

Section 1

Neuroanatomy

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COGS 17 A04

01/17/25

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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
- Office Hours: Thu 2-3 pm in-person @ SSRB Room 239 - better reach out before since the door is locked!

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



Ground Rules

Use this section to boost your learning

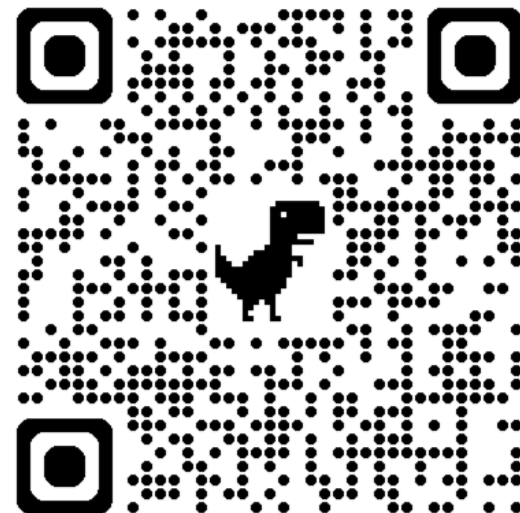
- The aim of this section is to review contents covered in class
- Attending section and actively engaging will improve your learning!
- It's okay to be wrong

Keep discussions on topic

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

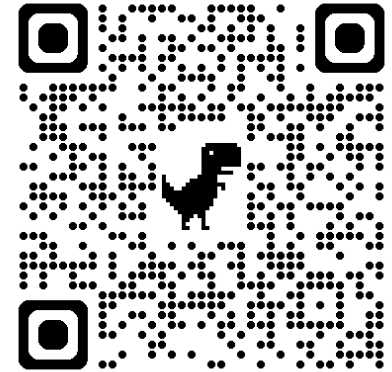
Section slides are on [github](#) (scan QR code)

Let's all get As!



Opportunities that you might be interested

[PNI Summer Internship Program](#) (scan QR code): Hands-on summer research internship at the Princeton Neuroscience Institute



- for *non-Princeton undergraduates* who are interested in pursuing a graduate degree in neuroscience or a related field
- nine weeks across early June to early August. *For 2025*, SIP will take place June 2 - August 1
- application for Non-Princeton Student Deadline (SIP) this year: February 3, 2025

[Innovators in Cognitive Neuroscience seminar videos](#)

- Dartmouth Center for Cognitive Neuroscience
- ~1h talk
- might use for extra credit essays?

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** Homework 3, Jan 27 - 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

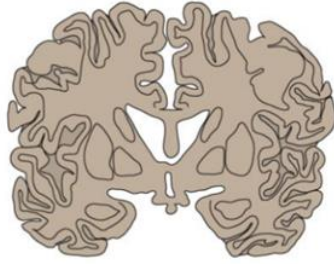
- SONA
- Essay
- Mnemonics
- Homeworks

Lecture 1

Anatomy of the Nervous System

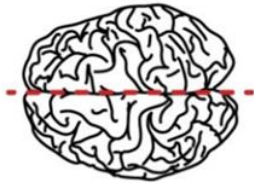
Planar Views of the Brain

Frontal or
coronal plane



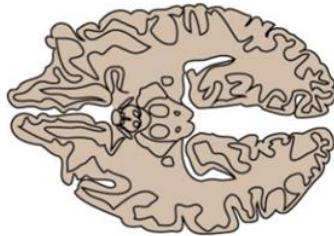
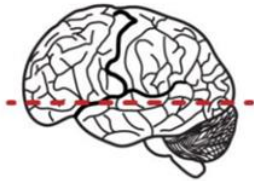
Coronal Plane -- From the **FRONT**

Sagittal plane



Sagittal Plane -- From the **SIDE**

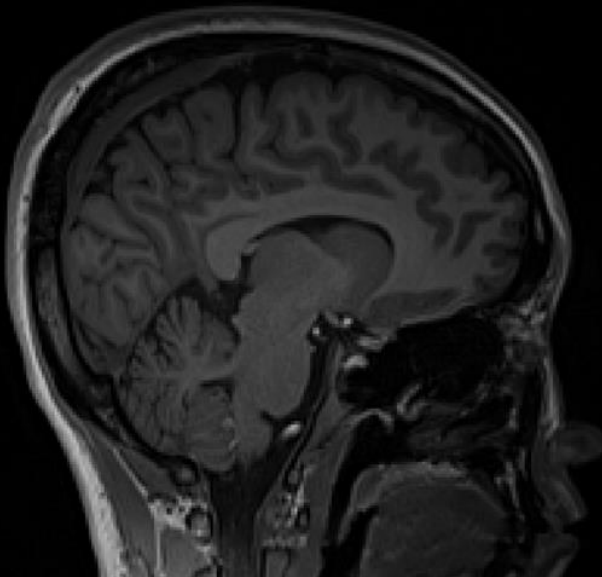
Horizontal plane



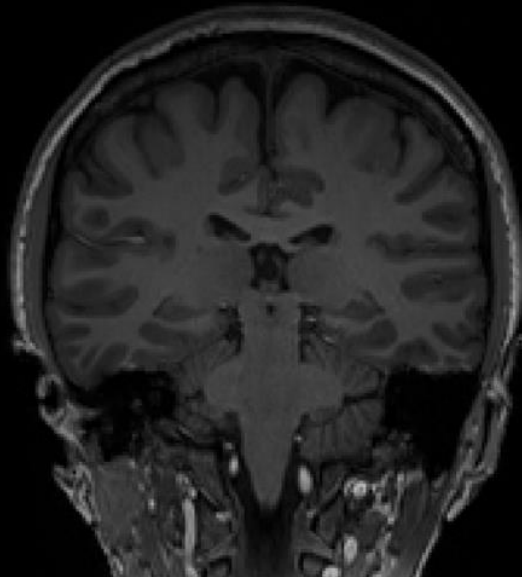
Horizontal Plane -- From the **ABOVE**

Planar Views of the Brain - Surprise Quiz

1)



2)



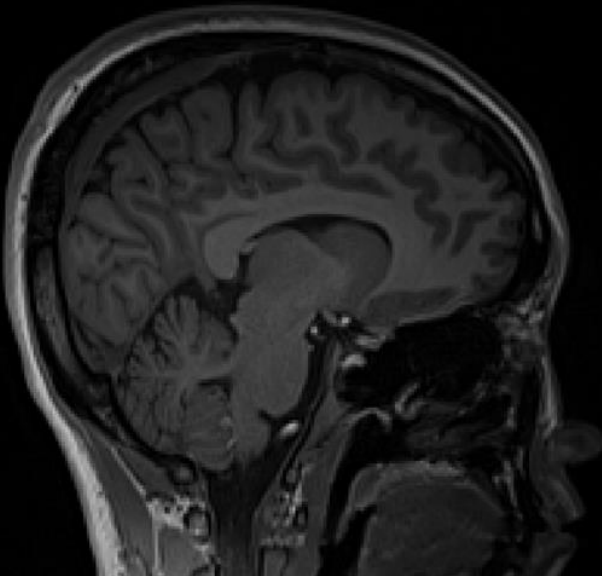
3)



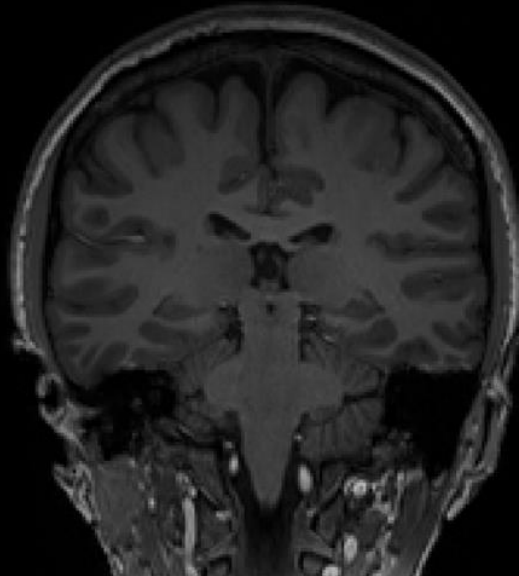
Guess whose brain this is 🤔

Planar Views of the Brain - Surprise Quiz

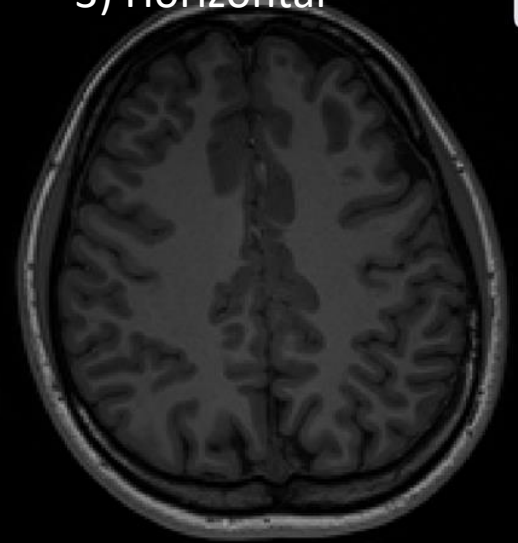
1) Sagittal



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

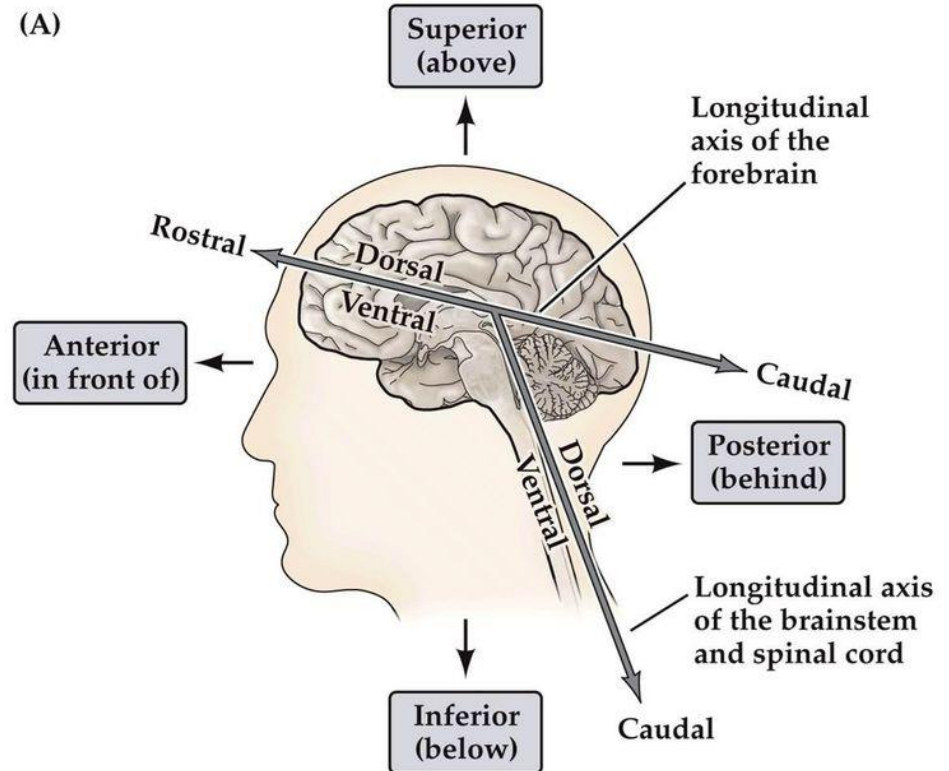
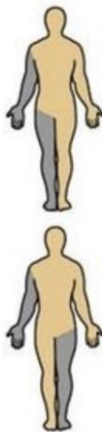
- Dorsal: The “top” of the brain
- Ventral: The “underside” of the brain

Anterior & Posterior

- Anterior: Front
- Posterior: Back

Bilateral Structure

- Ipsilateral: Same side
- Contralateral: Opposite side

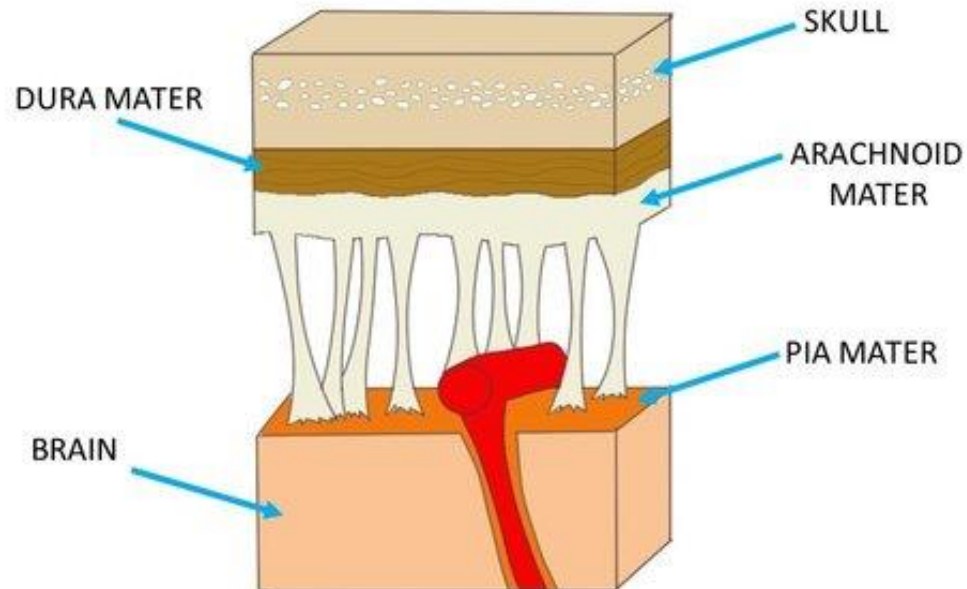


NEUROSCIENCE 5e, Figure A1 (Part 1)
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Support Structure

Meninges

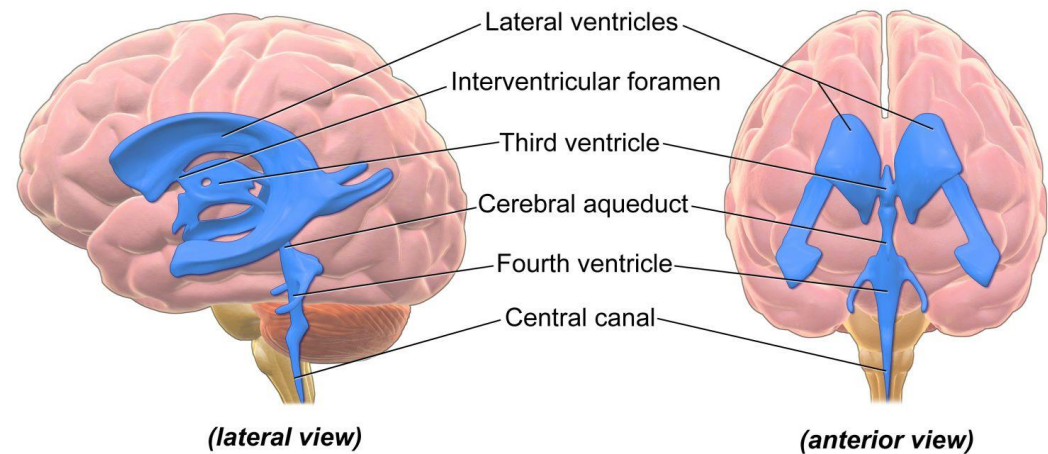
- Dura Mater: Thick outer layer
- Arachnoid Mater: Spider-web like, spongy layer filled with Cerebrospinal fluid (CSF), shock absorber
- Pia Mater: flexible inner layer that conforms to the brain and spine surfaces, include blood vessels



Support Structure

Ventricles

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



Feeding the brain

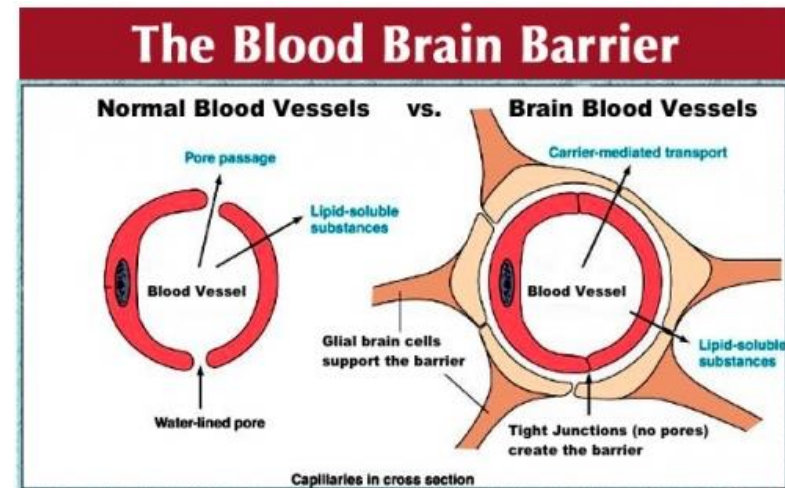
Blood Vessels

- 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 chemicals in the brain
- 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



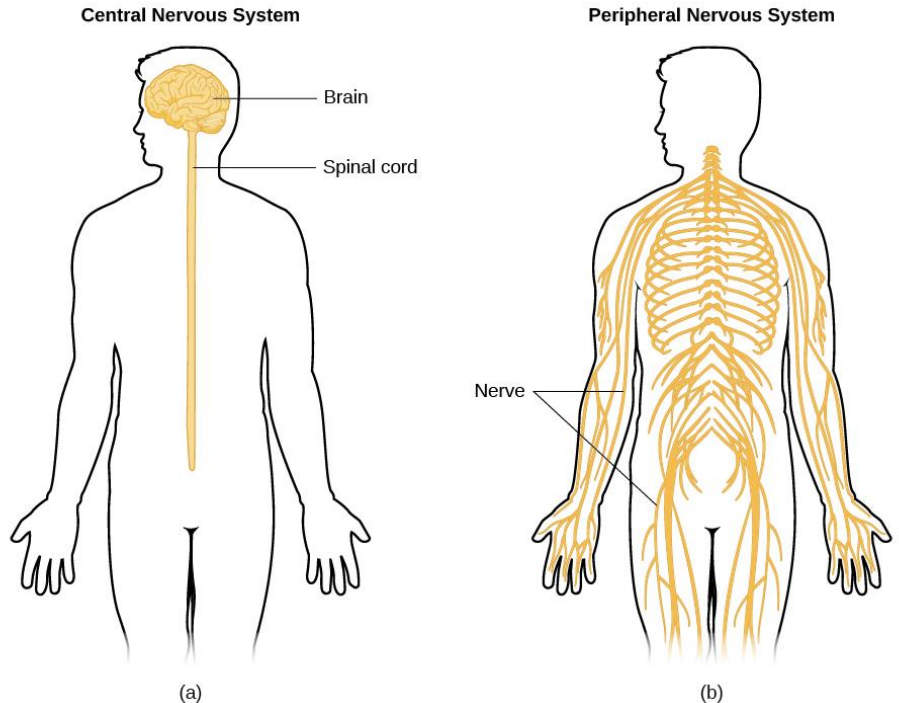
CNS vs PNS

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

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

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

Review Questions

Match definition to concept:

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

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

<u>PNS</u>	Somatic nervous system	<u>CNS</u>	Surrounded by bone and meninges
<u>CNS</u>	Brain and spinal cord	<u>PNS</u>	Autonomic nervous system

HindBrain

Medulla Oblongata

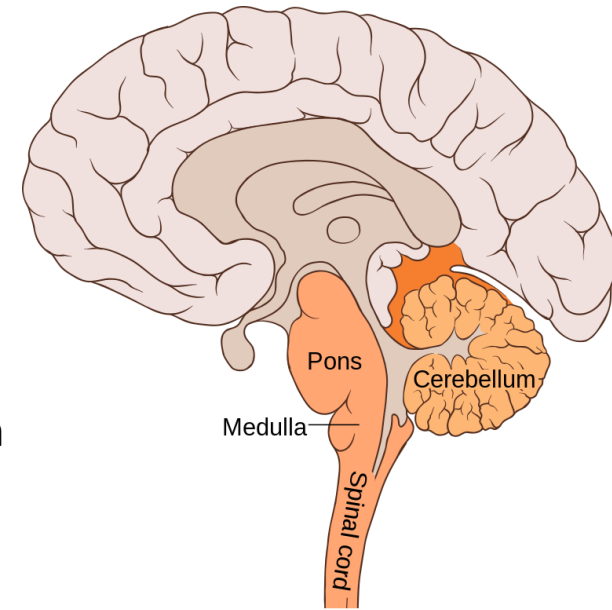
- Control vital reflexes (e.g., breathing, heart rate)

Pons

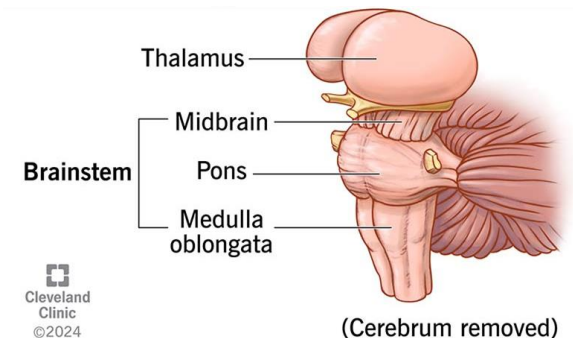
- Latin for “Bridge”
- Relay between cortex & cerebellum and brain & spinal cord
- Includes reticular formation (arousal) and raphe system (sleep)

Cerebellum

- Motor programs with real-time sensory coordination
- Guide movements
- Critical in timing actions and also important for shifting attention
- NOT the brain stem



+ Hypothalamus



Midbrain

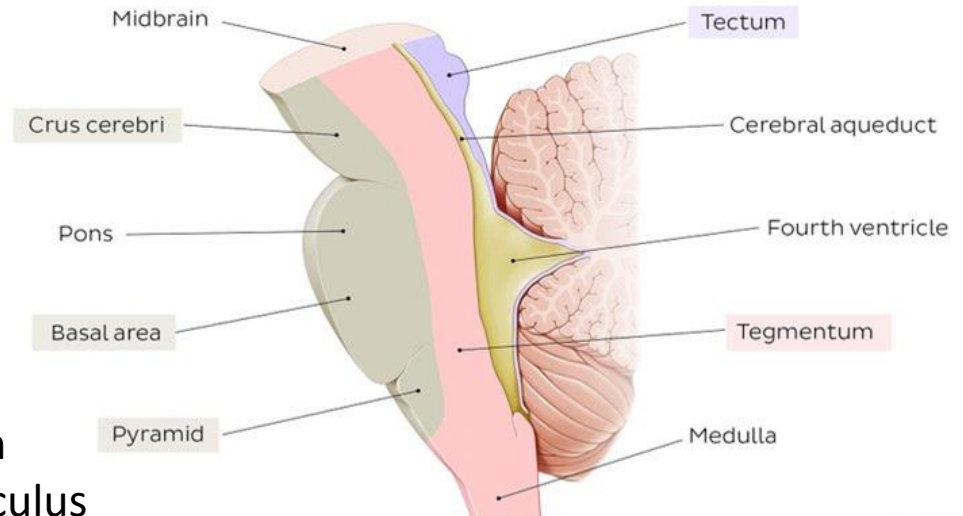
Entirely contained in the brain stem

Tectum

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

Tegmentum

- Latin for “Covering” or “Rug”
- 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)

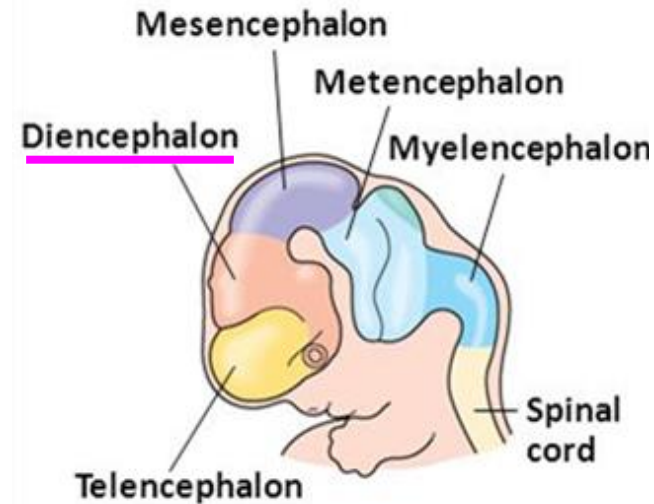
Diencephalon consists of the thalamus and hypothalamus

Thalamus

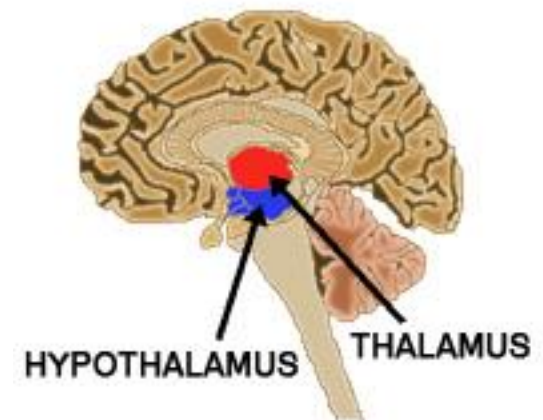
- Primary source of input to cerebral cortex
- Nuclei of many sensory and motor systems
- Involved in cortical arousal

Hypothalamus

- Hypo = “below”
- Oversees “4Fs”: Fighting, Fleeing, Feeding, F...
- Also regulates temperature and internal clock
- Controls the endocrine system via the Pituitary Gland



Embryo at 5 weeks



Review Questions

In regards to the Brainstem, indicate whether the following are TRUE or FALSE.

- A) The brainstem includes hindbrain, midbrain, and forebrain structures. []
- B) The Raphe System, which runs along the medial face of the brainstem, plays a role in feeding behavior. []
- C) The Reticular Activating System, that runs up the brainstem, arouses the brain. []
- D) The brainstem includes the Cerebellum. []
- E) The brainstem includes the Thalamus and Hypothalamus. []

Review Questions

In regards to the Brainstem, indicate whether the following are TRUE or FALSE.

A) The brainstem includes hindbrain, midbrain, and forebrain structures. **[T]**

B) The Raphe System, which runs along the medial face of the brainstem, plays a role in feeding behavior. **[F]**

C) The Reticular Activating System, that runs up the brainstem, arouses the brain. **[T]**

D) The brainstem includes the Cerebellum. **[F]**

E) The brainstem includes the Thalamus and Hypothalamus. **[T]**

Forebrain (Telencephalon)

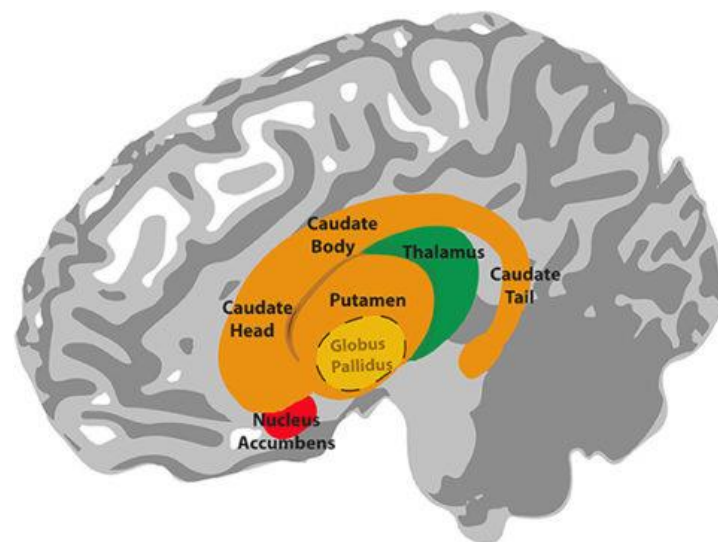
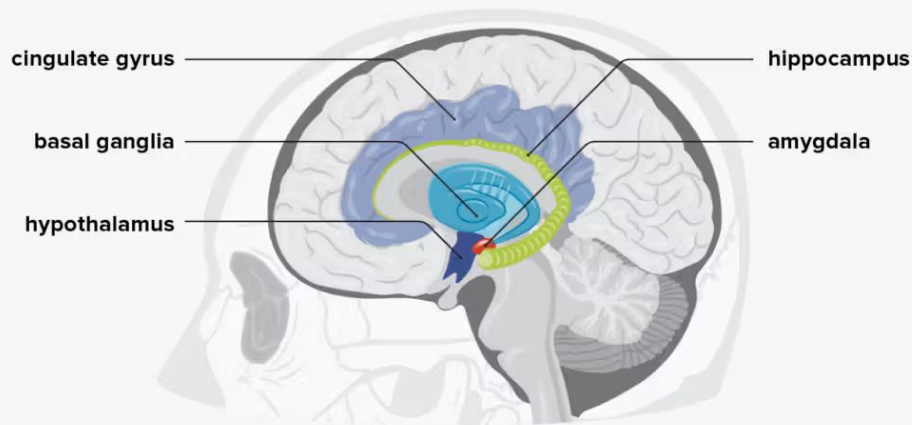
Limbic System

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

Basal Ganglion

- Includes caudate, putamen, and globus pallidus
- Control of movement, especially **planned sequential behaviors** (task setting)

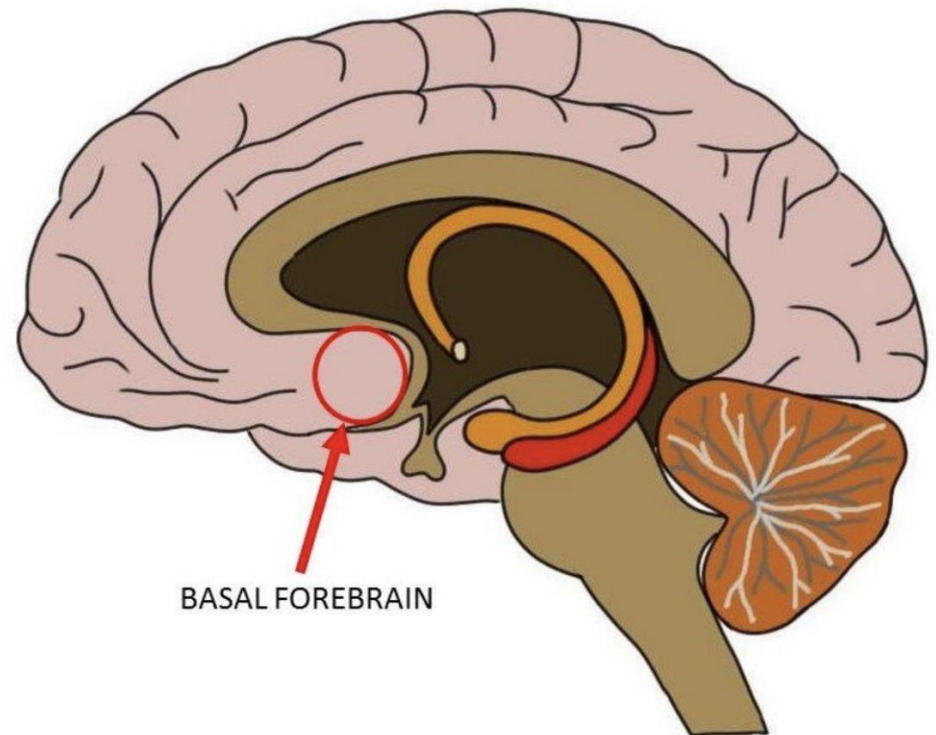
The limbic system



Forebrain (Telencephalon)

Basal Forebrain

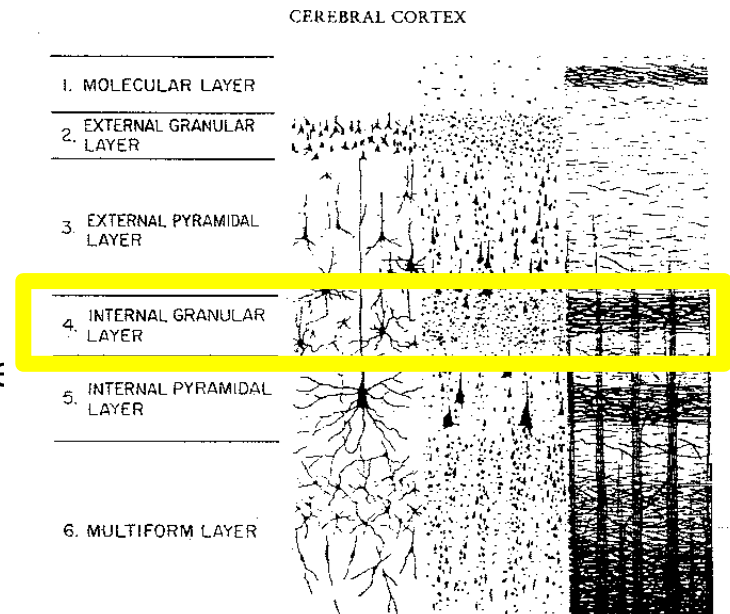
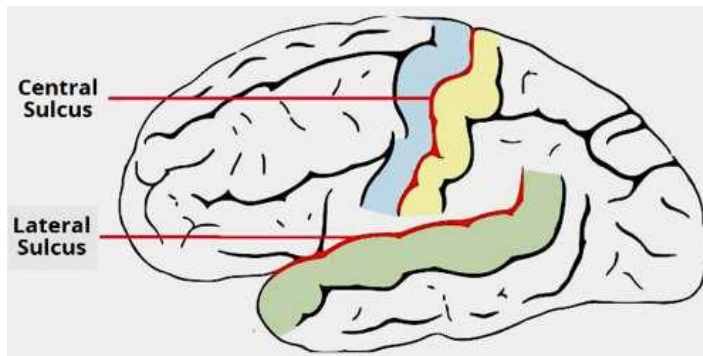
- attention and cortical arousal
- Main source of ACh (Acetylcholine, excitatory neural transmitter) and GABA (Gamma-Aminobutyric Acid, inhibitory neural transmitter)
- sleep/arousal cycles



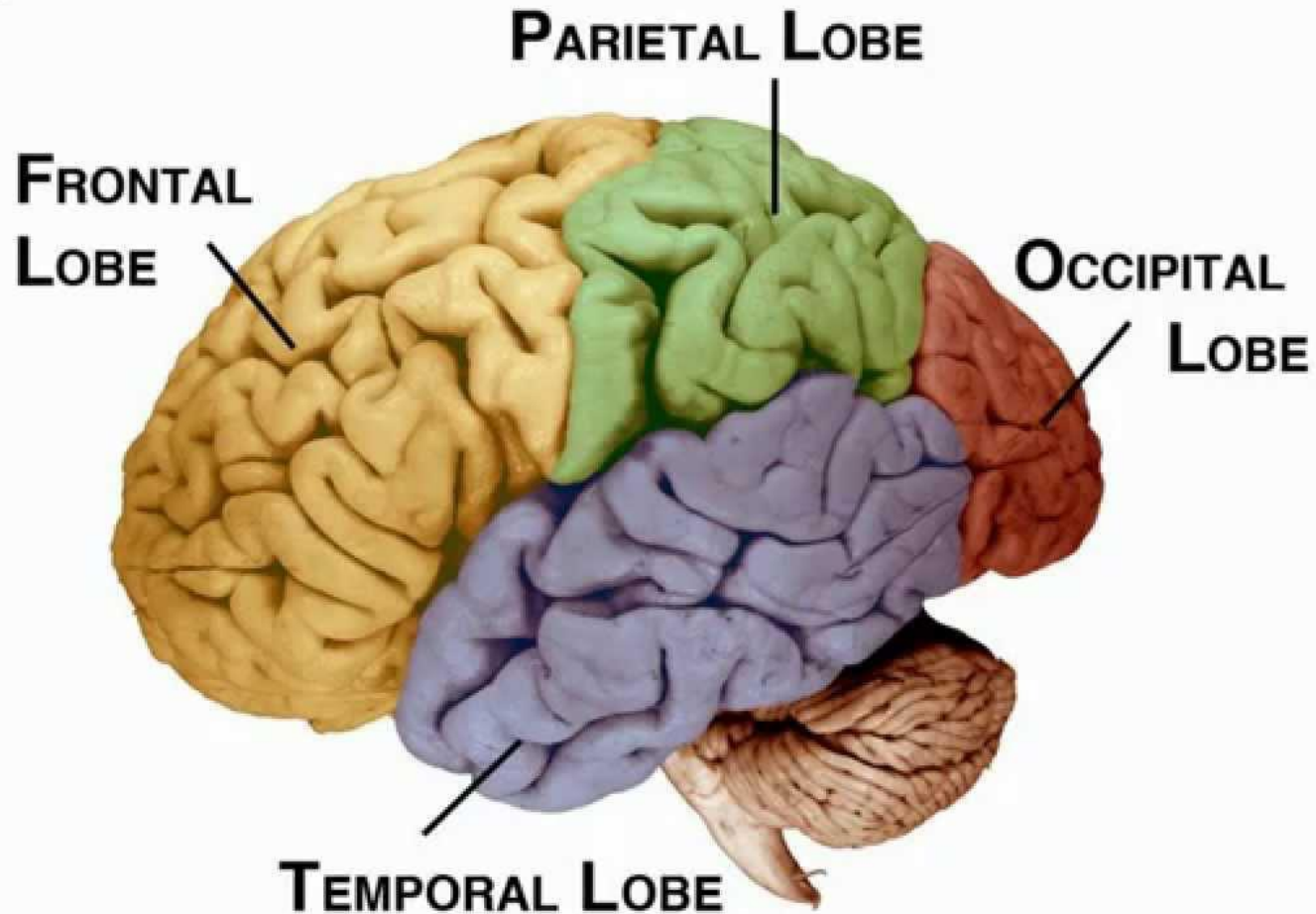
Cerebral Cortex

Organized into 6 layers

- Information projected in at layer 4
- Bulges = gyri
- Folds = sulci
- Central Sulcus divides parietal from frontal lobe
- Lateral Sulcus divides temporal from frontal lobe



Lobes of the Brain



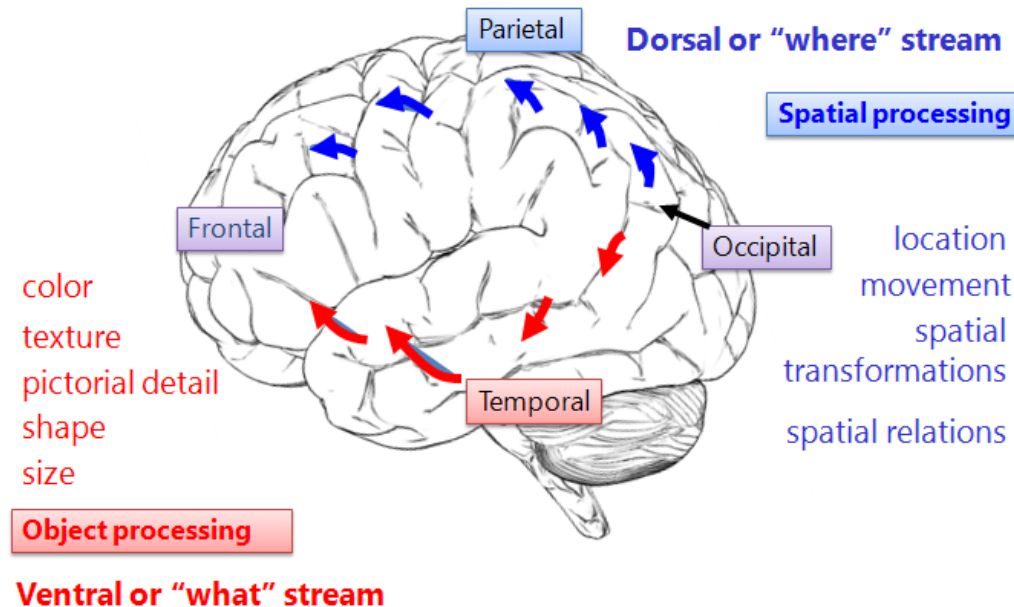
Breaking down the Lobes

Occipital Lobe

- Visual processing
- Contains V1 and receives projections from the thalamus & higher visual areas
- Separate pathways for details (e.g., color, depth) that project to other lobes

Temporal Lobe

- Contains auditory areas (including Wernicke's Area)
- Inferior Temporal: ventral "who/what" pathway, specializes for face detection
- Anterior Temporal: emotional expression and interpretation



Breaking down the Lobes

Parietal Lobe

- integrating visual and somatosensory info
- Spatial mapping
- Medial Temporal (MT): dorsal “where/how” pathway

Canonical cells

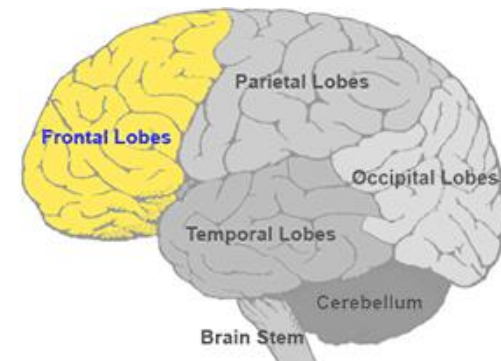
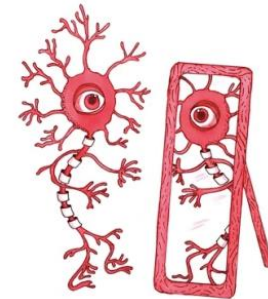
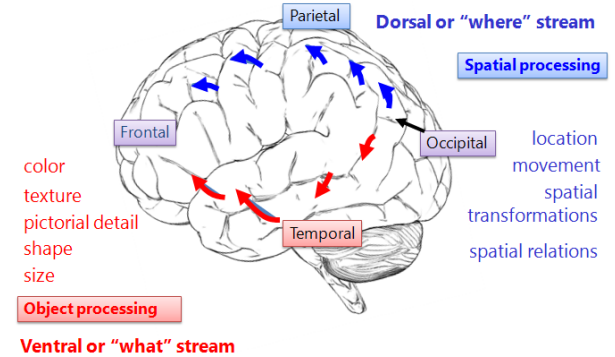
- Responds to “affordances” of objects
- Motor cortex also contains canonical cells

Mirror cells

- Respond to seeing self or other perform an action
- Promotes imitation

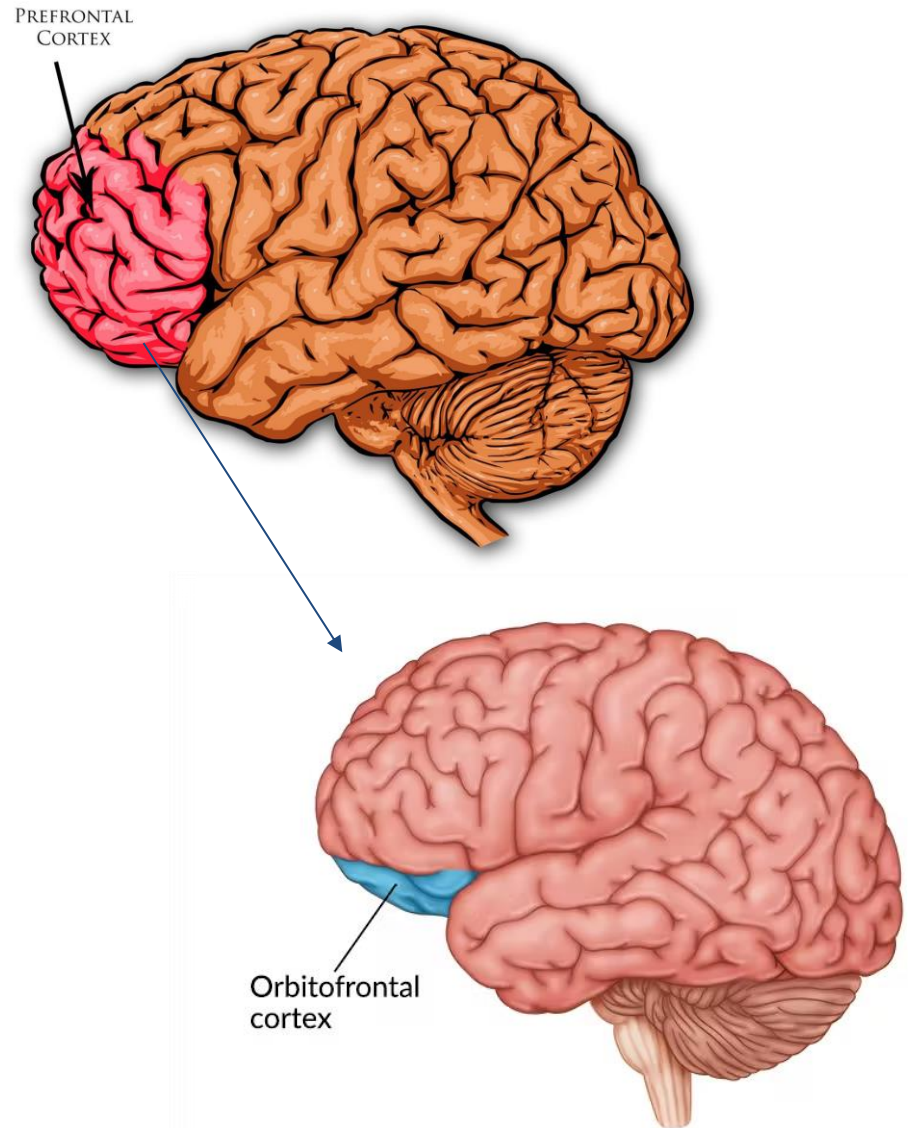
Frontal Lobe

- Important for motor movements, language production, and strategy
- Precentral gyrus: motor cortex
- Premotor areas contain mirror cells
- Contains Broca’s Area (prepare to speak)
- Prefrontal cortex



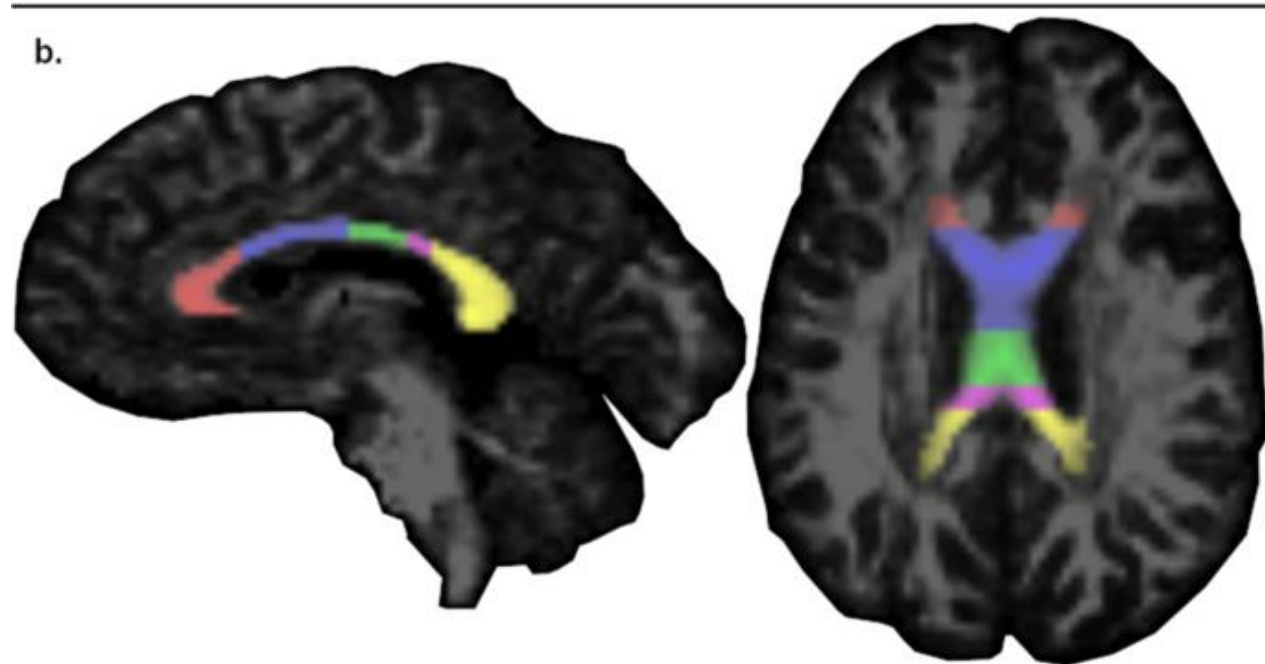
Prefrontal Cortex

- 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



Review Questions

- The cerebral cortex is composed of ____ layers.
- Information is projected into the cortex at layer ____.
- The bulges in the cortex are called _____ while the folds are called _____.
- choose the right option
 - The **inferior temporal (IT)/medial temporal (MT)** contains face cells and is part of the **dorsal/ventral** pathway for information on “who” and “what,” while the **inferior temporal (IT)/medial temporal (MT)** is part of the **dorsal/ventral** pathway and includes motion sensitive cells.
 - In the frontal lobe, there are **canonical/mirror** cells that respond to “affordances” of objects while the **canonical/mirror** system is said to react when you see yourself or others perform an action.

Review Questions

- The cerebral cortex is composed of 6 layers.
- Information is projected into the cortex at layer 4.
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- The **inferior temporal (IT)/medial temporal (MT)** contains face cells and is part of the **dorsal/ventral** pathway for information on “who” and “what,” while the **inferior temporal (IT)/medial temporal (MT)** is part of the **dorsal/ventral** pathway and includes motion sensitive cells.
- In the frontal lobe, there are **canonical/mirror** cells that respond to “affordances” of objects while the **canonical/mirror** system is said to react when you see yourself or others perform an action.

Spinal Cord

Consists of 31 segments along the spine

Dorsal Root

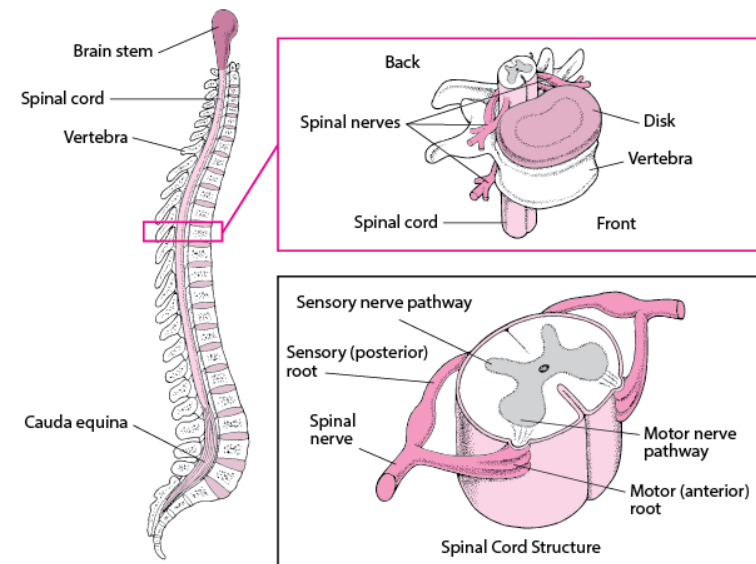
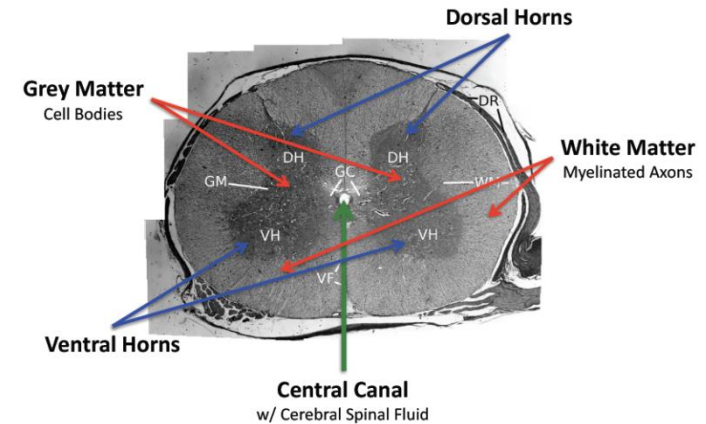
- Afferent nerves
- Information from body to brain

Ventral Root

- Efferent nerves
- Motor information to muscles and glands

Bell-Magendie Law

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



Peripheral Nervous System

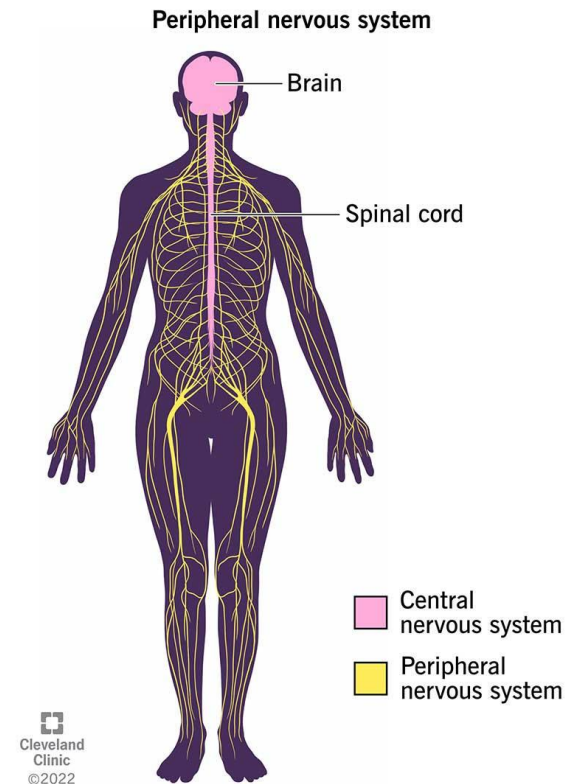
2 Subdivisions

Somatic

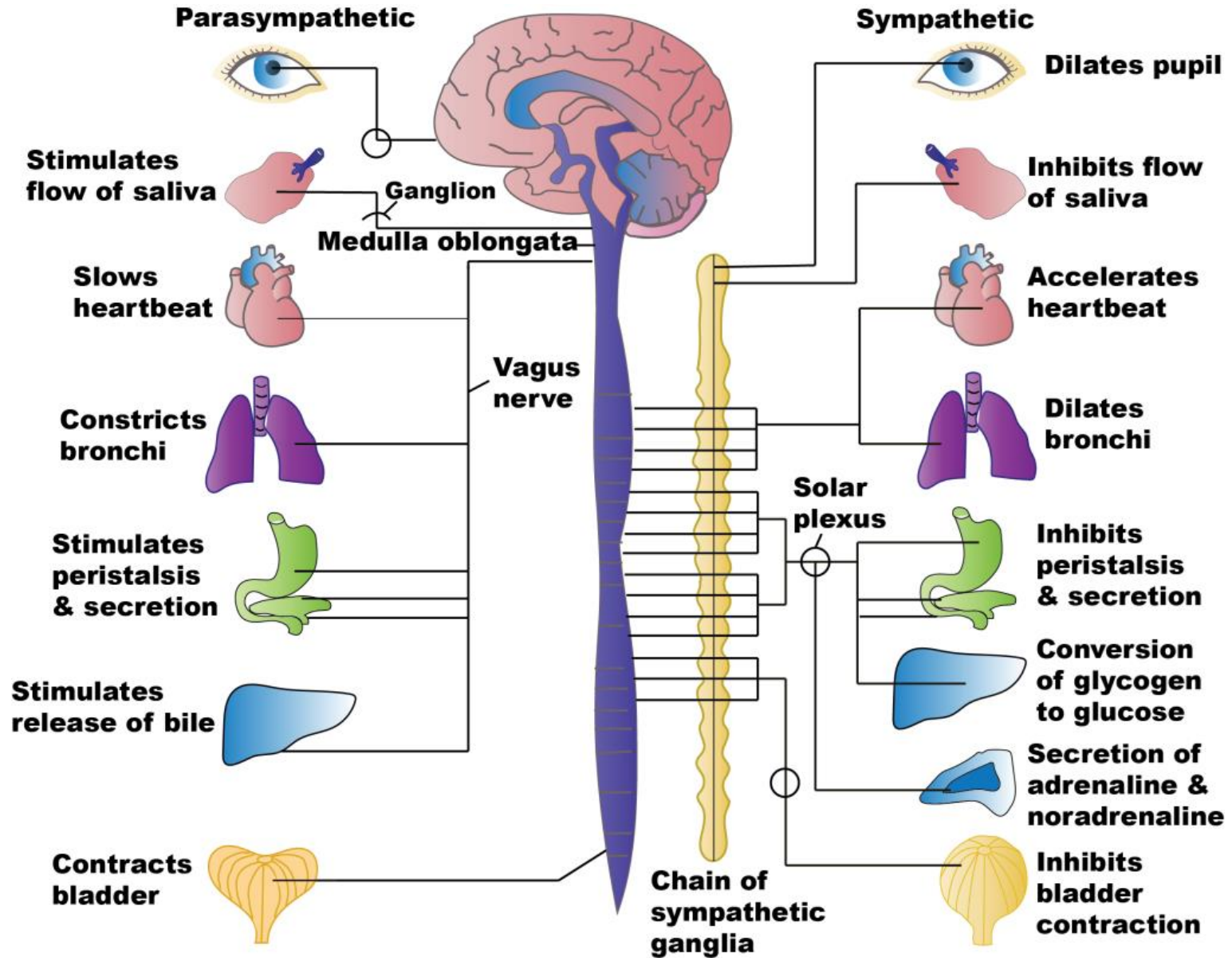
- 31 pairs of spinal nerves: sensory information from body, feedback from skeletal muscles, and motor output to muscles
- 12 cranial nerves: senses, feedback from some organs, motor control of eye movements, and control of facial expressions

Autonomic

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



Autonomic Nervous System



Enjoy the rest of the week!

