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Ecological, Economic and Social Sustainability

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NEUROANATOMY

2nd week – Cerebrospinal Membranes

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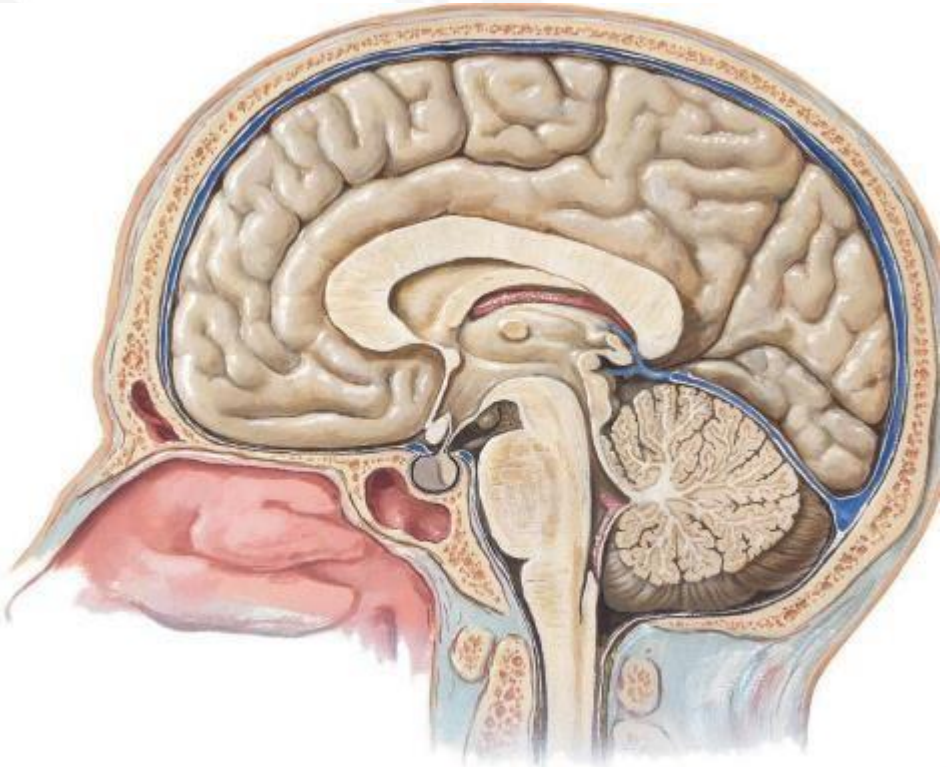
Neuroanatomy
Cerebrospinal Membranes

The brain and spinal cord are protected by being surrounded by three membranes called meninges.

These membranes go from outside to inside:

- hard membrane (duramater),
- spider-like membrane (arachnoid mater)
- thin membrane (piamater)



Membranes of the Central Nervous System (Meninges)

Dura mater (pachymeninx)

- Duramater encephali
- Duramater spinalis

Arachnoidea

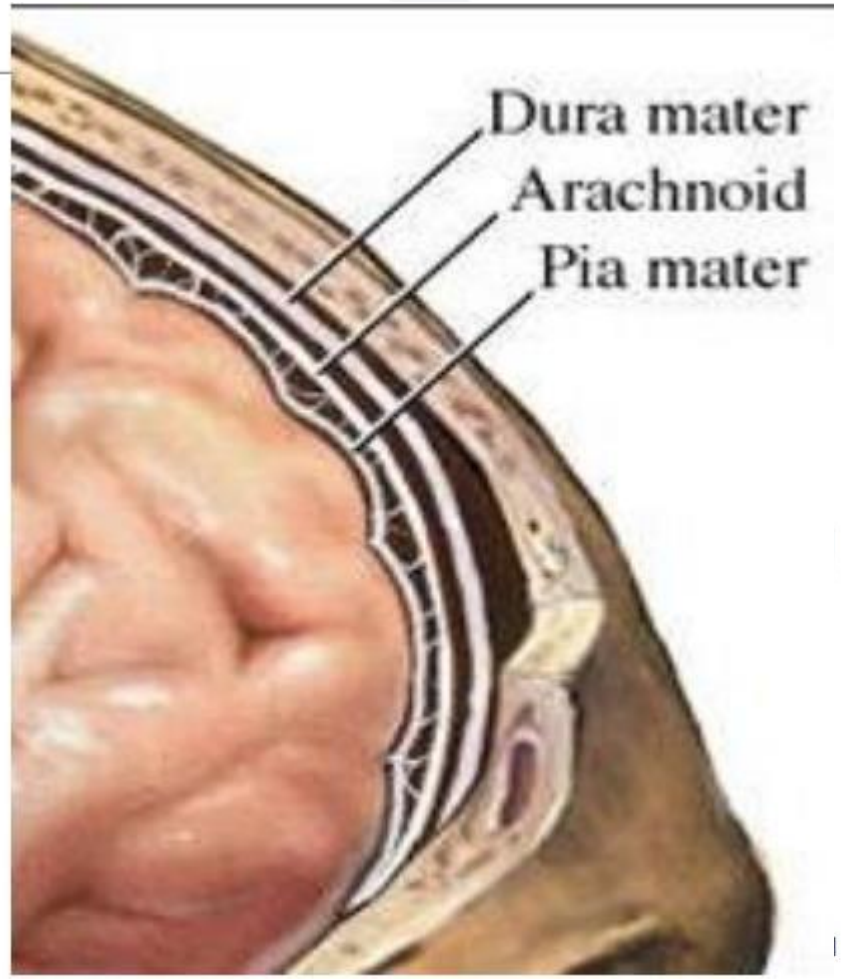
- Arachnoidea encephali
- Arachnoidea spinalis

Pia mater

- Piamater encephali ◦
- Piamater spinalis

✓ Cavum subdurale

✓ Cavum subarachnoidale



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Inflammation of the membranes surrounding the brain and spinal cord is called meningitis. This condition usually leads to high fever, headache due to meningeal irritation and neck stiffness. Laboratory examination of the cerebrospinal fluid taken by lumbar puncture is important in the diagnosis of the disease.

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A lumbar puncture (spinal tap) is a test used to diagnose certain health conditions. It's performed in your lower back, in the lumbar region. During a lumbar puncture, a needle is inserted into the space between two lumbar bones (vertebrae) to remove a sample of cerebrospinal fluid. This is the fluid that surrounds your brain and spinal cord to protect them from injury.

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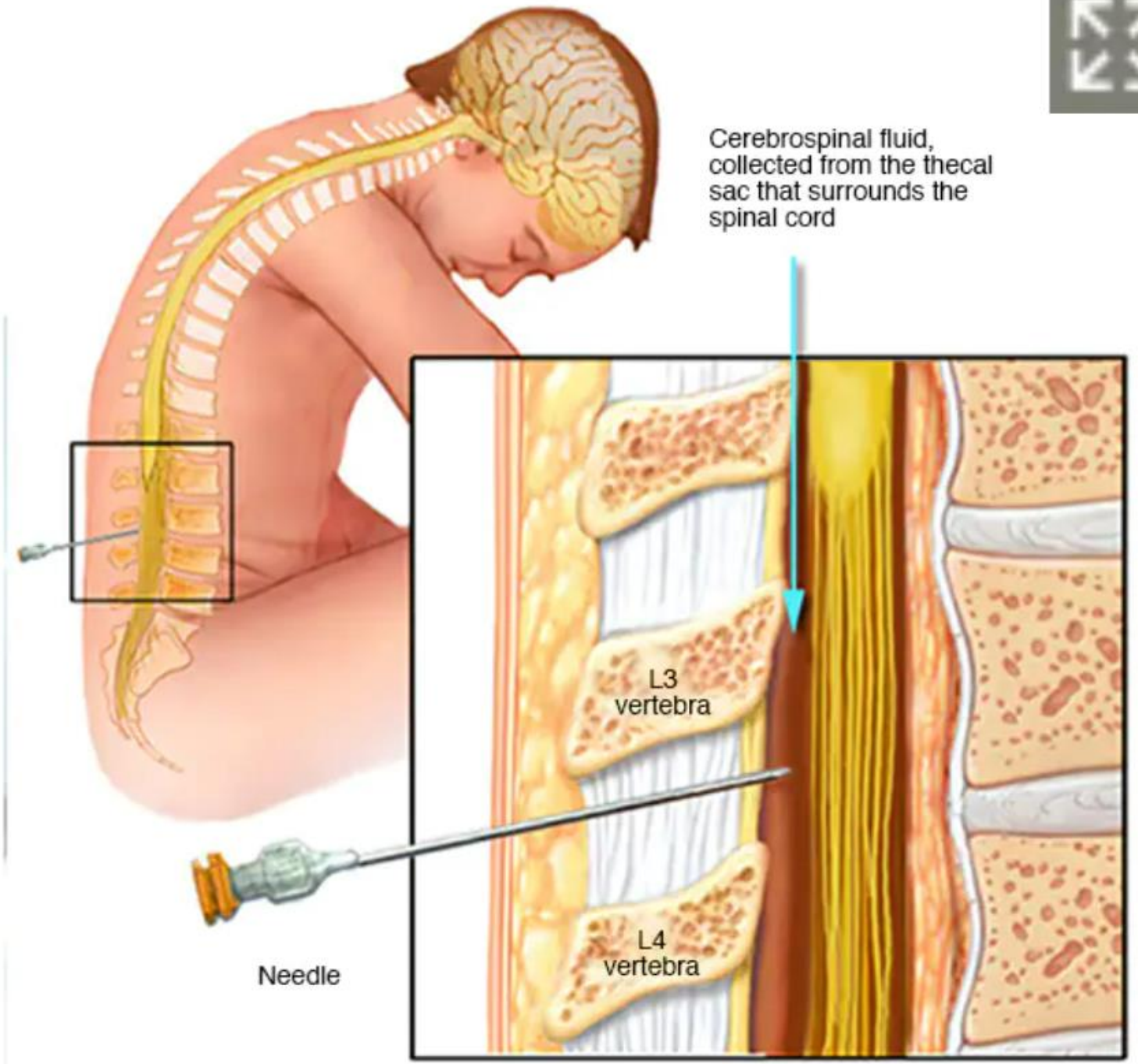

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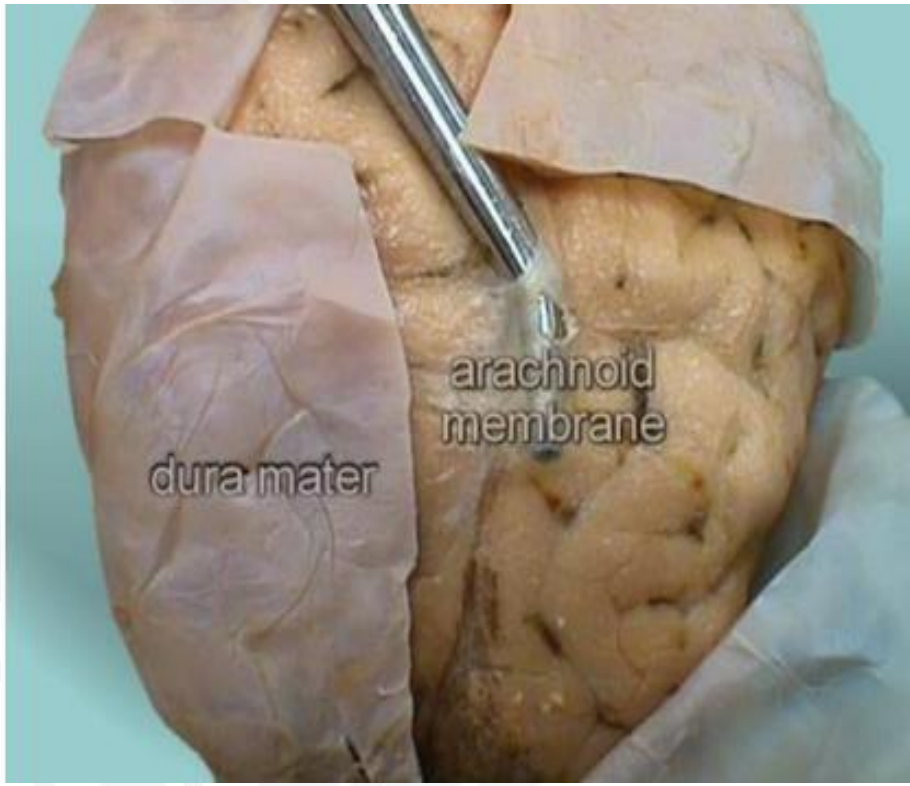
A lumbar puncture can help diagnose serious infections, such as meningitis; other disorders of the central nervous system, such as Guillain-Barre syndrome and multiple sclerosis; bleeding; or cancers of the brain or spinal cord. Sometimes a lumbar puncture is used to inject anesthetic medications or chemotherapy drugs into the cerebrospinal fluid.

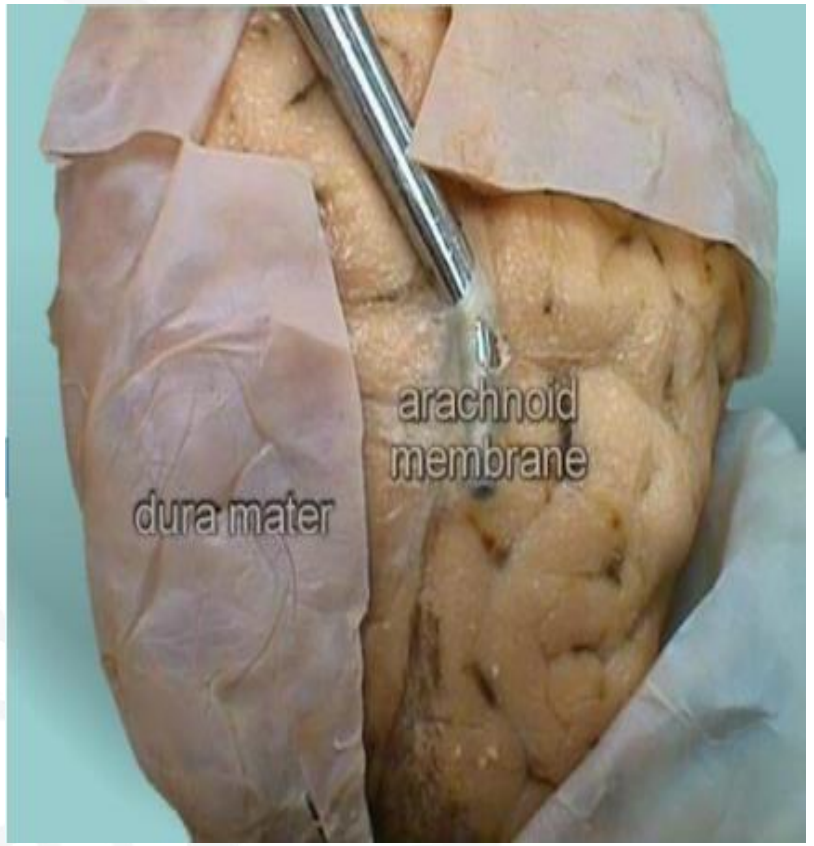
Duramater

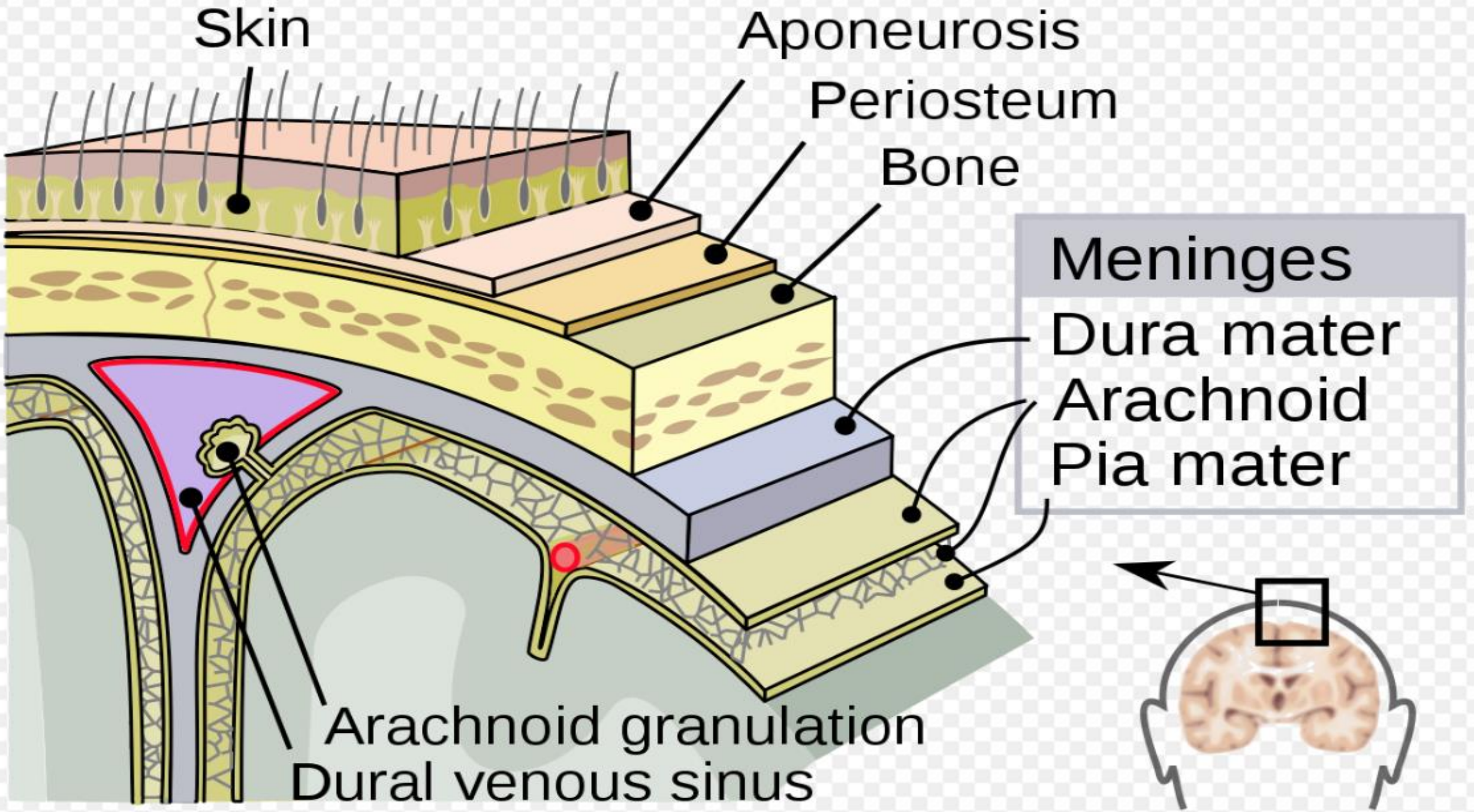
- It is a thick, durable bilayer membrane attached to the skull bone. It connects the brain to the skull and protects it from external impacts.
- It is located at the outermost point of the central nervous system. It is a fairly firm, hard, thick and vascular-poor fibrous membrane.
- Between it and Arachnoidea is a microscopic space called cavum subdurale.
- According to the organ it wraps; It is called Dura mater encephali or Dura mater spinalis.



Duramater encephali

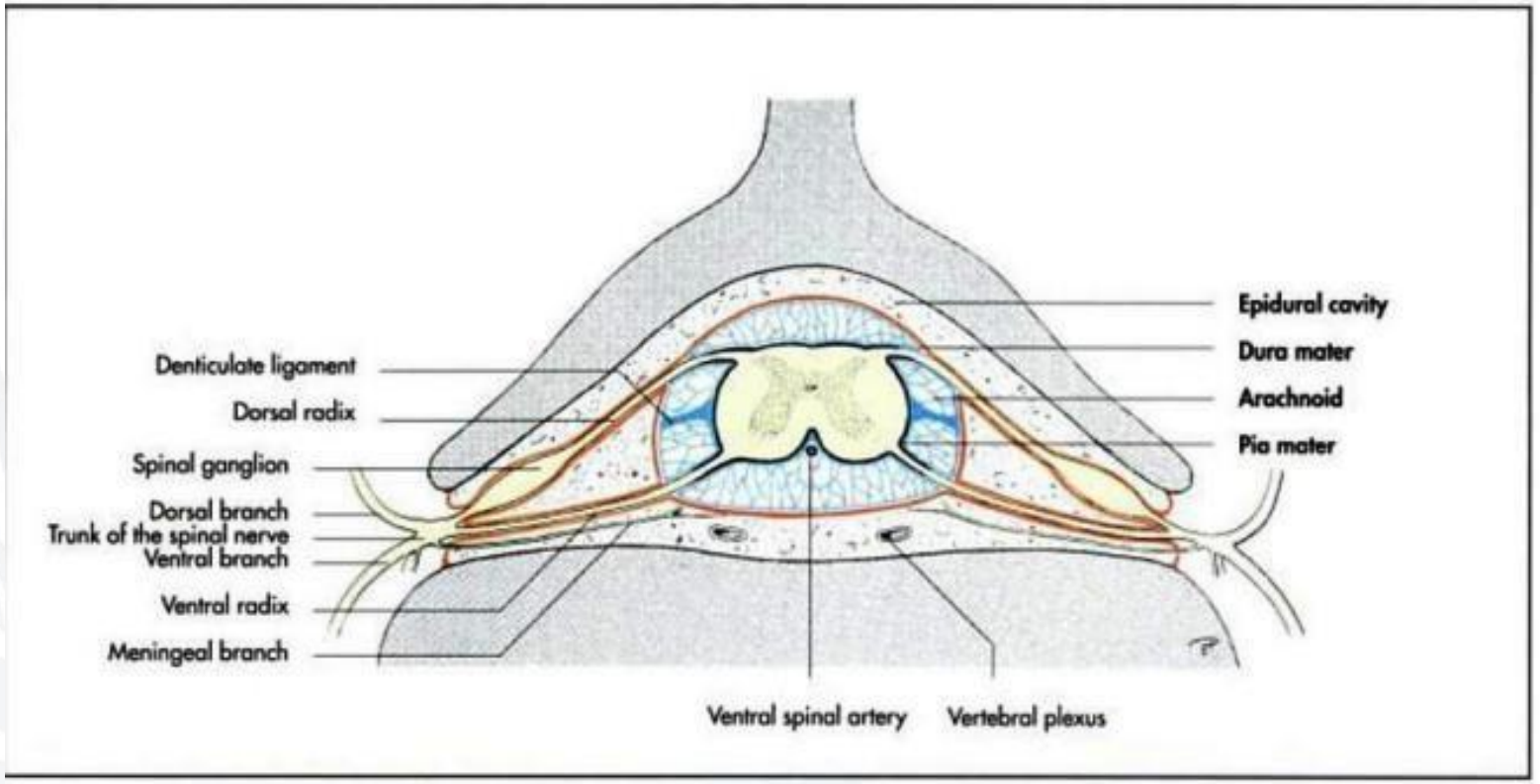
- It is located in the cavum cranii.
- It both surrounds the brain and forms the cavum cranii.
- It forms the periosteum of the bones.
- It is loosely attached to the bones except for a few places (Crista galli, crista sagittalis interna, tentorium cerebelli osseum, and crista petrosa).

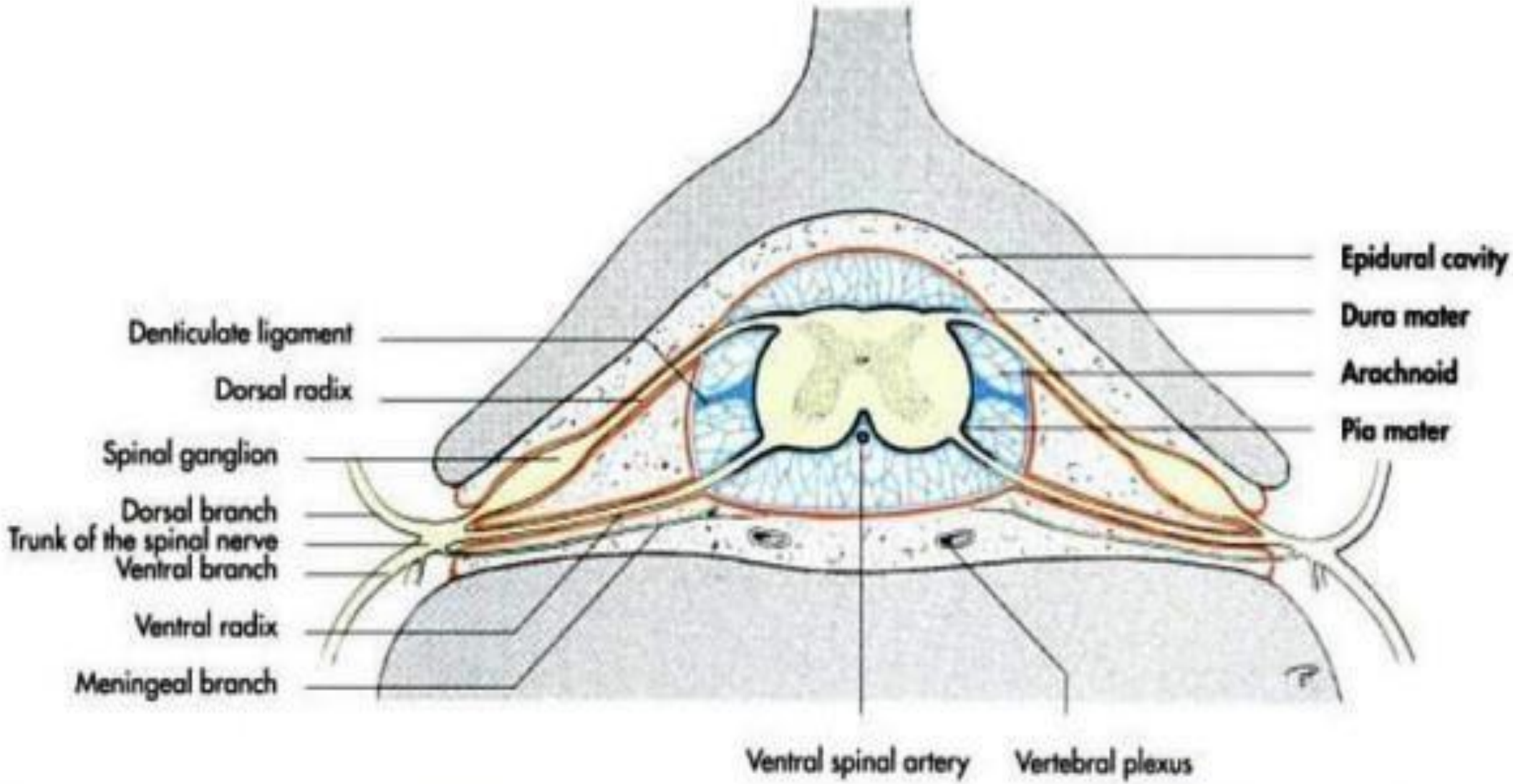



Skin
Aponeurosis
Periosteum
Bone
Meninges
Dura mater
Arachnoid
Pia mater
Arachnoid granulation
Dural venous sinus

Duramater spinalis

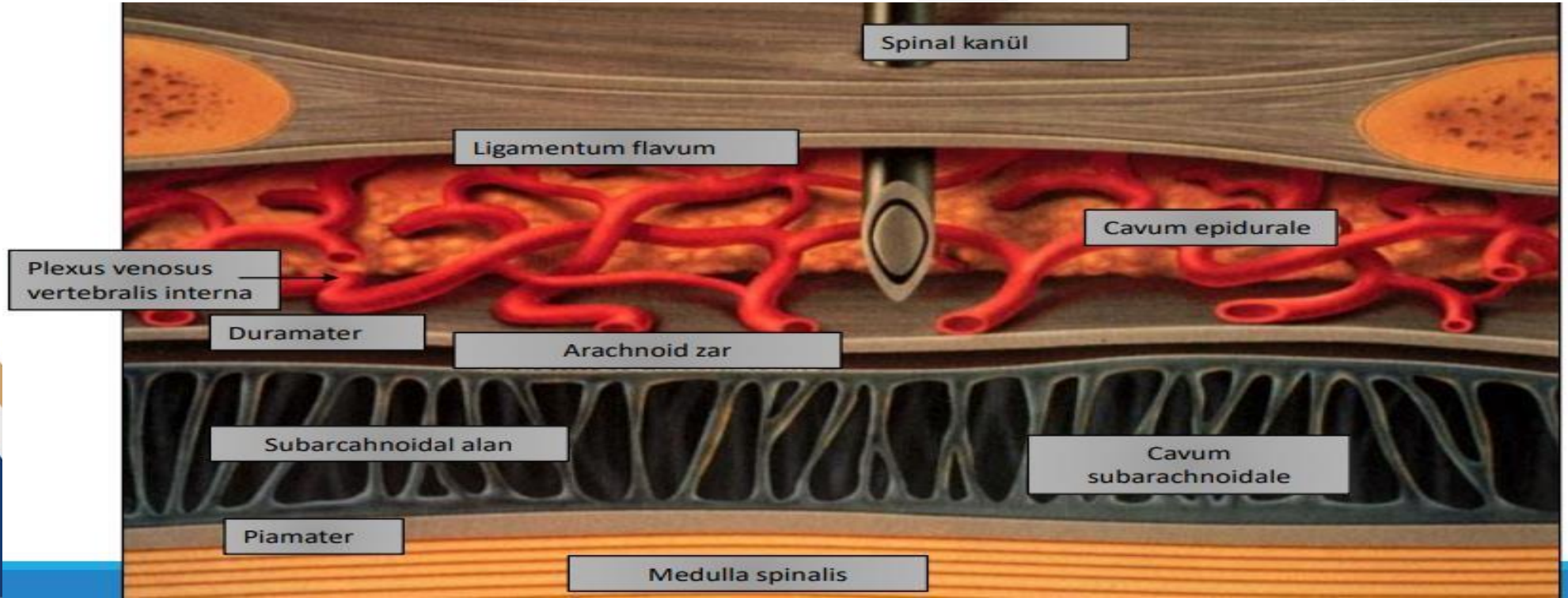
- It is located in the canalis vertebralis and m. surrounds the spinalis.
- It starts from the foramen magnum and ends in the middle of the sacrum as filum terminale externum.
- It has two leaves. (dura mater periostalis - dura mater meningialis)
- The space between the two leaves is called the spatium epidurale.



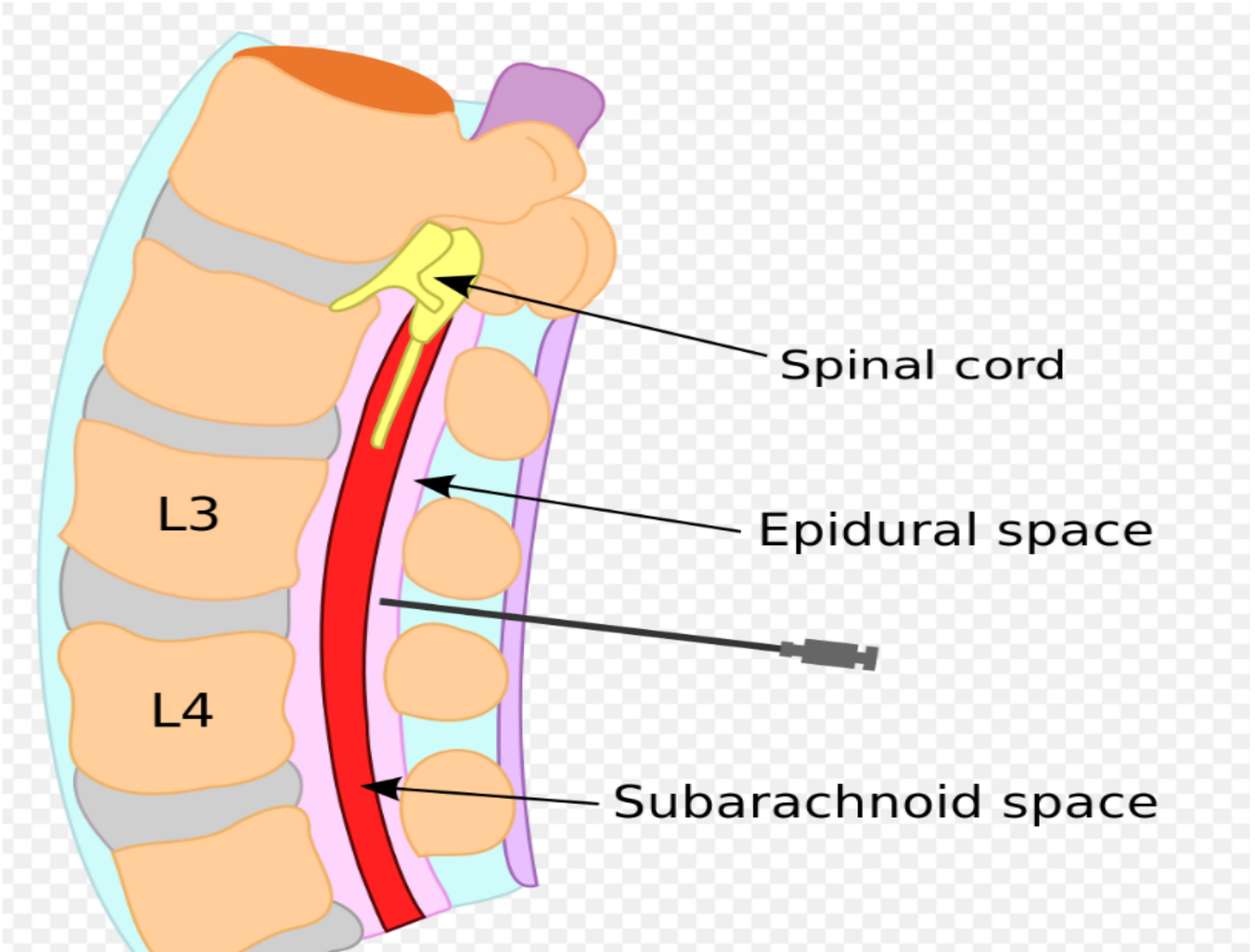

Epidural cavity
Dura mater
Arachnoid
Pia mater
Denticulate ligament
Dorsal radix
Spinal ganglion
Dorsal branch
Trunk of the spinal nerve
Ventral branch
Ventral radix
Meningeal branch
Ventral spinal artery
Vertebral plexus

Anatomy of the region in epidural anesthesia

- In epidural anesthesia, the area where the anesthetic is administered is the cavum epidurale. The cavum epidurale is a space formed between the dura mater and the periosteum, one of the cerebrospinal membranes surrounding the spinal cord.

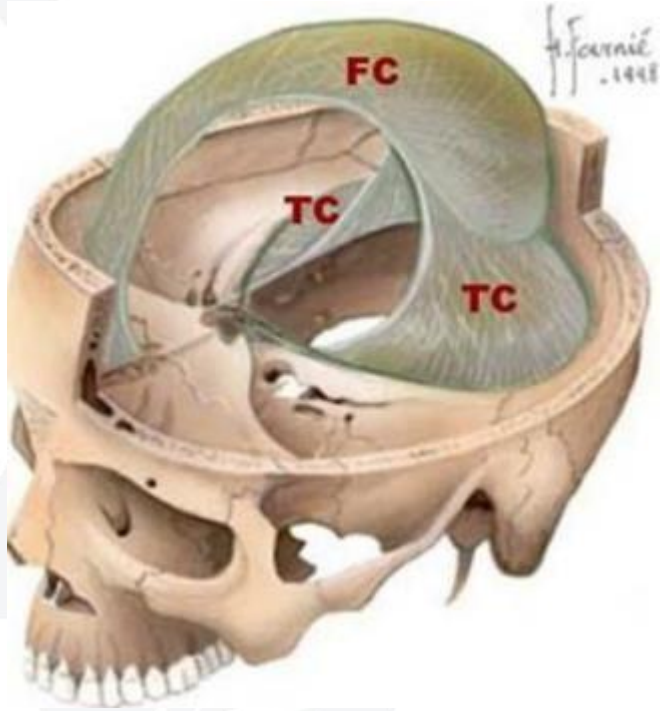


Anatomy of the region in epidural anesthesia



Duramater duplications

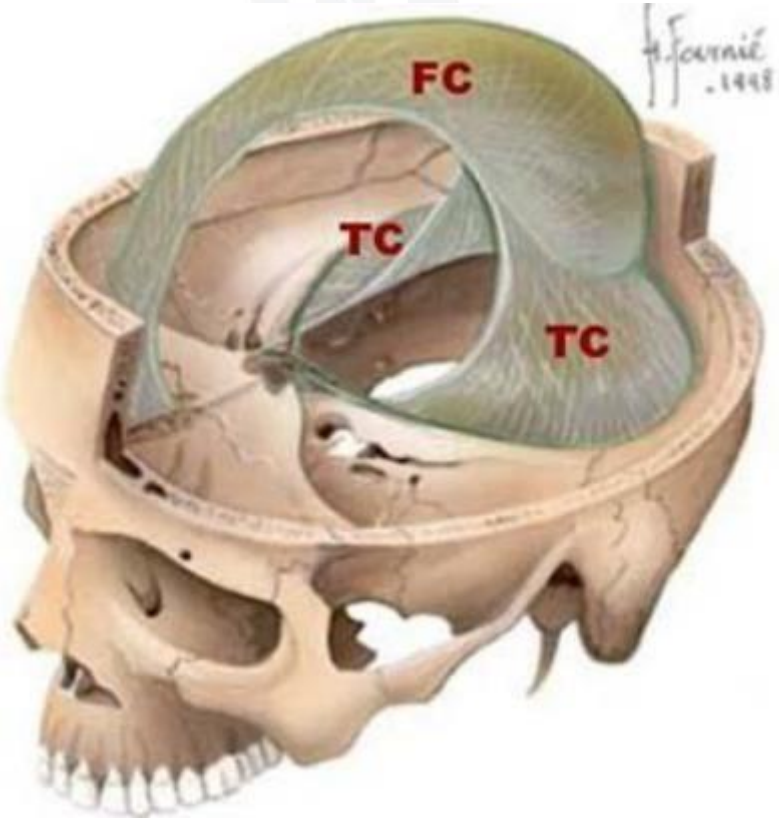
- Falx cerebri (FC)
- It is a sickle-shaped dura duplicator.
- It enters the fissura longutidinale cerebri between the two cerebral hemispheres. Its dorsal arch, which is convex, attaches to the crista galli and crista sagittalis interna.
- Its free ventral edge extends into the corpus calosum.
- The sinus sagittalis has entered between its two leaves.



Duramater duplications

Tentorium cerebri (TC)

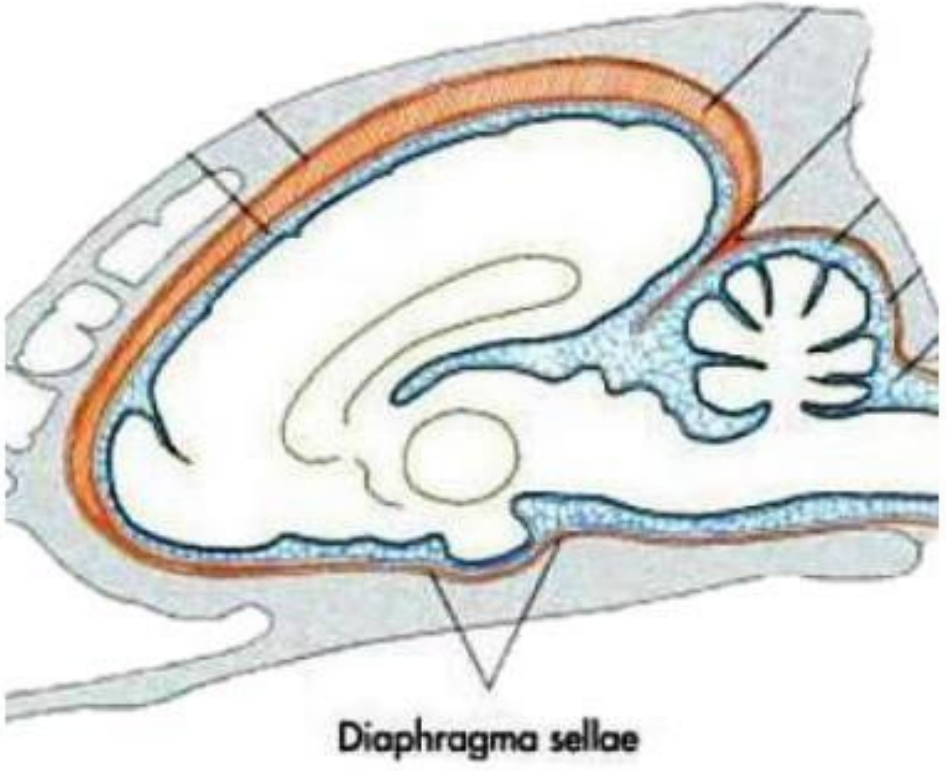
- It enters the fissura transversa cerebri between the large brain and the small brain.
- It contains the sinus transversa.



Duramater duplications

Diaphragma sellae turcicae

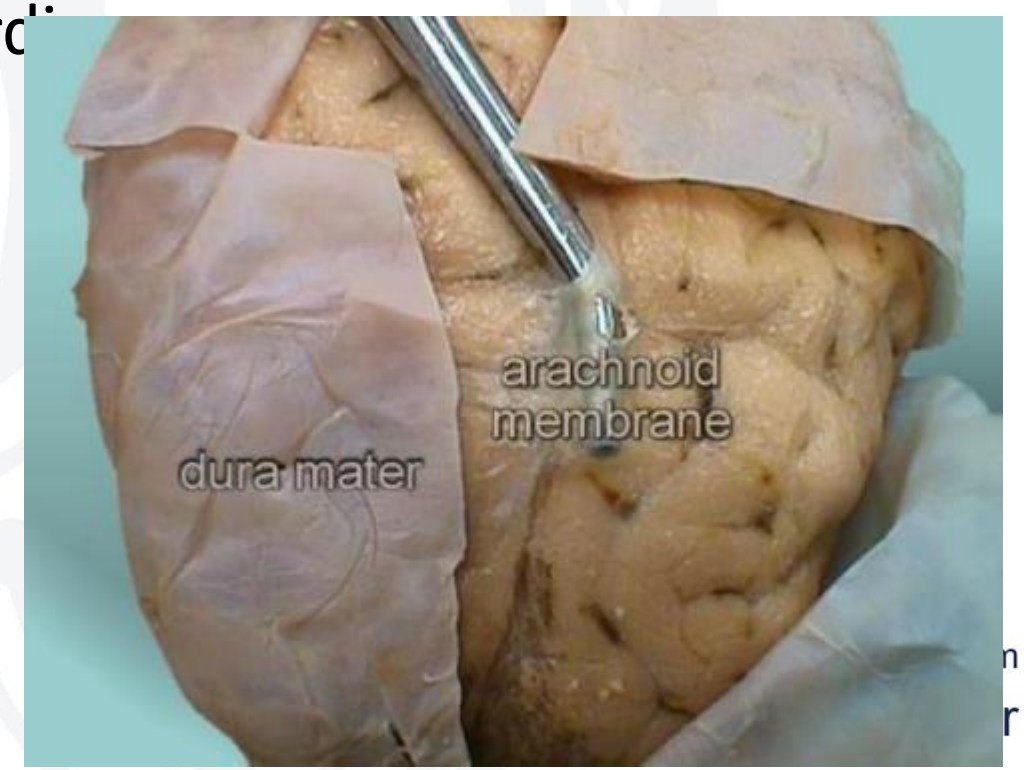
- It jumps from the sides of the dorsum sella or fossa hypophysialis onto the pituitary gland.
- It separates the pituitary gland from the brain.
- There is a hole in the middle for the handle that connects the gland with the brain.



Arachnoidea

It is a thin, connective tissue origin membrane that is poor in blood vessels. It does not enter the recesses on the brain and spinal cord. Accordi to the organ it wraps;

- Arachnoidea encephali
- Arachnoidea spinalis.



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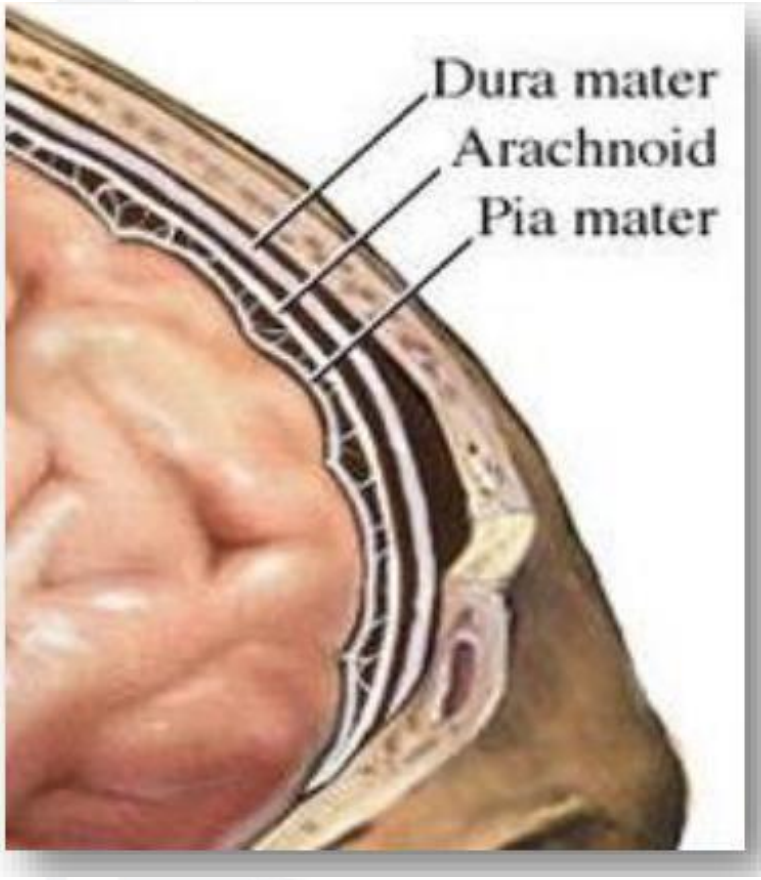
- The space between it and the dura mater is called the cavum subdurale, and the space between it and the pia mater is called the cavum subarachnoidale.
- The cavum is divided by the subarachnoidale trabecula'lae and contains the liqour cerebrospinalis.
- It acts as a mechanical protector.
- The space used for the removal of the liqour cerebrospinalis is the cavum subarachnoidale.



Piamater

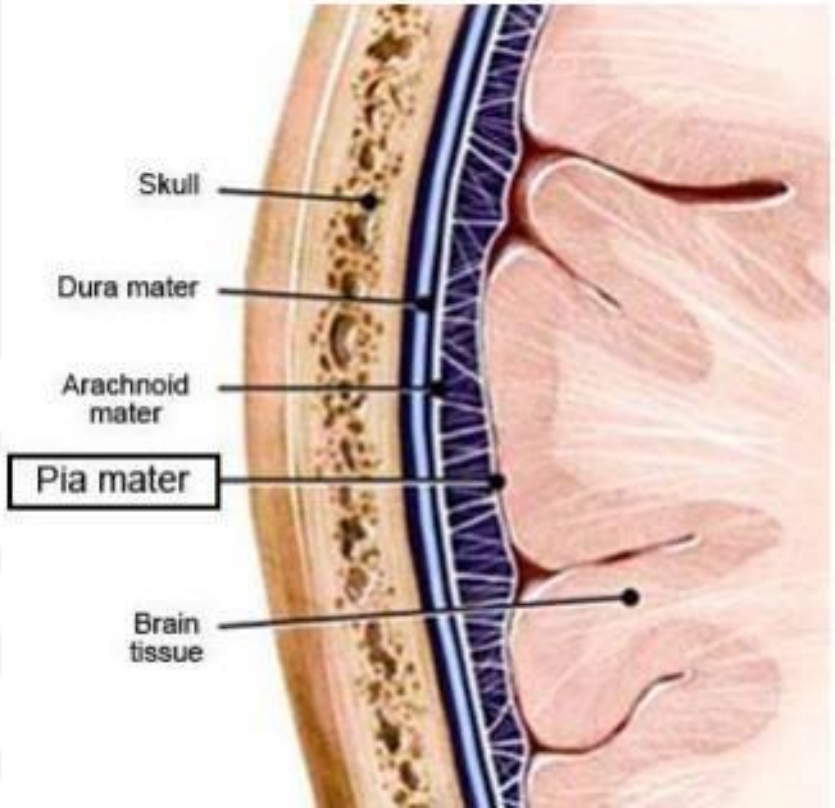
- It is an extremely thin, vascular-rich membrane.
- It covers the entire surface of the brain and spinal cord (including recesses).
- It provides nutrition to the central nervous the large number of vessels it carries.

➢ Arachnoidea - cavum subarachnoidea.

According to its formation;

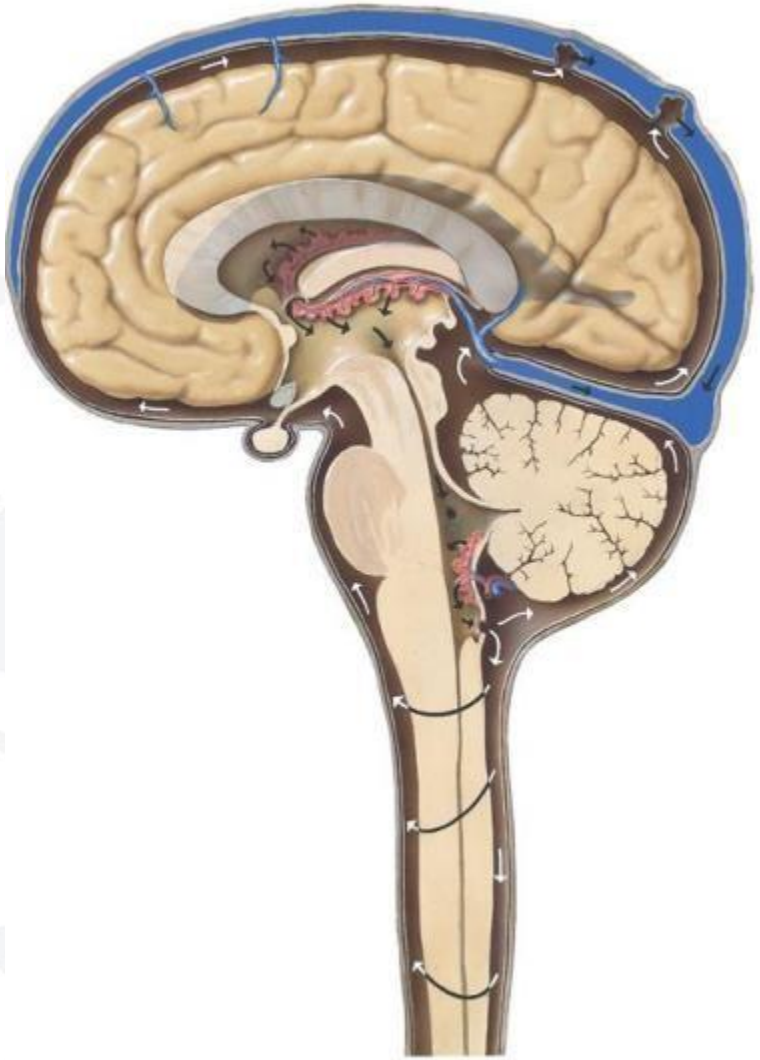
Pia mater encephali

Pia mater spinalis.



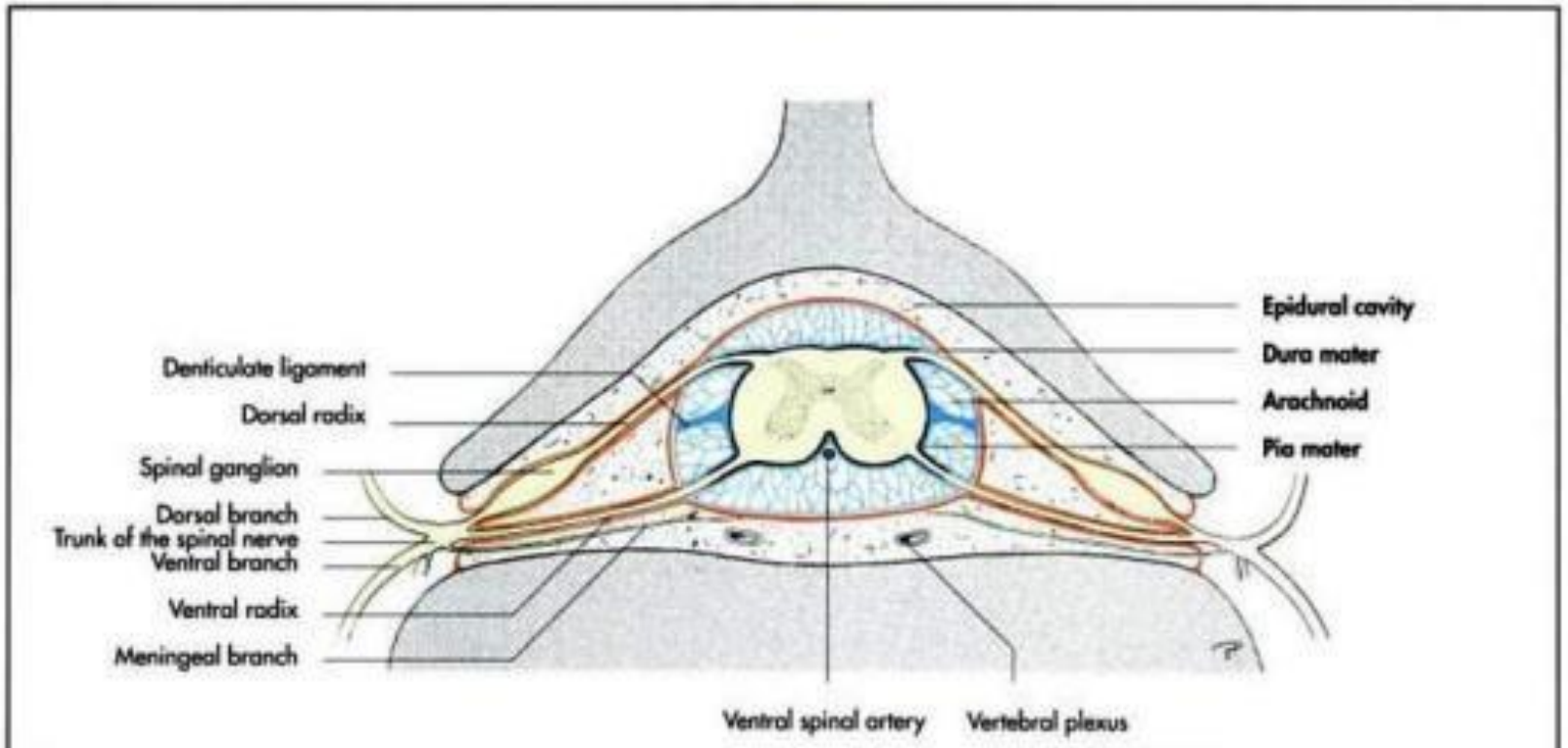
Pia mater encephali

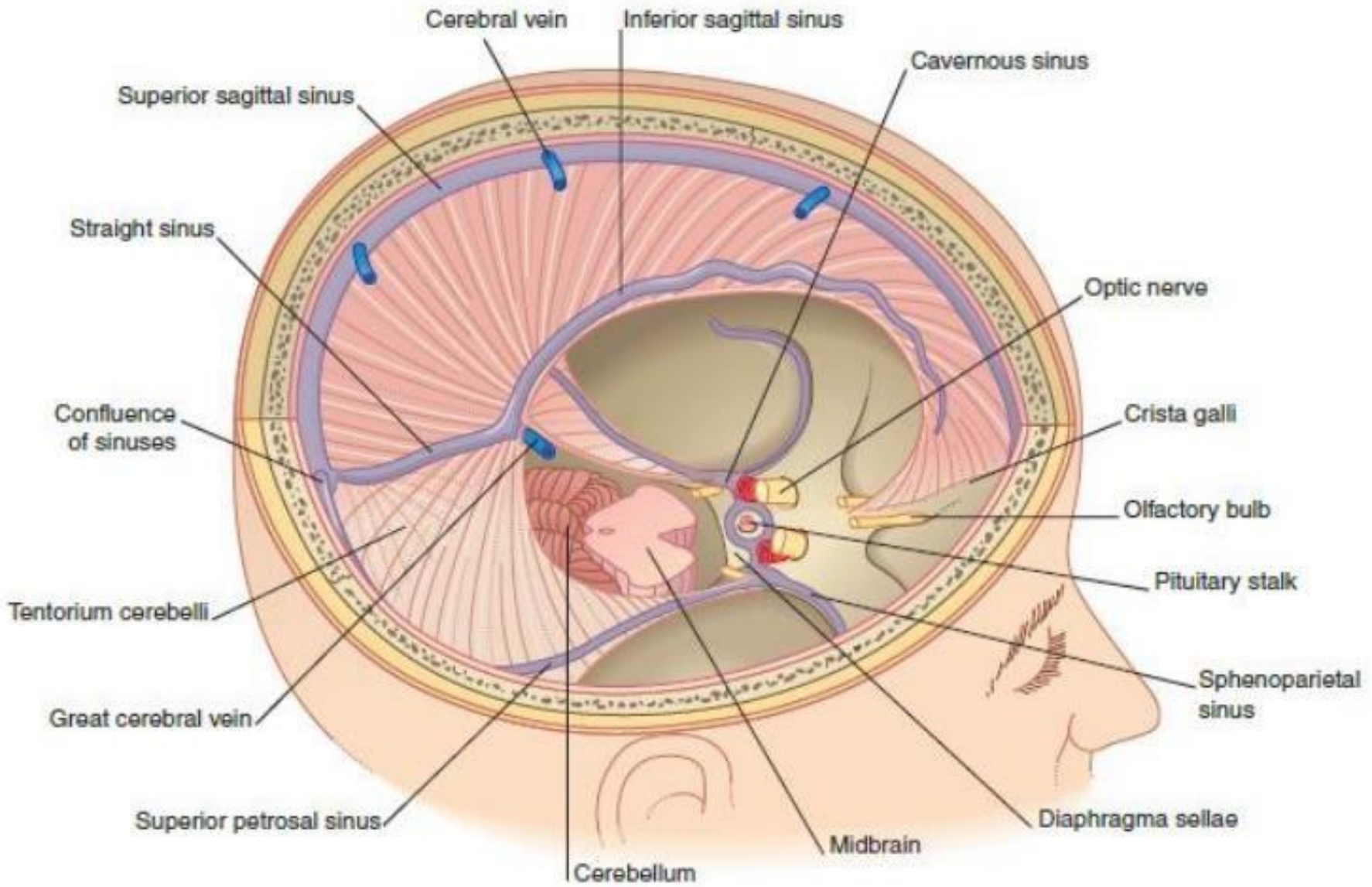
- It enters the ventricles of the brain, filling the grooves of the brain. Here it makes thickenings called interlining choroidea.
- Together with the veins on the tela choroidea, they form the plexus choroideus.
- Plexus choroideus are named according to the brain cavity they are in and secrete the liqour cerebrospinalis.



Piamater spinalis

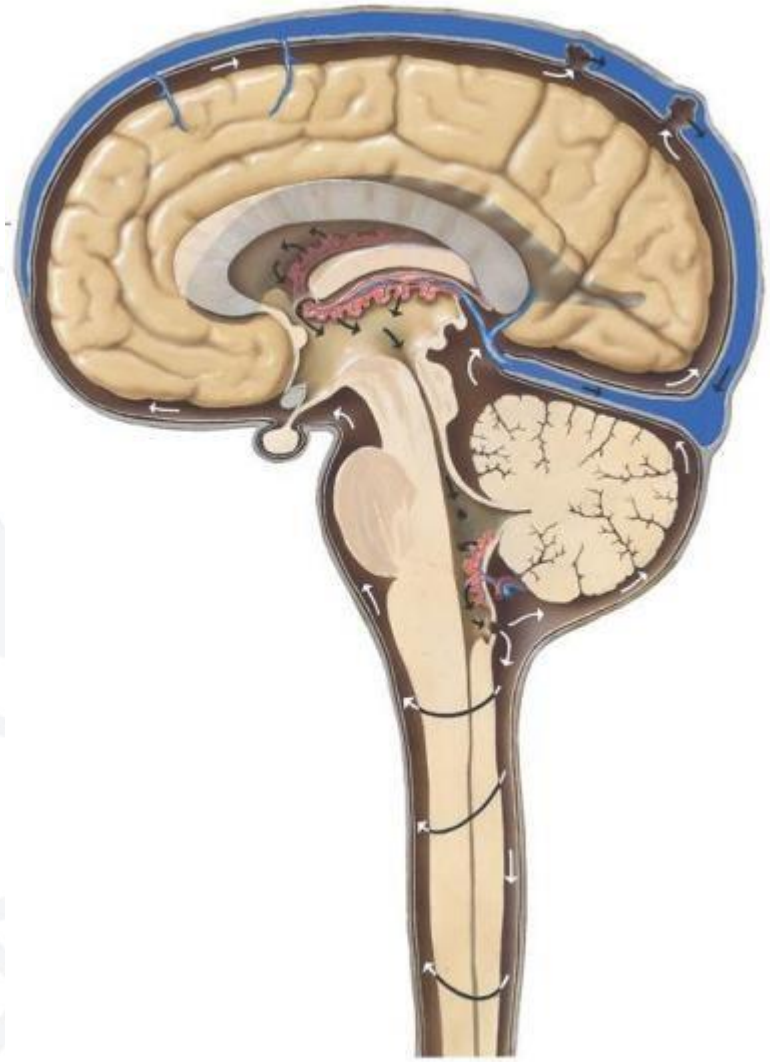
- It tightly surrounds the spinal cord.
- Especially the league stretching between the pia mater and the dura mater. There are ligaments called denticulatum. These bonds connect the 2 membranes together.




Cerebral vein
Inferior sagittal sinus
Cavernous sinus
Superior sagittal sinus
Straight sinus
Optic nerve
Confluence of sinuses
Crista galli
Olfactory bulb
Pituitary stalk
Tentorium cerebelli
Sphenoparietal sinus
Great cerebral vein
Superior petrosal sinus
Diaphragma sellae
Midbrain
Cerebellum

Cerebrospinal Fluid (CSF)

- CSF is the fluid formed by the choroid plexuses in the brain ventricles by filtering it from the blood.
- CSF is of vital importance in nourishing the nervous system tissue and removing wastes. The nervous system as a whole floats in the fluid, thanks to the fluid and cavities.
- It counters the blow to the brain as a whole, not locally.

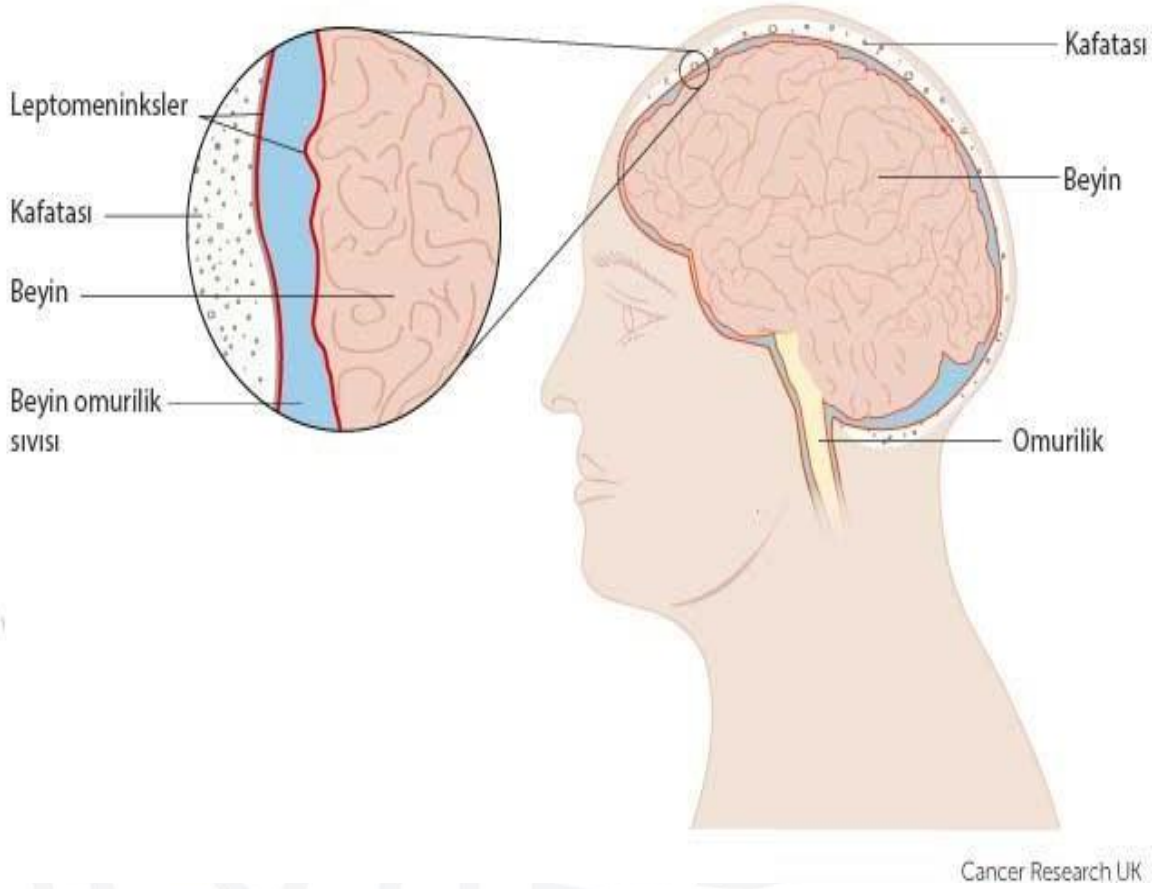


Cerebrospinal Fluid (CSF)

- CSF contains little protein, Na, Cl, K, Ca, glucose, and oxygen.
- It is in constant flow. 500 ml is produced per day.
- The normal amount of CSF is 150 ml.
- It can be absorbed by the arachnoids with villi in the arachnoid membrane, through the capillary wall in the piamater arachnoid mater, and through lymphatic drainage.
- Most of the CSF is secreted from the 4th ventricles.

Functions of CSF

- It protects the brain from mechanical effects such as hitting and hitting.
- It provides exchange of substances between blood and nerve cells.
- It helps to balance the ion exchange in the central nervous system.



Cancer Research UK

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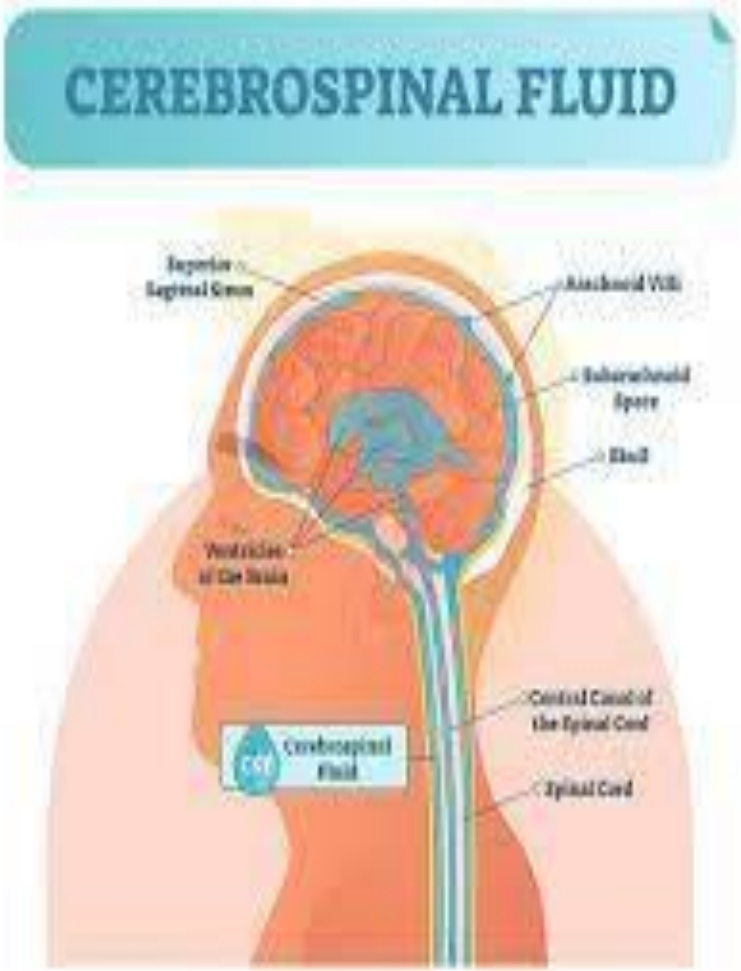
- Cerebrospinal fluid pressure is normally regulated by the absorption of fluid through the arachnoidal villi. Therefore, the rate of CSF formation is constant.

If there is an increase in the production of cerebrospinal fluid, a decrease in its absorption and an obstruction in the perivascular space, **the amount of CSF increases.**



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Conditions that increase CSF;

- Glioma
- hydrocephalus
- intracranial bleeding
- Meningitis

Symptoms showing increased CSF;

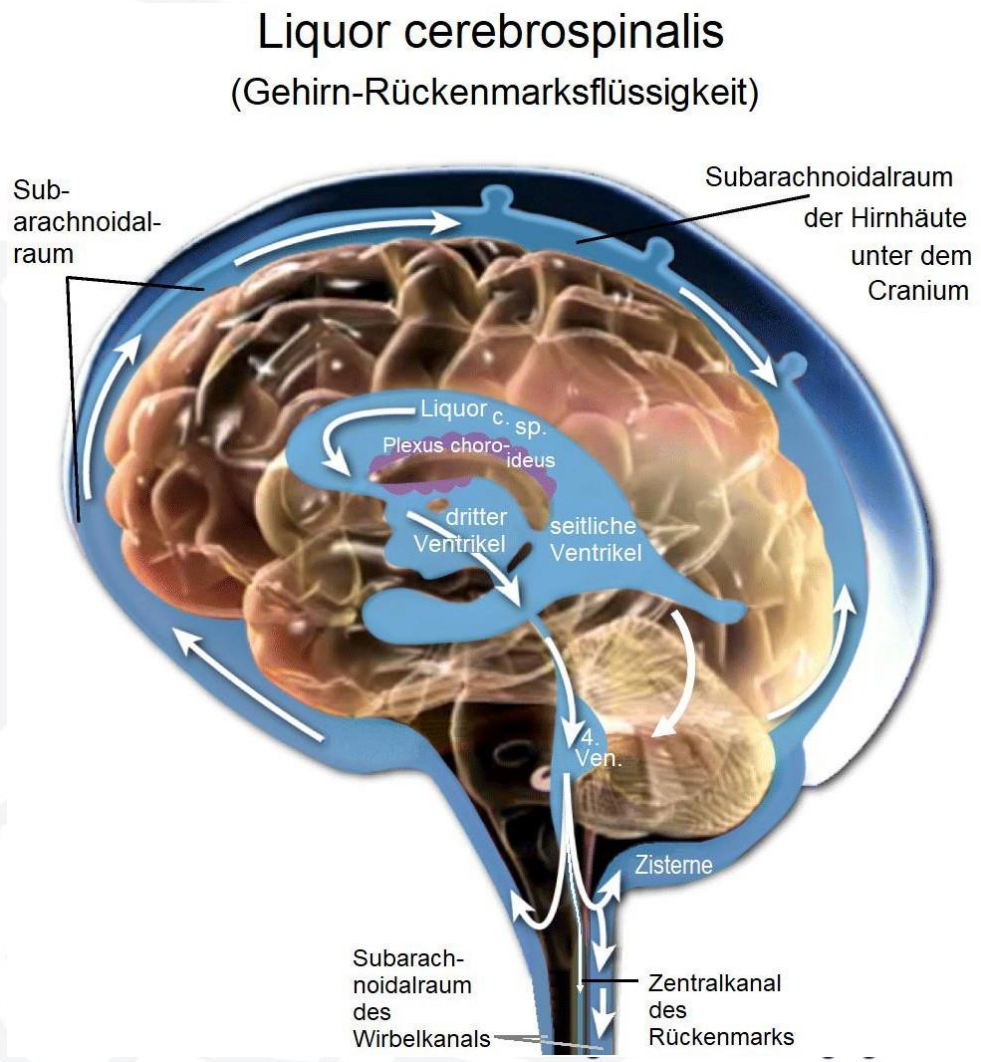
- Headache (as a result of contraction of the meninges)
- Vomiting
- Papilla stasis

(congestion develops after compression where the eye nerves are located.)

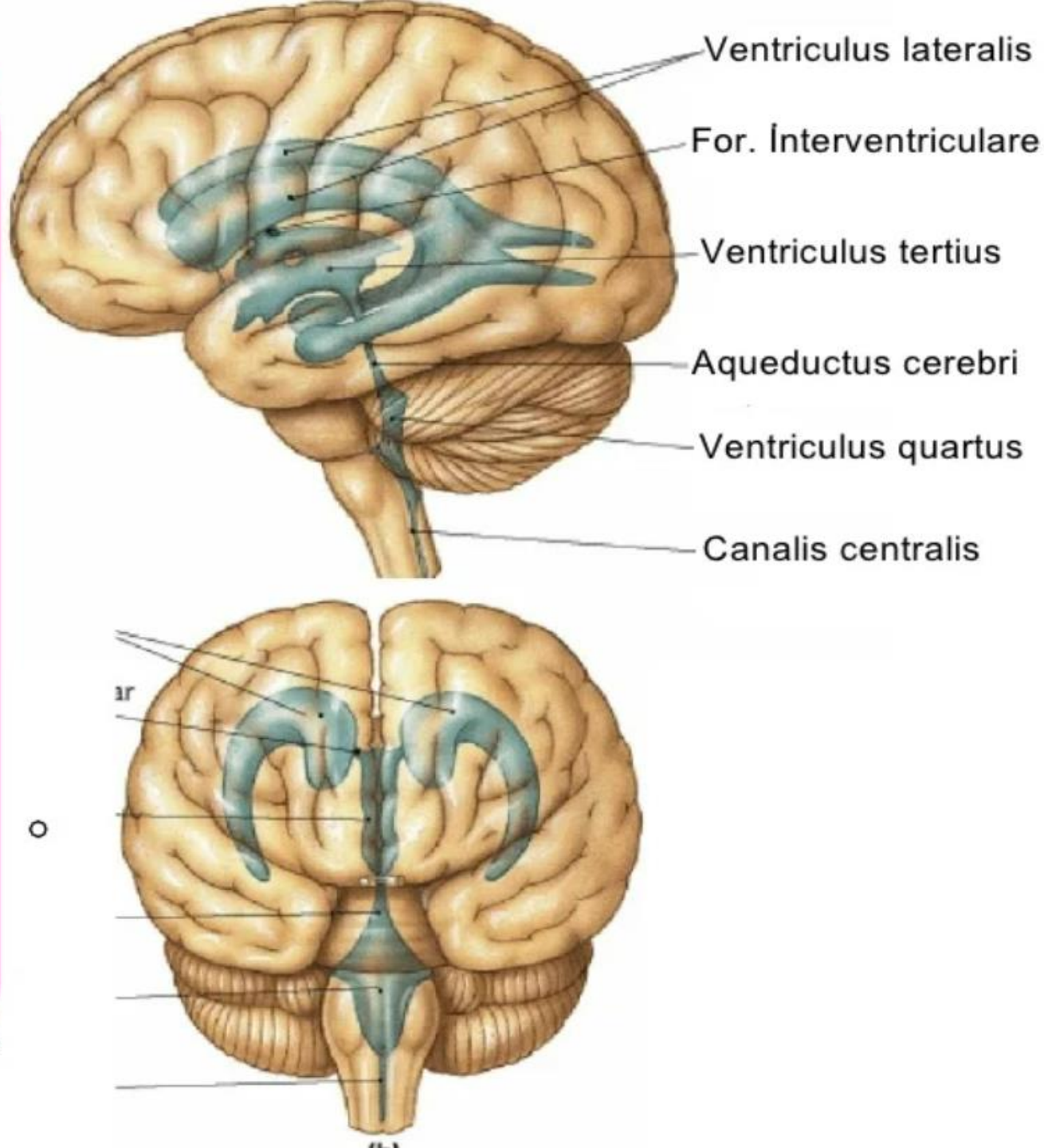
- bradycardia
- dizziness
- Loss of consciousness
- convulsion/seizure

Liquor cerebrospinalis

- Ventriculi laterales,
- For. interventriculare,
- Ventriculus tertius,
- Aquaductus mesencephali,
- Ventriculus quartus,
- Apertura lateralis ve medianus ventriculi quarti
- Cavum subarachnoidea or canalis centralis



- **Ventriculus**
- **Liquor cerebrospinalis**
  (Beyin-omurilik sıvısı = BOS)
- **Ventriculus lateralis**
  (I. ve II.)
- **Ventriculus tertius**
  (III.)
- **Ventriculus quartus**
  (IV.)
- **Canalis centralis**



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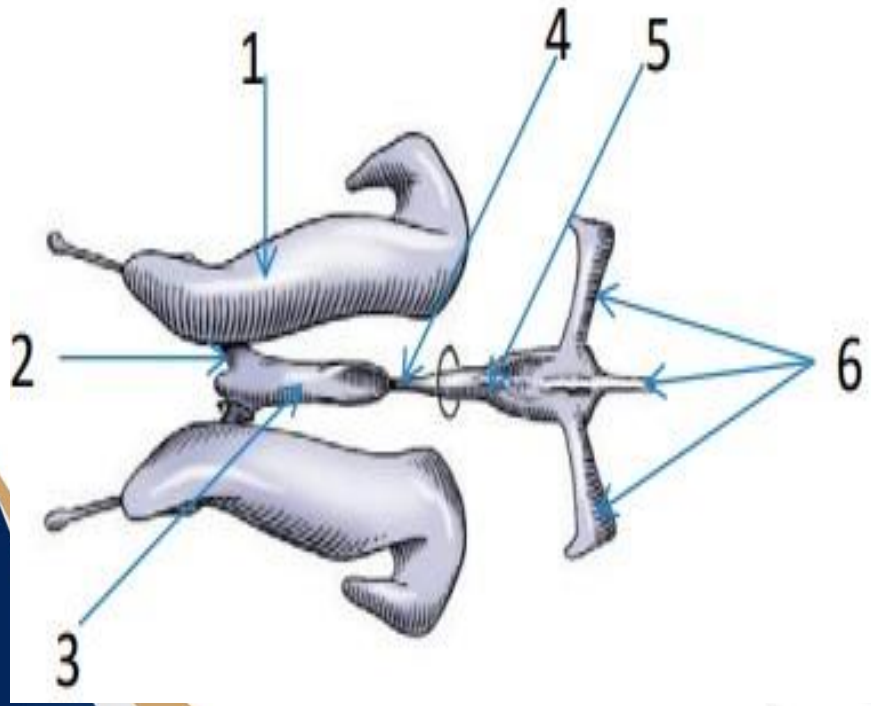


1. Ventriculi laterales,
2. For. interventriculare,
3. Ventriculus tertius,
4. Aquaductus mesencephali,
5. Ventriculus quartus,
6. Apertura lateralis ve medianus ventriculi quarti
7. Cavum subarachnoidea veya canalis centralis

Ventriculi laterales

- It is the space within the cerebral hemispheres on either side of the septum telencephali.
- Plexus choraideus in its walls play a role in the secretion of liqour cerebraspinalis.
- Each of them opens into the ventriculus tertius with the foroamen interventriculare.

Ventriculus tertius

- It is a narrow, ring-shaped space around the adhesio interthalamica.
- Located in rostrodorsal directions, for. While connecting to the ventriculus lateralis with holes called interventricularis
- It opens posteriorly to the ventriculus quartus via the aquaductus mesencephali.

Ventriculus quartus

- Cerebellum with pons and m. It is among the oblangata.
- **At its base** is the fossa rhomboidea.
- It contains pia mater folds called tela choroidea and formations called plexus choraideus, which are formed by these vessels.
- **Anteriorly**, it attaches to the venriculus tertius by the aquaductus mesencephali.
- **Posteriorly,** it connects to the aperture lateralis ventriculi quarti and aperture medinus ventriculi quarti cavum subarachnoidea, with a small hole to the canalis centralis

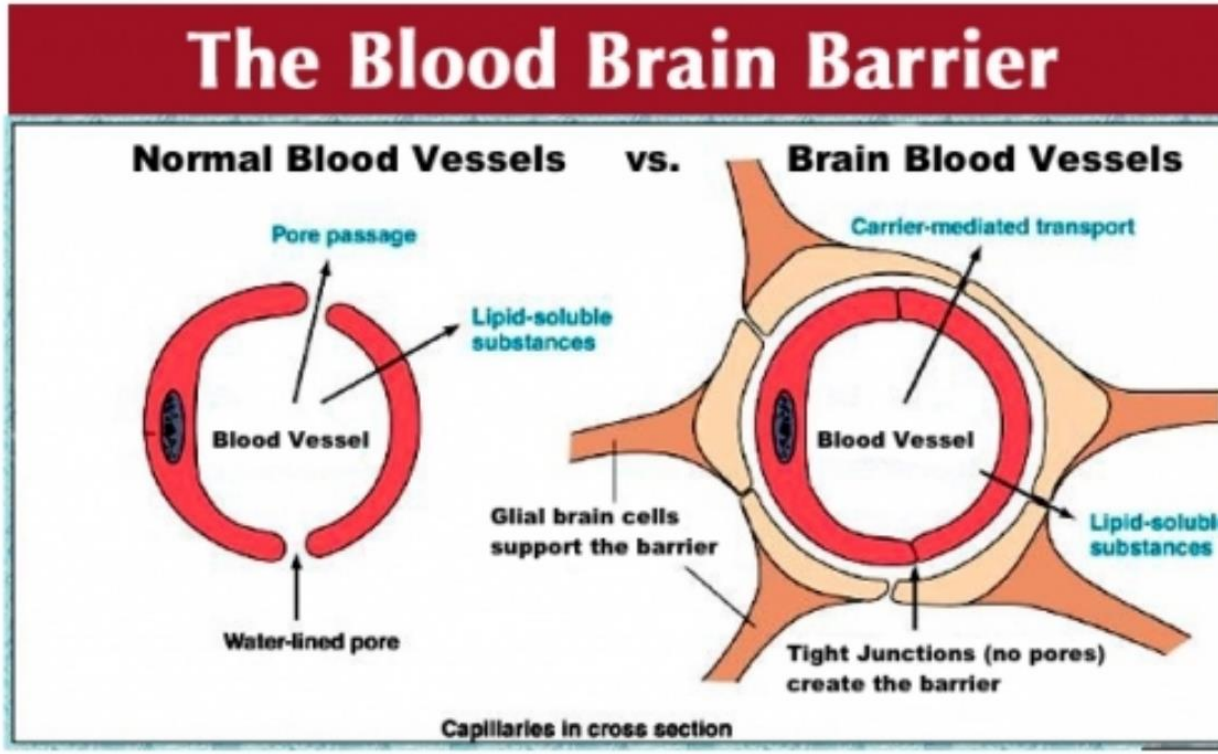
Blood Brain Barrier

- In general, the barrier is highly permeable to water, CO2, O2, lipid-soluble alcohol, and most anesthetics.
- It is poorly permeable to electrolytes such as Na, Cl, K, and to large organic molecules that are insoluble in plasma proteins and lipids.
- It is often impossible for antibodies and fat-insoluble drugs, most of which are in protein structure, to provide effective concentration in the CSF and brain parenchyma.

Blood Brain Barrier

The brain is fed with glucose.

A peculiarity of glucose delivery to neurons is that transport of glucose across the cell membrane to neurons is not insulin dependent as is the case with most other body cells.



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The blood brain barrier separates circulating blood from the extracellular fluid in the central nervous system. This barrier is a highly permeable structure. This structure is formed by endothelial cells connected by tight junctions. The blood-brain barrier allows water, some gases, and fat-soluble molecules to pass through by passive diffusion. The transport of glucose and amino acids is done by active transport.

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The blood-brain barrier does not allow the passage of many microorganisms and neurotoxins. Astrocytes are essential for the formation and proper functioning of the blood brain barrier. This structure covers the entire brain but is absent in a small part of the brain called the circumventricular organs.

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The purpose of this is that if various toxic substances are detected in the blood, this area immediately goes into an alarm state. Various behaviors are seen to expel the poison, such as vomiting.

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What Does the Blood Brain Barrier Do?

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There are many capillaries above the blood-brain barrier. There are tight connections around them in a way that is not seen in normal blood circulation.

Endothelial cells try to prevent the diffusion of even very small organisms such as bacteria. In addition, the passage of hydrophilic or very large molecules into the cerebrospinal fluid is also prevented.

Only diffusion of hydrophobic substances such as oxygen, carbon dioxide, hormones is allowed.

Cells in the blood brain barrier take up metabolic products such as glucose by active transport. Many proteins are used during active transport.

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What Happens If The Blood Brain Barrier Is Damaged?

Many diseases can occur if the blood-brain barrier is damaged or unable to function. The first of these is meningitis. Meningitis is inflammation of the membrane that surrounds the brain and spinal cord. The biggest cause of meningitis is infections caused by pathogens such as Streptococcus.

If these cross the blood-brain barrier and reach the meninges, they can cause inflammation. Damage to the lining of the brain can also lead to meningitis. Antibiotics used to treat meningitis can increase inflammation even more. Bacteria then secrete lipopolysaccharides from their cell walls. Lipopolysaccharides, which alter brain chemistry, may cause further damage to the brain.

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- Another disorder that can occur with damage to the blood-brain barrier is epilepsy.
- Epilepsy is a neurological disorder that causes recurrent and incurable seizures.
- Some studies show that there may be an interaction between albumin in the blood and astrocytes.

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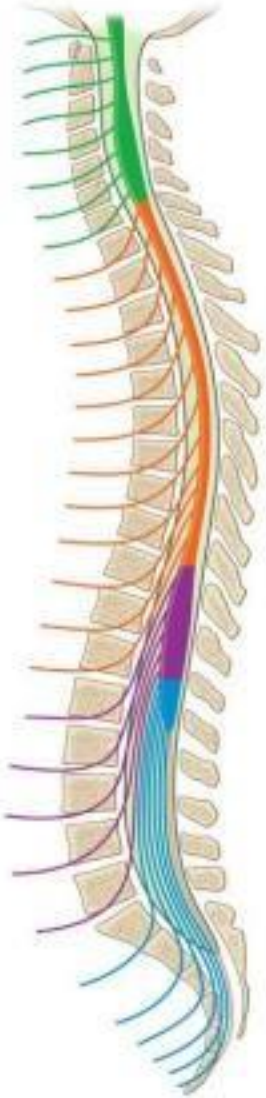
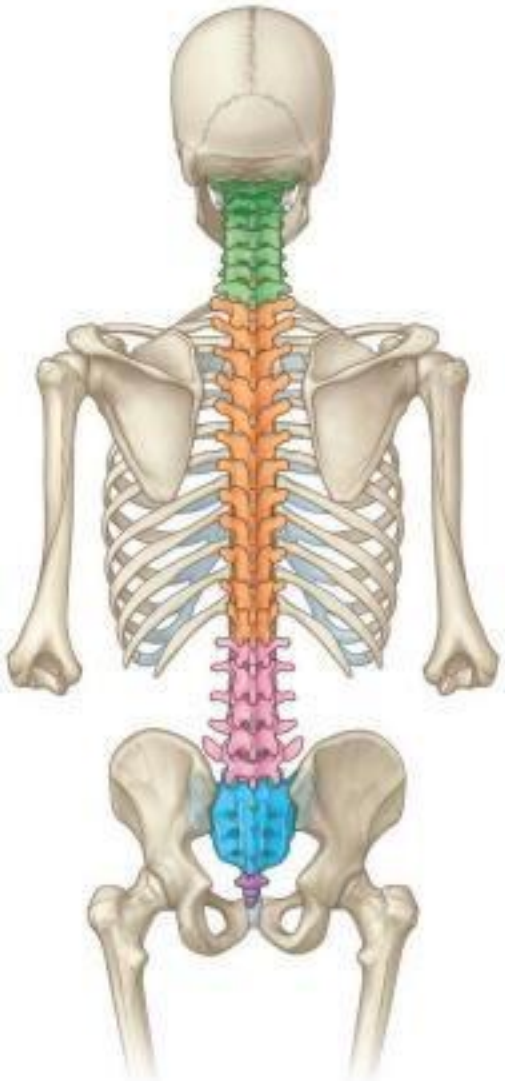
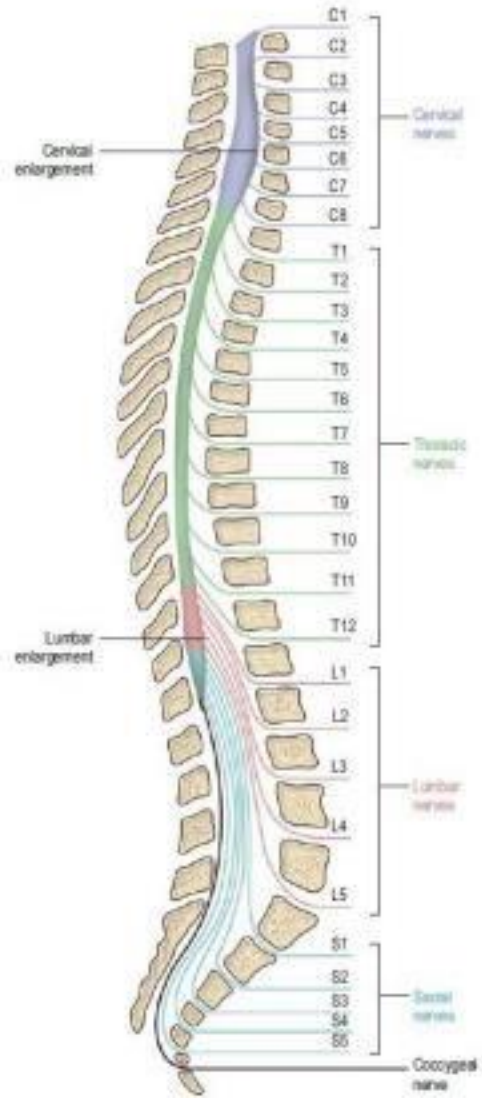
- These interactions may also be very important in epilepsy.
- There may be some abnormalities in the brain as a result of the blood-brain barrier not functioning and remaining weak.
- The number of seizures can increase when substances that should not be in the blood circulation of the brain travel.

MEDULLA SPINALIS (SPINAL CORD)







MEDULLA SPINALIS (SPINAL CORD)

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- Medulla spinalis,
- It extends downward as a continuation of the medulla oblongata.
- In humans, approximately 40-45 cm long, 1 cm in diameter
- and it is a formation weighing 30-42 gr.
- It is surrounded by the liquor cerebrospinalis within the canalis vertebralis.

MEDULLA SPINALIS (SPINAL CORD)

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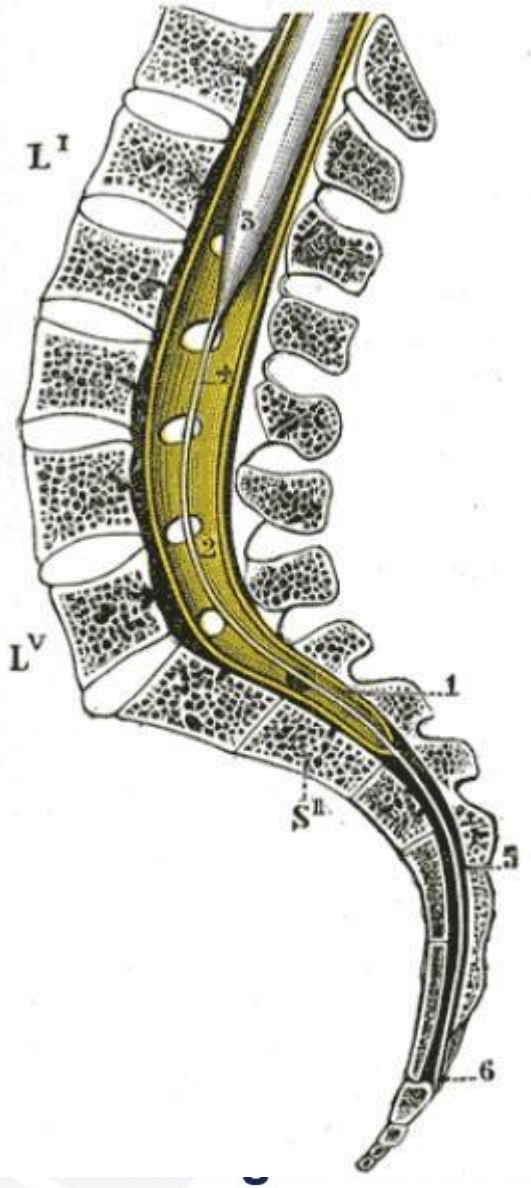
- It ends with a cone-shaped lower end (conus medullaris).
- At the tip of this cone is a thin piamater extension called filum terminale.
- Filum terminale is located in the cavity formed by the dura mater spinalis and is called filum terminale internum.



MEDULLA SPINALIS (SPINAL CORD)

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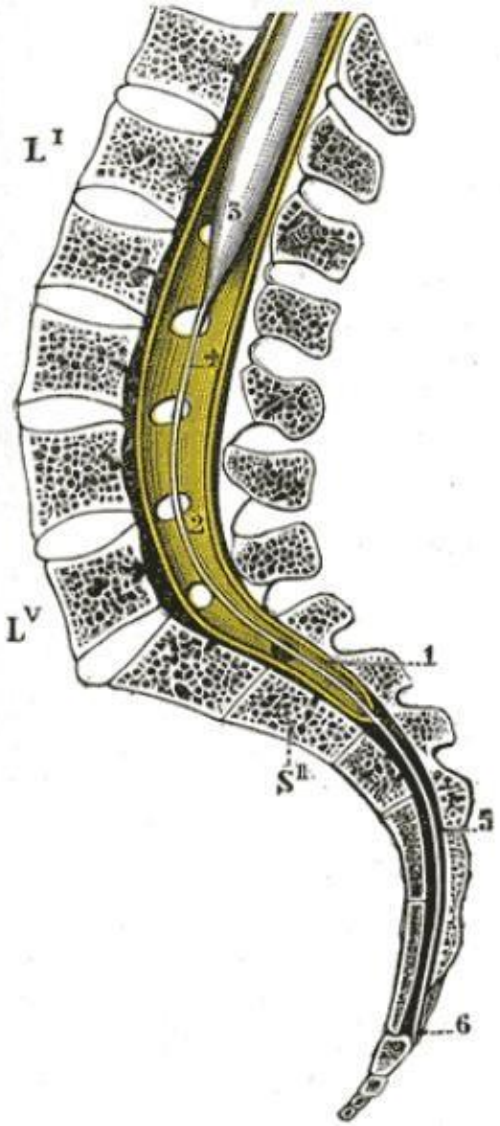
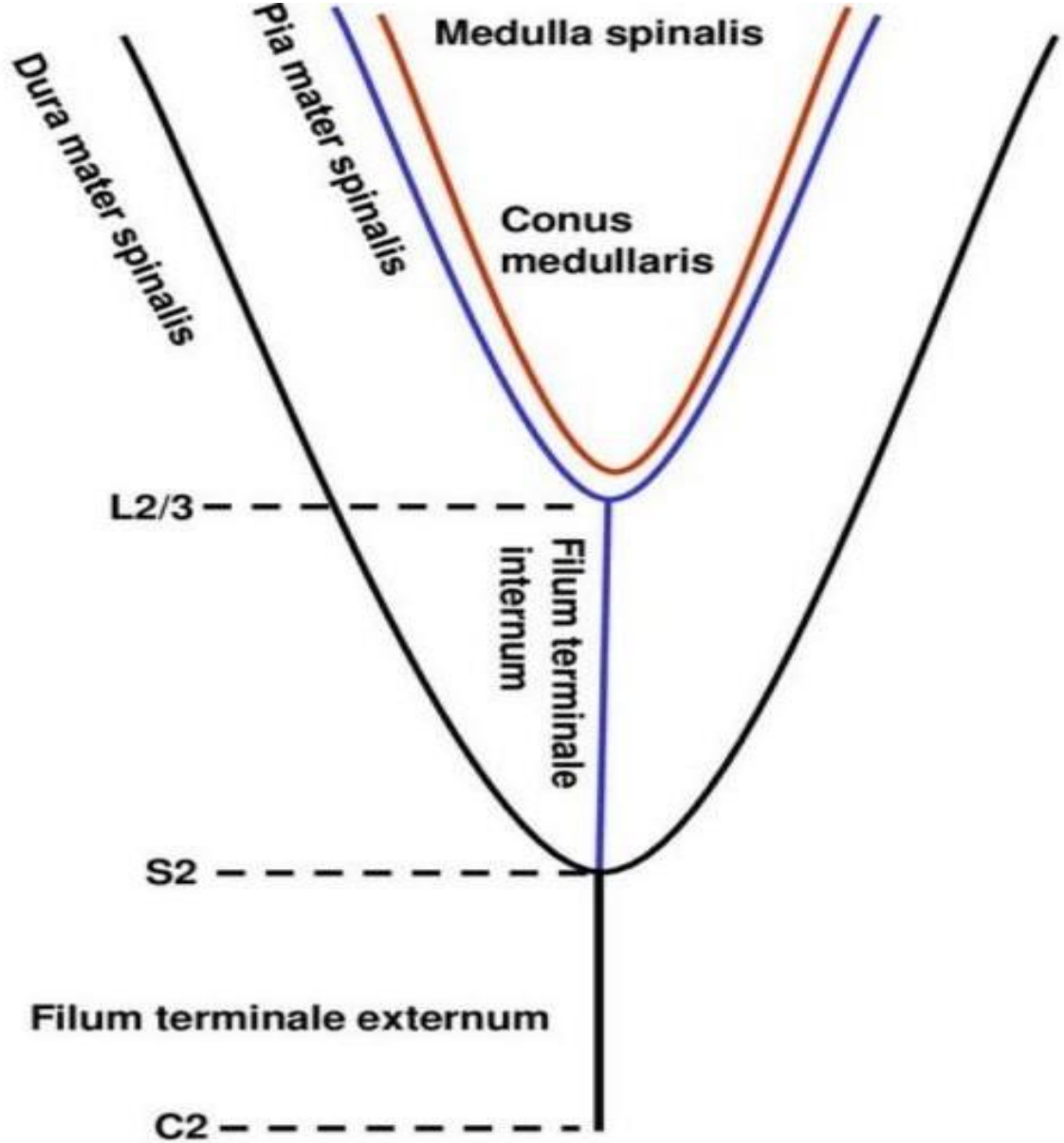
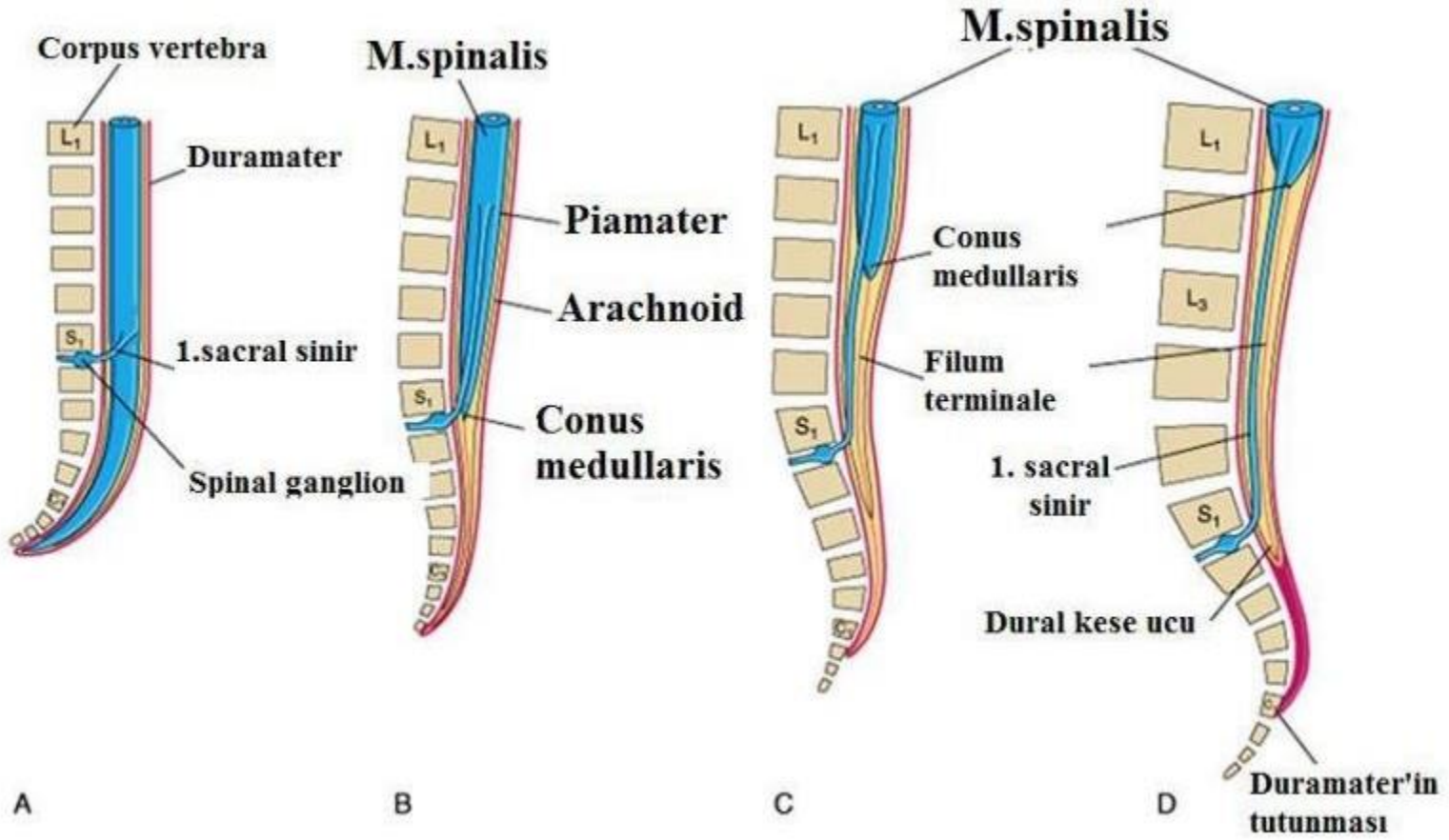
- It extends to the lower border of S2, surrounded externally by the dura mater spinalis and arachnoidea mater spinalis.
- The last 5 cm part of the dura mater spinalis, which is outside the cavity formed, is called filum terminale externum.
- It ends by attaching to the dorsal aspect of the first coccygeal vertebra, wrapped externally by the dura mater spinalis.

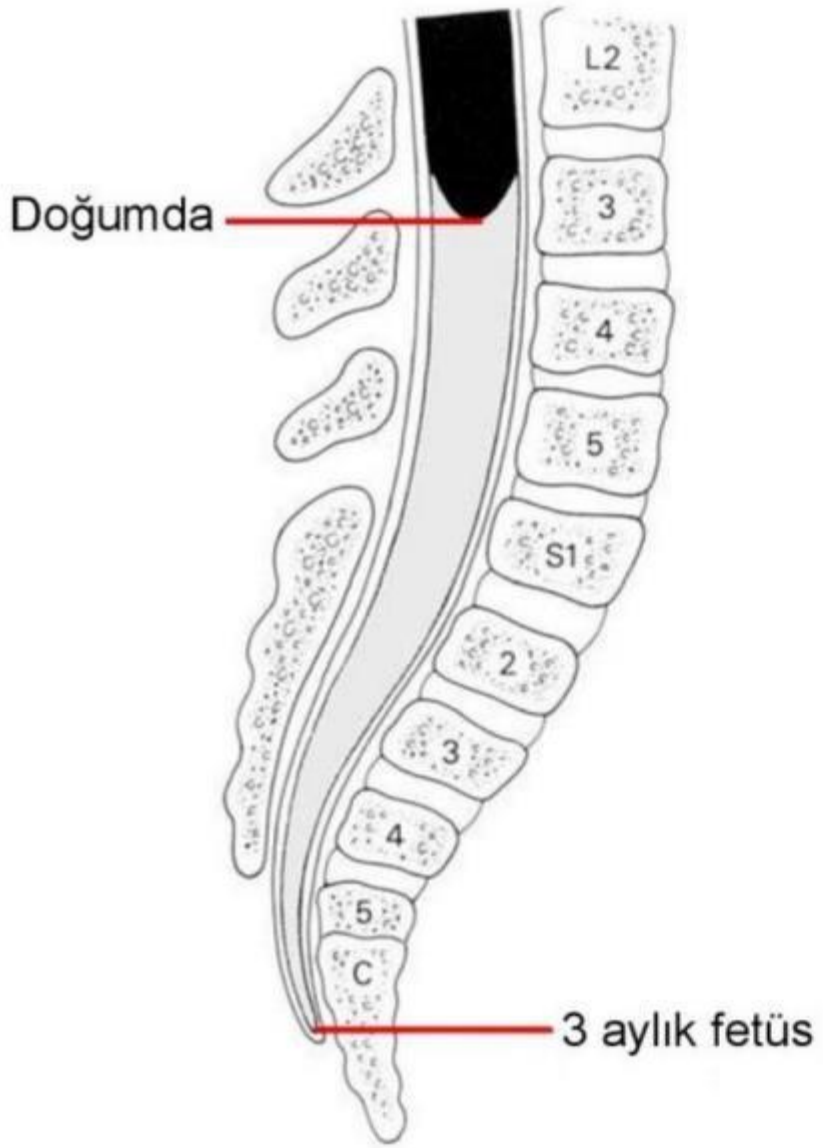


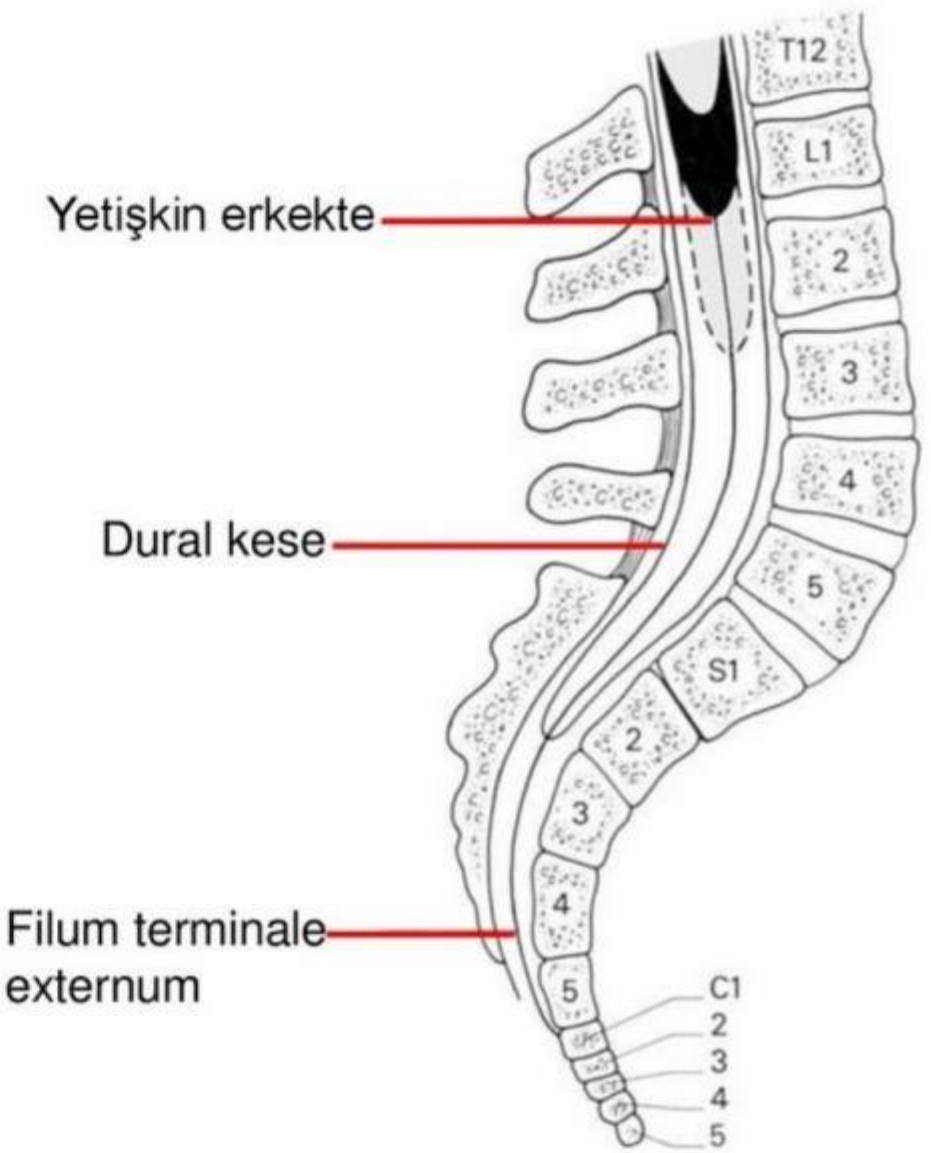

Medulla spinalis
Pia mater spinalis
Dura mater spinalis
Conus medullaris
L2/3
Filum terminale internum
S2
Filum terminale externum
C2

While it fills the entire vertebral canal in the 2nd-third month of intrauterine life, it is found in S1 in the 6th month.

Its lower end is located at L3 in adolescence and at L1-L2 in adults.



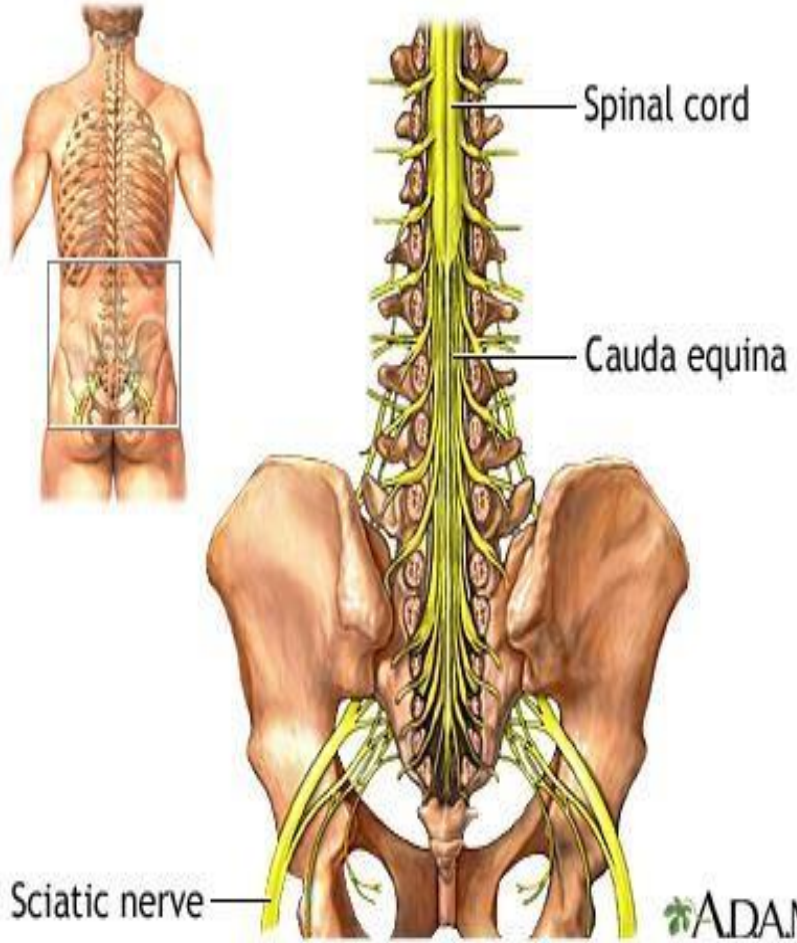

Doğumda
L2
3
4
5
S1
2
3
4
5
C
3 aylık fetüs

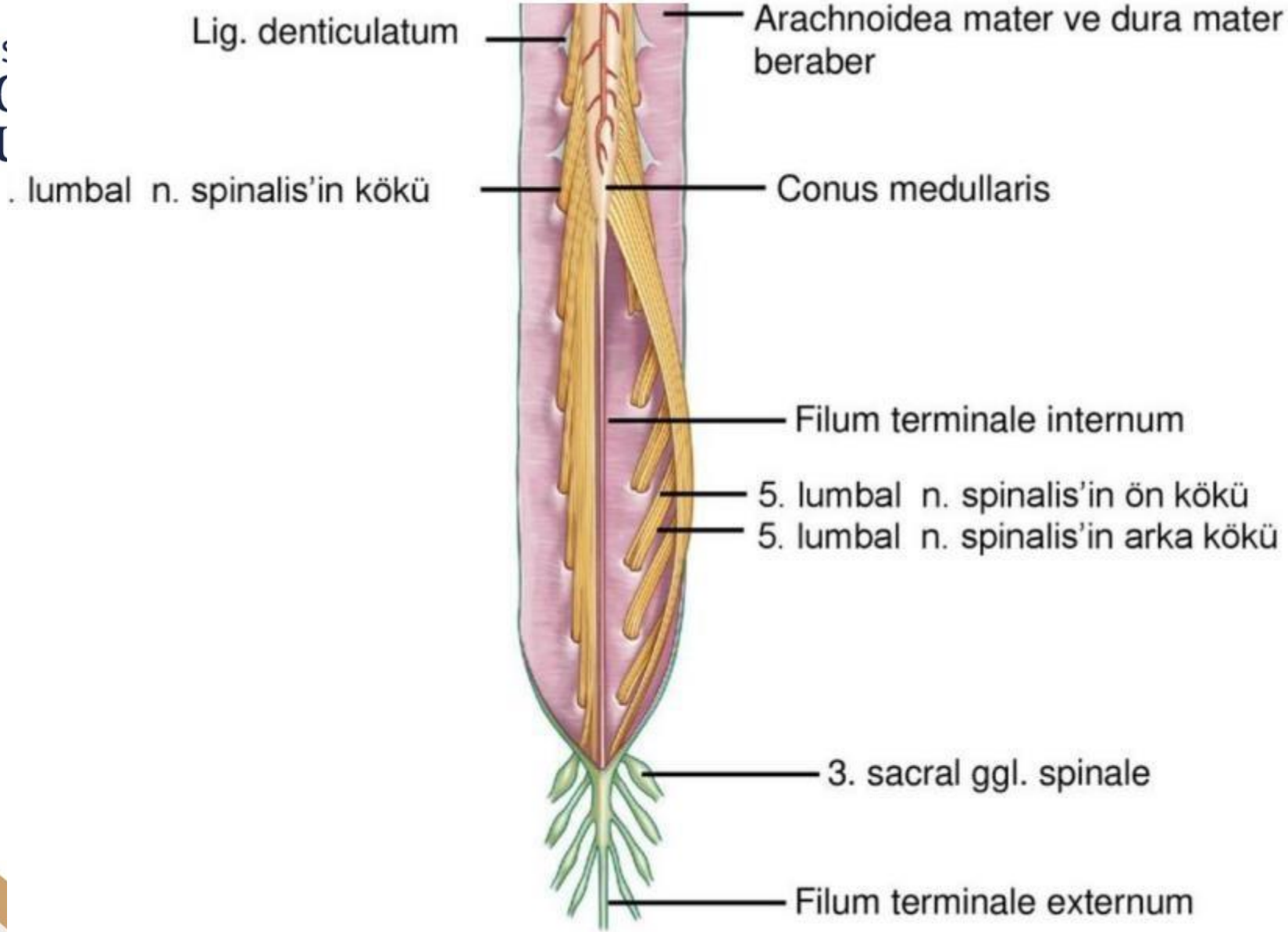

Yetişkin erkekte
Dural kese
Filum terminale externum
T12
L1
2
3
4
5
S1
2
3
4
5
C1
2
3
4
5

Cauda equina

- Spinal nerve roots originating from the lumbal and sacral spinal segments form a horsetail-like appearance around the filum terminale.

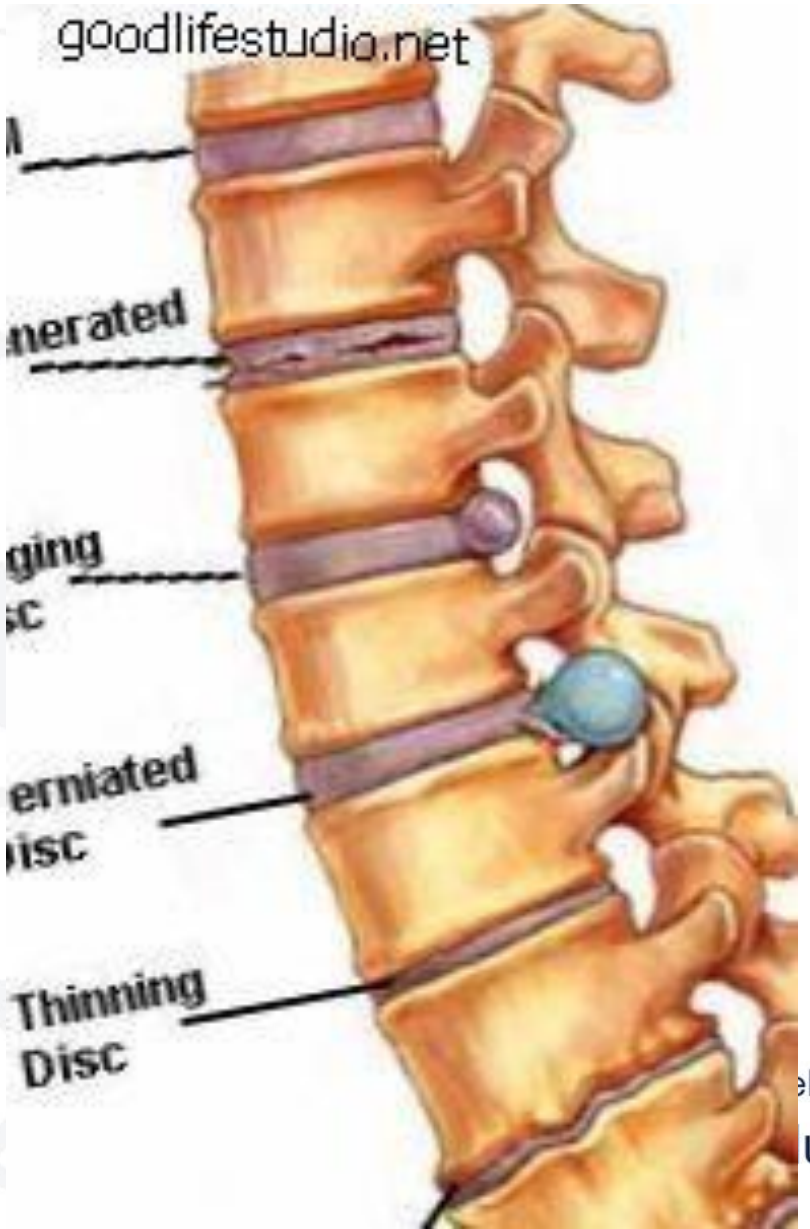
- The bundles of dorsal and ventral spinal nerve roots under the conus medullaris, the last part of the spinal cord, are called cauda equina.




Lig. denticulatum
Arachnoidea mater ve dura mater beraber
. lumbal n. spinalis'in kökü
Conus medullaris
Filum terminale internum
5. lumbal n. spinalis'in ön kökü
5. lumbal n. spinalis'in arka kökü
3. sacral ggl. spinale
Filum terminale externum

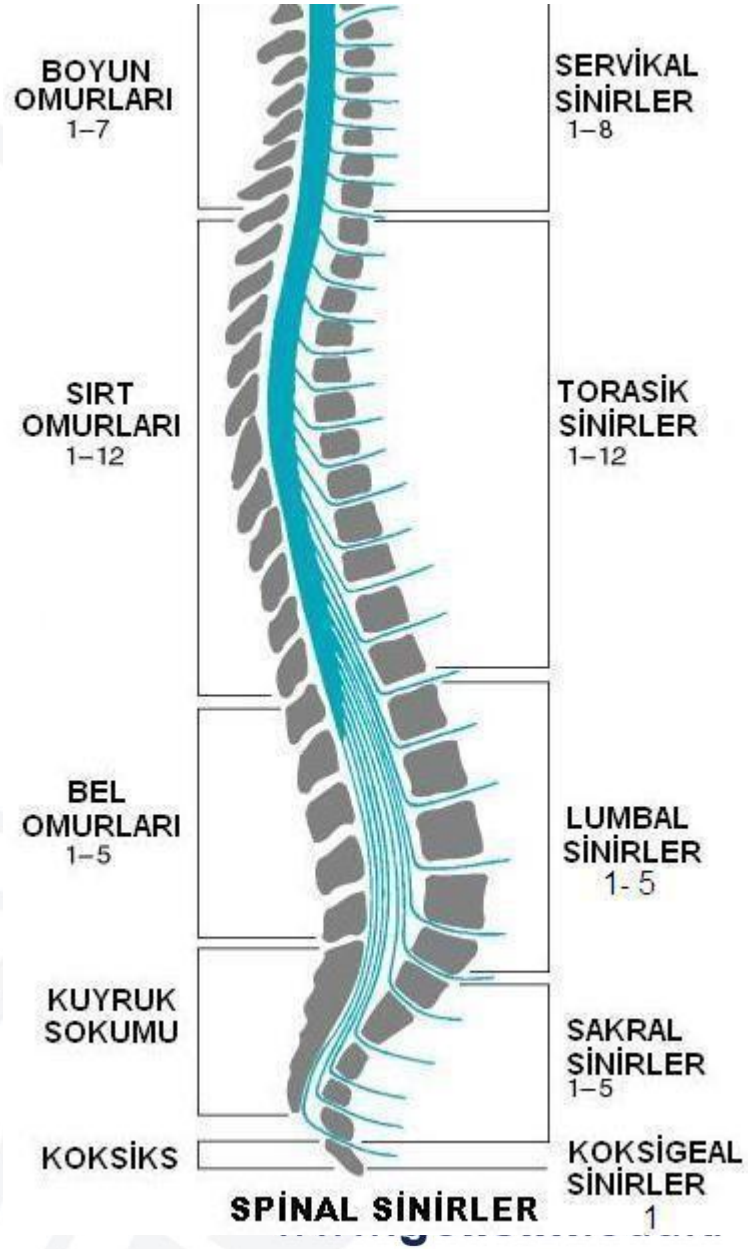
Medulla Spinalis

- Medulla spinalis is not completely cylindrical and dorsoventrally flattened. It shows two enlargements in the cervical and lumbar regions.



Medulla Spinalis

- The first enlargement (intumescentia cervicalis) is related to the upper extremity.
- It extends from the third cervical vertebra to the second thoracic vertebra and includes the C4-T1 spinal cord segments.
- The second enlargement, called Intumescentia lumbosacralis (L1-S3), is related to the hind limb.



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