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Review

Bacterial Protein Toxins as Anticancer Agents: Clinical Potential of *Pseudomonas* and Anthrax Toxins

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Abstract

Protein toxins are biologically active polypeptides produced by a variety of organisms, including bacteria, plants, fungi, and animals. These molecules exert potent and specific toxic effects on target cells and are primarily associated with pathogenicity and defense mechanisms of the organisms. In the past few decades, significant progress has been made in understanding their structure, mechanisms of action, and regulation. Among these, bacterial protein toxins have emerged as valuable tools particularly in the development of targeted therapies. A notable example is Botulinum toxin, originally known for its neurotoxic effects, which was approved as a therapeutic agent in 1989 for strabismus treatment, paving way for repurposing bacterial toxins for clinical use. This review provides an overview of the different classes of bacterial toxin-based therapeutics, with a particular focus on *Pseudomonas* exotoxin A (PE) from *Pseudomonas aeruginosa* and anthrax toxin from *Bacillus anthracis*. The modular architecture and potent cytotoxicity of these A-B type toxins have enabled their successful adaptation into targeted cancer therapies. The clinical approval of the PE-based immunotoxin, moxetumomab pasudotox, for the treatment of hairy cell leukemia, underscores the potential of this strategy. This review also discusses current challenges and outlines future directions for the advancement of bacterial toxin-based therapeutics.

Keywords: anthrax toxin; PE toxin; protein toxin; AB toxin; cancer therapy; immunotoxin

Key Contribution: This review highlights the therapeutic potential of bacterial protein toxins, focusing on how agents like *Pseudomonas* exotoxin A and anthrax toxin are being engineered to selectively target cancer cells, demonstrating significant clinical promise.

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1. Introduction

Bacterial toxins belong to a large, biochemically diverse family of biotoxins produced by numerous living organisms, including plants (phytotoxins), fungi (mycotoxins), and animals (zootoxins). Bacterial toxins, traditionally recognized for their pathogenic roles in several infectious diseases, have increasingly been investigated as potential therapeutic