

More Cheese, Please

Middle 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 of lactose-tolerant and lactose-intolerant people to see how the inputs, outputs, and processes of each person's digestive systems affect how they function to process dairy products. They then develop their own comparative model 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 of the key functions of the cells in the digestive system is the production of different enzymes. Those enzymes help break down (digest) foods into nutrients that can be absorbed. The structure of an enzyme is specific, and it determines the substrate type it can break down in the process of digestion.

In a digestive system, cells in the small intestine produce the enzyme lactase that digests lactose into two smaller units, glucose and galactose. These smaller products can be absorbed by the small intestine. Some individuals have a natural difference in their digestive processes, including decreased amounts of the enzyme, lactase. This is often referred to as lactose intolerance. Because of this decreased amount of lactase, more lactose passes from the small intestine into the large intestine without being broken down into glucose and galactose. Excess lactose in the large intestine 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 subsystem interact, including inputs, processes, and outputs, to contribute to a particular body function within the human body.

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 (MS)

• In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs* that are specialized for particular body functions.

*Please note that for the authenticity of this task, students are exploring the interaction between





organs, rather than full sub-systems, which still allows them to see groups of cells working together for particular body functions.

Science and Engineering Practices

Developing and Using Models (MS)

• Develop and use a model to describe phenomena.

Analyzing and Interpreting Data (MS)

• Analyze and interpret data to provide evidence for phenomena.

Crosscutting Concepts

Systems and System Models (MS)

• Models can be used to represent systems and their interactions - such as inputs, processes and outputs

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 inputs, outputs, and processes. 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

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.

Prompt 1

In order to understand what happens in Kim's body after she eats dairy products, let's first look at the digestive system of someone who does not experience painful symptoms after eating dairy products.

- Use Model 1 to learn about how this digestive system digests lactose, a two-unit sugar found in dairy products. This model shows two important subsystems, the small intestine and the large intestine.
- To learn more about how enzymes work, watch the video.

Model 1. How a Lactose Tolerant Person Digests Lactose







Use Model 1 to describe what is happening when a lactose tolerant person digests a dairy product. In your response, include inputs, processes, and outputs.

Prompt 1 Performance Outcome:

Use a model to describe the inputs, processes, and outputs between two organs, the small and large intestine, within a digestive system that properly digests dairy products.

SEP	Use a model to describe phenomena.
DCI	These subsystems are groups of cells that work together to form tissues and organs that interact to perform particular body functions.
CCC	Models can be used to represent systems and their interactions - such as inputs, processes and outputs.



Prompt 1 Rubric			
	Emerging	Developing	Proficient
Sample Student Response	Lactase turns into lactose and lactose turns into galactose and glucose.	The small intestine produces lactase and the lactase breaks down the lactose by binding onto it and turning it into glucose and galactose. Input > lactose, output > glucose and galactose. From what I can see, the lactase and lactose are fusing together, like in the video with the enzymes and substrates fuse. The result of these fusing are galactose and glucose that absorb.	When a lactose tolerant person digests cheese, lactose first comes into the small intestine and interacts with the enzyme called lactase. This enzyme then breaks down the lactose into glucose and galactose. Once it is broken down into two parts, it is absorbed into the small intestine. No lactose goes to the large intestine.
Look-Fors	Generally explains how the digestive system of a lactose tolerant person digests dairy, using little to no or irrelevant evidence from the model and no relevant inputs, processes, or outputs between the small and large intestines. OR Response is irrelevant or inaccurate.	Accurately explains how the digestive system of a lactose tolerant person digests dairy, using partial evidence from the model and some relevant inputs, processes, and/or outputs between the small and large intestines.	Accurately explains how the digestive system of a lactose tolerant person digests dairy, using sufficient evidence from the model and all relevant inputs, processes, and outputs between the small and large intestines.





Prompt 2

Now use Model 2 to learn about what is happening in Kim's body after she eats dairy products.









Use Model 2 to describe what is happening when a lactose intolerant person, like Kim, digests a dairy product. In your response, include inputs, processes, and outputs.

Prompt 2 Performance Outcome:

Use a model to describe the inputs, processes, and outputs between two organs, the small and large intestine, within a digestive system that improperly digests dairy products.

SEP	Use a model to describe phenomena.
DCI	These subsystems are groups of cells that work together to form tissues and organs that interact to perform particular body functions.
ссс	Models can be used to represent systems and their interactions - such as inputs, processes and outputs.

Prompt 2 Rubric			
	Emerging	Developing	Proficient
Sample Student Response	Kim's system still has lactose, so she has gas.	When Kim eats dairy products, lactose goes into her small intestine. And there is still lactose that goes into the large intestine. This makes Kim feel gassy, bloated, and	When a lactose intolerant person eats dairy, the lactose from the dairy enters the small intestine. There is not very much lactase in the small intestine, so it can only



		has the runs.	break down some of the lactose into galactose and glucose to be absorbed. This means there is still some lactose left behind to go to the large intestine. Once it's there, it causes gas and diarrhea as bacteria tries to break it down. This is why Kim doesn't feel well.
Look-Fors	Generally explains why Kim's digestive system improperly digests dairy products, using little to no or irrelevant evidence from the model and no relevant inputs, processes, or outputs between the small and large intestines. OR Response is irrelevant or inaccurate.	Accurately explains why Kim's digestive system improperly digests dairy products, using partial evidence from the model and describing some relevant inputs, processes, and/or outputs between the small and large intestines.	Accurately explains why Kim's digestive system improperly digests dairy products, using sufficient evidence from the model and describing all relevant inputs, processes, and outputs between the small and large intestines.





Prompt 3

a. Create a new model that compares what is happening in a lactose <u>tolerant</u> versus a lactose <u>intolerant</u> digestive system by:

- Circling the key differences between the two digestive systems on the models below
- Writing captions to describe each difference you circle



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

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Prompt 3 Performance Outcome:

Develop and use a model to compare how the small and large intestines work together through inputs, processes, and outputs in a well-functioning (ie. lactose tolerant) digestive system versus an improperly functioning (ie. lactose intolerant) digestive system.

SEP	Develop and use a model to describe phenomena.
DCI	These subsystems are groups of cells that work together to form tissues and organs that interact to perform particular body functions.
ССС	Models can be used to represent systems and their interactions - such as inputs, processes and outputs.

Prompt 3 Rubric				
	Emerging	Developing	Proficient	
Sample Student Response	3a. Circles and/or captions:The amount of lactose is different3b. Because they eat more cheese.	 3a. Circles and/or captions: lactase is different lactose left is different lactose is in large intestine for only lactose intolerant person 3b. People like Kim have symptoms like gas and diarrhea because the amount of lactase they have is different. This means they still have lactose at the end, which is bad. 	 3a. Circles and captions: Less lactase in lactose intolerant person More lactose remains in lactose intolerant person Lactose in large intestine in lactose intolerant person, causing gas 3b. Only lactose intolerant people have symptoms like gas and diarrhea because they have lactose in their large intestine. This is because unlike lactose tolerant people, they don't have enough lactase to 	



			break down all the lactose so there is some left.
Look-Fors	Model includes limited circles and/or captions to compare inputs and outputs. AND/OR Generally explains why a lactose intolerant person experiences painful symptoms using no evidence from models. OR Response is irrelevant or inaccurate.	Model includes circles and/or captions to partially compare relevant inputs and/or outputs. AND/OR Accurately explains why a lactose intolerant person experiences painful symptoms using limited evidence from models about the interactions between parts of the digestive system.	Model includes circles and captions to sufficiently compare all relevant inputs and outputs. AND Accurately explains why a lactose intolerant person experiences painful symptoms using sufficient evidence from models about the interactions between parts of the digestive system.

Prompt 4

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. Review Chart 1 to identify which dairy products have the highest and lowest amounts of lactose.





Chart 1. Amount of Lactose in Dairy Products



a. Which dairy product has the most lactose present?

Which dairy product has the least lactose present?

b. Which dairy product would cause Kim to experience the <u>least</u> symptoms and why? Support your answer using the data and what you've learned about lactose intolerance.

Prompt 4b Performance Outcome: Analyze and interpret data to explain how changing the input into the small intestine of the digestive system can affect the processes and outputs of the digestive system.		
SEP	Analyze and interpret data to provide evidence for phenomena.	
DCI	These subsystems are groups of cells that work together to form tissues and organs that interact to perform particular body functions.	



CCC

Models can be used to represent systems and their interactions - such as inputs, processes and outputs.

Prompt 4b Rubric			
	Emerging	Developing	Proficient
Sample Student Response	Cheddar cheese because it's tastier.	Cheddar cheese because it only has 0.1g lactose. Kim can't digest lactose very well so it is best if there is the least amount possible to reduce gas and diarrhea.	Cheddar cheese would cause the least symptoms because it has the least lactose (only 0.1g). This would mean less lactose enters the small intestine so even though Kim has less lactase enzymes, it would be okay. The lactase enzymes she has can break down the small amount of lactose in the cheddar cheese, so it won't go into the large intestine and make gas.
Look-Fors	Makes an inaccurate or irrelevant claim for which dairy product would cause the least symptoms. AND/OR Provides little to no evidence from the data and/or irrelevant reasoning.	Makes an accurate claim for which dairy product would cause the least symptoms. AND Provides relevant evidence from the data and partial or general reasoning about the inputs, outputs, and/or processes of the digestive system.	Makes an accurate claim for which dairy product would cause the least symptoms. AND Provides relevant evidence from the data and sufficient reasoning about the inputs, outputs, and processes of the digestive system.

