the lower side. In roots, auxin slows elongation, so the upper side grows faster and the root bends downwards.

Plant hormones (biology only) (2)

- Auxins: rooting powders that make cuttings grow roots; weed killers that make broad-leaved weeds grow out of control; promoting growth in tissue culture.
- Ethene: controls ripening, so fruit can be picked unripe and ripened when it reaches the shops.
- Gibberellins: end seed dormancy so seeds germinate, make plants flower, and increase fruit size.

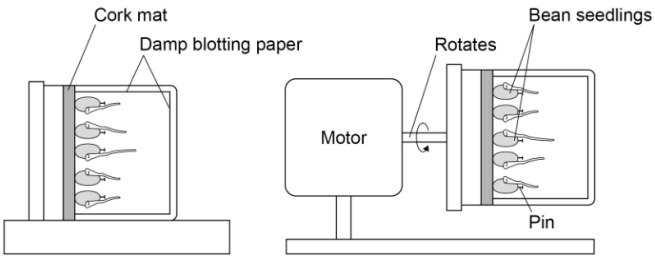
Figure: Plant hormones (biology only)



- Different shoot/root elongation responses to unequal **auxin** distribution.
- Match each part of the diagram to the text.

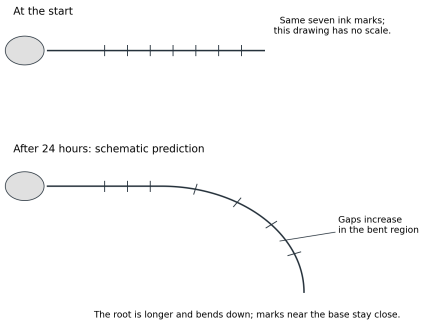
Figure: Plant hormones (biology only) (2)

Figure 6



- Seedling A in a stationary dish and seedling B in a slowly rotating dish (AQA GCSE Biology Paper 2H, June 2024, Figure 6)
- Match each part of the diagram to the text.

Figure: Plant hormones (biology only) (3)



- The predicted root: longer, bent downwards, with the ink marks further apart near the tip
- Match each part of the diagram to the text.

Sources for this lesson

- AQA, *GCSE Biology (8461) specification*, section 4.5 Homeostasis and response, and the required practical handbook.
- F. G. Banting, C. H. Best, J. B. Collip, W. R. Campbell and A. A. Fletcher, "Pancreatic extracts in the treatment of diabetes mellitus", *Canadian Medical Association Journal* 12 (March 1922), pages 141 to 146.
- AQA, *GCSE Biology* Paper 2 Higher (June 2021 to June 2025), the reaction-time, temperature, diabetes, **ADH**, follicle and root-growth questions, adapted.

Common errors

- Saying reflexes involve the conscious brain, or that catching a ruler is a reflex.
- Saying the **pupil** is a muscle; it is a hole controlled by the **iris**.
- Mixing up which **lens** corrects myopia (concave) and hyperopia (convex).

Common errors (2)

- Saying capillaries move closer to the skin; the blood vessels supplying them widen or narrow.
- Saying **sweat** cools you when it is produced; it cools you as it evaporates.
- Confusing **glycogen** (the store), **glucagon** (the hormone) and glucose (the sugar).

Common errors (3)

- Saying the kidneys make **urea**; the **liver** makes it.
- Saying **ADH** makes more urine; it makes less, more concentrated urine.
- Saying light destroys auxin, or applying the shoot rule to roots.

Key terms

- **Homeostasis**: keeping the conditions inside the body steady.
- **Reflex arc**: the pathway of a reflex, from receptor to effector through the **spinal cord**.
- **Synapse**: the gap between two neurones, crossed by a chemical.

Key terms (2)

- **Accommodation**: changing the shape of the **lens** to focus on near or distant objects.
- **Hormone**: a chemical messenger carried in the blood to a target organ.
- **Negative feedback**: a response that reverses a change and returns conditions to normal.

Key terms (3)

- **Selective reabsorption**: taking useful substances back into the blood in the kidney.
- **Ovulation**: the release of an egg from an ovary.
- **Phototropism**: a growth response to the direction of light.

Check yourself

- 1.
- Name the three parts of a control system and give an example of each. 2.
- Describe the pathway of a **reflex arc**. 3. (Biology only) Describe how the eye focuses on a near object. 4.
- Explain what happens when blood glucose rises after a meal. 5.