

Lac-Sense: The Lactose Detection Kit

Lac-Sense is a portable, user friendly, and inexpensive device that enables users to detect lactose in their foods & beverages.

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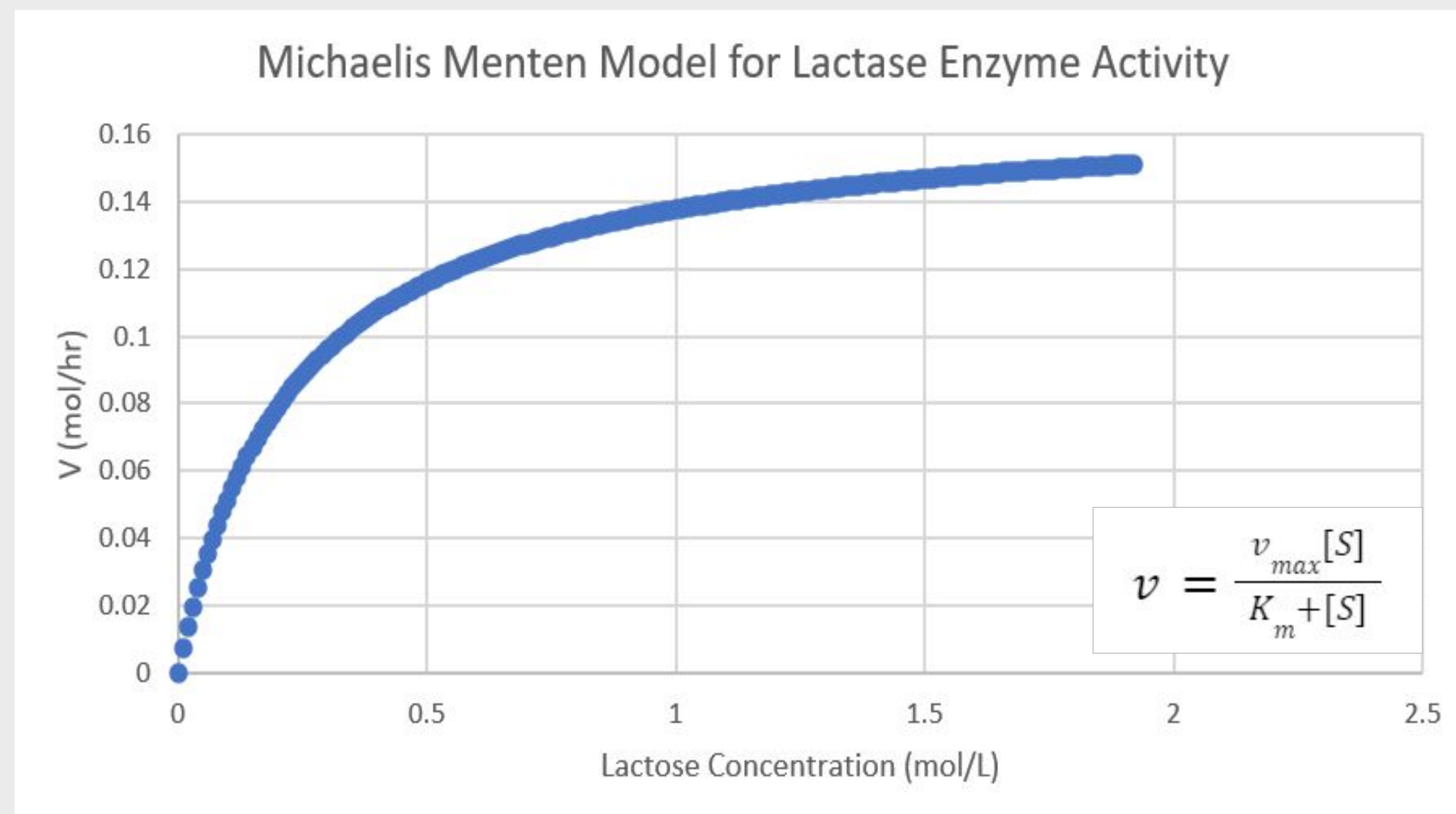


Figure 1. The Michaelis-Menten Model for Lactase. This model illustrates the expected activity of lactase at different concentrations of lactose. This model helped validate the Lac-Sense product by ensuring a quick reaction was possible.

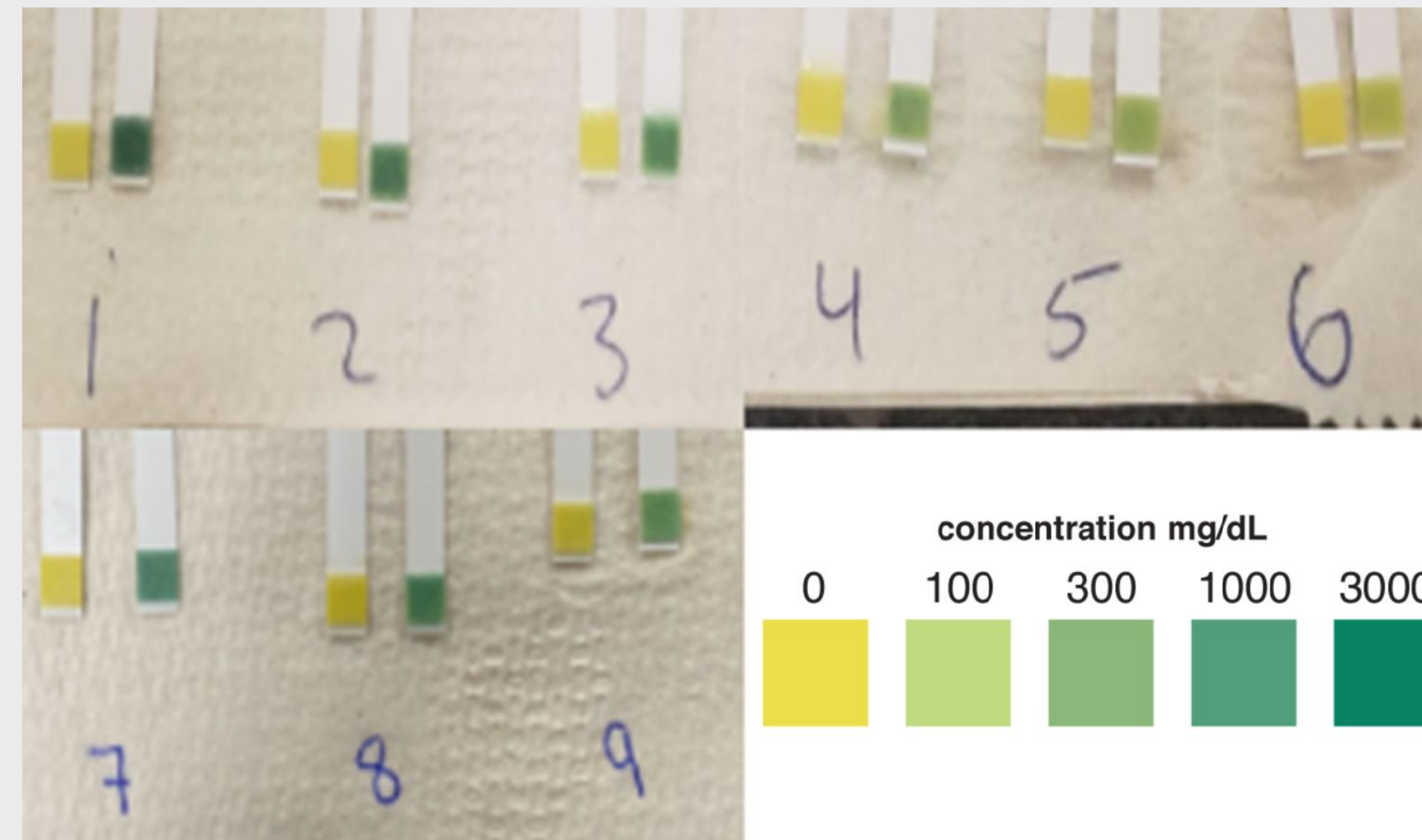


Figure 2. Final Concentration Results for Nine Different Ratios of Lactase-Lactose. Samples 1,2, and 3 had 250 FCC units of lactase. Samples 4,5, and 6 had 450 FCC units of lactase. Samples 7,8, and 9 had 100 FCC units of lactase. 250 FCC units produced the most noticeable change, so it was chosen for the final design. The units of the key for the glucose strips are mg/dL



How to Use Lac-Sense

Using Lac-Sense is a simple process:

1. Fill the Lac-Sense testing tube halfway with water.
2. Place a food sample the size of a few grains of rice or a few drops of the sample beverage into the testing tube.
3. If testing a food sample, use the sample pestle to homogenize the food sample by pressing down and twisting the pestle in the tube. If testing a beverage sample, shake the testing tube to mix the beverage with water.
4. Fill the Lac-Sense testing tube to the top with water, cap, and give one final shake.
5. Dip a glucose test strip into the testing tube, wait three seconds, then remove and set aside.
6. Dip a Lac-Sense Lactose Testing Strip into the testing tube, wait three seconds, then remove and set aside.
7. After 4 minutes, if the two strips are the same color, there was no reaction and lactose is not present in the food or beverage. If the Lac-Sense Lactose Testing Strip appears darker in color than the glucose test strip, there was an additional reaction and lactose is present in the food or beverage.



No Lactose Present

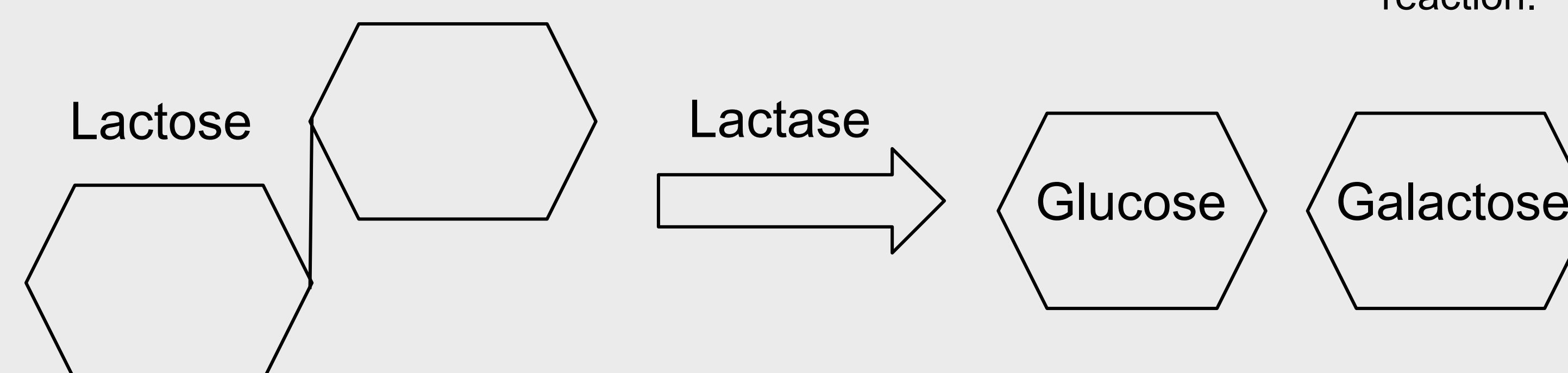
Lactose Present

The Need for the Product

68% of the world has some form of lactose intolerance. Due to cross-contamination and possible negligence in restaurants, consumers can't always trust the ingredients list. For situations like these, Lac-Sense, the lactose detection kit, is the perfect solution. All the user needs is a small amount of food, the Lac-Sense testing kit, and 5 minutes. After receiving accurate and easy to understand results, the users can make informed decisions about the food they are consuming.

The Science Behind Lac-Sense

Lactose intolerance is caused when the small intestine produces lower than normal levels of the lactase enzyme. This creates issues when lactose is consumed because the body can't properly digest it. Lac-Sense senses lactose by taking advantage of the reaction between lactose and lactase. When lactose is broken down by lactase, glucose and galactose are produced. Lac-Sense senses the elevated glucose concentration and turns this into a positive or negative test result. By using the same reaction that occurs in humans without lactose intolerance, Lac-Sense can help eliminate surprise symptoms of lactose intolerance.



Engineering Analysis

- To verify the validity of our design, mathematical models were created to explore the enzyme kinetics of lactase as well as force relationship of the sample homogenizer.
- A Michaelis Menten Model was created for Lactase to determine if the lactase-lactose reaction was fast enough for Lac-Sense to have a reasonable testing time.
- It was found that the reaction would take about 2 seconds when performed on the scale of the Lac-Sense kit.
- Another model was created using the relationship between force and area in order to determine the force required to homogenize a sample.
- The ideal force was based on the average force of a human chewing.
- It was found that 3.3 N of force is needed to homogenize the sample.

Physical Experiments

- Physical experiments were also conducted in order to make important design decisions for the Lac-Sense kit
- To determine the proper amount of lactase that should be embedded on the Lac-Sense modified strip, tests were performed using different concentration of lactase and lactose.
- It was determined that 250 FCC units was the optimal concentration of lactase for the modified strips.
- To determine the best homogenization method, a test was performed to compare results between pestle grinding and shaking the test kit tube. It was determined that either method produces accurate results.
- To determine the best method of immobilization of lactase on the modified strip, a lactose analog, ONPG was used.
- ONPG creates a yellow product when reacted with lactase, so the immobilization method that released the most lactase in solution was chosen to ensure a complete reaction.