Breaking the Chain —Viral Transmission

Objectives

Students will:

- identify viral structure and how structure is related to cellular infection
- explore how genetic mutations allow for the transmission and spread of viruses
- discover that technology can be use collect data on viral transmission and track the spread of viruses locally and globally
- create a presentation and 3-D model that will explain how altering the structure of viruses can be used to prevent cellular infection

OVERVIEW

In this lesson bundle, students will study how viruses infect cells and how data is used to track how viruses move through a population. They will learn how viral mutations are crucial to helping a virus spread, but also how these same mutations can be used to help stop its spread. After a refresher on viral structure and genetic mutations, students will form teams and work together to solve a puzzle using mutations in a viral genome to piece together and track the spread of a fictional virus. Next, students will pair up and look at current data about the genomic epidemiology of SARS-CoV-2 from www.nextstrain.org. They will identify and record important information about the transmission of that virus as they explore the data on the website, including the spread from country to country, the frequency of mutations in the virus, and a comparison to other viruses, such as the flu. In the final part of the lesson, students will learn how viruses, such as SARS-CoV-2, use receptors to enter cells and then use cellular tools to complete their genetic "hijacking" of the cell. Student teams will brainstorm ways that the viral structure could be genetically altered or mutated to theoretically stop the transmission of the virus (changing the shape of the receptor proteins, blocking transcription/translation mechanisms, etc.). They will then use consumable and classroom materials to create a model of the SARS-CoV-2 virus showing what they would alter in the virus. Student groups will present their ideas and models to the class for feedback.

The accompanying presentation was created with PowerPoint so that it can be used in a variety of classrooms. Modifications for distance learning or use in virtual classrooms are included throughout this lesson. If you are using a laptop with a projector, simply progress through the PowerPoint by clicking to advance. All of the interactive aspects of the presentation are set to occur on click. This includes images, text boxes, and links to outside videos, which will appear in your web browser. If you are using an interactive whiteboard, tap on each slide with your finger or stylus to activate the interactive aspects of the presentation. It does not matter where you tap, but you can make it appear as if you are making certain things happen by tapping them. Notes for each slide provide information for the instructor.

CONTENT AREAS

Genetics, Genomics, Viruses, Medicine

ACTIVITY DURATION

4 class sessions (45–50 minutes each)

GRADE LEVEL

Grades 9–12

ESSENTIAL QUESTIONS

- What is the structure of a virus?
- What role do genetic mutations play in viral transmission?
- How is technology used to collect data and track the spread of viruses?
- How do viruses enter cells and use them for reproduction?
- How could viral structure be genetically modified to prevent infection and spread of disease?

MATERIALS

All days

- Device with the ability to project—this can be projected virtually
- Student 1-1 devices (laptop, iPad)

For virtual classrooms or use in distance learning, student devices should have access to PowerPoint (or Google Slides), Padlet, Zoom, YouTube, Google Docs, Tinkercad, or Google Forms.

Links to Virtual Classroom student tools:

- https://padlet.com/
- https://zoom.us/
- https://www.youtube.com/
- https://www.tinkercad.com/

Day 1

- Sticky notes in three colors (at least one per student)
- Viral RNA Sequences (one copy for the class, cut into strips with one strip per student)

Day 2

- Tracking Pathogens capture sheet (one per pair of students)

Day 3:

- Infection Innovations capture sheet (one per student)
- Materials for creating viral models, including (but not limited to)
    - Play-Doh or modeling clay
    - pipe cleaners
    - hot glue and glue sticks
    - cardboard
    - craft sticks
    - scissors, craft knife
    - paint or markers
    - construction paper
    - dried pasta of various shapes
    - Styrofoam balls and sheets
    - poster board

For distance learning, students can use a virtual 2-D modeling website, such as Tinkercad, to create their models.

Day 4

- Infection Innovations Exit Ticket (one per group)

BACKGROUND

Viruses are all around us and inside us whether we realize it or not. And while many viruses are not lethal or even particularly dangerous to us, there are certainly some viruses that are cause for concern. With the pandemic of 2020 and the rapid spread of COVID-19 across the globe, knowledge of how viruses infect our cells and how viruses spread from person to person is more essential than ever. Through sequencing technology, scientists are able to identify and track viruses more quickly and efficiently than ever before. They can discover naturally occurring mutations in viruses through genomic sequencing, which allows them to discover patterns in transmission and predict where they will move and how they might evolve. Hopefully, in the future, we can use this technology and other types of genetic technology to stop viruses from entering and infecting our cells. While these breakthroughs may be years or even decades away, this lesson gives students the opportunity to learn about how viruses work and spread and gives them the opportunity to think about ways that genetics and genomics could allow us to use knowledge about structures of viruses and the cellular mechanisms they hijack to stop viral infection and spread.

This guide gives educators a collection of resources designed to help students investigate the role that mutations play in maintaining viral transmission and how genomic sequencing can help to track the spread of a virus. They will also brainstorm ways that mutations could be used to prevent viruses from infecting cells, halting the transmission. It provides slide-by-slide instructions to ensure educators are prepared to explain, discuss, and facilitate the hands-on content in the presentation. The presentation is designed to cover four class sessions, but it can be flexible depending on the students' needs and the time available. Extension ideas are included at the end of the lesson plan.

This lesson plan follows an inquiry-driven 5E instructional model: engage, explore, explain, elaborate, and evaluate. Over the course of four class periods, students will work together to understand the structure and mechanism of viruses and use data to discover how sequencing that identifies viral genetic mutations can give us a picture of how viruses move through populations. Finally, they will work in teams to brainstorm and create models showing how mutations might be used disrupt the transmission pathway and prevent viruses from infecting cells and continuing the spread.

ENGAGE | Slides 1–5

OVERVIEW

The instructor will open by displaying the question "What do you know about viruses?" Students will work together to create a schema map that will allow them to record their prior knowledge about viruses and new information they learn about viruses through watching video clips and correcting their misconceptions about viruses.

DAY 1 | SLIDE 1

Begin class by displaying Slide 1, with the question, "What do you know about viruses?" Explain to students that to open this lesson, they will create a schema map that will record what they already know about viruses, what they learn, and what misconceptions they have. Define "schema" as a general idea about something or, in this case, the information they already know about viruses.

DAY 1 | SLIDE 2

Lift the overhead screen to reveal a schema map on the front board or on a piece of poster board or large paper in the front of the classroom. Give students sticky notes in one color; this color will represent their schema about viruses. Ask students to write down any information they know (or think they know) about viruses on their sticky notes and stick these to the top row in the schema chart. Give students the opportunity to share their schema with the rest of the class as they place their sticky notes on the schema map; you can also review these with the students aloud.

The schema chart should be set up as seen below:

VIRUSES	
Schema	
New Learning	
Misconception	

Virtual/Remote Learning adaptation: Padlet (www.padlet.com) can be used to create a virtual classroom schema map to which students can be given a link allowing them to add their ideas and thoughts.

DAY 1 | SLIDE 3

Give students sticky notes in a second color. Explain to students that they will be watching two videos that introduce them to information about viruses and how they infect cells. Instruct them to write new information on these sticky notes as they watch the videos. Play the videos on the overhead screen as students record information on their sticky notes.

Video 1: *Flu Attack! How A Virus Invades Your Body* (https://www.youtube.com/watch?v=Rpj0emEGShQ)

Video 2: *How Viruses Like The Coronavirus Mutate* (https://www.youtube.com/watch?v=WOVJ9XgYvac)

DAY 1 | SLIDE 4

Ask students to place their sticky notes in the “New Learning” row of the schema map, giving them the opportunity to share the information as they do so. Once students are finished, the instructor should review the notes to see if any expand on information in the schema row and, if so, attach these notes to the appropriate schema row notes.

DAY 1 | SLIDE 5

The instructor should ask students or student volunteers to read through all of the remaining original “Schema” sticky notes. The class should determine if any of them would be better placed in the “Misconceptions” row. Ask students to use sticky notes in a third color to write a statement explaining each misconception. The two sticky notes should then be placed together in the “Misconceptions” row. The students should share their explanations with the class as they stick them to the schema map.

EXPLORE | Slides 6–10

OVERVIEW

Students will work together to identify mutations in the genome of a fictional virus and use those mutations to track its spread in student populations in the classroom.

DAY 1 | SLIDE 6

Begin by telling students that now that they have learned more about viruses and how they work, they will participate in an activity that models how scientists use the genetic code (DNA or RNA) of viruses to track their spread through populations. Ask students to watch the video clip https://www.youtube.com/watch?v=C45-ZjE8gLg) and think about how genome sequencing and viral mutations are important tools for tracking viral transmission.

DAY 1 | SLIDE 7

Give each student a strip of the viral sample RNA sequence from the fictional virus. (These should be cut apart prior to the lesson. There are enough for a class of 24, but not all have to be used and additional copies can be made for a larger class, as samples 1–12 are repeated in samples 13–24.) In the first part of the activity, ask students to move around the room, comparing their sequences to those of their classmates. When they find students whose bases (A,G, C, U) form the same sequence as their own, they should join them to form a "population." Each population should stay together and continue looking for all others in the classroom who "belong,"i.e., have the same sequence.

Virtual/RemoteLearning adaptation: Teachers can email a digital viral RNA sequence strip to each student and hold a Zoom meeting for the activity. A Zoom breakout room could be created for each group, with students joining as they compare their codes and find the room with the code matching their own. Then the whole group could rejoin the original Zoom room for discussion to end the activity.

DAY 1 | SLIDE 8

Once all students have found the other members of their population in the classroom, the instructor should display the original virus sequence on the overhead screen. Ask each population to determine how many mutations are present in its genome by carefully comparing its sequence with the original sequence, displayed on the slide.

DAY 1 | SLIDE 9

Ask students to think about how this information about the number of mutations might be used to determine the spread of the virus through populations in the classroom. How would they determine which was the first population to contract the virus? What about the second and third populations, and so on?

Students should make the connection that the population with a sequence closest to the original virus (with only two mutations) would be the first to contract the virus. The next population would have the least number of additional viruses (in this case two additional mutations, for a total of four). Ask the groups line up with the first population to contract the virus standing closest to the overhead screen displaying the original viral RNA sequence. The next group to contract the virus should stand a few steps ahead of them, then the next group, etc., to show their distance from the original virus.

DAY 1 | SLIDE 10

Ask students to reflect on what they have learned about viruses and how viral genomes can give scientists important information. Ask students to brainstorm and share their ideas about how this information could be used to help in a pandemic or the outbreak of a virus.

EXPLAIN | Slides 11–16

OVERVIEW

Students will pair up and look at current data about the genomic epidemiology of SARS-CoV-2 from www.nextstrain.org. They will identify and record the information they learn about the transmission of this virus as they explore the data on the website, including the spread from country to country, the frequency of mutations in the virus, and a comparison to other viruses, such as the flu.

DAY 2 | SLIDE 11

Begin class by explaining to students that, now that they have an understanding of what viruses are and how mutations in their genome can give us clues revealing how transmission is occurring, they will look further into the field of genomic epidemiology—the study of the role of genetic factors in determining health and disease in families, populations, and the environment.

In the next activity, they will explore an online interactive database, *Nextstrain*, that is used to track the spread of viruses using their genomic data.

DAY 2 | SLIDE 12

Ask students to find a partner; each pair should have at least one student device (iPad, laptop, etc.). Give each pair a copy of the *Tracking Pathogens* capture sheet. Assign or allow student groups to choose one pathogen from the home page (under the heading "Explore Pathogens") to focus on. There are enough pathogens for a class of 22 (11 pathogens); if the class is larger than 22, students could form some small groups of three. Ask students to go to http://nextstrain.org and follow the instructions on their capture sheets as they look at the data for their pathogens.

> **Virtual/Remote Learning adaptation:** The capture sheet can be posted as a Google Doc that can be shared with the students, allowing the students in each pair or small group to edit from their own devices.

Instructors may want to give the students a brief tutorial on how to use the *Nextstrain* site by displaying it on the overhead screen and pointing out aspects of the site they will be using.

DAY 2 | SLIDE 13

Give students time to complete the Tracking Pathogens sheet, answering questions and helping those who are in need assistance.

DAY 2 | SLIDE 14

When all groups have completed their capture sheets, ask each group to share the information about the pathogen the students researched and what they learned from the *Nextstrain* data. The instructor should display the web page for each group's pathogen so that students may refer to it as they present. Give the class the opportunity for feedback and to add new ideas as the groups discuss the patterns they see in the data or why the pathogen has spread the way the data shows.

> **Virtual/Remote Learning adaptation:** Student groups can share their information during a Zoom meeting, which will allow the instructor to display their data as a shared screen during the session.

DAY 2 | SLIDE 15

To conclude the activity, play the video at https://www.youtube.com/watch?v=UTzUtW3qs7M, which explains how professors at Yale University are sequencing viral genomes to track and learn about COVID-19 through *Nextstrain*.

DAY 2 | SLIDE 16

Ask students to reflect on how technology that can identify mutations in viruses is helpful in trying to learn more about them. Explain to students that the final part of the lesson will focus on the cellular mechanisms that viruses use to infect cells and how genetic mutations could play a role in helping to prevent them from doing so in the future.

ELABORATE | Slides 17–22

OVERVIEW

In this culminating activity, students use articles and videos to learn about the structure of the SARS-CoV-2 virus, how it uses cellular machinery to replicate itself, and what solutions other than vaccines, genomic epidemiologists and geneticists are working on to try to stop viruses from infecting cells. They will form groups of four, where each group member will research and become the group expert on one aspect of viruses, SARS-CoV-2, and possible treatments that are being explored. After taking notes from provided resources, group members will come together to share what they've learned with each other. They will then use their new knowledge to brainstorm ways that viral structure or mechanisms could be genetically altered to prevent infection of cells or ways that genomic epidemiology and gene therapy could be used to prevent the damaging effects of viruses, such as coronavirus, on the body. They will use classroom materials to create a 3-D model that demonstrates how their proposed solution could work based on their knowledge of viruses and genomics.

DAY 3 | SLIDE 17

Ask students to form groups of four. Explain to students that each group member will be researching and taking notes on one aspect of viruses. Give each student a copy of the Virus Background capture sheet and assign each group member one section of the sheet to complete on his or her own. The students will find links to online articles and videos that will help them answer the crucial questions for their sections.

DAY 3 | SLIDE 18

Give the students 15 minutes to read through or watch the resources provided and take notes on their sections of the capture sheets.

DAY 3 | SLIDE 19

After time to research, ask group members to come together. Each member should share the notes he or she took with the rest of the group. All group members should write down all notes so that each student will have all the information he or she needs for the next step of the activity.

DAY 3 | SLIDE 20

Ask the student groups to focus on Part 2 of the Infection Innovations capture sheet. Explain that now that they have background knowledge on COVID-19, their task is to try to come up with a way that viral or cellular structure could be genetically or structurally altered to help prevent infection. Students should use the "Brainstorming" section of the capture sheet to write down ideas. Remind students that they have learned about various catalysts that lead to infection, replication, and transmission of coronavirus and viruses in general. What steps in this pathway could perhaps be stopped through genetic modification? The instructor should circulate around the room as groups are brainstorming to field questions and discuss ideas with students.

DAY 3 | SLIDE 21

When the brainstorming is complete, student groups should move to the "Model Sketch and Materials" section of the capture sheet. Each group should choose its best idea and discuss how the students might use classroom materials to create a model that would help to explain their solution. Show students all materials that are available to them in the classroom to help them complete their sketch and materials list. Circulate around the room as groups are sketching to field questions and give feedback on model ideas.

> **Virtual/Remote Learning adaptation:** Students can use an online CAD program (such as Tinkercad) to create a 2-D digital version of their model, rather than building a 3-D model.

Once students have decided how they will build their model, give groups any remaining time in the class period to begin constructing their models.

DAY 4 | SLIDE 22

Begin the class period by asking students if they have any questions or concerns about their innovations and building their models. Remind them that when their models are complete, they will informally present their ideas using their models during the last part of the class period.

Give student groups the first 20 minutes or so of the class period to finish constructing their models and practice how they will present their ideas for preventing coronavirus from infecting cells and spreading throughout the body and to others.

EVALUATE | Slides 23–24

OVERVIEW

Students will present their SARS-CoV-2 solutions to the whole group. They will explain their models and use them to demonstrate how their potential solution could work. The class will then give feedback on each solution, weighing benefits and costs of each.

> **Virtual/Remote Learning adaptation:** Student groups can share their ideas during a Zoom meeting, which will allow the instructor to display their information and models as a shared screen during the meeting.

DAY 4 | SLIDE 23

With 30 minutes remaining in the class period, announce to students that it is time for each group to present its idea and model to the class. Each group should choose one or more spokespersons to present. Explain that each group will be given no more than five minutes to present its idea and 3-D model. After each group presents, give the whole class the opportunity to ask questions or give feedback on ideas and models.

DAY 4 | SLIDE 24

When all group presentations and feedback opportunities have concluded, give each group a copy of the Infection Innovations Group Exit Ticket. Ask the group to discuss how this activity went for them and what they learned from their experience and the feedback they received. The groups should turn in their exit tickets to conclude the lesson.

> **Virtual/Remote Learning adaptation:** The instructor can create a digital exit ticket using the google forms "Exit Ticket" template that can be emailed to students or posted on google classroom.

EXTENSION | Slide 25

If you have additional time and/or would like to further challenge your students, consider the following extension options:

- Students can go to https://media.hhmi.org/biointeractive/click/virus-explorer/ to click and learn through the "Virus Explorer," where they can look closely at various types of viruses, such as HIV and rabies.
- Students can learn about zoonotic diseases and how viruses jump from animals to humans in an occurrence called "spillover" by reading the article at https://www.news-medical.net/news/20200407/How-do-viruses-mutate-and-jump-to-humans.aspx or watching the TedEd video at https://www.youtube.com/watch?time_continue=1&v=xjcsrU-ZmgY&feature=emb_logo

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Next Generation Science Standards

- 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.
- HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS

Common Core ELA Standards

Grades 9–10

- CCSS.ELA-LITERACY.RST.9-10.2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- CCSS.ELA-LITERACY.SL.9-10.1.D Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify one's own views and understanding and make new connections in light of the evidence and reasoning presented.
- CCSS.ELA-LITERACY.SL.9-10.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Grades 11–12

- CCSS.ELA-LITERACY.RST.11-12.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- CCSS.ELA-LITERACY.SL.11-12.1.D. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; determine what additional information or research is required to deepen the investigation or complete the task.

ITEAA STANDARDS FOR TECHNOLOGICAL LITERACY

Technology and Society, Standard 3: Students will develop an understanding of the relationships among technologies and connections between technology and other fields of study.

J. Technological progress promotes the advancement of science and mathematics

Technology and Society, Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.

I. Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

Each Viral Sample sequence should be cut into a separate strip (except for the original virus), and each student should receive one for the activity.

ORIGINAL VIRUS (present at start of outbreak)	AAUCGCAGGCCUAUCUUUGA
VIRAL SAMPLE 1	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 2	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 3	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 4	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 5	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 6	AGUCAGAGCCGUAUCCUCGA
VIRAL SAMPLE 7	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 8	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 9	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 10	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 11	AGUCAGAGCCGUAUCCUCGA

VIRAL SAMPLE 12	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 13	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 14	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 15	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 16	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 17	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 18	AGUCAGAGCCGUAUCCUCGA
VIRAL SAMPLE 19	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 20	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 21	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 22	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 23	AGUCAGAGCCGUAUCCUCGA
VIRAL SAMPLE 24	AAUCGGAGGCCUAUCUUCGA

ORIGINAL VIRUS (present at start of outbreak)	NUMBER OF MUTATIONS	AAUCGCAGGCCUAUCUUUGA
Viral Sample Mutation Event 1—Yellow	2	AAUCGGAGGCCUAUCUUCGA
Viral Sample Mutation Event 2—Orange	4	AGUCGGAGCCCUAUCUUCGA
Viral Sample Mutation Event 3—Red	7	AGUCAGAGCCGUAUCCUCGA
Viral Sample Mutation Event 4—Dark Red	9	AGUCAGAGCCGUUUCCUCGC

STUDENT VIRAL RNA—MUTATION EVENT KEY

VIRAL SAMPLE 1	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 2	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 3	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 4	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 5	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 6	AGUCAGAGCCGUAUCCUCGA

VIRAL SAMPLE 7	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 8	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 9	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 10	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 11	AGUCAGAGCCGUAUCCUCGA
VIRAL SAMPLE 12	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 13	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 14	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 15	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 16	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 17	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 18	AGUCAGAGCCGUAUCCUCGA
VIRAL SAMPLE 19	AAUCGGAGGCCUAUCUUCGA

VIRAL SAMPLE 20	AGUCGGAGCCCUAUCUUCGA
VIRAL SAMPLE 21	AAUCGGAGGCCUAUCUUCGA
VIRAL SAMPLE 22	AGUCAGAGCCGUUUCCUCGC
VIRAL SAMPLE 23	AGUCAGAGCCGUAUCCUCGA
VIRAL SAMPLE 24	AAUCGGAGGCCUAUCUUCGA

Go to https://nextstrain.org/ and scroll down to the “Explore Pathogens” section.

A. Find the pathogen you will be tracking in this activity and click on it.

Name of the pathogen you’re tracking:

Do an Internet search to give some background on your pathogen. Questions that can be answered include the following:

- What type of pathogen is it—a bacteria, virus, other?
- How is the pathogen spread and transmitted between people and/or animals?
- What is the suspected origin of the pathogen?
- How does the pathogen affect the health of the person affected?
- Are there prevention strategies or treatments for the pathogen? If so, what are they?

Pathogen Background:

B. If possible, change the dataset to “Global.”

C. Next, change the “Color By” setting to “Country,” if possible.

In this activity you will be using both the "Phylogeny" and the "Transmissions" sections of the Nextstrain site.

D. On the Phylogeny menu, click on "Country" to see how the countries affected are color-coded. Study the Phylogeny and Geography sections to answer the following questions:

1. How many genomes were sampled in your data set?

2. What is the date of the earliest case? What is the date of the most recent?

3. Which countries or regions appear to have the most cases of your pathogen? (Move the mouse over the colored dots on the Phylogeny section for information or view the map in the Geography section.)

E. Click "Play" in the Transmissions section and use the animation to determine the following:

1. Where in the world did the pathogen appear to originate for your data set?

2. What countries did it spread to next?

3. Do you see any pattern emerging? Describe how the pathogen appears to spread.

4. Do you have any ideas or thoughts on why the pathogen has spread the way the data shows? What else does the data lead to you believe about your pathogen?

Part 1: Background on Coronavirus

Research Coronaviruses and Viral Structure	**Suggested Resources** • "Intro to Viruses" (Khan Academy): https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-immune-system/a/intro-to-viruses • "What Are Coronaviruses?" (TedEd): https://www.youtube.com/watch?v=D9tTi-CDjDU
NOTES:	
Research Cell Entry by Viruses	**Suggested Resources** "How Coronavirus Hijacks Your Cells" (New York Times): https://www.nytimes.com/interactive/2020/03/11/science/how-coronavirus-hijacks-your-cells.html "Why Is The Coronavirus So Good At Infecting Human Cells?": https://www.youtube.com/watch?v=v0IXtzfSPbw
NOTES:	

Research Viral Replication	**Suggested Resources** • "How Do Viruses Reproduce?":https://www.youtube.com/watch?v=QHHrph7zDLw • Covid-19 Animation: What Happens If You Get Coronavirus?" (0:00-2:45):https://www.youtube.com/watch?v=5DGwOJXSxqg&t=21s • "Coronavirus and COVID-19": https://www.youtube.com/watch?v=11f8h-fSM_M
NOTES:	
Research Possible Solutions Using Genomics	**Suggested Resources** • 'How to Fight COVID-19...With A Virus': "https://www.youtube.com/watch?v=SmKqYsxIBr4 • Targeting ACE2 Receptors to Prevent SARS-CoV-2 Virus from Attacking Human Cells": https://www.youtube.com/watch?v=iBz5kfLIynY • "How Scientists Are Trying to Develop A Coronavirus Vaccine" (Wall Street Journal): https://www.youtube.com/watch?v=7SuKywEZ5AM
NOTES:	

Part 2: Brainstorming Solutions

Part 3: Model Sketch and Materials

Infection Innovations: Group Exit Ticket

Join your group and answer the following questions before you leave class today.

Reflecting on your experience presenting your idea and model and receiving feedback from the whole group, answer the following questions:

1. What were the strengths of your idea and model?

2. What were the weaknesses of your idea and model?

3. What would you go back and change if given the chance to revise or improve your idea?