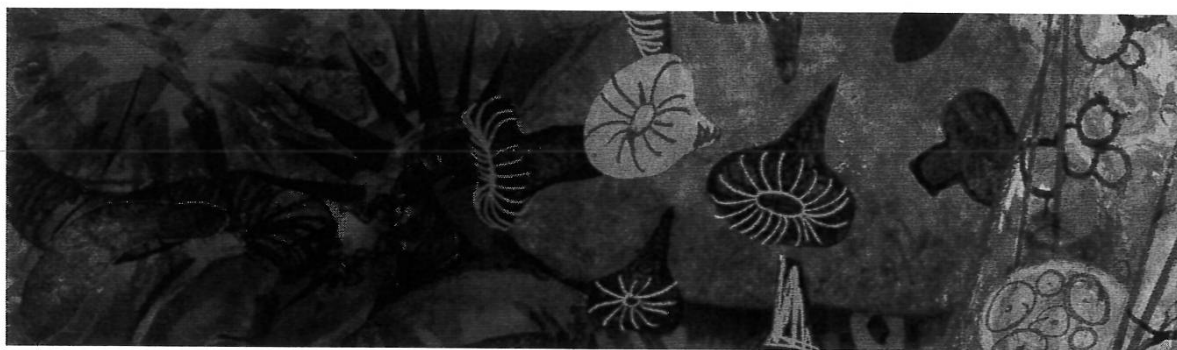


AmplifyScience



# Microbiome

Investigation Notebook

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Lesson 1.1: Introduction to the Scale of Living Things

Welcome to an exciting new year of science! Over the next few weeks, you will learn to think like a life scientist as you investigate the world around you. In your role as a student researcher, you will help the Microbiome Research Institute work to increase funding for new medical treatments that depend on microorganisms found on and in the human body. The head scientist at the Institute will explain more about this research in a video. Then, you'll view some amazing pictures of tiny objects that live on and in the human body, which will help you begin to think about the actual sizes and scale of all different types of living things.

### Unit Question

- How can having 100 trillion microorganisms on and in the human body keep us healthy?

### Chapter 1 Question

- How small are the microorganisms that live on and in the human body?

### Vocabulary

- microorganism
- organism
- scale

### Digital Tools

- Scale Tool

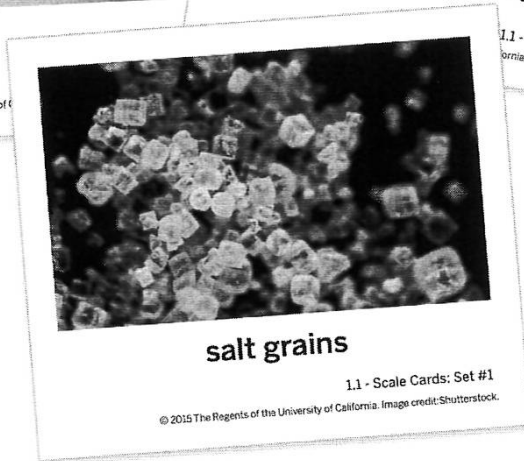
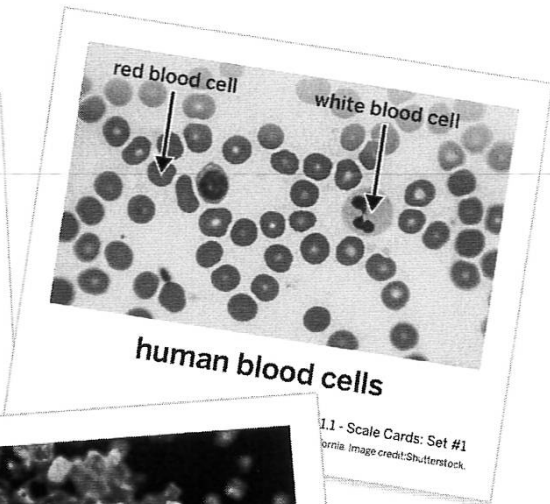
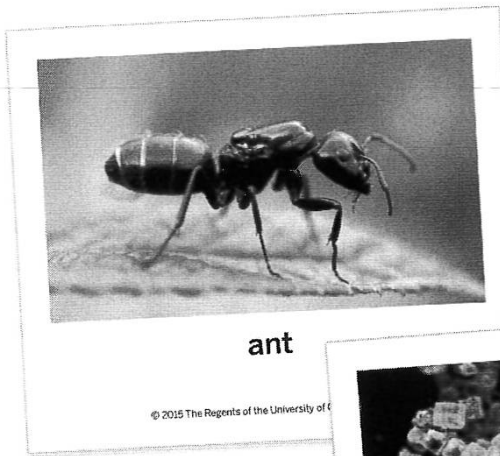


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## Exploring Scale

Sort the organisms and objects on the Scale Cards: Set #1 from smallest to largest (left to right). Remember to discuss your ideas as you work!

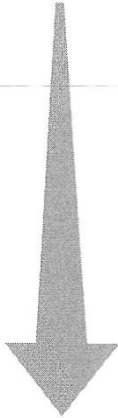


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## Reflection

Below are some of the objects featured on the Scale Cards: Set #1.

1. Rewrite the objects to order them from smallest to largest (top to bottom).
2. Use the Scale Tool to help you order the objects, if needed.

	<b>Smallest</b>	
grain of salt	_____	
<i>E. coli</i> bacteria	_____	
human	_____	
water molecule	_____	
skin cell	_____	
	<b>Largest</b>	

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## Homework: Reflecting About Microorganisms

Respond to the two questions below. Try to use some of the words below that you heard today.

- bacteria
- cell
- microorganism
- microscopic
- organism
- scale

1. What was surprising or interesting to learn about the very small organisms and objects in today's lesson?

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2. What other questions do you have about microorganisms?

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Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Lesson 1.2: How Small Is Small?

In the previous lesson, you learned that there are microorganisms living on and in the human body. You also compared the sizes of microorganisms to other tiny things. In this lesson, you will think very carefully about the small sizes of these microorganisms.

### Unit Question

- How can having 100 trillion microorganisms on and in the human body keep us healthy?

### Chapter 1 Question

- How small are the microorganisms that live on and in the human body?

### Key Concepts

- Many organisms are microscopic—so small that they cannot be seen with the naked eye.

### Vocabulary

- cells
- microorganism
- microscopic
- organism
- scale

### Digital Tools

- Scale Tool

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Warm-Up

Check each statement below that is true. **Note:** You can select more than one statement.

- Cells come in different sizes and shapes.
- All organisms are made of many cells.
- Some organisms are made of just one cell.
- All cells are the same size and shape.
- Most cells are too small to see with the naked eye.

What else do you know about cells? Record your ideas or any questions you have about cells.

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Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Understanding the Scale of Cells

Launch the Scale Tool to help you gather evidence about the objects on the new Scale Cards in Set #2.

- Ringworm fungus
- *C. difficile* bacteria
- Human liver cell

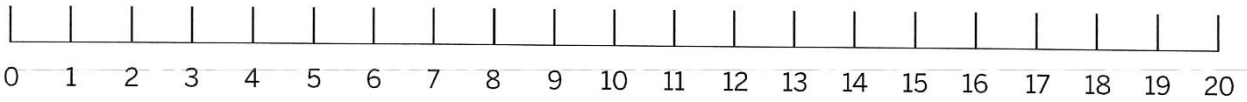
You won't find these items in the Scale Tool, but you can use the measurements on the Scale Cards: Set #2 and the measurements of other objects in the Scale Tool to help you place these items in the Scale Card Sort!

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Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Supersized Microorganisms

1. Choose two microorganisms from the Scale Cards or the Scale Tool.
2. Draw your microorganisms at 20,000 times their actual size.
3. Label each microorganism with its size and name.



scale: 20,000 times actual size  
2 centimeters (cm) = 1 micrometer ( $\mu\text{m}$ )

Name: \_\_\_\_\_

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## Reflection

Check each statement below that is true. **Note:** You can select more than one statement.

- Cells come in different sizes and shapes.
- All organisms are made of many cells.
- Some organisms are made of just one cell.
- All cells are the same size and shape.
- Most cells are too small to see with the naked eye.

Refer back to your Warm-Up on page 11. Did any of your answers change from your Warm-Up response? If so, why? Record your changes and your explanations below.

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## Homework: Comparing Objects at Different Scales

In this lesson, you learned that:

- Living things are made of cells.
- Cells are very small—in fact, almost all cells are microscopic.
- Some living things are made of just one cell.

Think about how the scale of cells compares to the scale of other objects. Launch the Scale Tool and complete the table below by finding examples of objects at each scale that is listed. Some parts of the table have been completed for you.

Scale	Objects at this scale	Size of object
thousands of kilometers		
thousands of meters	depth of the Grand Canyon	
meters	orca	8 meters
centimeters		
micrometers	red blood cell	8 micrometers
nanometers		

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## Homework: Reading “Cells”

You have learned a lot about cells, but there is so much more to know! Read and annotate the article “Cells” and answer the questions below.

1. What is one new thing you learned about cells from this article?

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2. What are organelles and why are they important?

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3. How are cells, tissues, organs, and systems related?

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## Lesson 1.3: Observing Microorganisms

Microorganisms are tiny, but there are some things that are even smaller! In today's lesson, you'll think about things that are even smaller than microorganisms, and you'll also learn how scientists observe microorganisms without a microscope. Also, using a routine called Word Relationships and what you've learned in the last few lessons, you will talk and work like a scientist to revise your initial response to the Chapter 1 Question: *How small are the microorganisms that live on and in the human body?*

### Unit Question

- How can having 100 trillion microorganisms on and in the human body keep us healthy?

### Chapter 1 Question

- How small are the microorganisms that live on and in the human body?

### Key Concepts

- Many organisms are microscopic—so small that they cannot be seen with the naked eye.
- All living things are made of cells.
- Almost all cells are microscopic.
- Even though they are both too small to see, cells are much bigger than molecules.

### Vocabulary

- cells
- microorganism
- microscopic
- scale



Name: \_\_\_\_\_

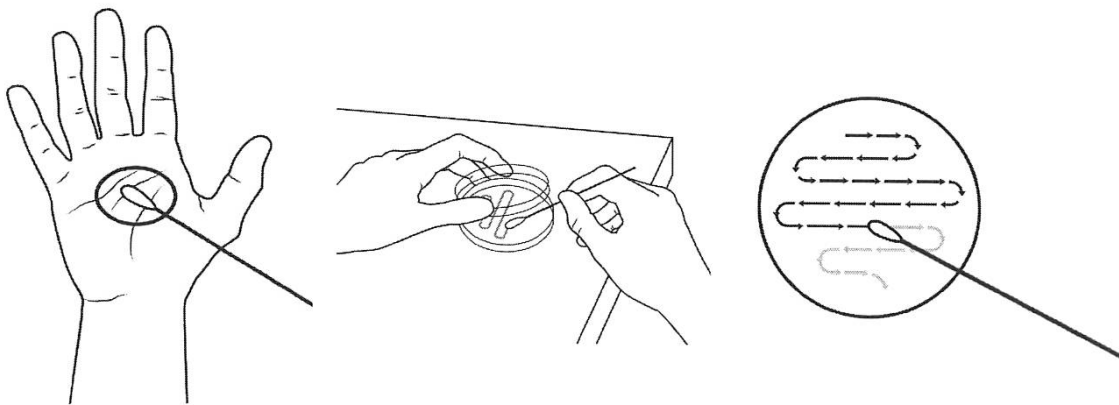
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## Investigating Microorganisms

### Observing Microorganisms

1. Can you observe microorganisms on your hand? (circle one)      **yes**    **no**
2. Do you think there are any microorganisms on your hand? (circle one)      **yes**    **no**

The images below show how a microbiologist could prepare a culture in order to grow and observe the microorganisms found on a person's hand.





Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Observing Microorganisms: Day 1

Refer to the Day 1 image of the petri dish that your teacher projected, and answer the questions below.

Can you see evidence of microorganisms? (circle one)      **yes**    **no**

Describe what you observe in the petri dish.

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Make a prediction: What do you think the petri dish will look like on Day 5?

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Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Observing Microorganisms: Day 5

Refer to the Day 5 image of the petri dish that your teacher projected, and answer the questions below.

Can you see evidence of microorganisms? (circle one)      **yes**    **no**

Describe what you observe in the petri dish.

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Make a prediction: What do you think the petri dish will look like on Day 9?

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Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Lesson 2.1: Reading “The Human Microbiome”

Today, you will return to your bacteria culture to see more evidence about microorganisms that came from your body! Then, you'll read more about these microorganisms in “The Human Microbiome” article. Using this article, you will begin to learn how to read like a scientist, carefully and actively, making sure you understand the text and images. You will record your questions and ideas as you read, and you'll have a chance to discuss your thoughts about the article with others. After reading today, you'll have a better understanding of what the human microbiome is and how it is possible to have trillions of microorganisms on and in the human body.

### Unit Question

- How can having 100 trillion microorganisms on and in the human body keep us healthy?

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### Chapter 2 Question

- How can fecal transplants cure patients infected with harmful bacteria?

### Vocabulary

- cells
- microbiome
- microorganism
- microscopic
- organism
- scale

Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Warm-Up

### Observing Microorganisms: Day 9

Refer to the Day 9 image of the petri dish that your teacher projected, and answer the questions below.

Can you see evidence of microorganisms? (circle one)      **yes**    **no**

Describe what you observe in the petri dish.

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Name: \_\_\_\_\_

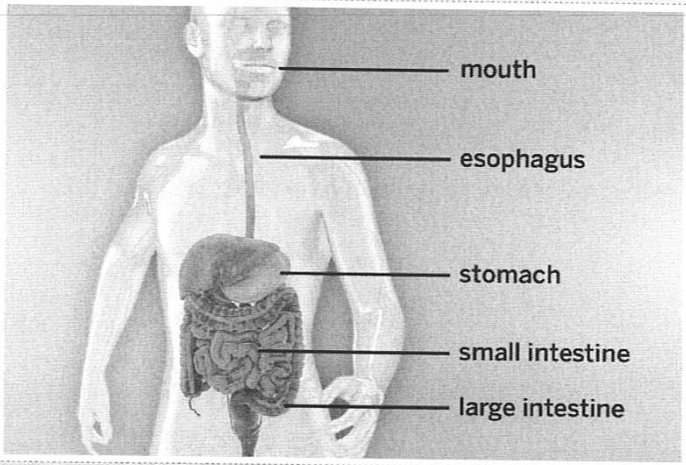
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## Introducing Active Reading

### Analyzing Example Annotations

- What do you notice about this student's annotations?
- How do you know that she was thinking carefully while reading and trying to understand the text?

Certain combinations of bacteria, fungi, and other microbes in the human microbiome can cause health problems, but other combinations may be able to keep people healthy. By identifying which combinations make people sick, scientists might be able to tell what changes to the microbiome could treat those illnesses or prevent them from happening at all. Someday, Lynch believes that doctors will be able to tell patients exactly what combinations of bacteria, fungi, and other microbes they need in their systems to stay healthy.



mouth  
esophagus  
stomach  
small intestine  
large intestine

Many of the microbes Dr. Susan Lynch studies are found in the human digestive system. (© 2015 The Regents of the University of California)

Do different people have different combinations? Why wouldn't they be all the same?  
Belle asked 3 days ago EDIT

Diagram Question: Are microorganisms all over the body or just in the digestive system?  
Lynn asked 4 days ago EDIT

Diagram Question: Is the digestive system really red?  
Lynn asked 4 days ago EDIT

Name: \_\_\_\_\_

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## Reading “The Human Microbiome”

1. Read and annotate the article “The Human Microbiome.”
2. Choose and mark annotations to discuss with your partner. Once you have discussed these annotations, mark them as discussed.
3. Now, choose and mark a question or connection, either one you already discussed or a different one you still want to discuss with the class.
4. Answer the reflection questions below.

### How similar is Active Reading to the way you normally read?

- I always read this way.
- It is somewhat similar to how I normally read.
- It is very different from the way I normally read.

### As I read, I paid attention to my own understanding and recorded my thoughts and questions.

- Never
- Almost never
- Sometimes
- Frequently/often
- All the time

### Active Reading Guidelines

1. Think carefully about what you read. Pay attention to your own understanding.
2. As you read, annotate the text to make a record of your thinking. Highlight challenging words and add notes to record questions and make connections to your own experience.
3. Examine all visual representations carefully. Consider how they go together with the text.
4. After you read, discuss what you have read with others to help you better understand the text.

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## Lesson 2.2: Beginning a Case Study of Patient 23

Here's the deal: A politician wants to cut funding for research on a new treatment that's being used to cure patients infected with a harmful bacteria called *C. difficile*. The treatment involves transplanting helpful bacteria from the poop of a healthy person into the gut of a sick person. Is this an amazing medical breakthrough, or is it just crazy?

The Microbiome Research Institute needs your help to build an argument about how this treatment isn't crazy. (In fact, it actually saves lives.) You'll start to construct this argument by learning more about helpful and harmful bacteria. Then, you'll examine data from a patient who actually received this treatment.

### Unit Question

- How can having 100 trillion microorganisms on and in the human body keep us healthy?

### Chapter 2 Question

- How can fecal transplants cure patients infected with harmful bacteria?

### Vocabulary

- bacteria
- cells
- microbiome
- microorganism
- scale



Name: \_\_\_\_\_

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## Warm-Up

After reading “The Human Microbiome” article, you learned that there are trillions of bacteria in the human microbiome. Which of these statements do you agree with most right now? (check one)

- Bacteria are disgusting! Most bacteria in the human microbiome are harmful.
- Bacteria are great! Most bacteria in the human microbiome are helpful.
- I'm not sure! Bacteria are kind of disgusting, but some of them might be helpful.

What other interesting things did you learn from reading “The Human Microbiome” article?

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What questions do you still have about the article?

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Name: \_\_\_\_\_

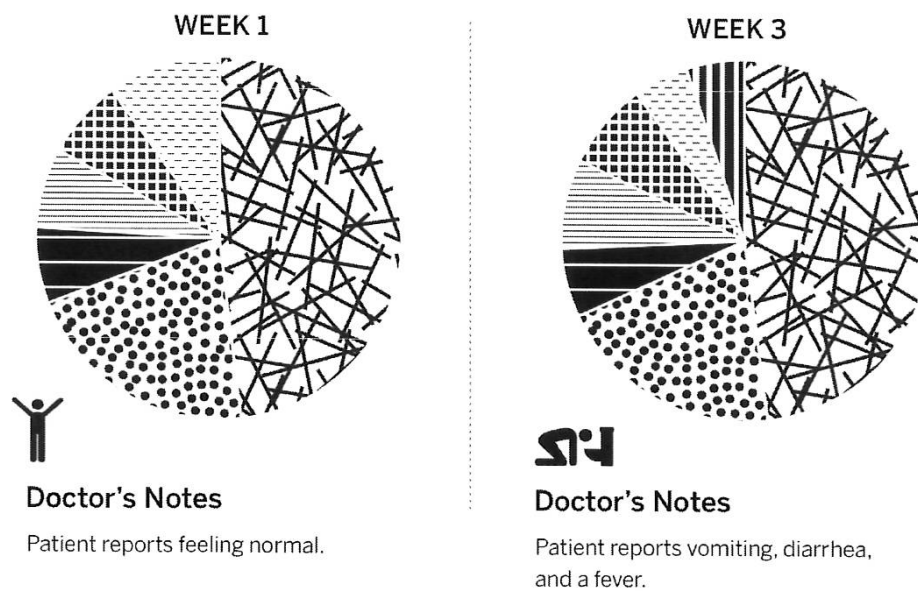
Date: \_\_\_\_\_

## Introducing Patient 23's Case Study

### Analyzing Data in Pie Charts

1. Annotate the case study pie charts below with your comments and questions.
2. Then, discuss the following questions with your partner:
  - What is the **same** about the patient's gut microbiome data from week 1 to week 3?
  - What is **different** about the patient's gut microbiome data from week 1 to week 3?
3. When you are finished discussing with a partner, answer the questions about the patient on the next page.

### Patient 23's Gut Bacteria



#### Gut Bacteria Key

Bacilli (including <i>L. reuteri</i> )	Actinobacteria (including <i>B. animalis</i> )	Epsilonproteobacteria (including <i>C. jejuni</i> )
Bacteroidaceae (including <i>B. fragilis</i> )	Gammaproteobacteria (including <i>E. coli</i> )	<i>C. difficile</i>
Prevotellaceae (including <i>Prevotella</i> )	Other	Space

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### Introducing Patient 23's Case Study (continued)

After your discussion, record your ideas below about why you think Patient 23 feels normal during week 1 but sick during week 3.

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The evidence that supports my ideas is . . .

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Name: \_\_\_\_\_

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## Second Read of “The Human Microbiome”

Reread the sections: “Your Body: Home Sweet Home for Bacteria,” “Helpful Bacteria and Alien Invaders,” and “Antibiotics and the Microbiome” from “The Human Microbiome” article. Then, highlight or add annotations with your ideas to parts of the text that relate to Patient 23. Using your annotations, answer the questions below.

1. What do bacteria do in a healthy gut microbiome?

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2. What is one type of bacteria found in a healthy gut microbiome?

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3. What is a type of harmful bacteria found in the human gut microbiome?

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4. What do harmful bacteria do in the gut microbiome?

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Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Reflection: Revising Explanations About Patient 23

Refer back to your initial explanation on page 31 about why Patient 23 felt sick during week 3. Use what you learned from your second read of "The Human Microbiome" to revise your explanation.

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