DNA ligase: The molecular glue that holds life together.

Alan Tomkinson*

Departments of Molecular Genetics & Microbiology, University of New Mexico, United States

Introduction

Deoxyribonucleic acid, or DNA, is the blueprint of life, carrying the genetic information that guides the development, functioning, and reproduction of all living organisms. The integrity of this molecule is paramount for the continuity of life. However, DNA is constantly subjected to damage and breaks due to various factors, including radiation, chemical agents, and even normal cellular processes. Repairing these damages is essential to prevent mutations and ensure genetic stability. One of the key players in this complex cellular drama is DNA ligase. [1].

DNA repair is a fundamental process that ensures the genome's stability. Without efficient repair mechanisms, organisms would accumulate genetic mutations, leading to a myriad of diseases and, in the long run, jeopardizing their survival. DNA damage can result from both endogenous and exogenous factors, such as errors in DNA replication, exposure to ultraviolet light, or the effects of chemical mutagens. Repair mechanisms have evolved to address these challenges, with DNA ligase playing a crucial role. [2].

DNA ligase is an enzyme that plays a central role in DNA repair and replication. Its primary function is to join together or "ligate" the phosphate-sugar backbones of adjacent DNA strands. It acts like the molecular glue that binds the broken ends of DNA molecules, ensuring their structural integrity and functionality.DNA ligase is essential during DNA replication, the process by which the entire genome is copied during cell division. As DNA polymerases synthesize new DNA strands, small gaps, or "nicks," are created between the Okazaki fragments on the lagging strand. DNA ligase repairs these nicks by sealing the phosphodiester bonds, thus forming a continuous and functional DNA molecule. [3].

DNA ligase plays a crucial role in various DNA repair mechanisms, including base excision repair (BER) and Nucleotide Excision Repair (NER). In BER, DNA ligase seals the gaps created during the removal of damaged or incorrect DNA bases. In NER, it rejoins the DNA strands after the excision of a damaged segment. These repair processes are vital for maintaining genetic integrity and preventing mutations.DNA ligase is a valuable tool in molecular biology and biotechnology. It is used in recombinant DNA technology to splice together DNA fragments from different sources, creating recombinant DNA molecules. This technique has revolutionized genetic engineering, enabling the creation of genetically modified organisms and gene therapy.

The catalytic activity of DNA ligase is facilitated by a complex set of biochemical reactions. It requires ATP (adenosine triphosphate) as an energy source and a DNA strand with a free 3'-hydroxyl (-OH) and a 5'-phosphate (-PO4) end. [4,5].

Conclusion

DNA ligase is an indispensable enzyme in the realm of genetics and molecular biology. It serves as the guardian of DNA integrity, ensuring that the genome remains intact and functional, free from errors and damage. Understanding the role of DNA ligase not only sheds light on the intricate mechanisms of DNA repair and replication but also underscores its significance in biotechnological advancements. As we continue to explore the depths of genetics and genomics, DNA ligase remains a crucial player in the quest to decipher the secrets of life encoded in our DNA.

References

1. Tomkinson AE. DNA ligases: structure, reaction mechanism, and function. Chem Rev. 2006 ;106(2):687-99.
2. Shuman S. DNA ligases: progress and prospects. Bio Chem. 2009;284(26):17365-9.
3. Cuenoud B, Szostak JW. A DNA metalloenzyme with DNA ligase activity. Nature. 1995 ;375(6532):611-4.
4. Altmann T, Gennery AR. DNA ligase IV syndrome; a review. Orphanet J Rare Dis. 2016;11(1):1-7.
5. Engler MJ. 1 DNA Ligases. 1982;1 (15):3-9.
6. Wilkinson A. Bacterial DNA ligases. Mol Micro Bio. 2001;40(6):1241-8.
7. Lohman GJ. DNA ligases. Curr Protoc Mol Biol. 2011;94(1):3-14.
8. Tomkinson AE. Mammalian DNA ligases. 1997;19(10):893-901.
9. Doherty AJ. Nick recognition by DNA ligases. J Mol Bio. 2000 ;296(1):43-56.
10. Willis AE. DNA ligase I deficiency in Bloom's syndrome. Nature. 1987 ;325(6102):355-7.

***Correspondence to:** Alan Tomkinson, Departments of Molecular Genetics & Microbiology, University of New Mexico, United States, Email: atomkinsonsal@ud.unm.edu

***Received:** 24-Oct-2023, Manuscript No. AARRGS-23-119060; **Editor assigned:** 28-Oct-2023, Pre QC No. AARRGS-23- 119060 (PQ); **Reviewed:** 10-Nov-2023, QC No. AARRGS-23-119060; **Revised:** 15-Nov-2023, Manuscript No. AARRGS-23-119060 (R); **Published:**22-Nov-2023, DOI:10.35841/aarrgs-5.6.176*

***Citation:** Tomkinson A. DNA ligase: The molecular glue that holds life together .J Res Rep Genet.2023;5(6):176*