

Section 1

Neuroanatomy

Sujin Park
COGS 17 A05

04/07/25

Introduction

Sujin Park

Education:

first-year PhD Student in Cognitive Science
MA Psychology
BA Political Science and Diplomacy & Psychology



Research:

- Biomarkers of Neurodevelopmental disorders

Contact Info:

- Email: sup031@ucsd.edu (Pls include COGS17 in subject line) or Canvas Inbox
- Discussion Section: Monday 1pm @ CSB 004
- Office Hours: Thursday 2pm (zoom link on the announcement on canvas)

Feel free to reach out if you have any questions or problems!

Ground Rules

Use this section to boost your learning

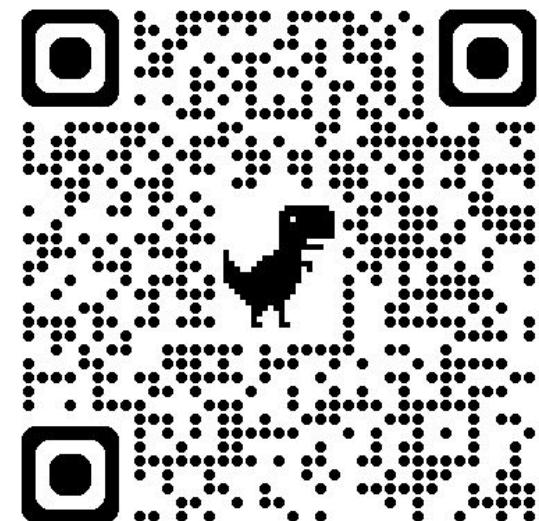
- The aim of this section is to review contents covered in class
- Attending section and actively engaging will improve your learning!
- It's okay to be wrong

Keep discussions on topic

- Everyone has different opinions about various things
- Let's keep the conversation about class and lecture subjects

Section slides are on github (scan QR code)

Let's all get As!



Important Reminders

Homework Problem sets

- Homework problems are Required, they guide your learning and will inform us of how you are doing for the lectures
- Due every Wednesday at Midnight (**EXCEPT** April 21st - Monday)
- IMPORTANT: NO LATE HOMEWORKS WILL BE ACCEPTED

Exams

- 4 Exams total: Online, Open book, “one shot” for consecutive 80 Minutes
- 3 Midterms are NON-cumulative
- 1 Final is Comprehensive (on the SAME DAY after 3rd Midterm)

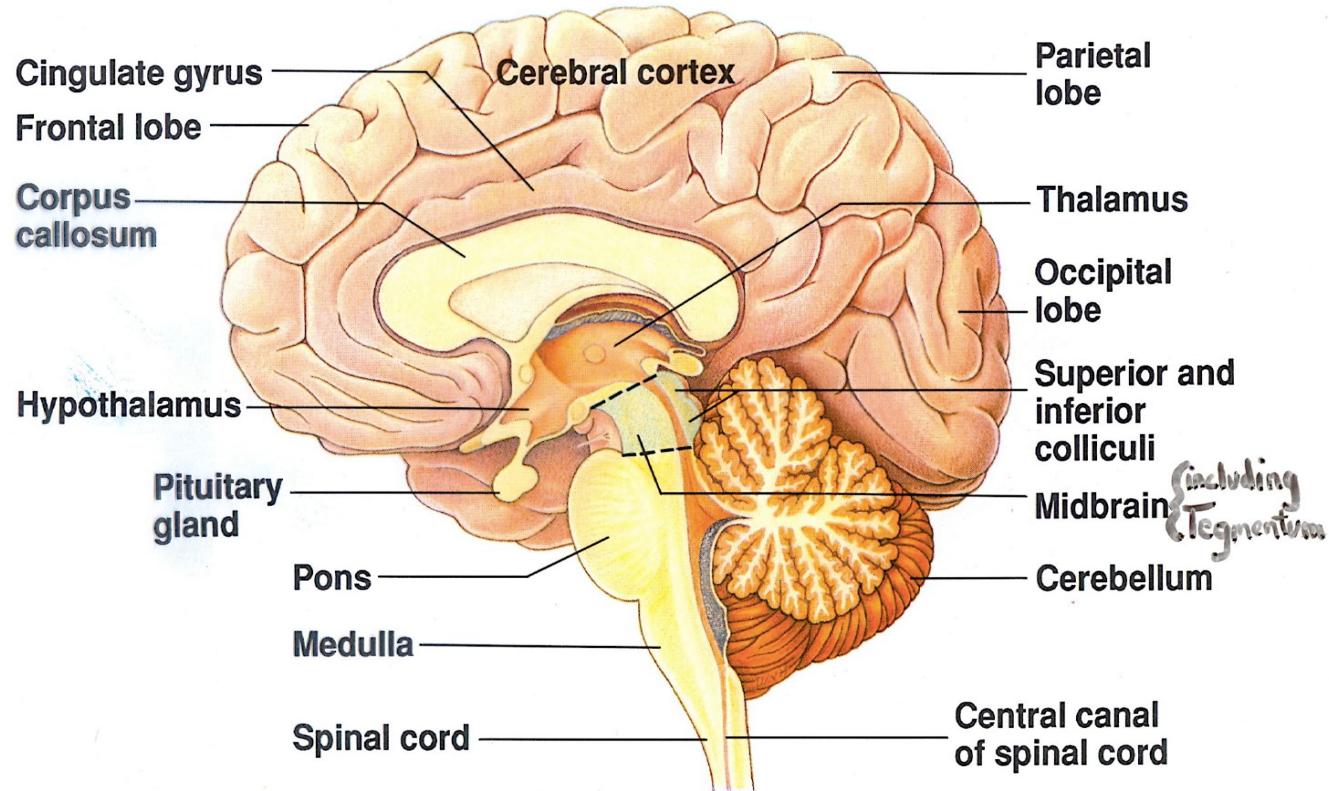
Extra Credit

- SONA
- Mnemonics
- Homeworks

Lecture 1

Anatomy of the Nervous System

Mid-Saggital Section



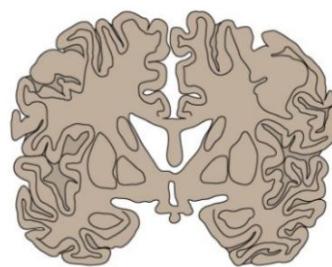
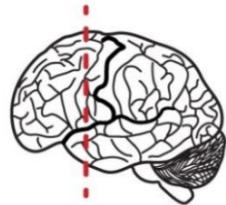
Sagittal section of human brain

After Nieuwenhuys et al., 1988

© 1992 Wadsworth, Inc.

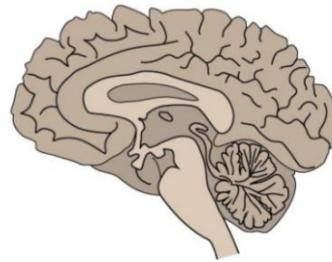
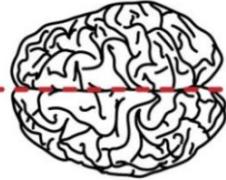
Planar Views of the Brain

Frontal or
coronal plane



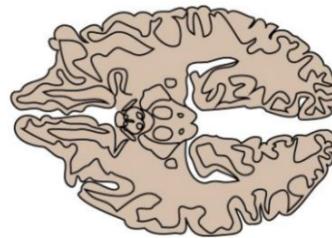
Coronal Plane -- From the **FRONT**

Sagittal plane



Sagittal Plane -- From the **SIDE**

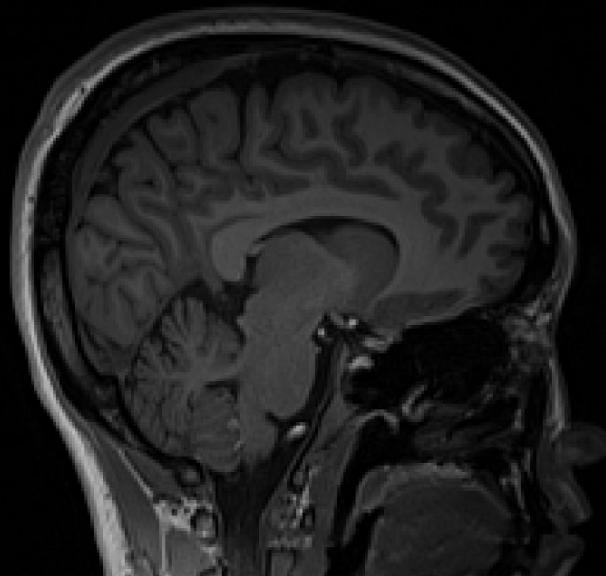
Horizontal plane



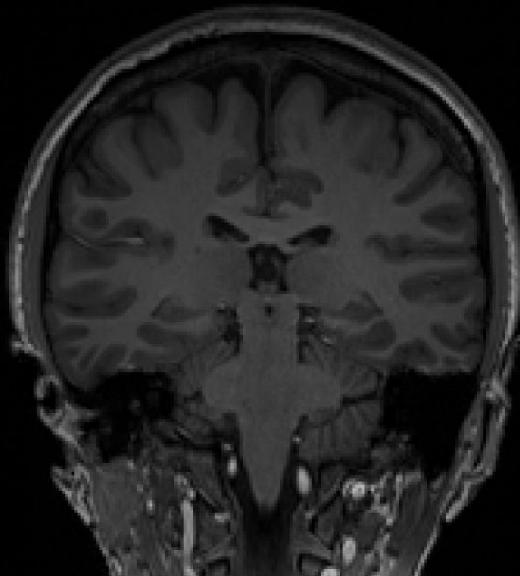
Horizontal Plane -- From the **ABOVE**

Planar Views of the Brain - Surprise Quiz

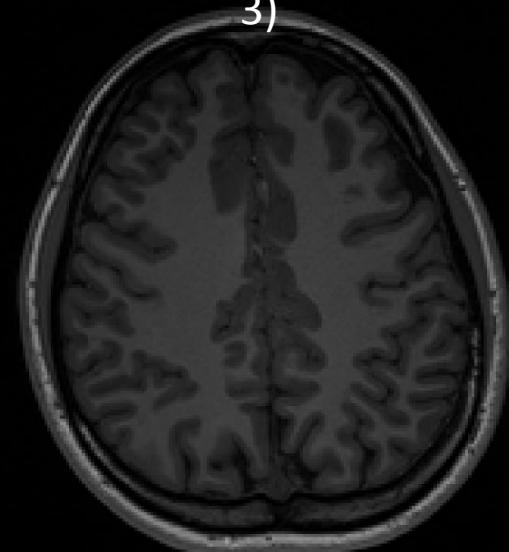
1)



2)



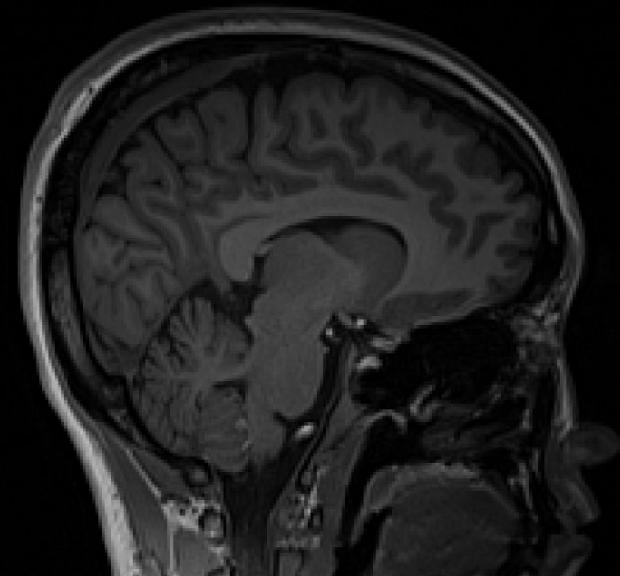
3)



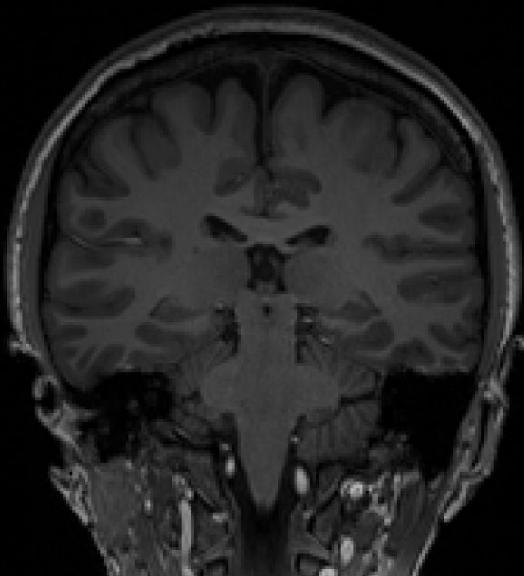
Guess whose brain this is 😊

Planar Views of the Brain - Surprise Quiz

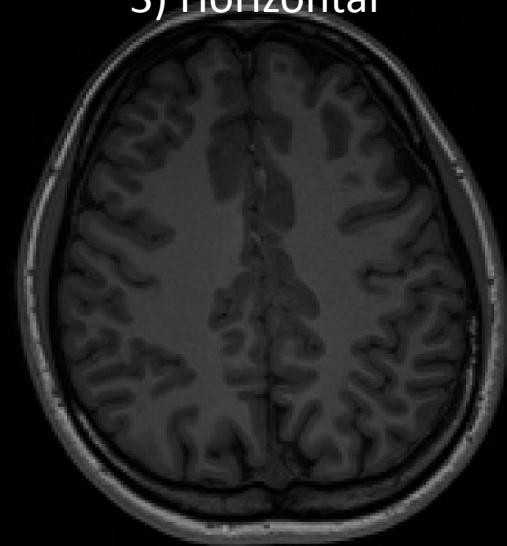
1) Sagittal



2) Coronal



3) Horizontal



Guess whose brain this is 😊

Orientation and Views

Lateral & Medial

- Lateral: Towards the sides (Outside)
- Medial: Towards the middle (Center)

Dorsal & Ventral

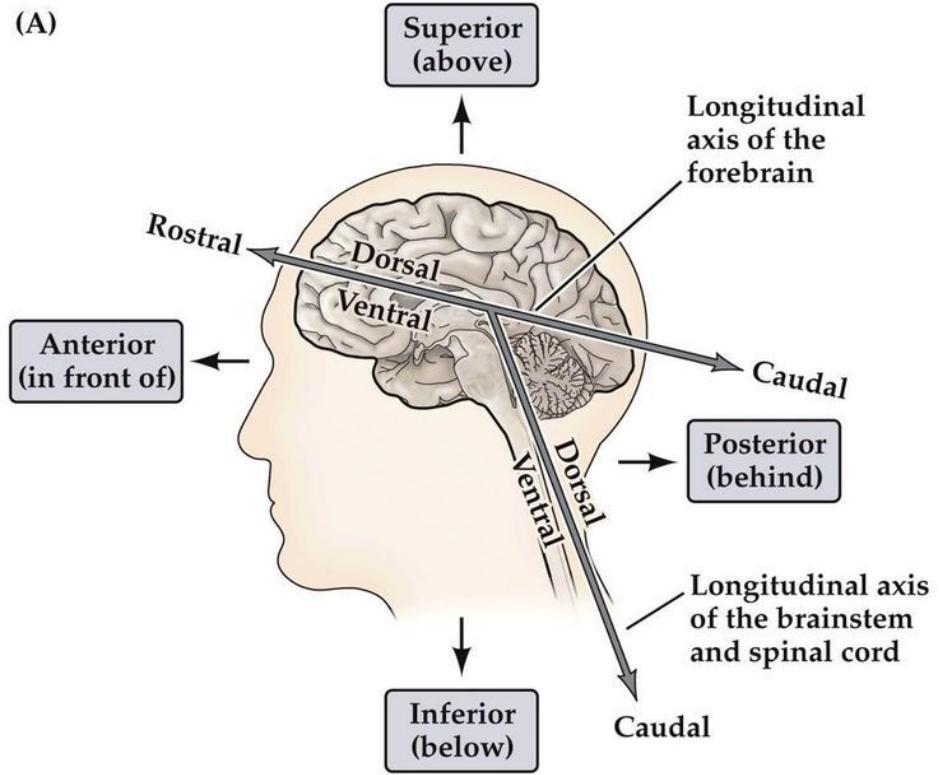
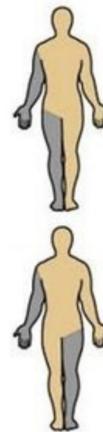
- Dorsal: The “top” of the brain
- Ventral: The “underside” of the brain

Anterior & Posterior

- Anterior: Front
- Posterior: Back

Bilateral Structure

- Ipsilateral: Same side
- Contralateral: Opposite side

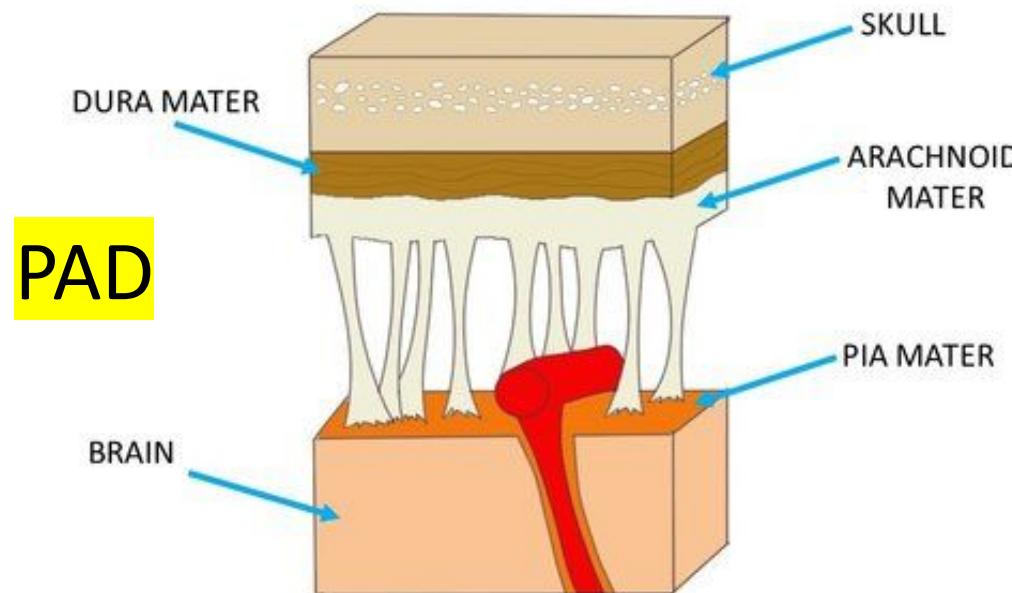


NEUROSCIENCE 5e, Figure A1 (Part 1)
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Support Structure

Meninges: surrounds CNS under bone

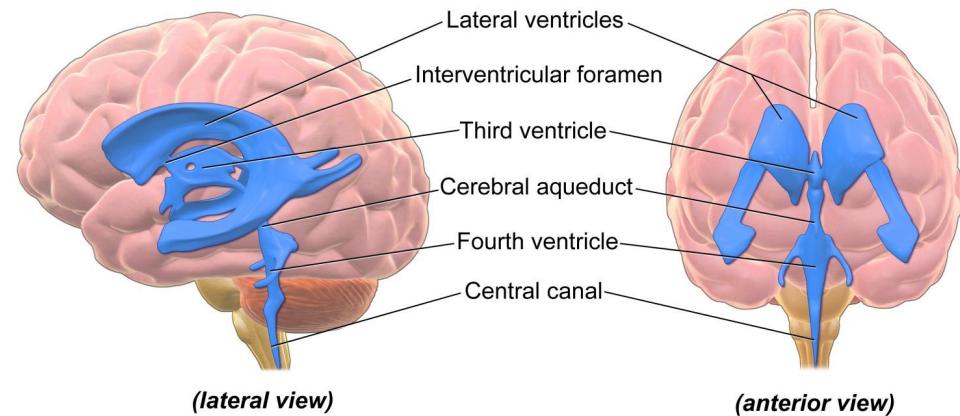
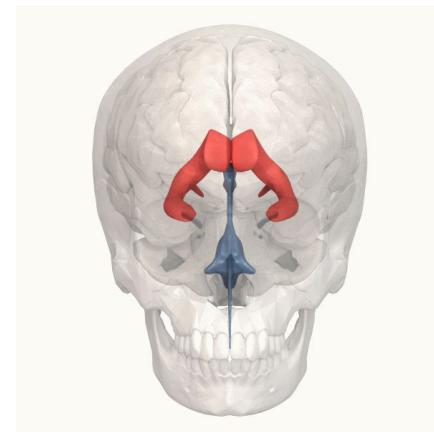
- Dura Mater (=Tough mother): Thick outer layer
- Arachnoid Mater: Spider-web like, spongy layer filled with Cerebrospinal fluid (CSF), shock absorber
- Pia Mater: flexible inner layer that conforms to the brain and spine surfaces, include blood vessels



Support Structure

Ventricles

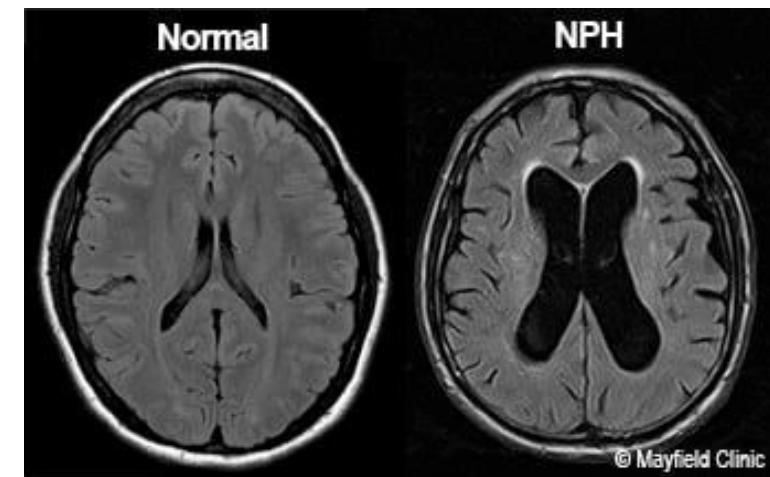
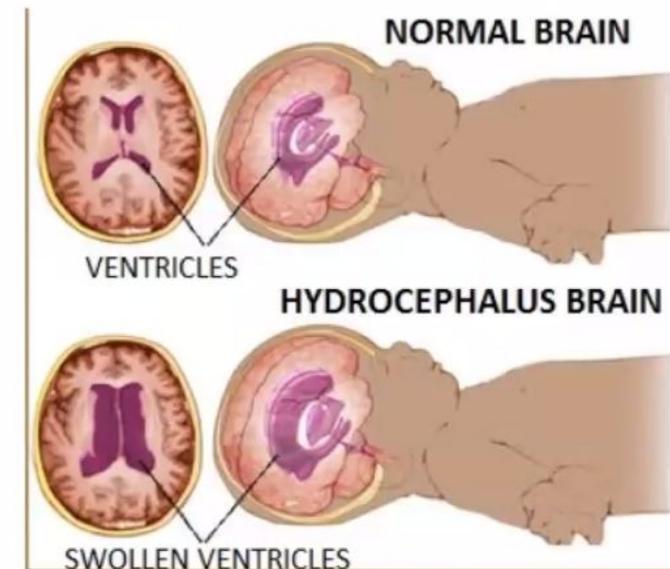
- Hollow, interconnected cavities
- produce and circulate CSF
- Structure:
 - 2 Lateral Ventricle
 - Central Third Ventricle
 - Cerebral Aqueduct
 - Central Fourth Ventricle



Hydrocephalus

Swollen ventricles

- When does this happen: CSF is not properly drained out through the cerebral aqueduct, the ventricles tend to swell up
- Then... CSF swelling pushes the brain matter against the PAD, replacing cortical matter with CSF
- Typically Fatal
 - Interventions can redirect excess CSF into the abdominal cavity to reduce the swelling



Hydrocephalus



Feeding the brain

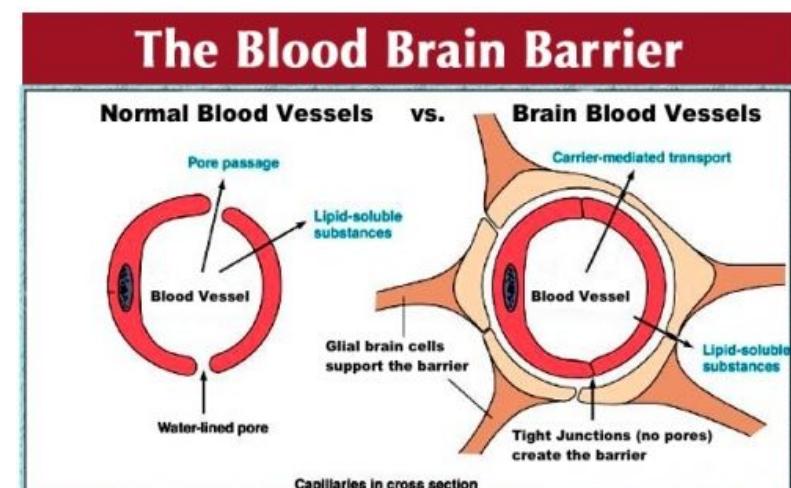
Blood Vessels

- Web of incoming **arteries** and outgoing **veins**
- Helps clear out the brain of waste
- Carries out “used” CSF
- 2% of body weight but uses 20% of blood supply



Blood-Brain Barrier (BBB)

- Strict control over what enters brain from bloodstream
- Protects the brain from infections
- Only small uncharged particles (O_2 , CO_2) and some fat-soluble molecules can passively cross BBB
- Astrocyte helps to create barrier



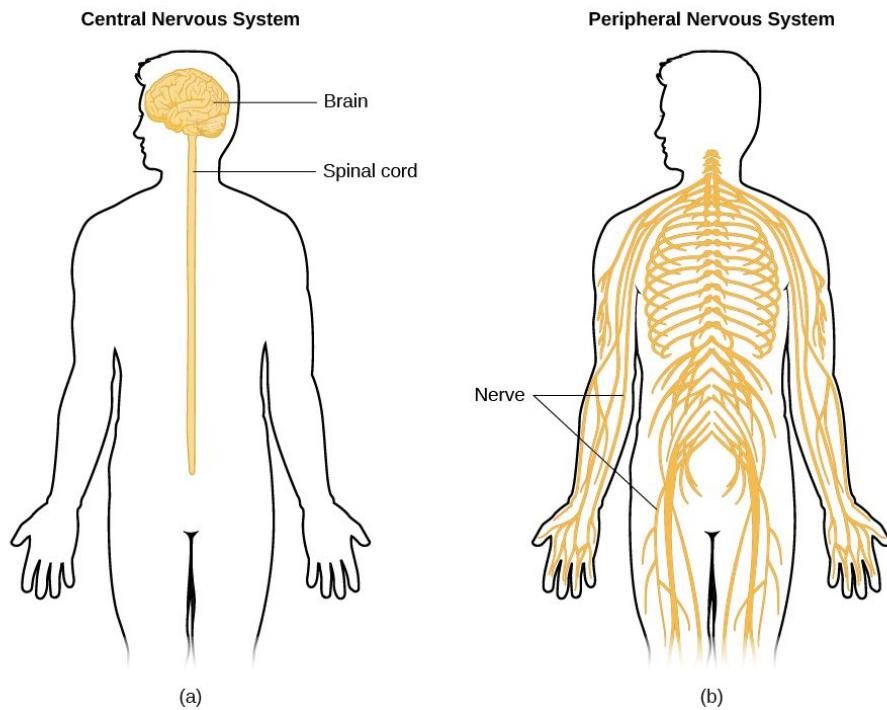
CNS vs PNS

Central Nervous System (CNS)

- Spinal cord and brain
- Encased in bone and meninges

Peripheral Nervous System (PNS)

- Nerves outside the CNS
- Somatic Nervous System:
interaction with the external
environment (Sensory/Motor)
- Autonomic Nervous System:
interaction with the internal
environment (internal organs)



Review Questions

Match definition to concept:

- Towards the center of the brain
- Bottom of the brain
- Top of the brain
- On both sides of the brain
- Same-side connections
- Towards the outside of the brain
- Opposite side connections

- A. Lateral
- B. Medial
- C. Dorsal
- D. Ventral
- E. Bilateral
- F. Ipsilateral
- G. Contralateral

Label as either pertaining to the central nervous system (CNS) or peripheral nervous system (PNS):

- Somatic nervous system
- Brain and spinal cord
- Surrounded by bone and meninges
- Autonomic nervous system

Review Questions

Match definition to concept:

- | | | |
|----------|----------------------------------|-------------------------|
| <u>B</u> | Towards the center of the brain | <u>A.</u> Lateral |
| <u>D</u> | Bottom of the brain | <u>B.</u> Medial |
| <u>C</u> | Top of the brain | <u>C.</u> Dorsal |
| <u>E</u> | On both sides of the brain | <u>D.</u> Ventral |
| <u>F</u> | Same-side connections | <u>E.</u> Bilateral |
| <u>A</u> | Towards the outside of the brain | <u>F.</u> Ipsilateral |
| <u>G</u> | Opposite side connections | <u>G.</u> Contralateral |

Label as either pertaining to the central nervous system (CNS) or peripheral nervous system (PNS):

PNS Somatic nervous system

CNS Brain and spinal cord

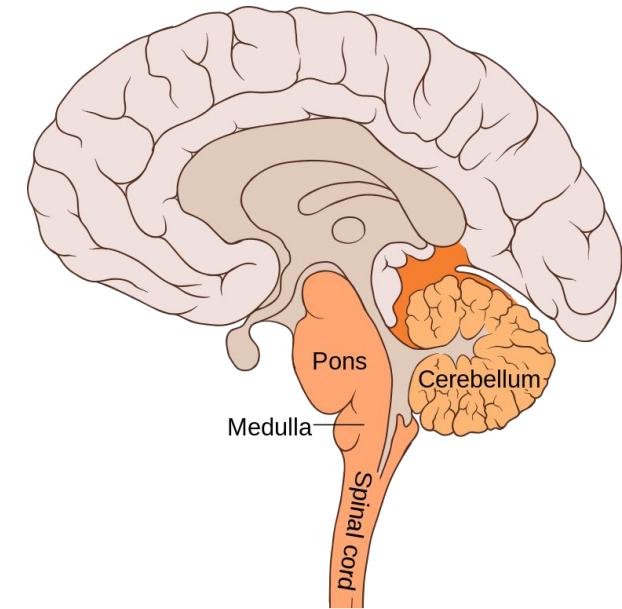
CNS Surrounded by bone and meninges

PNS Autonomic nervous system

HindBrain

Medulla Oblongata

- Control primal reflexes (e.g., breathing, heart rate, coughing, vomiting)
- functions that basically keep us alive



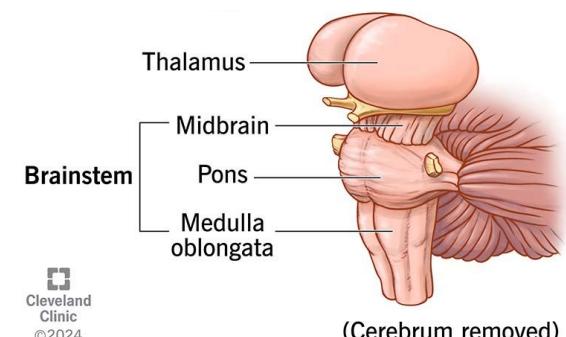
Pons

- Latin for “Bridge”: relay b/w cortex & cerebellum and brain & spinal cord
- Lateral: signals to/from cerebellum
- Medial: De-/Arousal system (i.e. reticular formation for arousal, and raphe system for sleep)

Cerebellum

- Store motor programs w/ real-time sensory coordination
- Critical in timing/well-coordinated actions and also important for shifting attention
- Propose motor sequences and guide movements
- NOT the brain stem

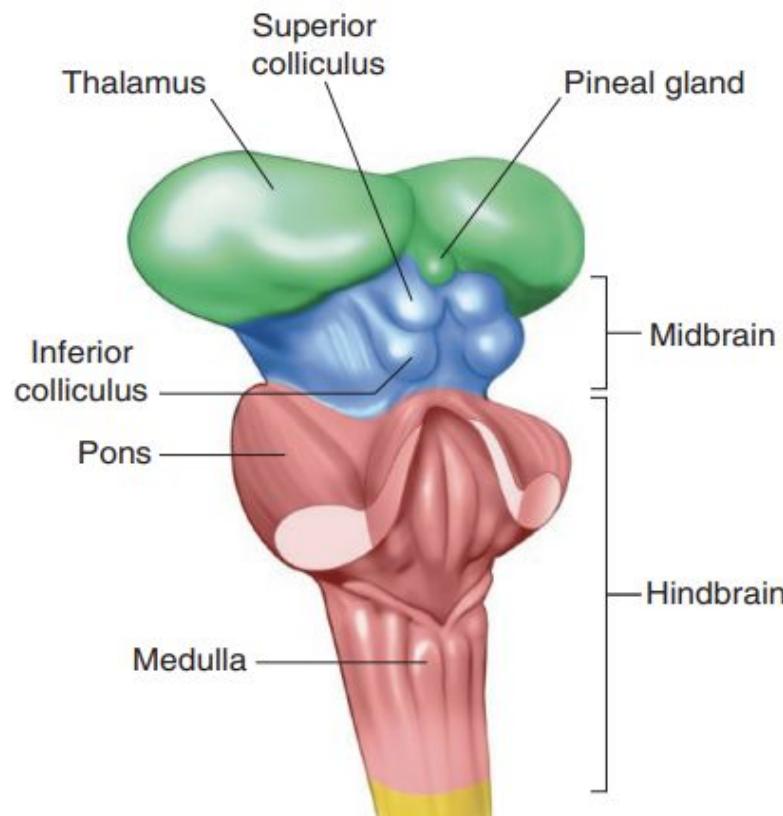
+ Hypothalamus



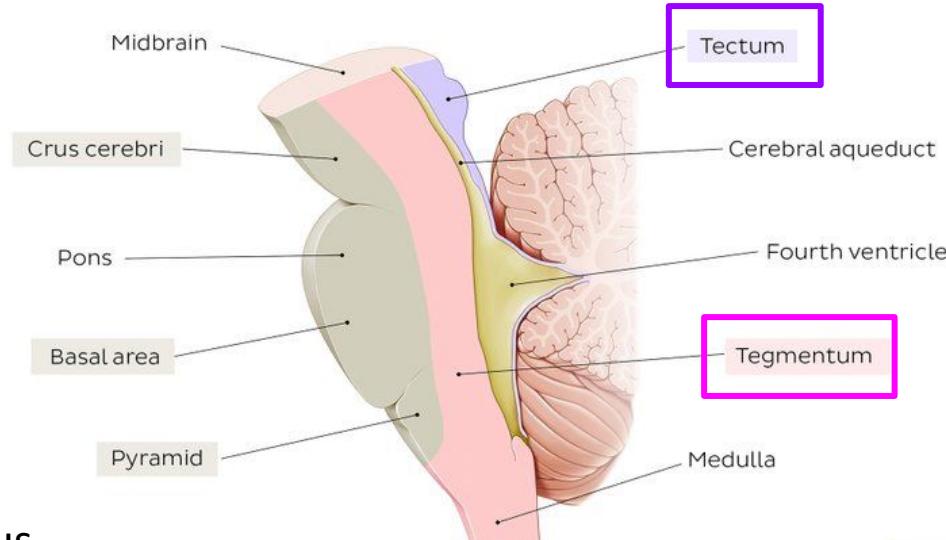
Brainstem

■ FIGURE 3.16 The Brain Stem.

The brain stem includes posterior parts of the forebrain (thalamus, hypothalamus, etc.), the midbrain, and the hindbrain. The cerebellum has been removed to reveal the other structures. This is a dorsal view of the brain stem. Refer to Figure 3.13 for its orientation with respect to the entire brain.

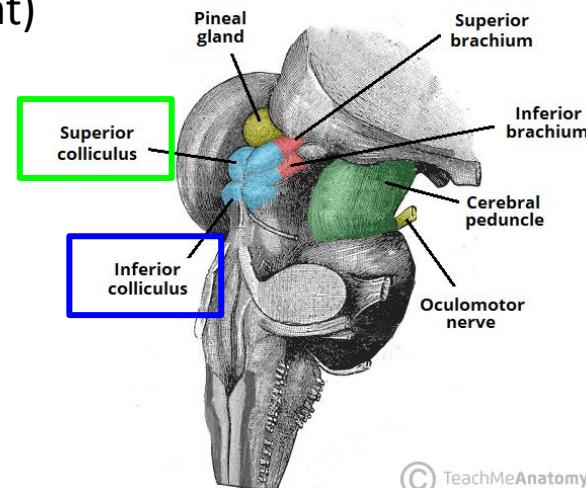


Midbrain



Tectum

- Latin for “Roof”
- Part of **sensory** pathways to the brain
- Consists of superior and inferior colliculus
 - 1) **Superior colliculus**: visual motion (including Blindsight)
 - 2) **Inferior colliculus**: auditory motion



Tegmentum

- Latin for “Covering” or “Rug”, below Tectum
- Contains major motor pathways and some cranial nerves
- Includes Red Nucleus and Substantia Nigra
- Contains cranial nerves to control eye movements



tectum to detect ‘em, tegmentum for momentum

Forebrain (Diencephalon)

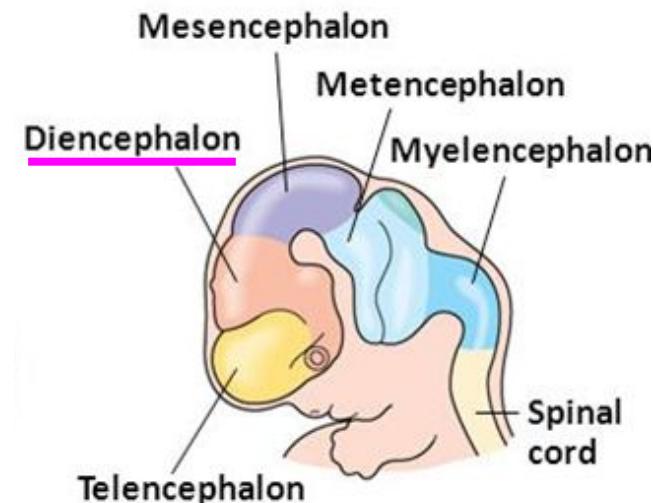
Diencephalon consists of the thalamus and hypothalamus

Thalamus

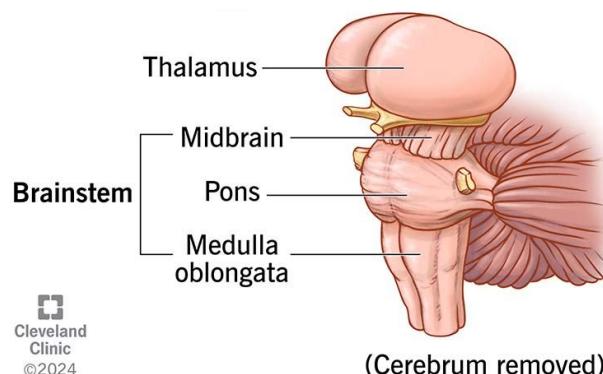
- Primary source of input to cerebral cortex
- Projects to/Receives from Sensory, Motor & Arousal sys
- Nuclei of many sensory and motor systems
- Involved in cortical arousal

Hypothalamus

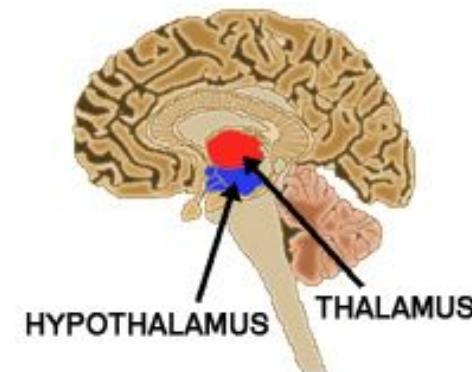
- Hypo = “below” → tucked in below Thalamus
- Oversees “4Fs”: Fighting, Fleeing, Feeding, F...
- Also regulates temperature and internal clock
- Neuro-Endocrine Sys: control brain + hormone sys by communicating to Pituitary Gland



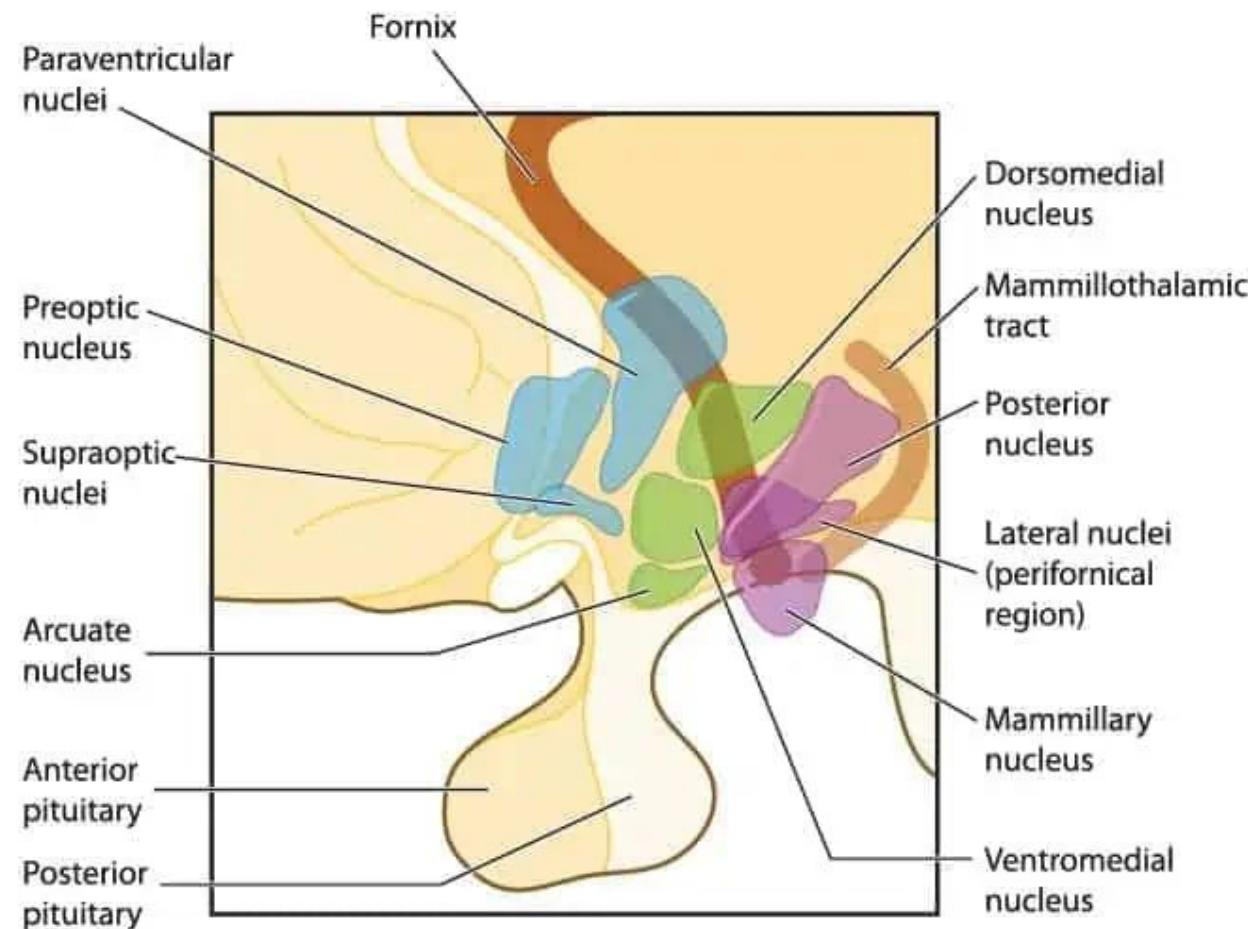
Embryo at 5 weeks



Cleveland
Clinic
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Forebrain (Diencephalon)



nuclei of Hypothalamus

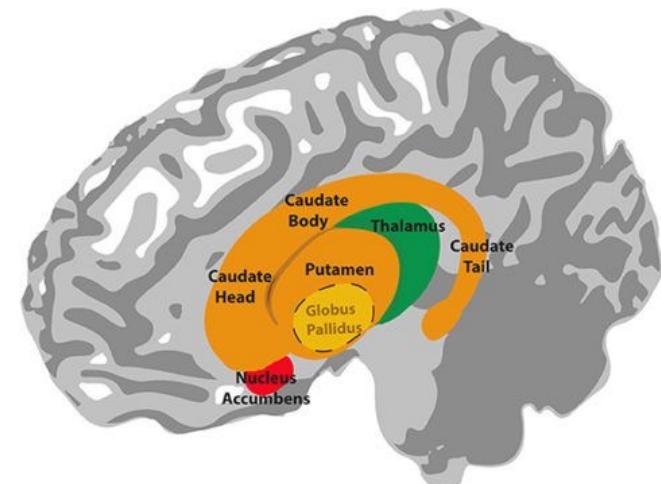
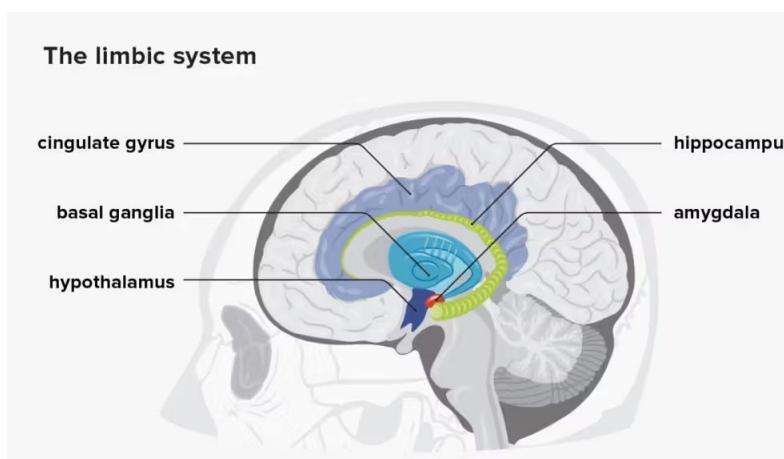
Forebrain (Telencephalon)

Limbic System

- Emotion, Motivation
- Hippocampus: formation of new memories and spatial mapping
- Amygdala: emotional expression and interpreting others' emotions
- Cingulate Gyrus: Valence +/- Evaluator, "RE-entrant System"
- Olfactory Bulb: exchanges olfactory information with the rest of the limbic system

Basal Ganglion

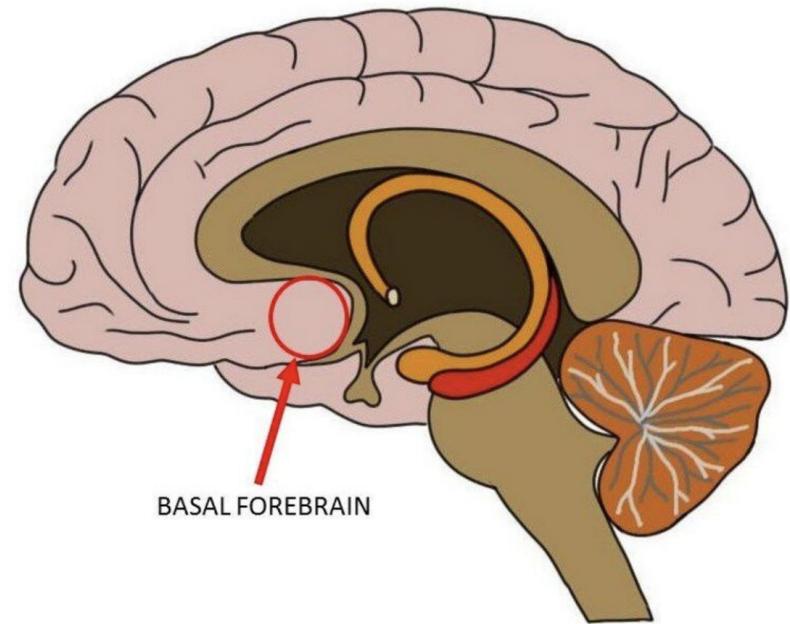
- Includes caudate, putamen, and globus pallidus
- "Motor Area", but diff. from cerebellum (which muscle to use): organizing activity into TASKS, especially **planned sequential behaviors** (task setting, check goals...)
- Another "RE-entrant system": bottom-up input + hierarchical cortical analysis



Forebrain (Telencephalon)

Basal Forebrain

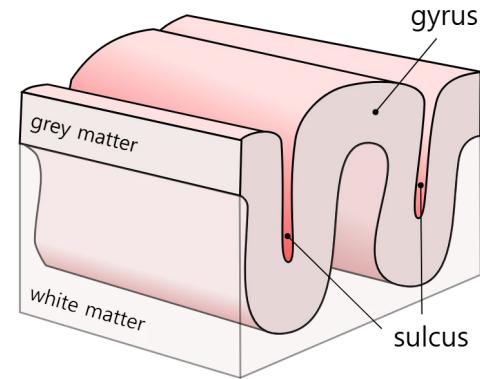
- Cortical area just anterior to Hypothalamus
- Major role in attention and cortical arousal
- Main source of ACh (Acetylcholine, excitatory neural transmitter; wakes you up in the morning...) and GABA (Gamma-Aminobutyric Acid, de-arousal/inhibitory neural transmitter; shut you down, put you to sleep...)
- Receives input from Raphe/Reticular Arousal System in Brainstem



Cerebral Cortex

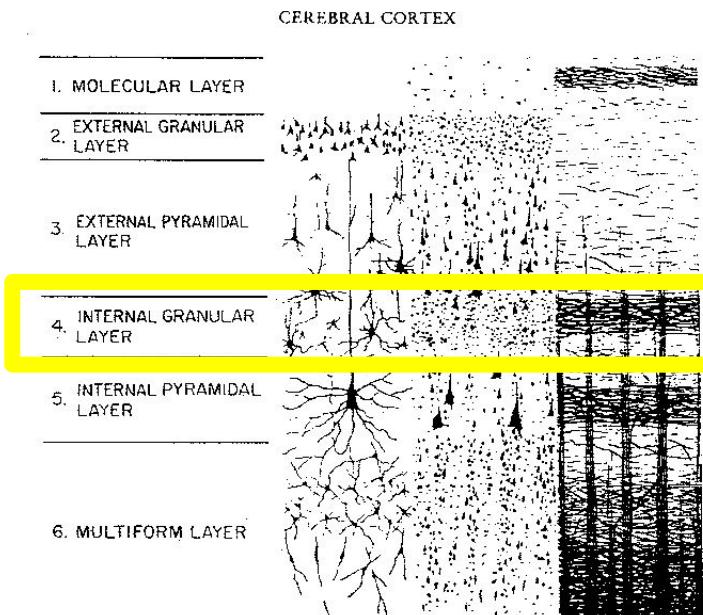
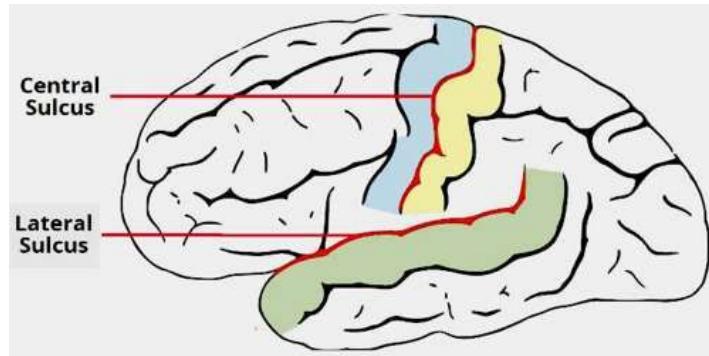
Organized into 6 layers (highly convoluted)

- Information projected to cortex enters at layer 4
- Bulges = gyri (sing. gyrus)
- Folds = sulci (sing. sulcus)

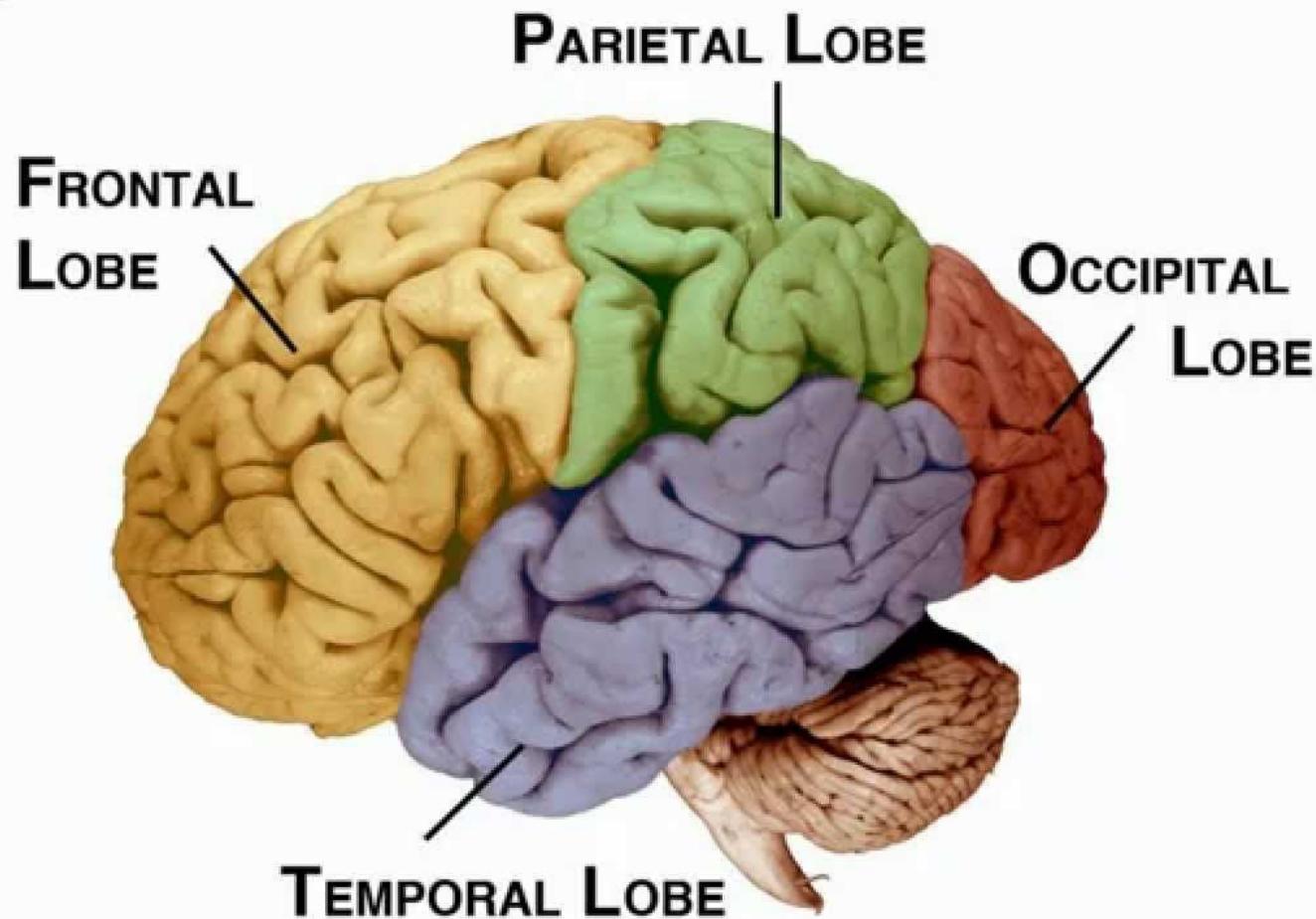


Landmarks

- Central Sulcus divides parietal from frontal lobe
- Lateral Sulcus/Fissure divides temporal from frontal lobe



Lobes of the Brain



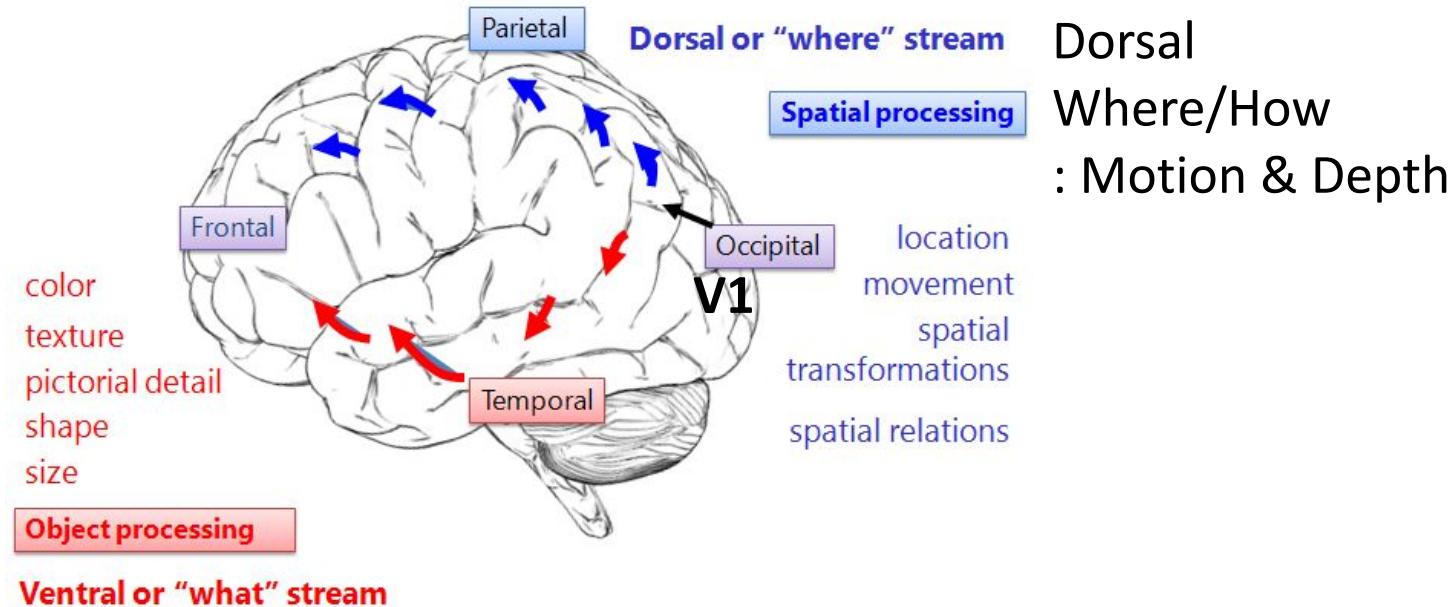
Breaking down the Lobes

Occipital Lobe

- Devoted to Visual processing
- Contains V1 (primary visual cortex) and receives projections from thalamus
- major visual pathways: Ventral/Dorsal stream

Temporal Lobe

- Contains Medial Temporal (MT) - includes Direction-sensitive motion detectors, Medial Superior Temporal (MST) - includes Optic flow detectors, Ventral Visual Pathway - include Face cells,, Auditory areas - includes Wernicke's Area, and Anterior Temporal - emotional expression and interpretation (esp. right hem)



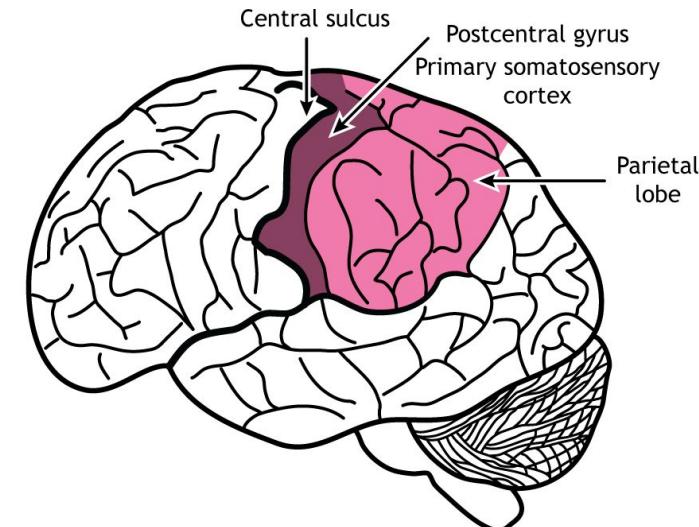
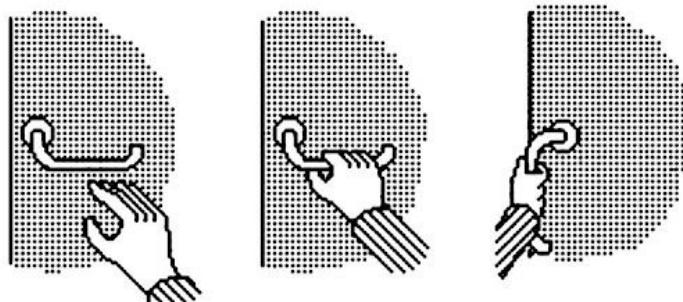
Breaking down the Lobes

Parietal Lobe

- integrating visual and somatosensory info (touch, pain, temperature, proprioception such as body position and movement, etc)
- Post-central gyrus (S1): primary somatosensory cortex
- also includes higher visual areas of “where/how” pathway, and the examples are...

Canonical cells

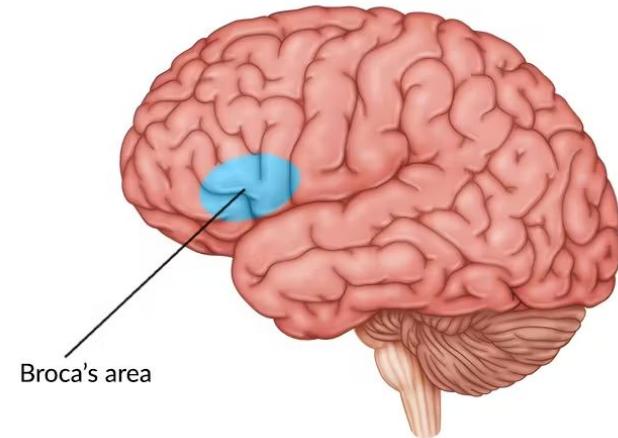
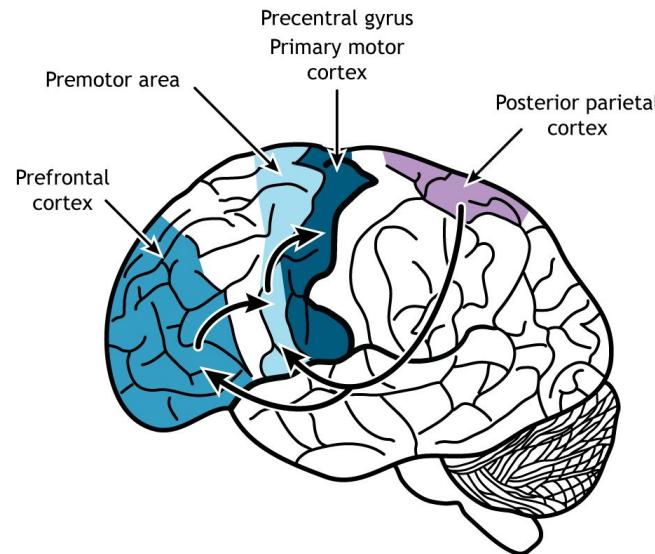
- Responds to “affordances” of objects (“Can I grab this object? How?)
- Activity reverberates w/ premotor cortex, to shape how hand approaches



Breaking down the Lobes

Frontal Lobe

- Important for motor movements, language production, and strategy
- Precentral gyrus: primary motor cortex (initiating and controlling voluntary movements, “Ok, execute!”)
- Premotor areas: anterior to motor cortex (action planning)
 - o includes mirror cells (w/ Parietal) which responds to seeing self or other perform familiar manual tasks
 - o includes Broca’s Area (speech production and articulation)
- Prefrontal cortex

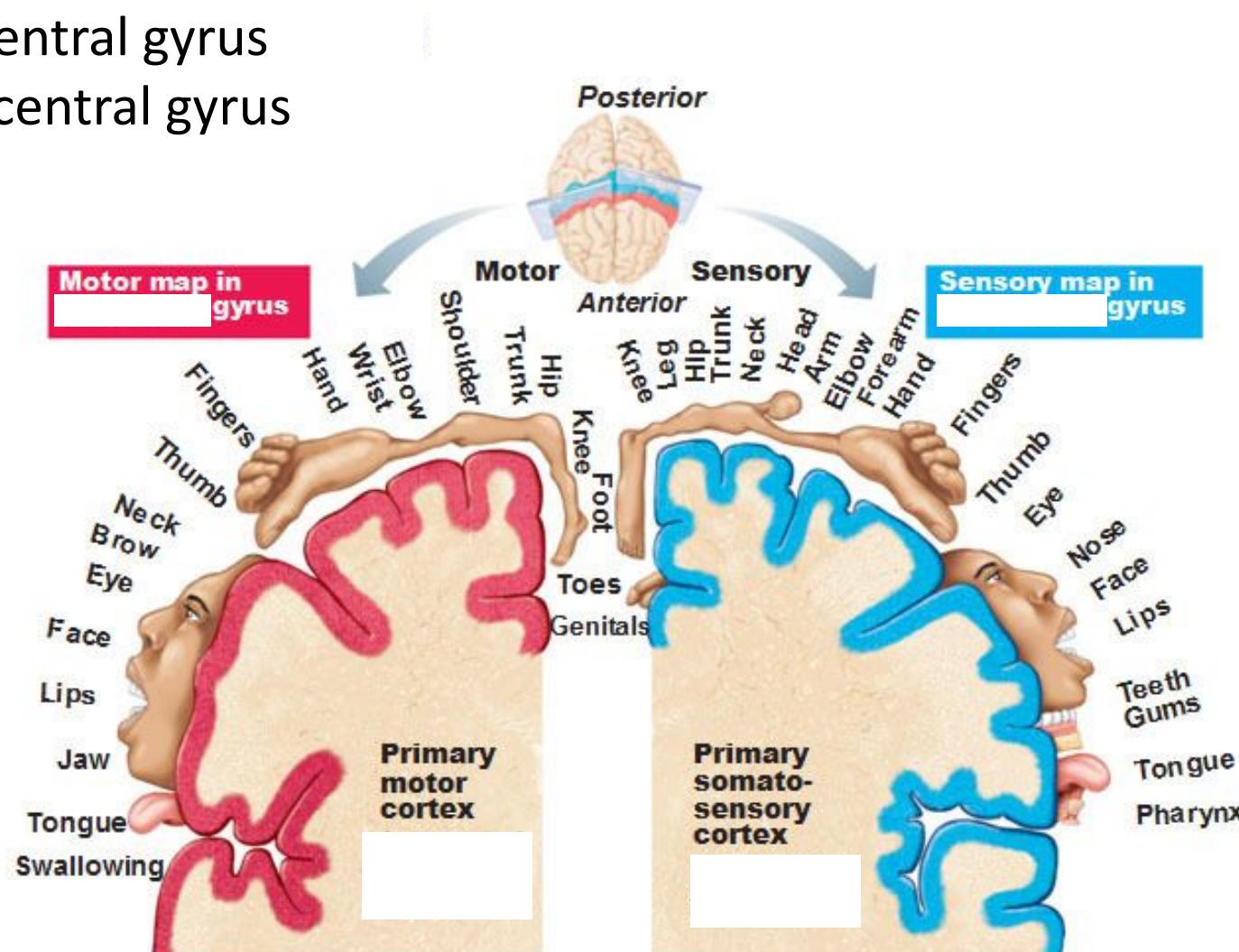


Breaking down the Lobes

Do you remember...?

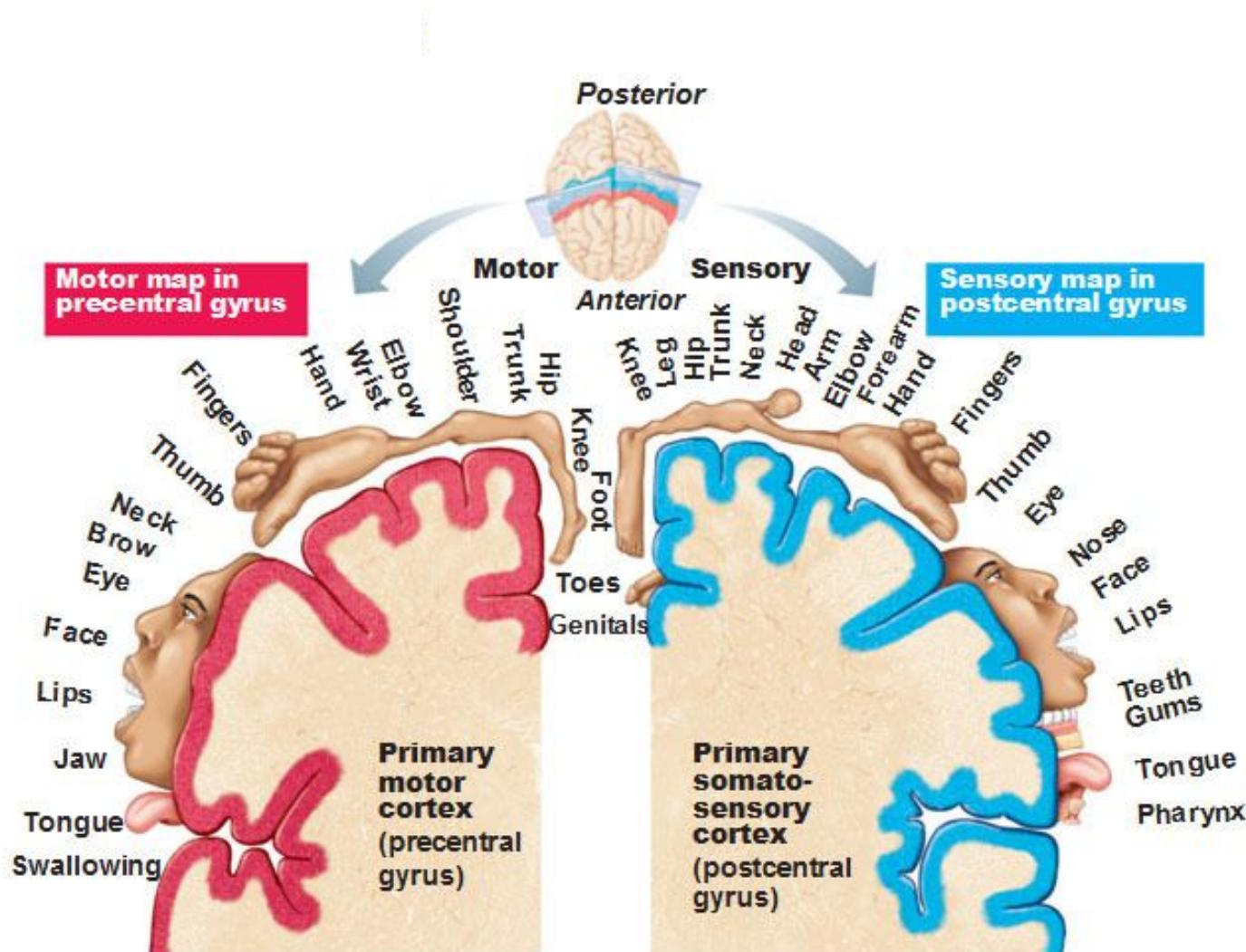
- precentral gyrus
- postcentral gyrus

Note that each hemisphere receives info from the opposite side of the body



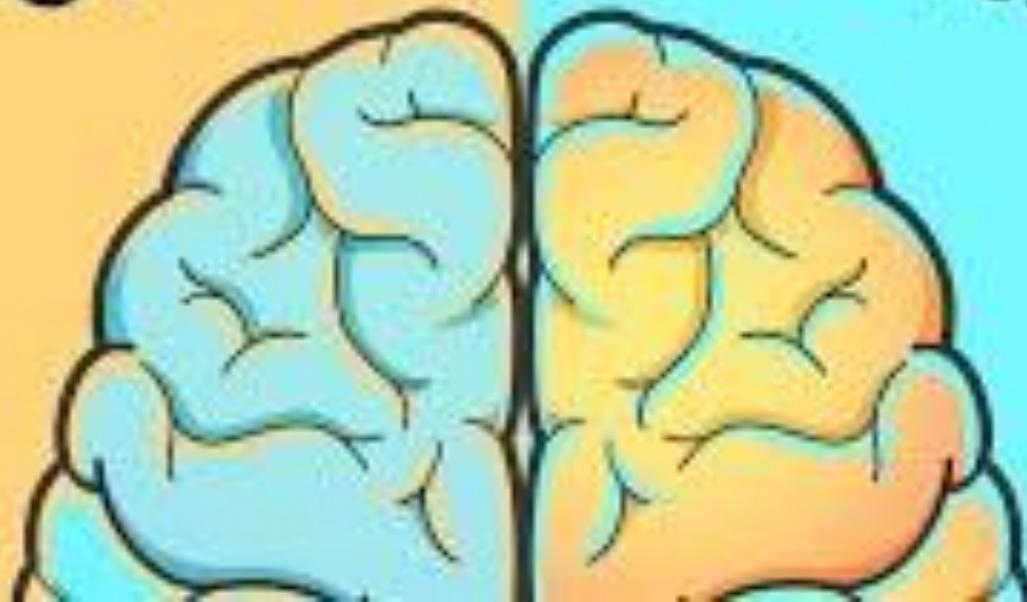
Breaking down the Lobes

Note that each hemisphere receives info from the opposite side of the body



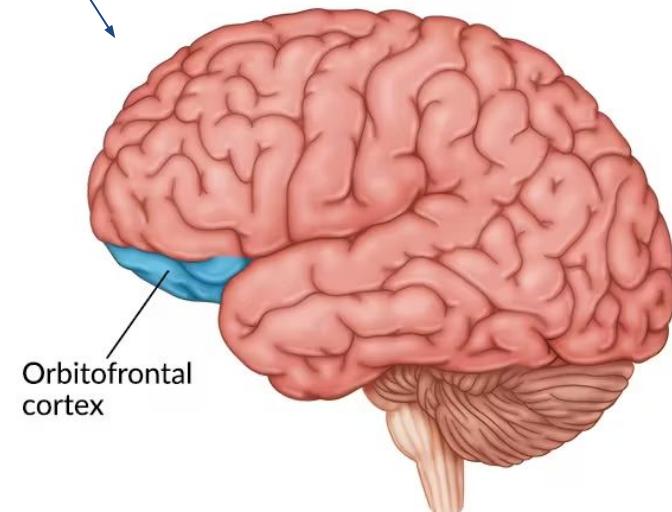
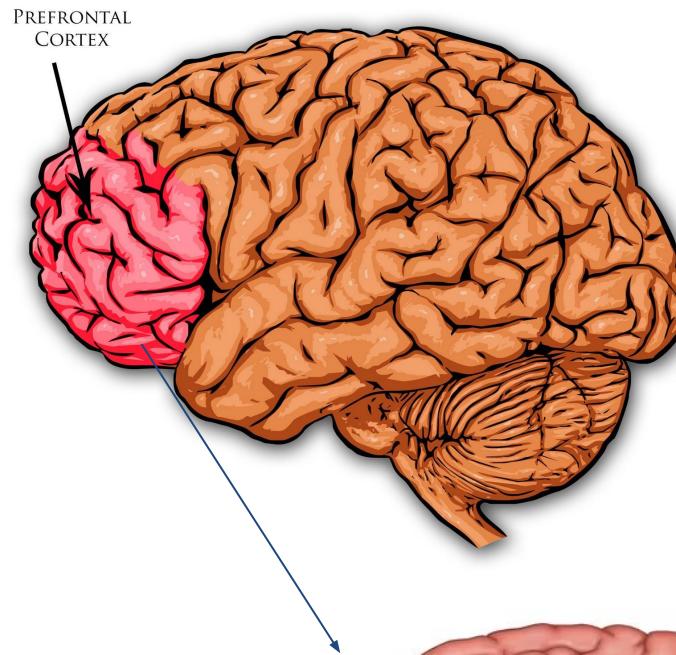
Breaking down the Lobes

**LEFT BRAIN
VS. RIGHT BRAIN**



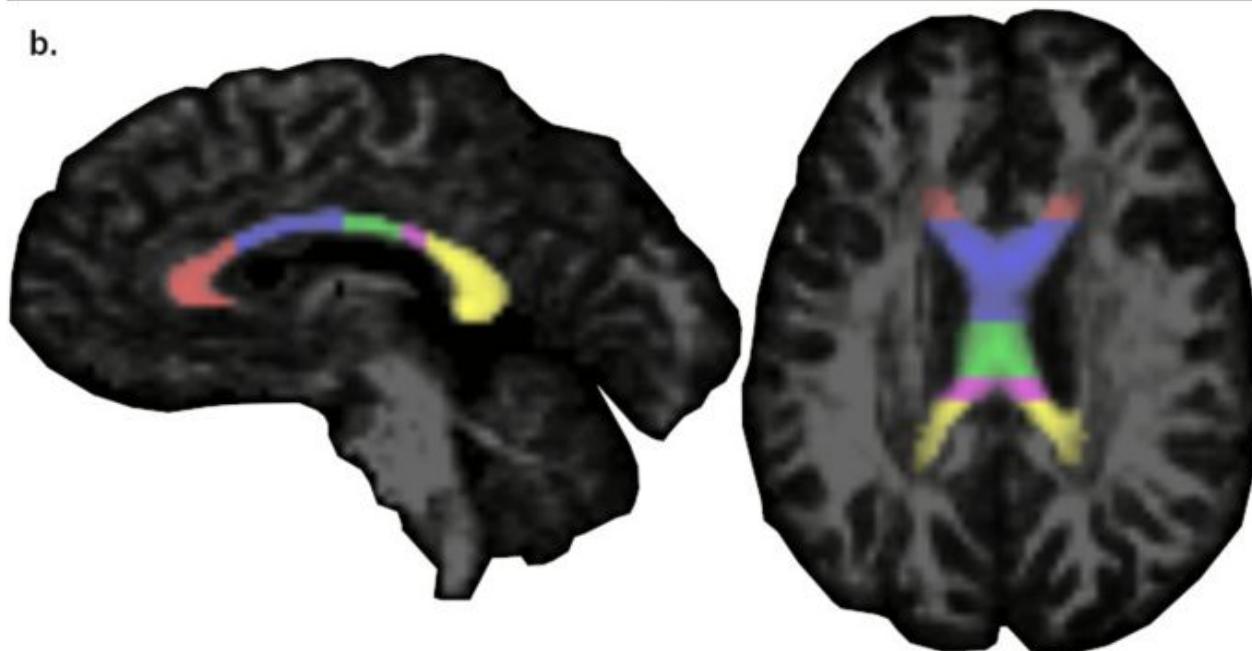
Prefrontal Cortex

- Self-control
- Delayed gratification
- Culturally/socially appropriate behavior
- Cost/benefit analysis
- Orbital-Frontal Cortex
 - Plays an important role in social strategy



Corpus Callosum

- Large axonal fibers connecting the two hemispheres
- Part of the “white matter” of the brain
 - Consists of mainly myelinated axons



Spinal Cord

Consists of 31 segments along the spine

Dorsal Horns

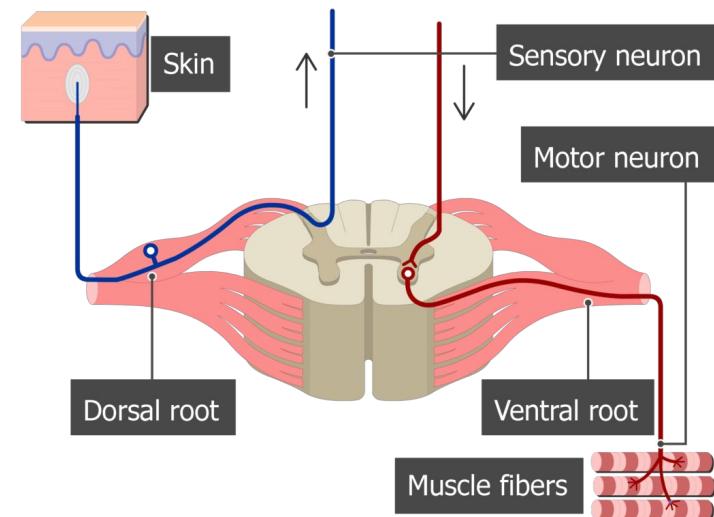
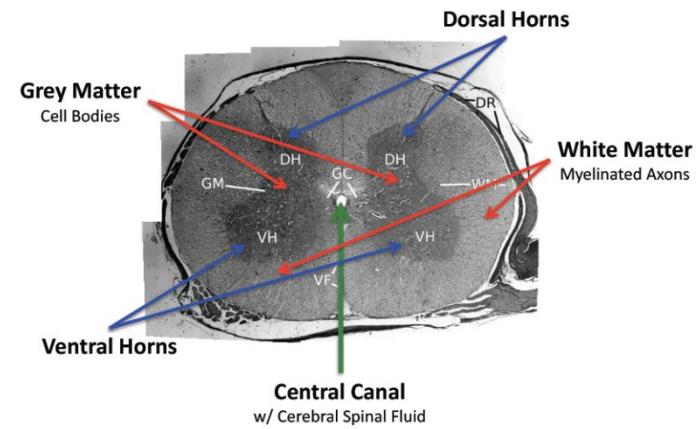
- Afferent nerves
- Information from body to brain

Ventral Horns

- Efferent nerves
- Motor information to muscles and glands

Bell-Magendie Law

- Sensory information goes in via dorsal horn and exits ventral horn



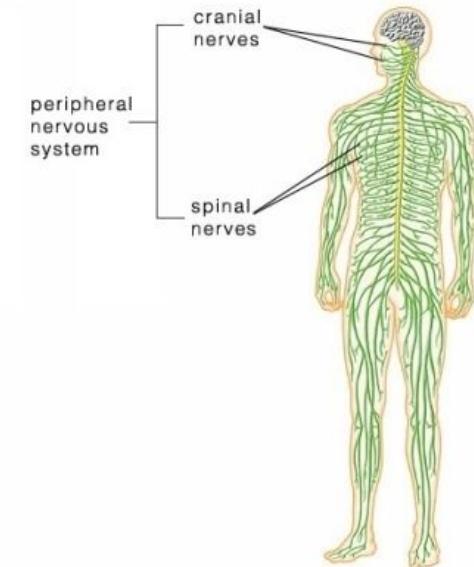
Peripheral Nervous System

Somatic NS

- 31 pairs of spinal nerves
 - Carry sensory input *from the skin, muscles, and joints to the spinal cord.*
 - Carry motor output *from the spinal cord to the skeletal muscles.*

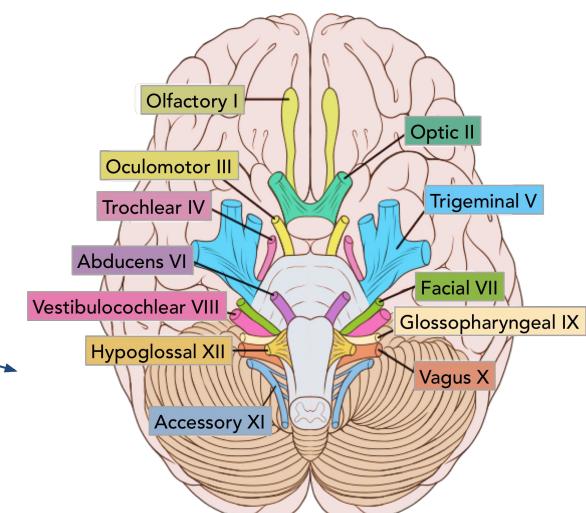
Structure of each spinal nerve pair:

- Dorsal root (afferent): brings *sensory signals* into the spinal cord.
- Ventral root (efferent): sends *motor signals* out to the muscles
- 12 cranial nerves: carrying sensory information from senses, receive feedback from some organs, control motor output to muscles that control eye movements, facial expressions



Autonomic NS

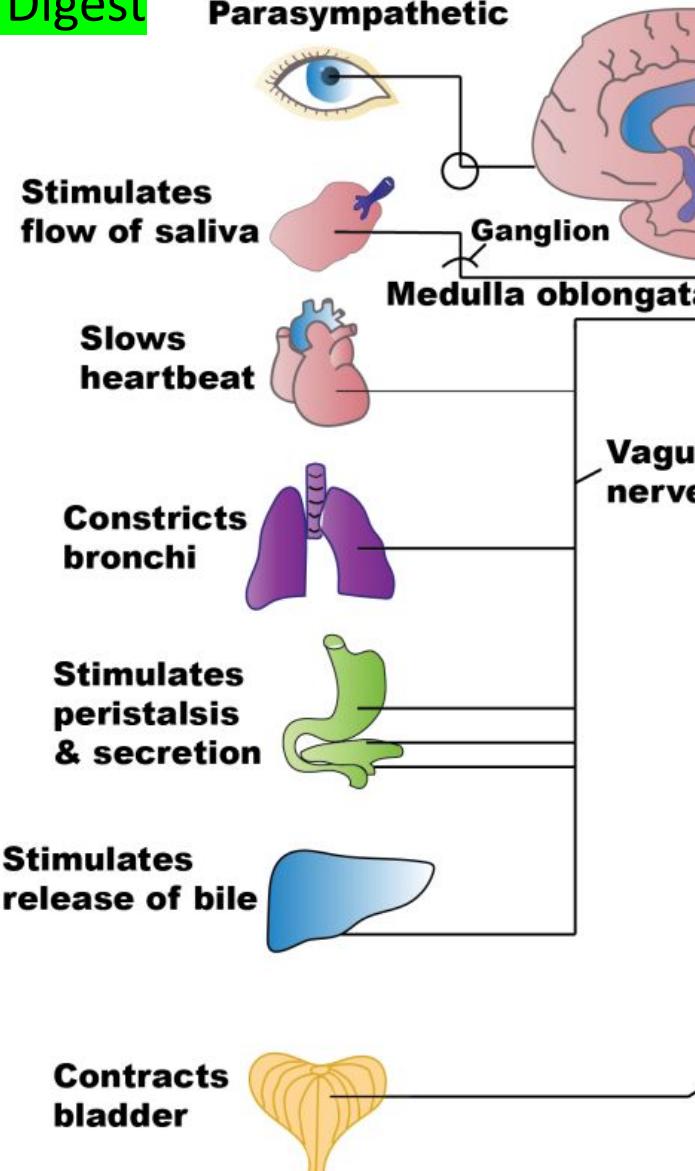
- Regulates internal state
- 1) Sympathetic “Fight or Flight”
- 2) Parasympathetic “Rest & Digest”



Autonomic Nervous System

Rest/Digest

Parasympathetic



Sympathetic

Fight/Flight

Dilates pupil

Inhibits flow of saliva

Accelerates heartbeat

Dilates bronchi

Inhibits peristalsis & secretion

Conversion of glycogen to glucose

Secretion of adrenaline & noradrenaline

Inhibits bladder contraction

Review Questions

Label as either a sympathetic response (S) or a parasympathetic response (P):

- Pupils dilate
- Increased heartrate
- Saliva production
- Bronchi constrict
- Halt digestion
- Facilitate sexual arousal
- Hold bladder
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See you next week!

