Osmosis and Diffusion

An Epic Adventure of Molecules

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This lab report covers an experiment involving Osmosis and Diffusion. The reader will gain insight into how particles move about depending on solutes, solvents, gradients, and membranes.

Introduction

- **Objective**

  The purpose of this experiment was to observe how molecules act when presented with a number of variables. For diffusion, two different types of crystals were placed on a petri dish containing a gel, and it was observed over time how the dye from the crystals diffused at different rates from each other. For osmosis, water and sucrose solutions were placed in dialysis tubes, sealed, and then placed into beakers containing either water or another sucrose solution. Over set periods of time, the tubes were weighed to determine to determine the rate of osmosis.

- **Background**

  Diffusion is the process of solute molecules being spread out on lower gradients. A lower gradient can be described as an area with less concentration of the solute molecules in question, creating a pressure difference, therefore making it possible for the molecules to spread via passive transport. Passive transport is a process by which molecule movement is driven by concentration or gradient, thereby not needing to expend any energy.

  Osmosis deals with the solvent rather than the solute; in particular, the solvent water. In a solution containing water and solute(s), water will move from a solution of lower solute concentration to a solution of higher solute concentration. Take, for example, a selectively permeable membrane that allows water to pass through, but not sugar molecules, because the membrane pores are too small for the sugar molecules, but large enough for water molecules. If one side of the membrane has a solution high in sugar, while the other side's solution has only water, water will be able to move both ways, but mostly it will move toward the side high in sugar solute. Similar to diffusion, in osmosis, water will move in the direction of lowest concentration of other water, and because the one side has solute molecules, that means there is less water concentration in comparison, and that is the direction water will want to flow.

Materials and Methods

- **Materials**

  <u>For the Diffusion portion of the experiment, the following materials were used:</u>
  - Petri dish containing agar gel.
  - (1) Crystal of potassium permanganate.
  - (1) Crystal of methylene blue.
  - A ruler that could measure millimeters and centimeters.
  - Forceps used to pick up and place crystals.
  - A device with which to keep time.

  <u>For the Osmosis portion of the experiment, the following materials were used:</u>
  - (5) Dialysis tubes.
  - (10) Dialysis tubing clips.
  - (5) Glass beakers large enough to suspend the dialysis tubes in solution after themselves being filled with 10ml of a solution.
  - (4) Pipet devices, 3 of which were for the different measured sucrose solutions, and 1 that was used for both instances of measured water.
  - Tap water source.
  - 20% sucrose solution source, of which 10ml needed.
  - 40% sucrose solution source, of which 10ml needed.
  - 60% sucrose solution source, of which 10ml needed, as well as enough to suspend a dialysis tube filled with 10ml of water in one of the glass beakers.
  - A measuring scale that accurately measured in grams.
  - A device with which to keep time.

- **Methods for Osmosis portion of experiment.**
  1. A total of (5) dialysis tubes were prepared. This was done by individually holding each one under a stream of tap water so that one end can be spread open. Doing so proved difficult or impossible to accomplish with dry tubes. After a tube was opened, a clip was placed on its closed end. The closed end was folded first to ensure a good seal. After all (5) tubes were spread open on one end, clipped on the other, and ensured not to hold significant amounts of water, they were lied out on a paper towel. On the paper towel was written numbers 1 through 5 for each tube to be placed near, so they would not get mixed up as the experiment progressed.
  2. A glass beaker was filled with tap water so that a pipet device could extract 10ml of water (2) times. The pipet containing 10ml of water was used to fill the #1 dialysis tube with 10ml of water. Afterward, air was squeezed out of the tube, the open end was folded, and a clip was used to secure the remaining unsecured side

of the tube. The #5 dialysis tube was prepared in the same fashion, with 10ml of tap water, and securely clipped closed. This same glass beaker will be used again to hold water in a later step, so do not mix it with the beaker that will contain sucrose. The two completed tubes were placed on the paper towel at the #1 and #5 marked positions.

3. The remaining dialysis tubes, #2, #3, and #4, were filled with 20%, 40%, and 60% sucrose solution, respectively. A different pipet device was used to measure 10ml of each solution to prevent contamination. Air was removed, and they were securely clipped shut as with the previous tubes containing water. The completed tubes were placed on the #2, #3, and #4 marked positions of the paper towel, with respect to the sucrose concentration.
4. The beaker previously used for water, and (3) others, were filled with enough tap water to suspend the filled dialysis tubes in solution, making (4) beakers with water. Beaker number (5) was filled with the same amount of 60% sucrose solution from the same source as dialysis tube #4. In summary, beakers 1 through 4 contained water, and beaker #5 contained 60% solution.
5. A timer was prepared to alarm at (15) minutes, and at the beginning of the countdown, all five tubes were placed in their correspondingly numbered beakers.
6. After 15 minutes, the tubes were removed, dried, and weighed separately, with their results recorded. The tubes were placed on the marked paper towel to keep track of them after each were measured.
7. After all were measured, the timer was again set for (15) minutes, and the tubes were again placed in their correspondingly numbered beakers.
8. This process of suspending the dialysis tubes for (15) minutes in solution, removing, drying, and weighing was performed (5) times of the course of approximately (75) minutes, giving (5) recorded weights for each dialysis tube on (15) minute intervals.

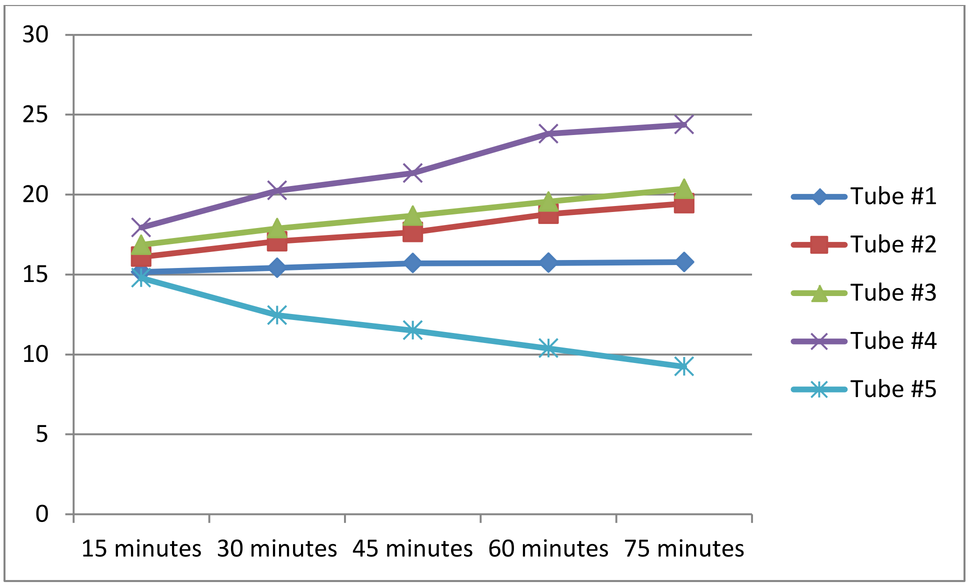
- **Methods for Diffusion portion of experiment.**
    1. A petri dish prepared with agar gel was placed on top of a ruler. The gel was translucent enough so that measurements can be made.
    2. Using the forceps, (1) crystal of potassium permanganate, and (1) crystal of methylene blue was placed on the gel of the petri dish, approximately (4) centimeters apart. The timer was immediately set for (15) minutes.
    3. After 15 minutes from the time the crystals were first placed, a measurement was taken in millimeters, again using the ruler that lie underneath the petri dish. Each crystal was measured to see how far its colored dye diffused, or spread, into the gel.
    4. These measurements, after 15 minute intervals, continued for (60) minutes, obtaining (4) measurements for each crystal.

Results

<u>Osmosis Table</u> – Weight of Dialysis tubes in grams by time in minutes.

	Tube #1	Tube #2	Tube #3	Tube #4	Tube #5
15 minutes	15.15	16.10	16.85	17.94	14.78
30 minutes	15.41	17.07	17.89	20.25	12.45
45 minutes	15.70	17.64	18.68	21.34	11.50
60 minutes	15.72	18.79	19.56	23.80	10.38
75 minutes	15.77	19.45	20.36	24.37	9.24

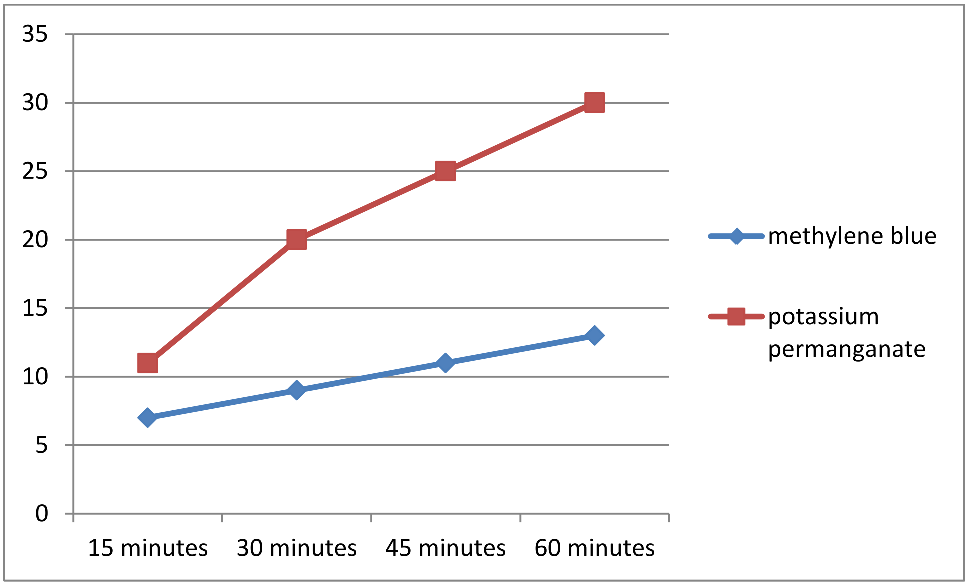
<u>Osmosis Chart</u> – Shows change in weight of tubes in grams over 75 minutes.



Diffusion Table – Distance of crystal dye diffusion in millimeters by time in minutes.

	15 minutes	30 minutes	45 minutes	60 minutes
methylene blue	7mm	9mm	11mm	13mm
potassium permanganate	11mm	20mm	25mm	30mm

Diffusion Chart – Shows fluctuations in distance of diffusion in millimeters over 60 minutes



Discussion

- **Analysis**
  In the Diffusion experiment, the results have indicated that both crystals will diffuse in the petri dish's agar gel. The potassium permanganate has been shown to diffuse more so than the methylene blue in the given time period. When taking into consideration the variables of diffusion, it is not likely that temperature played a role, as both samples were at the same temperature. A variable that can be considered is the size of the molecules, with the methylene blue being larger and having a higher molecular weight, therefore dispersing slower and with more friction.

  In the Osmosis experiment, the results have indicated that when a dialysis tube with a solute inside is placed in a beaker of just water (therefore a hypotonic solution), the water will move through the selectively permeable membrane of the dialysis tube, causing the tube to gain mass and expand. None of the examples burst, or lysed, due in part to the structural integrity of the dialysis tubes, and the limited time the experiment was performed. In the example where a dialysis tube containing only water is placed in a hypertonic solution that contains a solute, the water will travel out through the membrane into the solution that contains the solvent, causing the tube to lose mass and crenate, or shrink and shrivel. The tubes with a higher percentage of solute took in water at a faster rate than the tubes with a lower percentage. The one beaker where both the solvent and the contents of the tube was water, exhibited only minor fluctuations due to an isotonic state, or equilibrium.

The results do appear valid and consistent with scientific expectations.

- **Interpretation**
  The Osmosis and Diffusion experiments have shown how some basic principles of passive transport work, and how it might be applied to begin further understanding the concept in biological cells. One ambiguity that exists is the question of how selectively permeable the membrane of the dialysis tube was. Did it block all of the sucrose, or just make it difficult? Another factor would be that tap water was used, which is not likely to be pure water. How did its solutes, one of which was likely fluoride, affect the results?

Citations

Human Anatomy and Physiology I Supplemental Laboratory Materials (2011). Youngwood, PA: W.C.C.C.