

Introduction to the Dr. X Food Safety Film

This document explains the specific science concepts presented in the video, including fascinating facts relative to the topic. *Read this information before watching the video or conducting the activities and experiments.*

A. Background

1. The U.S. has one of the safest food supplies in world, but there is always room for improvement. The battle to prevent foodborne illness is waged every day because bacteria are everywhere. Food safety has to do with controlling bacteria. And since everyone eats, we all share the responsibility for keeping our food free from harmful bacteria.
2. An electron microscope uses electrons instead of visible light to produce magnified images. It can magnify bacteria a million times their actual sizes.
3. Bacteria are found everywhere, and under the right conditions, they multiply fast! Each bacterium contains all the genetic information needed to make a copy of itself. Bacteria multiply through binary fission, a process in which a cell's DNA doubles, the cell splits, and two independent cells are formed. Under ideal conditions, a single bacterium doubles with each division— 2 become 4, 4 become 8, etc. A single cell can turn into millions in a few hours and billions of cells within one day!

This rapid growth is not usually a problem with good bacteria; however, when it occurs with bad bacteria (aka pathogens), it is “bad” news. As pathogens multiply, some give off harmful toxins or become infectious. If pathogens get into our food and multiply, people can get sick.

4. Bacteria are small. One million bacteria could fit inside 1 square inch.
5. Required Conditions for Bacteria to Grow
 - *Time/Temperature:* Under the right conditions, some bacteria can double their numbers within minutes and form toxins that can cause illness within hours. To minimize bacterial growth in foods, keep food temperatures below 40° F (4° C) or above 140° F (60° C). The temperature range between these two temperatures is considered a danger zone.
 - *Nutrients:* To thrive, bacteria need many of the same nutrients as humans (glucose, amino acids, and some vitamins and minerals). For example, bacteria grow rapidly in high-protein foods such as meat, poultry, eggs, dairy and seafood.
 - *pH:* Microorganisms thrive in a environments with pHs above 4.6. That's why acidic foods such as vinegar and citrus juices are not favorable foods for pathogenic bacteria to grow; however, they may survive.
 - *Moisture:* Most bacteria thrive in moist environments; they do not grow on dry foods. That's why dry foods like cereals can safely sit out at room temperature. But, if dry foods like cereals or spices become contaminated from infected hands or equipment, bacteria can survive on the food and make people sick, growing and multiplying once the food is consumed.

Bacteria can multiply quickly — in fact, one cell can double in 20 to 30 minutes.

It can take less than 10 E. coli bacteria to make you sick.

B. The 4Cs of Food Safety

If bacteria can grow so rapidly under the right conditions, then how do we control them? It's simple:

1. **Cooking:** Kills bacteria by breaking down their cell walls and destroying enzymes, which they need to survive.
2. **Chilling:** Slows down bacteria's metabolism, thus slowing their growth.
3. **Cleaning:** Removes bacteria from hands and surfaces, which prevents spreading.
4. **Combating Cross-Contamination:** Not only can bacteria grow to large numbers and make people sick, but they can also spread everywhere. Separating foods prevents bacteria from spreading from one item to another.

C. How New Pathogens Develop

In addition to multiplying fast, bacteria can also mutate (adapt and evolve), a process that results in changes to their genetic codes. These changes happen very slowly and can make bacteria better able to survive. Mutations can evolve harmless bacteria into harmful bacteria that possess new genetic characteristics, such as antibiotic resistance.

D. Using DNA Fingerprinting to Identify Harmful Strains

- DNA (deoxyribonucleic acid) is the “genetic blueprint” for all living things. A DNA molecule looks like a double helix that is shaped like a long ladder twisted into a spiral. The ends are joined to form a continuous loop, like a rubber band.
- DNA contains the information that gives living things their traits or characteristics. In people, it determines characteristics such as physical features, behaviors and right/left-handedness. In bacteria, DNA molecules encode the information that enables bacteria to grow, reproduce and cause illness.
- Scientists use DNA “fingerprinting” to identify similar groups of bacteria. When a foodborne illness outbreak occurs, epidemiologists (scientists who track down disease causes and find ways to control them) immediately try to determine the source of food bacteria by examining the pathogen's DNA “fingerprint” to see if it matches “fingerprints” (patterns) of other samples.