3-31-anatomy

Brain anatomy through dance

Finding our way around

Anterior/Posterior

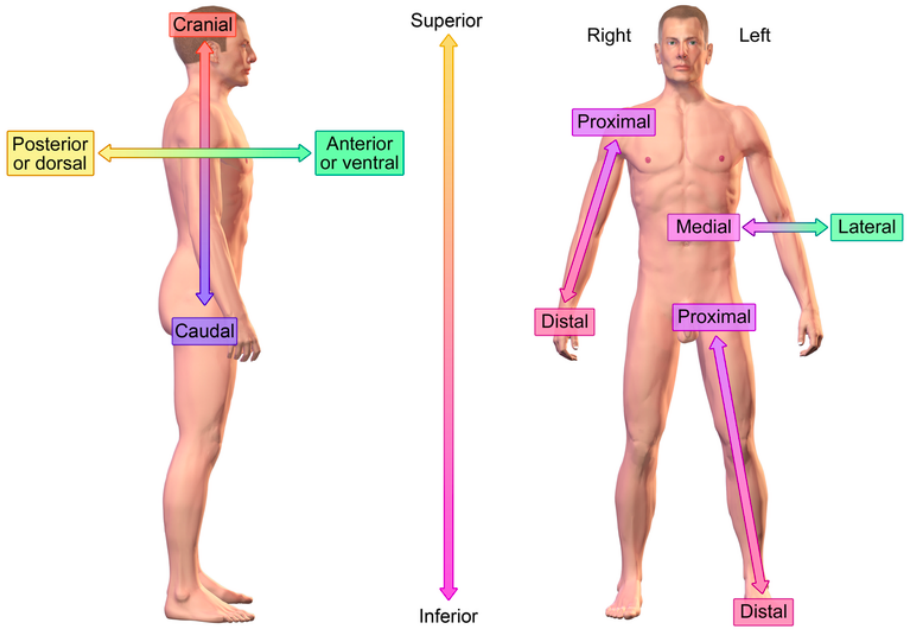
Medial/Lateral

Superior/Inferior

Dorsal/Ventral

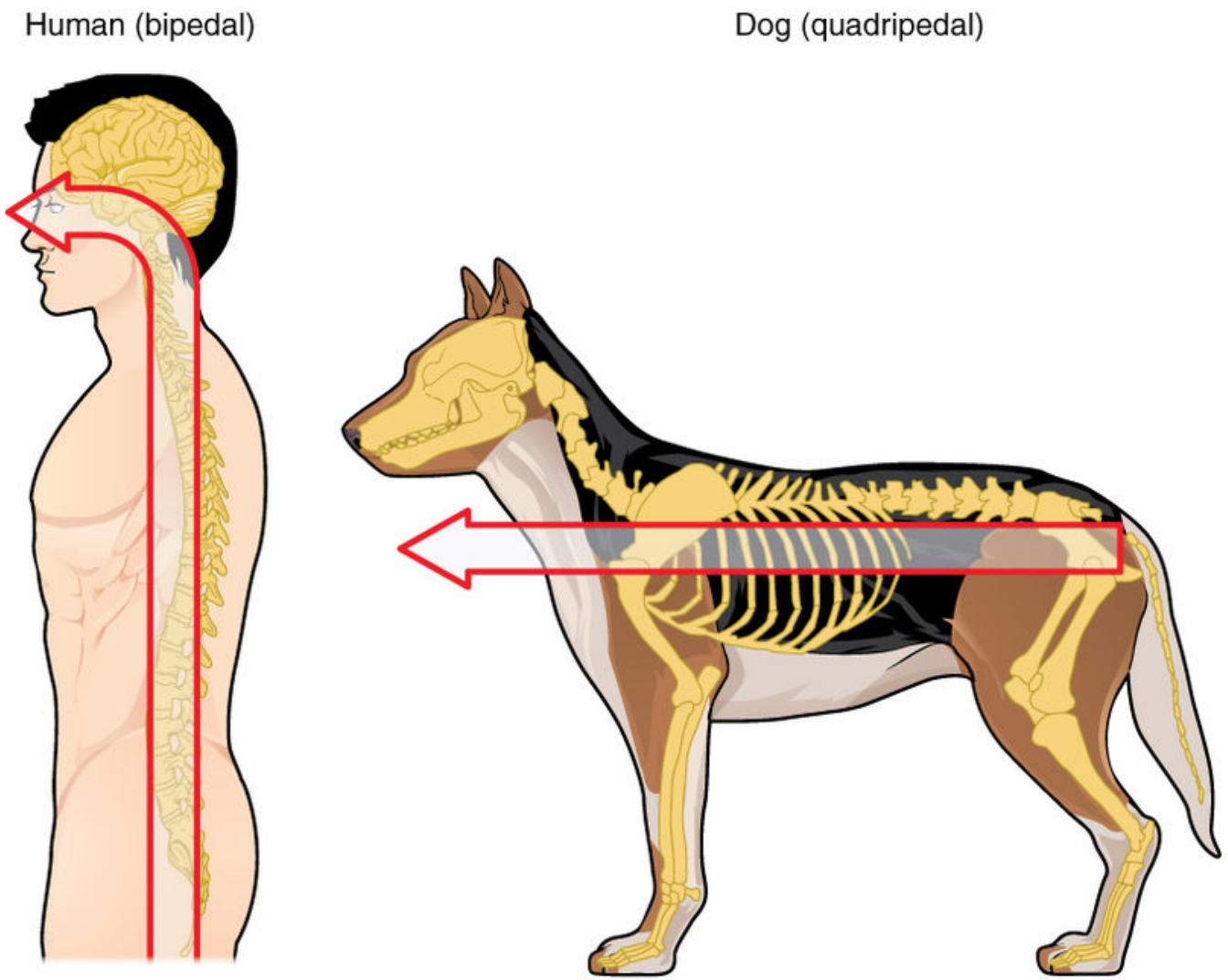
Rostral/Caudal

Directional image



https://upload.wikimedia.org/wikipedia/commons/thumb/e/e7/Blausen_0019_AnatomicalDirectionalReferences.png

Bipeds vs. quadripeds



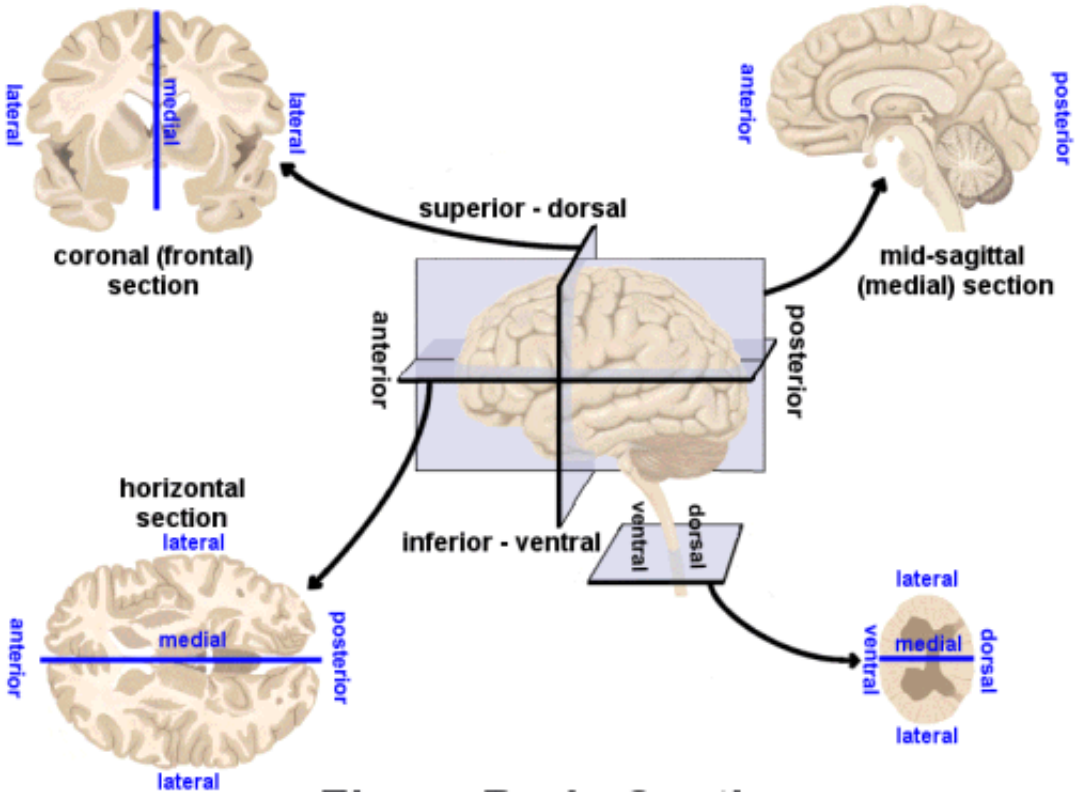
No matter how you slice it

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

Supporting structures

Meninges

Ventricular system

Blood supply

Meninges

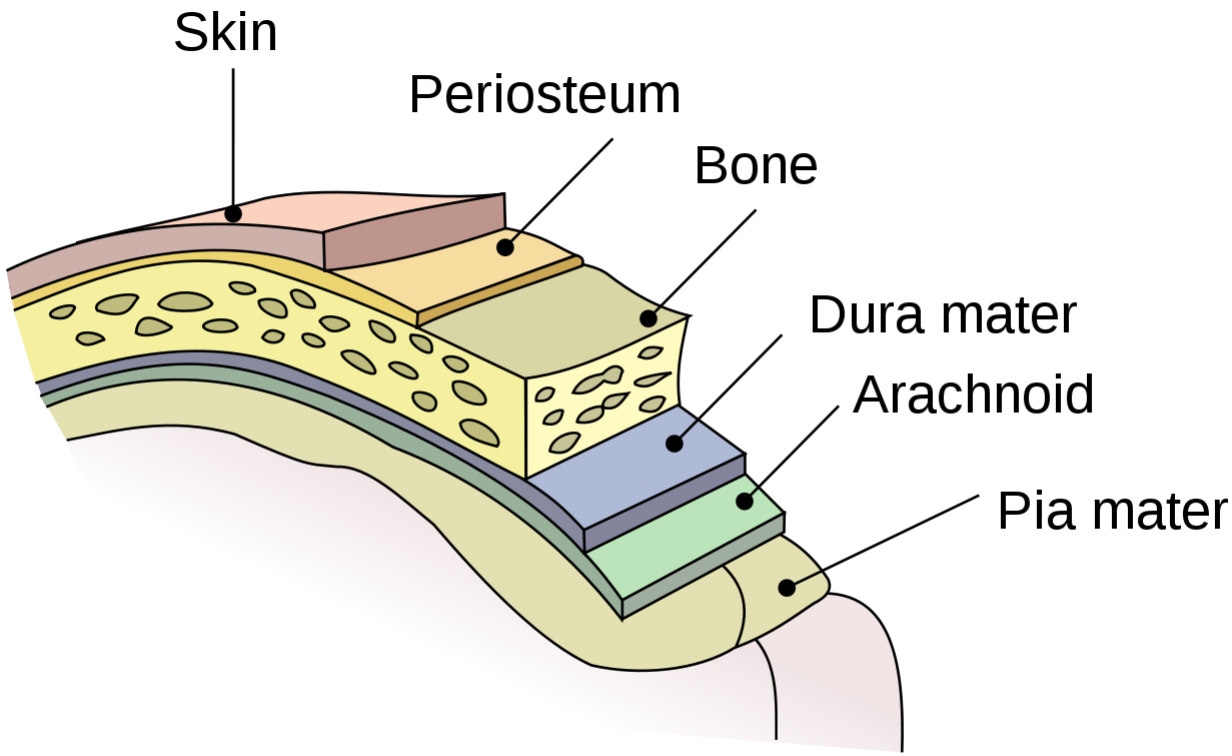
Dura mater

Arachnoid membrane

Subarachnoid space

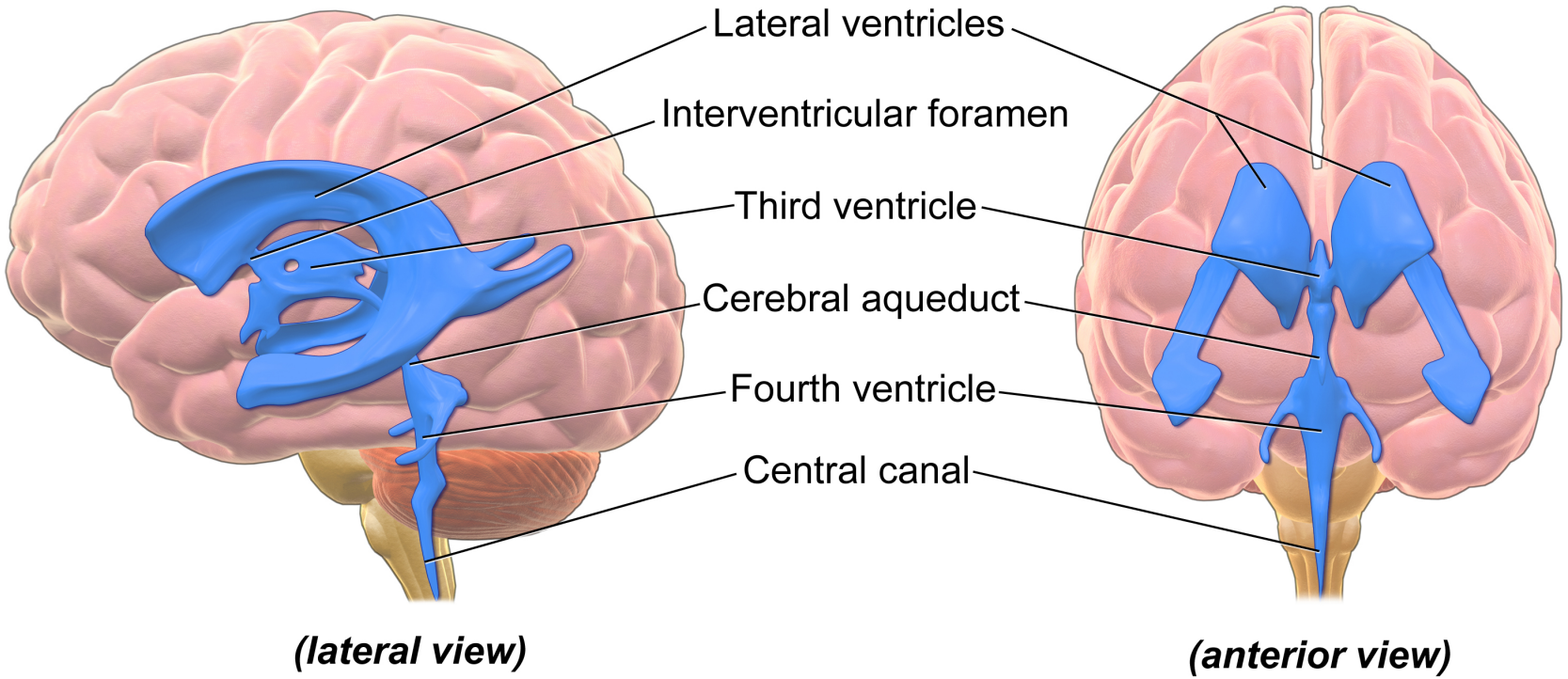
Pia mater

Meninges



https://upload.wikimedia.org/wikipedia/commons/thumb/8/8e/Meninge
en.svg/1280px-Meninges-en.svg.png

Ventricular system



https://upload.wikimedia.org/wikipedia/commons/d/d4/Blausen_0896_

Ventricles

Lateral (1st & 2nd)

3rd

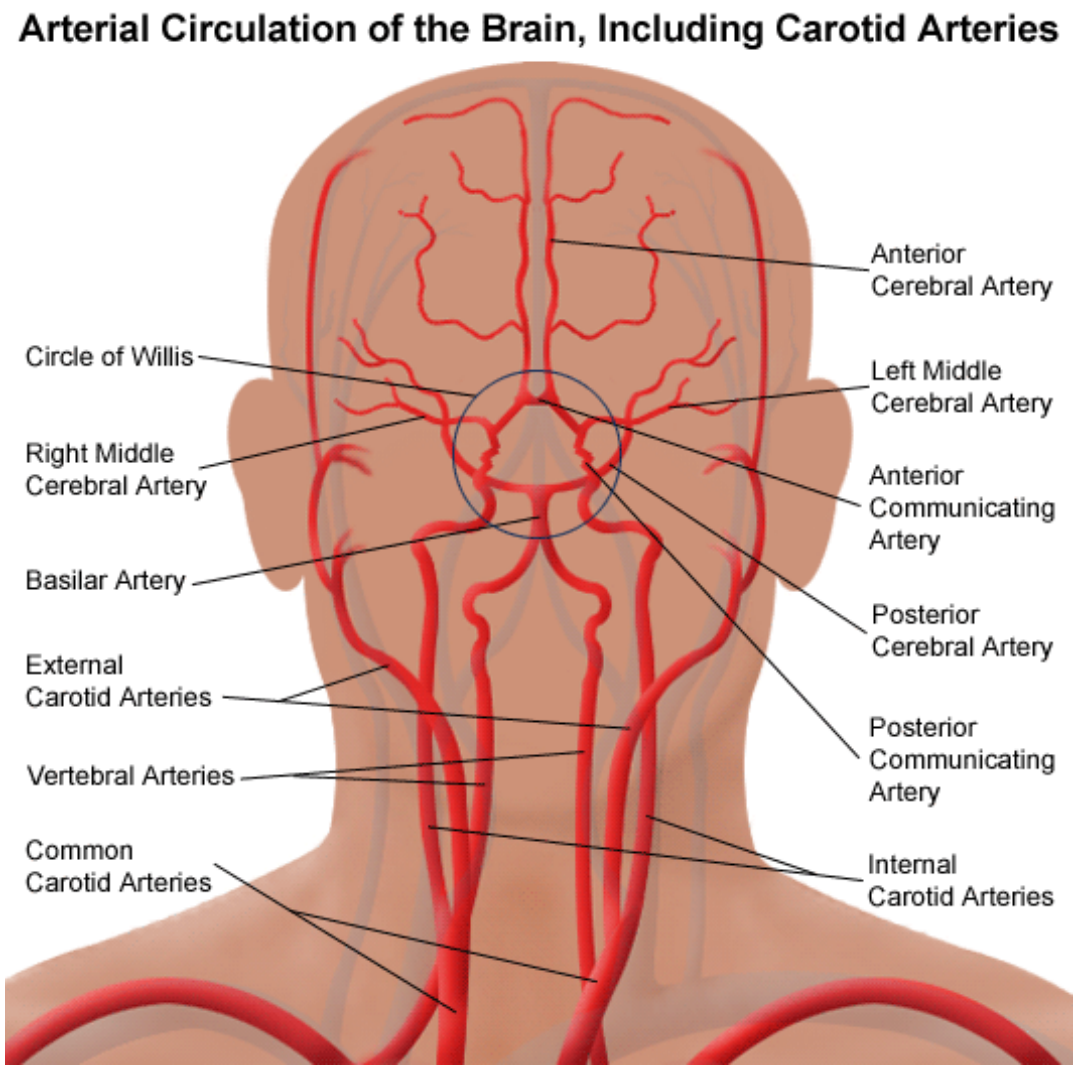
Cerebral aqueduct

4th

Cerebrospinal fluid (CSF)

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

Blood Supply



Blood Supply

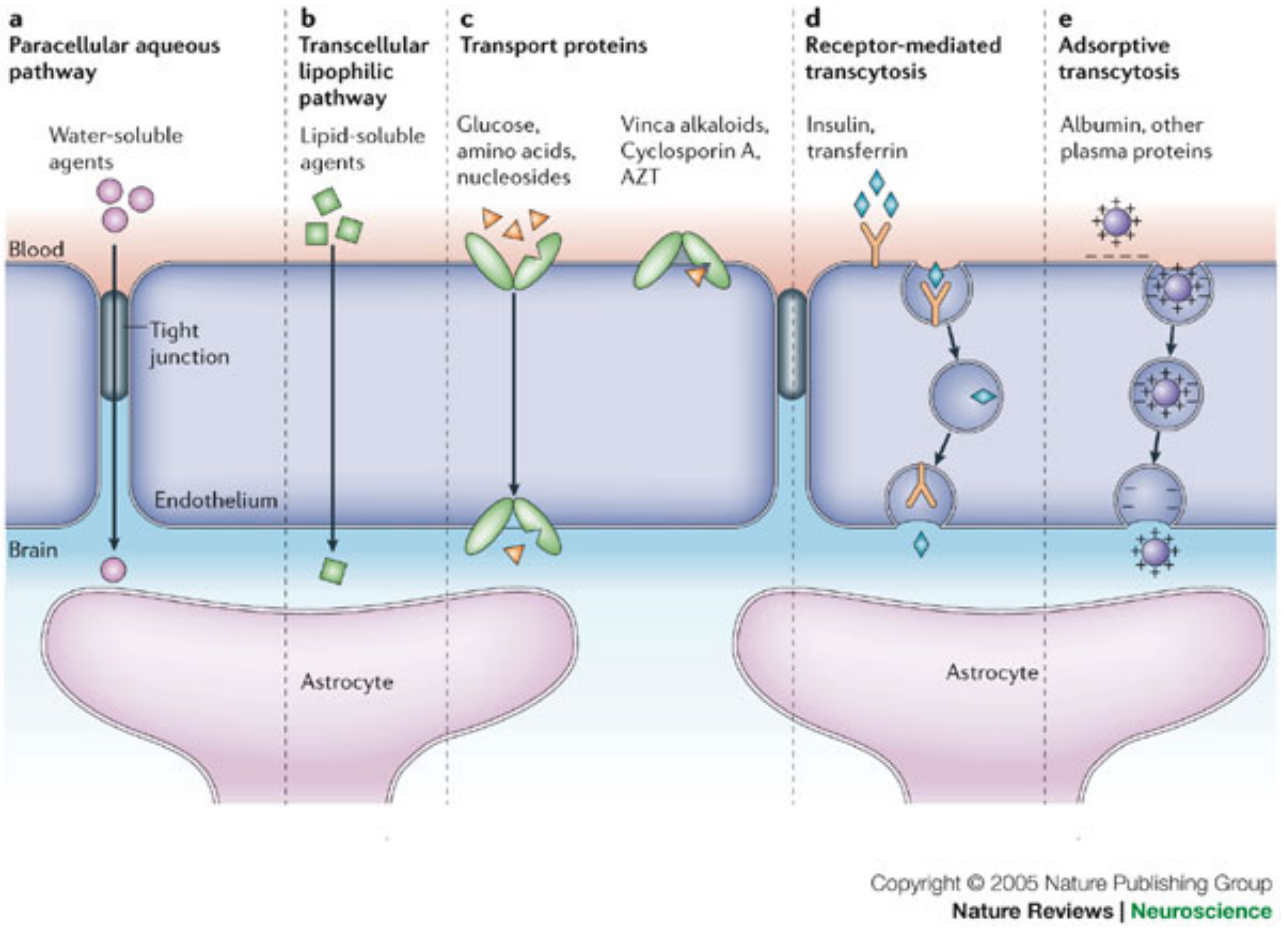
Arteries

- Circle of Willis

Blood/brain barrier

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

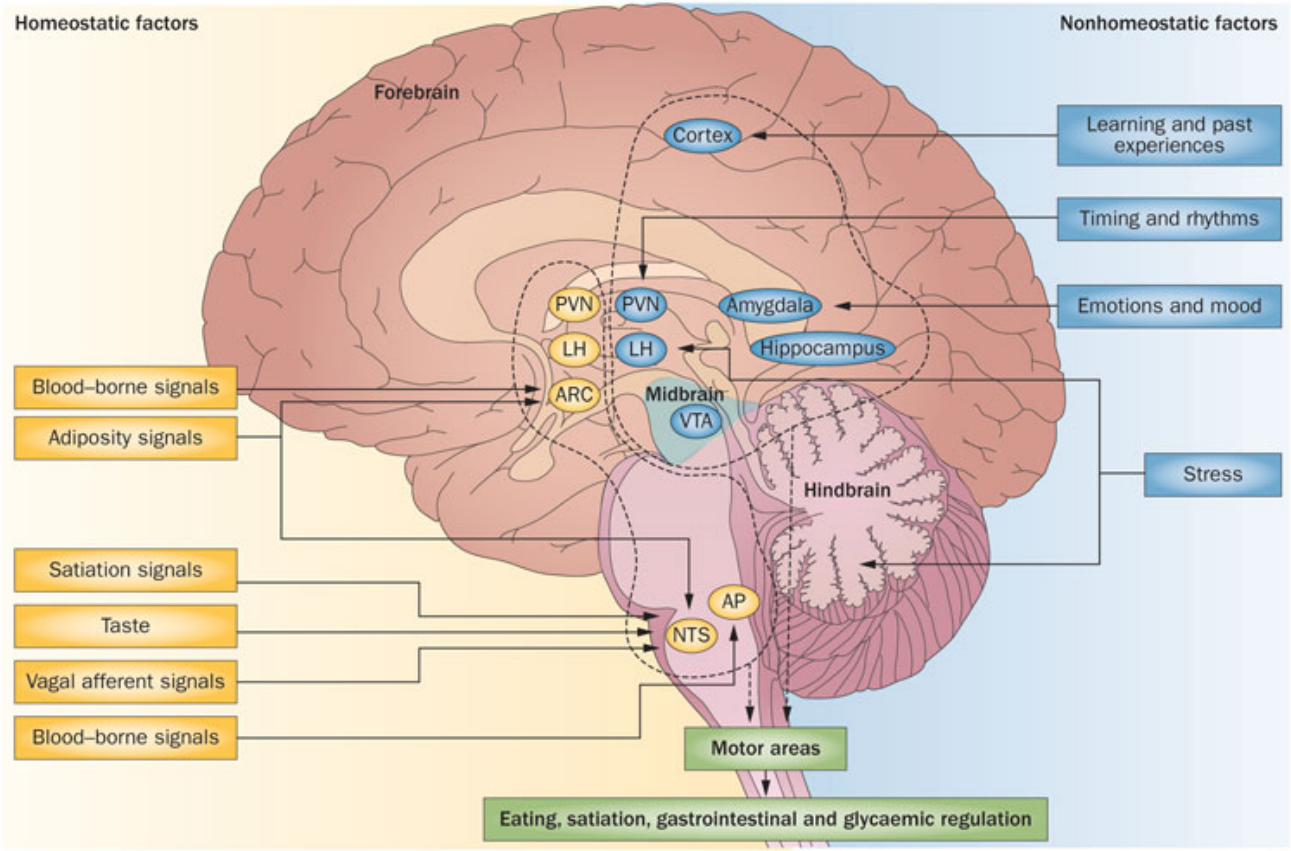
Blood/brain barrier



http://www.nature.com/nrn/journal/v7/n1/images/nrn1824-f3.jpg

Area Postrema

- Brainstem, blood-brain barrier thin



http://www.nature.com/nrendo/journal/v9/n10/images/nrendo.2013.13

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

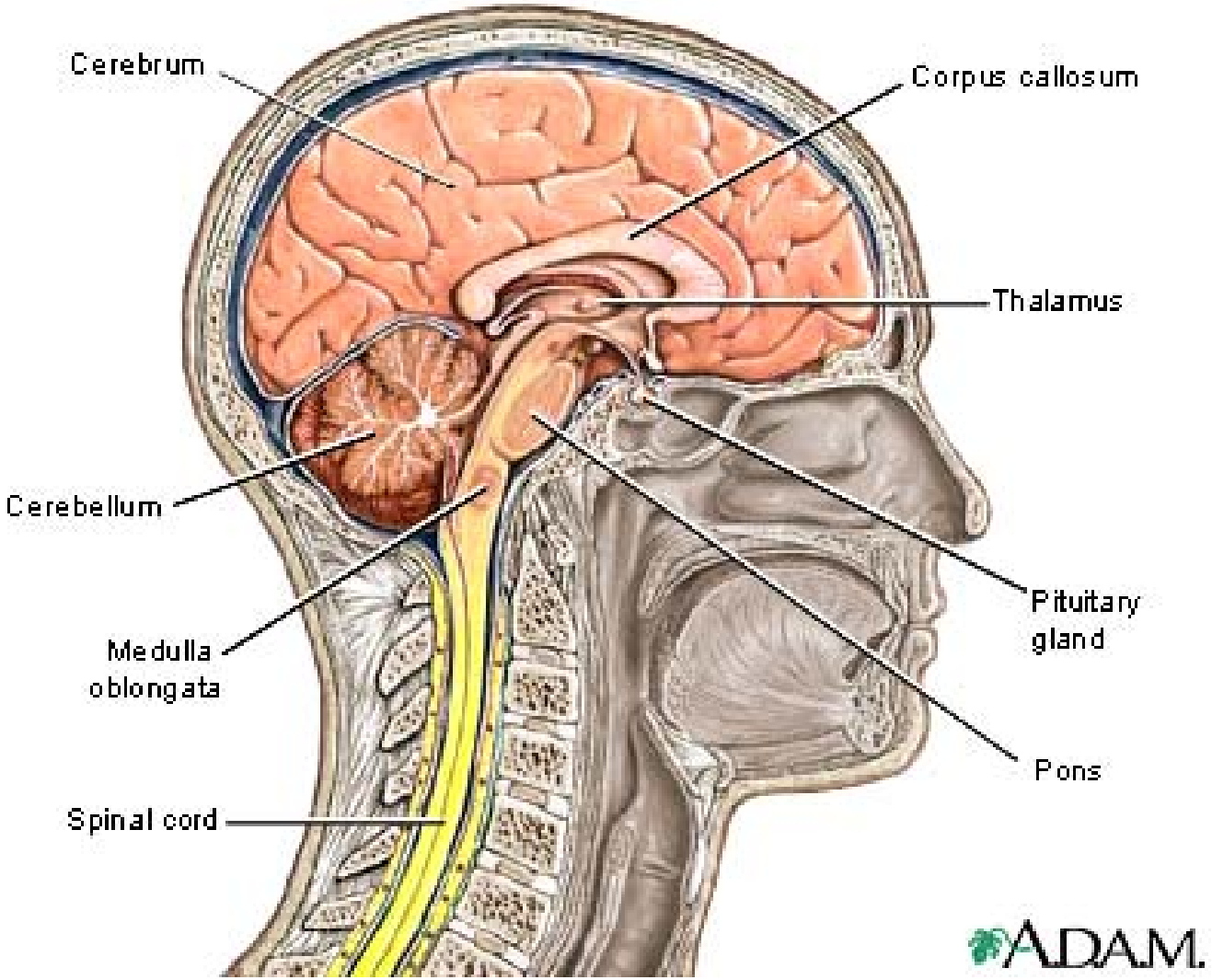
Major division	Ventricular Landmark	Embryonic Division	Structure
Hindbrain	4th	Metencephalon	Cerebellum, pons
	–	Mylencephalon	Medulla oblongata

Hindbrain

Structures adjacent to 4th ventricle

- Medulla oblongata
- Cerebellum
- Pons

Medulla oblongata



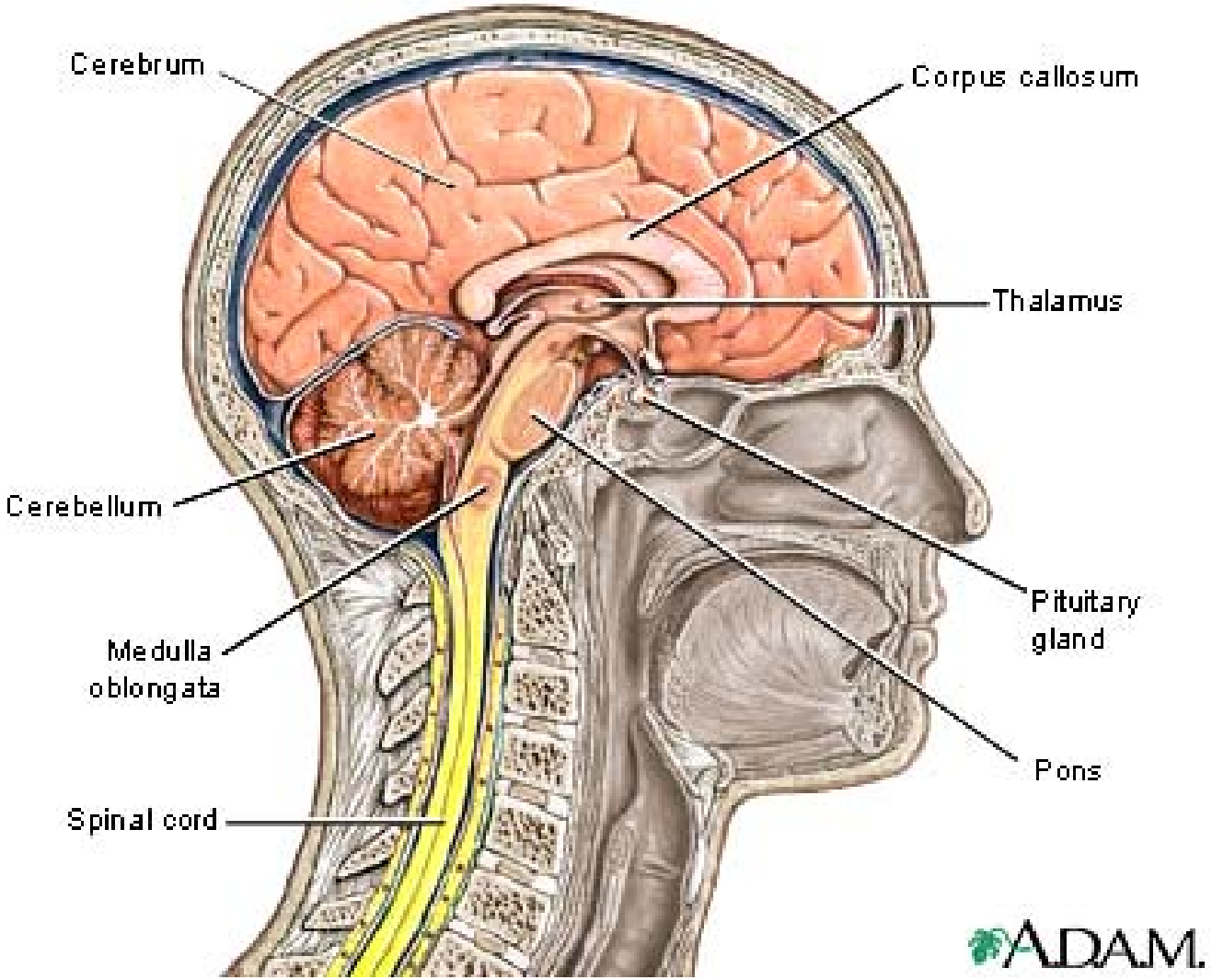
Medulla

- Cardiovascular regulation
- Muscle tone
- Fibers of passage

Cerebellum

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

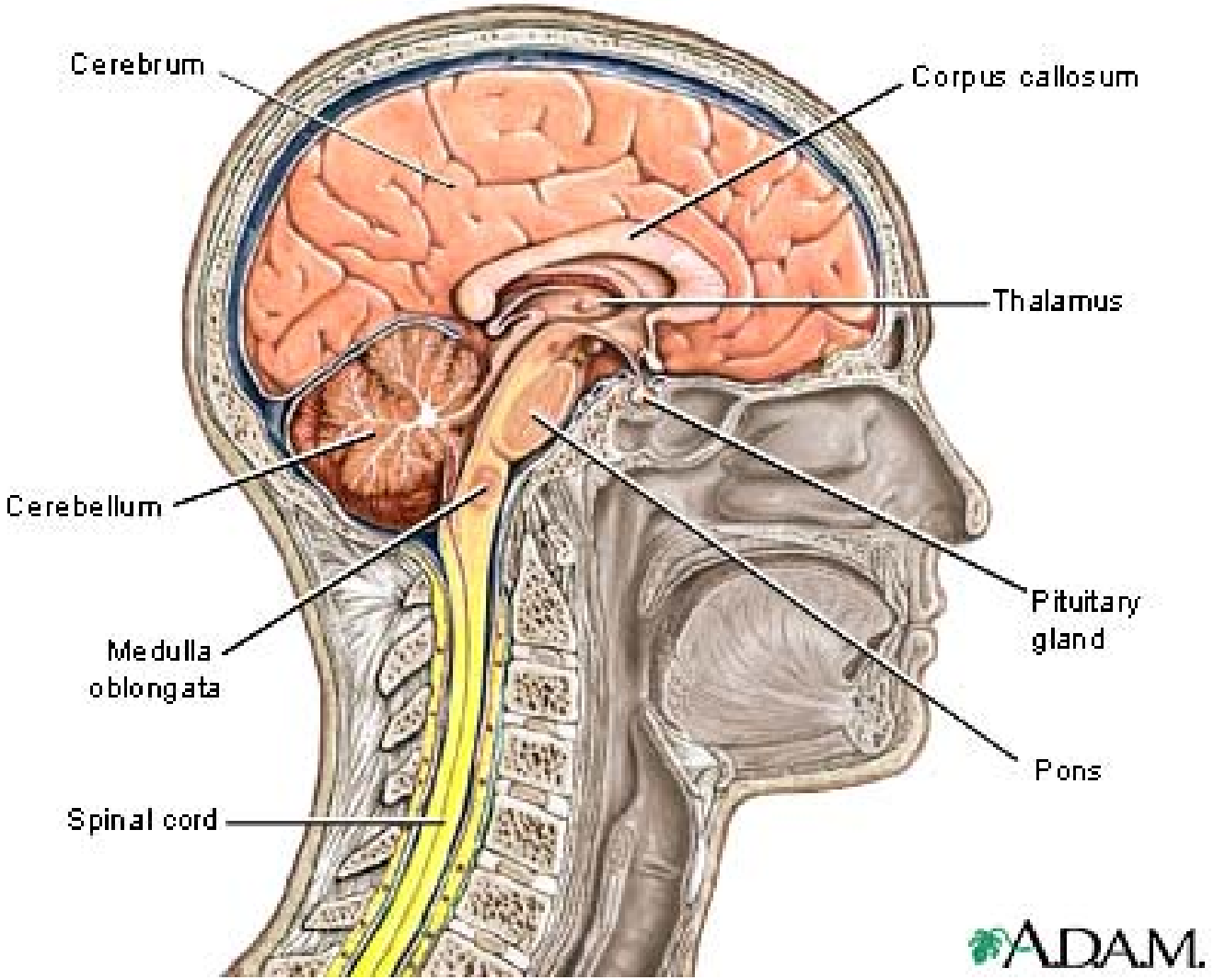
Hindbrain


Cerebrum
Corpus callosum
Thalamus
Cerebellum
Pituitary gland
Medulla oblongata
Pons
Spinal cord
A.D.A.M.

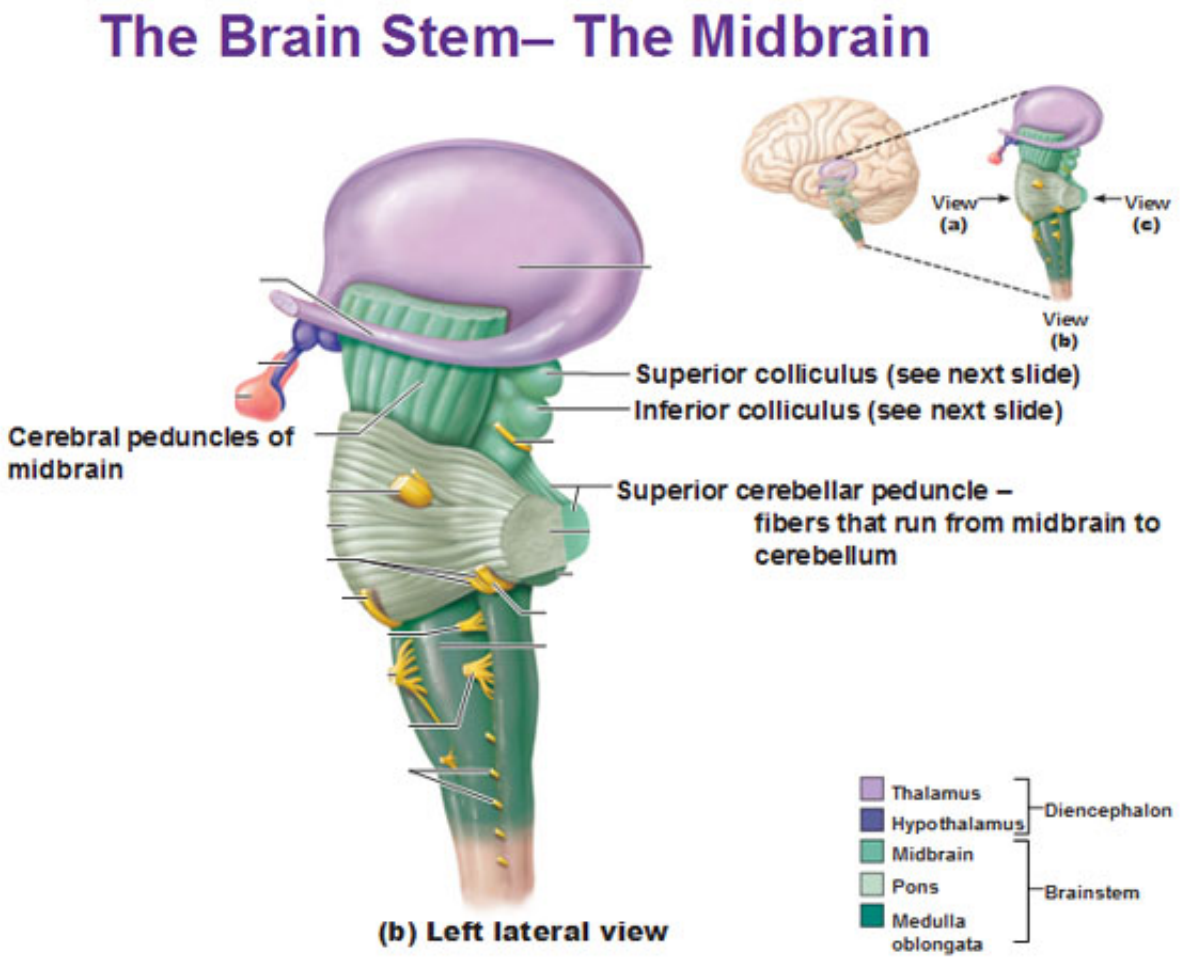
Pons

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

Hindbrain


Cerebrum
Corpus callosum
Thalamus
Cerebellum
Pituitary gland
Medulla oblongata
Pons
Spinal cord
A.D.A.M.

Midbrain



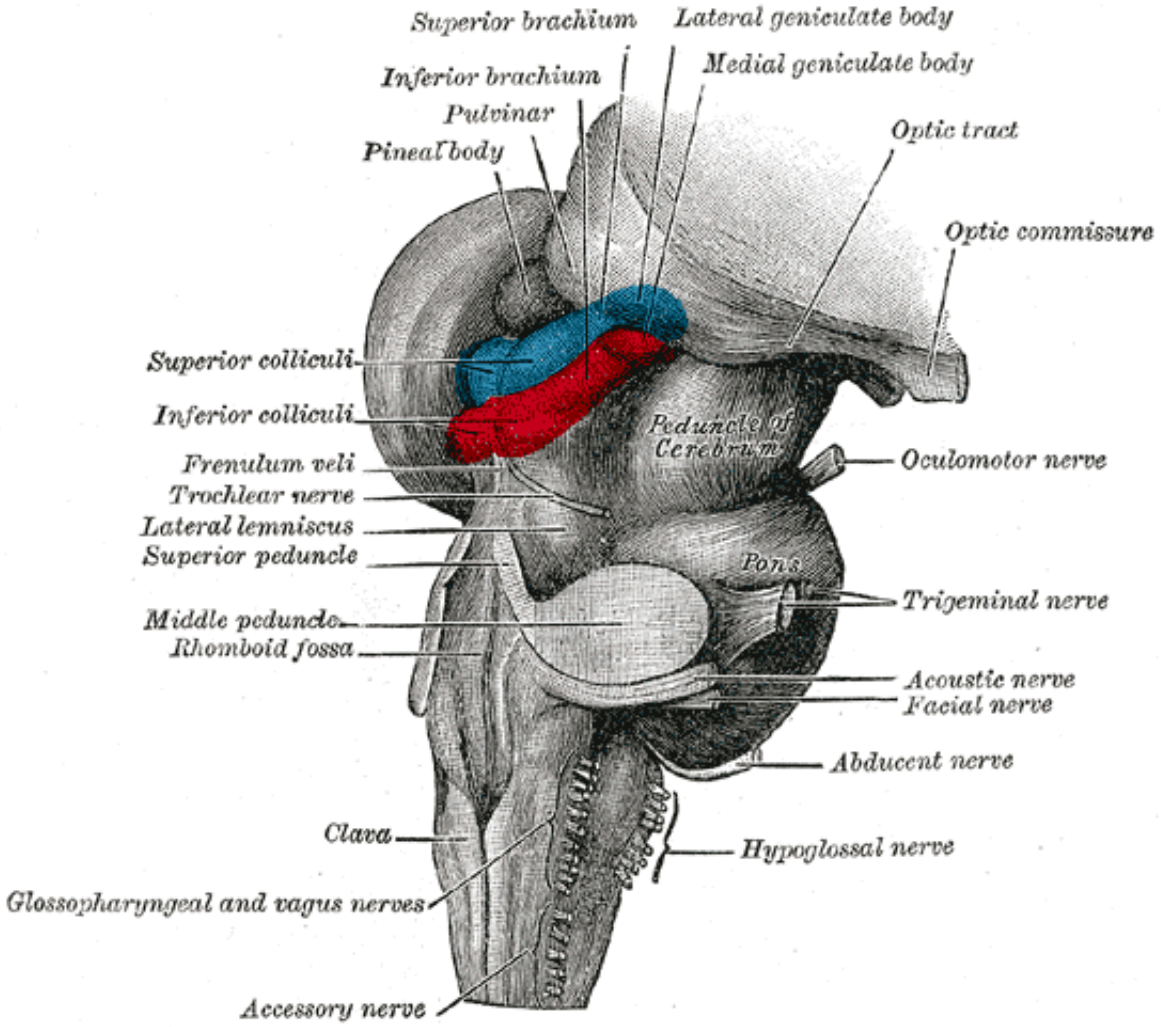
http://antranik.org/wp-content/uploads/2011/11/the-brain-stem.

Midbrain components

Tectum

Tegmentum

Tectum


Superior brachium
Lateral geniculate body
Inferior brachium
Medial geniculate body
Pulvinar
Optic tract
Pineal body
Optic commissure
Superior colliculi
Inferior colliculi
Peduncle of Cerebrum
Oculomotor nerve
Frenulum veli
Trochlear nerve
Lateral lemniscus
Superior peduncle
Pons
Trigeminal nerve
Middle peduncle
Rhomboid fossa
Acoustic nerve
Facial nerve
Abducent nerve
Clava
Hypoglossal nerve
Glossopharyngeal and vagus nerves
Accessory nerve

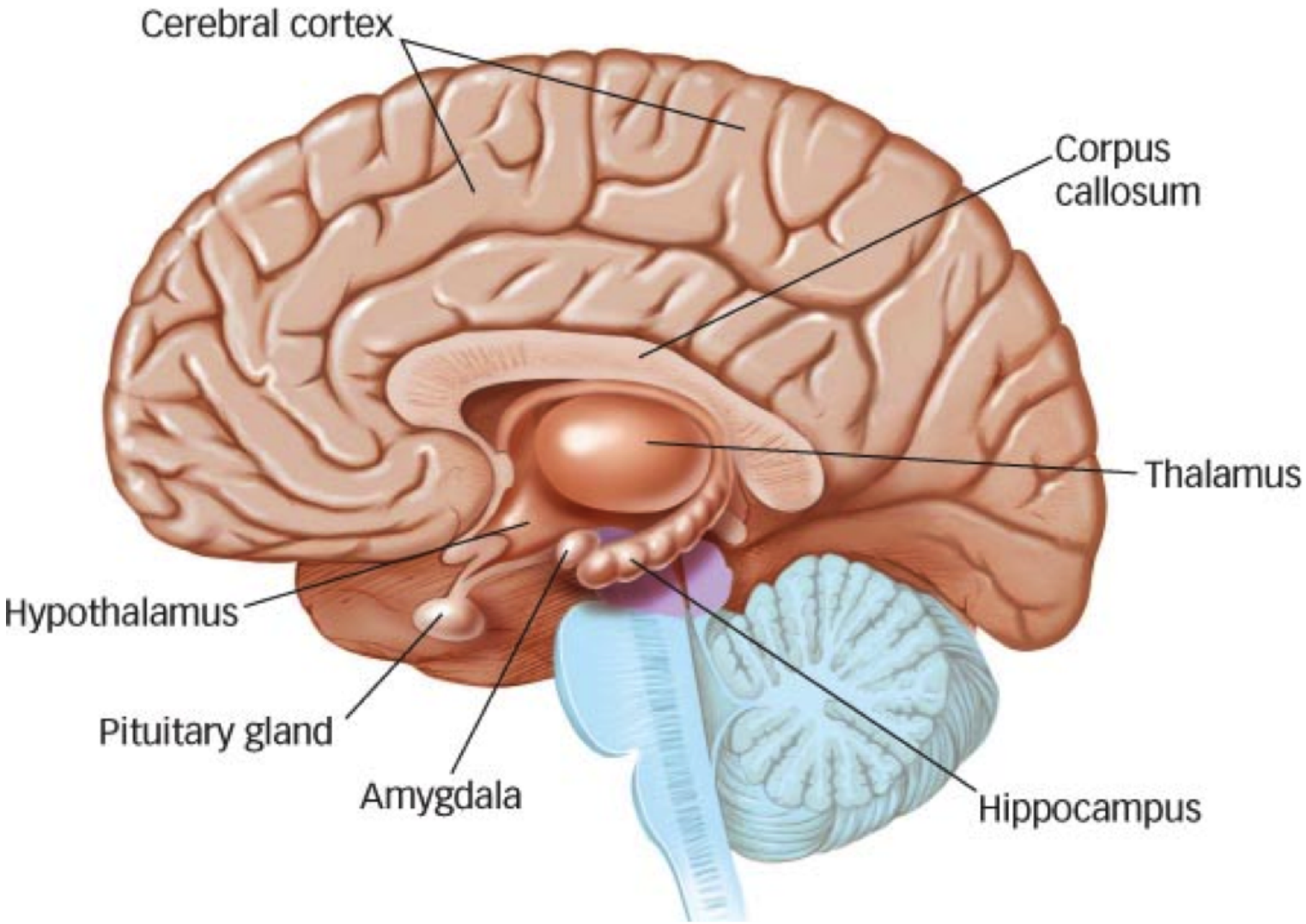
Tectum

- 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

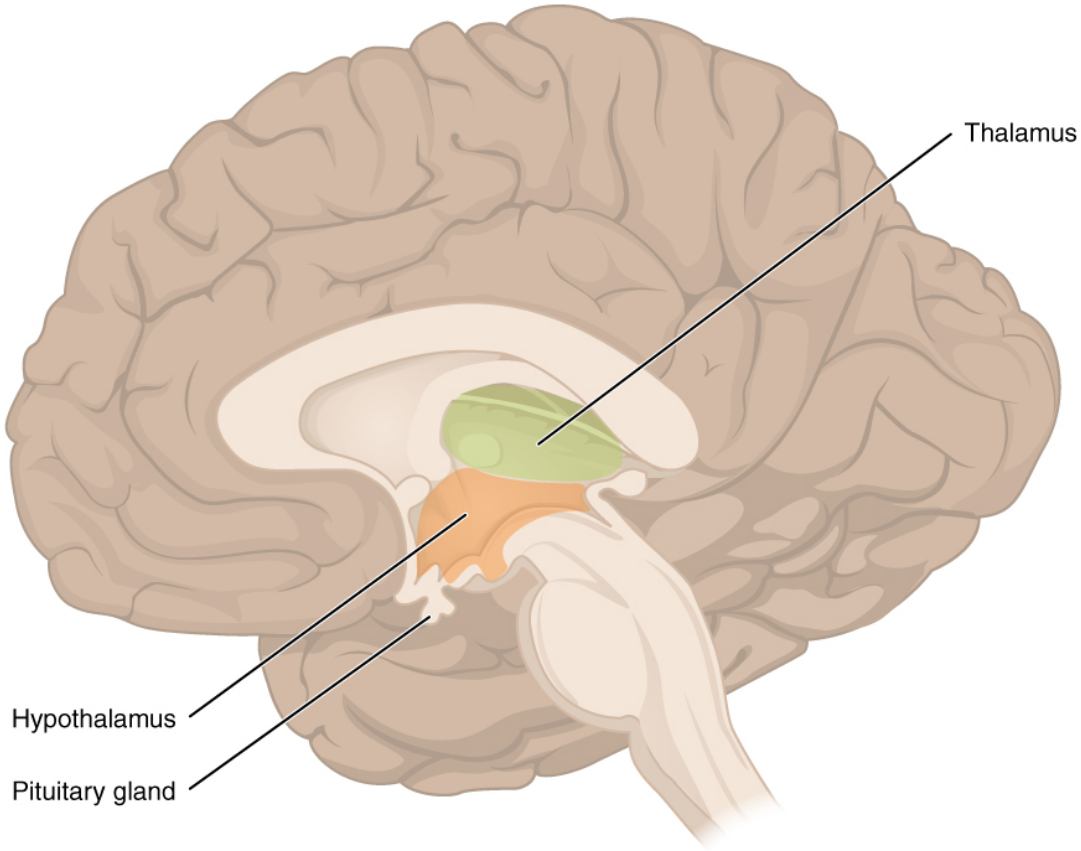

Cerebral cortex
Corpus callosum
Thalamus
Hypothalamus
Pituitary gland
Amygdala
Hippocampus

Forebrain Components

Diencephalon

Telencephalon

Diencephalon

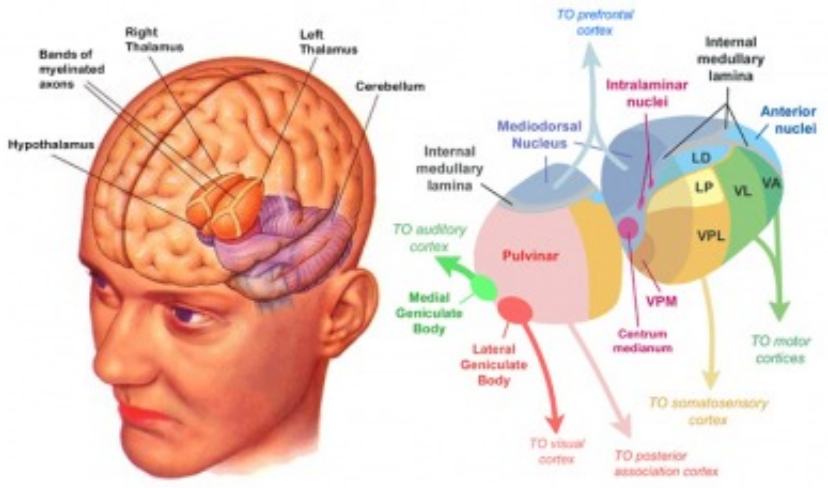


https://upload.wikimedia.org/wikipedia/commons/a/a0/1310_Dienceph

Diencephalon Components

- Thalamus
- Hypothalamus

Thalamus



http://neurobiologychapter3.weebly.com/uploads/1/4/1/8/1418733/511401x231

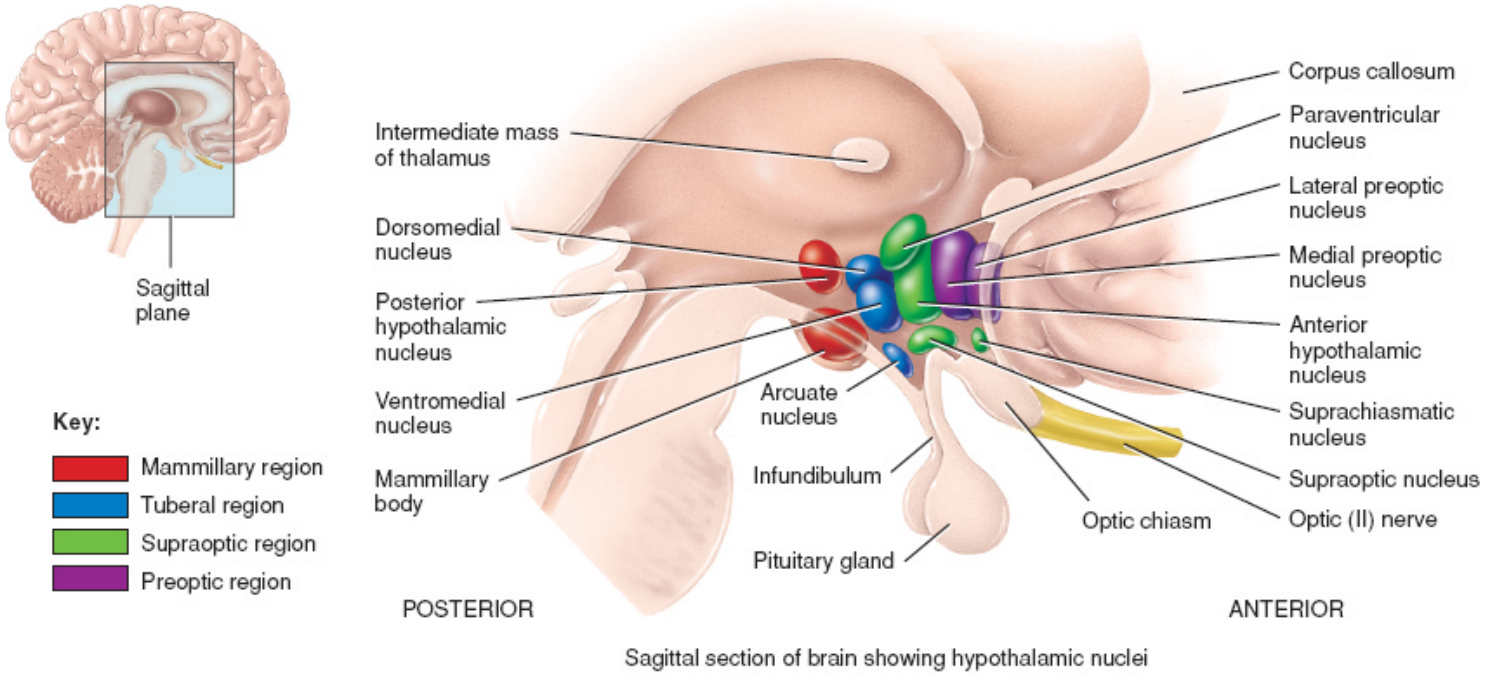
Thalamus functions

- 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/heart

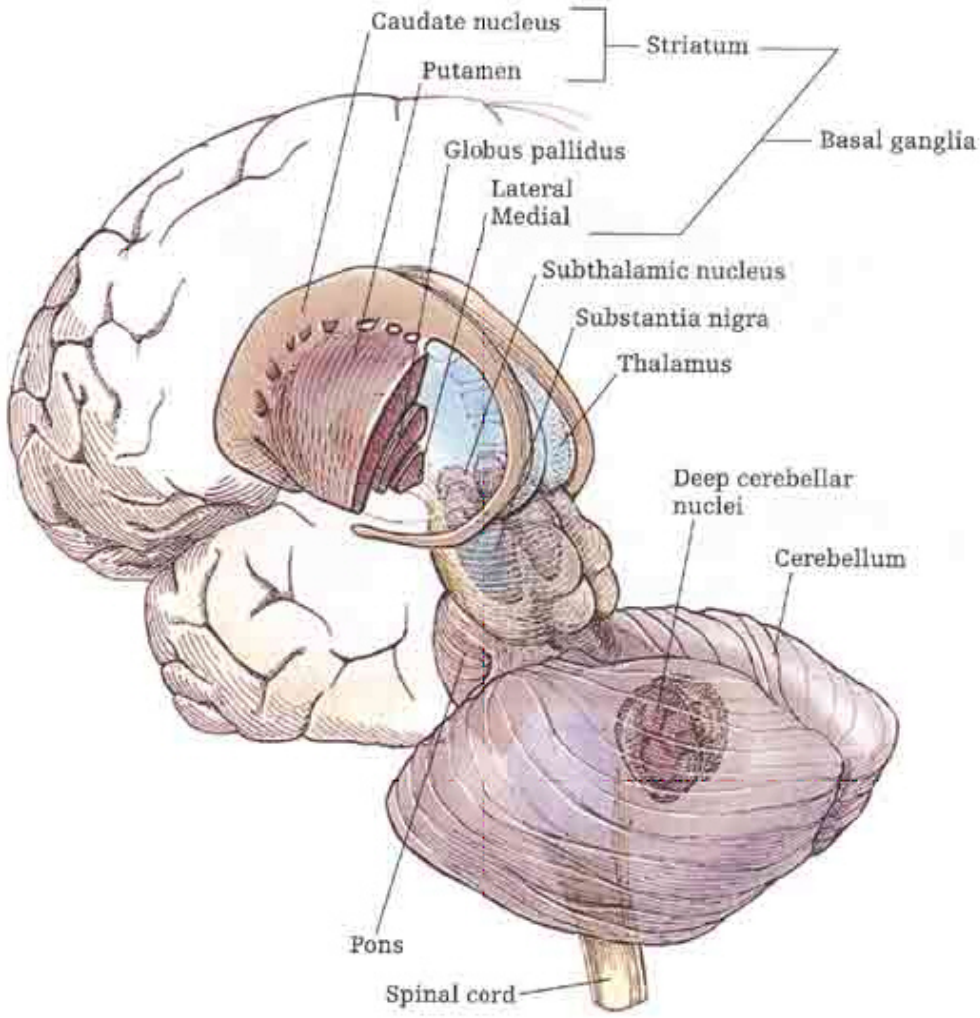
Telencephalon

- Basal ganglia
- Hippocampus, amygdala
- Cerebral cortex

Basal ganglia

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

Basal ganglia



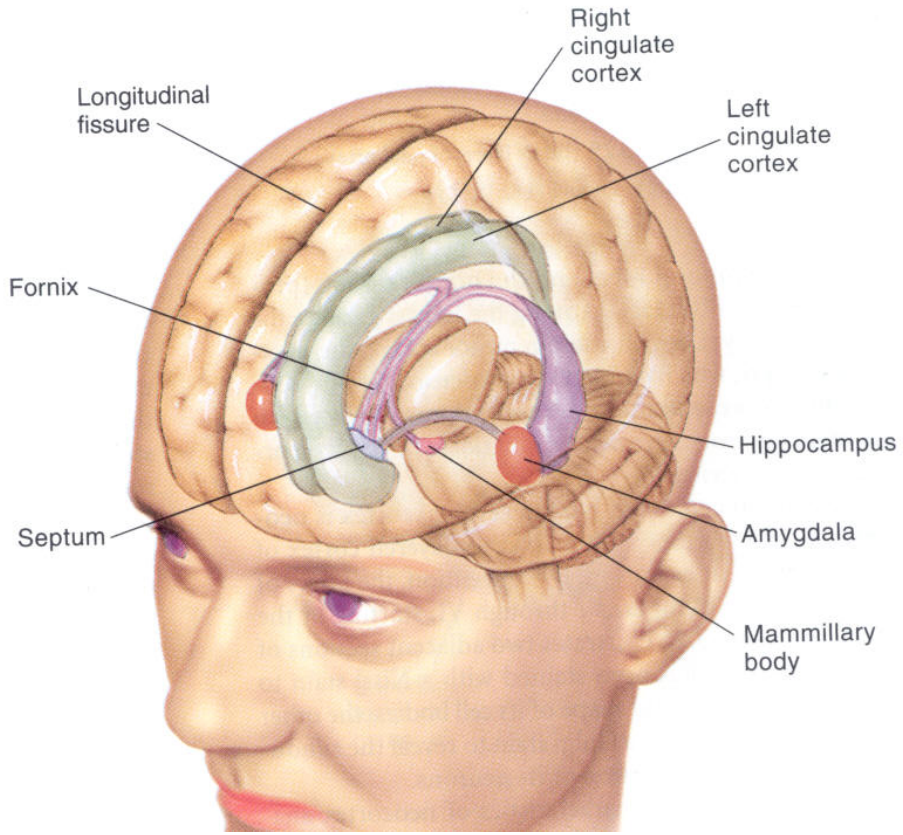
Basal ganglia

- 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

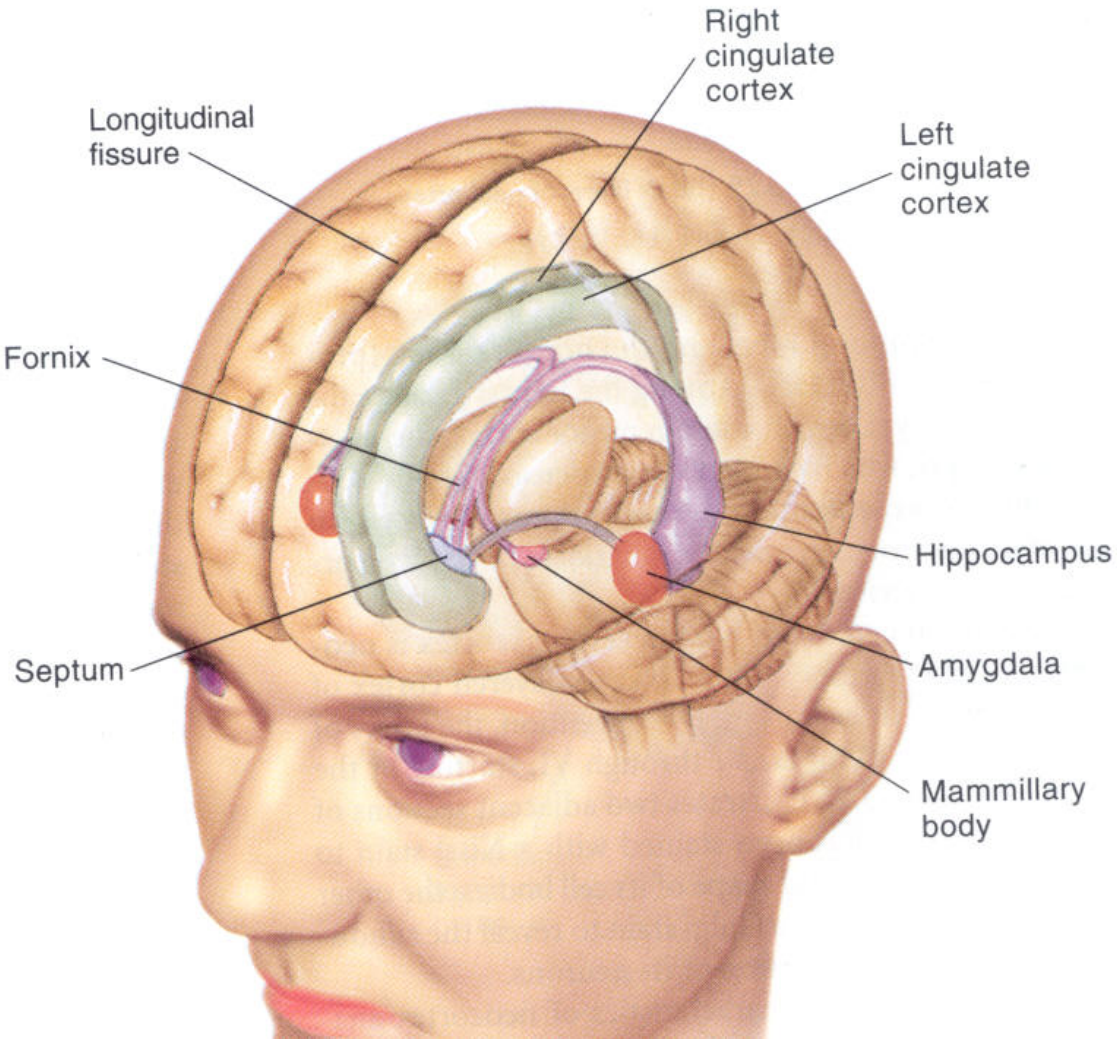


http://homepage.smc.edu/wissmann_paul/physnet/anatomynet/anator

Amygdala (“almond”)

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

Amygdala


Right cingulate cortex
Longitudinal fissure
Left cingulate cortex
Fornix
Hippocampus
Septum
Amygdala
Mammillary body

Cerebral Cortex

Cerebral hemispheres

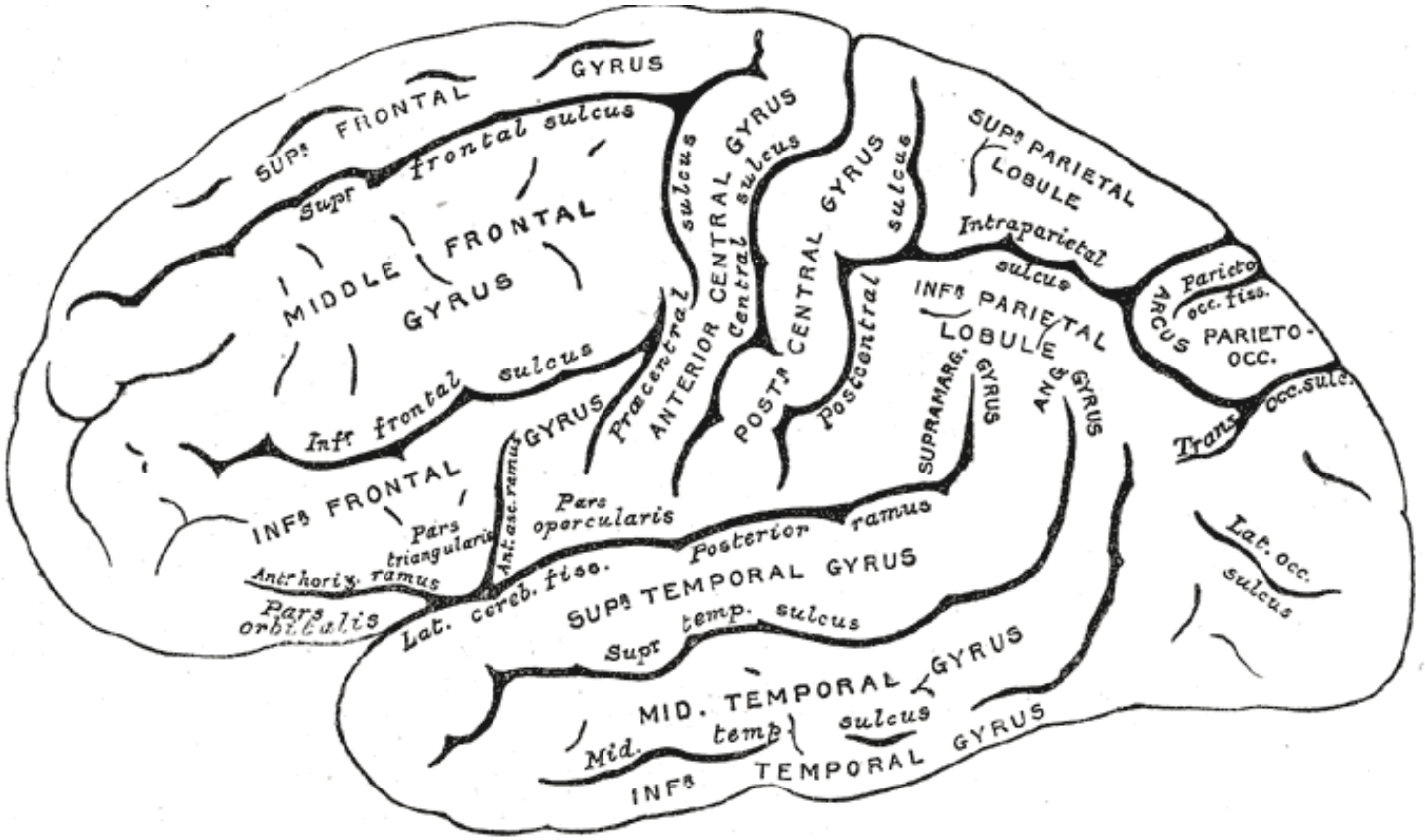
Groove (sulcus or sulci)

Bumps (gyrus or gyri)

Grey vs.white matter

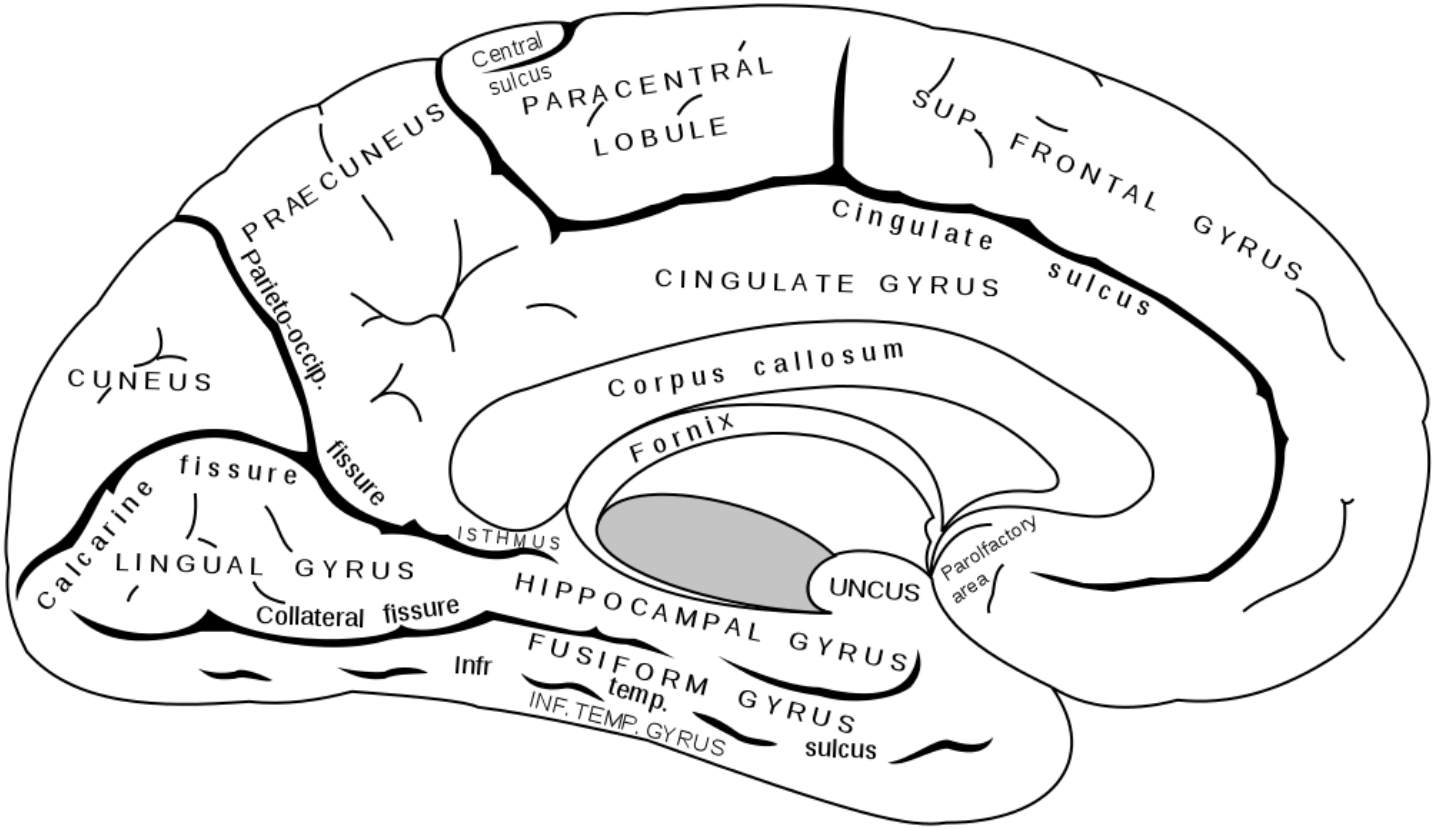
Lobes

Cortical Gyri – Lateral

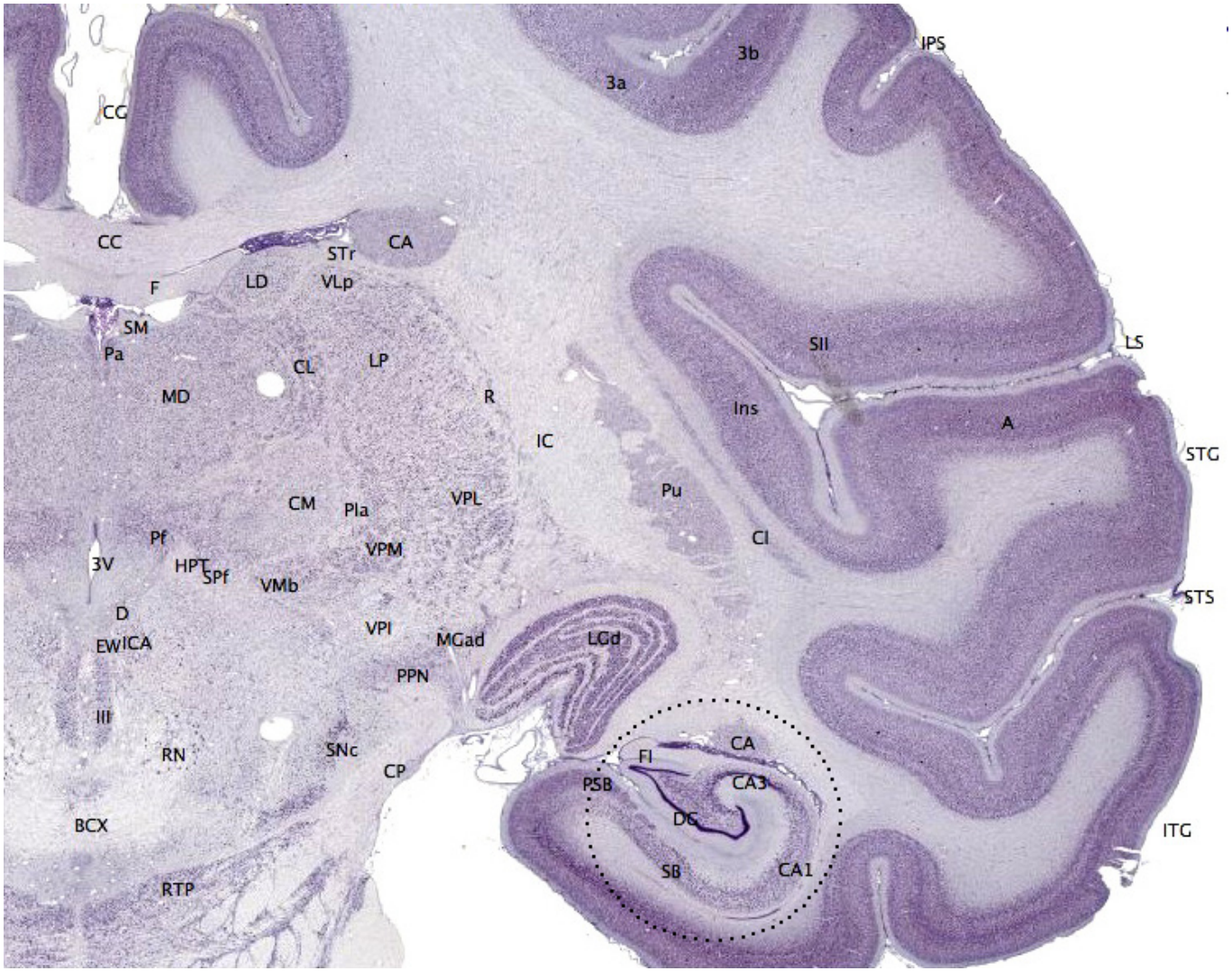


https://upload.wikimedia.org/wikipedia/commons/3/35/Gray726.png

Cortical Gyri – Medial



Gray vs. White Matter



Lobes of the cerebral cortex

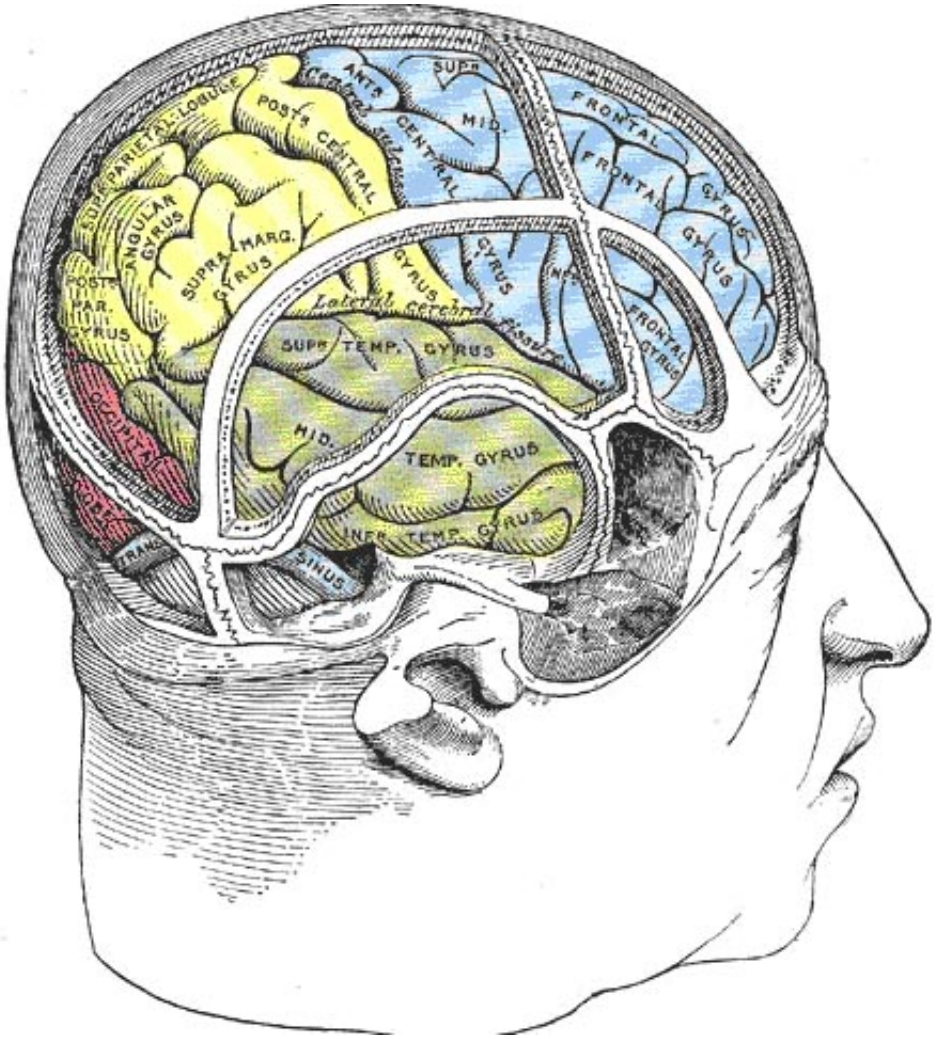
Frontal

Temporal

Parietal

Occipital

Lobes


ANTR. CENTRAL
SUPR.
MID.
CENTRAL
POSTR. CENTRAL
SUPR. PARIETAL LOBULE
ANGULAR GYRUS
SUPRA-MARG. GYRUS
POST. PAR. GYRUS
FRONTAL
FRONTAL
GYRUS
GYRUS
GYRUS
GYRUS
Lateral Cerebral Fissure
FRONTAL GYRUS
SUPR. TEMP. GYRUS
MID.
TEMP. GYRUS
INFR. TEMP. GYRUS
SINUS

Landmarks of the cortex

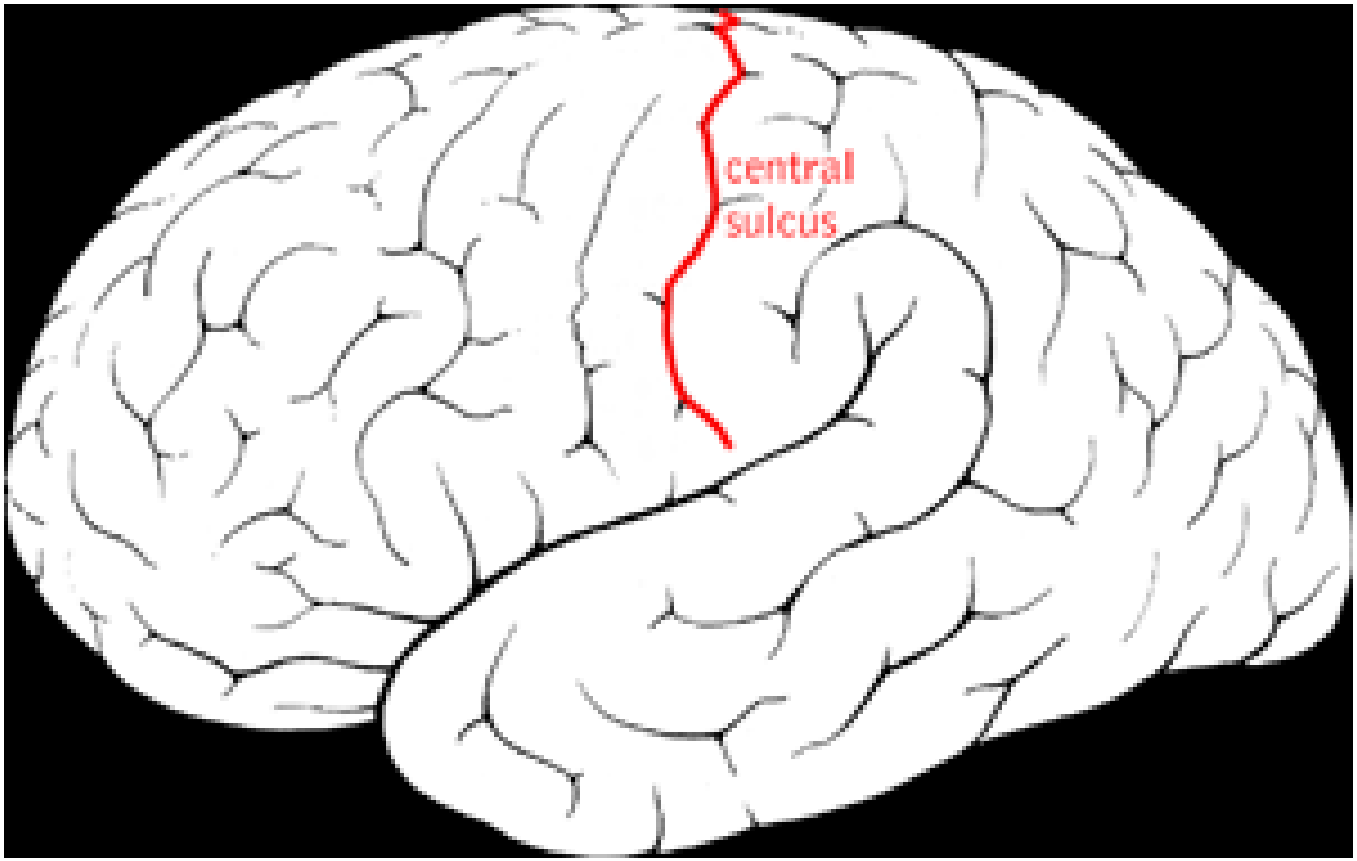
Longitudinal fissure

Landmarks of the cortex

Lateral sulcus/fissure

Landmarks of the cortex

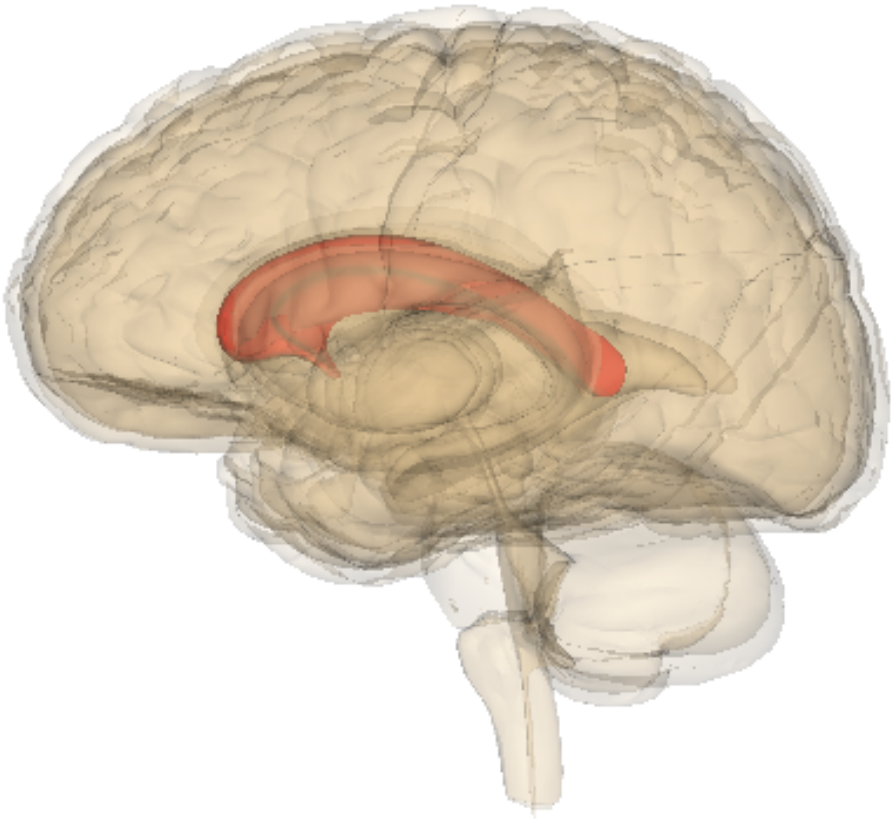
Central sulcus

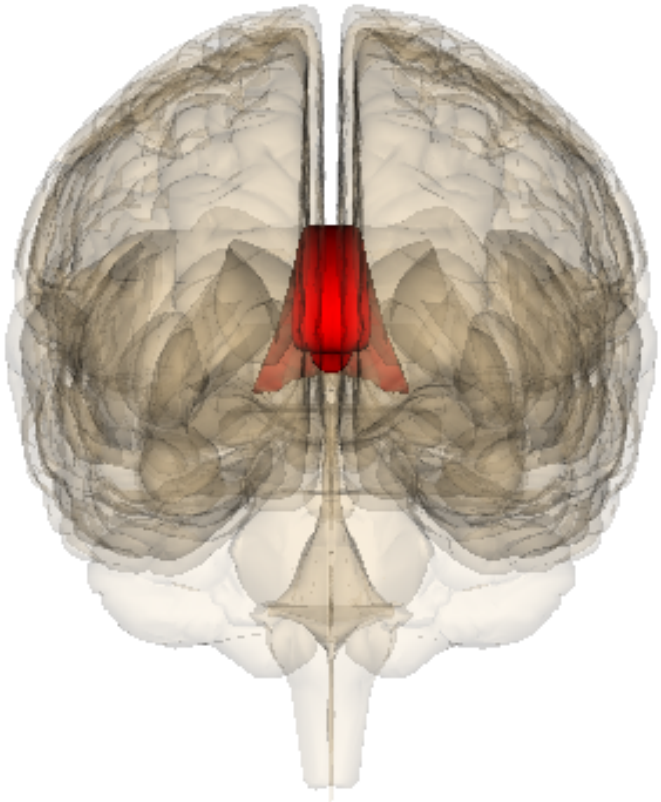


https://upload.wikimedia.org/wikipedia/commons/8/88/Central_sulcus_

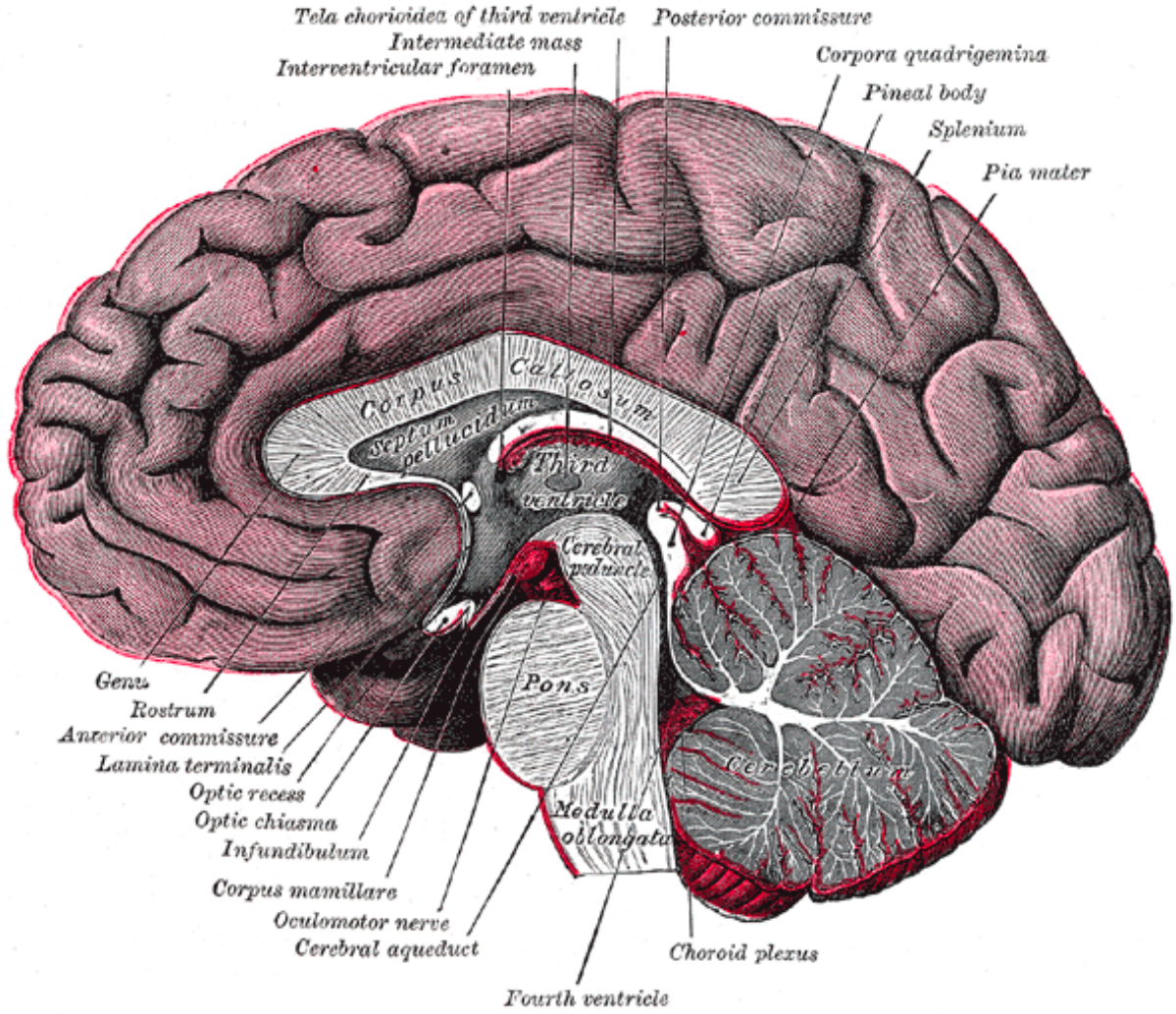
Representative fiber tracts in the cortex

Corpus callosum





Anterior, Posterior Commissures

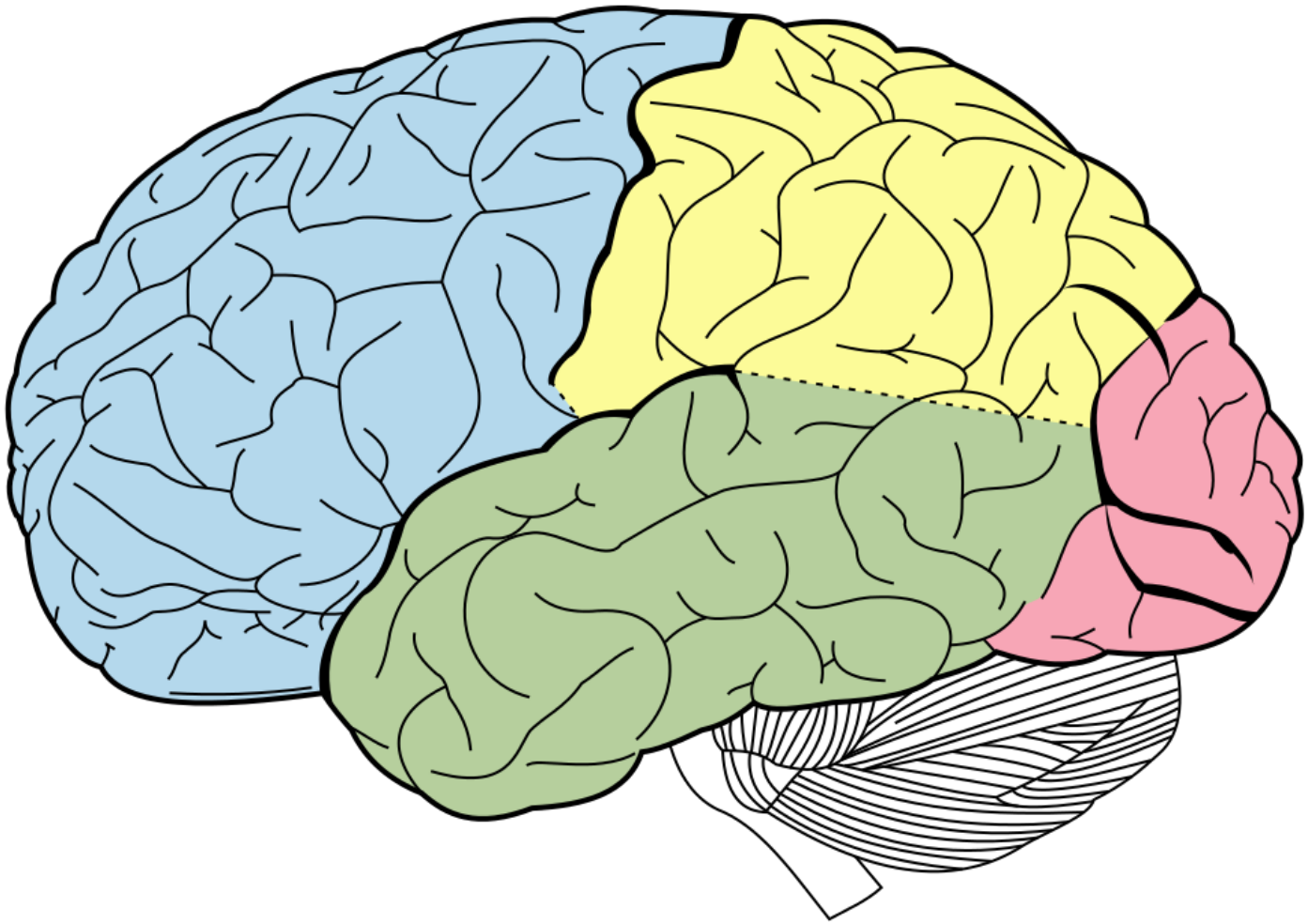


Frontal lobe

Where is it?

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

Lobes of the Cerebral Cortex



Frontal lobe

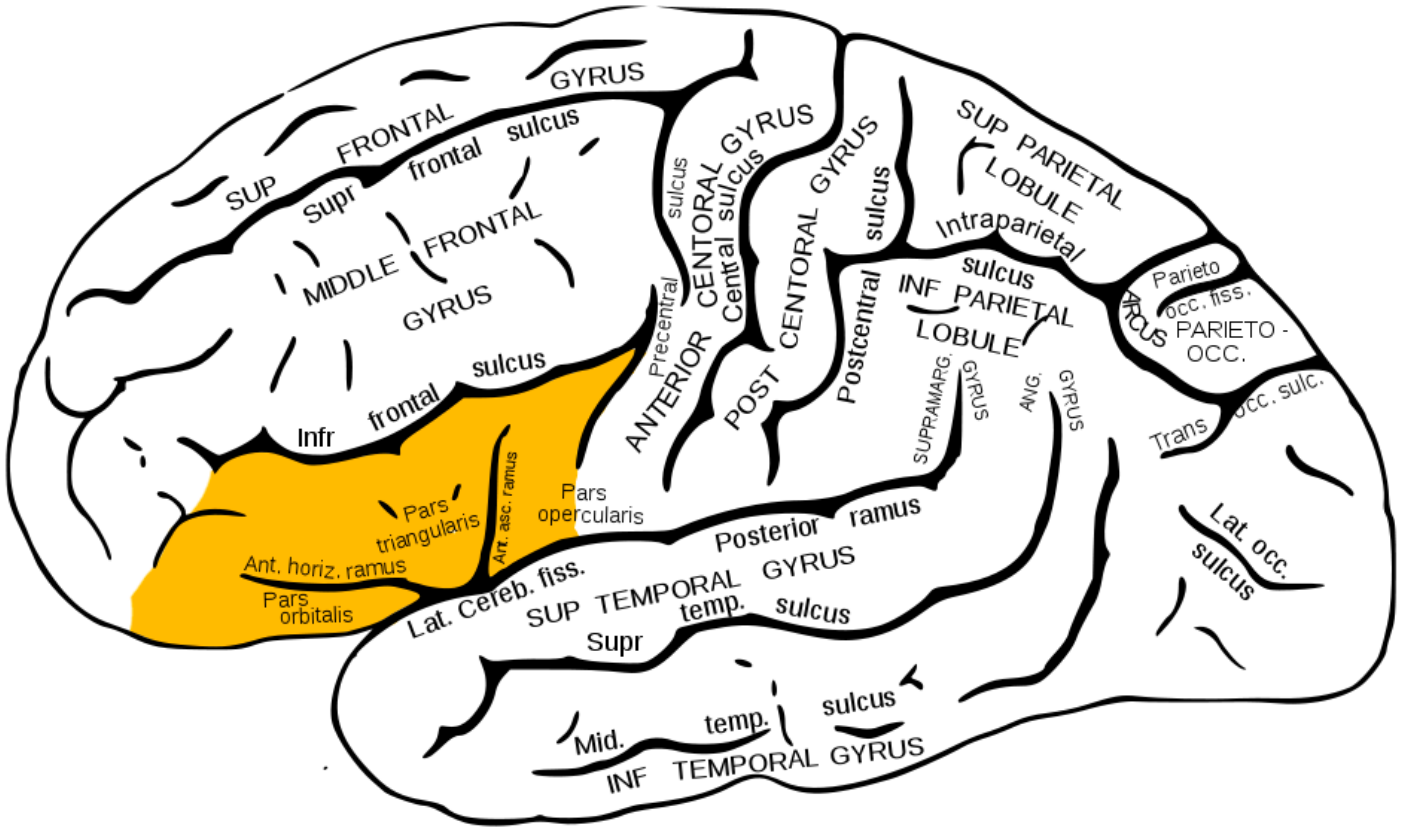
What does it do?

- 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

Cingulate Gyrus

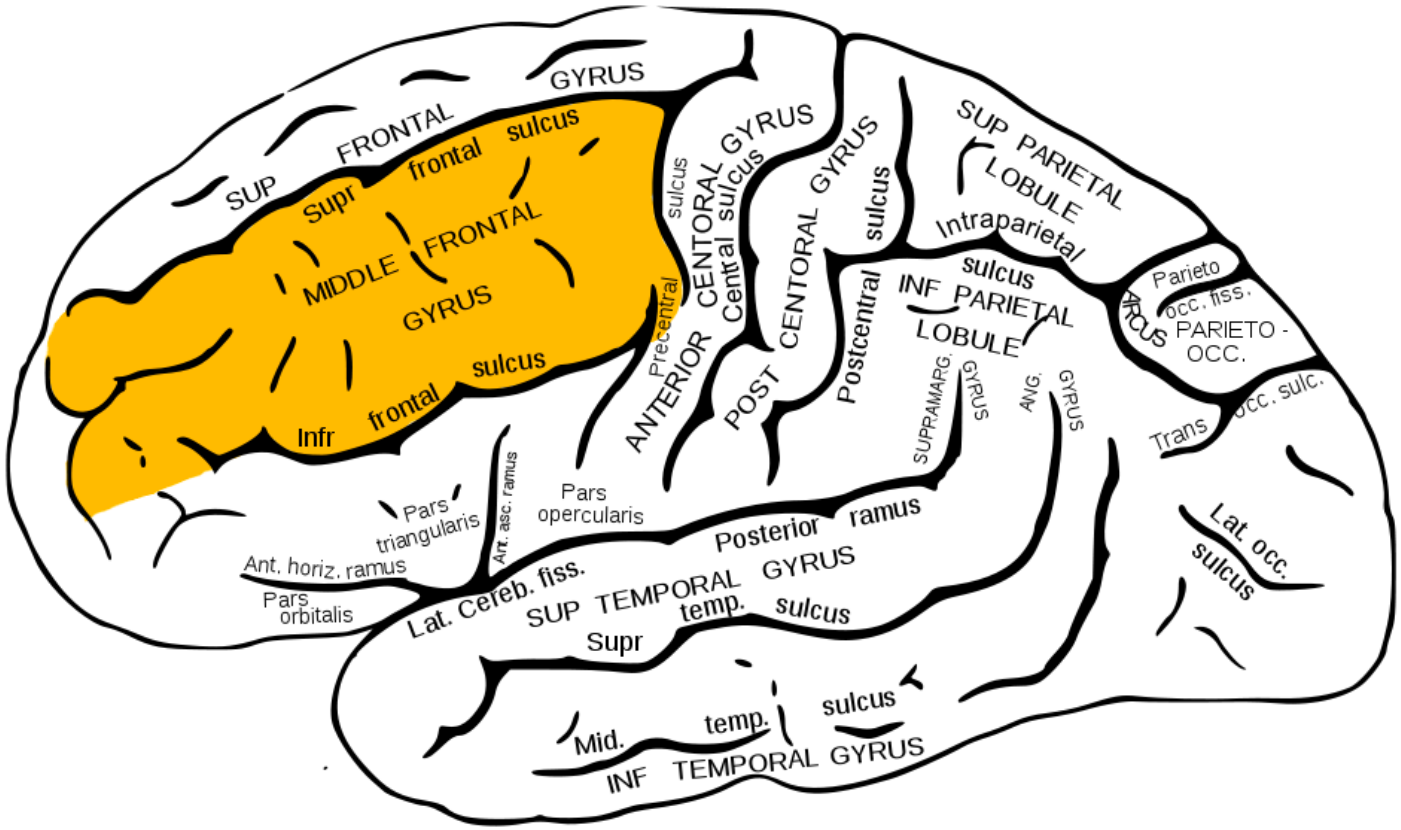
http://cis.jhu.edu/data.sets/cortical_segmentation_validation/photos/cir

Inferior Frontal Gyrus (IFG)



https://upload.wikimedia.org/wikipedia/commons/b/b2/Gray726_inferi

Middle Frontal Gyrus (MFG)



https://upload.wikimedia.org/wikipedia/commons/7/7f/Gray726_middle

Temporal lobe

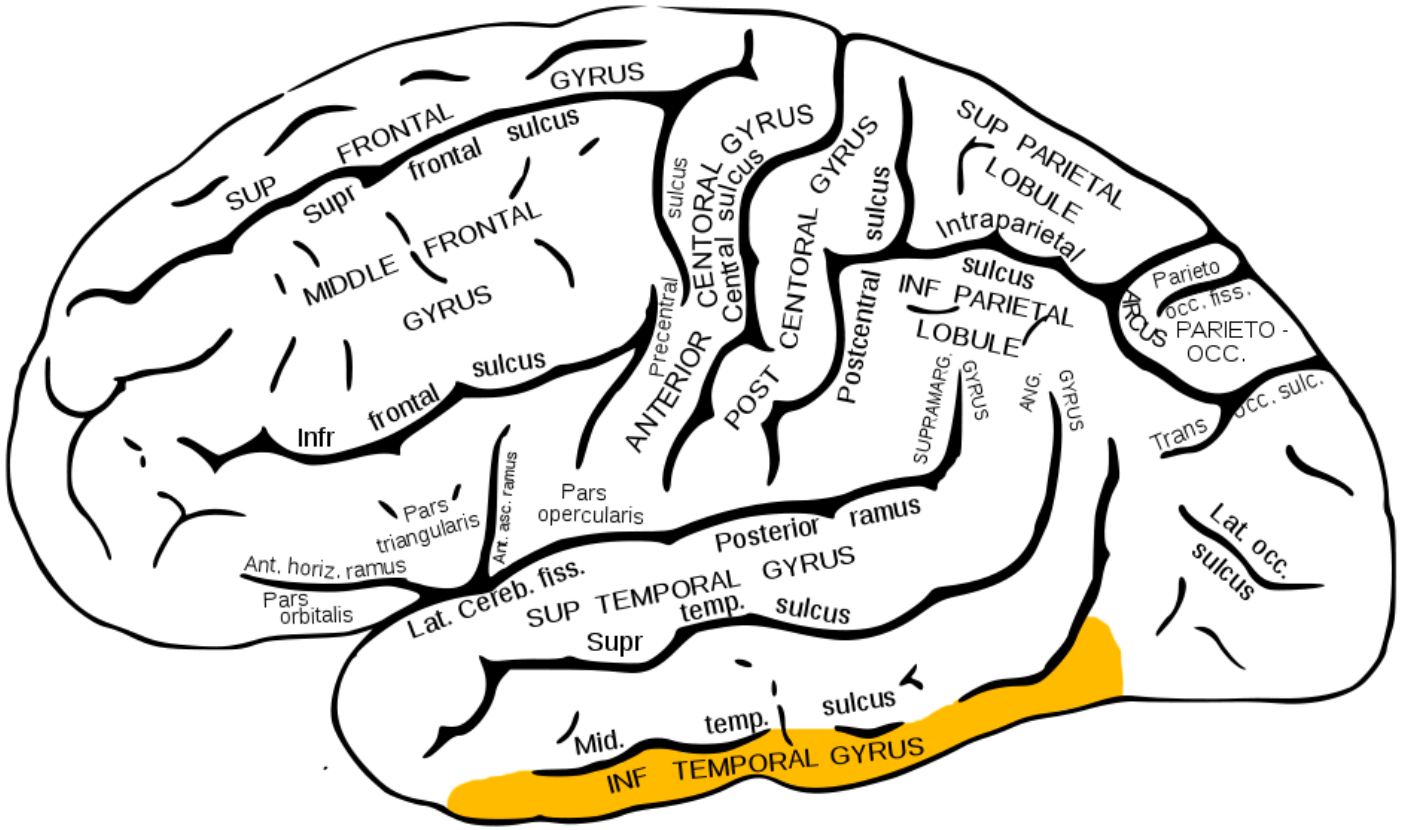
Where is it?

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

What does it do?

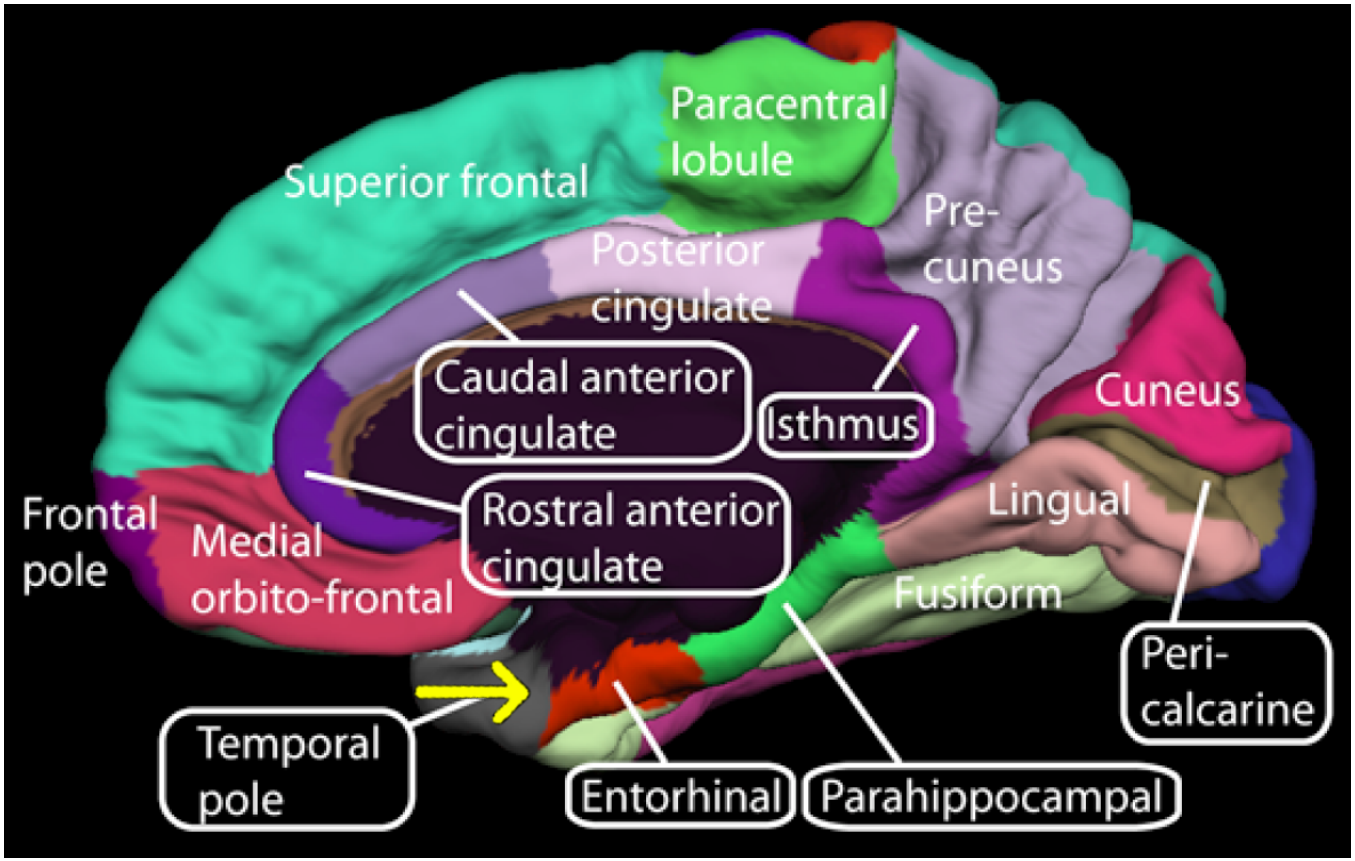
- Primary auditory cortex
- Object, face recognition
- Storage of memories about events, objects
- Amygdala, hippocampus

Inferior Temporal Gyrus (ITG)



https://upload.wikimedia.org/wikipedia/commons/1/18/Gray726_inferic

Entorhinal Cortex (ER)



https://upload.wikimedia.org/wikipedia/commons/1/15/Medial_surface_entorhinal_cortex.png

Parietal lobe

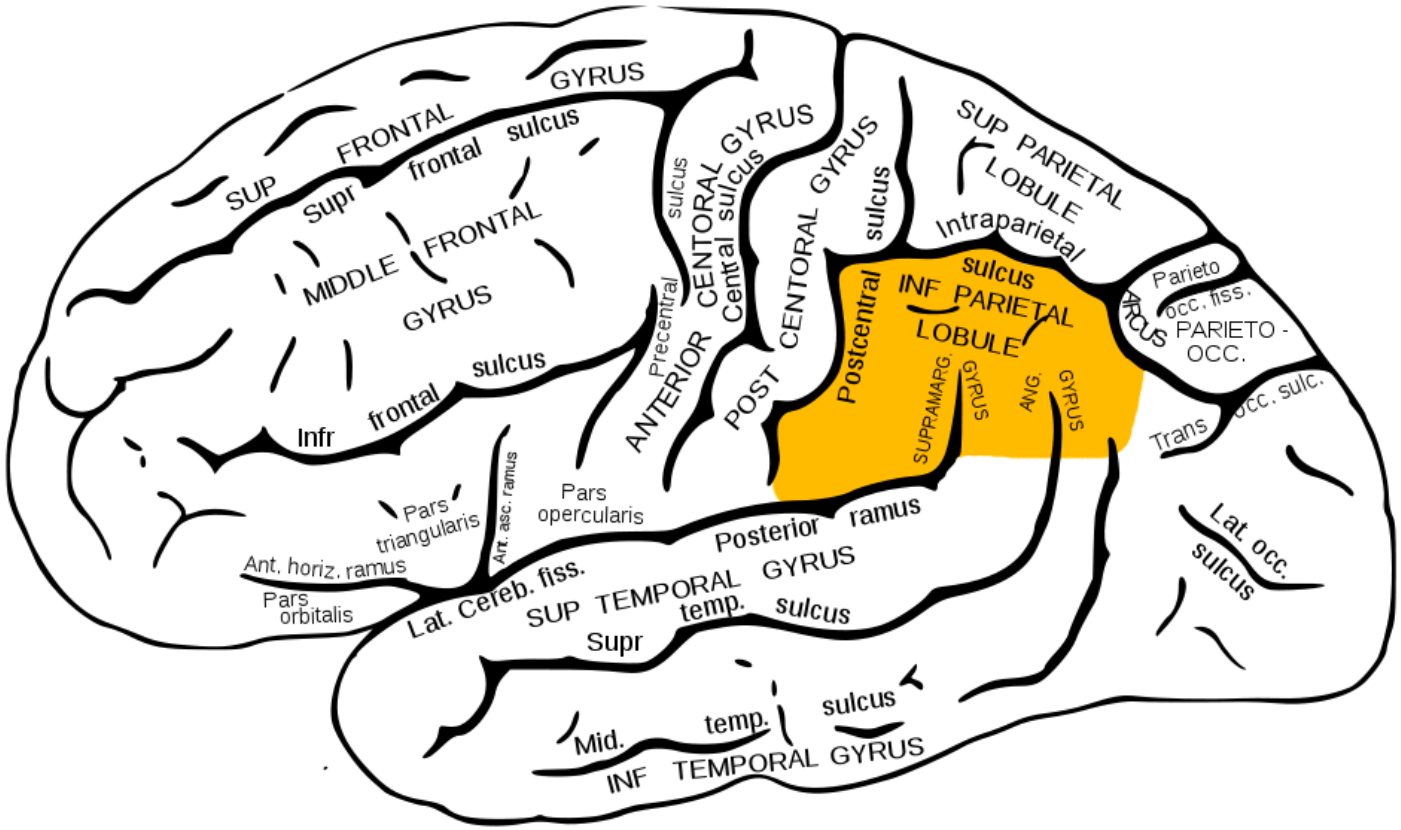
Where is it?

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

What does it do?

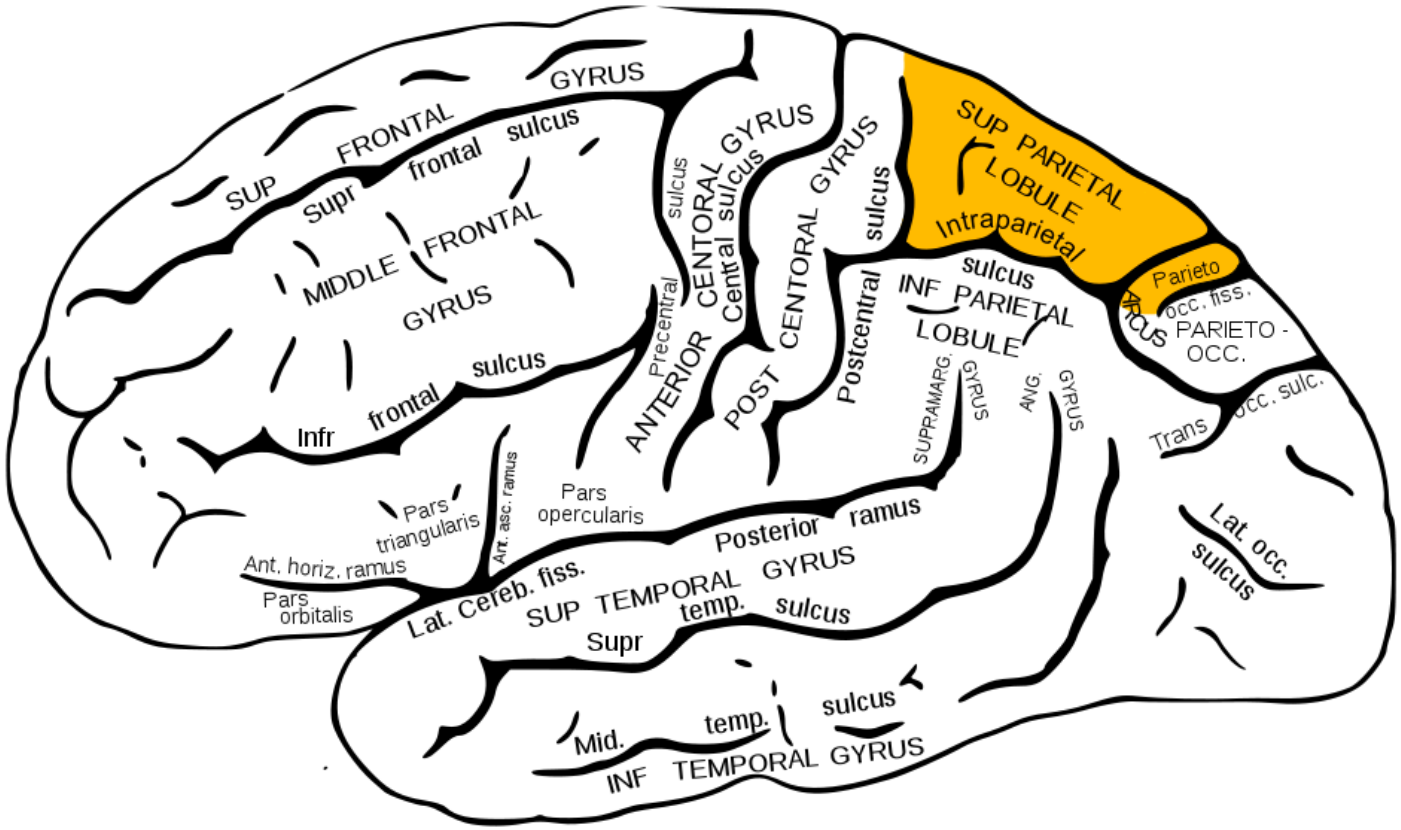
- Primary somatosensory cortex
- Perception of spatial relations, action planning

Inferior Parietal Lobule



https://upload.wikimedia.org/wikipedia/commons/e/e3/Gray726_inferic

Superior Parietal Lobule



https://upload.wikimedia.org/wikipedia/commons/9/9d/Gray726_super

Occipital lobe

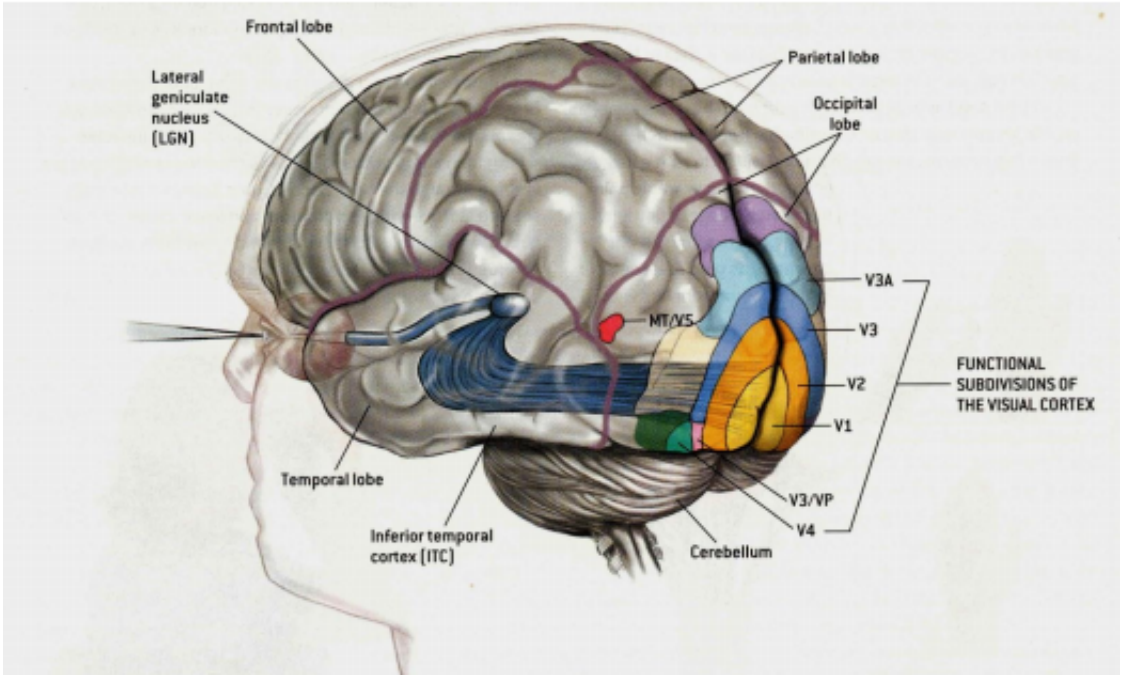
Where is it?

- Caudal to parietal & temporal lobes

What does it do?

- Primary visual cortex (V1)

Visual Cortex



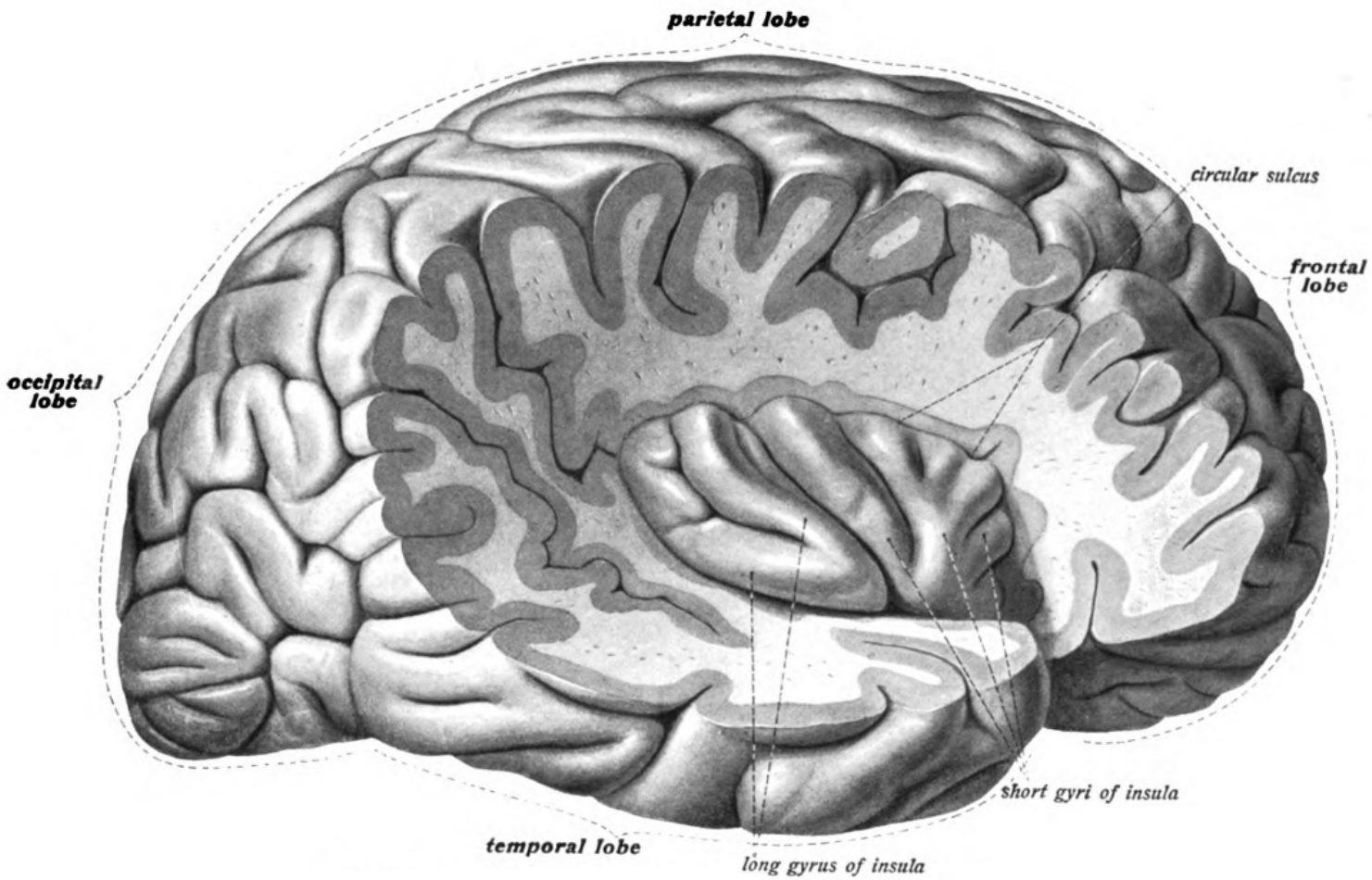
http://bethycotter.wdfiles.com/local–files/introducingtheeye/Screen%20Shot%202012-08-24%20at%2011.36.20%20PM.png

Insular cortex (insula)

Where is it?

- medial to temporal lobe
- deep inside lateral fissure

Insula



https://upload.wikimedia.org/wikipedia/commons/b/b4/Sobo_1909_633

Insula

What does it do?

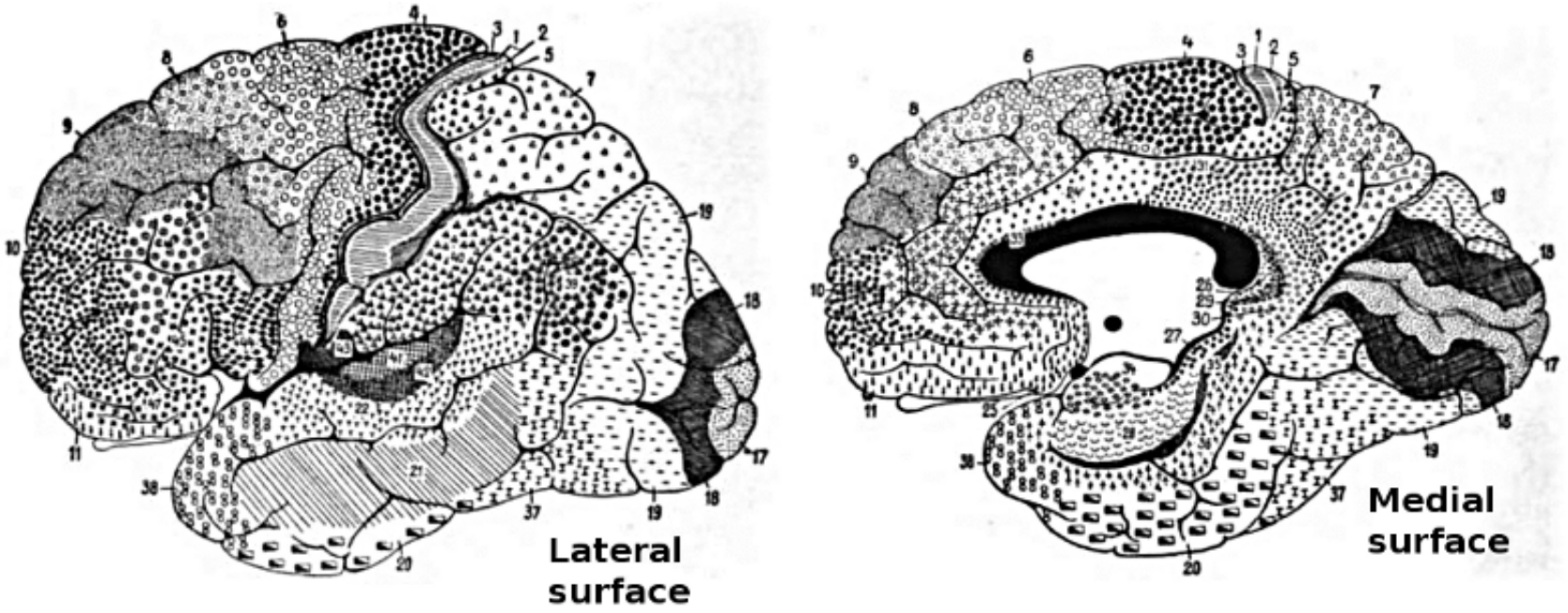
- Primary gustatory cortex
- self-awareness, interpersonal experiences, motor control

Brodmann Areas

Korbinian Brodmann

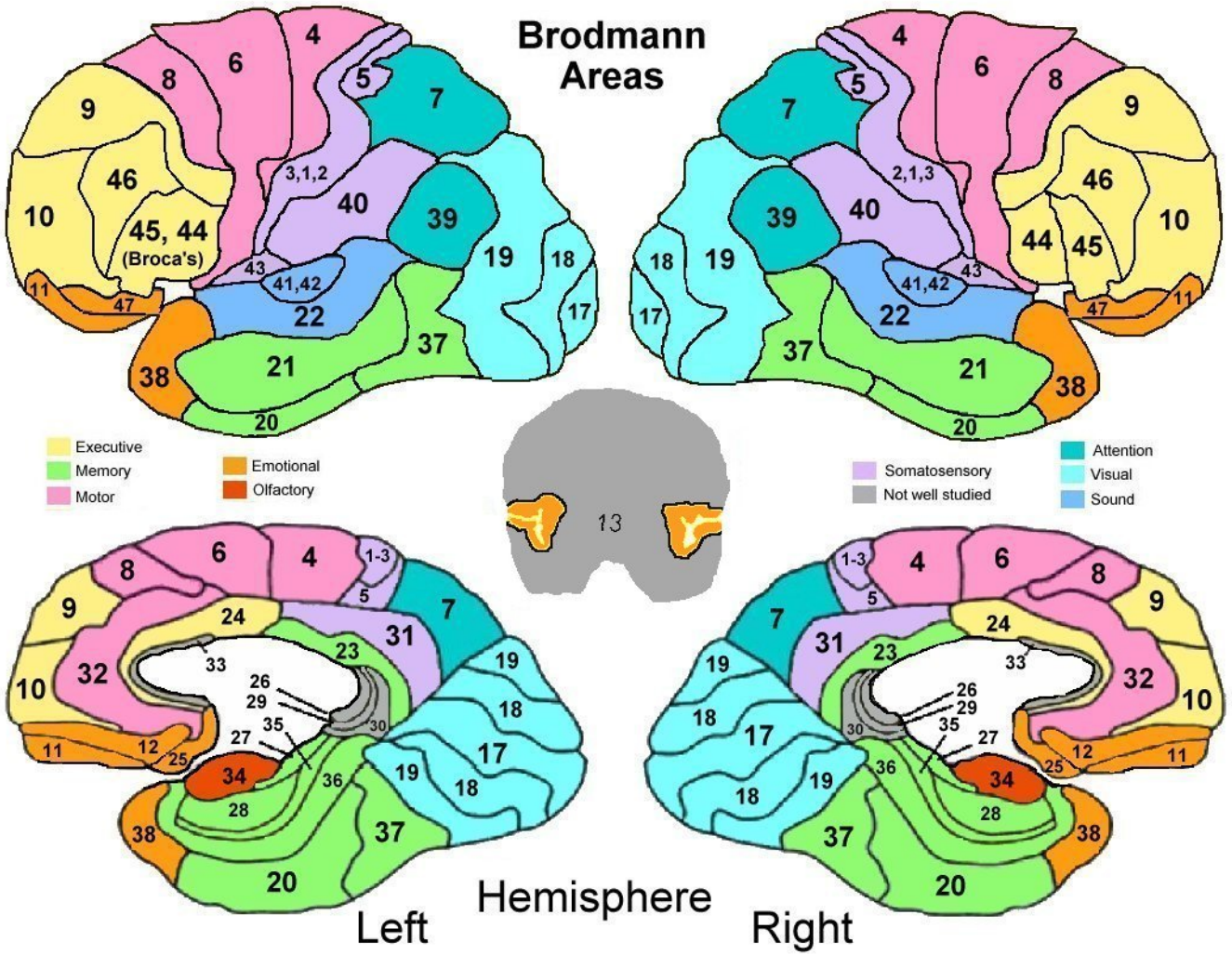
- Cytoarchitectonic differences in cerebral cortex

Brodmann Areas



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

Brodmann Areas

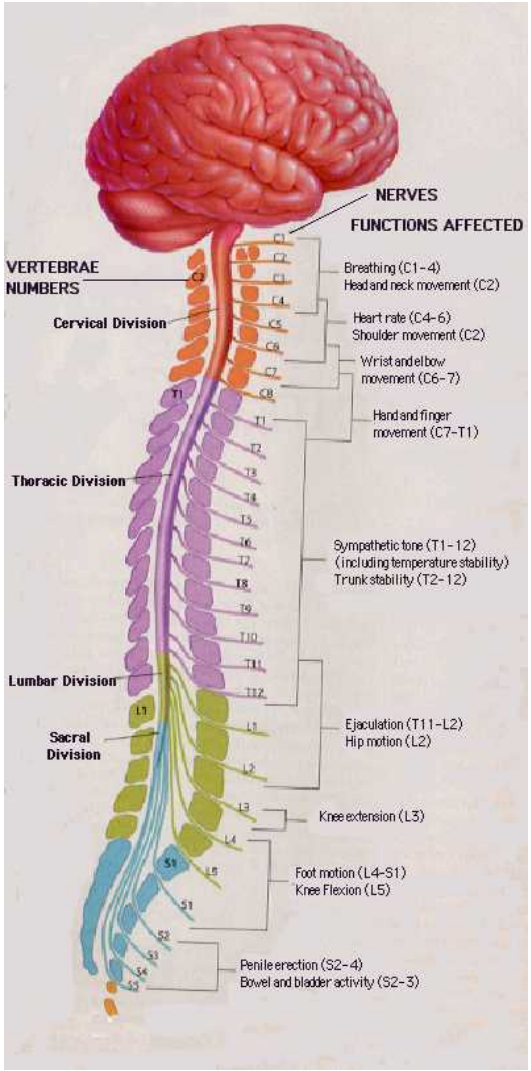


Spinal cord

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

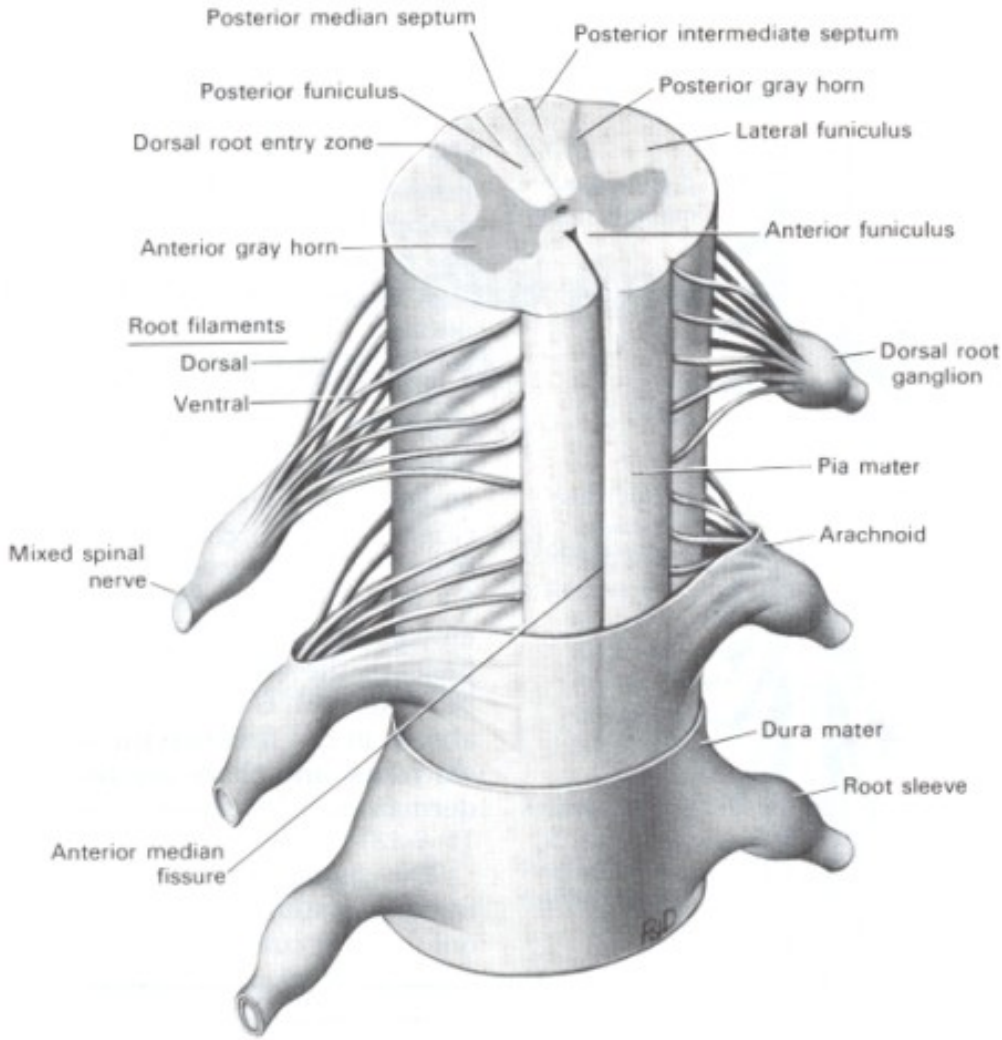

NERVES
FUNCTIONS AFFECTED
VERTEBRAE NUMBERS
Cervical Division
Thoracic Division
Lumbar Division
Sacral Division
Breathing (C1-4)
Head and neck movement (C2)
Heart rate (C4-6)
Shoulder movement (C2)
Wrist and elbow movement (C6-7)
Hand and finger movement (C7-T1)
Sympathetic tone (T1-12)
(including temperature stability)
Trunk stability (T2-12)
Ejaculation (T11-L2)
Hip motion (L2)
Knee extension (L3)
Foot motion (L4-S1)
Knee Flexion (L5)
Penile erection (S2-4)
Bowel and bladder activity (S2-3)

Spinal cord

Organization of the spinal cord

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

Spinal Cord


Posterior median septum
Posterior intermediate septum
Posterior funiculus
Posterior gray horn
Dorsal root entry zone
Lateral funiculus
Anterior funiculus
Anterior gray horn
Root filaments
Dorsal
Ventral
Dorsal root ganglion
Pia mater
Arachnoid
Mixed spinal nerve
Dura mater
Root sleeve
Anterior median fissure

Organization of the PNS

Somatic division

Autonomic

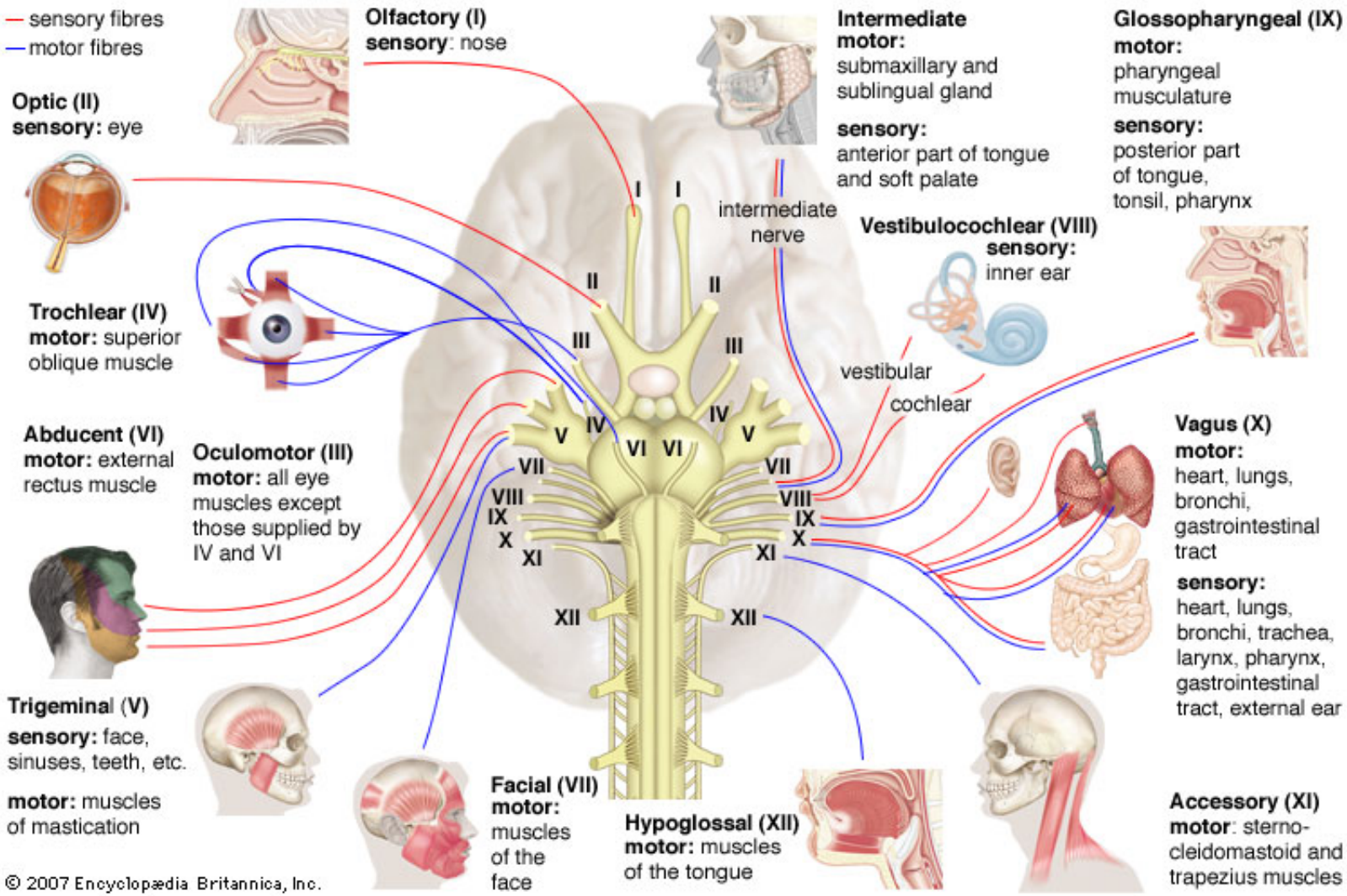
Cranial nerves

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

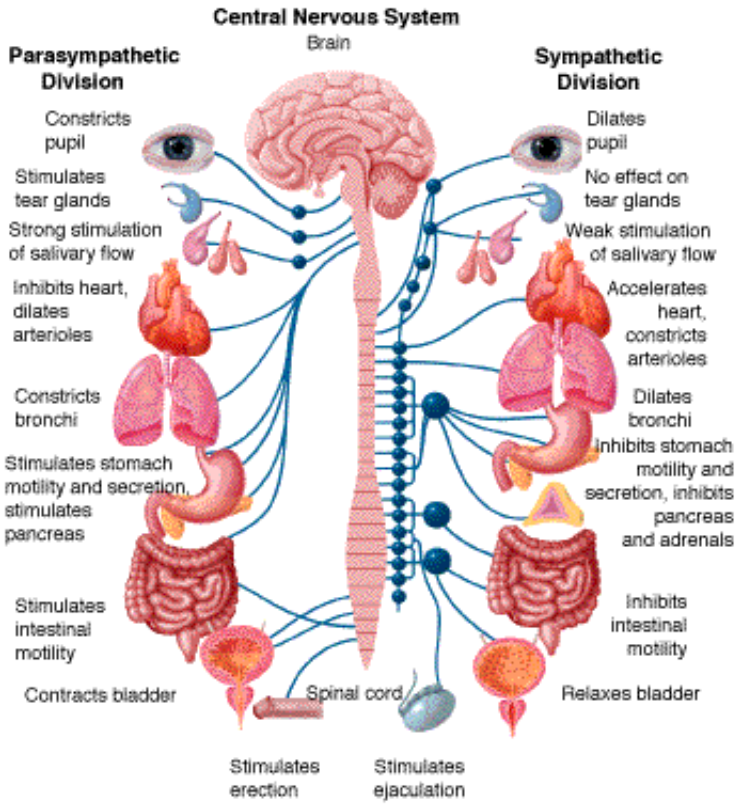
Cranial nerves



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

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