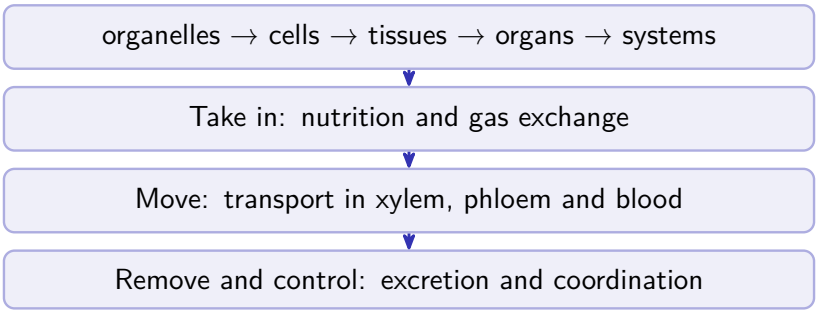
Topic 2: Structures and functions in living organisms

Edexcel International GCSE Biology 4BI1 · Section 2 · statements 2.1–2.95 · sheets 2.1–2.6

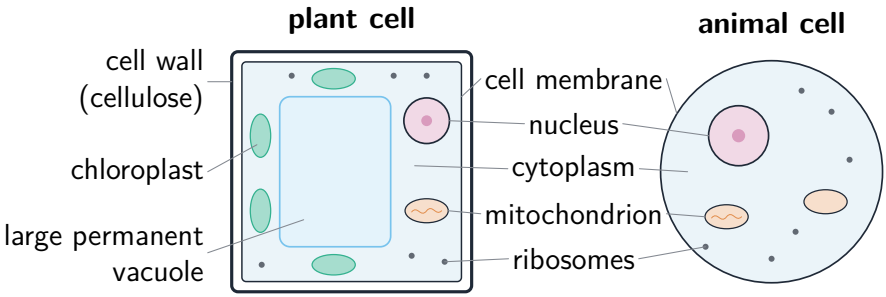
Three jobs every system serves



Plant and animal cells

Structure	Function
nucleus	contains DNA, controls the **cell**
cell membrane	controls what enters and leaves
mitochondria	release energy in respiration
ribosomes	protein synthesis
cell wall (plants)	strength (cellulose)
chloroplasts (plants)	absorb light for photosynthesis
vacuole	stores water and dissolved substances; large and permanent in plants

What only plant cells have



labelled in the middle: in both cells

Labels in the middle are in both cells; the three on the left are plant only.

(B) Differentiation and stem cells

Advantages

Could treat conditions such as paralysis or leukaemia.

Replace damaged cells that cannot repair themselves.

Disadvantages

Ethical concerns over using embryos.

Risk of rejection and of uncontrolled division.

Big molecules from small units

Molecule	**Built from**	**Test and positive result**
starch, glycogen	simple sugars	starch: iodine, yellow-brown → blue-black
glucose	(a simple sugar)	Benedict's, heated: blue → brick red
protein	amino acids	Biuret: blue → purple
lipid	fatty acids and glycerol	ethanol emulsion: cloudy white layer

Enzymes and denaturation

The substrate fits the **enzyme**'s **active site** and reacts faster.

↓

Warmer, up to the optimum, means more successful collisions.

↓

Above the optimum, or away from the optimum pH, the active site changes shape.

↓

The substrate no longer fits; the enzyme is denatured.

Practical: amylase digests starch at different temperatures or pH; test samples with iodine.

Diffusion, osmosis, active transport

Process	What moves, and which way	Example
diffusion	particles, high → low concentration	oxygen into blood
osmosis	water, dilute → more concentrated solution, across a partially permeable membrane	water into root hairs
active transport	substances against the gradient, using energy from respiration	mineral ions into root hairs

Use the evidence

Faster with a larger surface area to volume ratio, a steeper gradient and a higher temperature; slower over a longer distance.

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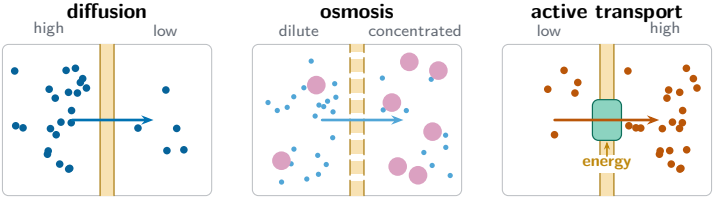
Down the gradient or against it



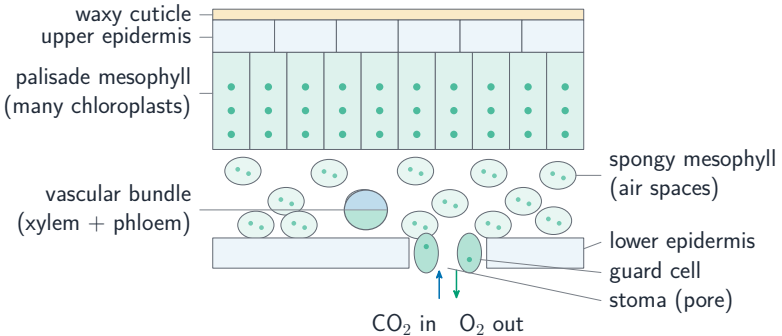
Only **active transport** moves particles from low to high concentration, and it needs energy.

Photosynthesis and its limiting factors

$$6CO_2 + 6H_2O \xrightarrow{\text{light, chlorophyll}} C_6H_{12}O_6 + 6O_2$$

1. **Limiting factors** Carbon dioxide concentration, light intensity and temperature.
2. **Rule** Raising one factor raises the rate only until another factor limits it.
3. **Minerals** Magnesium ions build chlorophyll (lack: yellow leaves); nitrate ions build amino acids.
4. **Practicals** Pondweed gives off oxygen; iodine tests a leaf for starch after removing light, CO_2 or chlorophyll.

A leaf built for photosynthesis



Match each layer to one job; carbon dioxide enters through the stomata.

Digestion in humans

Enzyme	Substrate	Products
amylase, maltase	starch	glucose
proteases	protein	amino acids
lipases	lipid	fatty acids and glycerol

Use the evidence

Bile is made in the liver, stored in the gall bladder: it neutralises stomach acid and emulsifies lipids into droplets. **Villi** in the ileum absorb the products.

Aerobic and anaerobic respiration

Type	**Word or symbol equation**
aerobic	$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
anaerobic, animals	glucose $\rightarrow$ lactic acid (oxygen debt)
anaerobic, plants and yeast	glucose $\rightarrow$ ethanol + carbon dioxide

Use the evidence

ATP supplies energy for muscle contraction, protein synthesis and **active transport**.

Gas exchange in leaves and lungs

(B) Leaf

Day: photosynthesis is faster, so net CO_2 in, O_2 out. Night: respiration only.

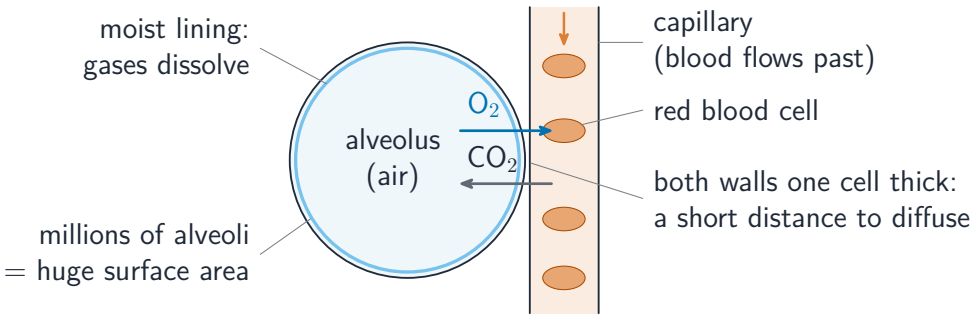
Hydrogen-carbonate indicator: yellow with more CO_2, purple with less.

Lungs

Breathe in: intercostals and diaphragm contract, volume up, pressure down, air pushed in.

Alveoli: one-cell-thick walls, huge surface, moist, capillary network.

An alveolus and its capillary



Thin walls, a large area and flowing blood keep **diffusion** fast.

Transport in plants

Xylem and phloem

Xylem: water and mineral ions, roots to leaves.

Phloem: sucrose and amino acids, leaves to the rest of the plant.

(B) Transpiration

Root hairs take in water by **osmosis**; water evaporates mostly through stomata.

Faster in low humidity, wind, high temperature and bright light.

Blood and the immune response

Component	**Job and adaptation**
plasma	carries CO_2, digested food, urea, hormones and heat
red blood cells	**haemoglobin** carries oxygen; biconcave, no nucleus, large surface
phagocytes	ingest pathogens
lymphocytes	release specific antibodies; (B) vaccination builds memory cells
(B) platelets	clotting

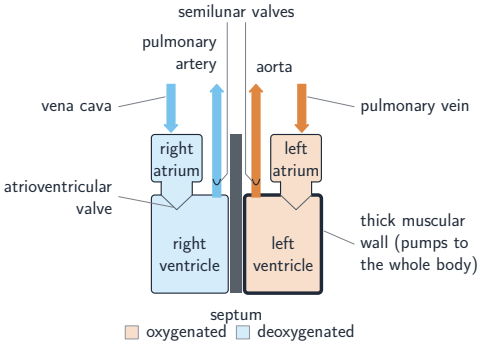
Heart and blood vessels

Vessel	Wall and lumen	Job
artery	thick, elastic, muscular; narrow lumen	away from the heart, high pressure
vein	thin; wide lumen; valves	back to the heart, low pressure
capillary	one **cell** thick	exchange with tissues

Use the evidence

The left ventricle has the thickest wall. Exercise and adrenaline raise heart rate. Coronary heart disease risks: smoking, high-fat diet, lack of exercise.

Following blood through the heart



The left ventricle has the thickest wall because it pumps blood round the whole body.

Excretion and (B) the nephron

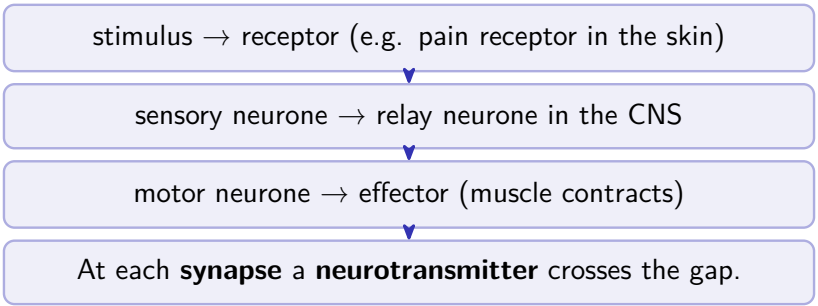
(B) Ultrafiltration: blood is filtered from the glomerulus into the Bowman's capsule.

All glucose is selectively reabsorbed at the proximal convoluted tubule.

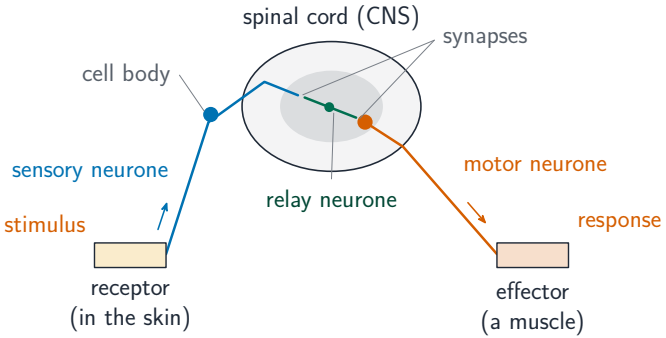
Water is reabsorbed from the collecting duct under ADH (osmoregulation).

Urine: water, urea and ions $\rightarrow$ ureter $\rightarrow$ bladder $\rightarrow$ urethra.

The reflex arc



Tracing a reflex arc



The relay neurone in the spinal cord makes the response fast and automatic.

Nerves, hormones and homeostasis

Hormone	Gland	Effect
adrenaline	adrenal glands	fight or flight; heart rate up
insulin	pancreas	lowers blood glucose
testosterone	testes	male characteristics
oestrogen, progesterone	ovaries	menstrual cycle
(B) ADH, FSH, LH	pituitary	water balance; menstrual cycle

Use the evidence

Skin: sweating and vasodilation lose heat. Shoots bend to light: **auxin** on the shaded side.

Check yourself

Your turn

Answer without notes, then check.

A. Why does heating an enzyme far above its optimum stop it working?

B. Distinguish diffusion, osmosis and active transport.

C. Write the symbol equation for aerobic respiration.

D. Compare arteries, veins and capillaries.

E. State the pathway of a reflex arc and one advantage of reflexes.