

Muse®

Invisible Kingdom

Unable to be seen with the naked eye, microbes are tiny living things found all around us. This issue of MUSE magazine explores how advancements in technology and the curiosity of great thinkers discovered that microorganisms can be both helpful and harmful.

CONVERSATION QUESTION

How are small microbes helping scientists answer big questions?

TEACHING OBJECTIVES

- Students will learn about the microorganisms that live in, on, and around us.
- Students will learn how microbes are used as evidence to solve crimes.
- Students will learn about the discovery of microbes.
- Students will construct explanations.
- Students will collect evidence to support a claim.
- Students will identify cause and effect relationships.
- Students will use critical thinking skills to record the duality of a particular element.
- Students will participate in a dramatic enactment.
- Students will create a timeline chronicling biological advancements in science as they relate to the study of bacteria.



In addition to supplemental materials focused on core STEAM skills, this flexible teaching tool offers vocabulary-building activities, questions for discussion, and cross-curricular activities.

SELECTIONS

- **Little Creatures Among Us**
Expository Nonfiction, ~970L
- **Bug Detective**
Expository Nonfiction, ~1020L
- **Windows to a Hidden World**
Expository Nonfiction, ~900L

Little Creatures Among Us

pp. 10–14, Expository Nonfiction

Students will learn about the microscopic critters that survive in the air, the ground, and even on the human body. The article details microbiological experiments and expresses the duality of microbes.



RESOURCES

Construct Explanations: Little Creatures

OBJECTIVES

- Students will learn about the microorganisms that live in, on, and around us.
- Students will construct explanations.
- Students will use critical thinking skills to record the duality of a particular element.

KEY VOCABULARY

- **ecosystem** (p. 12) a biological community of interacting organisms and their physical environment
- **complex** (p. 12) consisting of complicated or interrelated parts
- **radically** (p. 12;) in an extreme manner

ENGAGE

Conversation Question: How are small microbes helping scientists answer big questions?

Before introducing the article, grind up a piece of white chalk, blue chalk and pink chalk. Ask the class to look at their hand as you read aloud the sentence from page 12 that states, “Millions of microbes are living on just one square inch of skin.” Have three volunteers dip their hands into the powdered chalk until they are well-covered. Instruct the volunteers to walk around the room and touch different objects and surfaces. Discuss how the activity provides a visual representation of how easily microbes travel from one place to the next.

INTRODUCE VOCABULARY

Post and discuss the key vocabulary words and definitions on the board. Then display the following sentences and have students supply the correct word. Lastly, have students write their own sentences.

1. The legal case was so _____ that even the lawyers struggled to understand all of the details.
2. You must _____ change the way you do business if you want to attract new customers.
3. Pollution damages the _____ for plants, wildlife, and people.

READ & DISCUSS

Reinforce comprehension of the concepts in this article by using the following prompts to direct discussion.

1. How can microbes be helpful instead of harmful?
2. What kind of microbes can be found on or in the human body?
3. Explain the sentence, “Insect yeasts...could be the future of flavor.”
4. How do microbes travel from place to place?

SKILL FOCUS: Construct Explanations

INSTRUCT: Advise students to review the article focusing on the studies that were done. Distribute the graphic organizer, *Little Creatures*, and tell the class that they will complete the chart with a partner. Students will need to provide details of each study and a clear explanation of the outcomes.

ASSESS: Review the chart with the class. Discuss the value of the studies.

EXTEND

Critical Thinking: Discuss how the author of the article supports the claim that microbes can be both helpful and harmful. Create a T-chart on the board with the headings “helpful” and “harmful” and have the class suggest things to put in each column. Ask students to help you generate a list of other things that can be both helpful and harmful such as fire, rain, technology, etc. Have students choose one item from the list and create their own T-chart detailing the duality.

Little Creatures

Construct Explanations Three subheadings from the article are listed below. Using information from the article, as well as your own critical thinking skills, provide details of each study and a clear explanation of the outcomes.

Subheadings	Details of Experiment	Outcome of Experiment
<i>Bellybuttons and Armpits</i>		
<i>Smelly Clothes</i>		
<i>Shower Gunk</i>		

Bug Detective

pp. 16–19, Expository Nonfiction

This article examines how microbe communities are traced to individual places and people. Readers will learn methods for collecting and analyzing evidence.



RESOURCES

Collect Evidence: Bugging Out

OBJECTIVES

- Students will learn how microbes are used as evidence to solve crimes.
- Students will collect evidence to support a claim.
- Students will participate in a dramatic enactment.

KEY VOCABULARY

- **microbiome (p. 18)** the community of microorganisms in a particular environment
- **microbiologists (p. 19)** scientists that study biology dealing with the structure, function, and uses of microscopic organisms
- **microbial analysis (p. 19)** the study of the data related to microscopic organisms

ENGAGE

Conversation Question: How are small microbes helping scientists answer big questions?

Ask students to list ways that evidence is collected when trying to solve a crime. Have students think about TV shows, movies, and books in which a crime is trying to be solved. Pose the questions: *How is evidence collected? What kind of evidence is gathered? What evidence can directly link a suspect to a crime? Are evidence collections fail-proof?*

INTRODUCE VOCABULARY

Post and read aloud the vocabulary words. Tell students that many new vocabulary words have Greek and Latin roots, as well as prefixes and suffixes. Have students write the words and underline the similar word parts. Guide them to define the words parts *micro* (very small) and *bio* (living). Have students define the words based on these word parts, then reveal the more accurate definitions listed in the key vocabulary section. Ask: "How does knowing the meaning of roots, prefixes and suffixes help to give meaning to unfamiliar words?"

READ & DISCUSS

As a post-reading activity, lead a discussion based on the following questions:

1. What are microbes and where are they found?
How can microbes be a possible source of evidence at crime scene?
2. How did Hampton-Marcell stage a scene to catch a robber?
3. What is the difference between microbes collected from hands compared to footprints?
4. Do you think it's likely that microbes might replace other forms of evidence such as fingerprints and DNA?

SKILL FOCUS: Collect Evidence

INSTRUCT: This article provides information about the use of microbes for solving crimes. Present the graphic organizer, *Bugging Out*, and tell students that they will be reviewing the article and highlighting sentences that provide evidence to support each of the claims stated. Remind students to cite information and details using page numbers.

ASSESS: Have students peer-review their work by sharing completed worksheets with a partner. Circulate and guide as they discuss.

EXTEND

Drama: Have two or more students act out a robbery in front of the class. Then send a team of three "student detectives" to the crime scene and act out what to do from their pretend earpieces. Students from the class are called on to "talk" into the detective's earpieces and tell them what information to collect to study as evidence for the crime. Invite detectives to ask why they need to collect different types of evidence to provide dialogue about the reasons for microbe analysis.

Bugging Out

Collective Evidence Gather evidence from the text to support each claim. Include details and cite your findings by using page numbers.

Claim: Your microbial community is very unique to you.

Claim: Even if microbial fingerprints don't reveal a criminal's identity, they can provide important information about that person.

Claim: Fingerprints aren't the only potential source of incriminating microbes.

Windows to a Hidden World

pp. 32–35, Expository Nonfiction

Readers will learn about the impact of advancements in microbiology. Key scientists and important milestones are explored in the text.



ENGAGE

Conversation Question: How are small microbes helping scientists answer big questions?

Ask students to consider how progress in society is often due to a combination of advancements in technology and brilliant minds. Discuss famous people and inventions from the past. Then guide students to acknowledge modern day advancements that have led to breakthroughs in different fields. Ask: *What innovations have most profoundly impacted society at this time in history?*

INTRODUCE VOCABULARY

Post and review the three vocabulary words. Inform students that all of these terms can be found in the article, "Windows to a Hidden World". Have them use the title and the vocabulary terms to predict the content of the article. Revisit the predictions after the reading and challenge students to write a brief summary of the article, incorporating all three words.

RESOURCES

Cause and Effect: Invisible Invaders

OBJECTIVES

- Students will learn about the discovery of microbes.
- Students will identify cause and effect relationships.
- Students will create a timeline chronicling biological advancements in science as they relate to the study of bacteria.

KEY VOCABULARY

- **bacteria** (p. 33) microscopic single-celled organisms lacking a nucleus
- **culture** (p. 33) the product of growing a group of microorganisms or cells in a controlled laboratory setting
- **mutations** (p. 34) changes in the structure of a gene, resulting in a variant form that may be transmitted to subsequent generations

READ & DISCUSS

Post and discuss the questions prior to reading. Have students read the article independently and answer the questions in complete sentences.

1. How did Leeuwenhoek's invention reveal the world of microbes?
2. Why does some bacteria make humans and animals sick?
3. Why can't animals and people survive without microbes?
4. How has knowledge of DNA helped scientists learn about microbes?
5. What are the benefits of microbial research?

SKILL FOCUS: Cause and Effect

INSTRUCT: Guide students to acknowledge that an event in biology is often surrounded with causes and effects. Distribute the *Invisible Invaders* organizer and tell students that they will be recording the causes and effects of the events that have advanced the world's knowledge about bacteria. Have them reread the article with a partner to underline passages that will be helpful for this purpose.

ASSESS: The students may work in pairs to complete the organizer. Review the answers and invite students to share their responses.

EXTEND

Social Studies: As a class activity, work with the students to create a timeline chronicling the scientific community's knowledge about invisible microbes from the 1600s into the 21st century. Demonstrate how to properly set up the timeline from 1676 (microscope used to see bacteria in water) to 2024 (advanced DNA testing) and place dates and label events along the line. Ask for volunteers to assist at the board completing the time line. Remind students that a timeline is a tool for organizing information and can show how events in history are related.

Invisible Invaders

Cause and Effect Consult the article and explain the cause of the events listed below, as well as the effects of the action.

Cause	Event	Effect
	<p>In 1676, Antonie van Leeuwenhoek became the first person to see microbes and bacteria.</p>	
	<p>Robert Koch figured out how to prove that some bacteria caused diseases.</p>	
	<p>In the 20th century, biologists discovered DNA.</p>	
	<p>In the 21st century, scientists have new windows into the hidden world of microbes.</p>	