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LESSON

Getting Organized

In this series of activities, students are introduced to the main types of microbes, scientific classification, how scientists organize living organisms, and the organization of the human body.

GRADES

5 - 9

SUBJECTS

Biology, Health

CONTENTS

4 Activities

In collaboration with

educurious
learning that connects

ACTIVITY 1: INTRODUCTION TO MICROBES AND HUMAN BODY SYSTEMS | 1 HR

DIRECTIONS

This activity is a part of the Misunderstood Microbes unit.

1. Students make Human Body Microbial Maps to show their initial ideas about how the body is organized.

- Explain that the purpose of making a microbial map is for students to show their initial ideas about how the human body is a system of interacting subsystems.

- In partners, prompt students to use the body outline on the Human Body Microbial Map handout (or on chart/butcher paper, to facilitate drawing with greater detail and sharing out) to create their maps.
- Encourage students to use just one colored pencil to draw the systems of the body. In Step 3, students will use additional colors to add microbes that might be found in or on those body systems and their impacts on the body.
- As students collaborate on their models, circulate to understand their ideas and thinking.
    - Emphasize that there are no wrong ideas at this point; each group's map should show each partner's initial ideas about the organization and systems of the human body.

2. Elicit students' ideas about microbes in order to activate their prior knowledge and understand their thinking.

- Ask students to share what they think a microbe is and why microbes are important for human body systems, other organisms, and ecosystems. Record students' responses in a visible place to keep track of their thinking and to refer back to throughout the rest of the activity.
- Ask students:
    - *What is a microbe?* (Organisms that cannot be seen with the naked eye.)
    - *Why are microbes important for other organisms and ecosystems?* (Many organisms (including us!) rely on microbes to digest food, process waste, and protect from disease. In ecosystems, microbes are also crucial in decomposing waste and other organisms to cycle nutrients back into the food web. Additionally, some microbes produce their own energy through photosynthesis or chemosynthesis, and therefore are foundational to food chains, especially in extreme environments.)

3. Students build on their existing knowledge about microbes by watching a short video and reading the accompanying online information.

- Learn about microbes from the Misunderstood Microbes video:
    - Before starting the video, post these two questions to guide student viewing:
        - *What do you notice about the microbes? What similarities and differences do you see between the types of microbes shown?* (The microbes featured in the video are

eyelash mites, head lice, belly button bacteria, bacteria that cause stinky feet, and skin bacteria.) Students may notice that they vary in their shapes and relative sizes.
    - *Do you notice any patterns in the parts of the human body that are highlighted as habitats for microbes?* The video will show eyelashes, head/hair, belly button, feet, and skin. (Patterns that students may notice include: on the outside of the body, in crevices or areas that offer some amount of protection to the microbes.)

    - After watching the video, lead the class in a discussion, encouraging students to share their observations in response to the questions listed above.

- Learn about microbes by reading information provided online: Engage in multiple rounds of collaborative reading of the "Background Info" and "Fast Facts" sections on the Misunderstood Microbes video page.

    - The purpose of this reading is to give students a brief introduction to the many kinds of microbial organisms, and their importance to the human body and other ecosystems.

    Round 1: Read the information aloud to students. Model active reading by unpacking dense sentences, making use of the embedded definitions, and pausing to ask questions and make connections. Prompt students' sense-making by asking:

    - *What new ideas about microbes were surprising?*
    - *What terms/words/ideas in this article were challenging?*
    - *What do you want to know more about?*

- Direct students to return to their Human Body Microbial Maps to add in microbes using a new color of pencil. Ask:

    - *What microbes did you learn about from the video and the text?* Direct students to add the microbes to the body map on the area they affect and label.
    - *What other microbes do you know about?* Direct students to add the microbes to the body map on the area they affect and label.

    Round 2: Re-read the "Background Info" section on the Misunderstood Microbes video page with students, this time emphasizing the body systems that are discussed.

- Direct students to add additional body systems to their Human Body Microbial Maps. Ask:

- *What body systems were referenced in the video and the text? Place them on the body map and label.*
- *What other systems do you know about and think might have microbes?*

Round 3: Finally, students can start to categorize the microbes on their maps. Have them use the margins of their body map to:

- List positive microbes and their impact.
- List negative microbes and their impact.
- Encourage students to be creative in considering the type of microbes and their impact on different parts of the body.

4**. Introduce students to the Misunderstood Microbes unit and project.**

- If following the Misunderstood Microbes unit, describe the unit's learning arc and culminating project:
  - Tell students that they will return periodically to their Human Body Microbial Maps over the course of the unit they are starting today.
  - Outline some of the key learning activities that students will undertake during the unit, which include:
    - Using online interactives to understand how scientists organize and classify all living organisms.
    - Reading and interactives about the organization of the human body system.
    - Learning that living things are made of cells through hands-on investigation.
    - Readings and interactives to understand how microbes are helpful, harmful, and neutral to humans.
  - Introduce students to the unit's Driving Question and project:

    Driving Question: *Which microbes should we protect or eradicate to keep our bodies healthy?*

    Project: Students will 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. The microbes are:

- *E. coli* (bacteria)
- Botulism (bacteria)
- Measles (virus)
- *Giardia* (protozoan)
- Valley Fever (fungus)
- Ringworm (fungus)

- Create a *Know & Need to Know* chart based on students' understanding and questions about the Misunderstood Microbes unit.

  - Use the Think-Pair-Share process described below to elicit and record students' ideas and questions related to the unit, which can be revisited over time:

    - Ask students to think on their own and then discuss with a partner:

      - *What do we already know about microbes and the human body?*
      - *What do we need to know about microbes and the human body in order to create an evidence-based argument about the value of eradicating a particular microbe?*

  - Prompt students to share their ideas and questions in a whole-class discussion, recording their thoughts on the class *Know & Need to Know* chart.
  - Keep the chart in a visible place in the classroom or easily accessible online to be able to refer to students' expertise and questions with which they started off the unit. Students will more formally revisit the chart throughout the unit as they learn new content and develop new questions.

Tip

Step 2: Before the whole-class discussion, scaffold students' sharing of their ideas by having them engage in a Think-Pair-Share. Read more about this collaborative learning strategy in this article from Adolescent Literacy.

Modification

Step 3: To support students' comprehension of the reading, students can also complete the reading individually, in partners, or small groups.

Tip

Step 4: To learn more about facilitating a Know & Need to Know chart in project-based learning, this PBL Works blog provides explanation and examples.

Informal Assessment

Use students' responses from the various discussions and reading prompts, as well as the ideas they reveal in their *Human Body Microbial Maps*, to understand their initial thinking about microbes and human body systems. You can then leverage and build on students' ideas in subsequent activities in the Misunderstood Microbes unit.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Collaborate on creating a visual model to share their initial ideas about how the human body is organized into systems and the presence and impacts of microbes on the different systems of the body.

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Discussions
- Reading

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Creativity and Innovation
    - Critical Thinking and Problem Solving
- 21st Century Themes
  - Financial, Economic, Business, and Entrepreneurial Literacy
- Geographic Skills
  - Asking Geographic Questions
- Science and Engineering Practices
  - Asking questions (for science) and defining problems (for engineering)
  - Constructing explanations (for science) and designing solutions (for engineering)

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.

NEXT GENERATION SCIENCE STANDARDS

• 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.

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, and ecosystems through processes such as nutrient and energy cycling.

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
ecosystem	*noun*	community and interactions of living and nonliving things in an area.
eradicate	*verb*	to destroy or remove.
microbe	*noun*	tiny organism, usually a bacterium.
organism	*noun*	living or once-living thing.
system	*noun*	collection of items or organisms that are linked and related, functioning as a whole.

ACTIVITY 2: MICROBES ACROSS THE TREE OF LIFE | 1 HR

DIRECTIONS

1. Elicit students' ideas about how to classify and organize living organisms through a card sort activity.

- Ask students:
  - *What kinds of items do you organize or classify around the house, at school, or for sports or hobbies?*
  - *Why is it important to you to have those items organized?*
- As students share their answers, keep track of their ideas in a visible place.
- Connect student ideas to scientific classification by asking:
  - *Why is it important for scientists to classify and organize organisms?* (Students' answers will vary, but may include: having common terms to talk about the same organism, designate endangered species, understand broader patterns of how organisms are related to each other.)

Explain that students will decide on their own system of classification for living organisms through the Critter Card Sort.

- Pass out a set of Critter Cards to pairs or small groups of students.

  - Organisms to include: manatee, hyrax, elephant, *E. Coli*., yeast, protozoa, algae, orchid, fern, earthworm, ant, sea star, kangaroo, lizard, snake, sea nettle, frog, eagle, crab, mouse, salmon, dog, lobster, and clam.

- Prompt students to use the guidelines below as they create groups for the organisms on the cards:

  - Any kind of criteria can be used to form groups (for example legs/no legs), as long as all members agree on the grouping criteria.
  - Each grouping should be given a name.
  - Students should be prepared to explain their classification and naming system, and what features or criteria they used for grouping the organisms.

- After students have decided on their organism groupings, prompt them to share with another partner or group; elicit a few groups to share with the whole class.

2. Project the tree of life from the OneZoom Tree of Life Explorer to show how scientists have organized all living organisms based on their evolutionary relationships.

- Zoom in and out of the tree to see different organisms and how they are grouped together on the tree.

- Ask students to point out what they notice about organisms that are close together on the tree versus far apart.
- Explain that the tree of life is one system of organizing organisms, both living and extinct, via fossil evidence. The groupings are based on scientists' understanding of how closely related the organisms are, using evidence from the organisms' anatomical features and, if possible, their genetic information (DNA and RNA).
    - Organisms that are hypothesized to be closely related are found close together on the tree because they share a recent common ancestor.

- Ask students:
    - *How is the tree of life organization similar to or different from the grouping systems you used in the Critter Card Sort?*
    - *How did you use anatomical features in your sort?*

3. Introduce the Linnaean system of scientific classification and explain how it is also based on the manner in which living organisms are related.

- Zoom out on the OneZoom Tree of Life Explorer to show the group names on the branches, such as eukaryotes.
    - Clicking on the name will show the scientific name, the number of species, and pictures of representative species.

- Explain that in addition to visually showing how organisms are related, scientists also use the tree of life to give names to groups of organisms. For example, Eukaryota represents one of the main three groupings of organisms: domains.
- Introduce the rest of the groupings under the Linnaean classification system, emphasizing how the naming system is hierarchical. Walk through a representative example to show how one organism concurrently belongs to multiple groups, such as a Western terrestrial garter snake (*Thamnophis elegans*):
    - Domain: Eukaryota
    - Kingdom: Animalia
    - Phylum: Chordata
    - Class: Reptilia
    - Order: Squamata
    - Family: Colubridae
    - Genus: Thamnophis
    - Species: elegans

- Point out to students that Linnaean terms are in Latin, to standardize naming and communication about organisms across the world.

Apply the Linnaean system to the Critter Cards and microbes:

- Return to OneZoom and use the search box in the top right corner to locate some of the organisms on the Critter Cards.
    - Show how the elephant, hyrax, and manatee are each other's closest relatives.
    - Show the representative microbes on the Critter Cards (Bacteria: *Escherichia coli,* Protozoa: *Blepharisma japonicum,* Algae: *Dunaliella viridis*) to demonstrate how microbes are spread across the tree of life.

- Refer to the scientific names that were on the Critter Cards and ask students to identify the level of grouping that is referred to (genus and species).
- Review the definition of *microbes* from the *Introduction to Microbes and Human Body Systems* activity: organisms that cannot be seen with the naked eye.
- Prompt students to compare this type of definition to the Linnaean system of classification by asking:
    - *How is the term* microbes *similar to and different from the Linnaean system of scientific classification?* (Possible responses: Similar because both are based on physical characteristics that are shared by organisms; different because many types of organisms are microscopic, it does not clarify if organisms are related to each other.)

4. To facilitate making connections to the focal organisms for the Misunderstood Microbes unit, prompt students to learn more about five of the main groups of microbes.

- Explain that students will work with a partner to engage with the Microbe Passports online interactive, which introduces five of the six main groups of microbes: bacteria, viruses, fungi, protozoa, and algae.
- Distribute and review the Introducing Microbes Note Tracker for students to keep track of their thinking and respond to synthesis questions that help students to connect microbes to scientific classification. Note that students need to *hunt* for the types of microbes listed on their Note Tracker, but may use the additional spaces for any others that they are interested in recording.
- Lead a debrief discussion. Use students' responses to the synthesis questions on the tracker to solidify students' understanding that microbes are found across the entire tree of life.

Revisit the class *Know and Need to Know* chart for students to see how their thinking and understanding about microbes is already changing since the previous lesson. What questions can move from the *Need to Know* to the *Know* column?

Modification

Step 2: Have students explore the tree of life in more detail by opening OneZoom Tree Explorer on individual or partner computers.

Tip

Step 2: Tip for navigating the OneZoom Tree Explorer: From the OneZoom main page, Explore tab, choose one of the groupings below to automatically zoom into the "tips" of the tree and show organisms with which students are more familiar:

- Vascular plants
- Birds
- Amphibians
- Mammals
- Apes

Modification

Step 3: Have students re-sort the Critter Cards based on Linnaean taxonomy, either as a whole class or using the OneZoom Tree Explorer on individual or partner computers.

Modification

Step 3: To illustrate how the tree of life is organized into three domains, show the first 2:20 minutes of the video Exploring Deep-Subsurface Life: Life Domains.

Modification

Step 4: Engagement with the online interactive could also be structured as a jigsaw activity, with each student group focusing on two to three of the microbes.

Informal Assessment

Use the final debrief discussion as a way to gauge students' understanding of the tree of life, scientific classification, and microbes. If following the *Misunderstood Microbes* unit, review students' notes and responses on the Introducing Microbes Note Tracker to prepare for the informal assessment at the end of the *Deep Dive into the Cell* activity.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Understand that microbial organisms are found across the entire tree of life.

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Multimedia instruction
- Reading

Skills Summary

This activity targets the following skills:

- Science and Engineering Practices
  - Asking questions (for science) and defining problems (for engineering)
  - Constructing explanations (for science) and designing solutions (for engineering)

- Developing and using models

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Integration of Knowledge and Ideas, RST.6-8.9

NEXT GENERATION SCIENCE STANDARDS

• **MS. Biological Evolution: Unity and Diversity:**
MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

Preparation

BACKGROUND & VOCABULARY

Background Information

Scientists use physical characteristics and genetic information (i.e., DNA and RNA) to understand how organisms are related to each other, which they then use to create phylogenetic trees that depict these relationships. Organisms that are close to each other on a phylogenetic tree indicate that they have more recently shared a common ancestor and are more closely related to each other than organisms that are found farther apart on the tree. Scientists also use these patterns of evolutionary relatedness to classify all living organisms into groups using the Linnaean system of classification and binomial nomenclature. Since microbes represent multiple groups across the tree of life (including bacteria, archaea, protists, and fungi), the term microbes is not considered a scientific classification grouping. Additionally, viruses are a key group of microbes, but are not always considered to be living organisms given that they are not comprised of cells and can only survive and multiply within living organisms.

Prior Knowledge

["Organisms have different physical structures to support survival and reproduction.","Organisms inherit traits from their parents.","Organisms have unique life cycles, but all have in common birth, growth, reproduction, and death."]

Recommended Prior Activities

- Introduction to Microbes and Human Body Systems

Vocabulary

Term	Part of Speech	Definition
algae	*plural noun*	(singular: alga) diverse group of aquatic organisms, the largest of which are seaweeds.
anatomical features	*noun*	structure, form, or appearance of features relating to the body structure of organisms.
genus	*noun*	taxonomic category of structurally or phylogenetically related species.
Linnaean classification	*noun*	grouping based on physical and genetic characteristics following the methods of the Swedish botanist Carl Linnaeus.
organism	*noun*	living or once-living thing.
species	*noun*	group of similar organisms that can reproduce with each other.

ACTIVITY 3: THE INTERCONNECTED SYSTEMS OF THE HUMAN BODY | 1 HR

DIRECTIONS

This activity is part of the Misunderstood Microbes unit.

1. Prompt students to briefly review their Human Body Microbial Maps and the class *Know and Need to Know* chart from the *Introduction to Microbes and Human Body Systems* activity to activate their previous ideas.

- Ask students to share one or two of the body systems shown on their maps with another set of partners.
- Lead a class discussion to elicit and discuss a few student ideas about how the body system is organized.

- Ideas to listen for: There are multiple systems of the human body that perform different functions necessary for survival; those systems are composed of cells that form tissues and tissues that form organs.
- Then review some of the questions that students generated in the *Need to Know* column of the class *Know & Need to Know* chart, which will likely include questions related to how the body is structured.
- If following the *Misunderstood Microbes* unit, explain that before students can continue to address the unit's Driving Question (*Which microbes should we protect or eradicate to keep our bodies healthy?)*, they will need to learn more about the human body and how it is organized, which is the focus of the next two activities.

2. Lead a brainstorm discussion to reach a working definition of systems.

- Spark student thinking about systems by asking how the school is a system: *What are the inputs, outputs, what happens when it breaks down?* Elicit other ideas about systems in students' lives.
- Pass out the *Organization and Structure of the Human Body* infographic and ask students to talk with a partner about how our bodies are also systems.
- Ask: *What do all these systems have in common?*
- Prompt students to come to a common working definition of system that addresses these commonalities. If needed, build on this definition: collection of items or organisms that are linked and related, functioning as a whole.

3. Students use the *Organization and Structure of the Human Body* infographic to understand how the body is organized.

- Hand out the Human Body Organization Tracker. Have students work in pairs to complete the tracker as they refer to the infographic.
- Then have students revise their Human Body Microbial Maps in their original small groups, to reflect on their learning, and add in new understanding about body systems.
- Encourage students to draw from what they just learned about the structure of the human body as a system as they change or add more details to the body systems already on their maps. Prompt them to also add in other systems they had not considered.

4. Students collaboratively brainstorm and model different examples of how body systems rely on all levels of organization to function.

- Present an example scenario and its impacts on a body system: Describe what would happen if someone who has a peanut allergy unintentionally ingests peanuts. Elicit from students what system they think may be affected (immune system).
- Draw or use a model (similar to this one) that illustrates what happens when a person has an allergic reaction and describe the process using the information below. As you do so, have students keep track of the different levels of organization (cells, tissues, organs, and systems) that react or are impacted.
    - Cells in the immune system first identify the allergen (peanuts, in this case) as an invader. In response, the cells start overreacting by producing antibodies to fight off the invader. These antibodies travel to cells in other body systems that release chemicals, causing a widespread allergic reaction. This reaction usually causes symptoms in the nose, lungs, throat, sinuses, ears, lining of the stomach, or on the skin. Symptoms may include: increased mucus production, swelling of skin and muscles, drop in blood pressure, hives on the skin, constriction of airways, nausea.
    - Giving a dose of epinephrine (the main chemical in an epi-pen, which students may have heard of or even have one of their own) treats an allergic reaction across body systems by tightening the blood vessels to decrease swelling and increase blood pressure, increase heart rate, and relax muscles around airways.
    - Ask students: *What could happen after administering epinephrine if one component of the body system didn't work?* (Suggested response: The allergic reaction could continue, causing severe bodily distress, or even death.)

- Break up the class into four groups. Depending on your class size, the groups can be divided further into smaller groups of three to four students.
- As you modeled with the allergic reaction example, have each group determine and describe the cascading events that can result when something goes wrong with one of the body systems listed below (aligns with those introduced on the *Organization and Structure of the Human Body* infographic).

    - Digestive System
    - Respiratory System
    - Nervous System
    - Integumentary (skin/hair/nails) System

- Prompt groups to use markers and chart paper to create a diagram showing their ideas about how body systems rely on all levels of organization to function.

5. Students review and critique classmates' ideas about body systems as they present their models.

- Have each group present about their focal body system and how that system relies on all levels of the organization to function.
- After each presentation, prompt audience members to give feedback by praising new and interesting ideas, as well as asking clarifying questions about inaccurate ideas or representations on their peers' models.
  - Model for students how to ask clarifying questions that are grounded in the content of a group's ideas rather than the presentation or depiction on their model.
  - Emphasize that feedback should be helpful, specific, and kind.

Provide time for groups to come back together to review and address the questions posed to them by their classmates.

Tip

Step 5: Read about the benefits of peer critique and strategies for supporting students in providing helpful and kind feedback.

Informal Assessment

Keep track of students' ideas about body systems and organization that surface through the opening and debrief discussions, so that you can use and leverage their ideas in subsequent activities.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Apply their understanding of the human body's structural organization by revising their Human Body Microbial Maps (from the Introduction to Microbes and the Human Body activity).

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Discussions
- Multimedia instruction

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Critical Thinking and Problem Solving
- Science and Engineering Practices
  - Developing and using models
  - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

- **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.

NEXT GENERATION SCIENCE STANDARDS

• **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.

Preparation

BACKGROUND & VOCABULARY

Background Information

The human body is structured into levels of interrelated systems, which the body relies on to function. From the smallest level, it is organized into cells, tissues, organs, and larger systems. As such, it is a key example of a system: a collection of items or organisms that are linked and related, functioning as a whole. When something goes wrong with one part of a body system, it has cascading effects throughout the whole system and human body.

Prior Knowledge

["Organisms process and react to different types of information received through their senses"]

Recommended Prior Activities

- Introduction to Microbes and Human Body Systems
- Microbes Across the Tree of Life

Vocabulary

Term	Part of Speech	Definition
allergen	*noun*	substance (such as pollen) that induces a negative bodily reaction, such as sneezing, wheezing, itching, or difficulty breathing.

Term	Part of Speech	Definition
allergic	*adjective*	having a consistent, unusual, negative reaction to a substance.
allergy	*noun*	sensitivity to a specific substance (such as pollen) which causes a negative bodily reaction, such as sneezing, wheezing, itching or difficulty breathing.
digestive system	*noun*	series of organs and glands responsible for the ingestion, digestion, and absorption of food. Also called the alimentary canal.
immune system	*noun*	network of chemicals and organs that protects the body from disease.
integumentary system	*noun*	set of organs that form the external covering of the body and protects it from many threats such as infection (in humans, this includes skin).
interaction	*noun*	relationship between two or more forces, objects, or organisms.
nervous system	*noun*	cells, organs, and tissues including the brain and spine that respond to internal and external stimuli.
organ	*noun*	group of tissues that perform a specialized task.
respiratory system	*noun*	system where oxygen is taken into the body and an exchange of oxygen and carbon dioxide takes place; in humans consisting especially of the nose and lungs.
subsystem	*noun*	system that is part of a larger system.
symptom	*noun*	sign or indication of something.
system	*noun*	collection of items or organisms that are linked and related, functioning as a whole.
tissue	*noun*	cells that form a specific function in a living organism.

ACTIVITY 4: DEEP DIVE INTO THE CELL | 1 HR

DIRECTIONS

1. Project two visualizations to show the smallest level of organization of the human body: the cell.

- Show the Cell Size and Scale interactive to portray the small scale at which cells exist.
- Then show the Animal Cell infographic and give students some time to orient to the details and features of the cell.

- Have students make connections to microbes by asking them to share their initial observations about the features of an animal cell.
    - Ask: *What do you notice? What does this remind you of? How does it relate to the microbes you learned about in the* Introduction to Microbes and Human Body Systems *and* Microbes Across the Tree of Life *activities?* (Possible responses: Many of the microbes were single-celled organisms. Some microbes that we learned about were microscopic animals, but others had simpler cell organization, such as bacteria.)

- Prompt students to make connections that the cell itself is a complex system, similar to the body systems they learned about in *Interconnected Systems of the Human Body* activity, just at a different scale. Point out that single-celled microbes carry out all the activities of life that humans do (with the exception of viruses, which are not comprised of cells and can only survive and multiply within living organisms).

2. Use infographics to compare features of plant and animal cells.

- Distribute the Deep Dive into the Cell Investigation Guide; explain that this organizer will help students track their learning during this activity.
- Have students access the Plant Cell infographic and Animal Cell infographic on computers or distribute printed handouts. Ask students to use the table in Part A of the Investigation Guide to record the cell structures, their locations, functions, and which type of cell they are found in.
- Then follow the steps below to have students identify and discuss the common features that the two cell types share and that are distinct.
- Cells are the smallest functional units of life in all organisms. Ask students: *Do all cells look the same? Which structures might be the same in both a plant and an animal cell? Which might be different?*
    - Have students read and discuss the Plant Cell and Animal Cell infographics. In pairs, have students create a Venn Diagram (or use the one provided) comparing and contrasting the two types of cells. When finished, have student discuss their findings as a class, summarizing the similarities and differences noted.
    - Ask students: *How do cell structures relate to their function?* (One example of this is that plant cells have chloroplasts that allow them to perform photosynthesis for energy, but animal cells do not have chloroplasts since they get their energy elsewhere.)

- After discussing the similarities and differences between plant and animal cells, have students complete the synthesis question at the end of Part A. Tell them:
  - *Write a claim about how the plant cell's additional organelles help it to function. Support your claim with evidence from what you know about plants and their unique abilities.* (Possible claims: Cell wall provides additional structure for a plant, chloroplasts are needed to photosynthesize, larger vacuole stores liquid and helps to maintain cell structure.)

3. Conduct an investigation to compare different types of cells and a nonliving item.

- Introduce the lab and review the lab procedures, as detailed in Part B of the Investigation Guide. If you have selected specific nonliving items for students to choose from in the third part of the investigation, present those at this time.
- Review safety protocols for carrying out lab investigations. None of the chemicals or procedures in the lab investigation are dangerous, but students should use caution when swabbing their cheek with a toothpick and when using the microscopes.
- Distribute materials and have students complete the lab investigation in the same partner groups as in Step 2.
- During the lab, circulate to support students in using the lab tools as well as accurately viewing and interpreting their view of the items under the microscope.
- At the conclusion of the lab, students should respond to the synthesis questions in their Investigation Guide.

4. Lead a discussion to debrief and ensure students' understanding of the previous activities.

- Elicit students' responses to the synthesis questions in Part A and B from the Investigation Guide. Build on students' ideas as you facilitate a debrief discussion about the key features and functions of cell organelles, important differences between plant and animal cells, and how their investigation provided evidence that living things are made up of cells.

5. Revise Human Body Microbial Maps in original small groups for students to reflect on their learning and add in new understanding about cells.

- Encourage students to use their Investigation Guide to draw from what they just learned about cells as the smallest organizational structure of human bodies as they add more details to their maps.
- Prompt students to consider:
    - How to draw the relative scale between the different levels of body organization to show details on cells. For example, a “zoom in” circle similar to the view through a microscope.
    - How the microbes that students have already drawn on their body maps may interact with the cells of the body. Encourage students to use arrows or other symbols to make clear their ideas about which organizational level(s) (cells, tissues, organs, systems) of the body the microbe affects.

Modification

Step 1: If following the Misunderstood Microbes unit, you will revisit the Cell Size & Scale interactive in the Helpful Microbes activity to show the scale of other types of microbes that are smaller than a cell, but you may choose to show this now.

OBJECTIVES

Subjects & Disciplines

Biology

Learning Objectives

Students will:

- Apply their understanding of cells by revising their Human Body Microbial Maps.

Teaching Approach

- Project-based learning

Teaching Methods

- Lab procedures

- Multimedia instruction
- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Critical Thinking and Problem Solving
- Science and Engineering Practices
  - Engaging in argument from evidence
  - Planning and carrying out investigations

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.RST.6-8.3:**
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
• **CCSS.ELA-LITERACY.RST.6-8.7:**
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

NEXT GENERATION SCIENCE STANDARDS

• **From Molecules to Organisms: Structures and Processes:**
MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
• **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.

Preparation

BACKGROUND & VOCABULARY

Background Information

Cells are the smallest level of organization of the human body, as well as other multicellular organisms. The features and structure of cells differ widely between eukaryotic organisms such as plants and animals, which differ from microbial organisms such as bacteria and archaea. These structural differences have implications for how the cells/organism functions. Nonliving organisms do not have cells, which is a key feature that distinguishes them from living organisms.

Prior Knowledge

["Systems thinking at different scales","Interrelation of structure and function"]

Recommended Prior Activities

- 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
cell	*noun*	smallest working part of a living organism.
function	*verb*	to work or work correctly.
multicellular	*adjective*	composed of more than one cell.
organelle	*noun*	specialized part of a cell that performs a specific function.
photosynthesis	*noun*	process by which plants turn water, sunlight, and carbon dioxide into water, oxygen, and simple sugars.
scale	*noun*	distinctive relative size, extent, or degree.
single-celled	*adjective*	having or consisting of a single cell (also referred to as unicellular).
structure	*noun*	system of organization.
unicellular	*adjective*	having one cell.

Informal Assessment

Use the questions below to assess students' understanding of the main concepts covered in this lesson. Have students use their *Human Body Microbial Maps* to individually respond to the questions on an exit ticket:

- *Based on what you learned about microbes and scientific classification in the* Getting Organized *lesson activities, do you think* microbe *is a useful term? Write a claim that communicates your thinking and provides a definition of the term* microbes. *Use the notes you took about microbes in the* Microbes Across the Tree of Life *activity as evidence and include a reasoning statement that connects the evidence to your claim.*
- *After scraping their knee, one of your friends asks why we bleed after getting hurt. In three or four sentences, write an explanation. Use your* Human Body Microbial Map *as evidence and the following terms in your explanation: cell, tissue, organ, circulatory system, skin, body.*
- *At which level of body organization are microbes found? How does microbes' relative size help them impact the human body?*