

Forebrain

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Course News

Coffee Hour (with Dr.'s Wessendorf & McLoon)

Thursday, Oct 4
10:15-11:15am
and
Monday, Oct 8
9:00-10:00am

Surdyk's Café in Northrop Auditorium

Stop by for a minute or an hour!

Course News

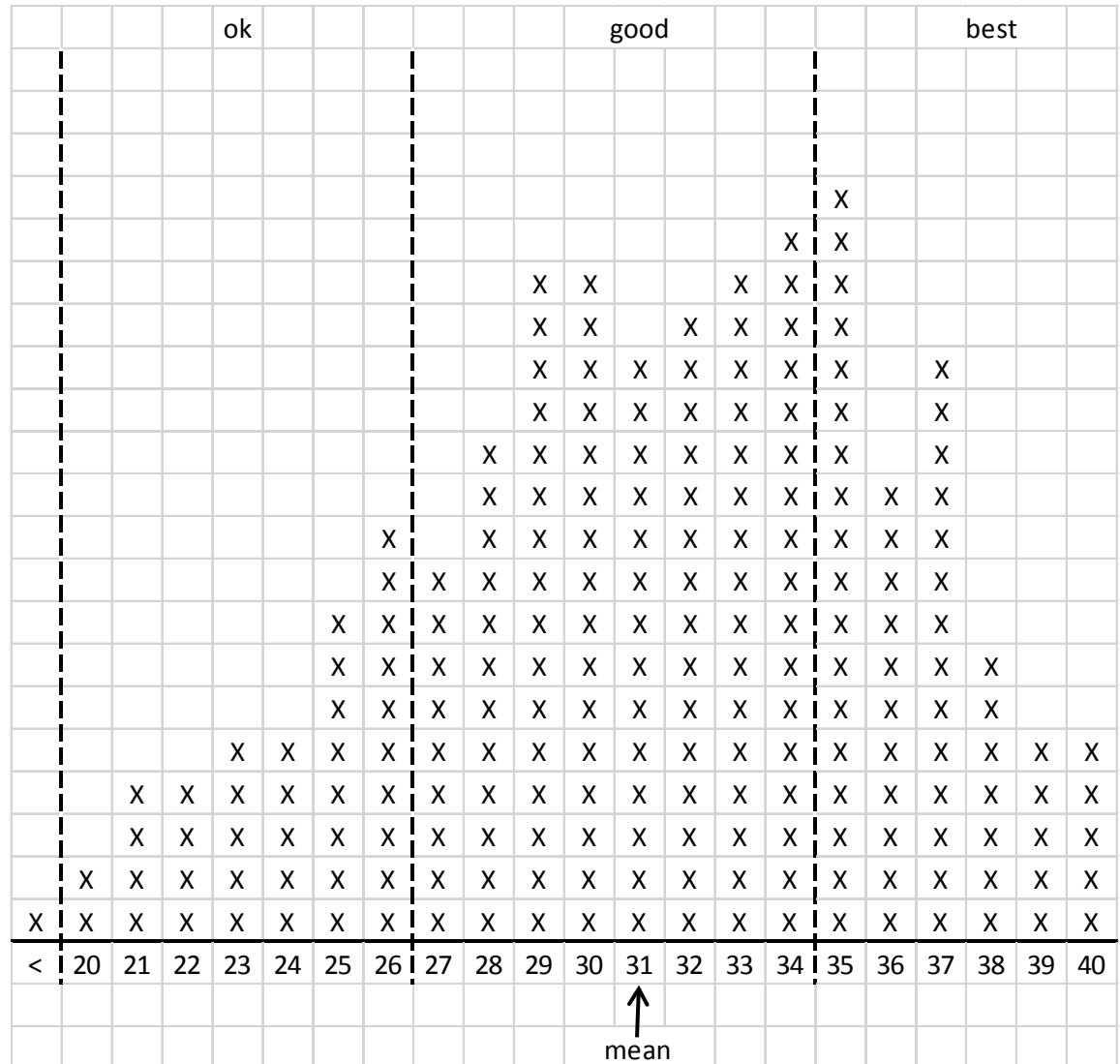
Exam 1 results:

mean = 31

Scores were uploaded to Canvas.

Exams will be returned in lab next week.

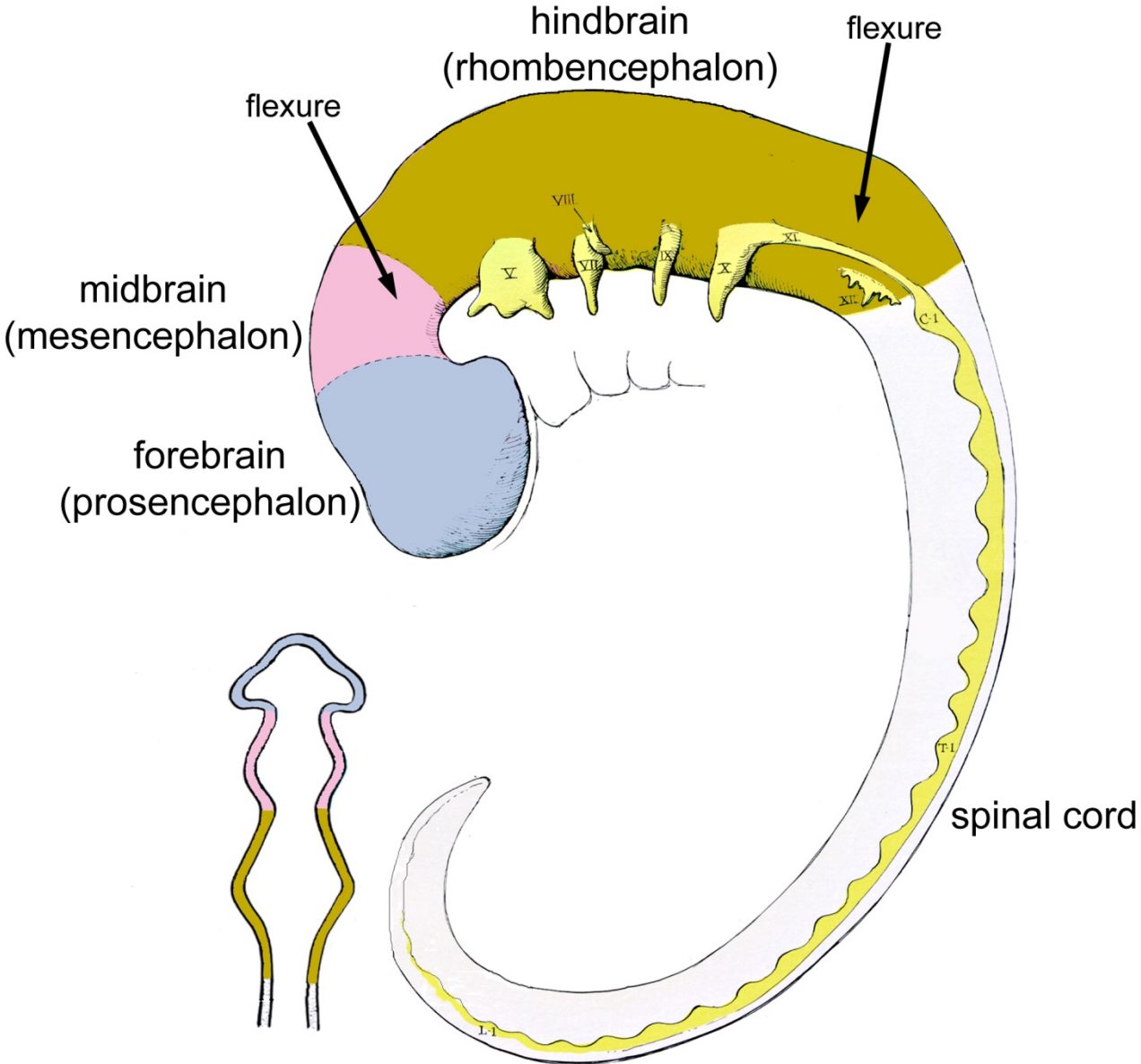
This graph is posted on the course website, and the exam with answers will be posted on Friday.



Forebrain

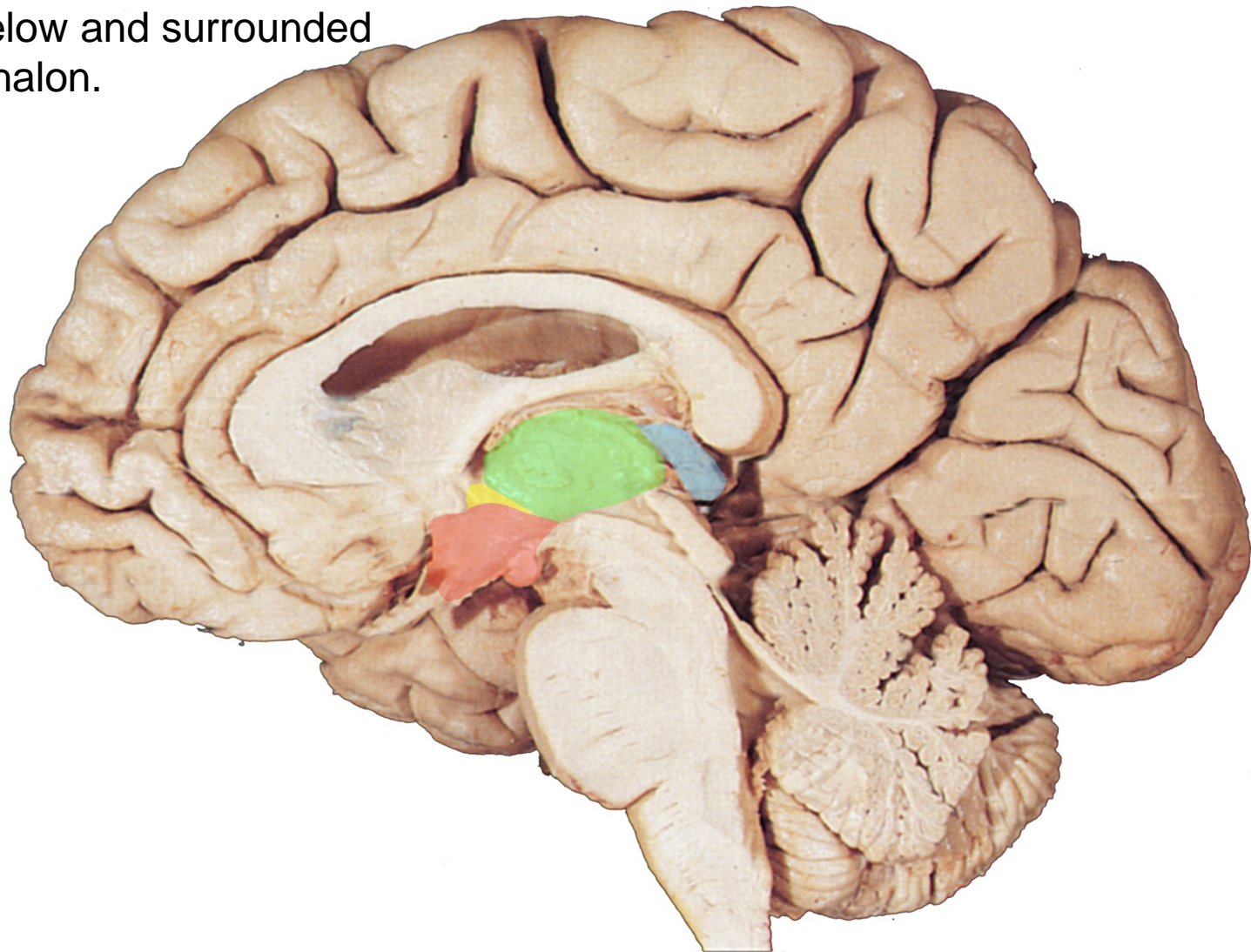
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Three Primary Brain Vesicles



Diencephalon

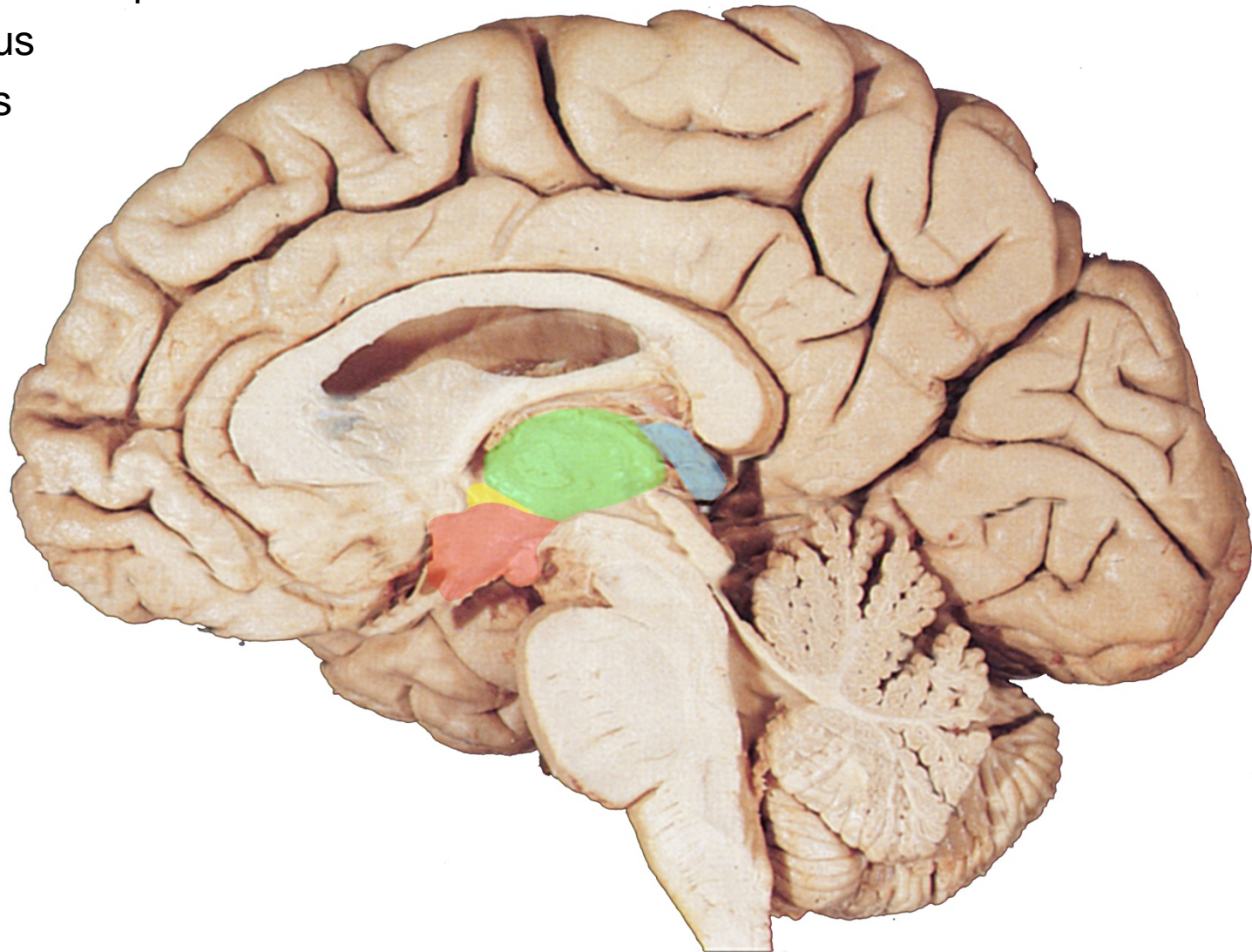
The diencephalon sits above the midbrain and below and surrounded by the telencephalon.



Diencephalon

The parts of the diencephalon are:

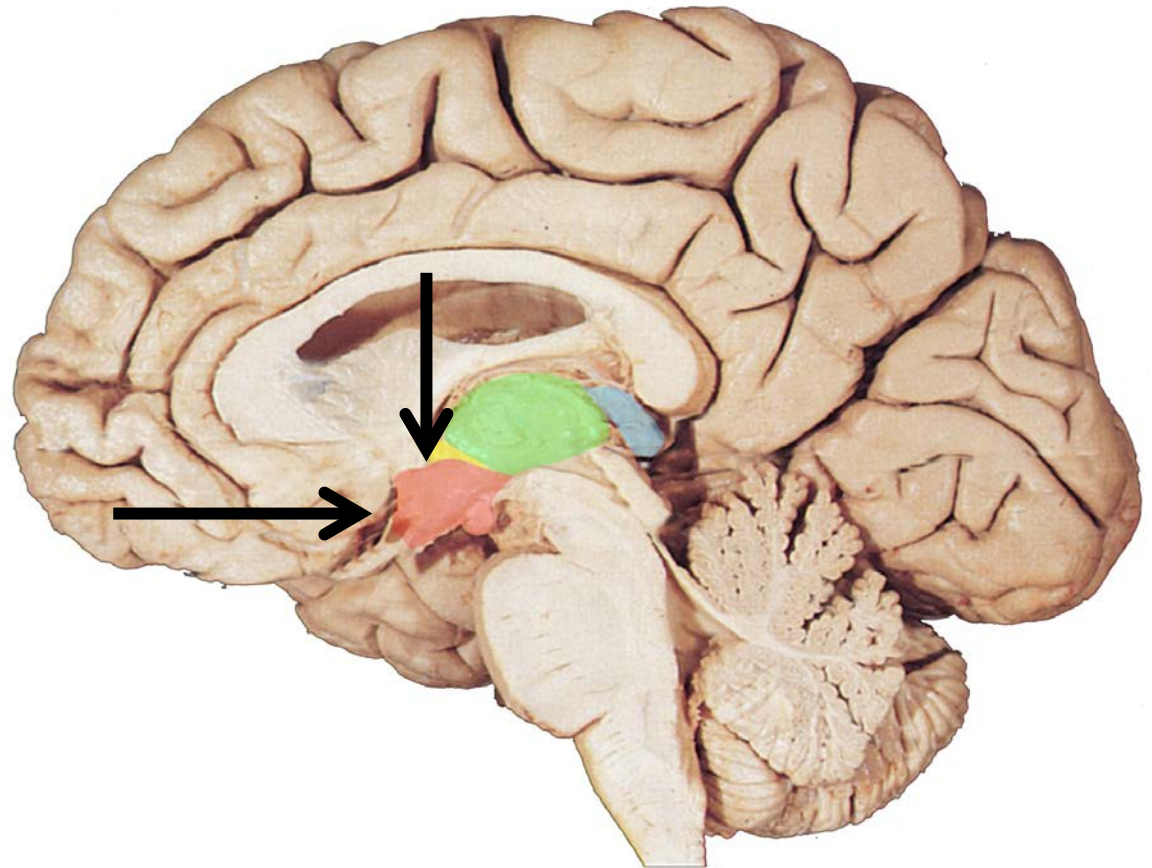
- Hypothalamus
- Subthalamus
- Thalamus
- Epithalamus



Hypothalamus

Participates in many essential functions including:

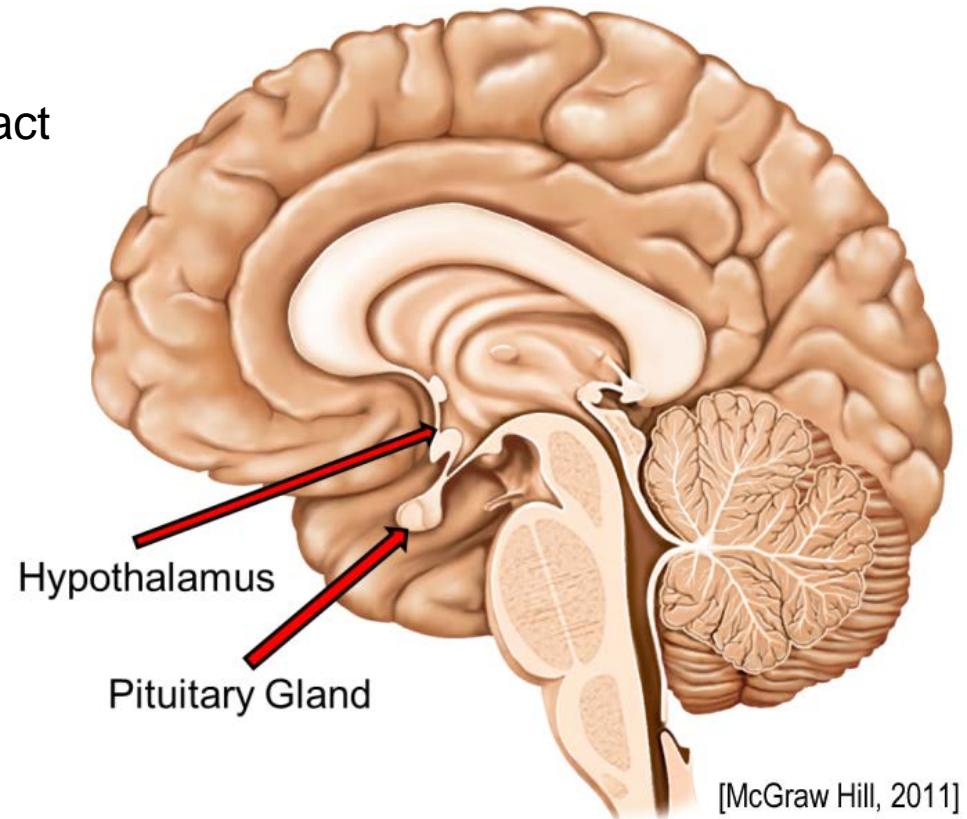
- temperature regulation
- feeding & drinking
- circadian rhythms
- aggression & flight
- sexual activity



Hypothalamus

Some neurons of the hypothalamus release hormones into the blood that act on the pituitary gland.

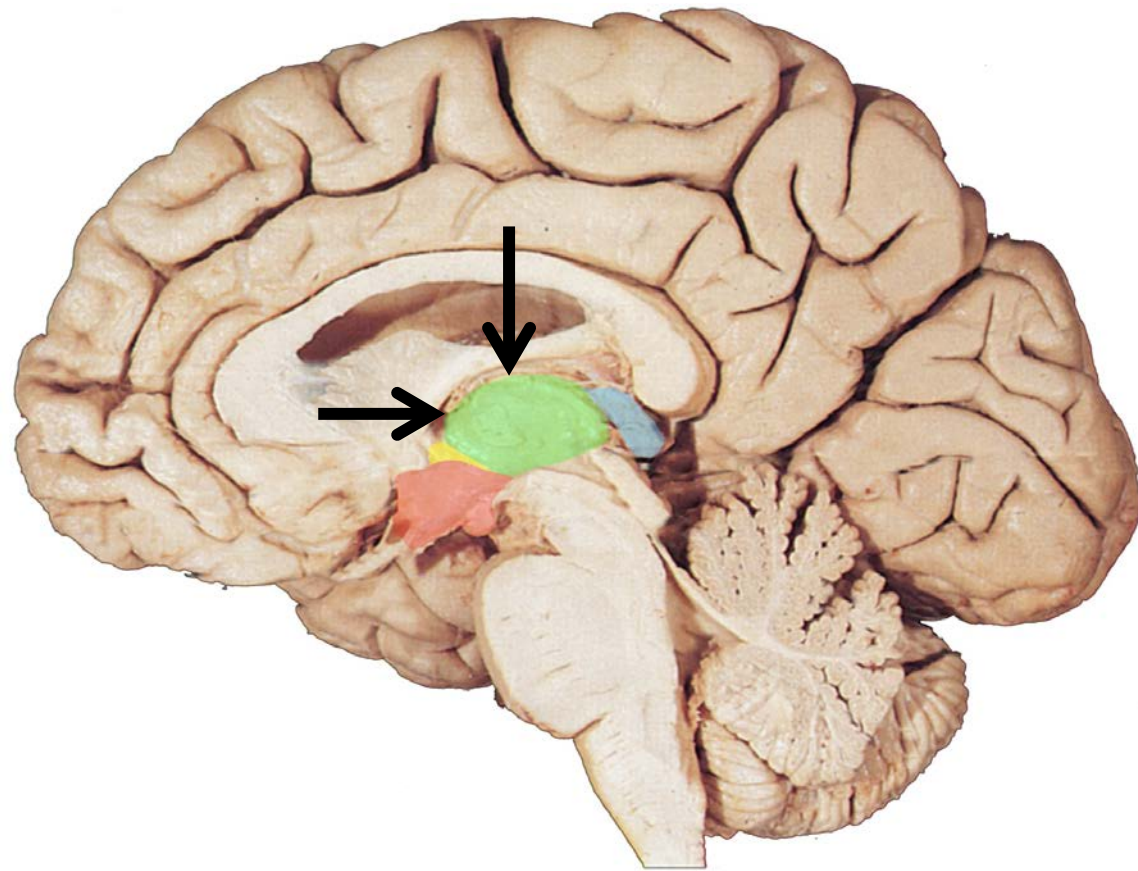
The pituitary gland is attached to the hypothalamus by the pituitary stalk.



Thalamus

The thalamus has two types of nuclei:

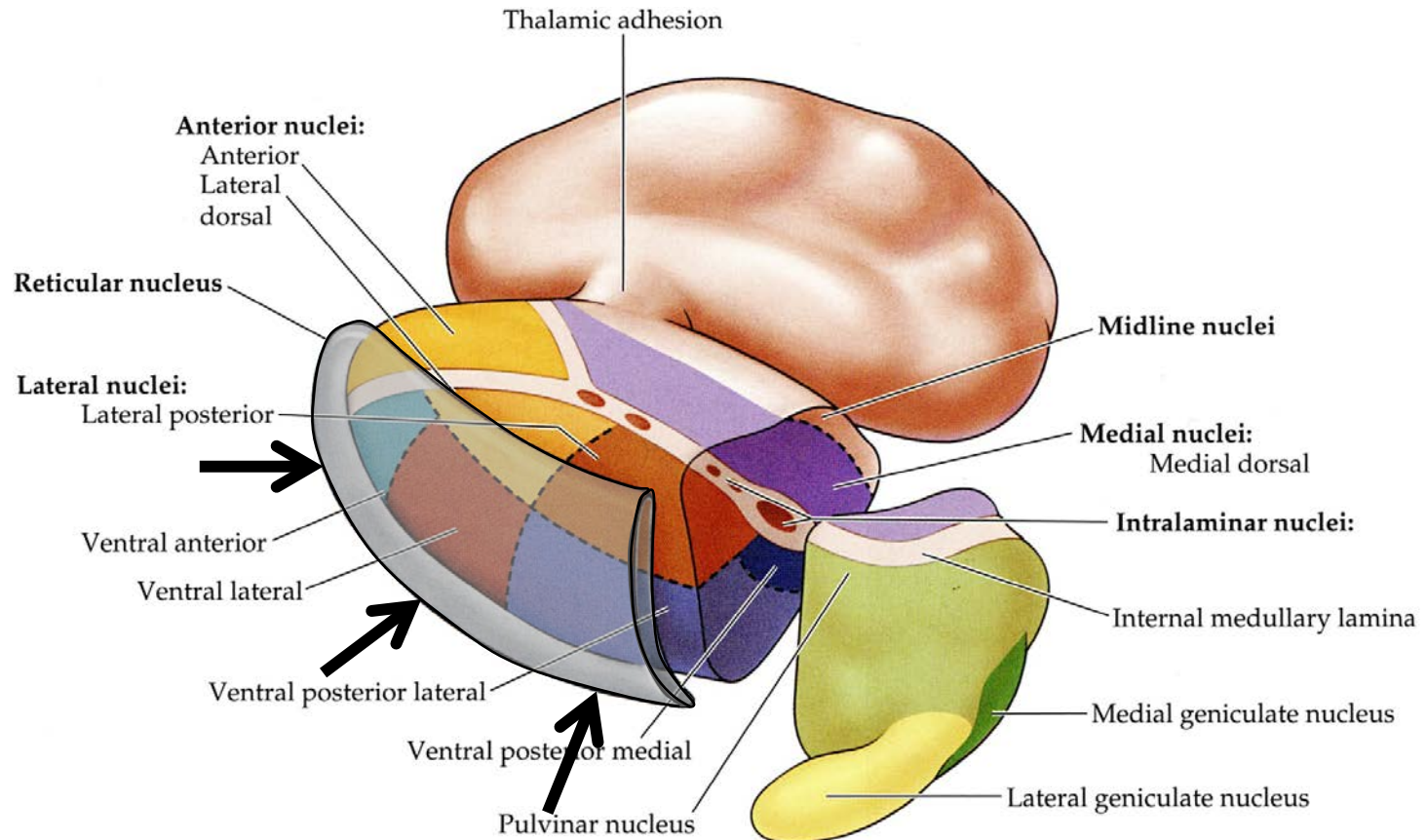
- Relay nuclei – relay specific sensory or motor information to specific regions of cortex
- Diffuse nuclei – have diffuse projections to cortex or thalamus



Thalamus

Diffuse nuclei

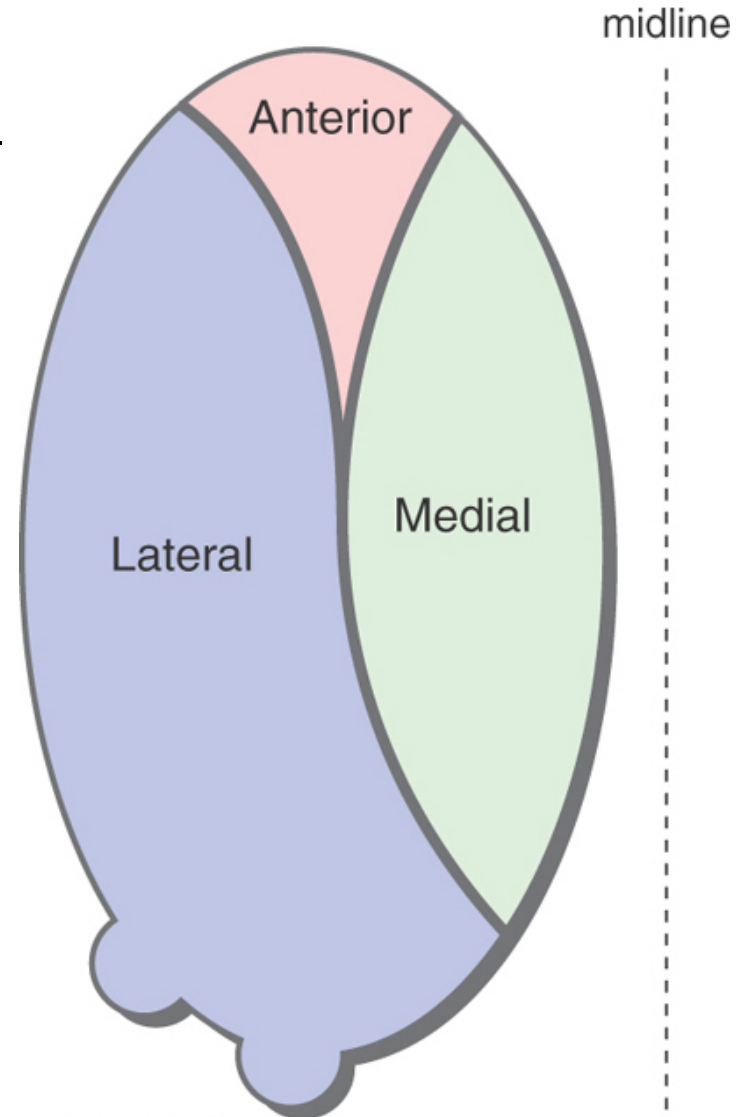
- are in the shell and intralaminar regions of the thalamus.
- are important for attention and arousal.
- include the **reticular nucleus** which forms a shell surrounding the thalamus



Thalamus

A sheet of myelinated axons, the internal medullary lamina, divides the thalamic relay nuclei into three major regions:

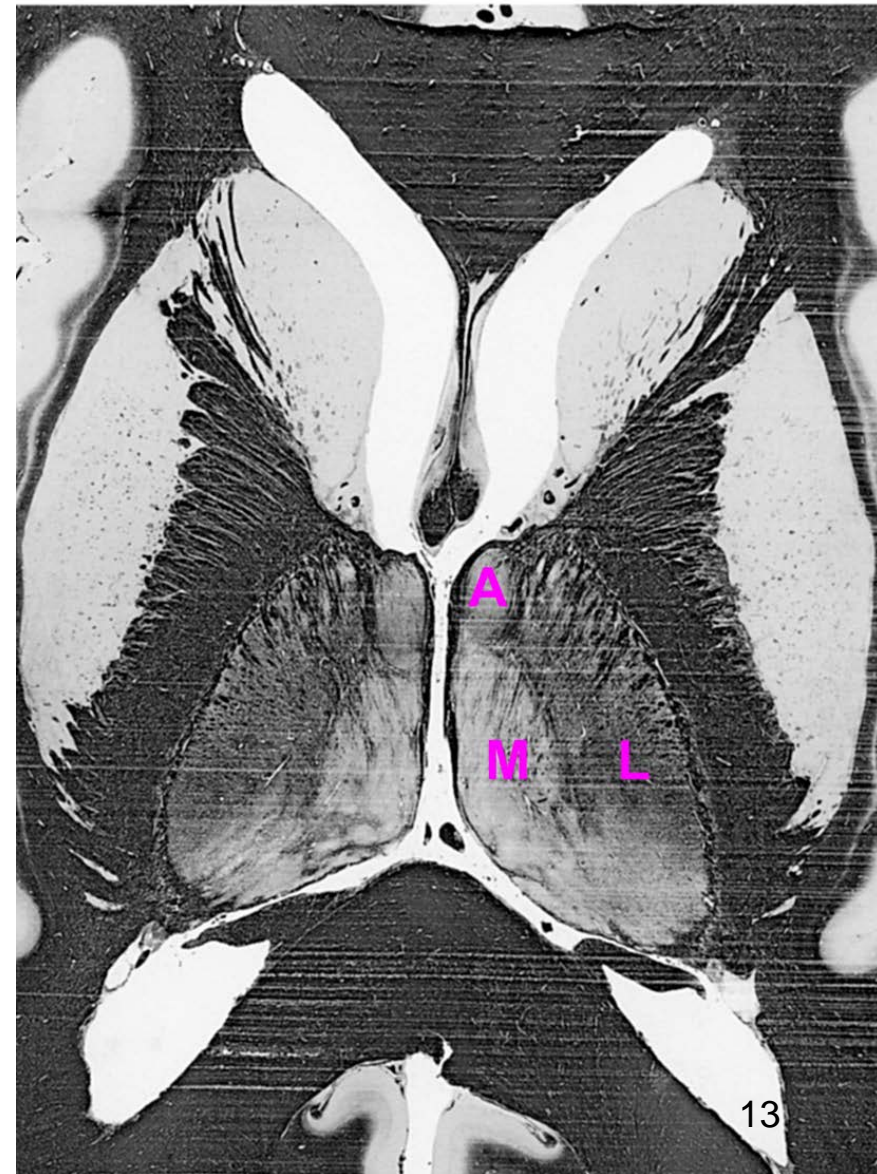
- Anterior (anterior nucleus)
- Medial (dorsomedial nucleus)
- Lateral (lateral group of nuclei)



Thalamus

A sheet of myelinated axons, the internal medullary lamina, divides the thalamic relay nuclei into three major regions:

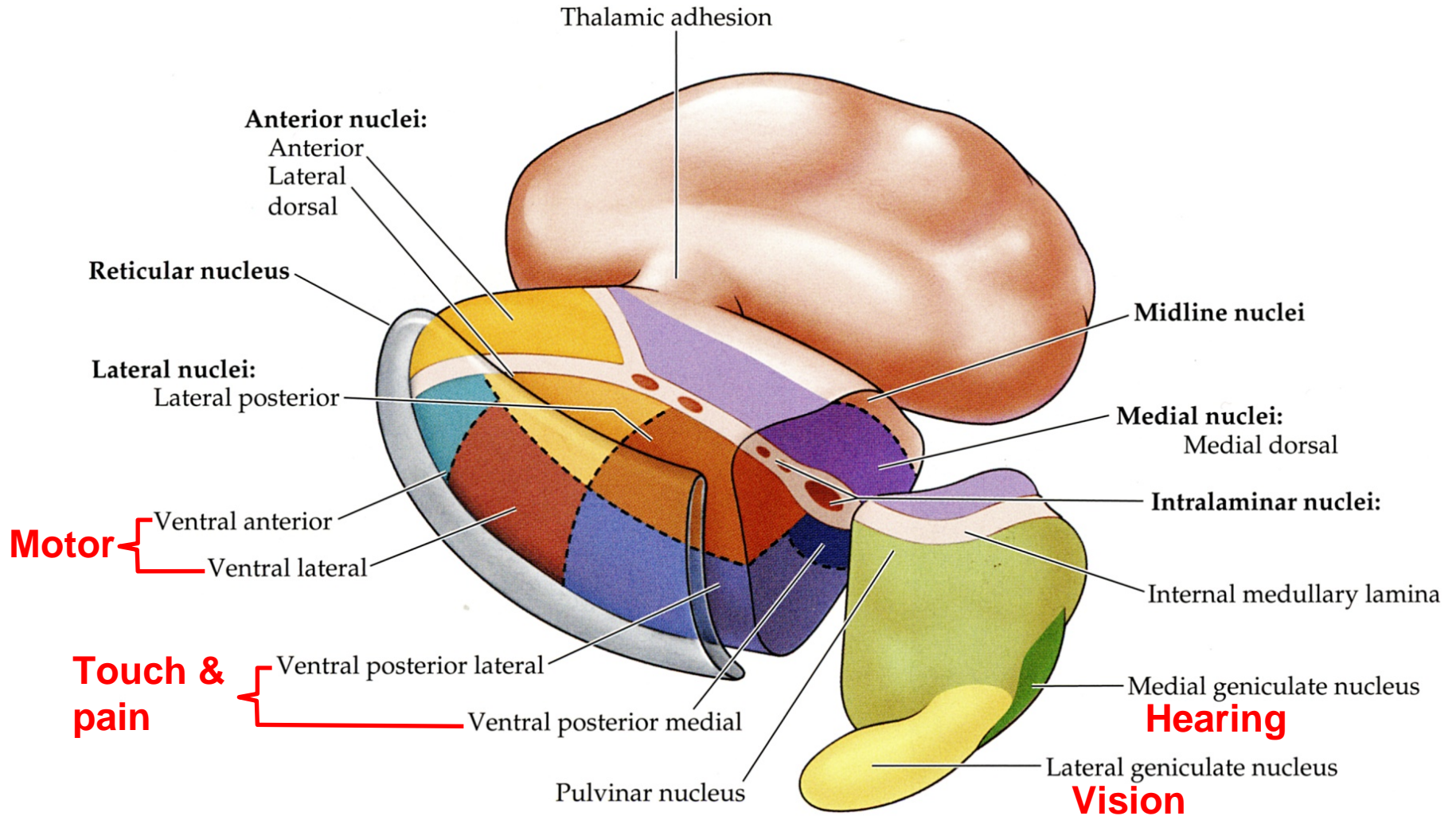
- Anterior (anterior nucleus)
- Medial (dorsomedial nucleus)
- Lateral (lateral group of nuclei)



(horizontal section)

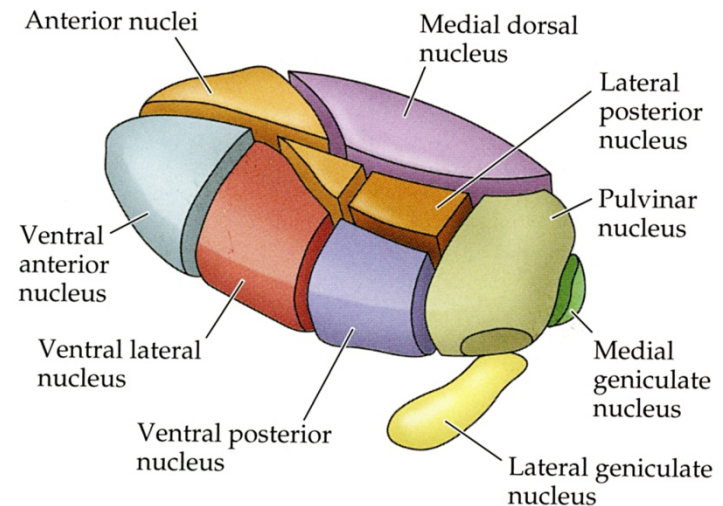
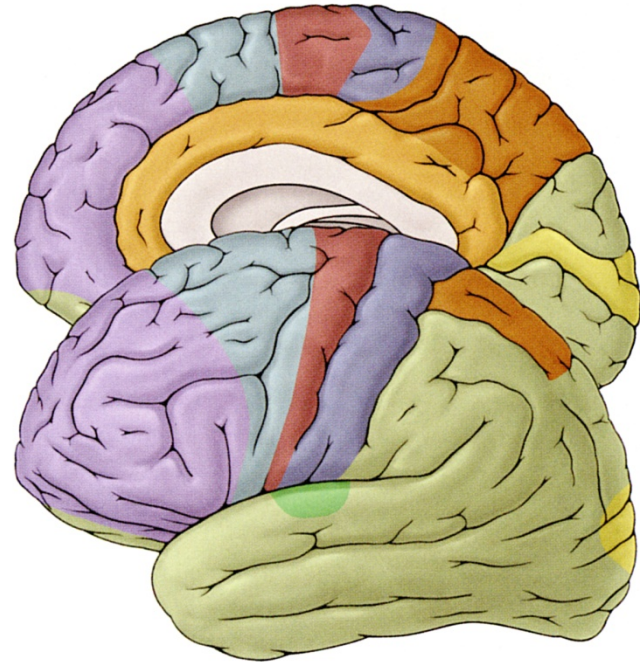
Thalamus

The lateral group of relay nuclei is further divided based on their connections & functions.



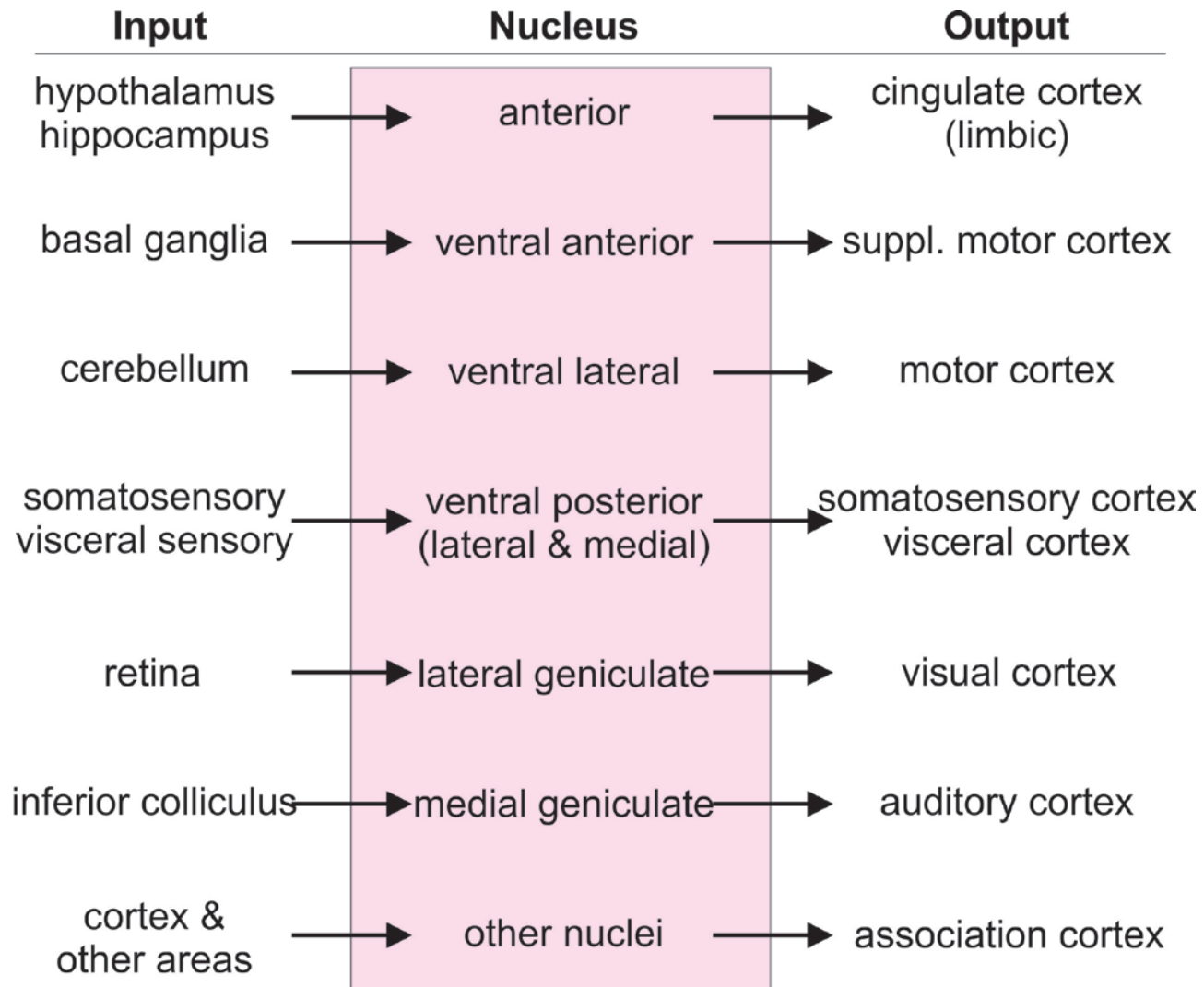
Thalamus

- Relay nuclei send axons to cortex.
- This projection is ipsilateral (to the same side).
- The pattern of the nuclei in thalamus approximately matches the pattern of their connections to cortex.



Thalamus

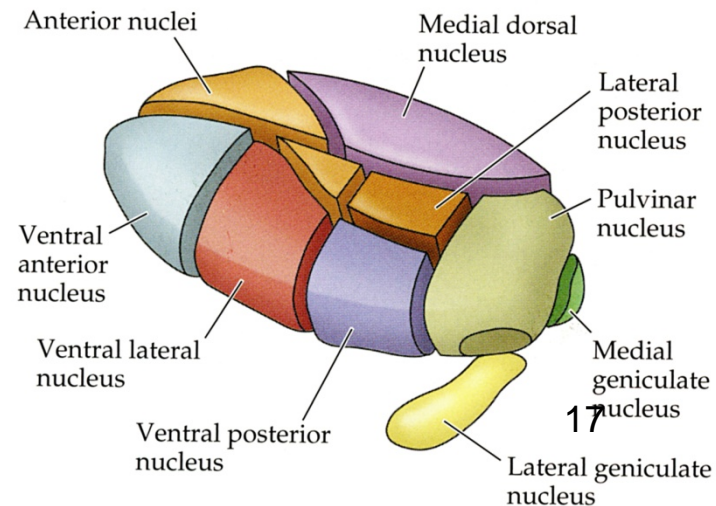
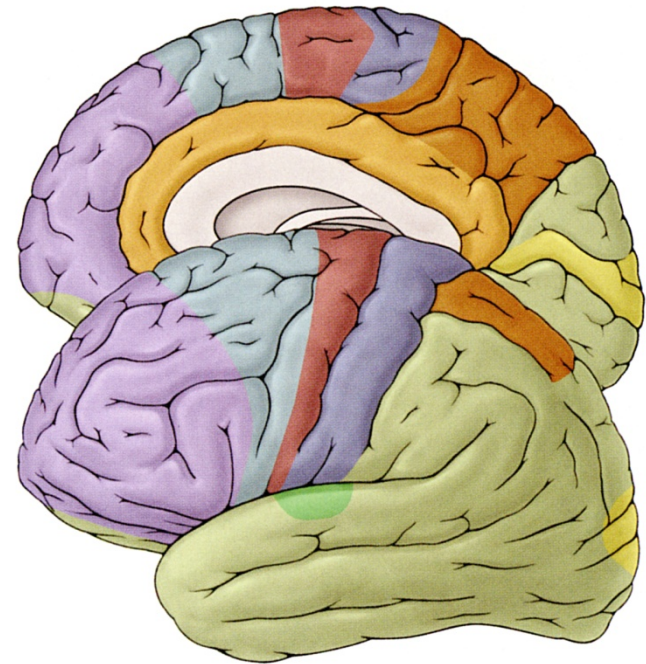
- Input and output relationships of the major relay nuclei:



Thalamus

Other thalamic nuclei carry multiple modalities and project to association cortex. For example:

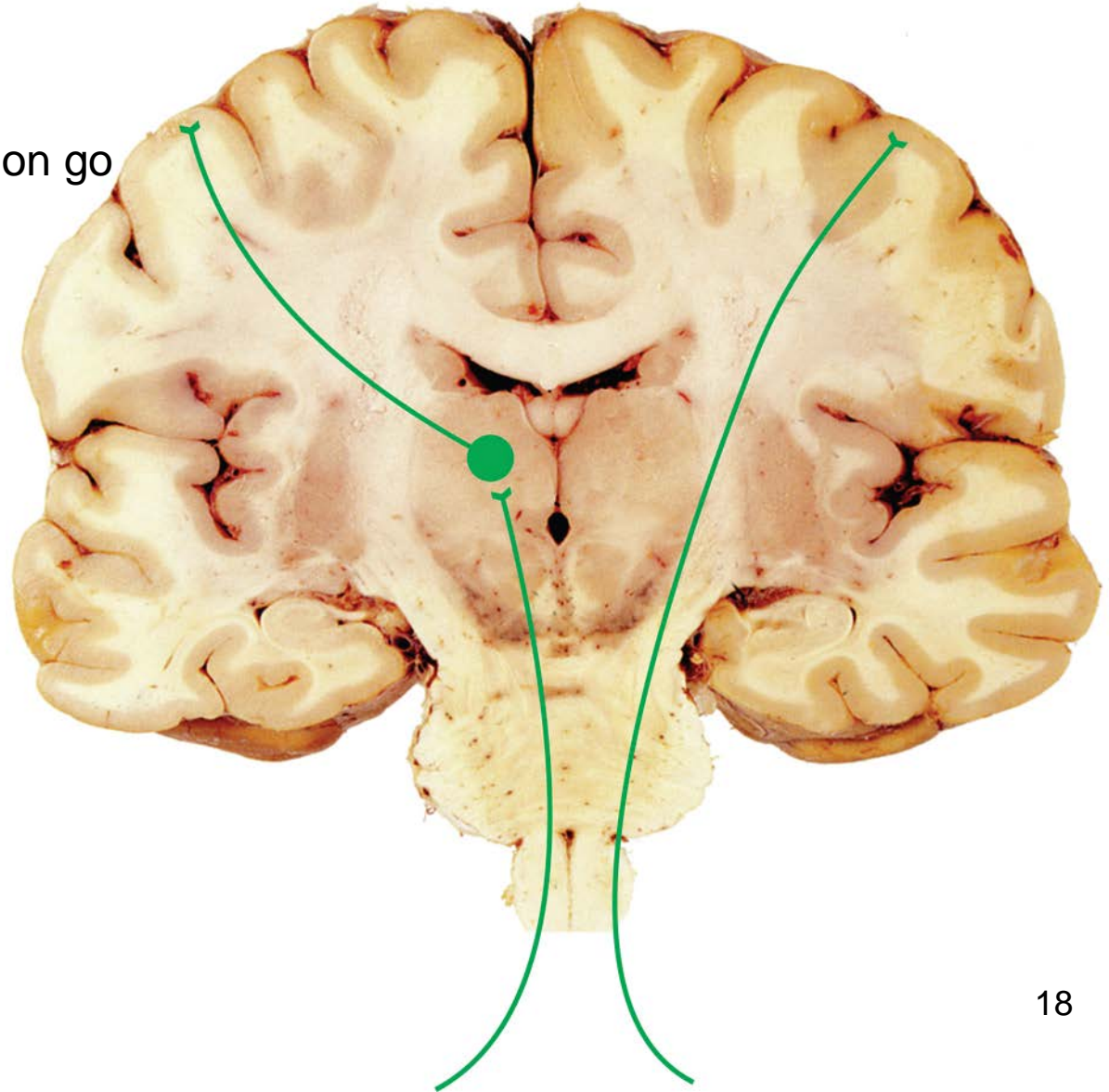
- Dorsomedial (medial dorsal) nucleus → prefrontal association cortex
- Pulvinar → parietal-occipital-temporal assoc. cortex



Thalamus

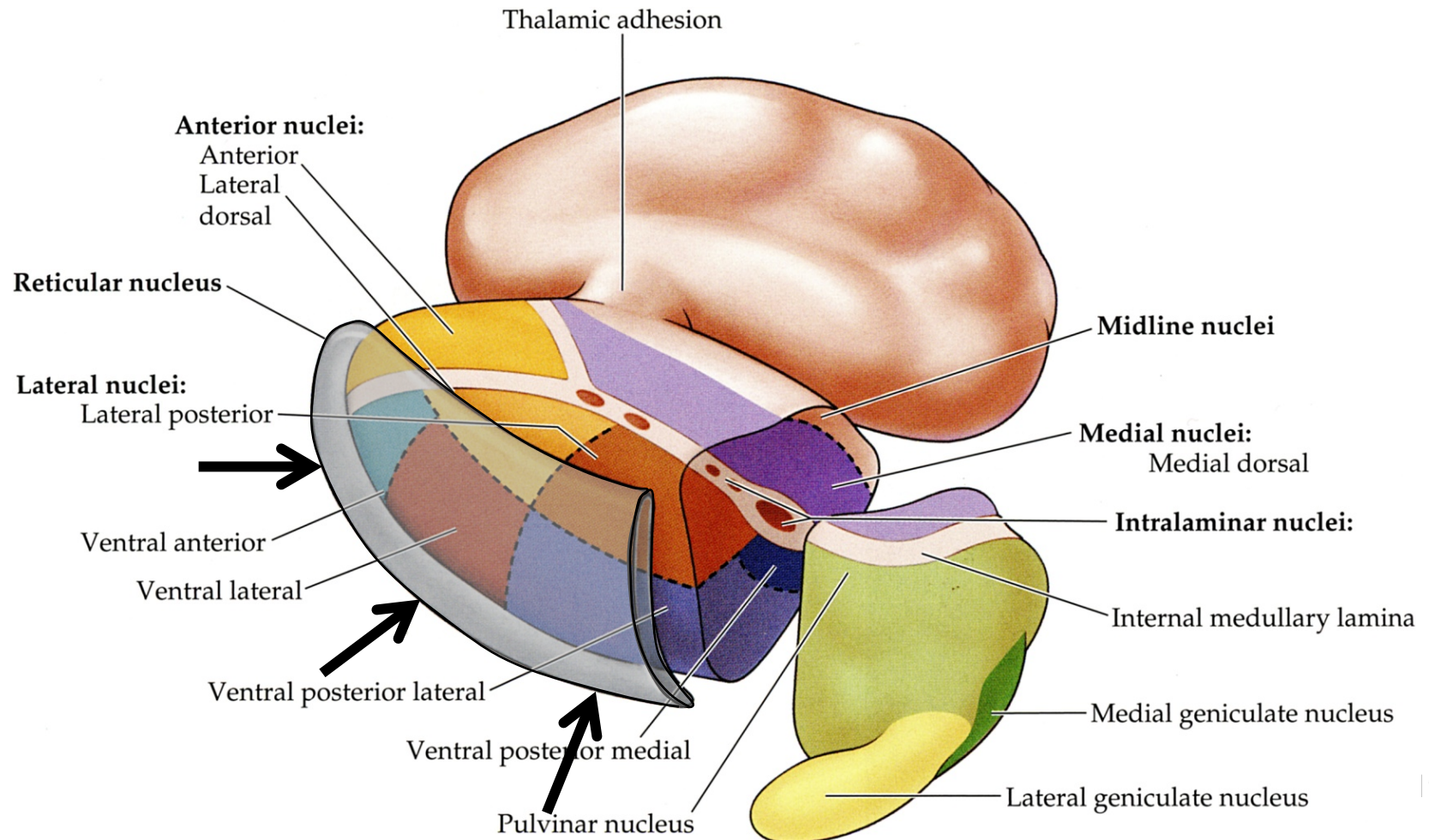
Why have a thalamus?

Why not have all information go straight to cortex without stopping in the thalamus?



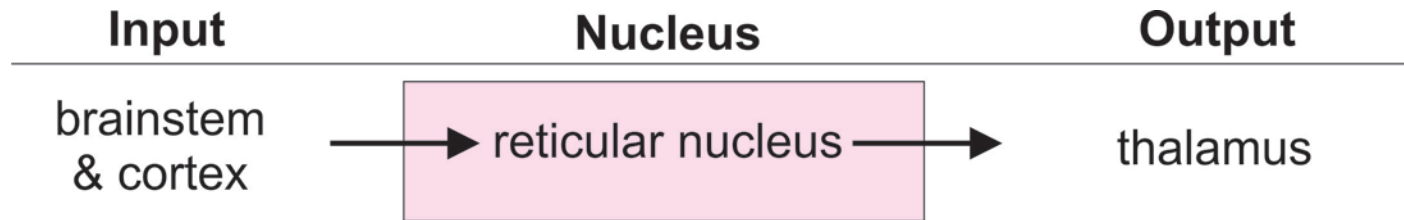
Thalamus

The flow of information from the thalamus to cortex is gated by inputs from the brainstem reticular activating system in the brain stem and the cortex **via the reticular nucleus of the thalamus.**



Thalamus

The flow of information from the thalamus to cortex is **gated** by inputs from the brainstem reticular activating system and the cortex via the reticular nucleus of the thalamus.

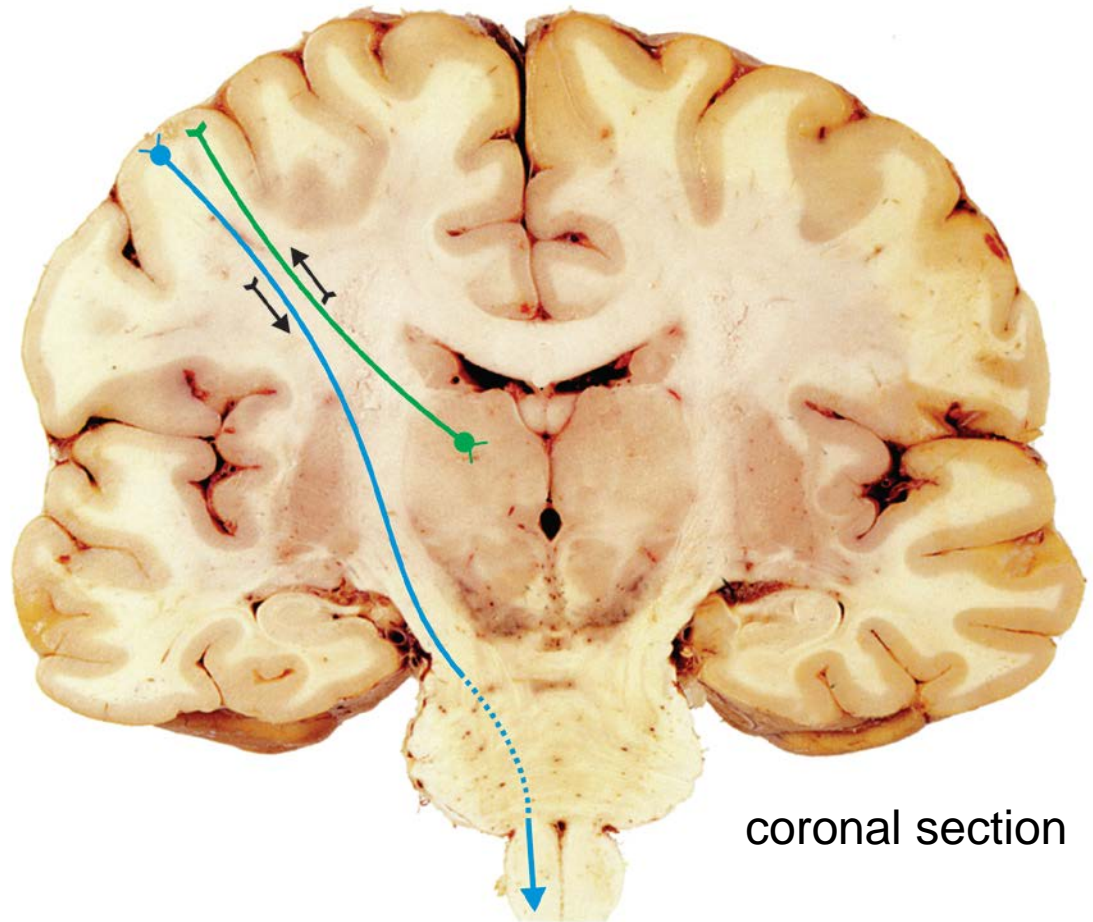


The reticular nucleus *inhibits* the output of other thalamic nuclei.

Gating is an important way to attenuate the flow of information when it is not needed such as during sleep or when concentrating on one thing for which other information would be distracting

Internal Capsule

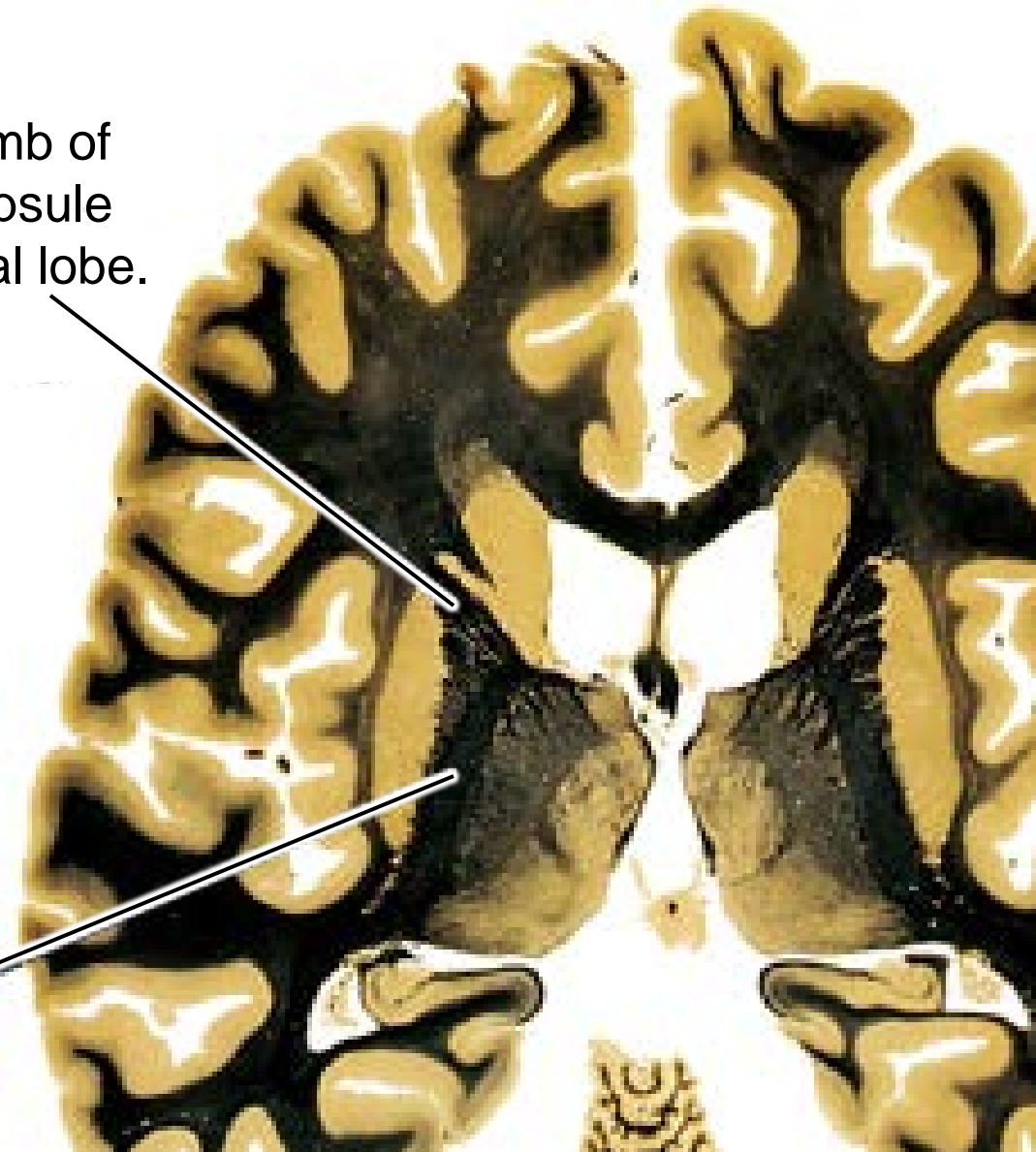
- Internal capsule: a superhighway of axons entering and exiting the cortex.
- Axons from neurons in thalamus ascend to the cortex via the internal capsule.
- Axons from neurons in the cortex descend via the internal capsule and pass just lateral to the thalamus.



Internal Capsule (horizontal section)

The anterior limb of the internal capsule serves the frontal lobe.

The posterior limb serves parietal, occipital and temporal lobes.



Questions on the diencephalon?

Telencephalon:

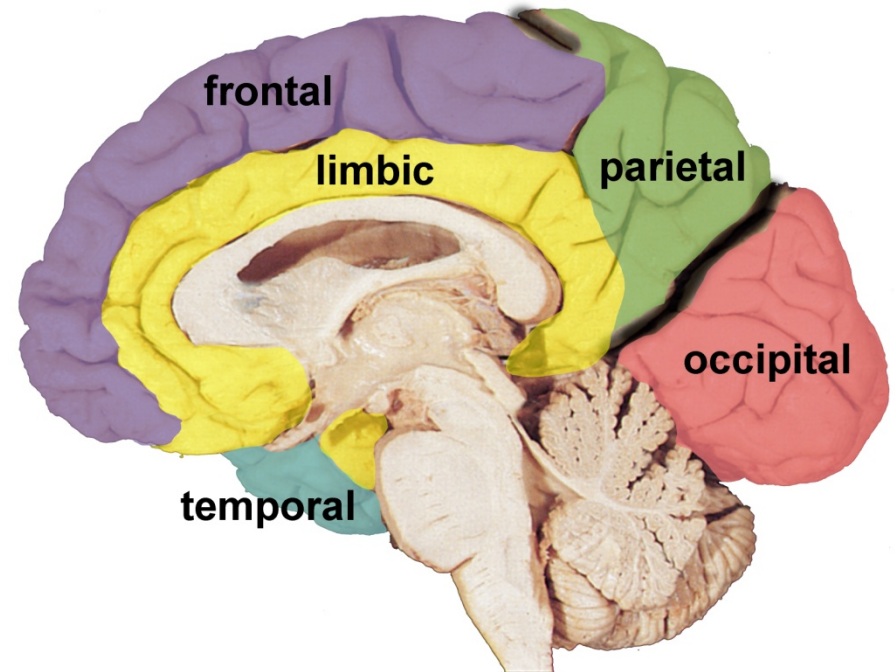
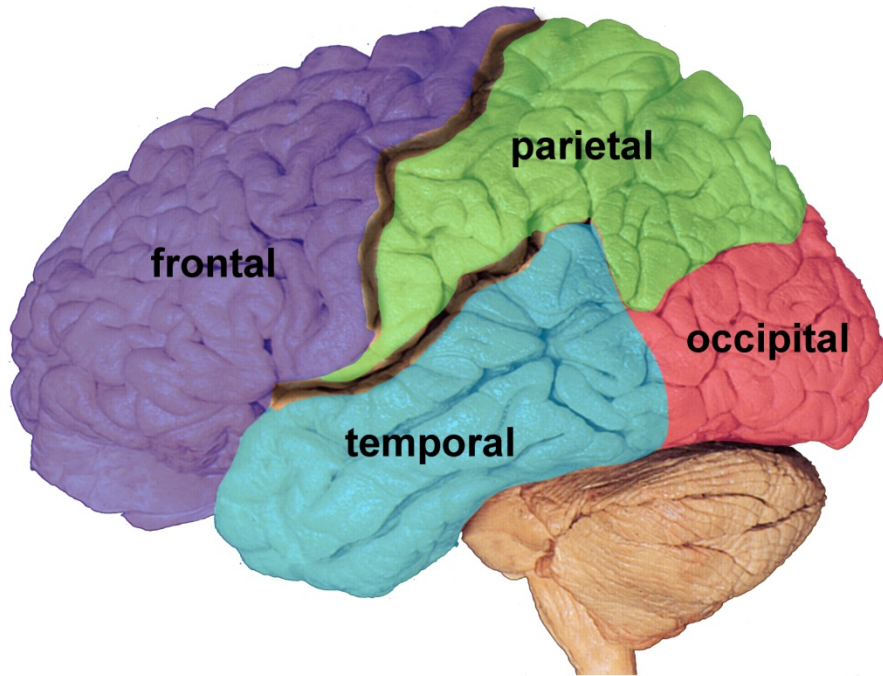
Two hemispheres separated by interhemispheric fissure

It is convenient to think of each hemisphere of telencephalon as having three parts that are highly interrelated:

- Neocortex (cortex)
- Limbic & olfactory systems (partly allocortex)
- Basal ganglia

Cerebral Cortex (Neocortex)

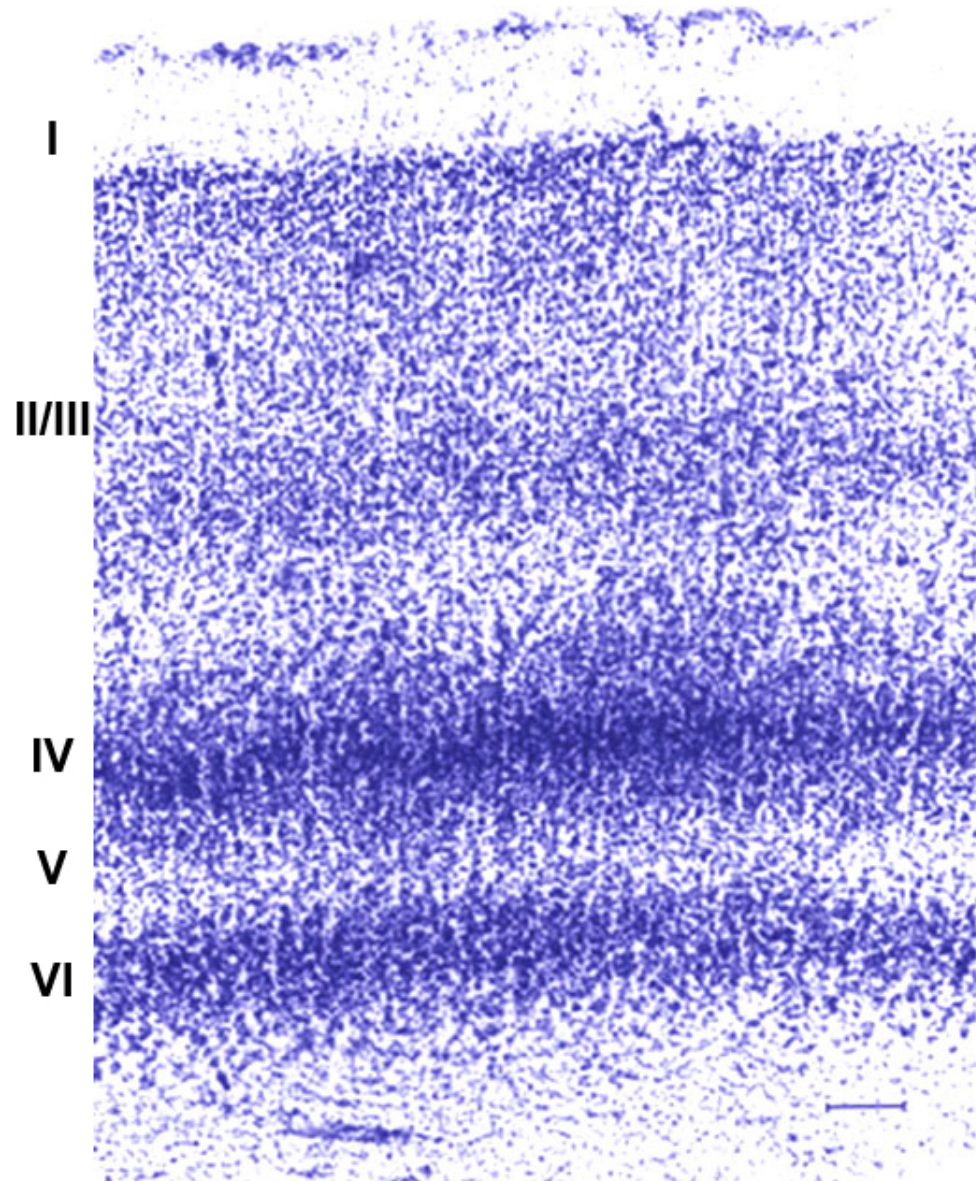
Cortex is divided into five major lobes (i.e. geographic regions).



Cerebral Cortex (Neocortex)

Neocortex – six cell layers

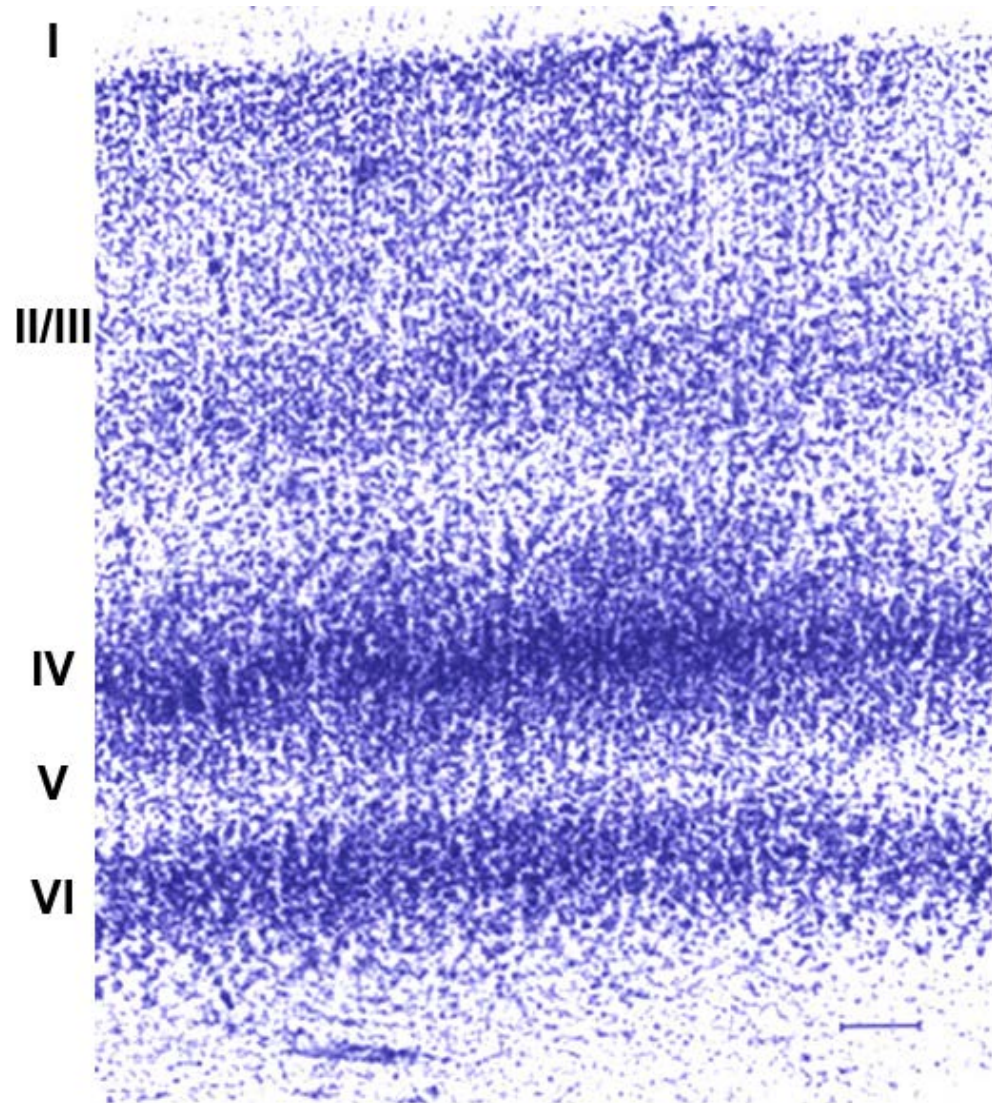
(Allocortex – 3-5 cell layers
Evolutionarily old
Includes hippocampus)



Cerebral Cortex (Neocortex)

Wiring the neocortex:

- Thalamus projects to layer IV.
- Layer IV projects to II & III.
- Layers II & III interconnect with other cortical areas.
- Layer VI projects to thalamus
- Layer V projects to lower CNS.

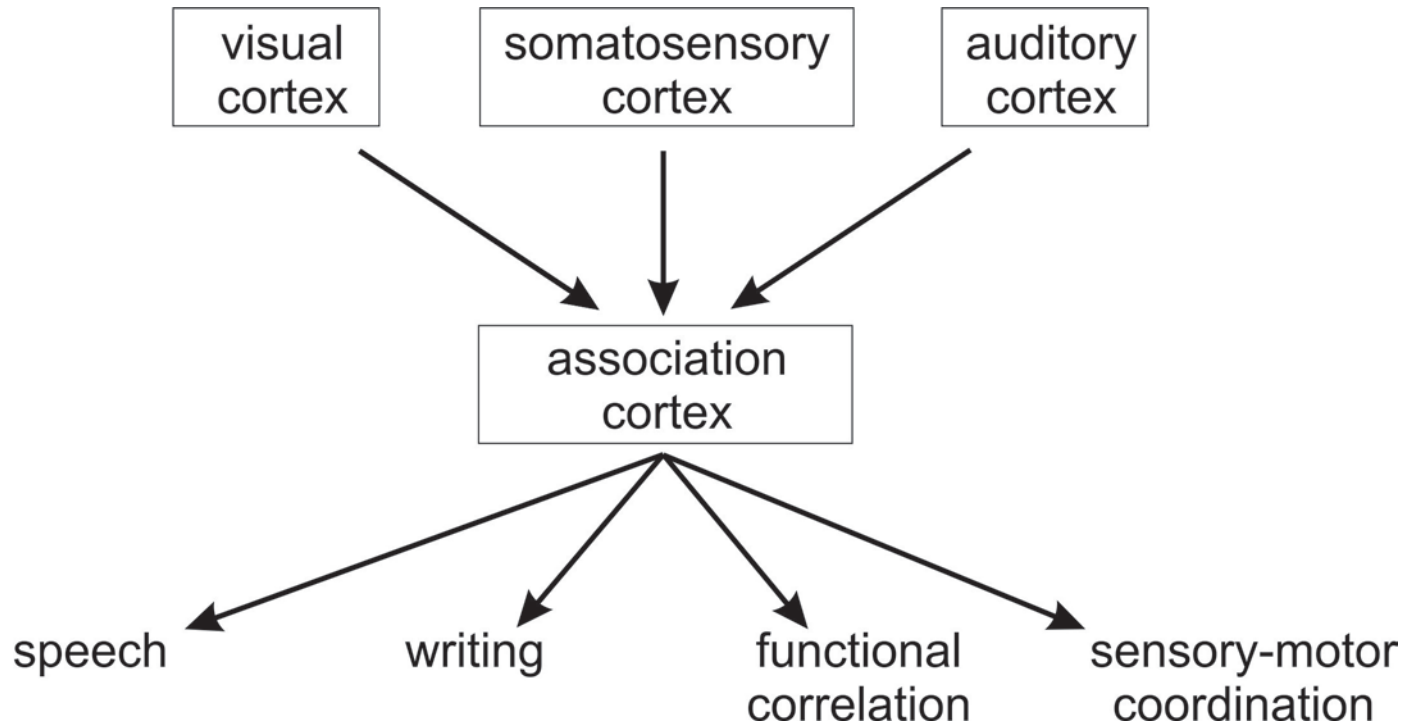




What is association cortex?



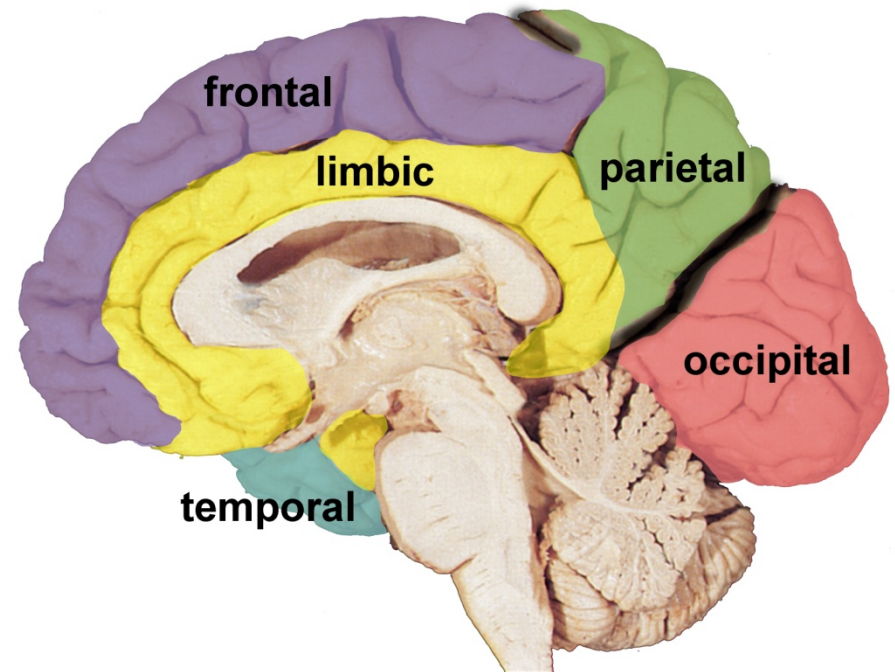
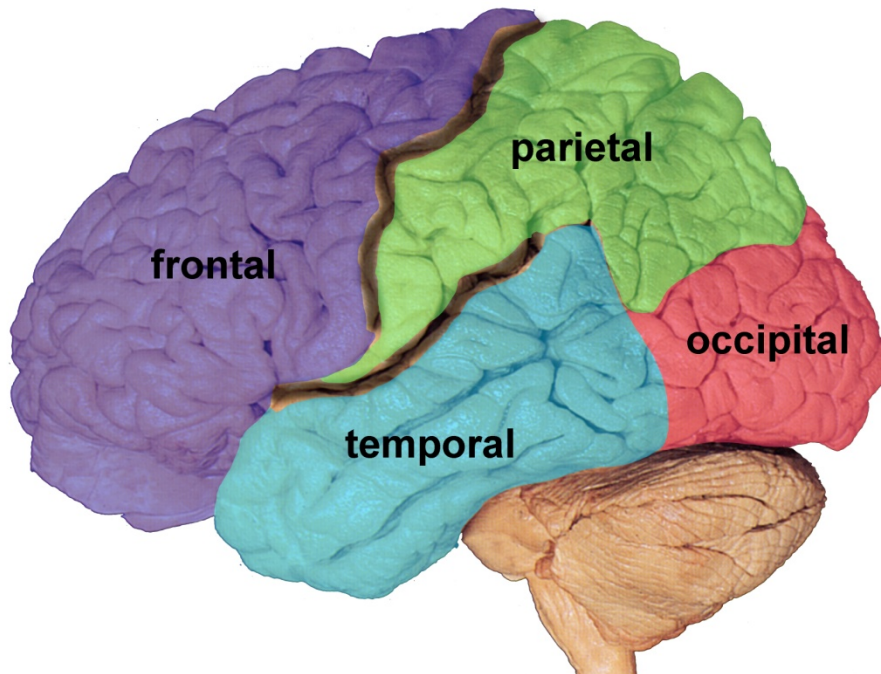
What is association cortex?



What is association cortex?

Association cortex is found in three main areas:

- Parietal
- Prefrontal
- Limbic



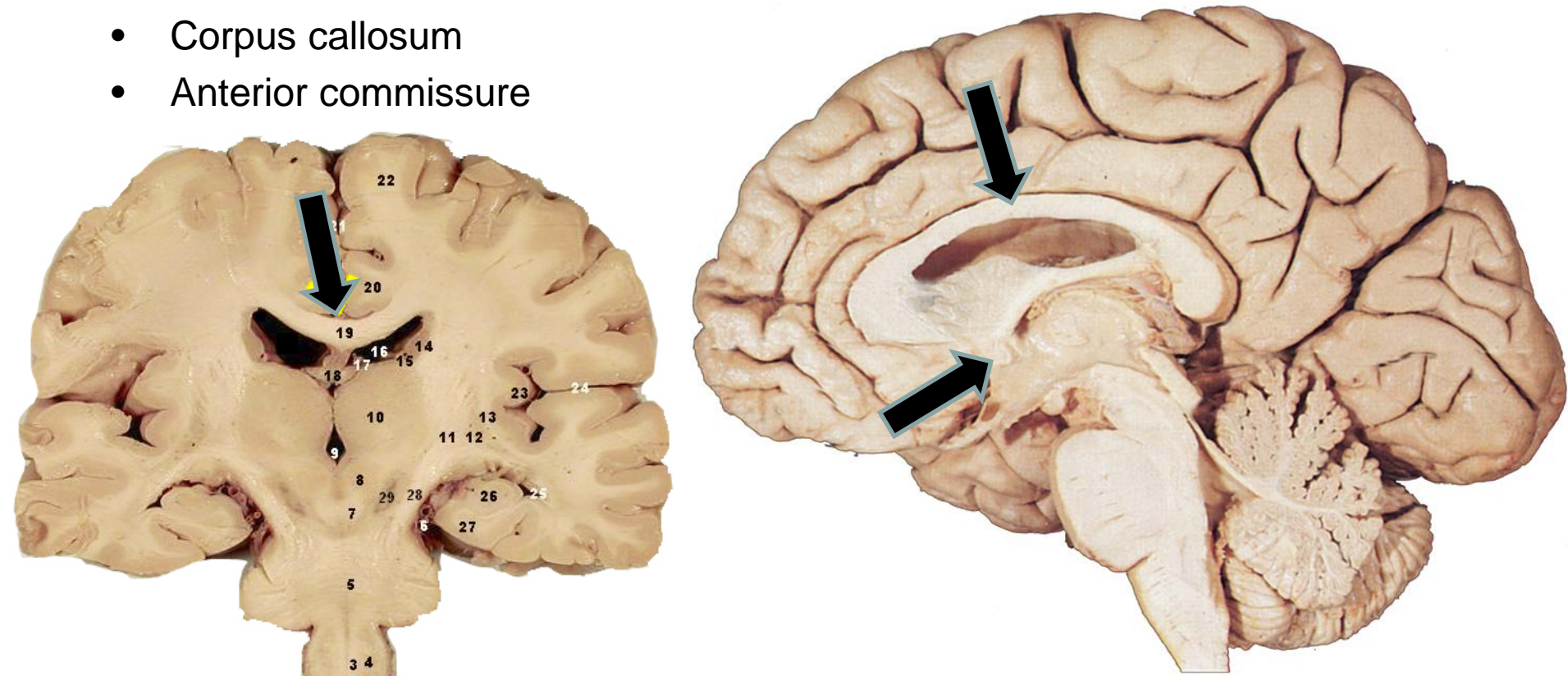
Cerebral Commissures

Commissures are discrete bundles of axons that cross the midline.

Typically, a region of cortex on one side of the brain communicates with the same region on the other side.

Two commissures interconnect the hemispheres of the cerebral cortex:

- Corpus callosum
- Anterior commissure





Cerebral Commissures

Epilepsy is characterized by seizures, which can result in the uncontrolled contraction of large groups of muscles.

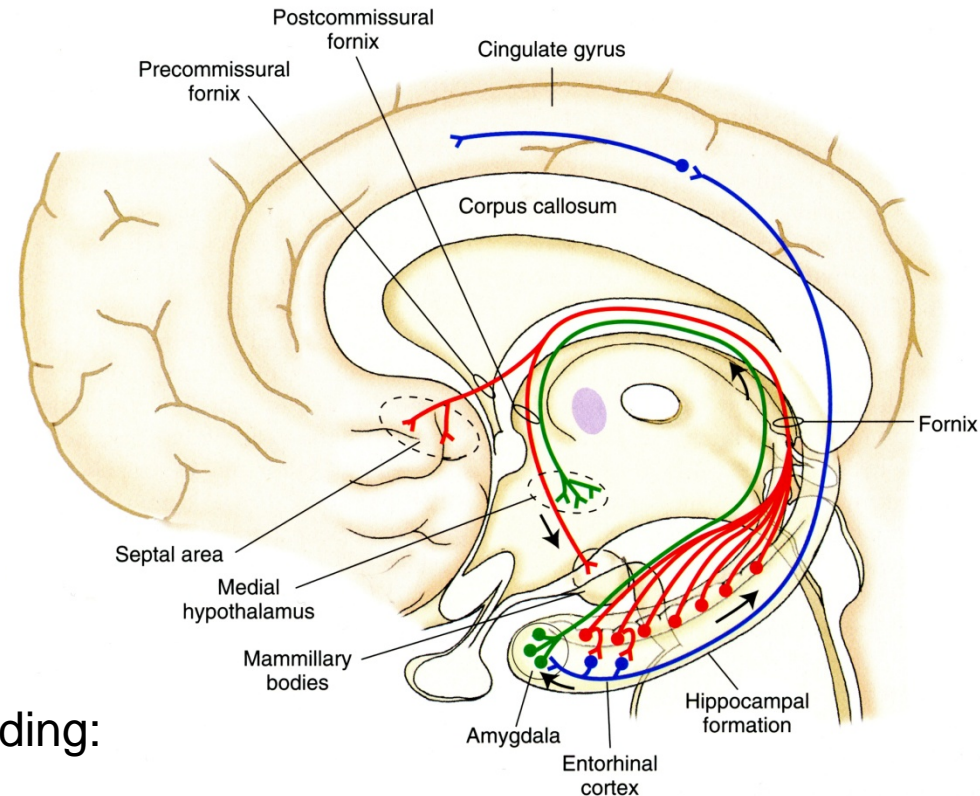
It is caused by synchronous excitatory activity in the cortex that spreads from an activation site.

In severe cases, portions of the corpus callosum can be surgically cut, which will prevent the spread of activity from one side of the brain to the other.

Limbic & Olfactory areas

The limbic / olfactory systems include:

- Olfactory bulb & tract
- Hippocampus
- Septal area
- Amygdala
- Anterior commissure
- Parts of many other structures including:
 - Prefrontal cortex
 - Cingulate gyrus
 - Anterior nucleus and other nuclei of the thalamus
 - Mammillary bodies and other nuclei of hypothalamus
 - Midbrain reticular formation



Limbic & Olfactory Systems

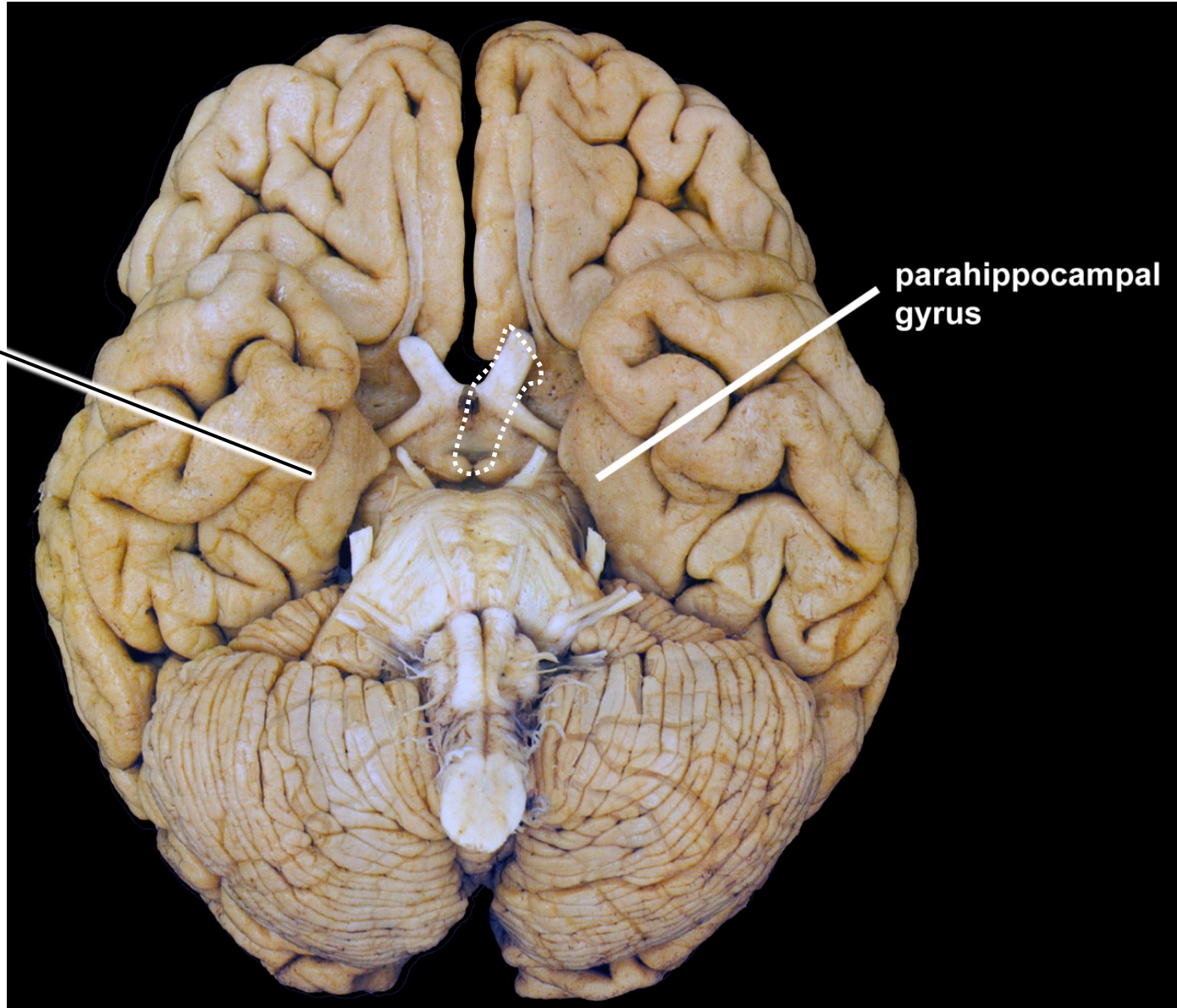
Parts of the limbic and olfactory systems are composed of allocortex (i.e. not neocortex). Allocortex is phylogenetically older than neocortex.

Allocortex has 3-5 cell layers:

- Hippocampus – 3 cell layers
- Amygdala – 3-4 cell layers

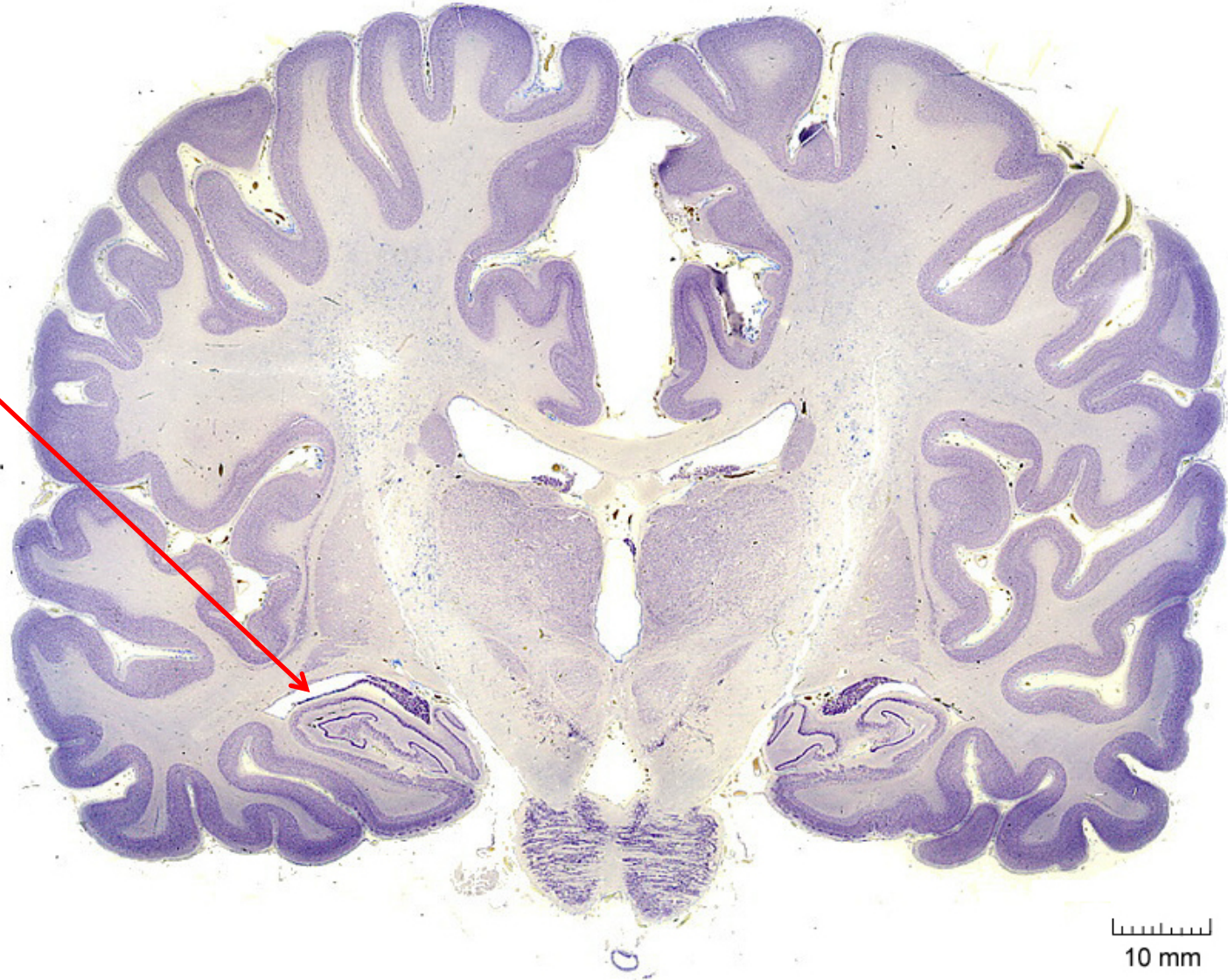
Limbic & Olfactory Systems

- Hippocampus is in the temporal lobe inside the parahippocampal gyrus.



Limbic & Olfactory Systems

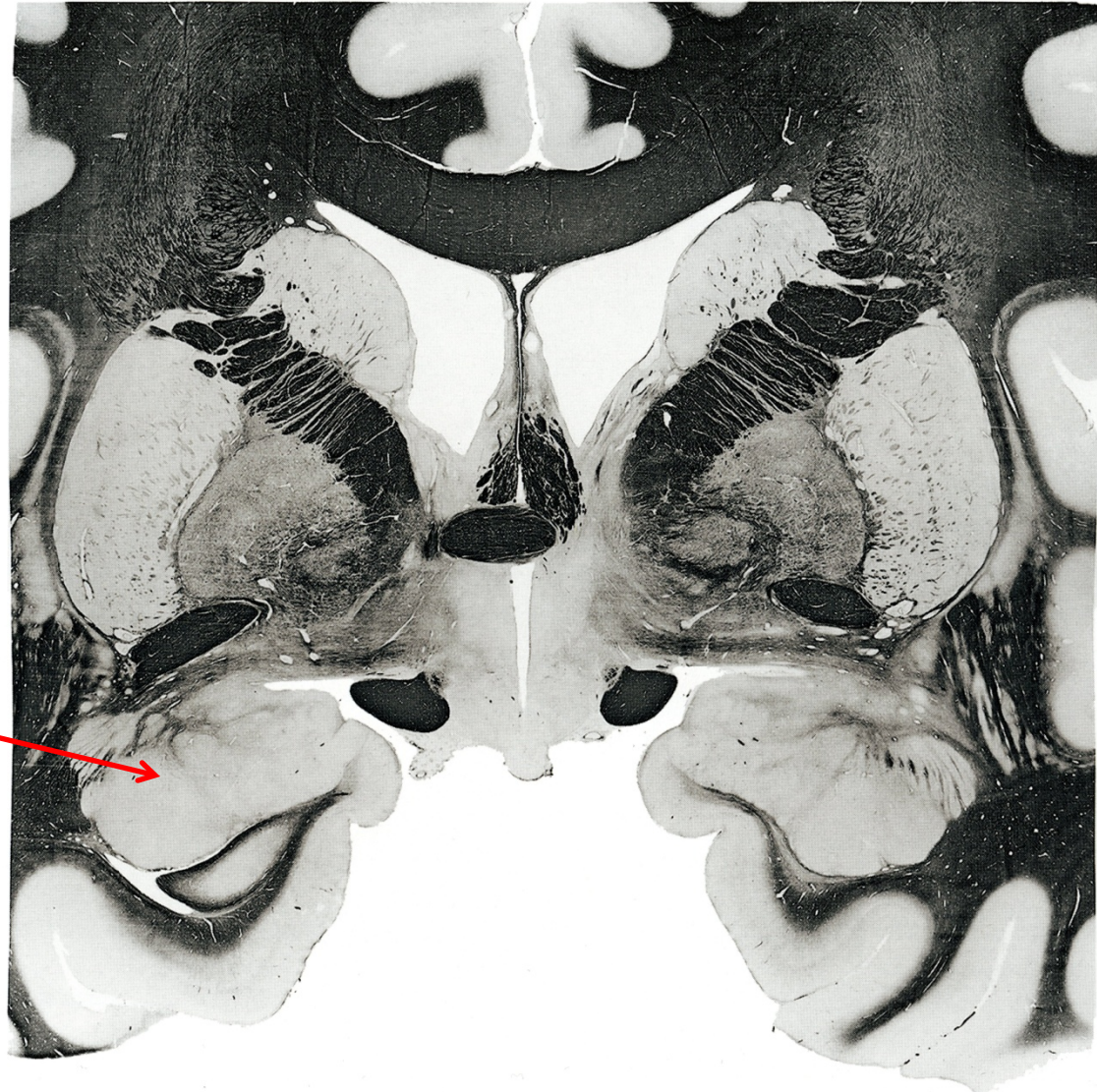
- Hippocampus is in the temporal lobe inside the parahippocampal gyrus.



Limbic & Olfactory Systems



- **Amygdala** is in the front of the temporal lobe, in front of the hippocampus
- Involved in conditioned fear responses.

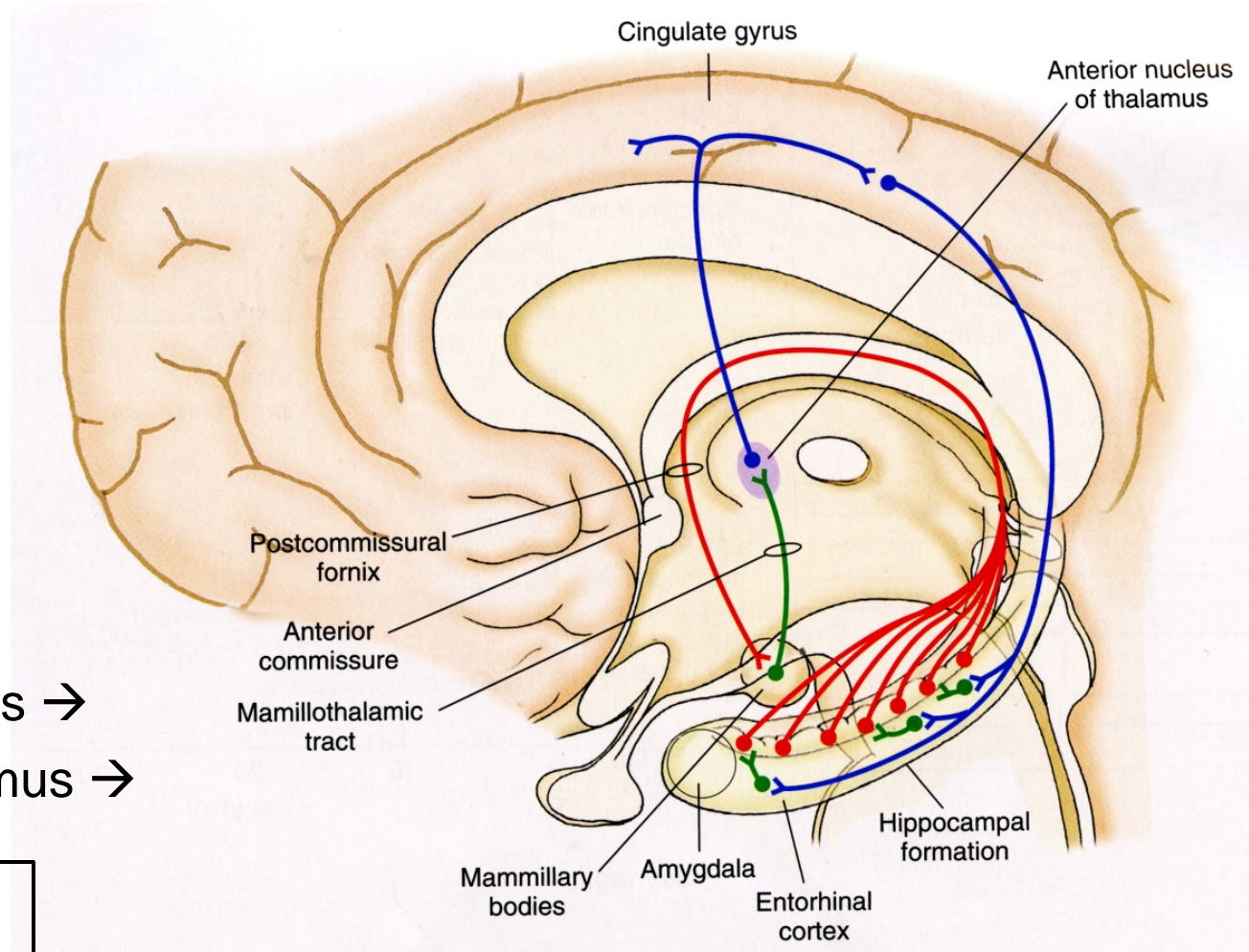


Learning and Memory: the Papez circuit

- **Disrupting it disrupts memory**

Papez circuit

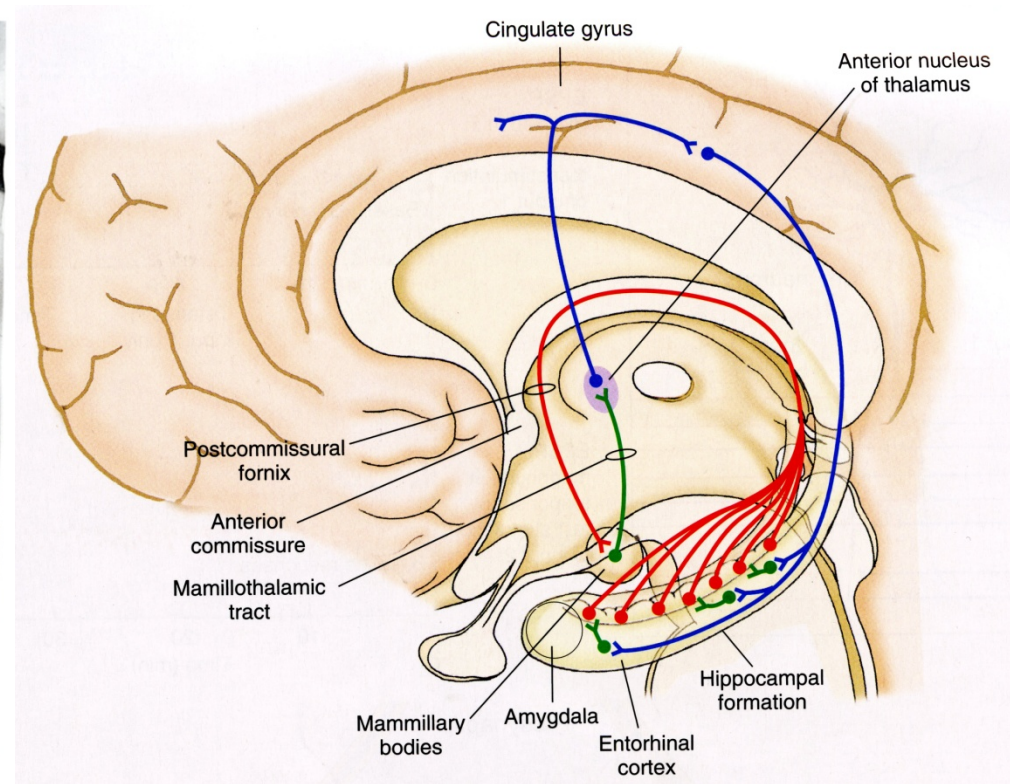
→ Hippocampus →
Mammillary bodies →
Anterior n. Thalamus →
Cingulate Cortex



Limbic & Olfactory Systems

Tracts of the limbic system include:

- Fornix – hippocampus to mammillary bodies
- Mammillothalamic tract – mammillary bodies to anterior nucleus of thalamus

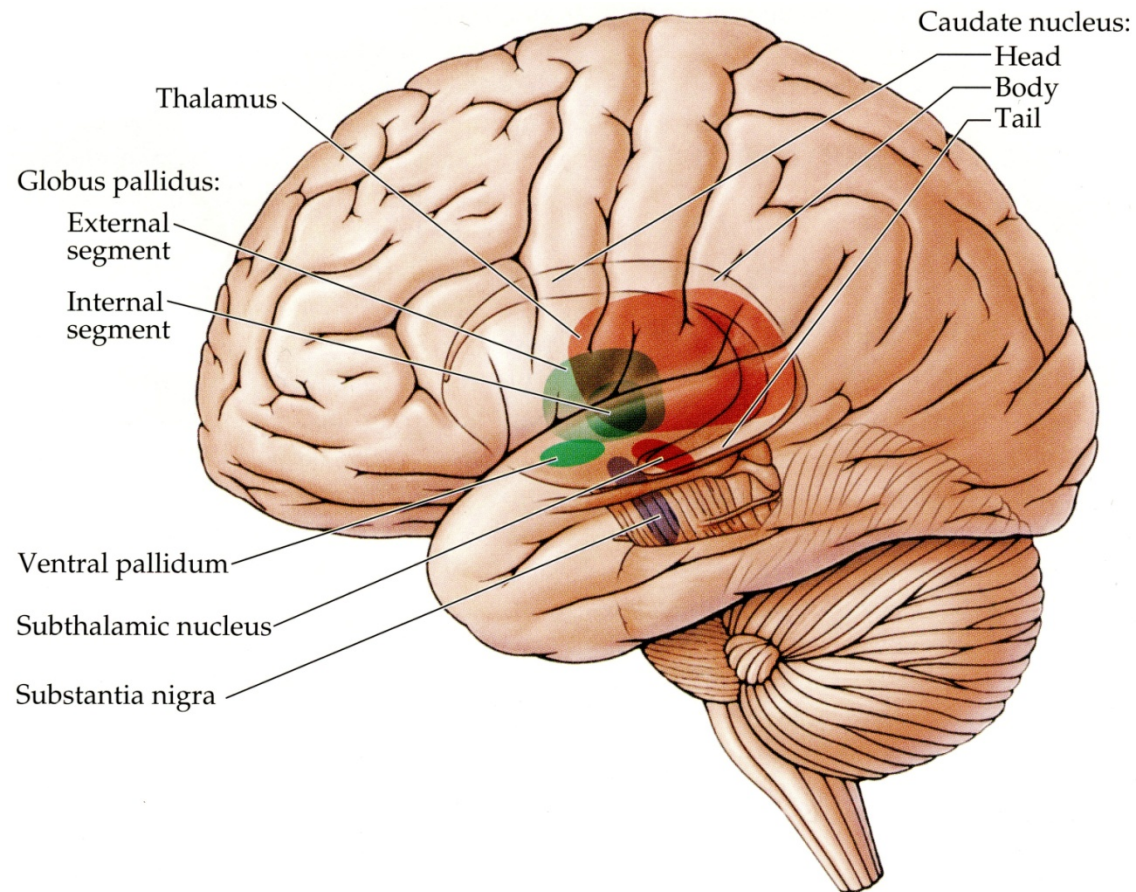


Basal Ganglia Anatomy

The basal ganglia consist of a number of nuclei in the basal region of the telencephalon, diencephalon and midbrain. These nuclei play important roles in the motor system and in motivation (including drug abuse).

The largest nuclei are:

- Striatum (telencephalon)
- Globus pallidus (telencephalon)
- Subthalamic nucleus (diencephalon)
- Substantia nigra (**midbrain**)



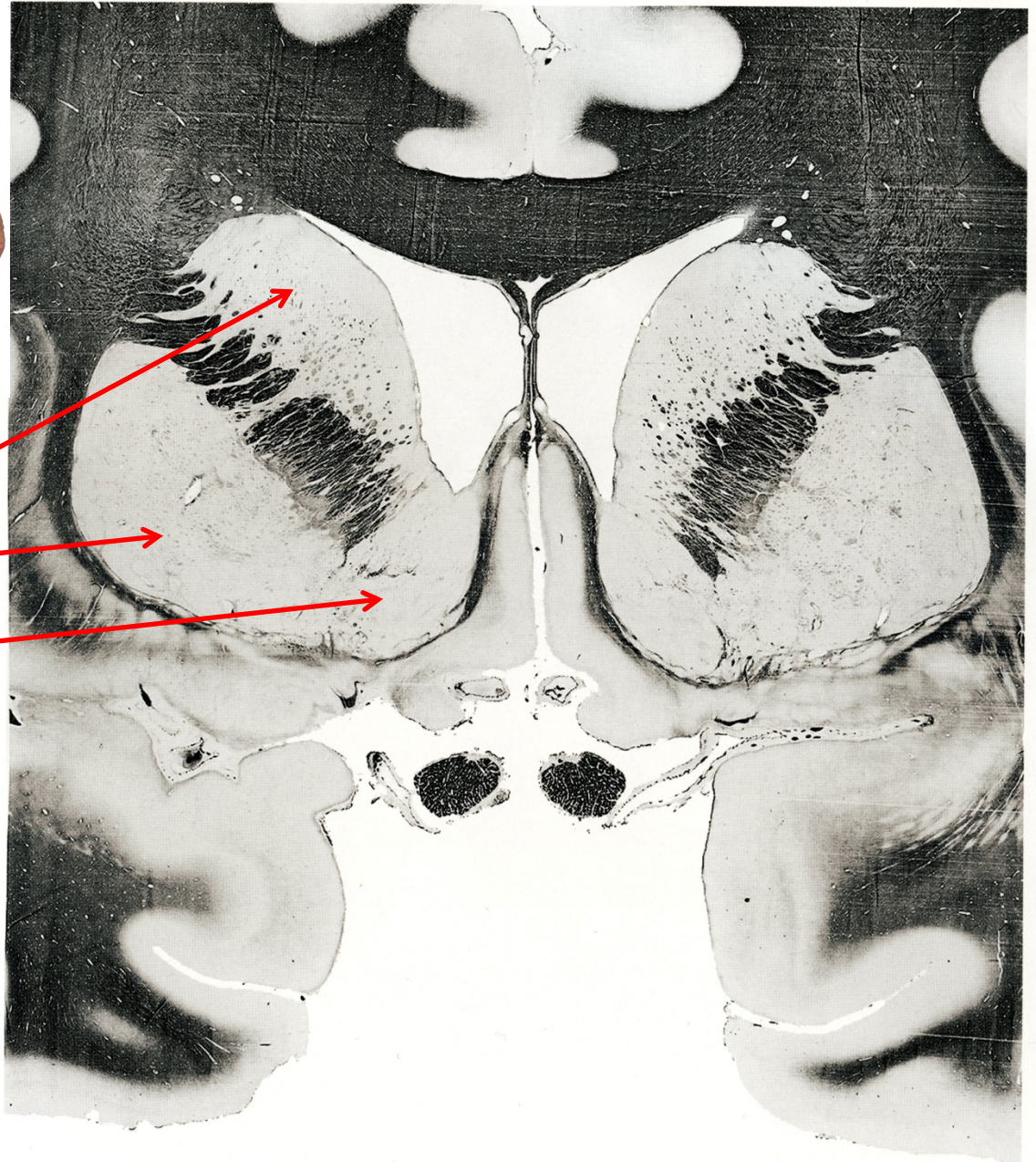
Basal Ganglia Anatomy

- The striatum is composed of three nuclei:
 - caudate nucleus
 - putamen
 - nucleus accumbens
- The striatum is more like one nucleus that is sometimes divided by the internal capsule, but which comes together at the front of the internal capsule.



Striatum:

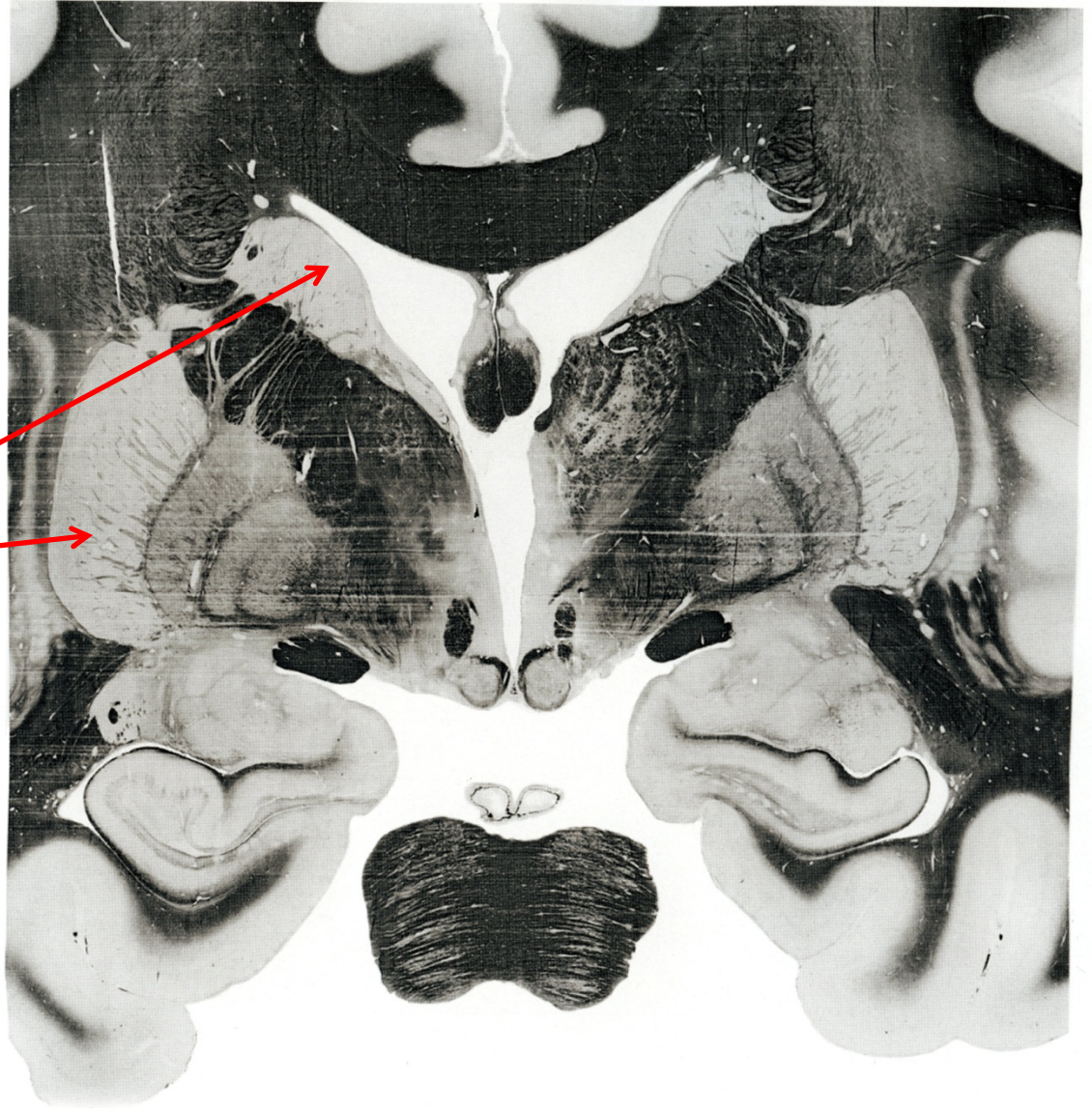
- caudate nucleus
- putamen
- nucleus accumbens

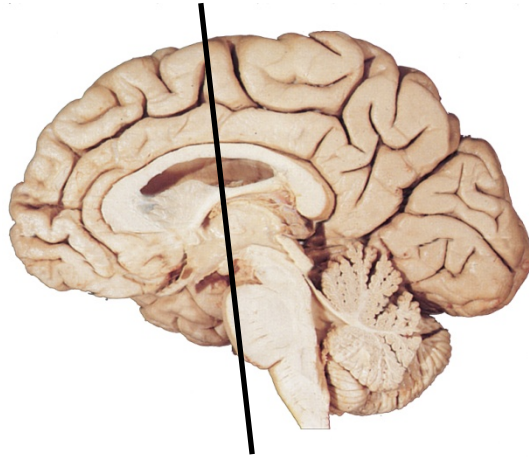




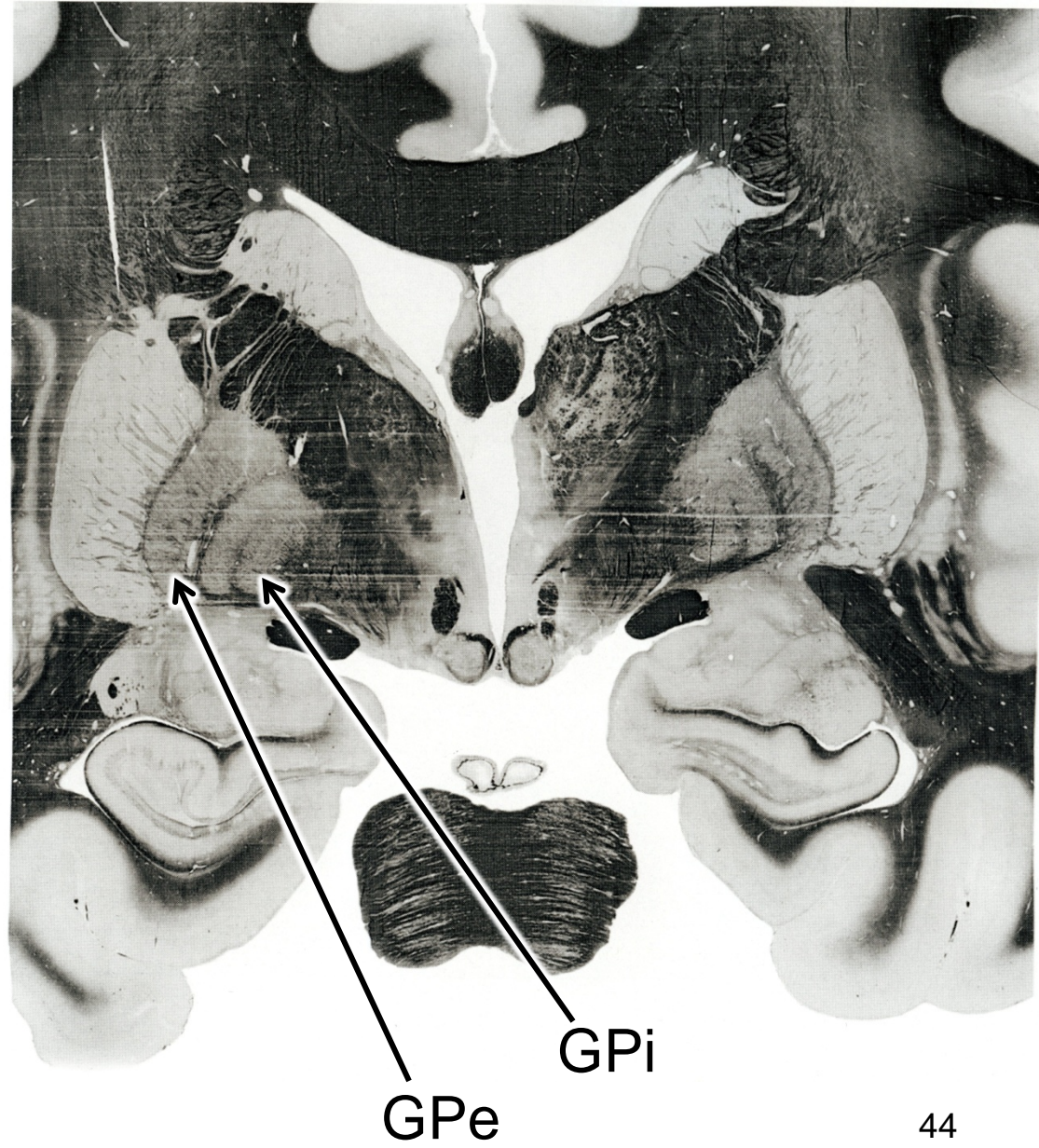
Striatum more caudally:

- caudate nucleus
- putamen
- (nucleus accumbens no longer present)

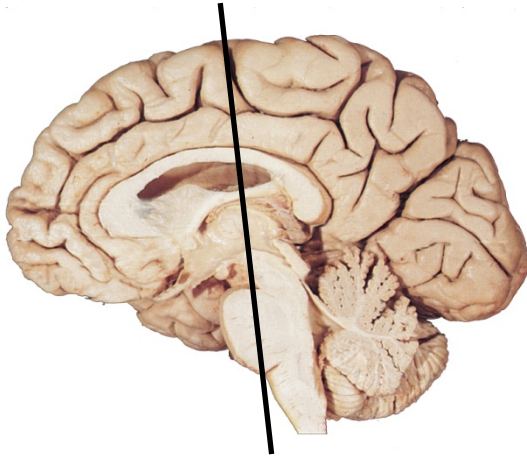




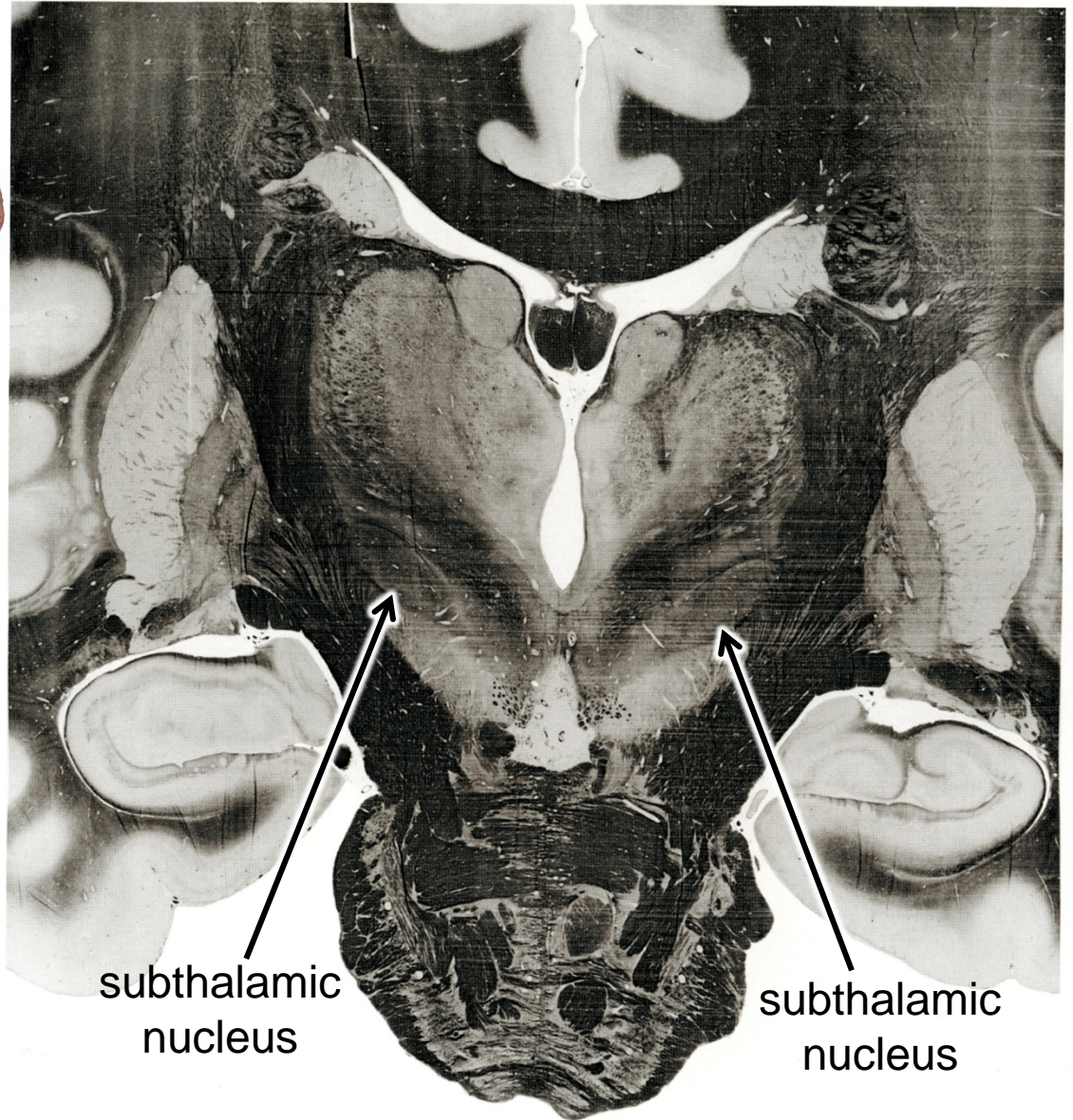
- **Globus pallidus:** two divisions
 - external (GPe) – internal circuitry of globus pallidus
 - internal (GPi) – output circuitry



Basal Ganglia Anatomy



- The subthalamic nucleus is part of the **diencephalon**, positioned just ventral to the thalamus and dorsal to the midbrain.



subthalamic
nucleus

subthalamic
nucleus

Questions?
