ANTIBIOTICS: PENICILLIN AND BEYOND

(1) Most of us have taken antibiotics at some point in our lives and the majority of us will need to take them multiple times before we die. Antibiotics are prescription drugs used to treat infections caused by bacteria like strep throat, ear infections, pneumonia, cholera, syphilis and tuberculosis. Some antibiotics also work against certain infections caused by fungi and protozoans. Antibiotics don't work on colds and flus because these are infections caused by viruses, though some doctors still wrongly prescribe antibiotics for these illnesses.

(2) Antibiotics either work by being bactericidal, meaning they kill bacteria, or by being bacteriostatic, meaning that they prevent bacteria from replicating. Bactericidal antibiotics destroy bacterial cell walls and cell membranes and can interfere with bacterial enzymes vital to the bacteria's survival; these include penicillin, sulfonamides and polymyxins. Bacteriostatic antibiotics work by disrupting the ability of bacteria to make proteins; these include tetracyclines and lincosamides.

(3) Antibiotics can also be classified as either narrow spectrum, meaning they kill only specific types of bacteria, or broad spectrum, meaning they can kill a wide range of bacteria. You might think that broad spectrum antibiotics are superior because they can kill many types of bacteria, but this means that they are also capable of killing good bacteria that do not cause infection. Broad spectrum antibiotics can kill the beneficial bacteria in your intestines. The absence of beneficial gut bacteria can lead to digestive complications as well as cause *C. difficile* infections. *C. difficile* is a disease-causing bacteria which easily takes over the intestines when beneficial bacteria are absent.

(4) Penicillin was accidentally discovered in 1928 by a Scottish scientist named Alexander Fleming. On the 28th of September 1928, Fleming noticed that one of his Petri dishes looked strange. The dish was meant to grow only staphylococcus bacteria but Fleming noticed that mold had contaminated his sample because it was growing in the dish with the bacteria. However, surrounding the mold

was an empty area where none of the bacteria seemed to grow. Fleming concluded that the mould must be secreting a chemical capable of killing or preventing the bacteria's growth. On further analysis, he discovered that the mould produced a bactericidal compound and Fleming named it penicillin after the mold growing in the dish, which was called *Penicillium*. Though penicillin was discovered in 1928, the technology to mass produce it wasn't developed until the 1940s. This is when antibiotics became the number one treatment for bacterial infections. Antibiotics were a huge advancement for medicine and Fleming, along with Howard Florey and Ernst Boris Chain, the two scientists who helped create the mass production method, were awarded the Nobel Prize in Medicine in 1945 for their work. Before the use of antibiotics, life expectancy was lower and childhood death rates were much higher. Infections easily cured by today's antibiotics killed many children during that era.

(5) We have now figured out that all antibiotics originate from nature and are produced by fungi and bacteria. Fungi synthesize antibiotics to protect themselves from bacterial infection. Bacteria manufacture antibiotics to kill competing bacteria. Once an antibiotic is discovered it can be developed into different variations. To date, there are over 100 antibiotics that have been developed, though health organizations are concerned that the rate of discovery of new antibiotics has slowed down greatly in the last 20 years.

(6) Though antibiotics are important for treating human bacterial infections, the majority of antibiotics are actually used in the

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commercial livestock farming of cattle, pigs, sheep and poultry. 80%-90% of the antibiotics used in the U.S. are used on livestock. Most of the antibiotics used for livestock are not used to treat infections. For reasons that aren't exactly clear, when antibiotics are put in the feed of livestock, it causes them to develop more muscle and milk very quickly. Large commercial farmers save a lot of money using antibiotics because it decreases the time it takes to raise livestock to a size appropriate for slaughter. Antibiotics used for non-medical reasons like this are called subtherapeutic antibiotics, but they are controversial because their widespread use contributes to antibiotic resistance.

(7) Antibiotic resistance occurs when antibiotics kill the weakest bacteria in a population but are unable to kill the strongest. As more antibiotics are used, more antibiotic resistant survivors are left. When these survivors pass on their antibiotic resistance to their offspring, the entire population eventually becomes resistant. There is great concern that an increasing number of bacteria are exhibiting antibiotic resistance and that this the beginnings of a public health crisis for which we are very unprepared. Health organizations blame the misuse and over-prescription of antibiotics as well as the heavy use of subtherapeutic antibiotics for causing the troubling rise in antibiotic resistance.

Article Questions

1) What is the difference between a bactericidal antibiotic and a bacteriostatic antibiotic?

2) What is the difference between a narrow spectrum antibiotic and a broad spectrum antibiotic?

3) How can the use of broad spectrum antibiotics lead to negative health consequences. Describe two of these negative health consequences.

4) What was the first antibiotic discovered, when was it discovered and who discovered it?

5) What did Fleming observe that caused him to suspect that the mold was producing a substance that prevented the bacteria from growing?

6) What are subtherapeutic antibiotics and what effect do they have?

7) What is antibiotic resistance and how does it develop?