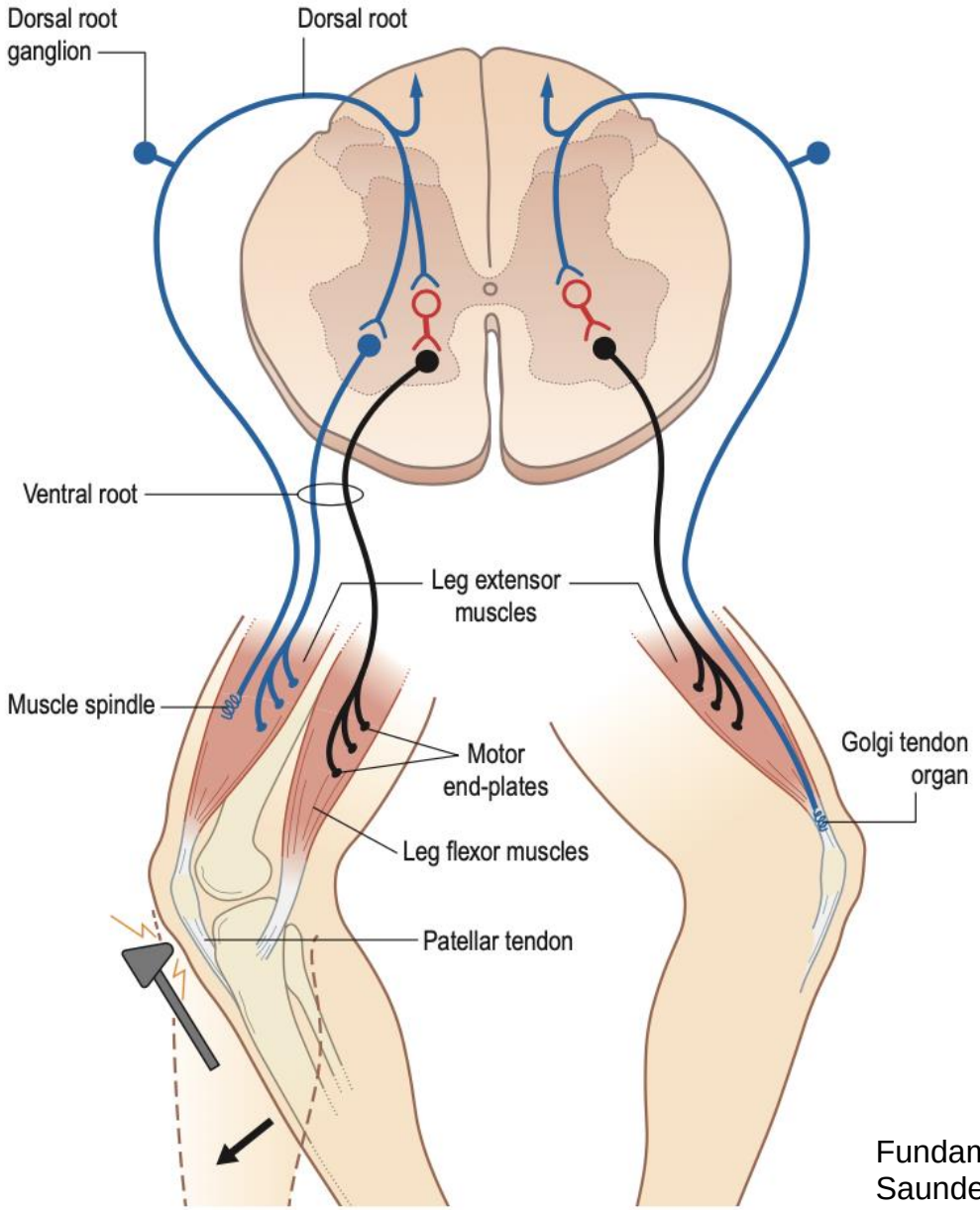
Neuroanatomy – general overview

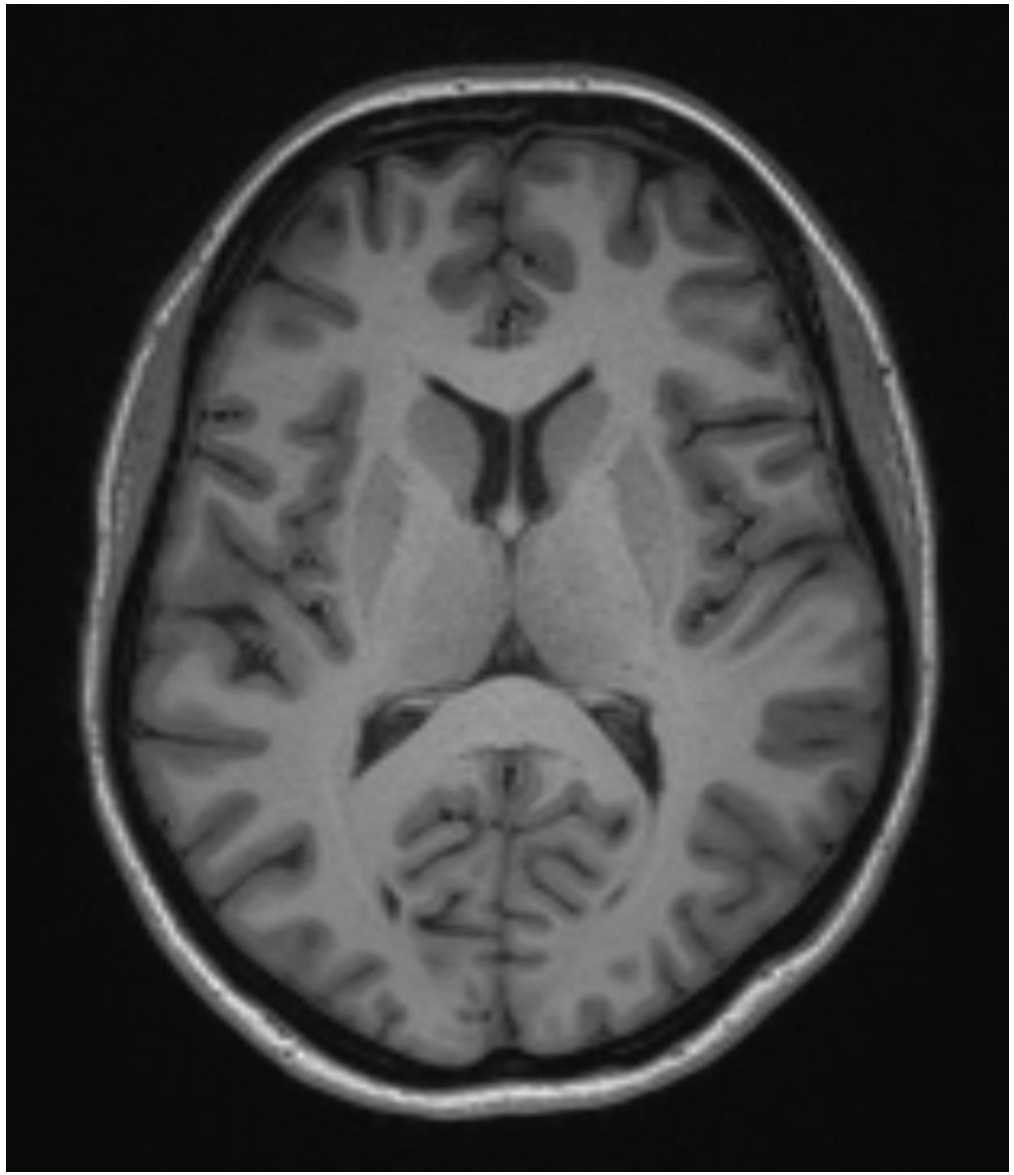
Function of the nervous system



- **neurons**
- ***Information encoding***
  - ***Specialized endins***
  - ***Creation of the information quantum***
  - ***Translation into electrical signal***
- ***Information conduction***
  - ***propagation***
  - ***Fast electrical signal conduction***
  - ***Action potential***
- ***Information transmission***
  - ***Other neurons***
  - ***Muscular cells***
  - ***Glandullar cels***
  - ***With the help of synapsis and neurotransmitter***

Fundamental Neuroscience for Basic and Clinical Applications, 4th Edition, 2013, Saunders, Elsevier.

Cetral nervous system



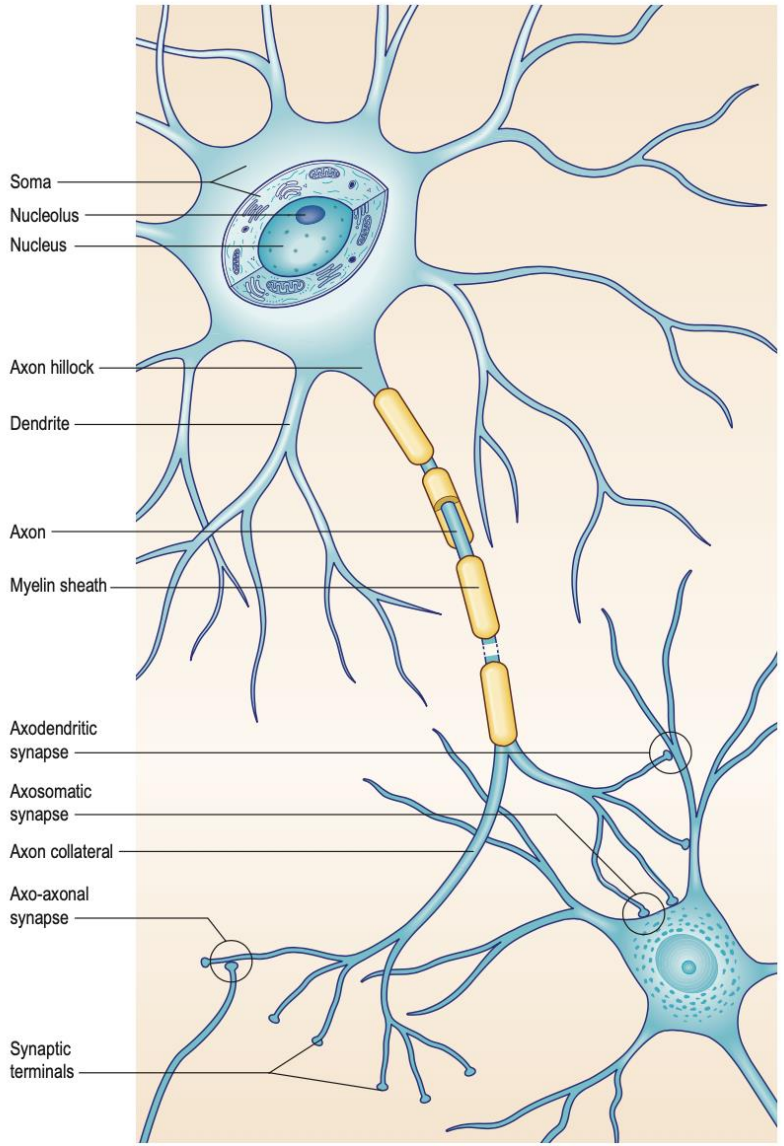
- **Grey matter – substantia grisea**
  - Somata (bodies) of the neurons
  - Nuclei
  - Grouping of the grey matter (basal ganglia)
  - Cortex
- *Neuropil – the largest volume of the nervous system*
  - Un-myelinizated axons, dendrites, synapses, glial processes
- **White matter – substantia alba**
  - Axons
  - Bundes of fibers
  - Tend to be organized in tracts
  - Zone where the tracts are organized – white matter
  - Telencefalon
  - Cerebellum
  - Medulla spinalis

Neuron

- **Neurons**
- ***Grouped in clusters***
- ***Nuclei, columnes, strata (CNS)***
- ***Ganglia (PNS)***
- ***Dispersed (ENS)***

- *Variability in size and shape*
- **Extreme ratio between surface and volume**
  - *Multiple processes*
  - *Classification according to the size, shape and localization*
- **Dendrites - multiple afferent processes**
- **Body (soma)**
- **Axon – unique efferent process**
  - **Axonal hillock**

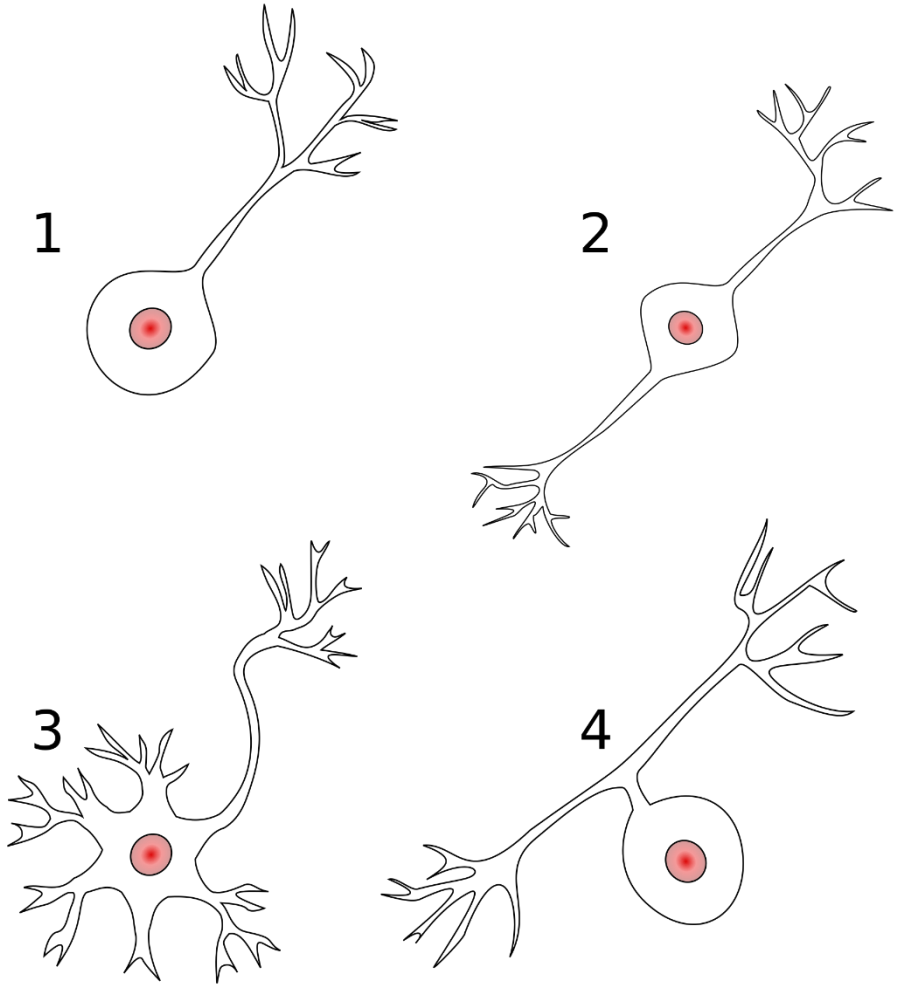
Grey´s Anatomy, 41th ed.



The arts of neurones

- **Morfologic**
- ***Unipolar (1)***
- ***Bipolar (2)***
- ***multipolar (3)***
- ***Pseudounipolární (4)***
  - ***Sensitive neurones of spinal ganglia***

- **Acording to the lenght of axon**
  - ***With the long neurite***
  - ***With the short neurite***
- **According to the function**
  - ***Projectory – connecting the distant parts of NS***
  - ***Interneurons - local connections of next parts of NS***



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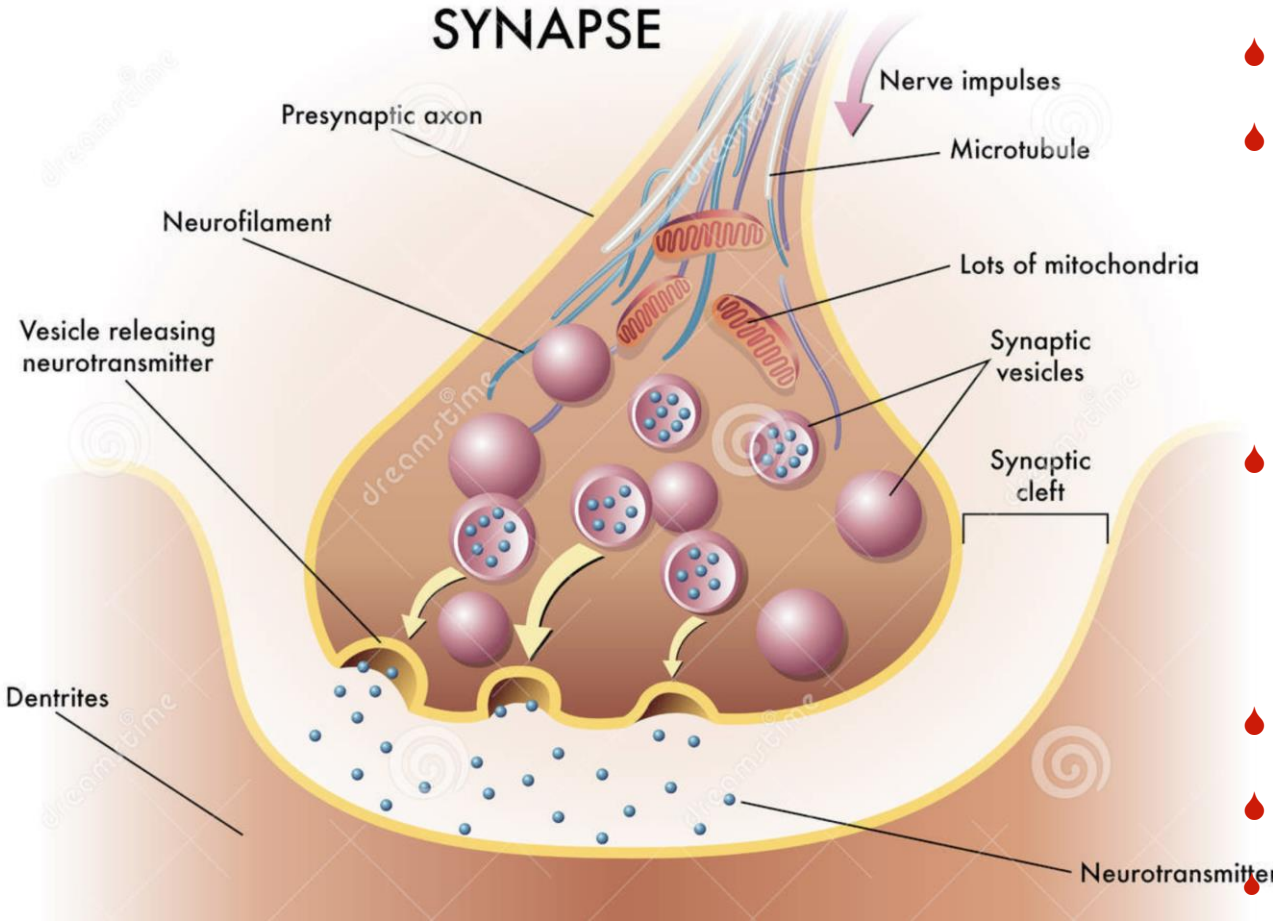
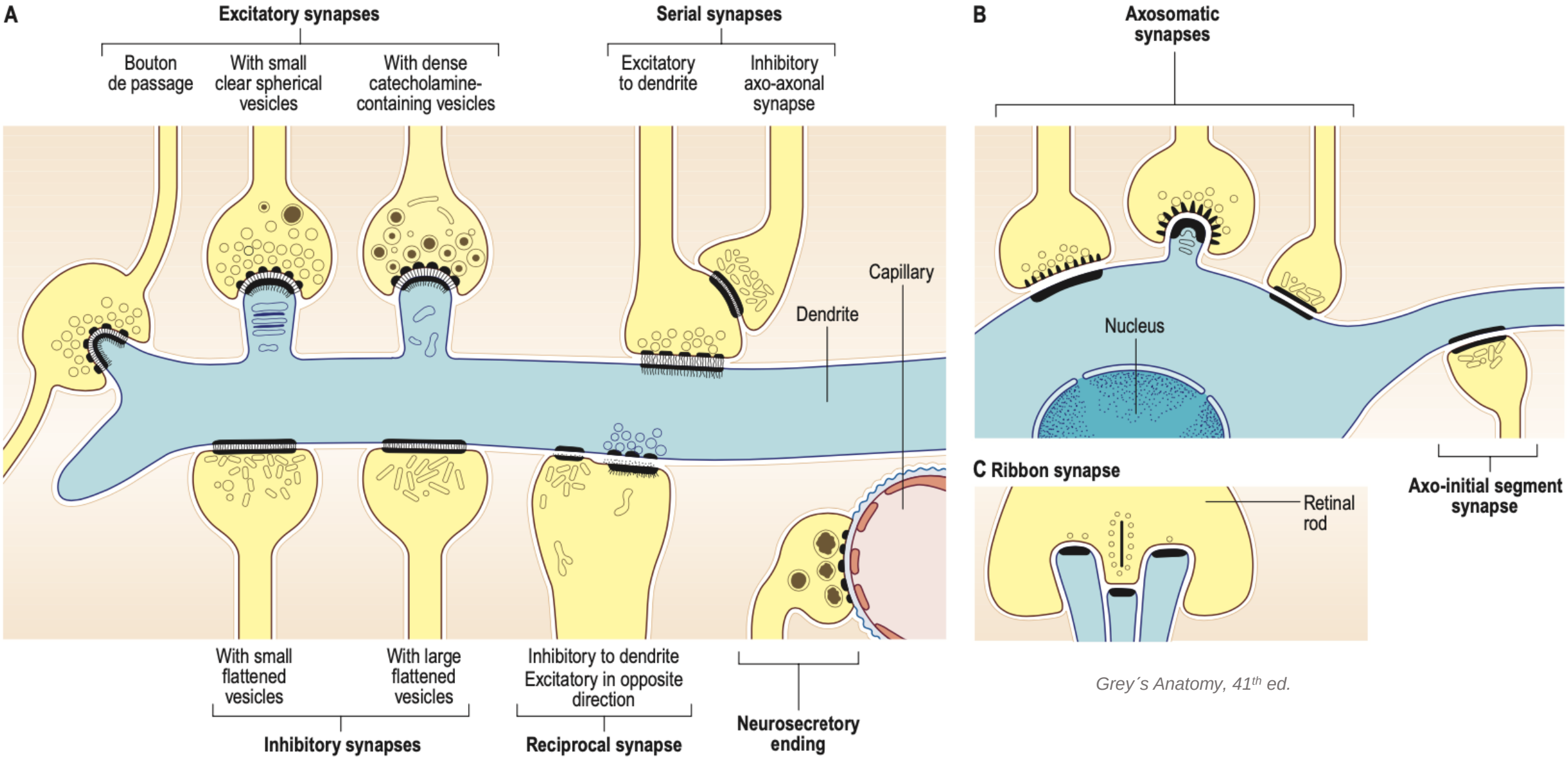
Neurotransmitters



- **Substances enabling transmission**
- ***Releasing of neurotransmitter***
  - ***Fast in classical neurotransmitters***
  - ***Les than one ms***
  - ***Acetylcholine (ACh)***
  - ***Gamaaminobutyric acid (GABA)***
- ***Biding to the receptor***
  - ***Bound to the receptor***
  - ***Iontotropic***
  - ***Metabolotropic***
- ***Electric potential changes***
- ***Extracellular inactivation of neurotransmitter***
  - ***acetylcholinesterase re-up-take, glie***

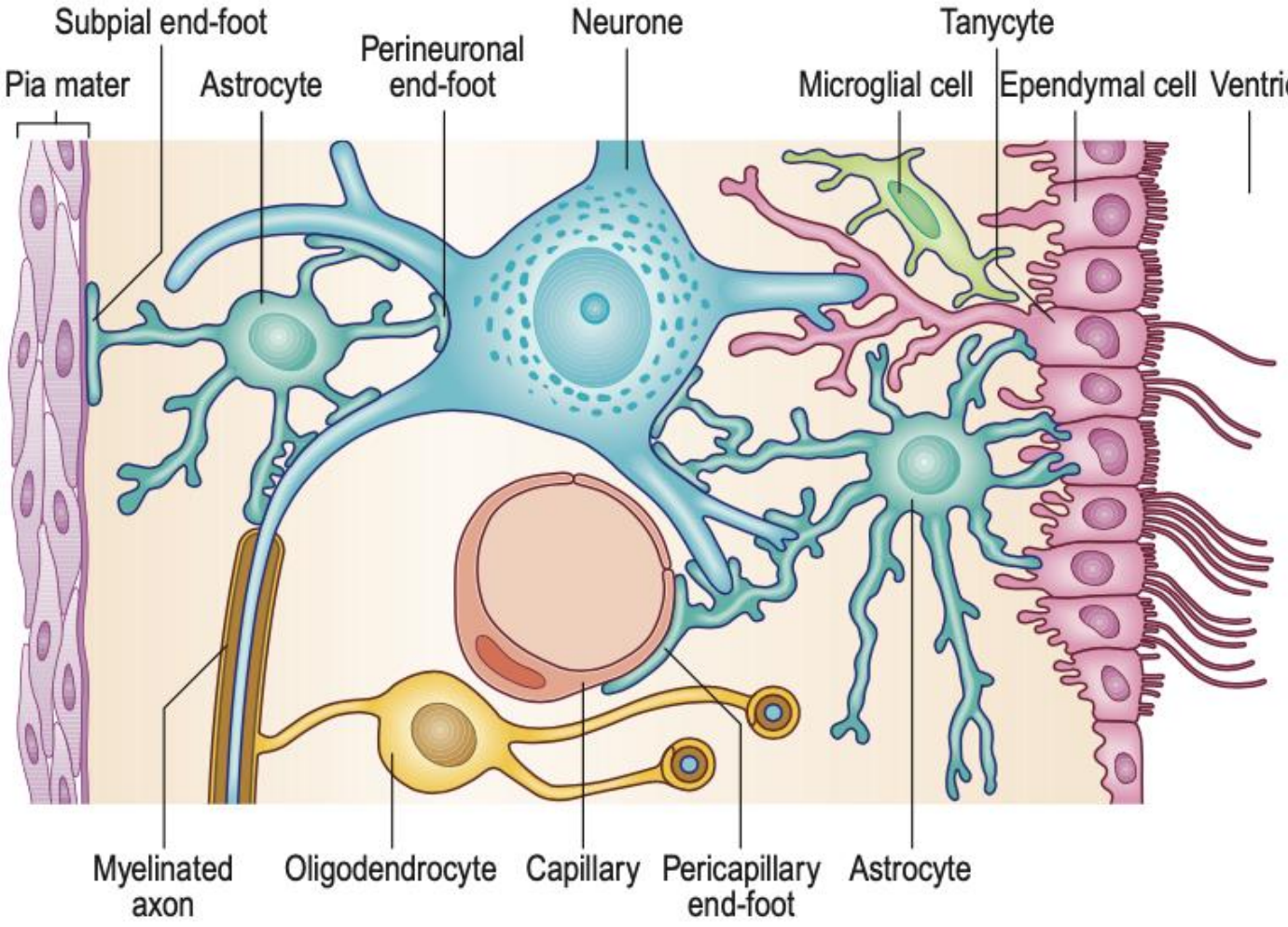


Grey´s Anatomy, 41th ed.

Neurotransmitters

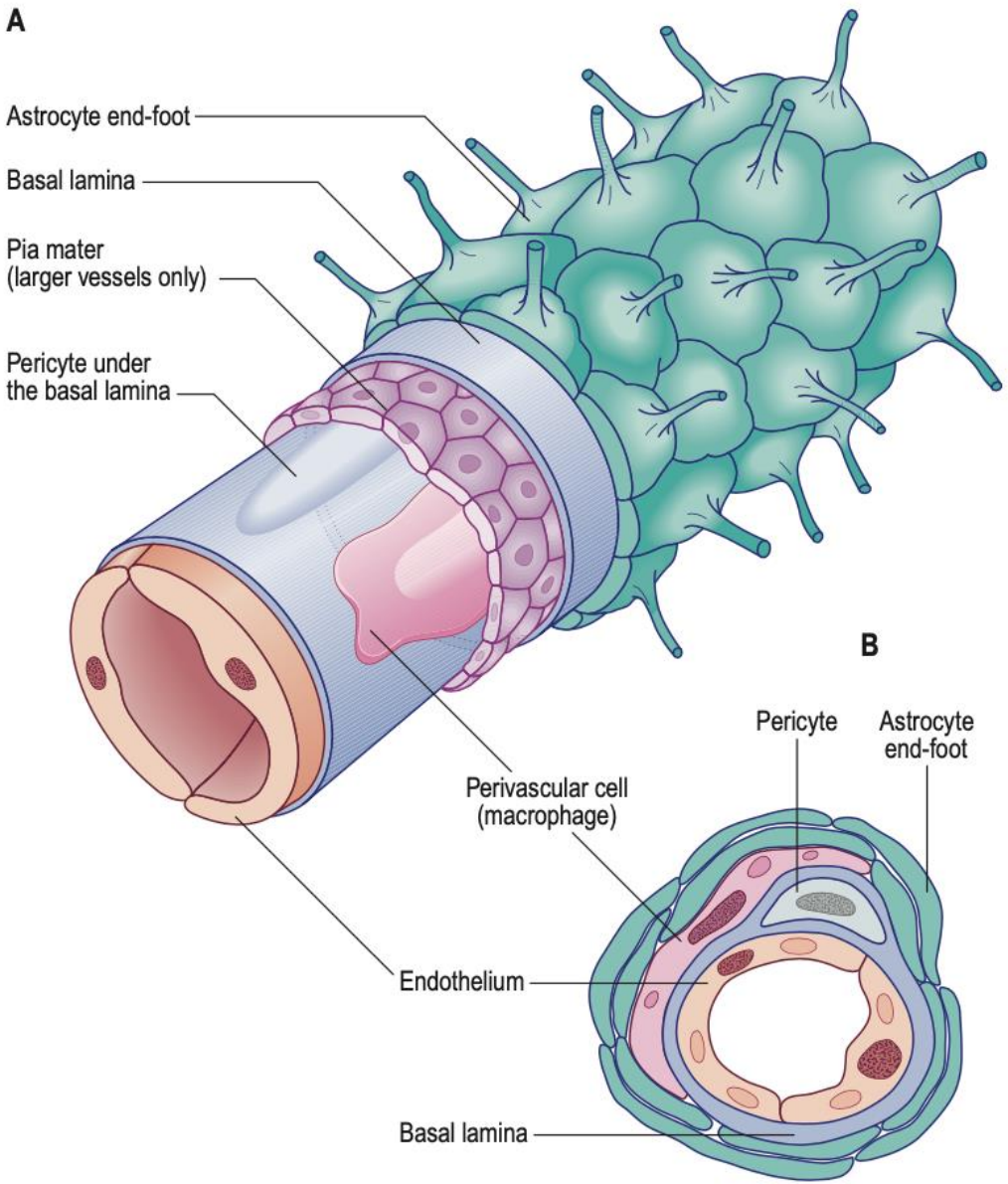
- **Acetylcholine ACh**
  - **Most frequent classical neurotransmitter**
  - **Nicotine receptors** – *fast and exciatatory effect in v CNS*
  - **Muscarine receptors** - *slower but more lasting effect, parasympaticus in ANS*
- **Monoamines**
  - *CNS – brain stem, axons are branching and spreading into whole CNS*
  - *Sympatic ganglia, adrenal medulla, chromafine tissue of paraganglia*
  - *Locus coeruleus in brain stem*
  - ***catecholamines***
  - ***Noradrenalin – NA * (norepinefrine) - sympaticus***
  - *alpha receptors – inhibition of enteric submucosal plexus*
  - *beta-receptors – constriction of smooth muscles of vascular wall*
  - ***Adrenaline***
  - *Similarly to NA*
  - ***Dopamine***
  - *dopaminergic system of CNS, substantia nigra – thalamus, basal ganglia, cortex*
  - ***Indolamines* – 5-hydroxytryptamine (serotonin), brain stem middle line**
  - ***Histamine* – loosely dispersed mainly in hypothalamus**

Glia



- **Astrocytes**
  - Syncytium in gray matter
  - Iont-exchanges
  - glucose transportation and exchange
  - Glucose flow maintenance
- **Modulation of ht eactivity – neuropil**
- **Neurovascular coupling**
- **Specialized (neurohypohysis)**
- ***Glia limitans***
- ***Oligodendrocytes***
  - ***Creation of the myelin sheath***
- ***Mikroglia***
  - ***Endogenous immune brain systém***
  - ***Origin in mesnechymal original monocytes***
- ***Ependyma***

Blood-brain barrier

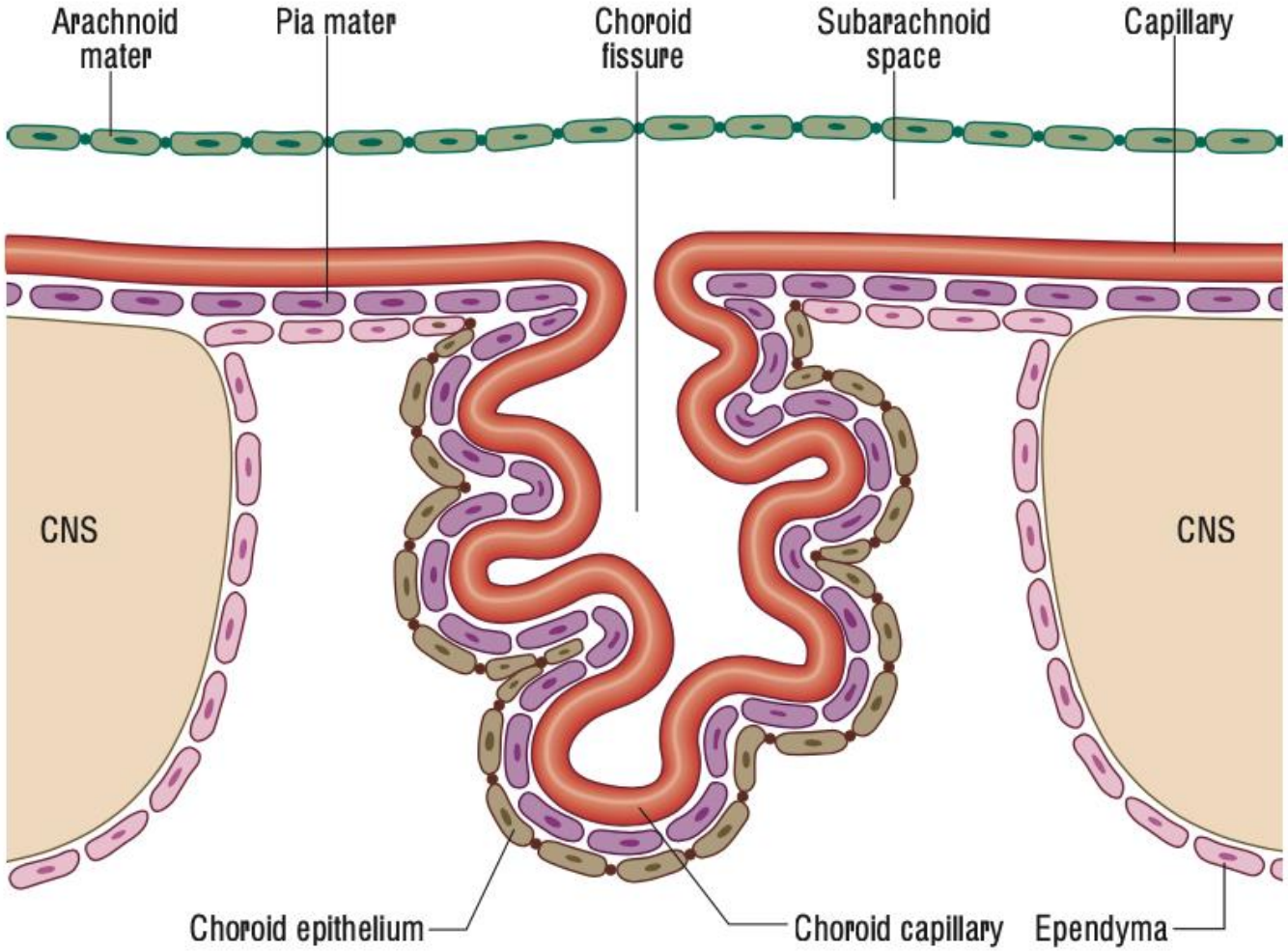


- **Proteins circulating in blood**
  - ***Spreading into almost all tissues***
  - ***exeption – brain, spinal cord and peripheral nerves***
- ***Tight connection***
  - ***Endothe- - astrocyte (footlet)***
- ***Limitation of the molecular exchange***
- ***Barrier less effective around ventricles***
- ***Not-limited Exchange of lipophilic substances***

Ependyma

- **Ependyma**
- ***Silgle-layered linig, in ventricula r systém and central canal***
- ***Microvilli, cilia - CSF flow***
- ***4 types***
  - ***Gray matter lining* – cuboid, up to 20 cilia, mikrovilli**
    - ***subependymal zone with progenitor cells in rodents (probably not in primates)***
  - ***White matter lining* – flat, rare cilia, no subependymal zone**
  - ***Circumventricular organs* – III. ventricel margins**
  - *Eminentia mediana hypothalami*
  - *subcommisural and subfornical organs*
  - *Organum asculosum laminae terminalis*
  - *area postrema IV. ventricle*
  - ***Chororid epithelium***
  - *gap-junctions and desmozomes*
- ***Subependymal space***

Choroid plexus



- **Roof of neural tube**
  - **Where no neurons are originating**
- **Creation of cerebrospnal fluid)**
- ***Liquor cerebrospinalis***
- ***Villar vascularized structure***
- ***pia mater***
- ***capillares***
- ***Choroid epithelium – derivate of ependyma***
- ***multiple microvilli***

Circumventricular organs

- *Sensoric and secretory role, lack of BBB*

- **area postrema (AP)**

  detection of toxins in food, food aversionnausea, vomitus, cardiorespiratory homeostase

- **eminentia mediana (ME)**

  mediation of RH, secretion, melatonine receptors

- **neurohypophysis (NH)**

  oxytocin, vasopresin

- **organum vasculosum laminae terminalis (OVLT)**

  osmoregulation, thirst

- **Pineal organ(PO)**

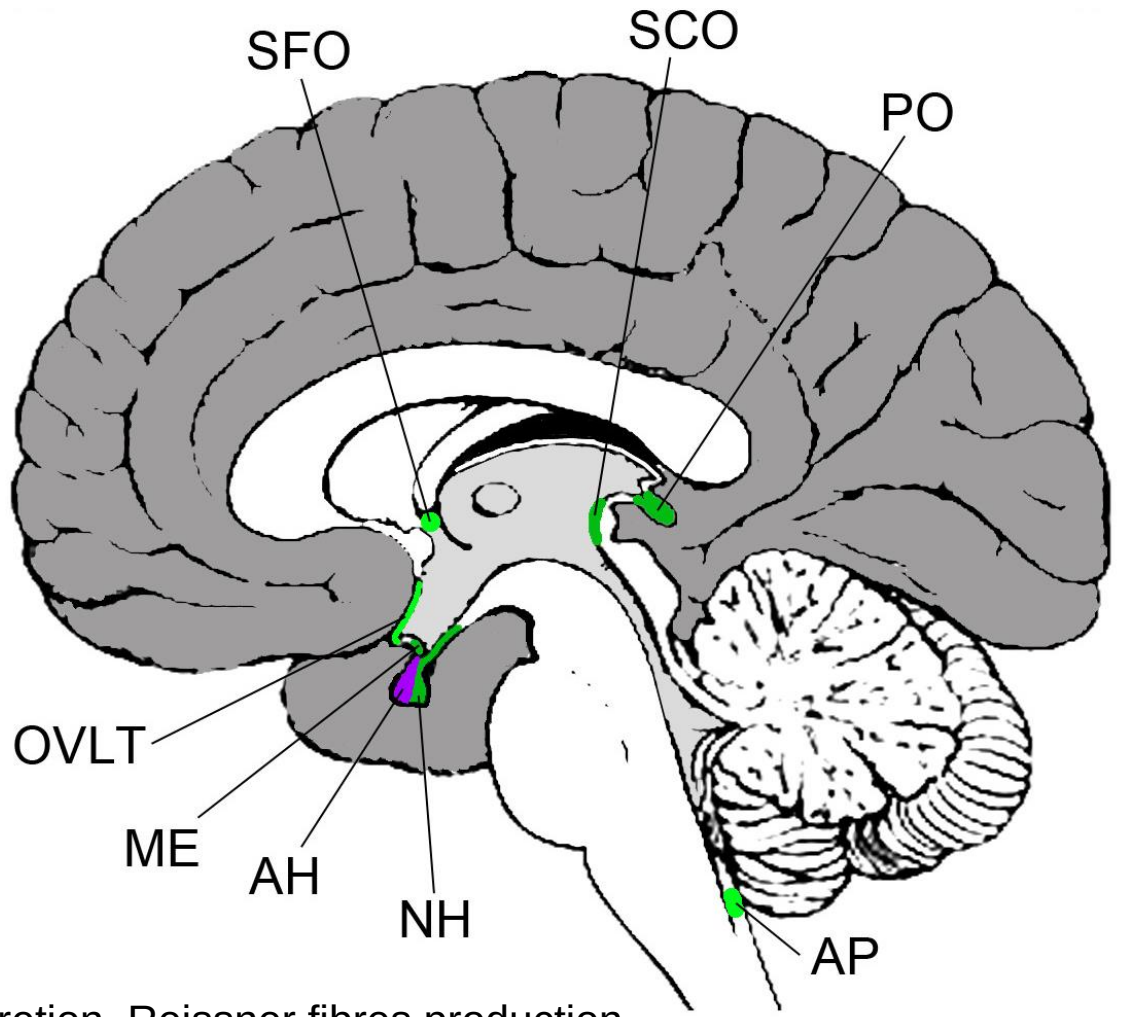
  melatonine, biorhytm

- **subcommissural organ (SCO)**

  CSF production and composition control, transthyretine secretion, Reissner fibres production

- **subfornical organ (SFO)**

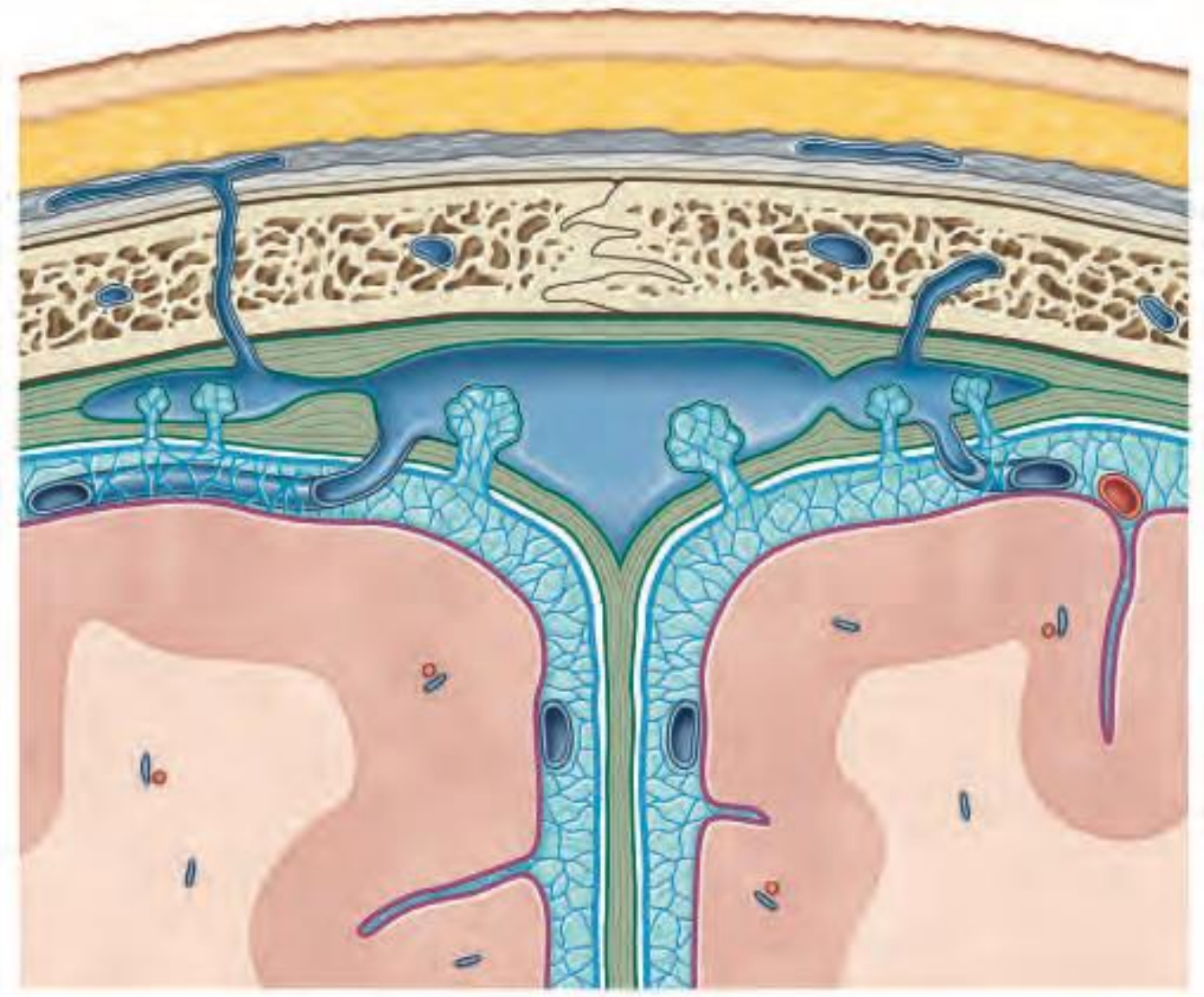
  osmoregulation, energetic homeostasis



Journal of Anatomy, Volume: 232, Issue: 4, Pages: 540-553, First published: 27 December 2017, DOI: (10.1111/joa.12771)

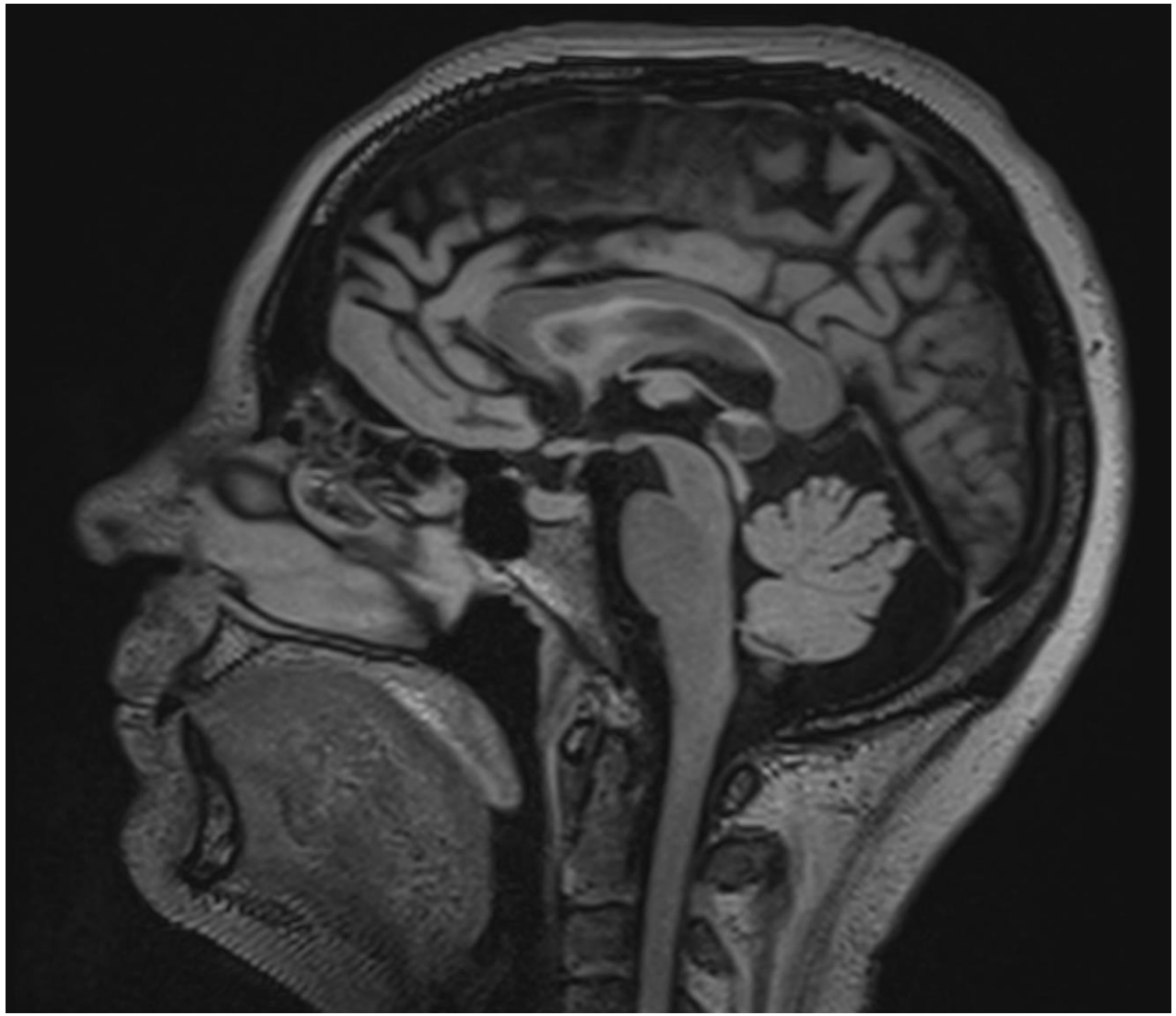
Sinus durae matris

- ***Spaces contained blood vess***
- ***Entered by***
  - ***superficial or deep veins***
- ***Sinus sagittalis superior***
- ***Sinus sagittalis inferior***
- ***Sinus rectus***
- ***Confluens sinuum***
- ***Sinus transversus***
- ***Sinus sigmoideus***
- ***Sinus cavernosus***
- *Sinus petrosus superior*
- *Sinus petrosus inferior*
- *Sinus intercavernosus*
- *Sinus sphenoparietalis*

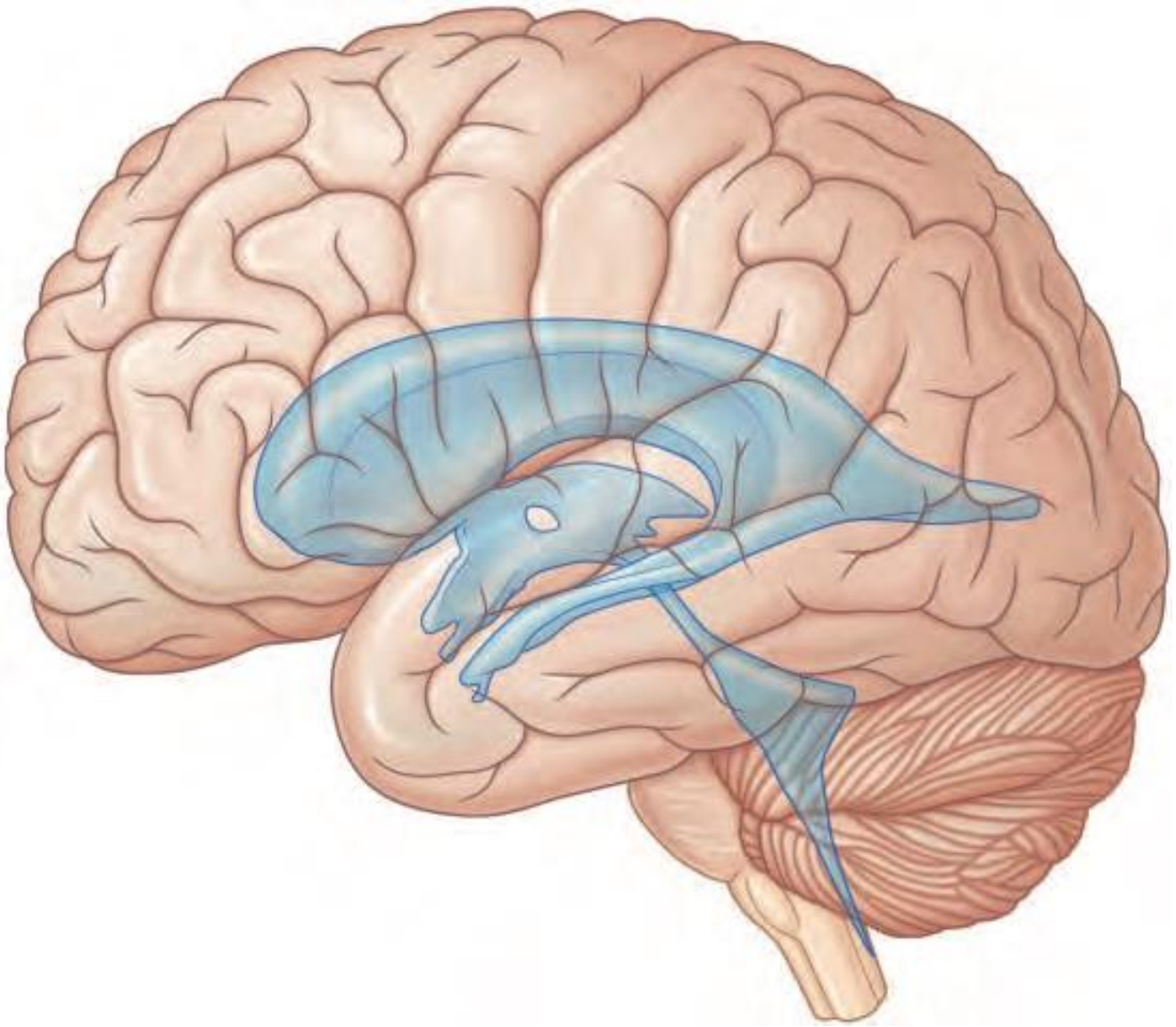


Liquor spaces (CSF spaces)

- **liquor cerebrospinalis**
- ***Production***
  - ***Choroid plexus***
  - ***Daily up to 500 ml***
  - ***Per hour 25 ml***
- ***Circulation***
- *Latral ventricles*
- *III. ventricle*
- *aquaeductus mesencephali*
- *IV. ventricle*
- *subarachnoid spaces*
- ***resorption***
  - ***villi arachnoidales – granulationes arachnoidales***
- ***hydrocephalus***

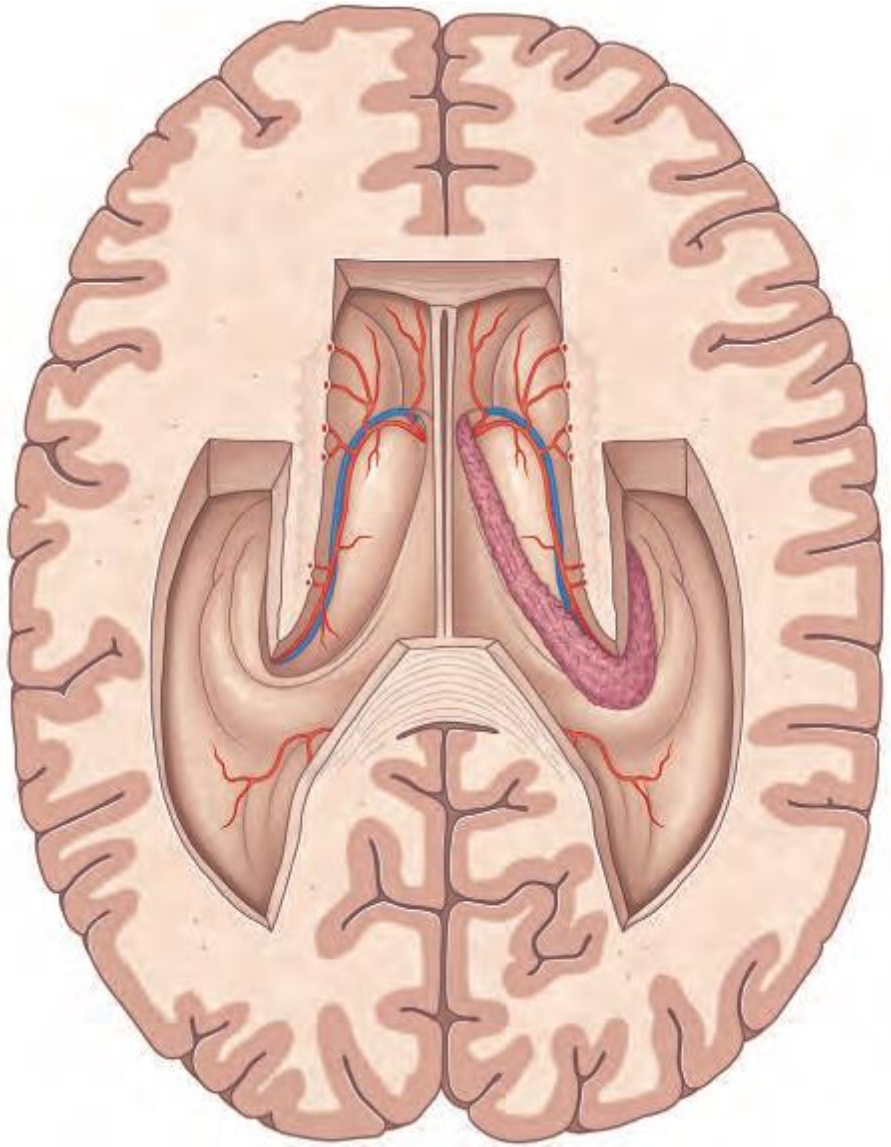


Ventricular system



- ***Ventriculus lateralis (twice)***
- ***Ventriculus tertius***
- ***Aquaeductus mesencephali (Sylvii)***
- ***Ventriculus quartus***

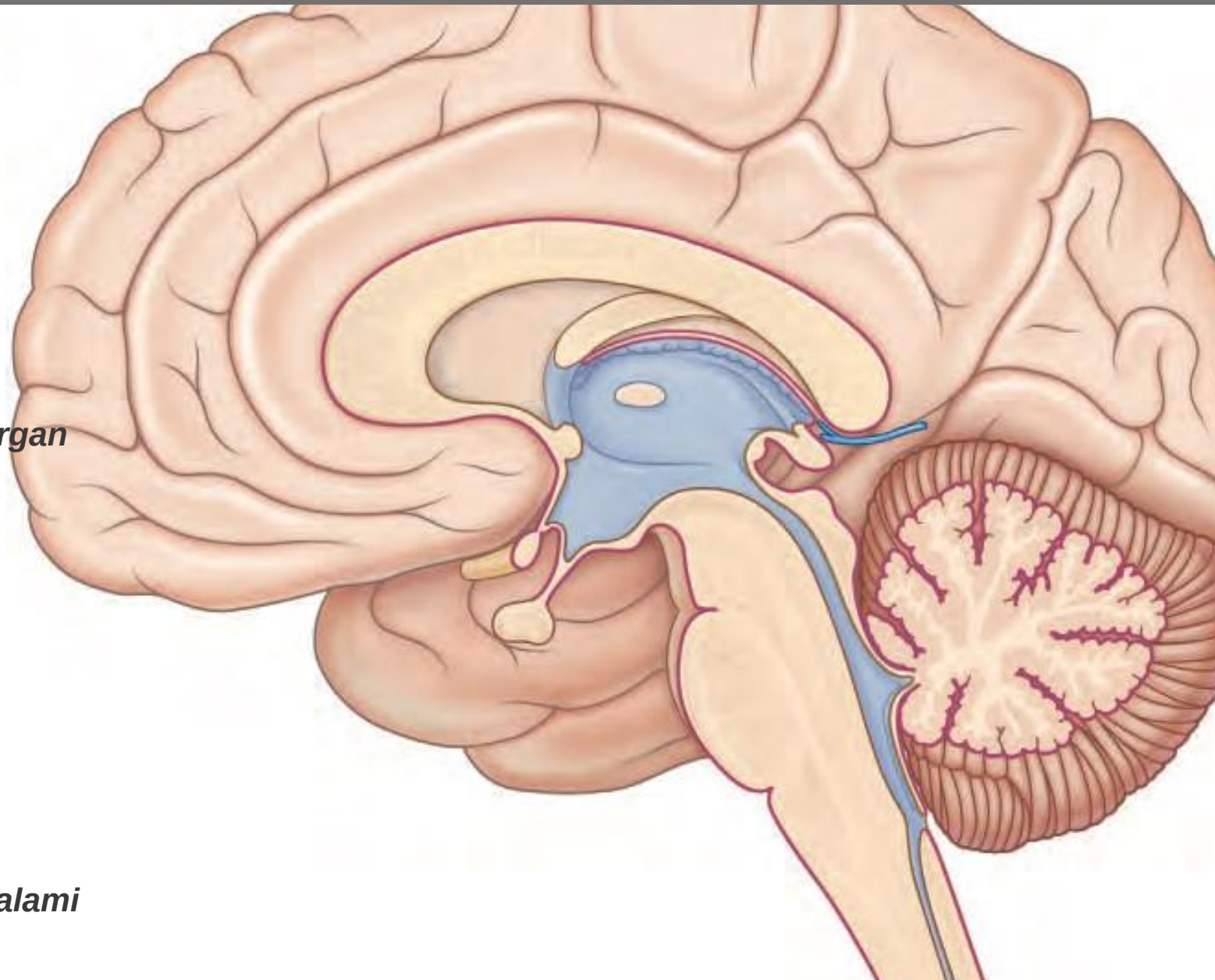
Lateral ventricles



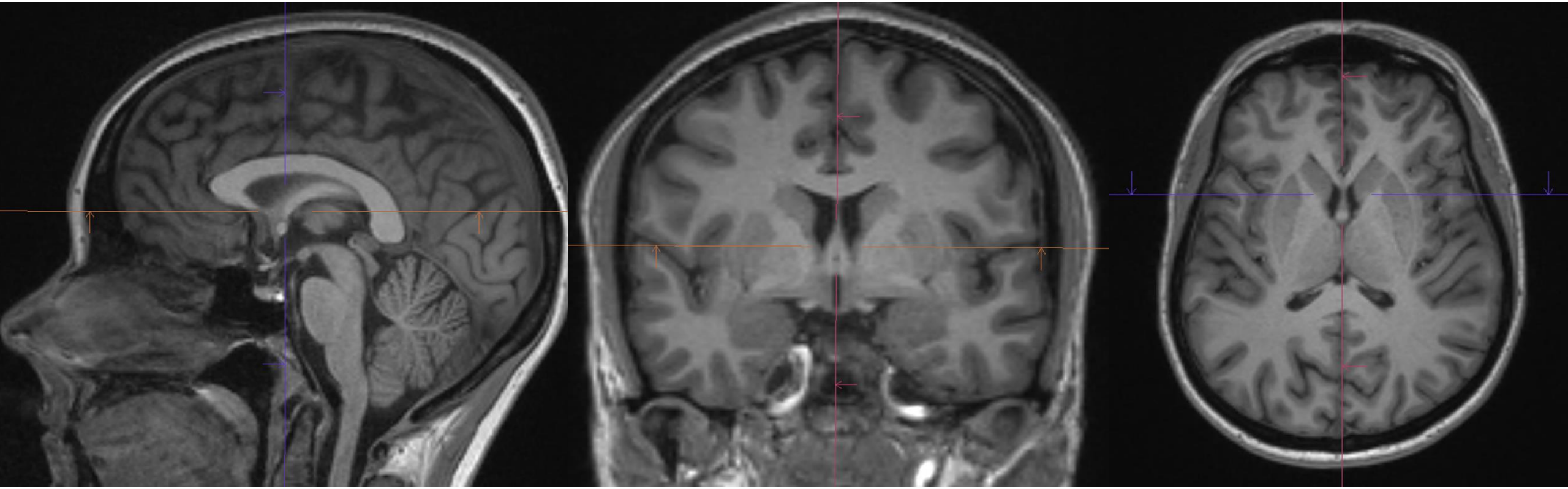
- **Cornu frontale (anterius)**
- ***Foramen interventriculare Monroi***
- ***Septum pellucidum***
- ***Cavum septi pellucidi***
  - ***Fluid filtrated, no communication***
  - ***100% fetuses, inadults cca 2%***
- ***Corpus ventriculi (Cella media)***
  - ***Lower outline fornix cerebri***
  - ***Divided fromt halamus by choroid fissure***
  - ***Plexus chorioidalis closing choroid fissure and fornix***
- ***Trigonum = atrium***
- ***Cornu occipitale (posterius)***
- ***Cornu temporale (inferius)***

III. ventricle

- Cleft-like
- *In middle line*
- *Roofed by choroid plexus*
- *Laterally thalames*
- *bottom*
  - *anteriorly hypothalamus*
  - *lamina terminalis – lamina terminalis organ*
  - *cisterna laminae terminalis*
    - *a. communicans anterior*
    - *krvácení z aneuryzmatu do komor*
  - *dorsally subthalamus*
  - *Recessus opticus (chiasma opticum)*
  - *Recessus infundibularis (hypophysis)*
- *Foramen interventriculare*
  - *Behind dividing columnae fornicis*
  - *commisura anterior*
  - *Dividing fornix and nucleus anterior thalami*



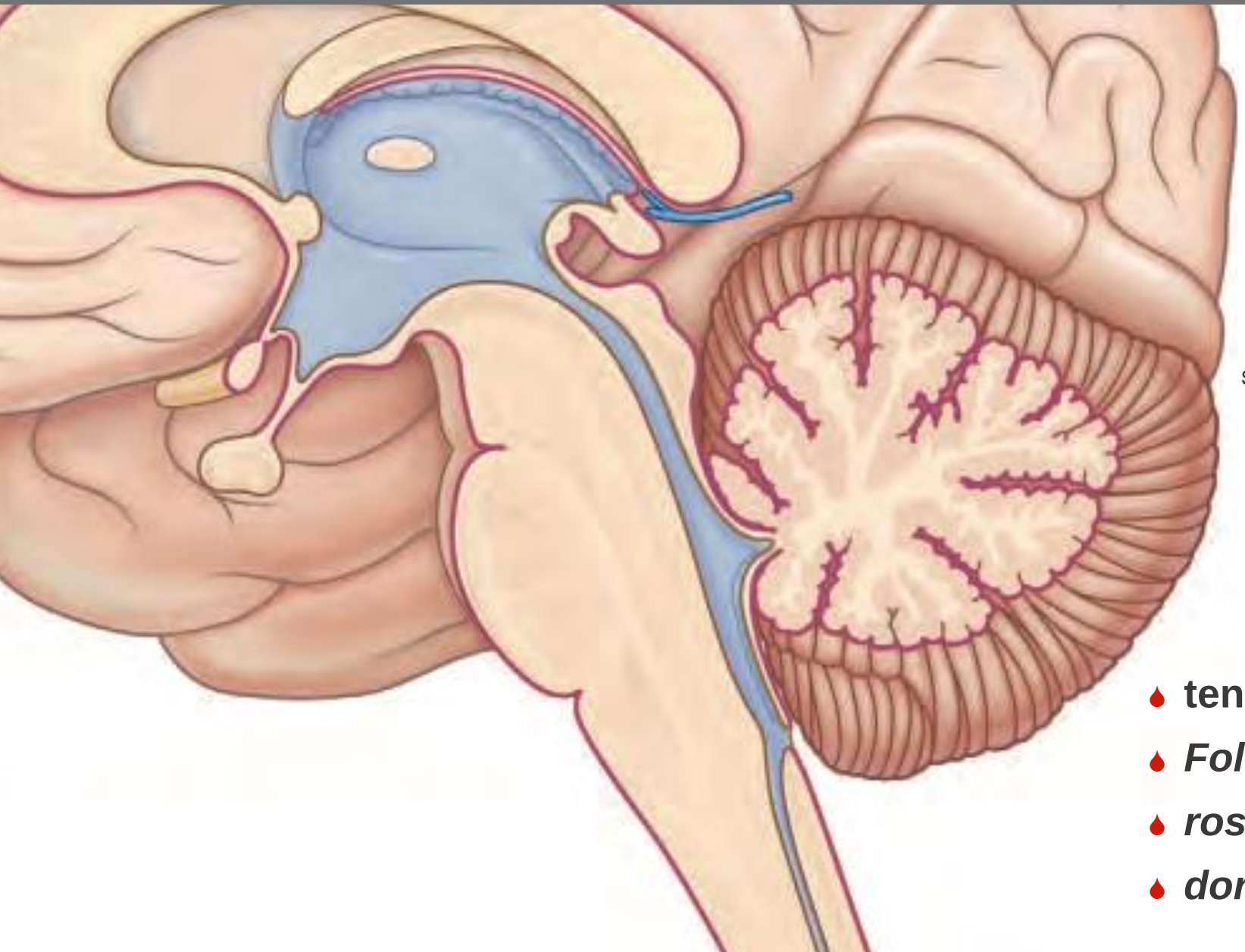
III. ventricle

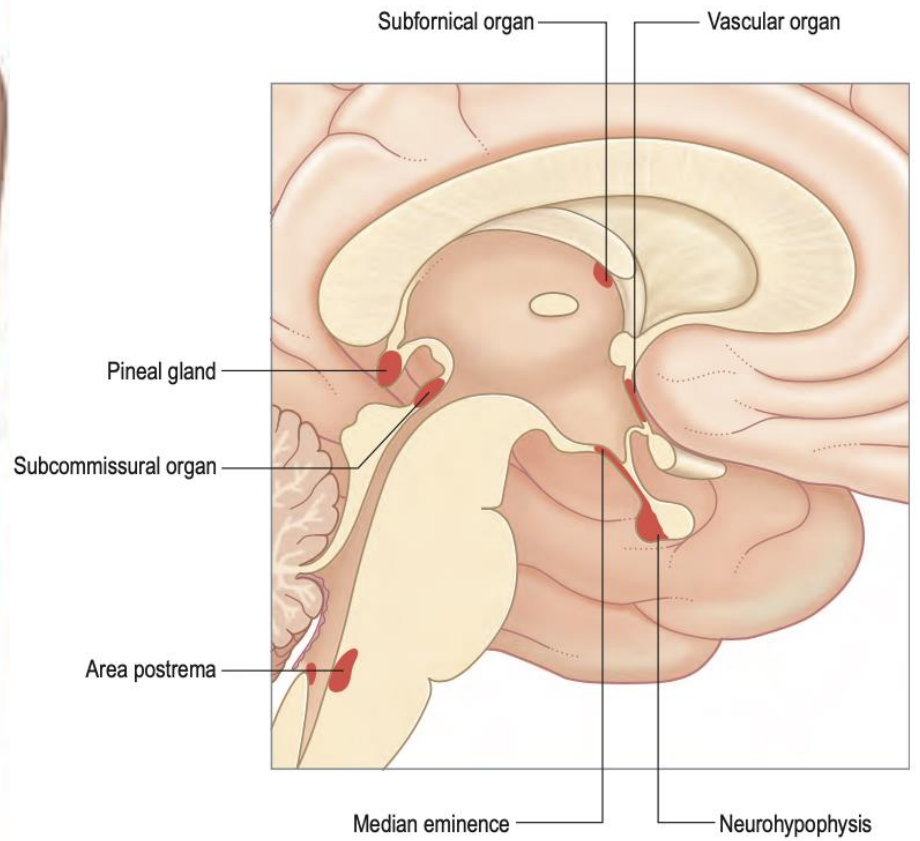


Aquaeductus mesencephali

- ***Midleline structure***
  - **Circular transsection**
  - ***1 – 2 mm***
  - ***length***
  - ***newborn12 mm***
  - ***Adult cca 20 mm***
- ***Dorsally is posterior commisure***
  - ***Runs dorsocaudally***
- ***Dorsal quarter of mesencelhali***
  - ***around periaqueductal grey matter***
  - ***Rostraly tegmentum mesencephali***
  - ***dorsally colliculi superiores et inferiorres (tectum)***
- ***Entering the IV. ventricle***
  - ***Nmesencephalon/pons interface***

IV. ventricle

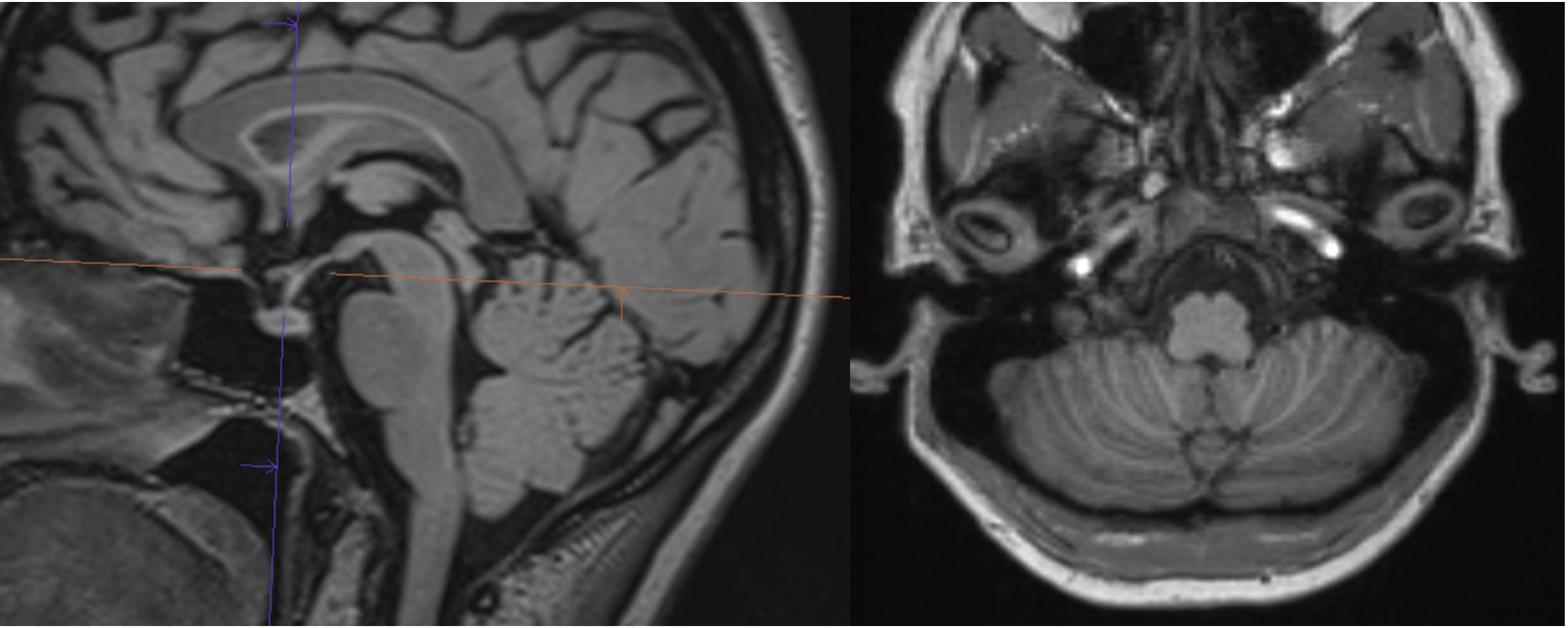




- **tent**
- ***Following aqueductus***
- ***rostrally pons and medulla oblongata***
- ***dorsally cerebellum***

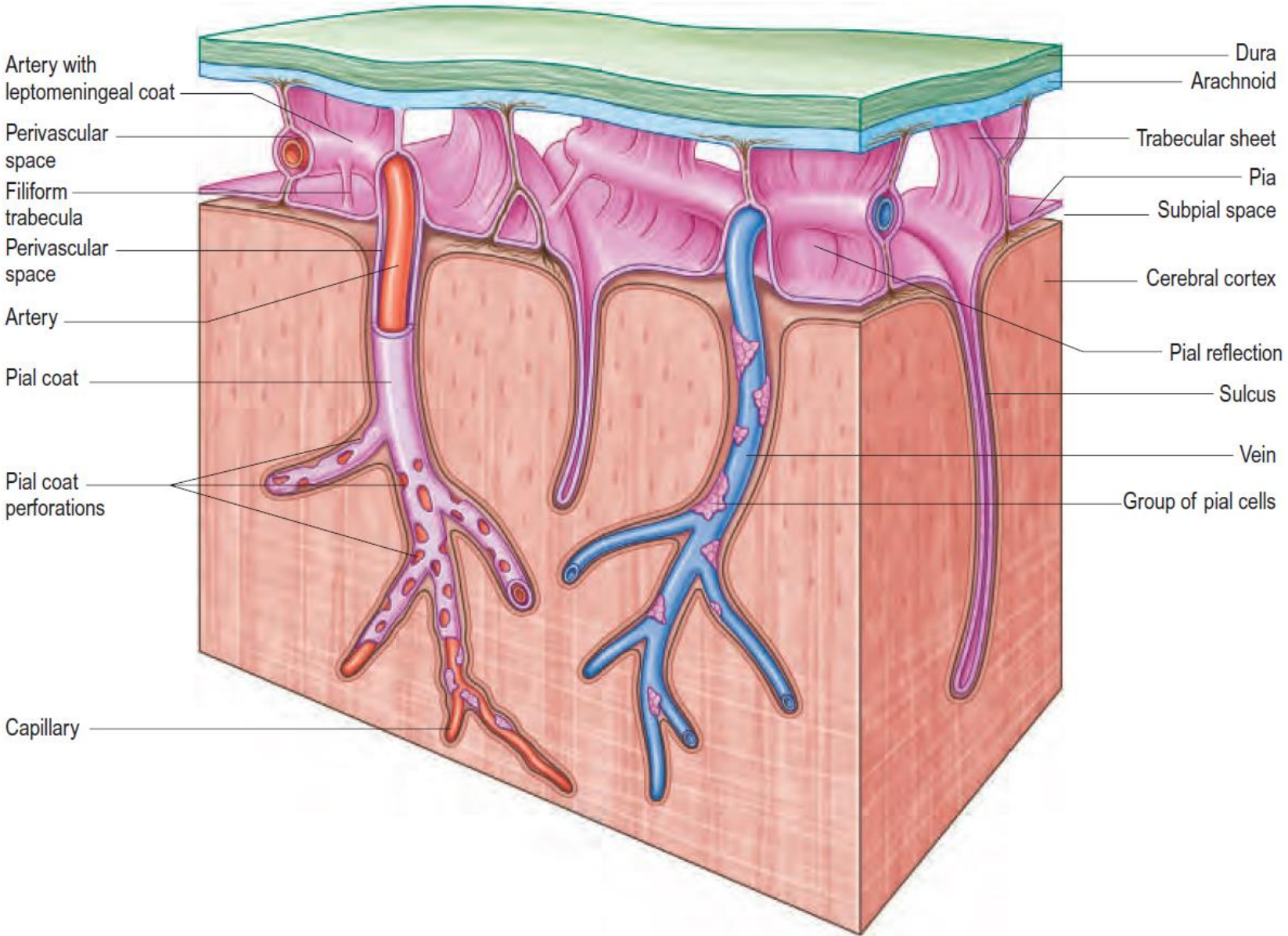
Aperturae ventriculi quarti

- **Apertura ventriculi quarti mediana (Magendi)**
- ***Aperturae ventriculi quarti laterales (Luschkae)***



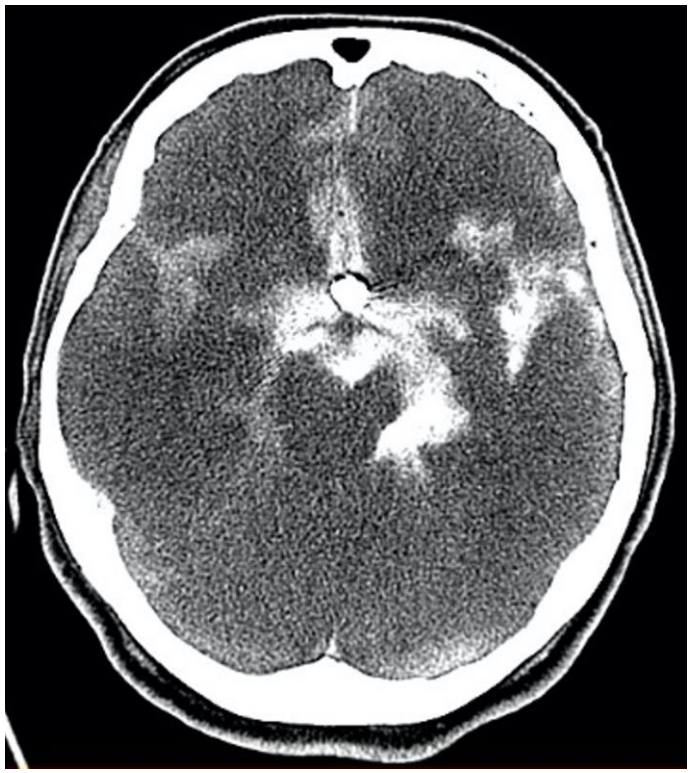
Meninges and meningeal spaces

- **Epidural space**
- **Dura mater**
- **Subdural space**
- **Arachnoidea**
- **Subarachnoideal**
- **Pia mater**
  - **Trabekules**
- **Subpial space**
  - **Coated pial vessels**
  - **Perivascular spaces**
  - **Robin-Virchow spaces**



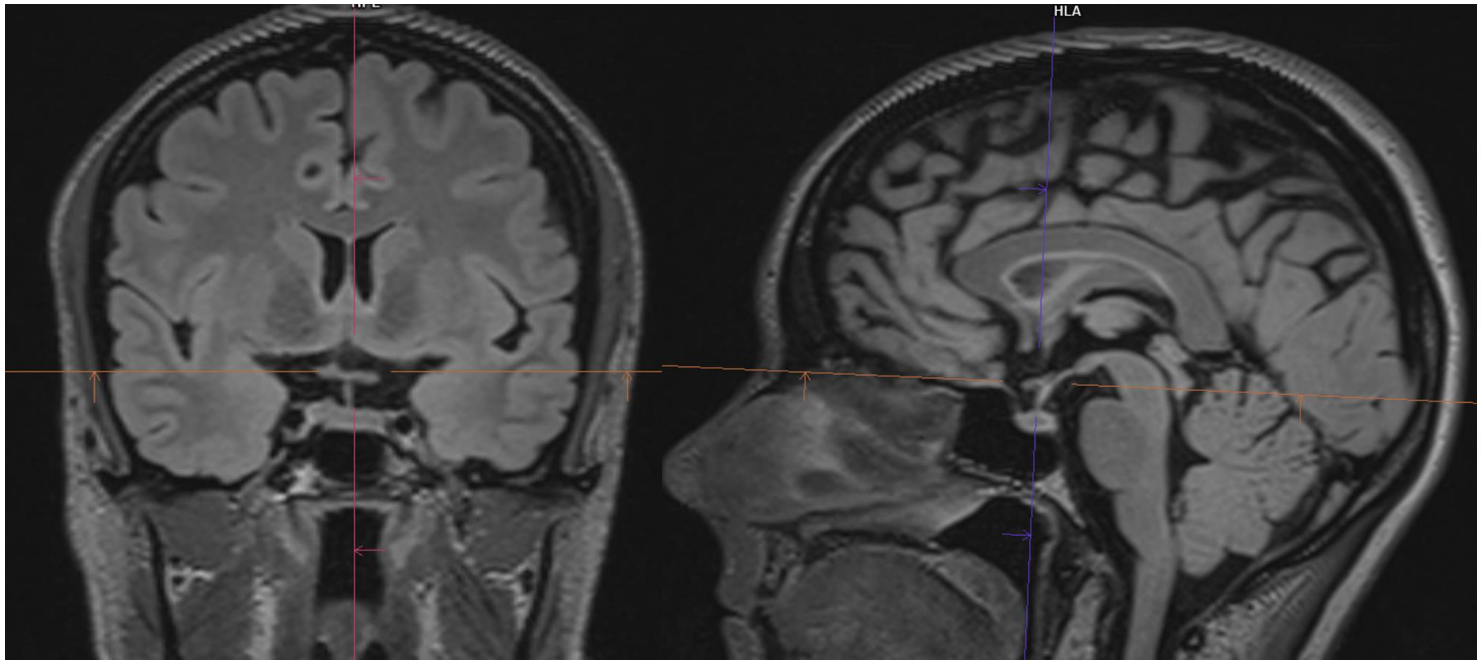
Meningeal spaces

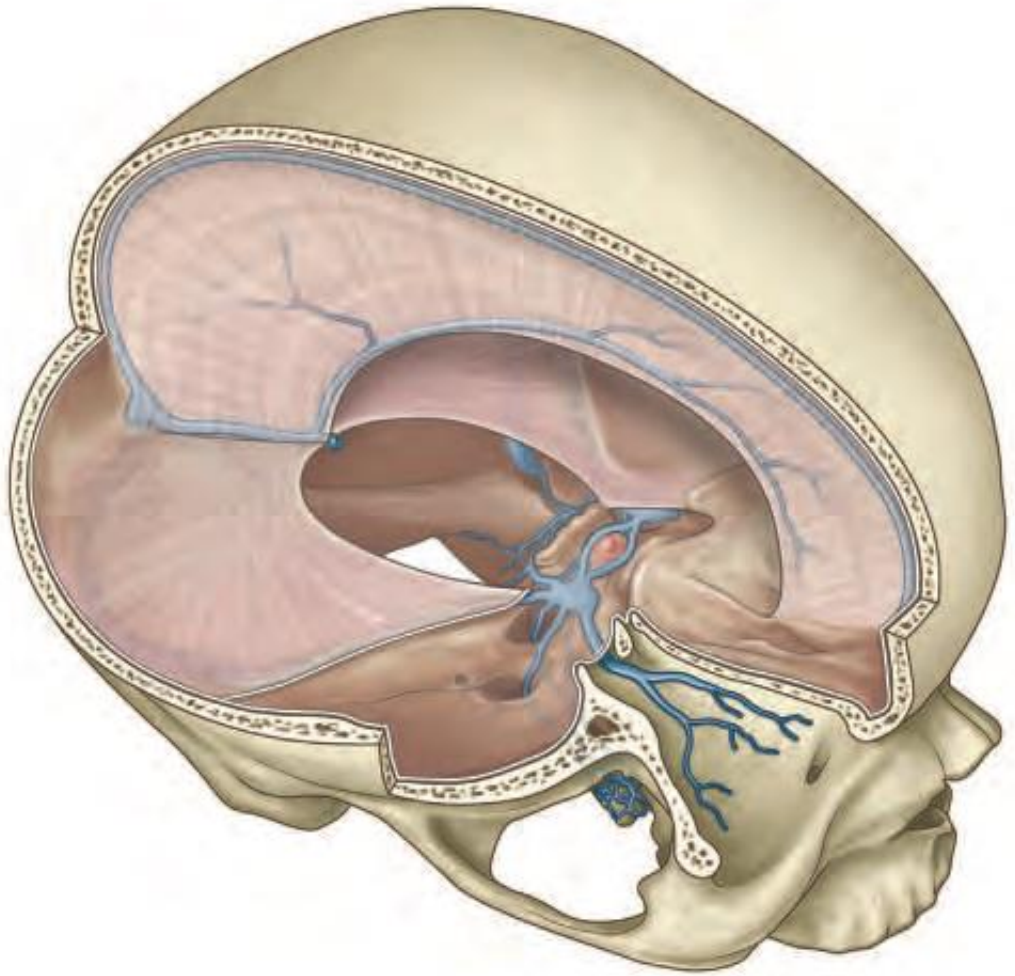
- ***Blood on computed tomography***
- ***Hyperdense due to protein content***
  - ***Epidural bleeding - a. meningica media***
  - ***Subdural bleeding – bridging veins***
  - ***Subarachnoid bleeding - aneuryzma***



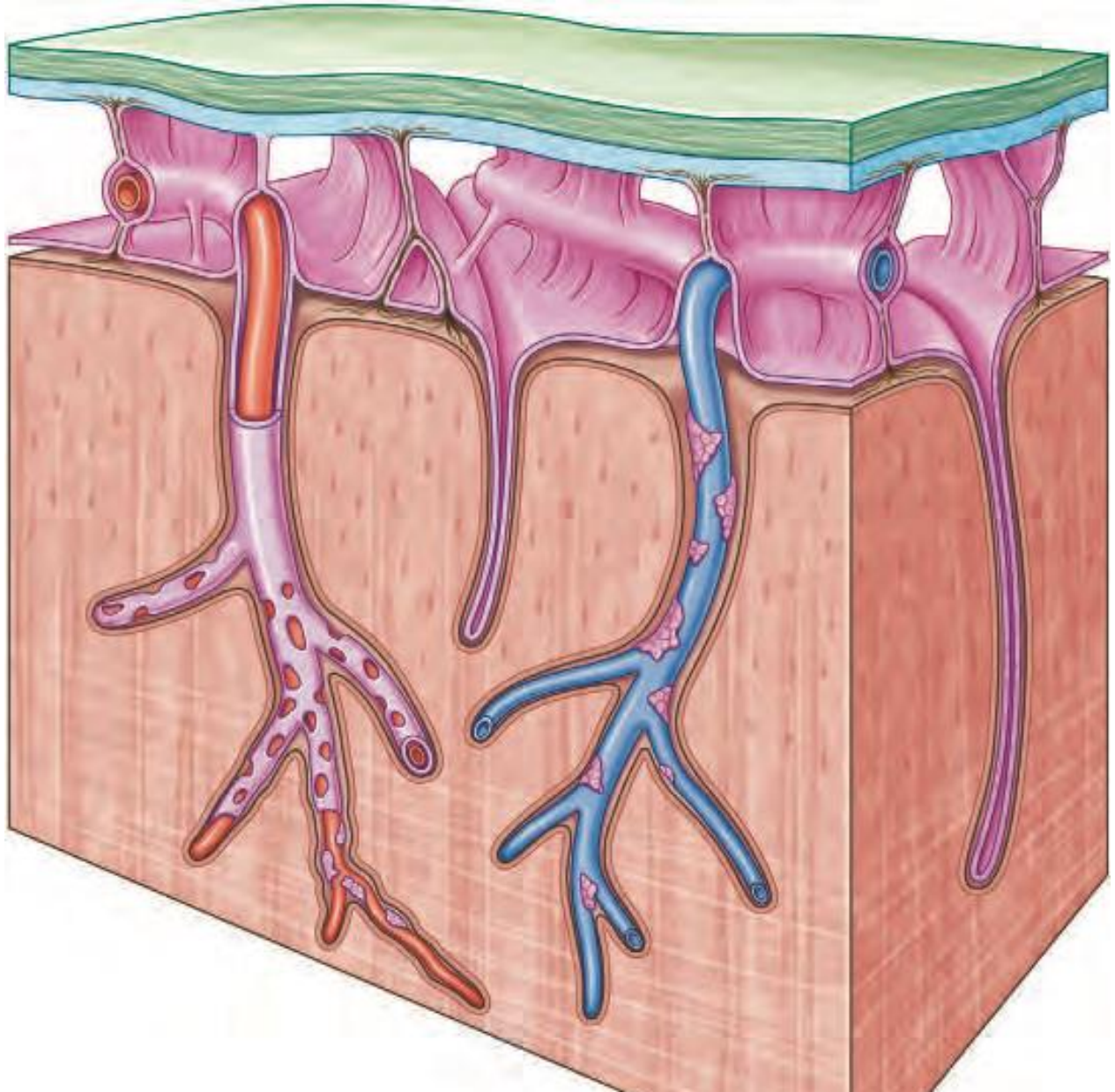
Dural duplicatures

- **Falx cerebri**
- ***Tentorium***
- ***Sinus durae matris***





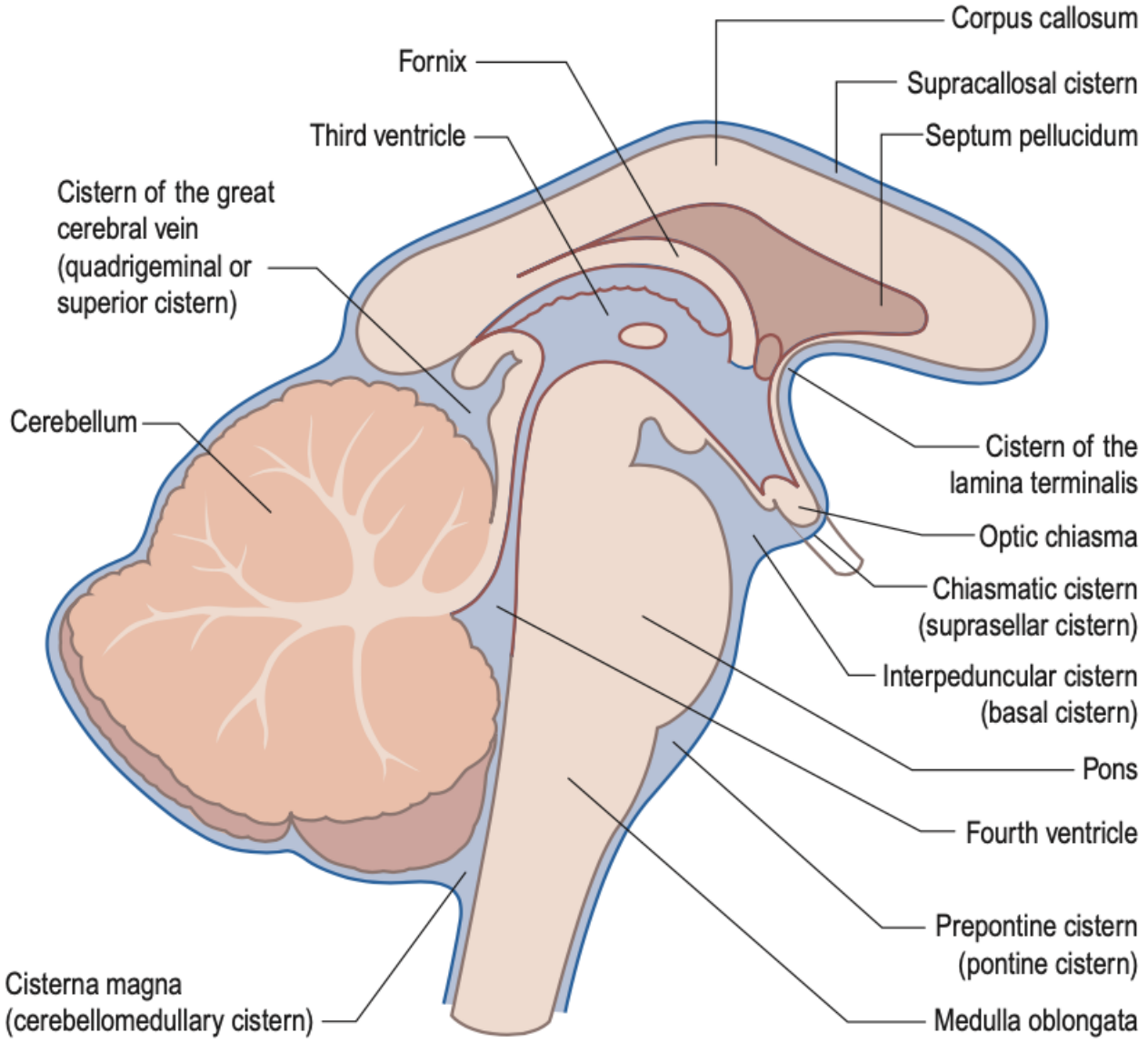
Subarachnoid space



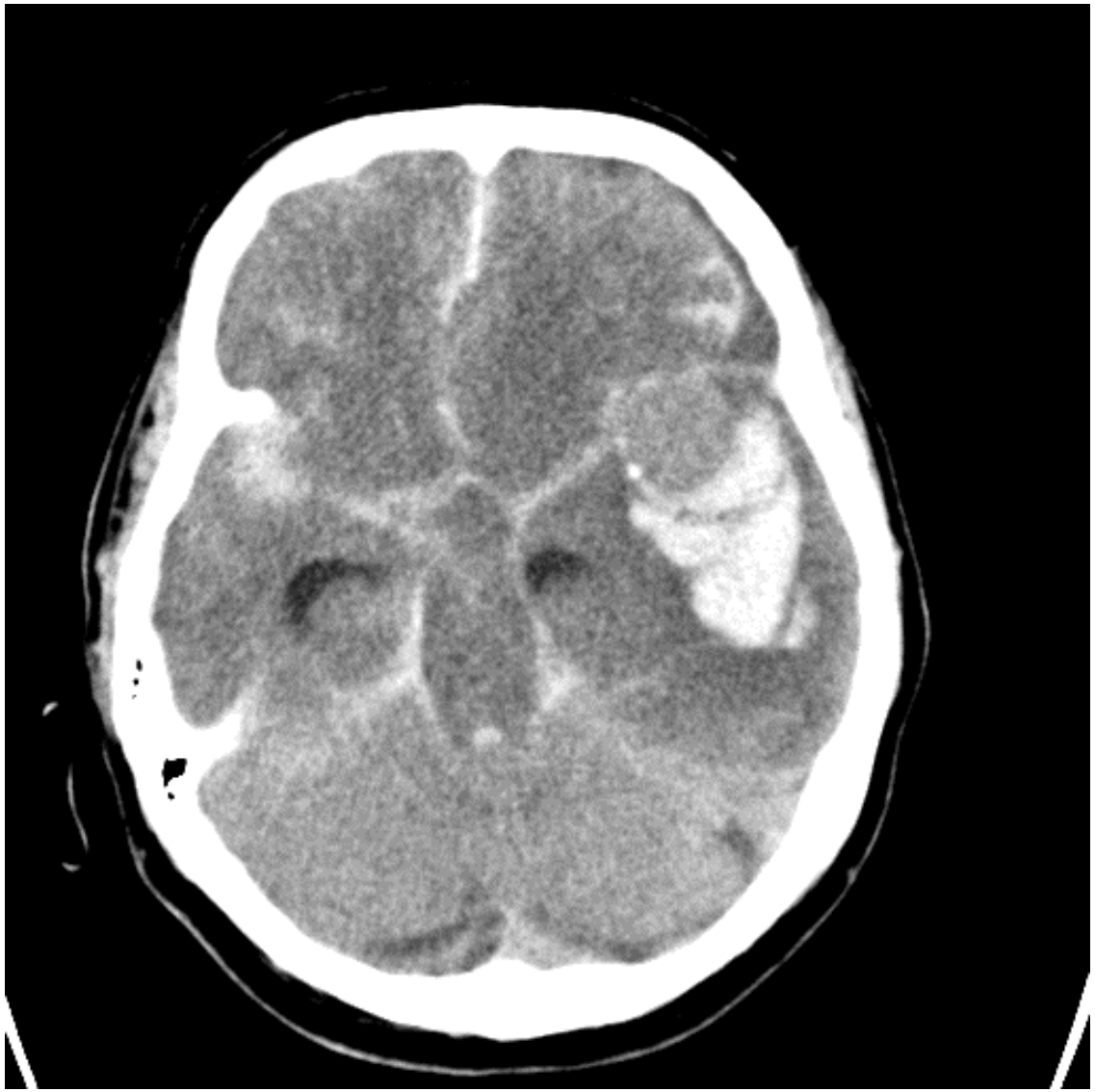
- **Outside brain and spine**
- ***Between pia mater and arachnoidea***
- ***CSF circulation***
- ***Motion power***
  - ***pulsation of blood and brain***

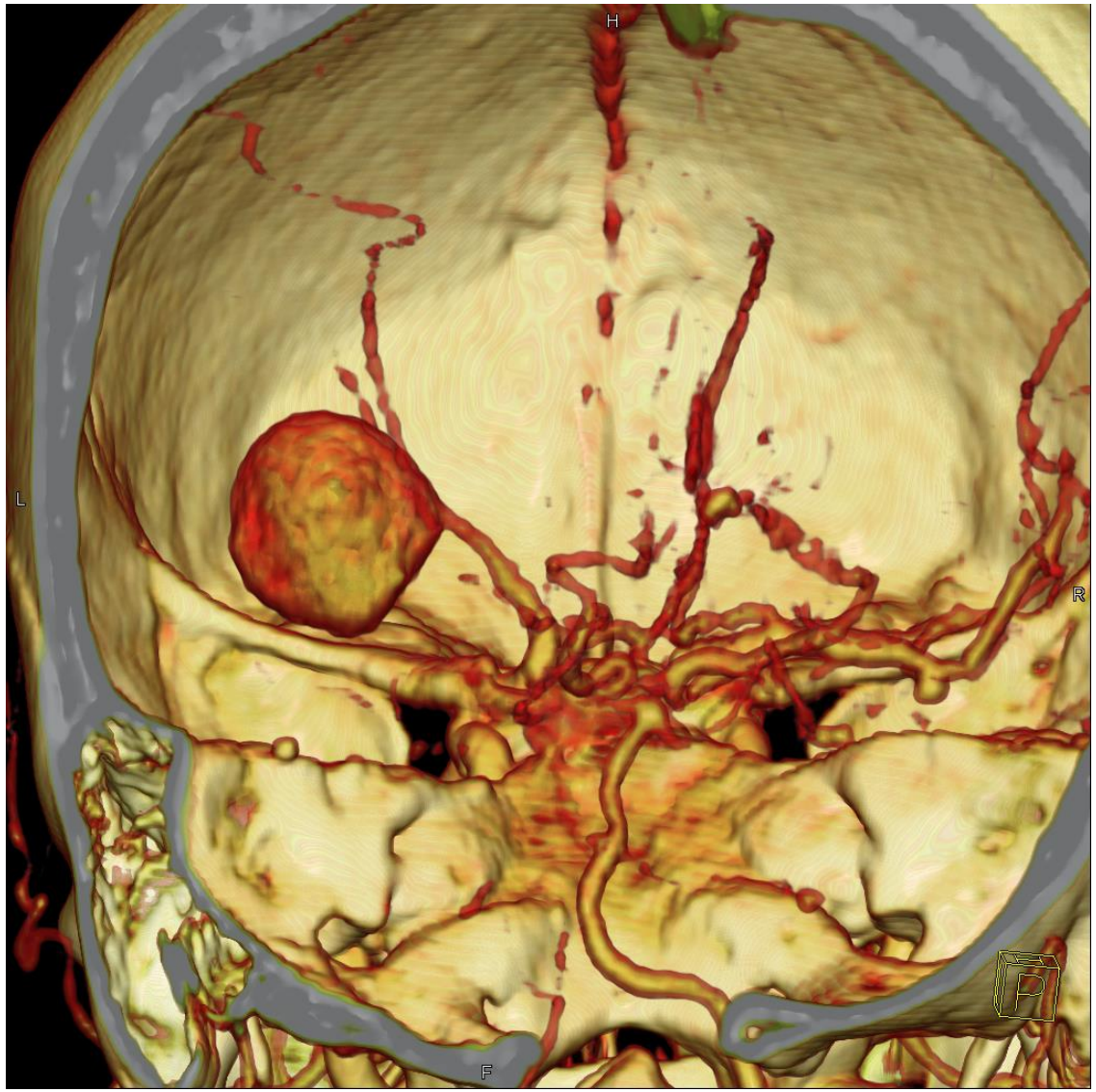
Cisternes

- **Cisterna magna (cerebelli, cerebellomedullaris)**
- **Cisterna premedullaris**
- **Ciaterna prepontina**
- **Cisterna cerebellopontina**
- **Cistern vermiana superior**
- **Cisterna interpeduncularis (basalis) (anterior)**
- **Cisterna cruralis (anterolateras)**
- **Cisterna ambiens (laterodorsal(**
- **Cisterna v. magnae (quadrigeminalis)**
- **Cisterna chiasmatica (suprasellar)**
- **Cisterna laminae terminalis**
- **Cisterna pericallosa**
- **Ciaterna velli interpositi**
- **Cisterna fossae Sylvii**



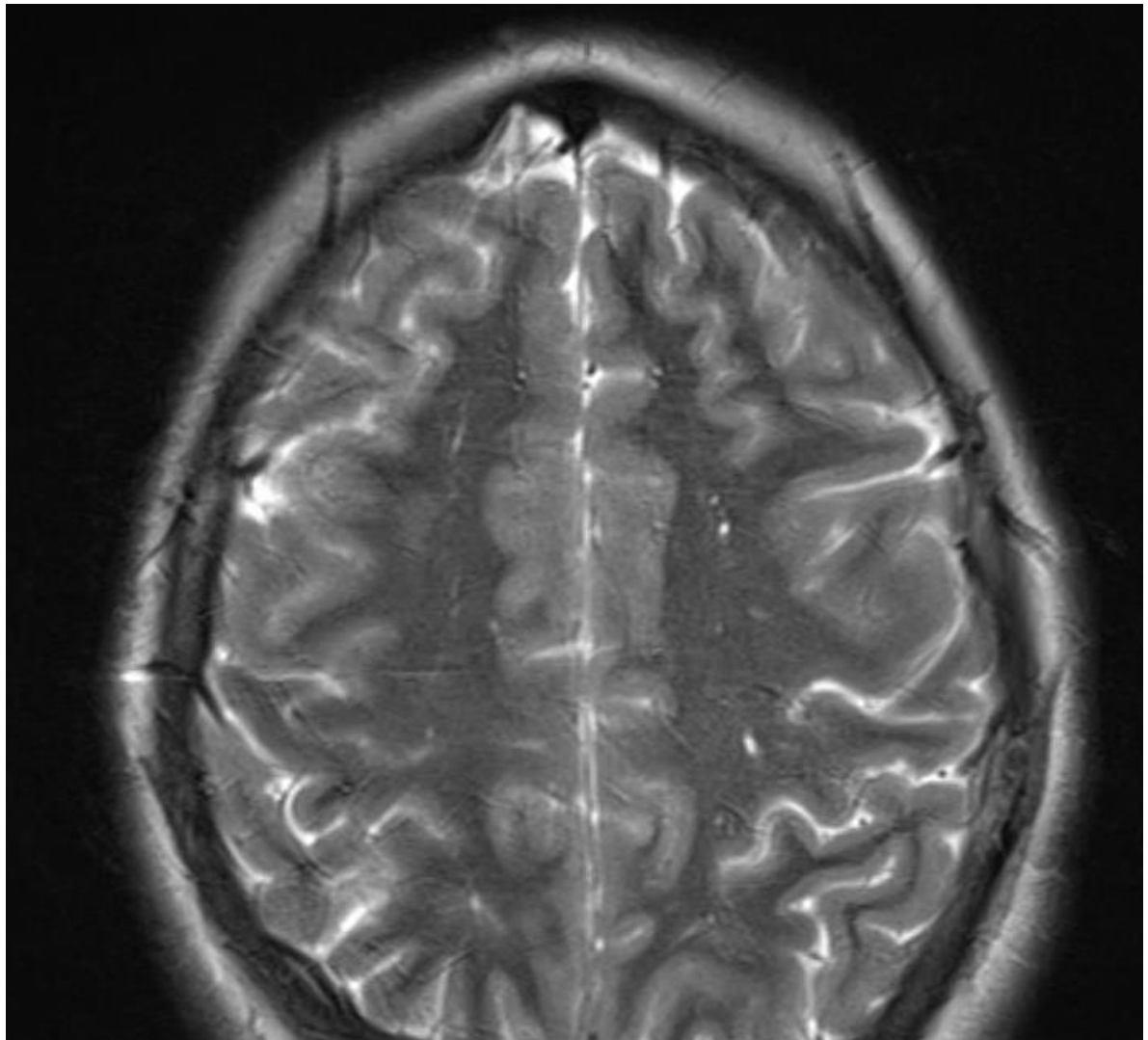
Subarachnoid bleeding from aneurysm

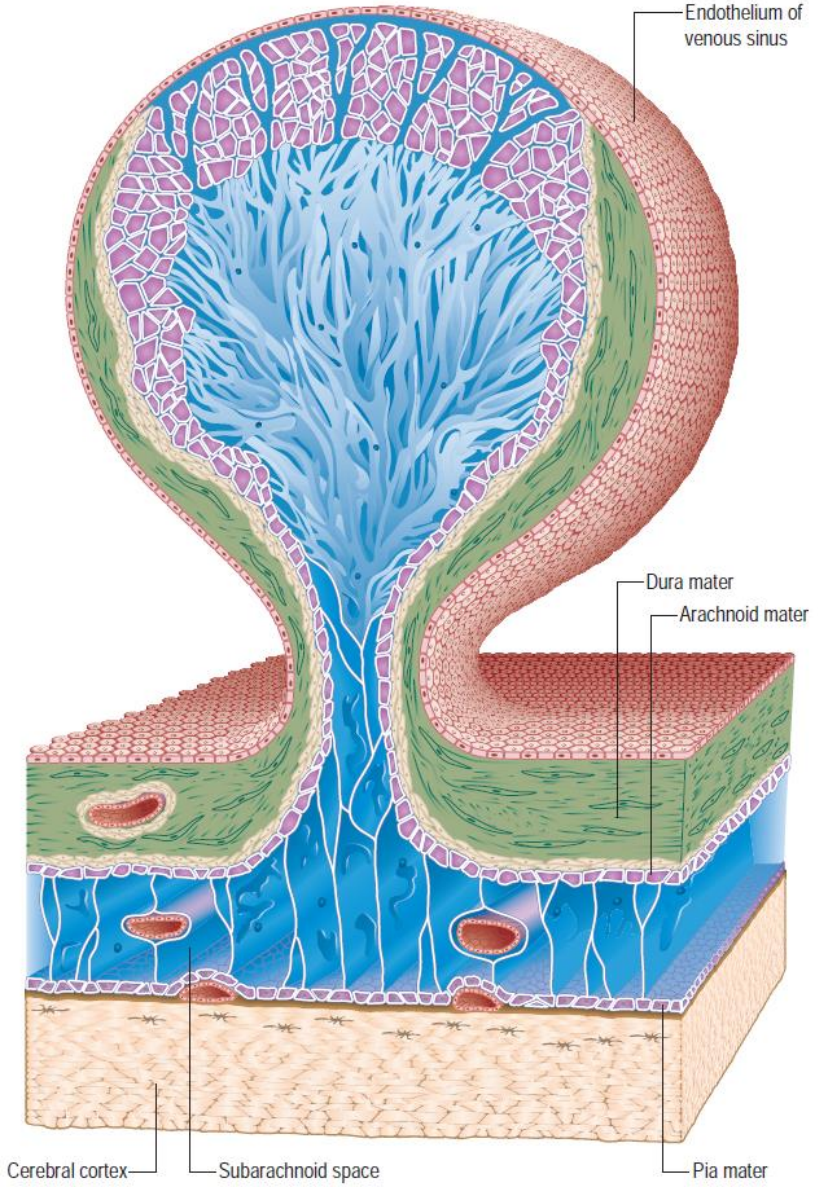




Arachnoidal granulations

- **CSF resorption**

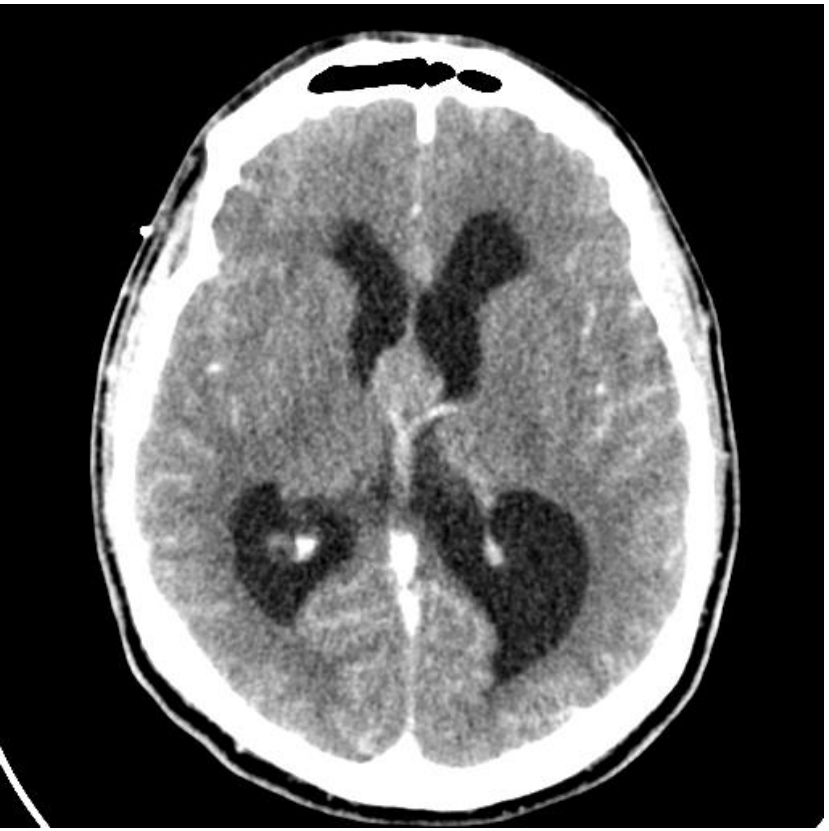


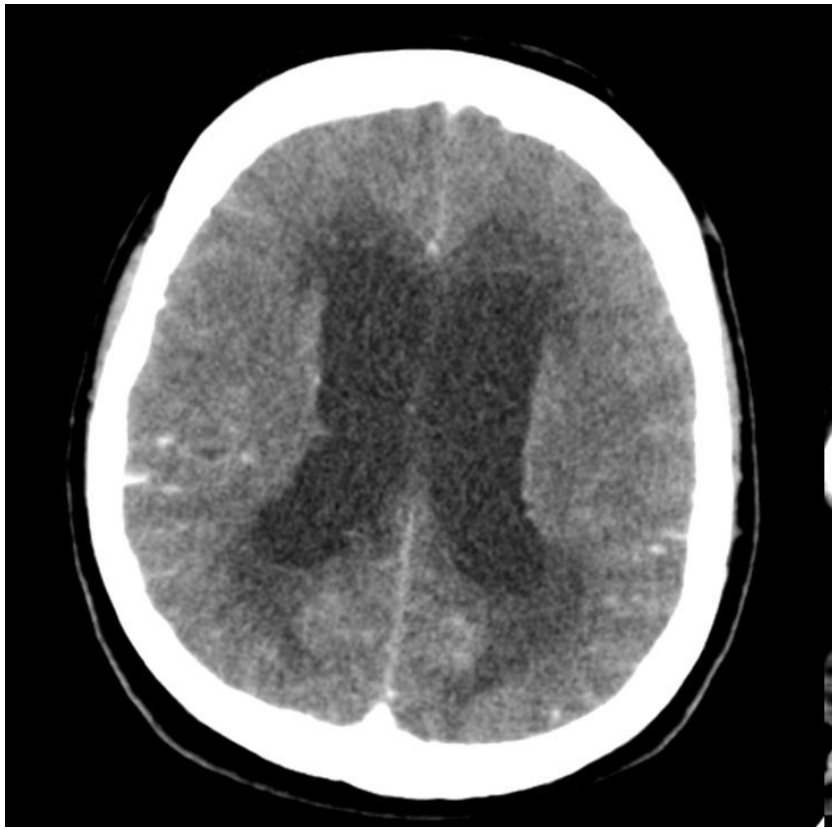


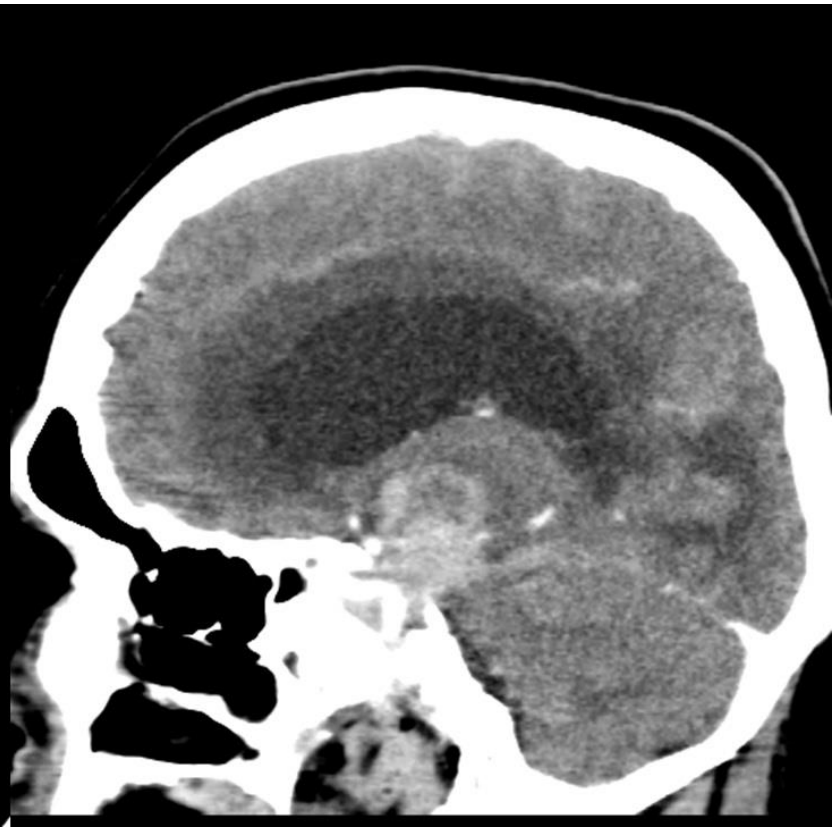
Hydrocephalus

Impaired outflouw of cerebrospinal fluid or impaired resorption

Subependymal ultrafiltration



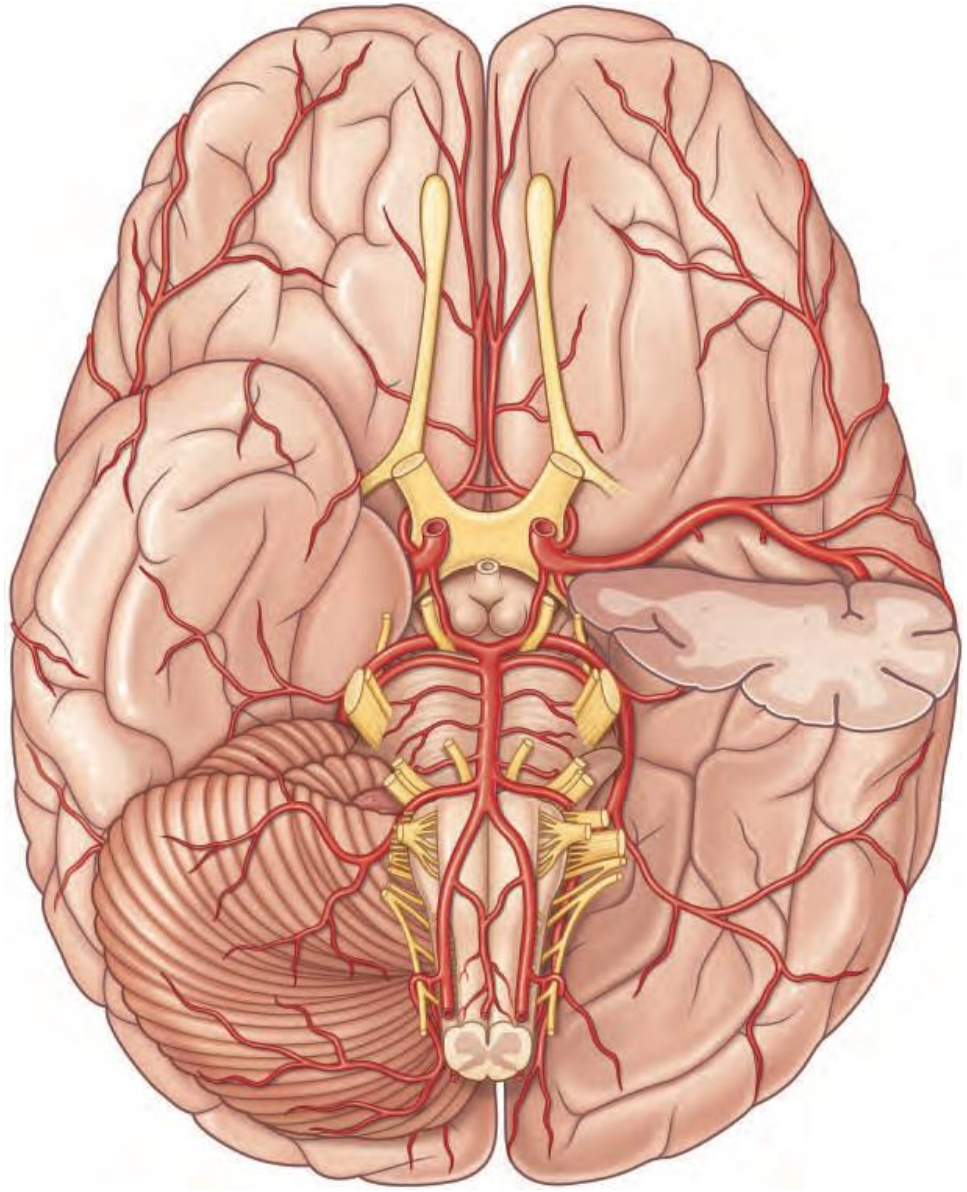




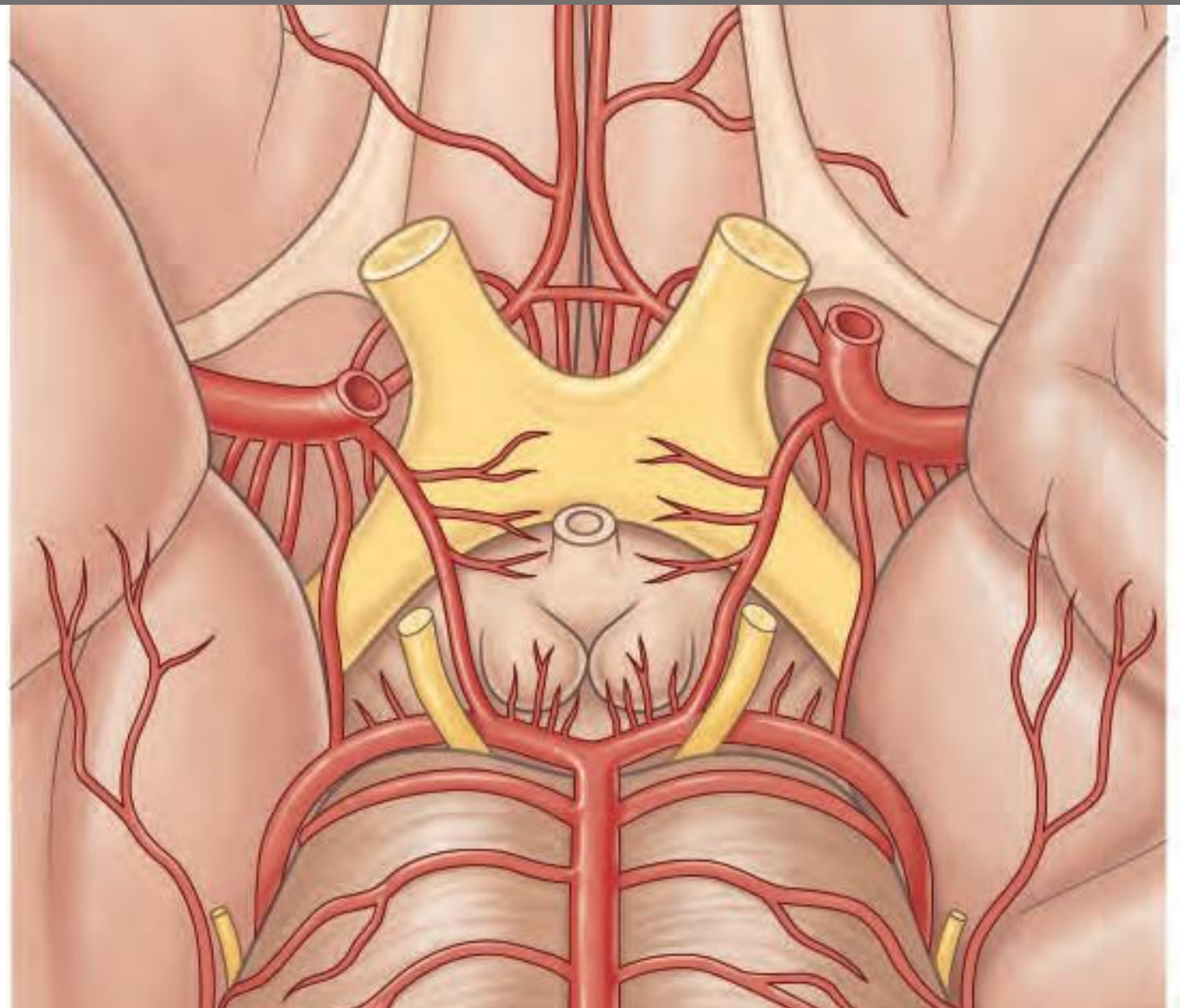
Brain arteries

- **sources**
- ***A. carotis interna – carotic system***
- ***ACA, ACM, AcomA***
- ***A. vertebralis – vertebrobasilar system***
- ***AV, AB, ACP, AcomP***
- ***Circulus arteriosus***

- ***Aa. centrales***
- ***Centrales anteriores – ACM, AcomA***
- ***Centrales posteriores – ACP, AcomP***



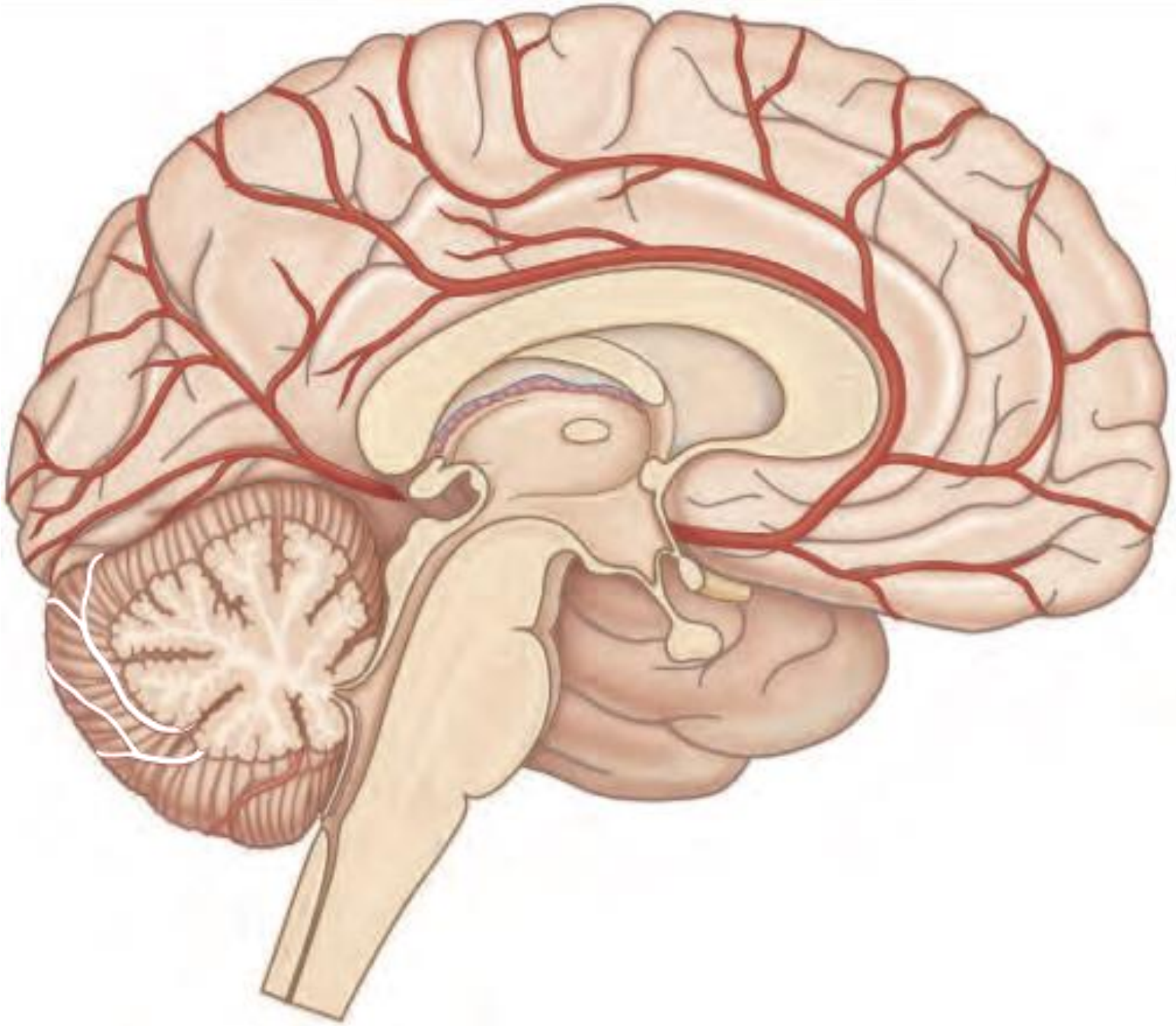
Circulus arteriosus (Willisi)



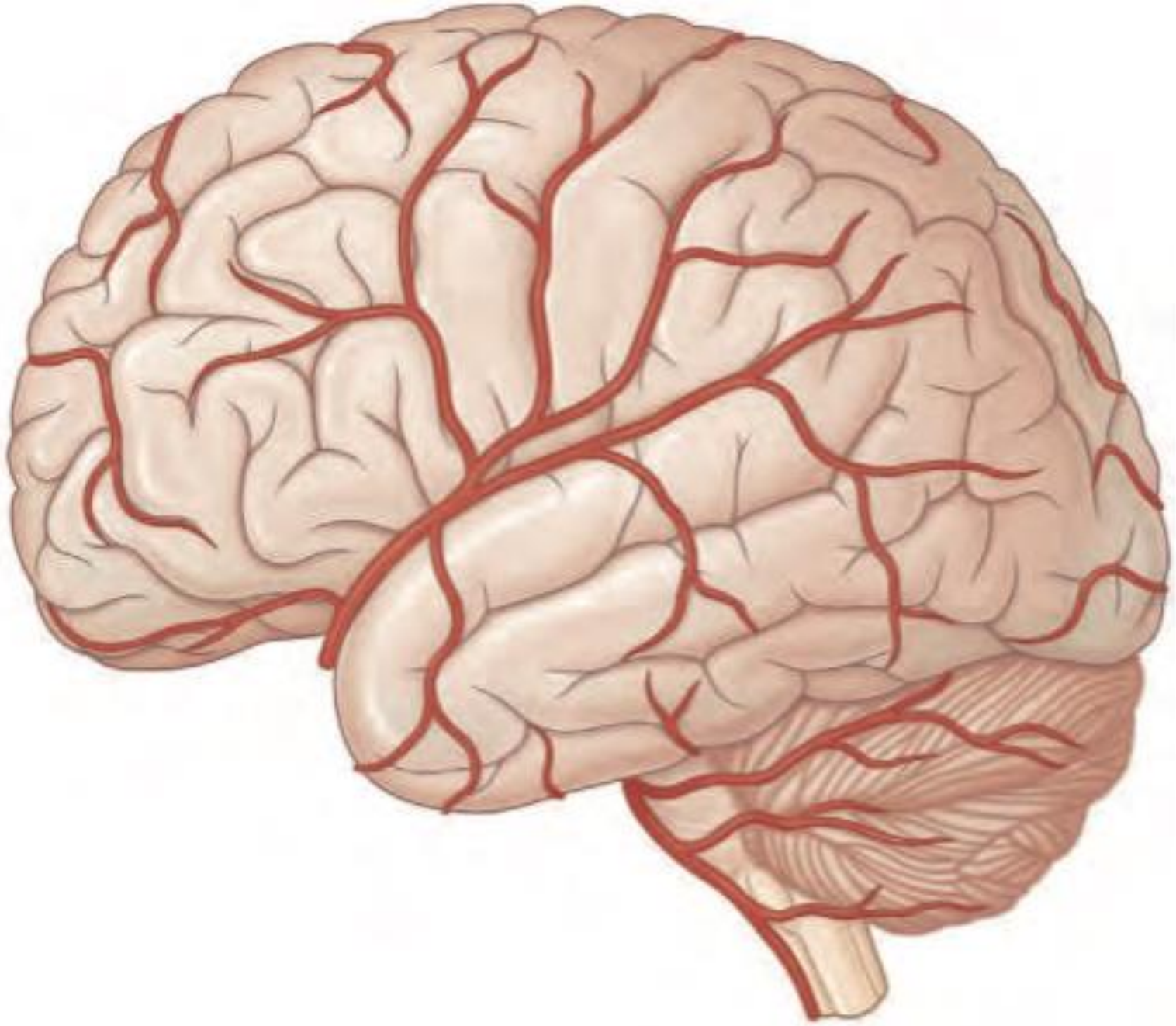
- A. carotis interna
- A. chorioidea anterior
- A. communicans posterior
- *A. cerebri anterior*
- *A. communicans anterior*
- *A. cerebri media*
- *A. basilaris*
- *A. cerebri posterior*
- *A. communicans posterior*

Carotic system

- **A. cerebri anterior:** *a. orbitalis, frontobasalis, pericallosa, callosomarginalis*
- ***A. cerebri media:*** *a. prefrontalis, precentralis, centralis, postcentralis, parietalis, angularis, temporalis anterior, temporalis media, temporooccipitalis*



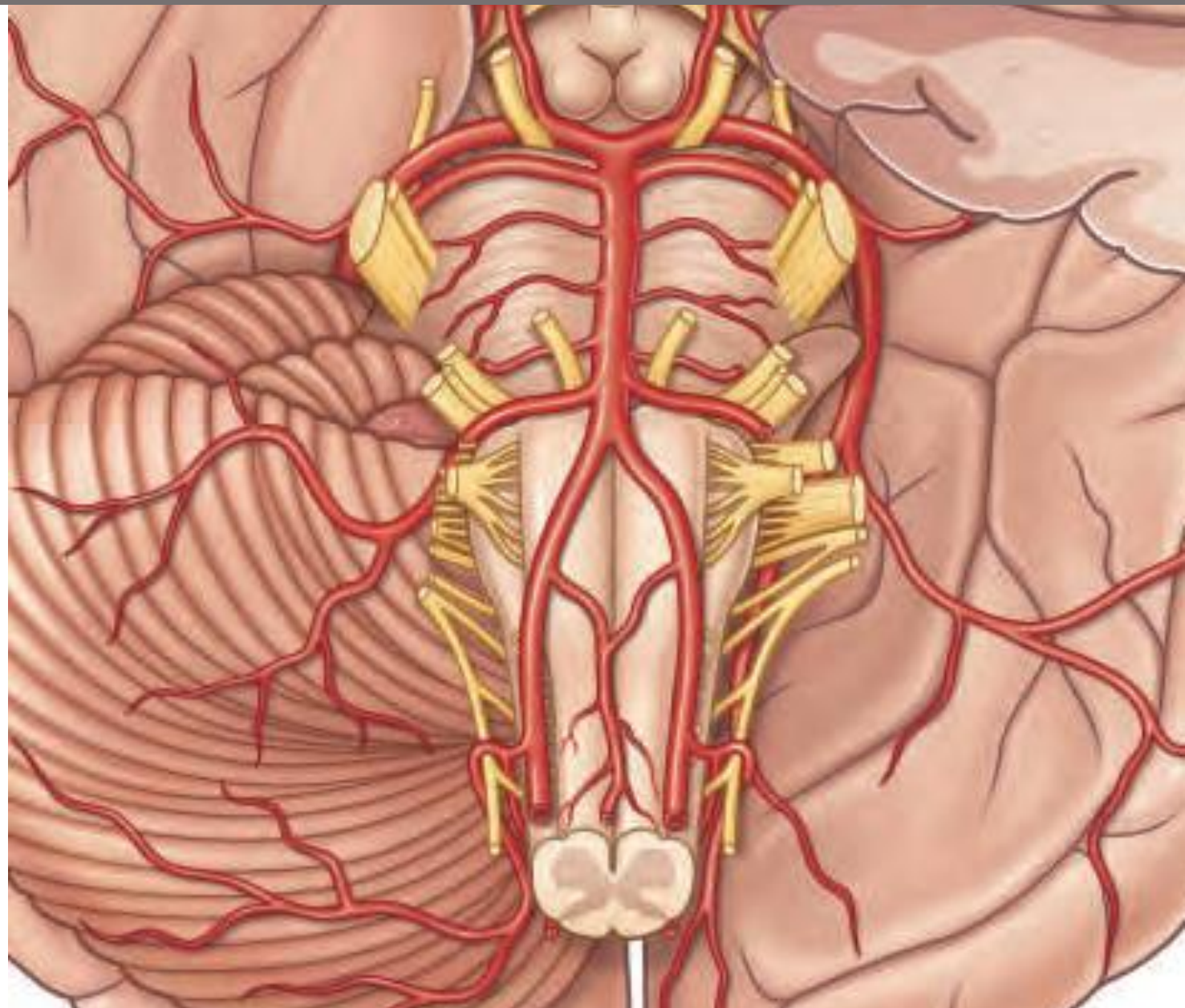
- **A. cerebri anterior**
- *A. orbitalis*
- *A. frontobasalis*
- *A. pericallosa*
- *A. callosomarginalis*

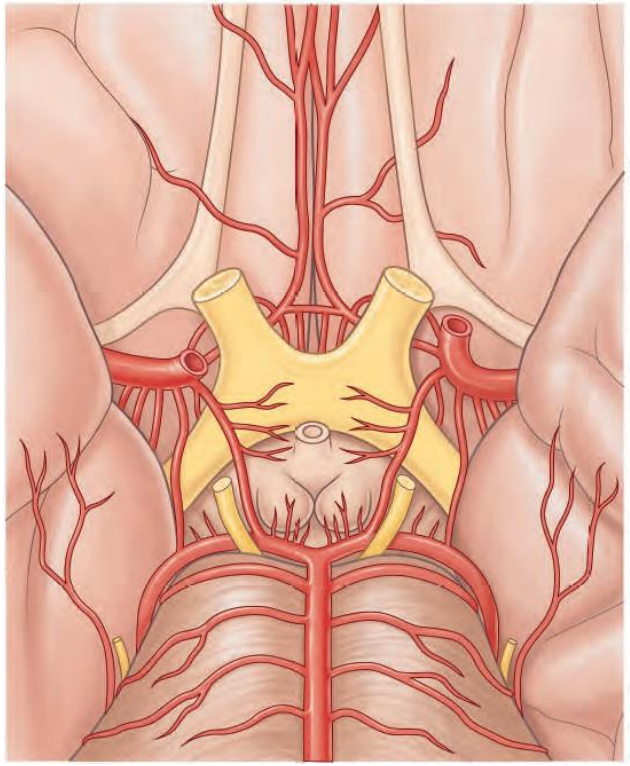


- ***A. cerebri media***
- *A. prefrontalis*
- *A. precentralis*
- *A. centralis*
- *A. postcentralis*
- *A. parietalis*
- *A. angularis*
- *A. temporalis anterior*
- *A. temporalis media*
- *A. temporooccipitalis*

Vertebrobasilar system

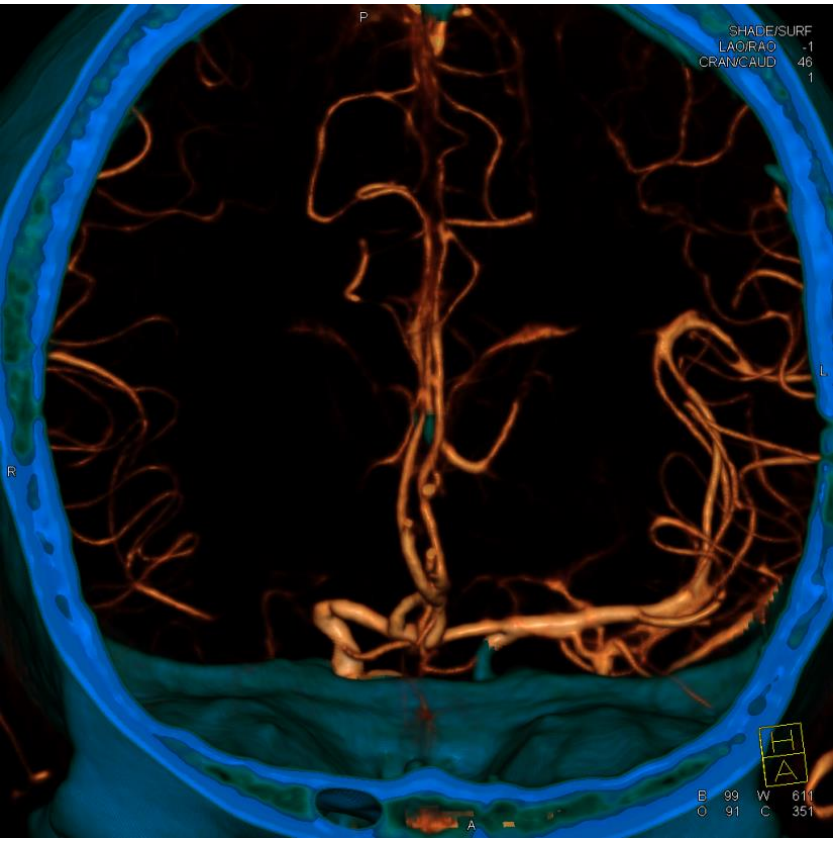
- **A. vertebralis**
- ***A. cerebelli inferior posterior (PICA)***
- ***A. basilaris***
- ***A. cerebelli inferior anterior (AICA)***
- ***Rami pontines***
- ***A. cerebelli superior***
- ***A. cerebri posterior***
- ***A.communicans posterior***

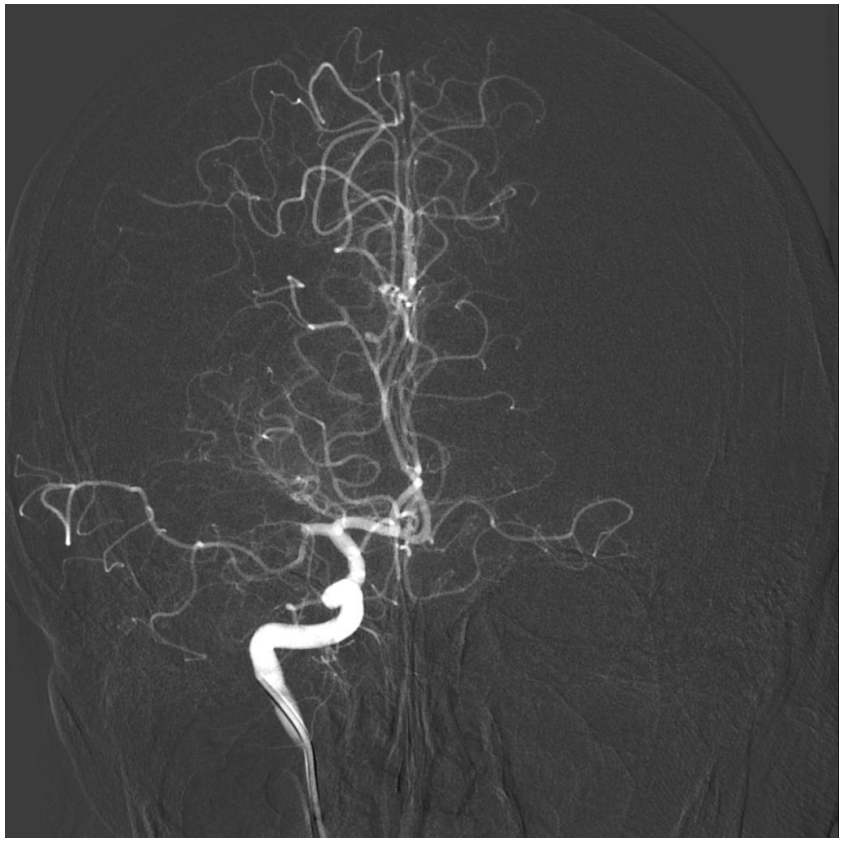


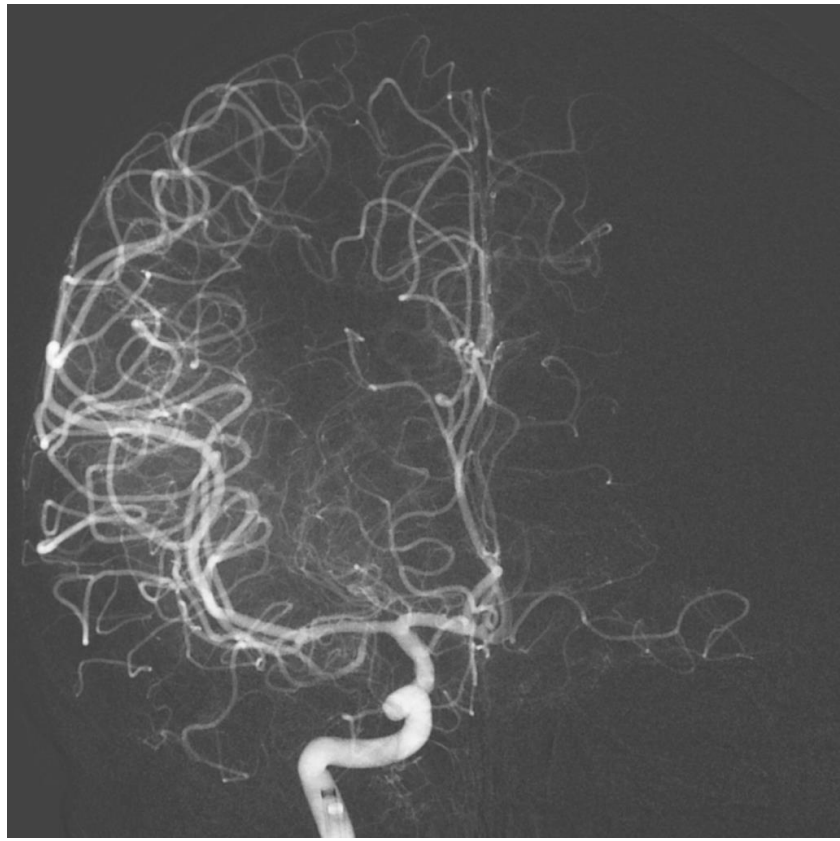


Grey´s Anatomy, 41th ed.

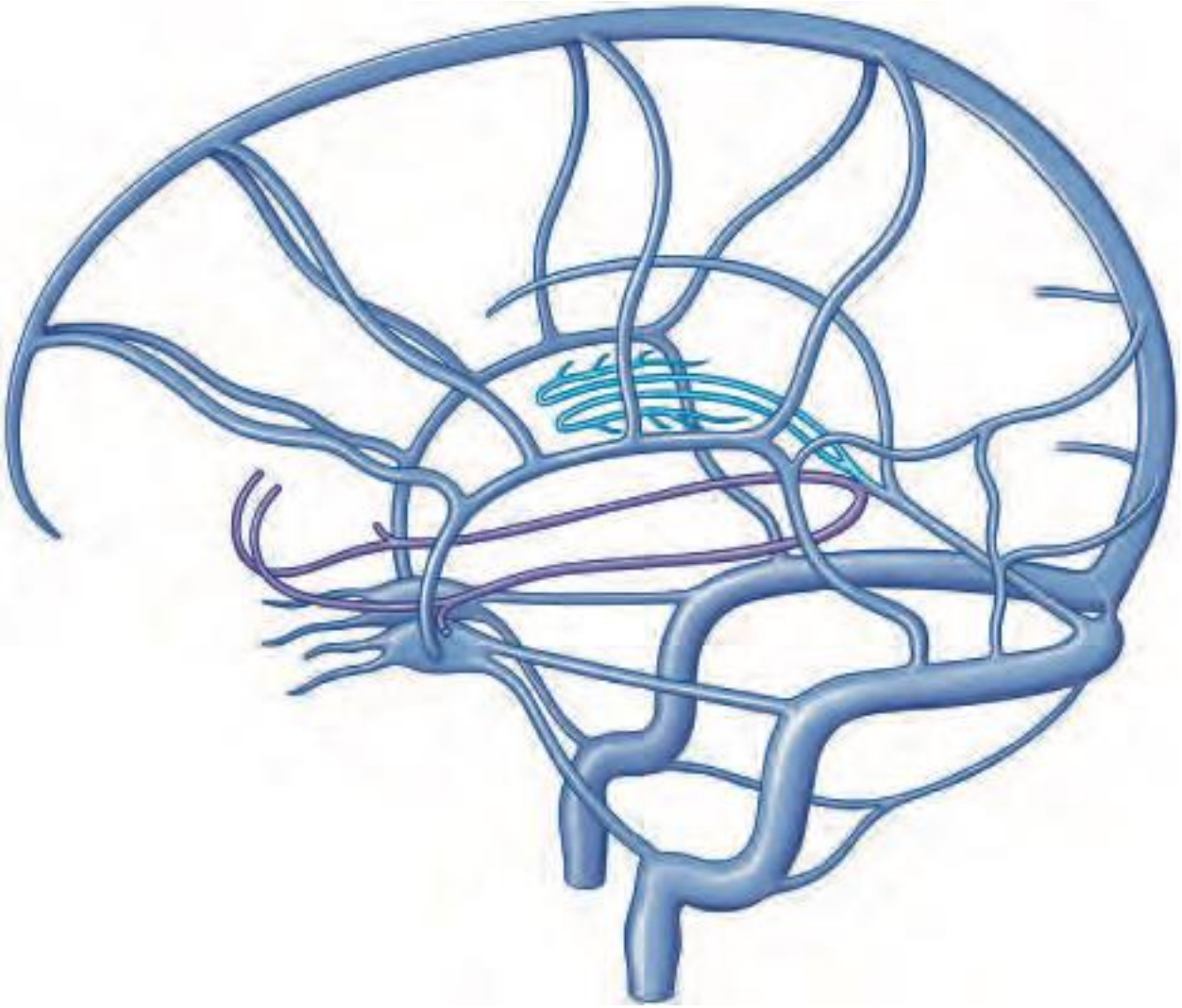
Interventional radiology in stroke





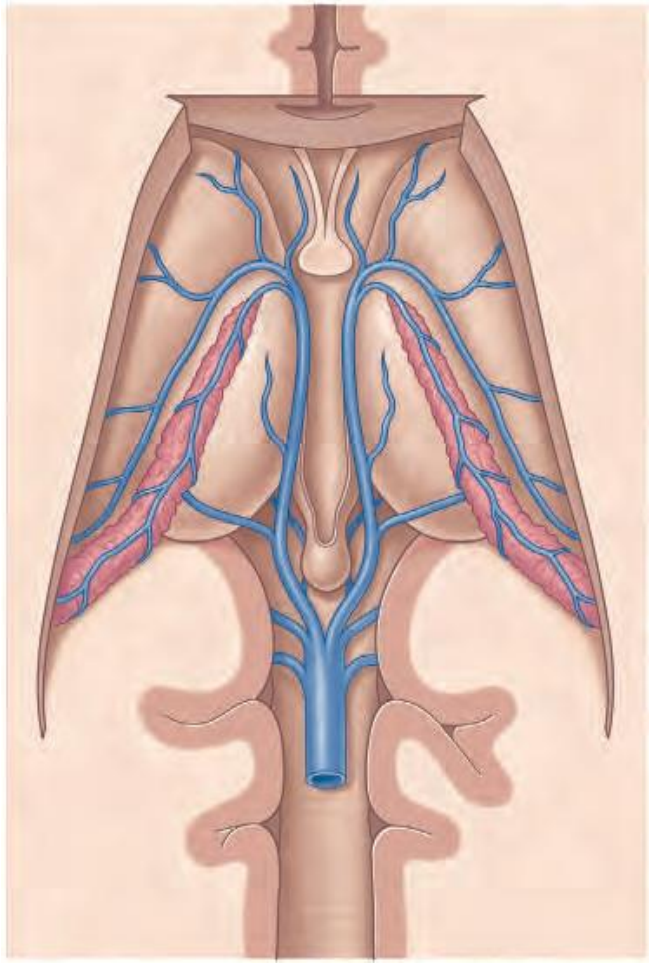


Veous systém of the brain

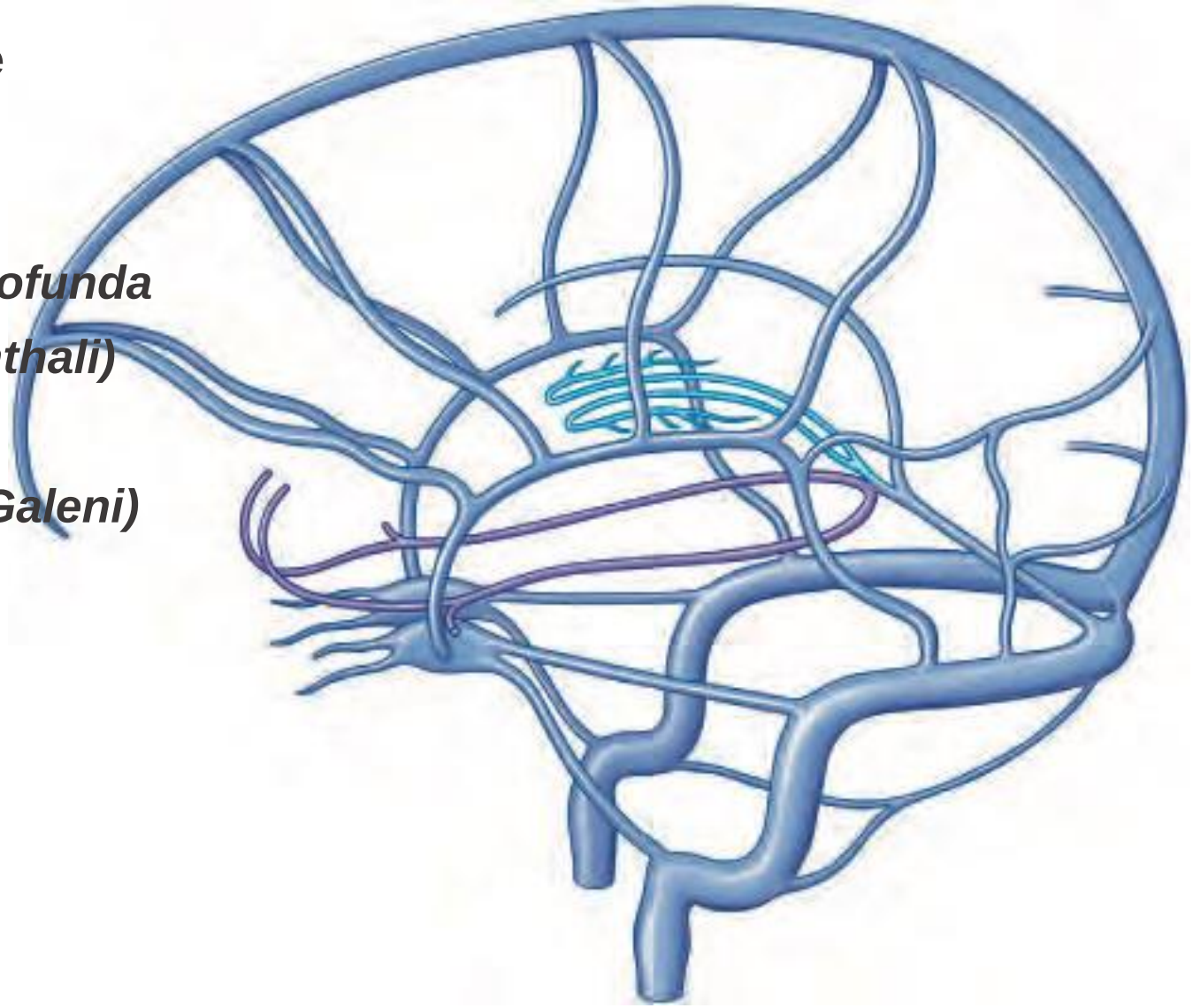


- Superficial
- Deep
- Sinuus durae matris
- Emissaria

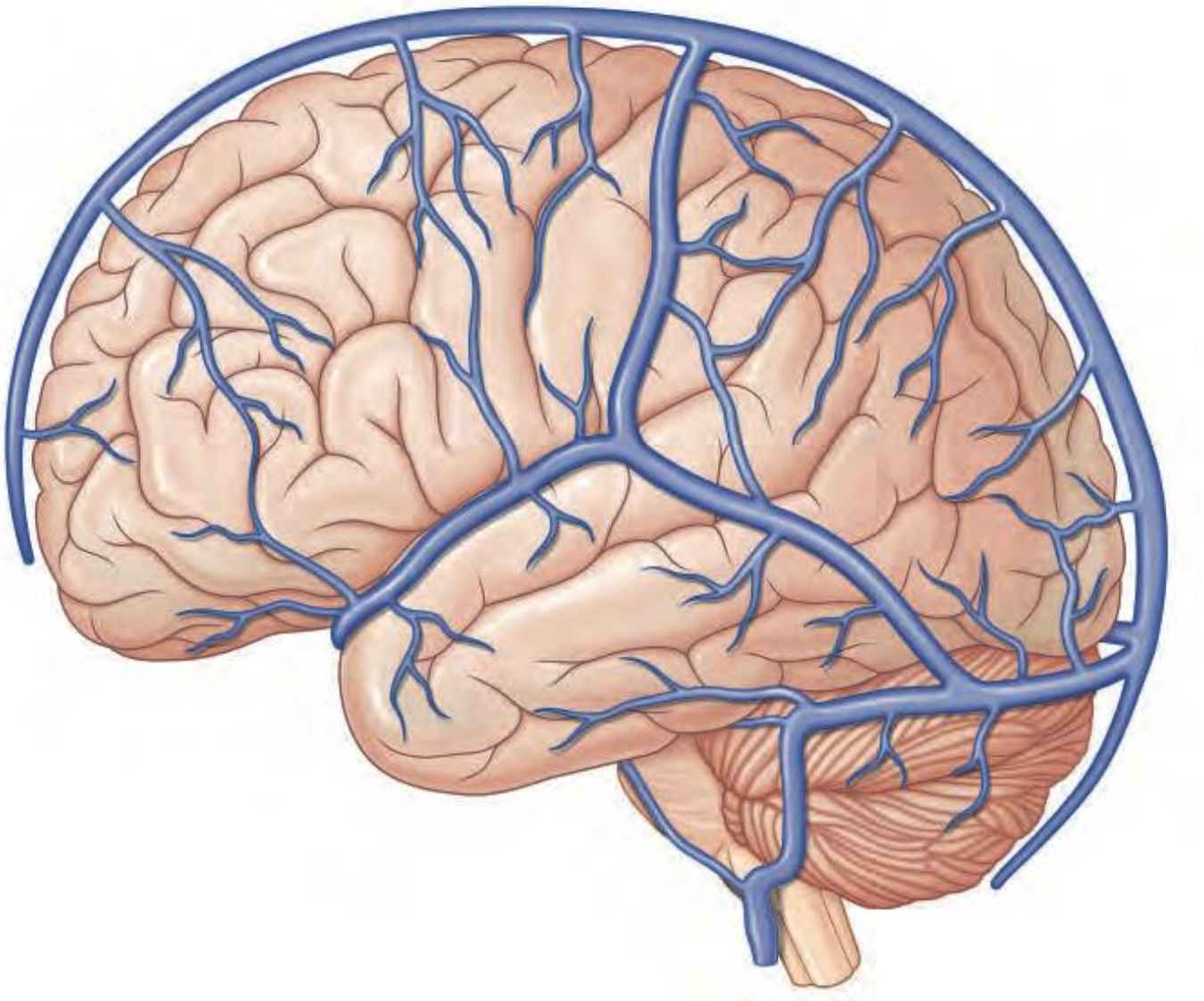
Deep cerebral veins



- **Vv. thalamostriatae**
- ***Vv. chorioideae***
- ***V. cerebri interna***
- ***V. cerebri media profunda***
- ***Vv. basales (Rosenthali)***
- ***Vv. cerebellares***
- ***V. magna cerebri (Galeni)***



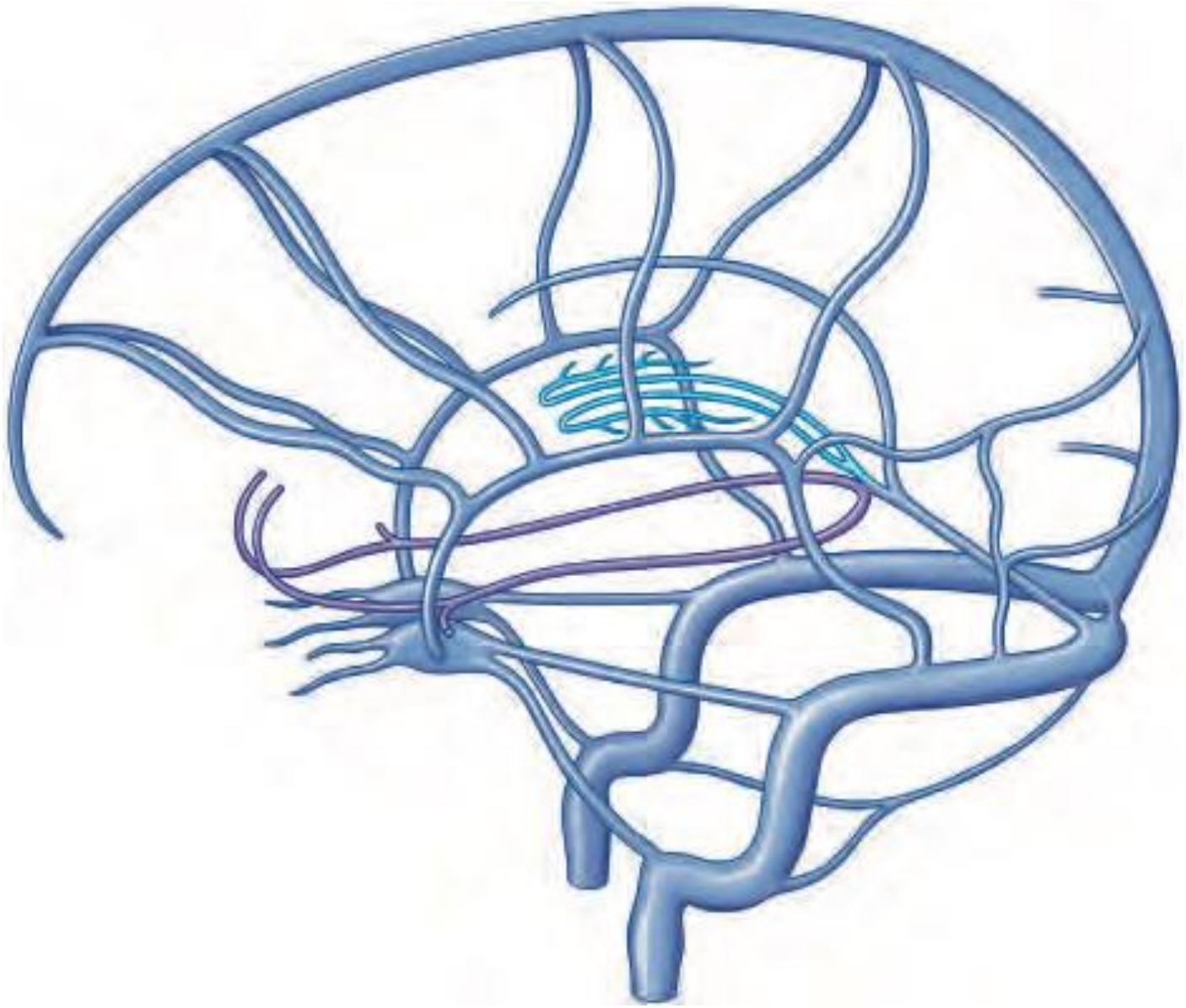
Superficial brain veins



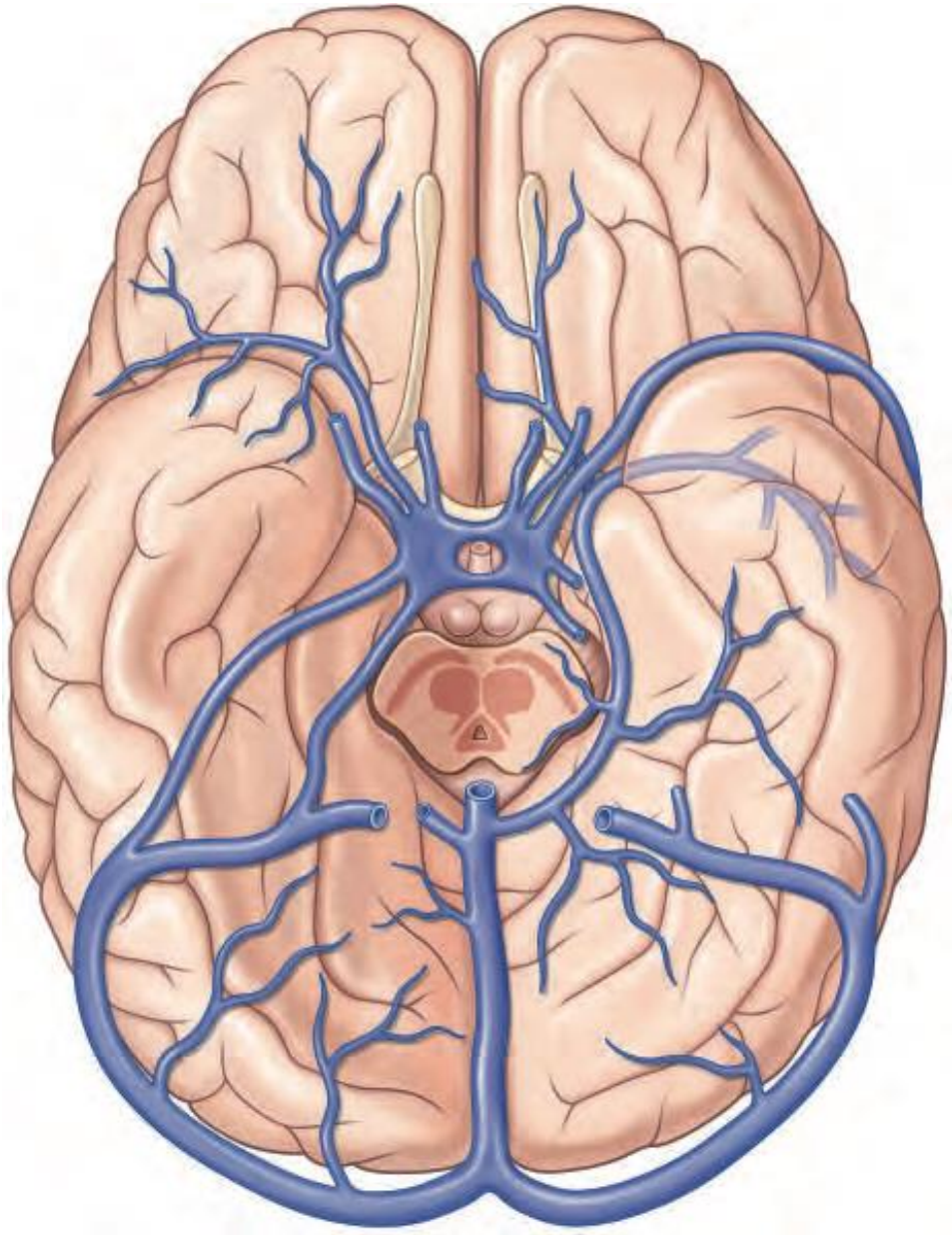
- Vv. cerebri superiores
- V. sulci centralis (Rolandi)
- Vv. cerebri inferiores
- Vv. temporales
- Vv. cerebellares
- *V. anastomotica superior (Trolardi)*
- *V. anastomotica inferior (Labbé)*
- *V. cerebri media superficialis*

- *Sinus sagittalis superior*
- *Sinus occipitalis*
- *Sinus transversus*
- *Sinus sigmoideus*

Dural sinuses



- ***Sinus sagittalis superior***
- ***Sinus sagittalis inferior***
- ***Sinus rectus***
- ***Confluens sinuum***
- ***Sinus transversus***
- ***Sinus sigmoideus***
- ***Sinus cavernosus***
- *Sinus petrosus superior*
- *Sinus petrosus inferior*
- *Sinus intercavernosus*
- *Sinus sphenoparietalis*



- V. cerebri media superificialis
- V. cerebri media profunda
- V. magna Galeni
- Sinus rectus
- Confluens sinuum
- Sinus transversus
- Sinus sigmoideus
- Sinus cavernosus
- Sinus petrosus superior
- Sinus petrosus inferior
- Sinus intercavernosus
- Sinus sphenoparietalis

Thrombosed sinuses