Telomere Encyclopedia Article

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Telomeres are specialized **DNA** regions that consist of short, tandemly **repeated sequences** at the ends of linear chromosomes. Telomeres are found in all **eukaryotes** and are essential for normal **cell** growth. During **DNA replication**, telomeres complete the synthesis of chromosomes that otherwise would have been lost or recombined with other chromosomes during **replication**. However, there is still some shortening of the telomere with each DNA replication that is theorized to be equivalent to cell aging.

In 1973, Aleksei M. Olovnikov, a scientist at the Institute of Biochemical Physics in the Russian Academy of Sciences in Moscow, proposed the telomere theory of aging. Olovnikov claimed that during **DNA synthesis**, DNA **polymerase** fails to replicate all of the nucleic acids resulting in shortened chromosomes with each successive generation. Eventually, the cell will no longer divide and after enough critical regions have been deleted, the cell cycle will arrest.

Telomeres are synthesized by the enzyme telomerase, a **reverse transcriptase** that contains its own **RNA** template complementary to the telomere. After DNA replication, the RNA primer is removed leaving a gap at the end of the newly synthesized strand of DNA. In order to fill in the gap, the enzyme telomerase catalyzes the extension of the template strand at the end. This extension of DNA forms a hairpin loop that attaches to the end **nucleotide** on the newly synthesized strand, thus completing the telomere.

The existence and persistence of telomerase in normal cells is under active study. Telomerase is one of the factors believed to control the length of telomeres that act as a biological clock for the cell. Telomerase is not active all the time, nor is it found in every cell of the body. Researchers have discovered that if the action of telomerase is interrupted, the telomere will be abnormally short and the aging process of the cell accelerates, resulting in cell death much earlier than normal. Likewise, scientists theorize that the uninhibited action of telomerase can lead to cell immortality. **Cancer** cells have been found to have active telomerase that increases **cell proliferation** by extending telomeres. Researchers claim that when newly formed **tumor** cells arise, they turn on a **gene** for telomerase. However, some cancer cells have been found to extend their telomeres without turning on this gene. By understanding the role of telomeres and telomerase, scientists hope to one day predict and treat the onset of disease.