Explain how this information can be used to determine the osmolarity of the potato tuber tissue

Updated April 24, 2017 By Athena Hessong Water will move across a membrane, a process known as osmosis. Find which direction the water will cross the membrane by determining the osmolarity of the solutions on either side of the membrane. According to Larry McGanhey of the College of St. Scholastica, osmolarity comes from the product of the molarity of the solution and the number of particles that result from dissolving that solution with water, known as dissociation. Find the osmolarity of two solutions to determine the direction the water will flow, as water moves across a membrane into an area with a greater osmolarity. Find the number of particles produced by dissolving a solute in water. Use one particle for compounds with covalent bonds, as they do not dissociate in water. For example, MgCl2 becomes three particles (Mg++ and 2 Cl-) when dissolved in water. Multiply the number of particles produced from dissolving the solution in water by the molarity to find the osmolarity (osmol). For instance, if your have a 1 mol solution of MgCl2: 1 x 3 = 3 osmol. Repeat multiplying the molarity by the number of particles for the other solution to find the osmolarity. Compare the osmolarities of the two solutions and note that the water will move across the membrane to the solution with the higher osmolarity. Thank you for your participation! Osmosis in Potato Tubers Andrew Dickson Background When a plant cell is bathed in a solution of the same concentration (isotonic) as its intracellular environment, its mass and volume remain the same. This is because water enters and leaves the cells at the same rate. There is no net loss or gain of water by osmosis. Samples of cells can be placed in a range of solutions of different concentration. The cells will gain water by osmosis when placed in solutions which are more dilute (hypotonic) than the intracellular environment. They will therefore gain mass. The cells will lose water in those solutions that are more concentrated (hypertonic) than the intracellular environment and so lose mass. The concentration of the... show more content...Some of the potatoes expanded and increased in mass whilst others shrunk and decreased in mass. This was caused by the diffusion of water from the cells to the sucrose solution or vice-versa through the process of osmosis. During osmosis water will diffuse across a semi-permeable membrane from a region of low solute concentration to a region of high solute concentration. The potato cylinders in both test tubes A and B with sucrose concentrations of 0% and 5% respectively, had a noticeable increase in mass, whereas the potato in test tube C even though having an increase in mass, was only marginal. This suggests that the sucrose concentration in test tube C, which was 10%, is almost the same concentration (isotonic) as the potato's cells intracellular environment because the mass remains relatively the same. This is because the movement of water into and out of the cells occurs at the same rate and results in no net loss or gain of water by osmosis. This also implies that the potato cylinders in test tubes A and B where bathed in a sucrose solution that was more dilute (hypotonic) than the intracellular environment of the potato's cells. The cells of the potato in test tubes A and B gained water by osmosis and therefore gained mass. However, the results show that in test tubes D and E with sucrose concentrations of 15% and 20% respectively, that there was a decrease in mass of the potato cylinders. This was Name:____ In this lab, you will observe the process of osmosis and diffusion. You will also learn how to calculate water potential. If you are not familiar with these concepts, make sure that you have looked them up in your textbook. If you don't know what these terms mean, this lab is not going to make sense to you. OBJECTIVES Investigate the processes of osmosis in a model of a membrane system Investigate the effect of solute concentration on water potential as it relates to living plant tissues Exercise 1 - Osmosis Across a Membrane 1. Obtain 6 strips of dialysis tubing and tie an knot in one end of each. 2. Pour approximately 15-20 ml of each of the following solutions into separate bags. Distilled Water 0.4 M sucrose 0.8 M sucrose 0.2 M sucrose 0.6 M sucrose 1.0 M sucrose 3. Remove most of the air from the bag (but leave a little bit of space) and tie the baggie. 4. Blot the bags to remove any sugar that may have spilled, check the bags for leaks. 5. Record the mass of each baggie in the data table. 6. Fill six beakers with enough distilled water to cover your bags. Place a bag in each one (keep track of which bag is in which beaker) 7. Let the bag sit for 20-30 minutes. -------- While this is running, set up potatoes for exercise 3. Predict what you think will happen during the experiment. (Think about which bags will lose water and which will gain water.) 8. After 20-30 minutes, remove the baggies from the water, and carefully blot dry and record the final weight. 9. To calculate: percent change in mass= (final mass-initial mass)/ initial mass. Then multiply answer by 100. Contents in Bag Initial Mass Final Mass Mass Difference Time in Beaker % Change in Mass Distilled Water 0.2 M 0.4 M 0.6 M 0.8 M 1.0 M 11. Graph the results for your individual data that shows the relationship between %change in mass and the molarity of the solution. The independent variable is on the X axis, and the dependent variable is on the Y axis ANALYSIS 1. Describe the relationship between the change in mass and the molarity of the sucrose in the dialysis tube. Based on scientific principles, did you observe what you expected? If not, suggest a reason or possible errors in set-up or data gathering. 2. Why did you calculate the percent change in mass rather than simply using the change in mass? 3. Predict what would happen to the mass of each bag in this experiment if all the bags were placed in 0.4 M sucrose solution instead of distilled water. Explain your response. 4. A dialysis bag is filled with distilled water and then placed in a sucrose solution. The bag's initial mass is 20 g, and its final mass is 18 g. Calculate the percent change of mass, showing your calculations. EXERCISE 2 - Determining the Water Potential of Potato Cells In animal cells, the movement of water into and out of the cell is influenced by the relative concentration of solute on either side of the cell membrane. If water moves out of the cell, the cell will shrink. If water moves into the cell, the cell may swell or even burst. In plant cells, the presence of a cell wall prevents the cells from bursting, but pressure does eventually build up inside the cell and affects the process of osmosis. When the pressure inside the cell becomes large enough, no additional water will accumulate in the cell even. So movement of water through the plant tissue cannot be predicted simply through knowing the relative solute concentrations on either side of the plant cell wall. Instead, the concept of water potential is used to predict the direction in which water will diffuse through living plant tissues. In a general sense, the water potential is the tendency of water to diffuse from one area to another. Water potential is expressed in in bars, a metric unit of pressure equal to about 1 atmosphere and measured with a barometer. Consider a potato cell is placed in pure water. Initially the water potential outside the cell is 0 and is higher than the water potential inside the cell. Under these conditions there will be a net movement of water into the cell. The pressure potential inside the cell will increase until the cell reaches a state of equilibrium. Directions: 1. Pour 100 mL of your assigned solution (it will be one of the six solutions listed above in Exercise 2) into a beaker. Slice a potato into 4 equal cylinders or slices, they will resemble french fries. 2. Determine the mass of all 4 potato cylinders together and record. 3. Place the cylinders into the beaker with your assigned solution and cover with plastic wrap. Leave overnight. 4. Remove the cylinders from the beakers and record the mass. Determine the temperature of the room. ________ 5. Complete the table and graph your results. Contents in Bag Initial Mass Final Mass Mass Difference %Change in Mass Distilled Water 0.2 M 0.4 M 0.6 M 0.8 M 1.0 M 6. Determine the molar concentration of the potato cores. This would be the sucrose molarity in which the mass of the potato core does not change. To find this, draw the straight line on your graph that best fits your data. The point at which this line crosses the x axis represents the molar concentration of sucrose with a water potential that is equal to the potato tissue water potential. What is the Molar concentration of the cores? ___________ 7. Calculate the solute potential (Ψ) for the sucrose solution using the formula below. Show your work! Solute Potential Formula: Ψ = -iCRT i = ionization constant (for sucrose, this is 1 because sucrose does not ionize in water) C = molar sucrose concentration at equilibrium (determined from graph) R = pressure constant (0.0831 liter bar/mole °K) | T = temperature °K (273 + °C) 8. Explain water potential and describe how it affects osmosis. 9. Explain how you would determine the molarity of a potato. Extension: Design an Experiment to Test an Unknown You are given a solution of sucrose that has an unknown molarity (.2, .4,.6, .8, 1.0), how could you use potatoes, distilled water, or other known solutions to determine the molarity of your unknown? - Be clear in your design, use another page and staple to this one. Conduct your experiment and include the results with your determination of which solution you had. Solutions will be color-coded by the instructor. Complete the CER chart below. Claim: Evidence: Reasoning: Suggest ways to improve your experimental design or to obtain greater confidence in your claim. If you were given another day to work on this, what would you do? Reading Time: 2 minutes Ever cut up some apples or potato slices just to see them turn funky colors and not be as fresh as they could be? What can you do to protect these fruits and vegetables and keep this from happening? What will keep potatoes (or other veggies) fresher: soaking it in regular water or saltwater? This month, I'm going to explain this question by explaining the concept of osmosis. Osmosis is a property of matter that deals with diffusion; a spreading out of particles from high concentration to low concentration. Basically, more stuff balances out with less stuff. Like spraying a bunch of perfume in one place, notice how it travels across the room? However, instead of stuff in the air, osmosis describes the motion of water going through something. I'm going to give you the experiment, and then we'll talk about how exactly this water motion occurs. Materials: A potato, salt, water (if you have distilled water, that kind is best), a couple of drinking glasses. Procedure: Fill two glasses with water In one of the glasses add 2-3 tablespoons of salt, and stir it in Slice up a potato into French fry-like pieces Make your observations on these pieces: pay attention to color, how flexible it is, smell, etc. Take a guess about how you think these slices might change by putting them into the different types of water Dunk the pieces in the water, and then let them sit overnight in it Remove the pieces onto a plate and make your final observations Explanation: You will notice some immediate differences in the potato slices. The color of the salted water one is dark brown; not a nice image of how you would like your potatoes preserved! The one in the regular water looks like a nice white freshly cut piece of potato. Moving on to the flexible test, the regular water one again feels firm and crisp (try to break the piece, it snaps!). The saltwater potato is bendy and doesn't snap at all. Osmosis is the key to understanding this issue. Osmosis is the diffusion of water across a semi-permeable membrane (yikes!) from an area of high concentration of water, to an area of low concentration. Semi-permeable membrane: a layer that only certain things can go through. For example, parts of the potato that water can pass through. Salt is the key here. Water will move from an area of less salt to more salt (more water to less water), and so when the potato is placed in the saltwater, all the water that is inside the potato (yes, plants have a lot of water inside of them, that's what gives a plant it's structure) moves out by osmosis. Thus, the potato gets all flimsy and not crisp anymore. Much like if you were to water all your houseplants with saltwater. They would all get flimsy and then die, and then your parents would be upset so don't try that at home, please. Experiment further: Does the process of osmosis work with other pieces of fruits or vegetables? What about the temperature of water? Does that make it get flimsy faster or slower? Lots of things for you to test... remember science is about making observations, testing ideas, and then asking more questions. I hope you enjoyed this simple experiment. Steve Davala is a middle school science teacher who likes to write and work with Photoshop. He's got two kids of his own, who both like science (even if what they really like doing best is mixing baking soda and vinegar). Bring Science HomeA water-moving science project from Science BuddiesCreate movement with salt! Learn how plant cells regulate water with an activity you can see--and feel. Credit: George RetseckAdvertisement Key Concepts Biology Osmosis Cells Chemistry Concentration Water transport Introduction Have you ever wondered how plants "drink" water from the soil? Water uptake in plants is quite complicated. A process called osmosis helps the water move from the soil into the plant roots—and then into the plant's cells. In this activity you will see for yourself how you can make water move with osmosis! Background Most water in the ground is not pure water. It usually contains dissolved mineral salts. Animals and plants need these salts (which include calcium, magnesium, potassium and the sodium you might be familiar with as table salt) to grow, develop and stay healthy. Different water sources carry different amounts of these salts. Nature wants to balance a system that is not balanced. So if you mix water with two different salt concentrations, the salts don't stay separated but spread out evenly through the solution until the salt concentration is the same throughout. You'll find a similar reaction if you separate two salt solutions with a semipermeable membrane. A semipermeable membrane is a type of barrier that only lets certain particles pass through while blocking others. This type of membrane usually lets water pass through but not the salts that are dissolved in the water. In this situation, because only water can move through this membrane, the water will start moving from the area of lower salt concentration (which has more water and less salt) to the area of higher salt concentration (which has less water and more salt). This water movement will only stop once the salt and water concentration on both sides of the membrane is the same. The process of moving water across a semipermeable membrane is called osmosis. Plants use this process to their advantage for water uptake. They create an environment of high salt concentration in their root cells that are in contact with the soil. The cell walls act as a semipermeable membrane that only let water through. Because the water outside the root cells has a lower salt concentration, water starts moving into the root cells due to osmosis. The water entering the plant fills up the cells and can travel to the rest of the plant. Osmosis, however, works in both directions. If you put a plant into water with a salt concentration that is higher than the concentration inside its cells, water will move out of the plant to balance out the concentration difference. As a result the plant shrinks and eventually dies. You will see this effect with your own eyes in this activity using potatoes and different saltwater solutions. Materials Distilled water Measuring cup with milliliters (mL) Table salt Weight scale with gram measurements Three plastic cups or glasses Spoon At least three potatoes Apple corer. (Alternatively, you can have an adult help you use a cutting board and knife.) Knife (and an adult helper to help you use it) Ruler Paper Pen or pencil Timer Paper towels Graphing paper (optional) Other vegetable(s) or fruit (optional) Preparation Prepare three different saltwater solutions. Create labels for the three cups: "0 grams," "2 grams" and "4 grams." To each of the cups add 100 mL of distilled water. Weigh out 2 grams of table salt, and add it to the cup that says "2 grams." Then weigh out 4 grams of table salt, and add it to the cup labeled "4 grams." Use a spoon to mix the solutions until all the salt is dissolved. Draw a table in which you can enter the starting measurements (length and diameter or width) and end measurements of each potato strip for every salt concentration (0, 2 and 4 grams). Prepare at least three potato cores. Carefully push the corer all the way through the potato, and remove the core carefully so the potato piece stays intact. (Alternatively, you can have an adult help cut the potato into strips that all have the same dimensions.) The potato pieces should be at least one-half inch thick and two inches long. (Ideally you will be able to prepare nine matching cores or strips so you can test three pieces in each solution to compare the results thoroughly.) Use a knife to carefully remove any potato skin from your cores, and rinse the cores quickly with water. Use a ruler to ensure each potato piece is the same size (ideally to the millimeter). Carefully use a knife to trim any pieces as needed. Measure the dimensions (length and diameter or width) of each potato strip in millimeters, and write the information in the table. Optionally, you can also weigh each potato piece and record their weights. Procedure Put one potato strip (or three if you made nine pieces) into each of the cups. While you do that feel the potato strips with your fingers and try to flex them a little bit. How do they feel? Are they easy to bend? Start your timer for 30 minutes. Let the potato strips sit in the different solutions for the whole time. What do you think will happen to the strips in each of the cups? After 30 minutes inspect the potato strips inside the solutions. Do you see any changes? Take the potato strip(s) out of the "0 grams" cup and place on a paper towel. While doing that feel the potato pieces again and try to bend them slightly. How do they feel? Are they easier or more difficult to bend than before? Use the ruler to measure the exact length and diameter or width (in millimeters) of each of the potato strips, and write the results in your table. What do you notice about the potato strip measurements? Optionally you can weigh these pieces and record their weights. Next take the potato strips from the "2 grams" cup, and place them on a paper towel; as you do this feel them. Measure their lengths and diameters or widths. Write your results in the table. Optionally you can weigh these pieces and record their weights. What changed about these potato strips? Repeat the same steps with the potato strips in the "4 grams" cup. Write your results in the table. Are your results for these similar or different compared with the other ones? How did the feeling of the strips compare based on what solution they were in? Why do you think this is? Compare the results in your table. How did the length and diameter or width of the potato strips change in each cup? What about the weights if you took them? Can you explain your results? Extra: If you weighed each of your strips before and after soaking them, compare the weights. How does the mass of the potato strips change in each solution? Extra: Leave the potato strips in the solutions for a longer time period. How do they look if you let them soak in the saltwater for one hour or overnight? Extra: If you have graphing paper, make a graph of your results with the salt concentration on the horizontal axis and the potato strip length or diameter after soaking on the vertical axis. Draw two lines to make your graph. For the first, connect each of the data points you found. For the second, draw a horizontal line starting at the point on the vertical axis that shows the original length of your potato strip. Based on your graph can you find a salt concentration at which the potato strip length should not change at all? Extra: How does the activity work with other vegetables or fruit? Try it to find out! Observations and Results Did your potato strips shrink and expand? At the beginning all the potato strips should have had the same length and should have all felt the same. When you put them into the different solutions, however, this starts to change. Whereas the potato strips in the "0 gram" cup probably got larger in size, the other potato strips probably got shorter after leaving them in the saltwater for 30 minutes. (If you didn't see any significant changes after 30 minutes, leave the potato strips in the saltwater solutions longer.) The shrinking and expanding of the potato strips is due to osmosis. Potatoes are made of cells, and their cell walls act as semipermeable membranes. The 0 grams solution contains less salts and more water than the potato cells (which have more salts and less water). To balance out these concentration differences, the water from the cup moves into the potato cells. The incoming water in the potato cells pushes on the cell walls and makes the cells bigger. As a result the whole potato strip gets bigger. The opposite is the case in the higher concentration salt solutions. If the salt concentration in the cup is higher than inside the potato cells, water moves out of the potato into the cup. This leads to shrinkage of the potato cells, which explains why the potato strips get smaller in length and diameter. Due to the shrinking of the potato cells the potato strip also becomes less rigid. If you bent the potato strips, you should have noticed that those that had been in the solution with the highest amount of salt were much easier to bend than the potato strips in the water without salt. If you made the graph you probably noticed that there is a salt concentration at which the potato strip neither expands nor shrinks. This should be where your data curve and your start length line intersect. At this point the salt concentration inside the potato cells and inside the cup are the same. Because the concentrations are already balanced no water moves. Cleanup Discard the saltwater solutions in the sink. Throw the potato strips into the compost, and clean up your workspace. You can cook with the other pieces of unused potato. More to Explore Osmosis, from Biology Dictionary Do Fish Drink? from McGill University's Office for Science and Society Cucumber Chemistry: Moisture Capture with Desiccants, from Scientific American Suck It Up! How Water Moves Through Plants, from Science Buddies STEM Activities for Kids, from Science Buddies Discover world-changing science. Explore our digital archive back to 1845, including articles by more than 150 Nobel Prize winners.Subscribe Now!