DIFFUSION & OSMOSIS: AN INQUIRY LAB

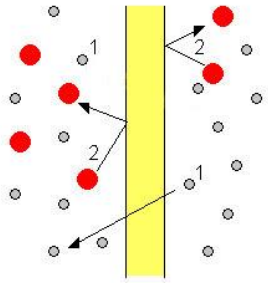
Background Information:

Diffusion:

Diffusion is the natural movement of a substance from an area of higher concentration to an area of lower concentration.
For example, the movement of perfume from the place you sprayed it into the rest of the room. Molecules are constantly in motion and as the air molecules bounce into the perfume molecules, the perfume molecules get moved around.

Osmosis:

Osmosis is the diffusion of water through a membrane. Osmosis is as simple a concept as diffusion, but can seem much more complicated to students.
Some membranes are selectively permeable, meaning that they will only allow some molecules to pass through, usually small molecules. Because H_2O is a small molecule, water can pass through a membrane and get trapped on one side because the other particles are unable to get across to equalize the concentration.
It looks like this:



Because the concentration of solute (red) is higher on the left side, the water (grey) will move to the left side as well to create the same solute to solvent concentration on both sides. Consequently, the left side of the membrane will will actually fill with water until it does not look balanced with the other side. In fact, it is precisely because the water molecules are trying to balance that they fill up one side.

When solutions are originally balanced on both sides of a membrane, scientists say that the cell is in an isotonic solution. In an isotonic solution, water will flow equally in and out of the cell because the concentrations of solutes are already balanced. This is called dynamic equilibrium, because although it is equal, the water is still moving in and out.

When a cell is in a solution that has a **higher** concentration of **solute** than the cell does (called a hypertonic solution), the water inside the cell will rush out to equalize the concentrations. This is called plasmolysis and the cell will eventually dry out and die if the situation continues.

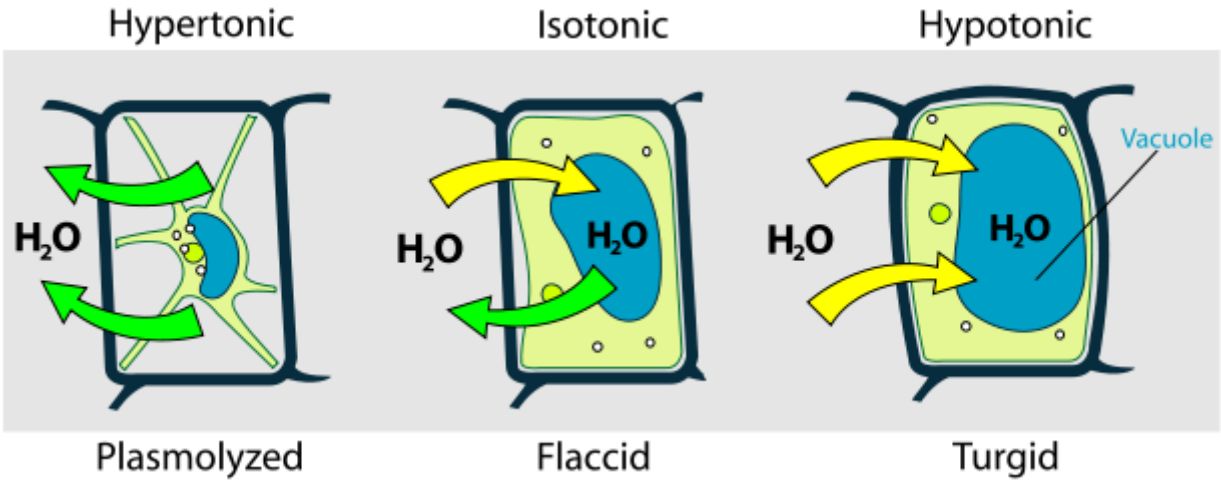
When a cell is in a solution that has a **lower** concentration of **solute** than the cell does (called a hypotonic solution), the water will rush in to the cell to equalize the concentrations. In animal cells, this can cause the cell to burst from the influx of too much water. In plant cells, however, it is called turgor pressure, because the plant cell vacuoles will contain the water and push out on the cell walls. This allows a well-watered plant to stand upright from stacks of rigid cell walls lining up together.

Passive v. Active Transport

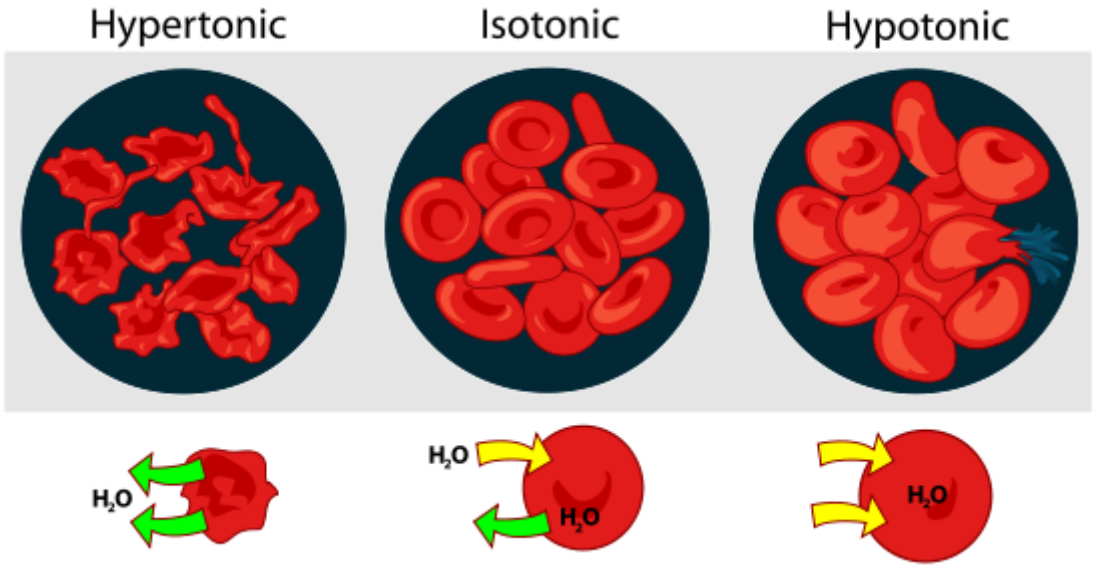
Both diffusion and osmosis are known as passive transport through the cell membrane, because neither process requires energy from the cell.

Some transport of materials across the cell membrane such as exocytosis (removal of waste against the concentration gradient) and endocytosis (both phagocytosis & pinocytosis) do require energy. These processes are moving substances from areas of low concentration to areas of high concentration (against the concentration gradient).

Osmosis in Plant Cells



Osmosis in Animal Cells



Teacher Reference: Egg Pictures

Teachers:

The following page shows what happens to the eggs during the experiment. Students are much more interested an engaged if real eggs are used, but these pictures can be used instead of real eggs for a few reasons:

1. Time is not available to prep the lab. Using these pictures gives you a no-prep option for this lab activity.

2. Students that are absent during the lab may use these pictures for reference.

Eggs in vinegar. Shells dissolve after 3 days.

De-shelled egg.

De-shelled egg in water.

De-shelled egg in corn syrup.

DIFFUSION & OSMOSIS LAB

Pre-lab prep:

Put 2 raw eggs into a container and cover with vinegar for 3 days. After 3 days, GENTLY rinse the shell off of the egg, revealing the very fragile cell membrane.
Put one of the de-shelled eggs into a container of corn syrup and one of the eggs into a container of distilled water. Wait for at least 2 hours, then answer the following questions regarding the eggs.

This question is regarding the egg in corn syrup. After dissolving the shell of each egg, the eggs now have a semipermeable membrane, which allows water to pass through them (by osmosis).

1. Make a drawing of the egg below. Include the container itself, the solution, and the egg. Label each solution either hypertonic or hypotonic. Then draw an arrow to represent the direction that the water moved (either into or out of the egg).

This question is regarding the egg in distilled water. After dissolving the shell of each egg, the eggs now have a semipermeable membrane, which allows water to pass through them (by osmosis).

2. Make a drawing of the egg below. Include the container itself, the solution, and the egg. Label each solution either hypertonic or hypotonic. Then draw an arrow to represent the direction that the water moved (either into or out of the egg).

3. Which is like passive mediated transport and which is like active transport:
   - Rolling a ball down a ramp
   - Rolling a ball up a ramp

   Explain your answer.

OSMOSIS FOLLOW-UP QUESTIONS:

Choose 5 of the following questions to answer.*

1. Explain why drinking ocean water to quench your thirst would be dangerous to humans.

2. Why do gardeners kill slugs by sprinkling salt on them?

3. A produce manager constantly sprays the vegetables in the produce section. Why?

4. You are observing a freshwater cell in pure water. You slowly add small amounts of salt to the water. How will the cell change and why?

5. You enjoy eating a delicious ham dinner, but you get very thirsty after eating the salty meal. Why?

6. When growing living cells in test tubes, biologists are very careful to use a solution known as Ringer's solution. Why is it important that Ringer's solution has a salt concentration exactly equal to body and cellular fluids?

7. What would happen to the cells of grass if too much fertilizer and too little water were sprayed on your lawn?

Diffusion & Osmosis Lab: ANSWER KEY

This question is regarding the egg in corn syrup. After dissolving the shell of each egg, the eggs now have a semipermeable membrane, which allows water to pass through them (by osmosis).

1. Make a drawing of the egg below. Include the container itself, the solution, and the egg. Label each solution either hypertonic or hypotonic. Then draw an arrow to represent the direction that the water moved (either into or out of the egg).

The water moved out of the egg, so the arrow should be pointing out of the egg into the solution. The water had a higher concentration inside the egg than in the very sugary corn syrup. Thus, the water moved from inside the egg (higher concentration) to outside the egg (lower concentration). The egg was in a hypertonic solution.

This question is regarding the egg in distilled water. After dissolving the shell of each egg, the eggs now have a semipermeable membrane, which allows water to pass through them (by osmosis).

2. Make a drawing of the egg below. Include the container itself, the solution, and the egg. Label each solution either hypertonic or hypotonic. Then draw an arrow to represent the direction that the water moved (either into or out of the egg).

The water moved into the egg, so the arrow should be pointing into the egg from the solution. The water had a lower concentration inside the egg than in the distilled water (pure) solution. Thus, the water moved from outside the egg (higher concentration) to inside the egg (lower concentration). The egg was in a hypotonic solution.

3. Which is like passive mediated transport and which is like active transport:
   - Rolling a ball down a ramp
   - Rolling a ball up a ramp

   Explain your answer.

   Passive transport is like rolling a ball down a ramp because it does not require energy. Active transport is like rolling a ball up a ramp because it requires energy.

Osmosis

Choose 5 of the following questions to answer.

1. Explain why drinking ocean water to quench your thirst would be dangerous to humans.
Ocean water is a hypertonic solution, which would draw the water out of your cells and into your stomach, which would further dehydrate your body.

2. Why do gardeners kill slugs by sprinkling salt on them?
The salt creates a concentration gradient, where the water is drawn out of the slugs from high concentration inside the slug to lower concentration outside the slug. It will die from dehydration.

3. A produce manager constantly sprays the vegetables in the produce section. Why?
The water creates a hypotonic solution, which allows water to pass into the vegetable cells. This creates turgor pressure, which makes the vegetables crisp.

4. You are observing a freshwater cell in pure water. You slowly add small amounts of salt to the water. How will the cell change and why?
The addition of salt creates a hypertonic solution, which will cause water to move out of the cell and it will go through plasmolysis.

5. You enjoy eating a delicious ham dinner, but you get very thirsty after eating the salty meal. Why?
The addition of salt causes water to move out of your cells because you have created a hypertonic solution in your mouth.

6. When growing living cells in test tubes, biologists are very careful to use a solution known as Ringer's solution. Why is it important that Ringer's solution has a salt concentration exactly equal to body and cellular fluids?
If the solution is not isotonic, the cells will either gain or lose water.

7. What would happen to the cells of grass if too much fertilizer and too little water were sprayed on your lawn?
Too much fertilizer creates a high solute concentration, which is hypertonic. The water will pass out of the grass cells, drying it out.