In Class Activity: Alginate Hydrogels

Work through and fill in the worksheet below. For the in-class portion, work in groups of 2-3 to complete the assignment. When ready, upload a copy of your completed problem set and any code you used to complete the assignment. Please submit by the specified due date in Canvas.

Overview: In this in class activity, you'll explore how alginate hydrogels can be designed for drug delivery applications. These simple materials can mimic how a drug is released from an injectable gel into soft tissue in the body.

Classmates you worked with for in class portion (if any):

1. In this activity, you will investigate the impact of crosslinker density on hydrogel stiffness. You have the following materials:

- 2 wt.% alginate (dissolved in water) with pink food dye
- Low (0.1 wt.%), medium (0.5 wt.%), and high (2 wt.%) concentration calcium chloride ($CaCl_2$) solutions (dissolved in water)
- White paper bowls
- Paper towels
- Nitrile gloves

Directions: Label three (3) paper bowls low, medium, and high $CaCl_2$. Pour each $CaCl_2$ solution into a paper bowl. Use the squeeze bottle to add drops or "worms" of alginate solution (pink) into each $CaCl_2$ solution. Wait about 10-20 seconds. Remove the alginate hydrogels from the solution and gently press them between your fingers. Compare how soft or stiff they feel.

Rank the stiffness of the three hydrogels (low → high $CaCl_2$).
Response:

What process/crosslinking mechanism causes alginate to form a gel in calcium chloride? (1-2 sentences)
Response:

Why does stiffness change with calcium concentration? (1-2 sentences)
Response:

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Describe one reason that the stiffness of the hydrogel may matter for drug delivery (2-3 sentences).
Response:

2. In drug delivery and tissue engineering, hydrogels are used to release molecules, like nutrients, drugs, or even cells, into the surrounding environment. The size of these molecules affects how quickly they escape from the hydrogel. In this section, we use blue food dye to represent small molecules and biodegradable glitter to represent larger molecules or biological objects (like biopolymers, nanoparticles, or cells).

- 2 wt.% alginate (dissolved in water) with blue food dye and biodegradable glitter
- High (2 wt.%) concentration calcium chloride ($CaCl_2$) solutions (dissolved in water)
- White paper bowls
- Paper towels
- Gloves (Optional – materials are food grade and not hazardous. Gloves can be worn to prevent food dye from staining fingers).
- Your cell phone

Directions: Use the squeeze bottle to slowly dispense the alginate mixture (blue + glitter) into a bowl of calcium chloride ($CaCl_2$) solution (2 wt.%) to form a “slime worm” hydrogel. Let the hydrogel sit in the $CaCl_2$ solution for about 10-20 s to crosslink. Once formed, transfer the alginate hydrogel into a separate bowl filled with plain water. Using your phone, take a top-down photo of the hydrogel sitting in the water. This represents time “zero”. At time points 0, 5, 10, and 15 minutes, gently swirl the water to ensure it is well mixed, then take a top-down photo of the bowl at each time point to document any visible changes in the water’s appearance. These images will be used to analyze how the small and large "molecules" (represented by the dye and glitter, respectively) are released from the hydrogel over time.

Create a figure showing your four images at each time point (0, 5, 10, and 15 min), where each time point is clearly labeled. Paste that figure below.
Response:

How does the water's appearance change over time? What does this tell you about the release of the blue food dye? (1-2 sentences)
Response:

Can you see glitter in the water? Why or why not? What does this imply about the movement of larger objects from the hydrogel? (2-3 sentences)
Response:

If blue dye represents a model drug, how could you turn your images into a graph of "drug release over time"? What additional information would you need? (2-3 sentences)
Response:

Why does the food dye diffuse out quickly while the glitter stays in the hydrogel? How does the size of molecules and the pore size of the hydrogel relate to this difference? If your "glitter" were cells, what would that mean for designing a hydrogel to deliver cells over time (i.e., what modifications might you make to a hydrogel to deliver cells)? (3-4 sentences)
Response: