GCC CHM 130LL Osmosis and Dialysis

Purpose:

The purpose of this experiment is to observe the closely related phenomena of osmosis and diffusion as it relates to dialysis. It is hoped that you will be able to explain your observations in terms of the movement of solvent particles. You will also learn terminology related to osmosis.

Background:

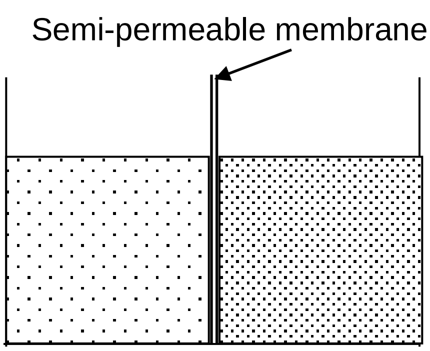
Solutions are mixtures of a **solvent** (usually water) and a **solute** (the substance dissolved in the solvent). In sugar-water, the water is the solvent and the sugar is the solute. The term **concentration** refers to the relative amount of each substance present. If you make a sugar-water solution with a lot of water and just a small amount of sugar, the solute concentration is low or dilute. If you make sugar water with lots of sugar the solute concentration is concentrated or high.

To understand osmosis, we must focus on the behavior of the solvent, not the solute.

Semipermeable membranes allow molecules of the solvent to pass through, but not the solute particles. In fact, the solvent molecules will pass through the membrane until the concentration is the same on both sides of the membrane. This will increase the pressure in the solution that receives the extra solvent molecules. This extra pressure is called osmotic pressure. Living cells may swell or burst if there is extra pressure inside them. If there is extra pressure on the outside, living cells may shrivel up and die.

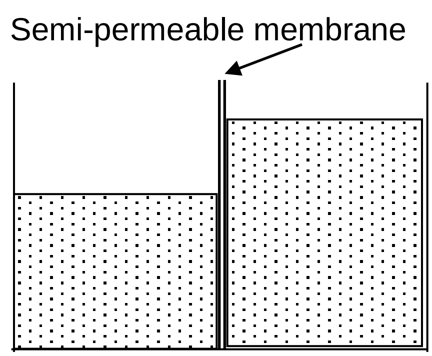
In the diagrams below, the dots represent sugar molecules. **Solvent flows from low to high solute concentration.** This membrane is a rigid one, so the increased pressure on the side that receives the solvent molecules causes the liquid level to rise. In this example, the left side is low concentration, so the solvent water molecules flow from the left to the right side until they are equal concentrations.

Before osmosis



lower concentration   higher concentration

After osmosis



Now they are equal concentrations but the right side has osmotic pressure

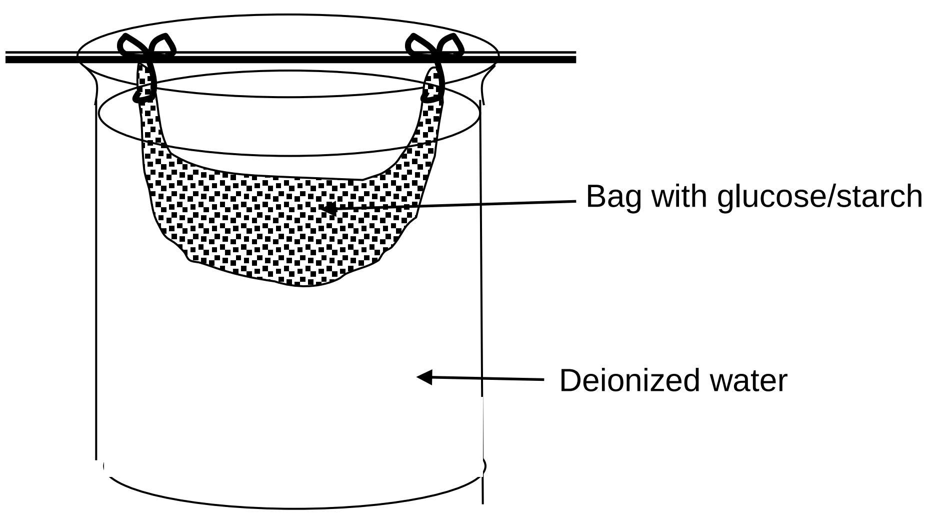
Remember the concentrated side must be diluted, so water flows into it. Solvent flows into the concentrated side.

Living Cells in our Bodies: Living cells immersed in a solution of different concentration can have solvent flow into or out of the cell. A **hypertonic** solution has a greater concentration than a cell. A **hypotonic** solution has a smaller concentration than a cell. An **isotonic** solution has the same concentration as a cell.

When water flows out of a cell the cell shrinks and becomes wrinkled which is called **crenation**. To avoid crenation salt-water fish constantly drink water and excrete the salt. When water flows into a cell until it becomes swollen or even bursts we call it **cytolysis**. Freshwater fish constantly urinate to prevent swelling or cytolysis. Dialysis tubing is a special type of semi-permeable membrane. It allows the solvent molecules and **some very small** solute particles to pass through. It does stop larger solute particles.

Part A. Dialysis Procedure:

1. Measure 10 mL of glucose solution using the graduated cylinder then pour into a small 50 mL beaker. Now measure 10 mL of starch solution and pour into the same 50 mL beaker. Mix briefly with a stirring rod.
2. Using forceps obtain a piece of soaked dialysis tubing from the supply beaker and put in your 250 mL beaker. (**Be sure not to touch the middle part of the tubing with your fingers; hold it only by the ends**.) **Carefully pry open one end and hold it open during the next step.**
3. Cut two pieces of string about 6 inches long each. Use string to **tightly** tie off the other end (unopened end) of the tubing. Tie this knotted end of the tubing to the end of a stick.
4. Insert the funnel into the open end of the dialysis tubing. **Slowly** pour the glucose/starch solution from the beaker through the funnel into the open end of the dialysis tubing. Remove the funnel and tie this end of the bag with a second piece of string. Tie this second end of the tubing to the opposite end of the stick.
5. Weigh the stick and bag filled with solution. Do this by "zeroing" a plastic weigh cup or beaker and then carefully placing the bag in the cup or in the beaker and then re-weigh. Record all the #'s as the initial mass.
6. Fill the 250-mL beaker ¾ full with deionized water. Submerge the **middle** of the glucose/starch bag in the water, making sure that the two tied ends and string are not in the water (see diagram below).
7. Let the apparatus sit undisturbed for approximately 60 minutes. **Do not discard the solution in the bag or the solution in the beaker**. You will analyze them BOTH later. Begin part B now.



8. SAVE the 250 mL beaker filled with solution. Weigh the stick and dialysis bag filled with solution like you did in step 5. Record all the numbers as the final mass.

Analysis of Solutions after Dialysis

You will test both the solution inside the bag and the solution in the beaker for two chemicals: starch and glucose. The glucose concentration can be estimated using a Chemstrip. The presence of starch makes use of the fact that dilute iodine solution is usually yellowish-orange brown, but in the presence of starch it turns blue or purple.

Analysis Procedure

1. Obtain 4 test tubes and label them A, B, C, and D.

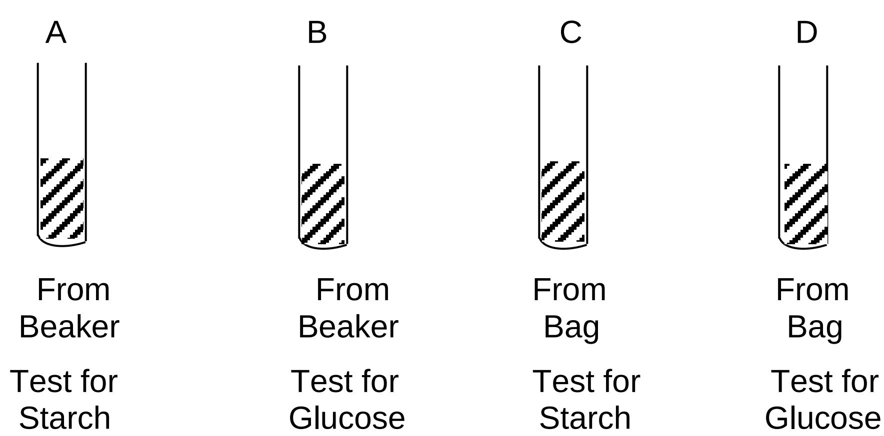
2. Remove solution from the beaker with a disposable pipette and add it to test tube A until 1/3 full. Repeat for test tube B.

3. Untie one end of the dialysis bag. Using another disposable pipet, remove solution from the bag and place it in test tube C until 1/3 full. Place some in test tube D until 1/3 full.

Note: *Some people are extremely sensitive to iodine (shellfish allergy). The solution you will use is very dilute, but if the fumes bother you use it in the hood. If you are allergic to shellfish, don't touch.*

4. Add 5 drops of Lugol's iodine solution to test tube A. Repeat for test tube C. Gently swirl the tubes, and observe and record any color change or other changes that occur. (Remember that yellow-brown means no starch and bluish-black indicates starch is present.) Record your results in the table on the report sheet. Pour these test tubes in the WASTE JAR then rinse them well.

5. Dip a Chemstrip in and out of test tube B, wait 2 minutes then read and record your results. Using a new Chemstrip, repeat for test tube D. Look at the bottle for your results. (Note that Chemstrips are used to determine the concentration of glucose in urine.)



Waste handling: Pour tubes A and C in the iodine waste container. Other solutions can be poured down the drain. Discard Chemstrips, dialysis bags, and potatoes in the regular trash.

Part B. Osmosis Procedure:

1. Obtain three 150-mL beakers, and label them 1, 2, and 3.
2. Using a cork borer or a knife cut three similarly sized pieces of potato.
3. Use an analytical balance to obtain the initial mass of each piece of potato. Do this by "zeroing out" each beaker (so the balance reads zero grams with the beaker on it.) Now weigh the pieces of potato in them. Remember to record ALL the numbers of the balance display.
4. Cover each potato piece with the appropriate liquid
   - Beaker #1: deionized water
   - Beaker #2: syrup
   - Beaker #3: salt water
5. **STOP! Let the tubing and potatoes soak now undisturbed**. Answer follow up questions # 6-12 on your lab report while waiting.
6. After at least 40 minutes have passed, remove the potatoes from the beaker, and dry them surfaces by lightly squeezing them in a paper towel. Keep track of which is 1, 2, and 3. Use a weighing cup to reweigh the pieces. Dry and clean off the cup each time. Remember to zero out the cup first then weigh the potato. Clean all your beakers.

***Waste handling**: Pour the distilled water, salt solution and syrup down the drain. Place the potato pieces in the regular trash. Dry off your weighing cup for reuse*

7. Calculate the percent change in the mass of each potato using the formula:

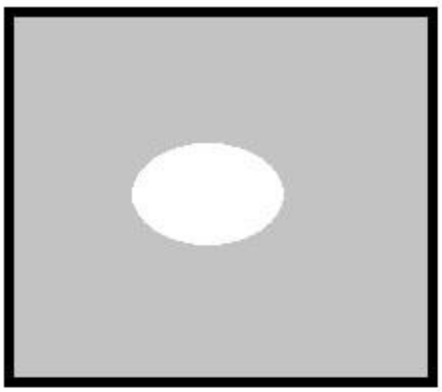
$$\% \text{ change in mass} = \frac{(\text{final mass} - \text{initial mass})}{\text{initial mass}} \times 100$$

8. Note that this percent may be positive or negative. Positive change if it gains weight and negative change if it loses weight. Pay attention to sig figs (you are subtracting)
9. For each potato piece, describe what caused the change in mass based on the initial concentration inside and outside the potato. In other words identify the high and low concentrations (solution or potatoes) and tell me exactly where solvent flowed to and from.
10. Answer all the potato questions now. Finish everything you can before you go back and finish part A. Removing the dialysis bag should be the last thing you do.

GCC CHM 130LL Report Name: ______________________________

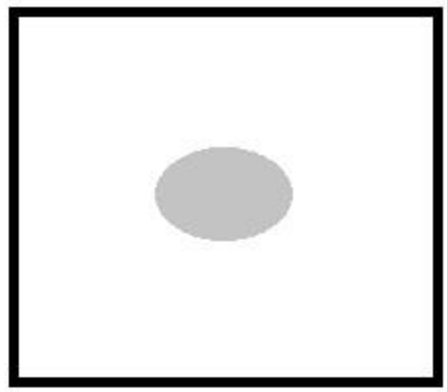
Osmosis and Dialysis Partners: _________________and _________________

Circle the correct terms for these two pictures of a cell in solution. Gray represents more concentrated solution than white. Remember solvent flows from low to high concentration. Draw an arrow in each box indicating if solvent is flowing into or out of the cell.



hypertonic or hypotonic

crenation or cytolosis



hypertonic or hypotonic

crenation or cytolosis

A. Dialysis

Initial mass of bag ______________
(incl. string and stick)

Final mass of bag _______________
(incl. string and stick)

Analysis of Solutions

Contents from	Color with Iodine added	Starch present?	Color of Chemstrip	Glucose Present?
Beaker				
Inside bag				

Explanation of results

Is the net flow of solvent from the beaker into the dialysis bag **or** from the dialysis bag into the beaker?

Explain how you knew the direction the solvent flowed using experimental data.

Did the sugar move? Circle one Yes No If yes from where to where?

From ____________________ to ________________________

Did the starch move? Circle one Yes No If yes from where to where?

From ____________________ to ________________________

Which of the molecules is bigger? Circle one Sugar starch

Which of the molecules is smaller? Circle one Sugar starch

B. Osmosis

Potato identification	1	2	3
Beaker contents	deionized water	syrup	salt water
Original mass	_______________	_______________	_______________
Final mass	_______________	_______________	_______________

Percent change in the mass of each potato (show each setup)

#1 = ____________ %

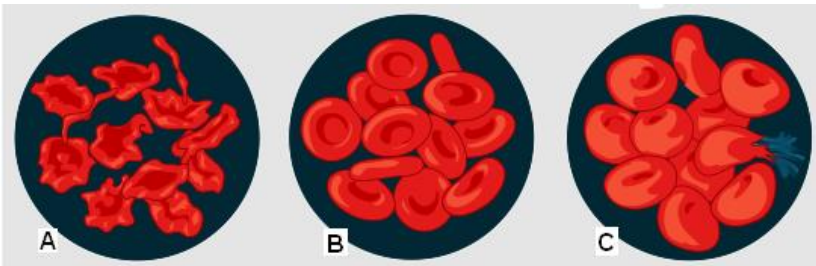
#2 = ____________ %

#3 = ____________ %

Potato	Did the mass go up, down, or stay about the same?	Did solvent flow? Yes or no?	If yes, from where? (potato or solution)	To where? (potato or solution)	Which was the MOST concentrated? (potato or solution)
1					
2					
3					

C. Follow up Questions

1. Potato 1 was in this type of solution: hypotonic hypertonic isotonic
2. Potato 2 was in this type of solution: hypotonic hypertonic isotonic
3. Potato 3 was in this type of solution: hypotonic hypertonic isotonic
4. Which potato underwent crenation? 1 2 3
5. Which potato underwent cytolysis? 1 2 3
6. Freshwater fish live in this type of environment: hypotonic hypertonic isotonic
7. Salt water fish live in this type of environment: hypotonic hypertonic isotonic
8. Imagine a living cell in a hypertonic solution. Will the solvent flow into or out of the cell? ______
9. Imagine a living cell in a hypotonic solution. Will the solvent flow into or out of the cell? ______
10. Crenation occurs in this type of solution: hypotonic hypertonic isotonic
11. Cytolysis occurs in this type of solution: hypotonic hypertonic isotonic
12. The following shows red blood cells in solution. Label each picture according to whether the solution is hypotonic, hypertonic, or isotonic.



A = ____________________

B = ____________________

C = ____________________