

Brain

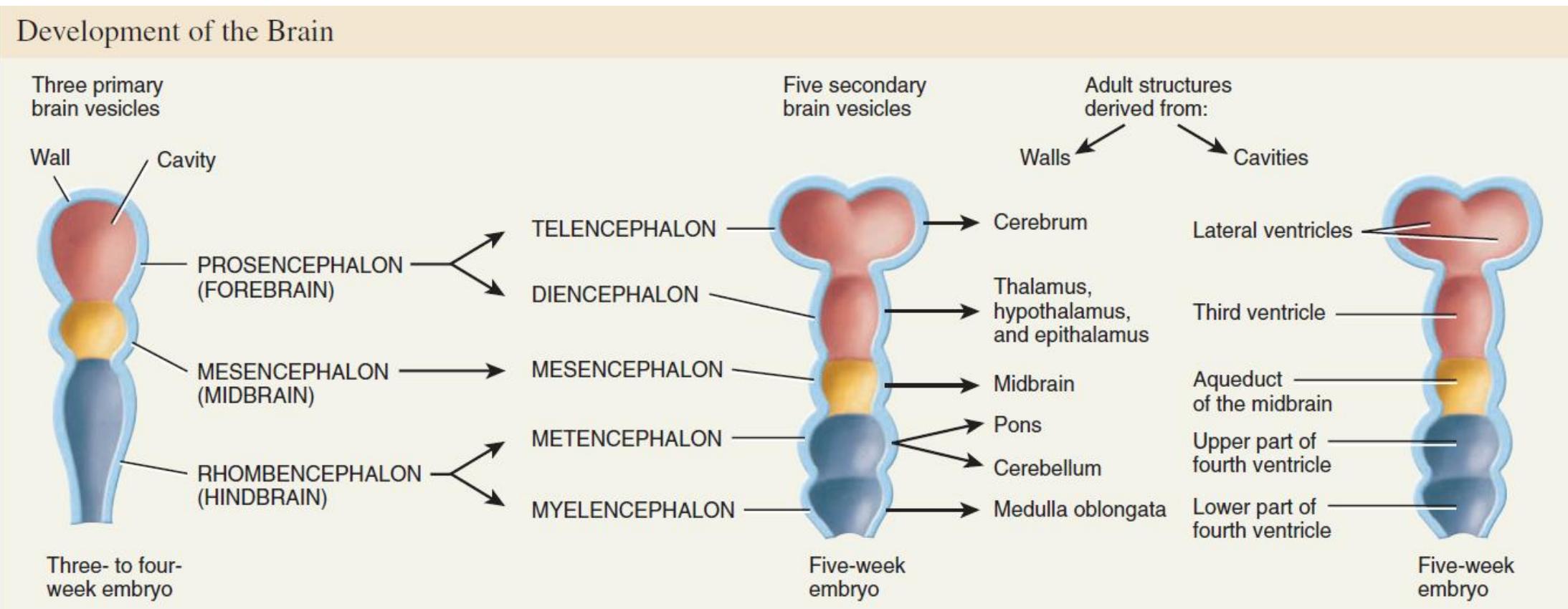
Unit 2

By
Dr. Neelam Shobha Nirala

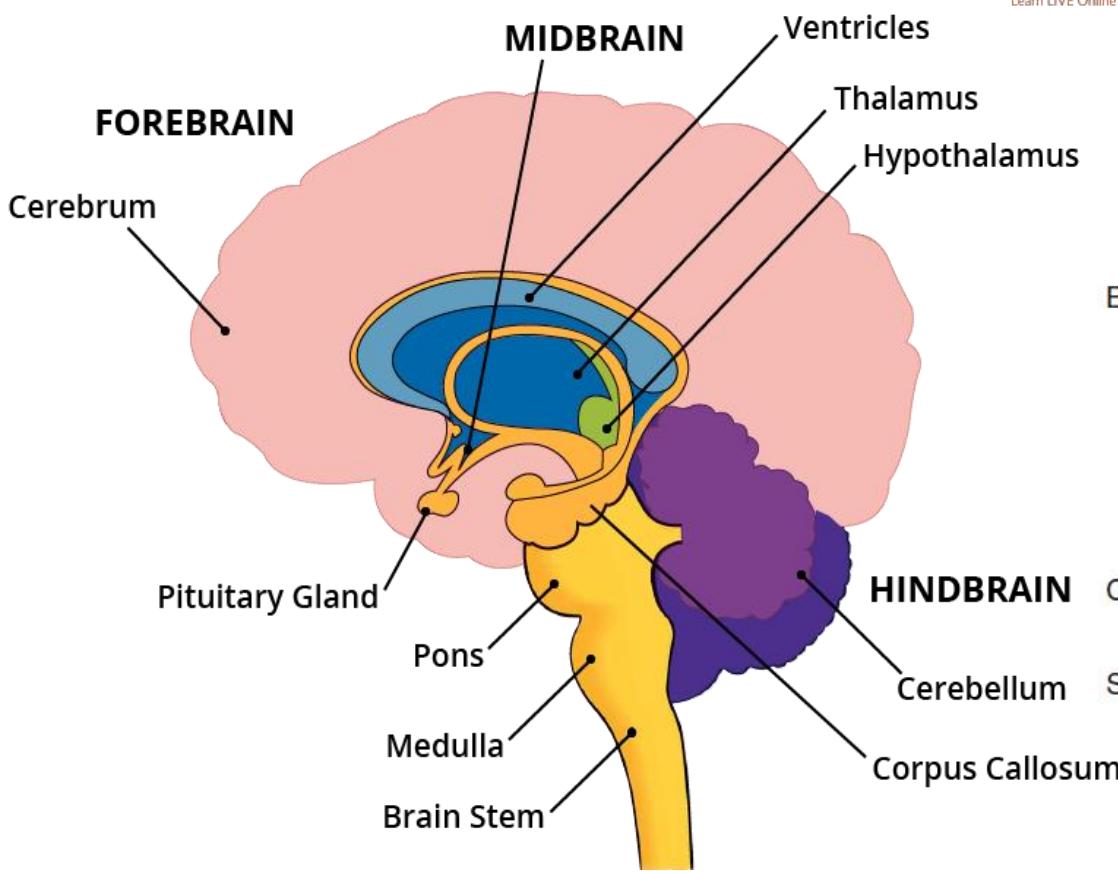
Brain facts

- Brain contains :-
 - About 100 billion neurons and 10 trillion to 50 trillion neuroglia
 - Mass of about 1300 g in adults.
 - On average, each neuron forms 1000 synapses with other neurons. Thus, the total number of synapses, about a thousand trillion or more.

Development of brain



Major parts of brain



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DIENCEPHALON:

Thalamus

Hypothalamus

Pineal gland
(part of epithalamus)

BRAIN STEM:

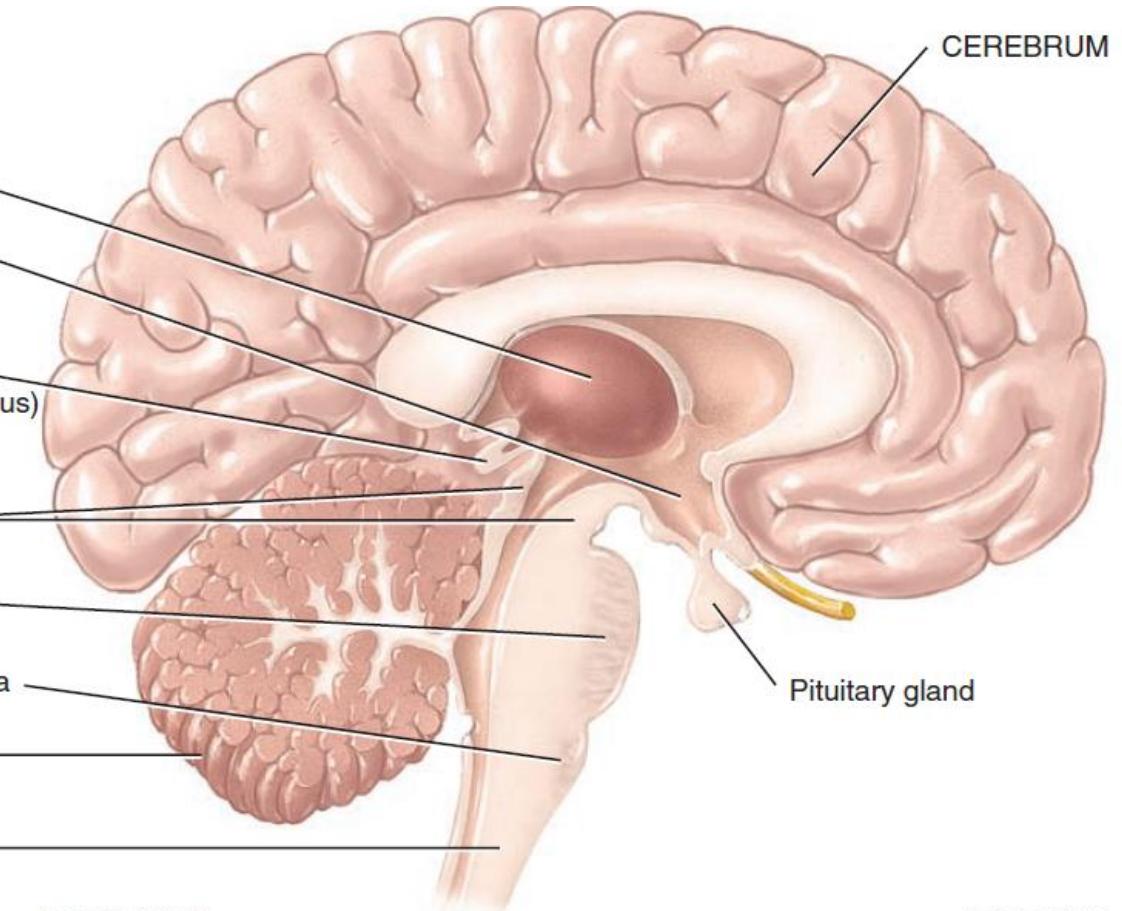
Midbrain

Pons

Medulla oblongata

CEREBELLUM

Spinal cord



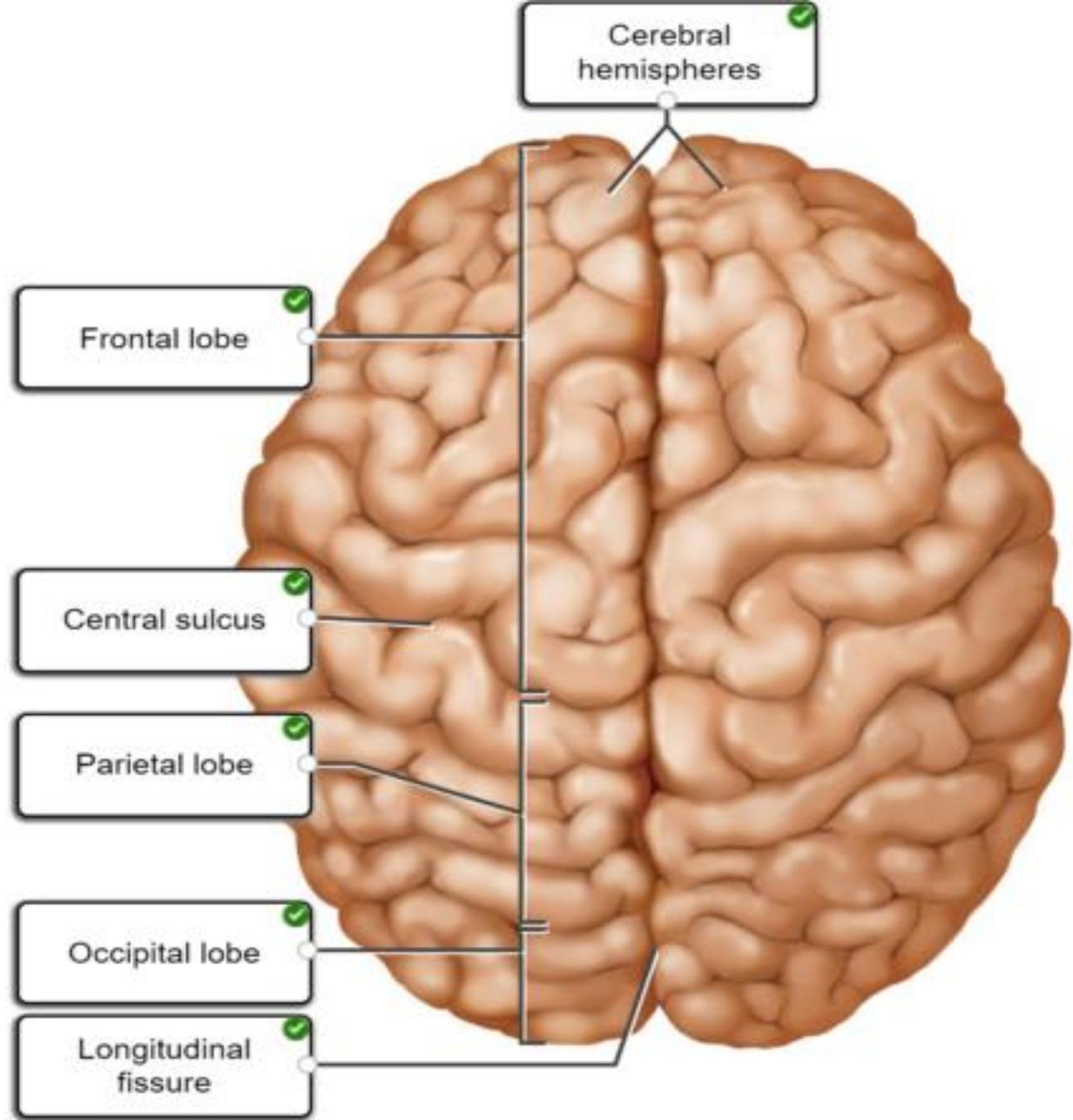
(a) Sagittal section, medial view

Major parts of brain

- **Cerebrum** (consists of 2 cerebral hemisphere)- is about 83% of brain volume.
- **Cerebellum** – is about 10% of its volume but containing over 50% of neurons.
- Fissure – longitudinal and transvers cerebral
- Gyri and sulci
- **Brainstem**- consists of diencephalon, midbrain, pons and medulla oblongata.

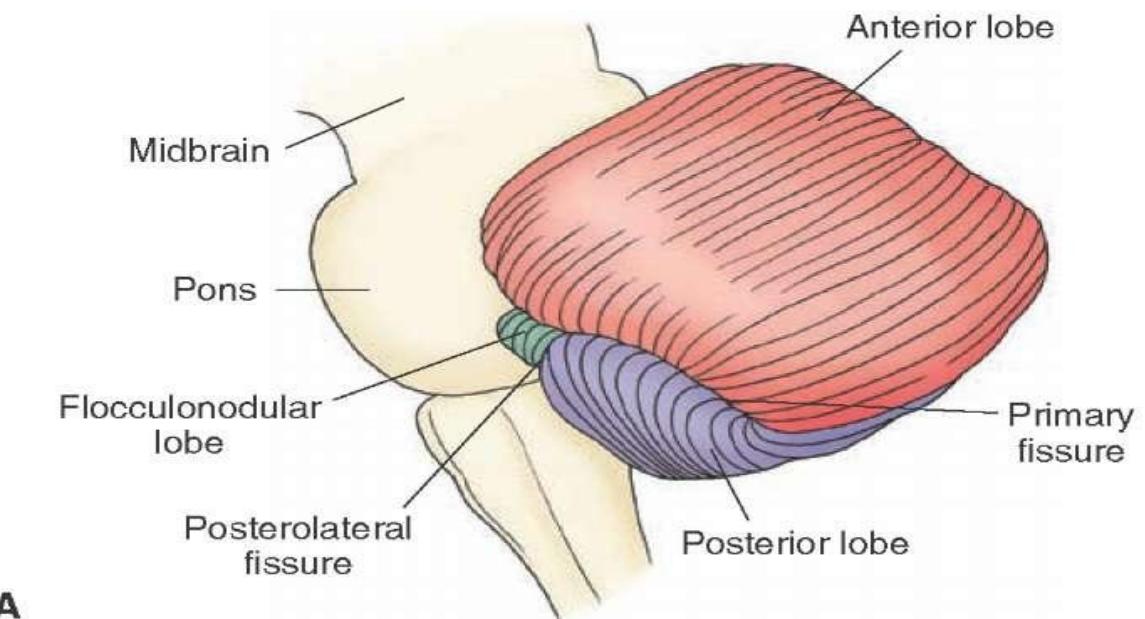
Brain major landmarks

- **Cerebrum:** the largest most conspicuous part.
- Cerebral hemisphere: 2 half globe like structure of cerebrum
- Gyri: the cerebral surface is marked by thick folds
- Sulci: gyri are separated by shallow grooves.
- Longitudinal fissure: the very deep groove the separate the right from left hemisphere.
- Corpus callosum (thick body): At the bottom of the longitudinal fissure, the hemispheres are connected by a prominent bundles of nerve fibers called corpus callosum.

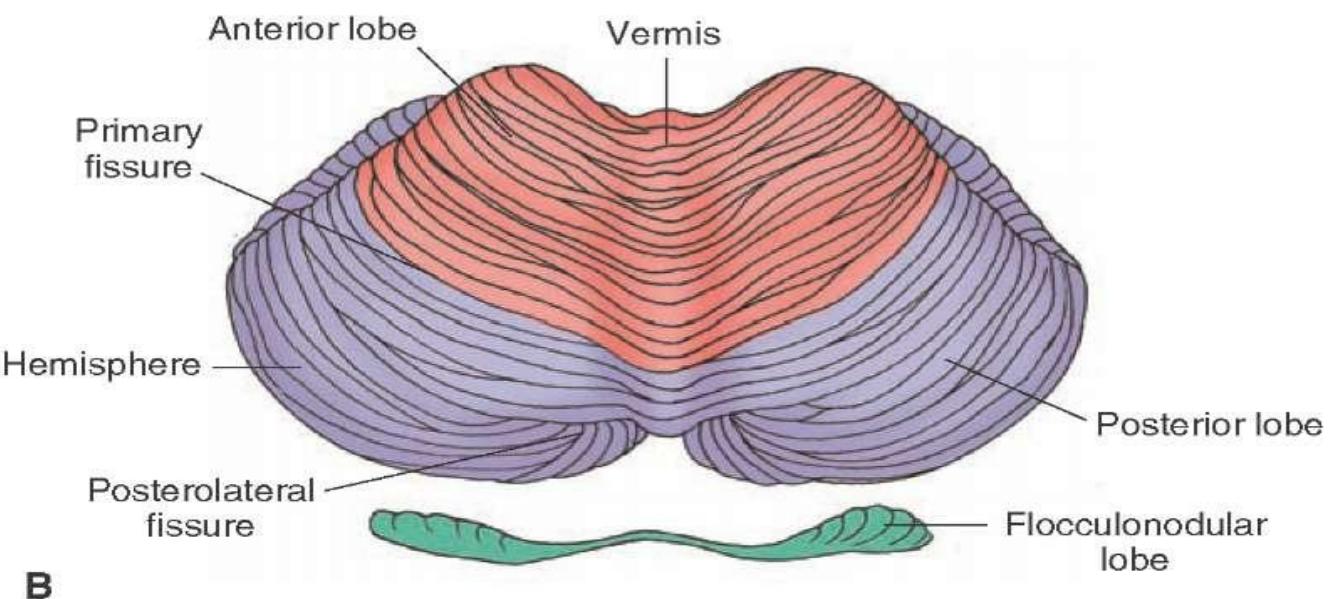


Cerebellum and brainstem

- Cerebellum is the second largest part of brain.
- Similar to cerebrum, it also consists of left and right hemispheres.
- It is marked by slender folds called folia separated by shallow sulci.
- Third part is brainstem. At foramen magnum of the skull, the brainstem connects to the spinal cord.



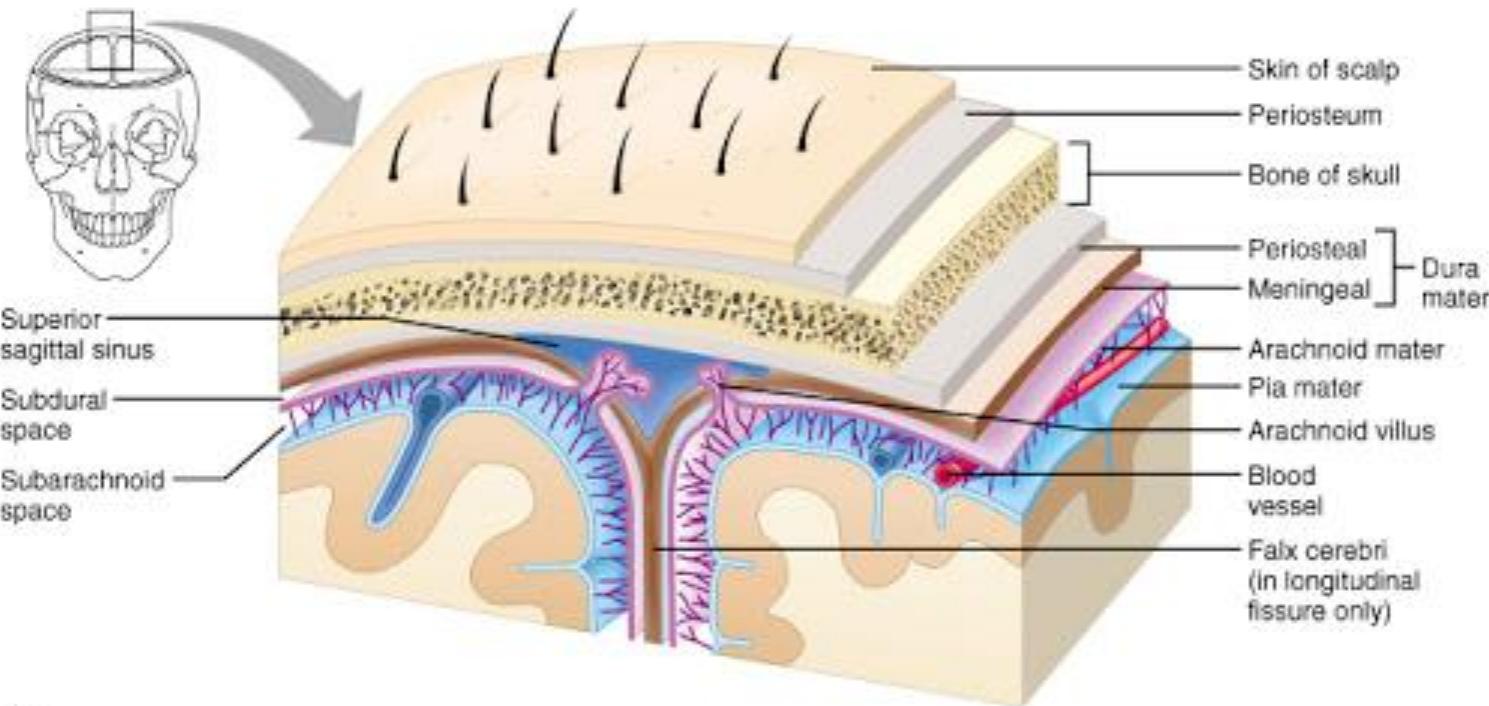
A



B

Meninges

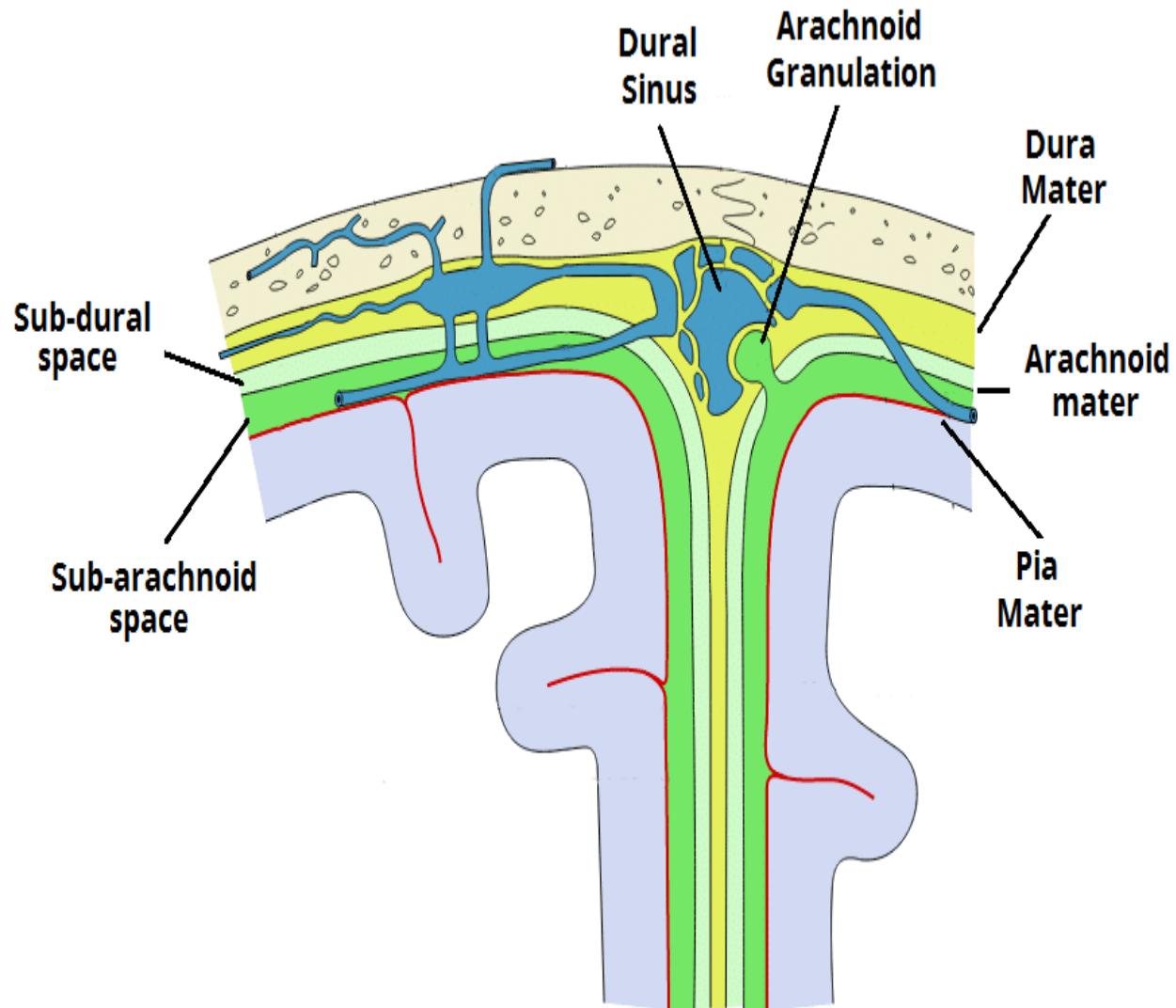
- **Dura mater:** It is the toughest and thickest of all, which lines the inside of cranium and forms a fibrous sac around the brain.
- It consists of two layer of tissue that are separated in some places to form blood filled spaces called **Dural sinuses**. These are veins that collects the blood circulated through the brain tissue.
- The dura mater folds inward to form tough fibrous walls between the two cerebral hemispheres and cerebellum hemispheres.



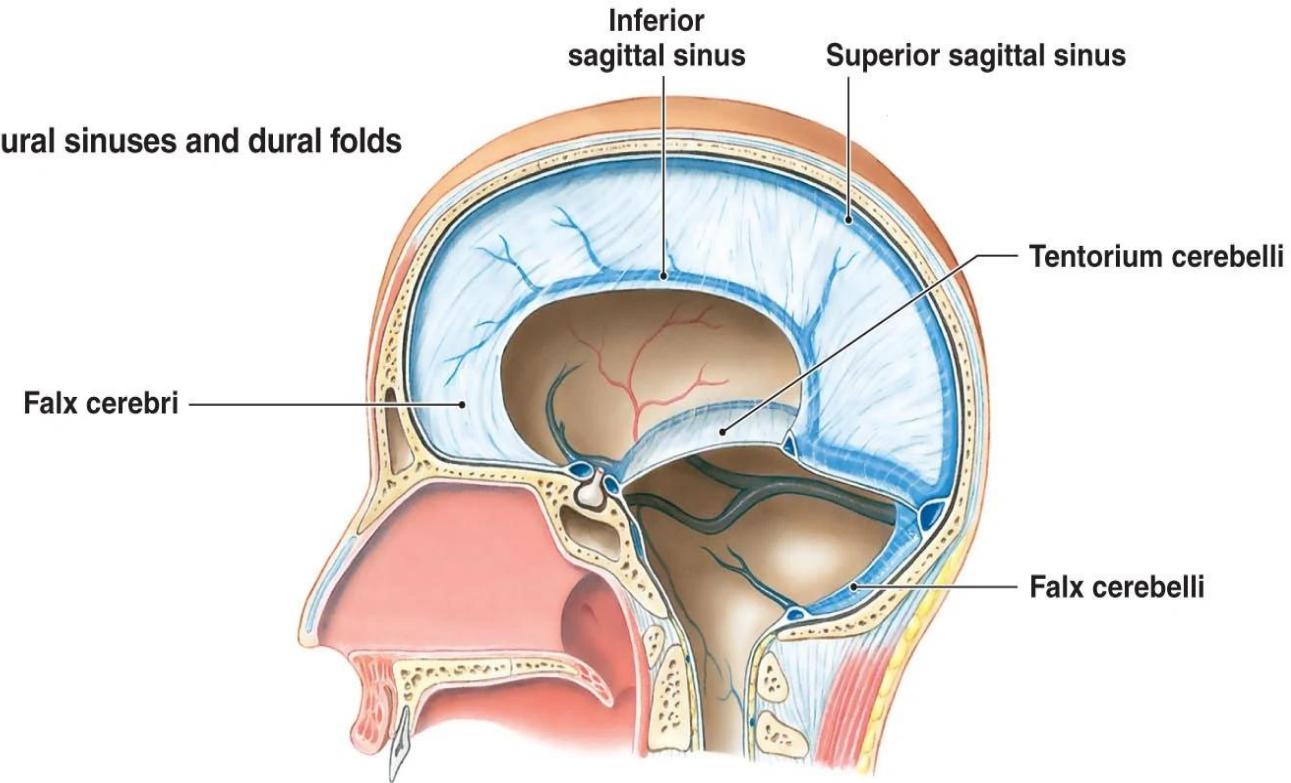
(a)

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Meninges and folds

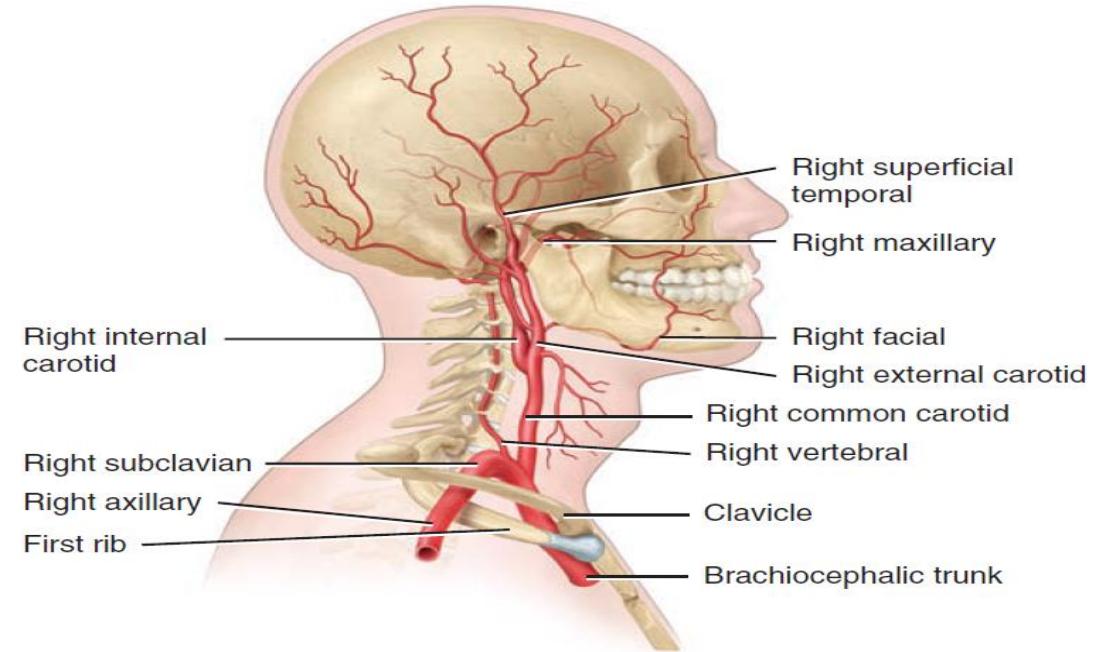
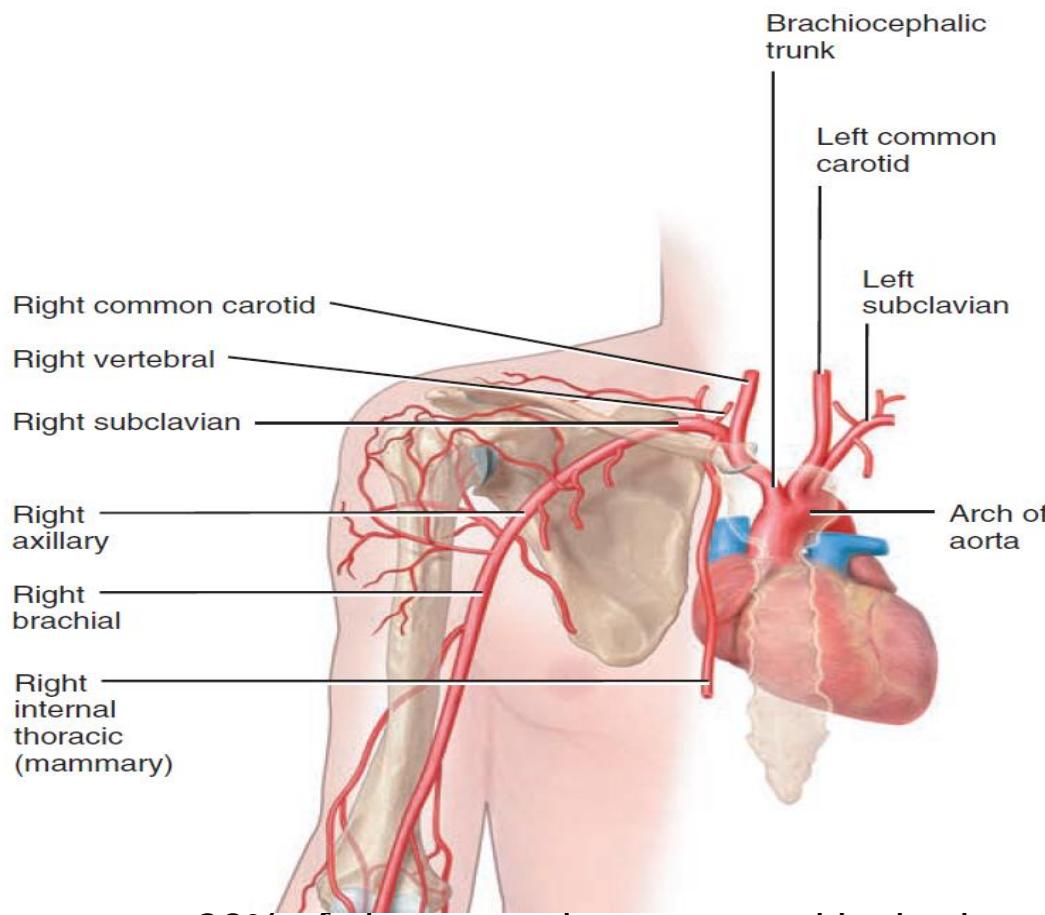


The dural sinuses and dural folds



- ❖ Cranial dura matter has 2 layers: periosteal and meningeal. They basically fuse together except for Dural venous sinus (Super sagittal sinus and transverse sinus).
- ❖ No epidural space(space between vertebrae and dura matter)
- ❖ 3 extension of dura matter separate parts of brain: falx cerebri: separate 2 hemispheres of cerebrum, falx cerebelli separates 2 parts of cerebellum and tentorium cerebelli: separate cerebrum from cerebellum

Blood flow to brain



(b) Right lateral view of branches of brachiocephalic trunk in neck and head

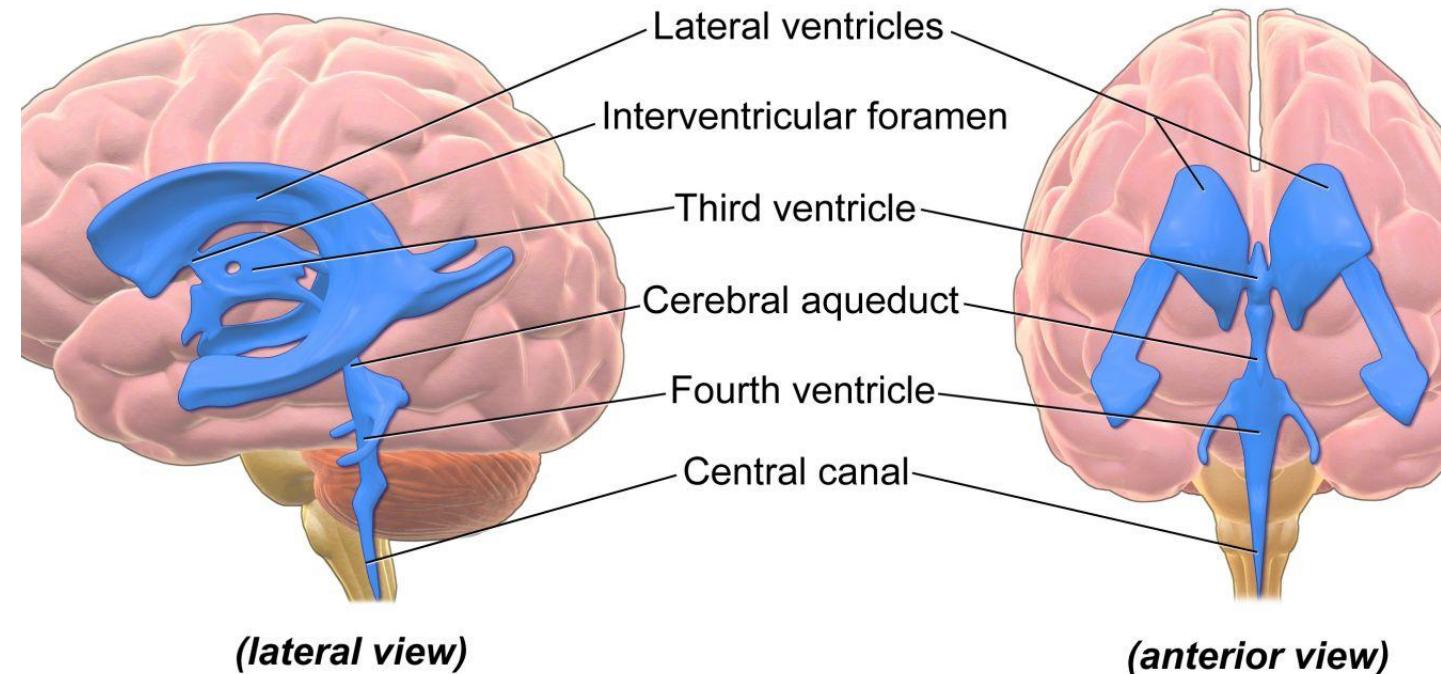
- ❖ Brain consume 20% of glucose and oxygen used by body.
- ❖ As no glucose is stored on brain, its supply must be continuous and neurons has to generate ATP exclusively from glucose and oxygen.
- ❖ Even a brief slowing of brain blood flow may cause disorientation or a lack of consciousness, such as when you stand up too quickly after sitting for a long period of time.
- ❖ Typically, an interruption in blood flow for 1 or 2 minutes impairs neuronal function, and total deprivation of oxygen for about 4 minutes causes permanent injury.

BBB

- The **blood–brain barrier (BBB)** consists mainly of tight junctions that seal together the endothelial cells of brain blood capillaries and a thick basement membrane that surrounds the capillaries.
- The processes of many **astrocytes** press up against the capillaries and secrete chemicals that maintain the **permeability characteristics of the tight junctions**.
- A few water-soluble substances, such as glucose, cross the BBB by active transport.
- Other substances, such as creatinine, urea, and most ions, cross the BBB very slowly. Still other substances—proteins and most antibiotic drugs—do not pass at all from the blood into brain tissue. However, lipid-soluble substances, such as oxygen, carbon dioxide, alcohol, and most anesthetic agents, are able to access brain tissue freely.
- Trauma, certain toxins, and inflammation can cause a breakdown of the blood–brain barrier.

Ventricles and cerebrospinal fluid

- Ventricles are internal cavity in brain that carries CSF. It consists of : **2 lateral ventricles** within each cerebral hemisphere. Then **third ventricle** in a narrow space between the hemispheres. **Fourth ventricle**. Between the cerebellum and brainstem.
- Both lateral ventricles are connected to third ventricle by a small pore and later is connected to fourth ventricle via a canal.
- These canal and chambers are filled with cerebrospinal fluid, which also fills the subarachnoid space and bathes the external surface of brain and the spinal cord.

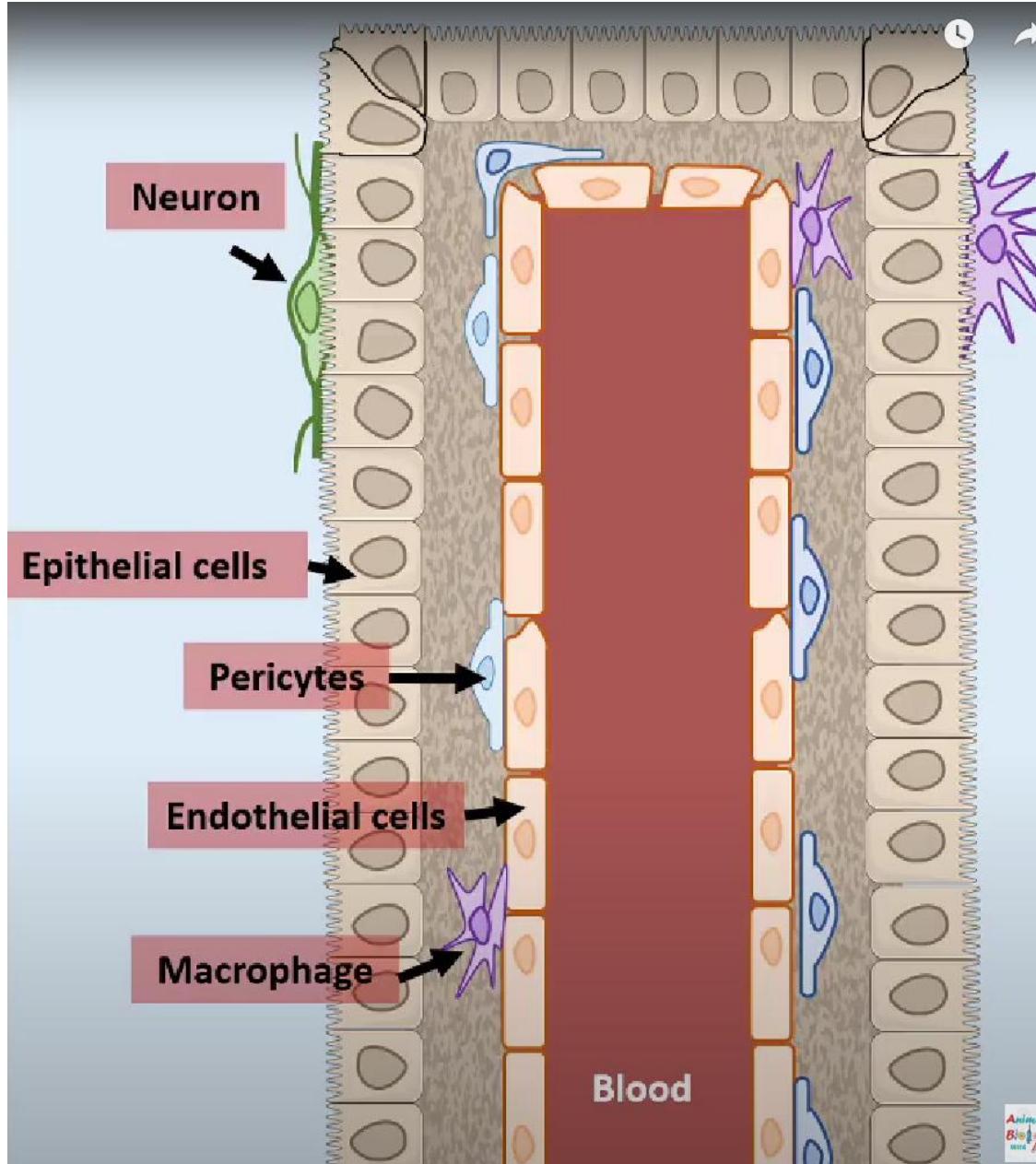


Cerebrospinal fluid

- **Cerebrospinal fluid (CSF)** is a clear, colorless liquid composed primarily of water that protects the brain and spinal cord from chemical and physical injuries.
- CSF continuously circulates through cavities in the brain and spinal cord and around the brain and spinal cord in the subarachnoid space (the space between the arachnoid mater and pia mater).
- The total volume of CSF is 80 to 150 mL in an adult.
- CSF contains small amounts of glucose, proteins, lactic acid, urea, cations (Na, K, Ca²⁺, Mg²⁺), and anions (Cl⁻ and HCO₃⁻); it also contains some white blood cells.
- CSF is produced by the **filtration of blood plasma by the layer of ependymal cells** that lines the ventricles.
- The fourth ventricle has 3 pores through which CSF exits the internal space and **enters the subarachnoid space to bathe the brain and spinal cord**.
- Functions of CSF:
 - **Mechanical Protection**- CSF serves as a shock-absorbing medium that protects the delicate tissues of the brain and spinal cord from jolts that would otherwise cause them to hit the bony walls of the cranial cavity and vertebral canal.
 - **Homeostatic function**.-The pH of the CSF affects pulmonary ventilation and cerebral blood flow, which is important in maintaining homeostatic controls for brain tissue. CSF also serves as a transport system for polypeptide hormones secreted by hypothalamic neurons that act at remote sites in the brain.
 - **Circulation**. CSF is a medium for minor exchange of nutrients and waste products between the blood and adjacent nervous tissue.

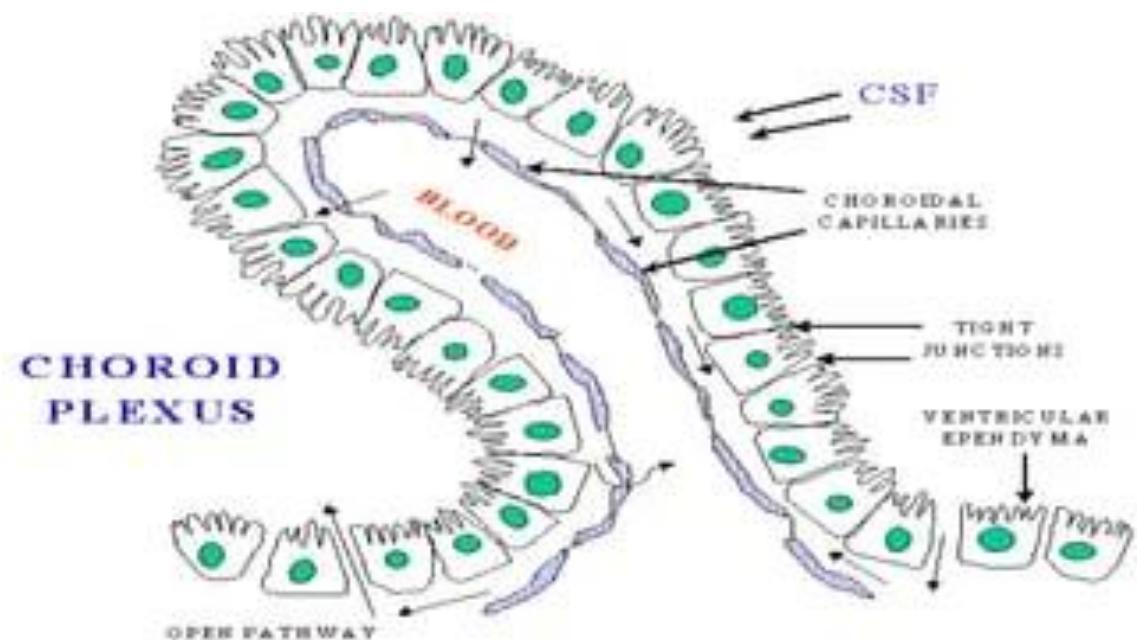
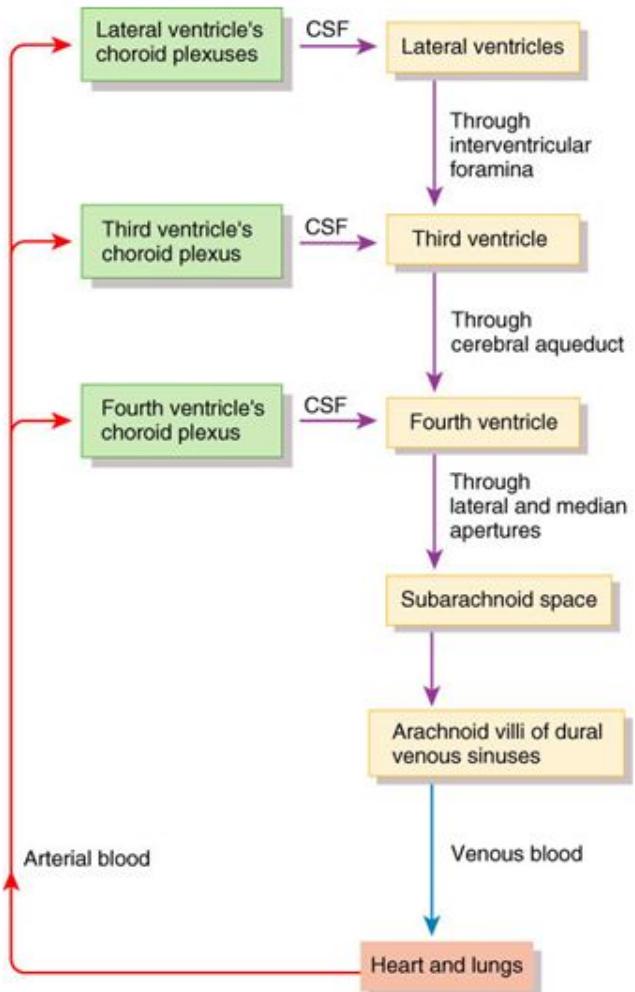
Formation of CSF

- The majority of CSF production is from the **choroid plexuses** networks of blood capillaries in the walls of the ventricles. Ependymal cells joined by tight junctions cover the capillaries of the choroid plexuses.
- Selected substances (mostly water) from the blood plasma, which are filtered from the capillaries, are secreted by the ependymal cells to produce the cerebrospinal fluid. This secretory capacity is bidirectional and accounts for continuous production of CSF and transport of metabolites from the nervous tissue back to the blood.
- Because of the tight junctions between ependymal cells, materials entering CSF from choroid capillaries cannot leak between these cells; instead, they must pass through the ependymal cells.
- CSF is gradually reabsorbed into the blood through **arachnoid villi**, fingerlike extensions of the arachnoid that project into the dural venous sinuses, especially the **superior sagittal sinus** .
- Normally, CSF is reabsorbed as rapidly as it is formed by the choroid plexuses, at a rate of about 20 mL/hr (480 mL/day). Because the rates of formation and reabsorption are the same, the pressure of CSF normally is constant. For the same reason, the volume of CSF remains constant



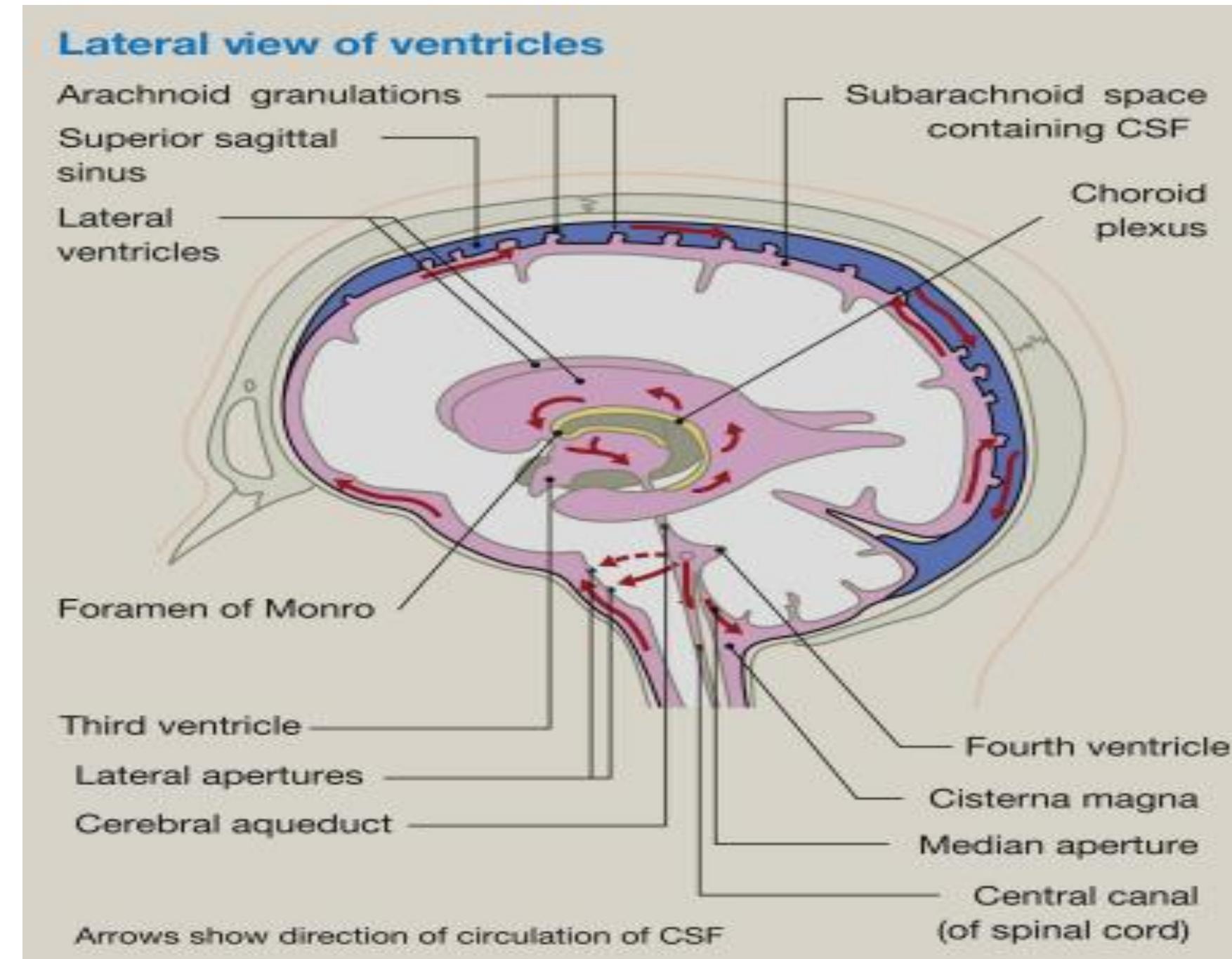
- CSF is basically produced from the villi like extension on the surface of choroid plexus.
- Choroid plexus is basically epithelial tissue with so rich network of blood capillaries.
- These cells are polarized and produce action potential supporting voltage-gated Na^+ , Cl^- and HCO_3^- ions.
- As only ions can cross the membrane, this transport of ions causes osmosis of water molecules through aquaporin channels.
- Due to tight junctions between the blood or its content cannot directly enter the brain but forced to pass through ependymal cells and secretes CSF.

CSF formation, circulation, and reabsorption



(c) Summary of the formation, circulation, and absorption of cerebrospinal fluid (CSF)

CSF



Assignment

- Individual student will select only one part of brain and explain few things as PowerPoint presentation in class:
 1. Its exact location
 2. Functions
 3. Regulatory centre for which physiological parameter

Links for videos

- [https://www.brainfacts.org/3d-brain#intro=false&focus=Brain-cerebral hemisphere-frontal lobe-orbitofrontal cortex&zoom=true](https://www.brainfacts.org/3d-brain#intro=false&focus=Brain-cerebral%20hemisphere-frontal%20lobe-orbitofrontal%20cortex&zoom=true)
- Neurotorium.org
 - For CSF formation and circulation
 - <https://www.youtube.com/watch?v=D4gq8MILGns&t=1s>
 - <https://www.youtube.com/watch?v=FvnoS1TCUCk&t=22s>
 - <https://www.youtube.com/watch?v=asQo6cmOjd0&t=224s>