NATIONAL GEOGRAPHIC

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LESSON

Microbes in and on Humans

Through the lens of human body system organization, students learn how microbes can be helpful or harmful to humans. In this series of activities, students engage in jigsaw reading activities and with online interactives, videos, and an infographic. They keep track of their ideas in order to reflect on their understanding over time. Students also analyze the design features of six public service announcements (PSAs) as they prepare to create their own PSA in a later lesson.

GRADES
6 - 8

SUBJECTS
Biology, Health

CONTENTS
3 Activities

In collaboration with

educurious
learning that connects

ACTIVITY 1: HELPFUL MICROBES | 1 HR

DIRECTIONS

This activity is a part of the Misunderstood Microbes unit.

1. Project a series of visuals to show the variation and relative scale of microbes.

- Use the slideshow featuring electron microscope pictures of microbes found at the top of the Small, Small World article to introduce students to the small scale of microbes.

Emphasize the variation in the microbes' body forms.

- Then use the Cell Size and Scale interactive to further solidify students' understanding of the miniscule scale at which microbes exist. Point out the cells and other structures that are present in the interactive, which students will be familiar with from the activities in the *Getting Organized* lesson.
- Prompt students to connect to their thinking about relative scale from the cell investigation in Activity 1.4. Ask students to discuss with a partner and then elicit their ideas via a whole-class discussion: *How does this visualization relate to our cell investigation in the previous activity?* (Possible responses: The different magnifications of the microscope allowed us to zoom in and out of seeing the cells, similar to this visualization.)

2. Organize students into jigsaw groups to become experts on a specific body system and how microbes help that system.

- Distribute and review the *Microbes: Our Best Frenemies* handout, which students will use to structure their learning throughout the *Microbes In or On Humans* lesson.
- Explain the purpose for reading: Learn how microbes impact specific body systems and our health.
- Arrange students into "expert" groups of four, to closely read one article about microbes and its interactions with a particular body system. Provide students in each group access to one of the following articles; the expert group will work together to complete Part A of the handout. Depending on the size of your class, there may be multiple expert groups per article.

    - Armpits Are "Rain Forests" for Bacteria, Skin Map Shows (integumentary System—skin)
    - Feeling Anxious? Have a Pickle (nervous / digestive Systems)
    - What's Up with the Bacteria in Your Gut? (digestive System)
    - Antibiotic Found in Noses—Here's What You Need to Know (respiratory System)

- Encourage groups to chunk the reading into sections, take turns reading those sections aloud, and stop to discuss each section and add relevant information to the handout before moving on. Model this approach as needed to prepare students.
- While the expert groups are reading, prompt students to discuss the main ideas of what they read and ensure they are successfully completing the table in Part A of the handout.
- As you circulate, press students to identify evidence in the text to support their ideas, especially about how microbes are beneficial.
- Reorganize students into jigsaw groups that have at least one expert from each article:

- Review the purpose for reading: Learn how microbes impact specific body systems and our health.
- Each group member is now an expert on a different body system and microbe and should share out to the rest of the group. The other group members will listen, ask questions, and take notes on the remaining body systems in Part A of the handout.

3. Lead a discussion to debrief students' ideas about how microbes help the systems of the human body and address open questions on the class *Know & Need to Know* chart.

- Elicit and discuss students' ideas from the previous step about how microbes are helpful to different body systems.
- Review some of the questions students generated in the *Need to Know* column of the class *Know & Need to Know* chart, which will likely include questions related to microbes' impacts on the human body.

    - Prompt students to decide if the ideas they shared from the readings help to answer some of these questions.
    - Add any new questions that students have about microbes and the human body.
    - Additionally, resolve any open questions in the *Need to Know* column that students now can answer as a result of completing the activities in the *Getting Organized* lesson.

- Explain that although students have some of the information to address part of the Unit Driving Question (*Which microbes should we protect or eradicate to keep our bodies healthy?*), they will be able to fully answer the question after the remaining two activities in the *Microbes In or On Humans* lesson.

4. Analyze a PSA to prepare for project work in the Misunderstood Microbes unit.

- Remind students of the project they will undertake in this unit: Small groups will collaborate to create a public service announcement (PSA) with an online animation app (teacher's choice) that introduces a particular microbe to their community. Their PSA will include an evidence-based argument regarding the value of eradication for the microbe based on how it impacts the systems of the human body.
- Explain that to prepare for making their own PSA, students will be watching and analyzing a variety of example PSAs throughout the *Microbes In or On Humans* lesson.

- Remind students that the purpose of a PSA is to inform or persuade the public and that effective PSAs use engaging visuals and text to communicate important information to the audience.
- Explain that students will critique how well this PSA conveys information and see if they can identify the target audience.
- Remind students that effective feedback is *specific, helpful, and kind*.
- Distribute the *PSA Design Analyzer*. Model for students how to use the design square to note the effectiveness of different design elements as they watch the first sample PSA. In the first design square, students should take notes about each of the following elements in the designated part of the square:

    - Visuals / Animation
    - Text
    - Information
    - Call to Action

- Show the How the Food You Eat Affects Your Gut PSA, prompting students to take notes on the first design square during and after watching.
- Ask students to share some of the effective and less-effective design elements that they noticed, either in small groups or as a whole class. (Possible responses: Students will likely point out many positive elements such as great animation and narration. Areas that could use improvement include sections with complicated information that might be hard for viewers to understand quickly. Also, while the purpose of the PSA becomes clear by the end of the video (it promotes understanding of how healthy food choices support healthy gut microbes) the key message is delayed; the call to action could be introduced much earlier.

5. Present options for the focal microbes students can select for their project work during the *Introduce a Microbe to the World!* lesson.

- Direct students to read the opening paragraphs about the following microbes on the CDC website:

    1. *E. coli* (bacteria)
    2. Botulism (bacteria)
    3. Measles (virus)
    4. *Giardia* (protozoan)
    5. Valley Fever (fungi)
    6. Ringworm (fungi)

- Ask students to rank their first, second, and third choices for which microbe they want to focus on in their projects. Explain that you will use their rankings to make project groups in the *Research a Microbe and Develop an Argument About its Eradication* activity.

Informal Assessment

The *Microbes: Our Best Frenemies* handout can be used to assess students' individual understanding about how microbes help the human body. Additionally, during the discussion in Step 3, assess the accuracy of connections that students make between systems of the body and how microbes help those systems function.

Extending the Learning

Teachers may choose to frame the ecological relationships discussed in this activity through the lens of symbiosis, emphasizing that the majority of the relationships between microbes and humans are neutral.

To solidify students' understanding of the different body systems and ways that microbes can be helpful to those systems, have students engage with the Your Microbial Friends interactive.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Analyze the design of a sample public service announcement.

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Jigsaw
- Multimedia instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
    - Media Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation
    - Critical Thinking and Problem Solving
- 21st Century Themes
  - Health Literacy
- Science and Engineering Practices
  - Asking questions (for science) and defining problems (for engineering)
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.RST.6-8.2:**
Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
• **CCSS.ELA-LITERACY.SL.7.1:**
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 7 topics, texts, and issues, building on others' ideas

and expressing their own clearly.

- **CCSS.ELA-LITERACY.SL.7.2:**

Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.

NEXT GENERATION SCIENCE STANDARDS

- **Crosscutting Concept 3:**

Scale, proportion, and quantity

- **Crosscutting Concept 4:**

Systems and system models

- **LS1.A: Structure and Function:**

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.

- **MS. From Molecules to Organisms: Structures and Processes:**

MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

- **Science and Engineering Practice 1:**

Asking questions and defining problems

- **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information.

Preparation

BACKGROUND & VOCABULARY

Background Information

Microbes are organisms that are too small to be seen by the human eye and include bacteria, archaea, protists, viruses, and fungi. Although some microbes cause disease, they are also crucial to the functioning of human bodies through processes such as digestion and aiding the immune system. The microbes found on a person's body are collectively known as a person's microbiome, especially those found in body organs and systems such as their skin, hair, and digestive system.

Prior Knowledge

["Relationship between structure and function","Organisms process and react to different types of information received through their senses","Systems thinking at different scales"]

Recommended Prior Activities

- Deep Dive into the Cell
- Introduction to Microbes and Human Body Systems
- Microbes Across the Tree of Life
- The Interconnected Systems of the Human Body

Vocabulary

Term	Part of Speech	Definition
electron microscope	*noun*	powerful device that uses electrons, not light, to magnify an image.
inform	*verb*	to provide knowledge.
magnification	*noun*	measurement of how enlarged an image is
microbe	*noun*	tiny organism, usually a bacterium.
persuade	*noun*	to convince someone to do or believe something through reasoning or argumentation.
scale	*noun*	distinctive relative size, extent, or degree.
system	*noun*	collection of items or organisms that are linked and related, functioning as a whole.

ACTIVITY 2: HARMFUL MICROBES | 2 HRS

DIRECTIONS

1. Students learn about harmful microbes from a PSA about foodborne disease that presents a case study about *Escherichia coli*, known as *E. coli*.

- Prepare students to watch the PSA by building background knowledge about *E. coli*. Show a picture of *E. coli* (See "Scanning Electron Microscope (SEM)" image in the slideshow at the top of this page) and ask what students know or can predict about this particular microbe.
- Build on students' prior knowledge as you provide the following information about *E. coli*: Scientific name: *Escherichia coli*

    - Scientific classification: Bacteria; one species that is further broken down into specific strains.
    - Where it is found: Normally lives in the intestines of humans and animals and are harmless.
    - Impacts on humans: Certain strains of it can make people sick.
    - How transmitted: By consuming water and food contaminated by infected feces.

- Prompt students to consider the following questions as they watch the *Foodborne Diseases* video:

    - *What is the purpose of this PSA?*
    - *Who is the intended audience?*
    - *What is its call to action?*

- Analyze the PSA and discuss the potential harm caused by *E. coli* microbes: discuss the following questions in a Think-Pair-Share or whole-class format:

    - *What is the PSA's purpose, audience, and call to action?* (Possible responses: The purpose is awareness and responsibility for prevention; intended audience is consumers; and the call to action is that understanding various factors that can lead to foodborne illness (farm, processing, transportation, vendors, consumers) helps us protect ourselves and communities.)
    - *Based on what you know about bacteria and other microbes, which parts of our food system could help transmit E. coli?* (Possible responses: Warm temperatures during transportation and unhygienic conditions at farms and vendors provide optimal environments for bacteria to survive and reproduce.)
    - *During the outbreak discussed in the PSA, lettuce, tomatoes, and sprouts were all considered possible sources. Why do you think fresh vegetables could be carriers for E. coli?* (Possible responses: Vegetables that have been exposed to contaminated water or another source of *E. coli* need to be washed thoroughly or cooked to eradicate the bacteria; this sometimes does not happen with vegetables that are consumed raw.)

- Support students in understanding how *E. coli* infiltrates and impacts the human body, through the lens of body system organization discussed in the *Getting Organized* lesson.
- Direct students to the PSA Design Analyzer. Prompt students to use the second design square to note the effectiveness of different design elements in this PSA. Discuss as needed.

2. Students learn about specific types of microbes that have harmful impacts on the human body through a jigsaw.

Expert groups collaborate to learn about specific types of microbes that can be harmful.

- Prompt students to return to their Microbes: Our Best Frenemies handout, which students will continue to use throughout this lesson.
- Use the same jigsaw structure and groupings that you used in the *Helpful Microbes* activity, follow the steps below to have students engage with and share about different parts of the *Infectious Agents* infographic.
- Assign each expert group to one type of the following infectious agents. Depending on the number of groups, it is likely multiple groups will be assigned to the same agent.

    - Bacteria
    - Protozoa
    - Viruses
    - Fungi

- Since parasitic worms are not microbes, use this part of the infographic to model how students should make sense of the reading and transfer key ideas to Part B of the handout.
- Provide time for expert groups to read about their assigned infectious agent.
- As you circulate to support understanding, prompt students to discuss the main ideas of what they read, define unfamiliar terms, and ensure they are focusing on how microbes are harmful to particular body systems.

Jigsaw groups share what they have learned about harmful microbes.

- Reorganize students into their jigsaw groups. Each group member is now an expert on a different type of microbe and should share out to the rest of the group. Group members should take notes on the remaining microbes listed in Part B of the handout.

3. Introduce the immune system and how it helps protect the body from infection or disease caused by microbes.

- Elicit students' initial ideas about the immune system and how it works.

- Then show the Innate Immune System video to introduce the body's first line of defense against microbes that cause infection or disease.
- Ask: *How does the immune system help the body to protect against the type of microbe that you became an expert in?*
- Then show the Adaptive Immune System video to introduce the body's second line of defense. This is relevant for all pathogens, but will especially help students whose focal microbe was a virus.

4. Analyze two sample PSAs about microbes' harmful impacts to help prepare students for their project work.

- Remind students about the project they will undertake in this unit: Students collaborate in small groups to create a public service announcement (PSA) with an online animation app (teacher's choice) to introduce a particular microbe to their community. Their PSA will include an evidence-based argument regarding the value of eradication of the microbe, based on its various impacts on the systems of the human body.
- Explain that they will watch and analyze two more sample PSAs.
- Direct students to the PSA Design Analyzer. They should use the third and fourth design
- squares to analyze the following design elements:

    - Visuals / animation
    - Text
    - Information
    - Call to action

- Show the Fight BAC (Bacteria) PSA, prompting students to take notes on the third design square during and after watching. Since this PSA is short (30 seconds), it may be helpful to show it a second time.
- Next, show the Fight the Bite: Lyme Disease PSA, prompting students to take notes on the fourth design square during and after watching.
- Encourage students to discuss the design elements that they noticed in the sample videos, either in small groups or as a whole class.

Tip

Step 3: In addition to the videos, have students engage more deeply about the immune system and its various lines of defenses by reading the following articles:

- Microbiology Online: Immune system
- Microbiology Online: Antibody-antigen complex

Modification

Step 4: If you have time and want students to consider how the same information (preventing Lyme disease) can be presented in very different ways, this TV news PSA about Lyme Disease Prevention provides a clear contrast to the rap song and music video approach.

Modification

Step 3: In addition to the videos, have students engage more deeply about the immune system and its various lines of defenses by reading the following articles:

- Microbiology Online: Immune System
- Microbiology Online: Antibody-Antigen Complex

Modification

Step 2: If you are pressed for time, consider re-structuring the jigsaw reading activity. Students can read the infographics in partners or small groups and then come together to share ideas in a whole class discussion.

Informal Assessment

The *Microbes: Our Best Frenemie*s handout can be used to assess students' individual understanding about how microbes harm the human body. Additionally, during the multiple discussions throughout the activity, assess the accuracy of connections that students make between systems of the body and harmful microbes.

Extending the Learning

Consider framing the ecological relationships discussed in this activity through the lens of symbiosis, emphasizing that the majority of the relationships between microbes and humans are neutral.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Explain how microbes can be harmful to systems of the human body.
- Understand how the body's immune system acts at different organizational levels to help protect the body from infection and disease.
- Analyze the design of three sample public service announcements (PSAs).

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Jigsaw
- Multimedia instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
    - Media Literacy
  - Learning and Innovation Skills

    - Creativity and Innovation
    - Critical Thinking and Problem Solving
- 21st Century Themes
    - Health Literacy
- Science and Engineering Practices
    - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

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Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
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Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly.
• **CCSS.ELA-LITERACY.SL.7.2:**
Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2:**
Cause and Effect
• **Crosscutting Concept 4:**
Systems and system models
• **LS1.A: Structure and Function:**
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.
• **MS. From Molecules to Organisms: Structures and Processes:**
MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

• **Science and Engineering Practice 8:**
Obtaining, evaluating, and communicating information.

Preparation

BACKGROUND & VOCABULARY

Background Information

Microbes are organisms that are too small to be seen by the human eye and include bacteria, archaea, protists, viruses, and fungi. Although most of microbes' interactions with humans are neutral or beneficial, they also can make us sick by acting as infectious agents. Microbes can cause disease through a variety of body organs and systems, which has cascading effects throughout the whole system and human body.

Prior Knowledge

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Recommended Prior Activities

- Deep Dive into the Cell
- Helpful Microbes
- Introduction to Microbes and Human Body Systems
- Microbes Across the Tree of Life
- The Interconnected Systems of the Human Body

Vocabulary

Term	Part of Speech	Definition
bacteria	*plural noun*	(singular: bacterium) single-celled organisms found in every ecosystem on Earth.
disease	*noun*	harmful condition of a body part or organ.
eukaryotic	*adjective*	relating to organisms whose cells have a nuceleus.
foodborne	*adjective*	caused by food contaminated with disease-causing germs or toxic substances.

Term	Part of Speech	Definition
fungi	*plural noun*	(singular: fungus) organisms that survive by decomposing and absorbing nutrients in organic material such as soil or dead organisms.
immune system	*noun*	network of chemicals and organs that protects the body from disease.
infectious agent	*noun*	something (such as a bacterium or virus) that causes disease; also referred to as a pathogen.
ingestion	*noun*	the act of eating or consuming.
pathogen	*noun*	organism that causes a disease, such as a virus.
prokaryotic	*adjective*	relating to organisms whose cells have no distinct nucleus.
protozoa	*noun*	one-celled organisms in the kingdom protista, such as amoebas. (singular: protozoan)
transmit	*verb*	to pass along information or communicate.
vector	*noun*	animal that transmits a disease from one organism to another.

ACTIVITY 3: MICROBE ERADICATION COMPLICATIONS | 1 HR

DIRECTIONS

This activity is part of the Misunderstood Microbes unit.

1. Introduce the idea of eradicating microbes and consider the implications of eradication.

- Project the short article about the eradication of smallpox: *This Day in Geographic History*: Smallpox Eradicated. Read the article to the class; model active reading as you pause to discuss unfamiliar terms as needed.
- Lead a brief discussion about the implications of eradication. Guiding questions:
    - Eradication *means to totally destroy the existence of something. What else can you think of that's been eradicated or should be eradicated?* (Possible response: Other diseases (polio and rabies are considered nearly eradicated), some invasive species, students might also suggest large-scale goals, such as eradicating world hunger or poverty.)
    - *Why do you think scientists focused on smallpox for eradication?* (Possible response: Because smallpox had a high mortality rate, it did not have a cure, and it was highly

contagious.)

- *Based on what you have learned about microbes in the past two activities, do you think eradication is always positive?* (Possible responses: Yes, because so many microbes cause disease and infection in humans. No, because the vast majority of microbes are helpful to humans.)

2. In preparation for their project work in the *Introduce a Microbe to the World!* lesson, read about the connections between microbes, a disease or condition that afflicts humans, and our efforts to eradicate the microbe.

- Explain that students will work with a partner to learn about two to three diseases and microbes on The Microbiome and Disease site and take notes on Part C of the Microbes: Our Best Frenemies handout.
- Highlight how students will think about the relative need to eliminate each disease or health condition by ranking it on a scale of importance. Provide two contrasting examples for students to consider. Ask:

    - *How important is it to eradicate acne for all people?*
    - *How important is it to eradicate cancer for all people?*

- Introduce the ranking scale (critical, important, debatable, unimportant) and prompt students to articulate a reasoning statement for their eradication rankings.
- Work with the class to select or assign diseases; ensure that all 15 diseases on the list will be read by at least one partner group.

3. Create a class Microbe and Disease Eradication Spectrum for students to visualize their rankings of which diseases and microbes should be eradicated.

- Draw a spectrum on the board that reflects the importance ranking for eradication that students used for their diseases:

    1. Critical
    2. Important
    3. Debatable
    4. Unimportant

- Have representatives from each partner group come up to the board and write their health condition/microbe where they think it should belong on the spectrum. For health conditions that were read about by more than one partner group, be sure they distinguish their rankings from each other.
- Elicit reasoning ideas from students for their rankings for particular health conditions/microbes, especially those with the *debatable* ranking.

    - As students share their reasoning, prompt them to share more about the biology of that particular microbe.
    - Note that many of the readings focus on the benefits and harmful aspects of microbes. If students are having trouble determining or reaching consensus for a ranking, have them present their viewpoints to the class and lead a brief discussion to show how microbes can be both beneficial and harmful.
    - Additionally, emphasize that studying microbiome and microbiology is an emerging field; press students to consider other possible uses or benefits that their microbe may have, that humans do not yet know about.

- Explain that this activity is preparing students for their project work in *Introduce a Microbe to the World!* lesson, during which they will decide if another type of microbe should be eradicated.

4. Show two sample PSAs related to the complications involved in trying to eradicate microbes, to help prepare students for their project work in the Misunderstood Microbes unit.
If needed, remind students of the project they will undertake in this unit:

- Students collaborate in small groups to create a public service announcement (PSA) with an online animation app (teacher's choice) to introduce a particular microbe to their community. Their PSA will include an evidence-based argument regarding the value of eradication of the microbe, based on its various impacts on the systems of the human body.
- Explain that they will watch and analyze two more sample PSAs.
- Direct students to the fifth and sixth design squares on the PSA Design Analyzer to analyze the following design elements:
    - Show the Antibiotic Resistance (short) PSA, prompting students to take notes on the fifth design square during and after watching.
    - Since this PSA is short (30 seconds), it may be helpful to show it a second time.
- Then show the Threat of Antibiotic Resistance (long) PSA, prompting students to take notes on the sixth design square during and after watching.

- Consider having students share out some of the design elements that they noticed in the sample videos, either in small groups or as a whole class.

Extending the Learning

Show and have students discuss the *Why Would Anyone Get a Fecal Transplant? Watch a Brother and Sister Explain* video, as an example of efforts to combat diseases that are caused by human attempts to eradicate microbes.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Understand some of the ways that human efforts to eradicate microbes may actually cause disease or health conditions.
- Analyze the design of sample public service announcements (PSAs).

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Multimedia instruction
- Reading

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information Literacy
    - Media Literacy
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Creativity and Innovation
    - Critical Thinking and Problem Solving
- Science and Engineering Practices
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.RST.6-8.2:**
Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
• **CCSS.ELA-LITERACY.RST.6-8.8:**
Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.
• **CCSS.ELA-LITERACY.SL.7.2:**
Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2:**
Cause and Effect
• **Crosscutting Concept 4:**
Systems and system models
• **LS1.A: Structure and Function:**

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.

- **MS. From Molecules to Organisms: Structures and Processes:**

MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

- **Science and Engineering Practice 7:**

Engaging in argument from evidence

- **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information.

Preparation

BACKGROUND & VOCABULARY

Background Information

Microbes are organisms that are too small to be seen by the human eye and include bacteria, archaea, protists, viruses, and fungi. Although most microbes' interactions with humans are neutral or beneficial, they also can make us sick by acting as infectious agents. Depending on the nature of their impacts on humans, the importance of eradicating particular microbes may vary.

Prior Knowledge

["Relationship between structure and function","Human body organization as complex system","Systems thinking"]

Recommended Prior Activities

- Deep Dive into the Cell
- Harmful Microbes
- Helpful Microbes
- Introduction to Microbes and Human Body Systems
- Microbes Across the Tree of Life
- The Interconnected Systems of the Human Body

Vocabulary

Term	Part of Speech	Definition
eradicate	*verb*	to destroy or remove.
eradication	*noun*	total destruction.
implication	*noun*	suggestion or hint.
microbiology	*noun*	study of the structure, function, and behavior of microscopic organisms.
microbiome	*noun*	microorganisms and genetic material present in or on a specific environment.

Informal Assessment

Provide students with their group's revised Human Body Microbial Maps from Lesson 1. Prompt them to individually choose one body system from their map and a type of microbe that they learned about in Lesson 2: bacteria, virus, protozoa, or fungi.

Students should then write an explanation about how the type of microbe impacts the body system. Their explanation should include responses to the following prompts:

1. *How does the microbe enter the body?* (Draw a labeled diagram to accompany your explanation if it is helpful to you.)
2. *After the microbe enters the body, what cells, tissues, and/or organs are affected?*
3. *Are the impacts of the microbe helpful, harmful, or neutral on the body system?* Provide at least two pieces of evidence to support your claim.
4. *How might the body's immune system respond to the microbe?*