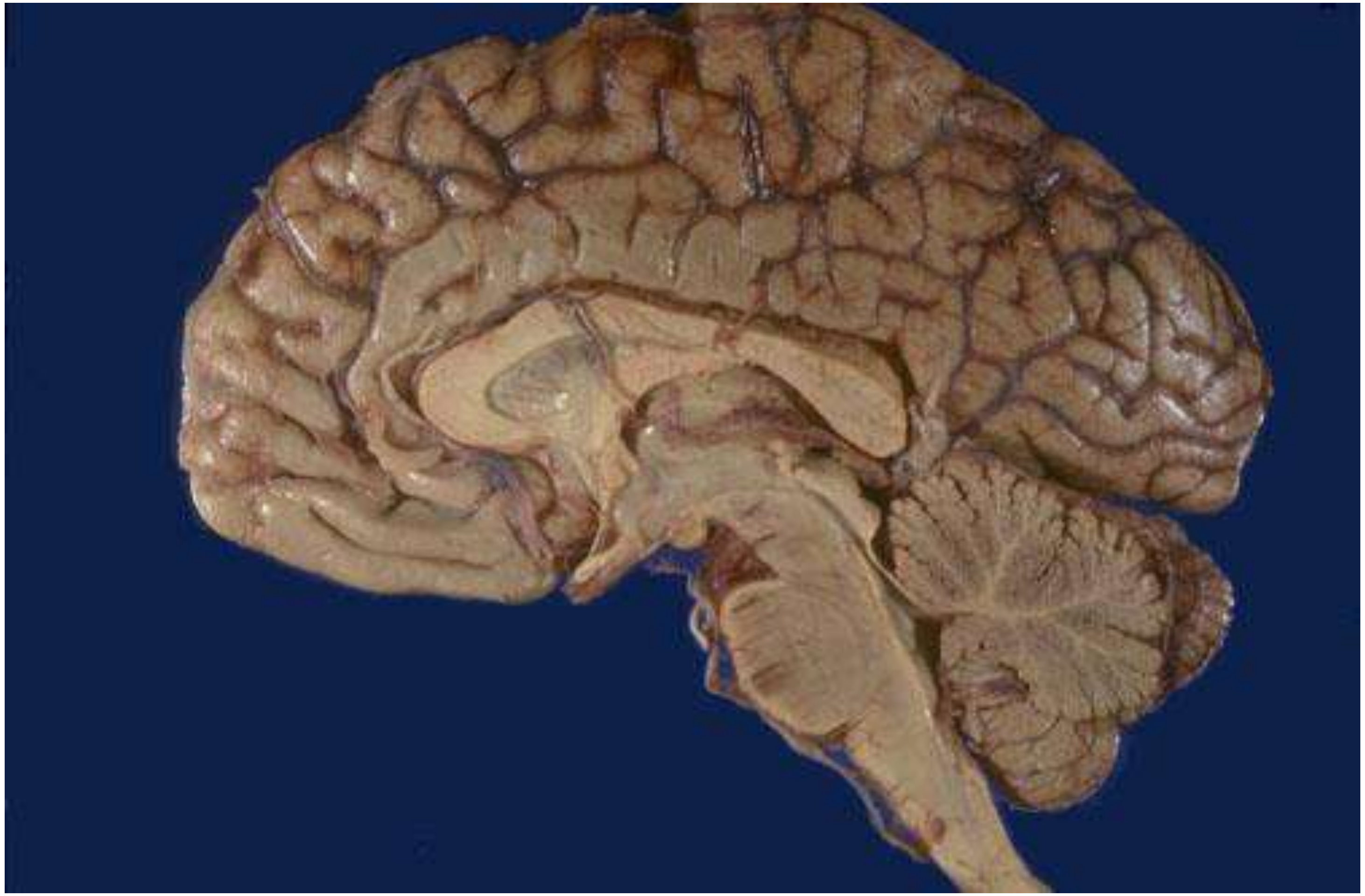


GROSS ANATOMY AND FUNCTION (per site)

reference:

Bhatnagar, S. (2018). *Neuroscience for the Study of Communicative Disorders* (M. Nobel, Ed.). Wolters Kluwer.

CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

CENTRAL NERVOUS SYSTEM

1

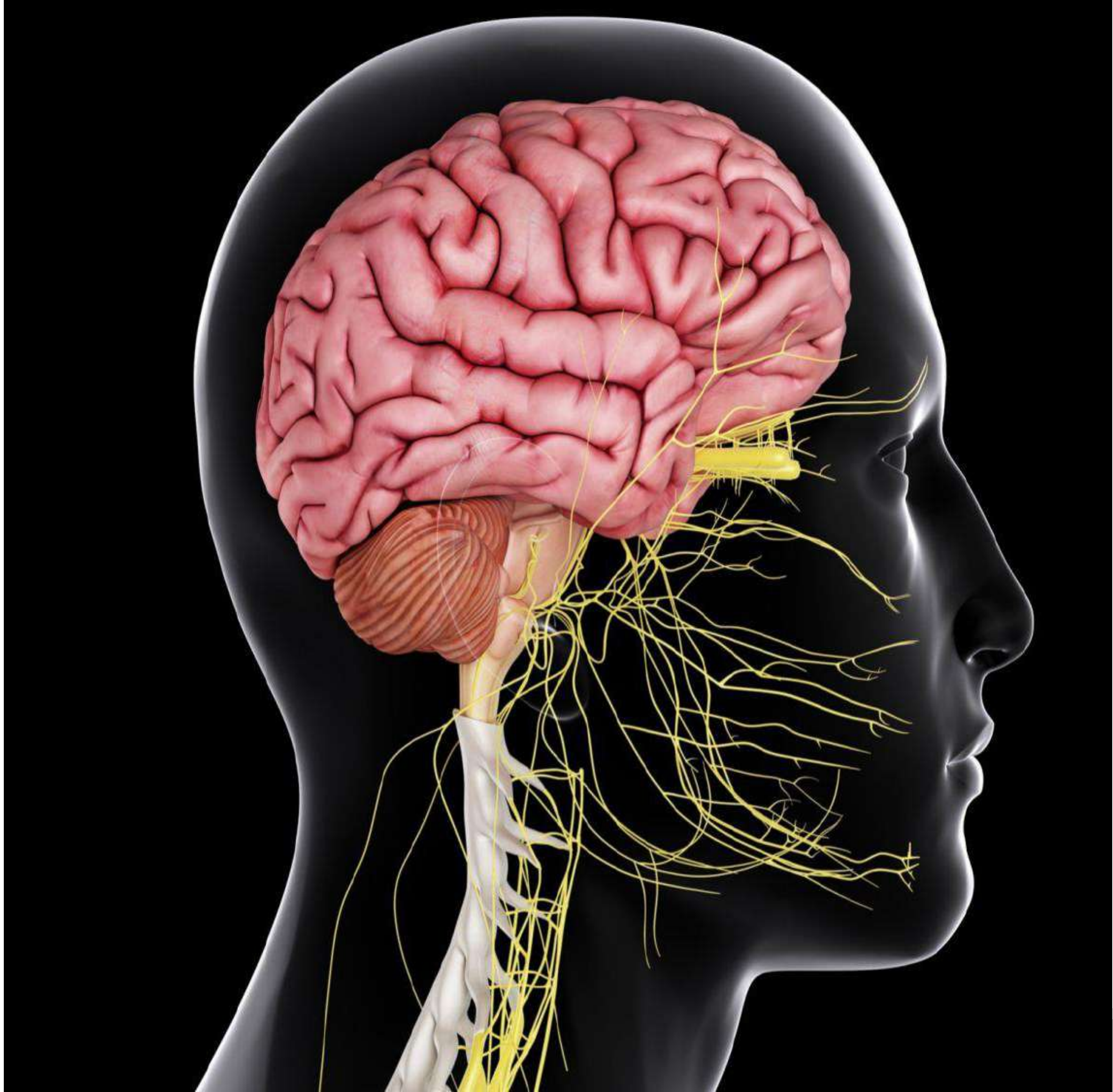
BRAIN – responsible for initiating, controlling, and regulating all sensorimotor and cognitive (mental) functions that generate and regulate human behavior

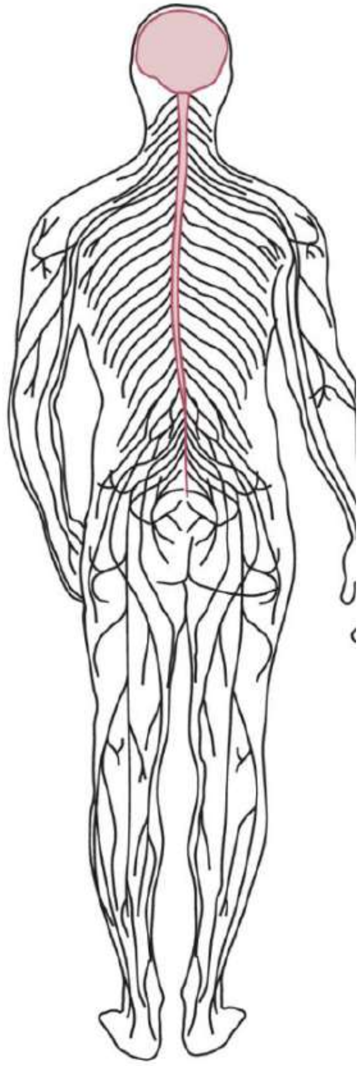
2

SPINAL CORD – a wired-cable structure in the CNS that transmits motor commands to various body parts and collects sensory information from peripheral body parts and transmits this information to the brain

CENTRAL NERVOUS SYSTEM

CNS is protected by a bony shell (skull and vertebral column—series of bones and cartilages that help the body withstand various movements without too much strain or discomfort)





PERIPHERAL NERVOUS SYSTEM

CRANIAL NERVES

SPINAL NERVES

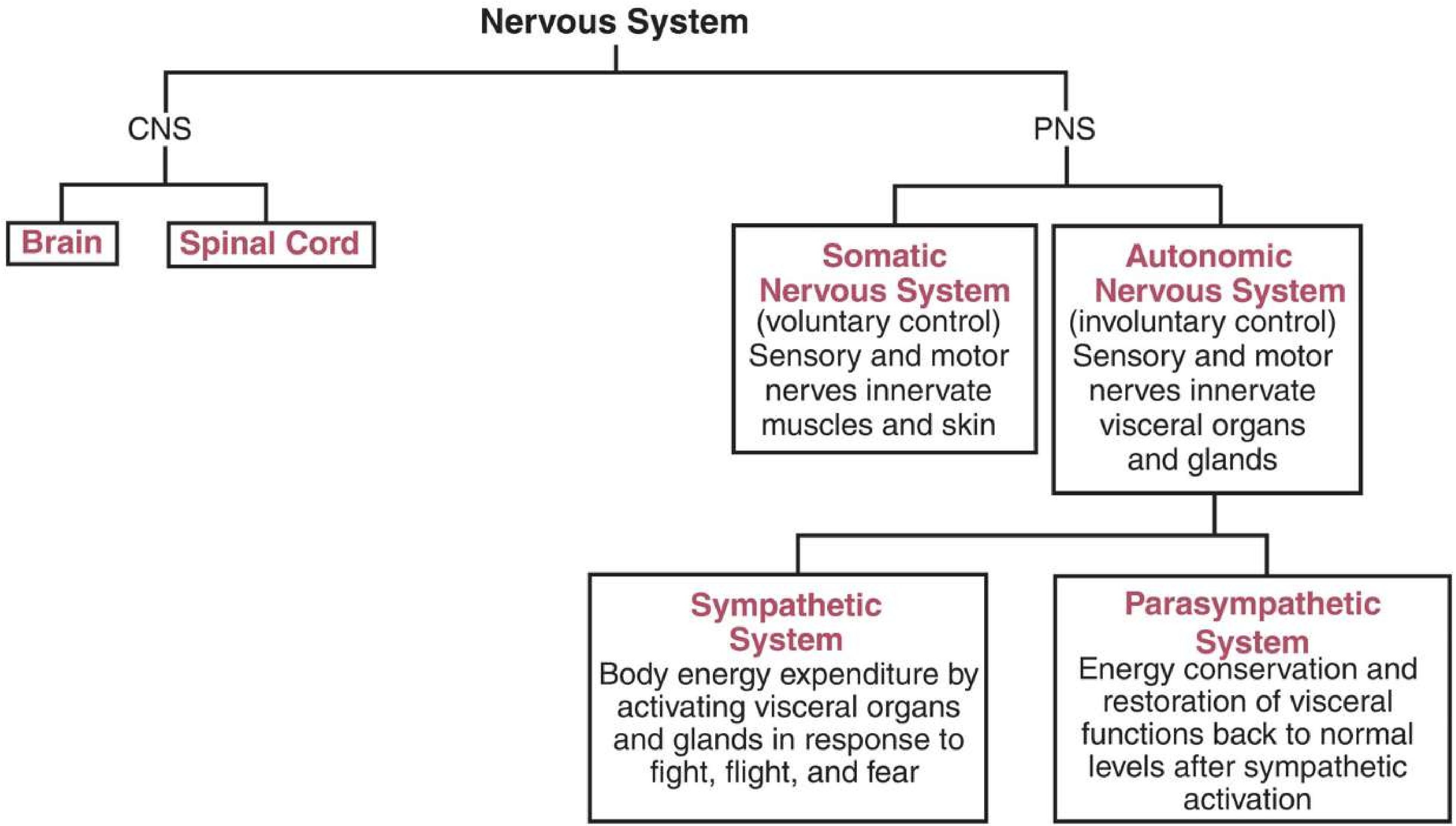
PERIPHERAL NERVOUS SYSTEM

1. PNS consists of sensory and motor nerves that are connected to the spinal cord and the brainstem.

2. Nerves extend to organs, muscles, joints, blood vessels, and skin surface.

3. The PNS consists of two major systems (somatic nervous system and the autonomic nervous systems).

4. Each of these systems contains two subsystems: efferent fibers (transit commands to muscles and glands) and afferent fibers (transmit sensory information to the CNS from receptors in the skin, muscles, and visceral organs.


Nervous System
CNS
PNS
Brain
Spinal Cord
Somatic Nervous System
(voluntary control)
Sensory and motor nerves innervate muscles and skin
Autonomic Nervous System
(involuntary control)
Sensory and motor nerves innervate visceral organs and glands
Sympathetic System
Body energy expenditure by activating visceral organs and glands in response to fight, flight, and fear
Parasympathetic System
Energy conservation and restoration of visceral functions back to normal levels after sympathetic activation

https://www.youtube.com/watch?v=EEQMpt1LI5U

Table 1-9

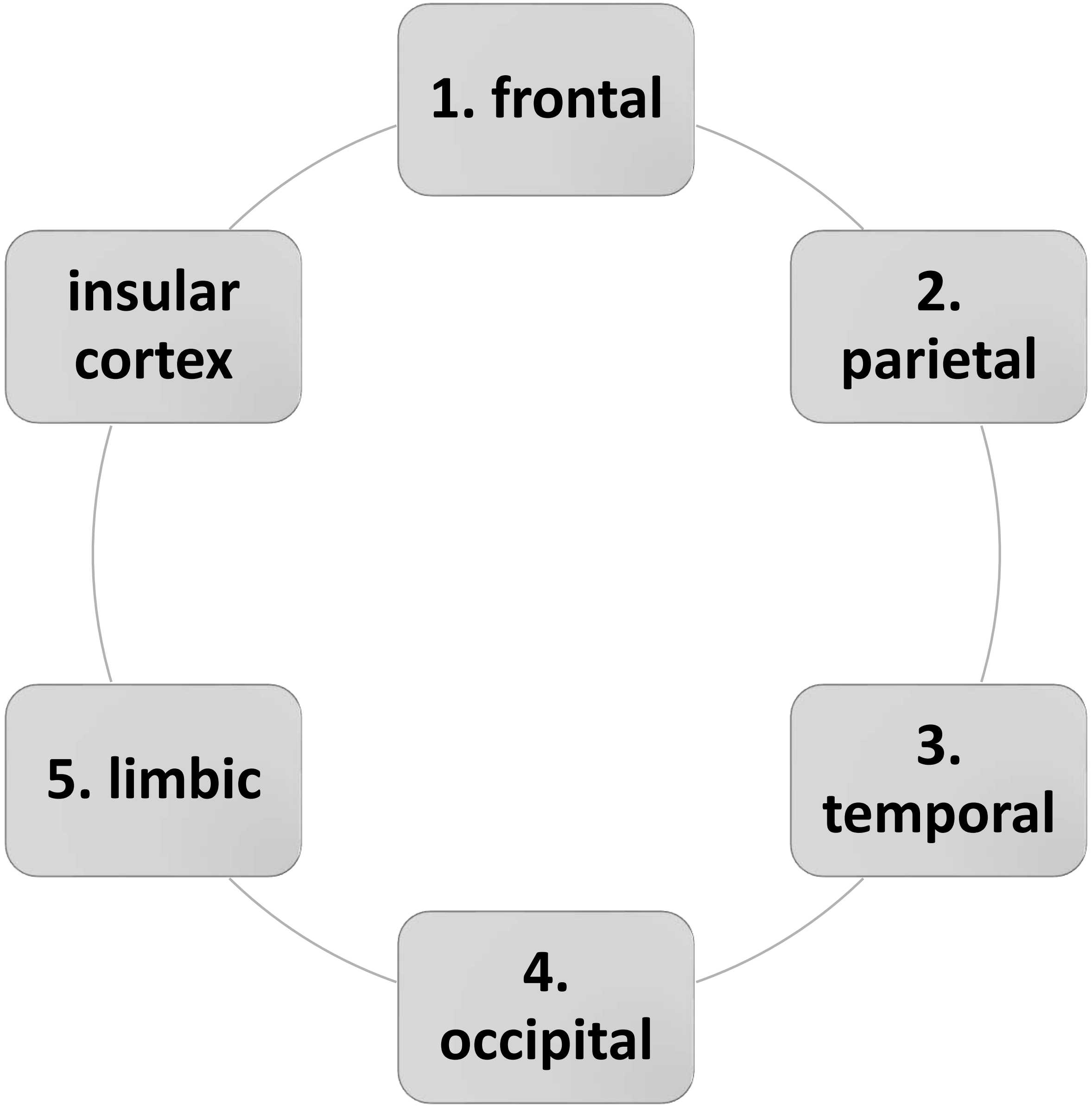
Functional Components of the Nervous System

General				Special			
Somatic		Visceral		Somatic		Visceral	
Efferent	Afferent	Efferent	Afferent	Efferent	Afferent	Efferent	Afferent
(GSE)	(GSA)	(GVE)	(GVA)	(SSE)	(SSA)	(SVE)	(SVA)
Activates muscles derived from somites, including skeletal, extraocular, and glossal (tongue) muscles	Mediates sensory innervation from somatic muscles, skin, ligaments, and joints	Projects to muscles of visceral organs, including pupillary constriction, gland secretion, and regulation of heart and tracheal muscles	Mediates sensory innervation from visceral organs, including larynx, pharynx, and abdomen	Does not exist	Mediates special sensations of vision from retina and of audition and equilibrium from inner ear	Projects to muscles of face, palate, mouth, pharynx, and larynx; does not include eye and tongue muscles	Mediates visceral sensations of taste from tongue and of olfaction from nose

https://www.youtube.com/watch?v=3MneKclhU8c

ANATOMY OF THE BRAIN - CEREBRUM

Cerebrum – Lobes of the Brain



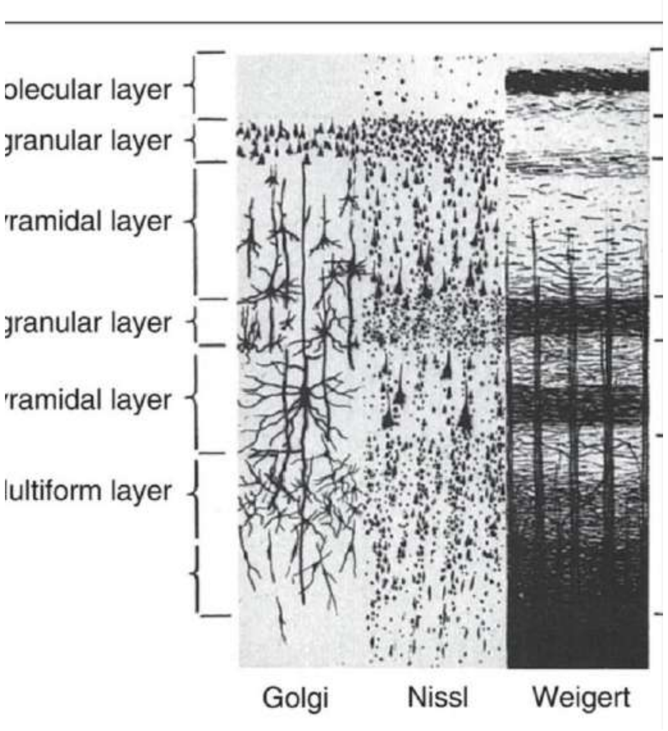
Cerebrum – Cell Layers

The density and architecture of various layers determine the sensorimotor functions and connections.

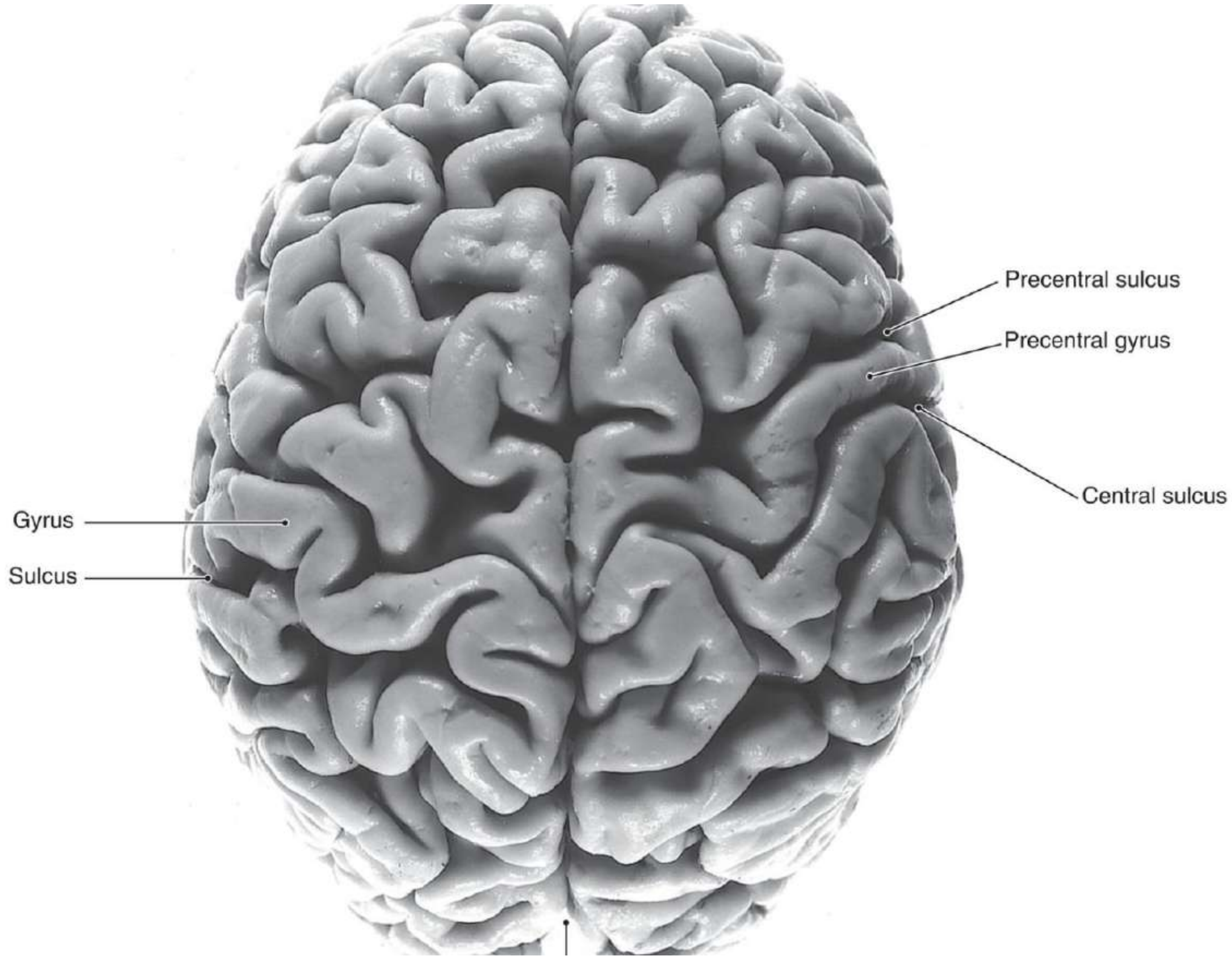
1. For example upper layers (isocortex) transmit to cortical areas and contributed to higher mental functions.

2. Middle layers (archicortex) help with memory and instinctual reflexes,

3. and lower layers mediate smell and emotional-motivational behavior.

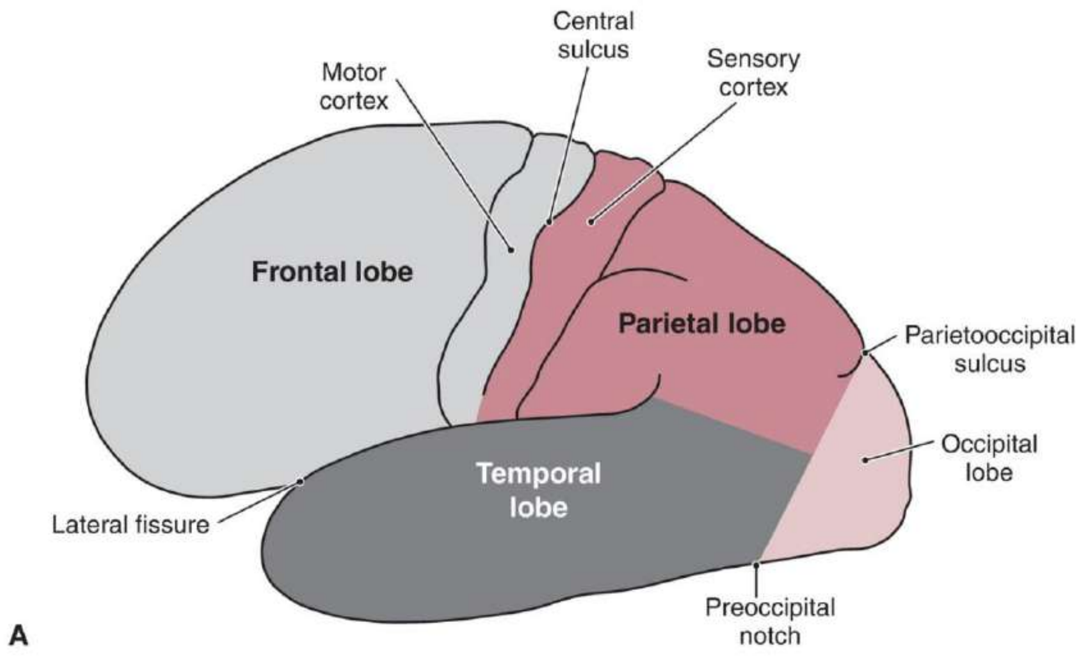


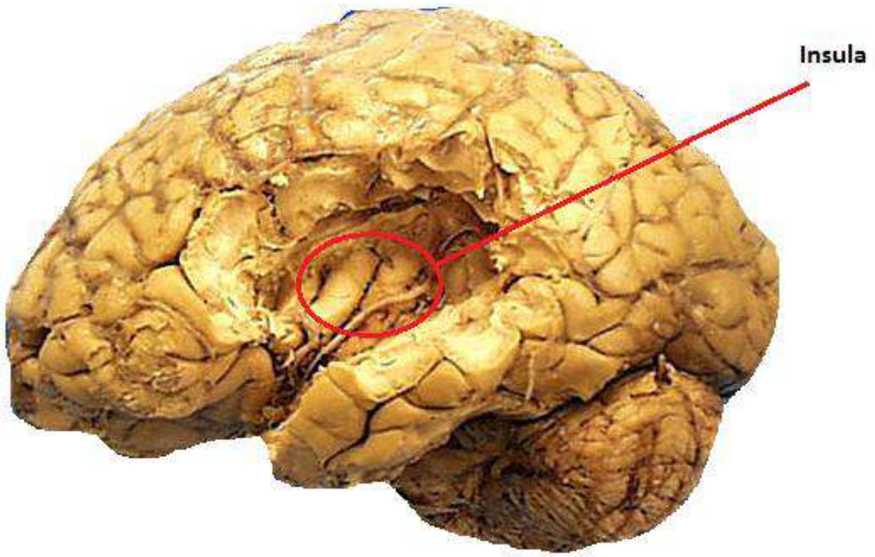
Cerebrum – Cerebral Hemispheres

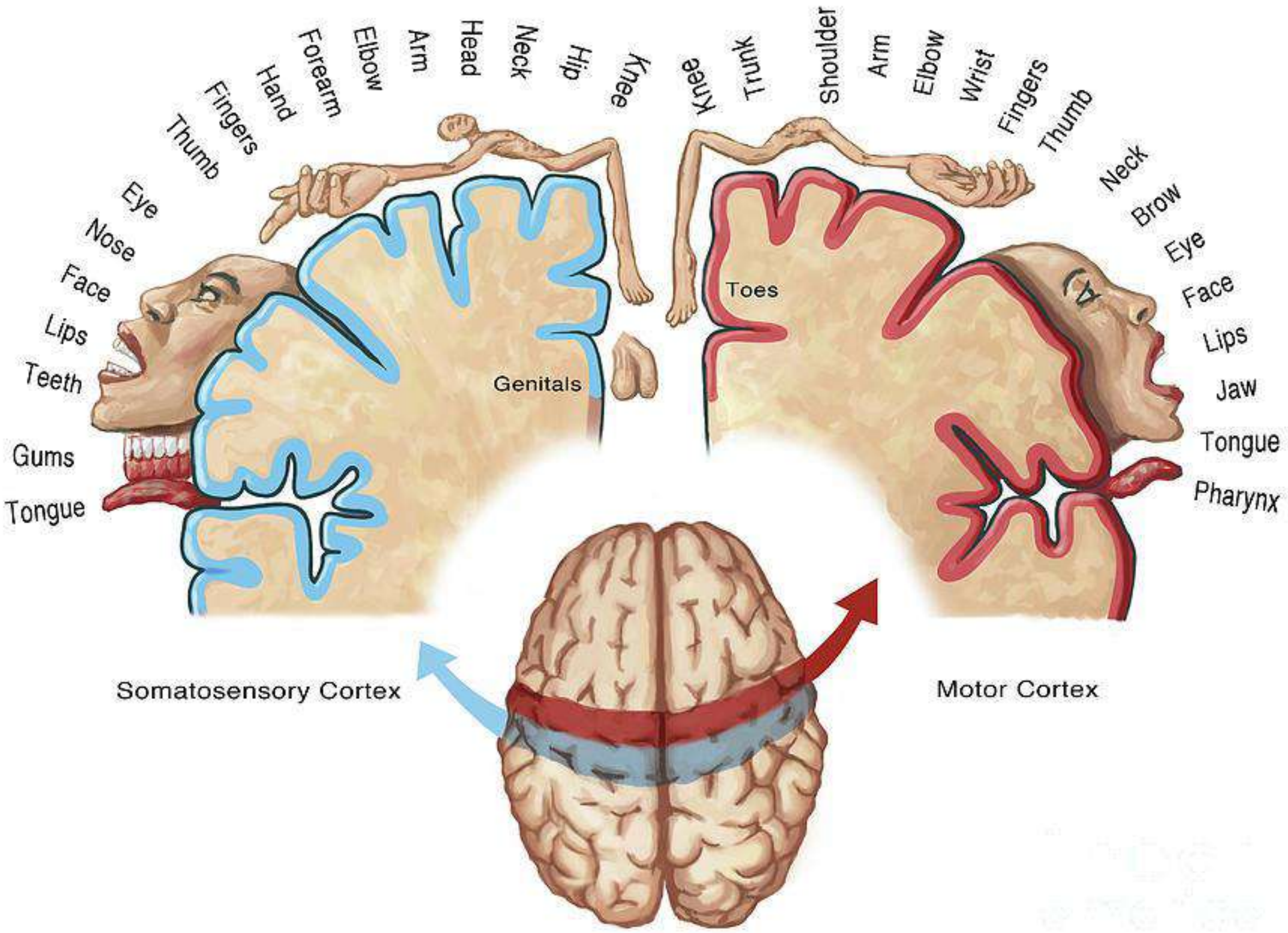


LEFT – LANGUAGE, SPEECH, CALCULATION, AND VERBAL MEMORY (if dominant)

RIGHT – NONVERBAL MEMORY, VISUOSPATIAL ACTIVITIES, PARALINGUISTIC, PRAGMATIC, AND MUSICAL ABILITY


Central
sulcus
Motor
cortex
Sensory
cortex
Frontal lobe
Parietal lobe
Parietooccipital
sulcus
Occipital
lobe
Temporal
lobe
Lateral fissure
Preoccipital
notch
A


Insula



Tongue
Gums
Teeth
Lips
Face
Nose
Eye
Thumb
Fingers
Hand
Forearm
Elbow
Arm
Head
Neck
Hip
Knee
Genitals
Knee
Trunk
Shoulder
Arm
Elbow
Wrist
Fingers
Thumb
Neck
Brow
Eye
Face
Lips
Jaw
Tongue
Pharynx
Toes
Somatosensory Cortex
Motor Cortex

Cerebrum – Cerebral lobes and corresponding clinical information – FRONTAL LOBE

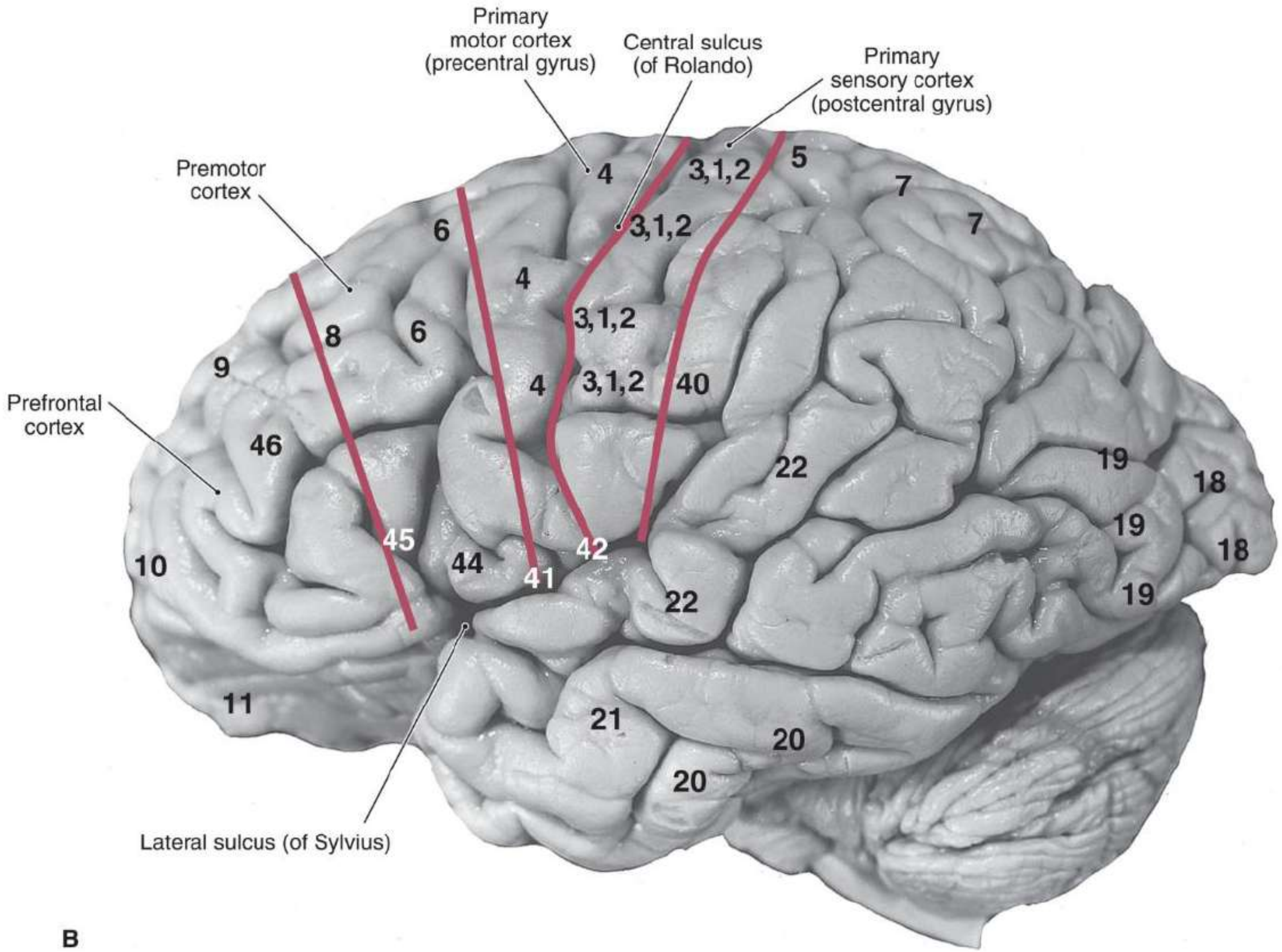
-contains primary motor cortex (BA 4)—fine and graded movements of arms, legs, and face…the more skill required the greater the representation

-rostral to precentral sulcus is the premotor cortex (BA 6, 8)—planning and initiation of skilled movements and regulates responsiveness of the primary motor cortex (helps to control speech, hand, and finger movements and eye-head coordination)

-prefrontal cortex—personality, emotion, mood, reasoning, abstract thinking, self-monitoring, planning, and control of executive functions and planning behaviors

-three large horizontal gyri in the prefrontal area – superior, middle, and inferior. In the dominant hemisphere, the inferior gyrus is Broca's area (BA 44-45)

-ventral surface of frontal lobe = emotions, personality, and inhibition—sense of smell


Primary
motor cortex
(precentral gyrus)
Central sulcus
(of Rolando)
Primary
sensory cortex
(postcentral gyrus)
Premotor
cortex
Prefrontal
cortex
Lateral sulcus (of Sylvius)
4
3,1,2
5
7
7
6
3,1,2
4
8
6
3,1,2
9
4
3,1,2
40
46
22
19
18
19
18
45
42
10
44
41
22
19
11
21
20
20

B

Cerebrum – Cerebral lobes and corresponding clinical information – PARIETAL LOBE

-between the frontal and occipital lobes and above the temporal lobe

-anterior boundary marked by central sulcus

-concerned with spatial orientation, cross-modality integration, memory, recognition and expression of emotions, prosodies, and cognition

-interpretation of somatic sensation (visceral are stomach, intestine, blood vessels, urinary bladder, uterus, etc.)

-houses the primary sensory cortex (post central gyrus) (BA 3,1,2)

-houses the sensory association cortex (BA 5, 7)

-sensation is disproportionately perceived (face and head in lower third of the postcentral gyrus and trunk, hands, arms, and legs in the upper portion of the gyrus)

Cerebrum – Cerebral lobes and corresponding clinical information – OCCIPITAL LOBE

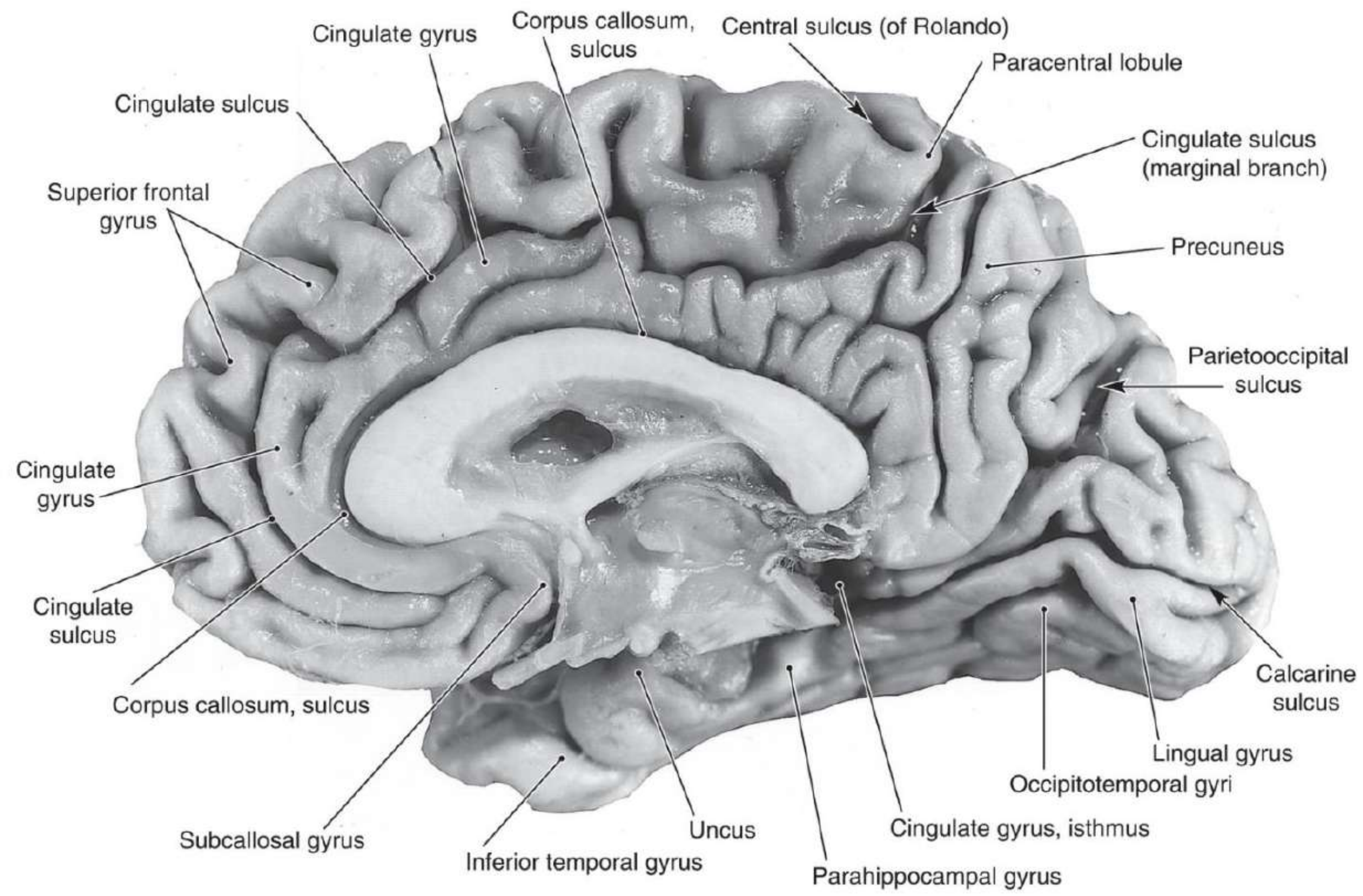
-contains primary (BA 17), secondary (BA 18), and associative (BA 19) visual cortical areas.

-located at the caudal part of the brain and behind the parietooccipital sulcus

-the primary visual cortex is split into upper and lower parts by the calcarine sulcus

-surrounded by the association visual cortex (involved with the elaboration, recognition, and appreciation of visual stimuli)

-patterns of representation in the primary visual cortex (upper visual cortex receives visual information from lower quadrants of the visual field and lower visual cortex receives visual information from upper quadrants of the visual field)



Cingulate gyrus
Corpus callosum, sulcus
Central sulcus (of Rolando)
Paracentral lobule
Cingulate sulcus
Cingulate sulcus (marginal branch)
Superior frontal gyrus
Precuneus
Parietooccipital sulcus
Cingulate gyrus
Cingulate sulcus
Corpus callosum, sulcus
Calcarine sulcus
Lingual gyrus
Occipitotemporal gyri
Subcallosal gyrus
Uncus
Cingulate gyrus, isthmus
Inferior temporal gyrus
Parahippocampal gyrus

Cerebrum – Cerebral lobes and corresponding clinical information – TEMPORAL LOBE

-located ventral to frontal and parietal lobes

-serves audition, memory, thought elaboration, comprehension of spoken and written language, and olfaction

-lateral surface contains three gyri (superior, middle, and inferior)—the superior temporal gyrus and sulcus run parallel to the lateral fissure and posteriorly turn up into the angular gyrus

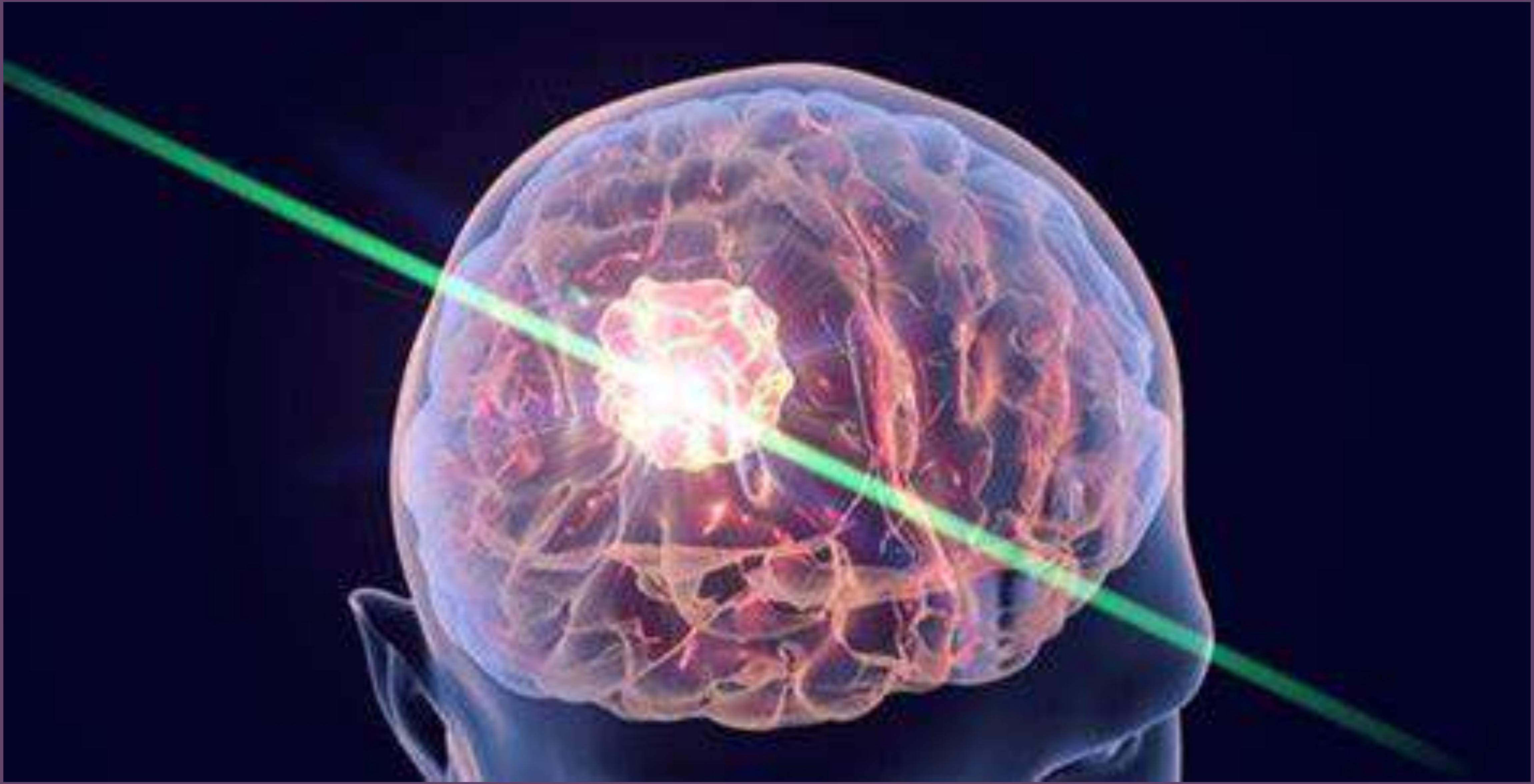
-the dorsal surface of the superior temporal gyrus dips into the insular cortex and houses convolutions known as Heschl gyri (the auditory cortex)—receives projections from both ears

-the medial and ventral surfaces of the temporal lobe house important structures such as the fusiform gyrus and the olfactory association area (uncus, parahippocampal gyrus, amygdaloid nuclear complex)

A 52-year-old man, who was examined by a neurologist, reported experiencing progressive disorientation to time and space for the past 2 months. He also reported having difficulty organizing his thoughts and making decisions. Lately, he had begun speaking incoherently using speech, which was marked with hesitancy, contained fewer functional markers, and consisted mostly of content words. The neurologist noticed the following:

Confusion about time and impaired memory for biological information
Mild right-sided hemiparesis (face, arm, and leg)
Partial visual field loss on the right side
Increased right-sided deep tendon reflexes
Altered personality (reclusive and socially unconcerned)
Aphasia (limited and effortful verbal output)
Relatively good auditory comprehension
The physician's suspicion about an underlying tumor (neoplastic growth) was confirmed by brain MRI studies, which revealed a large tumor bordering the frontoparietotemporal region in the left hemisphere. The patient was referred for a biopsy and possible surgical removal.

Question: Can you relate these clinical signs to the structures identified by MRI? What made the neurologist rule out a stroke?



Cerebrum – Alternative Structures – Insular Cortex

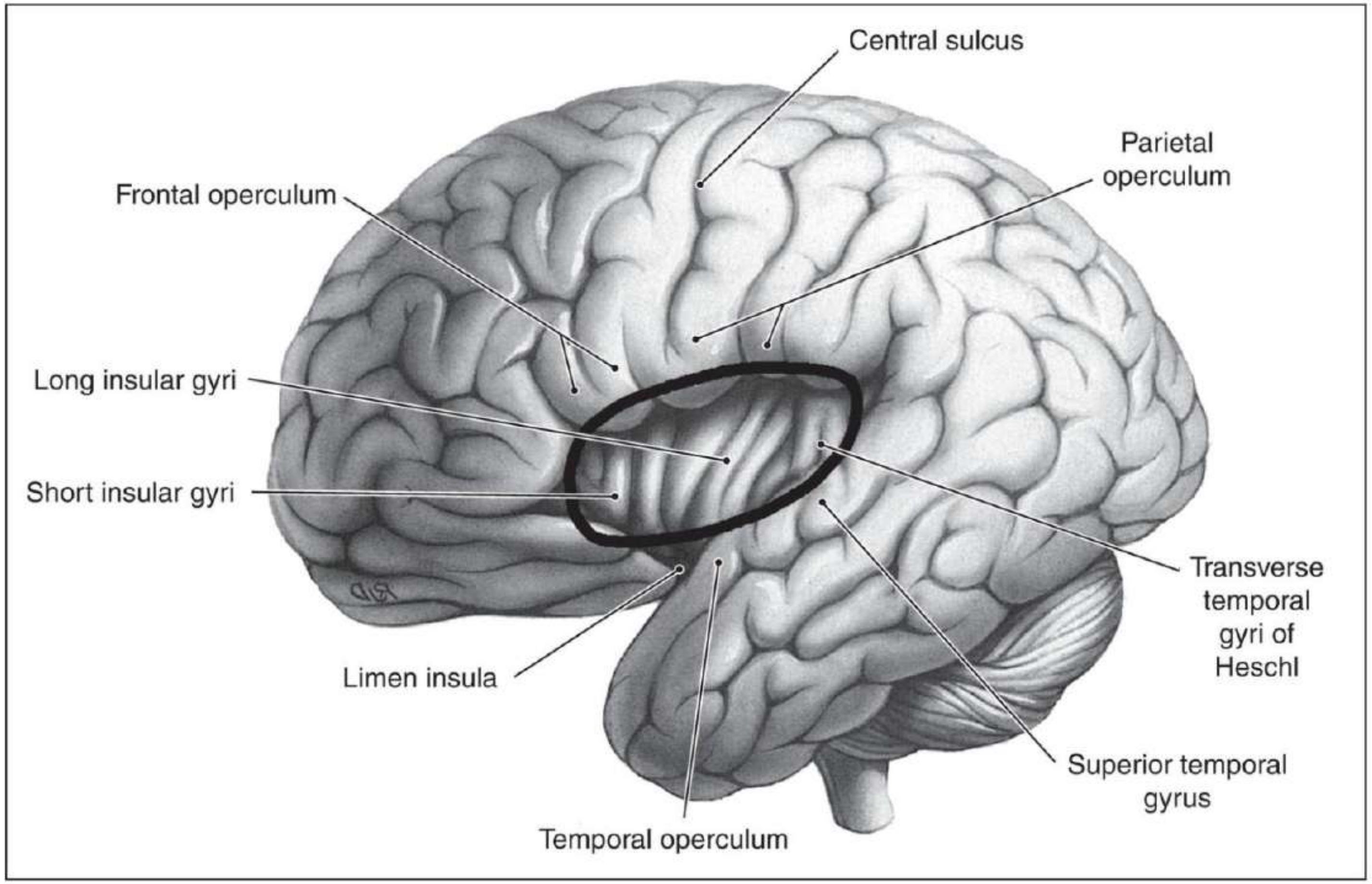
-concealed within depths of lateral fissure and exposed when opercular tissue is removed

-able to be activated through compassion and kindness

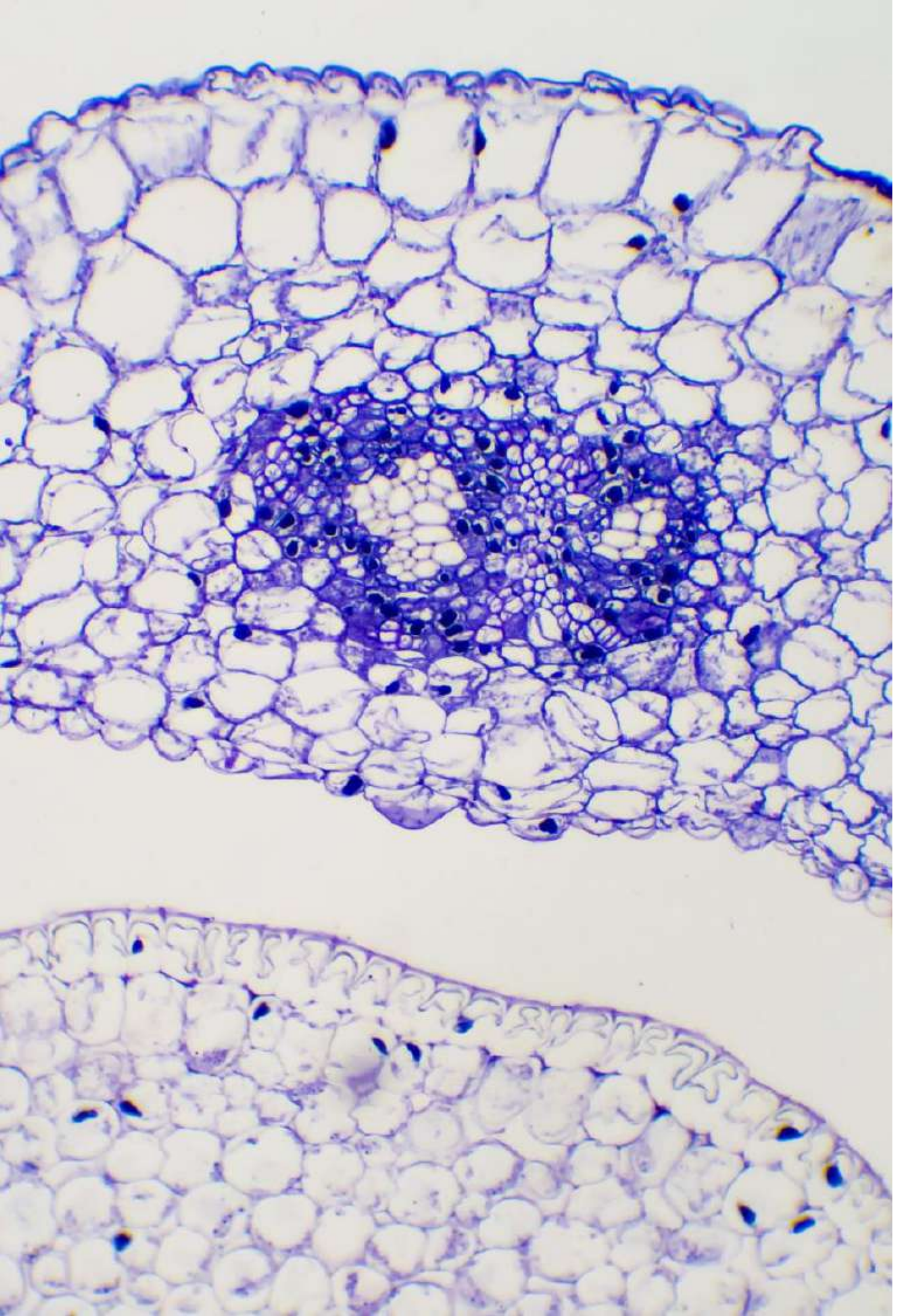
-short and long gyri that run parallel to each other

-more related to limbic and autonomic function

Within the insular cortex, afferents from sensory, limbic, autonomic and frontal brain regions converge and intermingle, establishing a basis for cross-modal and cross-functional association and possibly binding. While to date the neuronal underpinnings of such integration are not understood, below I will discuss how the linkage of different systems gives rise to diverse functional roles of the insula.



Cerebrum – Alternative Structures – Insular Cortex



Cerebrum – Alternative Structures – Limbic Lobe

-structures form a ring around the medial-most margins of the frontal, parietal, and temporal lobes.

*** cingulate gyrus

*** hippocampal formation

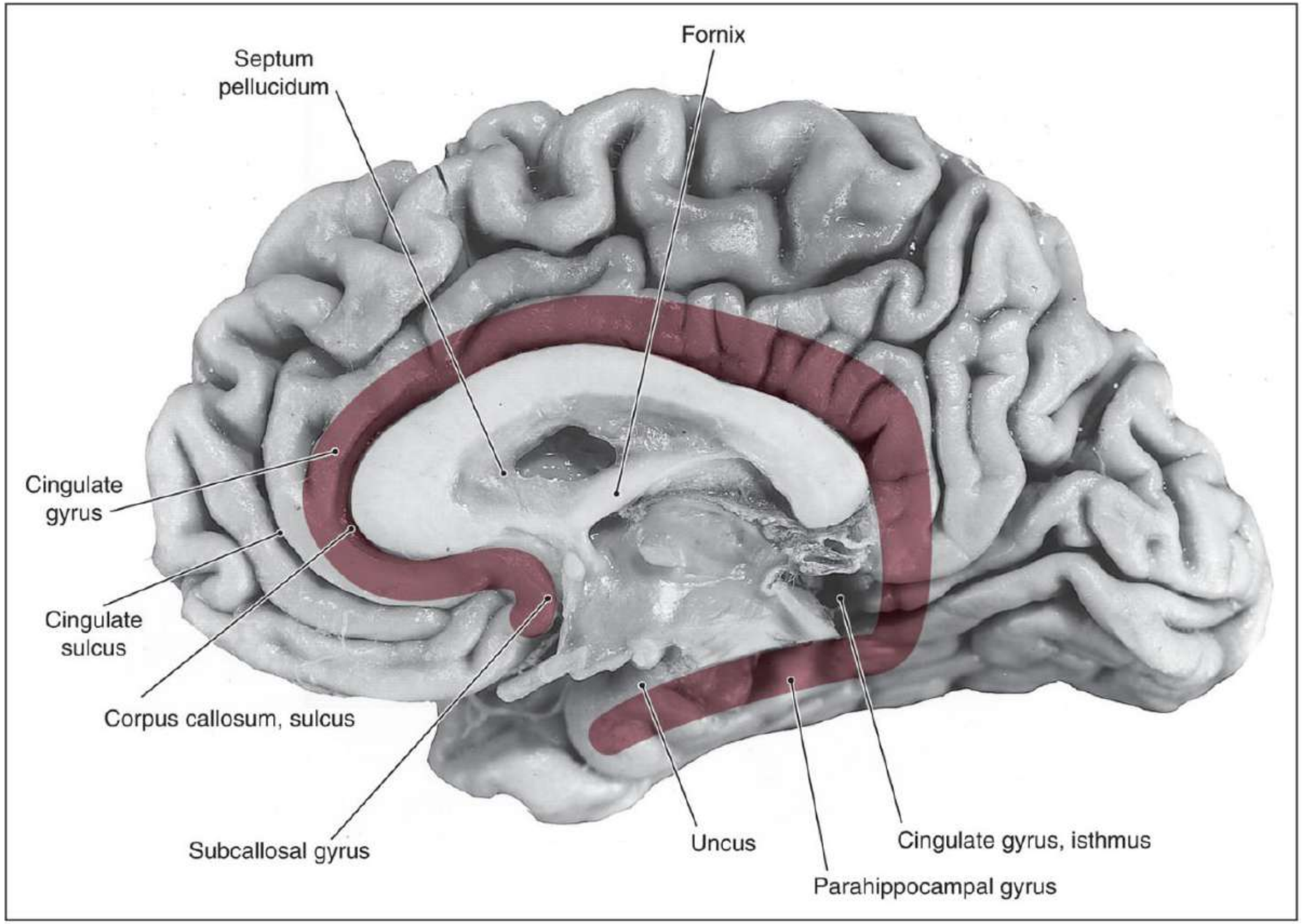
*** parahippocampal gyrus

*** uncus

*** subcallosal gyrus

*** amygdala

-structures provide the emotional drive to visceral and vegetative functions fundamental to surviving



Fornix
Septum pellucidum
Cingulate gyrus
Cingulate sulcus
Corpus callosum, sulcus
Subcallosal gyrus
Uncus
Cingulate gyrus, isthmus
Parahippocampal gyrus

Cerebrum – Alternative Structures – Basal Ganglia

01

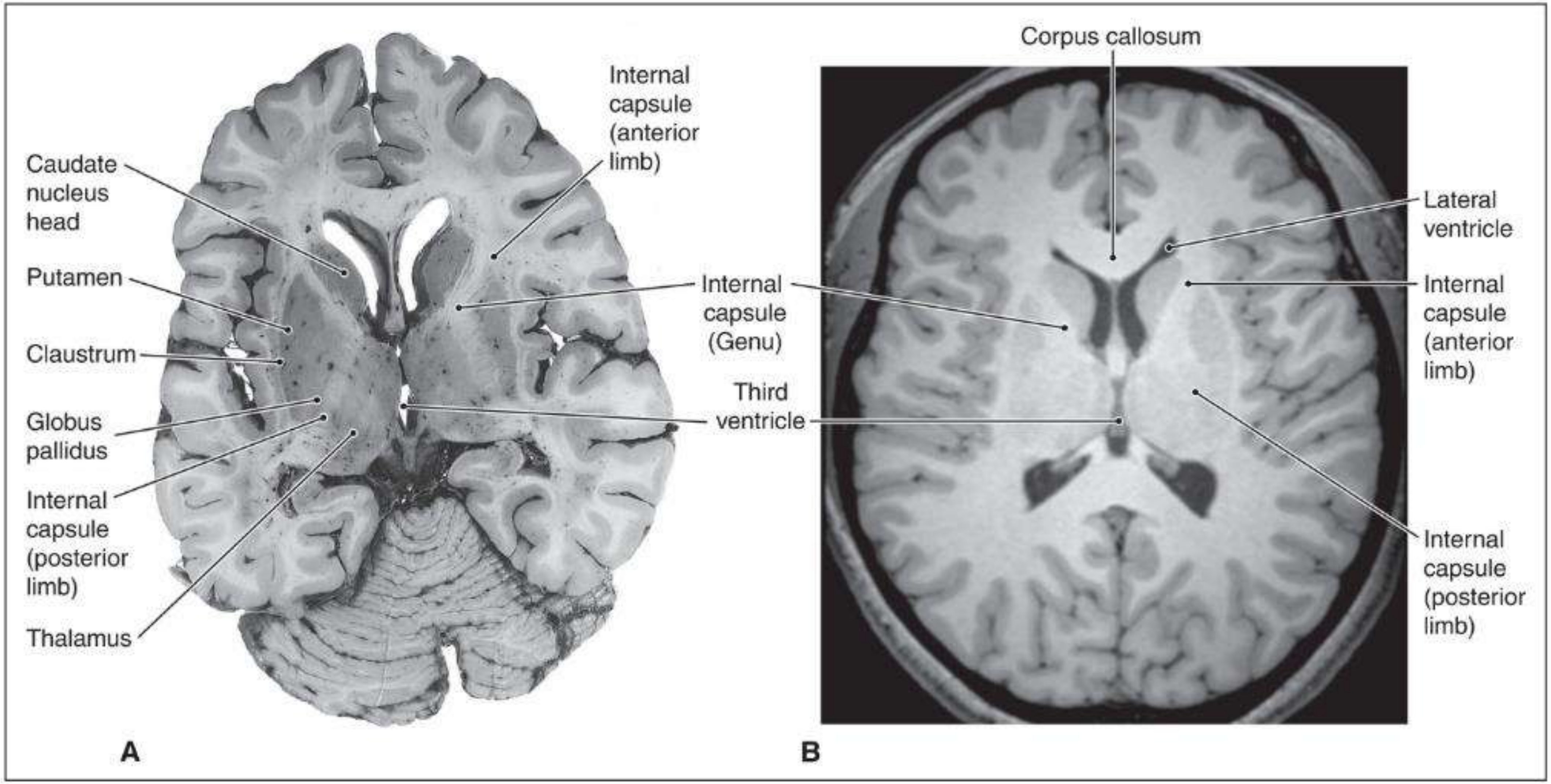
-a series of complex neuronal circuits in the brain

02

-regulate motor movements and muscle tone and may regulate some cognitive functions

03

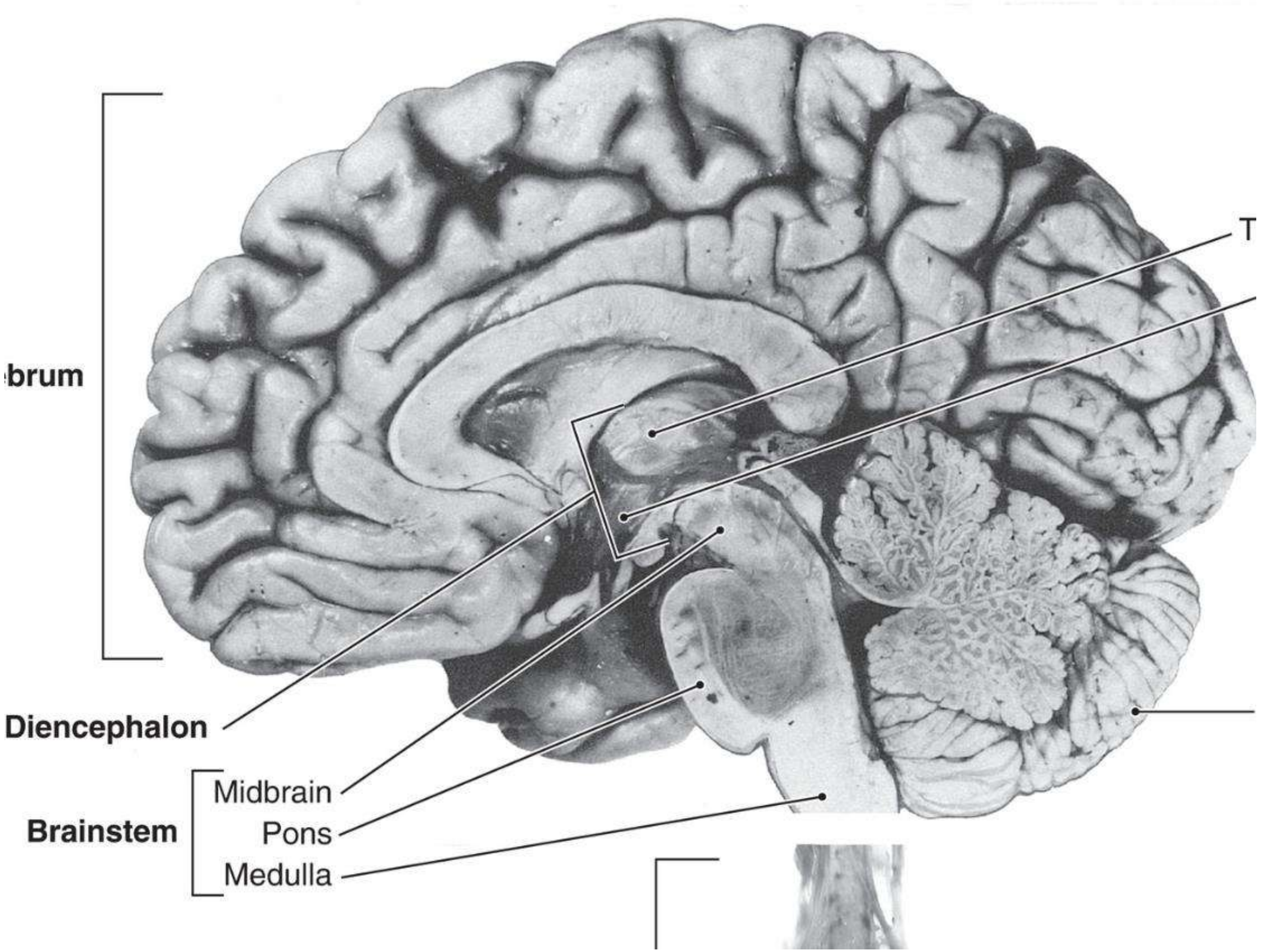
-FOUR NUCLEAR MASSES (caudate nucleus, putamen, globus pallidus, and claustrum)


Caudate nucleus head
Putamen
Claustrum
Globus pallidus
Internal capsule (posterior limb)
Thalamus
Internal capsule (anterior limb)
Internal capsule (Genu)
Third ventricle
Corpus callosum
Lateral ventricle
Internal capsule (anterior limb)
Internal capsule (posterior limb)
A
B

https://www.youtube.com/watch?v=J2sUuayzPas

The basal ganglia are key elements in the control of reward-based learning, sequencing, discrete elements that constitute a complete motor act, and cognitive function. Imaging studies of intact human subjects and electrophysiologic and tracer studies of the brains and behavior of other species confirm these findings.

ANATOMY OF THE BRAIN - DIENCEPHALON



Diencephalon - Thalamus

-relays sensorimotor information to the cortex

-contributes to cortically mediated speech and language functions

-thalamic lesions can cause impaired contralateral somatic (bodily experienced) sensation, as well as a burning sensation and a low threshold for pain

Diencephalon - Hypothalamus

The hypothalamus communicates with the brain, brainstem, and spinal cord by neural and hormonal projections. It serves 5 primary functions:

-autonomic, endocrinic, regulatory, drive, and emotion

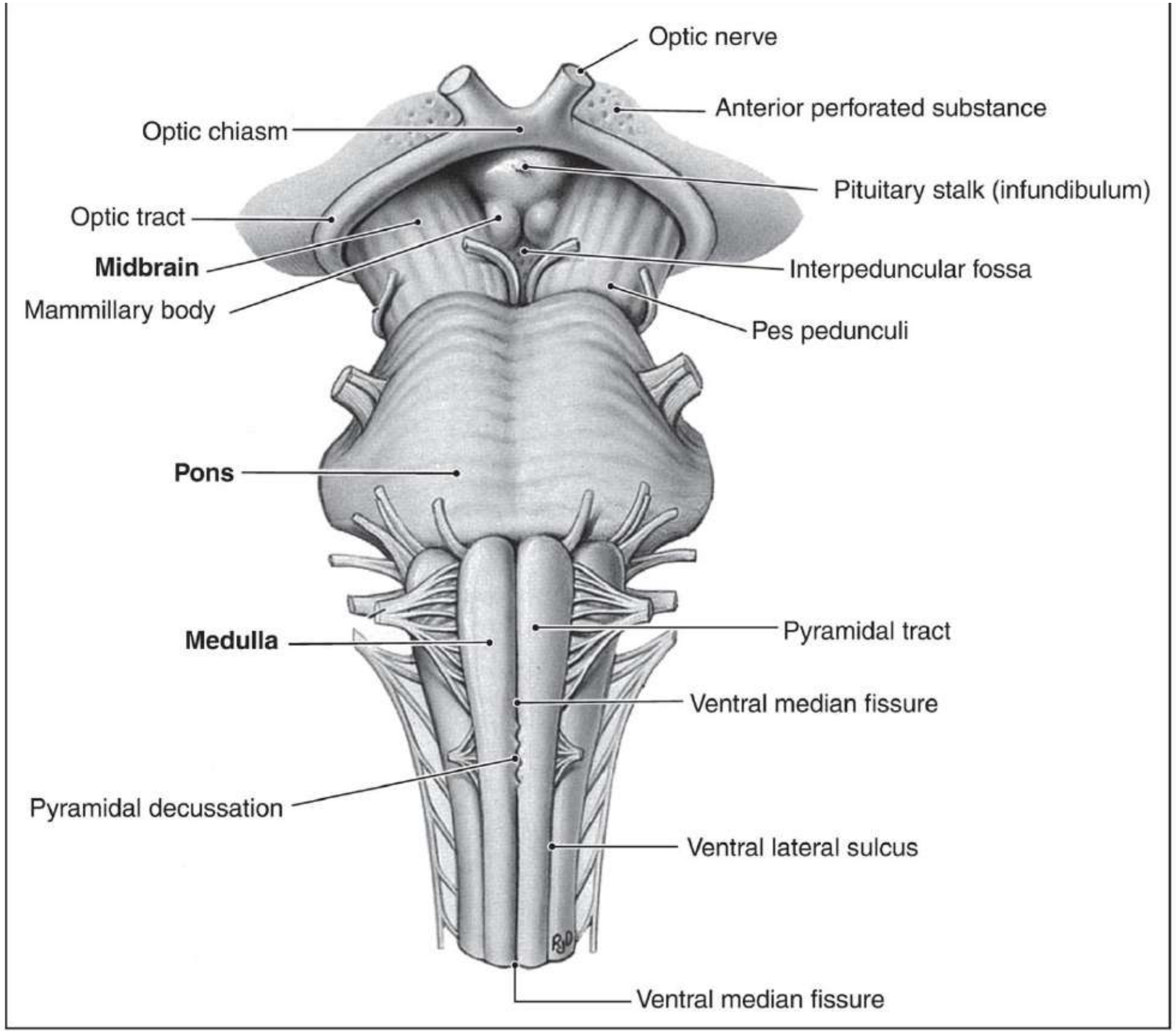
WITH EFFERENT PROJECTIONS TO THE BRAINSTEM AND SPINAL CORD, IT CONTROLS THE AUTONOMIC NERVOUS SYSTEM AND ITS FUNCTIONS

BY RELEASING HORMONES DIRECTLY INTO THE BLOOD SYSTEM, IT REGULATES ENDOCRINE FUNCTIONS

It helps to maintain body temperature, blood volume, food and water intake, body mass, reproduction, and regulation of circadian rhythms

WITH PROJECTIONS TO THE LIMBIC SYSTEM, THE HYPOTHALAMUS CONTRIBUTES TO DRIVES AND EMOTIONS

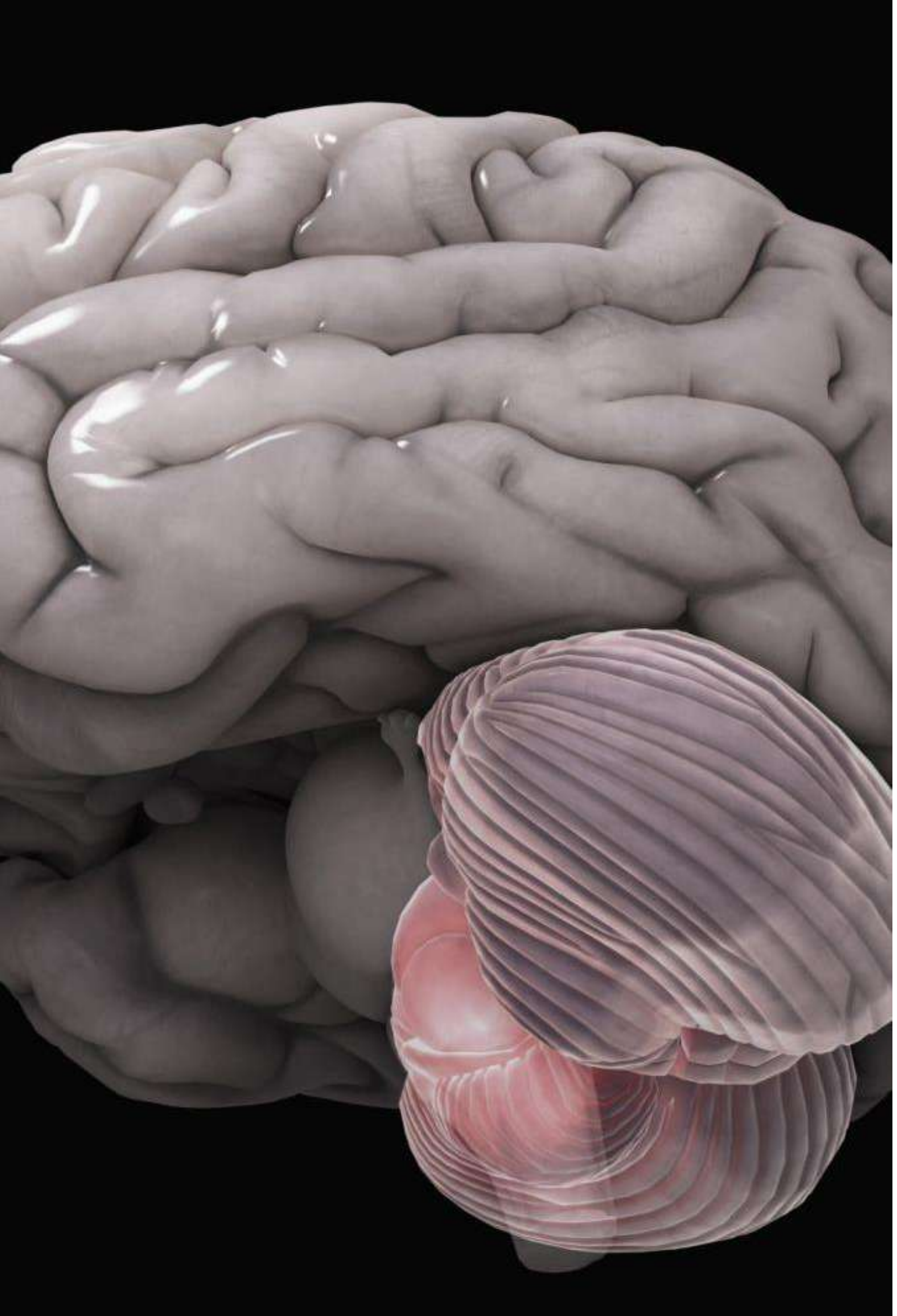
ANATOMY OF THE BRAIN-BRAINSTEM



Optic nerve
Anterior perforated substance
Optic chiasm
Pituitary stalk (infundibulum)
Optic tract
Midbrain
Interpeduncular fossa
Mammillary body
Pes pedunculi
Pons
Pyramidal tract
Medulla
Ventral median fissure
Pyramidal decussation
Ventral lateral sulcus
Ventral median fissure

https://www.youtube.com/watch?v=MxDP1B5mKWA

ANATOMY OF THE BRAIN-CEREBELLUM



CEREBELLUM

-equilibrium and coordination of skilled motor activity

-does not initiate motor activity-it modifies cortical motor functions through direct and indirect projections to the motor cortex and spinal cord

-modifies tone, speed, and range of muscular excursions in the execution of skilled motor functions

-bidirectional projections to the vestibular system make crucial contributions to the maintenance of equilibrium

-plays role in motor learning

-connected to the brainstem through the cerebellar peduncles https://www.youtube.com/watch?v=T-a8n75rBUY

Something to think about…

You see a patient who presents with stroke-like symptoms. The CT scan was negative. Do you:

1. walk away and say, “Great! This patient has no problems!”

2. check for an MRI…if so, why?

The MRI shows neural trauma to the left temporal/parietal region from a recent MVC. The left side is dominant (for language). What problems might you expect to see?

The patient is demonstrating visuospatial problems. Why?