University at Buffalo
Genome, Environment and Microbiome
Community of Excellence

STAGE 1 – DESIRED RESULTS

Lesson Title: Alex's Antibiotics Demonstration

Grade: middle/high school

Time: 30-40 minutes

Overview: This interactive activity involves hands-on manipulatives to demonstrate how antibiotics work and how they affect us. Students will learn that antibiotics have specific targets to fight bacterial infections and therefore do not work on viruses. Students will also learn that antibiotics can adversely affect the healthy human microbiome through the removal of good bacteria. Through this demonstration, students will discover important information regarding antibiotic use (continue taking antibiotics as prescribed, avoid antibiotics if you have a cold, etc.).

Learning Goals/Understandings:

NYS Science Core Curriculum (Grades 5-8):
7.1c In all environments, organisms interact with one another in many ways. Relationships among organisms may be competitive, harmful, or beneficial. Some species have adapted to be dependent upon each other with the result that neither could survive without the other.

Middle School Life Science Next Generation Science Standards (NGSS):
Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)

Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural and designed structures/systems can be analyzed to determine how they function. (MS-LS1-2)

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)

Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena. (MS-LS3-1),(MS-LS3-2)

NYS Living Environment Standards:

Key Idea 7: Human decisions and activities have had a profound impact on the physical and living environment.

High School Life Science Next Generation Science Standards (NGSS):

Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5), (HS-LS1-7)

Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline-and sometimes the extinction-of some species (HS-LS4-5)

Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena (HS-LS4-1), (HS-LS4-3)

Essential Questions:

-How do antibiotics affect us?

- How do antibiotics affect our microbiomes?
- How do antibiotics work when we have a bacterial infection or cold and why?

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Students will know:	Students will be able to:
• Antibiotics have specific targets to effectively fight a bacterial infection. • Why antibiotics are ineffective against viruses. • How antibiotics can be harmful to the healthy microbiome.	• Ask and answer questions. • Engage in discussions with peers and teacher. • Participate in demonstration.

STAGE 2 – ASSESSMENT EVIDENCE

Students' understanding will be assessed based on the following:

- Participation during demonstration
- True/false line questions

STAGE 3 – LEARNING PLAN

Summary of Learning Activities:

1) Before beginning a demonstration, have the balls separated into bowls for ease of use.
2) Introduce "Alex." Ask if anyone knows why his name is Alex. (Because Alexander Fleming was the first person to isolate an antibiotic, penicillin.) Engage in an informal discussion with students to gauge their prior knowledge about antibiotics (For a more formal discussion, students can fill out the "K" and "W" sections of the KWL chart, which can then be revisited at the end of the lesson).
3) Lay out the papers with the pictures of representative bad bacteria and the antibiotic. Explain that is what they represent.
    a. Have a volunteer dump the yellow balls, with red Velcro, into Alex. Tell students that these bad bacteria have now given Alex strep throat. Ask, "What do we do when we have strep throat?" (Go to the doctor and s/he will give antibiotics, after a throat culture to confirm strep.)
    b. Choose a volunteer to simulate the antibiotic. Ask, "What is on the antibiotic?" (Velcro) and "What is on the bacteria?" (Velcro) "So, what will happen when you put the antibiotic in Alex?" (The bacteria will stick to the antibiotic because they have a specific target.)

   c. Have the volunteer put the antibiotic into Alex, swish it around and pull it out. Point out that it was successful in removing bacteria, because of the Velcro target.
   d. Ask, "Is Alex cured yet? Should he stop taking the antibiotic? He is starting to feel better." (No, because there are still bacteria in him.)
   e. The volunteer, or a new volunteer, should continue putting the antibiotic into Alex to clear the infection. This demonstrates why it is important to take all of the antibiotics prescribed.

4) Remove the reference paper with the bad bacteria, and introduce the virus paper.
   a. Ask a volunteer to dump the viruses into Alex. These represent viruses that give Alex a cold. Ask "What are the viruses missing that the strep throat bacteria have?" (Velcro) "So, will the antibiotic work to clear the viral cold infection?" (No, because they do not have the targets.)
   b. Have a volunteer put the antibiotic in, swish it around, and pull it out. Ask "What did they remove?" (Nothing) Ask why. (Because the viruses do not have Velcro, so they don't stick to the antibiotic.)
   c. Ask students "How do we get rid of a cold?" (Rest, fluids, chicken noodle soup) Remove the balls by hand while explaining that those actions, along with our immune system, clear a cold.
5) For older audiences, remove the virus paper and introduce the paper with the microbiome.
   a. Put the microbiome balls into Alex. Ask what they notice about these balls, keeping in mind what they just learned about bacteria and viruses. (Some of the microbiome balls have Velcro.) Ask students "What does that mean?" (The antibiotics will remove them.)
   b. Give Alex a strep infection, by adding the "bad" bacteria balls. Ask what will happen when he takes an antibiotic. (The antibiotic will remove strep, but it will also remove good bacteria).
   c. Have a volunteer put in the antibiotic, swish, and remove. Ask "What comes out?" (both bad and good bacteria)
   d. Tell students that this is why it is a good idea to eat yogurt and take probiotics when you are taking antibiotics. It replenishes the good bacteria that the antibiotics remove.

6) Introduce the virus paper again.
   a. Leave the microbiome balls in Alex and add the viruses. Tell students that Alex now has a cold. Ask them, "Should he take an antibiotic?" (No) "Why?" (It will remove his good bacteria) "Will it help get rid of his cold viruses?" (No, it will only do damage to his good microbiome.)

b. Have a volunteer put the antibiotic in Alex and see what comes out. (good bacteria)
c. Drive home the point that antibiotics do harm to your good microbiome. This is why some people have upset stomachs or diarrhea when they take antibiotics. So, it is OK to take them for a bacterial infection because you have to get rid of it, but not for a viral infection, because they do no good, only harm.

7) Extension: If you are feeling confident and your audience has questions, you may add some fungi (yeast) to the microbiome, and demonstrate how taking an antibiotic depletes the bacteria in the microbiome, leaving room for the yeast to flourish. Hence, some people experience a yeast infection when on antibiotics.
8) Closure: True or False Line questions – Have students stand in a line. Read the statements below. Students step one step forward if they think the statement is true and one step back if they think the statement is false. Call on a student in the line to give a rationale and ask other students to add to previous students' comments.
   - You should stop taking an antibiotic once you start to feel better. (False, you should take antibiotics until you complete the full course to prevent antibiotic resistance).
   - Antibiotics kill good and bad bacteria. (True. Discuss with students how killing good bacteria affects the microbiome).
   - If you are sick with a cold, you should get rest, drink plenty of fluids, eat chicken noodle soup, and take antibiotics. (False. All are good actions except taking an antibiotic. A cold is caused by a virus, and antibiotics do not kill viruses).
   - You should eat yogurt and other probiotics when taking antibiotics. (True. It replenishes the good bacteria. Make sure students know what probiotics are – good bacteria).

Materials:

- Different color ping pong balls, with Velcro pieces glued on to the ones representing bacteria and paint stirrer, with Velcro to represent the antibiotic. Yellow balls with Velcro (bad bacteria), pink balls some with velcro (good bacteria)
- Bowls, to hold the different balls
- Printouts of the colored balls and paint stirrer and what each represents: bad bacteria, good bacteria, viruses, and antibiotic