

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

1

The nervous system

The nervous system

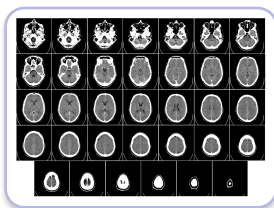
CNS 中枢神经系统

the **brain** 大脑 &
spinal cord 脊髓

PNS 周围神经系统

all the nerves outside the CNS

Neurones 神经元 carry fast **electrical impulses** 电脉冲: **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** 调节 the body's functions, using fast electrical impulses.

Central nervous system

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

Peripheral nervous system

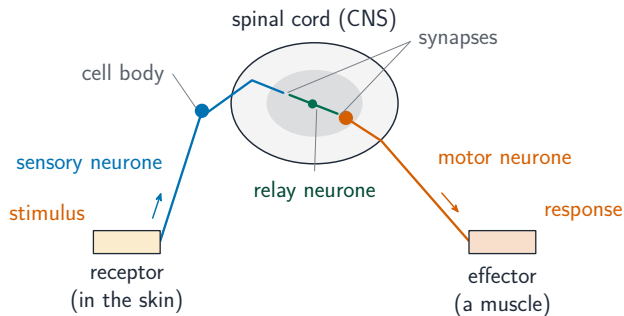
The **peripheral nervous system** 周围神经系统 (PNS): every nerve outside the brain and spinal cord, carrying impulses in and out.

Sense organs

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

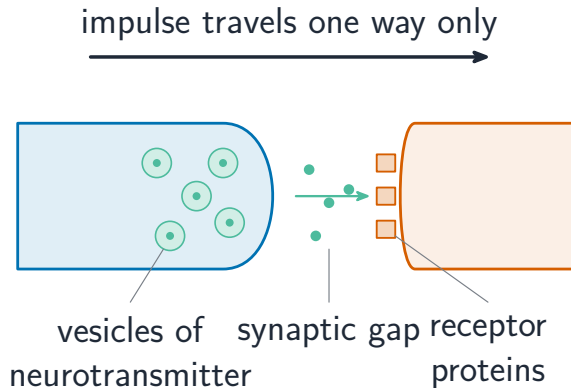
Receptor → sensory neurone → CNS → motor neurone → effector. Every nervous answer is somewhere on that line.

Reflex arc



- **sensory neurones** 感觉神经元 – carry impulses from receptors to the CNS.
- **relay neurones** 中间神经元 – pass impulses on inside the CNS.
- **motor neurones** 运动神经元 – carry impulses from the CNS to effectors (a muscle or gland).

Synapses



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

Neurotransmitter 神经递质
diffuses 扩散 across & binds
receptors – so impulses travel
one way only.

What crosses the gap

Vesicles

At the end of one neurone are **vesicles** 囊泡 holding **neurotransmitter** 神经递质 molecules.

The synaptic gap

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

Receptor proteins

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

One way only

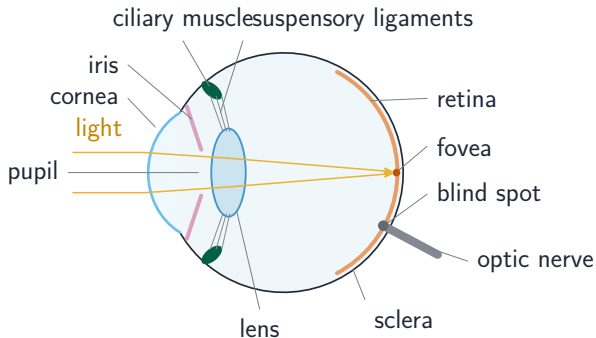
Vesicles are on one side and receptors on the other, so a synapse works in **one direction**.

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.

2

The eye

The eye



- **cornea** 角膜 & **lens** 晶状体 – **refract** 折射 light
- **iris** 虹膜 – controls the **pupil** 瞳孔
- **retina** 视网膜 – light receptors
- **optic nerve** 视神经 – to the brain

Pupil reflex and accommodation

pupil reflex

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

accommodation 视觉调节

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

The iris: two sets of muscle that oppose each other

Circular muscles

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

Radial muscles

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

Antagonistic

They are **antagonistic** 拮抗: 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** 角膜 **refracts** 折射 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

视觉调节

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

the parts

the **ciliary muscles** 睫状肌 and the **suspensory ligaments** 悬韧带

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.

3

Hormones & homeostasis

Hormones

adrenaline 肾上腺素 (adrenal glands) – readies the body for ‘fight or flight’

insulin 胰岛素 / glucagon 胰高血糖素 (pancreas) – control blood glucose

testosterone / oestrogen – male / female development

Hormones 激素 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** 内分泌腺, which release them straight into the blood – so they reach every organ, and only target cells respond.

Ovaries and testes

The **ovaries** 卵巢 make **oestrogen** 雌激素 for female development; the **testes** 睾丸 make **testosterone** 睾酮 for male development.

Adrenaline

It raises the breathing rate, the **heart rate** 心率, the blood glucose **concentration** 浓度 and the pupil diameter – and the **liver** 肝脏 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**.

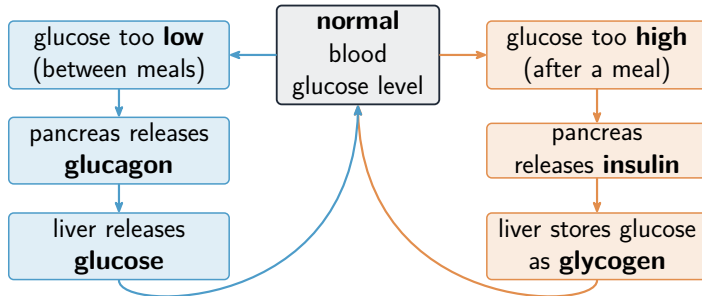
Speed, path and **duration** 持续时间: three columns that separate nervous from hormonal control in any comparison question.

Homeostasis: blood glucose

Homeostasis 稳态 keeps the inside steady by **negative feedback** 负反馈.

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

Type 1 diabetes 1 型糖尿病: no insulin made.



Controlling body temperature

too hot

sweating 出汗; **vasodilation** 血管舒张 – more blood to the skin loses heat

too cold

shivering 颤抖; **vasoconstriction** 血管收缩 – keeps heat in

Skin, blood and the set point

Too hot

You sweat, and the **arterioles** 小动脉 widen (**vasodilation** 血管舒张) so more blood flows to the skin **capillaries** 毛细血管 and loses heat.

Too cold

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

Set point

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

Gravitropism

Plants have their own version: **gravitropism** 向地性 is growth in response to **gravity** 重力 – 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 汗腺

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

hair erector muscles 立毛肌

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

fatty tissue 脂肪组织

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

arterioles 小动脉

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

too cold

you **shiver** 颤抖 – the muscles contract and **generate heat** – and the arterioles narrow (**vasoconstriction** 血管收缩), 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.

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Plants

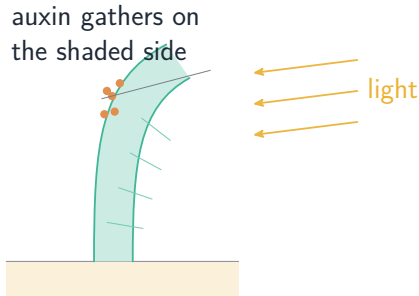
Tropisms

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

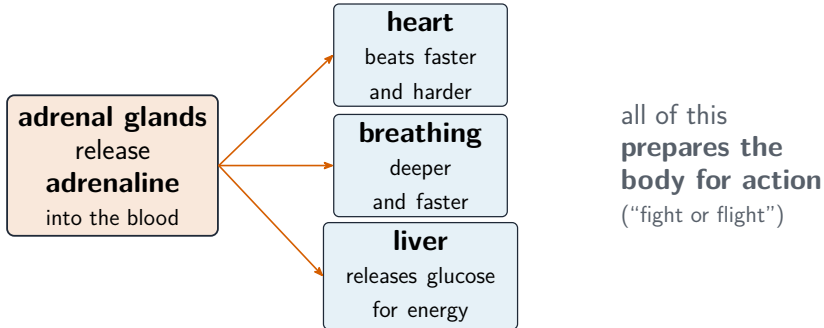
- **phototropism** 向光性 – shoots grow to light

- **gravitropism** 向地性 – roots down, shoots up

Auxin 生长素 gathers on the shaded side & makes cells elongate.

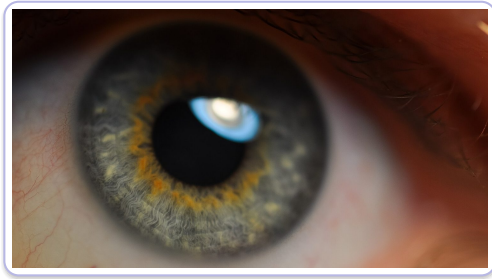


Adrenaline and its target organs



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

Parts of the eye



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

Rods and cones (Supplement)

rods 视杆细胞	very sensitive to light, so they work in dim light – but give no colour
cones 视锥细胞	three kinds, each absorbing a different colour, giving colour vision; they work best in bright light
the fovea 中央凹	where cones are packed most densely – the part of the retina giving the sharpest image
the blind spot 盲点	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

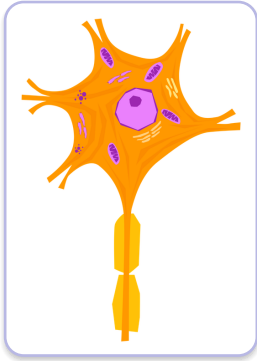
Rods for **sensitivity**, cones for **detail and colour**. Every question about night vision or colour blindness turns on that one trade.

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 感觉神经元

carries the impulse **from** the receptor **to** the **central nervous system** 中枢神经系统

relay neurone 中间神经元

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

motor neurone 运动神经元

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

the reflex arc

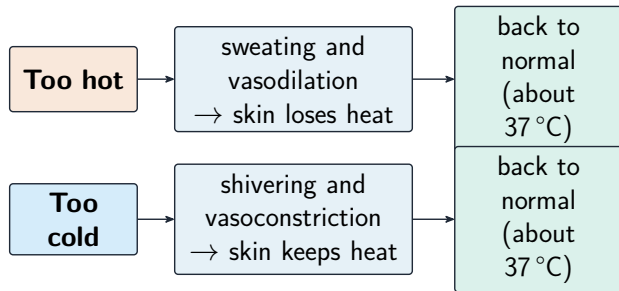
receptor → sensory → relay → motor → effector

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.

5

Recap

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