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Perspective

Role of Replication Enzymes in Clinical Genomics

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DESCRIPTION

Every cells genetic material is encoded in DNA. DNA replication is the process through which cells make copies of the genome's DNA. A cell must first copy (or duplicate) its entire genome before it can divide, ensuring that each daughter cell has a complete genome upon division. Biomolecules and organelles must be replicated in order to be redistributed among the cells prior to a cell duplicating and dividing into new daughter cells through either mitosis or meiosis. For cell development, repair, and reproduction in organisms, DNA replication is essential. Four steps for replicating DNA includes: Replication Fork Formation, Primer Binding, Elongation and Termination. The enzymes used in this process are known as replication enzymes.

Enzymes used in Genomics

DNA helicase: Its major function is to untangle the genetic code of an organism. Helicases are motor proteins that use the energy from ATP hydrolysis to move in one direction along a nucleic acid phosphodiester backbone, separating two bonded nucleic acid strands (thus the name "helicase"). Numerous helicases exist to represent the wide range of processes that require strand separation to be catalysed. Helicases are encoded by about 1% of eukaryotic genes.

DNA polymerases: The family of enzymes that catalyse the synthesis of DNA molecules from nucleoside triphosphates, the basic building blocks of DNA is known as DNA polymerase. These enzymes, which are required for DNA replication, typically function in groups to divide an initial DNA duplex into two identical copies. Different DNA polymerases carry out specific duties. DNA polymerase III is the primary enzyme involved in replication in prokaryotes. In order to repair DNA, DNA polymerase I and II must remove the primer and fill in the gaps. DNA polymerase is the key enzyme for replication in eukaryotes. The repair, proofreading, and primer removal are carried out by additional DNA polymerases. Five distinct DNA polymerases, numbered I through V, are found in prokaryotes. DNA polymerase comes in a wide variety of forms in eukaryotes as well. Prokaryotic cells use DNA polymerase III in the replication process, and eukaryotic cells primarily use DNA polymerase as the replication enzyme.

DNA primase: DNA polymerase can only add nucleotides to the 3'OH group of the last nucleotide; it cannot start replication from start. A primer is necessary to start the replication process. This enzyme called primase facilitates the creation of a short RNA primer needed to start DNA replication. It creates primer that is complementary to the DNA single strand.

DNA Gyrase or Topoisomerase: While double-stranded DNA is being unwound by elongating RNA-polymerase or by helicase in front of the progressing replication fork, DNA gyrase, sometimes known as just gyrase, is a subclass of Type II topoisomerases that reduces topological strain in an ATP-dependent way.

Exonucleases: Exonucleases are enzymes that function by sequentially cleaving nucleotides from a polynucleotide chain's end (exo). Exonucleases can function as editors during DNA polymerization in DNA replication, removing odd DNA structures that result from issues with fork progression, and they can be actively involved in fixing damaged DNA.

DNA ligase : An enzyme known as a ligase, or DNA ligase, is a special type of enzyme that makes it easier to connect two DNA strands together by facilitating the formation of a phosphodiester bond. It helps living things repair single-strand breaks in their duplex DNA, while other varieties (like DNA ligase IV) may only repair double-strand breaks (i.e. a break in both complementary strands of DNA).

CONCLUSION

A single double-stranded DNA molecule can produce many identical DNA helices through the process of DNA replication. A strand from the original molecule plus a freshly generatedstrand make up each molecule. The DNA uncoils and separates before replication. A replication template called a replication fork is created. DNA polymerases add new nucleotidesequences in the 5′ to 3′ orientation once DNA primers attach to the DNA. Eukaryotic cells' interphase nuclei

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are where DNA replication takes place. Before mitosis, during the S-stage (synthesis) of the cell cycle, DNA replication takes place. It is a significant event that occurs within human cells and enables the body to maintain homeostasis and structural integrity. Due to their numerous uses, enzymes involved in DNA replication are currently the subject of extensive research. The most prominent example of how scientist are employing these enzymes and make future improvements in them is the recent breakthrough Cas9/CRISPR technology, which uses nucleases to cleave the desired section of DNA and replace it with necessary nucleotides.