Take as Directed

Antibiotic Resistance Simulation

Introduction

A scratchy throat, an earache or a cut that won't heal—all could be signs of a bacterial infection. Antibiotics are prescribed to reduce the length and severity of infections. Antibiotics taken on time and finished completely are very effective. Study the effects of antibiotics on bacterial populations.

Concepts

- Antibiotic treatment
- Bacteria
- Antibiotic resistance

Materials

Bingo chips, red, 20
Bingo chips, blue, 15
Bingo chips, yellow, 15
Colored pencils
Die

Safety Precautions

The materials used in this activity are considered nonhazardous. Please follow all laboratory safety guidelines.

Procedure

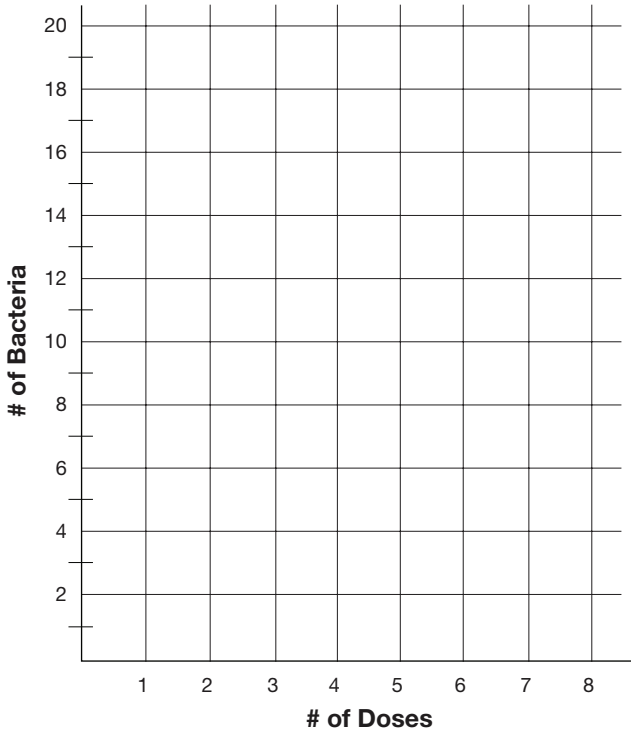
1. Obtain 20 red bingo chips, 15 blue bingo chips, 15 yellow bingo chips, and one die. Place 13 red, 6 blue, and 1 yellow bingo chip on the work surface in front of you and your partner. These chips represent harmful bacteria found in a patient's body before beginning antibiotic treatment. Set aside the remaining bingo chips.
2. It is time to take the first dose of antibiotics. Roll the die and follow the key below.

Number Tossed	Event	Results
2, 3, 4 or 5	Antibiotic was taken at appropriate time—bacteria killed	Remove 5 disks in the following order: remove red bingo chips first, followed by blue and then yellow as needed.
1 or 6	Antibiotic was not taken at the appropriate time.	Do not remove any bingo chips.

3. Record the number of each remaining type of bacteria in the table on the next page.
4. Bacteria are constantly reproducing in the host; in this case the host is the patient's body. If one or more bacteria of a particular type (color) are still present in the patient's body after the first dose (step 2), add one chip of that color to the population. *Example:* If the patient still has blue and red bacteria present, add one blue and one red chip to the population.
5. Repeat steps 2–4 at least eight times (or until all bacteria have been eliminated) to complete the table.
6. Using the data from the table, construct a graph displaying the number of each type of bacteria versus the number of doses. Use different color pencils to plot the following data: total number of bacteria, least resistant bacteria, medium resistant bacteria, and most resistant bacteria. Connect each set of data points by drawing a colored line.

Publication No. 11236
100917

		Bacterial Population			
Dose No.	**No. Rolled**	**Low Resistance (Red)**	**Medium Resistance (Blue)**	**High Resistance (Yellow)**	**TOTAL**
INITIAL	N/A	13	6	1	20
1					
2					
3					
4					
5					
6					
7					
8					



Analysis Questions

1. The different colors represent variations in bacterial resistance to antibiotics. What caused these variations to appear originally?

2. Not all bacteria survive and reproduce. What is the source of the selective pressure that is preventing some bacteria from reproducing?

3. Some bacteria have greater fitness than others. Why do some bacteria have greater fitness in this simulation?

4. Offspring carry the traits of the survivors of the generation they came from (e.g. generation 8 looks like survivors of 7, 7 looks like 6, etc.). Why do offspring look most like the survivors?

5. Bacterial populations do 1 of 2 things: develop an adaptation, or are eradicated. Describe what happened to your population, and explain why.

6. Imagine conditions changed and no antibiotics were used. Would these bacteria have greater fitness if no antibiotics were being used? Explain why or why not.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
- MS-LS1 From Molecules to Organisms: Structures and Processes
  - LS1.A: Structure and Function
- MS-LS2 Ecosystems: Interactions, Energy, and Dynamics
  - LS2.A: Interdependent Relationships in Ecosystems

Disciplinary Core Ideas: High School
- HS-LS1 From Molecules to Organisms: Structures and Processes
  - LS1.A: Structure and Function
- HS-LS2 Ecosystems: Interactions, Energy, and Dynamics
  - LS2.A: Interdependent Relationships in Ecosystems

Science and Engineering Practices
- Developing and using models
- Analyzing and interpreting data
- Constructing explanations and designing solutions

Crosscutting Concepts
- Cause and effect
- Scale, proportion, and quantity
- Structure and function

Discussion

Antibiotics are powerful drugs that are used to treat many serious and life-threatening diseases. Antibiotics are only effective against bacterial infections, some fungal infections, and some parasites. The principles of antibiotic treatment were actually dis-covered by accident in 1928 by Alexander Fleming (1881–1955). Fleming was culturing bacteria in glass dishes in his laboratory. However, mold (fungus) had contaminated some of his bacterial cultures. He planned on throwing them away but instead noticed that no bacteria grew in the vicinity of the mold. The bread mold named *Penicillium* produces an antibacterial chemical named penicillin.

Since the discovery of penicillin, scientists have developed numerous antibiotics to help stop the spread of infectious disease. Although antibiotics have been proven very useful, misuse of antibiotics has become a serious problem. Frequent unnecessary use has resulted in the evolution of bacteria which are resistant to many common antibiotics. These extremely antibiotic-resistant bacteria develop because the original antibiotic failed to kill all of the targeted bacteria. As a result, the remaining bacteria survive and become resistant to the original antibiotic. Doctors then prescribe a different antibiotic, but resistant forms of the bacteria quickly develop the ability to withstand the new antibiotic as well, bringing about a continual cycle requiring different, more powerful drugs to treat infection.

As more bacteria become resistant to the original antibiotic, the consequences become more severe. Consequences include longer lasting illnesses, increased risk of serious complications, and death. The inability of antibiotics to treat infection also leads to longer periods in which a person is contagious and able to spread resistant strains to other people.

References

"Antibiotics: Misuse Puts You and Others at Risk." Mayo Clinic. http://www.mayoclinic.org/antibiotics/ART-20045720 (Accessed January 2014)

Materials for *Antibiotic Resistance Simulation* are available from Flinn Scientific, Inc.

Catalog No.	Description
FB1928	Antibiotic Resistance Simulation—Super Value Kit

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.