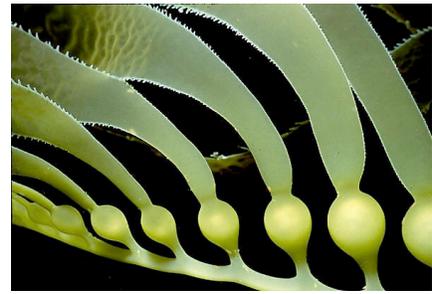




Kelp Beads



The Big Idea

- Polymers are long molecules made by linking many small molecules called monomers together. (All plastics are polymers)
- Kelp beads are made from monomers of kelp sugars that are linked by calcium ions.

Materials

Demonstration	Kelp beads (per group)	
<ul style="list-style-type: none"> • Various plastic items – bags, cups • 1 giant kelp blade or cool pictures of giant kelp 	<ul style="list-style-type: none"> • 1 small cup of alginate solution • 1 cup of calcium chloride solution • 1 empty cup • 1 mesh 	<ul style="list-style-type: none"> • 1 dropper per cup of alginate • cups of alginate mixed with various colors • Ziplock backs or cups with lids • Acrylic paint colors

There are enough supplies for 20 groups per rotation.

Prep Work

Prepare before the event:

- Prepare large containers of alginate solution (10g of powder per liter). Use the instructions provided with kit. It is best to prepare the alginate solution the night before the session to allow the powder to be completely mixed with the **BOTTLED** water.
- Prepare the calcium chloride solution (5 grams of powder per liter). This can be done at the same time as the alginate solution.

Prepare before the session:

- Mix some of the alginate solution with different colors of acrylic paint to allow families to create colored beads.
- Have each material in bins or piles that are easy to distribute.



Procedure

During session:

- ASK participants to describe plastics and why they are so widely used. Point out some of the plastic items around the room. Accept and acknowledge all relevant answers.
- Introduce the first concept, which is polymers are long molecules made of many smaller molecules named monomers. The physical properties of the polymer depend upon the type of monomers present and how the monomers are linked together. Therefore, there are many different types of plastics. Polymers and monomers can also be found in biological systems as well in the form of sugars also DNA.
- Display or show a picture of a giant kelp frond and describe the alginates (kelp sugars) that can be extracted from the kelp. The alginates are monomers that form polymers when exposed to calcium and other divalent metal ions.
- Have everyone stand up and explain they will be doing an activity that requires them to move around. They are all monomers and every time they bump into another monomer they will link arms creating a chain or polymer. Have everyone freeze and look around the room. Is there anyone standing alone? Where is the longest chain?
 - Have the single people move around and then ask the large chain to do the same. ASK the families what they notice.
 - Now have one of the instructors cross link two chains and explain how...
 - Have everyone take a seat and explain how they are going to attempt the same thing tonight
- Hand out the cups of clear alginate with the dropper and have the families examine them. Tell them that these cups contain the monomers before they have been linked together.
- Pass out the calcium chloride solutions and mesh square.
- Have the families use the dropper to create polymers by exposing the alginate to the calcium chloride solution. This needs to be done carefully, so demonstrate the use of the dropper and dropping the alginate solution into the calcium chloride slowly.
Emphasize that the dropper itself should not touch the calcium solution for the polymers will instantly form and clog it up.
 - The polymer formed will create a “skin” around the rest of the drop of alginate, therefore creating a bead of alginate. Since the alginate is a dilute solution in water, most of the bead is water and thus has an index of refraction that is similar to water. Light is not bent very much as it travels through the calcium solution and into the beads. The beads are therefore difficult to see when in the calcium chloride solution.
- After dispensing 2-3 droppers full of alginate into the calcium chloride, ASK the families what they have made. It should be difficult to tell without close examination. Have the families place the mesh over the empty cup and while holding the mesh tightly pour the

entire calcium chloride solution with contents through the mesh into the empty cup. The clear alginate beads should be caught by the mesh. This is an “OOOH AHHH” moment. Why do you see them now? ***The index of refraction of the beads is now very different from the surrounding air, therefore light is refracted more when traveling from air into the beads.***

- The alginate beads are squishy and are fun to play with. You can encourage the families to play with the beads at this point. (*They should wash their hands before leaving the session*). The beads should pop like little water balloons. If the beads are left in the calcium chloride longer, more of the calcium will diffuse into the beads and polymerize the alginate sugars. Thus the beads would feel tougher.
- This is a good time to introduce the idea that other substances can be bound within the beads and used for various biotechnological purposes, for instance medication encapsulation and delivery. Also point out the uses of alginates in the food industry (as mentioned in the background).
- It is now play time. Introduce the colored alginate solutions and let the families loose. Students generally find ways to make long worm-like objects. The beads can be taken home in the ziplock bags. If calcium chloride is added to the take bag, the beads will toughen over time. If the beads are left to dry the water will evaporate leaving them raisin-like.
 - **Note: Please caution the families to avoid eye contact and ingestion of the beads and calcium chloride.**

SAFETY / Troubleshooting / Notes

- They CANNOT eat the beads

Resources

- **Alginate structures** www.csun.edu/~hcbio029/lavalamp/AlginateStructures.pdf
- **Edible Alginate**
 - <http://www.lessonplanspage.com/ScienceEdibleSlimeAlginatePolymer18.htm>
 - <http://blog.khymos.org/2007/03/30/first-experiments-withsodiumalginate/>

Background

One of the major species of seaweeds that contains alginates is the giant kelp, *Macrocystis pyrifera*, which grows along the Californian coast as well as the northwestern and southwestern coasts of South America, and the southeastern coasts of Australia and New Zealand.

Alinates are made up of long chains of two monomers: guluronic acid and mannuronic acid. The chains can be made of all one monomer or mixtures of both. The stems of kelp are made of chains with more guluronic acid, and the leaves (fronds) have more mannuronic acid. Guluronic chains bind tightly to calcium; in mannuronic chains the calcium is more easily replaced by sodium, allowing the fibers to swell easily. [1]

The sodium alginate will instantly form gels when in contact with divalent metal ions, such as calcium and barium. The calcium alginate protects the seaweed from drying out during low tides.

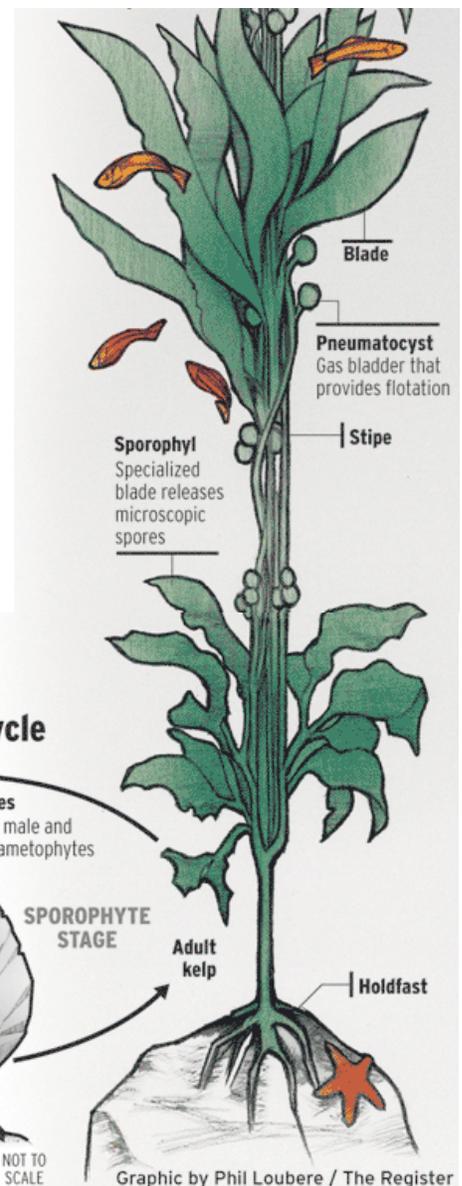
Sodium alginate is used in food preparations as a thickening agent, a stabilizer, and an emulsifier in ice cream, cream cheese, salad dressings, frozen foods, and pharmaceuticals.

Calcium alginate is the major ingredient in the “pimento” found in stuffed olives. [2] Alginates are used as thickeners in fat substitutes, pet food, stuffed olives, onion rings, low-fat sauces and spreads, and pie fillings. Propylene glycol alginate is stable in acids. It is used to preserve the foamy head on beers. [1]

A very important use of calcium-alginate is the formation of gel beads that are used to encapsulate enzymes, hormones, drugs, and whole cells for biotechnological and biomedical applications.

1. Why There's Antifreeze in Your Toothpaste, Simon Quellen Field, Simon Field

2. Glycoscience, Bertram O. Fraser-Reid, Kuniaki Tatsuta, Joachim Thiem



Giant kelp

Macrocystis pyrifera

The largest marine plant, the giant kelp is classified as a brown alga. It lives through photosynthesis, so it exists only at depths that sunlight can penetrate, and thrives in waters rich in nutrients from ocean upwelling. Kelp forests provide valuable habitat for a wide range of ocean species.

Habitat: Cool (42-68 degrees F.), nutrient-rich waters along Pacific coast. Needs rocky ocean floor to anchor itself.

Depth: 20-100 feet.

Size: Adult stage can reach hundreds of feet in length. Record is 213 1/4 ft.

Life span: Perennial, lives up to seven years.

Foes: Sea urchins, in particular, devour giant kelp. Kelp rely on sea otters, which eat the sea urchins, to maintain a balance.

Sources: Southern California Edison; National Marine Sanctuary Foundation; Monterey Bay Aquarium

