

Coordination and response

IGCSE Biology 0610 · Topic 14 revision notes

Everything from the 5 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. The nervous system

2. Sense organs and the eye

3. Hormones

4. Homeostasis

5. Tropic responses

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1 The nervous system

Syllabus 14.1

Electrical impulses travel along neurones. The mammalian nervous system is the **central nervous system** (brain and spinal cord) plus the **peripheral nervous system** (all the nerves outside them); together they coordinate and regulate body functions. A **reflex action** automatically and rapidly links a stimulus to the response of an effector (a muscle or gland) through a reflex arc: receptor, sensory neurone, relay neurone, motor neurone, effector. A **synapse** is a junction between two neurones.

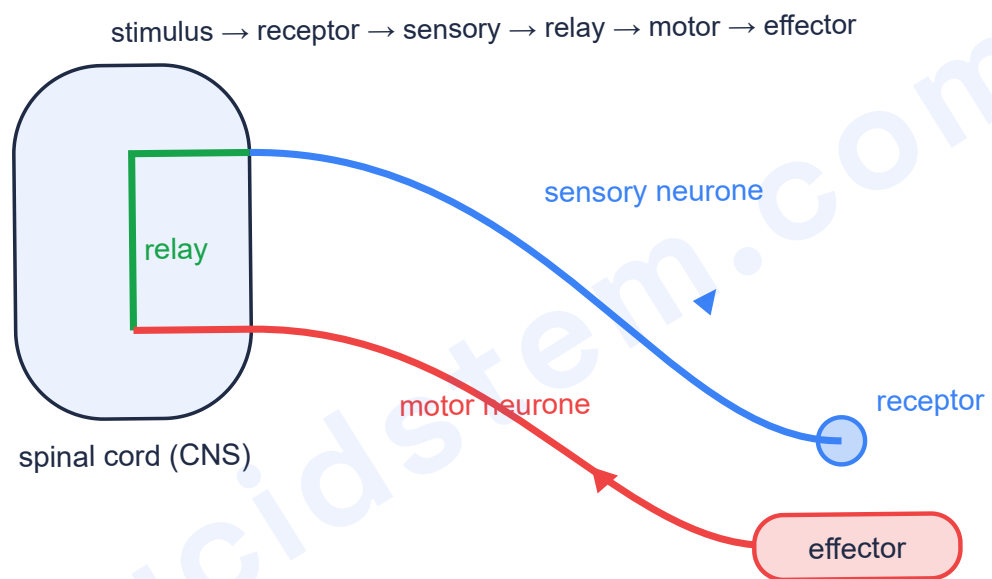


Fig. 1: a simple reflex arc; the relay neurone in the spinal cord links the sensory and motor neurones

Five links, one direction.

- ✓ **CNS:** brain and spinal cord. **PNS:** all the nerves outside them.
- ✓ **Reflex arc:** receptor, sensory neurone, relay neurone, motor neurone, effector.
- ✓ **Effectors** are muscles or glands; receptors detect stimuli.
- ✓ **Synapse (Extended):** release from vesicles, diffusion across the gap, binding to receptor proteins, new impulse.

Watch out!

A nerve and a neurone are not the same thing. A neurone is a single nerve cell; a nerve is a bundle of many neurone fibres.

In a spinal reflex the response does not wait for the brain.

Impulses do also travel up to the brain, which is why you feel the pain a moment after the hand has moved.

Neurotransmitter crosses the gap by diffusion, not as an electrical impulse and not by active transport. The impulse itself never crosses the gap.

2 Sense organs and the eye

Syllabus 14.2

Sense organs are groups of receptor cells responding to specific stimuli: light, sound, touch, temperature and chemicals. In the eye the cornea refracts light, the iris controls how much light enters the pupil, the lens focuses light on to the retina, the retina contains light receptors (some sensitive to different colours) and the optic nerve carries impulses to the brain. The pupil reflex changes pupil diameter as light intensity changes.

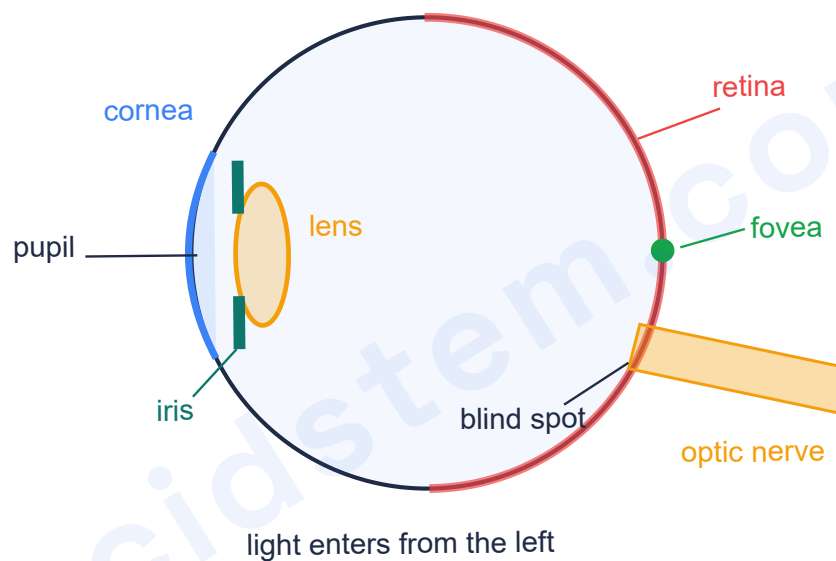


Fig. 1: horizontal section through the human eye; the blind spot is where the optic nerve leaves

Two reflexes, two muscle sets.

- ✓ **Cornea** refracts; **lens** focuses on to the retina; **iris** controls light entering the pupil.
- ✓ **Bright light:** pupil smaller; (Extended) circular muscles contract, radial relax.
- ✓ **Near object (Extended):** ciliary muscles contract, ligaments slack, lens fat, more refraction.
- ✓ **Rods (Extended):** dim light, not at the fovea. **Cones:** three kinds, colour, packed in the fovea.

Watch out!

The blind spot and the fovea are different places. The fovea has the most receptors (cones); the blind spot has none at all, because the optic nerve leaves there.

Circular muscles contracting make the pupil smaller, like pulling a drawstring. Students often swap the two sets: radial muscles contract to make the pupil wider.

When the ciliary muscles contract, the ligaments go slack, not tight. The ciliary ring gets smaller, so it stops pulling on the lens, and the elastic lens springs fatter.

3 Hormones

Syllabus 14.3

A **hormone** is a **chemical substance, produced by a gland and carried by the blood, which alters the activity of one or more specific target organs**. The adrenal glands secrete **adrenaline**, the pancreas **insulin**, the testes **testosterone** and the ovaries **oestrogen**. Adrenaline is secreted in fight or flight situations and increases breathing rate, heart rate and pupil diameter. Nervous control is faster but shorter-lasting than hormonal control.

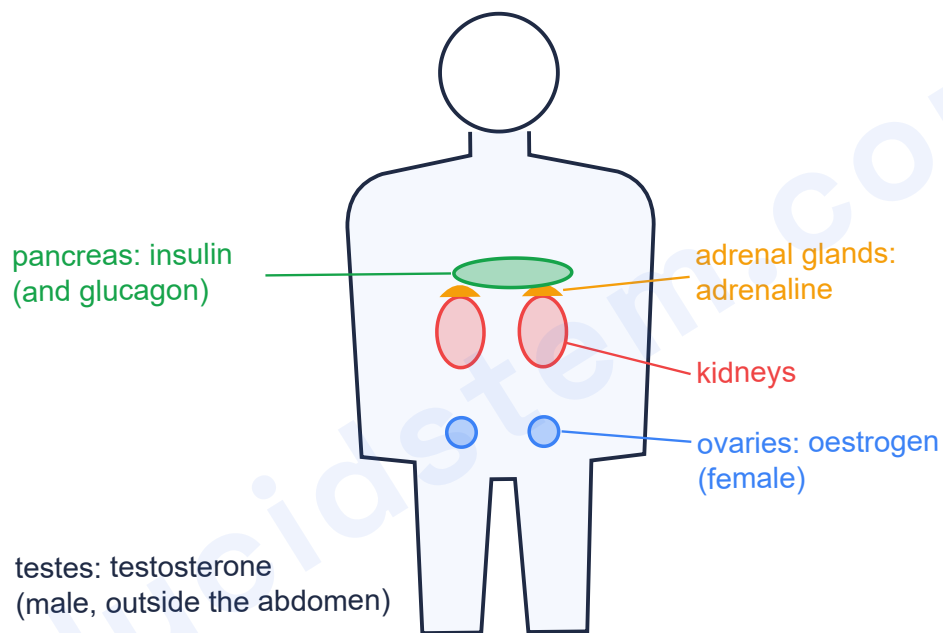


Fig. 1: endocrine glands and the hormones they secrete; the adrenal glands sit on top of the kidneys

Gland, blood, target.

- ✓ **Hormone:** chemical, made by a gland, carried by the blood, alters specific target organs.
- ✓ **Pairs:** adrenal glands and adrenaline, pancreas and insulin (and glucagon), testes and testosterone, ovaries and oestrogen.
- ✓ **Adrenaline:** breathing rate up, heart rate up, pupils wider; (Extended) blood glucose up.
- ✓ **Nerves vs hormones:** faster and shorter versus slower and longer-lasting.

Watch out!

A hormone is carried in the blood plasma, not by red blood cells, and it is made by a gland, not by the target organ. Do not confuse the adrenal glands with the kidneys they sit on.

Adrenaline increases pupil diameter. Do not mix this up with the pupil reflex, where bright light makes the pupil smaller.

The syllabus comparison is about speed of action and duration of effect. Write both halves: nerves are faster and their effect is shorter; hormones are slower and their effect lasts longer.

4 Homeostasis

Syllabus 14.4

Homeostasis is the maintenance of a constant internal environment. Insulin decreases blood glucose concentration. Extended: homeostatic control works by negative feedback: when a condition moves away from its set point, the body responds in a way that brings it back. The pancreas secretes insulin or glucagon and the liver stores or releases glucose; the brain controls sweating, shivering and the arterioles of the skin to keep core temperature close to 37 °C.

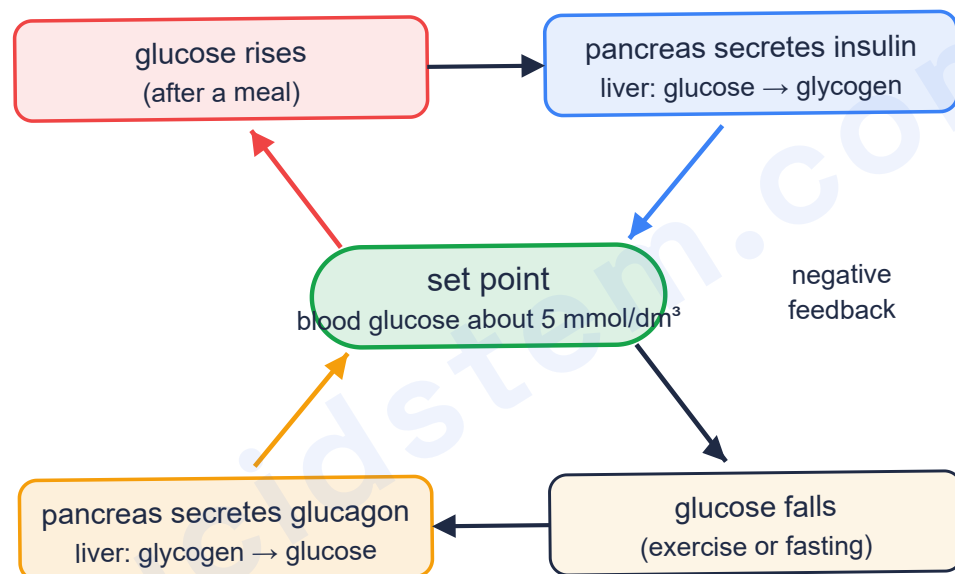


Fig. 1: negative feedback control of blood glucose; each change triggers a response that reverses it

Detect, respond, reverse.

- ✓ **Homeostasis:** maintenance of a constant internal environment. **Insulin** lowers blood glucose.
- ✓ **Negative feedback (Extended):** a change from the set point triggers a response that reverses it.
- ✓ **Glucose (Extended):** high: insulin, glucose to glycogen in the liver. Low: glucagon, glycogen to glucose.
- ✓ **Temperature (Extended):** hot: vasodilation, sweating. Cold: vasoconstriction, shivering, hairs up, insulation.

Watch out!

Negative feedback does not mean the response is bad or stops something. It means the response acts in the opposite direction to the change, so the level returns towards the set point.

Glycogen and glucagon sound alike. **Glycogen** is the storage carbohydrate in the liver; **glucagon** is the hormone that makes the liver break glycogen down.

In vasodilation the arterioles supplying the skin capillaries widen. Capillaries do not move up or down through the skin, and they cannot constrict: they have no muscle in their walls.

5 Tropic responses

Syllabus 14.5

Gravitropism is a response in which parts of a plant **grow towards or away from gravity**; **phototropism** is a response in which parts of a plant **grow towards or away from the direction of the light source**. Shoots grow towards light and away from gravity; roots grow towards gravity. Extended: these responses in a shoot are examples of chemical control of growth by **auxin**, which is made in the shoot tip, diffuses down the shoot, becomes unequally distributed and stimulates cell elongation.

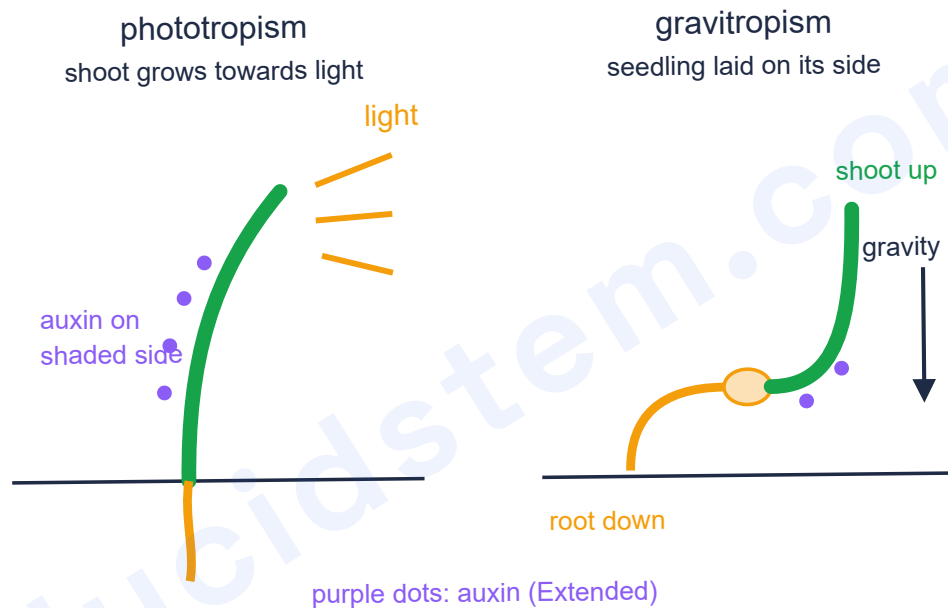


Fig. 1: a shoot bending towards one-sided light, and a seedling laid on its side turning its shoot up and its root down

Direction, growth, auxin.

- ✓ **Phototropism:** growth towards or away from the direction of light.
- Gravitropism:** towards or away from gravity.
- ✓ **Shoots:** towards light, away from gravity. **Roots:** towards gravity.
- ✓ **Investigations:** one-directional stimulus, a control (light from above or a clinostat), dark for gravitropism.
- ✓ **Auxin (Extended):** made in the tip, diffuses down, collects on the shaded or lower side, stimulates cell elongation.

Watch out!

A tropism is a response to the direction of a stimulus. A shoot in light from directly above grows straight up: it still responds to light, but there is no bending because the light is even all round.

In a gravitropism investigation the seeds must be kept in the dark (or lit evenly). Otherwise you cannot tell whether a shoot grew upwards because of gravity or because of light.

Auxin does not move to the lit side, and the lit side does not grow faster. More auxin on the shaded side makes those cells elongate more, so the shoot curves towards the light.