

Antibiotic Resistance Part 2: Tuberculosis Simulation

Development of antibiotics seemed miraculous. It seemed possible that some pathogens/diseases could be wiped out entirely. For example, experts confidently predicted the total eradication of tuberculosis by 2025. In industrialized nations where treatment was available, cases of TB became rare. But in the 1980's, TB cases showed a marked increase all over the world. In 1993, the World Health Organization declared the disease a global emergency.

Why did the health care community swing so rapidly from optimism to alarm over antibiotic use?

Bacteria are organisms that are subject to natural selection by their environment. Changing their environment by introducing antibiotics creates an opportunity for evolutionary change of the population.

How does the use of antibiotics affect a population of bacteria?

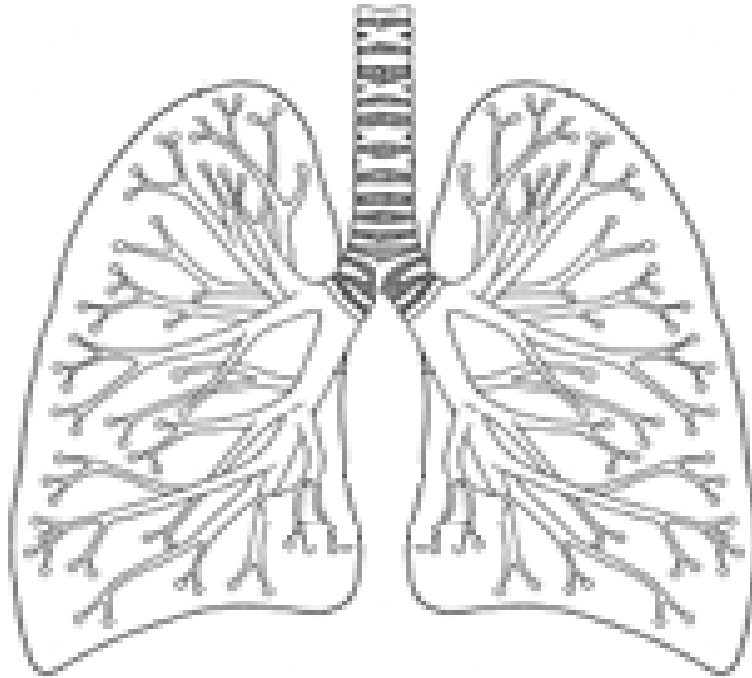
It takes a large population of bacteria to cause disease. For example, the lungs of a person who has an active case of TB contain hundreds of millions of bacteria.

Are all of these bacteria genetically identical (have the same DNA sequence)? Use your reasoning to explain the existence of antibiotic resistant bacteria.

Different writing utensils provided for this activity simulate genetic and phenotypic differences within the bacterial population.

Procedure:

1. Use the pens and pencils provided to fill the diagram of lungs with dots representing a bacterial infection.



What part of natural selection do the different writing utensils represent?

2. You feel sick and see a doctor. Your doctor prescribes “Pink Pearl” to treat your infection. (erasers represent antibiotics in this activity) Gently erase over the lungs pressing firmly but not so hard to tear the paper.

Describe the results taking note of which bacterial types have been completely erased, which are fainter but still present and which are as bold as ever.

3. You begin to feel better after your treatment with “Pink Pearl” but inside your lungs, the surviving bacteria now have more room to grow and divide. Add more “bacteria” of the same types that were able to survive Pink Pearl.
4. You feel very sick again and return to your doctor. This time a combination of antibiotics were prescribed “Ink and gum erasers.” Gently erase over the lungs again being careful not to rip the paper.

Describe the results.

Again you felt better for a time but then the symptoms returned. Why do you still feel sick?

5. Fill the lungs with the remaining bacteria that have survived all antibiotic treatments.

When you pass this disease on to someone else, which bacteria will the newly infected person acquire?

When you take an antibiotic, it begins killing some bacteria immediately. Some bacteria are harder to kill than others.

How can not finishing your prescribed antibiotic lead to the recurrence of your illness?

In the process of natural selection members of the population that are better suited for the environment are more likely to survive and reproduce. When you put antibiotic on the lungs, only those best adapted (containing resistance genes) were able to survive and the population of bacteria changes. The resistant bacteria reproduce rapidly, so within a short time, you are once again suffering from a full-blown infection.

Strains of tuberculosis bacterium that are resistant to multiple antibiotics have emerged since the 1990's. These strains are more difficult and costly to fight off. TB is only one example of pathogen that has developed antibiotic resistance. Others include bacteria that cause pneumonia, food poisoning, gonorrhea and even ear infections.