



TYPES OF ANTIBIOTICS, MECHANISMS OF ACTION, AND THE PROBLEM OF RESISTANCE

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Annotation: This article provides an extensive scientific review of the types of antibiotics, their mechanisms of action, pharmacological properties, and the scientific basis of antibiotic resistance. The adaptation mechanisms of microorganisms to antibiotics, mutation processes, formation of genetic resistance, and its impact on the global healthcare system are thoroughly analyzed. The emergence of resistant bacterial strains due to improper use of antibiotics, methods to combat resistance, and modern solutions are discussed based on theoretical and scientific approaches.

Keywords: antibiotic, resistance, microorganisms, mechanism of action, pharmacology, bacteria, antibacterial therapy.

Antibiotics began to be used in medicine based on deep scientific foundations, and their discovery saved humanity from many fatal infectious diseases. It was discovered that antibiotics are substances produced by fungi, bacteria, and certain actinomycetes found in nature, which inhibit the growth and reproduction of microorganisms and destroy them. The pharmacological properties of antibiotics, their classification, areas of application, and mechanisms of action in the body are widely studied in pharmacology, microbiology, and biochemistry. Today, one of the most important and urgent issues is the adaptation of microorganisms to antibiotics – that is, the problem of resistance. The emergence of resistant strains sharply reduces the effectiveness of antibacterial therapy, requires the development of new-generation antibiotics, and poses a major threat to the global healthcare system.

According to origin and chemical structure, antibiotics are divided into natural, semi-synthetic, and fully synthetic types. Beta-lactam antibiotics (penicillins, cephalosporins, carbapenems) act on the synthesis of the bacterial cell wall. Macrolides (azithromycin, erythromycin) inhibit protein synthesis within the cell. Aminoglycosides (gentamicin, streptomycin) affect ribosomes and disrupt protein synthesis. Fluoroquinolones block DNA replication and destroy bacteria. In addition, tetracyclines, sulfonamides, lincosamides, and glycopeptide antibiotics are also widely used in practice.

The action of antibiotics is achieved by blocking specific biological functions of microorganisms. The main target points include the cell wall, DNA synthesis, RNA transcription, protein synthesis in ribosomes, and metabolic processes. Beta-lactam antibiotics inhibit peptidoglycan synthesis, while macrolides block ribosomal activity, stopping the growth of



microorganisms. Aminoglycosides damage the structure of bacterial RNA and DNA, destroying them. Sulfonamides affect folic acid synthesis, slowing down bacterial growth and reproduction. As a result of uncontrolled use of antibiotics, non-compliance with proper dosage and duration, bacteria adapt and resistant strains emerge. This process has become a dangerous epidemiological issue worldwide. The self-medication of many patients and careless use of antibiotics in the veterinary field significantly accelerate this process. Additionally, some bacteria have the ability to transfer resistance genes to other microorganisms. Genetic mutations occurring in bacteria enhance resistance to antibiotics. The formation of resistance occurs in two main ways: mutational resistance and genetic resistance. As a result of mutation, changes occur in the bacterial genome, and the effect of the antibiotic begins to weaken. Genetic resistance occurs through gene transfer among bacteria via conjugation, transduction, or transformation. Bacteria produce a special enzyme called beta-lactamase, which breaks down penicillin and reduces its effectiveness.

The most effective way to combat resistance is the implementation of antibiotic stewardship, that is, a system of rational use of medications. Additionally, identifying resistant genes within microorganisms, choosing an appropriate therapy regimen, using combination drugs, and developing new generations of antibiotics are among the most important tasks. Antibiotic treatment should be carried out only based on a doctor's recommendation and after complete diagnostics.

Antibiotics are among the most important drugs in modern medicine, and their proper use plays a crucial role in human health and the stability of the healthcare system. It is essential to thoroughly study the types, mechanisms of action, and pharmacological properties of antibiotics and apply scientific methods to prevent resistance. It is possible to limit the problem of resistance through rational use of antibiotics, adherence to international standards, and strengthening control systems.

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