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Diencephalon

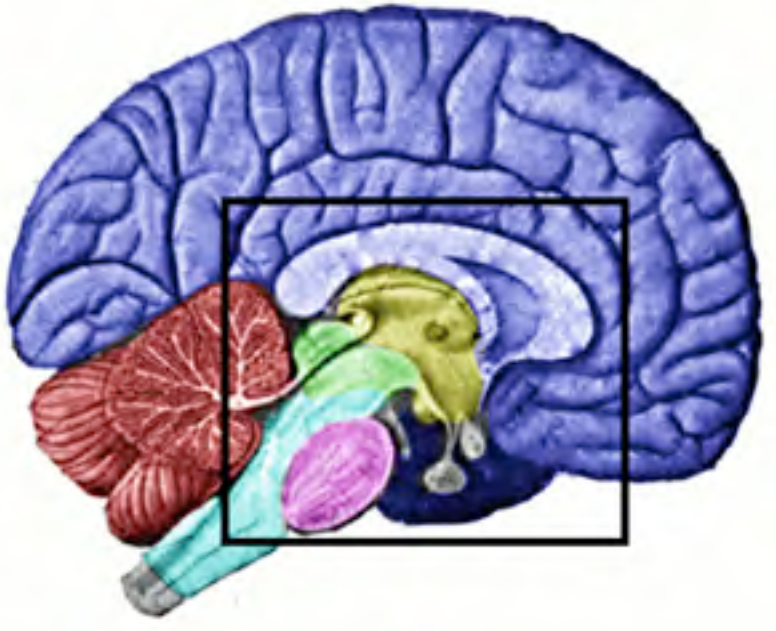
M1 – CNS Sequence

Peter Hitchcock, Ph.D.

Introduction to today' s lecture:

- I. Introduction to the Diencephalon (inter brain)**
- II. Anatomical subdivisions of the Diencephalon**
- III. Anatomical Boundaries of the Diencephalon - 3rd ventricle and internal capsule**
- IV. Dorsal thalamus - Organization and functional considerations**
- V. Interconnections between Dorsal Thalamus and Cerebral Cortex**
- VI. Ventral Thalamus**
- VII. Hypothalamus - Organization and functional considerations**
- VIII. Interconnections of the Hypothalamus**
- IX. Blood supply to the Dorsal Thalamus and Hypothalamus**

Midsagittal view

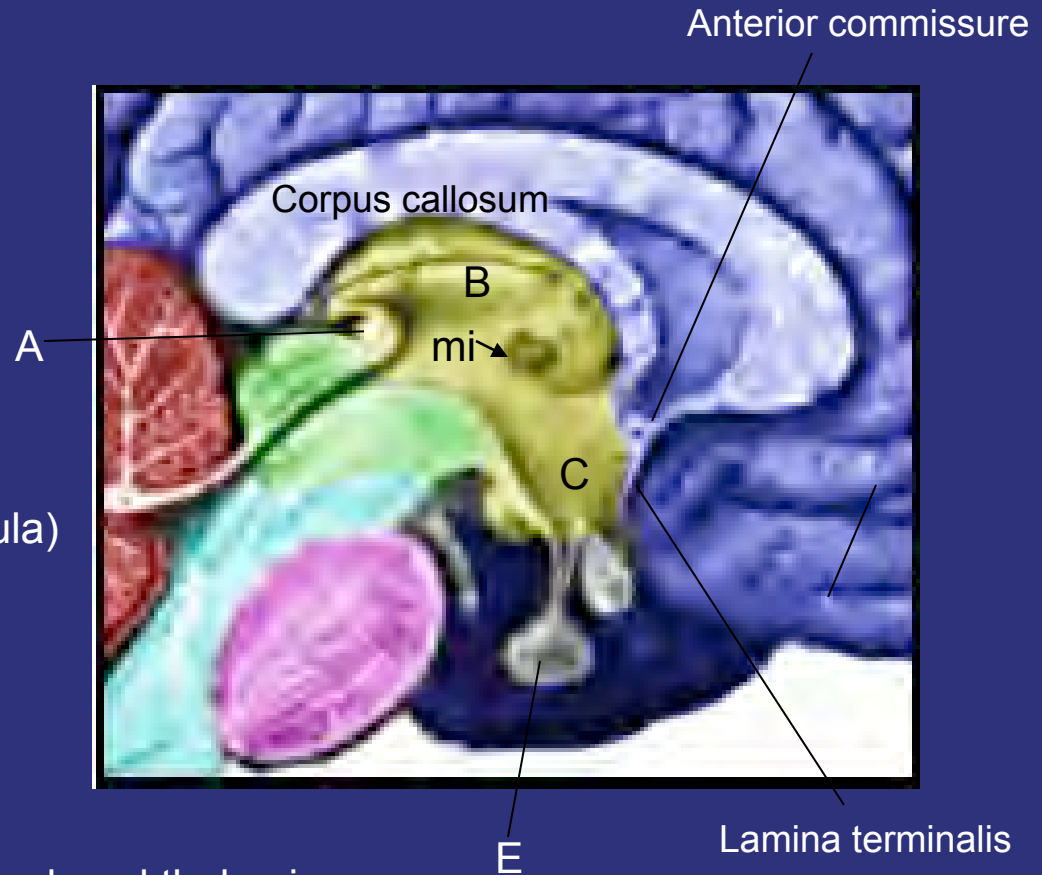


In the adult brain the diencephalon is completely surrounded by the telencephalon.

Regions of the Diencephalon:

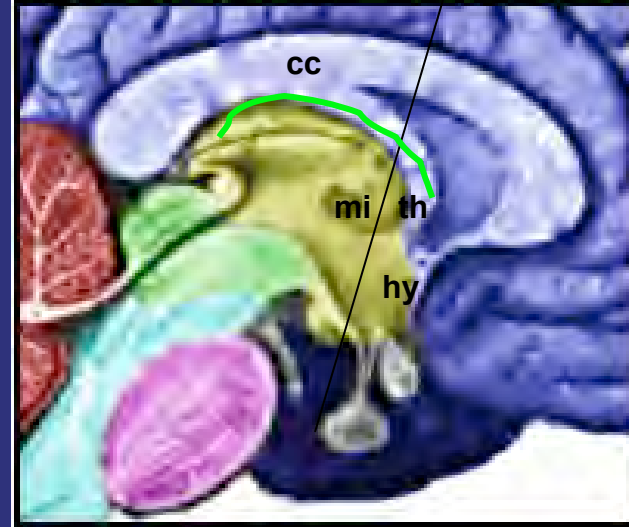
- A. Epithalamus (pineal gland and habenula)
- B. Dorsal Thalamus
- C. Hypothalamus
- D. Ventral thalamus (or subthalamus)
(not visible in this midline section)
- E. Posterior pituitary

mi. massa intermedia - adhesion between dorsal thalami

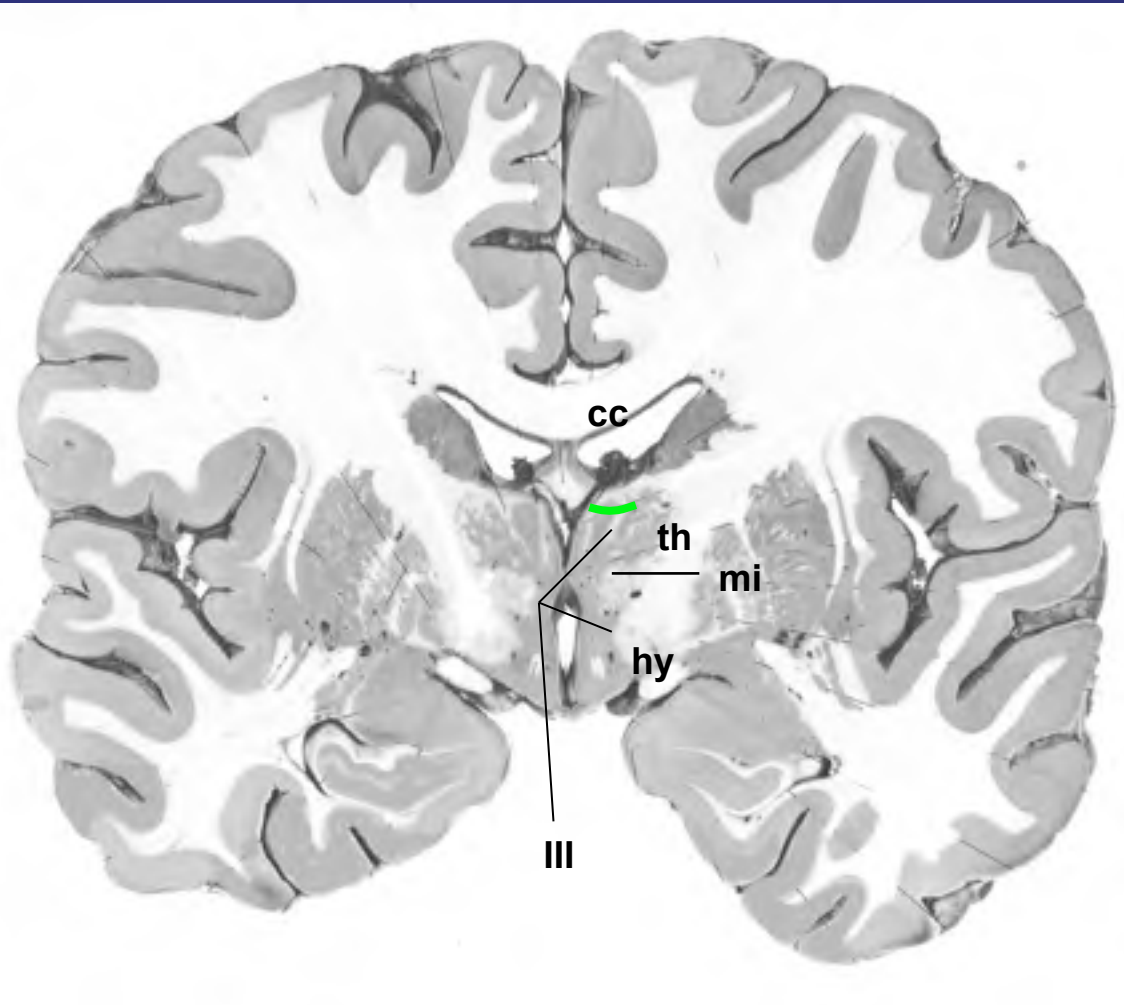


The **thalamus** (th) and **hypothalamus** (hy) form the walls and floor of the **third ventricle** (III).

The roof of the ventricle (in green) extends from the interventricular foramen to the pineal gland.



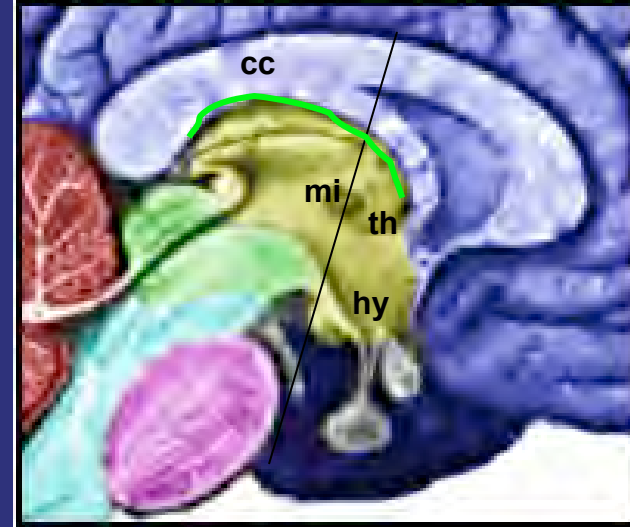
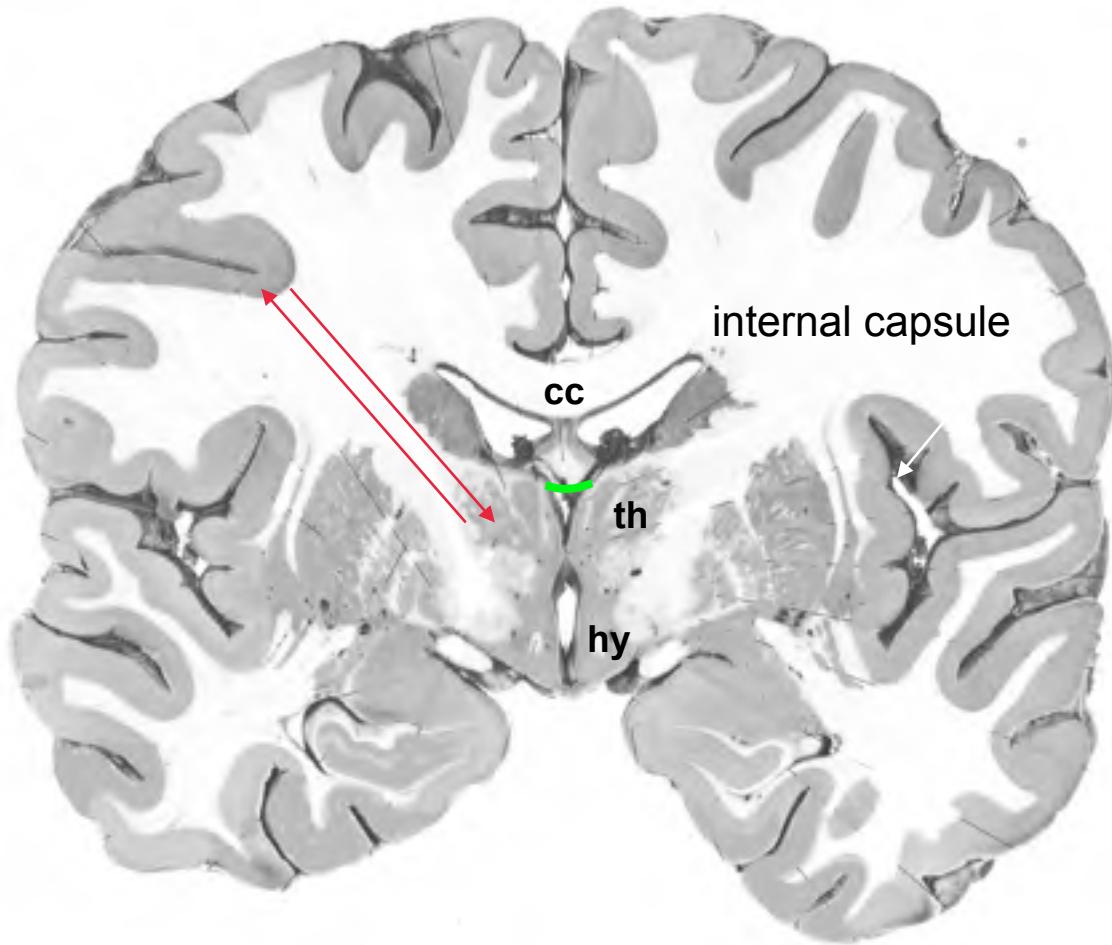
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The massa intermedia (mi) connects the left and right thalami in about 70% of human brains.

This bridge of tissue divides the third ventricle into upper and lower channels

The fibers of the **Internal Capsule** form the lateral boundary of the diencephalon.



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Most of the fibers in the internal capsule are reciprocal connections between the thalamus and the cerebral cortex, the **thalamo-cortical** and **cortico-thalamic** fibers.

Organization of Dorsal Thalamus - Four general principles :

1) The dorsal thalamus consists of two symmetrical, ovoid nuclei (many nuclei, actually) located in the diencephalon.

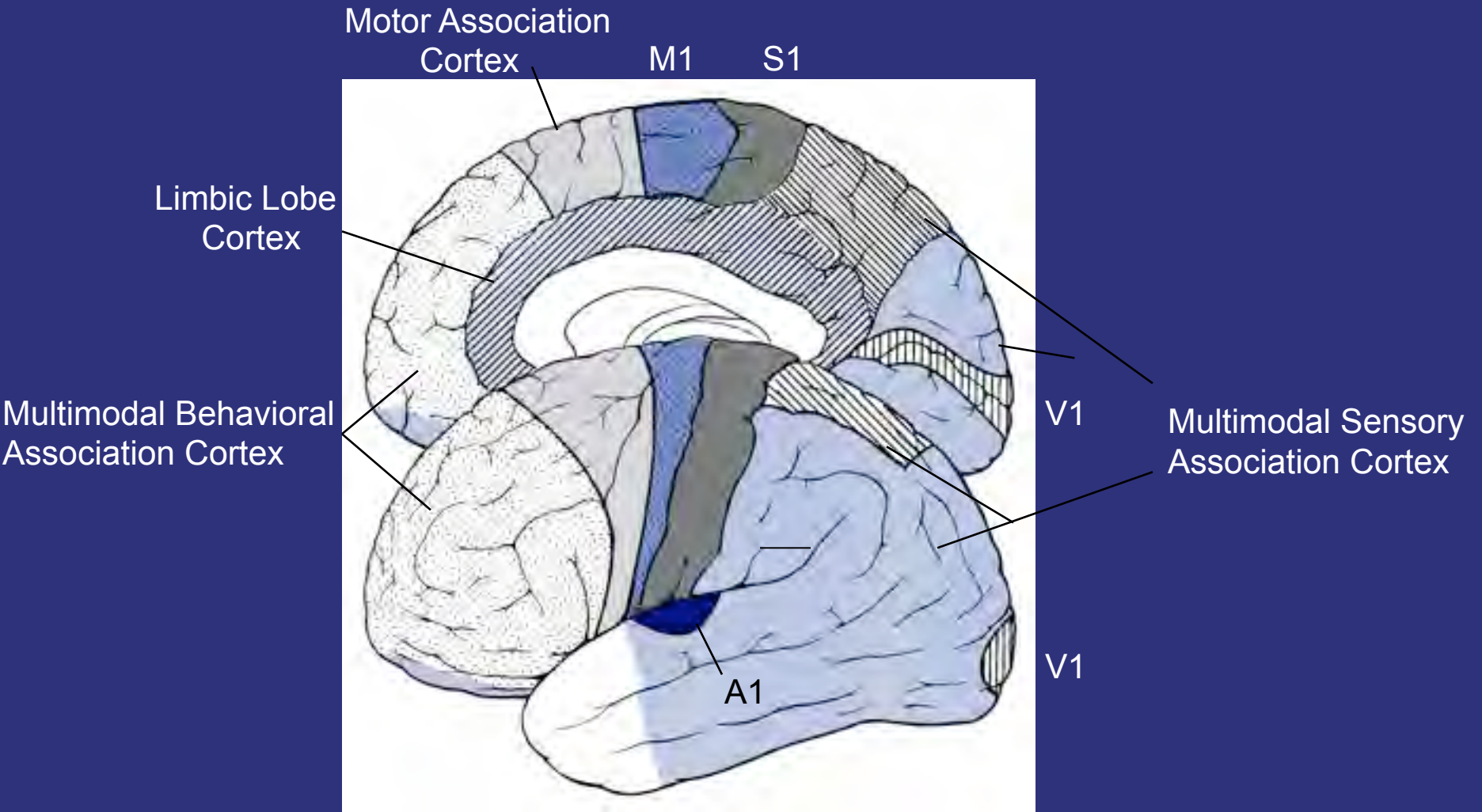
2) The dorsal thalamus is the principal relay structure for all sensory and motor information destined for the ipsilateral cerebral cortex.

- The one exception to this rule is olfactory information passes through the thalamus only indirectly**

3) Each half of the dorsal thalamus can be divided into numerous (about 26) nuclei, which receive particular inputs and send their axons to cortex in anatomically defined patterns.

4) Thalamic nuclei receive reciprocal connections from the cortex.

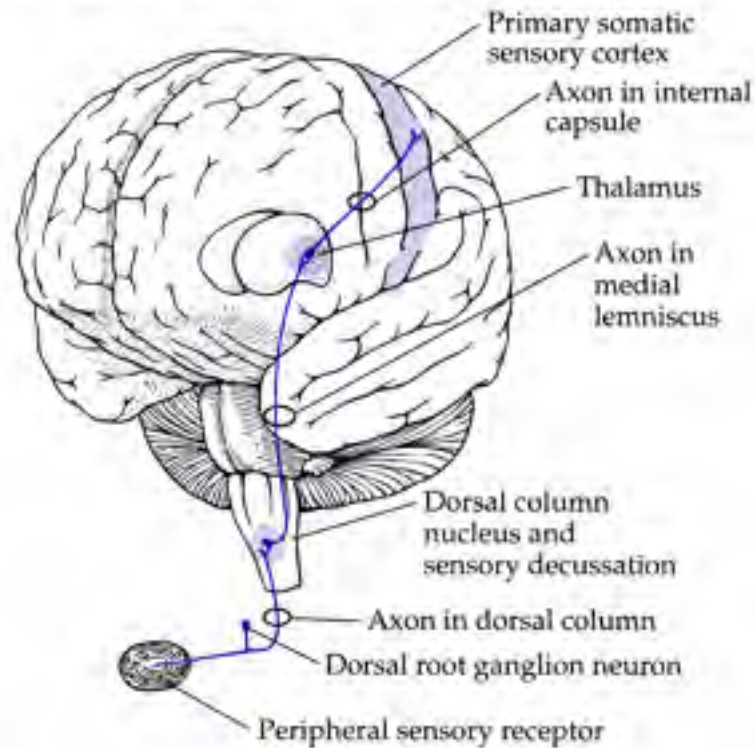
The Functional Areas of the Cerebral Cortex



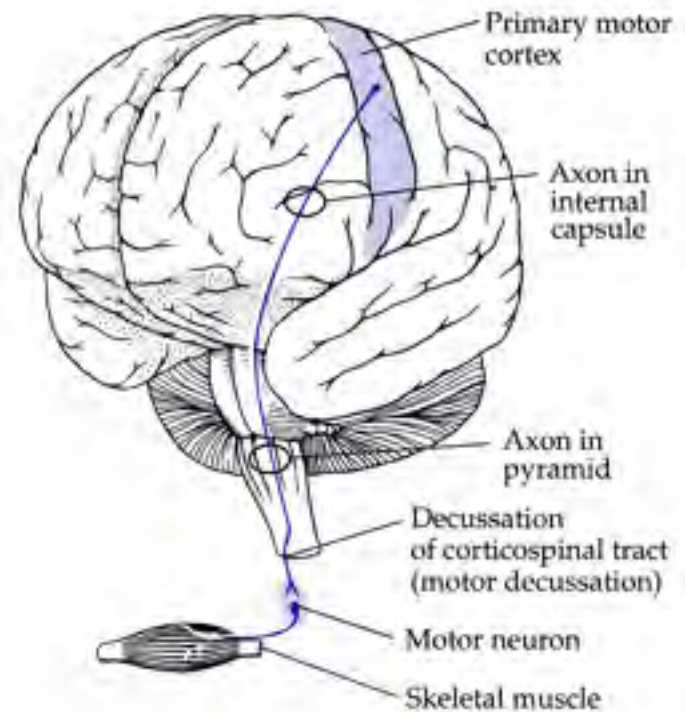
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- M1 primary motor cortex
- S1 primary somatosensory cortex
- V1 primary visual cortex
- A1 primary auditory cortex

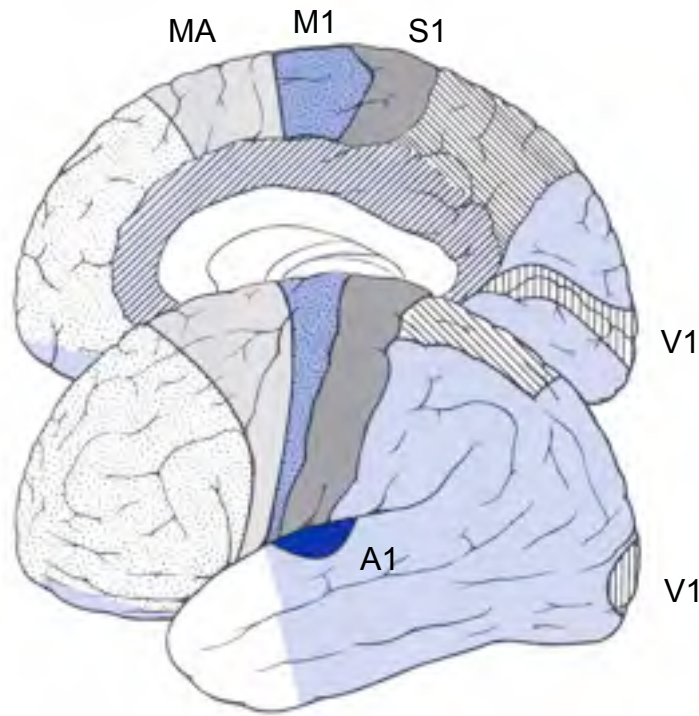
A Dorsal column - medial lemniscal system



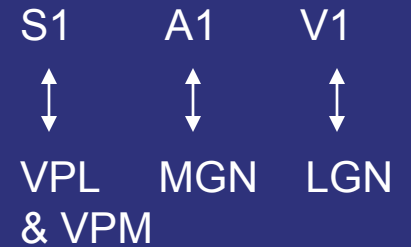
B Corticospinal tract



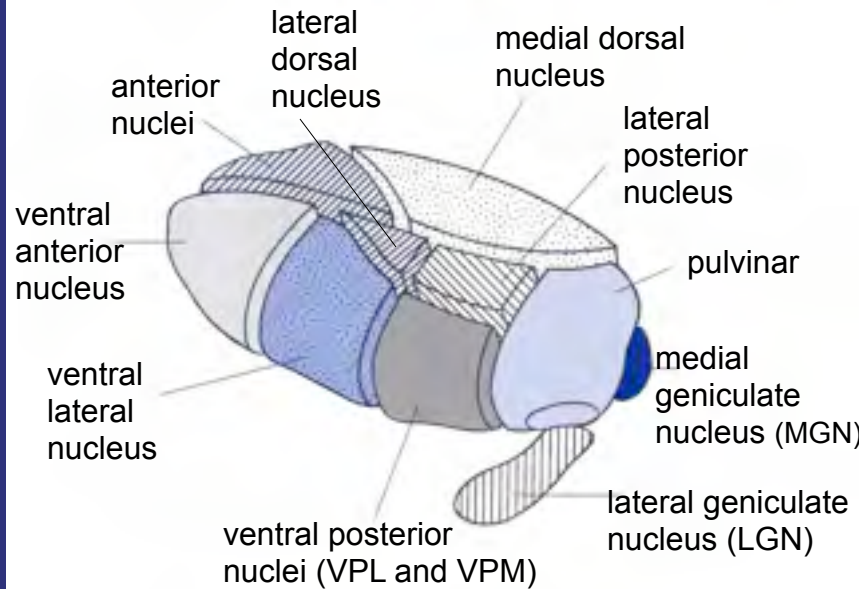
Posterior cerebral cortex analyzes and integrates sensory information.



primary sensory cortical areas:



Dorso-lateral view of the left dorsal thalamus



multimodal sensory association cortex



pulvinar & lateral posterior nuclei

The frontal lobe orchestrates beha

motor cortex (M1) &
motor association areas
(MA)



ventral anterior &
ventral lateral nuclei

limbic lobe

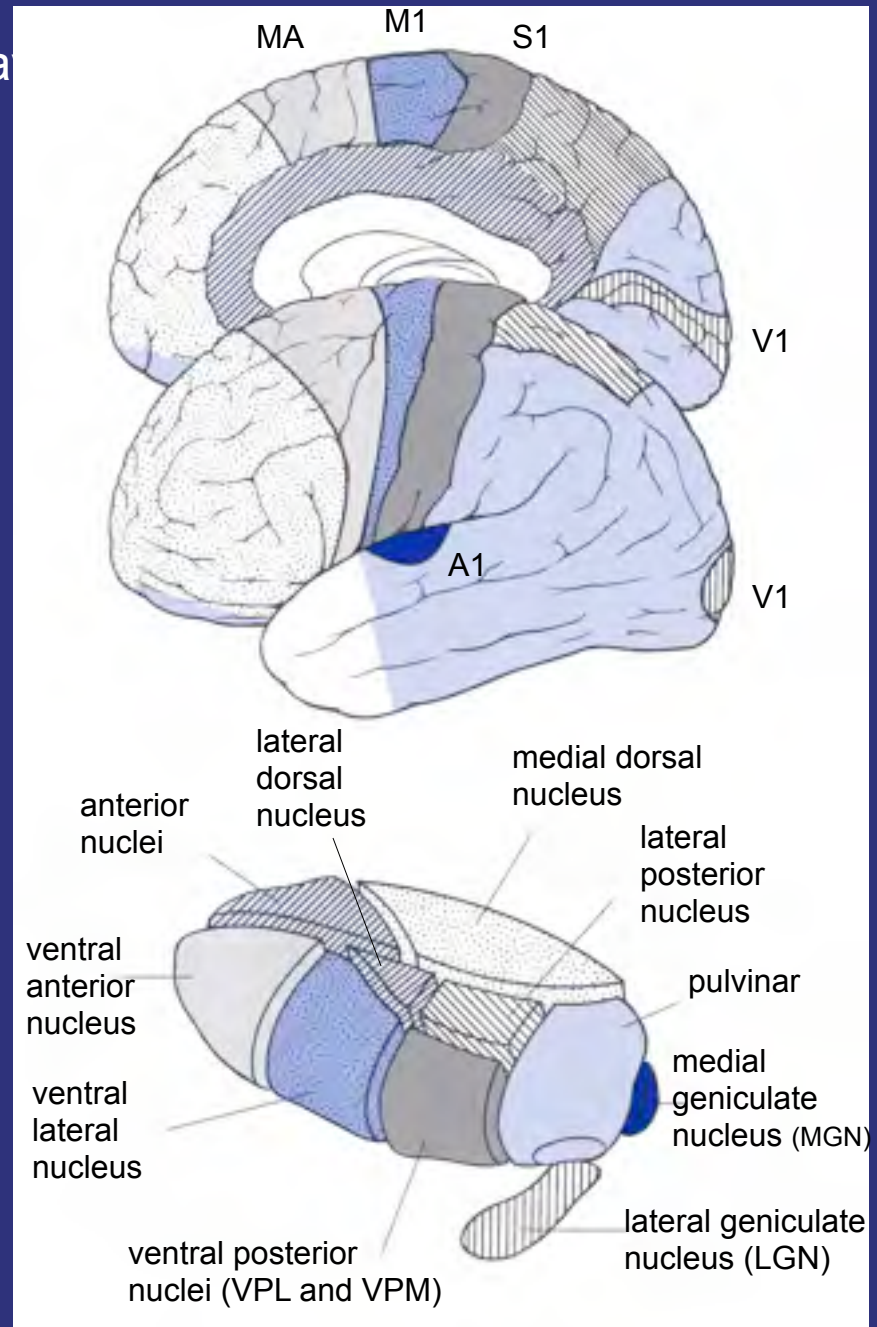


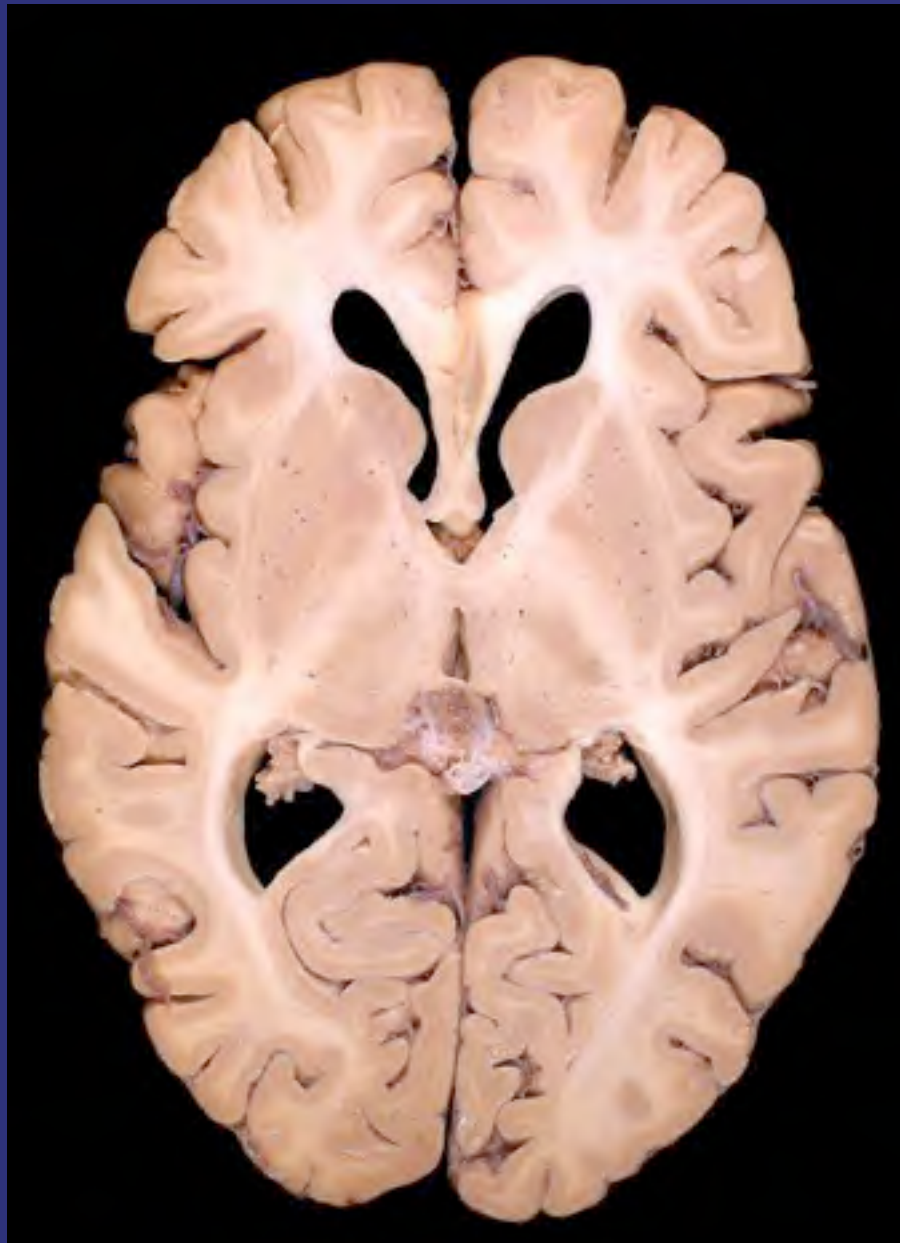
anterior &
lateral dorsal nuclei

frontal association cortex

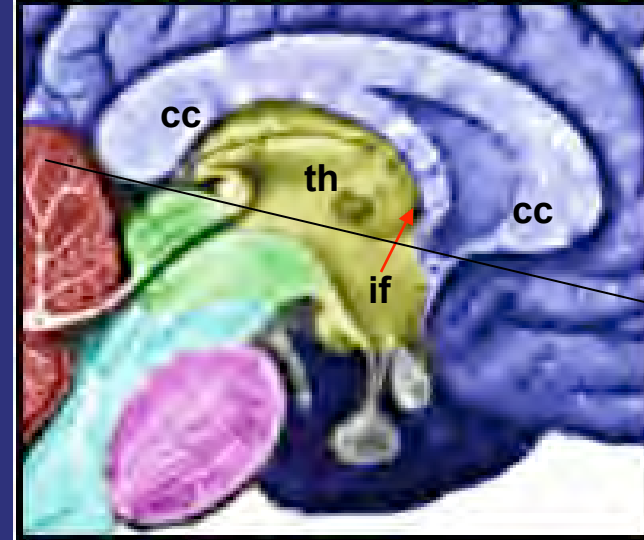
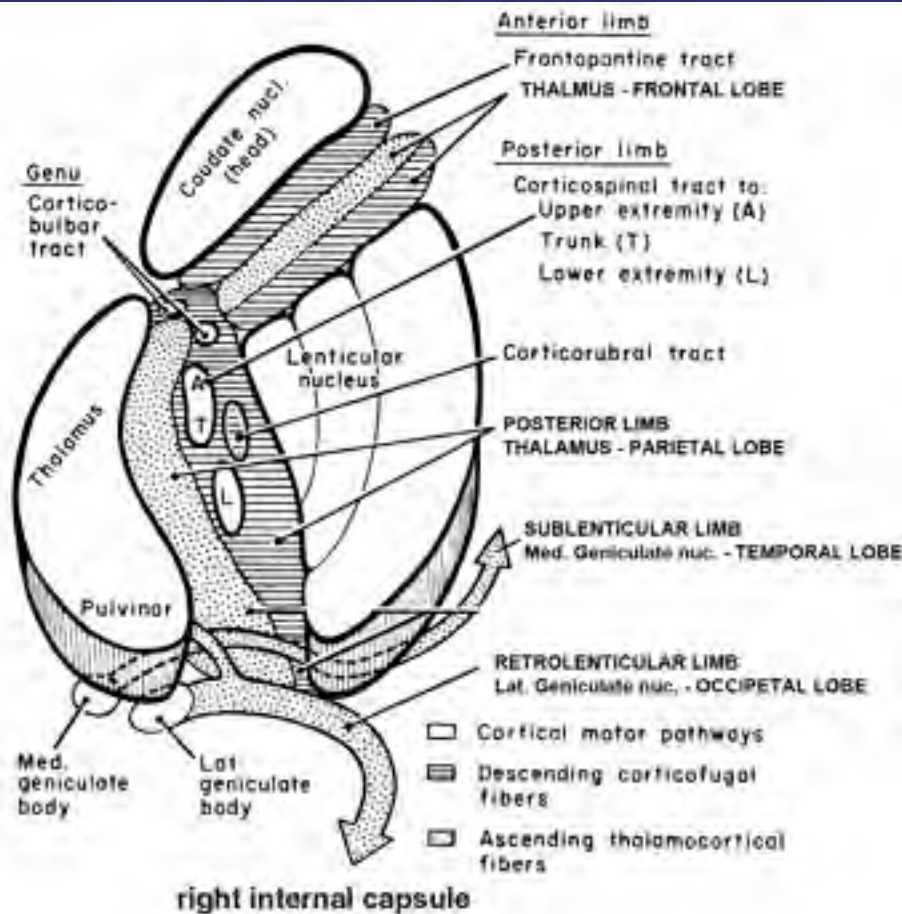


medial dorsal nucleus





The Right Internal Capsule



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Reciprocal connections between thalamus and cortex are found in four limbs of the internal capsule:

- anterior limb with frontal lobe
- posterior limb with parietal lobe
- retrolenticular limb with occipital lobe
- sublenticular limb with temporal lobe

The genu contains the corticobulbar axons.

Corticospinal axons are in the posterior limb.

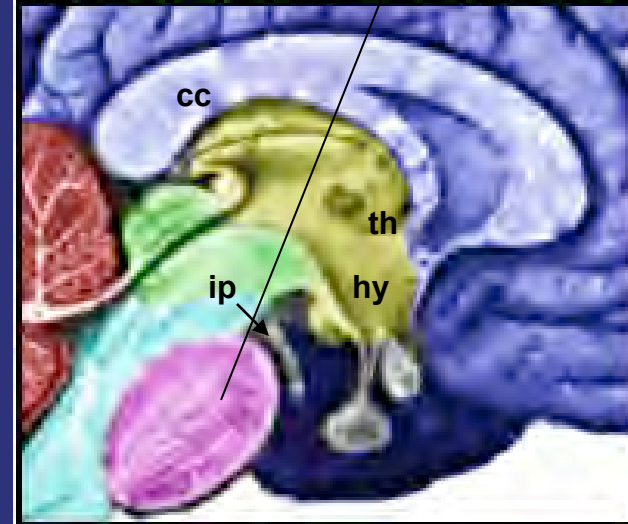
Corticopontine axons are in both the anterior and posterior limbs


What does the Dorsal Thalamus do? - Functional considerations

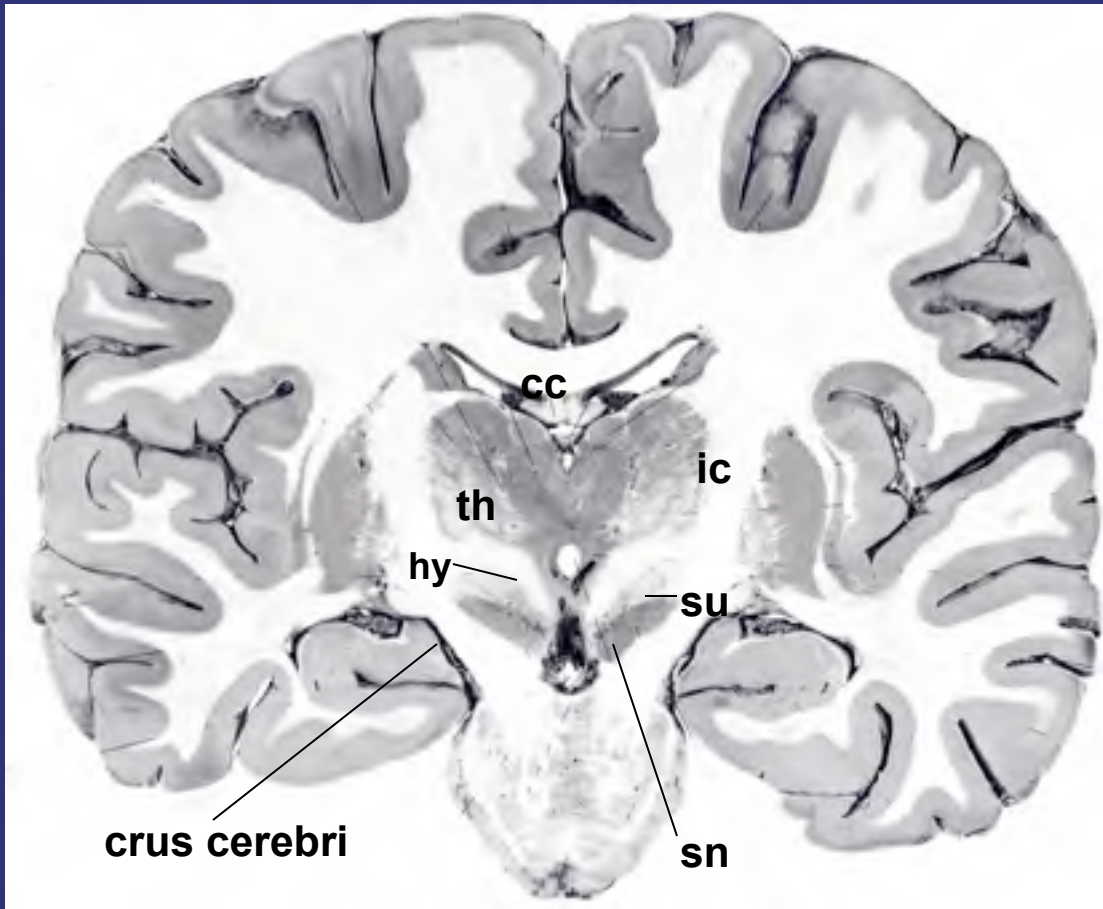
- The dorsal thalamus controls the flow of numerous streams of information to the cerebral cortex (origins - basal ganglia, hypothalamus, spinal cord, etc.)
- Only 5-10% of the synapses in the thalamus come from the afferents (the driving input). 90-95% of the synapses in the thalamus are modulatory and originate local inhibitory neurons and descending inputs from cerebral cortex.
- The dorsal thalamus is not a simple machine-like relay from a peripheral receptor to layer 4 of the cortex. The dorsal thalamus is a center that serves to control the flow of information from the periphery to the cortex.
- Cortical feedback to the dorsal thalamus plays a role in gating information that reaches the cerebral cortex. This feedback contributes to selective attention, enhanced responses for relevant stimuli and suppressed responses for distractive stimuli.
- Injuries to dorsal thalamus can result in sensory, motor and/or cognitive deficits.

The Ventral Thalamus (or subthalamus)

The ventral thalamus is lateral to the caudal part of the hypothalamus (hy). The **subthalamic nucleus (su)** is the largest nucleus in the ventral thalamus.



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The subthalamic nucleus (su) and substantia nigra (sn) belong to the basal ganglia.

The substantia nigra is in the base of the midbrain.

The Hypothalamus


The part of the diencephalon that controls visceromotor and endocrine functions and affective (emotional) behavior.

Organization

- rostrocaudal axis
- mediolateral axis - periventricular, medial, lateral

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.



Netter's image of
hypothalamus
removed

The hypothalamus
is a matrix of nuclei:

- Preoptic area
- Supraoptic area
- Tuberal area
- Mamillary area

Rostrocaudal organization

Netter's images of
hypothalamus
removed

Netter's image of
hypothalamus
removed

Medial-lateral organization

Periventricular – hormone release from
anterior pituitary

Middle - numerous discrete
Nuclei; anterior and posterior pituitary;
autonomic nervous system

Lateral - few discrete nuclei; cardiovascular
function; regulation of food and water
intake

The hypothalamus has reciprocal connections with the:

- Hippocampus
- Amygdala
- Brainstem tegmentum
- Thalamus (anterior/dorsomedial nuclei)
- Neocortex

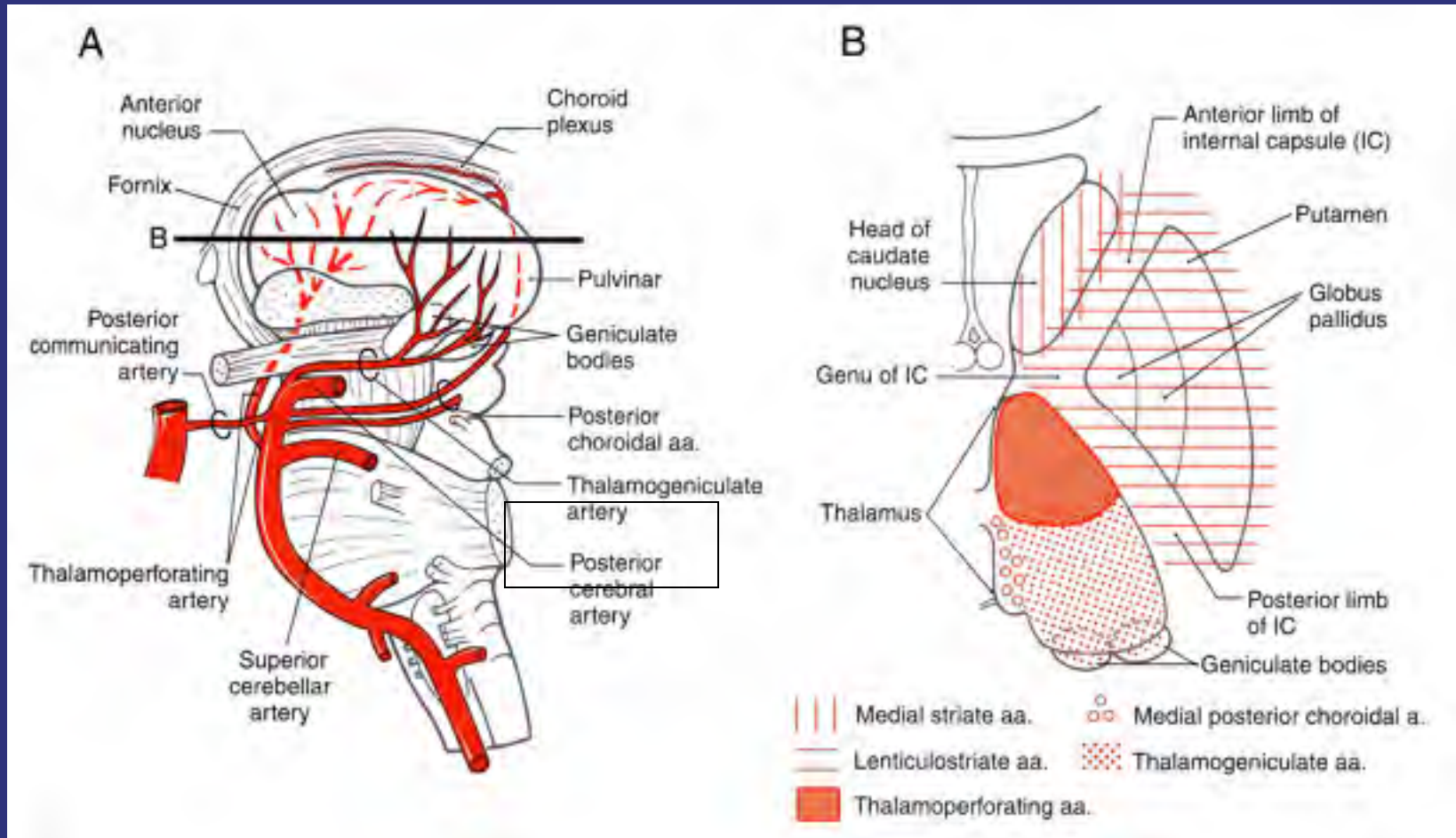
Blood supply to the dorsal thalamus

Thalamoperforating artery supplies the anterior dorsal thalamus

Thalamogeniculate artery supplies the posterior thalamus and geniculate bodies

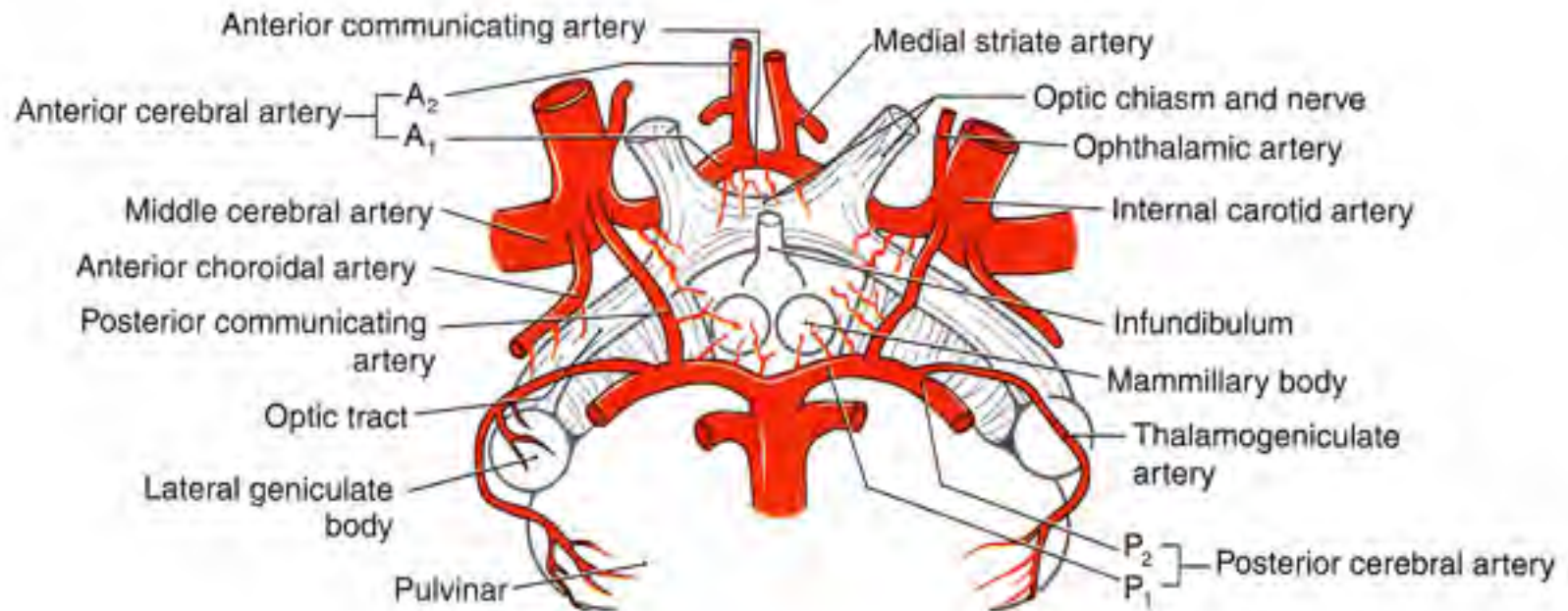
Branches from the middle cerebral artery supply the internal capsule.

Occlusion of the lenticulostriate arteries is a common cause of strokes that produce contralateral hemiplegia.





The **hypothalamus** is supplied with blood by small perforating branches from the **Circle of Willis**



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