**An investigation Into Osmosis and Diffusion**

Alex Yeoh

**Introduction**

This report explores the relative sizes of atoms and the relative concentrations of atoms in the membranes of living cells through the use of osmosis and diffusion. In this report, diffusion will be understood as the process of particles traveling down a concentration gradient from higher concentration to a lower concentration, and osmosis as the process of diffusion with the particles specifically being water molecules (Krane, 2019). The processes of osmosis and diffusion are vital for the maintenance of homeostasis in all forms of life. One use is the maintenance of the sodium-potassium pump in humans and animals which allow for nerve signals to be transmitted (Goodsell, 2009).

In this experiment, we tested the diffusion of potassium and iodine ions across a semi-permeable membrane and osmosis of cylinders of potato in hypertonic and hypotonic solutions. For the diffusion of potassium and iodine ions across a semi-permeable membrane, we will be placing starch into a dialysis tube and placing said tube into a sodium-potassium solution (Krane, 2019). For the osmosis of cylinders of potato in hypertonic and hypotonic solutions, we will be cutting out cylinders of potato and placing them into test tubes containing various concentrations of glucose solution (Krane, 2019). The hypotheses are if starch is placed in a dialysis tube that is placed in a potassium iodide solution then the starch will turn purple as the potassium iodide ions pass through the dialysis tube because the pores in the plastic are not large enough for large molecules like sugars and starches to pass but large enough for atoms to pass, and if cylinders of potato are placed into a solution of less than 0.3 molar then water would enter the cells and have a positive percent change, if they are placed in a 0.3 molar solution then the weight would not change and have a zero percent change, and if they are placed in a solution of greater than 0.3 molar then water will leave the cells and have a negative percent change.

**Methods**

The experiments were conducted following the procedures on pages 38-40 of the Bio 1120 laboratory manual (Krane, 2019) with some changes to the procedure. On step one of the procedures on page 38 all the preparations were done by the graduate teaching assistant (GTA) and the GTA doing parts 1-5 on step one. On step two of the procedures on pages 38 and 39, we worked in a group of three and otherwise followed the procedures as stated.

**Results**

Table 1. Change in weight of potato samples exposed to different concentrations of glucose solution

|  |  |  |  |
| --- | --- | --- | --- |
| Glucose (M) | Initial Weight(g)/Time | Final Weight/Time | Percent Change |
| 0 | 1.45 | 1.6 | 10.34 |
| 0.2 | 1.35 | 1.4 | 3.70 |
| 0.3 | 1.36 | 1.4 | 2.94 |
| 0.4 | 1.45 | 1.4 | -3.45 |
| 0.5 | 1.29 | 1.2 | -6.98 |
| 0.6 | 1.50 | 1.4 | -6.67 |
| 0.8 | 1.58 | 1.4 | -11.39 |

Figure 1. The figure above is a bar graph of the percent change of mass of the potato samples in different solutions of varying glucose concentration. The graph shows a general decrease of percent change of mass as the solution’s glucose concentration increases.

**Conclusion**

For step one of the experiment, the starch in the dialysis bag turned purple, meaning that the potassium iodide diffused through the dialysis bag and interacted with the starch inside. The results confirm my hypothesis as the starch turned purple as the hypothesis had predicted. The results also match literature as the literature predicted the ions to diffuse through the dialysis tube and turn the starch purple (Krane, 2019). My results also make sense based on what the laboratory manual says about osmosis and diffusion as the water and starch molecules could not diffuse past the dialysis tube, but the potassium and iodine ions could diffuse past the dialysis tube.

Some limitations to step one of the experiment are that the amount of potassium iodide solution was not measured out making it unclear if or how much the amount of potassium iodide solution would impact the results. A possible source of error is when the GTA was adding cornstarch solution to the dialysis tube they spilt it and decided to not measure the 20mL, instead opting to simply fill the dialysis tube with cornstarch solution. An improvement to step one of the experiment is that we could have used multiple beakers with differing amounts of potassium iodide solution to learn if the amount of potassium iodide would impact the outcome.

For step two of the experiment, the percent change of mass of the potatoes generally decreased as the glucose concentration of the solution it was submerged in increases as seen on figure 1. The results mostly confirm my hypothesis as the solutions of a lower concentration than 0.3 molar did gain weight and have a positive percent change, and the solutions of a higher concentration than 0.3 molar did have a negative percent change. However, at 0.3 molar the potato sample also had a positive percent change. My results make sense based off the literature as literature says that potatoes were isotonic in a solution of 11.5% sucrose which converts to a molarity of 0.34 (Hewitson, n.d.). My results also make sense based on what the laboratory manual says about osmosis and diffusion as the water always diffused from a higher concentration to a lower one, without regard to the concentrations being the potato cell or the environment.

A limitation of step two of the experiment is the temperature at which we conducted the step as the temperature could have an impact on where the isotonic point would be for a potato. Another limitation is that we only conducted the step with plant tissue, we could have done the experiment with animal cells. A possible source of error is the test tubes not being completely dry when I filled them with glucose solution, causing the actual solution to be more diluted than expected causing the potatoes to have a greater percent change in weight than they otherwise would have. This step of the experiment could be made better by repeating the entire step at different temperatures to discover the impact of temperature on osmosis and diffusion, but I doubt that it would change our results as particles would still travel from a higher concentration to a lower one, the only difference being higher temperatures causing the results to finalize sooner, and cooler temperatures causing the results to finalize later. Another way to make the experiment better is to have experimented with both plant and animal cells to learn of any differences that animal cells might have made, but I predict that animal cells would swell more and gain more weight than plant cells did because plant cells are limited by the turgor pressure exerted by their cell walls (Krane, 2019). Based on these findings, it is reasonable to believe that these concepts are used in the medical field, and they are in fact used in technology like the intravenous therapy drips; and based on these findings, it is likely that they use a solution that is isotonic to red blood cells because if the solution was hypertonic water would leave the cell killing it in the process, and if the solution were hypotonic it would cause water to swell into the cell rupturing it and killing the cell in the process.

**References**

Goodsell, D. (2009, October). PDB101: Molecule of the Month: Sodium-Potassium Pump. Retrieved from https://pdb101.rcsb.org/motm/118

Hewitson, J. (n.d.). What is the concentration of sucrose in potato cells? Retrieved from https://www.saps.org.uk/saps-associates/browse-q-and-a/431-what-is-the-concentration-of-sucrose-in-potato-cells

Krane, D. (2019). *Bio 1120: A Laboratory Perspective*. Cincinnati, OH: Van-Griner Publishing.