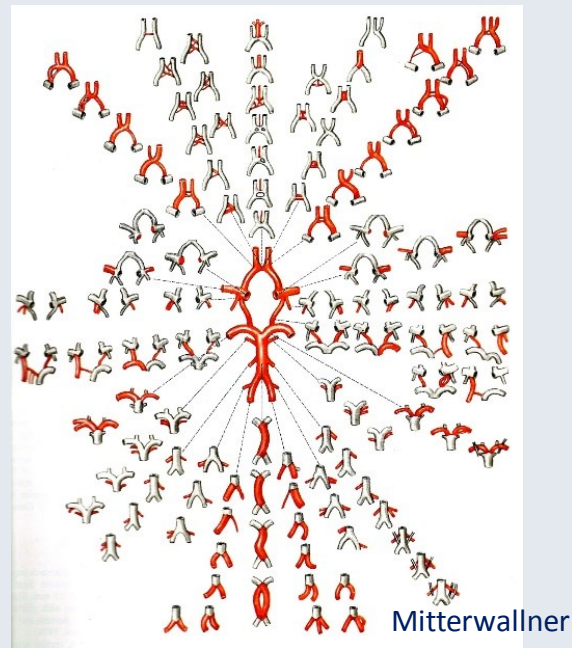


Blood supply to the brain. CSF circulation.



Dr. Emese Pálfi

Dr. Gábor Baksa / Dr. Tamás Ruttkay

Department of Anatomy, Histology and Embryology

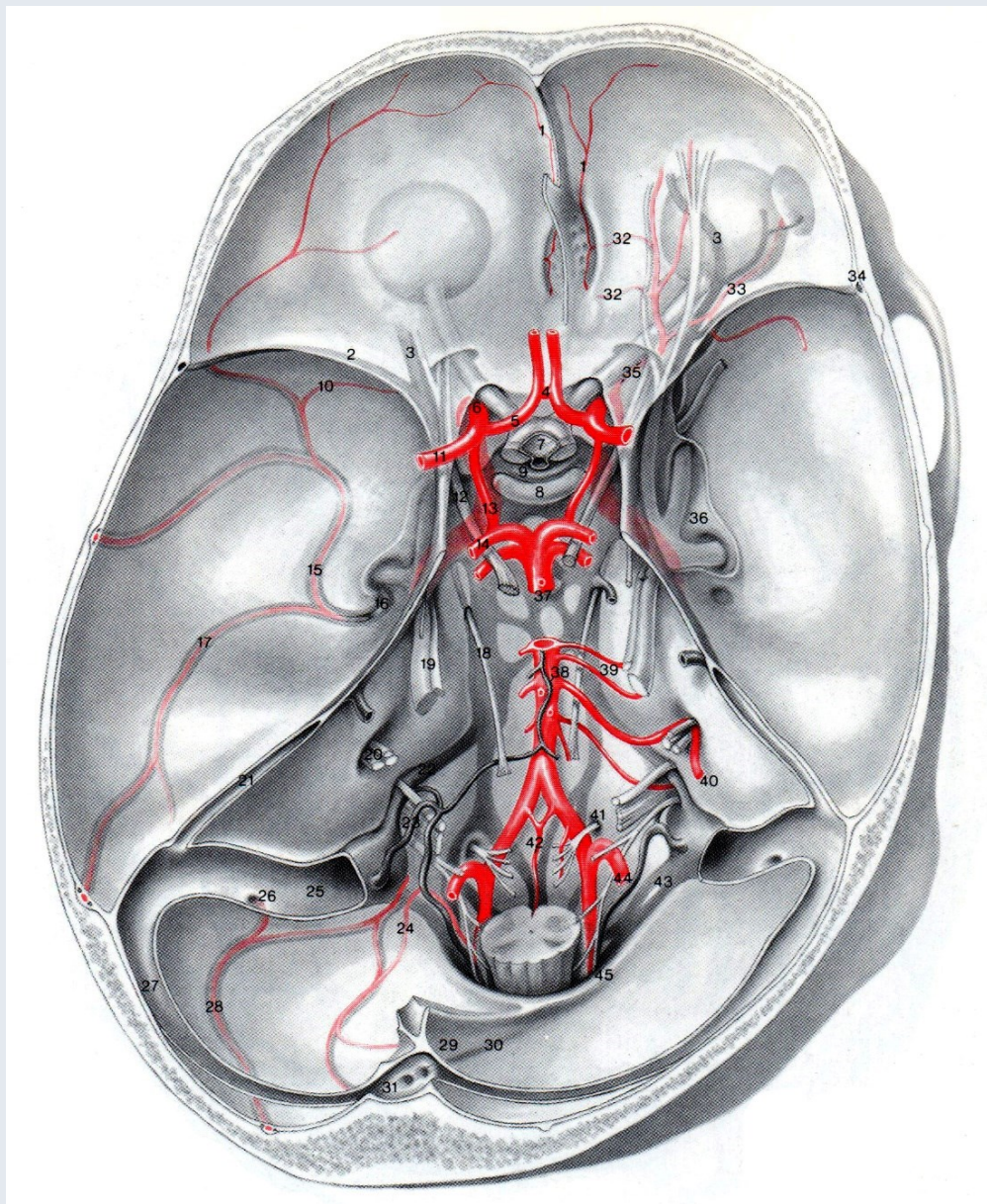
2019.

Special characteristics:

- Arteries and veins don't run parallel
- There is a connection between the extra- and intracranial system
- The veins drain into the venous sinuses of the dura mater
- The arteries are endarteries
- Histology of the vessels of the brain are different from the vessels on the periphery

Physiology:

- Despite anastomosis, the cerebral circulation is very vulnerable
- Satisfactory blood supply to 100 g of brain tissue is provided by approx. 40-50 ml of blood
- The brain needs 15% of the minute volume, respectively
 - 20% of oxygen
 - 25% of blood sugar
- Auto adjustment (normal) 70 – 160 Hgmm



Intracranial vessels:

- arteries
- veins (deep and superficial)
- sinuses of the dura mater (venous drainage)
- own vessels of the dura mater (meningeal)
- intracranial anastomoses
- anastomoses between the extra- and intracranium

Locations of the intracranial bleedings:

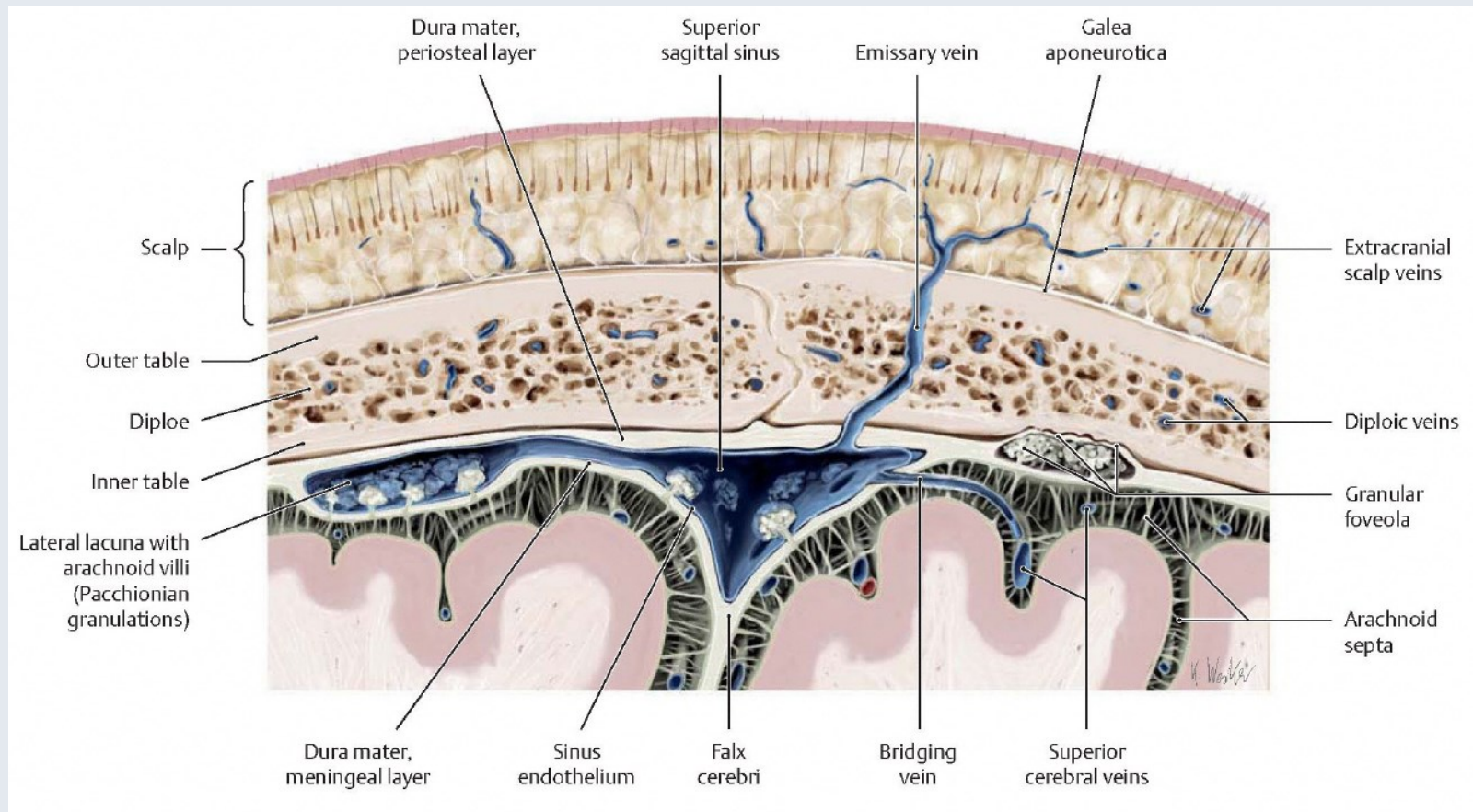
epidural – mostly from meningeal vessels or sinuses

subdural – mostly from cortical veins

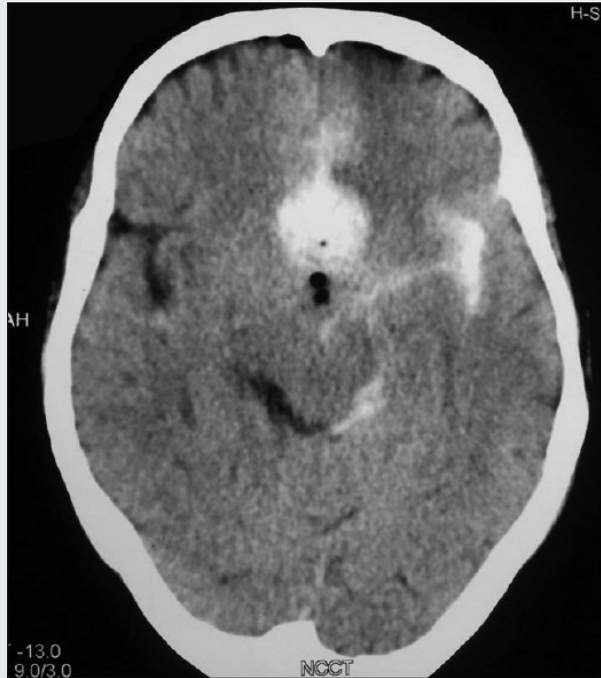
subarachnoidal – mostly from cortical and intracisternal vessels

subpial – mostly cortical vessels

intraparenchymal – mostly from cortical, deep and intracisternal vessels

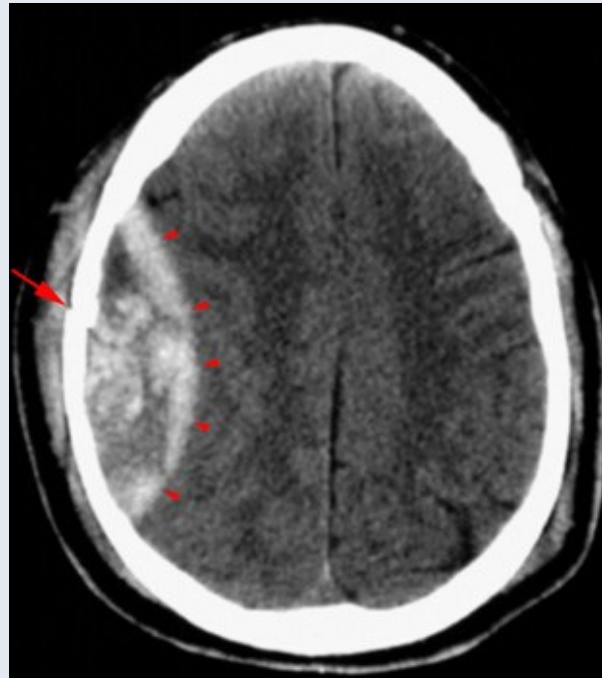


Examples for intracranial bleedings



www.neurologyindia.com

subarachnoidal



www.med-ed.virginia.edu

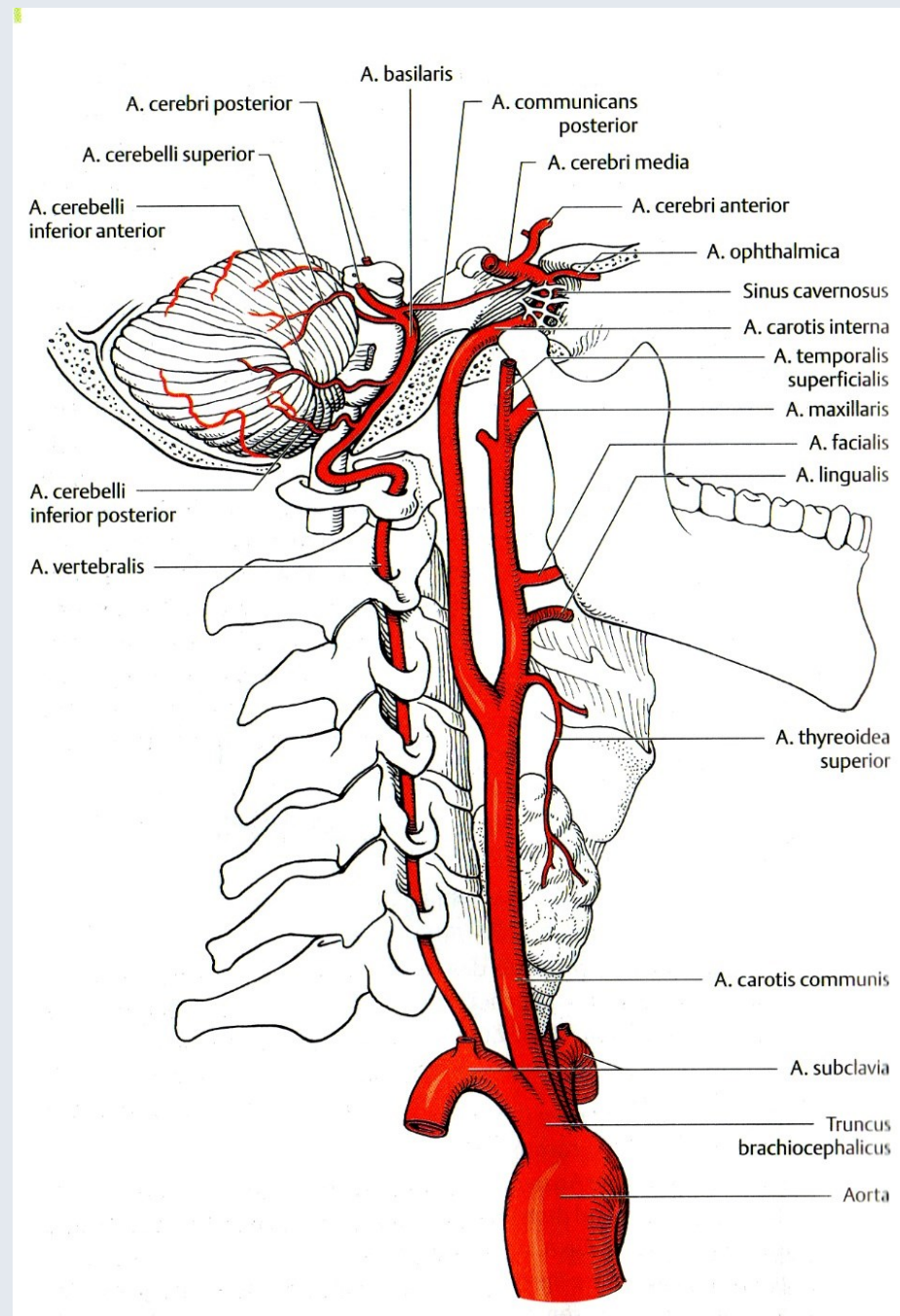
epidural



www.hindawi.com

subdural

Arteries of the brain



Arteries of the brain

Nieuwenhuys

Anterior paired trunks:

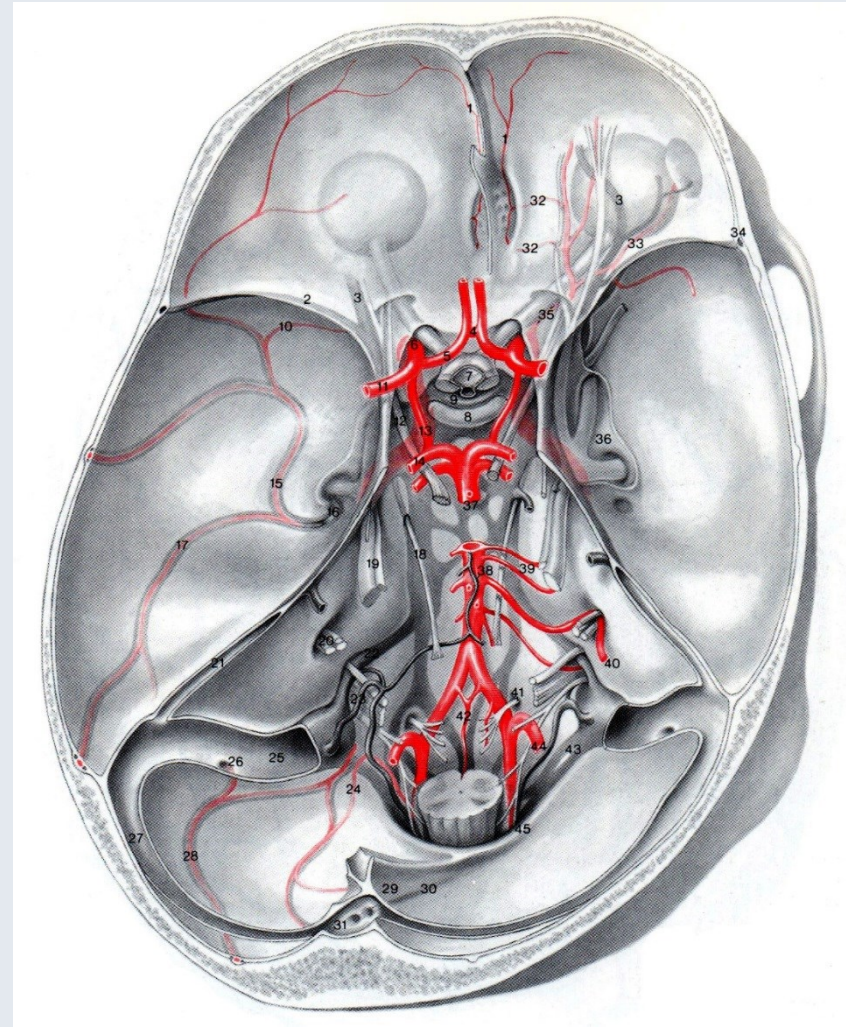
left and right internal carotid artery
(anterior circular system/carotis system)

Posterior paired trunks:

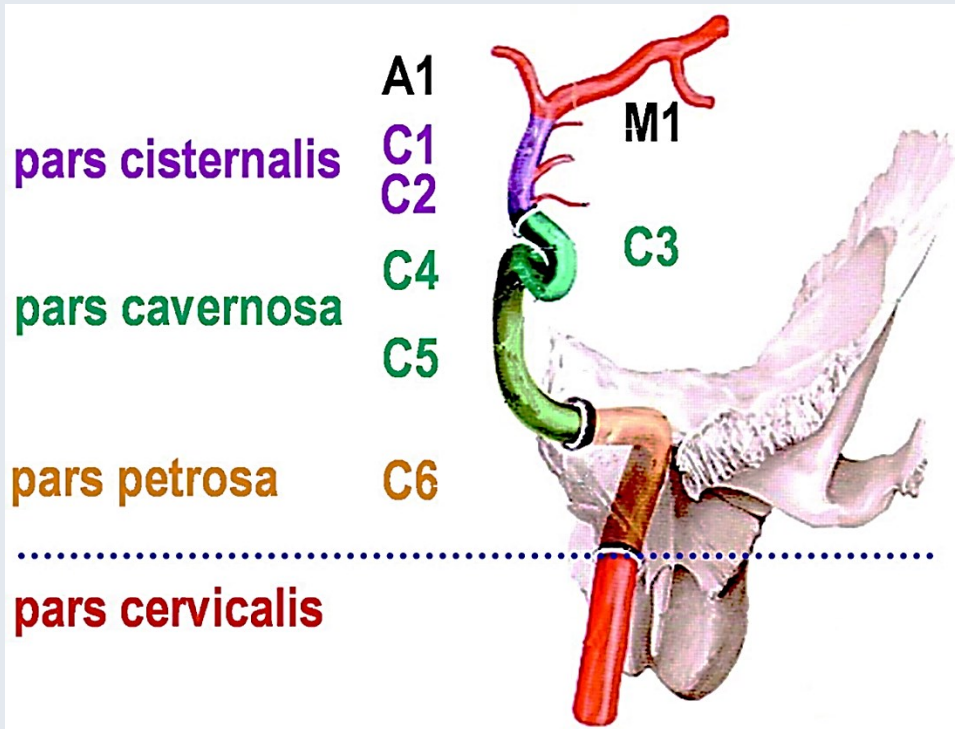
left and right vertebral artery
(posterior circular system/venterobasal system)

Often, asymmetry can be observed between the two sides

circulus arteriosus/circle of Willis



Vascular territory of the carotid



www.ajnr.org

Segments of the ICA:

cervical segment C7 segment
(without branches)

petrous/horizontal segment C6 segment
(branches to the tympanic cavity and sphenoidal sinus)

cavernous segment C3-5 segment
(*inferolateral and meningohypophyseal trunk, capsular arteries*)

cisternal segment C1-2 segment
(branches to the orbit and brain)

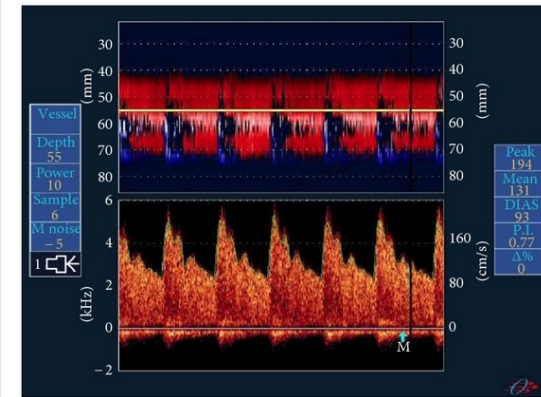
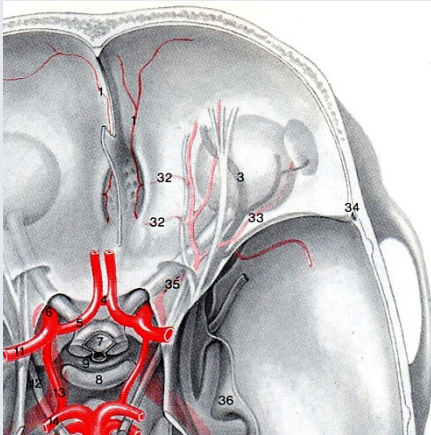
Branches of the cisternal segment:

(1) Medial to the ant. clinoid process: **ophthalmic artery (Ao)**

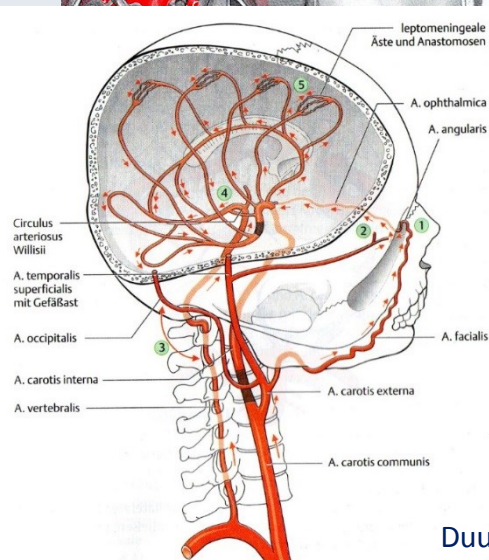
Vascular territory: orbit, sphenoidal sinus, ethmoidal sinus, and surrounding facial areas

→ Anastomosis with the facial artery is important

(blood supply problems; US window for the intracranial arteries)



www.hindawi.com

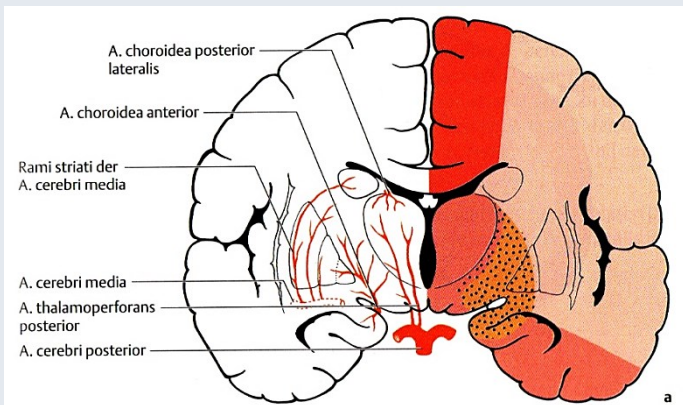


Duus

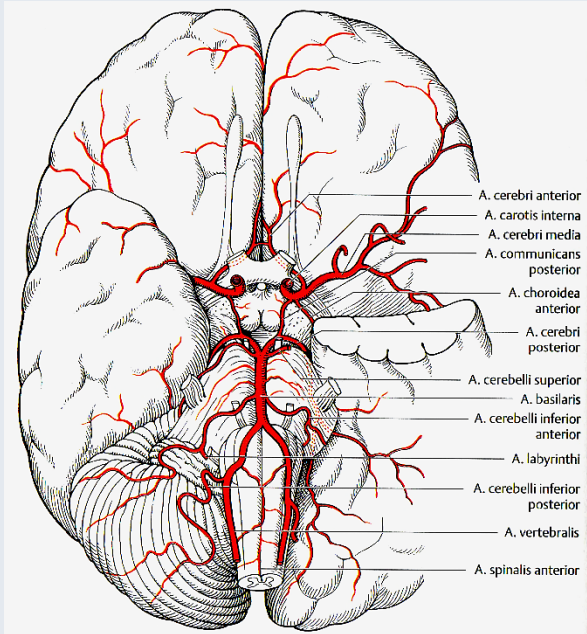
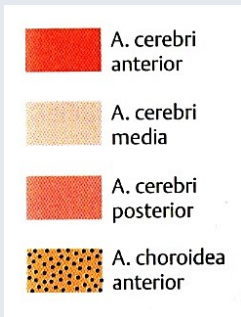
www.augen.uniklinikum-dresden.de

(2) Posterior communicating artery (PCOM): connection with the posterior cerebral arteries
 Vascular territory: optic chiasm, optic tract, hypothalamus, mamillary bodies, part of the thalamus

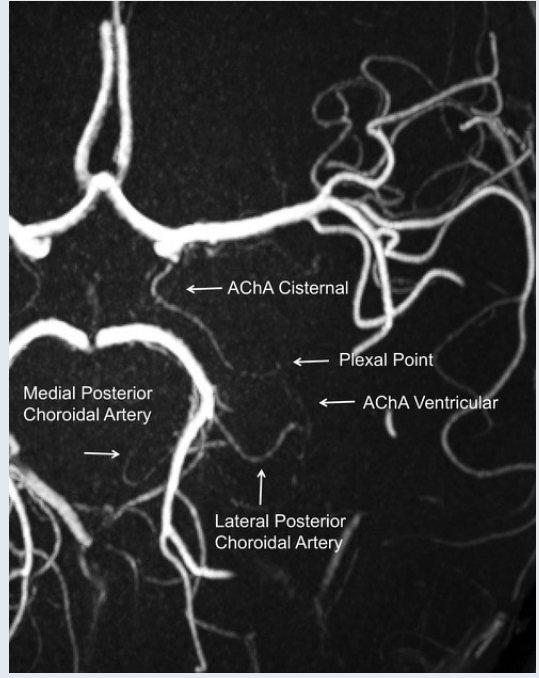
(3) Anterior choroidal artery (AChA): Cisternal segment (choroid fissure) and intraventricular segment
 Vascular territory: choroid plexus in the inferior horn of the lateral ventricle, basal ganglia, internal capsule, thalamus, olfactory cortex



Duus



Duus





Kurucz & Baksa

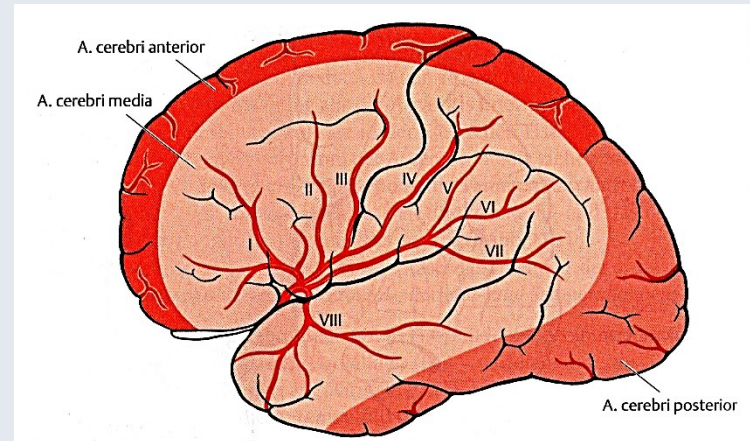
(4) Anterior cerebral artery (ACA):

precommunicating and postcommunicating segment

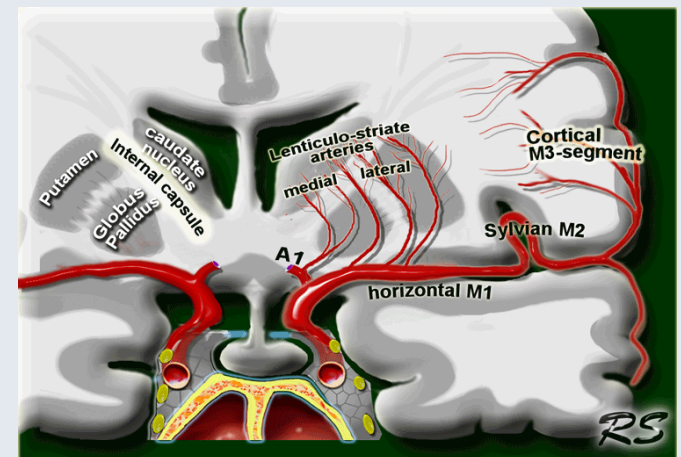
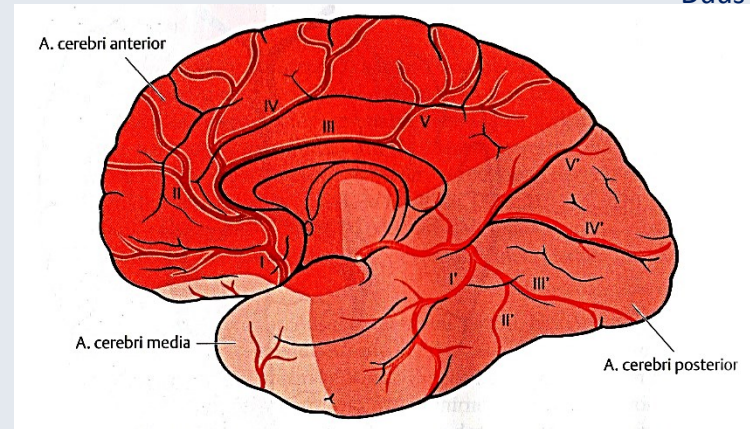
Vascular territory: basal part of the frontal lobe, medial side of the cerebrum until the parietooccipital sulcus, corpus callosum, optic chiasm, lamina terminalis, medial lenticulostriate branches

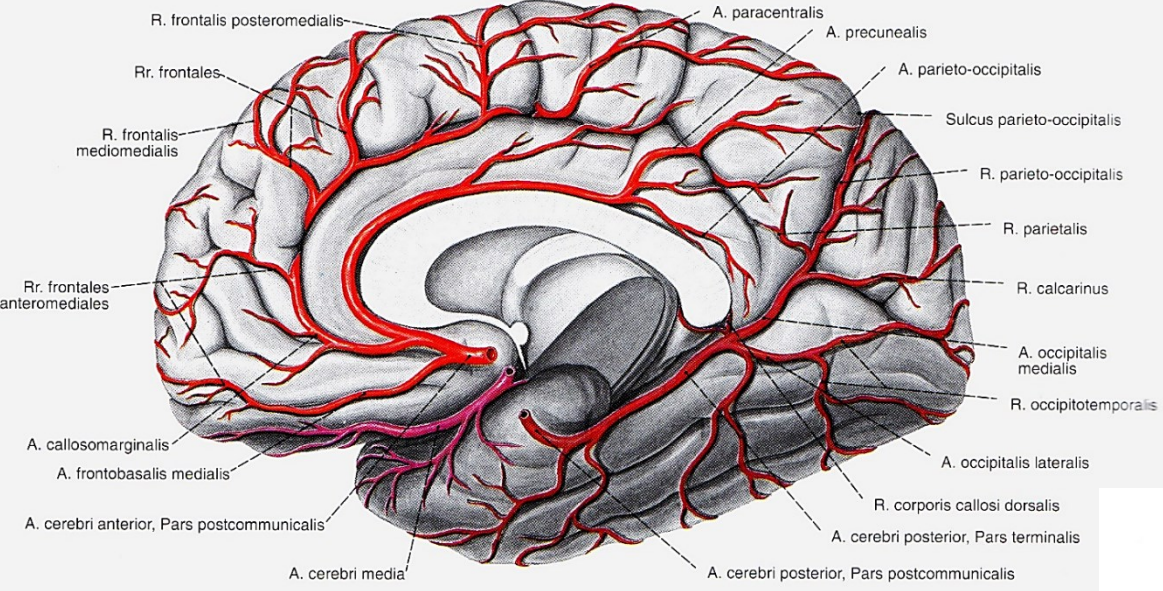
(5) Middle cerebral artery (MCA): sphenoidal, insular, opercular, cortical segments

Vascular territory: convex surface until the occipital lobe, deep white matter of the frontal, parietal, temporal and occipital lobes, lateral lenticulostriate branches

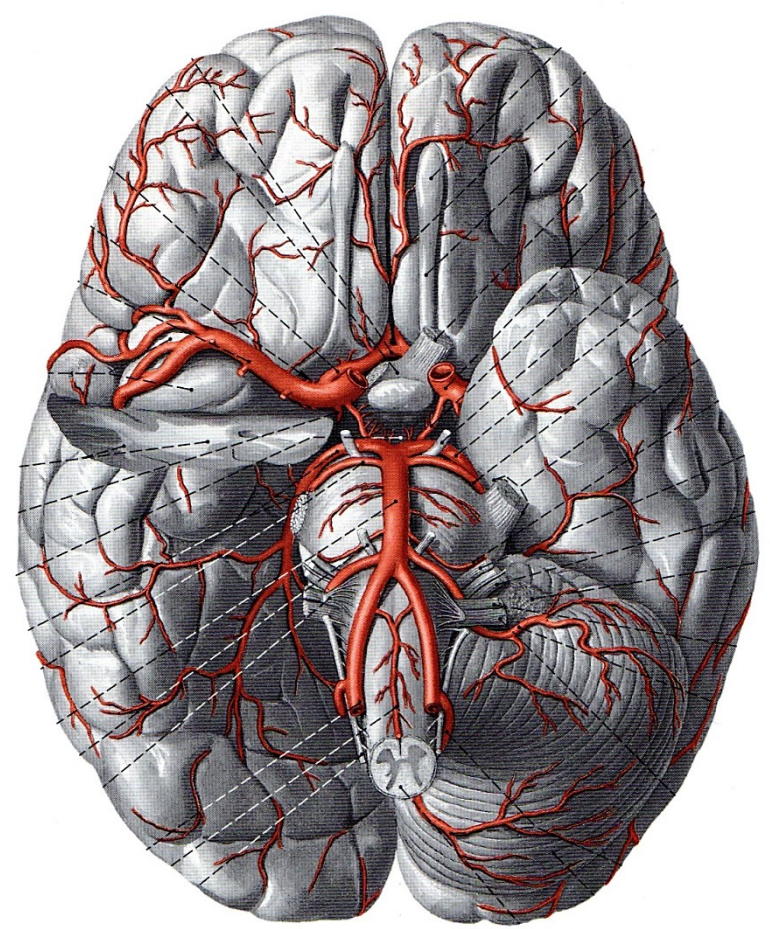


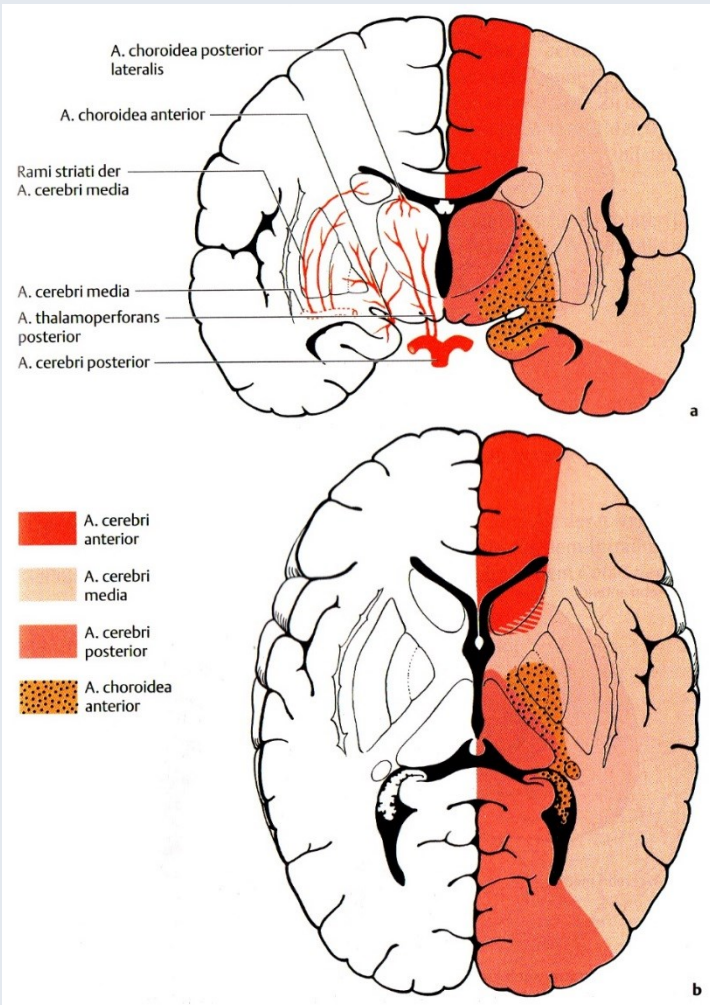
Duus





Sobotta

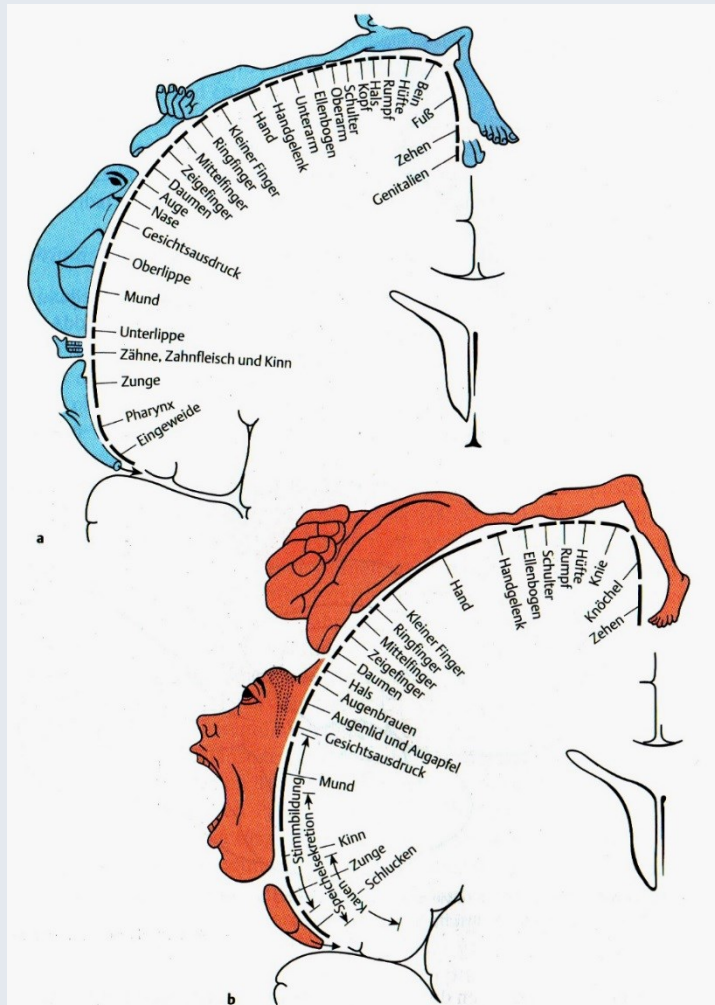




Duus

ACA vascular territory:

contralateral hemiparesis in the lower extremity



Duus

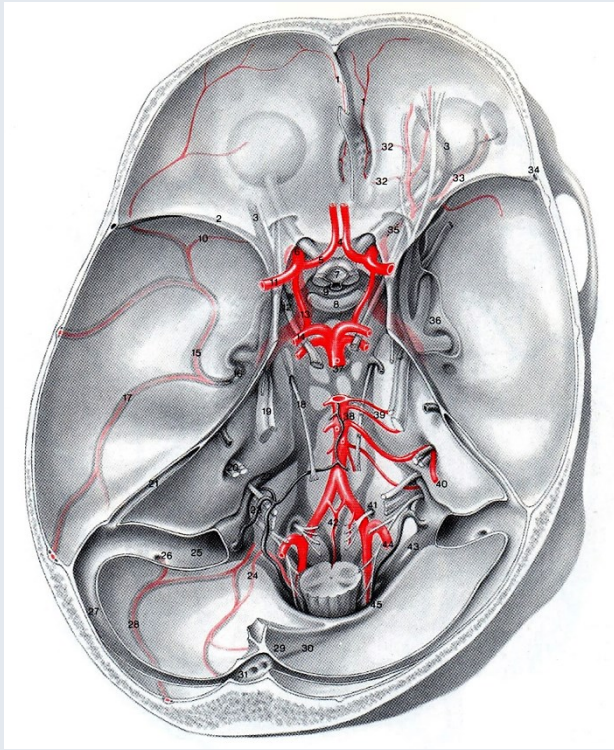
MCA vascular territory:

contralateral hemiparesis brachiofacial / upper limb possibly speech disorder, visual field loss

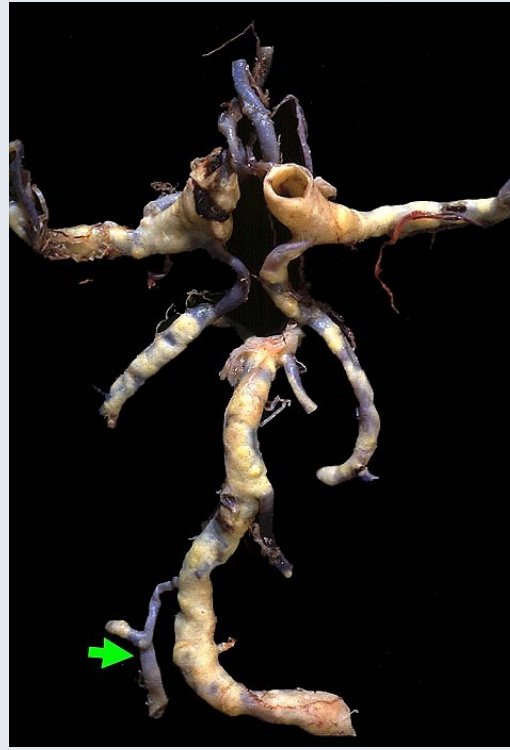
Disturbance of the blood supply of the ACA and MCA causes neurological symptoms:

dominant site: sensory (Wernicke-) or motorized (Brocka-) aphasia - speech disorder

Vascular territory of the vertebrobasilar system



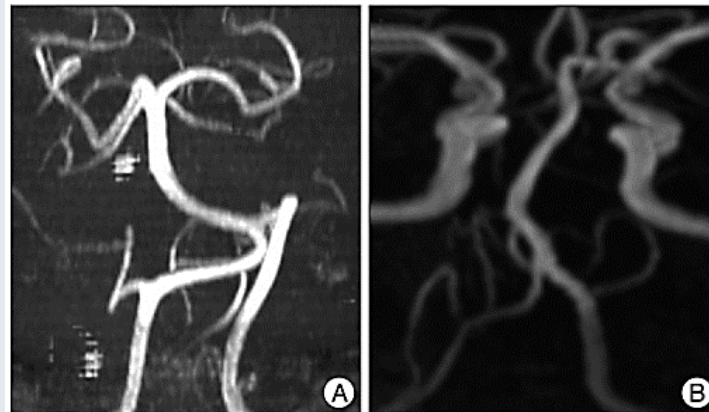
Nieuwenhuys



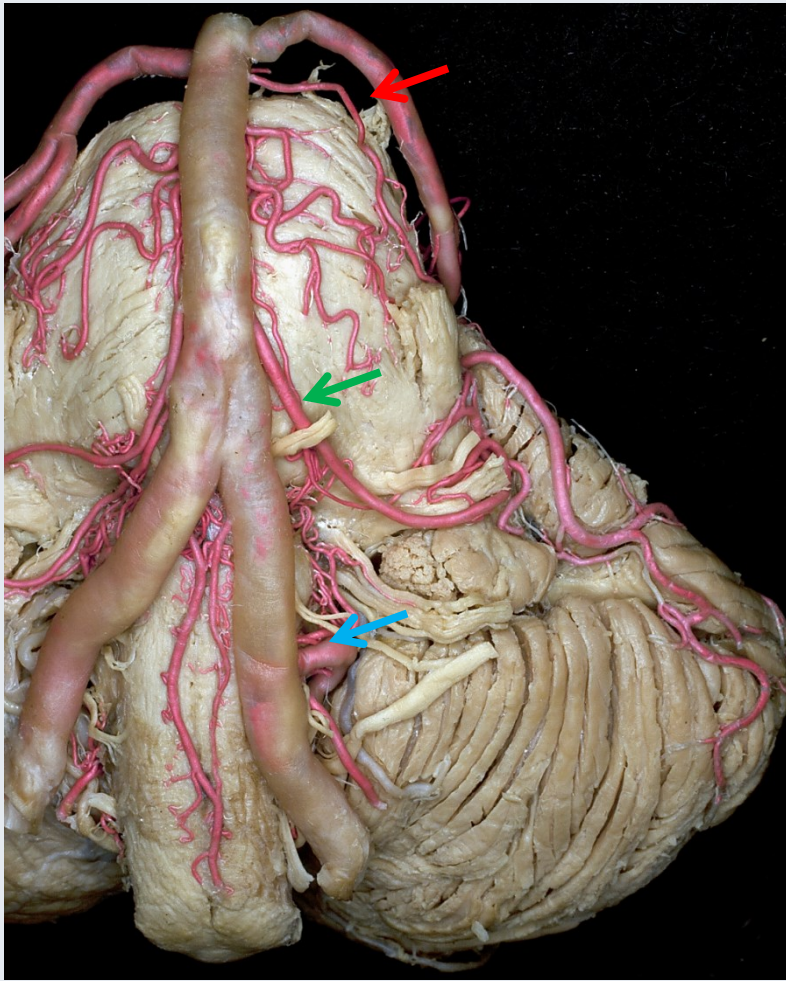
www.alf3.urz.unibas.ch

Supplies:

- brain stem
- cerebellum
- spinal cord
- cerebrum
- some areas of the diencephalon



Park JH J Korean Neurosurg Soc 2013



Eördögh

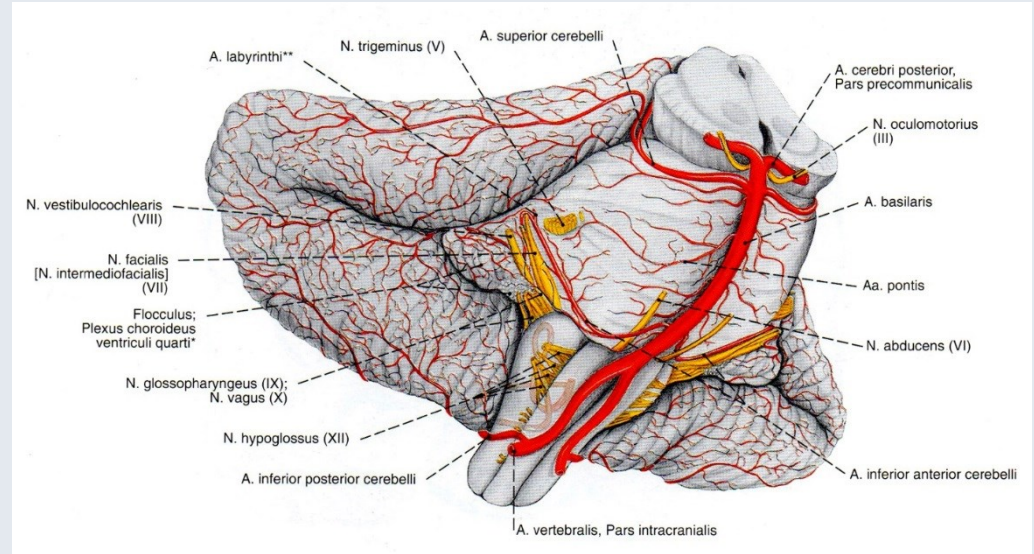
3 pairs of cerebellar arteries:

Superior cerebellar artery (SCA)

Anterior inferior cerebellar artery (AICA)

Posterior inferior cerebellar artery (PICA)

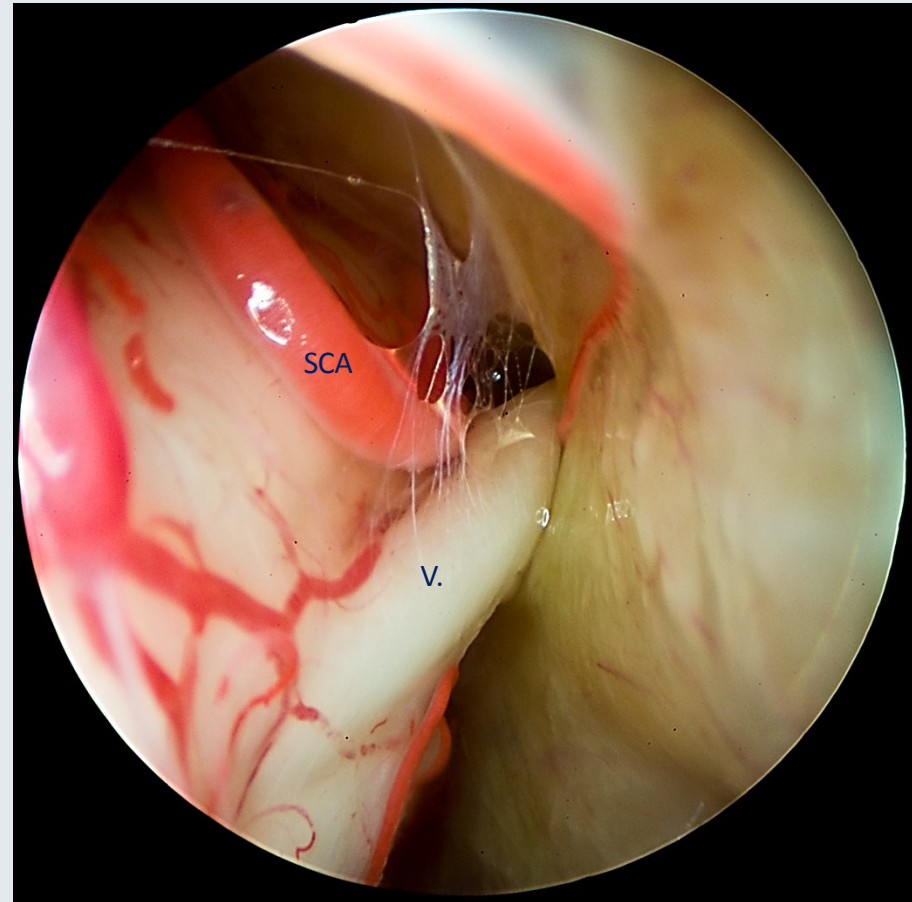
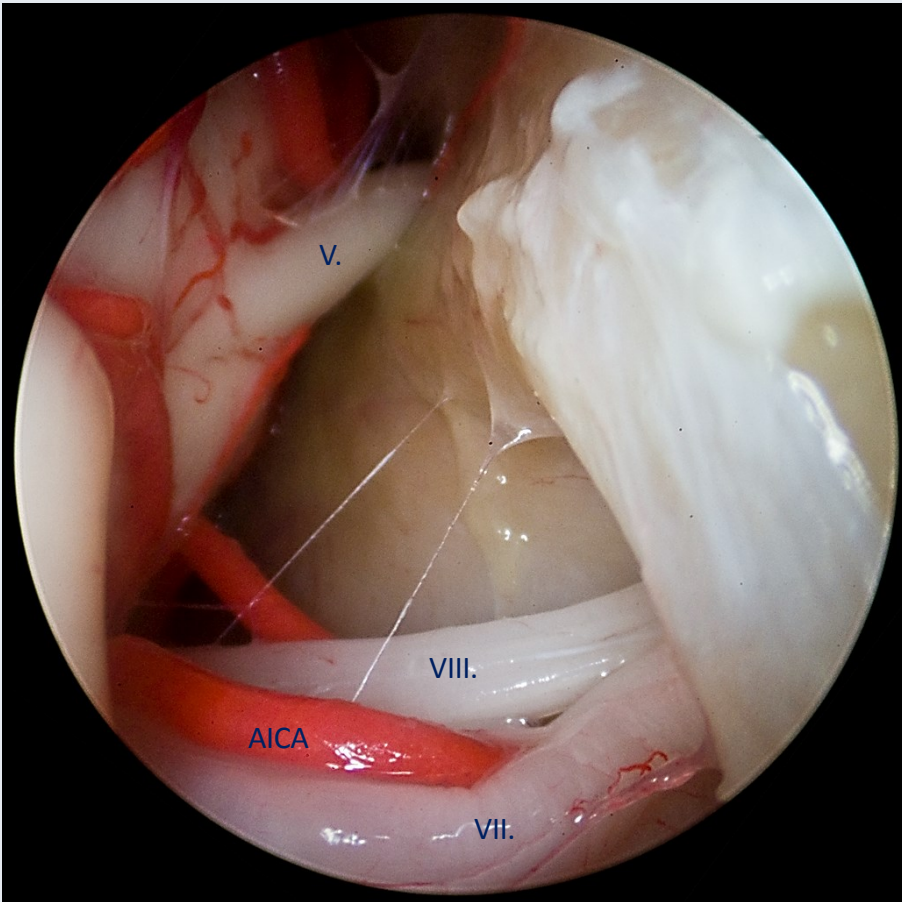
→ choroid plexus of the 4. ventricle



Sobotta

branches of the basilar artery
branch of the vertebral artery

„Neurovascular compression syndrome“



Kurucz, Eördögh, Baksa, Reisch

Trigeminal neuralgia – attacks of facial pain

Hemifacial spasm - irregular, involuntary muscle contractions (spasms) on one side (hemi-) of the face

Different vessels provide the blood supply to different levels of the brainstem and to certain areas of the cerebellum

→ in case of blood supply disorder brainstem and cerebellar syndromes

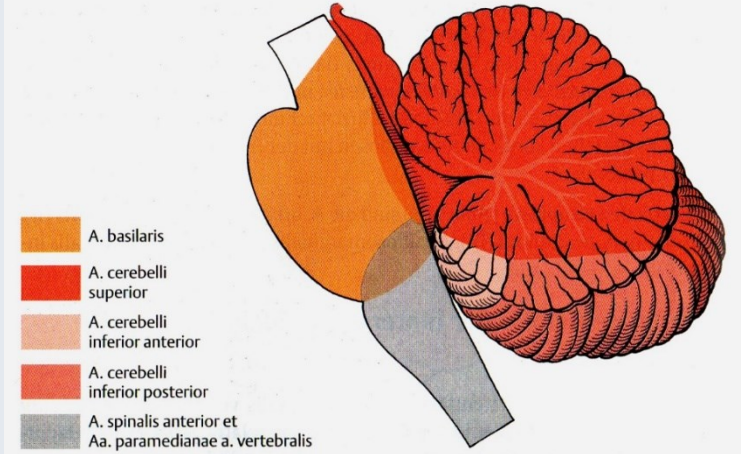
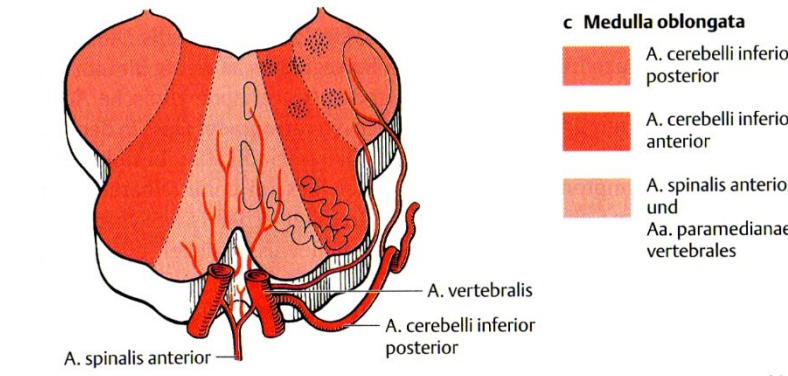
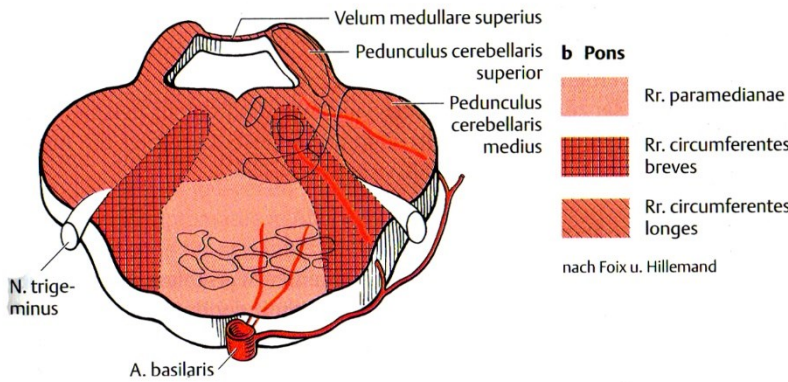
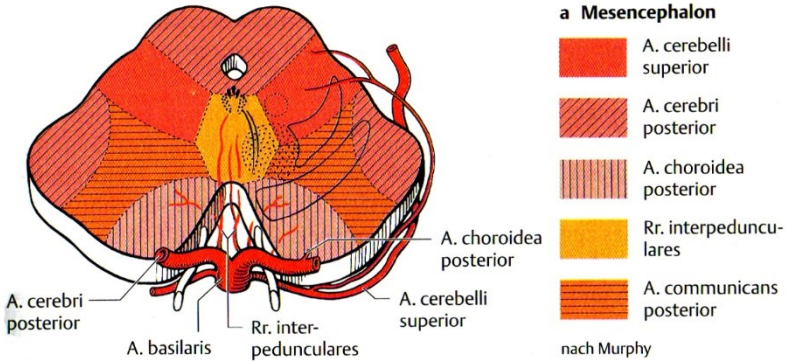


Abb. 11.7 Versorgungsgebiete der Kleinhirn- und Hirnstammarterien im Längsschnitt

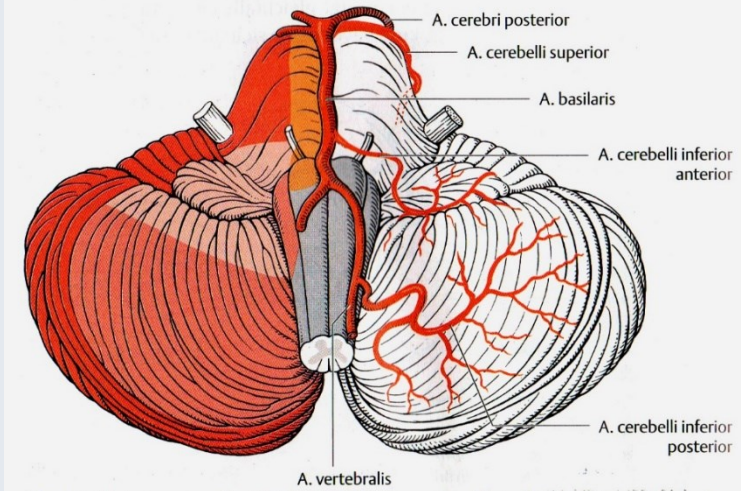
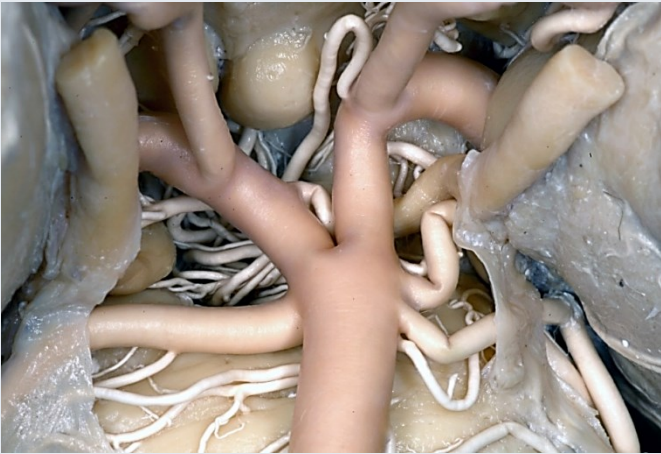


Abb. 11.8 Blutversorgung des Kleinhirns und Versorgungsgebiete der Kleinhirnarterien in der Ansicht von unten



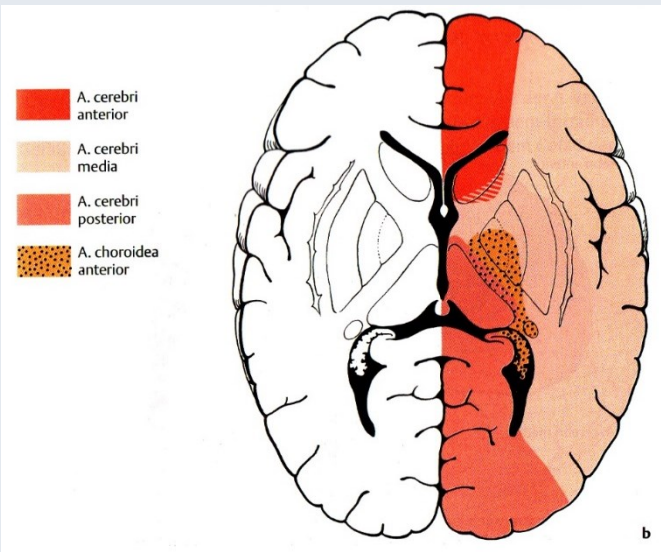
Kurucz & Baksa

Posterior cerebral artery (PCA):

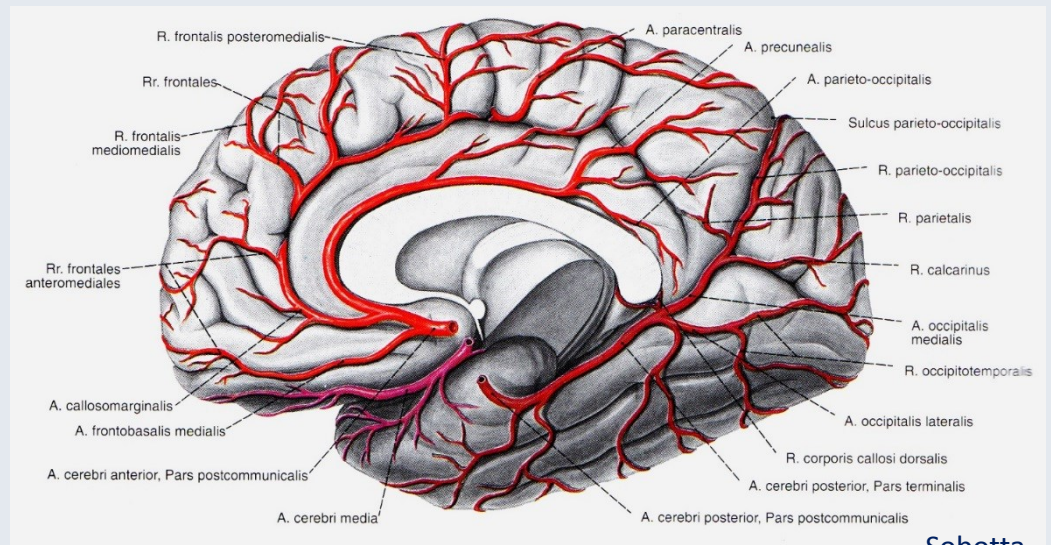
vascular territory: significant part of the occipital lobe - visual cortex, temporal lobe, corpus callosum, midbrain, thalamus

→ posterior choroid artery

(III. ventricle, choroid plexus of the lateral ventricle)



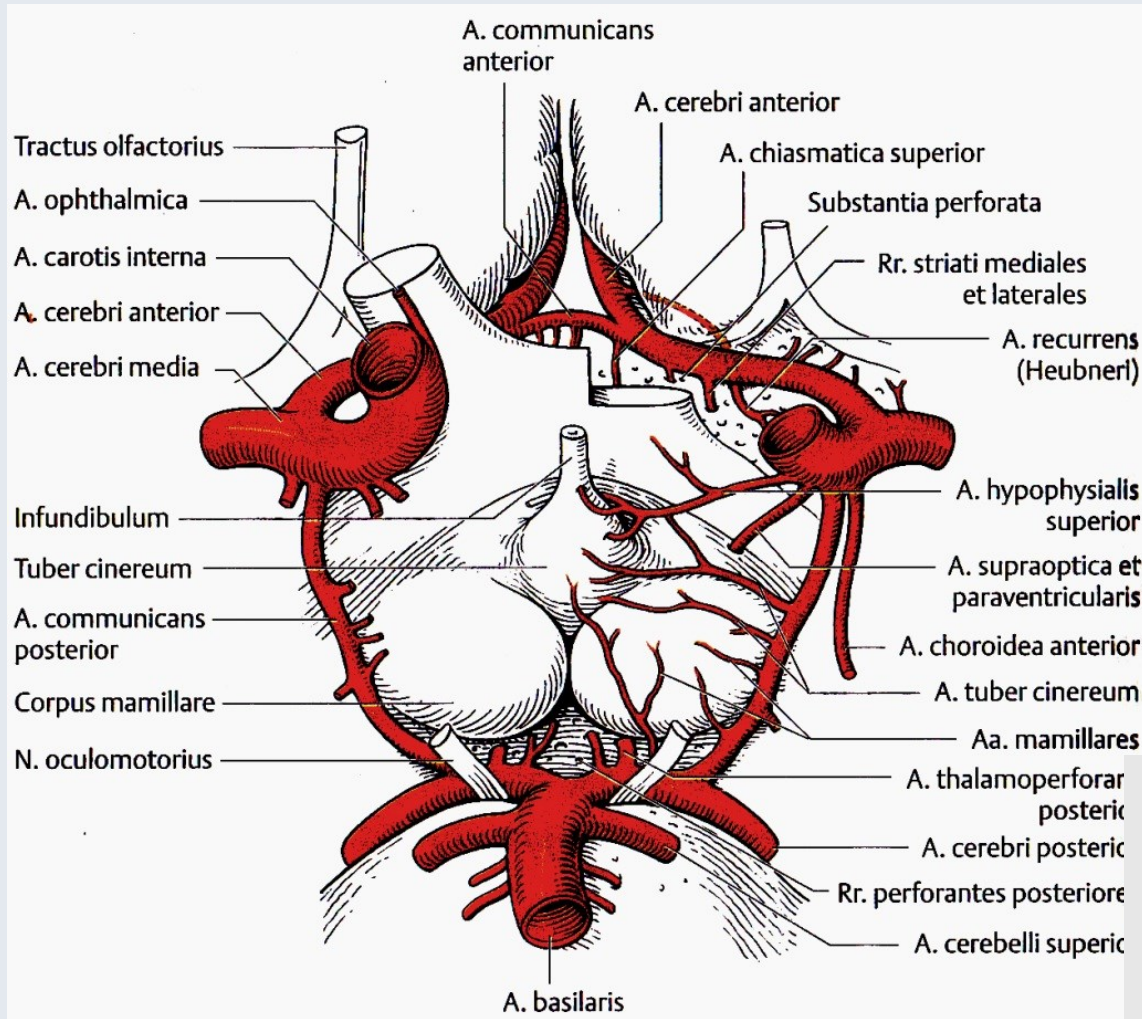
Duus



Sobotta

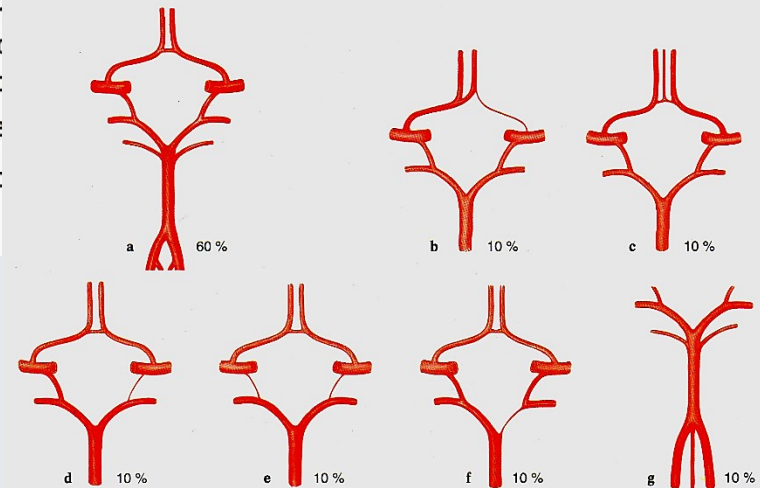
Leading symptoms of blood supply disorder in the vertebrobasilar supply zone: disturbance in walking, vertigo, unconsciousness, visual disturbance

Circulus arteriosus / circle of Willis

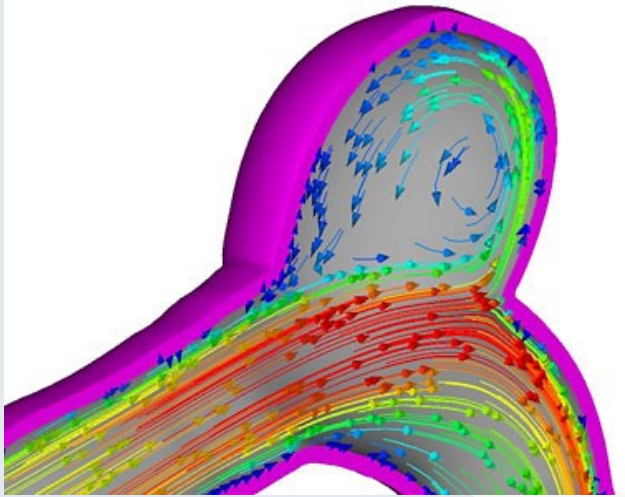
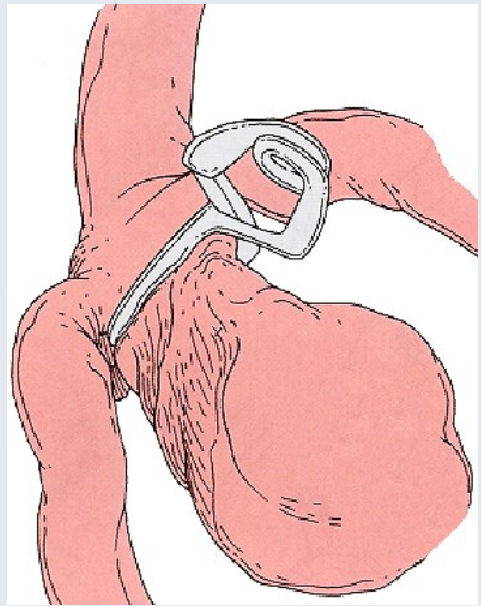
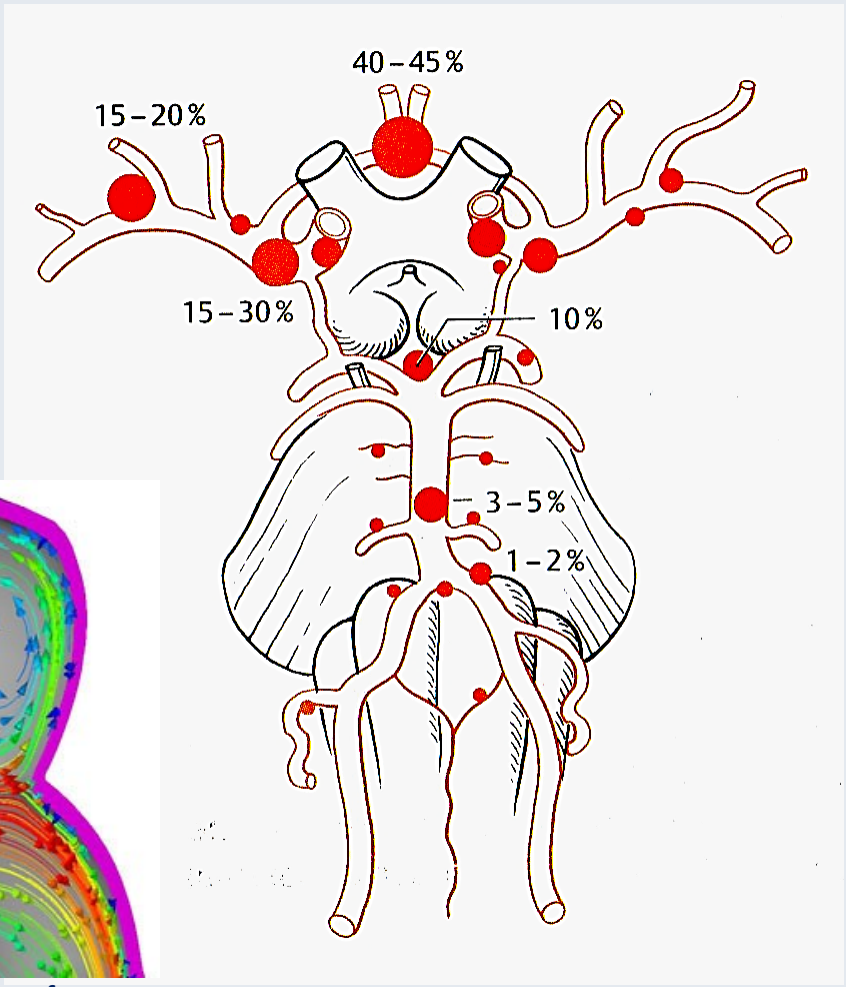
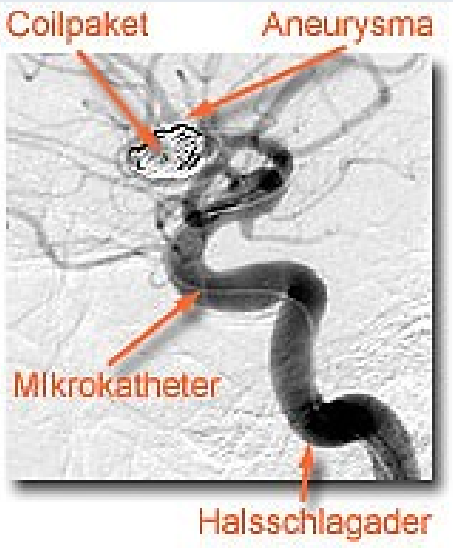


internal carotid artery
 anterior cerebral artery
 anterior communicating artery
 posterior communicating artery
 posterior cerebral artery
 basilar artery

Duus



Aneurysms



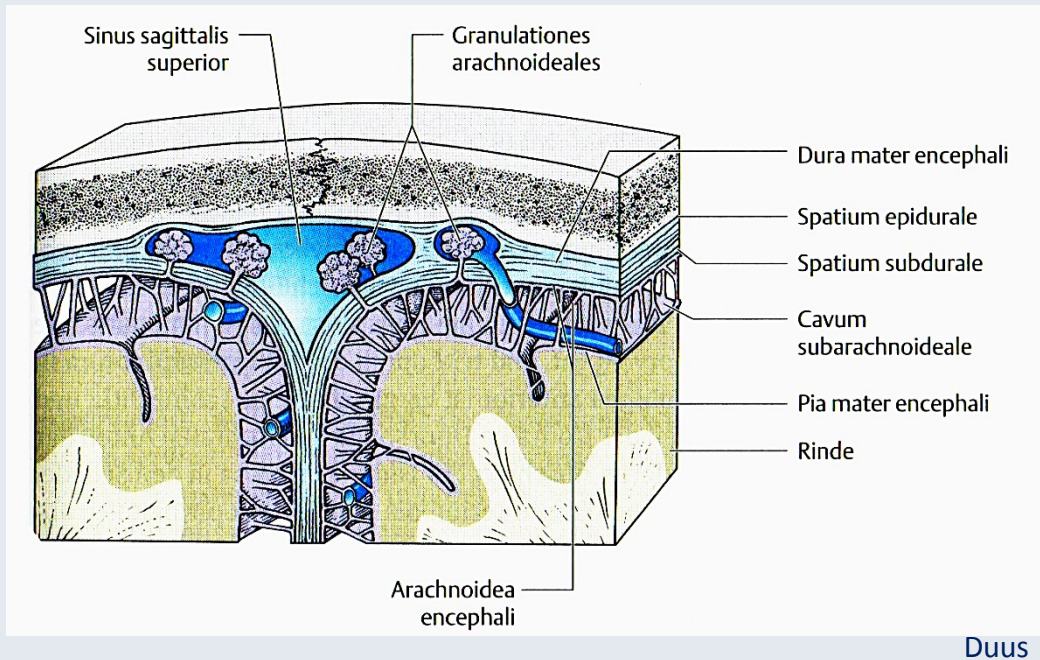
www.tafsm.org

Duus



www.uniklinikum-dresden.de

Cortical veins and dural venous sinuses

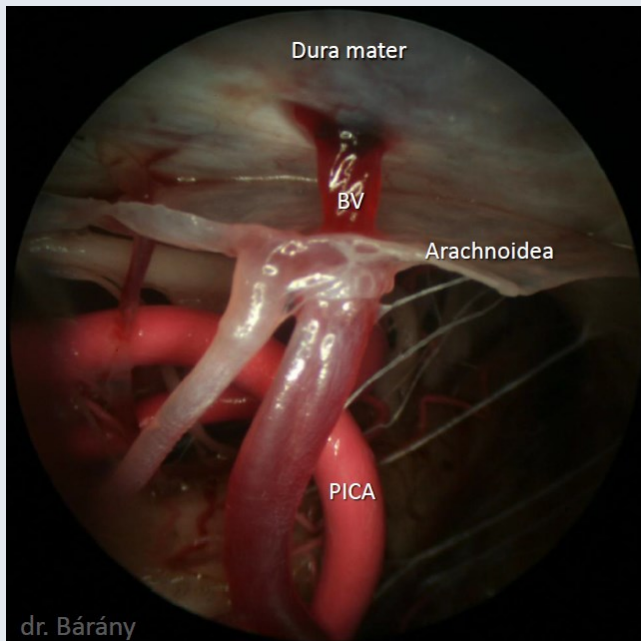


Venous sinuses → between the two layers of the dura

Functionally they belong to the veins but the wall structure is different: the dura mater is lined by endothelium.

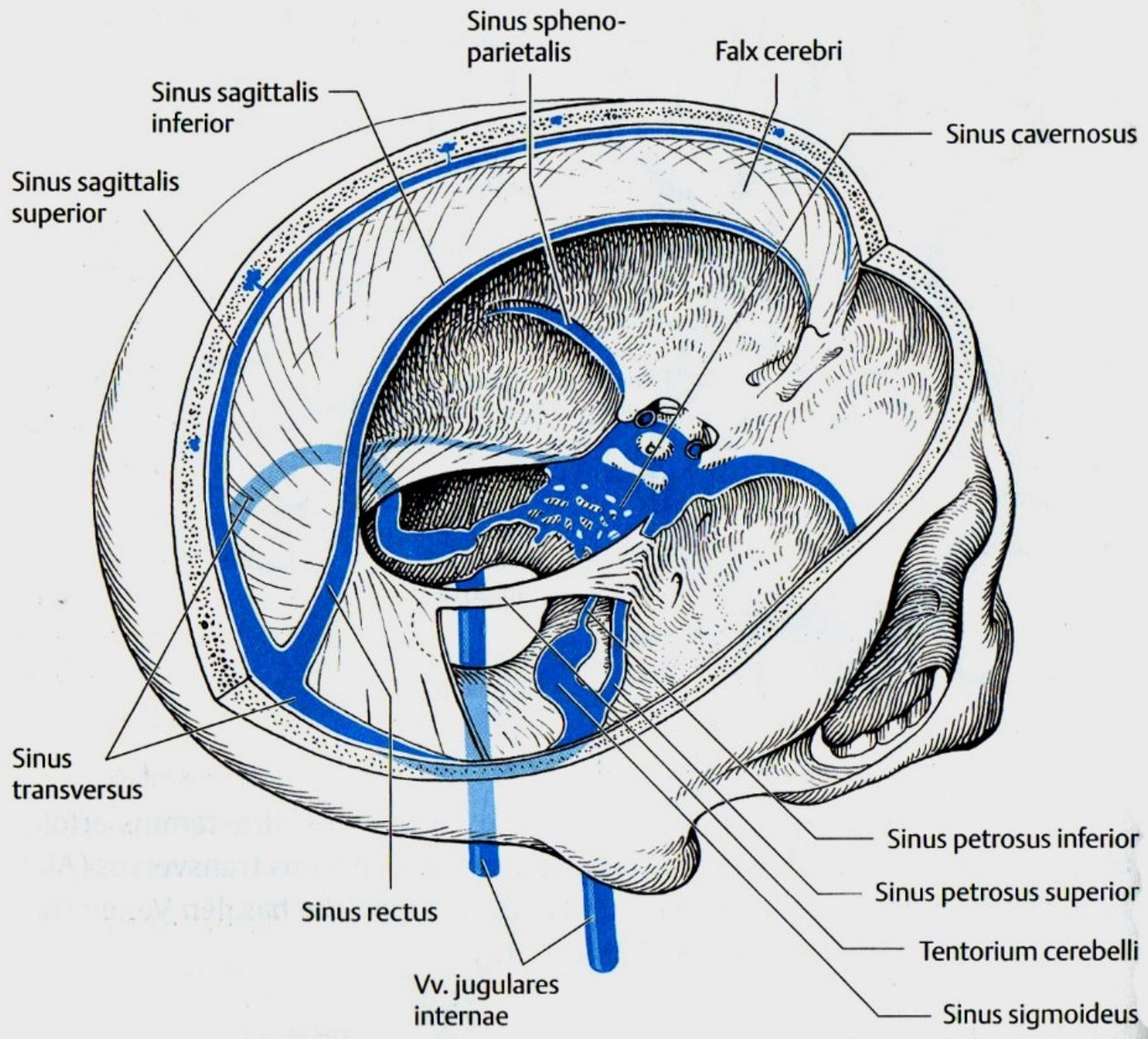
The blood enters them via the veins of the pons, which are running through both the subdural and subarachnoidal space.

In case of brain atrophy these veins can cause subdural bleeding.



The blood from the sinuses is drained into the internal jugular vein.

There is a connection between the internal and external venous system (compensation for venous occlusion, but infections can also spread inside from outside).



Important cortical veins:

superior anastomotic vein (Trollard)
 inferior anastomotic vein (Labbe)
 superior petrosal vein (Dandy)
 superior posterior cerebral vein
 superficial middle cerebral vein (Sylvian)

The cortical veins mostly drain into the cavernous and sphenoparietal sinus.

Deep veins:

basal vein (Rosenthal)
 internal cerebral vein (vein of septum pellucidum, thalamostriate vein, posterior choroid vein)

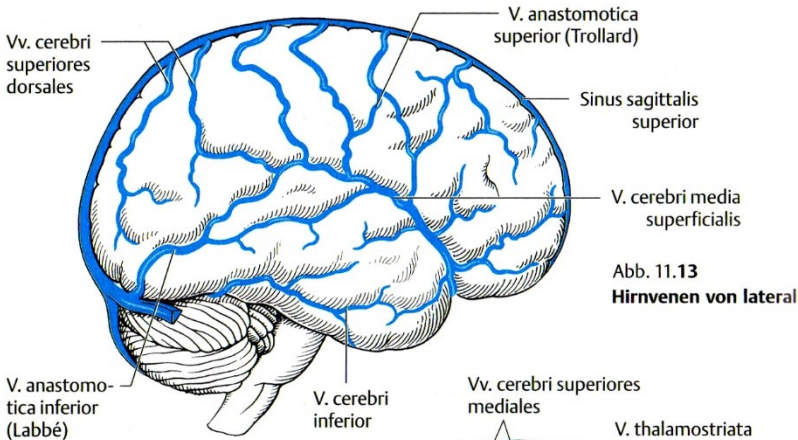
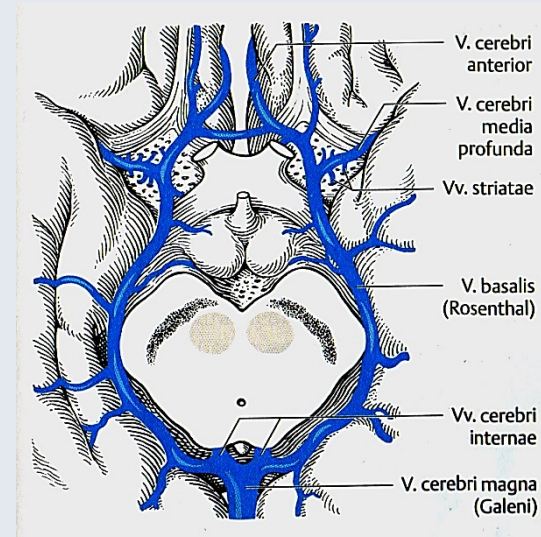


Abb. 11.13
Hirnvenen von lateral

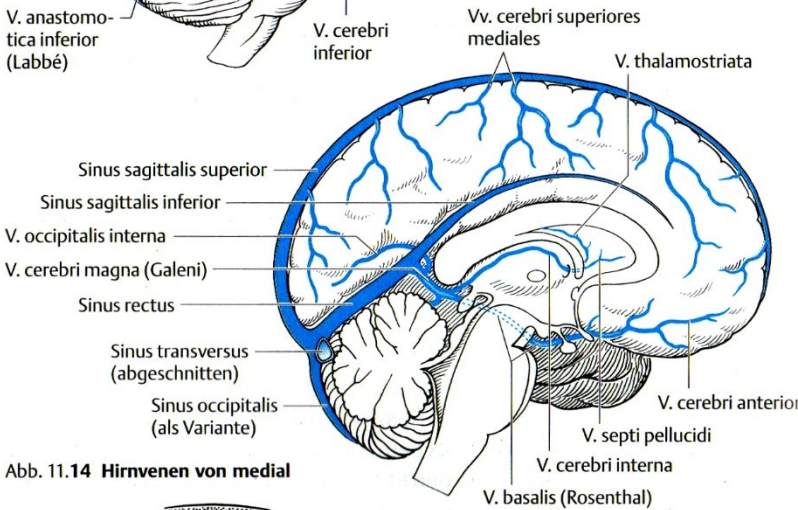


Abb. 11.14 Hirnvenen von medial

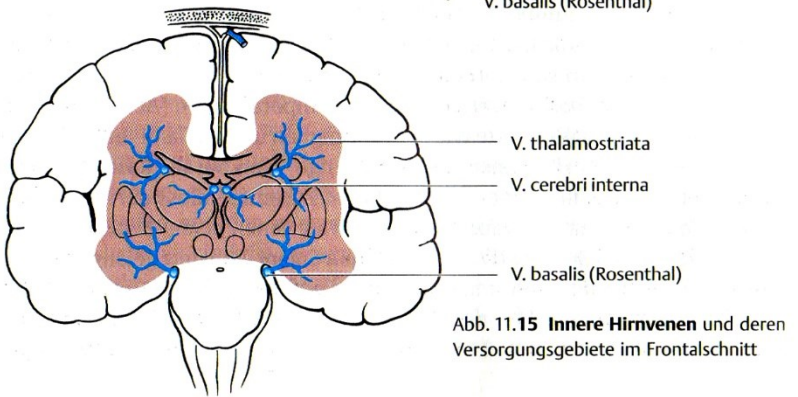


Abb. 11.15 Innere Hirnvenen und deren Versorgungsgebiete im Frontalschnitt

Other options for venous blood flow

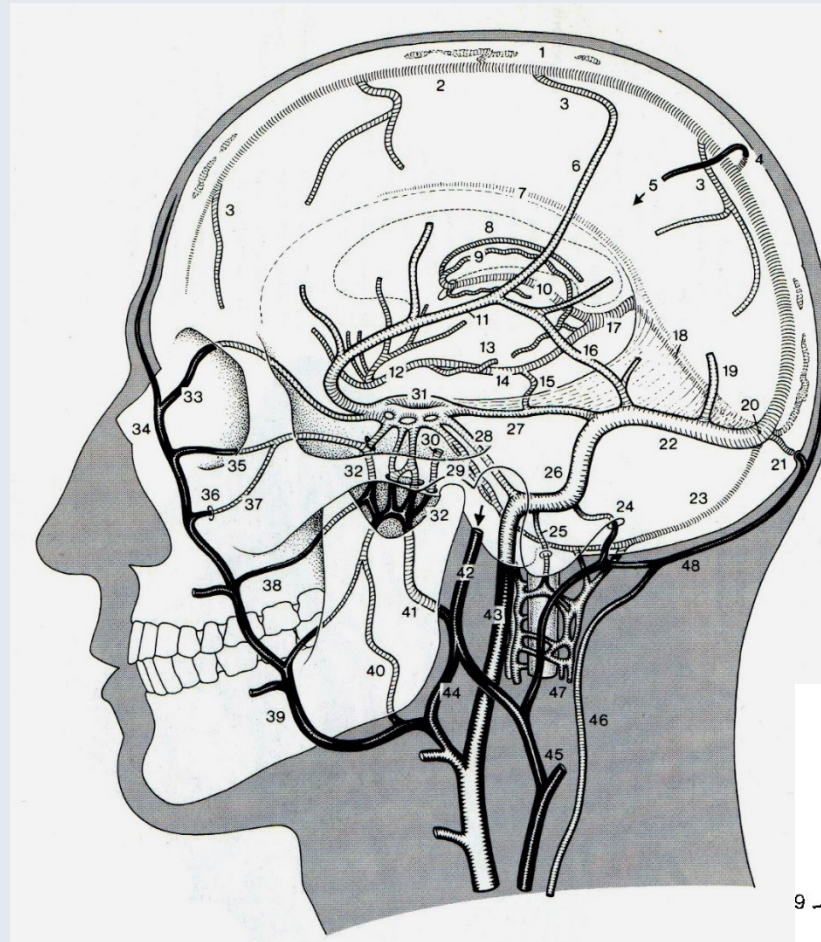
www.salerno.uni-muenster.de

Diploic veins:

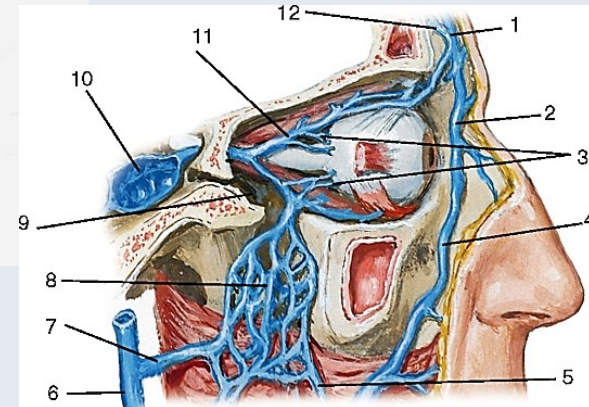
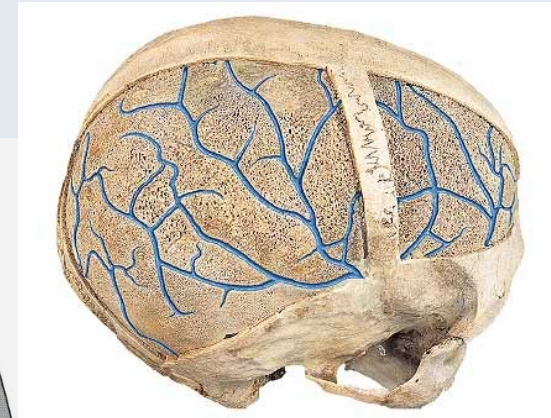
channel in the diploe between the inner and outer layers of the cortical bone

Emissary veins:

connect the extracranial venous system with the intracranial venous sinuses (parietal, occipital, mastoid, chondylar)



Nieuwenhuys

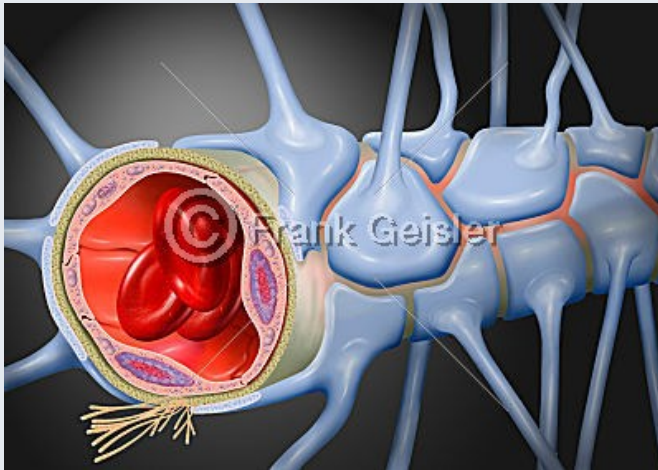


www.vmede.org

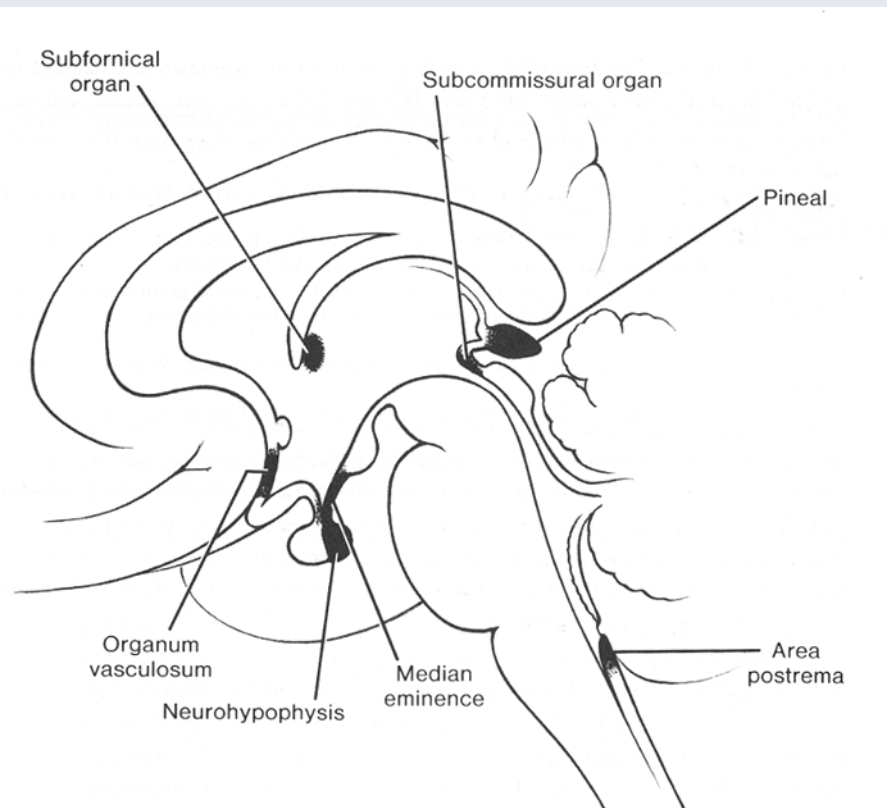
Blood brain barrier

Processes of glial cells + basal membrane
+ endothelial cells with tight junctions

allowing the diffusion of small
hydrophobic molecules (O₂, CO₂,
hormones)



www.medical-pictures.de

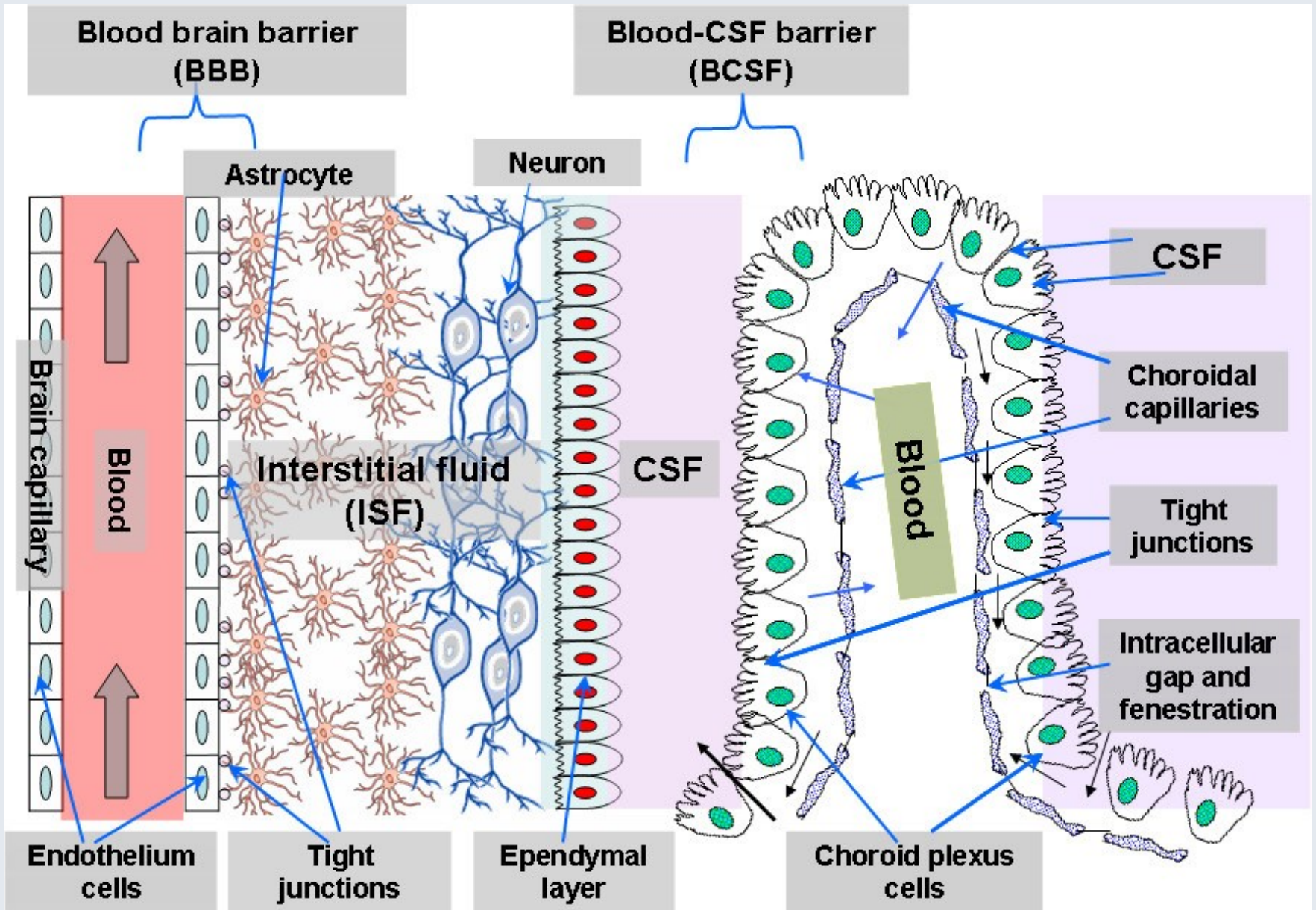


Lack of BBB:

These areas are located around the III. and IV. ventricles.

→ circumventricular organs (CVOs)

These specialized areas are points of communication between the blood, the brain parenchyma, and the CSF.



Liquor circulation

The cerebrospinal fluid (CSF) is produced by the choroid plexus of the ventricular system (400-800 ml daily).

The volume is approx. 120-200 ml, changes in every 6-7 hours.

Protein content is lower than the serum.

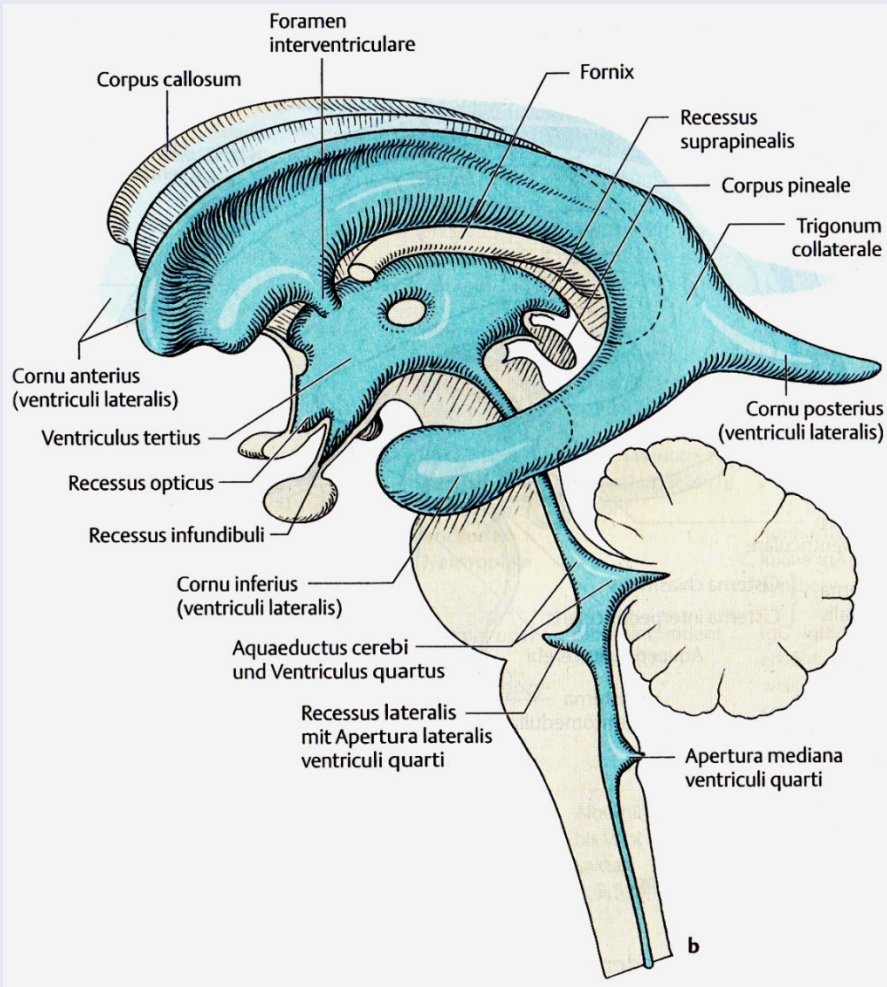
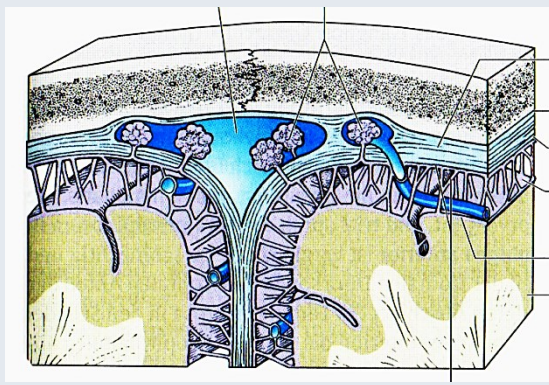
Sugar content is 50-70% of the blood sugar level.

Reabsorption: predominantly into the sinuses of the dura mater (arachnoid granulations) + lymphatic system + cortical vessels

It is clear, but in pathological conditions it becomes yellow, opal, bloody.

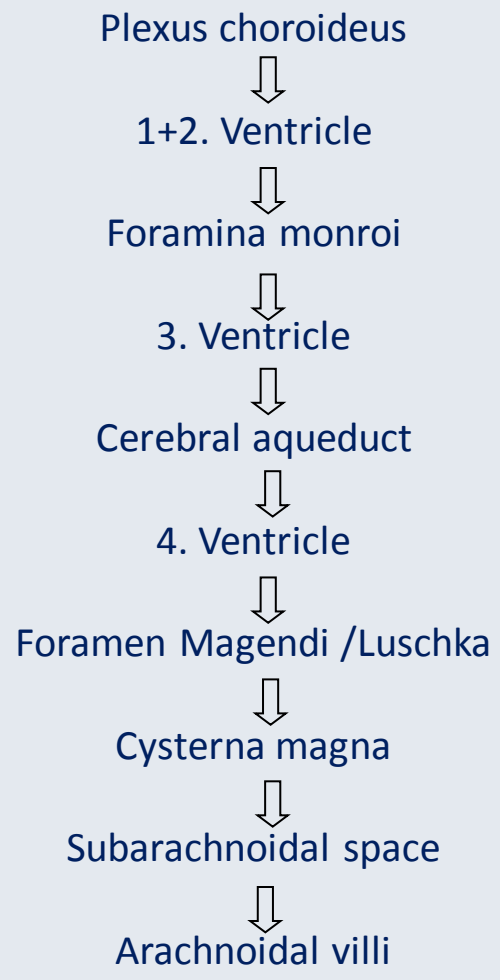
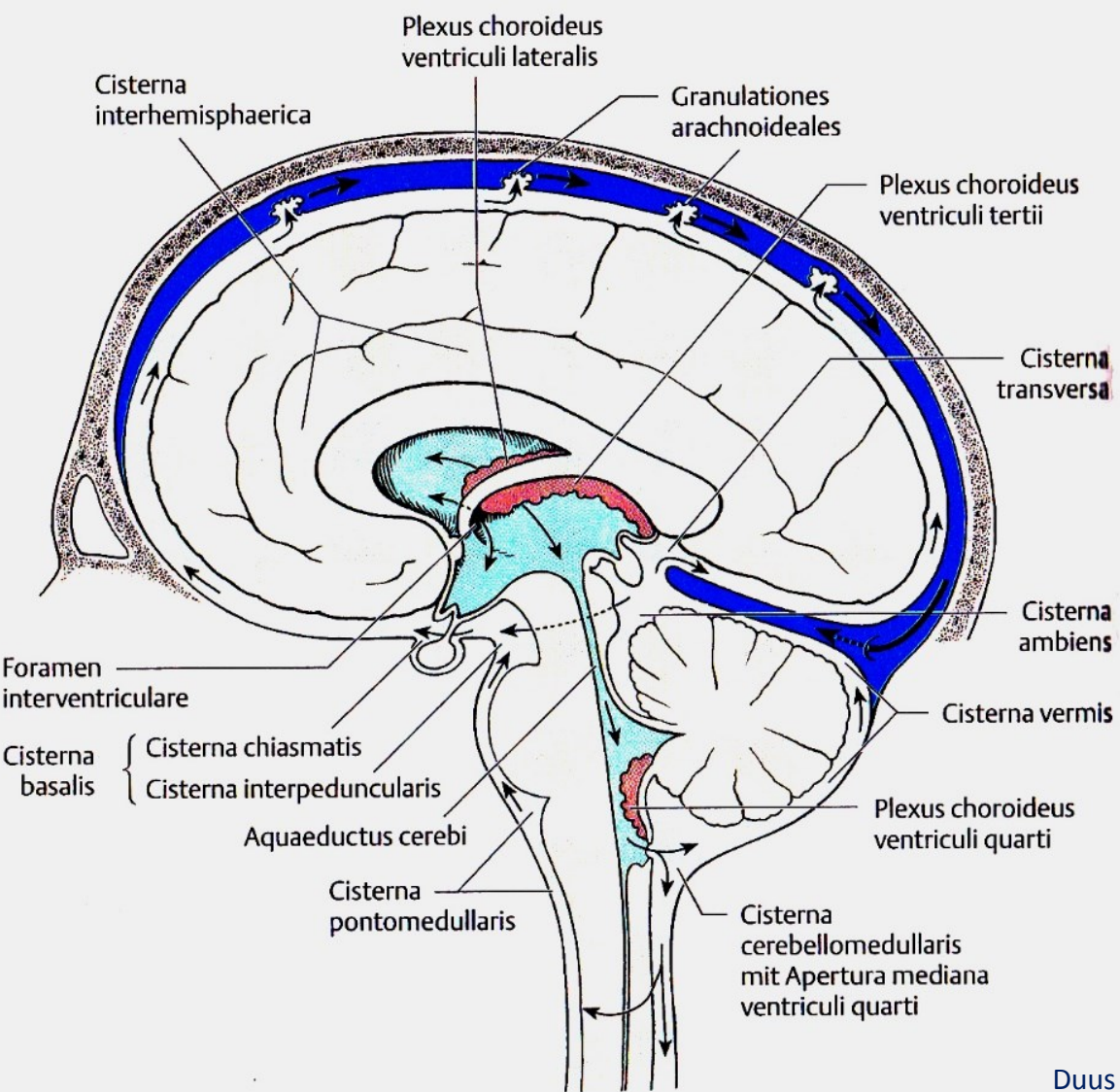
Inner and outer liquor spaces.

Liquor gain: usually under the L4 vertebra with lumbar puncture or by puncture of the cerebellomedullar cistern.



Inner liquor spaces:
I-IV. ventricles

Outer liquor spaces:
subarachnoideale space



Duus

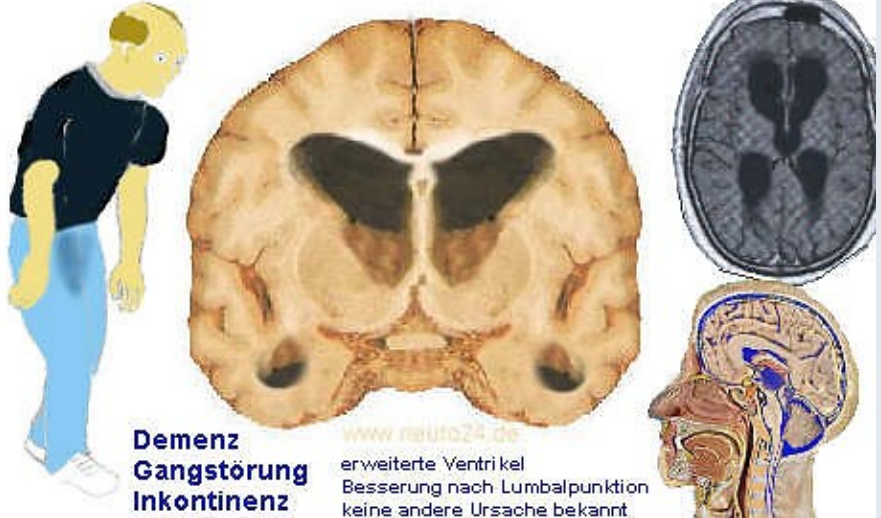
Lateral apertures (Luschka) and medial aperture (Magendie)

Hydrocephalus

www.hydrocephalus.info



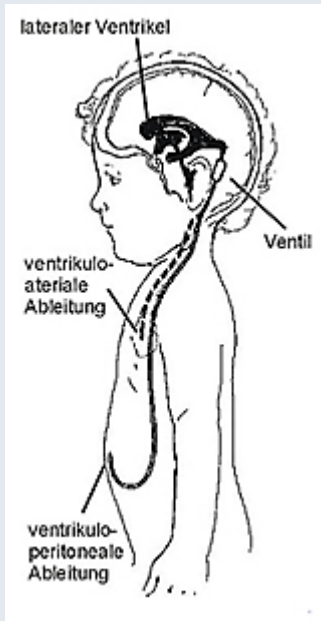
Der Normaldruckhydrozephalus



Demenz
Gangstörung
Inkontinenz

[www neuro24.de](http://www.neuro24.de)
erweiterte Ventrikel
Besserung nach Lumbalpunktion
keine andere Ursache bekannt.

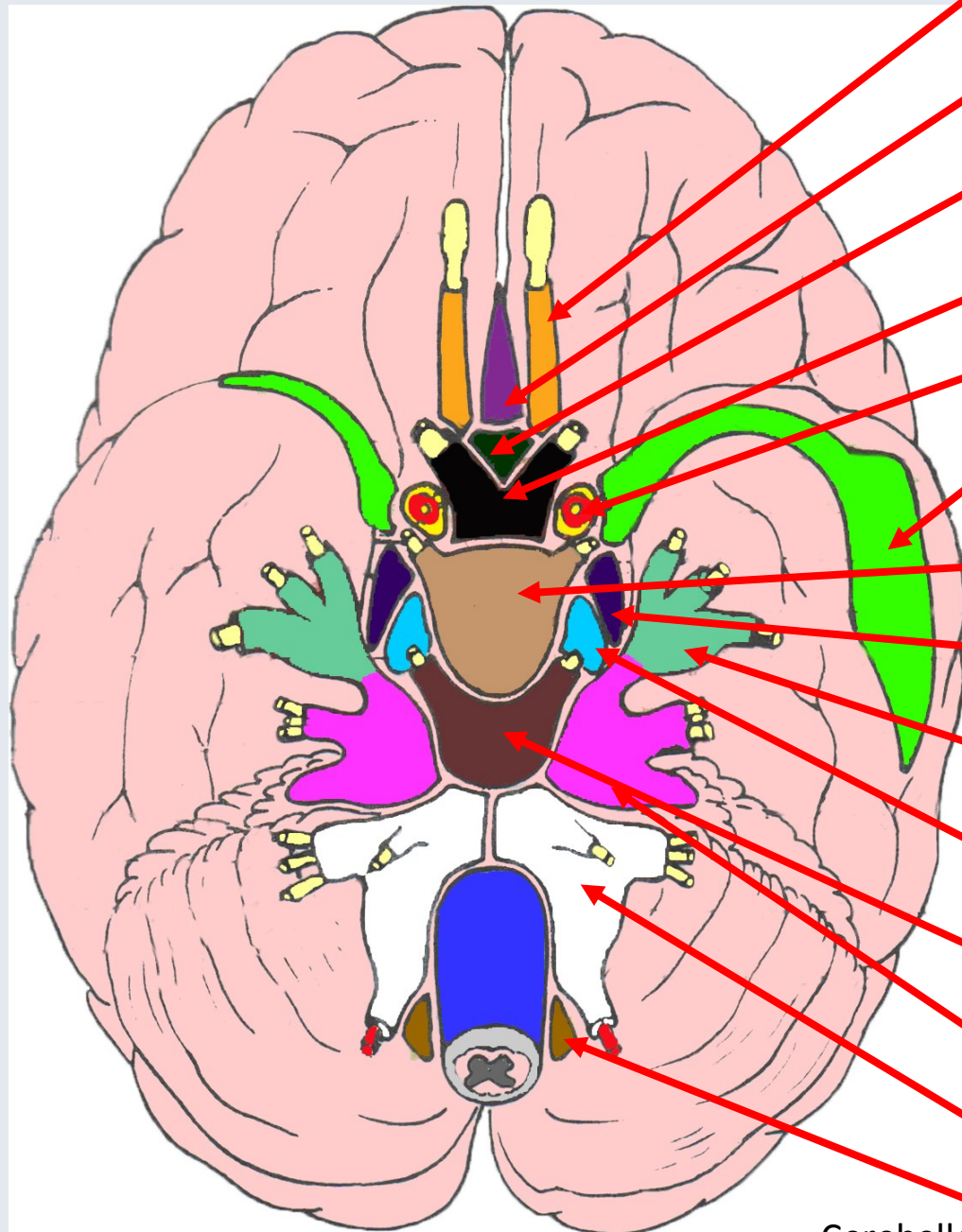
www.neuro24.de



Is there a communication with the subarachnoideal space?
Hypersecretion?
Malresorption?
Barrier in the flow?

www.motiv-medtech.de

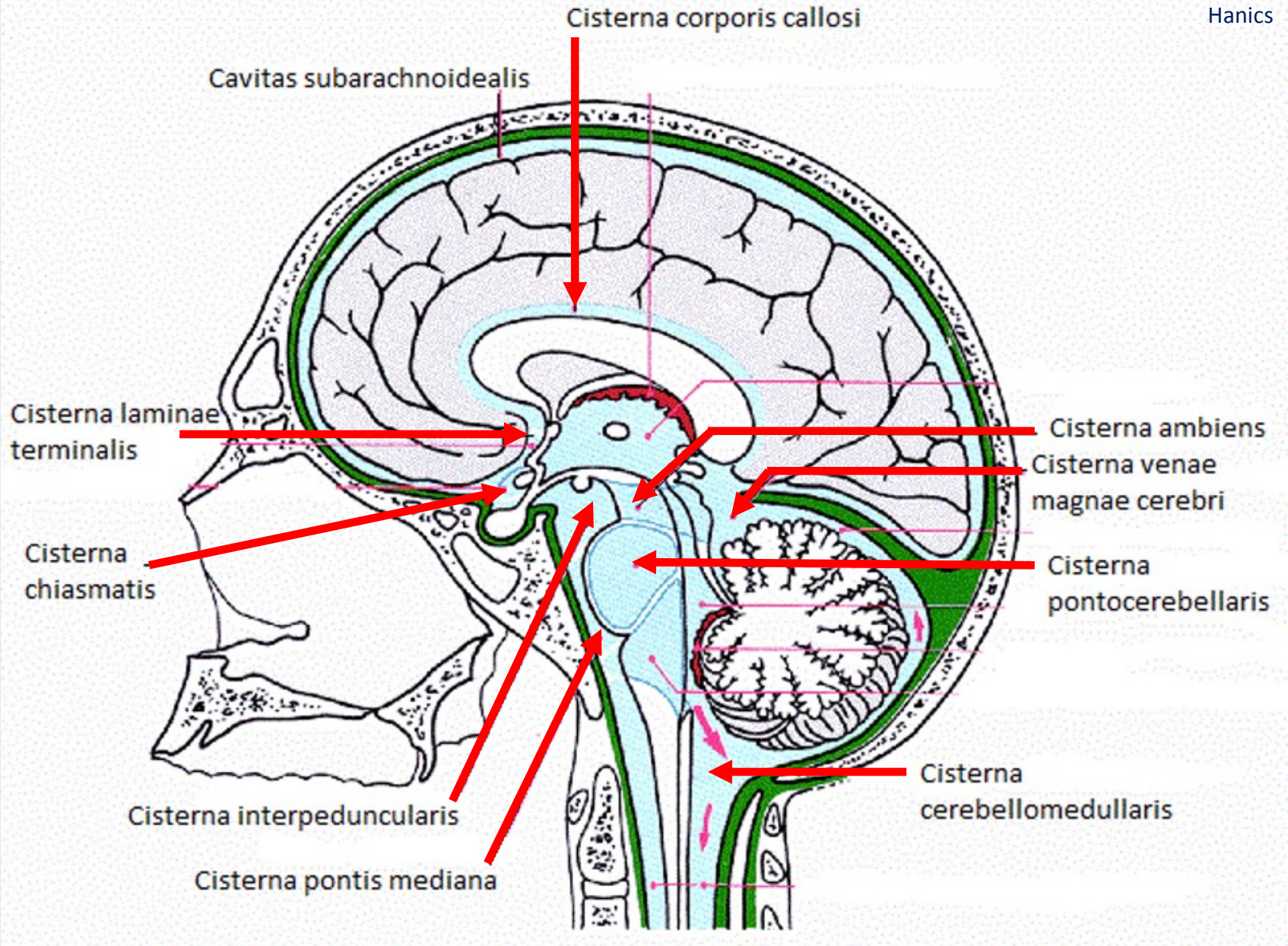
Subarachnoideal cisterns



- Olfactory cistern (*paired*)
- Cistern of corpus callosum (*unpaired*)
- Cistern of lamina terminalis (*unpaired*)
- Chiasmatic cistern (*unpaired*)
- Carotic cistern (*paired*)
- Cistern of the lateral fissure (*paired*)
- Interpeduncular cistern (*unpaired*)
- Crural cistern (*paired*)
- Trigeminal cistern (*paired*)
- Ambiens/superior cistern (*paired*)
- Cisterna pontis mediana (*unpaired*)
- Cerebellopontin cistern (pontis lateralis) (*paired*)
- Lateral crebellomedullar cistern (*paired*)
- Cerebellomedullar cistern/ cisterna magna (*unpaired*)

Subarachnoideal cisterns

Hanics



Thank you for your attention!

Dr. Gábor Baksa / Dr. Tamás Ruttkay: Az agyvelő vérellátása

Dr. Andrea Székely: Blood supply to the brain