Applications: Activity 1

Self-Assembly

Get It Together

We're Keeli and Connor and we love the great outdoors. While practicing setting up our tents for a camping trip, we noticed that some tents take forever to put together but others seem to come together all on their own!

Our question:

How can some things assemble all by themselves?

We headed to the **Children's Museum of Houston** where we learned about self-assembly, a type of bottom-up manufacturing in which molecules assemble themselves into complex patterns. Snowflakes are a great example of self-assembly! Then we visited **Rice University** to see firsthand how nanoscientists are using self-assembly to make tiny capsules that could be used to deliver drugs or clean up oil spills. Even fancy chefs are using self-assembly these days to trap tasty food ingredients! We wanted to see this for ourselves and so we went home to self-assemble capsules around ice cream toppings.

Nano Matters

One of the major barriers preventing nanotechnology applications from becoming mainstream is in mass manufacturing. Scientists are getting quite skilled at manipulating things atom by atom, but this approach results in the production of a single device. If they want to produce many items that look and function exactly the same, they need to come up with new "assembly lines." Manufacturing at the nanoscale is a whole new ballgame and self-assembly is one way scientists are getting the job done.

Icebreaker

Got game? This fun one models self-assembly.

15 minutes per game

DragonflyTV Skill: Modeling

Give your kids this set of rules and let them self-assemble into a pattern.

You'll need:

- an even number of people (about 10 works well)

Rules

1) You must hold hands. No hand can be left untouched.
2) Your right hand must touch another person's right hand and your left hand must touch another person's left hand.
3) You cannot cross your arms.

Results

The kids will be standing in a complete circle with each child alternating the direction they are facing.

Are you a nano-bit curious?

Self-assembly isn't unique to nanotechnology. Nature has been self-assembling things for billions of years. DNA self-assembles into a double helix, for example. The molecules just "know" where to go and click into place. Scientists realize that nature figured out the "rules" of the nanoscale a long time ago, and we can use this information to create new materials.

For additional self-assembly game ideas, visit: pbskidsgo.org/dragonflytv/show/selfassembly.html

Investigation

Try this tasty self-assembly activity.

1 hour or more

Guide your kids as they

Mixture 1

- 1/4 teaspoon sodium alginate
- 1/2 cup water
- 2 tablespoons filler ingredient*

Mixture 2

- 3/4 teaspoon calcium chloride
- 2 1/4 cups water

1) Combine the alginate and water in a blender according to Mixture 1.
2) Add the filler ingredient and blend again. (NOTE: Add 2–3 drops of food coloring to enhance the color.) Let this mixture stand for 15–30 minutes to remove air bubbles.
3) In the meantime, create Mixture 2 in a separate bowl.
4) Using an eye dropper or straw, drop Mixture 1 into Mixture 2 and watch self-assembly in action! (Note: For the best texture and flavor, do not let the pearls sit in Mixture 2 for more than 1 minute.)
5) Use a strainer to take the pearls out of the calcium chloride and rinse with fresh water before consuming (otherwise, they will taste salty).
6) Try dropping Mixture 1 into a bowl of plain water. It will not self-assemble because the conditions are not right.

You'll need:

- eye droppers or straws
- 2 bowls
- blender
- food grade sodium alginate (can be purchased at willpowder.net)
- food grade calcium chloride (can be purchased at willpowder.net)
- strainer
- measuring cups and spoons
- variety of "filler" ingredients (chocolate, strawberry, maple, and boysenberry syrup)
- food coloring (optional)

*Most any type of syrup works well as a filler ingredient. However, very acidic or very thick substances do not work as well (e.g., lemon juice and marshmallow fluff).

DFTV Adult Tip

Ordinarily, eating is not allowed in a laboratory. Here are two suggestions for how to approach this activity.

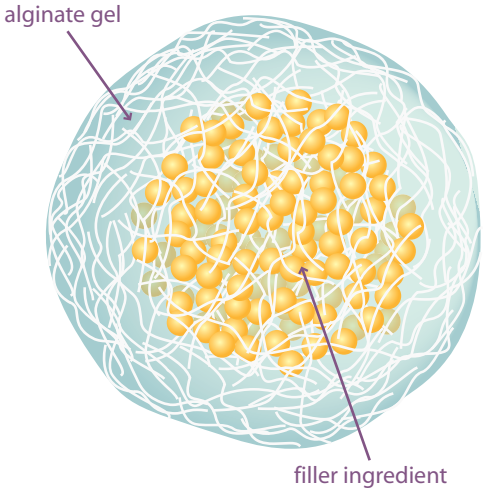
1) Alginate beads are being served in high-end restaurants as "fake" caviar or to set atop desserts. The kids can be food scientists for the day whose jobs are to make the best dessert topping.
2) Do the activity first as a scientific experiment during which no one eats anything. Then, after discussing results, each group can choose their best creation to sample.

Are you a nano-bit curious?

Alginate beads are macroscale self-assembled relatives of the capsules nanoscientists make in the lab. Scientists rely on the ability of molecules to assemble themselves according to certain rules (i.e., positive attracts negative and "water fearing"—hydrophobic—molecules stick to other hydrophobic molecules). By creating the proper conditions, you created capsules filled with food. Nanoscientists are doing the same thing, but filling the capsules with medicine, for example, to carry drugs to the diseased cells of the body without affecting healthy cells.

DFTV Science Helper

Alginate is a gummy substance that comes from seaweed and is commonly used as a food thickener (e.g., fruit-filled snacks and the red stuffing in green olives). Alginate is a long, stringy molecule that has lots of negative charges. Sodium (Na^+) has a positive charge in solution and serves to balance the negative charge on the alginate. Calcium chloride is just a type of salt. When the two are mixed, the calcium ions (Ca^{2+}) displace the sodium ions (Na^+), linking the long chains of alginate to form a gel. During this process, the "filler" ingredients get trapped on the inside while the water gets pushed to the outside of the pearls.



Keep Exploring!

Try varying the amount of alginate in Mixture 1 or salt in Mixture 2. Can you find the boundaries where the pearls won't assemble? Can you make different shapes? How big can the pearls get? Does the type of salt make a difference? Try table salt (sodium chloride).