TEACHERS GUIDE

AMSCI COVID KIT
ITEM # 6600-10

The AmSci COVID Kit gives students the opportunity to explore the novel coronavirus (SARS-CoV-2 or COVID-19) even as scientists continue to study and learn more about this new virus themselves. Students use science and engineering practices to ask questions, conduct experiments, and draw conclusions as they learn about COVID-19, how diseases spread, and the nature of scientific understanding – how it develops and evolves.

Materials Required

- Additional Fabric
- Water
- Hand Sanitizer Gel
- Paper Towels
- Pencil
- Ruler (Metric)
- Drop Cloth
- Plastic Sheet
- Facial Tissue
- Hair Dryer
- Oil
- Dish Soap

Included

- Lung Breathing Model (6080-30)
- Stethoscope (3648-01)
- Glow-Germ Lotion
- Handheld Black Light
- Plastic Test Tube
- 1ml Plastic Bulb Dropper
- 3 Colors Washable Tempera Paint
- 2 Disposable Masks
- Paper Confetti
- Ping Pong Ball
- Lung Volume Bag
- Lung Volume Bag Disposable Breathing Tube
- Drinking Straw
- Stop Watch
- 4 Disposable Cups
- 6 Sheets of Printer Paper

Goals & Objectives

See page 20 for Next Generation Science Standards (NGSS)

- Observe and discuss how viruses spread in the air after a cough or a sneeze
- Use models to visualize how real world pathogen affect the body and spread between people
- Assess the strengths and weaknesses of the models used
- Draw conclusions about real world pathogens – specifically SARS-CoV-2
- Apply new understanding to design a tool that could stop or minimize the spread of the disease

INTRODUCTION

The AmSci COVID Kit gives students the opportunity to explore the novel coronavirus (SARS-CoV-2 or COVID-19) even as scientists continue to study and learn more about this new virus themselves. Students use science and engineering practices to ask questions, conduct experiments, and draw conclusions as they learn about COVID-19, how diseases spread, and the nature of scientific understanding – how it develops and evolves.

HISTORY

While viral infections have been a normal, albeit unpleasant, aspect of the human experience from the very beginning, our understanding of illness as caused by infectious agents is a relatively new advancement in medical history. The pioneering work on germ theory and bacteria by Louis Pasteur and his colleagues in the mid-1800s set the stage for the identification of viruses as a separate class of class of pathogens at the end of the 19th century.

Dmitri Losifovich Ivanovski in Russia and Martinus Beijerinck in the Netherlands demonstrated the existence of a material that was smaller than bacteria but could cause disease in tobacco plants. While they could neither see nor grow this pathogen in culture the two coined the term “virus” to describe the infectious material. At nearly the same time, Friedrich Loeffler and Paul Frosch in Germany identified a similar agent, smaller than a bacterium, that caused foot-and-mouth disease in cattle.

Further advances in virology and genetics over the following decades led to a general understanding that viruses are microscopic pathogens that include a protein shell (capsid) around a small genome of DNA or RNA. Some viruses, including coronaviruses, also have a phospholipid membrane (envelope), as well. These infectious agents enter living cells and co-opt the cellular structures to make copies of themselves that exit the cell and continue on to infect other cells.

A new virus, SARS-CoV-2, appeared in China in December of 2019 and causes a respiratory illness (with additional non-respiratory symptoms in some cases) referred to as COVID-19. The virus belongs to a family of viruses known as coronaviruses that cause familiar diseases ranging from the serious such as SARS (Severe Acute Respiratory Syndrome), MERS (Middle East Respiratory Syndrome) to the mundane such as several common colds.

COVID-19 is relatively new in the scope of virology, and scientists are scrambling to learn as much as they can about the virus, how it spreads, its symptoms, and potential treatments. Since December, scientists and medical professionals have learned a great deal about the novel coronavirus and hope to quickly learn more in order to mitigate and stop the pandemic that has resulted as COVID-19 has spread around the world.

Using this kit, students can formulate their own understanding of COVID-19 and consider the real world challenges that scientists face as they seek knowledge and solutions. While the kit, in its entirety, is best suited for middle school students, many activities can be adjusted for use with younger and older students.

ACTIVITIES

1 Handwashing – Glow Germs

Purpose: Students demonstrate the effectiveness of handwashing for preventing the spread of pathogens such as coronaviruses.

Activity Set-Up:

Students need the following supplies for this activity:

- Glow Germ lotion
- Hand-Held Blacklight (With Batteries)
- Soap
- A Sink with Running Water
- Hand Sanitizer Gel (Optional)

Activation of Prior Knowledge: Ask students to think about what they know to do when they are sick and don't want to share germs with others (wash hands, cough into their elbow, etc.):

What things can you do to keep from spreading germs/disease/ viruses to other people?

A. Squeeze one or two pumps of Glow Germ lotion onto students' hands and have them rub in the lotion. Make sure that they get the lotion all over their hands – on the palm, the back of the hands, the fingers, even the fingernails.

B. *Optional:* or so without telling students that the lotion is special and before asking them to wash their hands.

C. Have students wash their hands at the sink. You may wish to tell them why or wait until after the first round of handwashing to go into more detail.

D. Explain to the students that the lotion has "glow germs" in it that are harmless but will glow under a blacklight.

E. Use the blacklight to view student hands. Use the results to jumpstart discussion about the importance of thorough handwashing.

F. Dim the lights and use the blacklight to examine students' faces and other objects around the room they may have touched where Glow Germs may have transferred. The results may be more impressive if students have spent a longer time between lotion application and handwashing.

G. Discuss how viruses and other pathogens might pass from

***Note**

It is always wise to DO an experiment ahead of time to be able to best present it to the class.

!

ACTIVITIES

Activities continued

person to person through cross-contamination.

Discussion Questions/Prompts:

- How well did you wash your hands? How can you tell?
- Did you find "germs" anywhere that surprised you? Why?
- What happened to the "germs" if you touched your face?
- What happened to the "germs" when you touched other objects?
- Why might handwashing be an important part of staying healthy?

Extension: Explore an online simulation for how viruses spread such as the Gizmos "Disease Spread" simulation at www.explorelearning.com.

2 Soap vs Coronavirus

Purpose: Students examine the effect of soap on a lipid (vegetable oil) and draw conclusions about the possible effects of soap on viruses that have an outer lipid membrane, like COVID-19.

Activity Set-Up:

Students need the following supplies for this activity:

- Large Test Tube with Lid
- Water
- Dish Soap
- Vegetable Oil

Activation of Prior Knowledge: Ask students to reflect on the Glow Germ activity:

Why do you think it is important to use soap instead of just scrubbing with warm or hot water?

Ask students to consider what they already know about oil and water.

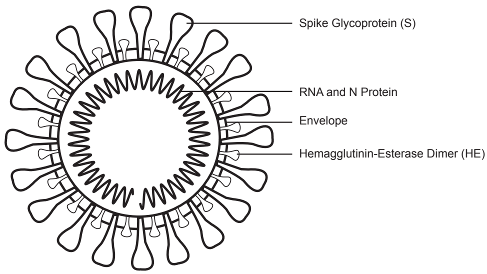

Figure 1

A. Show *Figure 1* to students and explain to students that some viruses, including coronaviruses, are surrounded by a phospholipid (fatty) membrane and that in this activity they will be examining the effect of soap on another lipid:

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Activities continued

vegetable oil.

B. Guide students through the following steps:

i. Fill the large test tube about half-way with water.

ii. Pour oil on top of the water until the test tube is about ¾ full and twist on the lid.

iii. Observe the water and oil. *Optional:* Draw a picture of the test tube.

iv. Shake the test tube vigorously and observe what happens. *Optional:* Draw a picture of the test tube.

v. Let the test tube sit for a few minutes and observe again. *Optional:* Draw a picture of the test tube.

vi. Open the test tube and add a squirt or two of dish soap.

vii. Reclose the test tube and observe.

viii. Shake the test tube vigorously again and observe what happens. *Optional:* Draw a picture of the test tube.

ix. Let the test tube sit for a few minutes and observe again. *Optional:* Draw a picture of the test tube.

C. Discuss student observations and ideas using the discussion questions and prompts.

<u>Discussion Questions/Prompts:</u>

- What happened to the oil and water mixture when you shook it *without* soap?
- What was diffierent about shaking the oil and water after the soap was added? What do you think is happening?
- Scientists know that some viruses, including coronaviruses, are surrounded by a lipid membrane envelope. Vegetable oil is also a lipid. Why might scrubbing with soap be more effective than just washing your hands with water?

Whats Happening?

The molecular structure of water (H20) results in polarity. The

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hydrogen atoms have a partial positive charge, while the oxygen atom has a slight negative charge. Due to this polarity, water molecules tend to be attracted to one another – the positive hydrogen ends are slightly attracted to the negative oxygen.

Oils, like the vegetable oil, are not polar and tend to minimize exposure to the polar water molecules by clumping together in water. Even after agitation, oil will separate from water rather than dissolve. This characteristic of oils is described as hydrophobic ("afraid" of water).

Soap molecules consist of two ends. One end is hydrophobic, like oil. The other end is polarized, like water, and is considered hydrophilic (water "loving").

The hydrophobic ends of soap organize themselves to be close to the oils, while the hydrophilic ends of soap organize themselves to be close to the water. In doing so, soap forms closed spheres, or micelles, around oil. *See Figure 2.*

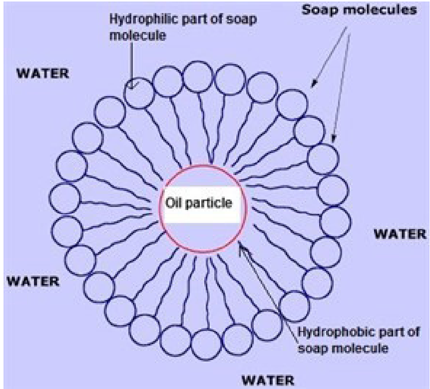

Figure 2

When students shake up the test tube with oil and water, the soap molecules can mix in between the oil and water and form smaller and smaller micelles.

The lipid layer around the coronavirus is made up of phospholipid molecules that have hydrophobic, oily tails, as well as a hydrophilic (water "loving") head or end. *See Figure 3*.

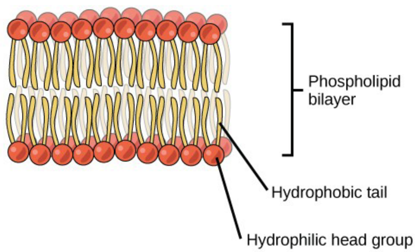

Figure 3

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Activities continued

Because the soap molecules are similar to the phospholipid bilayer, in that they have both hydrophobic and hydrophilic ends, they can wedge themselves in-between the phospholipid molecules of the virus envelope, weakening and eventually breaking up the membrane. The soap molecules then form micelles around the phospholipids and other proteins that were in the envelope, effectively destroying the virus. *See Figure 4.*

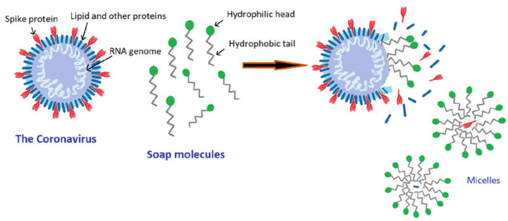

Figure 4

Therefore, soap not only helps to remove viruses and other dirt and oils from our skin, but it also works to breakdown the coronavirus envelope, rendering it harmless.

3 Sneeze Simulation

Purpose: Students explore how coronavirus might spread in the air from a cough or sneeze, as well as the possible effects of masks or other materials.

Activity Set-Up:

Students need the following supplies for this activity:

- 1ml Plastic Bulb Dropper
- Disposable Mask
- Facial Tissue
- 6 Sheets of Printer Paper
- Stool, Box, or Chair (30cm High)
- 3 Colors Washable Tempera Paint
- 4 Small Cups
- Water
- Paper Towel
- Pencil
- Metric Ruler
- Painting Drop Cloth or Tarp

- Protect the floor with a tarp, drop cloth or large piece of plastic, if necessary.

- Set up a box or other one-foot high stand and lay out six sheets of printer paper in a row. Use a ruler to mark the paper in centimeters at intervals. *See Figure 5*.

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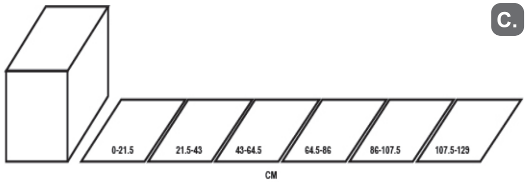

Figure 5

- Prepare 4 cups: Water in 1 cup. Colored paint in the other three cups.

Activation of Prior Knowledge: Ask students to think about the last time they sneezed. Have them briefly discuss the following question with a partner:
What came out of your mouth when you sneezed and how far do you think it traveled? Why? Or how?

<u>Procedure:</u>

A. Suck up approximately 4 drops of paint into the dropper.

B. Being careful to keep the paint in the tip of the dropper, arranged it so that it is laying on the box or chair with the tip peeking over the edge and pointing in the direction of the paper on the floor. *See Figure 6.*

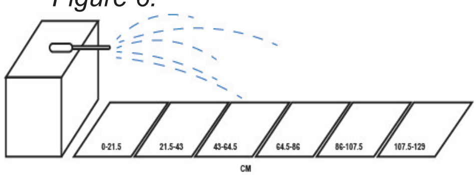

Figure 6

C. When ready, simulate a sneeze with the dropper by squeezing the bulb very quickly. The paint should spray out of the dropper onto the paper.

D. Measure the drops of paint ("sneeze") with a ruler and use the pencil to circle every drop that is 5 mm or wider.

E. Count up the number of 5 mm or larger droplets at each distance interval. If using a long sheet of paper, every 10 or 20 cm would work. If using sheets of paper, intervals can be the length of the paper width.

F. Create a histogram with the data. See the example in Figure X.

G. Rinse the dropper by sucking water in and out of it.

H. Repeat the procedure using a different color of paint while holding a tissue in front of the dropper. Create a histogram and compare it to the "tissue-free" histogram.

I. Repeat the procedure using a third color of paint while holding a disposable mask in front of the dropper. Create a histogram and compare it to the "mask-free" histogram.

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<u>Discussion Questions/Prompts:</u>

- How did the spread of the sneeze change as it went through different materials?

- Which tools or materials seemed to stop the spread of water droplets best?

- COVID-19 viruses are known to spread through mucus and saliva droplets. What tools or materials would you choose if you wanted to reduce how far sneeze droplets could spread?

- If the simulation were accurate, how far away would you want to stand from a sneezing person?

- Recent research (Bourouiba, 2020) suggests that both small and large droplets of mucus and saliva can travel between 23 and 27 feet when sneezed out. These distances are possible – even for a few larger droplets – thanks to the moist, warm, turbulent gas cloud created by the sneeze, itself, that can carry the droplets aloft for much farther than initially expected. How does this new research affect your responses?

- Scientific data suggests that real coughs can create up to 3000 droplets, the equivalent of talking for five minutes. Sneezes may yield up to 40,000 droplets. What does this suggest about the possibility for the spread of pathogens – especially COVID-19 – due to sneezing, coughing and talking?

<u>Extensions:</u>
Students can continue exploring sneezes and the spread of pathogens, by trying out the following ideas:

- Change the intervals for your histogram. Can the data be interpreted differently if considered in smaller or larger intervals? What does this mean?

- Measure the actual size of each droplet over 2mm. Graph your results in a scatter plot with droplet size on the x-axis and distance on the y-axis. What do your results suggest?

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- How could you simulate a more accurate sneeze? Design a more accurate sneeze simulation that can send droplets between 23 and 27 feet. What kinds of questions could you answer with your improved sneeze simulator?

4 To Mask or Not to Mask?

Purpose: Students explore how coronavirus might spread as aerosols in the air from a cough, sneeze, or heavy breathing associated with loud talking, singing, or exercise, and examine how masks of various materials can mitigate the spread.

Activity Set-Up:

Students need the following supplies for this activity:

- Paper confetti
- Hair dryer
- Measuring tape
- Disposable mask
- Various small pieces of fabric with a variety of weaves and textures
- Paper filters such as coffee filters, facial tissue, gift wrapping tissue, etc.
- Ping pong ball
- Stopwatch
- Optional: video camera with slow motion recording capability

Activation of Prior Knowledge: Ask students to reflect on the previous sneeze simulation activity as well as times that they have sneezed or coughed in real life. Have them briefly discuss the following question with a partner:

What came out of your mouth when you sneezed or coughed? Could you see all of it? How do you know?

Procedure:

A. Explain to students that when people cough, sneeze, and even sing or speak, droplets of saliva and mucus escape from their mouth. In the previous activity they considered the droplets that were large enough to detect once they land on surfaces. In this activity, students consider what happens to smaller droplets, commonly referred to as aerosols, that can remain suspended in the atmosphere for 10 or more minutes. Because aerosols are difficult to detect, students will use lightweight paper confetti to show air movement.

B. Select a hard, smooth surface with a bit of workspace such as a large table or a hard floor. Alternative: use the sneeze stand (box, chair, etc.) from the sneeze

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simulation.

C. Set a small pile of paper confetti (at least 15 pieces) near one end of the workspace or on top of the sneeze stand.

D. Set up a hair dryer so that it can blow directly on the confetti pile and will blow the paper across the workspace.

E. Simulate a cough or a sneeze by turning the hair dryer on “high” briefly and then turning it off again. Note what happens to the paper confetti. Measure and record the distance that each piece of confetti travels from the initial spot to where it stops moving.

F. Repeat 3 to 5 times, collecting data each trial.

G. Calculate the mean, median and mode for each trial. Advanced math students should use more advanced statistics to analyze the data.

H. *Optional: simulate singing or yelling by turning on the hair dryer for a longer period of time. Choose a lower setting if possible. Do the results differ from the simulated cough/sneeze? Should more confetti be added?*

I. Repeat the cough simulation but cover the front of the hair dryer with a disposable mask. Record observational and measurement data, analyze and compare to the “mask-free” data.

J. Test additional materials to see which minimize air movement on the outside of the “mask”.

K. *Optional: Visualize the turbulent air of a sneeze. Use a video camera (a cell phone or tablet camera would be sufficient) to record the hair dryer sneeze simulation. View the recorded video in slow motion. Repeat several times.*

L. Calculate the velocity: After visualizing what is happening to the air molecules and aerosols using the paper confetti, calculate the velocity of the simulated hair dryer sneeze.

   i. Set up the investigation so that the hair dryer is on a flat surface such as a table or hard floor and replace the paper confetti with a ping pong ball. Lay out a 1 meter measuring tape in the direction the hair dryer will blow.

   ii. Use the hair dryer to simulate a “sneeze” onto the ping pong ball. Use a stopwatch or video

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camera to record the time it takes for the ping pong ball to travel 1 meter.

iii. Repeat 5-10 times and record the results and calculate the velocity of the ping pong ball sneeze (velocity = distance/time = m/s).

iv. Repeat the velocity procedure while blocking the hair dryer with a disposable face mask.

Discussion Questions/Prompts:

- Which materials seemed to slow the flow of air the best? How can you tell?
- Air molecules are smaller than the gaps between fibers in masks and various fabrics, so why does the air not travel through freely?
- COVID-19 is thought to be carried in small, liquid aerosols that escape the mouth during sneezing, coughing, singing, and even breathing. These aerosols are often too small to detect with the eye but are significantly larger than gas molecules commonly found in the air around us, such as oxygen, nitrogen, and carbon dioxide. If this is the case, and based on the results from this activity, do you think that a mask could help minimize spread of the virus? Why or why not? Use evidence and reasoning to support your claim.
- Studies have suggested that actual sneezes and coughs average around 100 miles per hour (45 m/s). How did your sneeze simulation match up? What does this suggest about all of your sneeze simulation results?
- If you video recorded the sneeze simulation, what do you notice? Can you predict how an aerosol droplet might travel or where it might land? Why or why not? What might this mean for our understanding of the spread of COVID-19 if it is spread in aerosols (increasing evidence points to this conclusion)?
- What material(s) would you choose if you wanted to reduce spread of COVID-19 (or any other pathogens commonly found in saliva/ mucus aerosols)? Explain your reasoning.

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Activities continued

- Mask Design Challenge: Use techniques from the activity to test a variety of materials and shapes to design a mask that is both effective and comfortable.

Extensions:

- Visualize the breath: Use the guidelines and suggestions from this article (Verma, Dhanak & Frankenfield, 2020) from the National Institutes of Health to visualize the breath as aerosols and develop your own “mask tester” using a fog machine, simple pump, and mannequin or other head shape.

5 The Lungs

Purpose: Students examine how the lungs function to pull oxygen into the body and consider how COVID-19 may impact this function.

Activity Set-Up:

Students need the following supplies for this activity:

- Lung Breathing Model
- Water

Activation of Prior Knowledge: Ask students to take a deep breath in and then breathe out. Have them briefly discuss the following question with a partner:

*How did your body work to pull air into the lungs? What happens to the air once it is inside the lungs?**

**You may wish to have students share their discussions to identify misconceptions that students have. You do not need to correct anyone at this point, but use the lung breathing model to point out key observations that may help to confront these misconceptions and spark critical thinking.*

Procedure:

- Explain to students that while COVID-19 can cause symptoms in other parts of the body, the virus appears to impact the lungs most dramatically in the majority of cases. Therefore it is important to understand how the lungs function.
- Hold up the Lung Breathing Model and ask students to identify how each part of the model represents the parts of the respiratory system. Show *Figure 7* to help students if

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Activities continued

they get stuck.

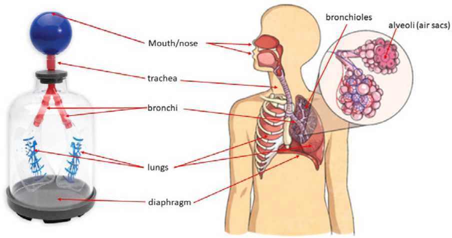

Figure 7

- Demonstrate how the lungs breathe in and out using the model: gently pull on the model diaphragm to demonstrate how the lungs fill with air and push on the diaphragm to show how air is pushed out of the lungs. Ask students to discuss what they think is happening.

- *Optional: Remove the lungs from the model and fill partway with water, explaining to the students that patients with severe COVID-19 may experience fluid in the lungs. Demonstrate lung function with water in the lung(s).*

Discussion Questions and Prompts:

- Why do the model “lungs” fill with air? What is going on here?

- How is the model different from the real respiratory system? Hint: What is missing from inside the lungs?

- Once inside the lungs, oxygen from the air passes across the walls of the alveoli into the blood stream. Each alveolus is wrapped in a mesh of capillaries (very small blood vessels). Why is it important to have lots of alveoli (about 300 million per lung!)? More surface area allows for more oxygen movement into the blood.

- In severe cases of COVID-19 the tissue of the lungs becomes inflamed and alveoli fill with fluid and dead cells. How might this affect the functioning or efficiency of the lungs? Explain your reasoning. Consider your discussion about the purpose of alveoli.

- What is the difference between positive pressure and negative pressure? Which kind of pressure do the lungs rely upon to function? How does the model demonstrate this?

- Modern respiratory ventilators

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Activities continued

rely upon positive pressure to push air into the lungs when patients are unable to breathe well enough on their own. How are ventilators different from typical breathing?

Extensions:

- Connect learning to physical science unit on air pressure.
- Research how an "iron lung" worked and what it was used for. Compare it to modern mechanical ventilation.

6 The Effect of Coronavirus On the Lungs

Purpose: Students mimic restricted airflow due to COVID-19 with a straw and demonstrate the resulting limited lung capacity using a lung volume bag in order to simulate the symptoms of COVID-19.

Activity Set-Up:

Students will need the following supplies for this activity:

- Lung Volume Bag
- Lung Volume Cardboard Tube
- Drinking Straw
- Stethoscope
- Stopwatch

Activation of Prior Knowledge: Ask students to take a deep breath of air and then breath it out. Have them briefly discuss the following question with a partner:

What do you think it would feel like if you couldn't fill up your lungs with a full breath of air?

Procedure:

A. Explain to students that the COVID-19 virus appears to infect many cells around the body including the upper and lower respiratory tract. The virus enters cells in these areas, essentially converting them into SARS-CoV-2 virus factories. The infection of viruses in the cells lead to cell death and inflammation. In the upper respiratory tract, COVID-19 infection can lead to sore throat, coughing, and even temporary loss of smell. Inflammation in the lower respiratory tract – the lungs – can lead to more severe symptoms. In the most serious of cases, inflammation can lead to swelling and the lungs may even begin to fill with fluid and immune system cells. In this activity, students will simulate the breathing symptoms and test the effects on lung volume. Students should record all of their measurements in a science

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notebook or on a sheet of paper.

B. Compare lung volume by having students complete the following steps:

a. Measure your lung volume (vital capacity) by blowing into a Lung Volume Bag

i. Place the lung bag mouthpiece into the opening of the Lung Volume Bag.

ii. Take the largest breath possible, hold your nose, and breathe out as much air as possible into the bag.

iii. Push all of the air into the bottom of the bag by laying it on a flat surface and sliding a folded piece of fabric or paper towel along the length of the bag.

iv. Measure the volume of the air using the gradations on the bag.

b. Blow into a lung volume bag through a narrower tube, such as a straw and measure lung volume using the same procedure as above.

c. Have students discuss the difference in lung volume results, as well as differences in how it felt to fill the bag through different size tubes. COVID-19 can inflame and narrow air passages in the lungs.

C. Simulate the feeling and symptoms of lower respiratory inflammation by having students complete the following steps:

a. Measure your resting heart rate by using the stethoscope and counting the number of heartbeats. You can count the beats in one minute or count the number of beats you hear in 6 seconds and multiply by 10. Use a clock with a second hand or a stopwatch to accurately measure the time.

b. Hang the stethoscope around your neck and hold the bell or chestpiece securely in your hand while you run in place or do an aerobic exercise such as jumping jacks for 60 seconds.

c. Observe how your breathing feels and measure your heart rate again right away.

d. Simulate the feeling of restricted breathing by doing the same exercise again, but this time breath through a 5 cm length of drinking straw. The narrow

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straw mimics the narrowed passageways in the lungs due to inflammation caused by COVID-19. Be sure to stop and breath normally if you feel lightheaded.

e. Observe how your breathing feels and measure your heart rate again right away.

f. After taking a break, repeat the exercise while breathing through the drinking straw and remeasure your lung volume using the Lung Volume Bag immediately after.

Discussion Questions/Prompts:

- In severe cases of COVID-19 the tissue of the lungs becomes inflamed and even filled with fluid and dead cells. How would you expect these symptoms to affect lung volume? Explain your reasoning.
- In what ways did the straw simulate the symptoms of COVID-19? In what ways was this model imperfect?
- What did it feel like to exercise while breathing through a straw? Imagine having this difficulty breathing while resting to better understand how it might feel to have restricted airflow in the lungs.
- How did restricted air flow affect your heartrate? How can you explain this? How are the heart and lungs related or connected? How might a respiratory infection, such as COVID-19 impact other parts of the body?

Extensions:

- Gather lung volume data and/or heartrate data for the whole class or for the family. Analyze it using statistics (mean, median, mode or even a t-test), and create a graph or chart to share and explain your findings.

RESOURCES

Bourouiba L. Turbulent Gas Clouds and Respiratory Pathogen Emissions: Potential Implications for Reducing Transmission of COVID-19. JAMA. 2020;323(18):1837–1838. doi:10.1001/jama.2020.4756

Verma S, Dhanak M, Frankenfield J. Visualizing the effectiveness of face masks in obstructing respiratory jets. Phys Fluids (1994). 2020;32(6):061708. doi:10.1063/5.0016018

GLOSSARY

Vocabulary:

- Coronavirus
- Cross-Contamination
- DNA
- Formite
- Lipid Membrane
- Micelles
- Pathogen
- Polarity
- RNA
- Virus

Next Generation Science Standards

Students who demonstrate understanding can:

3-PS2-1 Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.

3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.

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

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Standards Key

K = Kindergarten
3 = 3rd Grade (numbered by grade)
MS = Middle School
HS = High School
PS = Physical Science
LS = Life Science
ES = Earth Science

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MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

HS-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

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