Neuroscience Rounds

Basic Anatomy Overview

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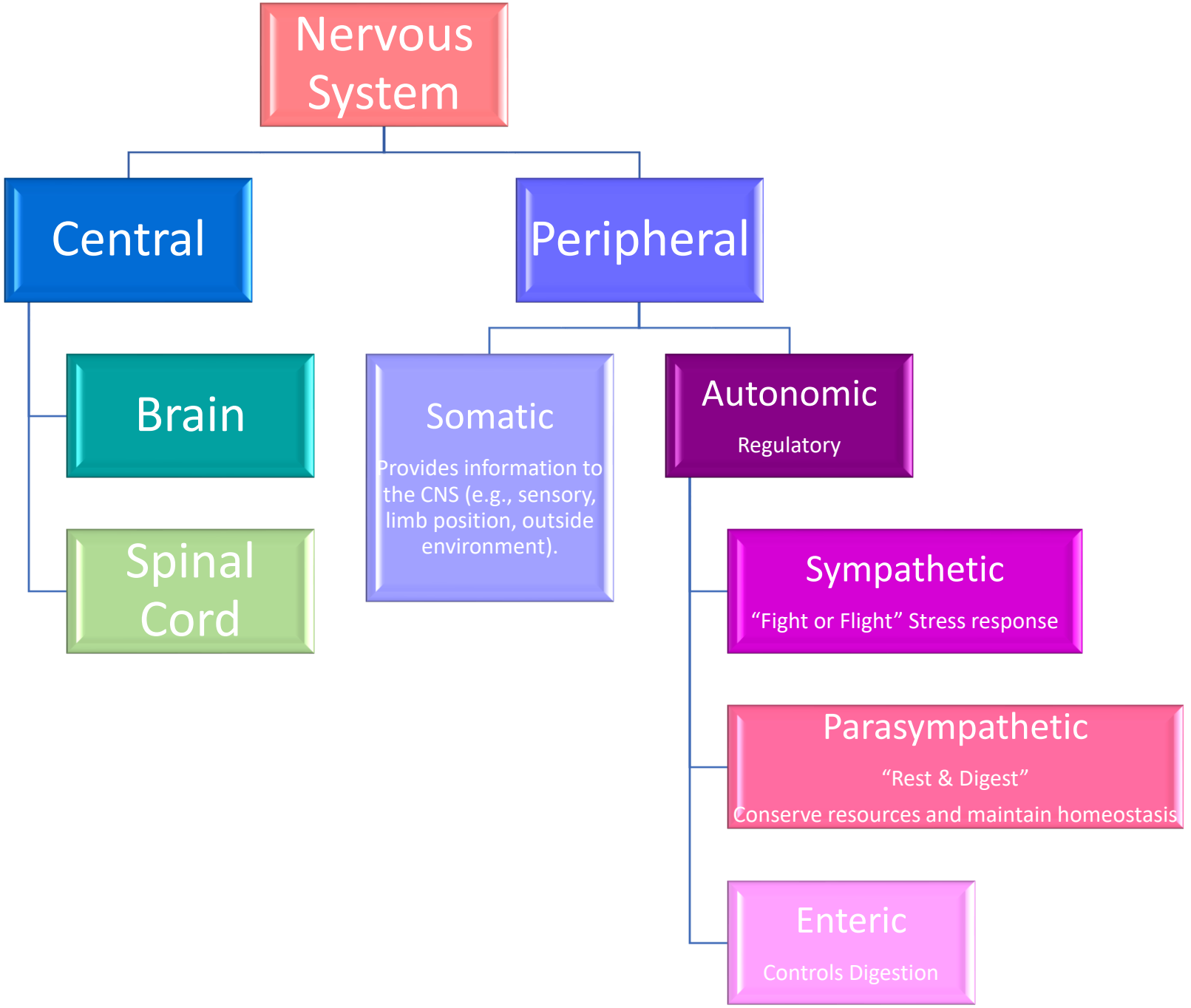
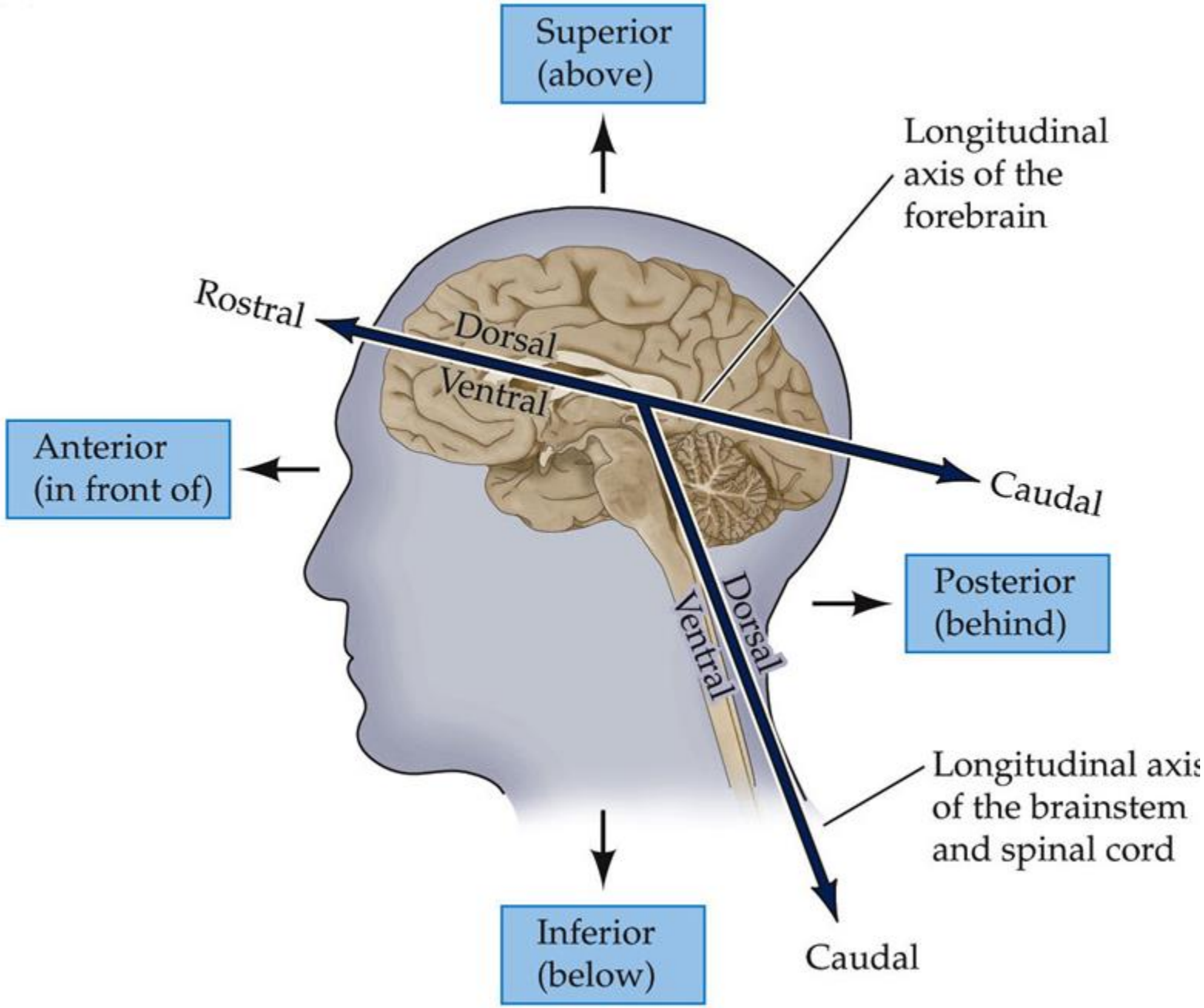
Kristy Snyder Colling, PhD


Nervous System
Central
Peripheral
Brain
Spinal Cord
Somatic
Provides information to the CNS (e.g., sensory, limb position, outside environment).
Autonomic
Regulatory
Sympathetic
"Fight or Flight" Stress response
Parasympathetic
"Rest & Digest"
Conserve resources and maintain homeostasis
Enteric
Controls Digestion

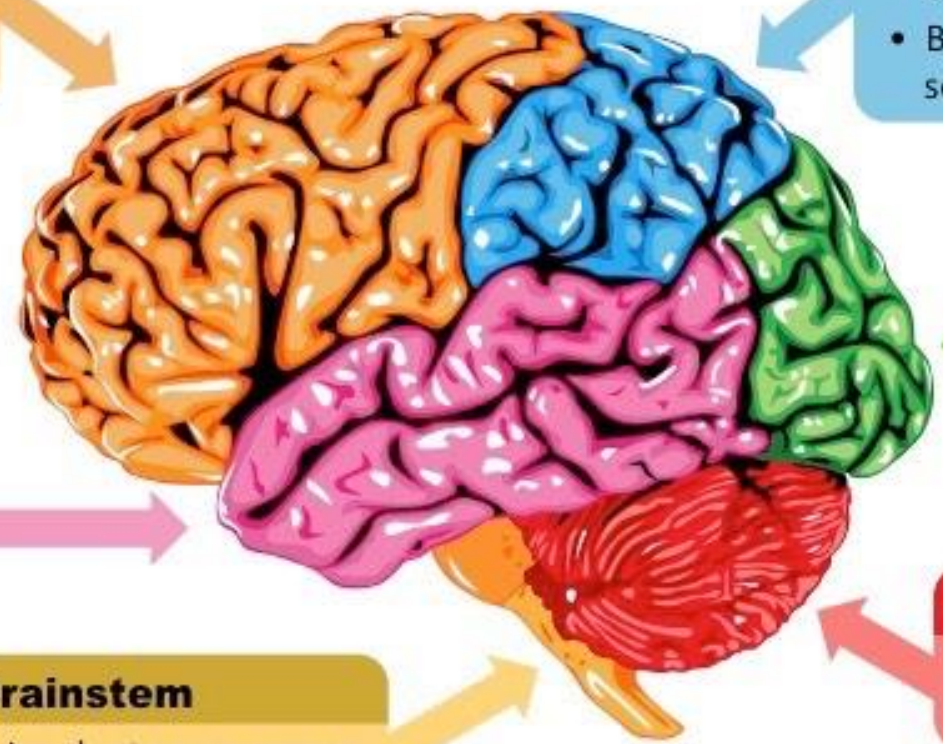


Medial – toward the inside or middle

Lateral – toward the outside

Afferent – toward the brain

Efferent – away from the brain



Frontal Lobe

- Motor control (premotor cortex)
- Problem solving (prefrontal area)
- Speech production (Broca's area)

Parietal Lobe

- Touch perception (somatosensory cortex)
- Body orientation and sensory discrimination

Occipital Lobe

- Sight (visual cortex)
- Visual reception and visual interpretation

Temporal Lobe

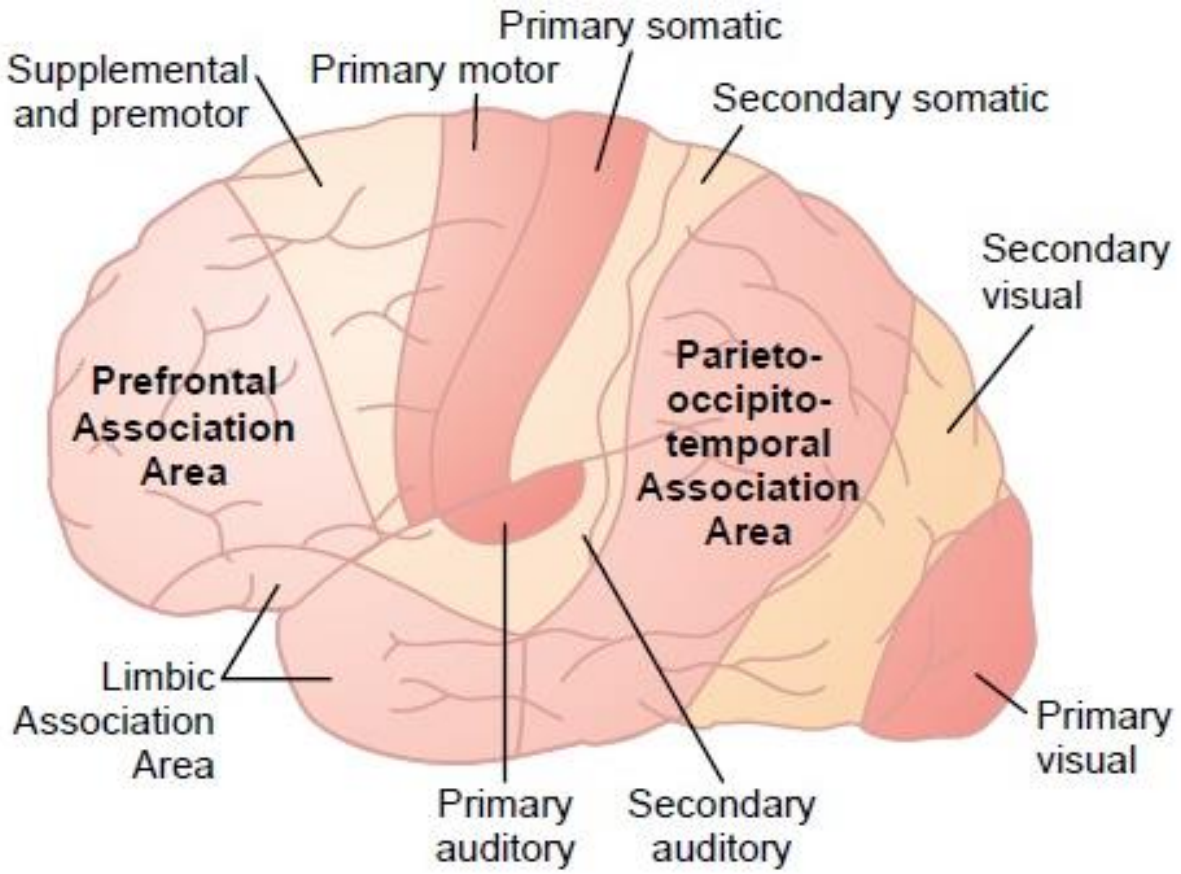
- Auditory processing (hearing)
- Language comprehension (Wernicke's area)
- Memory / information retrieval

Cerebellum

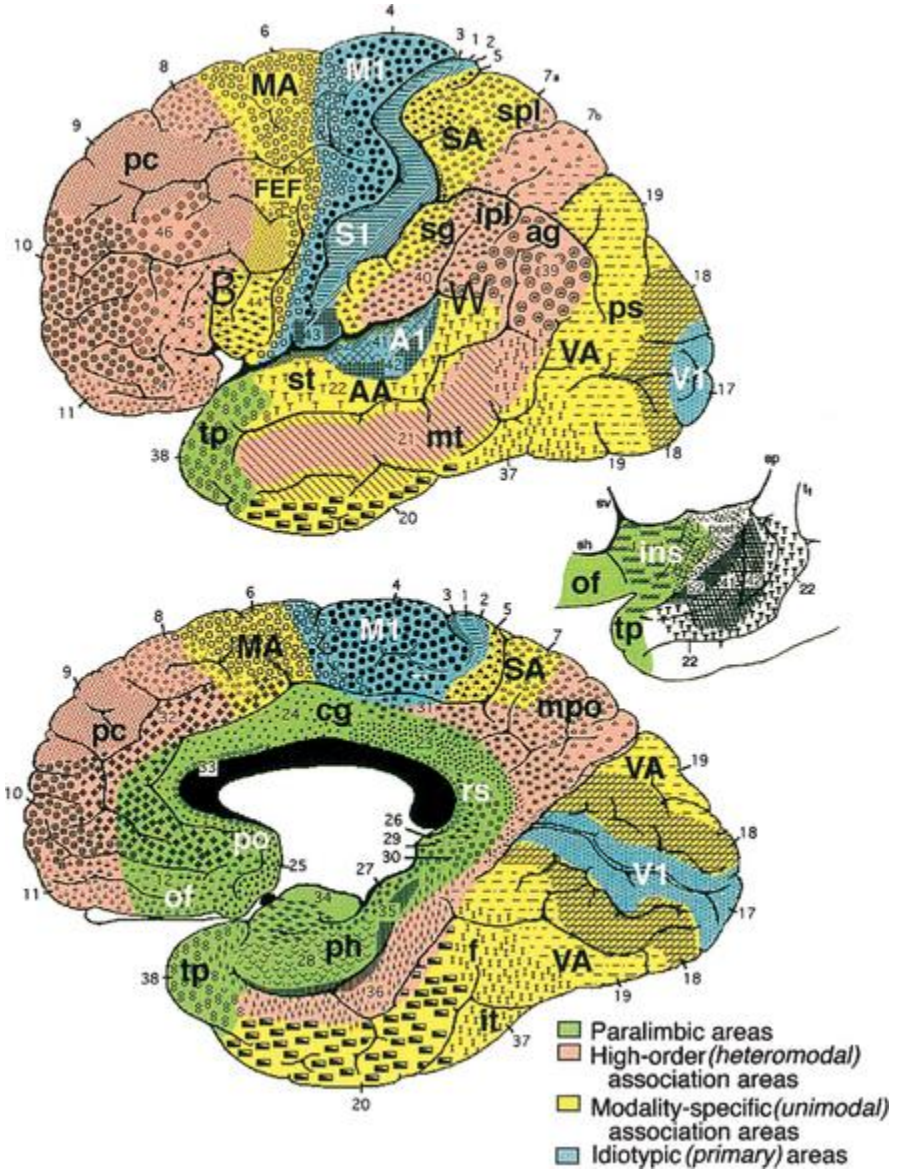
- Balance and coordination

Brainstem

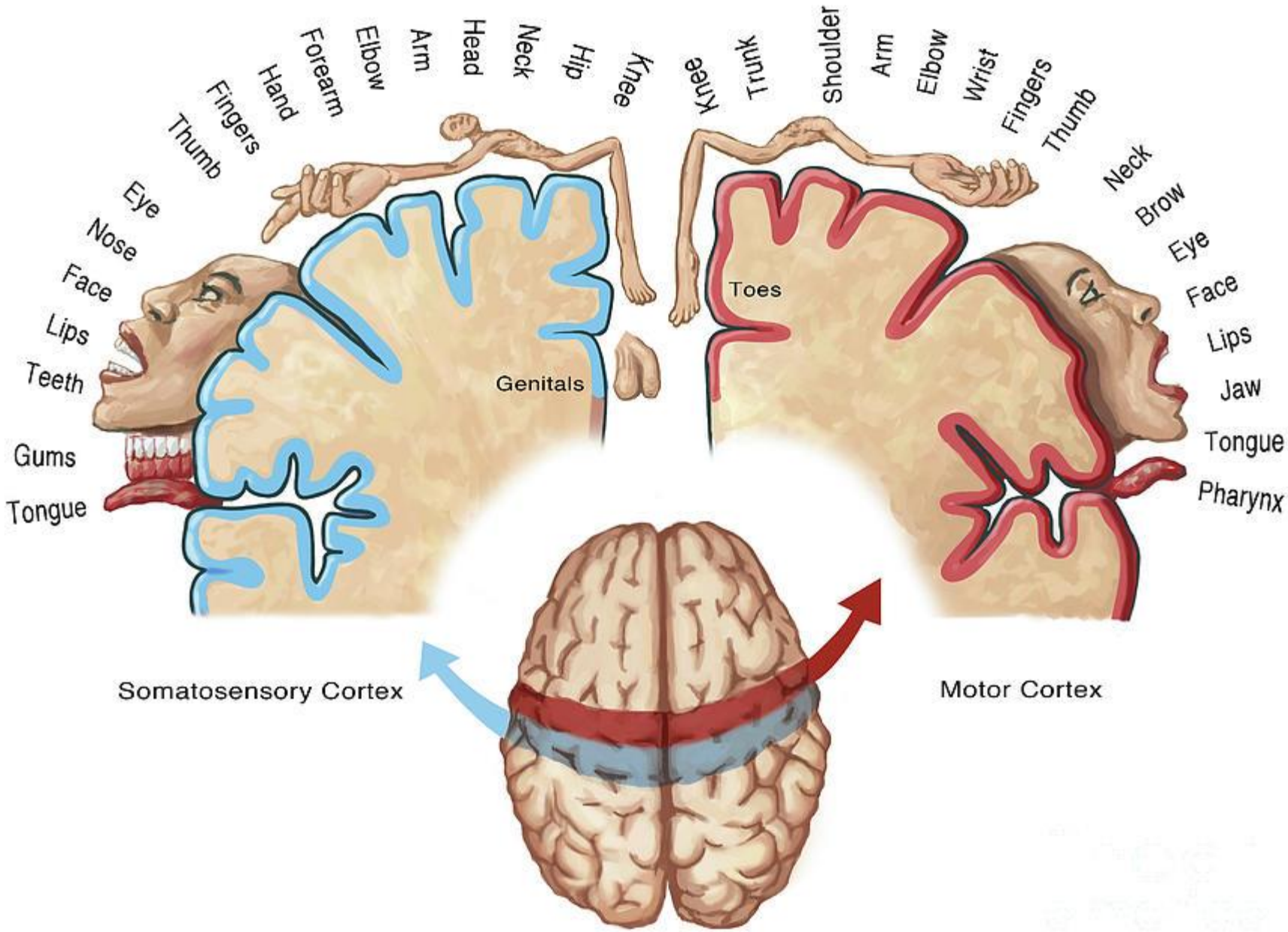
- Involuntary responses



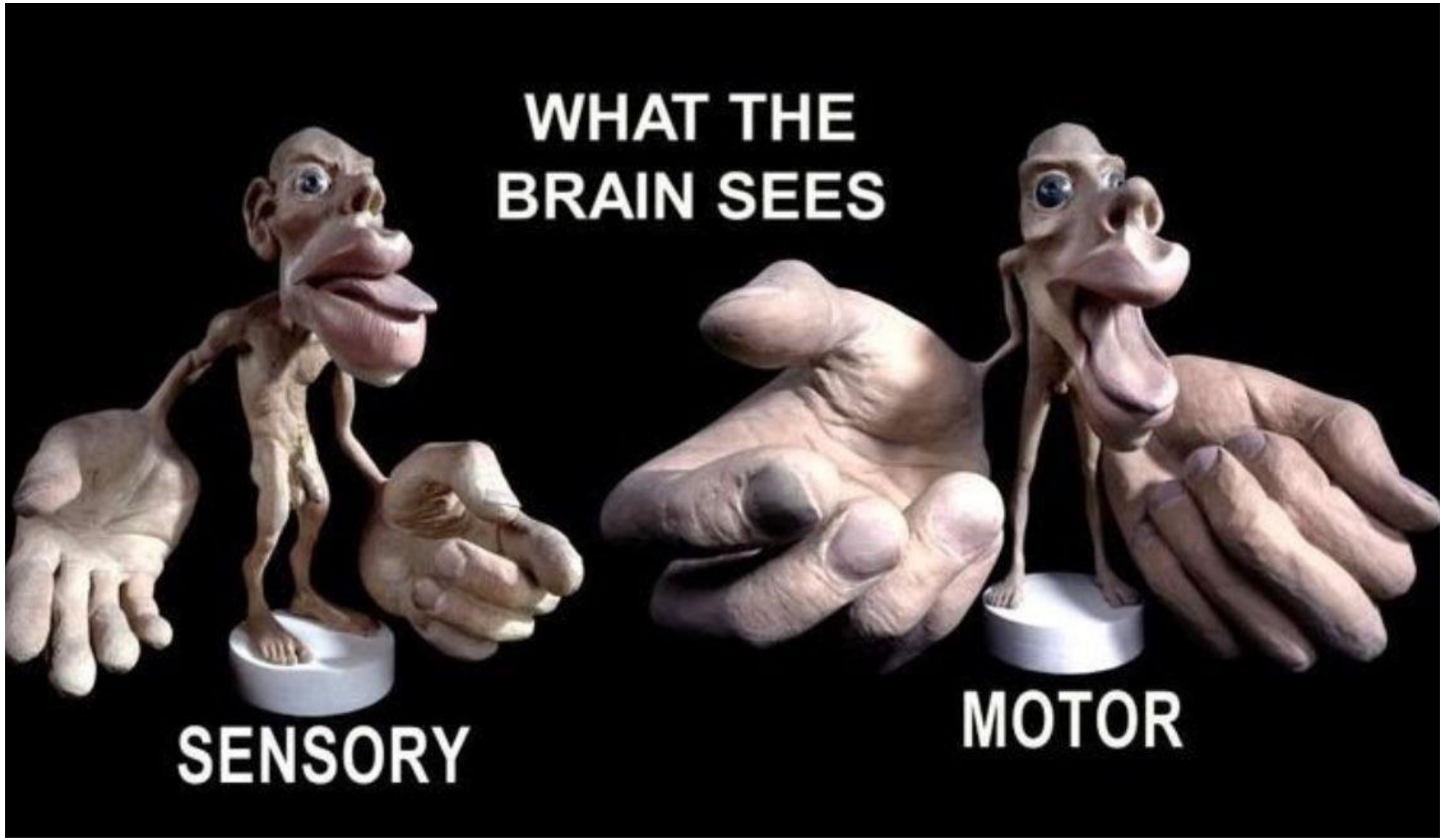
- Primary – basic processing of most elemental input (e.g., lines)
- Secondary – elaborative processing (e.g., shapes, objects)
- Association – Integrative processing (i.e., how you feel about an object, memories of the object)



- Primary/Idiotypic – basic processing of most elemental input (e.g., lines)
- Secondary/ Modality-Specific Unimodal Association – elaborative processing (e.g., shapes, objects)
- Association/High-Order Heteromodal – Integrative processing (i.e., how you feel about an object, memories of the object)

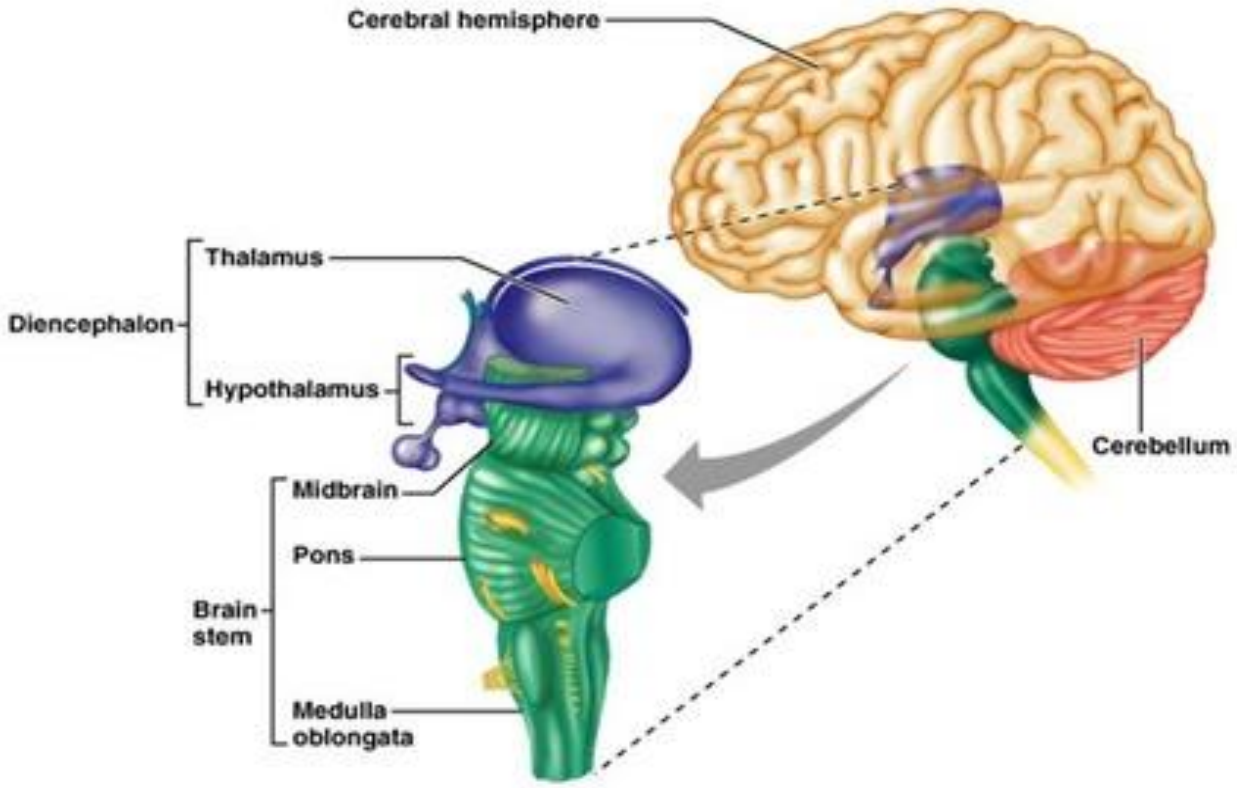


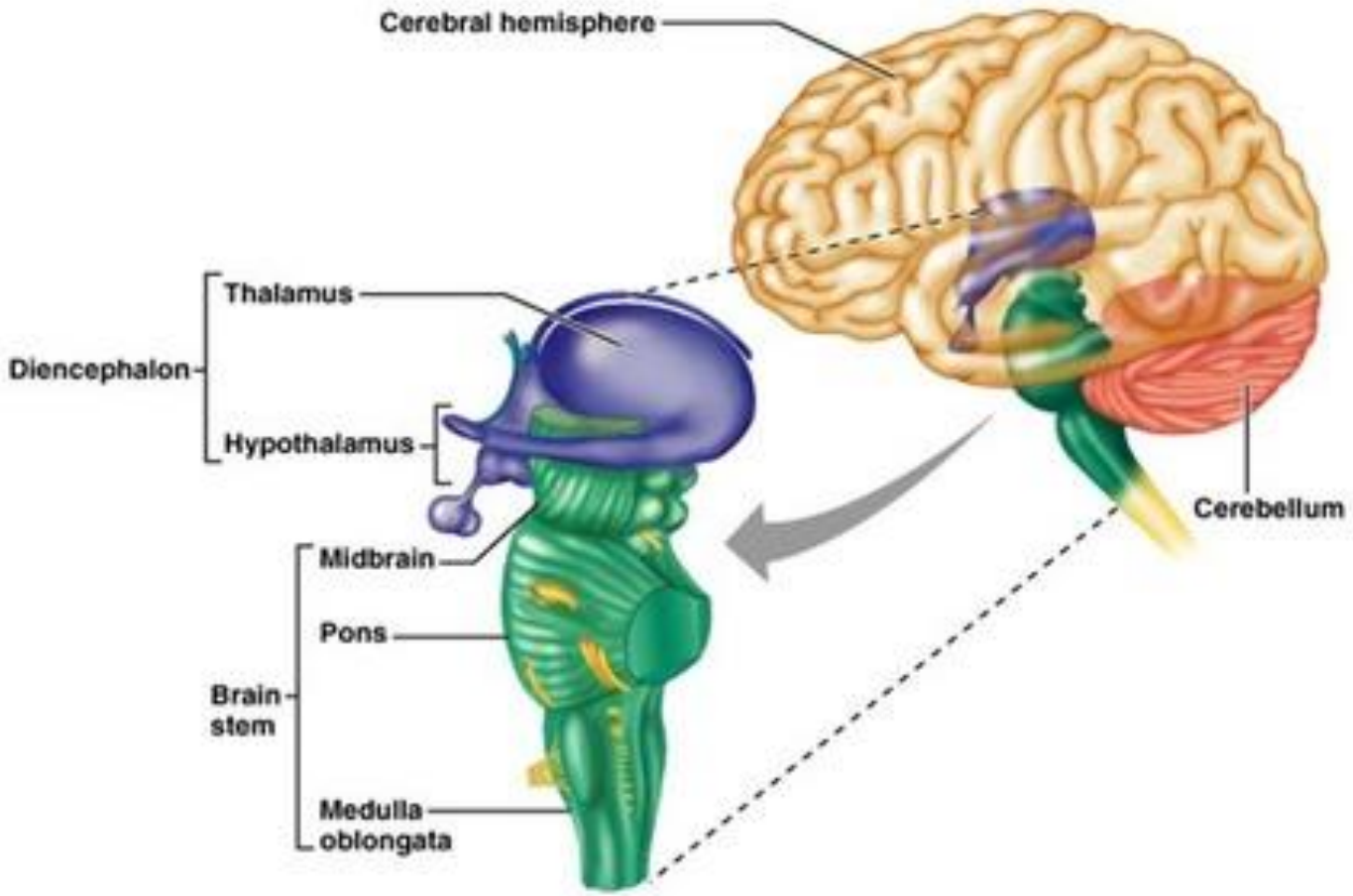
Somatotopic map - projection of body surface onto brain area


WHAT THE
BRAIN SEES
SENSORY
MOTOR

Brain Stem

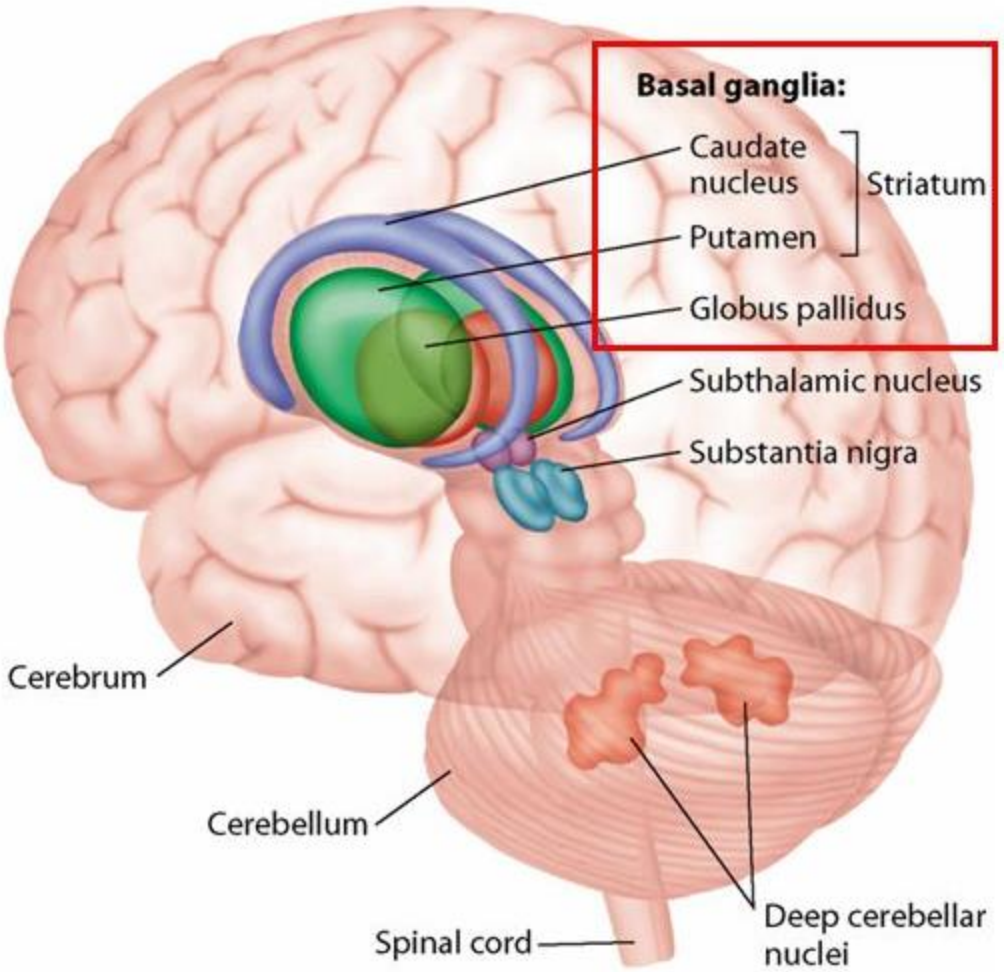
- Medulla
  - Part of autonomic system that regulates involuntary functions (e.g., Regulates blood pressure, respiration, sneezing, vomiting).
- Pons
  - Latin for bridge – conducts signals from the brain to the cerebellum, medulla, and thalamus
  - Roles in swallowing, facial expressions, hearing, taste, sleep, equilibrium, & voluntary control of bladder, respiration
- Midbrain
  - Eye movement and motor control
  - Relay nuclei of auditory and visual systems





Cerebellum

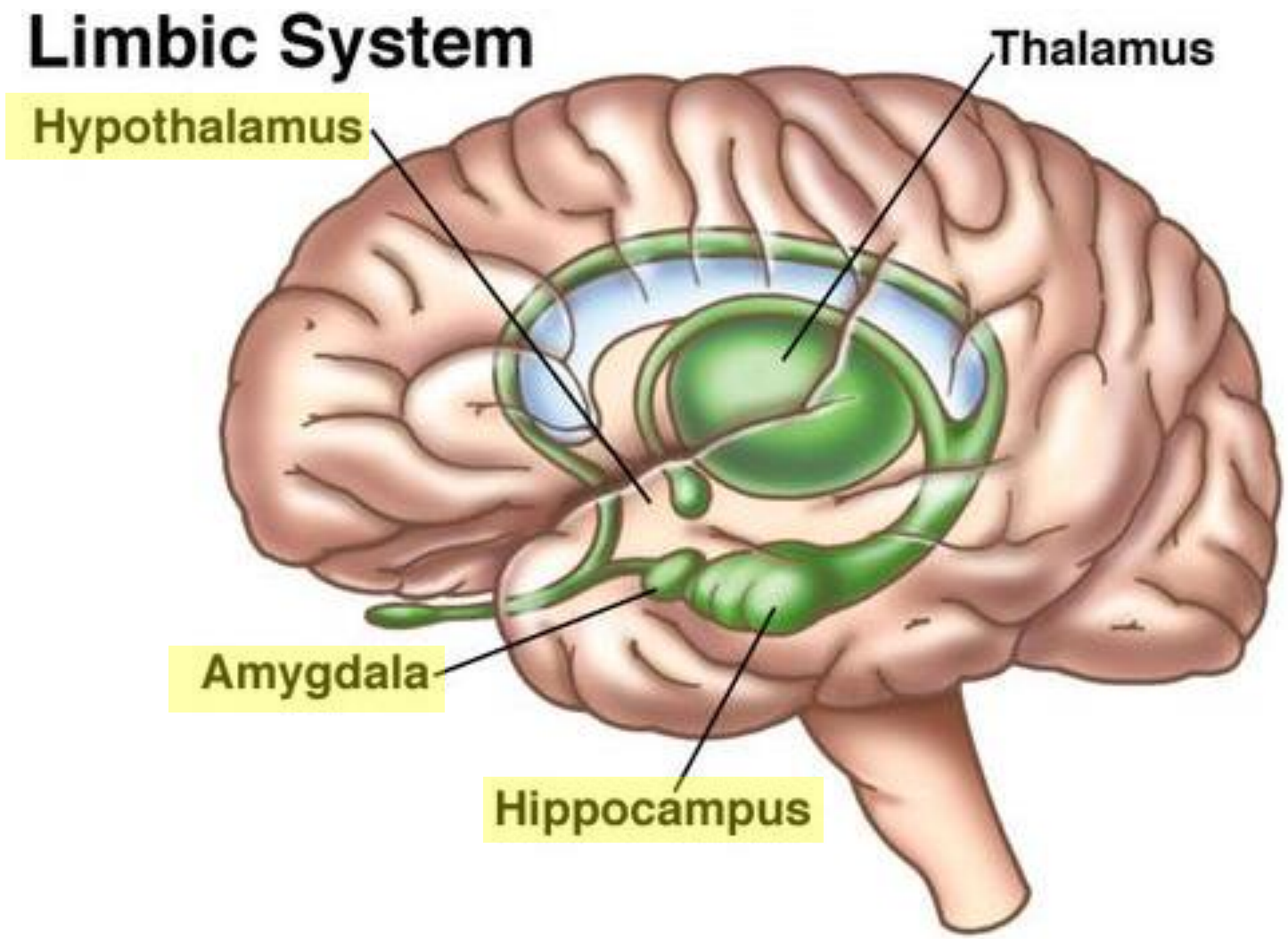
- Receives somatosensory input from spinal cord, motor info from cerebral cortex, & balance information and integrates it to coordinate planning, timing, and patterning of skeletal muscle contractions during movement.
- Initiation & Timing of motor movements, smooth progression of movements
- Monitors and makes corrective adjustments to motor plan



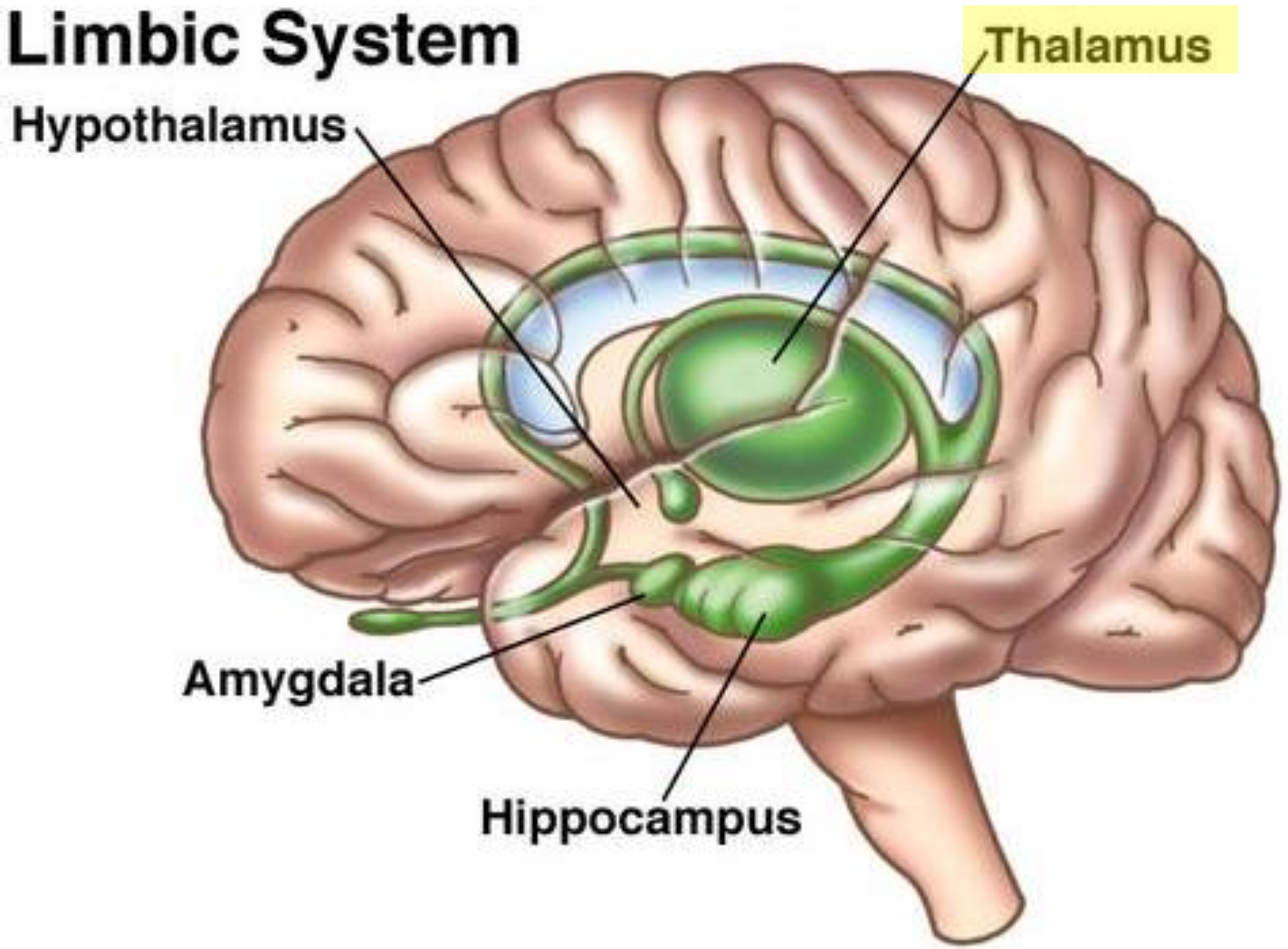
Basal Ganglia

- Helps plan and control complex movement patterns - action selection, sequence, movement initiation, intensity, and direction

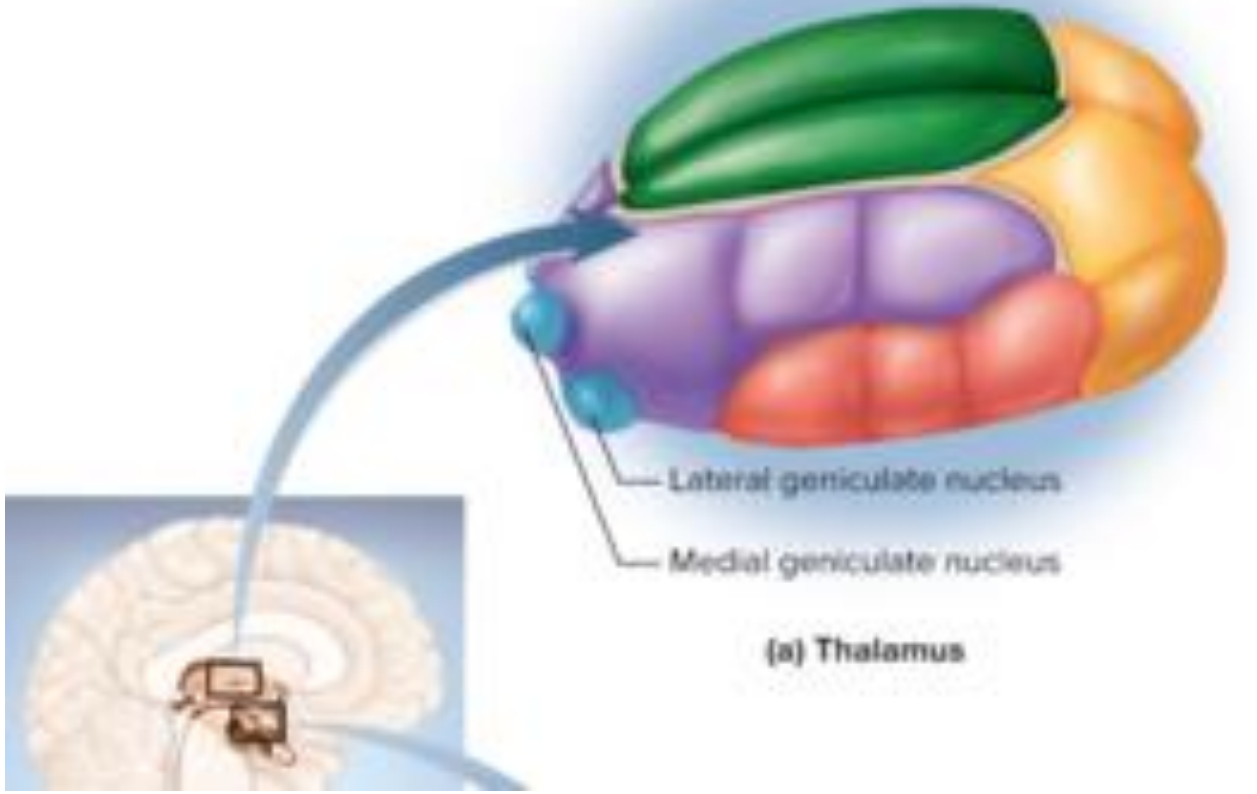
- Caudate – Integrates spatial information and motor behavior. Also, part of the reward system and helps selection actions based on changing values of goals
- Putamen – Extent and amplitude of movement
- Globus Pallidus – Inhibitory action that works to allow smooth movements (i.e., reduce tremors and jerks)
- Substantia Nigra – GABA & dopaminergic pathways, learning – observation of environment and location in space (spatial learning), movement timing
- Subthalamic Nucleus – action selection, role in impulsive choice between two equally rewarding stimuli



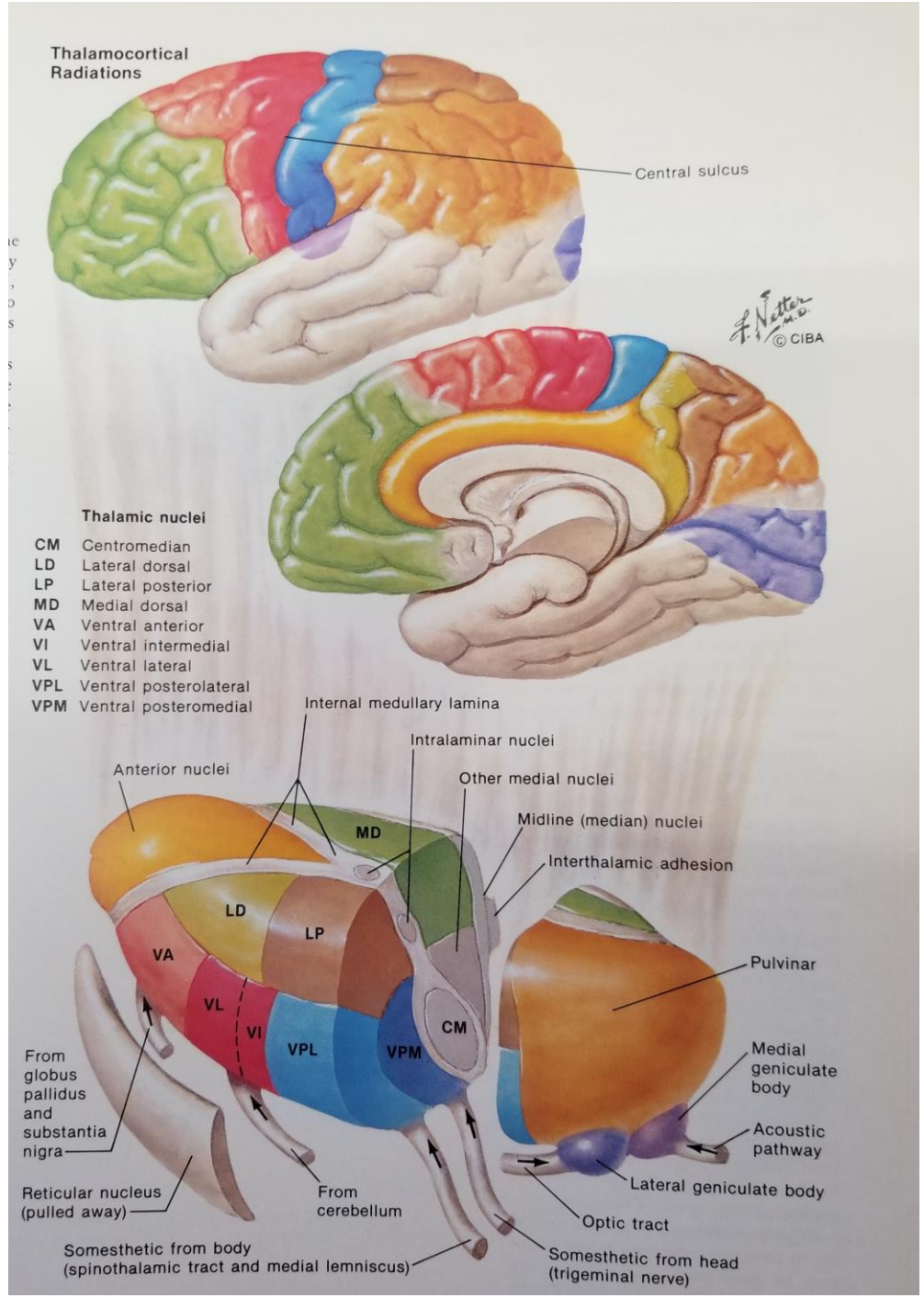
- Limbic System – learning, emotion, memory
  - Hippocampus – memory
  - Amygdala – coordinates autonomic and endocrine systems. Seat of "Fight or Flight" response – important in trauma, PTSD, anxiety
  - Hypothalamus – Links nervous and endocrine system. Regulates metabolic processes.



- Thalamus
  - Regulates awareness and emotional aspects of sensory experiences
  - Relay station - Processes and distributes sensory and motor information going to the cerebral cortex



- Anterior
  - Part of limbic system; memory & emotion
- Medial
  - Emotional output to prefrontal cortex. Awareness of emotions
- Ventral
  - Signals from cerebellum and basal nuclei to motor areas of cortex
- Lateral
  - Contributes to emotional function of limbic system
- Posterior
  - Relay of visual signals to occipital lobe (via lateral geniculate nucleus) and auditory signals to temporal lobe (via medial geniculate nucleus)


Thalamocortical Radiations
Central sulcus
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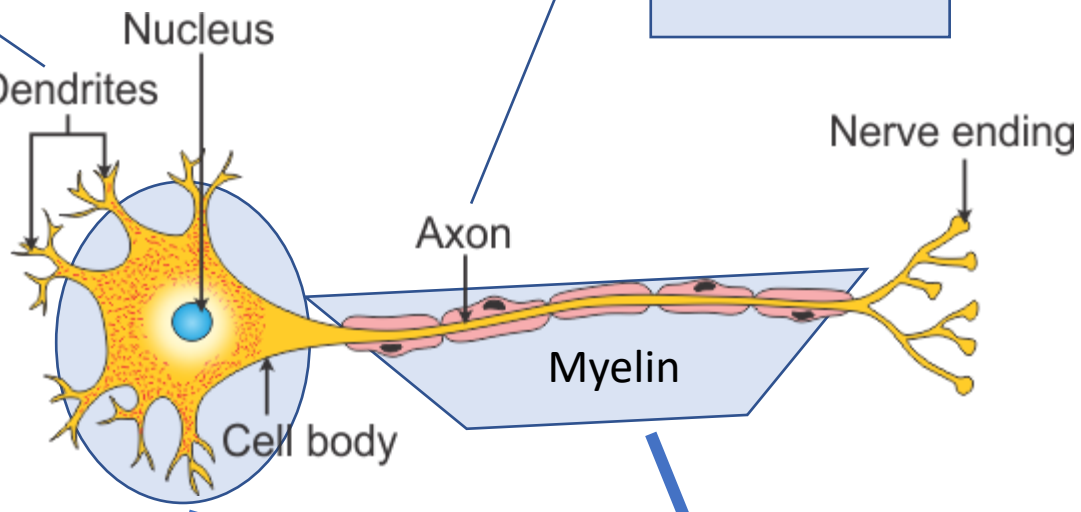
Thalamic nuclei
CM Centromedian
LD Lateral dorsal
LP Lateral posterior
MD Medial dorsal
VA Ventral anterior
VI Ventral intermedial
VL Ventral lateral
VPL Ventral posterolateral
VPM Ventral posteromedial
Internal medullary lamina
Intralaminar nuclei
Anterior nuclei
Other medial nuclei
Midline (median) nuclei
Interthalamic adhesion
MD
LD
LP
VA
VL
VI
VPL
VPM
CM
Pulvinar
From globus pallidus and substantia nigra
Medial geniculate body
Acoustic pathway
Lateral geniculate body
Reticular nucleus (pulled away)
From cerebellum
Optic tract
Somesthetic from body (spinothalamic tract and medial lemniscus)
Somesthetic from head (trigeminal nerve)

The Neuron

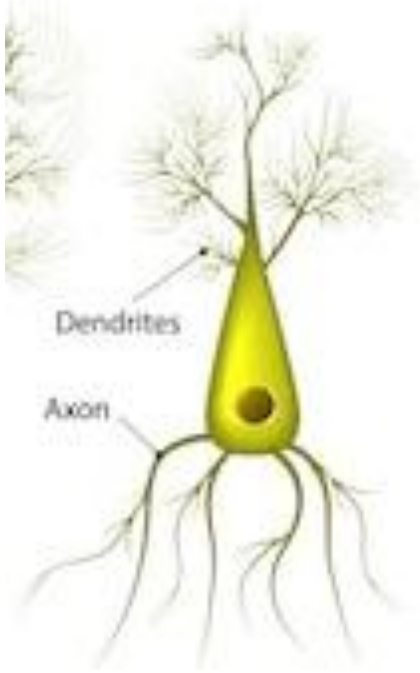
Receive information

Sends information



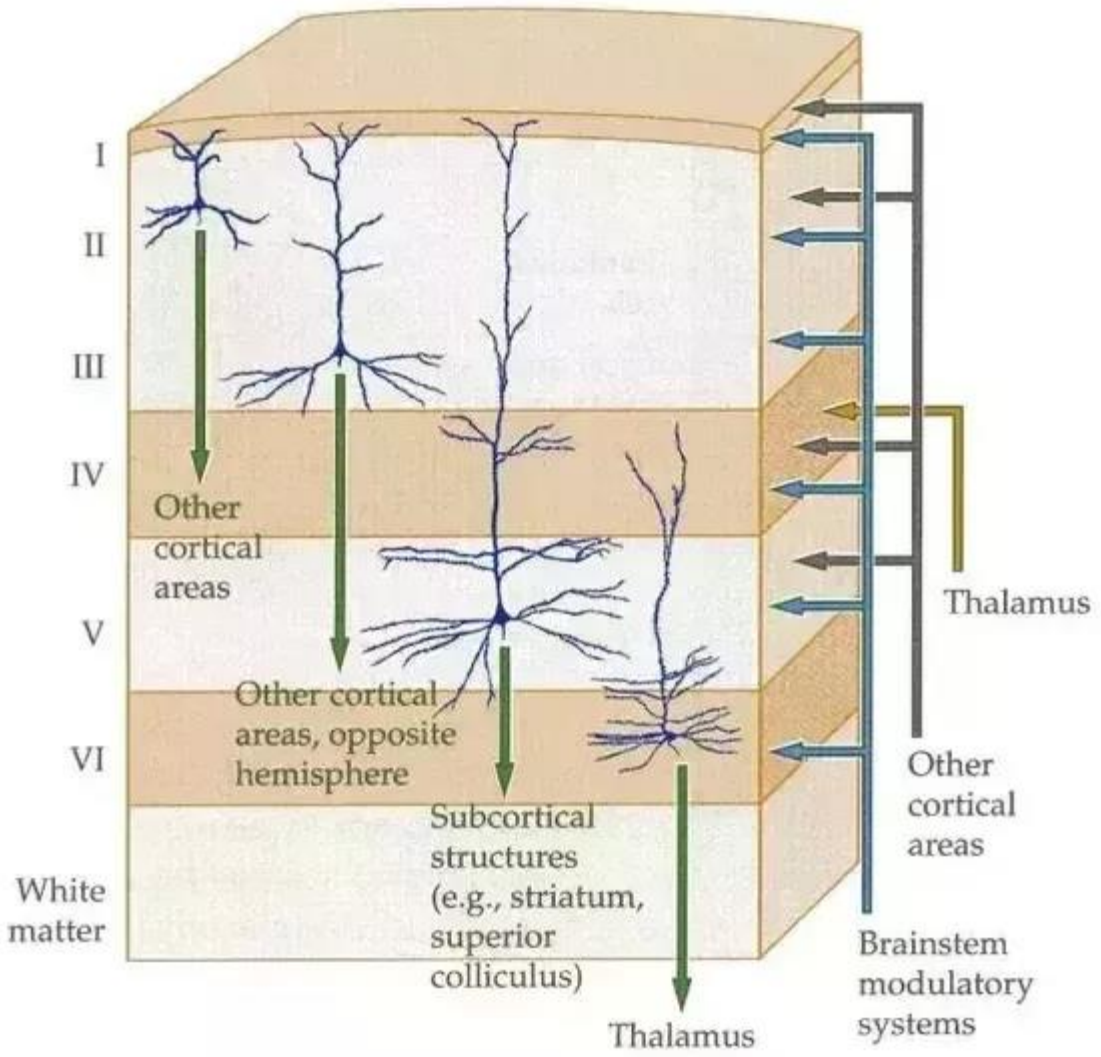
Gray Matter

White Matter

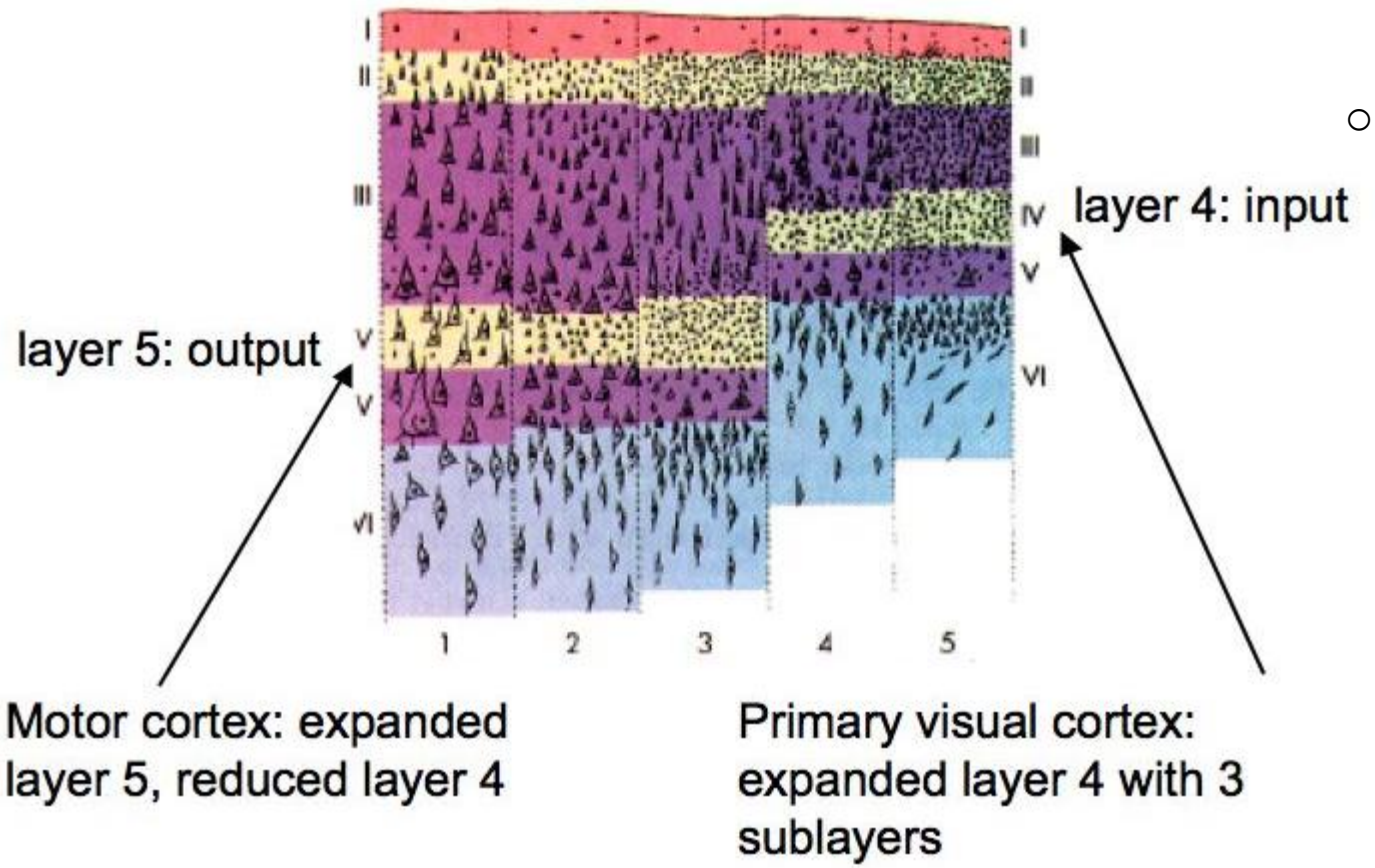


Pyramidal cell

- Two main types of cells in the cortex, each group can be subdivided by dendritic branching pattern
    - Pyramidal –
        - Shaped like a pyramid with apex pointing toward the surface of the brain.
        - Are projection neurons, carrying output from the local cortical area
    - Non-pyramidal –
        - Circular cell body
        - Primarily receive information and participate in local information processing



- Cortex has 6 layers numbered from the surface to deeper in the brain
    - 1 – Mostly glial cells and axons that run laterally and interconnect local cortical areas
    - 2 – mostly small pyramidal cell
    - 3 – larger pyramidal cells together provide most output for that region
    - 4 – nonpyramidal cells receive afferent information from the thalamus
    - 5 – largest pyramidal with longest axons that project to the basal ganglia, brain stem and spinal cord
    - 6 – pyramidal cells that project back to thalamus
    - White matter below carries axons to and from cortex



- Cortical layers vary in thickness
  - Layer 4 nonpyramidal cells are expanded in primary sensory areas because they receive many inputs from sensory relays in the thalamus (e.g., the primary visual cortex).
  - Layer 5 is thicker in motor areas because many large pyramidal cells output motor commands