



## Antimicrobial Resistance: What is it and What's at Stake?

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### Introduction

When Alexander Fleming first discovered antibiotics in the 1920s, he knew they could literally change the world. In many cases, what were once incurable and possibly deadly bacterial diseases have become simple one-time doctor's visits for an antibiotic prescription. Antimicrobial drugs have saved millions of lives and hopefully will continue to do so.

However, less than a century after Fleming's discovery, antimicrobial resistance (AMR) is threatening how well antibiotics work. For these drugs to be preserved, it is critical to understand what AMR is and why we should all care.



Sir Alexander Fleming in his laboratory

### What is Antimicrobial Resistance (AMR)?

AMR is the ability of certain bacteria to survive and multiply in the presence of antimicrobial drugs that are ultimately meant to kill it. This is especially problematic when the resistant bacteria are pathogens (i.e., cause disease). The ability to resist antimicrobial drugs is found in the bacterial DNA in the form of "resistance genes". Due to their ability to withstand the presence of antimicrobials, resistant bacteria survive better and multiply. They can also sometimes pass the DNA containing the resistance-genes to other bacteria, including pathogens. Thus, eventually resistance genes can become widespread and transmit between people, between animals, and from animals to people.

While it only rose to the public spotlight in recent decades, antimicrobial resistance is not a new phenomenon. Fleming himself was concerned about the possibility of resistance. In his Nobel Prize acceptance speech in 1945, Fleming said he observed resistance in his laboratory as well as in human infections. He knew that improper stewardship of the drugs would create resistance that would likely be impossible to reverse. Ultimately, this could make antimicrobials useless in the future.

*"But I would like to sound one note of warning...It is not difficult to make microbes resistant to penicillin in the laboratory by exposing them to concentrations not sufficient to kill them, and the same thing has occasionally happened in the body."*

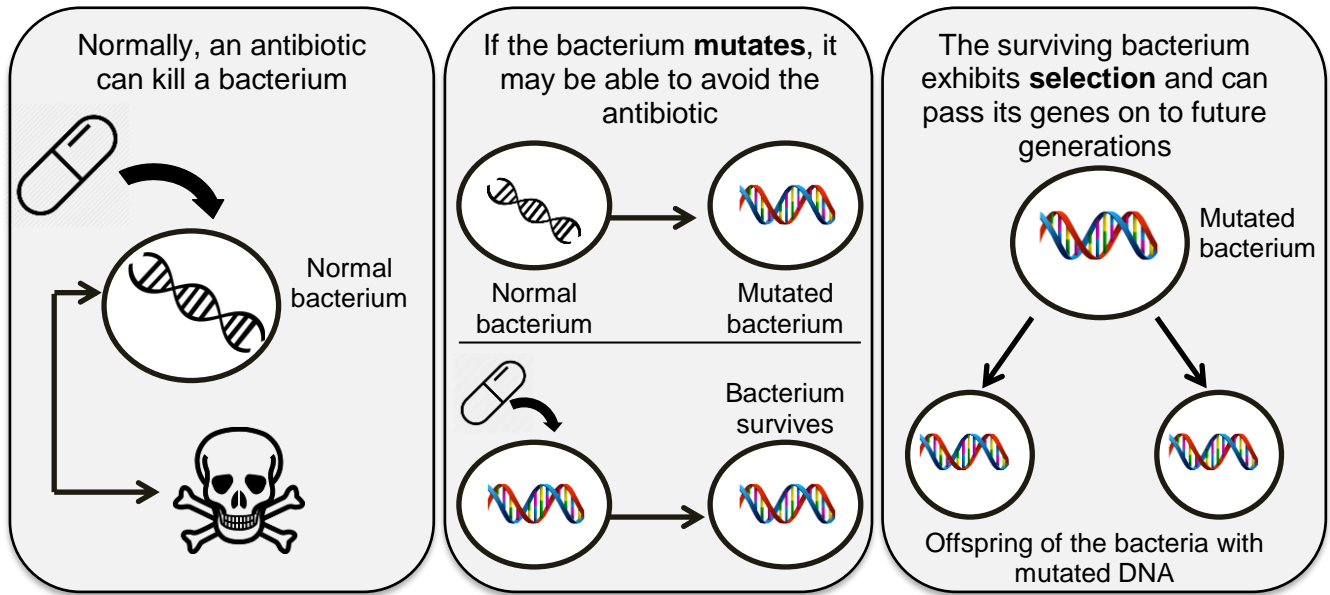
- Alexander Fleming, 1945

Although human activities can worsen AMR, AMR itself is a natural process. Microbes produce their own "natural" antibiotics to protect themselves, and correspondingly, bacteria evolved the ability to resist antibiotics over millions of years. Mutation and selection are the two main ways bacteria can become resistant.

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**Mutation** – is a random event that changes the DNA sequence. Mutations in bacterial DNA can add or remove different bacterial functions, such as AMR, or can have a neutral effect.

**Selection** – refers to an organism with an advantageous trait, such as AMR, surviving and reproducing better than organisms without that trait. Eventually, the organisms with the advantageous trait can outcompete other organisms for the same resources, and those other organisms will die out.



### The Human Role in AMR: Misuse and Overuse

While AMR is a naturally occurring process, human misuse and overuse of antibiotics has greatly sped up the development of resistance. The more antibiotics are used, the greater the chance that selection pressure will contribute to the spread of resistance. It is important to recognize that antibiotics do not affect viral infections and prescription should be avoided in such cases. Additionally, it is important to administer appropriate antibiotics at the correct dose and for the full course of treatment. Under-dosing antibiotics could encourage the bacteria to mutate and select for resistance genes without killing the bacteria.

*“The time may come when penicillin can be bought by anyone in the shops. Then there is the danger that the ignorant man may easily underdose himself and by exposing his microbes to non-lethal quantities of the drug make them resistant.”*  
- Alexander Fleming, 1945

### What’s at Stake?

From a human health standpoint, understanding why antibiotics are beneficial and even necessary is simple. If antibiotics lose effectiveness, people may start suffering from simple bacterial infections. Without antimicrobial drugs, people requiring procedures that compromise the immune system may be more prone to serious bacterial infections. Chemotherapy and major surgeries will become much more dangerous processes than they already are.

From an animal health standpoint, antimicrobial drugs greatly enhance animal welfare. Without these drugs, livestock will likely suffer more from disease. Additionally, antibiotics provide large economic benefits in the agricultural industry by preventing disease and enhancing growth.

No matter the profession, everyone has a stake in AMR because virtually all humans and animals benefit from antibiotics.

### **What is Being Done to Combat AMR?**

Scientists from all over the world in many different fields are researching the causes and outcomes of AMR. Additionally, new laws such as the Veterinary Feed Directive are in effect in order to increase judicious antimicrobial use. Public awareness has also played an important role in communicating the importance of judicious antimicrobial use. There is greater awareness of the importance of finishing an entire antibiotic course of treatment by taking all of the antibiotics prescribed by the doctor.

All in all, combating AMR must ultimately be a unified fight across disciplines and nations in order to preserve these critically important drugs.

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