

Exercise walk-through

1.9

Osmosis, diffusion and active transport (statements 2.4–2.5)

Pearson Edexcel · International A-Level · Biology

Read a health study like an examiner

Your turn

Gum disease correlates with endothelial damage. List three checks before claiming causation.

- A. Who was sampled, how selected, how many?
- B. Were confounders like smoking, age, diet controlled?
- C. Is there a mechanism and a dose-response pattern?

Four routes across a membrane

Route	Gradient	Protein	ATP
Diffusion	down	none	no
Facilitated	down	channel or carrier	no
Active transport	against	carrier pump	yes
Osmosis	water, down water potential	partially permeable membrane	no

DNA copies itself semi-conservatively

Unzip : helicase breaks the hydrogen bonds between the strands

Template : each old strand pairs with free nucleotides by complementary base pairing

Join : DNA polymerase links the nucleotides into a new strand

Exercises 2.1·2.3

2.1 State what is meant by osmosis, in terms of water potential. [2]

2.2 A channel protein and a carrier protein both do facilitated diffusion. State one way they differ. [2]

2.3 Root hair cells take up nitrate ions against a gradient. Name the transport route and state what it requires. [2]

Exercises 2.1·2.3

2.1 State what is meant by osmosis, in terms of water potential. [2]

2.1 Movement of water from a region of higher (less negative) water potential to a region of lower (more negative) water potential through a partially permeable membrane.

2.2 A channel protein and a carrier protein both do facilitated diffusion. State one way they differ. [2]

2.2 Channels are water-filled pores (often gated) through which small ions pass; carriers bind the molecule and change shape to carry it across.

2.3 Root hair cells take up nitrate ions against a gradient. Name the transport route and state what it requires. [2]

2.3 Active transport; ATP and carrier proteins.

Exercises 3.1·3.2

3.1 Potato cylinders of identical mass are placed in sucrose solutions of water potential -50 , -200 , -400 , -800 and -1200 kPa for one hour. The cylinder in -50 kPa gains 8 % in mass; the cylinder in -400 kPa loses 6 %. Estimate the water potential of the potato tissue, explain your reasoning, and predict the mass change of the cylinder in -1200 kPa. [5]

3.2 Glucose crosses the gut wall into blood with the help of a sodium gradient: sodium ions are pumped out of the cell by active transport, and glucose enters with sodium through a co-transporter. Explain why this arrangement lets glucose enter the blood even when its concentration in the cell is already high, naming the direct energy user. [5]

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3.1 Tissue water potential lies between -50 and -400 kPa – the two movements are opposite. Zero mass change lies closer to -50 kPa (gain of 8 % smaller in magnitude than loss of 6 %... gains and losses are 8 and 6, similar), so estimate about -220 kPa. At -1200 kPa the gradient is steepest and outward, so the cylinder loses more than 6 %, perhaps 12–15 %.

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3.2 The sodium pump keeps intracellular sodium very low; this maintains a sodium gradient into the cell whatever the glucose level. The co-transporter carries sodium down its gradient together with glucose, so glucose can enter even against its own gradient. The direct ATP user is the sodium-potassium pump carrying out active transport.

Exercise 3.3

3.3 A student models diffusion: drops of dye are placed at one end of three tubes of water 2 cm, 10 cm and 20 cm long. The time for colour to appear at the far end is 40 s, 620 s and 2 100 s. Explain how the results illustrate the relationship between diffusion distance and time, and why multicellular organisms cannot rely on diffusion alone for oxygen supply to deep cells. [5]

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3.3 Time grows much faster than distance: $2.5\times$ the distance gave $\sim 15\times$ the time, $10\times$ gave $\sim 52\times$ – approximately with the square of distance. Deep cells are centimetres from the surface, so diffusion time would be hours, far too slow for aerobic respiration; hence a transport system delivering oxygen close to every cell.