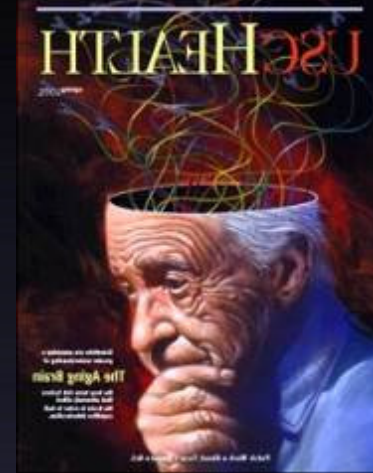
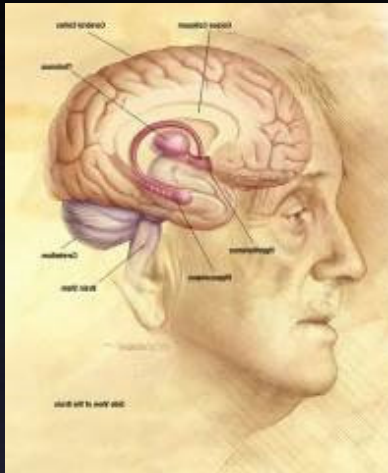


# PHYSIOLOGY OF AGING



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# Objectives

*At the end of this session you should be able to:*

- 1. Define Aging and its consequences*
- 2. Describe the theories of aging and terms Used*
- 3. Explain changes in different body systems during Aging*
- 4. Describe Important clinical conditions*
- 5. Elaborate Geriatric syndrome*

# AGING

**Aging is the progressive, universal decline first in **functional reserve** and then in **function** that occurs in organisms over time**

*Aging is not a disease; however, the **risk** of developing disease is increased, often dramatically, as a function of age.*

Elderly ----- Age 65 to 74  
Aged ----- Age 75 to 84  
Very Old ---- Age 85 and more

Young old (65–74),  
The middle old (75–84)  
Oldest old (85+)

# Aging is characterized by

- Changes in appearance (gradual reduction in height and weight loss due to loss of muscle & bone mass)
- A lower metabolic rate
- Longer reaction times
- Declines in certain memory functions
- Declines in sexual activity and in women menopause
- A functional decline in audition, olfaction, and vision
- Declines in kidney, pulmonary, and immune functions, declines in exercise performance, and multiple endocrine changes

(Craik and Salthouse, 1992; Hayflick, 1994, pp. 137-186; Spence, 1995)

# THE TERM AGEING

- **UNIVERSAL AGEING**: age changes that all people share)
- **PROBABILISTIC AGEING**: age changes that may happen to some (eg type two diabetes).
- **CHRONOLOGICAL AGEING**: referring to how old a person is
- **SOCIAL AGEING**: society's expectations of how people should act as they grow older
- **BIOLOGICAL AGEING**: an organism's physical state as it ages

## Some Theories of Aging

Hypothesis	How It May Work
Genetic	Aging is a genetic program activated in post-reproductive life when an individual's evolutionary mission is accomplished
Oxidative stress	Accumulation of oxidative damage to DNA, proteins, and lipids interferes with normal function and produces a decrease in stress responses
Mitochondrial dysfunction	A common deletion in mitochondrial DNA with age compromises function and alters cell metabolic processes and adaptability to environmental change

## Some Theories of Aging

Hypothesis	How It May Work
Hormonal changes	The decline and loss of circadian rhythm in secretion of some hormones produces a functional hormone deficiency state
Telomere shortening	Aging is related to a decline in the ability of cells to replicate
Defective host defenses	The failure of the immune system to respond to infectious agents and the overactivity of natural immunity create vulnerability to Inf..
Accumulation of senescent cells	Renewing tissues become dysfunctional through loss of ability to renew



# OXYGEN - free radicals (FR) and reactive oxygen species (ROS)

CELL METABOLISM

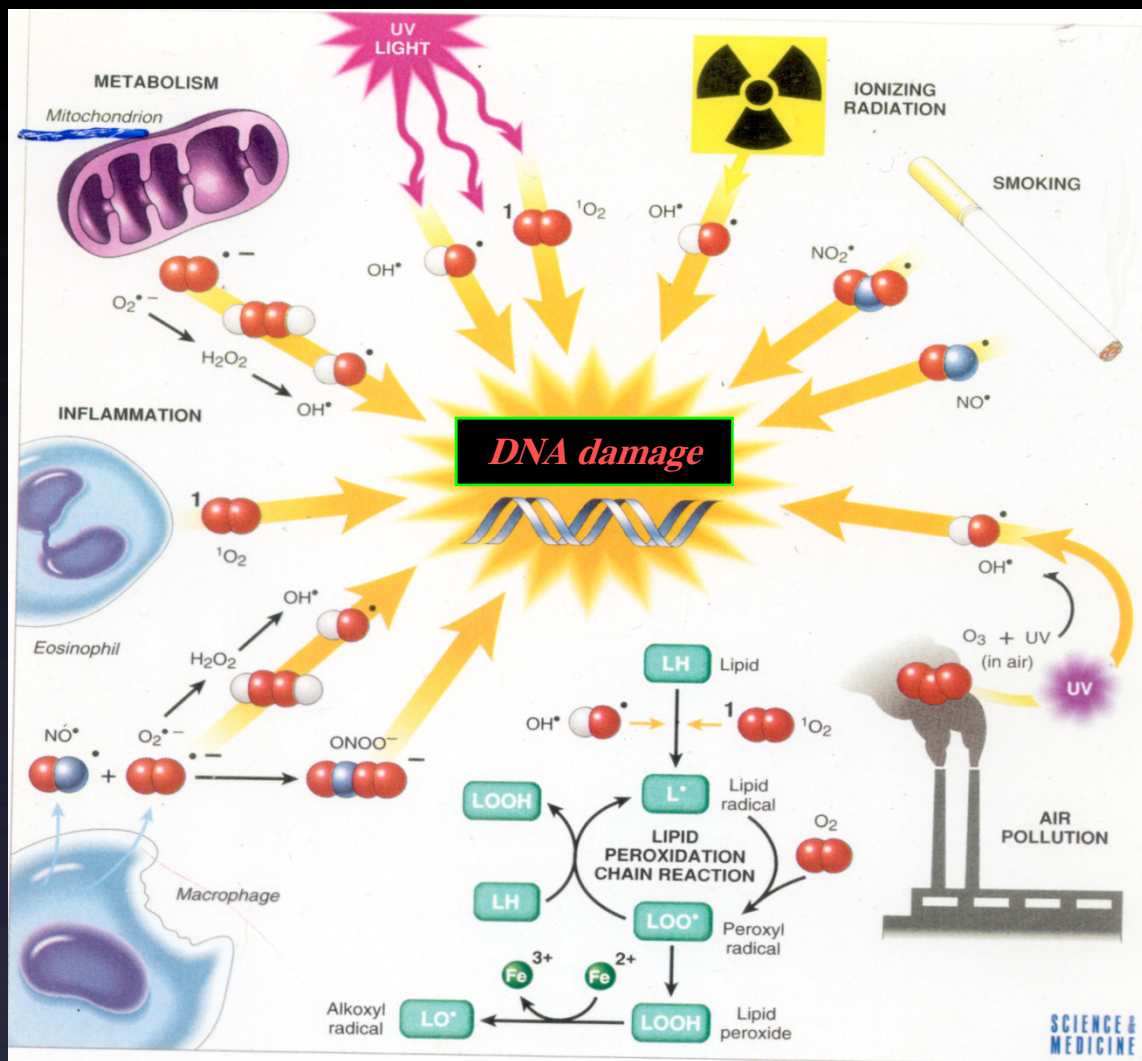
ENVIRONMENT

INFECTION

LIFESTYLE

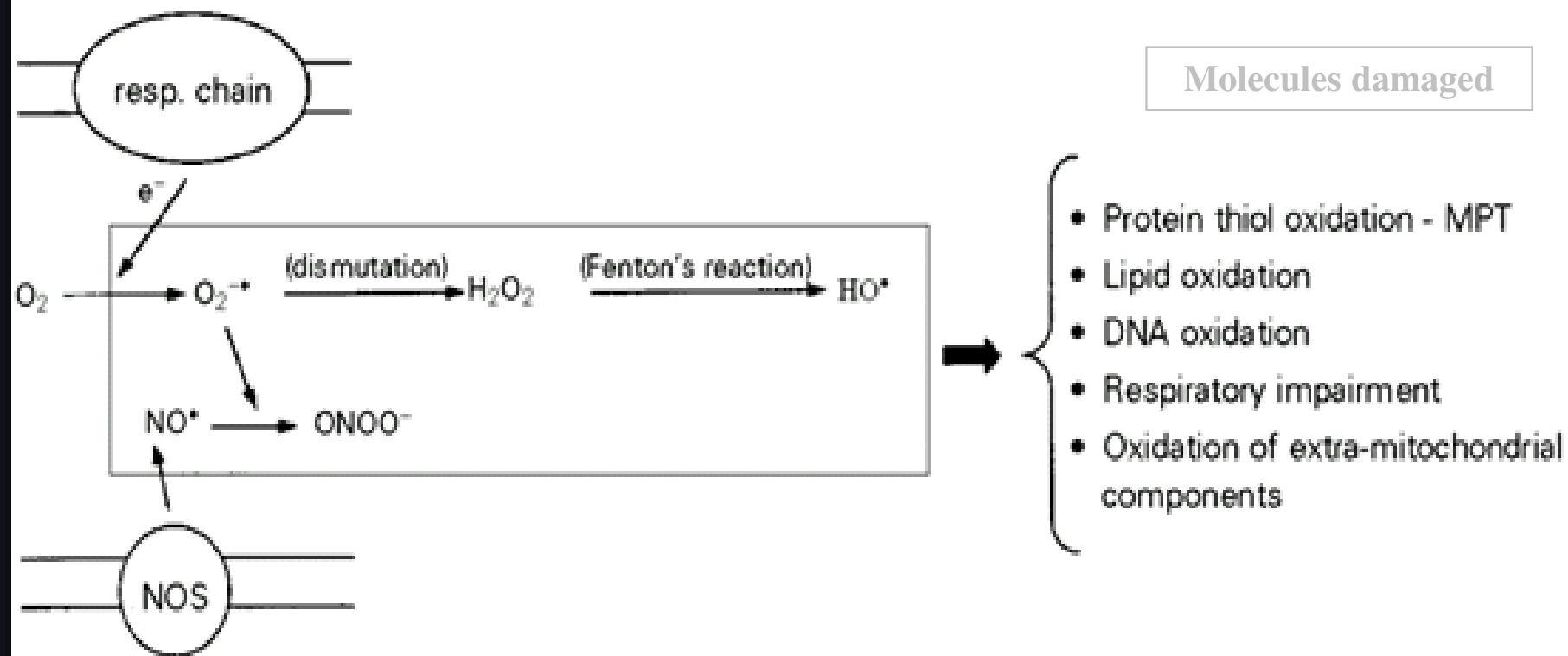
DIET

POLLUTION





# Mitochondria produce ROS:



The respiratory chain (resp. chain) produces superoxide radicals ( $O_2^{\cdot-}$ ), which generate hydrogen peroxide ( $H_2O_2$ ) and hydroxyl radicals ( $HO^{\cdot}$ ). Mitochondrial nitric oxide synthase (NOS) produces nitric oxide ( $NO^{\cdot}$ ), which combines with  $O_2^{\cdot-}$  to generate peroxynitrite ( $ONOO^-$ ). All these ROS may cause mitochondrial and cellular damage if present in excess.

MPT, Mitochondrial permeability transition.

Kowaltowski 2002

# Age-Related Physiological Changes

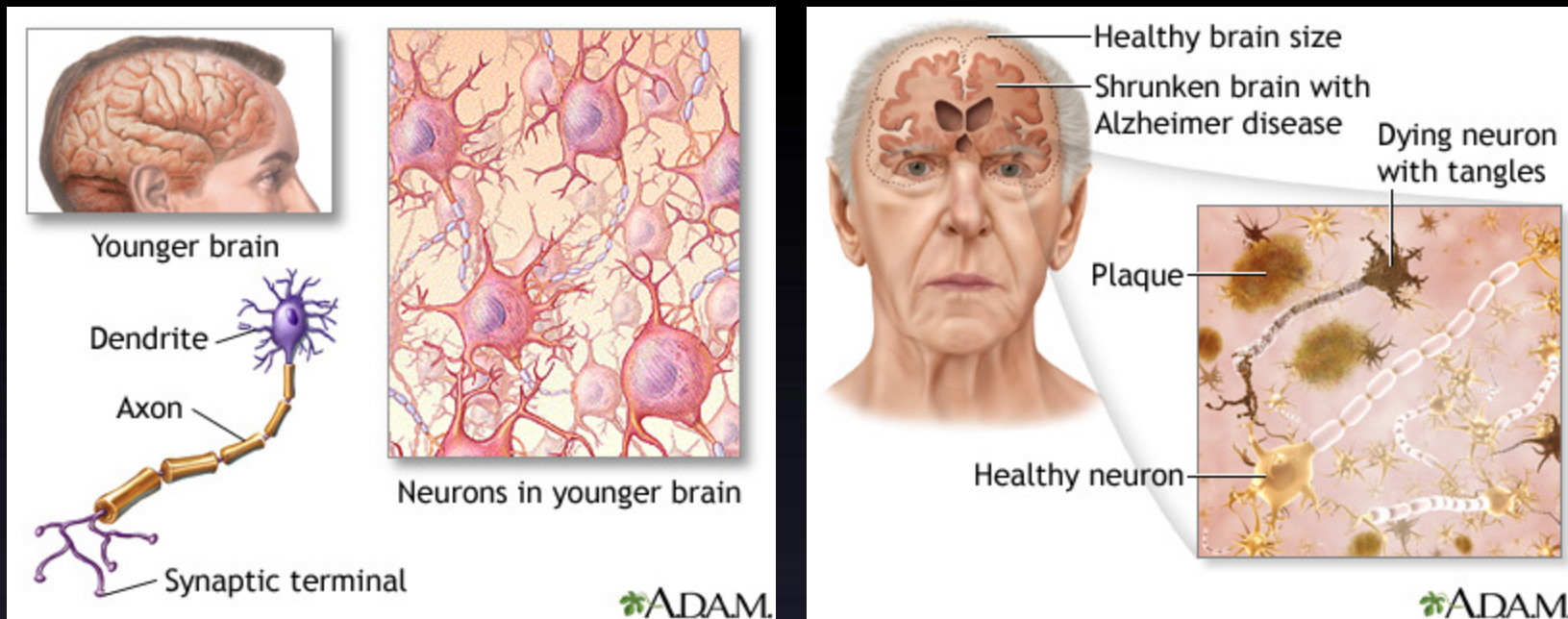
## Three Groups of Physiological Changes

- 1) Changes in **autonomic functions** and cellular homeostasis e.g. temperature, blood volumes and Endocrine changes
- 2) Reduction in **organic mass** e.g. brain, liver, kidneys, bones and muscles
- 3) Reduction in **organic functional reserve** e.g. lungs and heart

## Systems Affected

- Cardiovascular system
- Respiratory System
- Genitourinary System
- Gastrointestinal System
- Endocrine System
- Skin and Musculoskeletal System
- Nervous System
- Body temperature regulation
- Immune System
- Psychological Changes

# AGING NERVOUS SYSTEM



**“Use it or lose it!”**

**Individuals who remain mentally active perform better on cognitive tasks than those who engage in mental activity less often**

- **Accelerated rate of brain shrinkage after age 50.**
- **Loss of 100,000 neurons in the cortex per day.**
- **Irreversible process of brain dysfunction.**

# Nervous System

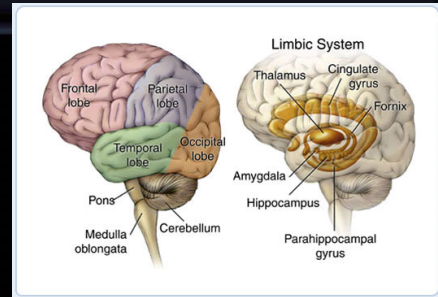
- **Neuronal loss** is normal in the aging brain but the ability to learn remains generally unchanged
- There is loss of **dendritic arborization**
- **Recall memory** is affected more than cognitive function in normal aging
- Lowered **seizure threshold**
- Reduced Sympathetic nervous system activity
- Reduced **Neurotransmitter levels** (Dopamine, Serotonin, Glutamate)
- Changes in sleep patterns
- Increased risk of stroke

Intellectual functioning defined as “Stored”  
memory increases with age  
Problem solving skills increase with age

# Brief Geriatric Assessment Instruments

Domain	Instrument	Comments
Cognition		
Dementia	MMSE	Widely studied and accepted
	Timed time and change test	Sensitive and quick
Delirium	CAM	Sensitive and easy to apply
Affective disorders	GDS 5-question form	Rapid screen
Visual impairment	Snellen chart	Universally used
Hearing impairment	Whispered voice	No special equipment needed
	Pure tone audiometry	Can be performed by trained office staff
Dental health	DENTAL <sup>c</sup>	
Nutritional status	Weight loss of >4.5 kg (>10 lb) in 6 months or weight <45 kg (<100 lb)	
Gait and balance	"Timed Get Up and Go" test	Requires no special equipment

# Aging nervous system



Structure	Regional function
Basal ganglia	Becomes bright in appearance due to iron accumulation (movements affected)
Subarachnoid space	Increase in size due to brain shrinkage
Hippocampus	Reduction in size due to cell loss in the structure. Part of limbic system Involved in learning & long term memory
Ventricles	Increase in size due brain shrinkage.
White Matter	Reduction in size due to neuronal atrophy in the deep brain. Involves in information transmission.

# Aging nervous system

## Changes

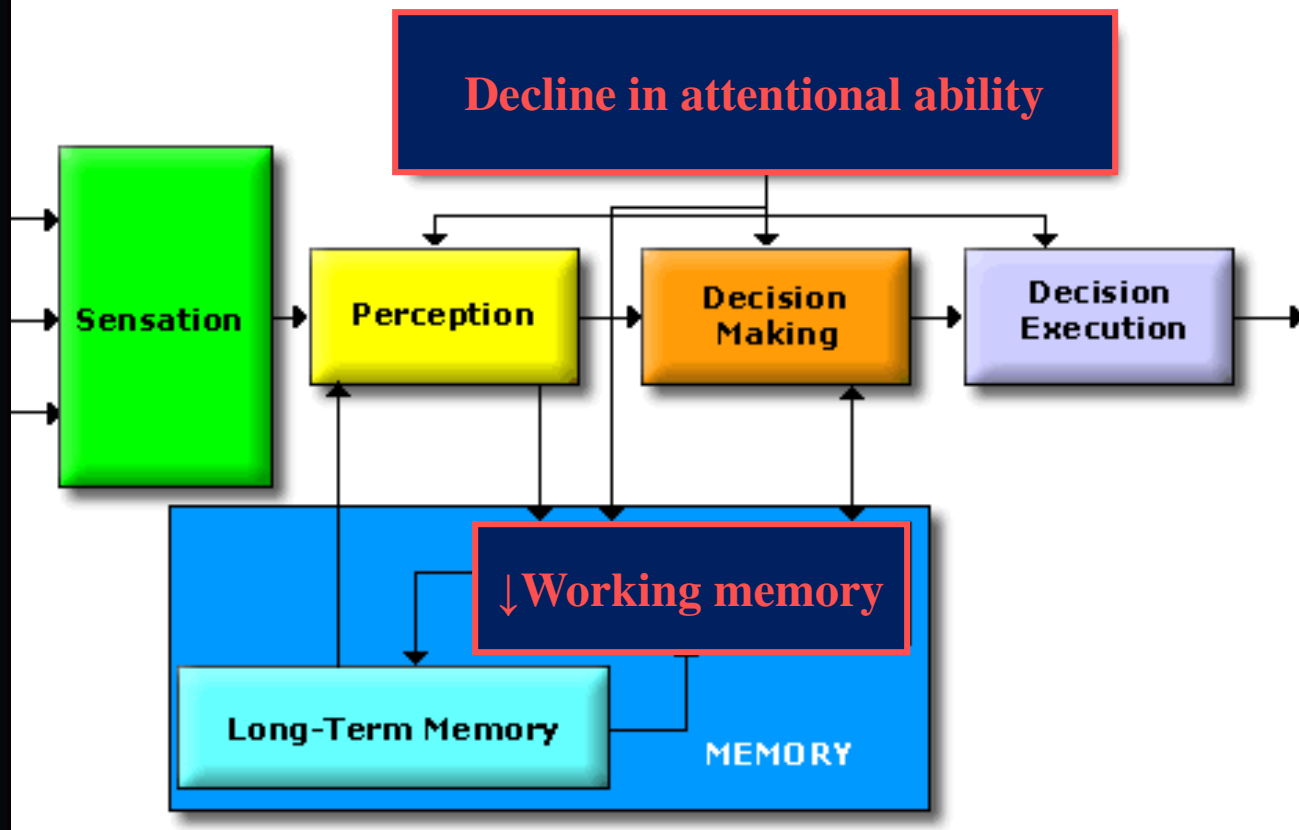
- Decreased brain weight
- Cerebral blood flow
- memory
- Alteration in CNS neurotransmitters
- Decreased vibratory sense

## Consequences

- Drug toxicities
- delirium
- Altered mood
- Decreased IQ scores
- “Benign senile forgetfulness”
- Increased postural instability
- Altered gait
- Falls, accidents



# COGNITIVE CHANGES IN AGING: MENTAL PROCESSING



## DECLARATIVE MEMORY OR EXPLICIT MEMORY

- EPISODIC MEMORY (Events)
- SEMANTIC MEMORY (Words, language) Late to ↓
- HIPPOCAMPUS AND IS ASSOCIATED WITH CONSCIOUSNESS

## SKILL MEMORY OR IMPLICIT MEMORY

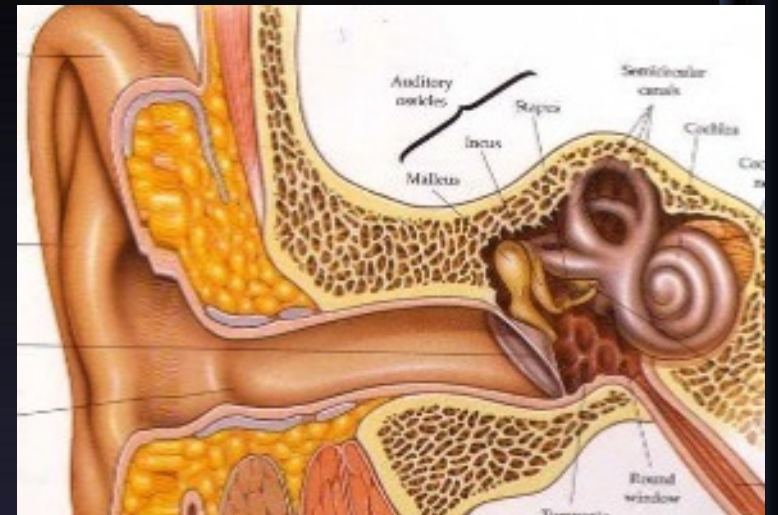
- IT DOES NOT INVOLVE AWARENESS.
- INVOLVES CEREBELLUM, MOTOR CORTEX, SENSORY CORTEX, VISUAL AREAS

There is decline in mental processing via reduction of attentional ability and decline in ability in forming **working memory** (mainly includes short term memory)

There is **decline in explicit memory** that involves hippocampus (surroundings & Skills) and is associated with awareness & attention unlike implicit.

# Hearing

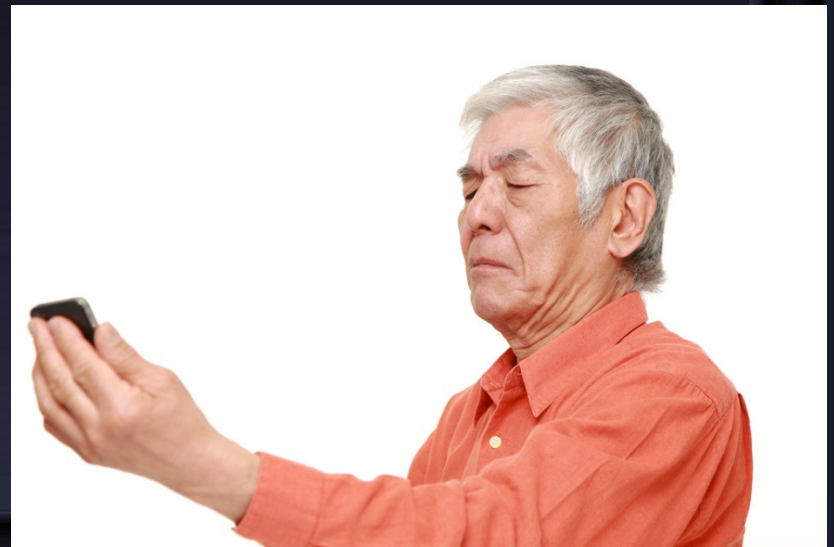
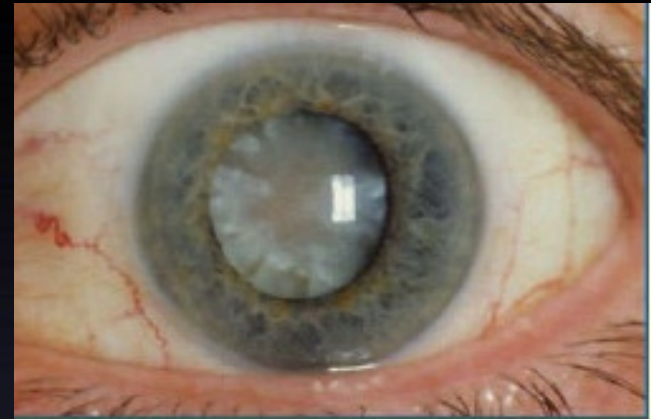
- **Presbycusis:** Part of normal aging (35% people over 60 years of age have bilateral, symmetric & progressive impairment for high pitched sounds sensorineural hearing loss)
- **Cerumen impaction:** is one of the most common reversible cause of conductive hearing loss in elderly



Damage to the hair cells of the organ of Corti may be caused by intense noise, viral infections, ototoxic drugs (e.g., salicylates, aminoglycoside antibiotics, furosemide and chemotherapeutic agents such as cisplatin), fractures of the temporal bone, meningitis, cochlear otosclerosis (see above), Ménière's disease and **Aging**

# Vision

- Loss of ability to see items that are close up begins in the 40's (**Presbyopia**)
- Size of **pupil** grows smaller with age: focusing becomes less accurate
- Pupil less sensitive to light
- Opacification of lens (**Cataract**)
- Lens of eye yellows making it more difficult to see red and green colors
- **Night vision** not as acute
- **Arcus Senilis**



# Disorders of the Sense of Taste

- Dorsum surface shows loss of filiform papilla
- Foliate papillae more prominent.
- Fissures increase
- Dryness of the mouth
- The ventral surface of the tongue shows the presence of nodular varicose enlargement also known as caviar tongue
- Loss of taste buds with age



Sensory gustatory losses are caused by inflammatory and degenerative diseases in the oral cavity; a vast number of drugs, such as antithyroid and antineoplastic agents; radiation therapy to the oral cavity and pharynx; viral infections; endocrine disorders; neoplasms; and **aging**

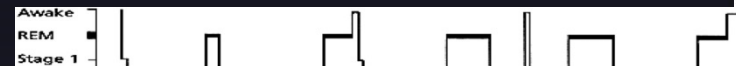
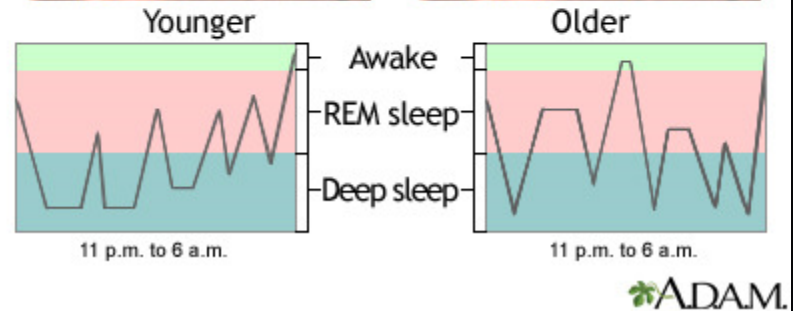
# Pain and Sense of Touch

- With age, skin is not as sensitive as in youth
  - Contributing factors include:
    1. Loss of elasticity
    2. Loss of pigment
    3. Reduced fat layer
- Safety Implications:
  1. Lessened ability to recognize dangerous levels of heat
  2. Lessened ability of body to **maintain temperature**
  3. Tendency to develop bruises, skin tears more easily



# SLEEP PATTERNS

- It tends to become more fragmented, with more awakenings during the night.
- Total sleep time stays the same or is slightly decreased (6.5 to 7 hours per night).
- The transition between sleep and waking up is often abrupt, which



## AS YOU AGE:



# *Geriatric Syndromes*

- *Dementia and Delirium*
- *Falls*
- *Urinary Incontinence*
- *Pressure Ulcers*
- *Functional Decline*



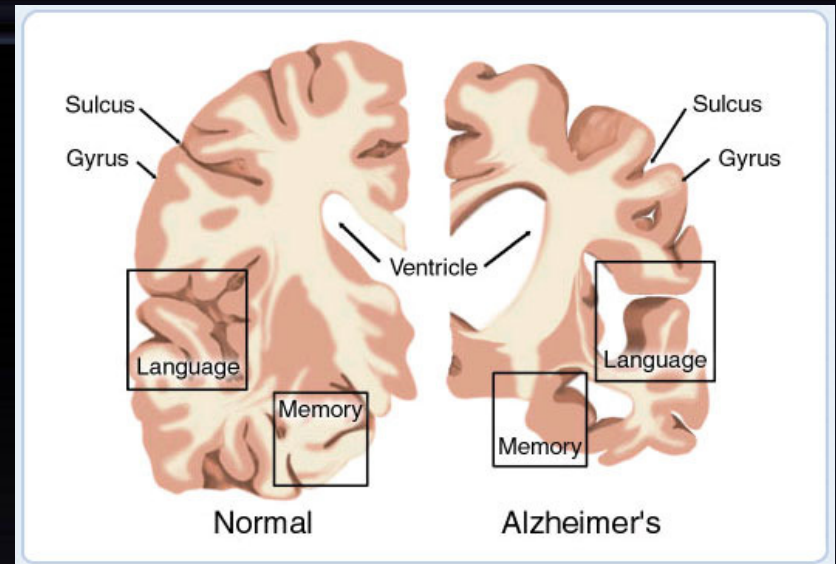
# Dementia and Delirium

- Dementia is a syndrome of **progressive decline** in which multiple intellectual abilities deteriorate, causing both cognitive and functional impairment.
- Delirium is an **acute state** of confusion
- Delirium may be the only manifestation of a **life-threatening illness** in the older adult.



Infection  
Drugs

# Alzheimer's Disease



- Alzheimer's disease is defined as premature aging of the brain, usually beginning in mid-adult life and progressing rapidly to extreme loss of mental powers similar to that seen in very, very old age.

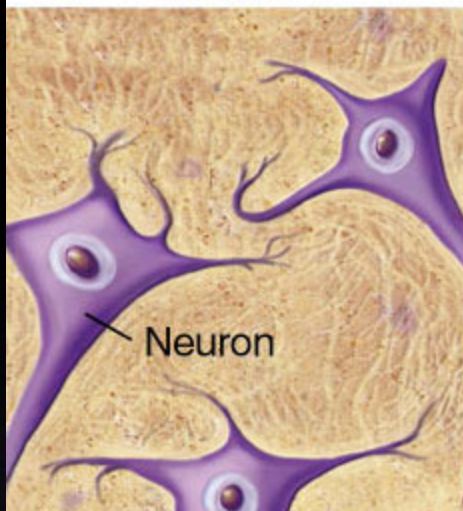
# Alzheimer's Disease

## (Features)

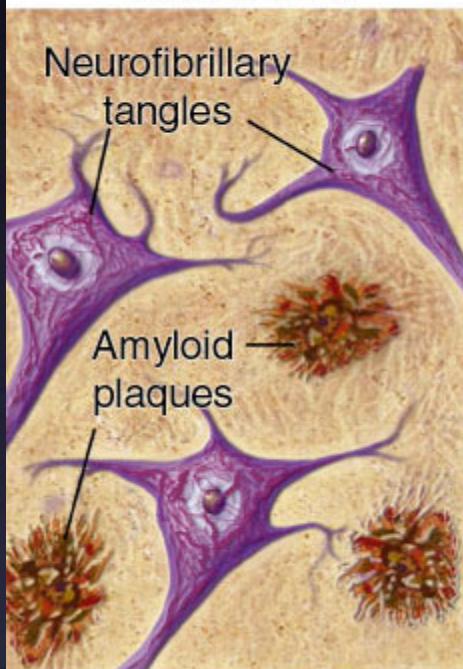
- (1) An amnesic type of memory impairment
- (2) Deterioration of language
- (3) Visuospatial deficits.

**Motor and sensory abnormalities, gait disturbances, and seizures are uncommon until the late phases of the disease.**

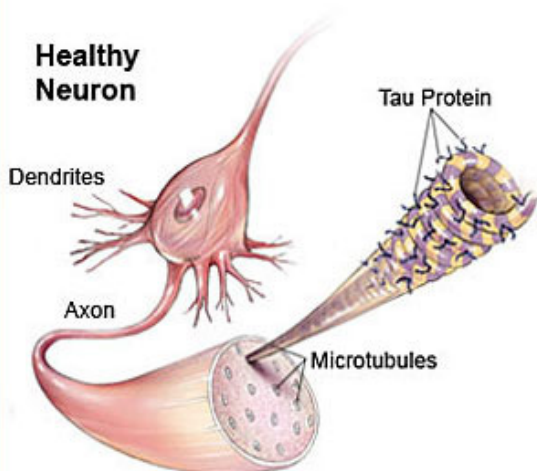
Normal



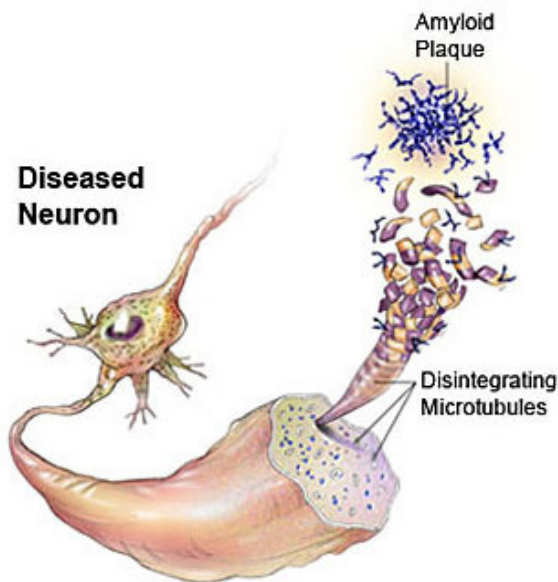
Alzheimer's



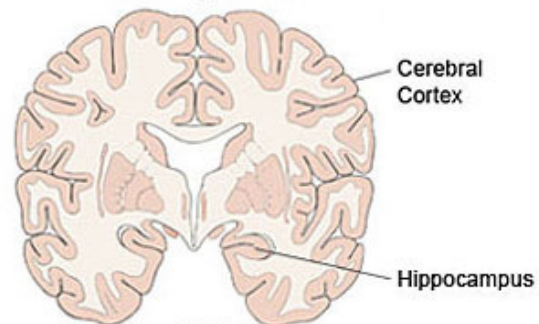
Healthy Neuron



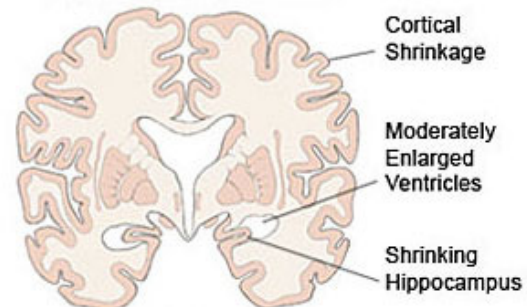
Diseased Neuron



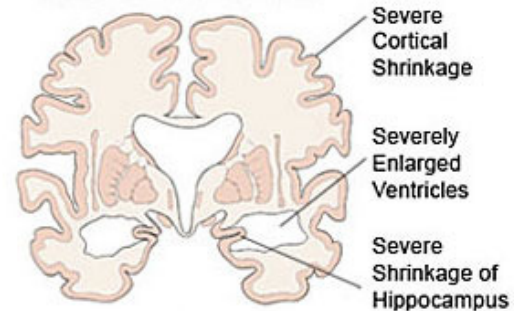
Healthy Brain



Mild Alzheimer's Disease



Severe Alzheimer's Disease



# Amyloid Plaques

- It is hallmark of Alzheimer's disease
- There is accumulation of **amyloid plaques between nerve cells** (neurons) in the brain.
- Amyloid is a general term for protein fragments that the body produces normally. Beta amyloid is a protein fragment snipped from an amyloid precursor protein (APP).
- In a healthy brain, these protein fragments are broken down and eliminated. In Alzheimer's disease, the **fragments accumulate** to form hard, insoluble plaques.

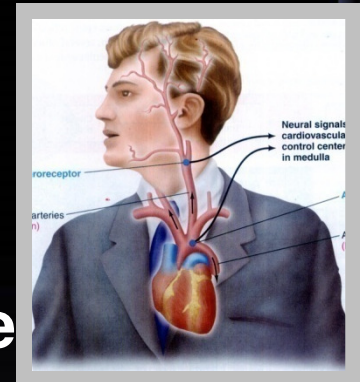
# Neurofibrillary Tangles

- These are insoluble twisted fibers found inside the brain's cells.
- Consist primarily of a protein called **tau**, which forms part of a structure called a microtubule. The microtubule helps transport nutrients and other important substances from one part of the nerve cell to another.
- In **Alzheimer's disease**, however, the tau protein is abnormal and the microtubule structures collapse.



# Carotid sinus hypersensitivity

- Carotid sinus syncope occurs when there is an exaggerated vagal response to carotid sinus stimulation,
- Provoked by wearing a tight collar, looking upwards or turning the head
- Carotid sinus syndrome occurs in the elderly and mainly results in bradycardia.
- Most common etiologies of atrioventricular block
- Do not massage both carotids simultaneously.





**Control of  
blood pressure**

**Short-term  
Control  
(Rapid)**

**Baroreceptor  
reflex**

**Long-term  
control**

**Renal  
compensation**

# Baroreceptor Reflex

Quick operation  
(within few  
seconds)

Mediated  
through  
autonomic nerves

Adjusts CO & TPR  
to restore BP  
to normal

Influences  
heart &  
blood vessels

**Pressure on the carotid sinus,  
produced by the  
tight collar or carotid massage**

**can  
cause**

**vasodilatation**

**marked  
bradycardia**

**Fainting  
or syncope**