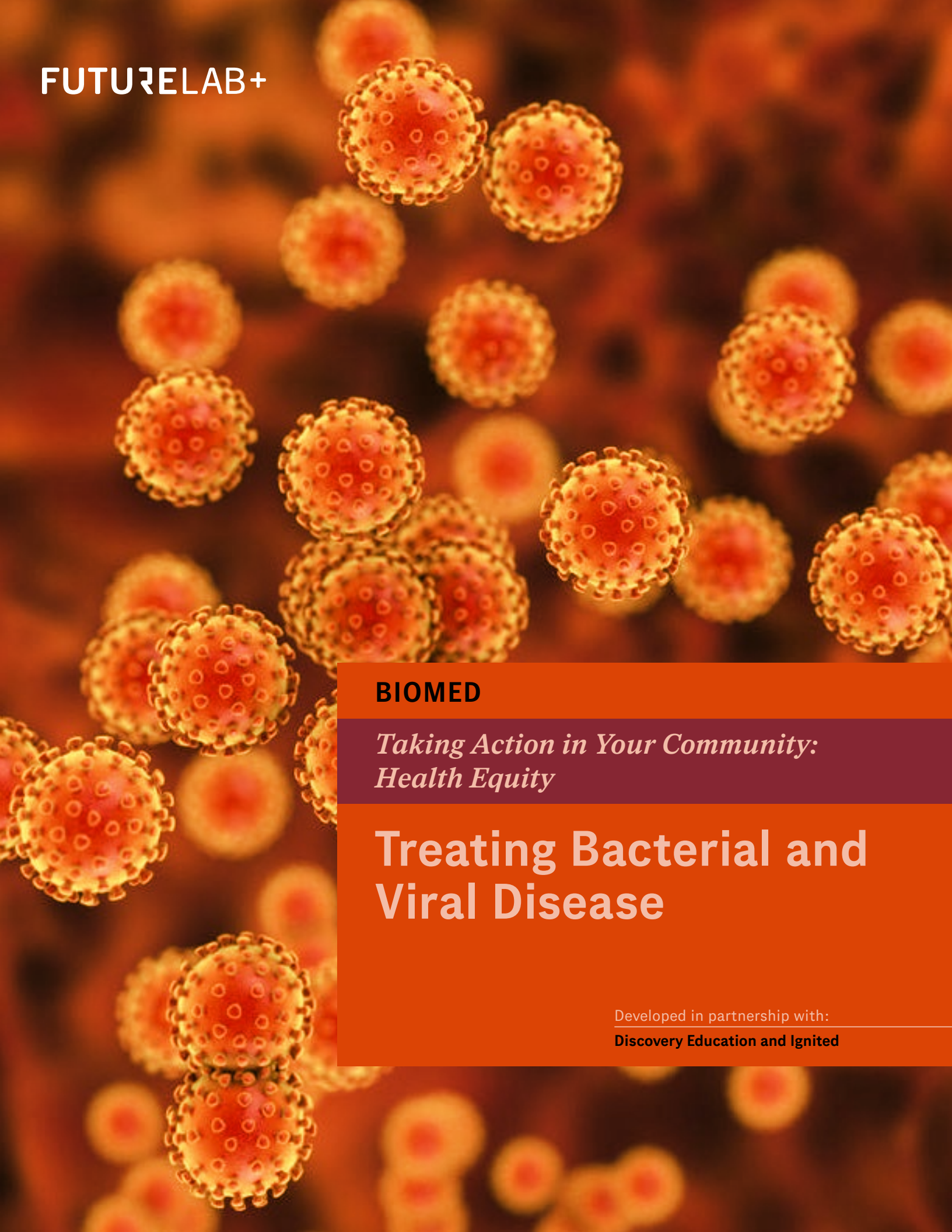
FUTURELAB+



BIOMED

Taking Action in Your Community: Health Equity

Treating Bacterial and Viral Disease

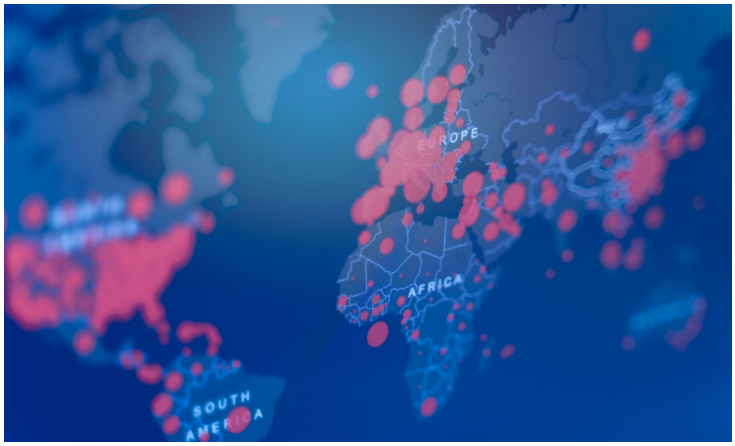
Developed in partnership with:

Discovery Education and Ignited

In this Lesson Plan:

Print the **Teacher Section** →

Print the **Student Section** →



Global Cases
COVID-19 cases by Country/Region/ Sovereignty.

—

Cover Image
This is an illustration of coronavirus particles.

This document is separated into two sections, For Teachers [T] *and* Student Resources [S]*, which can be printed independently.*

Select the appropriate printer icon above to print either section in its entirety.

Follow the tips below in the Range field of your Print panel to print single pages or page ranges:

Single Pages (use a comma): T3, T6

Page Range (use a hyphen): T3–T6

BIOMED / TAKING ACTION IN YOUR COMMUNITY: HEALTH EQUITY

Treating Bacterial and Viral Disease

DRIVING QUESTION

How are infectious diseases treated?

OVERVIEW

Infectious diseases are the leading cause of death worldwide. This is especially an issue for low-income individuals and within some ethnic populations or racial groups. Lack of basic needs make people more susceptible to infections and often people living in these conditions do not have access to proper medical care. Advances in antibiotics and antiviral medications for treating these diseases are essential for alleviating this crisis.

In this lesson, students will learn how viruses, prokaryotic, and eukaryotic cells reproduce. They will also learn how bacterial and viral infections are treated. Students will be better informed on the science of infectious diseases as well as the social issues surrounding the treatment of bacteria and viral infections.

ACTIVITY DURATION

Four class sessions
(45 minutes each)

ESSENTIAL QUESTIONS

How do viruses, prokaryotic cells, and eukaryotic cells reproduce?

What are antibiotics and how are they used?

What are antivirals and how are they used?

What treatments are available for viral diseases?

OBJECTIVES

Students will be able to:

Distinguish among prokaryotic, eukaryotic, cellular, and viral reproduction.

Define antibiotic and **describe** its use in treating infections.

Define antiviral and **describe** its use in treating infections.

Describe various treatments for viral disease.

BACKGROUND INFORMATION

Students should understand the differences between a prokaryotic and eukaryotic cell. It would also be useful for them to understand the basic structure of a virus and why it is not considered living (based on the characteristics of living things). It would be helpful for students to have prior exposure to reading an abstract or paper from a scientific journal. Being able to use or simply recognize binomial nomenclature could be useful when students come across the name of a bacteria and are able to distinguish it from a virus.

Materials

- **Computers with Internet Access**
- **How Do Pathogens Reproduce? Capture Sheet**
- **Bacterial Infectious Diseases Poster Assignment**
- **Bacterial Infectious Diseases Poster Rubric**
- **Marker**
- **Poster Board**
- **Ruler**
- **Sticky Notes**
- **How Do Antivirals Work? Capture Sheet**
- **Copies of Scientific Journal Articles**
- **Antiviral and Antibiotic Review Capture Sheet**
- **Disparities in the Treatment of Infectious Diseases Rubric**
- **Design Journal**

Pedagogical Framing

Instructional materials are designed to meet national education and industry standards to focus on in-demand skills needed across the full product development life cycle—from molecule to medicine—which will also expose students and educators to the breadth of education and career pathways across biotechnology.

Through this collection, educators are equipped with strategies to engage students from diverse racial, ethnic, and cultural groups, providing them with quality, equitable, and liberating educational experiences that validate and affirm student identity.

Units are designed to be problem-based and focus on workforce skill development to empower students with the knowledge and tools to be the change in reducing health disparities in communities.

SOCIAL-EMOTIONAL LEARNING

Students may have personal experiences with infectious disease, which is the subject of this lesson. They will need to use self-management during conversations. Caution should be taken to ensure the conversations around bacterial and viral infections are approached carefully and dealt with sensitively. Students will also discuss their opinions regarding vaccines. Students should be reminded to be socially aware and that every opinion should be heard and respected. Students will practice 3 SEL domains of "Social Awareness," "Relationship Skills," and "Responsible Decision-Making" in activities throughout this lesson.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Students will learn about instances in which disparities in infectious disease treatment have been discovered. It is important to highlight these differences while discussing healthcare management. Students are made aware of the associated challenges and are able to bridge the content with their cultural and linguistic heritage and build connections to their community. Lesson strategies included building awareness, which leads to solution-seeking thinking practices. Instilling these practices is also a part of the lesson. This empowers advocacy for self and community.

ADVANCING INCLUSIVE RESEARCH

This lesson focuses on a variety of bacterial and viral diseases. In order to effectively treat these diseases, it is important to gather data from as many global sources as possible.

COMPUTATIONAL THINKING PRACTICES

In this lesson, students use the computational thinking strategies of collecting data, analyzing data, and abstraction to examine how diseases are treated. Students gain experience collecting data from reputable sources, and learn how to ensure a scientific source contains valid data. In a culminating project, students analyze scientific studies and abstract out the relevant data in order to present it to the public, whose health literacy may vary.

CONNECTION TO THE PRODUCT LIFE CYCLE

An important part of developing new therapies is identifying the part of a pathogen that a drug will attack. This lesson explains how therapies are created to target these pathogens in the **discovery** phase of the product life cycle.

Have you ever wondered…

Why can one antibiotic be used to treat more than one disease?

There are many more antibiotics than antivirals. Antibiotics are often developed based on the bacterial structure or the key processes they perform. As a result, several antibiotics that have been developed work for multiple types of bacterial infections.

Why are there such few treatments for diseases caused by viruses?

Viruses depend on host cells to proliferate. They use the genome and proteins of the host to help them reproduce and survive. Medicines are developed to inhibit a particular process or structural component of a pathogen. The process becomes particularly challenging with viruses. Because viruses are inside the human body and utilize the cellular mechanisms of the host, antivirals may cause significant harm to the host.

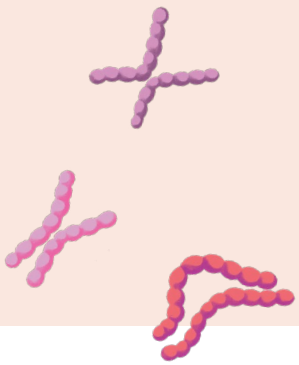
Does everyone need to be vaccinated?

Vaccines are a healthcare measure that help prevent infectious diseases. Doctors recommend that some individuals should receive certain vaccines. For example, people with compromised immune systems may be at high risk for actually being infected with the bacteria or virus.

MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

Vaccines are useful tools used in healthcare to prevent diseases. They can be used for both viral and bacterial diseases. Fewer treatments exist for viral diseases compared to bacterial diseases. Therefore, prevention of viral diseases through vaccination is extremely important.



How does this connect to careers?

Infectious disease specialists research diseases that affect humans. They are an integral resource during pandemics as they are looked at as the experts on a particular disease. They help inform epidemiologists and other public health officials concerning specific information about the disease.

Virologists specialize in infections caused by viruses. They play a large role in preventing and treating viruses that affect humans and other living things, including plants. Virologists help inform epidemiologists and other public health officials concerning specific information about viruses.

How does this connect to our world?

During a pandemic, health care and the economy can be largely disrupted. Understanding the science behind infectious diseases and how they affect humans can assist with both preparing and helping to alleviate the effects of a pandemic.

Day 1

LEARNING OUTCOMES

Students will be able to:

Distinguish among prokaryotic, eukaryotic, cellular, and viral reproduction.

COMPUTATIONAL THINKING IN ACTION

Students are using the computational thinking strategy of collecting data to research how pathogens reproduce.

INDUSTRY AND CAREER CONNECTION

Students will incorporate soft skills vital to excel as an infectious disease specialist. Emphasize to them that a major soft skill needed for this assignment is attention to detail. As they collect information, they need to be sure they are watching the videos and reading the information thoroughly to complete the assignment. Infectious disease specialists are knowledgeable on specific details that help provide them with more insight as to the cause of a disease. In addition, just like infectious disease specialists, students will need to manage their time well.

Procedure

Whole Group (5 minutes)

1. Notify students that for this assignment they will play the role of an infectious disease specialist. In this role, they will be responsible for learning how pathogens can divide or replicate. This is critical as these processes affect the severity of the infection and can make someone more sick after being infected.

2. Distribute the *How Do Pathogens Reproduce?* capture sheets with guided notes that students will need as they work through the webquest.

3. Tell students that they will use various Internet sites to locate information about the reproduction of viruses, prokaryotic cells (pathogens such as bacteria), and eukaryotic cells (pathogens such as fungi).

Small Group (30 minutes)

1. Divide students into three or six groups. Assign each group one type of cell division. Groups will begin working on their assignment using the capture sheet. A simple variation of *SOS* using *Padlet*, or similar software, will allow students to work together to complete the capture sheet and to accommodate the next step as a whole class.

2. Be sure to note any questions or areas of misconceptions students may have in order to review at the end of class. Each group can present and share their findings with the class.

Whole Group (10 minutes)

1. Review the images for eukaryotic cell replication, prokaryotic binary fission, and viral lytic cycle.

2. When reviewing each of the cycles, be sure to note the time it takes for each cycle to replicate. Ask students to *Give a Shout Out* about which cell or virus takes the shortest time to replicate. Which takes the longest?

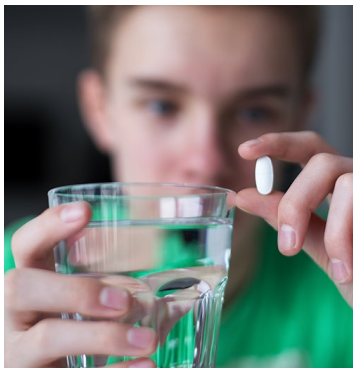
3. Have each group share their responses about why the time of the replication process is so important in human infection. Ask other groups to ask questions about the responses or to explain why an answer is correct. (Answers may include: The time can provide evidence of how long or how sick a person is with an infection. Time can help scientists in developing a medicine. For example, if a pathogen reproduces quickly, it may have a larger effect on an infected individual compared to a pathogen that reproduces more slowly.)

Day 2

LEARNING OUTCOMES

Students will be able to:

Define antibiotics and describe its use in treating infections.



INDUSTRY AND CAREER CONNECTION

Emphasize to students that a major soft skill demonstrated by infectious disease specialists and necessary for this assignment is openness to learning and organizational skills. Because some of the bacterial diseases will be new to students, they may not be that interested in the beginning. Therefore, an openness to learning would be a requirement in order for the assignment to be successfully completed. Infectious disease specialists have to be open to different ideas and thought processes as they research various aspects of diseases. In addition, because this project has several different components and will be worked on in groups, organizational skills will be the key. Students will need to make sure they do their portion of the assignment while ensuring it fits in with everyone else's information.

[1] https://medlineplus.gov/antibiotics.html

Procedure

Whole Group (5 minutes)	
1	Divide students into groups of three or four. Notify them that they will continue their role of infectious disease specialists for today's lesson.
2	Hand out the *Bacterial Infectious Diseases Poster Assignment*. Explain that students will be researching specific bacterial diseases and their treatments.
3	Let students know that the focus for today's lesson is antibiotics. Have them write the definition of an antibiotic at the top of their capture sheet: a medicine used to treat a bacterial infection.[1] Explain that they may have taken an antibiotic to prevent or treat an infection before.
4	For this assignment, students will work in groups to make an informational poster about a bacterial disease.

Teacher Note > *Students may not understand the connection between why they were sick (which pathogen affected them) and what they were given to treat the infection. Emphasize that if they were given an antibiotic such as amoxicillin, they were infected or sick with a bacteria.*

Small Group (30 minutes)	
1	Review the components of the assignment and allow students to view the poster rubric. Walk through the picture of the required antibiotic mechanism of action visual (on handout). Let them know that the picture does not have to be in depth, but should include the name of the antibiotic, an arrow pointing to the area that it affects, and an X on that particular area.
2	Be sure to review the *Bacterial Infectious Diseases Poster Rubric* with students.

Continues next page >

Day 2

Continued

Procedure

COMPUTATIONAL THINKING IN ACTION

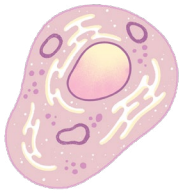
Here, students are practicing the computational thinking strategy of collecting data to review and gather information from reputable sources.

3	Notify students that they can use the resources provided. If they use other references they should make sure they are reputable (from a .gov or .edu site or a site that includes references at the end).
4	Have students assign roles such as researcher, artist, writer, and designer.
5	Lastly, let students know that their posters will be viewed by their classmates.

Teacher Note > *Students can use other resources besides the ones provided. Be sure they know how to identify reputable sources including websites, newspapers, and journal articles. References should offer facts rather than opinions. Journal articles should be peer-reviewed. Suggest that students use websites ending in .edu or .gov. They should still exercise caution because some .edu sites are created by college students, and may not be credible.*

Whole Group (10 minutes)

1	Have groups turn in their posters. Let them know that they will spend the first few minutes of class conducting a *Gallery Walk* of the Infectious Disease posters created by their classmates.
2	For their exit ticket to leave, have students note which antibiotic was used to effectively treat the disease they researched today.



Day 3

LEARNING OUTCOMES

Students will be able to:

Define antivirals and describe their use in treating infections.

Describe why antivirals would not be used for a bacterial infection.

CULTURAL AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Peer feedback provides support for culturally diverse students' use of standard English. It also helps to bridge the content from scholastic research to the reality of delivering complex information to a varied population.

COMPUTATIONAL THINKING IN ACTION

Students are using the computational thinking strategy of abstraction to identify commonalities in antibiotics.

Procedure

Whole Group (10 minutes)	
1	Remind students that they will spend the first few minutes of class conducting a *Gallery Walk* of the Infectious Disease posters created by their classmates.
2	Hand each student four to five sticky notes (one for each poster) and instruct them to divide it in half. They should write what they liked about a poster on the top half of the sticky note. The bottom half of the note should be used to highlight aspects of the poster that could be improved.
3	Be sure to remind students to be professional in their feedback. Feedback should be specific to the project and the information.
4	Students should spend one to two minutes on each poster. Groups should rotate until each poster has been seen by everyone.
5	After the activity is completed, have students revisit their own posters to view the feedback. Have groups spend the next few minutes reflecting on their feedback. What could be improved? What changes would they make? What did they do well? Why was it effective?

Whole Group (20 minutes)	
1	Ask students if they noticed similarities in the antibiotics used for the different diseases.
2	Let them know that scientists develop antibiotics based on the structure of the bacteria or certain processes that it performs. For example, the common antibiotic penicillin targets the bacterial cell wall.[2]
3	Have students draw a bacterial cell and label the cell wall.

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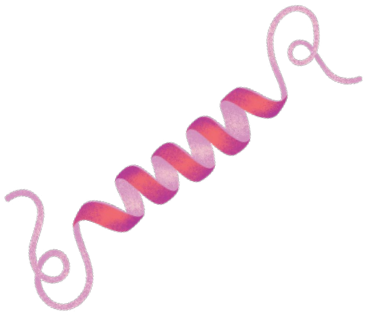
[2] https://tmedweb.tulane.edu/pharmwiki/doku.php/penicillin_g#:~:text=THE%201ST%20PENICILLIN&text=Mechanism%20of%20Action%3A,linking%20of%20the%20cell%20wall

Day 3

Continued



Procedure

4. Emphasize that all bacteria have a cell wall made up of peptidoglycan. For this reason, penicillin can be used to treat other bacterial infections caused by staphylococci and streptococci (though less effectively).

   a. Have students write the word penicillin on their paper.

   b. Instruct them to draw an arrow showing where *penicillin* affects the bacteria.

   A: cell wall

   c. Students should then place an X on the cell wall, indicating that the penicillin plays a role in destroying the cell wall.

5. Penicillin attacks the bacteria, preventing it from making its cell wall. Remind students that cellular organelles were discussed in the Crowdsourcing Innovations in Biotechnology Unit. Ask if they remember the function of the cell wall.

   A: It helps bacteria maintain its cell shape.

6. Also remind students that if the bacteria are unable to make a component, such as a cell wall, they are unable to divide. Recall student memory by asking which term describes bacterial cell division.

   A: binary fission

7. Let students know that an important part of the **discovery** phase of the product cycle of medicine is identifying the drug target. Emphasize that jobs in research play an important role in determining which portion of the pathogen will be used as a drug target.

8. Ask students if penicillin could be used as an antiviral. Students should answer no because viruses do not have a cell wall.

9. Tell students that many common antibiotics end in *-cillin* or *-mycin*. Examples include clindamycin, azithromycin, amoxicillin, and penicillin.

10. Notify students that they will be learning about antivirals in today's lesson. Gauge the percentage of the class that has heard of the term by asking them to raise their hands.

    a. Also ask the students in what context they have heard of the term.

    b. Ask them to make an educated guess (based on the *-prefix* anti and *-suffix* viral) as to what an antiviral possibly does.

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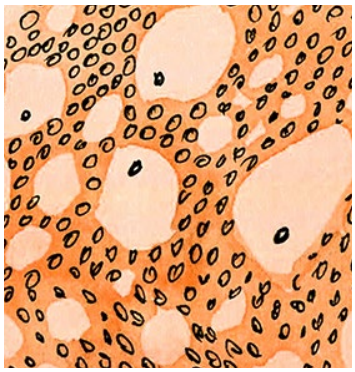
Day 3

Continued

Procedure



11 Distribute the *How do Antivirals Work? Capture Sheet*.

a. Have students answer the first question by writing the definition of antiviral as you define it out loud: a medicine used to treat a viral infection.[3]

b. Ask students to explain the difference between an antiviral and antibiotic. Have them write down their answer to the second question in the space provided. (Antibiotics treat bacterial infections whereas antivirals treat viral infections.)

- Ask students to raise their hands if they believe that an antiviral drug can be used to treat a bacterial infection. Emphasize that antivirals are made for a specific virus and that viruses are structurally different from bacteria. Therefore, they cannot be used to treat bacterial infections.
- Let students know that a viral infection can cause a bacterial infection. Tell them that many of the deaths during the influenza pandemic in 1918 were caused by secondary bacterial infections.[4]
- Ask students how they think this would occur. (Viral infection can damage the tissues and cells, allowing for an environment which can be easily infected by bacteria. In addition, the immune response against a virus can prevent the immune system from attacking the bacteria.[5])

c. For the third question, assess students' understanding of the mechanism of action of an antibiotic. Ask how they think scientists develop antivirals, based on the structure, actions, and processes of a virus. Have students record their answers in the appropriate space.

d. Give students two minutes to answer the fourth and fifth questions. Ask for a few answers, but do not provide the correct answer. Let students know that they will be watching a video next that will answer those questions.

e. Also review the images included on the general diagram of a virus life cycle, located on the *Antiviral and Antibiotic Review Capture Sheet*. Ask students to answer the sixth question: why antiviral drugs cannot be used to treat bacterial infections. (Antiviral drugs use the host cell and so the host may be harmed as well.)

12 Let students know that an important part of the **discovery** phase of the product cycle of medicine is identifying the drug target. Emphasize that jobs in research and early clinical development are focused on this phase of the cycle.

Continues next page >

[3] https://www.cdc.gov/flu/treatment/whatyoushould.htm

[4] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2692119/

[5] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3965630/

Day 3

Continued

Procedure

13	Play *Virology 2015 Lecture #20: Antivirals*, pausing for student responses.
14	Play video from
	a. 1:20–2:20 to answer questions 7 and 8
	b. 2:55–4:05 to answer questions 9 and 10
	c. 16:00–17:00 to answer question 11

Teacher Note > *Consider integrating a vocabulary development activity prior to watching this video.*

15	*Pause* at various points in the video to ensure that students have time to record or revise answers to questions that are covered in the video.
16	Remind students to compare their answers before and after watching the video. Have them do the same for #5 (before the video) and #11.
17	Let students know that because there are not many treatments for viral diseases, vaccinations can be used to prevent them. Ask students if they are familiar with vaccinations. Most students will be familiar with vaccines to some extent because they must submit immunization records to attend school.
18	After the video has finished, ask students if they have any questions.

Individual (10 minutes)

1	Explain to students that they will spend the rest of class working on the *Antiviral and Antibiotic Review* capture sheet.
2	Describe the assignment and let students know that they are able to use their notes. Also emphasize that this will be an individual assignment.
3	Students will turn in the assignment at the end of class. They can spend any remaining time responding to the guiding questions in their **Design Journal**—explaining the difference between cell and viral replication, and outlining treatment options and challenges. This exit ticket will help determine whether extended learning or any clarifications are required.

INDUSTRY AND CAREER CONNECTION

Emphasize that a major soft skill used by infectious disease specialists and needed for this assignment is having a good attention span and a sense of commitment. Because students will be using information learned from previous lessons to answer questions, they will need to be patient with themselves in retrieving the appropriate information necessary to answer the questions. Infectious disease specialists have a sense of commitment in improving the lives of others, which is a necessity in the public health environment.

Day 4

LEARNING OUTCOMES

Students will be able to:

Describe disparities in the treatments of bacterial or viral infection among ethnicities.

COMPUTATIONAL THINKING IN ACTION

In this activity, students are using the computational thinking strategies of analyzing data and abstraction to review scientific studies and present the relevant information to the public.

Procedure

Whole Group (5 minutes)	
1	Explain to students that for today's lesson, they will be reviewing articles from scientific journals. More specifically, these articles include studies that have been conducted to identify if there are any differences in race or class in terms of treatment of an infectious disease.
2	Let students know they will be divided into small groups and asked to dissect the study to present it to the public.
3	In the presentation students will need to identify the problem, prepare a graph representing the problem, brainstorm the causes of the problem, as well as think of possible solutions.
4	Inform students that they will be presenting this information to their classmates who have never read the study. As a result, they will need to be sure they are clearly communicating the information in a concise and understandable way.
5	Review the required components of the assignment *Disparities in the Treatment of Infectious Diseases* with students.

Small Group (25 minutes)	
1	Once students have been split into groups of two to three, they should begin by reading the abstract provided for the assignment silently to themselves. This will be completed individually before starting the group work. Give students five minutes to read and annotate the abstract. Provide them with ways to annotate, such as circling the problem and underlining the information they would need to create a graph. Also suggest that they browse the figures, including the tables, because they will use this information to create their graph.
2	If necessary to differentiate, provide the order of components in an abstract: problem, goal, method used to investigate the problem, results, and next steps. In addition, the articles with asterisks(*) have the abstract broken into the aforementioned components. (The article with the # sign is shorter than the other articles, including the components in a succinct manner.)

Continues next page >

Day 4

Continued

Procedure

3	Then give students an additional five minutes to talk with the members of their group to determine if they agree on identifying the problem and the information that will be necessary to create the graph. Use a timer to start and stop the groups.
4	Give students another 15 minutes to create their graphs and identify the cause and solution to the problem.

Whole Group (15 minutes)

1	Give each group three minutes to present the information gathered from their abstract.
2	Be sure they know to start with the problem, the data supporting the evidence of the problem, and follow by the cause and solution to the problem.
3	Engage with each group by having them clarify the evidence of causes and solutions to the problems.

Teacher note > *Students may have similar causes and solutions to different problems. Be sure to let them know that the cause of a problem can often be large, but have several underlying factors. Try to get students to dig deeper if the causes and solutions seem too general. Make sure to clarify any misconceptions that students may have.*

INDUSTRY AND CAREER CONNECTION

Emphasize to students that a major soft skill needed for this assignment is time management and the ability to set priority. Students will be given 20 minutes to agree on a problem, to agree on the type of graph, find one cause and propose two solutions. Students should set priority on the problem and type of graph because there can be more than one cause or solution. Additionally, much like an infectious disease specialist, students will need to be knowledgeable on the information and need to clearly present that information in a tight time limit.

National Standards

Next Generation Science Standards

Science and Engineering Practices

Obtaining, Evaluating, and Communicating Information

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Constructing an Explanation

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

Crosscutting Concepts

Structure and Function

Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Career and Technical Education (CTE)

A5.1

Use the Internet and World Wide Web to collect and share scientific information.

4.3

Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.

5.4

Interpret information and draw conclusions, based on the best analysis, to make informed decisions.

5.6

Read, interpret, and extract information from documents.

How Do Pathogens Reproduce?

ANSWER KEY

Do not share with students

Directions
You will be researching how pathogens like viruses and bacteria reproduce or increase. You will also be discovering how the cells that make up your body, eukaryotic cells, reproduce.

Eukaryotic Cellular Division
Visit the site *Mitosis: Eukaryotic Cell Division*

1a. What process occurs when eukaryotic cells reproduce or divide?

Mitosis and cytokinesis

1b. What are some examples of eukaryotic cells that divide?

Skin cells, hair cells, lung cells, muscle cells

1c. How long does this process take?

From a few hours to two to five days

1d. Interphase occurs before the cell divides. Describe the process of interphase.

During interphase the cell grows and the DNA is replicated.

Mitotic Phase
Visit the site *Mitotic Phase: Mitosis and Cytokinesis*

2. List the steps in order.
See next page for Part 2 of the question: draw a picture of each step.

2a. Step 1

Prophase

2b. Step 2

Prometaphase

2c. Step 3

Metaphase

2d. Step 4

Anaphase

2e. Step 5

Telophase

2f. Step 6

Cytokinesis

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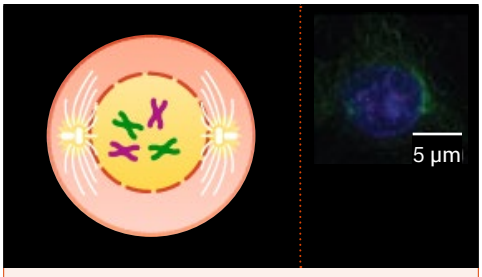
How Do Pathogens Reproduce?

ANSWER KEY **Do not share with students**

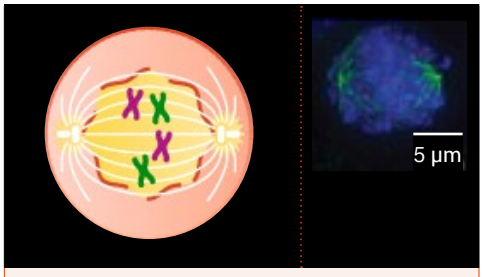
Continued

2. Draw a picture of the event above the dotted lines.



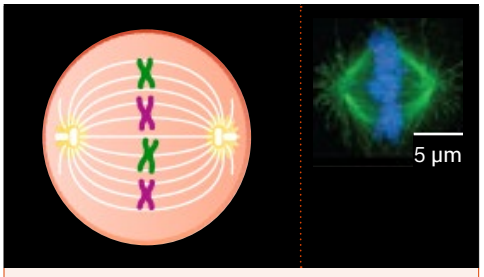
Prophase

Chromosomes condense and become visible
Spindle fibers emerge from the centrosomes
Nuclear envelope breaks down
Nucleolus disappears



Prometaphase

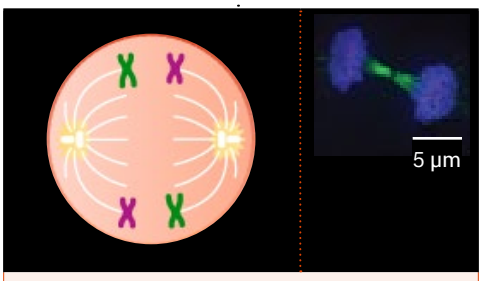
Chromosomes continue to condense
Kinetochores appear at the centromeres
Mitotic spindle microtubules attach to kinetochores
Centrosomes move toward opposite poles



Metaphase

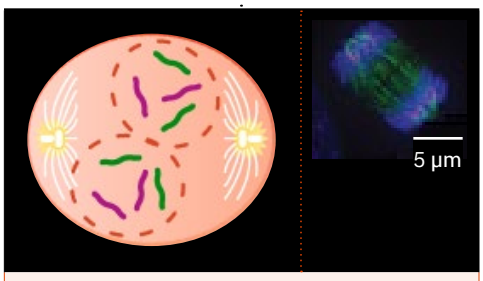
Mitotic spindle is fully developed, centrosomes are at opposite poles of the cell
Chromosomes are lined up at the metaphase plate
Each sister chromatid is attached to the spindle fiber originating from opposite poles

Mitosis



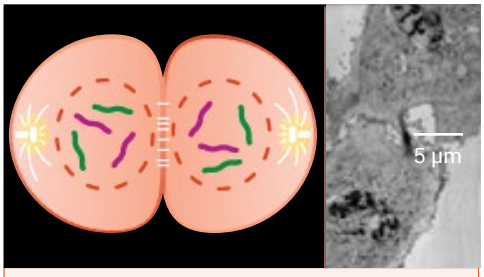
Anaphase

Cohesin proteins binding the sister chromatids together break down
Sister chromatids (now called chromosomes) are pulled toward opposite poles
Non-kinetochore spindle fibers lengthen, elongating the cell



Telophase

Chromosomes arrive at opposite poles and begin to decondense
Nuclear envelope material surrounds each set of chromosomes
The mitotic spindle breaks down



Cytokinesis

Animal cells: a cleavage furrow separates the daughter cells
Plant cells: a cell plate separates the daughter cells

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How Do Pathogens Reproduce?

ANSWER KEY **Do not share with students**

Continued

Prokaryotic Cellular Division
Visit the site *Prokaryote Reproduction*

3a. Which process occurs when prokaryotic cells reproduce or divide?

Binary Fission

3b. This is what type of reproduction (circle one):

ASEXUAL

SEXUAL

3c. How long does this process take?

20 minutes

Binary Fission
Visit the site *Binary Fission: Prokaryotic Cell Division*

4. List the steps in order. Draw a picture each step in the space provided.

4a. Step 1

Prokaryotic cell replicates (makes exact copy of) its chromosomes.

4b. Step 2

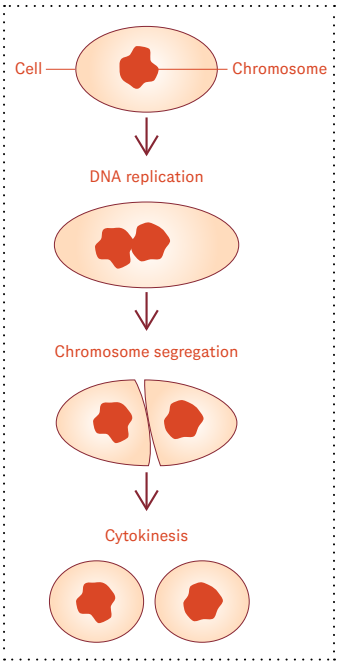
The cell elongates or grows in size.

4c. Step 3

The cell pinches off at the middle and a wall forms.

4d. Step 4

The cell splits in half.



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How Do Pathogens Reproduce?

ANSWER KEY

Do not share with students

Continued

4e. What is an example of a prokaryotic cell?

E.coli

4f. Which takes longer to divide—prokaryotic or eukaryotic cells? Why?

Eukaryotic cells take longer to divide because they are more complex. They have a nucleus and a lot more organelles compared to prokaryotic cells.

Viral Reproduction
Visit the site *Virus: Reproduction*

5. What is the name of the process in which viruses reproduce?

Lytic Infection

List the steps in order. Draw a picture of each step beneath its name.

5a. Step 1

Attachment

5b. Step 2

Entry

5c. Step 3

Replication

5d. Step 4

Assembly

5e. Step 5

Release

Continues next page >

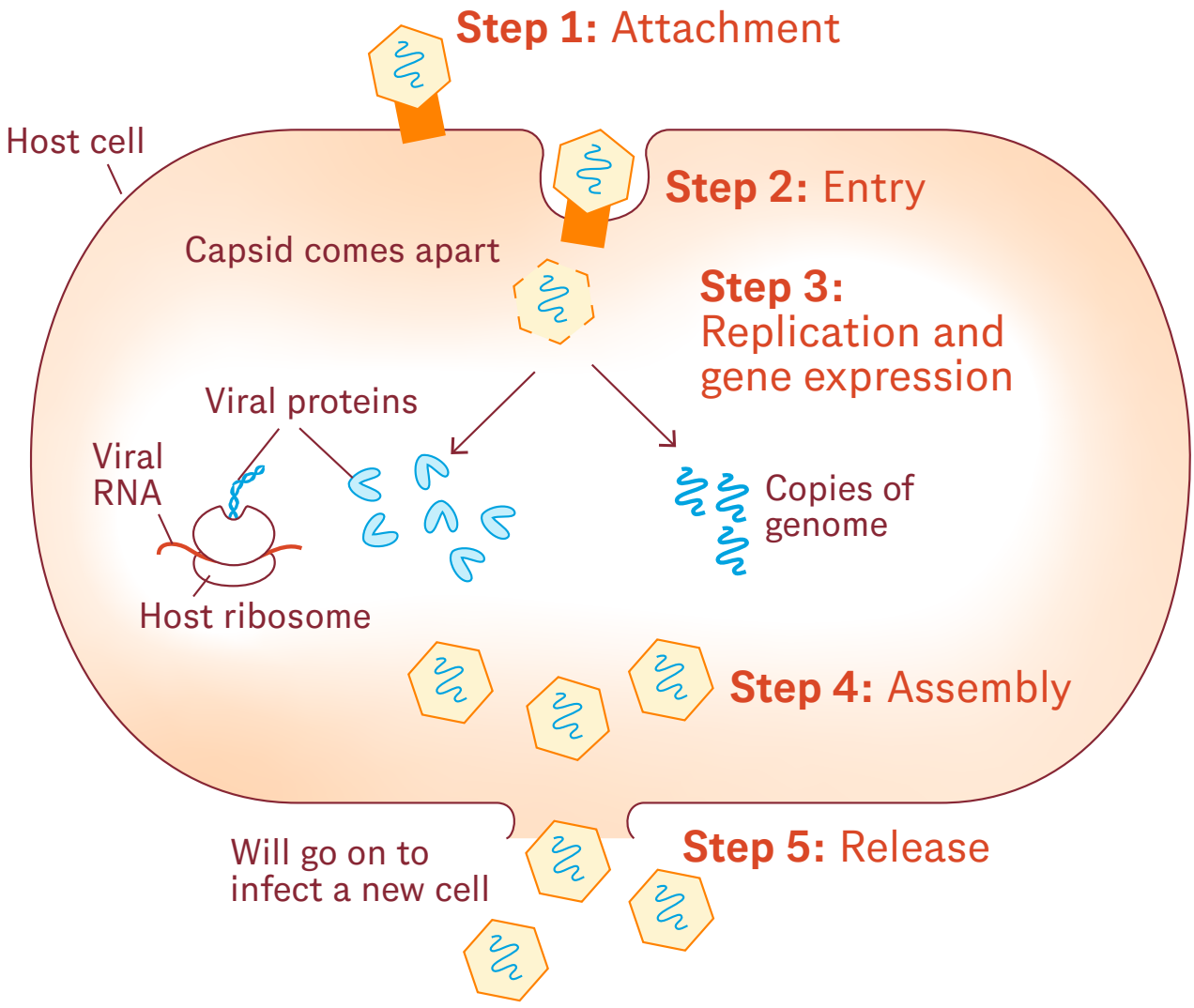
How Do Pathogens Reproduce?

ANSWER KEY **Do not share with students**

Continued

5. Draw a picture of each step beneath its name.

Virus Life Cycle



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How Do Pathogens Reproduce?

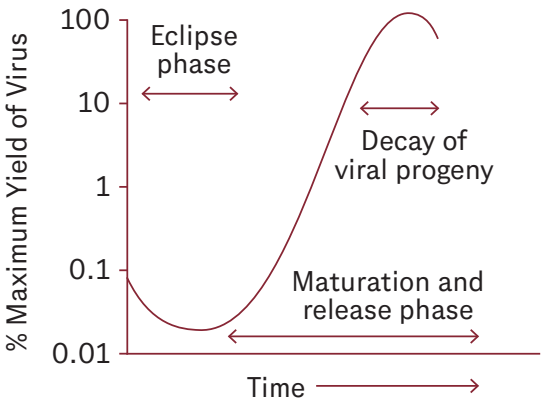
ANSWER KEY **Do not share with students**

Continued

How Viruses Multiply
Visit the site *Multiplication*

6. Refer to the figure and explanation below.

Reproductive Cycle of Viruses Infecting Eukaryotic Cells



The time scale varies for different viruses; it may range from 8 hours (e.g. poliovirus) to more than 72 hours (e.g. cytomegalovirus).

There are common features in the reproductive cycles of all viruses. During the eclipse phase, which can last several hours, the virus infects the cell. During the maturation phase, the viruses begin to use the host's genome and proteins to replicate, causing the virus count to increase. After the maturation phase, the host cells begin to lose their structure and can burst, releasing viruses. Viruses can take from eight hours to more than 72 hours to reproduce. In this time, the number of viruses produced can range from 1000 to 100,000 per cell.

6a. How long does it take for a virus to infect and reproduce in a eukaryotic cell?

8–72 hours

6b. Which reproduces more of itself in a day, a virus or prokaryotic cell? (Hint: This requires math—use a ratio. Use the larger values for the number of viruses and the time of eight hours).

Prokaryotic Cell: 20 minutes = 2 cells
20 minutes x 3 = 60 minutes; 2^3 = 8
So there are 8 bacterial cells created in 1 hour
8^24 = 4.72 x 10^21 cells

Virus: 8 hours = 100,000 viruses

8x4 = 24 hours
100,000 x 4 = 400,000 viruses

A prokaryotic cell reproduces more of itself in a day.

6c. List at least two ways that viral reproduction is different from eukaryotic and prokaryotic cells.

Viral reproduction requires a host cell whereas eukaryotic and prokaryotic cells do not. Viral reproduction takes from 8–72 hours to reproduce, while eukaryotic cells can take up to five days.

6d. What is an antibiotic?

An antibiotic is medicine used to treat a bacterial infection.

Continues next page >

How Do Antivirals Work?

ANSWER KEY — **Do not share with students**

Directions
While watching the video answer the following questions.

1. What is an antiviral?

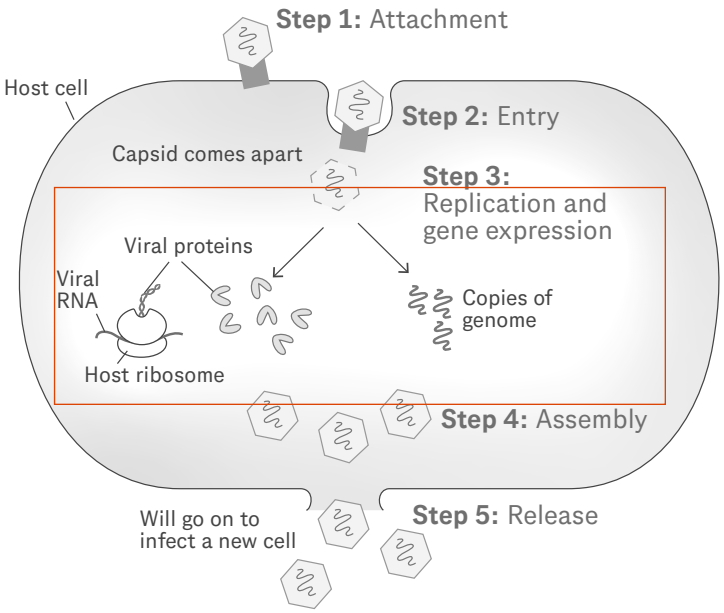
An antivirus is a medicine that treats a viral infection.

2. What is the difference between an antiviral and antibiotic?

Antivirals are used to treat viral infections and antibiotics are used to treat bacterial infections.

3. In the drawing below, place a box around the step(s) that involve virus reproduction.

Virus Life Cycle



4. Based on the process shown in Question 3, why do you think it would be more difficult to create an antiviral? In other words, why are there fewer antivirals compared to antibiotics?

As viruses use the host's machinery to replicate, it is hard to target a specific part of a virus because they are inside of a eukaryotic cell. Doing so may harm the eukaryotic cell at the same time.

5. How would scientists develop an antiviral? (Hint: Think about an antibiotic's mechanism of action from your bacterial disease poster assignment.)

Scientists could develop antivirals based on the structure of a virus or the processes it performs.

6. Why would an antiviral not work on bacteria or vice versa?

Antivirals target a virus and its actions inside eukaryotic cells, which are structurally different from bacteria. Antibiotics target bacteria that perform different actions. In addition, bacteria and viruses are made up of different components.

7. How long have scientists been researching antivirals?

for the past 50 years

Continues next page >

How Do Antivirals Work?

ANSWER KEY **Do not share with students**

Continued

8. Are there more antivirals or antibiotics? Provide supporting evidence.

There are hundreds of antibiotics compared to only about 100 antivirals available on the US market. One of the reasons for this is some viruses are hard to grow in "culture" or in the lab, so research cannot be performed on them.

9. How do antivirals work?

They target different stages in the viral replication cycles.

10. Why are there so few antivirals ?

Viruses have to use the host's cell machinery to replicate. When you inhibit the virus you inhibit the cell, which gives you side effects.
Only a few things you can target with a virus. You have to find functions that are specific for the virus which is difficult because it uses the host cell machinery. Some viruses are also hard to grow in "culture" or in the lab, so research cannot be performed on them.

11. How is the life cycle of a virus related to drug discovery?

The components of the life cycle, such as attachment, can be used as a target for antiviral discovery. Anything the virus uses to be successful can be inhibited in order to stop it.

Antiviral and Antibiotic Review

ANSWER KEY **Do not share with students**

Directions
Place the terms in the box in which they are most related.

Bacteria	Viruses	Binary fission	Host cell
Common cold	Amoxicillin	Antisense	Staphylococcus
HIV	Flu	Nucleosides	E. coli
Many	Few	Cell wall	Attachment
Lytic	20 minutes	8–72 hours	Particle

Antiviral	Antibiotic
Lytic 8–72 hours Antisense HIV Few Viruses Flu Nucleosides Common cold Host Cell Attachment	E.coli Binary Fission Staphylococcus Cell Wall Amoxicillin Many Bacteria 20 minutes

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How Do Pathogens Reproduce?

Directions
You will be researching how pathogens like viruses and bacteria reproduce or increase. You will also be discovering how the cells that make up your body, eukaryotic cells, reproduce.

Eukaryotic Cellular Division
Visit the site *Mitosis: Eukaryotic Cell Division*

1a. Which process occurs when eukaryotic cells reproduce or divide?

1b. What are some examples of eukaryotic cells that divide?

1c. How long does this process take?

1d. Interphase occurs before the cell divides. Describe the process of interphase.

Mitotic Phase
Visit the site *Mitotic Phase: Mitosis and Cytokinesis*

2. List the steps in order. Draw a picture of the event in the space provided.

2a. Step 1

2b. Step 2

Continues next page >

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How Do Pathogens Reproduce?

Continued

2c. Step 3

2d. Step 4

2e. Step 5

2f. Step 6

Continues next page >

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How Do Pathogens Reproduce?

Continued

Prokaryotic Cellular Division
Visit the site *Prokaryote Reproduction*

3a. Which process occurs when prokaryotic cells reproduce or divide?

3b. This is what type of reproduction (circle one):

ASEXUAL

SEXUAL

3c. How long does this process take?

Binary Fission
Visit the site *Binary Fission: Prokaryotic Cell Division*

4. List the steps in order. Draw a picture of each step in the space provided.

4a. Step 1

4b. Step 2

Continues next page >

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How Do Pathogens Reproduce?

Continued

4c. Step 3

4d. Step 4

4e. What is an example of a prokaryotic cell?

4f. Which takes longer to divide—prokaryotic or eukaryotic cells? Why?

Continues next page >

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How Do Pathogens Reproduce?

Continued

Viral Reproduction

Visit the site *Virus: Reproduction*

5. What is the name of the process in which viruses reproduce?

List the steps involved in viral replication and include a picture above the dotted lines.

5a. Step 1

5b. Step 2

5c. Step 3

5d. Step 4

5e. Step 5

Continues next page >

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How Do Pathogens Reproduce?

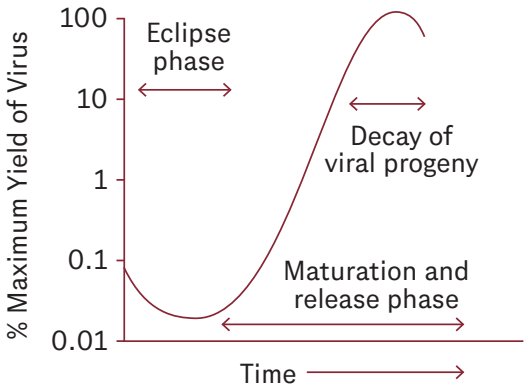
Continued

How Viruses Multiply

Visit the site *Multiplication*

6. Refer to the figure and explanation below.

Reproductive Cycle of Viruses Infecting Eukaryotic Cells



The time scale varies for different viruses; it may range from 8 hours (e.g. poliovirus) to more than 72 hours (e.g. cytomegalovirus).

There are common features in the reproductive cycles of all viruses. During the eclipse phase, which can last several hours, the virus infects the cell. During the maturation phase, the viruses begin to use the host's genome and proteins to replicate, causing the virus count to increase. After the maturation phase, the host cells begin to lose their structure and can burst, releasing viruses. Viruses can take from eight hours to more than 72 hours to reproduce. In this time, the number of viruses produced can range from 1000 to 100,000 per cell.

6a. How long does it take for a virus to infect and reproduce in a eukaryotic cell?

6b. Which reproduces more of itself in a day, a virus or prokaryotic cell? (Hint: This requires math—use a ratio. Use the larger values for the number of viruses and the time of eight hours).

6c. List at least two ways that viral reproduction is different from eukaryotic and prokaryotic cells.

6d. What is an antibiotic?

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Bacterial Infectious Diseases Poster Assignment

Directions

A group of infectious disease specialists have been asked to create posters that will make up an "infectious disease museum". You will be working with a group of students playing roles as infectious disease specialists. Infectious disease specialists are experts on various pathogens that can affect the health of a human, causing disease. Your goal is to locate information based on a specific bacteria that causes disease. Your group will choose one of the bacterial diseases listed below.

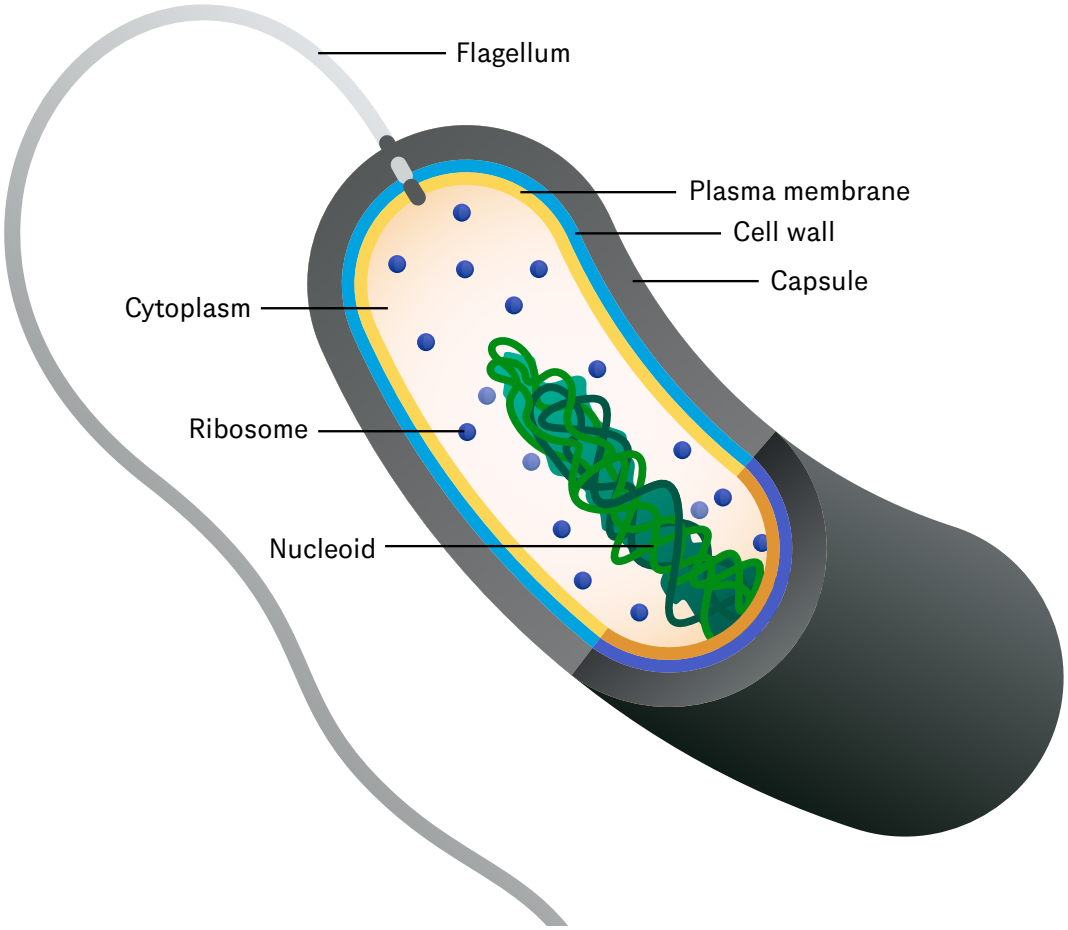
Bacterial Diseases

Cholera	Pertussis
Tuberculosis	Diphtheria
Syphilis	Lyme disease
Leprosy	Gonorrhea
Anthrax	Meningitis

You will be responsible for researching information and creating a poster that includes the following components:

A Name of disease
B Pathogen
C Percent of population affected
D Cause of infection
E Common symptoms
F Treatment
G Specific name of antibiotic
H Mechanism of action
I At least two pictures (one must depict the action of the antibiotic on the bacteria cell)
J A statistic or interesting fact related to your topic
K At least two reputable sources

Mechanism of Action Example



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Bacterial Infectious Diseases Poster Rubric

Score	4	3	2	1
Presentation of Information	The information was thoroughly researched and clearly presented; all members of the group participated.	The information was researched and well presented; all members of the group participated.	The information was researched but not in detail or was not presented in a coherent manner; some of the group members participated.	The information was not well researched and was not presented in a coherent manner; only one or two of the group members participated.
Antibiotic Mechanism of Action	There was a thorough (visuals, steps, etc.) explanation of how the antibiotic affects the bacteria.	There was an explanation of how the antibiotic affects the bacteria, although without aids (visuals, steps) the explanation was lacking.	There was no clear explanation of how the antibiotic affects the bacteria, leaving the viewer with questions.	There was no explanation of how the antibiotic affects the bacteria.
Required Components	All of the required project components are present.	Most of the project components are present.	Only half of the project components are present.	Less than half of the project components are present.
References	The group used more than two reputable sources.	The group used at least two reputable sources.	The group used sources that were not reputable or only had one source.	The group did not use any reputable sources.
Final Score				

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Bacterial Infectious Diseases Poster Reflection

Directions

Using the feedback from the members of your class, write one paragraph (at least five sentences) on what you felt you could have improved on, including what you would change about your project. Also reflect on what you did well and thus would keep the same.

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How Do Antivirals Work?

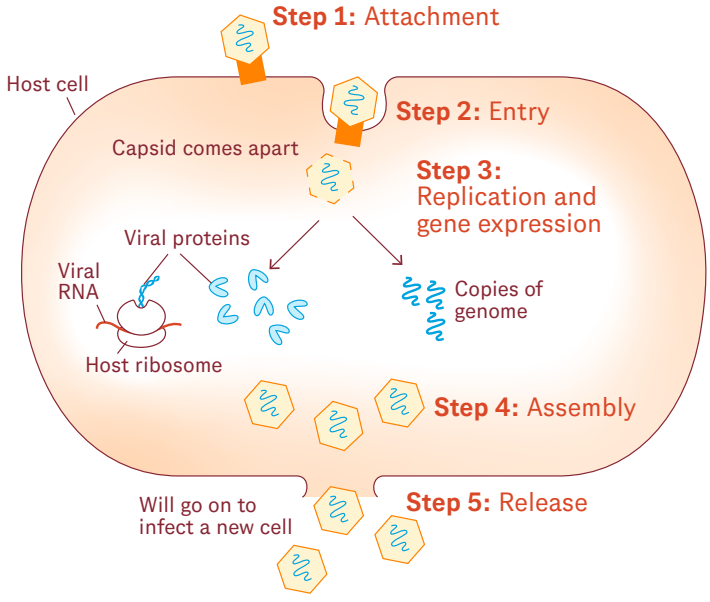
Directions
Complete questions 1–6 during your class discussion.
Answer questions 7–10 while watching the video.

1. What is an antiviral?

2. What is the difference between an antiviral and an antibiotic?

3. In the drawing below, place a box around the step(s) that involve virus reproduction.

Virus Life Cycle



4. Based on the process shown in Question 3, why do you think it would be more difficult to create an antiviral? In other words, why are there fewer antivirals compared to antibiotics?

5. How would scientists develop an antiviral? (Hint: Think about an antibiotic's mechanism of action from your bacterial disease poster assignment.)

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How Do Antivirals Work?

Continued

6. Why would an antiviral not work on bacteria or vice versa?

7. How long have scientists been researching antivirals?

8. Are there more antivirals or antibiotics? Provide supporting evidence.

9. How do antivirals work?

10. Why are there so few antivirals ?

11. How is the life cycle of a virus related to drug discovery?

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Antiviral and Antibiotic Review

Directions
Place the terms in the box in which they are most related.

Bacteria	Viruses	Binary fission	Host cell
Common cold	Amoxicillin	Antisense	Staphylococcus
HIV	Flu	Nucleosides	E. coli
Many	Few	Cell wall	Attachment
Lytic	20 minutes	8–72 hours	Particle

Antiviral	Antibiotic

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Disparities in the Treatment of Infectious Diseases

Directions

You will be playing the role of infectious disease specialists in order to identify the disparities in the treatments of bacterial and viral diseases in certain racial groups.

You will be assigned one of the studies and be asked to:

A Identify the problem
B Graph data (provided in the paper) that provides evidence of the problem
C Identify at least one cause of the problem
D Identify at least two solutions to the problem

Studies

Racial Disparities in Treatment Rates for Chronic Hepatitis C

Racial and Ethnic Disparities in Pneumonia Treatment and Mortality

Racial Differences in Antibiotic Prescribing by Primary Care Pediatricians

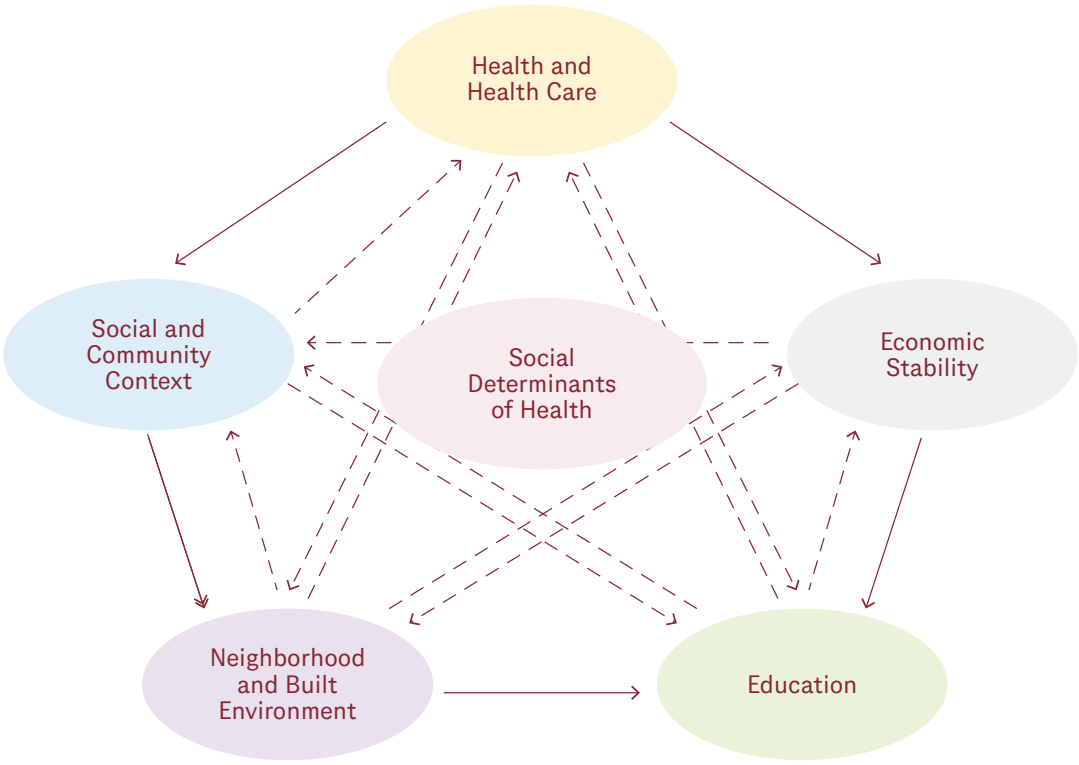
Race, Otitis Media and Antibiotic Selection

Understanding cross-sectional racial, ethnic and gender disparities in antiretroviral use and viral suppression among HIV patients in the United States

Racial/Ethnic Disparities in Antimicrobial Drug Use

Social Determinants of Health

The following image may help you in determining causes and solutions to the problem.



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Disparities in the Treatment of Infectious Diseases Rubric

Score	4	3	2	1
Problem	The group successfully identified the main specific problem from the article.	The group successfully identified a problem, although it was not the main one from the article.	The group identified a problem, but it did not pertain to the article.	The group did not identify the problem.
Graph	A graph is included that can be used as evidence of the problem and includes a title and axes labeled correctly.	A graph is included that can be used as evidence of the problem, but it does not include a title or the axes are not labeled correctly.	A graph is included, but cannot be used as supporting evidence for the problem.	No graph is included.
Cause	The group identified more than one specific cause of the problem.	The group identified one specific cause of the problem.	The group identified a cause, but it was not specific to the problem.	The group did not identify any causes.
Solutions	The group identified more than two specific and realistic solutions to the problem.	The group identified two specific and realistic solutions to the problem.	The group identified solutions, but they were not specific or realistic.	The group did not identify any solutions.
Final Score				

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