Telomeres

Mission Objective

Scientists in training will investigate what telomeres are and how the structures responded in space.

Background

What is a telomere?

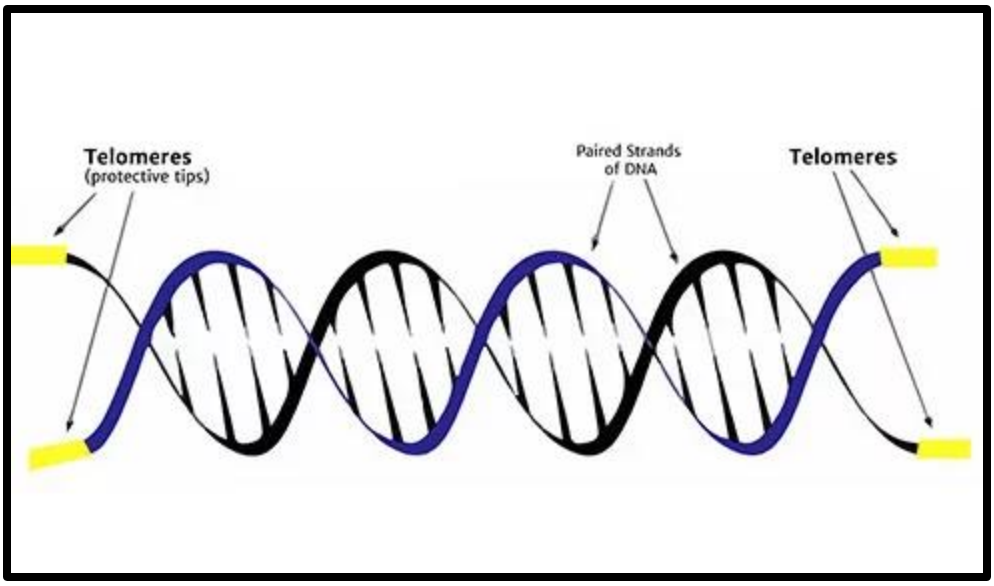
DNA contains all the instructions that make up who we are, every organ in our body (skin, liver, heart, lungs, kidneys, etc.), the color of our hair, our height, etc. All of our DNA, and thus the instructions are protected by structures called telomeres.

Telomeres are an important part of human cells and affect how our cells age. These important structures are like caps on the ends of DNA and protect our chromosomes from damage. You can imagine them like the plastic ends on shoelaces, without those plastic ends, shoelaces can get frayed and after a while can no longer do their job. Just like DNA, without telomeres DNA can get damaged and cells can no longer work correctly.

Our bodies, are made up of billions and billions of cells. In order to work throughout our whole lives, the cells need to replenish by copying themselves which they do constantly. However, every time our cells replenish and divide the telomeres shorten. Eventually, telomeres get too short to do their job of protecting our DNA. This causes damage to the DNA in our cells and they begin to "age" and stop functioning correctly. This is why telomeres are often referred to as a cellular clock, able to tell how old (how many divisions) a cell has undergone.

Telomere length does not show our actual chronological age (how many years old we are), but better reflects our biological age. Many scientific studies have shown that without the protection from telomeres our cells age and die. When telomeres get too short, it acts as a signal to the cell that it can no longer divide and reproduce which will ultimately cause those tissues and organs to degenerate (get weak) and eventually die.

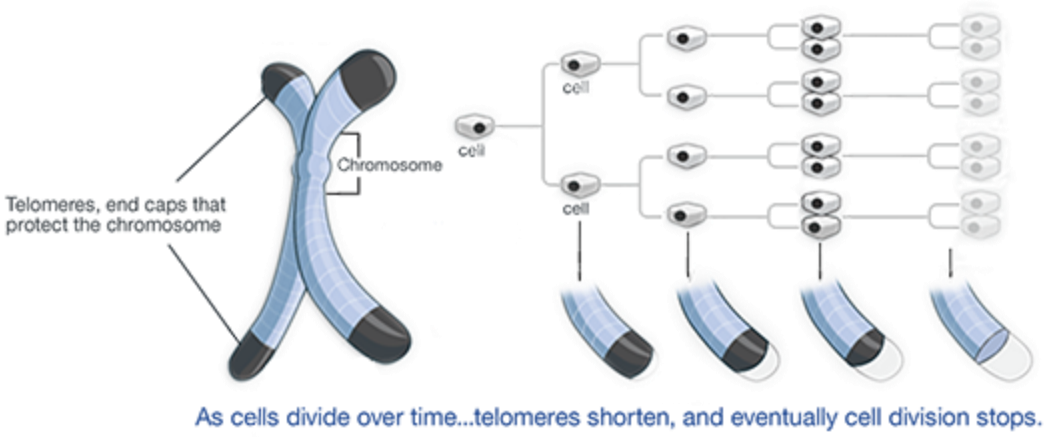
Telomeres in humans are made up of the DNA sequence TTAGGG repeated around 3,000 times.



What causes telomeres to shorten?

Telomeres naturally shorten as we age (and cells divide) but they can also be shortened by stress, smoking, obesity, lack of exercise and a poor diet.

An enzyme called telomerase, works to maintain and keep our telomeres long. As we age, the level of telomerase declines and that also contributes to the shortening of our telomeres over time. The 2009 Nobel Prize in Physiology/Medicine was awarded to the three scientists (Jack W. Szostak, Elizabeth Blackburn, Carol W. Greider) who discovered the role of telomerase.



As cells divide over time...telomeres shorten, and eventually cell division stops.

Materials

Wooden DNA piece or double helix

Telomere colored wooden blocks

Laminated cards with different life events/life choices

Event cards

The telomeres should be arranged in the following order:

The blocks should be in the following order: red, red, green yellow, yellow, yellow and repeated.

Methods

1. Show the participants the wooden DNA model or helix and explain to them that it represents your DNA, the DNA that are the instructions for the structure and function of living organisms. The colored blocks represent the telomeres or protective caps that shield DNA from damage during cell division/replication.

2. Set-up the timer and let the participants know that in this model, the cells are going to divide every minute, so they must remove two telomere blocks every minute. In addition, there is also a stack of event cards and each of those event cards may effect telomere length (increase the telomere length, decrease the telomere length or leave it alone).

3. The participants must pull 1 event card every minute and either add or take away additional blocks. Once out of the last red telomere block the cells can no longer divide! Check the time to see how long the cells survived. Discuss what types of events lead to increased or decreased telomere length and how space travel could affect telomere length.