Water, Water, Everywhere: Osmosis

Why and Orientation:

In an attempt to maintain internal balance a cell must deal with environmental changes. At the cellular level, materials such as food, wastes and oxygen need to move in and/or out of the cell to maintain this internal balance. Water is one of the materials that will move in and out of the cells. Osmosis is the process of water diffusing through a selectively permeable membrane.

Learning Objectives:

Students will be able to:

- Describe the relationship between the concentration of water on both sides of the membrane and the direction of movement of the water.
- State the effects of osmosis on a cell and its ability to maintain homeostasis.
- Explain how water molecules enter and leave the cell.

Prerequisites:

- Concentration
- Diffusion
- Basic cell organelles
- Basic nutrient structures

Information/vocabulary:

- Diffusion
- Concentration
- Homeostasis

Model 1:

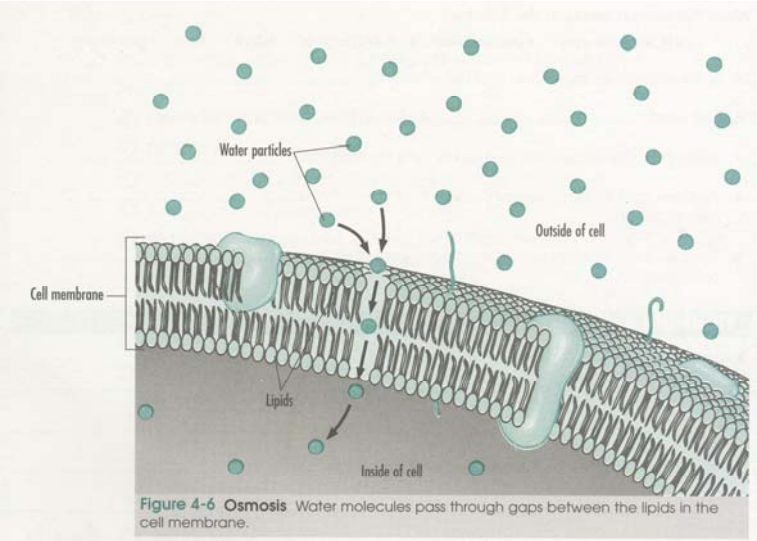


Figure 4-6 **Osmosis** Water molecules pass through gaps between the lipids in the cell membrane.

Pignatiello, Joseph, Siggens, Robert F. Jr., Di Chiappari, Frank, Madama, John (1998). *Essentials of Biology.* Austin: Holt, Rinehart and Winston.

Key questions:

1. In the diagram, are the water molecules more concentrated inside or outside the cell?

2. In the diagram, are the water molecules shown to be entering or leaving the cell?

3. What cell structure is the outer boundary of the cell?

4. What is the relationship between water concentration and the direction of the movement of water molecules?

5. If the picture were completed to include the whole cell, in what direction would the water molecules be moving? Explain your answer. (You can do this with words or draw a picture)

6. Explain why the model 1 which is shown on page 2 is an example of diffusion.

7. If the concentration of water became higher inside the cell than outside the cell, in which direction will the water move? Explain.

8. If salt were added to a container of 100% water, what would happen to the water concentration?

9. If salt were added to the water outside the cell, in which direction would water move across the membrane? Why?

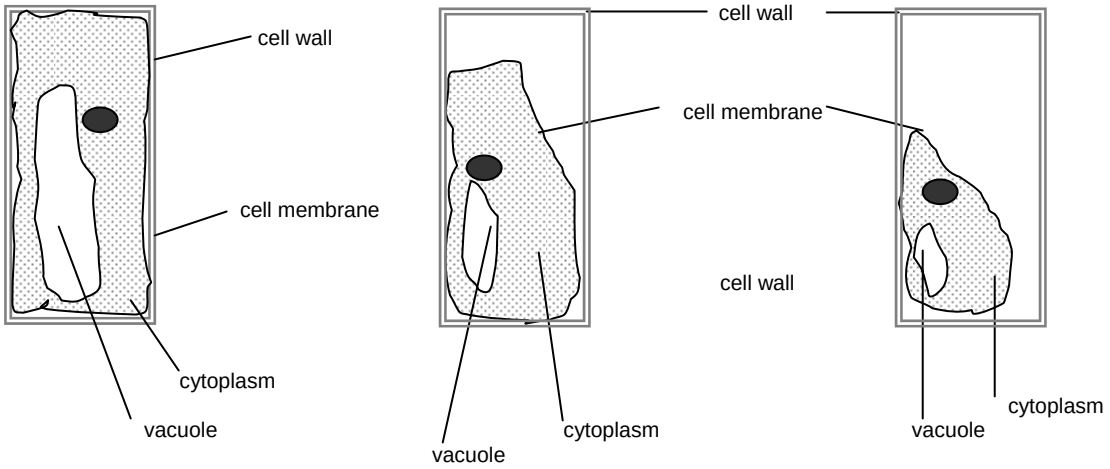
10. What do you think might happen to this cell if the process shown in the diagram were to continue? Explain.

11. How could the direction of water flow be reversed, i.e., water moves out of the cell? Explain.

12. Do you think starch molecules move through the membrane in the same fashion as water? Explain.

Model 2:

(1) Pond water (2) 8% salt water (3) 15% salt water



The diagrams above represent a typical plant cell as seen under a compound microscope. The cell has been placed in three different environments.

Key Questions:

1. What cell structure separates the cell from its environment and controls the movement of molecules in and out of the cell?

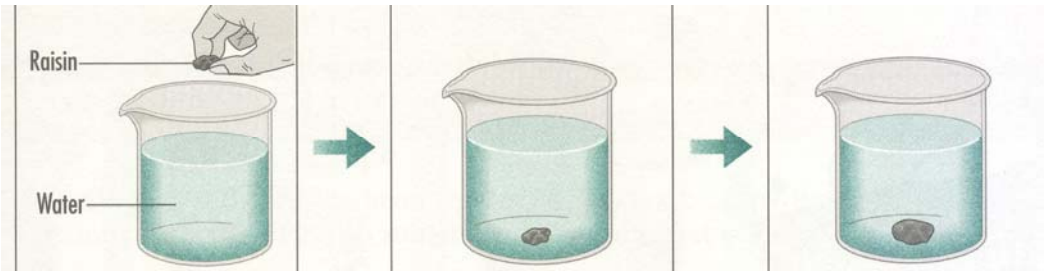
2. What cell structure encloses the cells of plants and provides a rigid shape?

3. If the same type of cell is placed in a 20% salt solution, what would the cell look like? Explain in words or show in a diagram.

4. If you wanted cell #3 above to return to the original appearance (cell #1), what could you do to the cell's environment? Explain.

Exercises:

1.



a raisin is dropped into a beaker of water after 1 minute after 15 minutes

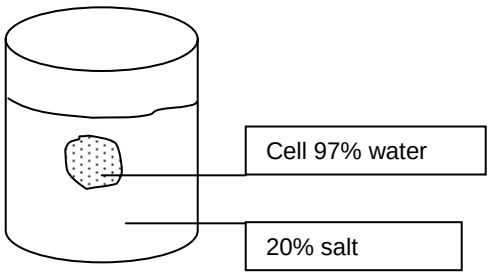
Pignatiello, Joseph, Siggens, Robert F. Jr., Di Chiappari, Frank, Madama, John (1998). *Essentials of Biology.* Austin: Holt, Rinehart and Winston.

Using the diagrams above, answer the following questions.

a. What changes do you observe in the appearance of the raisins after 15 minutes?

b. If the raisin were weighed before being placed in the water and then reweighed after being in water for 15 minutes, what do you think will have happened to the raisin's weight? Explain in terms of osmosis.

2. Diagram of beaker containing a cell.



Draw an arrow to show the direction of water movement. Explain.

Problems:

1. A child collected some snails from the shallow ocean water on a beach. When the child got home, he placed the snails in clean tap water in a fish bowl. The snails died. Based on the knowledge gained from this activity, explain why the snails were not able to survive in the fish bowl.

2. A teenager has been traveling on a band trip and found that he has forgotten to pack the 0.3% saline (salt in water) solution he usually uses for storing his contact lenses at night. Modern contact lenses have been developed that are permeable plastic. Why is it a bad idea to store contact lenses in tap water?

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Connections to the *National Science Education Standards*:

Cells have particular structures that underlie their functions. Every cell is surrounded by a membrane that separates it from the outside world. Inside the cell is a concentrated mixture of thousands of different molecules which form a variety of specialized structures that carry out such cell functions as energy production, transport of molecules, waste disposal, synthesis of new molecules, and the storage of genetic material.

Connections to *New York State Living Environment Core Curriculum:*

1.2a – Important levels of organization for structure and function include organelles, cells, tissues, organs, organ systems, and whole organisms.
1.2f – Cells have particular structures that perform specific job s. These structures perform the actual work of the cell. Just as systems are coordinated and work together, cell parts must also be coordinated and work together.
1.2g – Each cell is covered by a membrane that performs a number of important functions for the cell. These include: separation from the outside environment, controlling which molecules enter and leave the cell, and recognition of chemical signals. The processes of diffusion and active transport are important in the movement of materials in and out of cells.
5.2a – Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.

Why and Orientation:

In an attempt to maintain internal balance a cell must deal with environmental changes. At the cellular level, materials such as food, wastes and oxygen need to move in and/or out of the cell to maintain this internal balance. Water is one of the materials that will move in and out of the cells. Osmosis is the process of water diffusing through a selectively permeable membrane.

Learning Objectives:

Students will be able to:

- Describe the relationship between the concentration of water on both sides of the membrane and the direction of movement of the water.
- State the effects of osmosis on a cell and its ability to maintain homeostasis.
- Explain how water molecules enter and leave the cell.

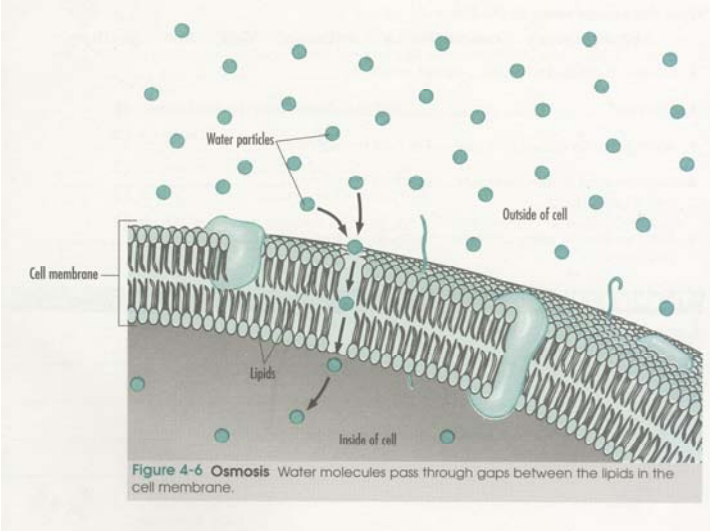
Prerequisites:

- Concentration
- Diffusion
- Basic cell organelles
- Basic nutrient structures

Information/vocabulary:

- Diffusion is the movement of molecules from an area of greater concentration to one of lesser concentration.
- Concentration is the relative amount of molecules of one type in a given area.
- Homeostasis is the self-regulating and self-maintaining system of internal stability of an organism.

Model 1:



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Key questions:

1. In the diagram, are the water molecules more concentrated inside or outside the cell? *Outside the cell*

2. In the diagram, are the water molecules shown to be entering or leaving the cell? *Entering the cell*

3. What cell structure is the outer boundary of the cell? *The cell membrane*

4. What is the relationship between water concentration and the direction of the movement of water molecules?

Water moves from a region of high water concentration to an area of low water concentration.

5. If the picture were completed to include the whole cell, in what direction would the water molecules be moving? Explain your answer. (You can do this with words or draw a picture)
   Water would still move into the cell because the entire cell is in this solution.

6. Explain why the model 1 which is shown on page 2 is an example of diffusion.
   Diffusion moves particles from an area of high concentration to an area of lower concentration. In this diagram water moves from an area of high to an area of low concentration.

7. If the concentration of water became higher inside the cell than outside the cell, in which direction will the water move? Explain*. Water will move out of the cell because the concentration gradient has been changed.*

8. If salt were added to a container of 100% water, what would happen to the water concentration?
   The concentration of water will decrease.

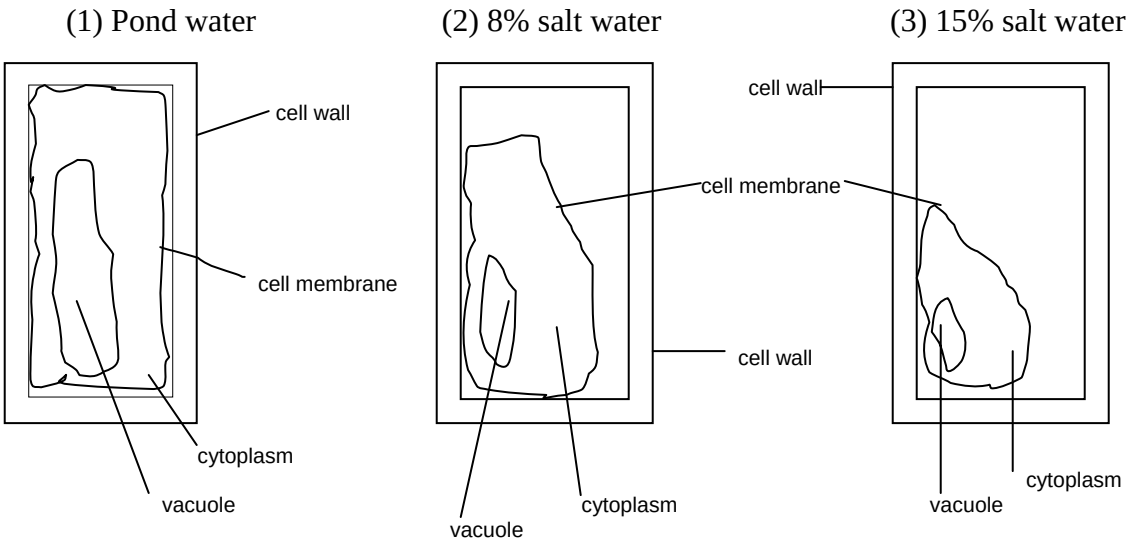
9. If salt were added to the water outside the cell, in which direction would water move across the membrane? Why?
   Water will move out of the cell because the water concentration decreases with the addition of salt.

10. What do you think might happen to this cell if the process shown in the diagram were to continue? Explain.
    The cell would explode or water would continue to move into the cell until equal concentration is reached.

11. How could you reverse the direction of water flow, i.e., water moves out of the cell? Explain. *You could add salt or some other solute until the water concentration is changed outside the cell.*

12. Do you think starch molecules move through the membrane in the same fashion as water? *Explain. I think starch is too big to move through this membrane.*

Model 2:



The diagrams above represent a typical plant cell as seen under a compound microscope. The cell has been placed in three different environments.

Key Questions:

1. What cell structure separates the cell from its environment and controls the movement of molecules in and out of the cell? *Cell membrane*

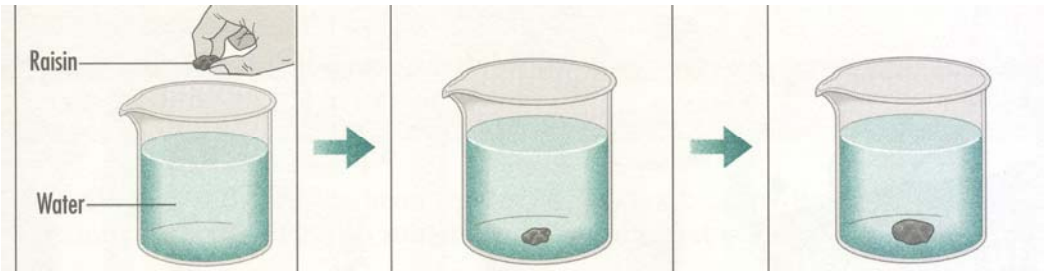
2. What cell structure encloses the cells of plants and provides a rigid shape? *Cell wall*

3. If the same type of cell were placed in a 20% salt solution, what would the cell look like? Explain in words or show in a diagram. *The cell membrane, vacuole and cytoplasm would have contracted even more because more water would have been drawn out of the cell into the solution due to the concentration.*

4. If you wanted cell #3 above to return to the original appearance (cell #1), what could you do to the cell's environment? Explain. *Place the cell in either distilled water or pond water to allow water to move into the cell by osmosis.*

Exercises:

1.



a raisin is dropped into a beaker of water after 1 minute after 15 minutes

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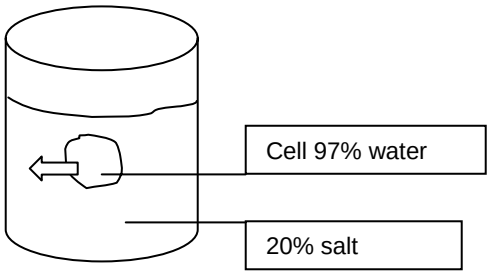
Using the diagrams above, answer the following questions.

a. What changes do you observe in the appearance of the raisins after 15 minutes?
The raisins become plump because water moves into the raisins. The water concentration is low inside the raisin when it is placed into the water and becomes higher as water moves into the raisin.

b. If the raisin were weighed before being placed in the water and then reweighed after being in water for 15 minutes, what do you think will have happened to the raisin's weight? Explain in terms of osmosis.
The weight increases because osmosis causes water to move into the raisin.

1. Diagram of beaker containing a cell.



Draw an arrow to show the direction of water movement. Explain.
Water moves from an area of higher concentration (97%) to an area of lower concentration (80%).

Problems:

1. A child collected some snails from the shallow ocean water on a beach. When the child got home, he placed the snails in clean tap water in a fish bowl. The snails died. Based on the knowledge gained from this activity, explain why the snails were not able to survive in the fish bowl.

The snail normally lives in salt water and its cells need to have a saline environment to function normally. When placed in tap water, water moved into the cells at a rapid rate and the cells and the snail cells did not have any way to withstand the pressure or to remove the excess water.

2. A teenager has been traveling on a band trip and found that he has forgotten to pack the 0.3% saline (salt in water) solution he usually uses for storing his contact lenses at night. Modern contact lenses have been developed that are permeable plastic. Why is it a bad idea to store contact lenses in tap water?

The contact lenses contain a 0.3% saline solution that enables them to maintain their shape. If the lenses are placed in tap water, the water moves into the lenses and causes them to be distorted in shape