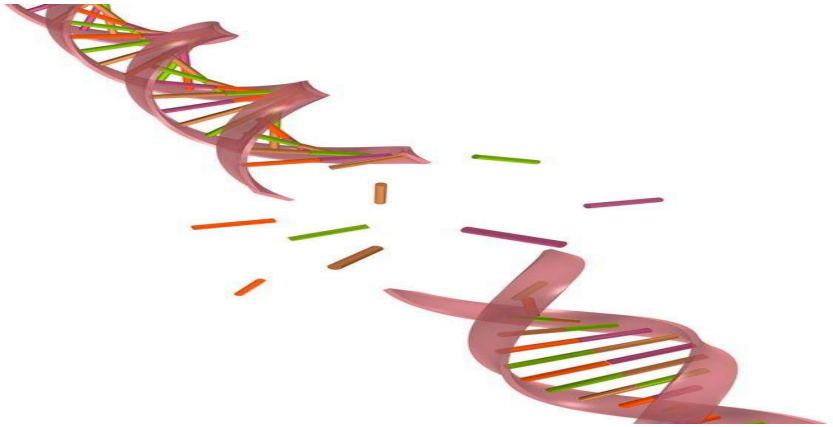
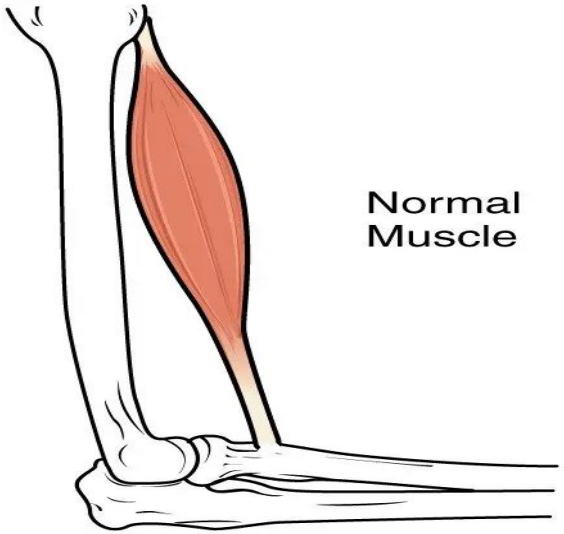
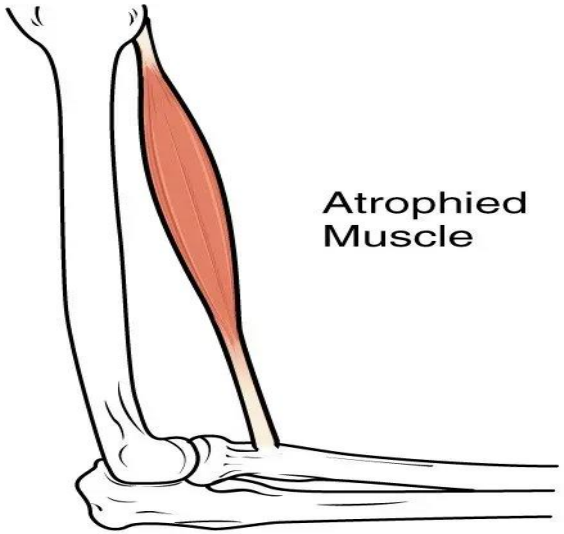
• Sarcopenia: The loss of muscle mass as we age and ways to slow its progression







- Written by Dana Rizzo RN, BSN, ACM-RN
- August 2024
- Dana.Rizzo@singhmail.com
- Area Manager for Waltonwood Ashburn Senior Living

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Objectives: Upon completion of this presentation the learner will be able to:

- **List Four Factors that affect Biological Aging.**
- **List eight Biomarkers of Aging.**
- **Define Apoptosis.**
- **Define Cell Senescence and the role of Telomeres.**
- **List three triggers for Apoptosis to occur.**
- **Discuss the role of the Mitochondria and ATP Production in the aging process.**
- **Define Sarcopenia.**
- **List three factors that contribute to Sarcopenia.**
- **List four lifestyle changes that can slow down the process of Sarcopenia.**

The Process of Biological Aging

- As cells age, they function less well.
- Eventually old cells must die. Programmed.
- Apoptosis is a type of cell suicide.
- Old cells die to make room for new cells. Cells can only divide a limited amount of times. Genes program this.
- The mechanism that limits cell division involves a structure called TELOMERE.
- TELOMERES are used to move the cell's genetic material in preparation for cell division.
- Every time a cell divides, the telomeres become shortened a bit.
- Eventually, telomeres become so short they can no longer divide.
- When a cell stops dividing, it is called SENESCENCE.
- <u>Three Triggers for Cell Death: Apoptosis:</u>
- A. Aging of the cell is a trigger.
- B. Excess number of cells is a trigger.
- C. Damage to a cell is a trigger.
- (Richard G. Stefanacci DO, MGH, MBA, Thomas Jefferson University, 2024)

Update on Chromosomes

Inside the nucleus of a cell, our genes are arranged along twisted, double-stranded molecules of DNA called chromosomes.

At the ends of the chromosomes are stretches of DNA called telomeres, which protect our genetic data, make it possible for cells to divide, and hold some secrets to how we age and get cancer and other diseases.

Telomeres have been compared with the plastic tips on shoelaces, because they keep chromosome ends from fraying and sticking to each other, which would destroy or scramble an organism's genetic information.

Yet, each time a cell divides, the telomeres get shorter. When they get too short, the cell can no longer divide; it becomes inactive or "senescent" or it dies.

This shortening process is associated with aging, cancer, and a higher risk of death. So telomeres also have been compared with a bomb fuse.

Like the rest of a chromosome, including its genes, telomeres are sequences of DNA chains of chemical code.

Like all DNA, they are made of four nucleic acid bases: G for guanine, A for adenine, T for thymine, and C for cytosine.

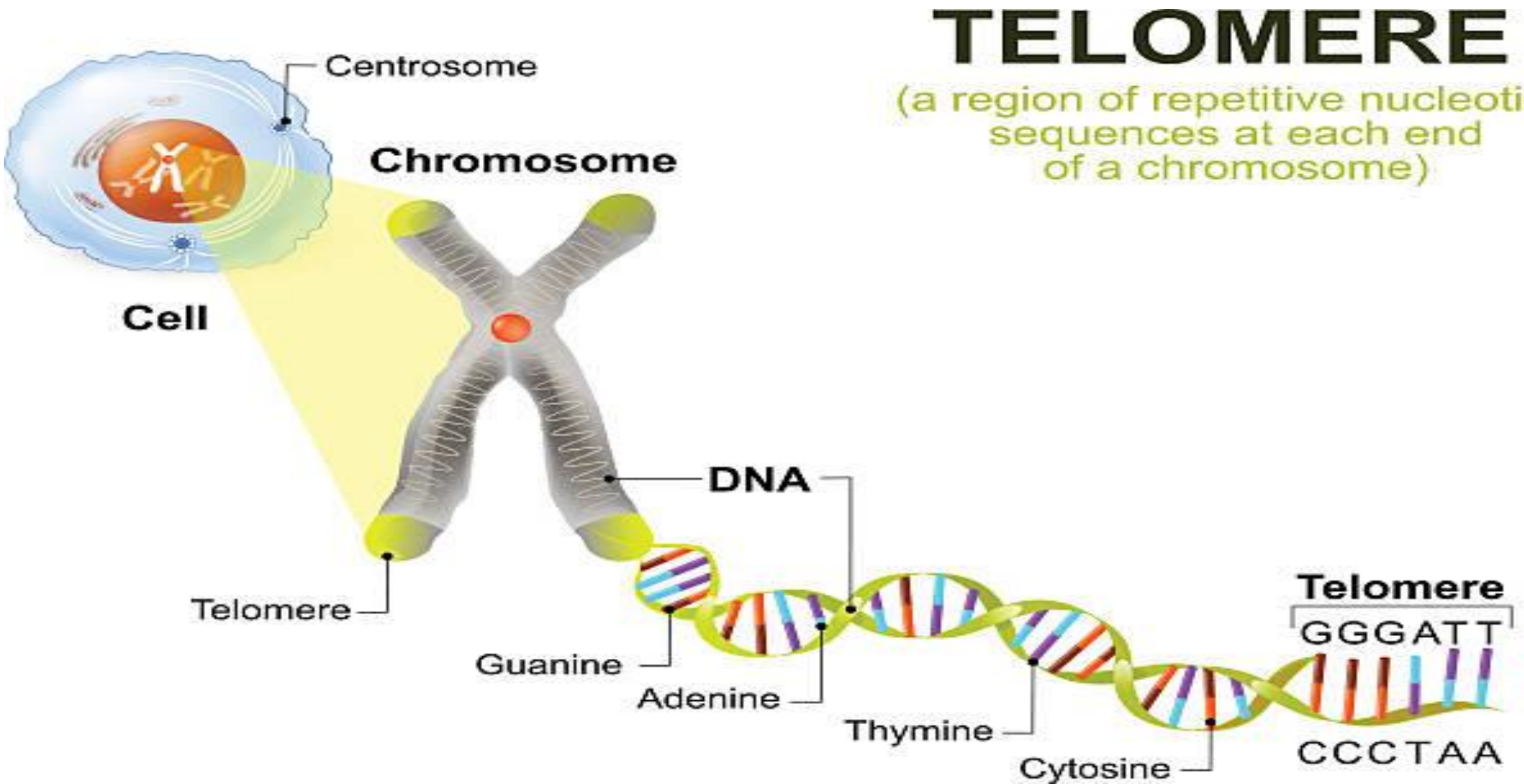
Telomeres are made of repeating sequences of TTAGGG on one strand paired with AATCCC on the other strand. Thus, one section of telomere is a "repeat" made of six "base pairs."
In white blood cells, the length of telomeres ranges from 8,000 base pairs in newborns to 3,000 base pairs in adults and as low as 1,500 in elderly people.

(An entire chromosome has about 150 million base pairs.) Each time it divides, an average cell loses 30 to 200 base pairs from the ends of its telomeres.

Cells normally can divide only about 50 to 70 times, with telomeres getting progressively shorter until the cells become senescent or die.

Telomeres do not shorten in tissues where cells do not continually divide, such as heart muscle.

The Process of Biological Aging



Why do chromosomes have telomeres?

Without telomeres, the main part of the chromosome, the part with genes essential for life, would get shorter each time a cell divides.

So telomeres allow cells to divide without losing genes. Cell division is necessary for growing new skin, blood, bone, and other cells.

Without telomeres, chromosome ends could fuse together and corrupt the cell's genetic blueprint, possibly causing malfunction, cancer, or cell death.

Because broken DNA is dangerous, a cell has the ability to sense and repair chromosome damage.
Without telomeres, the ends of chromosomes would look like broken DNA, and the cell would try to fix something that wasn't broken.

That also would make them stop dividing and eventually die. Apotosis

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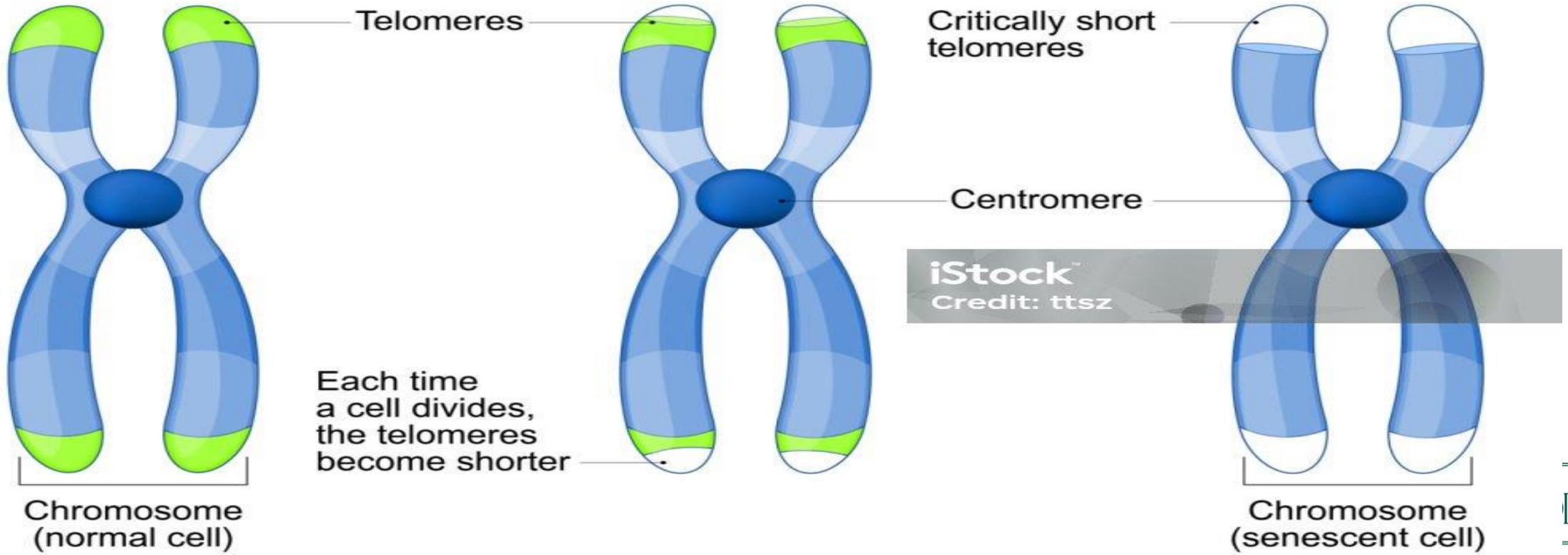
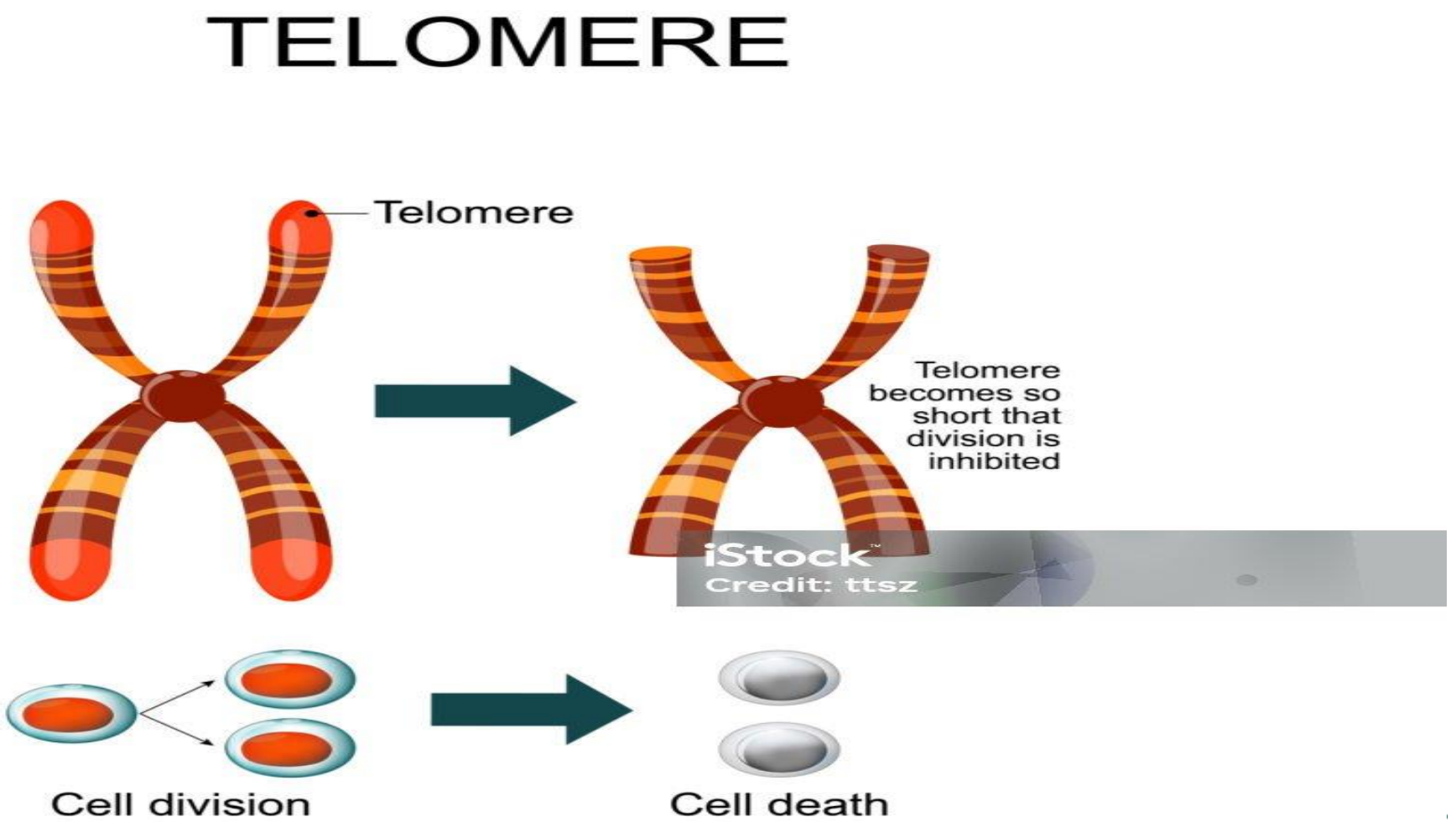
Hallmarks of aging

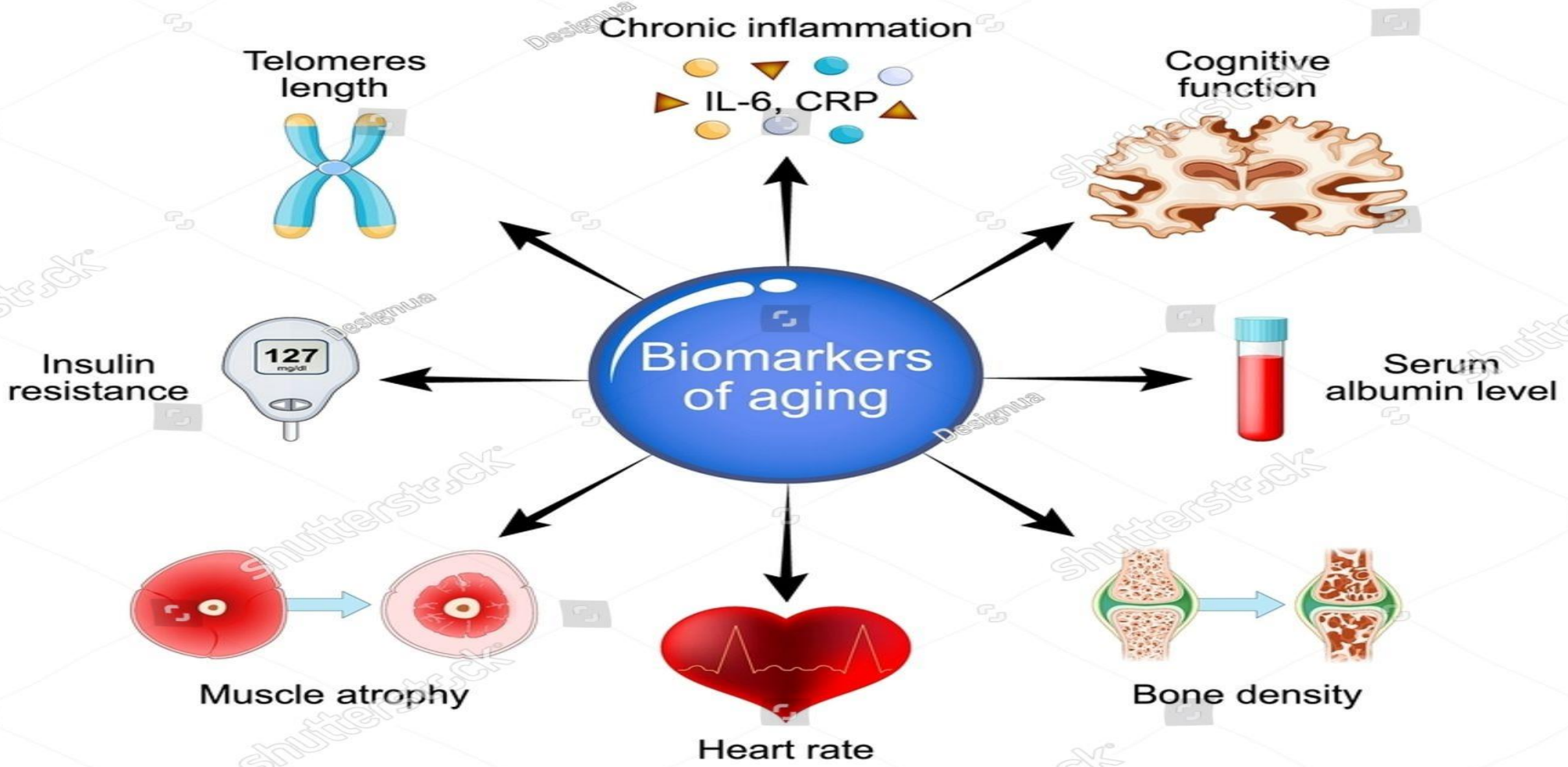
Cell division will cease once telomeres shorten to a critical length



The Process of Biological Aging



The biological process of aging



The Process of Biological Aging
Four Lifestyle Changes that may lengthen Telomeres:

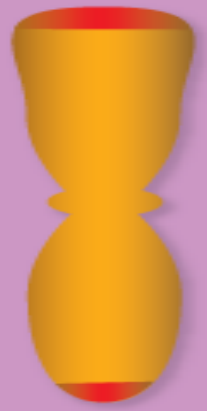
Diet
Exercise
Stress Management
Having a Social Life

- **These changes, per the research, can increase your Telomeres length by 10%.**
- **In the Control group, that did not make the lifestyle changes, their Telomeres continued to shorten by 30%.**
- **These Life-style changes can change the gene expression.**

- **(Dr. Elizabeth Blankton)**

SOME FACTORS IN AGING

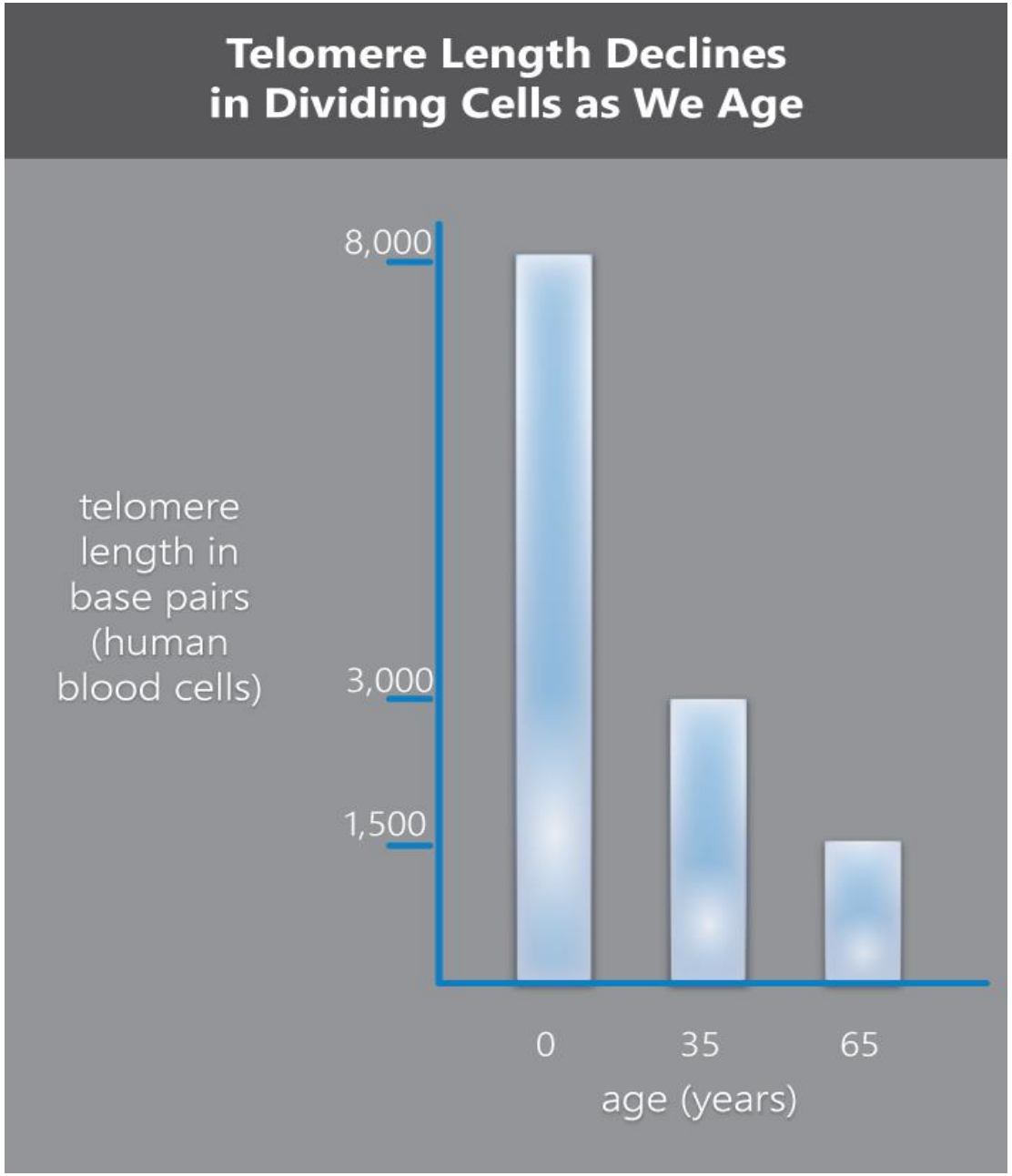
Telomere Shortening
chromosomes lose telomeres over time



Chrono-logical Age
risk factors increase over time

Oxidative Stress
oxidants damage DNA, proteins and lipids

Glycation
glucose sugar binds to and inhibits DNA, proteins and lipids



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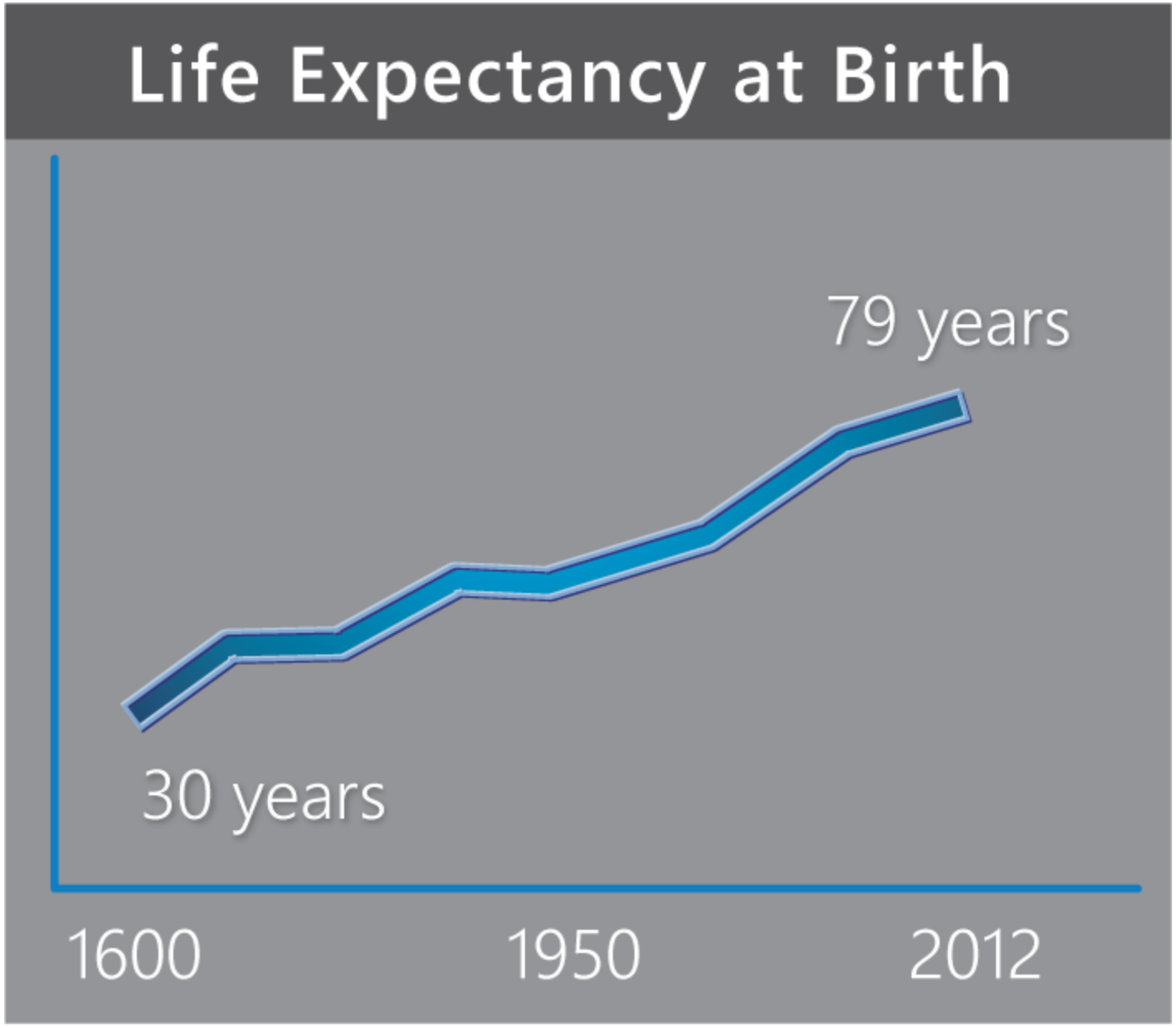

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Sarcopenia

- **Sarcopenia is age-related progressive loss of skeletal muscle mass and loss of skeletal muscle tissue leading to loss of function or strength.**
- **Affects our musculoskeletal system.**
- **Increases our frailty, falls, and fractures.**
- **Impacts our quality of life by reducing our ability to perform activities of daily living.**
- **Leads to functional decline per Jeremy D. Walston M.D.**
- **Main symptom of Sarcopenia is skeletal muscle weakness.**
- **Sarcopenia is a type of muscle atrophy caused by the natural aging process.**
- **<u>What contributes to Sarcopenia:</u>**
- **Being physically inactive**
- **Eating an unhealthy diet**
- **Obesity**
- **Poor Stress Management**

(Sarcopenia in Older Adults, Jeremy D. Walston M.D.)

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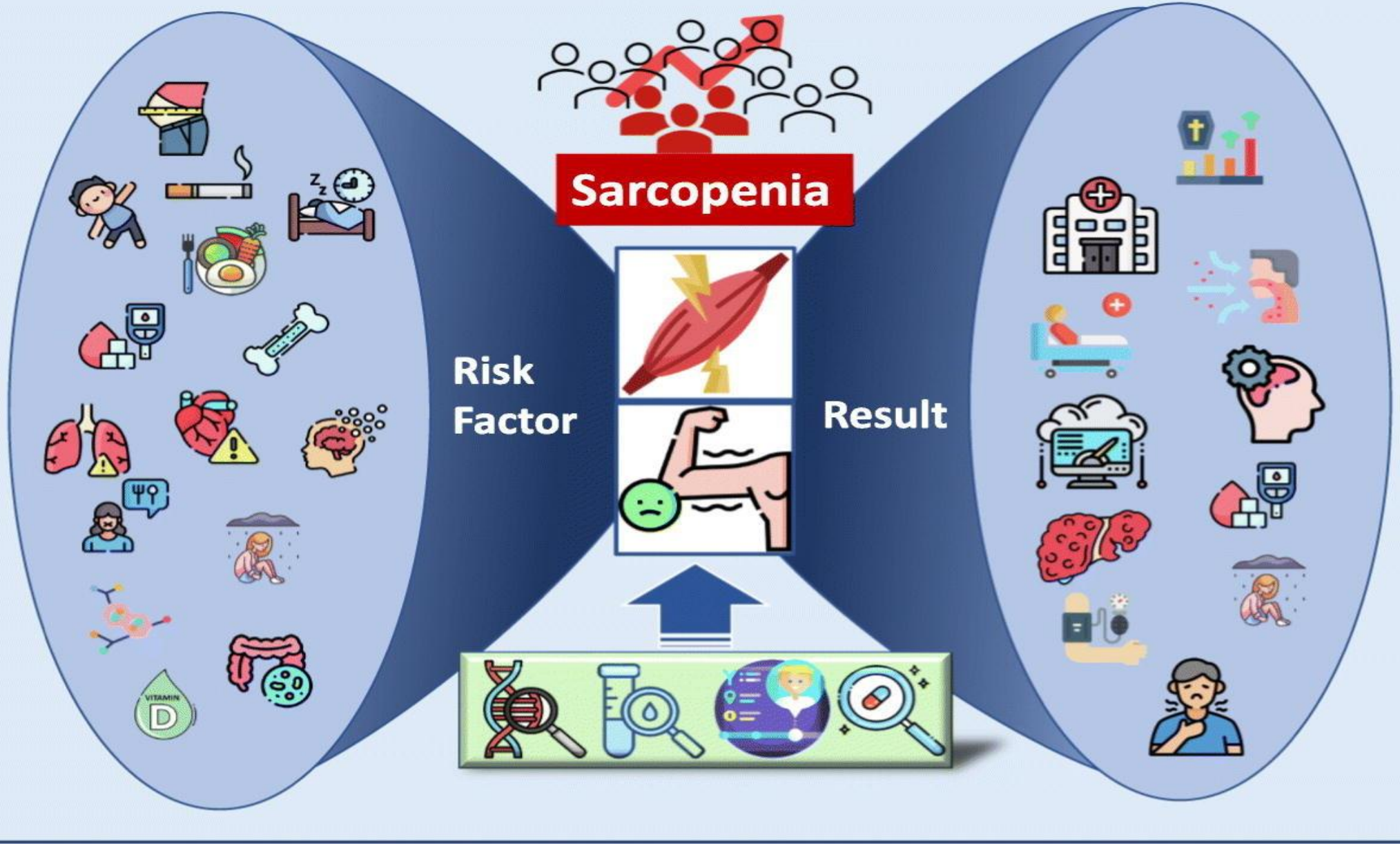
Epidemiology of Sarcopenia: Prevalence, Risk Factors, and Consequences



Causes of Sarcopenia: Age-Related Muscle Loss

- **Multifactorial Causes**
- **Environmental Causes (decreased activity, declined nutritional intake> pain and fatigue)**
- **Disease Triggers (activate Inflammatory Pathway Activation)**
- **Inflammatory Pathway Activation (chronic disease burden> RA, SLA, Renal Failure and CHF, create high levels of inflammatory cytokines)**
- **Mitochondrial Abnormalities (Reduction of ATP)**
- **Loss of Neuromuscular Junctions (reduction of fast twitch or type-II muscle fibers)**
- **Reduced Satellite Cell Numbers (age-related loss of ability to replenish and replace skeletal muscle)**
- **Hormonal Changes (decline in insulin-growth factor, testosterone, estrogen)**
- **Reduction in Tissue Growth Factor (TGF)-B (reduction is replacing skeletal muscle)**

- **(Jeremy D. Walston M.D.)**

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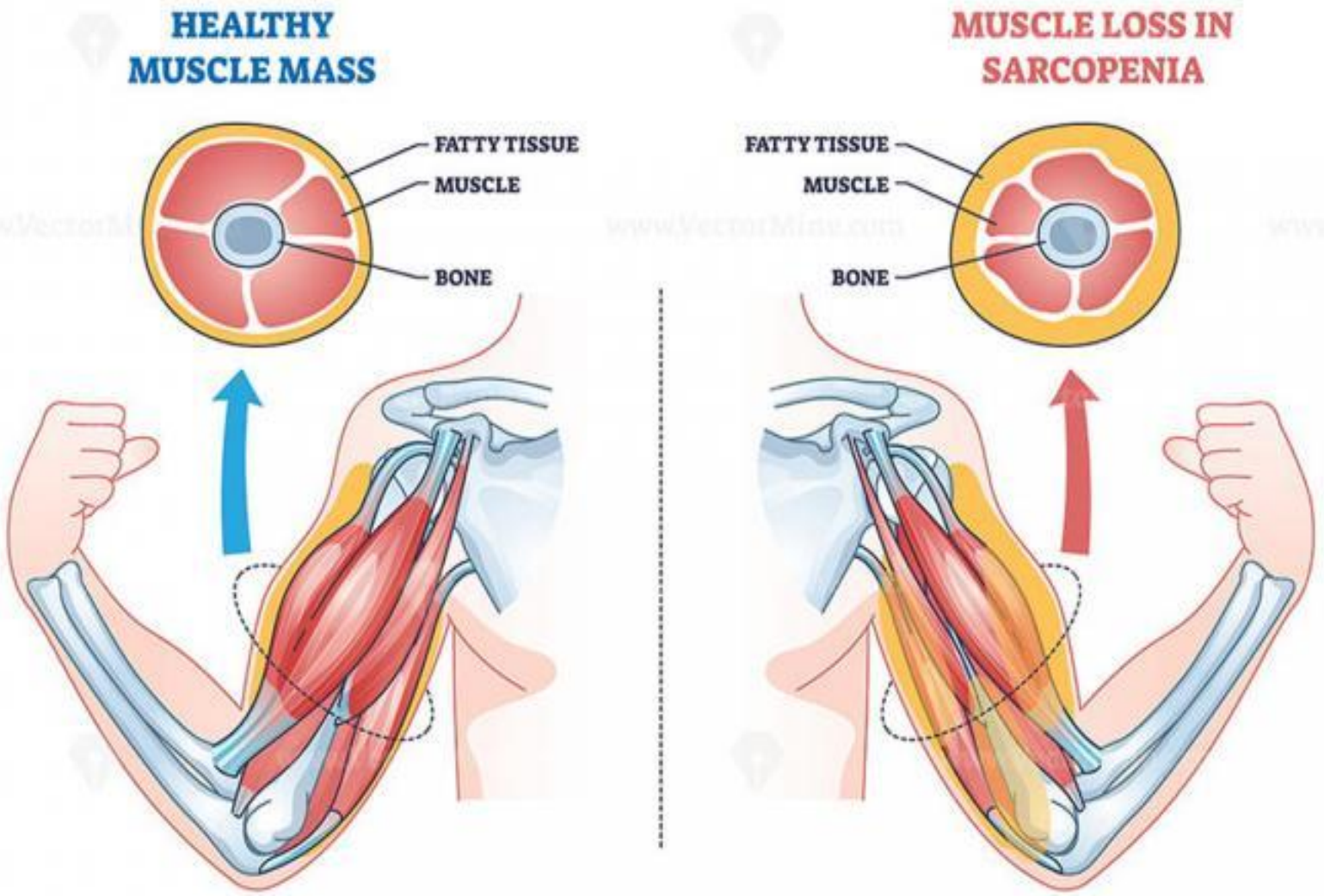
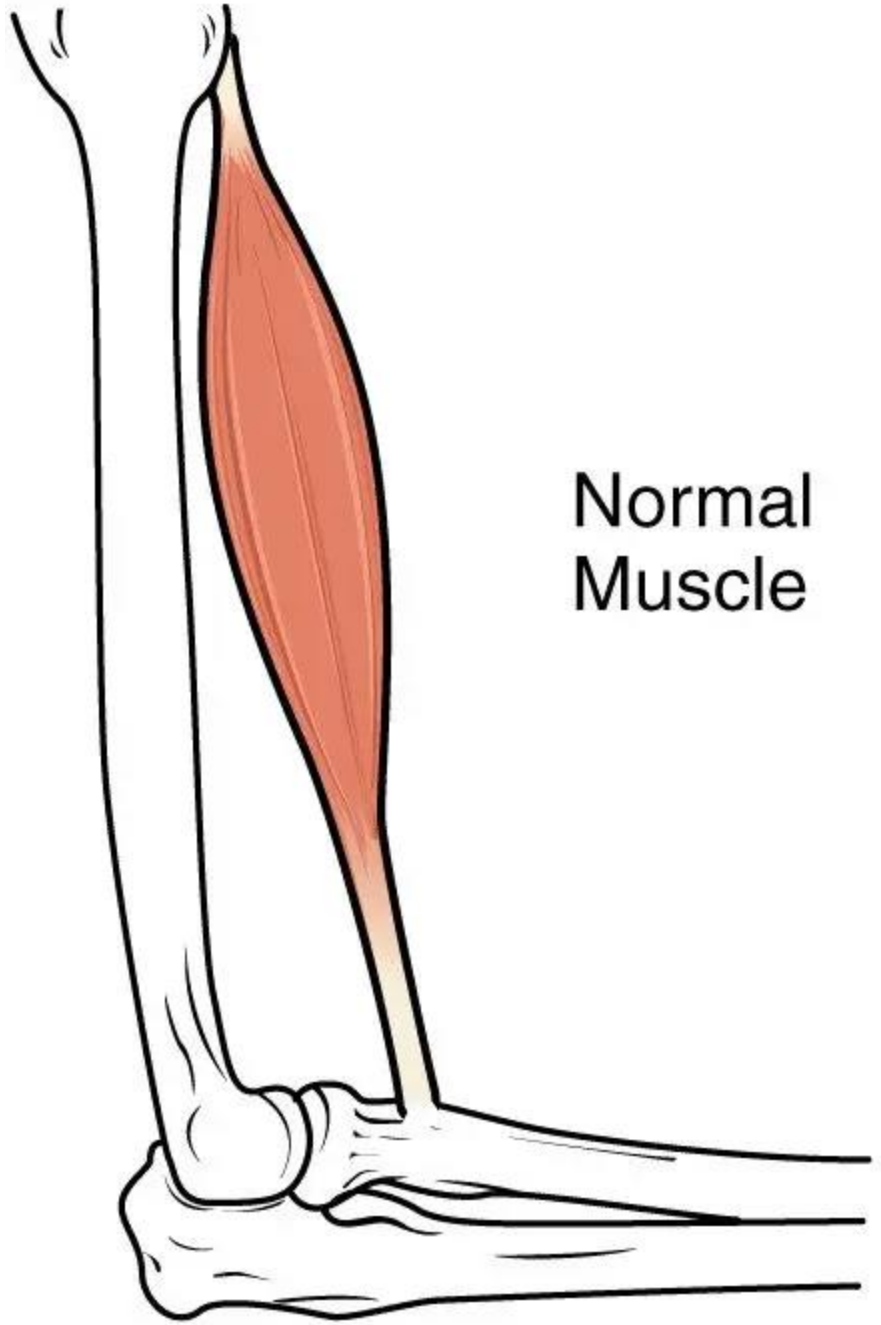
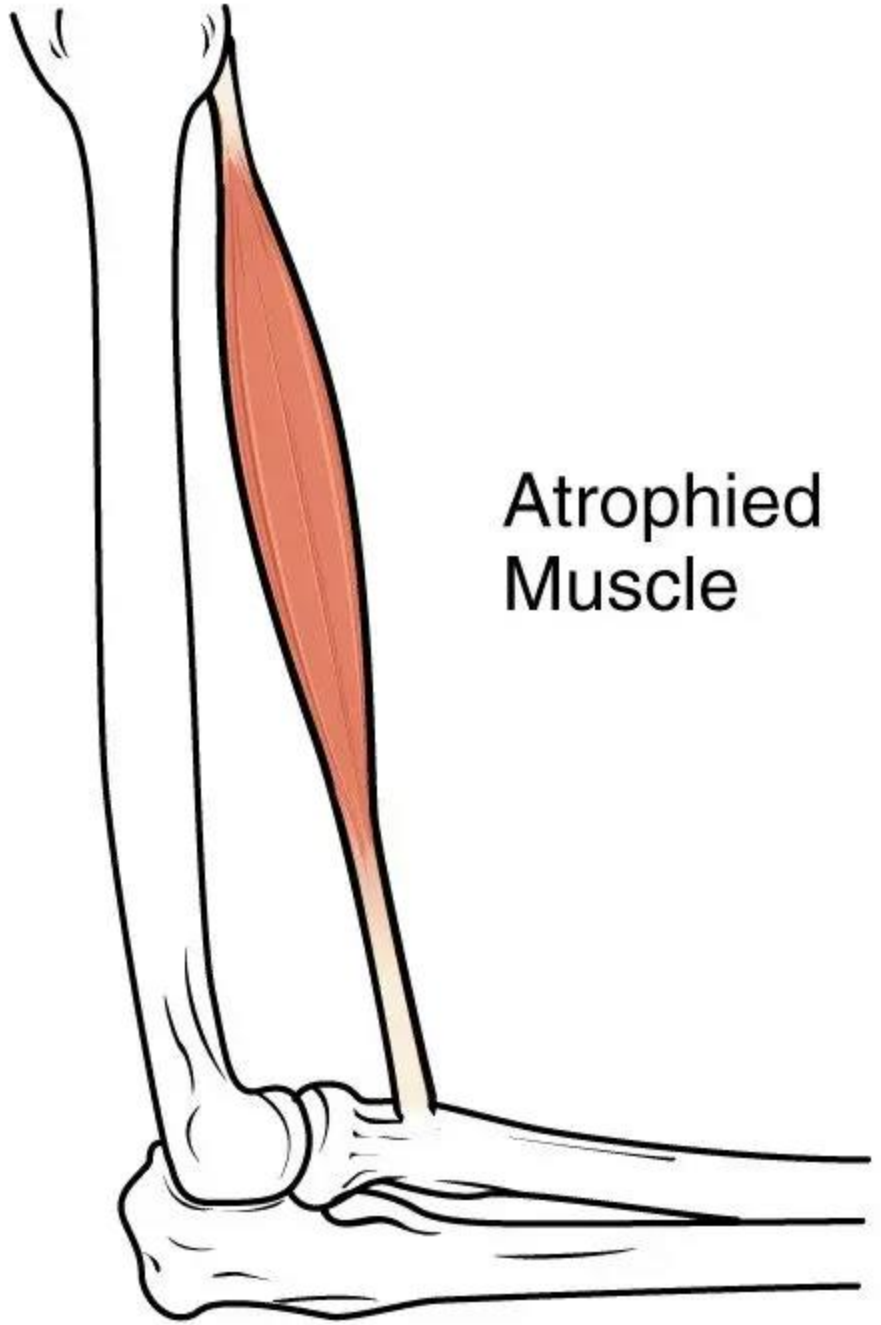
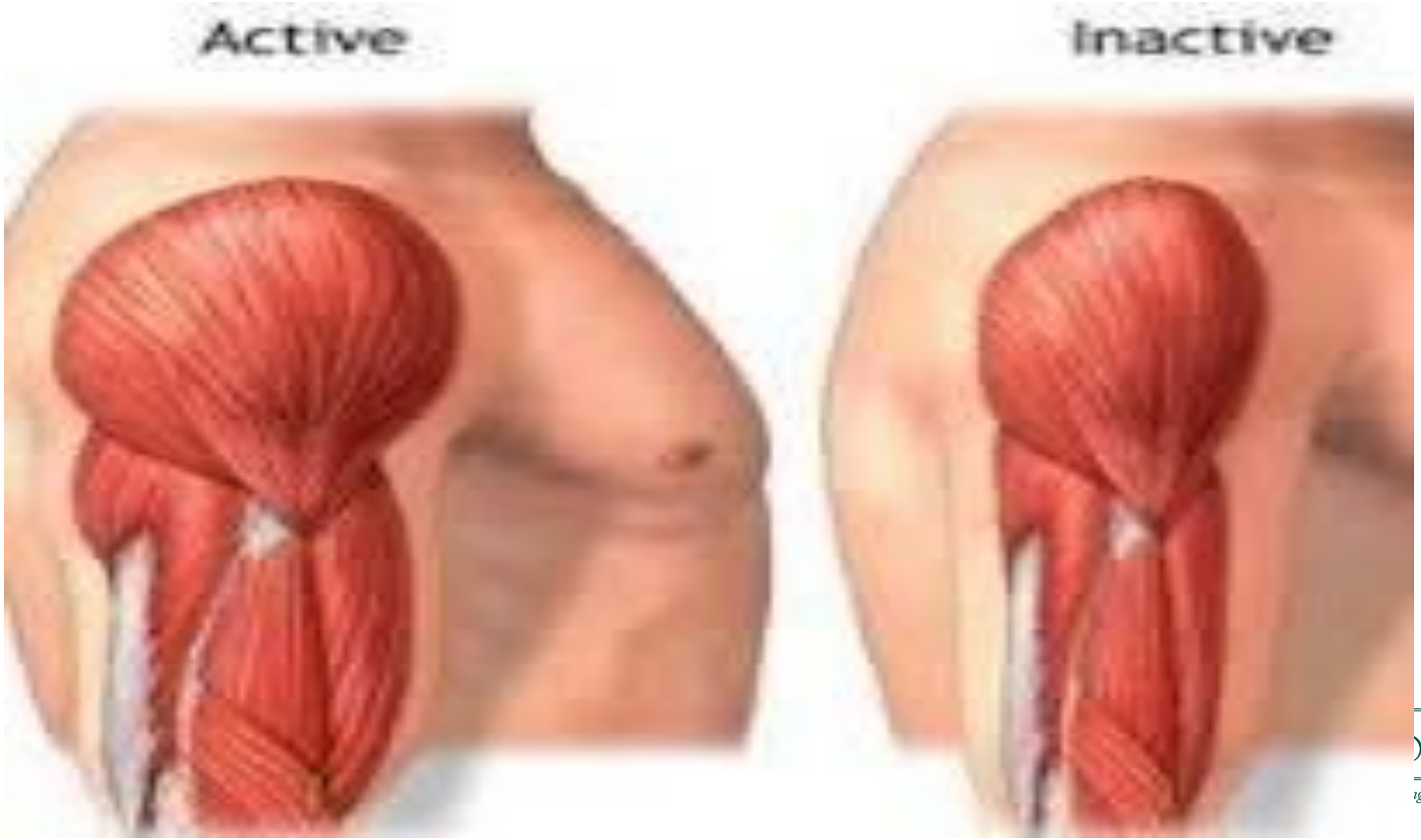
SARCOPENIA


HEALTHY
MUSCLE MASS
FATTY TISSUE
MUSCLE
BONE
MUSCLE LOSS IN
SARCOPENIA
FATTY TISSUE
MUSCLE
BONE


Normal
Muscle

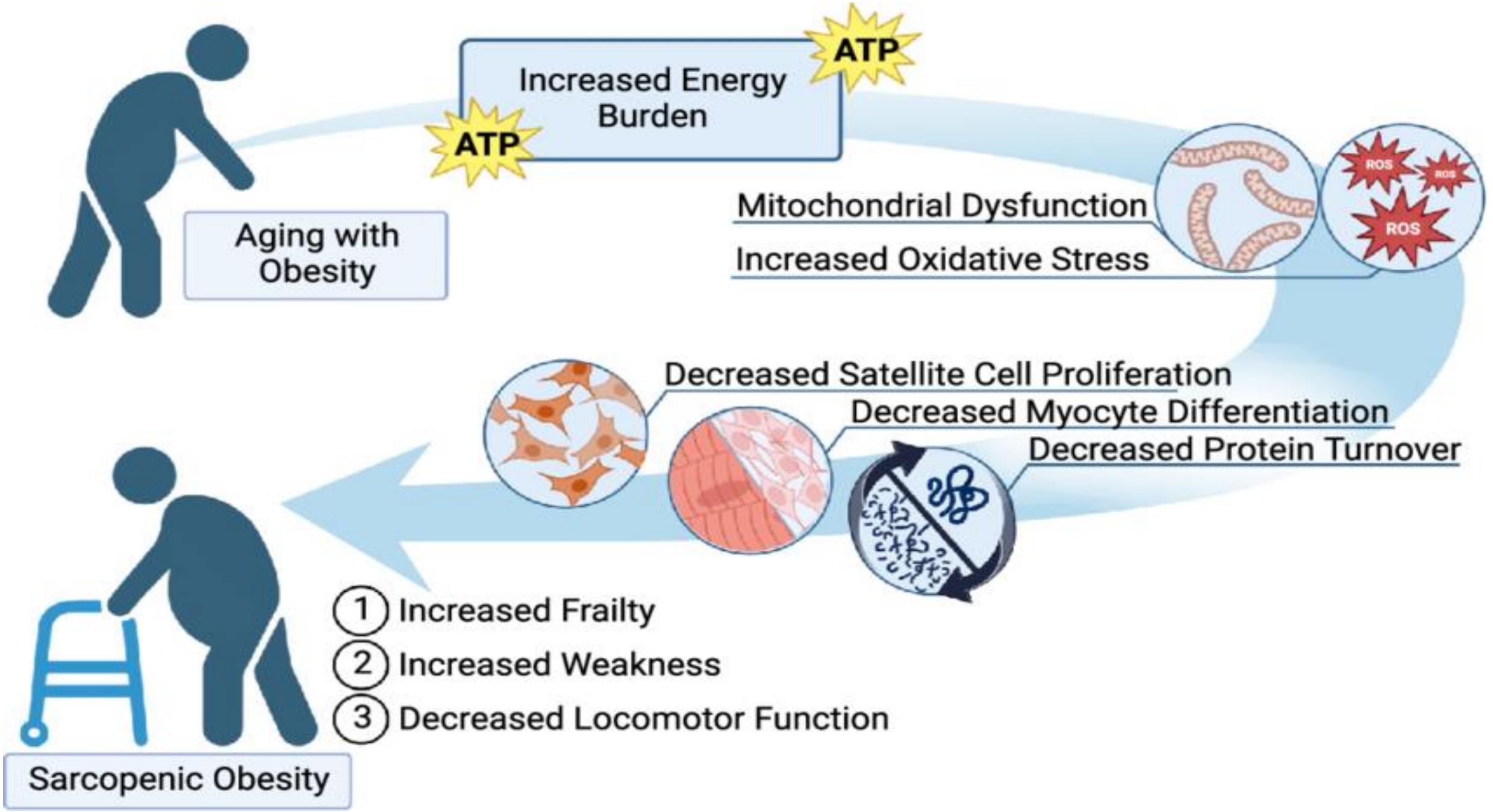

Atrophied
Muscle

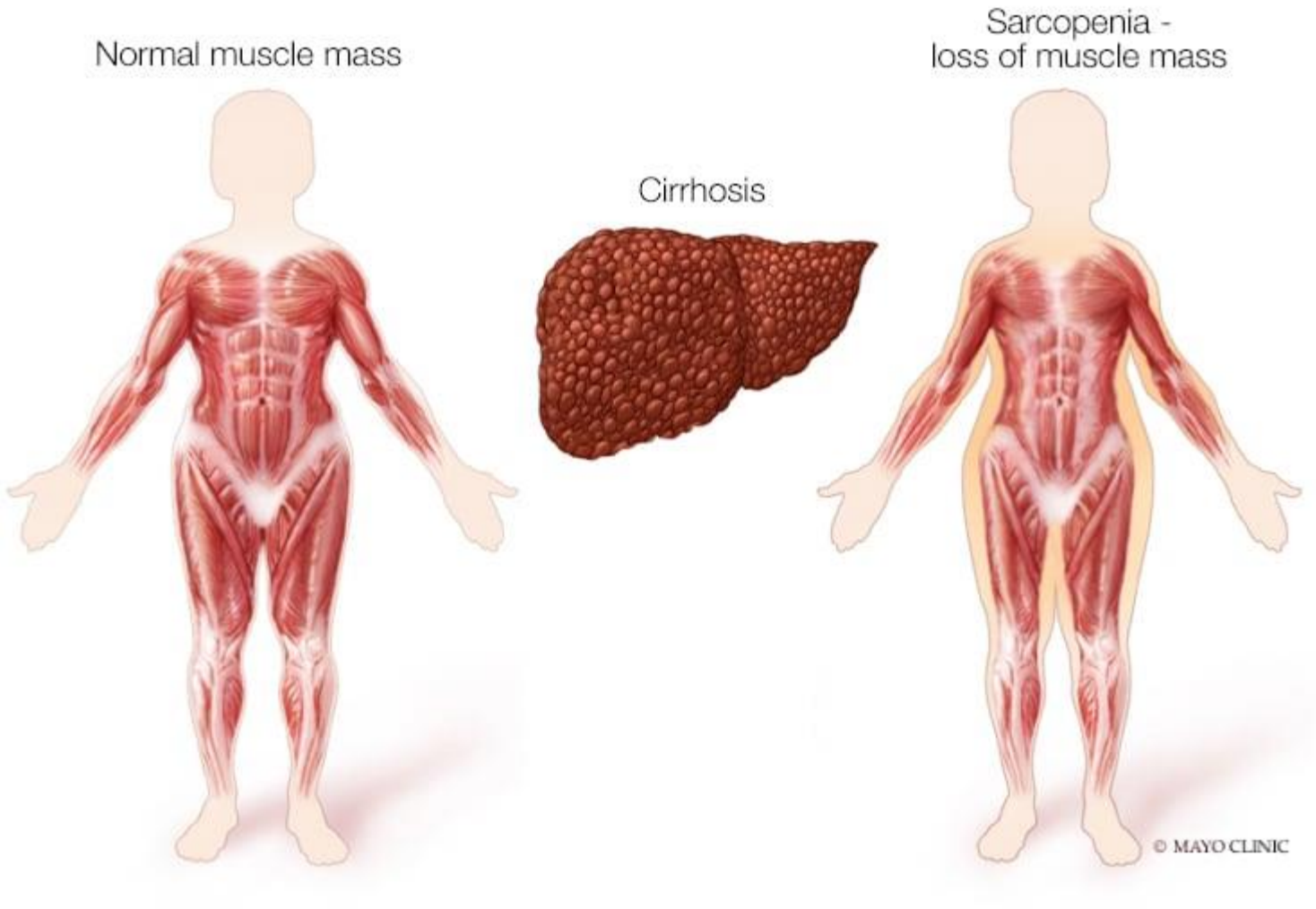

Active
Inactive

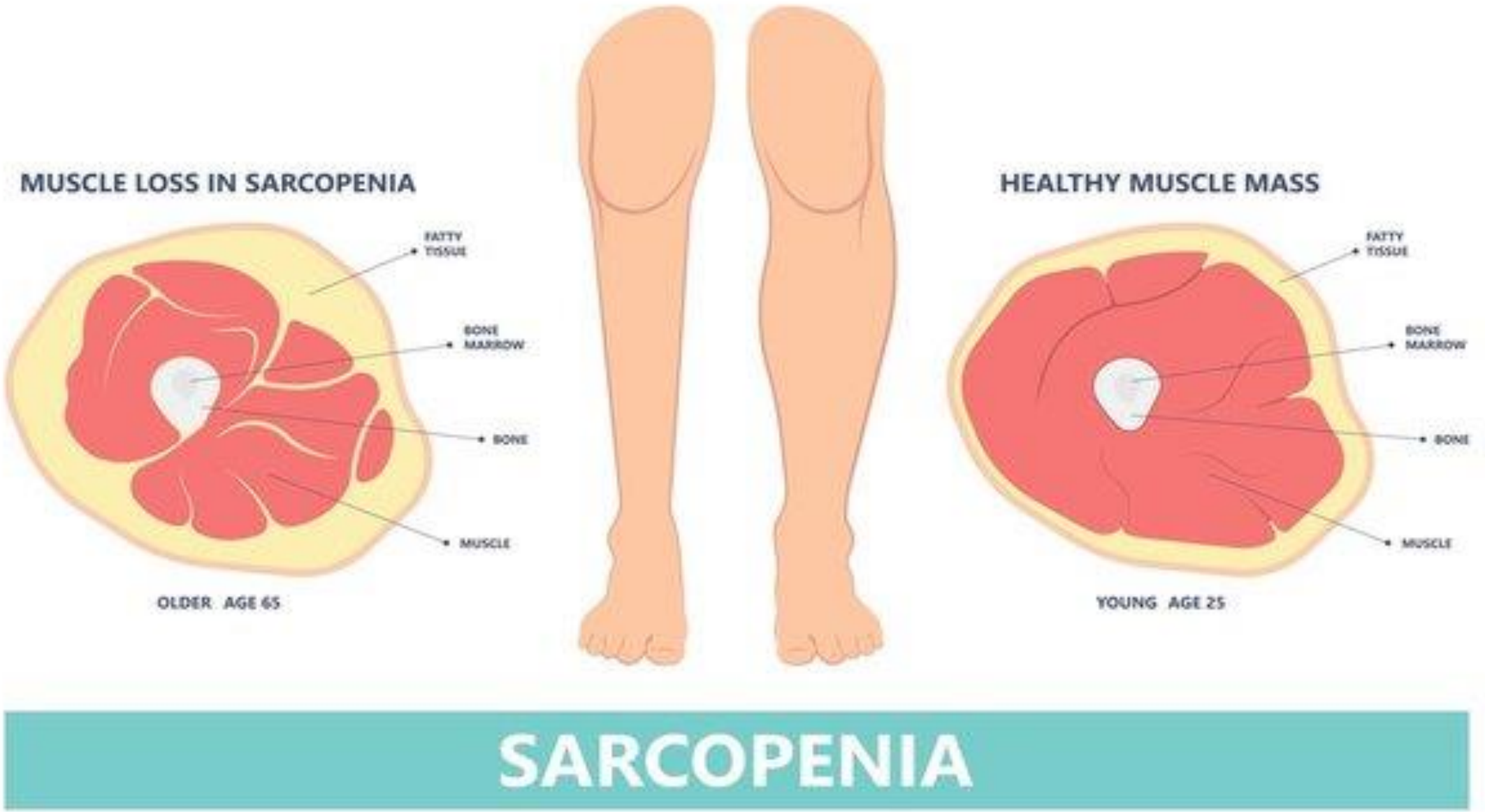
Sarcopenic Obesity

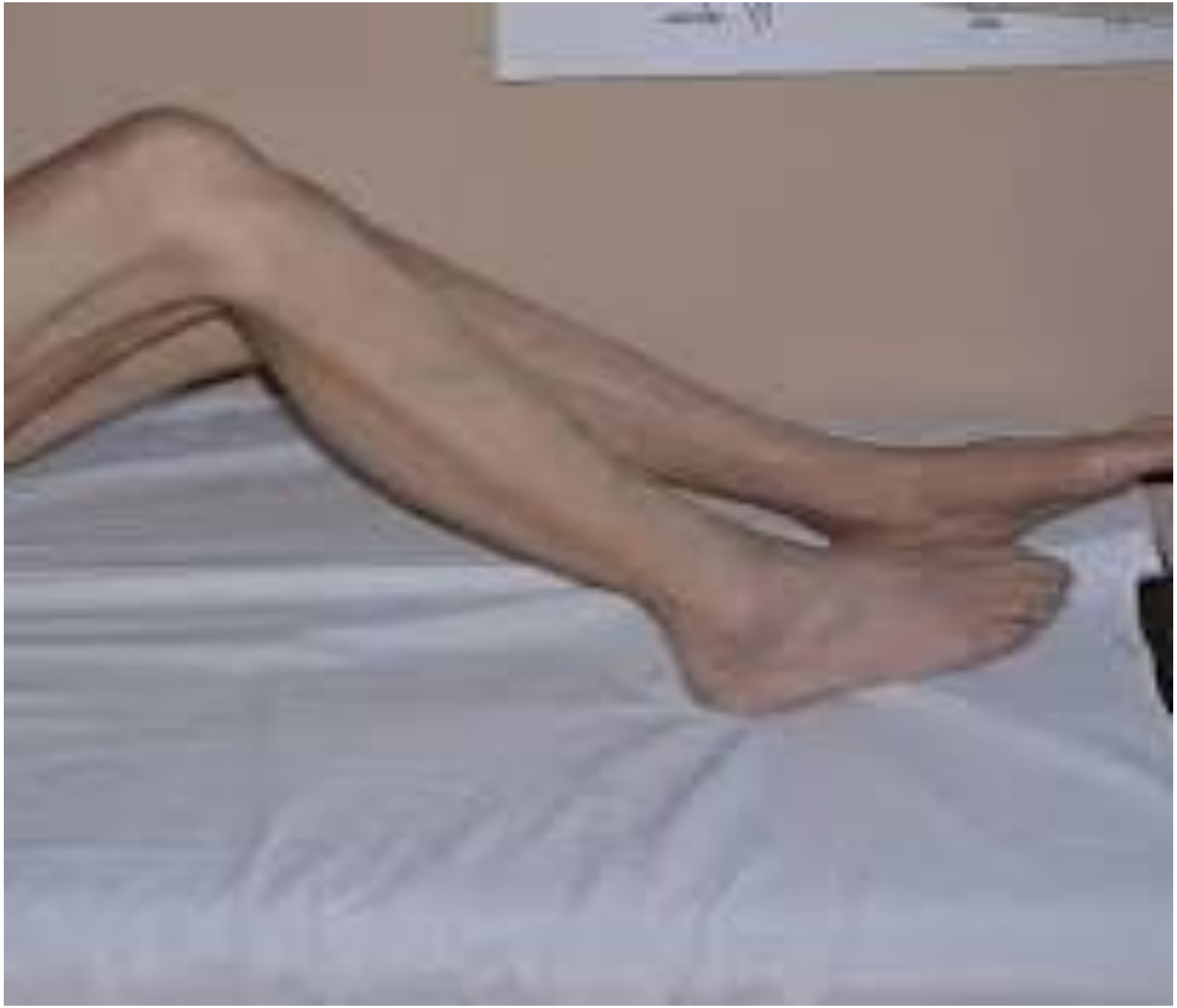
- **Sarcopenic Obesity is defined as people with a high body mass index (BMI).**

- **People with obesity and sarcopenia have a greater risk of complications, than with obesity or sarcopenia alone.**


Aging with Obesity
Increased Energy Burden
ATP
ATP
Mitochondrial Dysfunction
Increased Oxidative Stress
ROS
ROS
ROS
Decreased Satellite Cell Proliferation
Decreased Myocyte Differentiation
Decreased Protein Turnover
1 Increased Frailty
2 Increased Weakness
3 Decreased Locomotor Function
Sarcopenic Obesity




MUSCLE LOSS IN SARCOPENIA
FATTY TISSUE
BONE MARROW
BONE
MUSCLE
OLDER AGE 65
HEALTHY MUSCLE MASS
FATTY TISSUE
BONE MARROW
BONE
MUSCLE
YOUNG AGE 25
SARCOPENIA



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How Common is Sarcopenia?

- **At 60 years of age or older: the rates of Sarcopenia range from 5% to 13%.**

- **At age 80 years old or older: the rates of Sarcopenia increase 11% to 50% .**

How does Sarcopenia affect our bodies?

- **With aging there are multifactorial changes that may lead to sarcopenia:**
- **A decrease in both the number and size of your muscle fibers causes your muscles to thin leading to muscle atrophy. (Telomeres).**
- **Neurological decline due to loss of Neuromuscular junctions.**
- **Hormonal changes: decrease in testosterone and insulin-like growth factor (IGF-1)**
- **Declines in activity level**
- **Chronic illness related to chronic inflammation.**
- **Fatty Infiltration of fibrous and adipose tissue into the skeletal muscle.**
- **Poor Nutrition**

- **Biological Mechanisms also change**

- **Apoptosis: cell death process.**
- **Mitochondrial decline**
- **Angiotensin System changes**

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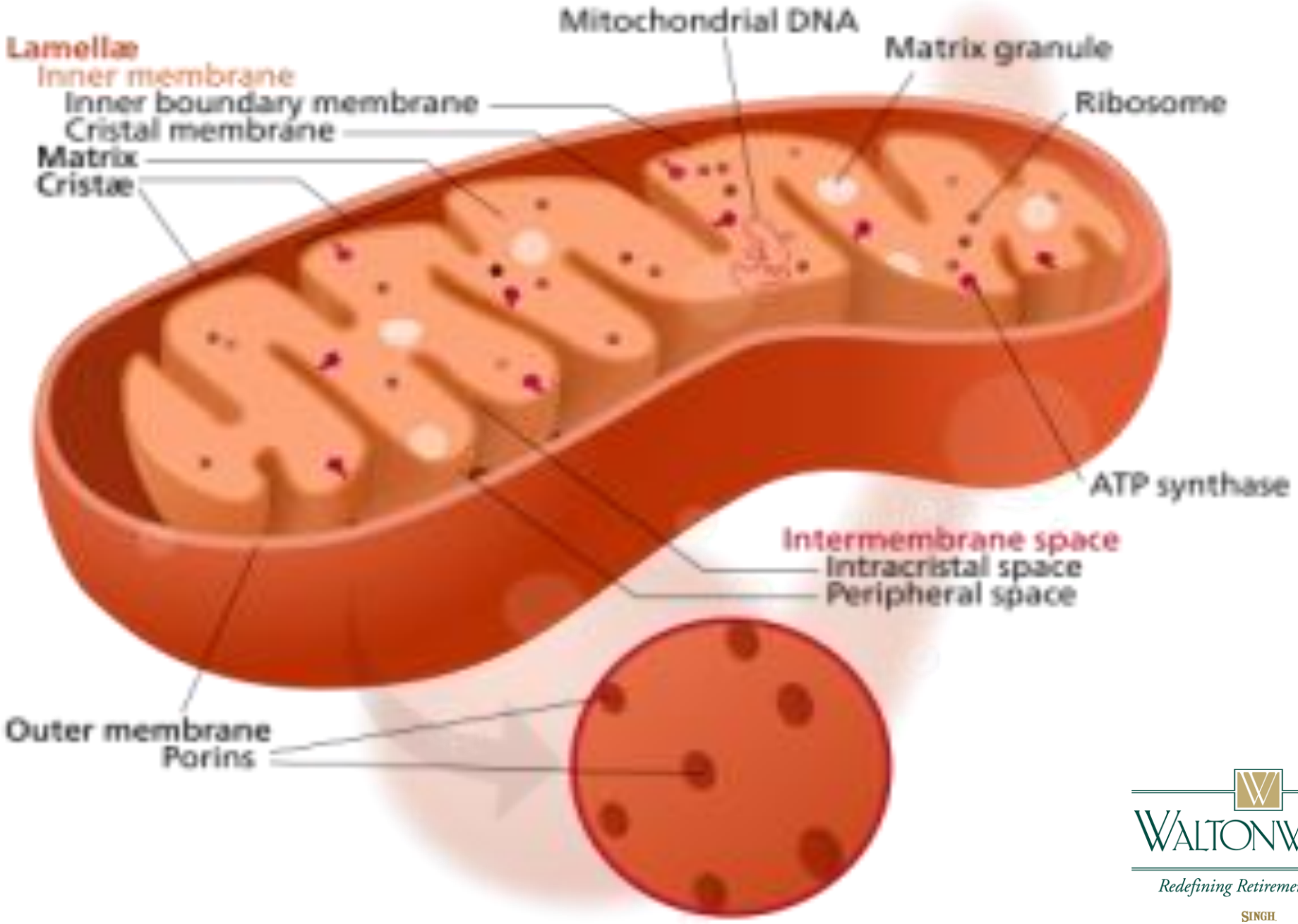


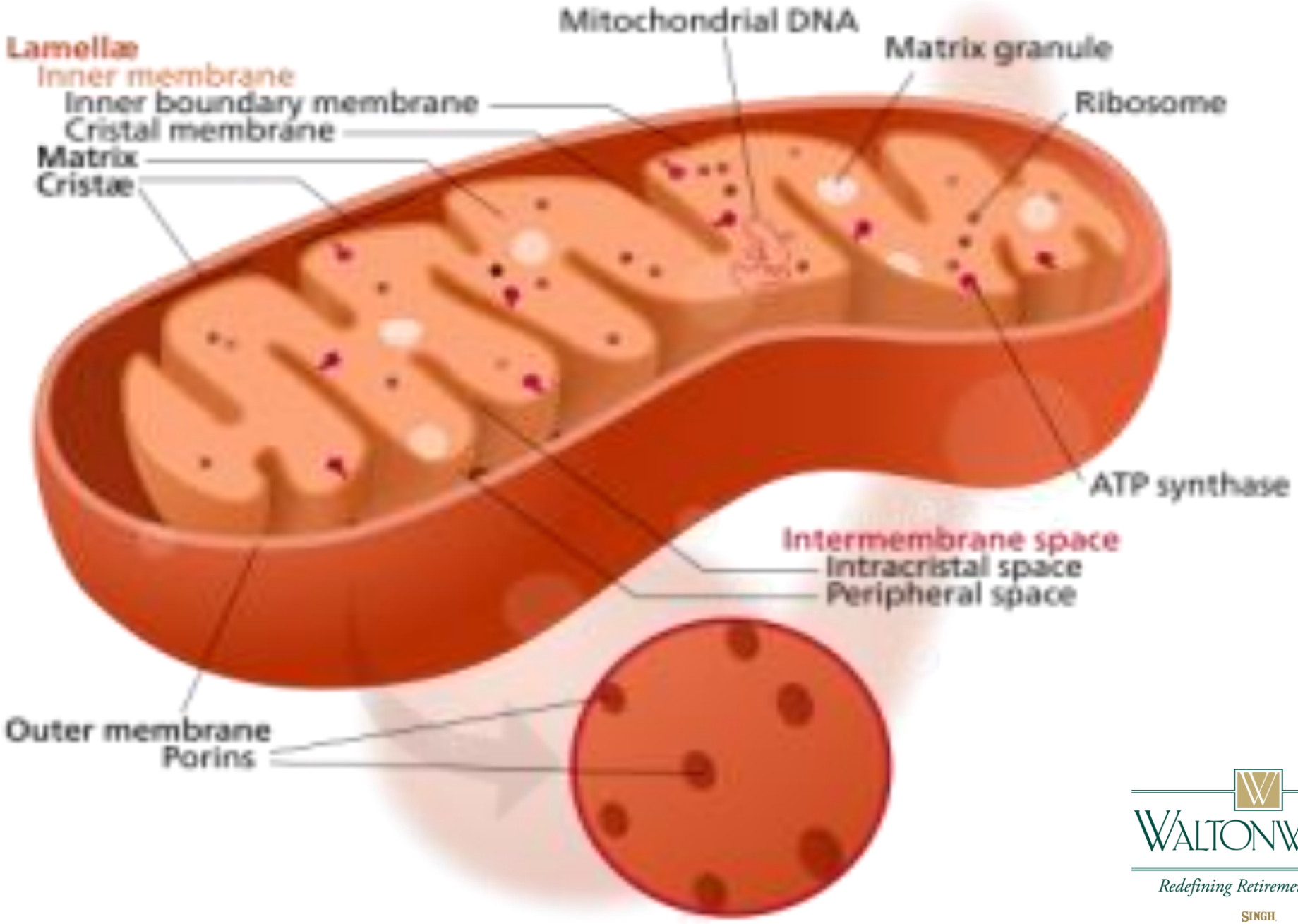
Mitochondria as regulators of organismal aging. The contribution of mitochondria to the aging process occurs through multiple distinct pathways. Although depicted as separate pathways, clear intersections occur as is evident between the connection between activation of the UPR^{mt,} and the induction of the inflammatory response. UPR mt, is the unfolded protein response that occurs within the mitochondria when the mitochondria experiences stress, it triggers this repair pathway, UPRmt. Which can lead to the activation of an inflammatory response within the cell. When mitochondria are under too much stress, they send signals to the nucleus of the cell to produce proteins in an attempt to repair the damage, but if the stress is too severe, this can trigger an inflammatory cascade as a last resort to eliminate the Damaged mitochondria. Aim is to to restore Homeostasis within the cell.

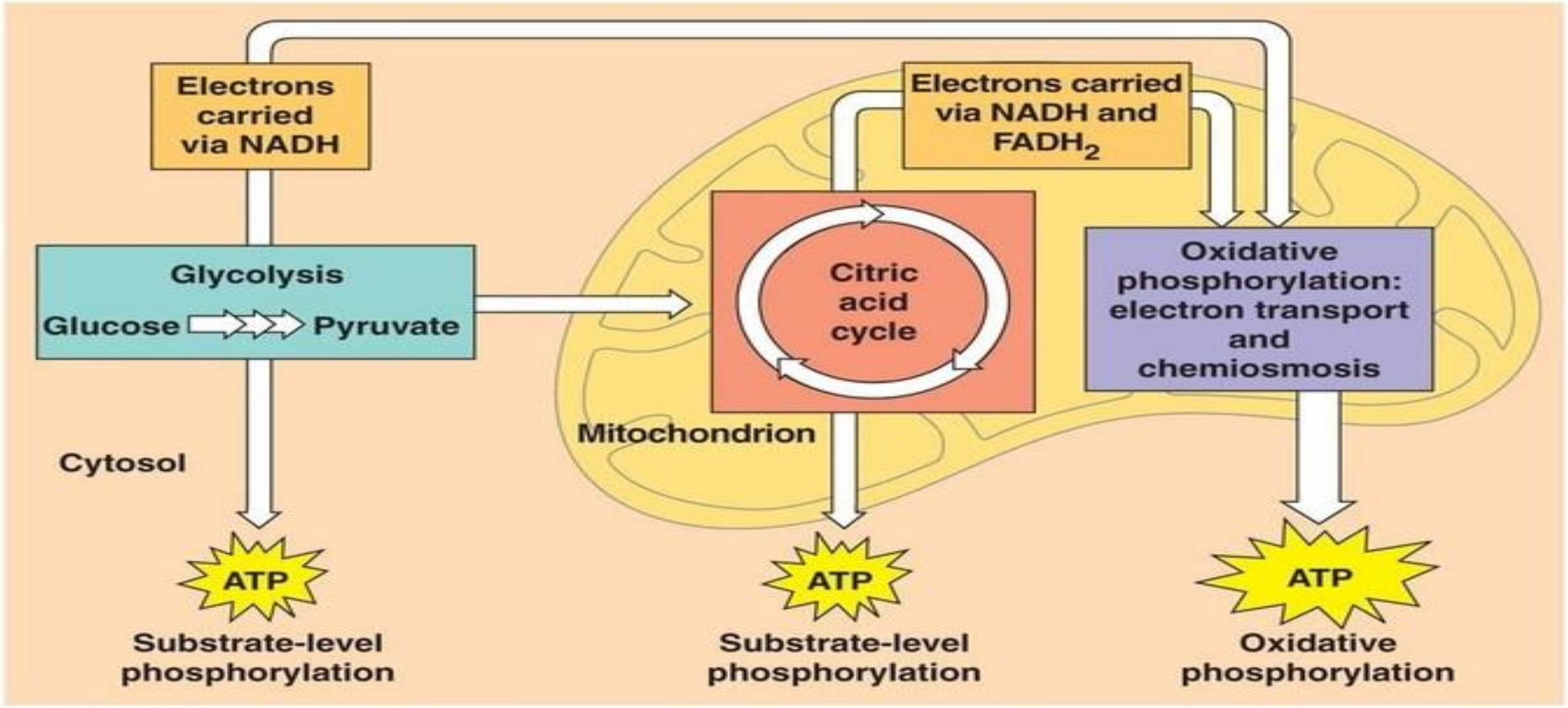
Mitochondria and the UPR mt (Unfold Protein Response)dysregulation has been linked to:

- **1. Neurodegenerative Disorders.**
- **2. Metabolic diseases.**
- **3. Inflammatory conditions.**

- **Mitochondrial dysfunction is a hallmark of ageing and is observed in the majority of acute and chronic diseases.**

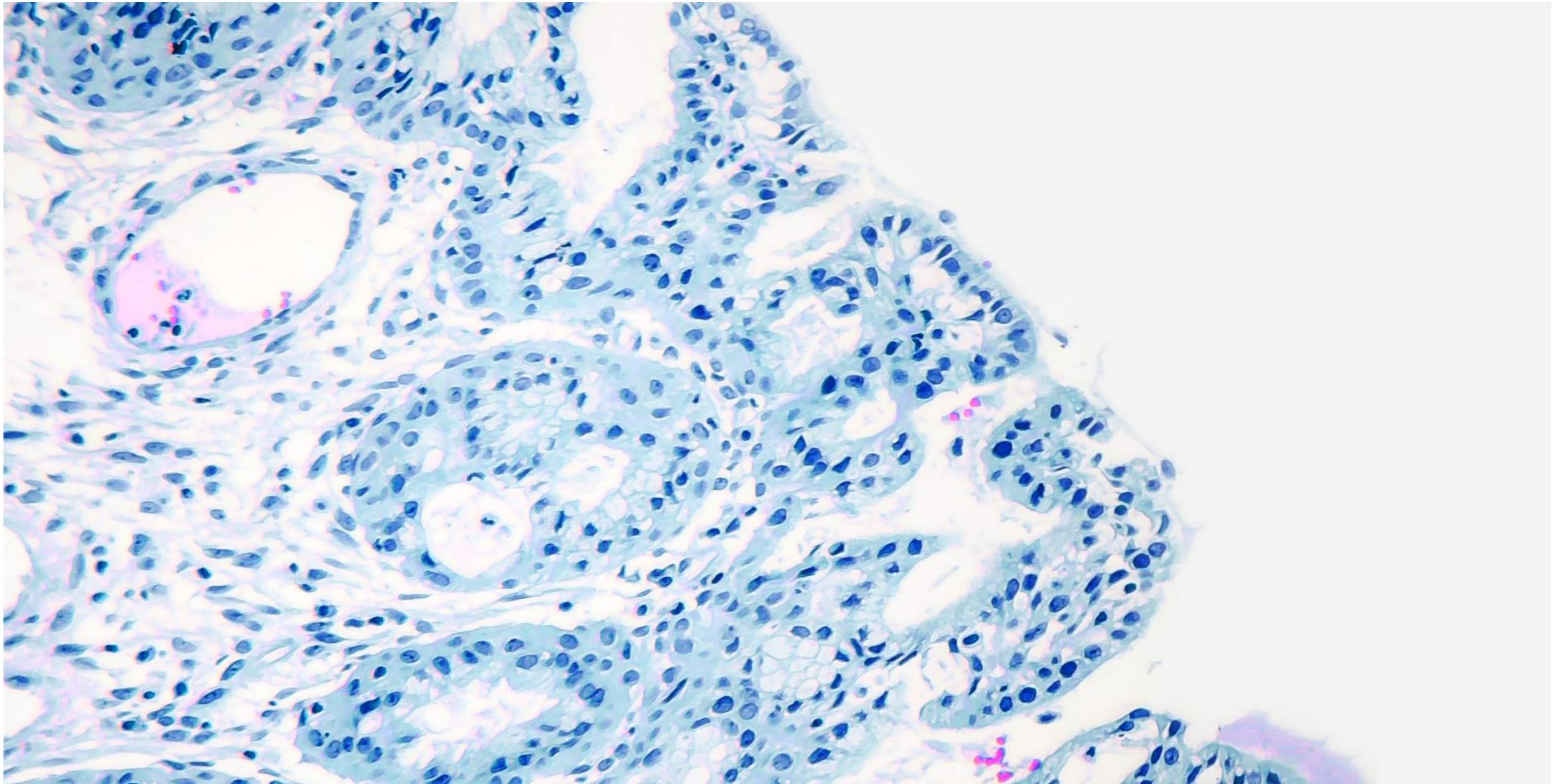
(Dr. Suzanne M. Cloonan, Kihwan, Kim, Pauline Esteves, et al.)





•Because so many organs and processes of the body are dependent on ATP(Adenosine triphosphate) and the mitochondria that makes it, symptoms can be vague and impact many organ systems. ATP is a molecule that stores and provides energy for the cells. ATP is called the energy currency of the cell. These symptoms include:

•Low muscle tone
•Difficulty swallowing
•Failure to thrive
•Learning disability
•Fatigue
•Delayed gut motility
•Heat/cold intolerance
•Migraines/headaches
•Lactic acidosis
•Liver disease
•Immune system problems
•Heart problems
•Kidney problems
•Neurological problems
•Autonomic dysfunction
•Pulmonary System: COPD, Tuberculosis, Pneumonia



Life Style changes to preserve Muscle Function and Mitochondria Health

- **Daily Exercise: Performance Exercise, Walking, Swimming, Resistance Exercising (can reverses sarcopenia).**
- **Diet: Must have nutritious food and protein- Mediterranean Diet, colorful salads, Thiamine Vitamin B1, best foods for mitochondria include: Vegetables, nuts, seeds, beans, lentils, dairy products, oily fish, lean meat fruits, whole grains. Reduce gluten.**
- **Stress Management**
- **Good Sleep Hygiene (7-9 hours of sleep per night).**
- **Belonging to social groups (church, senior groups, card clubs, bingo, travel trips).**
- **Maintain a healthy weight**
- **Annual Physicals**
- **Annual Dental checks**
- **Annual Vision and Hearing checks**
- **Build your Resilience so that when you are stressed you can recover quickly.**
- **Avoid smoking and second hand smoke**

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Summary

- **Today we discussed the age-related progressive loss of skeletal muscle mass and loss of muscle function or strength. A condition called Sarcopenia.**
- **Sarcopenia can contribute to functional decline, disability, frailty and falls.**
- **Sarcopenia has a multifactorial cause, with declines in nutrition, disease states,**
- **Inflammation, declines in neuromuscular junctions.**
- **Sarcopenia also results when there are age-related changes in the mitochondria, ATP production, apoptosis related to telomeres length, and a reduction in the angiotensin system function.**
- **Clinical interventions have focused on exercise and nutrition, with pharmaceutical testing lagging in part because of the lack of consensus definition.**

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