Antibiotic Resistance: Natural Selection at Work!

Name _____   Date _____

Introduction:

In 1943, penicillin was introduced as the "magic bullet" for curing many infectious diseases. By 1946, however, approximately 14 percent of *Staphylococcus aureus* strains isolated at a London hospital were resistant to penicillin. Today, scientists estimate that more than 95 percent of all *S. aureus* strains are penicillin-resistant.

After the introduction of penicillin, additional antibiotics were rapidly isolated and developed, including streptomycin and tetracyclines. Today, there are more that 100 antibiotics available. Nevertheless, some strains of at least three bacterial species (*Enterococcus facecium, Mycobacteria tuberculosis, Pseudomonas aeruginosa*) are resistant to all of these antibiotics, and health care workers fear the time is rapidly approaching when more deadly organisms escape the effects of all known antibiotics.

The primary reason for the increase in antibiotic resistance is evolution. When mutant genes arise that make a bacterium less sensitive to an antibiotic, that bacterium survives and produces descendants in an environment rich in antibiotics. That is, the process of natural selection operates. Multiple mutations may be required to result in fully resistant bacteria. However, once resistant genes appear, bacteria have a variety of mechanisms for exchanging those genes both within and across species. This exchange allows for "accelerated evolution" of bacterial species because the random mutation that results in antibiotic resistance need not happen in every individual bacterium, but can simply be acquired from another bacterium.

1. Explain how antibiotics cause a population of bacteria to evolve.

Day 1.

Today you will grow bacteria on a plate of nutrient agar. Nutrient agar contains all the necessary resources in order for bacteria to grow. You will inoculate two plates today with the bacteria ***Serratia marcescens***. One plate will contain plain nutrient agar. The second plate will contain nutrient agar plus the antibiotic ampicillin. (Marked with an "A").

2. Predict what will happen to the bacteria on each plate.

Directions for Day 1.

1. Obtain two plates, one with ampicillin (A) and one without.
2. Write your name on the bottom of the plate in permanent marker.
3. The micro-test tube your group gets contains a culture of *Serratia* bacteria. You will transfer some of the bacteria to each plate and then use a spreader to spread the bacteria across the agar.
4. **Perform the next steps quickly after removing the lid so you do not contaminate your plate. DO NOT place the lid down or talk over the open plate!**
   a. Using a sterile pipette, draw up the bacteria until the <u>second graduation on the pipette.</u>
   b. As shown below, release the bacteria culture onto the center of the plate.
   c. Use a sterile "blue" spreader to **gently** spread the bacterial culture across the entire plate.

Fill pipette to Second Graduation
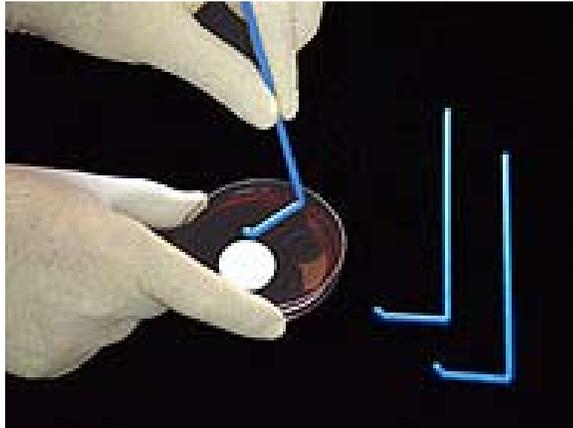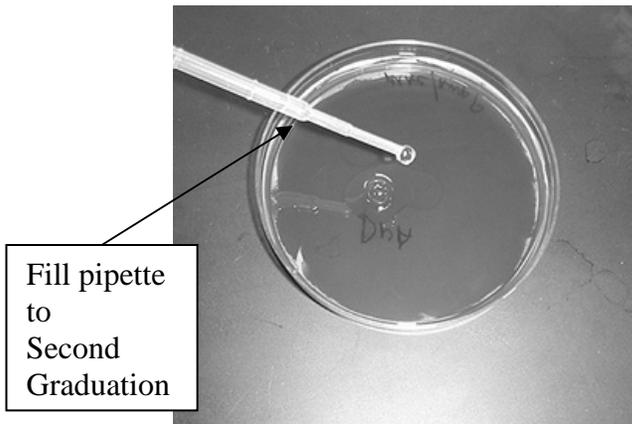
DO NOT TEAR or RIP the agar. Press GENTLY to spread the bacteria.

   d. Place the lid back over the plate. Dispose of your pipette and spreader in the appropriate location designated by your teacher.
   e. Repeat the above steps with the next plate.
   f. Let the culture dry no longer than 5 minutes and then place your plates, "upside down" in the location designated by your teacher. The bacteria will need 48 hours to grow before we check your plates again.
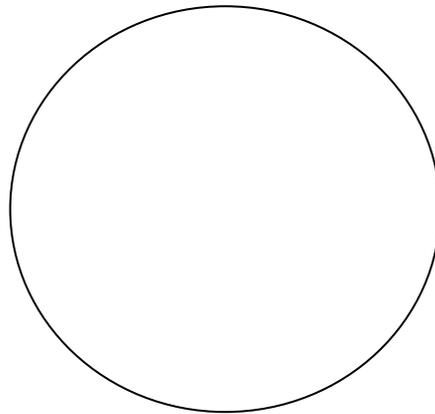
Day 2 Directions.

- Obtain plates. **DO NOT open your plates at any point!**

- Carefully examine each plate and then complete the activity on the next page.

1. Record your data by completing the diagrams and questions below.
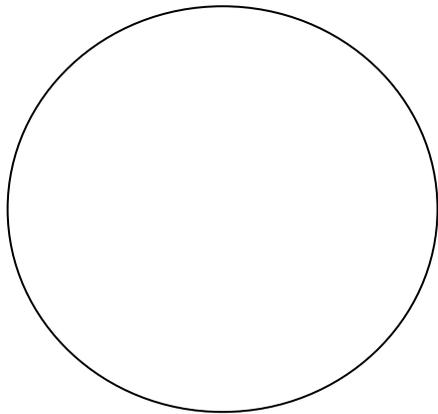
| No Ampicillin | Ampicillin |

- **Compare and contrast the growth on each plate in the space below.**

2. Which plate had more growth? Explain why.

3. Did the ampicillin plate have any growth? Explain why or why not?

4. **If so, does this mean that the antibiotic caused the bacteria to "mutate" and become resistant? Explain.**

5. **If you were infected with a pathogenic strain of *Serratia*, what would the results of this lab mean to your health? How would doctors need to treat your illness?**

6. **Explain the results of the lab in terms of Darwin's four principles of natural selection.**