The Impact of Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) Technology in combating the growing threat of Anti-Microbial Resistance

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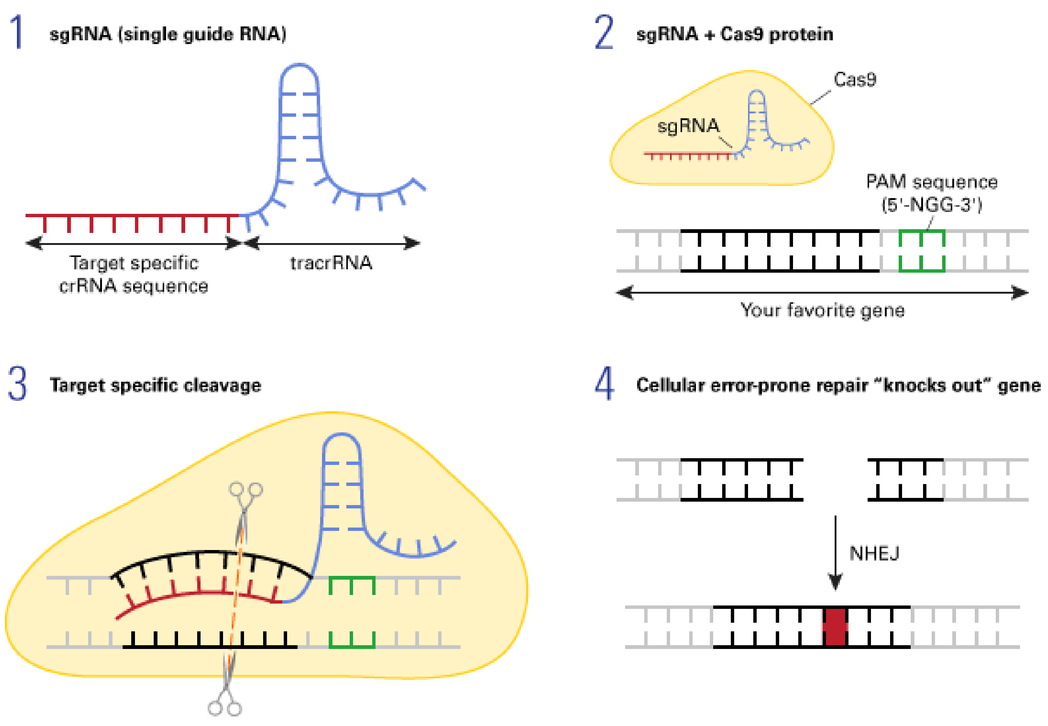
INTRODUCTION

CRISPR-Cas9 technology, a revolutionary tool in genetic engineering, has transformed the field of biotechnology by enabling precise and efficient genome editing in a wide range of organisms. CRISPR stands for Clustered Regularly Interspaced Short Palindromic Repeats, which are segments of prokaryotic DNA containing short repetitions of base sequences. Cas9, on the other hand, refers to CRISPR-associated protein 9, an enzyme that acts as molecular scissors to cut DNA at specific locations guided by RNA molecules (Barman et al., 2019). Antimicrobial resistance (AMR) is a pressing global health concern that threatens the effectiveness of antibiotics and other antimicrobial agents in treating bacterial infections. The overuse and misuse of antibiotics have accelerated the development of resistant strains of bacteria, making it challenging to combat common infections. This phenomenon not only jeopardizes individual patient outcomes but also poses a significant public health threat by potentially rendering current antibiotics ineffective against a wide range of pathogens (Ekwebelem et al., 2021).

The emergence of multidrug-resistant bacteria, often referred to as "superbugs," has highlighted the urgent need for innovative strategies to address AMR. Traditional approaches to developing new antibiotics have been unable to keep pace with the rapid evolution of resistance mechanisms in bacteria. As a result, alternative solutions are being explored to combat AMR and preserve the efficacy of existing antimicrobial agents (Ekwebelem et al., 2021).

STAGES IN CRISPR TECHNOLOGY IN AMR



Source:https://www.takarabio.com/learning-centers/gene-function/gene-editing/gene-editing-tools-and-information/introduction-to-the-crispr/cas9-system

GLOBAL THREAT OF THE ANTIMICROBIAL RESISTANCE

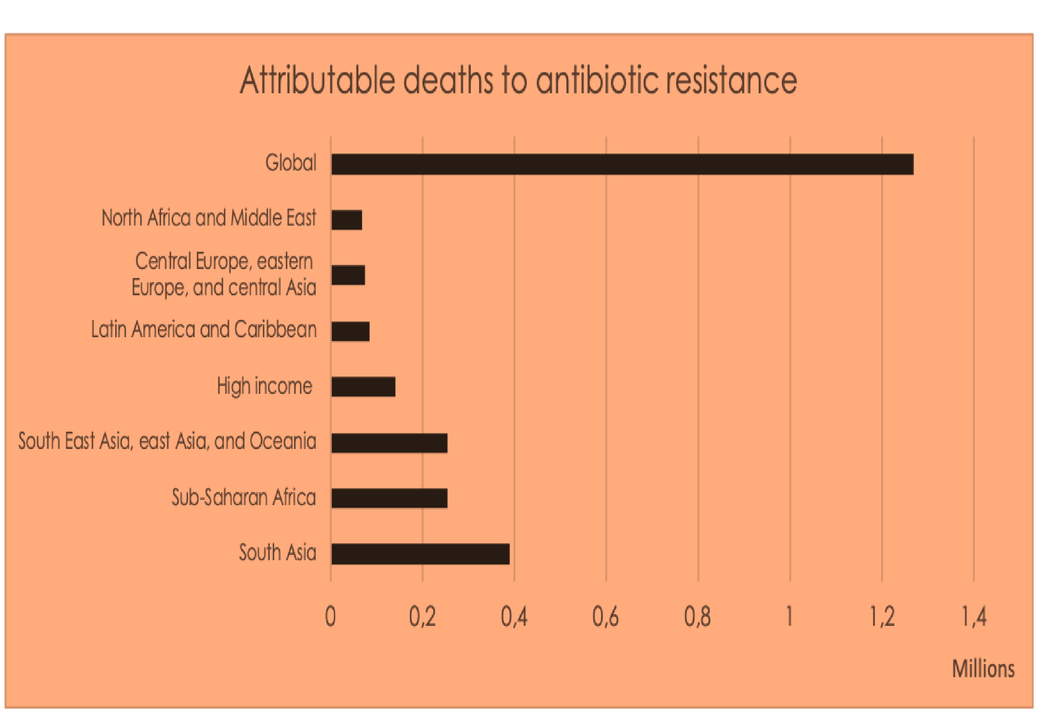


Figure 1: 2022 Attributable deaths to antibiotic resistance. (GRAM study)

THE POTENTIAL APPLICATION OF CRIPSR TECHNOLOGY IN COMBATING AMR

The stride of development of novel antibiotics lacks behind the stride of evolving antibiotic resistance, which is inadequate to tackle the upsurge in antibiotic resistance. As an outcome, genomic engineering approaches for gene knock-in and knock-out of sequence-specific DNA antibiotic targets have been projected as new boulevards for reducing and restraining antibiotic resistance in pathogens. These techniques include zinc finger nuclease (ZFNs), phage therapy application of peptide nucleic acid (PNA) as an ultra-fine-range antibiotic and collected frequently interspaced short palindromic repeat- CRISPR-associated (CRISPR Cas) systems (Mayorga-Ramos et al., 2023) The spread of antibiotic-resistant bacteria is a source of major global concern as it is a rising cause of fatal therapeutic failures, and this is anticipated to continue increasing in the future. On the other hand, the discovery of new antibiotics has stalled significantly over the past decade, and the development of novel approaches to address the spread of antimicrobial resistance genes demands substantial efforts. This dichotomy emphasizes the need to develop innovative antimicrobial strategies as a viable alternative to existing antibiotics. One major disadvantage of conventional antibiotics is the lack of species specificity, as they can induce metabolic and structural damage into large bacterial communities of both beneficial and pathogenic strains (Mayorga-Ramos et al., 2023)

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