Neuroanatomy lab introduction

> *Neuroanatomy provides the essential framework for understanding the principles of neurology.*

This lab is designed to help you build that foundation through hands-on exploration and clinical application.

Key focus areas

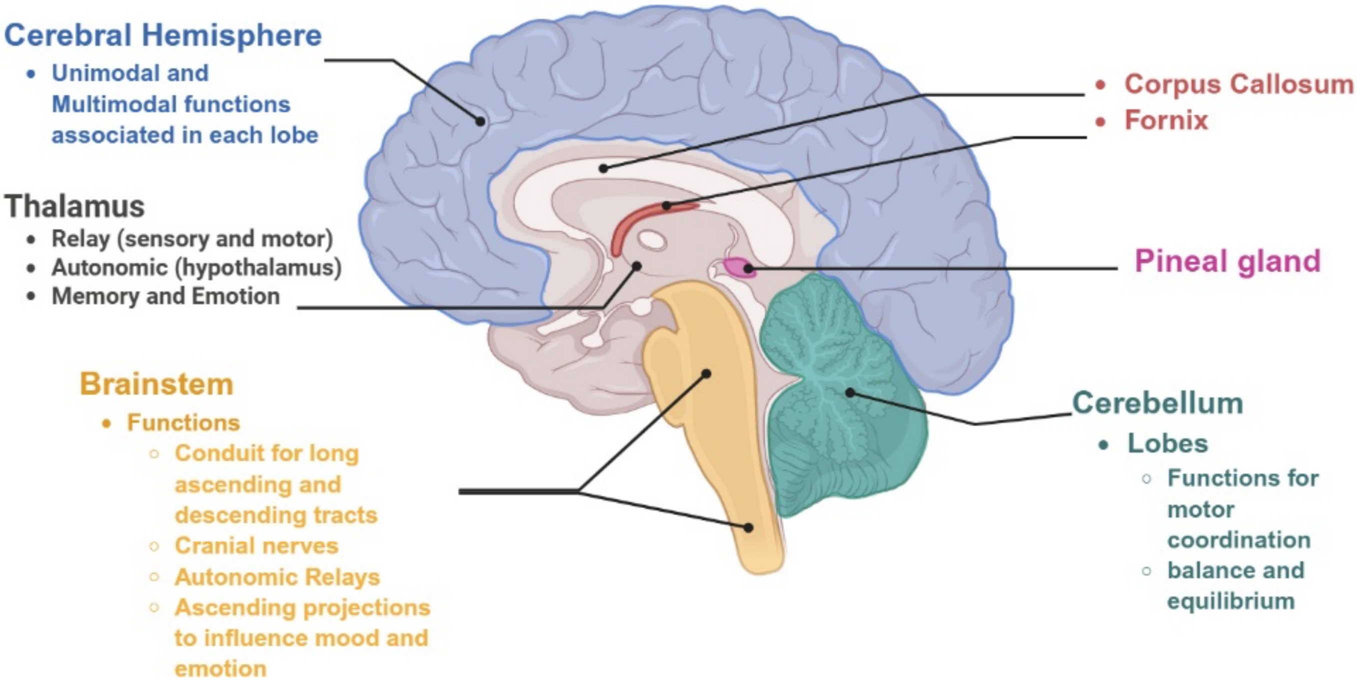
Topographic anatomy
Ventricular system, cerebrum, diencephalon, brain stem, and cerebellum

Three-dimensional relationships
Ventricular system and its connections to cerebral and brain stem structures

Clinical imaging
Using sectional anatomy and MRI to visualize and interpret these structures in context

Why it matters
A working knowledge of neuroanatomy is critical for accurate lesion localization, diagnostic reasoning, and applying neurological principles in patient care. By the end of this lab, you won't just know where structures are—you'll begin to appreciate the functional context of the content.

General Organization and Function of Cerebral Hemispheres, Thalamus, Brain Stem, & Cerebellum



Instructions for this lab

What you are expected to do

- ☐ Actively engage with all brain specimens, models, and images at each station.
- ☐ Work collaboratively within your group to identify anatomic structures.
- ☐ Use anatomic terminology when discussing structures.
- ☐ Refer to the pages on the Medicine Digital Learning site to guide your learning.
- ☐ Focus on **structure and spatial relationships** rather than the detailed clinical correlations.

Lab structure

- You will work in a **group of approximately eight students**.
- Your group will rotate through **five stations during the lab period (~1 hour and 40 minutes)**.
- Remain at your assigned station until instructed to rotate.
- Manage your time efficiently so that all group members participate.
- Use the checklists provided to make sure you have identified all the relevant structures.

Faculty interaction

- Some stations are **student-guided**; use provided resources to guide your learning.
- Some stations are **faculty-guided**; listen carefully as key anatomical features will be emphasized or demonstrated.

GOALS

By the end of this lab, you should be able to identify major neuroanatomical structures, describe their three-dimensional relationships, and recognize these structures on sectional anatomy and MRI.

Station goals

Following the stations, you should be able to:

1. Meninges and ventricles
   - Identify the lateral, third, and fourth ventricles
   - Trace ventricular connections
   - Identify major meningeal layers
2. Cerebrum, sulci, and gyri
   - Identify major lobes
   - Locate key sulci and gyri
3. Diencephalon and brainstem
   - Identify midbrain, pons, and medulla structures
   - Locate the attachments of the cranial nerves and describe their general functions
   - Identify thalamus and hypothalamus and associated structures
   - Describe spatial relationships between these regions
4. Cross-sectional anatomy
   - Identify major structures on coronal sections
   - Correlate sectional anatomy with whole-brain views and MRI
5. Blood supply and circulation
   - Identify major arteries of the anterior and posterior circulations
   - Describe the territories supplied by Circle of Willis vessels

Key reminder

The **functional and clinical significance** of these structures will be addressed in **large-group sessions**. Your primary goal in this lab is for **anatomical recognition and spatial understanding of the brain**.

Station 1. Meninges and ventricles

Identify the parts of the ventricular system on a mid-sagittal brain, coronal sections, and model.

The formation of the ventricular system, as it relates to development, was discussed in the Neuroembryology session.

REVIEW THE CLINICAL SIGNIFICANCE OF THE FLOW AND BLOCKAGE OF CSF

1. Development of the Nervous System →

FOR FURTHER REFERENCE

2. The meninges and ventricles →

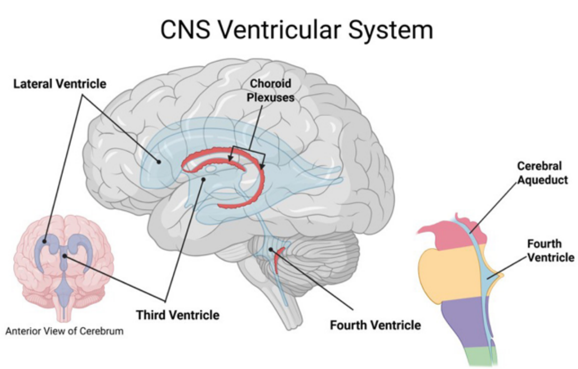


Figure 1.

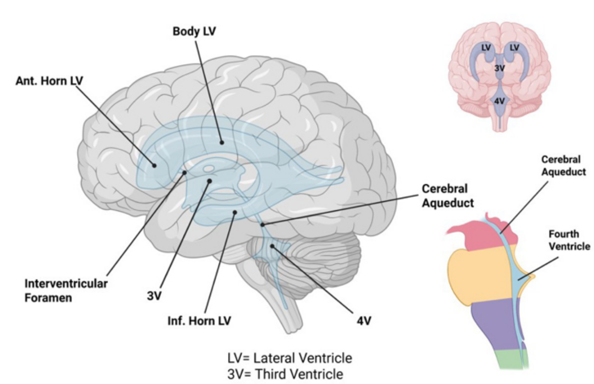


Figure 2.

- [ ] Lateral ventricles
    - [ ] Anterior horn
    - [ ] Body
    - [ ] Inferior horn
- [ ] Interventricular foramen
- [ ] Third ventricle
- [ ] Cerebral aqueduct
- [ ] Fourth ventricle

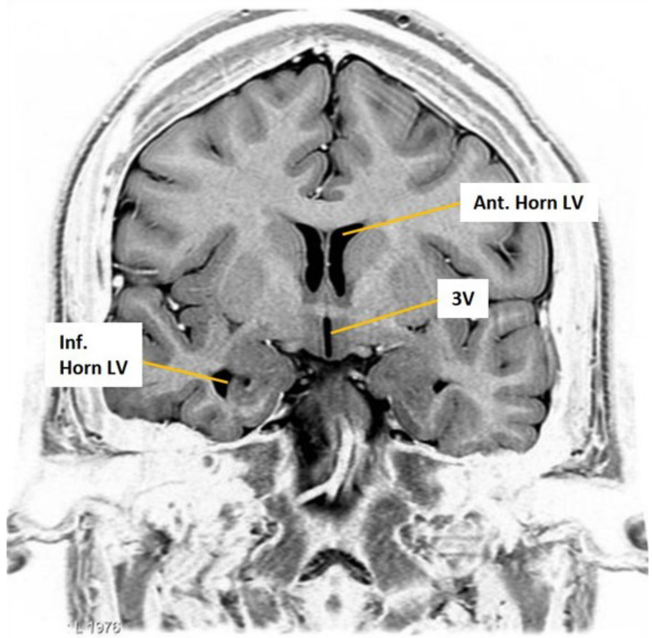


Figure 3.

Ventricles

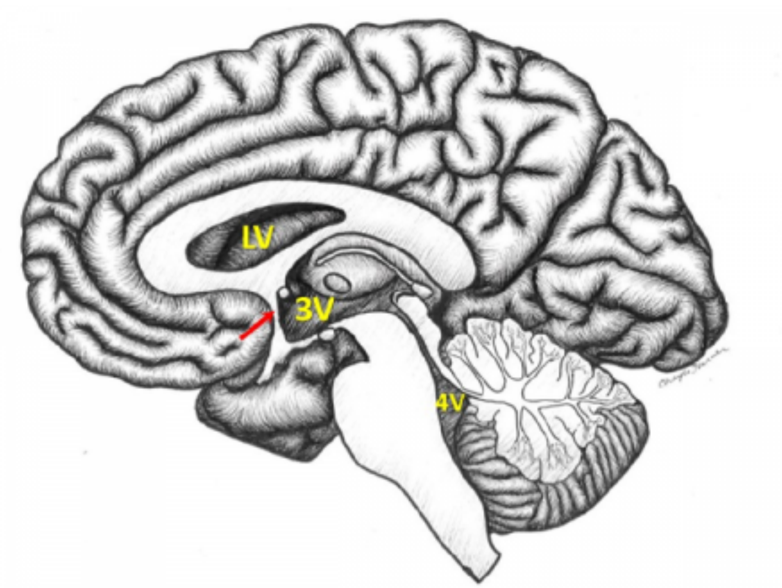


Figure 4. Diagram of the ventricular system. From Neuroanatomy: A Laboratory Guide (2e); Jansen and Lampa (2018).

LATERAL (LV)	THIRD (3V)	FOURTH (4V)

The shape of lateral ventricles changes from anterior to posterior

- Portions of the lateral ventricle include: the anterior horn, body, atrium, posterior horn, and inferior horn
- Septum pellucidum: The midline membrane separating the two lateral ventricles
- Interventricular foramen (foramen of Monro) opening into the 3V from the LV

LATERAL (LV)	THIRD (3V)	FOURTH (4V)

- Cerebral aqueduct (Sylvian aqueduct); the inferior exit point of the 3V
- Lamina terminalis (anterior border of 3V): red arrow in Figure 4.

LATERAL (LV)	THIRD (3V)	FOURTH (4V)

- Formed by a depression in the rhomboid fossa
- One median foramen (Magendie) and two lateral foramina (Luschka) exit from the 4V into the subarachnoid space. These openings are often difficult to visualize.

NOTE

Within all the ventricles are the choroid plexuses, which are producing cerebrospinal fluid.

GO TO VISIBLE VENTRICLES

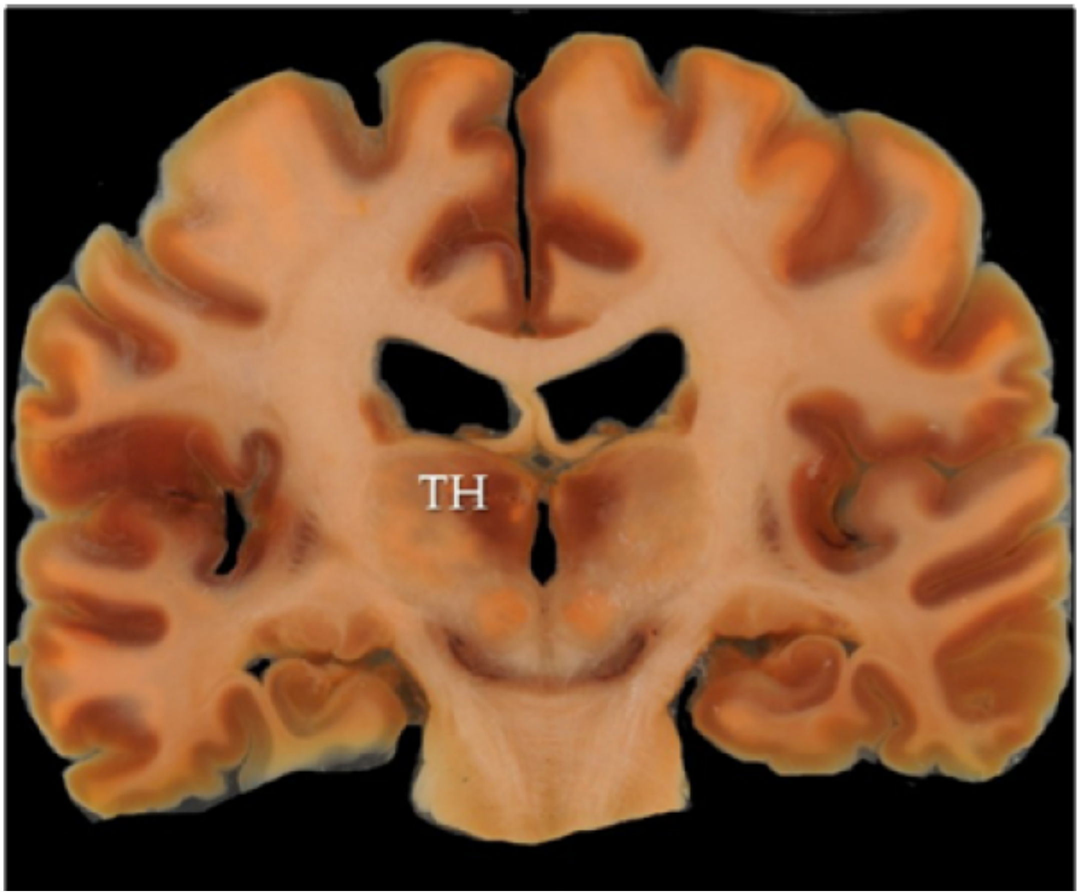


Figure 5. Coronal section through the thalamus. Note the lateral ventricles are located superior to the thalamus (TH), and the third ventricle is medial to the thalamus. Specimen from the Neuroanatomy Collection; Washington State University College of Veterinary Medicine.

Trace the flow of cerebrospinal fluid.

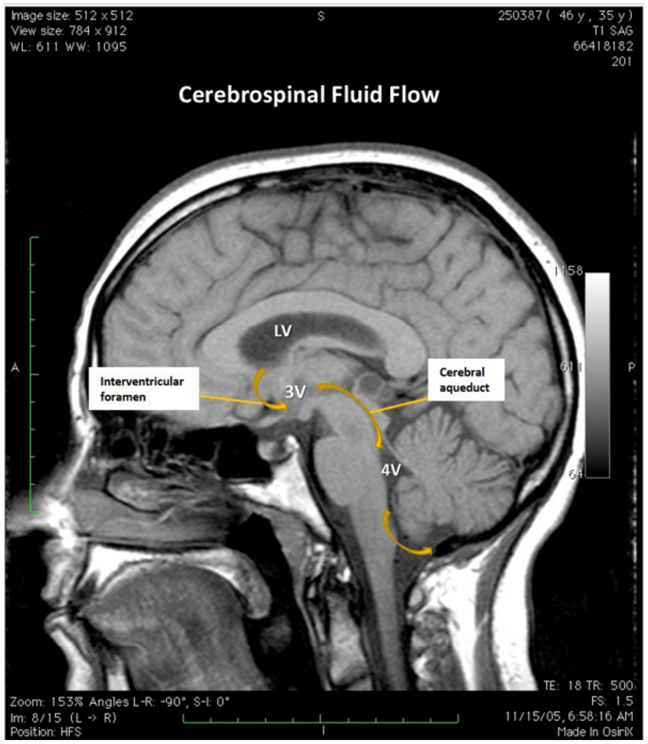


Figure 6. T1-MRI of ventricles, CSF flow, mid-sagittal section. from Neuroanatomy archive, Washington State University College of Veterinary Medicine.

CSF is produced in all of the ventricles by choroid plexuses (w/ a total volume of ~25 ml in all the ventricles); the MRI in Figure 6 indicates the direction of flow of cerebrospinal fluid between the ventricles.

FLOW OF CEREBRO-SPINAL FLUID

Meninges

REVIEW THE ANATOMY LAB

Lab 26: Scalp, Cranial Cavity, and Meninges →

- Pia mater
- Arachnoid mater
- Dura mater
    - Falx cerebri: Separating the cerebral hemispheres
    - Tentorium cerebelli: The tentorium cerebelli separates the cranial cavity into two compartment (Figure 7), and there is also a prominent tentorial notch that allows for passage of the brainstem
        - The supratentorial compartment contains the cerebrum.
        - The infratentorial compartment contains the brainstem and cerebellum.

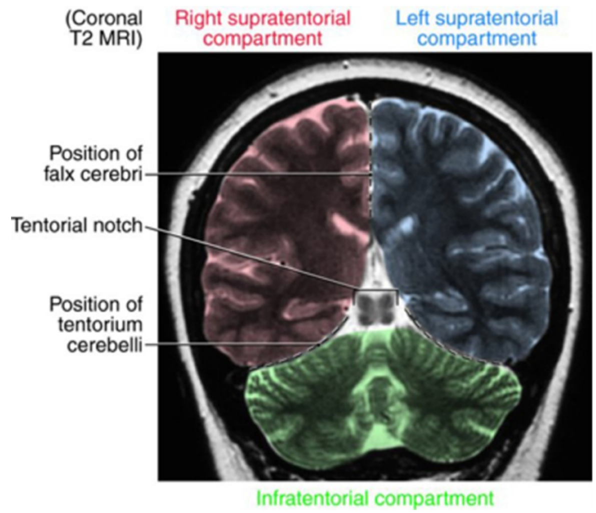


Figure 7. Supratentorial and infratentorial compartments. From Herniation Syndromes: Brain and Spinal Discs; Neuroanatomy in Clinical Context: An Atlas of Structures, Sections, Systems, and Syndromes, 9e, 2014; Copyright © Wolters Kluwer.

The brain and spinal cord are covered by the dura mater, arachnoid mater, and pia mater. The periosteal and meningeal layers of the dura are separated as the dural venous sinuses (e.g., superior sagittal sinus). Small tufts of arachnoid tissue, the **arachnoid villi**, project into the superior sagittal venous sinus (Figure 8).

The space between the arachnoid and pia mater is the **subarachnoid space** (Figure 8); it is enlarged surrounding CNS structures as cisterns.

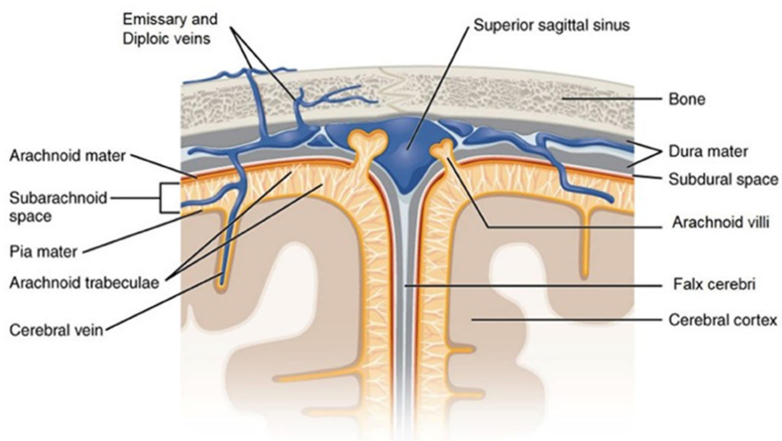


Figure 8. Meninges and meningeal spaces. By OpenStax, CC BY 4.0. Modified 7/09/18 Lampa.

NOTE

The meningeal spaces in the cranial cavity are only present between the periosteum and dura (**epidural space**) and dura and arachnoid (**subdural space**) in pathological conditions, like **hematomas** or **abscesses**. The only "real" space is the subarachnoid space that contains CSF.

THOUGHT QUESTION

Soft tissue structures may herniate inferior to the falx cerebri or through the tentorial notch. A mass that is supratentorial can force the brain into the tentorial notch, trans-tentorial herniation. What are signs and symptoms of a trans-tentorial herniation?

UNCAL HERNIATION

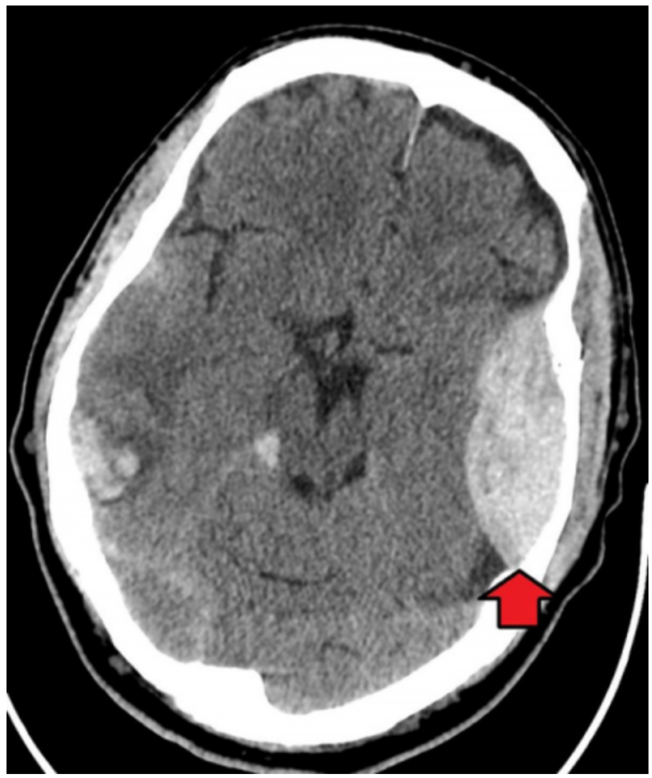


Figure 9. CT image of an epidural hematoma. By James Heilman, MD, Own work, CC BY-SA 4.0.

THOUGHT QUESTION

In a skull fracture, which significant artery is at risk of being damage leading to an epidural hematoma (indicated by the red arrow) in Figure 9?

Tearing of the bridging veins that connect into the superior sagittal sinus, often times accompanying a fall, can result in a subdural hemorrhage/hematoma. See Figure 10.

THOUGHT QUESTION

Why does the spread of a subdural hematoma (indicated by the blue arrow) appear more diffuse on a CT or MRI than an epidural hematoma?

Figure 10. Subdural hematoma (CT image). From Intracranial Hemorrhage and Related Conditions, McKean SC, Ross JJ, Dressler DD, Scheurer DB. Principles and Practice of Hospital Medicine, 2e; 2017. Copyright © 2018 McGraw-Hill Education. All rights reserved.

Meningeal spaces

- Epidural
- Subdural
- Subarachnoid
  - Cisterns are the naturally enlarged subarachnoid spaces where CSF collects. (Figure 11)
    - Interpeduncular cistern (anterior to the midbrain)
    - Cisterna magna (large space located around the spinal cord–medullary junction surrounding the foramen magnum)
    - Lumbar cistern (the subarachnoid space located from L3 to S2 after the termination of the spinal cord)

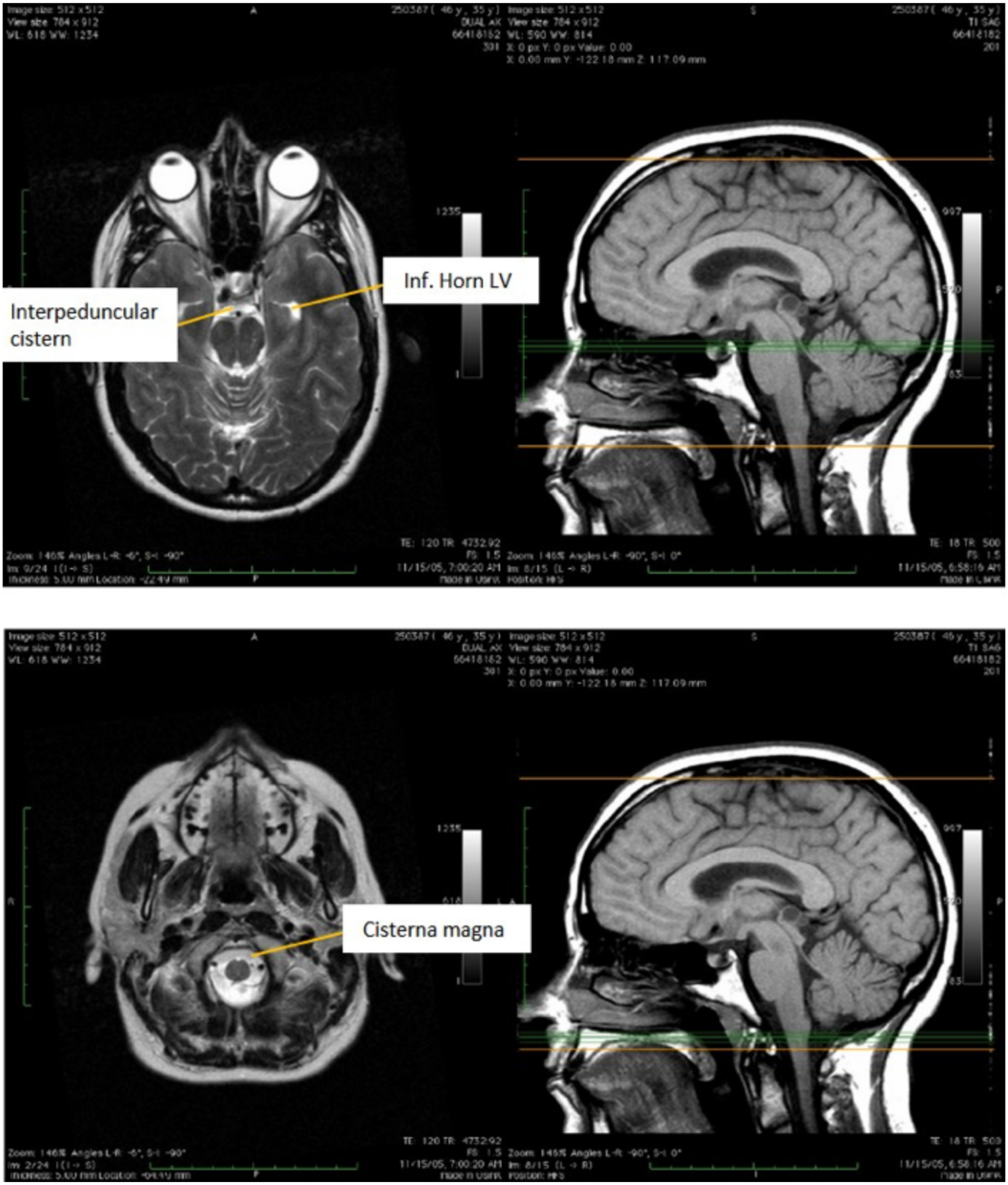


Figure 11. Horizontal T2-weighted MRI of subarachnoid cisterns (on the MRI images a green reference line indicates the level of the section). Note that the cerebrospinal fluid in the subarachnoid spaces on these images appears white. Images were generated from neuroanatomy archive. Washington State University College of Veterinary Medicine.

THOUGHT QUESTION

Identify the ventricles on sagittal sections through the cerebrum and on MRI images.

Identify arachnoid granulations (villi).

The arachnoid villi are the locations for the re-entry of the majority of the cerebrospinal fluid into the venous circulation (Figure 12).

- [ ] Arachnoid granulations

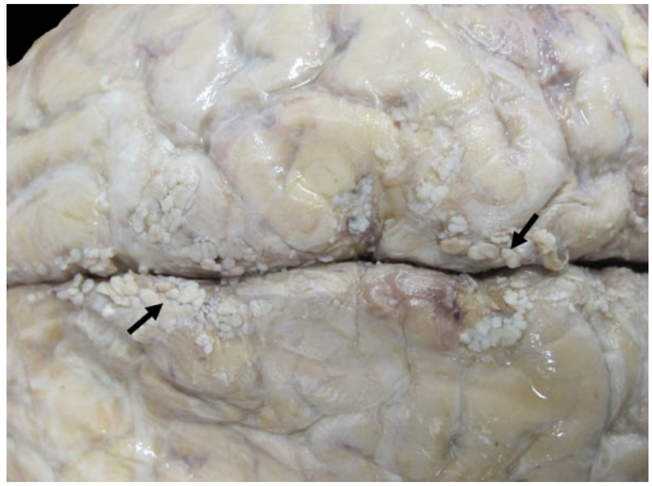


Figure 12. Arachnoid granulations. Image shows multiple arachnoid granulations (calcified arachnoid villi indicated by the black arrows) with lie adjacent to the longitudinal fissure. Note that the dura mater has been removed and only the arachnoid mater is visible on the superior surface of the cerebrum. Specimen from the Neuroanatomy Collection, Washington State University College of Veterinary Medicine.

Station 2. Cerebrum, sulci, and gyri

Introduction to neuroanatomy

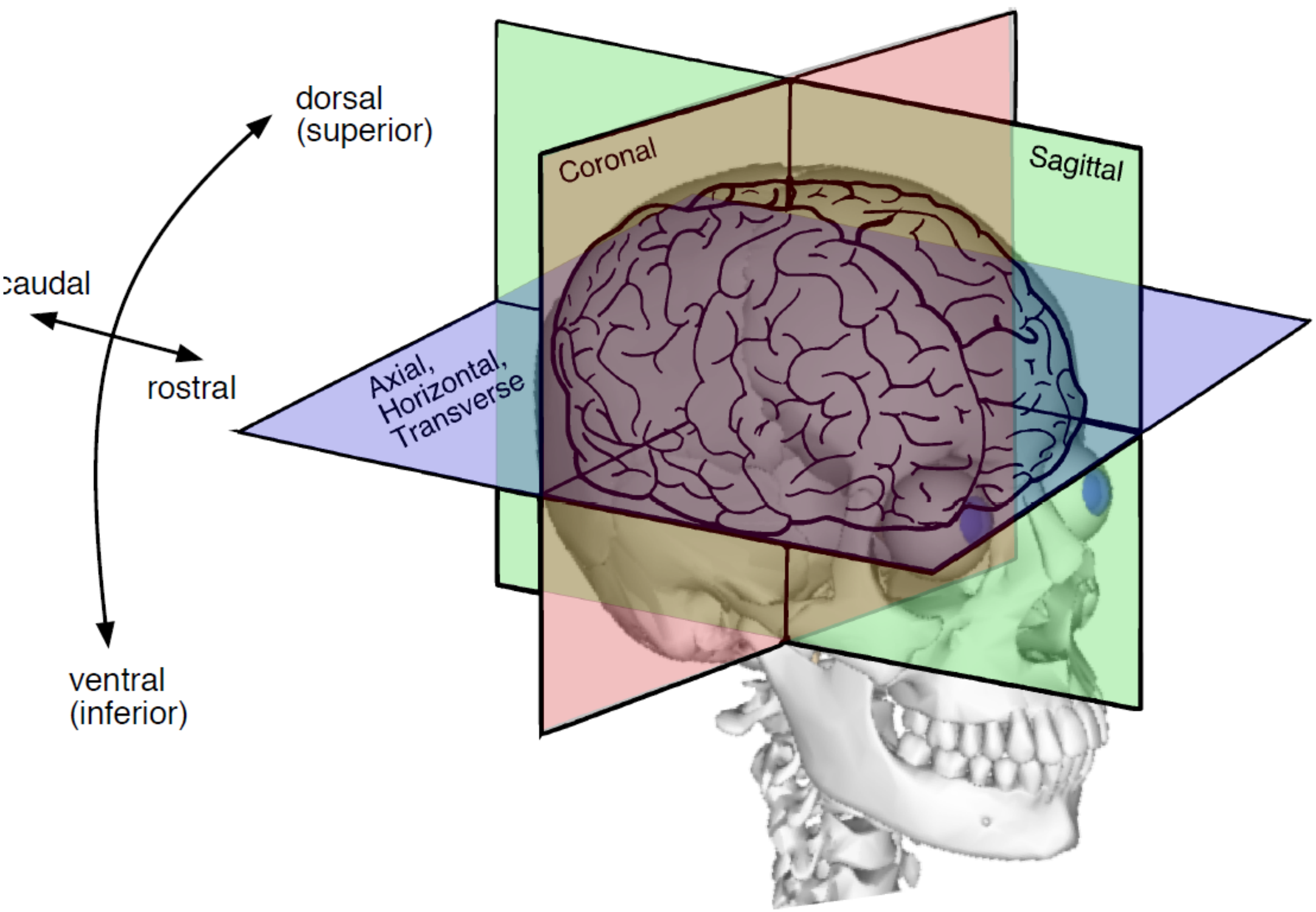


Figure 1. Anatomic directional terms. From Neuroanatomy: A Laboratory Guide (2e); Jansen and Lampa.

Cerebrum, sulci, and gyri

Lobes of the cerebrum

Recall that the surfaces of the cerebrum, and therefore the lobes, have a distinct topography that is formed by the sulci and gyri.

Sulcus (pl. sulci)

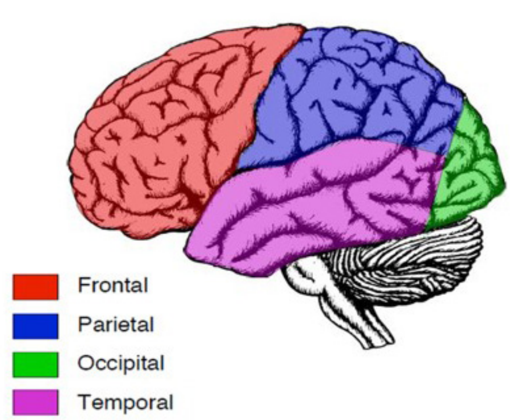
A groove or furrow (L.)

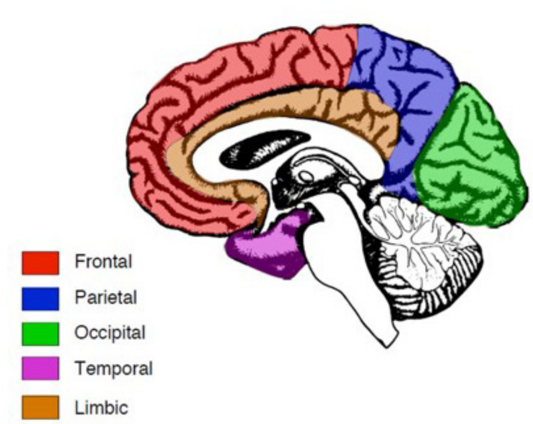
Gyrus (pl. gyri)

A ridge or convolution (L.)

Identify frontal, parietal, occipital, and temporal lobes of the cerebrum on a brain.

- [ ] Frontal lobe
- [ ] Parietal lobe
- [ ] Occipital lobe
- [ ] Temporal lobe





Lobes of the cerebral hemisphere. WSU_CVM_NEUROANATOMY IMAGE.

The **limbic** (limbus=*margin or border* L.) **lobe** is sometimes included as a functional lobe, but is in fact comprised of the medial portions of the frontal, parietal, and temporal lobes.

There is a loss of cortical tissue leading to narrowing of the gyri, widening of the sulci, or both in old age and disease processes. See Figure 3. The brain in panel A is from a normal patient, and the brain in panel B is from an older patient experiencing a loss of cortical tissue.

THOUGHT QUESTION

List some common neurologic disorders that could lead to a loss of cortical tissue, as seen in Figure 3B.

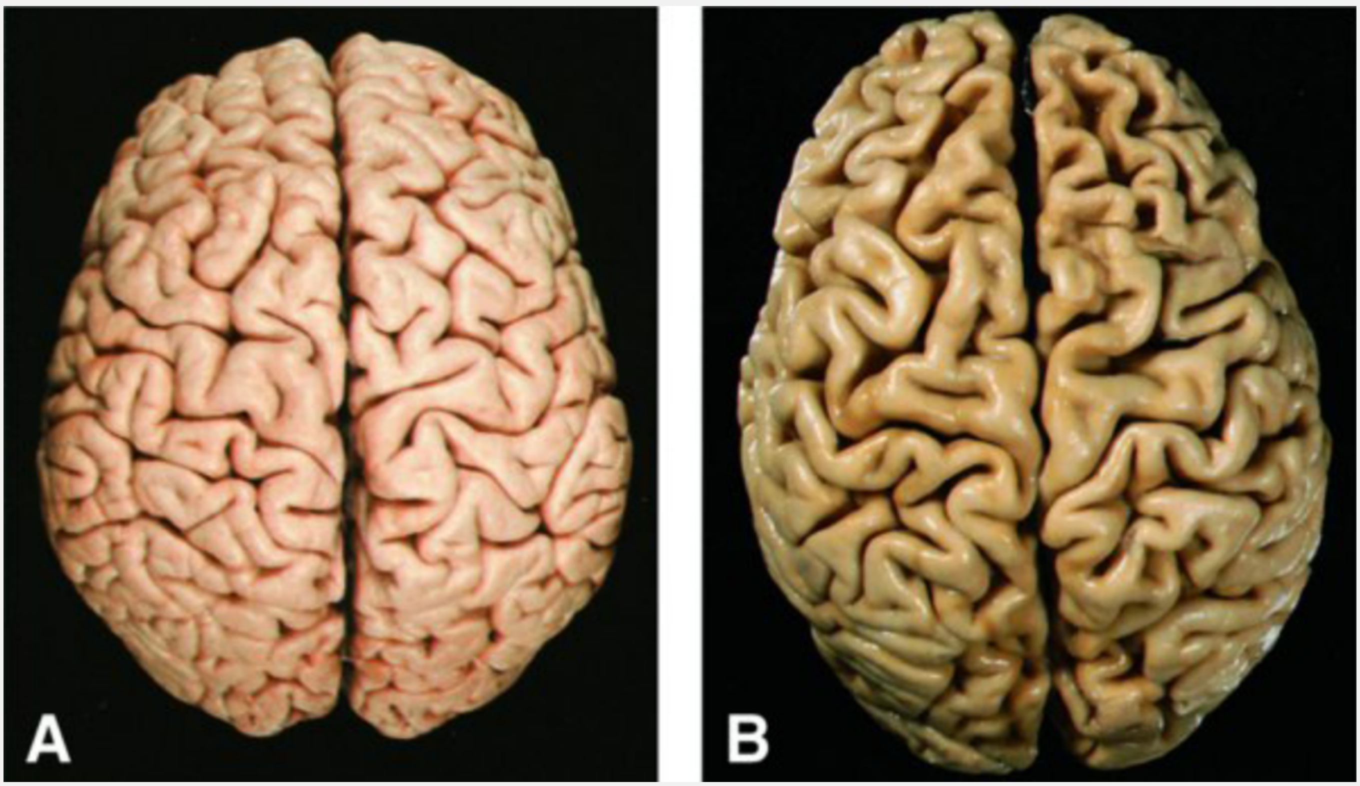


Figure 3. From Chapter 32: The Central Nervous System, Rubin's Pathology: Clinicopathologic Foundations of Medicine, 7e; Strayer et al. 2014; Wolters and Kluwer.

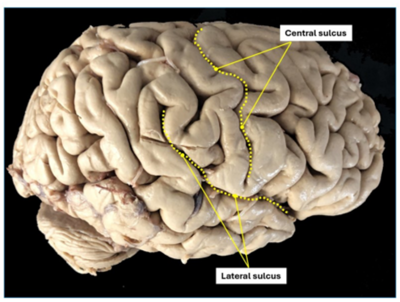
The cerebral cortex controls or receives information from the contralateral side of the body (Valsalva Doctrine). Therefore, unilateral cerebral lesions produce signs and symptoms on the opposite side of the body.

CLINICAL CORRELATION

All the regions of the cortex perform different and diverse functions. Understanding the localization and nature of focal injuries to the cortex as it relates to specific clinical symptoms is an extremely important role of any clinician.

Sulci/fissures of the cerebrum

Identify the sulci/fissures of the cerebrum on a brain.



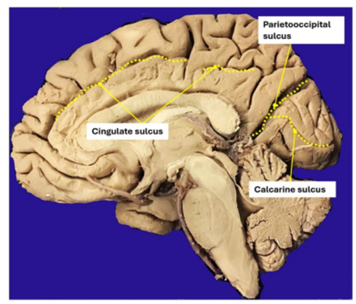


Figure 1.

Figure 2.

- ☐ Longitudinal, a.k.a. sagittal fissure/sulcus: Separating the two cerebral hemispheres
- ☐ Lateral sulcus (Sylvian fissure): Separating temporal lobe from parietal and frontal lobe
- ☐ Parieto-occipital sulcus: Separating the parietal and occipital lobes (seen medially)
- ☐ Central sulcus: Separating the frontal and parietal lobes
- ☐ Cingulate sulcus: Dorsal (superior) to the cingulate gyrus
- ☐ Calcarine sulcus—on medial surface of occipital lobe: Superior and inferior temporal sulci

Major gyri of cerebral lobes

Identify the major gyri of the cerebral lobes on a brain.

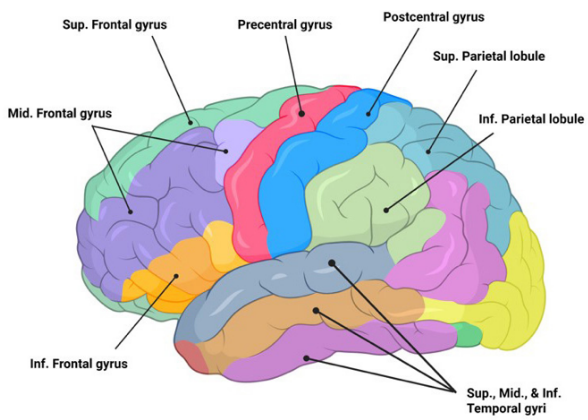


Figure 3. CREATED WITH BIORENDER.COM.

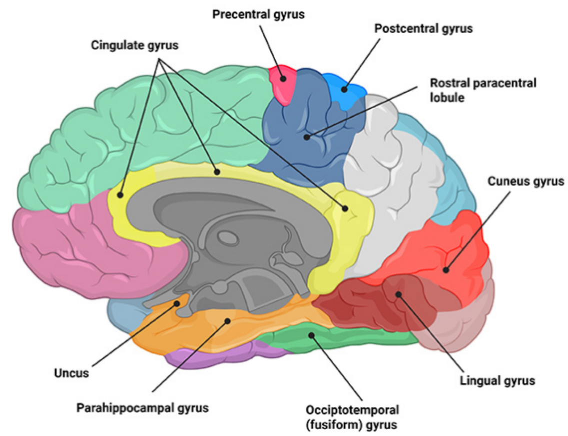


Figure 4. CREATED WITH BIORENDER.COM.

Frontal lobe

- ☐ Precentral gyrus
- ☐ Superior, middle and inferior frontal gyri
- ☐ Cingulate gyrus (superior to the corpus callosum)

Parietal lobe

- ☐ Postcentral gyrus
- ☐ Superior parietal lobule
- ☐ Inferior parietal lobule (supramarginal and angular gryi are parts of inferior parietal lobule)

Occipital lobe

- ☐ Lingual gyrus (inferior to the calcarine sulcus)
- ☐ Cuneus (posterior to the parieto-occipital sulcus and superior to the calcarine sulcus)

Temporal lobe

- ☐ Superior, middle and inferior temporal gyri
- ☐ Occipito-temporal (fusiform) gyrus
- ☐ Parahippocampal gyrus: Part of the medial temporal lobe
- ☐ Uncus: Part of the medial temporal lobe

☐ Insula: Deep in the lateral fissure; composed of multiple gyri

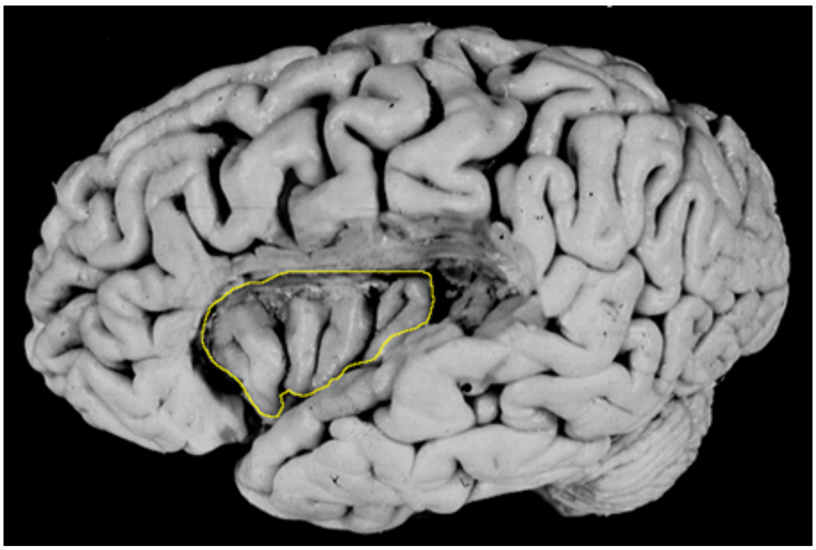


Figure 5. Left cerebral hemisphere dissected to expose insula. Specimen from Neuroanatomy Collection, Washington State University College of Veterinary Medicine. The insula is outlined in yellow on the above image. (Note: inferior portions of the frontal and parietal lobes have been removed.) The insular cortex has many functions, such as emotions, motor control, and homeostasis.

CLINICAL CORRELATION

From the perspective of a clinican, the anatomy of brain and spinal cord are thought of in terms of how they appear in sections or slices that are obtained by either CT or MRI imaging techniques.

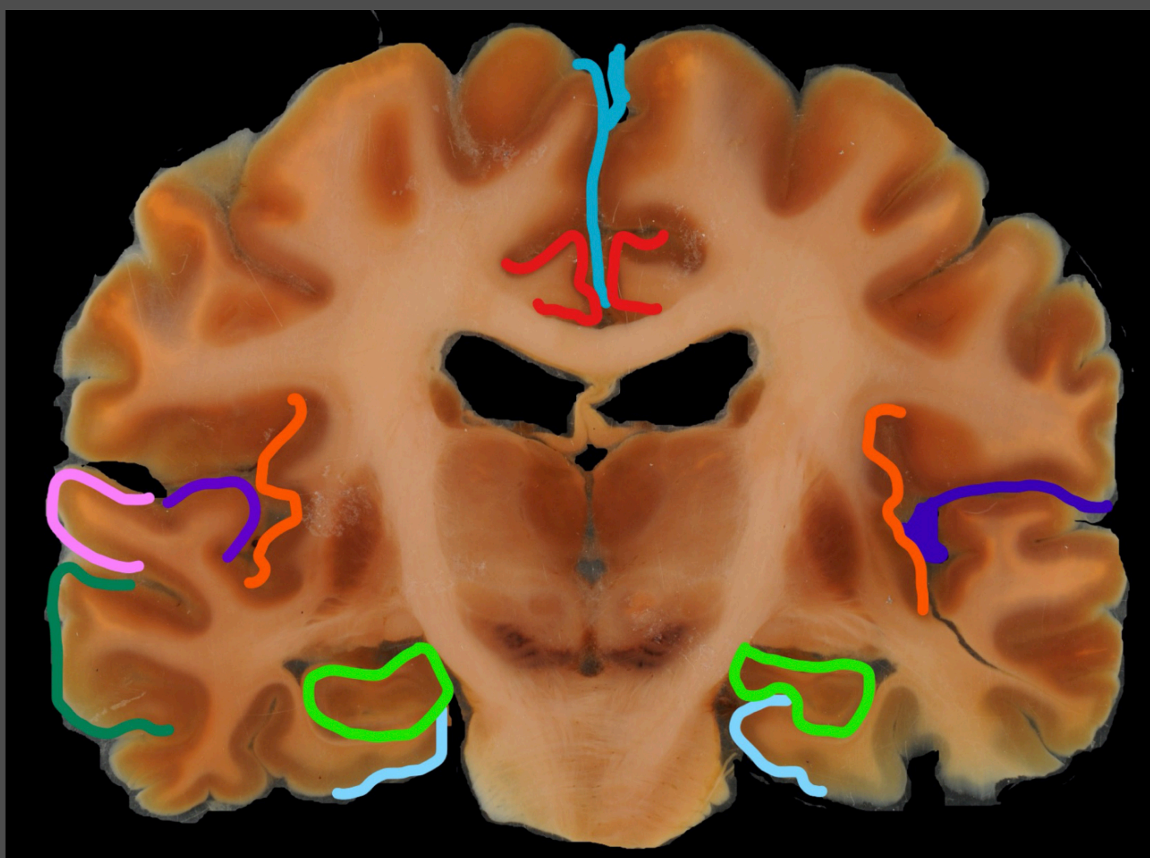
Coronal sections provide an excellent way of visualizing the anatomy of cerebrum. Topographic features that can be visualized include the depth of the sulci, differences in the gray and white matter, and the parts of the ventricular system. Pathologic changes to neuronal tissue and the extent of masses can be noted using these planes of section.

INTERACTIVE

What are each of these colored parts?

The coronal section is through the mid-thalamus and anterior portion of the midbrain and pons. Specimen from Neuroanatomy Collection, Washington State University College of Veterinary Medicine. (*Tap the right arrow for labels*)

Portions of the medial temporal lobe outlined in green and light blue is an area where degeneration of cortical tissue occurs during Alzheimer's disease (discussed in the limbic system lecture in FMS 512 using case examples and providing clinical contexts).



Axonal fiber bundles of the cerebrum

Identify the axonal fiber bundles of the cerebrum on a mid-sagittal brain.

Fiber bundles are classified as commissural, association, projection fibers.

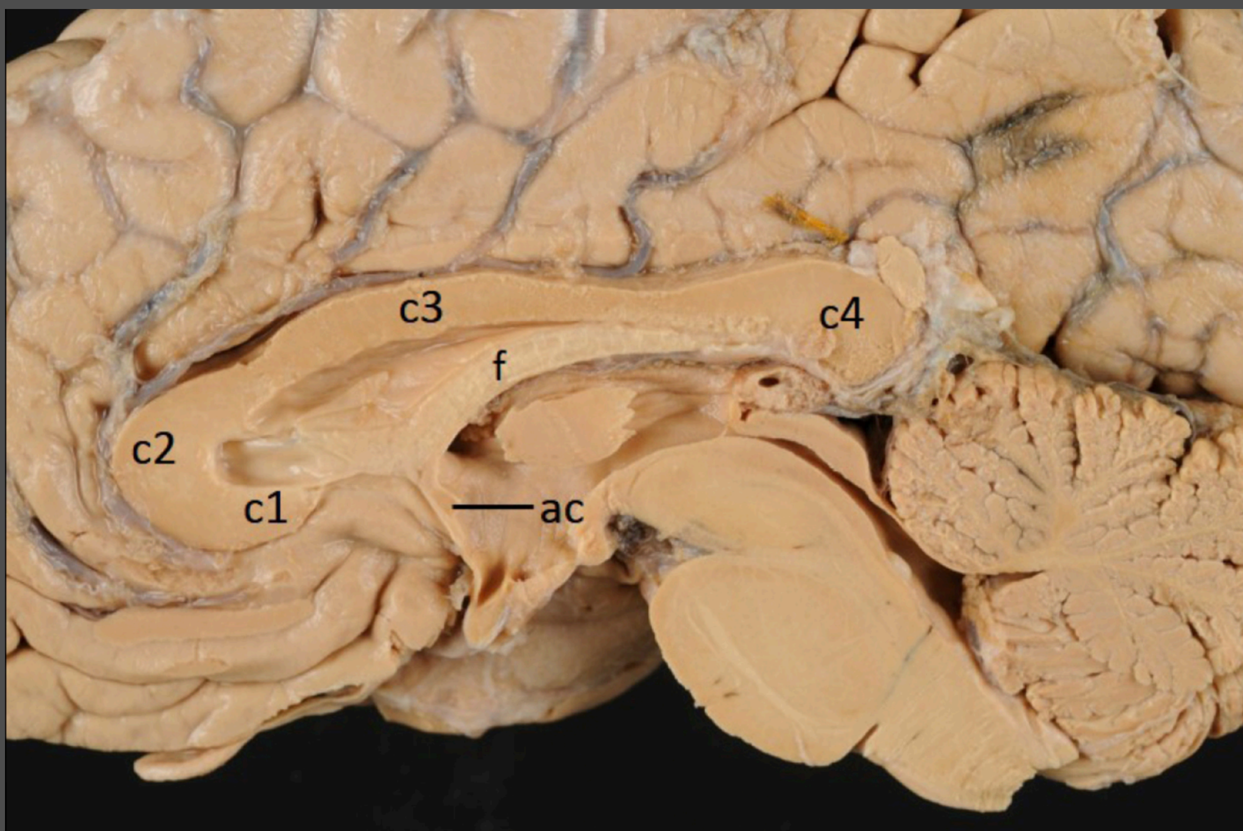
Locate the following axonal fiber bundles in the cerebrum, which can serve as good landmarks.

- [ ] Corpus callosum: A large bundle of commissural fibers located inferior to the cingulate gyrus
    - [ ] Consists of a rostrum, genu, body, and splenium
- [ ] Anterior commissure: A small bundle of commissural fibers that connects inferior portions of the temporal lobes
- [ ] Fornix: Association fibers which provide the major connection between the hippocampus and hypothalamus/thalamus. (This is a very important fiber tract in learning and memory and is discussed during the Limbic System lecture.)

INTERACTIVE

Which fiber bundles of cerebrum are each of these labeled parts?

Specimen from Neuroanatomy Collection, Washington State University College of Veterinary Medicine. (*Tap the right arrow for labels*)



Station 3. Diencephalon

The diencephalon is composed of the thalamus, hypothalamus, and epithalamus.

Thalamus

The thalamus is key structure that relays information to the cortex associated with motor and sensory information.

- There are also thalamus nuclei that form the connections in the memory and emotion circuit from the hippocampal formation. This portion of the thalamus and hypothalamus will be described in the functional neurocircuitry of the limbic system lecture.
- Interthalamic adhesion.

Hypothalamus

The hypothalamus contains key limbic-associated nuclear groups.

- Infundibulum (this connecting stalk may be missing on brain specimens)
- Mammillary bodies: Receives information for hippocampal formation via the fornix and projects to the thalamus. This is part of Papez circuit described in the Limbic System lecture (Neuroanatomy and limbic system functions).

- [ ] The optic chiasm [located anterior and ventral (inferior) to the hypothalamus].

Epithalamus

Identify the structures of the diencephalon on a mid-sagittal brain.

- ☐ Hypothalamus (**A** in the figure)
  - ☐ Mammillary body (#**2** in the figure)
- ☐ Thalamus (**B** in the figure)
  - ☐ Interthalamic adhesion (#**3** in the figure)
- ☐ Epithalamus (**C**), with pineal gland (#**4** in the figure)
- ☐ Anterior commisure (#**1** in the figure)

INTERACTIVE

What are each of these labeled parts?

Diencephalon components and associated structures. Specimen from Neuroanatomy Collection, Washington State University College of Veterinary Medicine. (*Tap the right arrow for labels*)

Station 4: The brainstem

Parts of the brainstem

MIDBRAIN
Mesencephalon

PONS
Metencephalon

MEDULLA
Myelencephalon

- The basal subdivision of the brainstem is the most anterior and contains mostly the descending fiber tracts.
- The tegmentum is the location of the cranial nerve nuclei, ascending fiber tracts, and the reticular formation. In the medulla, it also contains important neurons that are involved in cardiovascular and breathing reflexes.
- The tectum, which is posterior to the tegmentum, is really only prominent in the midbrain and is grossly represented by the **superior and inferior colliculi**. It contains the nuclei that are involved in vision, hearing, and reflexive control of pupillary constriction. Tectospinal tracts originating in the tectum supply the postural muscles that directly initiate reflexive movement to auditory and visual stimuli.
- Brain stem vascular lesions lead to multiple signs that may seem unrelated but can often be localized to a specific brain stem region. Knowledge of the brain stem anatomy will help with the localization. Examples of this will be presented in the functional neuroanatomy and circulation lecture.

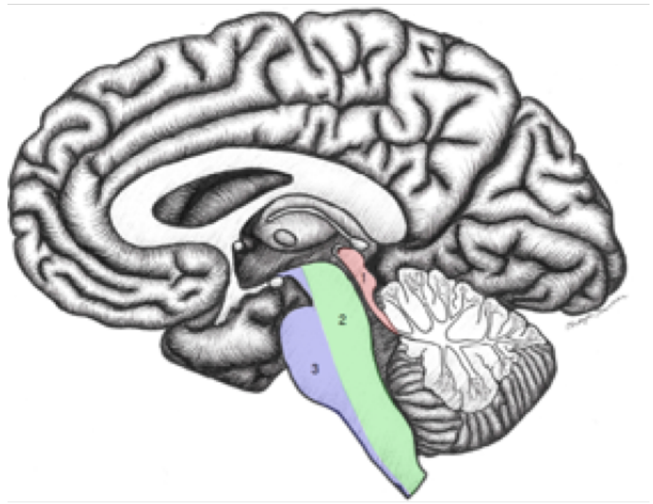


Figure 1. Subdivisions of the brainstem; mid-sagittal plane. Three subdivisions of the brainstem:

1. Tectum
2. Tegmentum
3. Basal region

Figure from Neuroanatomy: A Laboratory Guide (2e); Jansen and Lampa (2018).

Identify the portions and subdivisions of the brain stem on a mid-sagittal brain.

- ☐ Basal region of midbrain (cerebral peduncle)
- ☐ Tegmentum of midbrain
- ☐ Tectum of midbrain
- ☐ Basal region of pons (basis points)
- ☐ Tegmentum of pons

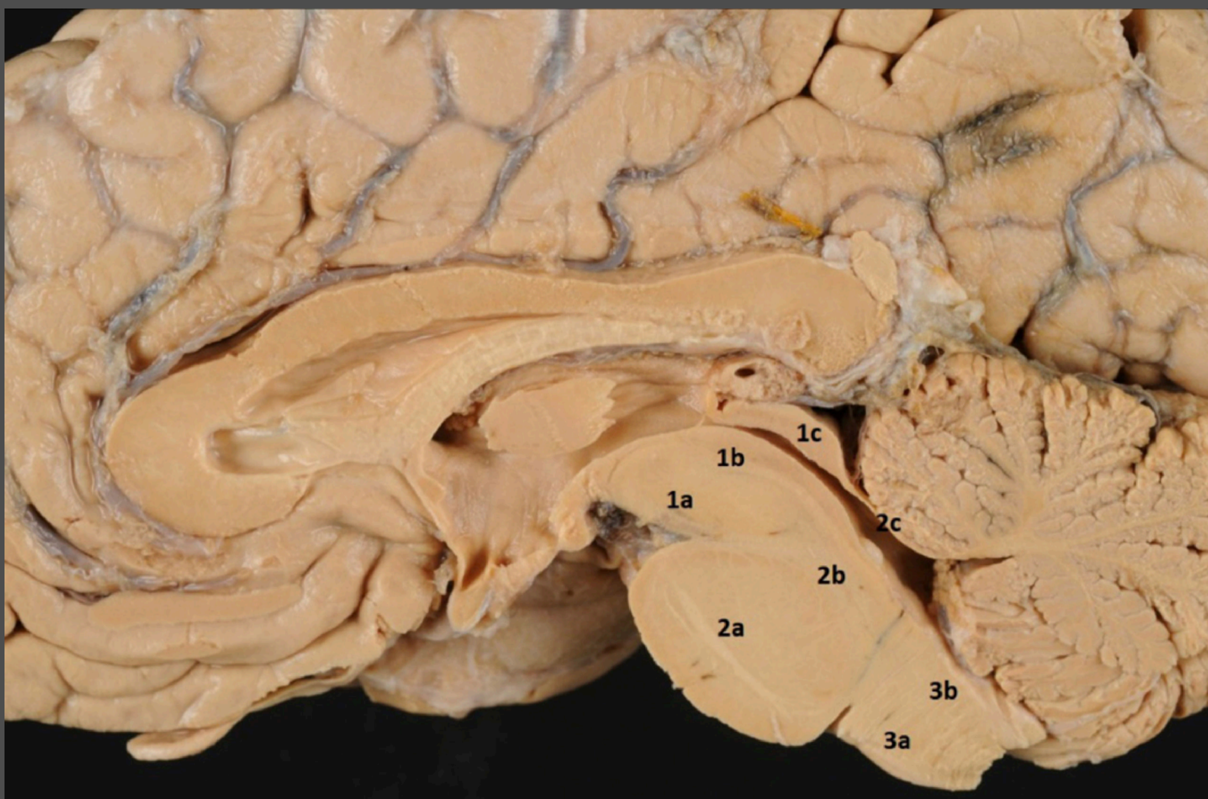
☐ Tectum of pons

☐ Basal region of medulla

☐ Tegmentum of medulla

INTERACTIVE

Subdivisions of the brainstem; mid-sagittal plane. (*Tap the right arrow for labels*)



Specimen from Neuroanatomy Collection, Washington State University College of Veterinary Medicine.

CHECK YOURSELF

On a sagittal image of a brainstem, locate the tegmentum and tectum (Figure 1 and the interactive above).

Identify the exernal features of the brain stem.

> *The relevant portions of the brain stem and their specific important nuclear groups and tracts contained within will be discussed in the large-group sessions.*

Utilize the external topography of the brain stem to locate internal structures as you a beginning to learn the cross sectional and and the related significance to lesion localization.
Examine the external topography of the brainstem and cerebellum and identify the following structures (Figure 2, Figure 3a, and Figure 3.b):

Midbrain

- ☐ Superior and inferior colliculi
- ☐ Cerebral peduncles (aka crus cerebri)
- ☐ Axons of cranial nerves III and IV

Pons

- ☐ Basal pons (aka basis pontis or base of pons)
- ☐ Middle cerebellar peduncle
- ☐ Axons of cranial nerve V

Pons/medulla junction

- ☐ Axons of cranial nerves VI, VII, and VIIII

Medulla

- ☐ Pyramids
- ☐ Olives (inferior olivary nucleus)
- ☐ Axons of cranial nerves IX, X, XI, XII

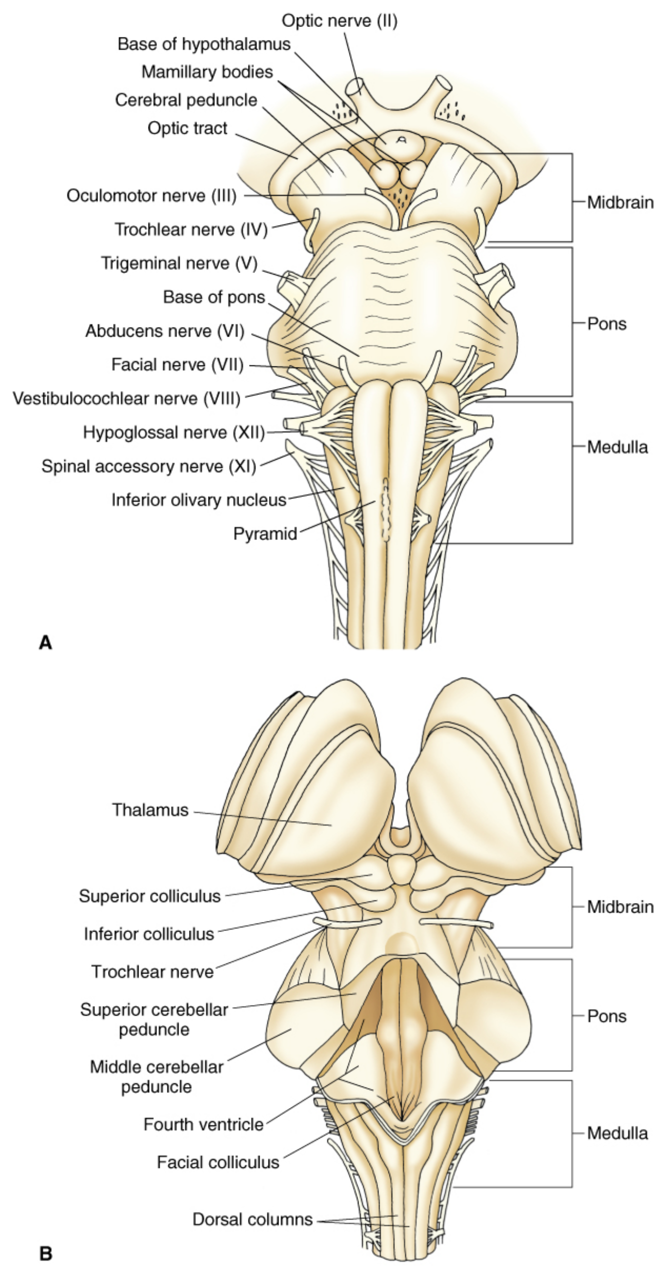


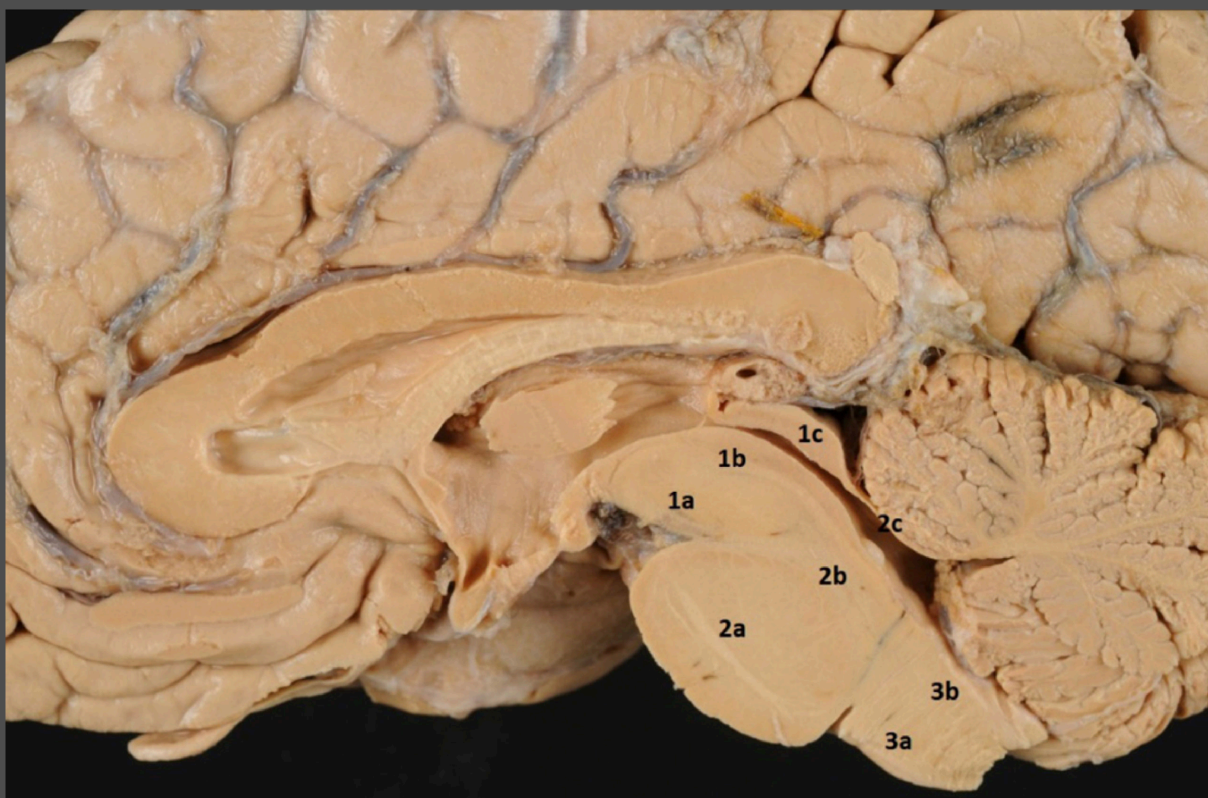
Figure 2. Ventral and dorsal surfaces of the brainstem. From Brainstem II: Pons and Cerebellum; Essential Neuro-

Cerebellum (pictured in Figure 3a)

- [ ] Tectum of pons
- [ ] Basal region of medulla
- [ ] Tegmentum of medulla

INTERACTIVE

Subdivisions of the brainstem; mid-sagittal plane. (*Tap the right arrow for labels*)



Specimen from Neuroanatomy Collection, Washington State University College of Veterinary Medicine.

CHECK YOURSELF

On a sagittal image of a brainstem, locate the tegmentum and tectum (Figure 1 and the interactive above).

Identify the exernal features of the brain stem.

> *The relevant portions of the brain stem and their specific important nuclear groups and tracts contained within will be discussed in the large-group sessions.*

Utilize the external topography of the brain stem to locate internal structures as you a beginning to learn the cross sectional and and the related significance to lesion localization.
Examine the external topography of the brainstem and cerebellum and identify the following structures (Figure 2, Figure 3a, and Figure 3.b):

Midbrain

- ☐ Superior and inferior colliculi
- ☐ Cerebral peduncles (aka crus cerebri)
- ☐ Axons of cranial nerves III and IV

Pons

- ☐ Basal pons (aka basis pontis or base of pons)
- ☐ Middle cerebellar peduncle
- ☐ Axons of cranial nerve V

Pons/medulla junction

- ☐ Axons of cranial nerves VI, VII, and VIIII

Medulla

- ☐ Pyramids
- ☐ Olives (inferior olivary nucleus)
- ☐ Axons of cranial nerves IX, X, XI, XII

Cerebellum (pictured in Figure 3a)

- ☐ Vermis: Separates two cerebellar hemispheres
- ☐ Cerebellar tonsil

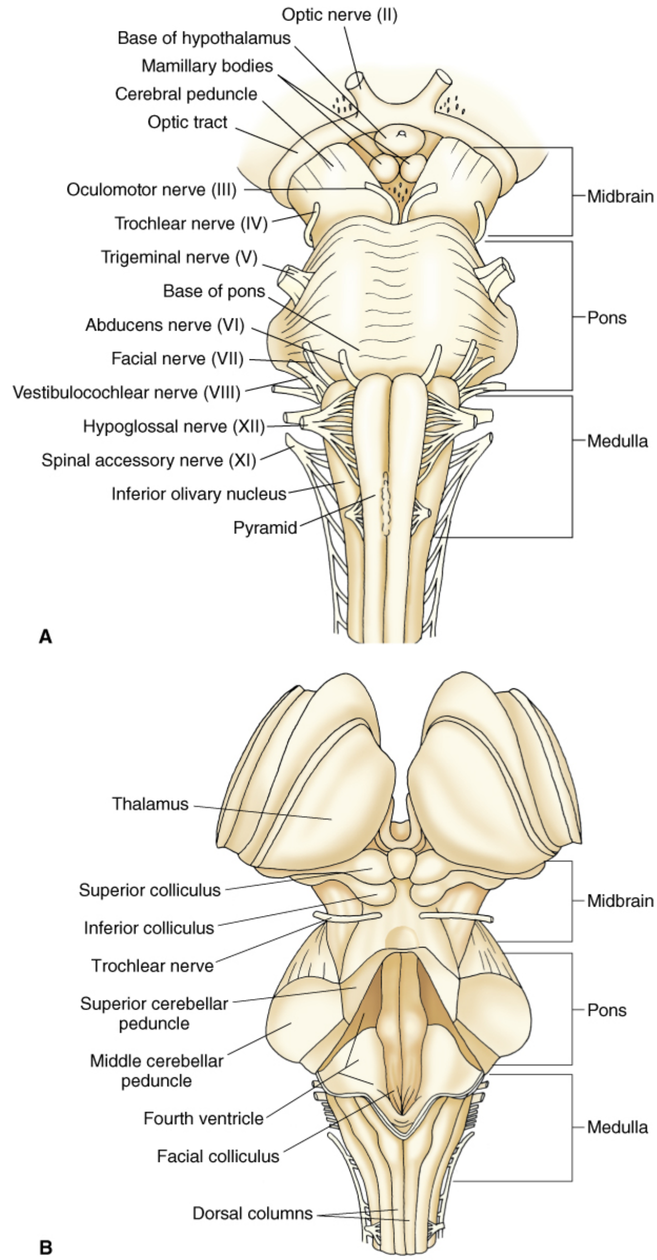


Figure 2. Ventral and dorsal surfaces of the brainstem. From Brainstem II: Pons and Cerebellum; Essential Neuroscience, 3e, 2015; Copyright © Wolters Kluwer.

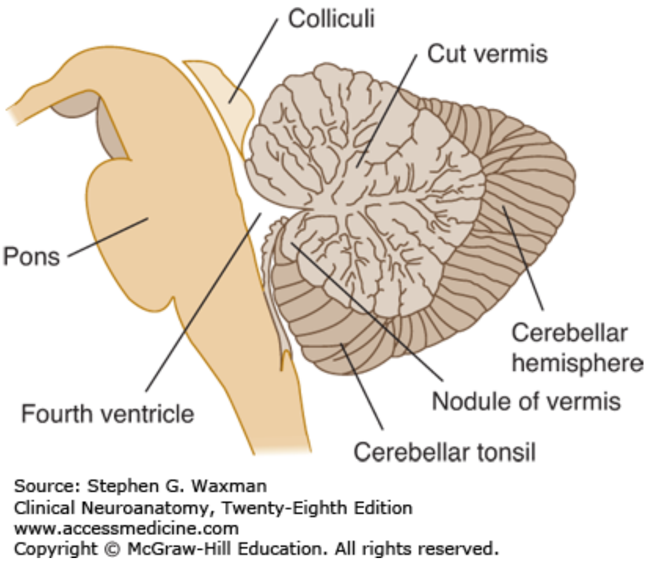


Figure 3a. Cerebellar anatomy. The Brain Stem and Cerebellum, Waxman SG. Clinical Neuroanatomy, 28e; 2017. Copyright © 2018 McGraw-Hill Education. All rights reserved.

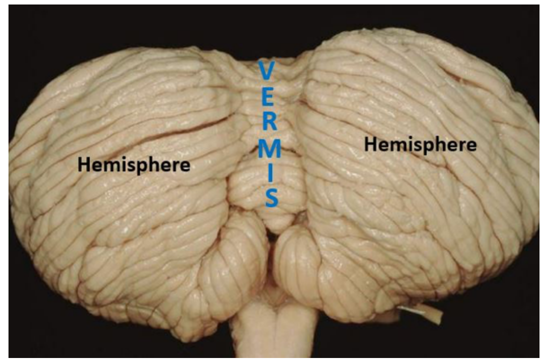


Figure 3b.

GO TO CRANIAL NERVES IN THE BRAIN

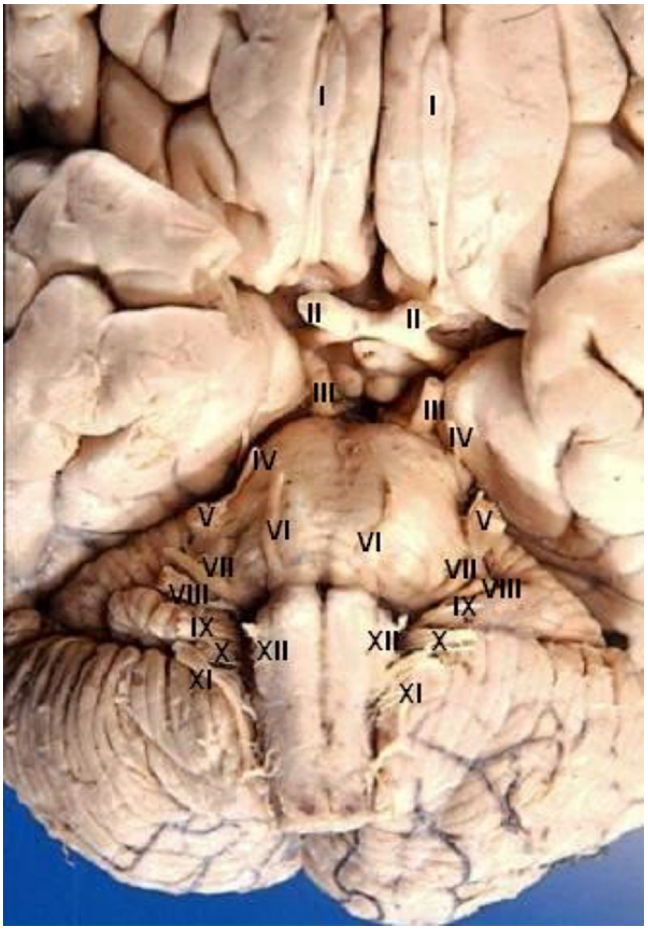


Figure 4. Inferior surface of the cerebrum and brainstem with cranial nerves. (Note the attachment points of Cranial Nerves I–XII to the cerebrum, diencephalon, and brainstem.) Wikimedia.org.

Note the exit points of the cranial nerve axons from medial to lateral on the brainstem (Figure 2 and Figure 4).

⊞

CEREBELLOPONTINE ANGLE TUMORS

⊞

TONSILLAR HERNIATION

Table 1. Cranial nerves: Numbers, names, and basic functions

Number	*Name*	*Basic function (afferent or efferent)*
I	Olfactory	Transmits smell to CNS
II	Optic	Transmits visual information to CNS
III	Oculomotor	Innervates inferior rectus, superior rectus, levator palpebrae superioris, medial rectus and inferior oblique; visceral motor (parasympathetic [PS] to sphincter pupillae and ciliary muscle)

IV	Trochlear	Innervates the superior oblique muscle
V	Trigeminal • Ophthalmic • Maxillary • Mandibular	Transmits somatic afferent sensory information from the face, cornea, and anterior portion of the tongue; innervates muscles of mastication, palate, and middle ear (Mandibular n.)
VI	Abducens	Innervates lateral rectus muscle
VII	Facial	Transmits taste from anterior portion of the tongue; provides motor innervation to muscles of the face; supplies visceral motor (PS) information to mucous glands in nasal and oral cavities, salivary glands, and lacrimal gland
VIII	Vestibulocochlear	Transmits hearing and balance information from the inner ear
IX	Glossopharyngeal	Transmits taste and general sensations from posterior portion of the tongue and pharynx, innervates pharyngeal muscles, supplies visceral motor information to the parotid salivary gland
x	Vagus	Transmits sensations from larynx and pharynx, supplies visceral motor information to thoracic and abdominal viscera to descending colon; supplies innervation to laryngeal and pharyngeal muscles
XI	Accessory	Innervates trapezius and sternocleidomastoid; innervation to laryngeal muscles via vagus
XII	Hypoglossal	Innervates muscles of the tongue

Overview of the brain stem

Station 5: Blood supply and circulation

Arterial blood supply

Review and identify the arterial supply.

Vertebral arteries supplying the brainstem and cerebellum

- ☐ Anterior and posterior spinal
- ☐ Posterior inferior cerebellar
- ☐ Basilar (unpaired)—multiple pontine branches also come directly off the basilar artery
    - ☐ Anterior inferior cerebellar
    - ☐ Superior cerebellar
    - ☐ Posterior cerebral
        - ☐ Posterior communicating

Internal carotid supplying the midbrain, thalamus, hypothalamus, and cerebrum

- ☐ Middle cerebral
- ☐ Anterior communicating
- ☐ Anterior cerebral

AN EPISODE OF VASCULAR INSUFFICIENCY TO NEURONS LEADS TO A STROKE.

Ischemic strokes are sudden blockages of blood flow to parts of the CNS are most commonly caused by a thrombus or an embolus. Clinical presentations of vascular insufficiency often present as specific functional losses.

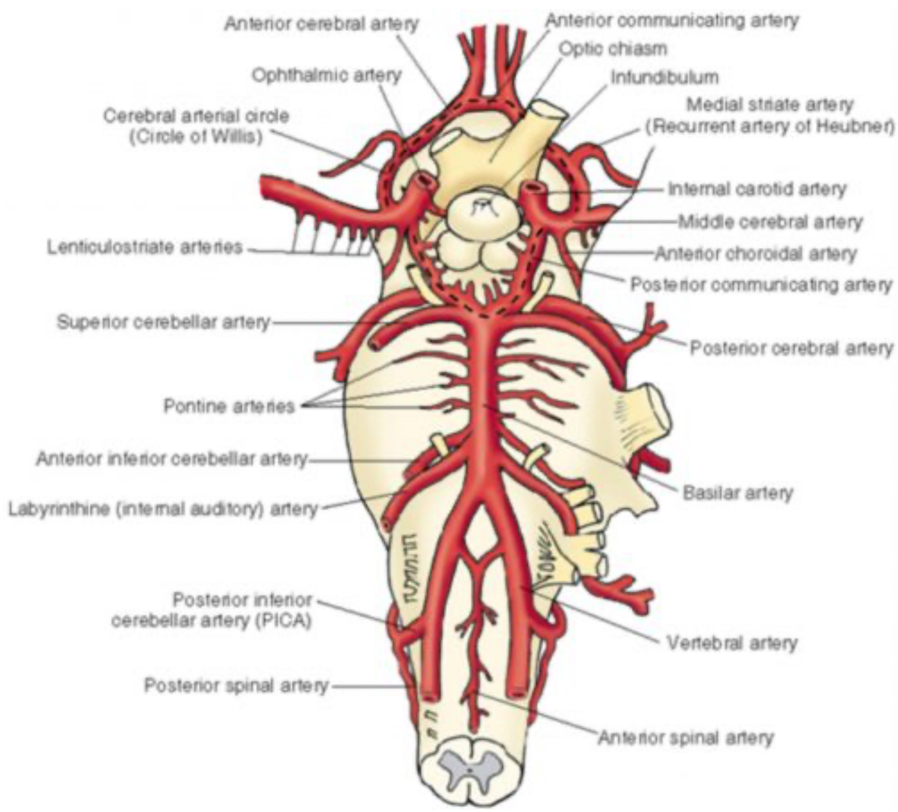


Figure 1. Anterior and posterior circulation (dashed line indicates the circle of Willis). Blood Supply of the Central Nervous System; Essential Neuroscience, 3e, 2015, Copyright © Wolters Kluwer. Accessed July 16, 2018.

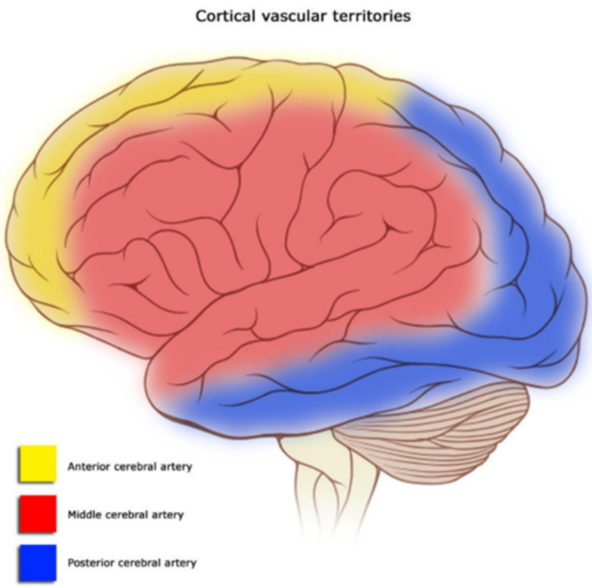


Figure 2. Vascular territories of the cortex. Commons.wikipedia.org.

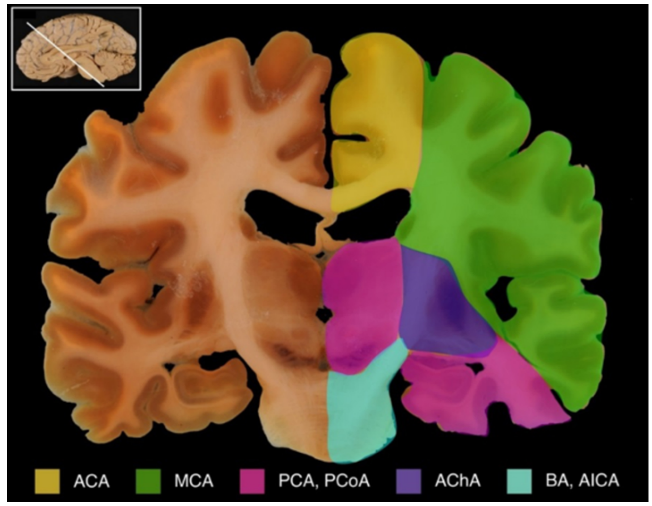


Figure 3. Coronal section of cerebral artery supply.

- ACha: Anterior choroidal
- BA: Basilar
- AICA: Anterior inferior cerebellar (other abbreviations previously mentioned).

From Neuroanatomy: A Laboratory Guide (2e); Jansen and Lampa.

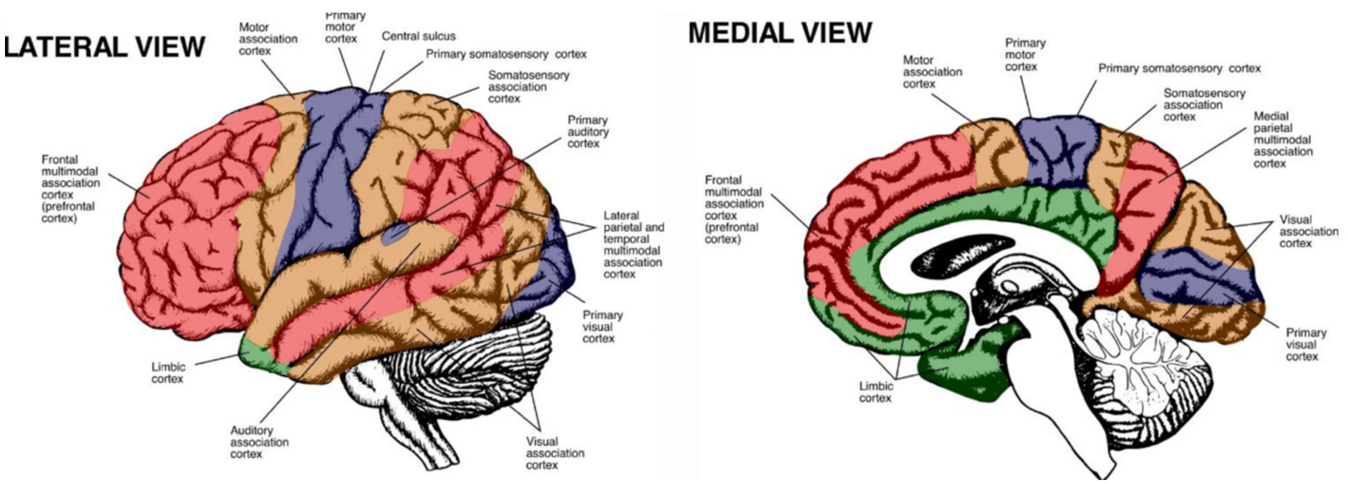


Figure 4. Lateral and medial views of functional areas of the cortex. From Neuroanatomy: A Laboratory Guide (2e); Jansen and Lampa.

Use the tables below to demonstrate on a specimen or draw on a whiteboard regions of the brain and brain stem supplied by these arteries.

Anterior Cerebral

- Area Supplied
- Focal Ischemia Loss of Function

Middle Cerebral

- Area Supplied
- Focal Ischemia Loss of Function

Posterior Cerebral

- Area Supplied
- Focal Ischemia Loss of Function

Anterior Inf. Cerebellar

- Area Supplied
- Focal Ischemia Loss of Function

Posterior Inf. Cerebellar

- Area Supplied
- Focal Ischemia Loss of Function

Ant. Spinal or Vertebral

- Area Supplied
- Focal Ischemia Loss of Function

Figure 5. For each of the arteries listed here, demonstrate on a brain specimen or diagram on a whiteboard to describe the area supplied by each artery.

Table 1. Anterior arterial circulation territories.

Anterior circulation	*Territory*	*Ischemic loss of function*
Internal carotid/central artery of retina	Retina	Monocular blindness
Middle cerebral artery	Lateral primary motor area (precentral gyrus)	Contralateral face and arm weakness
	Lateral primary somatosensory area (postcentral gyrus)	Contralateral face and arm anesthesia

	Internal capsule (lateral striate artery)	Contralateral arm, face, leg weakness and anesthesia
	Inferior frontal gyrus	Motor (Broca's) aphasia
	Frontal eye fields	Gaze to affected side
	Superior temporal gyrus	Receptive (Wernicke's) aphasia
	Angular gyrus	Hemianopia (either), alexia (left)
	Inferior parietal lobule (non-dominant side)	Contralateral sensory neglect, dressing apraxia, constructional apraxia
	Entire territory of middle cerebral artery (proximal to bifurcation into superior and inferior divisions)	Contralateral hemiparesis and hemianesthesia, plus global aphasia if dominant hemisphere affected
Anterior cerebral artery	Medial primary motor and somatosensory area (paracentral lobule)	Contralateral leg weakness and anesthesia
	Prefrontal cortex (orbital gyri and anterior pole of frontal lobe)	Apathy w/ potential memory loss

Table 2. Posterior arterial circulation territories

Posterior circulation	*Territory*	*Ischemic loss of function*
Posterior cerebral artery	Occipital lobe	Homonymous hemianopia (with macular sparing), alexia without agraphia
	Thalamus (diencephalon)	Hemi-sensory loss
	Midbrain	Oculomotor nerve palsy (mydriasis, diplopia), contralateral hemiparesis, hemi-sensory loss, possible loss of consciousness
Basilar artery	Basal pons	Contralateral hemiparesis, CN VI signs
	Anterior midbrain	Limb ataxia, medial rectus palsy/fixed and dilated pupil
Superior cerebellar artery	Lateral rostral pons	Optokinetic nystagmus, contralateral sensory loss (vibration, touch, position and pain and temperature)
Anterior inferior cerebellar artery	Lateral caudal pons	Ipsilateral facial paralysis, gaze palsy, deafness and tinnitus
	Vermis, anterior lobe of cerebellum	Ipsilateral limb ataxia, nystagmus, vertigo, nausea
Posterior inferior cerebellar artery	Lateral medulla	Vertigo, loss of pain and temperature from the limbs and trunk on contralateral side, loss of pain and temperature over the face on the ipsilateral side, truncal ataxia, dysphagia/dysphonia/palatal paralysis, Horner Syndrome

	Inferior cerebellar peduncle	Ataxia (limb and truncal)
Vertebral artery	Medial medulla, anterior spinal cord	Contralateral hemiparesis; touch, vibration and positional sense loss; CN XII sign
Note: Many cerebellar signs are very similar if superior cerebellar, anterior inferior cerebellar, and posterior inferior cerebellar arteries are occluded.		

Venous circulation

REVIEW THE ANATOMY LAB

Lab 26: Scalp, Cranial Cavity, and Meninges →

- The veins of the cerebrum drain into dural venous sinuses, which mostly drain into the internal jugular vein.
  - Cerebral veins
    - Great cerebral vein (of Galen): Deep venous drainage
      - Formed by internal cerebral veins which drain the diencephalon and basal ganglia
    - Superior cerebral veins (numerous): Superficial venous drainage drains into the superior sagittal sinus

- Review of dural venous sinuses (see Figure 6 and Figure 7)
    - Superior sagittal sinus (located superior marginal of falx cerebri)
        - Superior cerebral veins drain into the superior sagittal sinus
        - Contains arachnoid villi where the CSF is re-enters the venous system
    - Straight sinus: Ends posteriorly in confluence of sinuses; receives blood from the great cerebral vein (of Galen) and inferior sagittal sinus
    - Confluence of sinuses
    - Transverse sinuses
    - Sigmoid sinuses
    - Jugular bulb (of internal jugular vein)

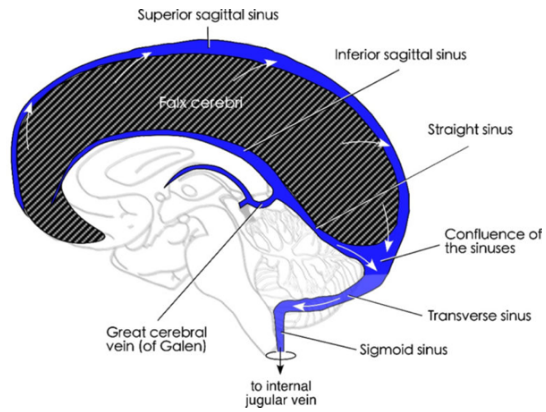


Figure 6. Venous sinus schematic. Figure from Neuroanatomy: A Laboratory Guide (2e); Jansen and Lampa (2018).

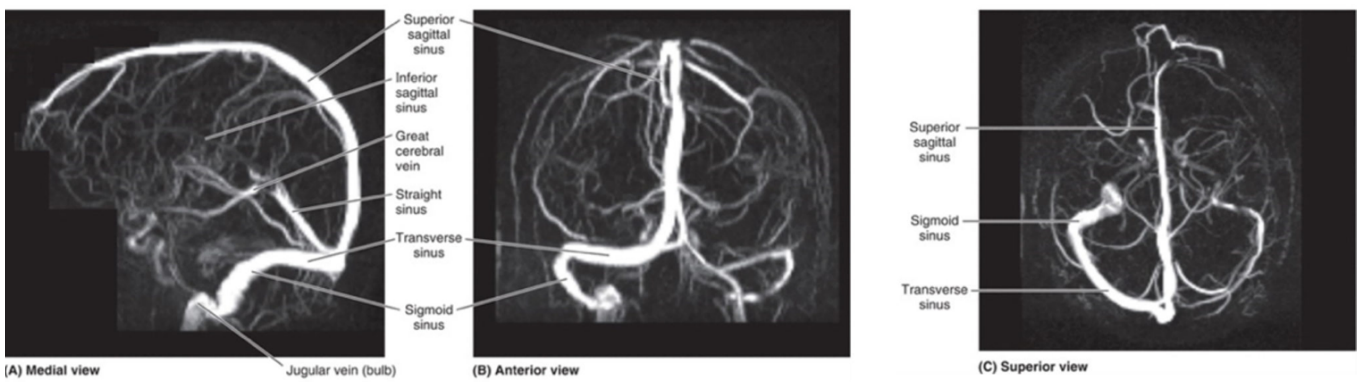


Figure 7. MR venogram of major venous sinuses. Figure from Clinically Oriented Anatomy, 8e, 2018. Accessed August 6, 2018.

CLINICAL SIGNIFICANCE OF THE DURAL VENOUS SINUSES

Besides returning blood from the nervous tissue of the cranial central nervous system, they are also potential routes for infections from more superficial vessels, as well as possible locations of venous thrombi. Signs from increased ICP result from occlusion of the dural sinuses.