Introduction to Neurophysiology

By Ruth-Elise and Michelle

What we'll go through:

- Overview of The Nervous System
  - Divisions
  - Cells of the NS
    - Neurons
    - Glial cells
- White and Gray Matter
- Main parts of the brain & its functions
- WooClap!

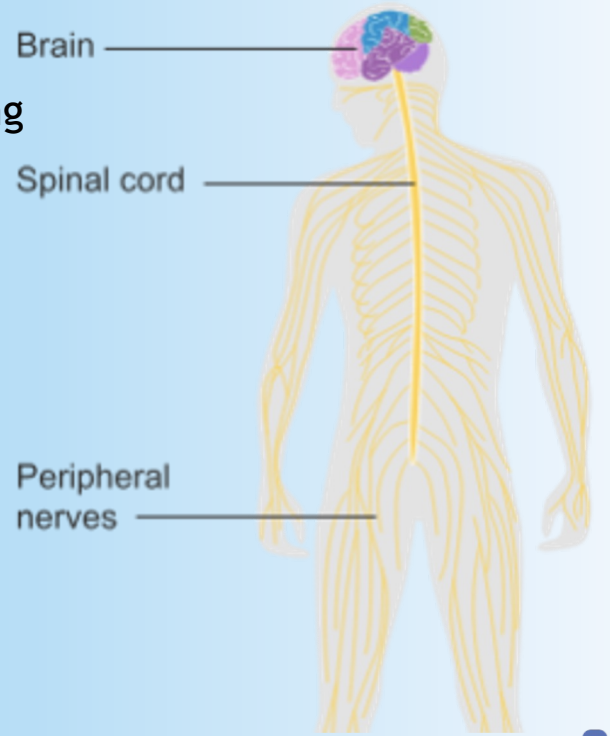
What is The Nervous System?

- = A complex communication network
- It's the major controlling, regulatory and communicating system in the body

→ **Receive and interpret all stimuli**
→ **Generate, modulate and transmit information between all parts of the body**
→ **Initiate appropriate responses to stimuli**

Composed of:

- The Brain
- The Spinal Cord
- Nerves
  - 12 pairs of cranial nerves
  - Peripheral nerves



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Divisions of The Nervous System:

Nervous System

CNS

PNS

Brain

Spinal Cord

Motor Division

Sensory Division

Autonomic

Somatic

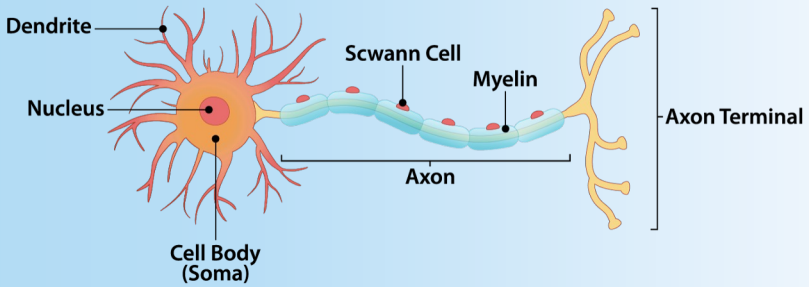
Sympathetic

Parasympathetic

Cells of the Nervous System

Neurons

- Main structural and functional unit of NS
- Conducting cells
- Every neuron consists of:
  → Cell body (Soma)
  → Processes
    - Axon and Dendrites

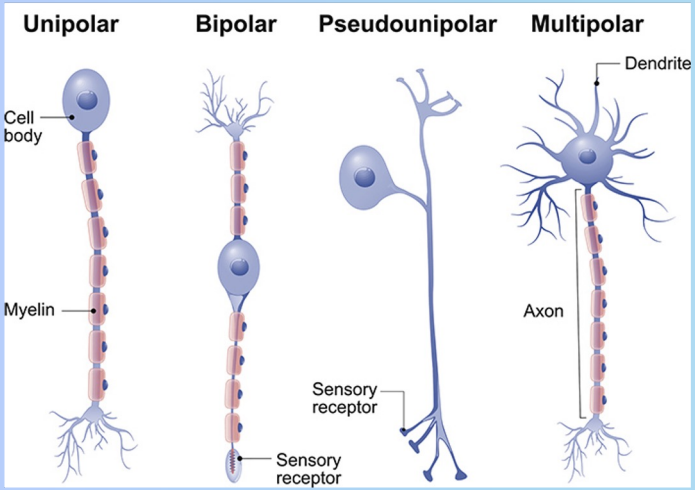


Axon	Dendrites
Long process	Short processes
Conduct impulses away from cell body	Receive impulses from other neurons - signals towards cell body

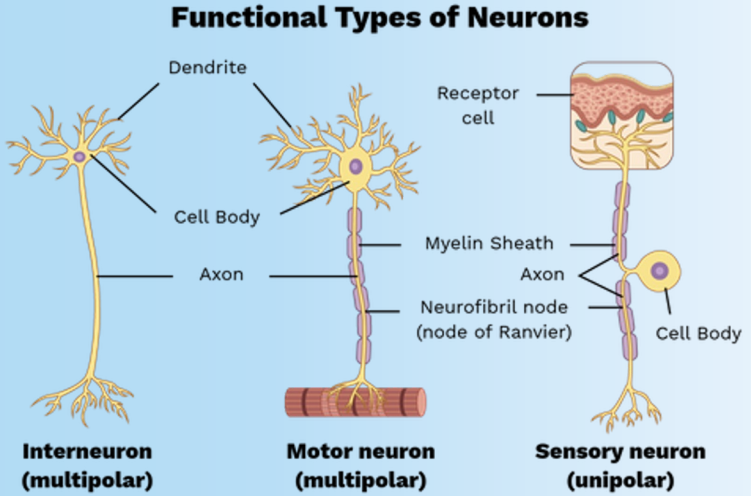
- **Synapse**
  → the place where neurons connect and communicate
  → at junctions between the axon of one neuron and dendrite of another
  → release of **neurotransmitters**

Different Neuron types

Depending on their <u>structure</u>:



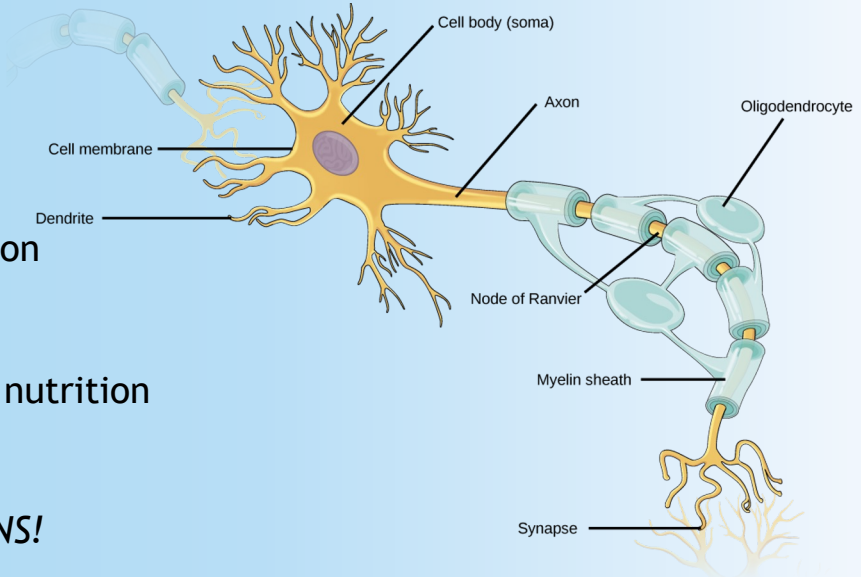
Depending on their <u>function</u>:



Cells of the Nervous System

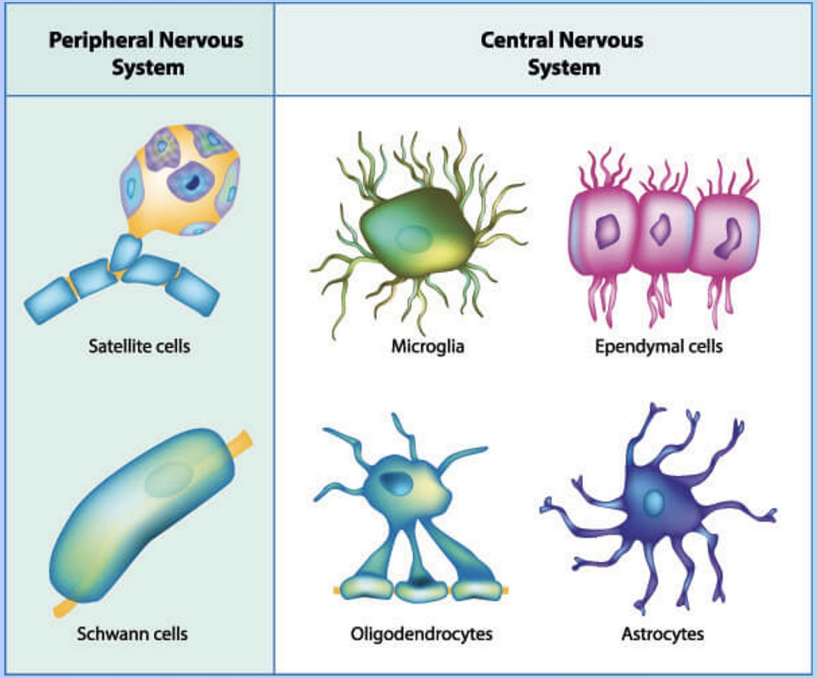
Glial cells

- Smaller, non-excitatory cells
- Support neurons by:
  - myelination
    - membranous sheath - insulating the axon
    - increasing the speed of the signals
  - maintaining homeostatic balance
  - providing structural support, protection and nutrition



→ *There are different glial cell types in the CNS and PNS!*

Glial cells in the PNS and CNS

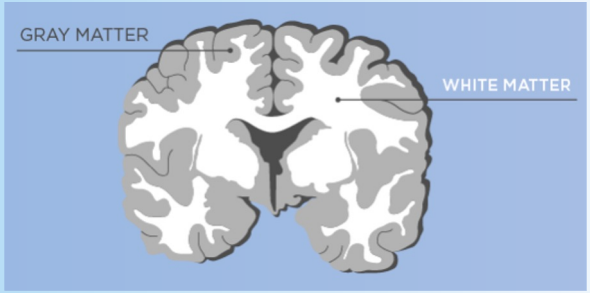


Cell type:	Function:	System:
Satellite	Surround neuron cell bodies in ganglia	PNS
Schwann	Myelinate neurons in PNS	PNS
Microglia	Remove dead cells and pathogens by phagocytosis	CNS
Ependymal	Line the ventricles of the brain, move CSF through ventricle system	CNS
Oligodendrocytes	Myelinate neurons in CNS	CNS
Astrocytes	Form scar tissues, participate in blood-brain-barrier, cytoskeleton	CNS

White VS Gray Matter

- **White matter** = Myelinated axons (lipid rich)
- **Gray matter** = Cell bodies, dendrites, interneurons

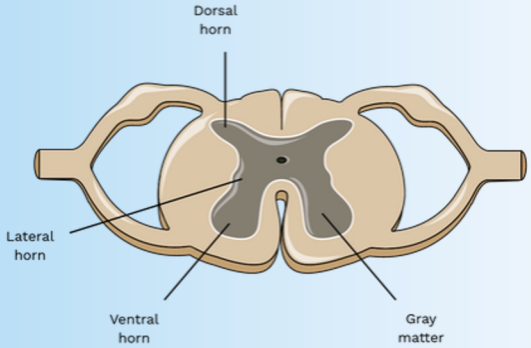
In the brain → white matter is the innermost layer
Of the spinal cord → gray matter is the innermost layer



Different terminology in CNS/PNS:

In the CNS:
- White matter = tracts (bundles of axons)
- Gray matter = nuclei (collection of cell bodies)

In the PNS:
- White matter = nerves (bundles of axons)
- Gray matter = ganglia (collection of cell bodies)



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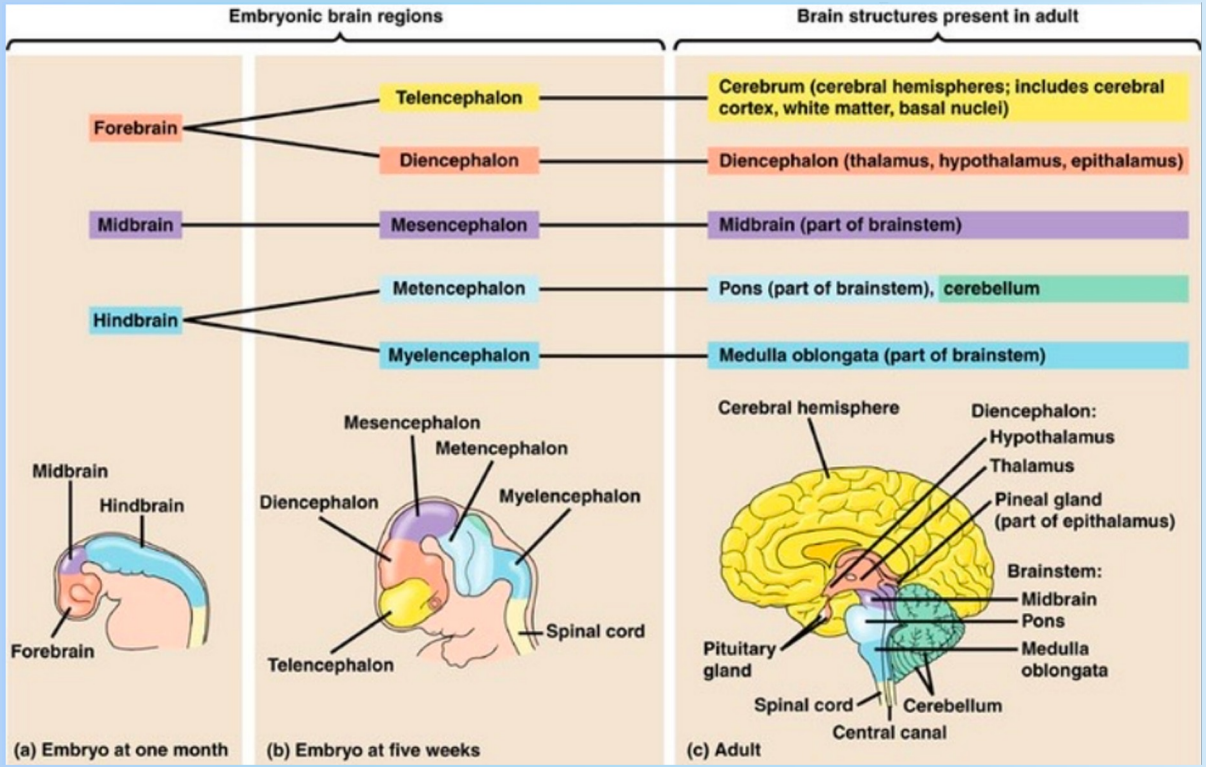
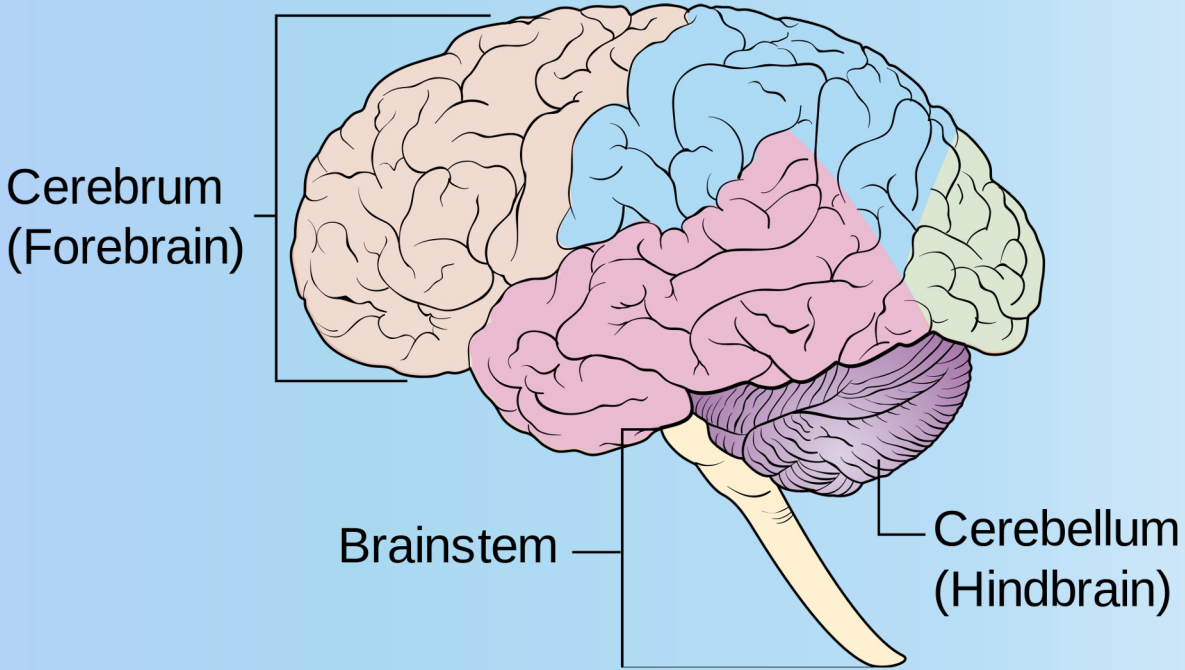
The Brain is divided into 5 parts:

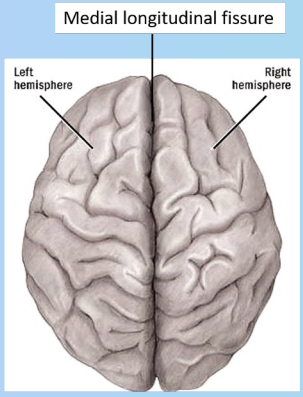


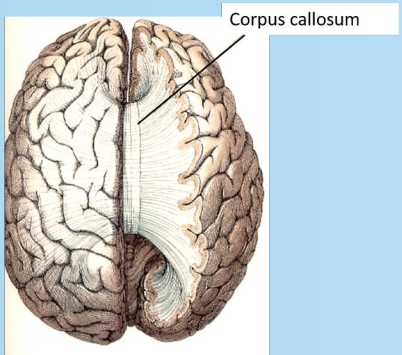


Cerebrum / “Telencephalon”

- The largest part of the brain
- Comprises gray matter (cerebral cortex) and white matter at its center

- **Functions**:
  - initiates and coordinates movement
  - regulates temperature
  - speech, judgment, thinking, touch, problem solving, emotions, vision, hearing +++





Cerebral cortex

- Latin for “bark” → the outer gray matter
- Covered with folds (**sulci**) and ridges (**gyri**)
- Divided into 2 halves / hemispheres by the **medial longitudinal fissure**
- Right hemispheres controls the left side of the body - and opposite!
- The two hemispheres communicate through **Corpus callosum**
  - a large, C-shaped structure of white matter and nerve pathways, at the center of cerebrum

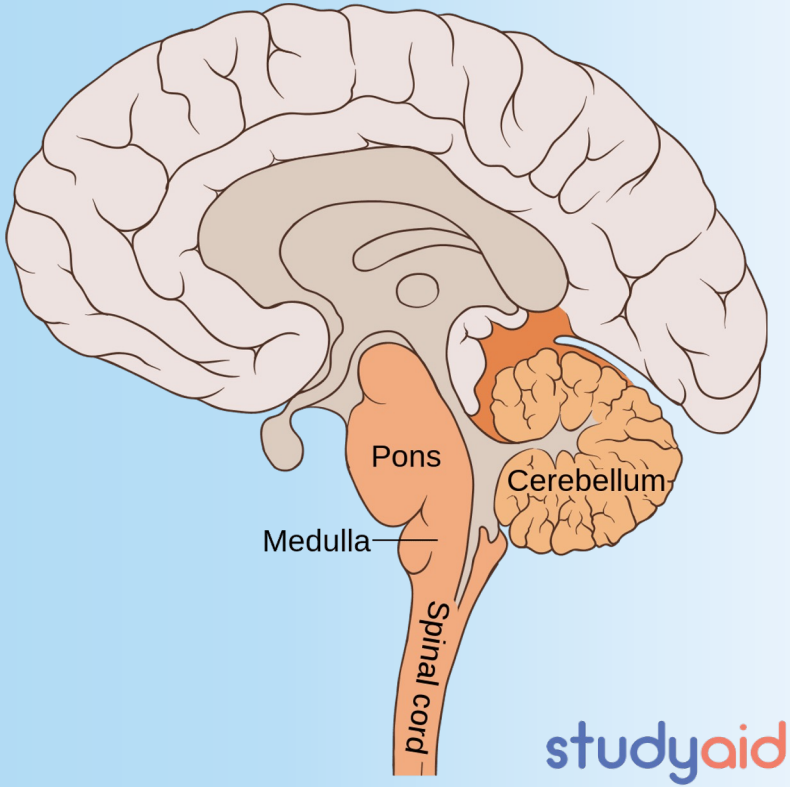
Brainstem and Cerebellum

Brain stem

- Connects the cerebrum with the spinal cord
- Includes:
  - Midbrain
  - Pons
  - Medulla
- Responsible for many vital functions of life, such as breathing, consciousness, BP, HR, sleep

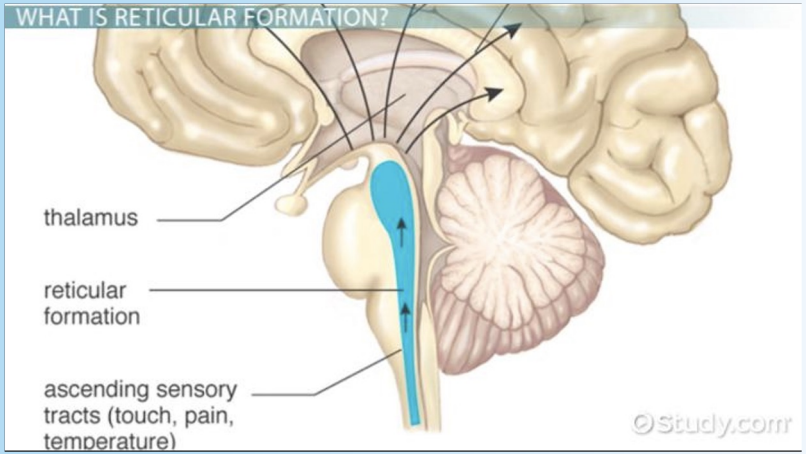
Cerebellum

- “Little brain” - located at the back
- Has 2 hemispheres
- Outer portion: neurons
- Inner area: communicates with cerebral cortex
- Responsible for coordinating of voluntary movements, maintaining posture, balance and equilibrium



Reticular Formation

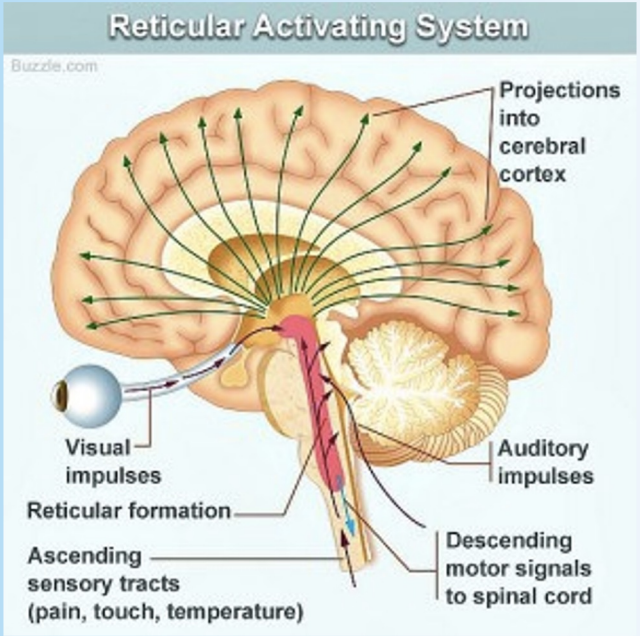
- Complex network of **brainstem nuclei** and **neurons**
- Serves as a major integration and **relay center** for many **vital brain systems** to coordinate functions necessary for survival
- **M**edial portion: **M**otor functions
- Lateral portion: Sensory functions



Reticular Formation

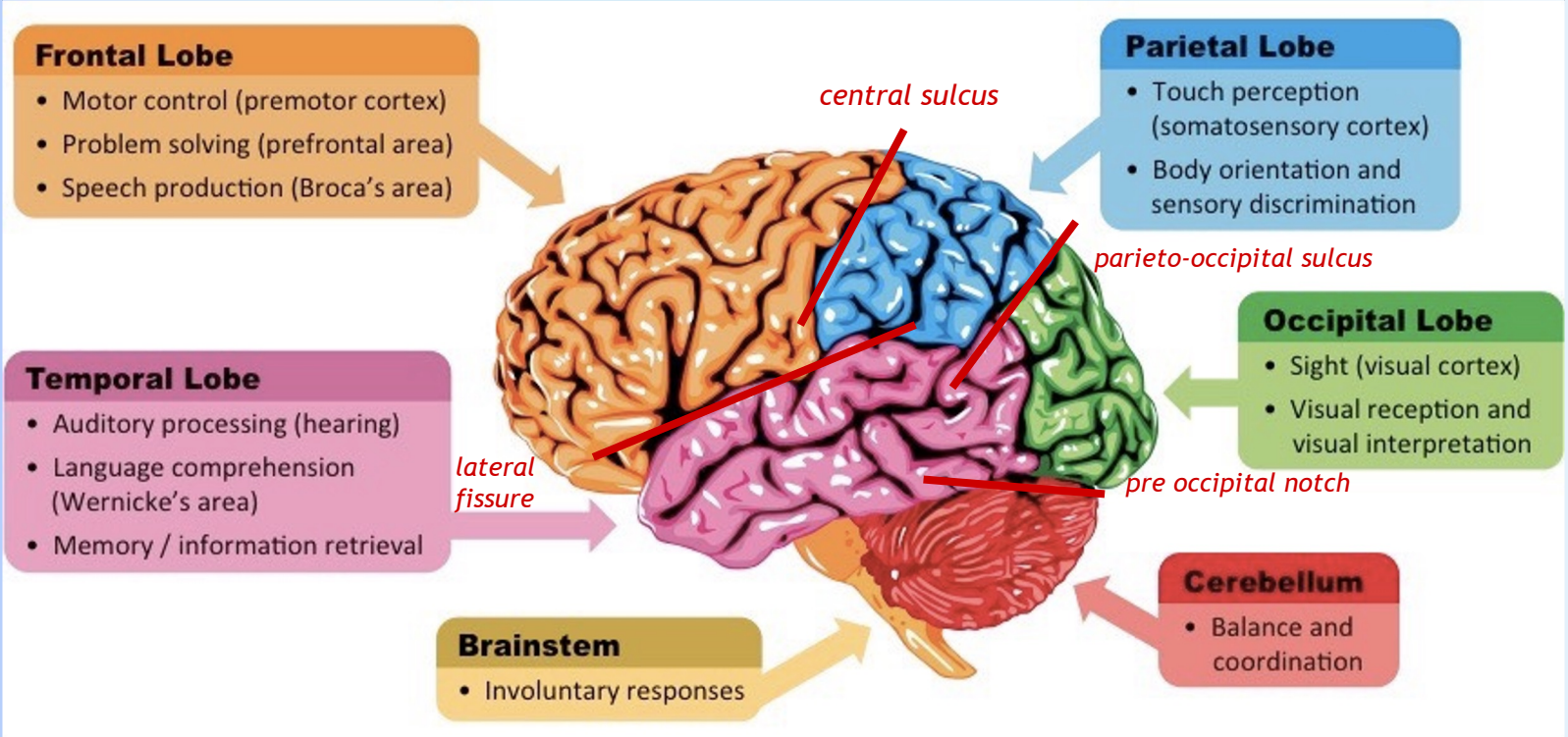
Components:

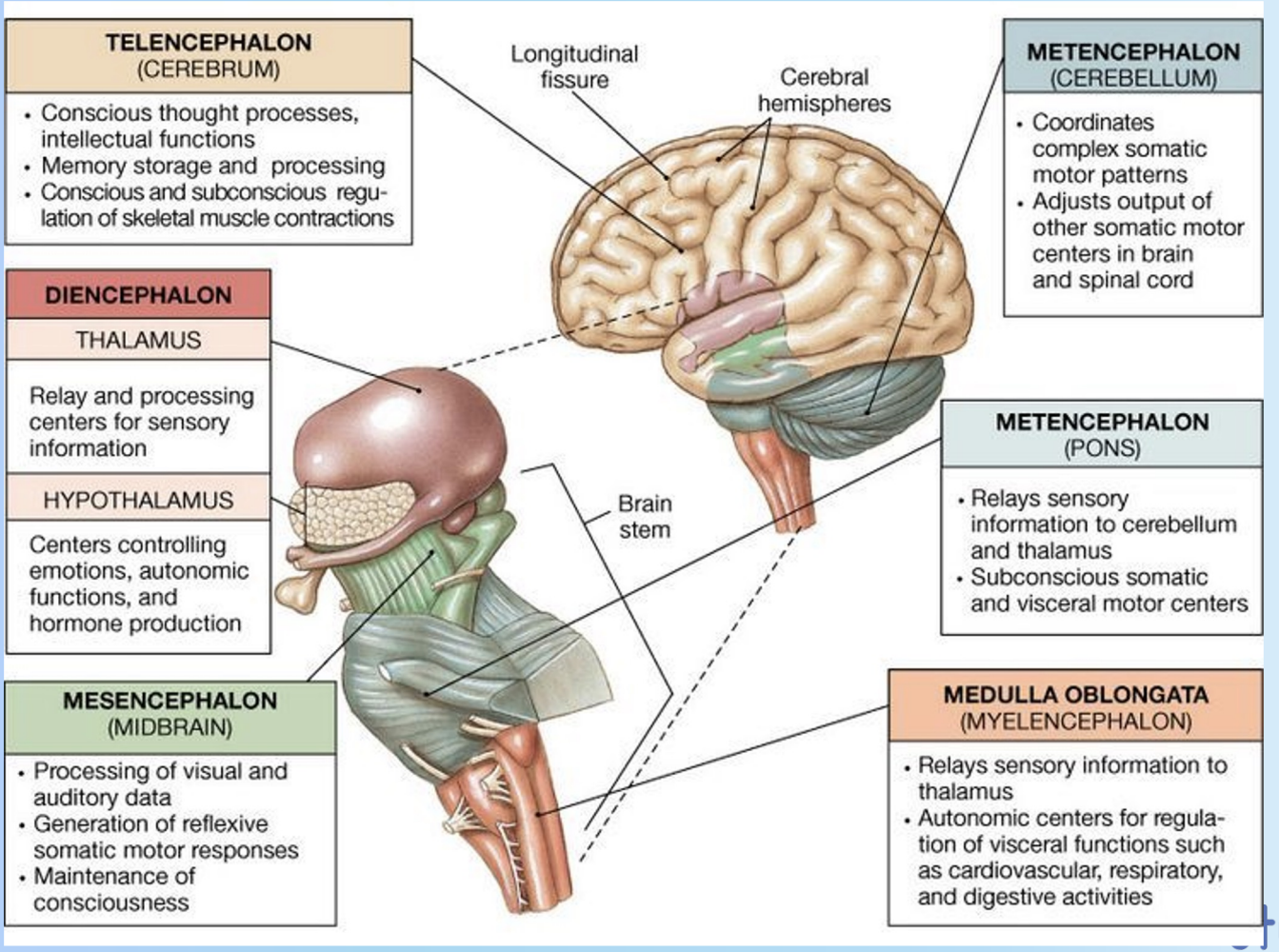
- **Motor**
  - Maintenance of muscle tone and posture (pontine & medullary reticulospinal tracts)
- **Sensory**
  - Processing of “slow pain” information (via the spinoreticular tract)
  - Maintenance of consciousness → the brain stem Reticular Activating System “awakens” the cortex in response to noxious stimuli
- **Autonomic**
  - Medullary “centers” control blood pressure, respiration, cardiac function and GI functions



If damaged reticular formation → Unconsciousness/Coma can occur

4 x Brain Lobes:




TELENCEPHALON
(CEREBRUM)
• Conscious thought processes, intellectual functions
• Memory storage and processing
• Conscious and subconscious regulation of skeletal muscle contractions
Longitudinal fissure
Cerebral hemispheres
METENCEPHALON
(CEREBELLUM)
• Coordinates complex somatic motor patterns
• Adjusts output of other somatic motor centers in brain and spinal cord
DIENCEPHALON
THALAMUS
Relay and processing centers for sensory information
HYPOTHALAMUS
Centers controlling emotions, autonomic functions, and hormone production
Brain stem
METENCEPHALON
(PONS)
• Relays sensory information to cerebellum and thalamus
• Subconscious somatic and visceral motor centers
MESENCEPHALON
(MIDBRAIN)
• Processing of visual and auditory data
• Generation of reflexive somatic motor responses
• Maintenance of consciousness
MEDULLA OBLONGATA
(MYELENCEPHALON)
• Relays sensory information to thalamus
• Autonomic centers for regulation of visceral functions such as cardiovascular, respiratory, and digestive activities