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Antimicrobial Peptides: Features, Action, and Their Resistance Mechanisms in Bacteria

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In recent years, because of increased resistance to conventional antimicrobials, many researchers have started to study the synthesis of new antibiotics to control the disease-causing effects of infectious pathogens. Antimicrobial peptides (AMPs) are among the newest antibiotics; these peptides are integral compounds in all kinds of organisms and play a significant role in microbial ecology, and critically contribute to the innate immunity of organisms by destroying invading microorganisms. Moreover, AMPs may encourage cells to produce chemokines, stimulate angiogenesis, accelerate wound healing, and influence programmed cell death in multicellular organisms. Bacteria differ in their inherent susceptibility and resistance mechanisms to these peptides when responding to the antimicrobial effects of AMPs. Generally, the development of AMP resistance mechanisms is driven by direct competition between bacterial species, and host and pathogen interactions. Several studies have shown diverse mechanisms of bacterial resistance to AMPs, for example, some bacteria produce proteases and trapping proteins; some modify cell surface charge, change membrane fluidity, and activate efflux pumps; and some species make use of biofilms and exopolymers, and develop sensing systems by selective gene expression. A closer understanding of bacterial resistance mechanisms may help in developing novel therapeutic approaches for the treatment of infections caused by pathogenic organisms that are successful in developing extensive resistance to AMPs. Based on these observations, this review discusses the properties of AMPs, their targeting mechanisms, and bacterial resistance mechanisms against AMPs.

Keywords: antimicrobial peptides, mechanism of action, pathogenic bacteria, bacteria resistance, resistance mechanisms

Introduction

Antimicrobial peptides

Bacterial pathogens have developed resistance to most of the conventional antibiotics available today. Therefore, generating novel medicinal antibiotics as an alternative to control and treat the infections caused by these pathogens is essential.[1–4] In this regard, antimicrobial peptides (AMPs) have attracted attention as a potential candidate that can be extracted from natural sources and used against antibiotic-resistant bacteria.[5–7] AMPs are found in all forms of life, from bacteria to plants, vertebrates, and invertebrates. They exhibit broad-spectrum antimicrobial properties against a wide variety of bacteria, fungi, protozoans, viruses, and surprisingly even cancerous cells. In addition, AMPs have immunomodulatory activities that are essential in adaptive immunoregulation and inflammatory response. Generally, large AMPs composed of 100 amino acids or more contribute to lysis, bind to nutrients, or target specific microbial macromolecules. On the other hand,

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