Cells in Solution

Compare membrane transport and predict water movement

FB.3.3 "Compare and contrast active and passive cellular transport. Analyze the movement of water across a cell membrane in hypotonic, isotonic, and hypertonic solutions."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline statements that compare the ATP needs of active and passive transport. Beside the first mention of each solution type, write "in," "out," or "no net" to show water movement relative to a red blood cell.

What Happens to a Red Blood Cell?

1. A red blood cell is surrounded by a membrane that controls what enters and leaves. Oxygen moves through the membrane from a region of higher concentration to a region of lower concentration. This diffusion is passive: the cell spends no ATP, its usable energy molecule. Some substances also move down a concentration gradient through membrane proteins, a process called facilitated diffusion. Active transport works differently. A membrane protein uses ATP to move a substance against its concentration gradient, from lower to higher concentration. Both active and passive transport can involve proteins, but only active transport requires cellular energy to push substances against a gradient.

2. Water moves across a membrane by osmosis, a form of passive transport. To predict water flow, compare the concentration of dissolved particles outside a cell with the concentration inside it. A hypotonic solution has fewer dissolved particles outside than inside, so water tends to enter the cell. A red blood cell in such a solution swells and may burst because it lacks a rigid cell wall. An isotonic solution has about the same concentration of dissolved particles on both sides. Water still crosses in both directions, but there is no net movement, so the cell stays about the same size.

3. Before a transfusion, a lab technician places red blood cells in three separate drops of liquid to see how they respond. In the hypertonic drop, the liquid outside has a higher concentration of dissolved particles than the cytoplasm. Water leaves the cells by osmosis, so they shrink. In the isotonic drop, the cells keep their usual size, while cells in the hypotonic drop swell. Osmosis is passive in every drop: water moves down its own concentration gradient without ATP. An ATP-powered pump can move other substances against their gradients, but it does not turn osmosis into active transport.

2 ANSWER WITH EVIDENCE

Use the passage

1. How does oxygen moving through the membrane differ from a substance moved by an active-transport pump? Compare direction along a concentration gradient and ATP use.

2. Facilitated diffusion and active transport can both use membrane proteins. What makes facilitated diffusion passive but active transport active?

3. Compare the net movement of water and the size of a red blood cell in hypotonic and isotonic solutions.

4. How do water movement and cell size in a hypertonic solution contrast with those in a hypotonic solution? Does either water movement require ATP?

3 YOUR TURN

Your own words

Imagine a pouch that contains sugar solution. Its membrane lets water pass but not sugar. In 4 to 5 sentences, describe one outside solution that would make the pouch gain water and another that would make it lose water, then compare the energy needed for those movements with a pump moving sugar from lower to higher concentration.

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PART 1 · READ AND MARK

Underline statements that compare the ATP needs of active and passive transport. Beside the first mention of each solution type, write "in," "out," or "no net" to show water movement relative to a red blood cell. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How does oxygen moving through the membrane differ from a substance moved by an active-transport pump? Compare direction along a concentration gradient and ATP use.	**Oxygen diffuses from higher to lower concentration without ATP. An active-transport pump uses ATP to move a substance from lower to higher concentration.**
2	Facilitated diffusion and active transport can both use membrane proteins. What makes facilitated diffusion passive but active transport active?	**Facilitated diffusion moves substances down their concentration gradient without ATP. Active transport uses ATP to move substances against that gradient.**
3	Compare the net movement of water and the size of a red blood cell in hypotonic and isotonic solutions.	**In a hypotonic solution, water enters and the cell swells. In an isotonic solution, there is no net water movement, and the cell stays about the same size.**
4	How do water movement and cell size in a hypertonic solution contrast with those in a hypotonic solution? Does either water movement require ATP?	**In a hypertonic solution, water leaves and the cell shrinks; in a hypotonic solution, water enters and the cell swells. Neither movement requires ATP.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

If the outside solution has less sugar than the pouch, water enters by osmosis and the pouch gains water. If the outside solution has more sugar than the pouch, water leaves by osmosis and the pouch loses water. Both water movements are passive and require no ATP. A pump moving sugar from lower to higher concentration would require ATP because it moves sugar against its concentration gradient.

Accept "equal water movement in both directions" for no net movement in an isotonic solution. For the open task, check that each predicted direction matches the stated relative sugar concentrations.