



The Telomere Assay: A Window to Cellular Aging

Featured on NBC

Telomere
Testing

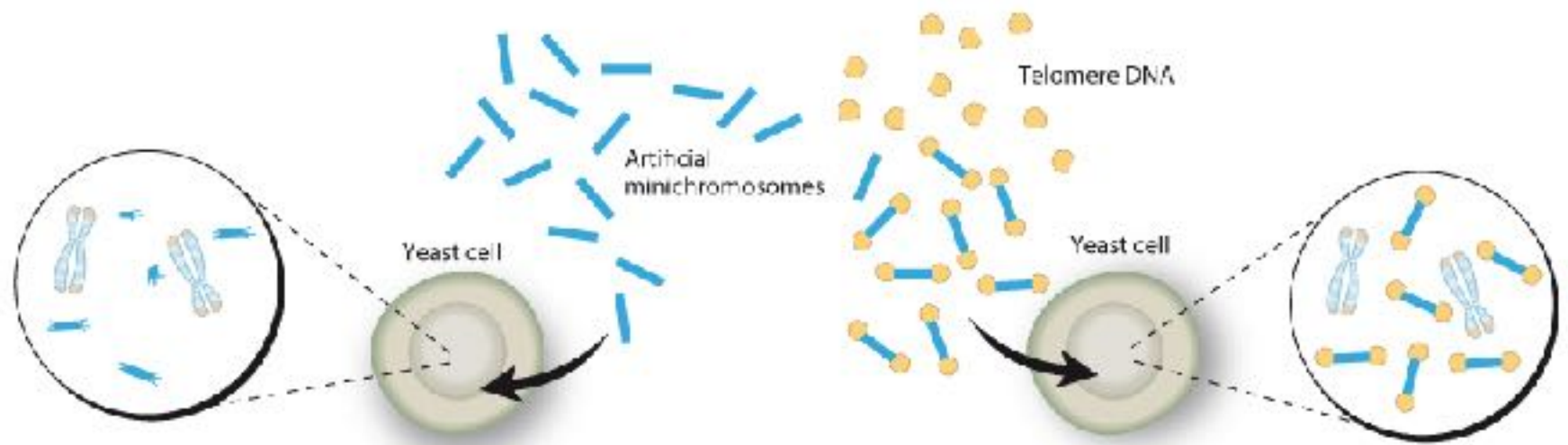


Telomere Research

2009 Nobel Prize in
Physiology or Medicine
awarded for the discovery of
of
*“how chromosomes are
protected by telomeres
and they enzyme
telomerase”*



The Science Behind It's Importance



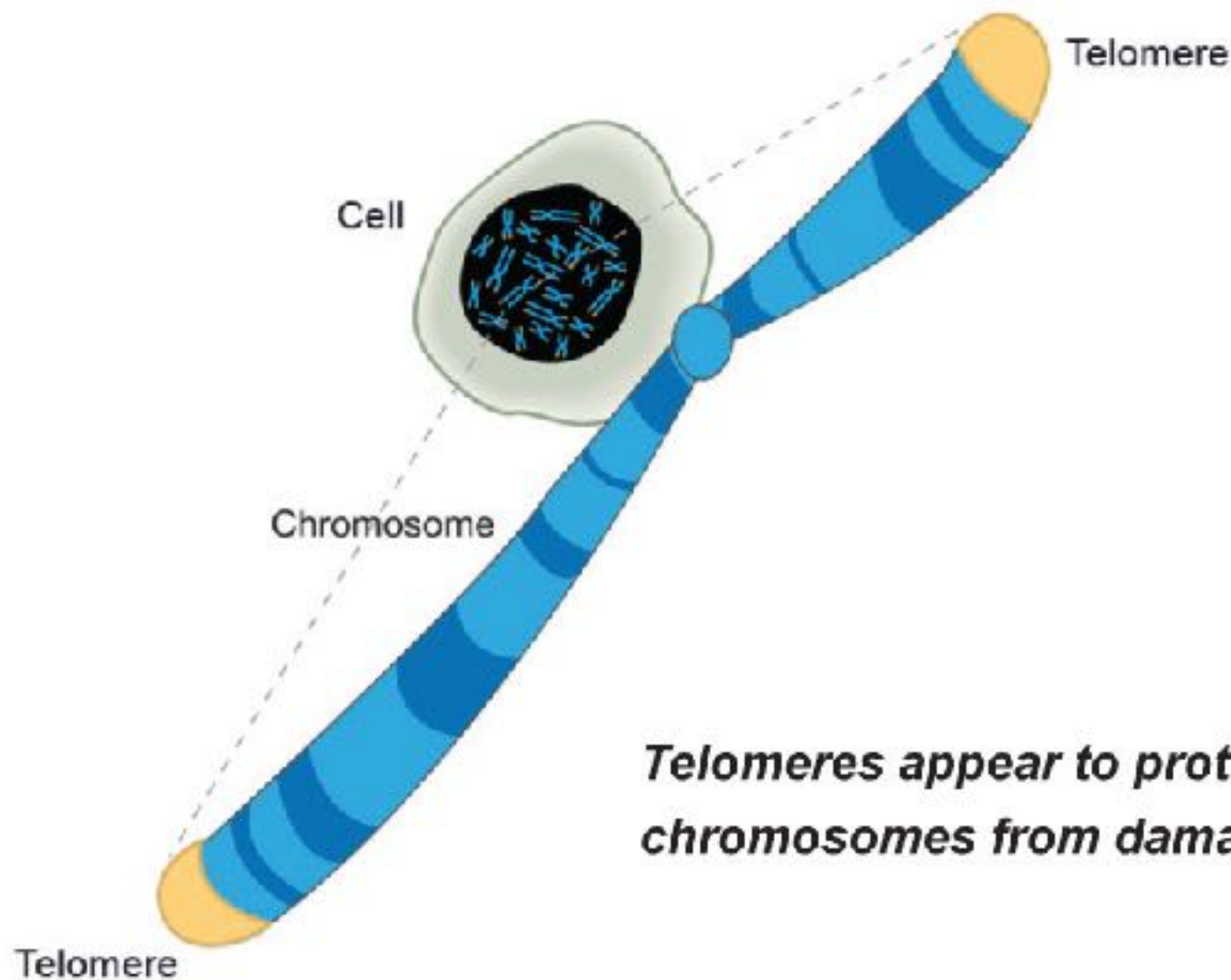
***Chromosomes without telomeres
were unprotected and damaged.***

***Chromosomes with telomere DNA
were protected and remained intact.***

What are Telomeres?

- Telomeres are...
 - Repetitive DNA sequences at the ends of all human chromosomes.
 - They contain thousands of repeats of the six-nucleotide sequence, TTAGGG.
 - In every human cell there are 23 pairs of chromosomes and thus 92 telomeres (one at each end of 46 total chromosomes) in every cell.

What is a Telomere?

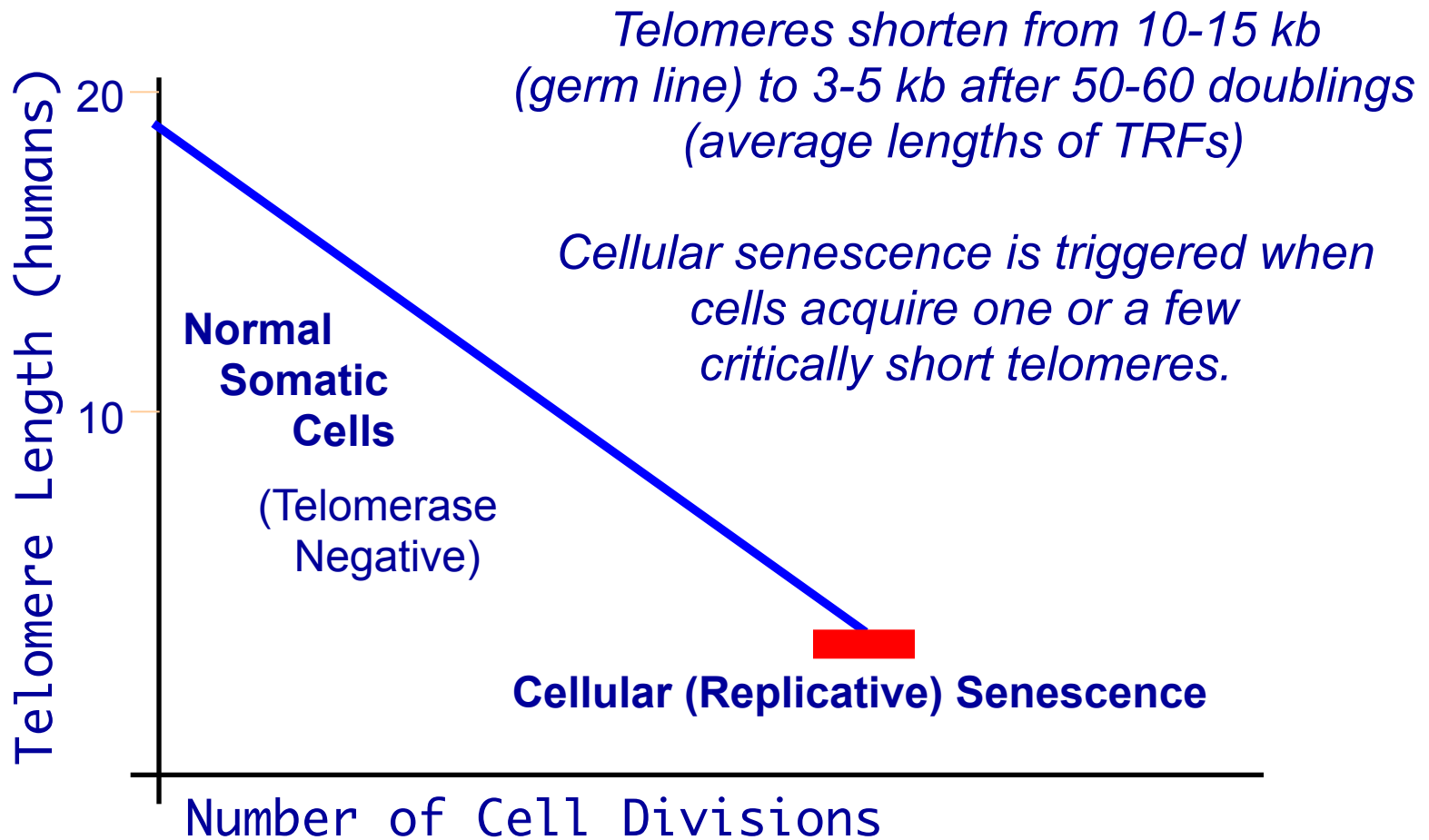


Telomeres appear to protect the chromosomes from damage.

What Do Telomeres Do?

- Telomeres protect and separate the chromosomes, similar to the way the plastic on the ends of our shoelaces "caps" and protects the shoelaces from unraveling.
- Every time a cell divides, the telomere get a little bit shorter. When the telomeres reach a critical size (~3 kb), the cells stop dividing.
- In this way telomeres act as both a cellular clock, and a brake on uncontrolled cell division (cancer).

Telomeres provide a means for "counting" cell division, because they shorten with each cycle



Telomeres & Aging

- It is believed that shortened telomeres in mitotic (dividing) cells may be responsible for some of the changes we associate with normal aging.
- Because there is very little telomerase in somatic tissues, older people have shorter telomeres particularly in actively regenerating tissues such as skin and intestinal epithelia.
- It is also thought that the telomere shortening mechanistically prevents uncontrolled cell division (e.g., cancer).

Factors Linked to Telomere Shortening

- Clinical findings linked to shortened telomeres
 - Oxidized LDL
 - Smoking
 - Obesity
 - Nutrient deficiencies
 - Sleep deprivation, poor quality sleep
 - Lack of estrogen
 - Lack of testosterone
 - Lack of human growth hormone
 - Increased homocysteine
 - Diabetes/ insulin resistance
 - Oxidative stress

TELOMERES

Calcium
Required cofactor to prevent DNA replication errors.²⁵

Folate Influences telomere length via DNA methylation.^{1,2,3}

B3 Extends lifespan of human cells in vitro; Slows telomere attrition rate by reducing reactive oxygen species in mitochondria.^{4,5}

B2, B6 and B12
Crucial for proper DNA methylation.^{6,7}

Cysteine
Stem cell treatment with N-acetyl cysteine corrects DNA damage in telomeres.⁸

Zinc Important cofactor for DNA repair enzymes; key role in regulating inflammation.⁹

Copper Key cofactor in the potent antioxidant superoxide dismutase that is known to protect telomeres.¹¹

Magnesium induced deficiency shortened telomeres in rat livers; Regulates chromosome separation in cell replication.¹²

Selenium In vitro supplementation extended telomere length in liver cells; selenoproteins protect DNA.^{13,14,15,16}

Glutathione
Interference of glutathione dependent antioxidant defenses accelerates telomere erosion.^{17,18}

Vitamin C Protects DNA from oxidation. In vitro studies show it slows down age-related telomere shortening in human skin cells.^{19,20}

Vitamin E Enhances DNA repair as well as removal of damaged DNA; Shown in vitro to restore telomere length on human cells.^{21,22}

Vitamin D
Positively associated with telomere length due to its anti-inflammatory role.²³

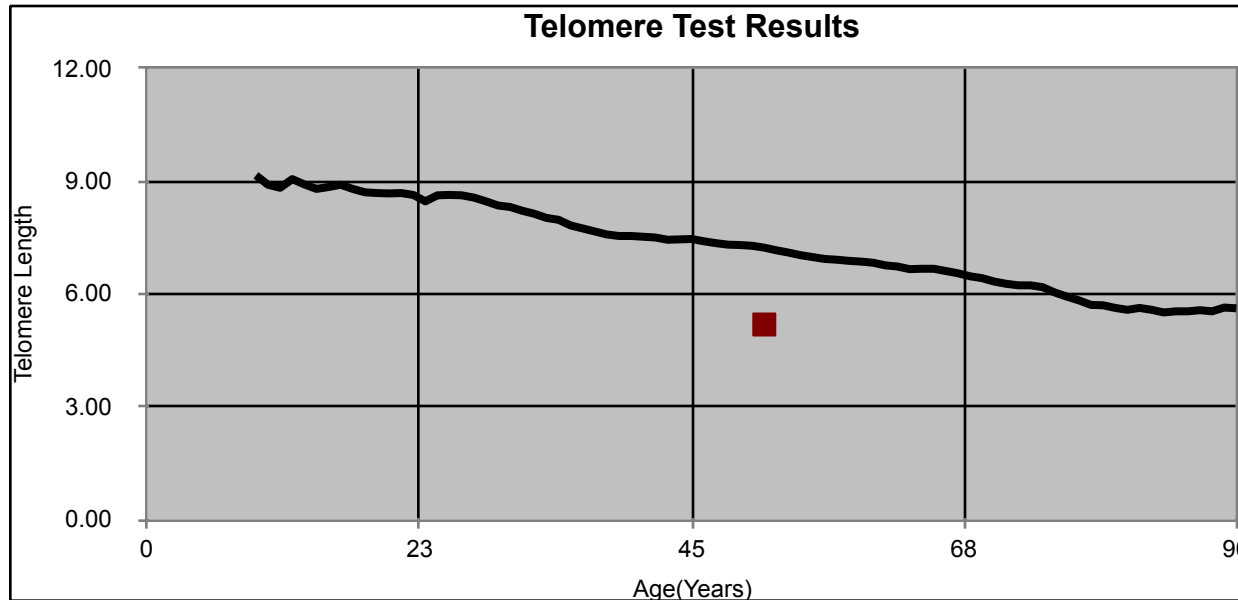
Manganese
Required cofactor in Mn superoxide dismutase, a deficiency in which decreases telomerase activity.²⁴

Meet My Patient - “Bob”

- 51 year old male
- Triathlete
- Stressful job (Litigation Attorney)
- Generally follows good diet
- Slim (good BMI)
- Executive physical results
 - Cholesterol 210, Triglycerides <100
 - CBC, chemistry, EKG = all normal
 - Told he is healthy, return in one year...



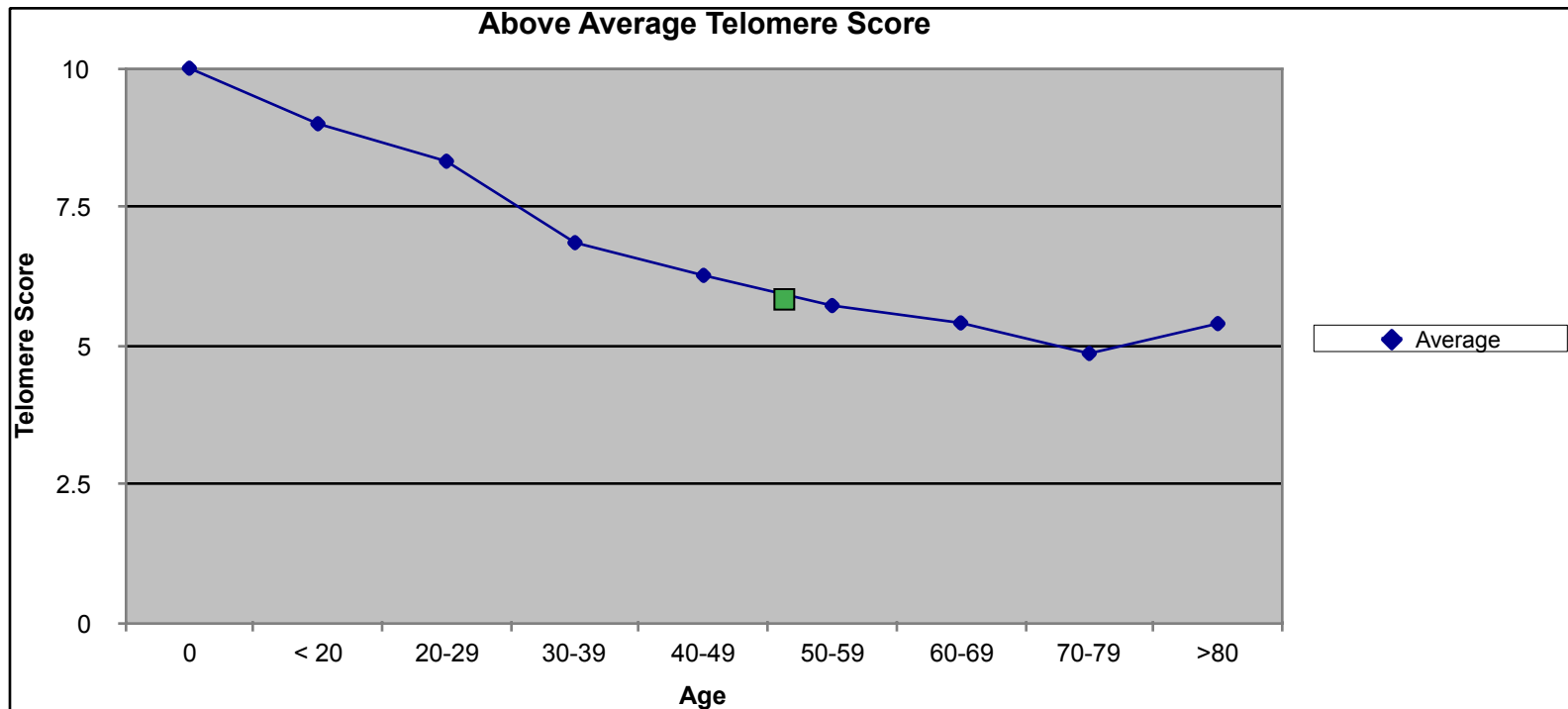
“Bob’s” Below Average Telomere Score



Patient Telomere Score = 5.19

Percentile = 7%

- A patient’s telomere score is compared to the average telomere score for each age group within a random sample population.



- Male in his late forties

- Patient Telomere Score: 9.34

- Percentile: 96

•The above graph depicts the patient’s telomere score compared to the average telomere score for each age group within a random sample population of approximately 800 individuals.

•A patient telomere score below the line (red box) represents a below average telomere score, and a patient score above the line (green box) represents an above average telomere score. If the patient’s age was not provided, a horizontal line representing the patient’s telomere score across all age groups will be shown.

What do I do with the results?

- **Good telomere score, good lifestyle**
 - Affirmation that what they are doing is working
- **Poor telomere score, bad lifestyle**
 - Impetus to make serious changes
 - Evidence of internal aging before external disease
- **Poor telomere score, good lifestyle**
 - Take a closer look at lifestyle
 - *Quality* of food they eat, excessive exercise, stress...
 - Look further into diagnostics
 - *Subclinical* nutritional deficiencies
 - Antioxidant & inflammatory status
 - Food sensitivities
 - Consider hormone replacement therapy

Modifiable Risk Factors

- Strengthen immune function
- Optimize methylation metabolism
- Limit inflammatory processes
- Improve mitochondrial function
- Reduce (manage) chronic stress
- Regulation of glycemic control & insulin function
- Correct nutritional deficiencies

What Do I Do with Results?

- Look further at available diagnostic tools
 - Food allergy (sensitivity) testing
 - Allergy testing is skin prick testing for anaphylaxis (IgE)
 - Sensitivity testing looks at delayed antibody reactions to food (IgG or IgA)
 - Hormone testing
 - Gut function and flora
 - Omega 3 Index
 - DHA and EPA levels
 - Omega 6: omega 3 ratio
 - **Correct nutritional deficiencies!!**