

Module: Science

Lesson Title: Antibiotic Resistance

Objectives and Standards

Students will:

- Recognize and understand basic concepts of antibiotics and resistance
- Compare and contrast two sides of an argument
- Identify and summarize the major ideas in an argumentative writing
- Define vocabulary terms such as antibiotics, resistance, bacteria, virus
- Identify the cause and effect of overuse of antibiotics

Prerequisite Skills Common Core State Standards	Science Content Area 2014 GED® Assessment Targets	Science Practices 2014 GED® Assessment Targets
Read and comprehend science/technical texts in the grades 6–8 text complexity band independently and proficiently. (CCSS.ELA-Literacy.RST.6-8.10)	Life Science: Human Body and Health Transmission of disease and pathogens, the effects of disease or pathogens on populations, and disease prevention methods	Comprehending Scientific Presentations (SP.1) Reasoning from Data (SP.3) Evaluating Conclusions with Evidence (SP.4)

Materials

- Computer, lcd projector, and speakers
- Internet access or download of video
- Chart paper and markers
- **Handout A: Antibiotics – Fact or Fiction?**
- **Handout B: Antibiotics: Understanding the Pros and Cons**
- **Handout C: Pros and Cons**
- **Handout D: Instructional Notes**
- **Handout E: Antibiotics – Fact of Fiction? Answers**
- **Handout F: 3-2-1 Chart**

Instructional Plan

Overview

In this lesson, students will become familiar with the use of antibiotics and the rise of antibiotic resistance. Students will determine both pros and cons of antibiotics, as well as learning about basic concepts identified in the thematic area of health and human systems.

Process

Begin the lesson by asking students if they have ever had an infection that required that they take an antibiotic. Have students share their experiences or the experiences of someone they know who has taken antibiotics.

Have students take a short quiz about antibiotics. Share with students that this quiz will not be scored, but will be used at the end of the lesson to recap the important health issue of antibiotics and antibiotic resistance. Provide each student with a copy of **Handout A: Antibiotics – Fact of Fiction?** and have them complete the quiz. Tell students to keep their quiz as they will review their answers at the end of the lesson.

Write the word **antibiotic** on the board. Under the word, write:

Anti – against

Biotic – living things

Tell students that the literal translation of antibiotics is something that is against living things. Explain that antibiotics are powerful medicines that fight infection or living things.

Tell students that in today’s lesson they are going to learn about how antibiotics work to kill bacteria, and how bacteria are fighting back and becoming resistant to the antibiotics. Have students watch the TED-Ed video on *Bacteria and Antibiotics*. The video can be watched online or downloaded from TED-ED at:

<http://ed.ted.com/lessons/how-antibiotics-become-resistant-over-time-kevin-wu>

Debrief the video by having students identify and share the central ideas of the film by identifying the *who*, *what*, *when*, *why*, *where*, and *how* of the video. From the 5Ws and H, have students draft a summary sentence. You may wish to have the students write their sentences on chart paper. Have students share their sentences with the class. Provide additional information or clarification as needed.

Ask students if there were any terms that were difficult to understand. Write the words on the board or chart paper and provide definitions throughout the lesson as appropriate. If words are not defined by the end of the lesson, have students research those definitions and share them with the class.

Provide students with an overview of antibiotics, what they treat and do not treat, antibiotic resistance, and effective health practices. Ensure that students have the “big” ideas before proceeding to the next activity. Information to cover should include the ideas from **Handout D: Instructional Notes**. This handout is for use as an instructor.

For additional information on antibiotics and antibiotic resistance, you may wish to access the Internet and visit the following websites:

- Antibiotic Resistance. Center for Disease Control
<http://www.cdc.gov/drugresistance/>
- Combatting Antibiotic Resistance. U.S. Food and Drug Administration
<http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm092810.htm>
- Antibiotics – An Overview. Khan Academy
<https://www.khanacademy.org/science/health-and-medicine/current-issues-in-health-and-medicine/Antibiotics-and-antibiotic-resistance/a/antibiotics-an-overview>

- What Is Antibiotic Resistance? Khan Academy
<https://www.khanacademy.org/science/health-and-medicine/current-issues-in-health-and-medicine/Antibiotics-and-antibiotic-resistance/a/what-is-antibiotic-resistance>
- Antibiotics. e-Bug. Public Health England's (PHE) Primary Care Unit.
http://www.e-bug.eu/eng_home.aspx?cc=eng&ss=1&t=Welcome%20to%20e-Bug

Explain that the use of antibiotics has both pros and cons. Provide each student with a copy of **Handout B: Antibiotics: Understanding the Pros and Cons**, an article on the pros and cons of using antibiotics for health issues, such as colds and respiratory infections.

To begin, ask students whether or not Dr. Cara Natterson is a qualified writer for this type of article. Have students research Dr. Natterson using their smart phones and share her expertise and background (graduate of Harvard and John Hopkins Universities, board certified physician, published author, etc.). Explain that when reading science articles, students should be knowledgeable about the authors and whether or not they have the expertise in the area being discussed.

Have students interact with the text while they are reading. Tell students that when reading, they should underline evidence from the pro side and circle evidence from the con side of the argument.

When students have completed their reading, provide each student with a copy of **Handout C: Pros and Cons**. Have students complete the chart, as well as determining which side they feel is better supported and why. Share with students that there are always two sides of an argument. The important thing is that each side should provide explicit and valid evidence.

After students have completed their charts, have a debate. Divide the class into small groups of 3-4 students, based on whether they support or do not support the use of prescription antibiotics. If the class took only one side of the argument, you will want to assign either the pro or con side to each group to ensure equal representation. Tell each group that their task is to construct an argument for or against the prescribing of antibiotics. Explain that they should develop a one minute persuasive speech in which they set the claim, for or against, and support their claim with evidence from the article. Each team should identify who will present their side of the argument. After each debate, have the class decide who was most effective and why. Reinforce the need for the speakers to provide explicit evidence from the article.

Have students retake the quiz **Handout A: Antibiotics – Truth or Fiction?** Debrief the quiz by have students support their answers. Discuss additional information as needed from the **Handout D: Antibiotics – Truth or Fiction? Answers**, as well as any additional questions from the class.

Have students identify one important thing that they learned from the lesson and one thing that they wish to know more about.

Sample Debriefing Questions

- What are antibiotics?
- Should you take antibiotics for a cold or flu? Why or why not?
- Why do antibiotics only work for a limited time?
- Why should you finish your course of antibiotics?
- What are reasons for taking or not taking antibiotics?

- What is antibiotic resistance?
- According to the experts, what is causing antibiotic resistance?

Assessments/Extensions

1. Provide students with real-world scenarios and ask for them to predict what they think may happen and why. Example: Predict what you think will happen if a person takes the same antibiotic six times in one year. Provide evidence for your answer.
2. Have students research a current issue regarding the use of antibiotics and antibiotic resistance. Have students write a short overview of the problem and what is currently being done to tackle the problem. Make sure that students provide the resources that they used. Have students share their findings with the class. Example: Due to media attention, MRSA is one of the most commonly known antibiotic resistant bacteria. What is being done in hospitals to tackle this problem?
3. Provide students with the article **Combatting Antibiotic Resistance** from the Food and Drug Administration: Consumer Health Information.
<http://www.fda.gov/downloads/ForConsumers/ConsumerUpdates/UCM143470.pdf>.

Have the students complete a 3-2-1 chart for the article. A sample copy of this graphic organizer is located in **Handout F: 3-2-1 Chart**.

Handout A: Antibiotics – Fact or Fiction?

Read each of the following statements and determine whether it is true or false.

T F 1. Antibiotics can kill viruses.

T F 2. You don't need to finish a course of antibiotics if you are feeling better.

T F 3. Left over antibiotics can be saved for use at a later date.

T F 4. You should not share antibiotics.

T F 5. Taking antibiotics weakens your immune system.

T F 6. Healthy people carry antibiotic resistant bacteria.

T F 7. Antibiotic use in hospitals is causing most of the antibiotic resistance seen today.

T F 8. Washing my hands helps to reduce antibiotic resistance.

e-Bug. Public Health England's (PHE) Primary Care Unit.

http://www.e-bug.eu/young_teacher_pack.aspx?cc=eng&ss=1&t=young%20teacher%20lesson%20pack

Handout B: Antibiotics: Understanding the Pros and Cons, Dr. Cara Natterson

Our country likes to split into teams over just about everything--from the broad swaths of political beliefs and religion to the narrowest minutiae of our favorite athletes. On the topic of medicine, the divisions are no less plentiful. Some prefer Western medicine and others Eastern; some are pro-vaccine and others anti; some are antibiotic enthusiasts and some are medication refusers. Ultimately, these beliefs guide what people put (and don't put) into their bodies.

Next week begins "Get Smart About Antibiotics Week," a three year old invention of the Centers for Disease Control. The goal, simply, is to educate people. You see, when it comes to medical notions, it's not okay just to pick a side. If you hail antibiotics as silver bullets or if you categorically reject them, neither approach is exactly right--or healthy. How did we wind up with such strong emotions about medication?

The antibiotic over-enthusiasts came by it honestly. When I was young, just after oral penicillin had become widely available, a pink, bubble gum flavored version 2.0 arrived in the form of amoxicillin. Most of us in our 30s, 40s and 50s can vividly remember the taste of that perfectly sweet, slightly chalky liquid going down. It seemed like whenever there was a sore throat or the slightest runny nose in our house, amoxicillin rushed to the rescue.

Apparently, I wasn't alone. Antibiotic enthusiasm was in full swing through the 1970s and 80s. Doctors admittedly overused the drugs and, as newer more potent variations were developed, they overused those too. We are seeing the repercussions today in the form of antibiotic resistance. It turns out that these drugs aren't magic bullets at all: when you have a common cold you are infected with a virus--not a bacteria--and as a result antibiotics have no benefit.

Though antibiotics do wipe out certain bacterial infections--like the bugs that cause sinusitis, pneumonia, urinary tract infections, and other ailments--whatever doesn't kill you does make you stronger and this goes for bacteria too. So when a patient is given an antibiotic, a series of things must go right: the infection needs to be susceptible to antibiotics, the doctor has to prescribe the right drug at the right dose, the patient has to take the entire course (which usually goes well beyond when he feels better), and all of the targeted bacteria must die. If one of these steps is missed, the bacteria residing in your body can build resistance to the very antibiotic you are taking. So much for over-enthusiasm.

The antibiotic rejecters generally understand the concepts of inappropriate antibiotic use and resistance, but their rationale isn't completely right either. This group will do anything possible to avoid the use of antibiotics. They will stay home from school or skip work in order to rest and hydrate and heal. These are terrific solutions, don't get me wrong, because the very act of staying put limits the spread of the infection. But the majority of antibiotic-rejecters will also pump themselves full of over-the-counter drugs, vitamins, supplements or herbs that promise non-pharmaceutical-grade remedies.

The problem here is that over-the-counter medicines are exactly that: medicines, just sold without a prescription. And because you can buy these straight off the shelf (the label usually replete with medicinal looking flowers or claims of "organic" or "natural" healing powers), consumers believe they are less dangerous. But it's actually the reverse that is true. Over-the-counter medicines are not subject to the rigorous testing that prescription drugs are--there is no agency assigned to make sure that your

therapeutic concoction really includes what is promised. Add to this that no one is studying the safety of its "all natural" ingredients. It actually takes consumer advocacy groups and vigilant individuals to identify the problems in vitamins, nutritional supplements, and other over-the-counter cures.

Antibiotic refusers also run the risk of rejecting the one treatment that can make them better. In many cases, the body gets through an illness and all ends well. But not infrequently enough, the bacteria organize a coup in the body and they take over. Infections that go untreated can cause grave illness, sometimes even death. If you need an antibiotic, refusing to take one can be life-threatening.

So in the end, neither group is right, and neither group is wrong. When we get sick, we should absolutely take good care of ourselves. That includes vigilant hand washing and pulling ourselves out of circulation so that we don't spread our illness to others. But we also need to rely upon the help of our doctors rather than using a self-diagnosis to demand or refuse particular treatment. Next week, educate yourself a-la CDC and learn a bit more about why and how particular antibiotics really work.

http://www.huffingtonpost.com/dr-cara-natterson/antibiotic-drugs_b_784324.html

Handout C: Pros and Cons

Pros (Evidence that Supports Use of Antibiotics)	Cons (Evidence that Opposes Use of Antibiotics)

Which side do you think is best supported? Defend your decision.

Handout D: Instructional Notes

Antibiotics are drugs used for treating infections caused by bacteria. For example, they are used to treat strep throat, which is caused by streptococcal bacteria, and skin infections caused by staphylococcal bacteria, meningitis, and pneumonia.

Antibiotics are either bactericidal, meaning they kill the bacteria, or they are bacteriostatic, meaning they slow the growth of bacteria. Penicillin is an example of a bactericidal antibiotic.

Although antibiotics kill bacteria, they are not effective against viruses. Therefore, they will not be effective against viral infections such as colds, most coughs, many types of sore throat, and influenza (flu).

Using antibiotics against viral infections

- will not cure the infection
- will not keep other individuals from catching the virus
- will not help a person feel better
- may cause unnecessary, harmful side effects
- may contribute to the development of antibiotic-resistant bacteria

Bacteria are continually adapting to develop ways of not being killed by antibiotics. Misuse and overuse of these drugs can contribute to a phenomenon known as antibiotic resistance. The more a person takes antibiotics, the more likely a person is to develop antibiotic resistance bacteria in one's body. Antibiotic resistance is a growing problem.

Antibiotic resistant bacteria can be carried by healthy or ill people and can spread to others just as other types of microbes would, for example by shaking hands or touching all types of surfaces on animals, vegetables or food where bacteria are present. That is why it is so important to wash one's hands and to make sure that care is taken in food storage and preparation.

To prevent resistance, antibiotics should only be taken as prescribed by a doctor or nurse. Important points to remember are:

1. Antibiotics do not need to be taken for colds and flu or most coughs, sore throats, ear infections or sinusitis as these usually get better on their own.
2. It is important to take the antibiotic exactly as instructed and complete the course of antibiotics, to decrease the risk of emergence of resistance.
3. Antibiotics are personal and prescribed for individuals and for a particular infection. They should not be shared or taken for a different illness.

Useful Vocabulary

- **Bacteria:** Microscopic, single-celled organisms that are found in the environment all around us, as well as inside and outside of us. Most bacteria are harmless to humans, but some can cause serious illnesses. A bacterial infection can contain billions of bacteria where not all of the bacteria are genetically the same, and some can be more resistant to a certain antibiotic than others.
- **Antibiotics:** The primary treatment for fighting bacterial infections. Different antibiotics have different mechanisms of acting on bacteria, but they fall into two general groups: those that kill bacteria, and those that prevent them from replicating.
- **Antibiotic course:** The number of days (and doses) that a certain antibiotic should be taken to fight an infection, as prescribed by a doctor or nurse practitioner. Antibiotic courses can vary from a few days to weeks, depending on the antibiotic and the type of infection.
- **Antibiotic resistance:** Many antibiotics have lost effectiveness because the bacteria they target have evolved (changed genetically) so that the mechanisms an antibiotic uses to attack the bacteria are no longer successful. Antibiotic-resistant bacteria, also called *superbugs*, can be created and multiplied by misusing antibiotics.
- **Virus:** A tiny organism or parasite that can infect any animal, plant, or bacteria and often lead to very serious or even deadly diseases. This may include flu or a cold to something more life threatening like HIV/AIDS.

Handout E: Antibiotics – Fact or Fiction? Answers

1. Antibiotics can kill viruses – False

Antibiotics can only be used to treat bacterial infections due to the different structures of bacteria and viruses. Antibiotics work by targeting specific parts of the bacteria, e.g. the cell wall, or only parts of the ribosome that are found in bacteria, and therefore are only effective against bacterial infections.

2. You don't need to finish a course of antibiotics if you are feeling better – False

Taking an antibiotic incorrectly increases the risk of the bacteria in your body developing antibiotic resistance. If you do not complete the course the infection may also not be completely killed. You should always take antibiotics as instructed by the nurse or doctor and ensure you complete the course. Not taking the correct dose (one or two capsules a day instead of three) means you get less antibiotic in the area of the infection. These lower concentrations can encourage the multiplication of resistant strains.

3. Left over antibiotics can be saved for use at a later date – False

You should not have any leftover antibiotics if you complete the course as prescribed, however if you do, take the unwanted antibiotics to a pharmacy to be disposed of safely.

4. You should not share antibiotics – True

Each antibiotic that is prescribed is personal to you and specific to your type of infection. Therefore antibiotics taken for one infection, will probably not work for another.

5. Taking antibiotics weakens your immune system – False

Most antibiotics do not negatively affect your immune system, so do not reduce your ability to fight off future infections. Antibiotics are designed to target bacteria, by directly killing them or slowing their growth. The body does not become resistant to antibiotics. It is the bacteria that become resistant through genetic mutations.

6. Healthy people carry antibiotic resistant bacteria – True

Antibiotic resistant bacteria can be carried by healthy or ill people. Antibiotic resistant bacteria can be passed on easily to others through contact (sneezes and coughs), everything we touch or even our poo! It is everyone's responsibility to help control antibiotic resistance.

7. Antibiotic use in hospitals is causing most of the antibiotic resistance seen today – False

Hospitals are not responsible for the high antibiotic use in humans. In 2013, 79% of all antibiotics consumed were prescribed in the community, by your GP. Only 15% were prescribed by hospitals, with 6% from other community prescribers such as dentists.

8. Washing my hands helps to reduce antibiotic resistance – True

Hand washing is the most important thing we can do to prevent the spread of infection. Antibiotic resistant bacteria can spread from person to person just as any other type of bacteria would. This includes through skin to skin contact and by touching surfaces where bacteria are present.

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Handout F: 3-2-1 Chart

Title of Article: _____

Source: _____

3 things you discovered

2 interesting things

1 question you still have