Name: _____

Partner(s): _____

Class: _____

Polymer Pie!

Background:

When we often think of polymers, the first thing that comes to mind might be plastics or rubber. However, polymers exist in nature as well as being created synthetically in the lab. Plants synthesize polymers of repeating glucose molecules in order to store sugar more effectively in grains and tubers (a specialized root) in order to use the energy in the future. There are 2 main types of starches: *amylopectin* which is highly branched and exhibits a star-like structure of hundreds of glucose units, and *amylose* which exhibits little branching. These two starches have very different properties from each other and will interact with water quite differently.

Pre-lab: (internet access required)

Draw the following structures:

Glucose

Starch

amylose

amylopectin

Define and describe:

Polymer

Glycosidic bond

Viscosity

Gel

Tyndall effect

Hydrophobic

Phase separation

List and describe at least 3 desirable properties of a good pie filling. Focus on texture and stability.

Problem: The recipe on the cornstarch package states that it is necessary to dissolve ¼ cup of cornstarch into 2 cups of water. How much water is needed to prepare 4.0 g of cornstarch? (¼ cup of cornstarch = 32.0 g, 1 cup of water is approximately 225 mL)

Materials

50 mL graduated cylinder

Balance

150 ml beaker

Hot plate or burner/ring stand apparatus

Thermometer

Stir rod/stir plate

Cornstarch

High amylose starch such as potato, kuzu root, or rice

Syringe or pipette

2 small test tubes

2 Semicircular lenses or petri dishes

Handheld laser

Lugol's reagent

Stopwatch

Procedure:

Day 1:

1. Obtain 4.0 grams of cornstarch and place it in the beaker.
2. Add your calculated amount of water from the pre-lab problem.
3. Stir constantly and heat the mixture slowly. Record the temperature when you notice a change in the appearance of the mixture.
4. Use the syringe or pipette to add 1.0 mL of the mixture to the test tube. Add 1 drop of the Lugol's reagent and stir. Record the time that it takes to see the characteristic dark blue color.
5. Pour the rest of the mixture to the petri dish and set aside to cool.
6. Repeat the procedure with the other starch.

Day 2:

1. Obtain your gel sample from yesterday and describe the extent of gelation and the appearance of the 2 gels.
2. Shine the handheld laser through the sample from the side and describe what you see.
3. Discuss within your group ways that you could improve the consistency of your gel, finalize a plan, get approval from your instructor, and test it.
   Your procedure:

Data:

Starch	Mass	Water (mL)	% by mass of starch	Drops of Lugol's reagent that it took to turn the gel blue	Angle of refraction/ extent of scattering
corn					
High amylose					
yours					

Conclusions

1. Calculate the % by mass of the starch in your samples using the following formula:

$$\frac{\text{Mass of starch}}{\text{Water + starch}} \times 100\%$$

2. How did the amylose content of the starch affect the final quality of the starch? Why do you think this is the case?

3. What type of a mixture did you create? How do you know? (hint: homogeneous, heterogeneous, which specific type)

4. Was there a difference in the number of drops that it took to turn the Lugol's reagent blue? Why do you think this is the case?

Extension: choose one of the following projects. All projects must contain at least 2 references.

- Create a vegan gelatin dessert complete with a recipe and bring in for the class
- Build a model showing how water "swells" the starch molecules along with a description of what is happening
- Scale up your recipe to create a higher amylose pie using another starch other than corn starch. Make sure to provide a recipe.
- Write a 1-2 page report about how the human body digests amylopectin vs. amylose.
- Create a meal plan following the USDA's dietary recommendations that includes high amylose carbohydrates