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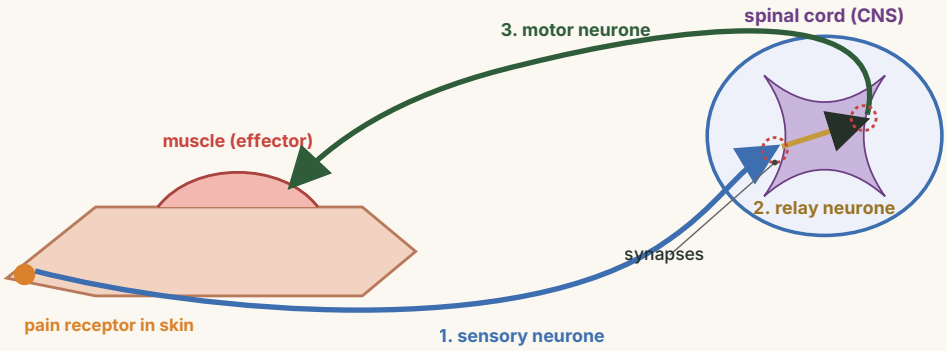
Specialist one-to-one Science, Maths & Economics tuition

AQA GCSE BIOLOGY · SPECIFICATION 4.5

Topic 5: Homeostasis and Response

Complete revision & exam preparation guide — key points to memorise, clear diagrams, practice questions and full answers

Key-point notes | Memory hooks | Required practical | Maths skills | Exam questions + answers



Prepared by iBLaurel · Specialist one-to-one Science, Maths & Economics tuition
Suitable for Foundation and Higher tier · Combined Science (Trilogy) and Separate Biology

START HERE

Contents and how to use this guide

5.1 Homeostasis and negative feedback
5.2 The nervous system
5.3 Synapses and reflexes
5.4 Reaction time (RP)
5.5 The brain (Bio)
5.6 The eye (Bio)
5.7 Vision defects (Bio)
5.8 Controlling body temperature (Bio)
5.9 The endocrine system
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5.11 The kidneys and water balance (Bio)
5.12 Kidney failure (Bio)
5.13 Puberty and the menstrual cycle
5.14 Contraception
5.15 Treating infertility (HT)
5.16 Adrenaline and thyroxine (HT)
5.17 Plant hormones and tropisms (Bio)
5.18 Uses of plant hormones (Bio, HT)
★ One-page memory sheet
✎ Summary questions
✓ Answers and mark scheme

How to use this guide

1. **Read** one section. Study the diagram and say the labels out loud.
2. **Learn the gold "Remember it" box** — short hooks that make facts stick.
3. **Cover and recall:** cover the page, write the key points and **equations** from memory, then check and correct in a different colour.
4. **Read the green "Exam tip" and red "Common mistake" boxes** — they show where marks are won and lost.
5. Finish with the **summary questions** (no notes), then mark them with the **answers**. Re-test the ones you got wrong 2–3 days later.

THE BIG IDEA OF TOPIC 5

The body keeps its internal conditions **steady** (homeostasis) using two communication systems: fast **nerves** and slower **hormones**. Most control works by **negative feedback**: if a level goes too high or too low, the body brings it back to normal. Plants respond to their surroundings too, using **plant hormones**.

Key boxes in this guide

Box	What it means
Remember it	Memory hook, rhyme or shortcut to memorise
Exam tip	How to write the answer to get the marks
Common mistake	Errors examiners see every year
Maths skill	Calculations and graph skills you must be able to do
RP	AQA Required Practical — can be asked in the written exam
BIOLOGY ONLY	Only for Separate (Triple) Biology, not Combined Science
HIGHER TIER	Only examined on the Higher tier paper

PART A

Homeostasis and the Nervous System

5.1 Homeostasis and negative feedback

AQA 4.5.1

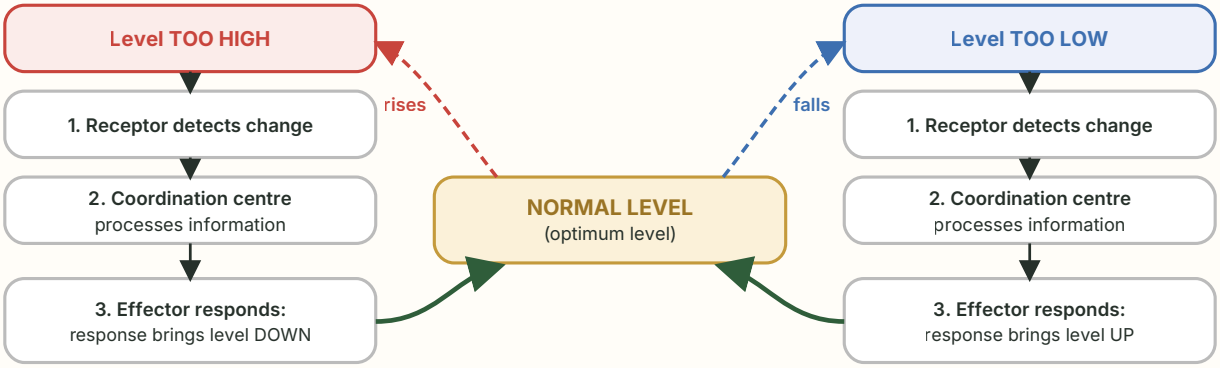
DEFINITION — LEARN IT

Homeostasis is the **regulation of the internal conditions** of a cell or organism to **maintain optimum conditions** for function, in response to internal and external changes.

- Cells need the **right conditions** to work properly, especially for **enzymes** to work.
- In the human body, homeostasis controls: **blood glucose concentration**, **body temperature** and **water levels**.
- These **automatic control systems** may involve **nervous** responses or **chemical** (hormonal) responses.

Every control system has three parts:

Part	Job	Example
Receptors	Cells that **detect stimuli** (changes in the environment)	Temperature receptors in the skin
Coordination centres	**Receive and process** information from receptors	Brain, spinal cord, pancreas
Effectors	**Bring about responses** that restore optimum levels	Muscles and glands



Negative feedback brings a level back to normal

- **Negative feedback**: if a level goes **too high**, the response brings it **down**; if it goes **too low**, the response brings it **up**.
- The effectors keep responding while they are stimulated — this can overshoot, but then the opposite response starts. It all happens **automatically**.

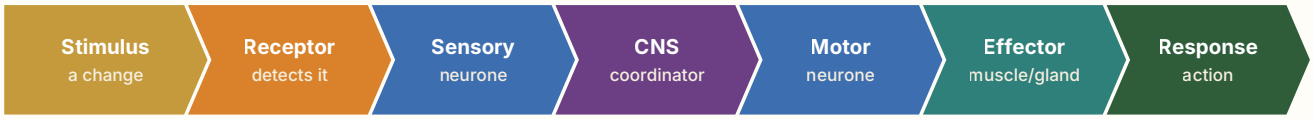
REMEMBER IT

Control system = **"RCE"** → **R**eceptor (detects), **C**oordination centre (decides), **E**ffector (does).
Negative feedback = **"do the opposite"** — like a thermostat.

5.2 The nervous system

AQA 4.5.2.1

- The nervous system lets humans **react to their surroundings** and **coordinate their behaviour**.
- Information travels as **electrical impulses** along **neurones** (nerve cells).



The pathway from stimulus to response — learn it in order

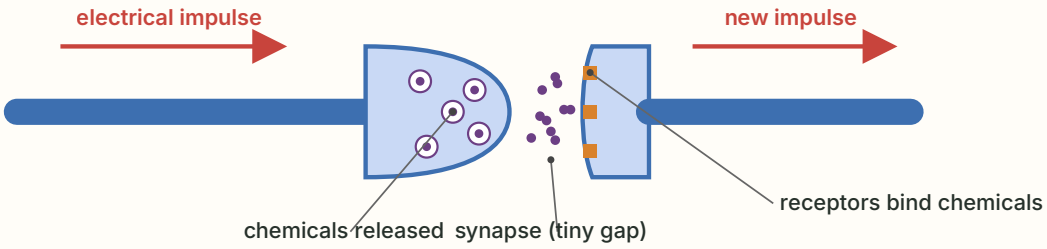
Part	What it is / does
Central nervous system (CNS)	The **brain and spinal cord**. The coordination centre: receives information, decides what to do and sends instructions
Receptors	Detect stimuli, e.g. light receptors in the eye, sound in the ear, taste on the tongue, pressure/pain/temperature in skin
Sensory neurones	Carry impulses **from receptors to the CNS**
Motor neurones	Carry impulses **from the CNS to effectors**
Effectors	**Muscles** (contract) or **glands** (secrete hormones)

REMEMBER IT

Sensory = **S**enses (towards the CNS). **M**otor = **M**ovement (away from the CNS, to muscles).
Order: **"Silly Rabbits Sometimes Can't Make Edible Raisins"** → Stimulus, Receptor, Sensory, CNS, Motor, Effector, Response.

5.3 Synapses and reflexes

AQA 4.5.2.1

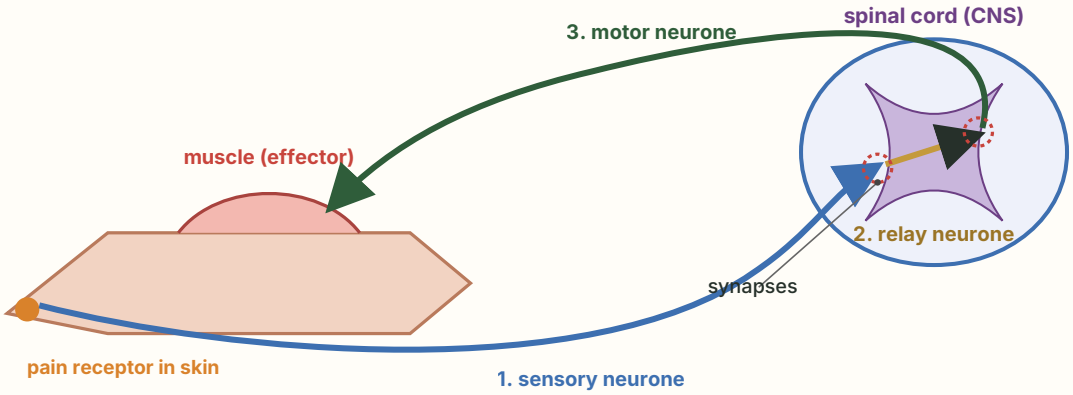


A synapse — the gap between two neurones

- A **synapse** is the **gap** where two neurones meet.
- When an impulse reaches the end of a neurone, **chemicals are released**. They **diffuse across the gap** and start a **new electrical impulse** in the next neurone.

Reflex actions

- **Reflex actions** are **automatic and rapid**. They **do not involve the conscious** part of the brain.
- They protect the body from harm, e.g. pulling your hand off something hot, or your **pupil shrinking** in bright light.
- The pathway is called a **reflex arc**.



A reflex arc: stimulus → receptor → sensory → relay → motor → effector

1. A **stimulus** (e.g. a hot object) is detected by a **receptor** in the skin.
2. Impulses travel along a **sensory neurone** to the **spinal cord**.
3. At a **synapse**, chemicals pass the signal to a **relay neurone** in the CNS.
4. At another synapse the signal passes to a **motor neurone**.
5. Impulses travel to the **effector** (a muscle), which **contracts** and moves your hand away.

EXAM TIP

Reflexes are **faster** because the impulse goes through the **spinal cord** (or an unconscious part of the brain) — you don't have to **think** about it. Use the words **rapid, automatic, no conscious thought**.

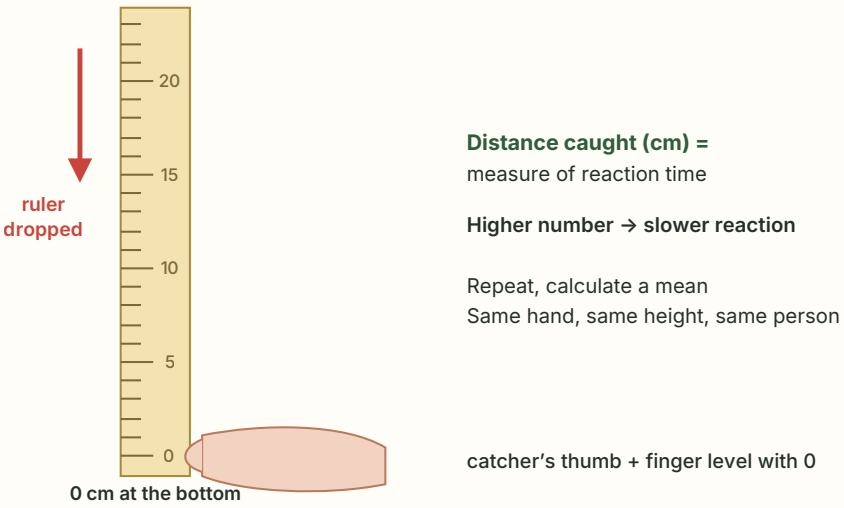
REMEMBER IT

Reflex arc neurones: **"SRM"** = **S**ensory → **R**elay → **M**otor. Synapse = **chemical** step; neurone = **electrical** step.

5.4 Investigating reaction time REQUIRED PRACTICAL

AQA 4.5.2.1

- **Reaction time** is the time it takes to respond to a stimulus — usually less than a second.
- It can be affected by **age**, **gender** and **drugs**, e.g. **caffeine** speeds it up.



The ruler-drop test

1. The person sits with their arm resting on the edge of a table.
2. Hold a ruler vertically between their thumb and finger, with the **zero** level with the top of the thumb.
3. Drop the ruler **without warning**. They catch it as quickly as possible.
4. Read the number at the top of the thumb. A **bigger distance = slower** reaction time.
5. Repeat several times and calculate the **mean**.
6. To test caffeine: give a caffeinated drink, wait 10 minutes, repeat steps 1–5.

Independent	Dependent	Control variables
Caffeine (or no caffeine)	Distance caught on the ruler / reaction time	**Same person**, **same hand**, same drop height, no other caffeine that day, same time of day

IMPROVING THE METHOD

A **computer test** (click when the screen changes colour) is **more precise**: it measures in **milliseconds**, removes human error in reading the ruler, and the person can't predict the drop from the tester's body language.

MATHS SKILL — MEAN REACTION TIME

Results: 242, 256, 253, 249, 235 ms. Mean = (242 + 256 + 253 + 249 + 235) ÷ 5 = 1235 ÷ 5 = **247 ms** = **0.247 s**.

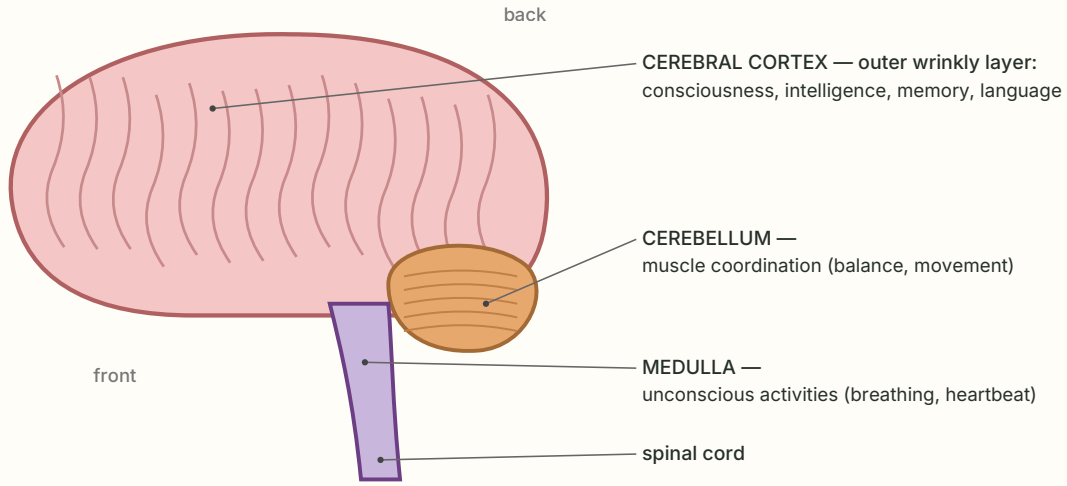
SAFETY

Too much caffeine can cause side effects (e.g. a fast heartbeat). Don't test anyone with a heart condition and avoid more caffeine for the rest of the day.

5.5 The brain BIOLOGY ONLY

AQA 4.5.2.2

- The brain controls **complex behaviour**. It is made of **billions of interconnected neurones**.
- Different **regions** of the brain carry out different functions.



Three main regions of the brain

Region	Function
Cerebral cortex	Outer wrinkly layer — **consciousness, intelligence, memory and language**
Cerebellum	**Muscle coordination** (balance, smooth movement)
Medulla	**Unconscious activities**, e.g. **breathing** and **heart rate**

How scientists study the brain:

Method	How it works
Studying patients with brain damage	If a small area is damaged, the effect on the patient shows what that area does (e.g. damage at the back → loss of sight)
Electrically stimulating the brain	A tiny electrode stimulates an area; scientists watch what happens (e.g. a muscle moves)
MRI scans	Make detailed pictures of the brain; show which areas are **active** during a task (e.g. listening to music)

- This knowledge has helped treat nervous system disorders (e.g. electrical stimulation to reduce tremors in Parkinson's disease).
- But the brain is **complex and delicate** and **easily damaged**, so investigating and treating it is **difficult and risky**.

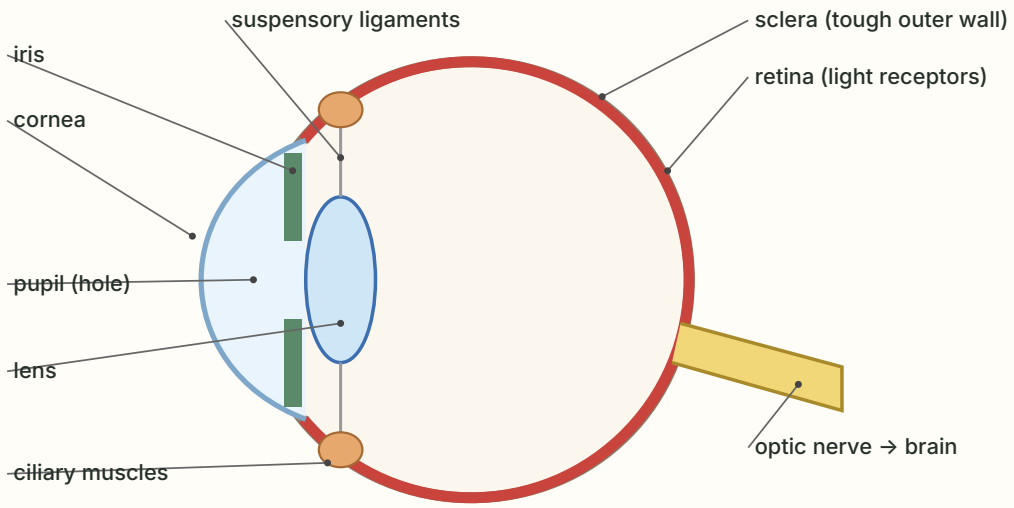
REMEMBER IT

Cortex = **C**lever (thinking, memory, language). Cere**bell**um = **bal**ance. **M**edulla = **M**achine-like (automatic: breathing, heartbeat).

5.6 The eye BIOLOGY ONLY

AQA 4.5.2.3

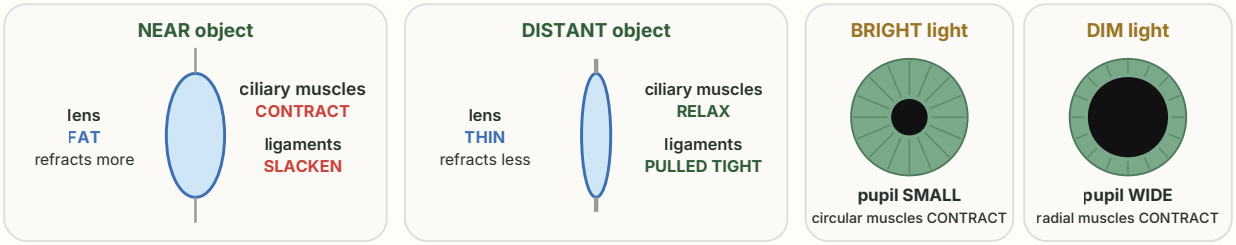
- The eye is a **sense organ** containing **receptors** sensitive to **light intensity and colour**.



Structure of the human eye

Structure	Function
Retina	Contains **receptor cells** sensitive to light intensity and colour
Optic nerve	Carries impulses from the retina to the **brain**
Sclera	Tough, white outer wall — protects and supports the eye
Cornea	**Transparent** front layer — **refracts** (bends) light into the eye
Iris	Coloured muscles that control the **size of the pupil**, and so how much light enters
Lens	Focuses light onto the retina
Ciliary muscles + suspensory ligaments	Change the **shape of the lens** to focus

Accommodation = changing the shape of the lens to focus on near or distant objects. **The iris reflex** protects the retina from very bright light.



Accommodation (left) and the iris reflex (right)

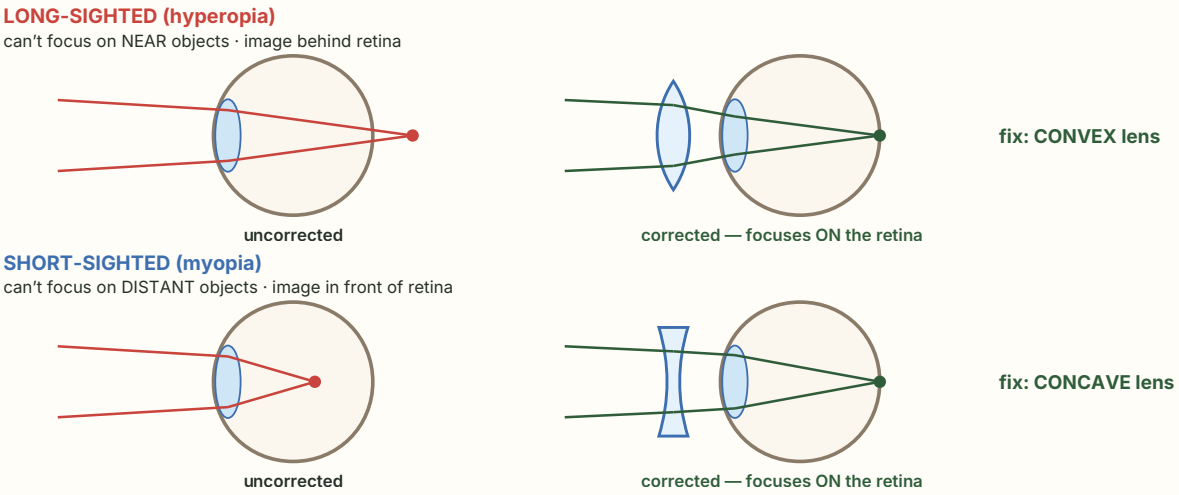
	Near object	Distant object
Ciliary muscles	**Contract**	**Relax**
Suspensory ligaments	**Loosen** (slacken)	Pulled **tight**
Lens	**Thicker** (fatter) → refracts light **more**	Pulled **thin** → refracts light **less**

REMEMBER IT

"Near — Contract — Fat." For far objects, do the opposite: muscles relax, ligaments tight, lens thin. **C**ornea **C**overs and bends light first; the **lens** fine-tunes the focus.

5.7 Vision defects BIOLOGY ONLY

AQA 4.5.2.3



Long- and short-sightedness and how lenses correct them

	Long-sighted (hyperopia)	Short-sighted (myopia)
Problem	Can't focus on **near** objects	Can't focus on **distant** objects
Cause	Lens the wrong shape (refracts too little) or eyeball **too short**	Lens refracts too much or eyeball **too long**
Image forms	**Behind** the retina	**In front of** the retina
Corrected by	**Convex** lens (curves outwards)	**Concave** lens (curves inwards)

Treatments:

Treatment	Notes
Glasses	Simple and safe; lenses refract light so it focuses on the retina
Contact lenses	Thin lenses on the surface of the eye; **hard** or **soft**. Almost invisible, good for sport — but risk of eye **infection**
Laser eye surgery	A laser changes the **shape of the cornea** to change how it refracts light. Risk of complications (infection, worse vision)
Replacement lens surgery	The natural lens is replaced with an artificial one. Higher risk — inside the eye, could damage the retina

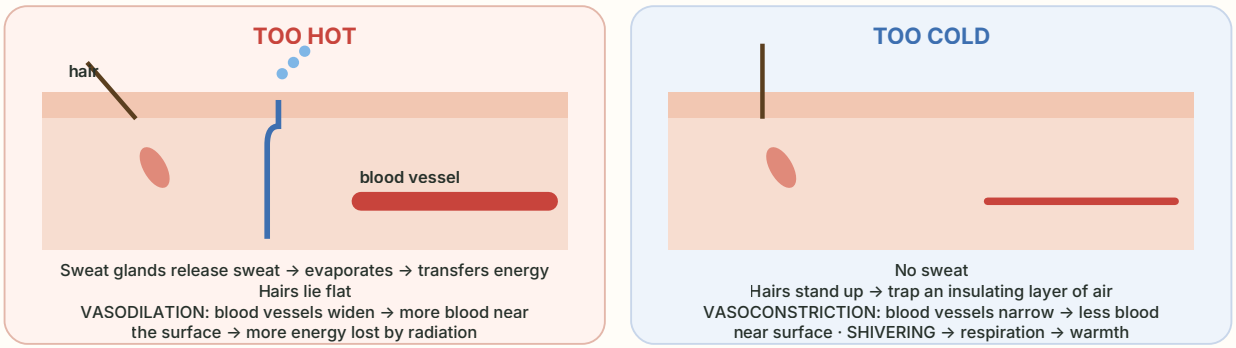
REMEMBER IT

Long-sighted → **convex** ("**L**ong **V**ision needs con**V**ex"). **Short**-sighted → con**cave** (short people live in **caves**).
Myopia = **My** view far away is blurry.

5.8 Controlling body temperature BIOLOGY ONLY

AQA 4.5.2.4

- Body temperature is kept at about **37 °C** — the optimum for **enzymes**.
- It is monitored and controlled by the **thermoregulatory centre** in the **brain**. It contains **receptors** sensitive to the temperature of the **blood**.
- The **skin** also contains temperature receptors that send impulses to the thermoregulatory centre.



How the skin responds when you are too hot or too cold

Too hot	Too cold
Sweating — sweat evaporates from the skin, transferring energy to the environment	**No sweat** is produced
Vasodilation — blood vessels supplying the skin capillaries **widen** → more blood flows near the surface → more energy transferred to the surroundings	**Vasoconstriction** — blood vessels supplying the skin capillaries **narrow** → less blood near the surface → less energy lost
Hairs lie flat	Hairs stand up → trap an **insulating layer of air**
	Shivering — muscles contract automatically → more **respiration** → energy warms the body

REMEMBER IT

Hot → **"Sweat and Dilate"**. Cold → **"Shiver and Constrict"**.
Vaso**dilation** = vessels **dilate** (widen); vaso**constriction** = vessels **constrict** (narrow).

COMMON MISTAKE

Blood vessels **do not move** closer to the skin. They **widen or narrow**, changing how much blood flows near the surface. And capillaries themselves don't dilate — the vessels **supplying** them do.

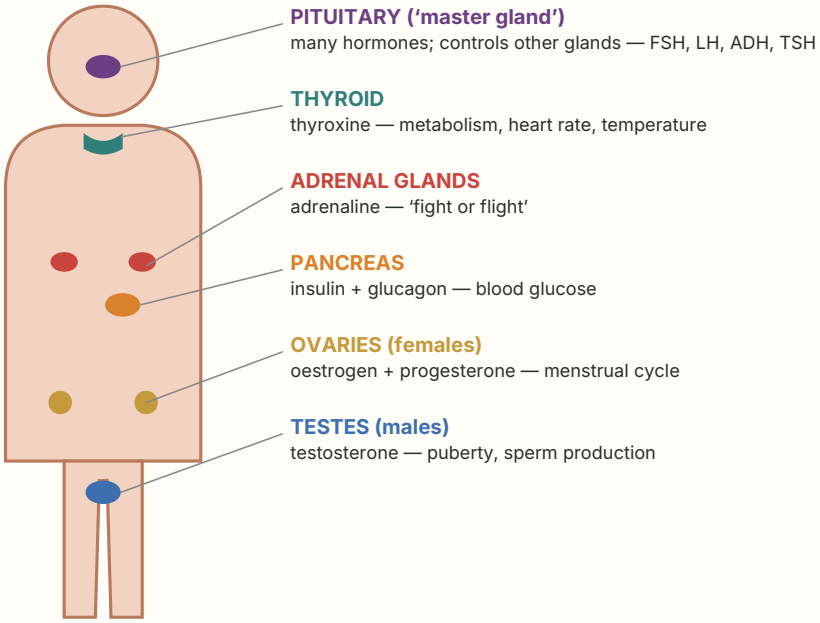
PART B

Hormonal Coordination

5.9 The endocrine system

AQA 4.5.3.1

- The **endocrine system** is made of **glands** that secrete **hormones** directly into the **bloodstream**.
- Hormones are **chemical messengers**. The blood carries them to a **target organ**, where they produce an effect.
- Compared with nerves, hormone effects are **slower** but act for **longer**.



The main endocrine glands and their hormones

The **pituitary gland** in the brain is the **'master gland'** — it secretes several hormones that act on **other glands**, telling them to release their hormones.

	Nervous system	Hormones
Message	Electrical impulses	Chemicals in the blood
Speed	**Very fast**	**Slower**
How long	**Short** time	**Longer**
Where	Very **precise** area	More **general** (whole body)

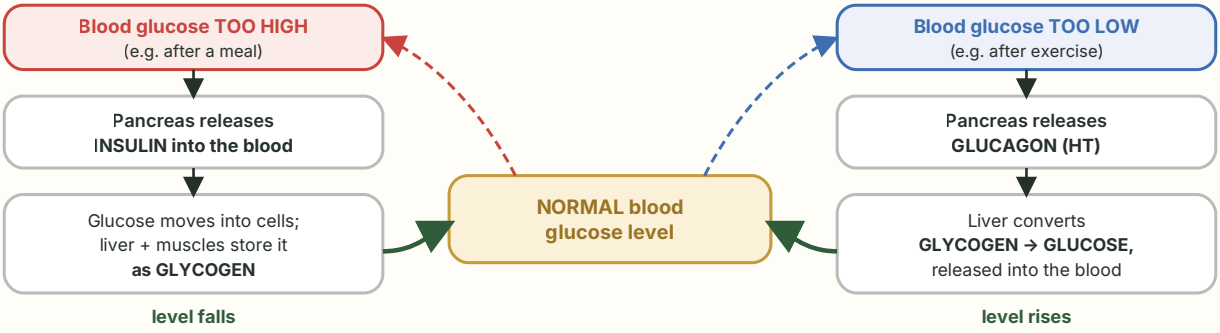
REMEMBER IT

Glands, head to toe: **"People Take Ages Planning Our Trips"** → **P**ituitary, **T**hyroid, **A**drenal, **P**ancreas, **O**varies, **T**estes.
Nerves = **text message** (fast, short). Hormones = **letter in the post** (slow, lasts).

5.10 Controlling blood glucose; diabetes

AQA 4.5.3.2

- Blood glucose concentration is **monitored and controlled by the pancreas**.
- If it is **too high**, the pancreas releases **insulin**. Glucose moves from the blood **into cells**. In **liver and muscle cells** excess glucose is converted to **glycogen** for storage.
- If it is **too low**, the pancreas releases **glucagon** HIGHER TIER. The liver converts **glycogen back into glucose**, which is released into the blood.



Negative feedback control of blood glucose

Diabetes

	Type 1 diabetes	Type 2 diabetes
Cause	The pancreas produces **too little (or no) insulin**	Body cells **no longer respond** to insulin
Result	Uncontrolled high blood glucose	Blood glucose rises to dangerous levels
Treatment	**Insulin injections** (often at mealtimes); limit simple carbohydrates; exercise	**Carbohydrate-controlled diet** and **exercise** (sometimes drugs)
Risk factor	Often starts in childhood	**Obesity** is a major risk factor

REMEMBER IT

Insulin puts glucose **IN** to cells (level goes down). **Glucagon** = "glucose is **gone**" → turns glycogen back into glucose (level goes up).
Type **1** = **no** insulin made. Type **2** = insulin made but **ignored**.

COMMON MISTAKE

Spell them carefully: **glucose** (sugar), **glycogen** (storage carbohydrate), **glucagon** (hormone). They are three different things.

GRAPH QUESTIONS

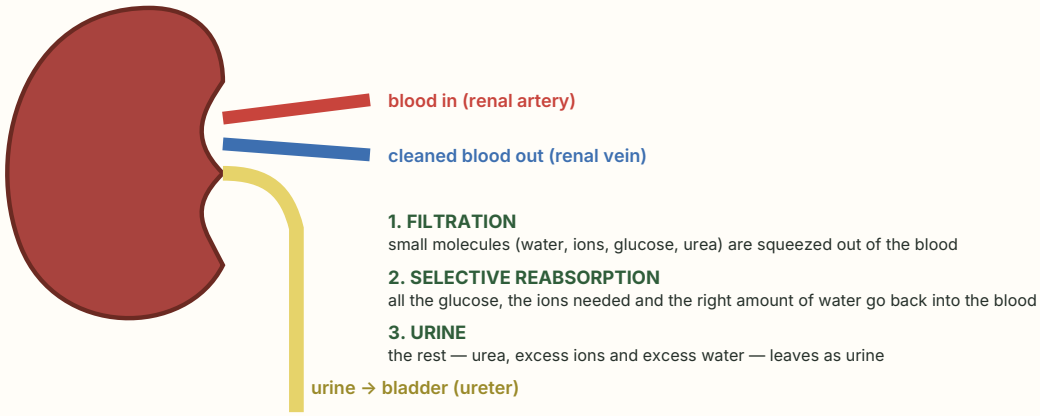
After a meal, glucose rises; in a healthy person insulin brings it back to normal within about 2 hours. In a person with diabetes it rises **higher** and stays high for **longer**.

5.11 The kidneys and water balance BIOLOGY ONLY

AQA 4.5.3.3

- The kidneys make **urine** by taking waste products out of the blood.

- **Filtration:** small molecules are filtered out of the blood. **Selective reabsorption:** useful substances (all the glucose, some ions, the right amount of water) are absorbed back into the blood.

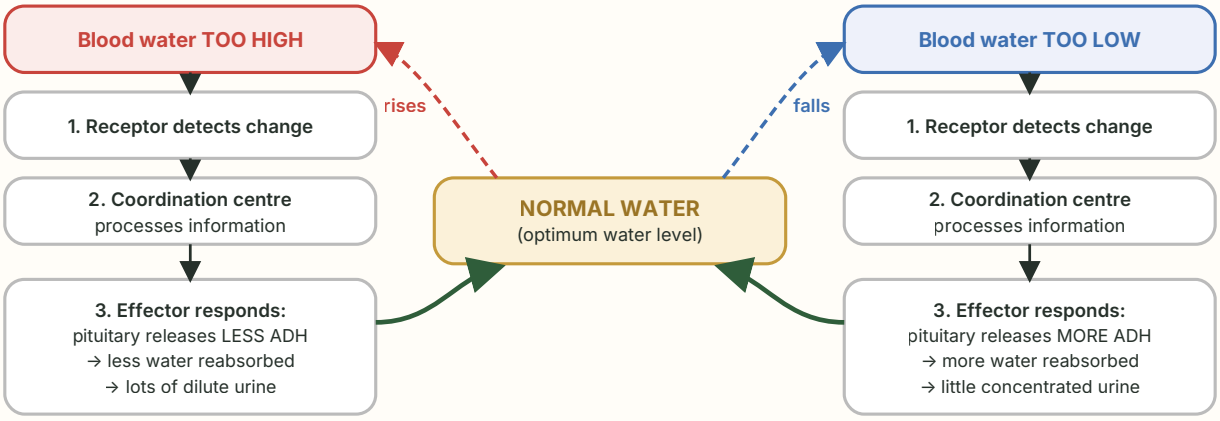


How the kidney cleans the blood

Substance	How it is controlled
Urea	Excess **amino acids** from protein digestion can't be stored. In the **liver** they are **deaminated** HIGHER TIER to form **ammonia**, which is toxic, so it is quickly converted to **urea**. Urea is filtered out by the kidneys and excreted in urine
Ions	Ions such as sodium come from food. Wrong ion levels could make too much water move into or out of cells by **osmosis** and damage them. Some ions are lost in sweat; the kidneys reabsorb the right amount
Water	Water is lost from the **lungs** (breathing out) and **skin** (sweat) — we can't control these. The kidneys balance water by changing the amount in **urine**

ADH controls water HIGHER TIER

- The concentration of urine is controlled by **ADH** (anti-diuretic hormone), released by the **pituitary gland**.
- ADH makes the kidney tubules **more permeable**, so **more water is reabsorbed** into the blood.
- It is controlled by **negative feedback**:



Negative feedback control of water in the blood

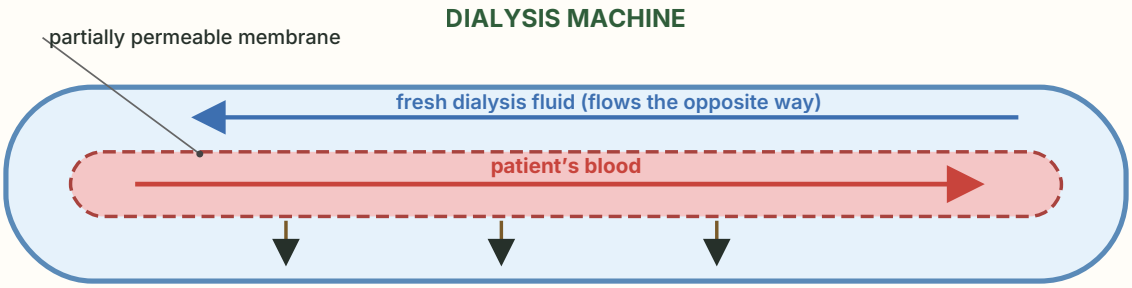
REMEMBER IT

Kidneys handle **"UIW"**: **U**rea, **I**ons, **W**ater.
ADH = Add Danger, Hold water: dehydrated → **more** ADH → **more** water kept → small amount of dark, concentrated urine.

5.12 Kidney failure BIOLOGY ONLY

AQA 4.5.3.3

- If the kidneys stop working, waste builds up in the blood and ion and water levels can't be controlled — eventually this causes **death**.
- People with kidney failure can be treated by **dialysis** or a **kidney transplant**.



urea + excess ions + water diffuse out across the partially permeable membrane
dialysis fluid has the SAME concentration of glucose + useful ions as healthy blood → these are NOT lost

How a dialysis machine works

- The patient's blood flows between **partially permeable membranes**, surrounded by **dialysis fluid**.
- The fluid has the **same concentration** of glucose and useful ions as healthy blood, so these are **not lost**.
- **Urea, excess ions and excess water diffuse** out of the blood into the fluid.
- Sessions are needed about **3 times a week**, each lasting **3–4 hours**.

	Dialysis	Kidney transplant
✓ **Pros**	Keeps the patient alive until a donor kidney is found; available to most patients	A **cure** — no more dialysis; **cheaper** in the long run; normal life
× **Cons**	Time-consuming and unpleasant; restricted diet; risk of blood clots or infection; **expensive** for the NHS	Long **waiting lists** for donors; donor kidney may be **rejected** by the immune system → **immunosuppressant drugs** for life (more infections); risks of surgery

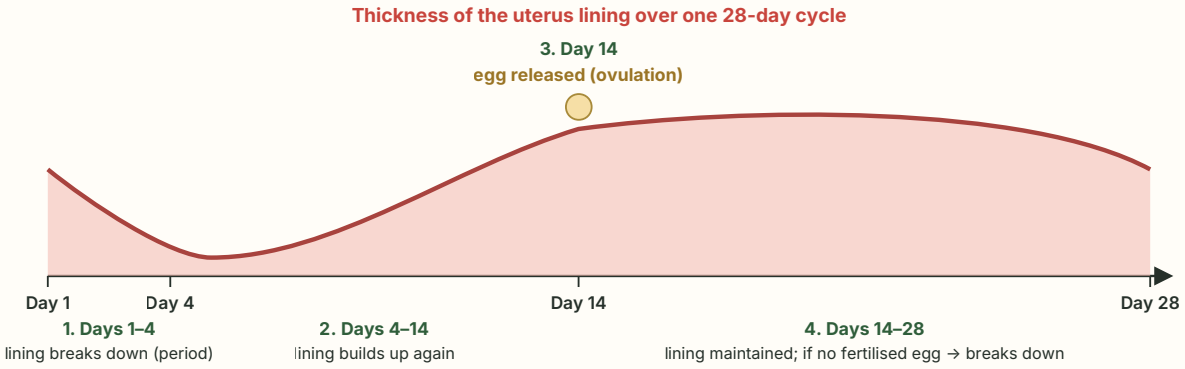
EXAM TIP

Donor kidneys must be a close **tissue-type match** to reduce rejection. Kidneys can come from people who have died (on the **organ donor register**) or from **living donors**, since we can live with one kidney.

5.13 Puberty and the menstrual cycle

AQA 4.5.3.4

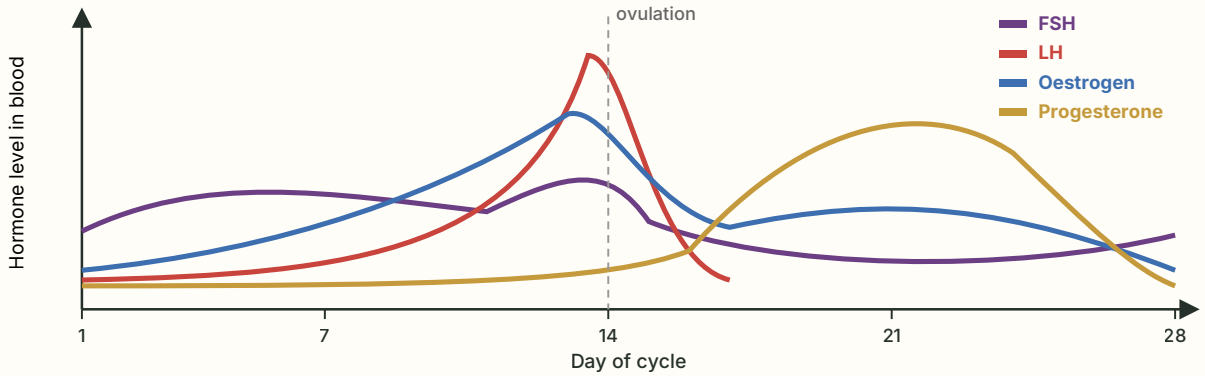
- At **puberty**, reproductive hormones cause **secondary sex characteristics** to develop.
- **Males: testosterone**, made by the **testes**, stimulates **sperm production**.
- **Females: oestrogen**, made by the **ovaries**, is the main reproductive hormone. At puberty, eggs begin to mature, and one is released about **every 28 days** (**ovulation**).



The four stages of the 28-day menstrual cycle

Hormone	Made in	Job
FSH (follicle-stimulating hormone)	Pituitary gland	Causes an **egg to mature** in the ovary; stimulates the ovaries to make oestrogen
LH (luteinising hormone)	Pituitary gland	Stimulates the **release of an egg** (ovulation) on about day 14
Oestrogen	Ovaries	Makes the **uterus lining grow** (thicken)
Progesterone	Ovaries (remains of the follicle after ovulation)	**Maintains** the uterus lining. When its level falls, the lining breaks down (period)

How the hormones interact HIGHER TIER



Hormone levels during the menstrual cycle

- **FSH** → egg matures + ovaries make **oestrogen**.
- Rising **oestrogen** → **inhibits FSH** and **stimulates LH**.
- **LH** peak → **ovulation** (day 14).
- **Progesterone** (after ovulation) → **inhibits FSH and LH** and keeps the lining. If no pregnancy, progesterone falls → period → FSH rises again.

REMEMBER IT

Order of action: **"F-O-L-P"** → **F**SH, **O**estrogen, **L**H, **P**rogesterone.
FSH = Follicle Starts (egg matures). **LH = Let it go** (egg released). **Oestrogen = Ornament the walls** (builds lining). **Progesterone = Protect** (maintains lining).

5.14 Contraception

AQA 4.5.3.5

Fertility can be controlled by **hormonal** and **non-hormonal** methods of contraception.

Hormonal methods	How they work
Oral contraceptive ('the pill')	Contains hormones (oestrogen and progesterone) that **inhibit FSH**, so no eggs mature. Over 99% effective, but side effects possible; doesn't protect against STIs
Injection, implant or skin patch	Slow release of **progesterone** to stop eggs maturing and being released, for months or years
Plastic IUD (some)	A T-shaped device in the uterus that releases progesterone

Non-hormonal methods	How they work
Barrier methods — condoms, diaphragms	Stop sperm reaching the egg. **Condoms** also protect against **STIs**
Copper IUD	Prevents the implantation of an embryo; copper kills sperm
Spermicidal agents	Kill or disable sperm (less effective on their own)
Abstaining around ovulation	Avoid sex when an egg may be in the oviduct ('natural' method) — not very reliable
Surgical sterilisation	Cutting or tying the oviducts (females) or sperm ducts (males) — **permanent**

REMEMBER IT

Hormonal methods mostly stop **eggs**. Barrier methods stop **sperm**. Only **condoms** also stop **STIs**.

"EVALUATE" QUESTIONS

Compare methods using: **effectiveness**, **side effects**, protection from **STIs**, how easy it is to **remember**, and whether it is **reversible**.

5.15 Treating infertility HIGHER TIER

AQA 4.5.3.6

- Some women have too little **FSH**, so their eggs don't mature. They can be given a **fertility drug** containing **FSH and LH** to stimulate ovulation.

IVF — in vitro fertilisation

1. The mother is given **FSH and LH** to make several eggs mature.
2. The eggs are **collected** from her ovaries.
3. They are **fertilised by the father's sperm** in the laboratory.
4. The fertilised eggs develop into **embryos**.
5. When they are tiny balls of cells, **one or two embryos** are inserted into the mother's **uterus**.

✓ Advantages	× Disadvantages
Helps infertile couples have a **child** · microscope techniques and time-lapse imaging have improved success	**Emotionally and physically stressful** · success rates are **not high** · **multiple births** are risky for mother and babies · expensive · side effects of hormones · **ethical issues**: unused embryos are destroyed

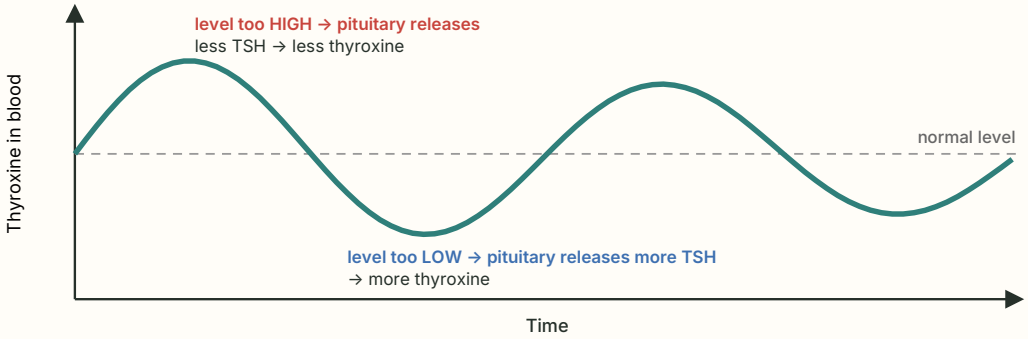
REMEMBER IT

IVF steps: **"Hormones, Harvest, Fertilise, Grow, Insert"**.

5.16 Adrenaline and thyroxine HIGHER TIER

AQA 4.5.3.7

	Adrenaline	Thyroxine
Gland	**Adrenal glands** (above the kidneys)	**Thyroid gland** (in the neck)
Released when	Times of **fear or stress**	Released all the time; controlled by **TSH** from the pituitary
Effect	Increases **heart rate** → more **oxygen and glucose** to the brain and muscles → prepares the body for **'fight or flight'**	Stimulates the **basal metabolic rate** (speed of chemical reactions at rest); important for **growth and development**



Thyroxine is controlled by negative feedback

- If thyroxine is **too high**, the pituitary releases **less TSH** → the thyroid makes less thyroxine.
- If thyroxine is **too low**, the pituitary releases **more TSH** → more thyroxine.

REMEMBER IT

Adrenaline = **A**larm (fight or flight). **Th**yroxine = **Th**ermostat for metabolism.

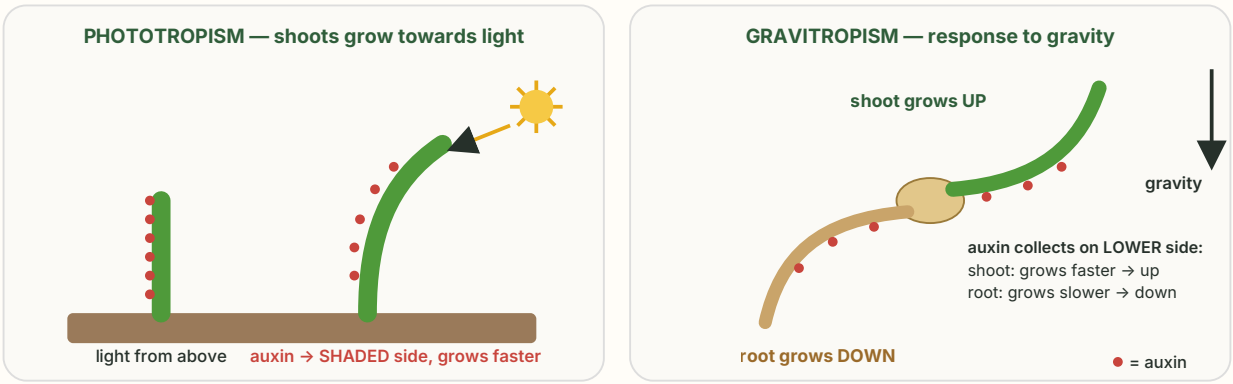
PART C

Plant Hormones

5.17 Plant hormones and tropisms BIOLOGY ONLY

AQA 4.5.4.1

- Plants produce hormones to **coordinate and control growth** and responses to **light** (**phototropism**) and **gravity** (**gravitropism**, also called geotropism).
- **Auxin** is made in the **tips** of shoots and roots and moves backwards to the region where cells **elongate**.
- **Unequal distribution of auxin** causes unequal growth rates, so the shoot or root **bends**.
- In **shoots**, auxin **promotes** growth. In **roots**, extra auxin **inhibits** growth.

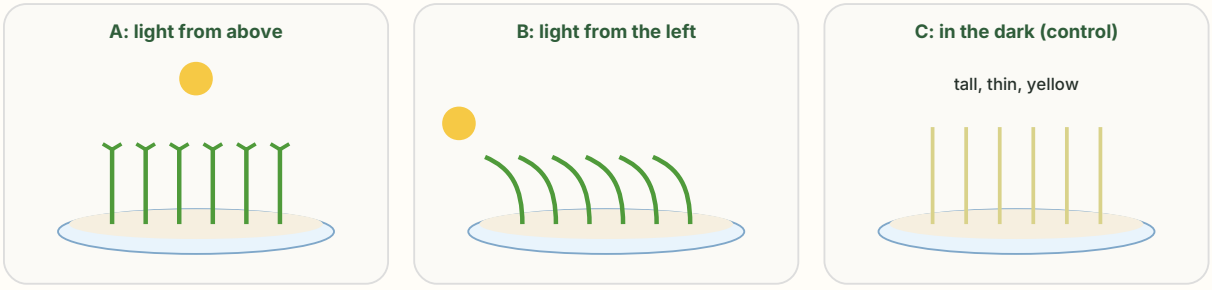


Auxin causes phototropism and gravitropism

Response	What happens
Shoot + light from one side	Auxin collects on the **shaded side** → those cells grow faster → shoot bends **towards the light**
Shoot lying sideways	Gravity makes auxin collect on the **lower side** → lower side grows faster → shoot bends **upwards**
Root lying sideways	Auxin collects on the **lower side** → it **inhibits** growth there → upper side grows faster → root bends **downwards**

- **Gibberellins** are important in starting **seed germination** HIGHER TIER.
- **Ethene** controls **cell division** and the **ripening of fruits** HIGHER TIER.

Required practical: light and seedlings REQUIRED PRACTICAL



Cress seedlings grown with light from different directions

1. Put 10 cress seeds onto moist filter paper in each of three Petri dishes.

2. Shine a light on one from above, one from one side; keep one in the dark.
3. Leave for a week, then **observe and measure** the seedlings.

Control variable	How to control it
Number and type of seeds	Same number of seeds from the same packet
Temperature	Keep all dishes in the same place, away from heaters and draughts
Water	Add the same volume with a measuring cylinder
Light intensity	Same bulb, same distance from each dish

REMEMBER IT

Photo = light, **gravi** = gravity. **Auxin → shady, lower side.** Shoots: auxin = **grow**. Roots: auxin = **slow**.

5.18 Uses of plant hormones

BIOLOGY ONLY HIGHER TIER

AQA 4.5.4.2

Hormone	Use	How it works
Auxins	**Weedkillers**	Selective weedkillers affect only **broad-leaved** weeds, disrupting their growth so they die; grass and cereal crops (narrow leaves) are unaffected
	Rooting powders	Cuttings dipped in rooting powder grow **roots** quickly → many **clones** of a good plant
	Tissue culture	Auxins added to the growth medium help small groups of cells grow roots and shoots
Ethene	**Controlling fruit ripening**	Fruit is picked **unripe** (firm, less damaged in transport), then ripened with ethene before sale. Ripening can be **delayed** in storage by removing ethene
Gibberellins	**Ending seed dormancy**	Makes seeds germinate when they otherwise wouldn't, all at the same time
	Promoting flowering	Plants flower without the usual conditions (e.g. long days, cold)
	Increasing fruit size	Seedless fruits (e.g. grapes) grow bigger when treated

REMEMBER IT

Auxins: **"WRT"** → **W**eedkillers, **R**ooting powder, **T**issue culture. **E**thene = **E**ating-ready fruit. **G**ibberellins = **G**erminate, **G**row bigger fruit, **G**et flowers.

★ LAST-MINUTE

One-page memory sheet

Topic	Must-know facts
Homeostasis	Keeping internal conditions optimum (glucose, temperature, water). Receptor → coordination centre → effector. Negative feedback reverses change.
Nervous system	Stimulus → receptor → sensory neurone → CNS (brain + spinal cord) → motor neurone → effector (muscle/gland) → response.
Synapse + reflex	Synapse: chemicals diffuse across gap. Reflex: rapid, automatic, not conscious. Sensory → relay → motor.
Reaction time RP	Ruler drop, distance caught; repeat + mean; same person, same hand; caffeine speeds up. Computer test more precise.
Brain (Bio)	Cerebral cortex (memory, language, intelligence) · cerebellum (coordination) · medulla (breathing, heartbeat). Study: damage, electrical stimulation, MRI.
Eye (Bio)	Retina, optic nerve, sclera, cornea (refracts), iris (pupil size), lens, ciliary muscles + suspensory ligaments. Near: contract, slacken, fat. Far: relax, tight, thin.
Vision (Bio)	Myopia (short): image in front, concave. Hyperopia (long): image behind, convex. Glasses, contact lenses, laser surgery (cornea), lens replacement.
Temperature (Bio)	37 °C; thermoregulatory centre in brain. Hot: sweat, vasodilation. Cold: shiver, vasoconstriction, hairs up.
Endocrine	Glands → hormones in blood → target organ. Pituitary = master gland. Hormones slower, longer, more general than nerves.
Blood glucose	Pancreas. High → insulin → glucose into cells, glycogen stored. Low → glucagon (HT) → glycogen to glucose. Type 1: no insulin → injections. Type 2: cells don't respond → diet + exercise; obesity.
Kidneys (Bio)	Filtration + selective reabsorption. Urea (from deamination in liver, HT), ions, water. ADH (HT) from pituitary → more water reabsorbed. Dialysis vs transplant.
Menstrual cycle	FSH (pituitary): egg matures. LH (pituitary): ovulation day 14. Oestrogen (ovary): lining grows. Progesterone: maintains lining. HT: oestrogen inhibits FSH + stimulates LH; progesterone inhibits FSH + LH.
Contraception	Hormonal: pill (inhibits FSH), implant, injection, patch, IUD. Non-hormonal: condoms (STIs), diaphragm, copper IUD, spermicide, abstinence, sterilisation.
Infertility (HT)	FSH + LH fertility drugs. IVF: hormones → collect eggs → fertilise in lab → embryos → insert 1–2. Stressful, low success, multiple births, ethics.
Adrenaline + thyroxine (HT)	Adrenaline (adrenal): fight or flight, heart rate ↑. Thyroxine (thyroid): metabolic rate; negative feedback via TSH.
Plant hormones (Bio)	Auxin: shaded/lower side; shoots grow towards light and up; roots down. HT: gibberellins (germination), ethene (ripening). Uses: weedkillers, rooting powder, tissue culture, ripening, dormancy, flowering, fruit size.

PRACTICE

Summary questions

Try every question **without notes**. Tick each one you get fully right; redo the rest in 2–3 days. Answers are in the next section. Questions marked **(Bio)** are for Separate Biology only; **(HT)** are Higher tier only.

Section A — Quick recall (1–2 marks each)

1. What is homeostasis?
2. Name three conditions controlled by homeostasis in humans.
3. What are the three parts of an automatic control system?
4. What is a stimulus?
5. What does the CNS consist of?
6. Name two types of effector.
7. What do sensory neurones do?
8. What is a synapse?
9. Give two features of a reflex action.
10. Name the three types of neurone in a reflex arc, in order.
11. Give one factor that affects reaction time.
12. (Bio) What is the function of the cerebellum?
13. (Bio) Which part of the brain controls breathing and heart rate?
14. (Bio) Give three methods used to study the brain.
15. (Bio) What is the function of the cornea?
16. (Bio) What does the iris do?
17. (Bio) What happens to the ciliary muscles when focusing on a near object?
18. (Bio) What type of lens corrects short-sightedness?
19. (Bio) What is the medical name for long-sightedness?
20. (Bio) Where is the thermoregulatory centre?
21. (Bio) Give two ways the body reduces heat loss when it is too cold.
22. What is a hormone?
23. Why is the pituitary gland called the ‘master gland’?
24. Give two differences between nervous and hormonal responses.
25. Which organ monitors blood glucose?
26. Where is excess glucose stored, and in what form?
27. (HT) What does glucagon do?
28. What is the difference between type 1 and type 2 diabetes?
29. (Bio) Name three things that are reabsorbed by the kidneys.
30. (Bio, HT) Which hormone controls water reabsorption in the kidneys, and which gland releases it?
31. (Bio) Give one advantage of a kidney transplant over dialysis.
32. Which hormone causes eggs to mature in the ovaries?
33. Which hormone stimulates ovulation?

34. What does progesterone do in the menstrual cycle?
35. Where is testosterone produced and what does it do?
36. Which method of contraception also protects against STIs?
37. (HT) How does adrenaline prepare the body for 'fight or flight'?
38. (Bio) Where is auxin made in a plant?
39. (Bio) What is gravitropism?
40. (Bio, HT) Which plant hormone is used to ripen fruit?

Section B — Exam-style questions

41. Explain how negative feedback helps to maintain a stable internal environment. [3 marks]
42. A chef touches a hot tray and immediately moves his hand away. Describe the pathway of this reflex from stimulus to effector. [5 marks]
43. Explain why reflex actions are faster than voluntary responses. [2 marks]
44. Plan an investigation to find out whether caffeine affects reaction time. [6 marks]
45. (Bio) Describe how the eye focuses on a distant object. [3 marks]
46. (Bio) Explain the cause of short-sightedness and how it can be corrected. [3 marks]
47. (Bio) Explain how the body responds when its core temperature rises too high. [4 marks]
48. Describe how blood glucose level is returned to normal when it is too high. [3 marks]
49. Compare the causes and treatments of type 1 and type 2 diabetes. [4 marks]
50. (Bio, HT) Alcohol reduces the production of ADH. Suggest how this can lead to dehydration. [3 marks]
51. (Bio) Explain how a dialysis machine removes urea from the blood but not glucose. [4 marks]
52. (HT) Explain how the hormones FSH, oestrogen and LH interact to control the first half of the menstrual cycle. [4 marks]
53. Evaluate the use of the oral contraceptive pill compared with condoms. [6 marks]
54. (HT) Describe the process of IVF and give two disadvantages. [5 marks]
55. (HT) Describe how the level of thyroxine is returned to normal if it rises too high. [3 marks]
56. (Bio) Explain why a plant shoot grows towards light coming from one side. [3 marks]
57. (Bio, HT) Describe two ways that plant hormones are used in agriculture or horticulture. [4 marks]

Section C — Maths and data skills

58. A student's reaction times were 0.28, 0.25, 0.30, 0.27 and 0.25 s. Calculate the mean. [1 mark]
59. Reaction time fell from 0.30 s to 0.24 s after caffeine. Calculate the percentage decrease. [2 marks]
60. Convert 247 ms into seconds. [1 mark]
61. A patient has dialysis 3 times a week for 4 hours each time. How many hours is this in a year (52 weeks)? [2 marks]
62. Blood glucose rose from 90 mg/100 cm^3 to 135 mg/100 cm^3 after a meal. Calculate the percentage increase. [2 marks]
63. In one clinic, 312 out of 1200 IVF cycles resulted in a birth. Calculate the success rate as a percentage. [2 marks]

ANSWERS

Answers and mark scheme

Section A — Quick recall

1. **What is homeostasis?**
   Regulating the internal conditions of a cell or organism to maintain optimum conditions for function.
2. **Name three conditions controlled by homeostasis in humans.**
   Blood glucose concentration, body temperature, water levels.
3. **What are the three parts of an automatic control system?**
   Receptors, coordination centres, effectors.
4. **What is a stimulus?**
   A change in the environment (internal or external).
5. **What does the CNS consist of?**
   The brain and spinal cord.
6. **Name two types of effector.**
   Muscles and glands.
7. **What do sensory neurones do?**
   Carry impulses from receptors to the CNS.
8. **What is a synapse?**
   The gap between two neurones, where chemicals diffuse across to pass on the signal.
9. **Give two features of a reflex action.**
   Rapid; automatic; does not involve the conscious part of the brain (any two).
10. **Name the three types of neurone in a reflex arc, in order.**
    Sensory, relay, motor.
11. **Give one factor that affects reaction time.**
    Age, gender, drugs such as caffeine (any one).
12. **(Bio) What is the function of the cerebellum?**
    Muscle coordination.
13. **(Bio) Which part of the brain controls breathing and heart rate?**
    The medulla.
14. **(Bio) Give three methods used to study the brain.**
    Studying patients with brain damage; electrically stimulating the brain; MRI scans.
15. **(Bio) What is the function of the cornea?**
    To refract light into the eye (it is transparent).
16. **(Bio) What does the iris do?**
    Controls the size of the pupil and so how much light enters the eye.
17. **(Bio) What happens to the ciliary muscles when focusing on a near object?**
    They contract (suspensory ligaments slacken, lens becomes fatter).
18. **(Bio) What type of lens corrects short-sightedness?**
    A concave lens.
19. **(Bio) What is the medical name for long-sightedness?**
    Hyperopia.
20. **(Bio) Where is the thermoregulatory centre?**
    In the brain.

21. **(Bio) Give two ways the body reduces heat loss when it is too cold.**
    Vasoconstriction; shivering; hairs stand up; no sweating (any two).
22. **What is a hormone?**
    A chemical messenger secreted by a gland into the bloodstream, which acts on a target organ.
23. **Why is the pituitary gland called the 'master gland'?**
    It secretes hormones that act on other glands, making them release hormones.
24. **Give two differences between nervous and hormonal responses.**
    Nerves are faster, act for a shorter time and on a precise area; hormones are slower, longer-lasting and more general (any two).
25. **Which organ monitors blood glucose?**
    The pancreas.
26. **Where is excess glucose stored, and in what form?**
    In the liver and muscles, as glycogen.
27. **(HT) What does glucagon do?**
    Makes the liver convert glycogen into glucose, which is released into the blood (raising blood glucose).
28. **What is the difference between type 1 and type 2 diabetes?**
    Type 1: the pancreas makes too little insulin. Type 2: body cells no longer respond to insulin.
29. **(Bio) Name three things that are reabsorbed by the kidneys.**
    All the glucose, some ions, the right amount of water.
30. **(Bio, HT) Which hormone controls water reabsorption in the kidneys, and which gland releases it?**
    ADH; the pituitary gland.
31. **(Bio) Give one advantage of a kidney transplant over dialysis.**
    It is a cure / cheaper in the long run / no time spent on dialysis / fewer diet restrictions.
32. **Which hormone causes eggs to mature in the ovaries?**
    FSH (follicle-stimulating hormone).
33. **Which hormone stimulates ovulation?**
    LH (luteinising hormone).
34. **What does progesterone do in the menstrual cycle?**
    Maintains the lining of the uterus.
35. **Where is testosterone produced and what does it do?**
    In the testes; stimulates sperm production.
36. **Which method of contraception also protects against STIs?**
    Condoms.
37. **(HT) How does adrenaline prepare the body for 'fight or flight'?**
    Increases heart rate, boosting delivery of oxygen and glucose to the brain and muscles.
38. **(Bio) Where is auxin made in a plant?**
    In the tips of shoots and roots.
39. **(Bio) What is gravitropism?**
    The growth response of a plant to gravity.
40. **(Bio, HT) Which plant hormone is used to ripen fruit?**
    Ethene.

Section B — Exam-style questions

41. **Explain how negative feedback helps to maintain a stable internal environment.** [3]
    - A receptor detects that a level is too high or too low (1)
    - The coordination centre processes the information and triggers an effector (1)
    - The effector produces a response that counteracts the change, bringing the level back to normal (1)
42. **A chef touches a hot tray and immediately moves his hand away. Describe the pathway of this reflex from stimulus to effector.** [5]
    - Heat is detected by (temperature/pain) receptors in the skin (1)
    - Impulses travel along a sensory neurone to the spinal cord (1)
    - At a synapse, chemicals pass the signal to a relay neurone (1)
    - Then across a synapse to a motor neurone (1)
    - Impulses reach the effector — a muscle — which contracts and moves the hand (1)
43. **Explain why reflex actions are faster than voluntary responses.** [2]
    - They don't involve the conscious part of the brain / no time spent deciding (1)
    - The impulse takes a short pathway through the spinal cord / few synapses (1)
44. **Plan an investigation to find out whether caffeine affects reaction time.** [6]
    - Use the ruler-drop test: person sits with arm on table; ruler held with zero at top of thumb
    - Drop without warning; record distance caught
    - Repeat several times; calculate a mean
    - Give a caffeinated drink; wait about 10 minutes; repeat the test
    - Control: same person, same hand, same drop height, no other caffeine, same time of day
    - Compare means; larger distance = slower reaction
    - *Level marking: clear method with controls and repeats for 5–6 marks.*
45. **(Bio) Describe how the eye focuses on a distant object.** [3]
    - Ciliary muscles relax (1)
    - Suspensory ligaments are pulled tight (1)
    - Lens is pulled thin, so it refracts light only slightly onto the retina (1)
46. **(Bio) Explain the cause of short-sightedness and how it can be corrected.** [3]
    - The lens refracts light too much / the eyeball is too long (1)
    - so light from distant objects focuses in front of the retina (1)
    - Corrected using a concave lens / contact lenses / laser surgery to change the cornea (1)
47. **(Bio) Explain how the body responds when its core temperature rises too high.** [4]
    - The thermoregulatory centre in the brain detects the rise (blood temperature receptors) (1)
    - Sweat glands produce sweat, which evaporates and transfers energy to the environment (1)
    - Blood vessels supplying skin capillaries dilate (vasodilation) (1)
    - so more blood flows near the surface and more energy is transferred to the surroundings (1)
48. **Describe how blood glucose level is returned to normal when it is too high.** [3]
    - The pancreas detects the high level and releases insulin (1)
    - Insulin causes glucose to move from the blood into cells (1)
    - In the liver and muscles, excess glucose is converted to glycogen for storage (1)

49. **Compare the causes and treatments of type 1 and type 2 diabetes.** [4]
    - Type 1: pancreas produces too little insulin (1)
    - Treated with insulin injections (1)
    - Type 2: body cells no longer respond to insulin (1)
    - Treated with a carbohydrate-controlled diet and exercise (1)
50. **(Bio, HT) Alcohol reduces the production of ADH. Suggest how this can lead to dehydration.** [3]
    - Less ADH released by the pituitary (1)
    - Kidney tubules less permeable, so less water is reabsorbed into the blood (1)
    - More, dilute urine is produced, so the body loses too much water (1)
51. **(Bio) Explain how a dialysis machine removes urea from the blood but not glucose.** [4]
    - Blood flows past a partially permeable membrane surrounded by dialysis fluid (1)
    - Dialysis fluid contains no urea, so urea diffuses out of the blood down a concentration gradient (1)
    - The fluid has the same glucose concentration as healthy blood (1)
    - so there is no concentration gradient and glucose does not diffuse out (1)
52. **(HT) Explain how the hormones FSH, oestrogen and LH interact to control the first half of the menstrual cycle.** [4]
    - FSH from the pituitary causes an egg to mature (1)
    - FSH stimulates the ovaries to produce oestrogen (1)
    - Oestrogen inhibits FSH and stimulates the release of LH (1)
    - LH stimulates the release of the egg (ovulation) on about day 14 (1)
53. **Evaluate the use of the oral contraceptive pill compared with condoms.** [6]
    - **Pill:** over 99% effective; hormones inhibit FSH so no eggs mature; doesn't interrupt sex; but must be taken every day, possible side effects (headaches, mood changes, blood clots), no STI protection
    - **Condoms:** barrier, no hormones, no side effects, protect against STIs; but less effective (can split), must be used every time
    - **Conclusion** justified, e.g. condoms better for new partners because of STI protection; pill more reliable for a long-term couple; or using both
    - *Level marking: balanced points + justified conclusion for 5–6 marks.*
54. **(HT) Describe the process of IVF and give two disadvantages.** [5]
    - Mother given FSH and LH to stimulate several eggs to mature (1)
    - Eggs collected and fertilised by sperm in the laboratory (1)
    - Fertilised eggs develop into embryos; one or two inserted into the uterus (1)
    - Any two disadvantages (2): emotionally/physically stressful; low success rate; multiple births risk; expensive; unused embryos destroyed (ethical issue)
55. **(HT) Describe how the level of thyroxine is returned to normal if it rises too high.** [3]
    - The rise is detected (by the brain/pituitary) (1)
    - The pituitary releases less TSH (1)
    - so the thyroid gland releases less thyroxine and the level falls back to normal — negative feedback (1)
56. **(Bio) Explain why a plant shoot grows towards light coming from one side.** [3]
    - Auxin moves to the shaded side of the shoot tip (1)
    - Auxin stimulates cell elongation in shoots (1)
    - The shaded side grows faster, so the shoot bends towards the light (1)

57. **(Bio, HT) Describe two ways that plant hormones are used in agriculture or horticulture.** [4]
    - Any two uses with explanation (2 marks each): auxins as selective weedkillers (kill broad-leaved weeds only); rooting powder for cuttings (grow roots quickly → clones); ethene to ripen fruit after transport; gibberellins to end seed dormancy / promote flowering / increase fruit size

Section C — Maths and data skills

58. **A student's reaction times were 0.28, 0.25, 0.30, 0.27 and 0.25 s. Calculate the mean.** [1]
    (0.28 + 0.25 + 0.30 + 0.27 + 0.25) ÷ 5 = 1.35 ÷ 5 = **0.27 s**
59. **Reaction time fell from 0.30 s to 0.24 s after caffeine. Calculate the percentage decrease.** [2]
    0.30 − 0.24 = 0.06 (1) → 0.06 ÷ 0.30 × 100 = **20%** (1)
60. **Convert 247 ms into seconds.** [1]
    247 ÷ 1000 = **0.247 s**
61. **A patient has dialysis 3 times a week for 4 hours each time. How many hours is this in a year (52 weeks)?** [2]
    3 × 4 = 12 hours a week (1) → 12 × 52 = **624 hours** (1)
62. **Blood glucose rose from 90 mg/100 cm³ to 135 mg/100 cm³ after a meal. Calculate the percentage increase.** [2]
    135 − 90 = 45 (1) → 45 ÷ 90 × 100 = **50%** (1)
63. **In one clinic, 312 out of 1200 IVF cycles resulted in a birth. Calculate the success rate as a** [2]

    312 ÷ 1200 × 100 (1) = **26%** (1)

FINAL EXAM ADVICE

Use the **key words** examiners look for: *homeostasis, negative feedback, receptor, effector, coordination centre, synapse, reflex arc, relay neurone, accommodation, vasodilation, vasoconstriction, thermoregulatory centre, insulin, glucagon, glycogen, ADH, selective reabsorption, FSH, LH, oestrogen, progesterone, auxin, phototropism, gravitropism*. In feedback questions always say what is **detected**, what is **released** and what **effect** it has.

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