

Coordination & Response

IGCSE Biology ■ Topic 14

IGCSE Biology



What we will cover

- 1 The nervous system
- 2 Reflex arc & synapses
- 3 The eye
- 4 Hormones
- 5 Homeostasis
- 6 Tropisms



The nervous system

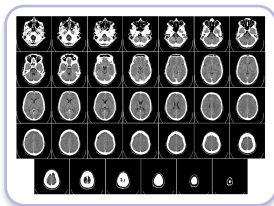
CNS

the **brain** & **spinal cord**

PNS

all the nerves outside the CNS

Neurones carry fast **electrical impulses** : **sensory** (to CNS), **relay** (within), **motor** (to effectors).



The nervous system coordinates responses

Two halves of one nervous system

What it does

The nervous system coordinates and **regulates** the body's functions, using fast electrical impulses.

Central nervous system

The brain and the spinal cord – where decisions are made.

Peripheral nervous system

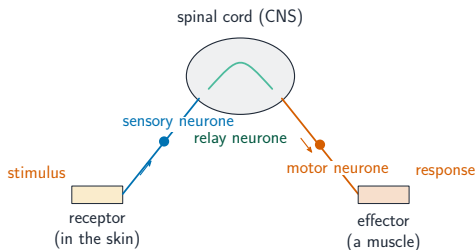
The **peripheral nervous system** (PNS): every nerve outside the brain and spinal cord, carrying impulses in and out.

Sense organs

Sense organs are groups of receptor cells that respond to a particular stimulus – light, sound, chemicals, touch, temperature.

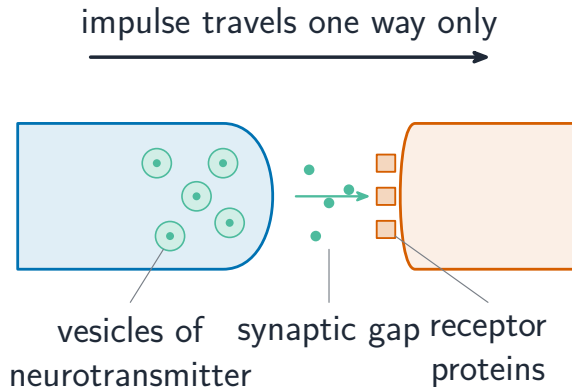
Receptor → sensory neurone → CNS → motor neurone → effector. Every nervous answer is somewhere on that line.

Reflex arc



- **sensory neurones** – carry impulses from receptors to the CNS.
- **relay neurones** – pass impulses on inside the CNS.
- **motor neurones** – carry impulses from the CNS out to a muscle or gland.
- **motor neurones** – carry impulses from the CNS to effectors.

Synapses



A **synapse** is a tiny gap between neurones.

Neurotransmitter diffuses across & binds receptors – so impulses travel **one way only**.

What crosses the gap

Vesicles

At the end of one neurone are **vesicles** holding **neurotransmitter** molecules.

The synaptic gap

The impulse cannot jump the **synaptic gap** ; it makes the vesicles release their neurotransmitter into it.

Receptor proteins

The next neurone carries **receptor proteins** shaped for that molecule. Binding starts a new impulse.

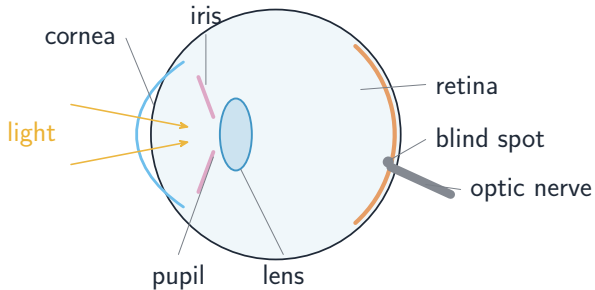
One way only

Vesicles are on one side and receptors on the other, so a synapse works in **one direction**.

The gap is not a fault in the wiring: it is what makes the nervous system a network of decisions rather than a bundle of wires.



The eye



- **cornea & lens** – refract light
- **iris** – controls the **pupil**
- **retina** – light receptors
- **optic nerve** – to the brain

Pupil reflex and accommodation

pupil reflex

bright light → pupil **smaller**;
dim light → pupil **wider**

accommodation

near → lens **fatter**;
far → lens **thinner**

The iris: two sets of muscle that oppose each other

Circular muscles

The **circular muscles** form a ring. Contract them and the pupil gets **smaller** – the response to bright light.

Radial muscles

The **radial muscles** run outwards like spokes. Contract them and the pupil gets **wider** – the response to dim light.

Antagonistic

They are **antagonistic** : one set contracts only as the other relaxes, because a muscle can pull but never push.

At the cornea

Light is bent before any of this: the **cornea refracts** it as it enters, and the lens only fine-tunes the focus.

Name which muscles contract *and* which relax. An answer that names only one half is only half a reflex.

Accommodation: focusing near and far (Supplement)

accommodation

changing the **shape of the lens** to focus on near or far objects

the parts

the **ciliary muscles** and the **suspensory ligaments**

near object

ciliary muscles **contract**, ligaments **slacken**, lens becomes **fatter**
– more refraction

far object

ciliary muscles **relax**, ligaments **pull tight**, lens becomes **thinner**
– less refraction

the trap

the muscles contracting makes the ligaments looser, not tighter
– the opposite of what intuition suggests

Write the chain in order every time: muscle, then ligament, then lens shape, then refraction.
Missing a link loses the mark even if the conclusion is right.



Hormones

adrenaline (adrenal glands) – readies the body for 'fight or flight'

insulin / glucagon (pancreas) – control blood glucose

testosterone / oestrogen – male / female development

Hormones are chemicals in the blood: **slower** but **longer-lasting** than nerve impulses.

Endocrine glands, and how hormones differ from nerves

Endocrine glands

Hormones are made by **endocrine glands** , which release them straight into the blood – so they reach every organ, and only target cells respond.

Ovaries and testes

The **ovaries** make **oestrogen** for female development; the **testes** make **testosterone** for male development.

Adrenaline

It raises the breathing rate, the **heart rate** , the blood glucose **concentration** and the pupil diameter – and the **liver** releases glucose to fuel it.

Duration

That is the real difference: a nervous response is fast and short-lived, a hormonal one slower and **longer-lasting**.

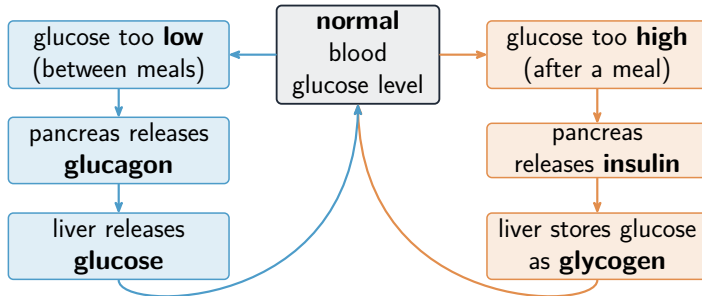
Speed, path and **duration** : three columns that separate nervous from hormonal control in any comparison question.

Homeostasis: blood glucose

Homeostasis keeps the inside steady by **negative feedback** .

- too high → insulin → store **glycogen**
- too low → glucagon → release glucose

Type 1 diabetes 1: no insulin made.



Controlling body temperature

too hot

sweating ; vasodilation – more
blood to the skin loses heat

too cold

shivering ; vasoconstriction – keeps heat in

Skin, blood and the set point

Too hot

You sweat, and the **arterioles** widen (**vasodilation**) so more blood flows to the skin **capillaries** and loses heat.

Too cold

Vasoconstriction narrows them, shivering releases heat from muscle, and hairs stand up to trap air.

Set point

Homeostasis keeps a constant internal **environment** by **negative feedback**: when a value moves off its **set point**, the body acts to bring it back.

Gravitropism

Plants have their own version: **gravitropism** is growth in response to **gravity** – roots down, shoots up.

The capillaries themselves do not move. It is the *arterioles* feeding them that widen or narrow.

The skin structures that control temperature (Supplement)

sweat glands

make sweat; as it **evaporates** it cools the skin

hair erector muscles

raise the hairs to **trap a layer of air**, which insulates

fatty tissue

gives **insulation** beneath the skin, reducing heat loss

arterioles

widen (**vasodilation**) so more blood flows near the surface and more heat is lost

too cold

you **shiver** – the muscles contract and **generate heat** – and the arterioles narrow (**vasoconstriction**), so less blood reaches the surface

The blood vessels themselves do **not** move up and down. It is the arterioles' *diameter* that changes, redirecting blood toward or away from the surface.

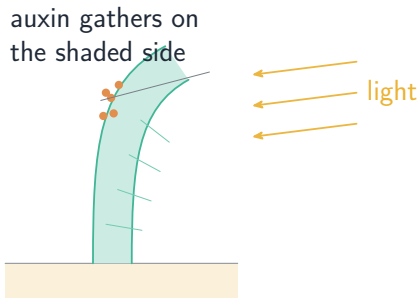


Tropisms

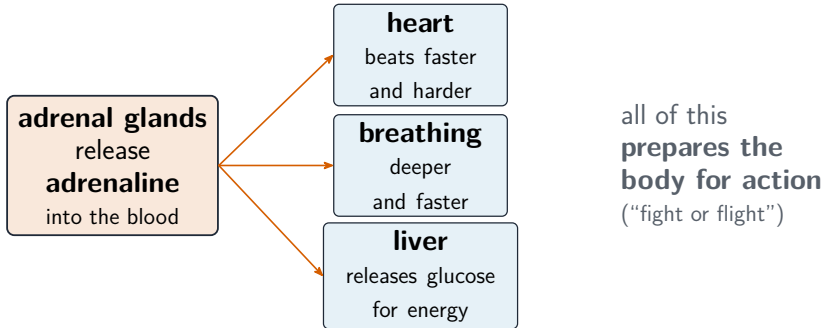
A **tropism** is a directional growth response.

- **phototropism** – shoots grow to light
- **gravitropism** – roots down, shoots up

Auxin gathers on the shaded side & makes cells elongate.

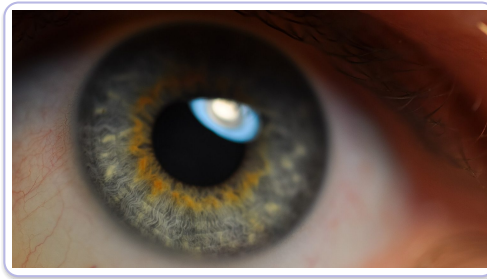


Hormones, continued



Adrenaline prepares the body for action by acting on several target organs

Parts of the eye



The black **pupil** is the hole light enters by; the coloured **iris** sets how wide it opens; the **retina** at the back carries the light receptors, some of them sensitive to different colours.

Rods and cones (Supplement)

rods

very sensitive to light, so they work in **dim** light – but give no colour

cones

three kinds, each absorbing a different colour, giving colour vision; they work best in **bright** light

the fovea

where cones are packed most densely – the part of the retina giving the **sharpest** image

the blind spot

where the optic nerve leaves the retina; there are no receptors there at all

why stars fade when stared at

looking directly puts the image on the cone-rich fovea, which is too insensitive for faint light

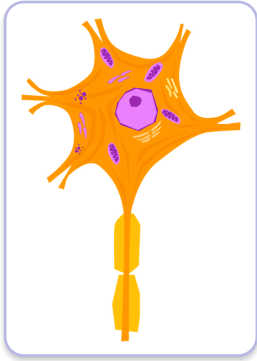
Rods for **sensitivity**, cones for **detail and colour**. Every question about night vision or colour blindness turns on that one trade.

Nervous control vs hormonal control

	nervous control	hormonal control
how it travels	electrical impulses along neurones	chemicals in the blood
speed	very fast	slower
duration	short-lived	longer-lasting
fast but brief, versus slow but lasting		

Nervous control is fast but brief; hormonal control is slower but longer-lasting

Neurones and the reflex arc



A neurone (nerve cell) carries electrical impulses around the body.

The three kinds of neurone

sensory neurone

carries the impulse **from** the receptor **to** the **central nervous system**

relay neurone

inside the CNS – connects the sensory neurone to the motor neurone

motor neurone

carries the impulse **from** the CNS **to** the effector – a muscle or a gland

the reflex arc

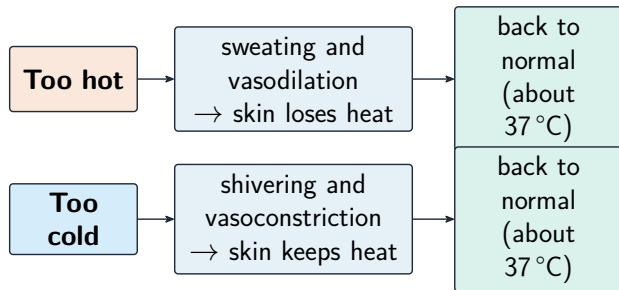
receptor → sensory → relay → motor → effector

why it is fast

the impulse does **not** travel to the brain first, so the response happens before you are aware of it

Name the neurone by **which way the impulse travels**, not by where it sits. That is the distinction every reflex-arc question tests.

Controlling body temperature (Supplement)



Negative feedback: a change away from about 37 °C triggers the response that reverses it, bringing the body back to normal.

Exam tips

- Nervous system: CNS (brain + spinal cord) and PNS (the nerves). Impulses travel along neurones.
- Learn the reflex arc in order: receptor → sensory → relay → motor → effector.
- At a synapse, neurotransmitter diffuses across the gap – this makes impulses go one way only.
- Eye: cornea and lens refract light; the lens changes shape (accommodation); rods for dim light, cones for colour.

Exam tips (continued)

- Hormones are slower but longer-lasting than nerves. Insulin lowers blood glucose; glucagon raises it.
- Too hot → sweating and vasodilation; too cold → shivering and vasoconstriction.
- Auxin from the shoot tip controls phototropism and gravitropism by making cells elongate.



Worked example – a reflex arc

You touch a hot plate and pull your hand away before you feel pain. Give the pathway.

- **Receptor** in the skin detects the heat (the stimulus).
- **Sensory neurone** to the spinal cord, where a **relay neurone** passes it across.
- **Motor neurone** carries it to the **effector** (the muscle), which contracts.
- The brain is **not** in the loop $\Rightarrow$ **fast and automatic**; pain comes after.

Learn the order: stimulus
 $\rightarrow$ receptor $\rightarrow$ sensory $\rightarrow$
relay $\rightarrow$ motor $\rightarrow$ effector
 $\rightarrow$ response. Skipping the
brain is **why it is fast** –
and that protects you.

Topic 14 – key takeaways

1

Reflex arc

receptor, sensory, relay, motor,
effector

2

Synapse

neurotransmitter diffuses; one way
only

3

Hormones

slower, longer-lasting; insulin
lowers glucose

4

Homeostasis

negative feedback keeps the inside
steady

Check yourself

- 1 What are the two parts of the CNS?
- 2 Why do impulses cross a synapse one way only?
- 3 Which hormone lowers blood glucose?
- 4 Which way does a shoot grow in phototropism?



Answers 1. the brain & spinal cord 2. neurotransmitter is on one side only 3. insulin
4. towards the light