ANTIBIOTIC RESISTANCE
TEACHER NOTES

Alabama Course of Study-Science
Biology: 8-Identify the structure and function of DNA. Relating ways chance, mutagens, and genetic engineering increase diversity.
Biology: 9-Differentiate between the kingdoms. Identifying ways in which organisms from the kingdoms are beneficial and harmful.

ENGAGE
- Ask students if they know the difference between prokaryotes and eukaryotes.
- Ask students how prokaryotes reproduce.
- Ask students “Have you ever taken an antibiotic and if so why?”
- Ask students “What is an antibiotic?”
- Ask students “What is bacteria antibiotic resistance?”
- Ask students “What is a plasmid?”

EXPLORE
Prepare a paper bag (lunch size) for each student in the class. For a class of 32, prepare 26 bags, each containing 5 yellow disks and 6 bags, each containing 5 purple disks.
*NOTE: For smaller classes, reduce the number of bags with yellow disks and the bags with purple disks by the same proportion (4 bags Yellow:1 bag Purple). For example, a class of 25 students would need 20 bags of yellow disks and 5 bags of purple disks.

The yellow disks represent plasmids that do not carry a gene for antibiotic resistance.
The purple disks represent plasmids that do carry a gene for antibiotic resistance.
The paper bag represents a single bacterium.
The disks represent plasmids.

Tell students to look inside their paper bags and observe the color of their bacterium’s plasmids, but not to tell other students the contents of their bacterium. Emphasize that when students exchange plasmids, they should not look into the paper bag when selecting a plasmid (disk). When the students exchange plasmids they are simulating conjugation.

On an overhead or on the board, draw Table 1 as depicted in the student laboratory handout.

Data Analysis
Student answers on data table and analysis questions will vary.
EXPLAIN
Antibiotics are natural substances secreted by bacteria and fungi that can inhibit the growth of or destroy other bacteria. Many antibiotics used to treat people today are typically derivatives of these natural products. Some antibiotics destroy bacteria by affecting their cellular structure. The antibiotic can weaken the cell walls of the pathogenic bacteria, which causes the bacterial cell to burst, or antibiotics can damage the plasma membranes resulting in the cellular contents leaking out of the cell. Another way antibiotics function is by interfering with the bacteria’s metabolism. Other antibiotics have a general blocking effect on bacterial cell metabolism or may interfere with protein synthesis by binding to ribosomes in pathogenic bacteria cells which results in the death of the bacteria. In addition, some antibiotics inhibit DNA biosynthesis. Although most antibiotics occur in nature, they are usually not available in quantities sufficient for large-scale production; therefore, a fermentation process is used to mass-produce antibiotics. The fermentation process most commonly used today involves isolating a desired microorganism, fueling growth of the culture, and refining and isolating the final antibiotic product.

In 1928, Alexander Fleming discovered that *Penicillium notatum*, a common mold, had destroyed staphylococcus bacteria in culture. The first antibiotic, penicillin, was isolated in 1939. In 1943, penicillin was mass-produced in order to treat wounded soldiers in WWII who had bacterial infections. However, only three years after this first mass-production of penicillin, antibiotic resistant strains of bacteria began to appear.

How Do Bacteria Reproduce?
Bacteria reproduce asexually. The most common method is binary fission, a kind of cell division, which results in two genetically identical bacterial cells. Most bacterial genes are carried on a single bacterial chromosome that consists of a circular DNA molecule and associated proteins. The process of cell division begins when the DNA of the bacterial chromosome begins to replicate at a specific place on the chromosome called the origin of replication, producing two origins. As the chromosome continues to replicate, one origin moves rapidly toward the opposite end of the cell, and the cell elongates. When replication is complete, the bacterium is now twice its initial size and its plasma membrane grows inward. The parent bacterium divides into two daughter cells, and each cell inherits a complete copy of the DNA.

Although binary fission is an effective way for bacteria to reproduce, there is no genetic variation. In order to introduce some genetic variation bacteria use recombination. Bacterial recombination can be accomplished through conjugation. Conjugation is the process of bacteria transferring pieces of their genes to other bacteria that they come into physical contact with via a conjugation pilus. A conjugation pilus, also called a sex pilus, is a proteinaceous tube through which one strand of donor plasmid DNA is transferred to the recipient.

http://survivalrivals.org/the-x-bacteria/animation
Antibiotic Resistance

Antibiotic resistance occurs when bacteria are altered in some way that reduces or eliminates the effectiveness of antibiotics. Susceptible bacteria can become resistant to antibiotics through a variety of mechanisms including, spontaneous DNA mutations or accepting antibiotic resistant genes from another bacteria. Once a bacterium acquires resistance it can then multiply and replace all of the bacteria that were killed off by the antibiotic. Antibiotic resistant bacteria use different mechanisms to neutralize or escape the effect of the antibiotic. Some bacteria develop the ability to enzymatically destroy or inactivate antibiotics while others can rapidly pump the antibiotic out before it can do harm to the cell. Other bacteria can alter the antibiotic attack site so that the antibiotic cannot properly bind and affect the function of the bacteria.

Antibiotic resistance is a major public health concern worldwide. The use of antibiotics promotes the development of antibiotic resistance. Each time a person takes antibiotics, susceptible bacteria are killed, but some resistant bacteria survive and multiply. These antibiotic resistant bacteria can quickly spread to others and threaten the community with a new strain of infectious disease that is more difficult to cure. Repeated and misuse of antibiotics are the primary causes of the increase in drug-resistant bacteria. Improper uses of antibiotics include taking them in order to treat viral infections such as the common cold, flu, most coughs and bronchitis, sore throats not caused by strep, and runny noses. Antibiotics cure bacterial infections, not viral infections, and taking them when they are not needed increases your risk of getting an infection later that resists antibiotic treatment.

CDC (Center For Disease Control) Recommendations

http://www.cdc.gov/getsmart/antibiotic-use/know-and-do.html

What To Do

- Talk with your healthcare provider about antibiotic resistance.
- When you are prescribed an antibiotic,
  - Take it exactly as the doctor tells you. Complete the prescribed course even if you are feeling better. If treatment stops too soon, some bacteria may survive and re-infect you.
  - Throw away any leftover medication once you have completed your prescription

Just because your doctor doesn't give you an antibiotic doesn't mean you aren't sick. Talk with your doctor about the best treatment for your illness. To feel better when you have an upper respiratory infection:

- Ask your doctor or community pharmacist about over-the-counter treatment options that may help you feel better
- Increase fluid intake
- Get plenty of rest
- Use a cool-mist vaporizer or saline nasal spray to relieve congestion
- Soothe a throat with ice chips, sore throat spray, or lozenges
What Not To Do

- **Antibiotics cure bacteria, not viruses such as:**
  - Colds or flu;
  - Most coughs and bronchitis;
  - Sore throats not caused by strep
  - Runny noses.
- **Do not** demand antibiotics when a doctor says they are not needed.
- **Do not** take an antibiotic for a viral infection like a cold or most sore throats.
- **Do not** take antibiotics prescribed for someone else. The antibiotic may not be appropriate for your illness. Taking the wrong medicine may delay correct treatment and allow bacteria to multiply.

If your doctor prescribes an antibiotic for you:
- **Do not** skip doses.
- **Do not** save any of the antibiotics for the next time you get sick.

EVALUATE

- Student’s interpretation of data collected in lab.
- Student’s answers to questions from the lab.

EXTEND

- Do antibiotics work on viruses such as the cold virus and the flu virus?
- Does antibacterial soap work better than regular soap?
  
  *How Stuff Works – antibacterial soap vs regular soap*
  
  *How Stuff Works – Testing Antibacterial soaps*
  
  *CDC – Get Smart – Antibiotic Resistance Questions and Answers*
- What are probiotics and are they really beneficial?
- What are some things you as students should do to prevent or slow antibiotic resistance?
- Could bacteria acquire genes for resistance to more than one antibiotic? What would be the advantage to the bacteria?