The Food Science Cookbook

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Tabel of Contents

Safety.. 1

Words to Remember.................................... 2

pH.. 3

Red Cabbage pH Experiment..................... 4

Equilibrium and Osmosis.............................. 5

Science of Jello.. 6

Gummy Bear Experiment........................... 7

Intermolecular Interactions.......................... 8

Mayo Experiment..................................... 9

Milk Curdling Experiment.................. 10-11

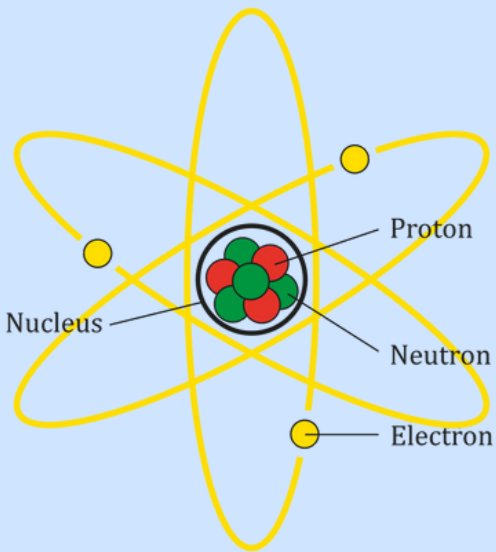
Food Science Lava Lamp........................ 12

Adult supervision is required for all experiments.

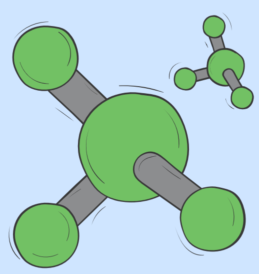
Do not eat any food made from or manipulated by the experiments. Exercise extra caution and use proper protective equipment when using a stove or working with hot substances.

Words to Remember:

- **Atoms:** The tiny building blocks that make up everything. Atoms are made of even smaller particles called protons, neutrons, and electrons. Protons have a positive charge, and electrons have a negative charge.



- **Molecule:** A group of atoms that stick together and create different things around us. Atoms in a molecule stick together because they share some of their electrons.

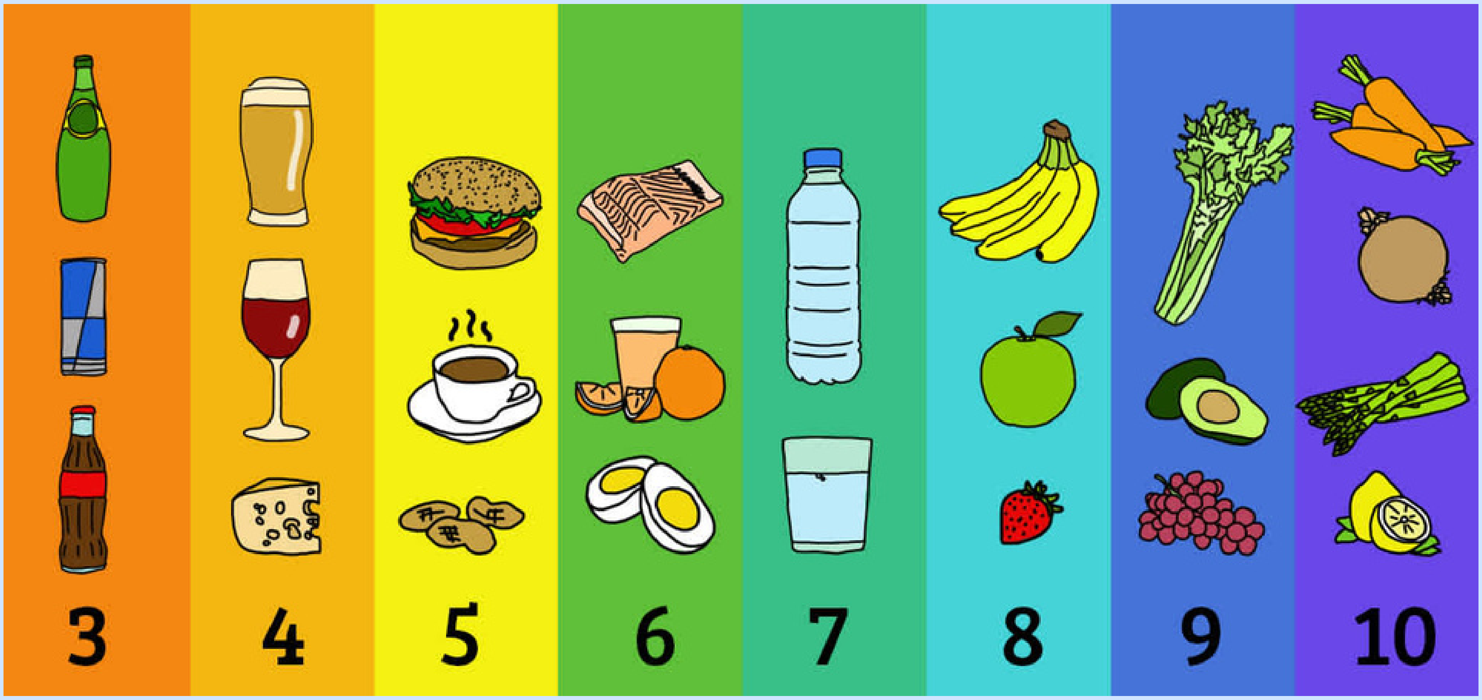


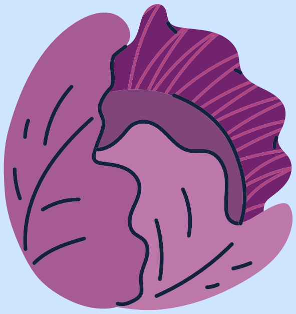
- **Ion:** An atom or molecule with a net electric charge due to the loss or gain of one or more electrons.

Acids and Bases

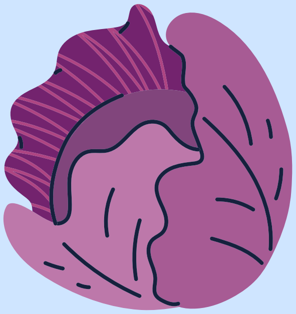
An acid is a molecule that lets go of protons. A base is the opposite of an acid. Instead of releasing protons, a base releases negatively charged ions. pH is a measure of how acidic or basic a substance is, with 0 being the most acidic and 14 being the most basic.

Foods and beverages can have a range of pH values!





Red Cabbage pH Experiment



Red cabbage contains cyanidin, a molecule that changes color at different pH conditions. It will become pink in acidic conditions (pH<7) and bluish in basic conditions (pH>7). In this experiment, you will explore the pH of various household liquids using red cabbage as a pH indicator!

Materials:

- Red Cabbage
- Boiling water
- Household liquids (lemon juice, vinegar, milk, coffee, baking soda, bleach, etc.)

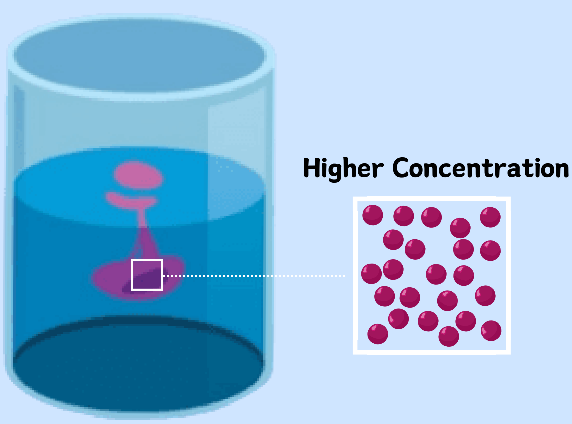
Instructions:

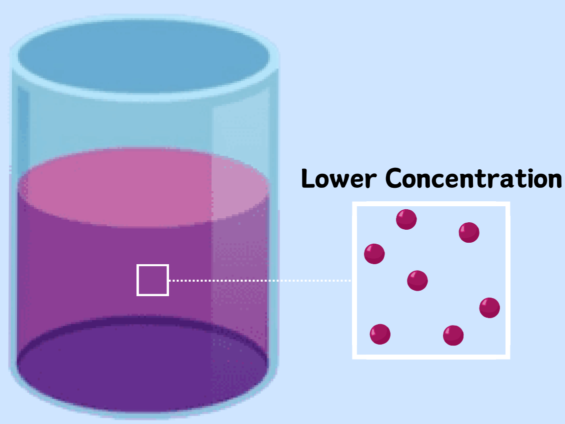
1. Chop up one cabbage
2. Pour boiling water over the chopped cabbage and allow it to steep for at least 10 minutes.
3. Strain your cabbage juice to obtain your pH indicator.
4. Separate your cabbage juice into cups and add drops of household liquids. View the color change and determine the pH!

Equilibrium and Osmosis

Imagine adding a drop of food coloring to a glass of water:

At first, there is a dark droplet of the food coloring molecules. This droplet is highly concentrated, meaning there are many food coloring particles in a given amount of space. With time the particles spread out, and you are left with an evenly colored mixture of a lighter color. When the concentration is the same throughout the glass, we say the system is in equilibrium. When the concentration of food coloring is unequal, it moves to be equally spread out.





Gummy Bear Experiment

If you place the gummy bear in water, there is more sugar inside the bear than in the water. This causes the water to move through the gelatin to make the concentration of sugar molecules more equal inside and outside the bear. This causes the gummy bear to grow! Alternatively, if you place the gummy bear in salt water, water will leave the gummy bear, causing it to shrink.

Materials needed:

- gummy bears
- water
- salt
- clear containers or cups

Instructions:

1. In two glasses, add 1/2 cup of tap water.
2. In one of the glasses of water, add 1/2 tbsp of salt and stir to dissolve.
3. Add 1-3 gummy bears in each glass.
4. Let the gummy bears soak for up to 24 hours
5. Observe the difference in the size of the gummy bears

The Jello Experiment

When the gelatin powder is added to hot water, the molecules of gelatin will unfold. As it cools, the molecules get tangled up together and stay interconnected. This makes a mesh-like structure of gelatin molecules with water in between, giving gelatin its bouncy structure. In this experiment, you will explore what impacts Jell-O formation!

Materials:

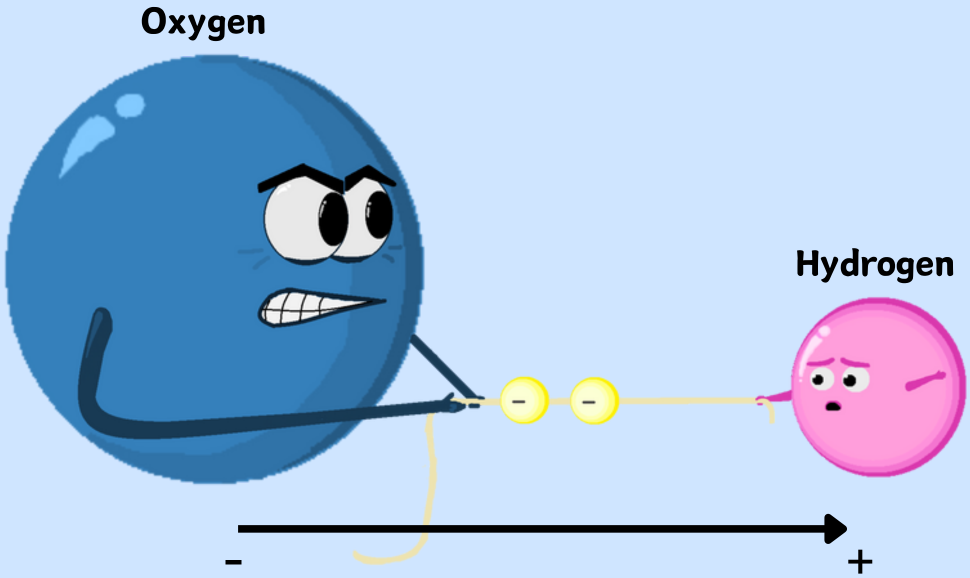
- Jell-O packets
- Lemon juice or vinegar
- Hot water

Instructions:

1. Follow the Jell-O package directions for a small portion of the powder. This Jell-O serves as a comparison for the following samples
2. For the other portions of Jell-O powder, try making Jell-O under other conditions. The following are examples, but use your imagination! Write down what you think will happen:
    a. Different temperatures of water
    b. Different ratios of water to powder
    c. Different pH liquids, such as vinegar or lemon juice
3. Take a look at all your Jell-O samples and describe their characteristics. Compare what you found to what you thought would happen.

Intermolecular Interactions

Water molecules are made of two hydrogen atoms and one oxygen atom. The oxygen atom tends to pull the shared electrons more strongly, making its side of the water more negative, while the side with the hydrogen atoms becomes more positive.

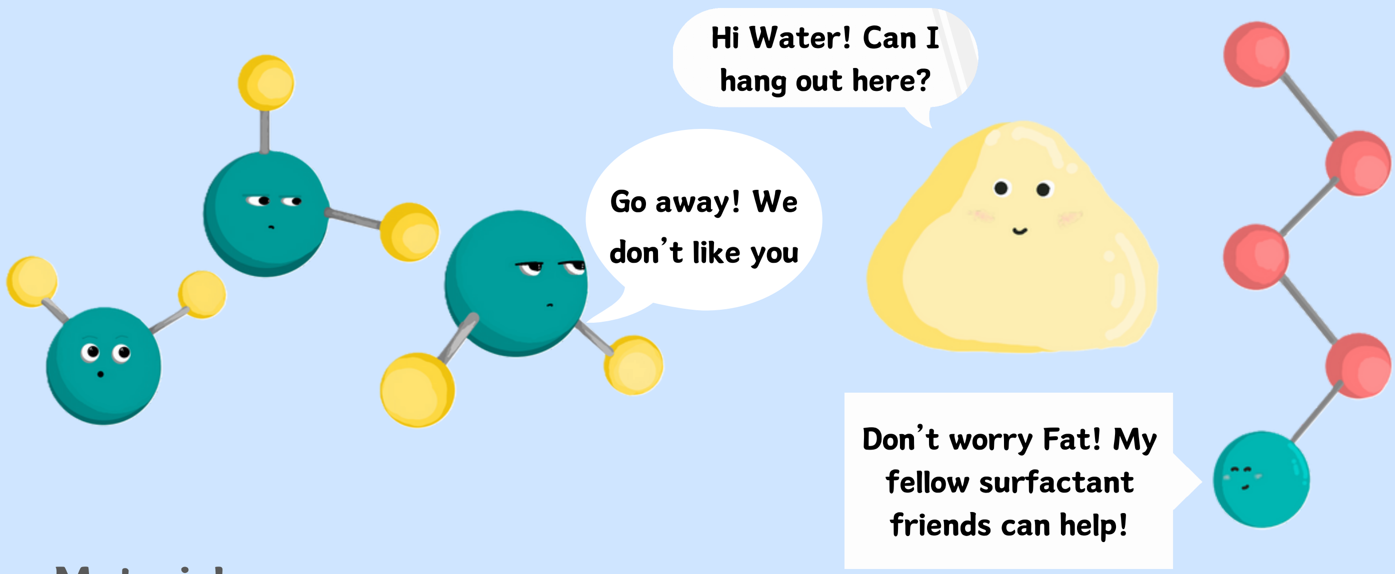


Think of it like a tiny magnet where one side is positive, and the other side is negative. Like magnets stick together, water molecules attract each other because of the positive and negative ends. Other molecules that act like magnets will stick to water. They are called hydrophilic (water-loving).

Fat molecules have no charge, so they won't stick to the water molecules. Molecules like fat are called hydrophobic (water-fearing). This is why if you add oil and water together in a cup, they separate into two layers, which has many impacts on cooking...

The Mayo Experiment

Mayonnaise is made of oil, vinegar, and egg. On their own, the oil and vinegar would separate because vinegar is hydrophilic and oil is hydrophobic. Egg helps hold the oil and vinegar together because it has emulsifiers. Emulsifiers have unique structures: part of the emulsifier likes to be in vinegar, and another part likes to be in oil. Keeping the two together helps make a nice and uniform texture.



Materials:

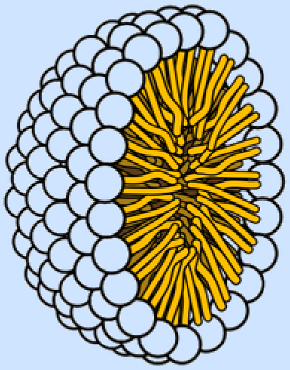
- 1 large egg at room temperature
- 1 tablespoon Dijon mustard
- 1 tablespoon red or white wine vinegar
- 1/4 teaspoon kosher salt
- 1 cup oil

Directions:

1. Whisk egg, mustard, vinegar, and salt.
2. Slowly add the oil in tiny drops; this is critical for proper emulsification.
3. When the mixture begins to thicken, add the rest of the oil in a very thin stream

Milk Curdling Experiment

Milk is a mix of many different substances, including water, fat, and protein. A protein found in milk has one part that likes interacting with water (hydrophilic), and another that does not (hydrophobic). Groups of the protein form spheres called micelles. In micelles, the hydrophobic parts are on the inside and the hydrophilic parts are on the outside.



The outside of the micelle is negatively charged. Like putting two negative ends of a magnet together, they push each other away. Adding lemon to the milk makes it acidic. Acids release positively charged protons into the milk, which pair up with the negatively charged outside of the micelle. The micelles stop pushing each other away and clump together, making solids. This cool trick is called coagulation, and it's the secret behind making cheese!

Milk Curdling Experiment

Materials:

- Milk
- Lemon
- Pineapple
- Lemon squeezer
- Food grater
- Two pieces of cheesecloth or cotton fabric

Instructions:

1. Take a fresh pineapple and cut off the rind. Cut the pineapple into small pieces and grate it.
2. Place the grated fruit in a piece of cheesecloth and squeeze at least one teaspoon of juice into 2 cups.
3. Put one of the cups into the microwave and heat it till it boils
4. Take a fresh lemon and use the lemon squeezer to make lemon juice. Add at least one teaspoon of juice to 2 cups
5. Again, put one of the cups into the microwave and heat it till it boils
6. Fill four other cups with one tablespoon of milk
7. Add each type of juice to one of the four cups of milk and wait for five minutes.
8. Observe which milk sample curdled the most.

Food Science Lava Lamp

Make a lava lamp with common cooking ingredients! This lava lamp works because of its density. Density is a way to measure how heavy something is for its size. Water is denser than oil, so it sinks to the bottom of the container. The Alka seltzer reacts with the water to produce air bubbles. These bubbles stick to water droplets and bring them to the surface of the container because the air is less dense than oil. At the top, the gas escapes, allowing the water to sink back to the bottom.

Materials:

- Water
- Oil
- Food coloring
- Alka seltzer tablets.
- A flask or glass

To make your own lava lamp:

1. Fill a flask 3/4 with oil.
2. Fill the rest of the way with water
3. Add a few drops of food coloring; this will mix with the water
4. Break an Alka Seltzer tablet into a few pieces and drop them in one at a time
5. Watch the chemical reaction start your lava lamp! You can add more Alka-seltzer to keep the reaction going