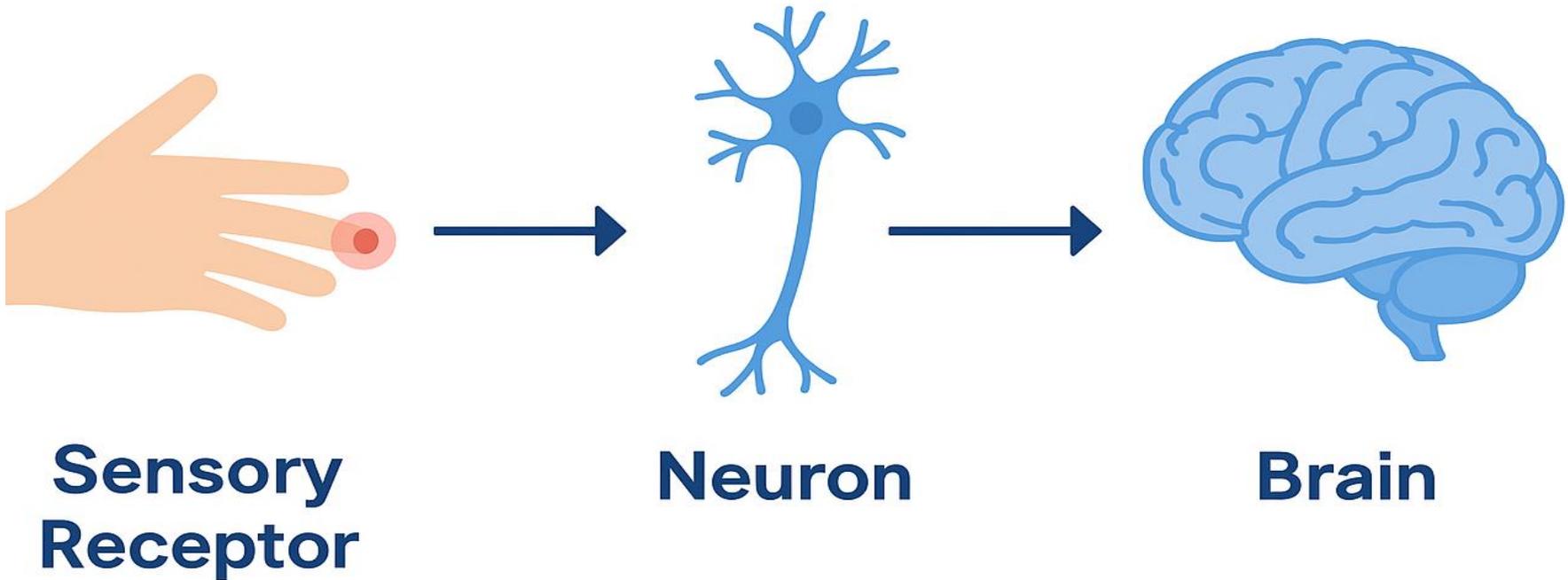


# From Sensation to Action: How the Brain Converts Signals into Response

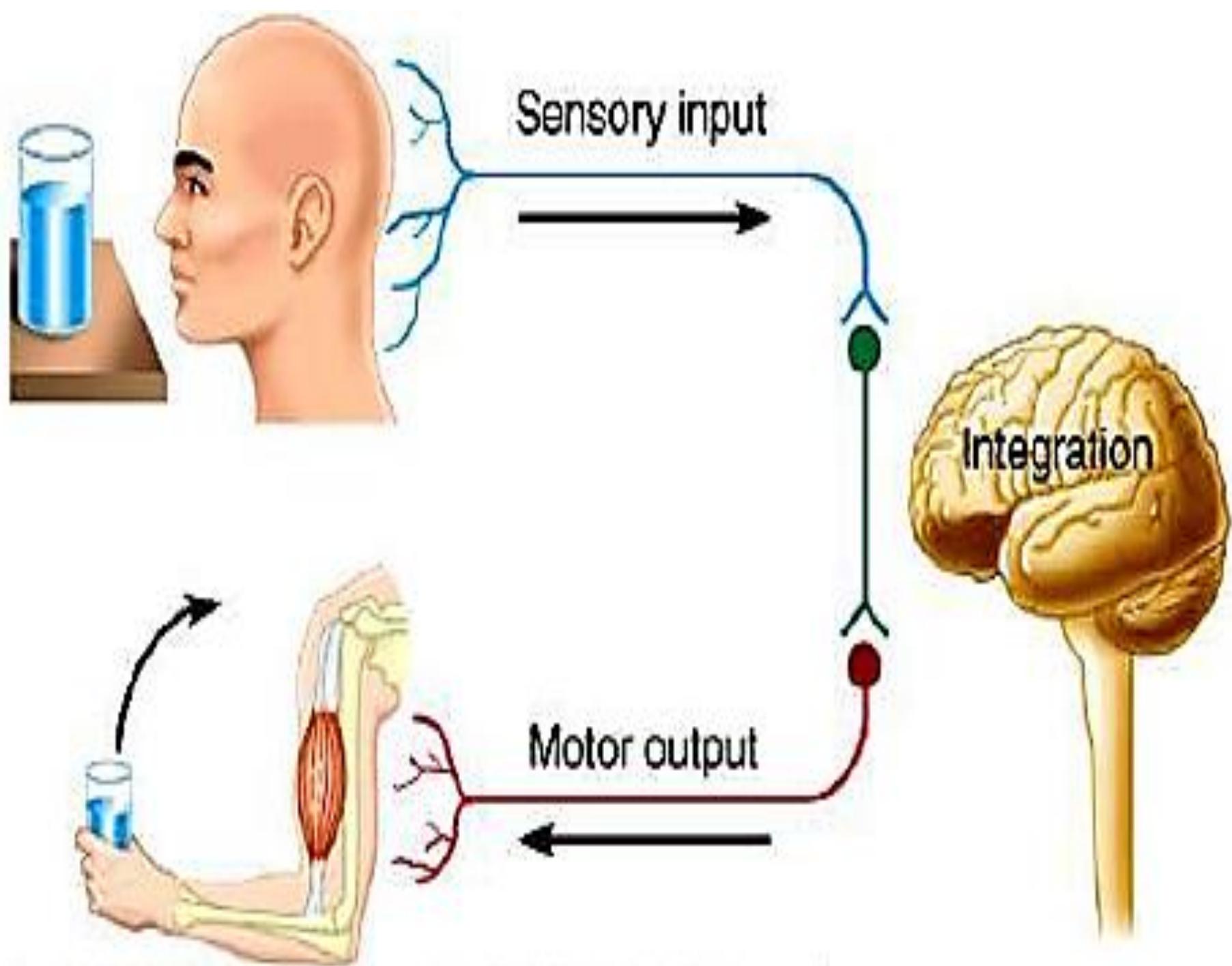


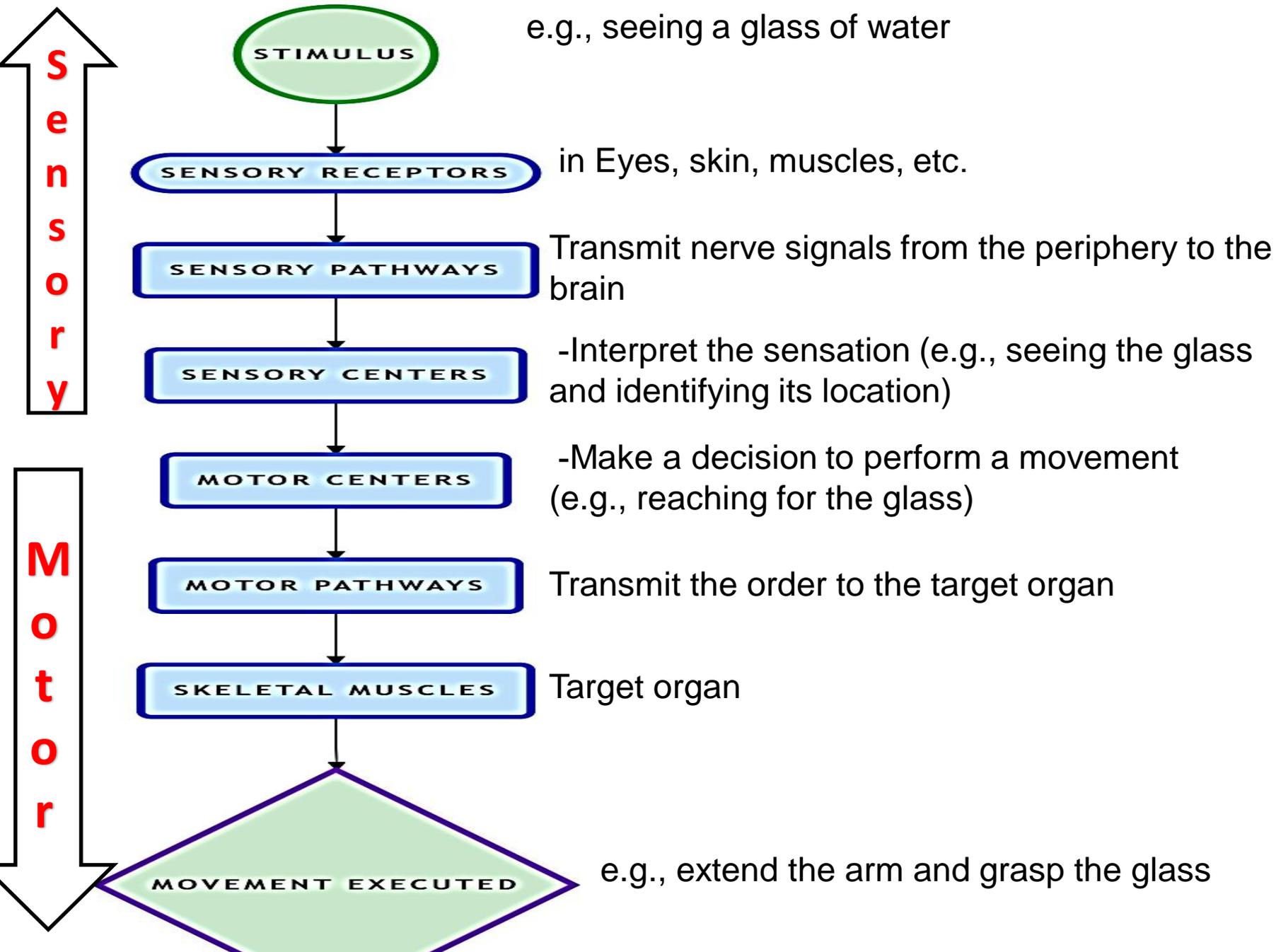
**PROF . KHALED ABDEL-SATER, M.D**

# Learning Objectives

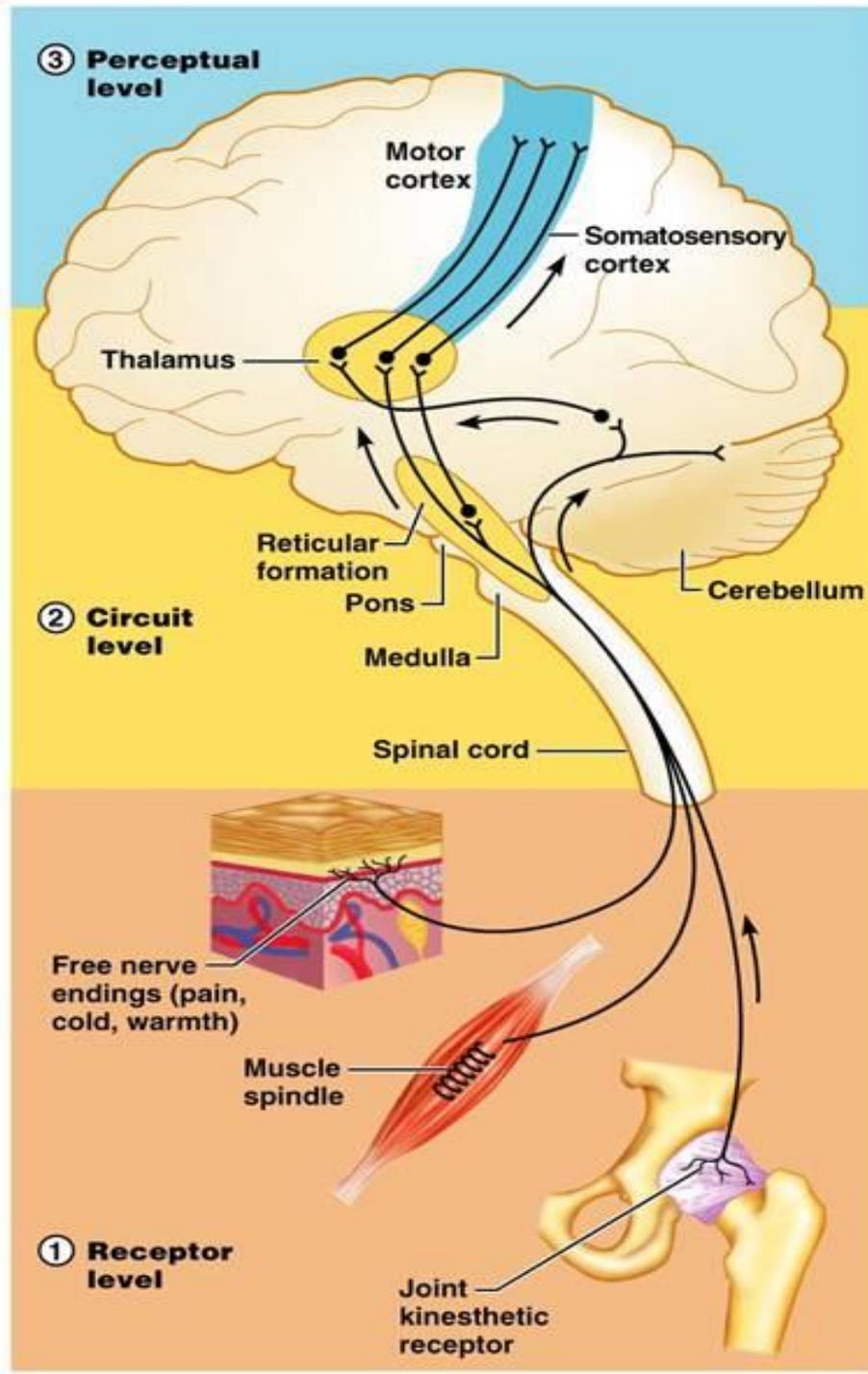
**By the end of the lecture the student will able to:**

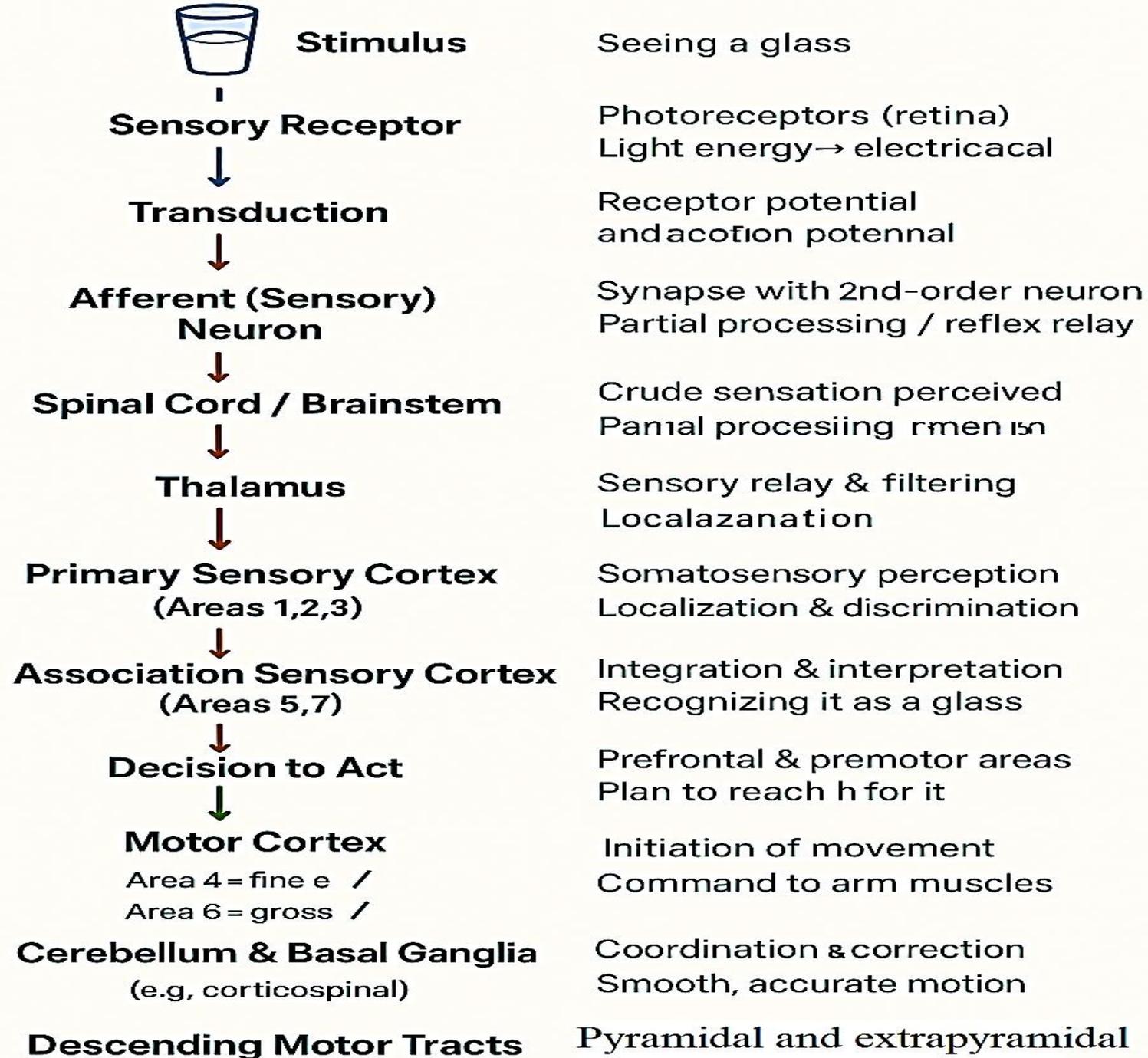
- 1. Trace** the sequential pathway of a neural signal from its origin at a sensory receptor to the execution of a motor response.
- 2. Explain** how the brain process sensory input and initiates motor output.
- 3. Describe** how receptors convert stimulus into electrical signal then how the brain understand this signal and convert it to motor.
- 4. Apply** the core principles of the sensorimotor pathway to predict the functional consequences of neural damage at specific points (e.g., stroke, spinal cord injury, neuropathy).





- 1. Stimulus**
- 2. Sensory receptor**
- 3. Afferent (sensory) nerve.**
- 4. Ascending tract**
- 5. Thalamus**
- 6. Sensory cortex.**
- 7. Motor cortex**
- 8. Descending tract**
- 9. Target organ**





# Stimulus

## ▪ Types of stimuli:

### I-According to the Nature of the Stimulus:

Electrical , mechanical (as pressure), chemical & thermal.

*Electrical stimuli* are usually used because:

- a. It is similar to the natural stimulus inside the body.
- b. Its intensity, duration and site of application can be easily controlled.
- c. Can be repeated for several times.
- d. Do not damaged the tissue.

## II-According to the Strength of the Stimulus:

- a. Subthreshold* (subminimal).
- b. Threshold* (minimal = Rheobase).
- c. Submaximal* (supraminimal).
- d. Maximal* .
- e. Supramaximal*.

# Receptors

## Def,

- They are specialized microscopic structures present at the peripheral end of afferent or sensory neurons.
- They are sensitive to stimuli.

## • Types

- Mechanoreceptors (touch, pressure)
- Thermoreceptors (temperature)
- Nociceptors (pain)
- Photoreceptors (light)
- Chemoreceptors (taste, smell)
- Proprioceptors (position)

# Sensory Afferent Neurons

## Functions of Afferent Neurons and Interneurons

1) Conduction of impulses

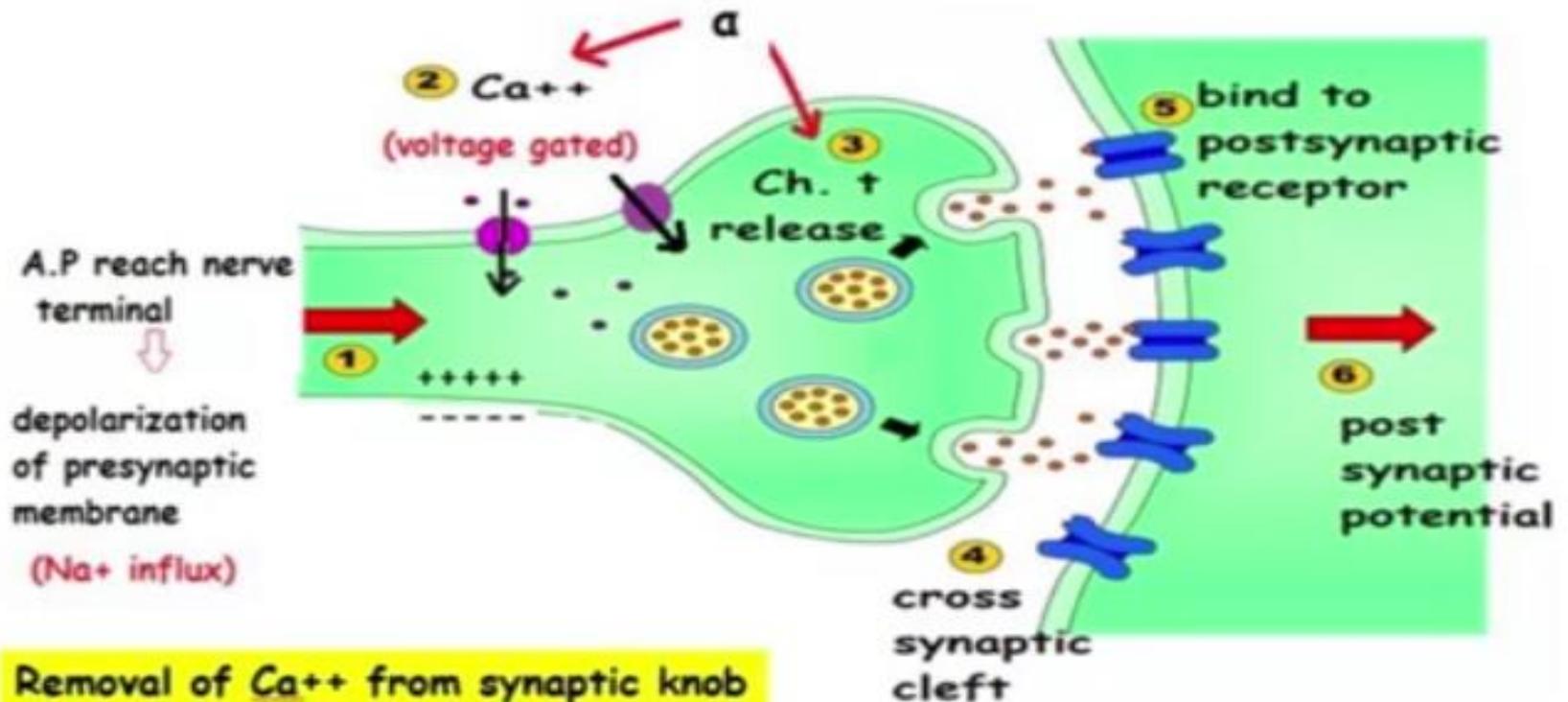
***2) Divergence.***

***3) Convergence.***

# Synapse

## 1- Release of chemical transmitter

## 2- Action on postsynaptic neuron

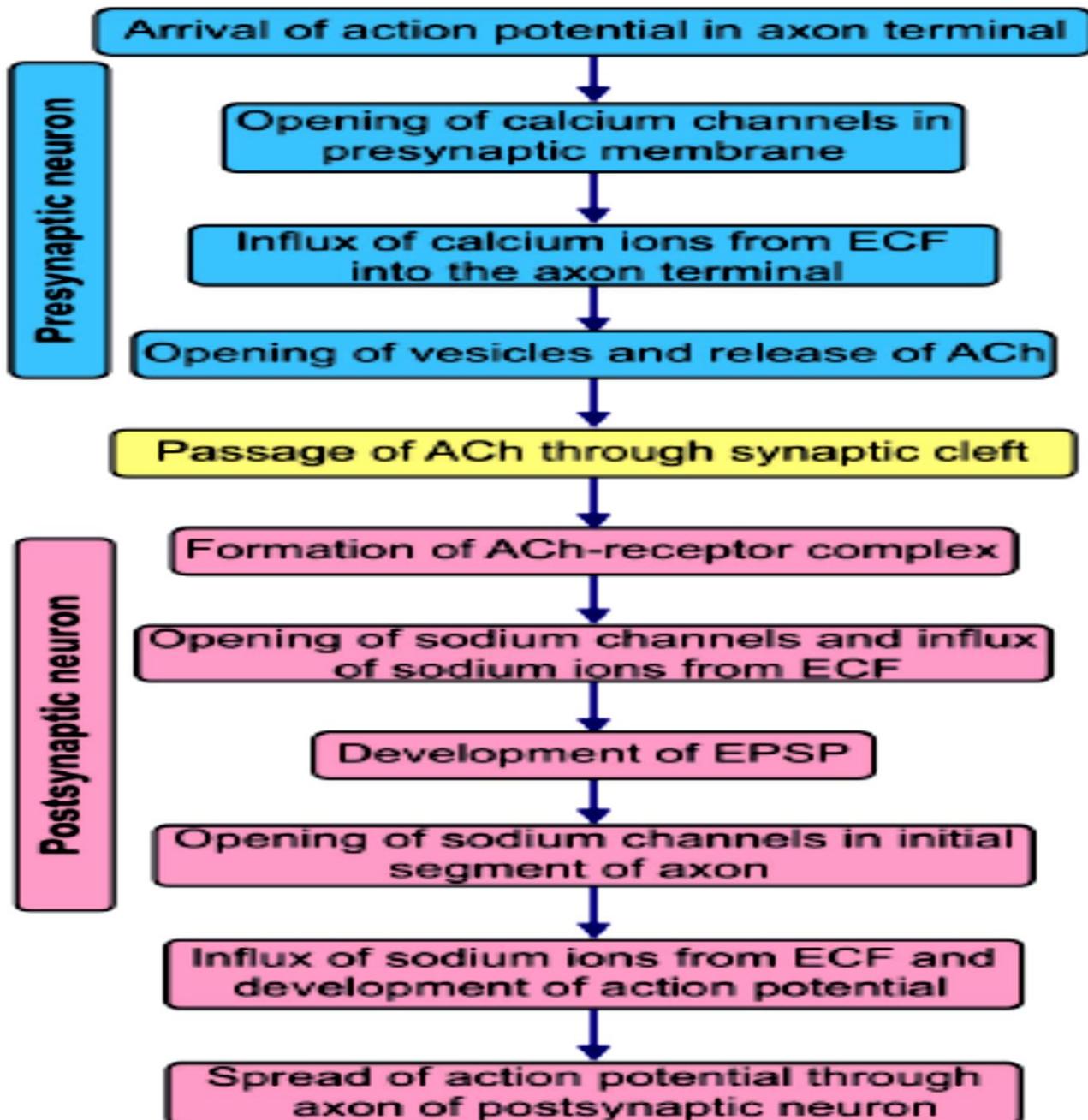


Removal of  $\text{Ca}^{++}$  from synaptic knob

1- bind to cytoplasmic Ptn

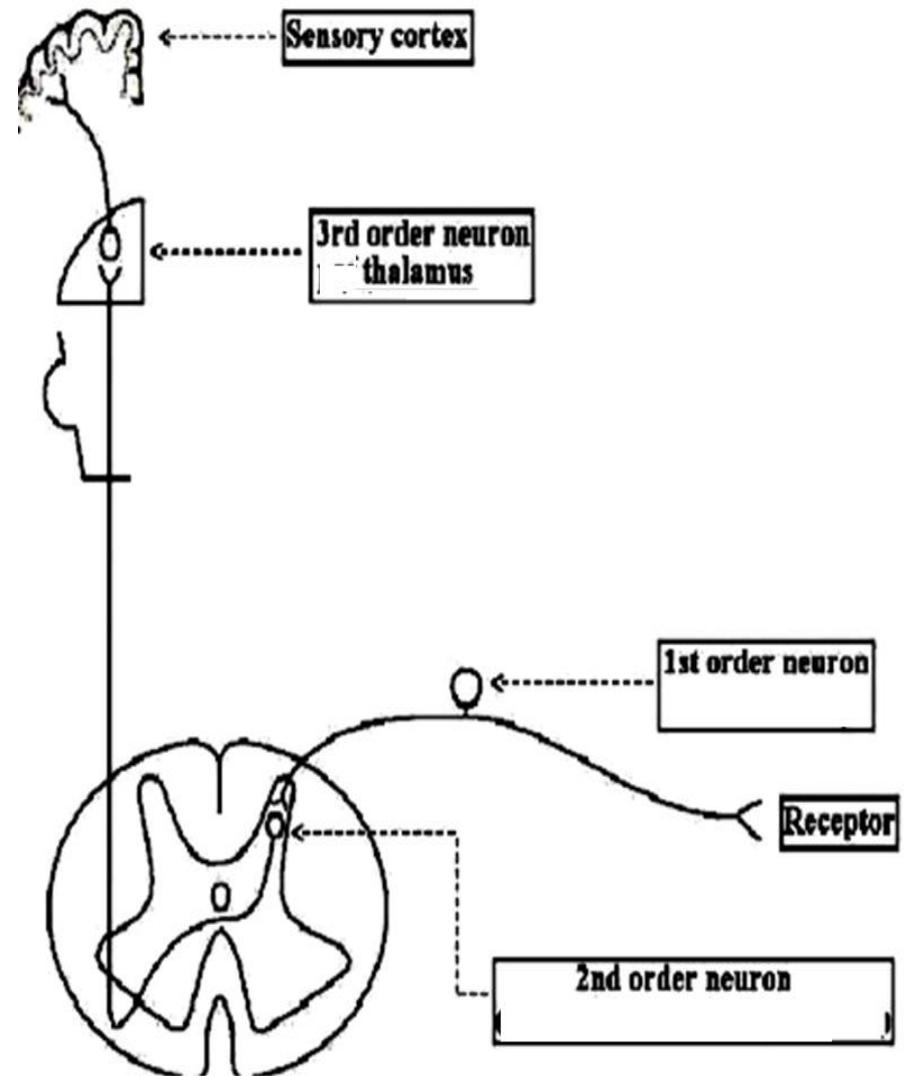
2-  $\text{Ca}^{++}$  cisternae

3- to ECF by  $\text{Ca}^{++}$  \  $\text{Na}^+$  pump

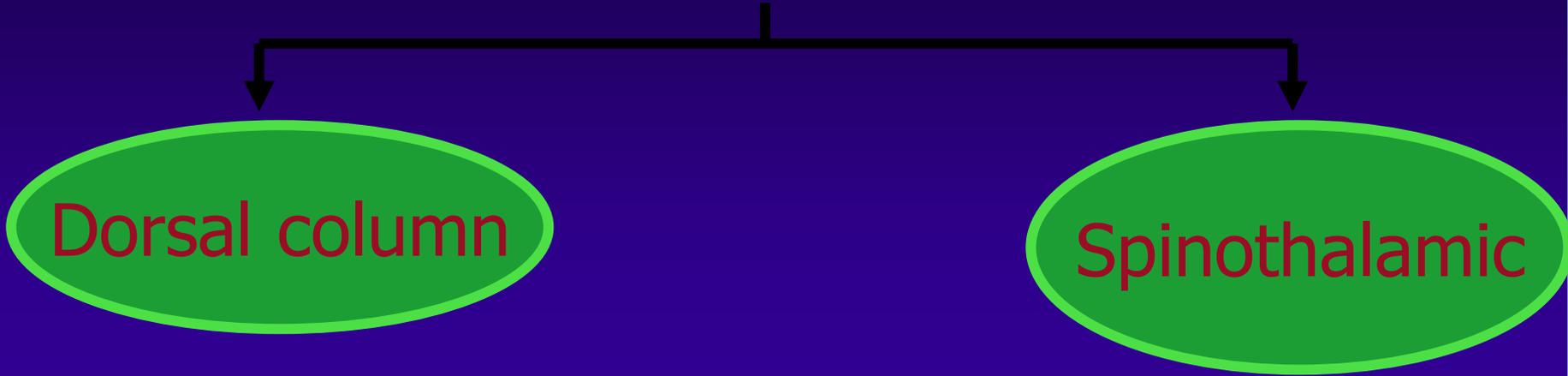


# Pathways to the CNS

- Receptor → First-order neuron → Spinal cord/brainstem → Second-order neuron → Thalamus → Third-order neuron → Cortex



# Sensory Pathways



1. Each carries different types of sensation to the somatic sensory area of the cerebral cortex

**FINE SENSATIONS**

**CRUDE SENSATIONS**

Cortical Sens. Area

Int. caps.

Thalamus

Lat. Lemniscis

Gracile & Cuneate n.

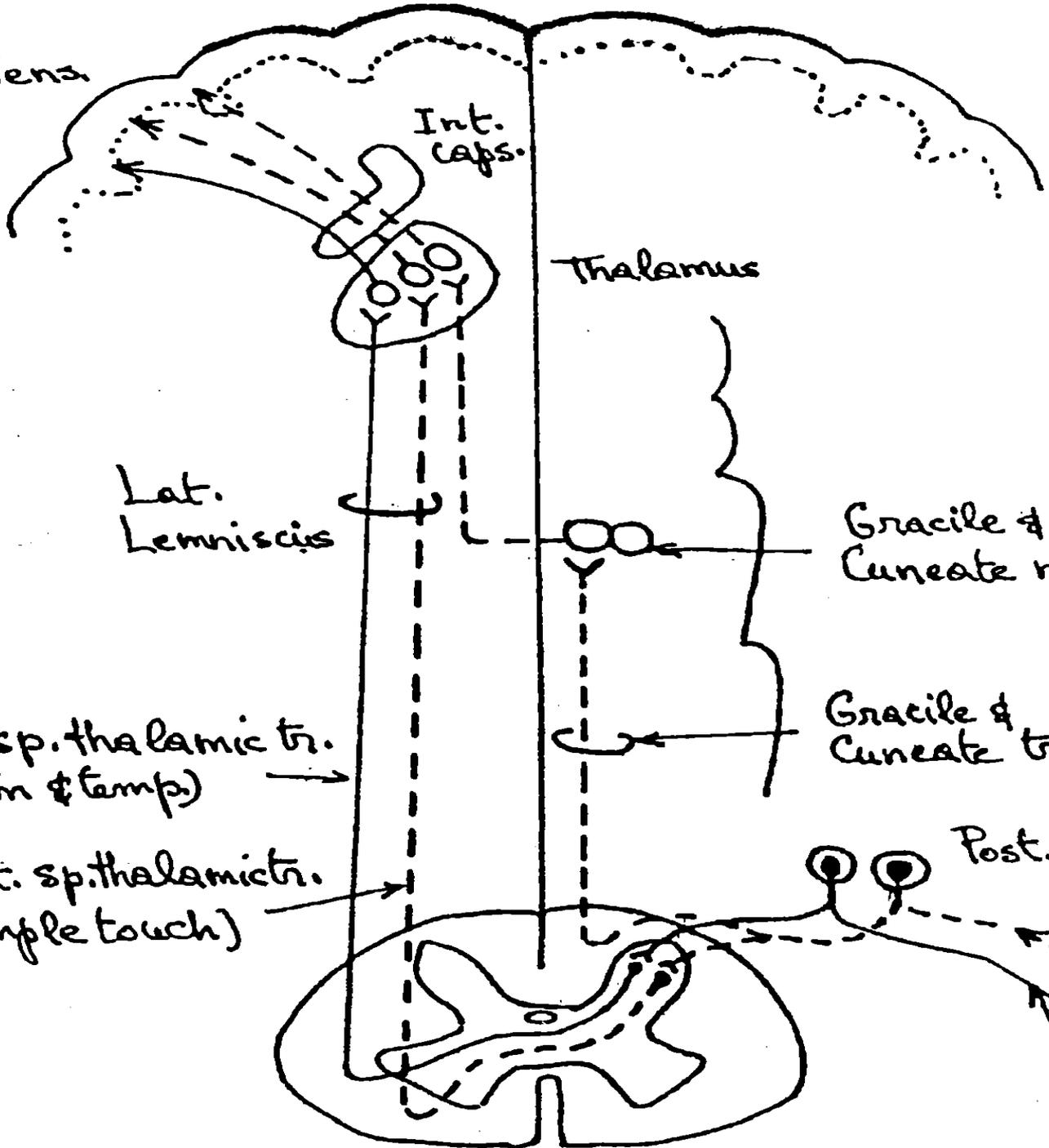
Lat. sp. thalamic tr. (pain & temp)

Gracile & Cuneate tr. (fine touch)

Vent. sp. thalamic tr. (simple touch)

Post. root g.

Touch  
Pain  
Temp.



# Functions of thalamus

- 1- Relay station for all fine sensations and MOTOR impulses from cerebellum to cortex.**
- 2-Center for protopathic sensations from opposite side of the body as crude touch, extreme degrees of temperature & slow pain.

Thalamus acts as a gateway to the cortex.  
Filters, integrates, and directs sensory input to specific cortical areas.

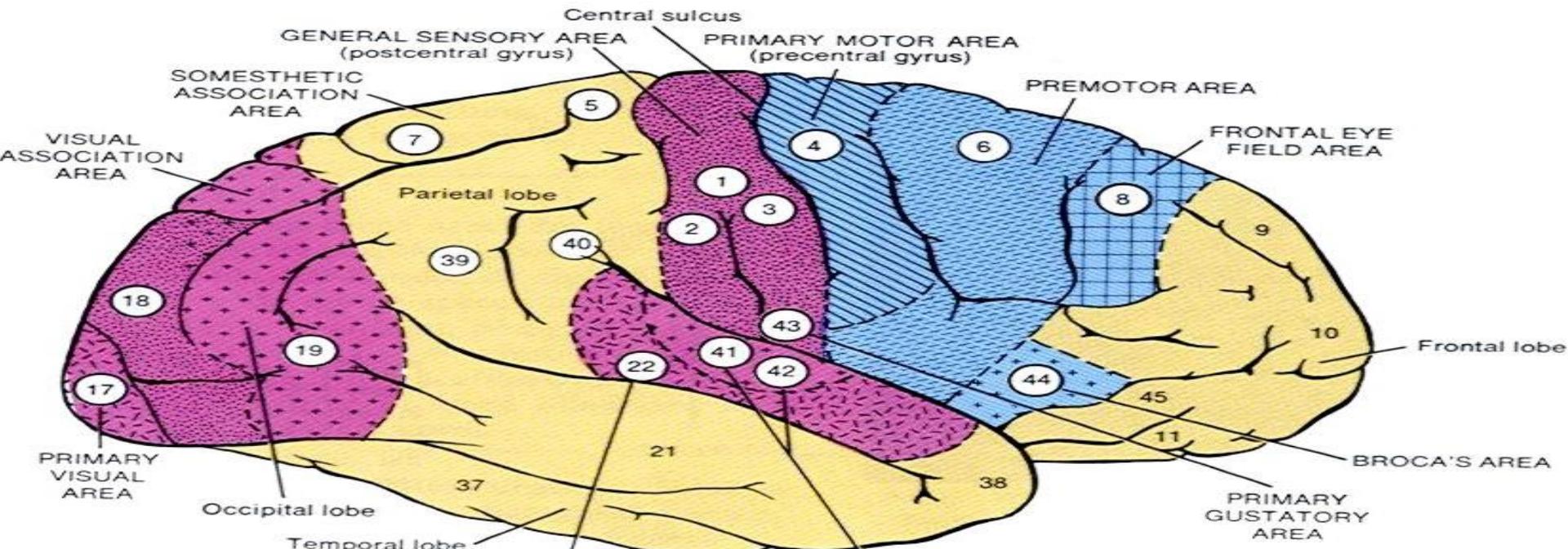
# Sensory Cortex

## Somatic sensory area I (Area 1,2,3)

Perception of the fine sensations: Fine touch, pressure, vibration, position & movement of joints & fine grades of temperature.

## Association Somatic Sensory Area (Area 5 &7)

interpretation & meaning of sensations.



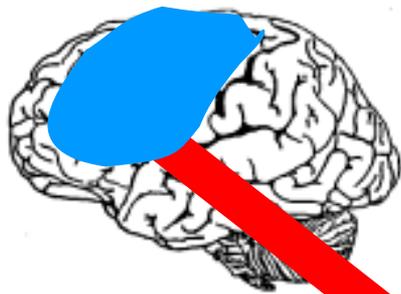
# Motor Cortex

- **Area 4:** It initiates the voluntary fine, discrete movements, especially of the hands & fingers (**skilled movements**).
- **Area 6:** It initiates the gross movements.



**skilled movements**

**Cerebellum and basal ganglia fine-tune responses**



# Desending Motor Tracts

Pyramidal

Extra pyramidal



Midbrain

Pons

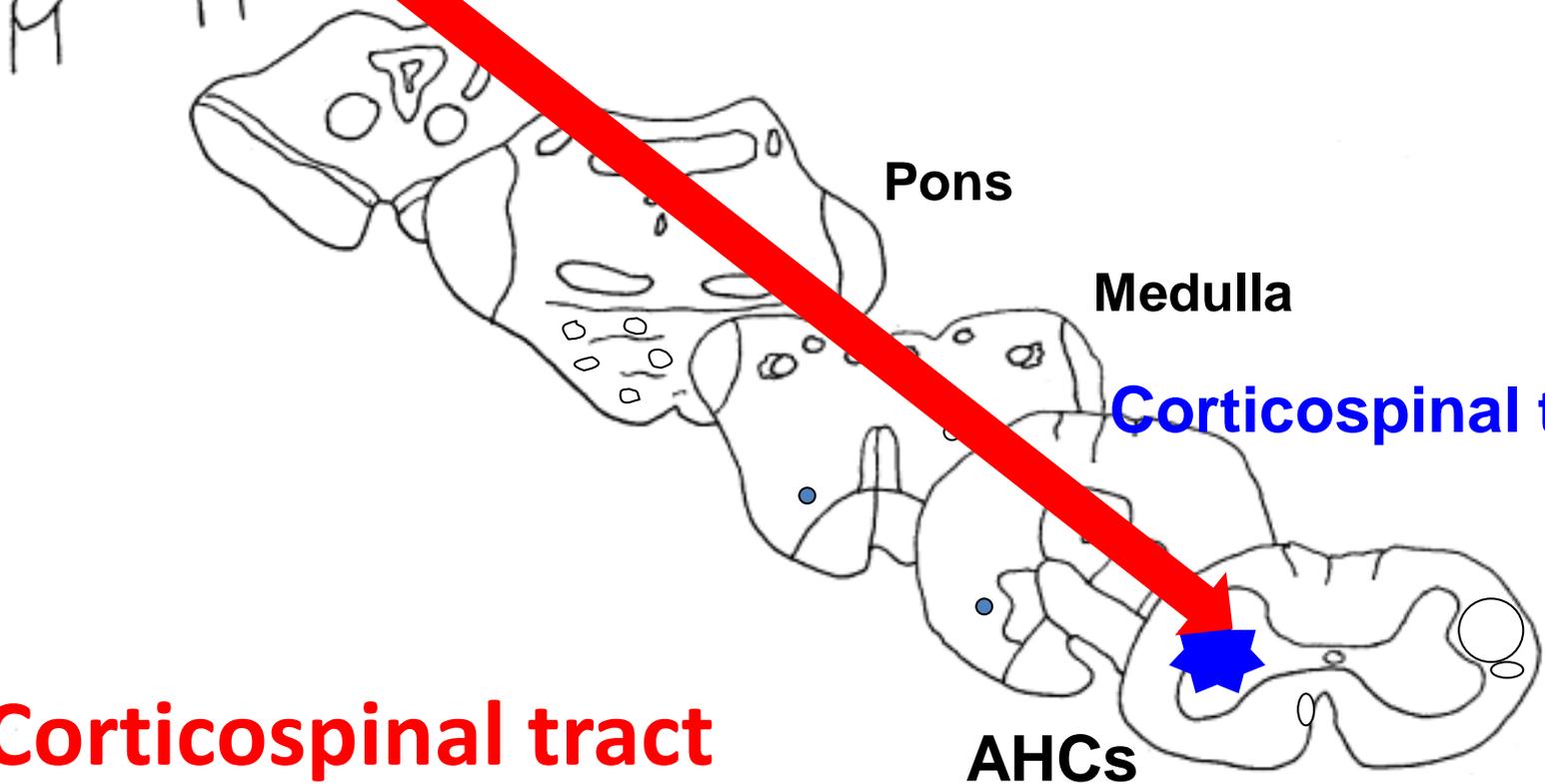
Medulla

Corticospinal tract

Corticospinal tract

AHCs

Spinal Cord



Stage	Key Components	Main Function
1. Reception	<b>Sensory Receptors</b> (Mechano-, Thermo-, Noci-, Photo-, Chemo-, Proprioceptors)	Detect a specific stimulus and transduce it into an electrical signal (Receptor Potential → Action Potential).
2. Transmission	<b>Afferent (Sensory) Neurons</b>	Carry sensory information from receptors to the CNS (Spinal Cord/Brainstem).
3. Ascending Pathway	<b>Sensory Pathways</b>	Relay signals to the brain via a 3-neuron chain: 1. <b>1st-order neuron</b> → Spinal Cord 2. <b>2nd-order neuron</b> → Thalamus 3. <b>3rd-order neuron</b> → Cortex
4. Processing & Relay	<b>Thalamus</b>	The "Gateway to the Cortex." Relays all fine sensations, filters sensory input, and is the center for crude sensations (pain, extreme temp).
5. Perception & Interpretation	<b>Sensory Cortex</b> - <b>Primary (Areas 1,2,3)</b> - <b>Association (Areas 5,7)</b>	- <b>Perceives</b> fine sensations (touch, vibration). - <b>Interprets</b> the meaning of sensations.
6. Decision & Motor Planning	<b>Brain</b>	Interprets sensation and makes a decision to perform a movement.
7. Motor Initiation	<b>Motor Cortex</b> - <b>Area 4</b> (Fine, skilled movements) - <b>Area 6</b> (Gross movements)	Initiates voluntary motor commands.
8. Coordination	<b>Cerebellum &amp; Basal Ganglia</b>	Fine-tune and coordinate movement plans for accuracy and smoothness.
9. Descending Command	<b>Descending Motor Tracts</b> (e.g., Corticospinal tract)	Carry motor commands from the brain down the spinal cord.
10. Execution	<b>Spinal Cord → Anterior Horn Cells (AHCs) → Efferent (Motor) Neurons</b>	Final relay in the CNS. Motor neurons carry the signal to the target organ (muscles).
11. Response	<b>Target Organ</b> (e.g., Muscles)	Executes the motor response (e.g., arm extension, grasping).