



More Cheese, Please

High School, Life Science

Task Overview

In this task, students use models and data to explain why lactose intolerant people experience lots of gas, bloating and diarrhea when they eat certain dairy products. Students explore models comparing the digestive systems of lactose-tolerant and lactose-intolerant people to see how specialized parts of the systems affect how they are able to process dairy products. They then annotate the comparative models to explain why only lactose intolerant people experience these painful symptoms. At the end of the task, students examine new data to recommend what types of dairy products lactose intolerant people might eat to cause less painful symptoms.

Background Information

The human body is a system made of many smaller systems. Those smaller systems are made of multiple parts (organs) that are made of tissues. Those tissues are made of cells with specialized functions. The digestive system has cells with specific digestion-related functions. One key example is the intestinal epithelial cell, which lines the small intestine. This kind of cell produces lactase, an enzyme that breaks down the two-unit sugar lactose into smaller digestible sugars called galactose and glucose. These cells have small finger-like projections called villi that help absorb these nutrients from the small intestine into the bloodstream.

Some individuals have a natural difference in their digestive processes, including producing decreased amounts of the enzyme, lactase. This is often referred to as lactose intolerance. Because of this decreased amount of lactase in the small intestine, more lactose passes from the small intestine into the large intestine without being broken down into glucose and galactose. When lactose enters the large intestine, it is consumed by bacteria in a process called bacterial fermentation which produces gas as a byproduct. This is what can lead to uncomfortable digestive symptoms, such as gas, bloating, and diarrhea. These symptoms happen more often when eating dairy products that have a higher lactose content, like milk.

Next Generation Science Standards

Three-Dimensional Claim

Use models and data to explain how parts of a body system interact, including matter flows within and between body systems, to perform essential functions of life.

This task is intended to elicit student learning of the following **NGSS elements** for each of the three dimensions:

Disciplinary Core Ideas

LS1.A: Structure & Function (HS)

- Systems of specialized cells within organisms help perform essential functions of life (HS-LS1-1).
- Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level (HS-LS1-2).

Science and Engineering Practices

Developing and Using Models (HS)

- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.

Analyzing and Interpreting Data (HS)

- Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.

Crosscutting Concepts

Systems and System Models (HS)

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Suggestions for Use

This task is intended to be used for formative assessment purposes - to identify students' strengths and needs with the above dimensions in order to provide feedback to students and guide shifts in instruction.

Assumptions

Students should have engaged with prior instructional experiences that ask them to develop and use models to represent systems and their interactions, including how matter flows between parts of a system. Students should also have engaged with phenomena related to how body systems interact; knowledge of the digestive system and enzymes is recommended but not required, as it is explored throughout the task. Lastly, students should have experience with analyzing and interpreting bar graphs.

Materials Needed

- [More Cheese, Please Student Guide](#)

Assessment Guidance

To introduce this task, we recommend reading the introduction together as a class and asking students if they have ever experienced these kinds of symptoms or know anyone with lactose intolerance. Make space for students to share their experiences and connect to the phenomenon of the task.

When introducing the task, students can watch a [video](#) (Original Source: [Lactose Intolerance by Nucleus Medical Media](#) on YouTube) if they would first like a review of the digestive system.

Introduction

When Kim eats dairy products, like cheese, she often experiences lots of gas, bloating and diarrhea. However, some dairy products do not make her feel this way. She likes to eat dairy products and wants to better understand why she can eat some dairy products and not others. Help Kim figure out how her body is responding when she eats different dairy products.

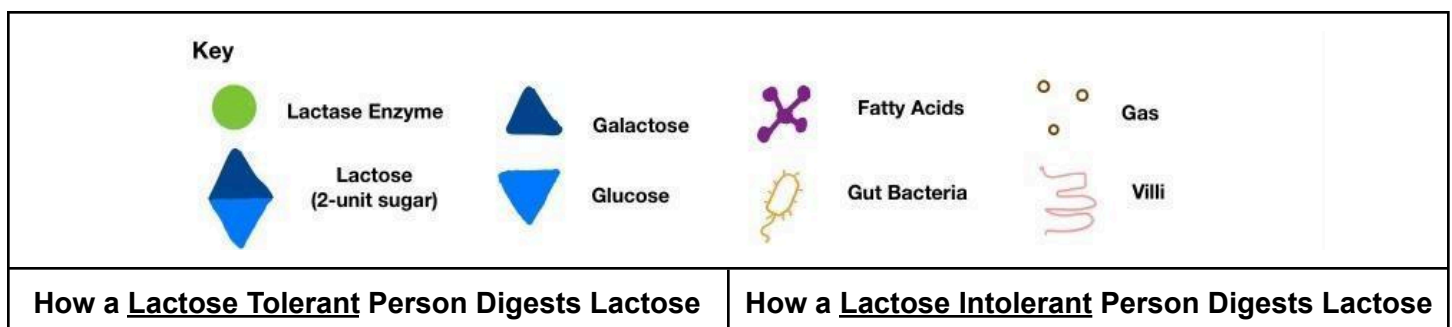
If you would first like a review of the digestive system, watch the [video](#) (just 0:00 - 1:10).

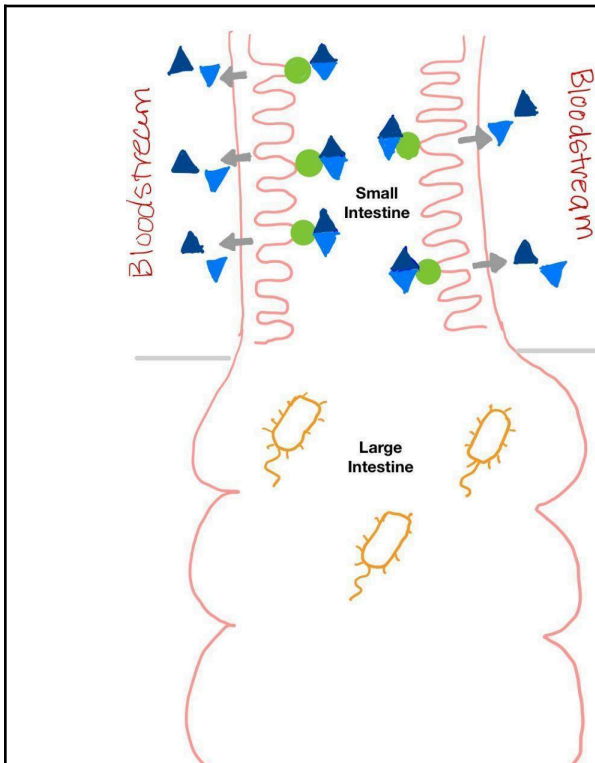
Prompt 1

In this task, you'll use models to figure out what happens in Kim's body after she eats dairy products. Both models show how lactose, a two-unit sugar found in dairy products, is digested in two important subsystems, the small intestine and the large intestine.

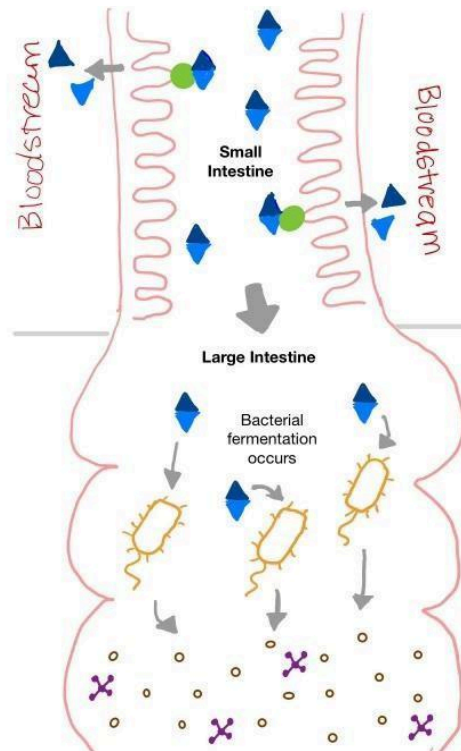
- The first model shows how a **lactose tolerant** person digests lactose
- The second model shows how a **lactose intolerant** person, like Kim, digests lactose

Go to the next page to see the models and answer the prompts.





Describe what happens when a **lactose tolerant** person digests the dairy product. Include interactions between parts of the system.



Describe what happens when a **lactose intolerant** person digests the dairy product. Include interactions between parts of the system.

Prompt 1 Performance Outcome:

Use models to describe interactions between specialized parts of two different digestive systems in order to explain what happens when each system contributes to the digestion of dairy products.

SEP

Use a model based on evidence to illustrate the relationships between systems or between components of a system.

DCI

Systems of specialized cells within organisms help perform essential functions of life. Any one system is made up of numerous parts and is itself a component of the next level.

CCC

Models (e.g., physical models) can be used to simulate systems and interactions—including matter flows—within and between systems at different scales.



Prompt 1 Rubric

	Emerging	Developing	Proficient
Sample Student Response	<p><i>Lactose Tolerant</i> - There are lots of lactase enzymes, galactose, glucose, and lactose close together.</p> <p><i>Lactose Intolerant</i> - Gas builds up.</p>	<p><i>Lactose Tolerant</i> - The small intestine and body works together to process and break down the food.</p> <p><i>Lactose Intolerant</i> - Undigested lactose sits in the gut and gets broken down by bacteria. This causes gas, bloating, and stomach cramps.</p>	<p><i>Lactose Tolerant</i> - Lactose goes in and the lactase enzymes break it down for use in the body.</p> <p><i>Lactose Intolerant</i> - Lactose goes in. There are not enough lactase enzymes to break down all of the lactose so some makes it through and gut bacteria break it down in fatty acids and gas.</p>
Look-Fors	<ul style="list-style-type: none"> • Cites general or irrelevant evidence from the model • Description of the interactions of specialized parts of the digestive system is missing • Explanation of the role of the specialized parts of the system in digesting lactose for a lactose tolerant person versus a lactose intolerant person is limited, vague, irrelevant 	<ul style="list-style-type: none"> • Uses some relevant evidence from the model • Describes some interactions of specialized parts of the digestive system • Partially explains the role of the specialized parts of the system in digesting lactose for a lactose tolerant person versus a lactose intolerant person 	<ul style="list-style-type: none"> • Uses all relevant evidence from the model • Describes all interactions of specialized parts of the digestive system • Sufficiently explains the role of the specialized parts of the system in digesting lactose for a lactose tolerant person versus a lactose intolerant person

Prompt 2

For this prompt, please use the models on the [previous page](#).



a. Add to the models to help you compare what is happening in a lactose **tolerant** versus a lactose **intolerant** digestive system.

- Circle the key differences between the two digestive systems
- Write captions to describe each difference you circle

b. **Villi** and **enzymes** are specialized structures in the digestive system that are very important to the digestion process. Use the models to explain how villi and enzymes work together during digestion.

c. Use the models to explain to Kim why only lactose intolerant people experience painful symptoms like gas when they eat dairy products.

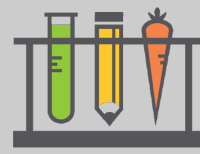
Prompt 2 Performance Outcome:

Develop and use models to explain how specialized parts of the digestive system interact and function in a lactose tolerant person versus a lactose intolerant person.

SEP	Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
DCI	Systems of specialized cells within organisms help perform essential functions of life.
CCC	Models (e.g., physical models) can be used to simulate systems and interactions—including matter flows—within and between systems at different scales.

Prompt 2 Rubric

	Emerging	Developing	Proficient
Sample Student Response	A. Scaffolding - no need to assess B. The bacteria is getting it. OR glucose and galactose.	A. Scaffolding - no need to assess B. The lactase enzyme must attach to lactose to be broken down.	A. Scaffolding - no need to assess B. Lactase enzymes break lactose down into galactose and glucose and the Villi



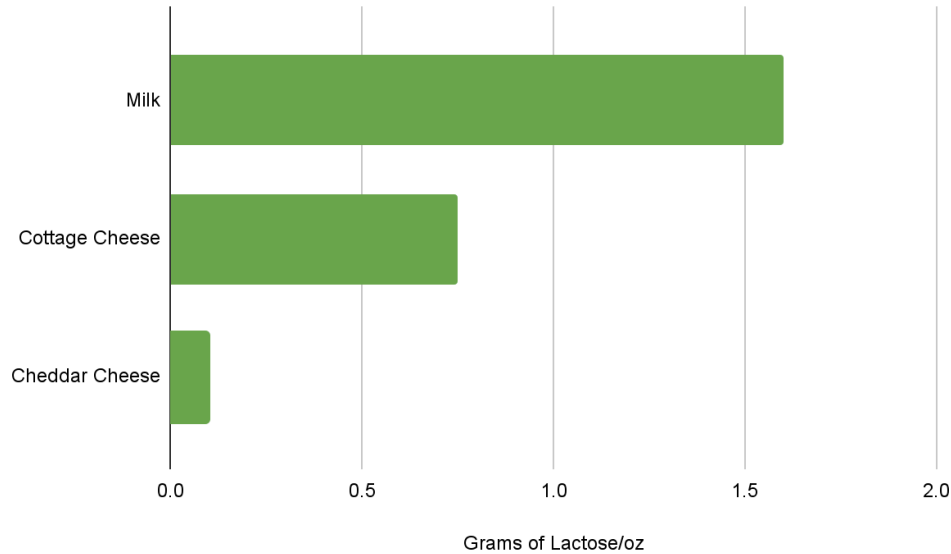
	<p>C. When you are lactose intolerant your body tries to process the dairy. OR There is too much bacteria.</p>	<p>C. They are missing some lactase enzymes. OR It is not digesting all the lactose.</p>	<p>absorb it for use in other areas.</p> <p>C. Lactose intolerant people don't have enough lactase enzyme to bond to all of the lactose which allows the lactose to make its way into the large intestine where it interacts with gut bacteria and ferments, producing gas and fatty acids.</p>
Look-Fors	<ul style="list-style-type: none"> • References general or irrelevant evidence from the model • Description of the functions and interactions of specialized parts of the digestive system is missing • Explanation of the digestion of a lactose tolerant person versus a lactose intolerant person is limited, vague, irrelevant 	<ul style="list-style-type: none"> • Uses some relevant evidence from the model • Describes functions of some relevant specialized parts of the digestive system • Partially explains interactions relevant to explaining the digestion of a lactose tolerant person versus a lactose intolerant person 	<ul style="list-style-type: none"> • Uses all relevant evidence from the model • Describes functions of all relevant specialized parts of the digestive system • Sufficiently explains interactions relevant to explaining the digestion of a lactose tolerant person versus a lactose intolerant person

Prompt 3

Now that Kim understands what is happening in her digestive system when she eats dairy products, she knows what to avoid. She does some research to find out if there are different amounts of lactose in dairy products, which is shown in the chart below.



Amount of Lactose in Dairy Products



Which dairy product would cause Kim to experience the least symptoms (if she Kim ate an equal amount of each)? Support your answer using **all** of the following:

- Data about amount of lactose in dairy products from the chart above
- Information about lactose digestion from the models on Page 2, and
- What you know about how different parts of the body work together as a system

Prompt 3 Performance Outcome:

Evaluate the impact of new data to explain how changing the input into the small intestine of the digestive system (e.g., amount of lactose) can affect how matter flows through the digestive system and impacts the function of the system.

SEP	Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.
DCI	Systems of specialized cells within organisms help perform essential functions of life. Any one system is made up of numerous parts and is itself a component of the next level.
CCC	Models (e.g., physical models) can be used to simulate systems and interactions—including matter flows—within and between systems at different scales.



Prompt 3 Rubric

	Emerging	Developing	Proficient
Sample Student Response	<p>Cheddar cheese has the least amount of an effect but still has some effect.</p> <p>OR</p> <p>Cheddar cheese because it has the least amount of lactose.</p> <p>OR</p> <p>The cheddar cheese because it has less stuff.</p>	<p>Cheddar cheese. There is less lactose so there isn't as much for the lactase enzyme to try and break down.</p> <p>OR</p> <p>Cheddar cheese because it has the least amount of lactose which means it is less likely many of the lactose will make it to the large intestine.</p> <p>OR</p> <p>Cheddar cheese because it has the least amount of lactose. She will produce the smallest amount of gas.</p>	<p>Cheddar cheese. It has the least lactose, so less lactose is floating around without a lactase enzyme to break it down. It will produce less gas.</p> <p>OR</p> <p>Cheddar cheese would cause the least discomfort. The limited amount of lactose can be digested by her limited lactase enzymes and would not create gas.</p>
Look-Fors	<ul style="list-style-type: none"> • Accurate claim • Cites relevant evidence based on evaluation of the new data from the graph <p>AND/OR</p> <ul style="list-style-type: none"> • Explanation of how the amount of lactose affects the process of lactose digestion is missing, vague, or inaccurate. 	<ul style="list-style-type: none"> • Accurate claim • Cites relevant evidence based on evaluation of the new data from the graph • Explains how the amount of lactose affects the process of lactose digestion including some of the steps of how lactose flows through the system 	<ul style="list-style-type: none"> • Accurate claim • Cites relevant evidence based on evaluation of the new data from the graph • Explains how the amount of lactose affects the process of lactose digestion including all of the steps of how lactose flows through the system