
Western

UNIVERSITY · CANADA

# Midterm #1 Review Session

TA: Greydon Gilmore

Physiology 2130

Oct 23rd, 2019

Western

# Your TA reminding you…

- **Room Assignments:**
  - Abba – Hwangin: Natural Sciences room 1
  - Ighani – Li: Natural Sciences room 7
  - Liang – Zia: Natural Sciences room 145
- **Breakdown (35 MC questions):**
  - Excitable Cell ~ 13 questions
  - Sensory Physiology ~ 10 questions
  - Motor Control ~ 5 questions
  - Endocrine Physiology ~ 7 questions

## What does it mean when an action potential will always have the same amplitude and duration? Doesn't the action potential skyrocket and die down after it reaches the threshold?

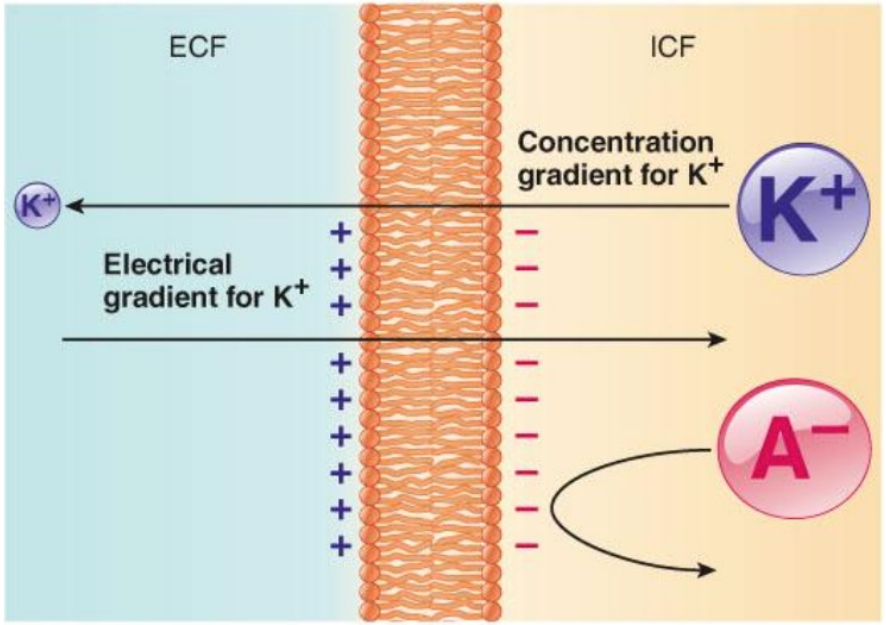
- What is meant by this is that the peak will always be around the same height
  - You cannot have a peak that is much lower or much higher than 30mV
- With graded potentials you have varying amplitudes

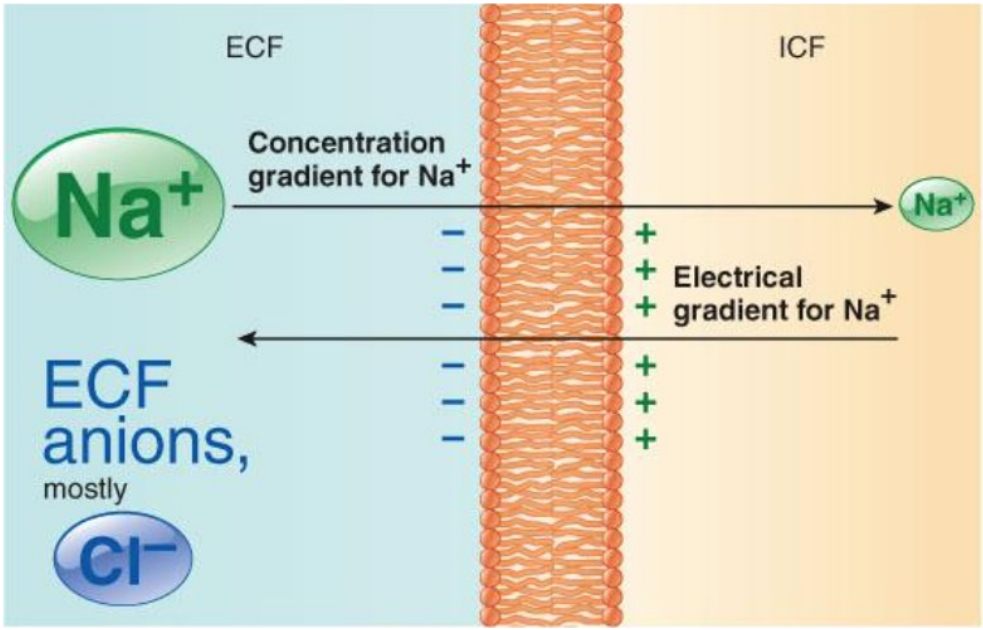
## Please answer in tutorial: how does the sodium potassium pump maintain the concentration gradients but not generate resting membrane potential? How then is resting membrane potential generated?

- This has to do with the ions present, as well as the channels
- All cells in the body have a resting membrane potential (RMP)
- At electrochemical equilibrium:
  - No NET movement of ions (i.e. ions continue to enter and exit the cell at an equal rate)
- The RMP is not generated by the $Na^+/K^+$ pump
- Rather, it is mainly generated by $K^+$ leaving the cell due to its high permeability (and $Cl^-$ entering the cell easily)
  - This establishes an electrical potential difference across the membrane with inside negative with resect to the outside (-70 mV)
- The $Na^+/K^+$ pump moves ions against gradients to return to RMP after AP
  - 3 $Na^+$ OUT and 2 $K^+$ IN for each ATP

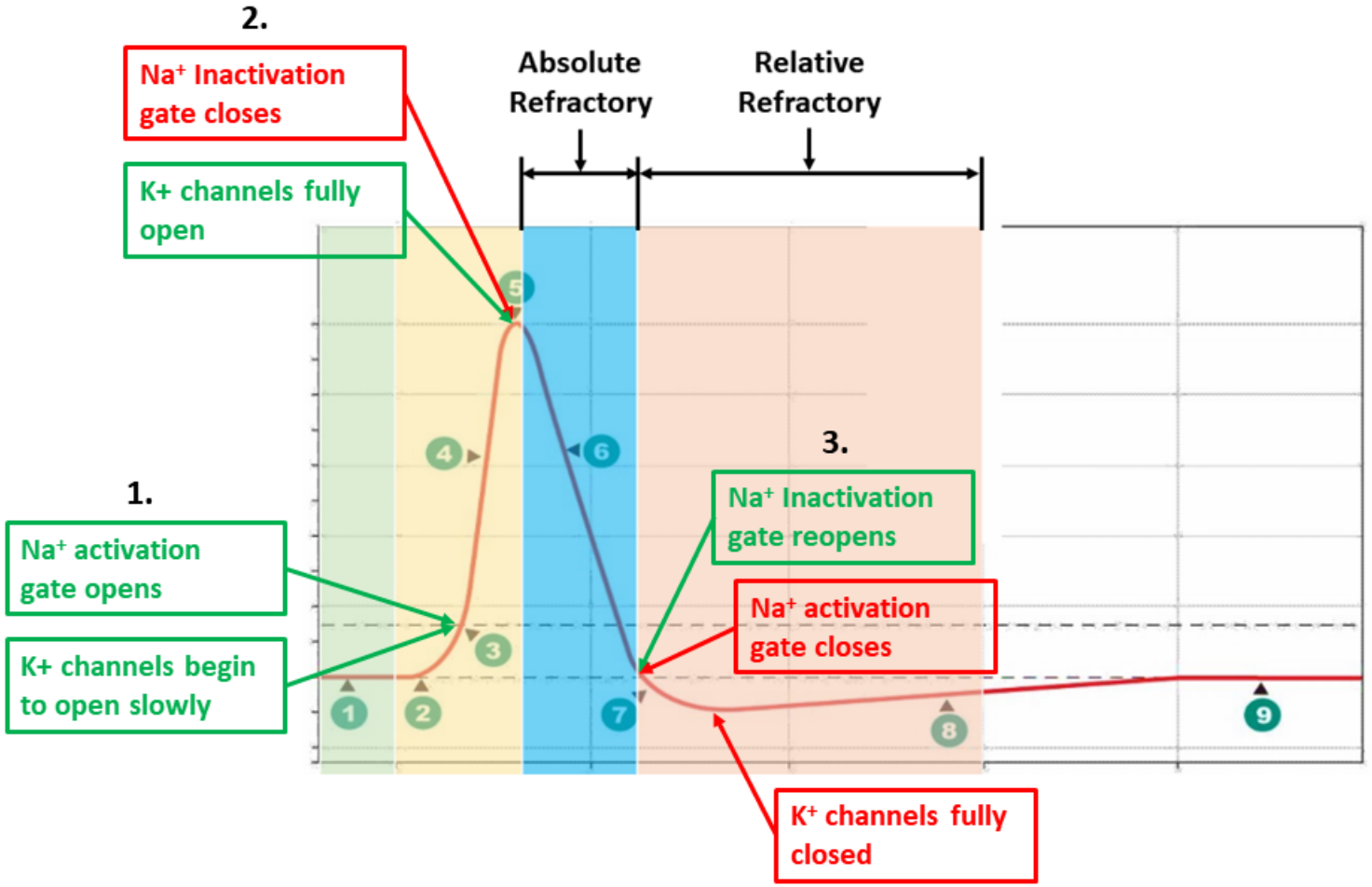
# Electrochemical Equilibrium

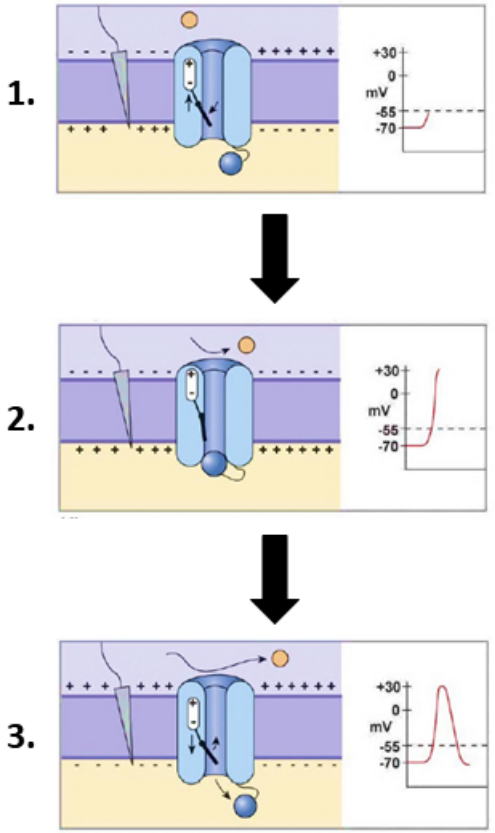
- Both $Na^+$ and $K^+$ move down their concentration gradients
  - There also exists an electrical gradient for both ions
- Thus, movement of either ion will stop once there is a balance between chemical and electrical gradients… electrochemical equilibrium



# Activation & inactivation gates, and how to remember when they are open and closed.



# Chapter 1

Dr. Woods

Western

# Chapter Overview

1. Homeostasis
2. Cell membrane and compartments
3. Diffusion and transport
4. Osmosis and tonicity
5. Action potential

# Which of the following cells are excitable?

1. Neurons
2. Cardiac Muscle Cells
3. Smooth Muscle Cells
4. Skeletal Muscle Cells

A) If only 1, 2 and 3 are correct
B) If only 1 and 3 are correct
C) If only 2 and 4 are correct
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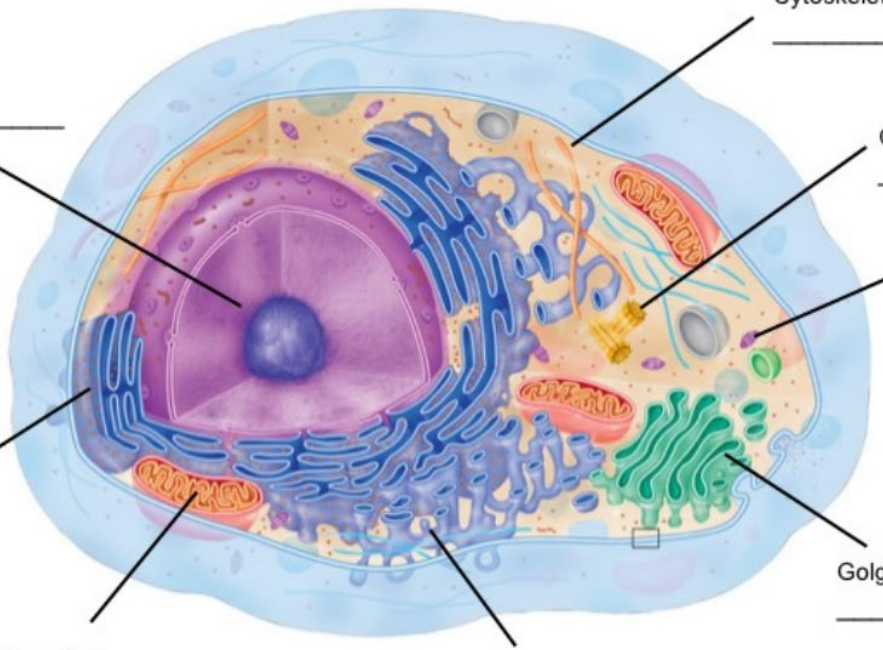
Excitable Cells:
- Generate and respond to electrical signals
- Include neurons and muscle cells

# The Cell


Cytoskeleton:
Nucleus:
Centrioles:
Lysosome:
Rough Endoplasmic Reticulum:
Golgi Apparatus:
Mitochondria:
Smooth Endoplasmic Reticulum:

# Functions of organelles

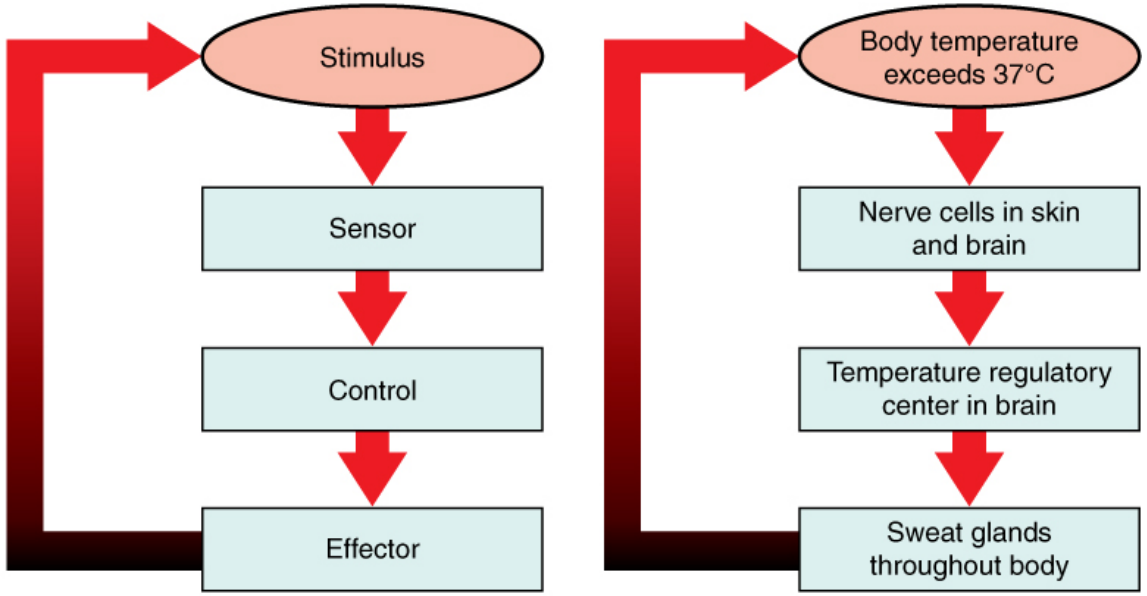
- Centrioles
  - Aid in cell division, in animals, by formation of spindle fibers that separate chromosomes during mitosis
- Mitochondria
  - Supply the cell with energy in the form of ATP
- Nucleus
  - Contains majority of cells genetic material
- Plasma Membrane
  - Protect the cell from its surroundings
  - Composed of a phospholipid bilayer with embedded proteins
- Lysosome
  - Houses enzymes for digestion and waste removal

# Functions of organelles

- Smooth Endoplasmic Reticulum
  - Manufacturing of lipid (fat) molecules
- Rough Endoplasmic Reticulum
  - Rough due to ribosomes being dispersed throughout the membrane to help in the production, folding and transportation of proteins
- Golgi Apparatus
  - Modify, sort and pack macromolecules (mostly proteins coming from the Rough ER)
- Cytoskeleton
  - Composed filaments and tubules, extending from plasma membrane to nucleus
  - Provides the cell shape and protects it from damage

# Negative feedback loops

- Monitor and respond to changes in the internal environment in order to maintain homeostasis

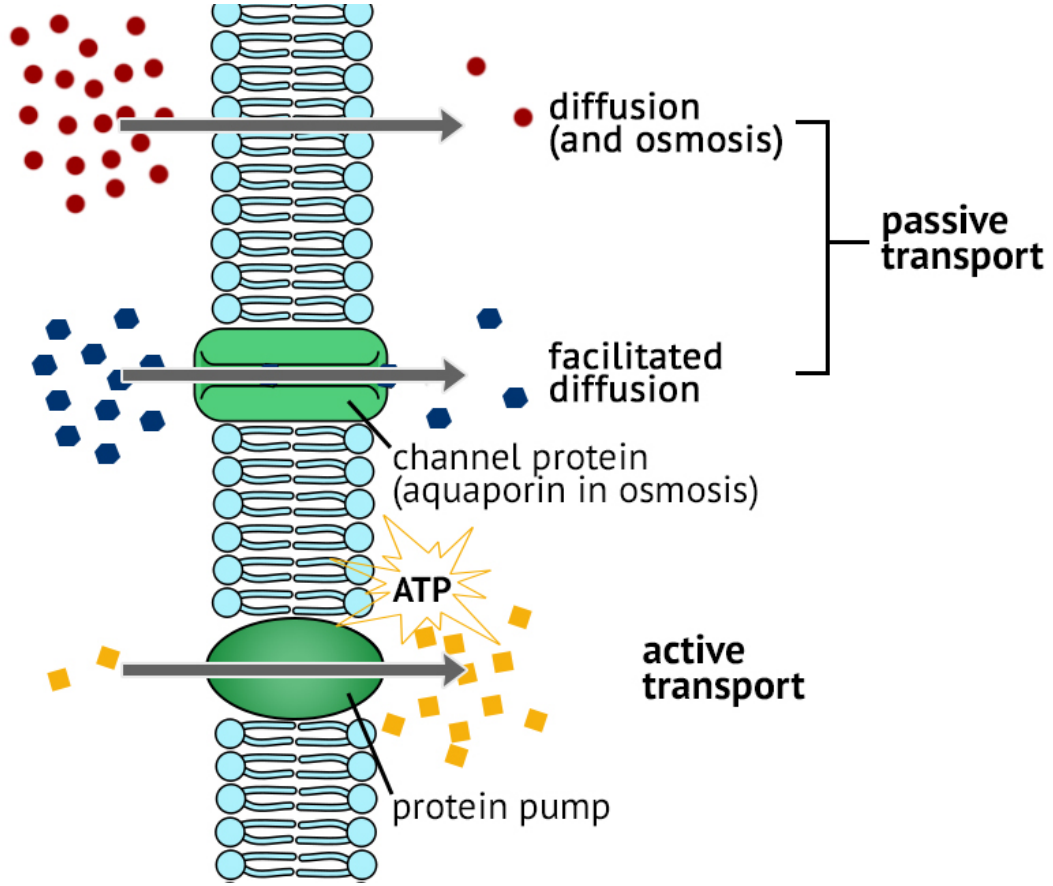



(a) Negative feedback loop

(b) Body temperature regulation

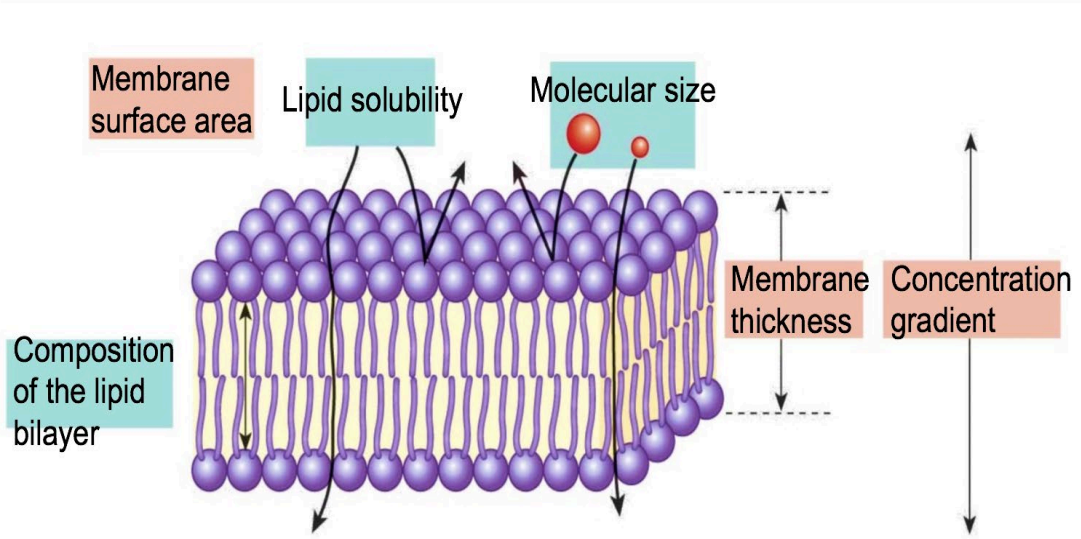
# Mechanisms of Membrane Transport

1. Endo/exocytosis
   - ➢ of small molecules
2. Diffusion through lipid bilayer
   - ➢ fat-soluble
3. Diffusion through protein channels
   - ➢ water soluble
4. Facilitated diffusion
   - ➢ large/bulky
5. Active transport
   - ➢ Against concentration gradient



# What affects rate of diffusion?

1. Concentration gradient
2. Composition of lipid bi-layer
3. Membrane thickness
4. Molecule size
5. Membrane surface area
6. Lipid solubility



# Mechanisms of Membrane Transport

| | Simple Diffusion | Diffusion | Facilitated Transport | Active Transport |
|---|---|---|---|---|
| Selective? | No (still needs to be small & hydrophobic) | Yes | Yes | Yes |
| Competitive inhibition? | No | No | Yes | Yes |
| Goes with concentration gradient? | Yes | Yes | Yes | No |
| ATP required? | No | No | No | Yes |

# Which of the following statements are TRUE regarding osmosis?

1. The osmotic pressure of a solution is proportional to the concentration of the solute
2. A 100 mM NaCl solution has a greater osmolarity than a 100mM LiCl solution because Na is larger than Li
3. The permeability of the membrane affects osmosis
4. Osmosis is the movement of a solute down its concentration gradient

A) If only 1, 2 and 3 are correct
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# Which of the following statements regarding the cell's membrane potential is TRUE?

1. Only neurons have a membrane potential
2. When an electrochemical equilibrium is reached (i.e. the electrical gradient force of an ion is equal in magnitude to its chemical gradient force), there is no movement of this ion across the membrane
3. The RMP is generated by the Na/K pump
4. It is affected by the concentration gradient of ions and the membrane permeability

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# Osmosis

- Osmosis is the net movement of WATER down its concentration gradient
- It is affected by:
  1. permeability of the membrane
  2. concentration gradient of solutes
  3. pressure gradient across the cell membrane
- Osmolarity is concerned only with the NUMBER OF PARTICLES in solution (NOT size or type/composition)

# Which of the following solutions would cause a red blood cell to swell?

A) 200mM NaCl

B) 300mM NaCl

C) 150 mM KCl

D) 100 mM KCl

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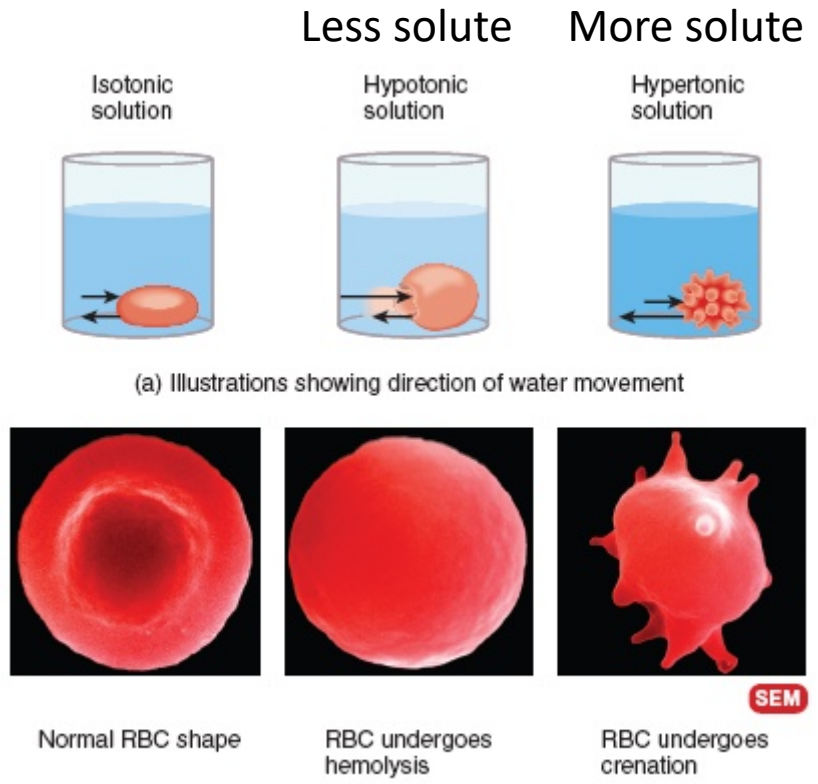
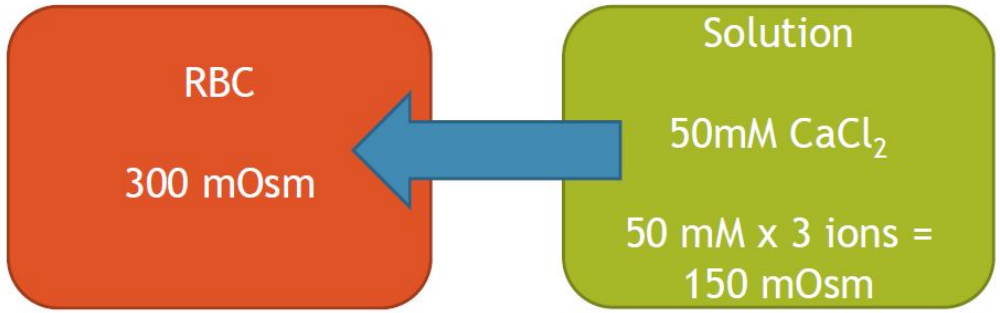
# Tonicity

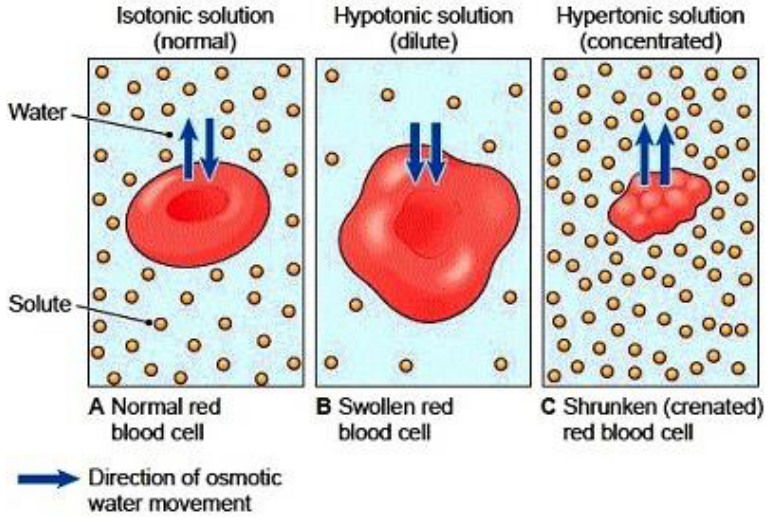

Less solute
More solute
Isotonic solution
Hypotonic solution
Hypertonic solution
(a) Illustrations showing direction of water movement
SEM
Normal RBC shape
RBC undergoes hemolysis
RBC undergoes crenation
(b) Scanning electron micrographs (all 15,000x)

# Tonicity Example

- A red blood cell is placed in a 50 mM CaCl2 solution. The cell will _____ because the solution is _____




- Water moves from the solution into the RBC



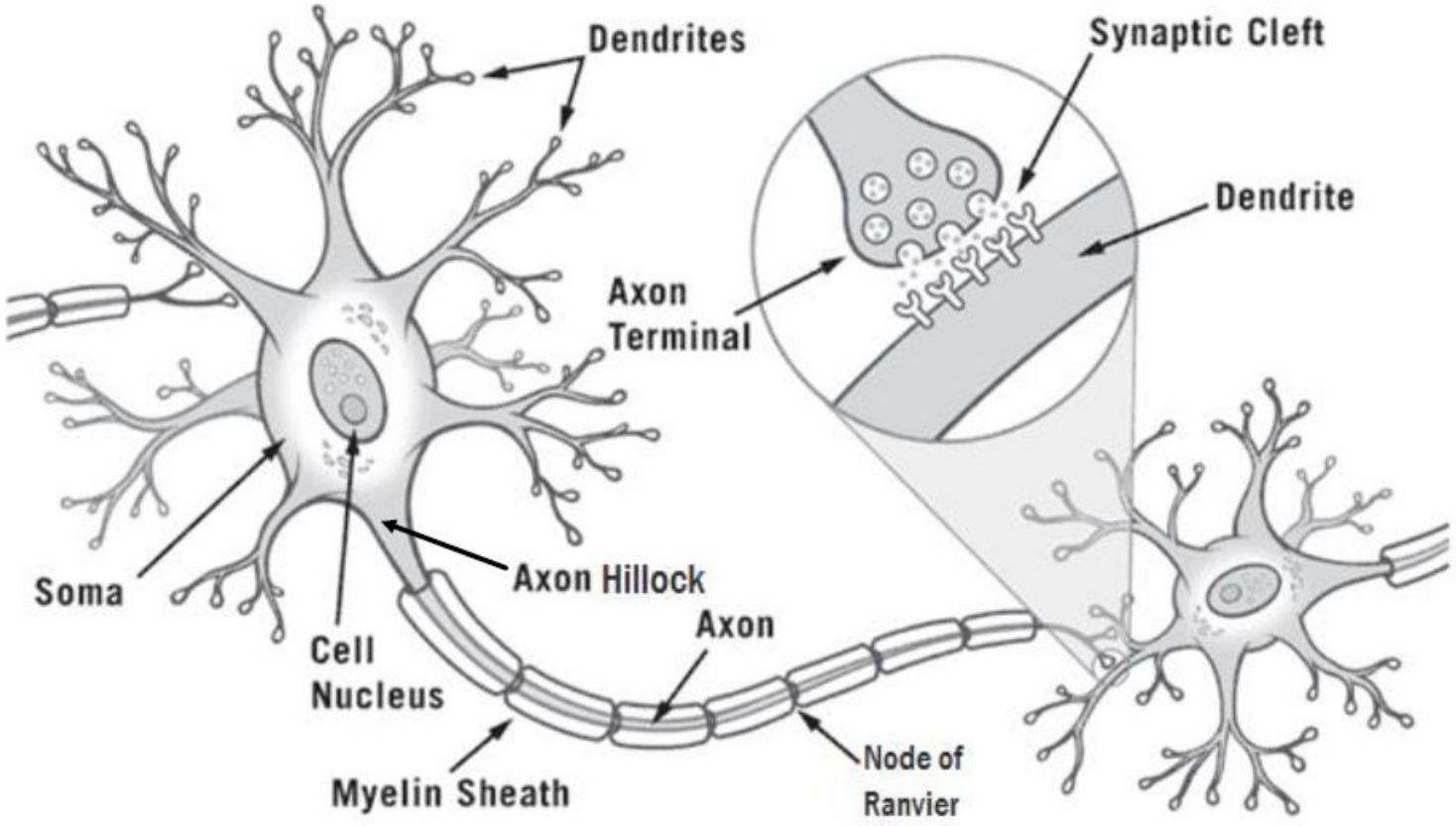
# Tonicity Example

- Only permeable to water

| Compartment 1 | Compartment 2 |
| --- | --- |
| 300mM of Glucose | 175mM of NaCl |

- Water moves from compartment A to B

# The Neuron


Dendrites
Synaptic Cleft
Dendrite
Axon
Terminal
Soma
Axon Hillock
Axon
Cell
Nucleus
Myelin Sheath
Node of
Ranvier

# Key Events and Their Locations

1. Incoming information received by the dendrites
2. Graded potentials occur in the dendrites/soma
3. An action potential is fired at the axon hillock if threshold is met
4. The action potential travels along the myelinated axon via salutatory conduction
5. The action potential arrives at the axon terminal of the pre-synaptic cell and the message is passed to the post-synaptic cell

# What is a main difference between a graded potential and an action potential?

A) Graded potentials do not experience current leak, whereas action potentials do

B) Graded potentials travel a long distance, whereas action potentials travel a short distance

C) Graded potentials occur at the soma, whereas action potentials start at the axon hillock

D) The amplitude of the graded potentials is not proportional to the stimulus strength, whereas the amplitude of action potentials is proportional to the stimulus strength

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# Graded Potentials vs. Action Potentials

| Graded Potentials | Action Potentials |
|---|---|
| Occur at dendrites/somas | Occur at axon hillock |
| Caused by mechanical or chemical-gated channels | Caused by voltage-gated channels |
| Can be a depolarization or hyperpolarization | Always a depolarization |
| Amplitude of potential is directly proportional to stimulus strength | All or nothing–Amplitude of potential is constant no matter the stimulus strength |
| Travel short distances | Travel long distances |

# Which of the following structures are correctly associated with their function?

A) Dendrites send outgoing signals
B) Myelin insulates axons to prevent ion/current leak
C) There are no ion channels at the Nodes of Ranvier
D) There are no organelles at the soma

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# How can we increase the propagation speed of an action potential down an axon?

A) Increase diameter of the axon
B) Decrease diameter of the axon
C) Myelinate the axon
D) A and C

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# Depolarization is caused by the opening of ____, causing ___ to flow ___ the cell.

A) VG $Na^+$ channels; $Na^+$ ions; into
B) VG $Na^+$ channels; $Na^+$ ions; out of
C) VG $K^+$ channels; $K^+$ ions, into
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**The $Na^+$ and $K^+$ voltage-gated channels are important in action potential conduction. Which of the following statements is/are true regarding the state of these channels during the repolarization phase?**

1. the $Na^+$ activation gate will be open
2. $Na^+$ will be leaving the cell
3. the $K^+$ voltage-gated channel will be open
4. the $K^+$ activation gate will be open

A) if only 1,2 and 3 are correct
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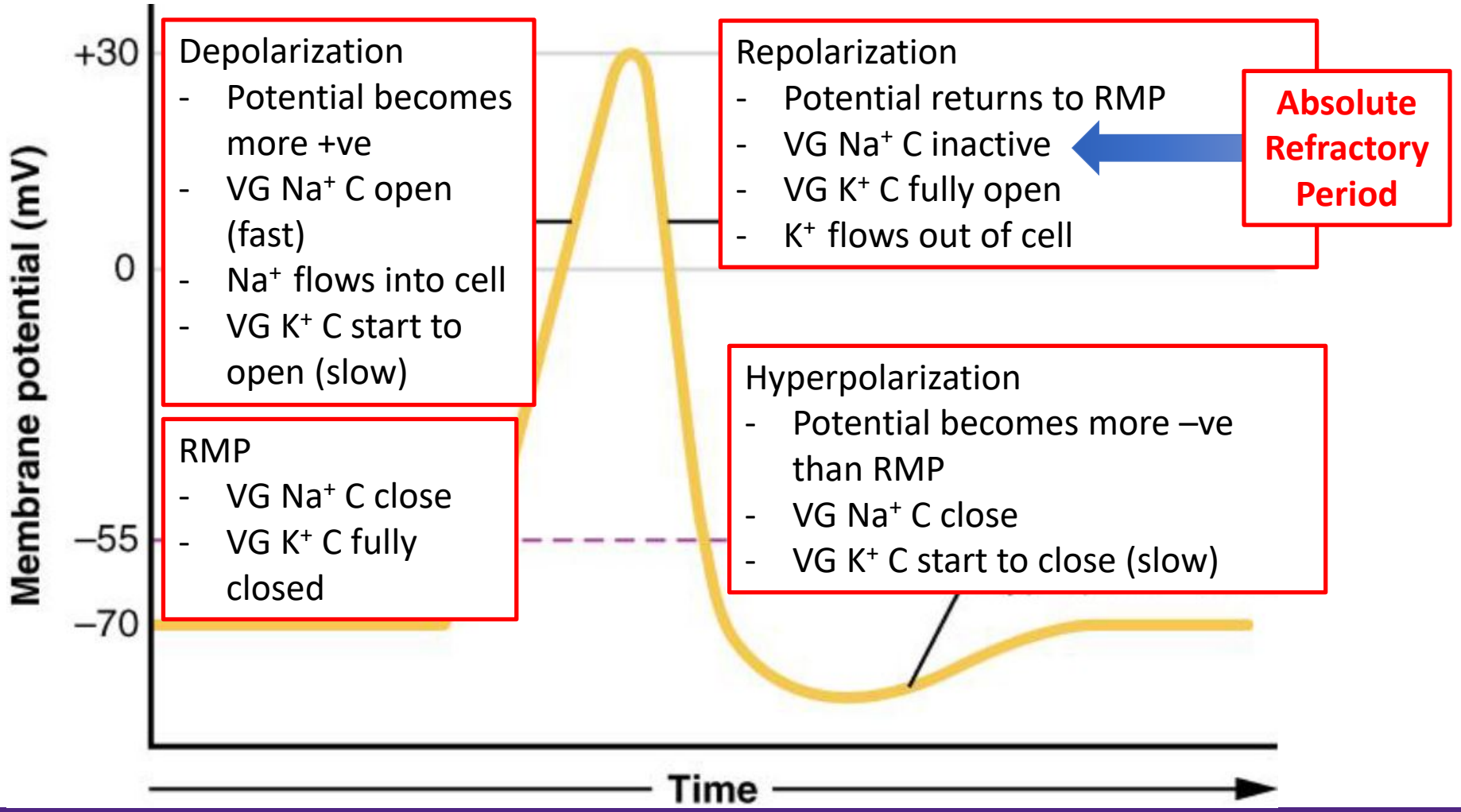
# The Action Potential




Depolarization
- Potential becomes more +ve
- VG $Na^+$ C open (fast)
- $Na^+$ flows into cell
- VG $K^+$ C start to open (slow)

RMP
- VG $Na^+$ C close
- VG $K^+$ C fully closed

Repolarization
- Potential returns to RMP
- VG $Na^+$ C inactive
- VG $K^+$ C fully open
- $K^+$ flows out of cell

**Absolute Refractory Period**

Hyperpolarization
- Potential becomes more –ve than RMP
- VG $Na^+$ C close
- VG $K^+$ C start to close (slow)

# Which of the following events take place at a chemical synapse?

1. VG $Ca^{2+}$ channels open, allowing $Ca^{2+}$ to flow out of the cell
2. VG $Ca^{2+}$ channels open, allowing $Ca^{2+}$ to flow into the cell
3. Neurotransmitters travel from the post-synaptic cell to the pre-synaptic cell
4. Neurotransmitters travel from the pre-synaptic cell to the post-synaptic cell

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# Synapse

What happens to extra neurotransmitters?

- Recycled into axon terminal
- Degraded by enzymes
- Diffuse out of cleft

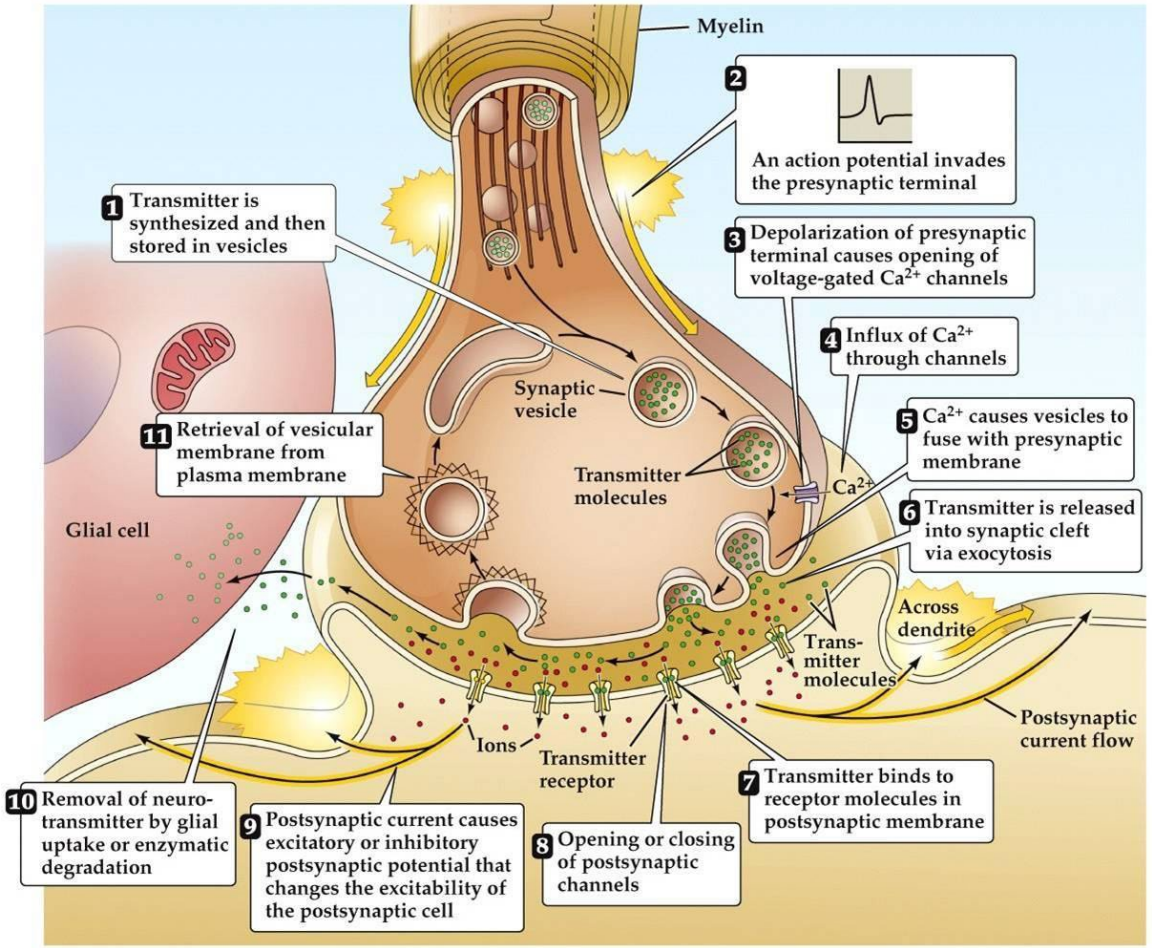
What happens to the post-synaptic cell?

If Na+ channels open: EPSP

- $Na^+$ into cell
- Depolarization of post-synaptic cell (graded potential towards threshold)

If $K^+$ or $Cl^-$ channels open: IPSP

- $K^+$ out of cell or $Cl^-$ into cell
- Hyperpolarization of post-synaptic cell (graded potential away from threshold)



# Chapter 2

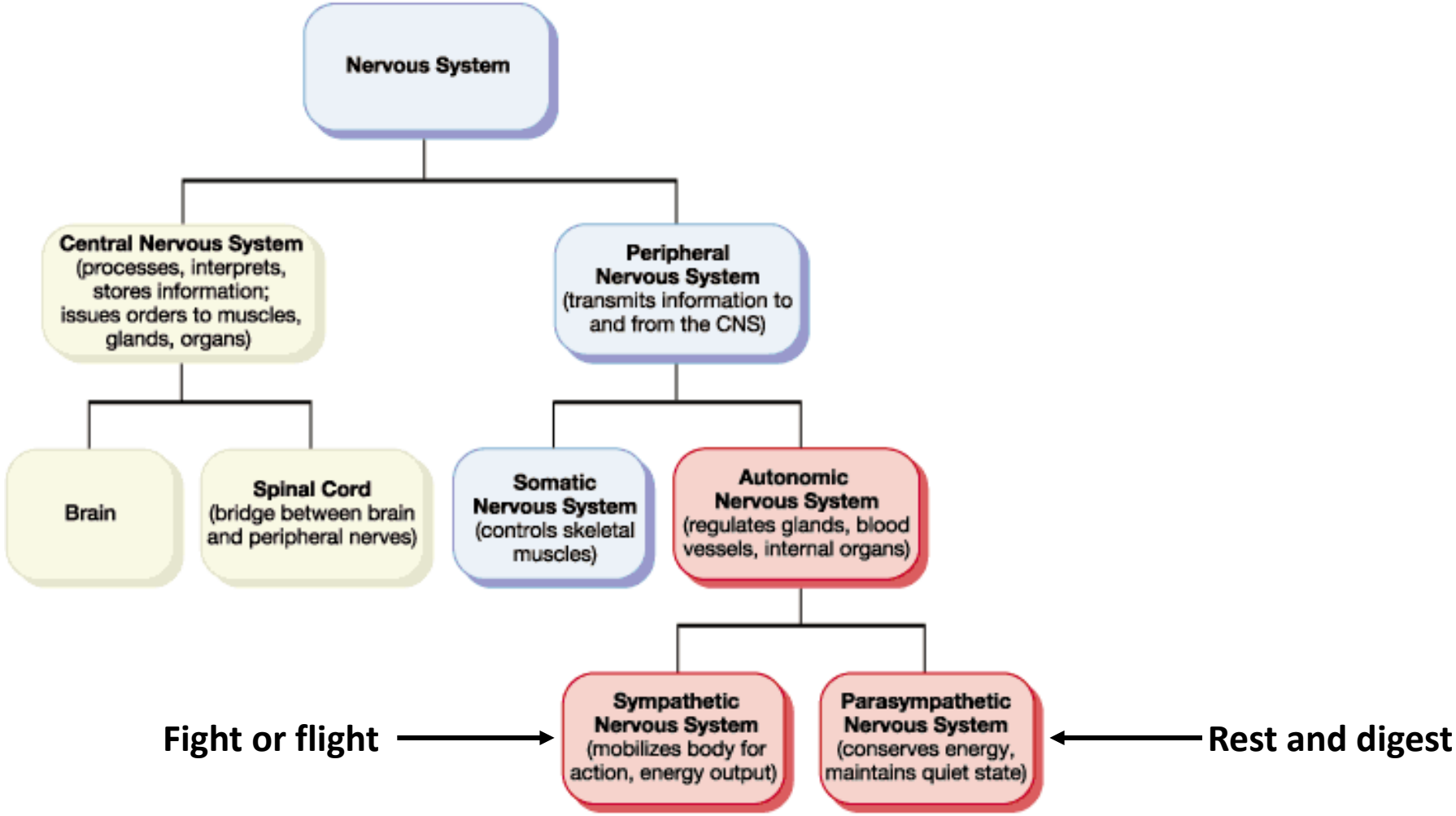
Dr. Everling

Western

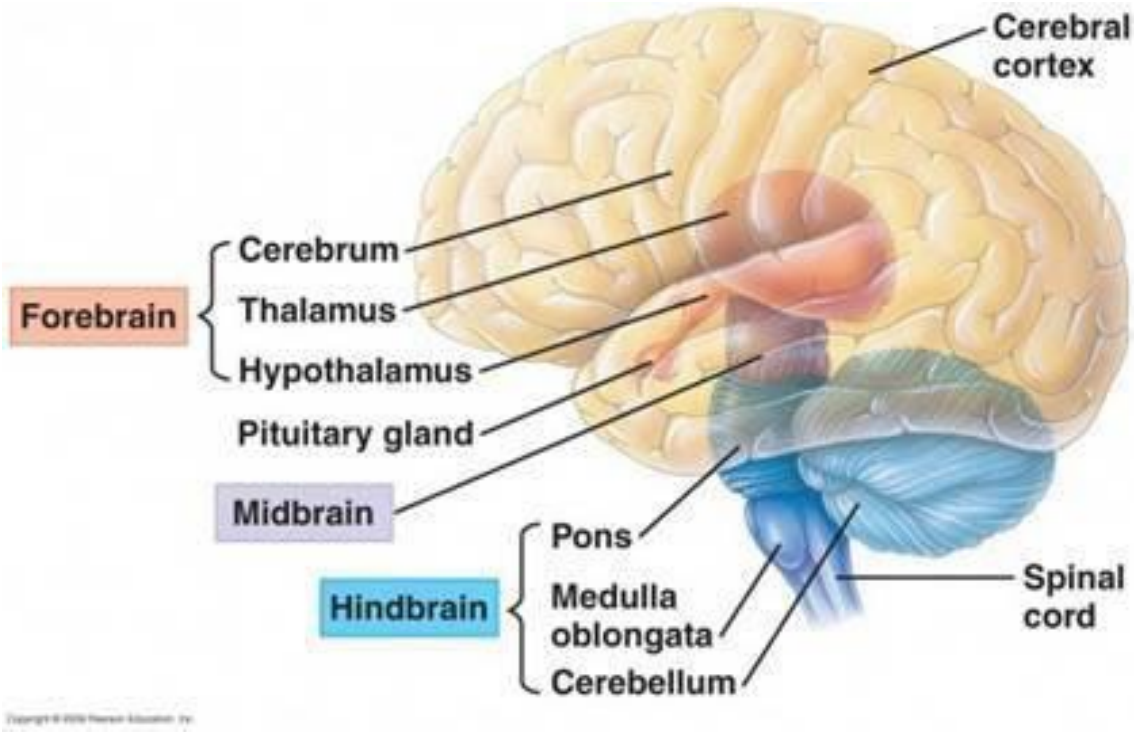
# Chapter Overview

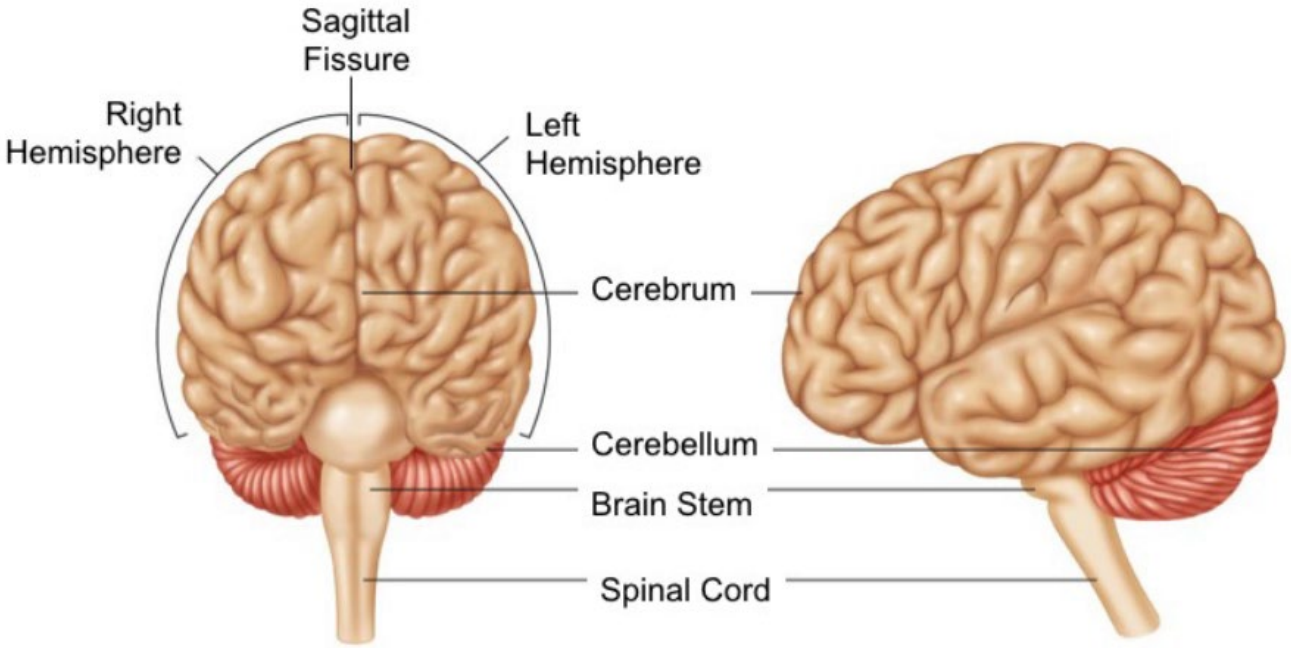
1. Nervous system overview
2. Touch
3. Vision
4. Audition

# Divisions of the Nervous System



# CNS Major Parts and Functions



# White vs. Grey Matter

| | White Matter | Grey Matter |
|---|---|---|
| **Colour** | White | Grey |
| **Components** | Axons | Cell bodies, dendrites and axon terminals |
| **Myelin present** | Yes, gives white appearance | No |
| **Function** | For communication between grey matter sites | Processing of information |

# Which of the following is true regarding the spinal cord?

A) The C1 spinal cord segment receives sensory input from all cervical dermatomes

B) The C1 spinal cord segment receives sensory input from the head and face

C) Lesion of the spinal cord at C8 will affect sensory input from all thoracic dermatomes

D) Lesion of the spinal cord at L1 will affect sensory input from all thoracic dermatomes

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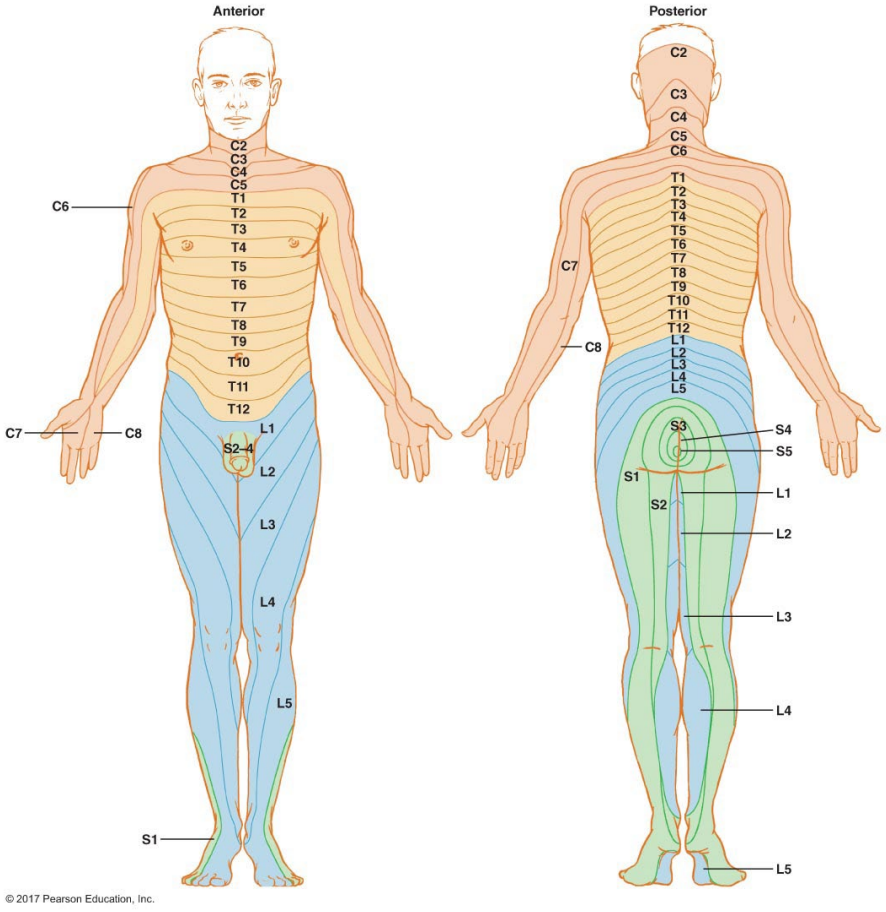
# CNS: The Spinal Cord

- White and gray matter are opposite to the brain (spinal cord: white external and grey internal)
- 31 segments
- Each segment has a pair of spinal nerves (PNS) – 31 pairs of spinal nerves
- Each segment receives sensory info and sends motor info to a similar region
- On the skin, the sensory region is called a dermatome



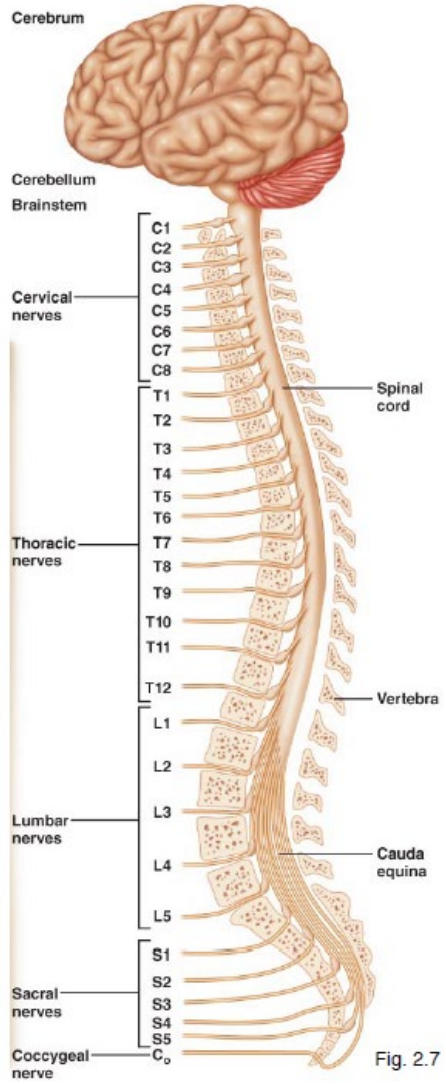
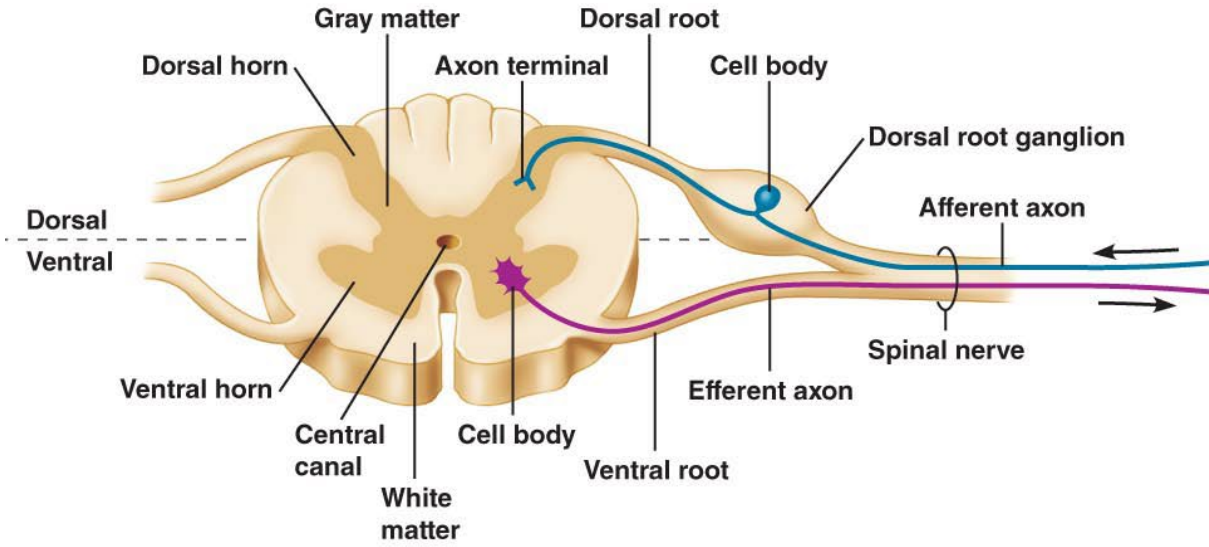




Fig. 2.7

# PNS: Spinal Nerves

- Sensory information is carried TOWARDS (afferent neuron) the spinal cord through the dorsal root
- Motor information is carried OUT (efferent) the spinal cord through the ventral root
- “SAME DAVE” sensory afferent motor efferent dorsal afferent ventral efferent



# Which of the following relationships are true regarding mechanoreceptors?

1. Receptors superficial in the skin have small receptive fields
2. Receptors deep in the skin have low tactile acuity
3. Receptors with small receptive fields have high tactile acuity
4. Receptors with large receptive fields have high tactile acuity

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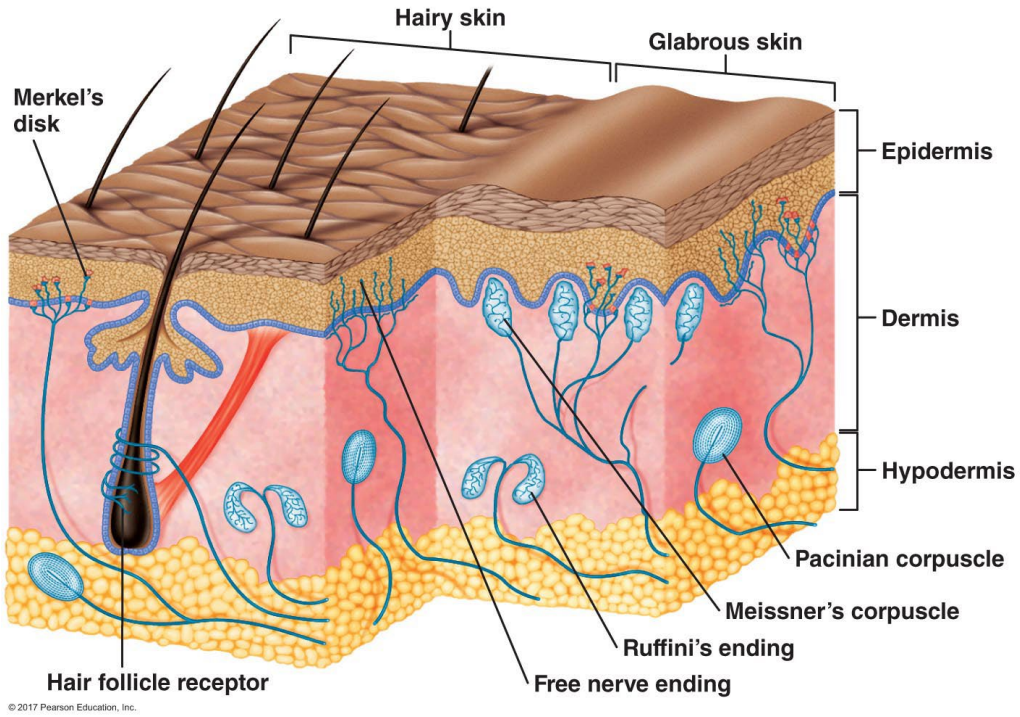
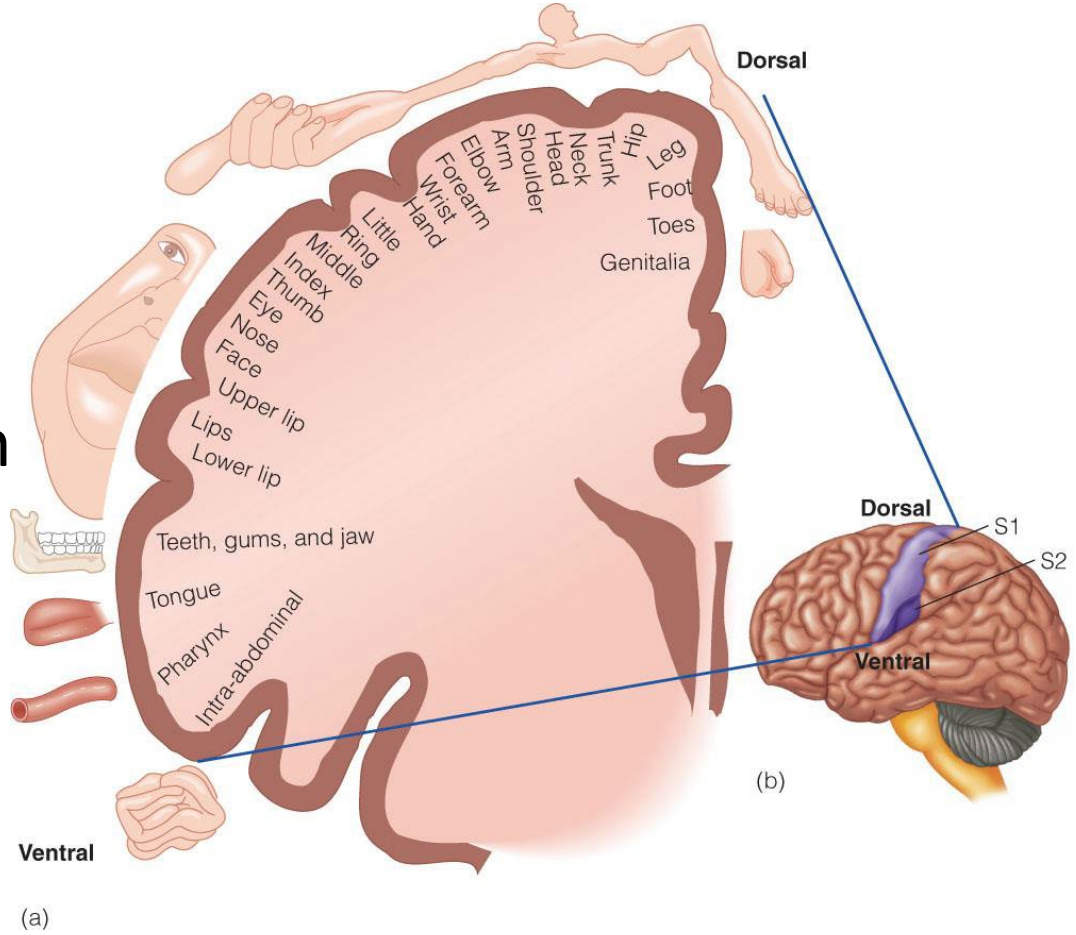
# Skin Mechanoreceptors




| Receptor | Location | Adaption Rate | Receptive Field Size |
|---|---|---|---|
| Merkel's Disks | Epidermis-Dermis Border | Slow | Small |
| Meissner's corpuscles | Dermis (Surface) | Rapid | Small |
| Ruffini's endings | Dermis (Deep) | Slow | Large |
| Pacinian corpuscles | Dermis (Deep) | Rapid | Large |

# Which lobe receives incoming somatosensory information?

- Located on postcentral gyrus (posterior to central sulcus; parietal lobe)
- Somatotopy: body regions correspond to specific points on the brain
- Magnification factor: particular body region are overrepresented
- There is plasticity in the somatosensory system (i.e. cortical maps can change)

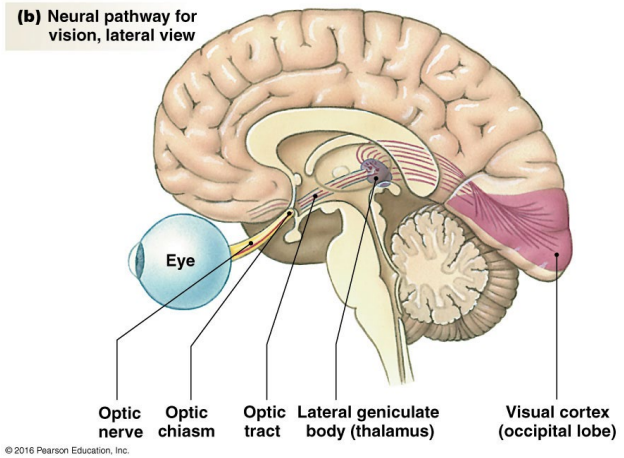


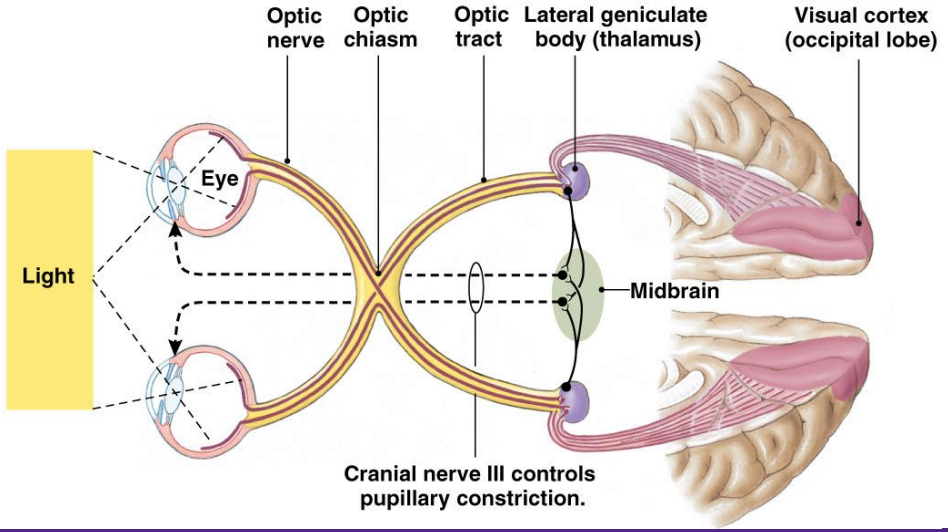
# Components of the Visual system

- 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)



# Which lesions of the visual pathway would result in a loss of visual perception in the contralateral visual field?

A) Lesion of the optic nerve
B) Lesion of the optic tract
C) Lesion of the optic chiasm
D) Lesion of the optic radiation

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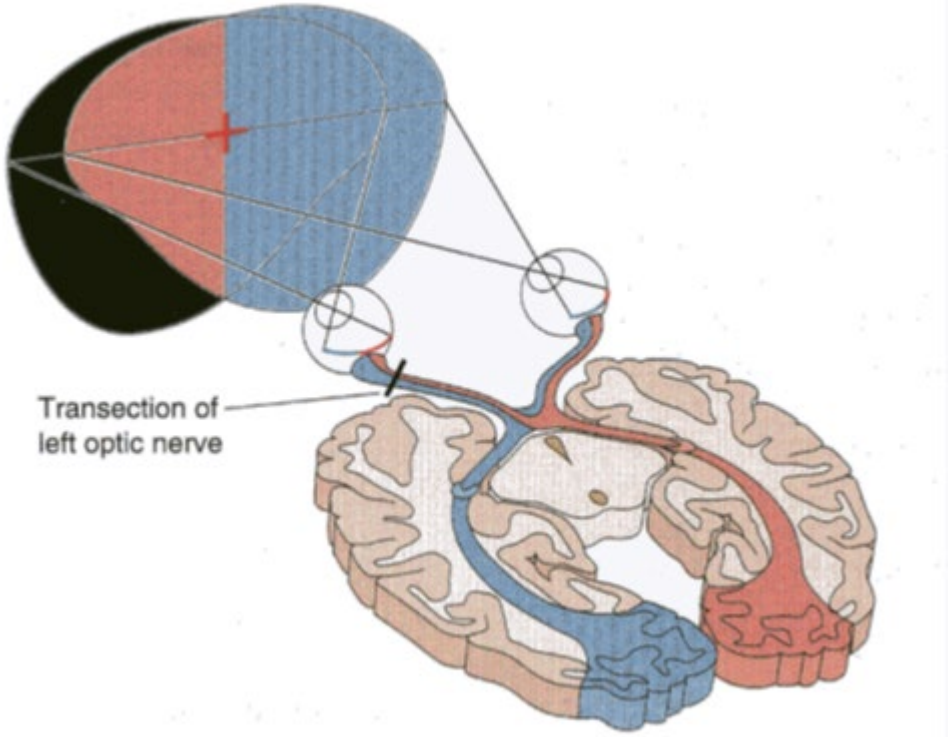
B) Lesion of the optic tract

C) Lesion of the optic chiasm

D) Lesion of the optic radiation

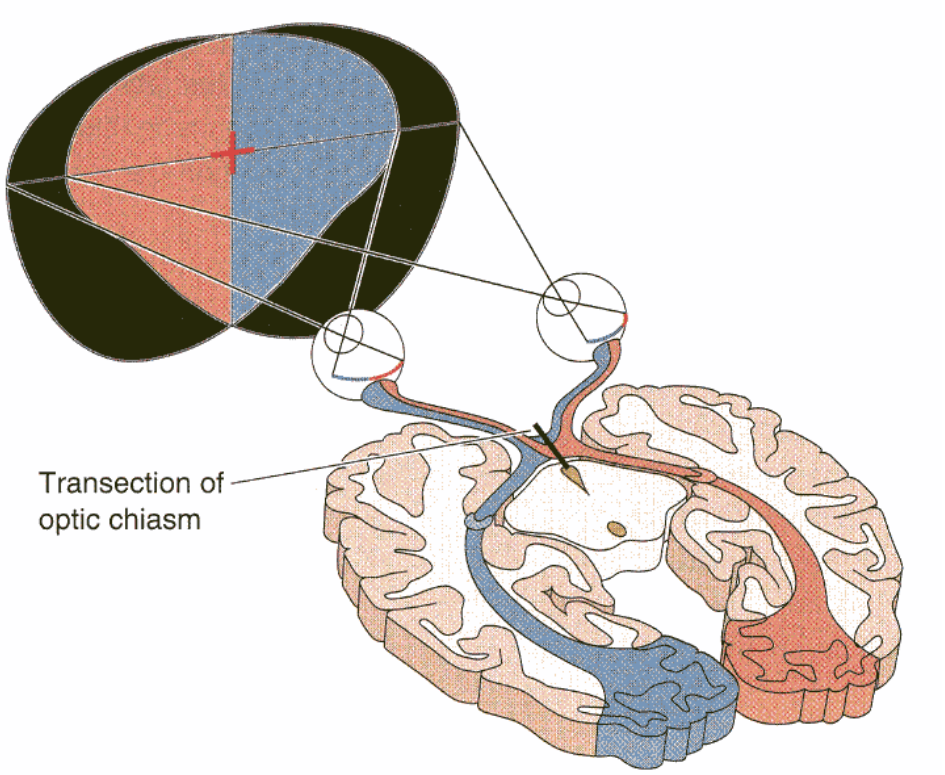
# Visual Pathway: Lesion at Optic Nerve

- 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)



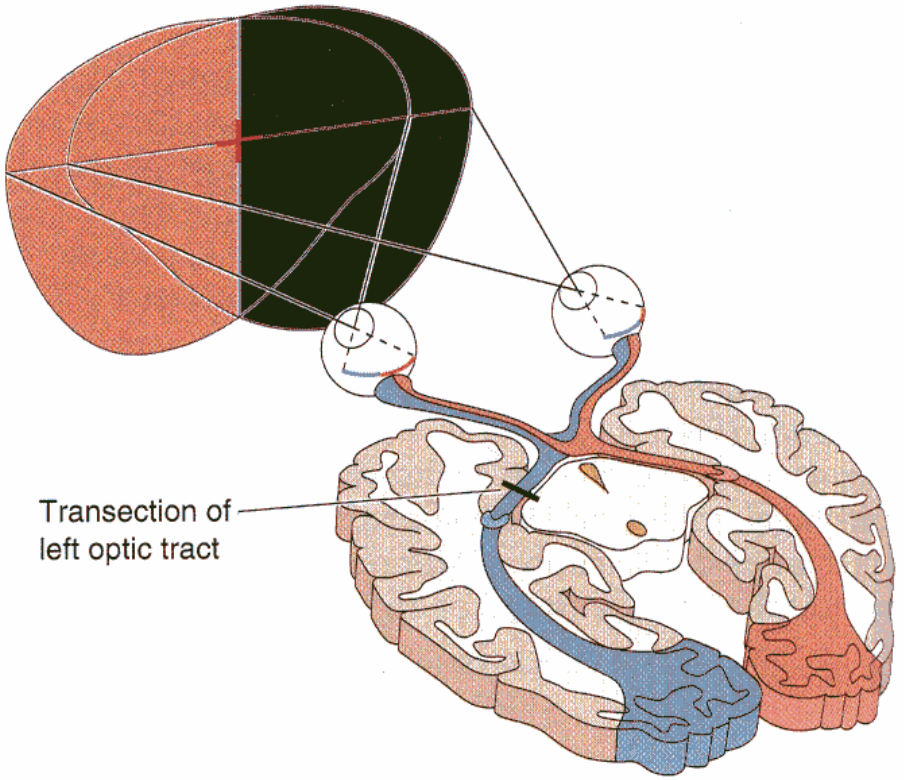
# Visual Pathway: Lesion at Optic Chiasm

- 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)

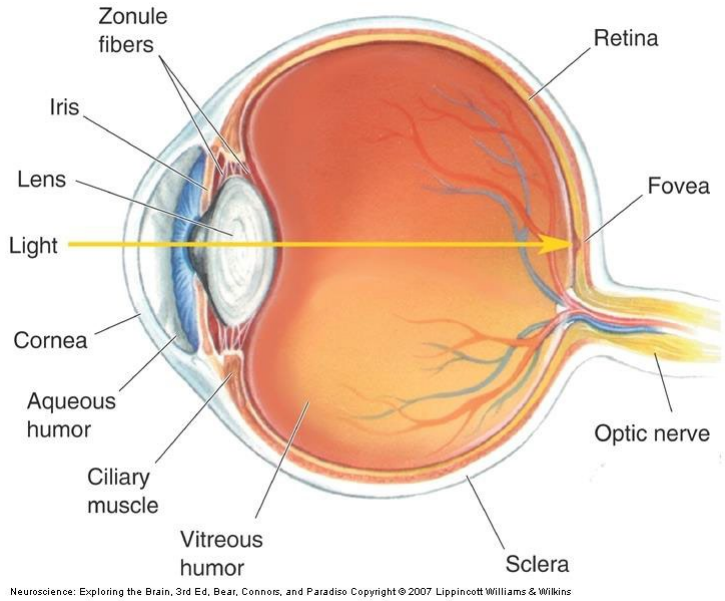


# Eye (Gross Anatomy)

- 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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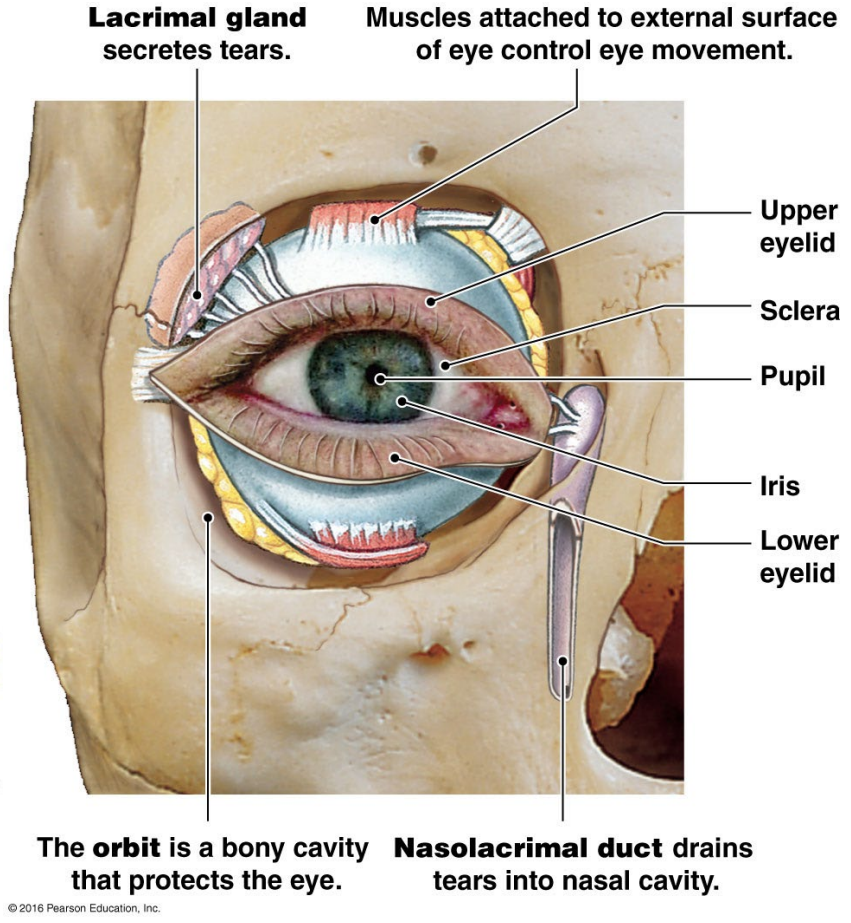


# Functions of Gross Eye Anatomy

- Pupil: Black space in center of eye
- Iris: Color part, regulates size of pupil
- Lens: Changes shape in response to distance of object
- Cornea: Protects the eye, found anterior to lens and pupil
- Sclera: Contains collagen fibers, protective layer around eye
- Conjunctiva: Thin film between eye and eyelid
- Optic Nerve: Where axons converge and leave eye

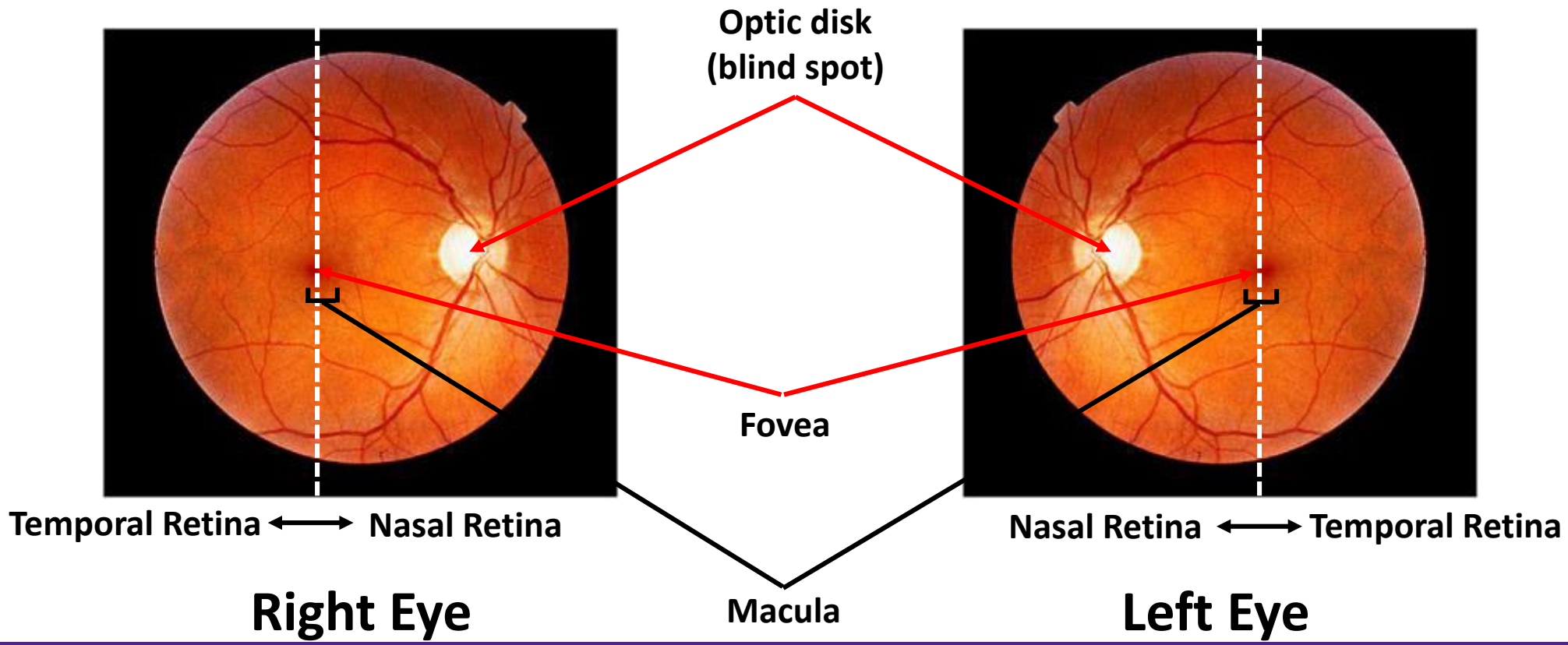
# Functions of Gross Eye Anatomy

- Extraocular eye muscles: Move eye around in orbit
- Ciliary Muscles: Intraocular muscles that pull on lens to change it's shape.
- Aqueous Humor: Fluid within the anterior chamber.
- Vitreous Humor: Clear/thick fluid within the posterior chamber.
- Retina: Consists of pigmented layer and several neuronal layers that are involved in phototransduction
- Fovea: Center of retina, provides accurate vision in the direction that it is pointed (contains only cones).

# Functions of Gross Eye Anatomy

- Photoreceptors: Phototransduction, light is converted to chemical energy.
- Rods: Light sensitive, white/black, function well in low light
- Cones: Color sensitive, red/green/blue
- Bipolar cells: First cell after action potential is generated in photoreceptors.
- Ganglion cells: The output neurons, axons form the optic nerve
- Horizontal cells: Side-to-side modulation
- Amacrine cells: Side-to-side modulation, inhibitory neurons
- Pigmented Epithelium: Absorbed excess light

# Eye (Gross Anatomy)



# The cell bodies of bipolar cells can be found in which layer of the retina?

A) Inner plexiform layer
B) Inner nuclear layer
C) Outer plexiform layer
D) Outer nuclear layer

# The cell bodies of bipolar cells can be found in which layer of the retina?

A) Inner plexiform layer

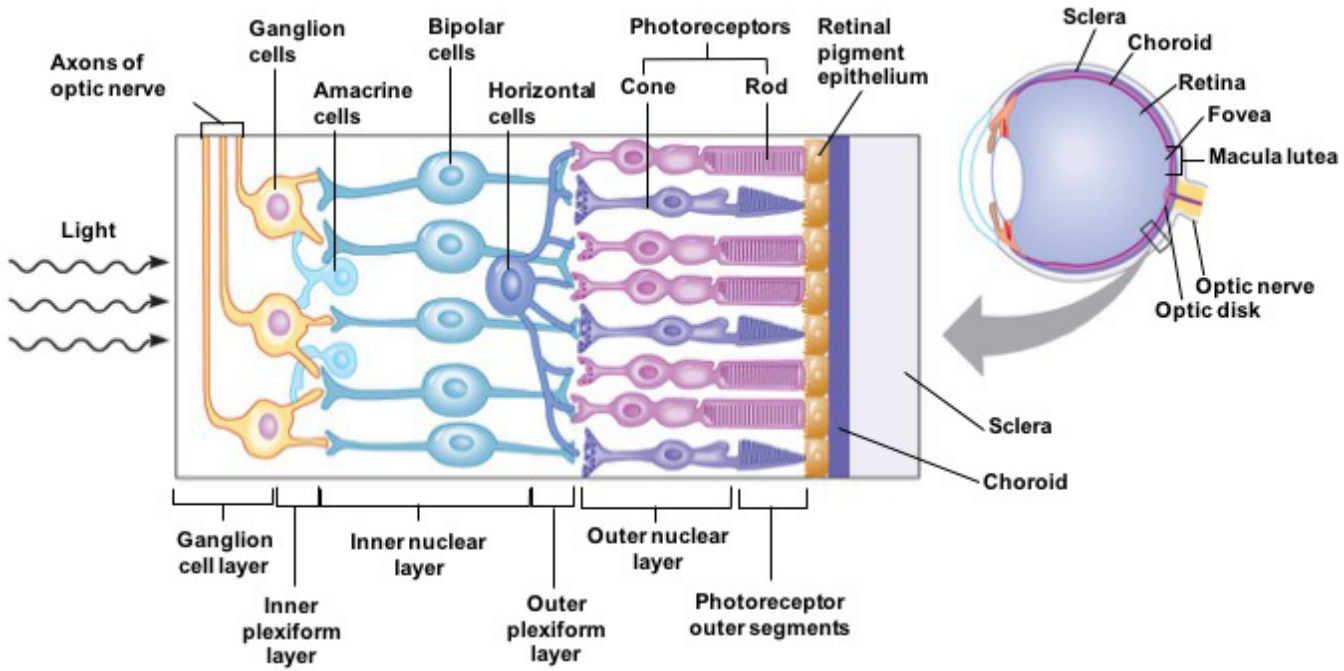
B) Inner nuclear layer

C) Outer plexiform layer

D) Outer nuclear layer

# Retinal Cells

- Main Pathway:
  - Photoreceptors (rods and cones)
  - Bipolar cells
  - Ganglion cells
- Modulation and Communication:
  - Horizontal cells
  - Amacrine cells



# Which of the following relationships are true regarding the retina?

1. Rods and cones are distributed evenly within the retina
2. The fovea contains both rods and cones
3. No photoreceptors are found within the optic disk
4. The fovea forms a pit, pushing bipolar and ganglion cells aside

a) If only 1, 2 and 3 are correct
b) If only 1 and 3 are correct
c) If only 3 and 4 are correct
d) If only 4 is correct
e) If ALL are correct

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a) If only 1, 2 and 3 are correct
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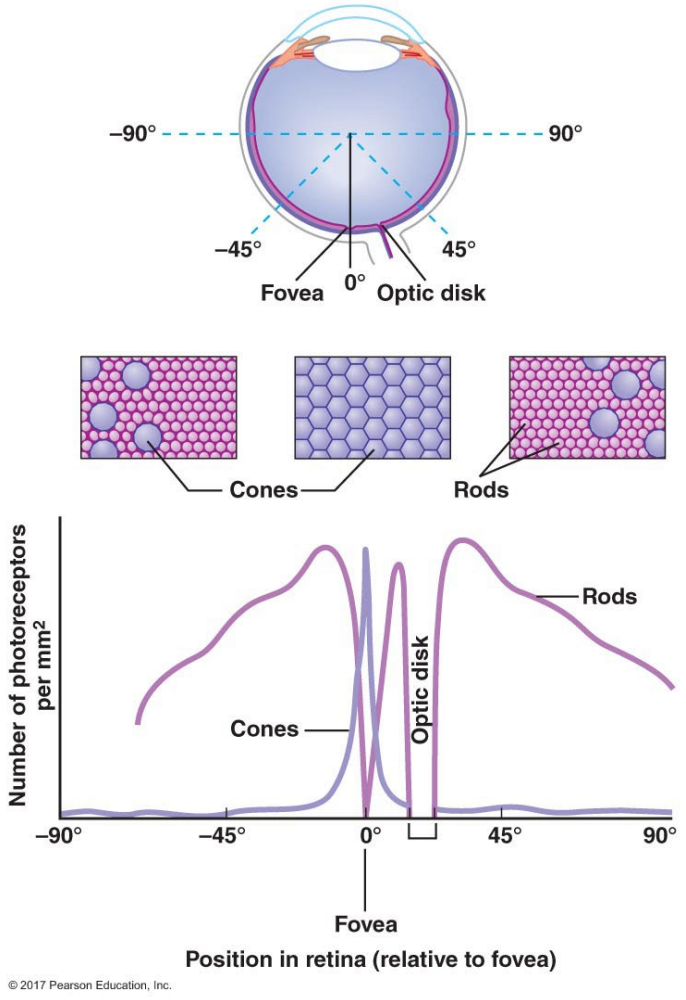
c) If only 3 and 4 are correct
d) If only 4 is correct
e) If ALL are correct

# 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) |



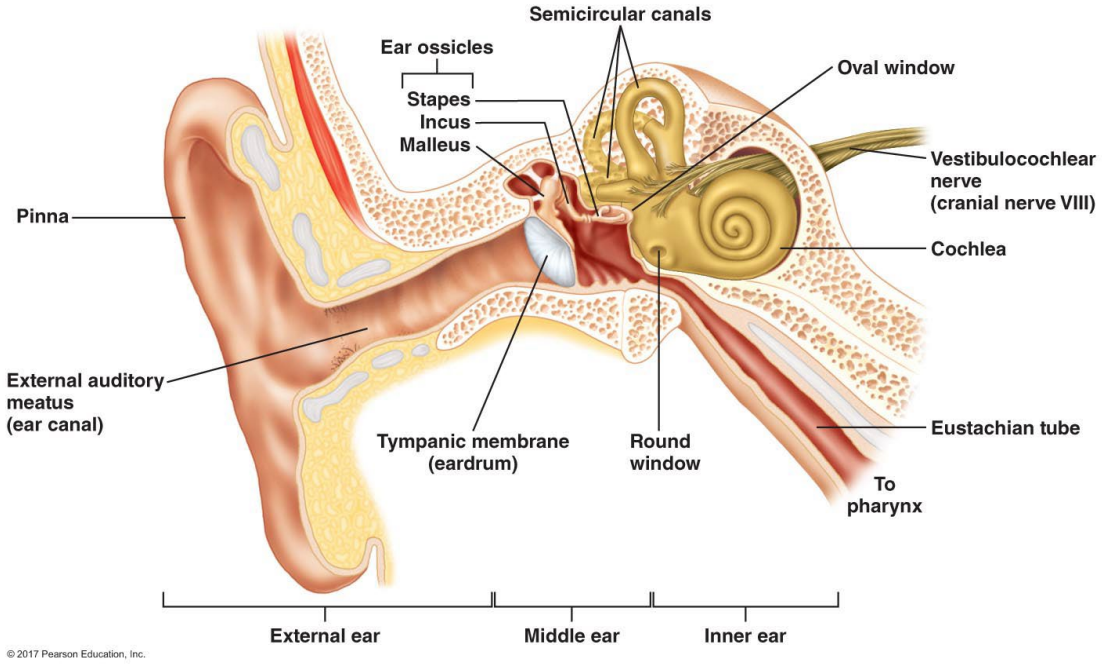
# Sensory: Auditory System

## Chapter 2: Dr. Everling

Western

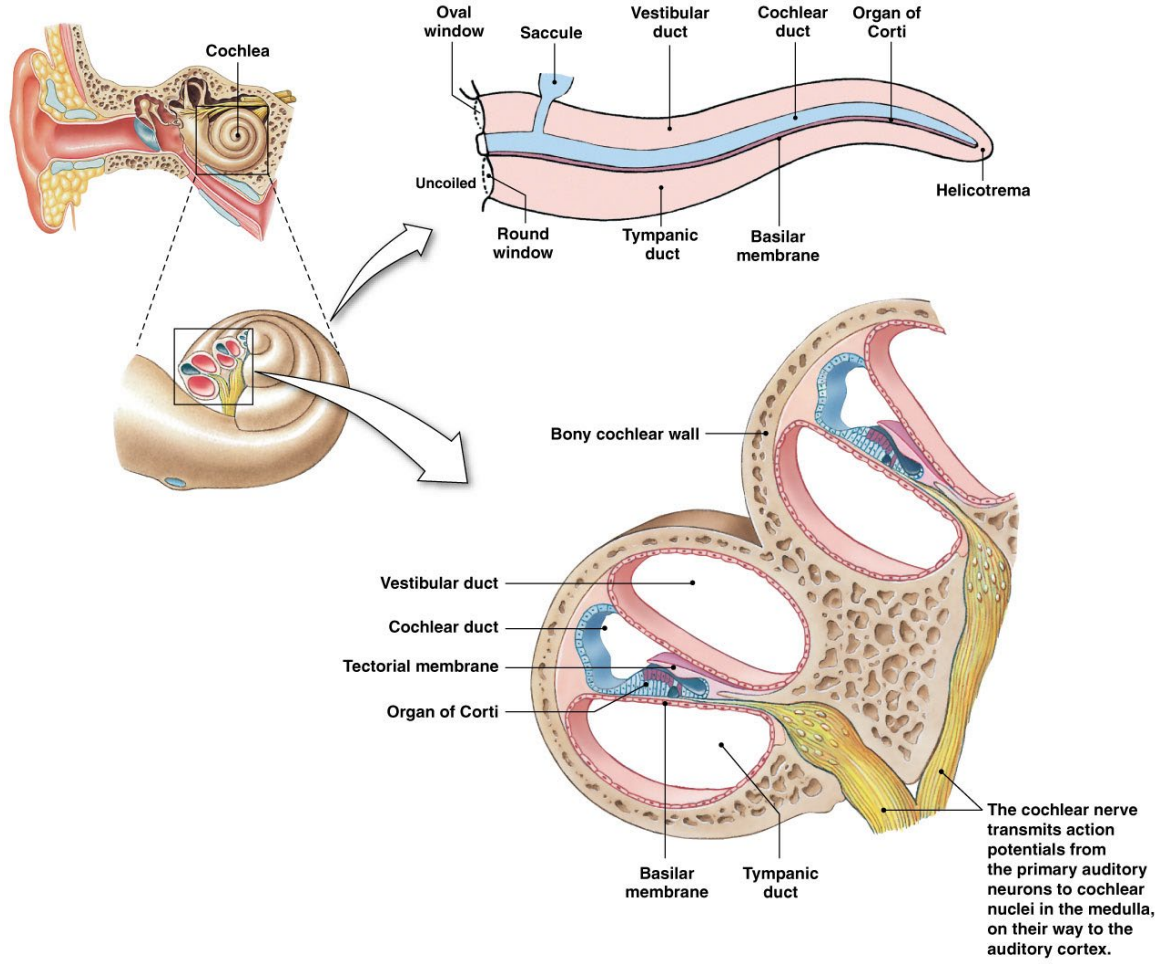
# Divisions of Auditory System

- 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



# Cochlea

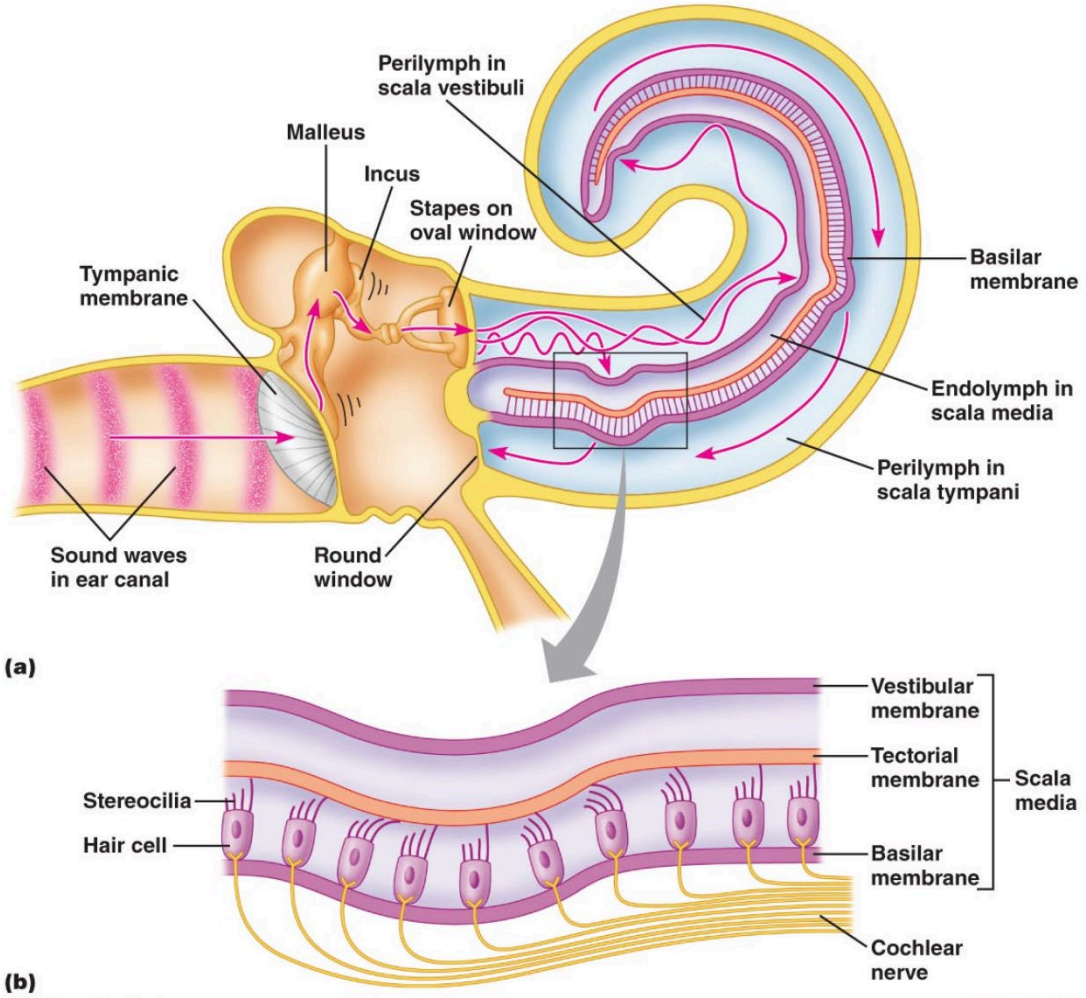
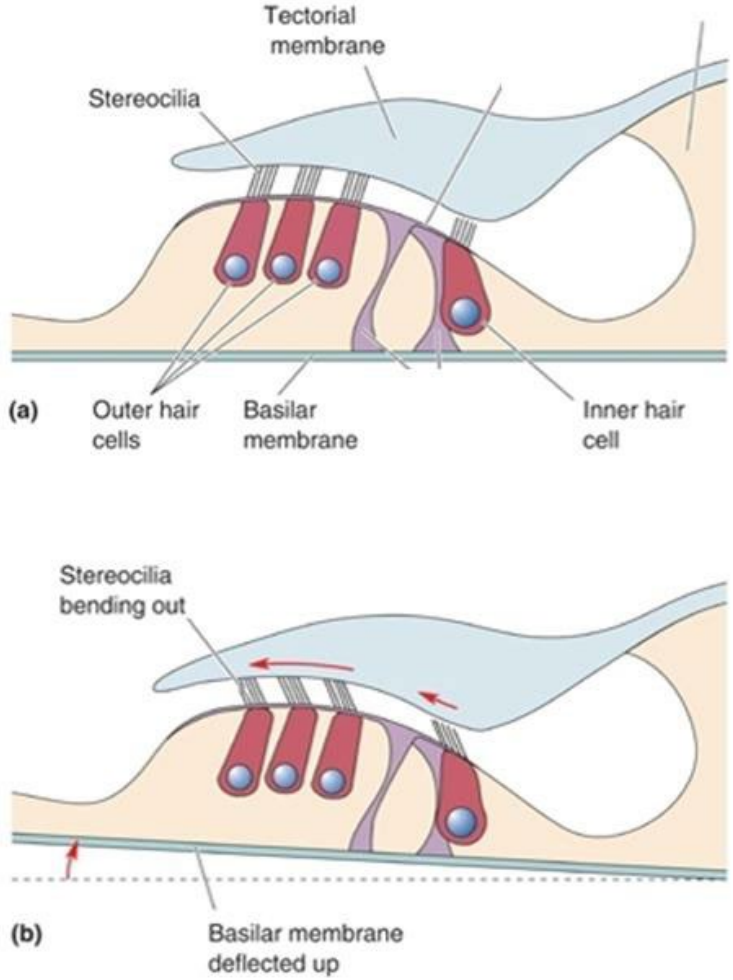



Fig. 2.44

# Divisions of Auditory System

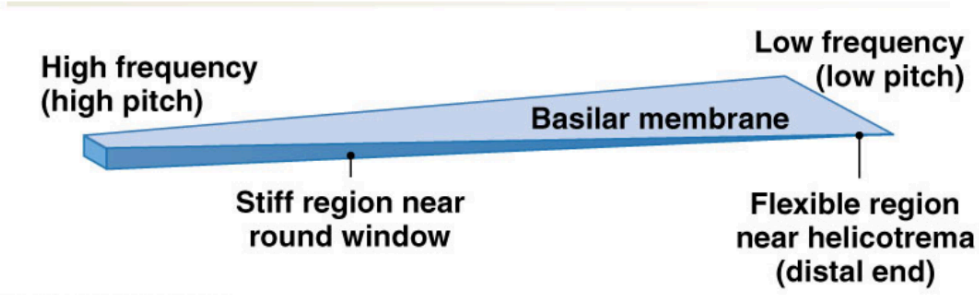
- Organ of Corti contains hair cells with stereocilia:
  - Fluid movements cause deflection of basilar membrane
  - Basilar membrane deflection leads to dragging of hair cells against the tectorial membrane
    - Stereocilia bend from dragging
  - Hair cells depolarize when stereocilia bend
    - Mechanically-linked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



# Basilar Membrane

- Gradient:
  - Base: narrow and stiff; detects high frequency
  - Apex: wide and floppy; detects low frequency

**How the Basilar Membrane is laid out**

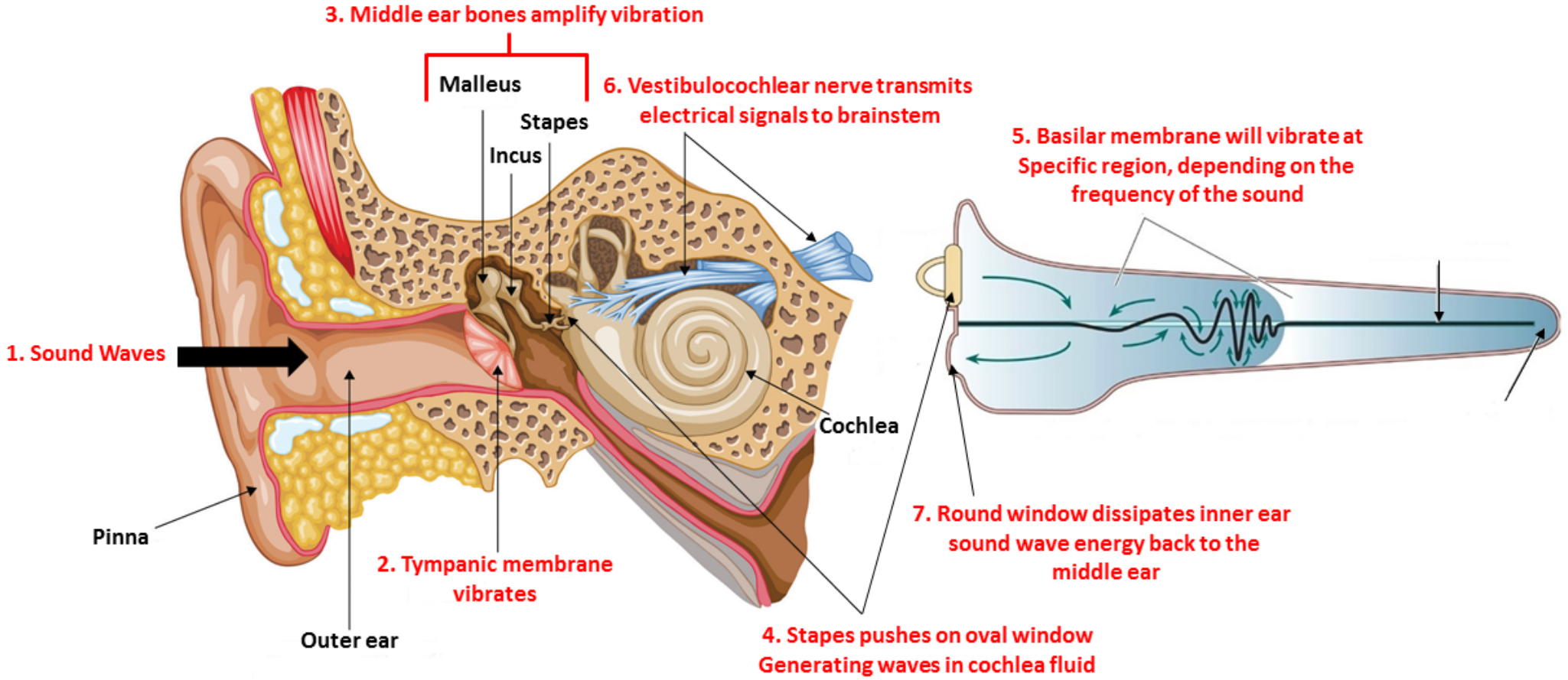



The **Base** is thin and the membrane is stiff (where high frequencies are encoded)

Fig. 2.45

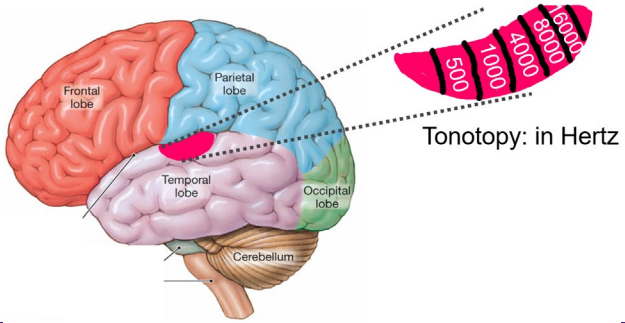
The **Apex** is wide and the membrane is less rigid (where low frequencies are encoded)

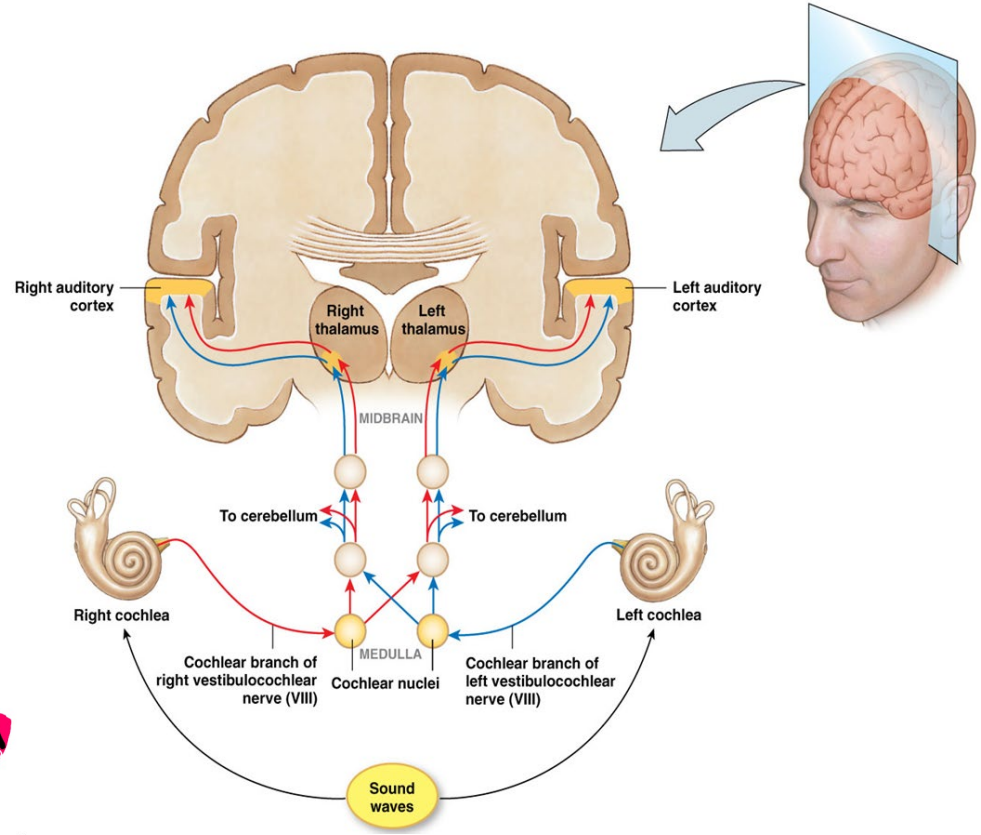
# How Sound Travels Through Ear



# 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



# Neurons in all the following structures receive input from both ears except:

A) Inferior colliculus
B) Cochlear nucleus
C) Medial geniculate nucleus
D) Superior Olive

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A) Inferior colliculus

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D) Superior Olive

# 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

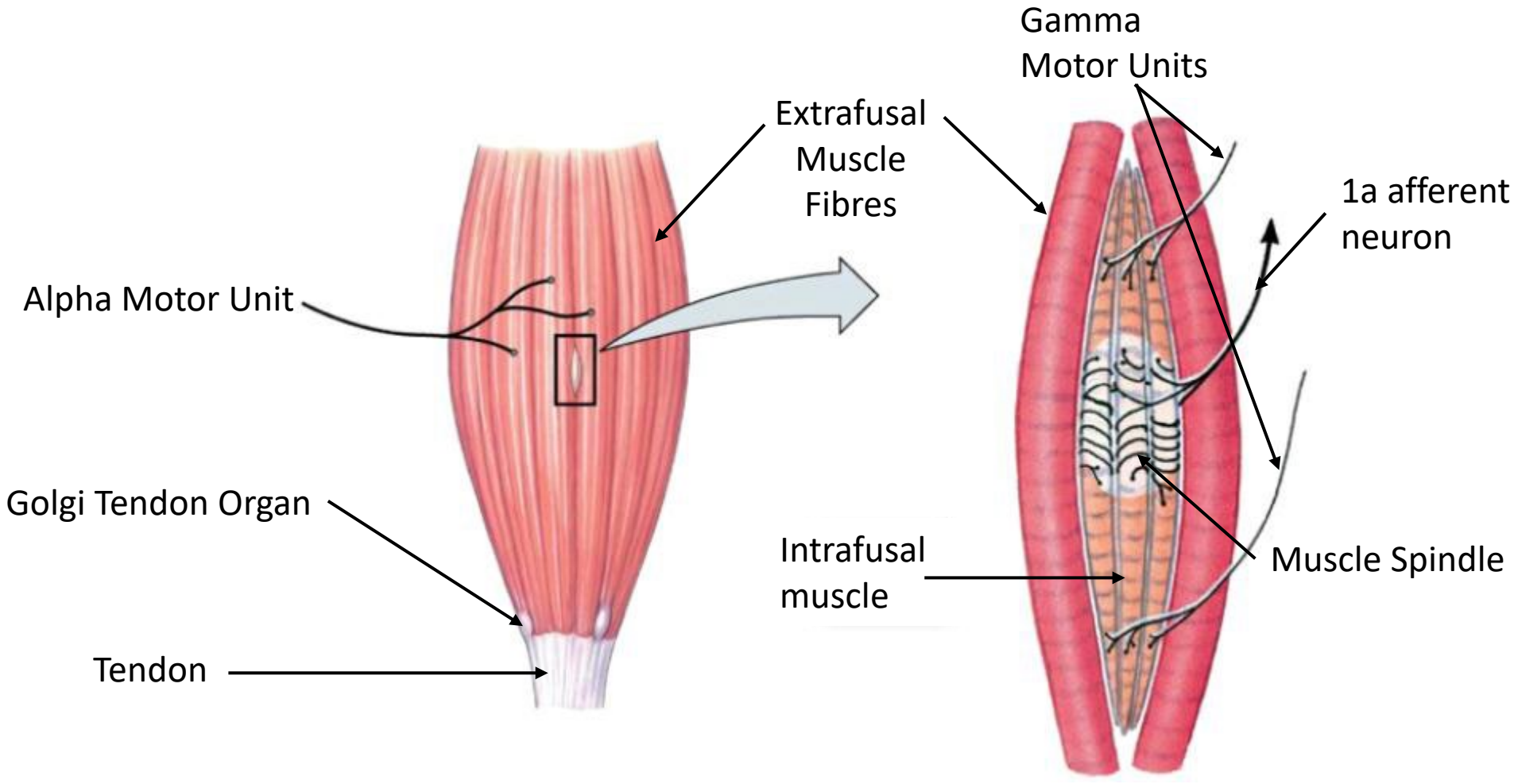
- A defect in the Central Nervous system
- e.g. tumours or strokes in the central auditory pathways

# Motor Physiology

Chapter 3: Dr. Everling

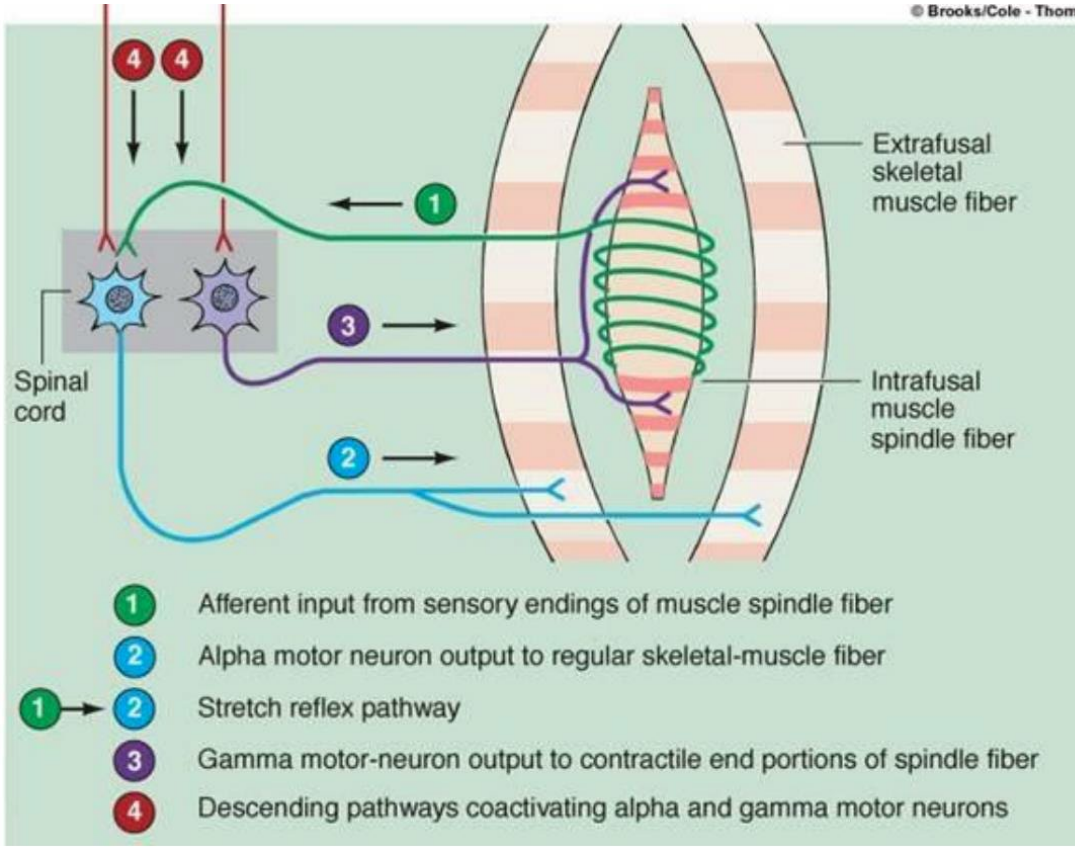
Western

# Muscle Anatomy



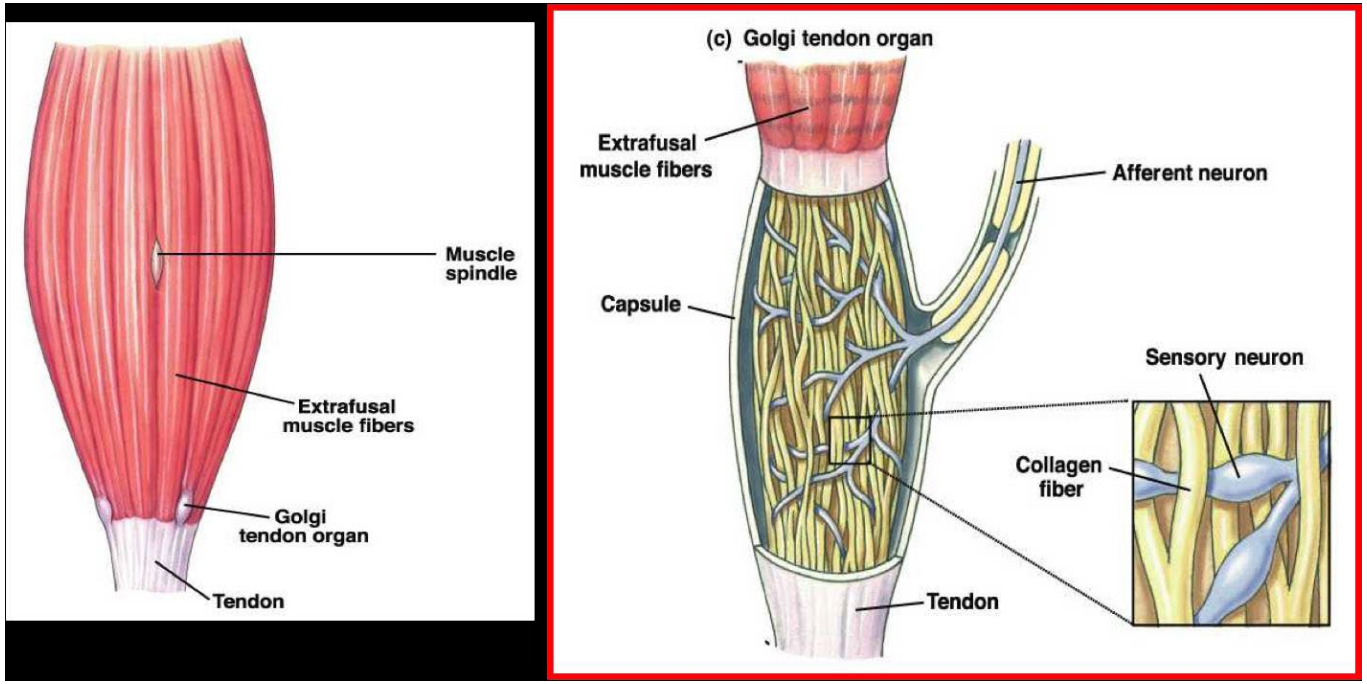
# Muscle Spindle

- 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

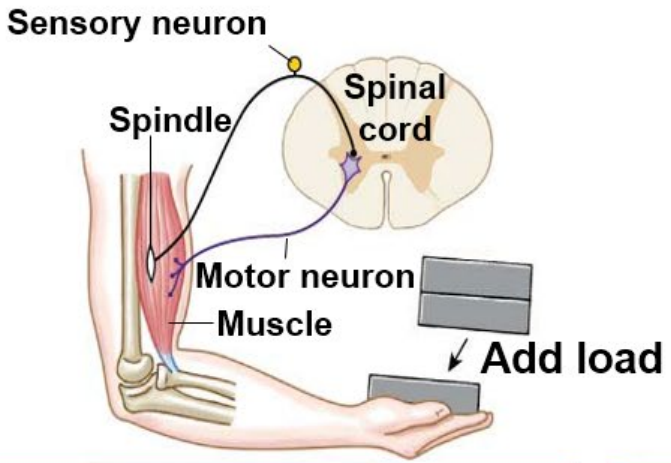
- Golgi tendon organ links muscle and tendon
- Collagen fibers woven around sensory receptors
- Increase in tension causes collagen contraction around sensory receptor, which sends info to CNS via 1b afferent neuron



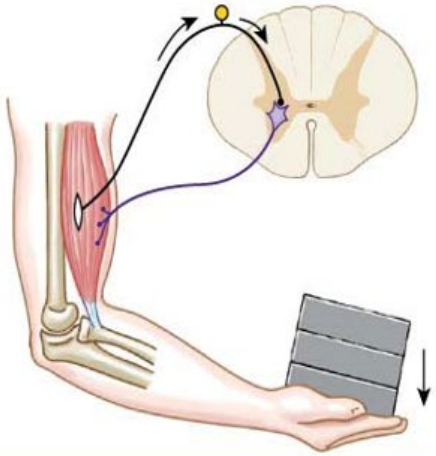
# Reflexes

- 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

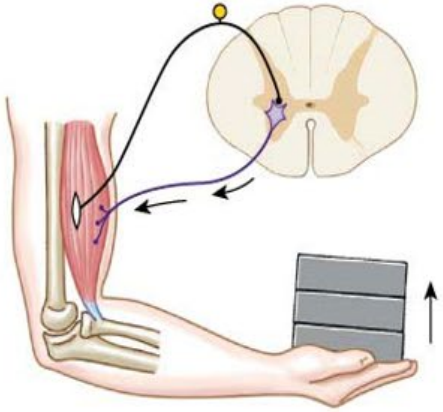
# Stretch Reflex




1. Load added to muscle.



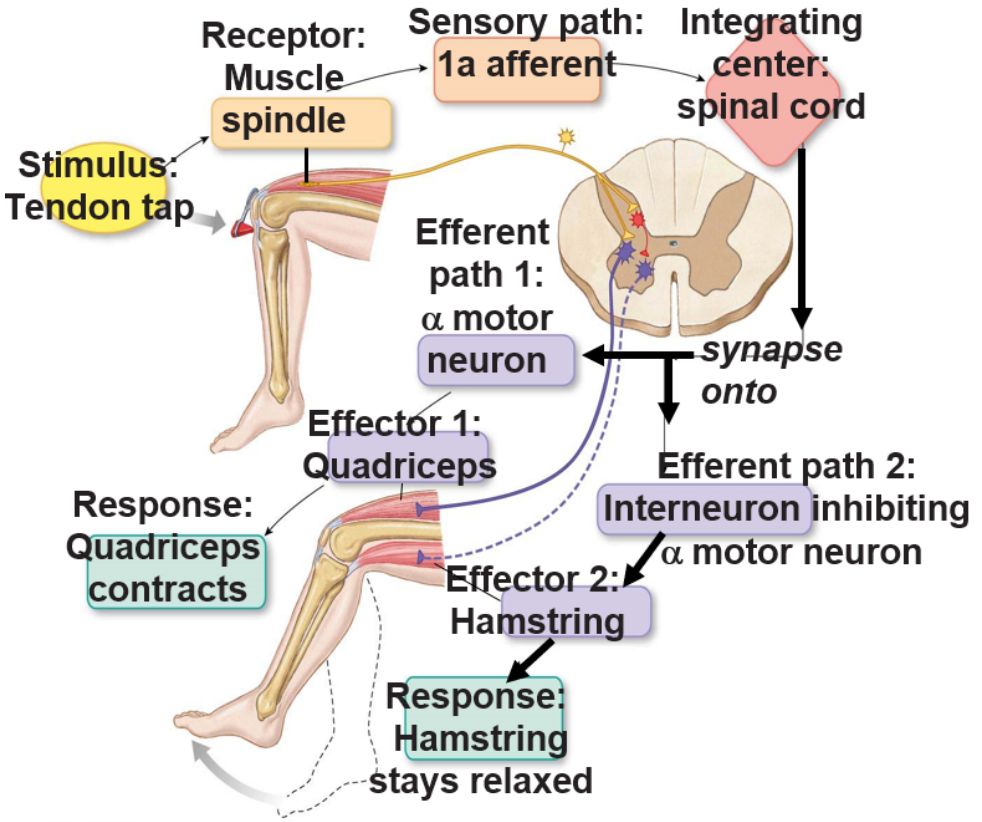
2. Muscle and muscle spindle stretch as arm extends. Muscle spindle afferents fire more frequently.



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.



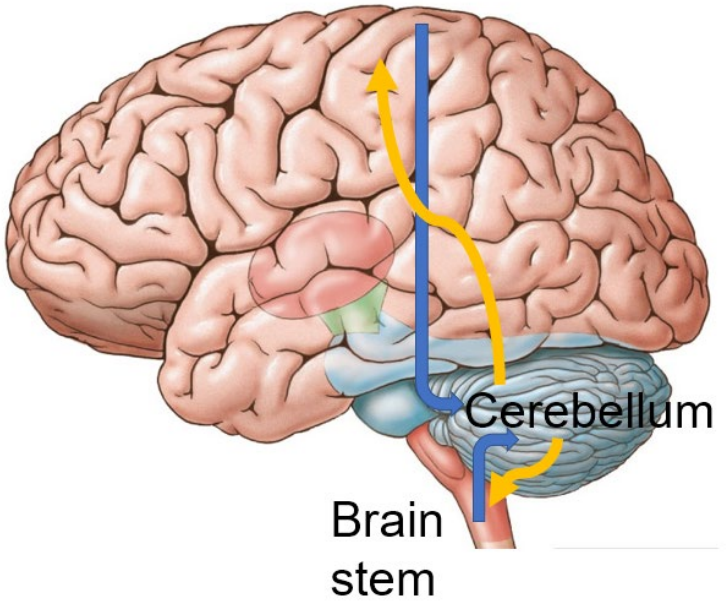
# Motor Physiology: The Cerebellum and Basal Ganglia

Chapter 3: Dr. Everling

Western

# The Cerebellum

- Function: evaluates difference between intended and actual movement action
- Cortex, brain stem and spinal cord send signals TOWARDS
- Cerebellum sends signals BACK, however these can be modified for motor learning

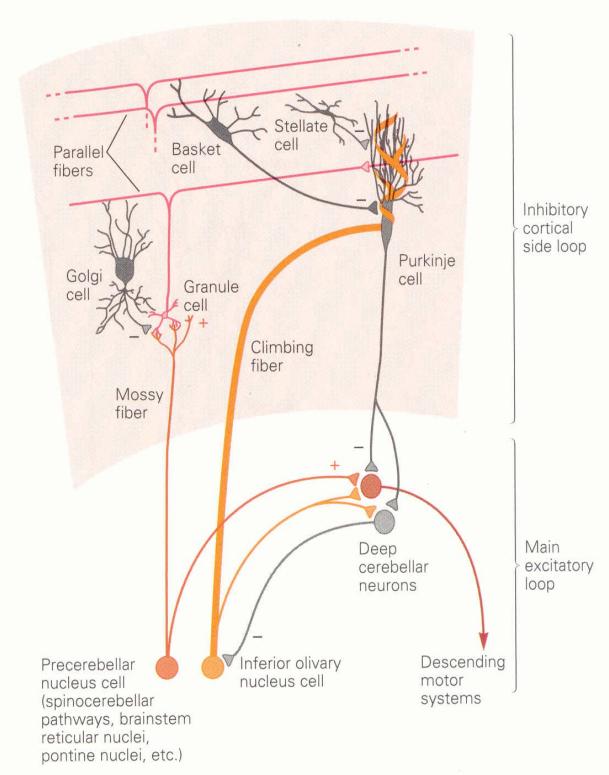


# The Cerebellum Circuit

Two inputs:

- Mossy fibers: Synapse on granule cells.
  - Axons of granule cells form parallel fibers which synapse on Purkinje cells
- Climbing fibers: Synapse directly on Purkinje cells.

- Mossy and climbing fibers excite Purkinjie cells, which provide cerebellum output through inhibition

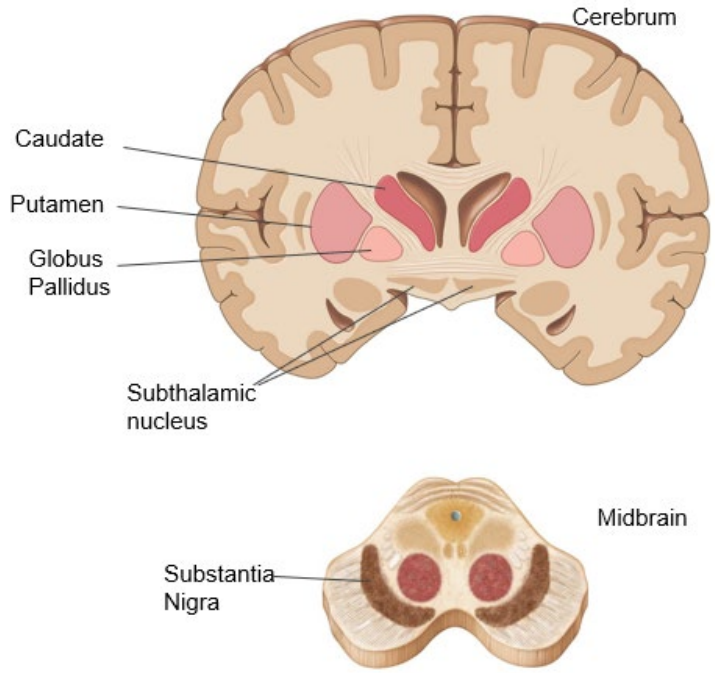


# The Basal Ganglia

- Function: regulating and planning movements
- Cortex send signals TOWARDS
- Basal ganglia sends signals BACK through the thalamus

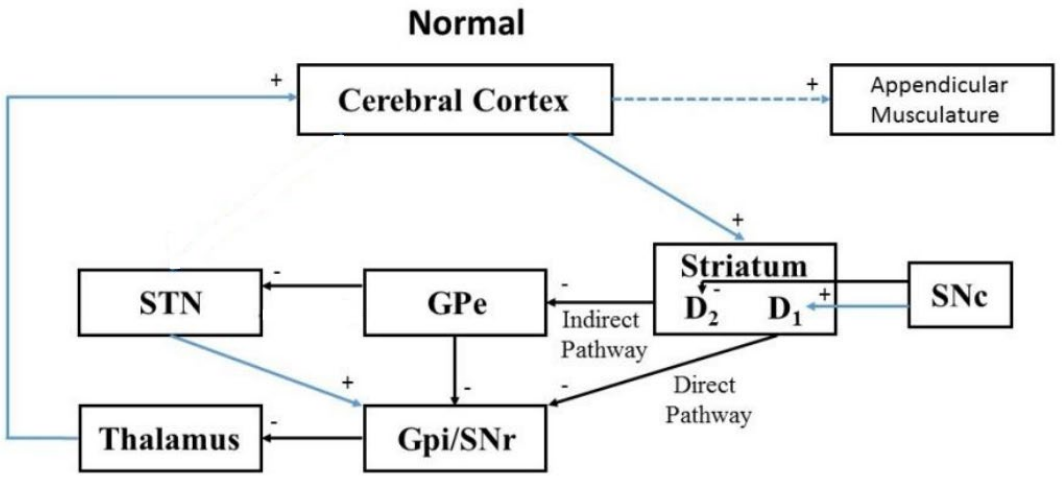
Two main functions

1. Production of movement – direct pathway
2. Inhibition of movement – indirect pathway



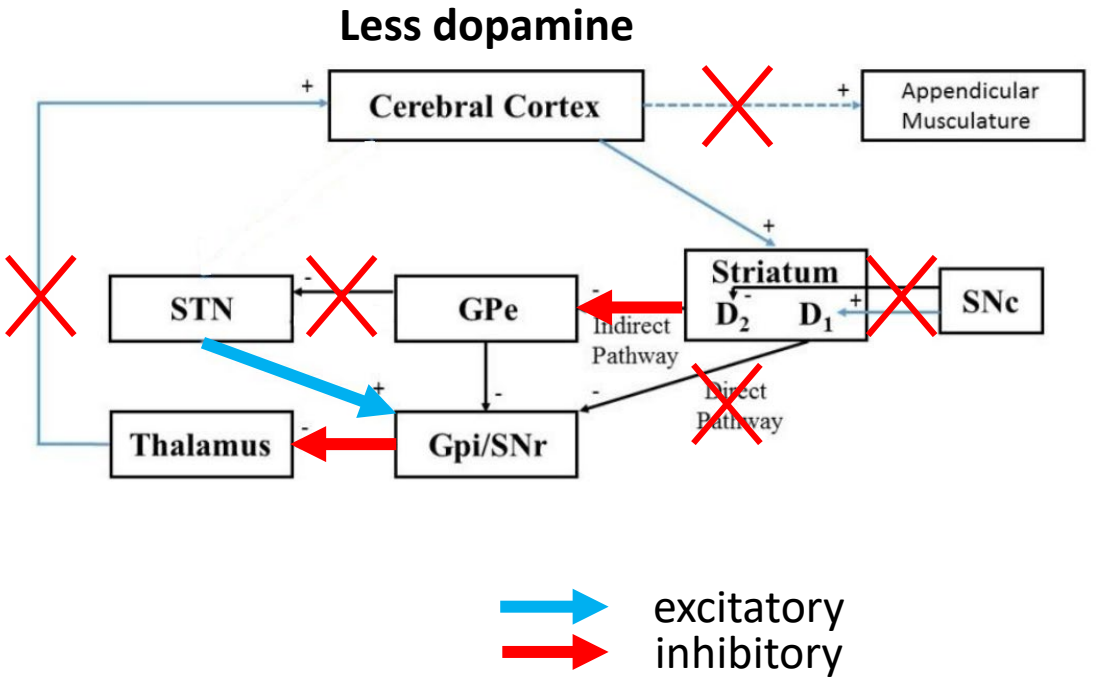
# Basal Ganglia Circuit

- Cerebral cortex sends excitatory signals to striatum (caudate + putamen)
- Direct pathway (movement):
  - striatum inhibitory projections to globus pallidus internal
  - globus pallidus inhibitory projections to thalamus
- Indirect pathway (Inhibit movement):
  - striatum inhibitory projections to globus pallidus external
  - globus pallidus external inhibitory projections to subthalamic nucleus
  - subthalmic nucleus excitatory projections to globus pallidus internal
- globus pallidus internal inhibitory projections to thalamus
- thalamus excitatory projections to cortex



# Less Dopamine

- Less dopamine from substantia nigra pars compacta
- Direct pathway DE-ACTIVATED:
  - striatum will not inhibit the globus pallidus internal
- Indirect pathway ACTIVATED:
  - striatum will inhibit globus pallidus external
  - globus pallidus external will no longer inhibit the subthalamic nucleus
  - subthalmic nucleus will cause excitation of globus pallidus internal
- globus pallidus internal inhibits the thalamus
- thalamus will no longer excite the cortex
- Movement inhibited



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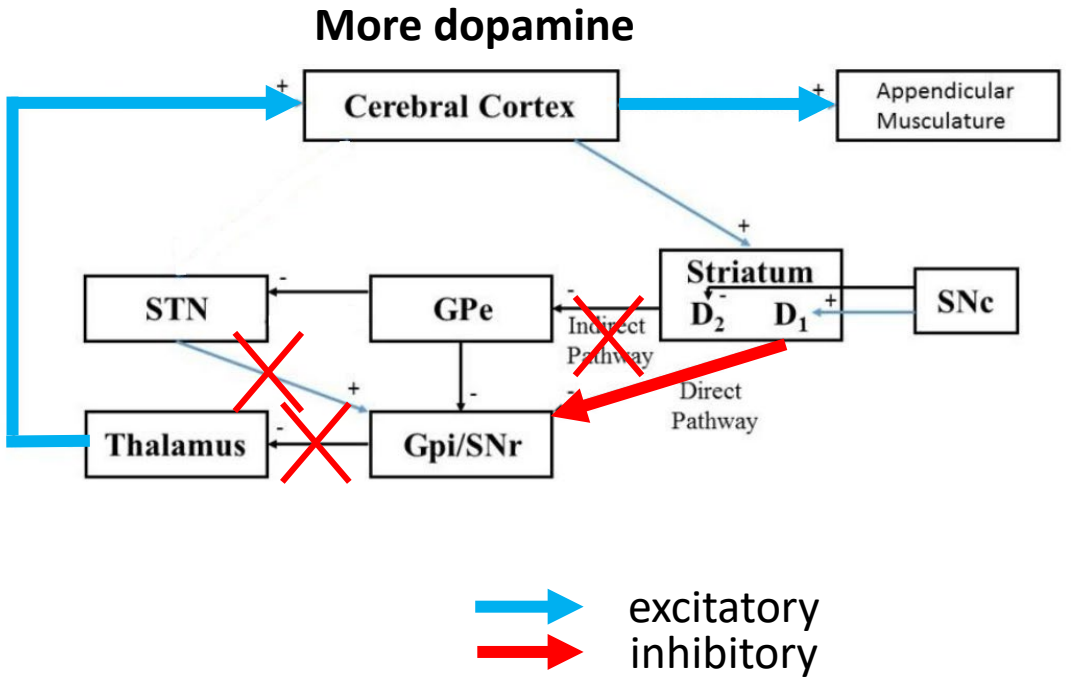
  - subthalmic nucleus will no longer excite the globus pallidus internal
- globus pallidus internal no longer inhibits the thalamus
- thalamus will excite the cortex
- Movement initiated



# Parkinson Disease

- Loss of neurons in substantia nigra pars compacta
- Direct pathway DE-ACTIVATED:
  - striatum will not inhibit the globus pallidus internal
- Indirect pathway ACTIVATED:
  - striatum will inhibit globus pallidus external
  - globus pallidus external will no longer inhibit the subthalamic nucleus
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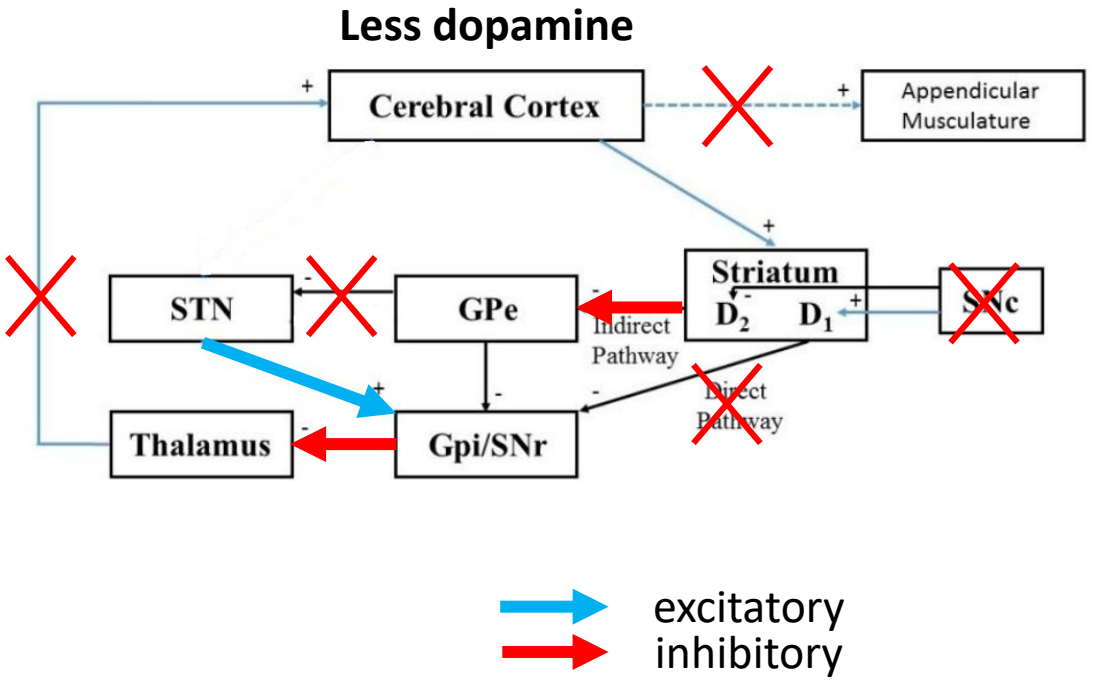
- globus pallidus internal inhibits the thalamus
- thalamus will no longer excite the cortex
- Movement inhibited



# Endocrinology: Introduction

Chapter 3: Dr. Beye

Western

# Which of the following best describes endocrine/hormonal signaling?

A) A cell sending a signal to itself
B) A cell sending a signal to its neighbor
C) A neuron sending a neurotransmitter to another neuron
D) A cell sending a signal to a distance organ

# Which of the following best describes endocrine/hormonal signaling?

A) A cell sending a signal to itself

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# Endocrinology

- Communication mechanism for organ systems and cells
- Utilizes hormones for cellular signaling to distant sites throughout the body

| Parameter | Nervous System | Endocrine System |
|---|---|---|
| **Type of signal?** | Neurotransmitters | Hormones |
| **Where do signals travel** | Synapse | Blood |
| **Communication Speed** | Rapid | Slow |

# Types of Hormones

- Hormone: A chemical signal secreted into the bloodstream to act on a distant tissue
- The target cells of the hormone need the receptor

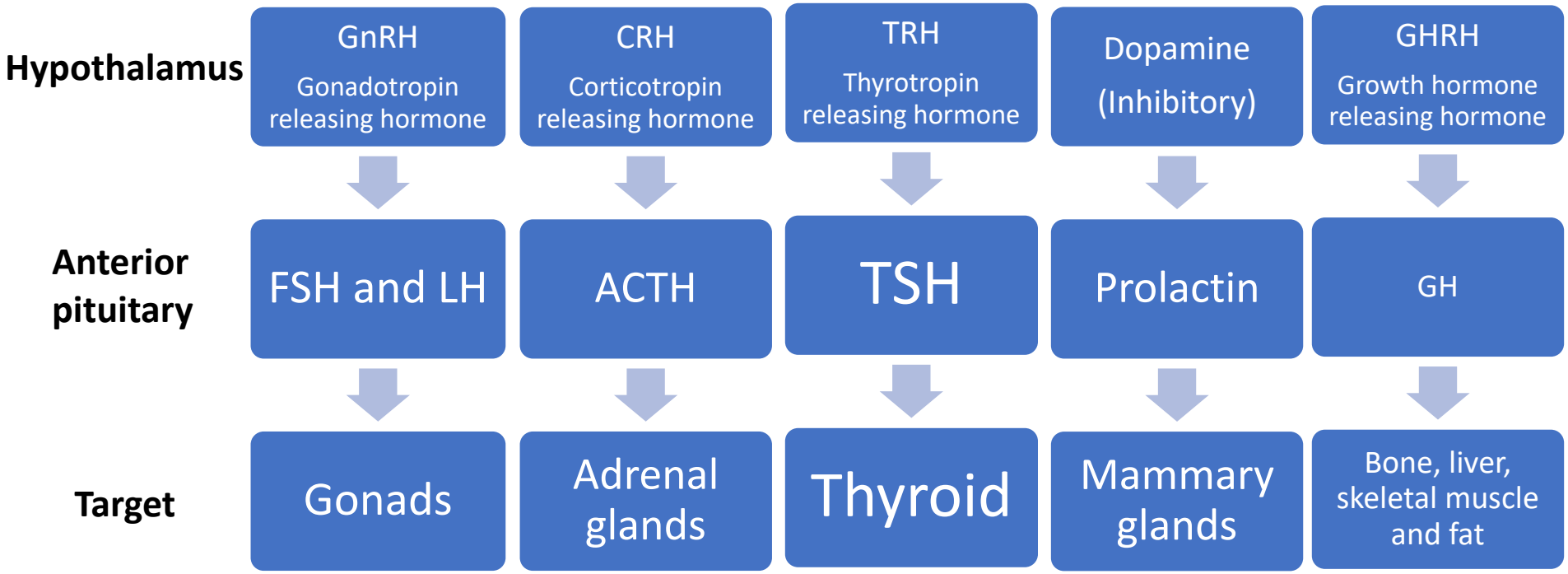
| Parameter | Peptide/Protein | Steroid | Amine | |
|---|---|---|---|---|
| | | | Hydrophilic | Hydrophobic |
| **Examples** | Hormones that end in "-in" | Hormones that end in "-ol" or "-one" | Epinephrine | Thyroid Hormones |
| **Precursor** | Amino acids | Cholesterol | Tyrosine | Tyrosine |
| **Solubility** | Hydrophilic | Lipophilic | Hydrophilic | Hydrophobic |
| **Blood transport** | Dissolves | Bound to protein | Dissolves | Carrier protein |
| **Receptor location** | Cell surface | Intracellular | Extracellular | Intracellular |
| **Speed of action** | Fast | Slow | Fast | Slow |
| **Goal** | Alter existing proteins | Produce new proteins | Alter proteins | Produce new proteins |

# Endocrine: Anterior pituitary and thyroid

Chapter 3: Dr. Beye

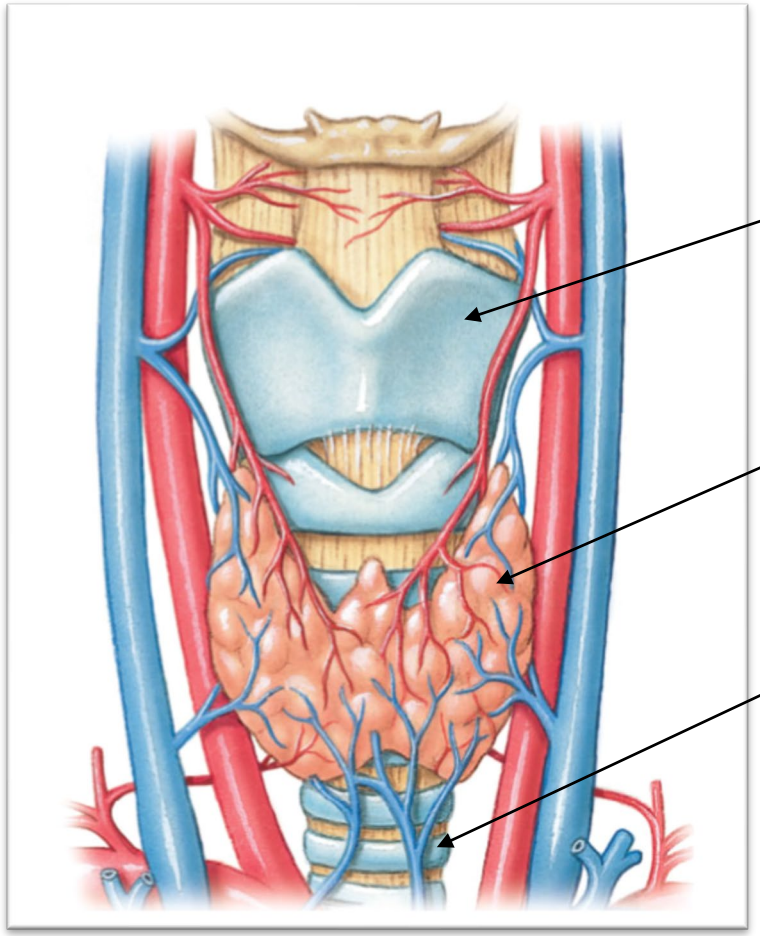
Western

# Hypothalamus-Anterior Pituitary

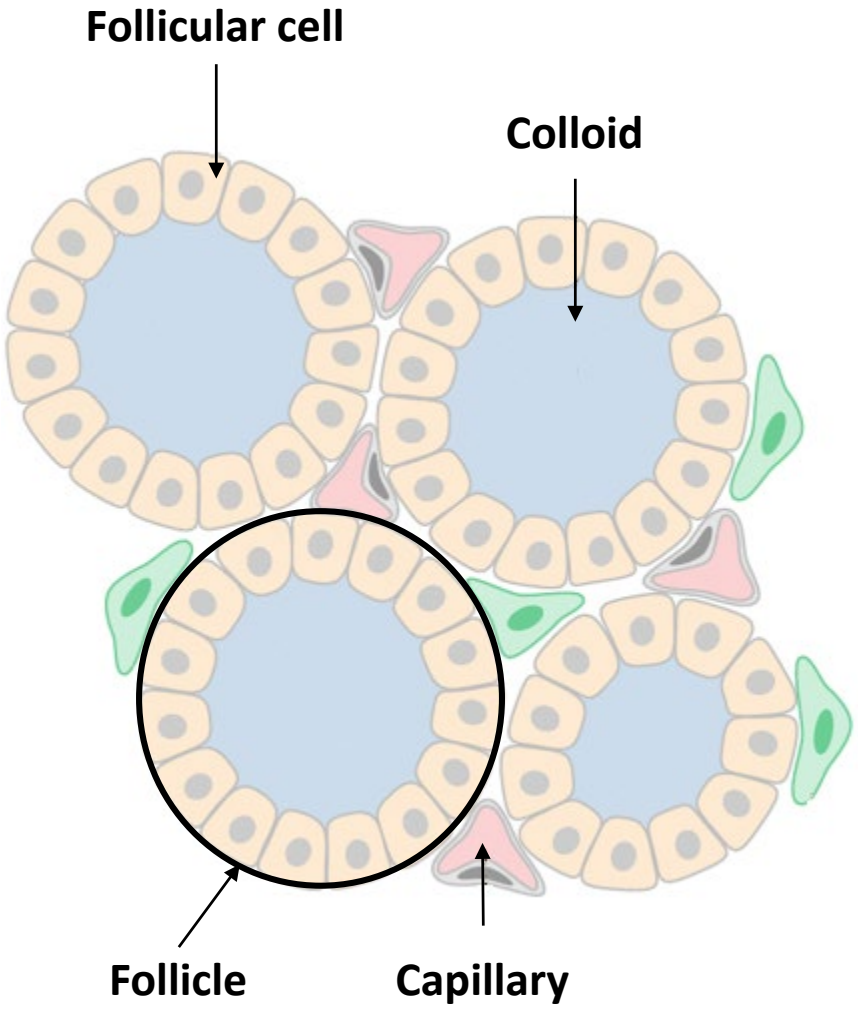



1. Hypothalamus makes and releases hormone into portal system
2. Hormone travels through hypothalamic hypophyseal portal system to ant pit
3. Hormone acts on ant pit to make and release a hormone into general circulation
4. Hormone travels through general circulation to target tissue

# Thyroid Gland



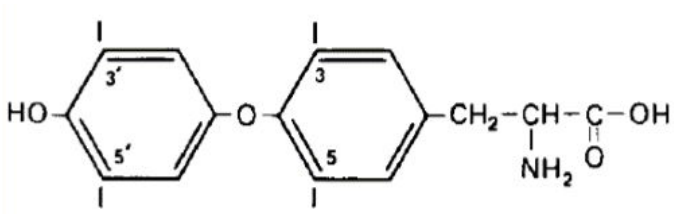
# Thyroid Gland



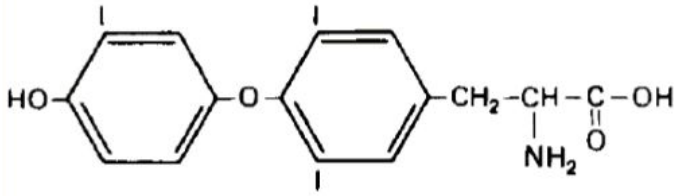

1. Capillary: TH transport
2. Follicle: functional unit where TH is made
3. Colloid: TH is made and stored here
4. Follicular cells: acquire and produce TH building blocks

# Thyroid Hormone Overview

- TH is an amine hormone with properties similar to steroid hormone
- Function: increase basal metabolic rate; acts on nearly every cell of body
- 2 key components: tyrosine and iodide



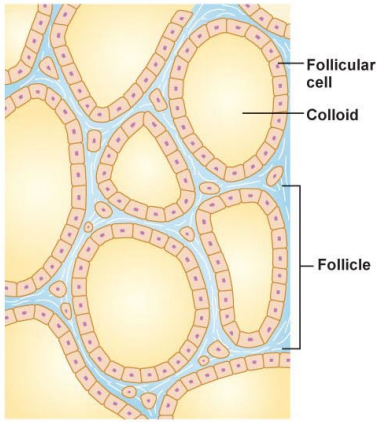

3,5,3′,5′-Tetraiodothyronine (thyroxine, $T_4$)

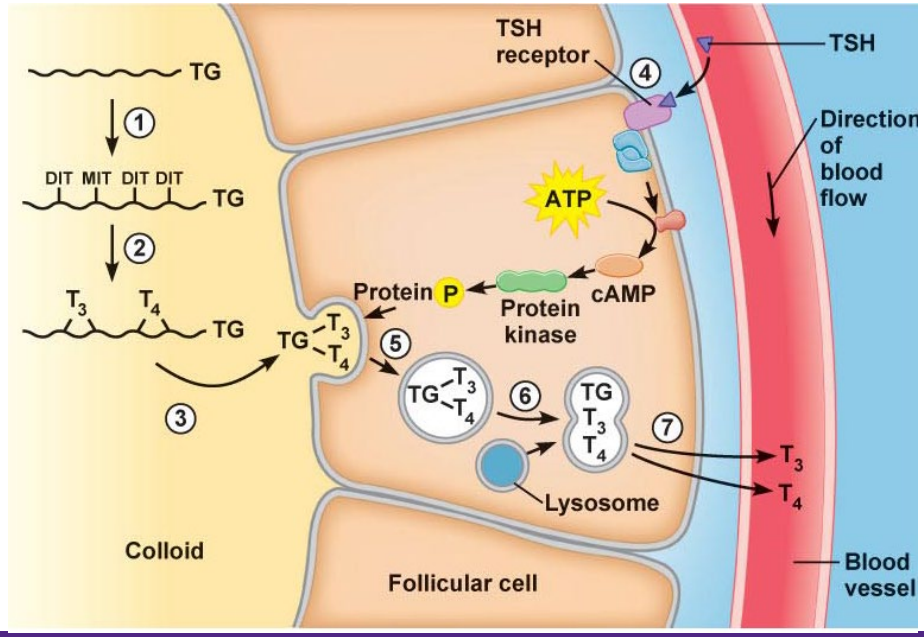



3,5,3′-Triiodothyronine ($T_3$)

# Thyroid Hormone Synthesis

1. Tyrosine residues of thyroglobulin iodinated
2. Two iodinated residues join by covalent bond
3. Thyroid hormones stored in colloid
4. TSH binds receptor and activates thyroid hormone synthesis
5. Follicular cells take in thyroglobulin by endocytosis
6. Endosome fuses with lysosome
7. Lysosomal enzymes cause release of T3 and T4
8. T3 and T4 diffuse into bloodstream



# Thyroid Gland and Adrenal Gland

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# Thyroid Gland Disorders

| | Hyperthyroidism | Hypothyroidism |
|---|---|---|
| **Symptoms** | Weight loss<br>Increase HR<br>Sensitive to heat<br>Fidgety, hyperactive, irritable | Weight gain<br>Decrease HR<br>Sensitive to cold<br>Fatigue, depression |
| **Causes** | ⬆ TRH or ⬆ TSH (leads to Goiter) Grave's disease: Ab to TSH receptor | ⬇ TRH ⬇ TSH<br>Poor diet/iodide deficiency (leads to Goiter)<br>Can also result in atrophy: Autoimmune destruction of thyroid gland |

# What Questions Do You Have?

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

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

Western