

muse®

Invisible Kingdom

Mighty microbes are doing their bit to keep the life force strongly in place on our planet. They may be small, but they are everywhere! See how they are helping scientists solve important mysteries.

CONVERSATION QUESTION

How are small microbes helping scientists answer big questions?

TEACHING OBJECTIVES

- **Students will learn how microbes are used as evidence to solve crimes**
- **Students will learn about microbes in space**
- **Students will learn the history of how microbes are studied**
- **Students will construct explanations**
- **Students will define problems**
- **Students will identify cause-and-effect relationships**
- **Students will obtain and evaluate information**
- **Students will research to collect evidence**
- **Students will analyze the causes and effects of historical scientific discovery**



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

SELECTIONS

- **Bug Detective**
Expository Nonfiction, ~950L
- **The Littlest Astronauts**
Expository Nonfiction, ~1050L
- **Windows to a Hidden World**
Expository Nonfiction, ~850L

Bug Detective

pp. 26–29, Expository Nonfiction

Students explore microbe communities traced to individual places and people. Use this article to learn methods for collecting and analyzing evidence.



RESOURCES

- Crime Report

OBJECTIVES

- Students will learn how microbes are used as evidence to solve crimes.
- Students will construct explanations.
- Students will write informative text.

KEY VOCABULARY

- **microbe (p. 27)** an extremely small living thing that can only be seen with a microscope
- **microbiome (p. 28)** the microorganisms in a particular environment
- **microbiologists (p. 29)** scientists that study biology dealing with the structure, function, and uses of microscopic organisms
- **microbial analysis (p. 29)** the study of the data related to microscopic organisms

ENGAGE

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

Have students look at their hand and describe to a partner what traces might be left behind when touching something. Ask students to describe what traces are visible and which are invisible to the naked eye. Have them repeat by looking at the bottom of their shoes.

INTRODUCE VOCABULARY

Students write the vocabulary words and underline the similar word parts. Ask them the meaning of the word parts *micro* (very small) and *bio* (living). Have students define the words based on these word parts, then look up definitions to see if they were correct.

READ & DISCUSS

Lead a class discussion based on the following prompts.

- Why are microbes a possible source of evidence at crime scenes?
- What is the difference between microbes collected from hands compared to footprints?
- Do you think microbes might replace other forms of evidence such as fingerprints and DNA?

CONCEPT/SKILL FOCUS: Obtaining, Evaluating, and Communicating Information

INSTRUCT: Have two or more students act out a robbery in front of the class. Then send in a team of three student “detectives” to the “crime scene” and act out what to do from the instructions they receive 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 the evidence for the crime. Invite detectives to ask why they need to collect different types of evidence to provide plenty of back-and-forth dialogue about reasons for collecting for microbe analysis.

Next, have students fill in the *Crime Report* that explains the steps for using microbes as evidence.

ASSESS: Review students’ verbal explanations and instructions to the detectives, as well as their written crime reports for correct use of academic vocabulary and understanding of how microbes are used for evidence.

EXTEND

Language Arts Have students research one of the common microbes found on the wheel chart in the article. Ask them to draw what the microbe looks like under magnification and write an informative paragraph that describes various aspects of the diagram.

Crime Report Write 3 important steps necessary to analyze microbe evidence.

Collecting Samples

- _____
- _____
- _____

Identifying Microbes

- _____
- _____
- _____

Using Databases

- _____
- _____
- _____

Using Microbes as Evidence

- _____
- _____
- _____

The Littlest Astronauts

pp. 30–31, Expository Nonfiction

Students learn how microbes are a part of space travel. Use this article to ask questions and define problems.



OBJECTIVES

- Students will read and analyze a nonfiction article
- Students will define problems
- Students will research to collect evidence

KEY VOCABULARY

- **microbiome** (p. 31) the microorganisms in a particular environment
- **microgravity** (p. 31) a condition in space in which there is a virtual absence of gravity
- **immune system** (p. 31) a body's defense system against infection and illness by destroying unfamiliar germs and parasites

ENGAGE

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

Have students look at the photographs on pages 30 and 31 with a partner and list the ways they think microbes might impact a space mission. Have them consider both positive and negative effects of microbes in space.

INTRODUCE VOCABULARY

Students skim the article for the key vocabulary words with a partner. Have them read the sentence or sentences where the words appear and discuss what the words mean using context clues. Have students then look up the words in a dictionary to compare and refine their knowledge of the word meanings.

READ & DISCUSS

Lead a class discussion based on the following prompts.

- How are microbes harmful and helpful to astronauts?
- How do microbes change in the conditions of space travel?
- Why are scientists interested in the changes to microbes in space?

CONCEPT/SKILL FOCUS: Define Problems

INSTRUCT: Explain that our bodies are used to a population of microbes and that many are necessary for the healthy functioning of our digestive tract. Have students read the article to define one problem astronauts face related to microbes. Then, have students write two questions they have about this problem.

ASSESS: Review student work to note if the problems they defined are related to microgravity and how this changes the microbes necessary for healthy digestion.

EXTEND

Language Arts Have students research information to fill in a class two-column research chart. Place one question at the top of each column.

- How do microbes work to help the human body?
- How do microbes cause disease or illness?

Students add information as they search to learn more about helpful and harmful microbes that live in and on the human body.

Windows to a Hidden World

pp. 38–41, Expository Nonfiction

The advancements of microbiology are explored as students learn about important milestones. Use this article to guide students to practice constructing explanations.



RESOURCES

- Microbiology Timeline Graphic Organizer

OBJECTIVES

- Students will learn the history of the discovery of microbes
- Students will identify cause-and-effect relationships

KEY VOCABULARY

- **bacteria** (p. 39) members of a large group of microorganisms, including some that can cause disease
- **microbe** (p. 39) an extremely small living thing that can only be seen with a microscope
- **agar** (p. 40) a gel substance obtained from seaweed and used in biological culture media
- **mutations** (p. 40) the changing of the structure of a gene, resulting in a variant form that may be transmitted to subsequent generations

ENGAGE

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

Ask students what science tools and methods could have helped scientists learn about organisms that are too small to be observed with the naked eye. Record their ideas to revisit after reading the article.

INTRODUCE VOCABULARY

Have students choose a partner and write the four vocabulary words on slips of paper. Students place the papers face down and take turns choosing one of the slips. The student with the word will attempt to define it. The other student looks up the word and decides if the definition given is correct.

READ & DISCUSS

Lead a class discussion based on the following prompts.

- How did Leeuwenhoek’s invention reveal the world of microbes?
- How has the knowledge of DNA helped scientists learn about microbes?
- Why are scientists interested in microbes?

CONCEPT/SKILL FOCUS: Cause and Effect

INSTRUCT: Explain that this article describes some of the main inventions and discoveries from the first view of microbes through a microscope to advanced PCR techniques. Direct students to use the *Microbiology Timeline* graphic organizer to record the progression of inventions and research found in the article.

ASSESS: Review students’ timelines to assess if they correctly identified the main historical events that advanced the field of microbiology.

EXTEND

Social Studies Have students use their completed microbiology timelines to identify long-term cause-and-effect relationships between scientific inventions and discoveries with a partner. Use the following structure to help those who need extra support.

_____ led to _____
Invention Discovery

Microbiology Timeline

Add important dates in the arrows, and descriptions of major inventions and discoveries in the bubbles. Start with the earliest inventions and discoveries at the bottom and work up to the most recent discoveries described in the article at the top.

