Cells in Balance

Model water movement and ion transport across a cell membrane

BIO.1D.2 "Develop and use models to explain how the cell deals with imbalances of solute concentration across the cell membrane (i.e., hypertonic, hypotonic, and isotonic conditions, sodium/potassium pump)."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each rule for predicting water movement, circle the three terms for comparing solute concentrations, and number the two ion movements made by the sodium-potassium pump. Use your marks to build a model of what happens at the membrane.

What Happens at the Membrane?

1. A lab technician places animal cells in clear dishes with different dissolved substances outside them. To predict each cell's change, draw a boundary for the membrane and record solute concentration on both sides. Solutes are dissolved particles, such as salts and sugars. A membrane lets water cross more readily than many solutes. Water moves in both directions, but its net movement is toward the side with more dissolved solute. The comparison matters more than the exact number of particles: a concentration of 150 units outside is high only if the concentration inside is lower. Draw a larger arrow for the net flow of water.

2. If the solution outside has more solute than the cell, it is hypertonic to that cell. Net water movement is outward, so an animal cell shrinks. If the outside has less solute, it is hypotonic: net water movement is inward, and an animal cell swells. When concentrations are equal, the outside is isotonic. Water still crosses both ways, but there is no net flow, and the cell's size stays about the same. These labels always compare a solution with a particular cell. Moving a cell between dishes can reverse the direction of net water flow.

3. Water movement is not the cell's only response to unequal concentrations. In the membrane, the sodium-potassium pump uses energy from ATP to move three Na^+ ions out for every two K^+ ions it moves in. Typically, Na^+ is more concentrated outside and K^+ inside. Both moves work against the ions' concentration gradients. A model should show the membrane, the two ion arrows, and ATP supplying energy. The pump helps maintain ion gradients needed for cell function; it does not simply turn a hypertonic solution into an isotonic one. To explain a cell's changing size, first compare total solute concentrations, then trace net water movement.

2 ANSWER WITH EVIDENCE

Use the passage

1. An animal cell has 120 units of solute inside and enters a solution with 190 units outside. Label the solution and explain which way your model's net water arrow points and what happens to the cell.

2. An animal cell has 120 units of solute inside and enters a solution with 50 units outside. Label the solution and explain which way your model's net water arrow points and what happens to the cell.

3. A cell has 120 units of solute inside and 120 units outside. How should your model show water movement, and what happens to the cell's size?

4. A cell's sodium-potassium pump is working while the cell is in a hypotonic solution. What ion arrows and energy source belong in your model? Does the pump immediately stop the cell from swelling? Explain.

3 YOUR TURN

Your own words

At the instant of each transfer, an animal cell has 120 units of solute inside. In three panels, model what happens when it enters solutions with 80, 120, and 160 units outside: label the membrane, solution type, net water movement, and expected size change. Add the sodium-potassium pump, its ion arrows, and ATP to one panel, then write one sentence explaining why the pump does not immediately erase the water effect.

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PART 1 · READ AND MARK

Underline each rule for predicting water movement, circle the three terms for comparing solute concentrations, and number the two ion movements made by the sodium-potassium pump. Use your marks to build a model of what happens at the membrane. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	An animal cell has 120 units of solute inside and enters a solution with 190 units outside. Label the solution and explain which way your model's net water arrow points and what happens to the cell.	**The solution is hypertonic to the cell. Net water movement is outward, so the cell shrinks.**
2	An animal cell has 120 units of solute inside and enters a solution with 50 units outside. Label the solution and explain which way your model's net water arrow points and what happens to the cell.	**The solution is hypotonic to the cell. Net water movement is inward, so the cell swells.**
3	A cell has 120 units of solute inside and 120 units outside. How should your model show water movement, and what happens to the cell's size?	**The solution is isotonic. Water crosses both ways with no net flow, so the cell's size stays about the same.**
4	A cell's sodium-potassium pump is working while the cell is in a hypotonic solution. What ion arrows and energy source belong in your model? Does the pump immediately stop the cell from swelling? Explain.	**Show three Na^+ moving out, two K^+ moving in, and ATP supplying energy. No. The pump maintains ion gradients but does not immediately equalize total solute concentrations, so net water movement can still make the cell swell.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1: 80 outside, 120 inside. Hypotonic. A net water arrow points through the membrane into the cell, which swells. Panel 2: 120 outside, 120 inside. Isotonic. Equal water arrows point both ways through the membrane, and cell size stays about the same. Panel 3: 160 outside, 120 inside. Hypertonic. A net water arrow points out through the membrane, and the cell shrinks. In panel 3, the membrane pump shows ATP supplying energy, three Na^+ moving out, and two K^+ moving in. The pump maintains ion gradients but does not immediately equalize total solute concentrations across the membrane.

Accept arrows of equal size in opposite directions for the isotonic panel, or a label stating no net water movement. Students may place the pump in any panel; its Na^+ and K^+ arrows must point in the correct directions.