Fermentation factories

Focus questions	How can fermentation produce a renewable fuel source?
Vocabulary	Renewable fuels, nonrenewable fuels, energy positive, glucose, distillers grain

What is in each bag? Describe the reaction. Fill in the boxes below.

	Bag ingredients					Reaction
A	Yeast	Water				
B	Yeast	Water				
C	Yeast	Water				
D	Yeast	Water				

$$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2$$

glucose — 2 ethanol — 2 carbon dioxide

Materials

- Snack-sized bags
- 50 ml water
- 1 tsp. yeast
- ¼ tsp. enzymes (amylase, glucoamylase)
- 1 tsp. sugars (simple & complex) as feedstocks: corn flour, corn starch, corn syrup, honey, and glucose
- Ruler to measure gas volume
- Index card or clipboard to measure gas volume

Procedure

1. Create the greatest volume of ethanol (measured by the volume of carbon dioxide generated) in the shortest time possible.
   - Work together in groups of 2–3 students.
   - Plan an experiment/several experiments to produce ethanol in a small bag environment.
   - You can use only the following materials/amounts provided by your teacher.
   - You have 1 or more class period(s) to experiment on your initial design(s) based on your plan.
   - Data must be collected and analyzed to provide evidence for your explanation and future design solution.
   - Report back to the class and provide future design solutions as a result of your current explanation.

2. How might your group plan an investigation to test the challenge? What two (or more) experiments can your group design to create ethanol as quickly as possible? How will your group measure which one of your experiments changes the most? Write your experimental groups below. Be sure to include your explanations for your group's experimental choices.
3. Make a prediction. What do you think will happen to each experimental group and why?

Group	**Reactants in fermentation bag**	**Prediction/why**
Group 1		
Group 2		
Group 3		

4. Determine a method for measuring carbon dioxide. Write your plan to measure CO_2 below.

5. Create your models. Use the materials provided to set up your fermentation factories.

6. Make Observations. Collect data from your group's experimental designs below. Include charts here to show your results.

7. Include graphs here to show your results.

Reflection

Create an explanation of the fermentation process of corn into ethanol. Reflect on the following questions while creating your explanation.

1. What is the purpose/role of each component in your group's fermentation bag design(s)? How did each component act upon another? Write/draw your most efficient design below.

2. What evidence did your group generate to clarify the role of each component in your group's design?

3. What are the reactants and products of your fermentation reaction?

Construct an explanation of the fermentation process of corn into ethanol.

Redesign: Create a future design solution to make ethanol production more efficient in a small bag environment based upon your explanation of the fermentation process and additional research.

Rubric for self-assessment

Skill	Yes	No	Unsure
I was able to construct an explanation for the fermentation process based on evidence.			
I provided possible future solutions for a more efficient fermentation design based on evidence.			