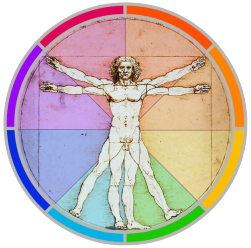
HUBS191 Lecture Material

This pre-lecture material is to help you prepare for the lecture and to assist your note-taking within the lecture, it is NOT a substitute for the lecture !



Please note that although every effort is made to ensure this pre-lecture material corresponds to the live-lecture there may be differences / additions.

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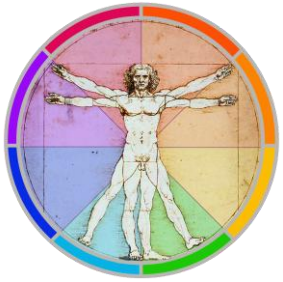
ŌTĀKOU WHAKAIHU WAKA



HUBS 191

Human Movement and Sensation

Theme 2: Integrating and coordinating roles of the nervous system

***Lecture 21*: Meninges and ventricular system**

Dr. Rob Munn, Director of Neuroscience
Department of Anatomy

Lecture 20: Post-lecture Quiz

• The dorsal white columns are part of:
(a) PNS; (b) spinal nerves; (c) sensory system; (d) efferent system.

• Spinal nerves contain all of the following except:
(a) Myelinated axons; (b) Sensory axons; (c) Motor axons; (d) filum terminale

• Which of the following is true of the spinal cord
(a) it is part of the PNS; (b) contains spinal nerves; (c) it contains sympathetic nerve fibers; (d) it contains perineurium.

• A peripheral nerve contains _____.
(a) Fascicles; (b) Conus medullaris; (c) Filum terminale; (d) Oligodendrocytes

Lecture 21: Learning objectives

After you have reviewed and studied this lecture, you should understand and be able to describe:

1. The meninges and their structural and functional properties in both the brain and spinal cord

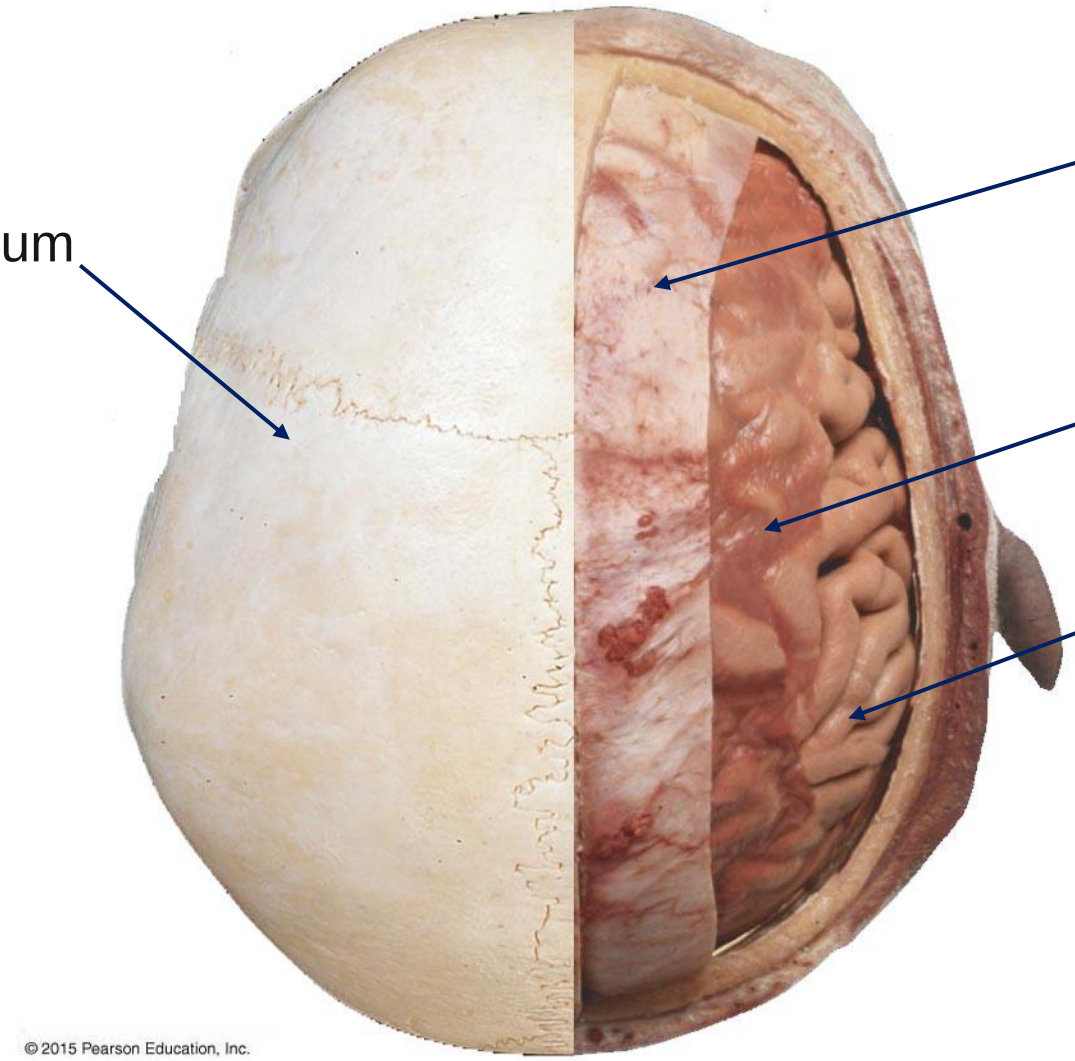
2. The special features of the meninges and the locations of different special features within different parts of the brain

3. The ventricular system, including
    a) the names of the ventricles
    b) the anatomical location of ventricles within different parts of the brain

4. Flow and circulation path of cerebrospinal fluid (CSF)

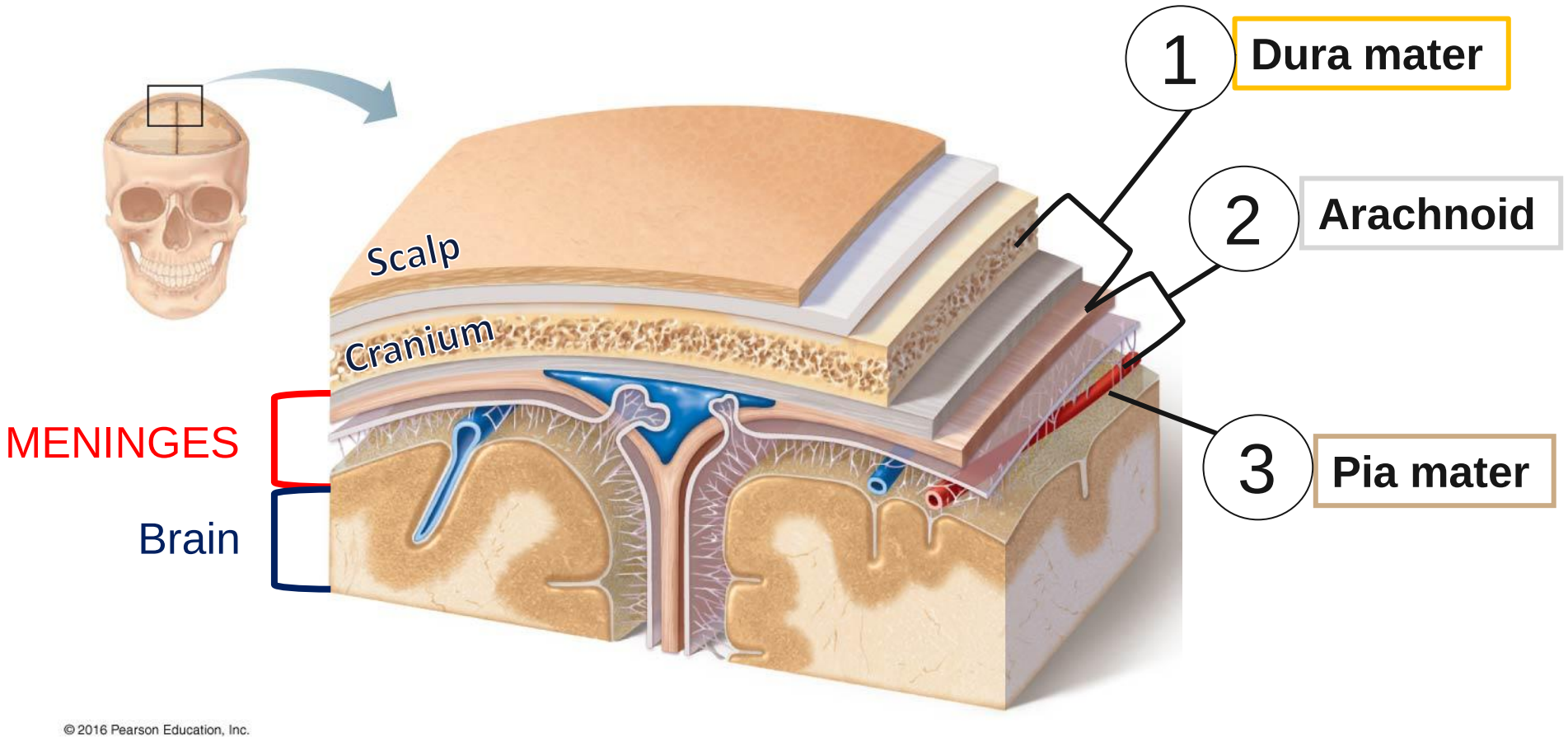
Meninges - Protective covering for the brain (from Greek *meninx* = membrane)

3 Layers



Modified from: Martini Atlas of the Human Body, plate 7c

Meninges: Three layers of protective tissue



From Marieb: Human Anatomy and Physiology, 10th ed, Fig. 12.22, p480.

See also: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

Dura mater = ‘Tough mother’

(*Dura* like Durable, *Mater* like Maternal)

Five Features

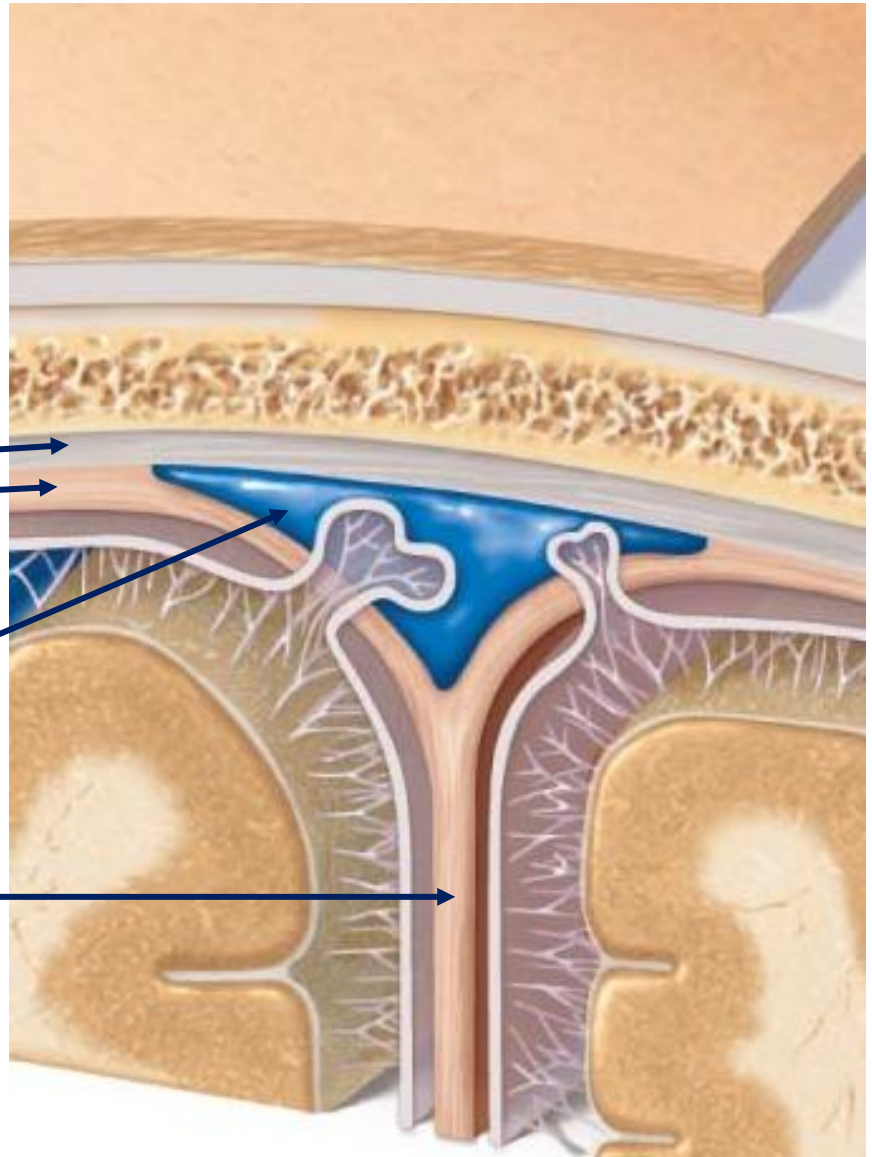
1. Outer-most layer of meninges

2. Dense and fibrous – tough

3. Two layers — 1. outer, 2. inner

4. Space between the layers forms ***venous sinuses*** – only in some places

5. **Inner layer** forms the ***dural folds***



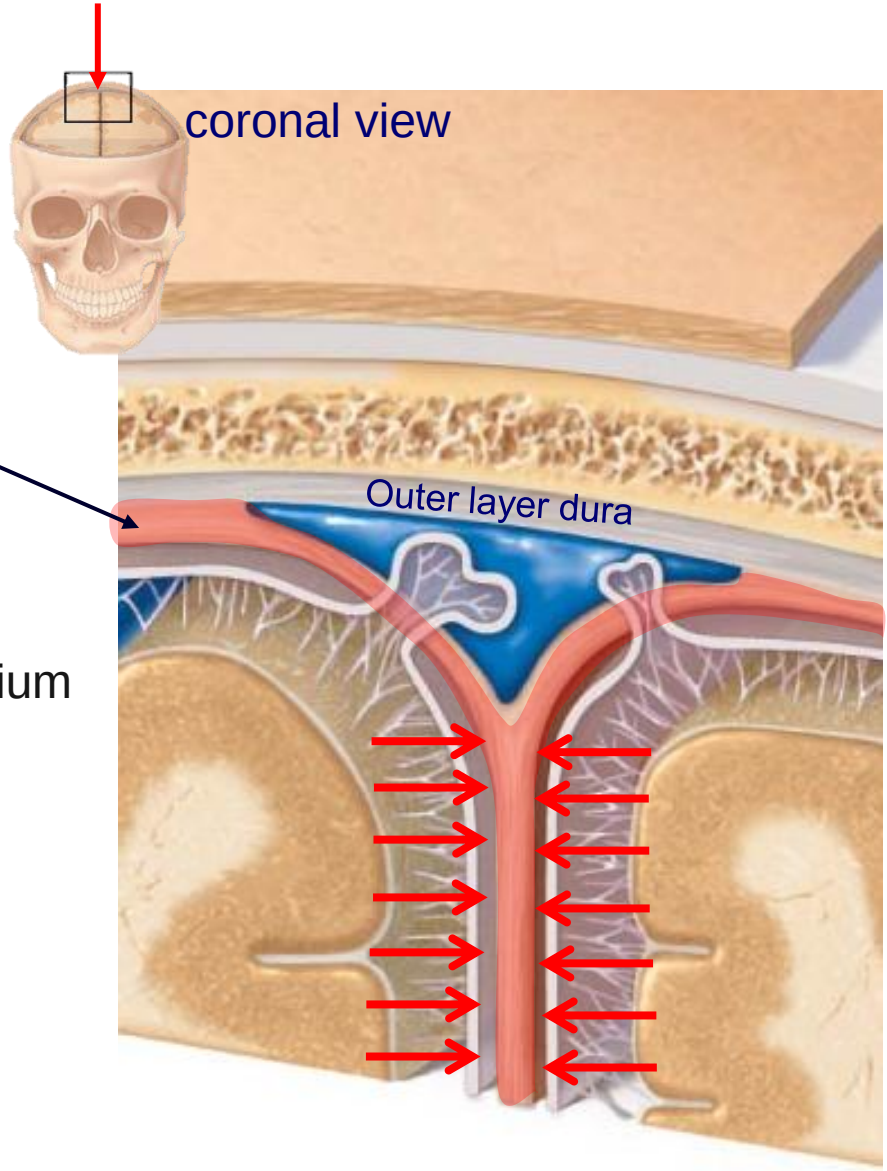
From: Marieb and Hoehn, Human Anatomy and Physiology, 10th ed, Fig. 12.22, p480

See also: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

Special features of Dura mater:
I. Dural folds

Three Features

1. Formed from inner layer of dura mater
2. Separate major divisions of brain
3. Provide stability of the brain within cranium



From: Marieb and Hoehn, Human Anatomy and Physiology, 10th ed, Fig. 12.22, p480

See also: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

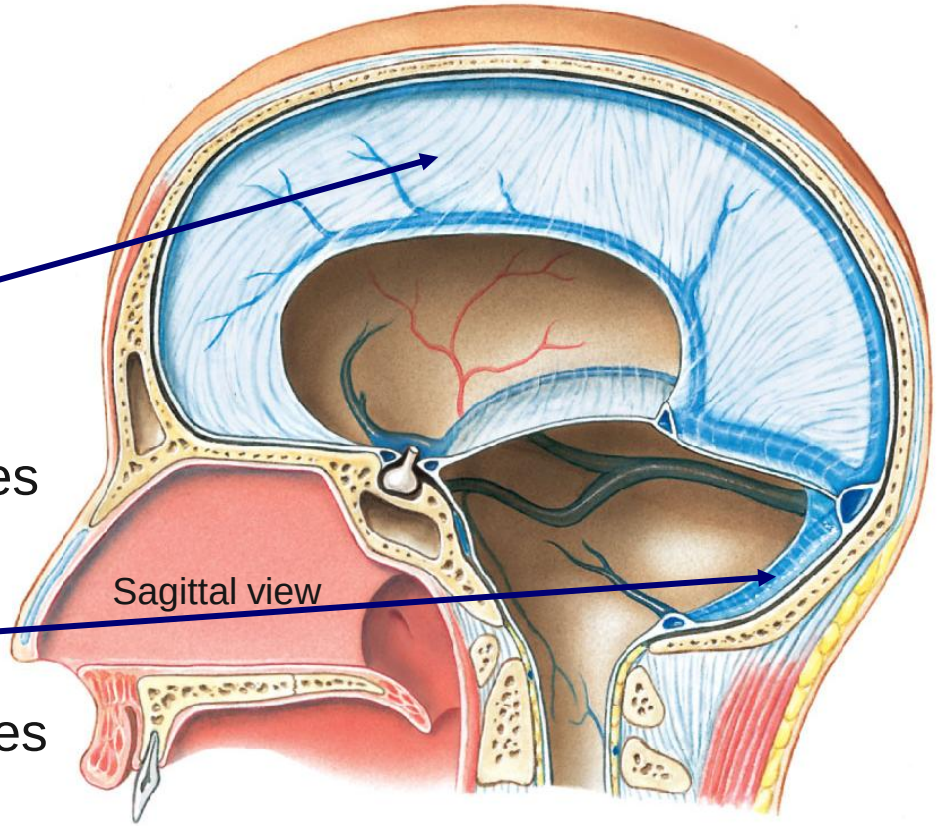
Special features of Dura mater:
I. Dural folds

Three of them:

1. **Falx cerebri**
   - separates cerebral hemispheres
   - median plane

2. **Falx cerebelli**
   - separates cerebellar hemispheres
   - median plane

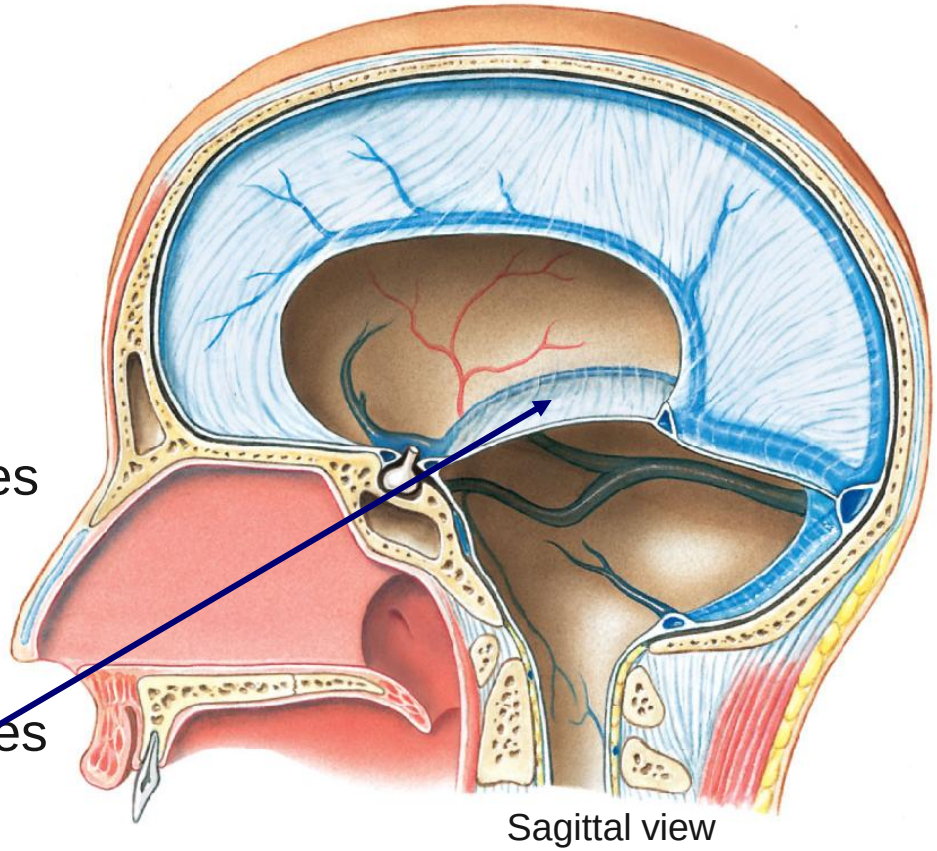
3. **Tentorium cerebelli**



Falx is Latin for “sickle"

From: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

Special features of Dura mater:
I. Dural folds


Sagittal view

Three of them:

1. **Falx cerebri**
   - separates cerebral hemispheres
   - median plane

2. **Falx cerebelli**
   - separates cerebellar hemispheres
   - median plane

3. **Tentorium cerebelli**
   - separates the cerebrum from the cerebellum
   - horizontal plane

From: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

Locations of Dural Folds

Posterior (“Back”) view of the brain

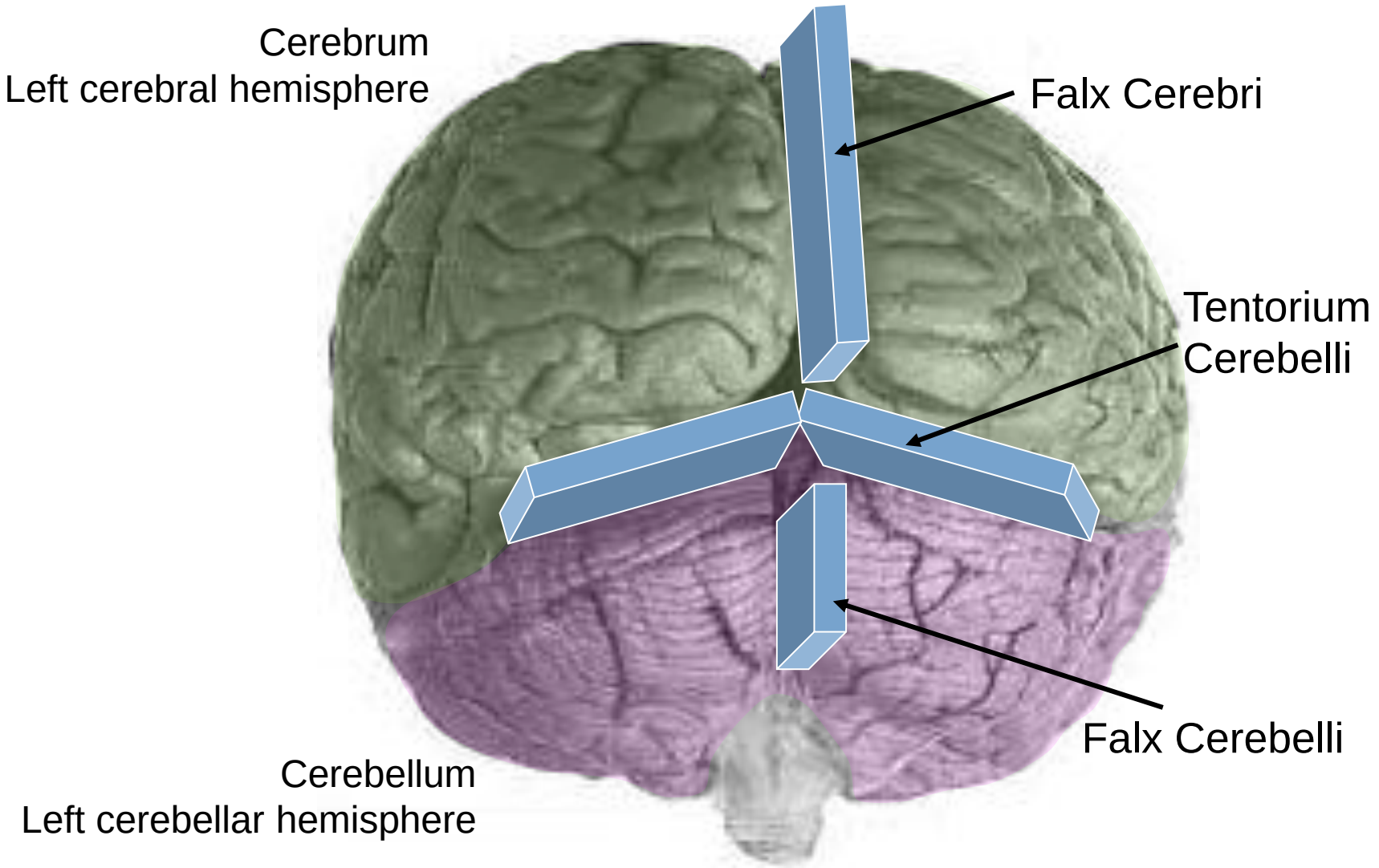


Image from: https://quizlet.com/251830796/posterior-view-of-brain-diagram/

Special features of Dura mater:
II. Venous sinus

Three Features

1. Located where the two layers of dura mater separate

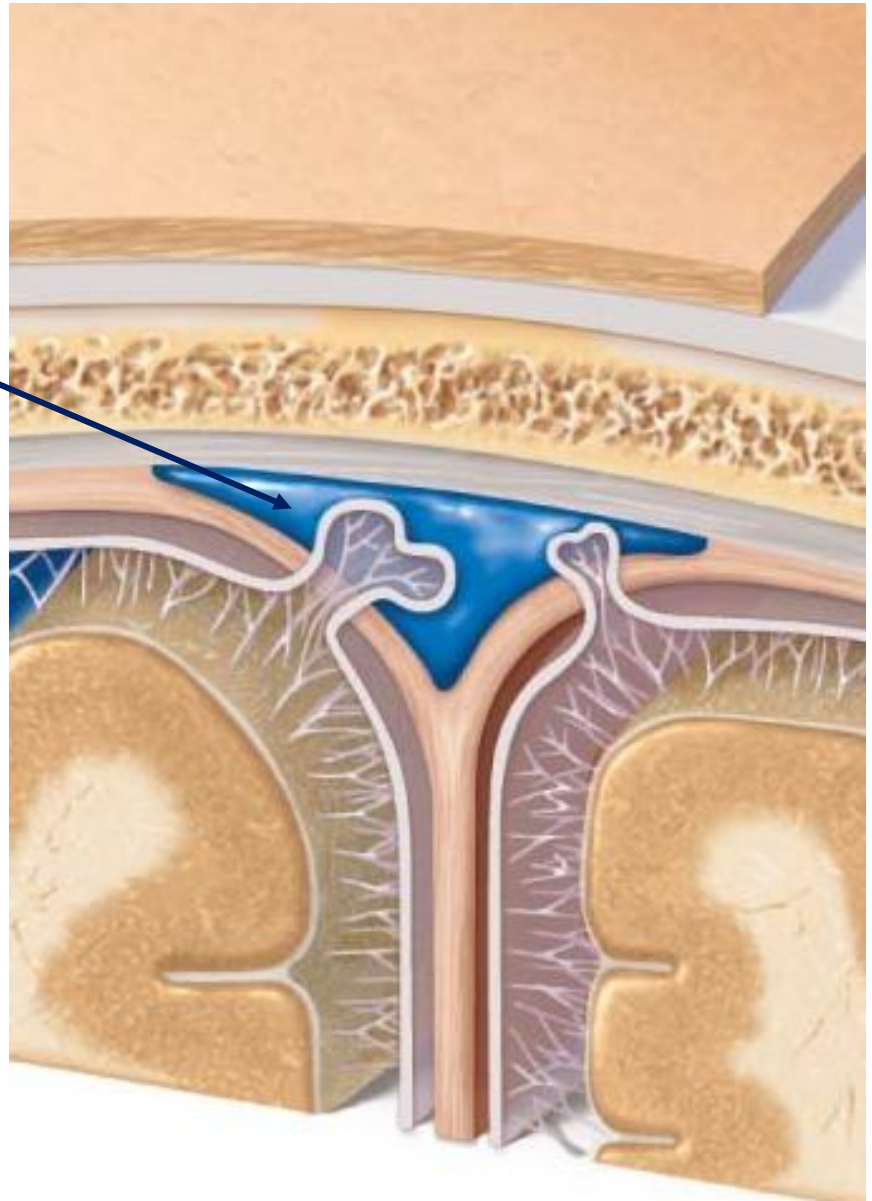
2. Collecting veins

3. They collect (2 things)

a) Venous blood from the brain

b) 'Old' CSF after it has cycled through the ventricular system

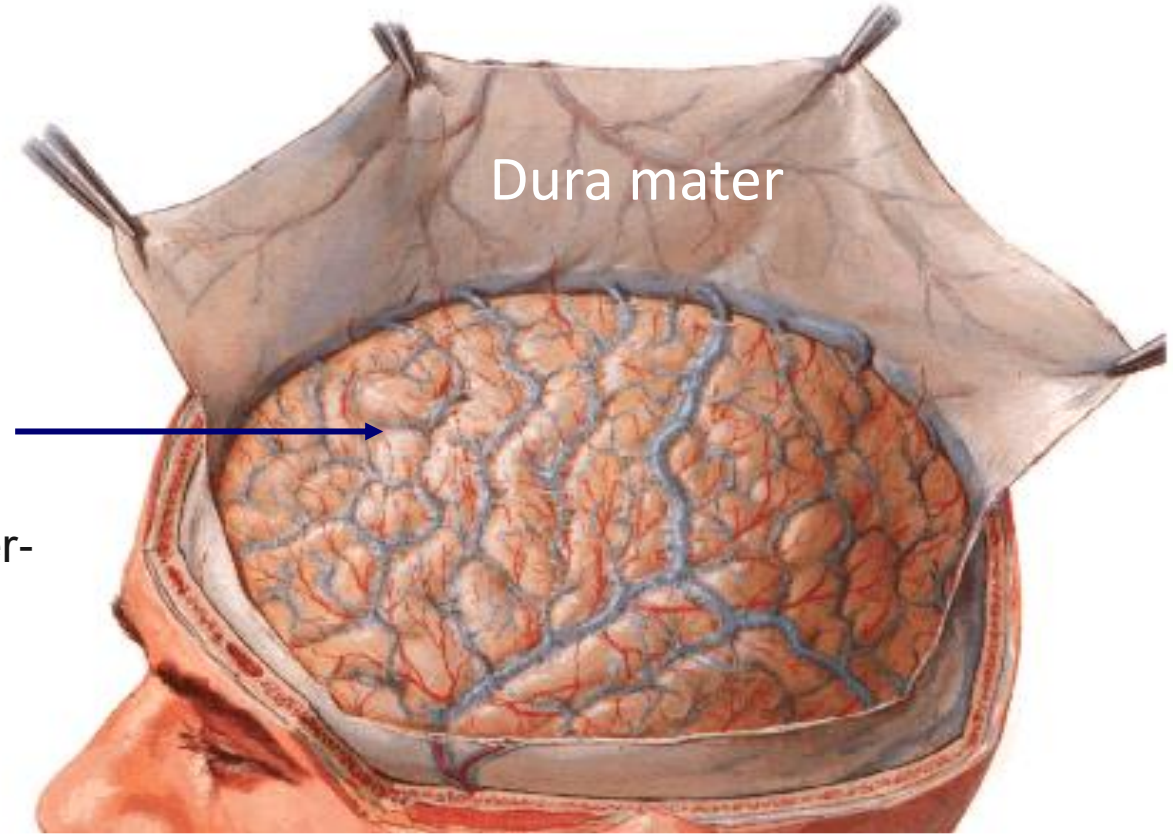
[more on this in a few slides]



From: Marieb and Hoehn, Human Anatomy and Physiology, 10th ed, Fig. 12.22, p480

See also: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

Arachnoid *('spider-like')* Layer
[sometimes just called arachnoid]



- Layer beneath the dura mater
- Named because it has a spider-like appearance

Image from: https://www.slideshare.net/MehulTandel/spinal-cord-1-intro-amp-grey-matter-dr-mehul-tandel

See also: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

Arachnoid

Five Features

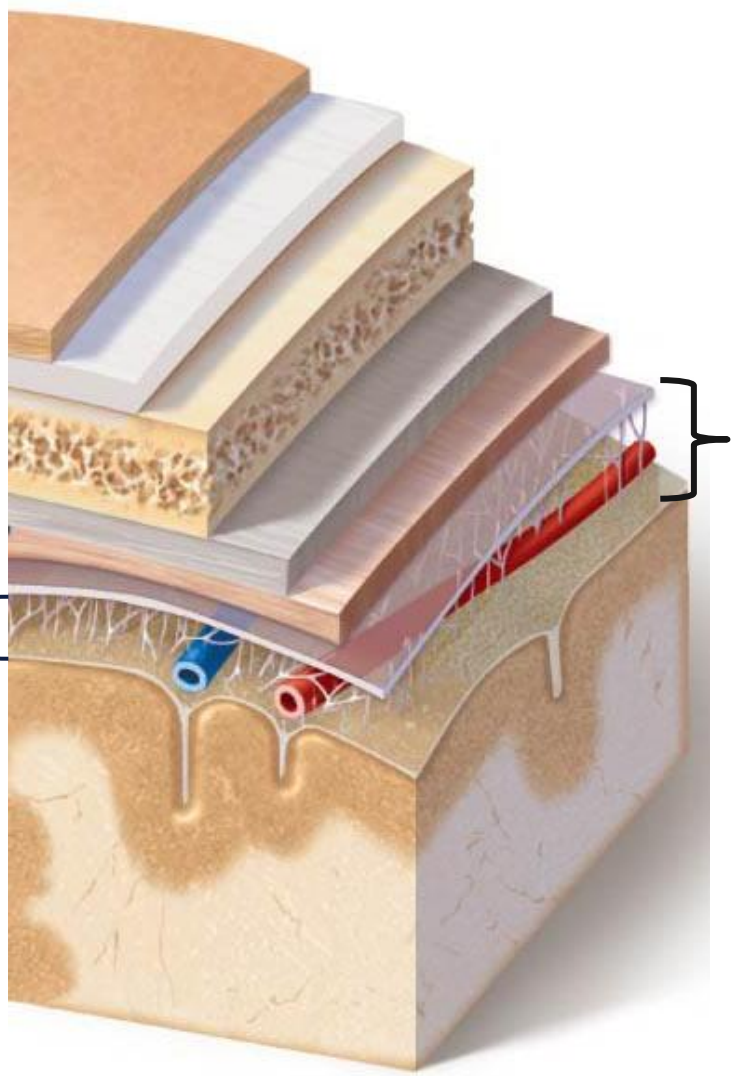
1. Layer **beneath** the *dura mater*

2. Layer **above** the *pia mater*

3. Does **not** extend into sulci ('valleys')

4. Contains 3 special features:
   - ***i. Subarachnoid space***
   - ***ii. Arachnoid granulations***
   - ***iii. Arachnoid Trabeculae***

5. Contains **blood vessels** (within the subarachnoid space, lying **on top of** *pia mater*)

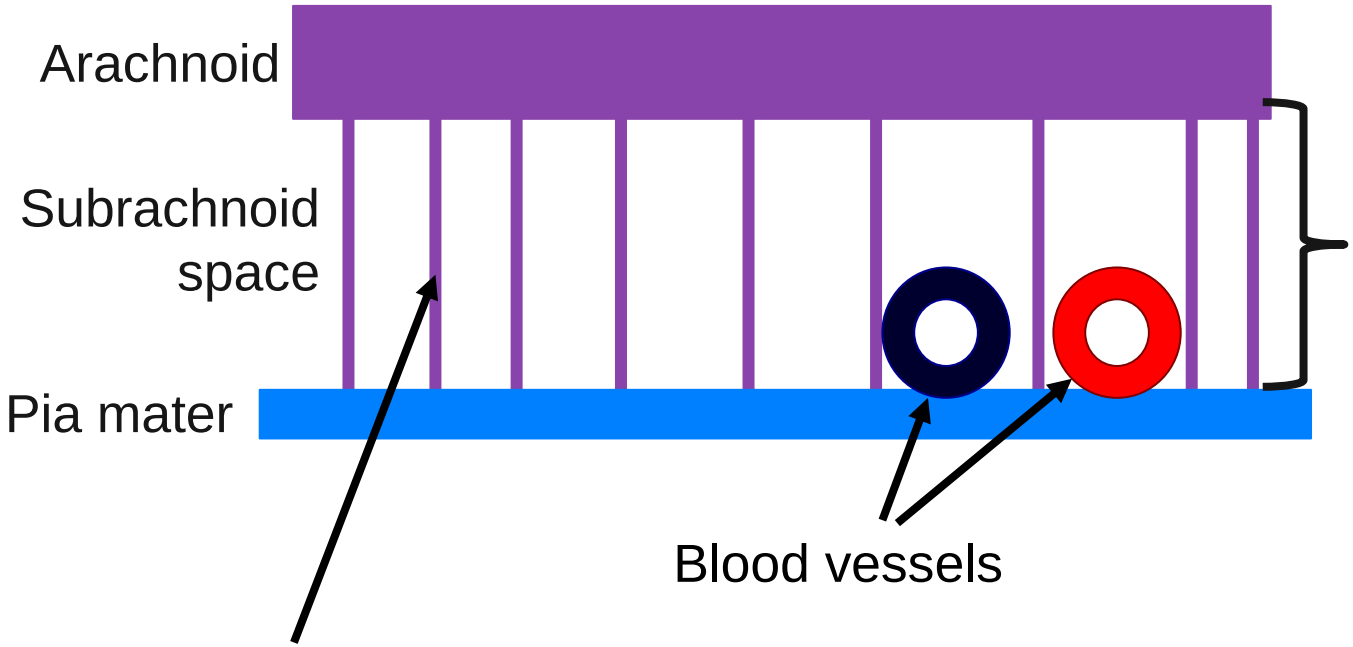


From: Marieb and Hoehn, Human Anatomy and Physiology, 10th ed, Fig. 12.22, p480

See also: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

Special features of the Arachnoid:
I. Subarachnoid space

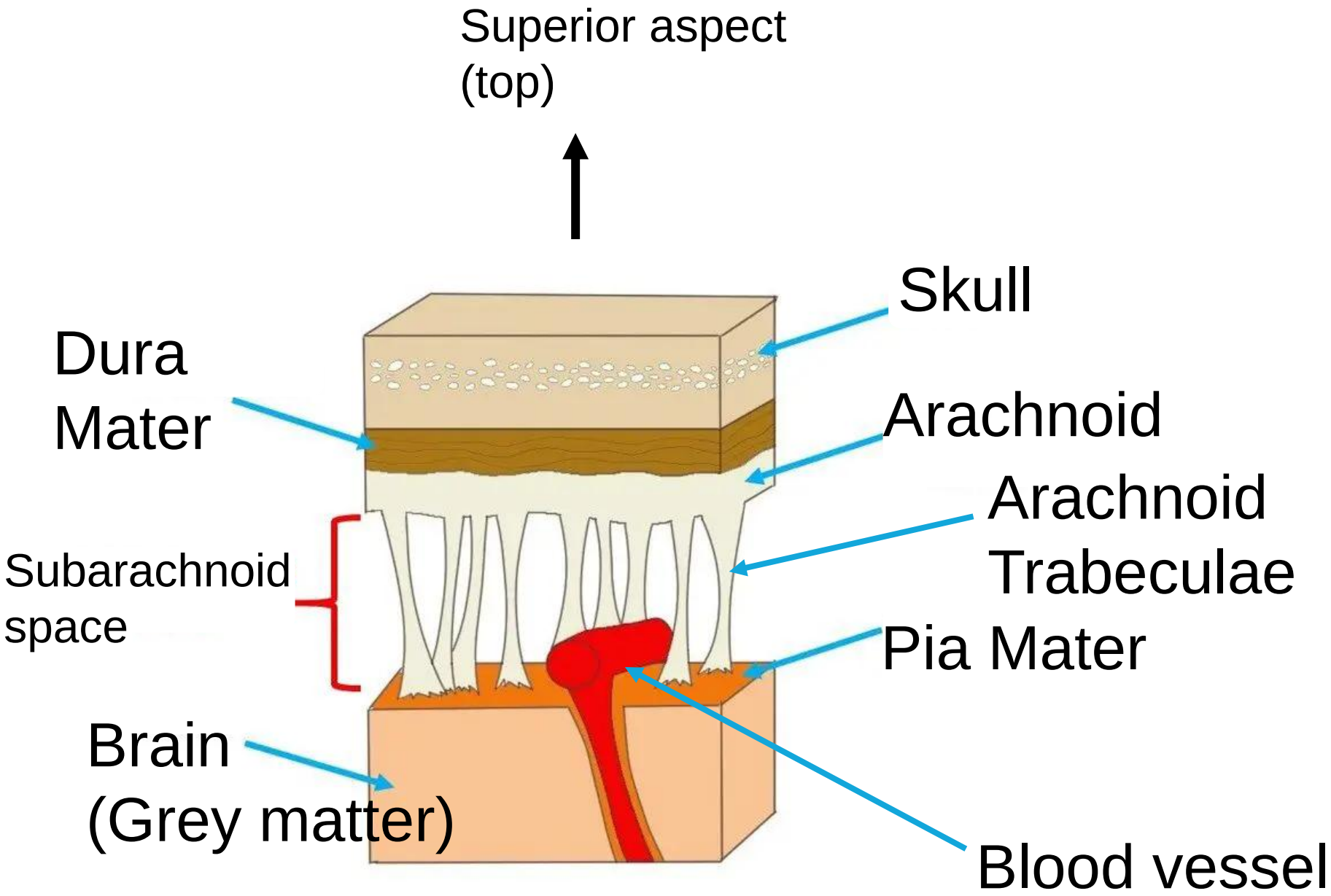
Space ***between*** the arachnoid and the pia mater
Outer layer of Arachnoid bound with **tight junctions**
Filled with cerebrospinal fluid (CSF)



Filled with cerebrospinal fluid

http://sites.cdnis.edu.hk/students/032872/2012/03/01/what-is-art/

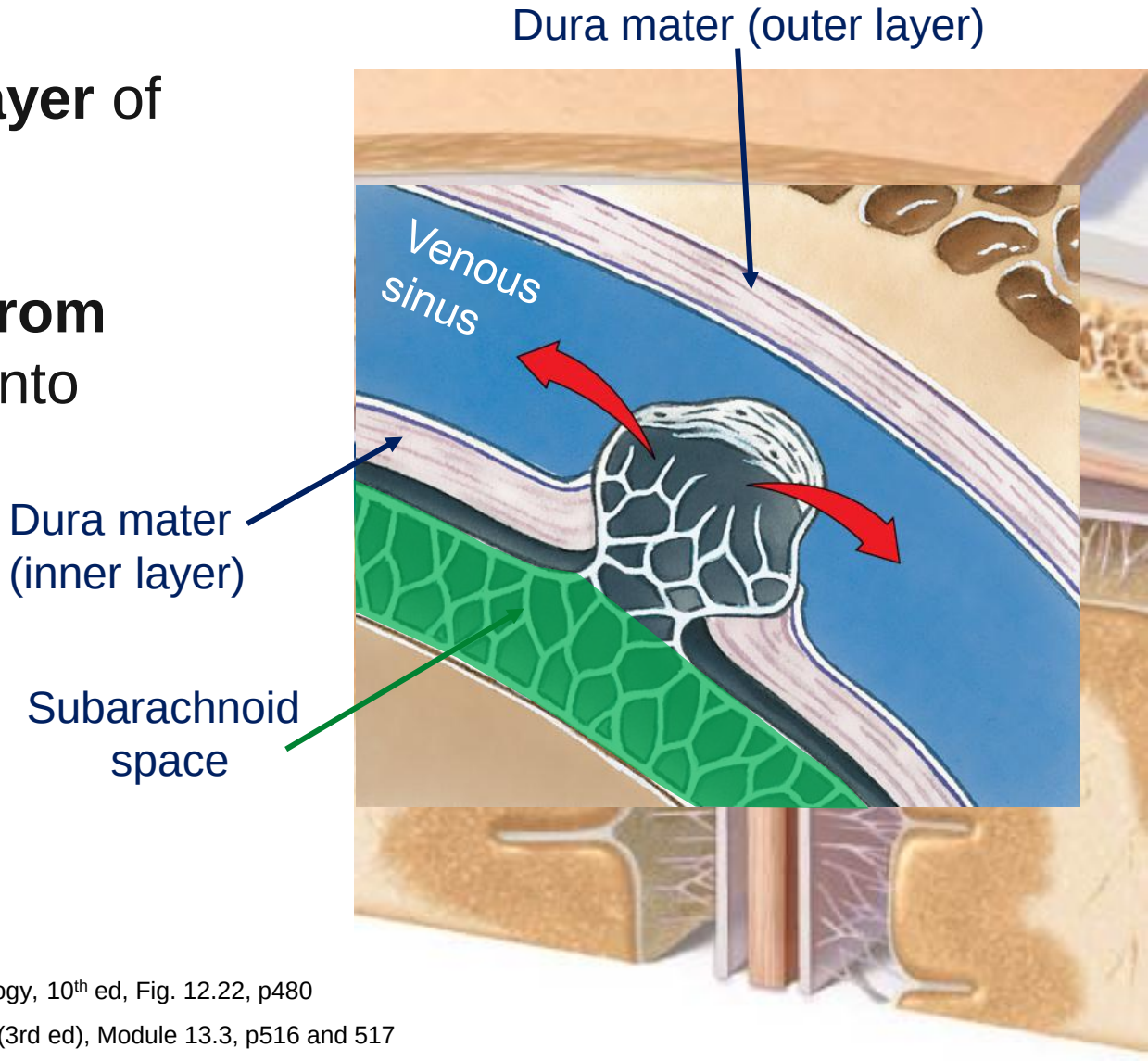
Trabeculae (dm from Latin, *Trabs*: beam, support)


Superior aspect
(top)
Skull
Dura
Mater
Arachnoid
Arachnoid
Trabeculae
Subarachnoid
space
Pia Mater
Brain
(Grey matter)
Blood vessel

Special features of Arachnoid:
II. Arachnoid granulations

Perforate the **inner layer** of ***dura mater***

Transport "old" CSF **from** subarachnoid space into **venous sinus**



From: Marieb and Hoehn, Human Anatomy and Physiology, 10th ed, Fig. 12.22, p480

See also: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516 and 517

Pia mater = 'delicate mother'

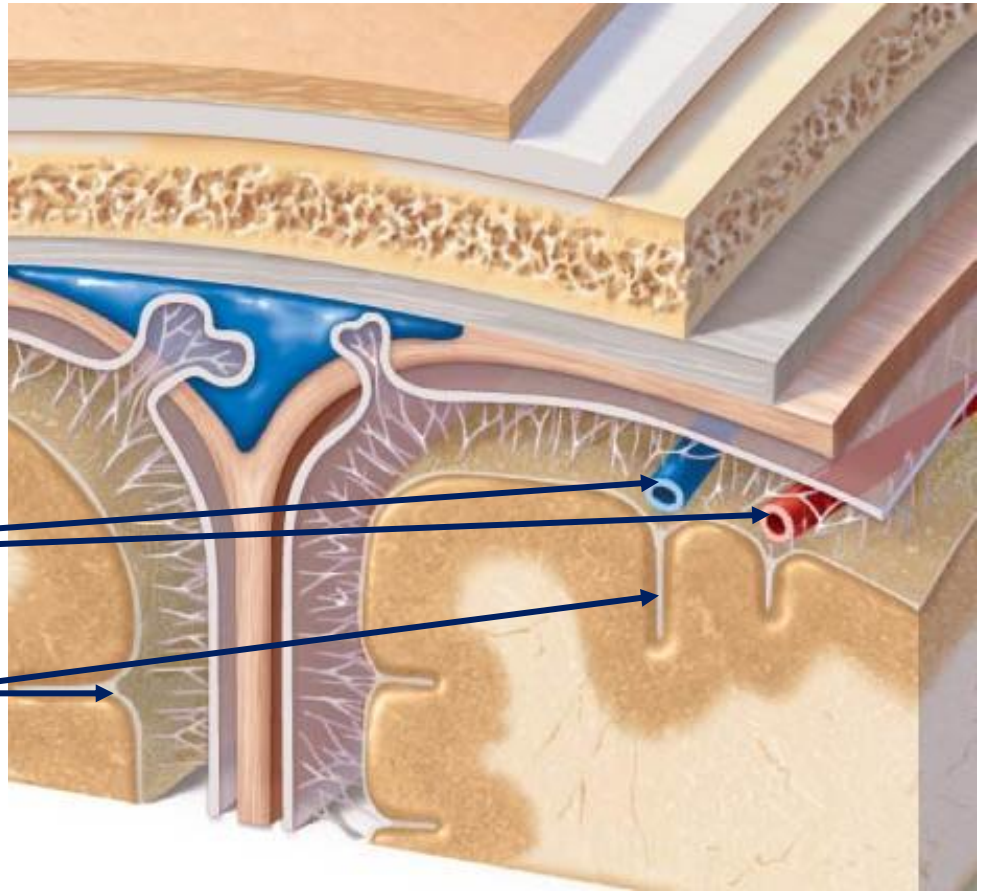
Four Features

1. **Inner layer** of the meninges

2. Transparent and delicate

3. Blood vessels in arachnoid sit **on top of** pia mater

4. **Adheres to brain** and **follows** gyri and extends into sulci

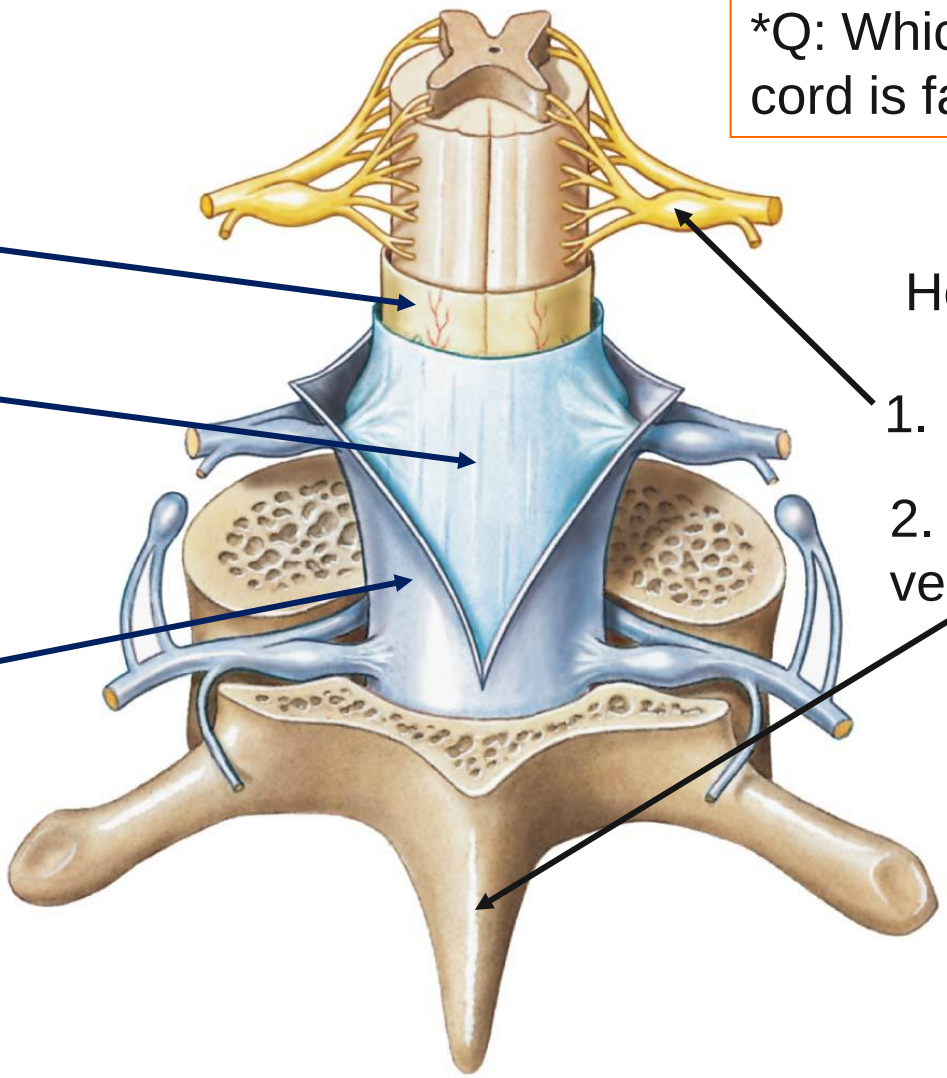


From: Marieb and Hoehn, Human Anatomy and Physiology, 10th ed, Fig. 12.22, p480

See also: Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p516

The meninges of the spinal cord

*Q: Which side of the spinal cord is facing you? Dorsal



How can you tell?

1. Dorsal root ganglion
2. Spinous process of vertebra

Martini et al., Visual Anatomy and Physiology (3rd ed), Module 12.3, p482

The ventricular system

Four Features

1. Network of interconnected “spaces” (= ventricles) within the brain

2. Filled with ***cerebrospinal fluid*** (CSF)

3. Spaces lined with ***ependymal cells***, which circulate the CSF (waving cilia)

4. CSF is produced by the ***choroid plexus***

Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.2, p515

The ventricular system

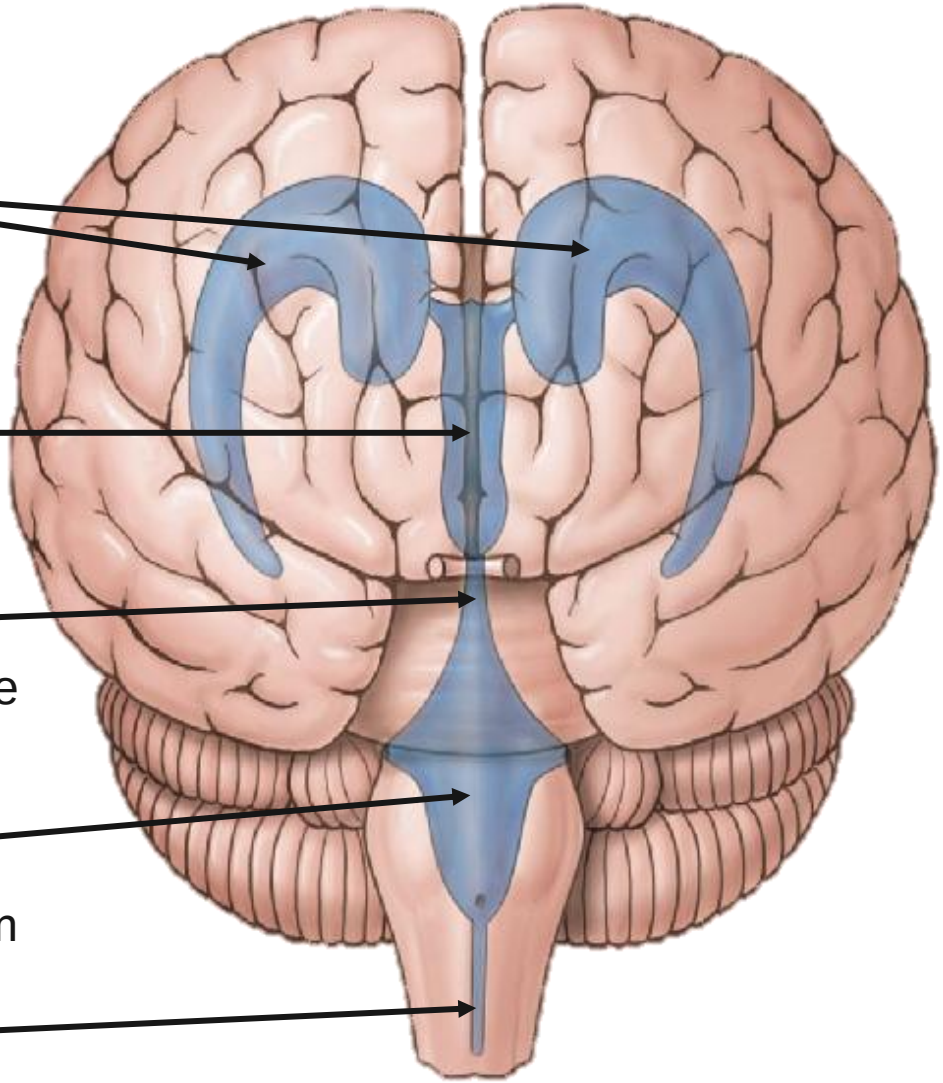
Lateral ventricles (2)
- Two of them
- One in each cerebral hemisphere

Third ventricle (1)
- Located in the diencephalon

Cerebral aqueduct (1)
- Connects 3rd ventricle to 4th ventricle
- Located in the midbrain

Fourth ventricle (1)
- Located at the level of the cerebellum

Central canal (spinal cord)



Anterior view
(facing you)

Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.2, p515

The ventricular system

Lateral ventricles (2)
- Two of them
- One in each cerebral hemisphere

Third ventricle (1)
- Located in the diencephalon

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Fourth ventricle (1)
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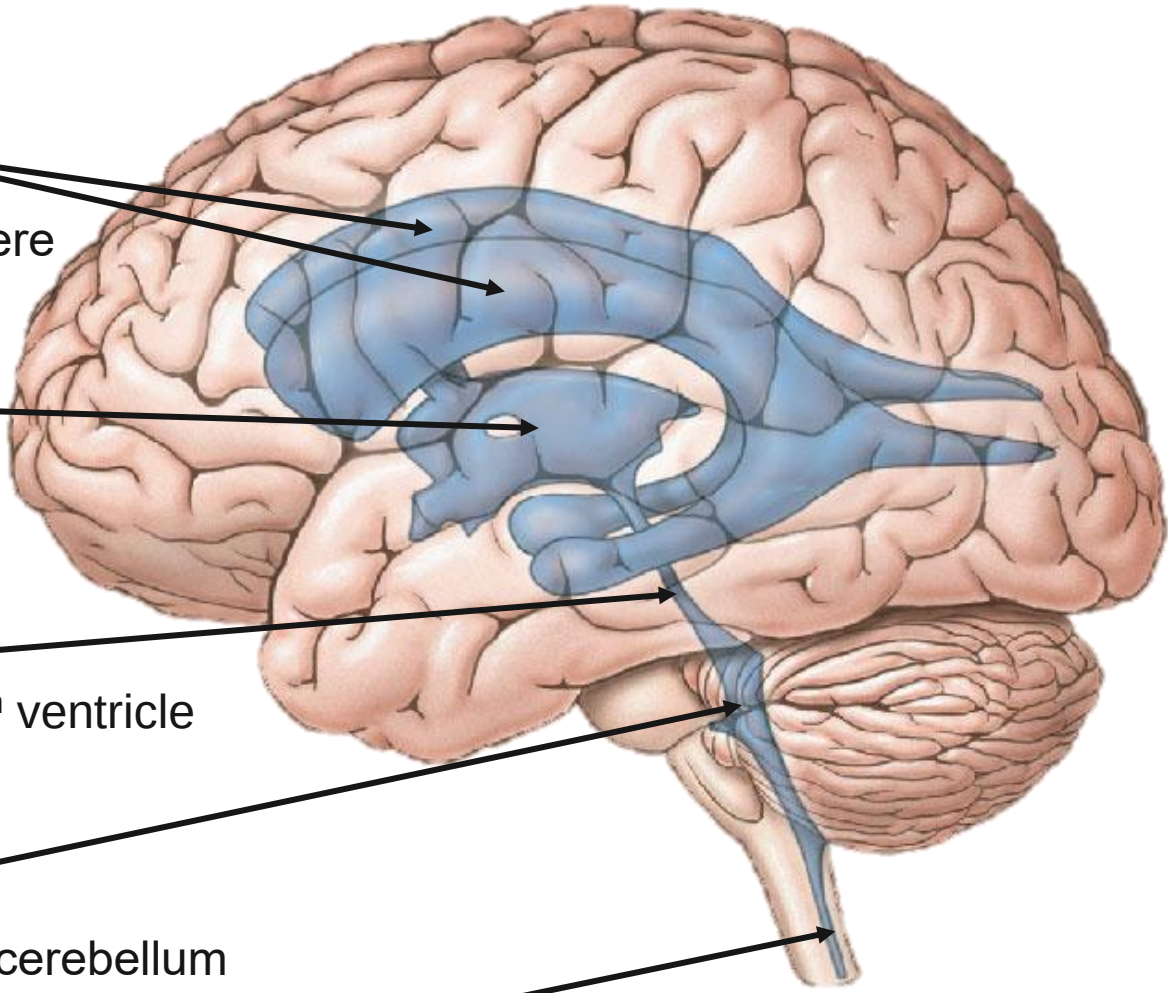
Central canal (spinal cord)



Lateral view
(from the side)

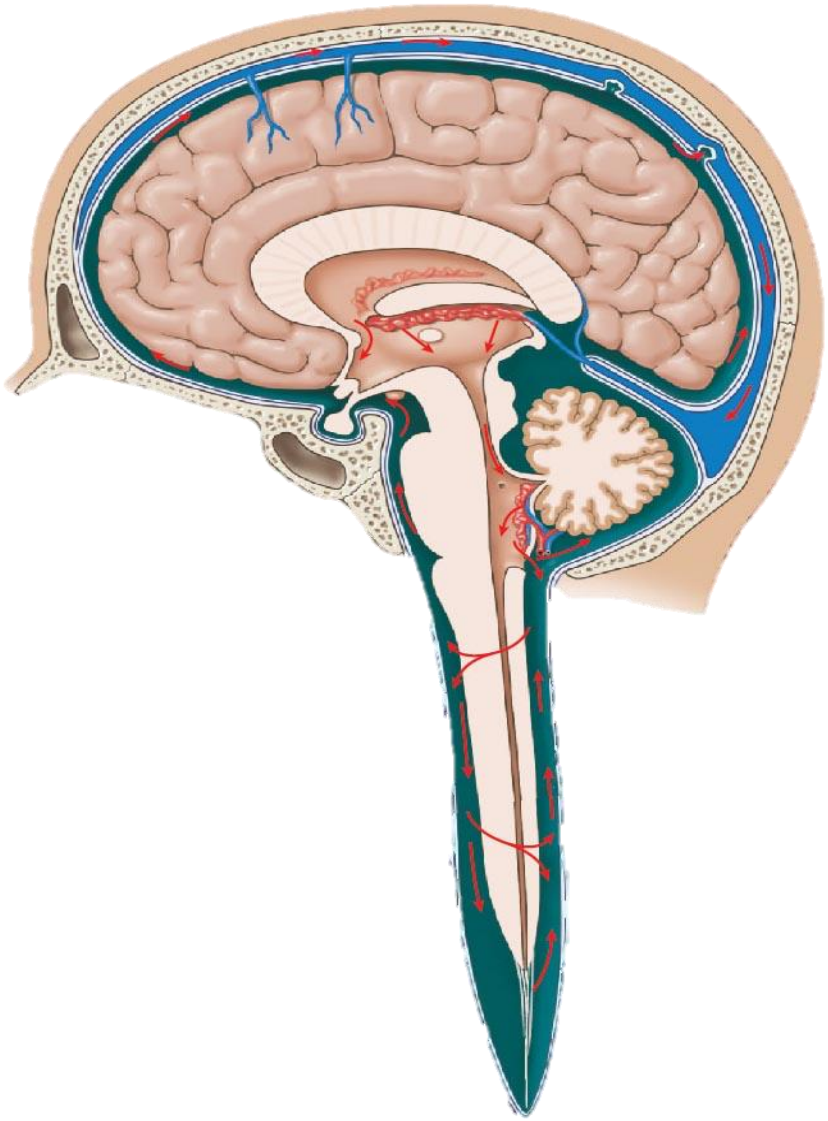
Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.2, p515

Image/animation: C Jasoni, 1998, University of Washington
Similar can be found at: https://radiopaedia.org/cases/brain-ventricle-anatomy-diagram?lang=gb

CerebroSpinal Fluid (CSF) and its circulation

Four Features

1. Produced by ***choroid plexus*** within the ventricles
2. Surrounds the CNS, within subarachnoid space
3. Provides support and cushion
4. Transports nutrients and waste



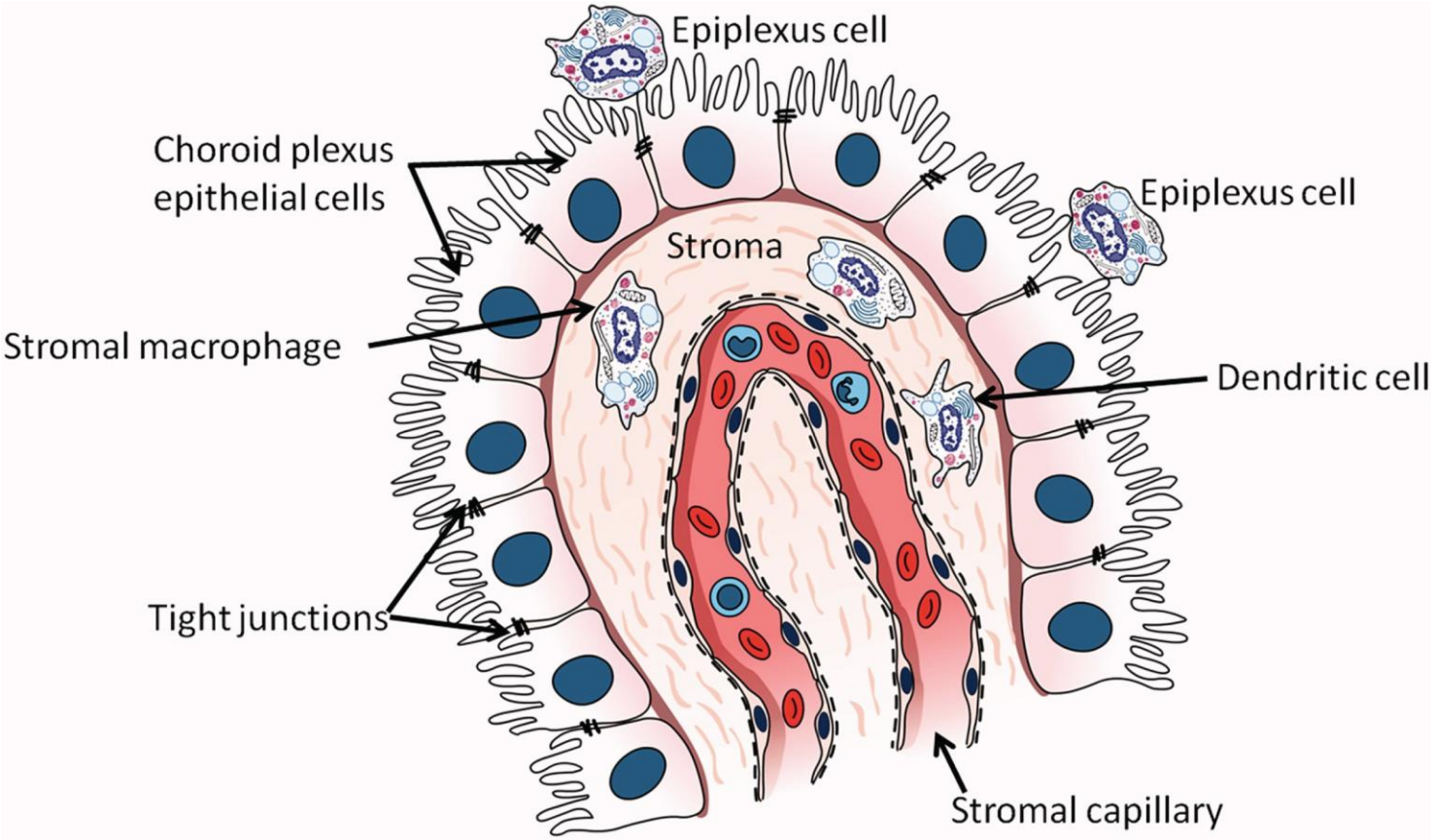
Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p517

Generation of CSF by the Choroid Plexus

Epithelial cells of the choroid plexus make up the blood/CSF barrier

Many immune cells (Macrophage, Dendritic cells, Epiplexus cells)

Villi of these cells help “push” the CSF around



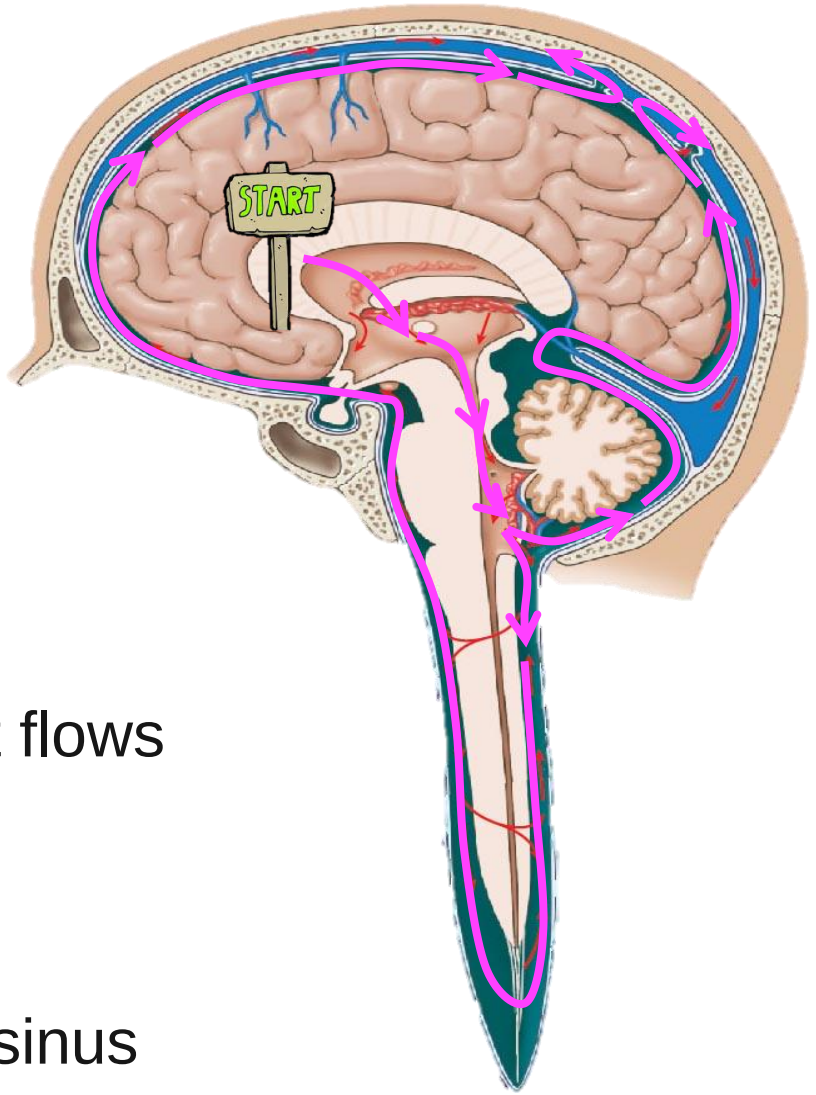
Kaur C, Rathnasamy G, Ling EA. J Neuropathol Exp Neurol 2016;75(3):198–213

CerebroSpinal Fluid (CSF) and its circulation

Circulation path

Start:

- Lateral ventricles
- 3rd ventricle
- cerebral aqueduct
- 4th ventricle
- subarachnoid space



Within subarachnoid space it flows around brain and spinal cord

- Exit: through **arachnoid granulations** into venous sinus

Martini et al., Visual Anatomy and Physiology (3rd ed), Module 13.3, p517

MRI showing pulsation of CSF

Function of Cerebrospinal Fluid

Ultrafiltrate of plasma

Provides protection and cushioning for brain

Nourishment (vitamins, necessary ions)

Hormones from blood (Leptin, Prolactin)

Removal of metabolic waste (e.g. from neurotransmitter metabolism)

Removal of foreign particles (drugs etc)

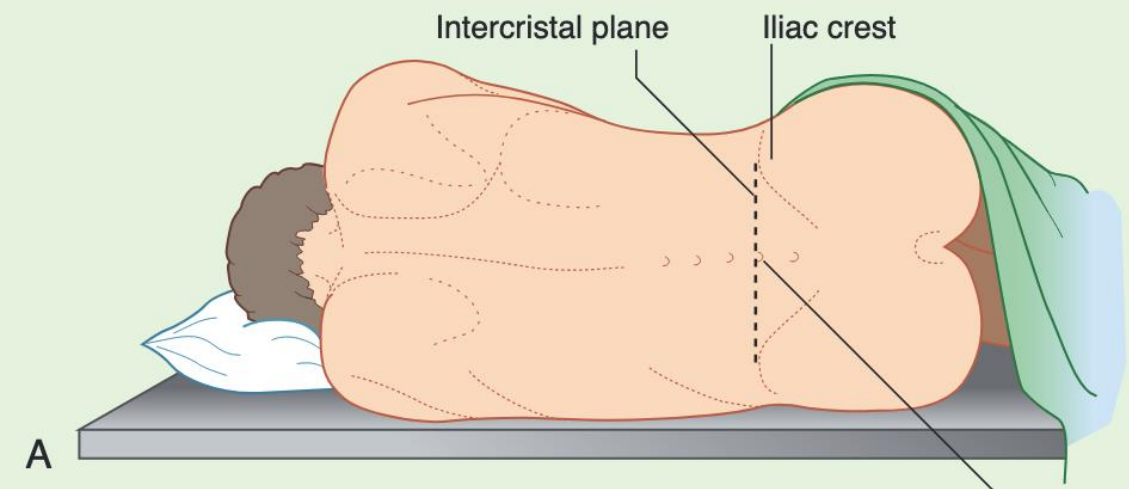
Usually considered sterile, can contain microbes in infection

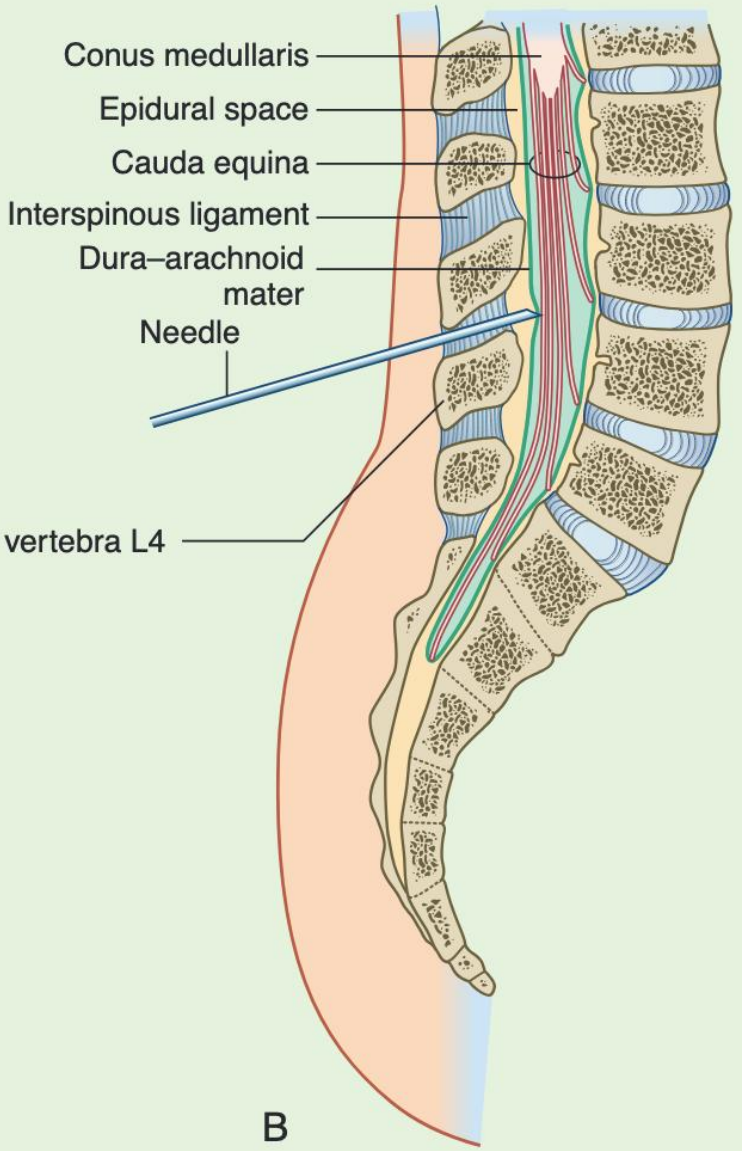
“Brain washing” during sleep

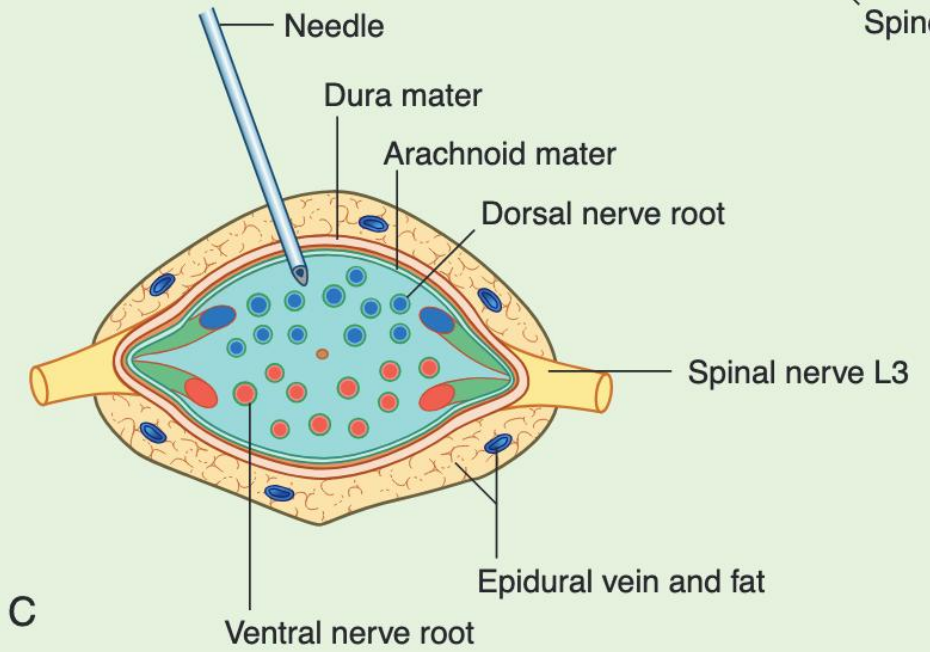
Blood flow (red) increases before a wave of CSF (blue) washes toxins away

Science. 2019 366(6465):628-631

Lumbar puncture







Lecture 21: Post-lecture quiz

1. Which of these is not a layer of meninges

(a) dura mater; (b) epineurium; (c) pia mater; (d) arachnoid

2. Cerebrospinal fluid (CSF) circulates around the brain in which layer of the meninges?

(a) arachnoid; (b) dura mater; (c) perineurium; (d) choroid plexus

3. Old/used CSF is transported into the venous circulation through which structure?

(a) choroid plexus; (b) arachnoid granulations; (c) dural reflections; (d) pia mater

4. The third ventricle is located with which brain region?

(a) cerebrum; (b) cerebellum; (c) diencephalon; (d) midbrain

HUBS191