LAB GUIDE
EXPLORE 1 LESSON 3

Food and Agriculture Center for Science Education

General Setup

This series of small investigations (labs) is intended to be set up as four stations. At each station, students will have a station card that includes data regarding the organ and materials needed to complete the lab. A station should consist of a table or grouping of desks. Prior to starting this lesson, prepare stations with station cards and materials. Below is an outline of each station, including a list of materials, set-up suggestions, and expected outcomes.

TEACHER TIP
Have milk already in a water bath at 37 degrees C. For every station, students will get the small amount they need at each station. Additionally, having a water bath already at room temperature for each station is ideal to eliminate time spent waiting for “materials” to heat up.

Station 1 - Mouth: Carbohydrates

Materials

- Whole milk
- Chocolate milk
- Distilled water (for rinsing pipettes)
- 37°C water bath
- Thermometer
- Three labeled test tubes
- Three pipettes (4-5 mL)
- Test tube rack
- Safety goggles

Set-Up

Students prepare test tubes with milk and amylase and put them in a water bath to mimic enzyme activity at body temperature. After their time in the water bath, students take a glucose testing strip and put it in the test tube—this strip tests for the presence of glucose in a solution. After determining whether glucose is present in the test tube, students use a Potassium Iodine solution to test for the presence of starch to see if it is a different sugar that might have been broken down.

Below are lab items that are station-specific:

Station	Enzyme	Reagent	Other
Mouth/Esophagus	Amylase	Iodine/Potassium Iodine Solution	
Stomach	Pepsin	Biuret Reagent	.1M HCl
Small Intestine (A)	Lactase	Glucose test strips (6 per group)	.1M NaOH
Small Intestine (B)	Lipase	Phenolphthalein	
Large Intestine			

Expected Outcomes

Amylase is an enzyme in saliva that breaks down starch. Through the investigation, students determine that there is no starch present in milk and determine that glucose is not a product of the breakdown of starch by amylase. They determine that milk does not contain glucose, so it must be some other type of sugar that makes up the nutrient composition. Since milk is not broken down by amylase, it will continue onto other organs through digestion, and the sugars in it must be broken down in a location other than the mouth.

Mouth: Amylase

Starch w/ Amylase: For comparison only Not part of the lab

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Station 2 - Stomach: Proteins

Materials

- Whole milk
- Heavy whipping cream
- Pepsin
- 37°C Water Bath
- Thermometer
- Four labeled test tubes:
    - 1A: WM (contains whole milk, HCl, and pepsin)
    - 1B: HWC (contains heavy whipping cream, HCl, and pepsin)
    - 2A: WM-C (contains whole milk and HCl, used as control)
    - 2B: HWC-C (contains heavy whipping cream and HCl, used as control)

Set-Up

Students set up test tubes with whole milk or cream and hydrochloric acid. The HCl is necessary to simulate the acid environment of the stomach necessary for pepsin to activate. Students will add pepsin to 1 test tube that contains whole milk and another containing heavy whipping cream. After the pepsin has been added, students will use a water bath to heat the test tube to a temperature close to normal body temperature, which helps further activate the enzyme. Using the Biuret reagent, students will work to determine if protein is present in milk and digested in the stomach.

Expected Outcomes

The stomach's acidity helps transform the consistency of liquid milk, mechanically and chemically, breaking it down into small fragments. Pepsin is an enzyme that breaks down proteins. Working with the HCl that is present in the stomach, the solid protein in milk (casein) and the liquid whey proteins begin to be digested. Biuret reagent turns violet in the presence of peptide bonds (which are long chains of amino acids). As proteins are digested and the peptide bonds break apart into amino acids, the biuret reagent appears lighter, more lavender or pink. Students recognize that proteins are broken down in the stomach and, if not absorbed through the lining of the stomach, what remains is passed onto the small intestine for further digestion and absorption into the body for protein synthesis.

Stomach: Pepsin

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Station 3 - Small Intestine: Fats

Materials

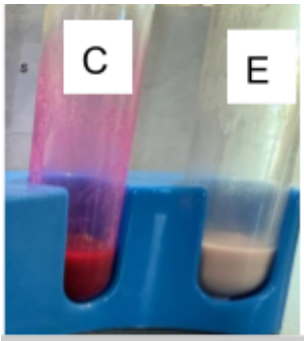
- Whole milk
- Skim/Nonfat milk
- Lipase
- Phenolphthalein
- 0.1M Sodium Hydroxide solution
- 37 Degrees Celsius Water Bath
- Thermometer
- Four labeled test tubes
- Five pipettes (4-5 mL)

Set-Up

Students set up test tubes with whole milk and Sodium Hydroxide. They repeat this process with skim or nonfat milk. To 1 test tube of each of the various milks, they will add an enzyme called lipase that works to break down fats. The test tubes enter the water bath to get them to approximately body temperature for the enzyme to activate. All tubes will receive 30 drops of phenolphthalein to test the pH to determine if digestion of fatty acids is taking place.

Expected Outcomes

Phenolphthalein is a pH indicator. A solution with a pH of >8 (known as an alkaline/basic environment) turns bright pink. Sodium Hydroxide is added to the solution initially to raise the pH to determine if digestion has occurred when using the enzyme lipase. This is necessary because milk does not naturally have a high enough pH. Lipid molecules are made up of chains of fatty acids. In milk, the lipid molecules are called triglycerides. They have three chains of fatty acids bonded to a glycerol backbone. As the fatty acids break apart during digestion (the acids break off from the glycerol backbone), the “acids” lower the pH of the solution. If digestion of fatty acids occurs in the test tube, it will lower the pH, and the color of the solution will lighten until it eventually becomes colorless. The fatty acids that are the products of digestion are absorbed in the small intestine.



Small Intestine: Lipase

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Station 3 - Small Intestine: Lactose

Materials

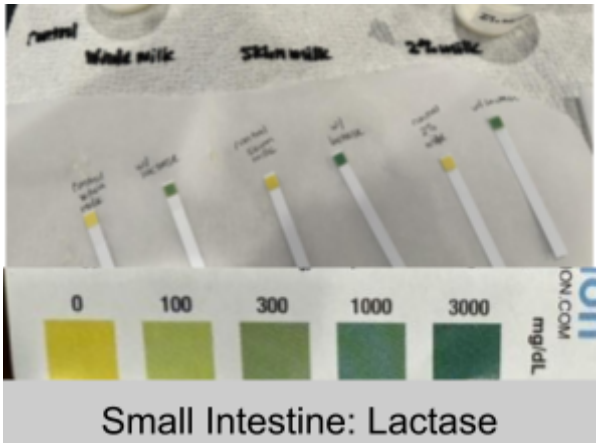
- Whole milk
- Skim/Nonfat milk
- Lactase
- Glucose strips
- 37^{O}C Water Bath (optional)
- Thermometer (optional)
- Four labeled test tubes
- Five pipettes (4-5 mL)

Set-Up

Students set up test tubes with whole milk or skim/nonfat milk. To 1 test tube of each type of milk, they will add an enzyme called lactase that breaks down the sugar in milk, which is in the form of lactose. The test tubes enter the water bath to get them to approximately body temperature for the enzyme to activate. They will use a glucose strip to test for the presence of sugar during digestion by the enzyme.

Expected Outcomes

In milk, most of the sugar is in the form of lactose. When lactose is digested by lactase, it breaks apart into two simple sugars: glucose and galactose. Using the glucose test strip in the solution, students will look for a positive green result. The darker the green, the more glucose present. After interpreting the results, students will determine that glucose is present in the test tubes containing the enzyme lactase. The higher the fat content, the more glucose is typically available after digestion. For this reason, students should see a lighter green result in the test tube with the skim/nonfat milk. The glucose produced through digestion is absorbed into the body in the small intestine for cellular energy.



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Station 4 - Large Intestine: NO LAB

Materials

- Reading Card

Set-Up

Students will read a card and identify enzymes that are not present in the large intestine.

Expected Outcomes

The focus of the labs is to identify where in the digestive system enzymes are present and what nutrient they are breaking down in milk. As students read the large intestine card, they discover there are no enzymes in the large intestine. Students will make note of this and move to another station. Alternative suggestions are to read the large intestine card as a whole group after all students have completed labs and discuss how this reading presents information that may be similar or different from the station cards they read for the labs.