Gummy bear osmosis

GLOBE		SDGs Associated	Type of Activity
Spheres	**Associated Protocols**		
Hydrosphere	Salinity Conductivity	13 (Climate action)	Exploratory

Overview
Participants will understand how density works.

Time
30 minutes

Prerequisites
None

School-level
Primary school students.

Purpose

This activity will help participants understand the concept of density and how water density can change with temperature.

Student's outcomes

- Understand density and specific gravity;
- Understanding of osmosis;

Background

Density is the 'lightness' or 'heaviness' of materials of the same size. Density indicates how large the molecules are and how close they are to each other in a given substance. The larger and closer together the molecules are, the greater the density of the substance (figure 1). Density is determined by how heavy something is compared to its volume. We say that a metal spoon has a greater density than a wooden spoon of the same size because the metal spoon is heavier. Which has greater density: a tennis ball or an iron ball of the same size?

The density of water is roughly 1 gram per milliliter however, this can change if you

- Change the temperature, for example, hot water has a lower density than cold water and for that reason hot water floats as a body above cold water.

- Add other substances to it, for example, saltwater is denser (1025 kg/m3) than fresh (1000 kg/m3) because of all the salts that are dissolved in the water.

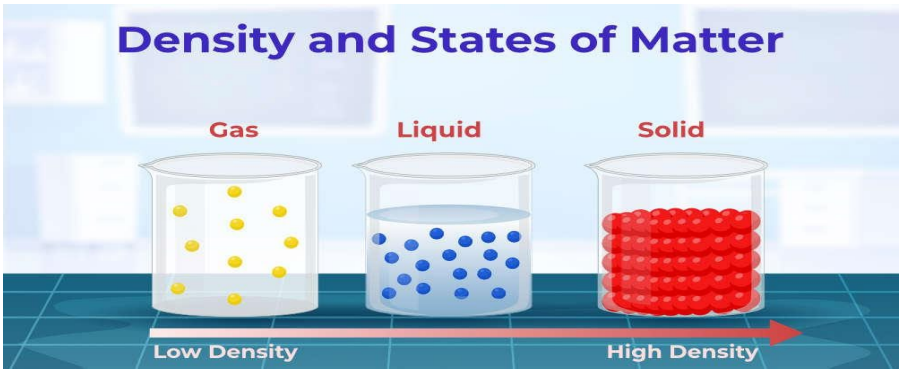

Figure 1 Density and states of matter. Source: https://media.geeksforgeeks.org/wp-content/uploads/20230311110034/Density.jpg

The gummy bear experiment has to do with osmosis (figure 2). This is the process by which water moves from an area with a lot of water to an area with less water, e.g., from a solution with a lot of water to a highly concentrated solution (less water). The gummy bear is semi-permeable. What does that mean? It can pass water molecules but not large molecules.

In your body, the cell membrane regulates what enters and leaves your cells using osmosis. The different concentrations of sugar, proteins, DNA and water between the inside and outside of the cell ensure that materials can flow in and out of the cell. But unlike our gummy bears, which are semi-permeable, our cells are selectively permeable; meaning that this process only allows specific material to enter and exit the cell membrane.

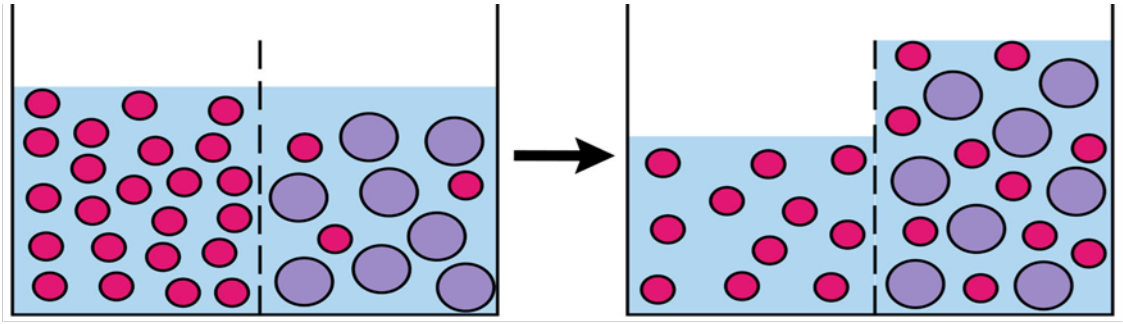

Figure 2 Osmosis. The red dots represent water and the violet dot is the solute particles. The water molecules pass through the membrane to reduce the concentration of the solution. Note how the solute particles cannot pass through the membrane. Source: https://www.science-sparks.com/wp-content/uploads/2018/09/Osmosis-Diagram-1536x536.jpeg

Seawater has a higher density than pure water. This is because seawater contains a lot of chemicals which causes a high salinity, the high salinity makes the water dense. The higher the salinity, the higher the density (more salt in the water). The density of seawater plays an important role in causing ocean currents and circulating heat. The dense water sinks below the

less dense water (Do you think that the dense water has a higher or lower temperature than the less dense water?).

Deep water is denser than shallow water. The water molecules are packed together more tightly because of the weight of water above pushing down. Rainfall, evaporation and solar radiation can cause the salinity and temperature of the ocean to rise and fall, subsequently affecting the density and causing water to sink or rise. This principle drives the deep ocean currents that circulate the world.

As a result of climate change, the ocean is gradually taking up additional heat. Even the smallest rise in temperature can have a big impact. For example, if you raise the temperature of 1 liter of water, from 20°C to 21°C. It would increase in volume by 0.21 milliliters. This may seem like a tiny increase, but the ocean contains about 1,400,000,000 cubic kilometers of water. Even a tiny increase adds up to a very large increase in volume and causes a substantial sea level rise.

Guiding Research Questions

- *What happens when you put the gummy bear in the water with salt and sugar?*

Scientific concepts

- Density
- Osmosis

Materials and Tools

- A pack of gummy bears
- Salt
- Sugar
- 4 bowls
- Water
- Optional: stopwatch and scale or ruler.

What to do and how to do it

Beginning

In the case of a large group, divide the participants into groups of 2 people. Give every group 3 bowls of water of the same temperature (room temperature, hot or cold).

Development

1. Pour the same amount of water into 3 dishes and measure the temperature. The bowls should have enough water to cover the gummy bears completely.
2. Add salt to the water in 1 of the bowls and sugar to another.
3. Place a red gummy bear in each bowl. Set aside 1 gummy bear to use later for comparison. Now we have to wait (start the stopwatch)!
4. After a while, you will see one of your gummy bears start to swell. How big can it get? It's up to you to find out.

5. Now compare the puffy gummy bear with the normal gummy bear. Do you see a difference? Do you know what happened?
6. Repeat the experiment with hot water. Measure the temperature of the water before continuing the experiment. Is there a difference?
7. Repeat the experiment with cold water. Measure the temperature of the water before continuing the experiment. Is there a difference? How did the temperature impact the experiment?

Closing

Discussion/Reflection

This process happened much faster when the gummy bear was in pure water because the water concentration difference between pure water and the gummy bear was the largest. The gummy bear in the salt water did not swell as quickly because the water concentration difference between the salt water and the gummy bear was less different. We call this difference a **concentration gradient**. The gummy bear in the salt water also did not grow as big because the water stopped moving in the gummy bear once the water concentration in the gummy bear and the salt water became the same.

Additional tests

1. Try different amounts of salt or sugar in the water. Can you predict the change in size as the salt or sugar concentration in the water increases?
2. What happens if you try this with hot and cold water?
3. Does the color of the gummy bear matter?
4. Is there a waterbody in your area? How does the density change after it rains? Or when it is dry? Are there any other changes in the water (e.g. the water is clearer, darker/ murkier)? How can you measure this change? You can use the GLOBE Conductivity (for freshwater water bodies such as rivers, lakes, or ponds) or the GLOBE salinity protocol (for saltwater water bodies such as salt lakes) to measure this change.

Bibliography

Britannica. 2023. “Osmosis.” December 14, 2023. https://www.britannica.com/science/osmosis.

Communications, Dick Jones. n.d. “Osmosis: Everything You Know about It Is (Probably) Wrong.” Accessed January 31, 2024. https://phys.org/news/2013-04-osmosis-wrong.html.

“Density.” n.d. Britannica Kids. Accessed January 30, 2024. https://kids.britannica.com/students/article/density/599545.

“Osmosis - Definition, Osmotic Pressure, Formula, Examples, & FAQs.” 2022. *GeeksforGeeks* (blog). January 25, 2022. https://www.geeksforgeeks.org/osmosis-and-osmotic-pressure/.

UCAR. n.d. “Rising Sea Level.” UCAR| Center for Science Education. https://scied.ucar.edu/learning-zone/climate-change-impacts/rising-sea-level.

"Water Density | U.S. Geological Survey." n.d. Accessed January 30, 2024. https://www.usgs.gov/special-topics/water-science-school/science/water-density.

"What Is the Density of Water? Formula, Factors, Examples & FAQs." 2022. *GeeksforGeeks* (blog). May 20, 2022. https://www.geeksforgeeks.org/density-of-water/.