DNA Replication

DNA replication is the process of creating a new DNA double helix from an original template. It is said to be semi-conservative, because the two resulting DNA double helices have one parent and one new strand. It begins with DNA gyrase uncoiling supercoils in the DNA, which stabilizes the separated single strands. Helicase separates the two DNA strands from each other in the original DNA helix, and single-stranded binding proteins help keep them separated. Once the DNA is stable and open, it is ready to be read. DNA polymerase is the enzyme that synthesizes the new strand by reading from the 3' to 5' direction on the leading strand. This allows for that strand to be built from the 5' to 3' direction, due to the anti-parallel orientation of DNA. Primase creates RNA primers, which are used are starting sites for DNA polymerase. Telomerase caps the DNA ends to prevent any unintended damage by exonucleases. In the lagging strand, DNA is still read from the 3' to 5' direction, but because the replication bubble is going in the opposite direction, short fragments have to be created. These are called Okazaki fragments, and they are joined together by DNA ligase.

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Characteristics

DNA Gyrase Uncoils Supercoil

DNA Gyro Uncoiling Supercoil

DNA gyrase helps uncoil supercoils in the DNA and stabilize it, as helicase works to separate the strands.

Helicase Separated DNA Strand

Helicopter-briefcase Separating DNA Strand

Helicase is a motor protein that moves along the phosphodiester backbone of DNA and separates two annealed strands into single strands.

Single-Strand Binding (SSB) Protein Keeps Strands Separated

Binder holding Open Single-strand

Single-stranded binding proteins are used to keep the strands separated from each other throughout replication.

DNA Polymerase Synthesizes New Strand

DNA Polly-mirror

DNA polymerase is the enzyme that reads DNA and creates a complementary DNA strand. This enzyme begins DNA synthesis at the site of an RNA primer, which is created by the enzyme primase.

3' To 5' Reading

Polly-mirror Reading from (3) Tree to (5) Hand

DNA is read in the 3' to 5' direction when being synthesized such that the new strand is made in the 5' to 3' direction. This means that one strand is made continuously, while the other is fragmented.

Primase Creates RNA Primer

Primate-ace spraying Primer onto RNA-rhinos

Primase creates the RNA primers that are used as starting markers for DNA polymerase.

Telomerase Caps DNA Ends

Telephone-mirror Capping End of DNA

Telomerase caps the ends of DNA, producing a region of hundreds of thousands of repetitive sequences on the 3-prime end. This protects the internal DNA sequences during replication damage, preventing unintended exonuclease activity and overall damage to the DNA sequence.

DNA Ligase Combines Okazaki Fragments

DNA Lion-Tiger-Ass combining O-Sock Fragments

The Okazaki fragments are the short sections of DNA that are discontinuous due to the 3' to 5' reading of the second strand. They are joined together by an enzyme called DNA ligase.

Okazaki Fragments On Lagging Strand

O-socks on Leggings Strand

The Okazaki fragments only exist on the lagging strand, because the leading strand is synthesized continuously.