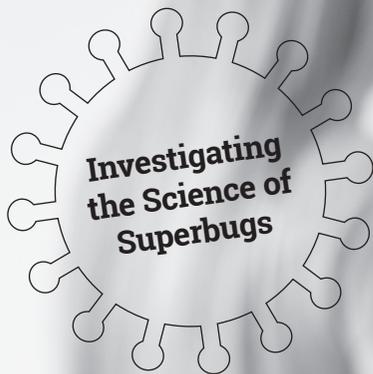


PATHWAYS



Investigating
the Science of
Superbugs



MAGAZINES
& ACTIVITY
SHEETS



TEACHING GUIDE

Science, ELA, and Health Activities About
Drug Resistance in Viruses and Bacteria

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National Institute of
General Medical Sciences

Viral and Bacterial Superbugs



Explore the basics of infectious diseases, then help students investigate why some bacteria and viruses can't be treated with drugs.

Objective

Students will use evidence to develop an explanation for why drugs sometimes fail to cure a disease.

NGSS Standards

MS-LS1-5 Explain how reproduction rates affect microbial evolution

MS-LS3-1 Model how microbes can become drug resistant

MS-LS4-4 Explain heritable traits in organism survival

HS-LS4-4 Use evidence to explain drug resistance and natural selection

Time

Part A: 60 minutes

Part B: 60 minutes

Allow extra time for writing, research, and presentations as needed.

Materials

- ▶ *Pathways* magazine
- ▶ Why Did the Medicine Fail? activity sheet
- ▶ Spread the Word About Superbugs activity sheet
- ▶ Vocabulary list at scholastic.com/pathways

PART A

1 Ask students to raise their hands if they've ever had a cold. Explain that colds are infectious diseases, meaning they can spread from one person to another. Ask: *Can you think of any other infectious diseases?* Record student responses, which could include strep throat, flu, measles, chicken pox, and COVID-19. (They might also include noninfectious diseases such as cancer or heart disease.)

2 Assess prior understanding about the causes and treatment of infectious diseases. Ask: *What do you think caused your cold? How do you think you "caught" it?* Have students work in pairs to discuss what they know so far about how science is used to try to reduce the spread of the diseases you recorded above. **For grades 9–12:** Focus on the differences between viruses and bacteria. Ask: *How does bacterial reproduction compare with viral reproduction? Are viruses "alive"?*

3 Conduct a demonstration (or provide hands-on materials to groups of students). Try to pick up a marble or button with one chopstick. Then spear a piece of clay with the single chopstick and show how you were able to pick it up. Ask students what they observed and concluded. Have them explain how this might relate to the discussion. (Answer: You need the right tool to attach/capture a specific object. It's the same with illness. Medicine targeted to a bacterium won't work on a virus.)

4 Hand out the student magazine (and vocabulary sheet as needed). Lead a discussion about the reasons drugs designed to cure an infection sometimes fail. To connect to other lessons you are teaching, you may wish to discuss:

- structural differences between viruses and bacteria
- how bacteria and viruses change/evolve over time

- natural selection (bacteria and viruses with certain traits are better adapted to survive and reproduce)

5 Discuss antibiotic and antiviral drug specificity in curing infections. Challenge students to consider how a prescribed drug might be inappropriate for a disease. Have students take their best guess at why antibiotics are ineffective against viruses, and why it's important to follow your doctor's instructions for taking an antibiotic even if you are feeling better before the medicine runs out.

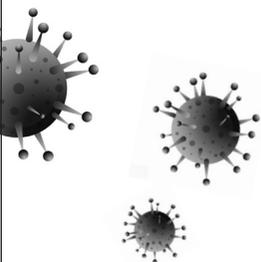
6 Hand out the Why Did the Medicine Fail? activity sheet. Answers:

- Q1)** Antibiotics are ineffective against viruses. Drugs have specificity.
- Q2)** Taking the medicine for the right number of days reduces the chance that some pathogens will survive and reproduce with mutations that resist the medicine. Then it could spread to new people, and the medicine won't work.
- Q3)** Tyler's medicine wasn't specific to his illness (e.g., antibiotics don't work on viruses) or his pathogen was already drug resistant. When Natasha stopped taking her medicine, only some of the population of the pathogen had been killed. What was left reproduced in her body and made her sick again.
- Q4)** People may die in larger numbers of diseases that hadn't been that deadly when medicines worked against them.

PART B

7 Hand out the Spread the Word About Superbugs activity sheet. Students will create a presentation to educate the public. They can choose their format (op-ed, poster, slides; see activity sheet).

To level down: Pair up students and assign a science concept to help narrow the focus.



Name _____

Why Did the Medicine Fail?

Read about two teens who got sick and went to see their doctors. Then come up with a hypothesis for what might have happened.



Scenario 1 Tyler woke up with stomach cramps and felt like he might throw up. He shuffled into the kitchen and told his mom he was sick. At first she was skeptical, and asked if maybe he was just nervous about his big math test that day. But when she took his temperature and saw he had a high fever, she took him to an urgent-care clinic. A doctor examined him and prescribed a five-day course of antibiotics. After five days, Tyler still felt terrible.

Scenario 2 Natasha had a scratchy throat and a headache for three days. She didn't want to tell anyone because she had a big track meet coming up. She attended practices and ran her race. The next day she felt worse than ever: Her throat felt like it was on fire and her head was pounding. Her doctor checked her out and gave her an antibiotic to take for five days. After two days of taking the medication, Natasha felt great and stopped taking the medicine. But five days later her symptoms came back.

1. Why is it important for a doctor to determine the type of pathogen (or type of germ) causing the symptoms before writing a prescription?

2. If someone is prescribed a medication, why is it important to take the medication for the number of days your doctor instructs?

3. Develop a hypothesis about why each of the scenarios above ended the way they did. Use your understanding about viruses, bacteria, and drug resistance to defend your conclusion.

4. What might happen in the coming years if people don't take action to stop the spread of drug-resistant germs?

Name _____

Spread the Word About Superbugs

Educate the public—other students, your family, or your community—about bacteria and viruses that can't be treated with drugs by creating an informational presentation.

STEP 1

CHOOSE Your Presentation Type

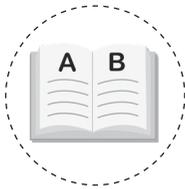
Pick from this list or make up your own (then clear it with your teacher).



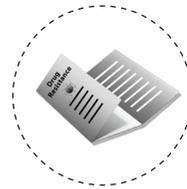
Write an **op-ed** for the school newspaper



Prepare a **poster** or **slide presentation** for the local library or PTA



Write a **children's book** for primary-grade students



Create a **graphic pamphlet** to distribute at school



Produce a **podcast** or **webpage** and include an interview with a doctor

STEP 2

PLAN Your Presentation Structure

On a separate sheet or document, organize what you will include in each section.

1 Hook Grab the audience's attention with a question or anecdote. Make sure your tone is appropriate for your audience (little kids, classmates, adults, etc.).

2 Problem Explain why some bacteria and viruses can't be treated with drugs and why this is a problem. Decide which concepts are important to present and how you will explain them. What vocabulary and level of detail will help your audience?

- Definition of infectious diseases
- Causes of infectious diseases
- Differences between viruses and bacteria
- How antibiotics and antiviral drugs work
- Specificity of medications
- How use of the drugs may cause resistance (mutation, natural selection)
- Molecular basis of drug resistance

3 Call to Action Your presentation should persuade your audience to take action, so make sure you explain clearly what steps they can take to tackle the problem.

