When Cells Swell

Use membrane structure and water properties to explain cell balance.

BIO.4 "Engage in argument from evidence to explain the regulation of cellular processes that maintain homeostasis, including active and passive transport. a..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the lab observations, circle membrane structures, and number each claim that explains how water or ions move. Use your marks to connect the evidence to the cells' different outcomes.

Two Drops of Blood

1. In a lab, two drops of blood are placed in separate dishes. One dish contains saline with about the same concentration of dissolved particles as blood plasma. The other contains nearly pure water. Under a microscope, red blood cells in the saline keep their usual shape, but cells in the water swell and some burst. These observations are evidence that a cell's surroundings affect its internal balance, or homeostasis. A membrane separates each cell from its surroundings, yet that boundary does not stop all movement. To explain the different outcomes, track where water can move and why.

2. The membrane is a double layer of phospholipids. Their water-attracting heads face the watery fluids, while their water-repelling tails point inward. This oily center blocks most charged ions from crossing freely. Some membrane proteins form channels, including aquaporins, that let water move across rapidly. Water moves by osmosis toward the side with more dissolved particles, without using cellular energy. In the nearly pure water, the cell interior has more dissolved particles, so water enters and the cell swells. In balanced saline, water still moves both ways, but there is no net gain.

3. Other membrane proteins help maintain the differences that cells need. A sodium-potassium pump uses energy from ATP to move sodium ions out and potassium ions in, each against its concentration gradient. This is active transport, unlike the passive flow of water through aquaporins. Water's polarity makes it a good solvent for ions, so dissolved salts help set the direction of osmosis. Hydrogen bonds between water molecules also give water a high specific heat: it changes temperature slowly, helping body fluids resist rapid temperature shifts. A pump cannot simply turn off osmosis when a cell is placed in nearly pure water.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use the lab observations and the direction of osmosis to explain why cells swell in nearly pure water but keep their shape in balanced saline.

2. Describe a model of the membrane that explains why charged ions do not cross freely but water can cross rapidly.

3. How does the sodium-potassium pump differ from water movement through aquaporins? Explain how each process affects cell balance.

4. Use two properties of water from the passage to explain how water helps organisms maintain homeostasis.

3 YOUR TURN

Your own words

Imagine a red blood cell is placed in a salt solution with more dissolved particles than its interior. Write five or six sentences predicting what happens, using a text model of the phospholipid layer and aquaporins, and explaining how water's polarity and the sodium-potassium pump relate to the outcome.

When Cells Swell

PART 1 · READ AND MARK

Underline the lab observations, circle membrane structures, and number each claim that explains how water or ions move. Use your marks to connect the evidence to the cells' different outcomes. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use the lab observations and the direction of osmosis to explain why cells swell in nearly pure water but keep their shape in balanced saline.	**Cells swell in nearly pure water because their interiors have more dissolved particles, so water enters by osmosis. In balanced saline, water moves both ways without a net gain, and the cells keep their shape.**
2	Describe a model of the membrane that explains why charged ions do not cross freely but water can cross rapidly.	**Phospholipid heads face the watery fluids, and their tails form an oily center that blocks most charged ions. Aquaporin proteins form channels that let water cross rapidly.**
3	How does the sodium-potassium pump differ from water movement through aquaporins? Explain how each process affects cell balance.	**The pump uses ATP to move sodium out and potassium in against their concentration gradients, helping maintain ion differences. Water moves passively through aquaporins by osmosis, which can change cell volume.**
4	Use two properties of water from the passage to explain how water helps organisms maintain homeostasis.	**Water's polarity lets it dissolve ions whose concentrations affect osmosis. Its high specific heat helps body fluids resist rapid temperature changes.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Because water is polar, salt dissolves in the surrounding solution. The phospholipid layer has water-attracting heads and an oily center that blocks most charged ions. Aquaporins provide channels through which water can move rapidly. Water leaves the cell by osmosis because the surrounding solution has more dissolved particles. The cell shrinks as it loses water. The sodium-potassium pump uses ATP to maintain ion gradients, but it does not pump water or stop this water loss.

Accept equivalent descriptions of a phospholipid bilayer and passive water movement. The open response should predict shrinking, not swelling, and distinguish the ATP-powered ion pump from osmosis.