D E P A R T M E N T O F
Biomedical Engineering
College of Engineering University of Wisconsin-Madison

Engineering Alginate Beads

Organization: University of Wisconsin-Madison Department of Biomedical Engineering

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General Description

Type of activity

The participants will do an activity that is an example of how scientists can influence chemistry and biology to work together in many applications. The students will make alginate beads using 1% alginate weight per volume and see how the alginate solution changes from a liquid to a gel once it has been added to a 50 mM calcium chloride solution.

Program Objectives

Big idea: Biology and chemistry interact in many aspects of life. Scientists can manipulate these interactions to form new uses for materials that already exist in biology.

Learning goals:

As a result of participating in this program, visitors will be able to:

1. Understand the need for tissue engineering techniques
2. Understand what alginate is and why it is used in tissue engineering
3. Think of other things that alginate can be used for other than tissue engineering

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Time Required

Set-up	Program	Clean Up
		
(10 minutes)	(20 minutes)	(10 minutes)

Background Information

Definition of terms

Alginate is a chemical compound that is derived from algae.

Program-specific background

Alginate is a common biomaterial that is used in tissue engineering and drug delivery. Its gelation properties enable the encapsulation of cells and growth factors, allowing specific delivery to desired locations in the body. Gelation occurs when calcium (or barium) ions interact with the alginate.

Alginate is also highly porous, which allows for easy diffusion of growth factors into and out of the gel. It is bioinert, or does not interact with the body to cause an immune response, and is easy to modify as to incorporate specific chemical structures that can influence cell adhesion or function.

References

1. Amsden, B.; Turner, N., Diffusion characteristics of calcium alginate gels. Biotechnol Bioeng 1999, 65 (5), 605-10. 6.
2. Wee, S.; Gombotz, W. R., Protein release from alginate matrices. Adv Drug Deliv Rev 1998, 31 (3), 267-285. 7.
3. Petruzzo, P.; Cappai, A.; Ruiu, G.; Brotzu, G., Cell microencapsulation: a new method. Transplant Proc 1994, 26 (6), 3507-8. 8.
4. Smidsrod, O.; Skjak-Braek, G., Alginate as immobilization matrix for cells. Trends Biotechnol 1990, 8 (3), 71-8

Materials

Making the Alginate beads:

- Dixie cups
- Plastic pipettes
- Plastic spoons
- 1 milliliter of 1% weight per volume alginate solution per group (divided into 1 mL tubes)
- Cooler to keep alginate cool when not in use
- 10 milliliters of 50mM $CaCl_2$ per group
- Paper towel
- Ruler or Calipers

Set Up

Time: 10 minutes

Step 1:
Set out 1 sheet of paper towel at each station

Step 2:
Place one dixie cup on top of each paper towel. Then add 10 mL of 50mM $CaCl_2$ to each dixie cup.

Step 3:
Place 1 plastic spoon and 1 plastic pipette at each station.

Step 4:
Just before the activity begins, set out 1 mL of 1% alginate at each station

Program Delivery

Time: 20 minutes

Safety:
Just for good practice, each participant should wear safety goggles and gloves. None of the materials are chemically unsafe.

Procedure and Discussion—Making Alginate Beads

Step 1:
Ask the participants to work in groups of two and choose a station.

Step 2:
Tell the participants to start by picking up the pipette and drawing the alginate solution up into the pipette.

Step 3:
Have the participants drip the alginate solution into the dixie cup of calcium chloride. Ask some groups (about half) to see if they can form the biggest alginate bead (in diameter); ask the other half if they can make the most alginate beads.

Step 4:
Once everyone has used up their alginate, have the groups either count their beads (if they were asked to make the most) or choose their largest bead (if they were asked to make the largest).

Step 5:
Measure the largest beads and record their size. Have the groups that counted the number of beads report their number to you.

Step 6:
Announce the winner of each task

Tips and Troubleshooting
The groups should be spaced out enough so that the participants have enough elbow room to use the pipette.

Ask the participants to take turns in their groups. One person should not be doing the entire activity.

Be sure to iterate that the beads need to be round. If the participants squeeze the alginate solution out of the pipette and into the calcium chloride solution too quickly, the alginate will form a string that ends up falling apart.

Common Visitor Questions
How does the alginate change from liquid to gel?
The calcium ions in the calcium chloride solution cause the alginate strands to crosslink, forming a gel.

What's the best method to make the largest bead?
There are many ways, but the most common is using the wall of the dixie cup, slowly squeeze out the alginate from the pipette until it forms a large ball. Then release the ball into the solution.

Going Further…

Reflecting on the project, ask participants if they can think of other uses for alginate besides cell encapsulation or drug delivery techniques. Are there other biomedical uses for alginate? Are there non-biomedical uses for alginate?

Clean Up

Time: 10 minutes

Carefully clean up each station. All materials are disposable, so they can be thrown away in the nearest trash. Calcium chloride solution can be dumped down the sink with running water.