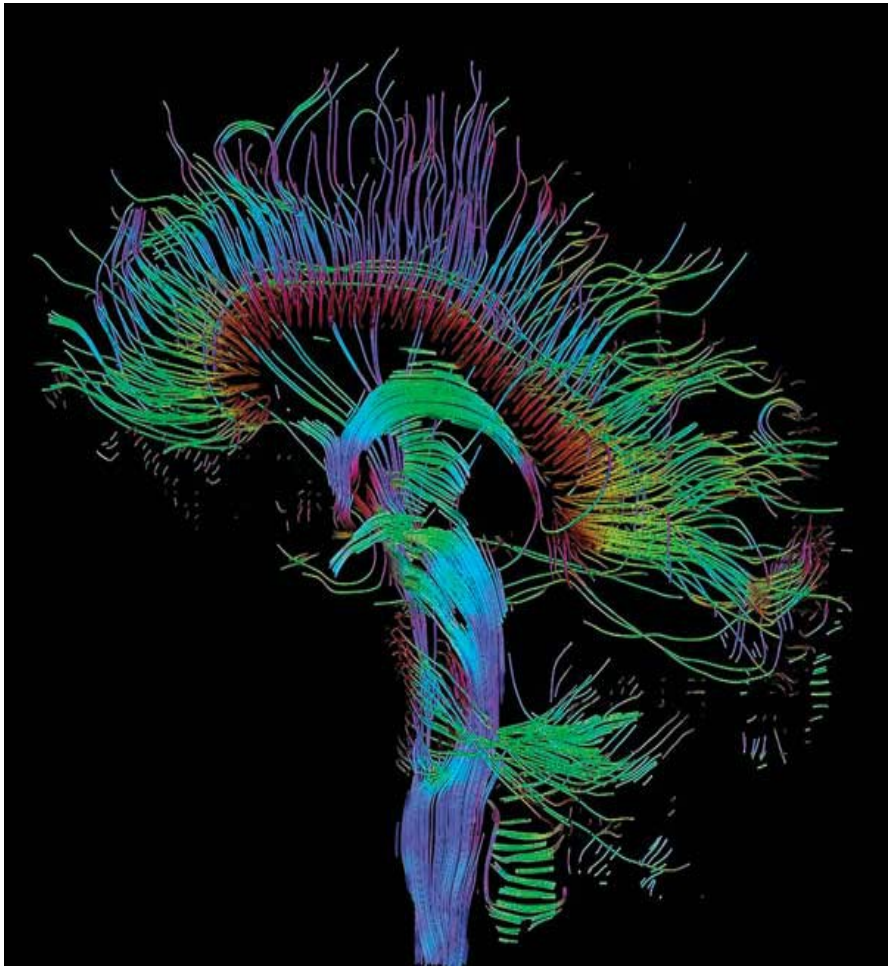
Chapter 14

Brain Structure

(Lab Objectives)



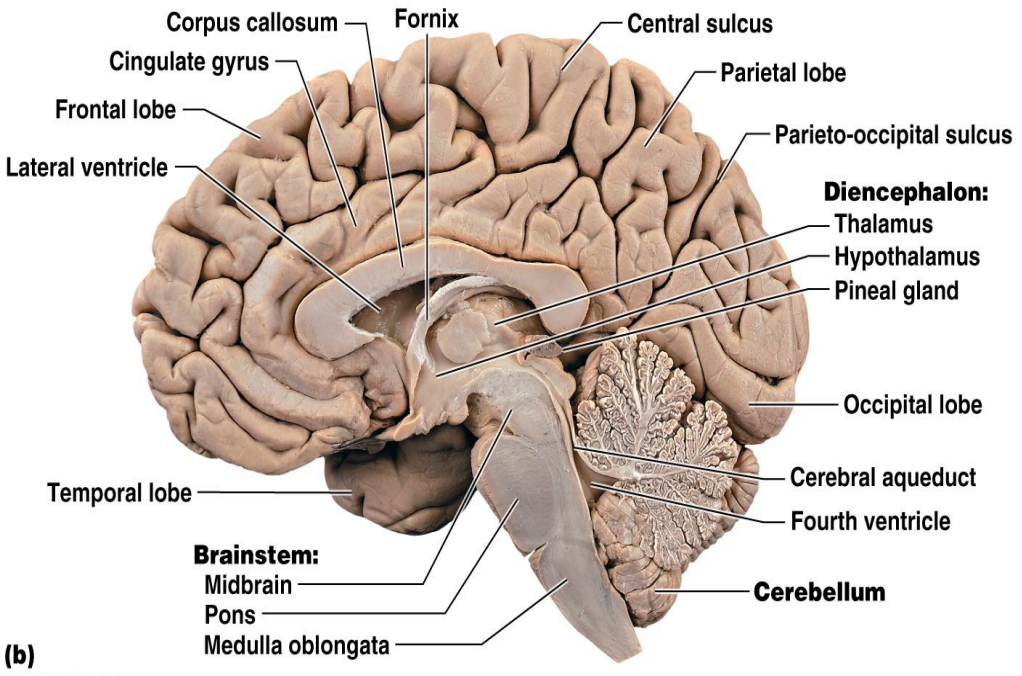
The Three Divisions of the Adult Brain

Know This For Your Exam

cerebrum is 83% of brain volume; cerebral hemispheres, gyri and sulci, longitudinal fissure, corpus callosum

cerebellum contains 50% of the neurons; second largest brain region, located in posterior cranial fossa

brainstem the portion of the brain that remains if the cerebrum and cerebellum are removed

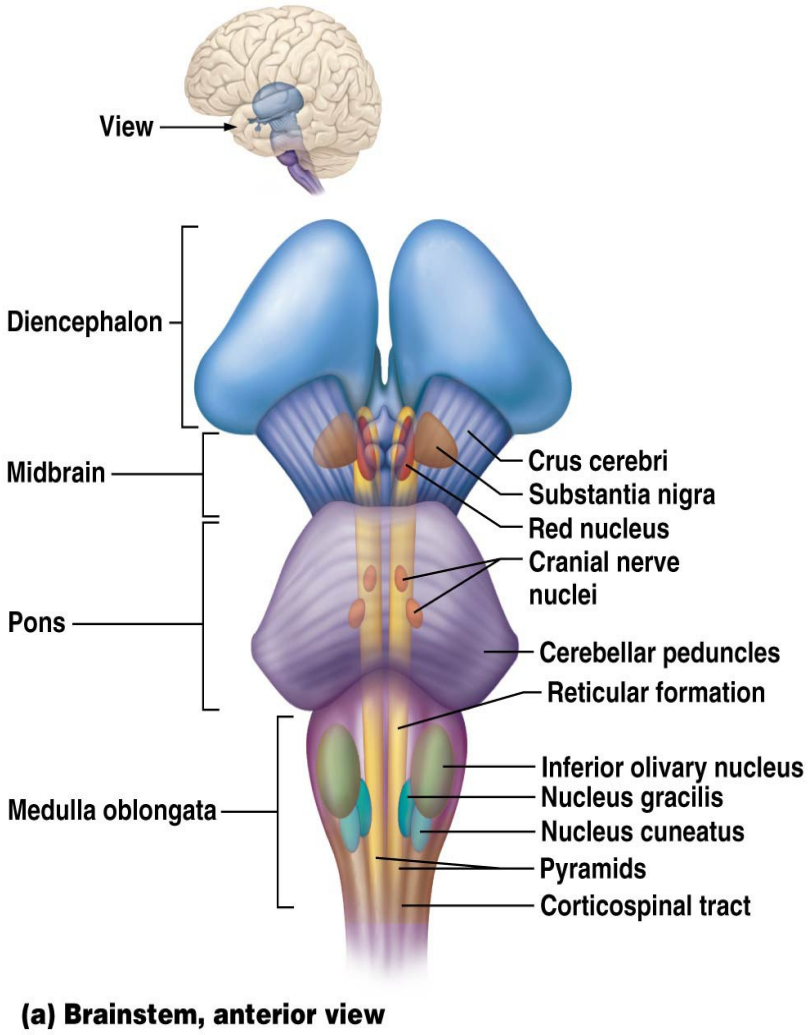


Brainstem

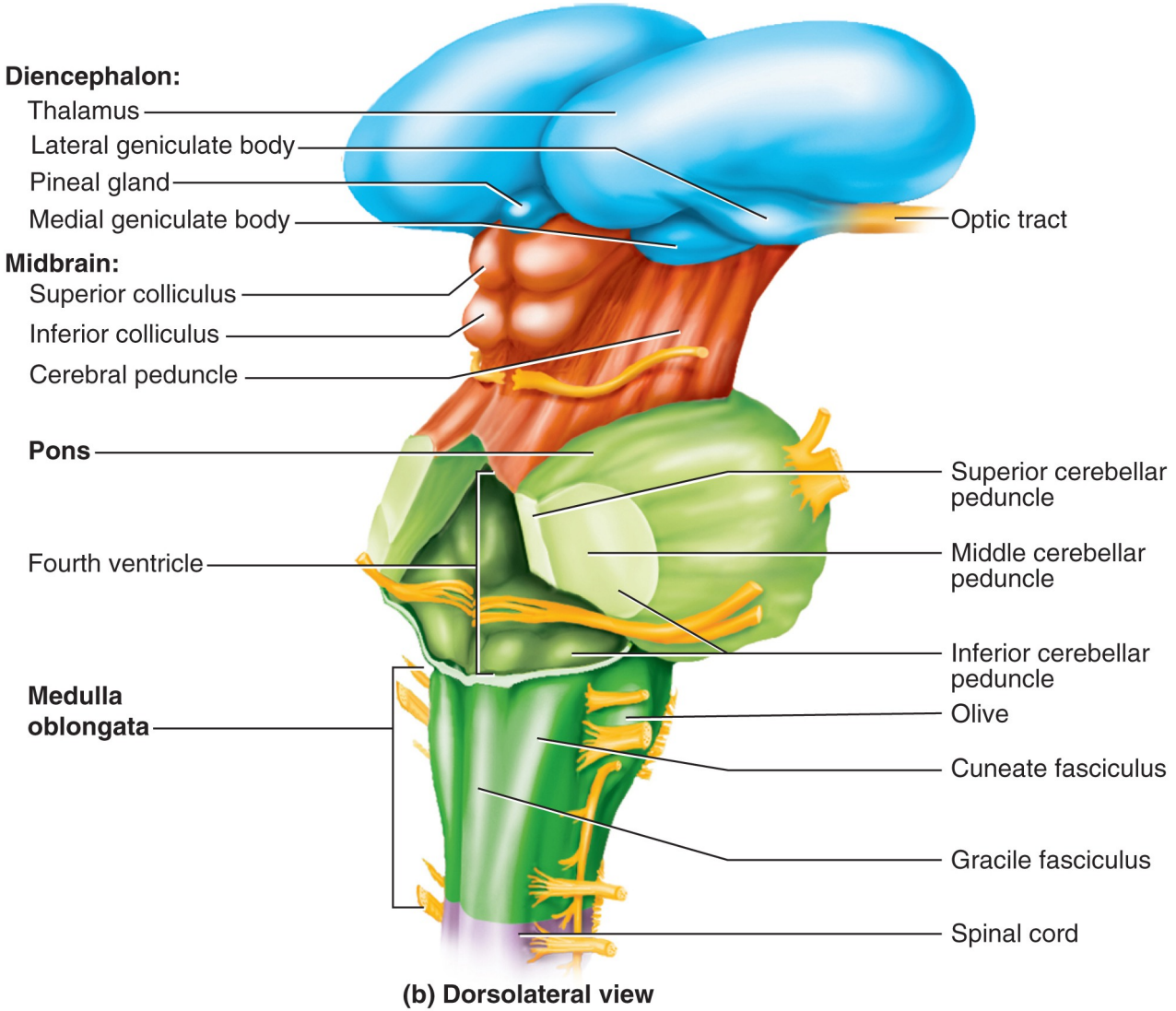
Know This For Your Exam

- After the cerebrum and cerebellum are removed from the brain, you are left with the brainstem and diencephalon.

- **Major components of the brainstem**
  - **diencephalon**
    - connects brainstem to cerebrum /// Parts = thalamus, epithalamus, hypothalamus
  - **midbrain**
  - **pons**
  - **medulla oblongata**



(a) Brainstem, anterior view

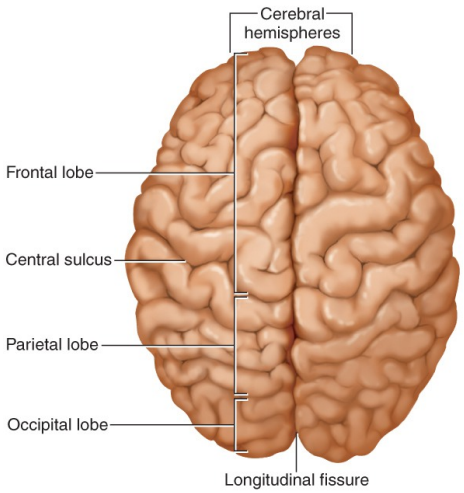


(b) Dorsolateral view

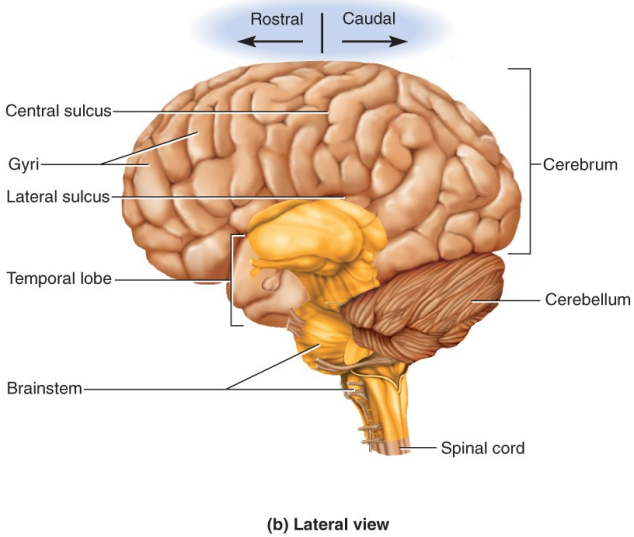
Note: Diencephalon also includes hypothalamus and epithalamus (pineal gland & habenula)

- Forebrain
  - Diencephalon
  - Cerebrum
- Midbrain
- Hindbrain
  - Brain Stem
  - Pons
  - Midbrain
  - Cerebellum

This structural arrangement is commonly used in the study of embryonic growth and brain development.

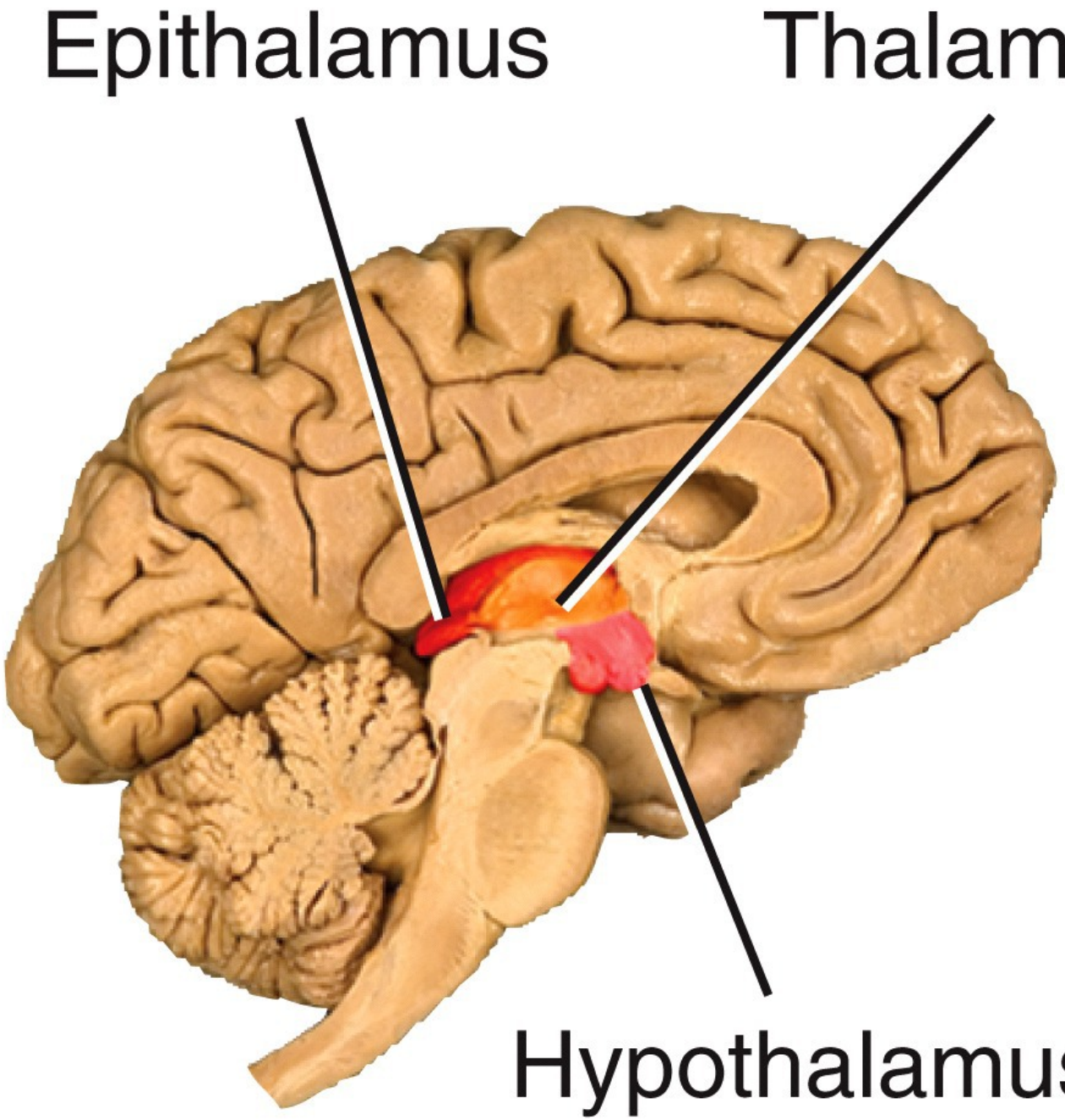


(a) Superior view



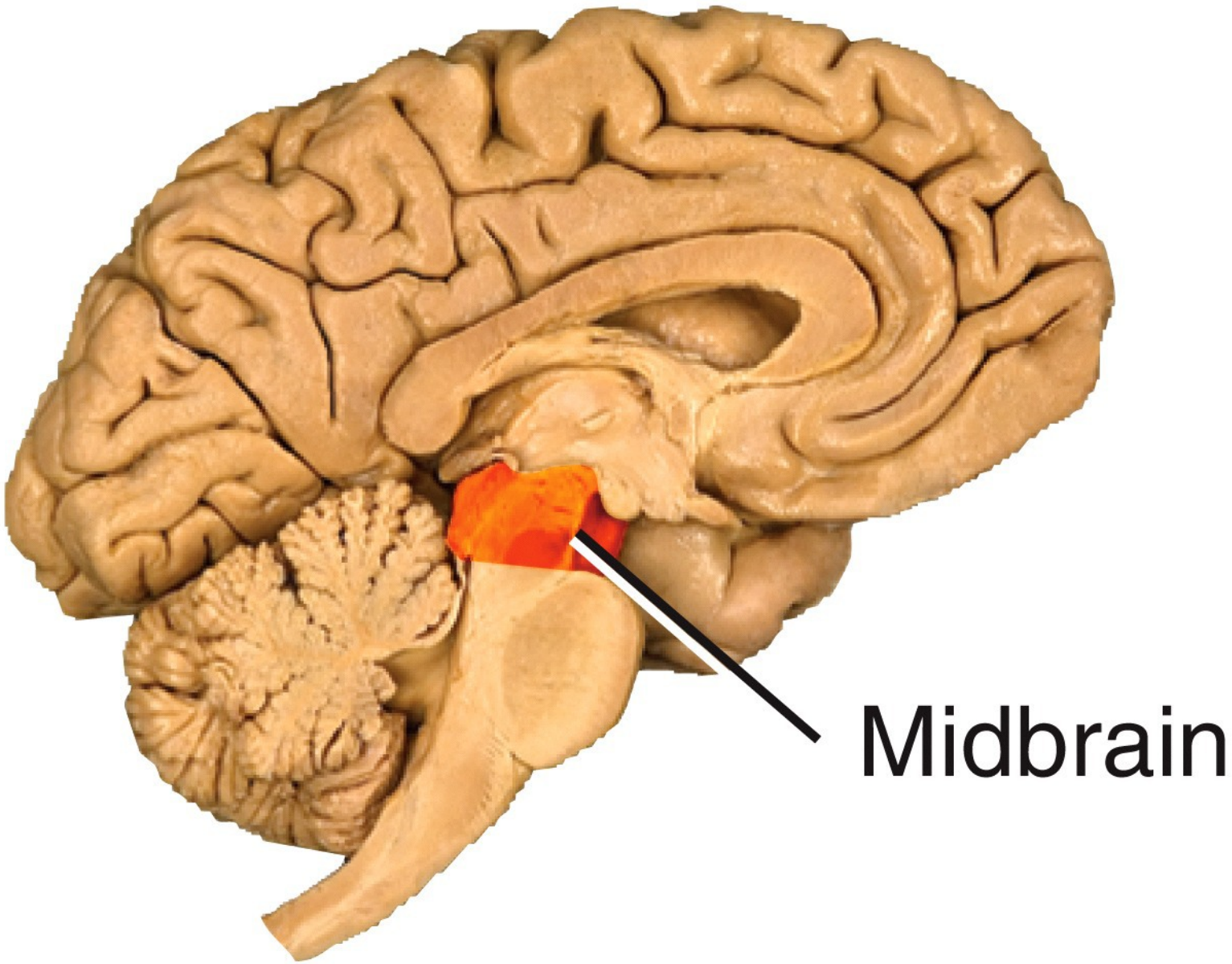
(b) Lateral view

(c) Lateral view

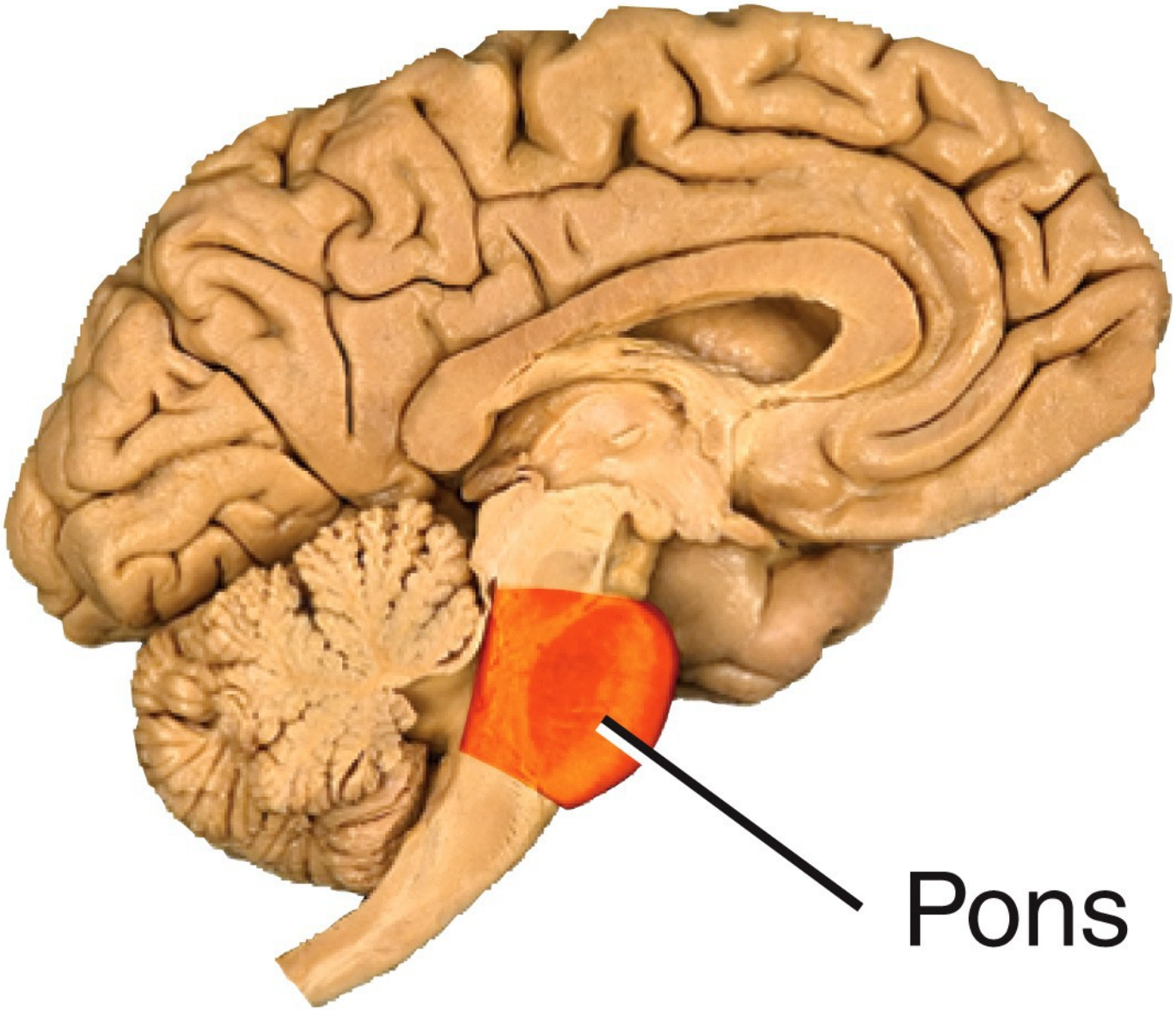


Dissection Shawn Miller, Photograph Mark Nielsen

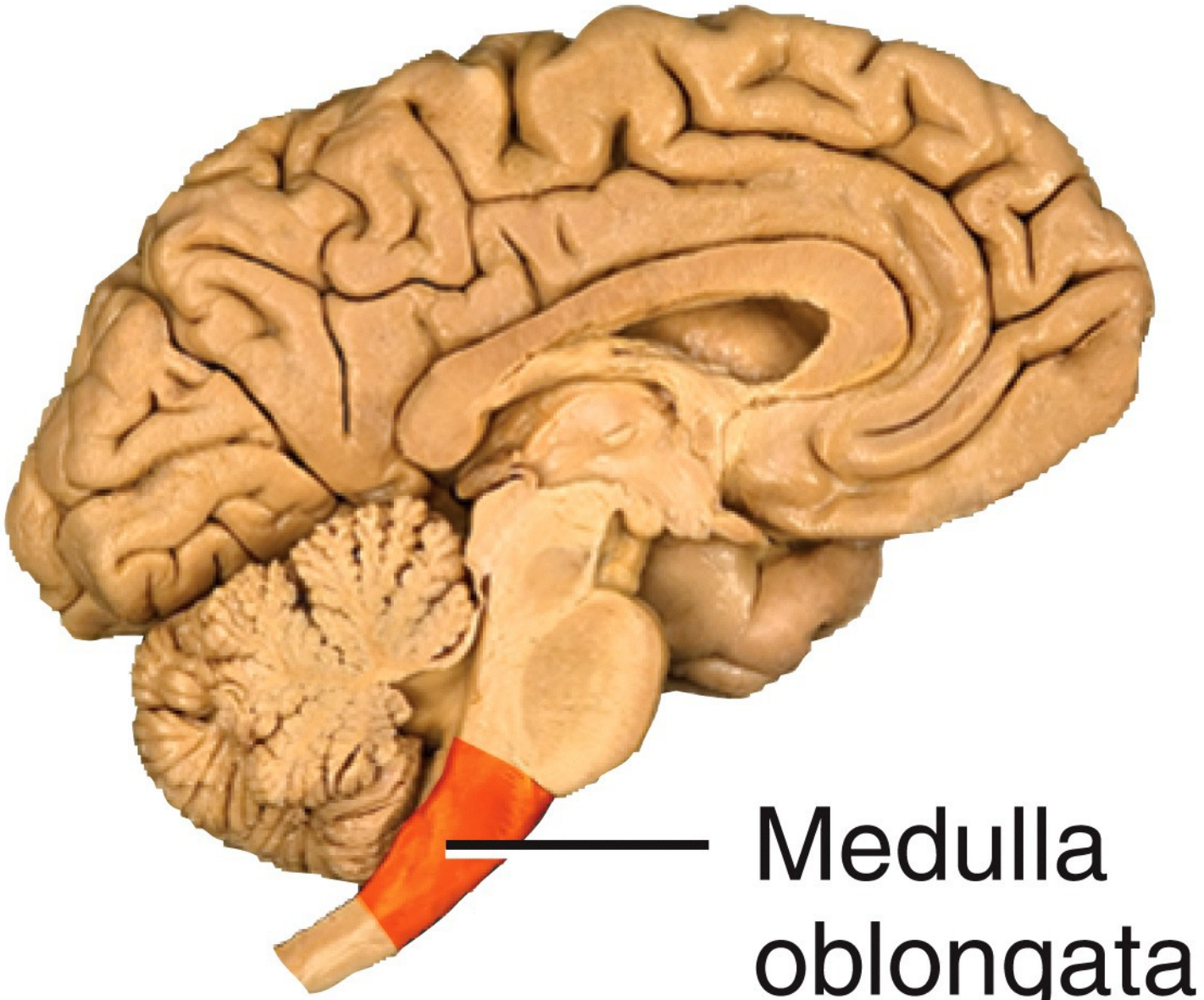
Three major components of the diencephalon



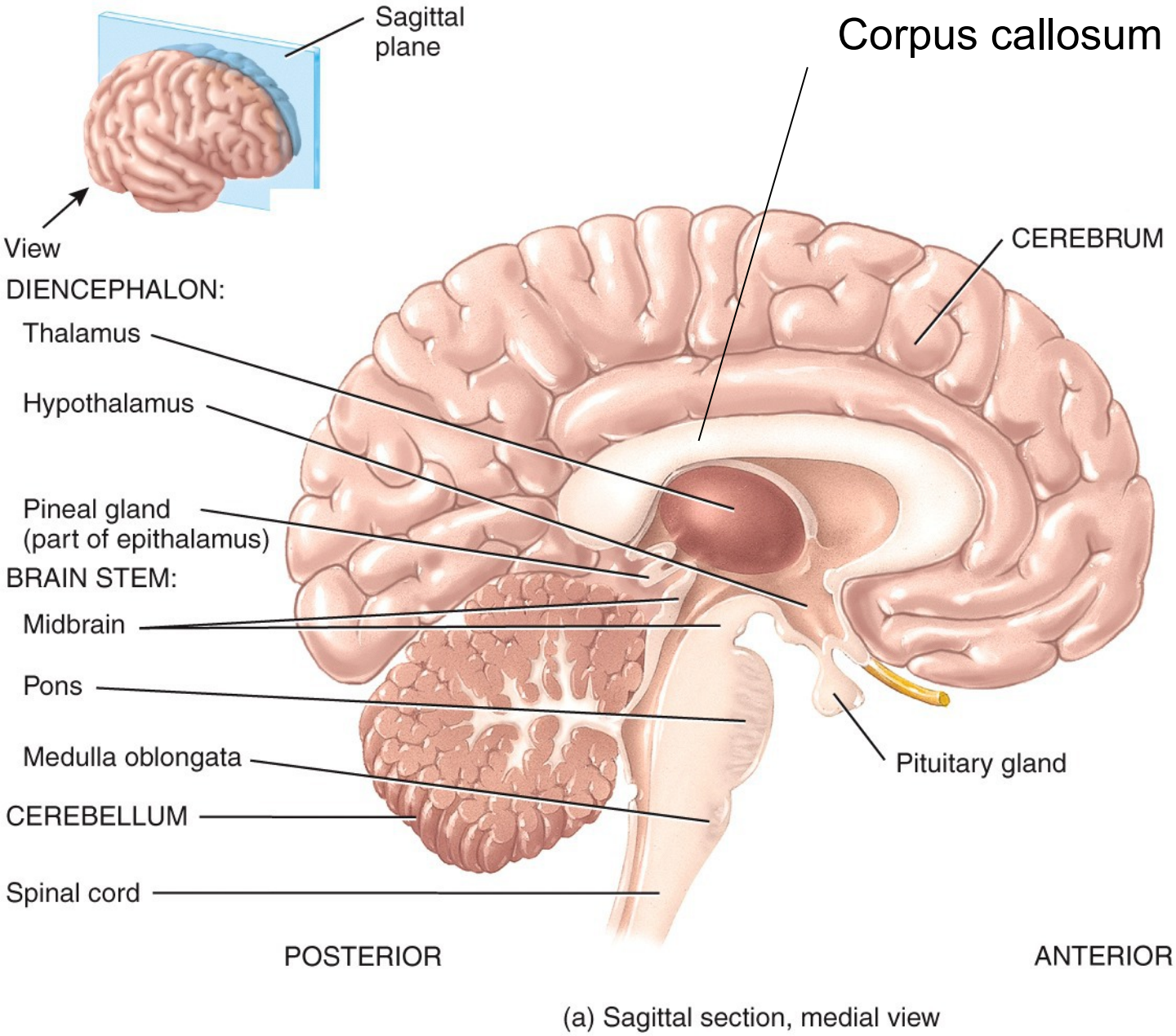
Dissection Shawn Miller, Photograph Mark Nielsen



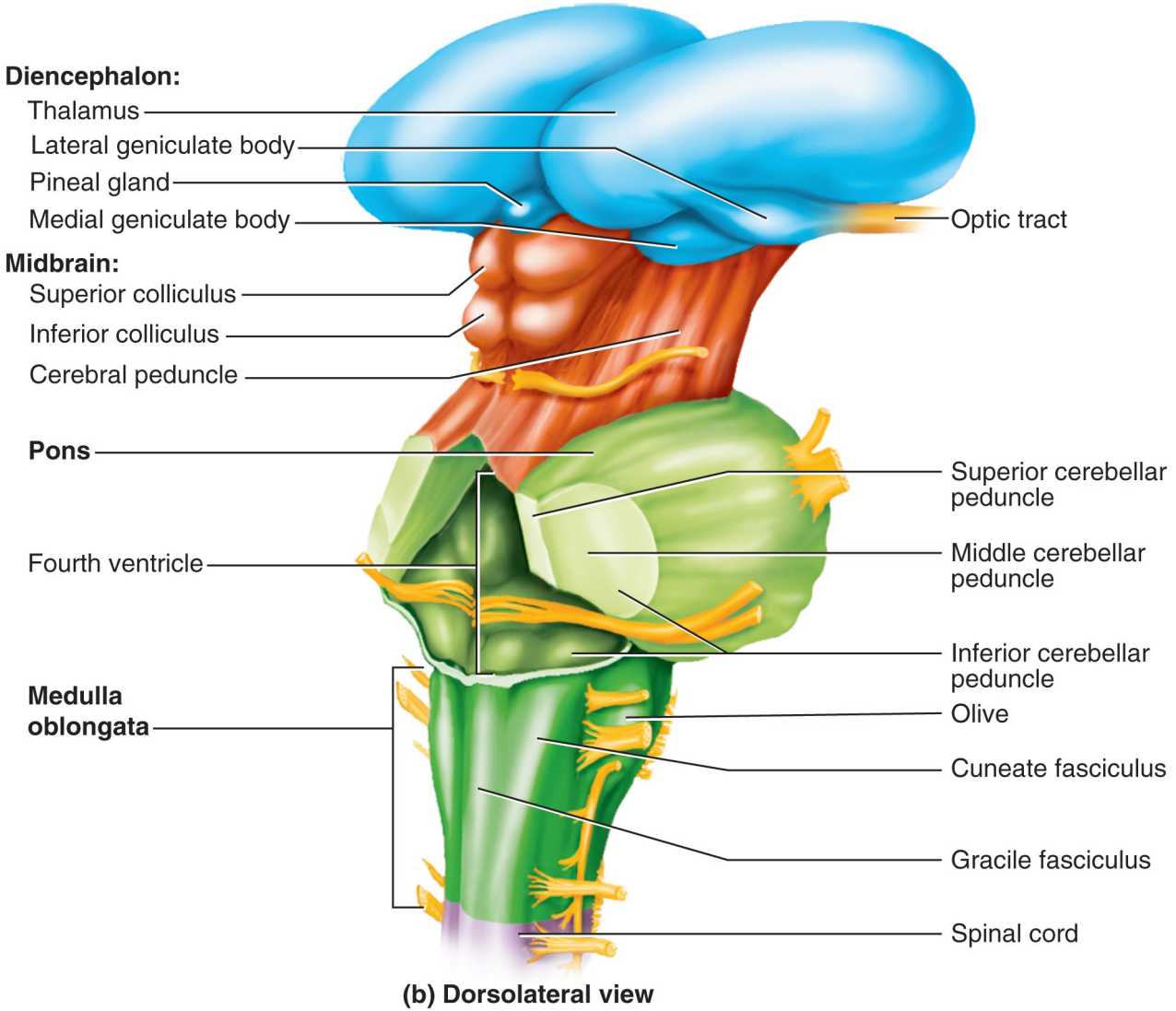
Dissection Shawn Miller, Photograph Mark Nielsen



Dissection Shawn Miller, Photograph Mark Nielsen

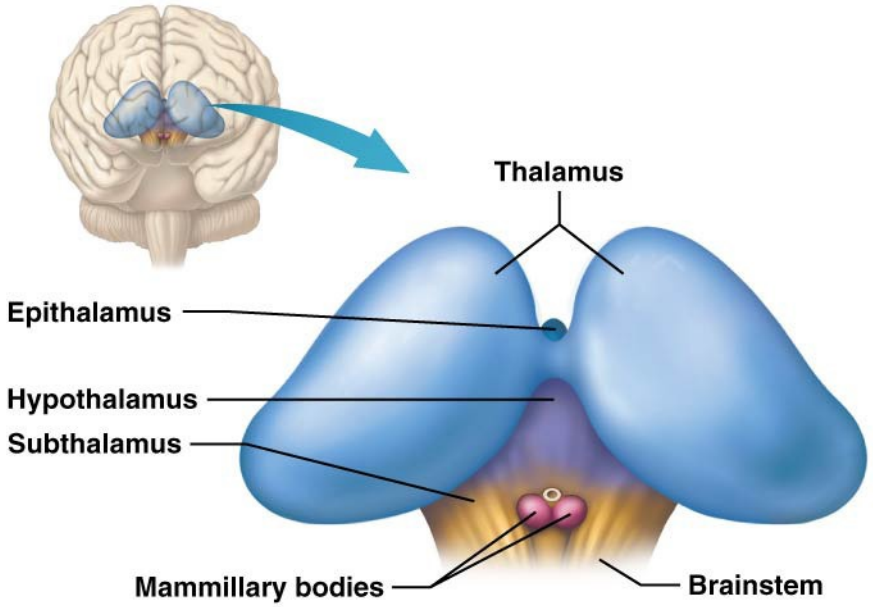


(a) Sagittal section, medial view

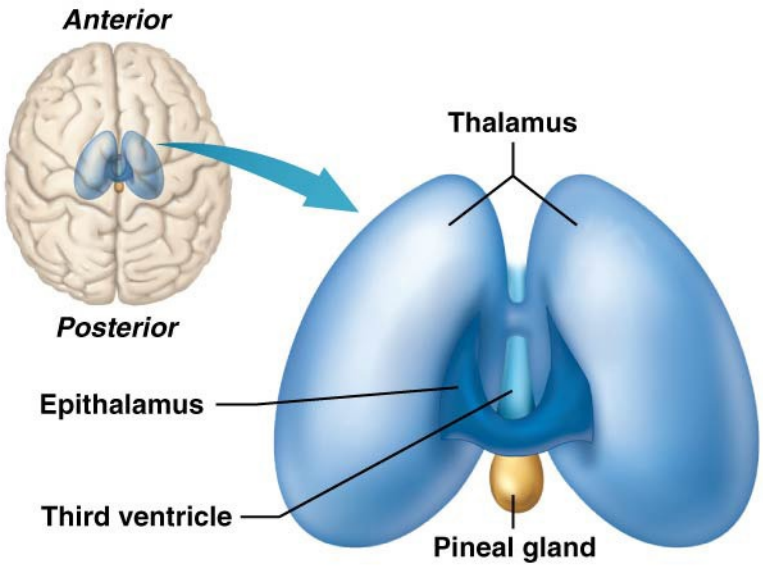


(b) Dorsolateral view

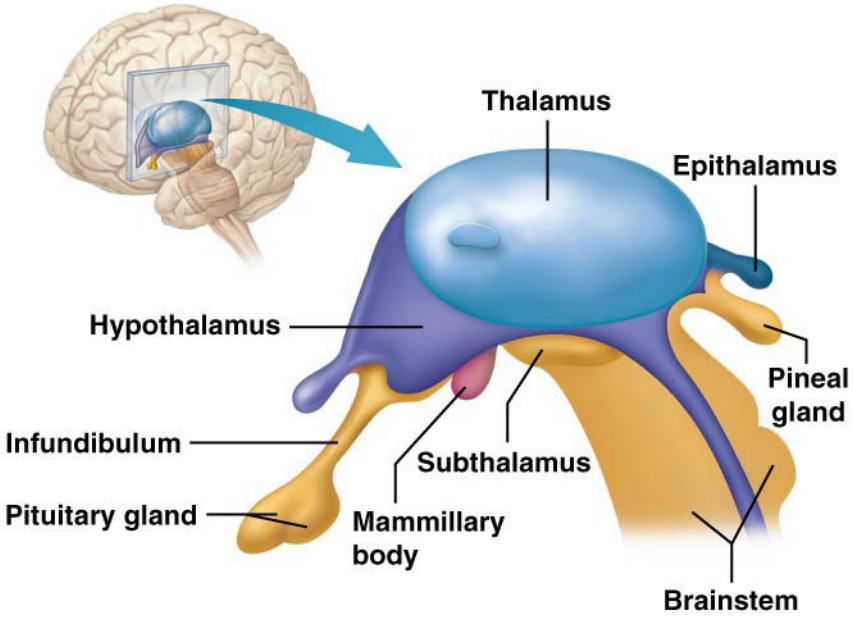
Note: Diencephalon also includes hypothalamus and epithalamus (pineal gland & habenula)



(a) Diencephalon, anterior view

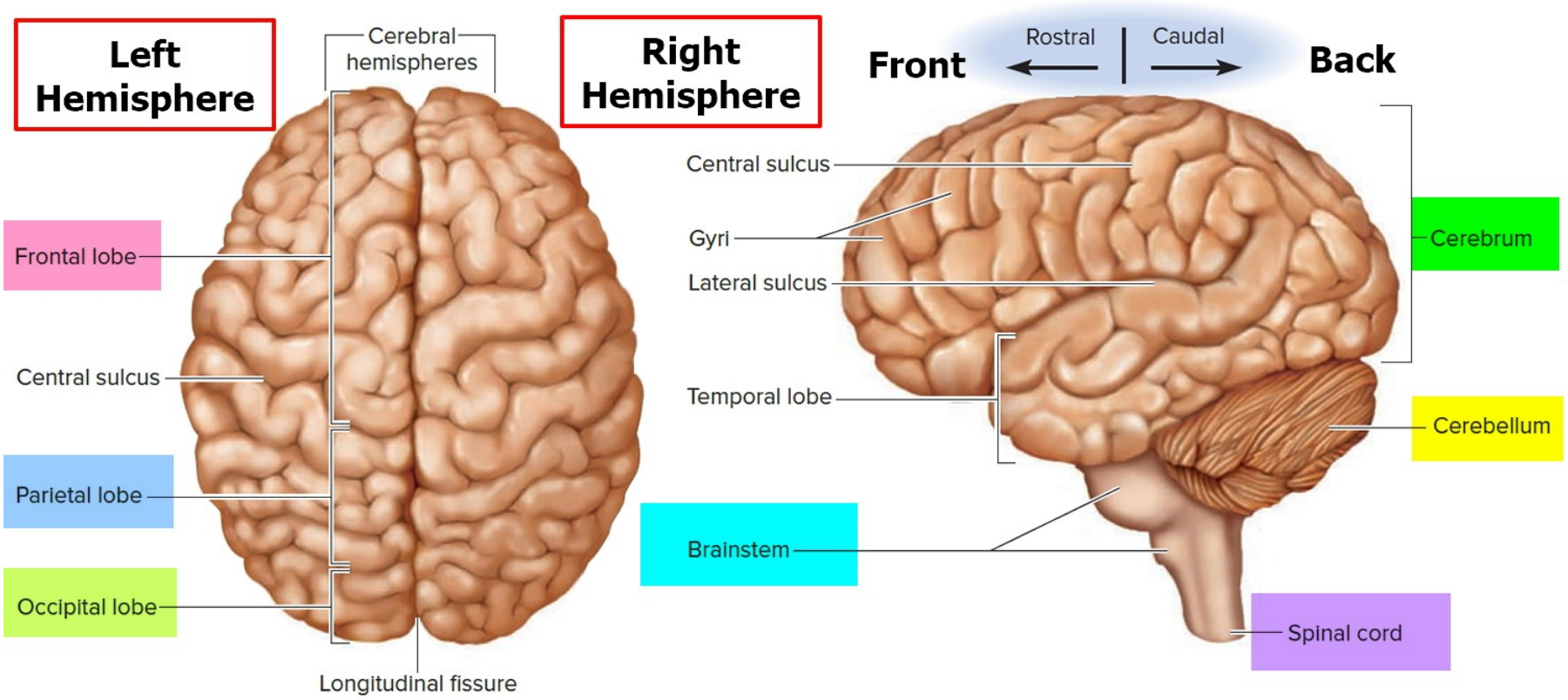


(b) Diencephalon, superior view



(c) Diencephalon, midsagittal section

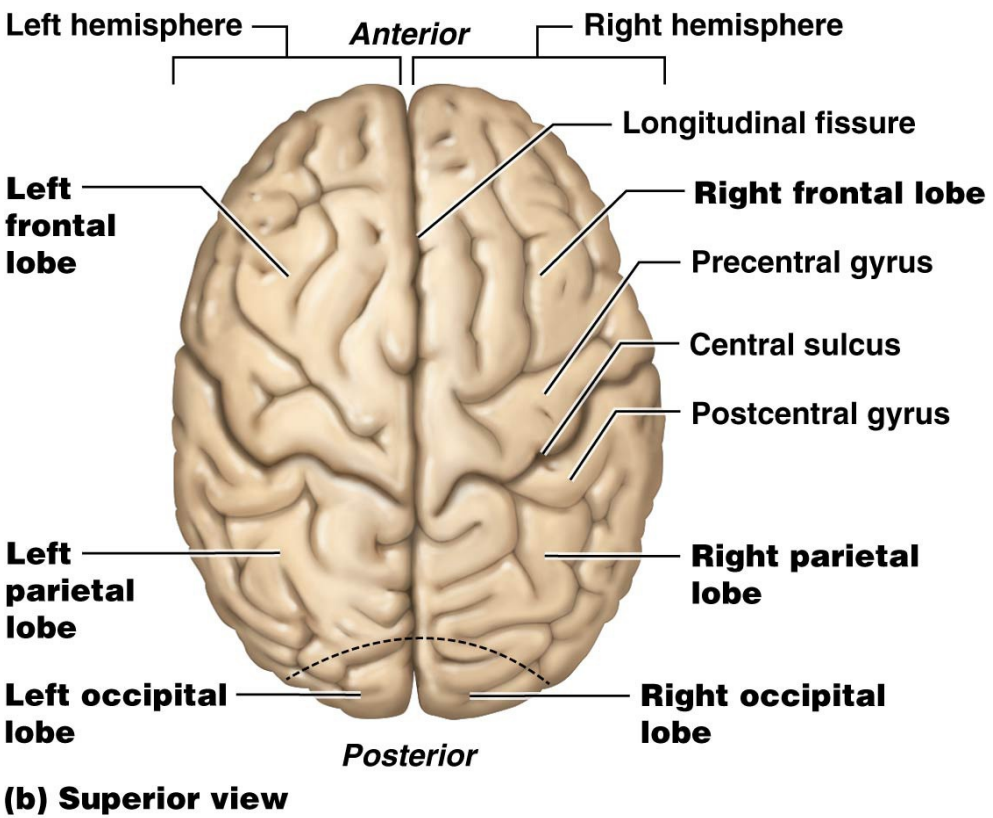
Cerebrum's Structures



adult human brain weighs // 1600 g (3.5 lb) in men and 1450 g in women

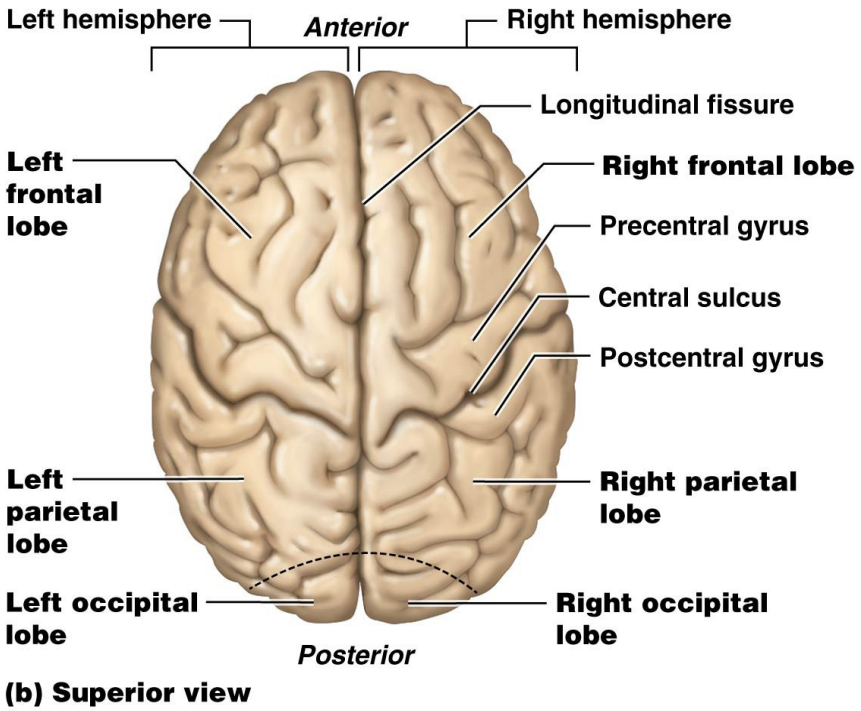
Cerebrum Structures

- **longitudinal fissure** – deep groove that separates cerebral hemispheres
- **central sulcus** – shallow groove // separates motor and sensory functions
- **gyri** - thick folds
- **sulci** - shallow grooves



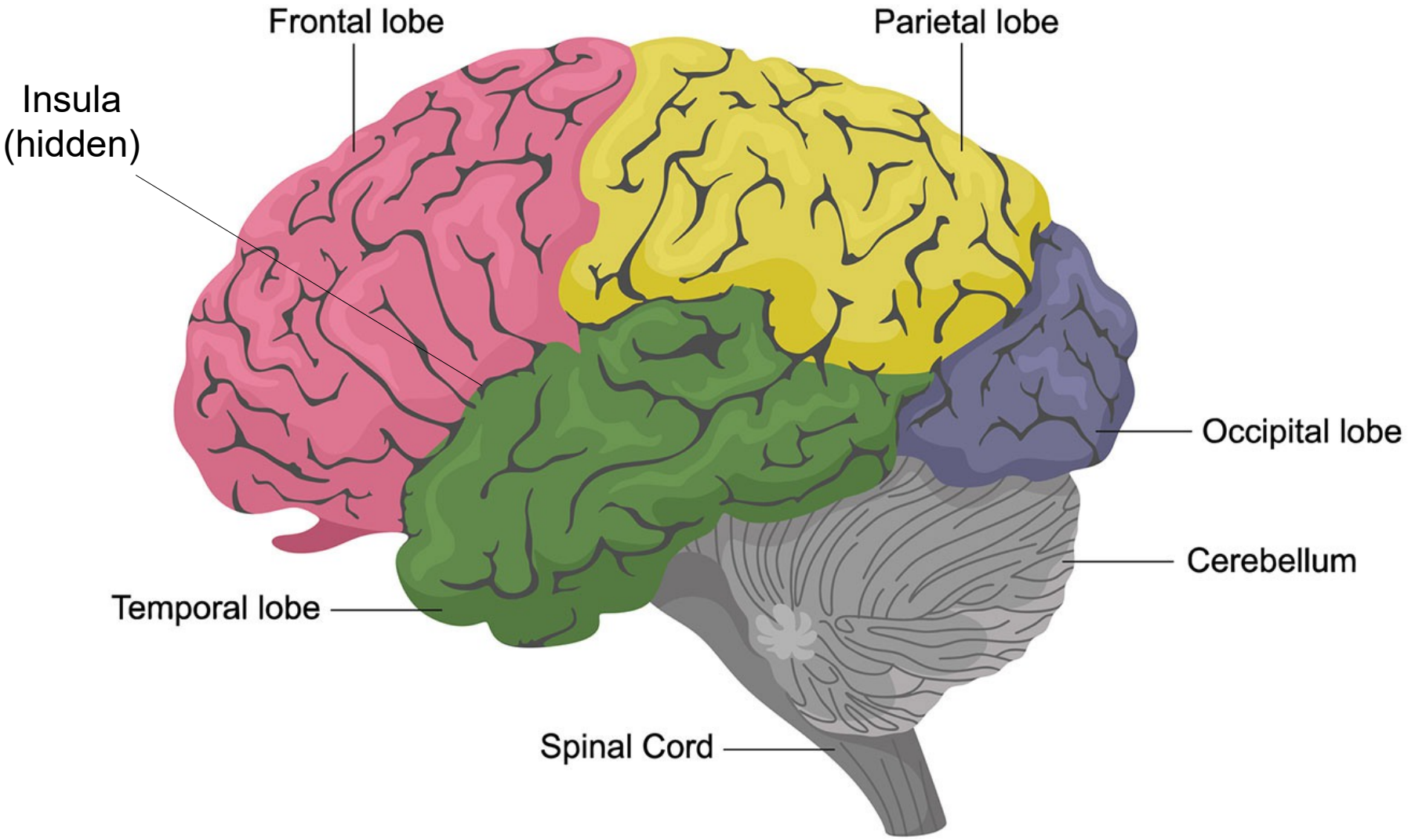
Gyrus singular (plural: gyri)
Sulcus singular (plural: sulci)

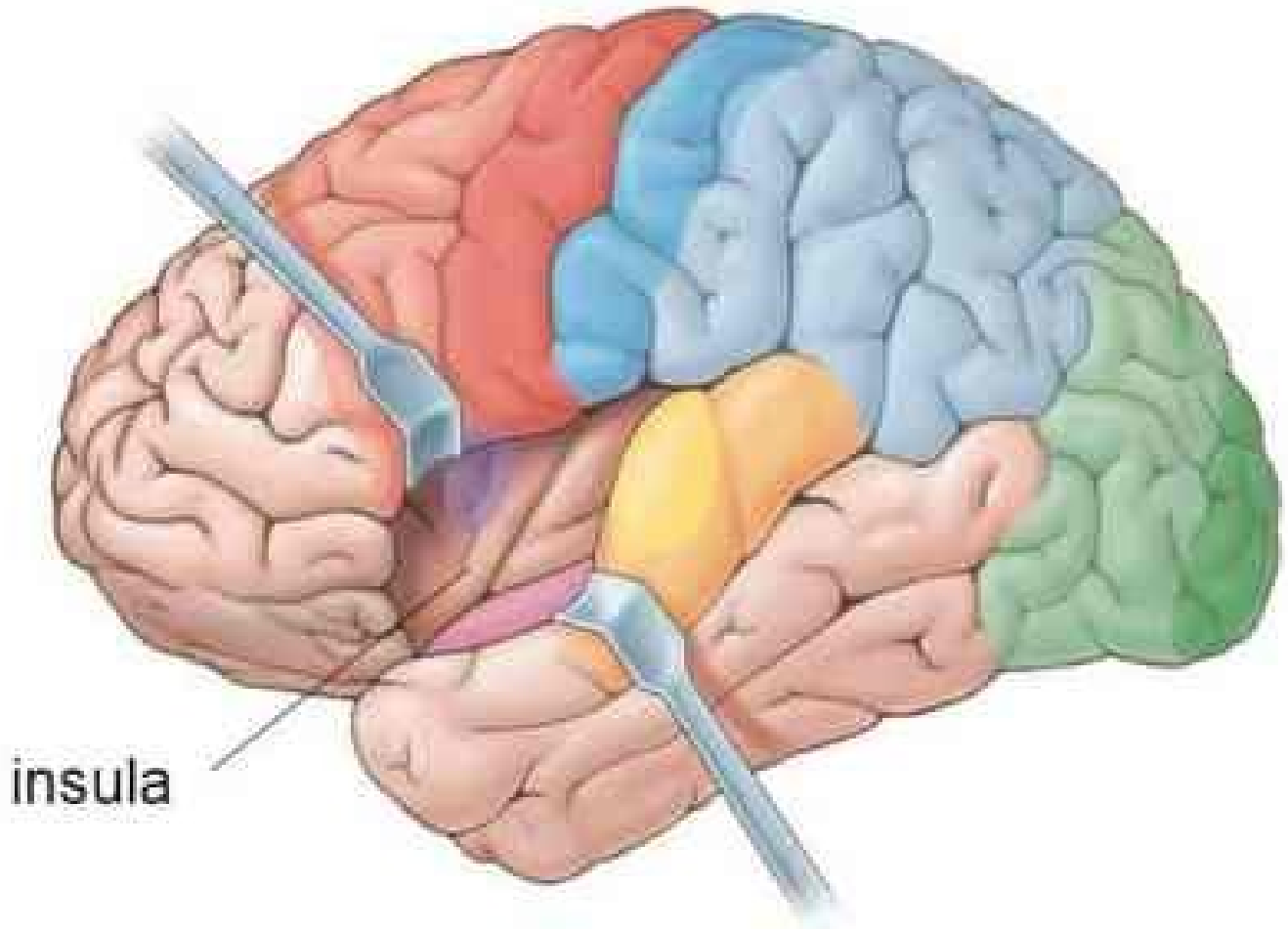
The Gross Anatomy of the Cerebrum



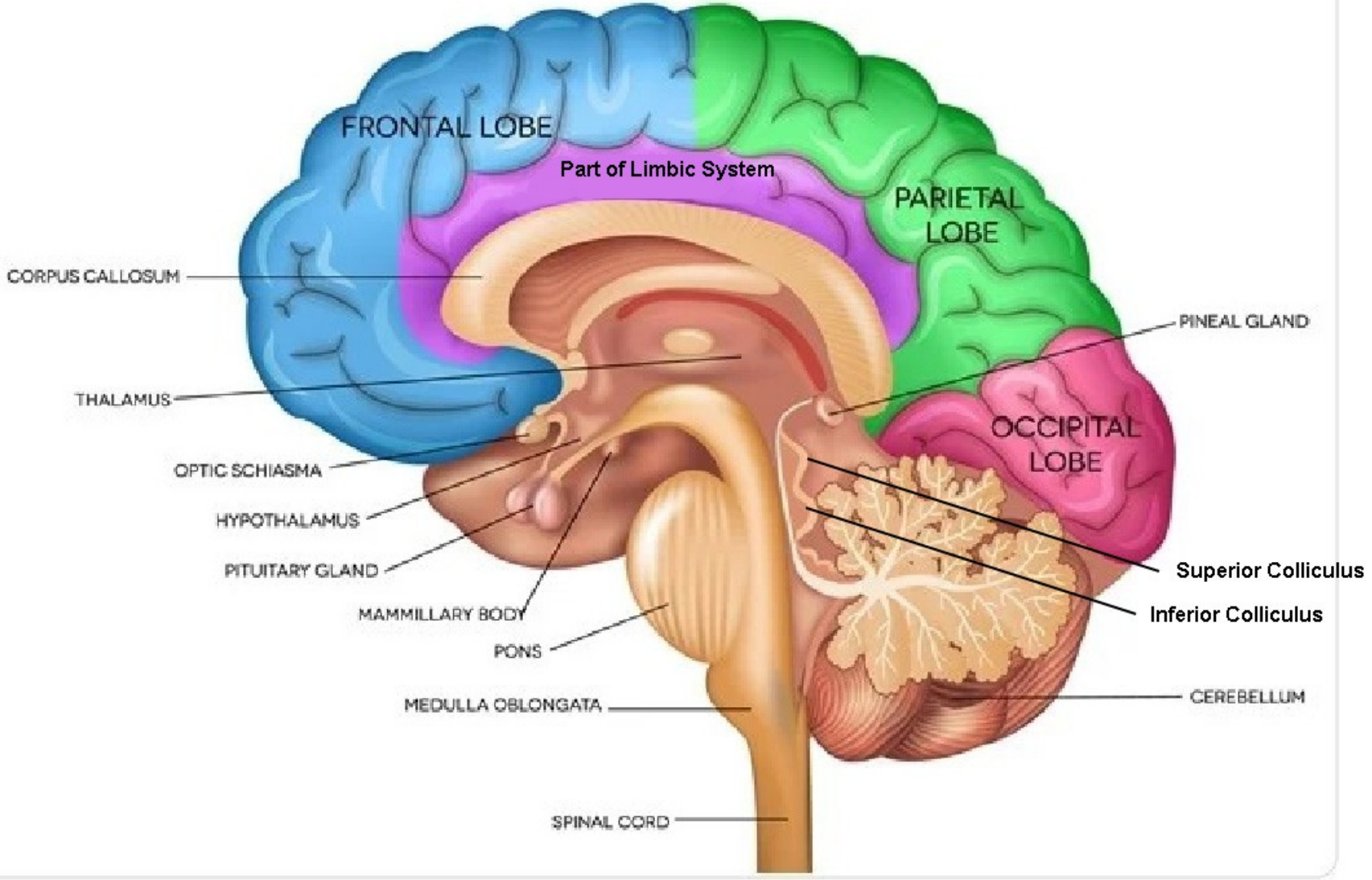
- Consist of two cerebral hemispheres // divided by longitudinal fissure
  - hemispheres connected by white fibrous tract the corpus callosum
  - gyri and sulci – increases amount of cortex in the cranial cavity
  - gyri increases surface area for information processing capability
  - sulci divide each hemisphere into five lobes named for the cranial bones that overlie them
  - cerebral cortex = tissue directly beneath pia matter / 4 mm
  - each hemisphere if flattened would be the size of a 13” pizza

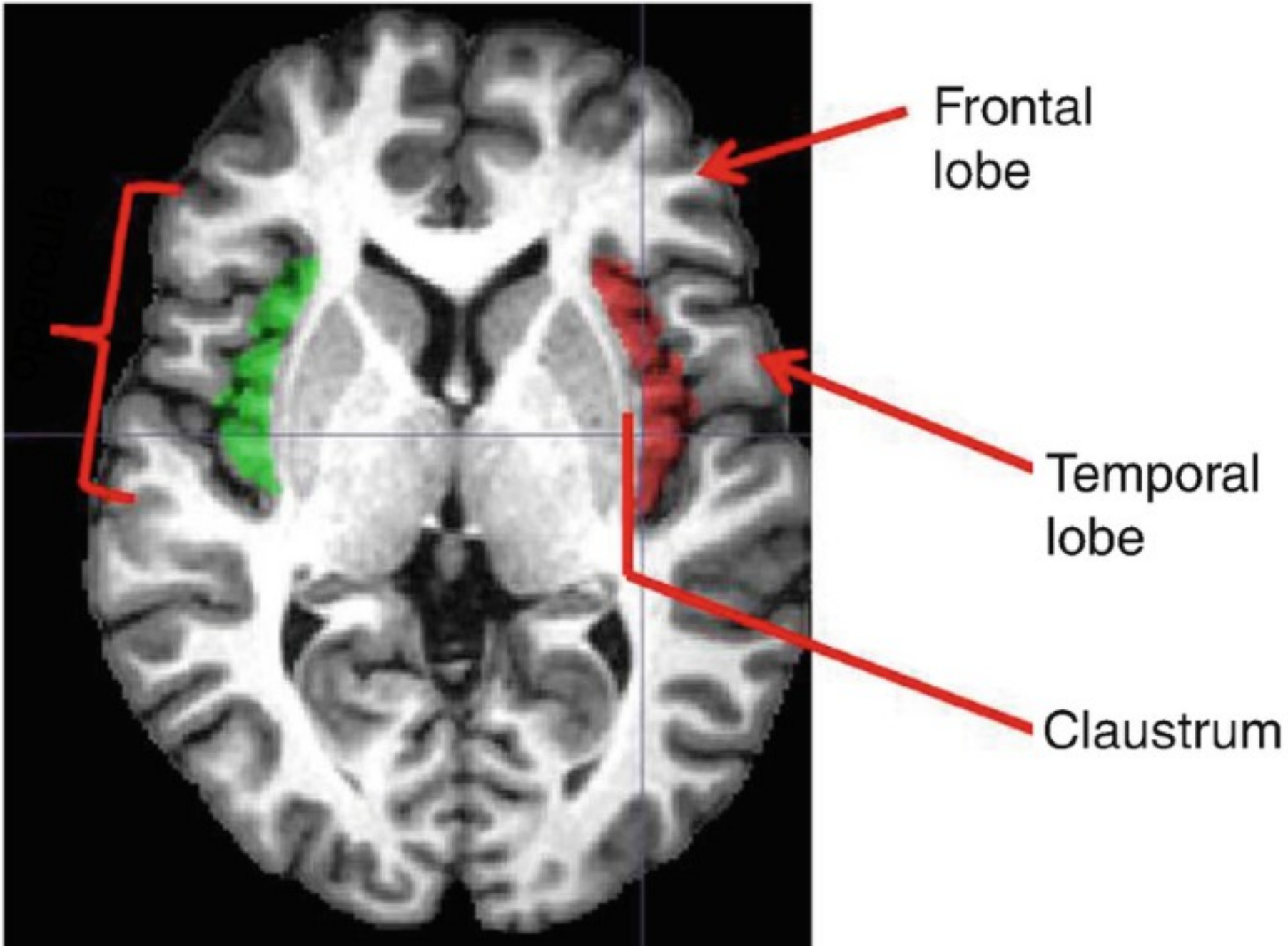
Cerebrum (Five Lobes)

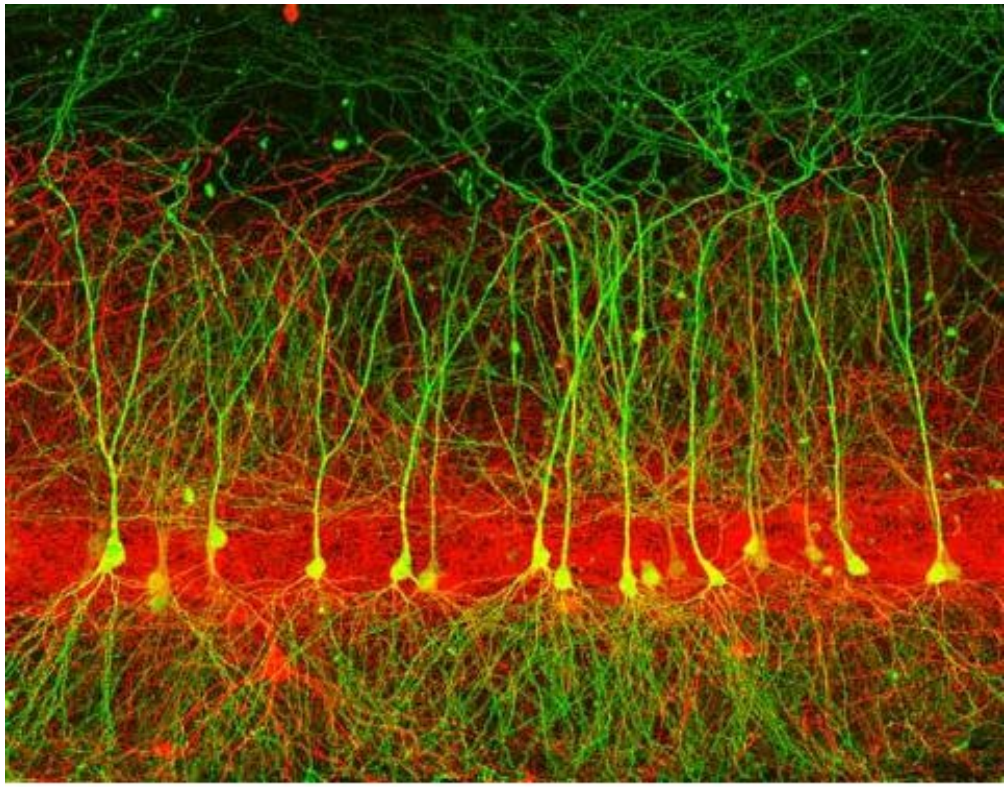



insula

ANATOMY OF THE BRAIN




Frontal lobe
Temporal lobe
Claustrum

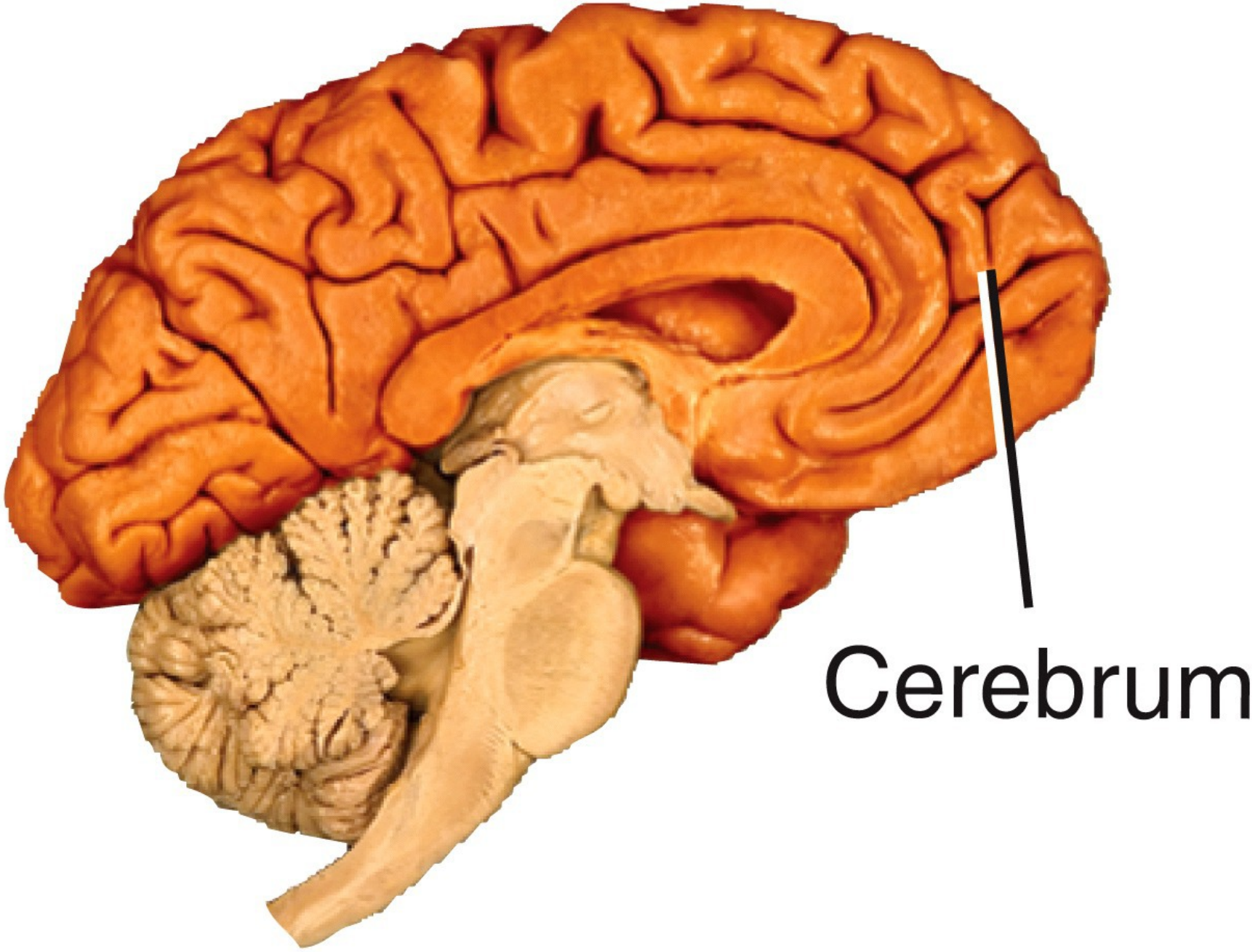


hhmi - www.BioInteractive.com

The key to understanding how our brains work lies in determining how each nerve cell or neuron continuously integrates the information it receives from other neurons via connections called synapses. For example, each pyramidal neuron (colored green) can receive tens of thousands of synapses from neurons belonging to several different brain regions. Interneurons (colored red) form local connections onto pyramidal neurons to form specific microcircuits. By using a combination of approaches including electrophysiology, microscopy, molecular biology and computer modeling, scientists are able to approach the complex puzzle of understanding how the 100 billion neurons in our brains make us who we are.

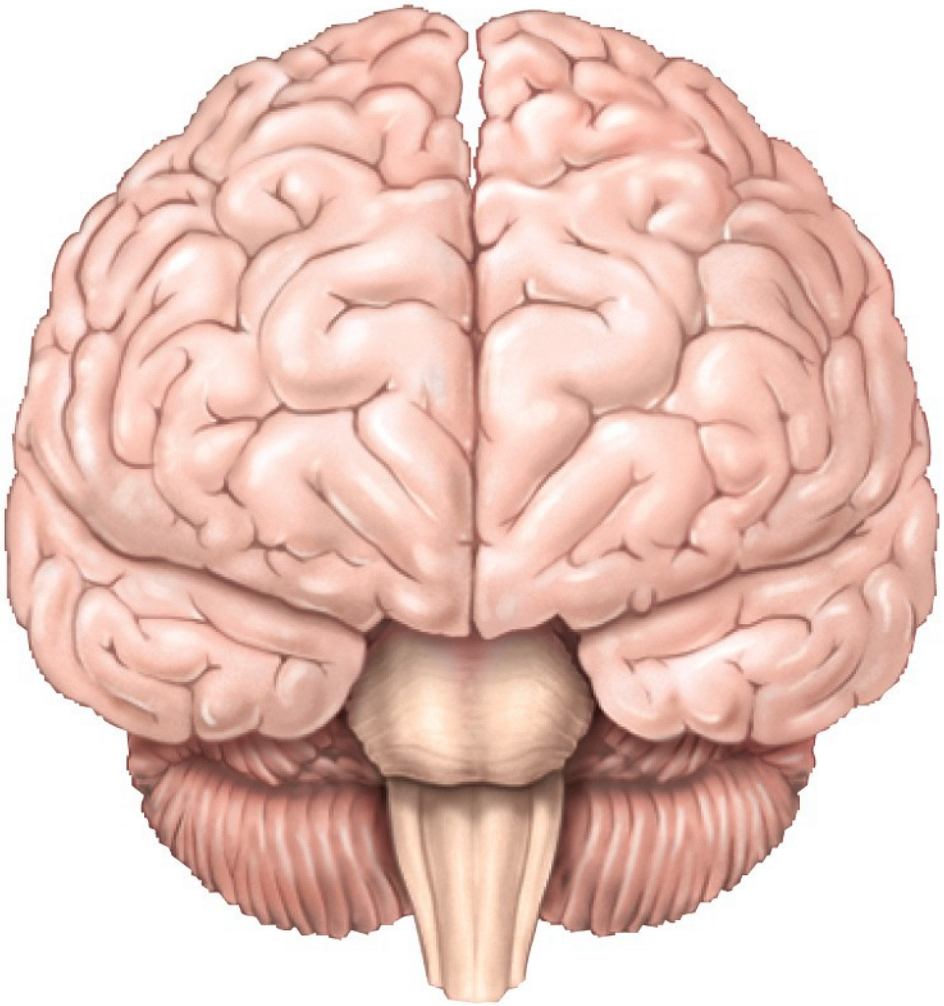
Technical Details:
The image was produced using array tomography. This technique involves collecting thousands of ultrathin serial sections of brain tissue that was fixed and stained, imaging them with a fluorescent microscope, and aligning all of them into a 3D reconstruction using a computer. The resulting image enables the detailed patterns of connectivity to be mapped between fluorescently-labeled neurons.

Credit:
Erik Bloss, PhD and Nelson Spruston, PhD., HHMI, Janelia Research Campus

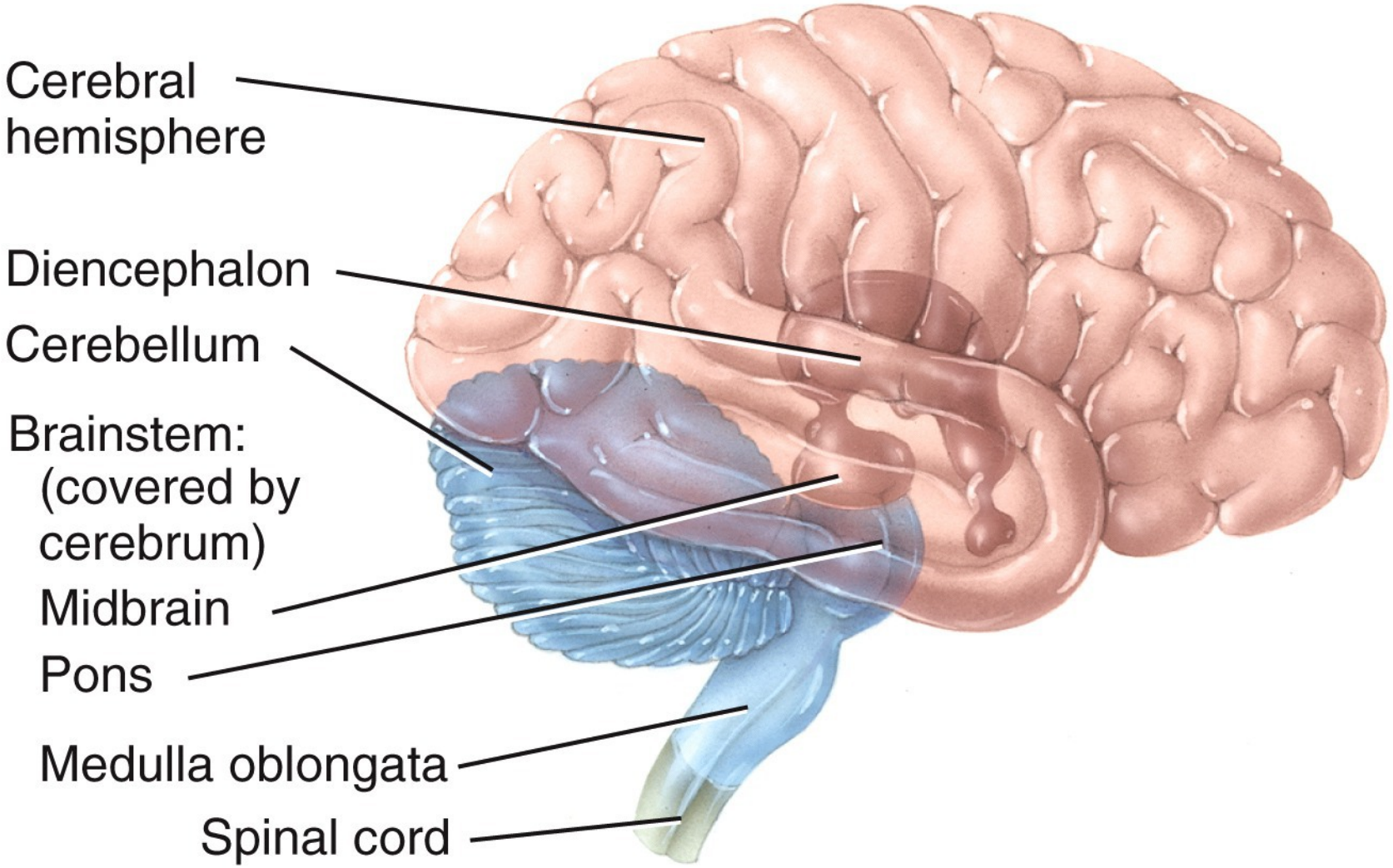


Dissection Shawn Miller, Photograph Mark Nielsen

Right hemisphere Left hemisphere

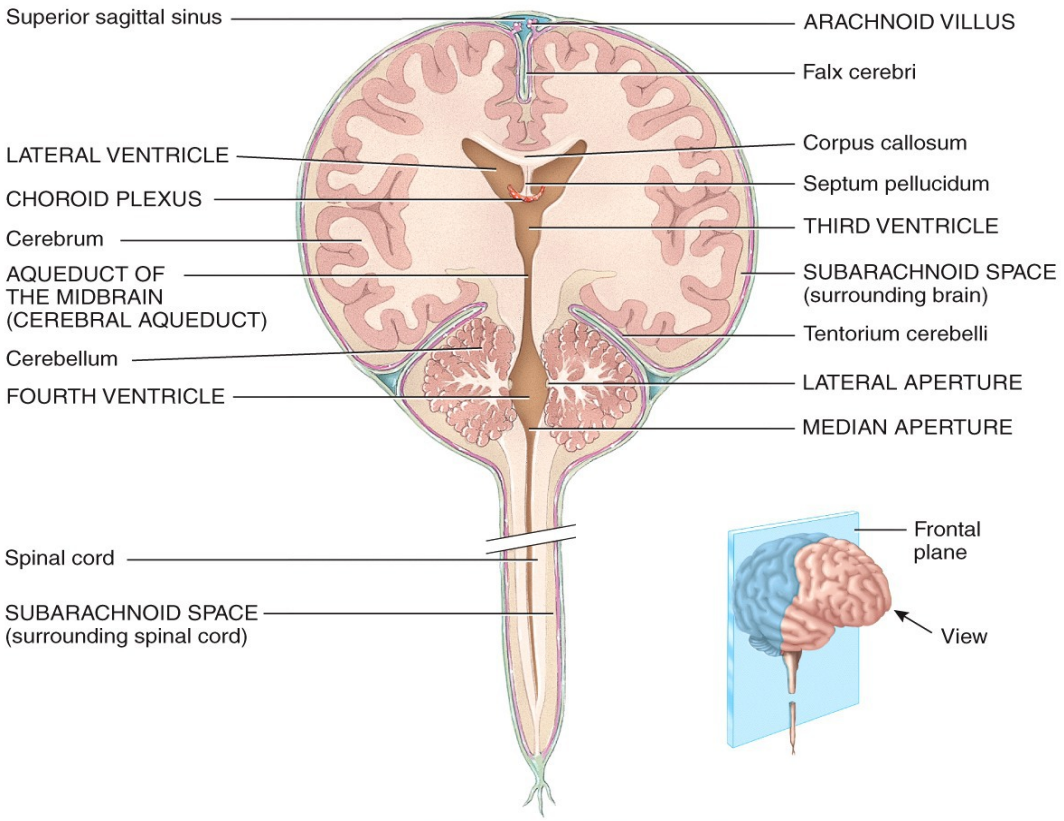


Anterior view


Cerebral hemisphere
Diencephalon
Cerebellum
Brainstem: (covered by cerebrum)
Midbrain
Pons
Medulla oblongata
Spinal cord

Gray and White Matter

- **gray matter** – consists of the neuron's cell bodies, dendrites, and synaptic knobs
  - dull grey-white color when fresh
  - due to little myelin on the surface of the cell bodies, dendrites and synaptic knobs
  - grey matter forms surface layer of cerebrum - **"the cortex" is about 4mm thick**
  - **cerebral cortex** covers the entire superficial surface of the cerebrum (similar cortex associated with cerebellum)
  - clusters of soma also form **nuclei** deep within brain (i.e. grey islands // control specific function like heart rate, sneezing, etc.)

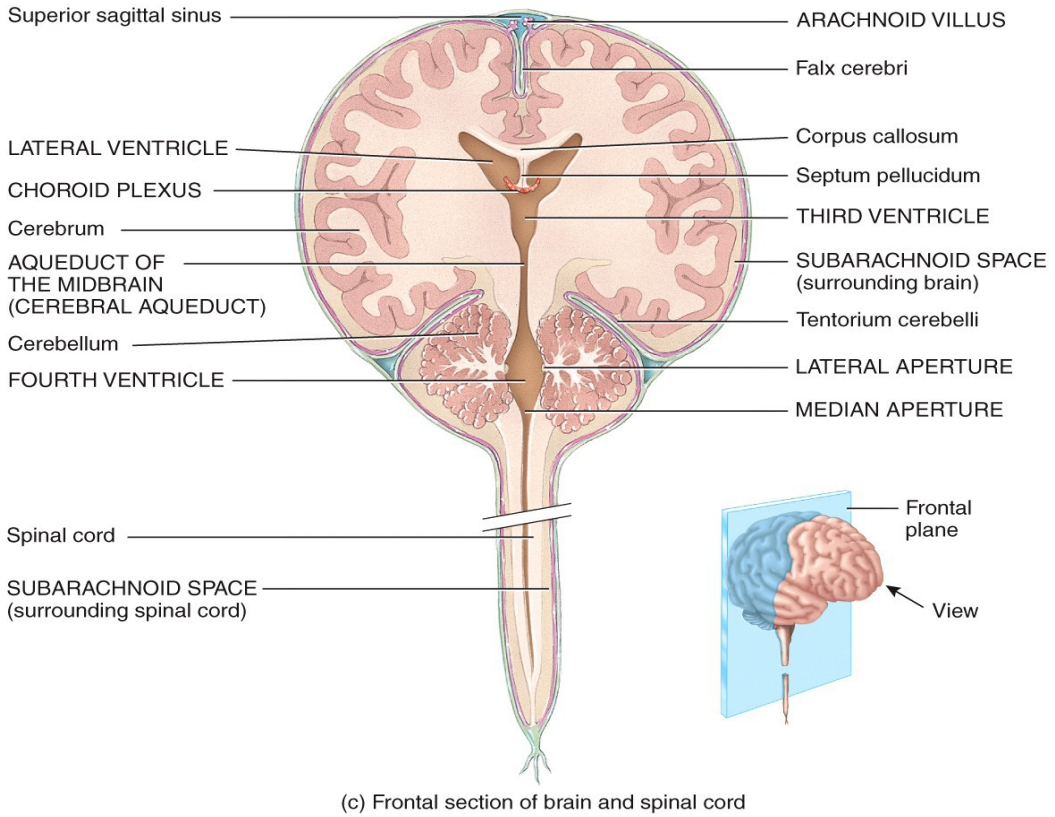


(c) Frontal section of brain and spinal cord

Gray and White Matter

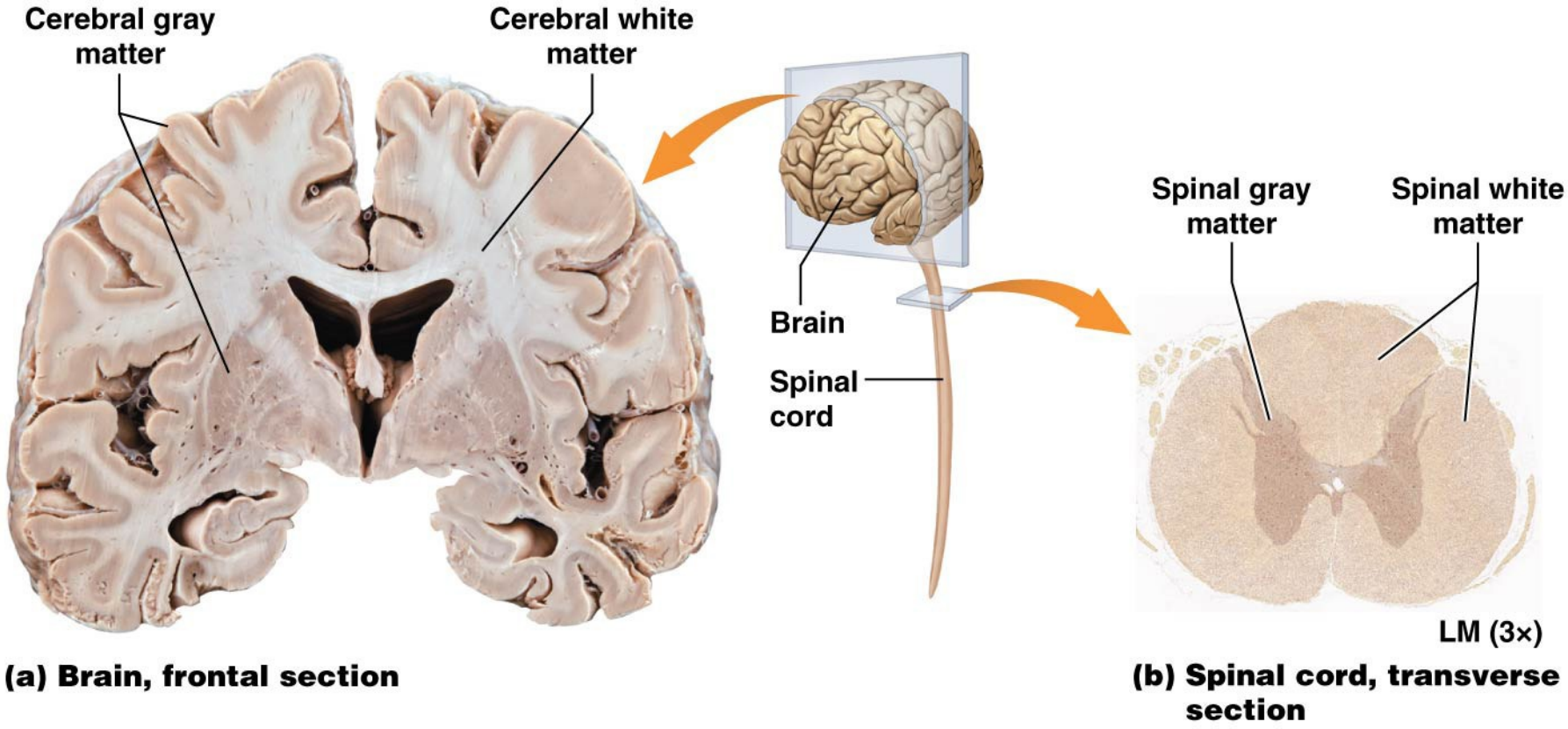
White matter = bundles of myalinated axons

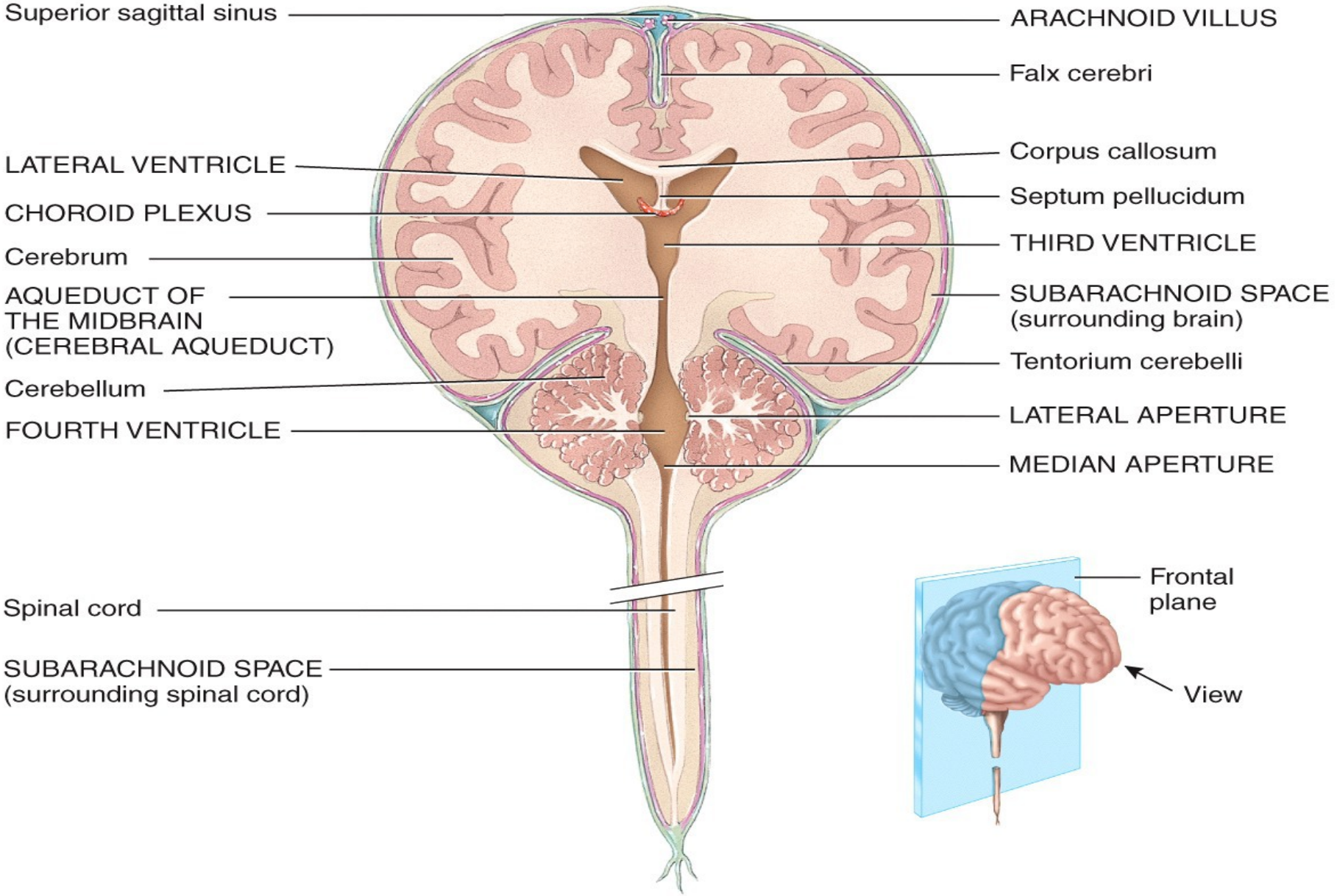
- lies deep to cortical gray matter, opposite relationship in the spinal cord
- pearly white color from myelin around nerve fibers
- this myelin arranged as tracts = bundles of axons
- within cerebrum connect one part of the brain to another, and to the spinal cord



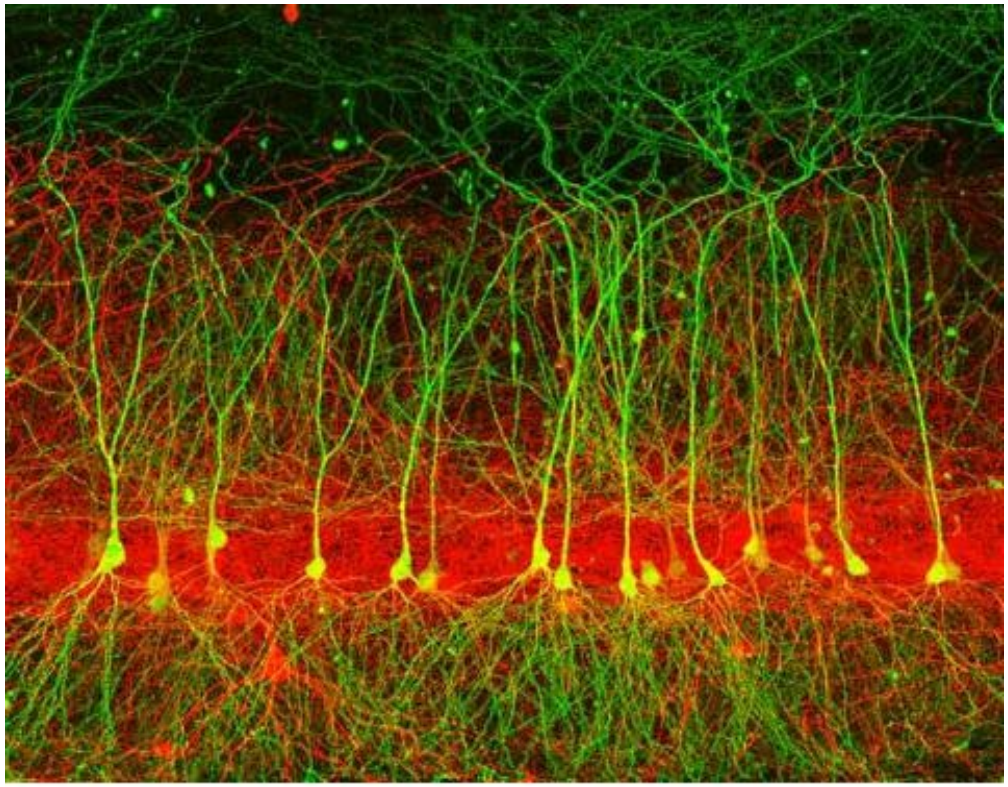
(c) Frontal section of brain and spinal cord

How white and gray matter in the CNS is organized in the brain and spinal cord.





(c) Frontal section of brain and spinal cord



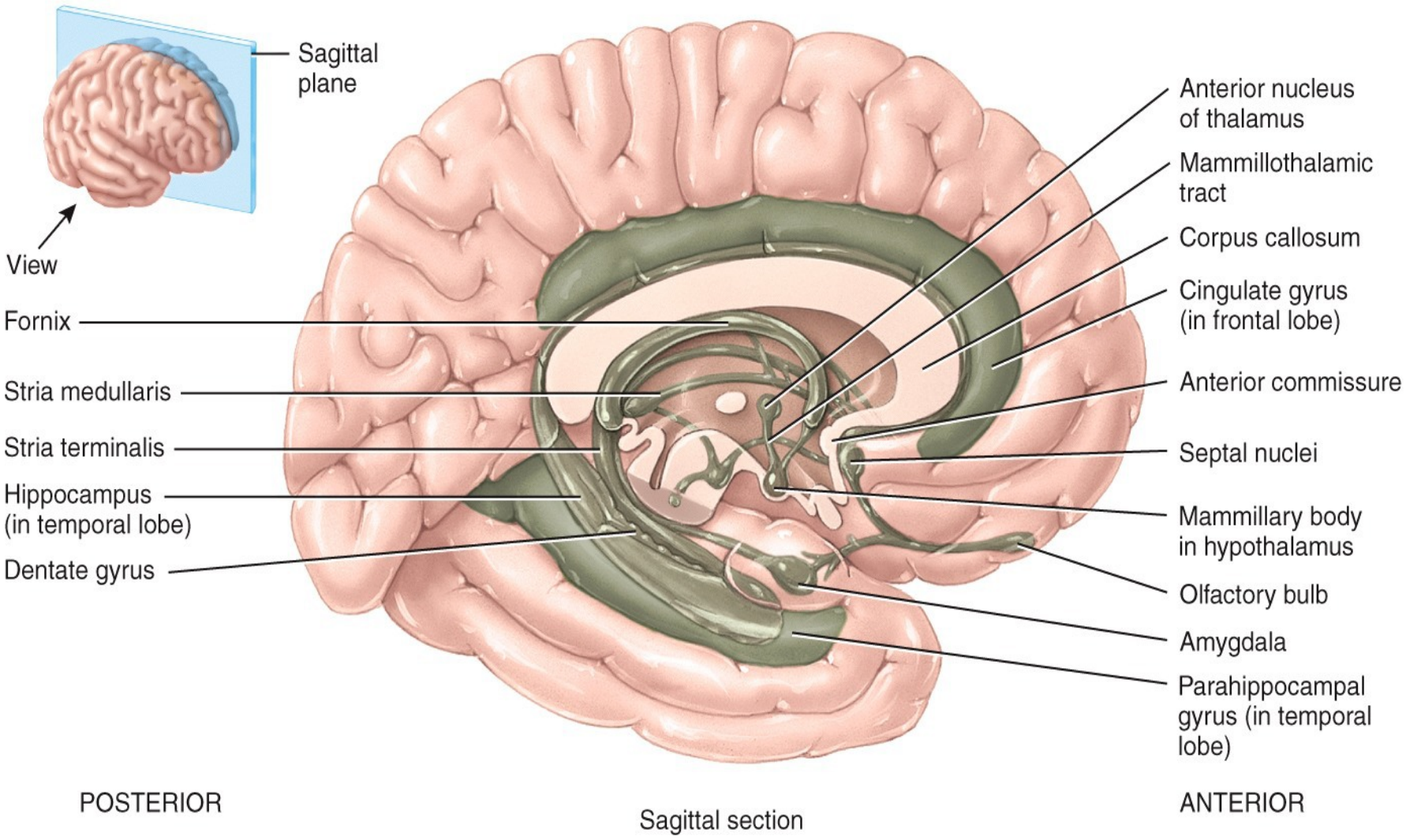
hhmi - www.BioInteractive.com

The key to understanding how our brains work lies in determining how each nerve cell or neuron continuously integrates the information it receives from other neurons via connections called synapses. For example, each pyramidal neuron (colored green) can receive tens of thousands of synapses from neurons belonging to several different brain regions. Interneurons (colored red) form local connections onto pyramidal neurons to form specific microcircuits. By using a combination of approaches including electrophysiology, microscopy, molecular biology and computer modeling, scientists are able to approach the complex puzzle of understanding how the 100 billion neurons in our brains make us who we are.

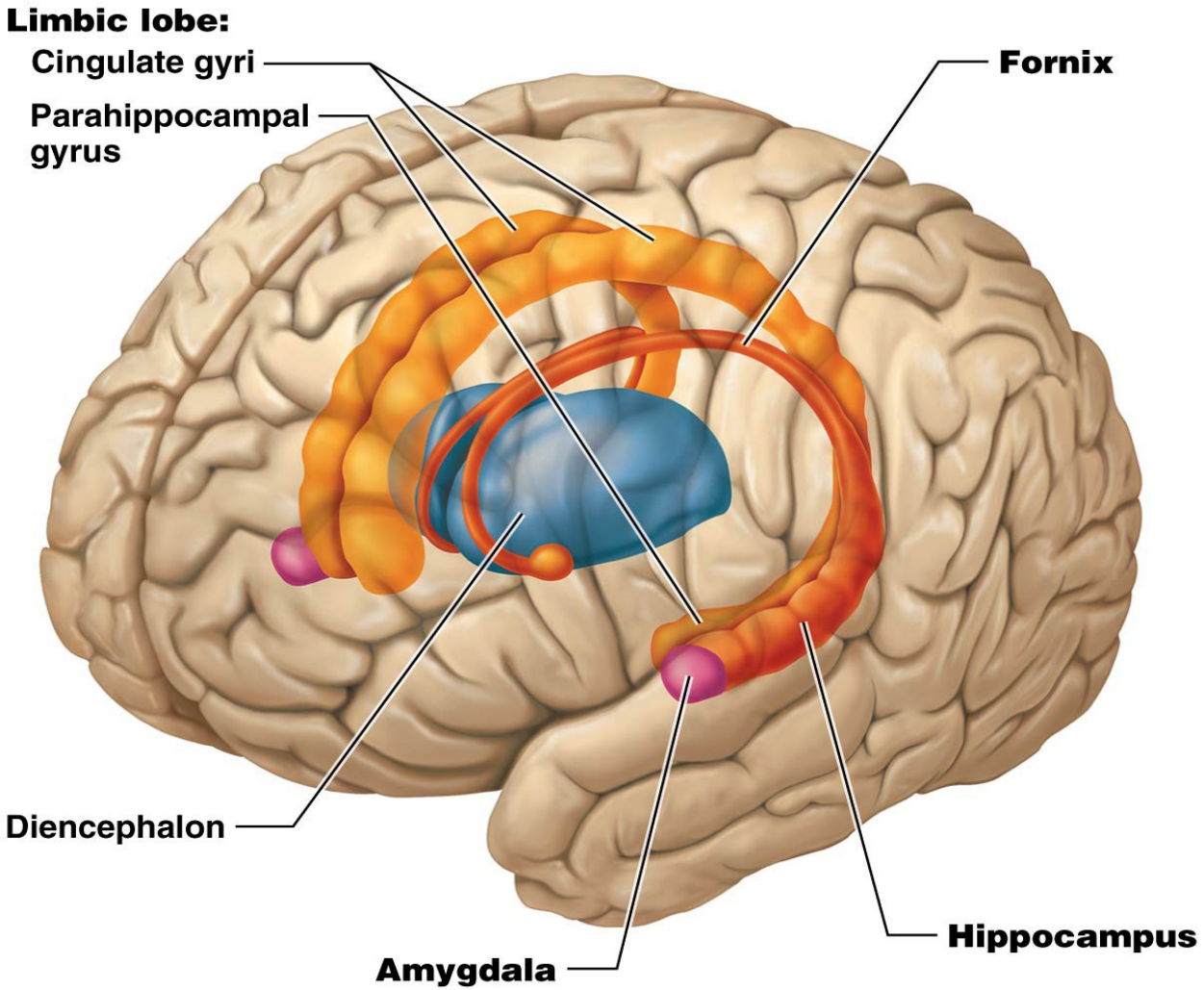
Technical Details:
The image was produced using array tomography. This technique involves collecting thousands of ultrathin serial sections of brain tissue that was fixed and stained, imaging them with a fluorescent microscope, and aligning all of them into a 3D reconstruction using a computer. The resulting image enables the detailed patterns of connectivity to be mapped between fluorescently-labeled neurons.

Credit:
Erik Bloss, PhD and Nelson Spruston, PhD., HHMI, Janelia Research Campus

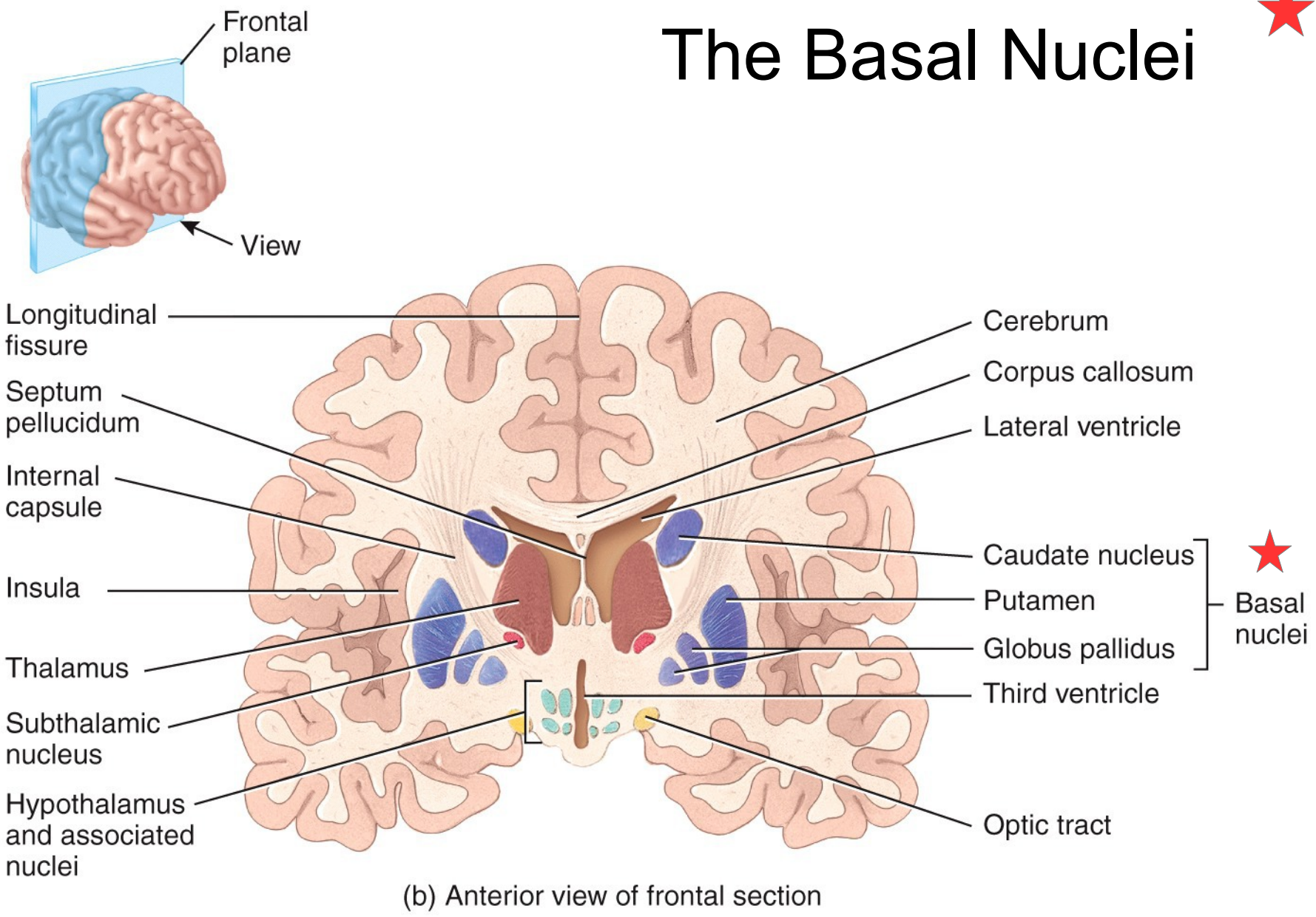
The Limbic System



Limbic System Structues (incomplete)

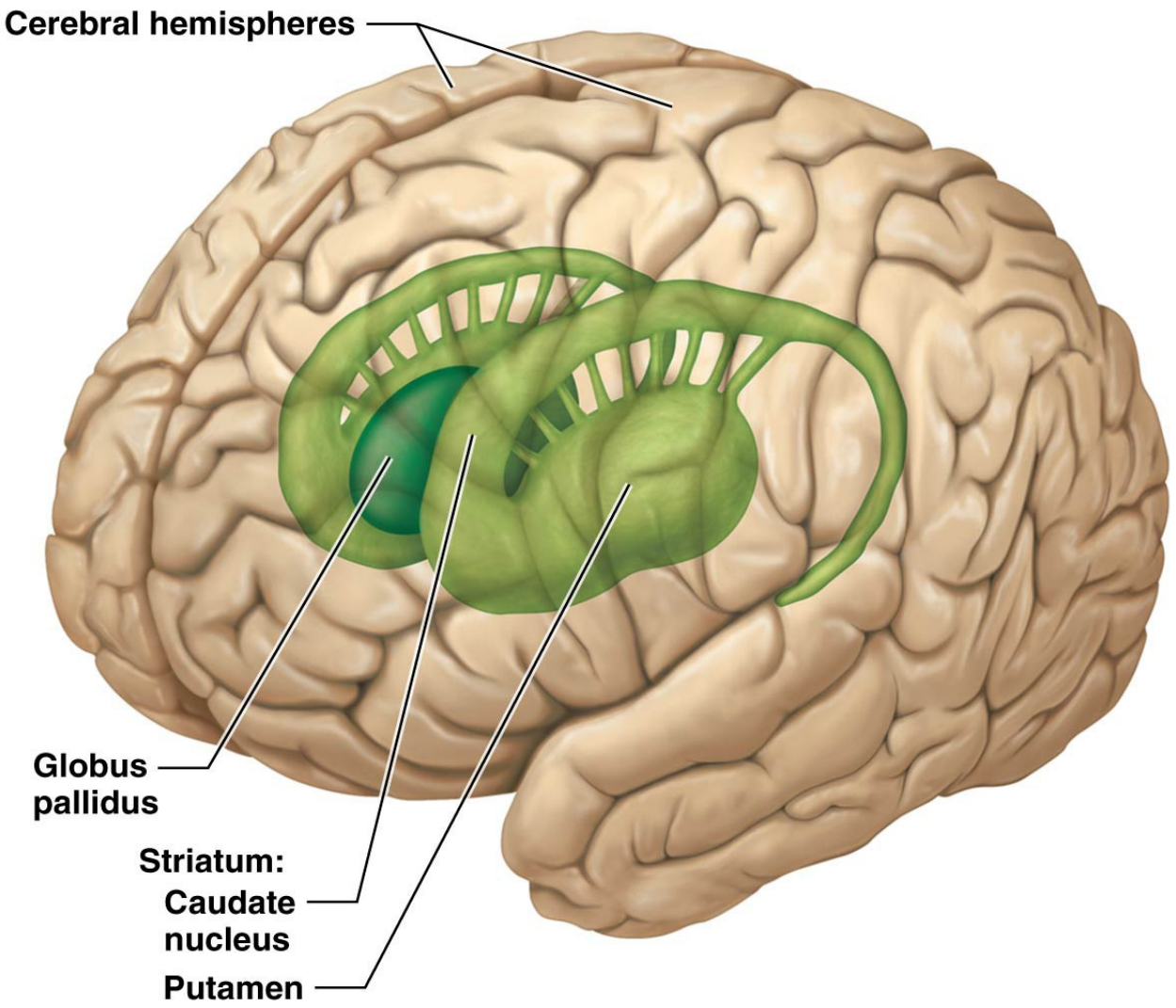


The Basal Nuclei

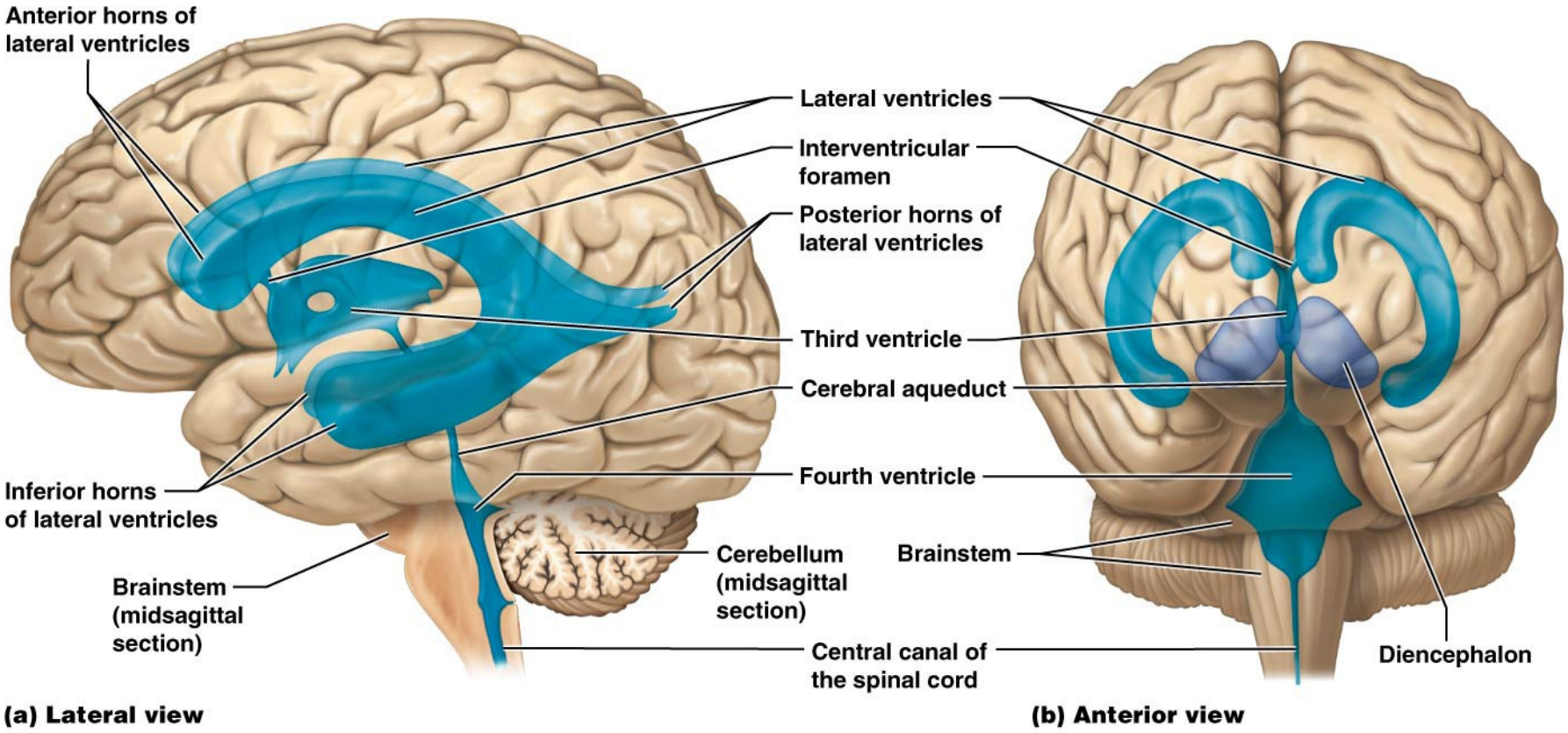


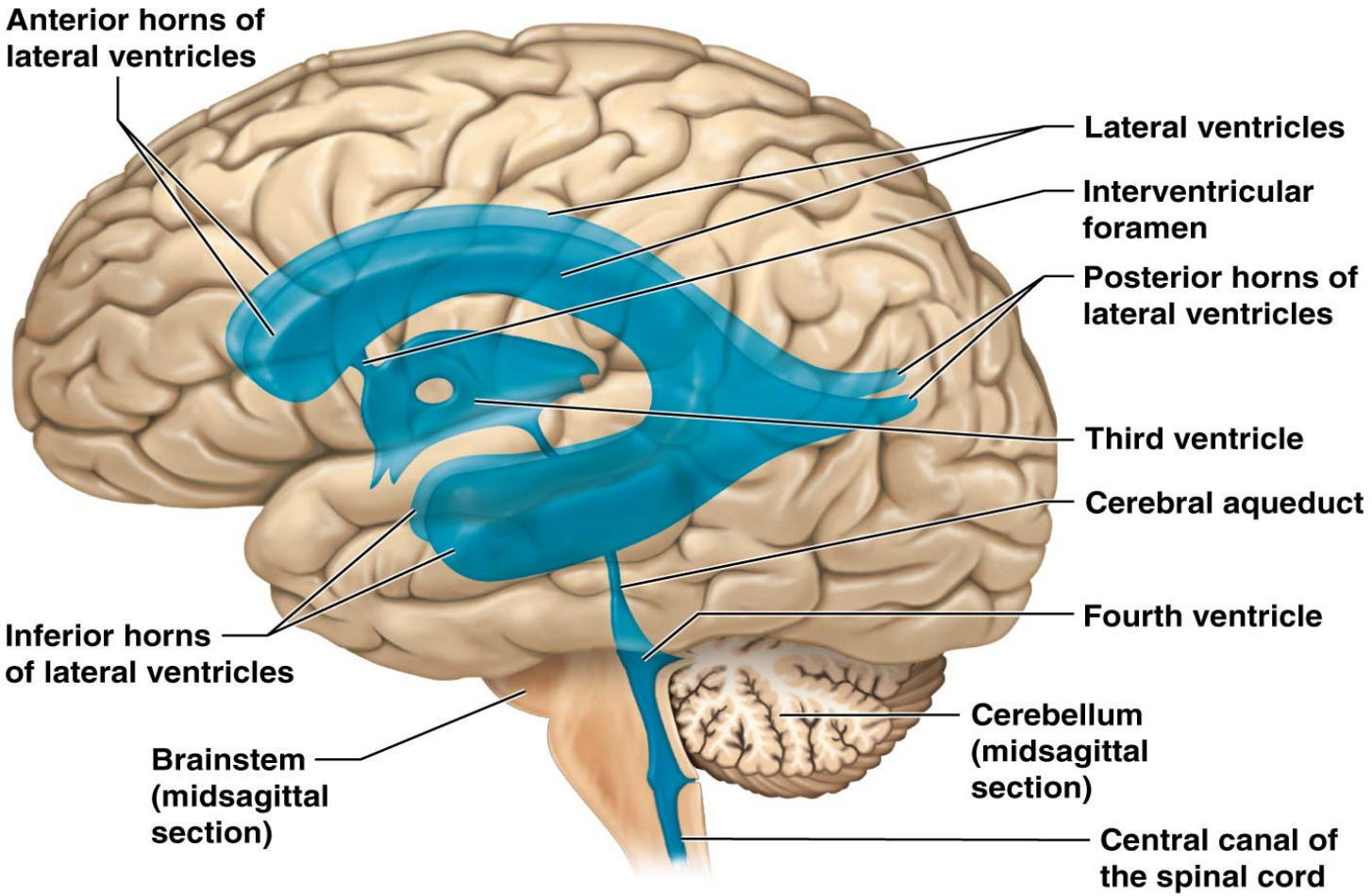
(b) Anterior view of frontal section

Structure of the basal nuclei.
(anterolateral view)

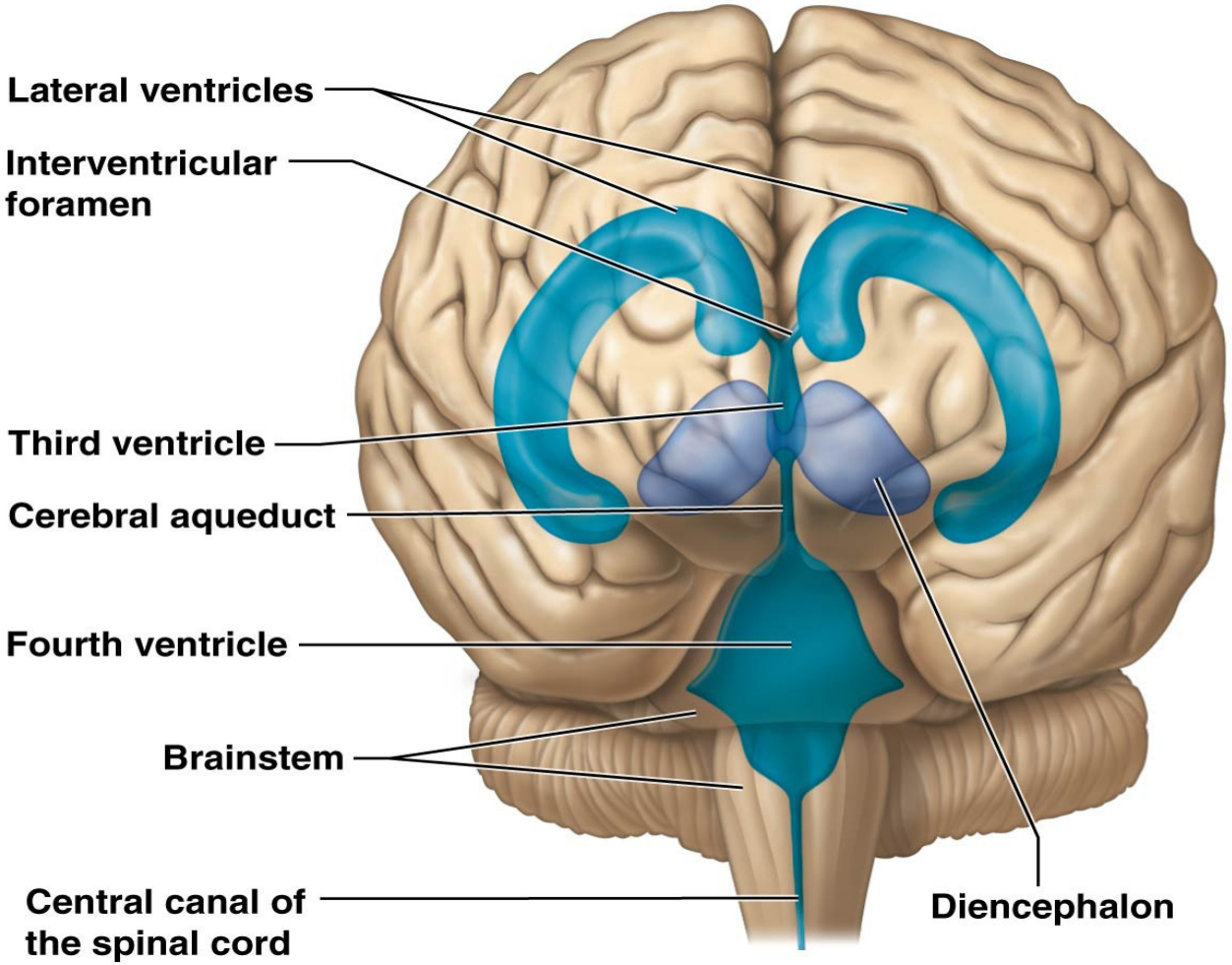


Ventricles of the Brain



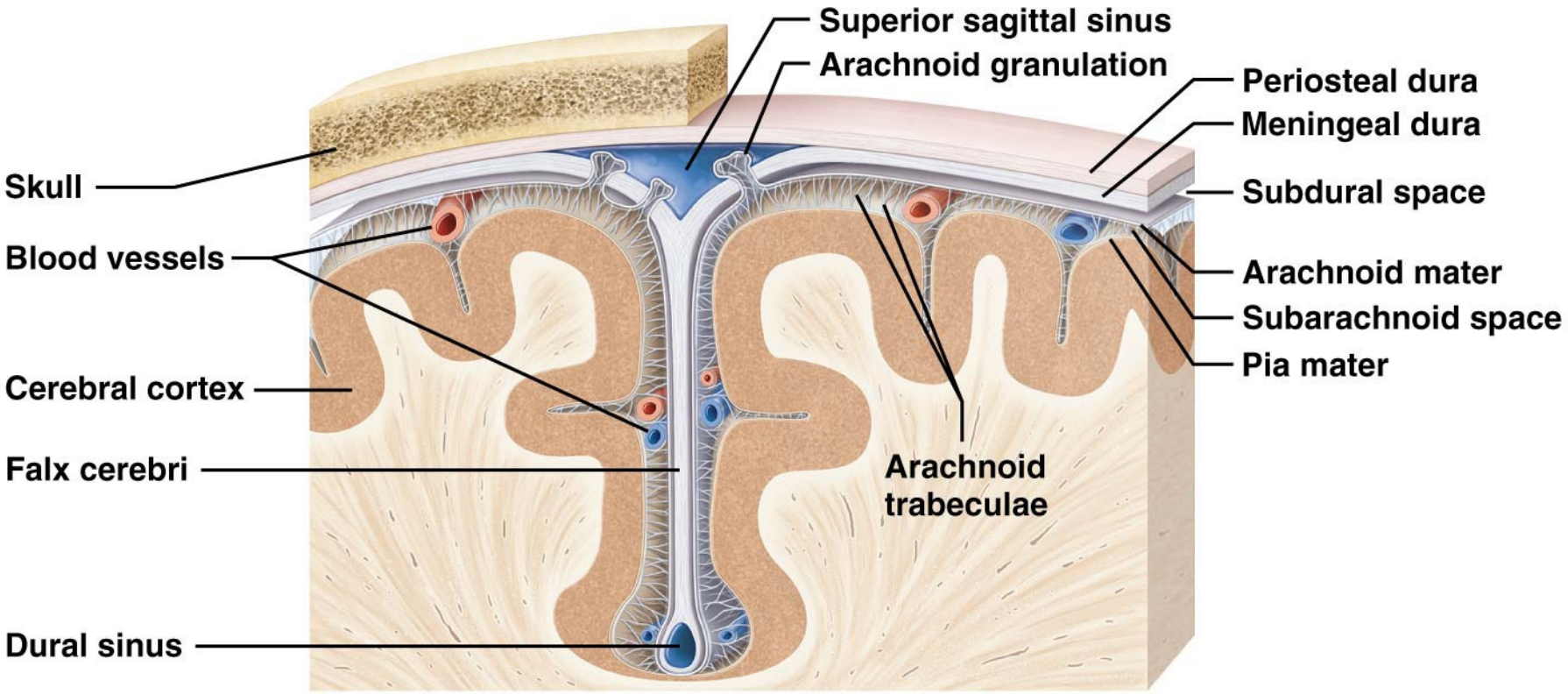


(a) Lateral view



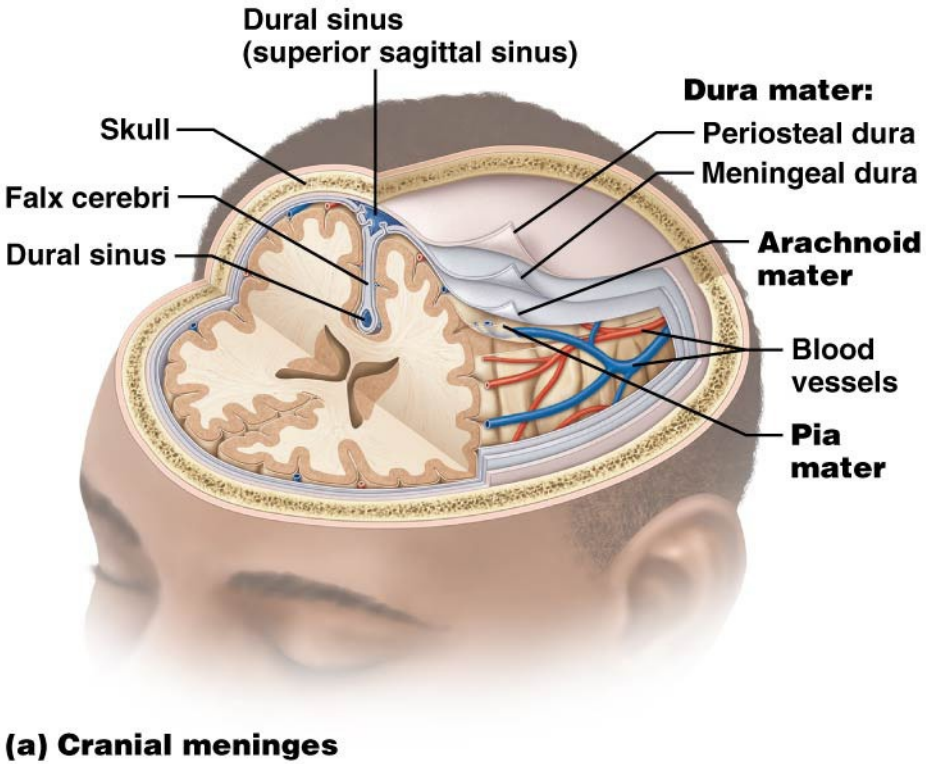
(b) Anterior view

Structure of the cranial meninges and dural sinuses.

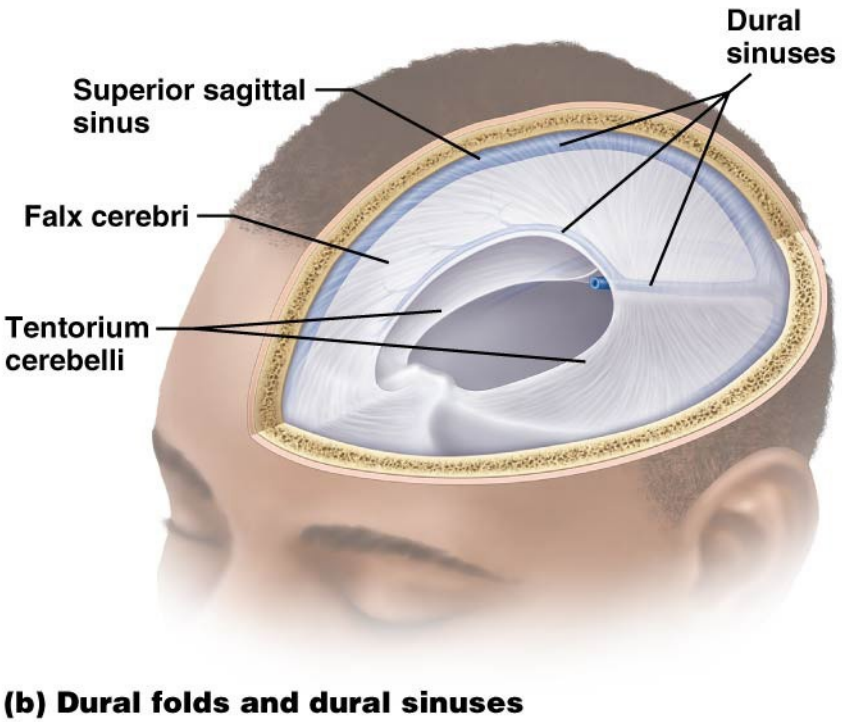


(c) Cranial meninges, frontal section

Structure of the cranial meninges and dural sinuses.

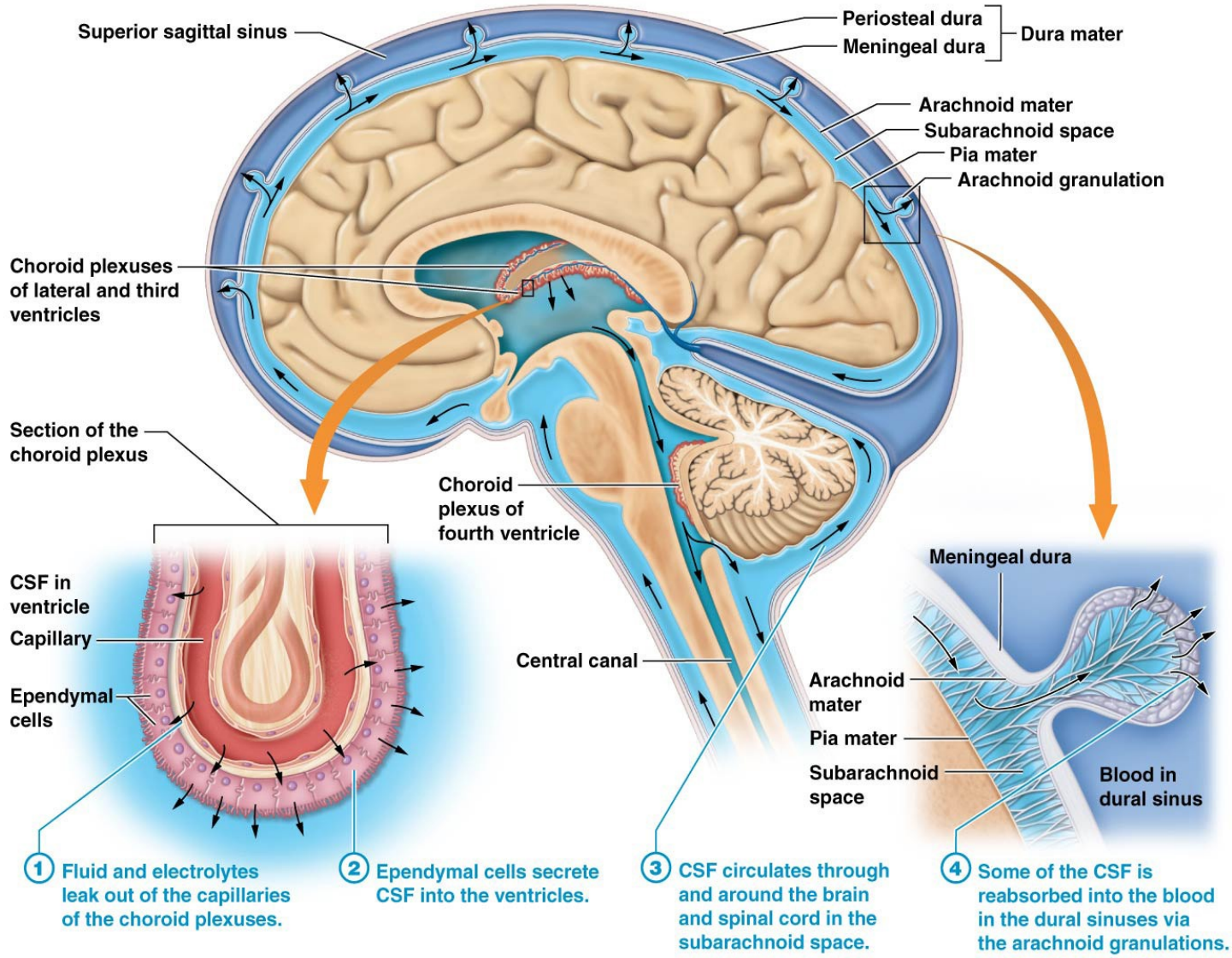


(a) Cranial meninges

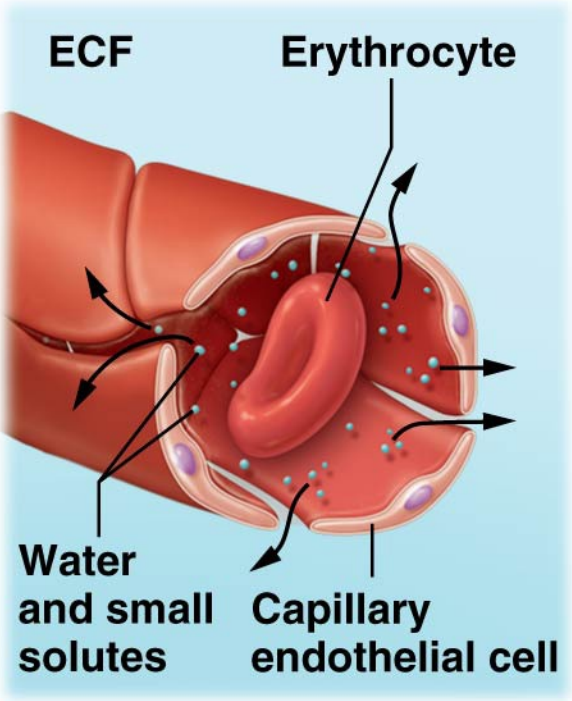


(b) Dural folds and dural sinuses

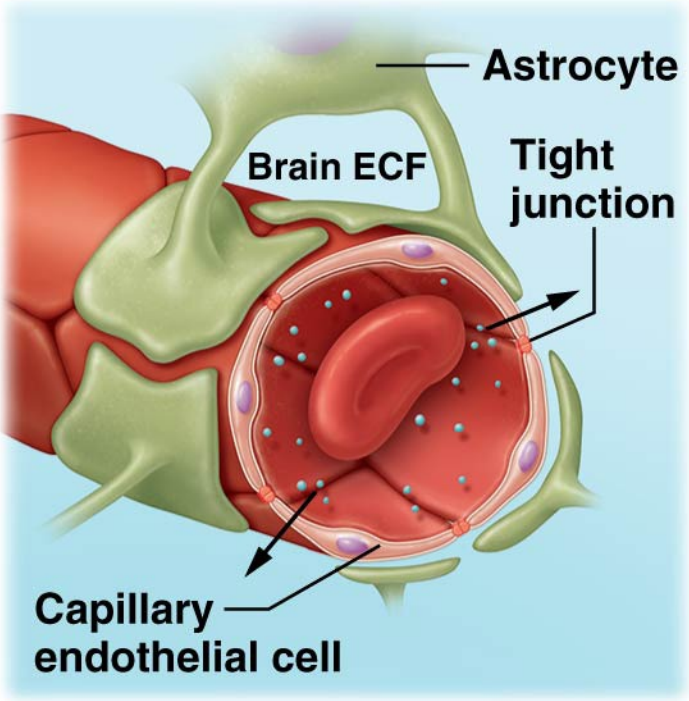
Formation and flow of cerebrospinal fluid (Blood CSF Barrier)



The blood-brain barrier.



A typical capillary allows water and small solutes to move from the blood to the ECF.

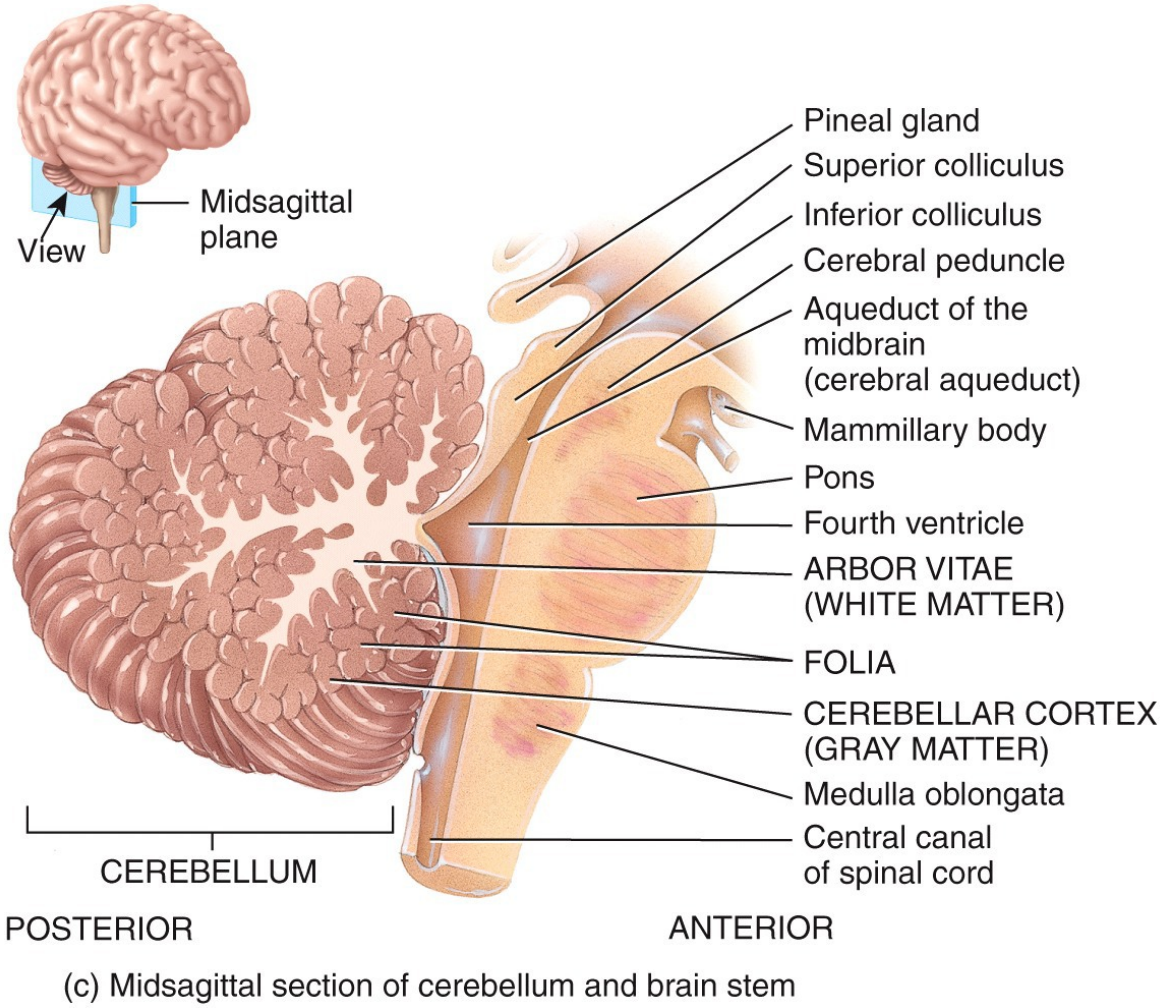


Astrocytes and tight junctions in brain capillaries limit the solutes that enter the brain ECF.

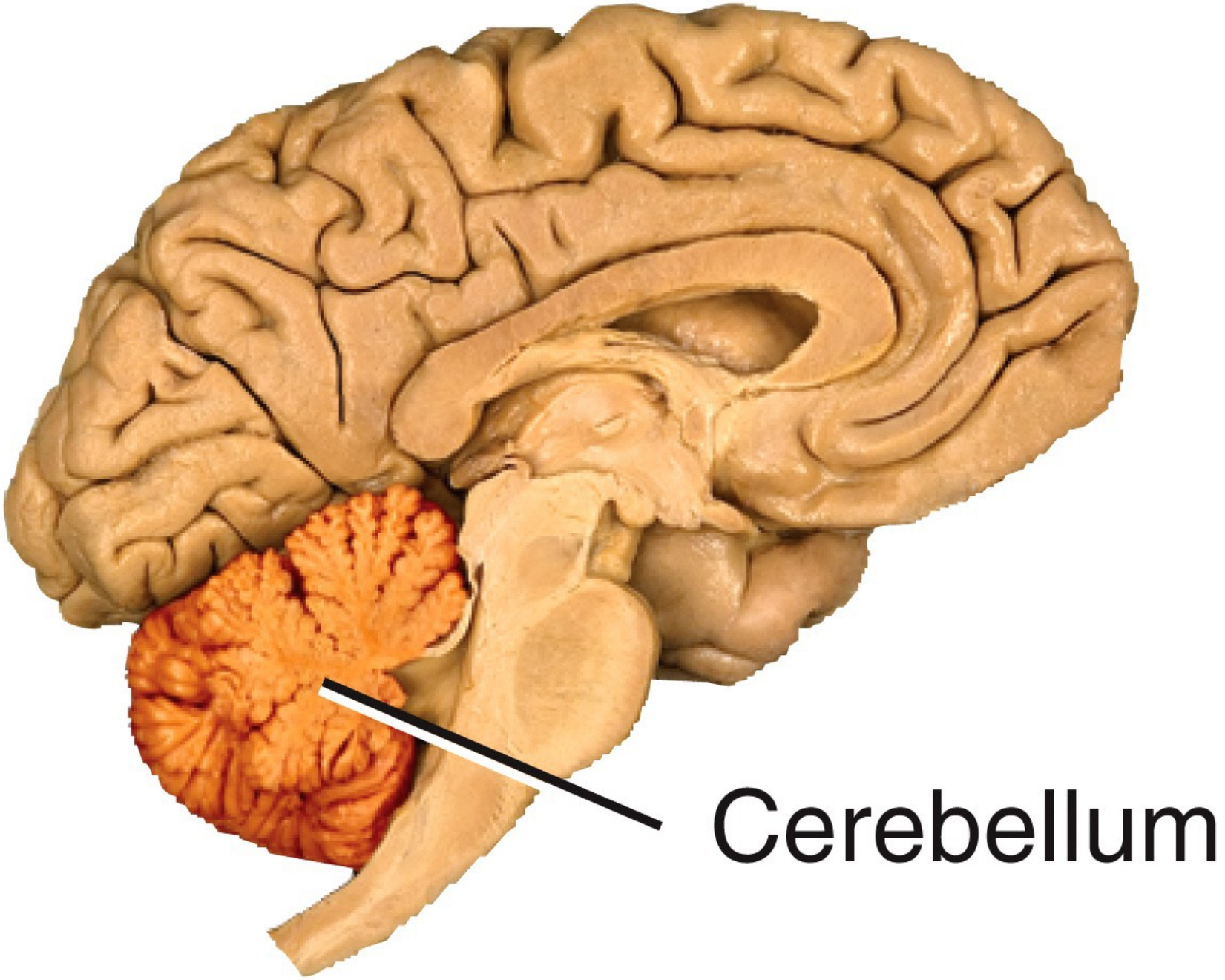
Note: There is a blood-cerbrofluid barrier but no cerbrofluid-brain barrier (from ventricles into interstitial fluid around brain's neurons).

Cerebellum

- occupies <u>posterior cranial fossa</u>
- marked by gyri, sulci, and fissures
- about 10% of brain volume
- contains over 50% of brain neurons

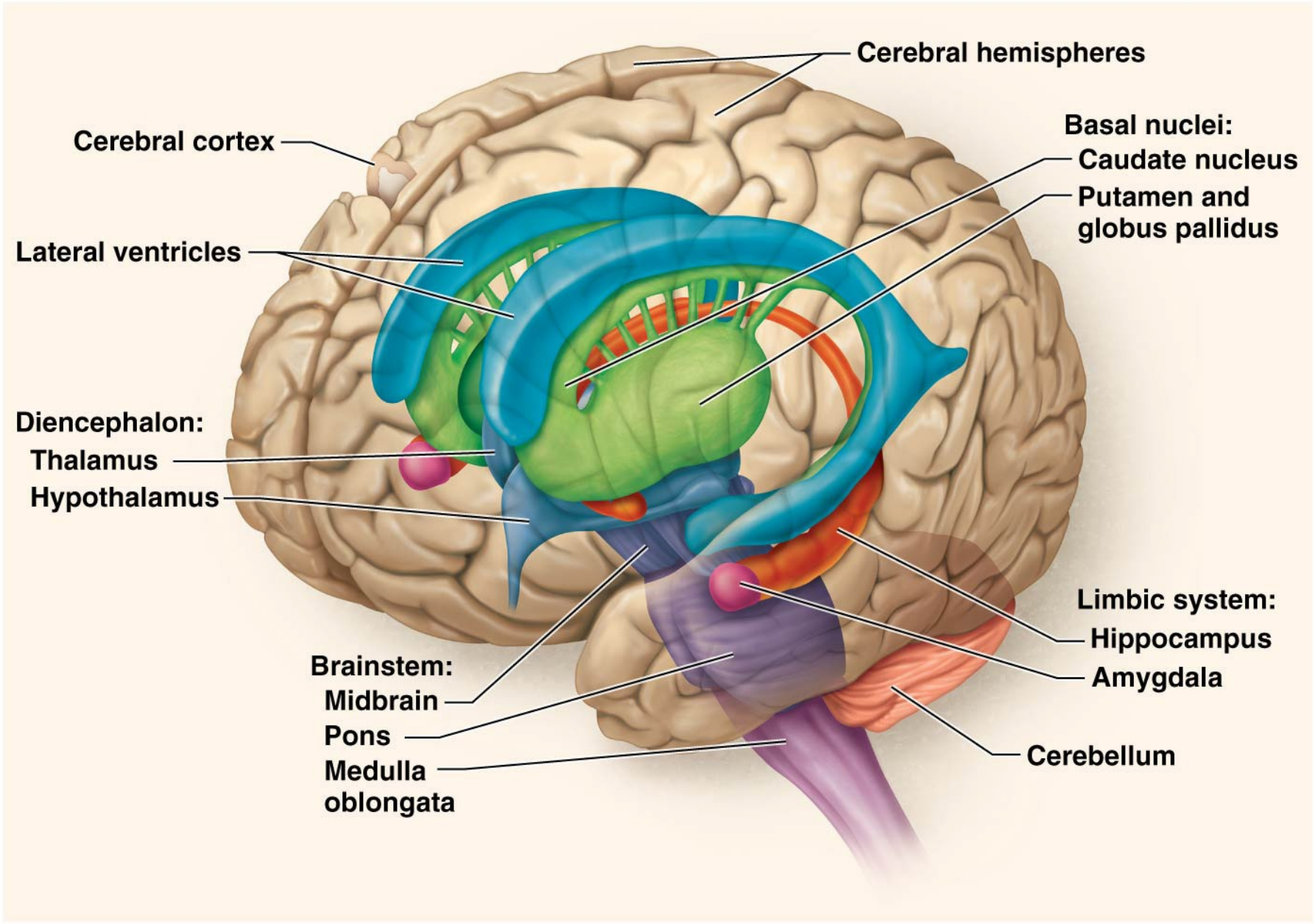


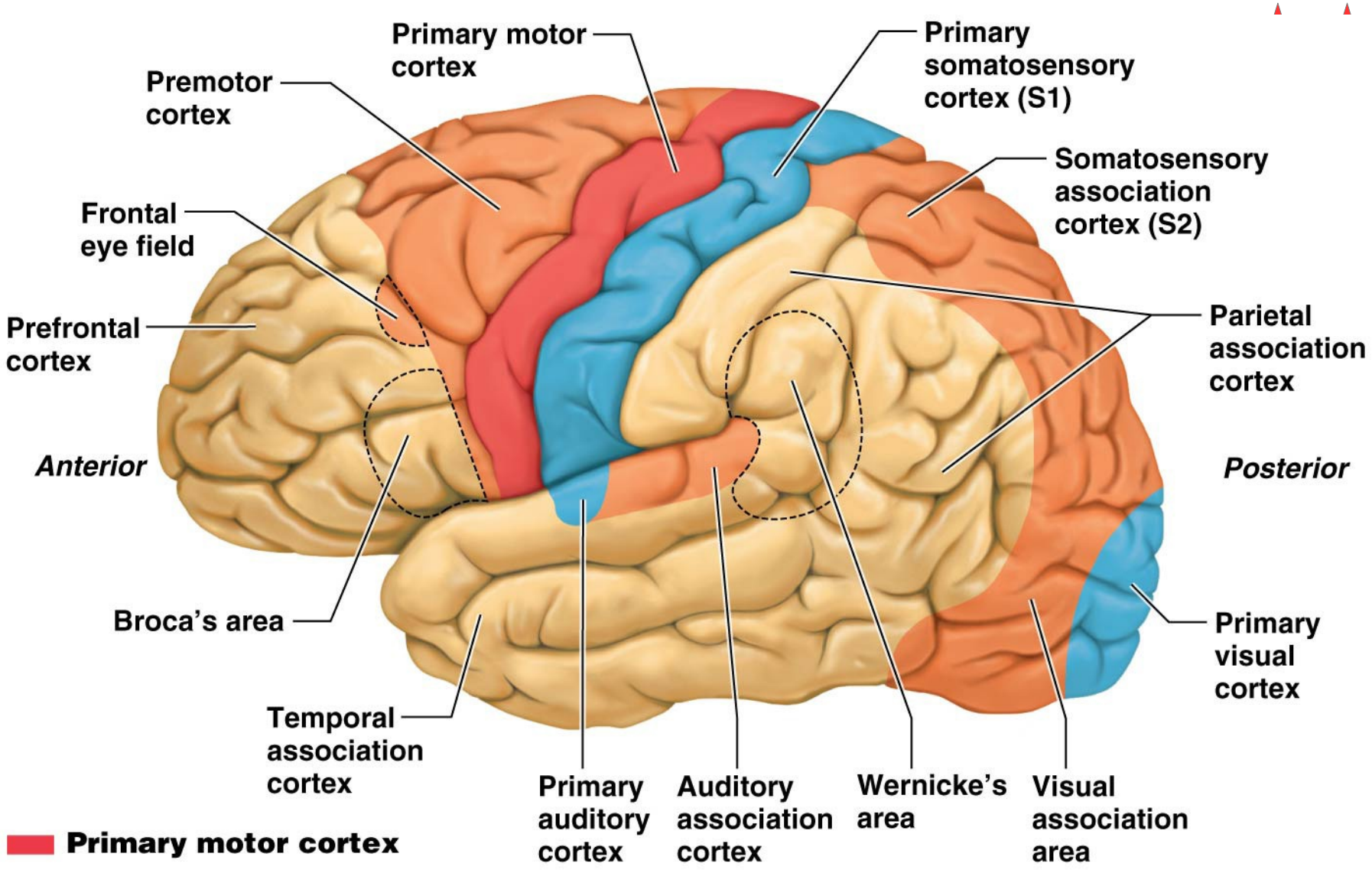
(c) Midsagittal section of cerebellum and brain stem



Dissection Shawn Miller, Photograph Mark Nielsen

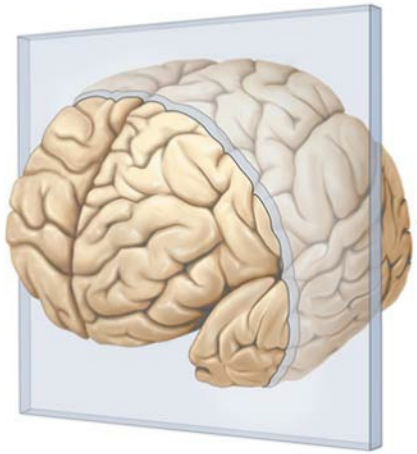
The Big Picture of Brain Anatomy.

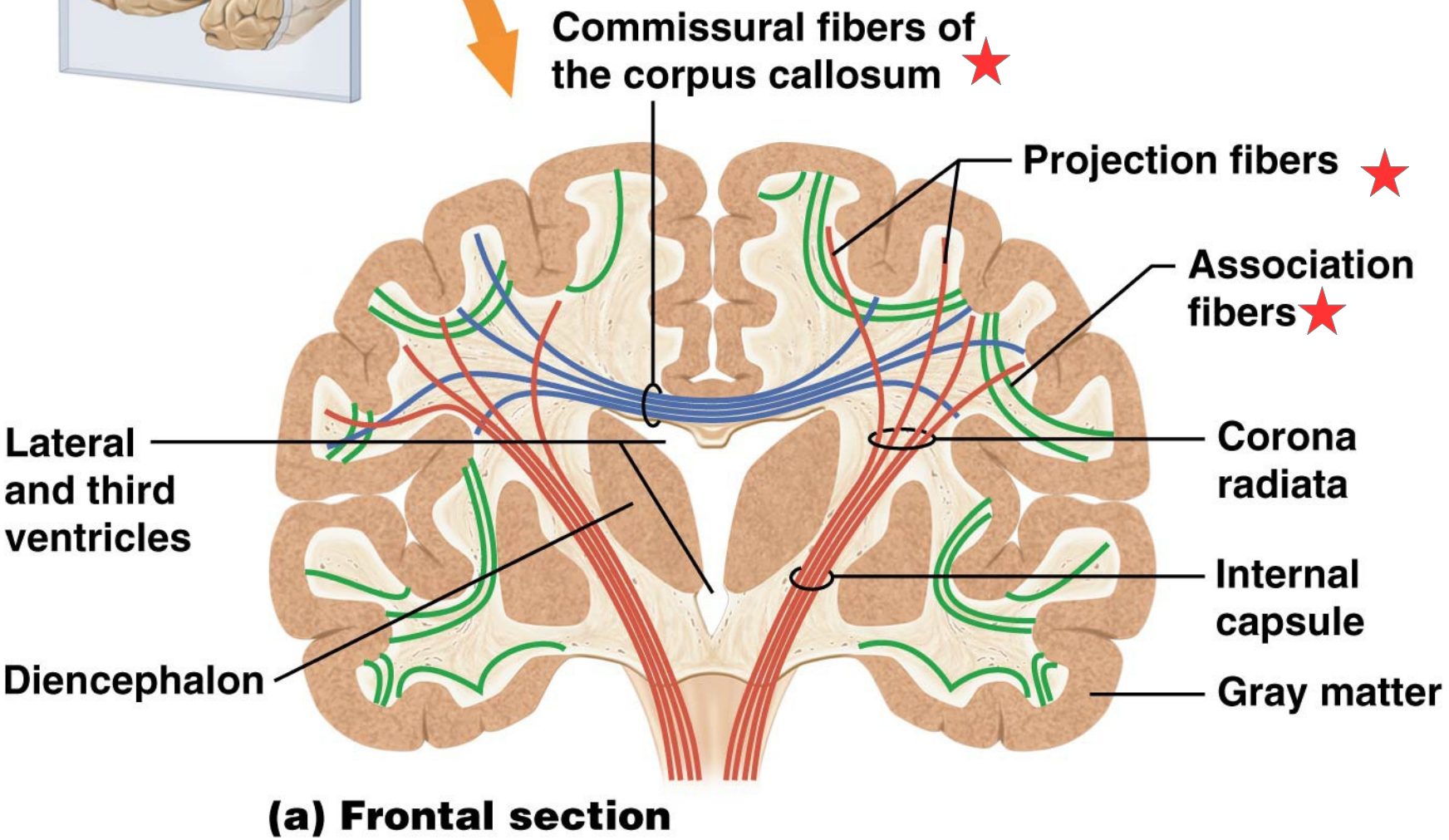




Mapping Brain Functions To Brain Regions

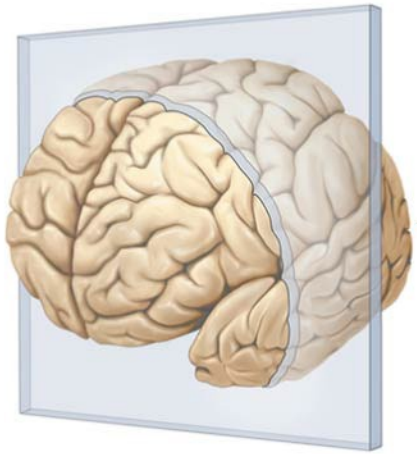
Association Fibers, Projection Fibers, and Commissural Fibers

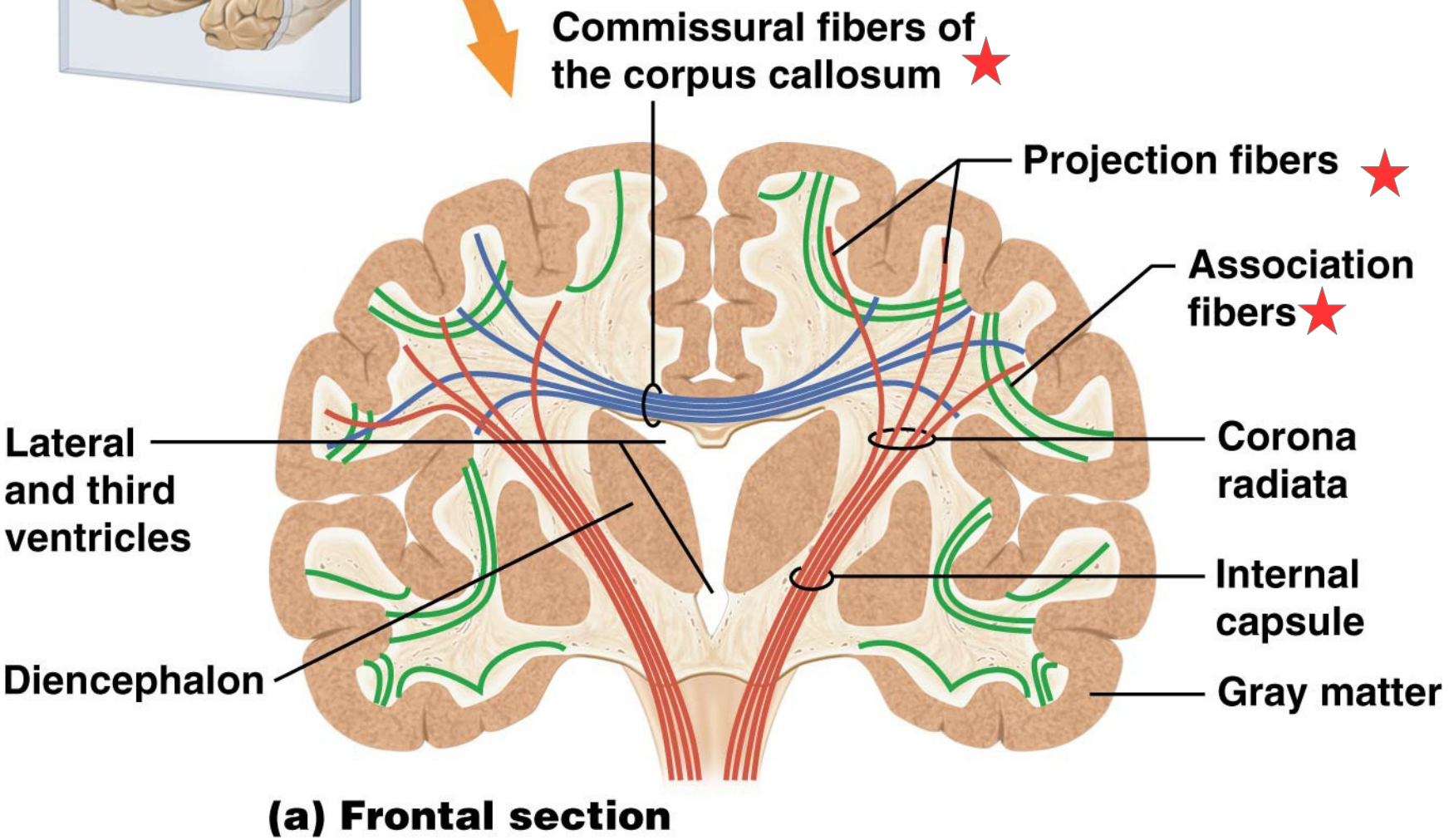




(a) Frontal section

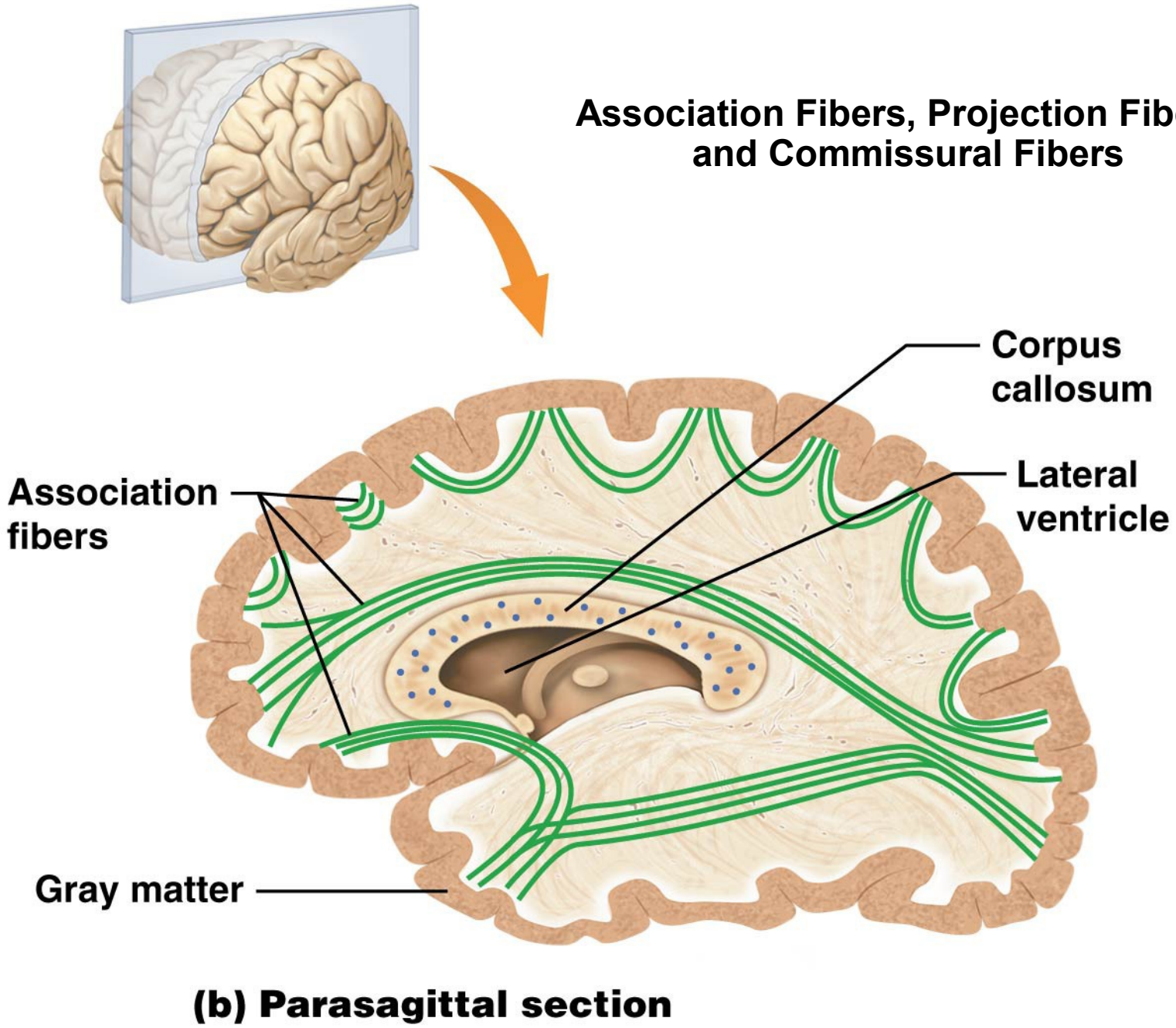
Association Fibers, Projection Fibers, and Commissural Fibers



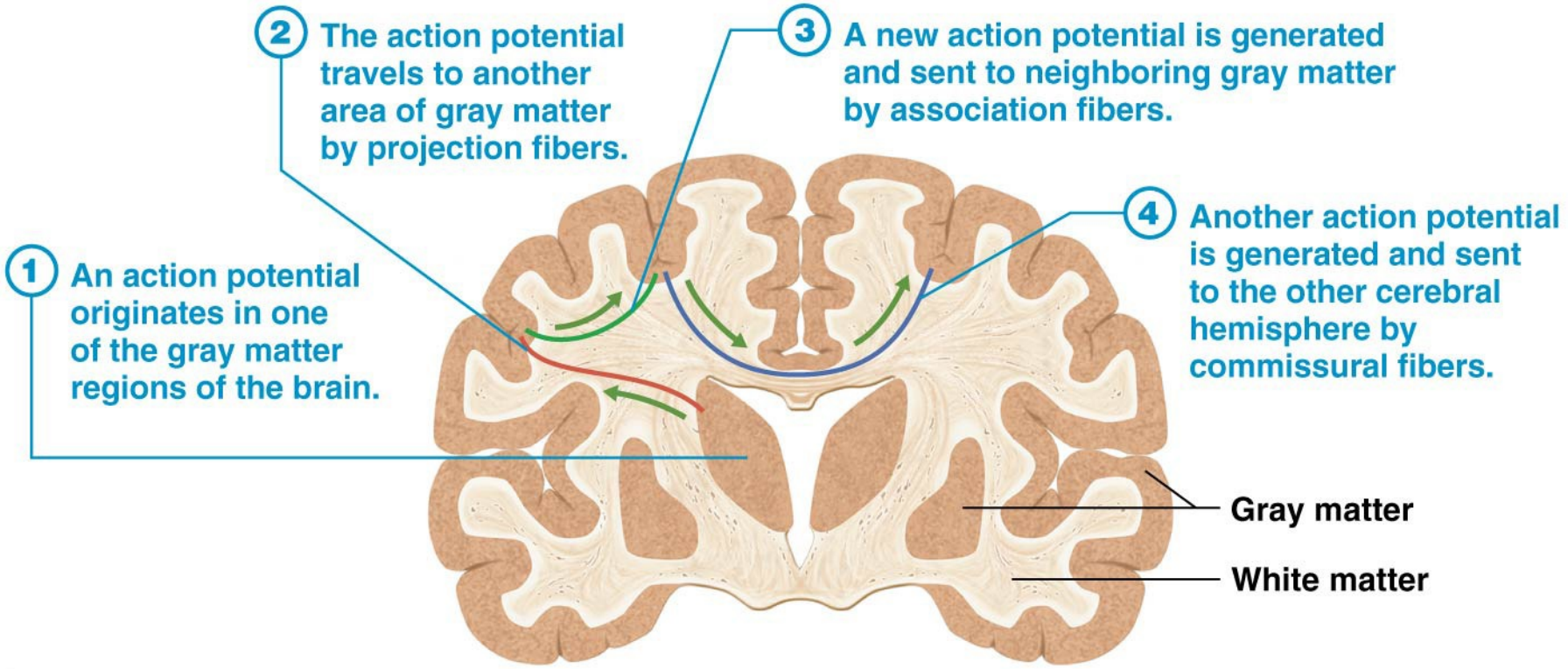


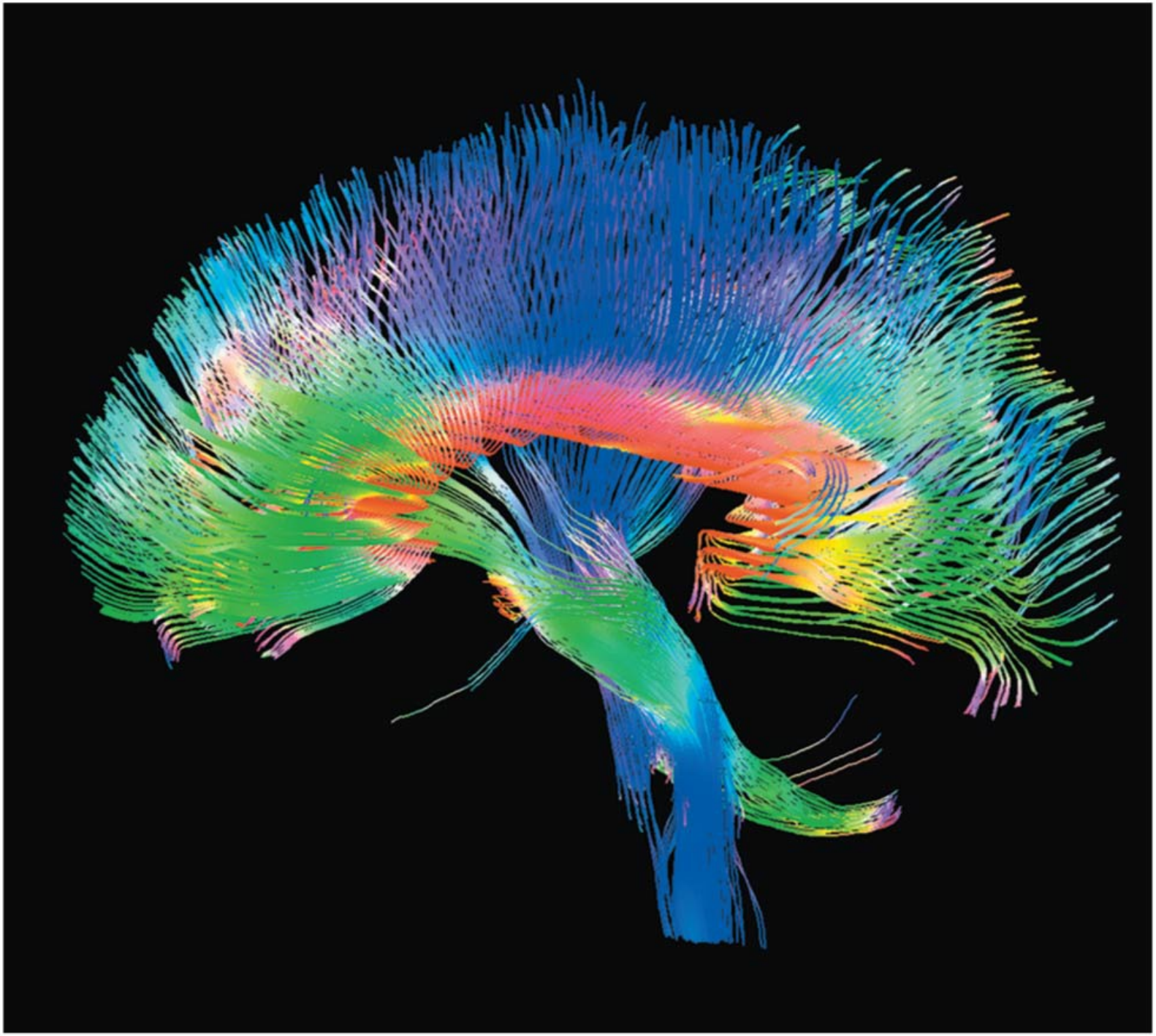
(a) Frontal section

Association Fibers, Projection Fibers, and Commissural Fibers



A possible pathway for conduction of an action potential in the brain.





Strange Factoids About Brain Function

Structurally, we have one brain, however. Functionally, we have many brains with different “types of memories” and different “states of awareness” (i.e. conscious, subconscious, and unconscious). This brings into questions how we reach decisions or form opinions and why! It's complicated. So how would you explain the following.....

If there is a “foul smell” in the room then you are more likely to make a “harsh decision”.

If you sit near a container of “hand sanitizer cleaner” then your political opinions shift more toward the “political right”.

If you hold a cup of “hot coffee” then you will have a “more pleasant feeling about your mother”.

If a woman's iris is dilated then men find her more “desirable”.