OSMOSIS

Imagine that you are in a room that's uncomfortably packed with other people. When someone finally opens a door, everyone is able to get out, and people move away from each other. This is one way for you to think about how osmosis works… movement from a place that is crowded to a place less crowded.

Osmosis is a very important natural process that occurs all around us. Plants depend on osmosis to take in water through their roots. The cells in our bodies absorb water by osmosis. Osmosis is important in **biochemistry** (the study of chemistry in living things), but it also is used in mechanical things. For example, reverse osmosis is used to remove **contaminants** (harmful things) from water.

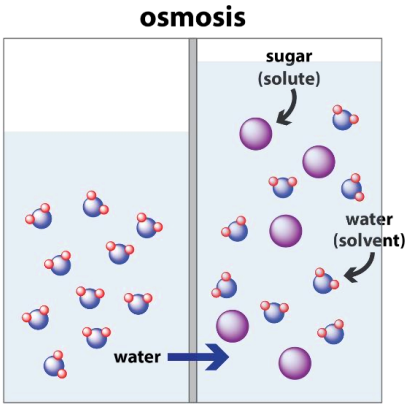
Osmosis involves the **diffusion**, or **passive movement**, of water or another **solvent** (a substance, either liquid or gas, that can dissolve other substances) from one side of a **semipermeable membrane** to another.

- **Passive movement** means that energy is not needed to cause the movement.
- A **membrane** is a very thin soft layer of material that separates two things.
- **Semipermeable** means that the membrane lets some things pass through, but not others. Small molecules can get through, but not larger ones.

A **solute** is substance that is dissolved in a **solution**. a mixture of two or more substances that stays evenly mixed. Substances that are combined to form a solution do not change into new substances. An example of a solute is the salt that is dissolved in saltwater. Saltwater is the solution, the salt is the solute, and the water is the solvent.

A **hypotonic** solution is one that has less of a dissolved substance, or solute, in it. A **hypertonic** solution has a greater concentration of solute when compared to another solution. During osmosis, water moves from the **hypotonic** side of the membrane to the **hypertonic** side. This continues until the concentration of solvent and solute is the same on both sides of the membrane.

In other words, molecules of a solvent, like water, move from the side with a high concentration of water (and lower concentration of solute) to the side with a lower concentration of water (and higher concentration of solute).

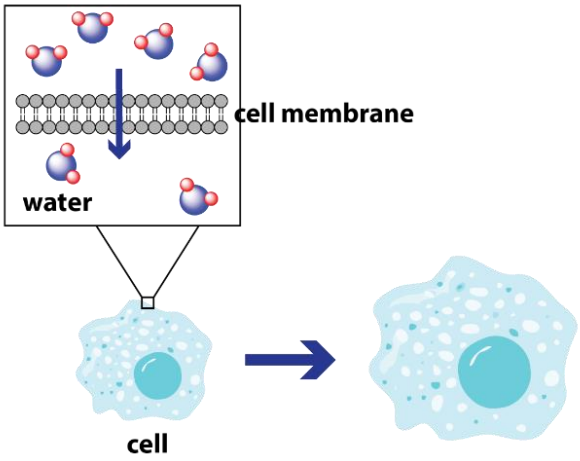


Hypotonic **Hypertonic**

High water/Low sugar → Low water/High sugar

Examples of osmosis

- In biology, very small membranes surround cells. Membranes also surround tissues. Tissue membranes are much bigger and may be made up of a thin layer of cells. In the human body, kidneys filter waste from the blood through the process of osmosis, and the intestines absorb nutrients through osmosis.



- Have you ever soaked dried fruit, like raisins, in water? They swell up due to osmosis – water travels from a place of high concentration to a place of low concentration!
- Gargling with saltwater can help a sore throat. When your throat tissue is swollen, there is excess water in the tissue. The higher concentration of salt in the salt water causes the water molecules to move out

of the swollen throat cells. This helps decrease pain and swelling. The salty water also creates an environment that bacteria can't live in.

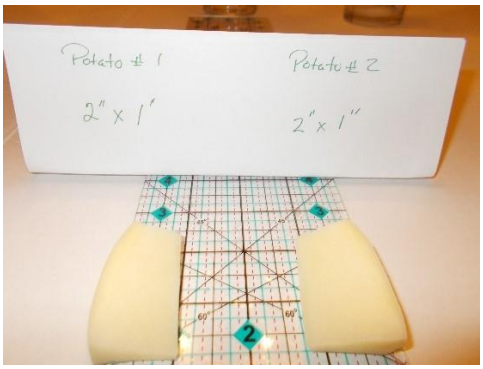
- Adding large amounts salt and sugar helps to preserve many foods. If bacteria get into these foods, the high concentration of sugar and/or salt, which is hypertonic to their cells, kills them.
- Reverse osmosis is used in the **desalination** of seawater. This is when salt is removed from seawater to create drinking water.

Activity #1: Explore osmosis with potatoes!

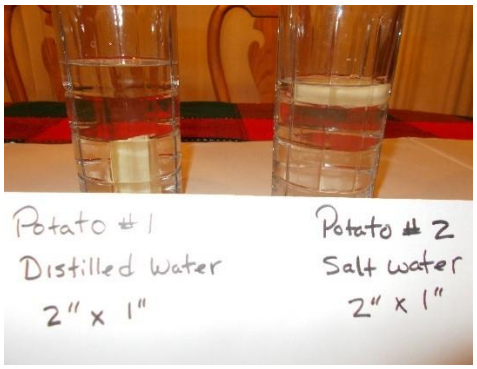
Materials:

- Potato
- Peeler and knife to peel and cut potato slices (with the help of an adult!)
- Two glasses or bowls
- Water (distilled is best, but you can also use tap water)
- Salt
- Measuring cup
- Measuring spoon
- Ruler
- Paper and pencil to record the size of your potato slices and other observations.

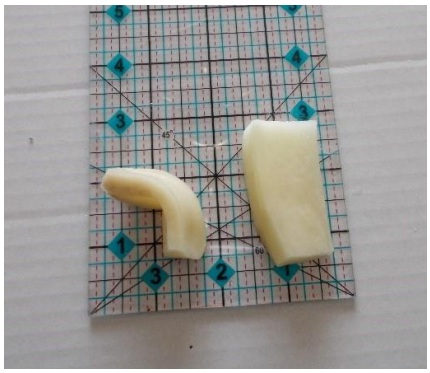
1. Fill each glass or bowl with 8 ounces of distilled or tap water.
2. Add 3 tablespoons of salt to one of the glasses/bowls and stir until the salt is dissolved.
3. Peel a potato, then slice it into strips.
4. Observe your potato slices and record your observations. Measure the length and width with a ruler. Note the color, texture, and smell of the potatoes.
5. Place one potato slice in the distilled water and one in the saltwater.
6. Let them soak for about 12 hours.
7. After 12 hours, remove the potatoes and see how they have changed.
8. Make note of color, texture and size.
9. Perform a flexibility test. Try to bend and snap each potato slice in half.

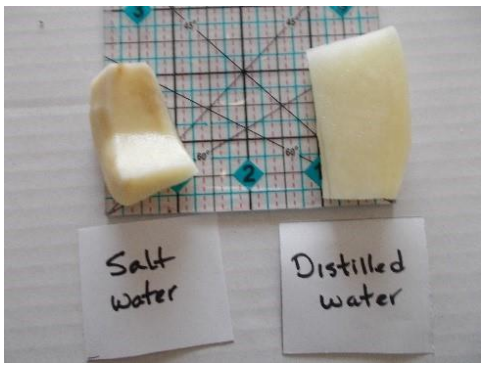


Two potato slices before soaking



Ready to soak for 12 hours





The potato that was soaked in salt water is on the left. The potato soaked in distilled water is on the right.

What happened?

Through osmosis, water moved from the area of less salt (hypotonic/inside the potato) to the area of more salt (hypertonic/saltwater solution). When the water that was inside the potato moved out, the potato shrunk and became very squishy. The potato that was soaked in distilled water remained crisp and became slightly larger because it absorbed a little water.

Activity # 2: Exploring osmosis with gummy bears

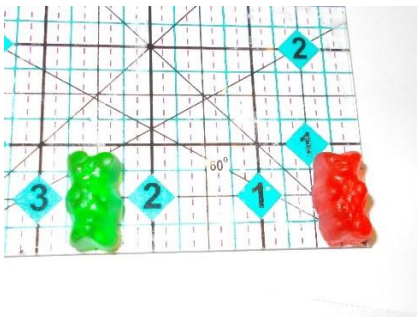
Materials:

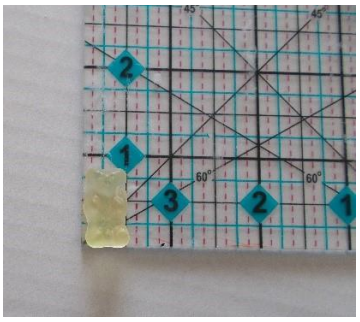
- Three gummy bears
- Ruler
- Three cups or bowls
- Distilled water (best) or tap water
- Measuring cup
- Measuring spoon
- Sugar
- Salt
- Paper and pencil to record your observations

Choose 3 gummy bears

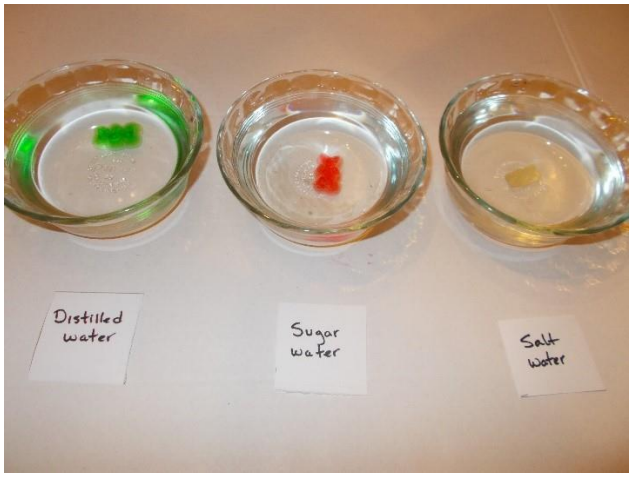
Other supplies as noted above

1. Measure the width and length of each gummy bear.
2. Fill three glasses or bowls with 8 ounces of distilled water or tap water.
3. Add 3 tablespoons of sugar to one of the glasses/bowls. Stir until the sugar is dissolved.
4. Add 3 tablespoons of salt to the third glass/bowl. Stir until the salt is dissolved.
5. Place a gummy bear in each bowl or glass. Label the glasses/bowls: distilled or tap water, sugar water, saltwater.
6. Leave the gummy bears in the water for 12 hours.

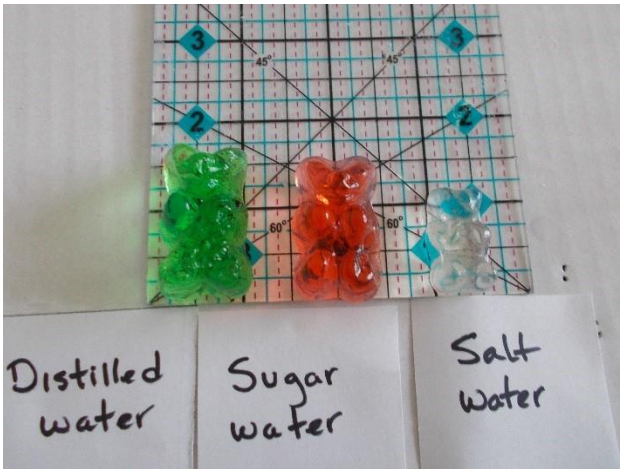




Gummy bears before soaking (¾" X ½")



Gummy bears soaking in solution



Gummy bears after soaking 12 hours

What happened?

In this activity, the gummy bears that were soaked in plain water and sugar water increased in size. The gummy bear soaked in salt water did not change much.

Looking at the ingredients on a pack of gummy bears, we can see that they have a very high sugar content, but no salt. The gummy bear in the distilled water absorbed the most water. The water moved to the area with a higher concentration of solute/sugar.

We can **hypothesize** (formulate an explanation) that the gummy bear soaked in sugar water also absorbed quite a bit of water because its solute/sugar concentration was probably higher than the sugar water solution. The water moved from the area with less sugar to the area with more sugar. The gummy bear that was soaked in saltwater absorbed very little water. We can hypothesize that the total number of solute particles must have been higher outside the gummy bear than inside. Perhaps salt couldn't cross the "membrane" into the gummy bear.

ADDITIONAL RESOURCES

Books available from the Washoe County Library System

The Blood-Hungry Spleen: And Other Poems About Our Parts by Allan Wolf

Cells by Shirley Smith Duke

Cells by Matt Mullins

Cells: Constructing Living Things by Jodie Mangor

From Head to Toe: The Amazing Human Body and How it Works by Barbara Seuling

Human Body Factory: [The Nuts and Bolts of Your Insides] by Dan Green

Mighty Animal Cells by Rebecca L. Johnson

Plant Cells and Life Processes by Barbara A. Somerville

Under Your Skin; Your Amazing Body by Mick Manning and Brita Granstrom

What Body Part is That? by Andy Griffiths

Willem Kolff and the Invention of the Dialysis Machine by Kathleen Tracy

You're Tall in the Morning but Shorter at Night and Other Amazing Facts About the Human Body by Melvin and Gilda Berger

Videos

Amoeba Sisters, *Osmosis and Water Potential* https://youtu.be/L-osEc07vMs

PBS, Curious Crew, *Diffusion and Osmosis* https://www.pbs.org/video/diffusion-and-osmosis-mxapli/

Peekaboo Kidz, Dr. Binocs Show, *What is Osmosis?* https://youtu.be/v80w3htJNyQ

Websites:

Exploratorium, Science of Food: Water, Brining Turkey https://www.exploratorium.edu/food/brining-turkey

Exploratorium, Science Snacks, Naked Egg https://www.exploratorium.edu/snacks/naked-egg

Let's Talk Science, STEM in Context, Osmosis and Its Role in Human Biology and Health https://letstalkscience.ca/educational-resources/stem-in-context/osmosis-and-its-role-in-human-biology-and-health