IB BIOLOGY | D3.3 | SL AND HL

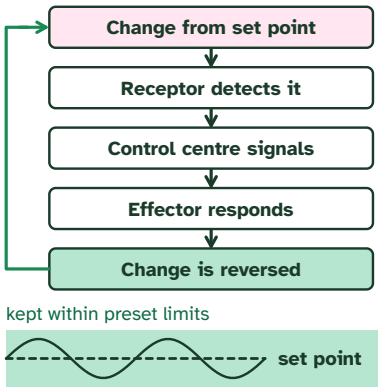
REVISION ON TWO PAGES

Keeping the inside *steady*

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

A receptor, a control centre and an effector hold each variable near its set point. The response always reverses the change: negative feedback.



Negative does not mean bad. It means the response opposes the change.

D3.3.1, D3.3.2 START HERE

Homeostasis by *negative feedback*

- **Homeostasis**: keeping the internal environment within **preset limits** around a set point, even when conditions outside change.
- Every loop has a **receptor**, a **control centre** and an **effector**. The **response reverses the change**, so it is negative feedback.
- It works **from above and below** the set point, and switches itself off once the change is reversed.
- **Not positive feedback:** that makes the change bigger, so the variable **runs away from the set point**. It suits all-or-nothing events such as childbirth.

FOUR VARIABLES HELD STEADY IN HUMANS

T Temperature	**P** pH	**G** Glucose	**O** Osmotic
core about 37 °C	blood 7.35 to 7.45	4 to 6 mmol L^{-1} fasting	blood about 0.3 osmol L^{-1}

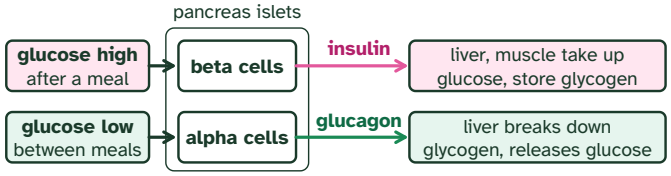
D3.3.3

Blood glucose: *two hormones*

- Hormones travel in the blood; only **target cells with the receptor** respond. The control centre is the **pancreas**.
- **High: beta cells** secrete **insulin**; target cells take up glucose. **Low: alpha cells** secrete **glucagon**; the liver releases glucose.

THE INSULIN RESPONSE — *BITS*

B Beta cells detect high glucose	**I** Insulin secreted into blood	**T** Target cells take up glucose	**S** Store the extra as glycogen



D3.3.4

When control breaks: *diabetes*

- Diabetes is a **long-term failure to control blood glucose**.

Type 1 little or no insulin
The **immune system destroys the beta cells**. Usually starts young; cannot yet be prevented. **Treat:** monitor glucose, inject insulin.

Type 2 insulin resistance
Insulin is made but **target cells respond poorly**. **Risks:** obesity, inactivity, a diet high in sugar and fat, age, family history. **Prevent, treat:** diet, exercise, healthy body mass; then drugs.

- High glucose with **plenty of insulin** points to **type 2**; with little insulin, type 1.

D3.3.5, D3.3.6

Thermoregulation: keeping heat in, *letting it out*

- **Receptors: peripheral thermoreceptors** in the skin; the hypothalamus senses the blood.
- **Control centre:** the **hypothalamus**; nerve impulses go to muscle, adipose tissue and skin.
- **Hormones:** the **pituitary** releases TSH; the thyroid releases **thyroxin**, raising metabolic rate.
- Birds and mammals also use **behaviour**; only human details are needed.

EFFECTOR	TOO COLD	TOO HOT
Skin arterioles	**Vasoconstriction**: less warm blood near the surface, less heat lost.	**Vasodilation**: more blood near the surface; heat lost by radiation.
Sweat glands	Little sweat.	**Sweat** evaporates, taking heat away.
Skeletal muscle	**Shivering** makes heat.	No shivering.
Hair erector muscles	**Hair erection** traps air (little use in people).	Hairs lie flat.
Brown adipose tissue	**Uncoupled respiration**: protons bypass ATP synthase, so energy is released as heat, not ATP.	Less heat made.

D3.3.7 to D3.3.10 HIGHER LEVEL

The kidney: filter, then *take back*

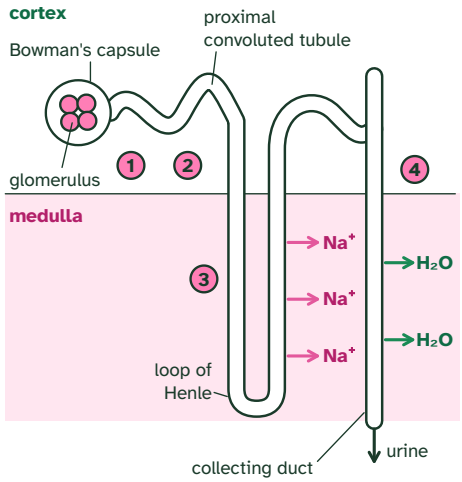
- **Excretion**: removing **waste products of metabolism**, such as urea (made in the liver from excess amino acids).
- **Osmoregulation**: keeping blood **osmotic concentration** within narrow limits, about 0.3 osmol L^{-1} (osmoles per litre).

1 · GLOMERULUS
Ultrafiltration
High pressure forces water and small solutes into Bowman's capsule. Blood cells and large proteins stay in the blood.

2 · PROXIMAL CONVOLUTED TUBULE
Reabsorption
All the glucose and most ions return by active transport; water follows by osmosis. Urea mostly stays: it is excreted.

3 · LOOP OF HENLE
A salty medulla
The ascending limb pumps Na^+ out actively and is impermeable to water, so the medulla stays concentrated.

4 · COLLECTING DUCT
Water taken back
Aquaporins let water leave by osmosis into the salty medulla. Water is never pumped.



Pink: Na^+ pumped out. Green: water leaving by osmosis.

- Concentrated blood: **osmoreceptors in the hypothalamus** detect it, the **pituitary releases more ADH**, and **vesicles fuse with the membrane**, adding aquaporins.
- After drinking a lot: ADH falls and aquaporins are taken back **into vesicles**, so plenty of dilute urine is made.

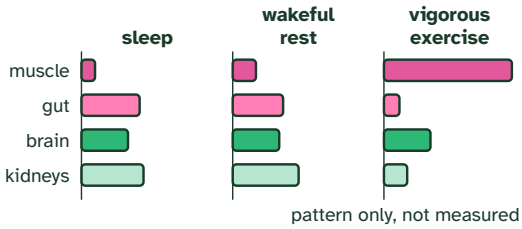
BLOOD TOO CONCENTRATED — *OAARS*

O Osmoreceptors detect it	**A** ADH from pituitary	**A** Aquaporins into membrane	**R** Reabsorb more water	**S** Small concentrated urine

D3.3.11 HIGHER LEVEL

Blood goes where it is *needed*

- Arterioles share out the blood: smooth muscle relaxes to **dilate** (more flow) or contracts to **constrict** (less).
- **Vigorous exercise:** muscles get **most of the blood**; gut and kidneys much less. **Wakeful rest:** shared more evenly. **Sleep:** muscles need little.
- The **brain gets a steady supply** at all times.



pattern only, not measured

WATCH OUT

Six mistakes that *cost marks*

- ✕ **Negative feedback is not bad feedback.** The response opposes the change, from above or below.
- ✕ **Glucagon is a hormone; glycogen is the store.** Spell both carefully.
- ✕ **Type 1 is not caused by sugar.** It is an immune attack on the beta cells.
- ✕ **Vessels do not move to the skin.** Skin arterioles change width, changing the flow near the surface.
- ✕ **Brown fat makes heat, not ATP.** Protons bypass ATP synthase.
- ✕ **Excretion is not osmoregulation.** Removing urea is excretion; controlling water is osmoregulation.

COVER THE SHEET

Can you *answer these?*

1. State four variables kept steady by homeostasis.
2. Explain why homeostasis uses negative feedback.
3. Describe how blood glucose falls after a meal.
4. Distinguish type 1 from type 2 diabetes.
5. Outline the roles of the hypothalamus and thyroxin.
6. Explain how vasodilation and sweating cool you.
7. Distinguish excretion from osmoregulation. HL
8. Outline ultrafiltration and reabsorption. HL
9. Explain how the loop of Henle helps save water. HL
10. Describe how ADH changes the collecting duct. HL
11. Compare blood flow to muscle in sleep and exercise. HL

IN THE EXAM

In a feedback answer, name all four parts: receptor, control centre, effector and a response that **reverses the change**, from above or below the set point.

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.