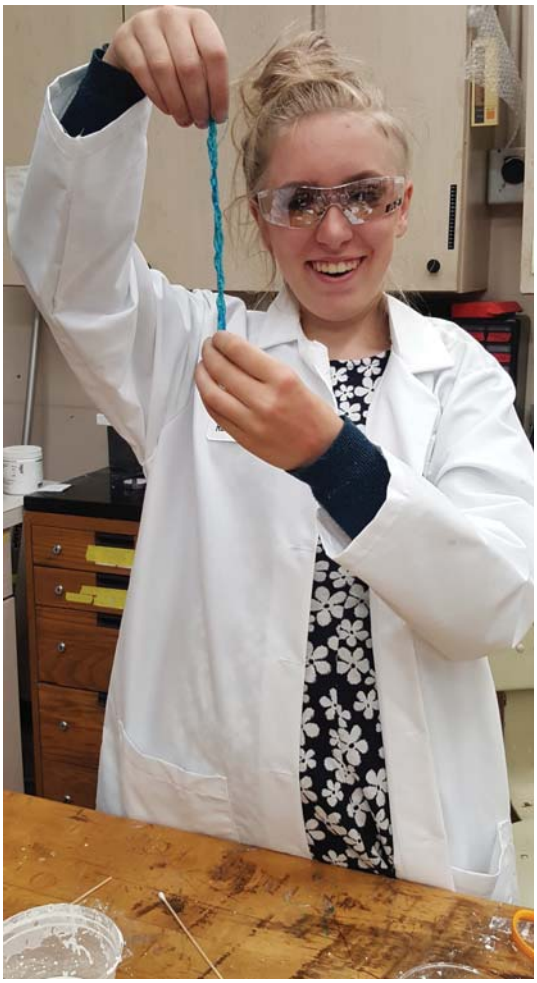
Slimy Spaghetti and Meatballs

Gels are jelly-like materials made mostly of liquid, but with a little polymer added to hold it all together and make it a solid. It is possible to mold gels into many different interesting shapes. In this demo, we will experiment with gels that form when one liquid comes in contact with a second liquid. If done right, the first liquid will solidify almost instantaneously. Here, we will make "slimy spaghetti and meatballs" by using a transfer pipette to gel jets (spaghetti) and drops (meatballs) to create an appetizing meal that you should definitely not eat! Really, don't eat it!!

What you will need to get started

- Solution A - 1.5% Sodium Alginate in water and Solution B - 5% Calcium Lactate in water
- Two 250ml or 500ml sealable bottles
- Petri dish or glass bowl
- Food coloring
- Transfer pipettes
- Probes – plastic forks, spoons and knives
- More Probes - your fingers
- Clean up - Paper towels



How to make slimy spaghetti

1. Mix solution A and solution B in separate bottles or use the premixed solutions provided
2. Add a few drops of food coloring for fun.
3. Fill several transfer pipettes with Solution A and a Petri dish with Solution B.
4. Squeeze a jet of Solution A out the pipette and into the pool of Solution B to form spaghetti.
5. Squeeze a drop of Solution A out of the pipette and into the pool of Solution B to form meatballs.

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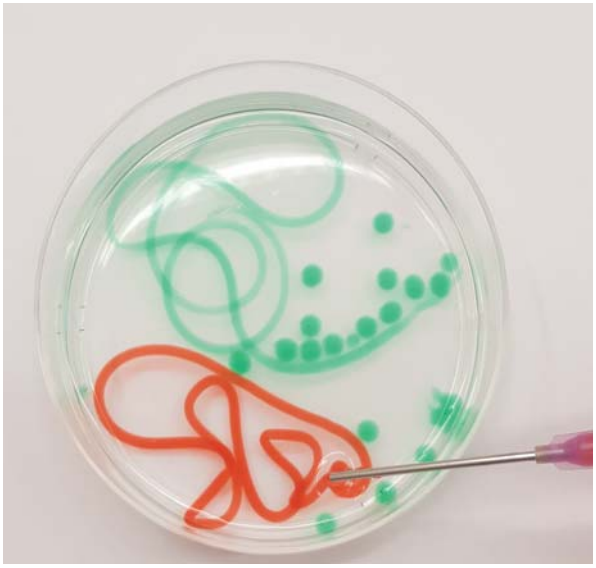
The Society of Rheology
K12 Outreach Activities

Science is FUN!

Let's experiment!

1. Use the plastic forks to scoop out some of the slime spaghetti. Is the spaghetti squishy or does it hold its shape well?
2. Can you press some of the spaghetti together to make a thicker spaghetti? Is it sticky?
3. How are the meatballs different from the spaghetti? Do they feel different? Are they sticky? What happens when you squeeze them.
4. The gel will get stronger the longer Solution A is in Solution B. Try taking one meatball out of the Petri dish quickly and a second meatball out after a few minutes. How are they different? Squeeze each and find out
5. Are the gels solid? Do the meatballs bounce? Are the gels liquid? Does the water drain out of them over time?



More experimental fun

1. Sticky gels can be used in so many places. Can you think where this slimy spaghetti can come in handy?

2. What other shapes would you like to mold this gel into? How can you do it? What would different shapes be useful for?

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How does it work?

Alginate is a type of polymer called a polysaccharide. Polymers are very large molecules which can have thousands or even millions of carbon molecules connected together to form a long chain. Think about a piece of spaghetti or a length of rope. In gels, the polymers are connected to each other at various points along the chain to create what is known as a cross-linked network. In this experiment, the chemicals in Solution B cause the polymer in Solution A to cross link and form a network. Because these polymers like water, they can store large volumes of water inside the network making the resulting gel network soft and squishy.

Polysaccharides occurs naturally in all brown algae as a skeletal component of their cell walls. Alginate is used in food because it is a powerful thickening, stabilizing, and gel-forming agent. Some foods that may include alginate are ice cream, fruit-filled snacks, salad dressings, pudding, onion rings, and even the pimento strips that are stuffed into green olives.

Most alginate used in foods is in the form of sodium alginate. In this demo, you created a gel out of sodium alginate. In order to form a gel, sodium alginate needs to come into contact with divalent ions such as calcium (Ca^{2+}). As soon as sodium alginate is added to a solution of calcium lactate, a gel forms as the sodium ions (Na^{+}) are exchanged with calcium ions (Ca^{2+}) and the polymers become crosslinked.

How does it work?

Other examples of polymer gels:

a. Egg whites: Egg whites, called albumen, are made up mainly of protein and water. Proteins are natural polymers. The proteins can be cross-linked by exposure to heat. When you cook them, the individual polymer proteins unravel and cross-link, similar to the way gelatin does, creating a more solid gel. This won't work as well on the yolk, which, while also protein-rich, has lots of fats and other properties that make it more difficult for it to become hard. You can do something similar when you whisk egg whites: By exerting mechanical energy in the whisking process, you cause the protein bonds to break, and subsequently re-connect. Once these new, strong bonds are formed, the egg stays in that state. The proteins have formed a network of strong, permanent cross-links. A cooked, chemically-altered or well-beaten egg will never go back to its original state. This is an example of a permanent cross-link.

b. Jelly: Jelly is a gel that gets its structure from a polymer called pectin, which is naturally occurring in most fruits (apples are particularly pectin-rich). Jellies are usually made by applying heat to a sugar-water-pectin mixture, which causes the pectin to cross-link.

c. Orbitz drinks: This drink was available for a short time in the 1990s. It consisted of a sweet drink with gel beads similar to the ones made in this experiment suspended in it. The beads seemed to defy gravity by floating in the drink and being fairly difficult to get moving. The secret was that the sweet liquid surrounding the beads also contained some polymer ingredients that created a weak mesh that held the beads in place.

d. Tapioca, the beads in bubble tea, etc.