Ryan Nguyen and Timmy Leisenring – Osmosis and Diffusion Lab – AP Bio Pd. 1

I. Introduction

Osmosis is the movement of water molecules across a semi-permeable membrane from areas of higher water concentrations (low solute concentrations) to areas of lower water concentrations (higher solute concentrations). The flow of water will reach equilibrium when flow from both areas become equal. This process is extremely important to biological functions and regulated by the osmoregulatory system. The system maintains a constant water equilibrium due to different hormones released by different parts of the body. Concentrations of solutes are also maintained as well. Ions, salts, and urea are controlled partially by water. Water concentrations around cells can be described by tonicity. Hypotonic describes environments less concentrated with solute compared to the cell's inner environment. Water will move into cells that are in hypotonic solutions. Hypertonic solutions describe environments that are more heavily concentrated with solutes as compared to within the cells. Water will move out from the cell at higher rates. Isotonic solutions are environments where both outside and inside the cells have the same solute concentration. This leads to no net movement of water into or out of the cell. It is quite dangerous for cells to be in hypotonic or hypertonic environments because cells can shrink or burst due to water concentrations.

The first experiment done tested the relationship between passive transport diffusion and surface area. This was tested by creating different sized agar blocks with different volumes infused with sodium hydroxide and phenolphthalein (a pH indicator) and submerging each block into sodium hydroxide and seeing how the mass and appearance changed. Sodium hydroxide is a base used in soaps, textiles and detergents. Hydrochloric acid was also used in this experiment. It is a strong acid that has corrosive effects in high concentrations. Two sets of three blocks were tested, one in the sodium hydroxide and one in the hydrochloric acid. The main piece of data measured for hydrochloric acid was the change in color of the cubes after a set amount of time. The measurement for the sodium hydroxide was the change in mass. Both sets compared surface area to volume. The only difference is the method of measurement. The hypothesis for this lab experiment was that surface area will affect diffusion rates of all three block volumes in both kinds of solutions of sodium hydroxide and hydrochloric acid.

A second experiment was done to determine the concentrations of a sucrose solution that was "mislabeled" within a lab. Six different solutions were died with different colors and placed into dialysis tubing for diffusion. The tubes were submerged in water and massed after a certain amount of time. The change in mass would allow interpretation for the amount of solute within a specific colored container. The control in this test was a dialysis tube filled simply with water. Dialysis tubing is a semi-pearmeable membrane that allows movement of some molecules like water, but not other molecules. Bigger molecules usually aren't able to move past the tubing. The objective of this lab was to determine the mystery concentrations in each colored solution.

II. Materials and Procedures

Materials

- Two 1x1x1 cm cubes of 2% agar containing sodium hydroxide and phenolphthalein
- Two 2x2x2 cm cubes of 2% agar containing sodium hydroxide and phenolphthalein
- Two 3x3x3 cm cubes of 2% agar containing sodium hydroxide and phenolphthalein
- Scale (measuring in grams)
- Weigh boat
- Timer
- 3 beakers containing 0.1 Molar concentration sodium hydroxide
- 3 beakers containing 0.1 Molar concentration hydrochloric acid
- Seven dialysis tubes
- Purple, orange, blue, yellow and green sucrose solutions of varying concentrations
- Water

Agar Blocks Procedure

1. Two sets of 1x1x1 cm, 2x2x2 cm and 3x3x3 cm cubes of 2% agar containing sodium hydroxide and phenolphthalein were made.
2. One set of cubes was massed. This set corresponded to set 2, the sodium hydroxide set.
3. All 3 agar cubes of set 1 were submerged, one each, in a beaker containing the hydrochloric acid solution for 4 hours.
4. Simultaneously, the 3 cubes of set 2 were submerged, one each, in a beaker containing the sodium hydroxide.
5. After 4 hours, the set 1 cubes were removed and cut in half and the depth of diffusion was measured.
6. The set 2 cubes were simultaneously removed and their final masses were taken

Dialysis Tubing Procedure

1. Seven dialysis tubes were opened and tied at one end so liquid could not escape.
2. Each tube was filled with 20 mL of purple, orange, blue, yellow and green sucrose solutions along with water as a control.
3. All of the tubes were then tied off on the open end so no liquid could escape.
4. All seven tube were massed for an initial reading.
5. The tubes were all submerged in a large beaker of water.
6. Over the course of 3 time increments of 45 minutes, each tube was then massed again, making sure to wipe away any excess liquid.
7. At the conclusion of the lab, each solution's mass was analyzed in comparison to its initial mass.

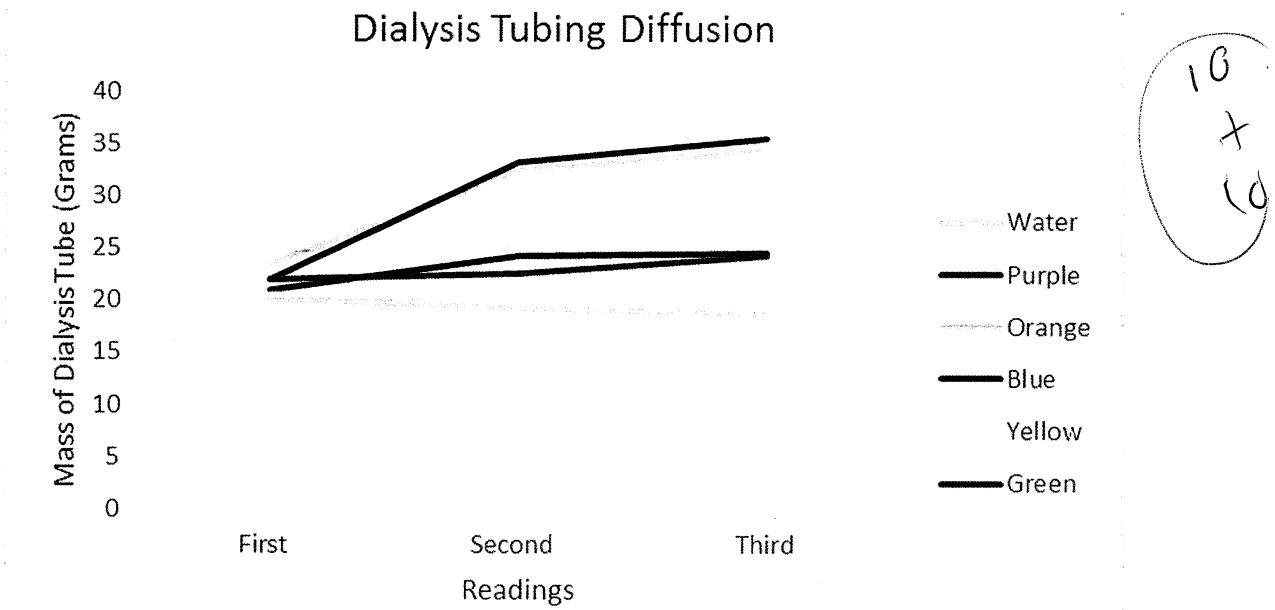
III. Results

Agar Blocks (HCl diffusion)

	1x1x1 Cube	2x2x2 Cube	3x3x3 Cube
Volume (cm^3)	1	8	27
Surface Area (cm^2)	6	24	54
Surface Area to Volume Ratio (SA/V)	6:1	3:1	2:1
Depth of HCl Diffusion from outer edge (cm)	0.6	0.6	0.6
Total Amount of Agar with HCl Diffusion after 4 hours (cm^3)	1	6	16
Percent of Agar Cube with Diffusion after 4 hours	100%	75%	59.26%

Agar Blocks (Sodium Hydroxide)

	1x1x1 Cube	2x2x2 Cube	3x3 Cube
Volume (cm^3)	1	8	27
Surface Area (cm^2)	6	24	54
Surface Area to Volume Ratio (SA/V)	6:1	3:1	2:1
Original Mass (g)	5.21	7.03	9.14
Final Mass after 4 hours (g)	6.31	7.87	9.52
Percent Change in Mass	21.11%	11.95%	4.16%



Color	Concentration

Water	0 M
Yellow	0.2 M
Green	0.4 M
Purple	0.6 M
Orange	0.8 M
Blue	1.0 M

IV. Conclusions

Based off of the data collected from the agar blocks lab, the hypothesis for the lab can be accepted. It appears that surface area and volume ratios do affect the rate of diffusion of water into the agar blocks. This can be seen by the tables represented. It appears that the block with the highest surface area to volume ratio (6:1) had the highest diffusion rate with 100% HCl diffusion after 4 hours. The second highest diffusion rate was with the block with the second highest surface area to volume ratio (3:1). That rate was 75% diffusion in 4 hours. The slowest diffusion rate was the block with the smallest surface area to volume ratio (2:1). That block only had a diffusion rate of 59.26% in 4 hours. The hypothesis is also supported by the sodium hydroxide diffusion set of agar blocks. The highest percent change in mass lay with the block with the highest surface area to volume ratio. Correspondingly, the percent changes were 21.11%, 11.95%, and 4.16% to 6:1, 3:1 and 2:1 ratios. It can be concluded then that the higher the surface area to volume ratios, the higher the diffusion rates. Therefore the lower the surface area to volume ratios, the lower the diffusion rates.

The second lab experiment results is shown in the graph. The readings show a general trend in which the higher the reading number, which means the longer that time has passed, the higher the mass of the dialysis tube. Thus means that there was a net positive flow of water into the tube. Accordingly then, the higher up the lines of data, the higher amount of mass. This also means that there was a higher concentration of solutes within the bags as well since water always moves down its concentration gradient. Therefore, concentrations of the solutions can be determined. They are shown in the above table. Water was the control.

Errors were present in data collection through the inaccuracy of scale readings, inaccuracy of measuring only the water in the tubes, inaccuracy of measuring the agar blocks especially when the cuts were not fully straight, and a few minutes in time variation for data collection. However, these small variations would not have had a major effect on the conclusion. To further this study, diffusion can be measured using different acids for the cubes, and using different and smaller solutions for the dialysis tube experiment.