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STUDY AND DETERMINATION OF THE SENSITIVITY OF MICROORGANISMS TO CHEMOTHERAPEUTIC DRUGS AND ANTIBIOTICS

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Annotation
This article provides a scientific analysis of the mechanisms of action of chemotherapeutic agents and antibiotics on microbial activity, as well as the methods used to determine their sensitivity. The excessive or improper use of antibiotics has led to an increase in resistant forms of microorganisms. Therefore, assessing microbial sensitivity to antibiotics is of great clinical importance for the correct treatment of infections, the rational selection of drugs, and the prevention of drug-resistant strains. The article discusses both theoretical and practical aspects of methods such as disk diffusion, minimum inhibitory concentration (MIC), and the automated VITEK system.

Keywords: antibiotic, chemotherapy, microorganisms, sensitivity, MIC, disk diffusion, VITEK system.

Introduction

Antimicrobial agents are among the most important therapeutic tools that have brought revolutionary changes in the history of medicine. The discovery of antibiotics and chemotherapeutic substances made it possible to treat infections that were once fatal. However, in recent years, the number of antibiotic-resistant bacterial strains has increased dramatically. This situation poses a serious problem for the global healthcare system and requires the development of new diagnostic and control mechanisms.

To fully understand the effects of antibiotics on microorganisms, it is essential to study their molecular targets, biochemical changes, and pharmacodynamic properties. Moreover, modern automated systems used to assess microbial sensitivity (such as the VITEK 2 system) accelerate laboratory diagnostics and minimize human error.

Main Part

1. Mechanism of Action of Chemotherapeutic Agents on Microorganisms

Chemotherapeutic agents inhibit the growth, reproduction, and metabolic activity of microorganisms, thereby keeping the infectious process under control. Their mechanism of action targets vital cellular systems:

Agents that disrupt DNA and RNA synthesis. Fluoroquinolones (ciprofloxacin, levofloxacin) block bacterial DNA gyrase and topoisomerase IV, preventing DNA strand unwinding. Metronidazole is activated inside anaerobic bacteria, leading to DNA fragmentation.

Agents that inhibit metabolic processes. Sulfonamides and trimethoprim inhibit folic acid synthesis, resulting in the cessation of DNA synthesis.

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Agents that affect cell wall synthesis. β-lactam chemotherapeutic agents (penicillins, cephalosporins) block peptidoglycan synthesis, causing cell lysis.

These agents exhibit high selectivity, acting specifically on bacterial enzyme systems while causing minimal harm to human cells.

2. Mechanism of Action of Antibiotics on Microorganisms

Antibiotics either kill microorganisms or inhibit their growth. Their main mechanisms of action include:

Inhibition of cell wall synthesis. β-lactams (penicillins, cephalosporins, carbapenems) block the PBP (transpeptidase) enzyme.

Inhibition of protein synthesis. Aminoglycosides (gentamicin, streptomycin) act on the 30S ribosomal subunit, while macrolides (azithromycin, erythromycin) affect the 50S subunit.

Inhibition of nucleic acid synthesis. Rifampicin blocks RNA polymerase, and fluoroquinolones inhibit DNA gyrase.

Disruption of cell membrane integrity. Polymyxins destabilize the membrane, causing ion leakage and cell death.

As a result, bacterial cells experience stress conditions that disrupt their physiological stability.

3. Methods for Determining Microbial Sensitivity to Antibiotics and Chemotherapeutic Agents

1. Disk Diffusion (Kirby–Bauer) Method

A bacterial suspension is evenly spread (“lawn technique”) on a nutrient agar plate, and antibiotic disks are placed on the surface. After incubation at 37°C for 18–24 hours, the diameter of the inhibition zone is measured.

Advantages: simple, inexpensive, and visually interpretable.

Disadvantages: does not determine MIC and may be unsuitable for some bacterial species.

2. Minimum Inhibitory Concentration (MIC) Method

Determines the lowest concentration of an antibiotic that completely inhibits bacterial growth. This method allows a quantitative assessment of antibiotic efficacy.

Advantages: accurate, reliable, helps in dose selection.

Disadvantages: time-consuming, requires specific laboratory conditions.

3. Automated VITEK 2 System

The VITEK 2 system analyzes bacterial biochemical reactions, growth kinetics, and antibiotic response using optical sensors. It provides results within 6–8 hours and reduces human error.

Advantages: fast, highly accurate, provides digital results.

Disadvantages: expensive, not available in every laboratory.

Conclusion

The study shows that chemotherapeutic agents and antibiotics affect microorganisms through various biochemical and molecular mechanisms. Modern methods — particularly the VITEK 2 automated system — enable rapid and precise determination of microbial sensitivity. This approach is of great importance in clinical microbiology for effective infection treatment, rational antibiotic use, and prevention of drug-resistant strains.

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