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Osmosis: In or Out?

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This introductory biology laboratory activity explored osmosis with solutions of unknown concentration using materials from a grocery store. In this lab, a raw egg minus the shell, served as the model cell, and was weighed then placed either in water, a sports drink, or corn syrup for 30 to forty-five minutes. Students calculated the average differences between the final and initial egg mass for each medium: water, sports drink, or corn syrup to determine whether the "cell" is hypertonic, hypotonic, or isotonic to the surrounding solution. While osmosis takes place, the instructor had ample time to cover background information of osmosis in order for students to be able to make conclusions based on their results.

Keywords: osmosis, measurement

Link to Original Poster: http://www.ableweb.org/volumes/vol-34/poster?art=67

Introduction

A solution consists of a solute and a solvent. Water is considered the universal solvent, particularly for living organisms because it can dissolve hydrophilic solutes such as electrolytes necessary for muscle contraction and nerve impulses. Sugars are another common solute and are used for cellular respiration. Water diffuses passively through semi-permeable membranes while most solutes cannot. Osmosis is the passive movement of water across membranes towards higher solute (hypertonic) concentrations until the solutions become isotonic, meaning the solutions will have an equal solute concentration, when possible. When one solution has a significantly greater solute concentration (high concentration gradient), more water is necessary to equilibrate the two solutions. Cells can even rupture or dehydrate if they are placed in extremely hypotonic or hypertonic solutions respectively. To determine whether water will flow into or out of a cell, there are two key things to remember: which is hypertonic (higher solute concentration), the medium or the cell and to know that water will diffuse towards the hypertonic solution.

Lab Objectives: Determine whether media and cell are hypotonic, hypertonic, or isotonic based on average mass changes.

Table 1. Solute and solvent concentration of cells and media in three possible scenarios.

Scenario	Cell	Medium
1	95% H_2O 5% solute	90% H_2O 10% solute
2	90% H_2O 10% solute	95% H_2O 5% solute
3	95% H_2O 5% solute	95% H_2O 5% solute

Table 2. Osmosis scenario outcomes and examples.

Scenario	Cell is (Hypertonic, Isotonic, or Hypotonic)	Medium is (Hypertonic, Isotonic, or Hypotonic)	Water moves (in or out of cell)	Cell Size (no change, increases, decrease)	Example
1					*Drinking sea water*
2					*Using tap water instead of saline eye drops.*
3					*-Using saline eye drops.* *-Sugar solution for IV fluids*

Materials

- Dozen large eggs
- Gallon of white vinegar
- Storage container with lid that will hold eggs and can be stored in a refrigerator
- Corn syrup
- Sports drink (red works well)
- Drink cups
- Balance (electronic or triple-beam)

Exercise

I have placed raw eggs in vinegar for several nights to remove the hard shell from the egg. The egg serves as the model cell for this osmosis investigation. We will measure the change in the mass of the egg to determine the direction of water flow (into or out of the "cell").

Lab Directions

1. Wipe remaining shell off of egg without busting the membrane.
2. Quickly rinse egg with water and blot dry.
3. First, weigh and record the INITIAL mass of each egg in Table 3.
4. Place an egg into a container with a sports drink, water, or corn syrup. Because corn syrup is much more dense than the egg, the egg will tend to float and a cup with a bit of water can be used to force the egg down into the corn syrup (Fig. 1).
5. Wait for 40 minutes (or a bit less). This time will be used to cover the background information and complete Table 2.
6. Remove egg from container and blot the water or sports drink off the surface. If the egg was in corn syrup, quickly rinse it with water and blot it dry.

Figure 1. Set-up for egg in a container of corn syrup.

7. Next, reweigh the eggs and record their FINAL mass in Table 3.
8. Now, calculate the difference (FINAL-INITIAL) mass and record in the last column of Table 3.
9. Calculate the average difference for each medium and record in Table 4.
10. Please answer the post-lab questions based on the results and background information.

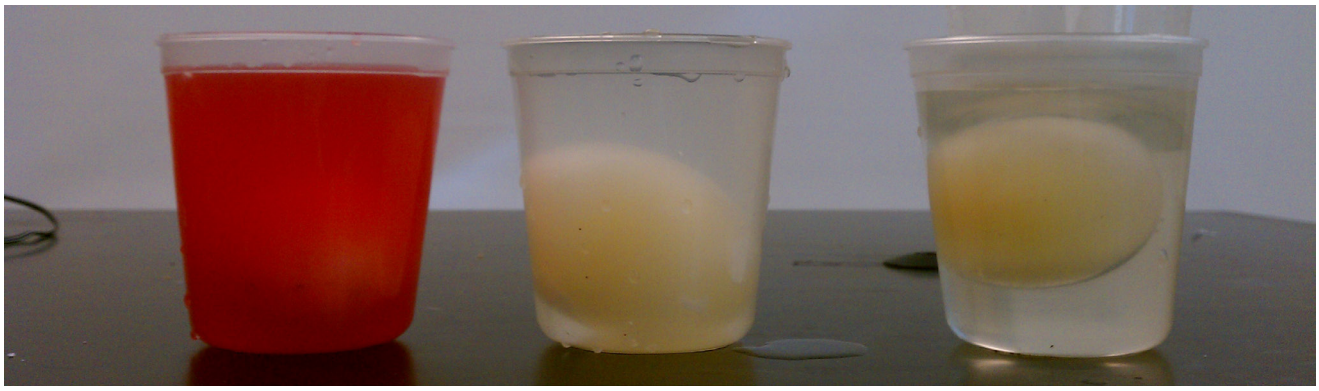

Figure 2. Eggs in red sports drink and other solutions.

The two tables below should be on the board for all students to record the information. The chart may need to be expanded based on the number of replicates (eggs) for each medium.

Table 3. Initial and final egg mass class results.

Media	INITIAL Egg Mass (grams)	FINAL Egg Mass (grams)	FINAL-INITIAL Egg Mass (Grams)
Sports Drink			
Sports Drink			
Sports Drink			
Sports Drink			
Water			
Water			
Water			
Water			
Corn Syrup			
Corn Syrup			
Corn Syrup			
Corn Syrup			

Table 4. Average difference for eggs in each medium.

Media	Average Difference= of the (FINAL-INITIAL Mass) for each medium. (g)
Sports Drink	
Water	
Corn Syrup	

Post-Lab Questions

1. Was the egg hypotonic or hypertonic to the sports drink? How do you know?
2. Was the egg hypotonic or hypertonic to the water? How do you know?
3. Was the egg hypotonic or hypertonic to the corn syrup? How do you know?
4. Why did the egg gain more mass with water than sports drink?
5. If there was a lot of shell left on the egg how would that affect osmosis? Which would take on more water: an egg with a lot of shell or an egg without any shell? Why?
6. If you wanted to decrease the salt concentration of a bag of saltwater, would you place the bag in a hypotonic, hypertonic, or isotonic solution? Why? (The bag is permeable to water, but not salt, only water can move in and out of the bag). Please label the bag and surroundings appropriately (hypertonic, hypotonic, or isotonic) and an arrow showing the direction that water will move.

Pre-Lab Directions for Instructor:

Place raw eggs in a storage container with vinegar in a refrigerator for at least two days before the lab activity. Results are best if the vinegar is refreshed at least once. Immediately before the lab activity, gently wipe or rub away the remaining shell from the egg using bare hands. Rinse the egg with cool water (egg can still be cooked) and blot dry to begin the lab. Be sure to explain how to use the electronic or triple-beam balance for the best results. The amount of each liquid does not matter as long as the eggs are immersed. I often begin the lab by determining the initial mass and use the waiting period as an opportunity to go through the three possible osmosis scenarios and outcomes chart.

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