NAME _____ CLASS _____ DATE _____

IB BIOLOGY · D3.3

# Homeostasis

**Notes to fill in alongside the guide.** Each numbered block matches a chapter of the guide, and of the lesson slides. Write in the gaps, answer the cues, annotate the figures, and sum up each section in your own words.

BY THE END YOU CAN

- [ ] Define homeostasis and name four variables that humans keep within limits D3.3.1
- [ ] Explain how negative feedback keeps a variable at its set point, from above and from below D3.3.2
- [ ] Explain how insulin and glucagon control blood glucose D3.3.3
- [ ] Describe the changes in type 1 and type 2 diabetes, with risk factors, prevention and treatment D3.3.4
- [ ] Explain thermoregulation as negative feedback, naming receptors, control centre and effectors D3.3.5
- [ ] Describe how humans lose and conserve heat, including brown adipose tissue D3.3.6
- [ ] Distinguish excretion from osmoregulation and say what the kidney does for each D3.3.7
- [ ] Explain ultrafiltration in the glomerulus and reabsorption in the proximal convoluted tubule D3.3.8
- [ ] Explain how the loop of Henle keeps the medulla salty D3.3.9
- [ ] Explain how ADH and aquaporins in the collecting duct control the water the body keeps D3.3.10
- [ ] Explain how blood supply to organs changes with sleep, rest and exercise D3.3.11

## 01 Holding the inside steady

D3.3.1

CUES

**Predict:** The air temperature drops from 20 °C to 5 °C. What happens to the temperature of the blood in a healthy person?

**What is meant by homeostasis?**

**What is meant by set point?**

NOTES

1 You live in air that swings from freezing to scorching and eat meals hours apart, yet your cells sit in conditions that hardly change. _____ is that steadiness.

2 A variable is kept within preset limits around a _____, whatever happens outside.

3 A homeostatic variable is held within _____, not at an exact value.

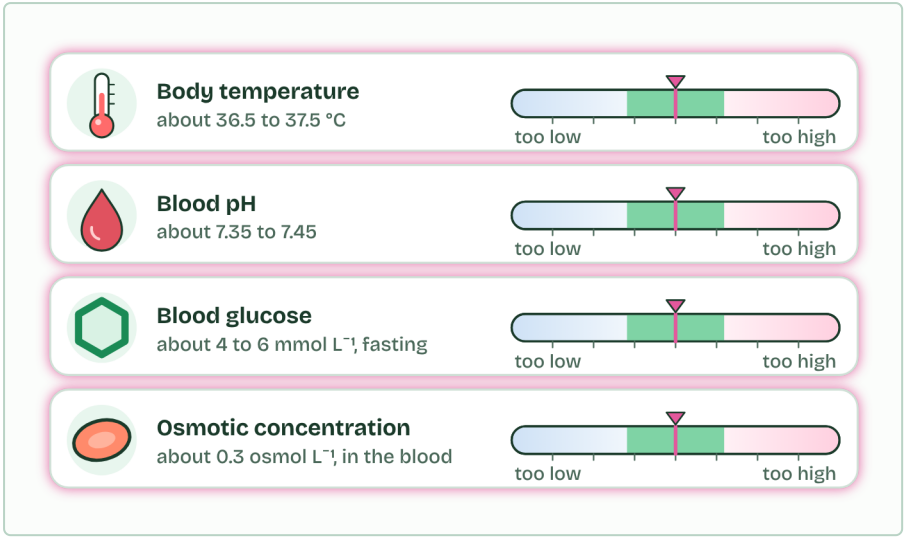
4 The four to know are _____, _____, _____ and _____.

5 The internal environment stays steady _____.

*Your own notes*

ANNOTATE THE FIGURE

Label each part and say what it does: body temperature, blood pH, blood glucose, blood osmotic concentration.




SUMMARY

Sum up section 01 in two or three sentences of your own.

# 02 A change that switches itself off

D3.3.2

CUES

**Predict:** A thermostat turns the heating on when a room is cold and off when it is warm enough. Why is this negative feedback?

**What is meant by receptor?**

**What is meant by control centre?**

**What is meant by effector?**

**What is meant by negative feedback?**

NOTES

1 A _____ detects the variable, a _____ compares it with the set point, and an _____ changes something that pushes the variable back.

2 The response is the opposite of the change, so it is _____.

3 A change pushes the variable _____ its set point.

4 A _____ detects the change.

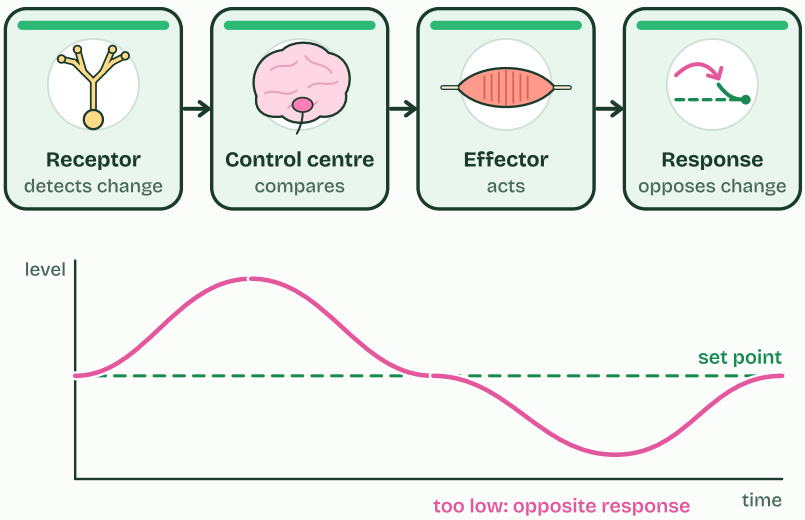
5 The _____ compares it with the set point and sends a signal.

6 An _____ acts on the signal.

*Your own notes*

ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each: 1 above; 2 receptor; 3 control centre; 4 effector; 5 response, falls back; 6 too low.



SUMMARY

Sum up section 02 in two or three sentences of your own.

# 03 Two hormones, one set point

D3.3.3

CUES

**Predict:** A person skips lunch and their blood glucose starts to fall. Which change comes next?

**What is meant by beta cells?**

**What is meant by insulin?**

**What is meant by alpha cells?**

**What is meant by glucagon?**

**What is meant by glycogen?**

NOTES

1 The control centre is the pancreas, which has two kinds of endocrine cell in clusters called islets. _____ secrete _____, and _____ secrete _____.

2 _____ glucose enters the blood and its concentration rises.

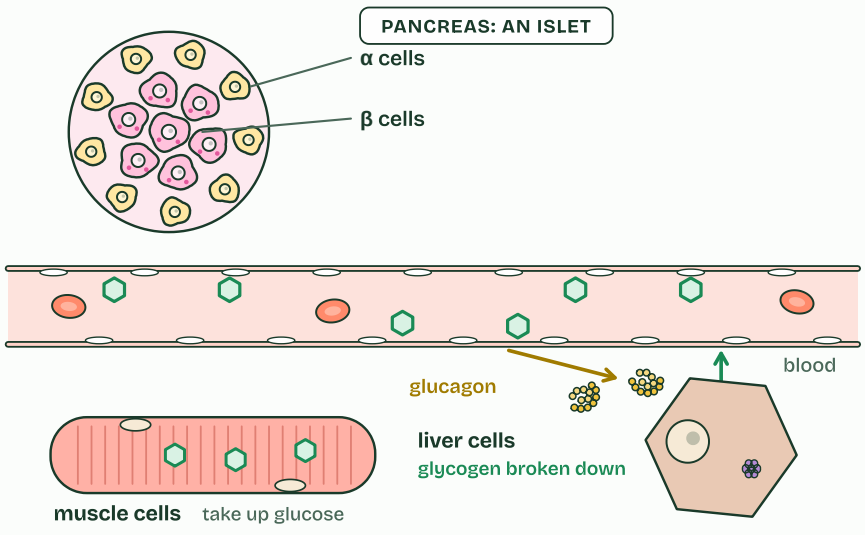
3 Insulin travels in the blood to target cells, mostly in the liver, muscle and fat. They take up more glucose, and the liver and muscle convert it to _____.

4 _____ the level falls.

*Your own notes*

ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each: 1 glucose; 2 Beta cells, insulin; 3 target cells, glycogen; 4 falls back; 5 low, Alpha cells, glucagon; 6 break down glycogen, rises.



REMEMBER IT

**The insulin response, in four letters**

| B | I | T | S |
|---|---|---|---|
| B | I | T | S |

SUMMARY

Sum up section 03 in two or three sentences of your own.

# 04 When the control breaks

D3.3.4

CUES

**Predict:** A person with diabetes has plenty of insulin in the blood but a high blood glucose level. Which is the most likely kind?

**What is meant by diabetes mellitus?**

**What is meant by insulin resistance?**

NOTES

1 _____ is the long-term failure to control blood glucose.

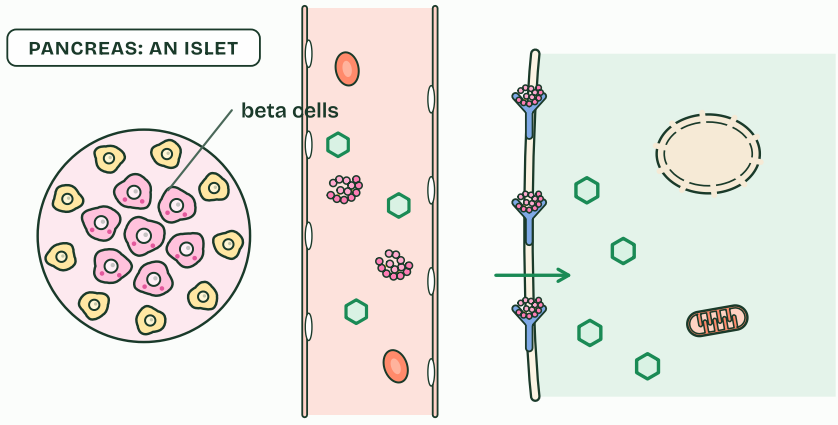
2 _____ is the loss of the beta cells.

3 _____ is _____: beta cells make insulin, but target cells respond to it poorly.

*Your own notes*

ANNOTATE THE FIGURE

The figure shows it as Healthy, Type 1 and Type 2. Note what changes each time.




**Healthy: beta cells make insulin, it binds receptors,** cells take up glucose, and blood glucose stays in range.

SPOT THE MISTAKE

What do students often get wrong about physiological changes that form the basis of type 1 and type 2 diabetes? Write the mistake, then put it right.

*The mistake*

*Put it right*

SUMMARY

Sum up section 04 in two or three sentences of your own.

## 05 A thermostat in the brain

D3.3.5

CUES

**Predict:** Which cells or organs detect the change when you step out into cold air?

**What is meant by peripheral thermoreceptors?**

**What is meant by hypothalamus?**

**What is meant by pituitary gland?**

**What is meant by thyroxin?**

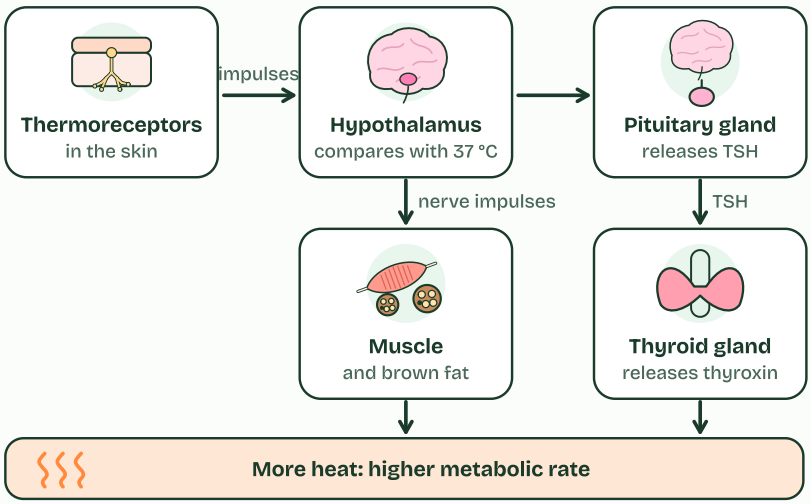
NOTES

1. There are two sets of sensors. _____ in the skin report the temperature of the outside, and cells in the _____ sense the temperature of the blood passing through it.
2. In the cold the hypothalamus signals the _____, which releases thyroid stimulating hormone (TSH) into the blood.
3. TSH makes the thyroid gland release _____, which raises the metabolic rate of most cells, so they release more heat from respiration.
4. **Receptors:** _____ in the skin, and the hypothalamus itself.
5. **Control centre:** the _____.
6. **Hormone route:** _____ (TSH), then thyroid gland (thyroxin), then a higher metabolic rate.

*Your own notes*

ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 Thermoreceptors; 2 hypothalamus; 3 effectors; 4 pituitary; 5 thyroid, thyroxin.




SUMMARY

Sum up section 05 in two or three sentences of your own.

# 06 Keeping heat in, letting it out

D3.3.6

CUES

**Predict:** A runner finishes a race on a warm day and their skin looks flushed and red. What is happening?

**What is meant by vasoconstriction?**

**What is meant by shivering?**

**What is meant by vasodilation?**

NOTES

1 Birds and mammals regulate body temperature by _____ means, changes inside the body, and by _____ such as seeking shade or putting on a coat.

2 _____ the hypothalamus triggers _____ of the arterioles that supply the skin.

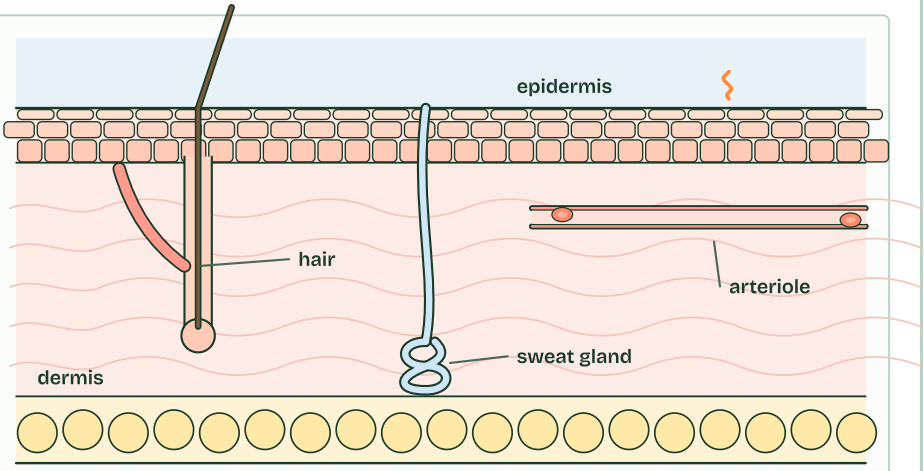
3 Muscles contract and relax rapidly: _____ uses ATP and releases heat.

4 _____ the arterioles widen, called _____.

*Your own notes*

ANNOTATE THE FIGURE

The figure shows it as Cold and Hot. Note what changes each time.




**Cold: arterioles narrow (vasoconstriction), less blood reaches the skin,** hairs are raised, and muscles shiver. Less heat is lost.

SPOT THE MISTAKE

What do students often get wrong about thermoregulation mechanisms in humans? Write the mistake, then put it right.

*The mistake*

*Put it right*

SUMMARY

Sum up section 06 in two or three sentences of your own.

# 07 A furnace that makes no ATP

D3.3.6

CUES

**Predict:** Brown adipose tissue is most abundant in newborn babies. Why is a baby more in need of it than an adult?

**What is meant by brown adipose tissue?**

**What is meant by uncoupled respiration?**

NOTES

1 Most of the body's fat, _____, stores energy and insulates. _____ is different: its cells are packed with mitochondria, which give it a brown colour, and its job is to make heat.

2 In brown fat the inner membrane has a protein that lets protons flow back *without* passing through ATP synthase. This is _____.

3 In _____ protons return through an uncoupling protein, not ATP synthase.

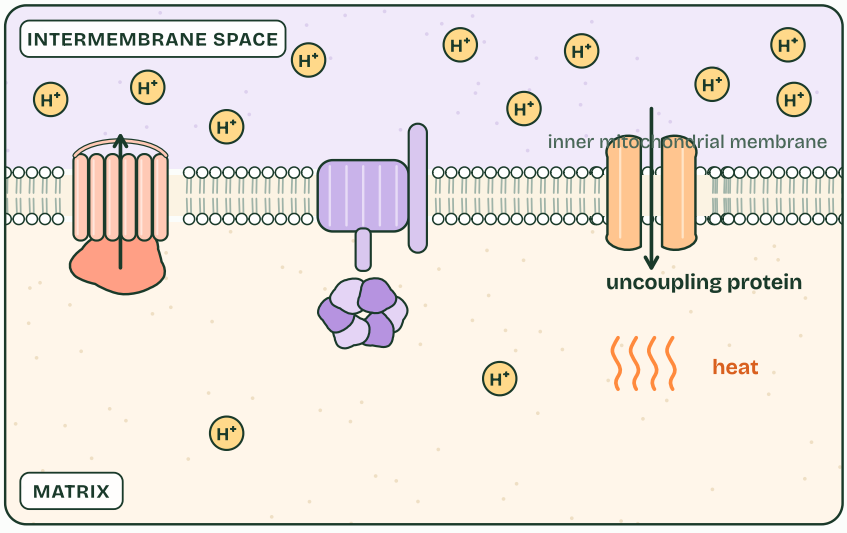
4 The energy is released as _____, and no ATP is made by that route.

5 Brown adipose tissue and _____ (shivering) are the _____ that make heat.

*Your own notes*

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 intermembrane space; 2 ATP synthase; 3 brown fat, uncoupling protein; 4 no ATP, heat.



SUMMARY

Sum up section 07 in two or three sentences of your own.

# 08 Clearing waste and balancing water

D3.3.7 HL

CUES

**Predict:** A person eats a very salty meal and drinks no water. Which change will happen in the blood?

**What is meant by excretion?**

**What is meant by urea?**

**What is meant by osmoregulation?**

**What is meant by osmotic concentration?**

NOTES

1 The kidney does two different jobs, and the exam asks you to tell them apart. _____ is the removal of the waste products of metabolism.

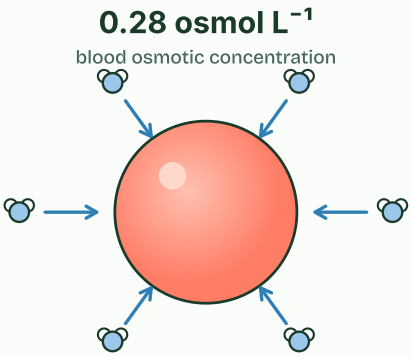
2 The kidney excretes _____, which the liver makes from excess amino acids. _____ is a separate job: keeping the total concentration of dissolved solutes, the _____, within narrow limits.

3 Osmotic concentration is measured in _____ (osmol $L^{-1}$), the number of solute particles in a litre of solution.

*Your own notes*

ANNOTATE THE FIGURE

The figure shows it as Too dilute, Set point and Too concentrated. Note what changes each time.




**Cells swell**

Blood is too dilute: water enters cells by osmosis.

SPOT THE MISTAKE

What do students often get wrong about role of the kidney in osmoregulation and excretion? Write the mistake, then put it right.

*The mistake*

*Put it right*

SUMMARY

Sum up section 08 in two or three sentences of your own.

## 09 Filter everything small, take back what you need

D3.3.8 HL

CUES

**Predict:** A person's urine contains protein, which is not normally found in it. Which part of the nephron is most likely to be damaged?

**What is meant by nephrons?**

**What is meant by glomerulus?**

**What is meant by bowman's capsule?**

**What is meant by ultrafiltration?**

**What is meant by proximal convoluted tubule?**

NOTES

1 Each kidney has about a million tiny filtering tubes, _____.

2 The first part is the _____, a knot of capillaries enclosed by the cup-shaped _____.

3 _____ happens here.

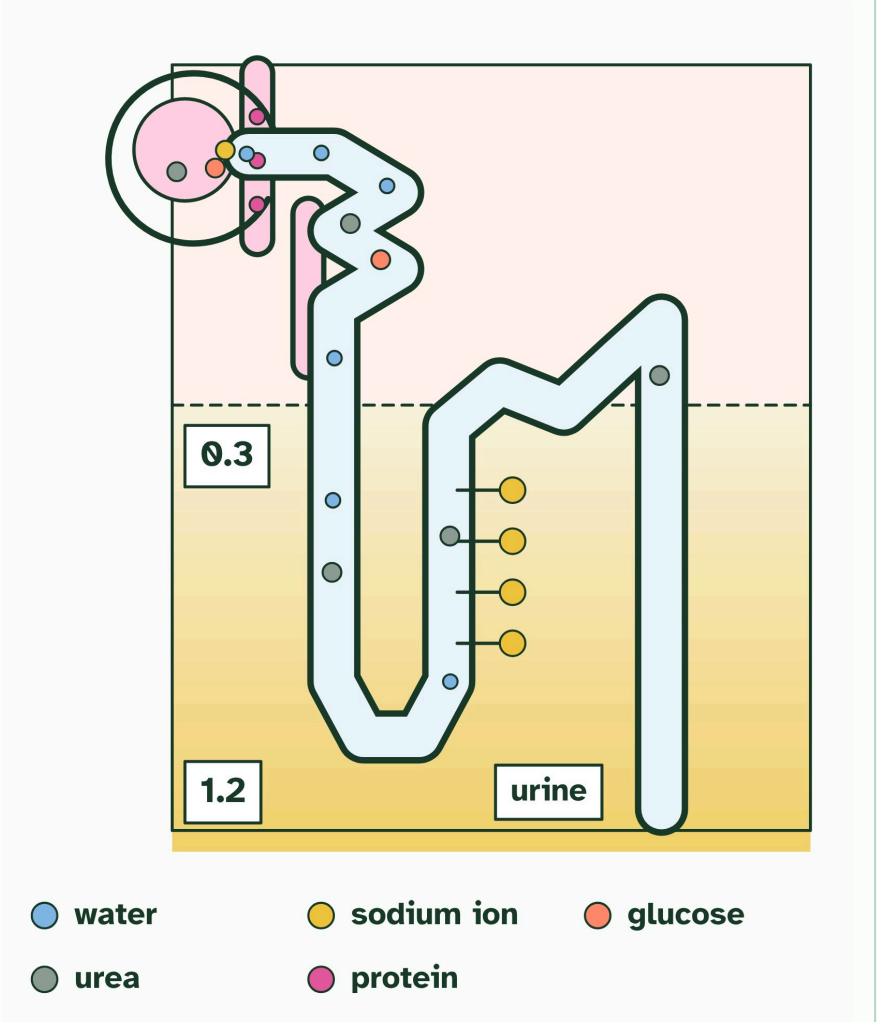
4 The fluid in the capsule is the _____.

5 The filtrate contains useful things, so the next part, the _____, takes them back.

*Your own notes*

ANNOTATE THE FIGURE

Annotate this still from the animation (Making urine in a nephron): what is happening, and why?




SUMMARY

Sum up section 09 in two or three sentences of your own.

# 10 Making the medulla salty

D3.3.9 HL

CUES

**Predict:** What would happen to the concentration of the medulla if the sodium pumps in the ascending limb stopped working?

**What is meant by loop of Henle?**

**What is meant by medulla?**

NOTES

1 The _____ makes it.

2 Cells in the wall of the _____ use active transport to pump sodium ions out of the filtrate into the tissue fluid of the _____.

3 This salty medulla is what lets the _____, which runs down through it, take back water by osmosis.

4 The ascending limb _____ by active transport and is _____.

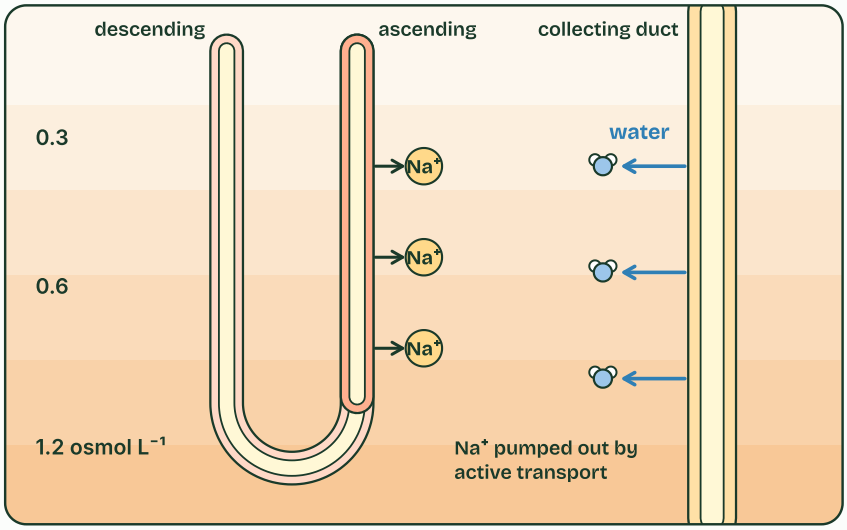
5 This keeps the medulla at a _____.

6 Water leaves the _____ by osmosis into the salty medulla.

*Your own notes*

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 down, up; 2 pumps sodium ions out; 3 very salty; 4 collecting duct.



SUMMARY

Sum up section 10 in two or three sentences of your own.

# 11 A hormone that opens the taps

D3.3.10 HL

CUES

**Predict:** After running a long way in the heat, an athlete makes only a little dark urine. Which change in the collecting duct cells explains it?

**What is meant by osmoreceptors?**

**What is meant by antidiuretic hormone (ADH)?**

**What is meant by aquaporins?**

NOTES

1 If you have not drunk for a while, the blood becomes more concentrated. _____ in the hypothalamus detect it and signal the pituitary gland, which releases more _____ into the blood.

2 ADH travels to the kidney and binds to receptors on the cells of the collecting duct. This makes vesicles inside the cells fuse with the cell membrane, which adds _____, channels that let water through.

3 So the aquaporins _____ between the cell membrane and vesicles inside the cell.

4 The blood is too _____. _____ in the hypothalamus detect it.

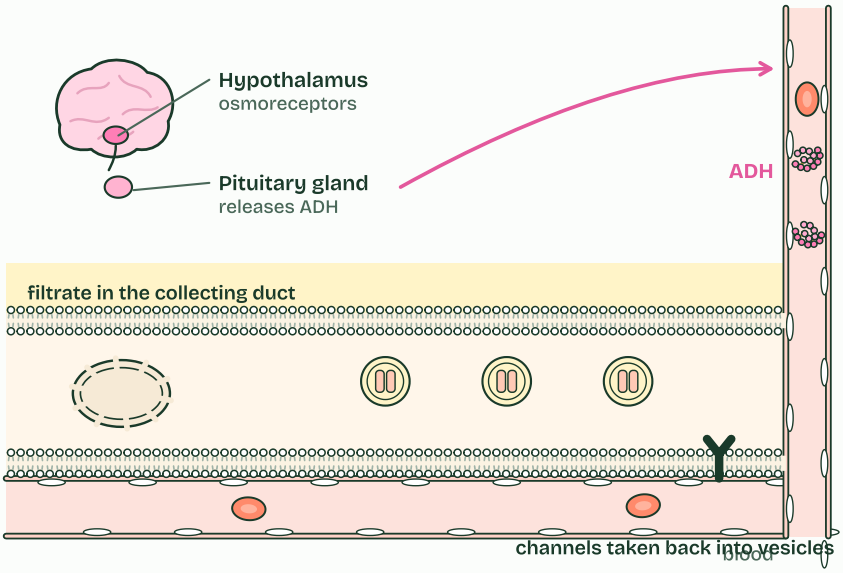
5 The _____ releases more _____.

6 ADH travels in the blood and _____ on the collecting duct cells.

*Your own notes*

ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each: 1 concentrated, Osmoreceptors; 2 pituitary gland, ADH; 3 binds to receptors; 4 fuse with the membrane, aquaporins; 5 osmosis; 6 taken back into vesicles.




REMEMBER IT

**Osmoregulation when the blood is too concentrated**

| O | A | A | R | S |
|---|---|---|---|---|
| O | A | A | R | S |

SUMMARY

Sum up section 11 in two or three sentences of your own.

# 12 Sending blood where it is needed

D3.3.11 HL

CUES

**Predict:** A person goes for a hard run straight after a large meal and gets a stitch and indigestion. What is the likeliest reason?

NOTES

1 The heart cannot supply every organ at its maximum all the time, so blood is _____ according to need.

2 In _____ the muscles need much more oxygen and glucose, and must lose heat.

3 In _____ the blood is shared more evenly, with a good share to the gut and the kidneys.

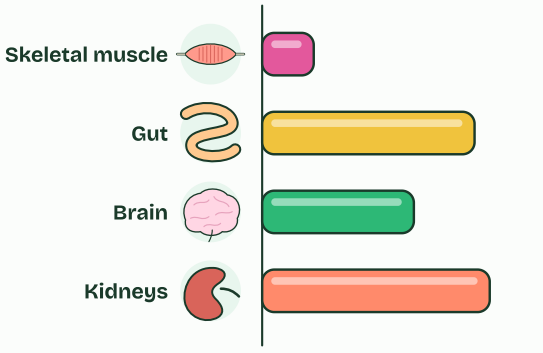
4 During _____ the muscles are still and need little.

*Your own notes*

ANNOTATE THE FIGURE

The figure shows it as Sleep, Wakeful rest and Vigorous exercise. Note what changes each time.

**Asleep: the gut, which is busy digesting, and the kidneys keep a good supply;** the muscles, which are still, are supplied little.



SPOT THE MISTAKE

What do students often get wrong about changes in blood supply to organs in response to changes in activity? Write the mistake, then put it right.

*The mistake*

*Put it right*

SUMMARY

Sum up section 12 in two or three sentences of your own.

## Check yourself

The check for this guide is online: a fresh paper of past-paper style questions from the exam bank on D3.3 each time, marked as you go, and saved to your Exam practice progress when you are signed in. Scan the code, or type the link.

biologybybradford.com/exam-maker/sit?topics=D3.3&level=HL&paper=quiz&marks=15&src=ep

**How this was made.** The course structure, the activities and the teaching choices come from my own classroom, my presentations and my years of teaching IB and AP Biology. I use Claude, an AI, to help write and build the interactive guides, lesson plans, slides and practice questions, and to draw the diagrams and code the interactives. I direct the work and review it against the IB and AP specifications before it goes live.