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Investigating Diffusion and Osmosis Through Nonliving Membranes

Introduction

Cells are the smallest unit of life in which living things are composed of either one or several thousand cells seen in plants, animals, and humans. Each of these cells is ringed around a type of shield which is called the cell's membrane. Each membrane is selectively permeable, which signifies that it is strong enough to separate the cell from anything around it. The cell membrane operates as a blockade that divorces the cytoplasm from the outside world. It consists of many details that make it work efficiently and ingeniously. Also, it is very decisive in regards to deciding whether something passes through or not. One of the most key facts about the cell membrane is that it consists of phospholipids. "Phospholipids are amphipathic with a polar head (phosphate group) and a hydrophobic tail (2 hydrocarbon chains)" (Alberts, Johnson, and Lewis 2002). Due to the chemical properties of the heads being attracted to water and the tails having a desire to avoid water, phospholipids self-assemble into micelles. "Cell membranes form from a phospholipid bilayer where the lipid tails interact with each other and the phosphate heads face the external water environment or the internal cytoplasm of the cell." ("4.1: Introduction - Biology LibreTexts") This means that these phospholipids can accomplish both dissolving's in water and not dissolve in water. Through them, we have the plasma membrane.

The plasma membrane acts as an intellectual barrier. It is an intellectual barrier because it will brilliantly choose what will enter the cell and what is not able to exit. It is extremely hard for polar, charged, or large molecules to journey through the membrane. They would need the oxygen of transmembrane proteins to do so. Transmembrane proteins, (TP) is a membrane protein that expands the universality of the cell membrane. Its major function is to act as a highway, which permits or not to transport across different substances. An example of a transmembrane protein is a substance referred to as aquaporin (Bienert 2014). This substance is a polar covalent bond formed between two non-identical atoms. It forms between atoms when there is a difference in the electronegativities. This permits the free movement of water within the cell membrane. The next crucial step in learning efficiently the functioning of the cell membrane which is known as diffusion. Diffusion is the expansion of particles of a substance in a solution. Diffusion is relevant to the cell membrane because, for any molecule to transport from one region to the next, either in or out of the cell, it needs to cross the cell membrane.

Diffusion is the movement within the cell membrane. Through the diffusion of a liquid, comes osmosis. For osmosis to jumpstart, the cell membrane must thrive in water and be permeable but impermeable to a solute. While testing osmosis in something, we are testing something called the tonicity in something. Tonicity is how a solution affects the cell when the cell is placed there. There can be several outcomes of tonicity while testing an item or thing. For

example, the item can swell up and double, triple in size (often referred to in biology as hypotonic solutions), it can shrink than its normal mass (often referred to as hypertonic solutions), or it can stay exactly how it was at the beginning of the testing (which is often referred to as isotonic solutions). It all depends on the type of solute being given, the time it is mixed, and how mixed the cells and the fluid are or not. It is important to test for this because, for humans, our body heavily relies on osmosis (the transportation of water from one place to the other. Osmosis works in our body constantly to make sure the cells in our bodies are healthy and not in any danger.

Purpose:

The purpose of this lab is to determine the effect(s) of different solutions to sacs containing dissimilar materials. The three solutions that will be used are a sugar-water solution, distilled water, and saltwater solution. Based on the outcome of this procedure, it is to be concluded which of these three different solutions are identifiable as hypotonic, hypertonic, or isotonic.

Hypothesis:

For the first sac consisting of 20% glucose solution and distilled water surrounding the outside part of the sac, I hypothesize that the sac will increase in size because the water outside would penetrate through the membrane (sac) and into the cell. For the second sac that contains 40% glucose solution submerged into 40% glucose solution, my prediction is that it will remain the same because the exact type and amount of solution are found inside and outside, therefore the solution would not transport in or out the cell but rather stay in place. For sac #3 that contained 10% of NaCI solution submerged in distilled water, I excogitate the sac will inflate and increase in size, proving osmosis in action. Lastly, for sac #4 containing 40% sucrose solution and distilled water on the outside, I believe the same results will be expected just as sac #1, where there will be an increase in size because the distilled water successfully penetrated the membrane ultimately causing inflation.

Materials:

- 2 dialysis sacs containing 20 ml of 40% glucose solution
- 1 dialysis sac containing 20 ml of 10% NaCI solution
- 1 dialysis sac containing 20 ml of 40% sucrose solution
- 3 beakers ½ filled with distilled water
- 1 beaker ½ filled with 40% glucose solution
- Boiling water
- Benedict's solution (light blue color)
- Test tubes
- Small funnel
- Fine Twine
- 25-ml graduated cylinder
- Wax marking pencil

- Laboratory Balance
- Test tube rack

Procedure:

1. First, label all materials with wax marker pencil.

(All sacs label as 1A-4A and all beakers as 1B-4B)

2. Using a funnel, Fill each sac one at a time, as the following:

Sac 1A= fill with 20 ml of 20% of glucose solution

Sac 2B= fill with 20ml of 40% glucose solution

Sac 3C= fill with 20ml of 10% of NaCI solution

Sac 4D= fill with 20 ml of 40% of sucrose solution

3. Tie each sack with fine twine.
4. Weigh each sac with a laboratory balance to make sure everything is perfectly equipped; Record weight accordingly in the chart.
5. Fill each beaker ½ as the following:

Beaker 1B=½ of distilled water

Beaker 2B= ½ of 40% of glucose solution

Beaker 3B= ½ of distilled water

Beaker 4B= ½ of distilled water

6. Drop the sac into the appropriate beaker, making sure sac is completely covered by the beaker solution.
7. Allow all sacs to remain still in beakers for 45 minutes; Observe.
8. One by one, quickly, and carefully remove sac from beaker, blot sac dry and record final weight accordingly in the data chart.
9. Calculate the weight change (increase/decrease, by how much) for each sac.
10. After 45 minutes, boil a beaker of water; Obtain dropper bottles of Benedicts solution, silver nitrate solution, test tube rack, 4 test tubes, and a test tube holder.
11. Now we will test for sugar: Obtain sample (will show as colorless) and Benedicts Solution (will appear as light blue color) and mix. Only test #1,2, and 4
12. Place the test tube in the boiling water
13. Observe the color change (will appear yellow, green, or brown)
14. Write down your observations
15. Test #3 testing for NaCI
16. Write all observations and conclusions

Results/Data:

Quantitative Data:

Experimental Data on Diffusion and Osmosis Through Nonliving Membranes

Beaker	**Contents of sac**	**Initial weight**	**Final Weight**	**Weight change**	**Benedict's Test- Beaker Fluid**	**Benedict's Tests- sac fluid**	**NaCI Test for Sac #4A and Beaker #4**
Beaker 1 ½ filled with distilled water	Sac 1, 20 ml of 40% glucose solution	7.1gm	8.0 gm	Increased by 0.9g	Positive	Positive	N/A
Beaker 2 ½ filled with 40% glucose solution	Sac 2, 20 ml of 40% glucose solution	6.9 gm	6.9 gm	Stayed the Same	Positive	Positive	N/A
Beaker 3 ½ filled with distilled water	Sac 3, 20 ml of 10% NaCI solution	7.2 gm	7.8 gm	Increased by 0.6g	N/A	N/A	Sac #4A: Positive Beaker #4B: Positive
Beaker 4 ½ filled with distilled water	Sac 4, 20 ml of 40% sucrose solution	7.1 gm	8.0 gm	Increased by 0.9g	Negative	Positive	N/A

Qualitative Data:

Before inserting the sacs into the beakers, I took the data of the initial weight for each, meaning the weight they started with just by having their solution contained inside without any contact with the beakers. After 45 minutes of each sac being submerged into a beaker with their various solutions, I observed whether the sac changed in size, whether it be increasing, decreasing, or remaining the same. According to the data above, we have three cases of increment and 1 case that remained the same. For sac #1 and #4, there is an obvious increment of 0.9g which tells us that water moved into the sac through the action of osmosis. For sac #2, the observations captured were non-moving, the sac remained the same, (no increase, no decrease). This is because inside and outside the sac, were an equal amount of the same solution, nothing had to

transported because it was all the same. For sac #3, there was an increment of 0.6g. This is because there was movement into the sac of distilled water that went from very concentrated to low concentration, resulting in an inflation of the sac. After these observations, we can tell if the solution moved in but we cannot tell if the solution moved out, diffusing the beaker. Therefore, we had to test #1,2, and 4 for sugar in the beaker, and #3 for silver chloride. After taking a sample of the solution of the beaker (colorless) and mixing it with Benedict's Solution (light blue color), there will be change in color (yellow, green, or brown), if it does change color. If we see any of the colors previously mentioned, it tests positive for sugar (which beakers #1 and #2 tested positive) and if it does not, then it is negative (which is beaker #4). Testing for NaCI, the beaker, and the sac both tested positive for silver chloride.

Conclusion:

After the conducted experiment, my hypothesis is all correct concerning the inflation of the sac as well as the sac that remained the same. The independent variable was the four solutions (glucose, sucrose, distilled water, and NaCI). The dependent variable was the transformation of the sac (because if the sac increased, it is because it depended on the solution to go through by osmosis, it cannot do its job by itself.) Concluding this report, it is an affirmative declaration that sacs #1,3 and 4 were hypotonic because they caused the sack to swell, and sac #2 was isotonic because it showed no effects to the sac, therefore, remaining the same.