# **STUDENT GUIDE** EXPLORE 1 LESSON 3



## Part 1: Our Motivation

Record questions we were trying to figure out that led to this investigation.

#### Questions:

- 1. How does milk get broken down in the body?
- 2. Where does the digestion of milk occur?
- 3. What do the mouth/esophagus, stomach, small intestine, and large intestine do in digestion?

Differences in Our Initial Models:

- We showed different organs in which the milk was digested.
- We disagreed on how each of these organs function and what their cells do.



#### Part 2: Creating Initial Claims

Make a claim that answers the question, "What organs most help digest milk? How?" Choose between the mouth/esophagus, stomach, small intestine, and large intestine. You can choose one organ or more than one organ.

I think milk is digested in the \_\_\_\_\_. This happens by...

- I think milk is digested in the mouth. This happens by chewing food.
- I think milk is digested in the stomach. This happens by stomach acid.
- I think milk is digested in the intestines. This happens by bile.

Review the claims the class made. Which claim is most favored by our class currently? Record the reasons that your classmates share to support this claim.

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Most of our class said that the milk is digested in the stomach by the stomach acid.

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## Part 3: Obtaining Evidence About What is in Milk

Using the "Chemistry of Milk" handout, identify the specific types of molecules that are found in milk. Record at least two specific examples for each of the four categories of nutrients in milk.

Category of Nutrient	Examples
Proteins	Whey
	Casein
	Lactose
Carbohydrates	Glucose and Galactose
	Saturated Fats
Fats	Monounsaturated Fats
	Polyunsaturated Fats
	Calcium
Vitamins and Minerals	Sodium
	Potassium
	Vitamins: Bl, BG, B12, A, C, E, D, K

# Part 4: Working With Orders of Magnitude

Analyze the Size & Orders of Magnitude tool to compare the relative sizes of the organs, tissues, cells, and molecules represented in the models on the "Enzyme Illustration" handout.

Object	Size (Max)	Scale Difference from Previous Model	Scale Difference from Human Body	Order of Magnitude Difference from Previous Model	Order of Magnitude Difference from Human Body
Gastrointestinal Tract	0.5 m in width	N/A	1	N/A	0
Small Intestine	3 cm in width	1/100	1/100	2	2
Intestinal Fold	3 mm in width	1/10	1/1000	I	3
√illi	70 um in width	1/1000	1/1,000,000	3	6
Epithelial Cells	10-20 um in width	I	1/1,000,000	0	6
Sucrase Enzyme	5 - 10 nm in width	1/1000	1/1,000,000,000	3	9

How does using orders of magnitude better help you understand what is shown in the "Enzyme Illustration" models?

Orders of magnitude can help us describe the relative sizes of the different parts of the small intestine. We can see that the small intestine is made of organs (10' m scale), cells (10<sup>-6</sup> m), and molecules (10<sup>-9</sup> m). It allows us to clearly see how the organization of the small intestine is made of smaller and smaller parts that make up each other. I can see that these models are not necessarily drawn at an accurate size, and most objects in the models are drawn much larger than they are in reality.

Record a summary of what you see in the "Enzyme Illustration" models about how a digestive enzyme breaks down the molecule sucrose.

- The small intestine is made of structures at different scales, including m (1), cm ( $10^{-2}$ ), um ( $10^{-6}$ ), and nm ( $10^{-9}$ ).
- The epithelial cells in the small intestine have an enzyme that breaks apart sucrose.
- The enzyme takes the molecule sucrase and breaks it apart into two smaller molecules, glucose and fructose.

## Part 5: Obtaining Evidence About How Enzymes Digest Molecules in Milk

At each station, read the text provided to help you gather additional information on the hierarchical function of each organ in the digestive system and how its cells support this function. Then, conduct the investigation described to gather evidence on how enzymes produced by the cells of each digestive organ help to break down the different molecules present in milk.

#### **Station: The Mouth**

Organ	Function of Organ in	Role of Specialized	How Enzymes Break Down
Organ	Digestion	Cells	Molecules in Milk

Mouth/ Esophagus	Breaks down food into small pieces, uses saliva to make a bolus, and with chemical and mechanical digestion, nutrients are then swallowed through the esophagus into the stomach.	Enzyme amylase is secreted along with saliva through chemical digestion to break down starches.	Amylase breaks down starches. There are no starches in milk.
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### Station: The Stomach

Organ	Function of Organ in	Role of Specialized	How Enzymes Break Down
Organ	Digestion	Cells	Molecules in Milk
	Nutrients enter, and	The enzyme pepsin is	Pepsin breaks down
	enzymes break down	released from epithelial	proteins into amino acids.
Stomach	nutrients such as proteins	cells in the lining of the	
	into smaller molecules like	stomach and helps to	
	amino acids.	break down proteins.	

## **Station: The Small Intestine**

Organ	Function of Organ in	Role of Specialized	How Enzymes Break Down
Organ	Digestion	Cells	Molecules in Milk

Small Intestine	Molecules enter the small intestine and are broken down into smaller molecules by enzymes.	Enzymes such as lipase and lactose are released from the lining of the small intestine to break down lipids (fats) and sugar (lactose).	Lipase breaks down fat globules into free fatty acids that are absorbed. Lactase breaks down lactose into glucose and galactose.
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#### **Station: The Large Intestine**

Organ	Function of Organ in	Role of Specialized	How Enzymes Break Down
Organ	Digestion	Cells	Molecules in Milk
	Fiber is digested by	Epithelial cells interact	N/A
	bacteria in the large	with bacteria to help	
	intestine. Other undigested	them digest fiber.	
Large	remnants of food are	Goblet cells produce	
Intestine	turned into stool and	mucus to aid in the	
	become waste.	movement of waste	
		through the large	
		intestine.	

# Part 6: Defending Claims

Use the evidence you gathered from each station to evaluate the claims that the class made at the start of the lesson.

- Choose two of the claims the class made.
- Record evidence in each column that is relevant to supporting or refuting the claim in the column.
- Explain your reasoning for how the evidence you chose helps you evaluate the claim.
- In the conclusion, decide if the evidence leads you to support, partially support, or refute the claim.

In your evidence and reasoning, be sure to:

- Describe how specialized cells and enzymes contribute to the function of digesting milk.
- Use orders of magnitude to identify the relative sizes of organs, glands, cells, and molecules involved in the digestion process.

Claim A:	Claim B:
I think milk is digested in the mouth. This happens	I think milk is digested in the stomach. This
by chewing food.	happens by stomach acid.
Evidence: The mouth station reading states that the mouth uses amylase $(10^{-9} \text{ m})$ from the acinar cells $(10^{-6} \text{ m})$ in the salivary glands $(10^{-3} \text{ m})$ to break down starch molecules. According to the Chemistry of Milk reading, milk does not have starch as a chemical component.	Evidence: The Stomach station reading states that milk has proteins as one of its chemical components. Proteins start to be broken down in the stomach by pepsin (10 <sup>-9</sup> m), which is released from chief cells (10 <sup>-6</sup> m). According to the Chemistry of Milk reading, milk does have proteins like whey and casein present in it.
Reasoning:	Reasoning:
Because milk does not have starch in it, milk	Milk does have proteins in it, so it is digested in
does not start to break down in the mouth.	the stomach. Other molecules in milk, like fats
Instead, the different molecules in milk are	and carbohydrates, are broken down in the small
digested in other parts of the digestive system	intestine when cells, like epithelial cells, release
by the enzymes released from cells like	enzymes to break down lactose, sucrose, and
epithelial cells in the small intestine.	fats.
Conclusion:	Conclusion:
Based on this evidence, I refute the claim that	Based on this evidence, I partially support the
milk is digested in the mouth.	claim that milk is digested in the stomach.