Introduction

I chose to focus my first personal inquiry on cells and cellular functions. Specifically, I investigated how elodea plant cells change when immersed in varying solutions. Osmosis is defined as the movement of water molecules from areas of high water concentration to low water concentration (OpenStax, 2013). It was therefore predicted that when elodea plant cells are immersed in a saline solution, water within the cells would leave the plant vacuole (where the concentration of water is higher) in order to bring the solution to equilibrium.

Osmosis and diffusion are concepts taught in most introductory biology classes. This coming fall, I will be teaching my first formal biology course and I am looking to re-vamp several of the labs used to demonstrate biological concepts. The "Elodea Osmosis Lab" serves not only to investigate the properties of osmosis and diffusion, but also provides additional hands-on experience with a microscope for students. I chose to complete this inquiry as a means to determine if the lab would be appropriate for college freshman and to iron-out methodology for the implementation into my lab curriculum.

Methods

Gathering materials and experimental preparation

A Leica BF 200 microscope containing three objective lenses (4x, 10x, and 40x) and necessary accessories including glass slides, coverslips, and lens paper were borrowed from a local high school teacher for use in this experiment. Elodea was purchased from a local aquarium store and kept in a vessel with supplied aquarium tank water at room temperature until beginning the experiment. Normal saline solution (0.9%) was prepared by dissolving 1 tsp of table salt (NaCl) into 8 oz. of tap water.

Slide preparation and observations

A single elodea leaf was removed from the plant and placed onto a clean glass slide. Several drops of aquarium tank water were added using a transfer pipette in order to submerge the leaf and then a cover slip was added, taking care to avoid air bubbles. The leaf was observed using both the low power (10x) and high power (40x) objectives and observations were documented by making sketches at each power. The process was then repeated using prepared saline solution.

Results

Elodea plant cells appeared as rectangular structures, similar to green bricks in a wall. Plant organelles including the cell wall, chloroplasts, and the central vacuole were visible using the microscope. Cells immersed in aquarium tank water displayed chloroplasts either around the inside edge of the plant cell, or dispersed within the cell. Some movement of chloroplasts was visible. Upon submerging cells in saline, chloroplasts in several cells appeared to clump together in the center of the cell; cell walls remained intact (Figure 1).

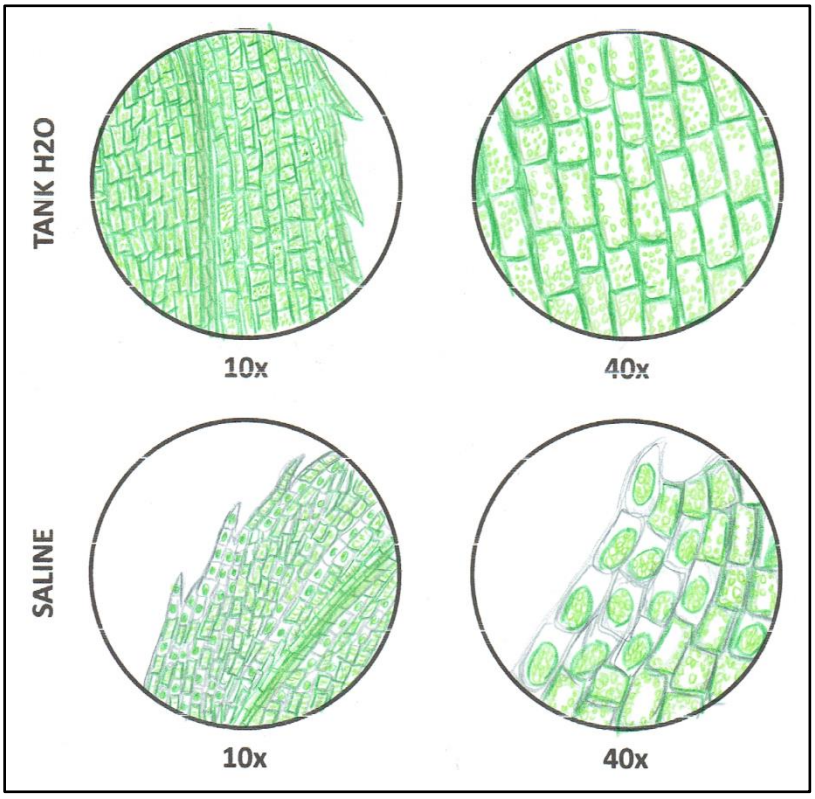

Figure 1. Sketches of Elodea cells in varying solutions

Discussion

I enjoyed completing this inquiry; it's been years since I've looked at anything under a microscope and this experiment helped me to re-familiarize myself with this important research tool. Using a basic light microscope, I was able to visualize living elodea plant cells as well as the impact that varying solutions have on cellular structures.

The 0.9% saline solution used to submerge the elodea cells is a hypertonic solution; as such, water from within the plant cell crossed the cell membrane in order to restore equilibrium per the mechanics of osmosis. Unlike an animal cell, the rigid plant cell wall does not allow the entire cell to shrink. The cell membrane pulls away from the wall however, constricting cell organelles to the center of the cell. This effect is called plasmolysis (OpenStax, 2013). Plasmolysis was directly observed in this experiment and was easily identifiable by viewing the chloroplasts only within the center of the cell. Interestingly, not all cells exhibited plasmolysis. This suggests that the concentration of water molecules in solution and the water molecules within the cells reached a state of equilibrium, or became isotonic, without all cells undergoing plasmolysis.

If I were to repeat this experiment again I would create a series of saline solutions with varying salt concentrations (1%, 3%, 5%) to use instead of using the saline solution I created for this inquiry. At some point, I would like for plasmolysis to be noticeable in every cell to ensure that all students are visualizing the effect. I could have easily have missed it using only the 0.9% saline if I wouldn't have done a thorough scan of the leaf under the low power objective. Using a concentration gradient also helps better demonstrate the mechanism of osmosis; as mentioned above, the number of cells that undergo plasmolysis is directly related to the concentration of solute. The higher the saline concentration, the more cells that will shrink as water leaves the cell to try to establish equilibrium. Other similar labs found only suggest that 5% saline is an adequate concentration to cause all cells to undergo plasmolysis ("Osmosis Demonstration Lab", n.d.).

Chloroplasts contain the predominant pigment in plants called chlorophyll. It was really interesting to observe how the color of the cell changed when the cells were immersed in saline. When the cells were in an isotonic state, the cell walls appeared to be dark green and the light green chloroplasts were dispersed throughout the cell. Upon undergoing plasmolysis, however, all chloroplasts (and thus chlorophyll) are pulled into the center of the plant cell. Cell walls appeared to lose all color, and looked like a gray shell. All green coloration moved to the center of the cell with the retracting cell membrane. This would suggest that no pigment is found in the cell wall, but the dark green coloration initially observed is housed in the membrane.

Conclusion

The course that I'll be teaching is the most introductory biology course offered in the department and students must pass my class before being able to declare as a biology major. I do believe that this lab would be appropriate as an introduction to osmosis and diffusion for these college freshman. It is a short lab with directions that are easy to follow and results that are easy to obtain. It will help reiterate osmosis and diffusion content matter while also prompting additional discussion about plant cells in general and providing additional hands-on opportunities with a microscope. I hope that they will enjoy the lab as much as I did, especially after I make a few modifications to the protocol.

Literature Cited

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