Crossing the Boundary

Investigate how cells move water and dissolved substances

BIO.1D.1 "Plan and conduct investigations to prove that the cell membrane is semi-permeable, allowing it to maintain homeostasis with its environment through active and passive transport processes."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline what researchers change in each investigation, circle what they measure, and number the results that would support passive or active transport. Use your marks to trace how each test supports its conclusion.

When Soil Gets Too Salty

1. At a school greenhouse, tomato seedlings can wilt after too much fertilizer is added to their soil. Dissolved salts raise the solute concentration outside root cells. A cell membrane is selectively permeable: some substances cross it more easily than others. Water can move across the membrane by osmosis, a passive process that does not require cellular energy. Water tends to move toward the side with a higher solute concentration. Transport proteins help some dissolved substances cross membranes. If water leaves root cells faster than it enters, their internal pressure falls and the plant may droop.

2. To test this prediction in cells that are easy to see, students place equal-sized strips of red onion skin in either plain water or a concentrated salt solution. Under a microscope, they count the fraction of cells whose living contents pull away from the rigid cell wall after ten minutes. A higher fraction in salt solution supports the prediction that water crossed outward through the membrane. They then return the salty strip to plain water and look for cells to fill again. Both groups need the same temperature, strip size, and viewing time. This test shows passive water movement; it does not test energy-driven transport.

3. A second investigation tests how living root cells absorb nitrate ions through membrane transport proteins. Moving nitrate from a lower concentration outside the cells to a higher concentration inside requires energy from ATP and is active transport. Students place equal masses of living root tissue in identical dilute nitrate solutions. One sample receives an ATP-production inhibitor for a short time; the other does not. Students measure nitrate inside washed cells before and after, nitrate outside, ATP levels, and cell survival. Greater uptake in cells with more ATP would support energy-dependent transport, but the students must also check for other effects of the inhibitor.

2 ANSWER WITH EVIDENCE

Use the passage

1. In the onion test, what do students change and measure to test whether water moves across cell membranes?

2. What result after the salty onion strip returns to plain water would strengthen the explanation that water moved out of its cells?

3. Why must students compare nitrate concentrations inside and outside root cells when testing for active transport?

4. Suppose the treated roots take up less nitrate. What two checks help determine whether reduced ATP, rather than dead cells, explains the result?

3 YOUR TURN

Your own words

Duckweed in a pond faces rising salt levels and low phosphate levels. Plan one test for passive water movement and a separate test for energy-dependent phosphate uptake. For each, name a comparison group, a measurement, and a result that would support your explanation; include a way to check that the plants remain alive.

Crossing the Boundary

PART 1 · READ AND MARK

Underline what researchers change in each investigation, circle what they measure, and number the results that would support passive or active transport. Use your marks to trace how each test supports its conclusion. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In the onion test, what do students change and measure to test whether water moves across cell membranes?	**They change whether onion skin is in plain water or concentrated salt solution and measure the fraction of cells whose contents pull away from the cell wall.**
2	What result after the salty onion strip returns to plain water would strengthen the explanation that water moved out of its cells?	**Cells that had pulled away from their walls would fill again as water moved back in.**
3	Why must students compare nitrate concentrations inside and outside root cells when testing for active transport?	**They must establish that nitrate moves into cells despite a higher concentration inside, which is movement against its concentration gradient.**
4	Suppose the treated roots take up less nitrate. What two checks help determine whether reduced ATP, rather than dead cells, explains the result?	**Check that ATP levels fell in treated cells and that the cells remained alive.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would place equal-sized duckweed leaves in normal pond water and salty pond water for the same amount of time. I would count the fraction of cells whose contents pull away from their walls. A larger fraction in salty water, followed by refilling in normal water, would support passive water loss and show that the cells survived. To test phosphate uptake, I would place equal masses of duckweed in identical low-phosphate water, adding an ATP-production inhibitor to only one group. I would measure ATP and phosphate inside washed cells before and after, plus phosphate outside. Greater phosphate uptake against its concentration gradient in living cells with more ATP would support active transport.

Accept other controlled designs that measure water movement and phosphate uptake separately. An active transport claim needs evidence of uptake against a concentration gradient and an energy comparison, with cell survival checked.