Telomeres and telomerase

Telomeres

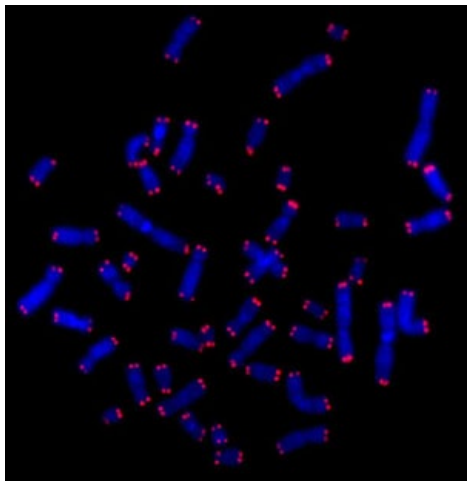
Telomeres are the ending parts of the eucaryotic nuclear chromosomes. Human telomeres consist of more than 2000 short repetitive sequences 5'-TTAGGG-3' which are associated with specialized proteins that protect telomeres from degradation by the enzymes. Telomeres are crucial structures of the chromosome - they take part in DNA replication, crossing-over and synapsis of homologous chromosomes during prophase of the first meiotic division, also they are necessary for chromosome integrity. Lenght of the telomeres depends on the cell cycle and senescence.

Telomere's task during replication

DNA replication requires DNA polymerase, deoxynukleotides, primer, sequence of the oligonucleotides, RNA sequence which anneals to DNA template following complementary base pairing rule and enables replication. DNA polymerase is not able to iniciate synthesis of the new DNA molecule itself, it can only lengthen already synthetized regions. That's why primers are required for the iniciation. After the end of replication primers are destroyed by the enzymes. DNA polymerase attaches nucleotids to 3′-ends so it can't replace the missing primer nucleotides on the 5′-end. As a result every new DNA molecule becomes shorter after the replication. DNA is shortened in repetitive telomere sequences for about 50-200 nucleotide paires. Lenght of the telomeres can be used for determination of replication age of the cells. If it reaches definite minimal length of the telomers, cell dies by apoptosis.

Telomerase

Some types of cells contain active enzyme telomerase, which has an ability to lengthen telomere sequences of the single-stranded DNA before replication. **Telomerase** is a ribonucleoprotein with RNA-dependent DNA-polymerase activity. It attaches new repetitive sequences to 3′-end of the single-stranded DNA. This mecanism compensates shortening of the telomeres during the DNA replication.



Chromosomes blue, telomeres red

Telomerase activity

Telomerase activity is connected with functions and proliferative activity of the cells. The level of telomerase activity is high in embryonic stem cells, in cells of the tissue with hight reparation activity (lymphocytes, hematopoietic stem cells, cells in basal layer of the epidermis, cells of the interstitional crypts) and in the male stem cells. On the contrary telomerase is almost absent in the differenciated somatic cells. Activation of the telomerase is also responsible for imortalisation of some cancer cells.

In 2009 Elizabeth H. Blackburn, Carol W. Greider and Jack W. Szostak were awarded the Nobel Prize in Physiology or Medicine for discovery and research of telomerase activity. (https://www.nobelprize.org/nobel_prizes/medicine/laureates/2009/advanced-medicineprize2009.pdf)

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