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LESSON

Germ Flow

Students are introduced to the unit's driving question about why germs make people sick more often during the winter. They then learn about microbes that cause illnesses and use an infographic to analyze findings on how viruses thrive in cold and dry conditions. Finally, students engage in a hands-on demonstration to show how far a sneeze can carry germs and consider how different activities help or prevent germs from spreading.

GRADES

3, 4

SUBJECTS

Biology, Health

CONTENTS

3 Activities

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ACTIVITY 1: SICK DAYS | 1 HR 15 MINS

DIRECTIONS

This activity is part of The Truth About Germs unit.

1. Engage students in the unit's driving question by having them share experiences related to the common cold.

- Ask students to think back to when they last had a cold, flu, or stomach bug. Use a Think-Pair-Share strategy to have students share responses to some or all of these follow-up

questions:

  - *What were your symptoms?*
  - *Did you have to miss school or other events?*
  - *How did you feel, either in your body or your emotions?*
  - *What time of year were you sick?*

- On the board or as a digital resource, tally students' responses to the final question, with the four seasons as column headers.
- Have students determine which season had the highest number (or proportion) of incidents of illness. This can be done individually, in partners, or as a class. Options, depending on the math standards that you are working with, include:

  - Adding up the tally marks for each category
  - Dividing up the tally marks for each category by the total number to calculate the fraction or decimal represented by each category
  - Creating a bar or line graph

- Lead the class in making sense of their data, to determine which seasons had the highest number of incidences of the common cold. Typical responses should indicate more students were sick in fall and winter.

2. Lead students through analyzing an authentic data representation to understand that people get sick more often in the winter.

- Project the *Flu Trends* website and select the "Current Flu Season" option to display a line graph of the percentage of people in the United States experiencing flu-like symptoms.

  - You may need to use the slider at the bottom of the graph to show a full year that includes the summer months.

- Support data literacy as you walk the class through the line graph, making sense of what it shows. For example, identify:

  - The units on the x-axis—Time/Years
  - The units on the y-axis—Percentage of people in the United States experiencing flu-like symptoms

- What the lines represent—The changes in the percentage of people in the United States experiencing flu-like symptoms over time
- The data sources—
  - Blue line: *The Centers for Disease Control*: *Weekly U.S. Influenza Surveillance Report*
  - Red line: *Flu Near You*, a website in which people can self-report if they have flu-like symptoms

- Have students practice interpreting trends by selecting two to three of the previous flu season year options.
  - For most years, the fall and winter months will show a higher percentage of people in the United States experiencing flu-like symptoms in comparison to the spring and summer months.

- Compare the results from the findings on the class' data table or graph to their findings from the *Flu Trends* graph.
  - Ask students if this is the same or different finding than what they found for their class.
  - If the trends are different, invite students' ideas about why this could be the case. Build on their ideas to emphasize the concept that it could be related to the small number of data points represented by each student in the class versus the *Flu Trends* graph, which draws from two different data sources of nationwide data: the U.S. Centers for Disease Control and self-reported data from the *Flu Near You* website.

3. Elicit students' initial hypotheses related to the unit's driving question of why germs make us sick more often in the winter.

- Introduce the unit's driving question: Why do germs make us sick more often during the winter?
  - Explain that students will investigate this question during the unit, applying what they learn about germs, our immune systems, and environmental factors.

- Distribute the *Question Quadrant* handout and use the Think-Pair-Share strategy to have students record and share their ideas in response to the unit's driving question.
  - The Question Quadrant helps scaffold and organize students' thinking about the unit's driving question by separating their ideas into possible factors: Germs, People, Environment, or Something Else.

    - For the Something Else category, direct students to identify additional factors that they think may also play a role. At this point, do not dispel any misconceptions that students may have.

  - Next, direct students to draw on the ideas they recorded for each factor to write an initial hypothesis that responds to the unit's driving question. Hypotheses could relate to just one factor or more factors.
  - Emphasize that students are not meant to identify the "right" answer at this point, but to share their initial thinking, just like scientists do.
  - Prompt students to also add one or two questions that they have about each factor.

- Create a shared class Question Quadrant chart to record class trends of students' initial hypotheses and questions, either on chart paper or digitally, that can be revisited over the course of the unit.

  - Be sure not to reveal the explanation to students at this point but ask probing questions as you elicit their initial hypotheses and questions.

4. Introduce the unit's final product: The Germology Game Show.

- Explain that students will create a Germology Game Show to communicate what they learn about germs and to challenge community members to think about why we get sick more often in the winter.

  - Determine in advance the format that students will present their trivia questions, whether a game show or otherwise (see Tips for suggestions). Share those details with students to foster excitement and engagement.

- Explain that the class will work collaboratively to create the game show as small groups develop questions and answers about each of the factors on the Question Quadrant.
- All the learning activities in the unit will support students in creating their game show questions and evidence-based answers that they will use to teach their community about germs and how to stay healthy during the winter.
- Create a class *Know and Need to Know* chart (See Tips for more details) to provide students a road map of guiding questions that will lead them to a successful unit project. Document students' ideas and questions in a public document, either on chart paper or digitally, so that the chart can be revisited throughout the unit.
- Have students discuss the following questions with a partner and then share their thoughts with the class:

- What do we already know about why germs make us sick more often in the winter?
- What do we need to know about why germs make us sick more often in the winter, in order to create a Germology Game Show to share what we learn with our community?

Tip

Step 1: Be sensitive to the fact that students' experiences of "being sick" may be more serious than the common cold, especially given the 2020-2021 COVID-19 pandemic. Direct the discussion to the common cold or focus more broadly on when students have observed that more people at school or in their communities have been sick with the common cold. Students can also have the option to individually write and submit their responses rather than share with a partner or the class.

Step 3: To orient yourself to the full explanation as to why germs make us sick more often in the winter, read the Background Information section and/or visit the resources in the Resources (For Further Exploration) section. Be sure not to reveal the explanation to students at this point, but it may help to generate probing questions as you prompt their initial hypotheses in Step 3.

Step 4: In preparation for introducing the unit's final product of a Germology Game Show, consider key factors in advance: 1) Is there a specific and/or authentic audience that you can invite for the game show? Some options include: peers or younger students at school, family members, and community members; and 2) What format for the game show best fits your class and school setting? Some options include: a live game show or quiz bowl, like the *National Geographic GeoBee*; self-quiz cards; an interactive quiz, such as *Gross Out*; or a MythBusters-style explanatory video, such as *How Much Water Can a Wet Dog Shake Off?* (2:44).

Step 4: To learn more about facilitating a *Know and Need to Know* chart in project-based learning, read the article *Using the Need to Know List to Support Gold Standard PBL Teaching* from PBL Works for explanations and examples.

Informal Assessment

On the *Question Quadrant* handout, assess students' initial hypotheses about why germs make us sick more often during the winter to understand their prior experiences, knowledge, and questions. Students' ideas and questions on the *Know and Need to Know* chart can also be used to assess their existing understanding. Use what you find out about students' thinking to guide subsequent instruction.

If the Common Core Math Standards are a focal point of instruction, use students' data representations in Step 1 and/or abilities to analyze the *Flu Trends* graphs in Step 2 as evidence for meeting these standards.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Collect and analyze data and graphs to determine that winter generally has the highest incidence rate of common illnesses.
- Share initial hypotheses about the unit's driving question: why germs make us sick more often during the winter.
- Understand the project and driving question for The Truth about Year Round Germs unit.

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Discussions
- Writing

Skills Summary

This activity targets the following skills:

- Geographic Skills
  - Asking Geographic Questions

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR MATHEMATICS

• **CCSS.MATH.CONTENT.3.MD. B.3:**
Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories.
• **CCSS.MATH.CONTENT.3.NF. A.1:**
Understand a fraction 1/b as the quantity formed by 1 part when a whole is partitioned into b equal parts; understand a fraction a/b as the quantity formed by a parts of size 1/b.
• **CCSS.MATH.CONTENT.4.NF.C.6:**
Use decimal notation for fractions with denominators 10 or 100.
• **CCSS.MATH.CONTENT.4.NF.C.7:**
Compare two decimals to hundredths by reasoning about their size.

NEXT GENERATION SCIENCE STANDARDS

• **Science and Engineering Practice 1:**
Asking questions and defining problems
• **Science and Engineering Practice 4:**
Analyzing and interpreting data
• **Science and Engineering Practice 6:**
Constructing explanations and designing solutions

THE COLLEGE, CAREER & CIVIC LIFE (C3) FRAMEWORK FOR SOCIAL STUDIES STATE STANDARDS

• **Causation and Argumentation: D2.His.14.9-12:**
Analyze multiple and complex causes and effects of events in the past.

• **Human Population: Spatial Patterns and Movements: D2.Geo.7.6-8:**
Explain how changes in transportation and communication technology influence the spatial connections among human settlements and affect the diffusion of ideas and cultural practices.

Preparation

BACKGROUND & VOCABULARY

Background Information

This unit focuses students' learning about germs, the environment, and the human immune system through the everyday phenomenon of why we get sick more often in the winter. By the end of the unit, students will be able to fully explain the phenomenon by discussing the following contributing factors. In the winter, there are environmental factors (i.e.,decreased humidity so droplet particles remain in the air for longer, dry air drying up the mucus in our noses) and stressors on our bodies (such as lack of natural vitamin D from the decreased levels of sunlight during the winter, less exercise, and constriction of airways) that decrease our immune systems' ability to fight off germs. Additionally, there are more indoor gatherings between people from different households in the winter, decreasing the levels of ventilation and forcing face-to-face contact for longer periods of time without a barrier of protection (i.e. mask) which increases the likelihood of spreading germs. Another factor is that viruses (which cause the common cold, influenza, and coronavirus) have been found to be more stable (cold temperatures make the virus coating tougher and more resilient) and stay in the air longer in cold and dry conditions. This is because the low amounts of moisture present in the air quickly evaporate, allowing the virus to stay in the air for longer times when the weather is cold and dry. It is important to note that we typically only get sick if exposed to the disease-causing germs and not from cold temperatures alone (unlike popular myths).

In Project-Based Learning (PBL) and the related approach of leveraging an anchoring phenomenon to engage and support students' science learning, teachers should understand the explanation for the phenomenon in order to anticipate and guide students' content learning. However, it is crucial to not reveal key aspects of the explanation or correct students' original hypotheses or misconceptions. Instead, throughout the unit, students will continually return to the unit driving question why germs make us sick more often during winter, revising their initial hypotheses as they learn more and deepen their understanding. Importantly, the

goal of this PBL unit is for students to share their understanding of this everyday, compelling, and relevant phenomenon with their community, through creating a Germology Game Show or similar type of product, which students are introduced to in this activity.

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
environment	*noun*	conditions that surround and influence an organism or community.
germ	*noun*	disease-producing microbe.
hypothesis	*noun*	statement or suggestion that explains certain questions about certain facts. A hypothesis is tested to determine if it is accurate.
symptom	*noun*	sign or indication of something.

ACTIVITY 2: GERMS ALL AROUND US | 1 HR

DIRECTIONS

This activity is part of The Truth About Year Round Germs unit.

1. Read a book and use an image gallery to introduce key ideas about microbes and germs.

- Connect to the ideas from the previous activity, *Sick Days*, by asking students to share what they know about how germs make us sick.
    - Reference and leverage ideas and questions that students shared on the class *Know and Need to Know* chart at the end of the previous activity.
    - Sample questions include:
        - *What types of germs are there? Do they all make us sick?*
        - *How do the germs that cause the common cold (or other illnesses, such as COVID-19) make us sick?*

- Read a text that introduces germs and microbes in an age-appropriate way, like the book *Tiny: The Invisible World of Microbes* (7:25). Read the text aloud as a class, pausing as needed for students' reflections and emphasize key ideas from the reading, including:

  - There are many different types of *microbes* (the broader term for organisms that are too small to see with our naked eyes without a microscope).
  - Most microbes don't make us sick and play very important roles in our bodies (e.g., digesting food, absorbing nutrients, protecting us against disease-causing microbes) and ecosystems (e.g., nutrient cycling, reforestation, waste decomposition).
  - Microbes reproduce by splitting in two (aka binary fission), so they can increase their population very quickly (within minutes).
  - *Germs* are microbes that make us sick.
  - Germs can get into bodies through different ways, such as these examples from *Tiny: The Invisible World of Microbes*: through our mouth or nose, a cut or wound, or sometimes through an insect's bite, such as a mosquito.

- Distribute the *Germs All around Us* handout. Show the *Introducing Microbes and Germs Image Gallery* to introduce the three main types of germs that will be the focus of this unit: viruses, bacteria, and fungi.

  - As you show the images and review the accompanying information, connect to the key ideas from the book and prompt students to take notes and write down their questions in Part A on their handout. Emphasize the diversity of microbes (diversity in shape, color, types, whether good/bad, origin, properties such as being able to survive at hot temperatures or at high pressures, or habitats such as soil, water, animals, plants, humans), and how most microbes are "good" and beneficial or have no effect on humans. For microbes that do make us sick (germs), highlight that different germs cause different types of illnesses. To segue to the next step, emphasize that viruses are one of the main types of germ that cause sicknesses (such as the common cold and flu) that affect us more often during the winter.

2. Use an infographic to analyze experimental data that shows how viruses thrive in cold and dry conditions.

- Use the class Question Quadrant from the *Sick Days* activity to explain that students will be exploring factors related to the Environment quadrant, while the next activity, *Spreading Germs*, will explore factors related to the People quadrant.

- Prompt students to identify the key factors of what weather is like in many areas that experience winter, leading to the factors of low temperature and low humidity.
- Project or distribute the *Guinea Pigs Can Get the Flu, Too!* infographic, which will walk students through an experiment that helps answer the unit driving question.
- As a class, collaboratively read the introduction at the top of the infographic about how Dr. Palese figured out that guinea pigs can get sick with the flu and the experimental set-up.
- Prompt students to use the labeled boxes in Part B of their *Germs All around Us* handout to identify the testable question that Dr. Palese and his team were investigating and make a prediction about what their findings will show.

  - Walk through the definition of *humidity* (how much water vapor, or moisture, is in the air) on the handout as needed with students.

- Support data literacy by using a Think-Pair-Share strategy to interpret the two graphs of the experimental findings as a class, having students share their interpretations of the elements below, based on evidence.

  - Each graph shows a different temperature condition: Cold weather (5°C or 41°F) and warm weather (20°C or 68°F).
  - For both graphs:

    - The x-axis shows the different humidity conditions: Low Humidity (35 percent) and High Humidity (80 percent).
    - The y-axis shows the percentage of guinea pigs that got sick in each experimental condition.
    - What the bars represent: The different percentages of guinea pigs that got sick in each combination of the two environmental conditions: low temperature and low humidity, low temperature and high humidity, high temperature and low humidity, high temperature and high humidity.

- Use the prompts and questions provided on the Understanding Results section of the handout to guide students to understanding the following key findings from the experiment:

  - In the low temperature and low humidity condition, 100 percent (all) of the guinea pigs got sick.
  - In the low temperature and high humidity condition, about 50 percent (half) of the guinea pigs got sick.

- In the high temperature and low humidity condition, 100 percent (all) of the guinea pigs got sick.
- In the high temperature and high humidity condition, 0 percent (none) of the guinea pigs got sick.

- Direct students to read the bottom section of the infographic and record their responses and ideas in the next boxes (Interpreting results and revisiting my prediction) on the handout. Lead a debrief discussion to solidify students' understanding of the interpretation of the evidence and how this experiment alone doesn't explain *why* viruses are best able to survive and spread in low humidity and low temperature conditions (but note that the infographic describes follow-up studies that help to explain this). It may be good to mention that in science we are looking for multiple clues (evidence) that support what we think is right or wrong. It is rare that one piece of evidence alone is determinant.

3. Connect to the unit driving question and project work by taking an interactive digital quiz about what students learned about microbes and germs.

- Have students respond to the final prompts on Part C of the handout, the first of which is regarding how the guinea pig experiment may change their ideas about why germs make us sick more often during the winter.

  - Note that students will formally discuss and revisit their initial hypotheses about this phenomenon in the next activity.

- Remind students that they will be sharing what they learn about germs in winter through a Germology Game Show to help educate their community at the end of the unit. Explain that now they will engage in one way to communicate about what they have learned, an interactive digital quiz (which may also be an option for their final product; see the options for the format of the Germology Game Show described in the *Sick Days* activity).
- Provide access to laptops or tablets and give the link to the *Germs All around Us Interactive Quiz*. Collaborate on the six to eight question quiz as a class or have students challenge each other in pairs.
- After the quiz, distribute the *Trivia Question Builder* handout and review the correct answers. Ask students to share what made the quiz both interesting and informative. Record students' answers in a shared document that can be accessed in subsequent activities.

- Consider also noting the three different question types in the quiz and using the *Trivia Question Builder* to point out to students that they will be using the same formats when they write their own trivia questions and evidence-based answers.

- Finally, lead students through a consensus process to choose two or three of the questions from the quiz that will be included in their Germology Game Show, based on the facts or ideas that students think community members will find interesting or need to know.

  - Have students circle the questions that they chose on their *Trivia Question Builder* handouts; be sure to store these in a safe place so that students can access in subsequent activities.

Informal Assessment

Use students' ideas from the *Germs All around Us* handout and their discussion of the *Germs All around Us Interactive Quiz* to assess their developing understanding about germs and microbes, as well as their ability to analyze and interpret data about what environmental factors affect viruses' abilities to survive and spread. The *Germs All around Us Answer Key* provides sample answers for the handout.

Extending the Learning

To support the focus on viruses in this activity, dive deeper into how viruses survive and reproduce, mutate, and jump between species through the video, *How Do Viruses Jump from Animals to Humans?*, from Ted-Ed and the encyclopedic entry, *Viruses*, from National Geographic. Consider drawing from what students learned about viruses during the COVID-19 pandemic, being sensitive to any trauma they may have experienced during that time.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Identify key concepts about microbes and germs: the three main types of microbes are viruses, bacteria, and fungi; most microbes do not make us sick; and those that do make us sick are called germs.
- Collaboratively analyze experimental data to understand key findings related to how viruses thrive in cold and dry conditions.
- Connect learning to the unit driving question by considering new ideas about why germs make us sick more often during the winter.

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Multimedia instruction
- Reading

Skills Summary

This activity targets the following skills:

- Critical Thinking Skills
  - Analyzing

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.RI.3.3:**
Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and

cause/effect.

• **CCSS.ELA-LITERACY.RI.4.3:**

Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

• **CCSS.ELA-LITERACY.SL.3.1:**

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.

• **CCSS.ELA-LITERACY.SL.4.1:**

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

NEXT GENERATION SCIENCE STANDARDS

• **Crosscutting Concept 2:**

Cause and Effect

• **MS-ESS3-2:**

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

• **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 naked human eye (without a microscope) 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, aiding the immune system, and absorbing nutrients, and ecosystems through processes such as nutrient and energy cycling.

Viruses in particular cause many of the illnesses that make us sick in the winter, such as the common cold and influenza. Lab research, such as the guinea pig study that students learn about through the infographic in this activity, has shown that viruses are best able to survive and spread in environmental conditions that have low humidity and low temperatures, which reflects winter weather conditions in many parts of the United States and around the world. Although the exact mechanism for these findings is not entirely clear and may vary depending on the type of virus, there is some evidence that shows that humid air may change the surface of the virus particle (also known as coating), making it harder to attack our cells. In drier air, viruses can stay active for longer and more successfully infect people. In terms of temperature, some viruses (such as influenza) have an outer envelope that coats the virus particle. In cold winter temperatures, the envelope hardens, which could help the virus spread between people. In warm temperatures, the envelope melts to be more liquid, making it harder to spread. Also, in cold winter conditions people spend more time indoors and with face-to-face contact.

Prior Knowledge

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Recommended Prior Activities

- Sick Days

Vocabulary

Term	Part of Speech	Definition
bacteria	*plural noun*	(singular: bacterium) single-celled organisms found in every ecosystem on Earth.
environment	*noun*	conditions that surround and influence an organism or community.
fungi	*plural noun*	(singular: fungus) organisms that survive by decomposing and absorbing nutrients in organic material such as soil or dead organisms.
germ	*noun*	disease-producing microbe.
humidity	*noun*	amount of water vapor in the air.
hypothesis	*noun*	statement or suggestion that explains certain questions about certain facts. A hypothesis is tested to determine if it is accurate.
microbe	*noun*	tiny organism, usually a bacterium.

Term	Part of Speech	Definition
temperature	*noun*	degree of hotness or coldness measured by a thermometer with a numerical scale.
virus	*noun*	pathogenic agent that lives and multiplies in a living cell.

ACTIVITY 3: SPREADING GERMS I 1 HR 40 MINS

DIRECTIONS

This activity is part of The Truth About Germs unit.

1. Lead a class discussion to have students share ideas about how germs spread and brainstorm how germs commonly enter human bodies.

- Connect to students' previous experiences and learning from the *Sick Days* and *Germs All around Us* activities by asking:
    - *When you got sick from a germ, where do you think that germ came from?* (Students' responses may include: Items in my environment—door handle, sink faucet, etc., other people, or the air.)
        - It may be helpful to point to the class Question Quadrant chart that helps to anchor students' learning and ideas in this unit.
        - Accept all student ideas, in the interest of building on their initial understanding.
            - Highlight that the *Germs All around Us* activity focused on environmental factors and this activity will focus on how germs spread between people.
- Lead a class brainstorm to gather students' ideas about how and where germs enter our bodies. Help students make connections between their responses to the opening question, as well as concepts from the *Germs All around Us* activity, such as:
    - Ideas from the book *Tiny: The Invisible World of Microbes* (7:25) that germs can get into bodies through our mouths, cuts, or sometimes even insect bites.
- Accept all student ideas, emphasizing that for viruses such as the common cold, influenza, and the coronavirus, the nose and mouth are the main pathways for entering our bodies.

- Build on this idea to elicit from students how the nose and mouth are also key pathways for viruses to leave our bodies, through coughs and sneezes.

2. Lead a class demonstration to simulate how sneezing helps germs travel between people.

- Building on students' ideas from the previous step, explain that now they will demonstrate one important way that germs travel if we don't cover our coughs and sneezes.
- Show a spray bottle filled with water and food coloring, then prompt students' ideas about the demonstration by asking:
    - *How will this spray bottle model what happens during a sneeze?* (The spray bottle represents a person's nose and mouth, and the water represents germ-filled droplets that get forced out in a sneeze.)
- Before spraying (see Setup):
    - Put down white butcher paper or another light-colored surface, so students can see how far the water droplets travel.
    - Prompt students to predict how far the droplets will travel. Students can mark or add tape to show their predictions.
- Simulate a sneeze with the spray bottle, repeating a few different times.
    - Have a volunteer help measure the maximum length the droplets travel, using a meter stick, yard stick, measuring tape, or the previously-noted increments that you added to the paper or surface (see Setup). Record the data in a class chart.
    - Invite students to see how close they were in their predictions.
- Then challenge students to determine how to make the sneeze droplets travel farther, and, conversely, brainstorm ways to keep droplets from traveling as a way to reduce the spread of germs.
    - Determine as a class which two or three ways to test, and repeat the predictions, simulation, and measurements.
    - Record the data in the class chart and have students create a line plot to represent the findings.
        - Direct students to mark off the horizontal scale of the line plot in the unit fractions that are relevant to fourth grade math standards (see Standards). If working with

third grade math standards, see Modifications.

- Lead a class discussion to debrief the simulations, with students using their line plots to support their understanding. Emphasize that droplets likely went a lot further than students predicted.
    - Support data literacy and help students make connections between the simulation and real sneezes by describing the experiment and showing images from the article, *See how a sneeze can launch germs much farther than 6 feet*. Point out the finding in the article that "a fine mist of mucus and saliva can burst from a person's mouth at nearly 160 kilometers per hour (100 miles per hour) and travel as far as 9 meters (27 feet)."
- Reflect on how measures such as covering the spray bottle helped to keep the droplets from traveling as far, and how we replicate this in real life by wearing masks or other preventative measures, to segue to the next step.

3. Facilitate a card sort about different activities that help or prevent germs from spreading.

- Introduce the card sort. Explain that students will consider how different everyday activities help or prevent germs from spreading, so they can apply these ideas to their hypotheses about why germs make us sick more often during the winter.
- Distribute the *Spreading Germs Card Sort* handout and scissors to pairs or small groups of students. Review the directions and circulate as students work together, being sure to:
    - Attend to students' thinking and ideas in preparation for the next step that relates their learning to the unit driving question.
    - Prompt students to explain their reasoning, especially for activities that they identify as "it depends" in terms of spreading germs.
        - Check that students question whether the activity is done in close or far proximity from other people. To relate to the unit driving question that will be revisited formally in the next step, they may also connect that some activities (playing in the snow versus swimming at the pool) are more seasonal or weather dependent.
    - Encourage creative ideas for other activities that help prevent germs from spreading.
- Invite students to share out their categories or circulate to see their peers' categorization and activity ideas.

- Ask students to find common themes across the categories, emphasizing how activities that help germs spread involve people being in close contact versus activities that keep germs from spreading involve people being distant from each other. Talk about how the climate/weather/season influences these activities and favor spread of germs

4. Connect students' learning to the unit driving question by revisiting their initial hypotheses about why germs make us sick more often during the winter.

- Remind students of the unit driving question: Why do germs make us sick more often during the winter?
- Have students access their individual *Question Quadrant* handout from the *Sick Days* activity.
- Ask students to generate any new questions they have; especially for this activity, they may have new questions for the People quadrant, such as:
    - What are other ways people help or keep germs from spreading?
    - What else can we do to keep from getting sick?
    - Are some of these activities easier to do or avoid than others?
- Next, have students revisit their initial hypotheses related to the unit driving question. To learn more about this practice, see Tips.
    - Direct them to add ideas from this activity (and the *Germs All around Us* activity) on sticky notes or in a different color than their original hypotheses.
- Prompt students to consider if the new ideas support or counter their original hypotheses about why germs make us sick more often in the winter.
    - Students may respond: I originally thought that germs made us sick more often in the winter because they use our bodies to keep warm in the cold temperatures. Now I think the fact that people are together more often in the winter may play a role, which is different than my original idea.
    - If their thinking has changed, have students write their new hypothesis on their *Question Quadrant* handout.
- Debrief and synthesize student thinking by returning to the class Question Quadrant chart and revisiting the class' initial hypotheses.
    - Discuss each quadrant sequentially, starting with Environment and then People.

- Document students' new thinking with sticky notes or a different color than their initial hypotheses.

- Explain that in the next activity, *Bad Germs: Keep Out!*, students will generate new ideas for the Germs and People quadrants as they explore more about how our bodies try to keep germs out.

5. Advance students' work on the unit project by modeling how to write trivia questions for the Germology Game Show.

- Redistribute students' individual *Trivia Question Builder* handouts. Explain that you will model how to use the ideas in this activity to create trivia questions and evidence-based answers, in preparation for students doing so on their own in following activities.
- Ask for volunteers to share: *What new facts or ideas from this activity do you want to share with your community through the Germology Game Show?*
- Record students' facts and ideas in a public document, such as on the class whiteboard or chart paper.
- Select one fact or idea to model how to write a trivia question and evidence-based answer. Choose a fact/idea that is especially common among students, relies on a key piece of evidence, or would be of interest to adults and kids in their community.
- Follow the steps on the *Trivia Question Builder* handout as you record your process of developing a question, answer choices, and scientific explanation for each answer choice.

  - Talk through your thinking process, emphasizing how to communicate about cause-and-effect relationships between different factors related to Germs, People, Environment, or Something Else.
  - Invite students' ideas to model the kind of collaborative process students should use when developing questions with different partners and group members throughout the unit.
  - If relevant, explain how supporting evidence for the answer choices could come from ideas or visuals from the brainstorm in Step 1, the demonstration and data in Step 2, or the card sort in Step 3.

    - For example, you may say: *We decided people in our community really need to know that sneezes carry germs much farther than they think. I think this would work best as a fill-in-the-blank question. The question could be, "Sneeze droplets can carry germs at the speed of _____ miles per hour and travel as far as _____ feet." Answer choices could include "1, 10, 100, or 1000 miles per hour" and "7, 17, 27, or 37 feet," with the*

correct answer being: nearly a hundred miles an hour and travel as far as 27 feet. For each answer choice, we could include the graphs of sneeze data and our measurements with our interpretation of what it means.

- Prompt students to review the question-and-answer choices that you wrote and determine if it will make sense and be interesting to someone in the community. If needed, have students help to revise the language or content to make it more accessible.
- Have students record the question, answer choices, and explanations on their handout, as the first question in the *Spreading Germs* Question Set.
- Save the recorded process to refer to as students write their own trivia questions in subsequent activities.

- Finally, lead the class in collaboratively writing a second question for the *Spreading Germs* Question Set, based on another interesting idea that students determine community members will find interesting or need to know.

Informal Assessment

Use students' ideas about how and where germs enter our bodies, as well as their ideas from the card sort of activities that help or prevent germs from spreading, to assess their prior knowledge and experiences about the immune system, which can guide instruction in the next activity in the unit. Additionally, use students' questions in Step 4 to assess their abilities to ask questions that demonstrate cause-and-effect relationships between people, germs, and getting sick.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Use a simulated model of a sneeze to demonstrate how far germ droplets can travel.
- Create an accurate line plot of measurement data using a horizontal scale marked off in fractions of units.
- Identify how different everyday activities help or prevent germs from spreading.
- Generate new questions and hypotheses about why germs make us sick more often during the winter.
- Collaborate as a class to create trivia questions and evidence-based answers about how germs spread.

Teaching Approach

- Project-based learning

Teaching Methods

- Brainstorming
- Demonstrations
- Discussions

Skills Summary

This activity targets the following skills:

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **CCSS.ELA-LITERACY.SL.3.1:**
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.
• **CCSS.ELA-LITERACY.SL.4.1:**
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.

- **Crosscutting Concept 2:**

Cause and Effect

- **Crosscutting Concept 3:**

Scale, proportion, and quantity

- **Science and Engineering Practice 2:**

Developing and using models

- **Science and Engineering Practice 4:**

Analyzing and interpreting data

- **Science and Engineering Practice 5:**

Using mathematics and computational thinking

- **Science and Engineering Practice 6:**

Constructing explanations and designing solutions

- **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information.

Preparation

BACKGROUND & VOCABULARY

Background Information

The COVID-19 pandemic brought a new level of attention to slowing the spread of germs through simple, everyday measures, such as wearing a mask, keeping distance between people, washing hands, covering coughs and sneezes, and cleaning commonly used items/surfaces. Sneezing is a first-line immune response intended to expel microbes or particles that enter the nose. Sneezing can propel droplets more than 6 meters (20 feet) at speeds up to 160 kilometers per hours (100 miles per hour), making it a primary way to spread germs between people.

The types of preventive measures discussed in this activity serve to minimize all types of infectious transmission between people, as also made evident during the COVID-19 pandemic in which rates of other respiratory illnesses plummeted. For example, a drastic decrease in flu cases has been reported during the pandemic time. Although the benefits of activities that minimize the spread of germs are evident through these kinds of statistics and are directly

discussed in this activity, be sure to also be sensitive to students' experiences in terms of the challenging and traumatic impacts of having lived through a pandemic. Talk about adapting to online classes full-time, avoiding touching people including handshakes or hugs, having to use hand sanitizer, or washing hands often. How will students think about bacteria moving forward as activities/businesses slowly reopen?

Prior Knowledge

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Recommended Prior Activities

- Germs All Around Us
- Sick Days

Vocabulary

Term	Part of Speech	Definition
environment	*noun*	conditions that surround and influence an organism or community.
germ	*noun*	disease-producing microbe.
hypothesis	*noun*	statement or suggestion that explains certain questions about certain facts. A hypothesis is tested to determine if it is accurate.
model	*noun*	image or impression of an object used to represent the object or system.
simulation	*noun*	copy or reenactment.
virus	*noun*	pathogenic agent that lives and multiplies in a living cell.

NATIONAL GEOGRAPHIC

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