NAME _____ CLASS _____ DATE _____

IB BIOLOGY · C3.1

Integration of body systems

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

- [ ] Record a tropism in seedlings with annotated drawings and by measuring the angle of curvature, and say what limits the precision and accuracy of the measurements C3.1.17
- [ ] Explain positive phototropism as growth towards light from one side C3.1.18
- [ ] Outline what phytohormones are, with examples of what several of them do C3.1.19
- [ ] Explain how auxin efflux carriers move auxin from cell to cell and concentrate it in one part of a plant C3.1.20
- [ ] Explain how auxin makes cells grow longer, and how a gradient of auxin makes a shoot bend C3.1.21
- [ ] Explain how auxin from shoot tips and cytokinin from root tips keep root and shoot growth in step C3.1.22
- [ ] Explain the positive feedback between ethylene and fruit ripening, and why it makes ripening fast and together C3.1.23
- [ ] Explain why the parts of an animal must work in a coordinated way, and give an example of an emergent property C3.1.1
- [ ] Place cells, tissues, organs and body systems in order, and explain how their integration gives a property none of them has alone C3.1.2
- [ ] Compare nervous and hormonal signalling, and say what the blood carries between organs C3.1.3
- [ ] Describe how the brain brings together several inputs, and its part in learning and memory C3.1.4
- [ ] Tell conscious from unconscious processes, and say what the spinal cord does for the unconscious ones C3.1.5
- [ ] Explain how sensory neurons bring messages from receptor cells to the spinal cord and the cerebral hemispheres C3.1.6
- [ ] Explain how motor neurons carry messages from the cerebral hemispheres to muscles, which contract C3.1.7
- [ ] Describe a nerve in section as a bundle of sensory and motor fibres, some myelinated, inside a protective sheath C3.1.8
- [ ] Trace a pain reflex arc through its receptor, sensory neuron, interneuron, motor neuron and muscle, and say why it is involuntary C3.1.9
- [ ] Explain how the cerebellum coordinates the timing of muscle contractions and keeps balance C3.1.10
- [ ] Explain how the pineal gland's melatonin, set by light and dark, helps set the cycle of sleeping and waking C3.1.11
- [ ] Explain how epinephrine from the adrenal glands prepares the body for vigorous activity C3.1.12
- [ ] Explain how the hypothalamus and pituitary gland control the other endocrine glands C3.1.13
- [ ] Explain how baroreceptors and chemoreceptors, the medulla and nerves control heart rate by negative feedback C3.1.14
- [ ] Explain how chemoreceptors and the brainstem control ventilation rate by negative feedback C3.1.15
- [ ] Explain which parts of swallowing, peristalsis and egestion are under the CNS and which under the enteric nervous system C3.1.16

01 Watching seedlings grow

C3.1.17 HL

CUES

Predict: Two students measure the same seedling's angle of curvature. One photographs it square-on from the side; the other from above and to one side. Whose angle is more accurate?

What is meant by tropism?

What is meant by positive tropism?

What is meant by negative tropism?

What is meant by qualitative?

What is meant by quantitative?

What is meant by angle of curvature?

What is meant by precision?

What is meant by accuracy?

What is meant by systematic error?

What is meant by reliable?

NOTES

1 A _____ is a growth response whose direction is set by where a stimulus comes from.

2 Growth towards the stimulus is a _____, and growth away from it is a _____.

3 A drawing gives _____ data: draw the same tray of seedlings at set times, say 0, 6 and 24 hours, with an arrow for the direction of the light, the shoots drawn to scale against a scale bar, and short notes on what you see, such as how many have bent and where along the shoot the bend is.

4 A measurement gives _____ data.

5 Here it is the _____: the angle between the vertical, the way the shoot grew before, and the line its tip now points along.

6 Every measurement has limits. _____ is how finely you measure and how closely repeats agree. _____ is how close a measurement is to the true value.

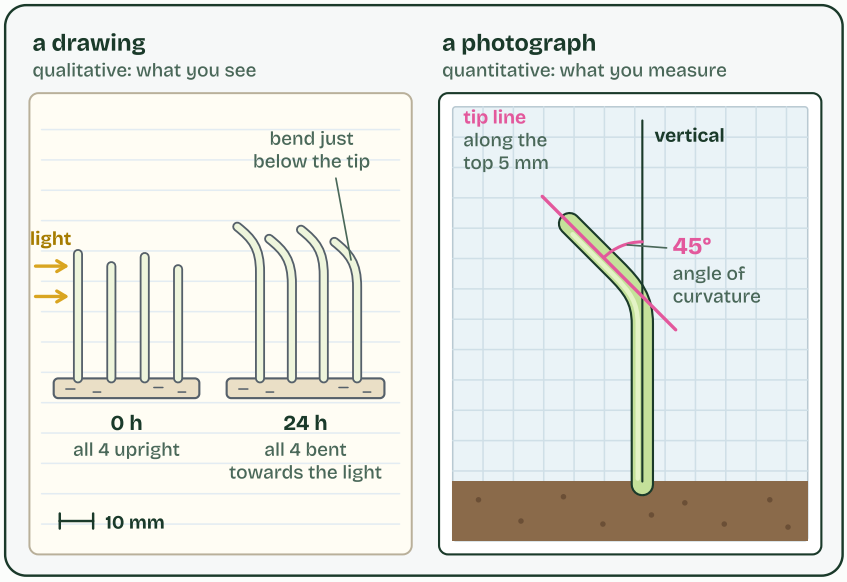
7 A camera that is not square-on to the bend makes every angle look smaller or larger than it is. That is a _____, and it limits accuracy, however carefully you read the protractor.

8 Many seedlings and repeat trays make the result more _____.

Your own notes

ANNOTATE THE FIGURE

Number the 2 steps on the figure and note what happens at each: 1 drawing; 2 photograph.



SPOT THE MISTAKE

A student writes: "Precise means accurate." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

02 Growing towards the light

C3.1.18 HL

CUES

Predict: The tip of a grass seedling is covered with a foil cap, and the seedling is lit from one side. What happens?

What is meant by positive phototropism?

What is meant by coleoptile?

NOTES

1 Grow a seedling on a windowsill and it leans towards the window. That is _____: a shoot lit from one side grows towards the light.

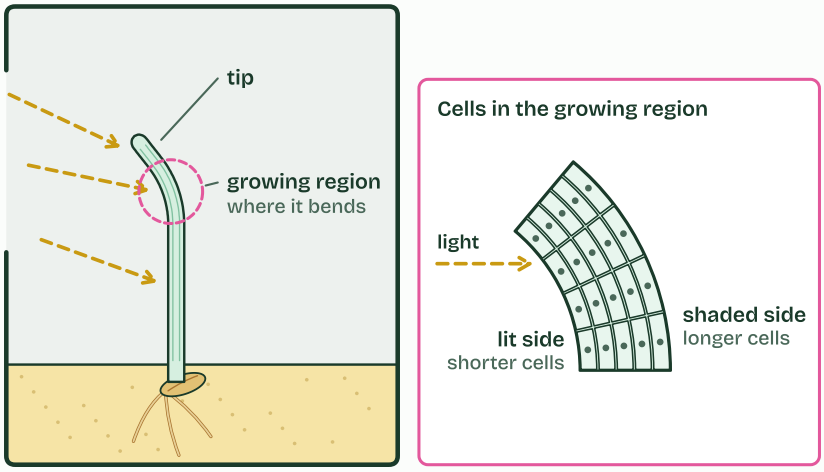
2 The classic experiments were done on grass seedlings, whose young shoot grows up inside a pointed sheath called the _____.

3 _____: a shoot lit from one side grows towards the light, because cells on its shaded side grow longer than those on its lit side.

Your own notes

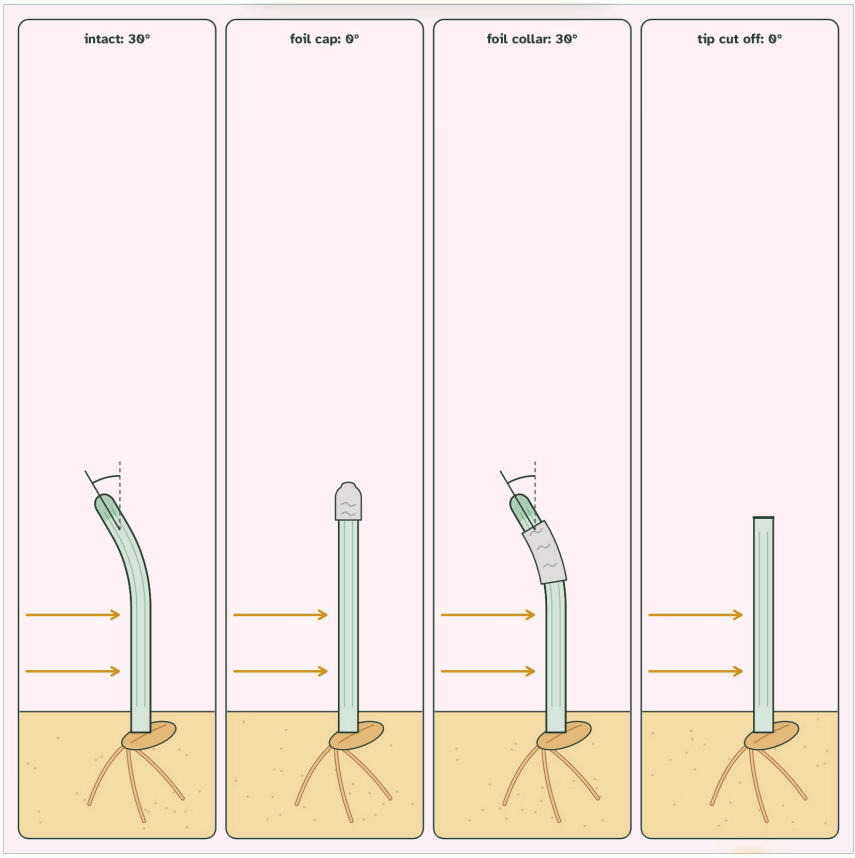
ANNOTATE THE FIGURE

Label the key parts and add a note on what it shows.



ANNOTATE THE FIGURE

Annotate this still from the animation (A seedling finds the light): what is happening, and why?



SPOT THE MISTAKE

A student writes: "The light pulls the shoot round." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

03 Plant hormones

C3.1.19 HL

CUES

Predict: Abscisic acid is sprayed on the leaves of a well-watered plant in bright light. What happens to its rate of photosynthesis over the next hour?

What is meant by phytohormones?

NOTES

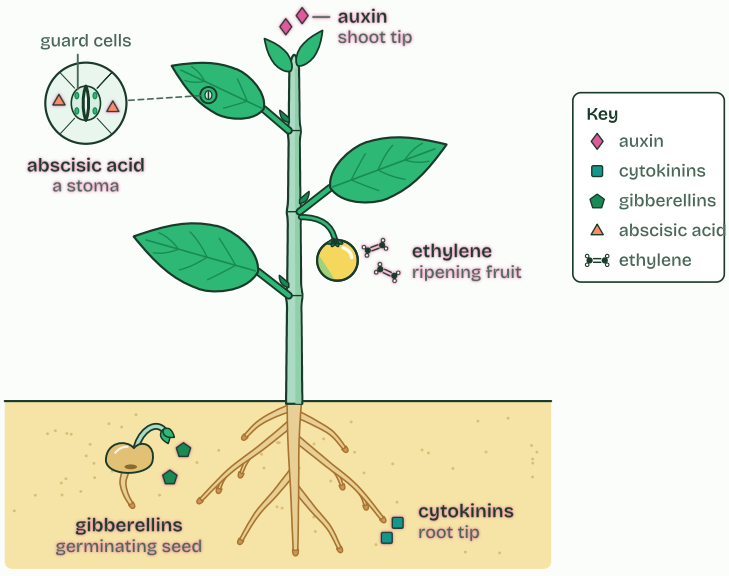
1 They do it with _____: signalling chemicals, made in small amounts, that control how a plant grows and develops and how it responds to what happens around it.

2 _____ are signalling chemicals made in small amounts that control growth, development and responses to stimuli.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: auxin, abscisic acid, ethylene, gibberellins, cytokinins.



REMEMBER IT

The five best-known phytohormones

A	C	G	A	E
A	C	G	A	E

SPOT THE MISTAKE

A student writes: “Plant hormones travel in the blood.” Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

04 Moving auxin one way

C3.1.20 HL

CUES

Predict: In a row of five cells, every cell has its auxin efflux carriers on its left side, but the middle cell's carriers are blocked by a chemical. Auxin is added to the right-hand cell. Where does it build up?

What is meant by auxin efflux carriers?

What is meant by apoplast?

What is meant by concentration gradient?

What is meant by active transport?

NOTES

1 To leave, auxin needs _____, proteins in the membrane (called PIN proteins) that move it out of the cell.

2 Then auxin leaves through that side into the _____, the cell walls and spaces between the cells, and the next cell along takes it in.

3 If all the cells of a tissue place their carriers on the same side, auxin is passed from cell to cell in one direction, and builds up in one part of the plant: a _____ that the cells keep up.

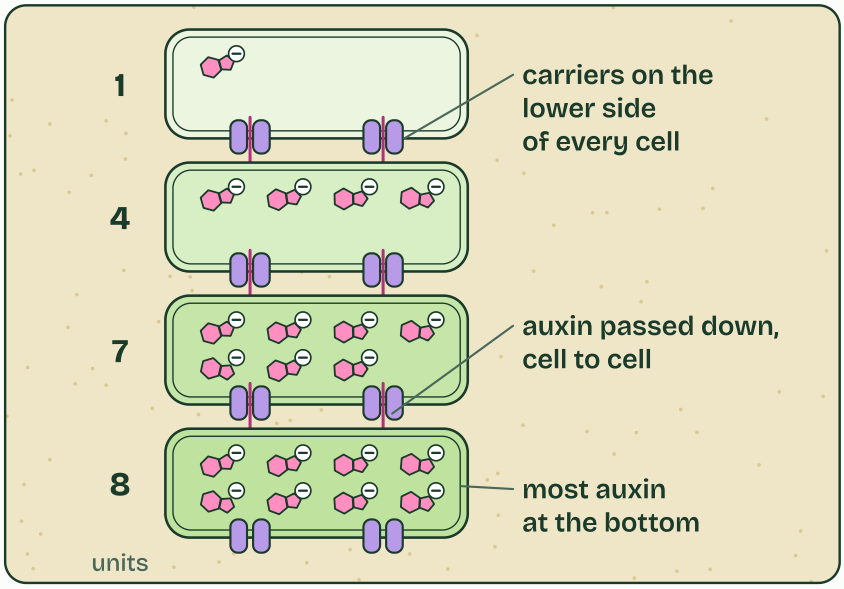
4 So the movement counts as _____, and it can build auxin up where there is already more of it.

5 _____ move it out, through whichever side of the cell they are placed on.

Your own notes

ANNOTATE THE FIGURE

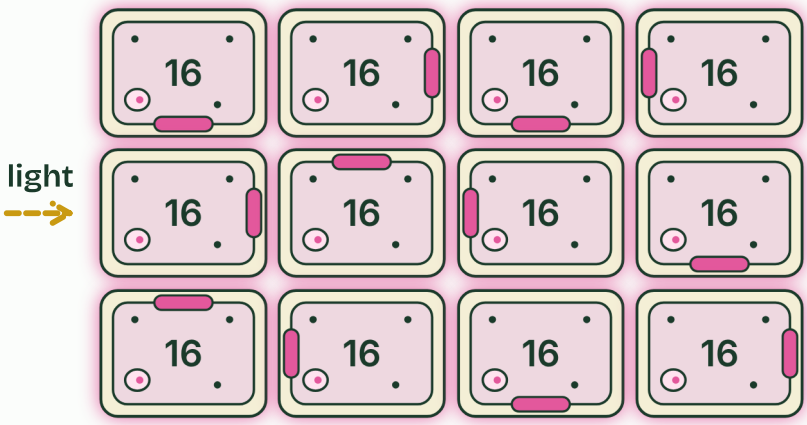
Number the 4 steps on the figure and note what happens at each: 1 no charge; 2 negative ion; 3 Efflux carriers; 4 down.



ANNOTATE THE FIGURE

Label the key parts and add a note on what it shows.

Point the pumps



SPOT THE MISTAKE

A student writes: “Auxin is pumped into cells.” Spot 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 How auxin stretches a cell

C3.1.21 HL

CUES

Predict: Short pieces of shoot, with their tips cut off, are floated in an acidic buffer instead of an auxin solution. What happens?

What is meant by cross-links?

What is meant by proton pumps?

What is meant by cell elongation?

NOTES

1 The wall is built of long fibres of cellulose wrapped round the cell, held to each other by _____.

2 It makes the cell pump hydrogen ions out of its cytoplasm into the apoplast, through _____ in the plasma membrane, which use ATP.

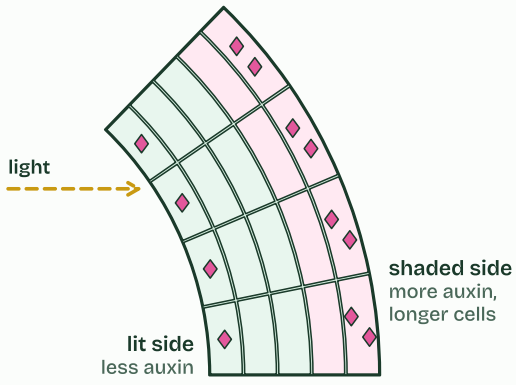
3 Water still enters by osmosis, and the pressure inside now stretches the loosened wall: the cell grows longer, and adds new wall material as it does. That is _____.

4 In acid, the _____ between cellulose fibres loosen, and water entering by osmosis stretches the wall: the cell elongates.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 Proton pumps; 2 more acidic, cross-links; 3 Water, grows longer; 4 shaded side.



SPOT THE MISTAKE

A student writes: “The acid dissolves the wall.” Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

06 Roots and shoots in step

C3.1.22 HL

CUES

Predict: A gardener pinches out the growing tip of a basil plant. What happens over the next two weeks?

What is meant by cytokinin?

What is meant by apical dominance?

NOTES

1 Root tips make _____, which travels up to the shoots in the xylem sap, with the water (B3.2).

2 At a shoot tip, the auxin moving down the stem holds back the side buds just below it, so the main shoot grows up rather than out: _____.

3 Shoot tips make auxin, which is moved down to the roots; root tips make _____, which travels up to the shoots in the xylem sap.

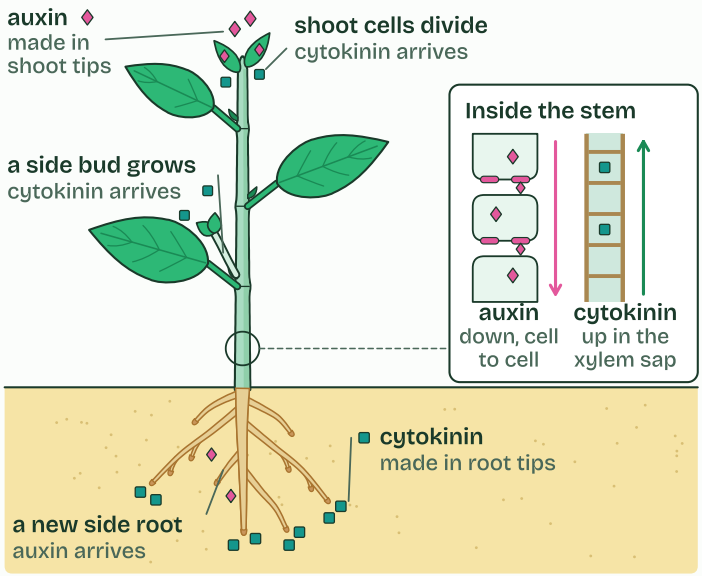
4 Auxin from the shoot helps roots grow and branch; _____ from the roots makes shoot cells divide and side buds grow.

5 The balance matters: auxin from the tip holds back the side buds and _____ pushes them.

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each: 1 auxin, cytokinin; 2 down, up; 3 new side roots, side buds, divide.



SPOT THE MISTAKE

A student writes: “Auxin stops shoots growing.” Spot 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 One ripe banana

C3.1.23 HL

CUES

Predict: A box of green bananas is stored with a sachet that absorbs ethylene from the air. What happens?

What is meant by ripening?

What is meant by positive feedback?

What is meant by negative feedback?

NOTES

1 Ethylene sets off _____.

2 A loop like this, where a change causes more of the same change, is _____.

3 Most feedback loops in living things are the other kind. _____ pulls a value back towards a set point, as you will see in the human body.

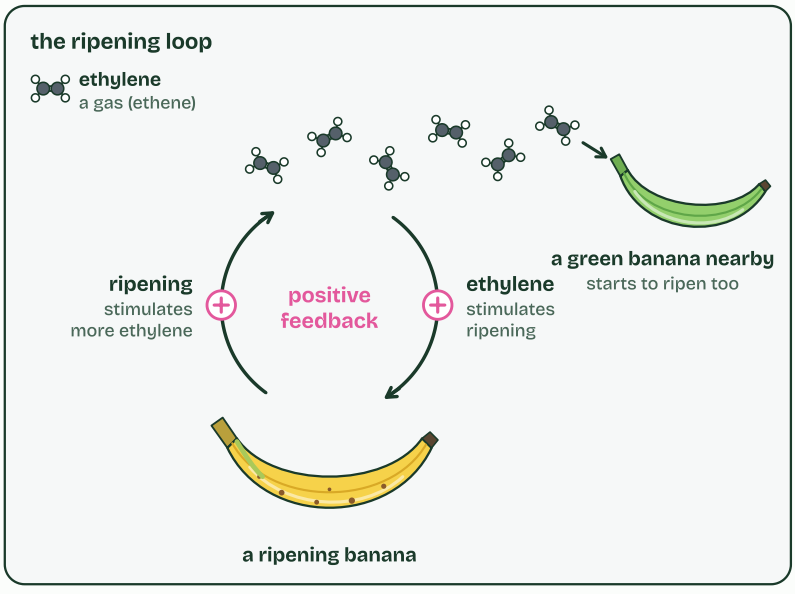
4 Ethylene (ethene) is a gas that stimulates _____: colour change, sugars from starch, softening and scent.

5 _____ stimulates more ethylene production: positive feedback, so ripening speeds up and spreads to nearby fruit.

Your own notes

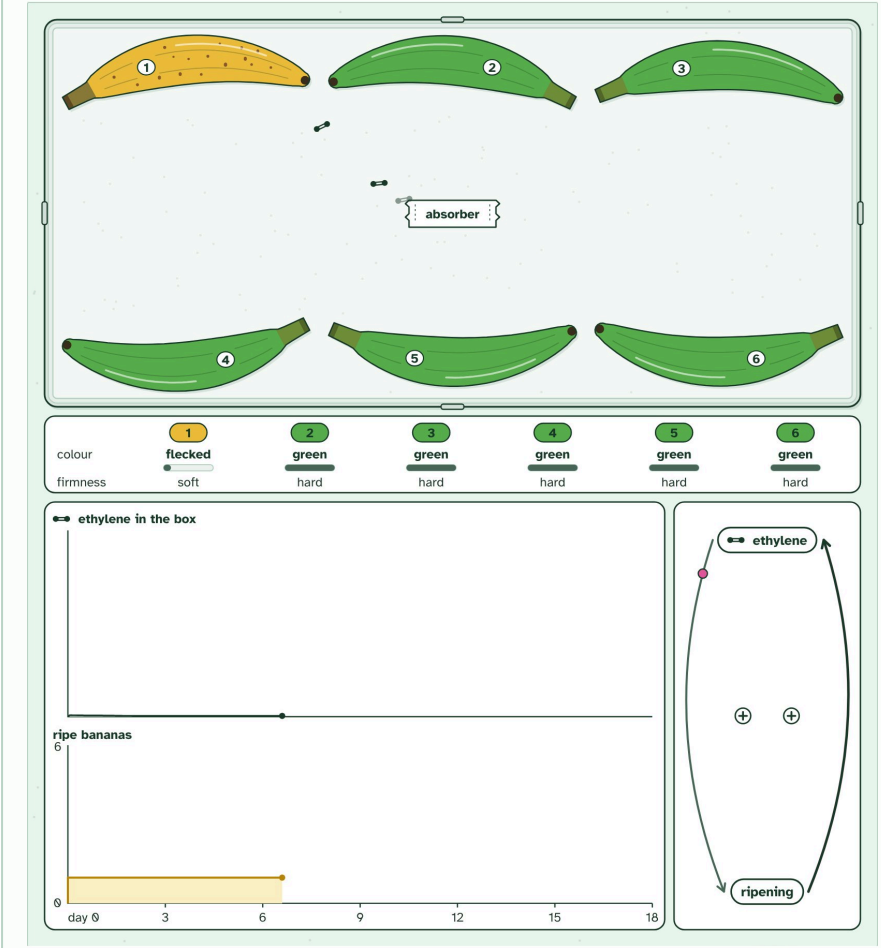
ANNOTATE THE FIGURE

Label the key parts and add a note on what it shows.



ANNOTATE THE FIGURE

Annotate this still from the animation (One ripe banana): what is happening, and why?



SPOT THE MISTAKE

A student writes: "Positive feedback means good feedback." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

08 Many parts, one animal

C3.1.1 C3.1.2

CUES

Predict: A cheetah's legs, lungs, heart and brain are each healthy, but none of them is connected to the others. Can it sprint?

What is meant by integration?

What is meant by tissue?

What is meant by organ?

What is meant by body system?

What is meant by emergent property?

NOTES

1 Getting the parts of a body to act together like this is _____, and every living system needs it.

2 Similar cells working together make a _____; several tissues make an _____; organs that work together make an organ system, or _____; and the systems, integrated, make the organism.

3 A property of the whole that none of its parts has is an _____.

4 Two systems do most of the integrating, and they fill the rest of this guide: the _____ and the _____.

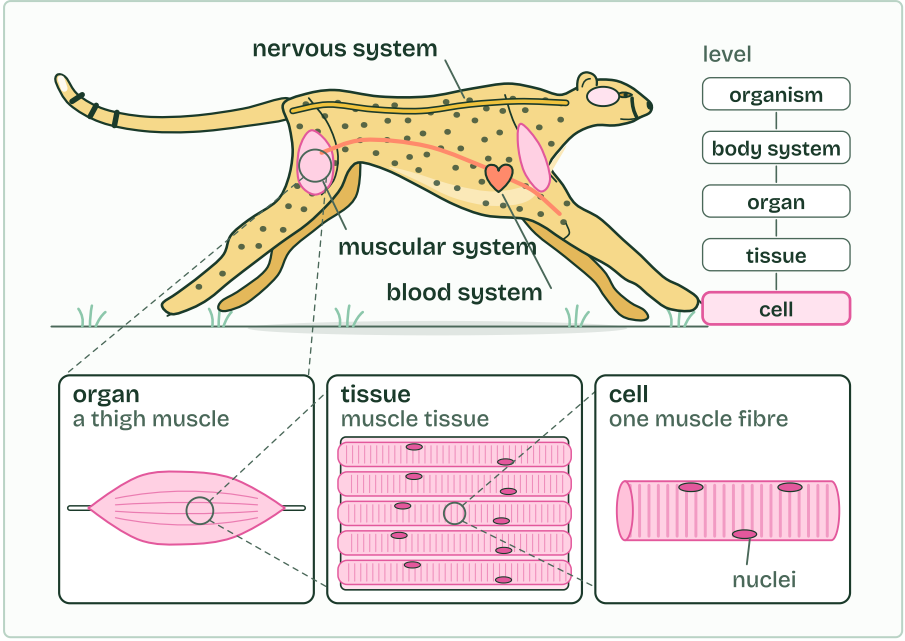
5 _____ coordinates the parts of a system so they perform an overall function together.

6 An _____ belongs to the whole and to none of its parts: a cheetah's sprint.

Your own notes

ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 organism; 2 body systems; 3 organs; 4 tissues; 5 cells.



SPOT THE MISTAKE

A student writes: "A tissue is any group of cells." Spot 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 Three ways to get a message across

C3.1.3

CUES

Predict: A hot pan burns a fingertip. A hormone, released at the same moment from a gland in the head, must reach the same fingertip. Which message arrives first?

What is meant by nervous system?

What is meant by endocrine system?

What is meant by hormones?

What is meant by target cell?

NOTES

1 The _____ sends impulses along neurons, cells with long fibres that run the whole way to their target (it crosses the small gaps between neurons with a chemical: C2.2).

2 The _____ works through glands that secrete _____ into the blood.

3 The blood carries a hormone to every part of the body, but only a _____ with the right receptor responds to it.

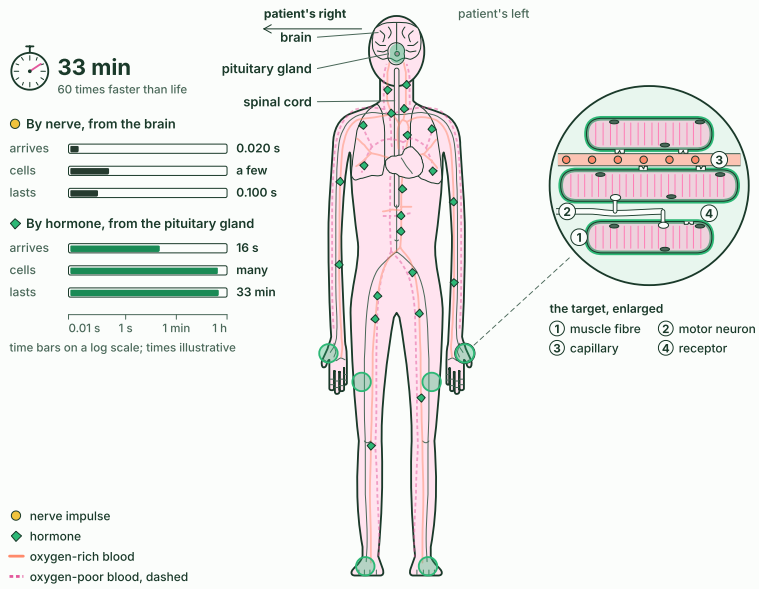
4 The blood system integrates the organs by _____, carrying materials and energy from the organ that supplies them to the organ that uses or removes them: oxygen from the lungs to the muscles; carbon dioxide back to the lungs; glucose from the gut and the liver to the brain; urea from the liver to the kidneys; heat from working muscle to the skin; and the hormones themselves.

5 _____: secreted into the blood, slower, reach every organ, act only on cells with the receptor, often longer-lasting.

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each.



SPOT THE MISTAKE

A student writes: "A hormone acts on every cell it reaches." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

10 The brain: many inputs, one picture

C3.1.4

CUES

Predict: A patient can hold a phone number in mind for half a minute and gets faster each day at a new drawing task, but cannot remember meeting you an hour ago. What does this show?

What is meant by cerebral hemispheres?

NOTES

1 The _____ receive what the senses send, put the messages together, compare them with what is stored from before, and choose a response.

2 Its other parts each have a job you will meet in this guide: the _____ (chapter 11), the _____ of the brainstem (heart rate and breathing, chapters 19 and 20), the _____ and _____ (chapter 18), the _____ (chapter 16), and the _____ below it (chapter 12).

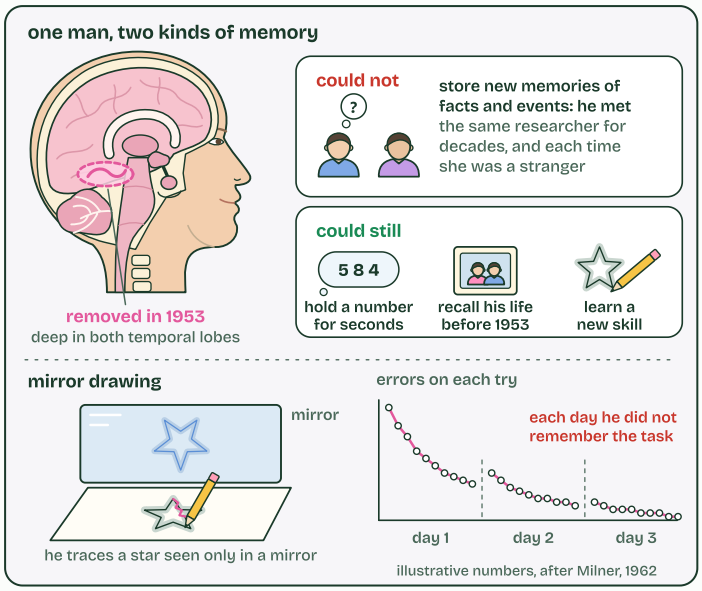
3 The brain also _____ and _____.

4 The _____ combine information from several senses, compare it with memory and choose a response.

Your own notes

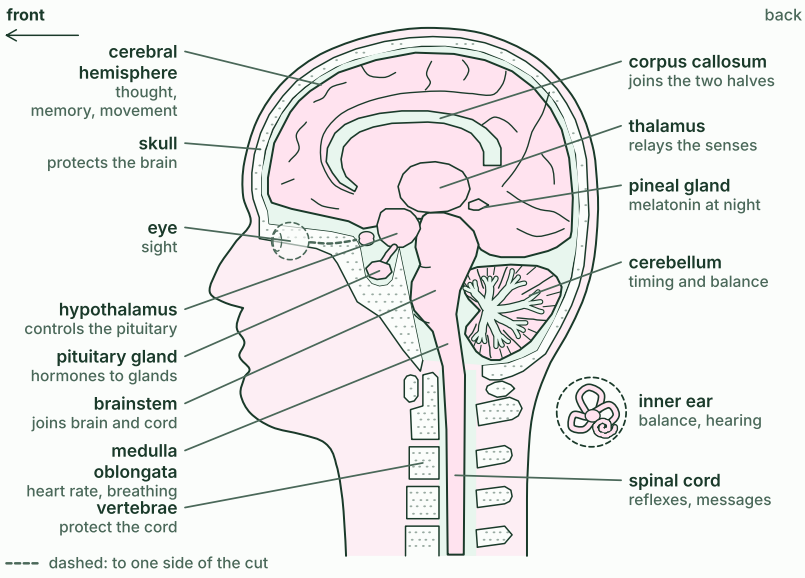
ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 temporal lobes; 2 could not; 3 could still; 4 mirror drawing.



ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each.



SPOT THE MISTAKE

A student writes: “We use only ten percent of our brains.” Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

11 The little brain

C3.1.10

CUES

Predict: A person whose cerebellum is damaged is asked to throw a ball at a target. What is most likely?

What is meant by cerebellum?

NOTES

1 The _____ (Latin for "little brain") sits under the back of the cerebral hemispheres.

2 It takes in messages from the eyes, from the balance organs of the inner ear and from stretch receptors in the muscles and joints, and sends out signals that adjust the _____ and the _____ of each contraction, so the right muscles contract, in the right order, by the right amount.

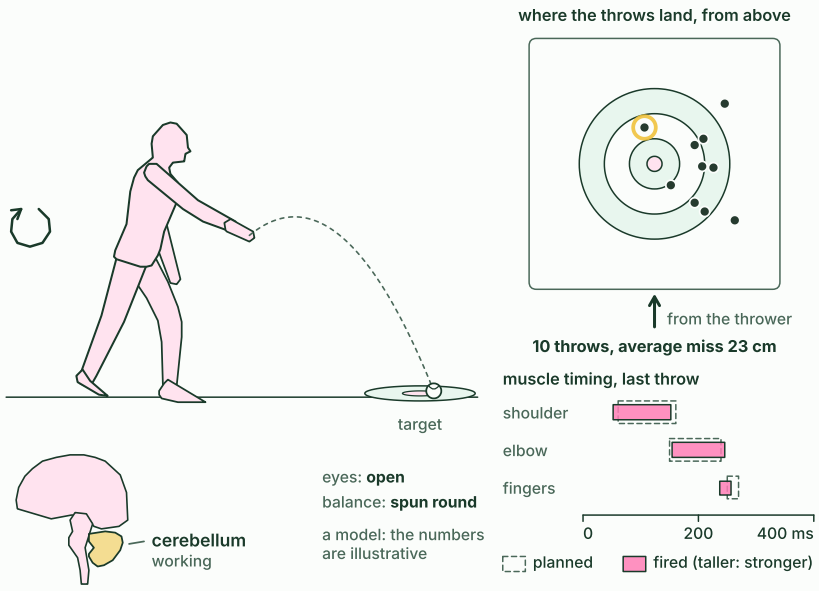
3 It does the same for _____, adjusting the muscles of the legs and trunk as your weight shifts.

4 The _____ coordinates skeletal muscle contraction: the timing and force of each muscle in a movement.

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each.



SPOT THE MISTAKE

A student writes: “The cerebellum starts voluntary movements.” Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

12 Aware or automatic?

C3.1.5

CUES

Predict: A person's spinal cord was cut across in the middle of the back months ago. A pin touches the sole of their foot. What happens?

What is meant by conscious?

What is meant by unconscious?

What is meant by spinal cord?

What is meant by grey matter?

What is meant by interneurons?

What is meant by white matter?

NOTES

1 Some of what your body does you are aware of and can control: speaking, reading this, swinging a bat. These are _____ processes, dealt with by the cerebral hemispheres.

2 Others go on without your awareness: digesting a meal, your heart beating, a blink at a speck of dust, a hand pulled from something hot. These are _____.

3 The _____ runs from the base of the brain down the back, inside the vertebrae.

4 In the middle is a butterfly of _____: cell bodies and the _____ that connect one neuron to another.

5 Around it is _____: myelinated fibres running up to the brain and down from it.

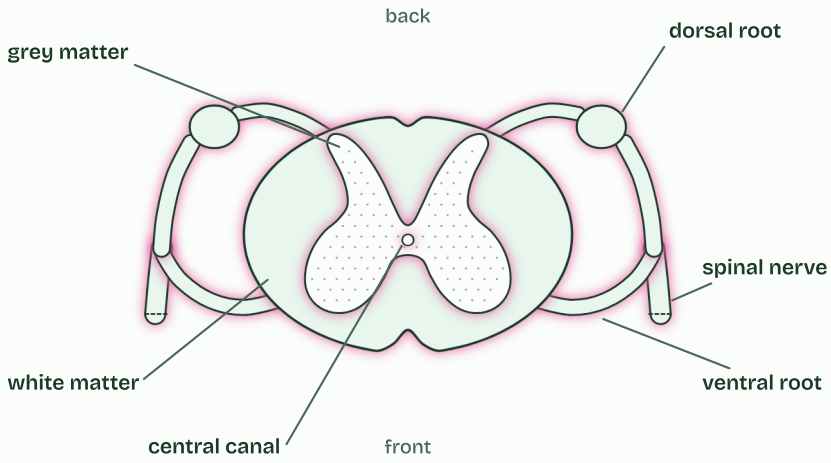
6 _____ processes: aware and controllable, in the cerebral hemispheres. Unconscious: without awareness.

7 The _____ integrates unconscious processes such as reflexes, in its grey matter, and carries messages to and from the brain in its white matter.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: spinal nerve, spinal nerve, ventral root, ventral root, dorsal root, dorsal root, white matter, grey matter, central canal.



SPOT THE MISTAKE

A student writes: "The spinal cord only carries messages." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

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

13 In by sensory, out by motor

C3.1.6 C3.1.7

CUES

Predict: A person watches a ball fall and catches it. Put these in order: motor neuron, receptor cells in the eye, cerebral hemispheres, arm muscle, sensory neuron. Which comes third?

What is meant by receptor cells?

What is meant by sensory neurons?

What is meant by central nervous system?

What is meant by motor neurons?

What is meant by effector?

NOTES

1 Your eyes, ears, skin and muscles hold _____.

2 Each detects one kind of stimulus. _____ convey their messages to the _____ (CNS: the brain and spinal cord).

3 The output goes the other way. _____ carry messages from the CNS, for a voluntary movement from the cerebral hemispheres, to muscles, which are stimulated to contract.

4 A muscle that responds is an _____.

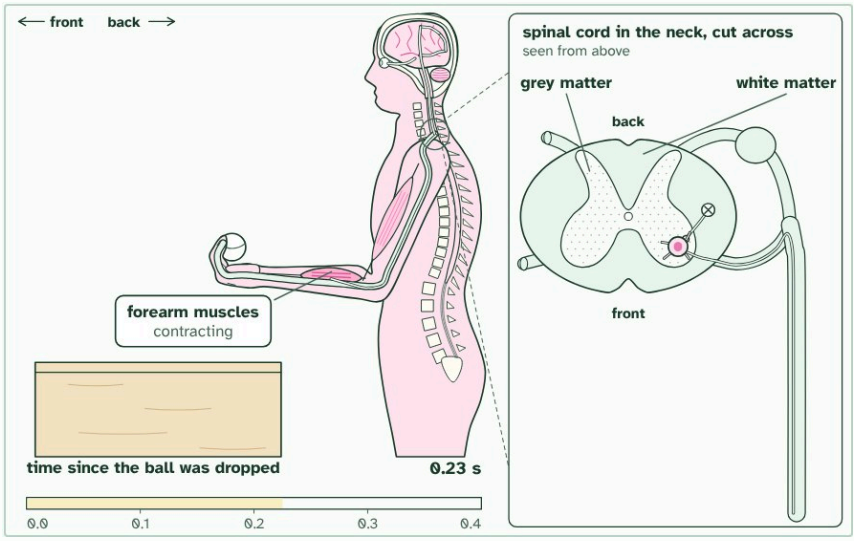
5 _____ carry messages from receptor cells to the CNS: input to the spinal cord and the cerebral hemispheres.

6 _____ carry messages from the cerebral hemispheres to muscles, which are stimulated to contract.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Catching a falling ball): what is happening, and why?



SPOT THE MISTAKE

A student writes: “Sensory neurons carry light, sound or pain.” Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 13 in two or three sentences of your own.

14 Inside a nerve

C3.1.8

CUES

Predict: One nerve in a person's arm is cut. They lose all feeling in part of the hand and cannot move some of the fingers. What does that show about the nerve?

What is meant by nerve?

What is meant by nerve fibres?

What is meant by myelinated?

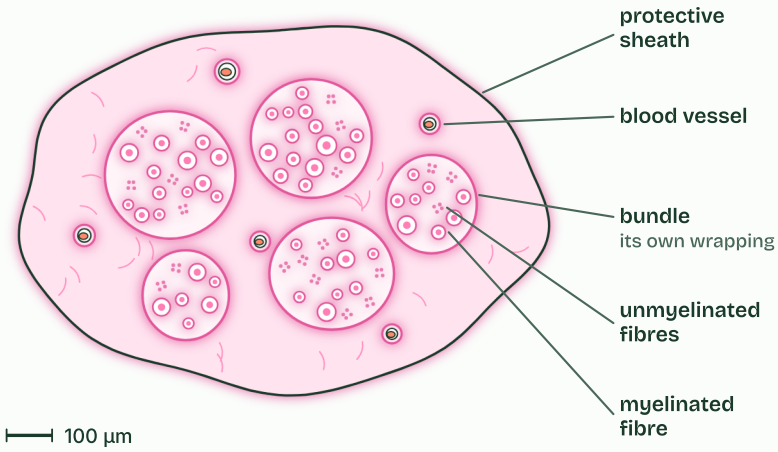
NOTES

1. A _____ is a bundle of hundreds or thousands of _____, the long axons of many neurons, running side by side like the wires in a cable.
2. Outside is a tough protective _____ of connective tissue, with small blood vessels in it.
3. Many fibres are _____: a pale ring of fatty myelin round a darker axon.
4. Others are _____: thin, with no ring, often lying in small groups.
5. A nerve is a bundle of _____ in a protective sheath, not one cell.
6. Some fibres are _____ (a ring round the axon), some unmyelinated.

Your own notes

ANNOTATE THE FIGURE

Label each part and say what it does: protective sheath, blood vessel, blood vessel, blood vessel, blood vessel, blood vessel, a bundle of fibres, a bundle of fibres, a bundle of fibres, a bundle of fibres, a bundle of fibres, myelinated fibre, myelinated fibre, myelinated fibre, myelinated fibre, myelinated fibre, unmyelinated fibres, unmyelinated fibres, unmyelinated fibres, unmyelinated fibres, unmyelinated fibres.



SPOT THE MISTAKE

A student writes: "A nerve is a neuron." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 14 in two or three sentences of your own.

15 The pain reflex

C3.1.9

CUES

Predict: A person pulls a hand away from a hot object. When do they feel the pain?

What is meant by reflex?

What is meant by involuntary?

What is meant by reflex arc?

What is meant by free nerve ending?

NOTES

1 A _____ is a fast response to a stimulus that does not wait for a decision.

2 It is _____.

3 The route it takes is a _____.

4 A _____ of a sensory neuron in the skin of the hand is the pain receptor.

5 The _____ carries impulses up the arm into the spinal cord.

6 In the _____ the message crosses to a single _____, which passes it to a _____.

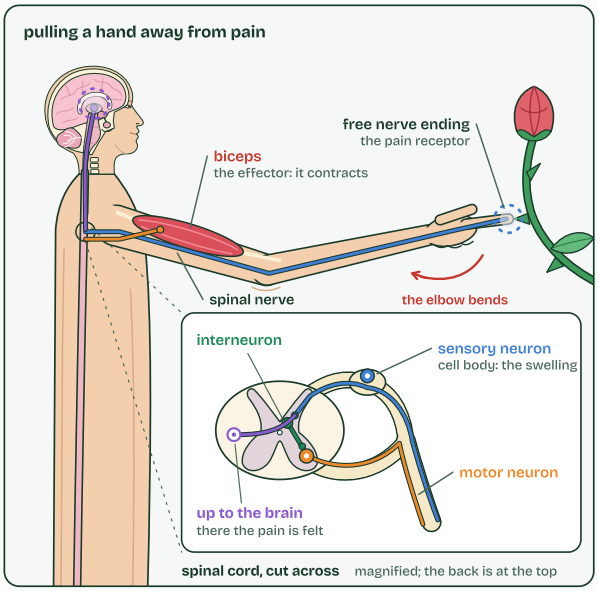
7 Pain _____: free nerve ending, sensory neuron, interneuron in the grey matter, motor neuron, skeletal muscle.

8 It is _____ and fast, and protects before the brain is aware.

Your own notes

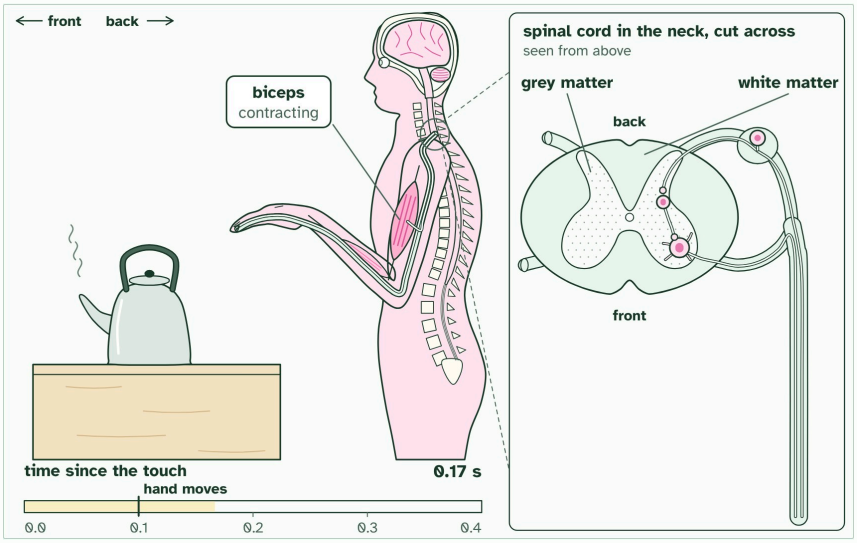
ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 spinal cord; 2 free nerve ending, sensory neuron; 3 interneuron; 4 motor neuron, biceps; 5 brain.



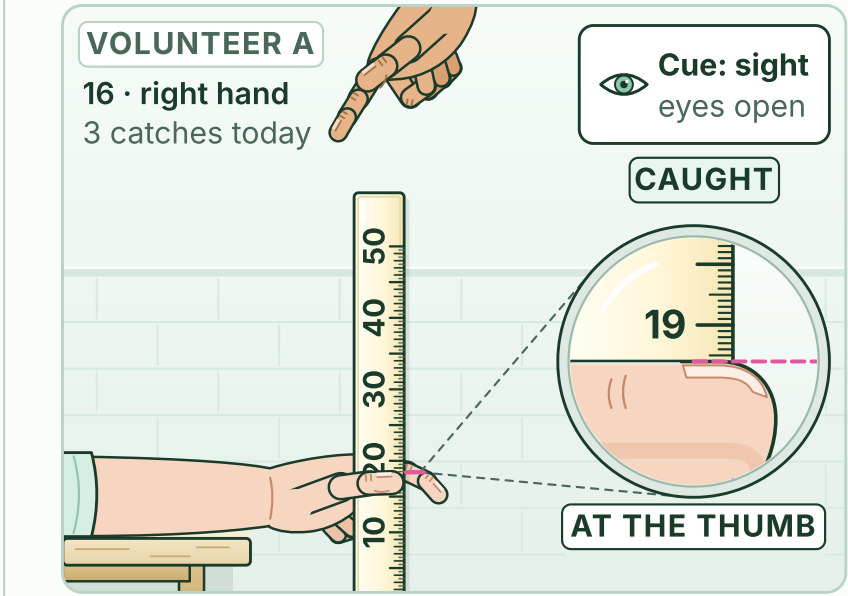
ANNOTATE THE FIGURE

Annotate this still from the animation (The pain reflex): what is happening, and why?



ANNOTATE THE FIGURE

Number the 2 steps on the figure and note what happens at each: 1 Set up; 2 Caught.



SPOT THE MISTAKE

A student writes: "The brain makes a reflex happen." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 15 in two or three sentences of your own.

16 Dark, light and sleep

C3.1.11

CUES

Predict: A person lives in a room with no windows, lit by a bright lamp for 20 hours a day. What happens to their night-time melatonin?

What is meant by circadian rhythm?

What is meant by pineal gland?

What is meant by melatonin?

NOTES

1 Your body runs on a cycle of about 24 hours, a _____: sleep and waking, body temperature and many hormones rise and fall with it.

2 The clock controls the _____, a small gland deep in the brain, which secretes the hormone _____.

3 Its secretion is _____, following day and night: low through the day, rising in the evening about two hours before you usually fall asleep, highest in the middle of the night, and falling before you wake.

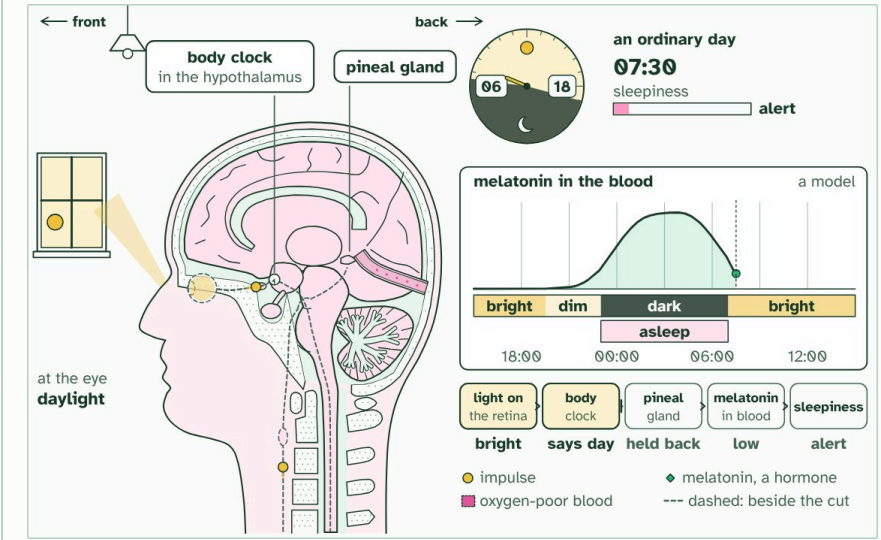
4 The _____ secretes melatonin in a diurnal pattern: high at night, low by day.

5 _____ prepares the body for sleep and helps set the cycle of sleeping and waking.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Dark, light and sleep): what is happening, and why?



SPOT THE MISTAKE

A student writes: “Light raises melatonin.” Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 16 in two or three sentences of your own.

17 Ready to run

C3.1.12

CUES

Predict: A person is startled and runs. Compared with rest, what happens to the blood flow to the gut and to the leg muscles?

What is meant by epinephrine?

What is meant by adrenal glands?

NOTES

1 Part of that is _____ (adrenaline), the hormone of "fight or flight".

2 In danger or excitement, the hypothalamus sends impulses down the spinal cord and out along nerves to the _____, which sit on top of the kidneys.

3 the _____ beats faster and more strongly, pumping more blood each minute;

4 the _____ in the lungs widen, so air moves in and out more easily (the faster breathing of exercise comes mostly from the carbon dioxide loop, chapter 20);

5 the _____ breaks down glycogen to glucose, raising the blood glucose that muscles use as fuel;

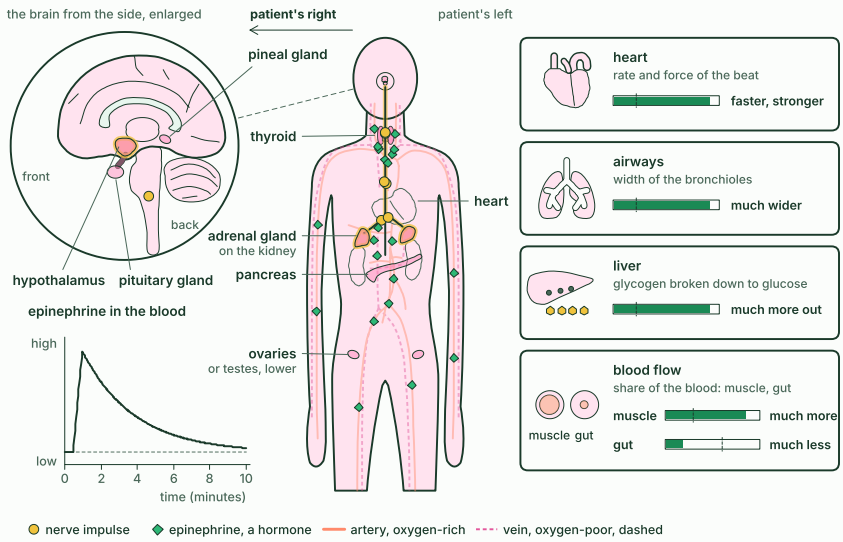
6 the _____ to skeletal muscle widen while those to the gut and skin narrow, sending the blood to the muscles;

7 the _____ widen, letting more light into the eyes.

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each.



SPOT THE MISTAKE

A student writes: "Adrenaline only speeds up the heart." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 17 in two or three sentences of your own.

18 The hypothalamus and the pituitary

C3.1.13

CUES

Predict: A drug blocks the receptors on a target gland that respond to a pituitary hormone. What happens to the pituitary's output of that hormone?

What is meant by hypothalamus?

What is meant by pituitary gland?

What is meant by negative feedback?

NOTES

1 The _____, at the base of the brain, is where the nervous system and the endocrine system meet.

2 It receives nerve messages about the body and the world outside, and it monitors the blood flowing through it. It controls the _____, a gland the size of a pea that hangs just beneath it on a short stalk.

3 A response that reverses the change that caused it is _____.

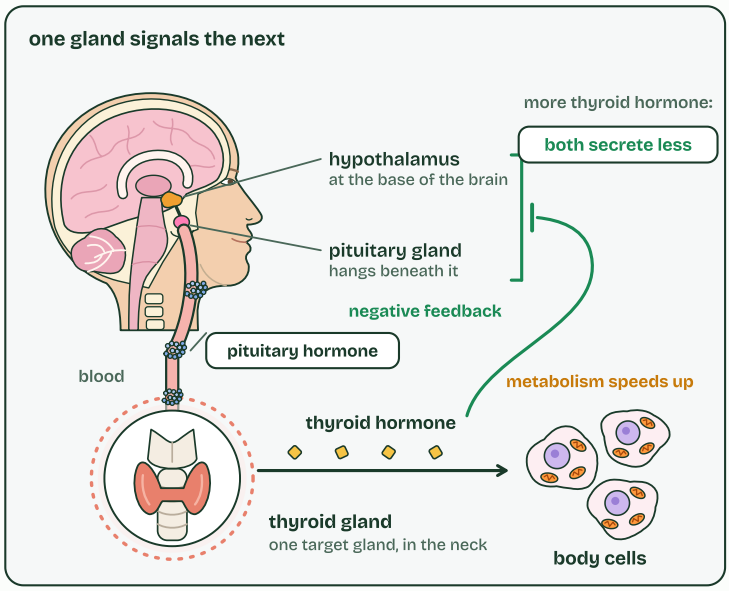
4 The _____ links the nervous and endocrine systems and controls the pituitary gland.

5 The glands' own hormones feed back to the _____ and pituitary: negative feedback.

Your own notes

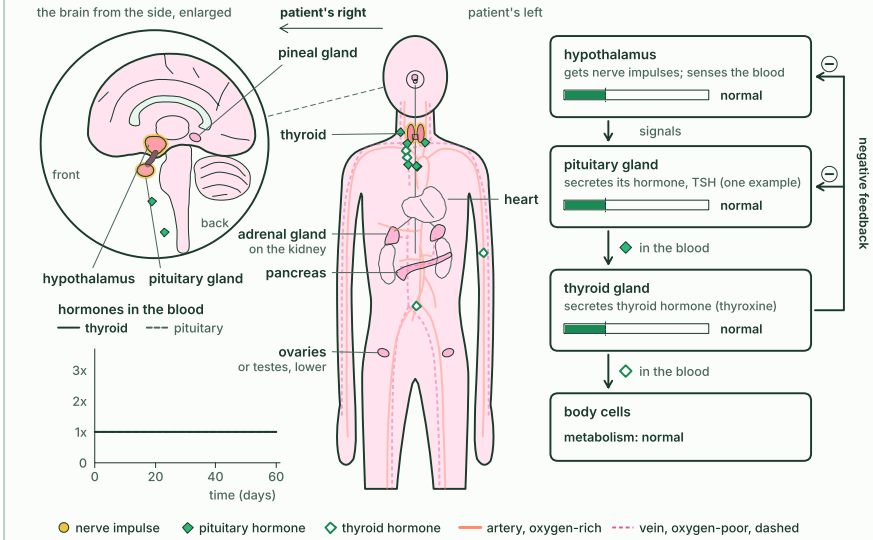
ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 hypothalamus, pituitary gland; 2 signals; 3 blood; 4 target gland; 5 secrete less.



ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each.



SPOT THE MISTAKE

A student writes: “The pituitary is the boss of the body.” Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 18 in two or three sentences of your own.

19 Keeping the beat right

C3.1.14

CUES

Predict: During hard exercise the blood leaving the working muscles carries more carbon dioxide. What happens to the heart rate?

What is meant by baroreceptors?

What is meant by medulla oblongata?

What is meant by stroke volume?

What is meant by chemoreceptors?

NOTES

1 A loop has a _____ that detects a change, a _____ that decides, and an _____ that acts.

2 The receptors for heart rate are in the walls of the arteries. _____ in the aortic arch and the carotid arteries of the neck sense how much the wall is stretched, so they monitor blood pressure.

3 Sensory neurons carry their impulses to the control centre, the _____ of the brainstem.

4 The medulla coordinates a response and sends impulses along nerves to the heart, changing the _____ and the _____.

5 Pressure is not all the medulla is told about. _____, in small bodies in the walls of the same arteries and in the brainstem itself, monitor the blood's pH and its concentrations of oxygen and carbon dioxide.

6 Two cases. _____: working muscles make more carbon dioxide, and in hard exercise lactic acid too, both lowering the pH, so in the IB's model the heart speeds up, as above.

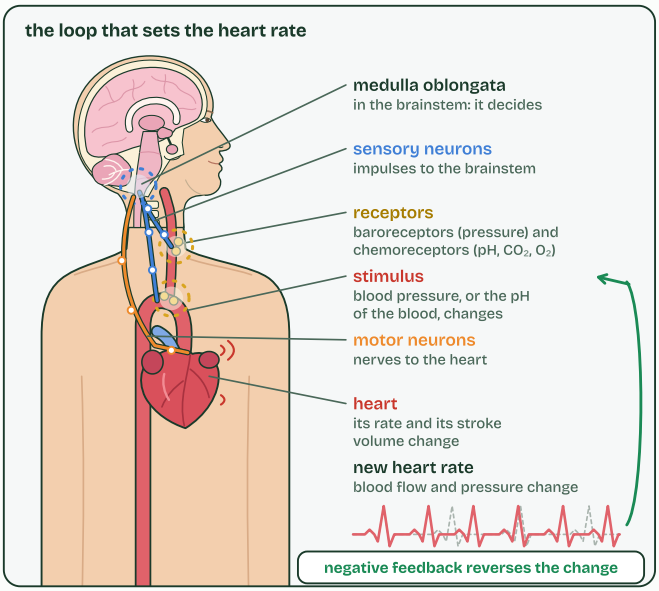
7 _____ (blood pressure) and chemoreceptors (pH, carbon dioxide, oxygen) in the aortic arch and carotid arteries; chemoreceptors in the brainstem too.

8 The medulla coordinates and sends impulses to the heart, changing heart rate and _____.

Your own notes

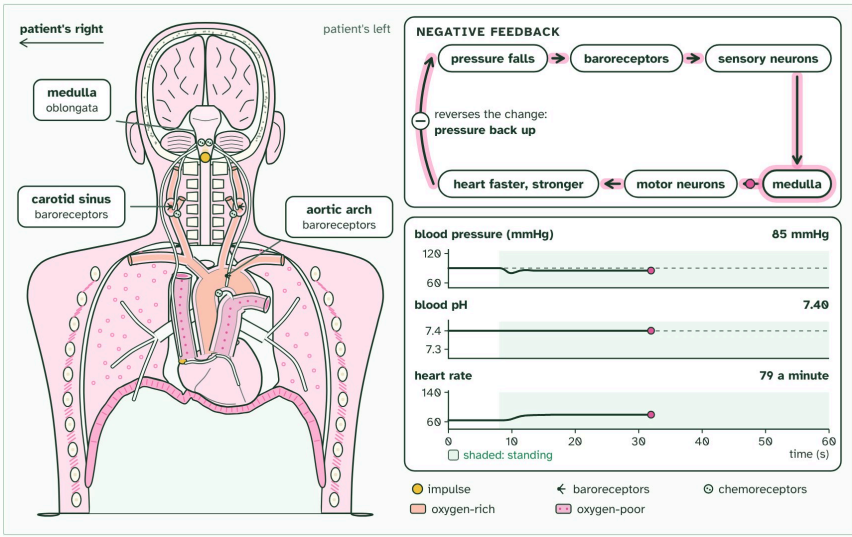
ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each.



ANNOTATE THE FIGURE

Annotate this still from the animation (Heart rate under control): what is happening, and why?



REMEMBER IT

The parts of every feedback loop, in order

R Rabbits	C Can	E Escape
R	C	E

SPOT THE MISTAKE

A student writes: "Baroreceptors detect oxygen." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 19 in two or three sentences of your own.

20 Breathing to order

C3.1.15

CUES

Predict: A person finishes a hard sprint and stands still, but their breathing stays fast for another minute. What keeps it fast?

What is meant by ventilation rate?

NOTES

1 Carbon dioxide dissolves in the blood and reacts with water to form carbonic acid, which releases hydrogen ions: so _____.

2 _____ monitor the pH of the blood and of the fluid round the brain; chemoreceptors in the aorta and carotid arteries add their own reports.

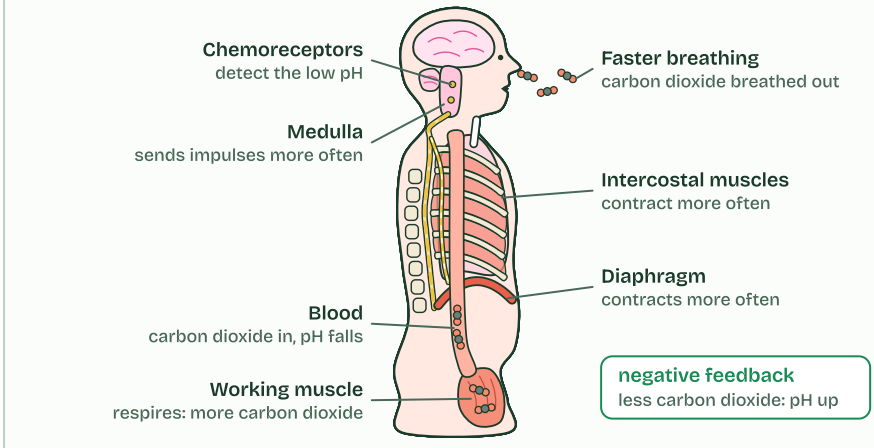
3 When the pH falls, the medulla sends impulses more often along the nerves to the _____ and the _____, which contract more often and more strongly.

4 The _____ rises, and breaths get deeper (B3.1).

Your own notes

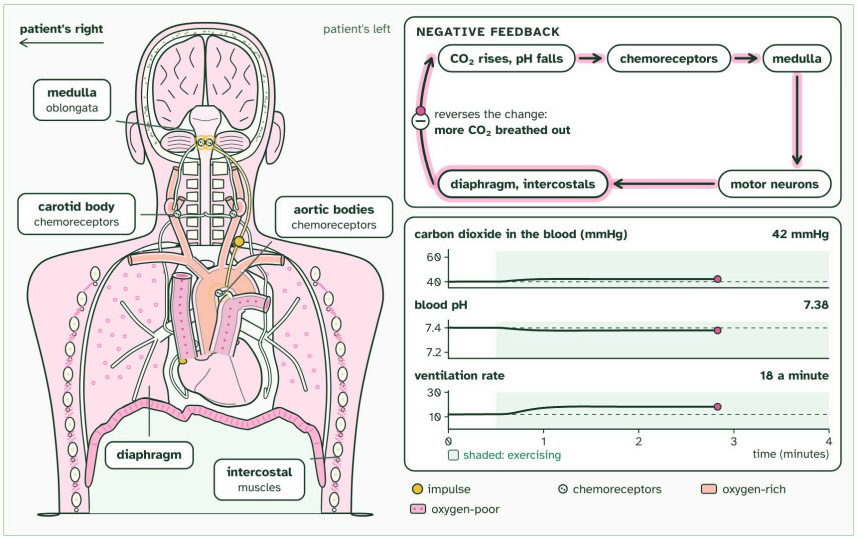
ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each: 1 carbon dioxide; 2 pH falls; 3 Chemoreceptors, medulla; 4 diaphragm, intercostal muscles; 5 ventilation rate, negative feedback.



ANNOTATE THE FIGURE

Annotate this still from the animation (Breathing under control): what is happening, and why?



SPOT THE MISTAKE

A student writes: "Low oxygen is what makes us breathe faster." Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 20 in two or three sentences of your own.

21 A gut with a mind of its own

C3.1.16

CUES

Predict: A student swallows a mouthful of bread. By the time it reaches the small intestine, what controls the squeezing of the gut wall?

What is meant by peristalsis?

What is meant by bolus?

What is meant by enteric nervous system?

What is meant by egestion?

NOTES

1 Food is moved along the gut by _____: a wave of contraction in the muscle of the gut wall, the muscle just behind a mass of food (a _____) contracting while the muscle in front of it relaxes.

2 The _____ controls the two ends, voluntarily.

3 Between those points, from the oesophagus through the stomach and the small and large intestines, peristalsis is involuntary, controlled by the _____ (ENS): a net of hundreds of millions of neurons in the gut wall.

4 _____ is the IB's word for getting rid of undigested material as faeces; it is not excretion, which removes waste made by the body's own metabolism.

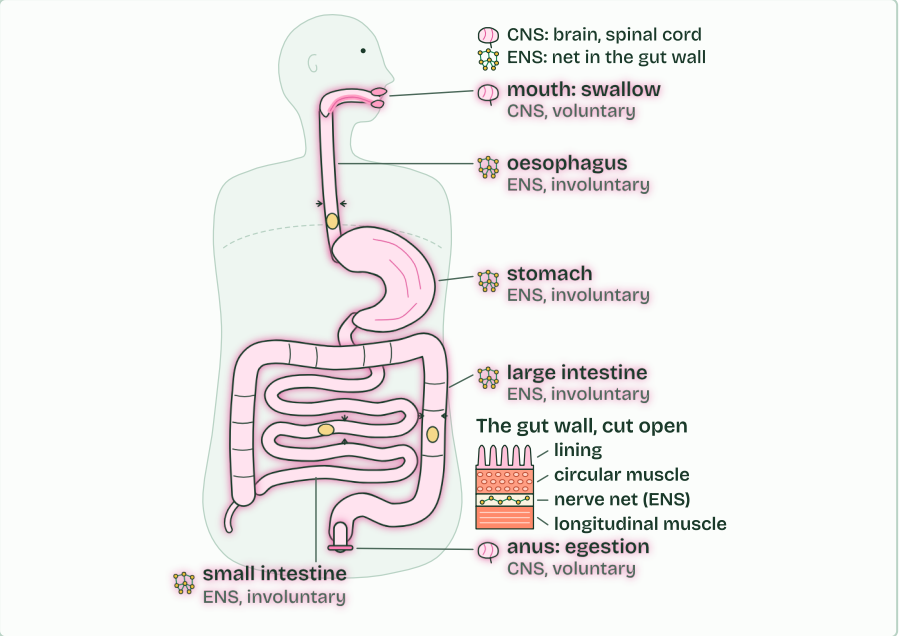
5 The CNS controls the start (swallowing) and the end (_____), voluntarily.

6 Between them, the ENS in the gut wall controls _____, involuntarily, and coordinates the passage of material.

Your own notes

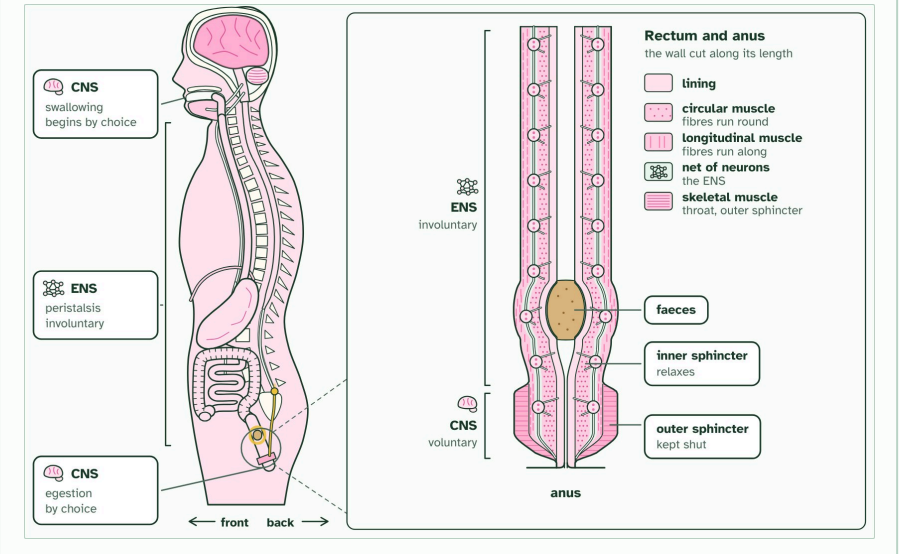
ANNOTATE THE FIGURE

Label each part and say what it does: small intestine, large intestine, anus: egestion, oesophagus, stomach, mouth: swallowing starts, mouth: swallowing starts, oesophagus, stomach, large intestine, anus: egestion, small intestine.



ANNOTATE THE FIGURE

Annotate this still from the animation (A bolus down the gut): what is happening, and why?



SPOT THE MISTAKE

A student writes: “Peristalsis moves blood in the veins.” Spot the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 21 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 C3.1 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=C3.1&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.