Investigating Osmosis

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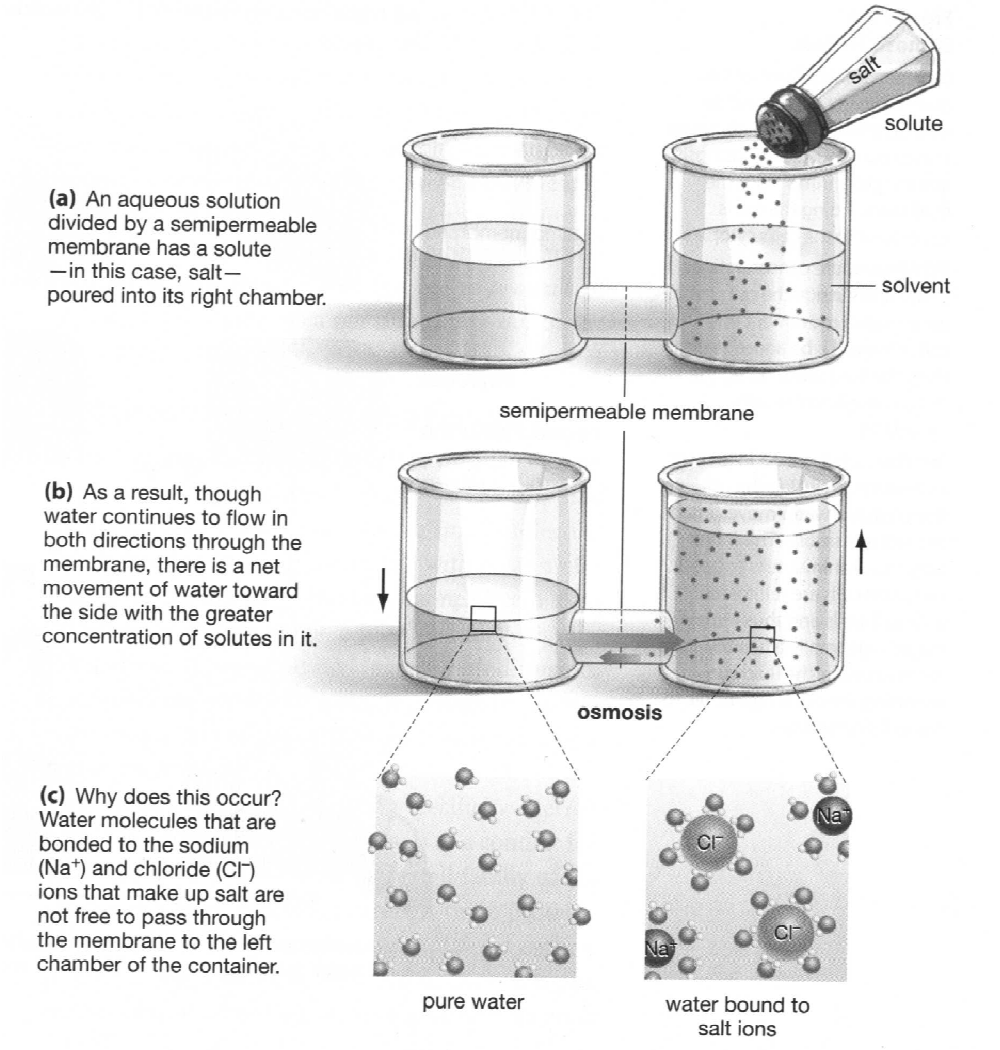
Osmosis is the **diffusion** of water across a **selectively permeable membrane**.

1. What is diffusion**?**

2. What does it mean to say that a membrane is selectively permeable?

Use the explanation of osmosis in the figure to answer questions 3-5. (This figure uses the term semi-permeable membrane, which is another name for a selectively permeable membrane).



(Figure from Krogh, Biology -- a Guide to the Natural World, Fourth Edition)

Na+ and Cl- cannot cross this selectively permeable membrane. Therefore, the water molecules that are attracted to these dissolved ions cannot cross the selectively permeable membrane. <u>Only unbound water molecules can cross the selectively permeable membrane</u>.

[1] Teachers are encouraged to copy this Student Handout for classroom use. A Word file, which can be used to prepare a modified version if desired, and Teacher Preparation Notes are available at http://serendip.brynmawr.edu/sci_edu/waldron/#osmosis.

3. To explain why osmosis moved water from the beaker on the left with no solute to the beaker on the right with dissolved salt, complete the following sentences.

Only _____ water molecules can cross the selectively permeable membrane. The
(bound/unbound)
concentration of unbound water molecules is higher in the beaker with _____ .
(no solute/dissolved salt)
Diffusion results in the net movement of substances from regions of _____ concentration to
(higher/lower)
regions of _____ concentration. Therefore, osmosis results in the flow of water across the
(higher/lower)
selectively permeable membrane from the beaker that contains _____
(pure water/water with dissolved salt)
to the beaker that contains _____ .
(pure water/water with dissolved salt)

In our bodies and in all biological organisms, **each cell is surrounded by a selectively permeable plasma membrane** (also called the cell membrane). Water diffuses into and out of a cell across the selectively permeable cell membrane. Several terms are useful for discussing osmosis across the plasma membrane.

4. A solution is **hypertonic** if the concentration of dissolved substances is <u>higher</u> in the solution outside a cell than in the cytosol inside the cell. (The cytosol is the semi-fluid substance around the nucleus and other organelles inside a cell.) A solution with a higher concentration of dissolved substances has a lower concentration of unbound water molecules. When cells are placed in a hypertonic solution, will water flow into or out of the cell? Explain your reasoning.

5. A solution is **hypotonic** if the concentration of dissolved substances is <u>lower</u> in the solution outside a cell than in the cytosol inside the cell. Is the concentration of unbound water molecules higher in a hypotonic solution or inside the cell?

When cells are placed in a hypotonic solution, will water flow into or out of the cell?

An **isotonic** solution is one in which the concentration of dissolved substances is <u>the same</u> outside and inside the cell. Consequently, there is no net movement of water across the plasma membrane.

<u>Designing Your Experiment</u>

In this lab you will use dialysis tubing which is a selectively permeable membrane, so it will model the properties of the plasma membrane. You will create dialysis tubing "baggies" to represent cells. You will use water and/or starch solution (starch dissolved in water) as the fluids inside the baggy and outside the baggy.

6. Which molecule is smaller: starch or water?

7. You will design an experiment to answer the questions in this table. Begin by predicting the answers you expect. In making your predictions, assume that the smaller molecule (starch or water) can pass through the dialysis tubing selectively permeable membrane and the larger molecule cannot.

Question	**Prediction**
1. Can starch cross the dialysis tubing by diffusion?	
2. Can water cross the dialysis tubing by osmosis (diffusion)?	
3. If the concentration of unbound water molecules is <u>higher inside</u> the dialysis tubing baggy, which way does water move?	
4. If the concentration of unbound water molecules is <u>higher outside</u> the dialysis tubing baggy, which way does water move?	
5. If the concentration of unbound water molecules is <u>the same</u> inside and outside the baggy, is there any net movement of water?	

8. Plan how you will test your predictions using the following materials: water, starch solution, three beakers, each with its own baggy of dialysis tubing, iodine (an indicator for the presence of starch), scale or ruler, and graduated cylinder.

In the table below, draw a diagram showing the contents of each beaker and dialysis tubing baggy. Be specific about which solutions will be in each baggy and beaker. Predict what you think will happen in each case. Describe what you will measure. Put the number for each of the five questions listed above next to the measurement that will allow you to answer this question.

	Beaker 1	Beaker 2	Beaker 3
Diagram showing the contents of beaker and baggy			
Predict which molecules will move which way.			
What will be measured? How?			

After your teacher has approved your experimental design, set up your beakers and baggies. To make a dialysis tubing baggy, soak the tube in water for a minute, fold the bottom 1 cm up and tie the folded part with a piece of string tightly to create a bag. To open the other end of the tube, rub the end between your fingers until the edges separate and blow in to open the bag for ease of pouring. When you pour the appropriate fluid in each baggy, leave some space to allow water to diffuse in during the experiment. Then, fold 1 cm of tubing and tie off the top of the tube with string Rinse off the tube and string in fresh water and squeeze any excess water from the string.

9. Why is this last step important, particularly if you will be weighing your baggies at the beginning and end of your experiment?

Results and Interpretation

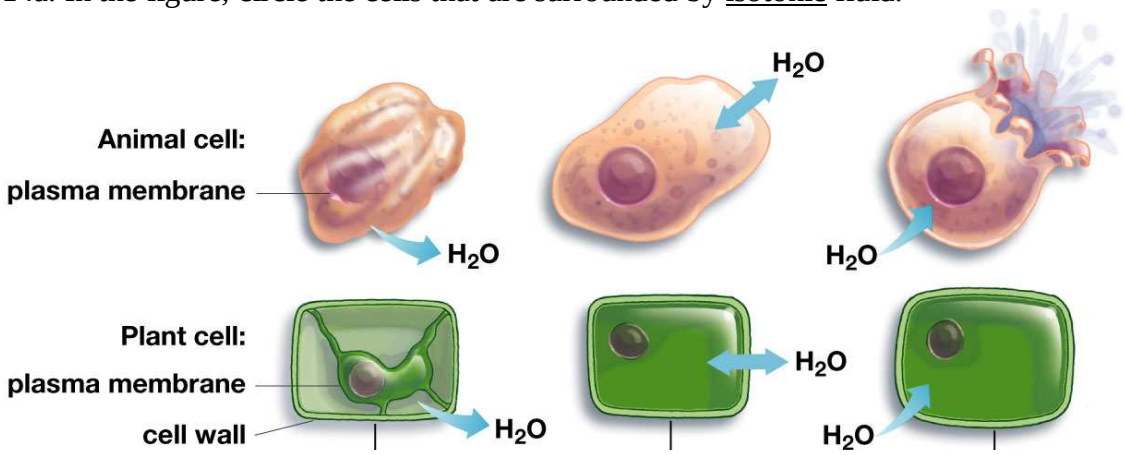
10. You will have to wait 20 minutes for the effects of osmosis to be observable. While you are waiting, create a data table to record your data. Then answer question 14 on the next page.

11. Record your data in your data table.

12. Were your predictions correct? If not, what do you think accounts for the differences between your predictions and your observations?

13. Summarize your results to describe the effects of osmosis across a selectively permeable membrane.

14a. In the figure, circle the cells that are surrounded by <u>isotonic</u> fluid.



Use the relative concentrations of dissolved substances and unbound water inside vs. outside the cells to explain what is happening in these cells.

14b. Use asterisks to identify the cells that are surrounded by <u>hypertonic</u> fluid. Use the relative concentrations of dissolved substances and unbound water inside vs. outside the cells to explain what is happening.

14c. Use arrows to identify the cells that are surrounded by <u>hypotonic</u> fluid. Use the relative concentrations of dissolved substances and unbound water inside vs. outside the cells to explain what is happening.

14d. Explain the reason for the difference in the effect of surrounding hypotonic fluid on animal vs. plant cells.

14e. Suppose that animal cells had cell walls. What problem would this cause?