



Mechanisms of Drug Resistance in Infectious Diseases: From Bacteria to Viruses

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INTRODUCTION

Drug resistance refers to the phenomenon where pathogens such as bacteria, viruses, fungi, or parasites evolve to become less responsive or entirely resistant to the drugs that once effectively treated them. This issue is a growing concern worldwide, presenting serious challenges to public health, medical treatments, and global efforts to control infectious diseases. Resistance can occur naturally through mutation and selection pressures, but misuse and overuse of drugs in both healthcare and agriculture significantly accelerate the process. Pathogens can develop resistance through several mechanisms. These include genetic mutations that alter the target site of the drug, changes that reduce the drug's ability to enter or stay inside the pathogen, or mechanisms that pump the drug out before it can exert its effect. Some bacteria, for example, produce enzymes that can break down antibiotics, rendering them ineffective. In other cases, pathogens can acquire resistance genes from other resistant organisms through horizontal gene transfer, further spreading resistance. Mutations in Target Sites many drugs work by targeting specific proteins or enzymes that are crucial for the survival or replication of pathogens. A mutation in the gene encoding this target protein can result in a version of the protein that the drug can no longer bind to or inhibit effectively.

DESCRIPTION

Altered Permeability pathogens may change their cell wall or membrane structure to make it harder for drugs to enter. In some cases, they may develop efflux pumps, which actively expel drugs before they can exert their effects. Enzymatic Degradation some bacteria produce enzymes, such as beta-lactamases, which can degrade certain antibiotics before they can interfere with the bacteria's growth. Acquisition of Resistance Genes through processes such as conjugation,

bacteria can exchange genetic material with one another, including genes that confer resistance to certain drugs. The emergence of drug resistance is primarily driven by the overuse and misuse of drugs. In healthcare settings, antibiotics are often prescribed unnecessarily for viral infections (against which they are ineffective) or when dosages are not taken as prescribed, encouraging the survival of resistant strains. Incomplete courses of treatment and the use of low quality drugs further exacerbate this issue. In agriculture, the widespread use of antibiotics to promote animal growth, often at subtherapeutic doses, leads to the selection of resistant pathogens.

CONCLUSION

Increased Mortality and Morbidity infections caused by drug resistant pathogens are harder to treat, leading to prolonged illness, more severe infections, and an increase in death rates. Common infections such as pneumonia, urinary tract infections, and tuberculosis are becoming more difficult to treat with existing drugs. Economic Burden the costs associated with drug resistance are substantial. Patients infected with resistant strains often require longer hospital stays, more complex treatments, and the use of more expensive drugs. This places a significant financial burden on healthcare systems worldwide, particularly in low and middle income countries. Loss of Treatment Options as resistance spreads, the effectiveness of current treatments diminishes, and fewer new drugs are being developed.

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CONFLICT OF INTEREST

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