Enzyme action in ruminants

Focus question	How does the pH and temperature of an environment affect enzyme activity?
Vocabulary	Ruminants, enzymes, fermentation, starch, polysaccharide, monosaccharide

Dairy cattle belong to a class of mammals known as ruminants. One distinctive characteristic of ruminants is their multi-chambered stomach that helps break down the insoluble complex carbohydrates found in hay, grass, and cattle feed. As the complex carbohydrates make their way through the cow's digestive tract, they are broken down through the process of fermentation. The cow can then absorb the nutrients, turning the feed into energy for daily activities and milk production.

Enzymes are a type of protein that catalyze, or speed up, chemical reactions. Digestion enzymes help break down large molecules (polymers) into smaller molecules (monomers). Enzymes are highly specialized molecules. In general, each enzyme can only perform one specific reaction, due to their specific shape. Enzymes work best within specific temperature and pH ranges. When an enzyme is in an environment outside of its optimum range, its shape changes and it becomes denatured. This means that it will no longer work as well.

Amylase speeds up the breakdown of starches into simple sugars. Since amylase is not found in the saliva of ruminants, it can be added as a supplement to feed to help facilitate the breakdown of starches into simple sugars, used by cells as the primary source of energy.

Materials

- 3 disposable pipettes
- Iodine solution in a dropper bottle (or with another pipette)
- Test tube rack
- 3 test tubes (labeled as pH 4, pH 7, pH 10)
- Well plate
- Stopwatch (or phone)
- Sharpie

Procedure

1. With a Sharpie, label three test tubes with "4", "7", and "10".
2. Add 2 mL of amylase solution to each of the test tubes.
3. Add 1 mL of the buffer solution with a pH of 4 to the test tube labeled "4".
4. Add 1 mL of the buffer solution with a pH of 7 to the test tube labeled "7".
5. Add 1 mL of the buffer solution with a pH of 10 to the test tube labeled "10".
6. Gently mix each of the solutions.
7. Let the solutions sit for at least 60 seconds.
8. Add 2 mL of the starch solution to each of the test tubes.
9. Gently mix each of the solutions.
10. With a Sharpie, label the wells in the well plate with "4", "7", and "10".
11. Create a data table to record your results.

12. Add a drop of iodine to each of the labeled wells on the well plate.
13. Use the pipette to add approximately 5 drops of the starch solution/buffer solution (ph 4) to the iodine drop in the well labeled “4”.
14. Record the color change in the data table. Black–purple indicates a positive result for starch. Orange indicates a negative result.
15. Repeat this process with the amylase/buffer solutions with a pH of 7 and 10.

Data table

Reflection

1. What is the name of the enzyme in this lab?

2. What is the optimum pH for amylase, based on your lab results?

3. Based on your results, at what pH is amylase denatured?

4. Why is it important to add the buffer to the enzyme before adding the starch?

5. How might adding amylase as a supplement for cows increase the efficiency of a starch-based feed?

Rubric for self-assessment

Skill	Yes	No	Unsure
I can tell that a chemical change took place through the action of the enzyme.			
I can explain how the iodine shows that a chemical change did not take place.			
I can determine when an enzyme is ineffective or denatured.			