

Name: _____

Date: _____

Student Activity Sheet for Modeling Biologics Manufacturing

Introduction (3-5 minutes)

In this activity, you will model the complex biologic manufacturing process. First, you will model the cellular expansion process that occurs in a bioreactor. Then, you will lyse the cells to isolate the proteins from the dyed cell debris. Lastly, you will model the advanced filtration process to purify proteins so they can be used as medicines.

Part I: Modeling Cellular Expansion (10-15 minutes)

First, you will model the cellular expansion process to create many proteins inside the cells.

1. Label 2 cups as follows:
 - Bioreactor 1: Cells without sugar
 - Bioreactor 2: Cells with sugar
2. Pour 1/4 cup of warm water (105-110°F) into each cup.
3. Add 2 teaspoons of active yeast to each up.
4. Add 1 teaspoon of sugar to the cells with sugar cup.
5. Mix the cup, modeling a bioreactor, containing cells without sugar and the bioreactor containing cells with sugar.
6. Wait 2-3 minutes and then mix again. Answer the following 2 questions in your group during the first 5 minutes of the incubation.



What color was the yeast, water, and the resulting solution?



Does either cup smell? What does it smell like? Add your answer to Table 1.

7. After 5 and 10 minutes, measure the height of the foam from the table up to the top of the foam from the outside of each cup. Record your results in Table 1. Use your results to inform the answers to the following questions.



Does the solution expand more or less as time goes on?



Is sugar required for the cell expansion or "growth" process?

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Bioreactor Model, Cup Number	Does the model bioreactor have a color or smell?	Expansion: Height of foam at 5 minutes (cm)	Expansion: Height of foam at 10 minutes (cm)
Cup 1 (without sugar)			
Cup 2 (with sugar)			

Table 1. Modeling cellular expansion and cell lysis to harvest proteins.

Part II: Modelling Cellular Lysis (10 minutes)

Next, you will lyse the cells open to isolate the proteins from them.

1. Transfer 1 tablespoon of yeast with sugar to both cup 3 and cup 4.
2. Add 1 tablespoon of hydrogen peroxide containing one drop of dye per cup.
3. Stir the solution with the tablespoon in 2–3 minute increments for up to 10 minutes to harvest and lyse the cells.
4. Measure the height of the foam after 1, 5 and 10 minutes. Record your results in Table 2. This will simulate cell harvesting and lysis of the cells to isolate your protein product from the dyed “cell debris.”

? *What happens when you add hydrogen peroxide to the expanded yeast? Does it foam more or less? At what times does this occur in the 5-10 minute incubation?*

Bioreactor Model, Cup Number	Lysis: Height of foam at 1 minute (cm)	Lysis: Height of foam at 5 minutes (cm)	Lysis: Height of foam at 10 minutes (cm)
Cup 1 (without sugar)			
Cup 2 (with sugar)			

Table 2. Modeling the role of cell lysis in the protein extraction process.

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Part III: Modeling Filtration for Purification (5-8 minutes)

Lastly, you will filter the dyed “cell debris” from the protein product.

1. Place a funnel and a coffee filter each over a new empty cup.

? *What color was the solution before filtration? Record your answer in Table 3.*

2. Measure and pour 1 tablespoon of the activated yeast solution with sugar into the funnel. This will simulate a no-filtering condition (negative control).
3. Measure and pour 1 tablespoon of the activated yeast with sugar into the filter. This will simulate the complex filtering process used for protein isolation.

? *What color was the solution after filtration? Record your answer in Table 3.*

4. Wait for gravity filtration of the protein product for about 3-5 minutes.

? *How much of the solution remains after filtration compared to the unfiltered product? Was the dyed “cell debris” caught by the funnel or filter? Check the funnel and filter to find out.*

? *Why is filtration needed for the purification of proteins? Use your results to inform your answer.*

Filtration Container	Color of the lysis byproduct before filtering	Color of the filtered protein product after filtering	Time to filter (min: sec)	Volume of filtered product (tsp)
Cup 3 (no filter, negative control)				
Cup 4 (with filter)				

Table 3. Modeling the role of filtration in the protein purification process.

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Reflection Questions and Wrap Up (3-5 minutes)

- ? What were the main steps and concepts of the biologic manufacturing process?
- ? How has biologic manufacturing impacted the field of medicine?
- ? What careers are in the biomedical science field that manufacture biological medicines?
- ? What did you learn today?