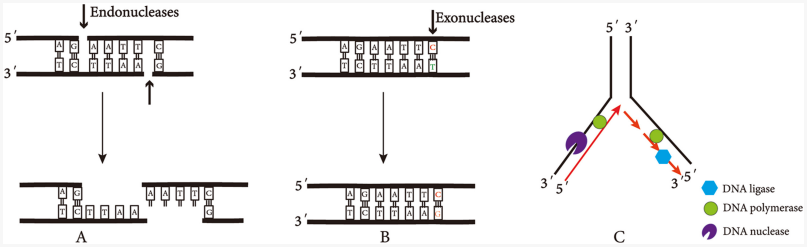
Unlocking the Power of DNA Exonucleases and Endonucleases in Immunity

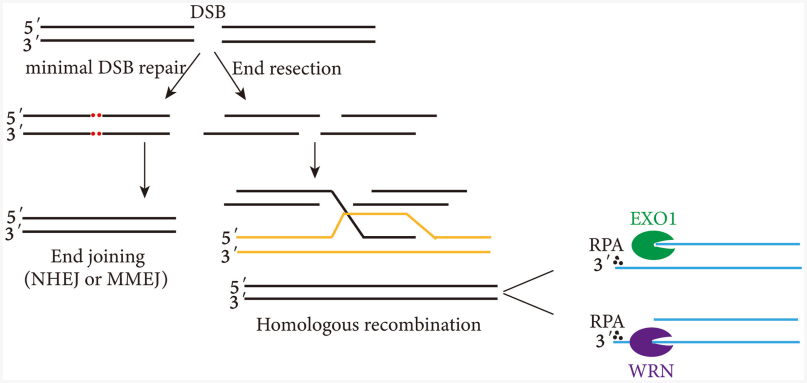
SHANNON, CLARE, IRELAND, March 2, 2025 /EINPresswire.com/ -- A recent review highlights the critical role of DNA exonucleases and endonucleases in immune response and disease management, shedding new light on their potential applications in genomic stability, autoimmune disorders, and cancer treatment.

DNA exonucleases and endonucleases are essential in maintaining genome integrity, executing precise cleavage of damaged or foreign DNA to initiate immune responses. These nucleases play a pivotal role in activating key innate immune pathways, such as the cGAS-STING pathway, which enables the body to mount an effective anti-viral and anti-tumor response.

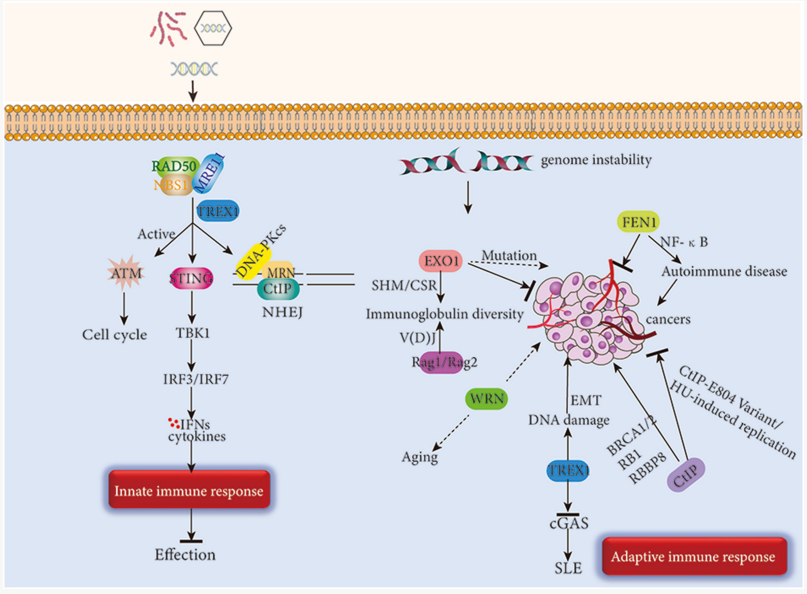
The analysis explores the dual-edged nature of genomic instability, revealing how mutations in these nucleases contribute to various autoimmune diseases, including rheumatoid arthritis and Aicardi-Goutières syndrome. Conversely, targeting exonuclease and endonuclease activity could be leveraged to disrupt the genomic integrity of cancer cells, increasing their susceptibility to immunotherapy and radiation treatments.



Functions of DNA nucleases. (A) DNA endonuclease recognition specific sites. (B) Mismatch repair. (C) DNA replication.



Functions of DNA nucleases in DNA repair.



DNA nucleases in the immune response.

MRE11, a nuclease with dual exonuclease and endonuclease activity, is crucial for DNA damage repair and modulating the immune response. It also plays a role in T-cell lifespan regulation, making it a potential target for autoimmune therapies. EXO1, known for its role in mismatch repair (MMR), influences the immune response by enhancing checkpoint therapies in specific cancer types, particularly those with microsatellite instability (MSI). TREX1, a cytoplasmic exonuclease, prevents dsDNA accumulation, thereby reducing autoimmunity risks while also acting as a key regulator of tumor immunogenicity in radiotherapy. FEN1 and MUS81-EME1, essential for DNA metabolism and repair, are linked to tumor proliferation and could be targeted to enhance immunotherapy efficacy.

The findings highlight the potential of nuclease-based therapeutic interventions for both immune disorders and cancer. Understanding how these enzymes regulate DNA integrity and immune signaling offers promising avenues for future exploration, with significant implications for personalized medicine and immunotherapy strategies.

This review opens the door to novel therapeutic targets, emphasizing the importance of a balanced approach in leveraging nuclease activity to combat disease progression while preserving genomic stability.

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Reference
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Genes & Diseases Editorial Office
Genes & Diseases
+86 23 6571 4691
editor@genesndiseases.com
