

# The Alginate Worm Connection or "When Algy Meets Calcium"



Sodium alginate, also called algin, comes from a special large brown algae seaweed or kelp found in the Pacific Ocean. It has a very interesting property of forming gels in the presence of calcium ions. Now you can make some terrific, colorific wormy gel things by connecting, or bonding, alginate with calcium ions.

**Recommended for ages 5 and up with adult supervision.**

**This Kit Contains:** 1 liter 0.8 % sodium alginate solution with red cabbage extract, 25 grams calcium chloride, 5 cups, 5 forks, 5 droppers, small scoop, plastic tub and these instruction sheets.

**You will need:** water, paper towels, and various acids and bases such as lemon juice, baking soda, vinegar, clear ammonia cleaning solution, detergent containing sodium carbonate.

## Caution!

This is a safe and non-toxic chemical experiment kit when used as directed.

However, anything can be dangerous when used in the wrong way. Always use any chemical, including household chemicals, with care.

Do not drink or taste the chemicals in this kit. Keep the chemicals away from infants and young children.

Always ask permission to use any household materials.



Use safety glasses for Experiment 3.

If any chemical gets on the skin or in the eyes or mouth, the best first aid is to wash with lots of water.

Read the directions carefully. Never experiment with something you know nothing about. Experiment with small amounts of materials.

It will be less dangerous and easier to control than large amounts; and you will conserve your resources.

Keep the caps on the bottles when not in use. Calcium chloride is deliquescent. That means it will absorb moisture from the air.

Discard the gels in the trash; do not put the gels down the sink.

Wash with water, any cups, droppers, forks and the plastic container that you used in your experiments.

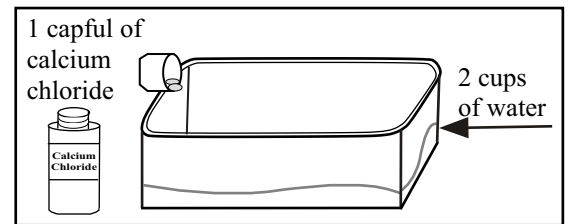
Wash your hands and put away your materials when finished.

## Experiment 1 Wormy Things

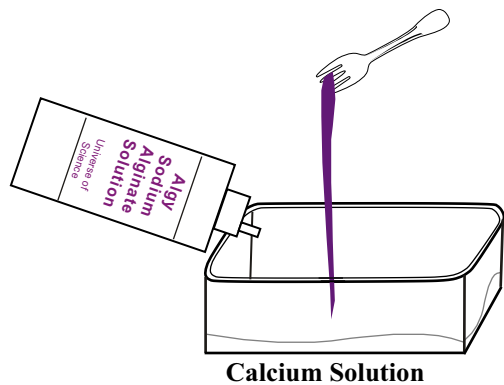
For our Alginate Worm Connections, we will use two solutions: **Algy** and **Calcium**. Chemists call a mixture of something dissolved in something else a **solution**. A solution also means an answer to a problem. In chemistry, you may be able to find a solution with the solution. Words can be confusing, so it is a good idea to use a dictionary.

**Algy** is our short name for sodium alginate. It is already mixed and is ready to use.

You will need to make a **Calcium Solution**. Take every thing out of the large plastic "shoe-box" container that this kit came in. Put 2 cups of water in it. Add one capful of calcium chloride to the water, and swirl the box back and forth gently. The white pellets of calcium chloride will begin to disappear. They **dissolve** in the water.



**This is the Calcium Solution**



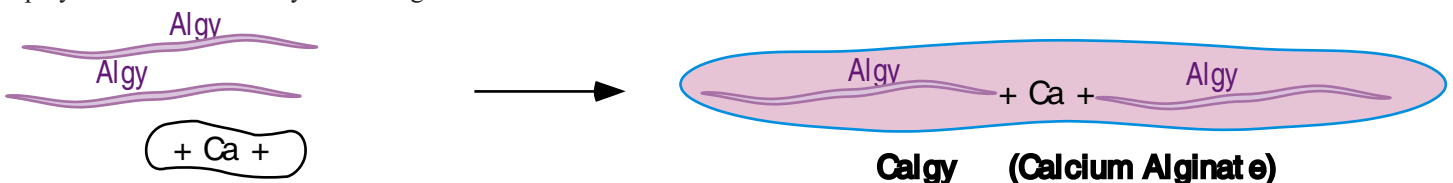
Now we are ready for **Algy** to meet **Calcium**.

Take the bottle of Algy and pop up the flip-top lid and squeeze one drop of **Algy** into the **Calcium Solution**. Look where the drop lands and see how it begins to react. Now add a squirt of **Algy** and see what happens. Take the fork and try to pull up the "wormy thing". It should be like jelly. You may be able to pull up a long string of jelly. Place it on the paper towel. Scientists call substances like this **gels**. They are safe to touch, but remember: **Do not eat any of these experiments.**

Add another squirt of Algy to the Calcium Solution. This time leave the worm in longer. Watch carefully. Can you see any changes?

The outer edge of the "worm" will begin to turn blue. It is reacting with something. More about this later.

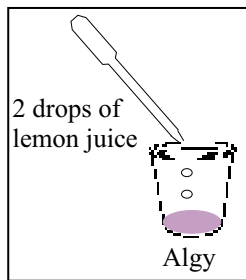
**How did it happen?** When Algy meets Calcium, Calcium grabs and holds two Algy. And this is a new **substance**. A substance is a kind of matter that has definite chemical composition. We can call the wormy things "Calgy". Chemists call them **Calcium Alginate**. "Calgy" is different than Algy and does not stay in the solution. It is not soluble in water and does not dissolve. Algy is made of long molecules called polymers and that is a key in forming the worms.



## Experiment 2 Color Changing Algy

You will need lemon juice for this experiment.

First we will practice using the dropper. The dropper is also called a pipet, which comes from a French word meaning “little pipe”. Pour some water into a cup. Then put the dropper tip in the water and squeeze slightly. Notice that air bubbles come out. Keep the dropper in the water and release the bulb. Look at the water move up the dropper. Squeezing the air out creates a **vacuum**, or empty space. Releasing the bulb allows the liquid to move into the empty space and fills the dropper. Hold the pipet over the cup and practice squeezing out one drop at a time.



Empty the cup and squirt about 1 teaspoon of the Algy Solution into it.

The exact amount is not important.

Then add a few drops of lemon juice to it. What happens?

The Algy Solution will turn pink or light red.

**Algy** is a purple color because we put an amazing pigment, or colored material, in it - red cabbage juice. Red cabbage can actually change colors in the presence of different acids and bases. Lemon juice is a weak acid and acids will turn red cabbage juice red.

Look at the pH chart to the right. pH is a measure of acidity.

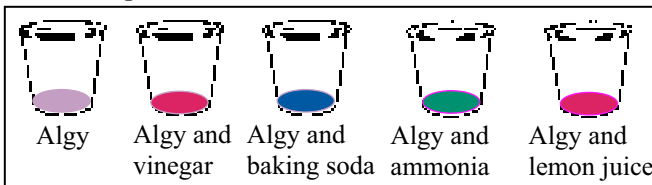
What is the pH of Algy with lemon juice in it? What is the pH of the original Algy?

Save the red Algy for Experiment 3.

## Experiment 3 Worms of Different Colors

You will need different acid and bases such as lemon juice, vinegar, baking soda, clear ammonia cleaning solution and detergent containing sodium carbonate for this experiment. **Caution: Do not use ammonia with young children.**

Take 4 more cups and put about 1 teaspoon of Algy in each. In cup 2 add a few drops of vinegar, in cup 3 a little baking soda and in cup 4 add a little ammonia cleaner. What happens to each?



Cup 1 will be our control, and we can compare it to

the others. A **control** allows the experimenter, that's you, to **observe**, or see, how changing one thing affects the experiment. This is very important so we can know what changed what. Scientists use controls to help them see how something causes something else to change. A **variable** is the something that can cause the change. In our experiment, the acids and bases are the variables. How will acids and bases change the wormy things?

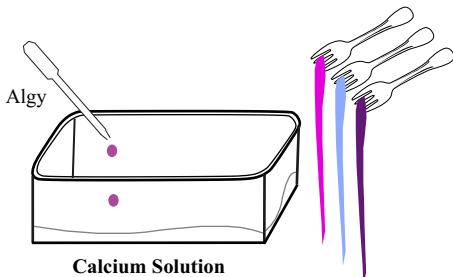
What is the pH of each solution?

If necessary, make more of the calcium chloride solution (1 capful in 2 cups of water) in the large container, as you did in Experiment 1.

When you are ready to make worms of different colors, use the droppers to squirt the different Algy mixtures into the Calcium Solution. You could also pour the Algy in. What happens?

What do you think is the best color or best pH to make “Calgy”?

Chemists know that chemical reactions are often affected by the pH or **acidity** of the solution. Do you think pH makes any difference in forming the calcium alginate gel?



## Experiment 4 Jelly Worm Eggs

We will make Calgy, or the calcium alginate gel, in a different way in this experiment and get a little surprise. Put a small squirt of Algy in a clean cup. Then use the small scoop and add 1 pellet of calcium chloride to the Algy. Watch it react or change. Pull it up with a fork. It will look like a jelly egg.

This time calcium chloride is dissolving in the sodium alginate solution. And as it dissolves, the calcium begin to react with the alginate. The “skin” on the Jelly Worm Eggs is thick because there is lots of calcium nearby to react with alginate. Calcium is more “concentrated” in this experiment than in the other experiments.

## Chemistry of Algy

Chemistry is the science what things are made of and how they change or react.

We could see the “Algy” change when it met Calcium in the solution.

We could also see the color change. These are **chemical changes** or **chemical reactions**.

This is a model or symbol of “Algy”:



The actual molecule of Algy, or sodium alginate, is too small for us to see. Scientists use models to help explain things that are hard to see.

This type of chemical substance is called a polymer. **Polymers** are long chains of many molecules linked together. Knowing about polymers can help us “see” or understand how the wormy things are formed.

Chemically, alginate is a polymer made of many sugar units linked together. It is a polysaccharide, like starch. Polysaccharides are carbohydrates that our bodies use for energy. The prefix **poly** means **many**, and the word saccharide refers to sugar. The seaweed that makes our alginate, uses alginate to makes its cell walls. If you ever stepped on seaweed on the beach, it feels like it is made of gel

## Red Cabbage Juice Acid-Base Indicator pH Chart



1 pellet of calcium chloride



a small amount of Algy in a cup

**Chemistry of Calgy:** Ca is the chemical symbol for calcium. When Algy is squirted into the Calcium Solution, calcium grabs and holds 2 Algy chains. As it does this, the long Algy polymers trap and hold water from the solution. Calgy is like a molecular net holding water. It is soft and squishy because it is mostly water. This strange **state of matter** is called a **gel**. A gel is a liquid trapped in a solid.

The following is the chemical equation for this reaction. The arrow means yields or produces.



The calcium is in the form of a divalent ion,  $\text{Ca}^{++}$ . It has a positive 2 charge. It holds onto two long groups at a time. Sodium is a monovalent ion,  $\text{Na}^+$ . Di is a prefix meaning 2, and mono means one.

Because calcium can hold 2 of the alginate chains, or 2 parts of one long chain, it is less soluble in water than sodium alginate. That is why it comes out of solution. It starts to clump. As it does this, it traps water from the solution.

### The Calcium Connection

You may have noticed that the wormy things skin turns blue. That is because calcium chloride itself is slightly **basic**, or **alkaline**.

As Algy hits the Calcium Solution a reaction takes place and forms a film around the Algy and some unreacted sodium alginate is trapped inside. The wormy thing is actually filled with liquid Algy. If the worm is kept in the solution for a longer time, more  $\text{Ca}^{++}$  can **diffuse**, or pass through the film and react with the sodium alginate still inside. This makes a **thick "skin"** on the wormy calcium alginate gel. And the worms become more blue as more of the slightly basic calcium chloride solution diffuses through.

Calcium is an essential element for our good health. Calcium is needed for the construction of bones and teeth. It is also needed for nerve conduction and muscle contraction. We can not make a move without calcium.

The word calcium comes from the Latin word "calx", which meant lime, as in limestone which is made of calcium carbonate.

Hardwater has large amounts of calcium. It is a problem because it can form scale (calcium carbonate) in pipes. It also prevents soap from lathering or forming lots of bubbles. What will happen if hardwater is used to make an alginate solution?

### The Red Cabbage Juice Connection

Red cabbage juice contains beautiful compounds called anthocyanins that change colors at different pH. pH is a measure of acidity and alkalinity on a scale of 0 to 14, where 7 is neutral, acids are less than 7 and bases or alkalies have a pH greater than 7.

### Suggestion for a science fair or classroom research projects

1. You may try other sources of calcium to form the gel with sodium alginate.

Try a "Tums". You will need an antacid tablet of the type that has calcium in it such as "Tums" and a little vinegar. The active ingredient in "Tums" is calcium carbonate. Place half of a "Tums" tablet in a cup and add 2 teaspoons of water. Stir with a stick. Notice that the white particles will not dissolve. Most of it is a starch binder to help hold the tablet together. Also calcium carbonate is not very soluble in water. Add a teaspoon of vinegar to help it dissolve. Then add a squirt of "Algy" to the Tums mixture.

Try adding a squirt of "Algy" to Orange Juice that has calcium added to it.

2. What other metal ions will react to gel sodium alginate? Calcium is a metal in Group II of the periodic table and as mentioned earlier, it forms +2 ions. Will other metal ions such as magnesium ( $\text{Mg}^{+2}$ ), zinc ( $\text{Zn}^{+2}$ ) or copper ( $\text{Cu}^{+2}$ ) form a gel with a sodium alginate solution? You will need a small amount of chemical supplies such as magnesium sulfate which is available as Epsom salt. Also, zinc nitrate and copper sulfate may be available in a science or chemistry department laboratory. **Caution:** do not eat any material made in this experiment.

3. Are there other common algae that will make an alginate connection with calcium and form a gel?

4. Try adding a little common table salt to some of your wormy gels and see how the gel breaks down.

### More on Alginate

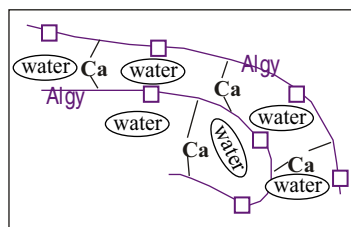
Algae is plural for alga which comes from the Latin word for seaweed. Algae are primitive or simple plant life and are important for all plant life in water.

Alginate is extracted or remove from the seaweed and used for many purposes. One interesting use in medicine is for wound dressings (like a bandage). This is especially good for burn victims. The alginate gel keeps bacteria out while keeping the wound moist and promotes healing. The gel dressing can be rinsed away with saline solution (salt water) so changing the dressing will not hurt like pulling off a regular bandage.

Alginate and its chemical relative alginic acid, is an ingredient in some stomach medicines. Apparently it is used to coat the stomach wall. Look for it on labels in a drug store. That may sound strange, but it is nutritious, which means that it is a good source of energy for living things. Sodium alginate is actually similar to the flour that we bake with. Flour is made from the grain, or seeds, of plants such as wheat. Another common seaweed product that you may use in biology class is agar. It is used as a nutrient for growing cultures.

Alginates are used in the food industry as thickeners and in meat substitutes. It is also used as emulsifiers to keep other ingredients suspended, so they do not settle out. You can understand how it can do these things after seeing the thick or **viscous** Algy solution. It is also used in ice cream to help prevent ice crystals forming. Look on packaged food labels and read the ingredients.

Alginate gels are also used in making dental impressions, that is, a mold of teeth. The mixture for making the dental impression contains certain additives that slow down the reaction to form the gel so that an impression of the teeth can form while the gel sets and more calcium so the gel will be firmer than our Wormy Things.



Model of "Calgy"  
calcium alginate gel

