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Epigenetic Reprogramming of Aging: Reversing the Clock for Regenerative Medicine

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Abstract : Aging is a complex biological process characterized by the progressive decline of physiological functions and increased vulnerability to age-related diseases. Epigenetic changes, particularly DNA methylation alterations, play a critical role in the aging process by influencing gene expression and genomic stability. This study explores the potential of epigenetic reprogramming as a strategy to reverse aging phenotypes in human fibroblasts. Using CRISPR-Cas9 gene editing and small molecule inhibitors targeting DNA methylation and histone acetylation, we successfully induced significant changes in DNA methylation and gene expression profiles. Our results demonstrate a global reduction in DNA methylation levels and the identification of differentially methylated regions (DMRs) associated with cellular senescence and DNA repair. Additionally, treated fibroblasts exhibited enhanced proliferative capacity, reduced cellular senescence, and improved differentiation potential. These findings suggest that epigenetic reprogramming could be a promising approach for regenerative medicine, offering potential therapeutic strategies to counteract age-related decline and extend healthy lifespan.

Keywords : epigenetic reprogramming, aging, regenerative medicine, DNA methylation, cellular rejuvenation, CRISPR-Cas9, senescence
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