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Biology Lab

Diffusion Through A Membrane

Pd: A
**Title:** Diffusion Through a Membrane

**Introduction:** The “Diffusion Through A Membrane” Lab covered many topics dealing with diffusion, cells, and molecules. Diffusion is the movement of molecules from an area of greater concentration (where there is more of the molecule) to an area of lesser concentration (where there is less of that molecule). They will continue to do so, until the molecules have reached a state of equilibrium, meaning that both areas are balanced with the same amount of molecules. (1) Diffusion of molecules in cells occurs through a membrane, which is a layer between the cell wall and the contents of the cell containing pores. Cell membranes are selectively permeable, meaning that it allows some materials/molecules to pass through it, and others are not. (2) Whether molecules are able to pass through the membrane depends on the size of the molecules (smaller ones can, and larger ones cannot). Part 1 of the lab focused on this type of diffusion, and required us to create our own model cells (pouring starch and glucose in tied dialysis tubing), so we could test which substances would diffuse through a membrane (the ones with smaller molecules) and which ones couldn’t (and therefore, the larger molecules.) We tested which molecules diffused with starch indicator solution (called Lugol’s Iodine) and Glucose Indicator Strips. When starch indicator solution comes into contact with starch, it turns black, and when Glucose Strips turn green, it shows the liquid contains glucose. These tests would help us to figure out what had diffused where. For this investigation, I hypothesized that the cell would become amber colored, because the iodine solution would diffuse into it (I did not yet know that when Starch Indicator solution mixes with
starch the product turns black). I also predicted that the water outside the cell would get cloudy from some starch diffusing through (This was an incorrect prediction...see results for actual outcome). Osmosis, which was the main focus of the second part of the lab, is defined as “diffusion of water across a membrane.” It has to do with cells maintaining balance in the amount of water that is inside them, in order for them to properly function. In cells, water and solutes (which are dissolved substances that extract water from a cell) diffuse in and out of the cell to make sure there is an equal amount of water and solute on each side, so the cell will remain healthy. (3) A cell needs enough water so it doesn’t dehydrate, but at the same time, it needs solutes as well so it doesn’t swell and explode. In this part, we saw the effect of salt (a solute) on the cell and the amount of water in the cell, by looking at onion skin cells with distilled (pure) water and then salt solution water. Another part of this lab was chemical testing, which was discovering how indicator solutions work. This was done by a series of mixing tests in test tubes. We used indicator solutions to prove that when a substance mixes with its indicator solution, a reaction happens and will show a (color) change, alerting you of the presence of the tested substance. When an indicator solution is tested on a substance it is not meant for, no reaction will occur, proving that it is not the substance that matches with the indicator solution. In some cases, such as glucose, heat may be needed to initiate the reaction. All of the investigations and tests done in this lab made us able to visualize the basic principles of diffusion, and topics related to it, and therefore, we can now apply that knowledge to real-life procedures and situations.
**Materials:**

**Part 1**

- ✔ Dialysis Tubing
- ✔ Dental Floss
- ✔ (Benedict’s) Glucose Indicator Solution
- ✔ (Lugol’s) Starch Indicator Solution (containing Iodine)
- ✔ Test Tube Rack
- ✔ 7 Test Tubes
- ✔ Tap Water
- ✔ Concentrated Glucose Solution
- ✔ Starch Solution
- ✔ Droppers/Pipettes
- ✔ Beaker
- ✔ Test Tube Holder
- ✔ Hot Water Bath
- ✔ Paper Towels

**Part 2**

- ➢ Red Onion
- ➢ Scalpel/Knife
- ➢ Microscope
- ➢ Microscope Slide
- ➢ Cover Slips
Methods:

Part 1

Make a “Cell”

1) To make a cell, I took the dialysis tubing (20 cm) and ran it under warm water and rubbed it. This made the material open up and look like a tube.

2) I fastened the tube tightly closed (so it wouldn’t leak the contents I was about to put in) by folding one end up and tying it with the dental floss.

3) I poured Glucose Solution into the tube until it became about \( \frac{1}{4} \) full.

4) I poured Starch Solution into the tube until it became \( \frac{1}{2} \) full.

5) I sealed the tube by folding and tying it with dental floss just as I had done with the other end before.

6) I made sure the solutions in the tube were thoroughly mixed by shaking it gently.

7) I rinsed off the cell under running water to make sure there was no leftover residue from the poured solutions on the outside.

8) I placed my cell in a beaker and filled the beaker with water, just so it covered the cell.

9) I set the beaker aside for 20 minutes, to let the diffusion happen.

10) After 20 minutes, I looked at the beaker and observed the change in color (the cell turned black and the water stayed the same).
11) I tested the water for glucose by placing a Glucose Indicator strip in the water for a couple seconds. (The strip turned green, meaning the water tested positive for glucose.)

**Chemical Testing**

1) I got a test tube rack and placed 6 test tubes inside of it.

2) I placed 10 drops of Starch Indicator Solution in 3 of the test tubes. I then put 10 drops of Distilled Water in one, 10 drops of Starch in the next, and 10 drops of Glucose in the last.

3) I placed 10 drops of Glucose Indicator Solution in the other 3 test tubes. I then put 10 drops of Distilled Water in one, 10 drops of Starch in the next, and 10 drops of Glucose in the last.

4) For the 3 test tubes containing Starch Indicator Solution, I made sure they were mixed, and then observed them, and which one changed color. (The data table shows the results.)

5) For the 3 test tubes containing Glucose, I heated them in a hot water bath, and observed them, and which one changed color. (The data table shows the results.)

**Part 2**

**Osmosis**

1) I scraped off a very thin sliver of red onion skin with a scalpel.

2) I made a wet mount slide of the onion skin by putting the skin on a microscope slide, putting a drop of water on the skin on the slide, and then placing a cover slip on top of the slide.
3) I hooked up and turned on my microscope and observed the cells of the onion skin on low and then high power, and drew what I saw. (See Results.)

4) I added salt solution to the slide by placing a small piece of paper towel at the edge of the cover slip (to absorb the water) and adding a few drops of salt solution to the other edge side (to soak in the slide.).

5) I observed the cells again, on the same setting of my microscope, and drew what I saw. (See Results.)

6) I replaced the salt solution in the slide (using the same method as I did to put it in) with distilled water.

7) I observed the cells again, on the same microscope setting, and drew them again.

**Results:**

**Part 1**

**Make a “Cell”**
The preceding drawing shows exactly what changes occurred in my cell in Part 1, through a “Before and After” diagram. The beaker on the left is the Initial State and the one on the right is the Final State. The drawing shows what was put in and what yielded, as well as the color changes that occurred. As you can see, in the Initial State, the cell contained Glucose and Starch only, and was a cloudy whitish color. The water contained Starch Indicator Solution only, and the water was an amber color from it. In the Final state (after the diffusion), the cell contained Glucose, Starch, and Starch Indicator Solution, and the cell had turned black. The water now contained the Starch Indicator Solution, as well as Glucose, but the water still stayed an amber color.

The above drawing is similar to the first one, except it shows where the molecules of Starch, Glucose, and Starch Indicator Solution were located at the beginning and end of the experiment. As before, the left beaker is the Initial State, and the right one is the Final State. In the diagram, Starch is represented by “S”, Glucose by “G” and Starch
Indicator Solution by “I” (because it contains Iodine.) As you can see, in the beginning, the Starch and Glucose were only in the cell, and the Starch Indicator Solution only in the water. By the end, the Starch still remained only in the cell (because its molecules were too large to diffuse through the membrane), but the Glucose and the Starch Indicator Solution had diffused through the membrane, and were balanced and mixed throughout the water and cell.

**Chemical Test Results**

<table>
<thead>
<tr>
<th>Indicator Solution</th>
<th>Material Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Used</strong></td>
<td><strong>Distilled Water</strong></td>
</tr>
<tr>
<td>Blue-colored</td>
<td>Blue (no change)</td>
</tr>
<tr>
<td>Glucose Indicator</td>
<td></td>
</tr>
<tr>
<td>Solution</td>
<td></td>
</tr>
<tr>
<td>Amber-colored</td>
<td>Dark Amber/Brown</td>
</tr>
<tr>
<td>Starch Indicator</td>
<td>(no change)</td>
</tr>
<tr>
<td>Solution</td>
<td></td>
</tr>
</tbody>
</table>

This Data Table shows the Results of the Chemical Test I performed with the Indicator Solutions. The left column contains the two indicator solutions and the right area shows what the color result was for each Indicator Solution with Distilled Water, Starch, and Glucose. As you can see, when both indicator solutions were mixed with the water, no change occurred. When the starch mixed with the starch indicator solution, a major change occurred--it turned blackish blue. And when the glucose mixed with the
glucose indicator solution, and was heated, it turned bright orange. This is because any indicator solution will only react with its own substance, so any other substance that is tested with it will not produce results, and that it the purpose of indicator solutions—to be able to identify whether a substance is the indicated solution substance or not.

Part 2

Osmosis

The drawings above depict what happened during the osmosis in an onion cell experiment. They are the illustrations of what I saw through the microscope in the three different trials. In all three of the drawings, the cell walls, cell membranes, and cytoplasm are labeled. The one on the left is the original, in which water was in the wet mound slide. As you can see, there is little space between the cell wall and membrane, and this is because the cell had a lot of water in it, making the inside large. The middle picture is the view after I put the salt solution in the slide, removing the water. The result of this, as it
can be seen, was that the cell membrane significantly shrunk, making the inside of the cell with the cytoplasm very small. This is because when the salt diffused in, the water diffused out. The drawing on the right shows what happened when I then replaced the salt solution with distilled water. This produced basically the identical view as the original, since it was back to being mainly water again, with the cell wall and membrane very close to each other. This happened because once the water was put back in, the salt diffused out.

**Discussion:**

This lab explained and visualized various different aspects of diffusion and osmosis, as well as chemical testing. With the cell experiment, because the iodine starch indicator solution had greater concentration on the outside (water), in order to balance out, it diffused into the cell, making the cell a black color, because the starch reacted with its indicator solution. On the other hand, the glucose originally had greater concentration on the inside of the cell, and diffused out to create a state of equilibrium. The glucose indicator strip test proved this by the strip turning green, which means the water tested positive for glucose. Since the water did not turn black at all, it means that no starch was able to diffuse out. The reason that the starch indicator solution and the glucose were able to diffuse through the membrane and the starch was not, is that starch is a polymer, which means its molecules are large, and glucose and the iodine starch indicator solution are monomers, meaning that their molecules are smaller. This lab clearly showed that the monomers were able to diffuse through the membrane pores because of their small size,
while the polymer was just too large. This concept explains why in many animals, it is necessary that starch digest into glucose for transport in the blood, because the glucose will be able to pass through membranes that the starch could not. If the cell experiment had been done backwards, and the starch indicator solution was put in the cell, and the starch and glucose had been put in the water, the exact opposite results would have occurred—the water would have been black and not the cell. The whole section about chemical testing proved that when a substance mixes with its indicator solution, a reaction will occur and cause a color change. The indicator solution will ONLY work with the substance it is meant for, and will not react at all if that substance isn’t present. These tests are extremely useful when trying to identify mystery ingredients as well as proving what a substance is. The heat test was very important for the glucose and glucose indicator reaction. A way to prove that it is the mixing of the two that creates the bright orange color, would be to do the heat test on glucose alone, and then the heat test on glucose indicator solution alone, and that would not produce any results proving that it is only when they join that the reaction happens. Part 2 of the lab, which was all about osmosis, demonstrated the principle that salt and water make each other diffuse out when the other is present. This was precisely proved when the walls and membranes shrunk away from each other after the salt was added in, and when the water was added back/diffused in, they went back to the original state of being tightly close to each other. This concept of osmosis would account for why organisms can be harmed on heavily salted roadways in the winter, because the organisms’ cells would shrink, and therefore they would dehydrate. Also, osmosis explains why patients in hospitals are treated with I.V. medicines that contain a saline solution, and not distilled water, because the salt in
the saline solution keeps balance of about 2% salt, instead of all water, which would make the cells seriously swell and even cause them to rupture. Osmosis also plays an important role in the lives of fresh-water organisms. Since their contractile vacuoles collect excess water, there is a need for osmosis to keep the water flowing through. If these organisms were to suddenly be moved to the ocean (in salt water) their contractile vacuoles would be almost useless because they wouldn’t hold much from being so shrunken by the salt water, and therefore no excess water would be removed, which needs to happen for them to survive properly. Another real-life situation that can be explained by osmosis is why popcorn makes people thirsty. This occurs because the large amounts of salt in the popcorn diffuses and eliminates the water out of our bodies’ cells, making the body feel the need to replenish it, and that is why you drink a lot. All my tests in this lab went smoothly without any confusion or problems, giving me all accurate results, so I would say it was an extremely well designed lab. The only thing that was a little vague at first was the directions for the test tube part, and they possibly could’ve been written out clearer, but it wasn’t that hard to figure out and the rest of the lab was wonderful. For the cell part, my hypothesis was partially correct and partially incorrect. I predicted that the iodine starch indicator solution would diffuse into the cell, which was accurate, but I guess the color result wrong, and the result was black not amber. I also inaccurately predicted that the starch would diffuse out, making the water cloudy, which did not happen, but at least I know why it didn’t now—the molecules were too big. All the tests and investigations from this lab taught basic concepts which will be able to be applied to many situations in the environment as well as our own lives.
Bibliography

(1) http://www.biologycorner.com/bio1/diffusion.html

(2) http://www.biology-online.org/1/1_cell.htm

(3) Lab sheets

Pictures From:

