**REVERSE SPHERIFICATION – LABORATORY PROTOCOL**

**Materials**

* Sodium alginate ([https://www.amazon.com/Alginate-Molecular-Gastronomy-Non-GMO-Certified/dp/B00BLPNHLW/ref=sr\_1\_6?crid=PED01U5RJ5TQ&keywords=sodium+alginate&qid=1684182541&sprefix=sodium+alginate%2Caps%2C98&sr=8-6](https://www.amazon.com/Alginate-Molecular-Gastronomy-Non-GMO-Certified/dp/B00BLPNHLW/ref%3Dsr_1_6?crid=PED01U5RJ5TQ&keywords=sodium+alginate&qid=1684182541&sprefix=sodium+alginate%2Caps%2C98&sr=8-6))
* Calcium lactate ([https://www.amazon.com/Calcium-Lactate-Molecular-Gastronomy-Certified/dp/B00FT3CT66/ref=sr\_1\_7?crid=11JRV5EGKNA1C&keywords=calcium+lactate&qid=1684182577&sprefix=calcium+lactate%2Caps%2C101&sr=8-7](https://www.amazon.com/Calcium-Lactate-Molecular-Gastronomy-Certified/dp/B00FT3CT66/ref%3Dsr_1_7?crid=11JRV5EGKNA1C&keywords=calcium+lactate&qid=1684182577&sprefix=calcium+lactate%2Caps%2C101&sr=8-7))
* Xanthan gum ([https://www.amazon.com/Its-Just-Xanthan-Nothing-Friendly/dp/B07N8GTV8J/ref=sr\_1\_5?crid=28O1WVS5TS2PD&keywords=xanthan+gum&qid=1684182679&rdc=1&sprefix=xanthan+gum%2Caps%2C114&sr=8-5](https://www.amazon.com/Its-Just-Xanthan-Nothing-Friendly/dp/B07N8GTV8J/ref%3Dsr_1_5?crid=28O1WVS5TS2PD&keywords=xanthan+gum&qid=1684182679&rdc=1&sprefix=xanthan+gum%2Caps%2C114&sr=8-5))
* Juice
* Spherification spoons ([https://www.amazon.com/DEAYOU-Perforated-Spherification-Mixologist-Multi-Color/dp/B0BFKB5QKZ/ref=sr\_1\_10?crid=1RXLD7D62PIYK&keywords=spherification+spoon&qid=1684182765&sprefix=spherification+spoon%2Caps%2C90&sr=8-10](https://www.amazon.com/DEAYOU-Perforated-Spherification-Mixologist-Multi-Color/dp/B0BFKB5QKZ/ref%3Dsr_1_10?crid=1RXLD7D62PIYK&keywords=spherification+spoon&qid=1684182765&sprefix=spherification+spoon%2Caps%2C90&sr=8-10))
* Droppers/pipettes ([https://www.amazon.com/Disposable-Transfer-Calibrated-Essential-Laboratory/dp/B08CMPRNC3/ref=sr\_1\_9?crid=3NP13MKUNVUU3&keywords=transfer+pipettes&qid=1684182867&sprefix=transfer+pipettes%2Caps%2C112&sr=8-9](https://www.amazon.com/Disposable-Transfer-Calibrated-Essential-Laboratory/dp/B08CMPRNC3/ref%3Dsr_1_9?crid=3NP13MKUNVUU3&keywords=transfer+pipettes&qid=1684182867&sprefix=transfer+pipettes%2Caps%2C112&sr=8-9))
* Food containers ([https://www.amazon.com/Tosnail-Pack-Plastic-Storage-Containers/dp/B07T2HQYK5/ref=sr\_1\_16?crid=3A7V51ZUD9SNV&keywords=clear+plastic+food+containers&qid=1684182982&sprefix=clear+plastic+food+containers%2Caps%2C97&sr=8-16](https://www.amazon.com/Tosnail-Pack-Plastic-Storage-Containers/dp/B07T2HQYK5/ref%3Dsr_1_16?crid=3A7V51ZUD9SNV&keywords=clear+plastic+food+containers&qid=1684182982&sprefix=clear+plastic+food+containers%2Caps%2C97&sr=8-16))
* Immersion blender ([https://www.amazon.com/Bonsenkitchen-Handheld-Electric-Immersion-Stainless/dp/B09SH9XH37/ref=sr\_1\_11?crid=3A021FNXKMDGI&keywords=immersion+blender&qid=1684183161&sprefix=immersion+blender%2Caps%2C102&sr=8-11](https://www.amazon.com/Bonsenkitchen-Handheld-Electric-Immersion-Stainless/dp/B09SH9XH37/ref%3Dsr_1_11?crid=3A021FNXKMDGI&keywords=immersion+blender&qid=1684183161&sprefix=immersion+blender%2Caps%2C102&sr=8-11))

***Sodium Alginate solution*** (made at least one day in advance):

1. In a large vessel (pitcher or beaker that can hold close to 1 gallon), add distilled water and 18.9g sodium alginate
2. Mix using immersion blender
3. Store in gallon jug, make at least a day in advance so the air bubbles can disperse

***Calcium Lactate Brine*** (made in advance for convenience):

1. In a large vessel (pitcher or beaker that can hold close to 1 gallon), add distilled water and 40g calcium lactate
2. Mix using immersion blender
3. Store in gallon jug, make in advance for convenience of prep

***Encapsulated juice solution*** (*made in advance for younger level grades*)

1. In a large vessel (pitcher or beaker that can hold majority of juice), add juice and calcium lactate (40g/gallon or 2.5g/cup)
2. Add xanthan gum to thicken texture as needed (start with about 0.6g (1/8tsp) for every cup, add more if needed, for younger students, a little thicker can help)
3. Mix with immersion blender

(*made in class for older grade levels*)

1. In a 250mL cup ([https://www.amazon.com/250ml-Beaker-Polypropylene-10mL-Graduations/dp/B01FY4X1G6/ref=sr\_1\_19?crid=IQX2OHWC6IC3&keywords=250+mL+beaker&qid=1684183687&sprefix=250+ml+beaker%2Caps%2C102&sr=8-19](https://www.amazon.com/250ml-Beaker-Polypropylene-10mL-Graduations/dp/B01FY4X1G6/ref%3Dsr_1_19?crid=IQX2OHWC6IC3&keywords=250+mL+beaker&qid=1684183687&sprefix=250+ml+beaker%2Caps%2C102&sr=8-19)) add ~100mL juice, 1-2g calcium lactate & 0.3g xanthan gum
2. Mix with immersion blender

**Procedure for producing beads**

1. Using a dropper, drop prepared juice solution in sodium alginate container
2. Use a spoon if needed to carefully submerge & swirl to get spherical shape
3. Do not let the beads touch one another in the sodium alginate solution
4. Carefully remove the beads with the strainer spoon
5. Place beads into distilled water bath, rinse
6. Using strainer spoon, move beads to calcium lactate brine container
7. Allow beads to sit in calcium lactate brine to help beads retain shape (30 mins)

**Suggestions for independent and dependent variables**

***Independent variables***

* pH of water bath
* pH of encapsulated juice
* temperature of one of the bath solutions
* thickness of encapsulated juice (amount of xanthan or thickener used)
* concentration of calcium lactate (in brine or in juice)
* size of bead
* different thickening/gelling agents (guar gum, pectin, carrageenan, agar agar, locust bean gum)

***Dependent variables***

* bead rigidity (how much force is required to “pop” the bead)
* size of bead
* sphericity of bead (measure on x,y,z axis)
* shelf life of bead (consider how you would package to sell)
* cloudiness of bead (turbidimeter or spectrophotometer)
* freeze-thaw capability