NERVOUS SYSTEM

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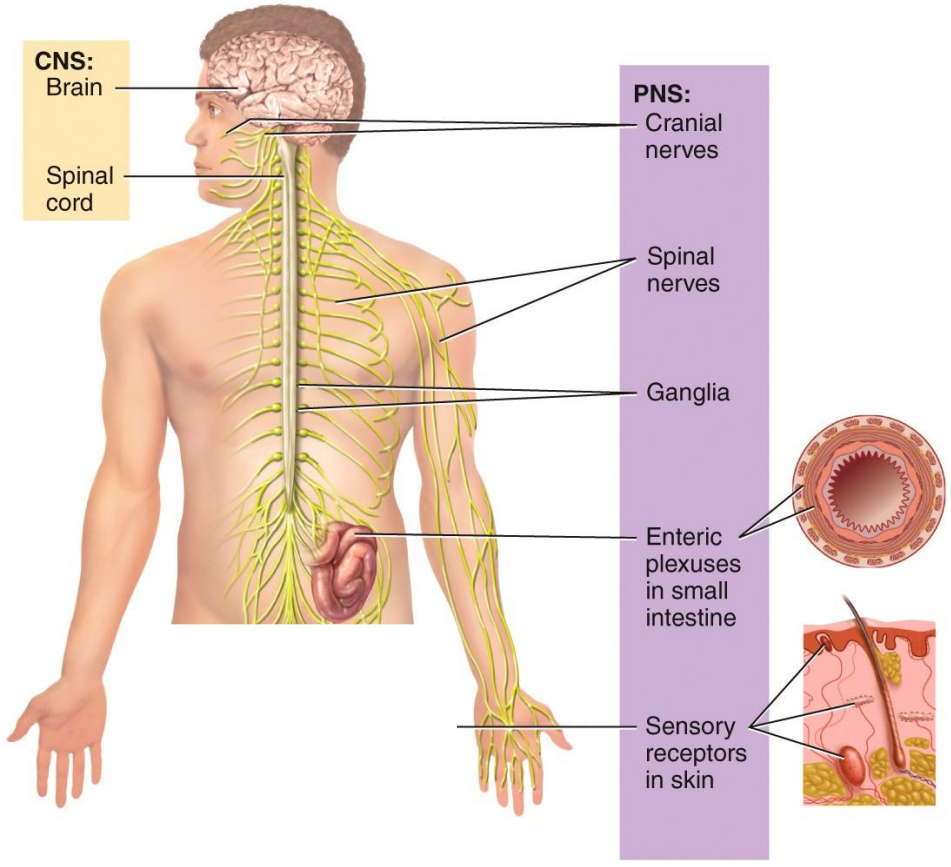
- Main sulci and gyri
- Functional areas of brain
- Ventricles
- Spinal cord

Anatomical Organization of the Nervous System: Components



Organization of the Nervous System

- The nervous system consists of two major divisions:
  - Central nervous system (CNS)
    - Brain and spinal cord
  - Peripheral nervous system (PNS)
    - Cranial nerves that emerge from the brain
    - Spinal nerves that emerge from the spinal cord

Functional Organization of the NS

- Sensory function: Sensory or afferent receptors
- Integrative function: Interneurons
- Motor function: Motor or efferent neurons

Functional Organization

- The somatic nervous system (SNS) of the PNS
- Autonomic nervous system (ANS)

Somatic Nervous System

- The somatic nervous system (SNS) of the PNS consists of sensory and motor neurons.
  - Somatic sensory neurons convey information to the CNS from sensory receptors.
  - Somatic motor neurons convey information from the CNS to skeletal muscles only.

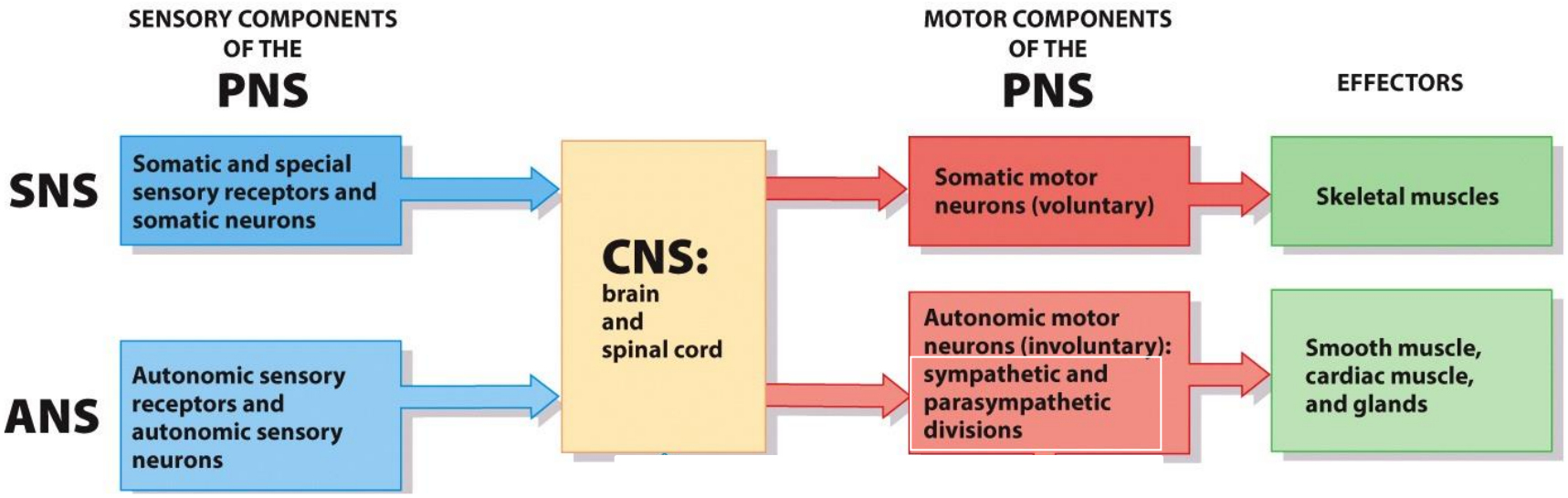
Autonomic Nervous System

- Autonomic nervous system (ANS) of the PNS also has sensory and motor components.
  - Sensory neurons, called autonomic (visceral) sensory neurons, convey information to the CNS mainly from visceral organs.
  - Autonomic motor neurons convey information from the CNS to smooth muscle, cardiac muscle, and glands.

Autonomic Nervous System

- The motor part of the ANS consists of two branches: the sympathetic division and the parasympathetic division.
- The sympathetic neurons increase heart rate.
  - Fight-or-flight
- The parasympathetic neurons slow it down.
  - Rest-and-digest

Functional Organization of the Nervous System



CENTRAL NERVOUS SYSTEM (CNS):
Brain & Spinal Cord

Introduction

- The brain is the center for intellect, emotions, behavior, and memory.
- Different regions of the brain are specialized for different functions.

Brain Development

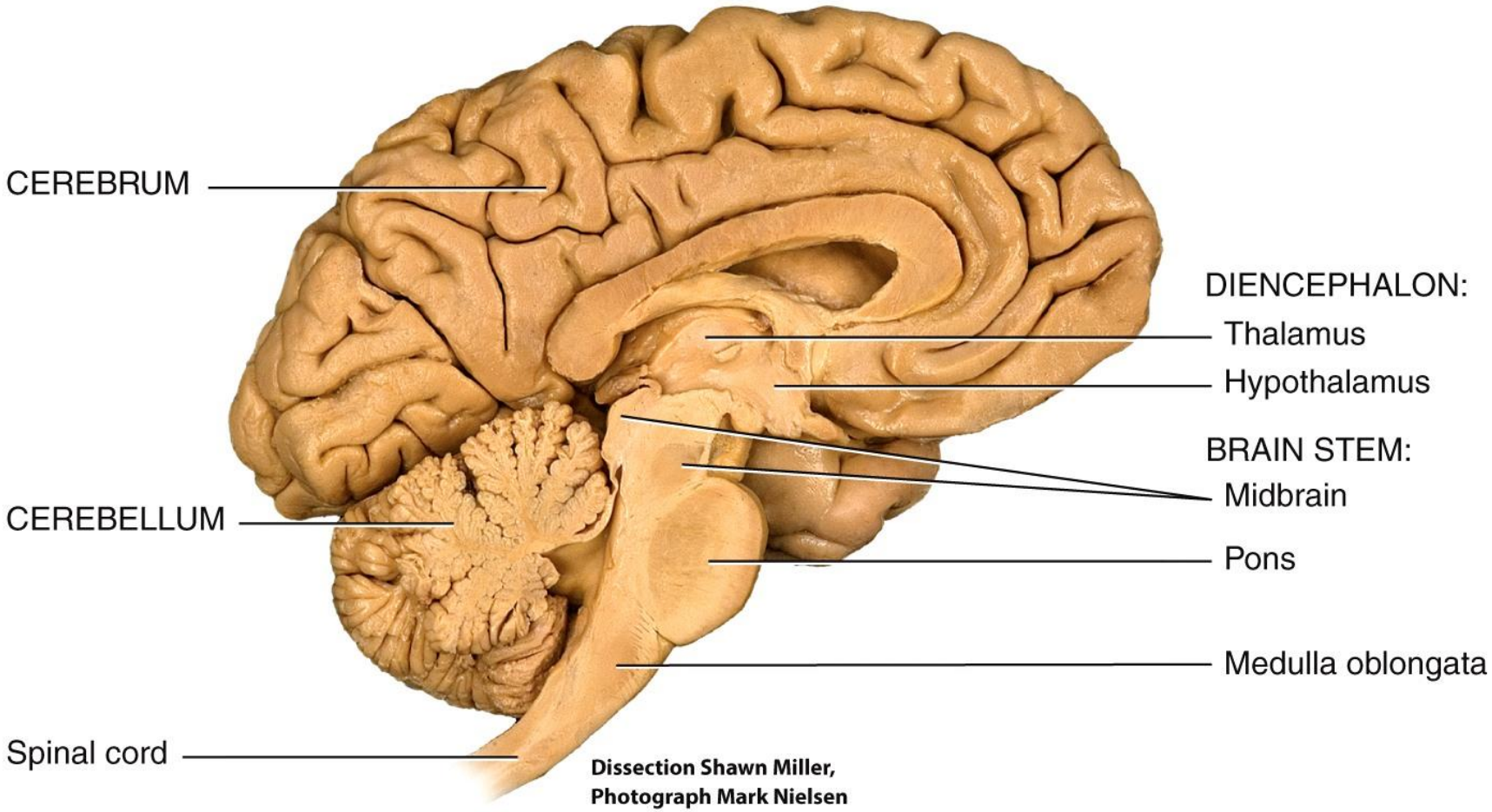
- Neural tube

Major Parts of the Brain

- Brain is the part of CNS that lies within the skull & continues with spinal cord through foramen magnum

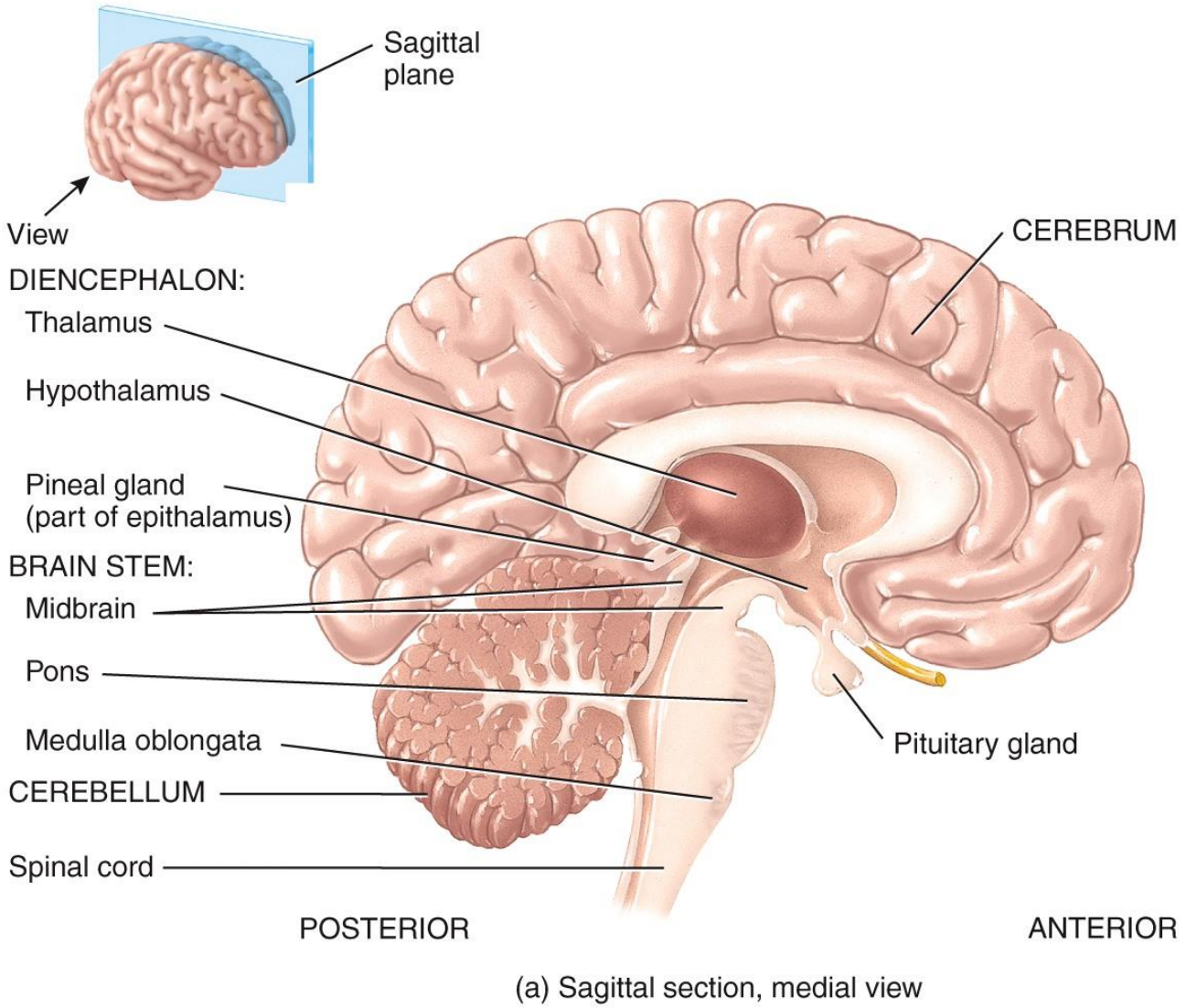
- Adult brain consists of four major parts
  - Cerebrum
  - Diencephalon
  - Brain stem
  - Cerebellum

The Brain



(b) Sagittal section, medial view

The Brain



(a) Sagittal section, medial view

Protective Coverings of the Brain

- Cranium (skull)
- Cranial meninges

Protection is aided by:

- Cerebrospinal fluid (CSF)
- Blood–brain barrier

The Cranial Meninges

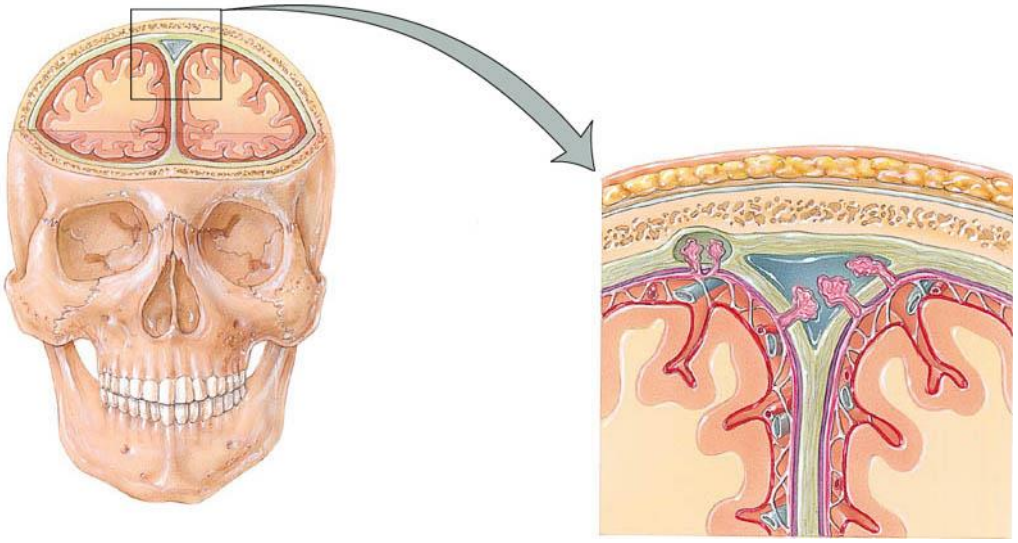
3 layers of C.T.,

FUNCTION:

1. protects the brain

2. provides supporting framework for a. & v.

3. shock absorber (CSF)



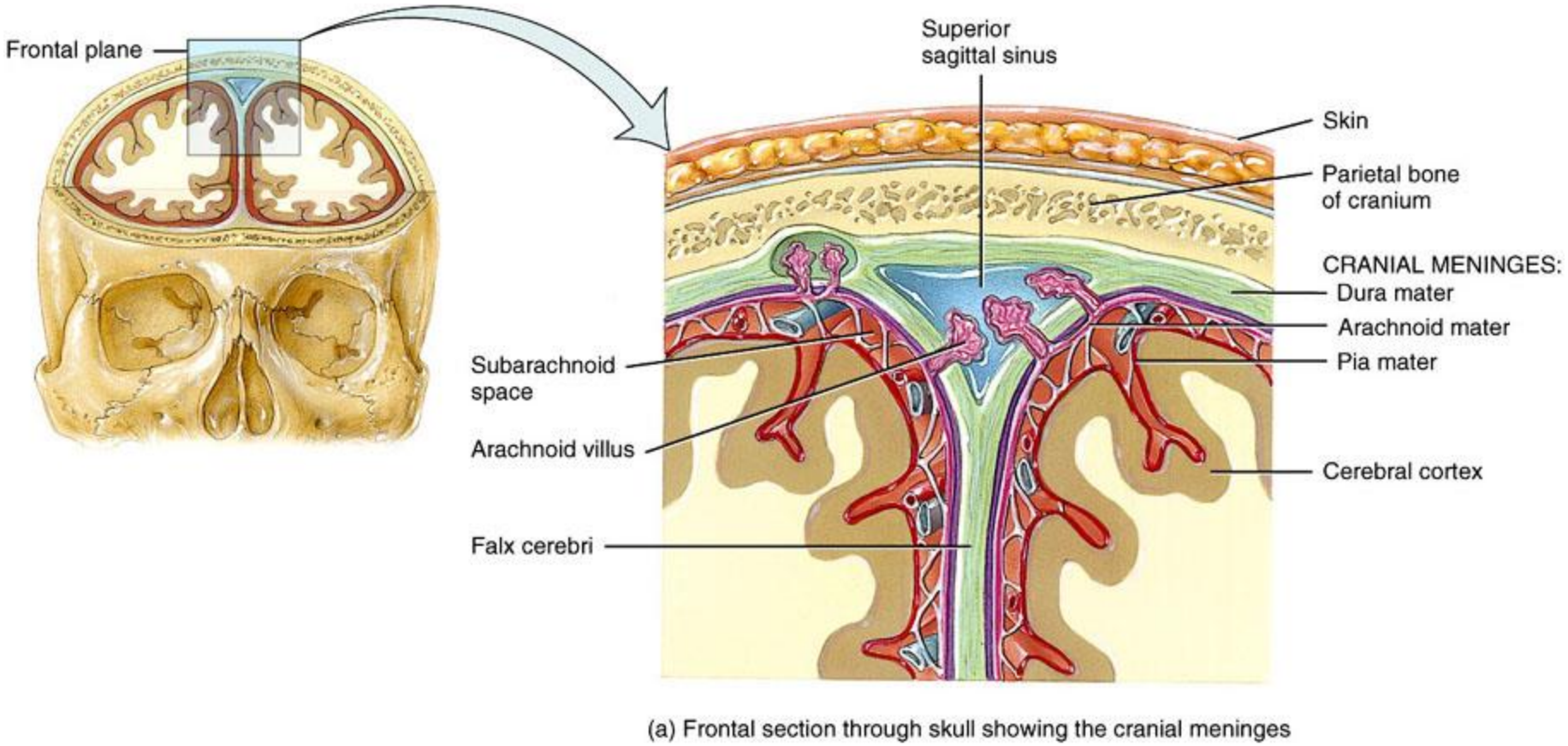
3 layers:

Dura mater

Arachnoid mater

Pia mater

The Protective Coverings of the Brain

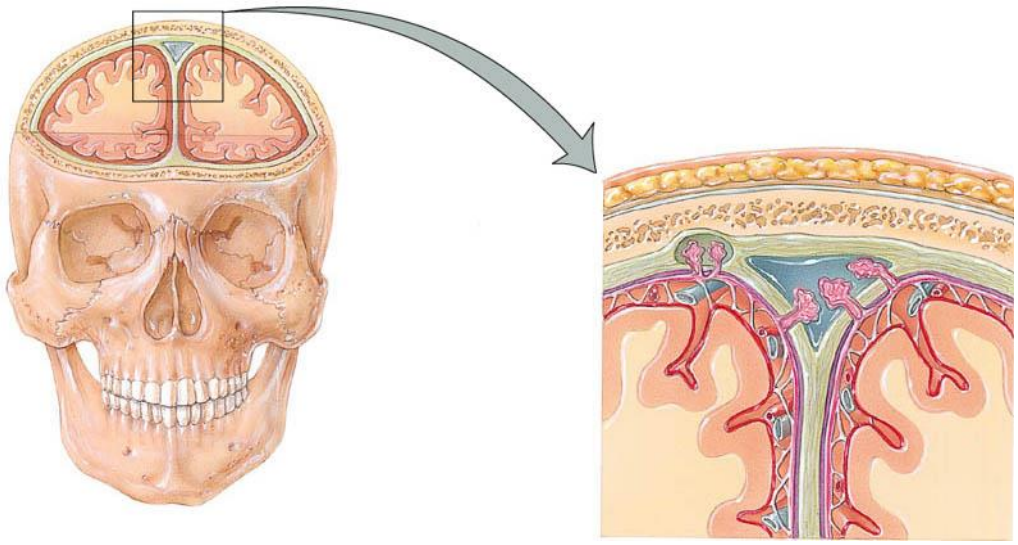


(a) Frontal section through skull showing the cranial meninges

Figure 19.02a Tortora - PHA 11/e

Dura Mater

- Tough & thick external fibrous double layered membrane.



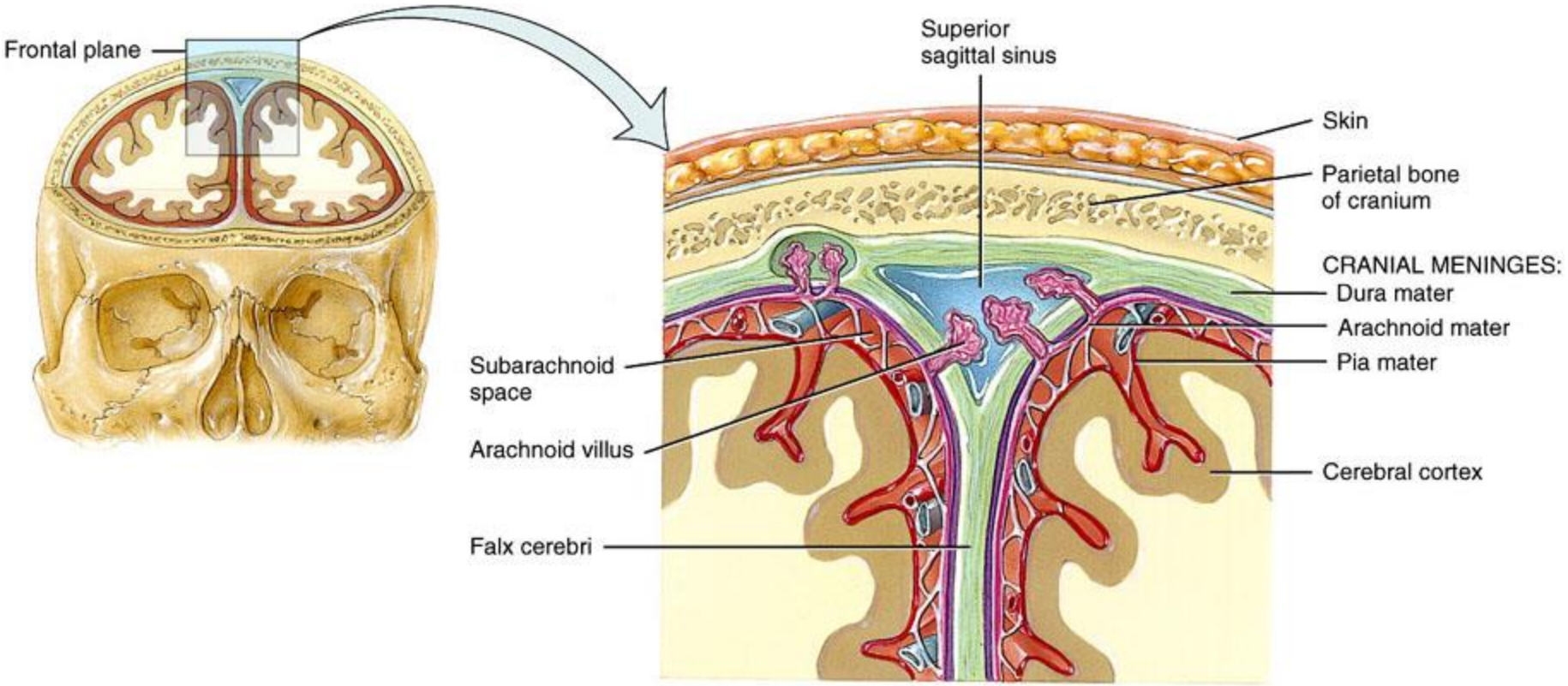
Brain Venous Sinuses are located between periosteal & meningeal layers of dura mater

Arachnoid Mater

- Thin, intermediate layer that attaches to pia mater through web-like arachnoid trabeculae
- Held against Dura by pressure of CSF
- Avascular layer

Subarachnoid space:

- Between arachnoid & pia
- Contains: arachnoid trabeculae & Cerebrospinal fluid (CSF)



(a) Frontal section through skull showing the cranial meninges

Figure 19.02a Tortora - PHA 11/e

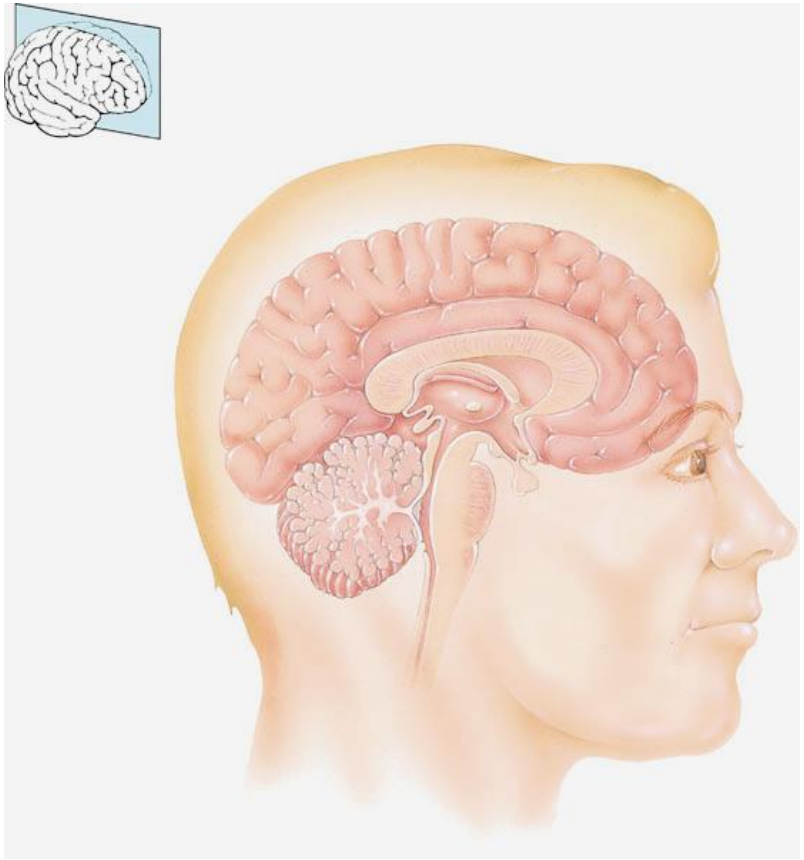
Pia Mater

- Very thin & delicate membrane that is highly vascularized

- Adheres to brain surface & follows its contours

Major Parts of The Brain

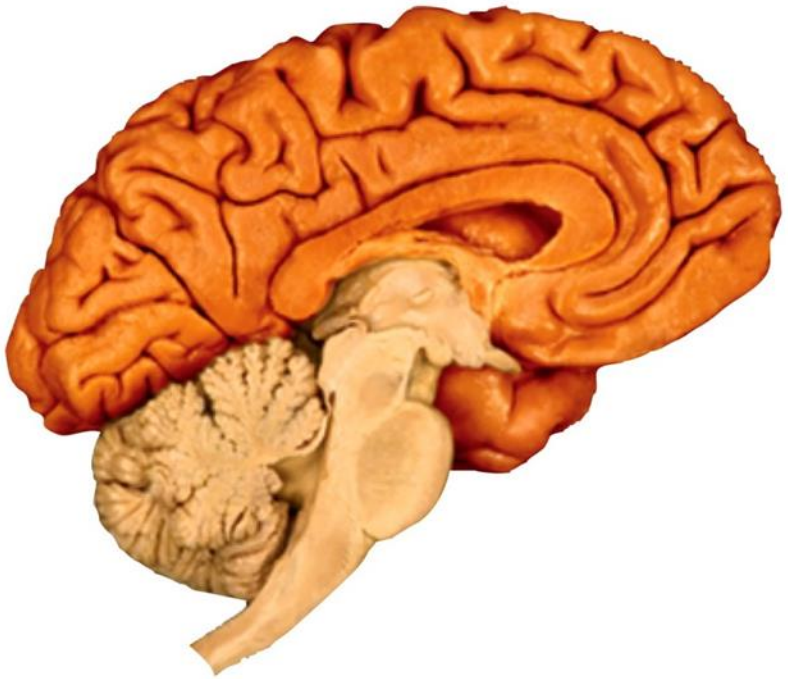
- Forebrain: (prosencephalon)
  - Cerebrum
  - Diencephalon
- Midbrain (mesencephalon)
- Hindbrain: (rhombencephalon)
  - Pons
  - Medulla oblongata
  - Cerebellum



Brain Stem

- Mid brain
- Pons
- Medulla Oblongata

Brain stem VS Hindbrain

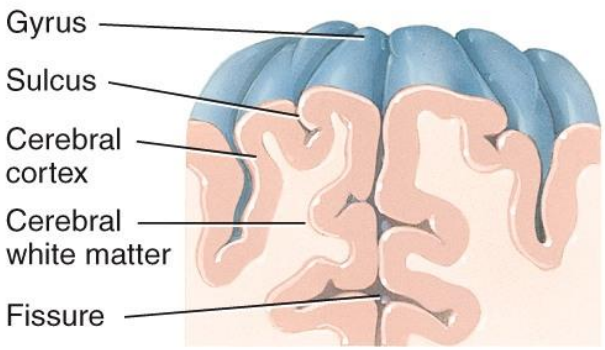


Dissection Shawn Miller, Photograph Mark Nielsen

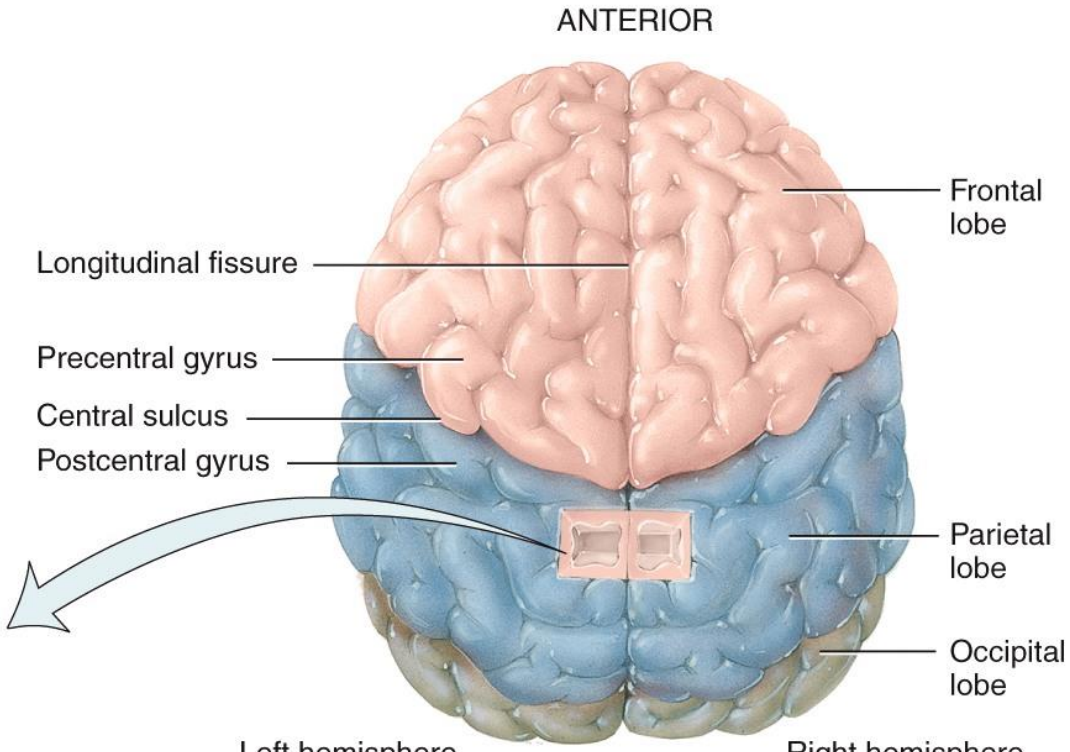
Cerebrum

- Largest part of brain
- 2 hemispheres: (Rt. & Lf.)
  separated by a fissure
  (longitudinal fissure)
- Folded into elevations (Gyri) & depressions (Sulci)
- Corpus callosum

Cerebrum



Details of a gyrus, sulcus, and fissure



(a) Superior view

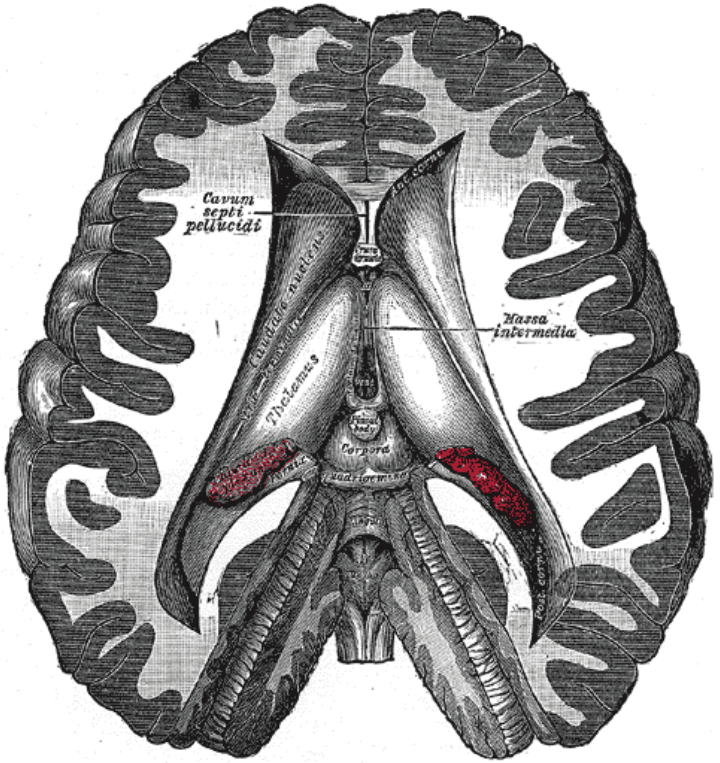
Internal Structure of Cerebrum

Outer Layer:

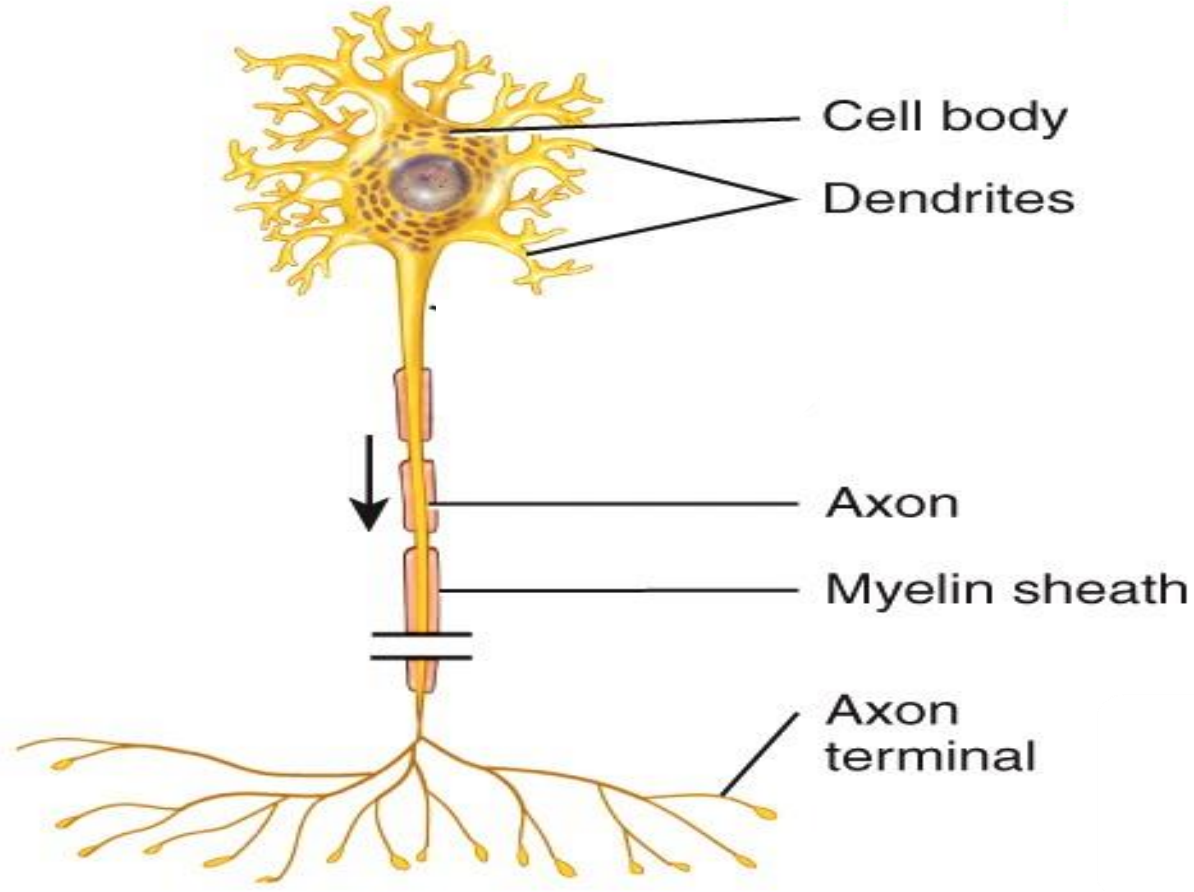
- The Cerebral Cortex
- Gray matter
- folded from outside into: gyri & sulci

Inner Layer:

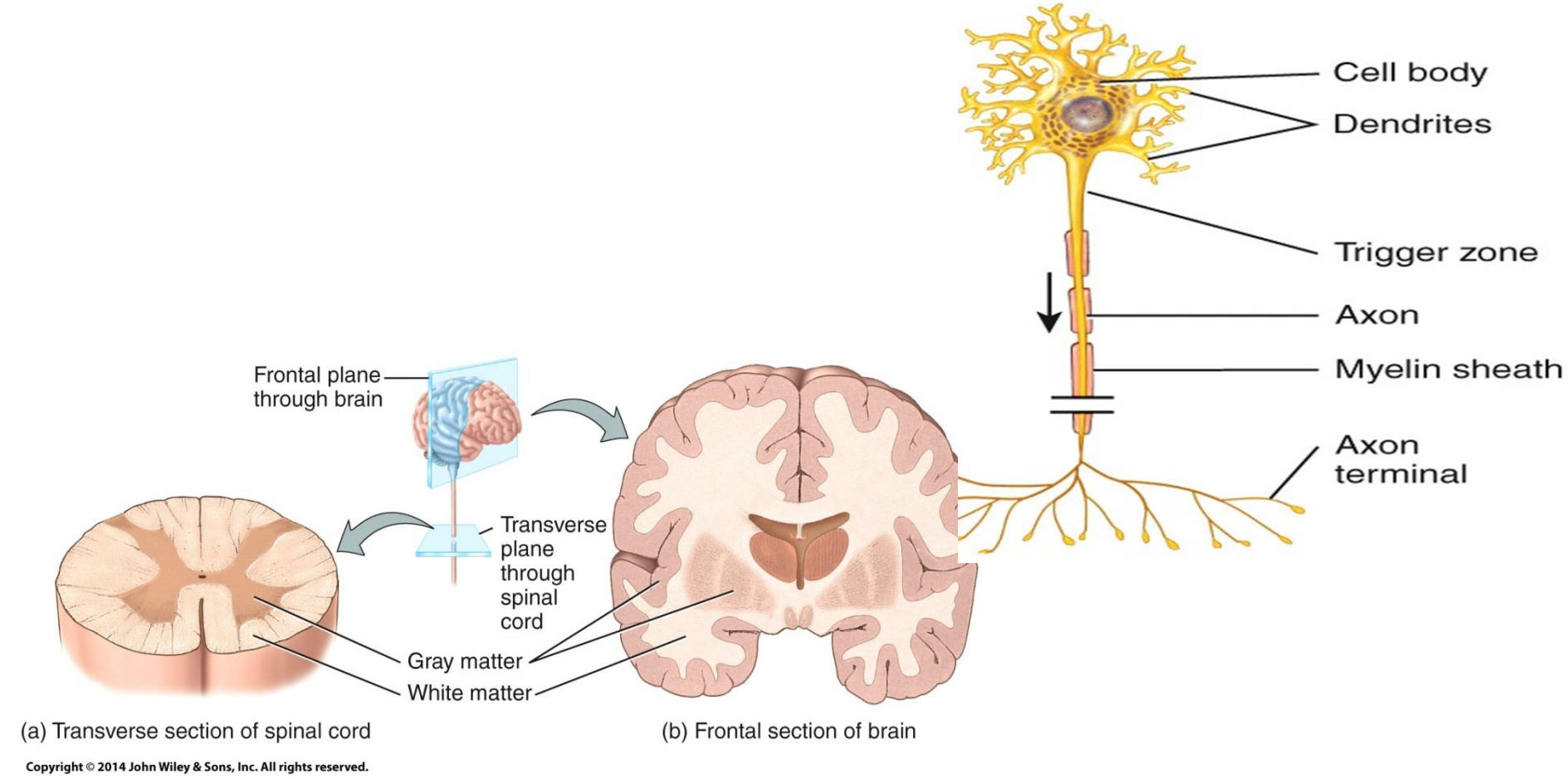
- white matter



Structure of Neurons



Distribution of Gray Matter and White Matter in the Spinal Cord and Brain



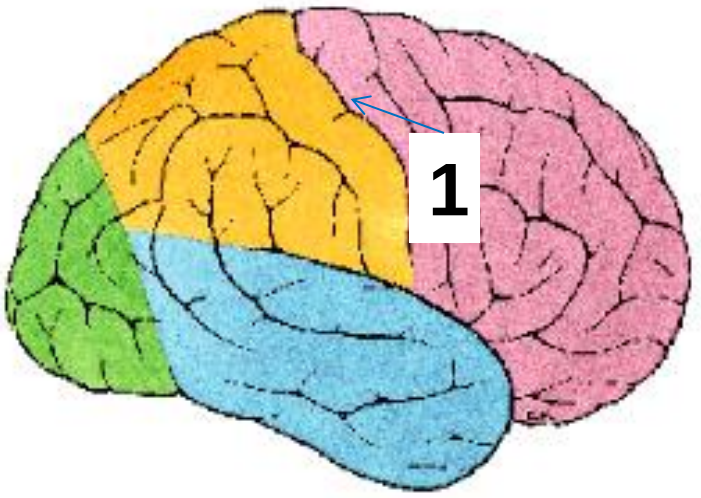
Gray and White Matter

- The white matter is aggregations of axons of many neurons.
- The gray matter of the nervous system contains neuronal cell bodies, dendrites, axon terminals, and neuroglia.

- Aggregation of cell bodies in white matter:
  - Brain Nuclei
  - Dorsal root ganglia (in PNS)

External Aspect of Cerebrum

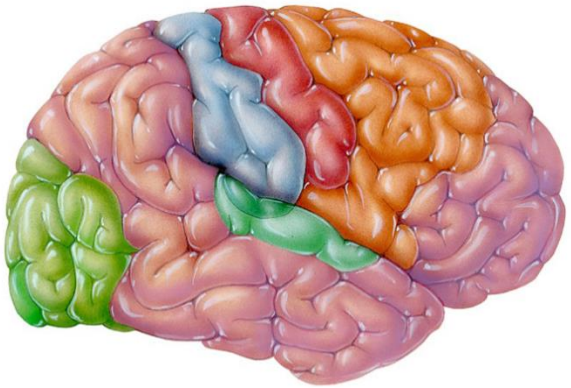
1. Central Sulcus:



Located between 2 important gyri:

Precentral gyrus

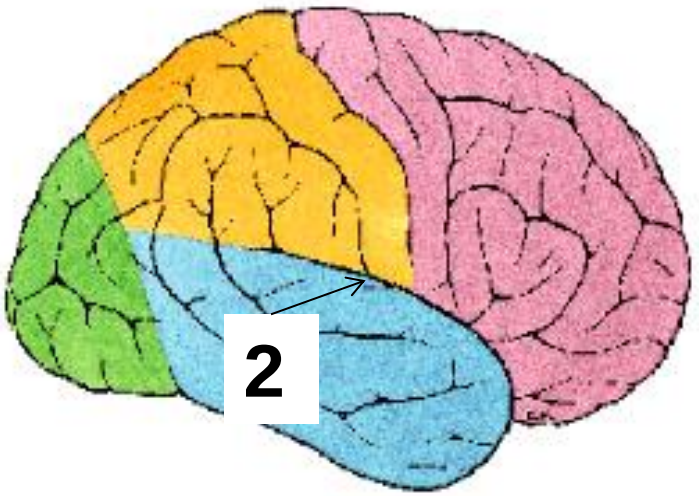
Postcentral gyrus



External Aspect of Cerebrum

Subdivided by sulci into lobes:

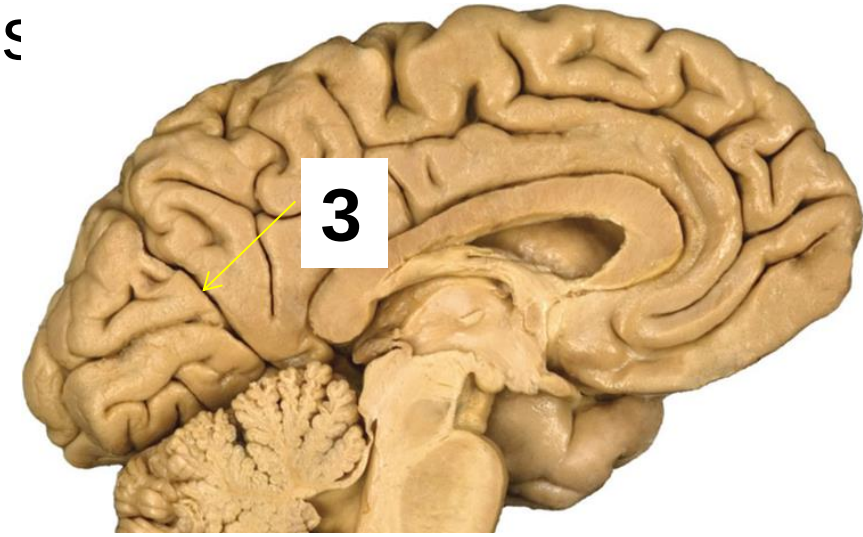
1. Central sulcus
2. Lateral fissure



External Aspect of Cerebrum

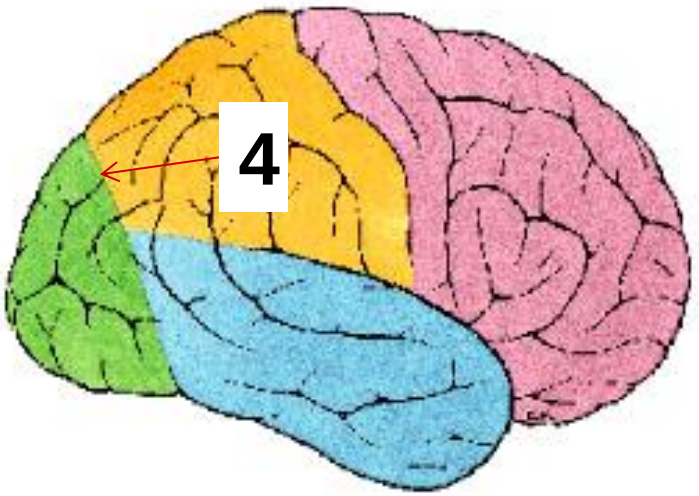
Subdivided by sulci into lobes

1. Central sulcus
2. Lateral fissure
3. Parietoccipital sulcus



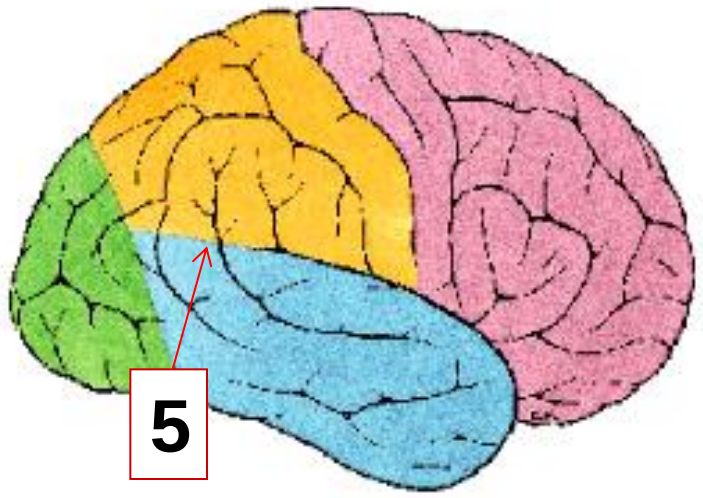
External Aspect of Cerebrum

1. Central sulcus
2. Lateral fissure
3. Parietoccipital sulcus sulcus
4. 1st imaginary line



External Aspect of Cerebrum

1. Central sulcus
2. Lateral fissure
3. Parietoccipital sulcus sulcus
4. 1st imaginary line
5. 2nd imaginary line



External Aspect of Cerebrum

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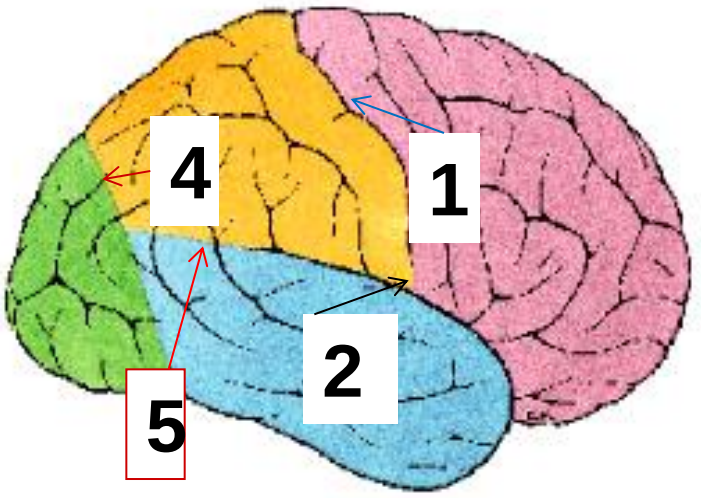
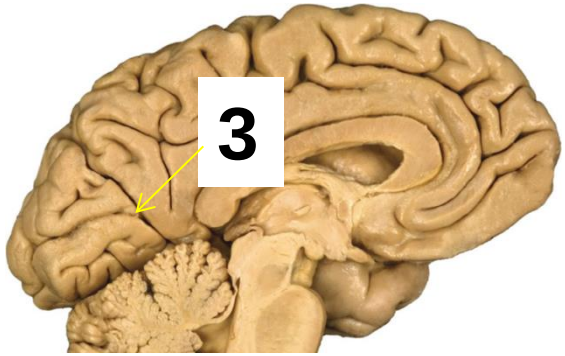
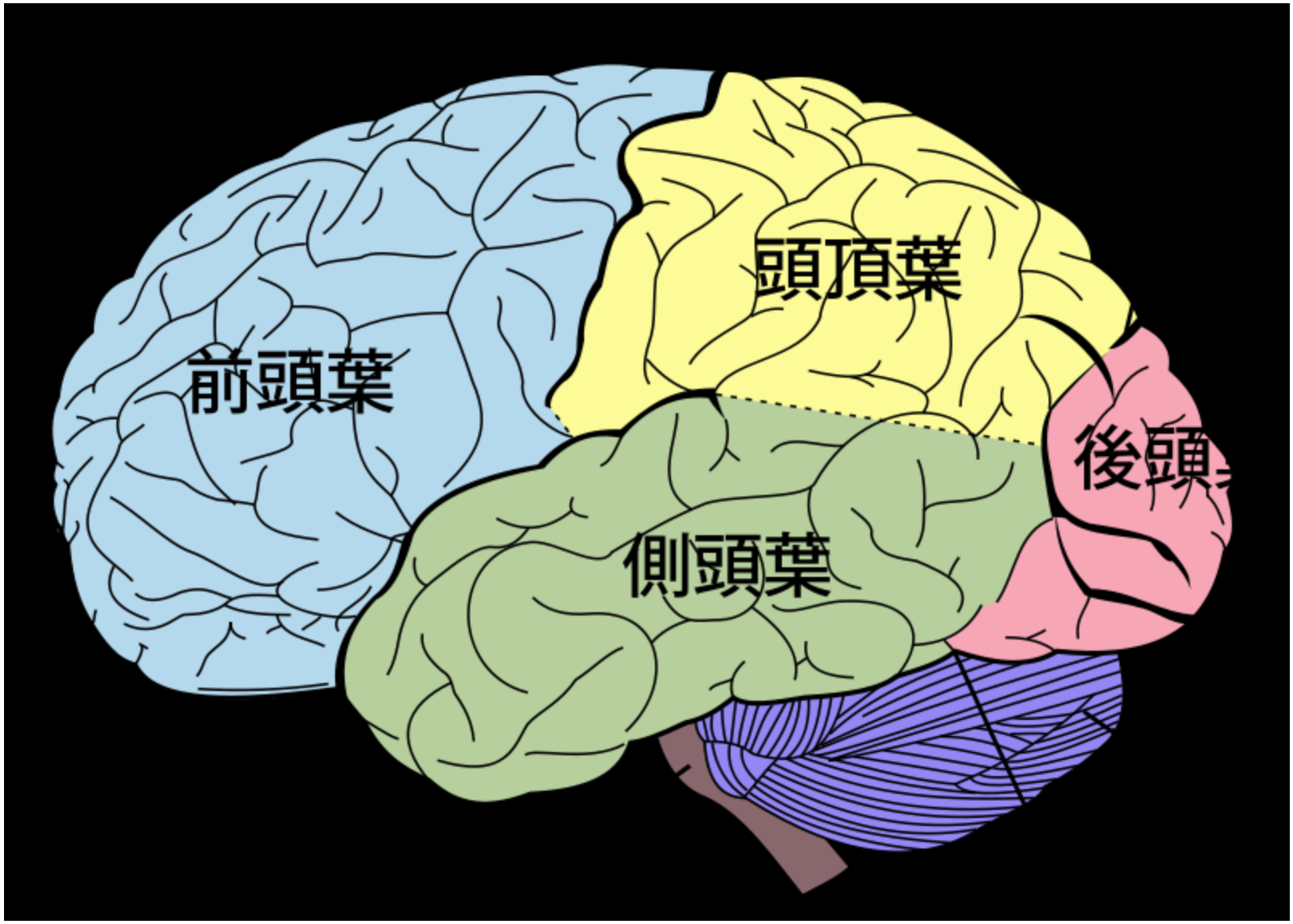






External Aspect of Cerebrum

Folded into Gyri & Sulci
* ↑ surface area

Subdivided by sulci into lobes:

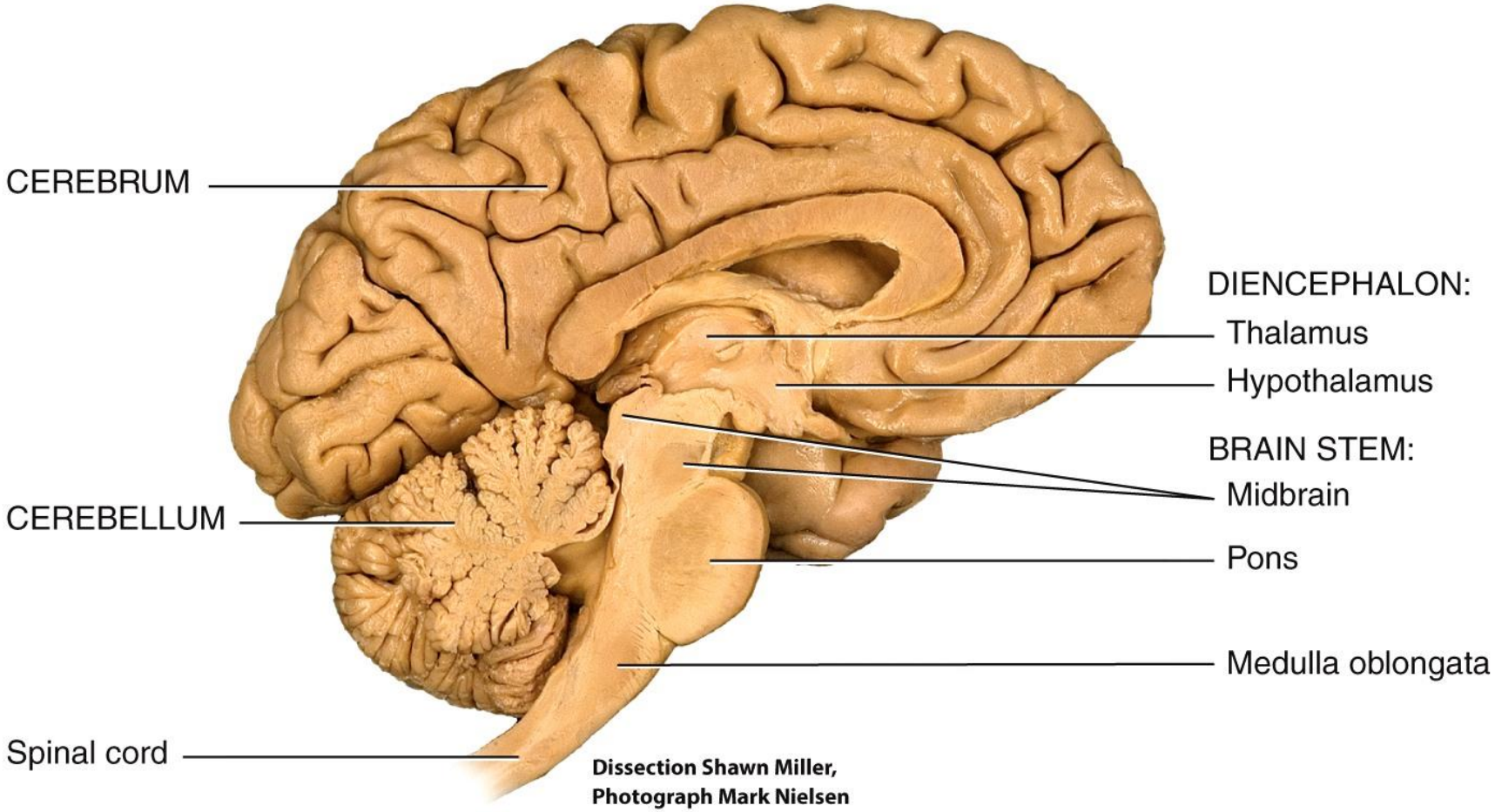
1. Frontal
2. Parietal
3. Occipital
4. Temporal

External Aspect of Cerebrum

Folded into Gyri & Sulci

* ↑ surface area

The Medial Aspect of the Brain



(b) Sagittal section, medial view

Functional Organization of the Cerebral Cortex

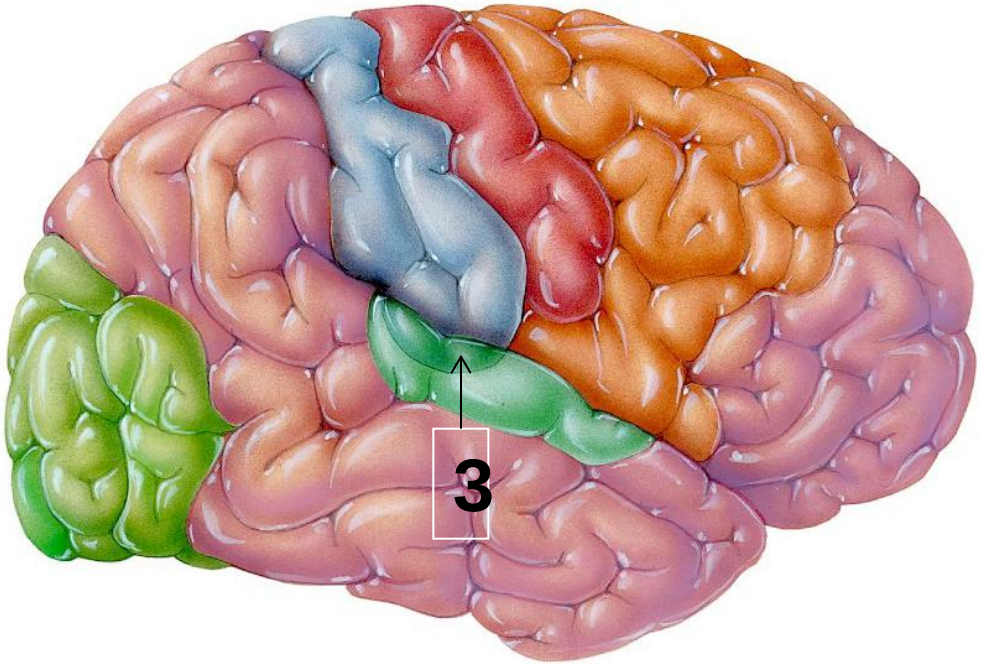
- Sensory areas
  - Primary somatosensory area
  - Primary visual area
  - Primary auditory area
  - Primary gustatory (taste) area
  - Primary olfactory area
- Motor areas
  - Primary motor area
  - Broca's (motor speech) area

Main Functional Regions in Cerebrum

1. Motor area:

2. Sensory area:

3. Primary Auditory area:
interpretation of sound

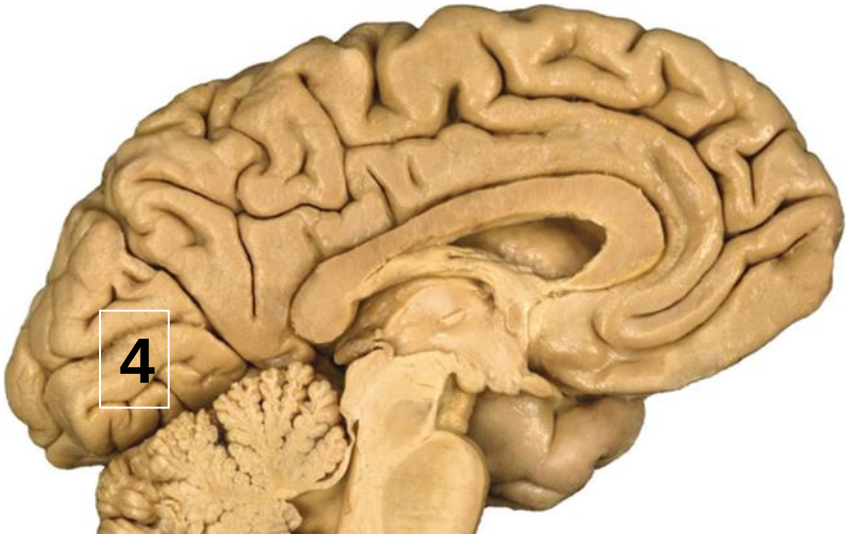


4. Visual area:

interpretation of vision

mainly on medial aspect of occipital lobe

(*post. pole of cerebrum*)



5. Motor Speech area:

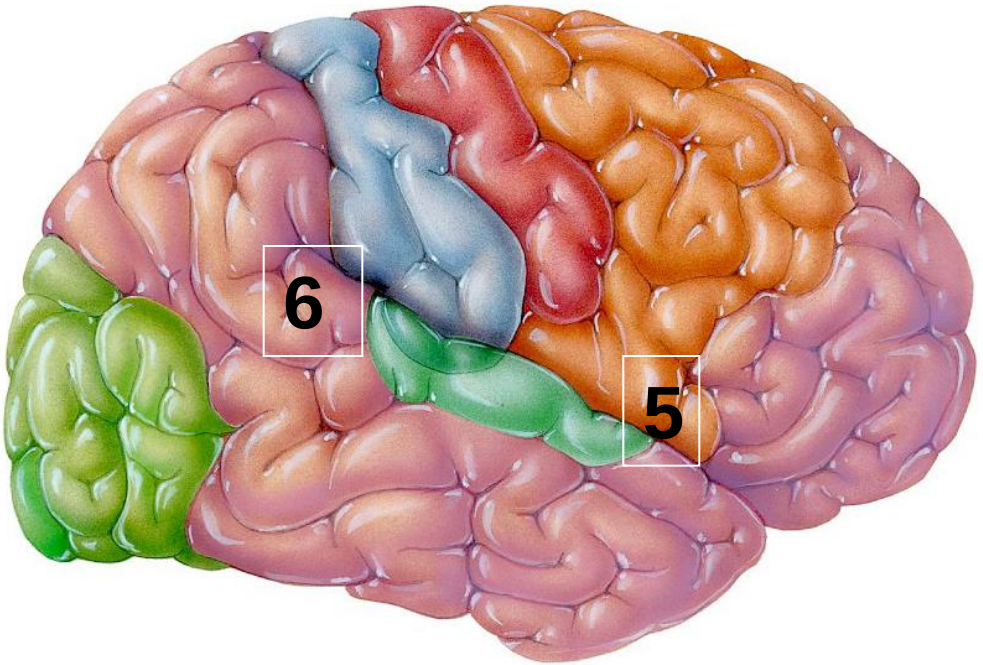
(Broca's area)

Planning & production of speech in a comprehensive way

6. Wernicke's (Language) area

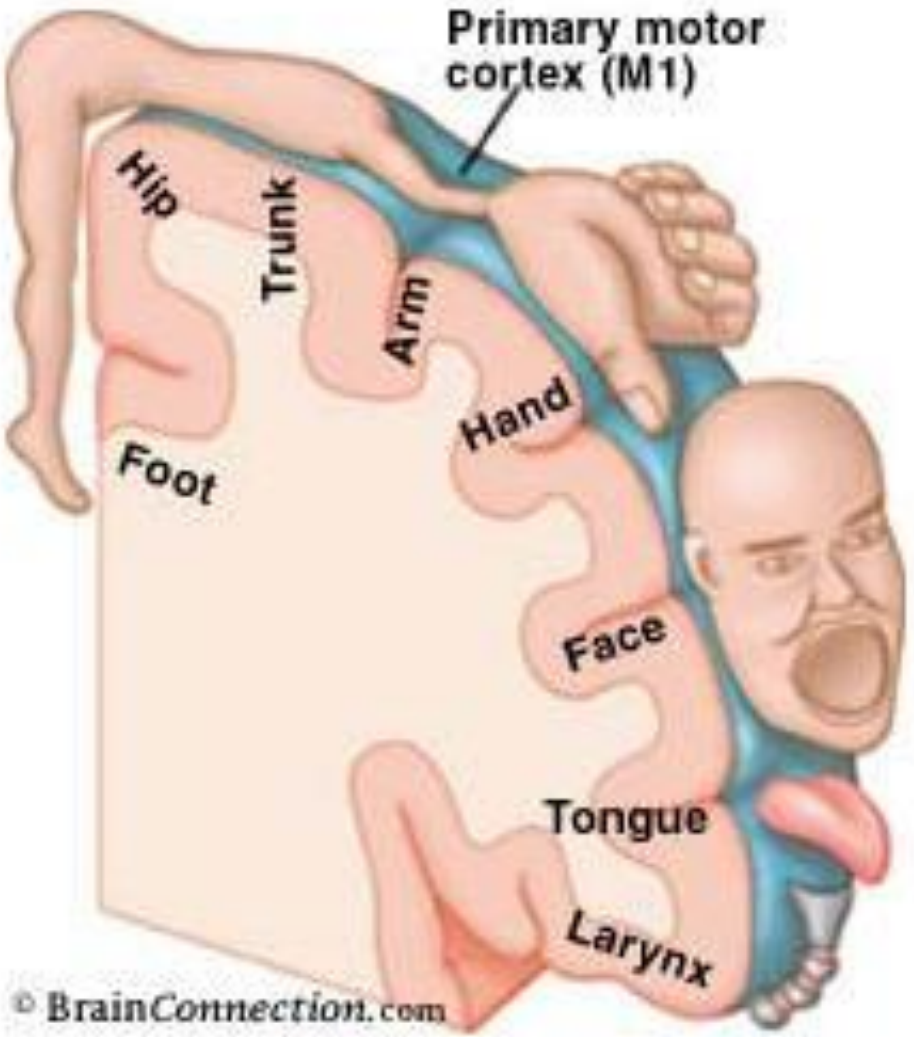
(sensory speech area)

understand the meaning of speech by recognizing spoken words

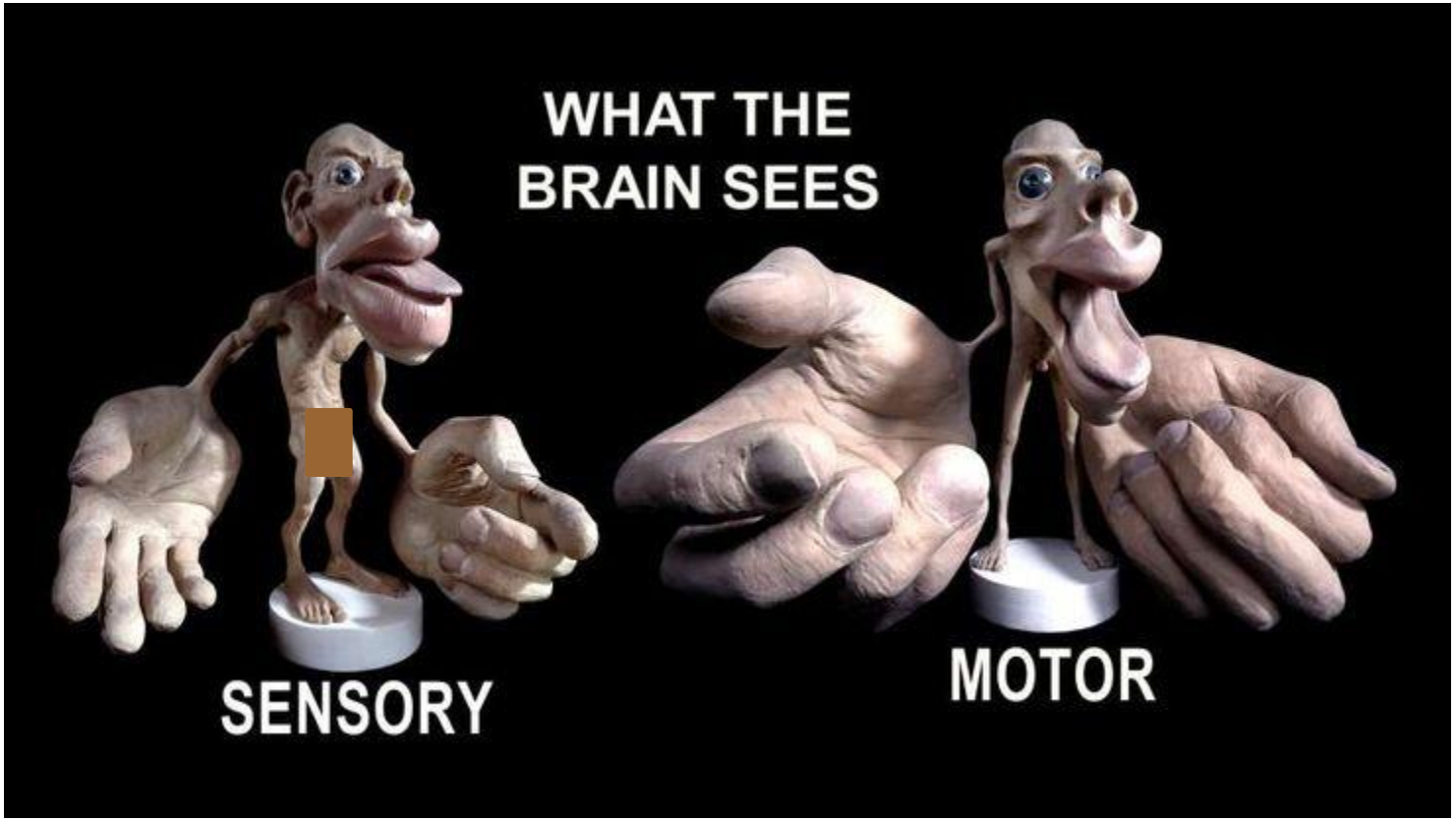


CEREBRAL HOMUNCULUS

1. Inverted
2. Disproportional
3. Contralateral



CEREBRAL HOMUNCULUS



1. Inverted
2. Disproportional
3. Contralateral

Precentral Gyrus

- **The primary motor area**

- **Contralateral: Controls voluntary movement on opposite side of the body**

  Because:

  ⇨Nerve fibers from precentral gyrus cross over to other side

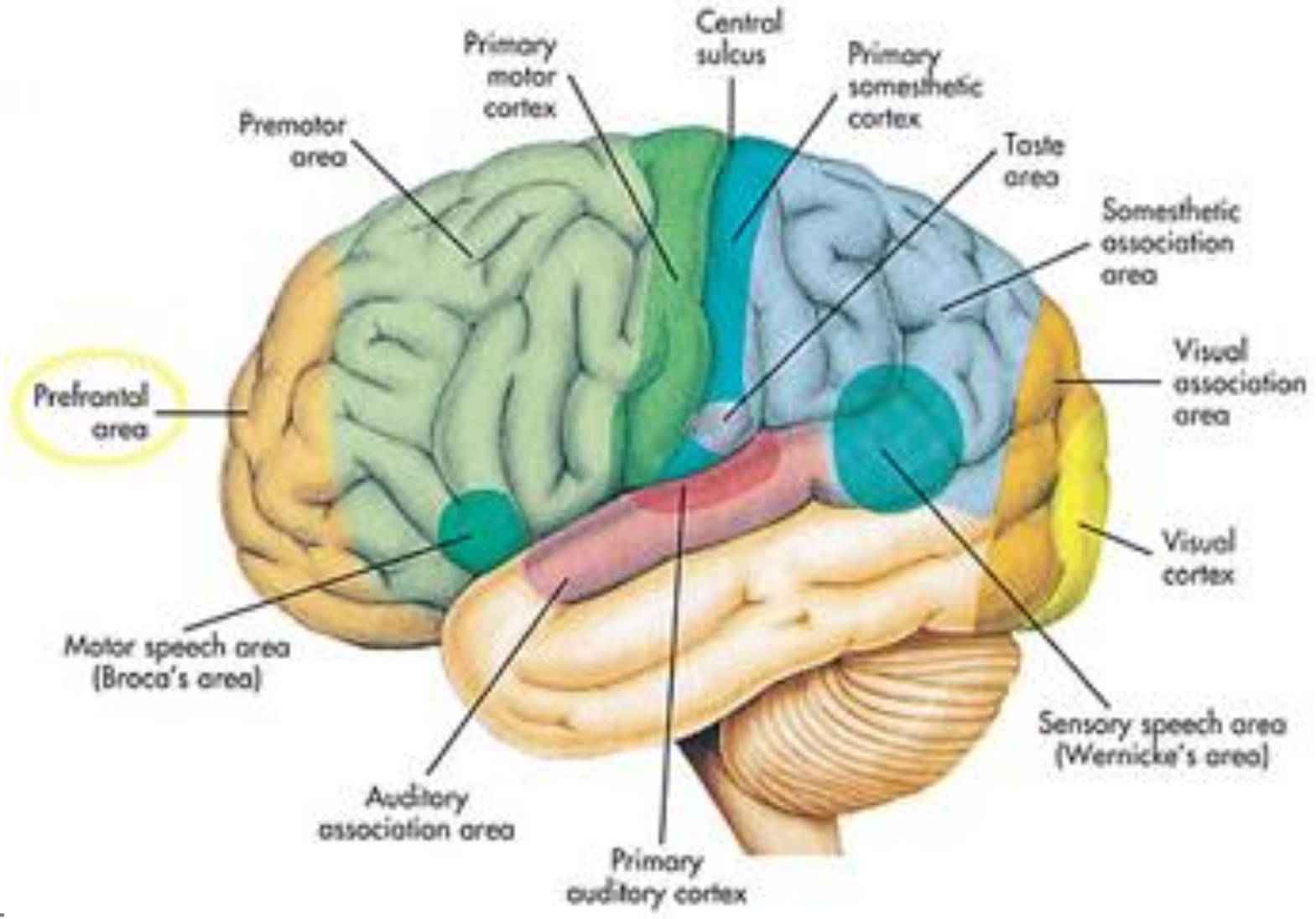
- **Motor control in precentral gyrus is represented in an inverted position**
- **Disproportional**

Postcentral Gyrus

- **The primary sensory area (sensory nerve cells)**
- **Receives inputs for: pain, thermal sensation, touch & pressure**
- **Receives the sensations from opposite side of the body**

  - Contralateral
  - Inverted
  - Disproportional

Cerebrum

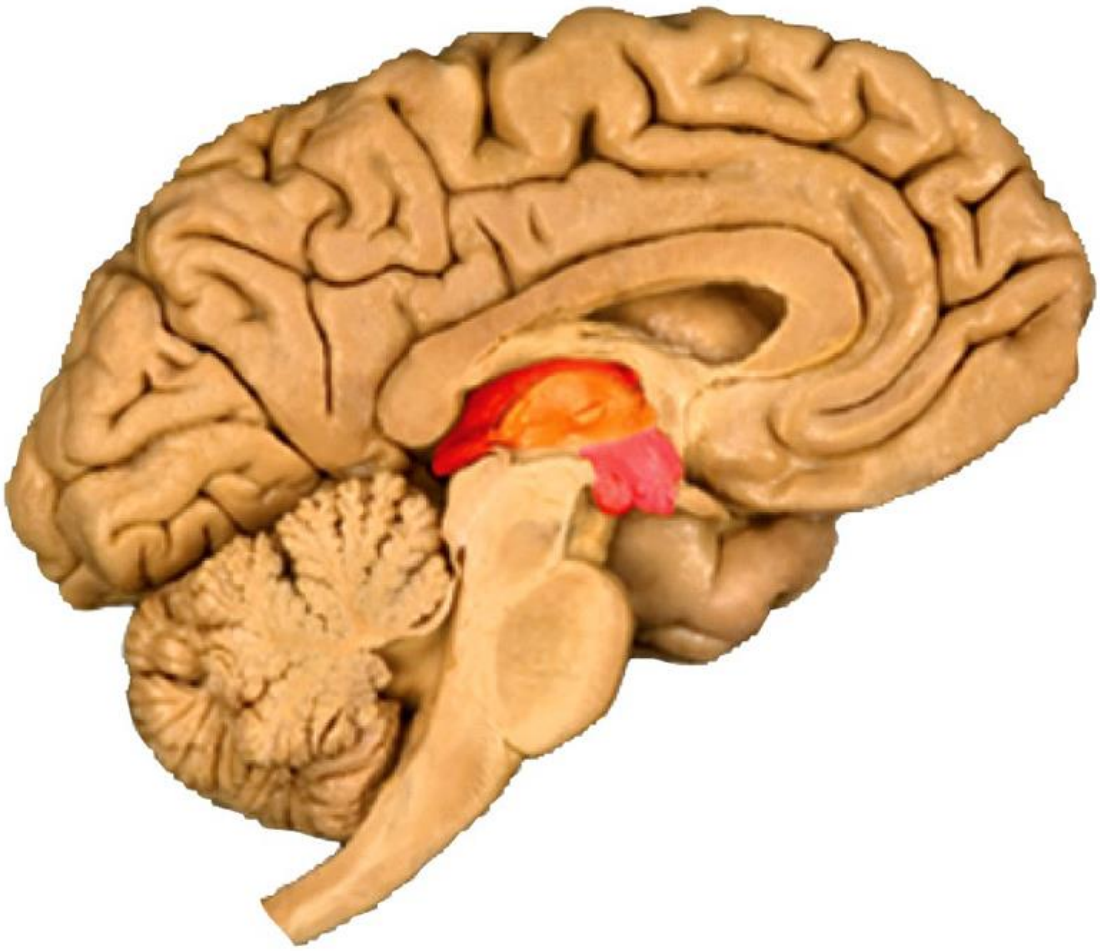

Primary motor cortex
Central sulcus
Primary somesthetic cortex
Premotor area
Taste area
Somesthetic association area
Visual association area
Prefrontal area
Visual cortex
Motor speech area (Broca's area)
Sensory speech area (Wernicke's area)
Auditory association area
Primary auditory cortex

Diencephalon

Hidden by cerebrum

Consists mainly of:

- **Thalamus (meaning ?)**
- **Hypothalamus**



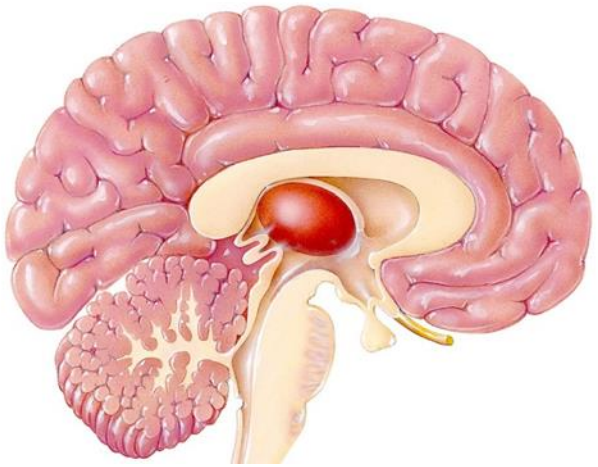
Dissection Shawn Miller, photograph Mark Nielsen

Thalamus

- **Paired oval masses of gray matter (contains many nuclei)**
- **Interthalamic connection:**

  a bridge of gray matter joins the two thalami (*in 80% of human brains*)

- **A major relay station for sensory pathways**



Hypothalamus

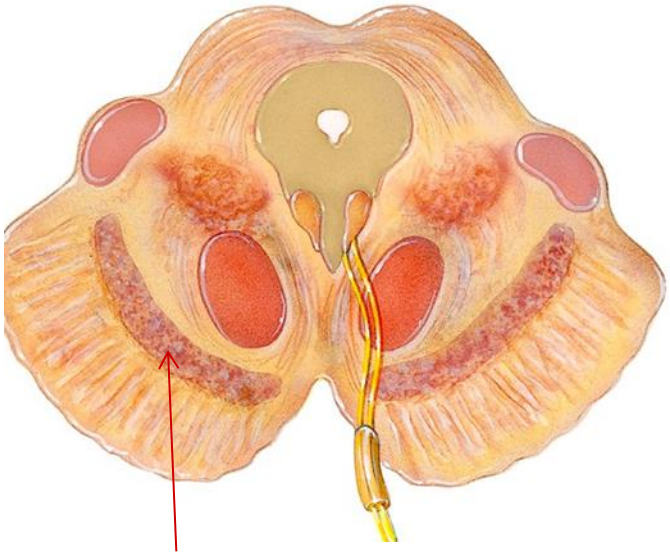
Contains special nerve cells that secrete several neurohormones

- Hypothalamus links 2 systems

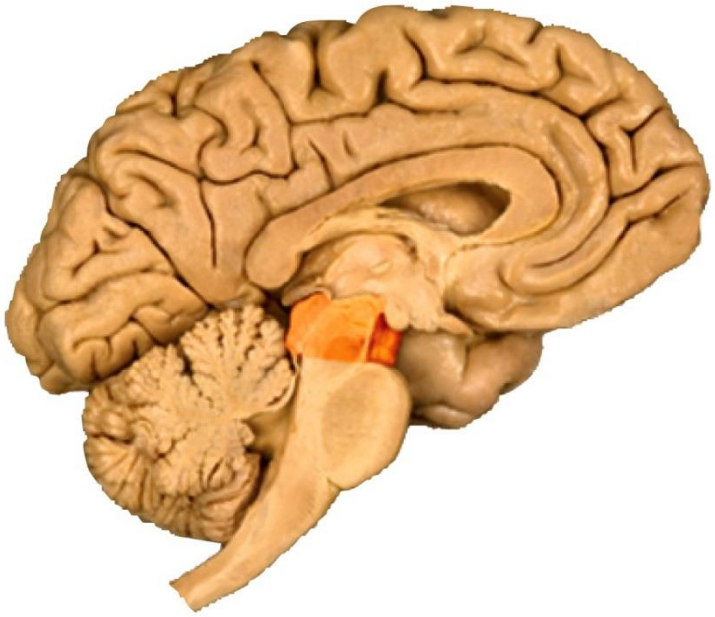
- Major functions
  - Control of the ANS
  - Control pituitary gland secretions
  - Control water retention (kidneys)
  - Regulation of eating and drinking
  - Control of body temperature
  - Regulation states of consciousness

Midbrain

- Sup. Part of brain stem
- Connects forebrain to hindbrain
- Damage to substantia nigra -----?.



substantia nigra

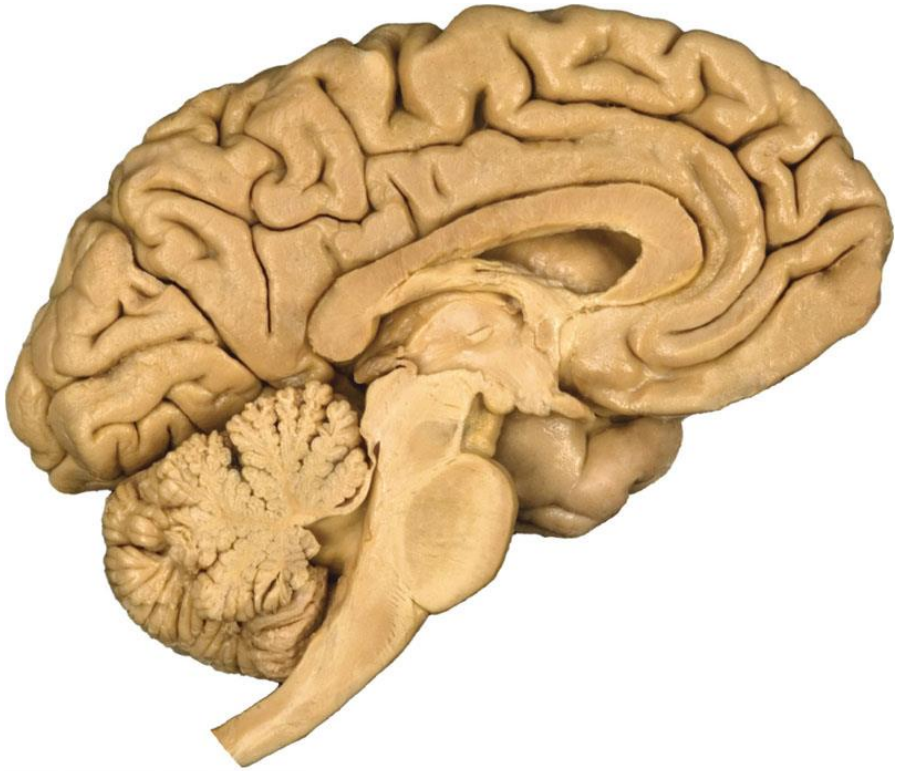


Dissection Shawn Miller, photograph Mark Nielsen

The Hindbrain

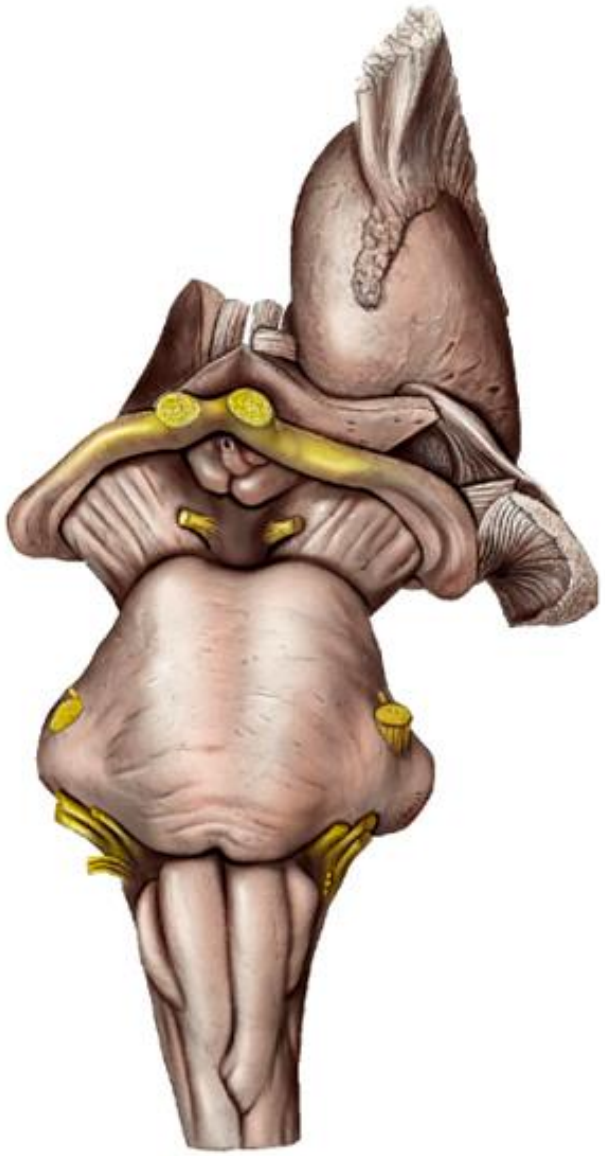
Made up:

- Pons
- Medulla oblongata
- Cerebellum



Pons

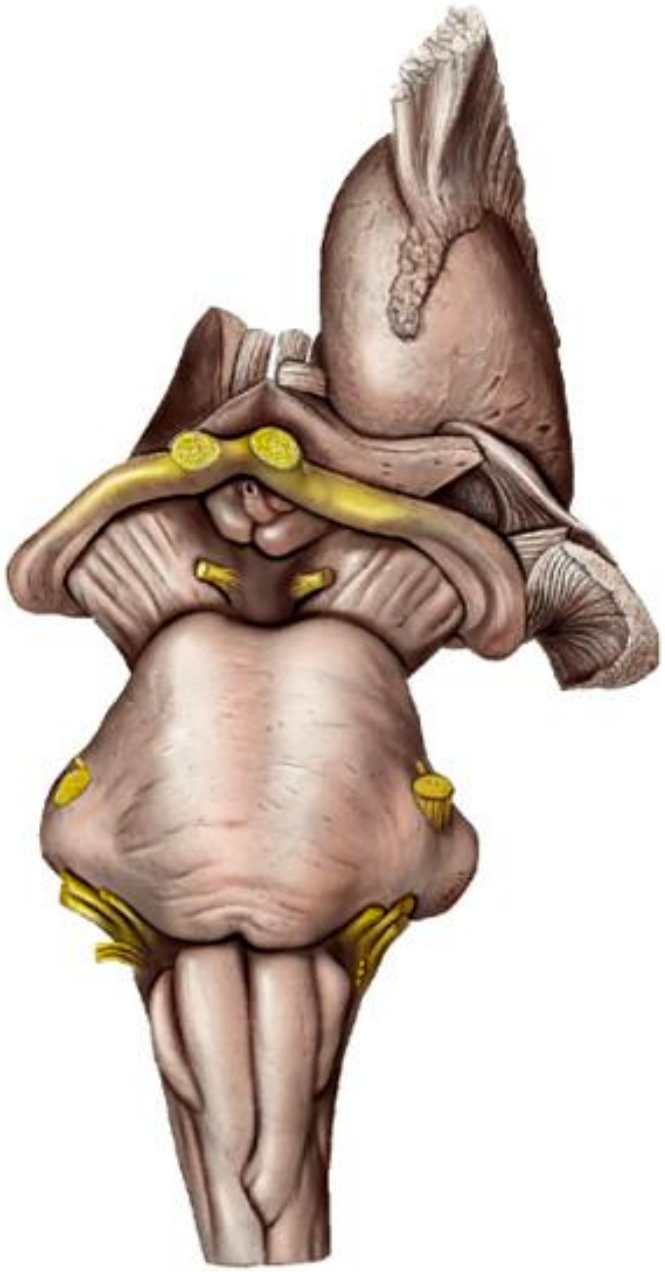
- Middle part of brainstem
- Ant. To cerebllum
- Contains bundles of axons that connect the 2 halves of cerebellum
- Controls arousal (being awake)



Medulla Oblongata

- Lower part of brainstem

- contain bundles of motor neurons located in precentral gyrus

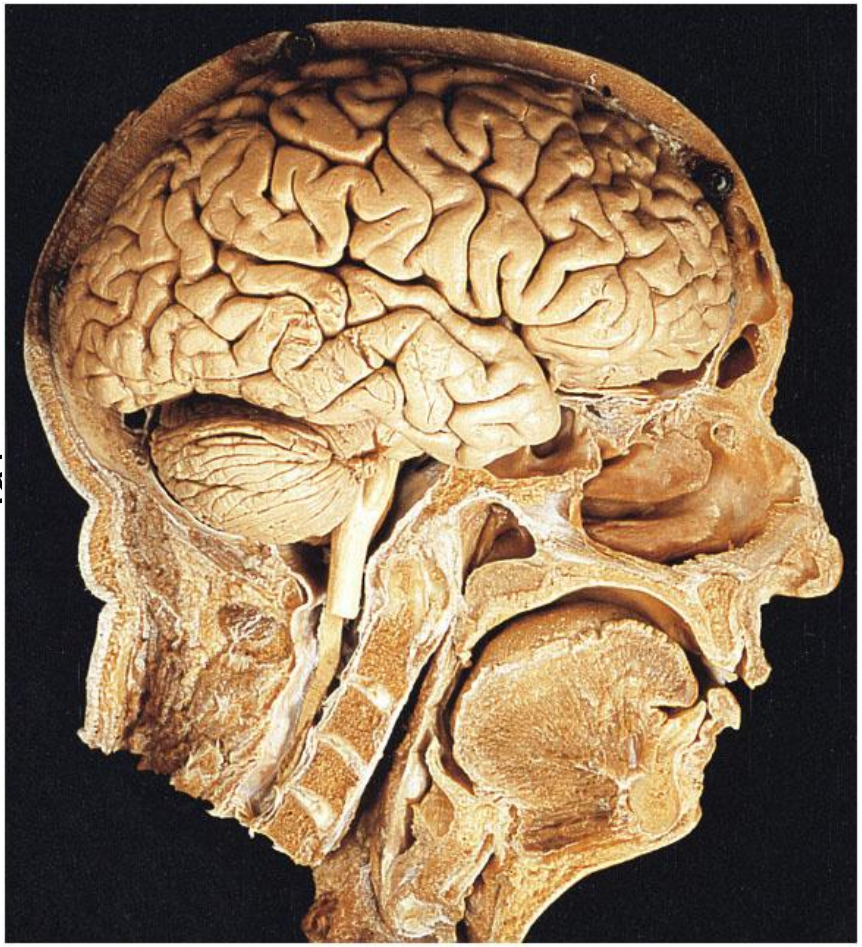


Cerebellum

- **Location:**
  post. Cranial fossa
  behind pons & MO

- **Function:**
  Coordination of muscle tone & movements on same side of the body

  Regulates posture & balance


Mark Nielsen

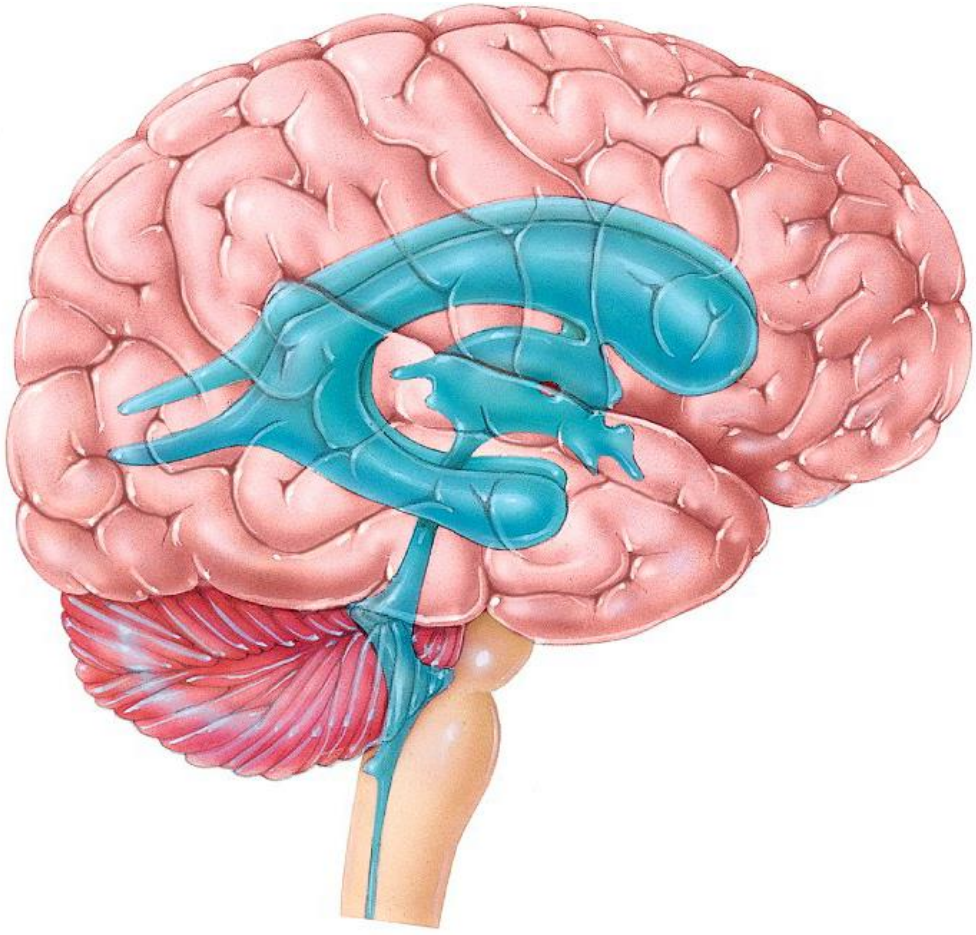
Ventricular System of The Brain

Consists of:

- 2 lat. Ventricles
- 3rd ventricle
- 4th ventricle

* Contain choroid plexuse

⇨ CSF



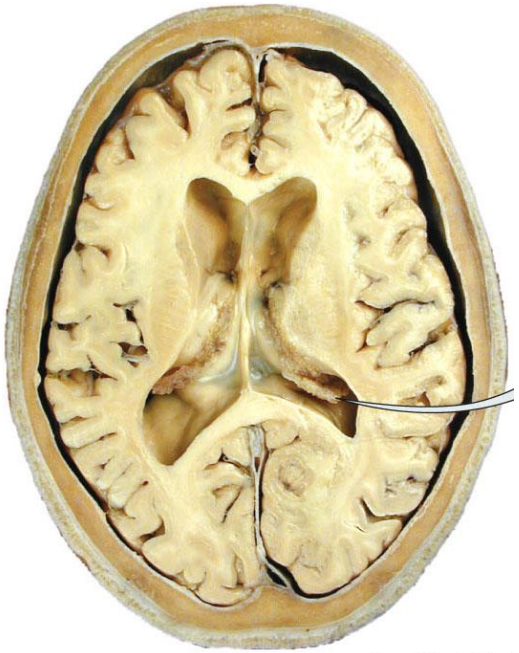
Lateral Ventricles

Located within cerebrum

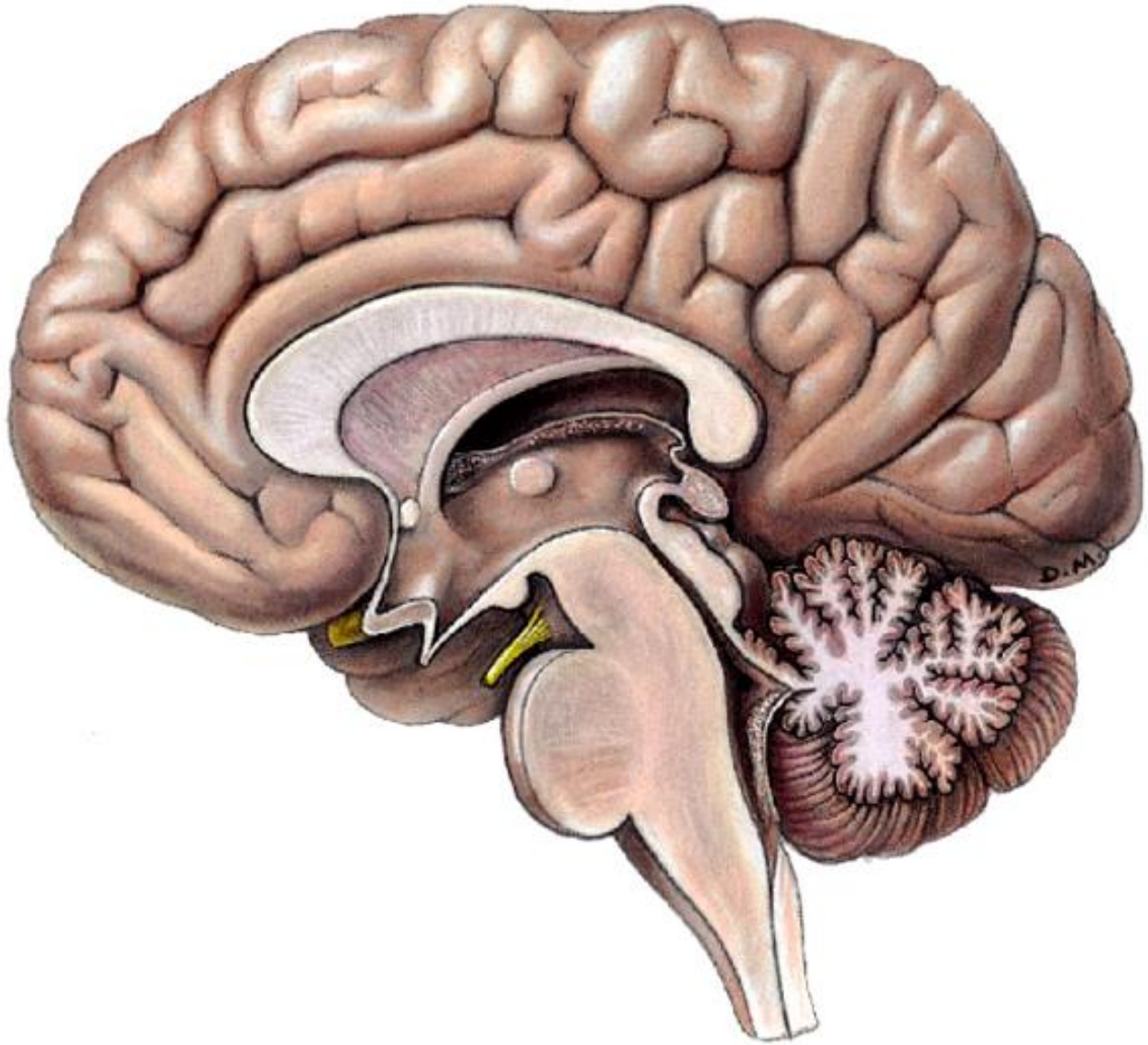
2 large cavities that filled with CSF

Communicate with 3rd ventricle

* Separated from each other by septum pellucdum



Septum Pellucidum



Brain Blood Flow and the Blood–Brain Barrier

- The blood–brain barrier (BBB):
  - Allows oxygen and glucose into brain
  - Protects from harmful substances and pathogens
  - Proteins and antibiotics cannot cross the BBB.
  - Oxygen, carbon dioxide, anesthetic drugs, and alcohol can cross the BBB.

Clinical Connection

Steve Allen/Photo Researchers, Inc.

Hydrocephalus in a newborn

Spinal Cord

External Anatomy of The Spinal Cord

From medulla oblongata

↓

To L1 - L2 disc

2 enlargements:

- **Cervical (upper limb n.)**
- **Lumbar (lower limb n.)**

Tapering termination:

- **Conus medullaris**

Cauda equina

The roots of lumbar , sacral & coccygeal spinal nerves

Internal Anatomy of The Spinal Cord

2 layers

- **Outer: White Matter**
- **Inner: Gray Matter (H-shape)**

Gray Matter

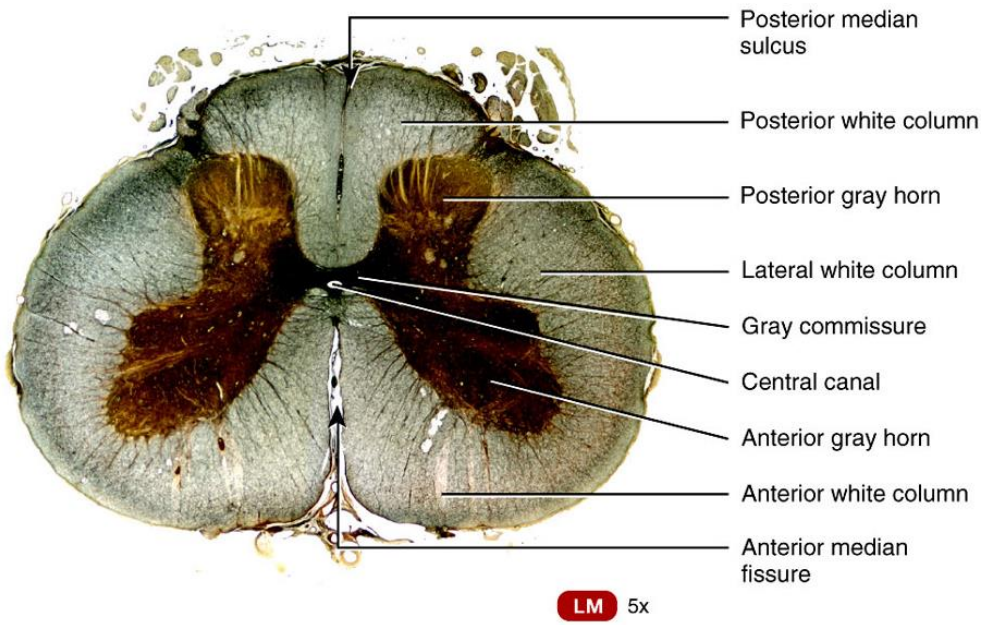
- **Anterioer (ventral) horn**

cell bodies of motor neurons

- **Posterior (dorsal) horn**

cell bodies of sensory neurons

- **Gray commissure**



Transverse section of thoracic spinal cord

Figure 18.03b Tortora - PHA 11/e

- Organization of the Nervous System
- CENTRAL NERVOUS SYSTEM (CNS): Brain & Spinal Cord
- Gray and White Matter
- Major Parts of the Brain
- Protective Coverings of the Brain/ Meninges
- External Aspect of Cerebrum: lateral and median
- Main sulci and gyri
- Functional areas of brain
- Ventricles
- Spinal cord

Thank You