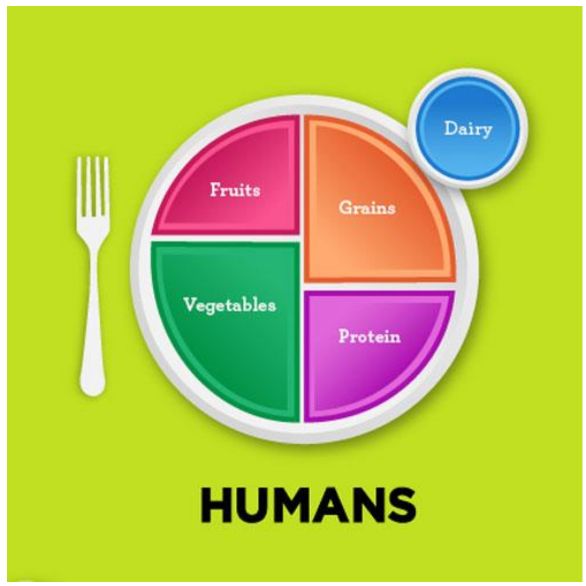
# Chemistry of Food:

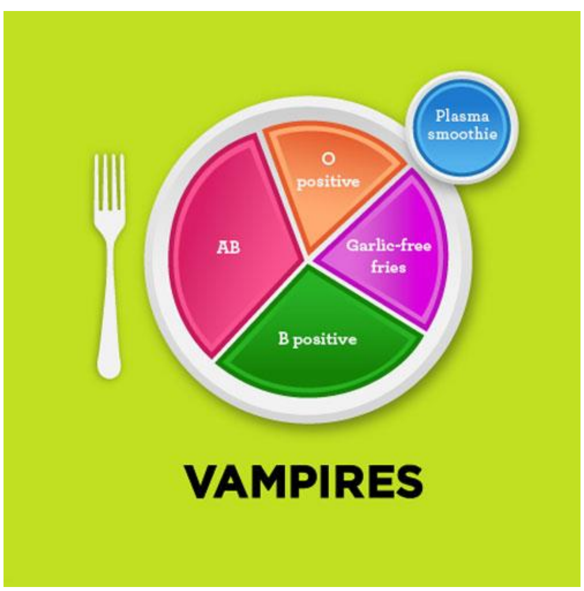
## Understanding food and cooking using chemistry

Friday, January 24, 2014

**Name:**

**Group:**





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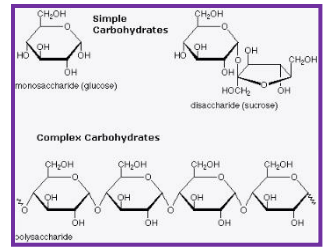
**SECTION** **PAGE**

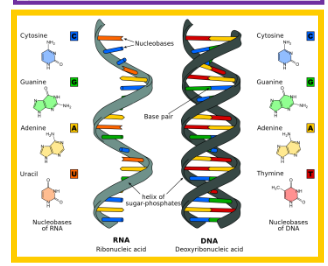
**Terms to learn:**

Four main classes of **biological macromolecules:**

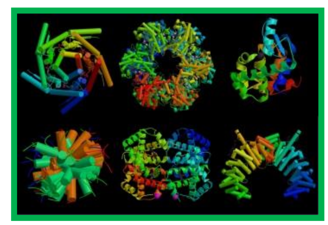
**1) Carbohydrates:** Contain chains of carbon, oxygen, and hydrogen atoms. They are made by plants. (think of them as **SUGARS** or "**quick fuel**").



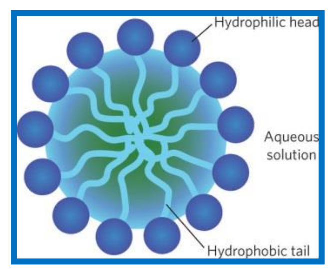

**2) Nucleic acids:** Building blocks of life! These make up the spiral chains of DNA, RNA, etc. (think of these as **blocks in the code for life**)



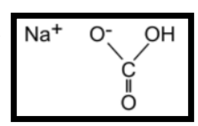

**3) Proteins:** 3-D folded chains of nitrogen, carbon, oxygen, and hydrogen atoms. In biology they can be catalysts (or more). They are made up of amino acids that are **essential for life.**



**4) Lipids:** FAT! These molecules are called "amphiphiles" because they have two parts; one part that dissolves in water and the other that cannot (think of these as a **backup store of energy**).

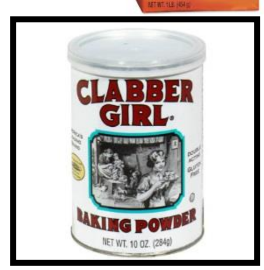



**Baking soda:** Sodium bicarbonate is basic (pH 7-14) in water it is used in cooking, cleaning, etc. It reacts with acids (like vinegar) to neutralize (pH 7) solutions and form $CO_{2(g)}$. In baking, the sodium bicarbonate reacts as soon as mixed with acid solution.





**Baking powder:** A mixture of baking soda and a solid acid like Cream of Tartar and a drying agent (keeps things dry). Because it stays dry it allows for an acid-base reaction to occur during the baking process.




# **PART I:** What's in our food?

**EVERYING** is made up of chemicals. Plants, signs, cars, FOOD, TVs, phones, etc. (the list goes on forever) are all made up of different chemicals.

**Even the air** you breathe is made up of a mixture of several different chemicals in gas form (nitrogen ($N_2$), oxygen ($O_2$), argon (Ar) and carbon dioxide ($CO_2$)).

Which of the **chemicals** in these foods do you know?

Can you tell which food is **healthier** based only on the list of chemicals?

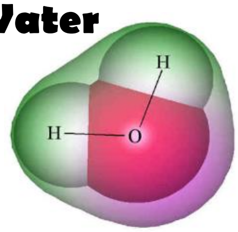


The **amount** of different kinds of chemicals in food is not what makes food healthy or unhealthy.

**Some** chemicals are **good** for you and you could not live without them.

**Some** are **toxic**.

**Water**




**Carbon monoxide**



If you want to know what chemicals are in your food and if they are good for you, you have to do research! (start with google!)

# Starch Search

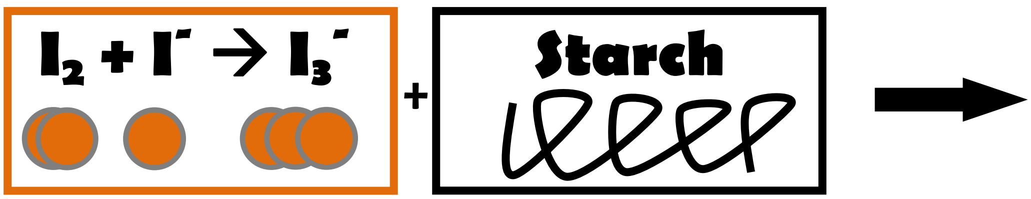
*Background:*

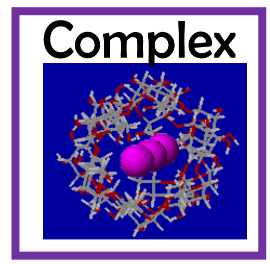
## What is starch?

Starch is a **carbohydrate** that most green plants use to store energy. We eat starches for "quick" energy and in our diets we get a lot of our starches from **grains (wheat/corn) and potatoes**. Pure starch is made up of two large organic chains called amylose and amylopectin.

## How can you find it?

If you want to know if something contains starch, there is a simple test that can be done by adding iodine. When an iodine solution (a light brown) is added to a starch solution, the starch coils (like a cage) around the triiodine and the solution **turns a bright purple** (complex).




**Objective:** Qualitatively identify which foods contain starch

**Safety/Special rules: Do not eat anything during lab, wear gloves, do not touch the iodine solution**

*Experiment:*

**Procedure:** (Write observations as you go, see pg 6)

1) Find a partner, 10 small Dixie cups and:
   - ½ cup of dry cracker crumbles
   - Small dish of table salt
   - ¼ cup of corn starch
2) Label each Dixie cup (using a permanent marker) 1-10 (**record** in table!)
3) Divide the ½ cup of crackers equally between cups #1, #2 and #3
   - Fill all 3 cups with DIFFERENT amounts of warm water (**record** which cup has the most/least water)
4) With the remaining cups:
   - Fill cup #4 with water
   - Put the corn starch into cup #5
   - Fill cups #6-#10 with equal amounts of five different food items from the table (**record** the things you picked and observations in the table)
   - Fill each cup (#4-#10) with warm water
5) Which cups do you think contain starch? Why?

6) Scientists make a hypothesis about what they think they will observe during an experiment. You will add iodine solution to test for starch. What do you think you will observe for each cup when you do this? **Write** your hypotheses in the table.
7) Add a drop of iodine solution to each of the cups and mix each solution thoroughly (**record** observations in table!!)

## Analysis:

Which cups contain starch? Which ones do not? How can you tell?

For which cups do your hypotheses agree with you observations? Which ones do not agree?

Scientists use "controls" to see what happens when no reaction occurs. In the reaction (between iodine and starch) which cup acts as the "control"?

What happened when you added different amounts of water to the cups with crackers (cups #1-3)? Why do you think this happened?

If you add another drop of iodine solution to one of your cups what do you think will happen? (After you answer, try it and find out!)

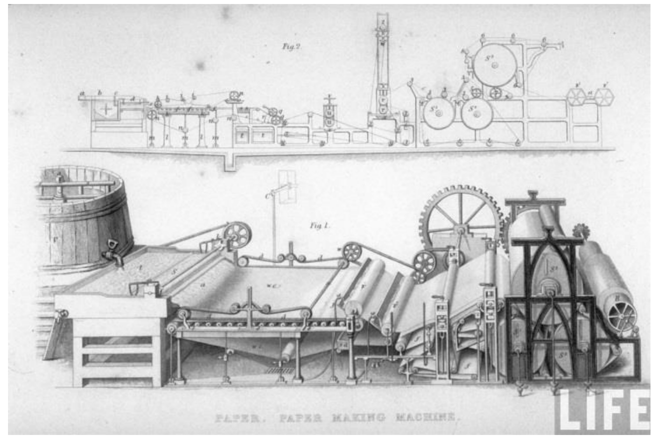
Can you tell which item tested had the most starch? Why or why not?

Why would anyone want to know if something has starch in it?

**Data:** (fill in the blanks with your observations)

| Cup Number | Cup contents | Hypothesis | Observations |
|---|---|---|---|
| 1 | Saltine Cracker | | |
| 2 | Saltine Cracker | | |
| 3 | Saltine Cracker | | |
| 4 | water | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

**FUN FACTS:** Starch is also an adhesive used in paper making. What do you think would happen if you dropped some iodine solution onto a piece of paper?




# Gluten Galore

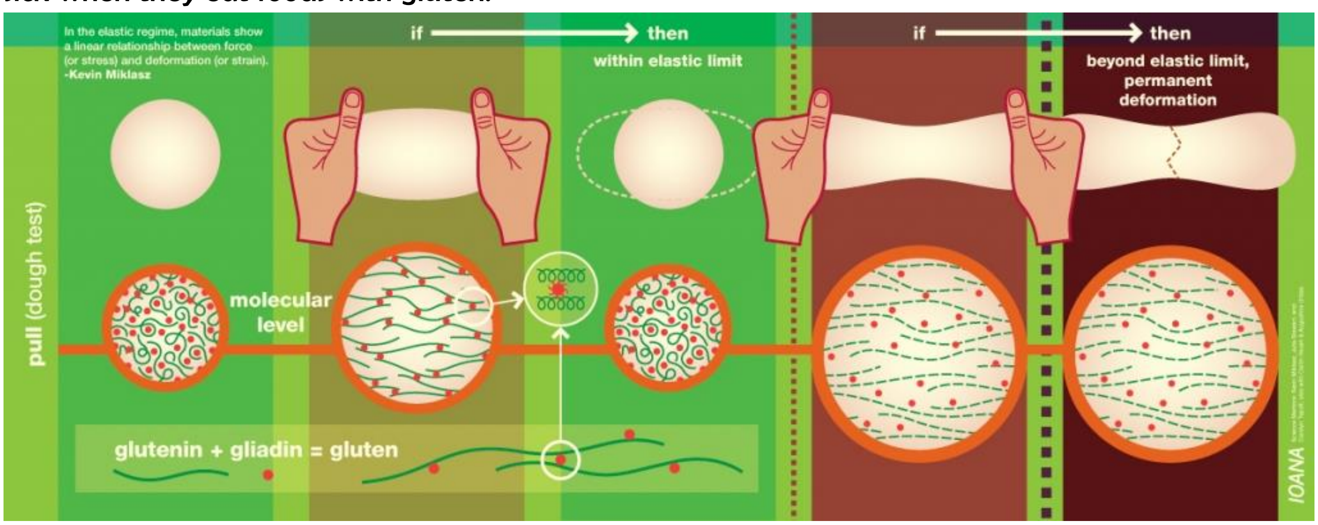
*Background:*

### What is gluten?

Gluten is a **protein** found naturally in different types of wheat based products (rye, barley, etc); however it is also used as an additive to many other food products such as chocolate, deli meat, soy sauce, etc. Gluten is mainly responsible for making dough elastic (stretchy) and it is an important to getting bread to rise properly. It is made out of two proteins called glutenin and gliadin.

### Why are people going "gluten-free"?

A large percentage of the people who eat only foods that are "gluten-free" do so as a part of a diet/heath plan (it is scientifically unclear whether this is an effective way to lose weight). However, there is a subset of the population that has a type of gluten intolerance (Celiac disease) and get very sick when they eat foods with gluten.




**Objective:** Extract the gluten from different types of flour

**Safety/Special rules: Do not spray water bottle at anything other than gluten tests, wear gloves and do not eat anything during this experiment**

**Procedure:**

1) Find a partner, four medium sized empty plastic cups and a large squirt bottle of water
2) Fill each cup 1/3 full of different types of flour:
    - Whole wheat flour (cup 1)
    - All-purpose flour (cup 2)
    - Self-rising flour (cup 3)
    - Rice flour (cup 4)
3) Label each cup with a permanent marker (so you know which flour is in which cup!)
4) Add a small amount of water to the bottom of each cup (no more than 3-4 squirts)
5) Mix the flour and water (in each cup) with your fingers until you have a rubbery ball of flour (use your gloves and make sure not to mix the different kinds of flour)
6) Have one partner hold the ball of dough from cup #1 over the now empty cup,
7) Have the other partner spray the dough ball with the water to rinse it (make sure to keep the rinse water in the cup)
8) While you rinse the ball of dough, slowly stretch and mold the dough, making sure that each part of the dough gets rinsed
9) Stop rinsing the dough when the water coming off of the ball of dough becomes clear
10) Repeat the rinsing steps 9-14 with each cup of flour

**Data:** (fill in the blanks)

| | **Whole wheat flour** | **All-purpose flour** | **Self-Rising flour** | **Rice flour** |
|---|---|---|---|---|
| Draw what the rinsed dough ball looks like | | | | |
| Observations | | | | |

## Analysis:

Describe the water that came off of the ball of dough during the cleaning process. How clean did it look? What do you think is washing off of the dough?

What stopped the dough from completely dissolving and washing away with the water? What do you think is left in the ball of dough that you cleaned? Why?

Explain the differences between the balls of dough from each trial (different types of flour). Are any of the balls larger than the others? Why might the balls of dough be different?

Which flour has the most gluten? Which has the least? How can you tell?

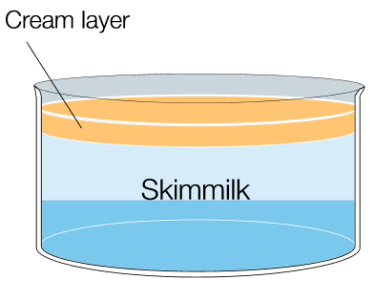
**FUN FACTS:** Some products such as lipstick, toothpaste and vitamins may use gluten during processing!

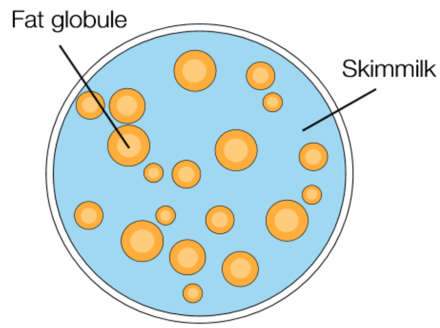
# Mystery milk

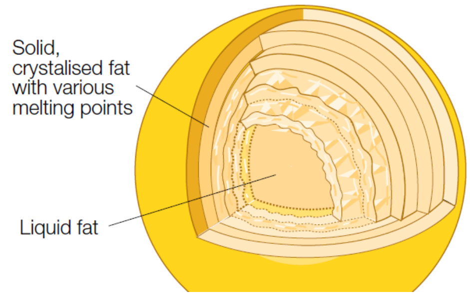
*Background:*

## What is in milk?

Milk is a mixture of **lipids**/fat globules (particles), **proteins** (casein micelles/particles and whey), **carbohydrates** (lactose/sugar) and minerals in water.

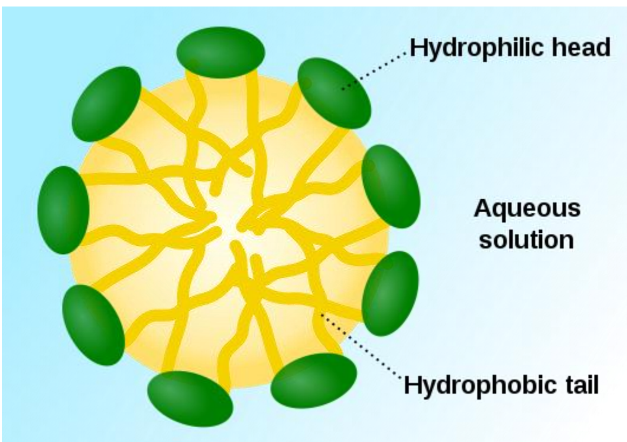



## What is interesting about milk?

Some of the proteins in milk (like casein proteins) are both *hydrophobic* **(dislike water)** and *hydrophilic* (**love water**). When these proteins are in water they stick together into small balls called micelles. The lipids in milk are mostly hydrophobic and they form a layer on top of the milk when it sits for too long. Different types of milk (skim, 2%, etc.) have different concentrations of **fat**, **proteins** and **carbohydrates**.




**Objective:** Understand the difference between skim, 2% and heavy whipping cream.

**Safety/Special rules: Do not drink any of the materials used in this lab and be careful not to get food coloring on your clothes!**

## Procedure:

1) Find a partner, 3 small cups filled with milk (labeled 1, 2 and 3), 2 small cups of water, a small cup of dish soap and a bottle of food coloring
2) Milk
   - Examine all of the cups of milk and record your observations below
   - Slowly add a drop of food coloring to the center of each cup
   - Examine all of the cups and record your observations below
   - Dip a Q-tip into the dish soap and carefully and gently touch the center of the drop of food coloring with the soapy end of the Q-tip **(don't stir the milk!)**
   - Examine all of the cups and **record** your observations below
3) Water
   - Stir salt into one of the cups with water (cup #2)
   - Allow the cups to sit still while you make observations
   - Once the water has stopped moving, add a drop of food coloring to each cup
   - **record** your observations below

## Data:

**Observations of Milk**

| | | |
|---|---|---|
| | | |
| **Cup 1** | **Cup 2** | **Cup 3** |

**Observations of Water**

| | |
|---|---|
| | |
| **Cup 1** | **Cup 2** |

## Analysis:

You had cups with regular 2% milk, skim milk, and heavy cream. Which type of milk was in each cup? How do you know?

What happened when you added food coloring to the center of the milk? Why do you think that happened? Did each cup of milk have the same response? Why or why not?

What happened when you touched the food coloring drop with the soapy Q-tip (in milk)? Why?

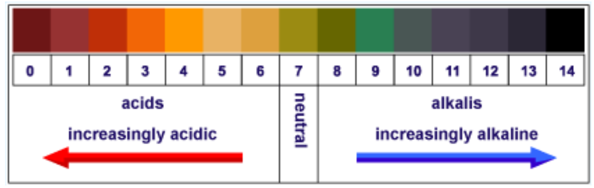
What was different about the adding food coloring to regular water compared to salt water? How does the salt make this happen?

Did the food coloring in the water behave different from or similar to the food coloring in the milk? Why do you think it was so different/similar?

**FUN FACTS:** It takes 29 cups of milk to make 1 pound of butter. The casein in milk helps cool your mouth after eating spicy food!

# PART II: Cooking with chemical reactions

## Painting with food




*Background:*

### Radical radishes and red cabbage

Usually you aren't supposed to play with your food, but sometimes when you do, interesting things can happen. The skin of radishes and red cabbages are both known as **acid/base indicators**. This means that they can change color depending on the pH of solution they are testing.



**Objective:** Use you knowledge from the demo to understand what is happening with a colorful picture you make!

**Safety/Special rules: Do not eat anything in this lab! Wear gloves when you are working with the vinegar, baking soda and the vegetables.**

### Procedure:

1) Find a place to work with: a piece of white paper, a cup of baking soda solution, a cup of vinegar and 2 cotton swabs
2) Using ONLY a radish, red cabbage leaf and grape juice concentrate draw a picture onto your white sheet of paper
   - Get creative with your picture and try to cover as much of the paper as possible!!
3) Write observations about the color that each food makes on the paper
4) Using a black marker, draw a black line down the center of your picture

LEFT

5) Dab a cotton swab into the baking soda solution and LIGHTLY cover the entire LEFT SIDE of your picture with the solution (do not make your paper TOO wet!)
6) Write observations about what your picture looks like now
7) Air-dry your picture by waving your hands over it for about 60 sec.
8) Dab a cotton swab into the vinegar and LIGHTLY cover the entire LEFT SIDE of your picture with the solution (do not make your paper TOO wet!)

RIGHT

9) Dab a cotton swab into the vinegar and LIGHTLY cover the entire RIGHT SIDE of your picture with the vinegar (do not make your paper TOO wet!)

## Data:

Observations after coloring:

Observations after baking soda solution (Left side)

Observations after vinegar (Left side)

Observations after vinegar (Right side)

## Analysis:

Is vinegar an acid or base? What about baking soda?

Describe what you think was happening when you added the vinegar to the baking soda on the picture? Why do you think this happened?

When you added only vinegar to the right side of to the picture what happened? Why do you think this happened?

Try making a different picture and experimenting with the order of the vinegar and baking soda. Can you make the picture return to normal?

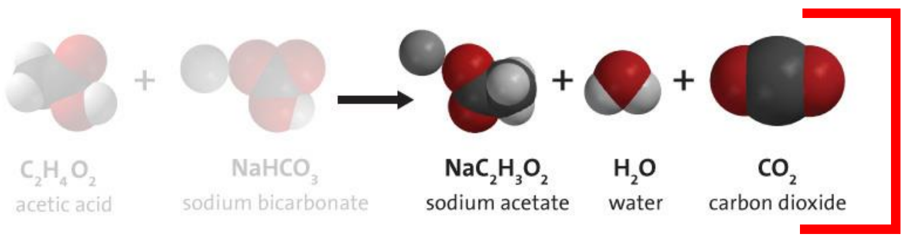
**FUN FACTS:** Some radishes can grow up to 3ft long!

# Chemistry of Brownies

*Background:*

## What is the difference between brownies and chocolate cake?

Baking actually involves quite a bit of chemistry! In fact the one major difference between brownies and chocolate cake is a simple chemical reaction. Most people who make *chocolate cake* use a combination of both **baking soda** and **baking powder**. On the other hand, *brownies* are generally made with just baking powder (and less) which allows them to be "flatter". This is because the addition of **baking soda** into an acidic mixture (chocolate and milk are acidic) **quickly release $CO_2$** while **baking powder** releases **$CO_2$ slowly** while baking.




**Reaction with baking soda**

**Safety/Special rules:** Let the UO student run the microwave and **wash your hands** before you make your brownie! ****YOU CAN EAT IN THIS "lab"****

**Objective:** Understand the difference between baking powder and soda in cooking


## Procedure:

- Find a partner, two microwavable paper cups and two forks
- Before you start pick who is partner A and partner B
  - Partner A will add 3 pinches of baking soda
  - Partner B will add 3 pinches of baking powder
- Into each cup add:
  - 1 large spoonful of melted butter to each cups
  - 4 large spoonfuls of water
  - a small pinch of salt
  - 2 large spoonfuls of sugar
  - 1 large spoonful of cocoa powder
  - 2 large spoonfulls of flour
  - **The appropriate amount of baking soda or powder** **(depends on which partner you are)**
  - Draw a line on the outside of the cup at the top of your mixture
- Make a hypothesis about what the 2 brownies will do when cooked (**record**)!
- With the assistance of a UO student, put the cup of chocolately goo into the microwave and wait!

- Once out of the microwave carefully draw a line marking the height of your brownie after baking
- Enjoy your brownie!

## Analysis:

**HYPOTHESIS**

What happened to partner A's brownie? What about partner B's brownie? Who's brownie grew bigger? Why?

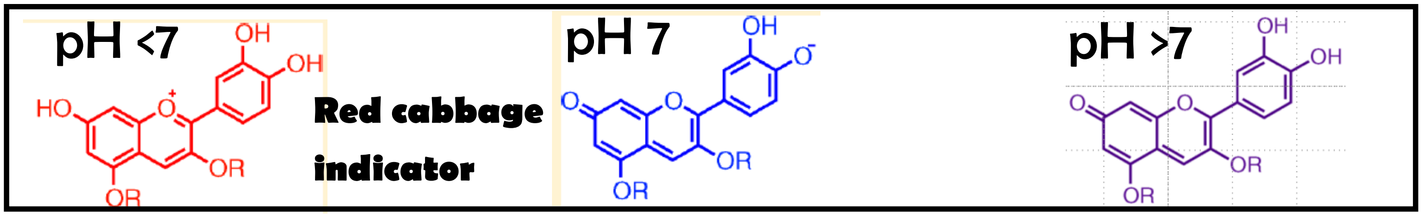
If you were to make another mug brownie, is there anything you will do differently?

**FUN FACTS:** According to legend, the first brownie ever made was a mistake! The baker didn't have enough baking powder when trying to make cake.

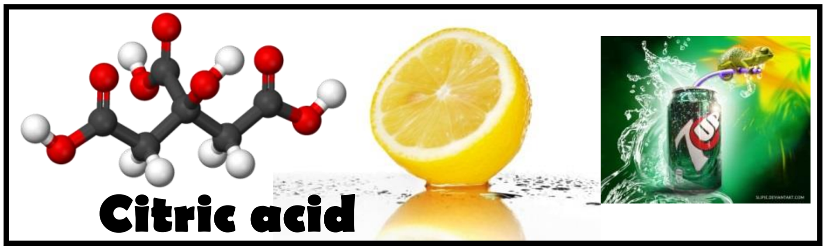
# Color changing drinks

*Background:*

**pH Indicators:** Red cabbage indicator (also used in the Painting with Food experiment) and blueberries are common **food indicators**. This means they can change their color depending on pH without adding toxic chemicals. This is because both of these foods are rich in antioxidants called anthocyanins. These antioxidants are blue at pH 7, purple when basic and red when acidic!




## What chemicals are we looking at in this experiment?:




**Baking soda**


**Safety/Special rules: You can drink what you make during this lab!! Just make sure your hands are clean before you start!**

## Procedure:

**1)** Find a small cup of the red cabbage indicator, the blueberry juice indicator and a ½ can of 7-up

**2)** Red cabbage indicator

a. Pour the red cabbage indicator into a larger cup and fill the cup to the half way mark with water (**record** the color in **A**)

b. Add a pinch (or two) of baking soda (don't add too much!) **Record** what happened in **B**

c. Fill a DIFFERENT glass ½ full of 7-up and add a pinch of citric acid (**Record** what happened in **C**)

d. Pour the contents from the cup in part b into the cup from part c (**record D**)

e. YOU can drink it if you want!

**3)** Blueberry juice indicator

a. Fill a new cup ½ full of water and add sugar (**record E**)

b. Add the blueberry indicator (**record F**)

c. Add baking soda until the color changes (not too much!) (**record H**)

d. You can drink it if you want!

## Data:

### Red cabbage indicator

| | | | |
|---|---|---|---|
| | | | |
| A | B | C | D |

### Blueberry indicator

| | | |
|---|---|---|
| | | |
| E | F | H |

## Analysis:

### Cabbage indicator

Which ingredients for this drink are acidic? Which ones are basic? How can you tell?

What color is the red cabbage indicator when the drink is acidic? What color is it when the drink is basic?

Why does baking soda fizz when added to 7-up?

What would happen if more baking soda was added to the pink solution? Why do you think that? Try it out and see if your hypothesis is right!

**Blueberry indicator**

What color was the drink before you added the baking soda? What color was the drink after you added the baking soda?

Is sugar water acidic or basic? How can you tell based on what you observed in this experiment?

If there is extra time, see if you can make a drink with the color and taste that you want using these ingredients! You could even try mixing the indicators together to get new colors.

**Write down any new drink recipes you come up with here. (Don't forget to give your tasty creation a fun and descriptive name!)**

**FUN FACT:** Blueberries have more antioxidants than any other fruit or vegetable!