511-2015-08-31-anatomy

Rick Gilmore

2015-09-01 07:49:28

Today's Topics

Gross neuroanatomy

Neuroanatomy Lab

Brain anatomy through dance

Finding our way around

Anterior/Posterior

Medial/Lateral

Superior/Inferior

Dorsal/Ventral

Rostral/Caudal

Directional image

Bipeds vs. quadripeds

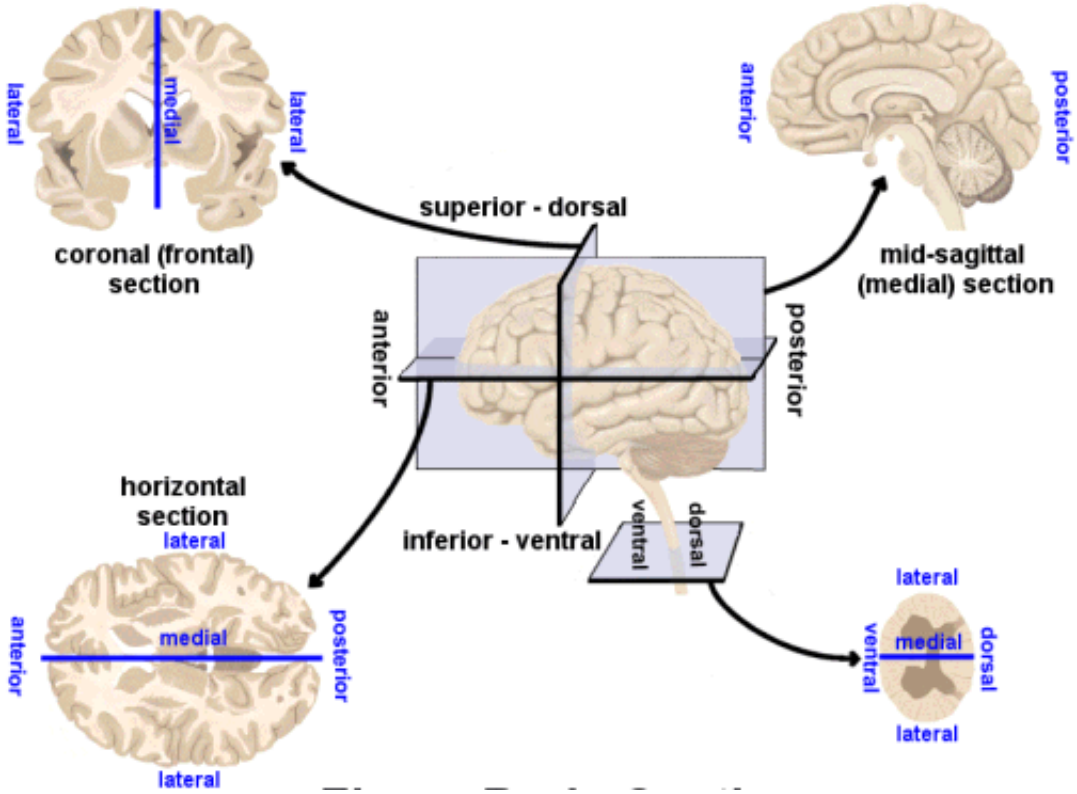
No matter how you slice it

Horizontal/Axial

Coronal/Transverse/Frontal

Sagittal (from the side)

Slice diagram



http://www.scienceteacherprogram.org/biology/chillemistudentguide1-06/brain_directions_planes_sections__directions_-_small.gif 8/92

Supporting structures

Meninges

Ventricular system

Blood supply

Meninges

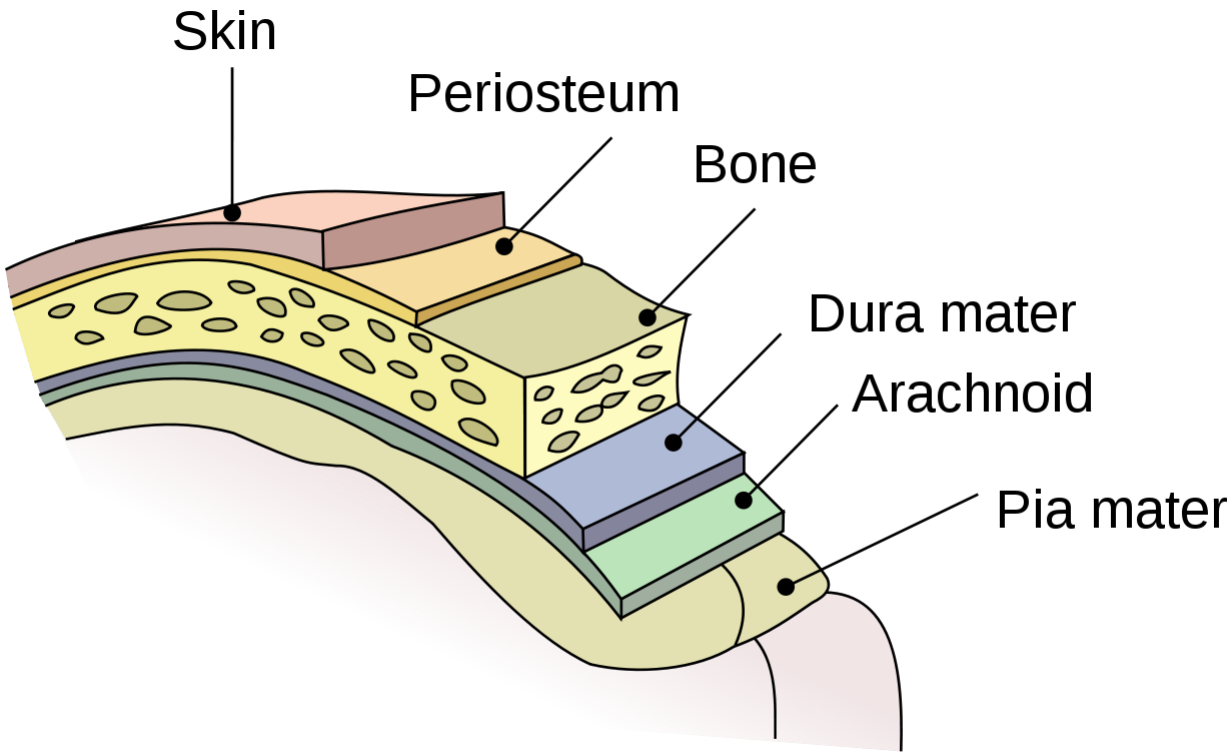
Dura mater

Arachnoid membrane

Subarachnoid space

Pia mater

Meninges



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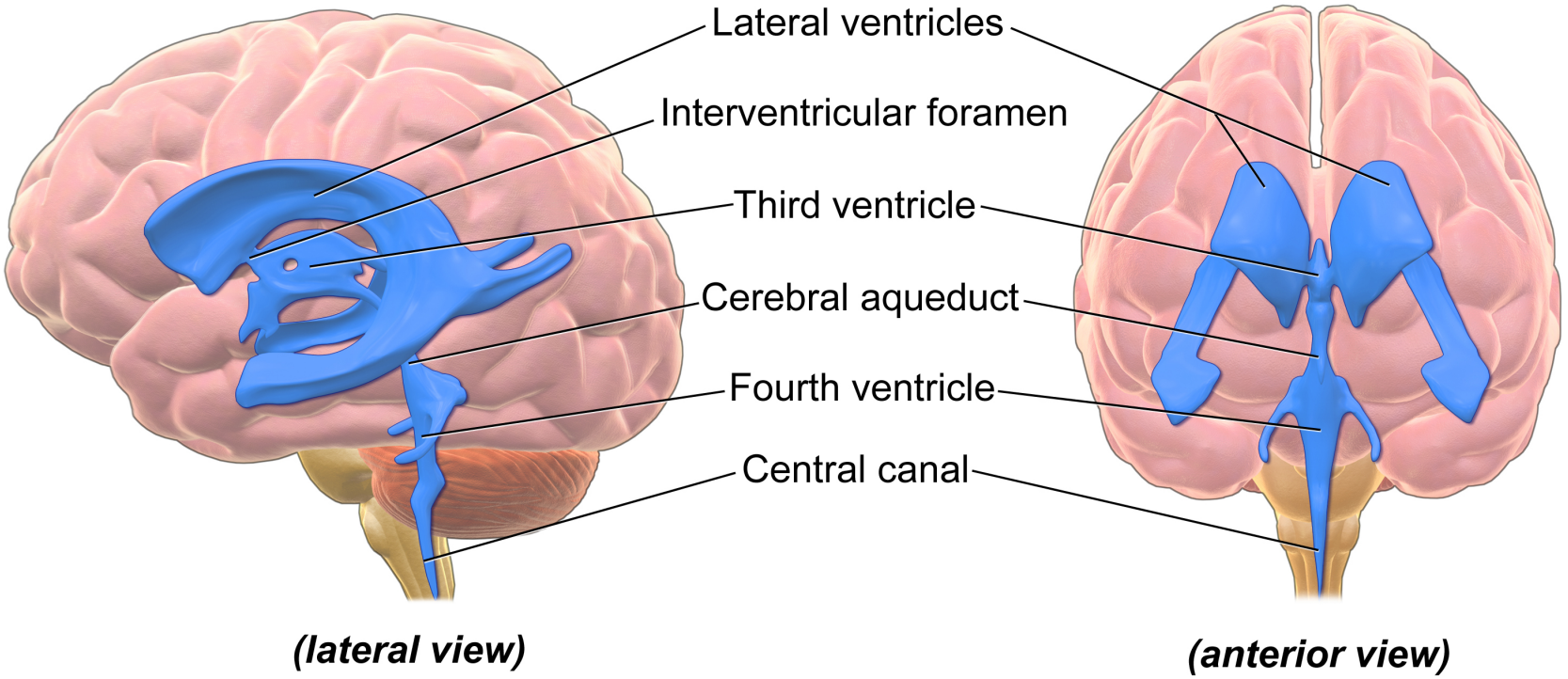
Ventricular system



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Ventricles

Lateral (1st & 2nd)

3rd

Cerebral aqueduct

4th

Cerebrospinal fluid (CSF)

- Clears metabolites during sleep (Xie et al. 2013).

Blood Supply

Blood Supply

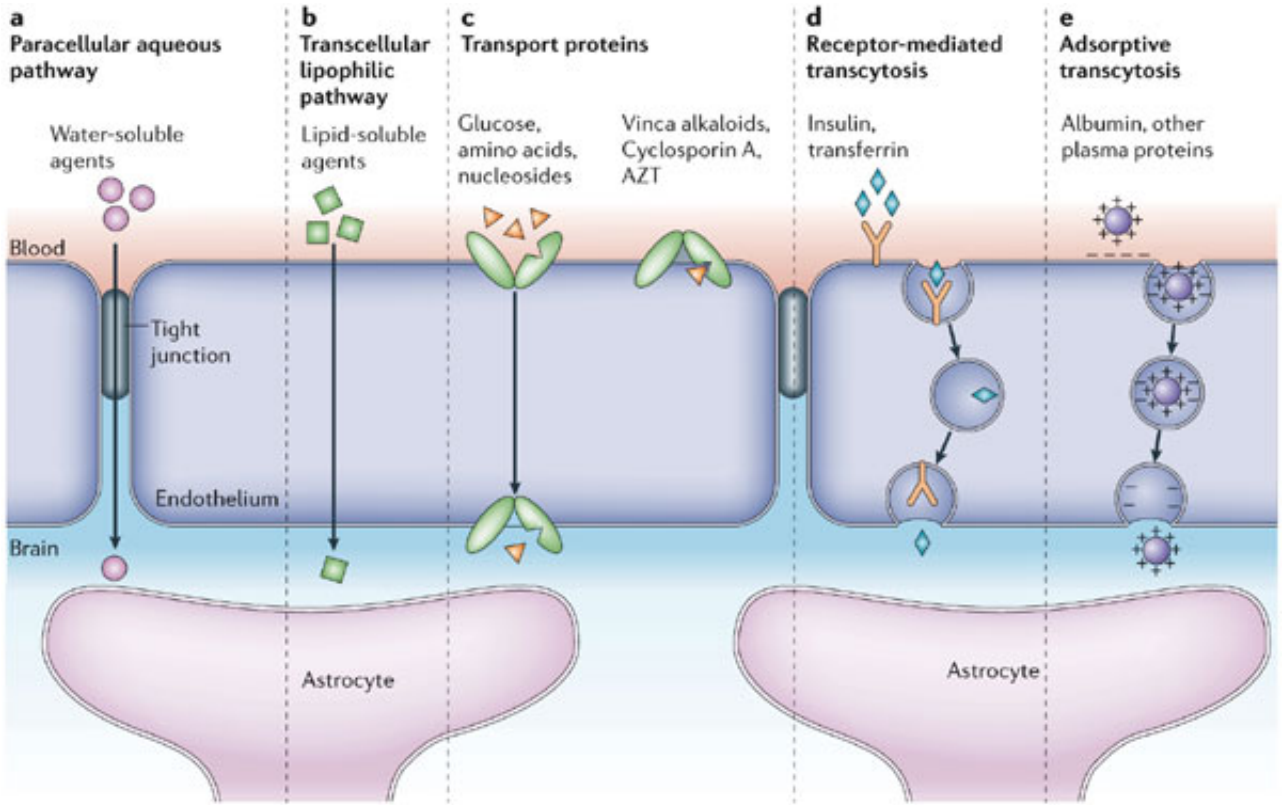
Arteries

- Circle of Willis

Blood/brain barrier

- Cells forming blood vessel walls tightly packed
- Active transport of molecules typically required

Blood/brain barrier



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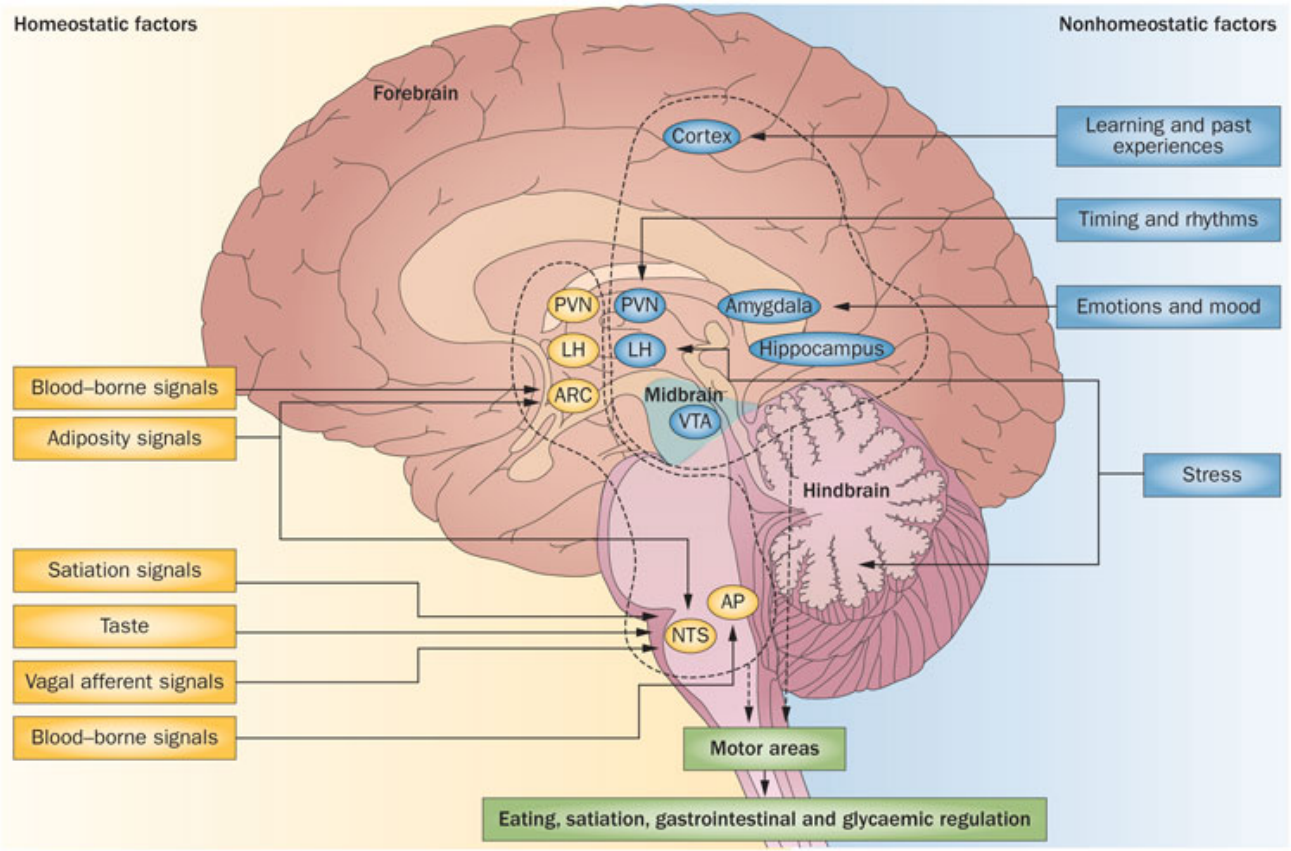
Area Postrema

- Brainstem, blood-brain barrier thin



Organization of the Nervous System

Central Nervous System (CNS)

- Brain
- Spinal Cord
- Everything encased in bone

Peripheral Nervous System (PNS)

Organization of the brain

Major division	Ventricular Landmark	Embryonic Division	Structure
Forebrain	Lateral	Telencephalon	Cerebral cortex
			Basal ganglia
			Hippocampus, amygdala
	Third	Diencephalon	Thalamus
			Hypothalamus
Midbrain	Cerebral Aqueduct	Mesencephalon	Tectum, tegmentum

Organization of the brain

Major division	Ventricular Landmark	Embryonic Division	Structure
Hindbrain	4th	Metencephalon	Cerebellum, pons
	–	Mylencephalon	Medulla oblongata

Hindbrain

Structures adjacent to 4th ventricle

- Medulla oblongata
- Cerebellum
- Pons

Medulla oblongata

Medulla

- Cardiovascular regulation
- Muscle tone
- Fibers of passage

Cerebellum

- “Little brain”
- Dorsal to pons
- Movement coordination, simple learning

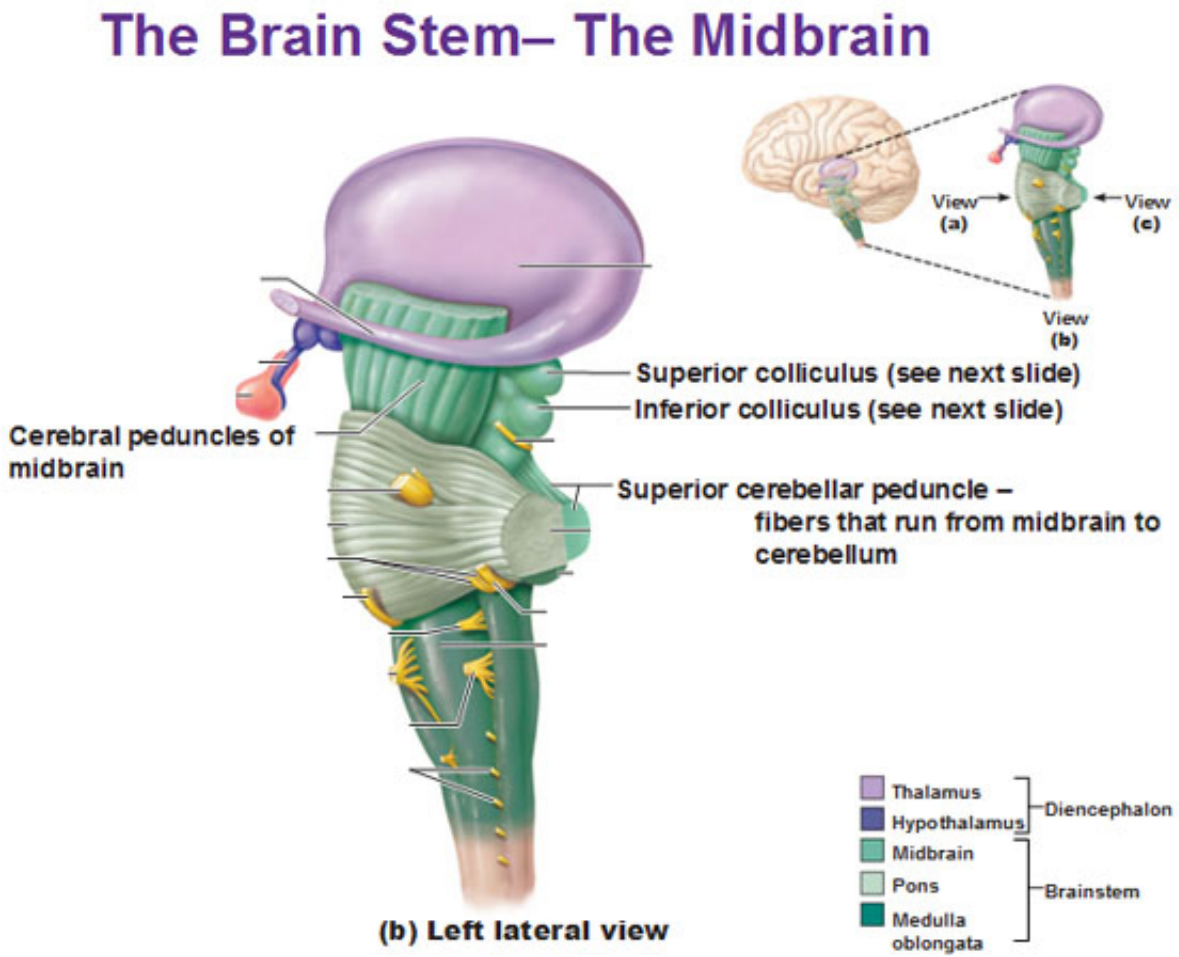
Hindbrain

Pons

- Bulge on brain stem
- Neuromodulatory nuclei
- Relay to cerebellum

Hindbrain

Midbrain



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Midbrain components

Tectum

Tegmentum

Tectum

Tectum

- Superior and inferior colliculus
- Reflexive orienting of eyes, head, ears

Tegmentum

- Species-typical movement sequences
- Neuromodulatory nuclei
  - Dopamine (DA)
  - Norepinephrine (NE)
  - Serotonin (5-HT)

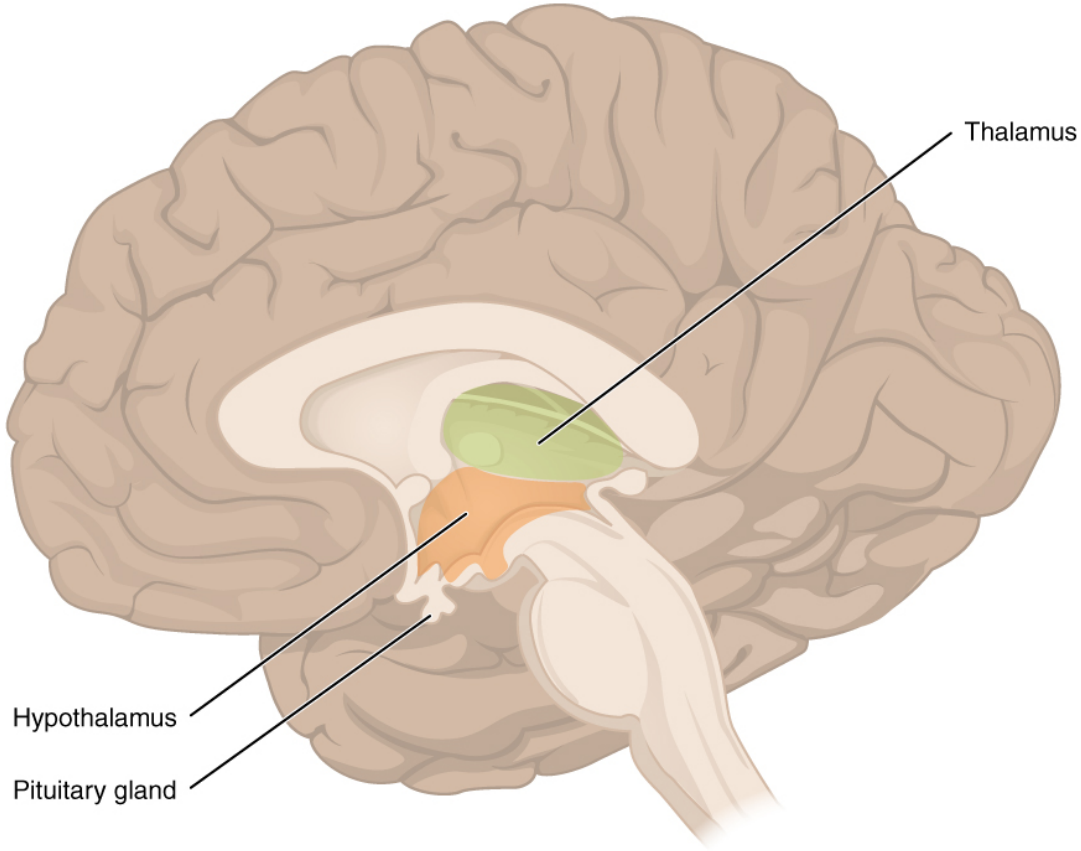
Forebrain

Forebrain Components

Diencephalon

Telencephalon

Diencephalon



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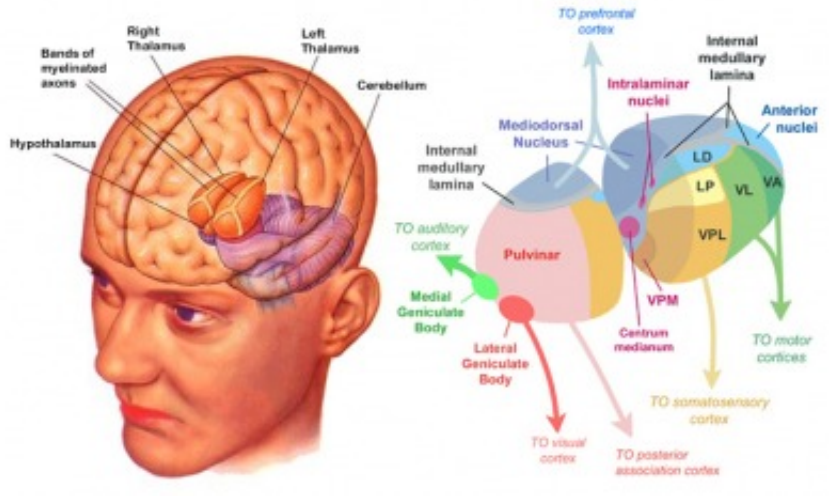
Diencephalon Components

- Thalamus
- Hypothalamus

Thalamus



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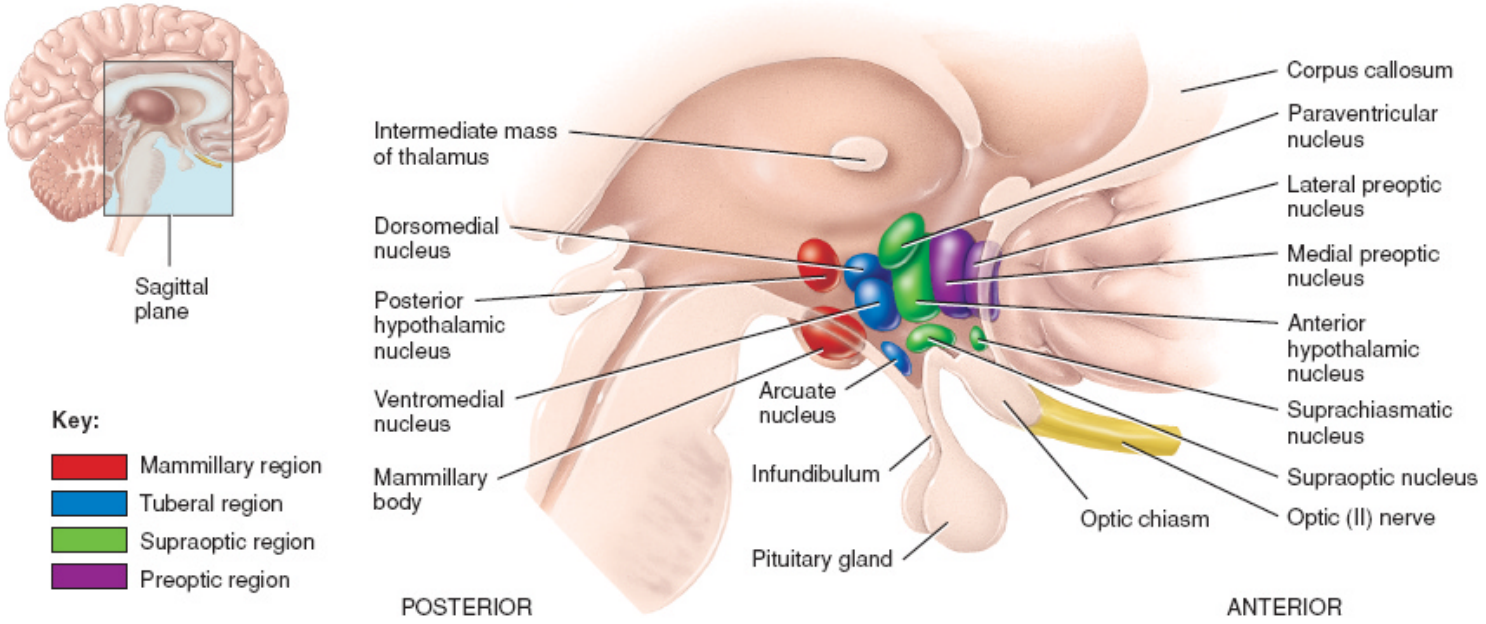
Thalamus functions

- Input to cortex
- Functionally distinct nuclei (collection of neurons)
- Lateral geniculate nucleus (LGN), vision
- Medial geniculate nucleus (MGN), audition

Hypothalamus

- Four Fs: fighting, fleeing, feeding, and reproduction
- Controls pituitary gland (“master” gland)
    - Anterior (indirect release of hormones)
    - Posterior (direct release of hormones)
        - Oxytocin
        - Vasopressin

Hypothalamus



Sagittal section of brain showing hypothalamic nuclei

http://higheredbcs.wiley.com/legacy/college/tortora/0470565101/hearthis

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Telencephalon

- Basal ganglia
- Hippocampus, amygdala
- Cerebral cortex

Basal ganglia

- Skill and habit learning
- Sequencing of movement
- Example: Parkinson's Disease

Basal ganglia

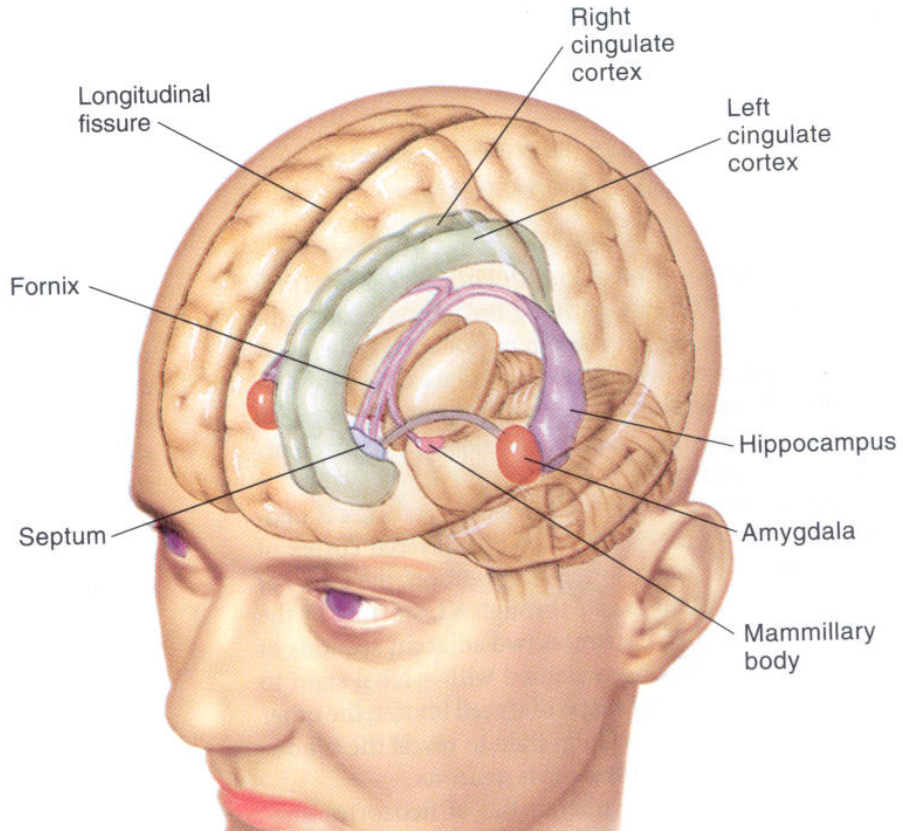
Basal ganglia

- Striatum
  - Caudate nucleus
  - Putamen
- Globus pallidus
- Subthalamic nucleus
- Substantia nigra (tegmentum)

Hippocampus

- Immediately lateral to lateral ventricles
- Memories of specific facts or events
- Fornix projects to hypothalamus
- Mammillary bodies

Hippocampus



http://homepage.smc.edu/wissmann_paul/physnet/anatomynet/anatomy

Amygdala (“almond”)

- Physiological state, behavioral readiness, affect
- NOT the fear center! (LeDoux 2015).

Amygdala

Cerebral Cortex

Cerebral hemispheres

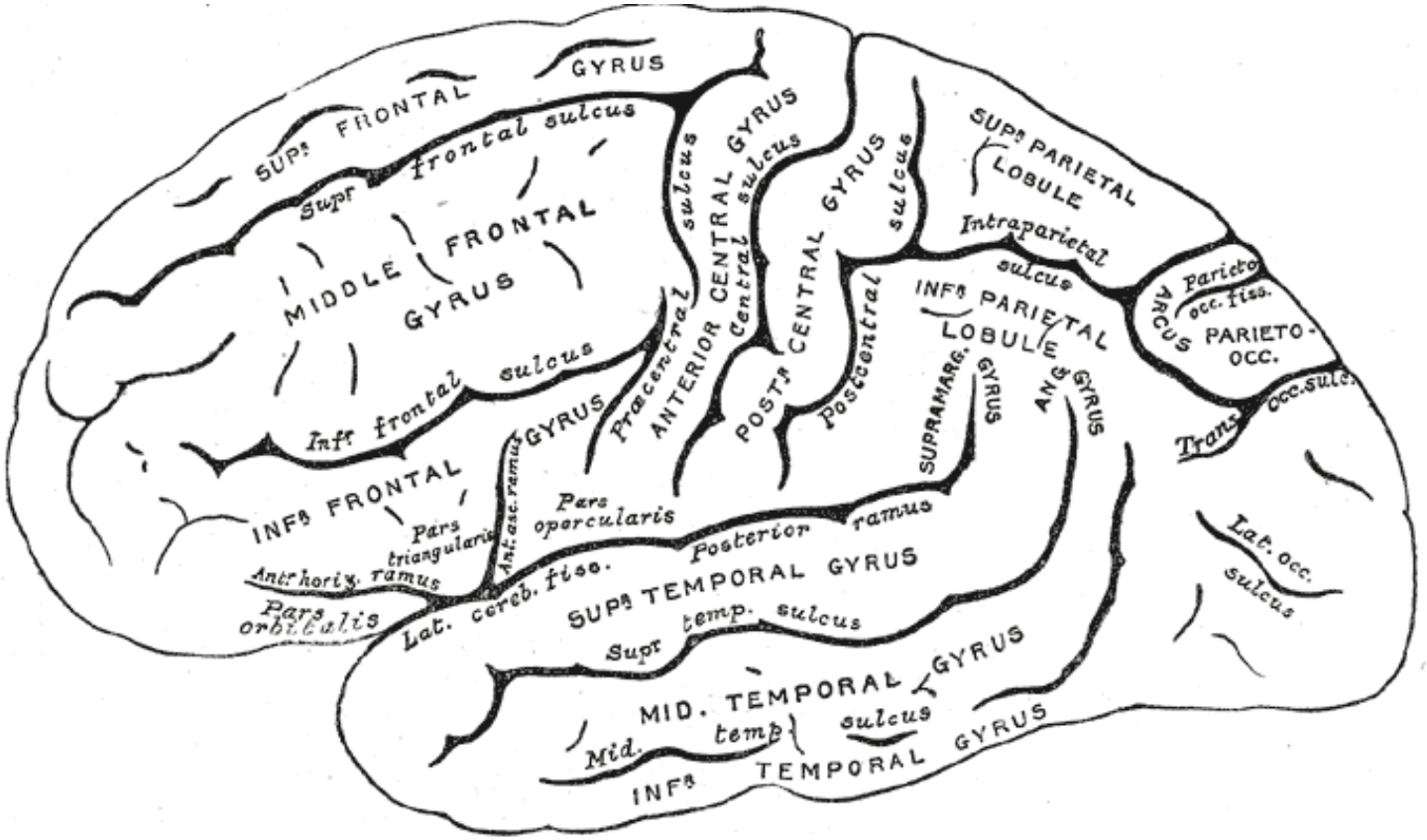
Groove (sulcus or sulci)

Bumps (gyrus or gyri)

Grey vs.white matter

Lobes

Cortical Gyri – Lateral



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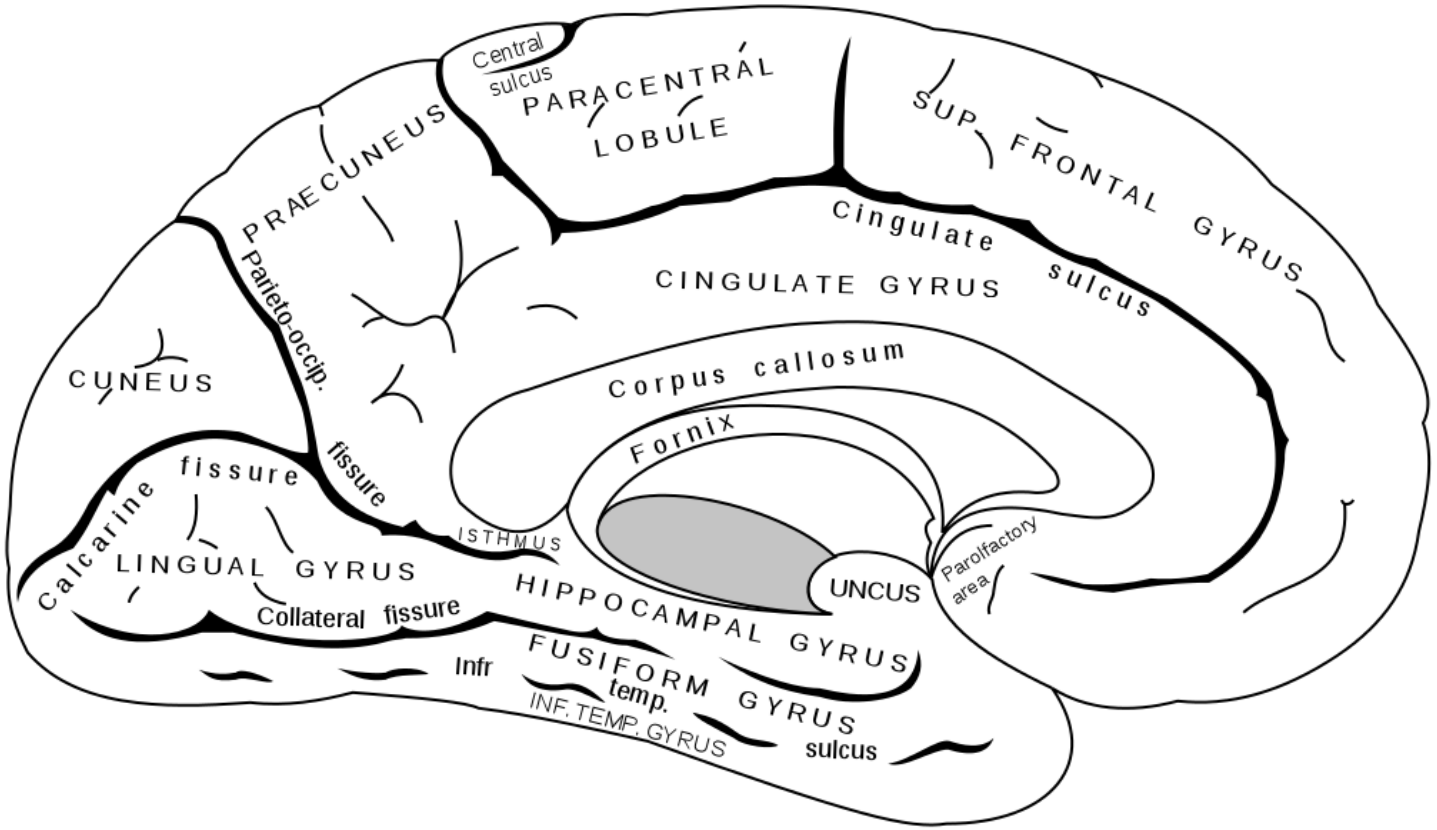
Cortical Gyri – Medial



Gray vs. White Matter

Lobes of the cerebral cortex

Frontal

Temporal

Parietal

Occipital

Lobes

Landmarks of the cortex

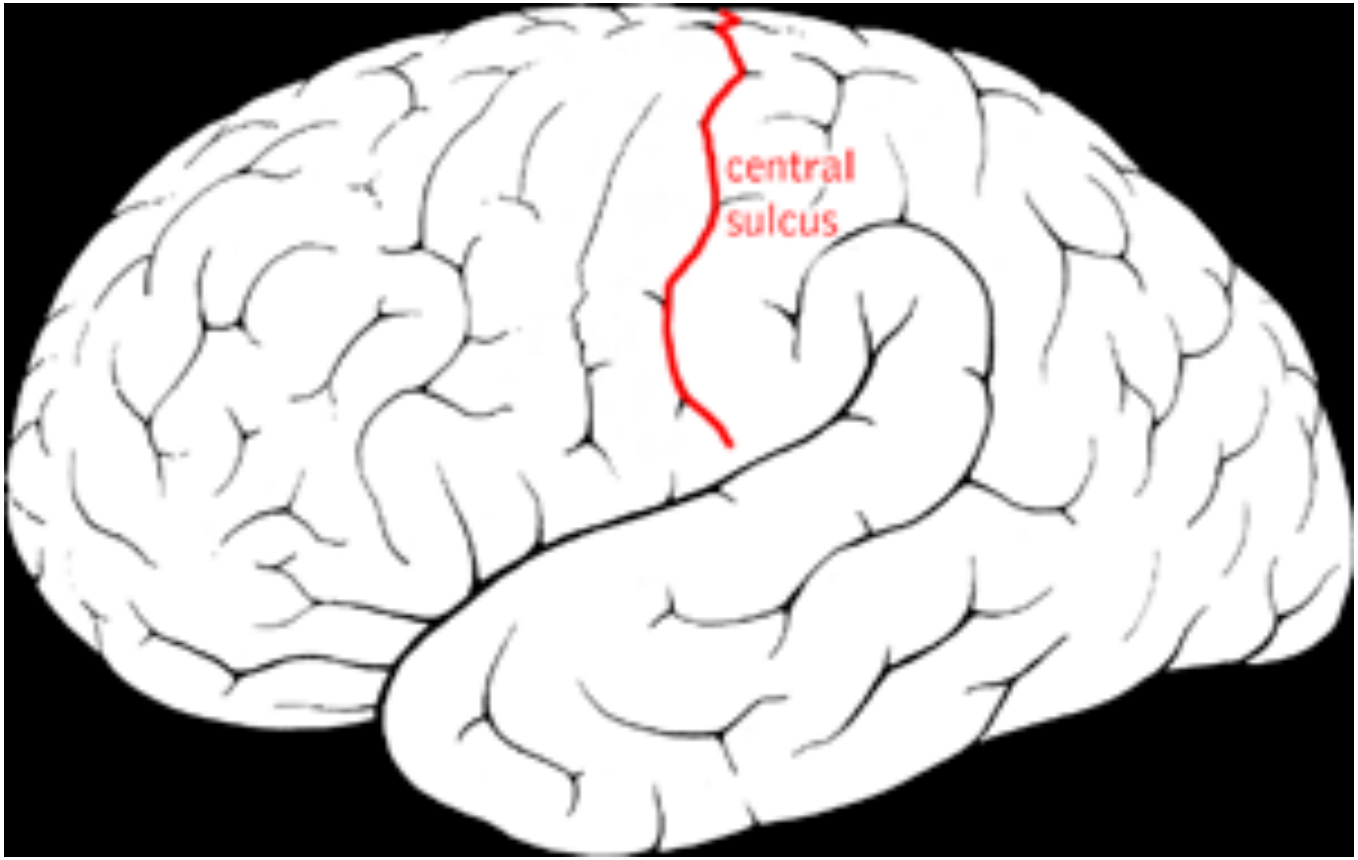
Longitudinal fissure

Landmarks of the cortex

Lateral sulcus/fissure

Landmarks of the cortex

Central sulcus



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Representative fiber tracts in the cortex

Corpus callosum

Anterior, Posterior Commissures

Frontal lobe

Where is it?

- Anterior to central sulcus
- Superior to lateral fissure
- Dorsal to temporal lobe

Lobes of the Cerebral Cortex

Frontal lobe

What does it do?

- Primary motor cortex (M1)
  - Supplementary motor cortex
  - Frontal eye fields (FEF)
- Prefrontal cortex
  - Planning, problem solving, working memory…?
- Basal forebrain
  - Nucleus accumbens
- Anterior cingulate cortex (ACC)
- Primary olfactory cortex

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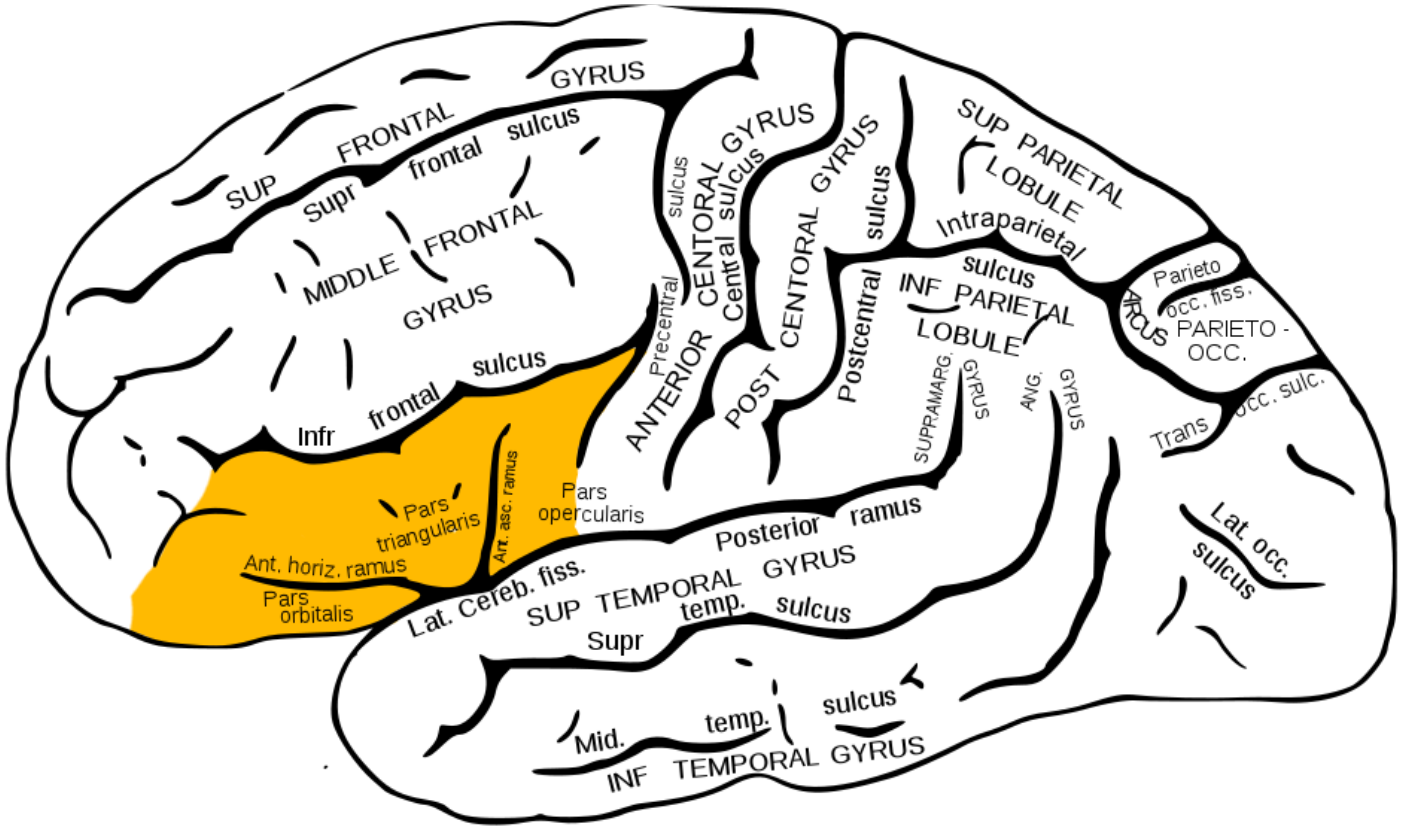
Cingulate Gyrus

http://cis.jhu.edu/data.sets/cortical_segmentation_validation/photos/cing

Inferior Frontal Gyrus (IFG)



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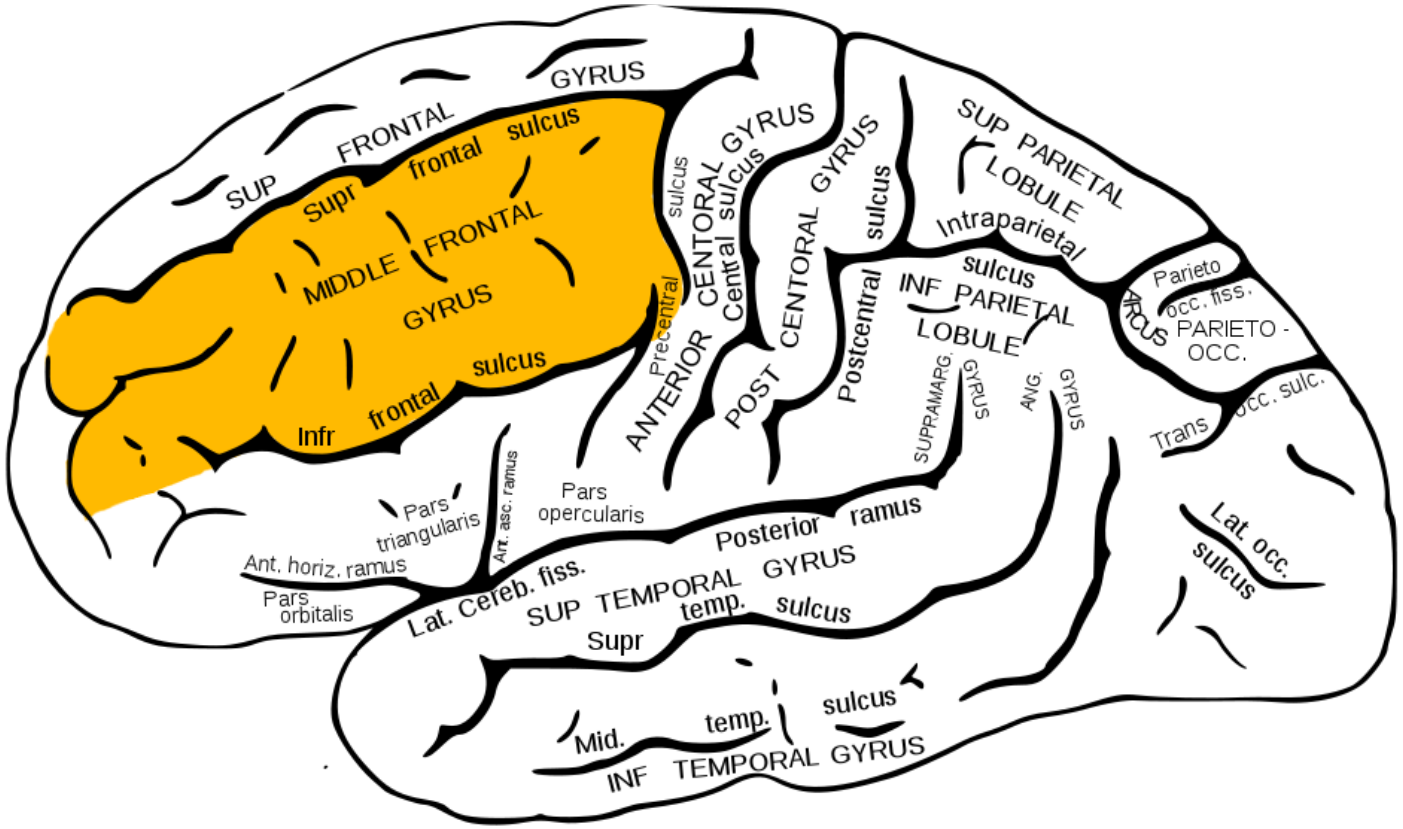
Middle Frontal Gyrus (MFG)



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Temporal lobe

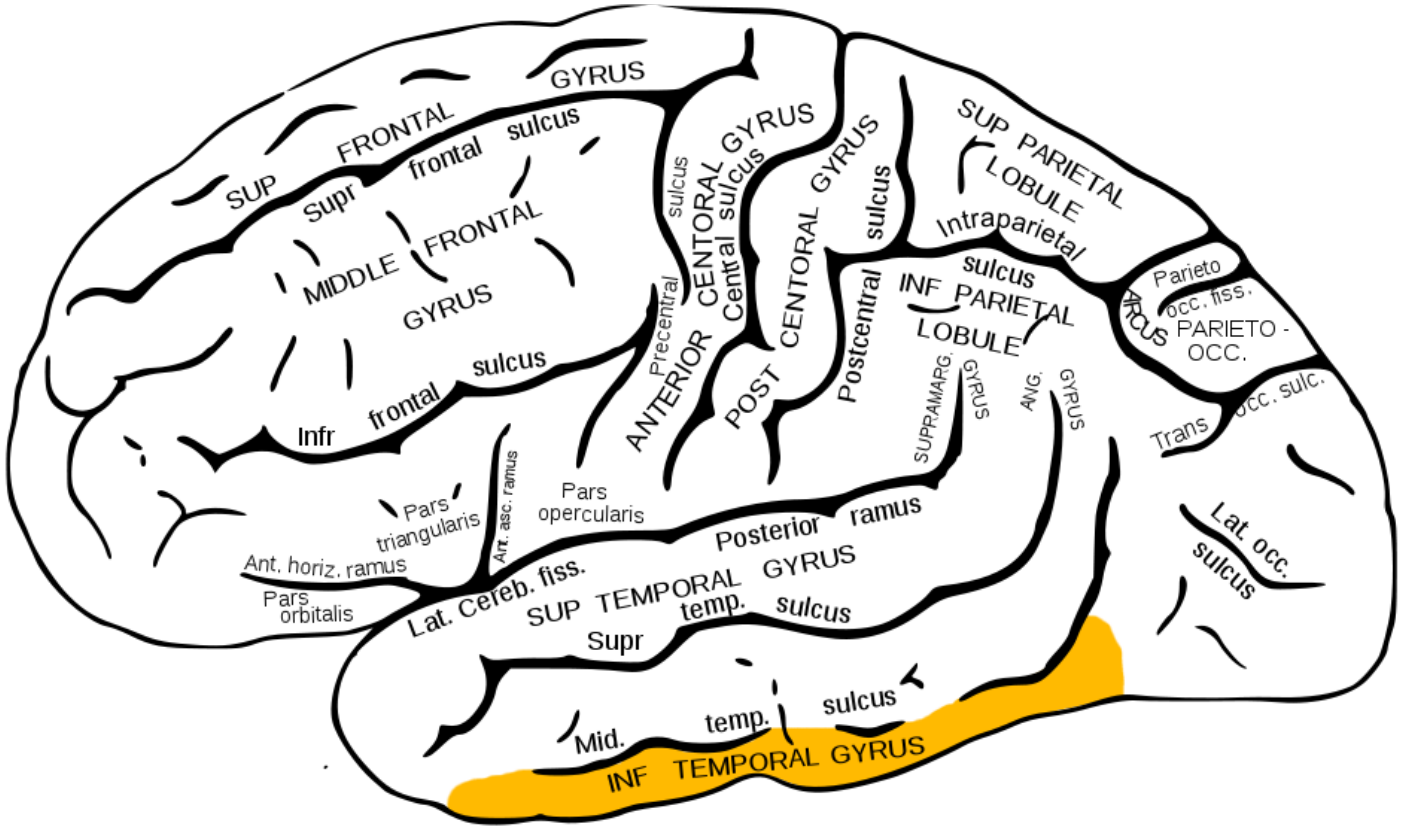
Where is it?

- Ventral to frontal, parietal lobes
- Inferior to lateral fissure ## Temporal lobe

What does it do?

- Primary auditory cortex
- Object, face recognition
- Storage of memories about events, objects
- Amygdala, hippocampus

Inferior Temporal Gyrus (ITG)



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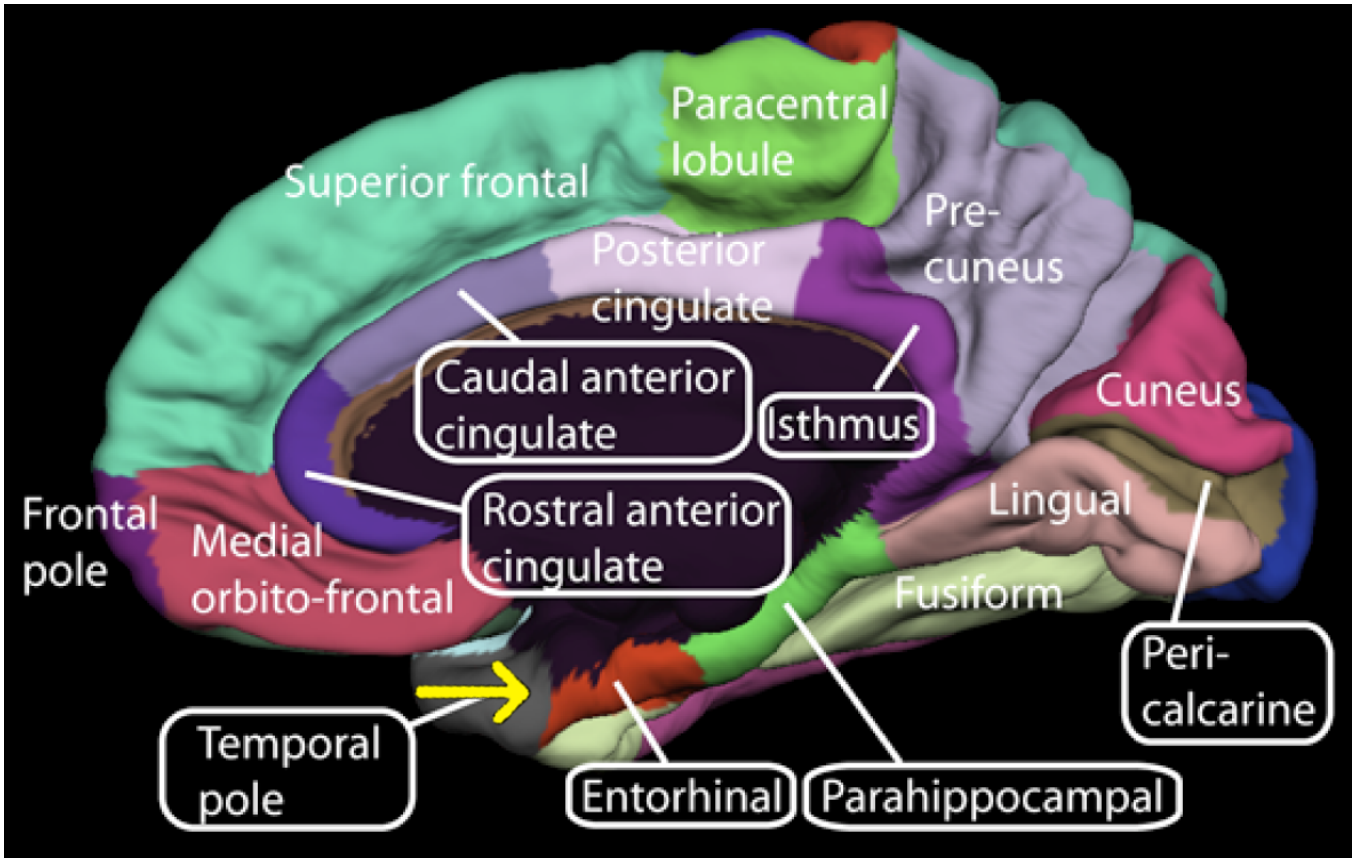
Entorhinal Cortex (ER)



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Parietal lobe

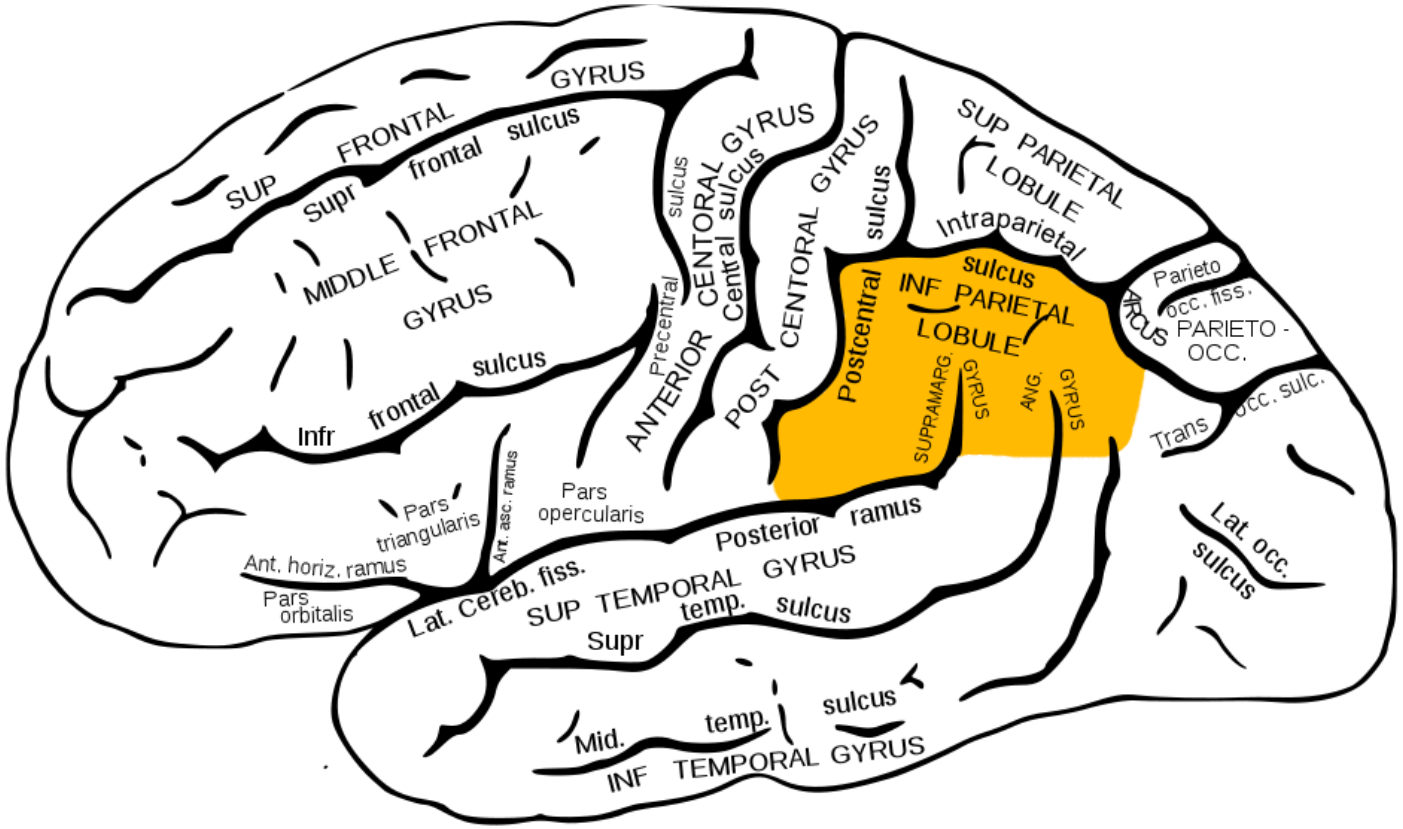
Where is it?

- Caudal to frontal lobe
- Dorsal to temporal lobe
- Posterior to central sulcus

What does it do?

- Primary somatosensory cortex
- Perception of spatial relations, action planning

Inferior Parietal Lobule



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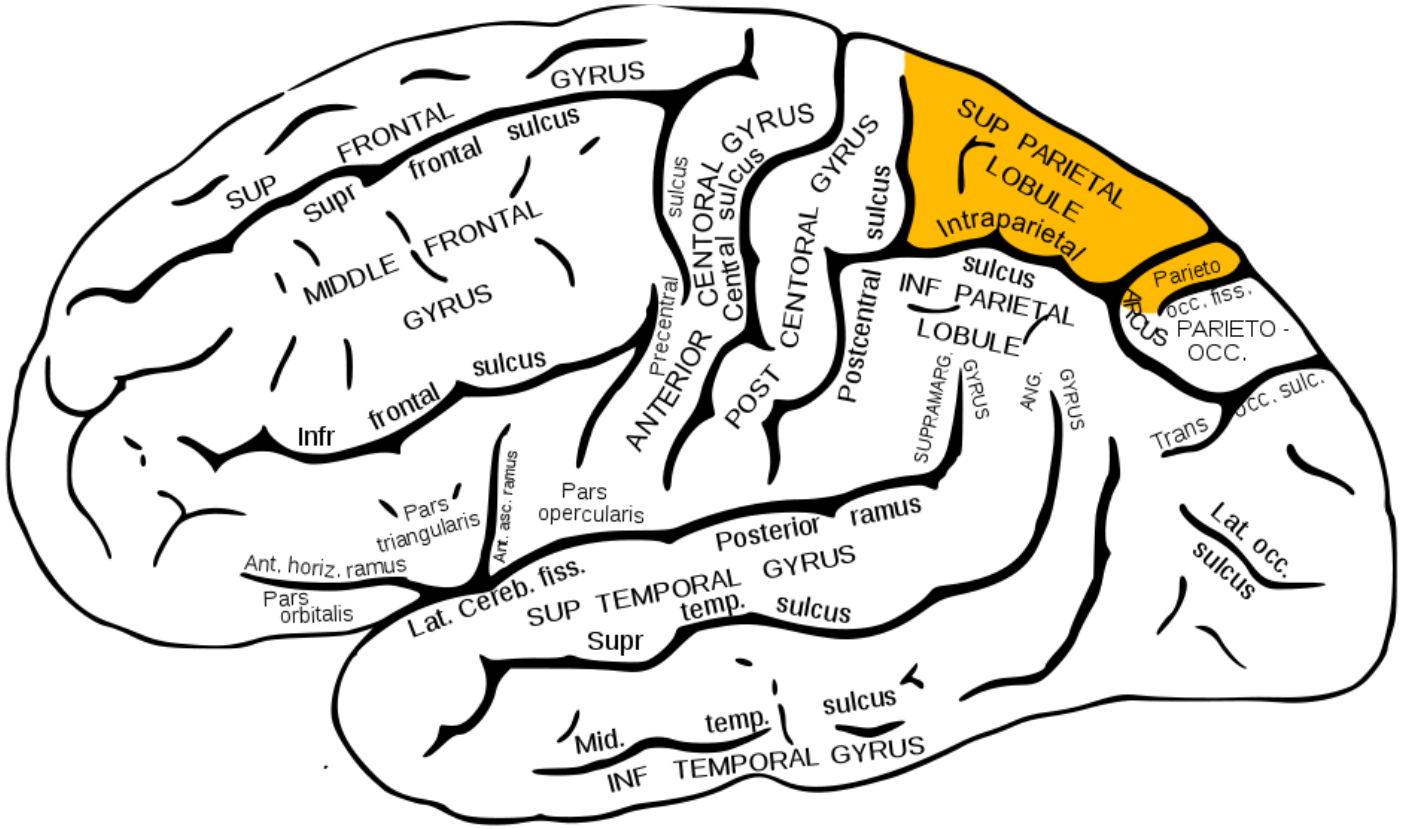
Superior Parietal Lobule



https://upload.wikimedia.org/wikipedia/commons/9/9d/Gray726_superio

Occipital lobe

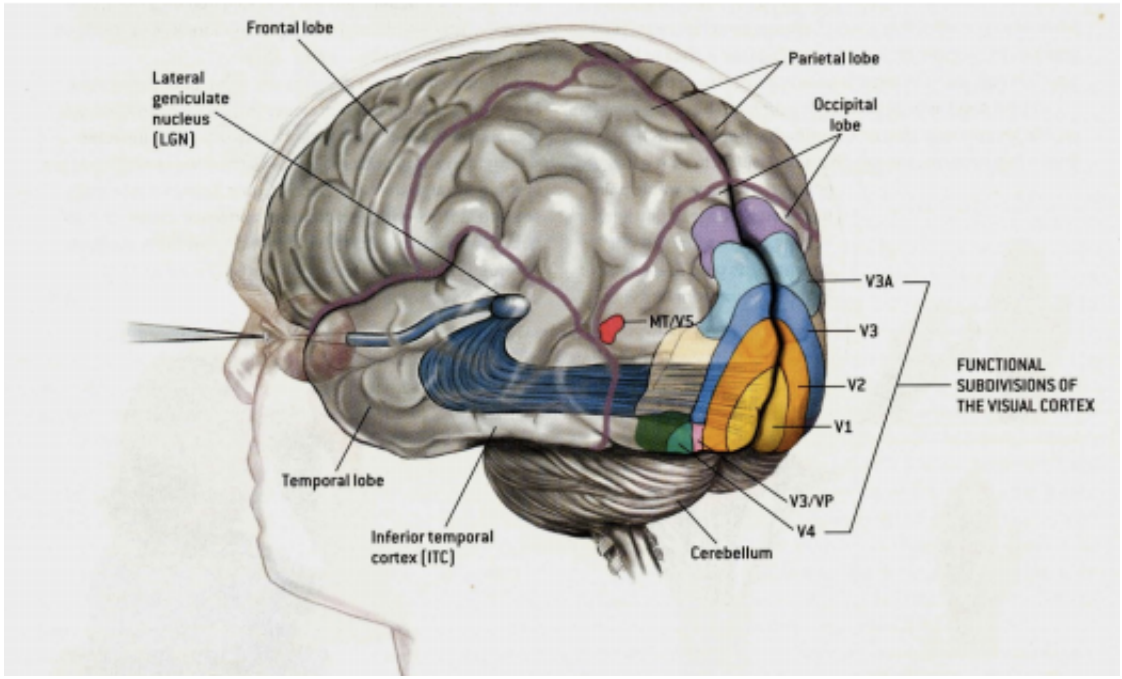
Where is it?

- Caudal to parietal & temporal lobes

What does it do?

- Primary visual cortex (V1)

Visual Cortex



http://bethycotter.wdfiles.com/local–files/introducingtheeye/Screen%20Shot%202012-08-24%20at%2011.36.20%20PM.png

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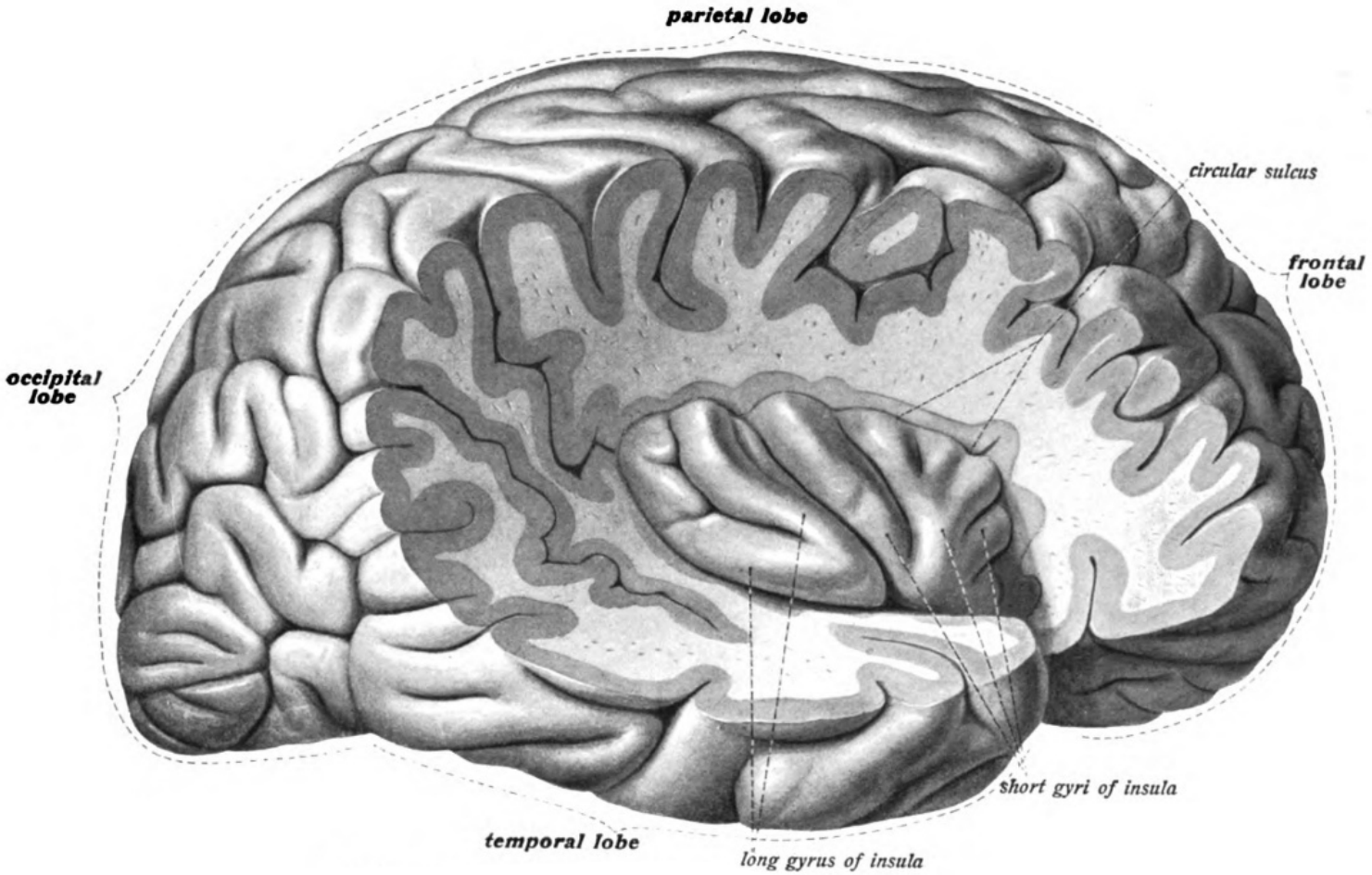
Insular cortex (insula)

Where is it?

- medial to temporal lobe
- deep inside lateral fissure

Insula


parietal lobe
circular sulcus
frontal lobe
occipital lobe
short gyri of insula
temporal lobe
long gyrus of insula

Insula

What does it do?

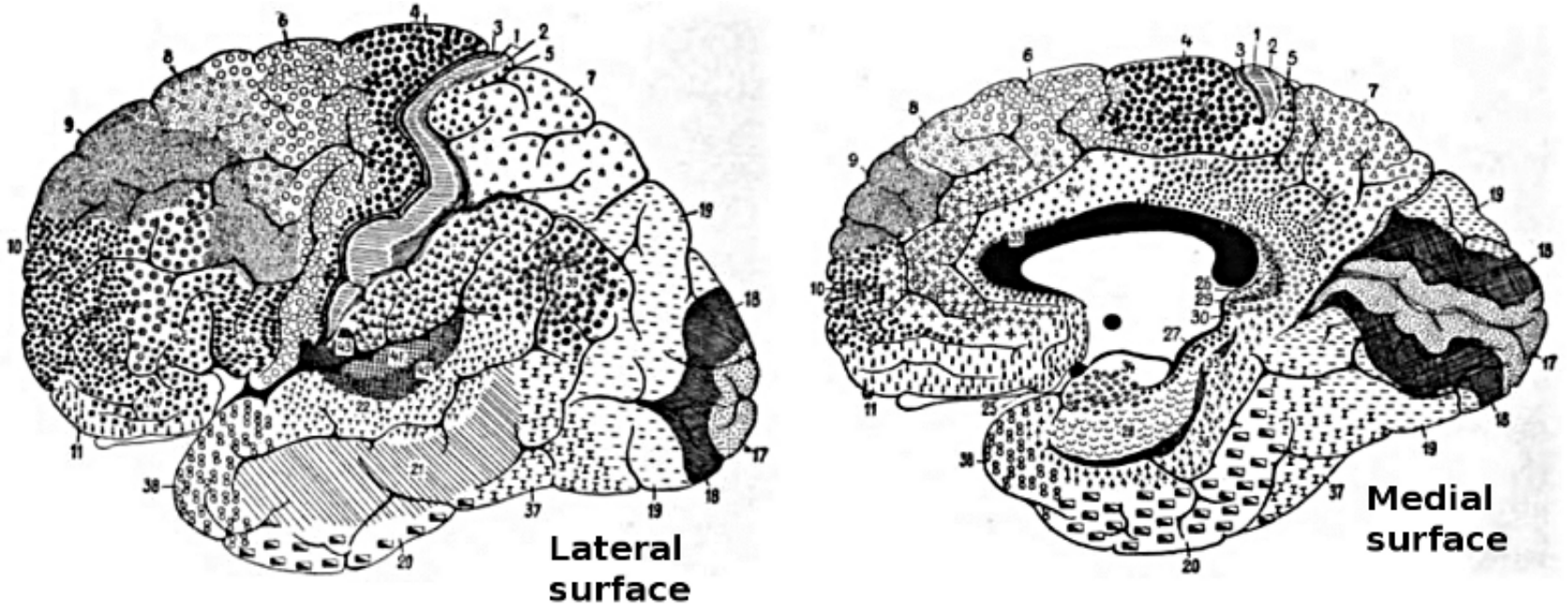
- Primary gustatory cortex
- self-awareness, interpersonal experiences, motor control

Brodmann Areas

Korbinian Brodmann

- Cytoarchitectonic differences in cerebral cortex

Brodmann Areas



https://upload.wikimedia.org/wikipedia/commons/0/09/Brodmann-areas.png

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Brodmann Areas

Spinal cord

Rostral/Caudal axis

- Spinal column w/ vertebrae
- Cervical (8), thoracic (12), lumbar (5), sacral (5), coccygeal (1)
- Spinal segments & 31 nerve pairs
- Cauda equina

Spinal cord

Spinal cord

Organization of the spinal cord

- Dorsal/Ventral
    - Dorsal root (sensory)
    - Ventral root (mostly motor)
- Grey (interior) vs. white matter (exterior)

Spinal Cord

Organization of the PNS

Somatic division

Autonomic

Cranial nerves

Spinal nerves

Cranial nerves

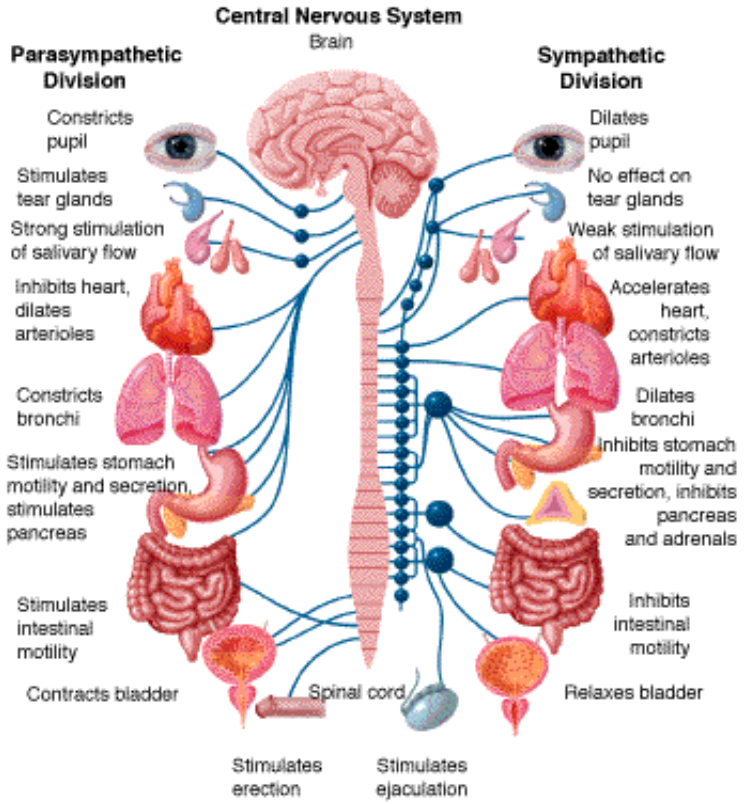
- Afferents (input), efferents (output), or mixed
- Innervate head and neck
- Olfactory (I), ocular (II), (VIII) auditory, vagus (X), etc.
- Spinal nerves

Cranial nerves

Autonomic nervous system

- CNS & PNS components
- Controls “vegetative functions”
  - Limited voluntary control
- Two divisions
  - Sympathetic
  - Parasympathetic

ANS



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Sympathetic division

- Prepares body for action
- “Fight or flight”
- Spinal cord
    - ganglion chain along spinal column to End organs
- NTs
    - Preganglionic:ACh
    - Post: NE

Parasympathetic division

- “Around” sympathetic
- Restorative function
- “Rest & digest”
- Spinal cord -> ganglia near end organs -> end organ
    - NT:ACh

References

LeDoux, Joseph. 2015. “The Amygdala Is NOT the Brain’s Fear Center.” *Psychology Today*. https://www.psychologytoday.com/blog/i-got-mind-tell-you/201508/the-amygdala-is-not-the-brains-fear-center.

Xie, Lulu, Hongyi Kang, Qiwu Xu, Michael J Chen, Yonghong Liao, Meenakshisundaram Thiyagarajan, John O’Donnell, et al. 2013. “Sleep Drives Metabolite Clearance from the Adult Brain.” *Science* 342 (6156). American Association for the Advancement of Science: 373–77. doi:10.1126/science.1241224.