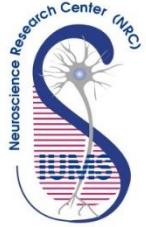


A close-up photograph of a branch with several small, yellow, star-shaped flowers. Some flowers are fully bloomed, while others are still buds. Water droplets are visible on the petals and leaves, suggesting a recent rain or dew. The background is blurred.

Welcome

Photography By
Behnam Jameie
Tehran Deymah 1391



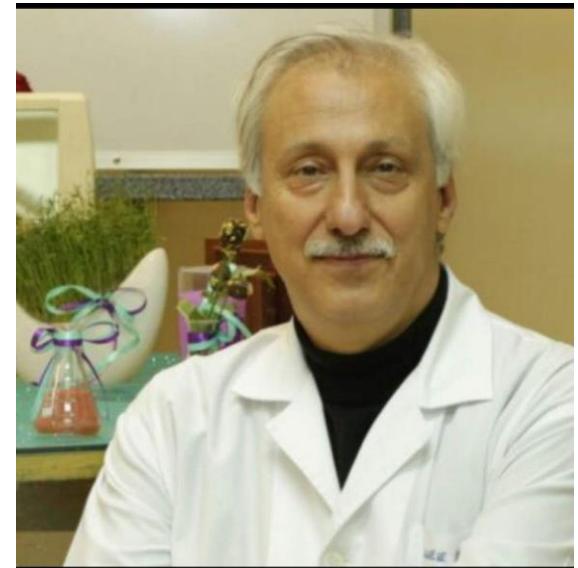
Introduction to Human Nervous System

By: Professor Seyed Behnamedin Jameie

Prof of Anatomy & Neuroscience

Neuroscience Research Center

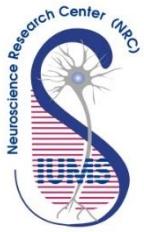
Iran University of Medical Sciences





Human NS Importance & Function

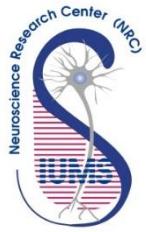
- Human NS, definitely the human brain, is the most complex structure and system in the living world.
- Master controller and communicating system in the body
- NS acts as a regulator and coordinator of all human functions
- NS acts in close to endocrine and immune system.
- It helps human to respond effectively to different stimuli and adapting to environment.
- By evolution of human cerebral cortex, higher cortical functions give human unique abilities in cognitive function



Human NS Function

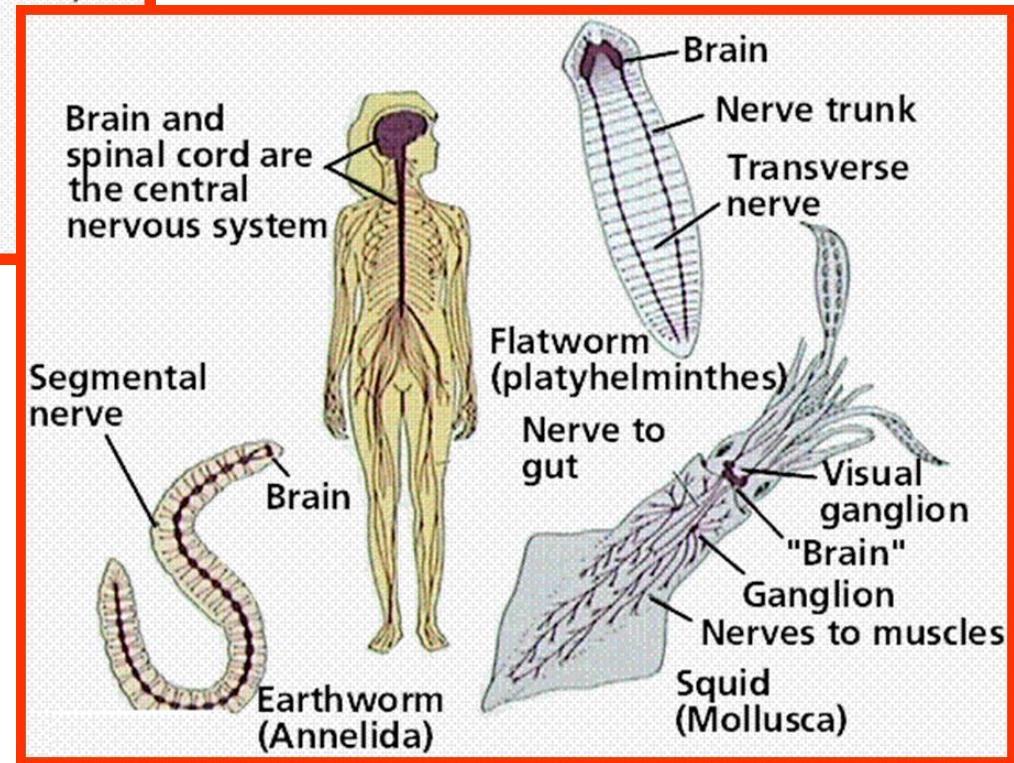
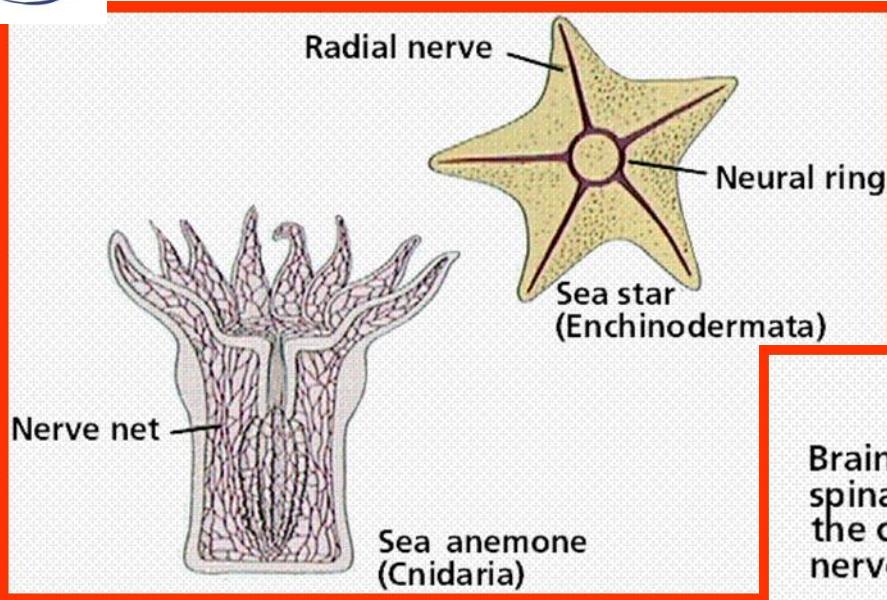
1. Sensory input – gathering information
2. Integration
3. Motor output

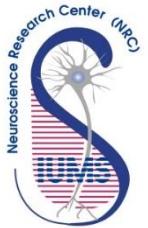
The NS does not work alone in maintaining homeostasis.



The ability of cells to respond to the environment has evolved over billions of years

Comparative Anatomy





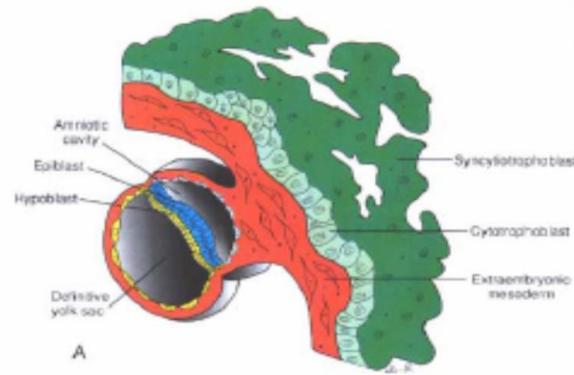
Neurolation

How does NS form?

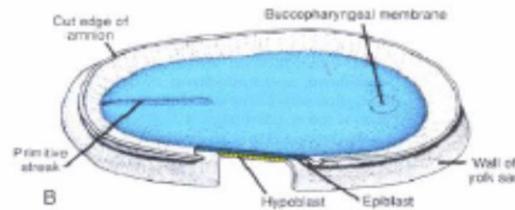
- NS forms since the end of week 3 to week 8 of intrauterine life.
- NS originates from embryonic Ectoderm.
- Neurolation passes through different steps as follows:
 - *Proliferation*
 - *Differentiation*
 - *Migration*
 - *Synaptogenesis and synaptic rearrangement*

Neurolation Ectoderm and Neural plate Phase

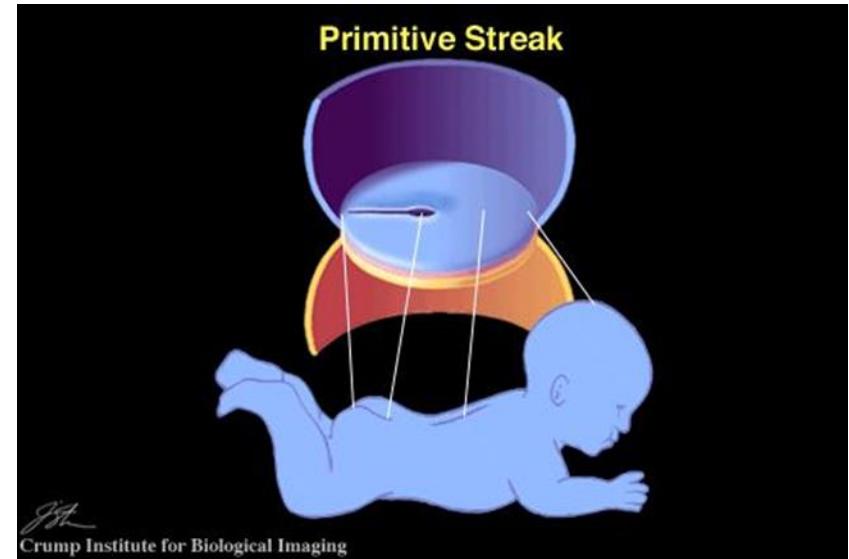
Bilaminar Germ Disc at End of Week 2



A



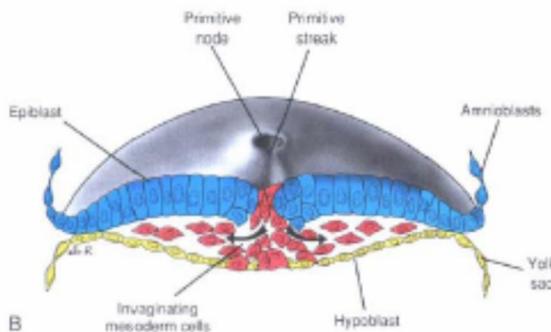
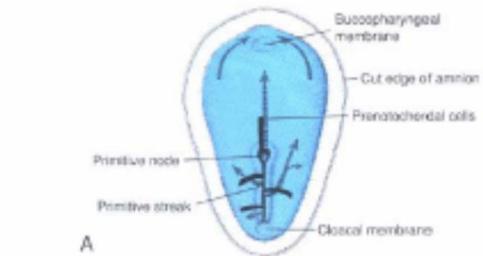
B



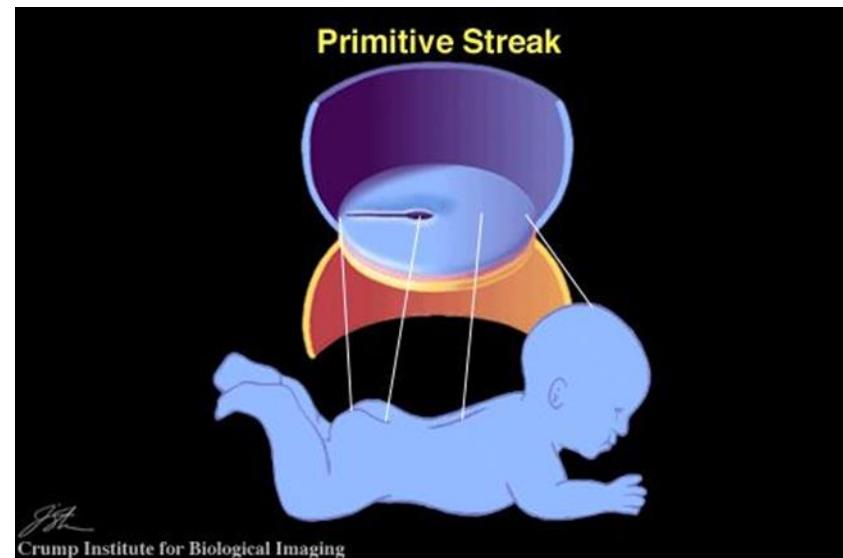
Neurolation Ectoderm and Neural plate Phase

Week 3

Gastrulation Forms Trilaminar Germ Disc and Notochord

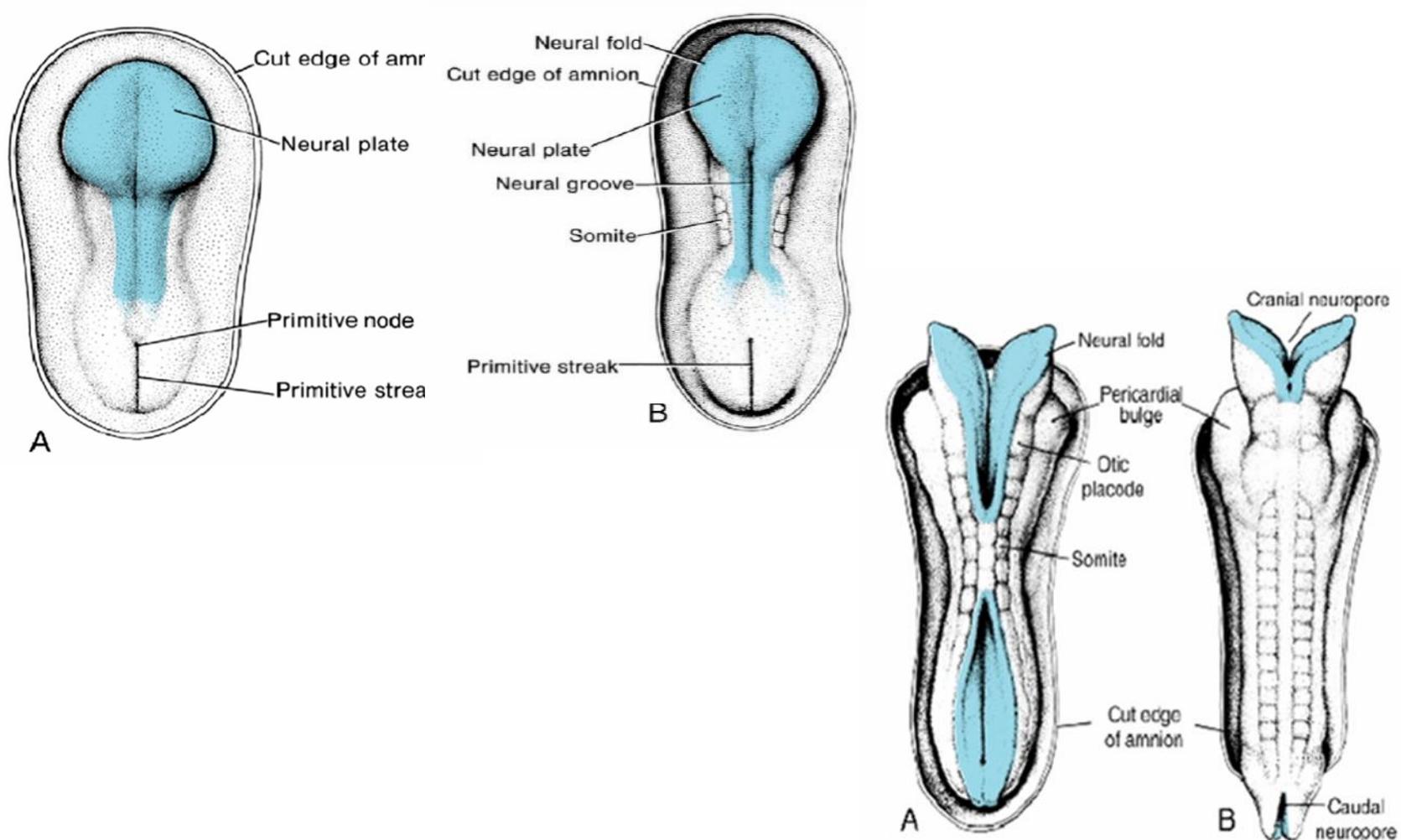


- Epiblasts migrate
 - into primitive streak and primitive pit
- Epiblasts differentiate to form
 - 3 embryonic tissue types
 - ectoderm
 - mesoderm
 - endoderm
 - Notochord



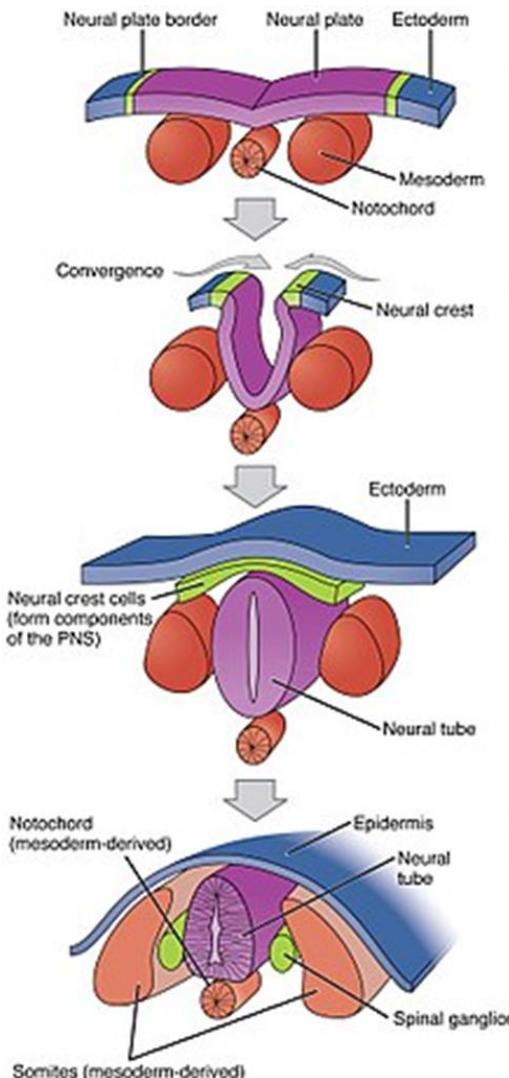
Neurolation

Neural plate Phase/ Primary Neurolation

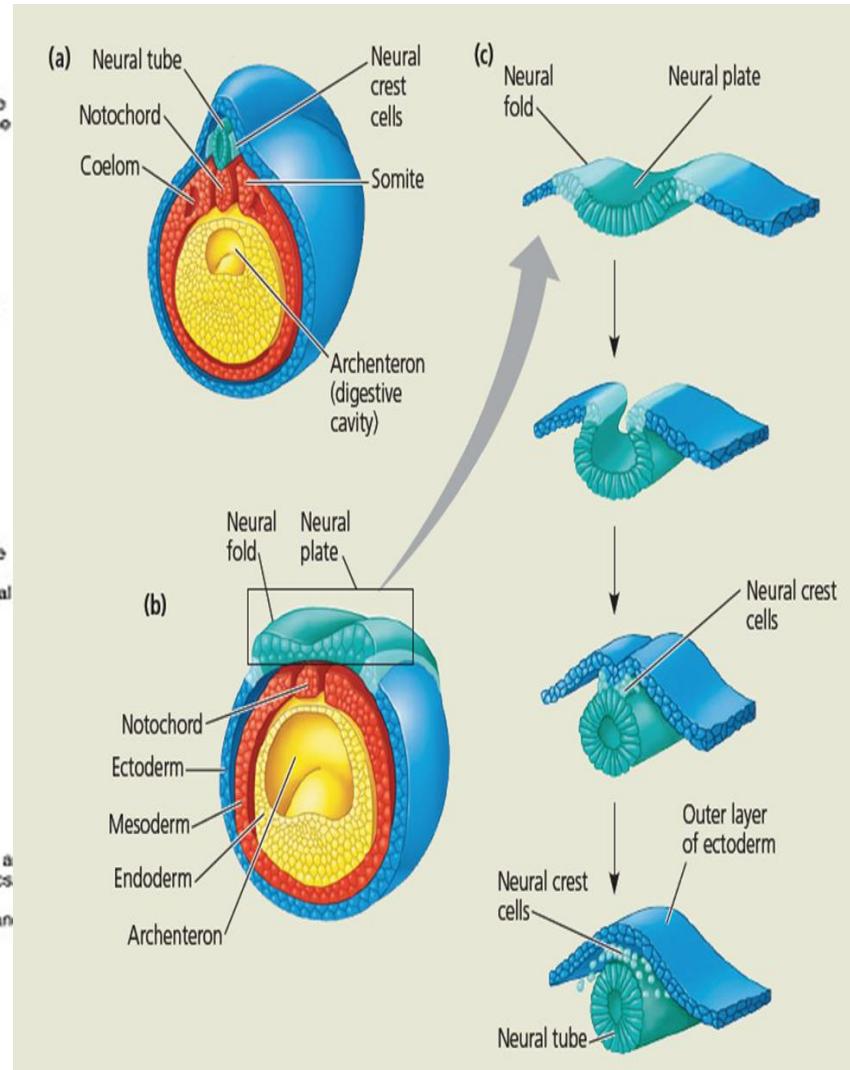


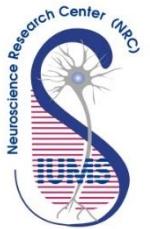
Neurolation

Neural plate Phase/ Primary Neurolation



- ① Neuroectodermal tissues differentiate from the ectoderm and thicken into the neural plate. The neural plate border separates the ectoderm from the neural plate.
- ② The neural plate bends dorsally, with the two ends eventually joining at the neural plate borders, which are now referred to as the neural crest.
- ③ The closure of the neural tube disconnects the neural crest from the epidermis. Neural crest cells differentiate to form most of the peripheral nervous system.
- ④ The notochord degenerates and only persists as the nucleus pulposus of the intervertebral discs. Other mesoderm cells differentiate into the somites, the precursors of the axial skeleton and skeletal muscle.





Secondary Neurolation

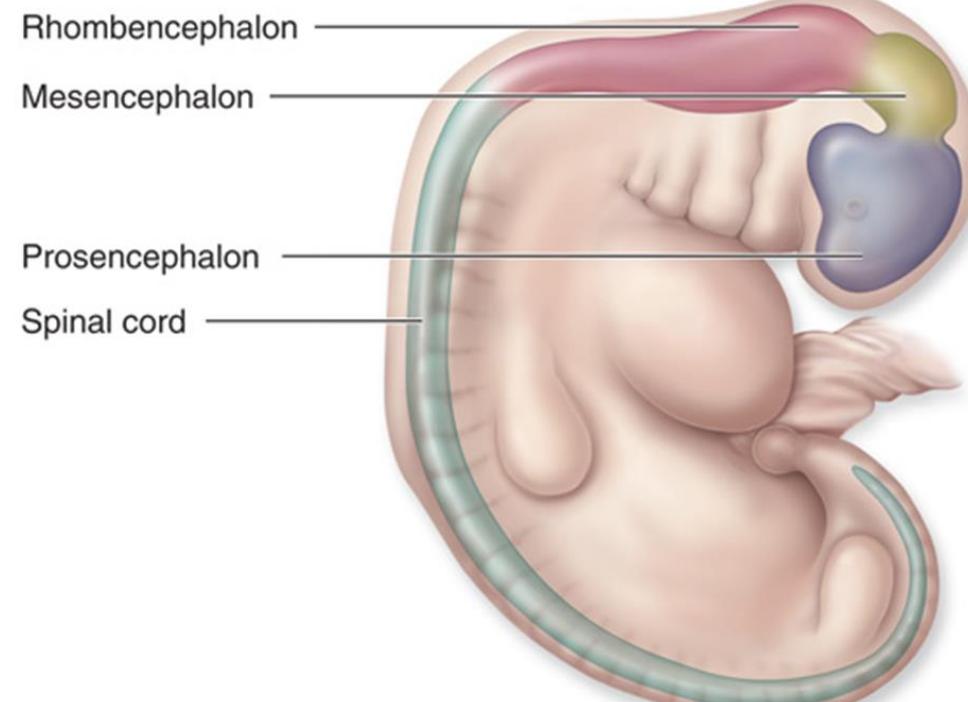
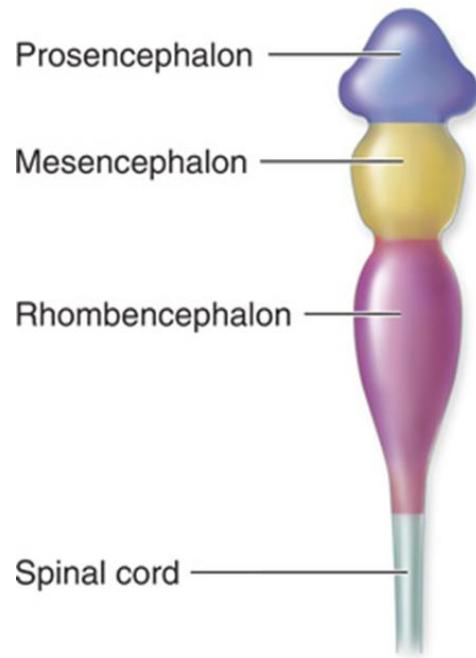
Primary:

- Starts from ectoderm
- Folds to form a tube

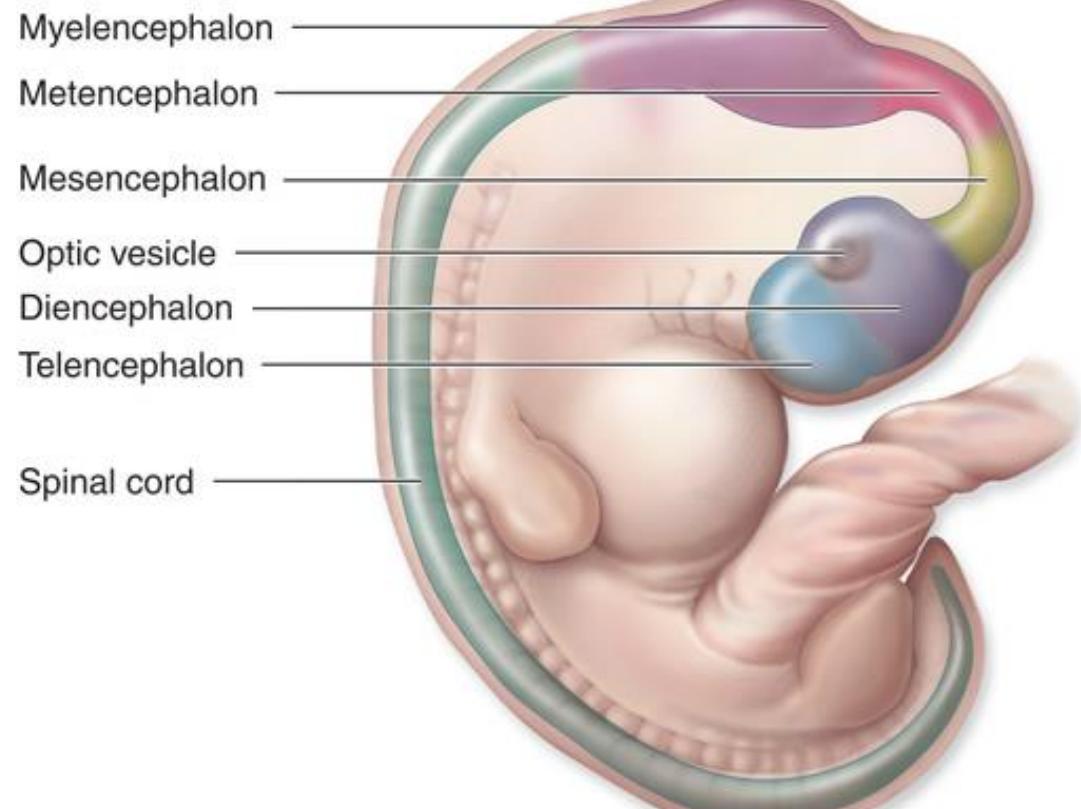
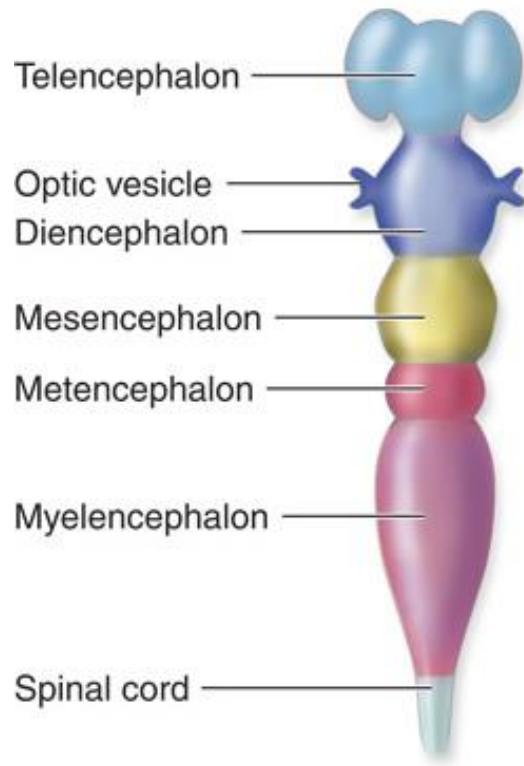
Secondary:

- Starts from mesenchyme
- Condenses, then hollows
- Undergoes an epithelial transition

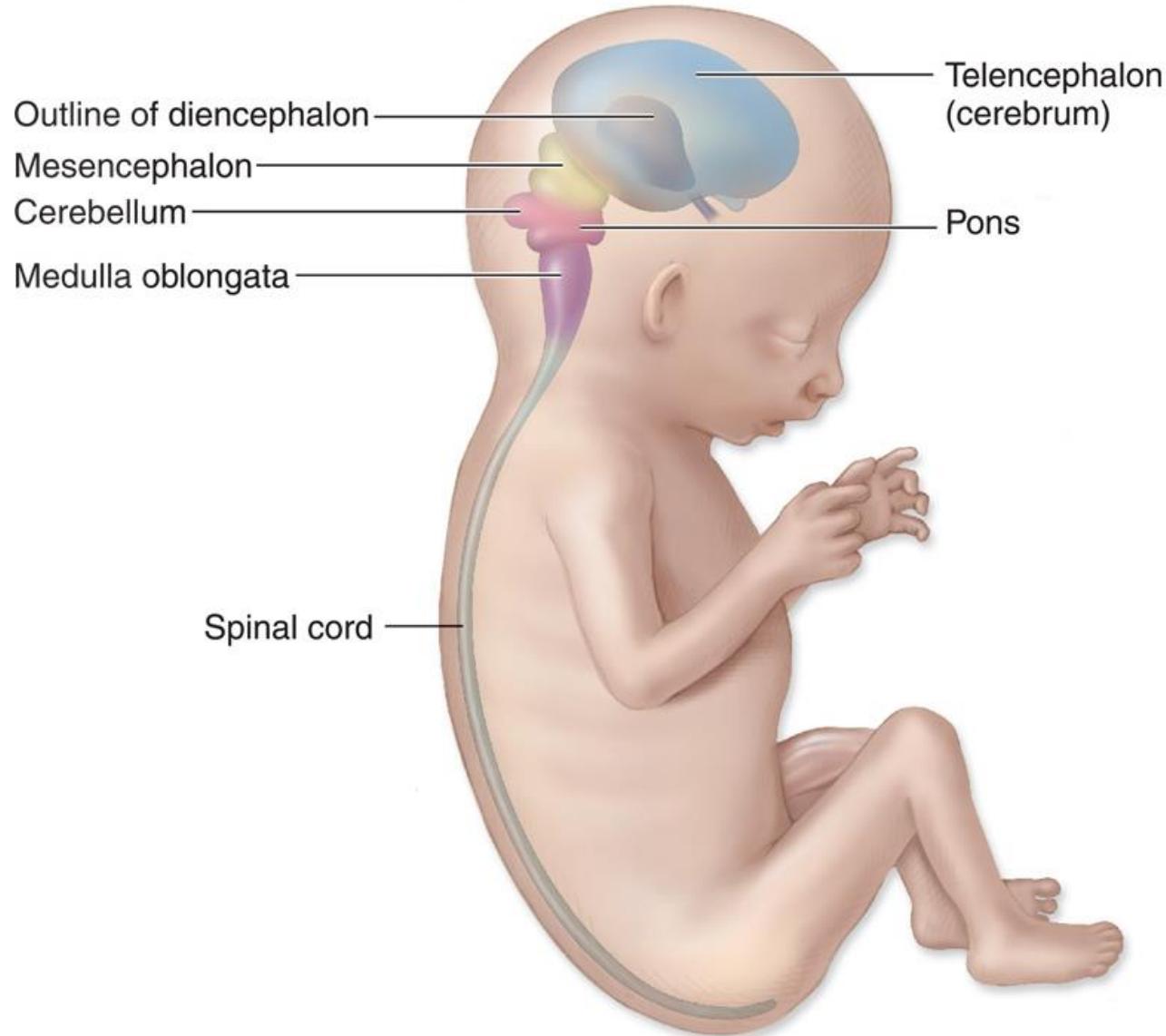
Neurulation



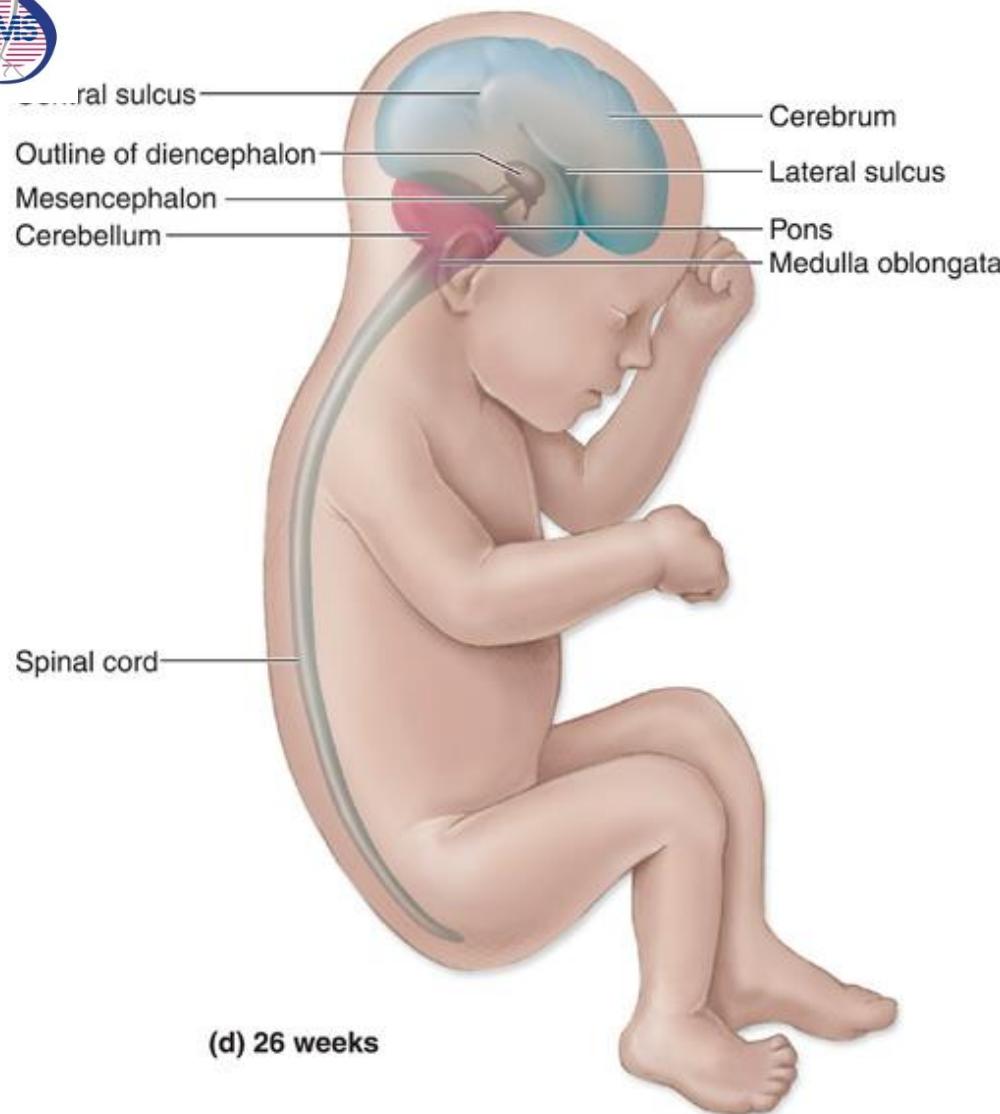
(a) 4 weeks

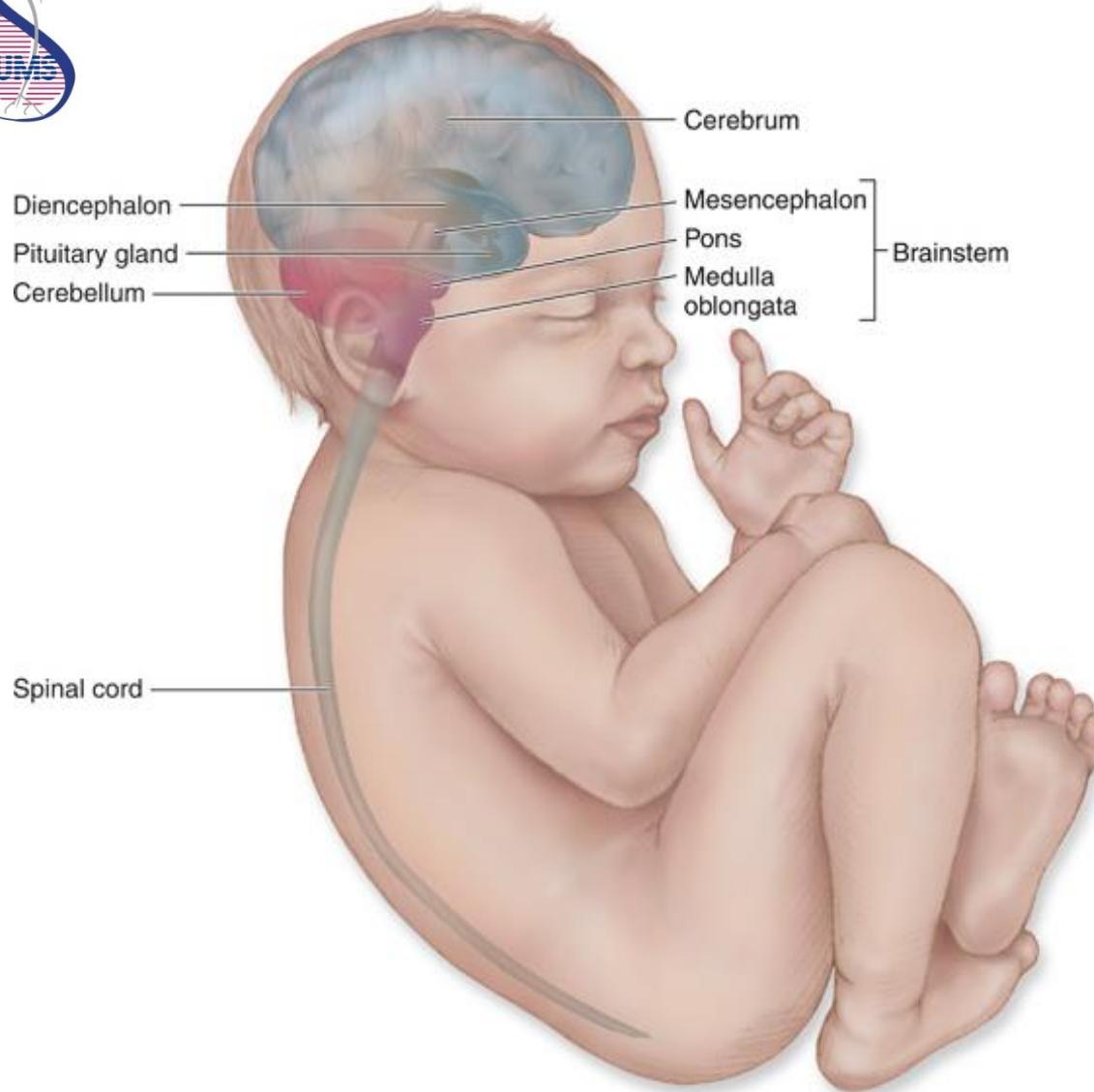


(b) 5 weeks



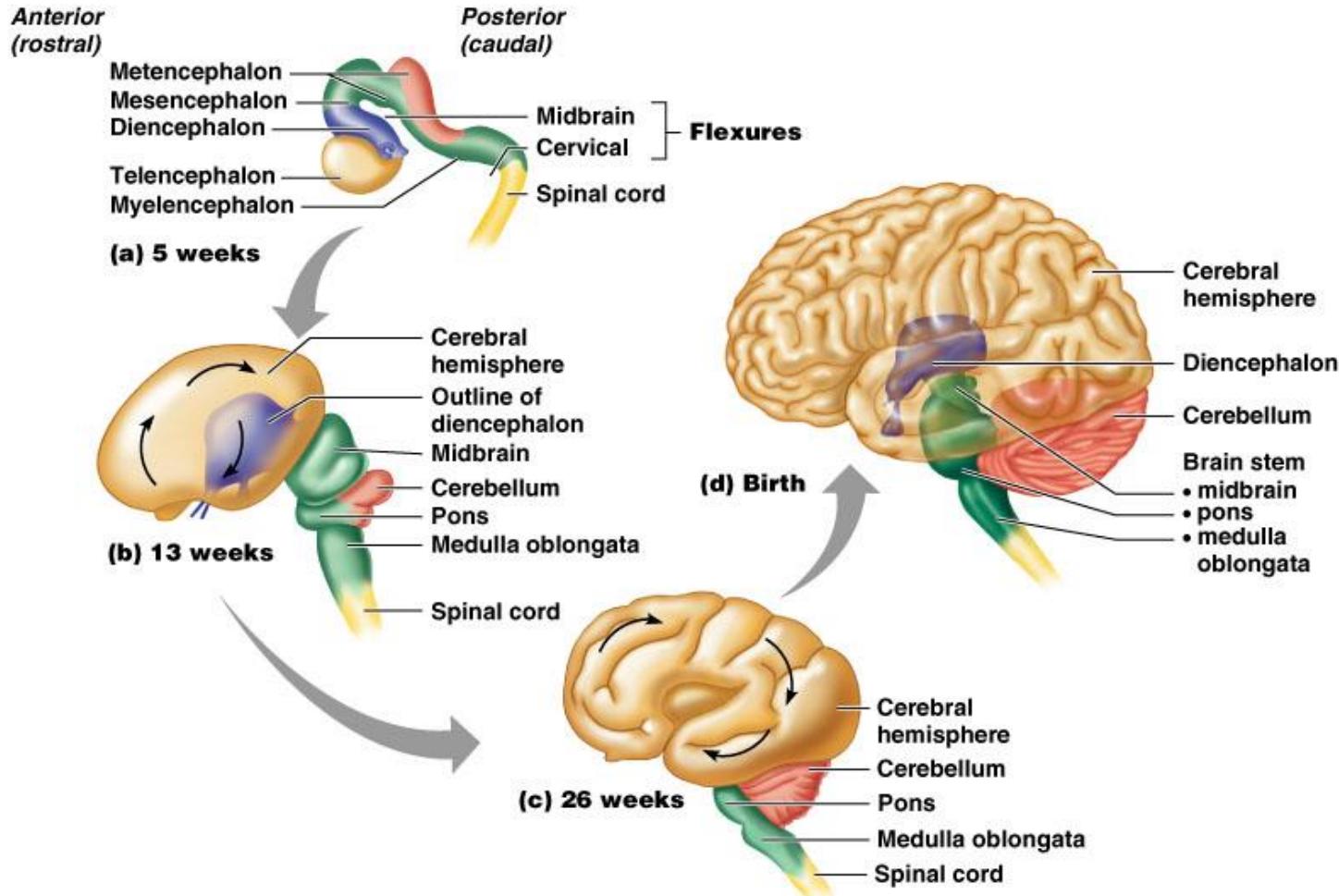
(c) 13 weeks
Prof Dr Behnam Jameie





(e) Birth

Neurolation in Summary



The Brain's 4 Major Regions

□ Prosencephalon (forebrain)

- Telencephalon: cerebrum
- Diencephalon: epithalamus, thalamus, hypothalamus

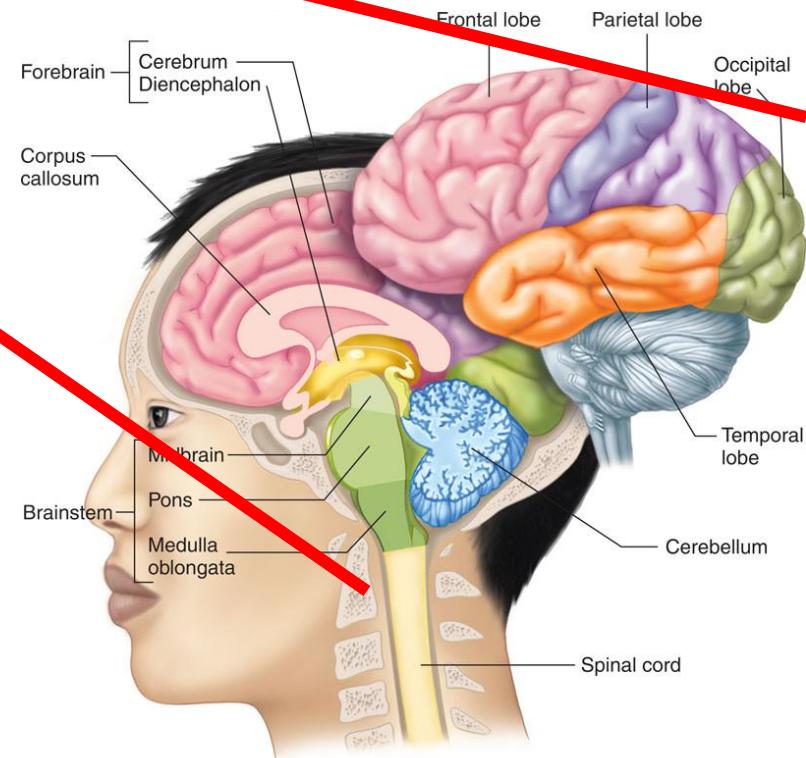
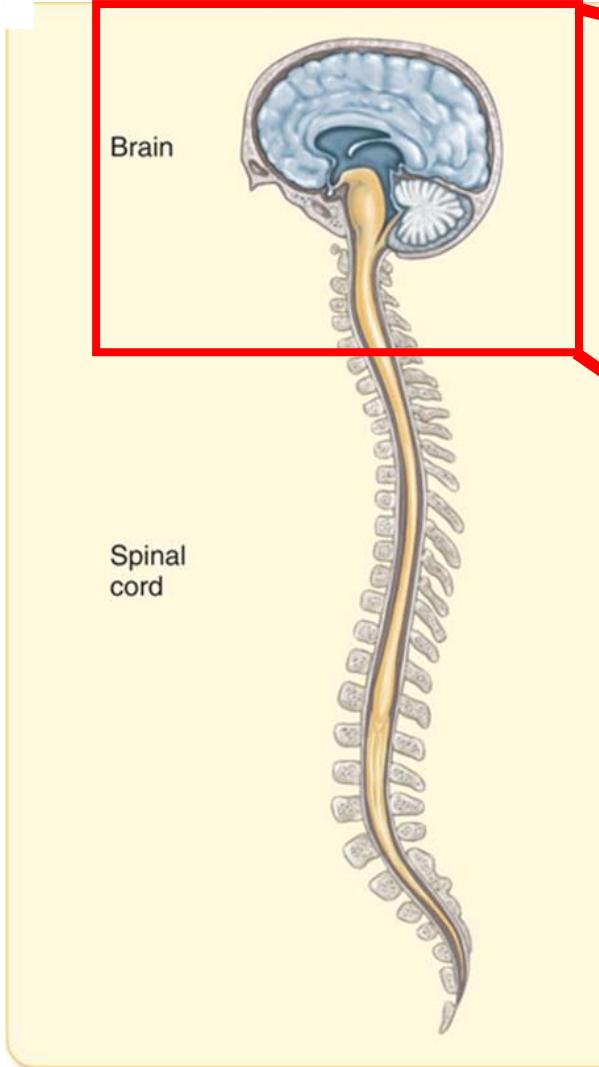
□ Mesencephalon (midbrain)

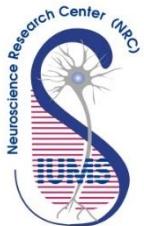
- Mesencephalon: cerebral peduncles, colliculi

□ Rhombencephalon (hindbrain)

- Metencephalon: pons, cerebellum
- Myelencephalon: medulla oblongata

Neural Axis Postnatal life





Structural Classification of the Nervous System

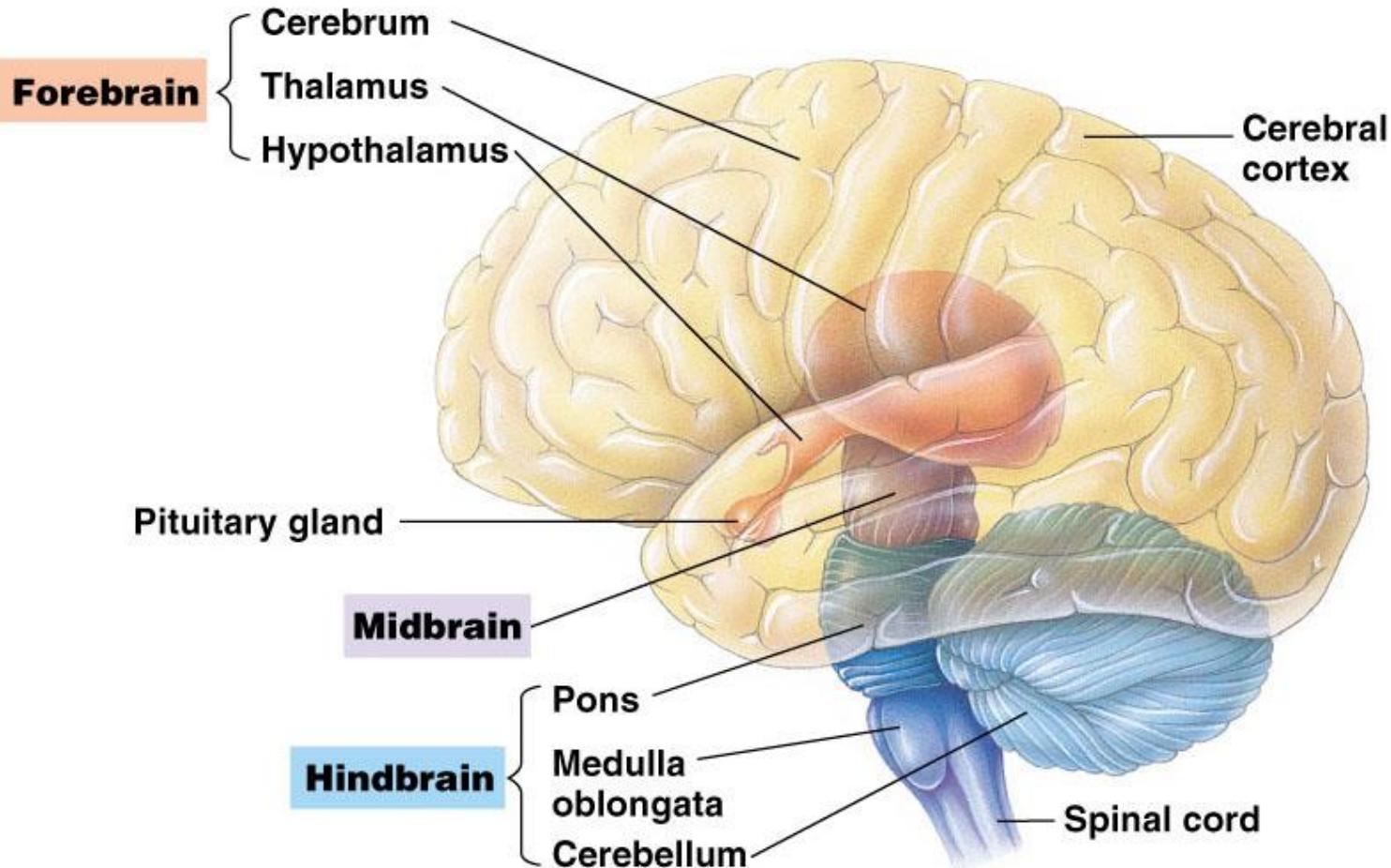
❑ Central nervous system (CNS)

- Brain
- Spinal cord

❑ Peripheral nervous system (PNS)

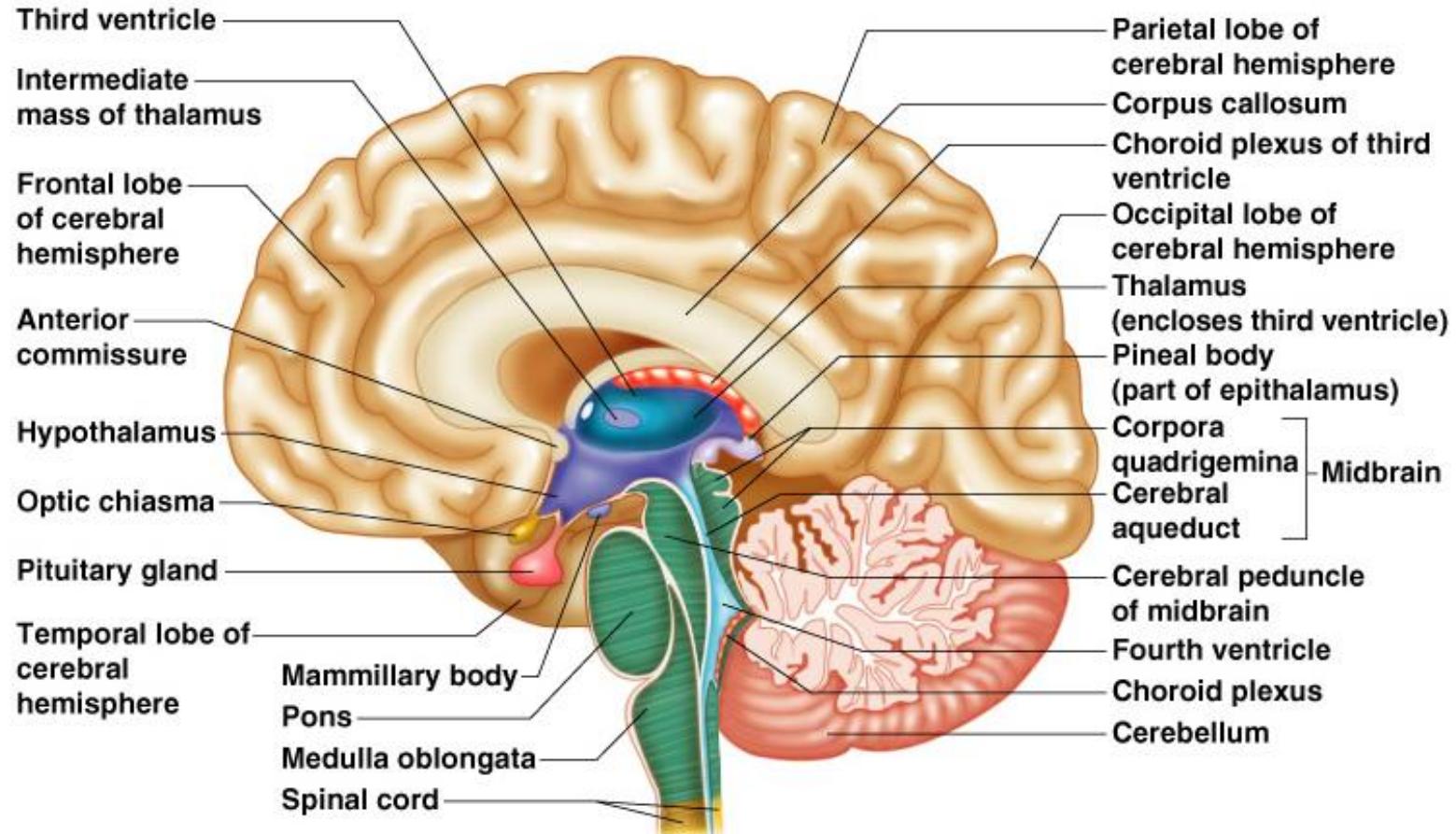
- Nerve outside the brain and spinal cord
- 43 pairs nerves (31 pairs Spinal nerves & 12 pairs Cranial nerves)
- Many different types of receptors

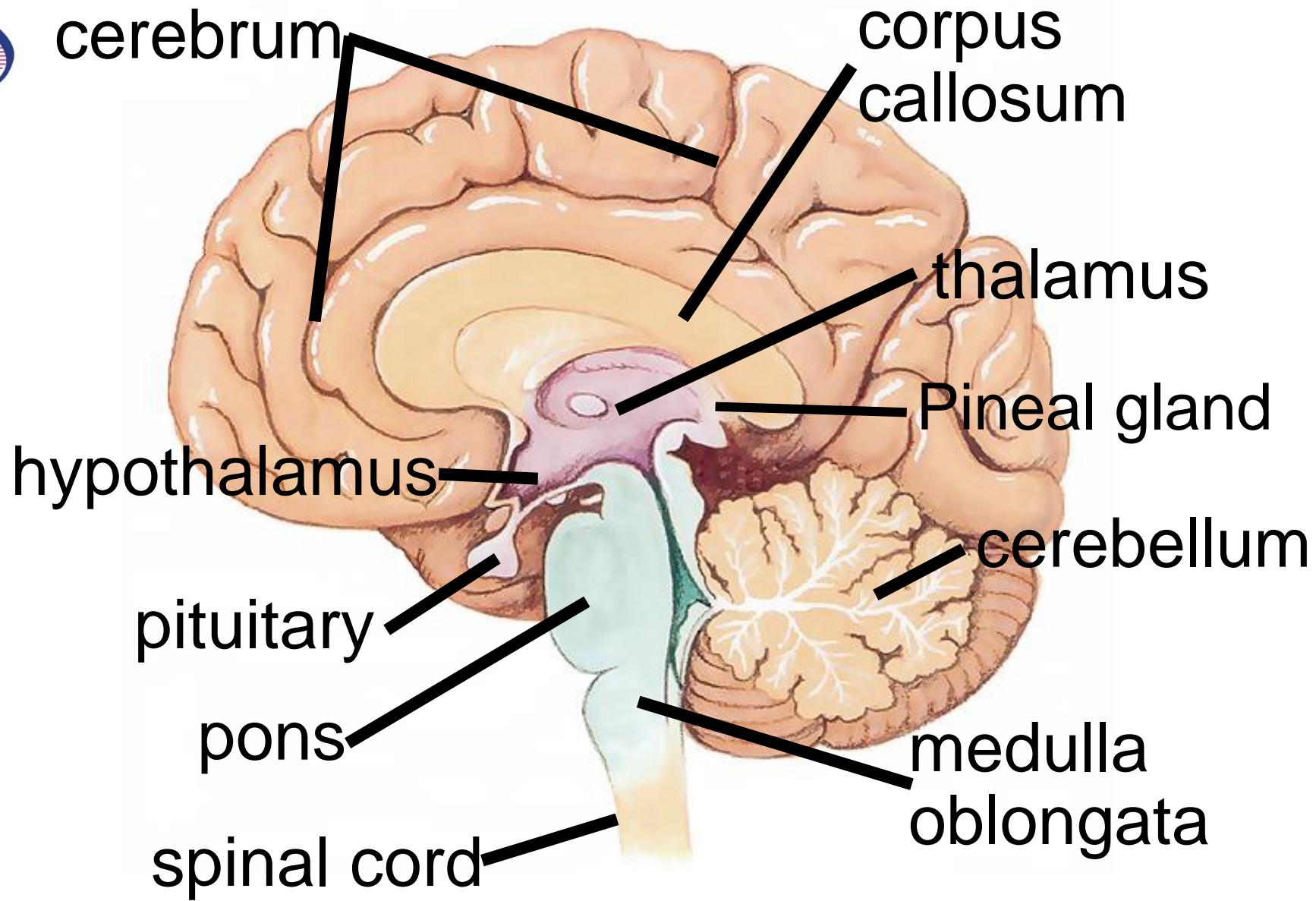
Regions of the Brain Lateral View



F

Regions of the Brain Medial View

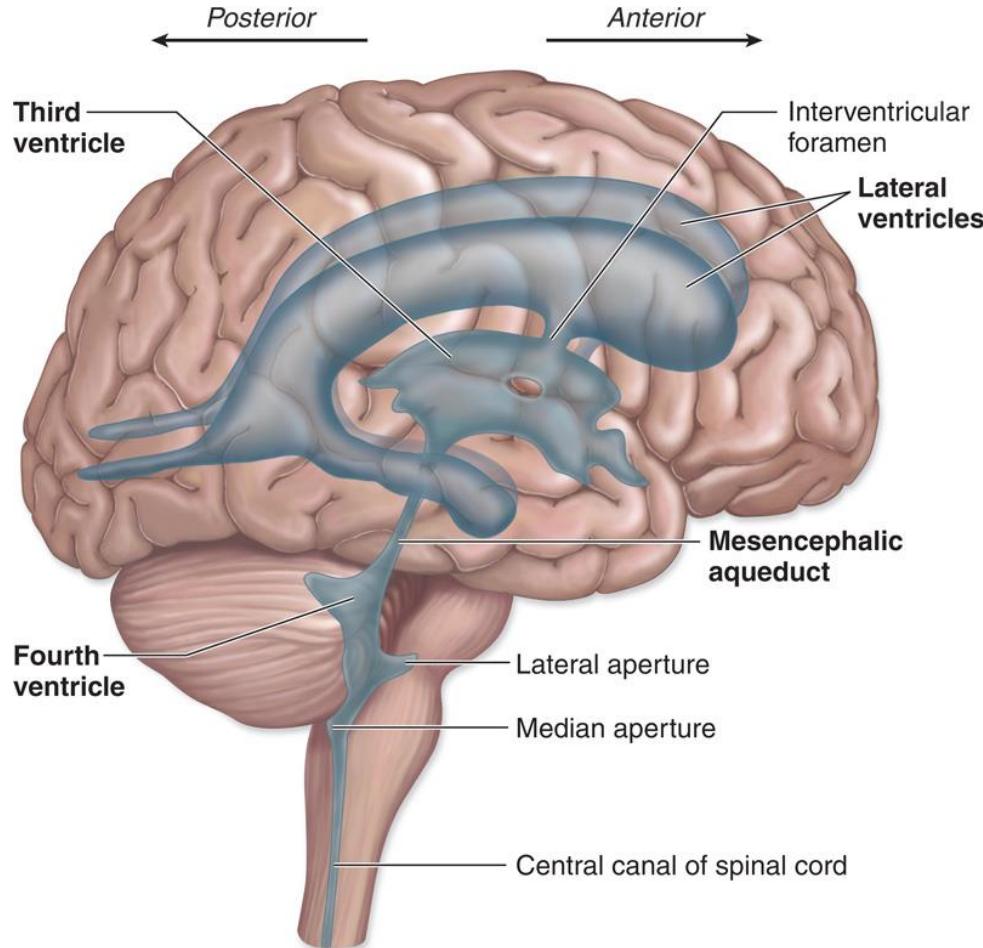




Brain Ventricular System

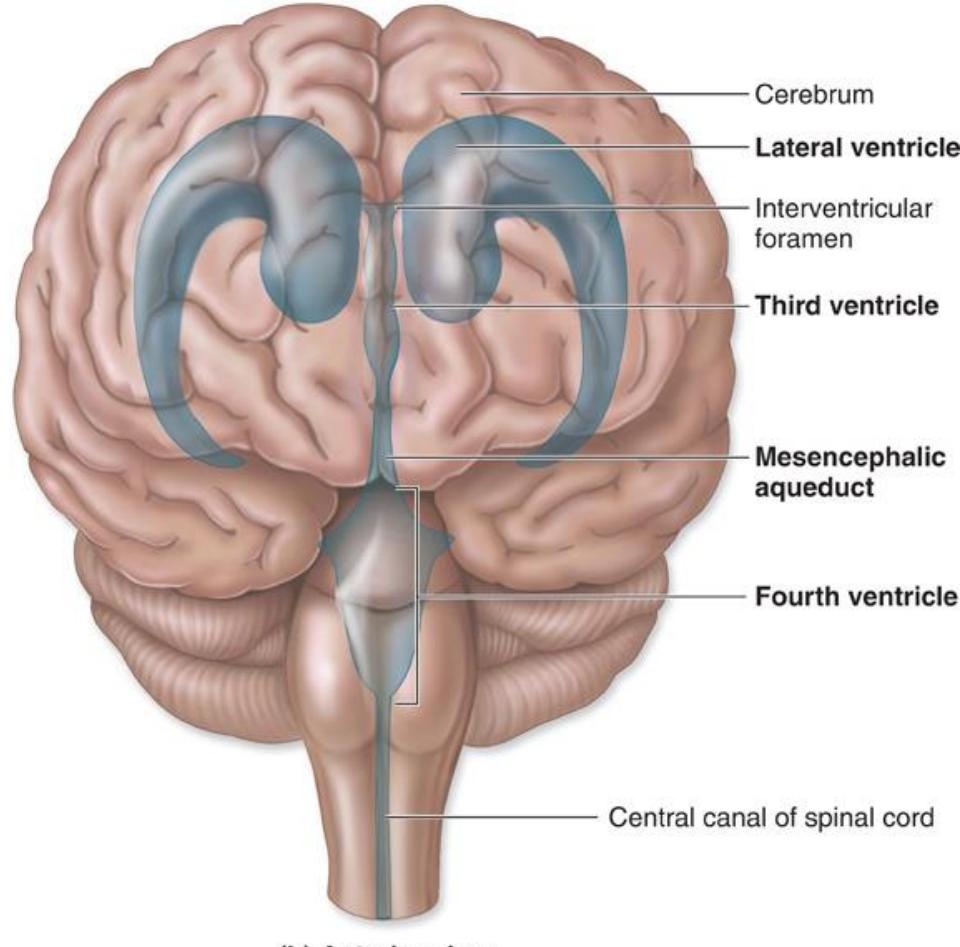
- Cavities or expansions within the brain that are derived from the lumen (opening) of the embryonic neural tube.
- Continuous with one another as well as with the central canal of the spinal cord.
- Four ventricles in the brain.
 - two lateral ventricles are in the cerebrum, separated by a thin medial partition called the septum pellucidum
 - within the diencephalon is a smaller ventricle called the third ventricle
 - each lateral ventricle communicates with the third ventricle through an opening called the interventricular foramen
- The fourth ventricle is located within the pons and cerebellum.

Brain Ventricular System

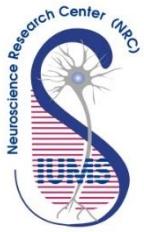


(a) Lateral view
Prof Dr Behnam Jameie

Brain Ventricular System



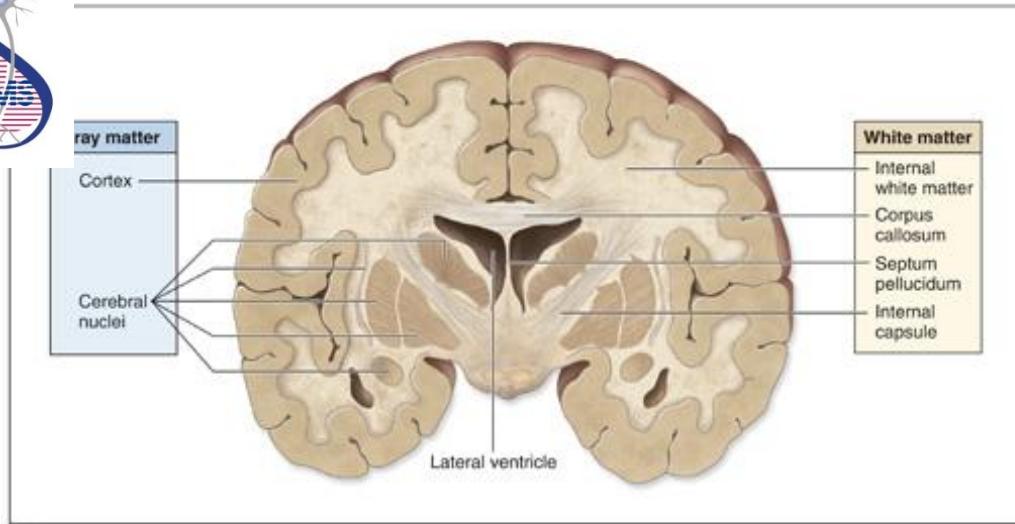
(b) Anterior view



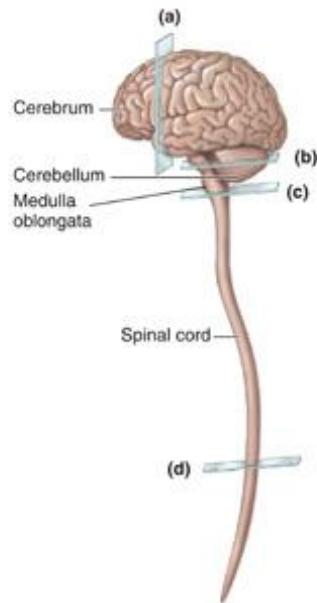
Organization of Brain Tissue

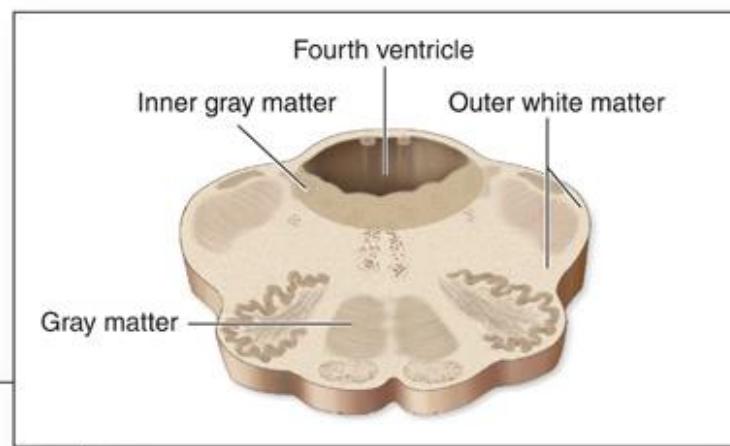
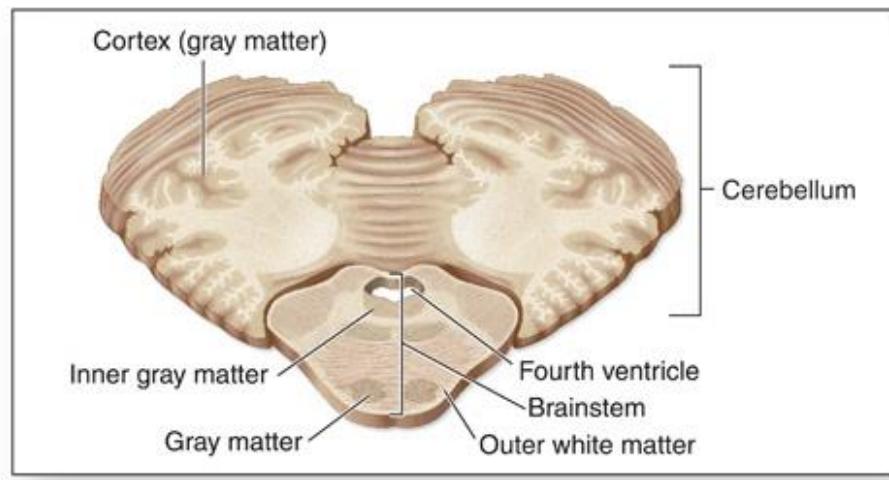
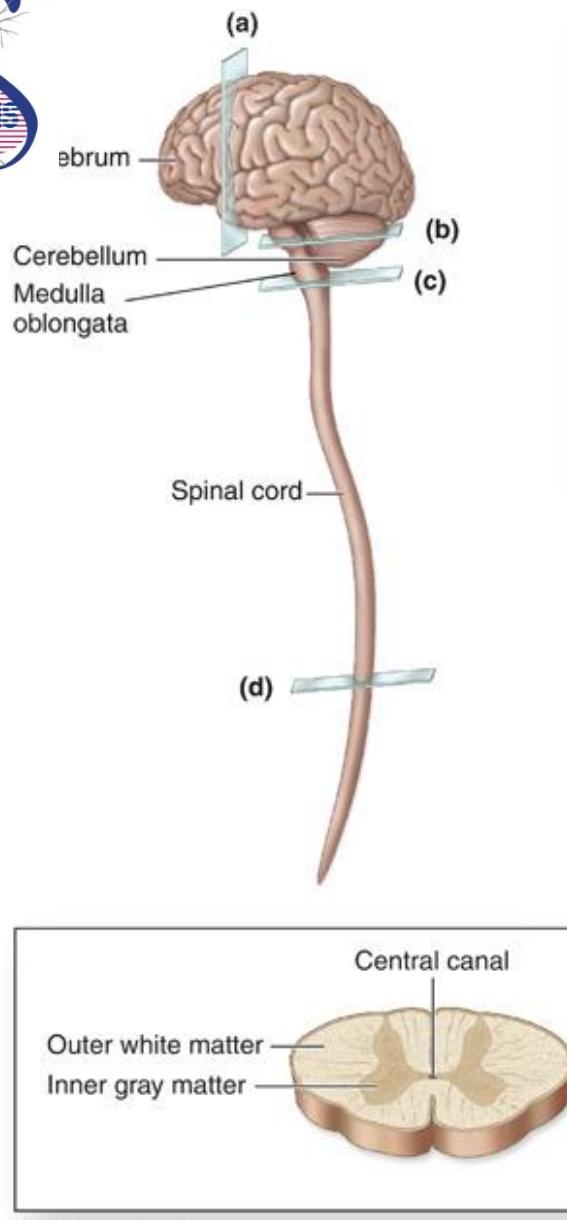
- White matter lies deep to the gray matter of the cortex.

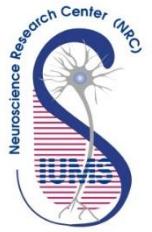
- Within the masses of white matter:
 - discrete innermost clusters of gray matter called cerebral nuclei (or basal nuclei).
 - are oval, spherical, or sometimes irregularly shaped clusters of neuron cell bodies.



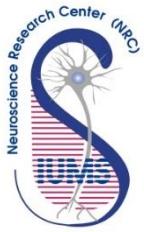
(a) Frontal section of cerebrum







مغز واسط / Diencephalon



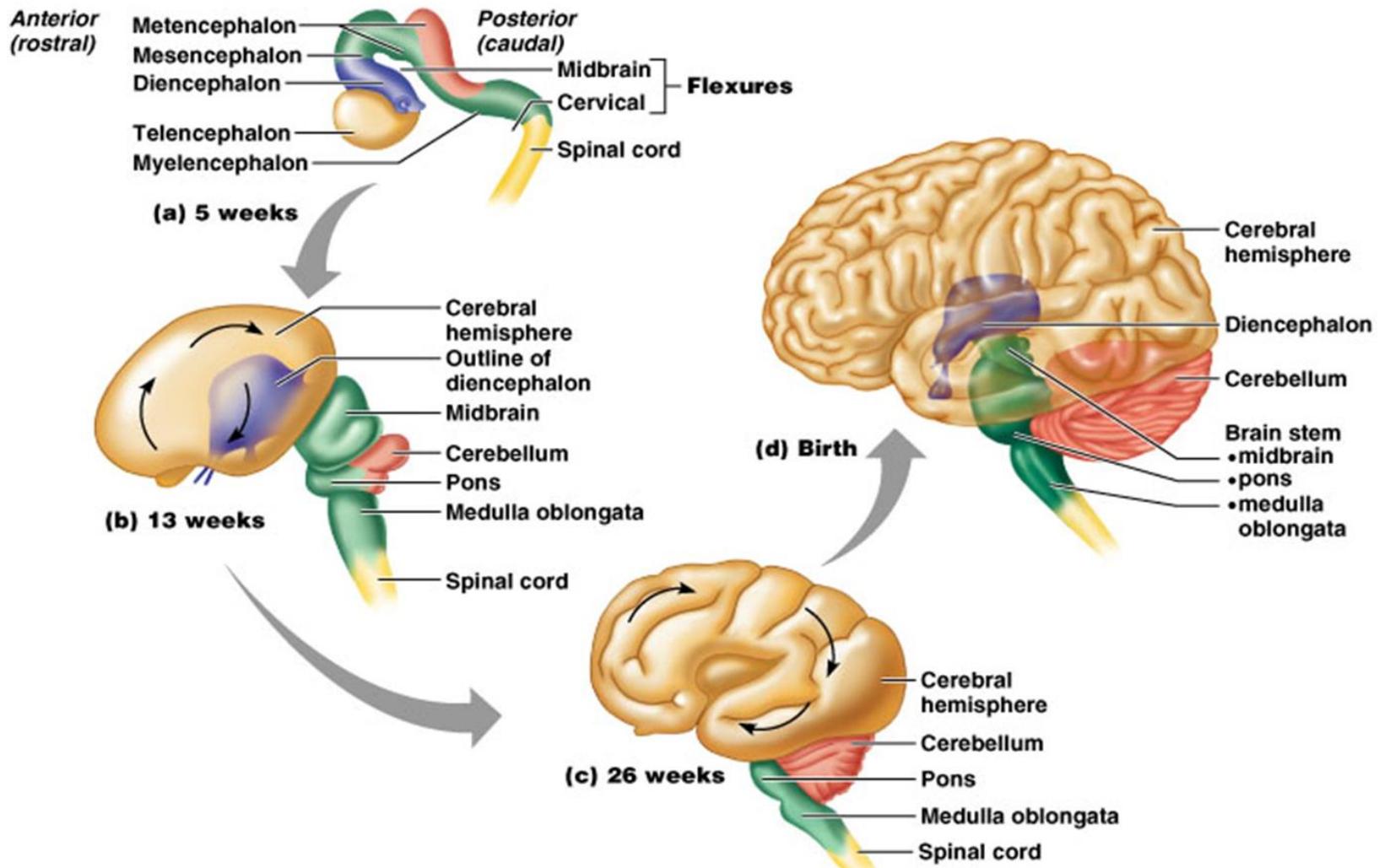
Diencephalon: Introduction & Definition

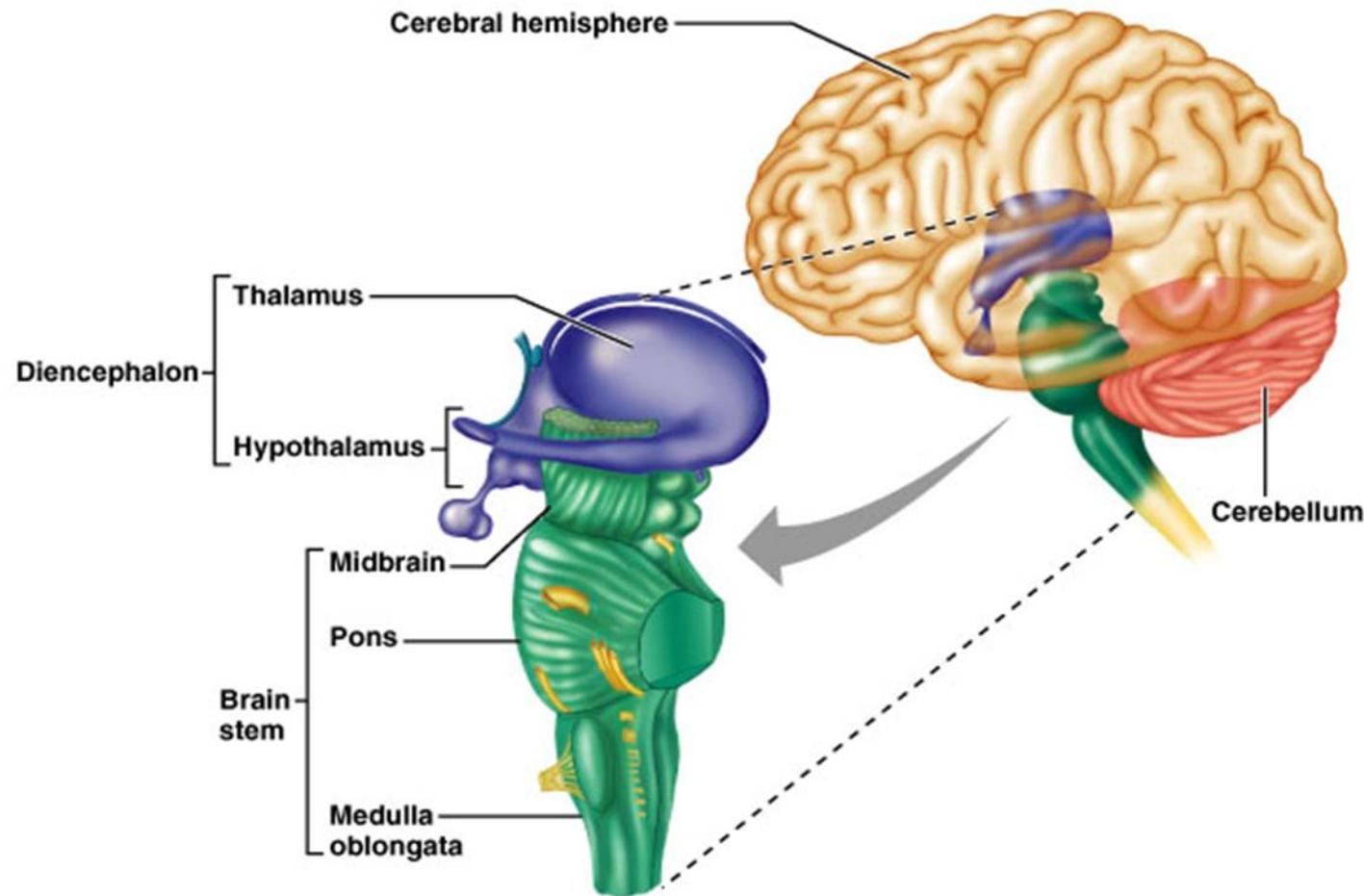
- Diencephalon is a part of prosencephalon or forebrain
- Forms the center core of the forebrain
- Cerebral hemispheres envelop the diencephalon and midbrain
- Primarily composed of gray matter and a collection of specific nuclei located symmetrically around and below to third ventricle.
- Lies between midbrain and cerebrum, almost entirely surrounded by cerebral hemisphere
- Third ventricle separates two halves of diencephalon in coronal and transverse view of forebrain.
- Although the 3rd ventricle is not a part of diencephalon, its boundaries helps to define the diencephalon.

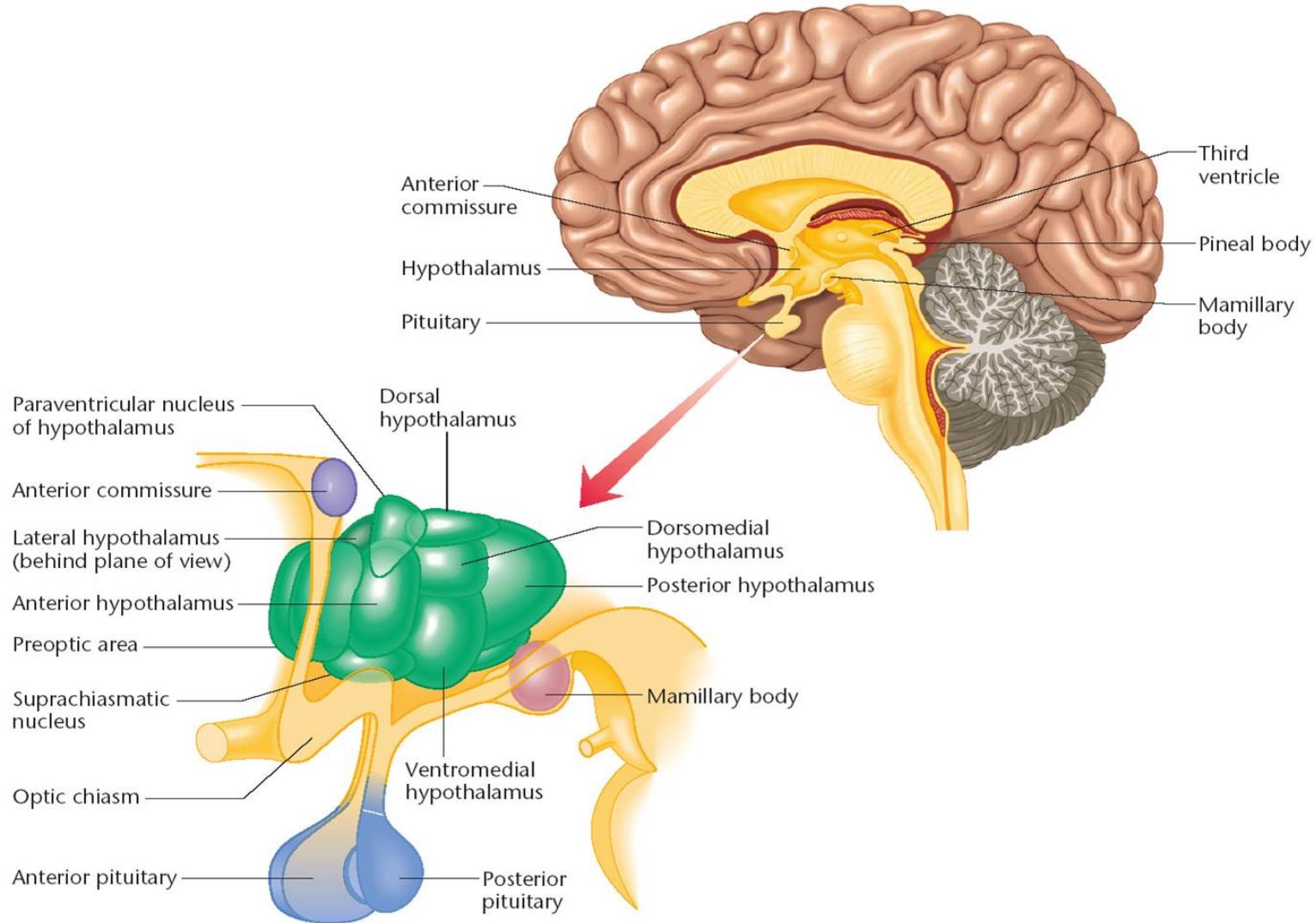
Neuroembryology of Diencephalon

(a) Neural tube	(b) Primary brain vesicles	(c) Secondary brain vesicles	(d) Adult brain structures	(e) Adult neural canal regions
Anterior (rostral)	Prosencephalon (forebrain) Mesencephalon (midbrain) Rhombencephalon (hindbrain)	Telencephalon Diencephalon	Cerebrum: Cerebral hemispheres (cortex, white matter, basal nuclei) Diencephalon (thalamus, hypothalamus, epithalamus)	Lateral ventricles
Posterior (caudal)		Mesencephalon Metencephalon Myelencephalon	Brain stem: midbrain Brain stem: pons Cerebellum Brain stem: medulla oblongata	Third ventricle Cerebral aqueduct Fourth ventricle
			Spinal cord	Central canal

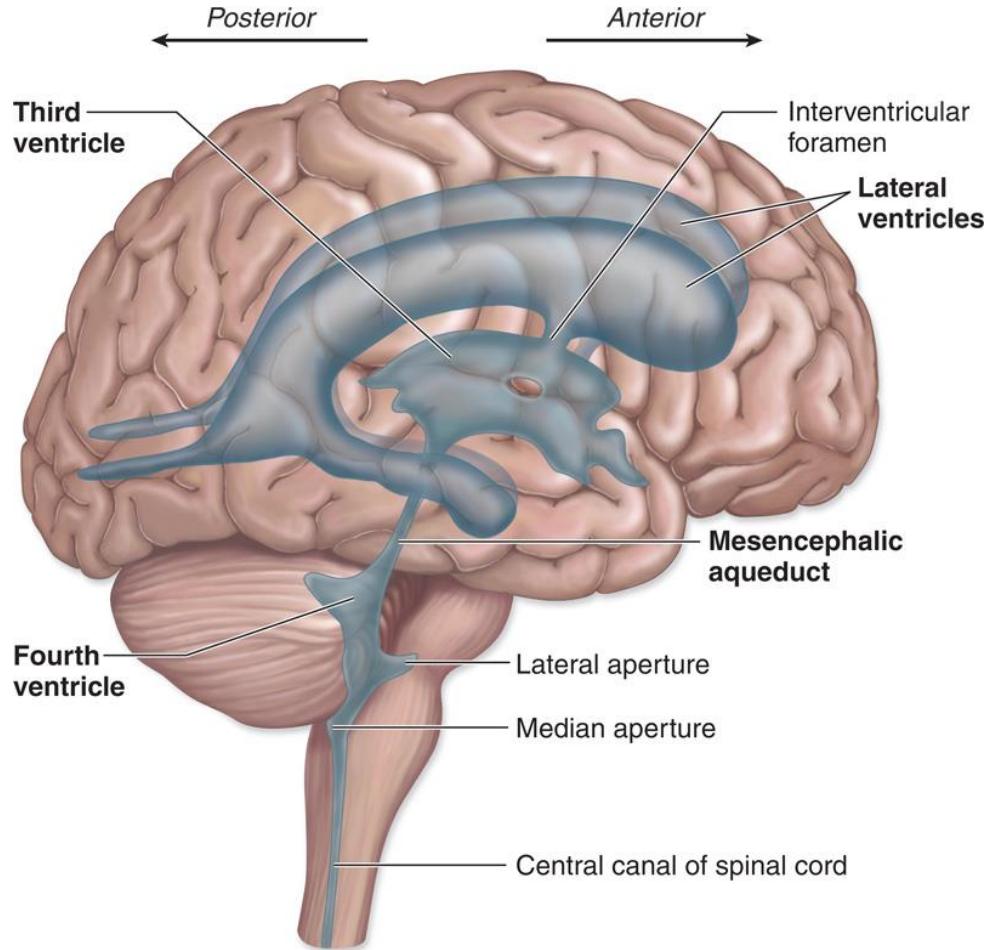
Neuroembryology of Diencephalon



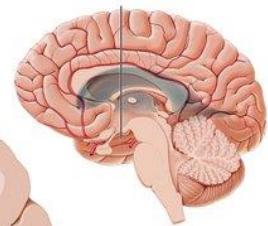
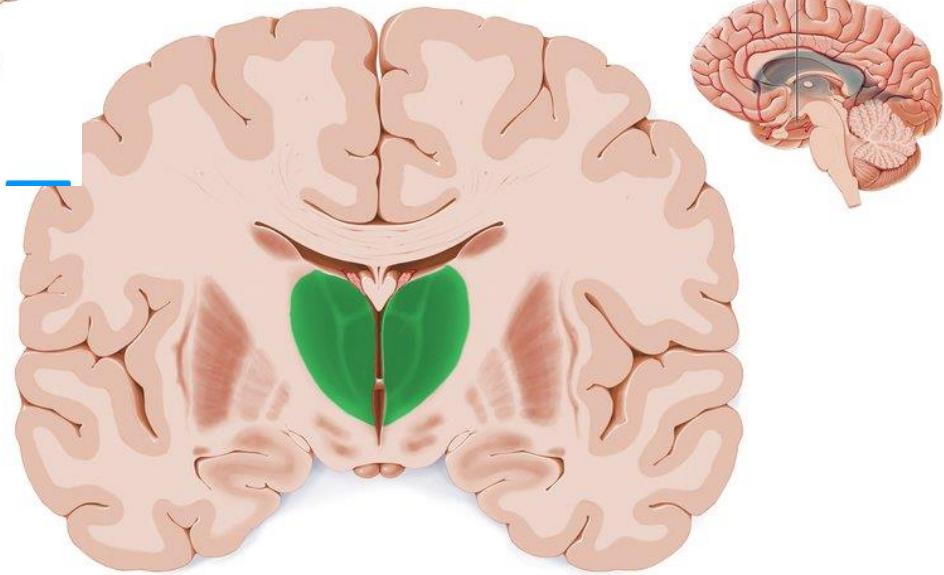
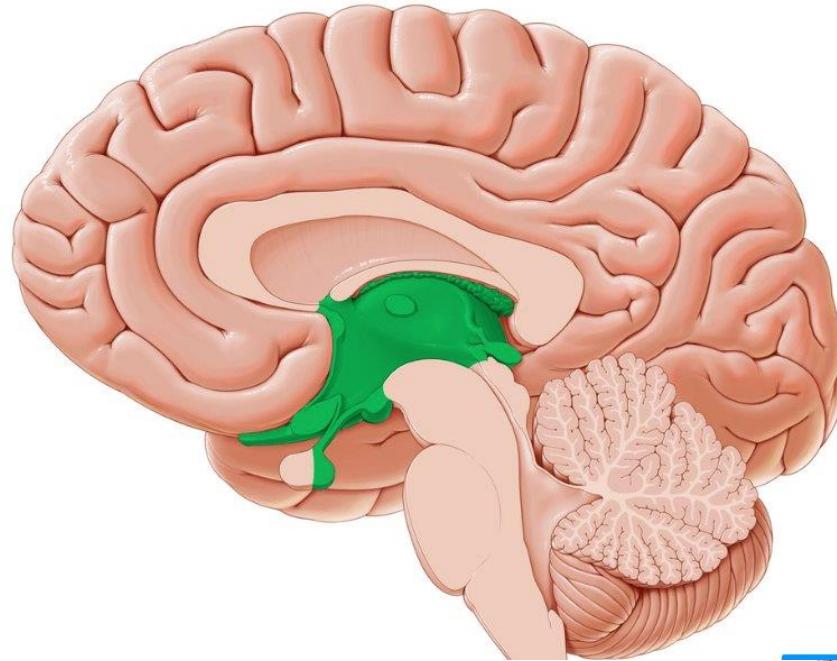




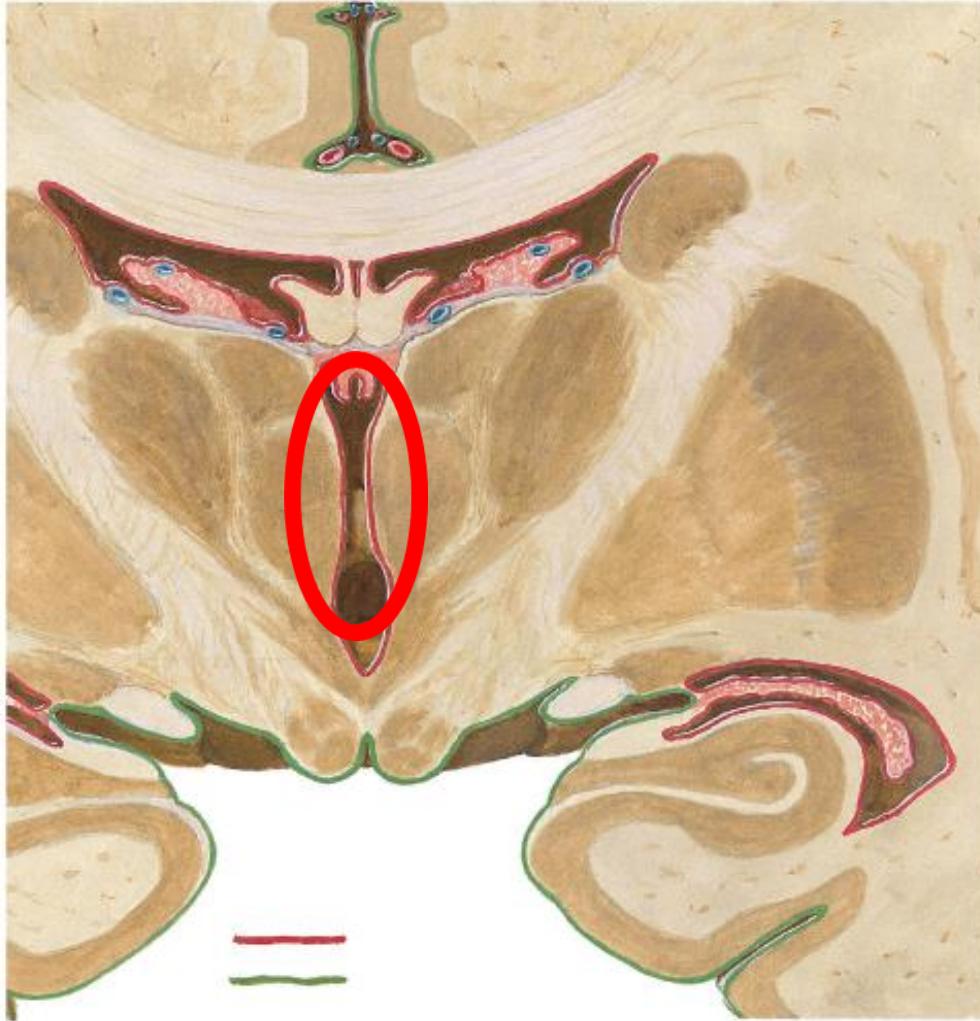
Brain Ventricular System



(a) Lateral view
Prof Dr Behnam Jameie

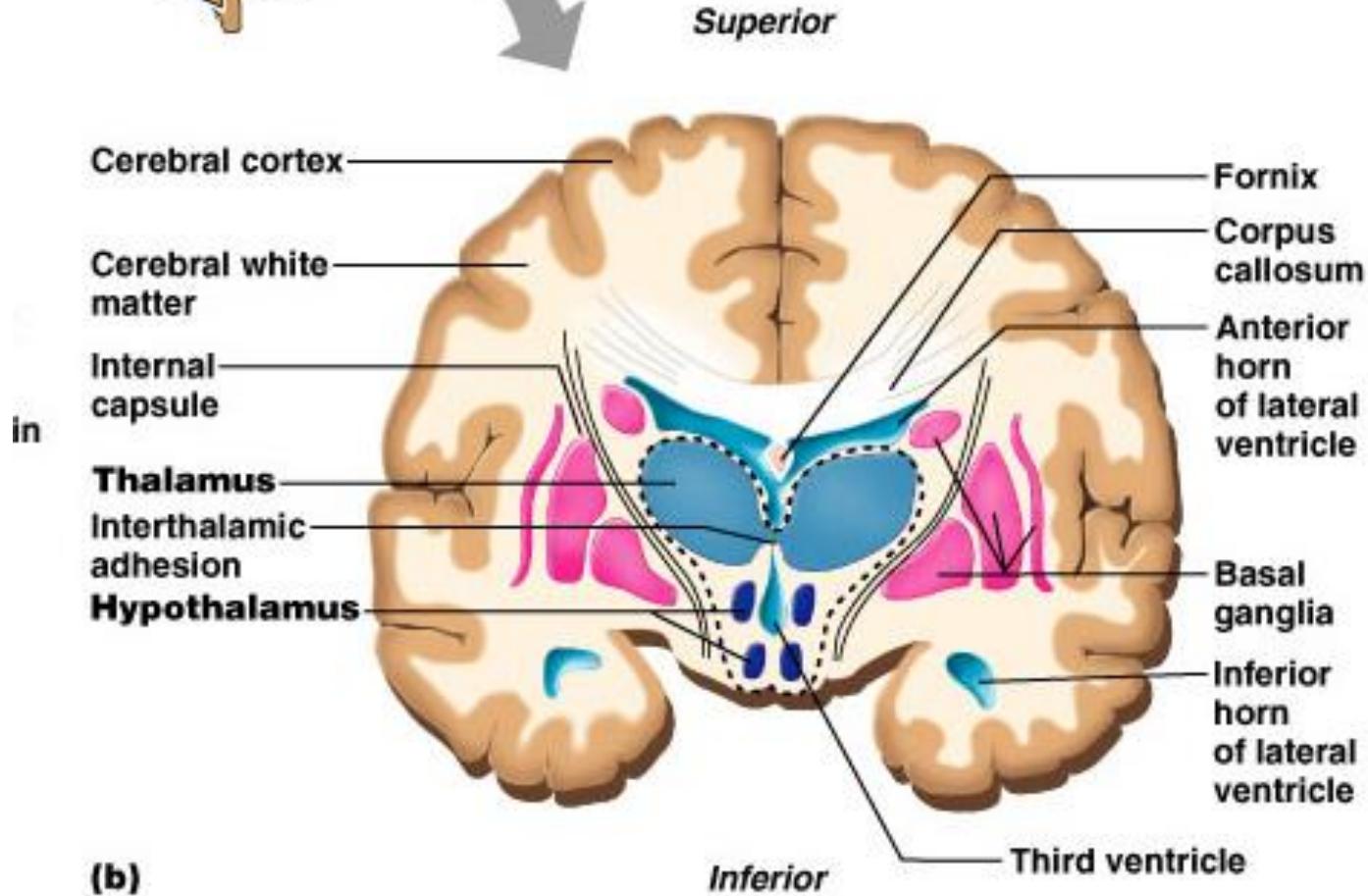
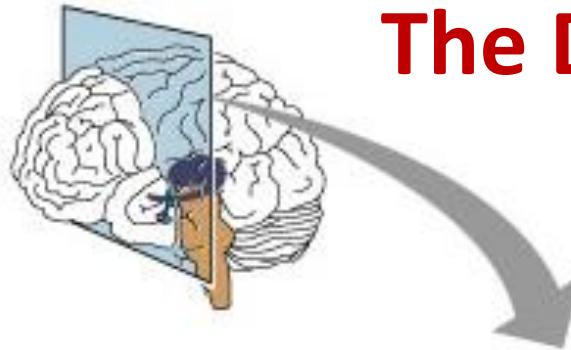


Diencephalon/ Coronal View



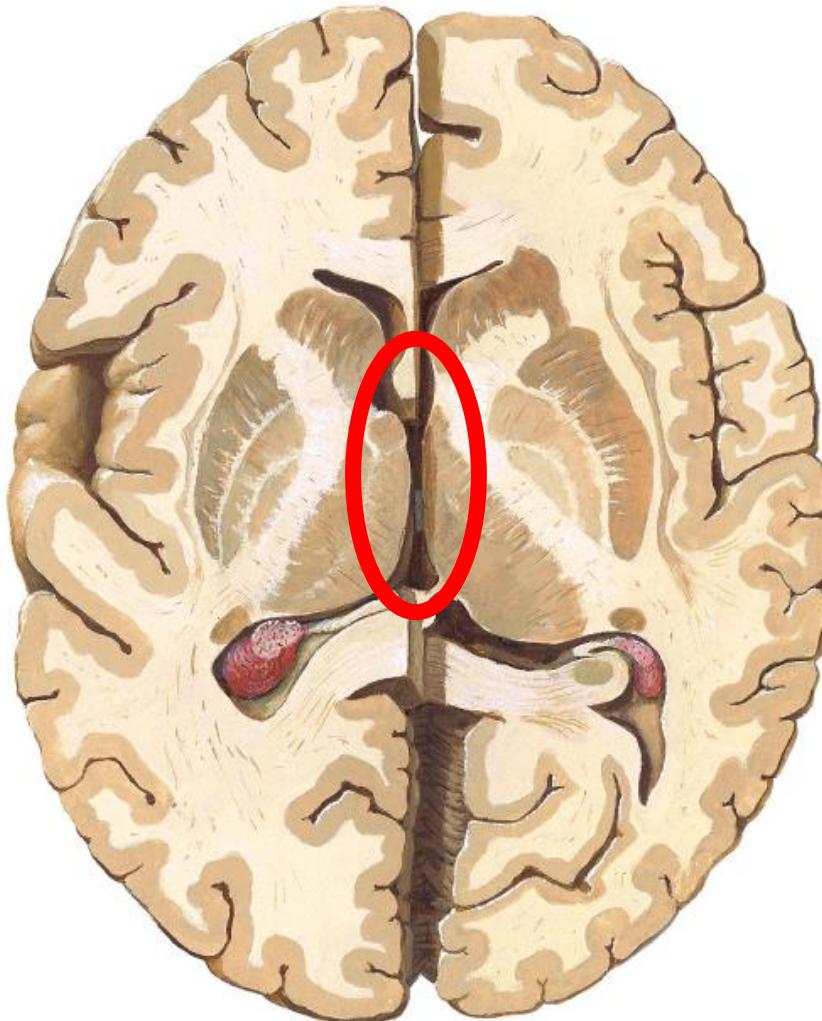
**Third ventricle separates
two halves of diencephalon
in coronal and transverse
view of forebrain.**

The Diencephalon



(b)

Diencephalon/ horizontal view



Third ventricle separates two halves of diencephalon in coronal and transverse view of forebrain.

Third ventricle

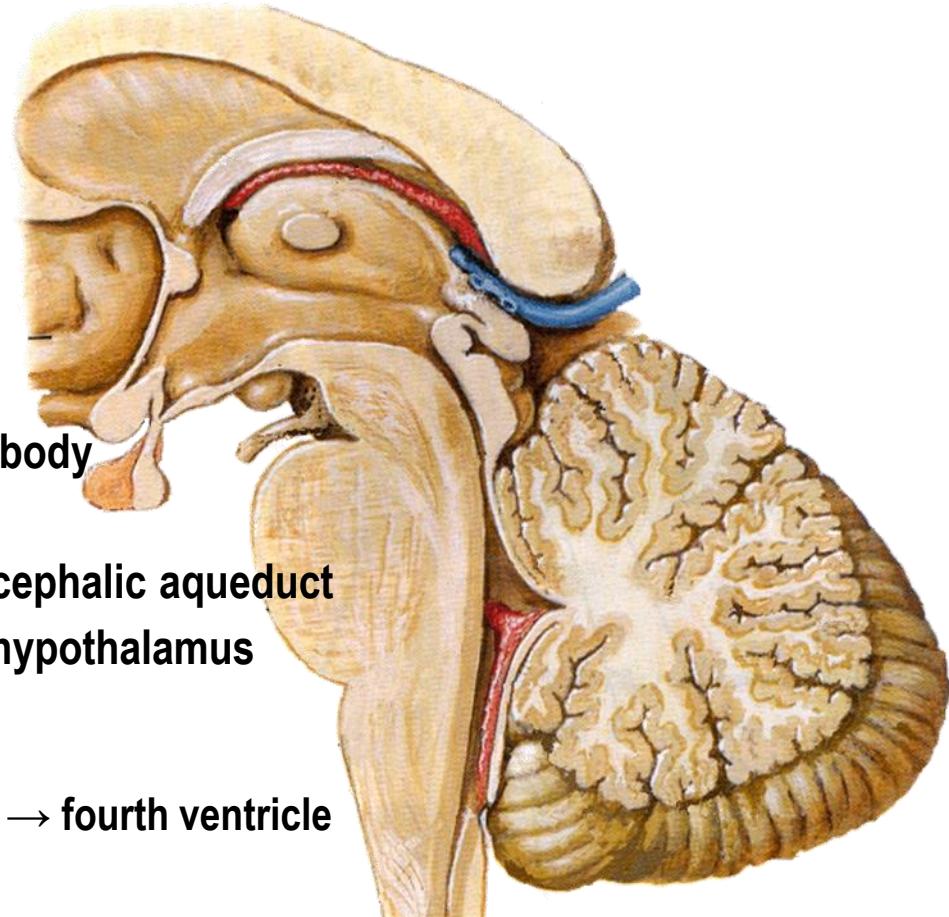
- Position: a narrow ventricle cleft lies within diencephalons

- Boundaries

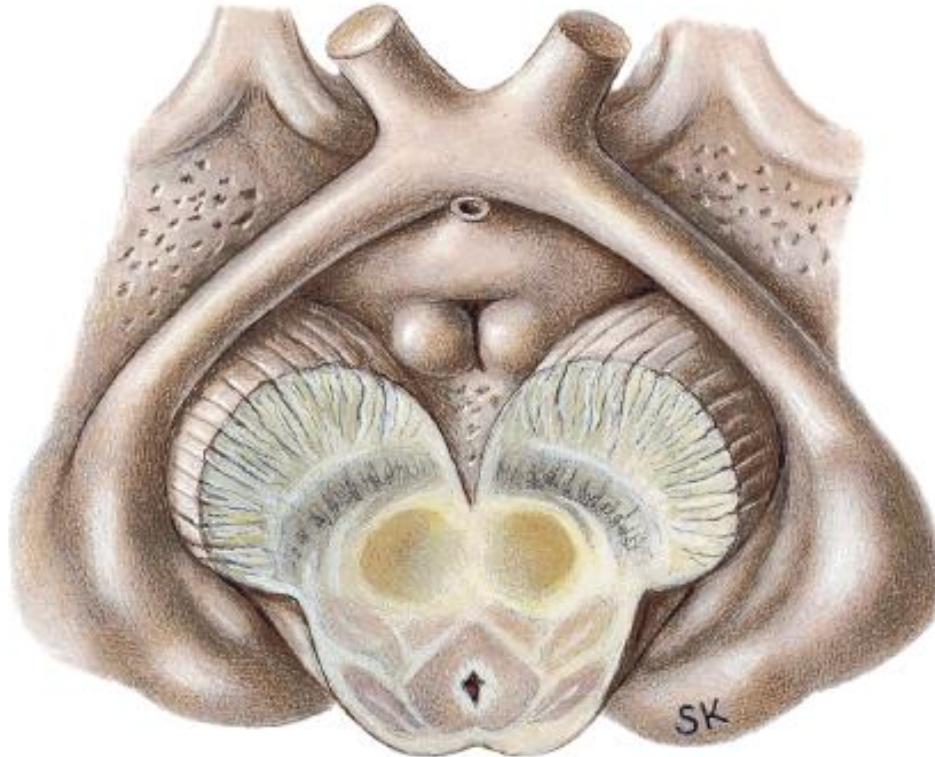
- Roof: choroids plexus
- Floor:
 - optic chiasma
 - tuber cinereum
 - infundibulum and mamillary body
- Anterior: lamina terminalis
- Posterior: continuous with mesencephalic aqueduct
- Lateral wall: dorsal thalamus and hypothalamus

- Communication

Third ventricle →mesencephalic aqueduct → fourth ventricle



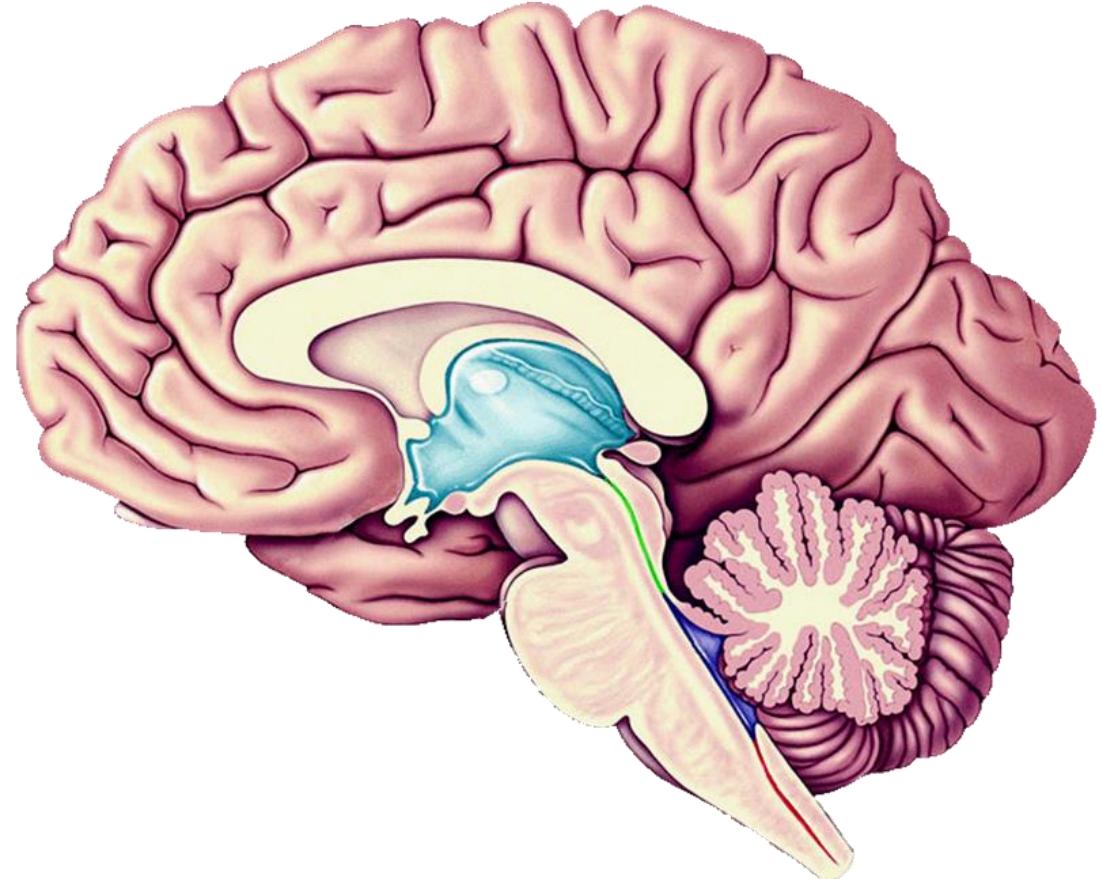
3rd Ventricle floor



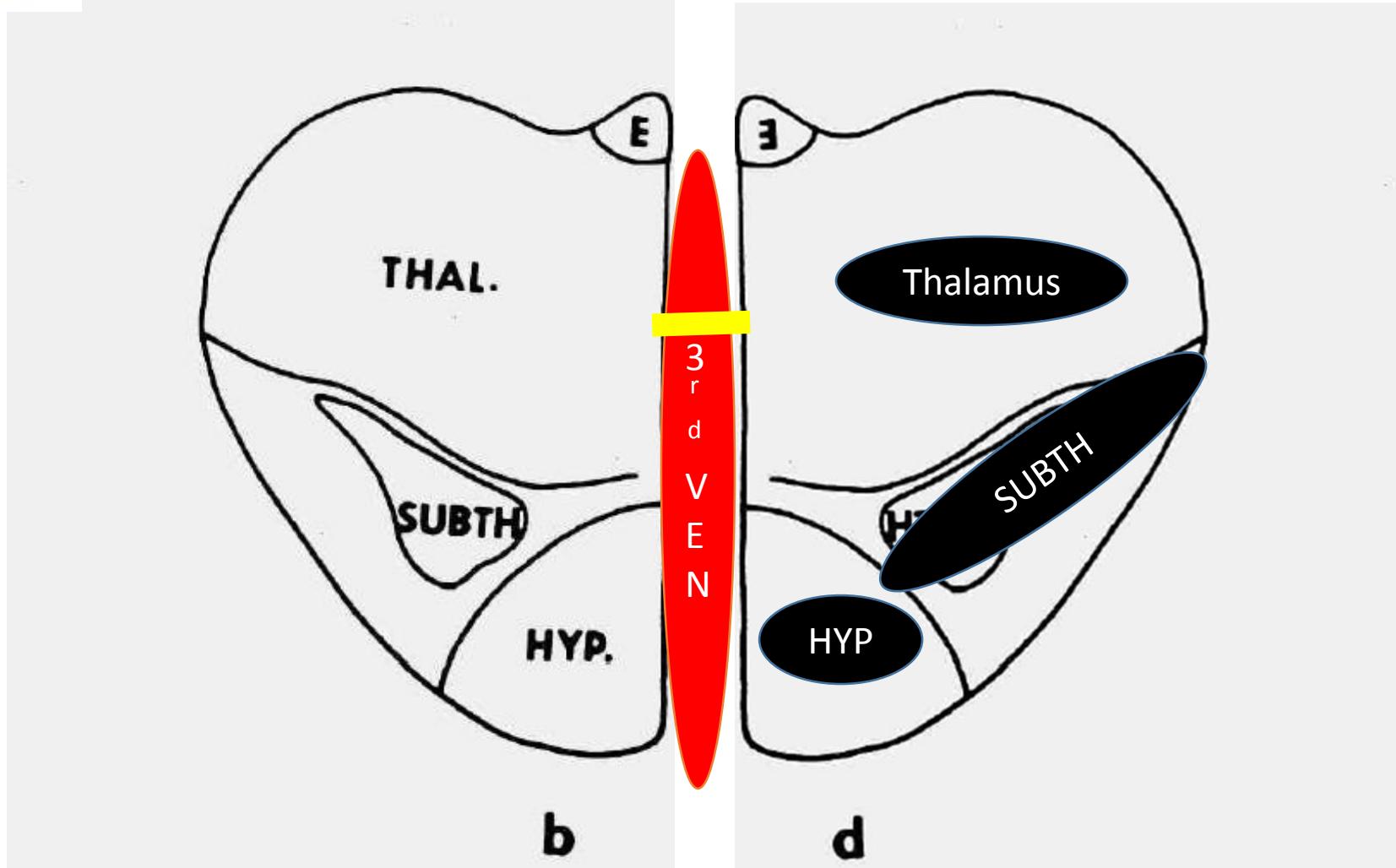
- Chiasma opticum**
- Infundibulum**
- Tuber cinereum**
- Corpus mamillare**
- Tractus opticus**

Subdivision of Diencephalon

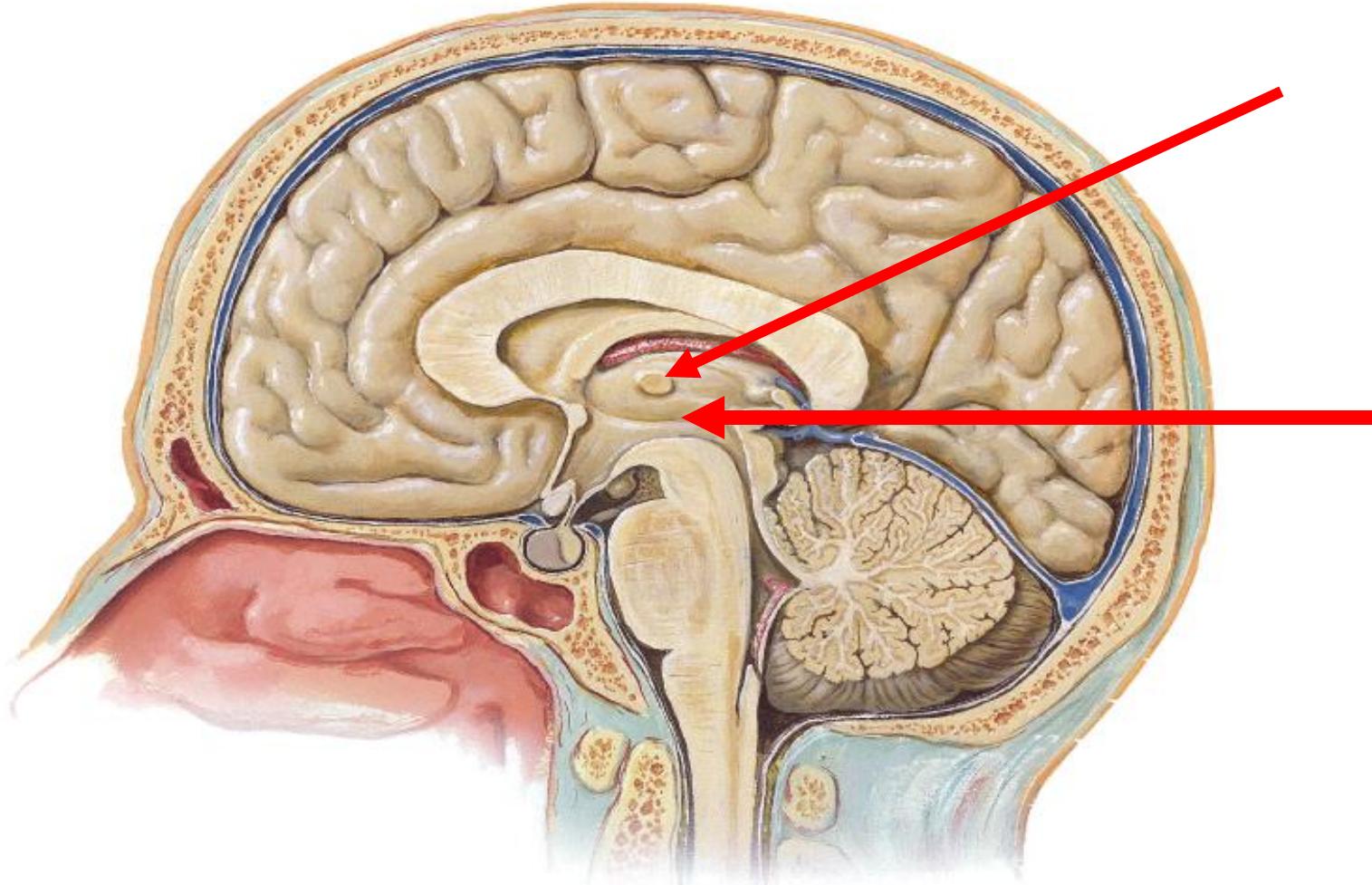
- Dorsal thalamus
- Metathalamus
- Epithalamus
- Subthalamus
- Hypothalamus



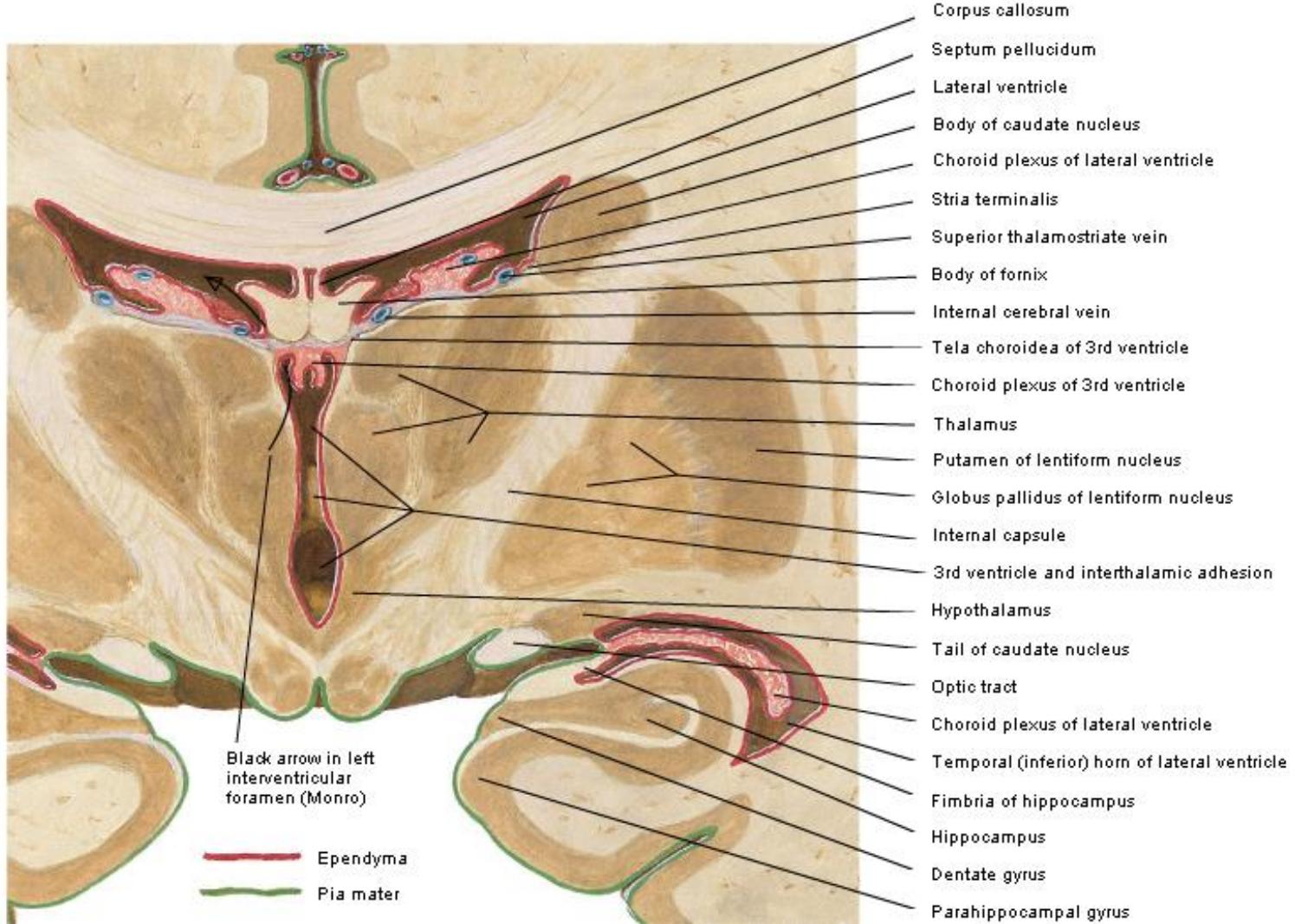
Schematic view of Diencephalon



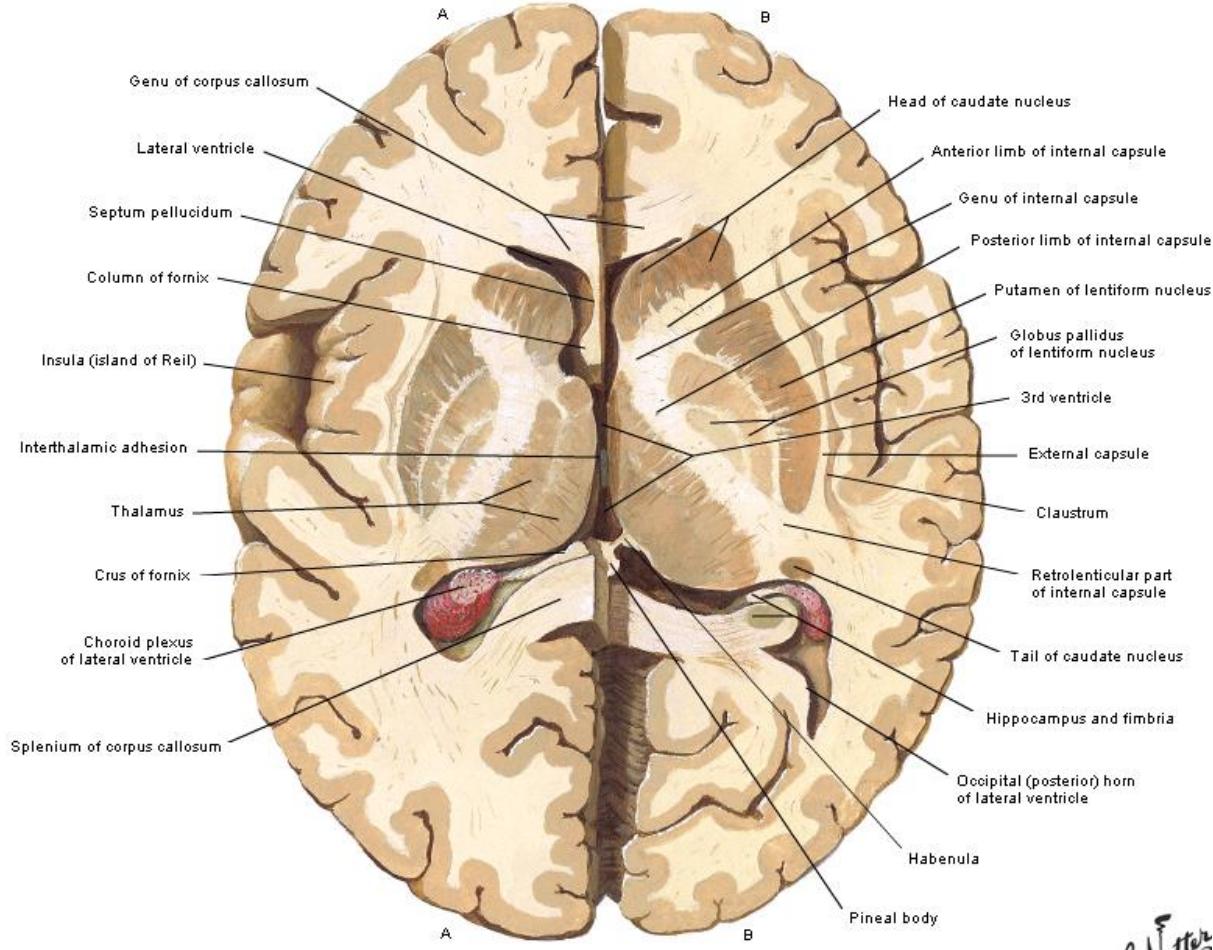
Lateral Wall of Diencephalon Right view



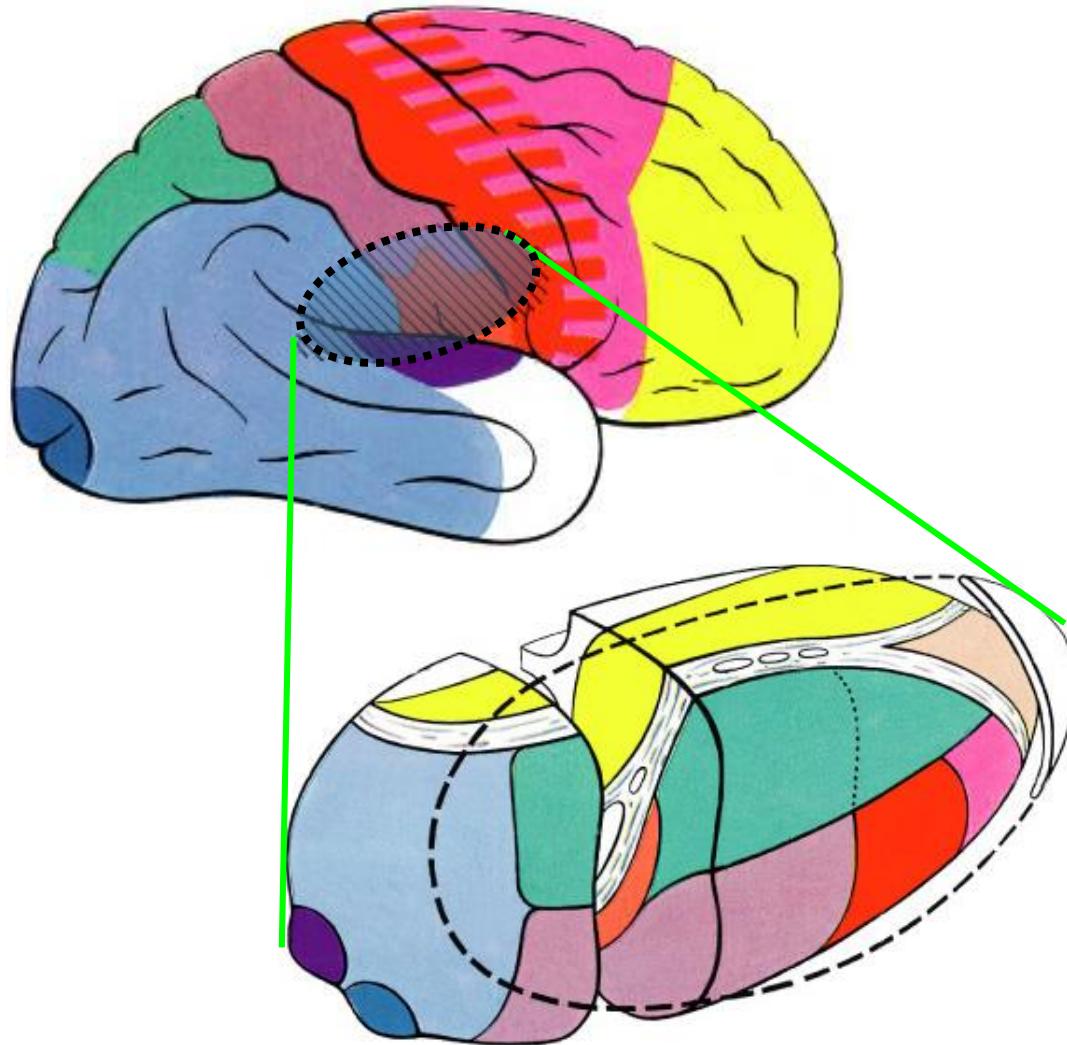
Dorsal Thalamus



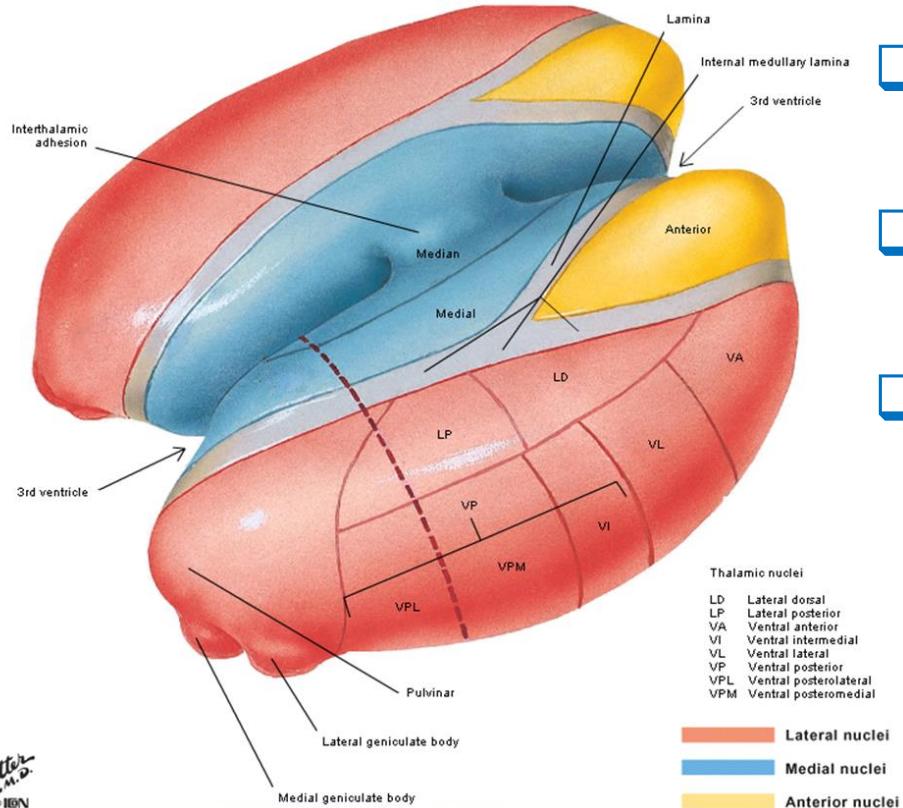
Dorsal Thalamus



Dorsal Thalamus

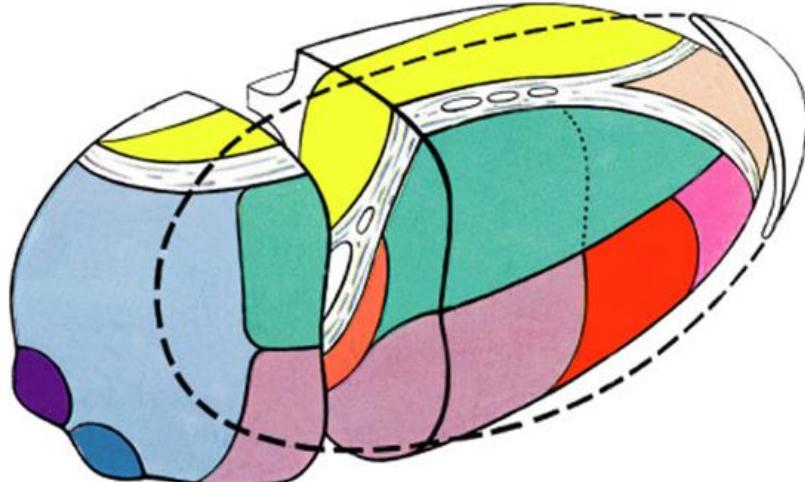


Dorsal Thalamus



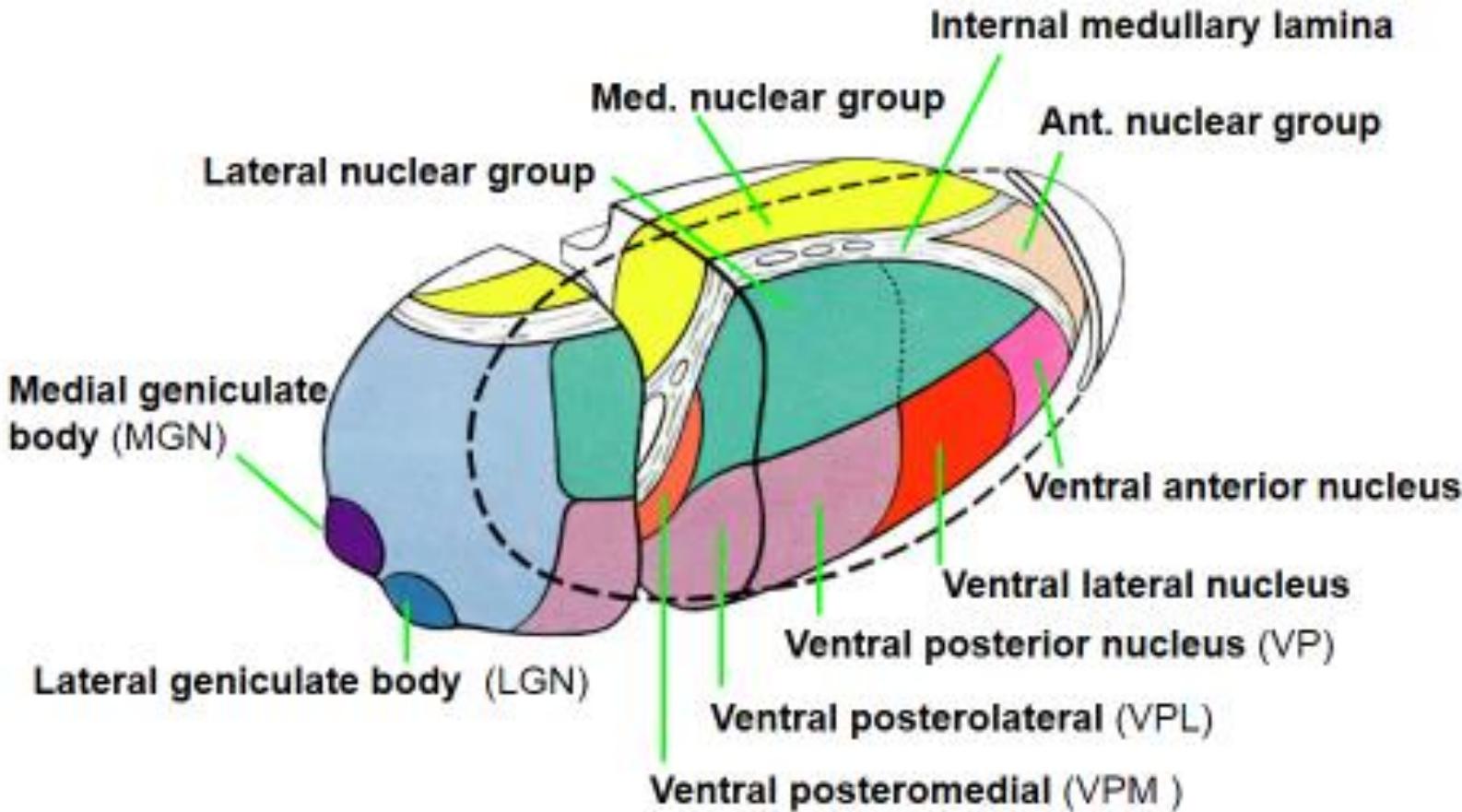
- Makes up 80% of the diencephalon
- Contains approximately a dozen major nuclei
- Send axons to regions of the cerebral cortex
- Nuclei act as relay stations for incoming sensory messages

Dorsal Thalamus External features



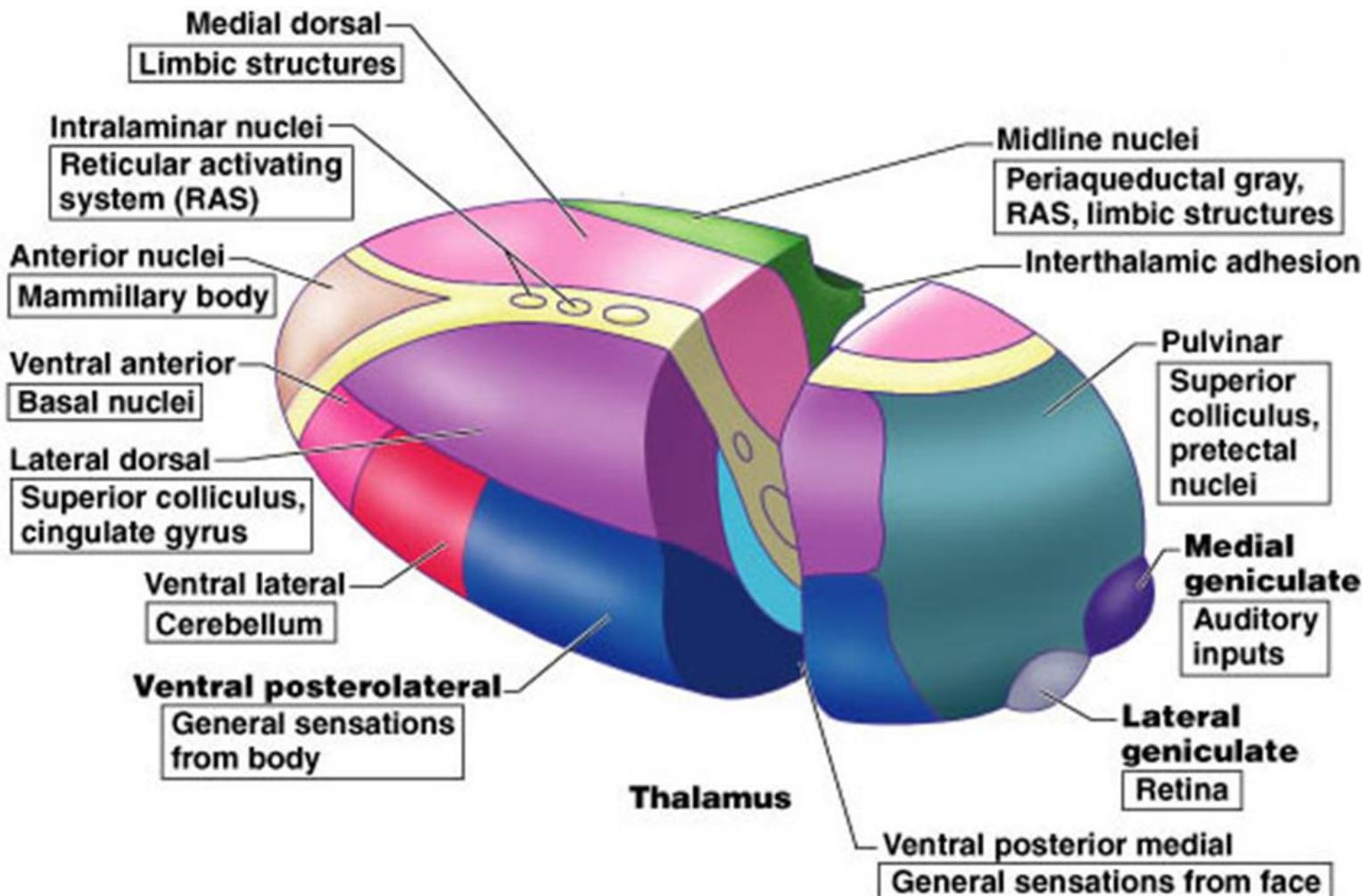
- A large egg-shaped nucleus mass
- Anterior end — anterior thalamic tubercle
- Posterior end — pulvinar
- Right and left portion of thalamus are joined by interthalamic adhesion
- Floor—hypothalamic sulcus

Dorsal Thalamus , Nomination and Subdivision Right Thalamus

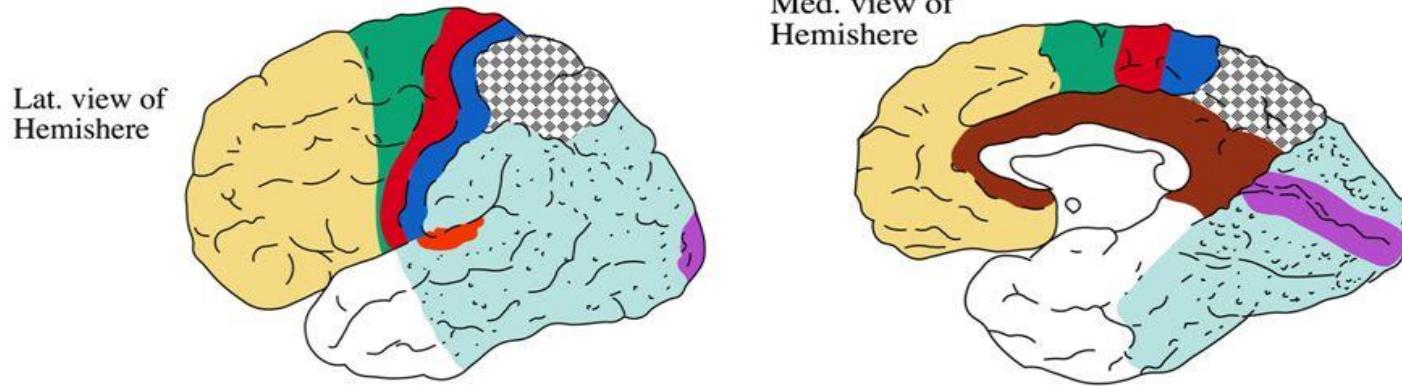


Subdivision	Principal Nuclei	Common abbreviation
Ant. nuclear group		
Med. nuclear group		
Lat. nuclear group		
Dorsal tier of the nuclei	Lateral dorsal	LD
	Lateral posterior	LP
	Pulvinar	
Ventral tier of the nuclei	Ventral anterior	VA
	Ventral lateral	VL
	Ventral posterior	VP
	Ventral posterolateral	VPL
	Ventral posteromedial Prof Dr Behnam Jameie	VPM 53

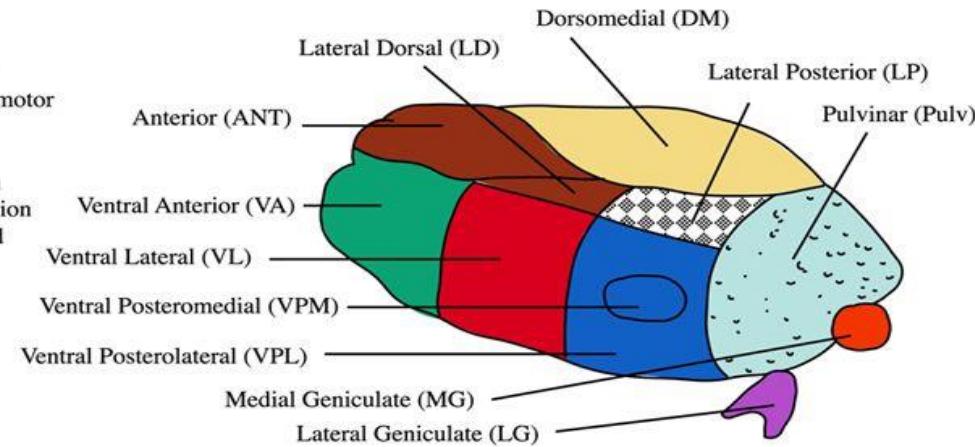
Functional Connections



Thalamus and Cerebrum



Thalamus	Cortical Field
ANT →	cingulate gy.
VA →	supplementary motor
VL →	premotor & primary motor
VPL →	primary sensory
VPM →	primary sensory
DM →	prefrontal association
LP →	post. parietal association
Pulv →	parietal, temporal and occipital association
MG →	primary auditory
LG →	primary visual



Thalamus

Functional subdivision

Nonspecific relay nuclei: receive afferents from rhinencephalon and reticular formation of brain stem, project mainly to hypothalamus and corpus striatum

- Midline nucleus group
- Intralaminar nuclear group
- Thalamic reticular nucleus

Association nuclei: receive input from many converging sources and in turn project widely to the association areas of cerebral cortex

- Anterior nuclear group
- Medial nuclear group
- Dorsal tier of lateral nuclear group

Functional subdivision

Special relay nuclei

- Vent. anterior nucleus (VA)
- Vent. intermediate nucleus (VI)

Receiving dentate nucleus, globus pallidus and substantia nigra to motor cortex

- Vent. posteromedial nucleus (VPM)

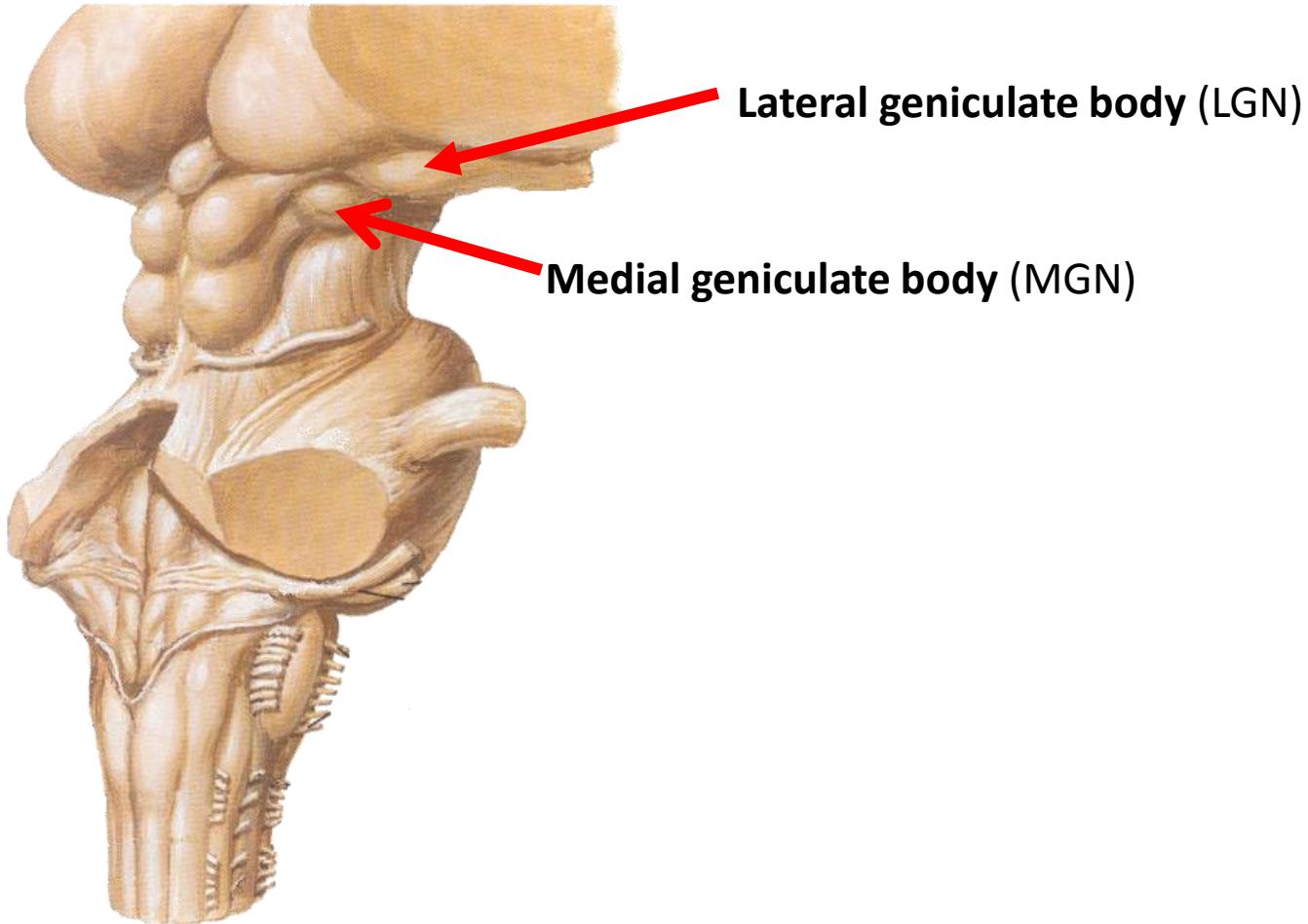
receives trigeminal lemniscus

- Vent. posterolateral nucleus (VPL)

receives medial lemniscus and spinal lemniscus

Projects to first somatic sensory area via central thalamic radiation

Metathalamus



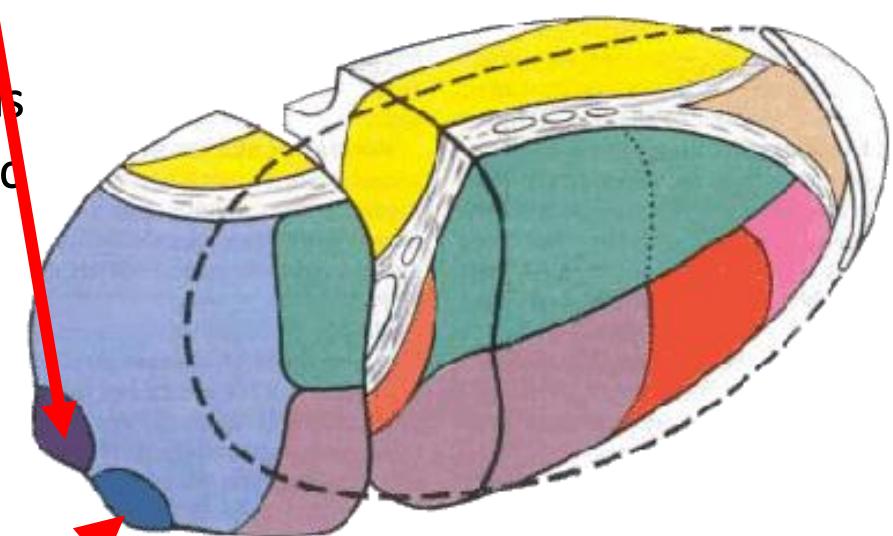
Metathalamus

Medial geniculate body (MGN)

Auditory Relay station

Receive fibers from inferior colliculus

Projects to auditory area via acoustic radiation



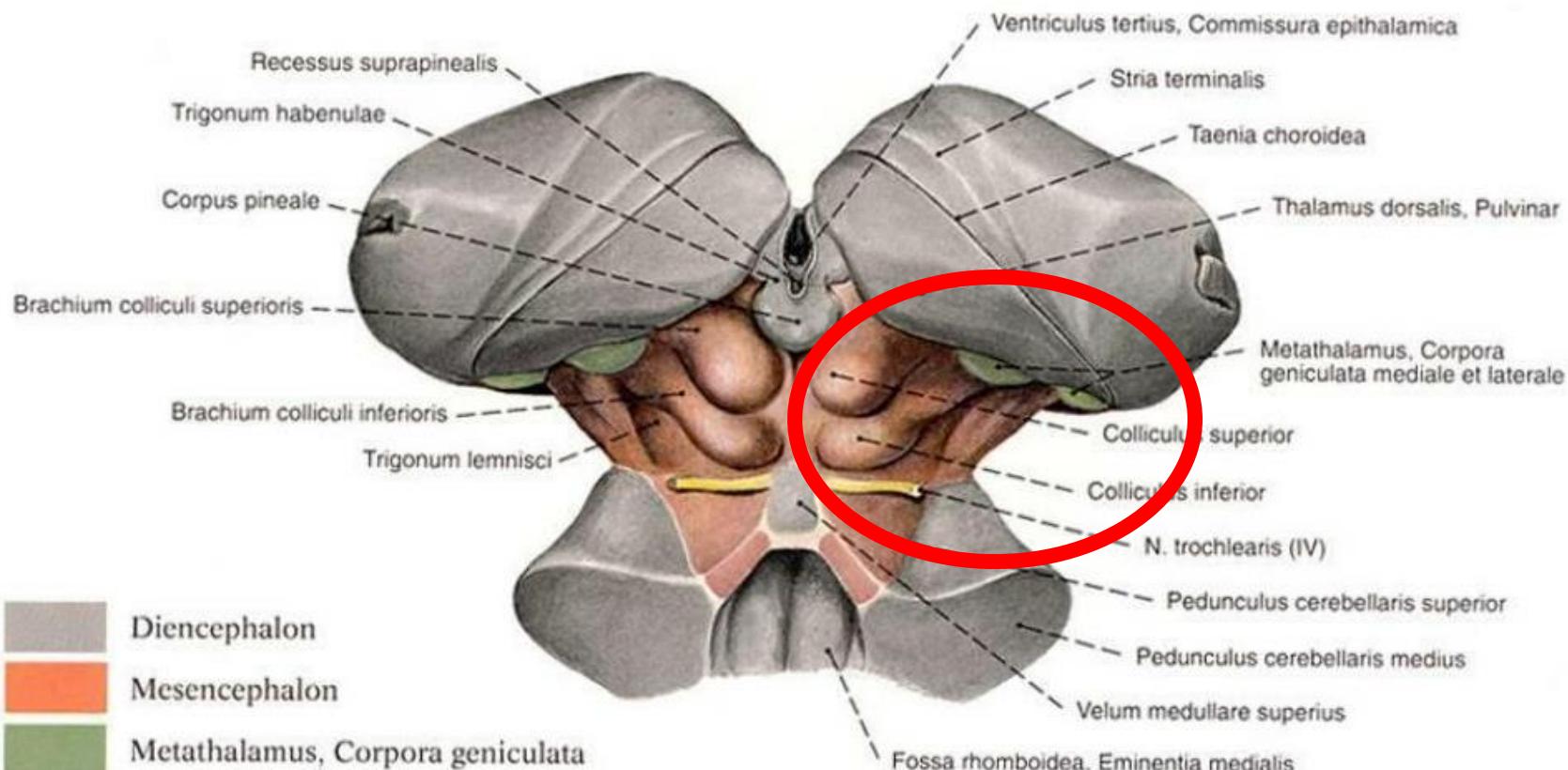
Lateral geniculate body (LGN)

Visual Relay station

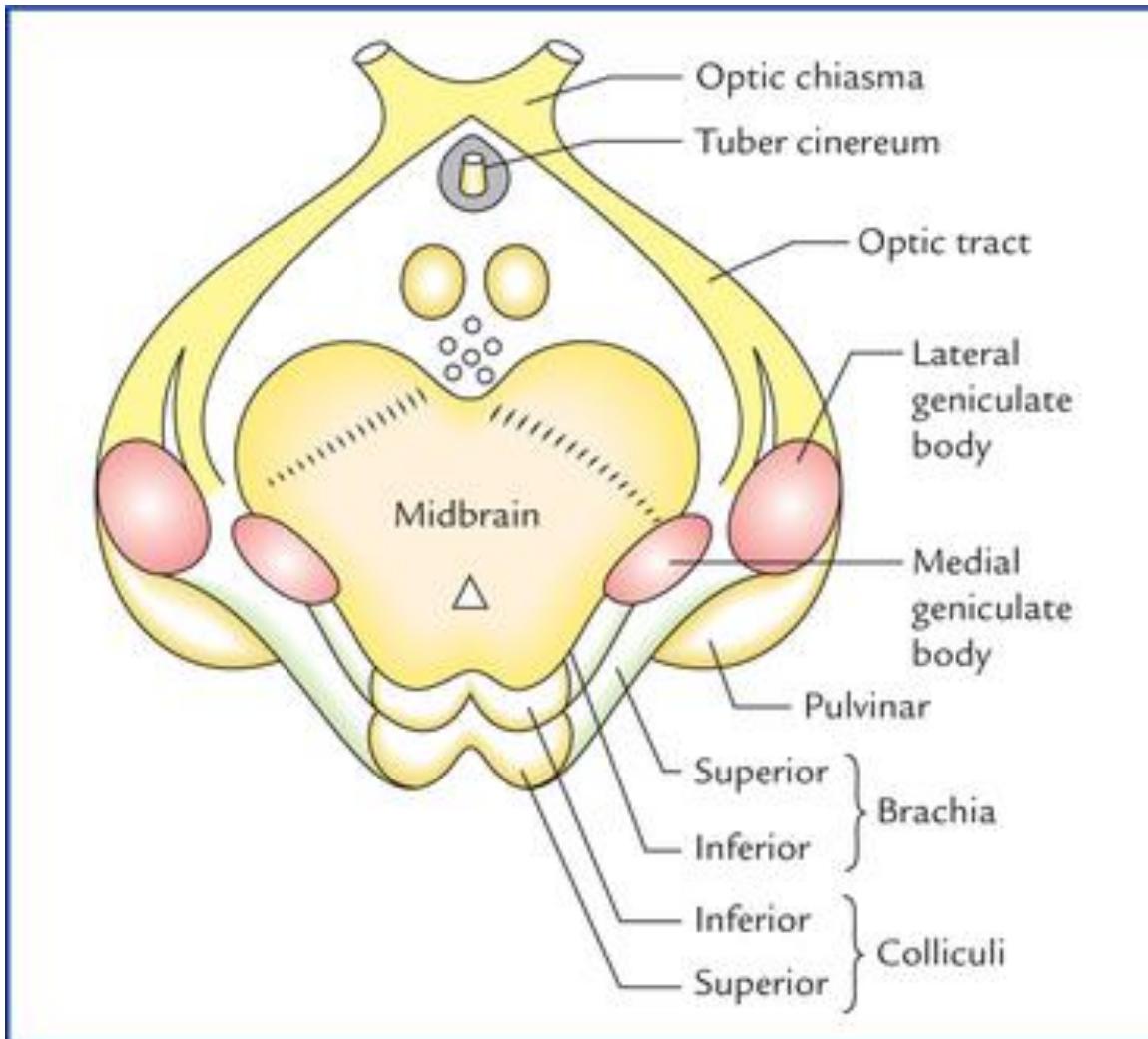
Receive fibers from optic tract

Projects to visual area via optic radiation

Metathalamus

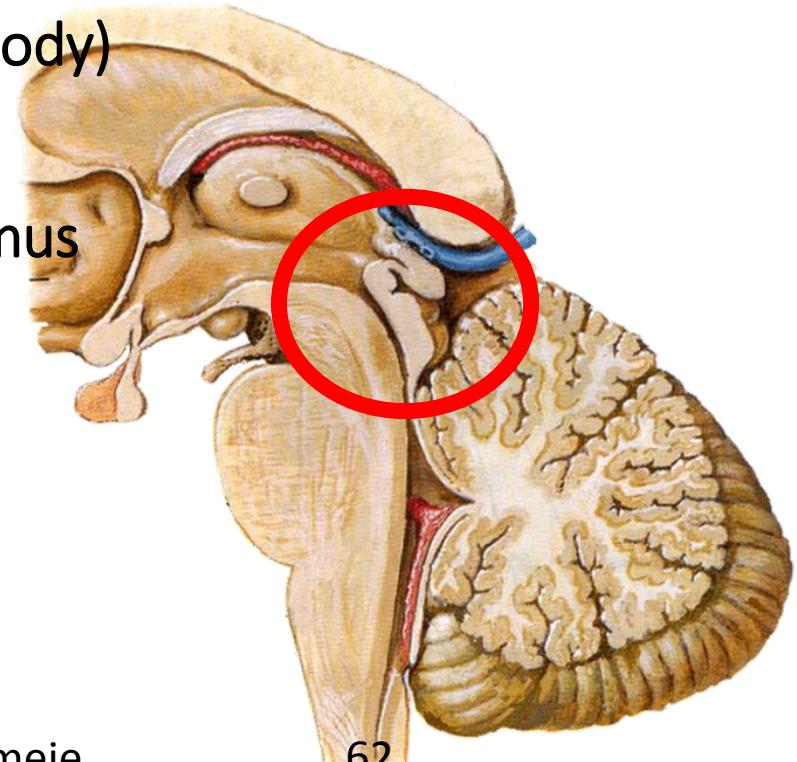


Metathalamus /Connections



Epithalamus

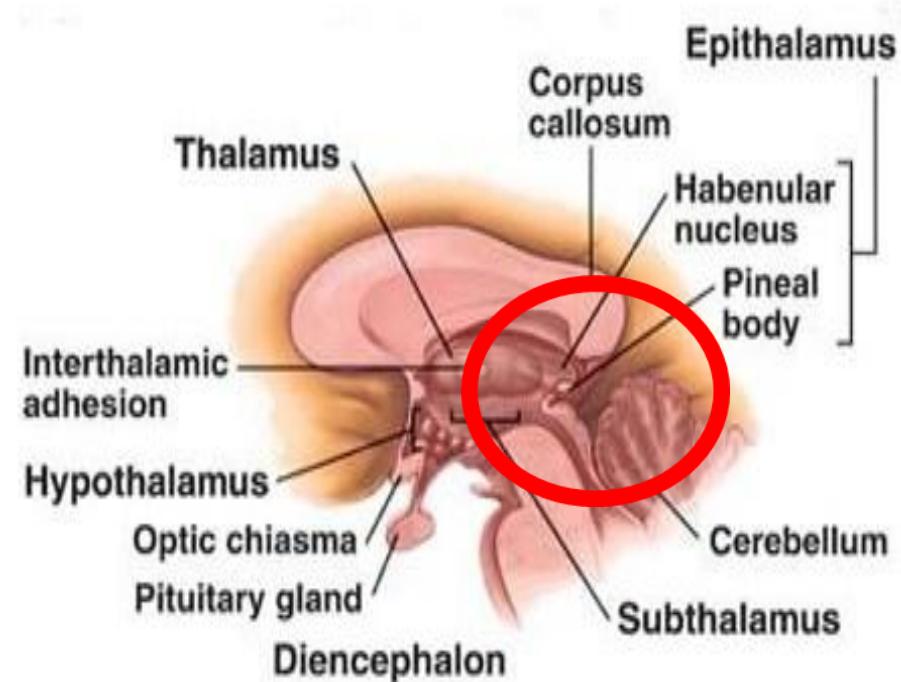
- Forms part of the “roof” of the third ventricle
- Consists of a tiny group of nuclei
- Includes the pineal gland (pineal body)
- Secretes the hormone melatonin
- Under influence of the hypothalamus



Epithalamus

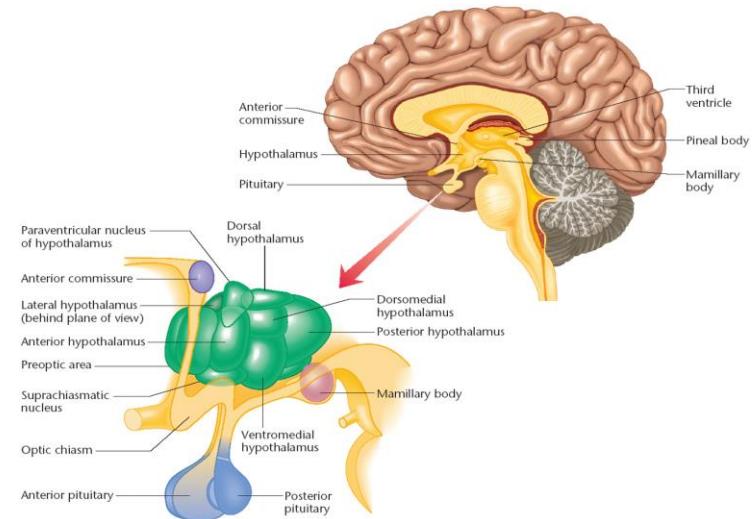
includes

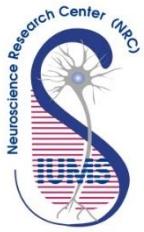
- Thalamic medullary stria
- Habenular trigone
- Habenular commissure
- Pineal body
- Posterior commissure



Hypothalamus/General Inf & Topography

- The part of the diencephalon that controls visceromotor and endocrine functions and affective (emotional) behavior.
- Weighs about 4 grams
- Occupies the bottom and infero-lateral walls of the III ventricle
- In the center of the limbic system.
- At the crossing of numerous nerve pathways.
- Surrounded by the circle of Willis.





Hypothalamus / Function

□ Major functions:

- Control of the pituitary gland (both anterior and posterior)
- Control of the autonomic nervous system
- Control of a variety of behaviors that are essential for survival (of the individual and of the species):
 - eating, drinking, sleep, sexual behavior, parental behavior, and aggression.
- Partially regulate water balance, food intake, body temperature, blood pressure, body metabolism, etc.

Functions of Hypothalamus

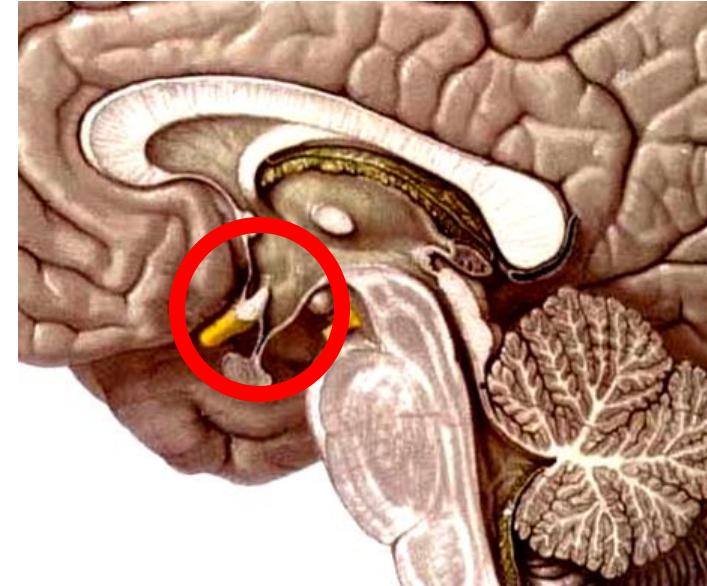
- Autonomic control
- Endocrine control
- Temperature regulation
- Regulation of food and water intake
- Emotion and behavior
- Control of circadian rhythms

Hypothalamus/Location

Position – lies ventral to thalamus

Boundaries

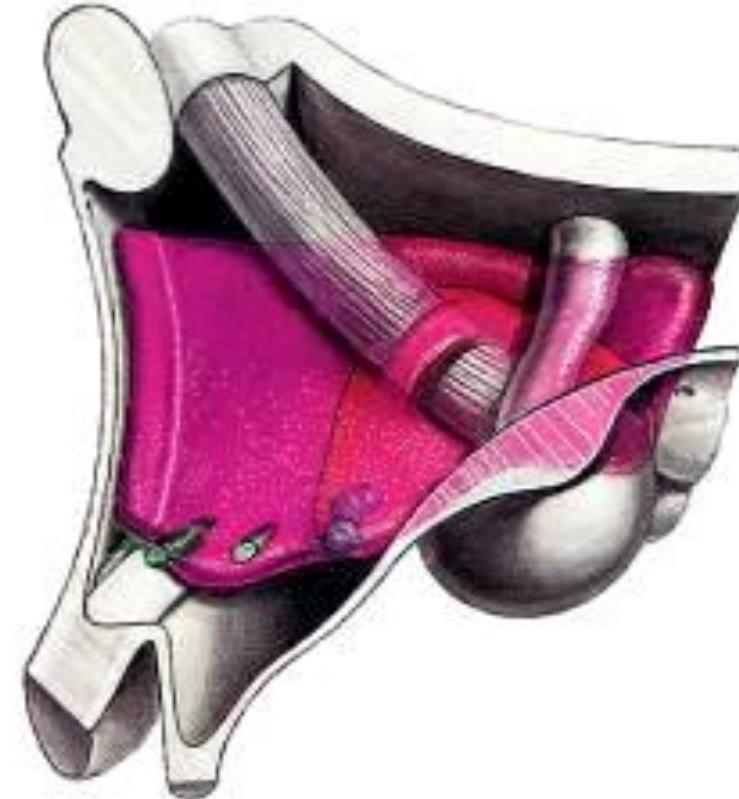
- Superiorly: hypothalamic sulcus
- Inferiorly:
 - optic chiasma
 - tuber cinereum
 - Infundibulum
 - mamillary body
- Anterior: lamina terminalis
- Posterior: continues with midbrain tegmentum



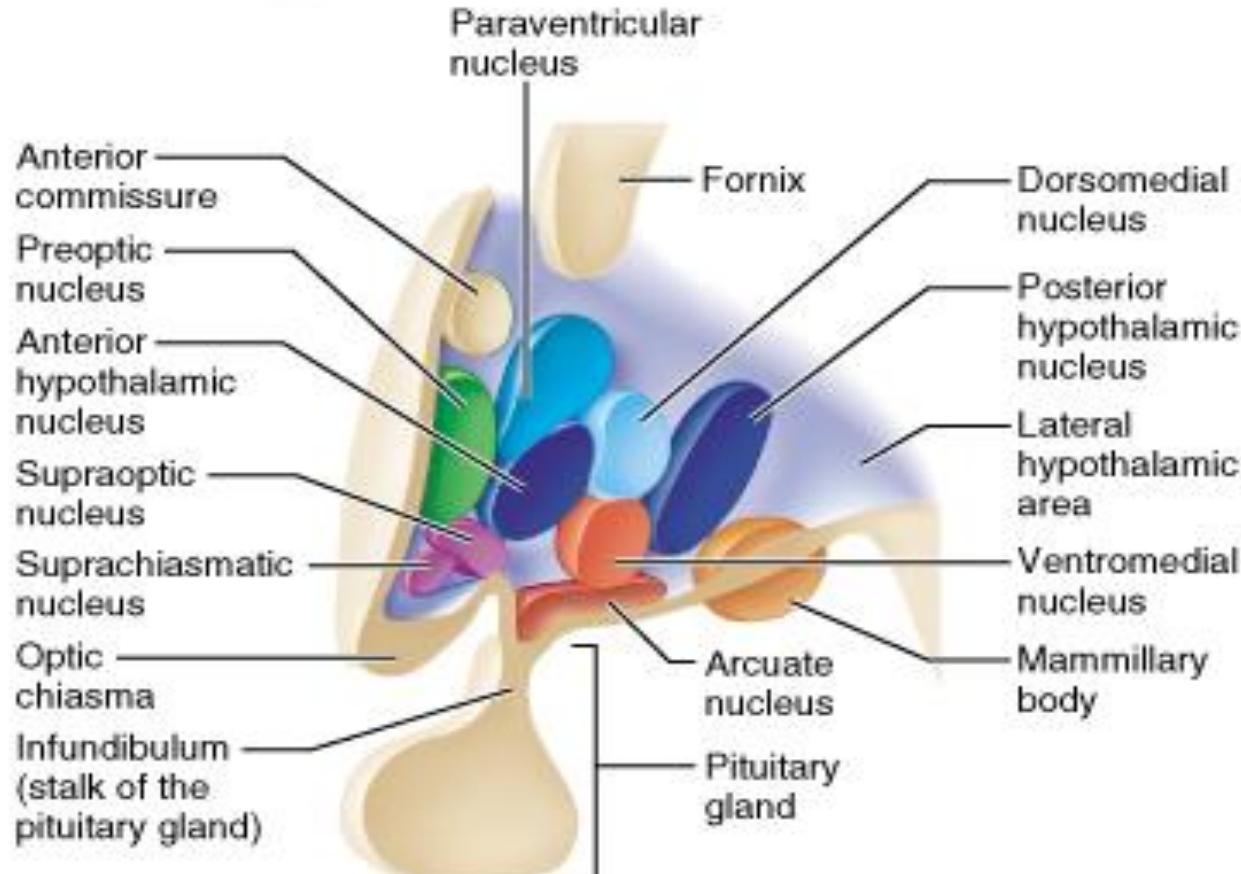
Hypothalamus

Subdivisions

- Preoptic region
- Supraoptic region
- Tuberal region
- Mamillary region

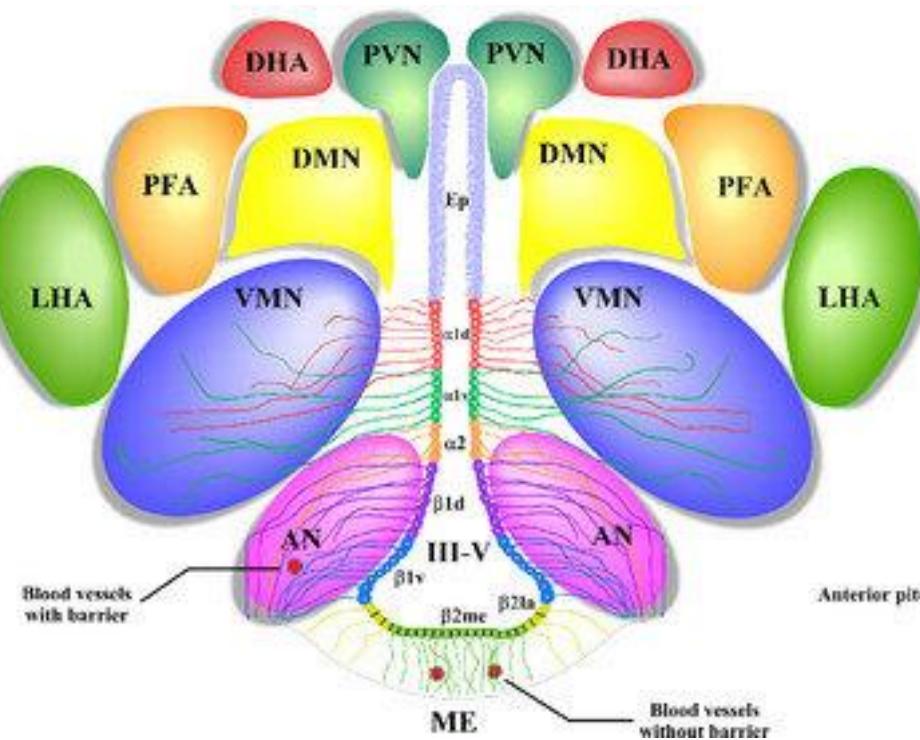


Hypothalamus / Subdivision

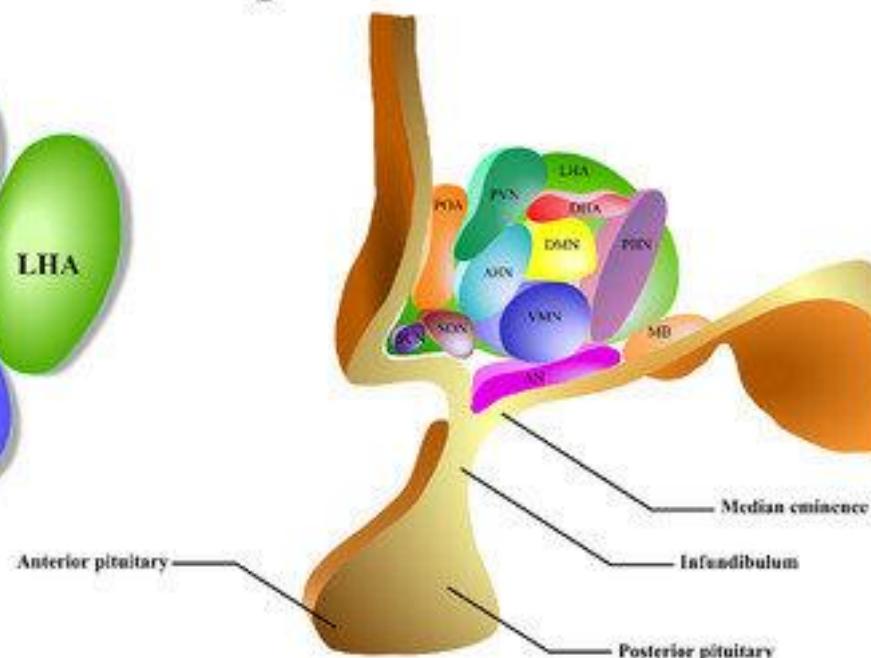


(b)

A



B



Important Nuclei of Hypothalamus

□ Supraoptic region

- Supraoptic nucleus—produce antidiuretic hormone (ADH, vasopressin)
- Paraventricular nucleus—produce oxytocin
Tuberal region
Infundibular nucleus
- Ventromedial nucleus
- Dorsomedial nucleus

□ Mamillary region

- Mamillary nucleus
- Posterior hypothalamic nucleus

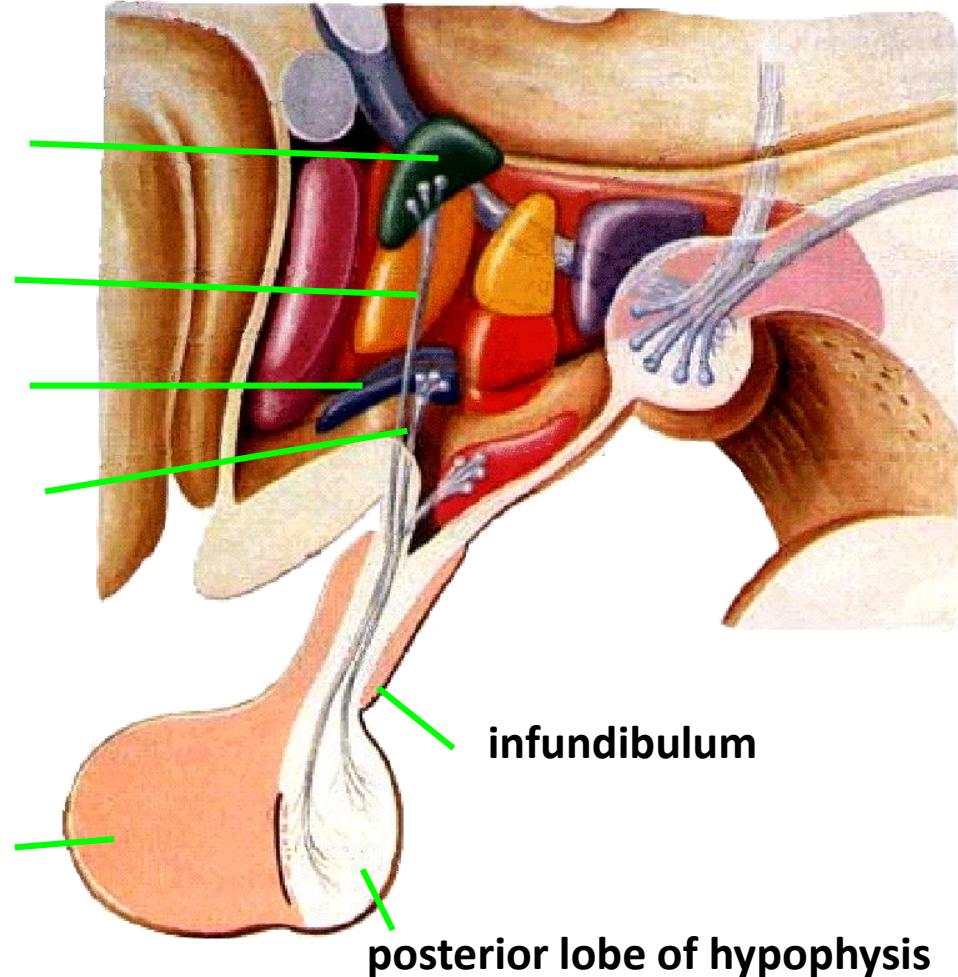
Paraventricular nucleus

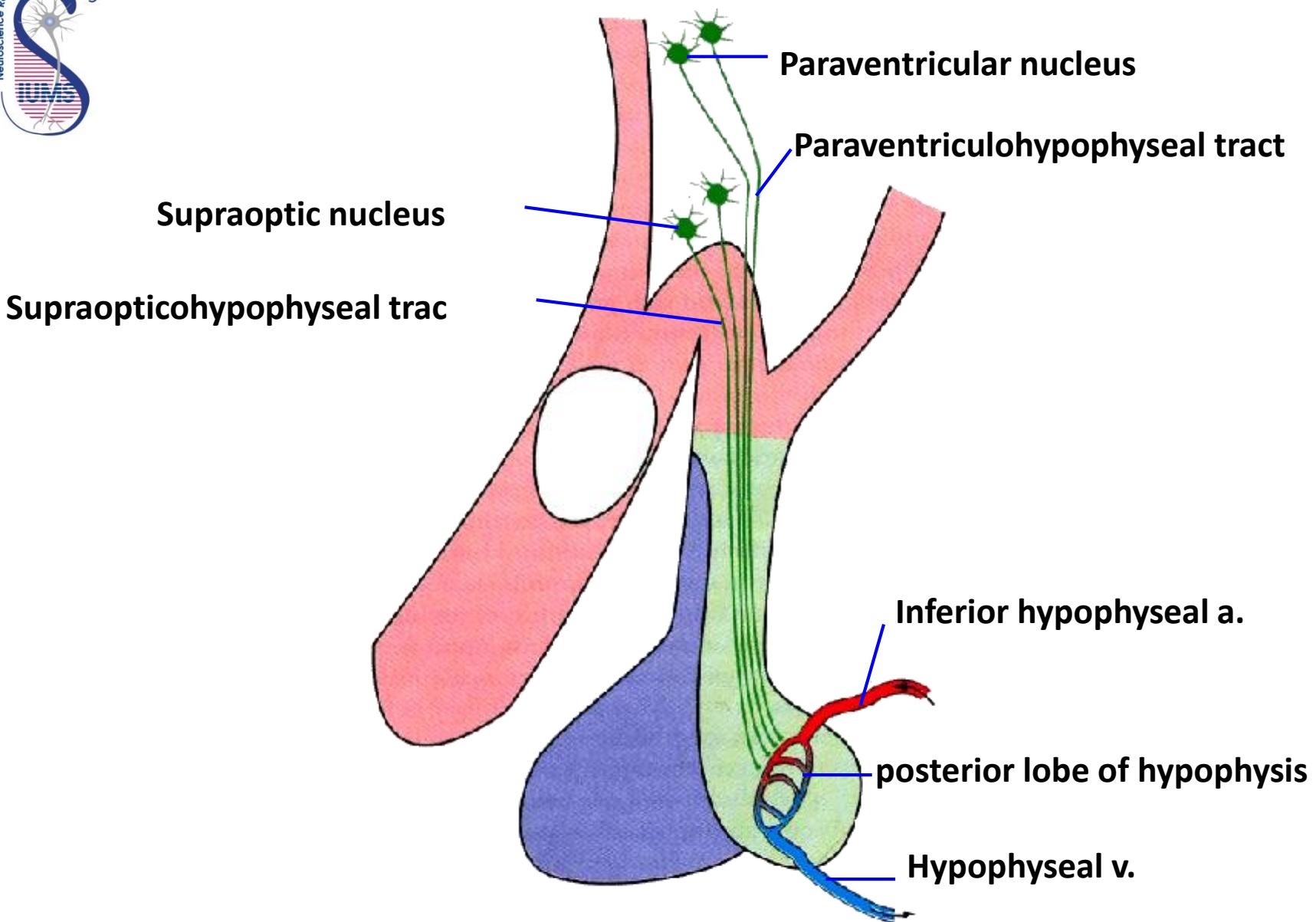
Paraventriculohypophyseal tract

Supraoptic nucleus

Supraopticohypophyseal tract

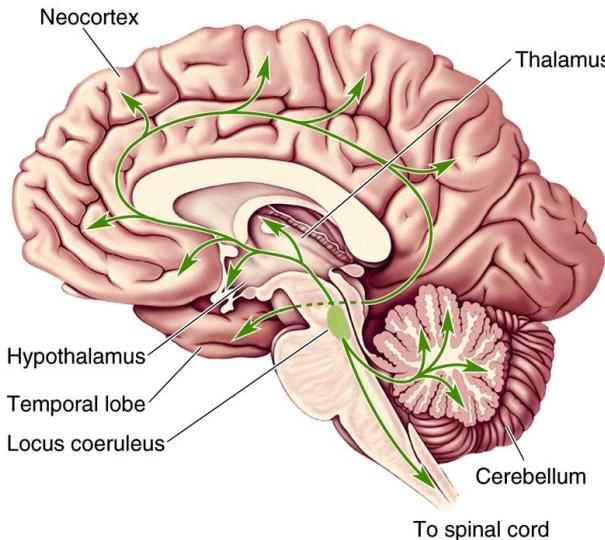
anterior lobe of hypophysis



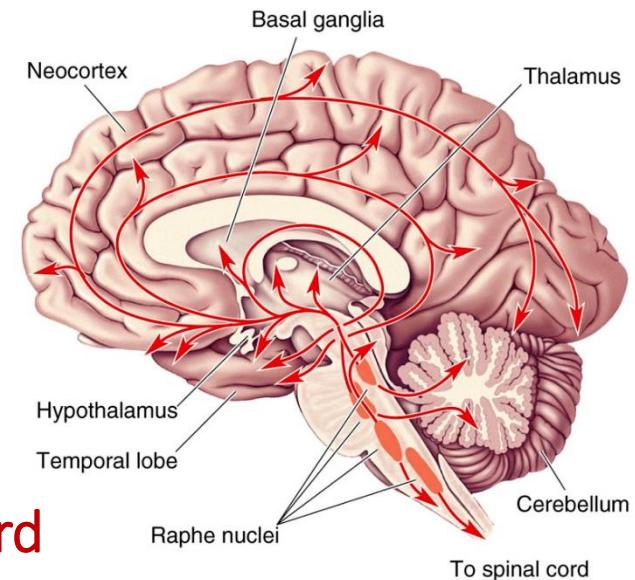


Connections of Hypothalamus

Norepinephrine system



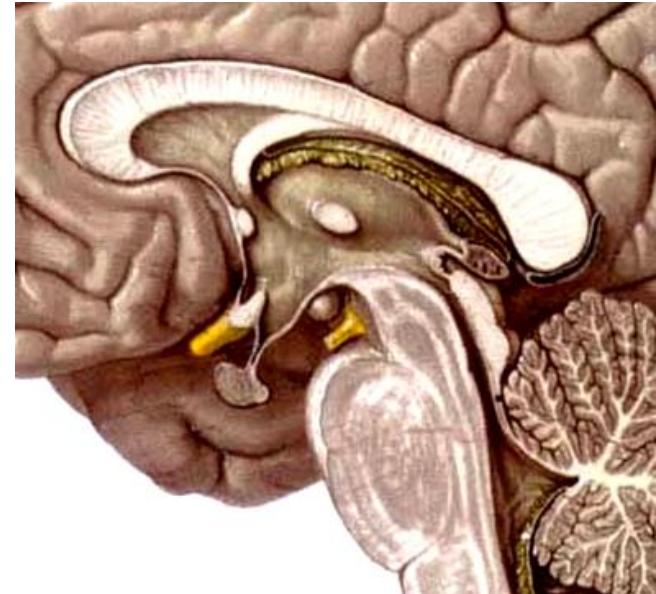
Serotonin system

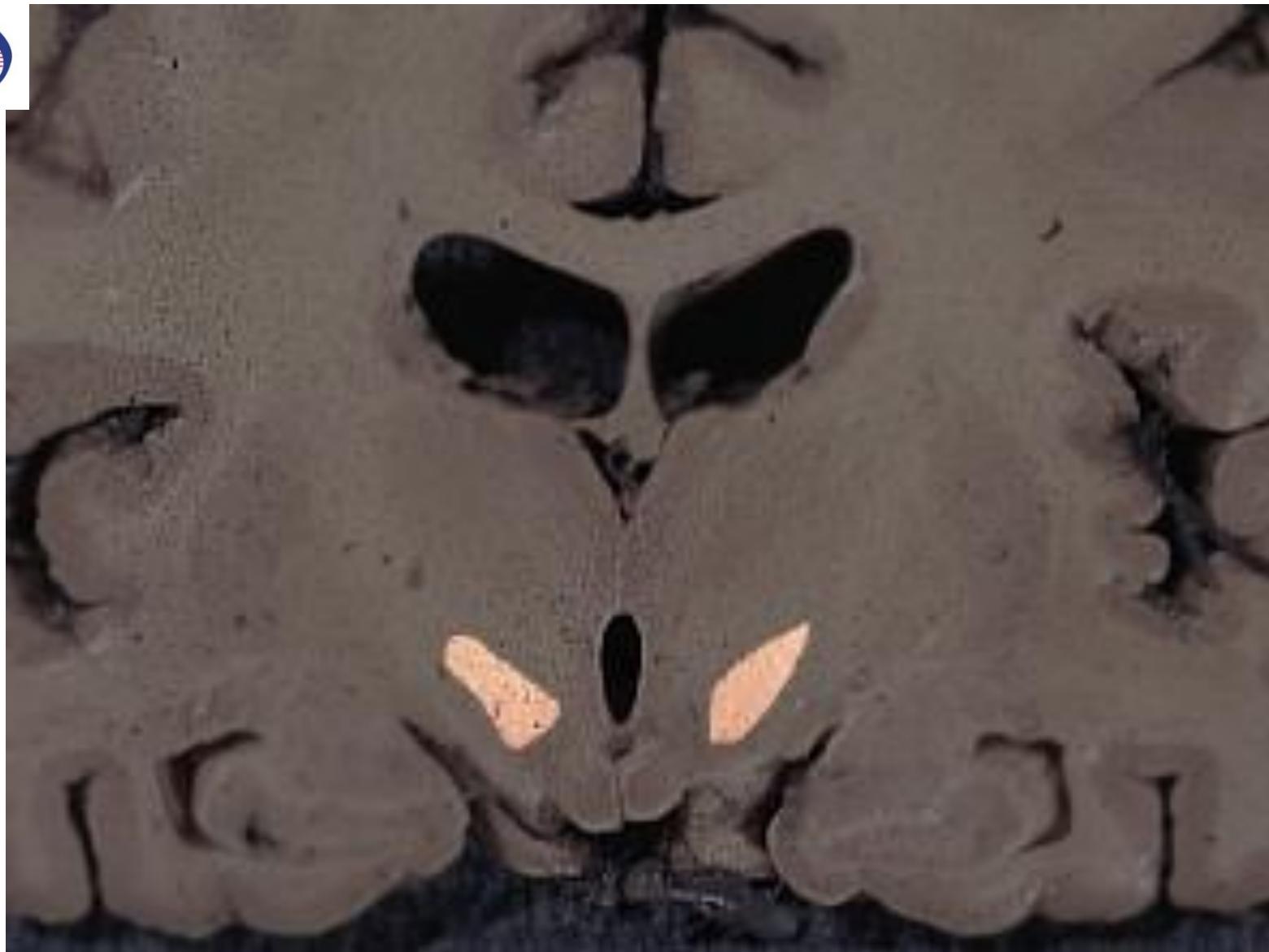


- Connects with limbic system
- Connects with brainstem and spinal cord
- Connects with dorsal thalamus
- Connects with hypophysis

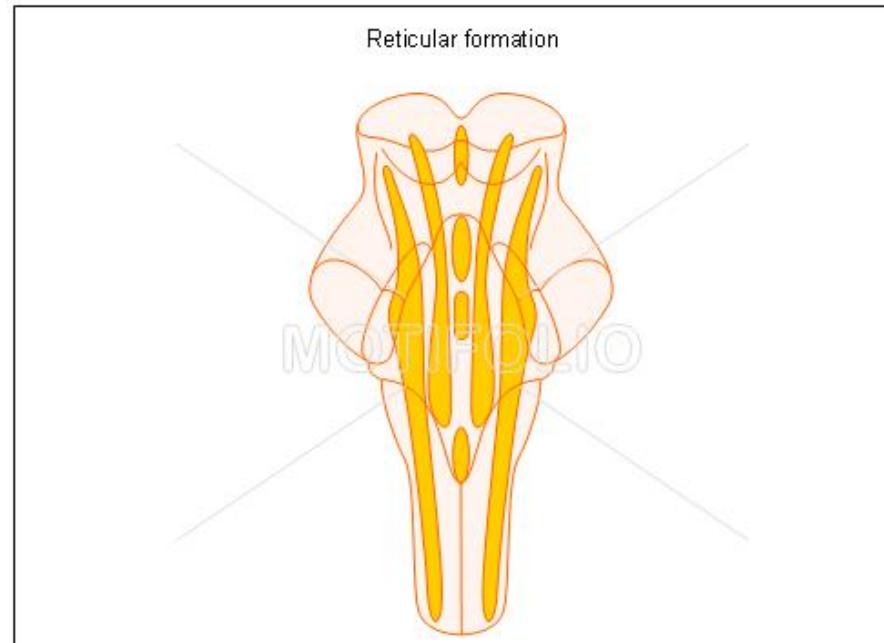
Subthalamus

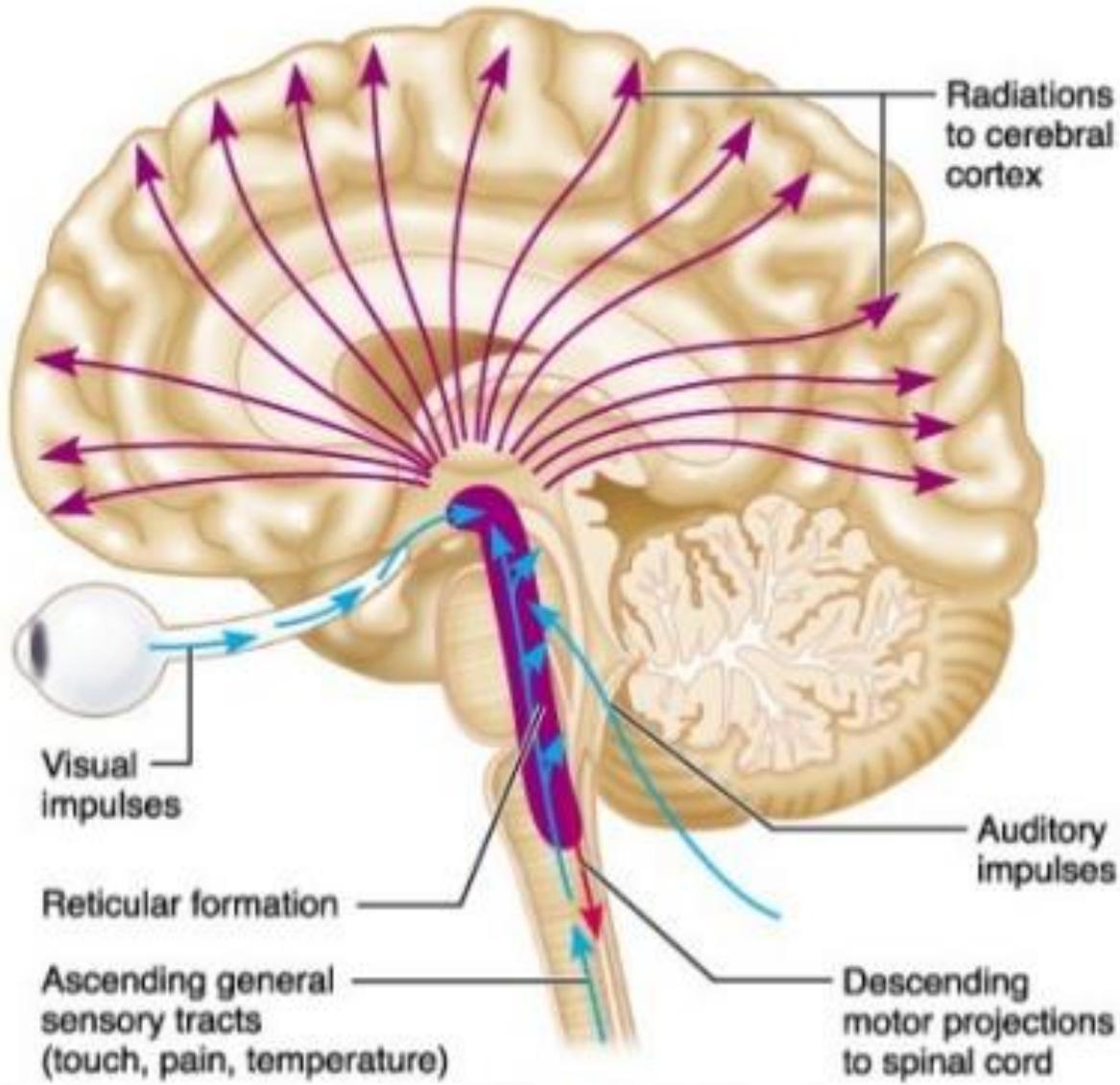
- **Position:** transition zone between diencephalons and tegmentum of midbrain
- **Content:** subthalamic nucleus, parts of red nucleus and substantia nigra





Reticular Formation/RAS & Limbic System

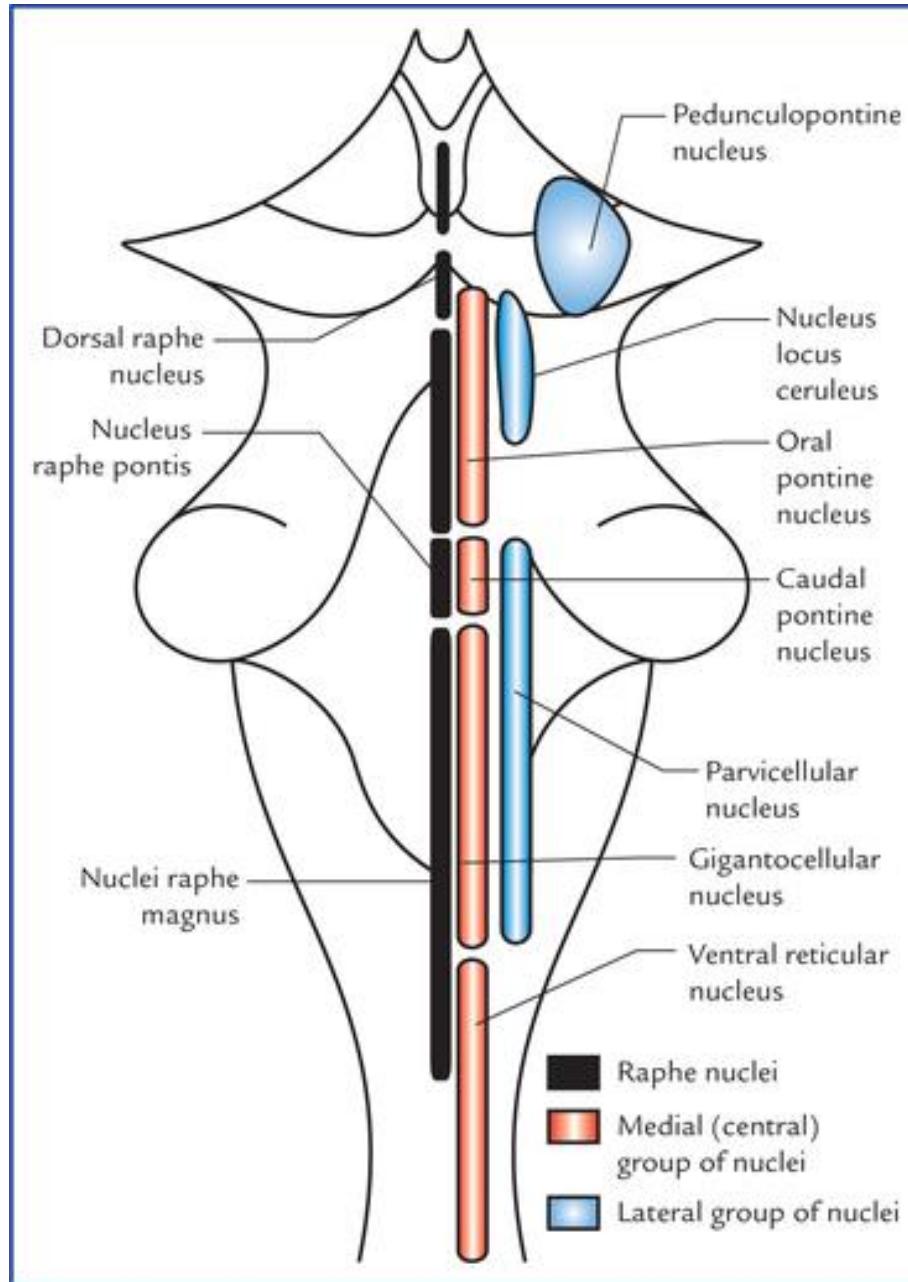


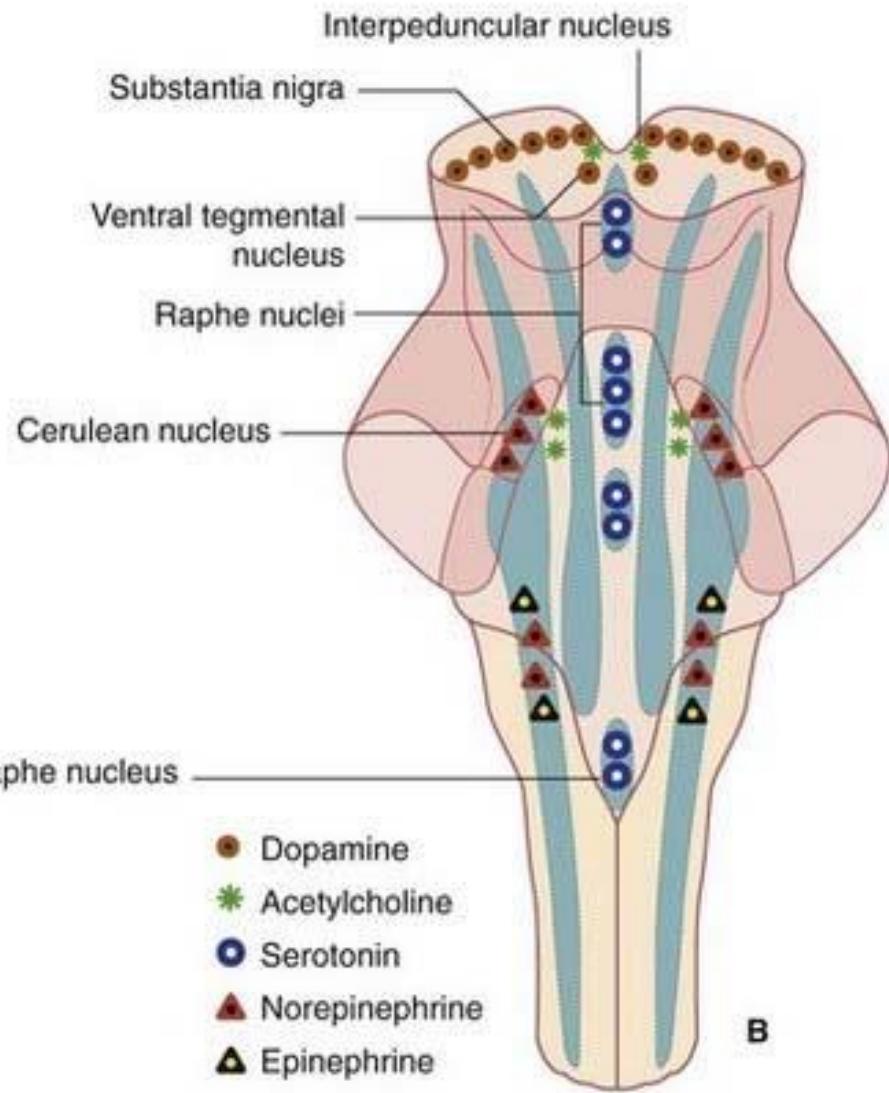
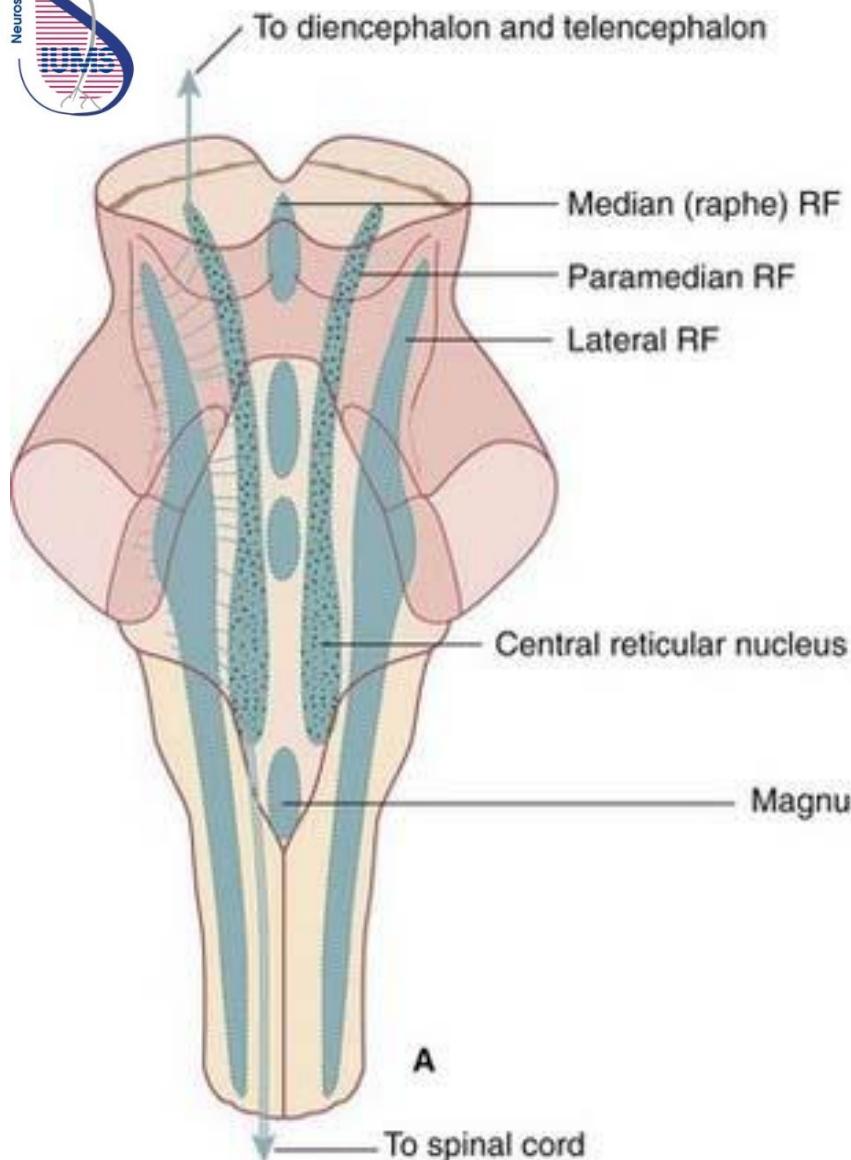


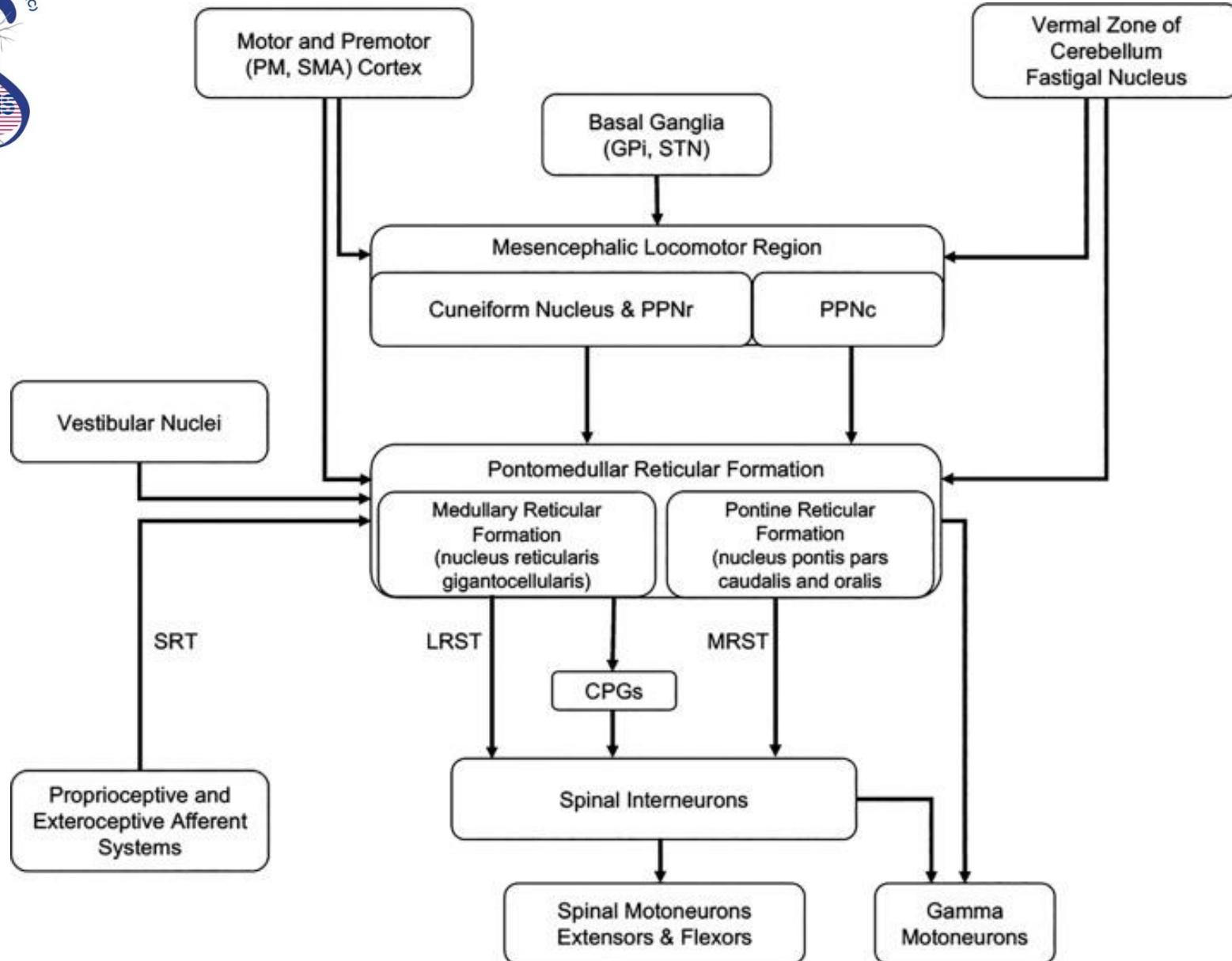


Anatomical Extension

- The reticular formation extends cranially to the diencephalon (subthalamus, hypothalamus and thalamus) and caudally to the spinal cord in the cervical region.
- These extensions are either actual or projectional.
- Some centres of cerebrum and cerebellum are also closely related functionally to the reticular formation of brainstem.
- RF is described to be consisting of network of nerve fibres and scattered neurons, among them a number of regions with fairly localized cell groups called **reticular nuclei**.









Thank you for your attention

*Photography by
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Chitgar Tehran Farvardin 1398*