The Membrane Test

Trace water movement and test what the evidence shows

BIO.1D "Students will describe the structure of the cell membrane and analyze how the structure is related to its primary function of regulating transport in and out of cells to maintain homeostasis..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two details that explain how membrane structure controls movement. Circle the three solution conditions, then write "in," "out," or "no net change" beside each to show water's net movement.

What Makes an Onion Cell Shrink?

1. A cell in a tide pool faces a changing mix of dissolved substances, called solutes. Its membrane helps keep internal conditions steady, a state called homeostasis. The membrane is a double layer of phospholipids: water-attracting heads face watery spaces, while water-repelling tails meet inside the layer. This arrangement forms a barrier to many charged particles. Membrane proteins provide routes for particular substances, so the membrane does not allow everything through equally. Water can cross the membrane by osmosis, including through channel proteins called aquaporins. Movement down a concentration gradient is passive; moving a substance against its gradient requires energy.

2. Test red onion cells under a microscope. View one thin piece of tissue in plain water and record whether its colored cell contents touch the rigid cell wall. Replace the water with concentrated salt solution without moving the tissue. Keep a second piece in plain water for comparison. After several minutes, the membrane of some salt-treated cells pulls away from the wall as water leaves by osmosis. The wall stays in place, making the gap visible. Count cells with visible gaps in both pieces before and after treatment. These observations show water movement, not whether salt ions crossed the membrane.

3. The salt solution is hypertonic to the onion cells if it has a higher concentration of solutes that cannot readily cross the membrane. In that case, net water movement is outward. A hypotonic solution has a lower concentration of such solutes, so net water movement is inward. In an isotonic solution, water moves both ways with no net change. Transport is not limited to water: in animal cells, the sodium-potassium pump uses ATP to move three Na^+ ions out and two K^+ ions in per cycle. Both ions move against their concentration gradients, helping maintain ion differences important for cell function.

2 ANSWER WITH EVIDENCE

Use the passage

1. How do the phospholipid layer and membrane proteins play different roles in controlling the movement of charged particles?

2. If more salt-treated onion cells than comparison cells develop gaps beside their walls, what does that show about water movement?

3. Why keep a second piece of onion tissue in plain water? What claim about salt ions would the gap counts not support?

4. How does the sodium-potassium pump help an animal cell maintain different ion concentrations inside and outside?

3 YOUR TURN

Your own words

Design a new investigation using equal-sized potato pieces in distilled water, a solution known to be isotonic to potato cells, and a hypertonic sugar solution. In five sentences, state what you would measure and hold constant, predict the mass change in each solution, explain the membrane's role, and name one conclusion the mass measurements alone cannot support.

ANSWER KEY

The Membrane Test

PART 1 · READ AND MARK

Underline two details that explain how membrane structure controls movement. Circle the three solution conditions, then write “in,” “out,” or “no net change” beside each to show water’s net movement. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How do the phospholipid layer and membrane proteins play different roles in controlling the movement of charged particles?	**The phospholipid layer blocks many charged particles, while membrane proteins provide routes for particular substances.**
2	If more salt-treated onion cells than comparison cells develop gaps beside their walls, what does that show about water movement?	**Water left the salt-treated cells across their membranes, causing the membranes to pull away from the walls.**
3	Why keep a second piece of onion tissue in plain water? What claim about salt ions would the gap counts not support?	**The second piece provides a comparison for changes over time without salt treatment. Gap counts do not show whether salt ions crossed the membrane.**
4	How does the sodium-potassium pump help an animal cell maintain different ion concentrations inside and outside?	**Using ATP, the pump moves three Na^+ ions out and two K^+ ions in against their concentration gradients.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would weigh three equal-sized potato pieces, soak each in one solution for 30 minutes, blot them the same way, and weigh them again. I would keep the solution volume and temperature the same for each piece. The piece in distilled water should gain mass, the isotonic piece should have little net mass change, and the piece in hypertonic sugar solution should lose mass. Water crossing the selectively permeable cell membranes explains these mass changes. Mass measurements alone cannot show whether sugar molecules crossed the membranes.

Accept predictions that distinguish net water movement from water moving in both directions. Students should not claim that a change in mass proves sugar or salt cannot cross the membrane.