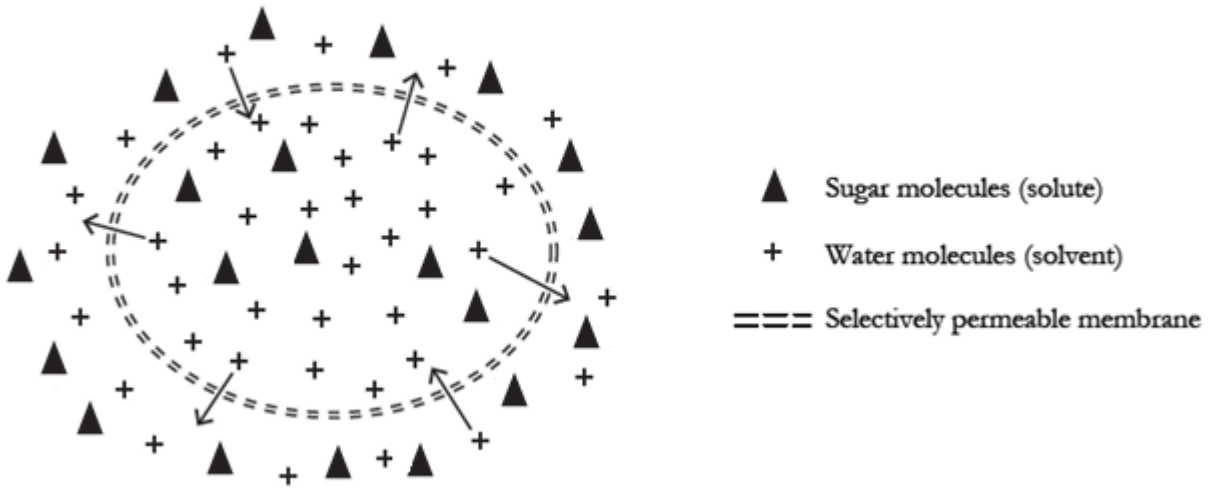
Transport in Cells

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. 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?

2. 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		

3. 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.

4. 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?

5. 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.

6. Applying what you already know about the random movement of molecules, what will eventually

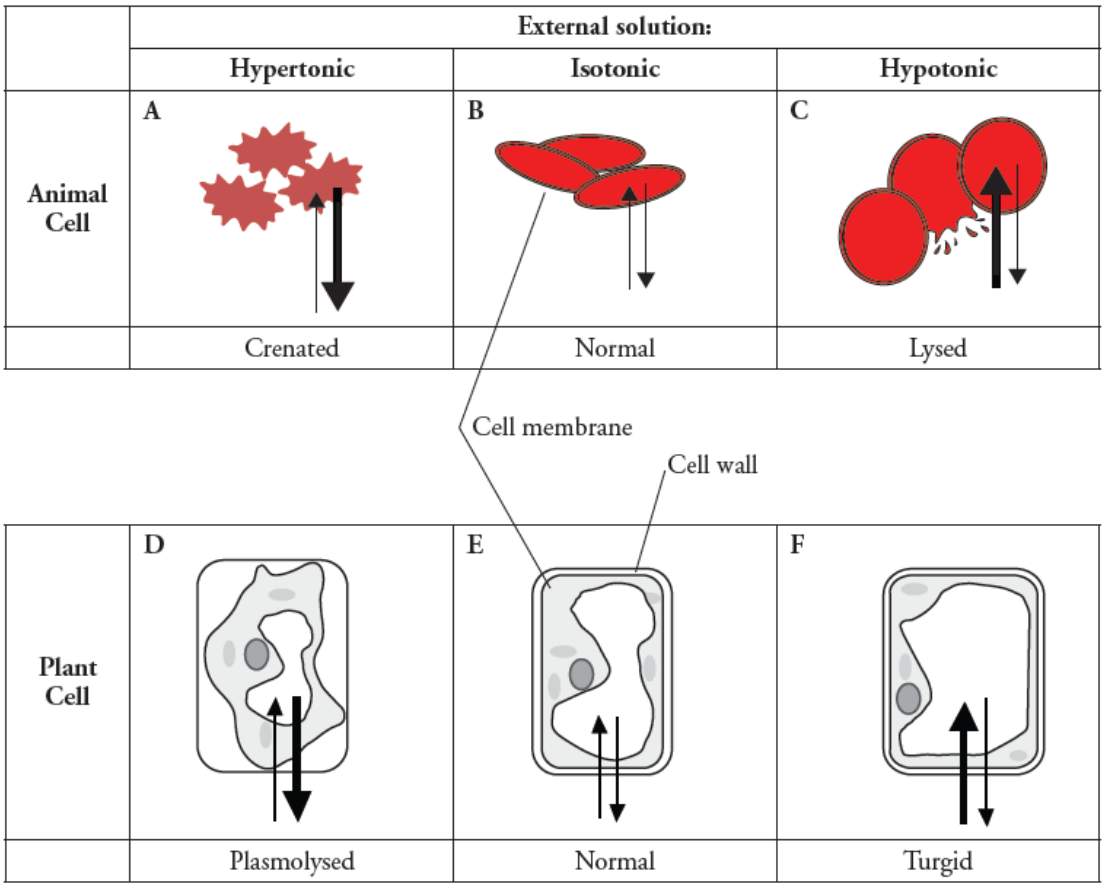
happen to the concentration on both sides of the membrane?

7. 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.

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



8. 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?

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

10. 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.

11. 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 _____.

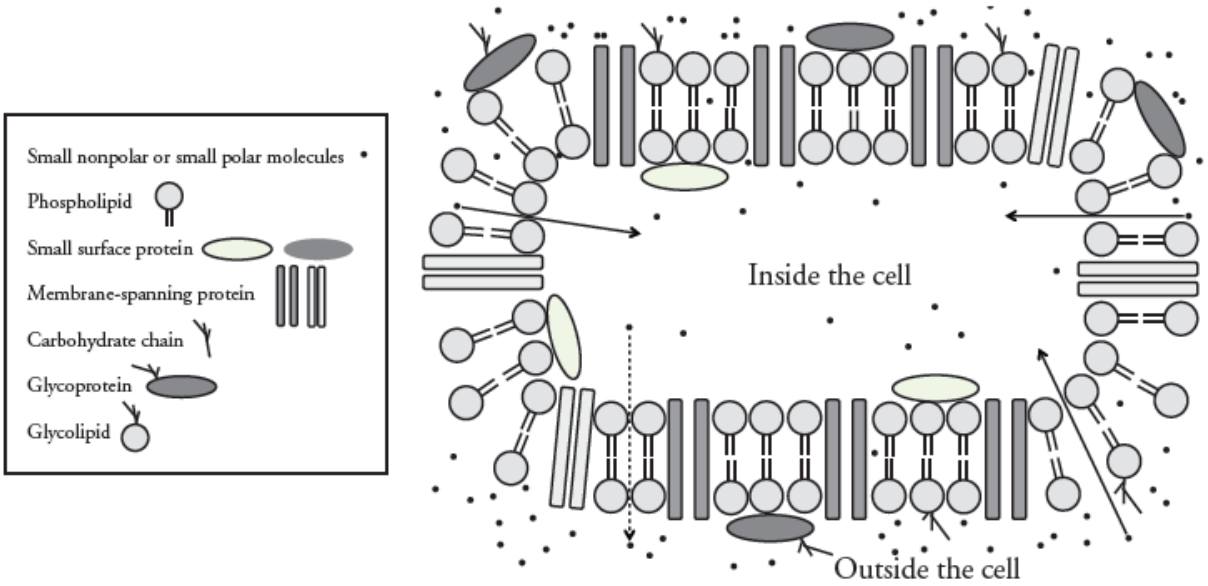
    c. An isotonic extracellular solution is _____.

12. 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?

Model 3 – The Selectively Permeable Cell Membrane



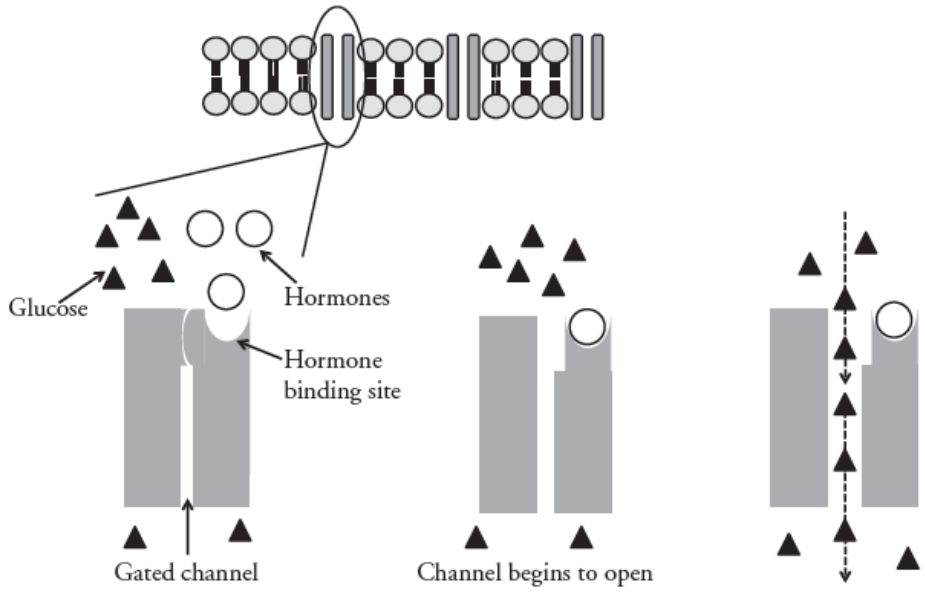
12. What two major types of biological molecules compose the majority of the cell membrane in Model 2?
13. What types of molecules are shown moving across the membrane?
14. Where exactly in the membrane do these molecules pass through?
15. How does the concentration of the small molecules inside the cell compare to that outside the cell?

Read This!

When there is a difference in concentration of a particular particle on either side of a membrane, a

concentration gradient exists. Particles move along the concentration gradient from high to low concentration until a state of **equilibrium** is reached. At that point, there is no more net movement in one direction, although the particles continue to move randomly across the membrane, often called **dynamic equilibrium.** The net movement of particles along the concentration gradient is called **diffusion**.

Model 4 – Facilitated Diffusion



16. Which part of the cell membrane is shown in more detail in Model 3?
17. What type of molecules attach to the protein?
18. Explain in detail what happened that allowed the glucose molecules to pass through.

Read This!

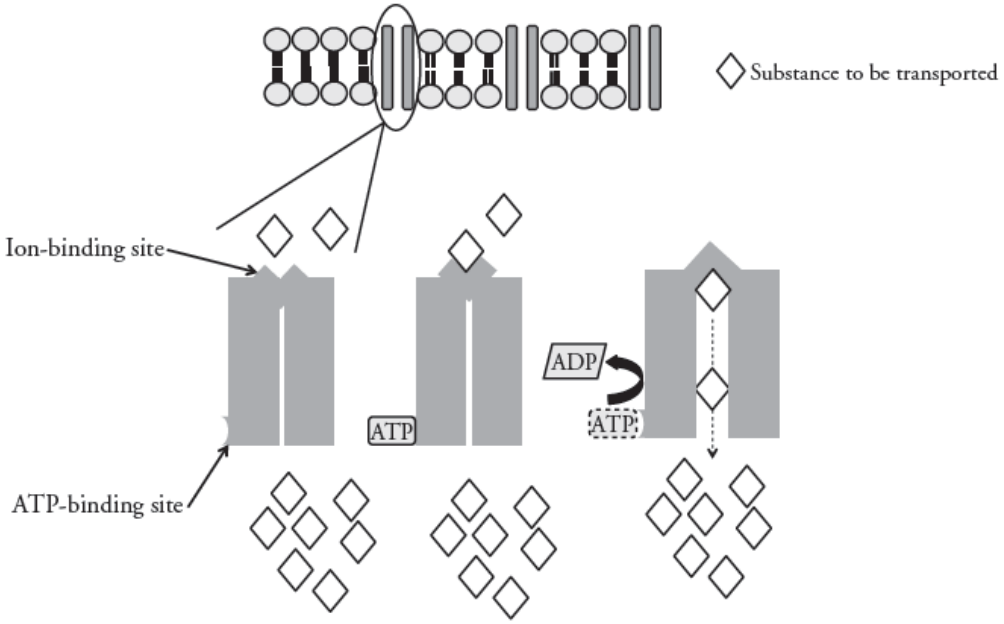
Some molecules, such as glucose, use gated channels as shown in Model 4; however, not all channels are gated. Some channels remain permanently open and are used to transport ions and water across the cell membrane.

---

19. Discuss with your group why the type of protein channel in Model 3 is called a gated channel.

20. To **facilitate** means to help. Explain why this type of diffusion is called facilitated diffusion.

Model 5 – Active Transport



21. Which part of the cell membrane is shown in more detail in Model 5? Look back at Model 3 if needed.

22. List two binding sites found on the protein.

23. In which direction is the transported substance moving—from an area of high concentration to low or from an area of low concentration to high? Support your answer.

24. Is the substance being moved along (down) a concentration gradient? Justify your answer.

25. ATP is a type of molecule that can provide energy for biological processes. Explain how the energy is being used in Model 4.

26. What happens to the ATP after it binds to the protein?

27. With your group, complete the table below to show the difference between active and passive transport.

	Active Transport	Passive Transport	
		Diffusion	Facilitated Diffusion
Requires energy input by the cell			
Molecules move along (down) a concentration gradient			
Moves molecules against (up) a concentration gradient			
Always involves channel (membrane-spanning)proteins			
Molecules pass between the phospholipids			
Moves large molecules			
Moves small nonpolar and polar molecules			