

A Comparative Analysis of CRISPR-Cas9 and RNA Interference Mechanisms in Gene Expression Modulation

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Abstract. This study investigates the differential efficacy of CRISPR-Cas9 and RNA interference (RNAi) in modulating gene expression, addressing their applications in therapeutic settings. Utilizing a structured comparative framework, this analysis evaluates target accessibility, off-target effects, and phenotypic outcomes. Results highlight CRISPR-Cas9's superior precision, while RNAi demonstrates robust silencing efficacy in specific contexts. The findings enhance our understanding of genetic tool selection, offering insights into optimizing therapeutic interventions for genetic disorders.

Keywords: CRISPR-Cas9, RNA interference, gene expression modulation, genome editing, therapeutic intervention, genetic disorders, off-target effects, functional genomics

Introduction

The precision modulation of gene expression is pivotal in understanding biological processes and developing therapeutic strategies for genetic disorders. In recent years, the advent of CRISPR-Cas9 and RNA interference (RNAi) technologies has revolutionized our approach to genetic manipulation. CRISPR-Cas9, a groundbreaking genome editing tool, offers unprecedented specificity in gene targeting, enabling precise modifications that have transformed research across various life science disciplines. Conversely, RNAi provides a

mechanism for transient gene silencing, offering an alternative strategy for functional genomics and therapeutic applications. However, the comparative merits of CRISPR-Cas9 and RNAi in gene expression modulation remain underexplored, necessitating a detailed investigation into their respective mechanisms and outcomes. This paper provides a comprehensive analysis of CRISPR-Cas9 and RNAi, focusing on their mechanisms, target specificity, and physiological impacts. We present experimental data comparing their effectiveness in various cellular contexts and discuss the implications of these findings for future research. Our study aims to guide researchers in selecting appropriate genetic tools based on specific experimental needs and therapeutic goals.

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