Kelp Beads

The Big Idea

1) Polymers are long molecules made by linking many small molecules called monomers together. (All plastics are polymers)

2) Kelp beads are made from monomers of kelp sugars that are linked by calcium ions.

Background

marinebio.org/i/giant_kelp.jpg Oct 21, 2008

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

Materials

Kelp beads (per group)

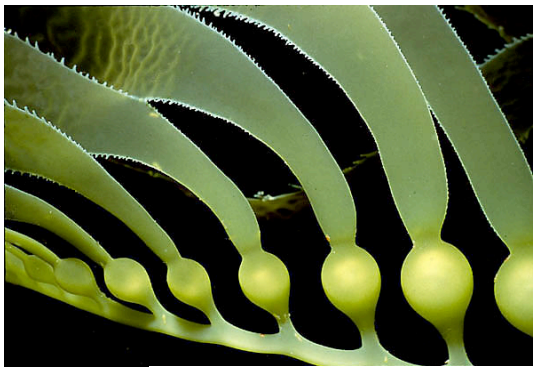
1 cup of labeled alginate solution
1 cup of labeled calcium chloride solution
1 empty cup
1 mesh
1 dropper
cups of alginate mixed with various colors

To Take Home

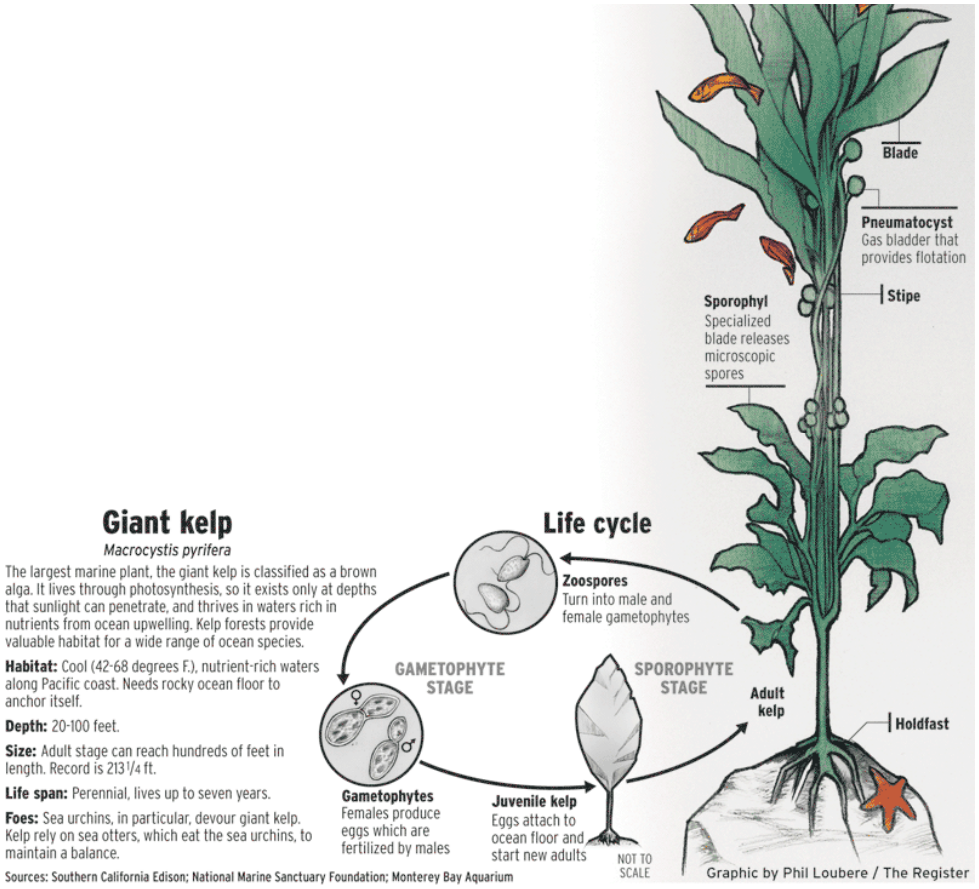
Plastic soufflé cups and lids for the beads.

To demonstrate

Various plastic items – bags, cups
1 giant kelp blade **or** cool pictures of giant kelp



www.westworld.com Oct 21, 2008



http://www.ocregister.com/newsimages/news/2007/08/07kelp_gp.gif Oct 21, 2008

Procedure

To prepare <u>before</u> the session:

1. Prepare large containers of alginate solution. 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 water.
2. Prepare the calcium chloride solution. This can be done at the same time as the alginate solution.
3. Mix some of the alginate solution with different colors of food coloring to allow families to create colored beads.
4. Have each material in bins or piles that are easy to distribute.

<u>During session</u>

1. Ask participants to describe plastics and why they are so widely used. Point out some of the plastic items presented. Accept and acknowledge all relevant answers.

2. 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.

3. 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. Hand out the cups of alginate and have the families examine them. Tell them that these cups contain the monomers before they have been linked together.

4. Pass out the calcium chloride solutions and droppers. 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.

5. 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 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).

6. 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 plastic soufflé cups with lids. If calcium chloride is added to the take home cup, the beads will toughen over time. If the beads are left to dry the water will evaporate leaving them raisin-like.

Notes: Please caution the families to avoid eye contact and ingestion of the beads and calcium chloride.

Resources

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