



Extension FactSheet

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Antibiotic Resistance: Questions and Answers

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What Are Antibiotics?

Antibiotics are chemical substances, either produced naturally by microorganisms or manufactured synthetically, that are lethal to other microorganisms. Antibiotics act by interacting with specific targets within bacteria. They are used for the treatment of bacterial infections in humans, plants, and animals.

What Is Antibiotic Resistance (AR)?

Antibiotic resistance (AR) describes the ability of a microorganism to be unaffected by (or resistant to) the effects of a particular antibiotic. Antibiotic resistance should be clearly differentiated from the term antibiotic residue, which is used to describe trace amounts of the actual antibiotic (chemical).

Why Is AR a Problem?

A problem arises when a plant, animal, or person becomes infected with a disease-causing bacterium that harbors antibiotic resistance to the drug that would be the most suitable treatment for that infection. In many cases, other drugs, to which the bacteria is not resistant, can be used to combat the infection. However, in cases where our choices of effective drugs are limited, or the bacterium is resistant to multiple different antibiotics, treatment for the infection becomes extremely difficult. The primary concern is that the bacteria that people contact (either through infections or in their every day life — through environmental or food exposure) are more frequently resistant to an increasing number of antibiotics.

Where Do AR Organisms Come From?

Antibiotic resistant bacteria were identified shortly after the identification of antibiotics and long before the use of any antibiotic in agriculture. In fact, since many antibiotics are naturally occurring products of microorganisms, bacteria have probably developed AR mechanisms long before they were actually identified by scientists.

Some bacteria are naturally resistant to certain antibiotics simply because they lack the specific target for the antibiotic. Other bacteria can acquire resistance to antibiotics as a result of sporadic mutations that change their targets so they are not recognized by the antibiotic. A third way that bacteria may become resistant to antibiotics is through the acquisition of DNA that codes for antibiotic resistance. An example of this last type of antibiotic resistance is the acquisition of DNA that codes for a protein that actually degrades or breaks down the antibiotic (such as penicillin), so it cannot act on its target site.

In general, resistance among bacteria is specific for a particular class of antibiotics. For example, the mechanisms that provide resistance to one antibiotic do not necessarily confer resistance to all antibiotics. Sometimes, however, one mechanism of resistance may be effective for multiple different antibiotics or chemicals. For instance, one of the mechanisms that confers resistance to tetracycline is actually a pump to rid the bacteria of heavy metals. It just so happens that it gets rid of tetracycline, too. Importantly, bacteria can acquire and maintain the mechanisms to exhibit resistant to multiple different antibiotics. This is called multi-drug resistance.

How Does Agriculture Contribute to AR?

The debate over the role of modern agricultural practices and the emergence and dissemination of AR organisms is highly polarized. Some parties claim that most, if not all, of the AR is due directly to the indiscriminate use of antibiotics in agriculture. On the other hand, there are other groups that are reluctant to even acknowledge any role whatsoever of agricultural use of antibiotics in the emergence of AR bacteria. Truthfully, the answer probably lies somewhere in the middle of these two extremist opinions.

Undisputedly, it has been demonstrated that the use of antibiotics in animals can at least transiently increase the number of antibiotic-resistant organisms being subsequently detected in that group of animals. What is not known, however, is the overall contribution these changes in the bacterial population have on

total environmental or foodborne contamination with AR organisms. Strict withholding periods are required before animals treated with antibiotics are allowed to be sent for slaughter and to enter the food chain. Other, possibly more significant human exposure sources to AR organisms cannot be ignored. These include domestic sewage, hospital sewage, and naturally occurring environmental reservoirs of AR organisms.

What Is Being Done to Control AR?

The concern about AR among bacteria is global. Groups from around the world have been involved in advancing our understanding of and the control of AR bacteria. A tripartite approach involving surveillance, research, and education has been emphasized.

First, surveillance programs, such as the National Antimicrobial Resistance Monitoring System (NARMS), provide valuable information about the prevalence and recent changes in the prevalence of AR bacteria. There is much that is not known about the emergence and dissemination of AR in animals, people, and the environment.

Second, increasing our knowledge of the epidemiology of these organisms will provide the information needed to make sound, scientifically justified recommendations for the control of AR bacteria.

Finally, the role of education among health-care professionals, farmers, and the public is considered essential. Education has focused on methods to control the spread of AR organisms, such as the development of Prudent Antibiotic Use Guidelines for physicians, veterinarians, and farmers.

Together, these three components can be assimilated to provide scientific justification for any policy recommendations for methods to control AR. As research continues and our knowledge base increases, it is expected that more specific recommendations to control AR will be forthcoming.

Want More Information?

An abundance of information is available on AR and agricultural use. Caution should be used when reviewing information, especially that which is published without peer-review (newspapers, magazines, etc.). Some authors present biased information, either out of ignorance or in order to promote their own agenda. The most impartial information can be found in reputable scientific journals. However, even in these publications, the author's biases may be reflected in the interpretation of the data. Therefore, information even from these sources should also be reviewed critically.

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