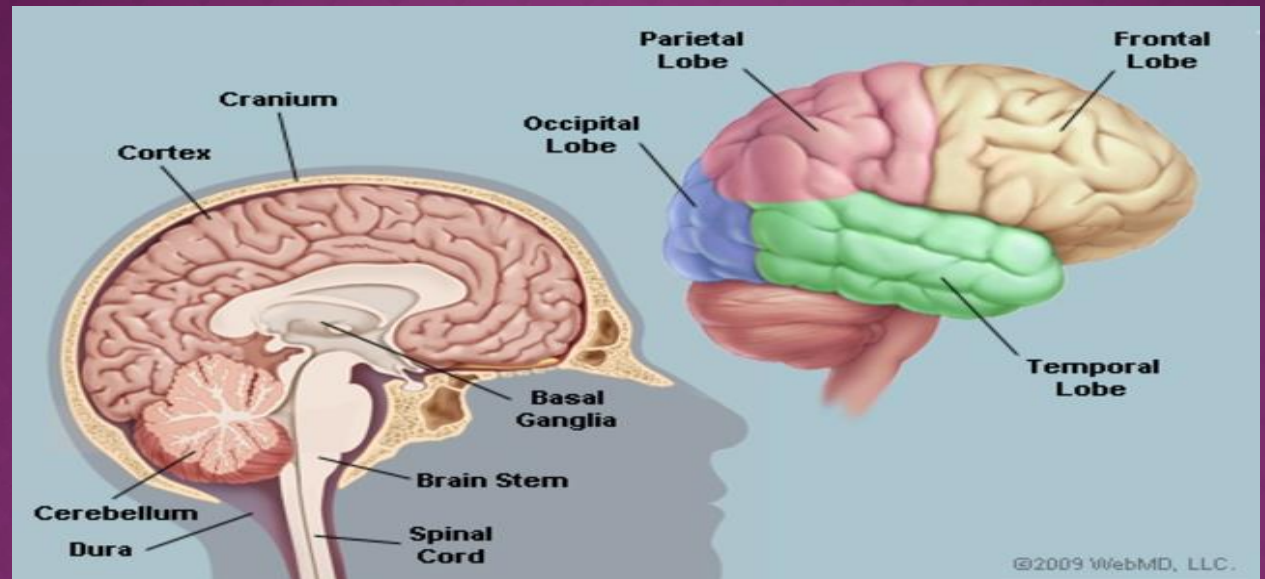
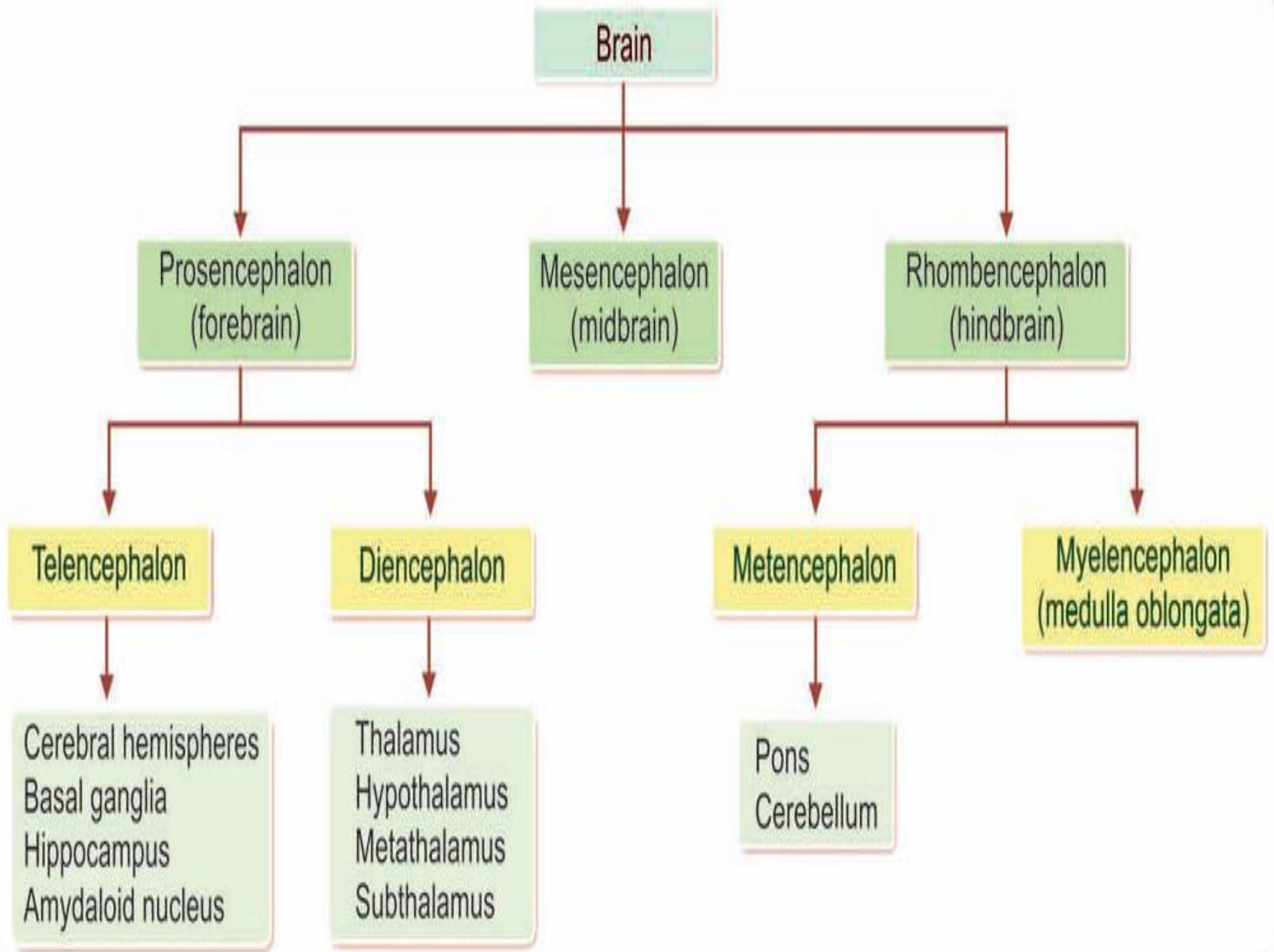
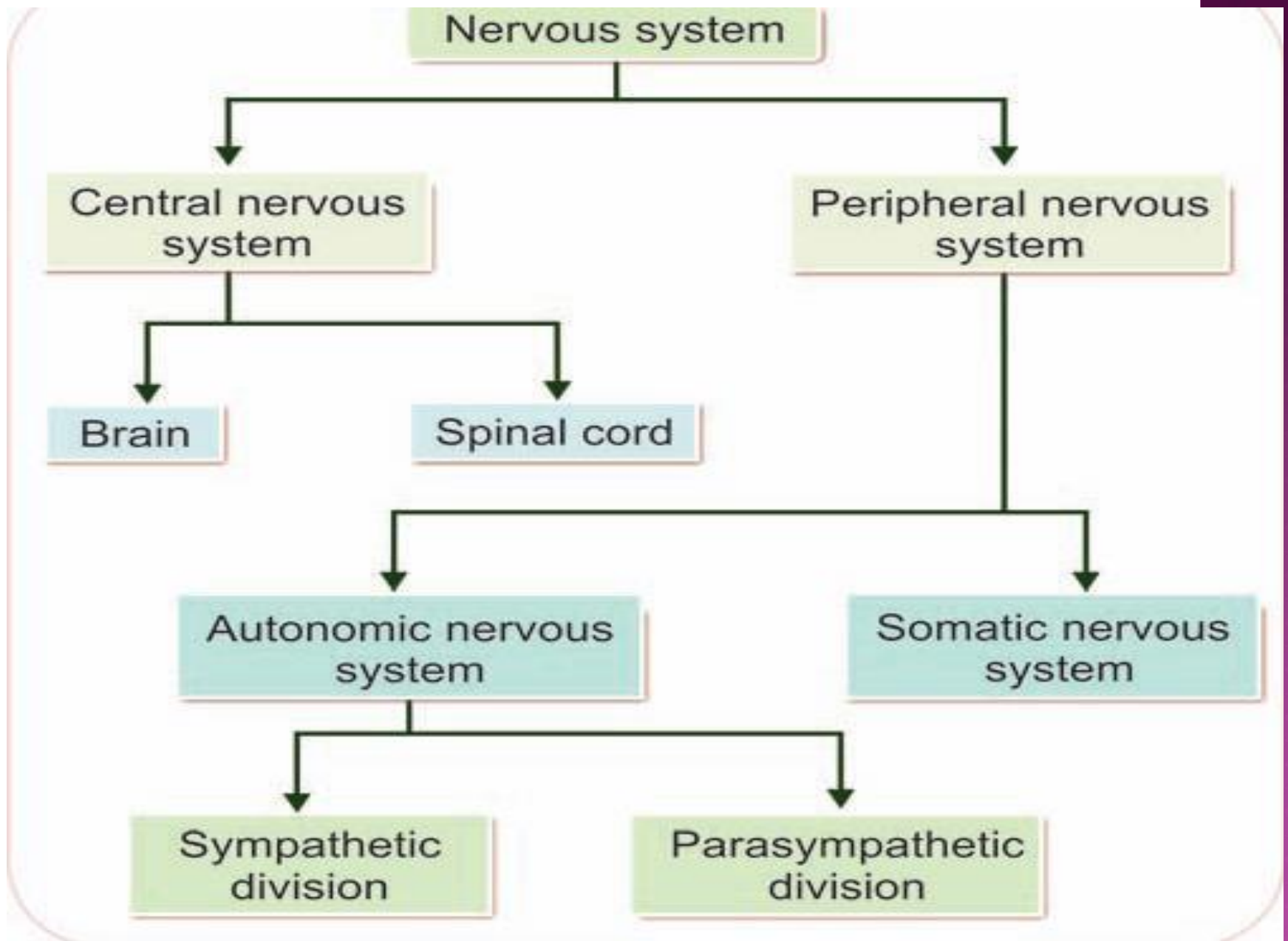


# INTRODUCTION OF CNS



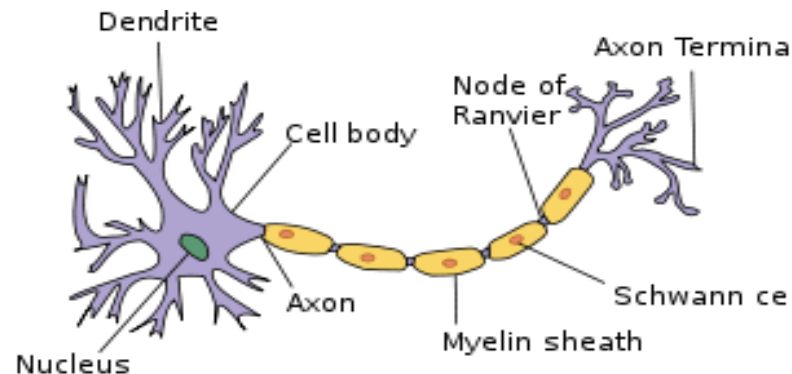
DR NIYATI N PATEL  
MPT IN NEUROLOGICAL CONDITIONS





# NEURONS

- **Neuron or nerve cell is defined as the structural and functional unit of nervous system.**
- It is different from other cells by two ways:
  - 1. Neuron has branches or processes called axon and dendrites
  - 2. Neuron does not have centrosome. So, it cannot undergo division.



# CLASSIFICATION OF NEURON

- Neurons are classified by three different methods.
  - A. Depending upon the number of poles
  - B. Depending upon the function
  - C. Depending upon the length of axon.

# DEPENDING UPON THE NUMBER OF POLES

## 1. Unipolar Neurons

- Unipolar neurons are the neurons that have only one pole. From a single pole, both axon and dendrite arise
- This type of nerve cells is present only in embryonic stage in human beings.

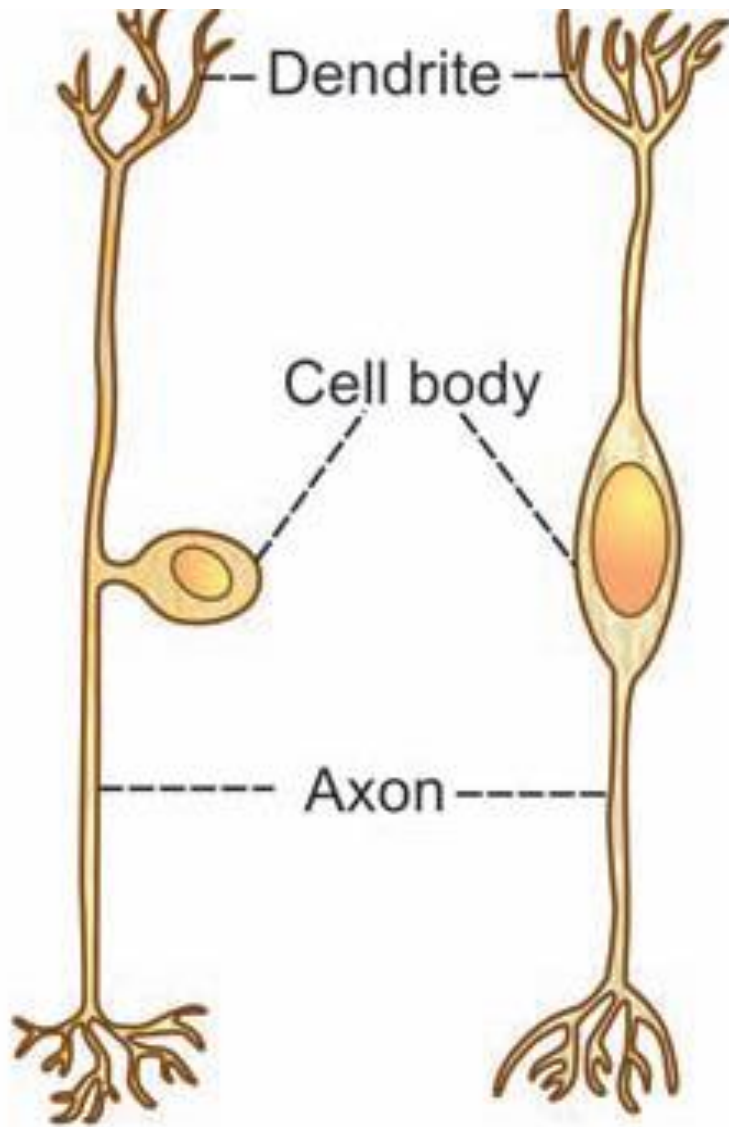
## 2. Bipolar Neurons

- Neurons with two poles are known as bipolar neurons.
- Axon arises from one pole and dendrites arise from the other pole.

## 3. Multipolar Neurons

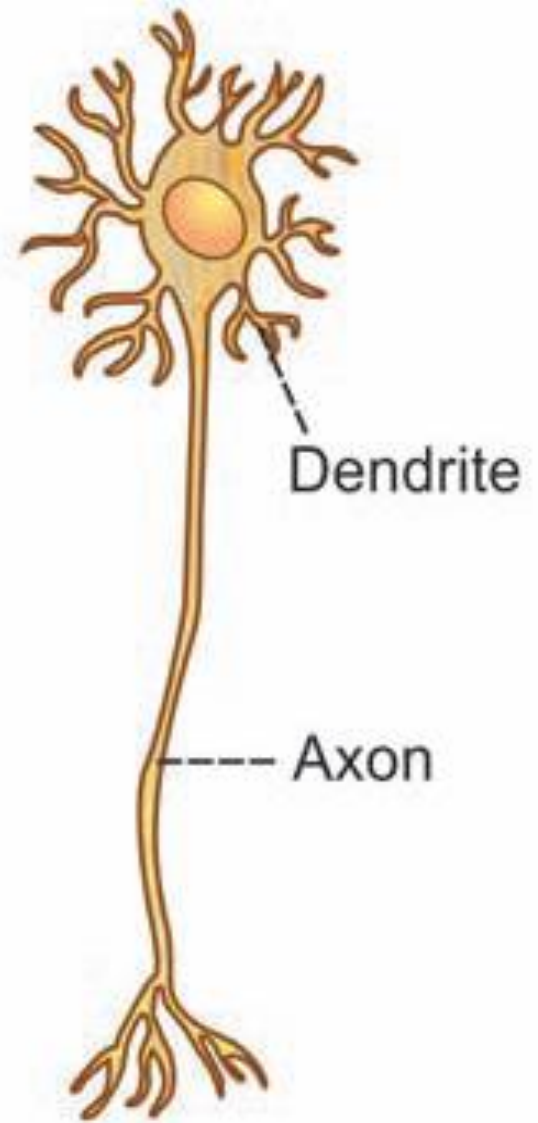
- Multipolar neurons are the neurons which have many poles.
- One of the poles gives rise to axon and all other poles give rise to dendrites.





Unipolar neuron

Bipolar neuron



Multipolar neuron

# DEPENDING UPON THE FUNCTION

- On the basis of function, nerve cells are classified into two types:
  - 1. Motor or efferent neurons
  - 2. Sensory or afferent neurons.
- **1. Motor or Efferent Neurons**
  - Motor or efferent neurons are the neurons which carry the **motor impulses from central nervous system to peripheral effector organs** like muscles, glands, blood vessels, etc.
  - Generally, each motor neuron has a long axon and short dendrites.
- **2. Sensory or Afferent Neurons**
  - Sensory or afferent neurons are the neurons which carry the **sensory impulses from periphery to central nervous system.**
  - Generally, each sensory neuron has a short axon and long dendrites.

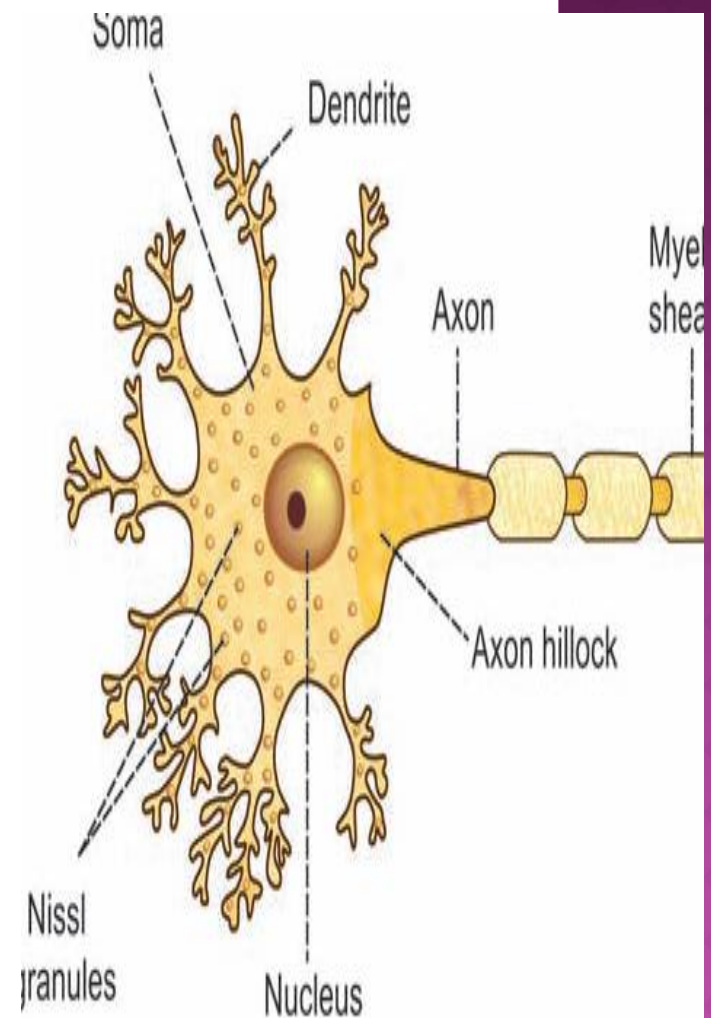


# DEPENDING UPON THE LENGTH OF AXON

- Depending upon the length of axon, neurons are divided into two types:
  - 1. Golgi type I neurons
  - 2. Golgi type II neurons.
- **1. Golgi Type I Neurons**
  - Golgi type I neurons have **long axons**.
  - **Cell body of these** neurons is in different parts of central nervous system and their axons reach the remote peripheral organs.
- **2. Golgi Type II Neurons**
  - Neurons of this type have **short axons**.
  - **These neurons** are present in cerebral cortex and spinal cord.

# STRUCTURE OF NEURON

- Neuron is made up of three parts:
  - 1. Nerve cell body
  - 2. Dendrite
  - 3. Axon
- Dendrite and axon form the **processes of neuron**
- Dendrites are **short processes** and the axons are **long processes**.
- **Dendrites and axons** are usually called **nerve fibers**.



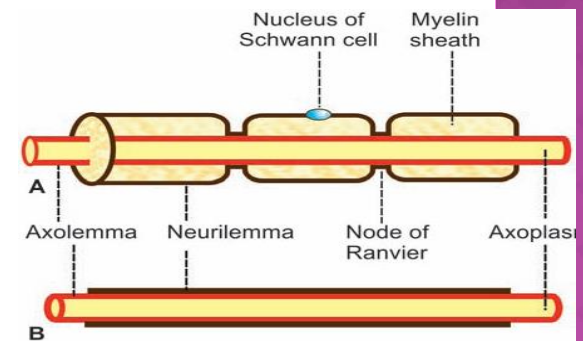
## ○ NERVE CELL BODY

- Nucleus
- Nissl Bodies (Ribosomes)
- Neurofibrils
- Mitochondria
- Golgi Apparatus

## ○ DENDRITE (Branched process)

## ○ AXON (Longer process)

- Non myelinated nerve fiber
- Myelinated nerve fiber



# CLASSIFICATION OF NERVE FIBERS

1. Depending upon structure
2. Depending upon distribution
3. Depending upon origin
4. Depending upon function
5. Depending upon secretion of neurotransmitter
6. Depending upon diameter and conduction of impulse (ErlangerGasser classification)

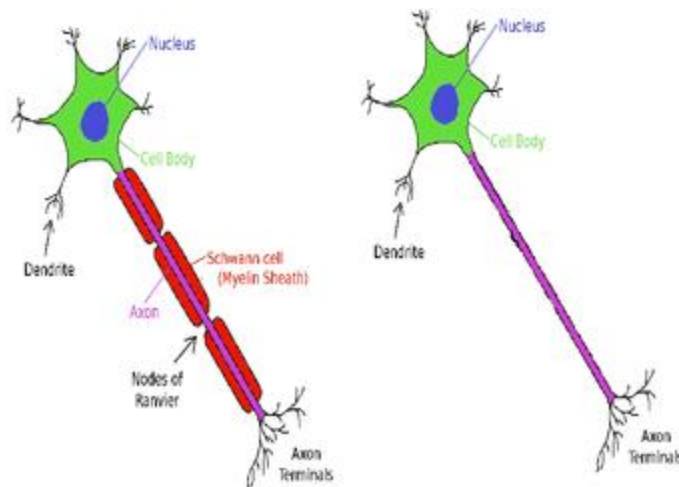
## ○ DEPENDING UPON STRUCTURE

### ■ Myelinated Nerve Fibers

- Myelinated nerve fibers are the nerve fibers that are covered by **myelin sheath**.

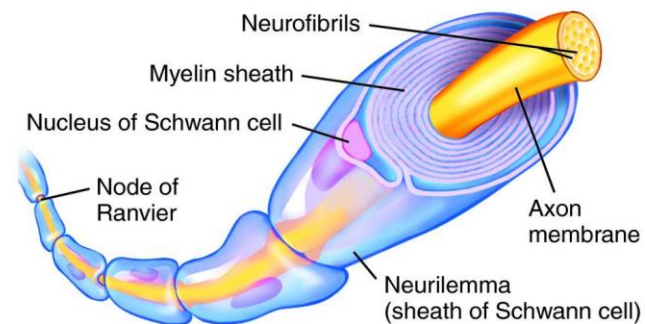
### ■ Non-myelinated Nerve Fibers

- Nonmyelinated nerve fibers are the nerve fibers which are not covered by myelin sheath.



## ○ MYELIN SHEATH

- Myelin sheath is a thick lipoprotein sheath that insulates the myelinated nerve fiber.
- Myelin sheath is not a continuous sheath.
- It is absent at regular intervals.
- The area where myelin sheath is absent is called **node of Ranvier**.
- **Segment of the nerve fiber between two nodes is called internode.**
- **Myelin sheath is responsible for white color of nerve fibers.**



## ○ DEPENDING UPON DISTRIBUTION

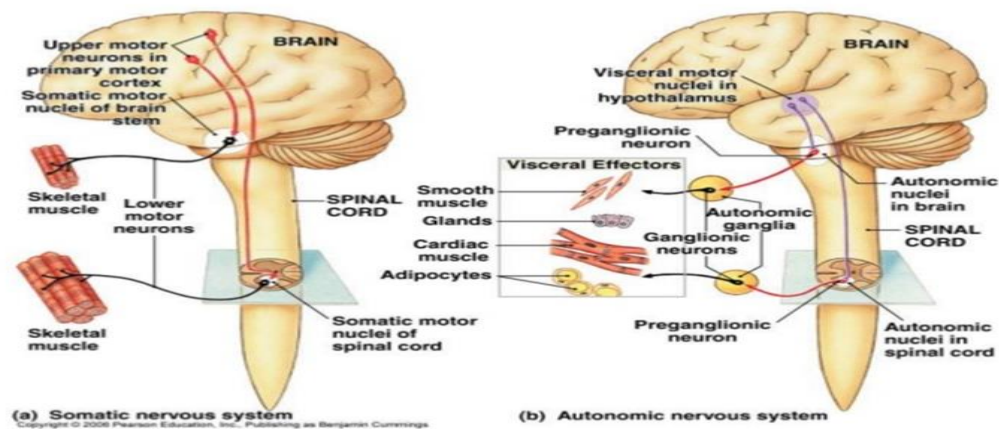
### ■ Somatic Nerve Fibers

- Somatic nerve fibers supply the **skeletal muscles** of the body.

### ■ Visceral or Autonomic Nerve Fibers

- Autonomic nerve fibers supply the various **internal organs** of the body.

Somatic vs. Autonomic





## ○ DEPENDING UPON ORIGIN

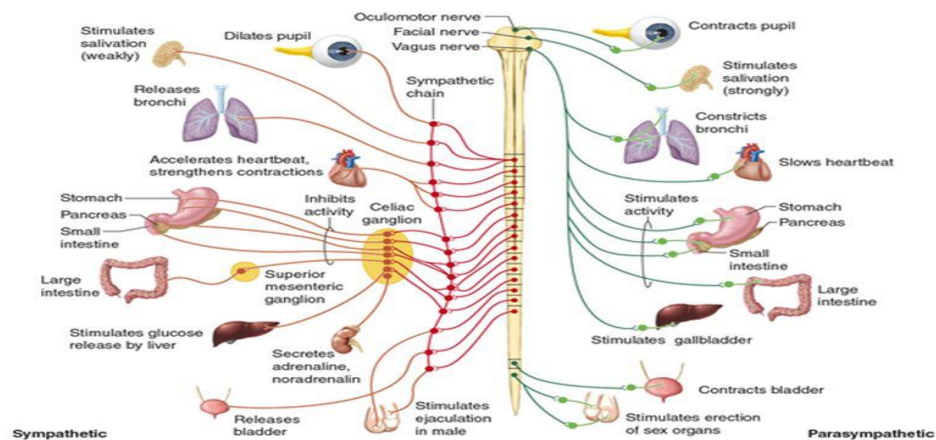
### ■ Cranial Nerve Fibers

- Nerve fibers arising from brain are called cranial nerve fibers.

### ■ Spinal Nerve Fibers

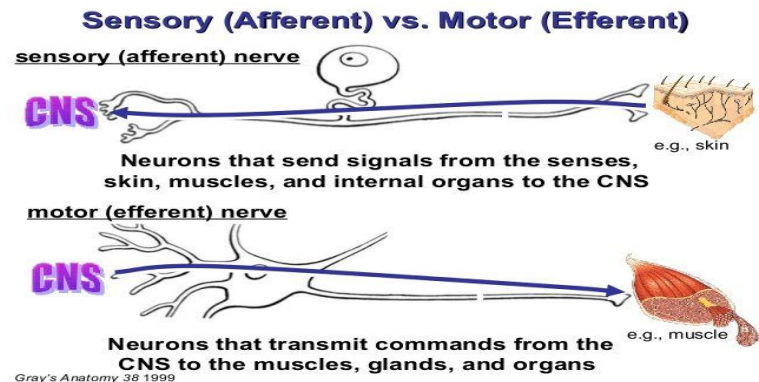
- Nerve fibers arising from spinal cord are called spinal nerve fibers.

Examples of Cranial vs. Spinal Nerve Activities



## ○ DEPENDING UPON FUNCTION

- **Sensory Nerve Fibers (afferent nerve Fibers)**
  - Sensory nerve fibers carry sensory impulses from different parts of the body to the central nervous system
- **Motor Nerve Fibers (efferent nerve fibers)**
  - Motor nerve fibers carry motor impulses from central nervous system to different parts of the body.



## ○ **DEPENDING UPON SECRETION OF NEUROTRANSMITTER**

### ■ **Adrenergic Nerve Fibers**

- Adrenergic nerve fibers secrete nor adrenaline.

### ■ **Cholinergic Nerve Fibers**

- Cholinergic nerve fibers secrete acetylcholine.

○ **DEPENDING UPON DIAMETER AND CONDUCTION OF IMPULSE (ERLANGER-GASSER CLASSIFICATION)**

Type	Diameter ( $\mu$ )	Velocity of conduction (m/sec)
A Alpha	12 To 24	70 to 120
A Beta	6 to 12	30 to 70
A Gamma	5 to 6	15 to 30
A Delta	2 to 5	12 to 15
B	1 to 2	3 to 10
C	< 1.5	0.5 to 2

# PROPERTIES OF NERVE FIBERS

- ◉ Excitability
- ◉ Conductivity
- ◉ Refractory Period
- ◉ Summation
- ◉ Adaptation
- ◉ Infatigability
- ◉ All Or None Law

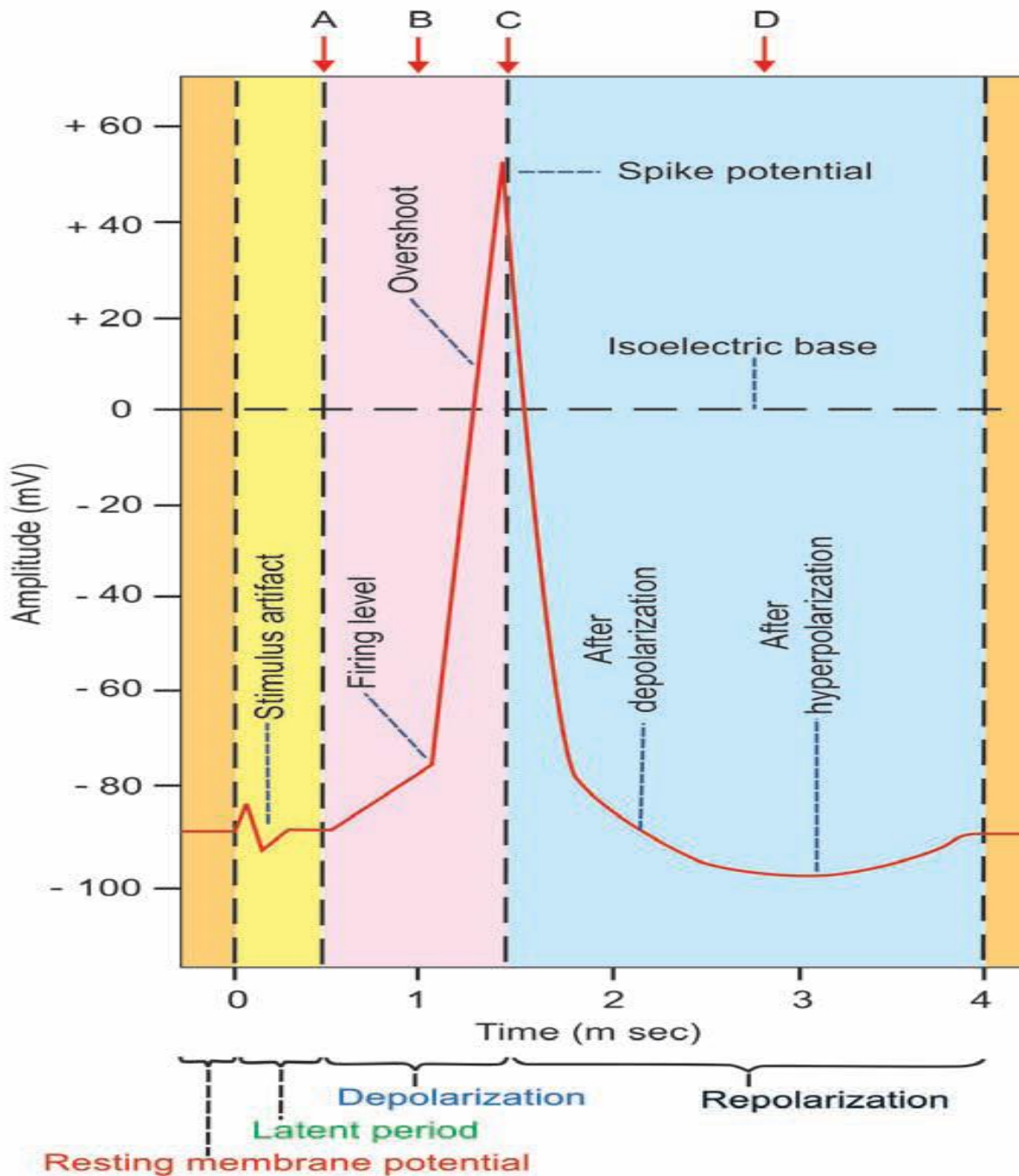
# EXCITABILITY

- ⦿ Defined as the **physiochemical change** that occurs in a tissue when stimulus is applied
- ⦿ ***Response Due to Stimulation of Nerve Fiber***
  - Action potential or nerve impulse (Propagated)
  - Electrotonic potential or local potential (Non Propagated)

## ACTION POTENTIAL

- Action potential is defined as a series of electrical changes that occur in the membrane potential when the muscle or nerve is stimulated.
- Action potential occurs in three phases:
  - 1. **Latent Period** - Latent period is the period when no change occurs in the electrical potential immediately after applying the stimulus. It is a very short period with duration of 0.5 to 1 millisecond.
  - 2. **Depolarization** - action potential in which **inside of the muscle becomes positive and outside becomes negative.**
  - 3. **Repolarization** - after depolarization the **inside of muscle becomes negative and outside becomes positive.** So, the polarized state of the muscle is re established.





## Action potential in a skeletal muscle

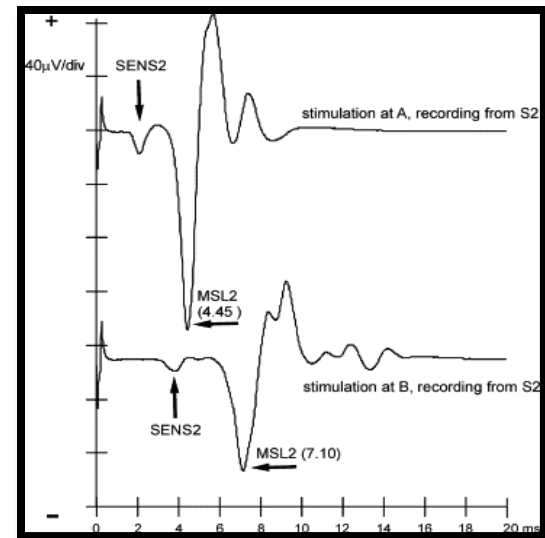
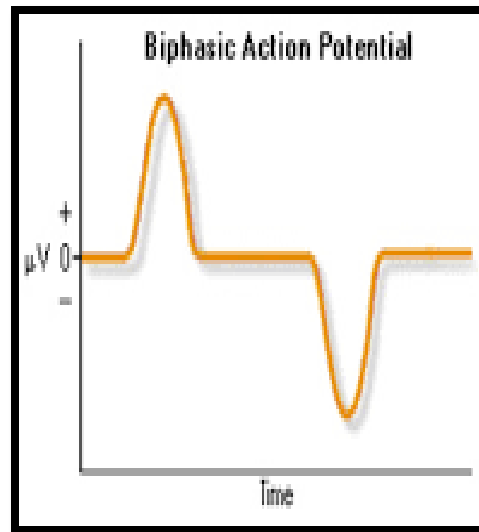
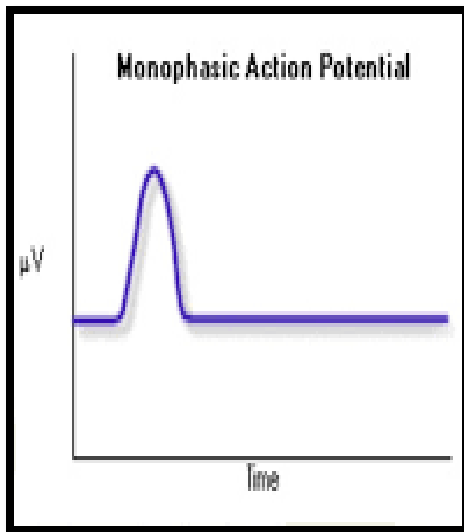
A = Opening of few  $\text{Na}^+$  channels

B = Opening of many  $\text{Na}^+$  channels

C = Closure of  $\text{Na}^+$  channels and opening of  $\text{K}^+$  channels

D = Closure of  $\text{K}^+$  channels

- Types of action potential
  - Monophasic Action potential
  - Biphasic Action potential
  - Compound Action potential

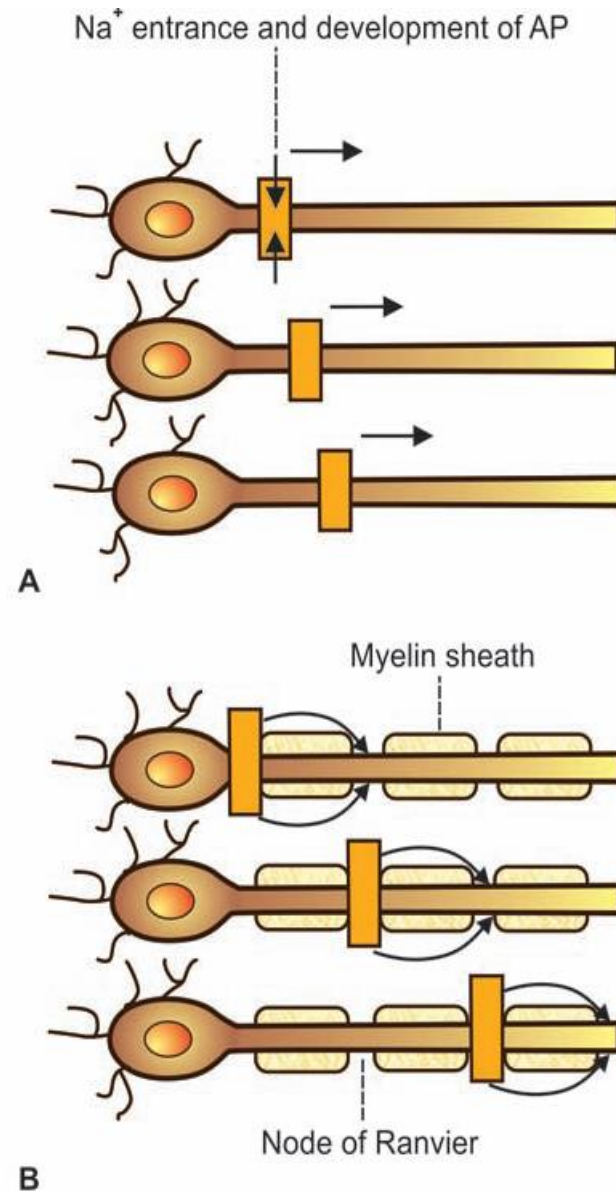


# Properties of action potential and graded potential

Action potential	Graded potential/Electronic potential
<ul style="list-style-type: none"><li>• Propagative</li><li>• Long distance signal</li><li>• Both depolarization &amp; repolarization</li><li>• Obeys all or none law</li><li>• Summation is not possible</li><li>• Has refractory period</li></ul>	<ul style="list-style-type: none"><li>• Non propagative</li><li>• Short distance signal</li><li>• Only depolarization/ Hyperpolarization</li><li>• Does not obey all or none law</li><li>• Summation is possible</li><li>• No refractory period</li></ul>

# CONDUCTIVITY

- Conductivity is the ability of nerve fibers to transmit the impulse from the area of stimulation to the other areas.



# REFRACTORY PERIOD

- Refractory period is the period at which the nerve does not give any response to a stimulus.
- TWO TYPES OF REFRACTORY PERIODS
  1. ***Absolute Refractory Period***
    1. Absolute refractory period is the period during which the nerve **does not show any response** at all, whatever may be the strength of stimulus.
  2. ***Relative Refractory Period***
    1. It is the period, during which the nerve fiber **shows response**, if the strength of stimulus is increased to maximum.

# SUMMATION

- When **one subliminal stimulus** is applied, it **does not produce any response** in the nerve fiber because, the subliminal stimulus is very weak.
- However, if **two or more subliminal stimuli** are applied within a short interval of about 0.5 millisecond, the **response is produced**.
- It is because the **subliminal stimuli are summed up together** to become **strong enough to produce the response**.
- This phenomenon is known as summation.

# ADAPTATION

- ◉ While stimulating a nerve fiber **continuously**, the excitability of the nerve fiber is **greater in the beginning**.
- ◉ Later the **response decreases** slowly and finally the nerve fiber does not show any response at all.
- ◉ This phenomenon is known as adaptation or **accommodation**.
- ◉ ***Cause for Adaptation***
  - When a nerve fiber is stimulated continuously, depolarization occurs continuously.
  - Continuous de polarization inactivates the sodium pump and increases the efflux of potassium ions.



# FATIGABILITY

- Nerve fiber cannot be fatigued, even if it is stimulated continuously for a long time.
- The reason is that nerve fiber can conduct only one action potential at a time.
- At that time, it is completely refractory and does not conduct another action potential.

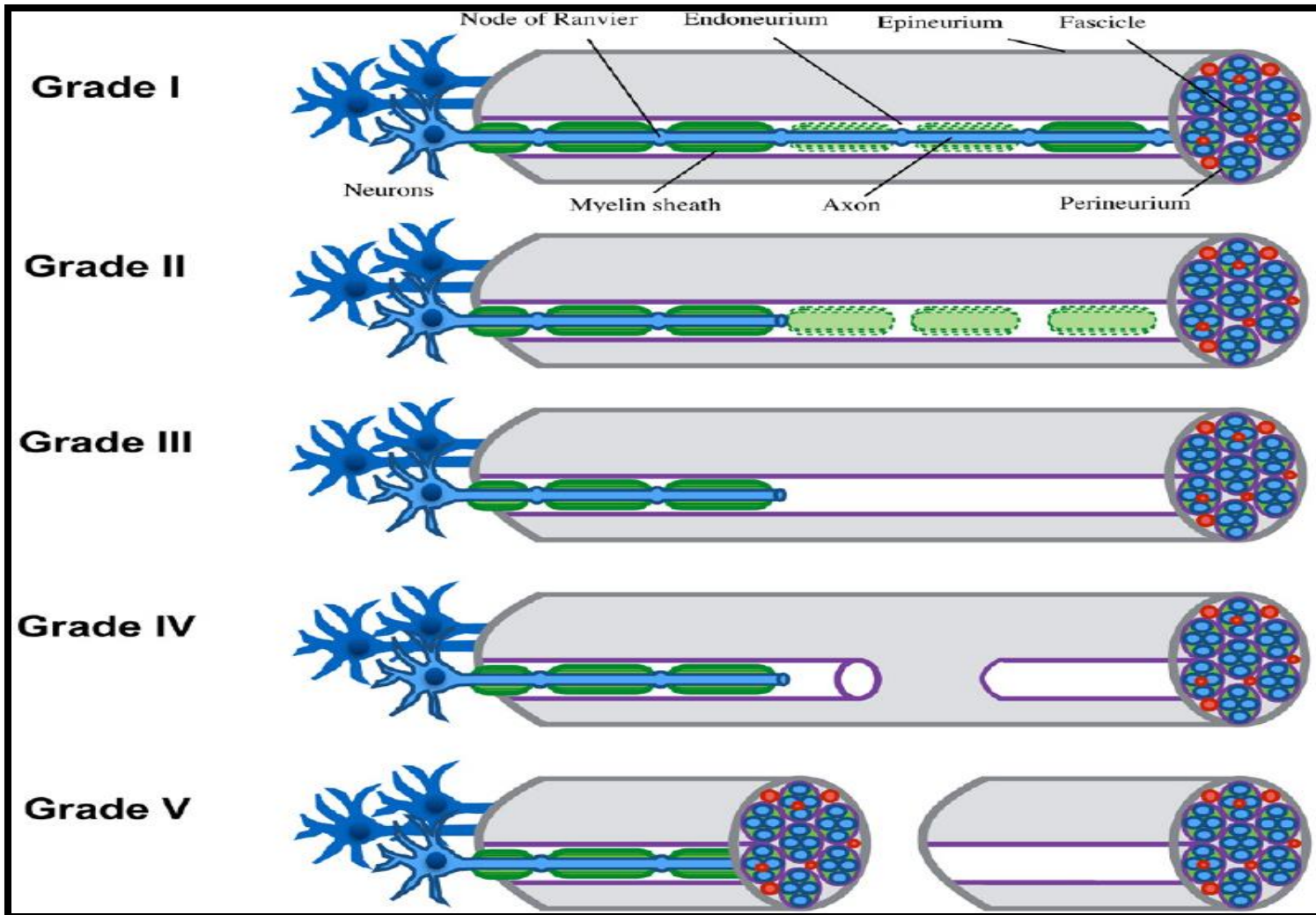
# ALL-OR-NONE LAW

- All-or-none law states that when a nerve is stimulated by a stimulus it **gives maximum response** or **does not give response** at all.

# DEGENERATION & REGENERATION

- When a nerve fiber is injured, various changes occur in the nerve fiber and nerve cell body. All these changes are together called the **degenerative changes**.
- The term **regeneration** refers to **regrowth of lost or destroyed part of a tissue**. The injured and degenerated nerve fiber can regenerate. It starts as early as **4th day after injury**, but becomes more effective only **after 30 days** and is completed in about **80 days**.
- ***Causes for Injury***
  - 1. Obstruction of blood flow
  - 2. Local injection of toxic substances
  - 3. Crushing of nerve fiber
  - 4. Transection of nerve fiber.

# SUNDERLAND CLASSIFICATION OF NERVE INJURY



# NEUROGLIA

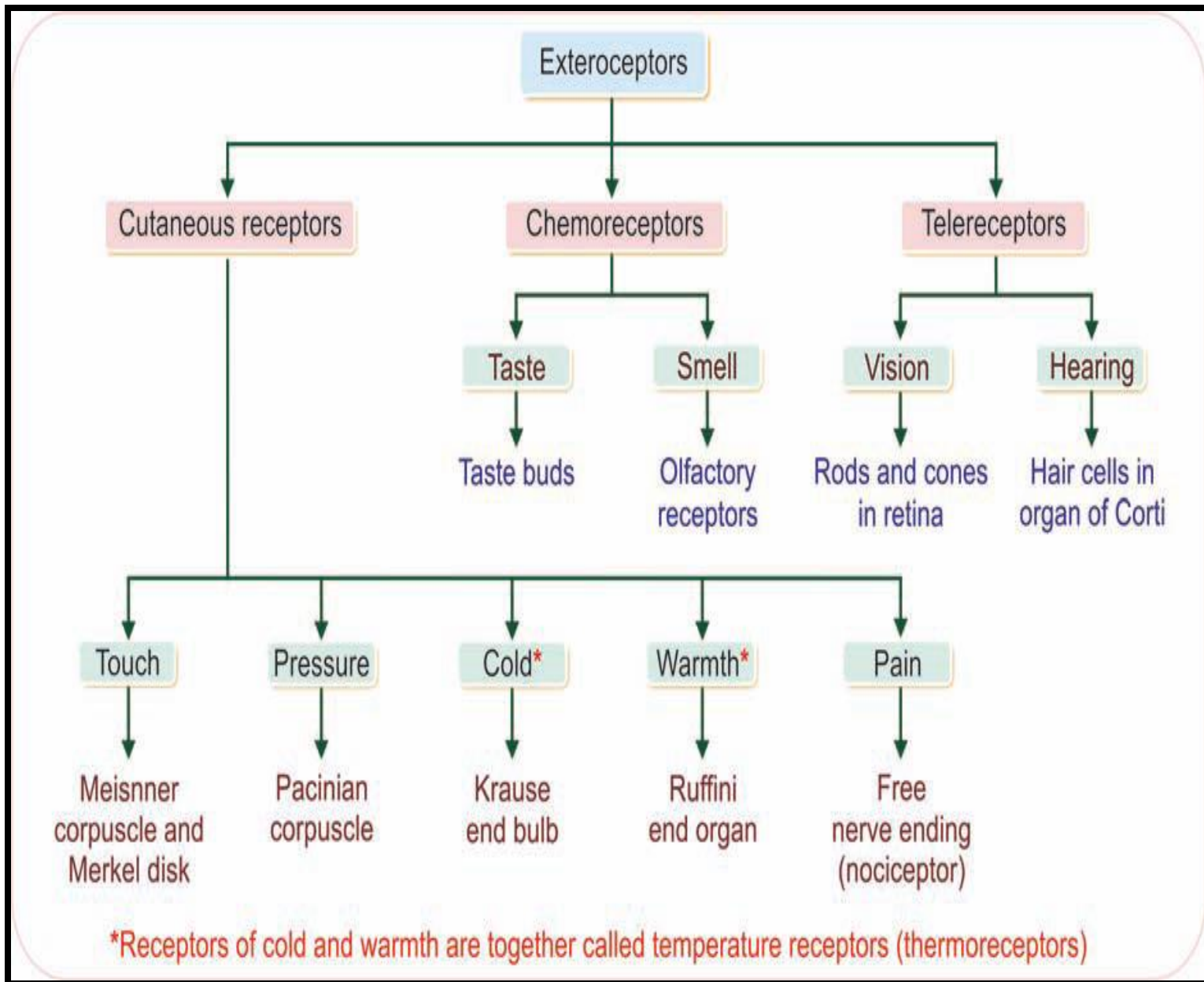
- Neuroglia or glia (glia = glue) is the **supporting cell of the nervous system.**
- Neuroglial cells are **non-excitabile.**

CENTRAL NEUROGLIAL CELLS	PERIPHERAL NEUROGLIAL CELLS
ASTROCYTES (STAR SHAPE & PRESENT IN BRAIN) MICROGLIA (PHAGOCYTOTIC CELL & MACROPHAGES OF CNS) OLIGODENDROCYTES (MYELIN SHEATH IN CNS)	SCHWANN CELLS (MYELIN SHEATH IN PNS) SATELLITE CELLS (EXTERIOR SURFACE OF PNS)

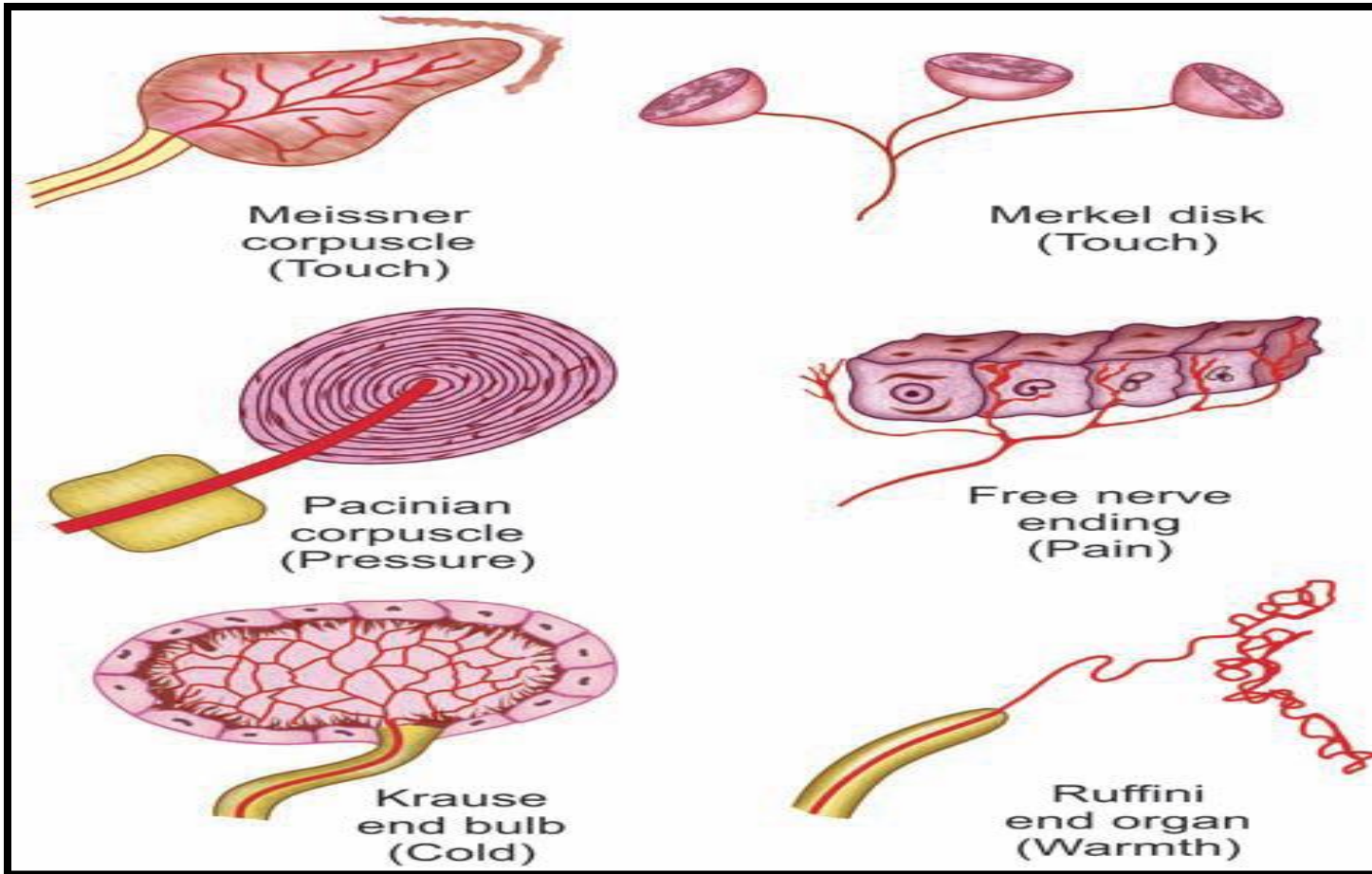
# RECEPTOR

- Receptors are sensory (afferent) nerve endings that terminate in periphery as bare **unmyelinated endings** or in the form of specialized **capsulated structures**.
- **Classification of receptors**

Exteroceptors (outside of the body)	Interoceptors (within body)
Mechanoreceptor/cutenous receptors (skin area) Chemoreceptors (chemical stimuli) Telereceptors (distance receptor)	Visceroceptors (viscera) Proprioceptors (joint position)







# Cutaneous receptors



## Interoceptors

### Visceroceptors

Receptors	Situation
1. Stretch receptors	Heart
2. Baroreceptors	Blood vessels
3. Chemoreceptors	GI tract
4. Osmoreceptors	Urinary tract Brain

### Proprioceptors

Receptors	Situation
1. Muscle spindle	Muscle
2. Golgi tendon organ	Tendon
3. Pacinian corpuscle	Ligament
4. Free nerve ending	Facia Joint
5. Hair cells	Vestibular apparatus

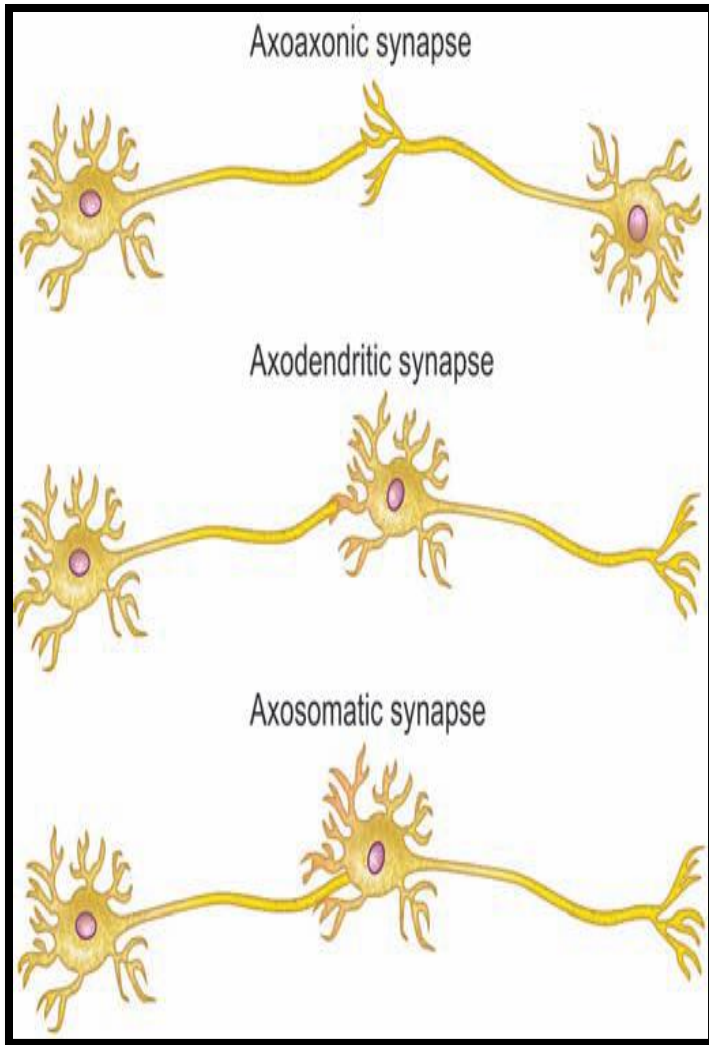
## ◎ **PROPERTIES OF RECEPTORS**

- **SPECIFICITY OF RESPONSE -MÜLLER LAW**
- **ADAPTATION - SENSORY ADAPTATION**
- **RESPONSE TO INCREASE IN STRENGTH OF STIMULUS - WEBERFECHNER LAW**
- **SENSORY TRANSDUCTION**
- **RECEPTOR POTENTIAL**
- **LAW OF PROJECTION**

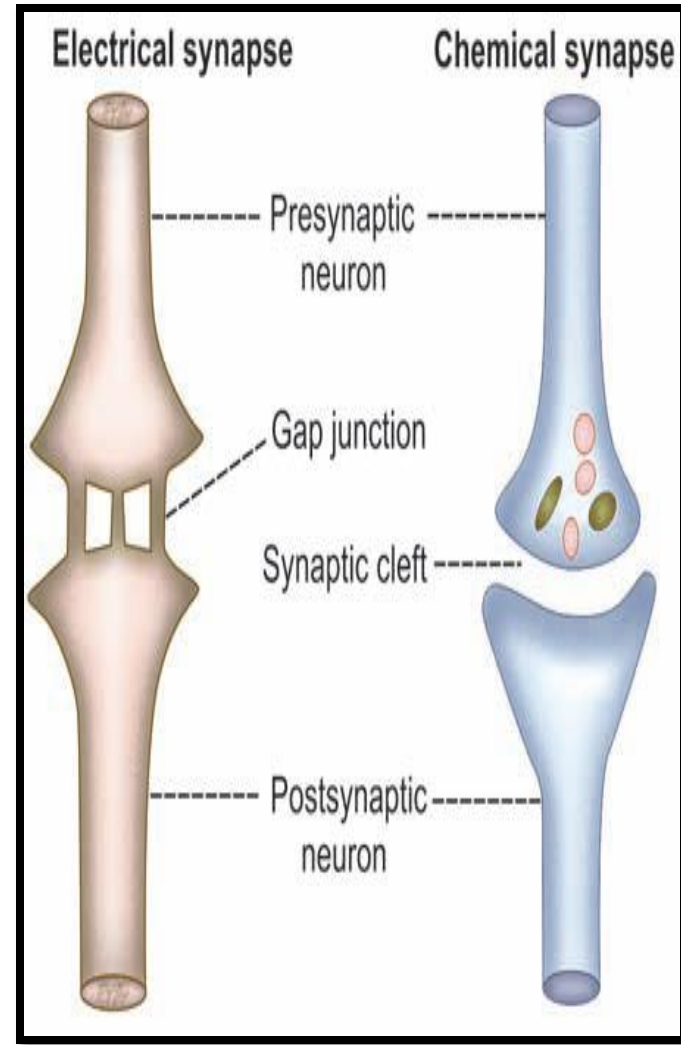
# SYNAPSE

- Synapse is the junction between two neurons.
- It is not an anatomical continuation But, it is only a physiological continuity between two nerve cells.
- CLASSIFICATION OF SYNAPSE

Anatomical classification (depends on ending of axon)	Physiological classification (depends on mode of impulse transmission)
Axoaxonic synapse Axodendritic synapse Axosomatic synapse	Electrical synapse Chemical synapse

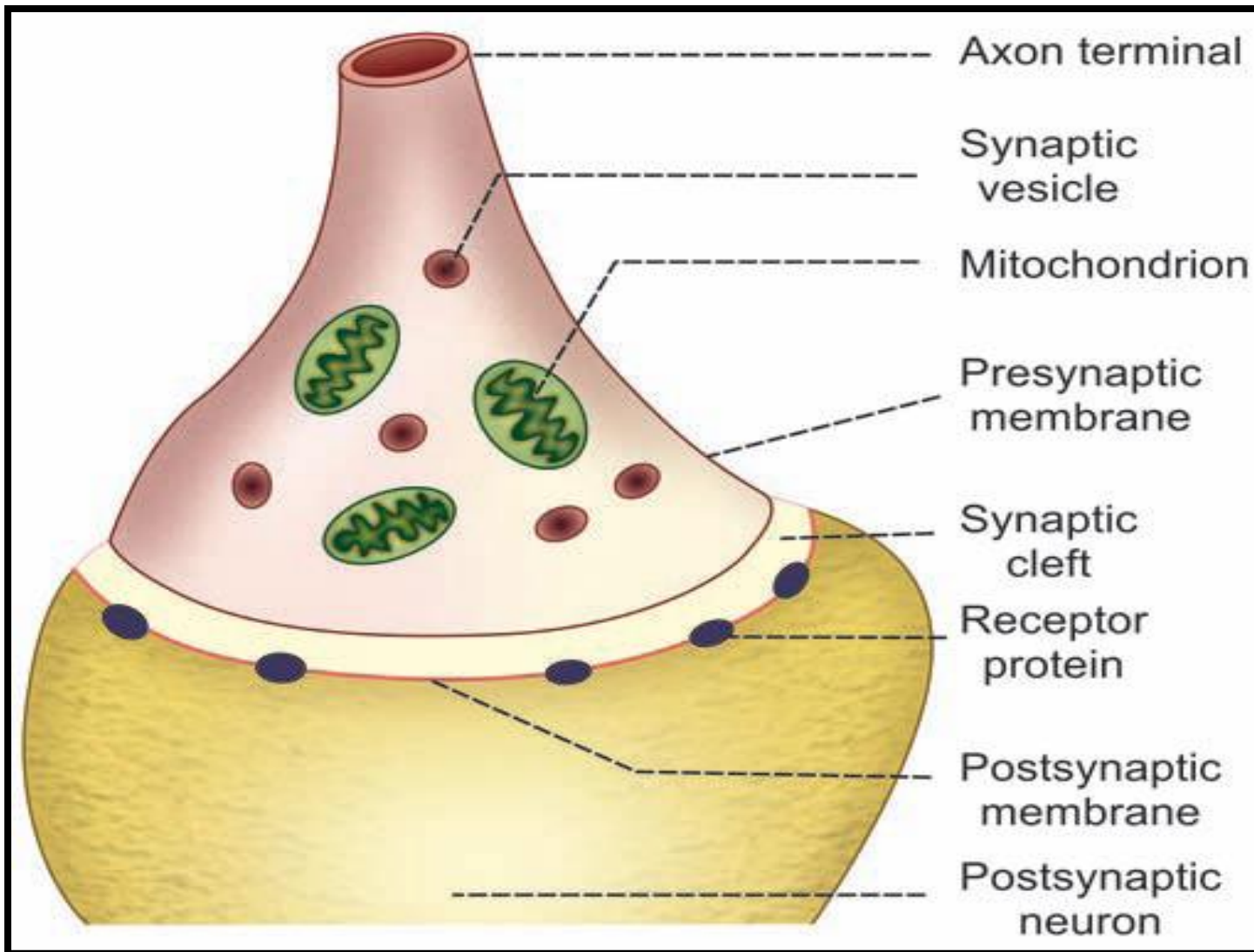


Anatomical



Physiological

# CHEMICAL SYNAPSE



# STRUCTURES OF SYNAPSE

## ○ Presynaptic

- **Mitochondria**, which help in the synthesis of neurotransmitter substance
- **Synaptic vesicles**, which store neurotransmitter substance.

## ○ Synaptic cleft & Post synaptic

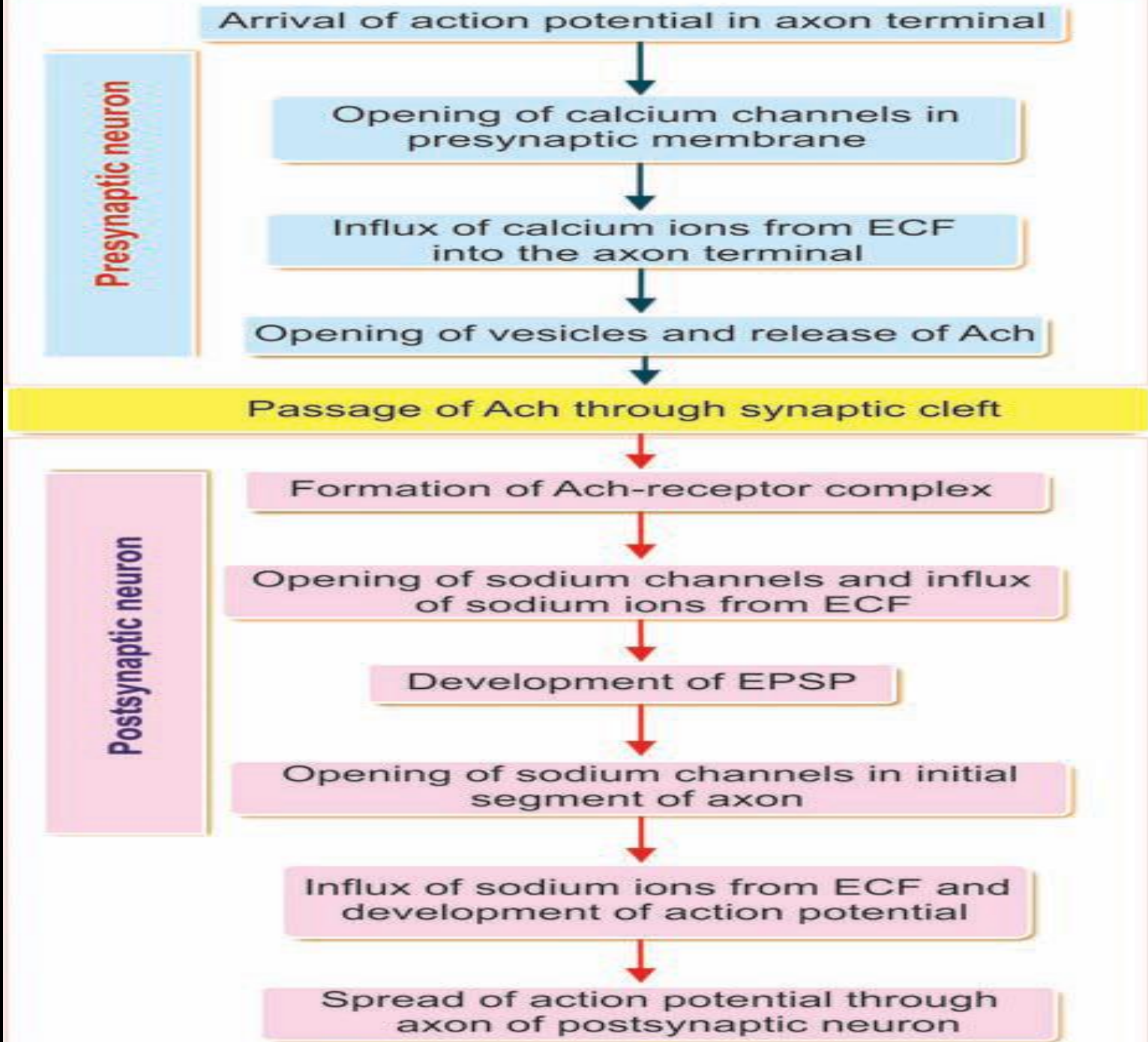
- Postsynaptic neuron is called **postsynaptic membrane**.
- It contains some **receptor proteins**.
- **Small space** in between the presynaptic membrane and the postsynaptic membrane is called **synaptic cleft**.

## ○ **FUNCTIONS OF SYNAPSE**

- Main function of the synapse is to transmit the impulses, i.e. action potential from one neuron to another



# Excitatory potential





# Inhibitory potential

Presynaptic neuron

Arrival of action potential in axon terminal

Opening of calcium channels in presynaptic membrane

Influx of calcium ions from ECF into axon terminal

Opening of vesicles and release of GABA

Passage of GABA through synaptic cleft

Postsynaptic neuron

Formation of GABA-receptor complex

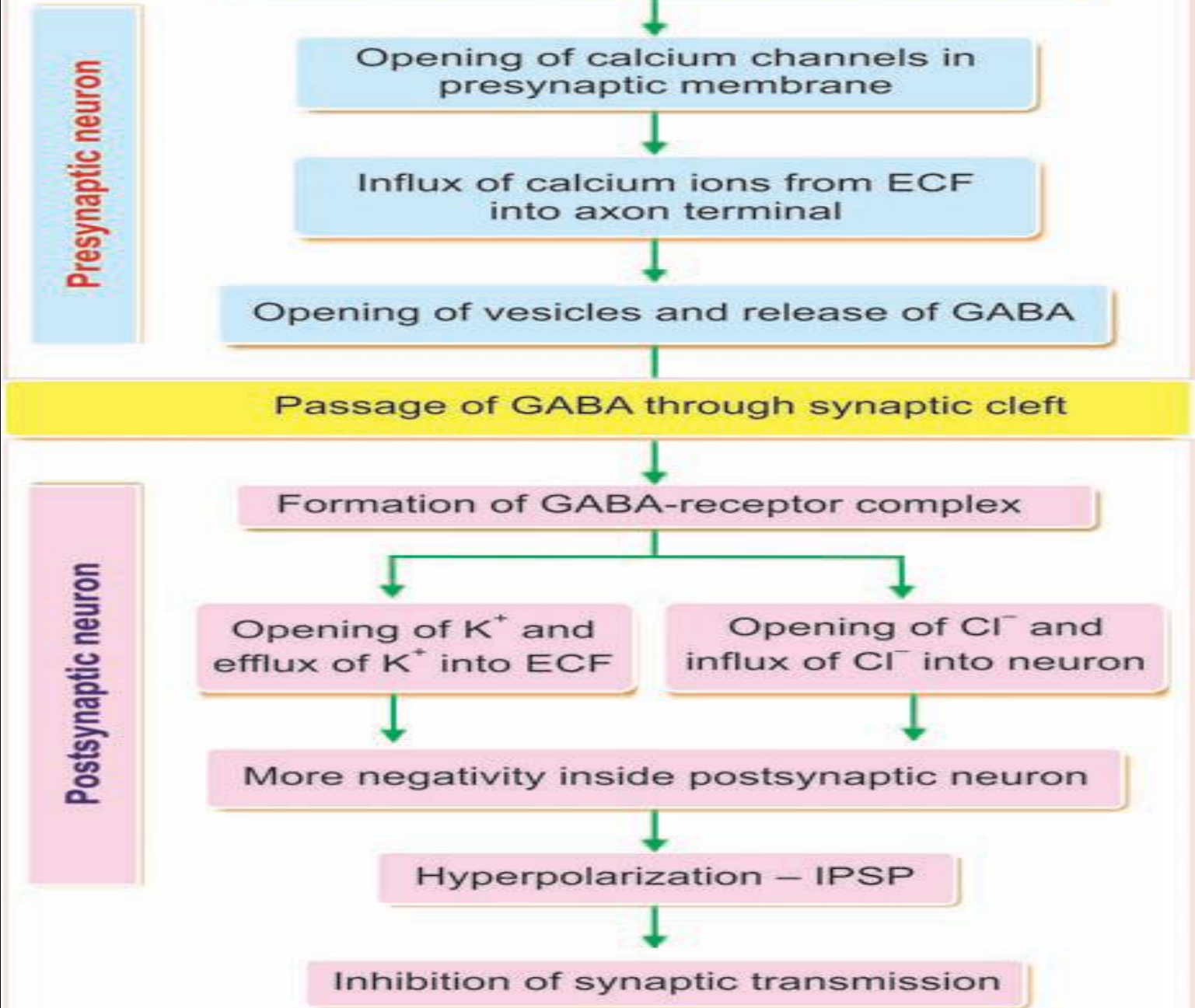
Opening of  $K^+$  and efflux of  $K^+$  into ECF

Opening of  $Cl^-$  and influx of  $Cl^-$  into neuron

More negativity inside postsynaptic neuron

Hyperpolarization – IPSP

Inhibition of synaptic transmission



## ⊙ PROPERTIES OF SYNAPSE

### ⊙ ONE WAY CONDUCTION - BELL-MAGENDIE LAW

- According to BellMagendie law, the impulses are transmitted only in **one direction in synapse**, i.e. from presynaptic neuron to postsynaptic neuron.

### ⊙ SYNAPTIC DELAY

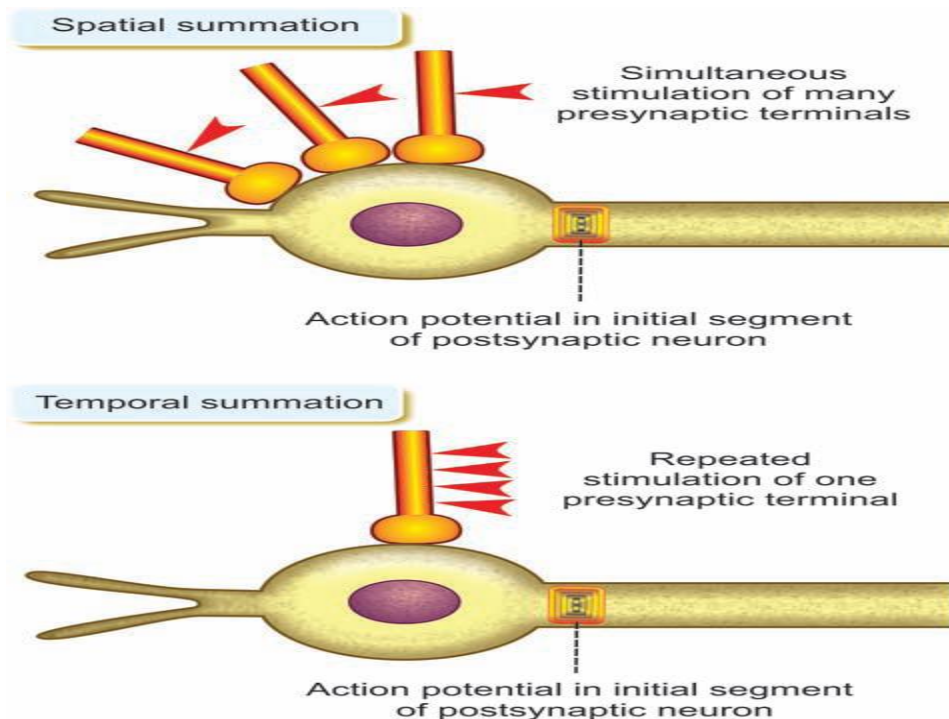
- Release of neurotransmitter
- Passage of neurotransmitter from axon terminal to postsynaptic membrane
- Action of the neurotransmitter to open the ionic channels in postsynaptic membrane.

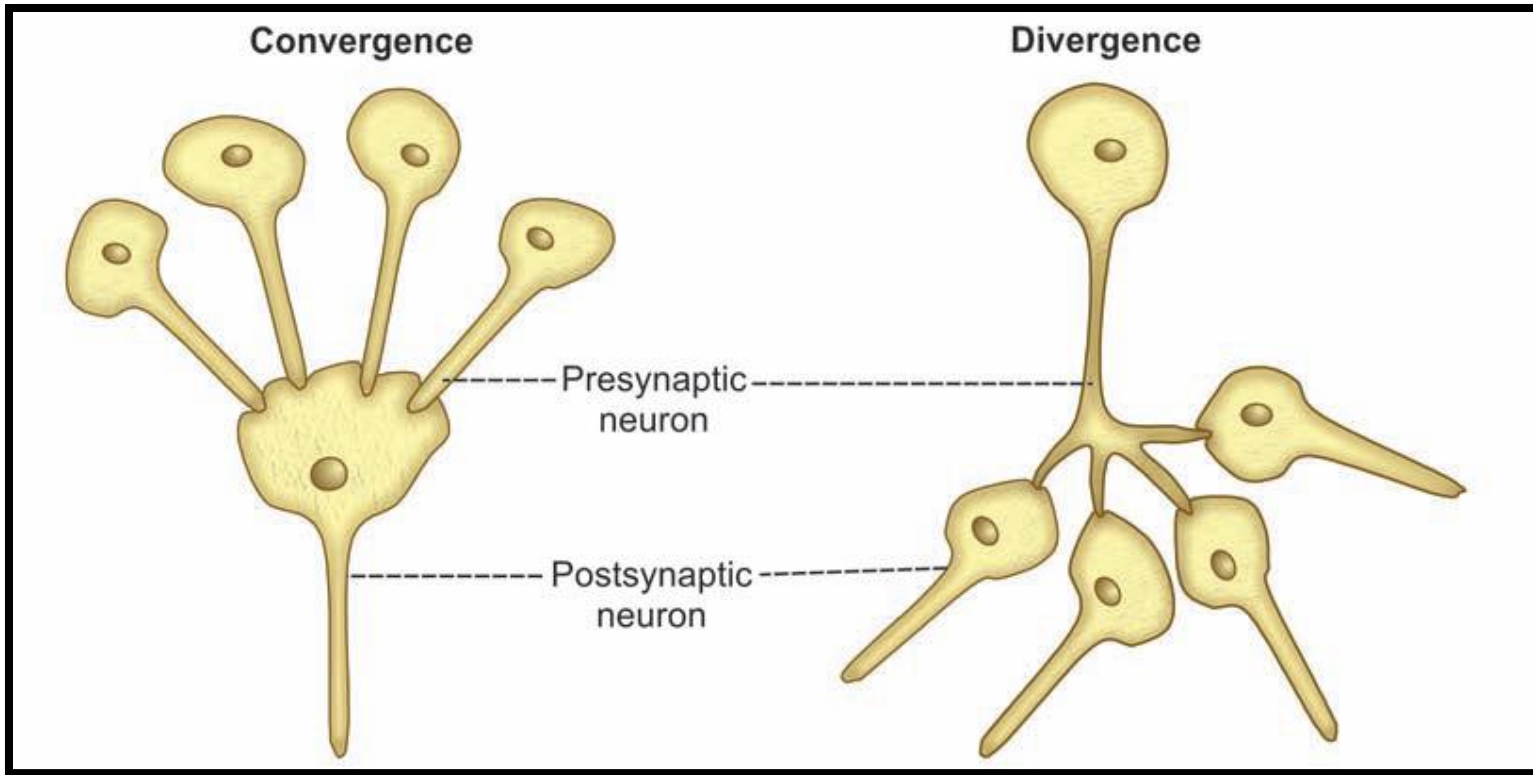
## ◎ FATIGUE

- Fatigue at synapse is due to the **depletion of neurotransmitter substance, acetylcholine.**
- Depletion of acetylcholine occurs because of two factors:
  - i. Soon after the action, acetylcholine is destroyed by acetylcholinesterase
  - ii. Due to continuous action, new acetylcholine is not synthesized

## ○ SUMMATION

- Summation is the fusion of effects or progressive increase when single presynaptic terminal is stimulated repeatedly.





## **CONVERGENCE**

Convergence is the process by which **many presynaptic** neurons terminate on a **single postsynaptic** neuron

## **DIVERGENCE**

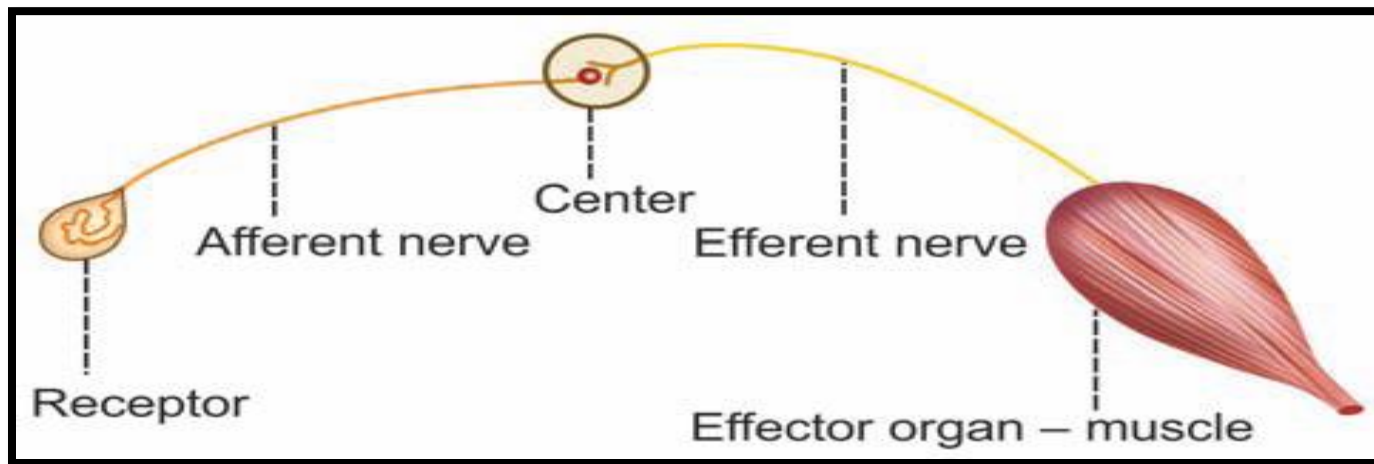
Divergence is the process by which **one presynaptic** neuron terminates on **many postsynaptic** neurons.

# REFLEX

- Reflex activity is the response to a peripheral nervous stimulation that occurs without our consciousness.
- It is a type of **protective mechanism** and it **protects the body** from irreparable damages.

- ◉ **REFLEX ARC**

- ◉ Reflex arc is the anatomical nervous pathway for a reflex action. A simple reflex arc includes five components



## ○ CLASSIFICATION OF REFLEXES

1. Depending upon whether inborn or acquired
2. Depending upon situation - anatomical classification
  - Cortical, Cerebellum, Midbrain, Bulbar/Medullary & Spinal Reflexes
3. Depending upon purpose - physiological Classification
  - Protective/flexor & antigravity/extensor
4. Depending upon number of synapse
  - Monosynaptic & polysynaptic
5. Depending upon whether visceral or somatic
6. Depending upon clinical basis
  - Deep reflex & superficial reflex



<b>Deep tendon reflex</b>	<b>Superficial mucous membrane reflexes</b>	<b>Superficial cutaneous reflexes</b>	<b>Pathological reflexes</b>
Jaw jerk	Corneal reflex	Scapular reflex	Babinski sign
Biceps jerk	Conjunctival reflex	Upper abdominal reflex	Clonus
Triceps jerk	Nasal reflex (sneezing reflex)	Lower abdominal reflex	Pendular movements
Supinator jerk or radial periosteal reflex	Pharyngeal reflex	Cremasteric reflex	
Wrist tendon or finger flexion reflex	Uvular reflex	Gluteal reflex	
Knee jerk or patellar tendon reflex		Plantar reflex	
Ankle jerk or Achilles tendon reflex		Bulbocavernous reflex	
		Anal reflex	

## ◉ REFLEXES IN MOTOR NEURON LESION

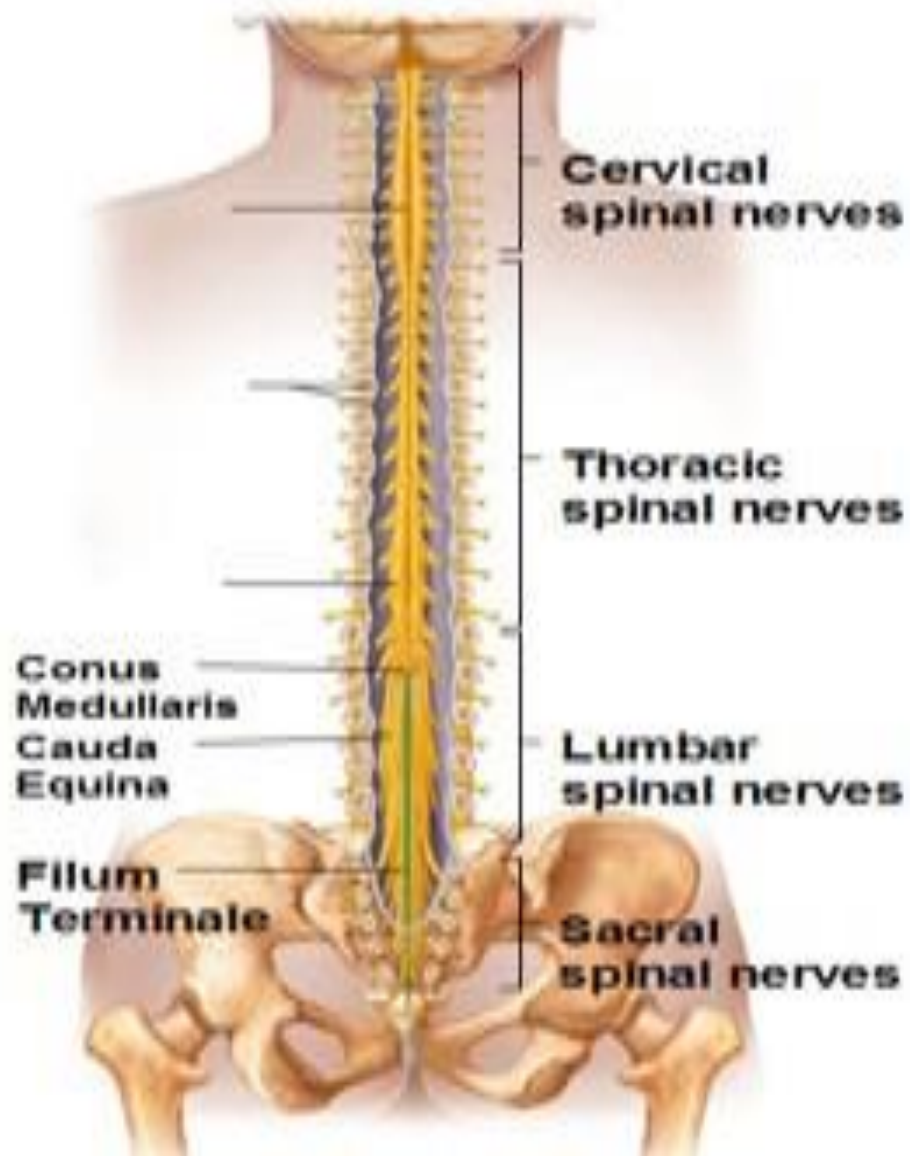
### 1. UPPER MOTOR NEURON LESION

- ◉ During upper motor neuron lesion, all the superficial reflexes are lost. Deep reflexes are exaggerated and the Babinski sign is positive.

### 2. LOWER MOTOR NEURON LESION

- ◉ During lower motor lesion, all the superficial and deep reflexes are lost.

# Spinal Cord



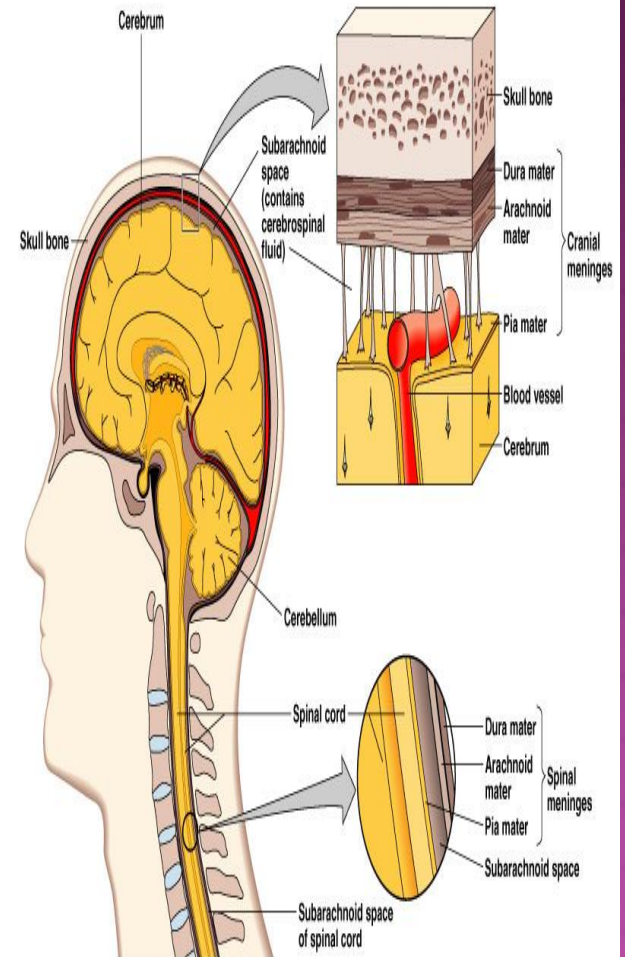
# SPINAL CORD

## ○ *Situation and Extent*

- **Vertebral canal**
- It extends from **foramen magnum** where it is continuous with medulla oblongata, above and up to the **lower border of first lumbar vertebra**

## ○ *Coverings*

- Spinal cord is covered by sheaths called **meninges**, which are membranous in nature.
- Meninges are **pia mater, arachnoid mater & dura mater**.
- **These coverings** continue as coverings of brain.
- Meninges are responsible for **protection and nourishment** of the nervous tissues.



## ◉ ***Shape and Length***

- Shape- cylindrical
- Length - 45 cm in males and about 43 cm in females.

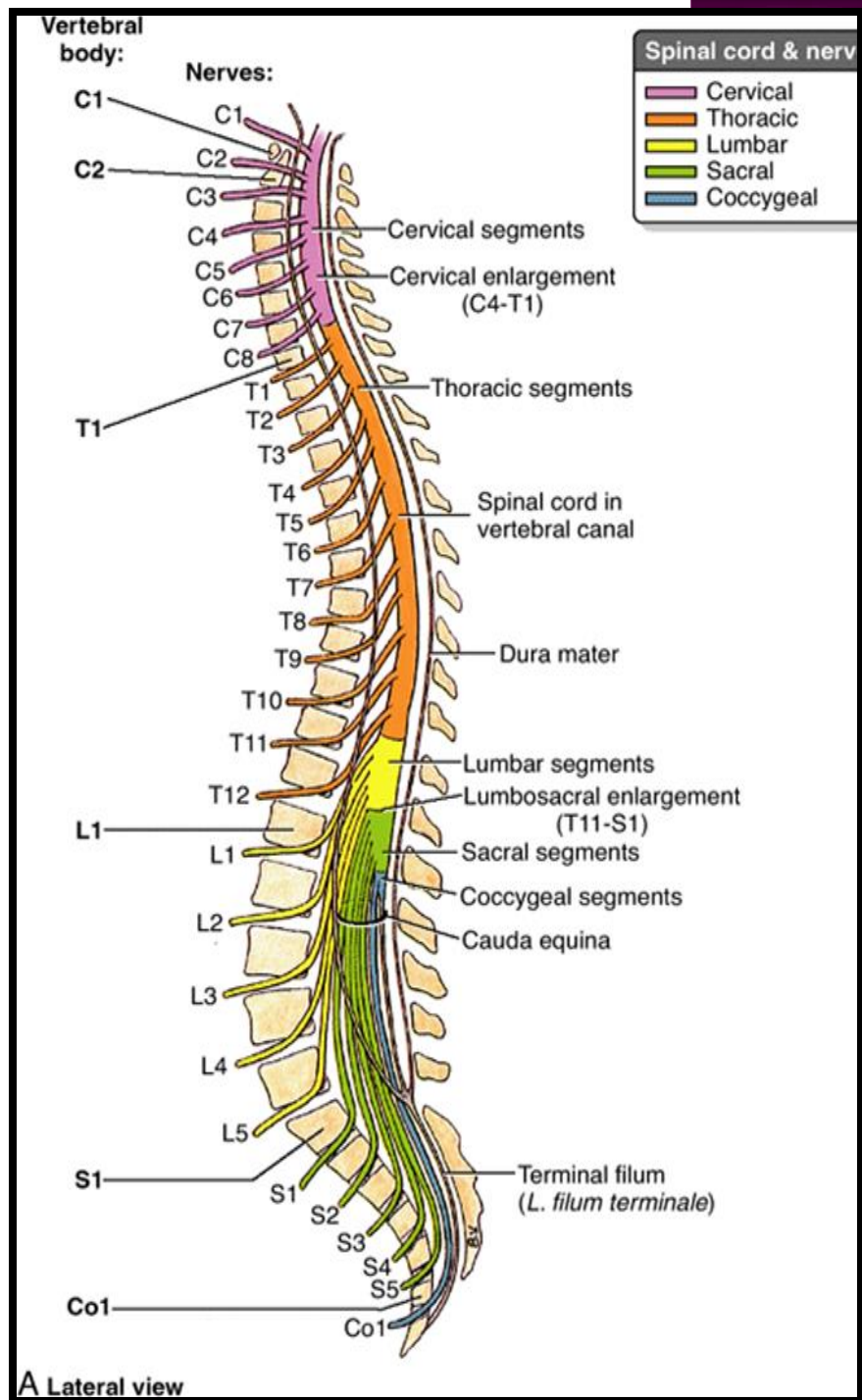
## ◉ ***Enlargements***

- **Cervical enlargements** - upper extremities
- **lumbar enlargements** - lower extremities

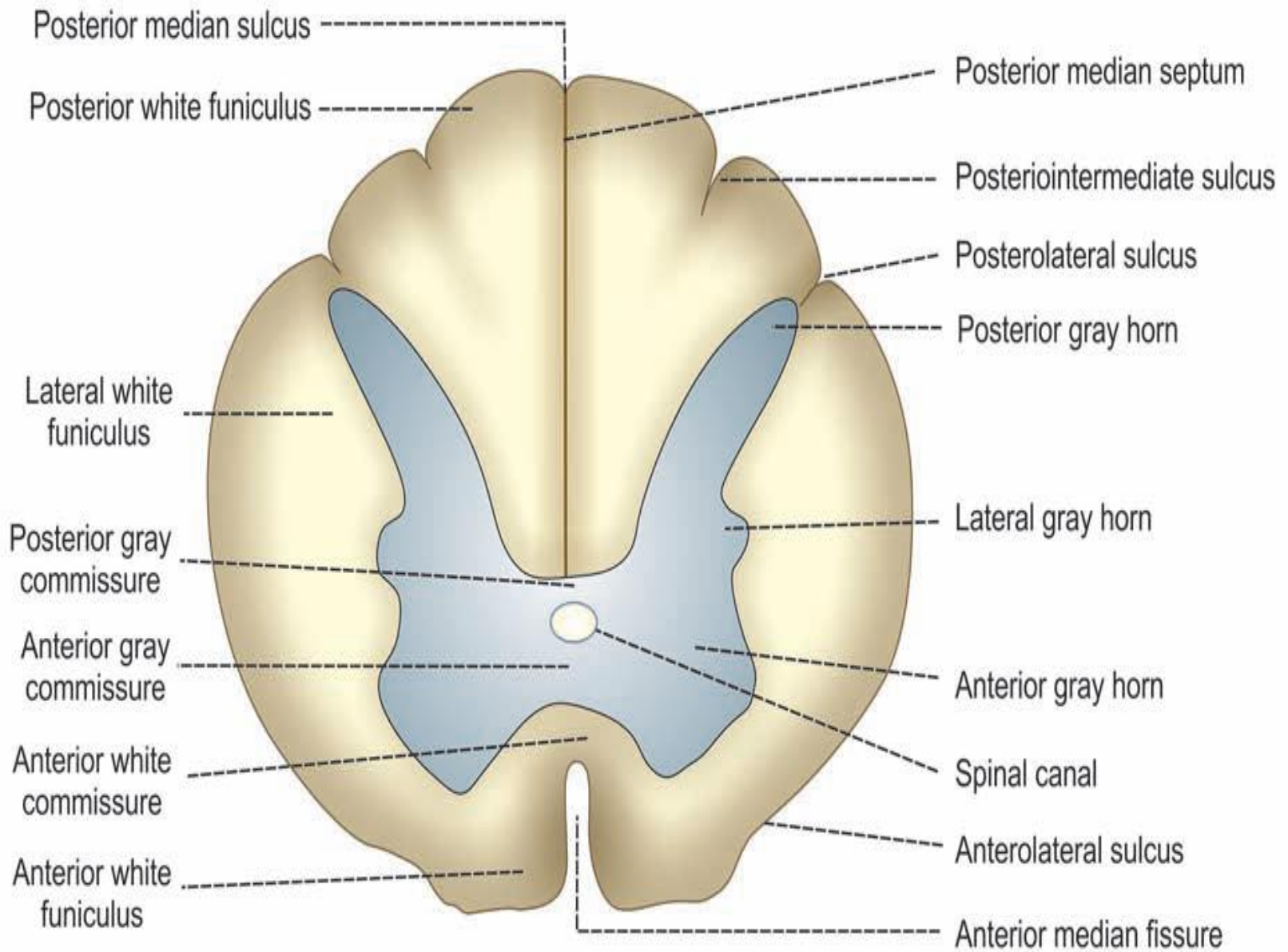
## ◉ ***Conus Medullaris and Filum Terminale***

- Below the lumbar enlargement, spinal cord rapidly narrows to a cone-shaped termination called **conus medullaris**.
- **A slender non-nervous filament called filum terminale extends from conus medullaris downward to the fundus of the dural sac at the level of second sacral vertebra.**

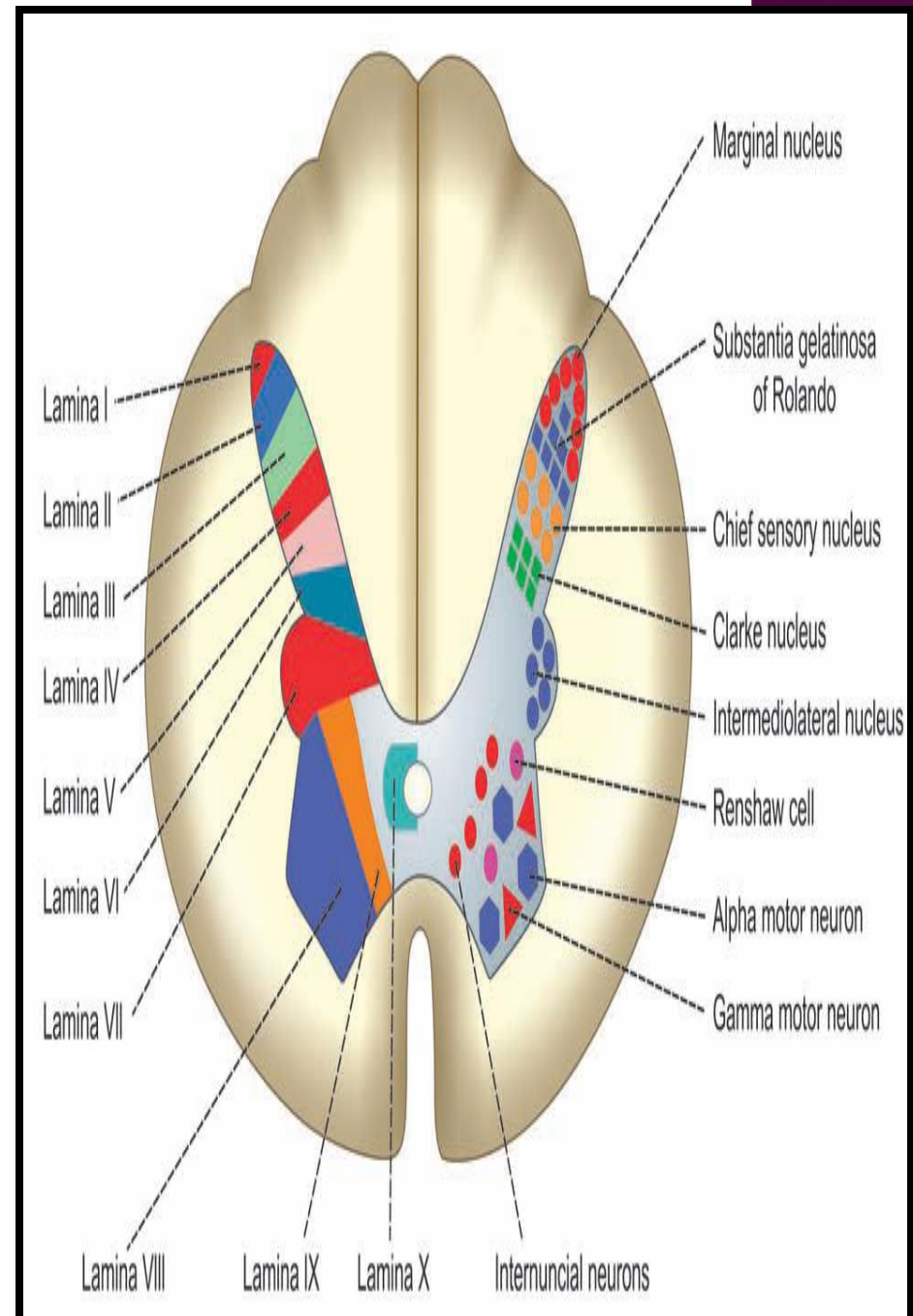
1. Cervical segments/Cervical spinal nerves = 8
  2. Thoracic segments/Thoracic spinal nerves = 12
  3. Lumbar segments/Lumbar spinal nerves = 5
  4. Sacral segments/Sacral spinal nerves = 5
  5. Coccygeal segment/Coccygeal spinal nerves = 1
- Total = 31







- Neurons in Grey matter
  - Golgi type 1 (anterior aspect, long axons-tracts)
  - Golgi type 2 (posterior aspect, short axons-interneurons)
- Contents of grey matter
  - Nuclie
    - *Alpha motor neurons*
    - *Gamma motor neurons*
    - *Renshaw cells*
  - Lamina



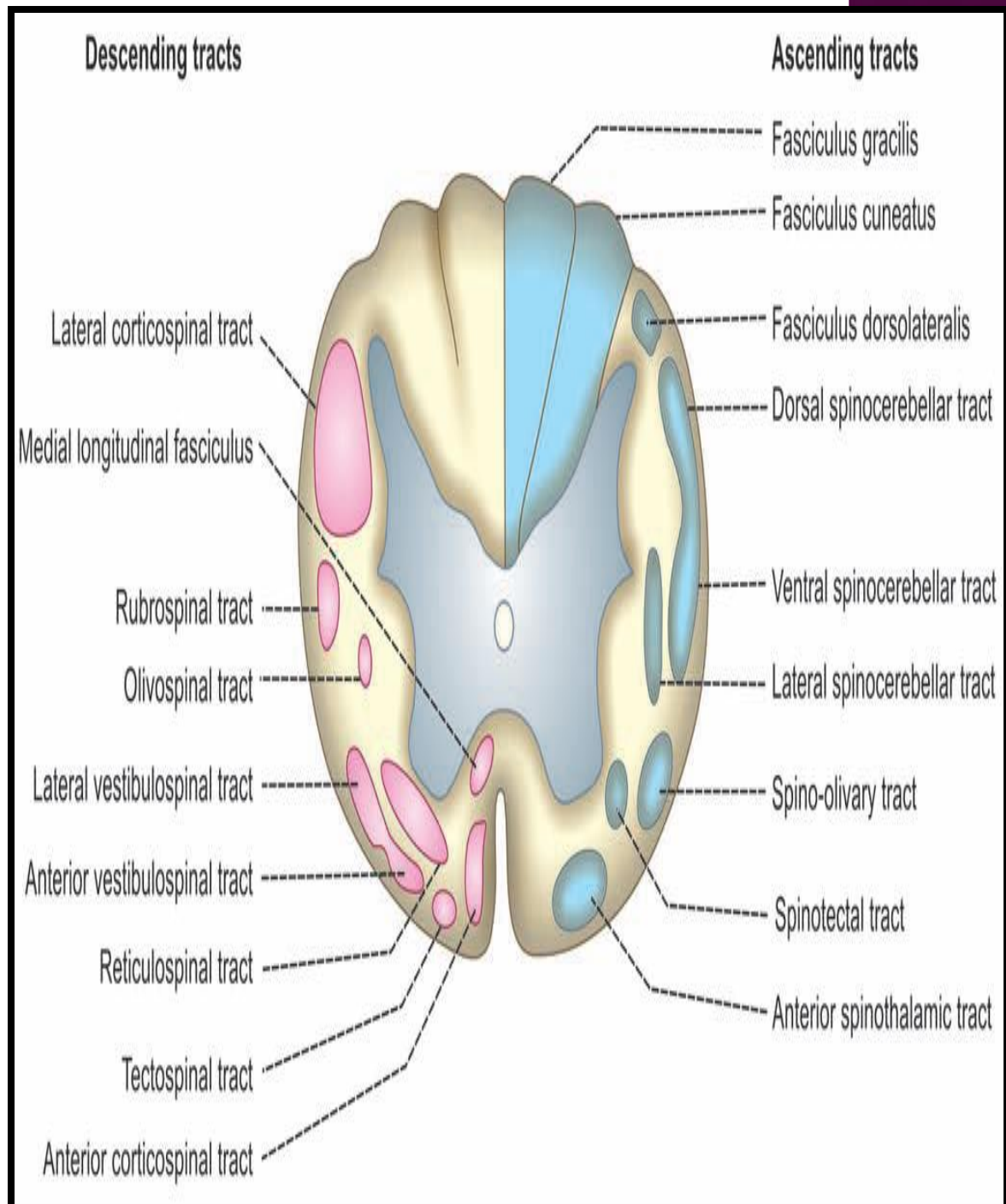


## ○ White matter

- Anterior or Ventral White Column
- Lateral White Column
- posterior or dorsal White Column

## ○ Tracts

- **Shorts tracts**
- **Long tracts**
  - Ascending tracts
  - Descending tracts



## ○ ASCENDING TRACTS OF SPINAL CORD

### ■ First Order Neurons

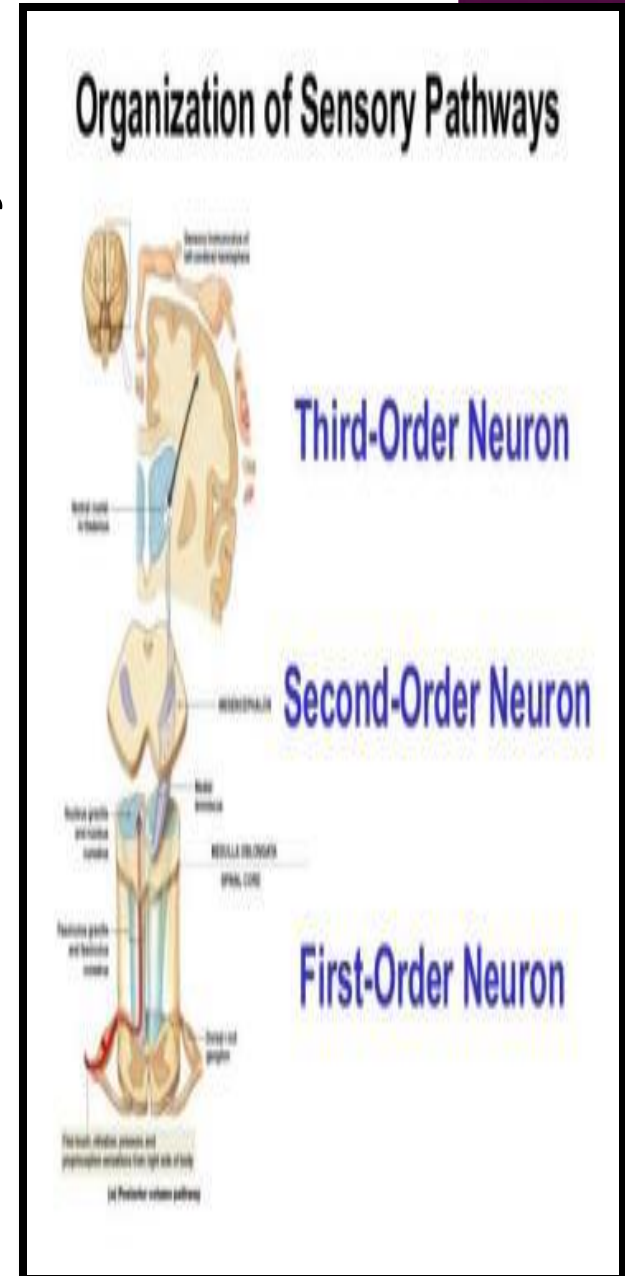
- Receptors to sensory neurons present in the posterior gray horn of spinal cord
- Nerve cell bodies - located in the posterior nerve root ganglion.

### ■ Second Order Neurons

- Posterior gray horn to ascending tracts of spinal cord.
- These fibers carry sensory impulses from spinal cord to different brain areas below cerebral cortex (subcortical areas) such as thalamus.

### ■ Third Order Neurons

- Subcortical areas
- Fibers of these neurons carry the sensory impulses from subcortical areas to cerebral cortex.

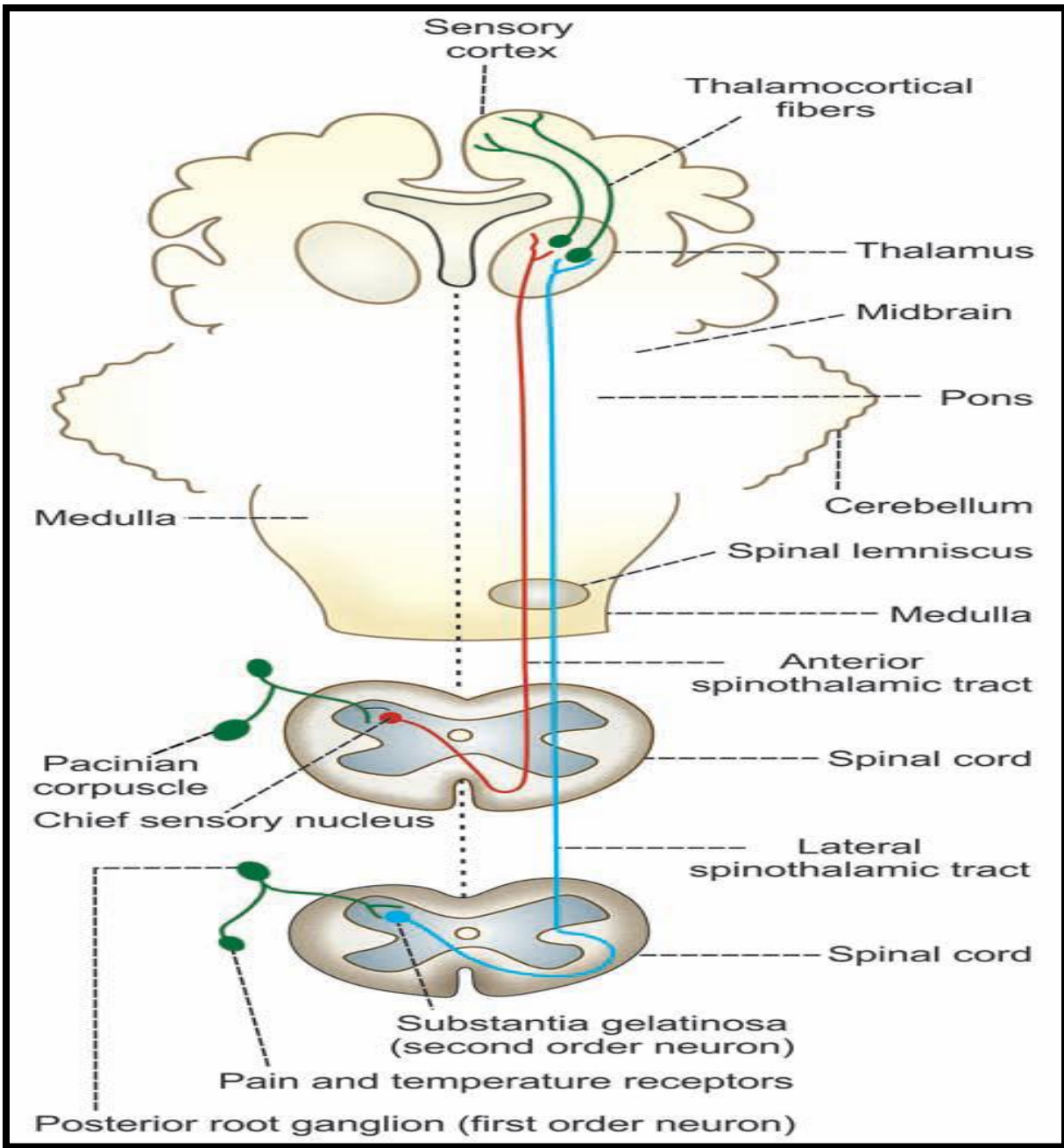


## ○ Ascending tracts

White column	Tract
Anterior white column	1. Anterior spinothalamic tract
Lateral white column	1. Lateral spinothalamic tract 2. Ventral spinocerebellar tract 3. Dorsal spinocerebellar tract 4. Spinotectal tract 5. Fasciculus dorsolateralis 6. Spinoreticular tract 7. Spino-olivary tract 8. Spinovestibular tract
Posterior white column	1. Fasciculus gracilis 2. Fasciculus cuneatus

- ◉ **Tract** : Anterior spinothalamic tract
- ◉ **Origin**: Chief sensory nucleus
- ◉ **Course**: Crossing in spinal cord Forms spinal lemniscus
- ◉ **Termination**: Ventral posterolateral nucleus of thalamus
- ◉ **Function**: Crude touch sensation

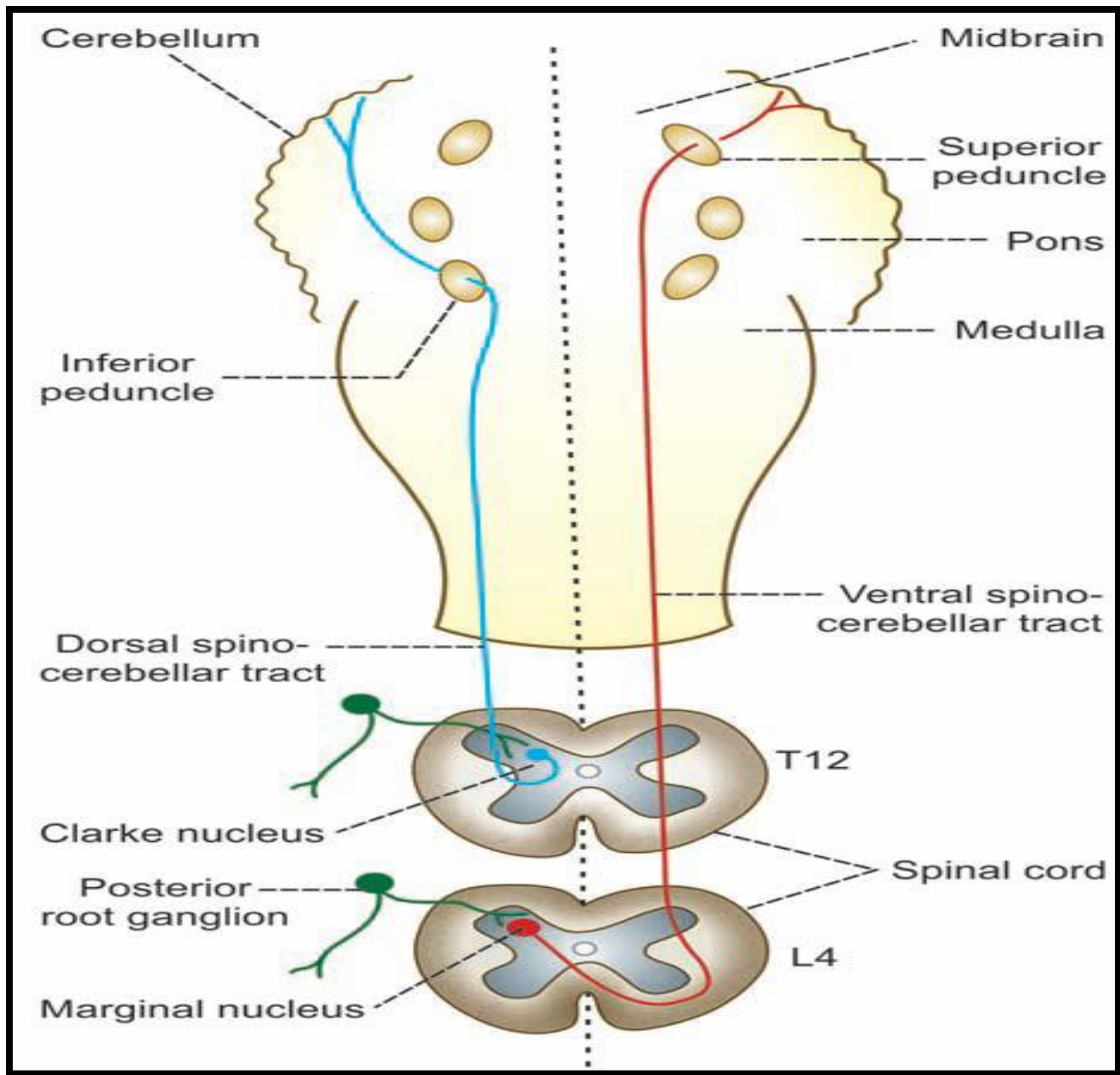
- ◉ **Tract** : Lateral spinothalamic tract
- ◉ **Origin**: Substantia gelatinosa
- ◉ **Course**: Crossing in spinal cord Forms spinal lemniscus
- ◉ **Termination**: Ventral posterolateral nucleus of thalamus
- ◉ **Function**: Pain and temperature sensation



- ◉ **Tract** : Ventral spinocerebellar tract
- ◉ **Origin**: Marginal nucleus
- ◉ **Course**: Crossing in spinal cord
- ◉ **Termination**: Anterior lobe of cerebellum
- ◉ **Function**: Subconscious kinesthetic sensations

- Tract** : Dorsal spinocerebellar tract
- Origin**: Clarke nucleus
- ◉ **Course**: Uncrossed fibers
- ◉ **Termination**: Anterior lobe of cerebellum
- ◉ **Function**: Subconscious kinesthetic sensations





- ◉ **Tract** : Spinotectal tract
- ◉ **Origin**: Chief sensory nucleus
- ◉ **Course**: Crossing in spinal cord
- ◉ **Termination**: Superior colliculus
- ◉ **Function**: Spinovisual reflex

- Tract** : Fasciculus dorsolateralis
- ◉ **Origin**: Posterior nerve root ganglion
- ◉ **Course**: Component of lateral spinothalamic tract
- ◉ **Termination**: Substantia gelatinosa
- ◉ **Function**: Pain and temperature sensations



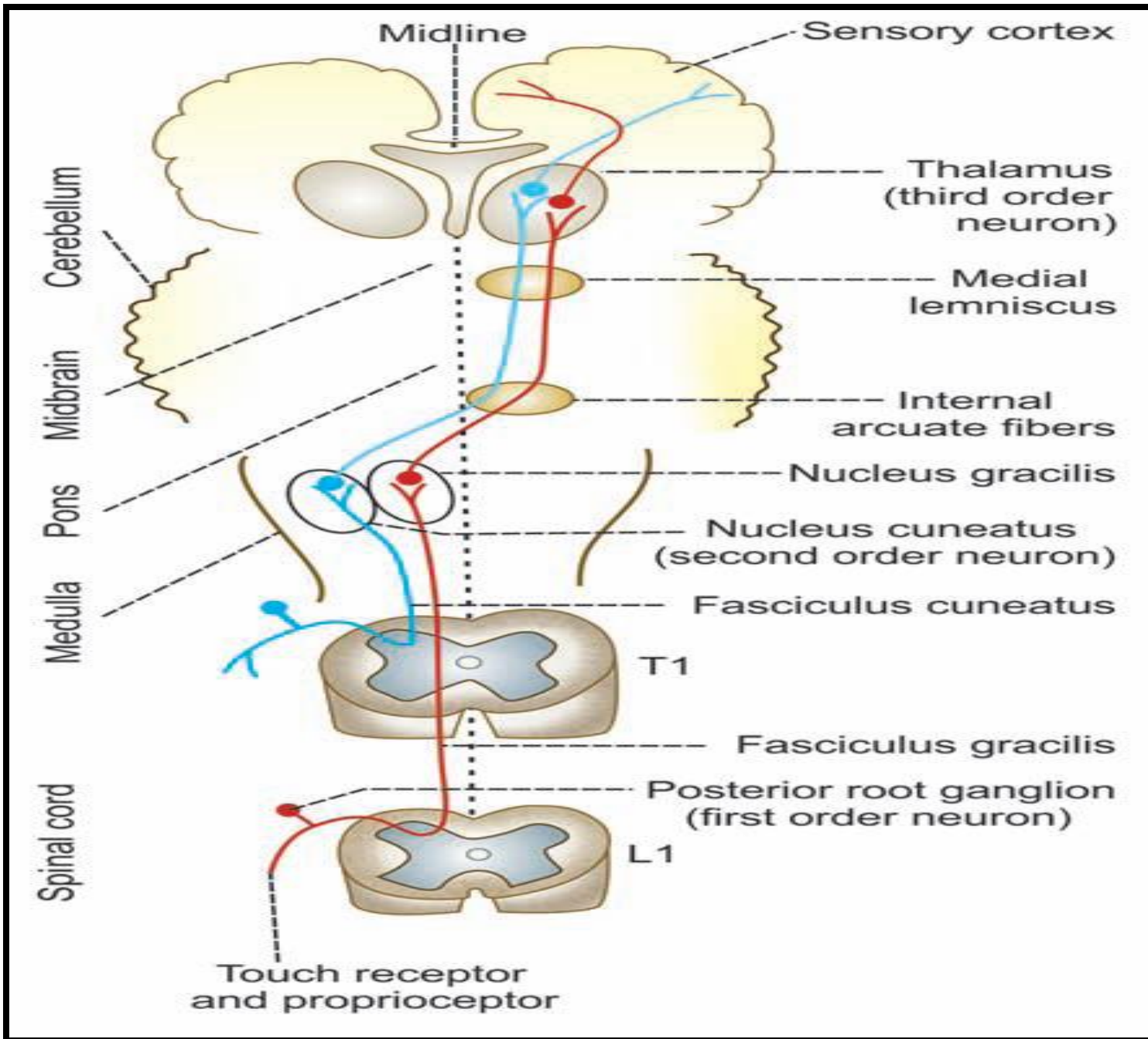
- ◉ **Tract** :Spinoreticular tract
- ◉ **Origin**: Intermediolateral cells
- ◉ **Course**: Crossed and uncrossed fibers
- ◉ **Termination**: Reticular formation of brainstem
- ◉ **Function**: Consciousness and awareness

- ◉ **Tract** : Spino-olivary tract
- ◉ **Origin**: Non-specific
- ◉ **Course**: Uncrossed fibers
- ◉ **Termination**: Olivary nucleus
- ◉ **Function**: Proprioception

- ◉ **Tract :**  
Spinovestibular tract
- ◉ **Origin:**
- ◉ **Course:** Non-specific  
Crossed and  
uncrossed fibers
- ◉ **Termination:**  
Lateral vestibular  
nucleus
- ◉ **Function:**  
Proprioception

- ◉ **Tract** : Fasciculus gracilis
- ◉ **Origin**: Posterior nerve root Ganglia
- ◉ **Course**: Uncrossed fibers  
No synapse in spinal cord
- ◉ **Termination**: Nucleus gracilis in medulla
- ◉ **Function**:
  - Tactile sensation
  - Tactile localization
  - Tactile discrimination
  - Vibratory sensation
  - Conscious kinesthetic sensation
  - Stereognosis

- ◉ **Tract** : Fasciculus cuneatus
- ◉ **Origin**: Posterior nerve root ganglia
- ◉ **Course**: Uncrossed fibers No synapse in spinal cord
- ◉ **Termination**: Nucleus cuneatus in medulla
- ◉ **Function**:
  - Tactile sensation
  - Tactile localization
  - Tactile discrimination
  - Vibratory sensation
  - Conscious kinesthetic sensation
  - Stereognosis

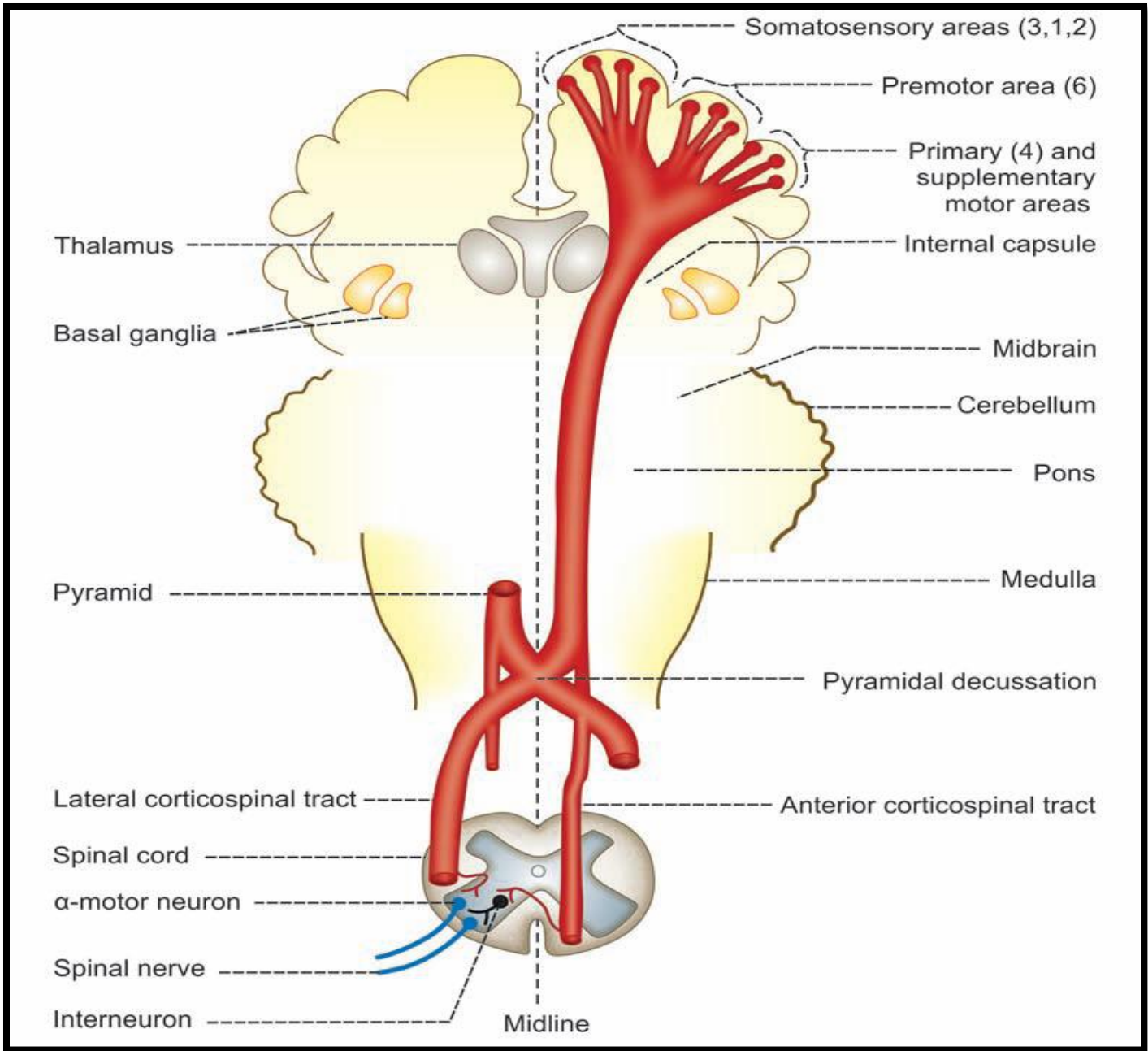


## ○ Descending tracts

Types	Tracts
Pyramidal tracts	<ol style="list-style-type: none"><li>1. Anterior corticospinal tract</li><li>2. Lateral corticospinal tract</li></ol>
Extrapyramidal tracts	<ol style="list-style-type: none"><li>1. Medial longitudinal fasciculus</li><li>2. Anterior vestibulospinal tract</li><li>3. Lateral vestibulospinal tract</li><li>4. Reticulospinal tract</li><li>5. Tectospinal tract</li><li>6. Rubrospinal tract</li><li>7. Olivospinal tract</li></ol>

- **Tract** : Anterior corticospinal tract
- **Situation**: Anterior white column
- **Origin**: Betz cells and other cells of motor area
- **Course**: Uncrossed fibers
- **Function**:
  - i. Control of voluntary movements
  - ii. Form upper motor neurons

- **Tract** : lateral corticospinal tract
- **Situation** : Lateral white column
- **Origin**: Betz cells and other cells of motor area
- **Course**: Crossed fibers
- **Function**:
  - i. Control of voluntary movements
  - ii. Form upper motor neurons





- ◉ **Tract** : Anterior vestibulospinal tract
- ◉ **Situation**: Anterior white column
- ◉ **Origin**: Medial vestibular nucleus
- ◉ **Course**: Uncrossed fibers Extend up to upper thoracic segments
- ◉ **Function**:
  - i. Maintenance of muscle tone and posture
  - ii. Maintenance of position of head and body during acceleration

- Tract** : Lateral vestibulospinal tract
- ◉ **Situation**: Lateral white column
- ◉ **Origin**: Lateral vestibular nucleus
- ◉ **Course**: Mostly uncrossed Extend to all segments
- ◉ **Function**:
  - i. Maintenance of muscle tone and posture
  - ii. Maintenance of position of head and body during acceleration

- ◉ **Tract** : Reticulospinal tract
- ◉ **Situation:** Lateral white fasciculus
- ◉ **Origin:** Reticular formation of pons and medulla
- ◉ **Course:** Mostly uncrossed  
Extend up to thoracic segments
- ◉ **Function:**
  - i. Coordination of voluntary and reflex movements
  - ii. Control of muscle tone
  - iii. Control of respiration and diameter of blood vessels

- ◉ **Tract** : Tectospinal tract
- ◉ **Situation:** Anterior white column
- ◉ **Origin:** Superior colliculus
- ◉ **Course:** Crossed fibers  
Extend up to lower cervical segments
- ◉ **Function:**  
Control of movement of head in response to visual and auditory impulses

- ◉ **Tract** : Rubrospinal tract
- ◉ **Situation**: Lateral white column
- ◉ **Origin**: Red nucleus
- ◉ **Course**: Crossed fibers Extend up to thoracic segments
- ◉ **Function**: Facilitatory influence on flexor muscle tone

- ◉ **Tract** : Olivospinal tract
- ◉ **Situation**: Lateral white column
- ◉ **Origin**: Inferior olivary nucleus
- ◉ **Course**: Mostly crossed Extent - not clear
- ◉ **Function**: Control of movements due to proprioception

## COMPLETE TRANSECTION OF SPINAL CORD

- Complete transection of spinal cord occurs due to:
  - 1. Bullet injury, which causes dislocation of spinal cord
  - 2. Accidents, which cause dislocation of spinal cord or occlusion of blood vessels.
- Complete transection causes immediate **loss of sensation and voluntary movement below the level of lesion.**

- Effects occur in three stages:
  - 1. Stage of spinal shock
  - 2. Stage of reflex activity
  - 3. Stage of reflex failure

## ○ 1. *Stage of Spinal Shock*

○ Stage of spinal shock is the first stage of effects that occurs immediately after injury. It is also called **stage of flaccidity**.

### 1. *Paralysis of limbs*

1. *Cervical injury - quadriplegia/tetraplegia*
2. *Thoracic/lumbar injury- paraplegia*

### 2. *Flaccid paralysis*

### 3. *Loss of reflexes*

### 4. *Loss of sensations*

### 5. *Effect on visceral organs*

### 6. *Heart rate*

### 7. *Venous return*

### 8. *Effect on blood pressure*

## 2. *Stage of Reflex Activity*

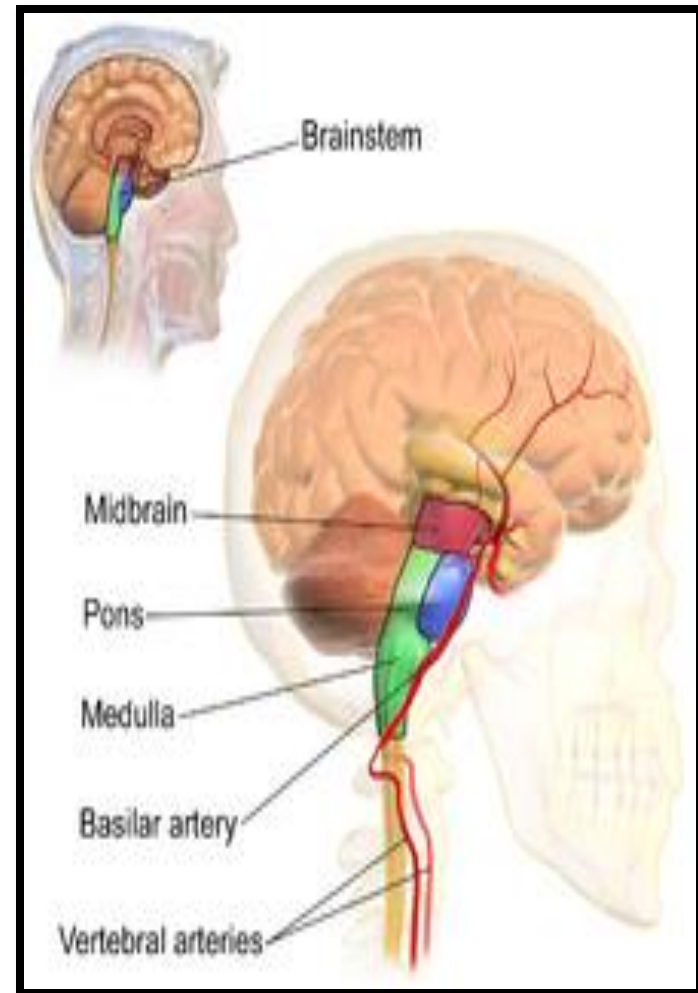
- ◉ Stage of reflex activity is also called **stage of recovery**. After 3 weeks period, depending largely upon the general health of the patient
  - functional activities return to smooth muscles
  - Next, the sympathetic tone to blood vessels returns.
  - Lastly, after another 3 months, the tone in skeletal muscle returns
  - Flexor reflexes appear first. To elicit the flexor reflex, a painful stimulus is required. First reflex, which usually appears, is the Babinski reflex.
  - After a variable period of 1 to 5 weeks of reappearance of flexor reflexes, the extensor reflexes return.
  - This reaction constitutes the spasm in flexor muscles of both the lower limbs, evacuation of urinary bladder and profuse sweating. This is known as the mass reflex.



- ◉ ***Stage of Reflex Failure***
- ◉ Though the reflex movements return, muscles below the level of injury have less power and less resistance.
- ◉ deterioration of condition with infection

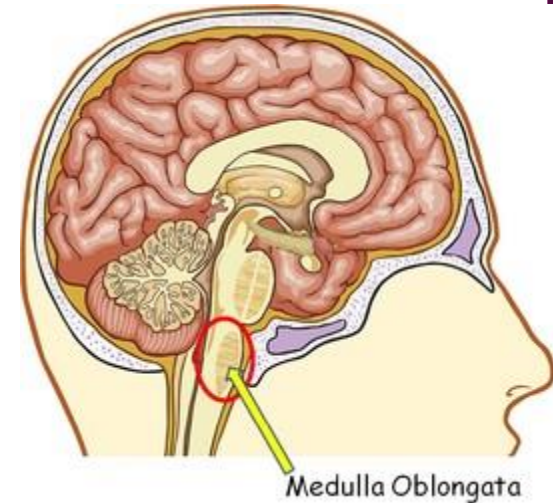
# BRAINSTEM

- Brainstem is the part of brain formed by **medulla oblongata, pons and midbrain.**
- Brainstem contains **ascending and descending** tracts between brain and spinal cord.
- It also contains many **centers** for regulation of **vital functions** in the body.



# MEDULLA OBLONGATA

- Medulla oblongata or medulla is the **lowermost part of brain.**
- It is situated **below pons** and is **continued downwards as spinal cord.**
- Medulla forms the main pathway for **ascending and descending tracts** of the spinal cord.



# FUNCTIONS OF MEDULLA OBLONGATA

## ○ 1. *Respiratory Centers*

- Dorsal and ventral group of neurons form the **medullary respiratory centers**, which maintain normal rhythmic respiration

## ○ 2. *Vasomotor Center*

- Vasomotor center controls **blood pressure and heart rate**.

## ○ 3. *Deglutition Center*

- Deglutition center regulates the **pharyngeal and esophageal stages of deglutition**

#### ⊙ **4. Vomiting Center**

- Vomiting center induces vomiting during irritation or inflammation of gastrointestinal (GI) tract

#### ⊙ **5. Superior and Inferior Salivatory Nuclei**

- Salivatory nuclei control the secretion of saliva

#### ⊙ **6. Cranial Nerve Nuclei**

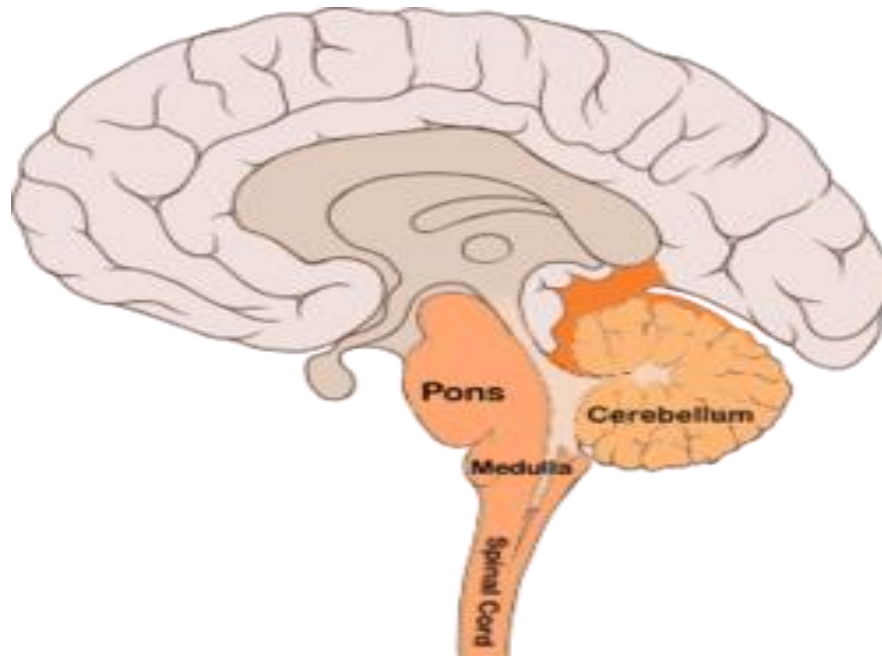
- Nuclei of 10th, 11th, 12th and some nuclei of 5<sup>th</sup> and 8th cranial nerves are located in the medulla oblongata

## ◉ 7. *Vestibular Nuclei*

- Vestibular nuclei contain the second order neurons of vestibular nerve
- **Superior, medial, lateral and inferior** vestibular nuclei.
- Medial and inferior vestibular nuclei **extend into medulla.**

# PONS

- Pons forms a bridge between medulla and midbrain





# FUNCTIONS OF PONS

- Axons of pontine nuclei join to **the middle cerebellar peduncle** & pons pathway that connects **cerebellum with cerebral cortex.**
- **Pyramidal tracts** pass through the pons
- Medial lemniscus is joined by the fibers of **5th, 7th, 9th and 10th cranial nerves** in pons
- **Nuclei of 5th, 6th, 7th and 8th cranial nerves** are located in pons
- Pons contains the **pneumotaxic and apneustic centers** for regulation of respiration

# MIDBRAIN

- Midbrain lies between pons and diencephalon.

## Midbrain

### Tectum

#### *Superior colliculus :*

1. Small structure & imp center for reflex
2. Tectospinal tract, superior colliculus controls the **movements of the eyes, head, trunk and limbs**, in response to visual impulses

#### *Inferior colliculus:*

The center for auditory reflexes , produces reflex vocalization

### Cerebral peduncles

#### *Basis pedunculus:*

Laterally temperopontine fibres  
Medially frontopontine fibers  
Middle pyramidal tract fibers

#### *Substantia nigra:*

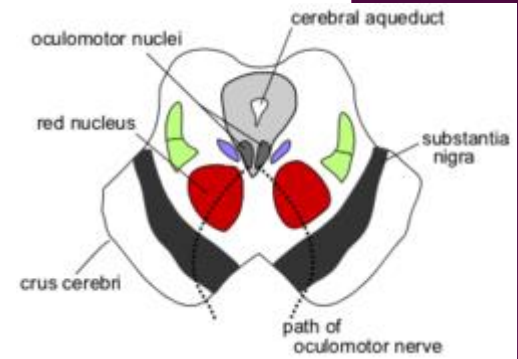
Situated below the red nucleus.

#### *Tegmentum:*

Dorsal to substantia nigra, upward to the reticular formation  
Superior cerebellar peduncle,  
Crossing of rubrospinal tracts  
Efferent fibers of 3rd, 4th and 6th Cranial nerves.

# RED NUCLEUS

- Red nucleus is a large oval or round mass of **gray matter**, extending between the **superior colliculus** and **hypothalamus**.
- Two parts
  - **Nucleus magnocellularis (larger)**
    - This fibers form the **rubrospinal** and **rubrobulbar** tracts
  - **Nucleus parvocellularis (smaller)**
    - This fibers form the **rubroreticular** tract



# CONNECTIONS OF RED NUCLEUS

## ○ Afferent connection

- Corticorubral fibers
- Pallidorubral fibers
- Cerebellorubral tracts

## ○ Efferent connections

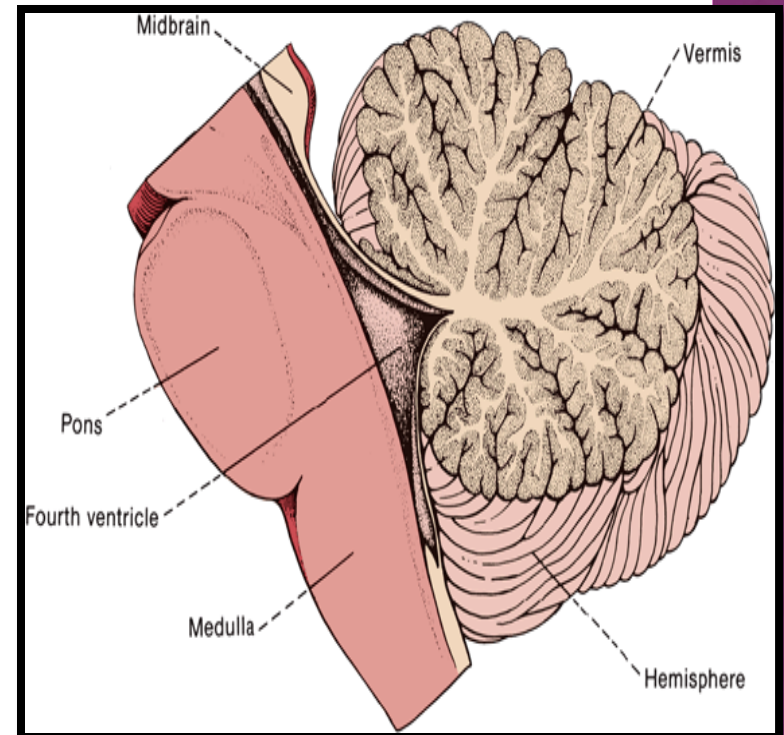
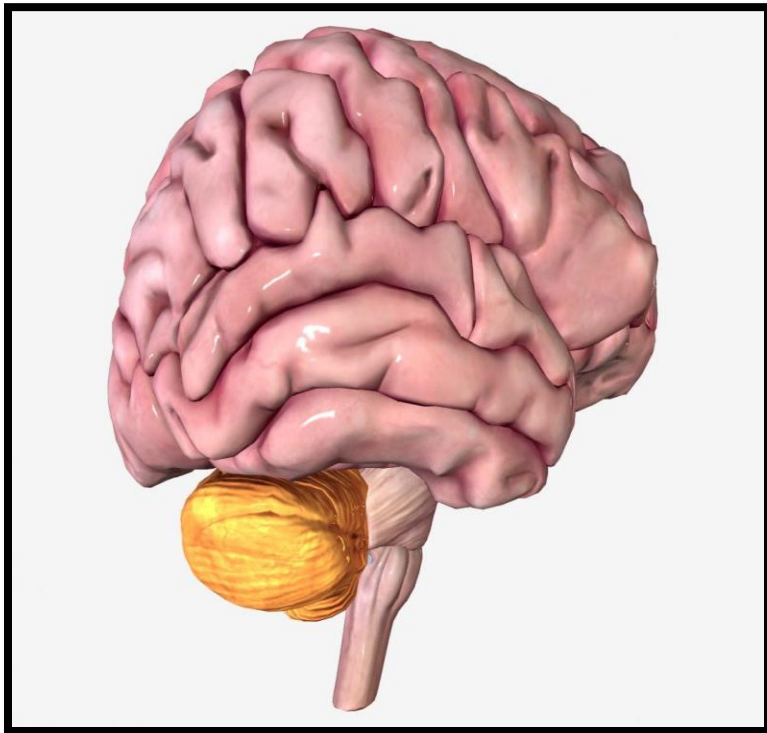
- Rubrospinal tract to spinal cord
- Rubrobulbar tract to medulla
- Rubroreticular fibers to reticular formation
- Rubrothalamic tract to lateral ventral nucleus of thalamus
- Rubroolivary tract to inferior olivary nucleus
- Fibers to nuclei of 3rd, 4th and 6th cranial nerves.

# *FUNCTIONS OF RED NUCLEUS*

- ◉ *Control of muscle tone*
- ◉ *Control of complex muscular movements*
- ◉ *Control of righting reflexes*
- ◉ *Control of movements of eyeball*
- ◉ *Control of skilled movements*

# CEREBELLUM

- Cerebellum consists of a narrow, worm-like central body called **vermis** and two lateral lobes, the right and left **cerebellar hemispheres**



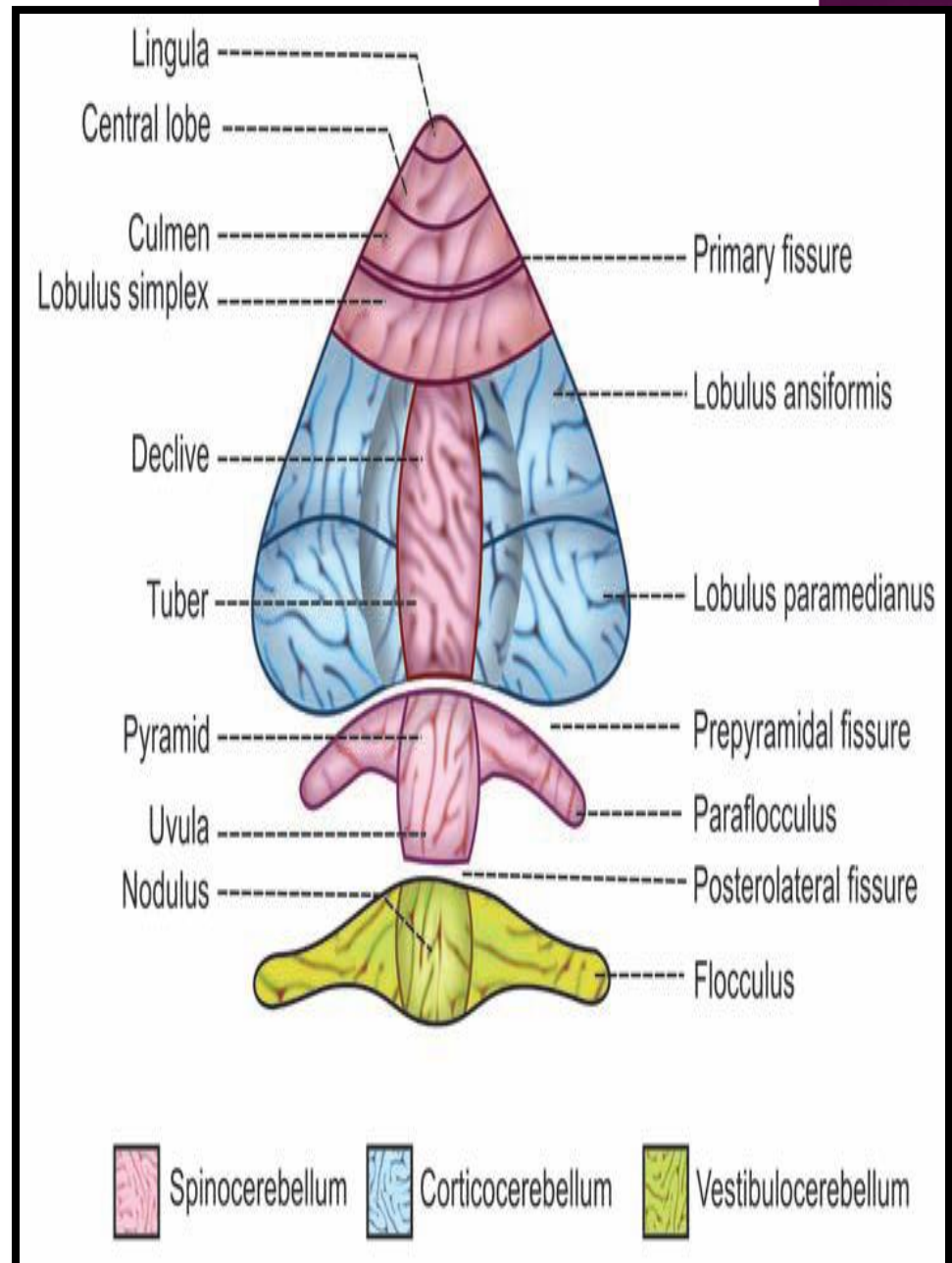
## ○ VERMIS :

### Superior vermis

- 1. Lingula
- 2. Central lobe
- 3. Culmen
- 4. Lobulus simplex
- 5. Declive

### Inferior vermis

- 6. Tuber
- 7. Pyramid
- 8. Uvula
- 9. Nodulus + flocculi = flocculonodular lobe



## ○ **CEREBELLAR HEMISPHERES**

- **1. Lobulus ansiformis or ansiform lobe** - larger portion of cerebellar hemisphere
- **2. Lobulus paramedianus or paramedian lobe** - smaller portion of cerebellar hemisphere.



# DIVISIONS OF CEREBELLUM

- A. Anatomical divisions
- B. Phylogenetic divisions
- C. Physiological or functional divisions

## ⊙ ANATOMICAL DIVISIONS

### ⊙ 1. *Anterior Lobe*

- Anterior lobe includes lingula, central lobe and culmen..

### ⊙ 2. *Posterior Lobe*

- Posterior lobe consists of lobulus simplex, declive, tuber, pyramid, uvula, paraflocculi and the two portions of hemispheres, viz. ansiform lobe and paramedian lobe.

### ⊙ 3. *Flocculonodular Lobe*

- Flocculonodular lobe includes nodulus and the lateral extension on either side called flocculus.

## ◎ PHYLOGENETIC DIVISIONS

### ◎ 1. *Paleocerebellum*:

- i. **Archicerebellum**, which includes flocculonodular lobe
- ii. **Paleocerebellum proper**, which includes lingula, central lobe, culmen, lobulus simplex, pyramid, uvula and paraflocculi.

### ◎ 2. *Neocerebellum*

- It includes declive, tuber and the two portions of cerebellar hemispheres, viz. lobulus ansiformis and lobulus paramedianus.

## ○ **PHYSIOLOGICAL OR FUNCTIONAL DIVISIONS**

### ○ **1. *Vestibulocerebellum***

- Vestibulocerebellum includes flocculonodular lobe that forms the archicerebellum.

### ○ **2. *Spinocerebellum***

- Spinocerebellum includes lingula, central lobe, culmen, lobulus simplex, declive, tuber, pyramid, uvula and paraflocculi and medial portions of lobulus ansiformis and lobulus paramedianus.

### ○ **3. *Corticocerebellum***

- Corticocerebellum includes lateral portions of lobulus ansiformis and lobulus paramedianus.

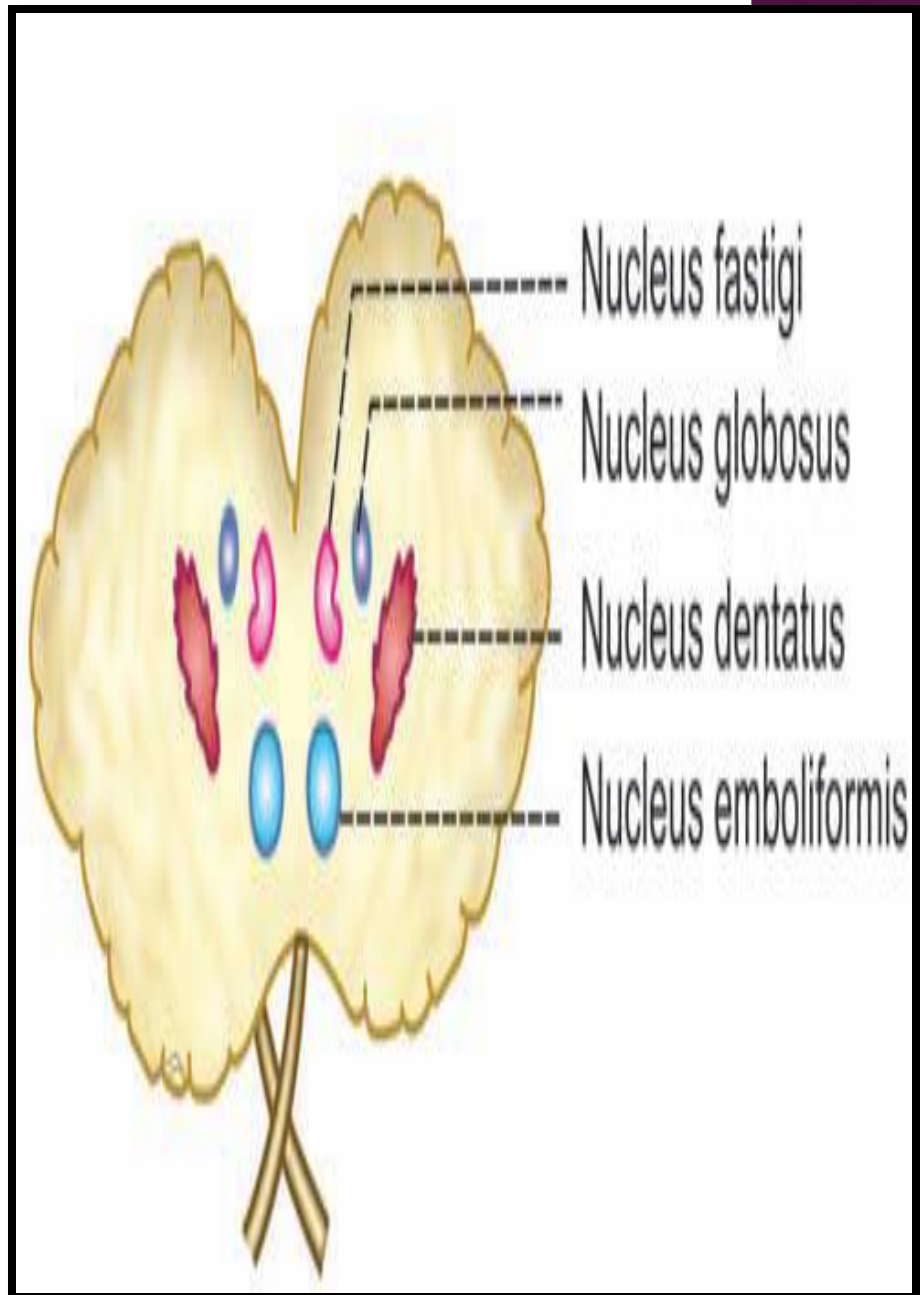
# FUNCTIONAL ANATOMY OF CEREBELLUM

## ◎ GRAY MATTER

- 1. Outer molecular (**Parallel, climbing, Dendrites of Purkinje cells and Golgi cells**)
- 2. Intermediate Purkinje layer
- 3. Inner granular layer (**granule cells and Golgi cells**)

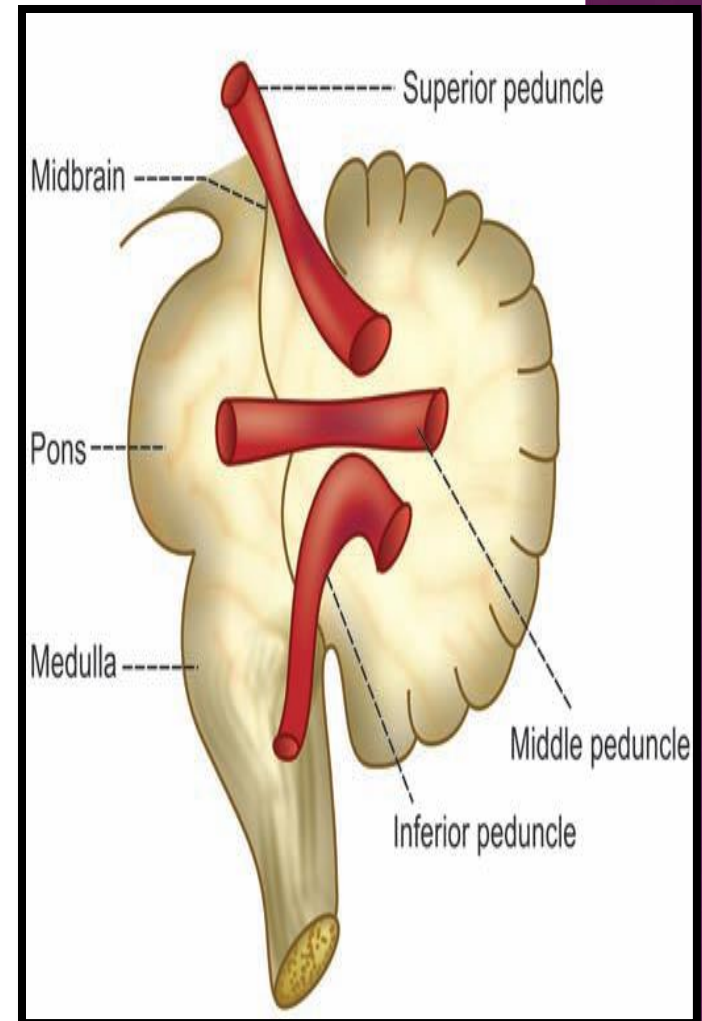
## ○ CEREBELLAR NUCLEI

- ***Fastigial Nucleus-***  
midline on the roof of IV ventricle.
- ***Globosus Nucleus-***  
lateral to nucleus fastigi
- ***Emboliform Nucleus-***  
below the nucleus fastigi and nucleus globosus
- ***Dentate Nucleus-***  
lateral to all the other nuclei



## ○ WHITE MATTER OF CEREBELLUM

- Superior cerebellar peduncles between cerebellum and midbrain
- Middle cerebellar peduncles between cerebellum and pons
- Inferior cerebellar peduncles between cerebellum and medulla oblongata



## ○ **VESTIBULOCEREBELLUM**

- Vestibulocerebellum is connected with the vestibular apparatus and so it is known as vestibulocerebellum

## ○ **STRUCTURES**

- Includes the flocculonodular lobe that is formed by the nodulus of vermis and its lateral extensions called flocculi

## ○ **FUNCTIONS**

- Tone, posture and equilibrium



## ◎ SPINOCEREBELLUM

- Spinocerebellum is connected with spinal cord

## ◎ COMPONENTS

- Medial Portions Of Cerebellar Hemisphere, Paraflocculi And The Parts Of Vermis, Viz. Lingula, Central Lobe, Culmen, Lobulus Simplex, Declive, Tuber, Pyramid And Uvula

## ◎ FUNCTIONS

- Tone, posture and equilibrium
- Localization of tactile

## ○ **CORTICOCEREBELLUM**

- Corticocerebellum is the largest part of cerebellum, Because of its connection with cerebral cortex

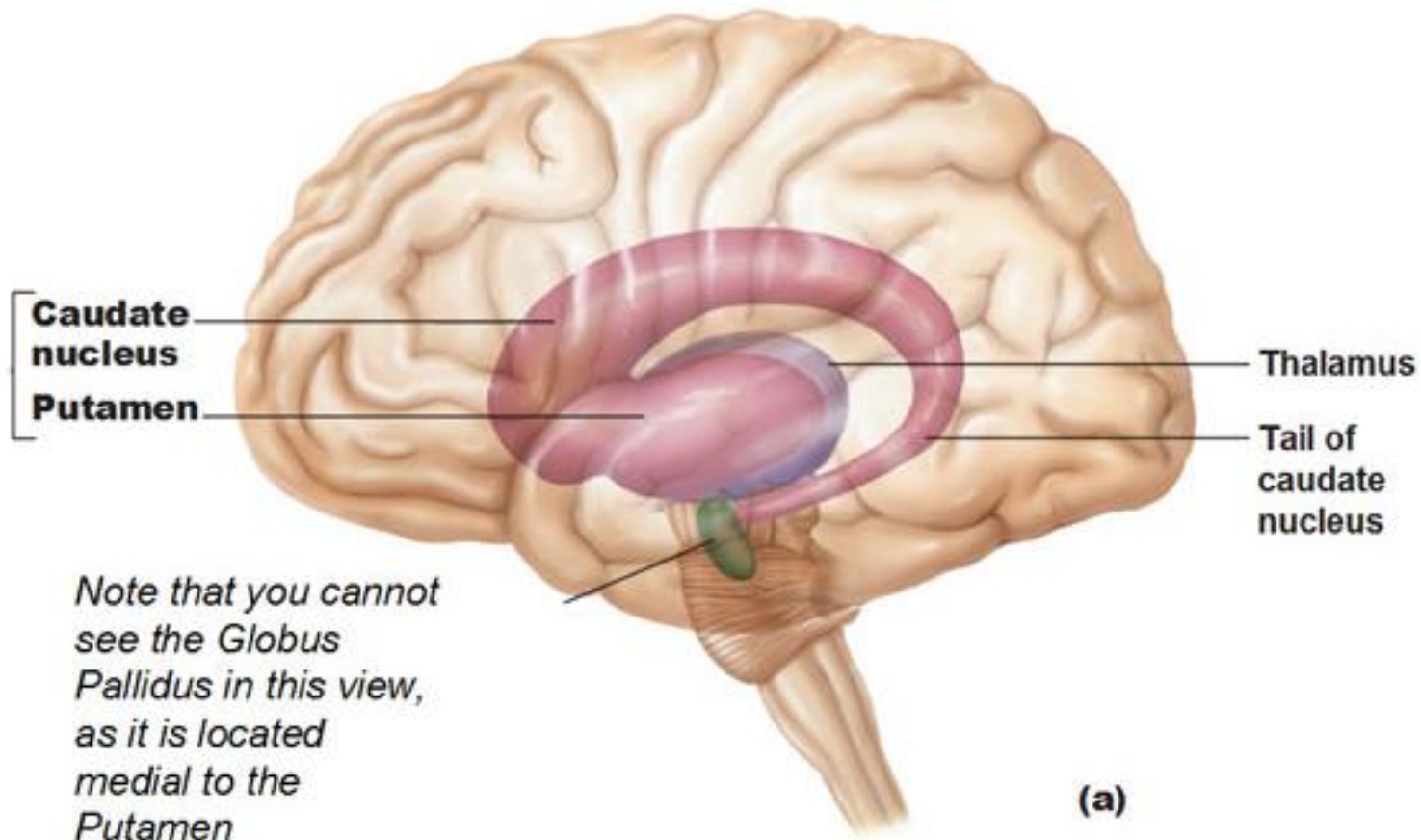
## ○ **COMPONENTS**

- Corticocerebellum includes the lateral portions of cerebellar hemispheres

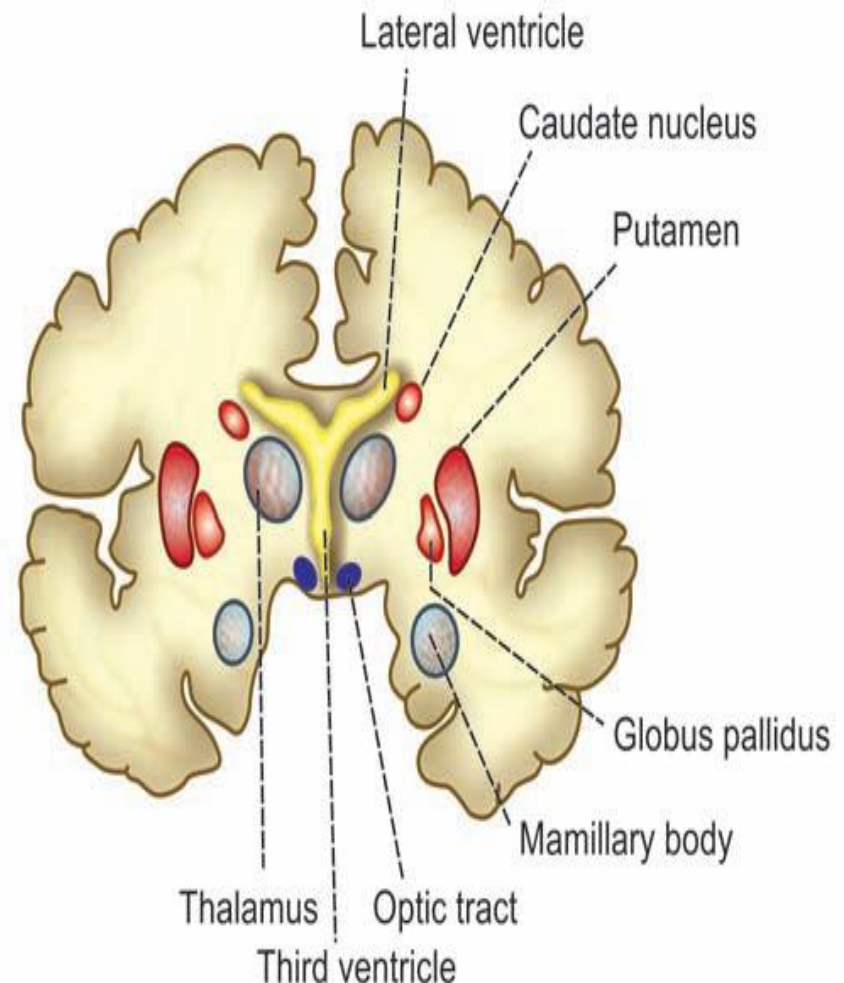
## ○ **FUNCTIONS**

- Integration and regulation of well-coordinated muscular activities

# BASAL GANGLIA

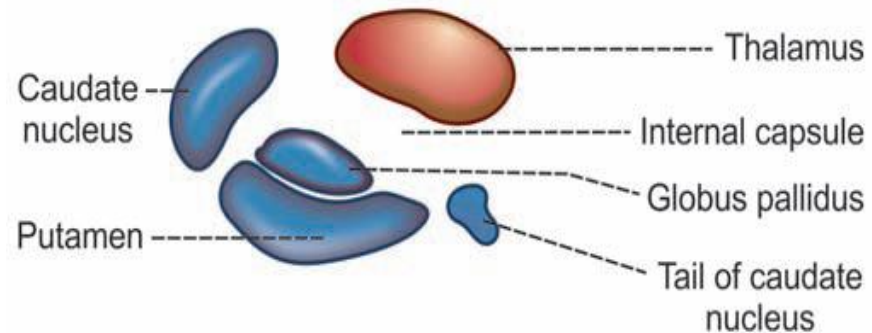
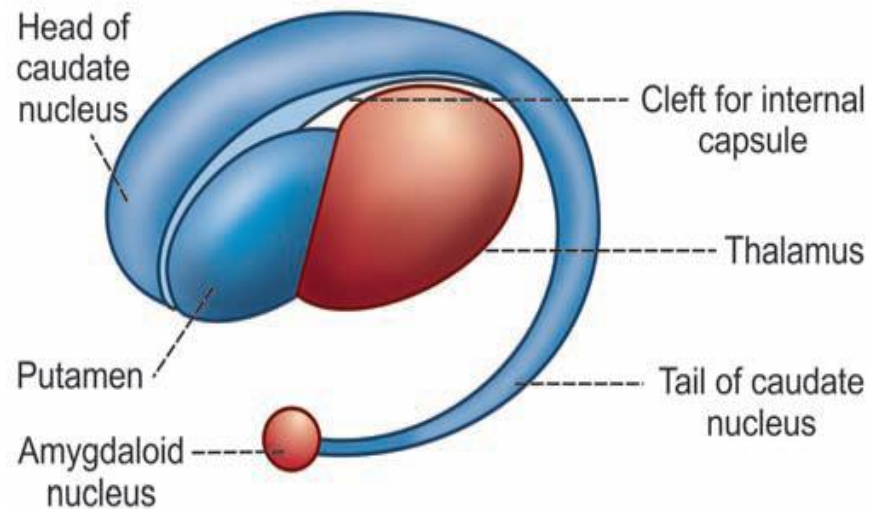


- Basal ganglia are the scattered masses of gray matter submerged in subcortical substance of cerebral hemisphere
- Basal ganglia form the part of extra pyramidal system, which is concerned with motor activities.



# COMPONENTS OF BASAL GANGLIA

- 1. Corpus striatum
- 2. Substantia nigra
- 3. Subthalamic nucleus



## ◉ 1. Corpus striatum

- Mass of gray matter situated at the base of cerebral hemispheres in close relation to thalamus

***Caudate Nucleus*** : Caudate nucleus is an elongated arched gray mass, lying medial to internal capsule.

- Caudate nucleus has a head portion and a tail portion

**Lenticular Nucleus:** Lenticular nucleus is a wedgeshaped gray mass, situated lateral to internal capsule. A vertical plate of white matter called **external medullary lamina**

- Outer putamen
- Inner globus pallidus

## ◎ **SUBSTANTIA NIGRA**

- Substantia nigra is situated below red nucleus.
- It is made up of large pigmented and small nonpigmented cells.
- The pigment contains high quantity of iron.

## ◎ **SUBTHALAMIC NUCLEUS OF LUYS**

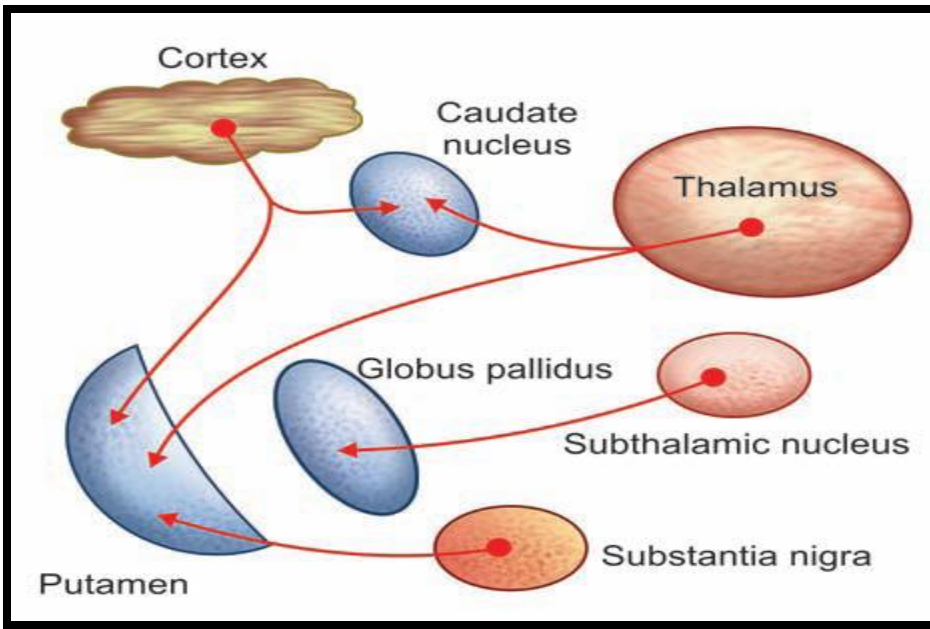
- Subthalamic nucleus is situated lateral to red nucleus and dorsal to substantia nigra.

# CONNECTIONS OF BASAL GANGLIA

- ① 1. Putamen to globus pallidus
- ② 2. Caudate nucleus to globus pallidus
- ③ 3. Caudate nucleus to putamen.

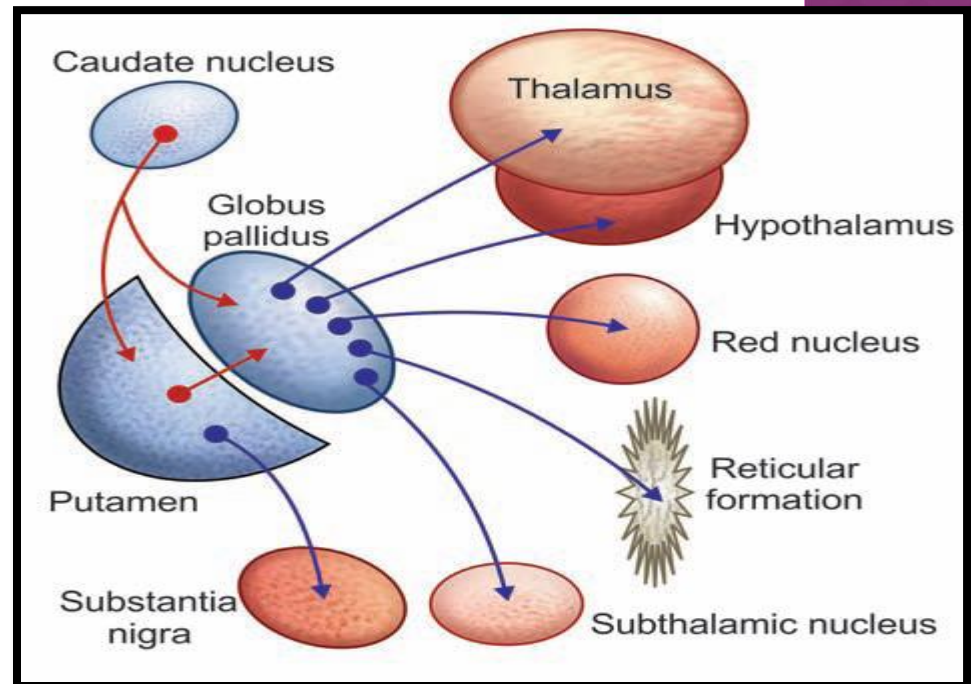


Component	Afferent connections from	Efferent connections to
Corpus striatum	<ol style="list-style-type: none"> <li>1. Thalamic nuclei to caudate nucleus and putamen</li> <li>2. Cerebral cortex to caudate nucleus and putamen</li> <li>3. Substantia nigra to putamen</li> <li>4. Subthalamic nucleus to globus pallidus</li> </ol>	<ol style="list-style-type: none"> <li>1. Thalamic nuclei</li> <li>2. Subthalamic nucleus</li> <li>3. Red nucleus</li> <li>4. Substantia nigra</li> <li>5. Hypothalamus</li> <li>6. Reticular formation (Most of the</li> </ol>
Substantia nigra	<ol style="list-style-type: none"> <li>1. Putamen</li> <li>2. Frontal lobe of cerebral cortex</li> <li>3. Superior colliculus</li> <li>4. Mamillary body of hypothalamus</li> <li>5. Medial and</li> </ol>	Putamen
Subthalamic nucleus	Globus pallidus	<ol style="list-style-type: none"> <li>1. Globus pallidus</li> <li>2. Red nucleus</li> </ol>



**Afferent connections of corpus striatum**

**Efferent connections of corpus striatum**



# FUNCTIONS OF BASAL GANGLIA

## ○ 1. CONTROL OF MUSCLE TONE

- Gamma motor neurons of spinal cord are responsible for development of tone in the muscles
- **Decrease the muscle tone by inhibiting gamma motor neurons through descending inhibitory reticular system in brainstem**
- During the lesion of basal ganglia, muscle tone increases leading to rigidity

## ⊙ 2. CONTROL OF MOTOR ACTIVITY

### ⊙ *Regulation of Voluntary Movements*

- a. Premotor area
- b. Primary motor area
- c. Supplementary motor area

### ⊙ *Regulation of Conscious Movements*

- Fibers between cerebral cortex and caudate nucleus are concerned with regulation of conscious movements (cognitive control)

### ⊙ *Regulation of Subconscious Movements*

- Cortical fibers reaching putamen → regulation of some subconscious movement

### ◉ **3. CONTROL OF REFLEX MUSCULAR ACTIVITY**

- Visual and labyrinthine reflexes are important in maintaining the posture

### ◉ **4. CONTROL OF AUTOMATIC ASSOCIATED MOVEMENTS**

- Automatic associated movements are the movements in the body (motor activities)

### ◉ **5. ROLE IN AROUSAL MECHANISM**

- Globus pallidus and red nucleus are involved in arousal mechanism because of their connections with reticular formation

- ◉ **6. ROLE OF NEUROTRANSMITTERS IN THE FUNCTIONS OF BASAL GANGLIA**
- ◉ **Dopamine** released by dopaminergic fibers from substantia nigra to corpus striatum
- ◉ **Gamma aminobutyric acid (GABA)** secreted by intrinsic fibers of substantia nigra to corpus striatum
- ◉ **Acetylcholine** released by fibers from cerebral cortex to caudate nucleus and putamen
- ◉ **Substance P & Enkephalins** released by fibers from globus pallidus reaching substantia nigra
- ◉ **Noradrenaline** secreted by fibers between basal ganglia and reticular formation
- ◉ **Glutamic acid** secreted by fibers from subthalamic nucleus to globus pallidus and substantia nigra

## ○ APPLIED PHYSIOLOGY - DISORDERS OF BASAL GANGLIA

- PARKINSON DISEASE
- WILSON DISEASE
- CHOREA
- ATHETOSIS
- CHOREOATHETOSIS
- HUNTINGTON CHOREA
- HEMIBALLISMUS
- KERNICTERUS

# CEREBRAL CORTEX

- **Cerebral cortex is also called pallidum and it consists of two hemispheres**
- **Both the cerebral hemispheres are separated by a deep vertical fissure**
  - Separation is complete anteriorly and posteriorly
  - Middle portion, the fissure extends only up to **corpusm callosum** (connecting the two hemispheres)
- **Surface of the cerebral cortex is characterized by**
  - **Sulci** - Slight Depression
  - **Gyri** - Raised Ridge



## ○ HISTOLOGY OF CEREBRAL CORTEX

### ○ LAYERS OF CEREBRAL CORTEX

- Gray matter
- White matter
- ***Molecular or Plexiform Layer*** - dendrites or axons from cells of deeper layers
- ***External Granular Layer*** - Dendrites & Axons end (axons enter white substance of the hemisphere)
- ***Outer Pyramidal Layer***
  - Medium pyramidal cells - outer portion
  - larger pyramidal cells - deeper portion
- ***Internal Granular Layer*** - horizontal fibers, which appear as a white strip known as outer strip
- ***Ganglionic Layer or Internal Pyramidal Layer*** - Pyramidal cells in this region are otherwise known as **Betz cells or giant cells**
- ***Fusiform Cell Layer*** - white matter of cerebral hemisphere

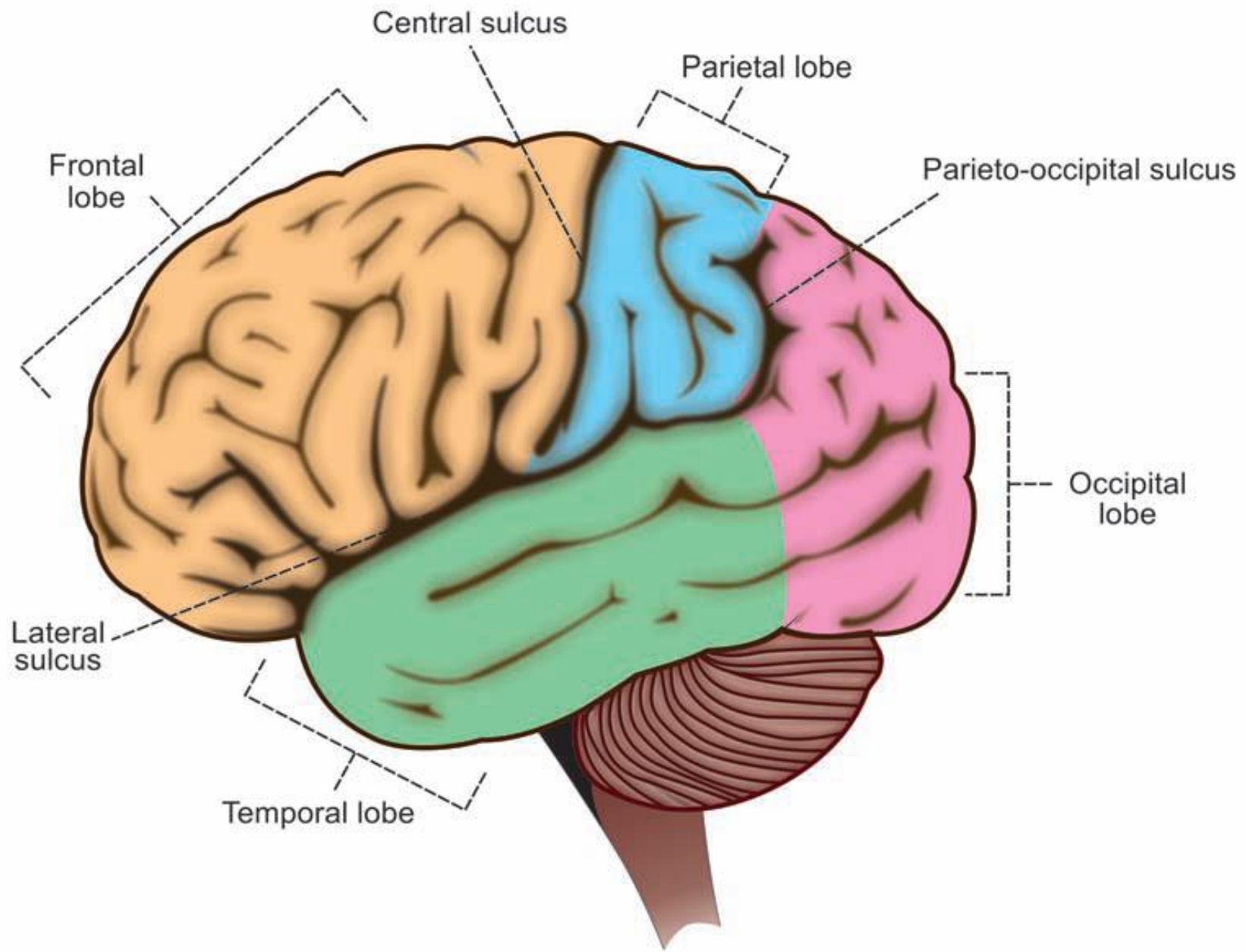
## ○ **LOBES OF CEREBRAL CORTEX**

### ○ **Four lobes**

- 1. Frontal lobe
- 2. Parietal lobe
- 3. Occipital lobe
- 4. Temporal lobe

### ○ **Four main fissures and sulci**

- **Central sulcus** (frontal and parietal lobes)
- **Parieto-occipital sulcus** (parietal and occipital lobe)
- **lateral sulcus** (parietal and temporal lobes)
- **Callosomarginal fissure** (temporal lobe and limbic area)



## ⦿ **CEREBRAL DOMINANCE**

⦿ Cerebral dominance is defined as the dominance of **one cerebral hemisphere over the other in the control of cerebral functions**

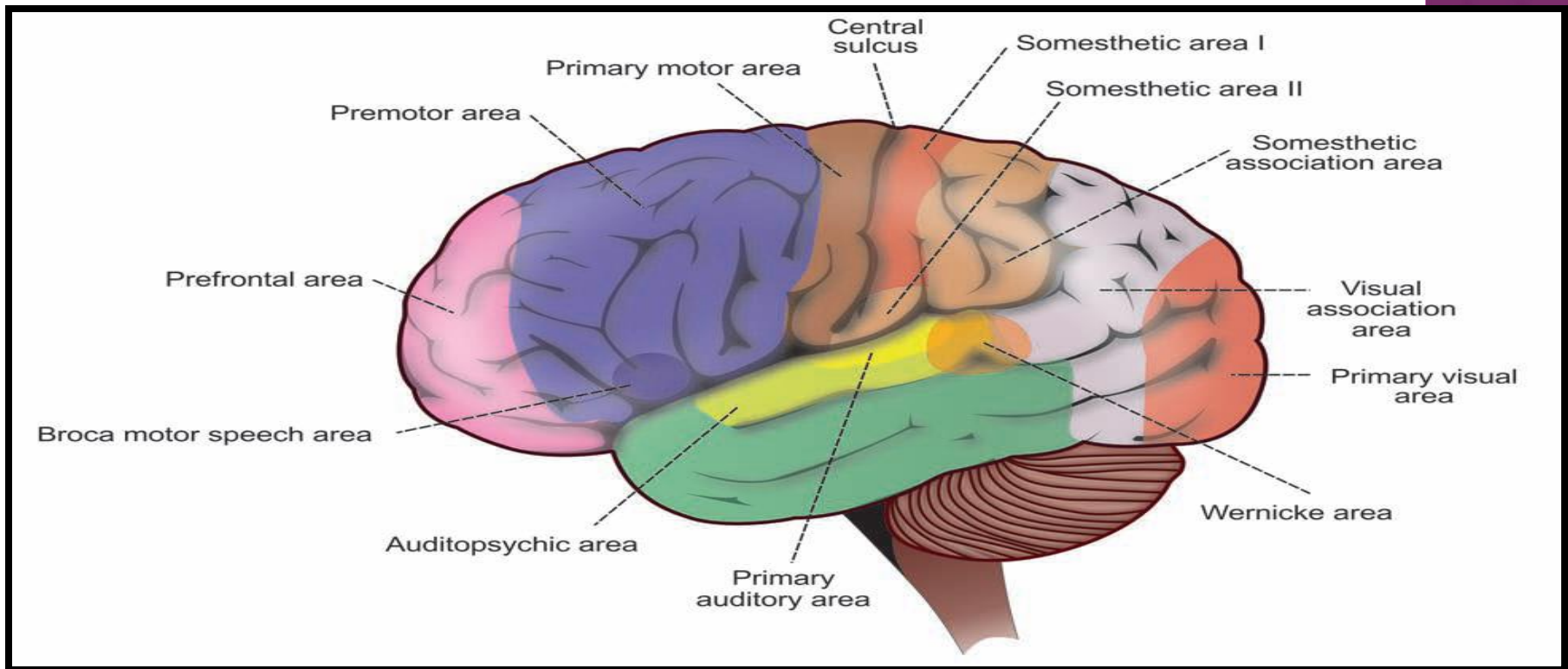
- Right handed - left hemisphere  
(representational hemisphere)
- Left handed - right hemisphere  
(representational hemisphere)

# FRONTAL LOBE OF CEREBRAL CORTEX

- Frontal lobe of cerebral cortex is divided into two parts:
  - A. Precentral cortex, which is situated posteriorly
  - B. Prefrontal cortex, which is situated anteriorly
- **PRECENTRAL CORTEX**
- **Includes**
  - Central sulcus
  - Precentral gyrus
  - Posterior portions of superior, middle and inferior frontal gyri

○ Precentral cortex is further divided into three functional areas:

- 1. Primary motor area
- 2. Premotor area
- 3. Supplementary motor area.



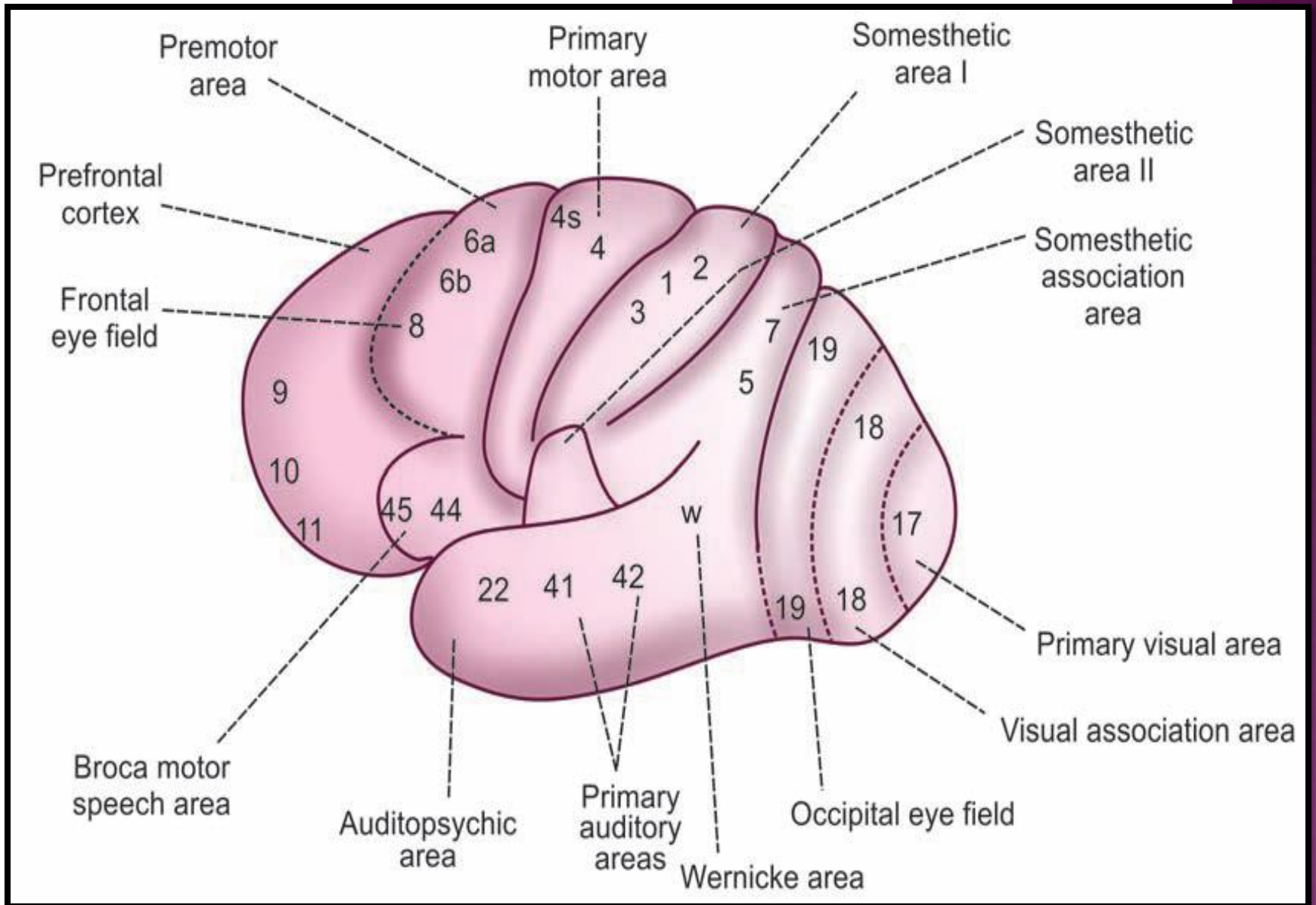
- ◉ ***Primary Motor Area (giant pyramidal cells)***
- ◉ **Functions of primary motor area - initiation of voluntary movements and speech**
- ◉ ***Area 4***
  - It activates both  **$\alpha$ -motor neurons and  $\gamma$ -motor neurons** simultaneously by the process called **coactivation**
- ◉ ***Effect of lesion of area 4***
  - The ability to walk is not affected
  - **Hemiplegia with spastic paralysis.**
  - (Hemiplegia means the paralysis in one half of the body)

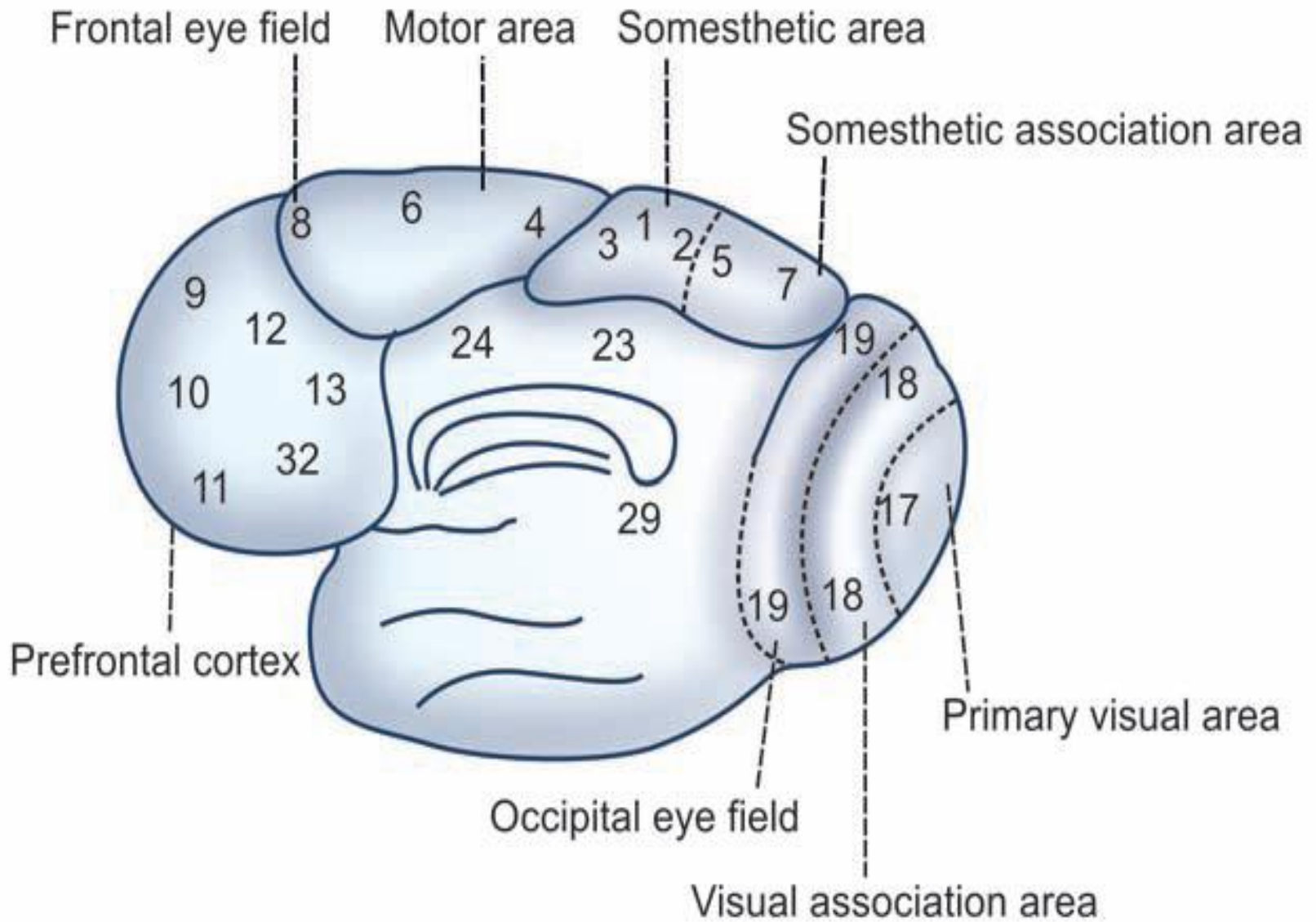
- ◉ ***Premotor Area (6, 8, 44 and 45)***
- ◉ ***Area 6 - Posterior portions of superior, middle and inferior frontal gyri***
  - ***Functions of area 6 - coordination of movements & cortical center for extrapyramidal system***
- ◉ ***Area 8 - frontal eye field***
  - ***Function of area 8 - Frontal eye field is concerned with conjugate movement of eyeballs***
- ◉ ***Area 44 & 45 (Broca area) - motor area for speech- dominant hemisphere***
  - ***Function of Broca area - movements of tongue, lips and larynx, which are involved in speech***



## ○ ***Supplementary Motor Area***

- Medial surface of frontal lobe rostral to primary motor area
  - Motor movements are elicited by electrical stimulation of this area like raising the contralateral arm, turning the head and eye and movements of synergistic muscles of trunk and legs
- ***Function of supplementary motor area - coordinated skilled movements***





# PREFRONTAL CORTEX OR ORBITOFRONTAL CORTEX

- Prefrontal cortex is the anterior part of frontal lobe of cerebral cortex
- Areas present in prefrontal cortex are 9, 10, 11, 12, 13, 14, 23, 24, 29 and 32.
  - Medial Surface Areas -12, 13, 14, 23, 24, 29 & 32
  - Lateral Surface Areas - 9, 10 & 11
- ***Functions of Prefrontal Cortex***
  - The higher functions like emotion, learning, memory , social behavior, short-term memories, intelligence & personality

## ◉ APPLIED PHYSIOLOGY - FRONTAL LOBE SYNDROME

◉ Emotional instability

◉ Lack of concentration

◉ Impairment of recent memory

◉ Apart from mental defects, there are some functional abnormalities also:

- i. Hyperphagia (increased food intake)
- ii. Loss of control over sphincter of the urinary bladder or rectum
- iii. Disturbances in orientation
- iv. Slight tremor

# PARIETAL LOBE

- Parietal lobe is divided into three functional areas:
  - A. Somesthetic area I
  - B. Somesthetic area II
  - C. Somesthetic association area

- **SOMESTHETIC AREA I (SOMATOSENSORY AREA I OR PRIMARY SOMESTHETIC OR PRIMARY SENSORY AREA)**
- ***Areas of Somesthetic Area I (3,1 & 2)-***  
Anterior part - 3, Posterior part - 1 & 2
- ***Functions of Somesthetic Area I***
  - Responsible for perception and integration of cutaneous and kinesthetic sensations
  - Sensory feedback to the premotor area
  - The movements of head and eyeballs

- ◉ **SOMESTHETIC AREA II**
- ◉ *Functions of Somesthetic Area II* - perception of sensation
  
- ◉ **SOMESTHETIC ASSOCIATION AREA (area 5 & 7)**
- ◉ *Functions of Somesthetic Association Area* - sensations like stereognosis



- ⦿ **APPLIED PHYSIOLOGY - PARIETAL LOBE**
- ⦿ 1. Contralateral disturbance of cutaneous sensations
- ⦿ 2. Disturbances in kinesthetic sensations
- ⦿ 3. Loss of tactile localization and discrimination

# TEMPORAL LOBE

- Temporal lobe of cerebral cortex includes three functional areas
  - A. Primary auditory area
  - B. Secondary auditory area or auditopsychic area
  - C. Area for equilibrium

- ◎ **PRIMARY AUDITORY AREA (area 41,42 & wernicke area)**
- ◎ ***Functions of Primary Auditory Area***
  - Primary auditory area is concerned with perception of auditory impulses, analysis of pitch and determination of intensity and source of sound

## ◎ **SECONDARY AUDITORY AREA**

- Secondary auditory area occupies the superior temporal gyrus. It is also called or **auditopsychic area or auditory association area.**
- It includes area 22

## ◎ **AREA FOR EQUILIBRIUM**

- Area for equilibrium is in the **posterior part of superior temporal gyrus**
- It is concerned with the **maintenance of equilibrium of the body**
- Stimulation of this area causes **dizziness, swaying, falling and feeling of rotation**

- ◉ **APPLIED PHYSIOLOGY - TEMPORAL LOBE SYNDROME**
- ◉ **Kluver- Bucey syndrome**
- ◉ **Aphasia**
- ◉ **Auditory disturbances s/a frequent attacks of tinnitus, auditory hallucinations with sounds like buzzing, ringing or humming**
- ◉ **Disturbances in smell and taste sensations**
- ◉ **Visual hallucinations**

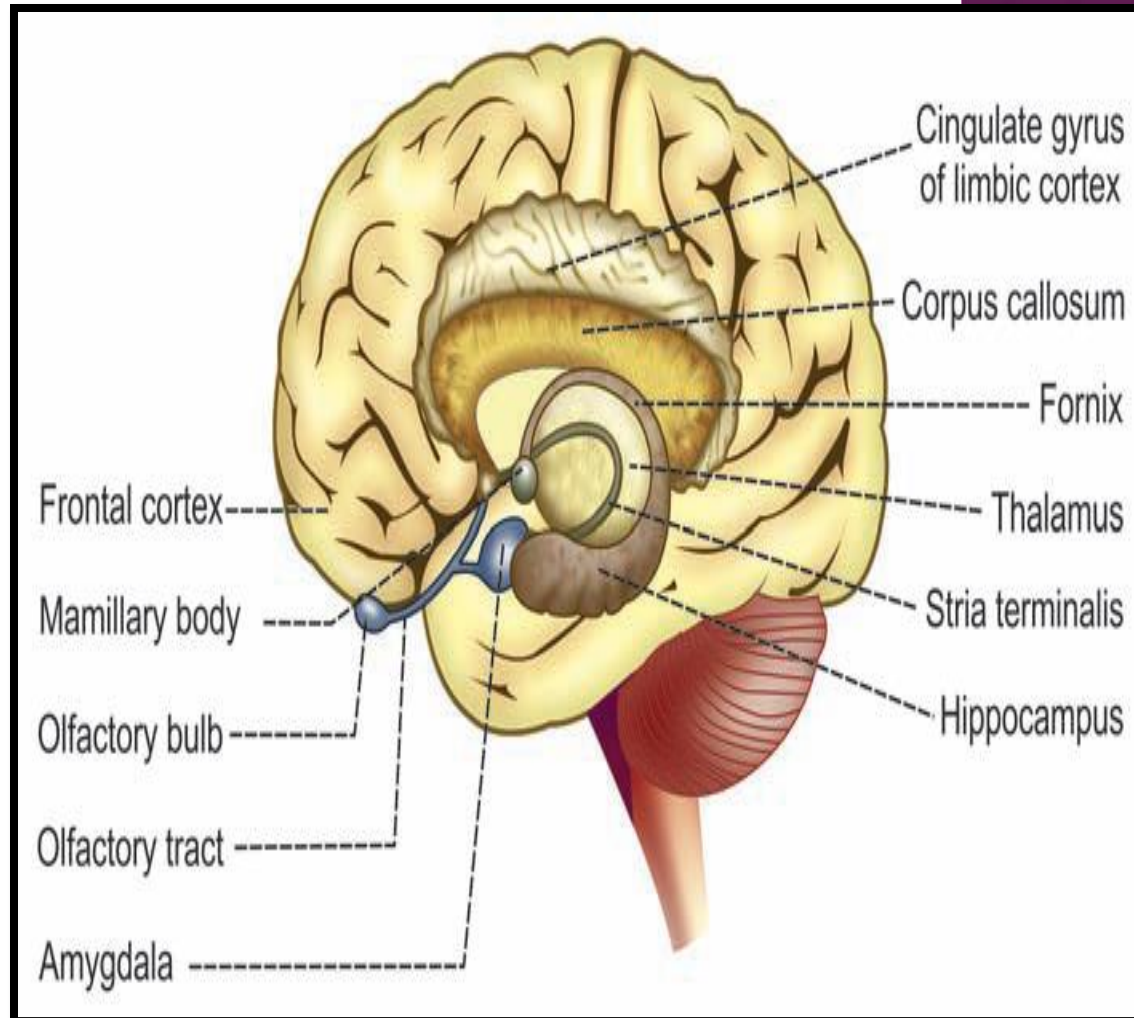
# OCCIPITAL LOBE

- Occipital lobe is called the **visual cortex**
- **AREAS OF VISUAL CORTEX**
  - 1. Primary visual area (area 17)
  - 2. Secondary visual area or visuopsychic area (area 18)
  - 3. Occipital eye field (area 19)
- ***Functions of Occipital Lobe***
  - Primary visual area (area 17) is concerned with **perception** of visual sensation
  - Secondary visual area (area 18) is concerned with **interpretation of visual sensation**
  - Occipital eye field (area 19) is concerned with reflex **movement of eyeballs**

- ◉ **APPLIED PHYSIOLOGY - *Occipital Lobe***
- ◉ Lesion in the upper or lower part of visual cortex results in hemianopia
- ◉ Bilateral lesion leads to total blindness

# LIMBIC SYSTEM

- ◉ Limbic system is a complex system of cortical and subcortical structures that form a **ring around the hilus** of cerebral hemisphere





# Limbic system

## Archicortical structures

1. Hippocampus
2. Dentate gyrus

## Paleocortical structures

1. Piriform cortex
2. Olfactory lobe
3. Olfactory tubercle

## Juxtallocortical structures

1. Cingulate gyrus of limbic cortex
2. Orbitoinsulotemporal cortex

## Subcortical structures

1. Amygdaloid complex
2. Septal nuclei
3. Thalamic nuclei
4. Hypothalamic nuclei
5. Caudate nucleus
6. Reticular formation of midbrain

## ○ **FUNCTIONS OF LIMBIC SYSTEM**

### ○ **1. OLFACTION**

- Piriform cortex and amygdaloid nucleus form the olfactory centers.

### ○ **2. REGULATION OF ENDOCRINE GLANDS**

- Hypothalamus plays an important role in regulation of endocrine secretion

### ○ **3. REGULATION OF AUTONOMIC FUNCTIONS**

- Hypothalamus plays an important role in regulating the autonomic functions such as:
  - i. Heart rate
  - ii. Blood pressure
  - iii. Water balance
  - iv. Body temperature

## ⦿ 4. REGULATION OF FOOD INTAKE

- Along with amygdaloid complex, the feeding center and satiety center present in hypothalamus regulate food intake

## ⦿ 5. CONTROL OF CIRCADIAN RHYTHM

- Hypothalamus is taking major role in the circadian fluctuations of various physiological activities

## ⦿ 6. REGULATION OF SEXUAL FUNCTIONS

- Hypothalamus is responsible for maintaining sexual functions in both man and animals

## ◉ 7. ROLE IN EMOTIONAL STATE

- Emotional state of human beings is maintained by hippocampus along with hypothalamus

## ◉ 8. ROLE IN MEMORY

- Hippocampus and Papez circuit play an important role in memory

## ◉ 9. ROLE IN MOTIVATION

- Reward and punishment centers present in hypothalamus and other structures of limbic system are responsible for motivation and the behavior pattern of human beings

# PROPRIOCEPTORS

- Proprioceptors are the receptors, which detect and give response to movement and change in position of different parts of the body
- These receptors are also called **kinesthetic receptors**

- ◉ **Situation of proprioceptors**
- ◉ Muscle spindle - Skeletal muscles
- ◉ Golgi tendon organ - Tendons
- ◉ Pacinian corpuscle
  - Skin
  - Fascia over muscles
  - Tendons
  - Tissues around joint
  - Joint capsule
- ◉ Free nerve ending
  - Skin
  - Skeletal muscles
  - Tendons
  - Fascia over muscles
  - Joints
- ◉ Labyrinthine proprioceptors -Labyrinth