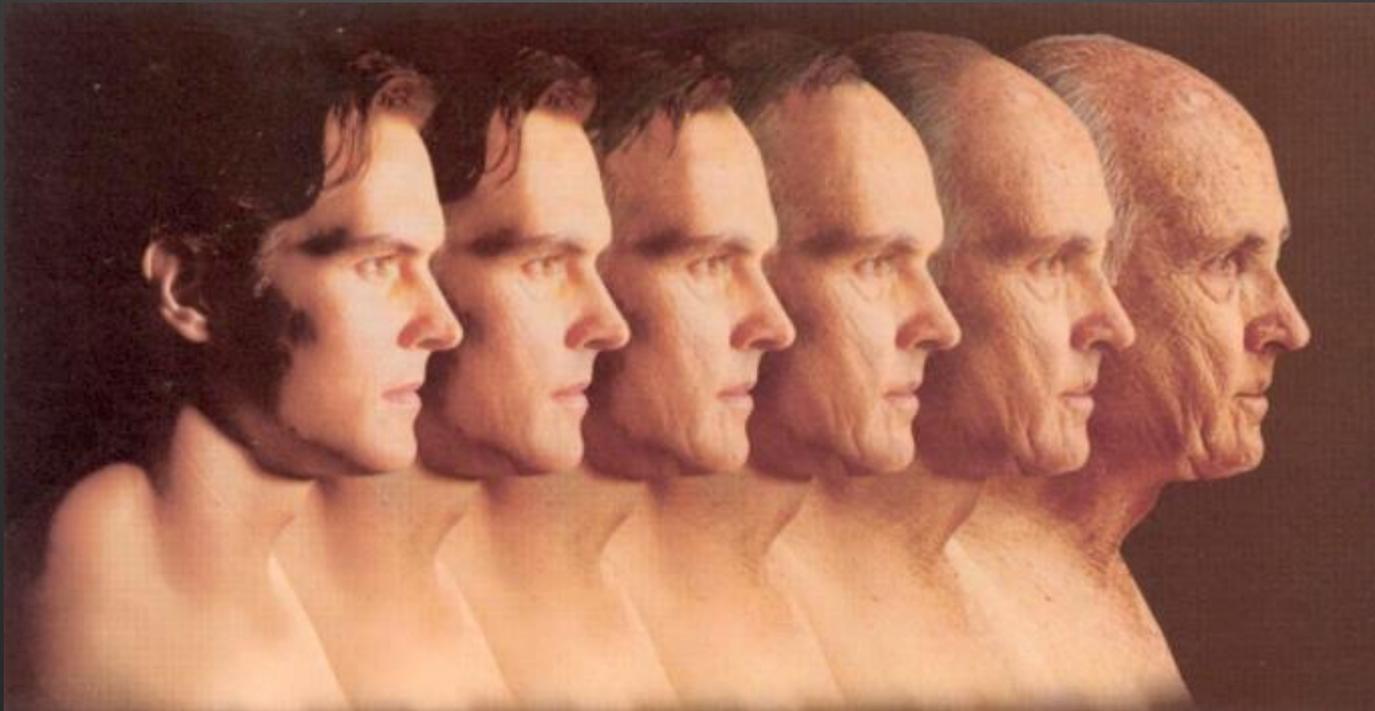


Normal Aging



Amanjot (Mona) Sidhu, MD, MHM, FRCPC

Faculty/Presenter Disclosure

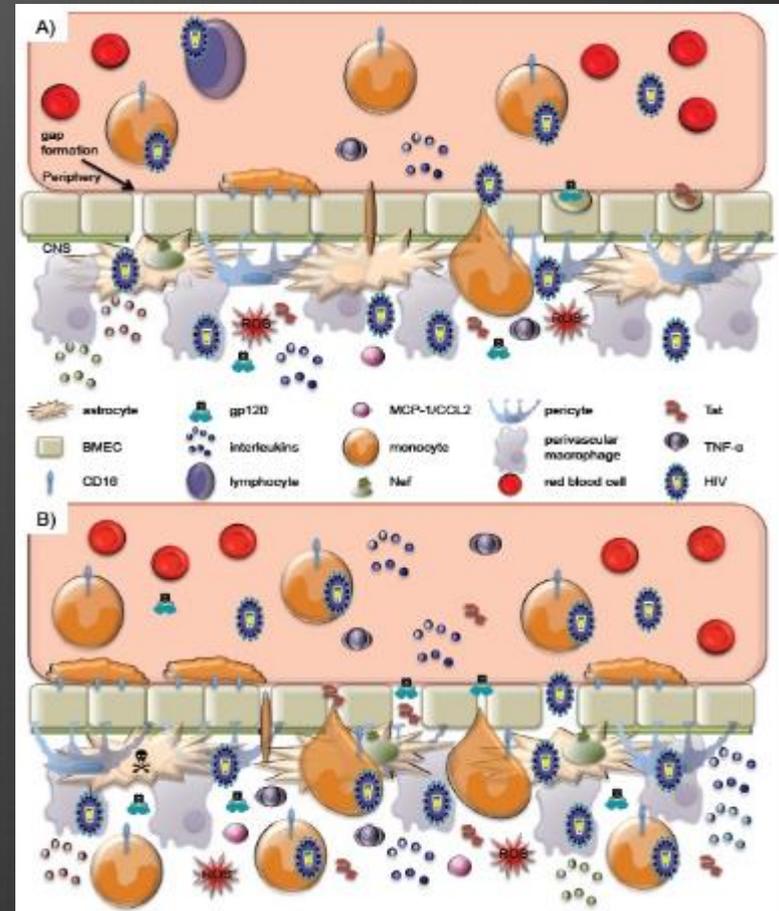
- ⊗ Faculty: Amanjot Sidhu
- ⊗ Relationships with financial sponsors:
 - ⊗ Grants/Research Support: **None**
 - ⊗ Speakers Bureau/Honoraria: **None**
 - ⊗ Consulting Fees: **None**
 - ⊗ Patents: **None**
 - ⊗ Other: **None**

Objectives

- ⊗ Review theories of aging
- ⊗ Review signs of normal aging in each system
- ⊗ Discuss the effects of normal aging on frailty, cognition and pharmacology
- ⊗ Trivia challenge!

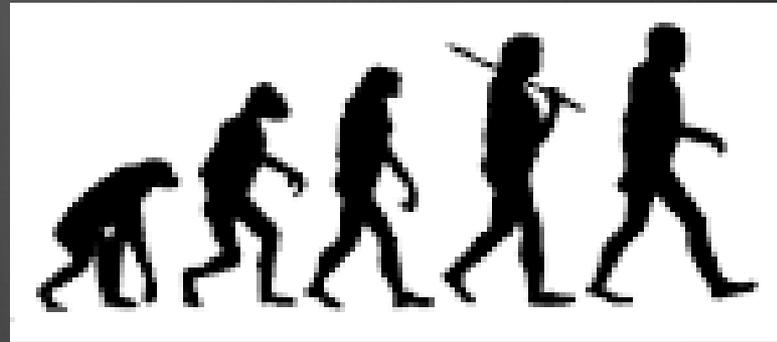
What is aging?

- loss of homeostasis, or a breakdown in maintenance of specific molecular structures and pathways
- consequence of the evolved anatomic and physiologic design of an organism.



Theories of Aging

⦿ Evolutionary



⦿ Psychosocial



⦿ Physiologic

Evolutionary

- ⦿ the impact of natural selection on the reproductive fitness of a species
- ⦿ two main evolutionary theories of aging:
 - ⦿ mutation accumulation theory
 - ⦿ antagonistic pleiotropy theory.

Evolutionary

⊗ Mutation Accumulation Theory

- ⊗ **Nonadaptive** trait
- ⊗ result of the declining force of natural selection with age

⊗ Antagonistic Pleiotropy Theory

- ⊗ **Adaptive** trait
- ⊗ Genes that can influence several traits are selected for and affect individual fitness in opposite (ie, antagonistic) ways at different stages of life

Psychosocial

- ⦿ changes in behavior, cognitive function, coping ability, relationships, roles, and social interactions



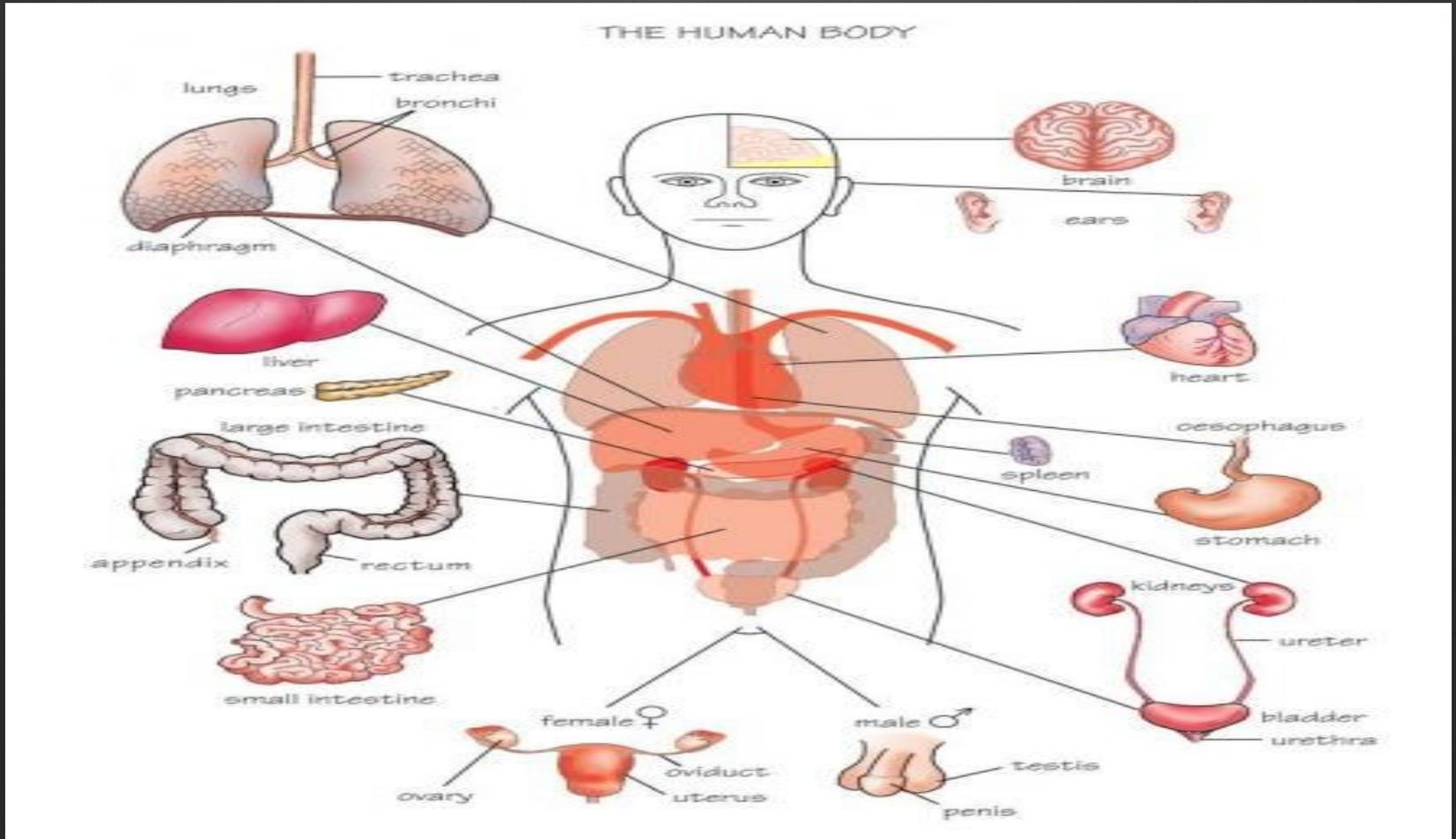
Psychosocial

- ⊗ *Disengagement theory* - quantity and quality of relationships ↓
- ⊗ *Activity theory* - alterations in regular activities
- ⊗ *Life-course theory* - progressive adjustment of older individuals to declining health, retirement, reduced income, loss of spouse /family members, and new living arrangements
- ⊗ *Continuity theory* - using familiar strategies as an adaptive strategy to deal with changes that occur during normal aging.
- ⊗ *Gerotranscendence theory* - natural progression toward a goal of achieving maturation and wisdom, with a shift in perspective

Physiologic

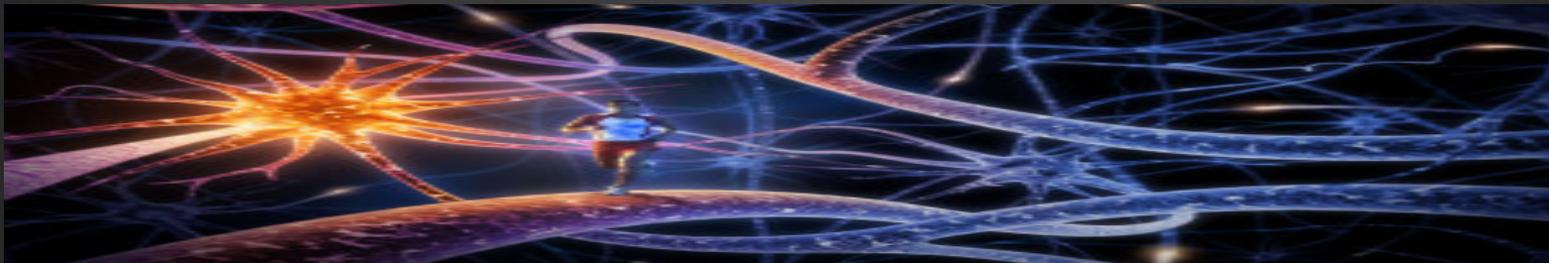
- ⊙ **Genetic Damage** - genes are susceptible to hits from *chemical* changes, *environmental* damage by ionizing radiation, aflatoxin, and alkylating agents that **alter function** of structural, signaling and/or repair molecules, and that these cumulative hits give rise to an aging phenotype

Organ Systems



Nervous System

| Change | Consequence |
|--------------------------|----------------------|
| ↓ Number of neurons | ↓ Muscle innervation |
| ↓ Action potential speed | ↓ Fine motor control |
| ↓ Axon/dendrite branches | |

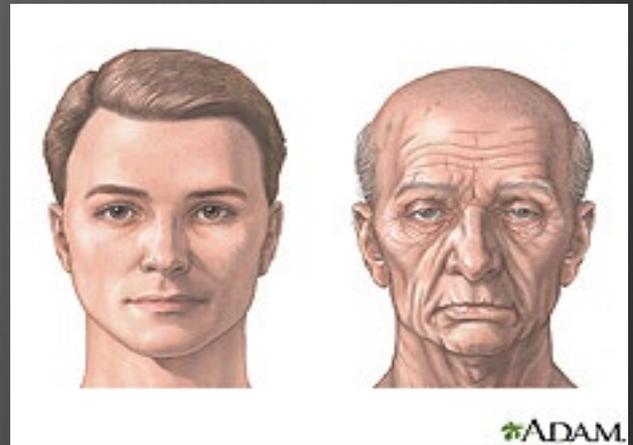


Musculoskeletal System

| Change | Consequence |
|--------------------------------|--------------------------|
| Fibers shrink | Tissue atrophies |
| ↓ Type II (fast twitch) fibers | ↓ Tone and contractility |
| ↑ Lipofuscin and fat deposits | ↓ Strength and endurance |



Dermatology

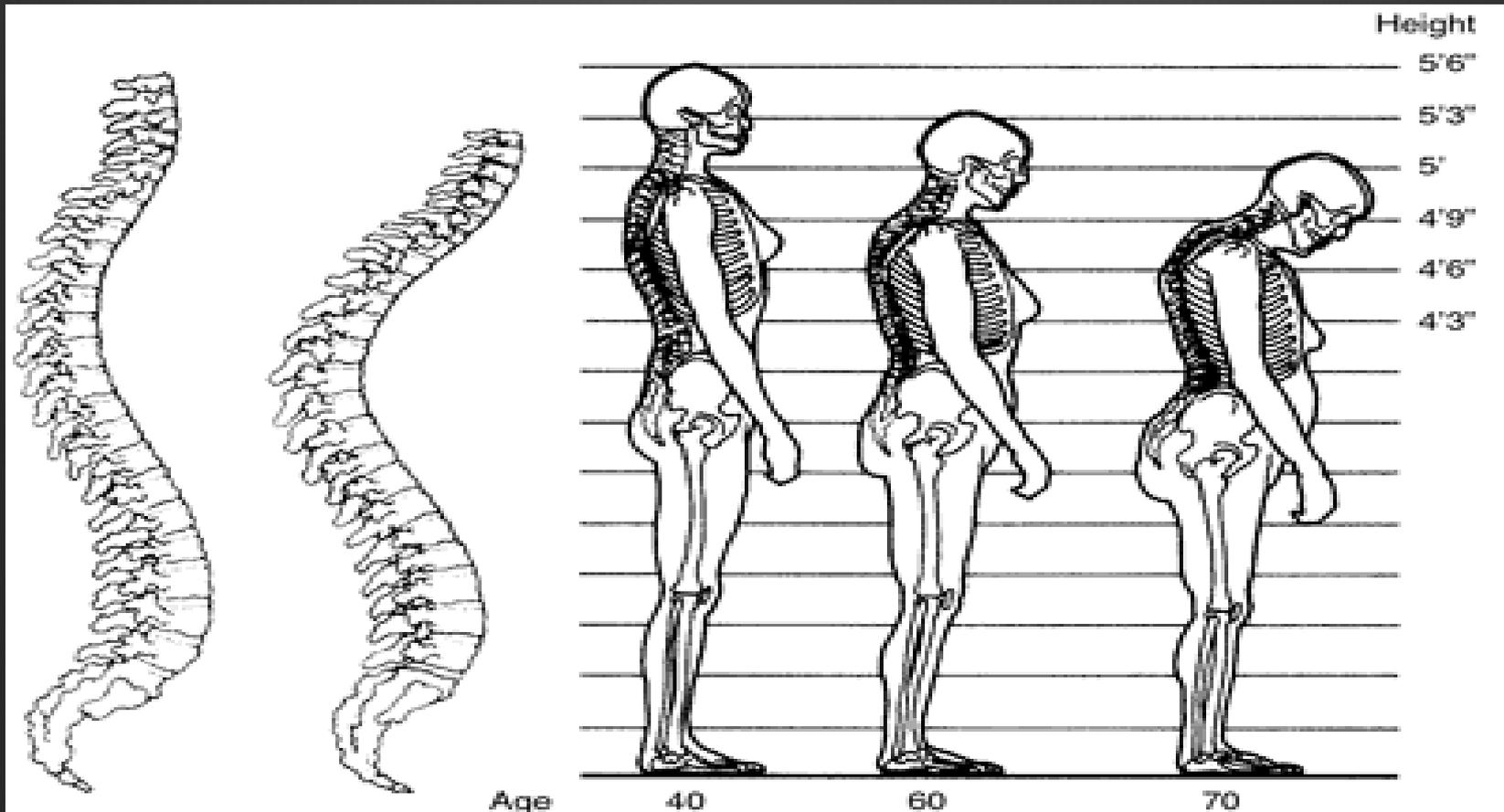


| Change | Consequence |
|--|--|
| ↓ Thickness (thinner epidermis) | Loss of elasticity |
| ↑ Collagen cross-links | Wrinkling and sagging |
| ↓ Melanocytes and melanin | Greying of hair |
| Linear nail growth slows, and nail thickness and strength decrease | Nails become brittle, dull, opaque, and yellowish. |
| ↓ hyaluronic acid | Dry skin |

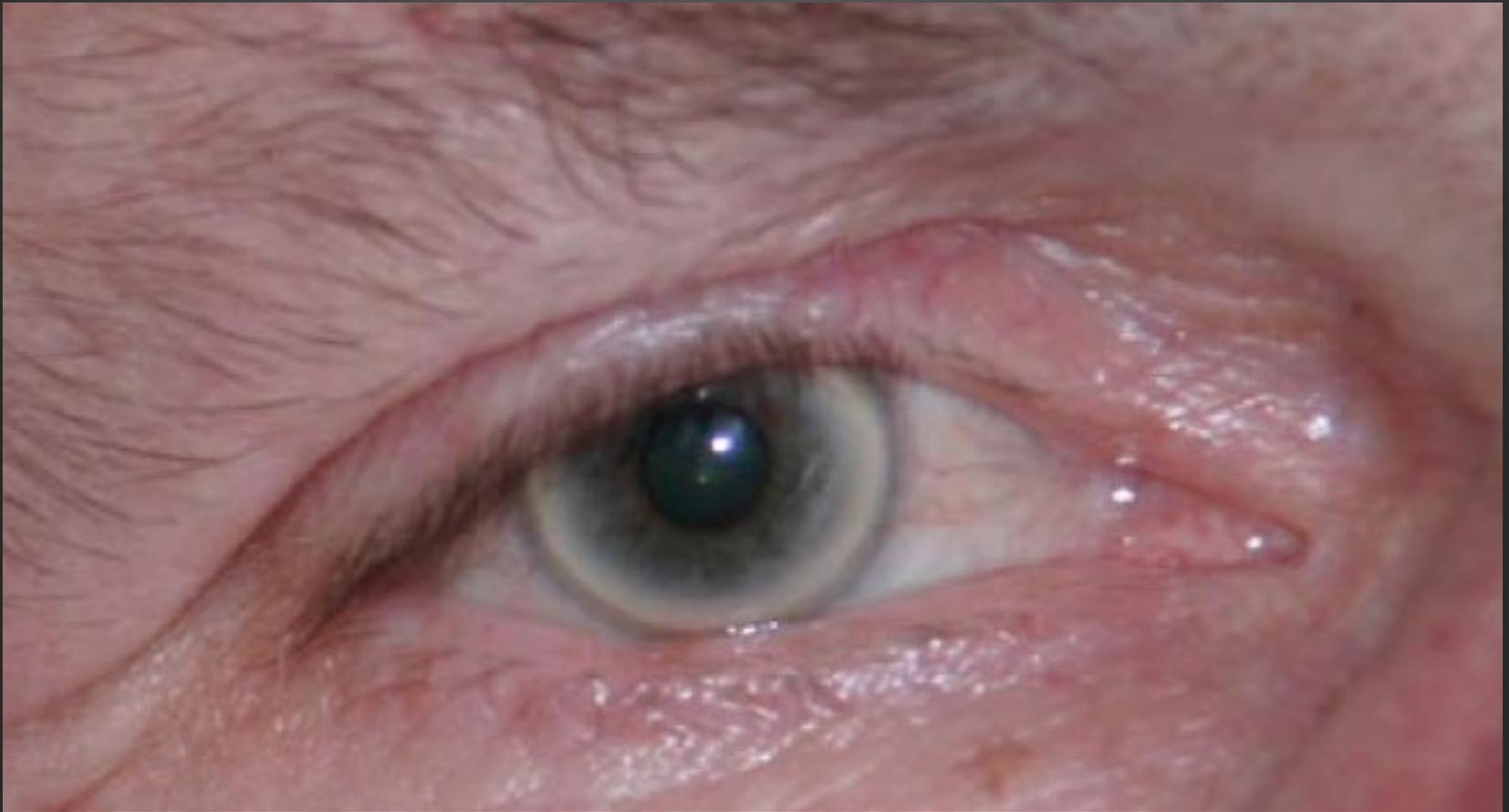
Skeletal/Bone

| Change | Consequence |
|--|---|
| ↓ Bone density | Brittle bones, prone to fractures |
| Joints become stiffer, less flexible Intervertebral discs gradually lose fluid Joints lose cartilage | Movement slows and may become limited, decreased arm swing Decrease in height, shortening of the trunk Inflammation and stiffness |

Skeletal/Bone



Name this finding



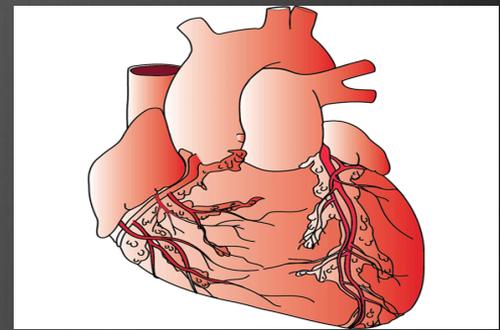


Eyes/Ears



| | Change | Consequence |
|------|---|--|
| Eyes | ↑ Lipid infiltrates/deposits | ↓ Transparency of the cornea (arcus senilis) |
| | ↑ Thickening of the lens | Difficulty in focusing on near objects |
| | ↓ Pupil diameter | ↓ Accommodation and dark adaptation |
| Ears | ↑ Thickening of tympanic membrane | ↑ Conductive deafness (low-frequency range) |
| | ↓ Elasticity and efficiency of ossicular articulation | ↑ Sensorineural hearing loss (high-frequency sounds) |
| | ↑ Organ atrophy | |
| | ↓ Cochlear neurons | |

Cardiovascular



| Change | Consequence |
|---|---|
| ↑ Left ventricular wall thickness | Stressed heart is less able to respond |
| ↑ Lipofuscin and fat deposits | Ventricular stiffness |
| ↑ Stiffness and ↑ aortic diameter | Increased afterload |
| Fibrosis, myocyte hypertrophy, and calcium deposition | Conduction system (prolonged PR, and QRS, RBBB) |
| Pacemaker cells are lost at a rate of 10% per decade | Tachy/Brady syndrome |

True/False

Older adults are more prone to atelectasis.

⦿ TRUE

⦿ WHY?

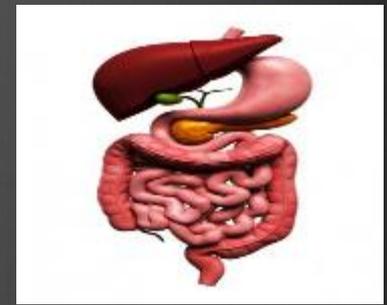
⦿ Costochondral calcification-->
intercostals less able to expand chest

Pulmonary



| Change | Consequence |
|---|---|
| ↓ Elastin fibers | ↓ Effort dependent and independent respiration (quiet and forced breathing) |
| ↑ Collagen cross-links | ↓ Exercise tolerance and pulmonary reserve |
| ↓ Elastic recoil of the lung | |
| ↑ Residual volume | |
| ↓ Vital capacity, forced expiratory volume, and forced vital capacity | |

Gastrointestinal



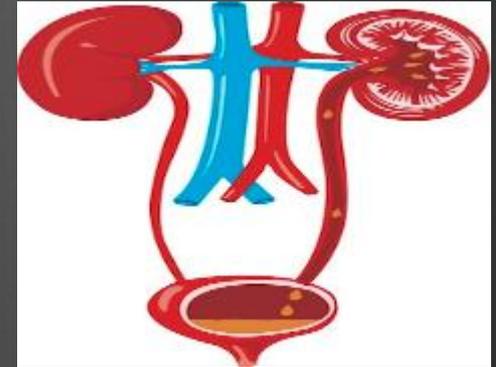
| Change | Consequence |
|--|--|
| Increase in nonperistaltic spontaneous contractions of the esophagus | ↑ Dysphagia, gastric emptying delayed |
| ↑ Achlorhydria | ↑ Plasma gastrin levels |
| Altered intestinal absorption, increased lipase production | ↓ Iron absorption |
| ↑ Lipofuscin and fat deposition in pancreas | ↓ B ₁₂ and calcium absorption |
| ↑ Mucosal cell atrophy | ↑ Incidence of diverticula, transit time, and constipation |

True or False

⊙ Taste bud numbers – increase

⊙ Olfactory acuity – decrease

Renal/Urinary



| Change | Consequence |
|---|-----------------------------------|
| ↓ Kidney size, weight, and number of functional glomeruli | ↓ Ability to resorb glucose |
| ↓ Number and length of functional renal tubules | ↓ Concentrating ability of kidney |
| ↓ Glomerular filtration rate | Medication toxicities |
| ↓ Renal blood flow | |

How does bladder function change with age?

- ↓bladder capacity (↓elasticity)
- ↓contractility ---> ↑PVR
- More uninhibited bladder contractions

What are some medications that need to be renally dosed/not used at all in the older patient?

- ⊗ NSAIDs should be avoided all together
- ⊗ Gabapentin
- ⊗ Antibiotics (for eg. Fluoroquinolones)
- ⊗ Codeine
- ⊗ Some beta blockers (atenolol)
- ⊗ Newer anticoagulants

What normal changes in body composition affect pharmacokinetics in aging?

- Increased body fat
- Reduced lean body mass
- Reduced total body water

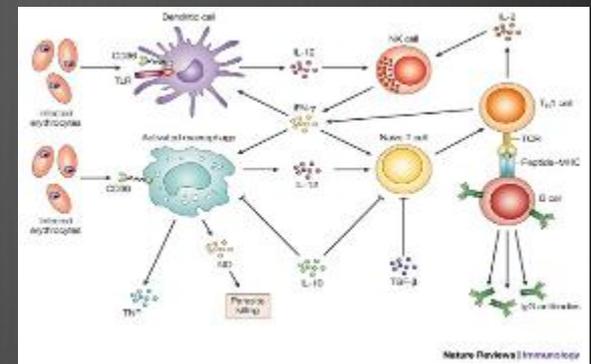
What normal changes in aging increase vulnerability to dehydration?

- ⊗ Decreased body water reserves
- ⊗ Decreased thirst drive
- ⊗ Reduced activity and responsiveness to RAA system
- ⊗ Reduced ability to concentrate urine

Immune

- ⊗ gradual decline in the immune system maintenance contributes significantly to increased morbidity and mortality in late life.
- ⊗ contributes to aging by limiting systemic defensive and repair responses that impact the functional capacity of other organ systems.
- ⊗ An elevated pro-inflammatory state has been observed in older individuals as marked by increased levels of cytokines (such as interleukin-6) and macrophage activation markers.

Immune

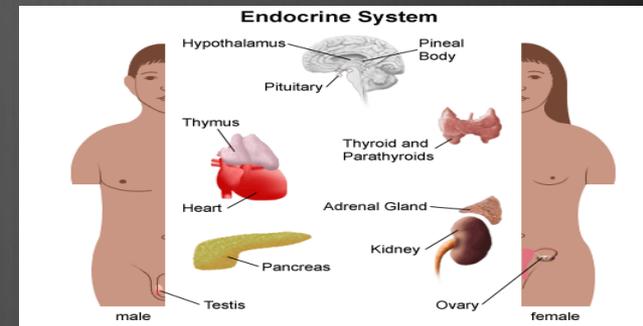


| Change | Consequence |
|--|--|
| ↓ Primary and secondary response | ↓ Immune functioning |
| ↑ Autoimmune antibodies | |
| ↓ T-cell function, fewer naive and more memory T cells | ↓ Response to new pathogens |
| Atrophy of thymus | ↓ T lymphocytes, natural killer cells, cytokines needed for growth and maturation of B cells |

Endocrine

- ⊗ With increasing age synthesis and secretion of a number of hormones change.
- ⊗ The circadian cycles of certain hormones also become irregular.
- ⊗ The occurrence of changes in hormone levels and signaling are a major cause of loss of homeostasis, views aging as arising from dysregulated hormones.

Endocrine



| Change | Consequence |
|---|--|
| <p>↑ Atrophy of certain glands (eg, pituitary, thyroid, thymus)</p> | <p>Changes in target organ response, organ system homeostasis, response to stress, functional capacity</p> |
| <p>↓ Growth hormone, dehydroepiandrosterone, testosterone, estrogen</p> | |
| <p>↑ Parathyroid hormone, atrial natriuretic peptide, norepinephrine, baseline cortisol, erythropoietin</p> | |

Older people are prone to
hyperthermia.

 True

  False

What are normal changes in sleep with aging?

- ⦿ Decreased sleep efficiency
- ⦿ Decreased deep sleep (stage 3,4)
- ⦿ More arousals
- ⦿ Phase shift

| Body System | Pathologies or Diseases that Increase in Incidence with Increasing Age |
|--------------------|--|
| Nervous | Cerebrovascular accident, dementias |
| Muscle | Sarcopenia |
| Skin | Decubitus ulcers, fungal infections (especially toenails) Neoplasms (basal and squamous cell carcinomas, melanoma) |
| Skeletal | Osteoporosis Rheumatoid arthritis, osteoarthritis |
| Cardiovascular | Hypertension, thrombosis, anemia |
| Heart | Congestive heart failure, myocardial infarction |
| Vasculature | Coronary artery disease, atherosclerosis, varicose veins, hemorrhoids |
| Pulmonary | Chronic bronchitis, emphysema, pneumonia, pulmonary embolism Sleep apnea, stertorous breathing Lung cancer |
| Eyes | Entropion, ectropion, cataracts, age-related macular degeneration, glaucoma Diabetic retinopathy |
| Ears | Presbycusis Tinnitus, dizziness, vertigo |
| Digestive | Esophageal strictures, hiatal hernia Atrophic gastritis, acute gastritis, peptic ulcer, diverticulitis Fecal incontinence, cirrhosis, gallstones, pancreatitis Cancer |
| Urinary | Urinary incontinence Benign prostatic hyperplasia |
| Immune | Autoimmune disorders (multiple sclerosis, myasthenia gravis) |
| Endocrine | Leukemias Diabetes Grave disease |

Don't let aging
get you down.

It's too
hard to
get
back up!

