

# Human Anatomy

Lec.18

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## Brain

### Nervous System

The nervous system is divided structurally into two main parts: the **central nervous system**, which consists of the brain and spinal cord, and the **peripheral nervous system**, which consists of 12 pairs of cranial nerves and 31 pairs of spinal nerves and their associated ganglia. Functionally, the nervous system can be further divided into the **somatic nervous system**, which controls voluntary activities, and the **autonomic nervous system**, which controls involuntary activities. The nervous system integrates and regulates many body activities such as circulation and respiration. It usually acts quite rapidly and can also modulate effects of the endocrine and immune systems.

### The Brain

#### ➤ Gross Anatomy of the Brain

In general, the brain is composed of the cerebrum, cerebellum, and brainstem (midbrain, pons, and medulla oblongata) (**Fig. 1C**). The most notable feature of the human brain is its large cerebral hemispheres. When the calvaria and dura are removed, gyri (folds), sulci (grooves), and fissures (clefts) of the cerebral cortex are visible (**Fig. 1 A&B**). In addition, four lobes can be recognized (*frontal, parietal, occipital, and temporal*) with the fifth either the *insula* or the *limbic* lobe (**Figs. 1A & 2**).

#### ➤ Parts of the Brain

The brain is that part of the central nervous system that lies inside the cranial cavity. It is also known as encephalon. It is continuous with the spinal cord through the foramen magnum. It consists of the following parts (**Figs. 1 & 2**):

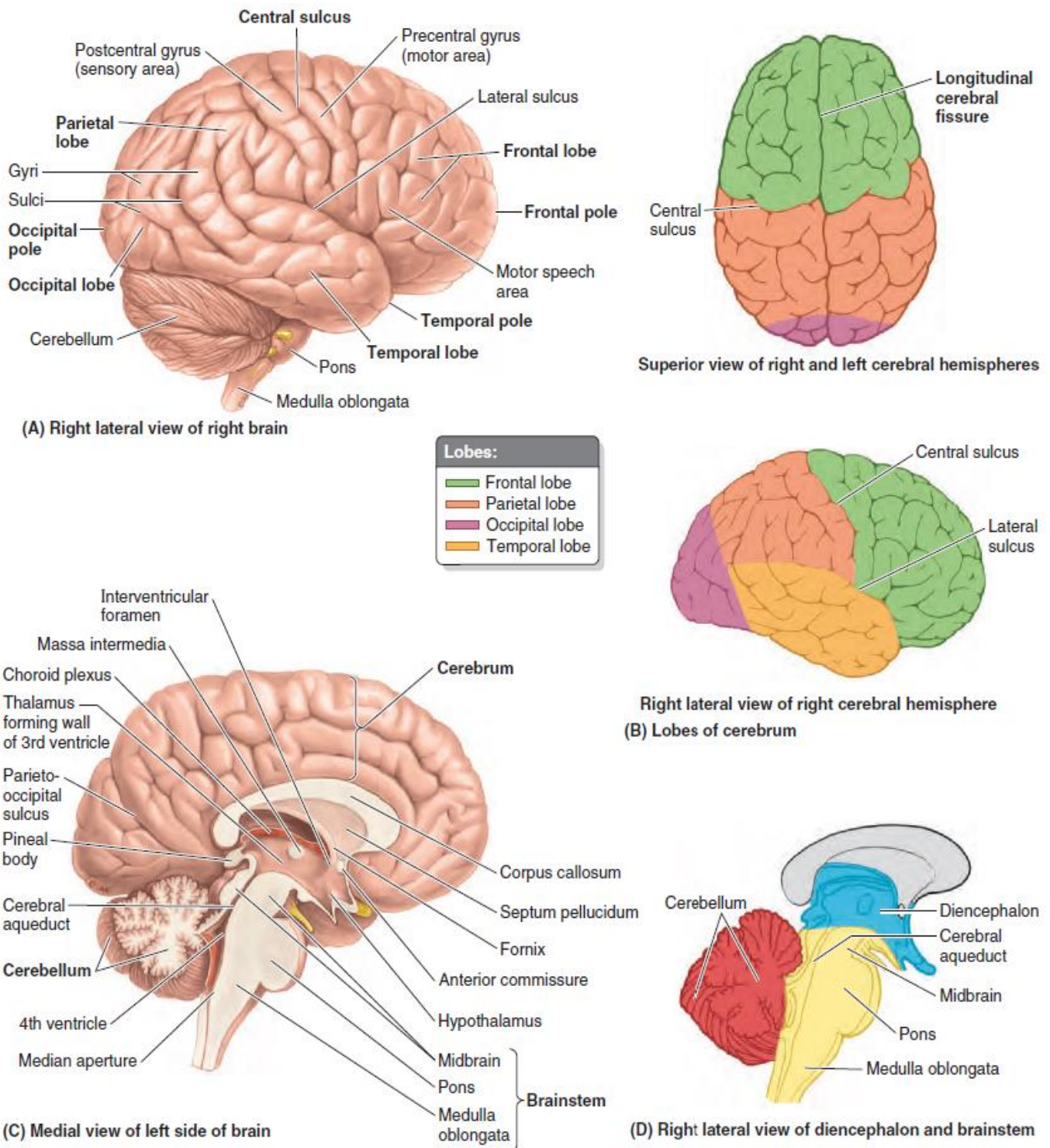
**A. Forebrain:** It is further subdivided into cerebrum and diencephalon

➤ **Cerebrum:** It is the largest part of the brain and consists of two cerebral hemispheres connected by a mass of white matter called the corpus callosum.

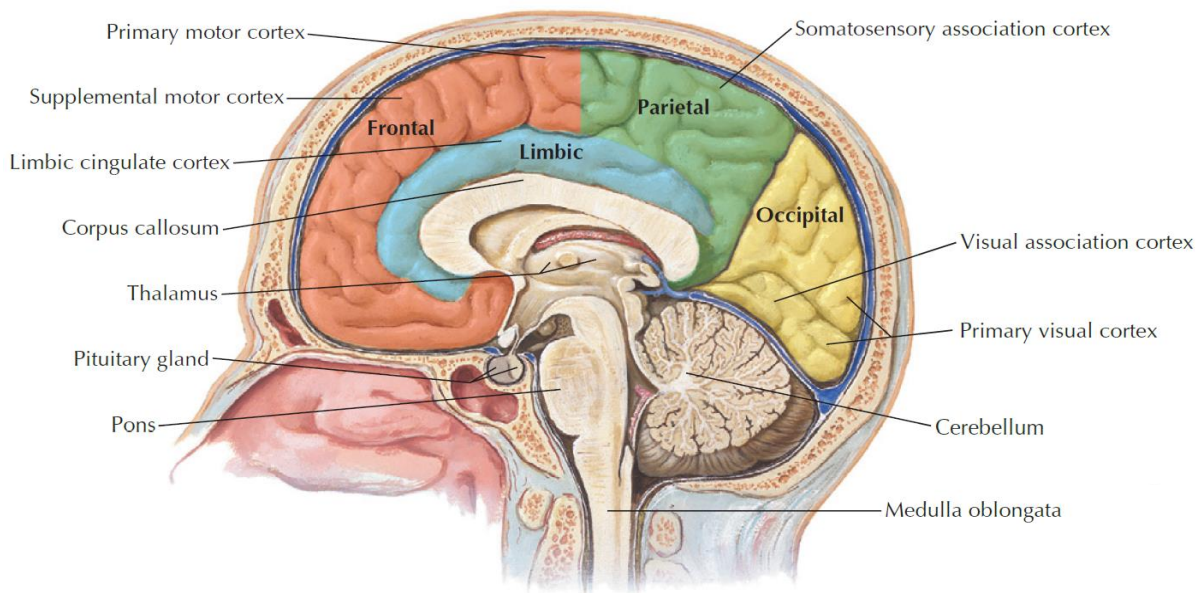
➤ **Diencephalon:** It is almost completely hidden from the surface of the brain. It consists of a dorsal **thalamus** and a ventral **hypothalamus**.

**B. Midbrain:** It is the narrow part of the brain that connects the forebrain to the hindbrain. It is made up of cerebral peduncles.

**C. Hindbrain:** It is made up of pons and medulla oblongata (ventrally) and cerebellum (dorsally).



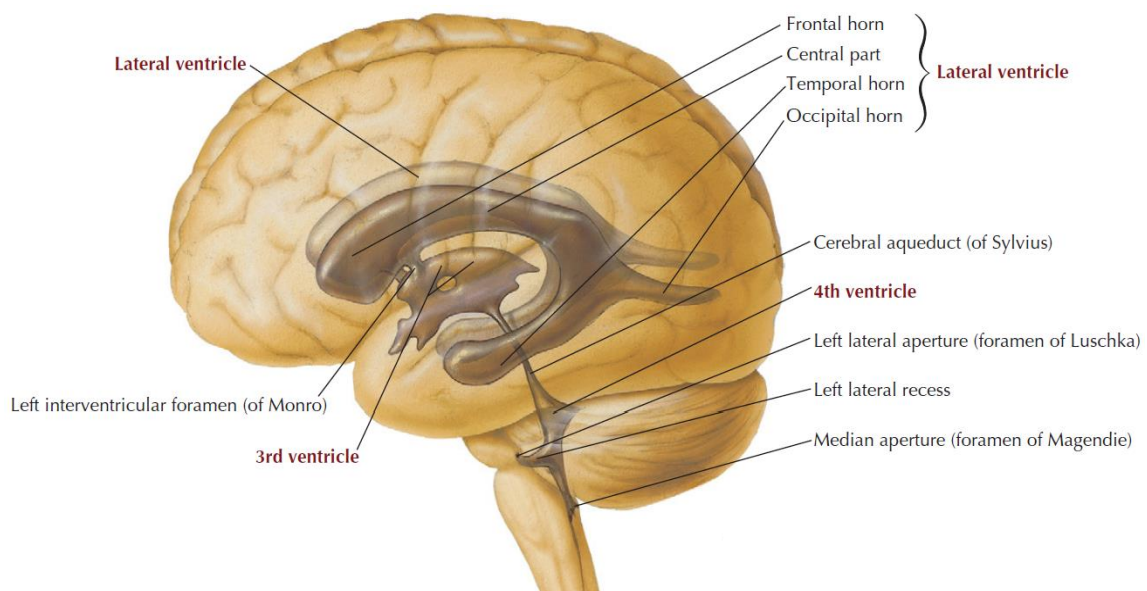
**FIGURE 1:** Structure of brain.



**FIGURE 2:** Brain and brainstem.

## Ventricular System of the Brain

The ventricles of the brain consist of the two lateral ventricles, the 3rd ventricle, and the 4th ventricle connected by the cerebral aqueduct (**Fig. 3**). The cerebrospinal fluid (CSF), largely secreted by the choroid plexuses of the ventricles, fills these brain cavities and the subarachnoid space of the brain and spinal cord. It protects the brain by providing a cushion against blows to the head. The CSF in the subarachnoid space provides the buoyancy that prevents the weight of the brain from compressing the cranial nerve roots and blood vessels against the internal surface of the cranium. In addition, it removes the waste products that associated with neuronal activity.



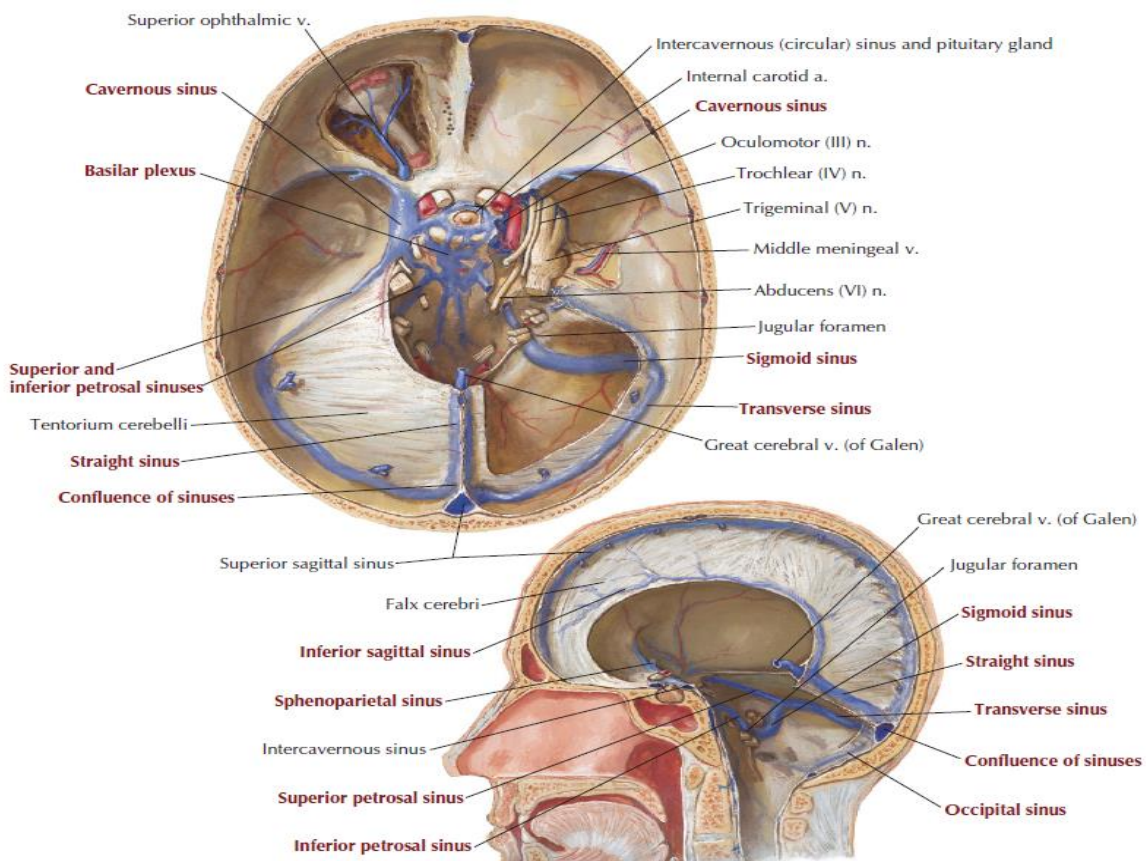
**FIGURE 3:** Ventricular system of the brain.



## The Venous Blood Sinuses (Dural Sinuses)

The venous sinuses of the cranial cavity are blood-filled spaces situated between the layers of the dura mater; they are lined by endothelium. Their walls are thick and composed of fibrous tissue; they have no muscular tissue. The sinuses have no valves. They receive tributaries from the brain, the diploë of the skull, the orbit, and the internal ear. The dural venous sinuses are: (**Fig. 4**) [*See also Fig. 2, Lecture 9*]

- The **superior and inferior sagittal sinuses**
- The **straight sinus**
- The **right transverse sinus** (a continuation of the superior sagittal sinus)
- The **left transverse sinus** (a continuation of the straight sinus)
- The **sigmoid sinuses** (a direct continuation of the transverse sinuses)
- The **occipital sinus**
- The **confluence of sinuses** (meeting of superior sagittal, inferior sagittal, straight, and occipital sinuses)
- The **basilar sinus**
- The **superior and inferior petrosal sinuses**
- The **cavernous sinus** (on each side of the sella turcica)
- The **sphenoparietal sinus**
- The **emissary veins**



**FIGURE 4:** Dural venous sinuses.

## Blood Supply of the Brain

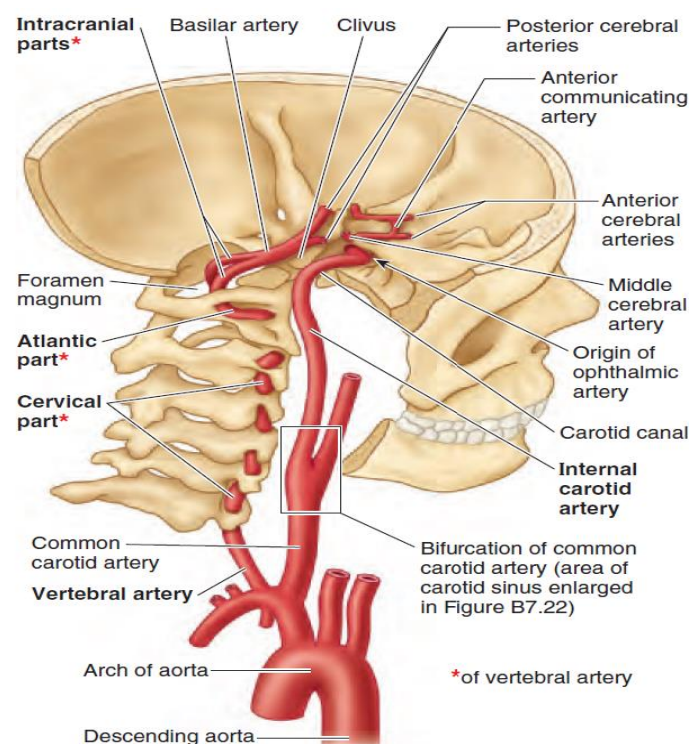
### ➤ Arteries of the Brain

Although it accounts for only about 2.5% of body weight, the brain receives about one sixth of the cardiac output and one fifth of the oxygen consumed by the body at rest. The brain is supplied by the two internal carotid and the two vertebral arteries (**Fig. 5**). The four arteries anastomose on the inferior surface of the brain and form the **circle of Willis** (Discussed in the previous lecture).

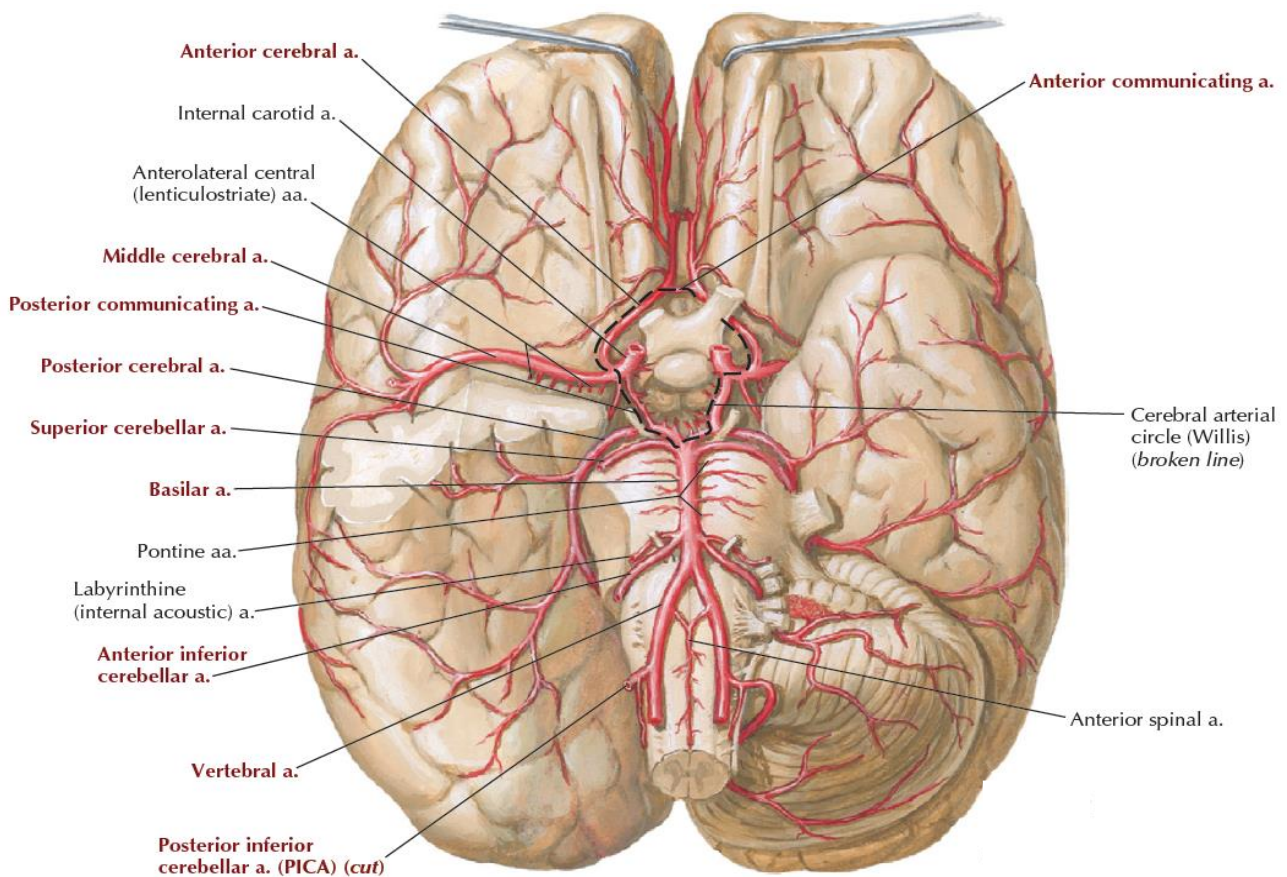
The terminal branches of the internal carotid arteries are the **anterior** and **middle cerebral arteries** (**Figs. 5 & 6**). The anterior cerebral arteries are connected by the **anterior communicating artery**. Near their termination, the internal carotid arteries are joined to the posterior cerebral arteries by the **posterior communicating arteries**. The intracranial parts of the vertebral arteries unite at the caudal border of the pons to form the **basilar artery** (**Figs. 5 & 6**). It ends by dividing into the two **posterior cerebral arteries**.

### ➤ Veins of the Brain

The veins of the brain have no muscular tissue in their thin walls, and they possess no valves. Venous drainage from the brain occurs via **cerebral** and **cerebellar veins** that drain to the adjacent dural venous sinuses. The **great cerebral vein** is formed by the union of the two internal cerebral veins and drains into the straight sinus (**Fig. 4**).



**FIGURE 5:** Arterial supply to brain.



**FIGURE 6:** Arterial circle on base of brain.

## Cranial Meninges

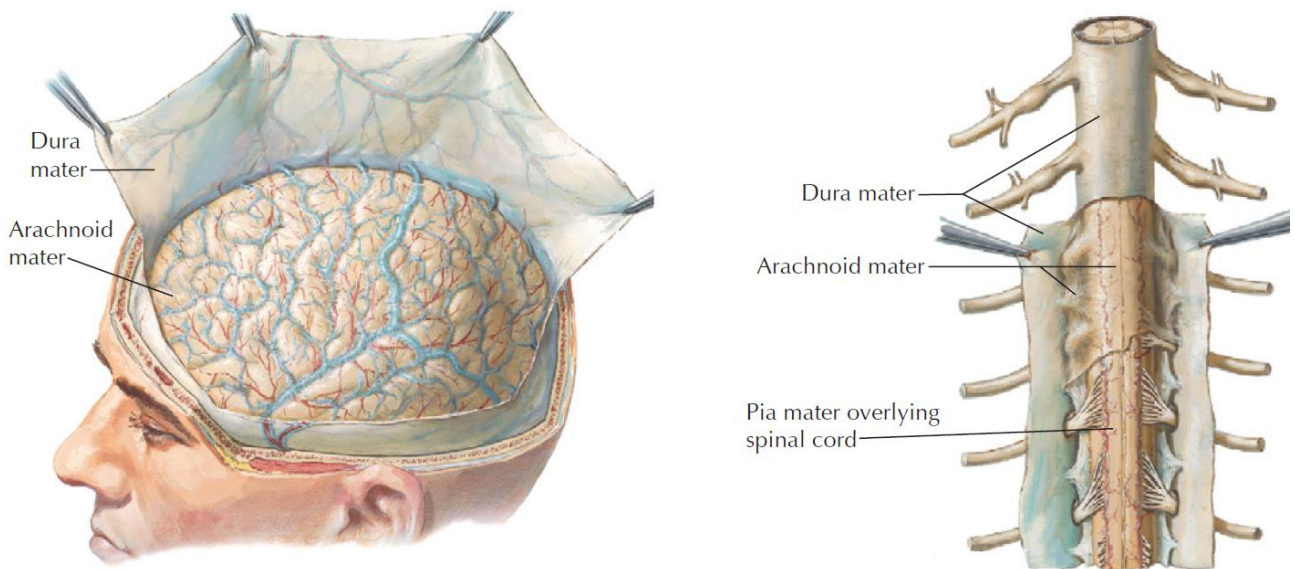
The brain and spinal cord are surrounded by three membranous connective tissue layers called the meninges. The cranial meninges protect the brain, form the supporting framework for blood vessels and venous sinuses, and enclose the subarachnoid space (a fluid-filled cavity), which is vital to the normal function of the brain. The three layers include the following (**Figs. 7 & 8**):

**1. Dura mater:** tough, thick external fibrous layer that is richly innervated by sensory nerve fibers. The cranial dura is distinguished from the spinal dura by its two layers (**Fig. 8**). The outer **periosteal layer** is attached to the inner aspect of the cranium; the inner **meningeal layer** is in close contact with the underlying arachnoid mater.

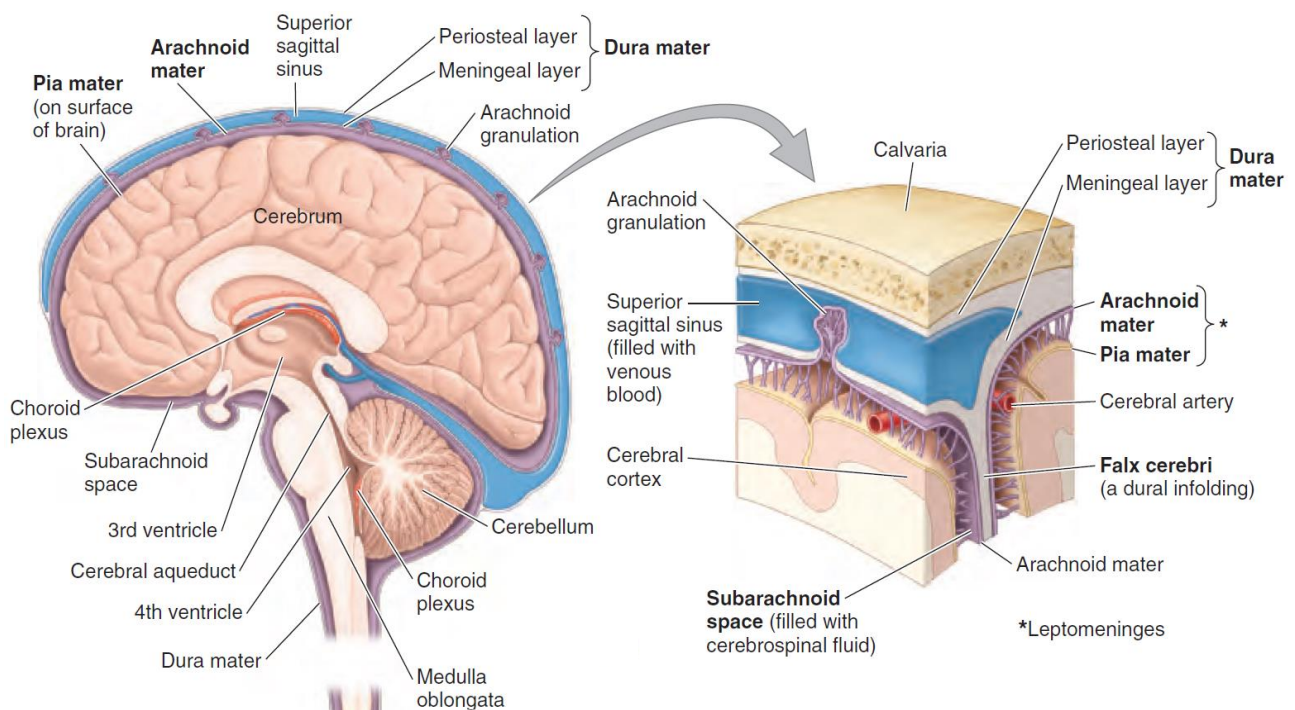
**2. Arachnoid mater:** thin intermediate avascular layer directly beneath the dural surface; it is separated from the dura by a potential space, the subdural space. The space between the arachnoid and the underlying pia is called the subarachnoid space and contains CSF, which bathes and protects the central nervous system.

**3. Pia mater:** delicate internal vasculated layer of connective tissue that intimately envelops the brain and spinal cord.





**FIGURE 7: CNS meninges.**



**FIGURE 8: Cranial meninges of the brain.**

### Dural Nerve Supply

Branches of the trigeminal (CN V), vagus (CN X), first three cervical nerves (C1-C3), and branches from the sympathetic system pass to the dura. A portion of the dura in the posterior cranial fossa also may receive some innervation from the glossopharyngeal nerve (CN IX) and hypoglossal nerve (CN XII). The arachnoid and pia mater lack sensory innervation.

## **Dural Arterial Supply**

Numerous arteries supply the dura mater from the internal carotid, maxillary, ascending pharyngeal, occipital, and vertebral arteries. From a clinical standpoint, the most important is the middle meningeal artery, which is commonly damaged in head injuries.

## **Dural Venous Drainage**

The meningeal veins lie in the endosteal layer of dura. The **middle meningeal vein** follows the branches of the middle meningeal artery and drains into the pterygoid venous plexus or the sphenoparietal sinus.

## **Clinical Focus**

Numerous sensory endings are in the dura. The dura is sensitive to stretching, which produces the sensation of headache.

### ➤ **Meningitis**

It is a serious condition defined as an inflammation of the arachnoid and pia mater. It results from bacterial or viral infections, drug reactions, and systemic diseases.

### ➤ **Epidural Hematomas**

It is the collection of arterial blood between the periosteal dura and bony cranium.

### ➤ **Subdural Hematomas**

It is the collection of venous blood between the meningeal dura and arachnoid mater.

### ➤ **Subarachnoid Hemorrhage**

It is the collection of arterial blood between the arachnoid and pia mater.

### ➤ **Transient Ischemic Attack (TIA)**

It is a temporary interruption of focal brain circulation that lasts less than 24 hours. The most common cause is embolic disease which may temporarily block a vessel.

### ➤ **Stroke**

Cerebrovascular accident (CVA) or stroke is a localized brain injury that lasts more than 24 hours. Stroke is classified into the following two types:

✓ **Ischemic** (80%): infarction; thrombotic or embolic.

✓ **Hemorrhagic**: occurs when a cerebral vessel weakens and ruptures.



## **References**

- 1. Snell RS: Clinical anatomy by regions. Lippincott Williams & Wilkins, 2011.**
- 2. Keith LM: Clinically Oriented Anatomy, 7th edition. Wolters Kluwer, 2014.**
- 3. Hansen JT: Netter's Clinical Anatomy, 3<sup>rd</sup> edition. E-Book with Online Access. Elsevier Health Sciences, 2014.**