Overview of the Brain

Lecture 3

November 8, 2016

Good Books for Learning about the Brain

- **Brain, Mind, and Behavior** 3rd Edition**,** by Floyd Bloom (Author), Charles A. Nelson (Author), Arlyne Lazerson (Author)

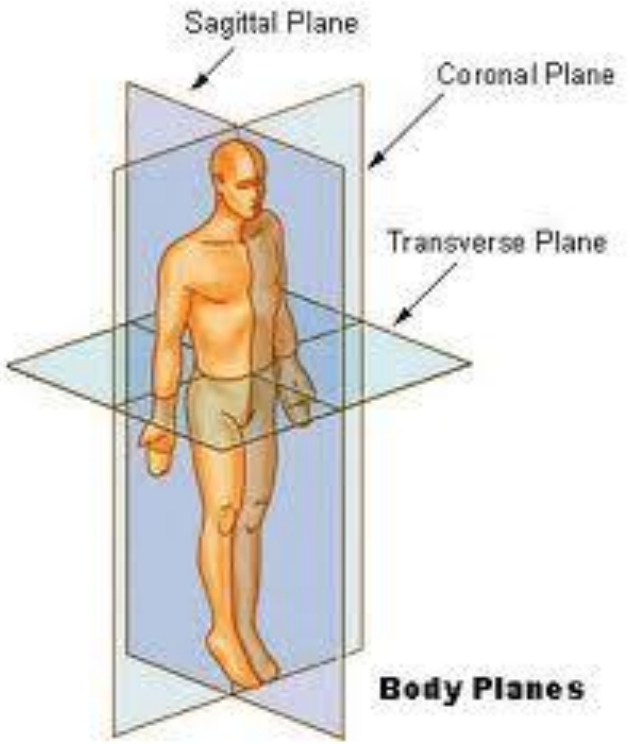
- **Neuroscience: Exploring the Brain** 4th Edition**,** by Mark F. Bear (Author), Barry W. Connors (Author), Michael A. Paradiso (Author)

- **Principles of Neural Science, Fifth Edition (Principles of Neural Science (Kandel))** 5th Editionby Eric R. Kandel (Editor), James H. Schwartz (Editor), Thomas M. Jessell (Editor), Steven A. Siegelbaum (Editor), A. J. Hudspeth (Editor)

Good websites for learning about the brain

- http://www.brainfacts.org/
- http://www.dana.org/
- http://faculty.washington.edu/chudler/neurok.html
- http://thebrain.mcgill.ca/index.php
- http://neuroscience.uth.tmc.edu/toc.htm

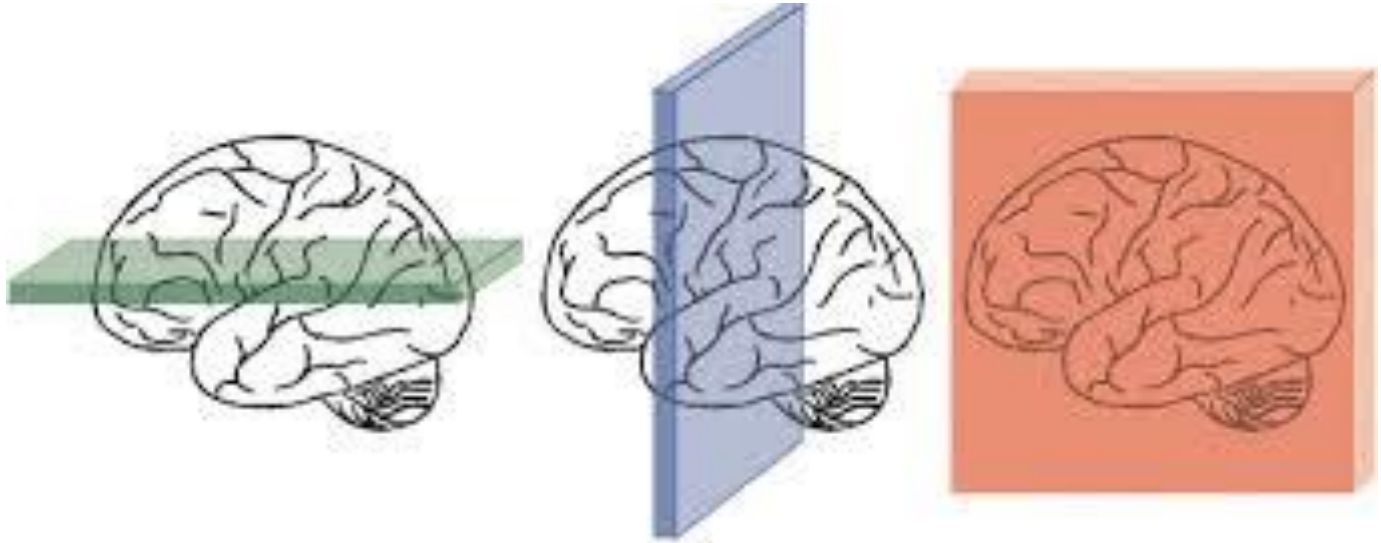
Planes of the Body



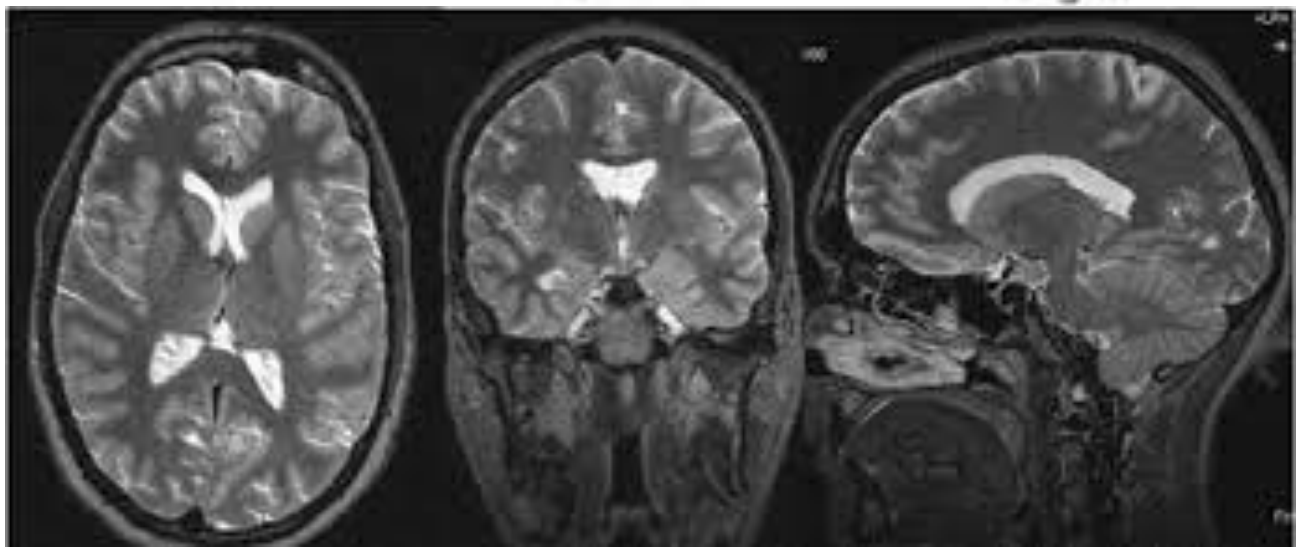
- Sagittal Plane = Cuts into symmetric halves along the midline
- Coronal (frontal) plane = divides into asymmetric anterior and posterior portions
- Transverse (axial) = cuts across the body

- Planes are perpendicular to each other

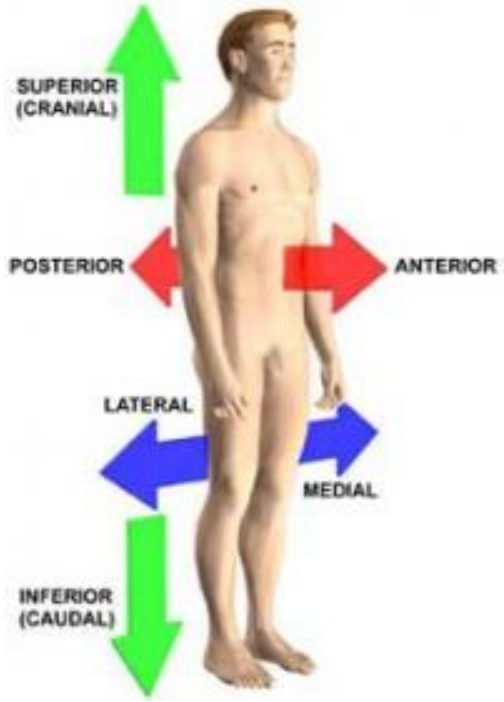
Same planes in the brain

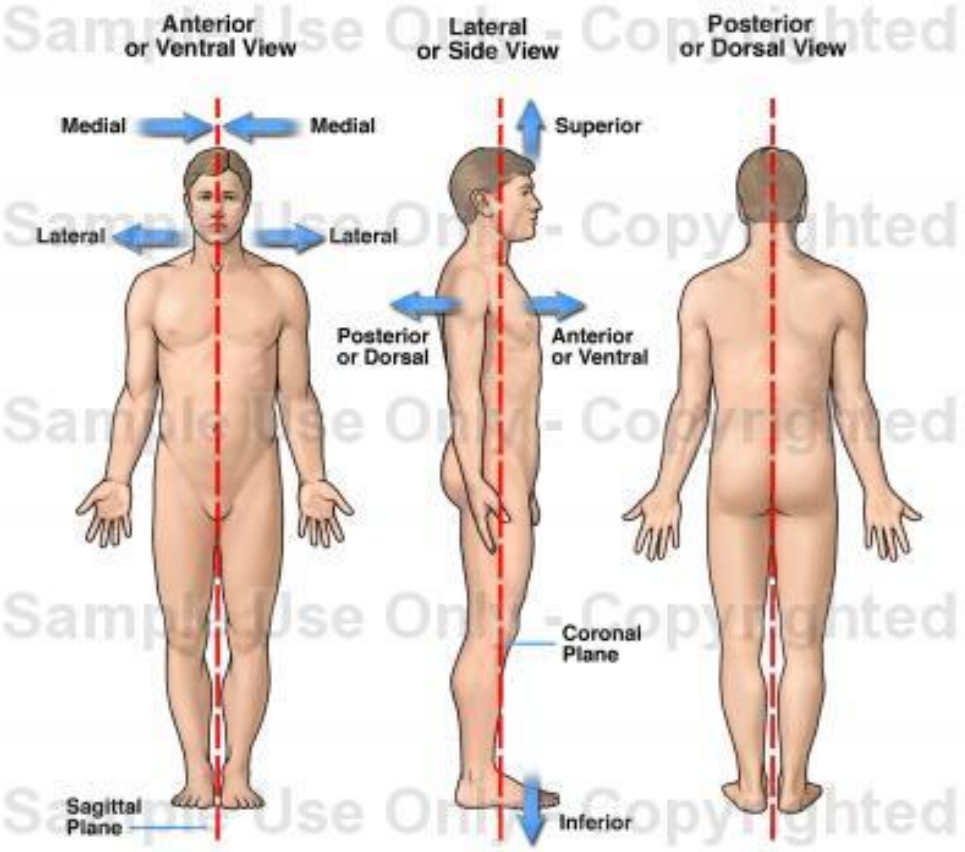


Axial Coronal Sagittal



Directions of the Body



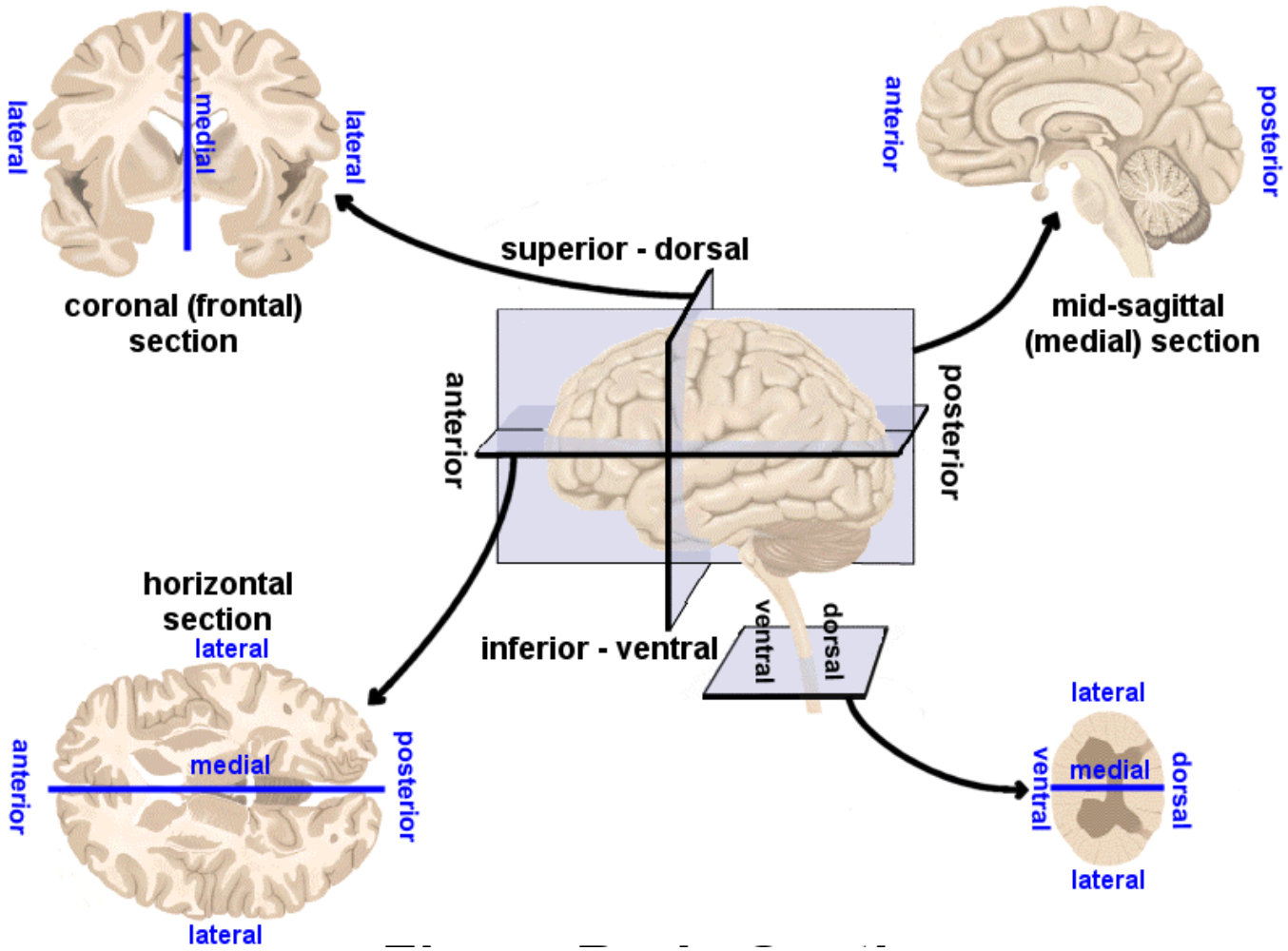


In the coronal (frontal) plane – anterior (ventral) & posterior (dorsal)

In the sagittal plane – medial & lateral

In the axial (transverse) plane – inferior (caudal) & superior (cranial)

Direction of the Brain

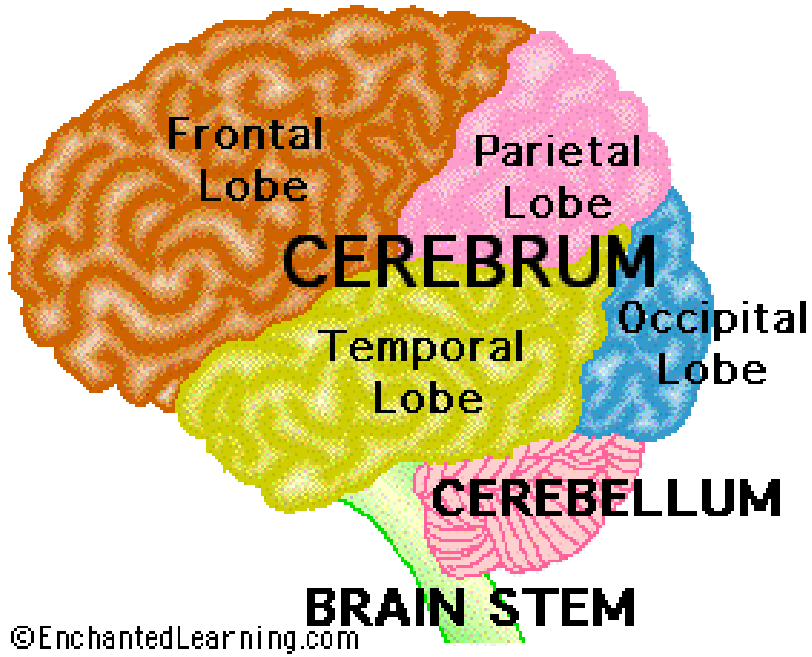


The Brain

Large soft mass of nervous tissue

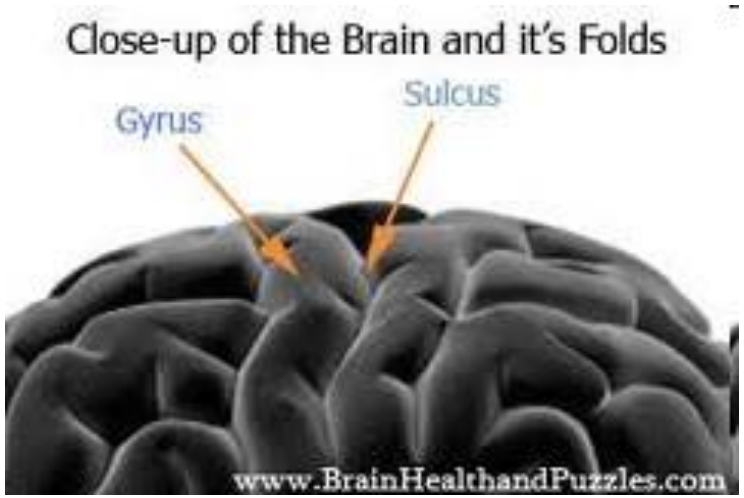
Major parts –

1. Cerebrum
2. Limbic System/ Mid-brain
3. Brain stem
4. Cerebellum



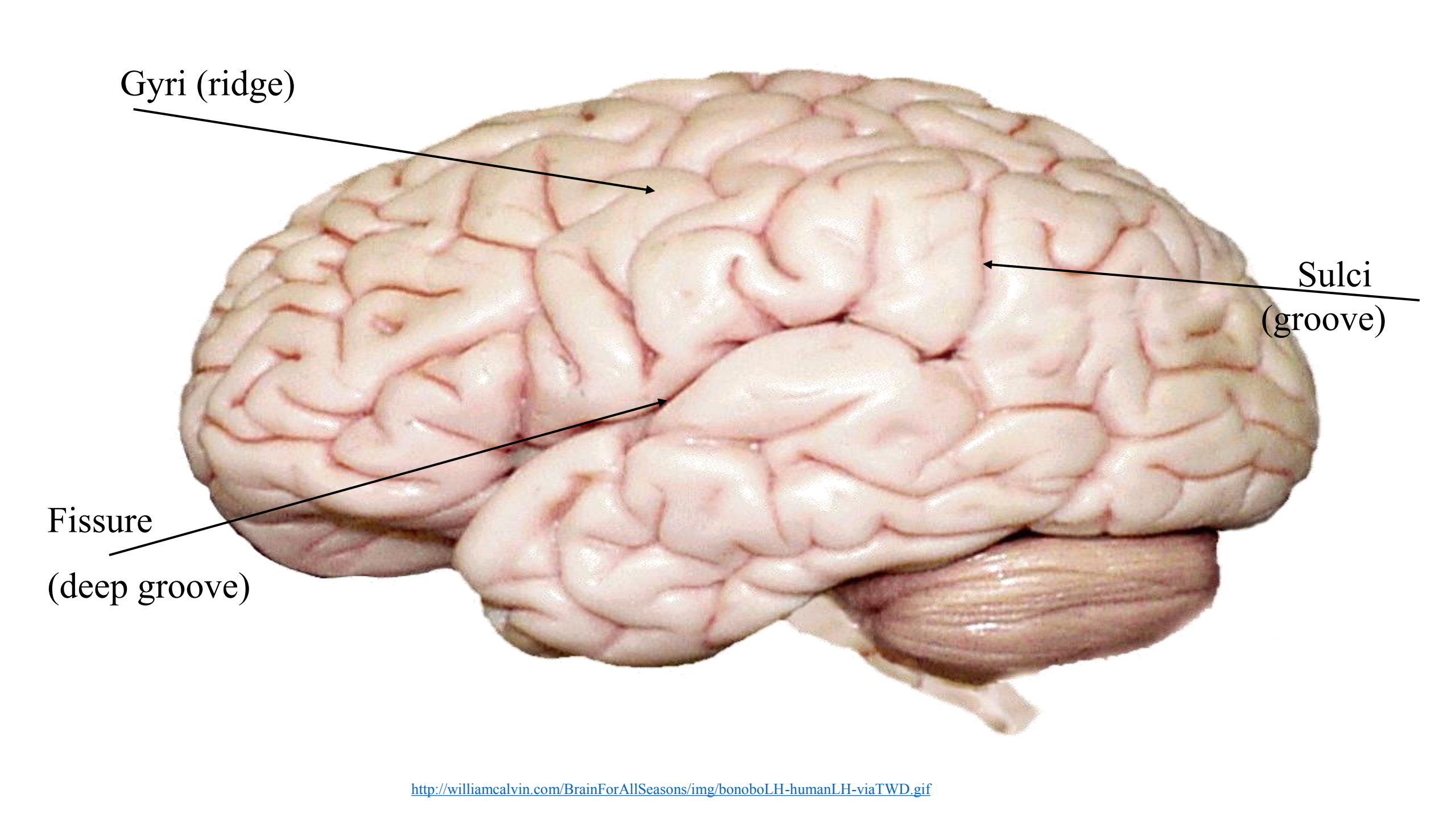
Cerebrum

- Divided into 2 hemispheres
- Largest and most obvious portion of the brain
- Has convoluted ridges (gyri), narrow grooves (sulci) and deep fissures
- Total surface area = about 2.25m^2



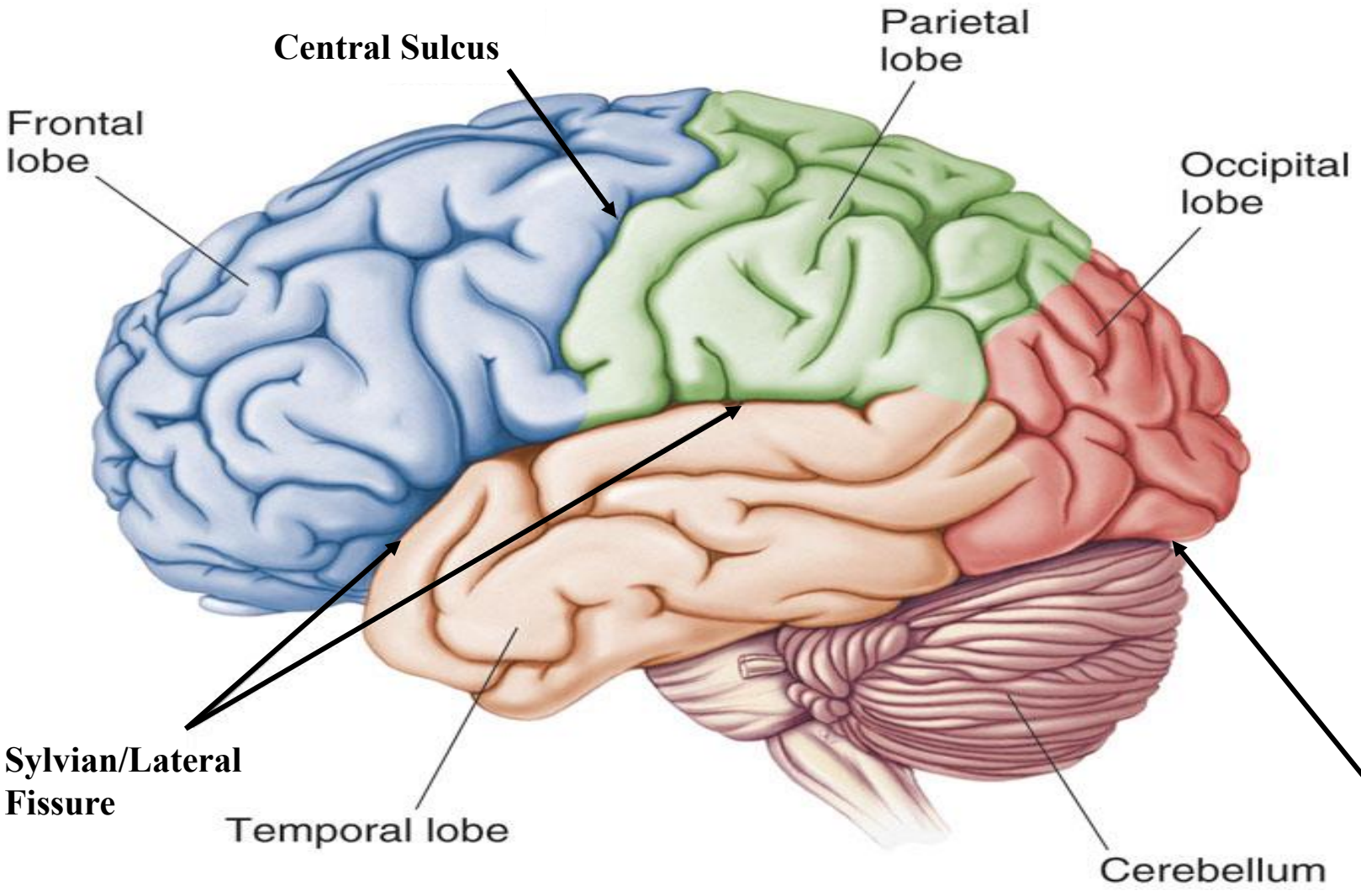
Cerebral Features

- **Gyri** – Elevated ridges “winding” around the brain.
- **Sulci** – Small grooves dividing the gyri
  - **Central Sulcus** – Divides the Frontal Lobe from the Parietal Lobe
- **Fissures** – Deep grooves, generally dividing large regions/lobes of the brain
  - **Longitudinal Fissure** – Divides the two Cerebral Hemispheres
  - **Transverse Fissure** – Separates the Cerebrum from the Cerebellum
  - **Sylvian/Lateral Fissure** – Divides the Temporal Lobe from the Frontal and Parietal Lobes



http://williamcalvin.com/BrainForAllSeasons/img/bonoboLH-humanLH-viaTWD.gif

Specific Sulci/Fissures:



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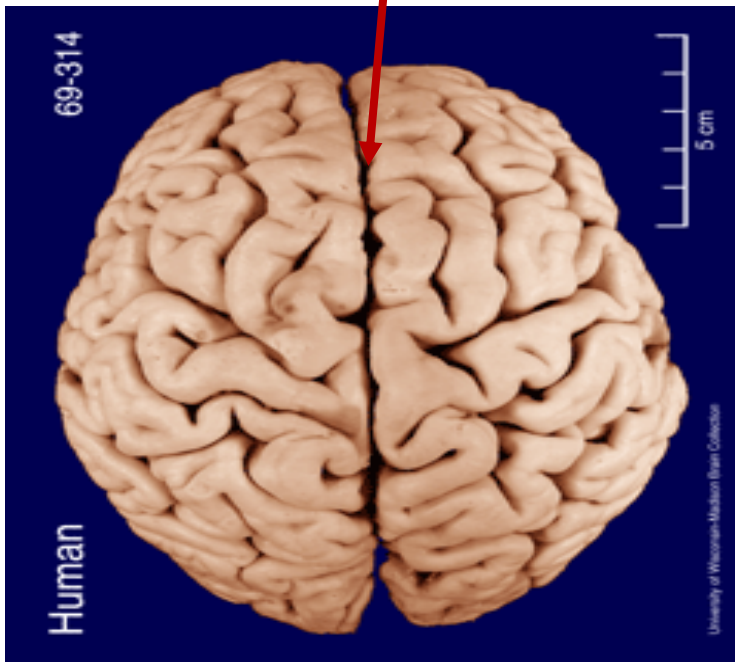
Longitudinal Fissure



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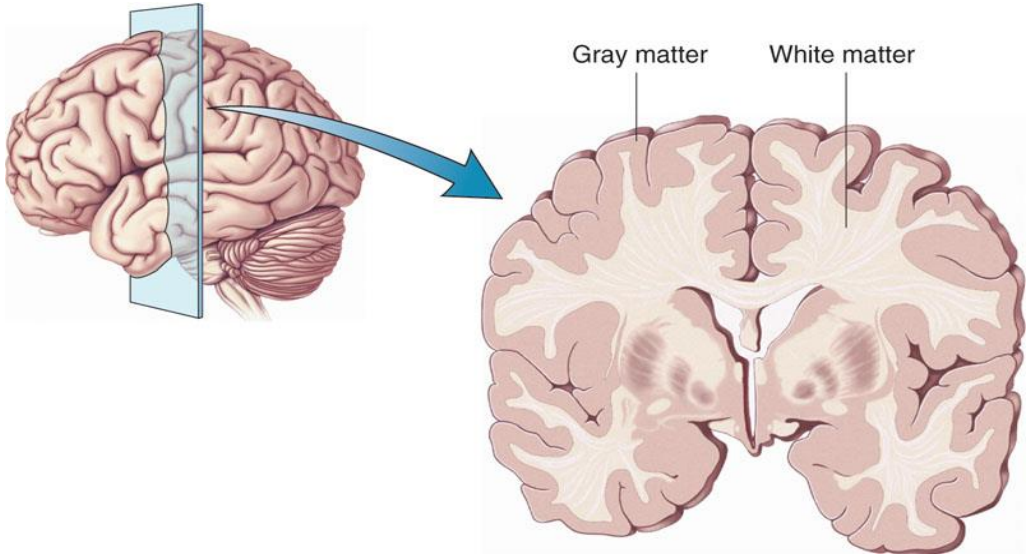
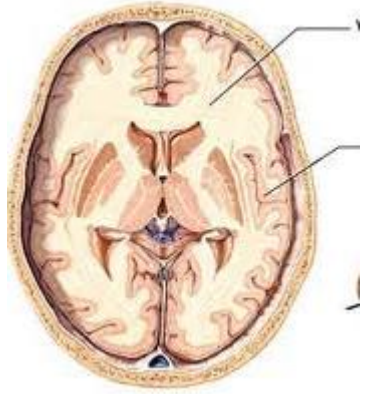
Cerebrum (cont.)

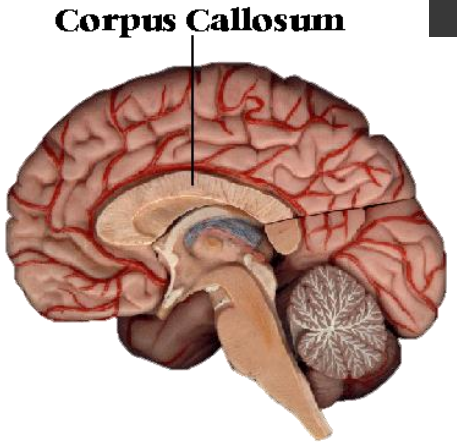
- Outer layer is called cerebral cortex
  - Contains gray matter (neurons with unmyelinated axons)
  - Is 2-4 mm thick
  - Cerebral cortex has over 50 billion neurons and 250 billion glial cells



Cerebrum (cont.)

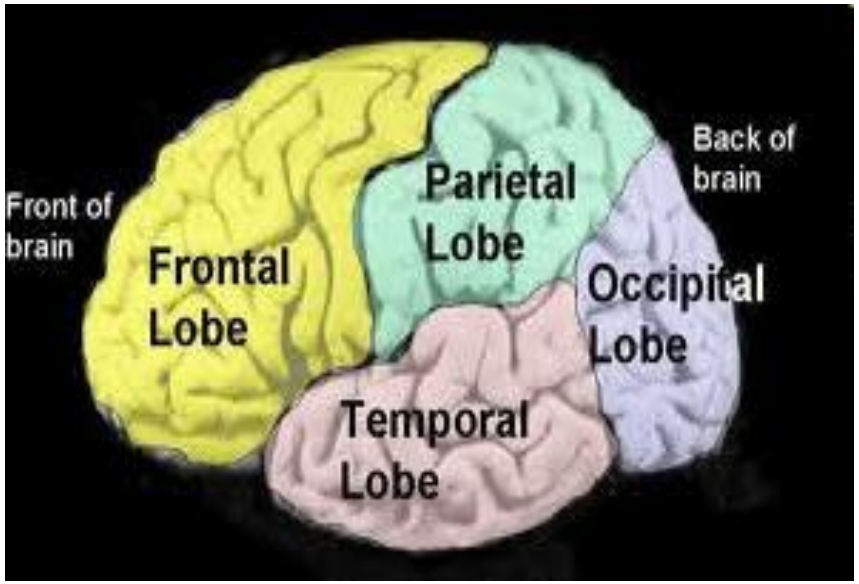
- Thicker inner layer is the white matter
  - Consists of interconnecting groups of myelinated axons that project between and connect cortical areas
  - Connection between two cerebral hemispheres is called the corpus collosum
- Left side of the cortex controls sensory and motor functions on the right side of the body, and vice versa





Lobes of the Brain

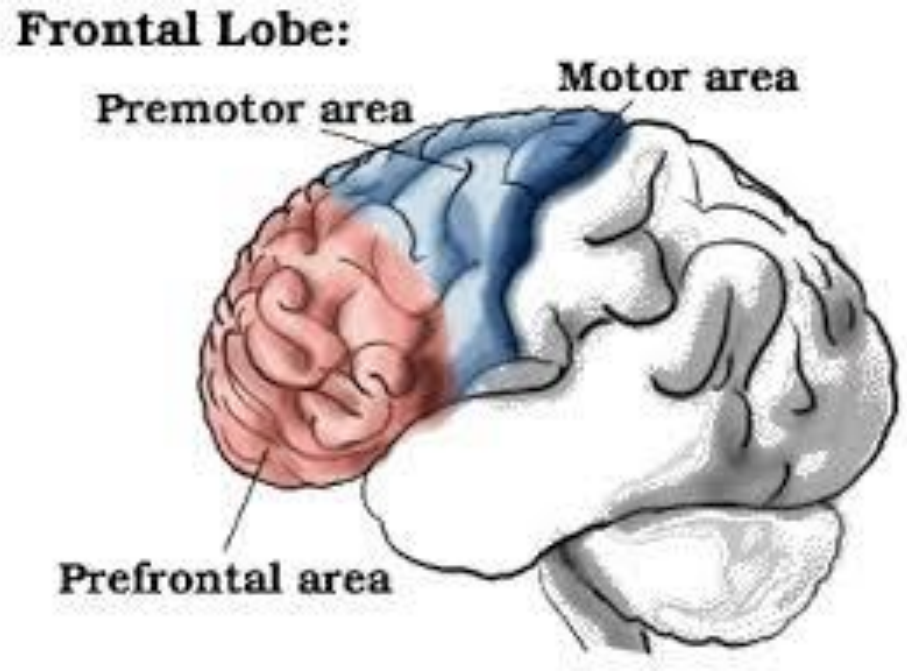
- Part of the Cerebrum
- Fissures divide the brain into lobes
- Lobes have different functions

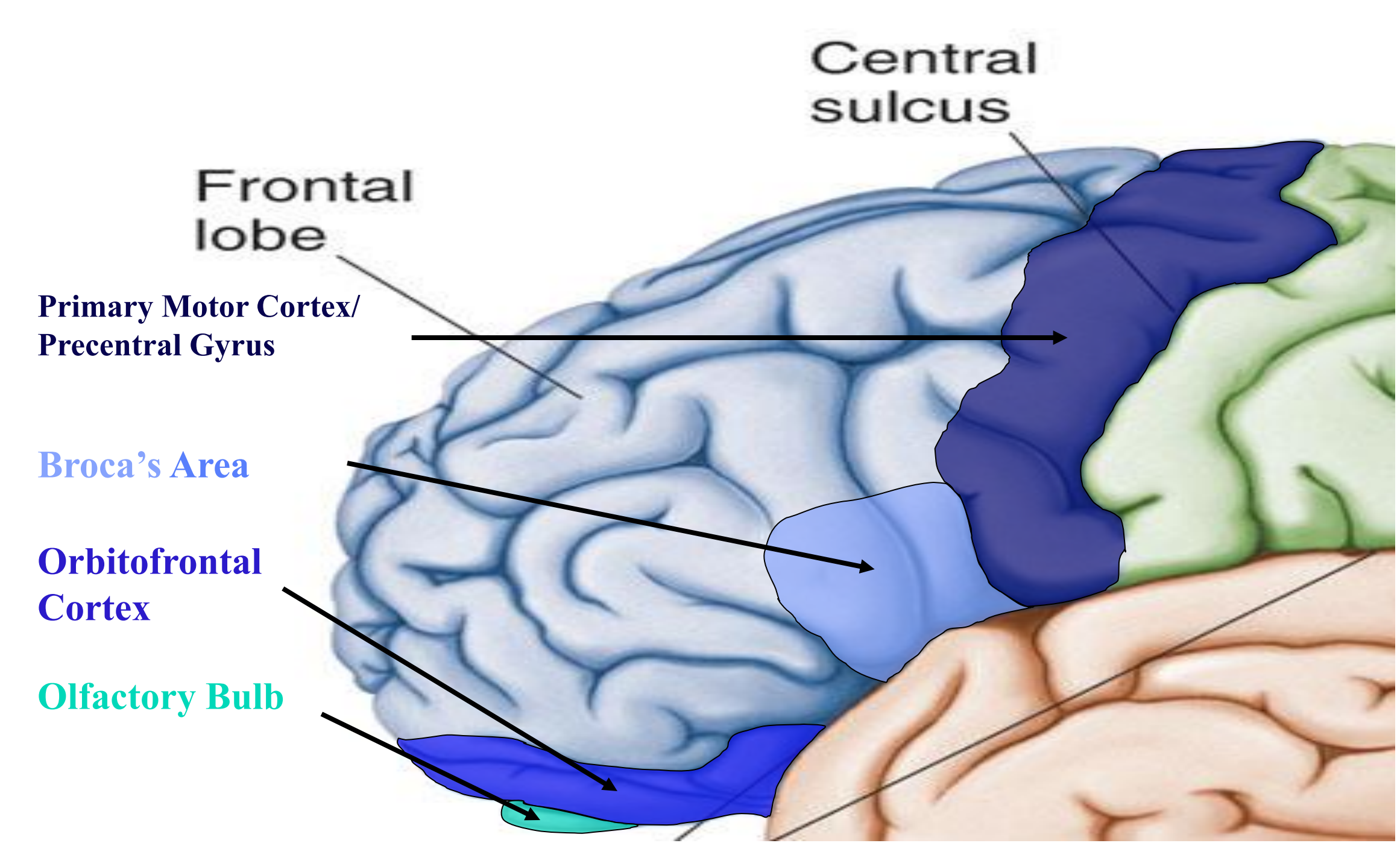


Brain Lobes – Frontal

- Voluntary movement, planning, reasoning, judgment (executive functioning), short-term memory, motivation, reward

- Integrates stimuli, emotion, memory to form responses





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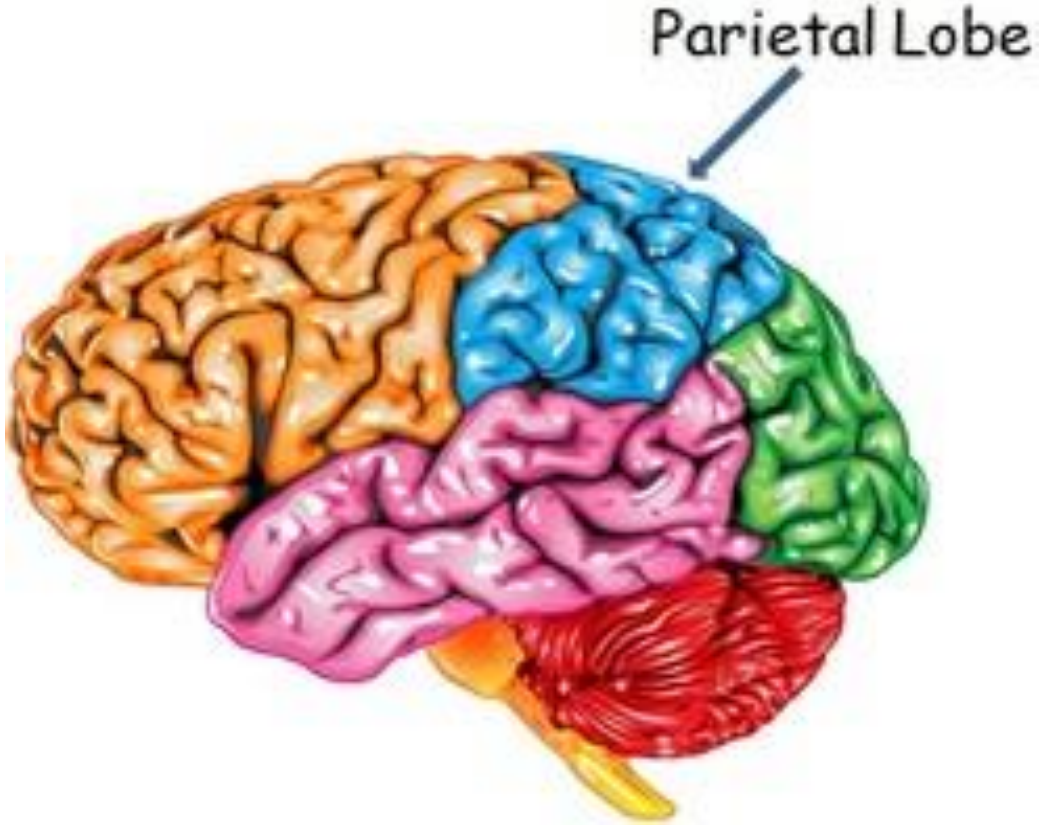
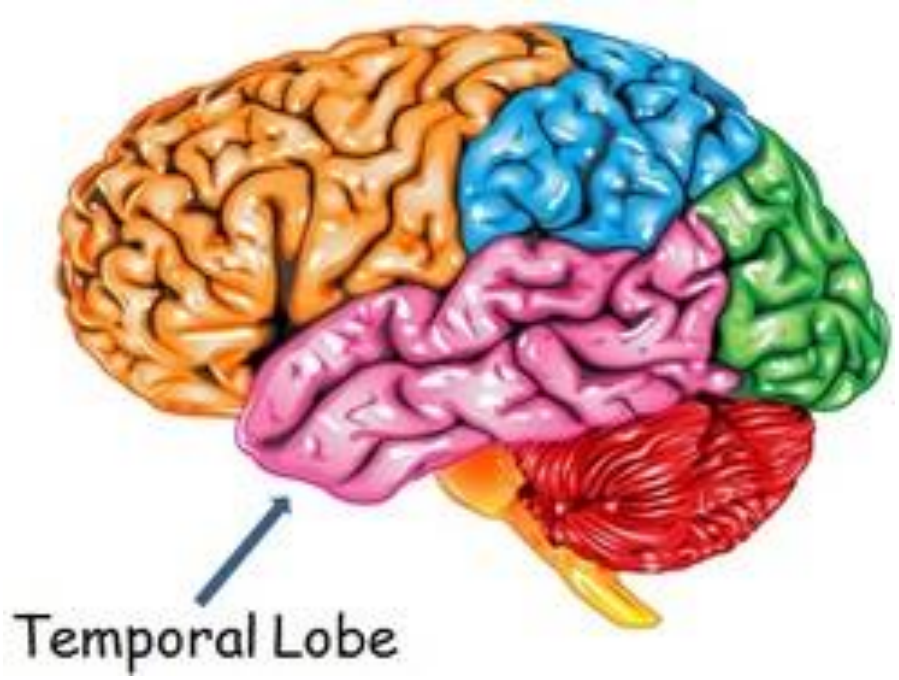
Brain Lobes - Parietal

- Integration of sensory information from different modalities
- Involved with mapping and coordination
- Parietal association cortex enables individuals to read, write, and solve mathematical problems



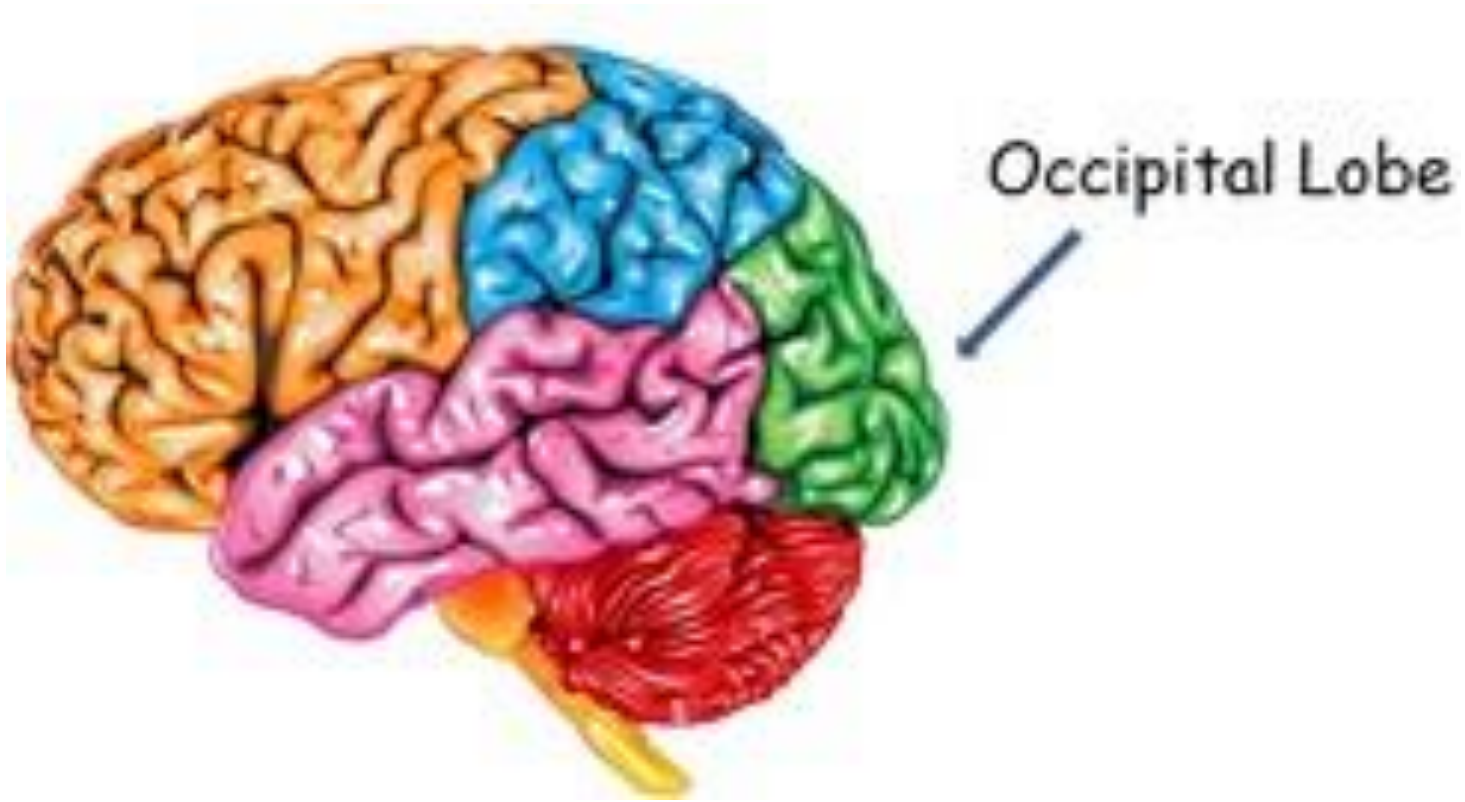
Brain Lobes - Temporal

- Involved in auditory perception (contains primary auditory cortex)
- Important for the processing of semantics in both speech and vision
- Contains the hippocampus and plays a key role in the formation of long-term memory



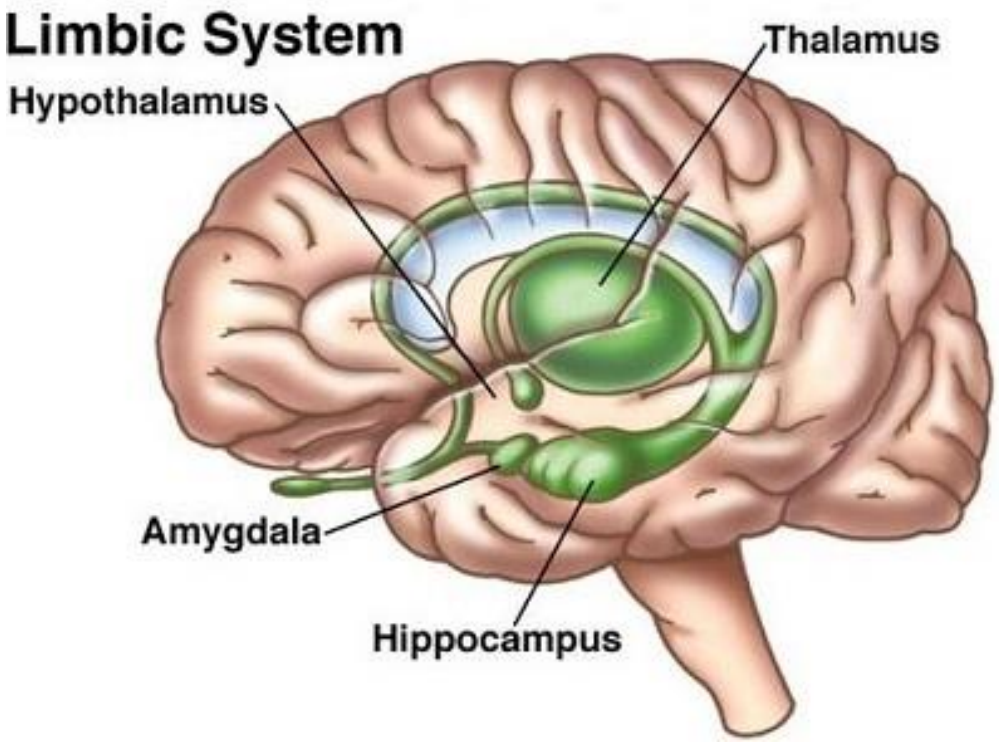
Brain Lobes - Occipital

- Visual processing center
- Visual perception and spatial processing



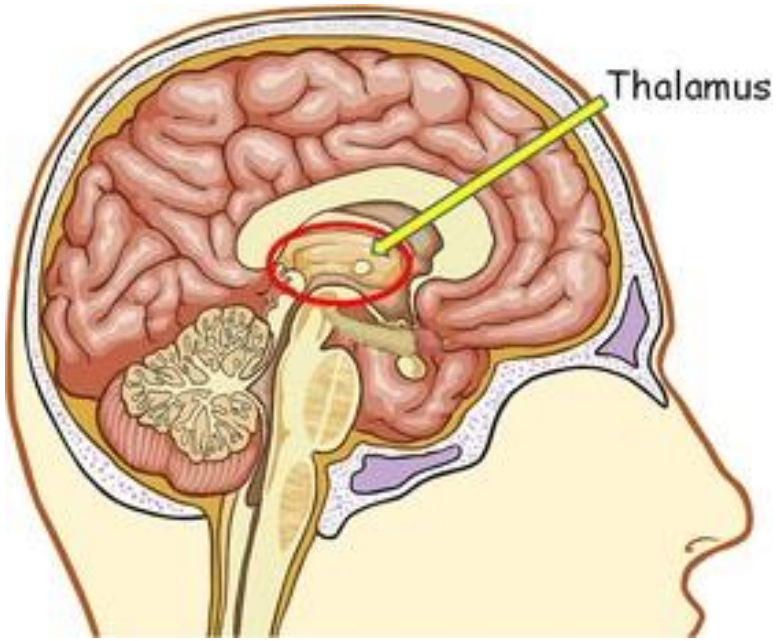
Limbic System/Midbrain

- Deep part of the brain located inside the cerebrum
- Main parts are thalamus, hypothalamus, amygdala and hippocampus
- Often called the emotional center of the brain
- Support a variety of functions including emotion, behavior, long term memory, and olfaction



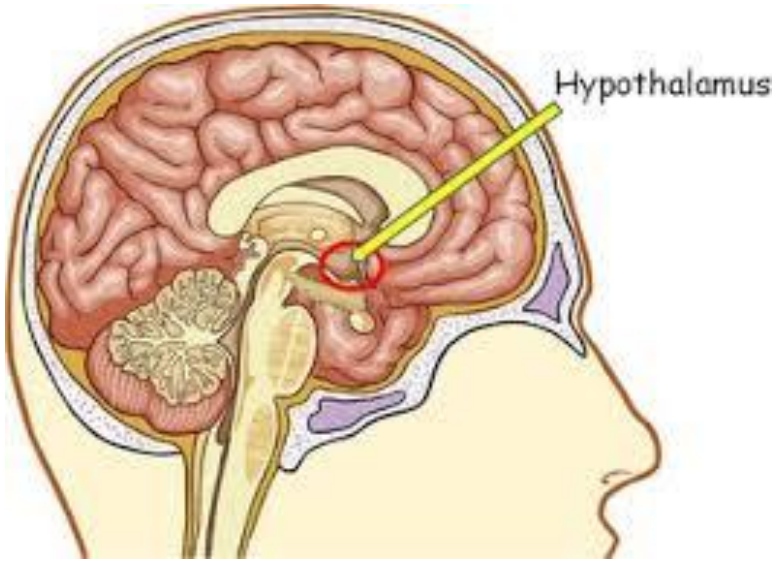
Thalamus

- Relay center between a variety of subcortical areas and the cerebral cortex
- Every sensory system (with the exception of the olfactory system) has a “hub” in the thalamus that receives sensory signals and sends them to the associated primary cortical area
- Plays a role in sleep and wakefulness



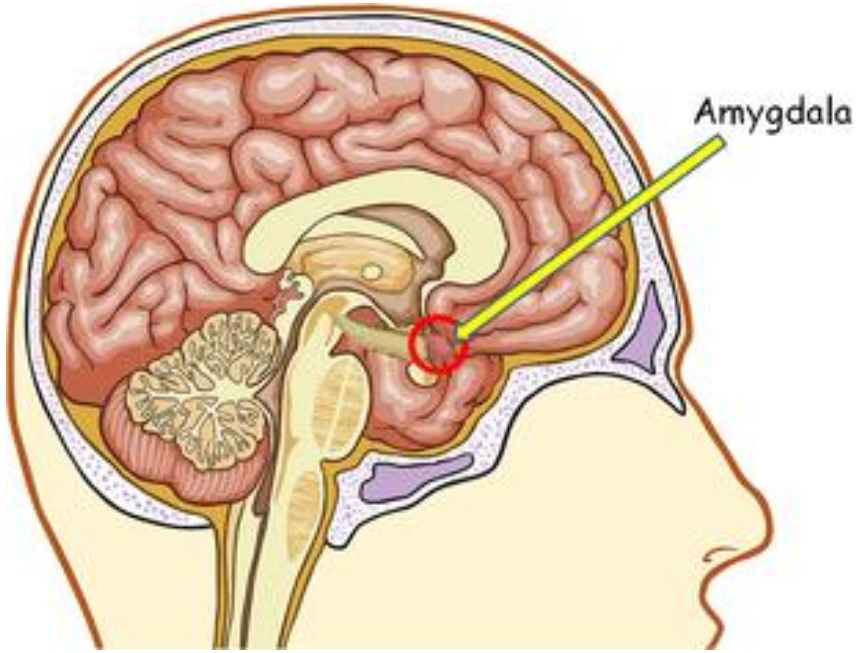
Hypothalamus

- Involved autonomic nervous system (homeostasis)
  - temperature regulation
  - water and nutrient balance (thirst)
  - sleep-wake patterns (circadian rhythms)
  - food intake (hunger)
  - some endocrine (hormonal) control



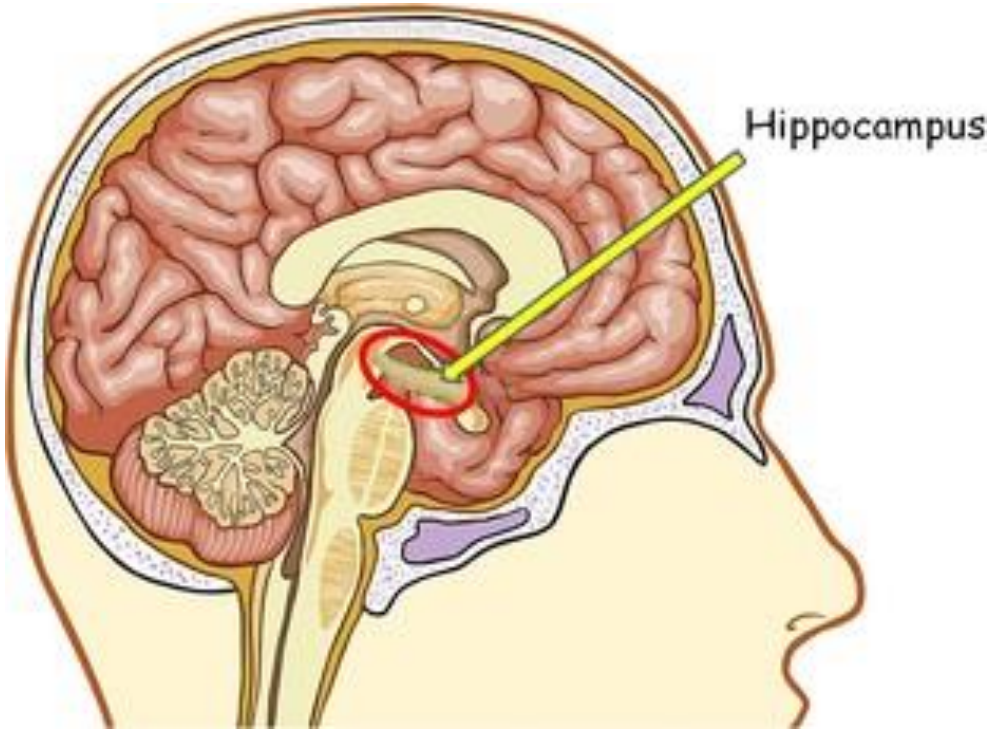
Amygdala

- Key player in emotional processing
  - A left and a right amygdala
  - Expression of fear and fear conditioning
  - Expression of pleasure
  - Positively correlated in size to aggression levels
  - Linked to phobias



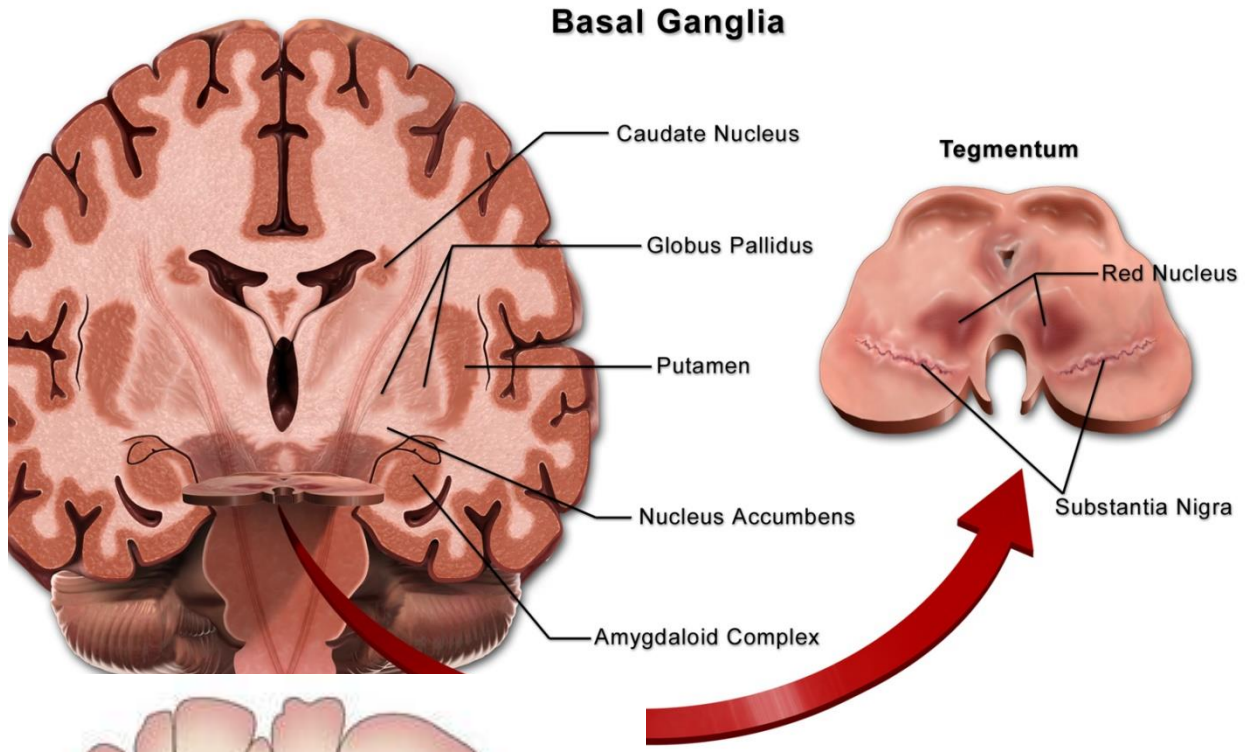
Hippocampus

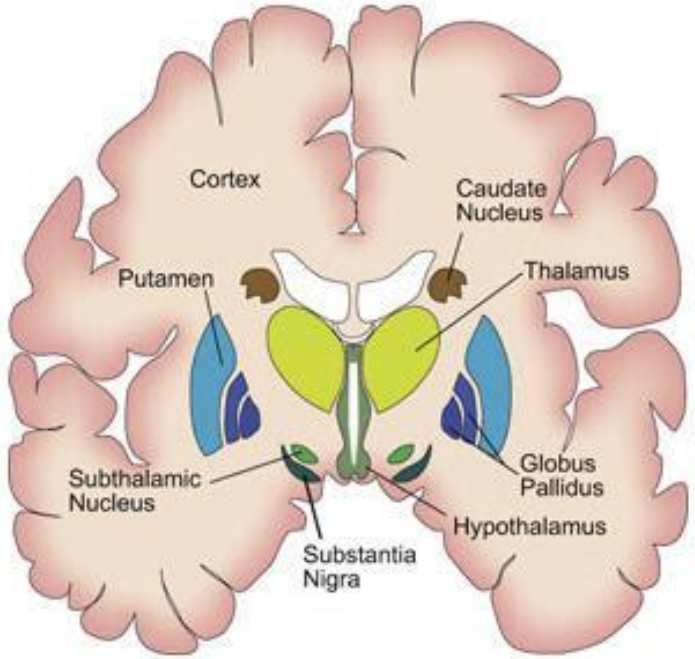
- A left and a right hippocampus
- Key player in memory
- Spatial navigation
- Emotions
- Located in medial temporal lobe



Basal Ganglia

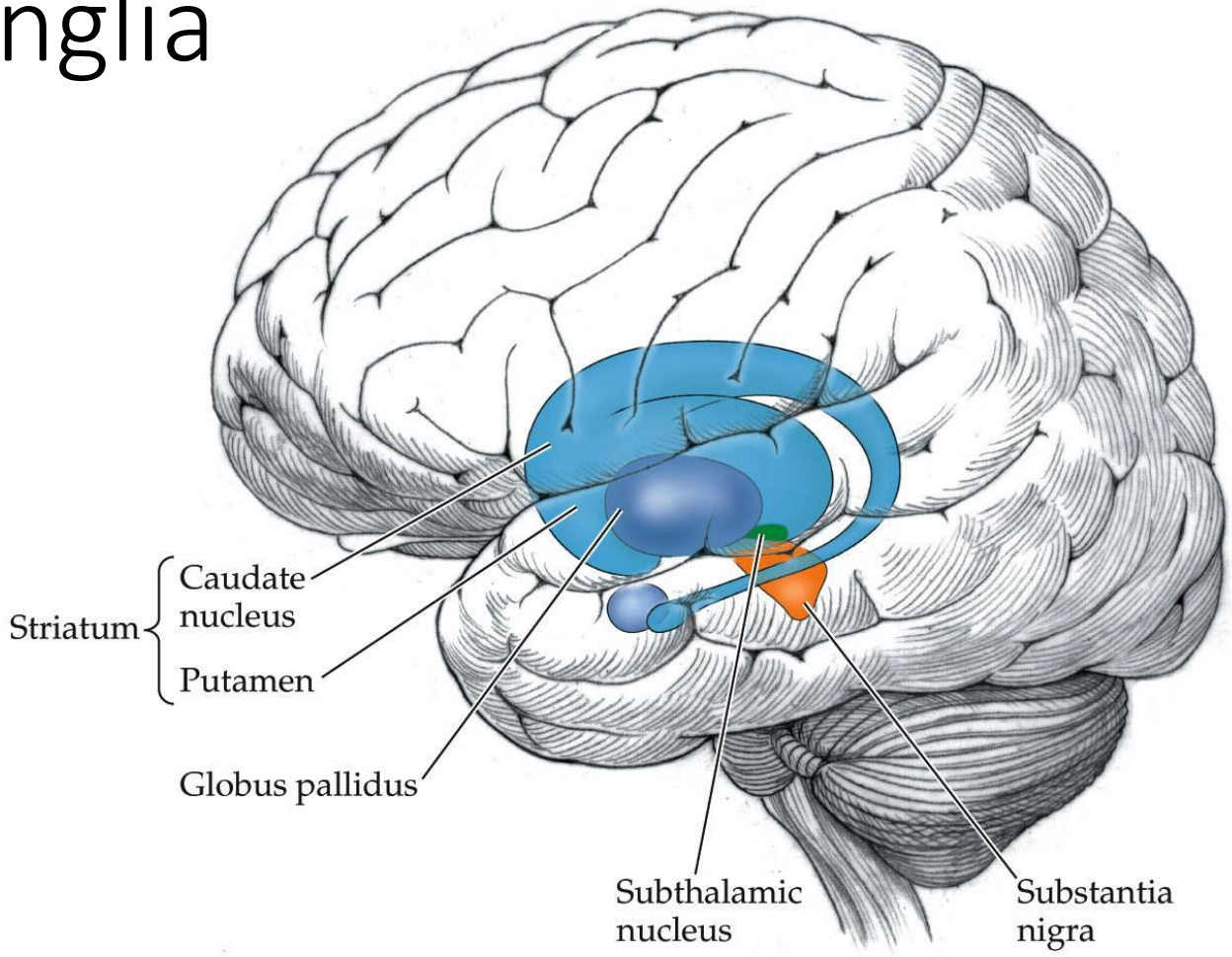
- Groups of neurons that lie deep within the brain
  - Dorsal Striatum
    - Caudate
    - Putamen
  - Ventral Striatum
    - Nucleus Accumbens
    - Olfactory region
  - Globus Pallidus
  - Subthalamic Nucleus
  - Substania Nigra





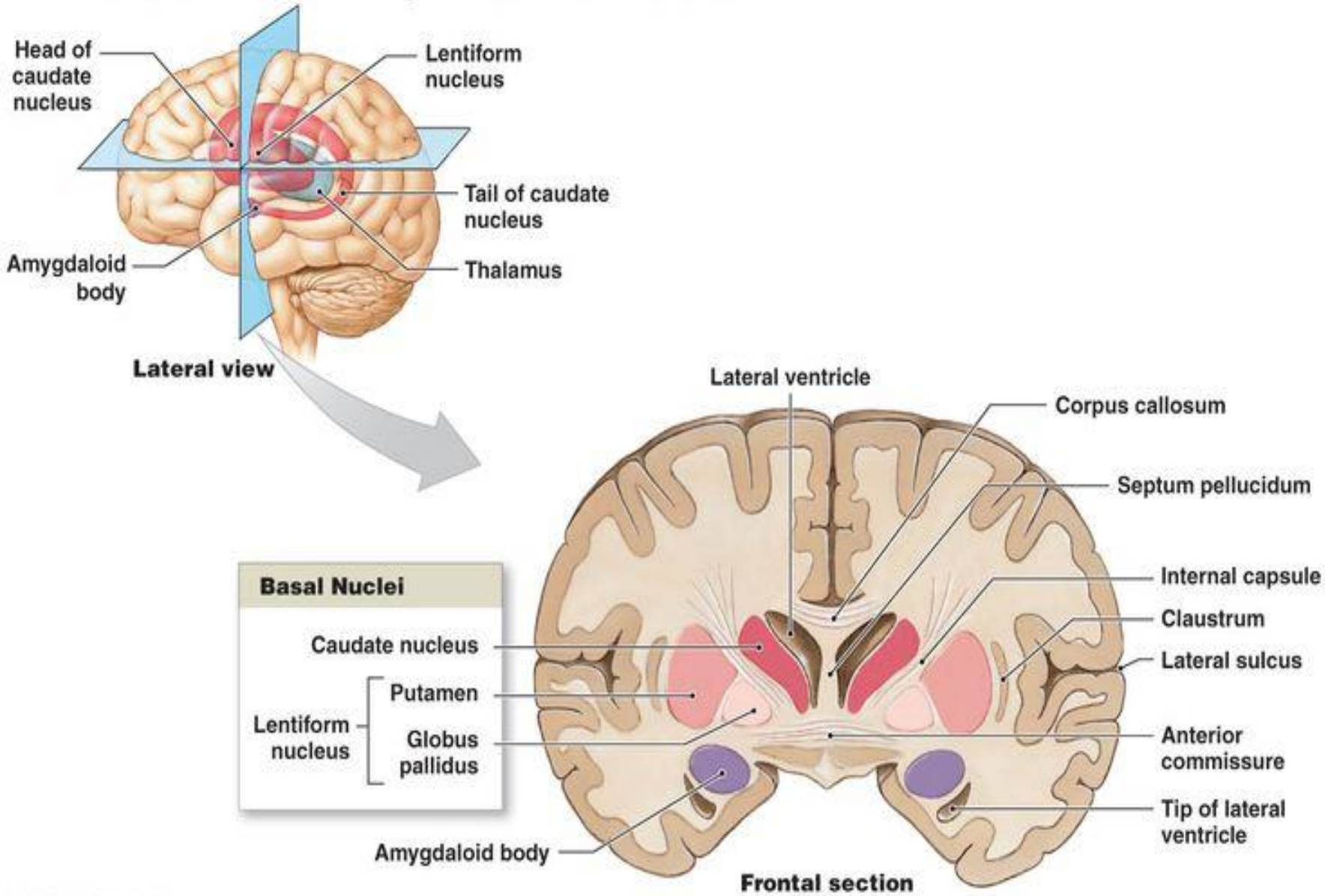
Striatum & Basal Ganglia

- Dorsal – Caudate nucleus and putamen, divided by white matter
- Ventral – Nucleus accumbens and olfactory region



***Biological Psychology 6e*, Figure 11.18**

A frontal section of the brain showing the locations of the basal nuclei

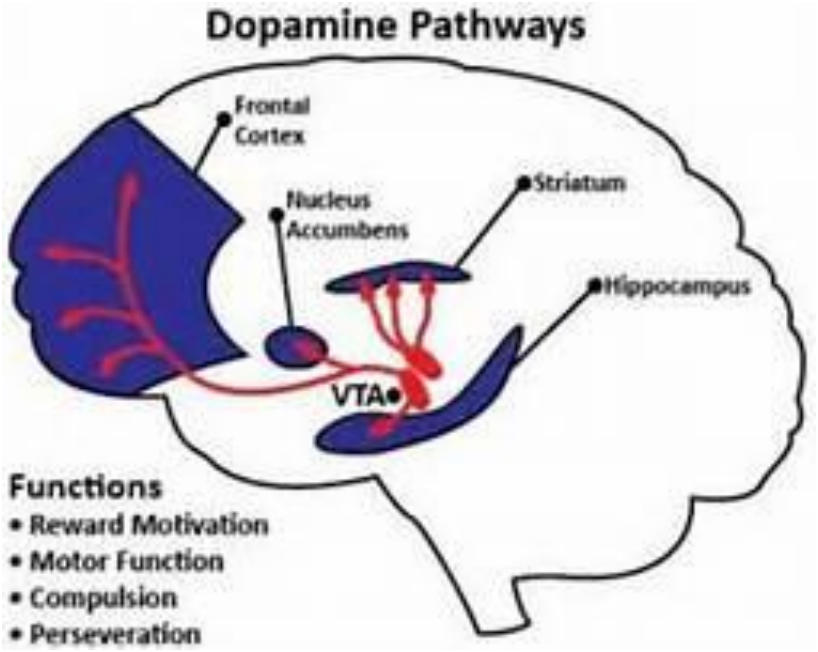


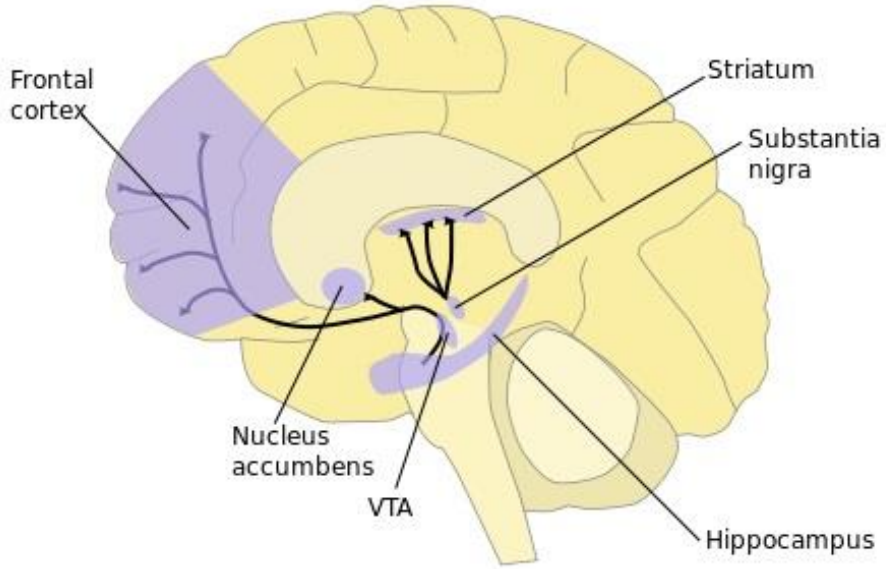
Ventral tegmental area

Group of neurons close to the midline on the floor of the midbrain

Origin of dopaminergic cell bodies (dopamine neurotransmitter)

Part of reward network in the brain

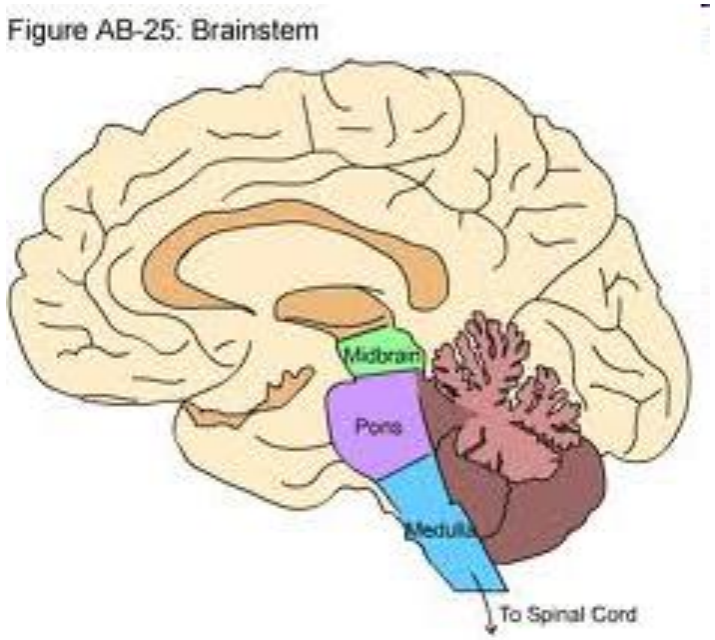




Brain Stem

- Connects the brain with the spinal cord
- Automatically controls vital functions like breathing

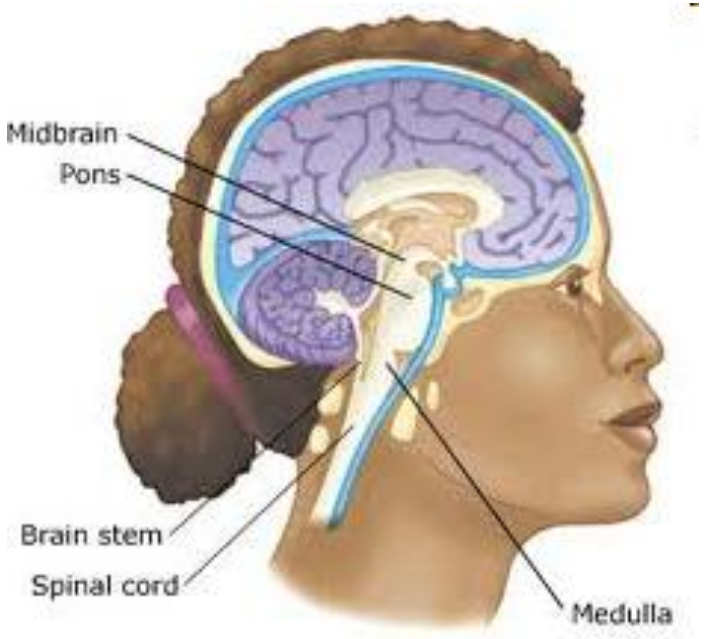
- 3 Regions:
  - Midbrain
  - Pons
  - Medulla Oblongota



Brainstem - Midbrain

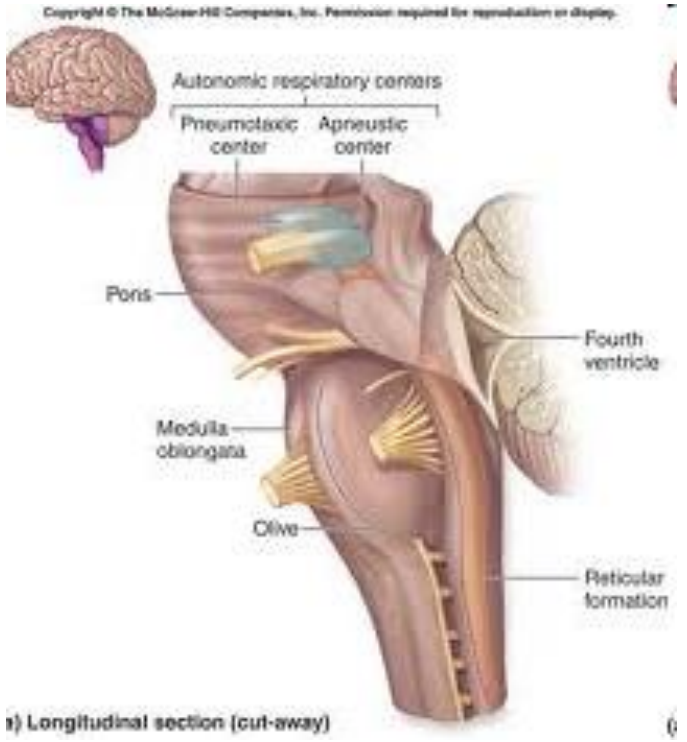
- Connects the pons and cerebellum with the cerebrum
- Located at the upper end of the brain stem

- Involved with:
  - Visual reflexes
  - Movement of eyes
  - Focusing of the lenses
  - Dilation of the pupils



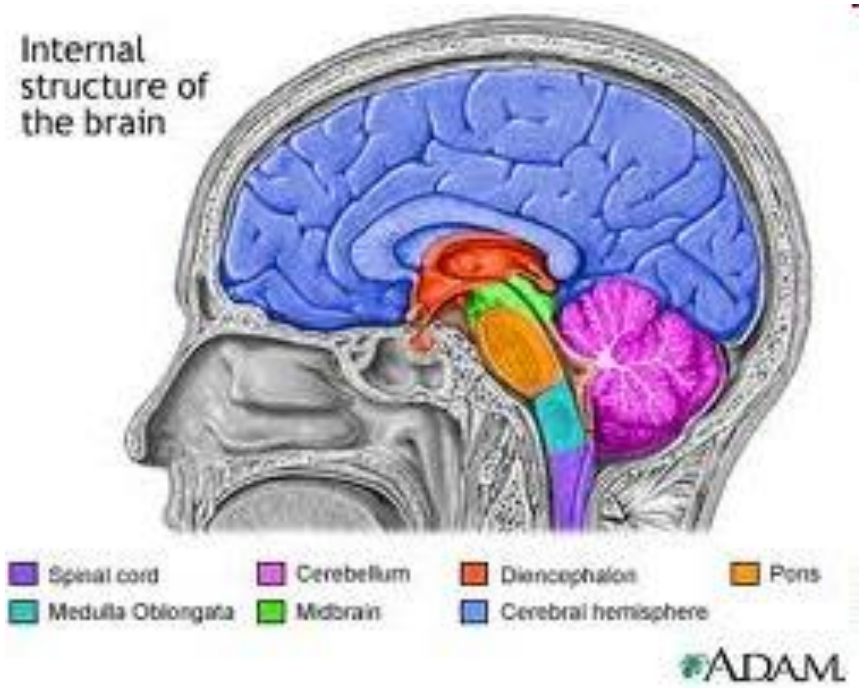
Brainstem - Pons

- Rounded bulge between the midbrain and medulla oblongata
- Functions with medulla oblongata to control respiratory function



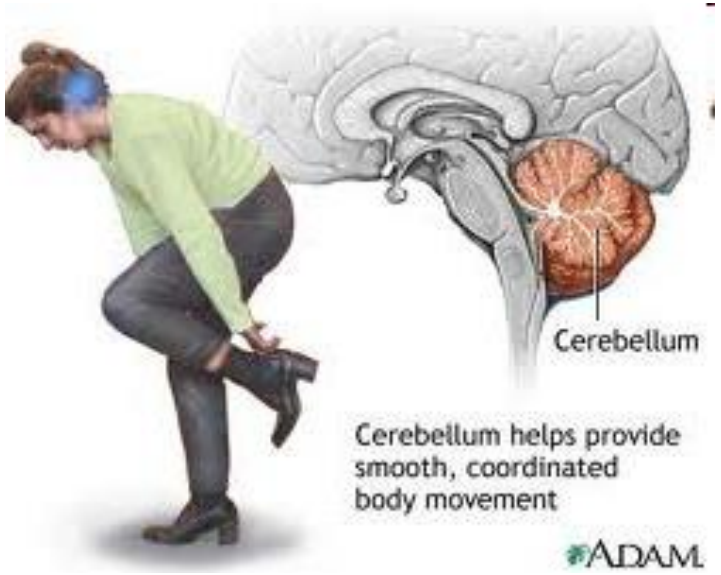
Brainstem - Medulla Oblongata

- Lower most part of brainstem
- Connects pons to spinal cord
- Contains vital centers that regulate
  - Heart rate
  - Respiratory rate
  - Constriction and dilation
    of blood vessels
  - Blood pressure
  - Swallowing
  - Vomiting
  - Sneezing
  - Coughing



Cerebellum (Latin for “little brain”)

- Second largest part of the brain
- Processes sensory information
- Involved with coordinating skeletal muscle contractions and voluntary motor movement
- Processing center involved with coordination, balance, body position, and timing of movements
- Not well understood in terms of function

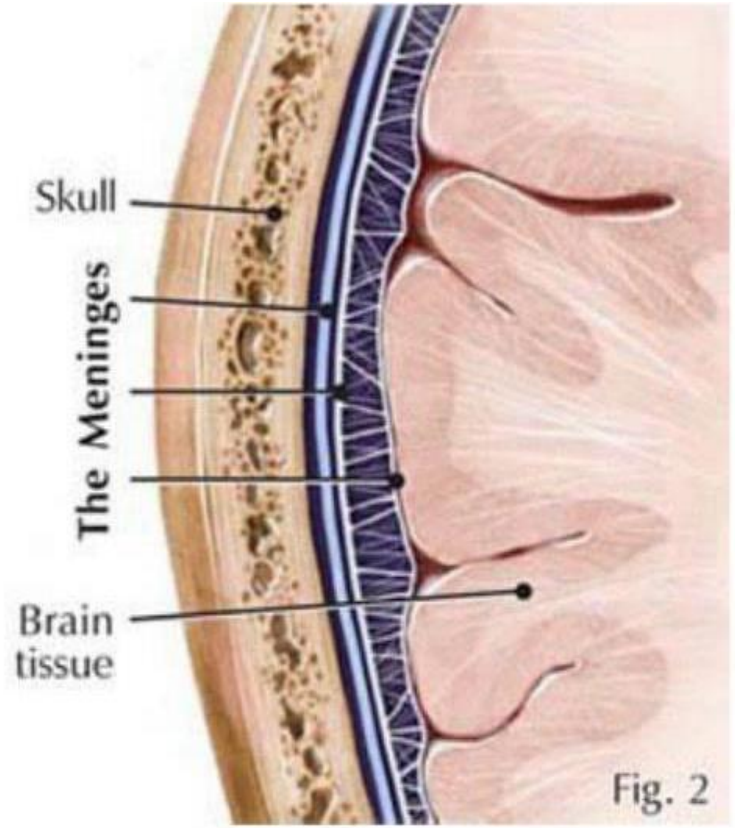


Brain Protection

Skull: protects our brain from injury (bumps). Without it, soft brain tissue would damage easily

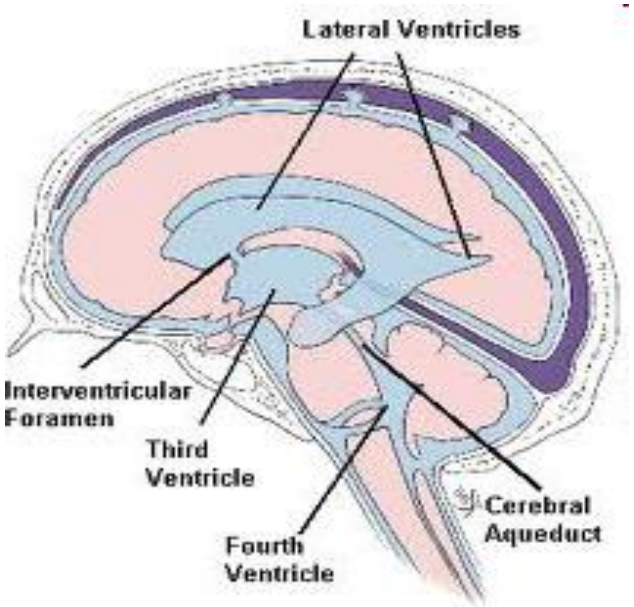
Cerebrospinal Fluid (CSF): Fluid surrounding the brain. Acts as a shock absorber and stops our brain bumping around in our skull

Meninges: three layers (membranes) of protective tissue with CSF between each layer also help to protect the brain and act as a shock absorber when we get a bump to the head.



Cerebral Spinal Fluid (CSF)

A clear, colorless bodily fluid, that occupies the subarachnoid space and the ventricular system around and inside the brain and spinal cord



CSF Main Functions

- Buoyancy: allows the brain to maintain its density without being impaired by its own weight
- Protection: CSF protects the brain tissue from injury when jolted or hit
- Chemical stability: Rinses the metabolic waste from the central nervous system through the blood-brain barrier
- Prevention of brain ischemia: Decreases total intracranial pressure but reducing fluid levels when necessary and facilitates blood perfusion

In summary

- Anatomical directions of the body and brain
- Parts of the brain – main sections & the four lobes
- Brain protection through the meninges and spinal cord