Western

UNIVERSITY · CANADA

Tutorial 6
Sections 009/010

TA: Greydon Gilmore

Physiology 2130

Oct 15th, 2019

Western

Your TA reminding you…

- **1st Peerwise assignment** (1.5%)
  - Post 2 MC questions: due Oct 16th @ midnight (Tomorrow!)
  - Answer 5 MC questions: due Oct 18th @ midnight
    - 38 students wrote 2 MC Q's
    - 43 students answered 5 MC Q's
- **1st Quiz** (1%)
  - Opens: Oct 21st @ 4pm
  - Closes: Oct 22nd @ 4pm
- **1st Midterm** - Oct 25th @ 6pm-7pm (15%)
- **Midterm Review session**
  - When: Tuesday, Oct 22nd from 6:00-8:00pm
  - Where: Auditorium B, University Hospital, 3rd floor

Today

- No group work!
- Learning Catalytics Question
- Vision
- Audition
- Motor Control

Question from anonymous suggestion box…

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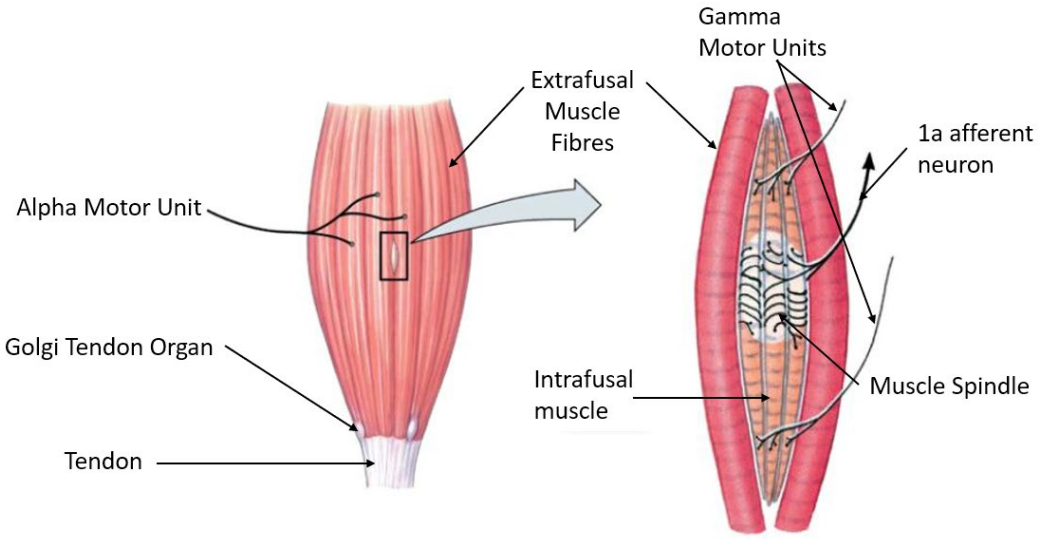
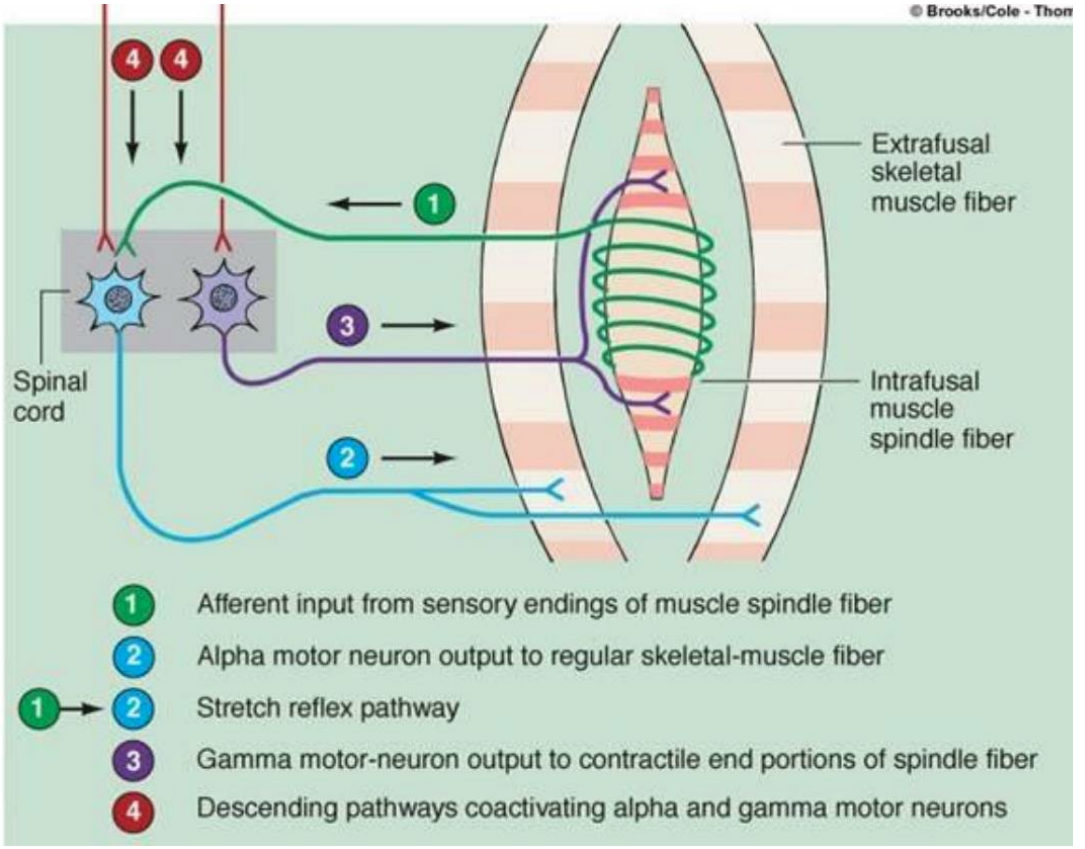
How do gamma neurons regulate gain of muscle spindles, and how does the inhibitory inter-neuron in the antagonistic patellar tendon reflex work?

- Extrafusal fibers: normal contractile fibers, outer muscle
- Alpha motor neuron innervates extrafusal muscle fibers
- Intrafusal fibers: internal muscle fibers of muscle
- Gamma motor neurons innervate intrafusal fibers.



How do gamma neurons regulate gain of muscle spindles, and how does the inhibitory inter-neuron in the antagonistic patellar tendon reflex work?

- Stretching of muscle spindle/intrafusal muscle fiber
- Info sent from muscle spindles to CNS via 1a afferent neurons
- CNS processes info
- Alpha motor neuron causes extrafusal muscle fiber contraction
- Gamma motor neuron causes intrafusal fiber contraction



Learning Catalytic Question

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Vision: Eye and Retina

Chapter 2: Dr. Everling

pp.

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Electromagnetic Spectrum

- Light is electromagnetic energy emitted in the forms of waves
- Our eyes are sensitive to a small part of this spectrum called visible light (400 –700 nm)

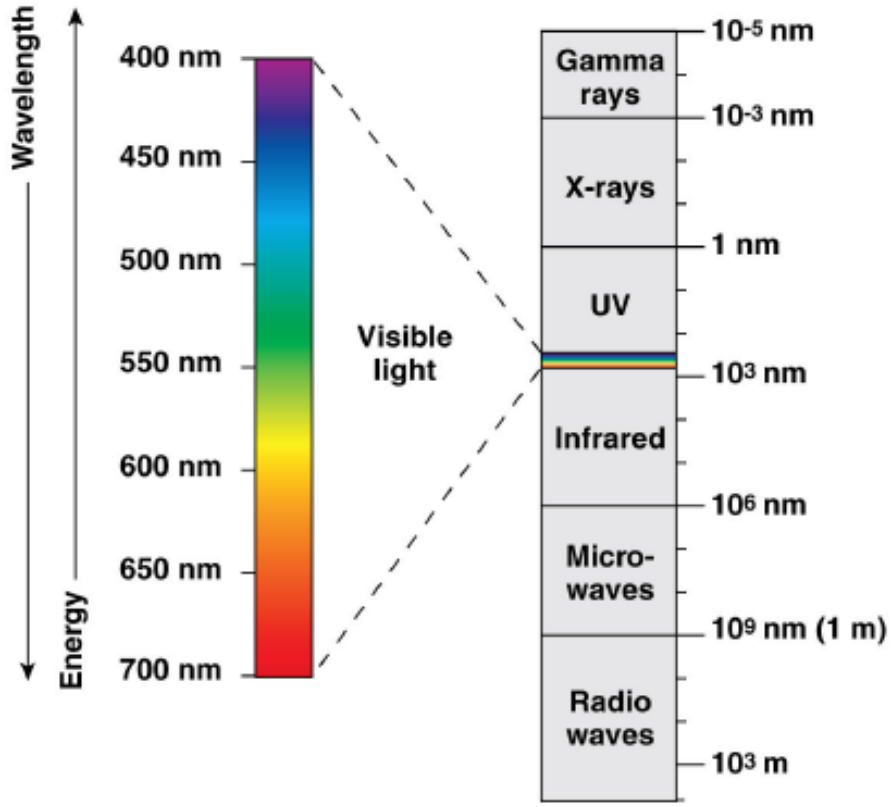

Fig. 2.21

The first structure which the majority of retinal ganglion cells project to, and synapse with, in the brain is the…

A) Visual cortex
B) Optic chiasm
C) Lateral geniculate nucleus
D) Superior colliculus

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A) Visual cortex

B) Optic chiasm

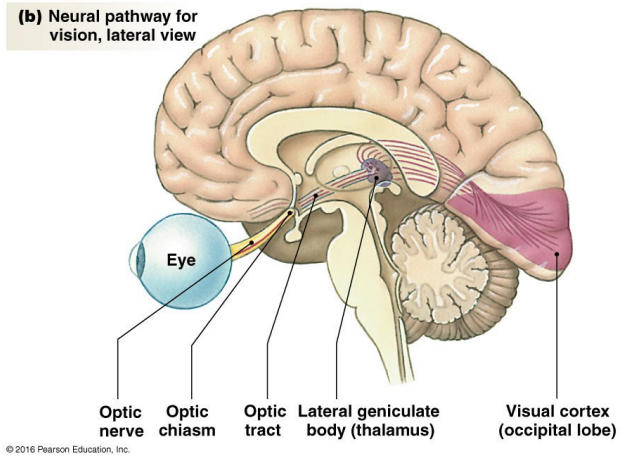
C) Lateral geniculate nucleus

D) Superior colliculus

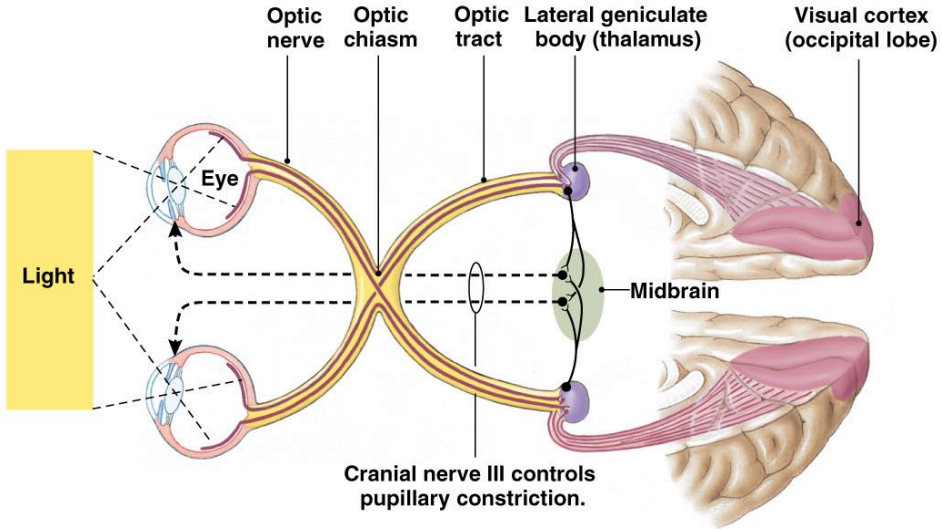
Components of the Visual system

Fundamental Components:

Eye →Retina →Optic Nerve →Optic Chiasm →Optic Tract →LGN →Optic Radiations →Primary Visual Cortex



- Retinal Targets:
  - Lateral geniculate nucleus (LGN)
    - Main target (90% of info)

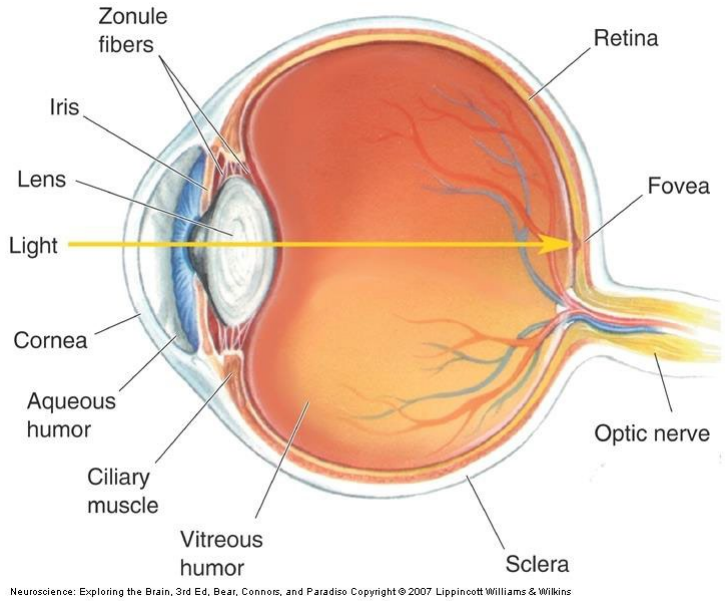


Eye (Gross Anatomy)

- Pathway of light:

Cornea →Anterior Chamber (with aqueous humor) →Pupil →Lens →Posterior Chamber (with vitreous humor) →Retina

- Other important Structures:
  - Iris
  - Sclera
  - Conjuctiva
  - Extraocular Eye Muscles
  - Ciliary Muscles
  - Fovea
  - Optic disk (Blindspot)



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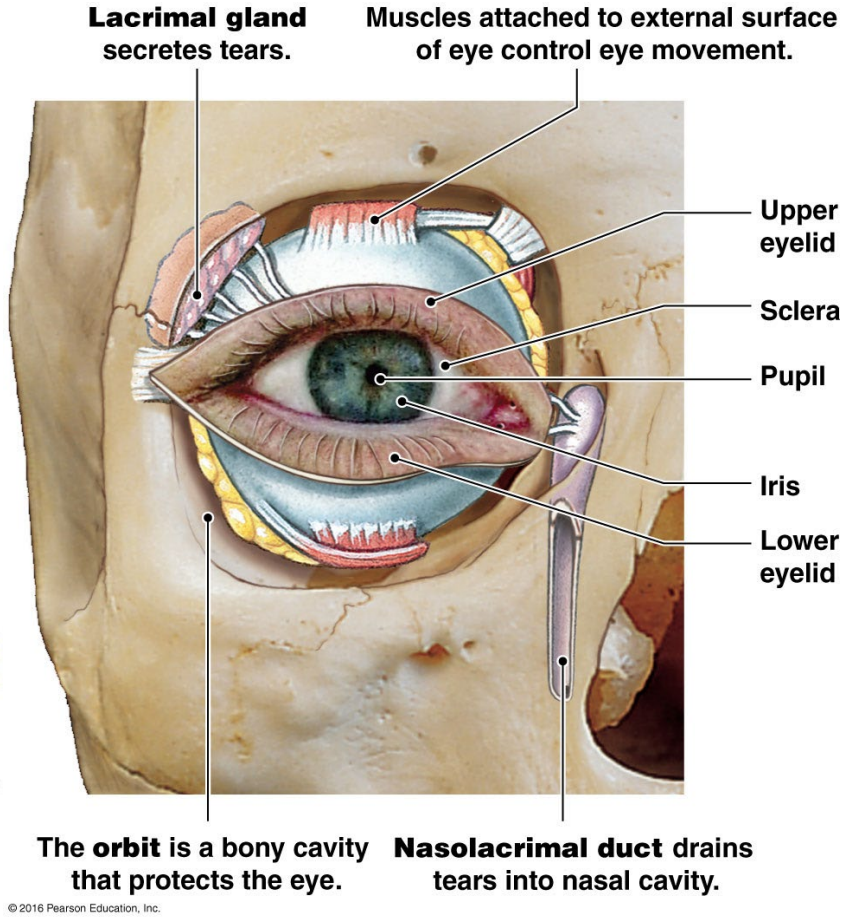
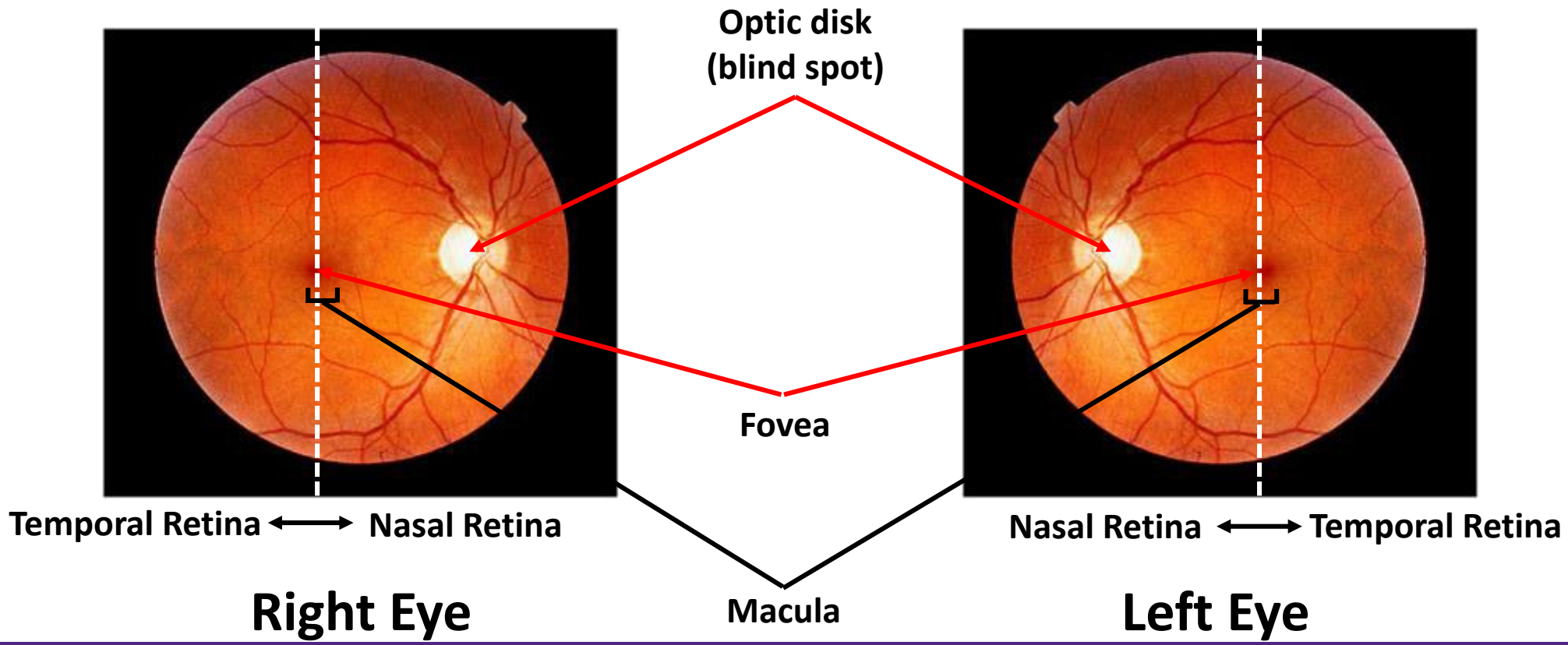


Eye (Gross Anatomy)



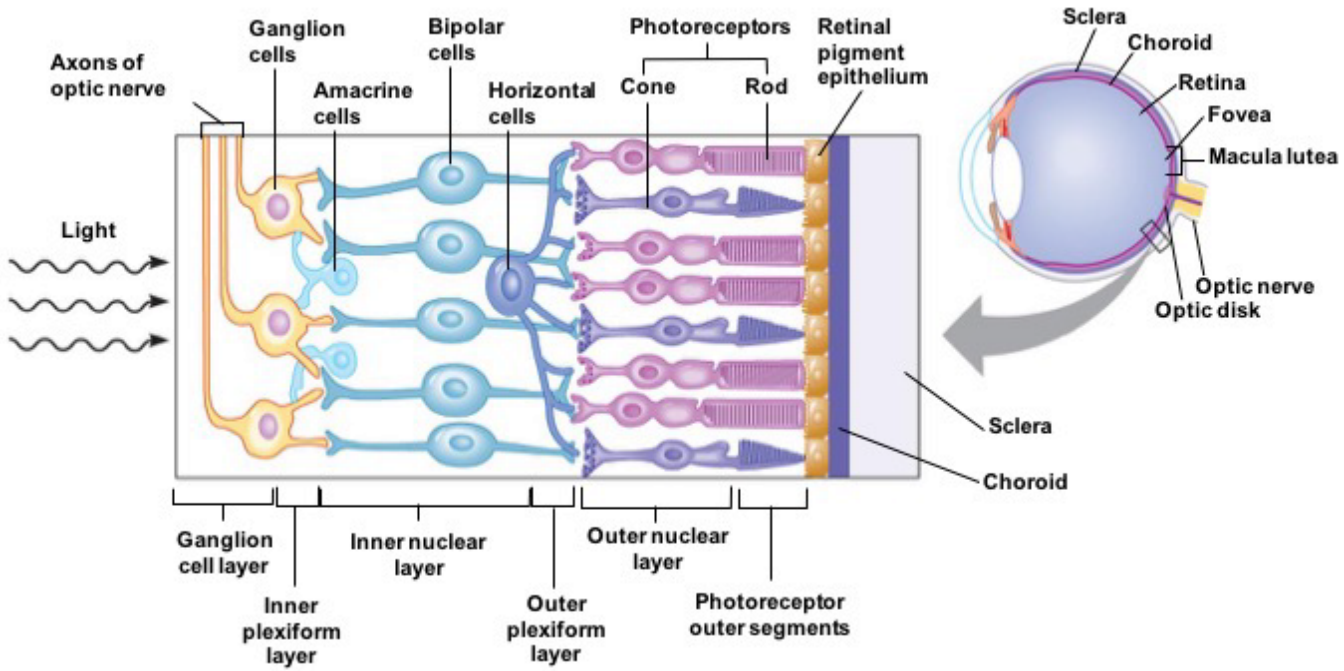
Retinal Cells

Main Pathway:

- Photoreceptors (rods and cones)
- Bipolar cells
- Ganglion cells

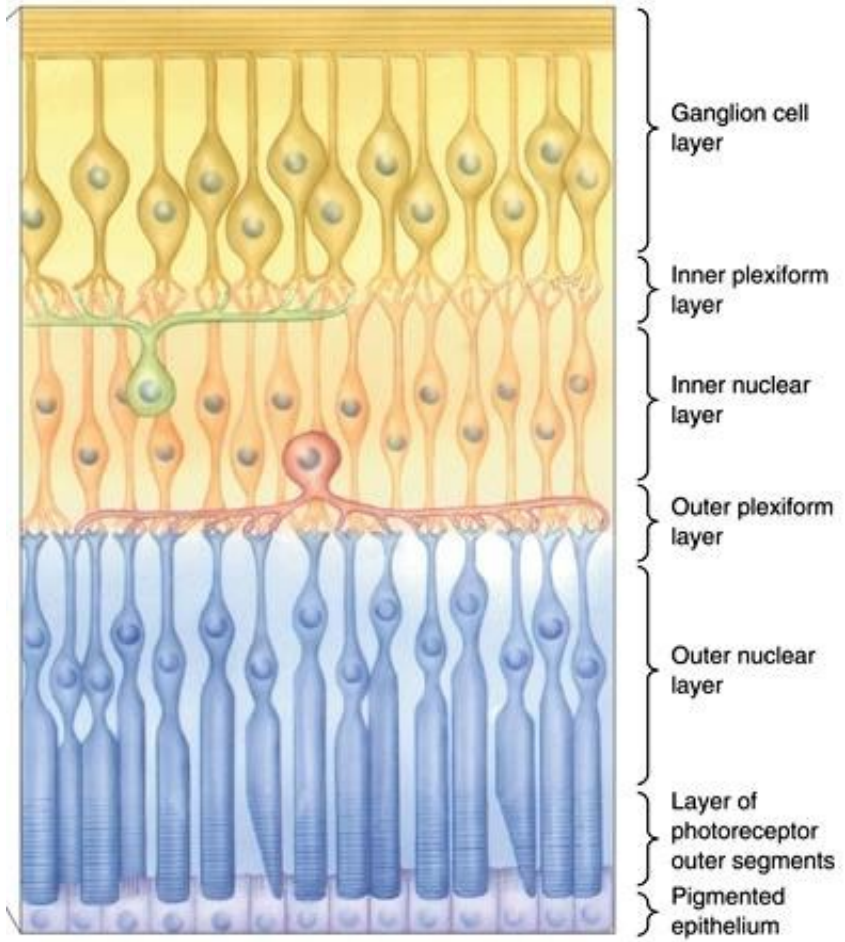
Modulation and Communication:

- Horizontal cells
- Amacrine cells



Retinal Layers

- Nuclear layers: cell bodies
- Plexiform layers: synapses
    1. Ganglion cell layer
    2. Inner plexiform layer
    3. Inner nuclear layer
    4. Outer plexiform layer
    5. Outer nuclear layer
    6. Photoreceptor outer segments



The fovea is the part of the retina that contains photoreceptors called…

A) Rods
B) Ganglion cells
C) Cones
D) Amacrine cells

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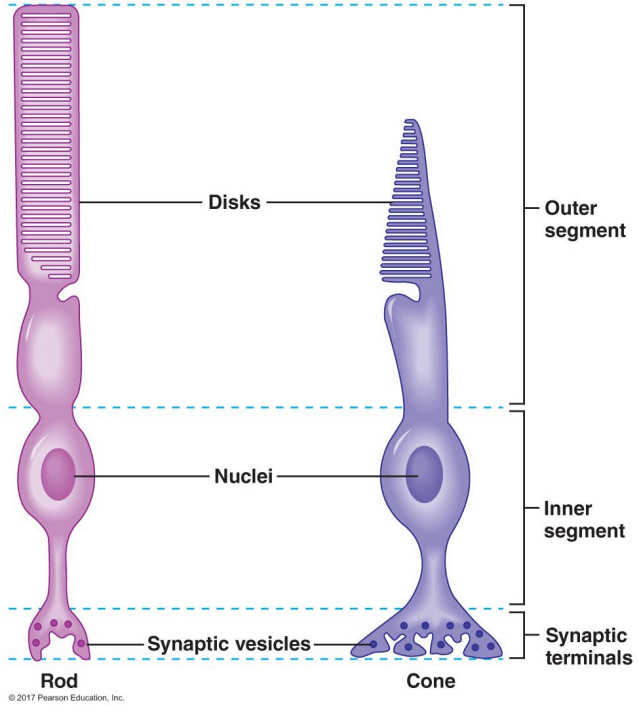
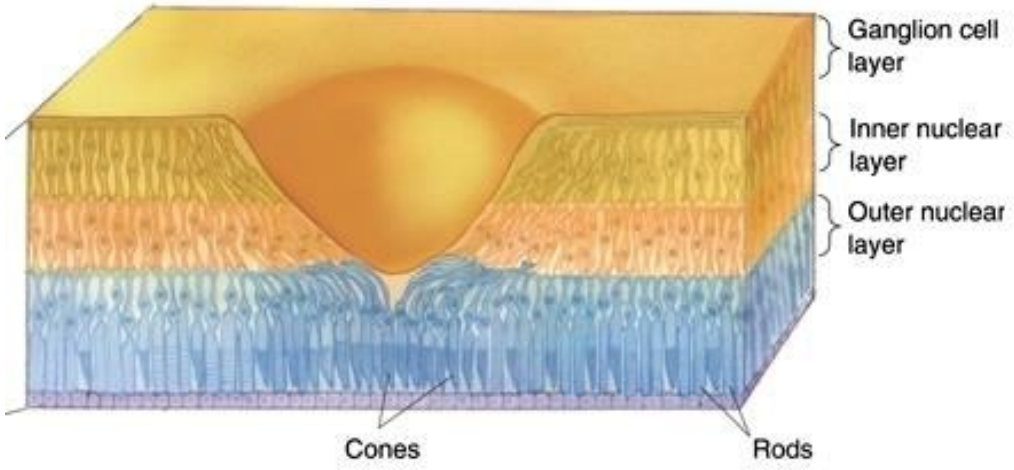
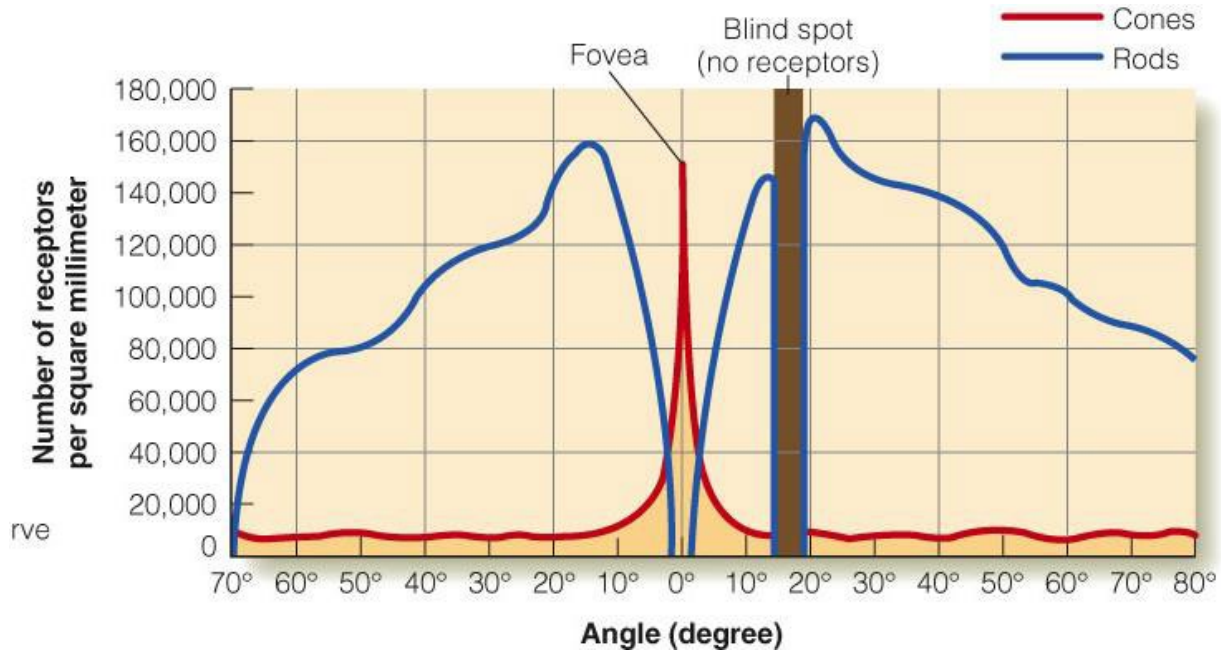
Photoreceptors

- Two parts:
  - Outer segment: photosensitive part
  - Inner segment: cell body

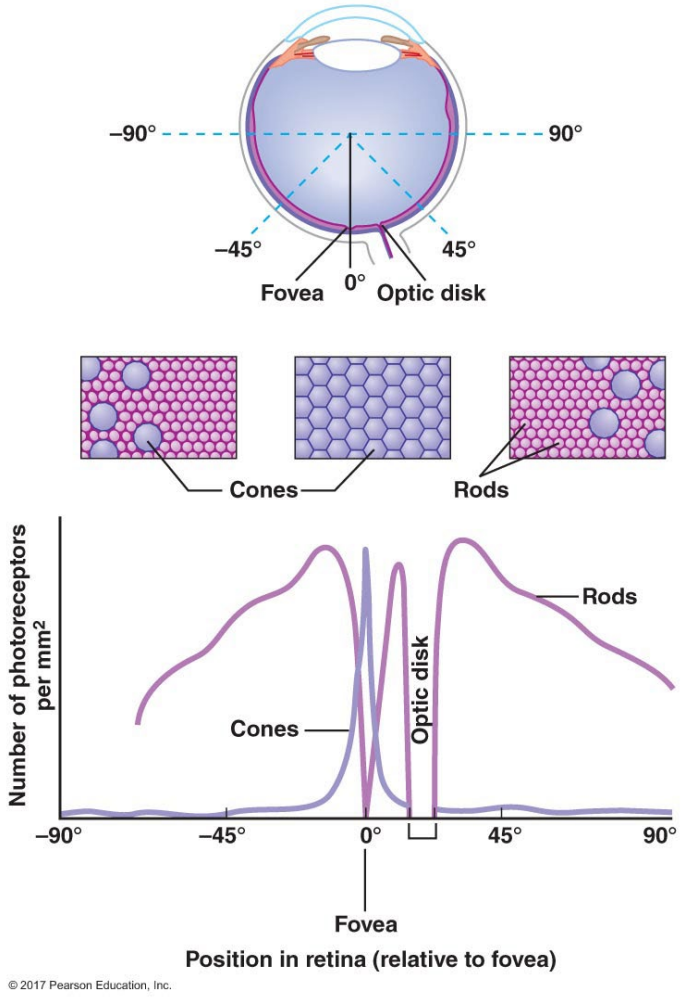






Two Photoreceptors: Rods vs. Cones

Feature	Rods	Cones
Sensitive to…	White/Black	Color
Lighting conditions…	Dim light	Daylight
Located	Around retina	Only in fovea
Amount	Many (120 million/retina)	Few (5 million/retina)



Axons extending from the nasal part of the retina project to the _____ side of the brain, whereas axons from the remainder of the retina project to the _____ part of the brain.

A) Dorsal, ventral
B) Opposite (contralateral), same side (ipsilateral)
C) Same side (ipsilateral), opposite (contralateral)
D) Medial, Lateral

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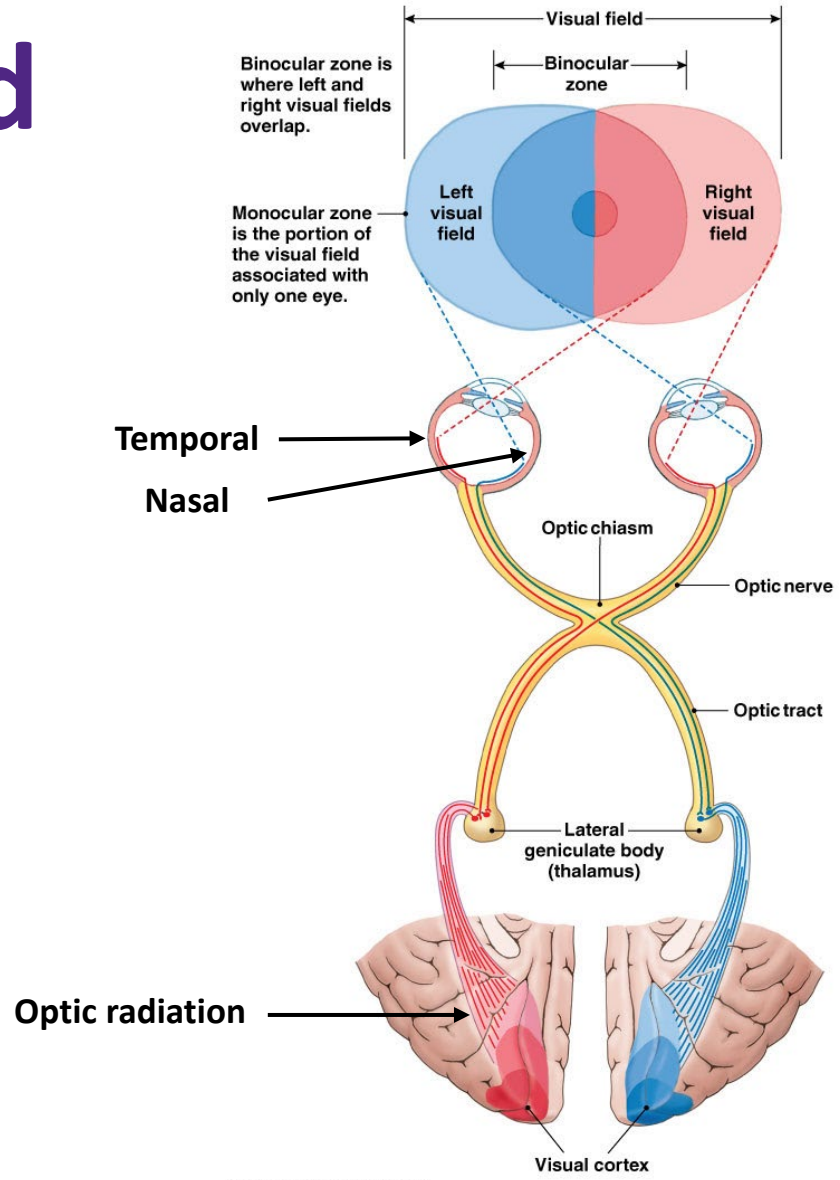
Visual Field

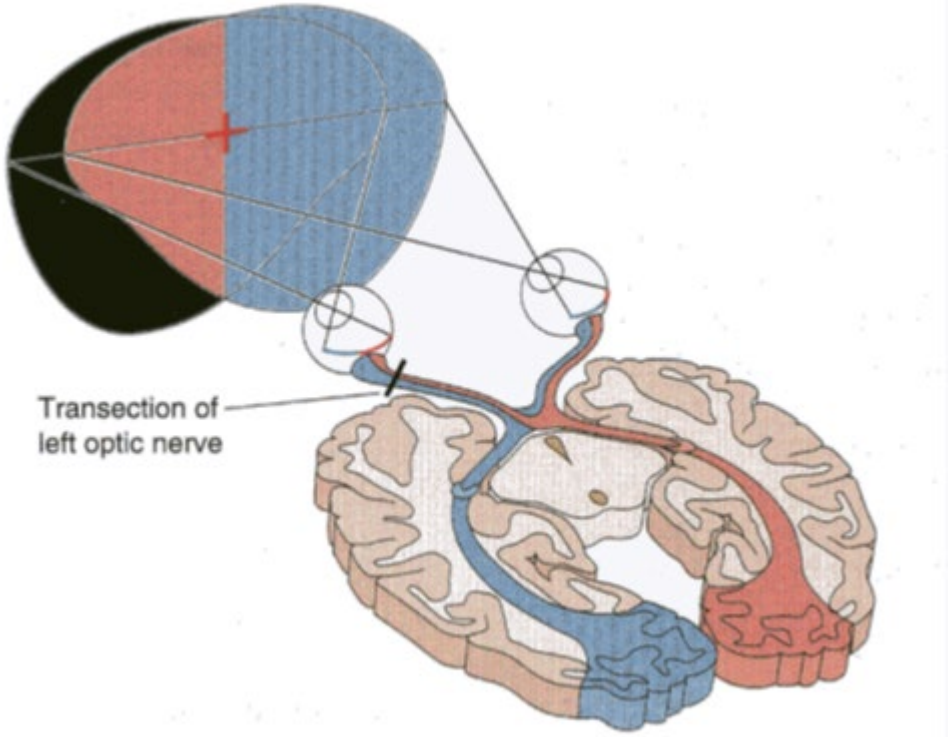
KEY POINTS TO REMEMBER:

- Info from each visual field is sent to OPPOSITE side of each retina
- Info from each visual field is sent to CONTRALATERAL hemisphere
- Temporal retina axons DO NOT cross optic chiasm
- Nasal retina axons DO cross optic chiasm



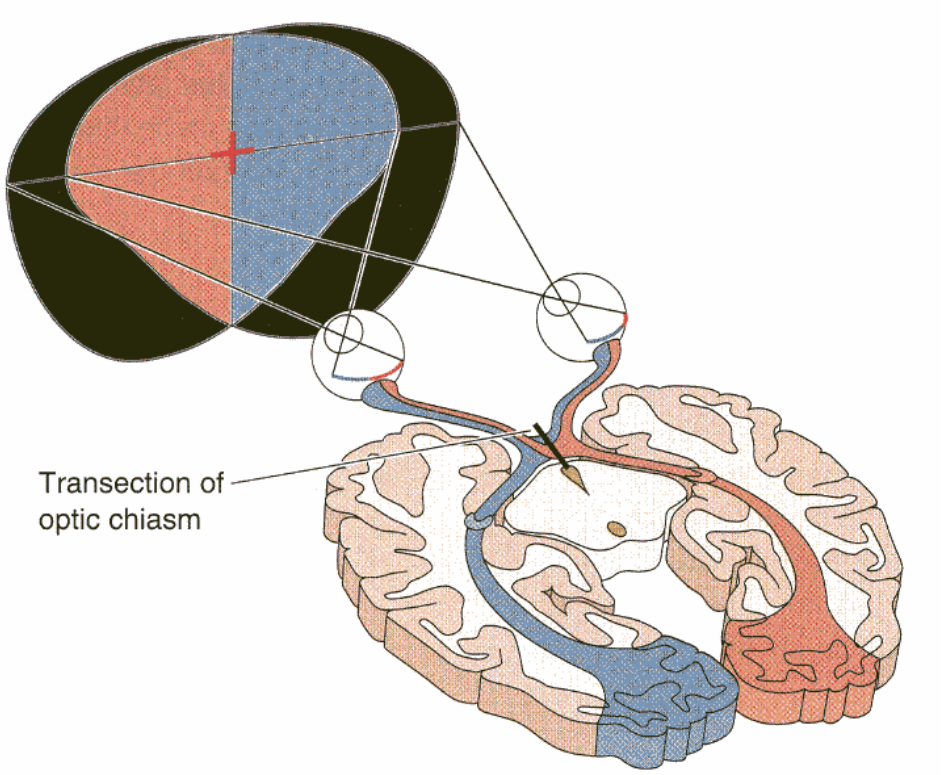
Visual Pathway: Lesion at Optic Nerve

- Left optic nerve lesion
  - See only visual field of right eye (same as closing left eye)
- Right optic nerve lesion
  - See only visual field of left eye (same as closing right eye)



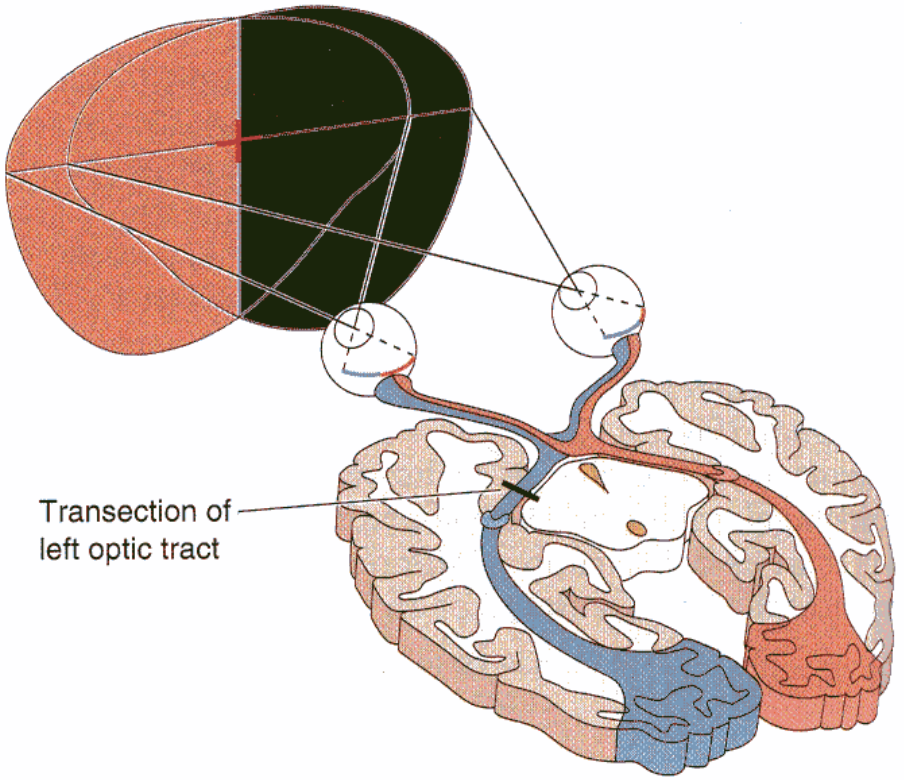
Visual Pathway: Lesion at Optic Chiasm

- Lesion at optic chiasm
  - Tunnel Vision (i.e. lose nasal retina axons, which carried info from peripheral vision)



Visual Pathway: Lesion at Optic Tract

- Left optic tract lesion
  - See only left hemifield (i.e. lose right hemifield)
- Right optic tract lesion
  - See only right hemifield (i.e. lose left hemifield)



Sensory: Auditory System

Chapter 2: Dr. Everling

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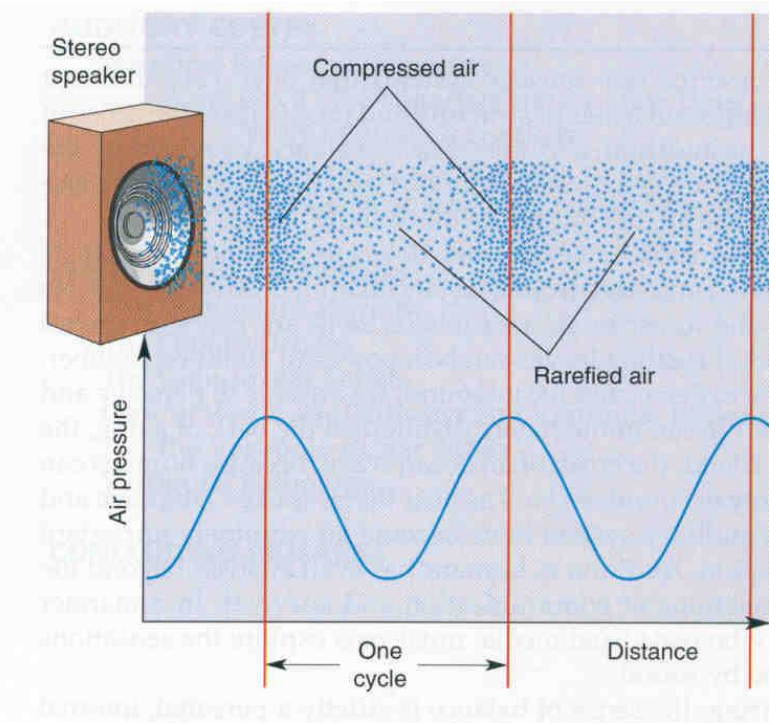
Sound

- Sound is variations in air pressure
- Intensity (Loudness): difference in pressure between compressed air patches (amplitude)
  - Measured in Decibels (dB)
- Frequency (Pitch): # of compressed air patches
  - Measured in Hertz (Hz): # of cycles/second
  - Human frequency range: 20 – 20000 Hz
  - Most sensitive range: 2000 – 4000 Hz



Pinna is a shell-like structure which is a part of:

A) Inner ear
B) Outer ear
C) Middle ear
D) None of the above

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Divisions of Auditory System

Outer Ear: AIR

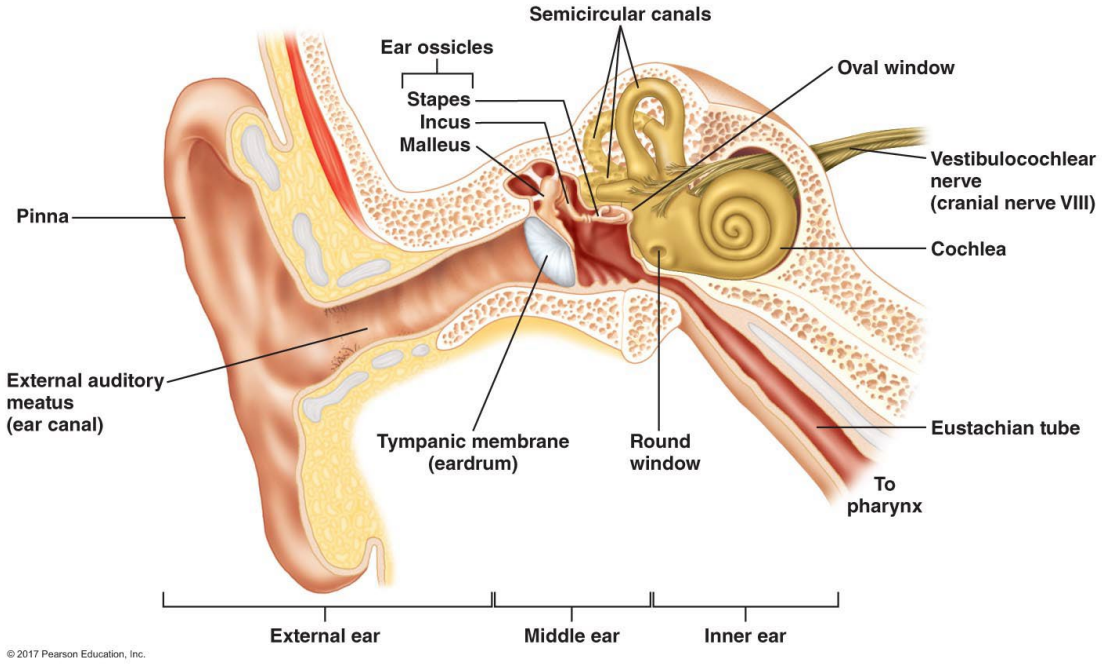
- Auricle (Pinna)
- Auditory Canal: enhances intensity by resonance (reflection of sound waves in closed tube enhances intensity of certain frequencies)

Middle Ear: AIR

- Tympanic Membrane (Eardrum): transmits sound from air to ossicles
- 3 Ossicles: Malleus, Incus and Stapes: convert air pressure changes to mechanical pressure
- Auditory (Eustachian) Tube: important in changing air pressure

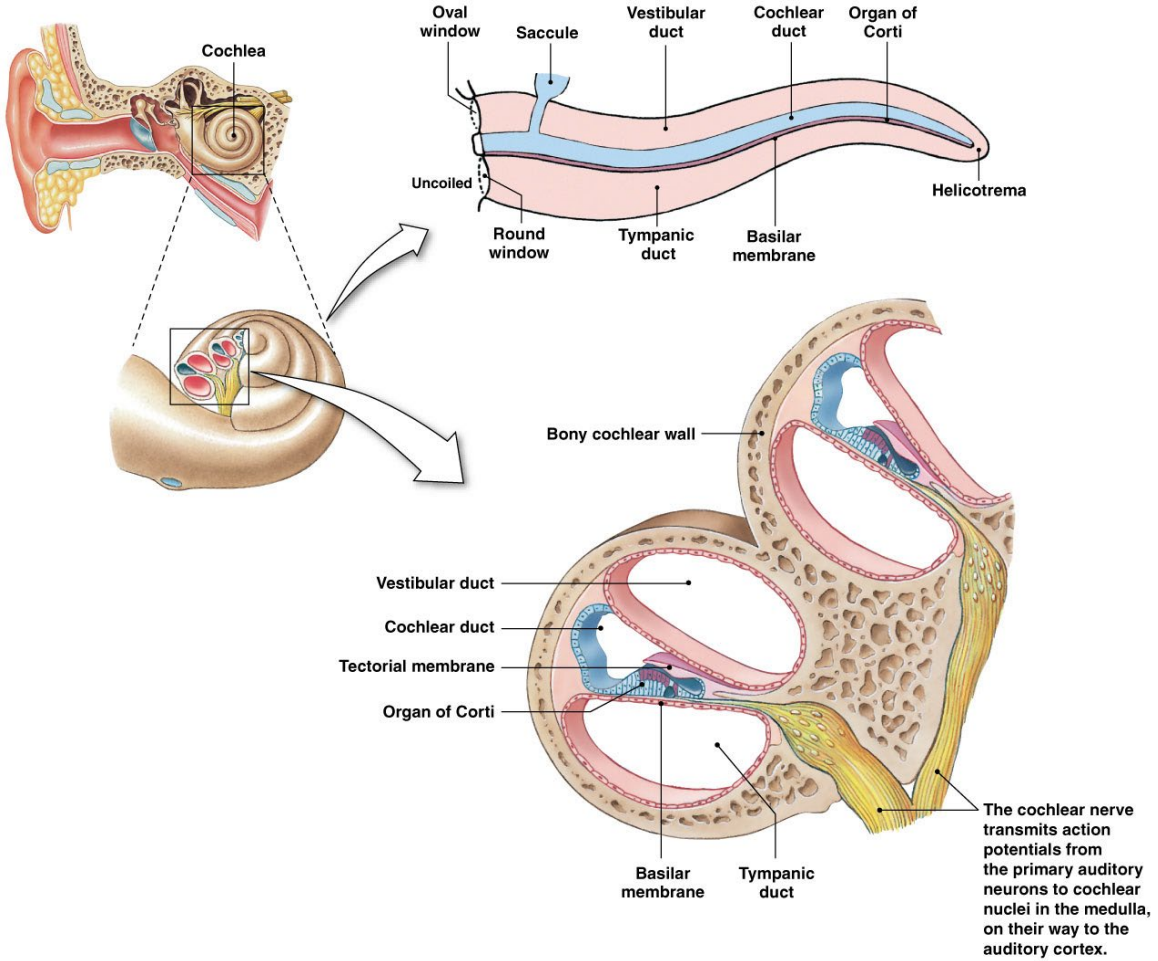
Inner Ear: FLUID

- Cochlea: convert fluid vibrations into electrochemical impulses carried to brain



Cochlea

- Two windows
  - Oval Window: connected to stapes; transfers vibrations to perilymph fluid
  - Round Window: counterbalances movement of oval window



The receptors in the Organ of Corti are hair cells. How are they stimulated?

A) By air-borne waves
B) Displacement of the vestibular membrane
C) Displacement of tectorial membrane
D) Displacement of basilar membrane

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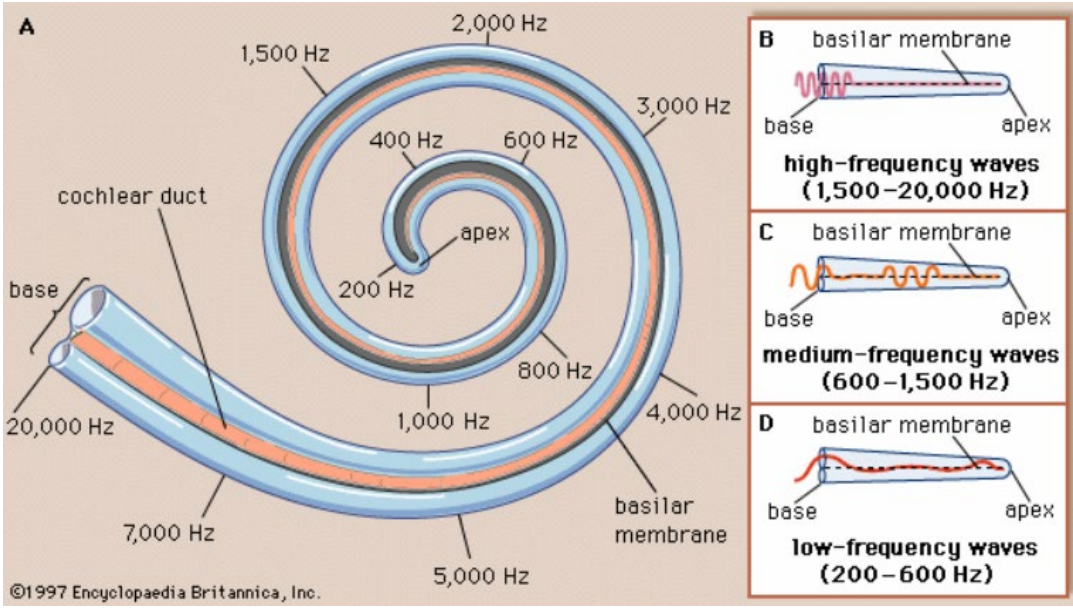
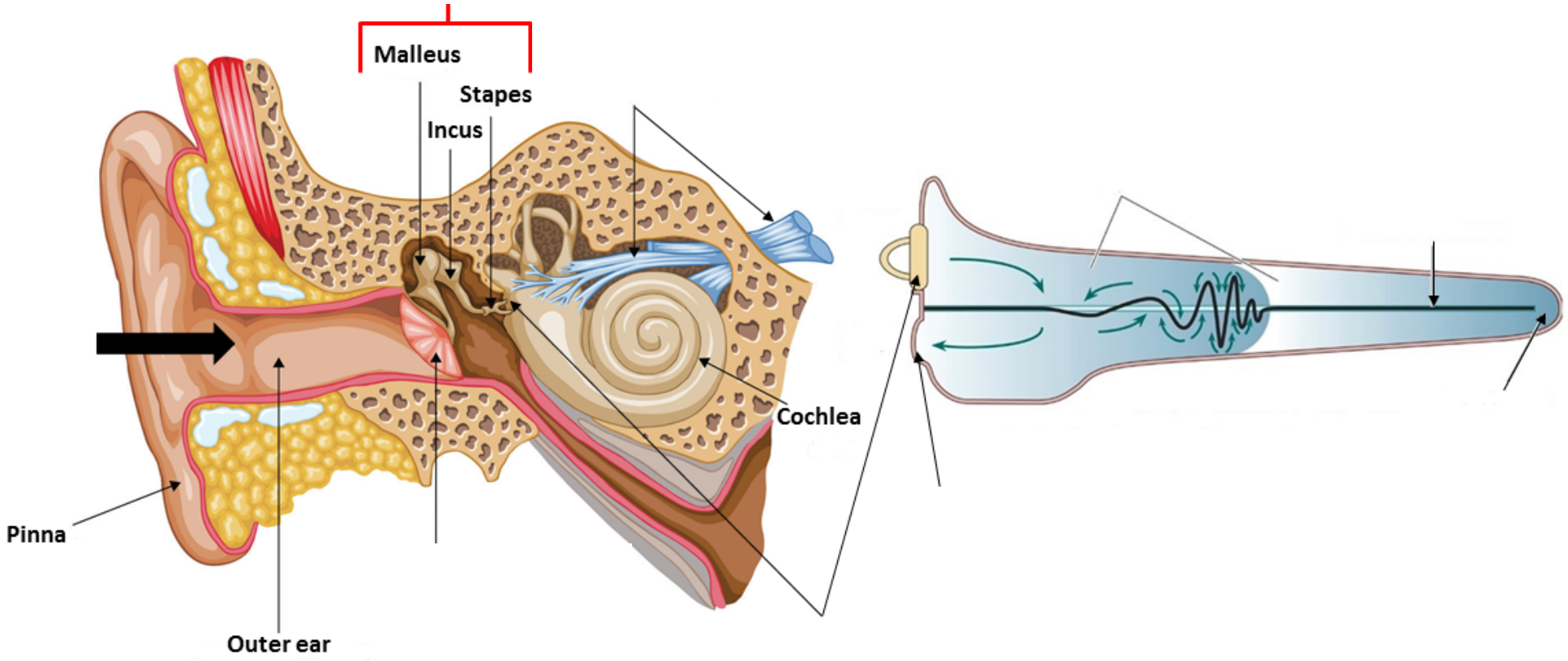
Cochlea

- Tonotopic map
- Cochlea shows an orderly map of frequencies along its length
  - Base: narrow and stiff; detects high frequency
  - Apex: wide and floppy; detects low frequency

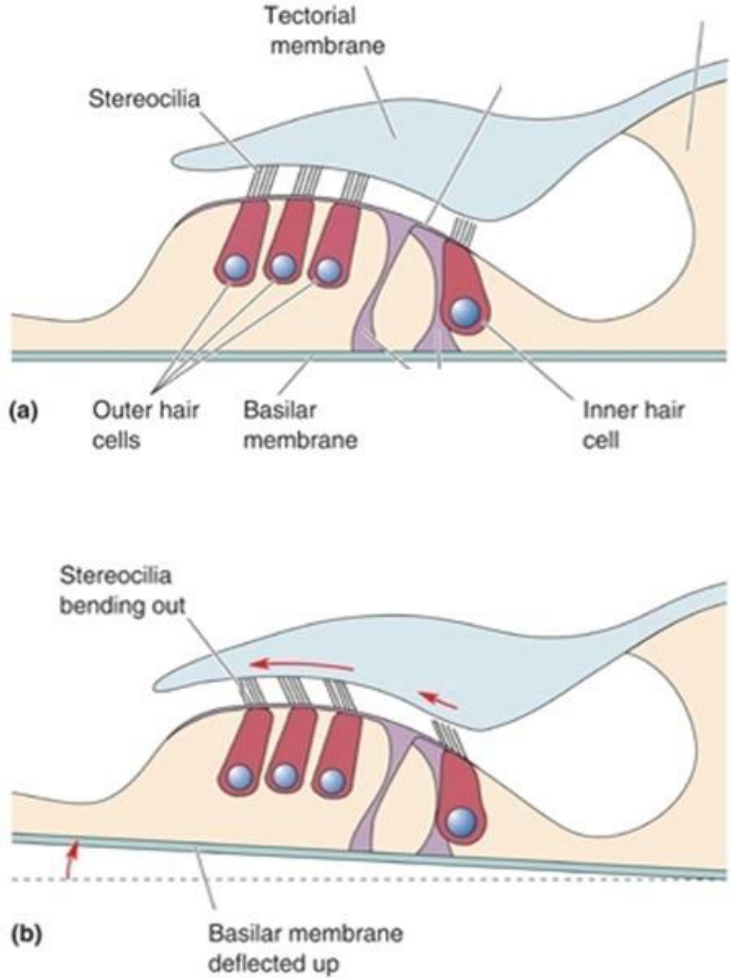


How Sound Travels Through Ear



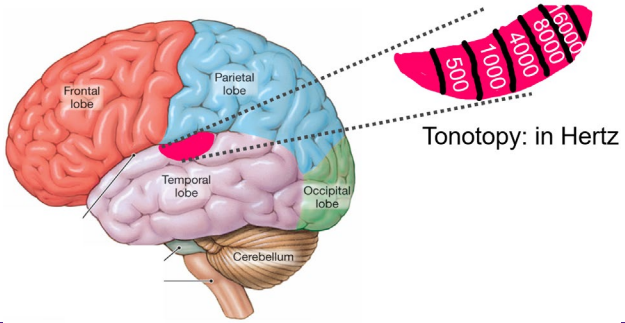
Divisions of Auditory System

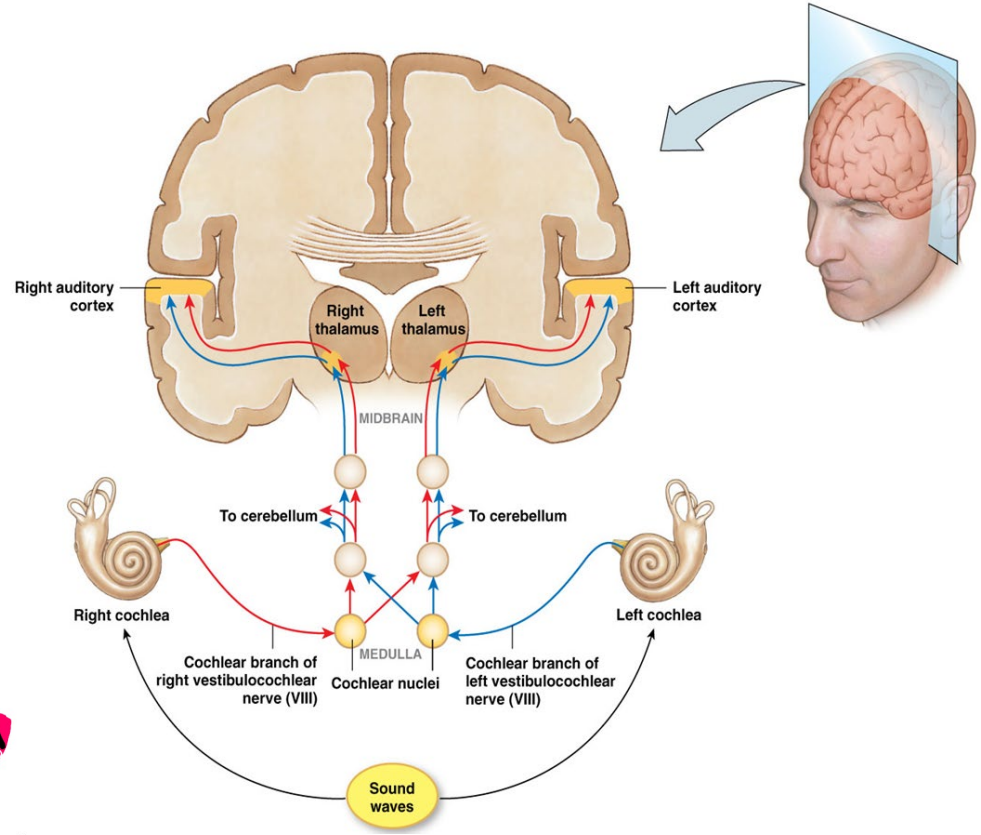
- Organ of Corti contains hair cells with stereocilia:
  - Fluid movements cause deflection of basilar membrane
  - Basilar membrane deflection leads to dragging of hair cells against the tectorial membrane
    - Stereocilia bend from dragging
  - Hair cells depolarize when stereocilia bend
    - Mechanically-linked ion channels open (depolarization)
    - Aka brings cell to threshold → AP is fired
  - When hair cells bend in other direction the cell is hyperpolarized



Auditory Pathway

- Auditory Nerve (Vestibulocochlear nerve)
  - Formed by axons of spiral ganglion cells
- Medulla
  - Info from right and left ears combine
- Midbrain
  - Projections to cerebellum
- Primary Auditory Cortex (Temporal Lobe)
  - Tonotonic Map:
    - Anterior: Low frequencies
    - Posterior: High frequencies





Hearing Loss

Conductive: Sound is unable to be transmitted through outer or middle ear.

- A mechanical defect
- e.g. Extremely loud sounds rupture eardrum or damaged ossicles

Sensorineural: damage to structures of inner ear that affects hair cells, or to auditory nerve (nerve deafness)

- e.g. Extremely loud sounds damage Organ of Corti
- e.g. Presbycusis (old + hearing), i.e. degenerations in the cochlea

Central: Damage to auditory pathways upstream from cochlea

- A defect in the Central Nervous system
- e.g. tumours or strokes in the central auditory pathways

Motor Physiology

Chapter 3: Dr. Everling

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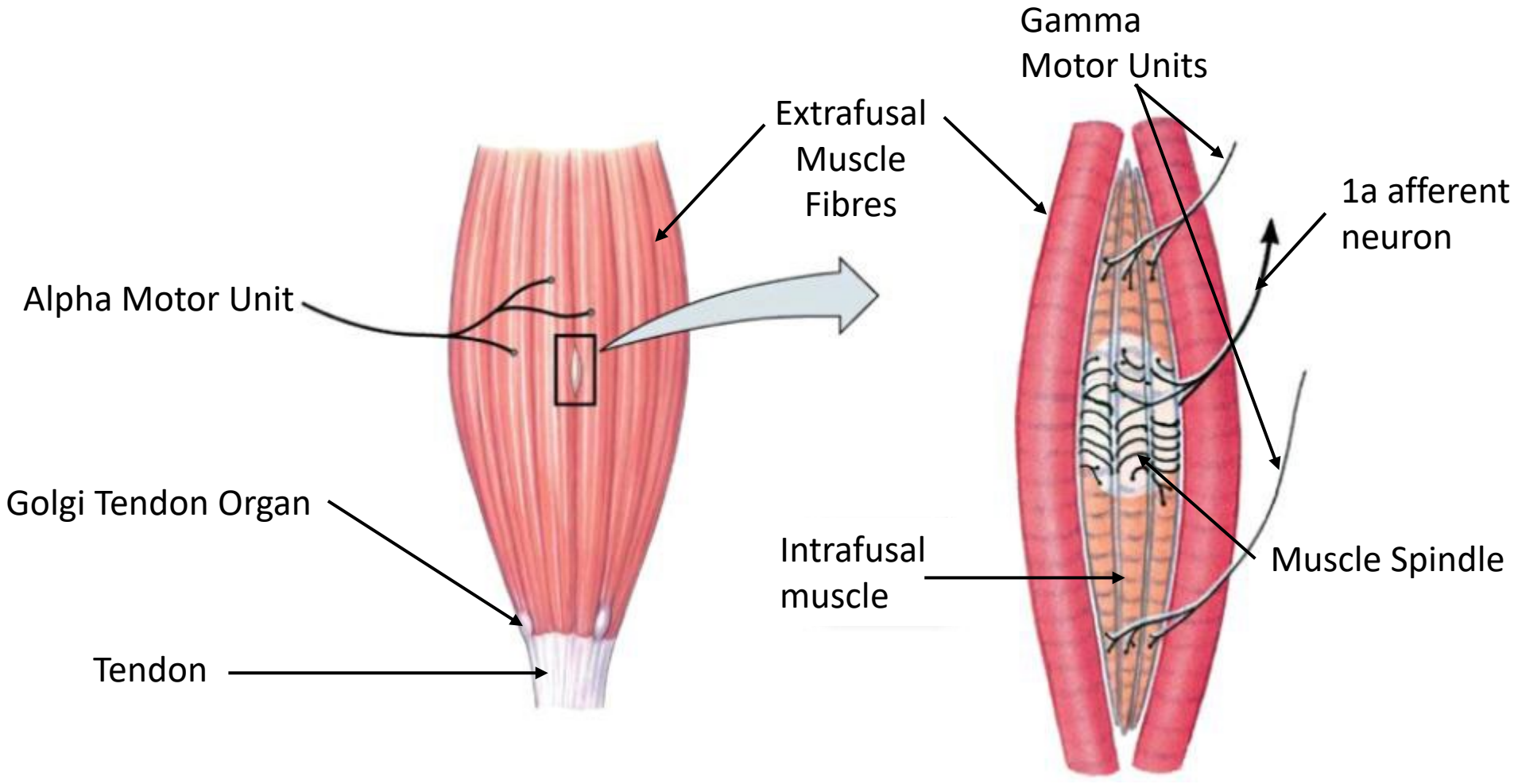
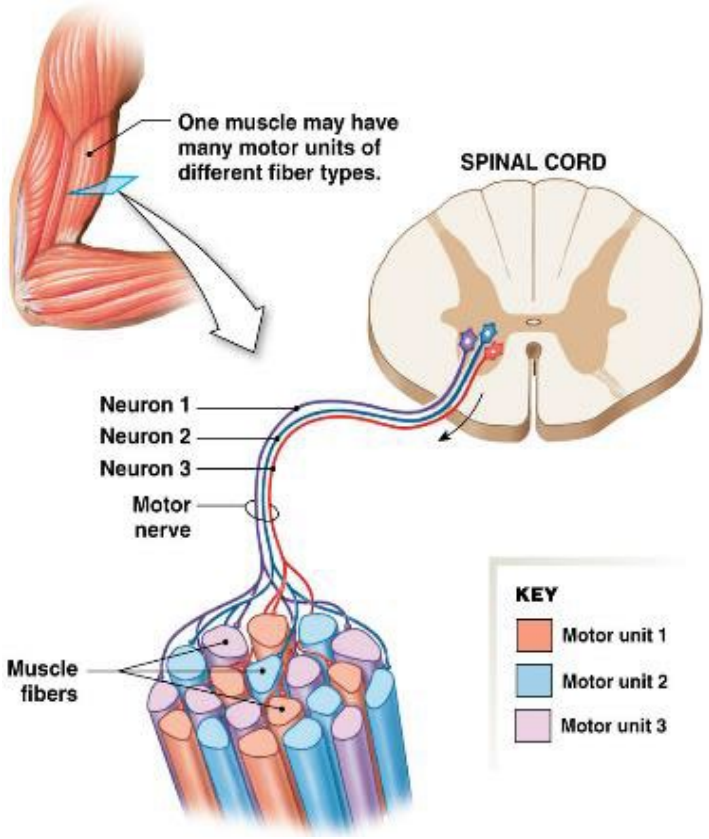
Muscle Anatomy



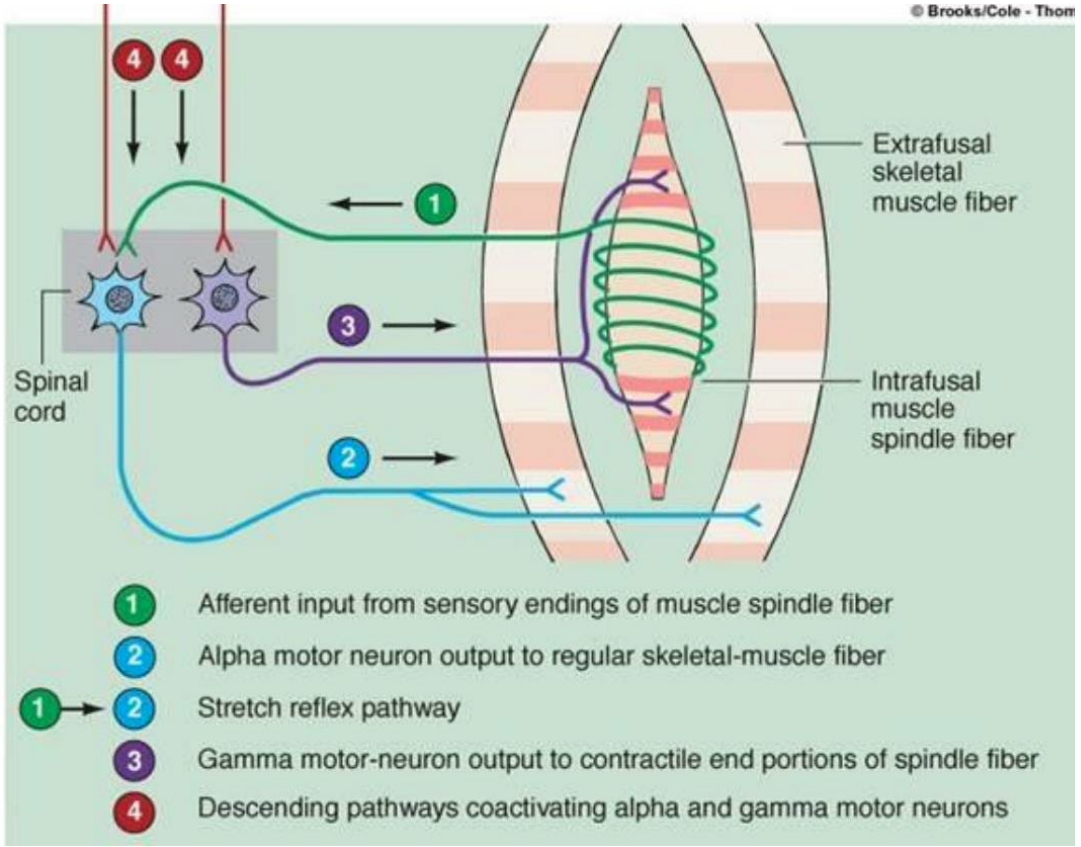
Motor Unit/Pool

- Motor Unit: Group of skeletal muscle fibers and the 1 somatic motor neuron that controls them
- Motor Neuron Pool: group of motor neurons that innervate a single muscle



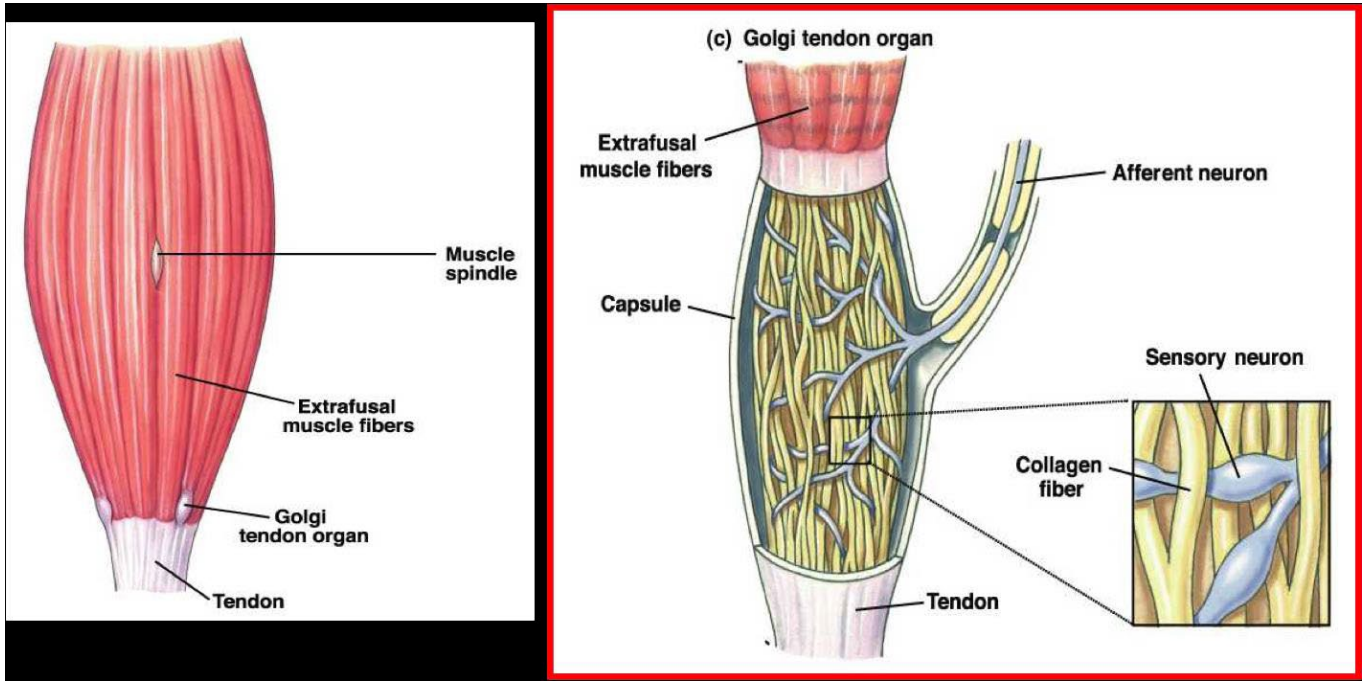
Muscle Spindle

- Stretching of muscle spindle/intrafusal muscle fiber
- Info sent from muscle spindles to CNS via 1a afferent neurons
- CNS processes info
- Alpha motor neuron causes extrafusal muscle fiber contraction
- Gamma motor neuron causes intrafusal fiber contraction



Golgi Tendon Organ

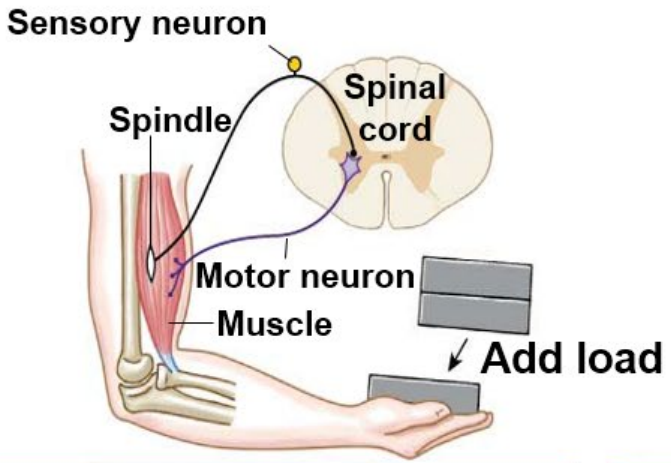
- Golgi tendon organ links muscle and tendon
- Collagen fibers woven around sensory receptors
- Increase in tension causes collagen contraction around sensory receptor, which sends info to CNS via 1b afferent neuron



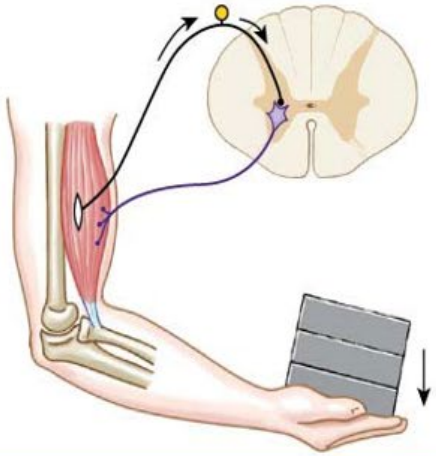
Reflexes

- Reflex: involuntary response to a stimulus which requires the integrity of the nervous system
- Reflex arc involves: Receptor →Afferent neuron →Synapse →Motor neuron → Effector
- Monosynaptic reflex: Pathway in a reflex arc that contains only 1 synapse (ex: stretch reflex)
- Polysynaptic reflex: Pathway in a reflex arc that contains more than 1 synapse (ex: withdrawal reflex)
- Reciprocal Innervation: Contraction of a muscle is accompanied by simultaneous inhibition of antagonistic muscle

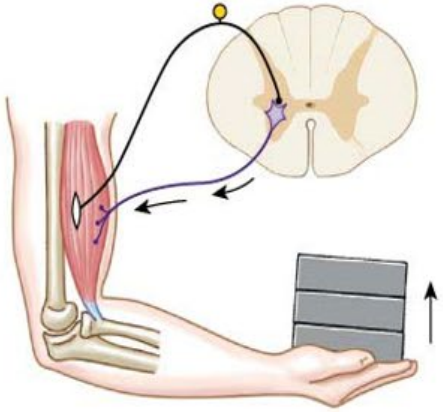
Stretch Reflex



1. Load added to muscle.



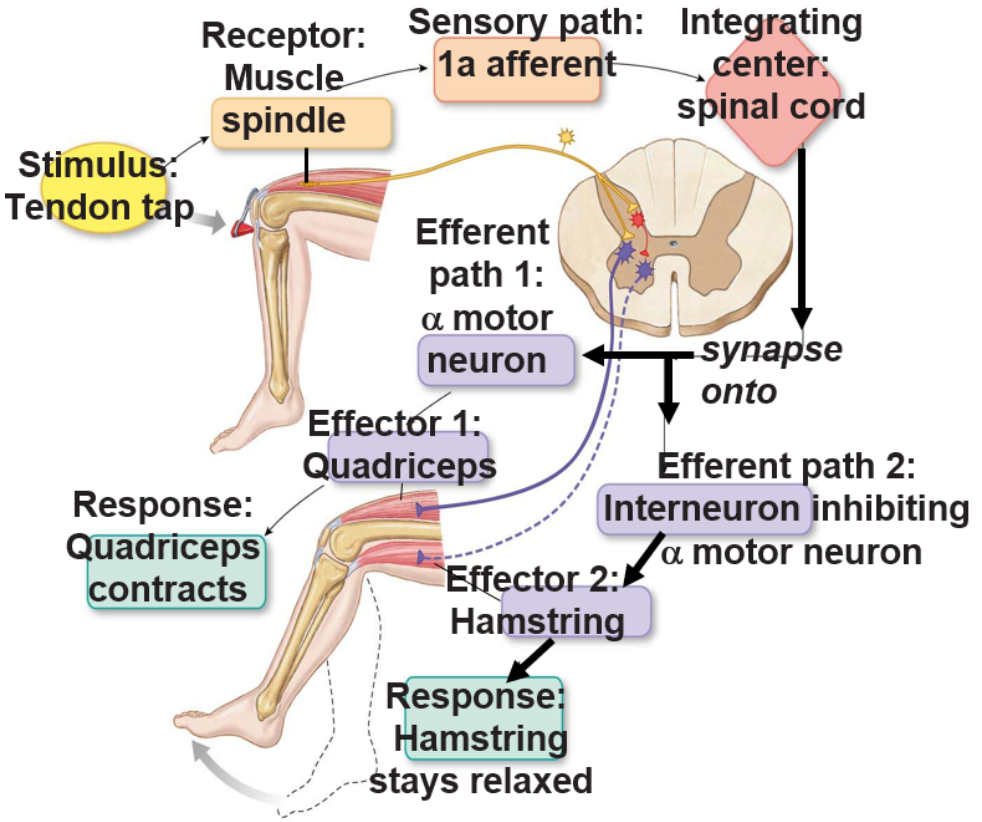
2. Muscle and muscle spindle stretch as arm extends. Muscle spindle afferents fire more frequently.



3. Reflex contraction initiated by muscle stretch restores arm position and prevents damage from over-stretching.

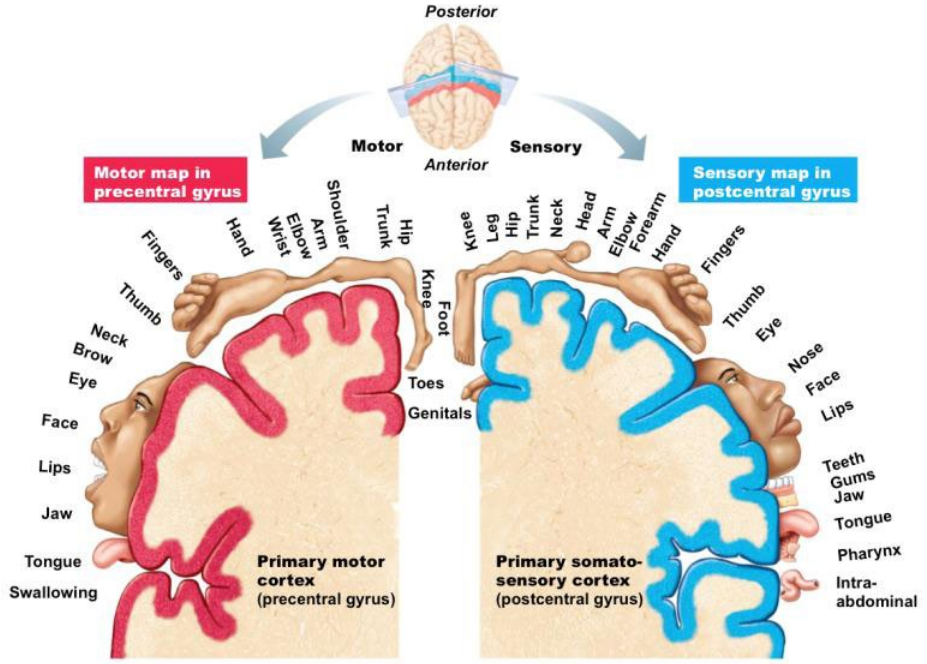
Patellar Tendon Reflex

1. Tapping patellar tendon stretches quadriceps femoris (extensor muscle)
2. Muscle spindle in quadriceps femoris stretches, activating 1a afferent to fire action potentials.
3. 1a afferent directly synapses (monosynaptic) on alpha motor neuron to quadriceps femoris – muscle contracts and lower leg swings forward.
4. Collateral from the 1a afferent also excites an inhibitory interneuron in the spinal cord.
5. Inhibitory interneuron inhibits alpha motor neuron to antagonistic (Hamstring) muscle. The hamstring is a flexor muscle.
6. Antagonistic muscle relaxes (reciprocal innervation (inhibition) so leg can extend and swing out.



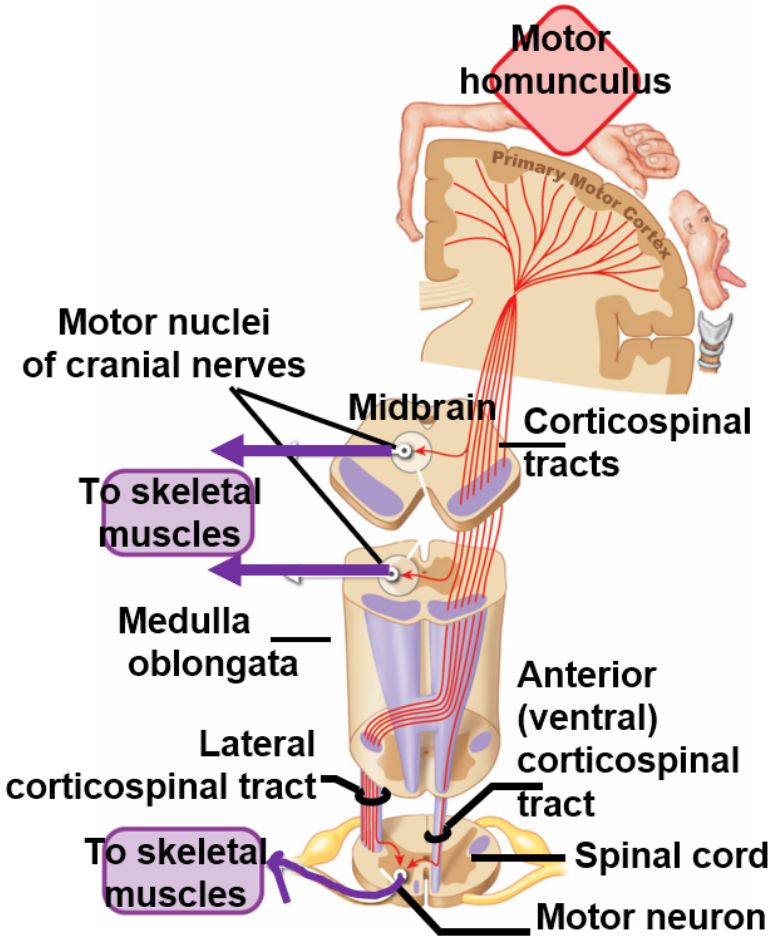
Motor Cortex, Homunculus vs. Somatosensory Cortex

- Motor homunculus: Found in primary motor cortex, which is precentral gyrus
- Sensory homunculus: Found in somatosensory cortex, which is postcentral gyrus



Corticospinal Tracts

- Corticospinal pathway (pyramidal tract) is the primary pathway that leaves the motor cortex to innervate motor neurons in the spinal cord
  - Left side of body controlled by right motor cortex
  - Axons cross at brain stem or spinal cord



Next Tutorial (Oct 22nd)

- Endocrinology

What Questions Do You Have?

You can ask in the **Owl forums** as well!

Also anonymously ask questions in the **online dropbox**!!

Western