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CRISPR-Cas9 Technology in Cancer Therapy: Advancing Precision Genome Editing for Targeted Cancer Treatment

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ABSTRACT

Cancer remains one of the major global health challenges due to its complex genetic characteristics, uncontrolled cellular growth, and ability to develop resistance against conventional therapeutic approaches. Recent developments in molecular biotechnology have introduced CRISPR-Cas9 technology as a promising genome-editing tool with the potential to transform cancer research and treatment. This technology enables targeted modification of specific DNA sequences through the interaction of guide RNA (gRNA) and the Cas9 endonuclease, allowing researchers to investigate and manipulate genes associated with cancer development and progression.

The present review focuses on the potential applications of CRISPR-Cas9 in cancer therapy, particularly in the regulation of oncogenes, restoration of tumor suppressor gene functions, and improvement of immune-based therapeutic strategies. It also explores the use of CRISPR-mediated gene editing in identifying cancer-specific molecular targets, understanding drug resistance mechanisms, and developing genetically modified immune cells for enhanced tumor recognition. Furthermore, emerging delivery approaches, including lipid nanoparticles and viral vectors, are discussed in relation to their ability to improve the targeted transportation of genome-editing components.

Despite its therapeutic potential, several limitations continue to affect the clinical application of this technology, including unintended genetic modifications, delivery difficulties, tumor heterogeneity, and concerns regarding long-term genomic stability. Addressing these challenges through improved editing accuracy, advanced delivery systems, and comprehensive safety assessment is essential for future clinical applications.

Overall, CRISPR-Cas9 represents an important advancement in cancer biotechnology and provides new opportunities for developing precise, personalized, and potentially more effective therapeutic strategies. Continued research may help establish genome-editing approaches as an important component of future cancer treatment.

Keywords: CRISPR-Cas9, Cancer Therapy, Genome Editing, Gene Regulation, Tumor Suppressor Genes, Oncogenes, Immunotherapy, Precision Medicine.