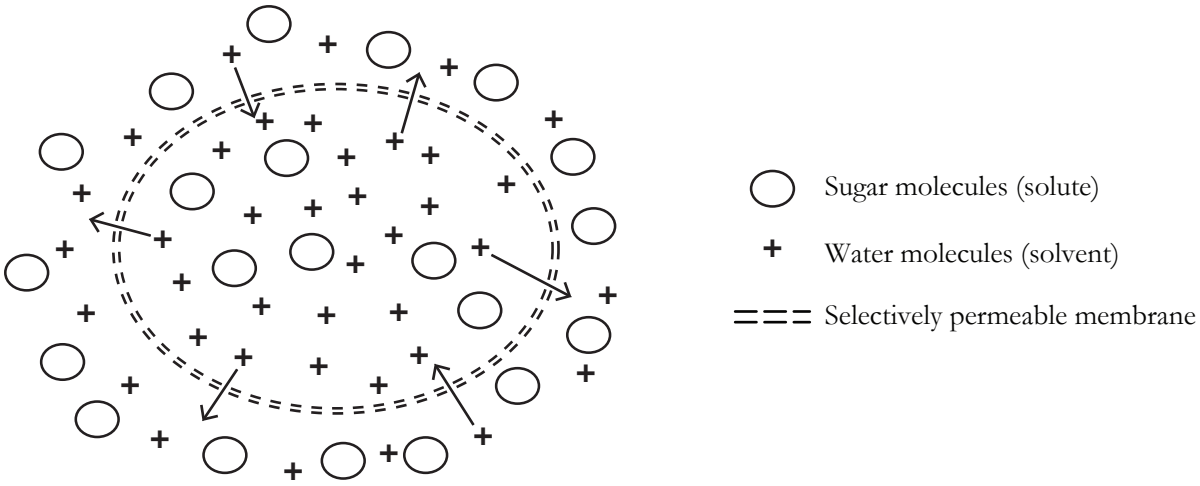
Transport in Cells

How do water molecules move in and out of cells?

Why?

Water accounts for over 70% of the human body. If water levels are not regulated and maintained in an organism the consequences can be disastrous. Cells and tissues may swell, blood cells burst, or the brain may expand so much it pushes on the skull, leading to brain damage and death. So what exactly is the process that allows organisms to regulate and maintain their water content?

Model 1 – Movement of Water In and Out of Cells



1. A solution consists of a solute and a solvent mixed together. For the solution in Model 1 identify and provide the symbol for the

   a. solute.

   b. solvent.

2. Consider the size of the sugar and water molecules in Model 1. Which molecules in the diagram in Model 1 are able to move through the selectively permeable membrane?

3. Complete the table below by counting the molecules in Model 1.

	Inside the Cell	**Outside the Cell**
Number of sugar molecules		
Number of water molecules		
Ratio of water to sugar		

4. Which solution in Model 1 is more concentrated—the solution inside the cell or outside of the cell? Explain your answer in terms of the ratio of solute to solvent particles.

5. Consider the arrows indicating movement of water across the membrane.
   a. In which direction are water molecules moving—into or out of the cell?

   b. Are more water molecules moving into or out of the cell?

   c. Is the net direction of water movement into or out of the cell?

6. Circle the correct word below to indicate the change in the concentration of the sugar solution on each side of the membrane as water molecules move.
   a. The solution inside the cell will become (more/less) concentrated with the net movement of water.
   b. The solution outside the cell will become (more/less) concentrated with the net movement of water.
7. Applying what you already know about the random movement of molecules, what will eventually happen to the concentration on both sides of the membrane?

8. The definition of **diffusion** is the movement of molecules across a membrane from an area of high concentration to an area of low concentration. According to this definition, is the cell in Model 1 undergoing diffusion? Explain.

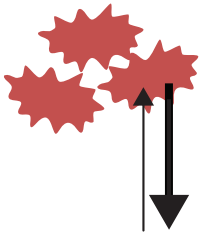
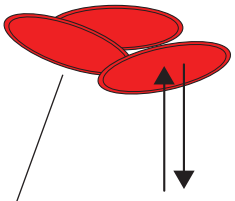
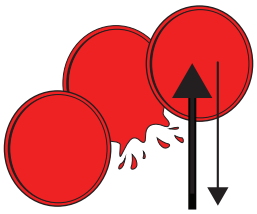
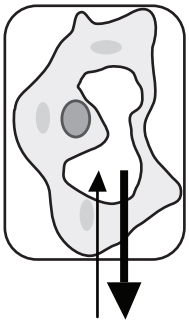
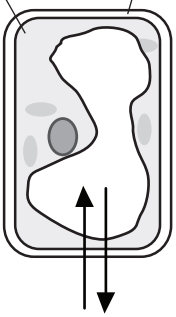
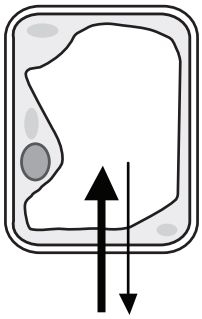
9. In the cell diagram in Model 1, where is the higher concentration of <u>water</u>—inside or outside of the cell?

10. Is the cell in Model 1 undergoing diffusion if you consider the concentration of <u>water</u> on either side of the selectively permeable membrane? Explain.

Read This!

Osmosis is the movement of water from high water concentration to low water concentration across a semi-permeable membrane.

Model 2 – Osmosis in Plant and Animal Cells

	External solution:		
	Hypertonic	**Isotonic**	**Hypotonic**
Animal Cell	**A** 	**B** 	**C** 
	Crenated	Normal	Lysed
Plant Cell	**D** 	**E** 	**F** 
	Plasmolysed	Normal	Turgid

11. Using your knowledge of cells, which type of cells in Model 2—animal or plant—have

    a. a selectively permeable membrane?

    b. a permeable, rigid cell wall?

12. The arrows in Model 2 show movement of water into and out of the cells. What does the thickness of the arrow indicate?

13. For each question use diagrams A–F in Model 2. Which cells show

    a. a net increase in water?

    b. a net decrease in water?

    c. no net change in water?

14. Consider the definition for osmosis and the net movement of water from a dilute solution (high concentration of water) to a concentrated solution (low concentration of water).

    a. Describe the concentration of the solution surrounding cells A and D (**extracellular**), relative to the concentration of the solution inside cells A and D (**intracellular**).

    b. Describe the concentration of the extracellular solution of cells C and F, relative to the intracellular solution of cells C and F.

    c. Describe the concentration of the extracellular solution of cells B and E, relative to the concentration of the intracellular solution of cells B and E.

15. Using the diagrams in Model 2 and the answers to the previous question, develop definitions for the following words.

    a. A hypertonic extracellular solution is _____.

    b. A hypotonic extracellular solution is _____.

    c. An isotonic extracellular solution is _____.

16. Consider the cells in Model 2 that are in hypertonic solutions.

    a. Describe what has happened to the plant cell.

    b. What word is used to summarize these changes to the plant cell?

    c. What word would be used if the cell were from an animal?

17. Consider the cells in Model 2 that are in hypotonic solutions.

    a. Describe the changes to the plant cell.

    b. What word summarizes these changes to the plant cell?

    c. What word would be used if the cell were from an animal?

18. When animal cells are in a hypotonic solution they can undergo **lysis**. However, plant cells do not, they only become turgid.

    a. Define lysis based on the diagram in Model 2.

    b. What structure on the plant cell prevents lysis from occurring in a hypotonic solution?

Extension Questions

19. Using the concept of osmosis, explain why water is sprayed over produce in a grocery store. How might this change the appearance of the produce, and why would this change be desirable?

20. Suppose you made a lettuce salad in the afternoon, added salt and other seasonings, and then put the salad in the refrigerator. When you took the salad out of the refrigerator for dinner, the lettuce looked wilted and some water was in the bottom of the bowl. Use the principles of osmosis to explain what happened.

21. In extreme cases, it is possible to die from drinking too much water. The consumption of several liters of water in a short amount of time can lead to brain edema (swelling) and death. Explain the effect of ingesting an extremely large amount of water at the level of the brain cells, including the role of osmosis in this process.

22. The diagram below shows a single-celled organism called *Paramecium,* which lives in freshwater environments. This organism contains a specialized organelle called a contractile vacuole that helps maintain osmotic balance. Predict how this organelle might help the organism survive given that it is constantly immersed in a hypotonic solution.