Welcome to NSTA’s Daily Do

Teachers and families across the country are facing a new reality of providing opportunities for students to do science through distance and home learning. The Daily Do is one of the ways NSTA is supporting teachers and families with this endeavor. Each weekday, NSTA will share a sensemaking task teachers and families can use to engage their students in authentic, relevant science learning. We encourage families to make time for family science learning (science is a social process!) and are dedicated to helping students and their families find balance between learning science and the day-to-day responsibilities they have to stay healthy and safe.

What is Sensemaking?

Sensemaking is actively trying to figure out how the world works (science) or how to design solutions to problems (engineering). Students do science and engineering through the science and engineering practices. Engaging in these practices necessitates students be part of a learning community to be able to share ideas, evaluate competing ideas, give and receive critique, and reach consensus. Whether this community of learners is made up of classmates or family members, students and adults build and refine science and engineering knowledge together.

Where Do 'New' Diseases Come From?
Introduction
Today's task, Where do "new" infectious diseases come from?, creates an opportunity for students to look at examples of infectious diseases they might know a lot about and compare them to diseases they want to know more about. Students engage in science and engineering practices - including the use of a simulation (mathematical model) - to figure out how "new" infectious disease-causing bacteria can come from bacteria that have been around for awhile.

This task has been modified from its original design in order to be used by students, parents, and teachers in distance and home learning. While students could complete this task independently, we encourage students to work virtually with peers or in the home with family members. Before you begin the task, you may want to access the accompanying Where Do "New" Infectious Diseases Come From? Google slide presentation.

Presentation of Phenomena (What am I exploring today?)
Guidance: Students will be introduced to the phenomenon through the video - bacteria and viruses are different; also, some bacteria and viruses change over time making the diseases they cause harder to treat. The goal is to get students thinking about where new bacterial and viral infections come from and how to treat the resulting diseases. Presenting a phenomenon and asking students to generate questions about it creates a need to figure out the answer to those questions. This is authentic engagement and a powerful learning process (unlike "learning about" the difference between bacteria and viruses and being asked to recall the information later).

Presenting the Phenomenon:
Have students watch the video clip (slide 2). Ask them to think about the idea introduced in the video clip (slide 2). "Where do "new" infectious diseases come from?" and have them write any questions they have down on a sheet of paper. ALL student questions are okay at this point. Our goal it to motivate curiosity and not distinguish between "good questions" and "bad questions" or "right questions" and "wrong questions". Common questions will arise for most students, which is what this task builds upon.

Investigative Questions (What questions do I have about what I just saw?)
Investigative questions are common questions kids may ask after they are introduced to the phenomena. Although questions may vary, many students are curious about the differences between viruses and bacteria. This is the one we will focus on first.
Guidance: It is important to allow time for thinking. Many students have ideas and questions but need time to formulate their idea or question into words. Some students may also benefit from writing things down first before they share. As adults we may be tempted to give them questions we feel might be important to explore, however we need to refrain from this and allow our students to practice asking their own questions.

Common Questions: (slide 3)

- What causes us to get sick?
- How do you know when you have a bacterial infection or a viral infection?
- What is the difference between a bacteria and a virus?
- Are there other good ways to not get infections besides washing your hands?
- Which one is living and which one is not?
- How do you treat a viral infection if you can't take antibiotics?
- How do bacteria grow?

We want to focus on one question in particular at this point (slide 4):

- What causes us to get sick?
- How do you know when you have a bacterial infection or a viral infection?
- **What is the difference between a bacteria and a virus?**
- Are there other good ways to not get infections besides washing your hands?
- Which one is living and which one is not?
- How do you treat a viral infection if you can't take antibiotics?
- How do bacteria grow?

Connection Guidance: If students ask about hand washing, consider asking them to mimic washing their hands and time them. Then set a timer for at least 20 seconds but no more than 30 seconds and have them wash their hands. Many people do not wash their hands properly or for enough time. When you don't wash your hands with soap for at least 20 seconds you can continue to spread bacteria and viruses (and other things). Last, don't forget to wash your thumbs and fingertips!

Conducting an Investigation (How do bacteria grow and respond to antibiotics?)

We want to explore more about what students know about bacteria and viruses, their similarities and differences. Use **Slide 5** to have discussion about what students already understand to be true about them and fill in the chart accordingly.
Guidance: We are trying to figure out what students know about bacteria and viruses, however the goal is to figure out where new infectious diseases come from. It is not necessary (at this time) for students to figure out all the differences between bacteria and viruses so it is very appropriate to give them some general information:

- Bacteria are living and viruses are not
- Bacteria are cells and can grow and reproduce on their own
- Viruses are not cells and can not reproduce on their own.
- Viruses need a host cell in order to reproduce.

We then want to revisit our original questions, and investigate:

- What causes us to get sick?
- How do you know when you have a bacterial infection or a viral infection?
- What is the difference between a bacteria and a virus?
- Are there other good ways to not get infections besides washing your hands?
- Which one is living and which one is not?
- How do you treat a viral infection if you can't take antibiotics?
- How do bacteria grow?

We are going to investigate the question "How do bacteria grow?" (Slide 7). After students watch the video and analyze the graph, have them add to their charts they made about bacteria and viruses. It is expected that students will know more about bacteria than viruses at this point, but this is okay and will be a strong connection to investigating viruses more later, especially in the Enrichment Extension (see end of task).

Investigation 1
We remember from our discussion earlier that antibiotics are used to treat bacterial infections. We think that is because antibiotics kill bacterial cells. We are going to conduct an online simulation to investigate how antibiotics affect bacterial cells.

Access the Student Activity Sheet. The activity sheet is also available in Spanish. (NOTE: Familiarize yourself with the instructions of the simulation before running the simulation to collect data. Feel free to "play in the sandbox" with the simulation to explore its various features prior to collecting data for the investigation.)

After Investigation 1, students will have figured out (slide 13):

- There were different kinds of bacteria in the simulation (this is called "variation" within a population).
- We started with 10 of each kind, but we noticed that we did not end up with 10 of each kind.
- Bacteria with less pores survived more than bacteria with more pores.

But we also remember from earlier, that bacteria reproduce. So, we wonder what would happen if we allowed them to reproduce like we saw in the video earlier. This leads to Investigation 2 (slide 14)
After Investigation 2, students will have figured out (slide 15):

- Bacteria with fewer pores survive.
- Bacteria with more pores die out, eventually eliminating their population.
- Even if we start with bacteria that have fewer pores (3 to 4), their populations will outnumber bacteria with more pores (5 to 6) by the end.

Guidance: This investigation also allows students the opportunity to use the science and engineering practice mathematics and computational thinking. As students engage in the simulation they are making predictions based on a mathematical model, counting bacteria populations and looking at graphical representations of data. After students have completed the investigation consider engaging them in a discussion about how they used math in this activity to build the relationship between math and science.

**Building Consensus**

Let's look back at what we did:

- We asked questions that we had about bacteria and viruses.
- We made a chart that documented similarities and differences among bacteria and viruses.

We conducted an investigation and discovered that:

- Bacteria are living things and make more of themselves (reproduce).
- Antibiotics work on some, but not all, bacteria.
- In the simulation "New" bacterial infections are the result of changes in bacteria populations that make them different (mutations) from the generations of bacteria before them.

So, let's go back to our original questions:

- What causes us to get sick?
- *How do you know when you have a bacterial infection or a viral infection?*
- What is the difference between a bacteria and a virus?
- Are there other good ways to not get infections besides washing your hands?
- Which one is living and which one is not?
- How do you treat a viral infection if you can't take antibiotics?
- How do bacteria grow?

**WATCH THE VIDEO** (slide 18)

After watching the video, have your student once again consider how viruses and bacteria are similar and different. What information did they pull from the video that help students to continue to help them answer their questions.

**Guidance:** Here we can take stock of all the things we figured out about viruses and bacteria. Although, we did not figure out all the differences between viruses and bacteria, we have learned many things about how they are both similar and different. Have students reference their chart and add to it if they would like, but the big take aways are:
Viruses (nonliving) and bacteria (living) can both cause illnesses. Diseases/illnesses caused by bacteria can usually be treated with antibiotics. Some bacteria have changed and can not be treated by antibiotics. Some bacteria in a population have changed enough that antibiotics don't kill them anymore.

To answer our phenomena question *Where do "new" infections diseases come from?*

- We figured out that some "new" infectious diseases come from diseases that were already here, or "old disease". New infectious diseases come from older or established infectious diseases. Our evidence for this comes from the simulation. We saw bacteria that were just a little different were able to survive and reproduce and other bacteria were totally eliminated.
- We can predict that viruses can also change in some way too but we don't think viruses change in the same way because: they do not grow and reproduce like bacteria because they are not alive and also because they can not be treated with antibiotics.

Connection Guidance: Recall a time when you were sick and how the doctor chose to treat it - an antibiotic versus not. Consider how you would explain to a friend who is frustrated the doctor did not give the an antibiotic for their congestion and cough. (This task could also be built in as a formative assessment)

If your students are conceptually ready to dig into viruses please continue on to the enrichment activity. In the NGSS, the study of viruses are not specifically identified however, are usually studied at the high school level due to their structure and function.

**Enrichment Extension**

We have made some really interesting observations about bacteria and bacterial infections. But, how does that help us to understand what is going on today with the COVID-19 pandemic?

**How do mutated viruses (ex. COVID-19) and bacteria (ex. MRSA) come to exist?**

Now that we have explored the idea of mutated infectious diseases, we will investigate further the relationships among various families of bacteria and viruses that have long histories. You can access the slides for the Enrichment Extension by clicking the link.

**Guidance:** These activities and extensions are considered “micro lessons”. They are not intended to replace classroom science learning, and are not intended to be used as “homeschool” stand-alone science lessons. They are not intended to result in children being able to generate robust, complete scientific explanations of phenomena. Conversely, they are intended to move student thinking along the continuum of complexity. Engaging in this extension will further a student's progression along that continuum.
Examine the images and complete the charts seen in slides 2 through 4.

**Suggested Question Prompts:**
- What relationships among the bacterial infections do you notice?
- What relationships among the viral infections do you notice?
- How does a viral infection like COVID-19 compare with a bacterial infection like MRSA?

**Have students write an explanation:**
- Apply what you learned about bacterial reproduction and the emergence of MRSA to write a scientific claim explaining the relationship between COVID-19 and other respiratory illnesses such as SARS and MERS. Be sure to use evidence and reasoning to support your claim.

**NSTA Collection of Resources for Today's Daily Do**
NSTA has created a [Where Do "New" Infectious Diseases Come From? resource collection](#) to support teachers and families using this task. If you're an NSTA member, you can add this collection to your library by clicking ADD TO MY LIBRARY located near the top of the page (at right in the blue box).

**Check Out Previous Daily Dos from NSTA**
The NSTA Daily Do is an open educational resource (OER) and can be used by educators and families providing students distance and home science learning. Access the [entire collection of NSTA Daily Dos](#).

**Acknowledgement**
This Daily Do is inspired by and uses materials from the [Why Don’t Antibiotics Work like they Used To?](#) storyline created by Inquiry Hub and Next Gen Storylines. Next Gen Storylines and Inquiry Hub Biology are an open-source resources that can be used by parents and teachers to implement students driven learning.

You can follow both of these programs on Twitter @nextgenstoryli1 and @inquiry_hub