



# Thalamus

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# Learning outcomes:

- **At the end of the lecture, you will be able to:**

1. Describe the thalamic nuclei.
2. Explain the functions of the thalamus.
3. Explain the reticular activating system and factors affecting its activity.



# Thalamus

- ❑ It is an ovoid gray mass located in the diencephalon.
- ❑ The two thalami of both sides are separated by the 3rd ventricle with interconnection by a narrow band called interthalamic adhesion.
- ❑ The gray matter of the thalamus is divided internally by lamina of white matter into many separate nuclei.



# Thalamic nuclei

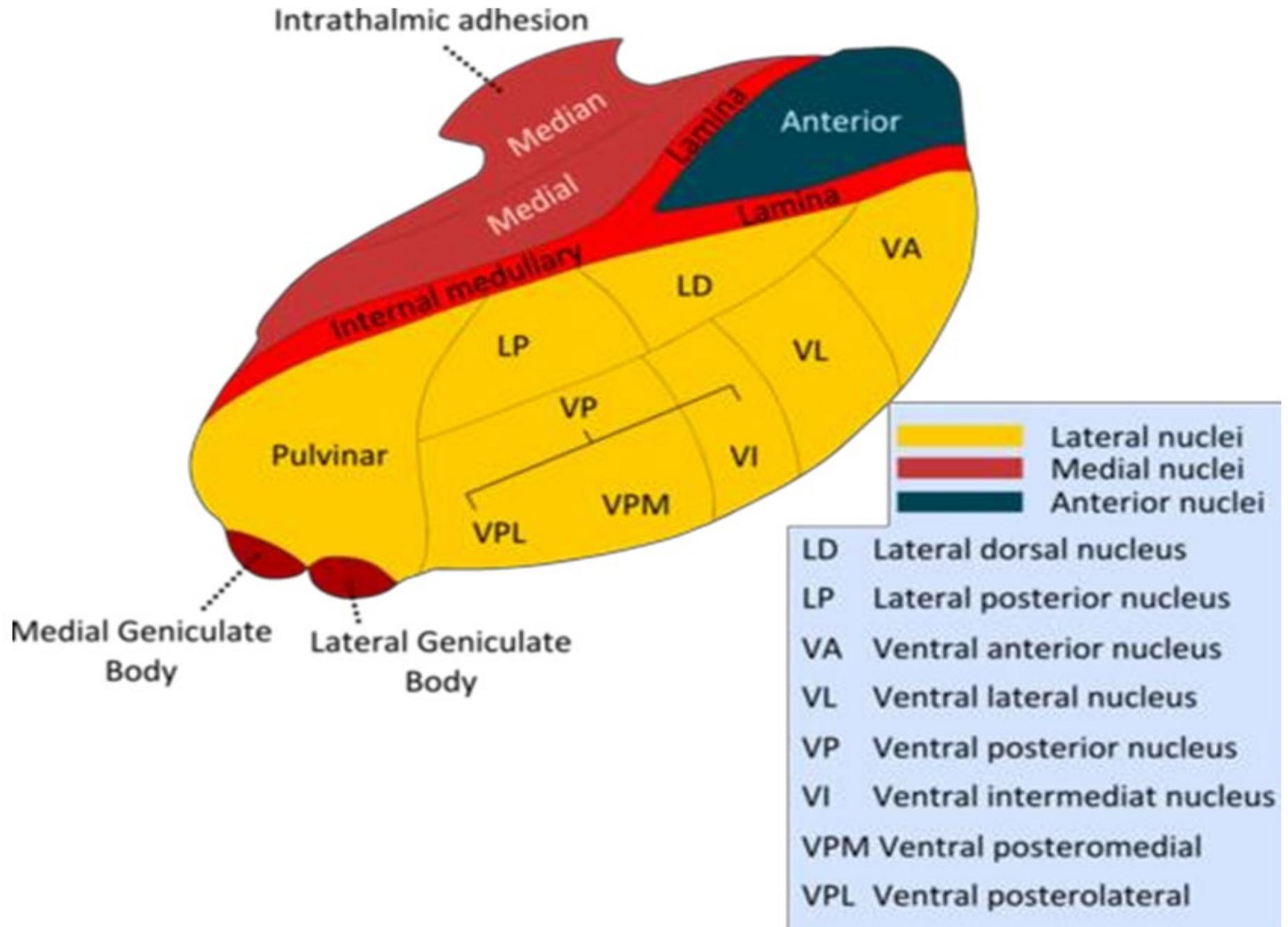
Functionally, thalamic nuclei are divided into:

1- Specific nuclei: Receive well defined afferents and project to specific areas in the cerebral cortex. They include:

i- Anterior nuclei.

ii- Medial nuclei.

iii- Lateral nuclei





**2- Non-specific nuclei:** **Receives** input mainly from **R.A.S**, and **project** diffusely to **all parts** of the neocortex. **They includes:**

**i- Intralaminar nuclei.**

**ii- Midline nuclei.**

**iii-Reticular nuclei.**



# Functions of thalamus

## 1-Sensory functions

### A) Thalamus acts as a sensory relay station:

**All ascending sensory pathways** before reaching the cerebral cortex relay in the thalamus especially those carrying **fine epicritic sensations** from **opposite** side of the body.

*i) Somatic sensory pathways* relay in **ventral posterior (VP)** nucleus of the **opposite** side, where those



- from **body** → relay in **lateral part of VP** nucleus
- from **face & taste** → relay in **medial part of VP** nucleus

*ii) Special sensations:*

- **Vision:** the optic fibers from both **retinae** reach **L.G.B.** and projected to the **visual cortex**.
- **Hearing:** auditory fibers from both **ears** relay in **M.G.B.** before reaching the **auditory cortex**.

## **B) Gating of the ascending sensory information:**

- **Corticofugal impulses** are transmitted back from the **cerebral cortical sensory areas** to the **thalamic relay nuclei** which already project to these areas.
- **This cortical-feedback is inhibitory**, and it **decreases** transmission through these nuclei particularly when the **sensory input is very high**.



## C) Thalamus as a sensory center:

Discrimination of many sensory impulses occurs in the thalamus but the sensations felt are of crude protopathic nature e.g: diffuse pain & crude touch.

## 2- Motor functions:

- Ventral anterior (VA) and ventral lateral (VL) nuclei relay motor signals from the **basal ganglia** and **cerebellum** to the **motor** and **premotor areas** of the frontal lobe to control their functions.
- V.P.L nucleus relays **proprioceptive** signals to the **motor** cortex. This provides sensory information about **position** and **movements** of the different parts of the body.

### 3- Association & integration functions:

- Anterior and medial thalamic nuclei together with hypothalamus and limbic system play a role in integrating the visceral and somatic motor responses evoked during **emotions**.
- The reciprocal connection between the dorsomedial (D.M) nucleus of the thalamus and prefrontal areas may play a role in the coding, storing and recalling of memory.

## 4- Arousal function:

- The non-specific thalamic nuclei receive excitatory signals from the R.A.S of brain stem, and project it to almost all areas of the cerebral cortex, producing **arousal** and **wakefulness**.

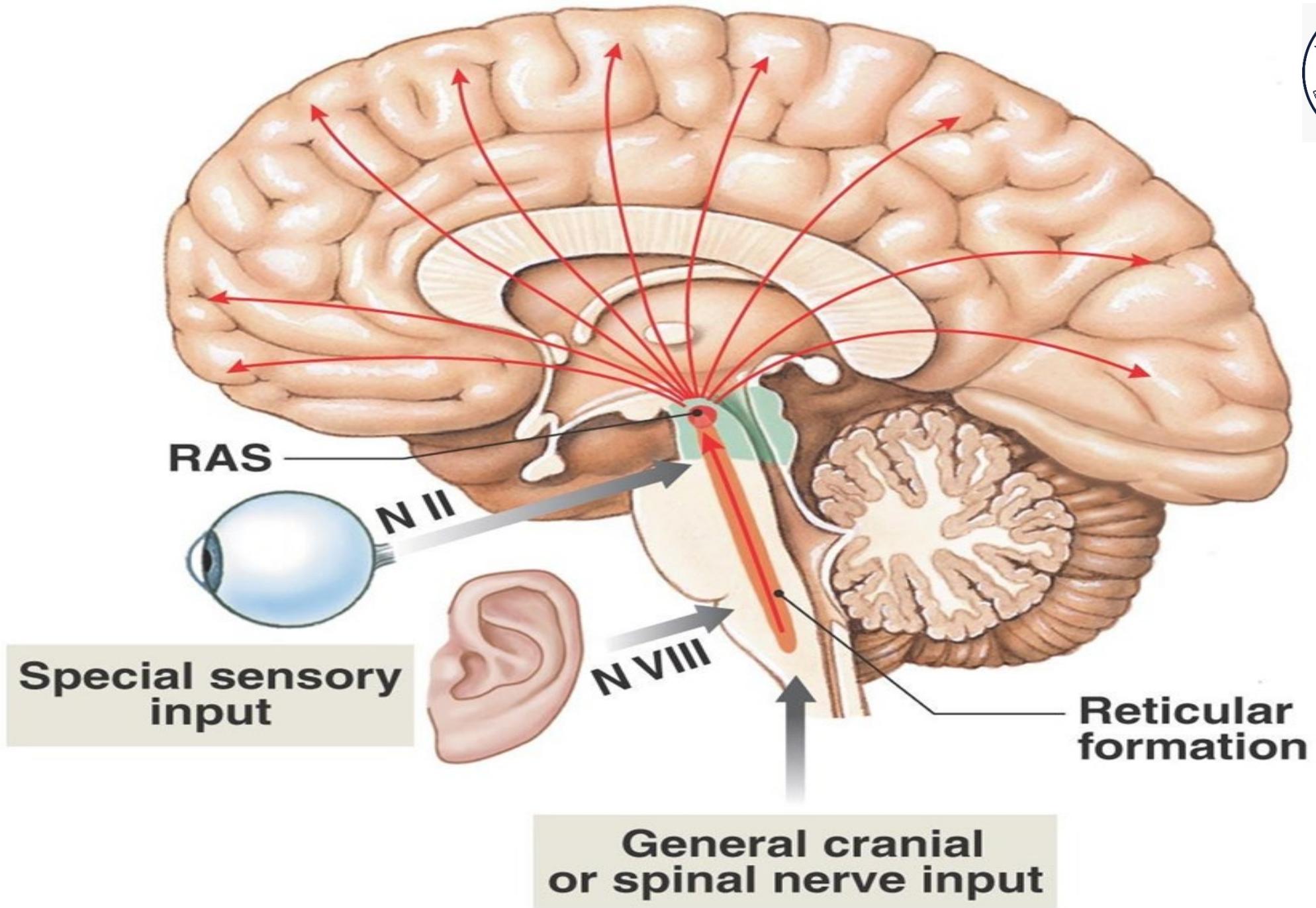


# Wakefulness (Arousal)

➤ Def.: The state of **consciousness** in which the person is aware of the various **sensory stimuli**, as well as, **his feelings, thoughts and ideas**. It also enables the person to **pay attention to external stimuli**.

## ➤ Reticular activating system (RAS):

- The RAS consists of facilitatory reticular formation (in **pons**) with its upward projections to the non-specific thalamic nuclei, from which the excitatory signals project diffusely to all areas of the neocortex, causing generalized activation of the brain.
- This activation of the brain produces arousal and wakefulness.





# ➤ Factors affecting activity of R.A.S

## 1-Sensory signals:

- Sensory signals from every sensory system in the body produce activation of RAS neurons.
- **Pain and proprioceptive** signals are **stimulatory** than others.



## 2-Feedback signals:

- Feedback signals from the cerebral cortex are sent back to RAS, whenever the cortex becomes activated by **thinking or motor activity**.
- This corticofugal feed-back activates **R.A.S** which in turn sends more excitatory signals to the **cortex** to enhance its activity.



## 3-Neurotransmitters:

- Epinephrine and norepinephrine: Lower the threshold for excitation of neurons of the R.A.S.
- Serotonin: Released mainly by the neurons of raphe nuclei in medulla. It suppresses R.A.S and could play a role in sleep. Administration of anti-serotonin drugs → insomnia.



## 4-Reticular inhibitory area (RIA):

- Located in medulla oblongata.
- When this area becomes excited, it inhibits RAS by increased secretion of serotonin.
- ❖ The normal wakefulness-sleep cycles may be regulated through **alternating reciprocal** activity in between **RAS** and **RIA**.

## 5-Drugs:

- Sympathetic drugs: as amphetamine and adrenaline increase the activity of RAS (explain alert state during emergency and stress).
- Anesthetic drugs: ↓ conduction through RAS synapses → unconsciousness.



# References

1. Costanzo, Linda S. "BRS Physiology (Board Review Series)." (2018).
2. Ganong, William F. "Review of medical physiology." (2020).
3. Hall, John E and Hall, Micheal E. "Guyton and Hall Textbook of medical physiology." (2021).