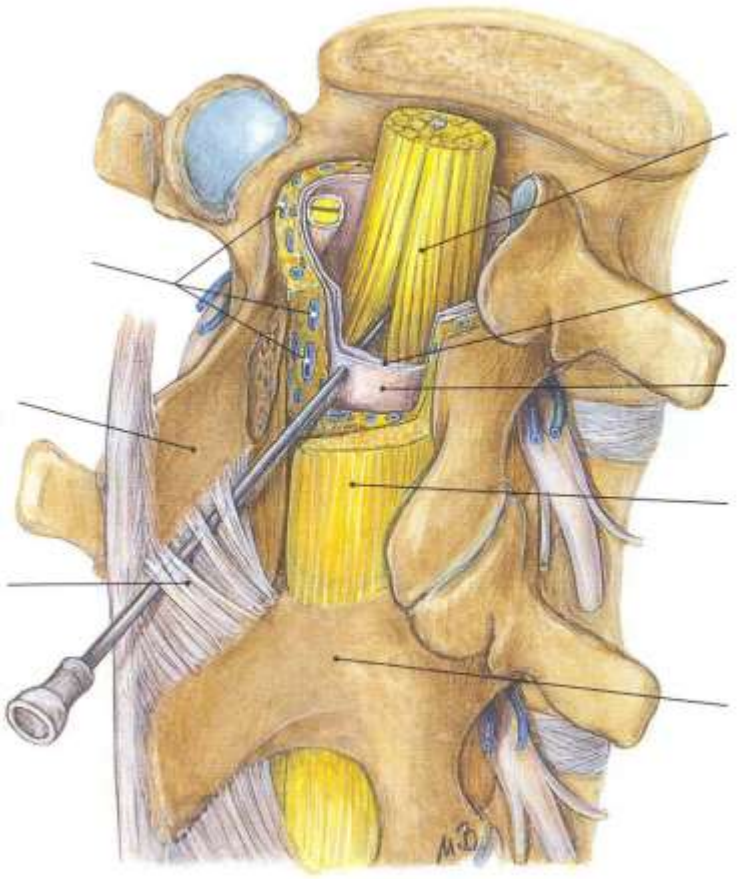
Brain ventricles, cerebrospinal fluid, Coverings and blood vessels of the brain

MUDr. Veronika Němcová, CSc.

Cerbrospinal fluid

production – choroid plexus
absorbtion –arachnoid granulations
Ventricles and subarachnoidal space 140 ml
Daily 500 ml
Mechanic support of the brain(„it floats“)
Chemical communication in the CNS (neurons-CSF-wall of ventricles– neurons)



Ventricles

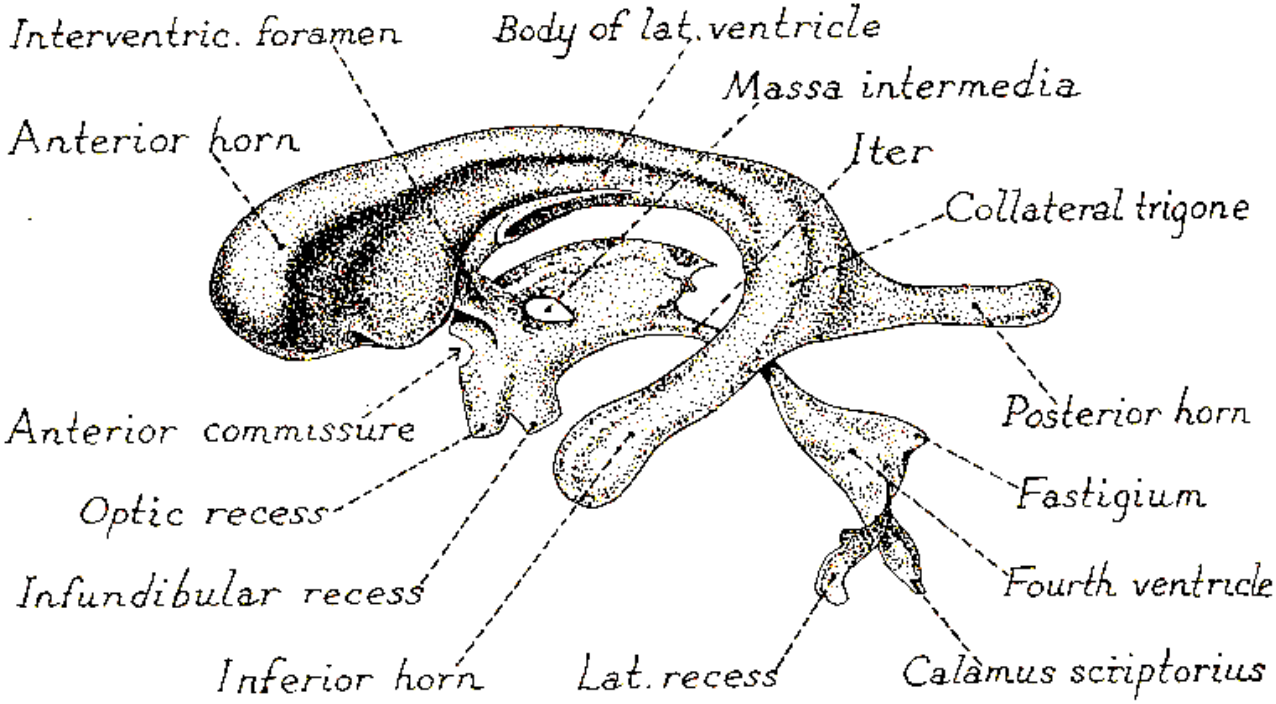
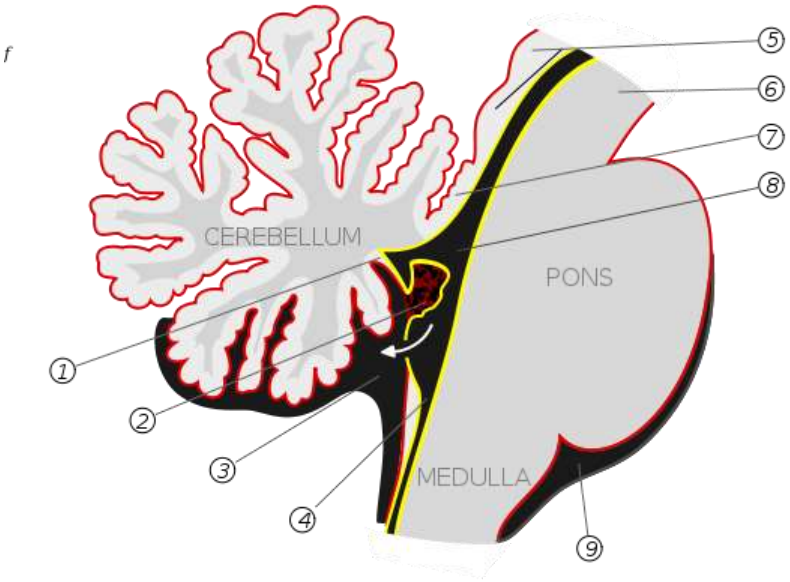


FIG. 305. Cast of the brain ventricles, viewed from the side. Only the left lateral ventricle is represented. (After Rauber-Kopsch.)

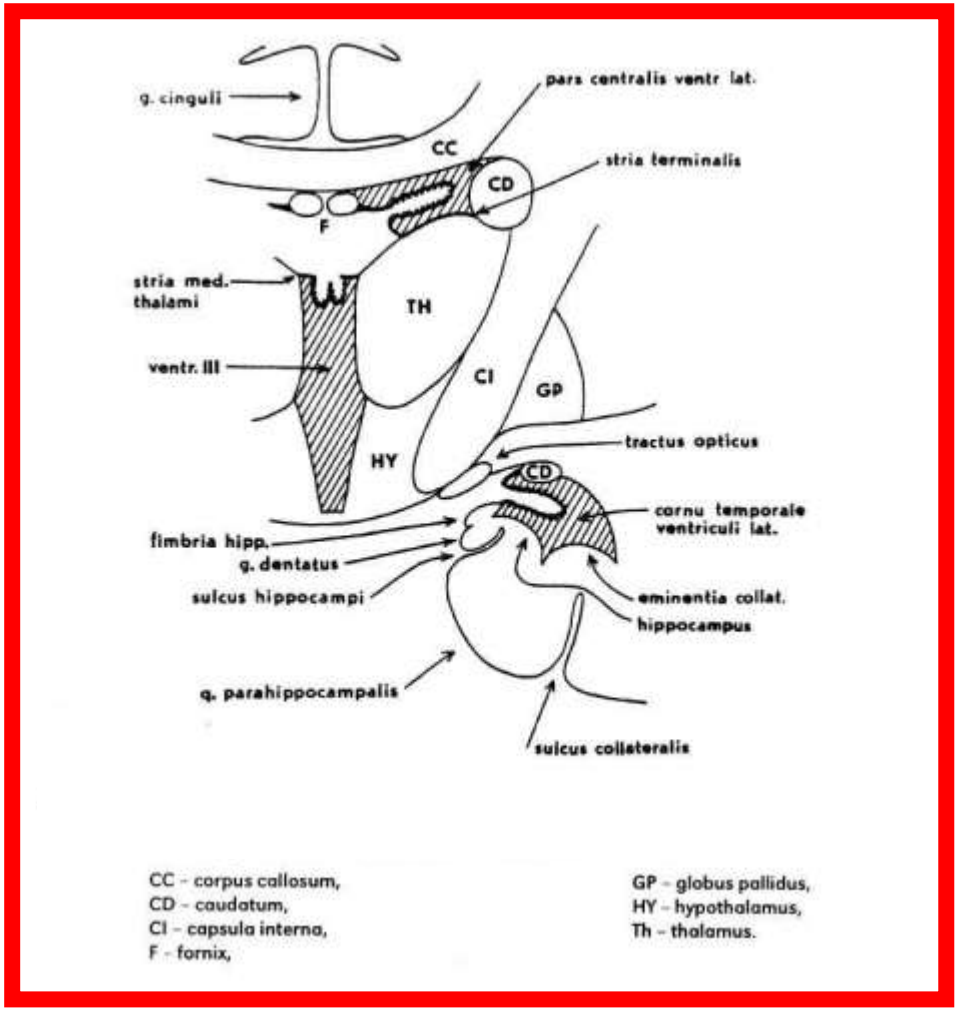
CSF comes from ventricles to subarachnoid space through:

A) Median aperture of the IV.ventricle 3
= foramen Magendi

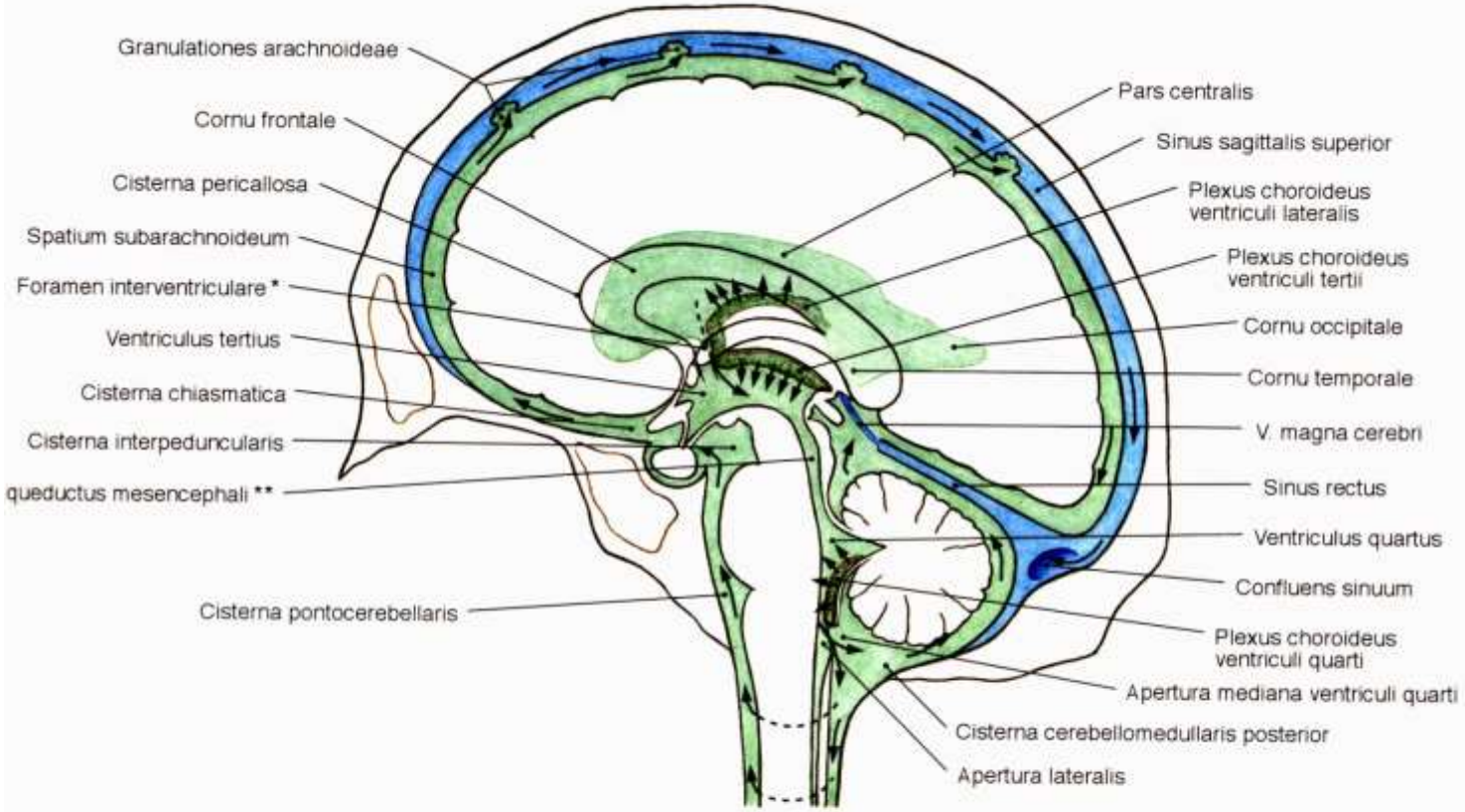


B) Lateral apertures of the IV.ventricle
= Foramina Luschkae
Laterally in the tela choroidea ventriculi quarti

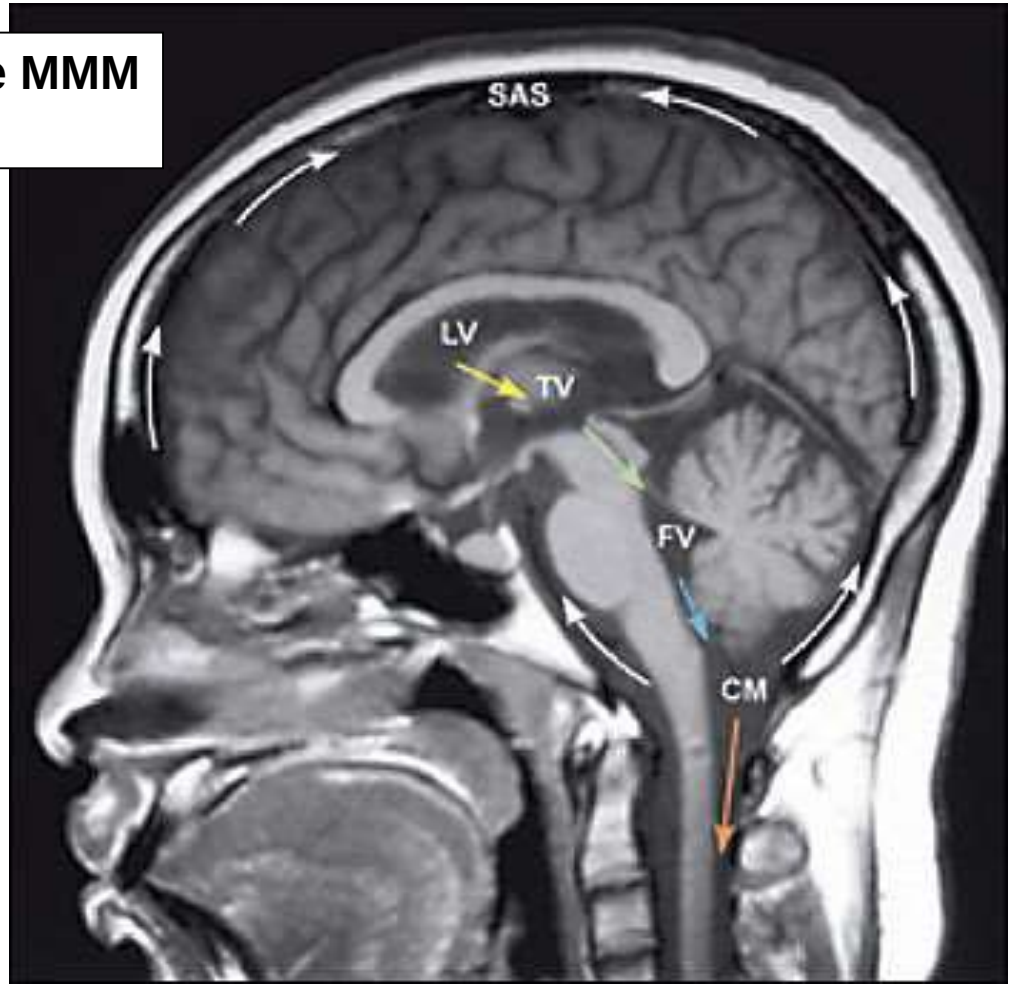
Frontal secion through the ventricles



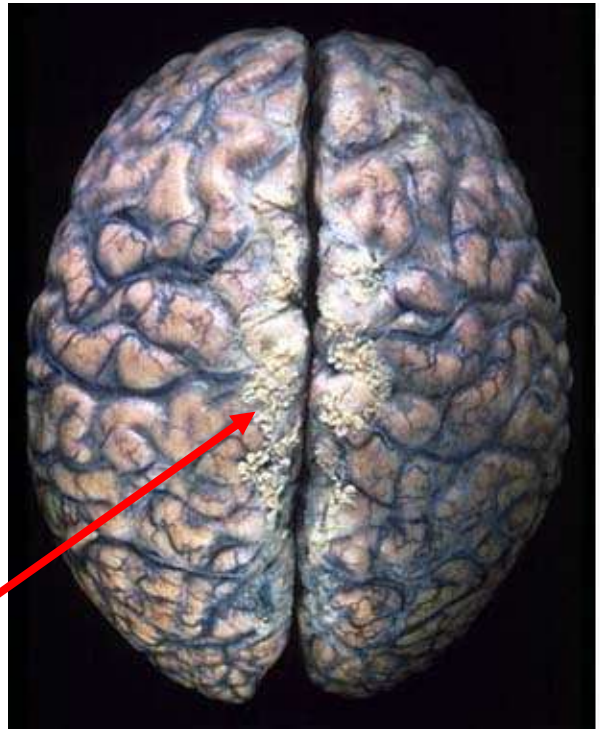
Lateral ventricles, interventricular foramen , III. ventricle, aqaeductus mesencephali, IV. ventricle, apertura mediana + aperturae laterales



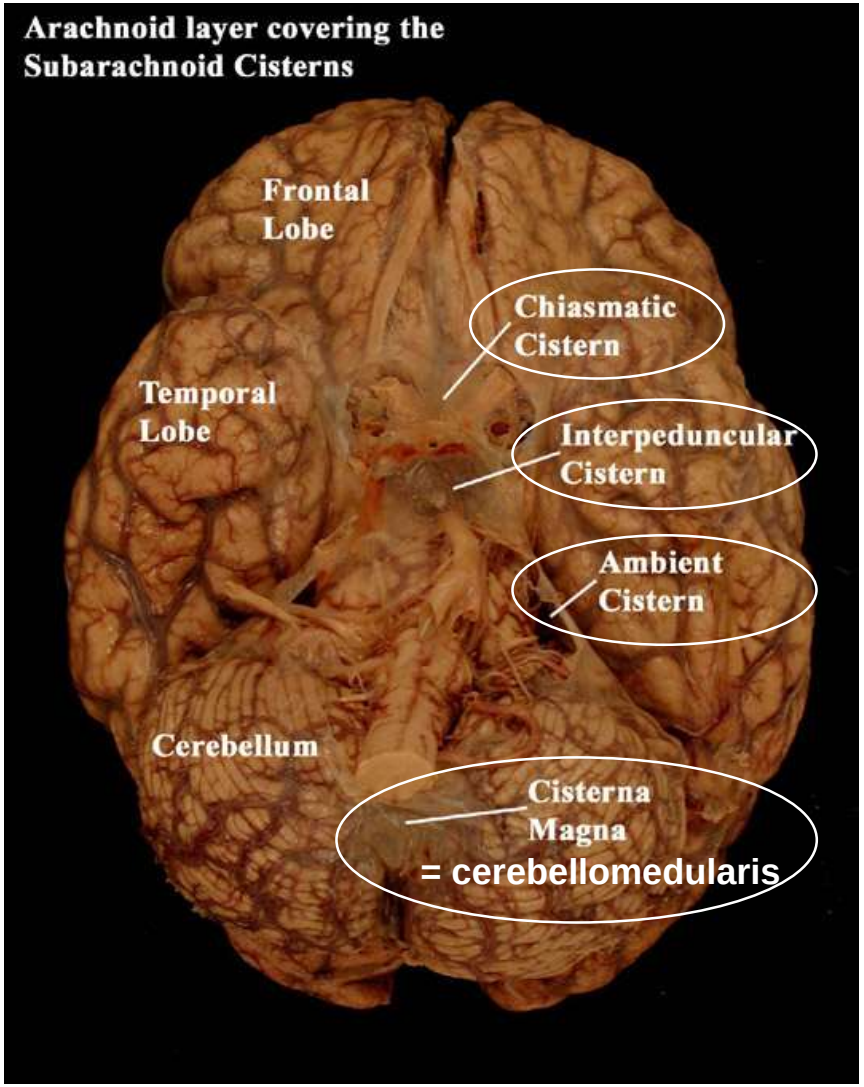
Cirkulace MMM MR



Granulationes arachnoidales
absorbtion to sinus sagittalis superior



Cisternae subarachnoidales



Between pia mater and arachnoid

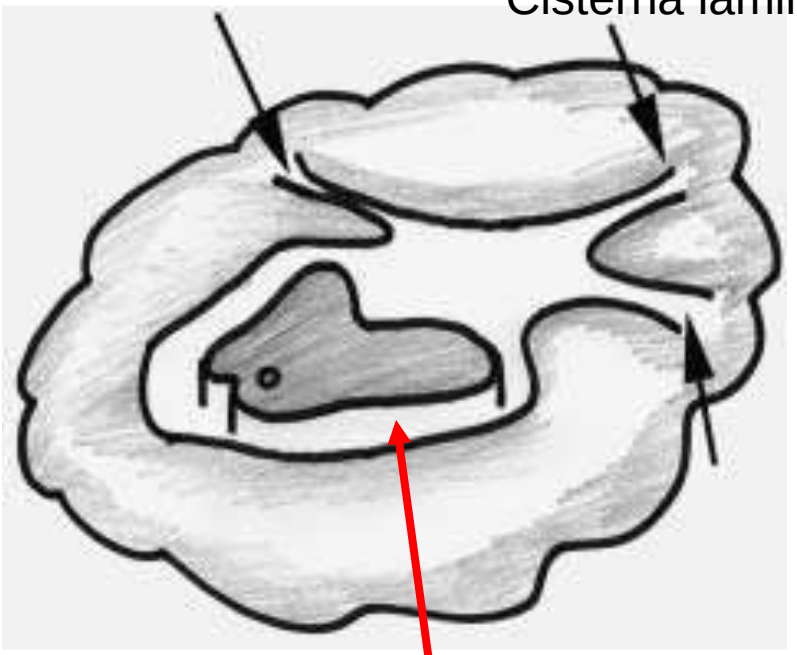
Other cisterns:
Cisterna fossae lateralis cerebri
Cisterna pontis
Cisterna laminae quadrigeminae
Cisterna corporis callosi

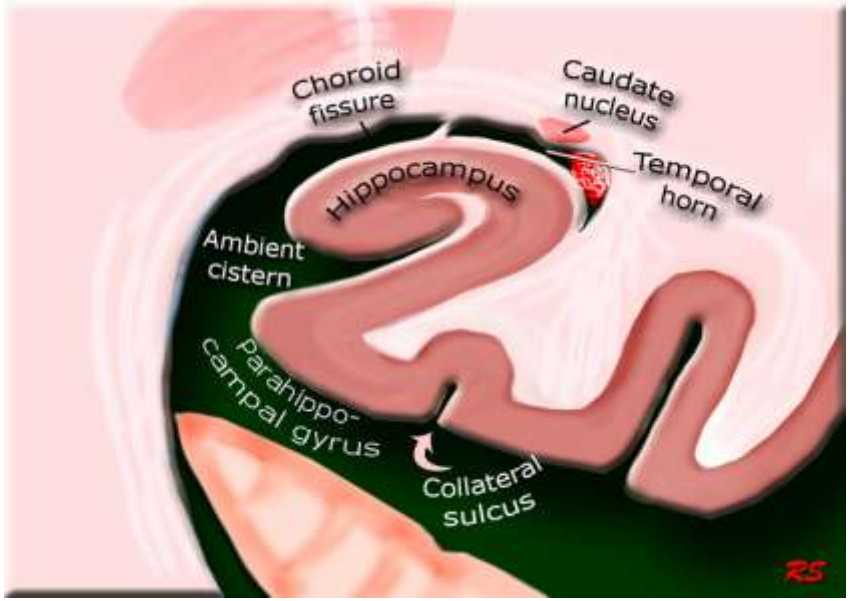
Cisterna ambiens

Between quadrigeminal and interpeduncular cistern

Cisterna fossae lateralis

Cisterna laminae teminalis



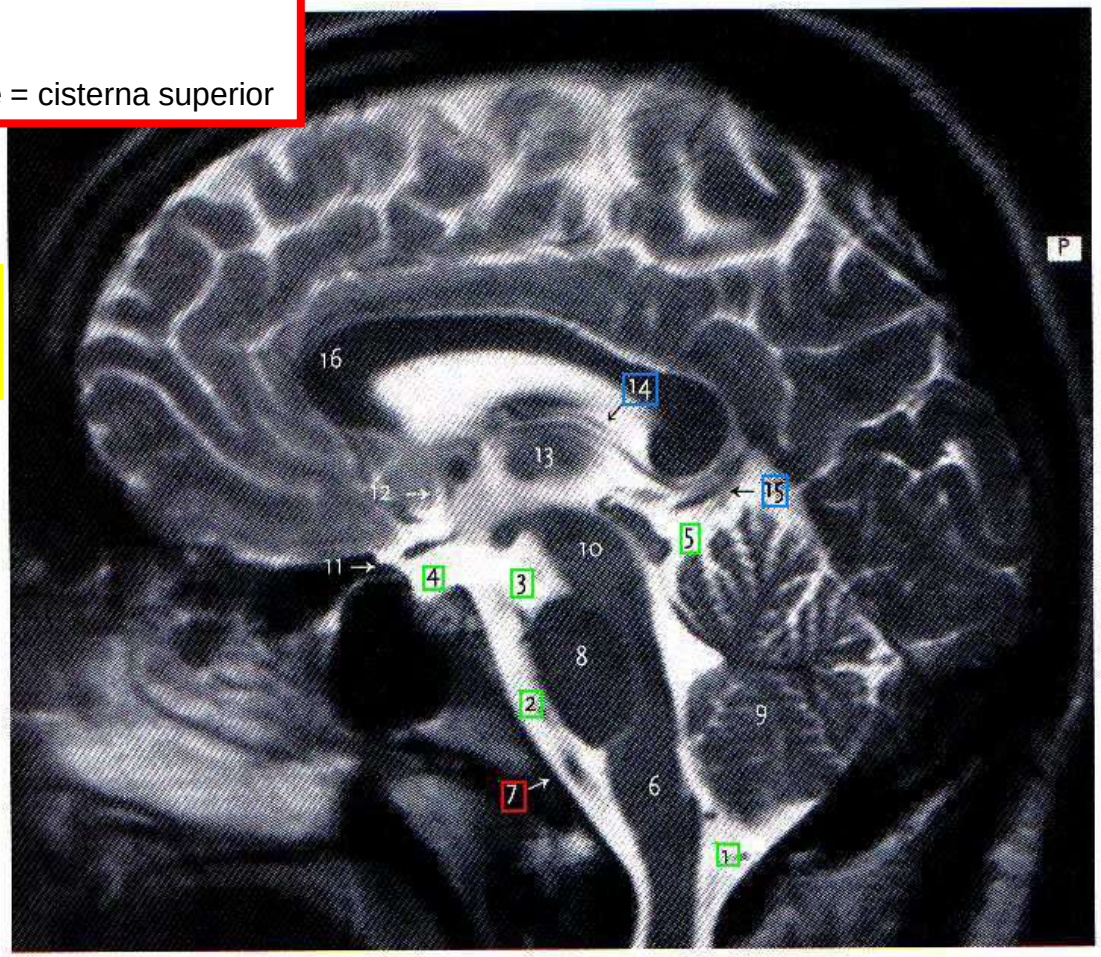


Cisterna ambiens

http://www.medigraphic.com/pdfs/anaradmex/arm-2005/arm051f.pdf

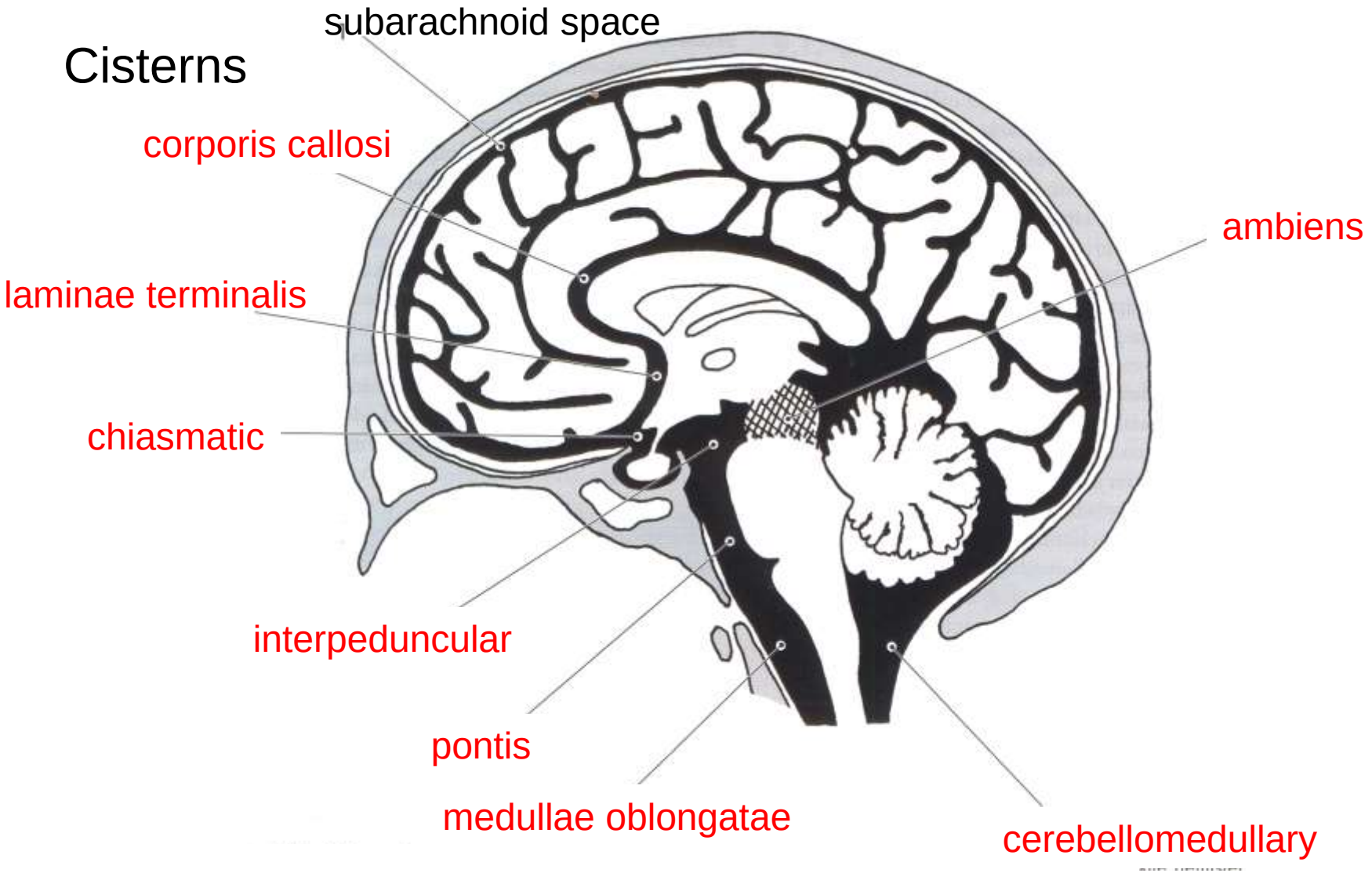
1 Cisterna cerebellomedullaris
2 Cisterna pontis
3 Cisterna interpeduncularis
5 Cisterna laminae quadrigeminae = cisterna superior

MRI – T2W
CSF is white

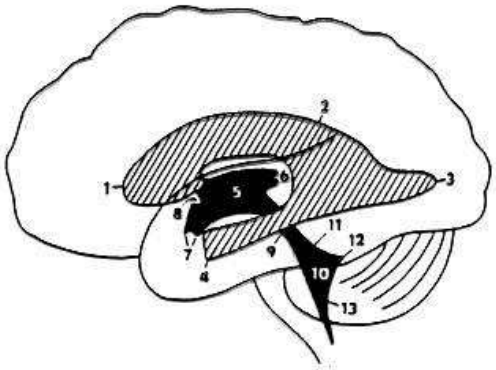


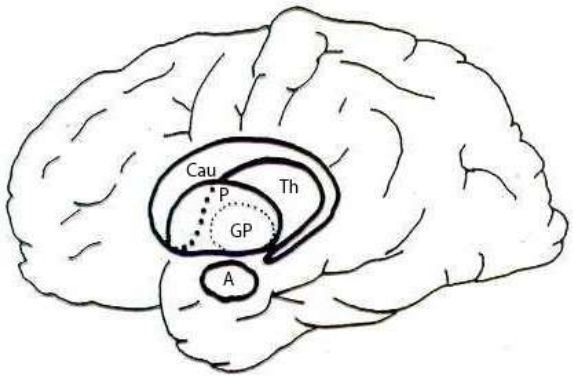
1 *cisterna cerebellomedullaris;* 2 *cisterna pontis;* 3 *cisterna interpeduncularis;* 4 *cisterna chiasmatis;* 5 *cisterna superior;* 6 *medulla oblongata;* 7 *a.basilaris;* 8 *pons;* 9 *cerebellum;* 10 *mesencephalon;* 11 *n.opticus;* 12 *commissura anterior;* 13 *thalamus;* 14 *v.cerebri interna;* 15 *v.cerebri magna;* 16 *corpus callosum.*

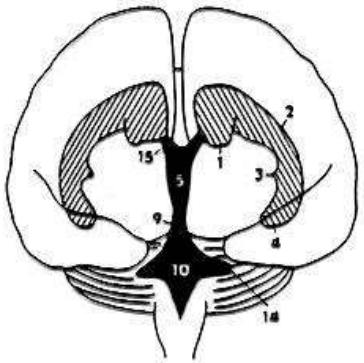
Cisterns


subarachnoid space
corporis callosi
ambiens
laminae terminalis
chiasmatic
interpeduncular
pontis
medullae oblongatae
cerebellomedullary

Ventricles and basal ganglia

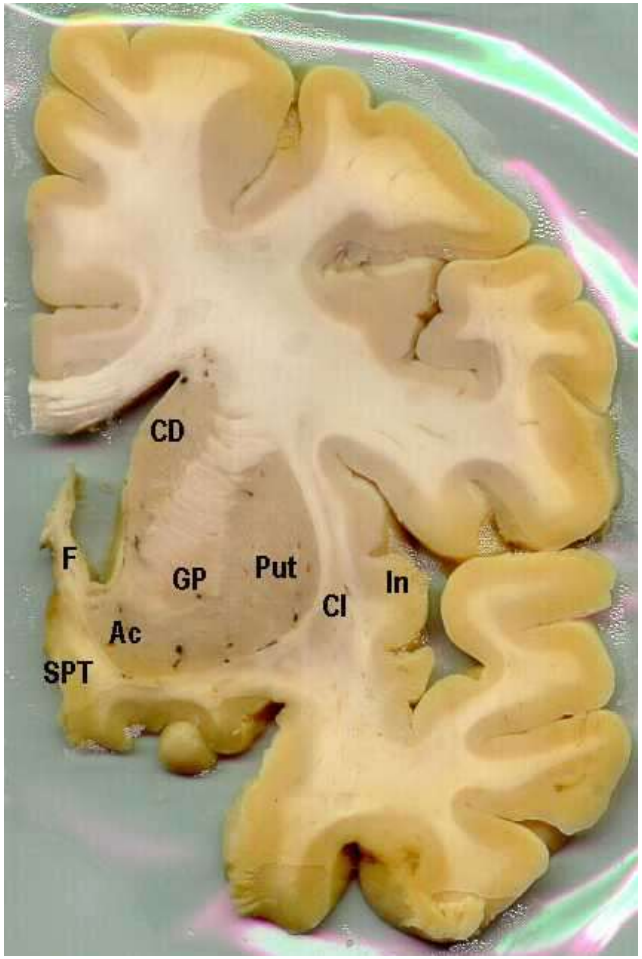


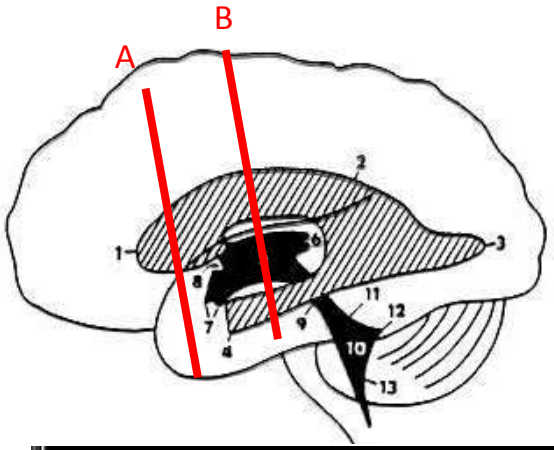


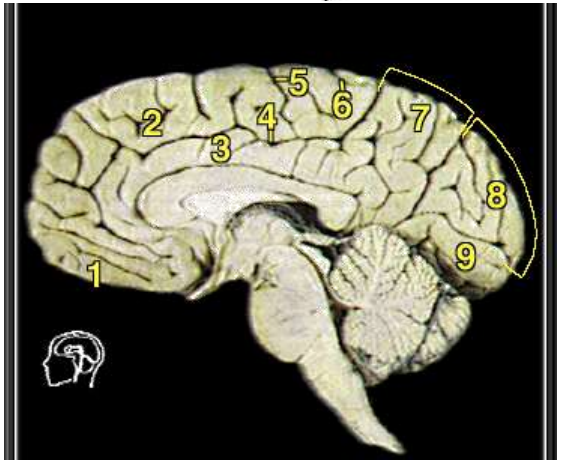


Cornu frontale ventriculi lateralis

A

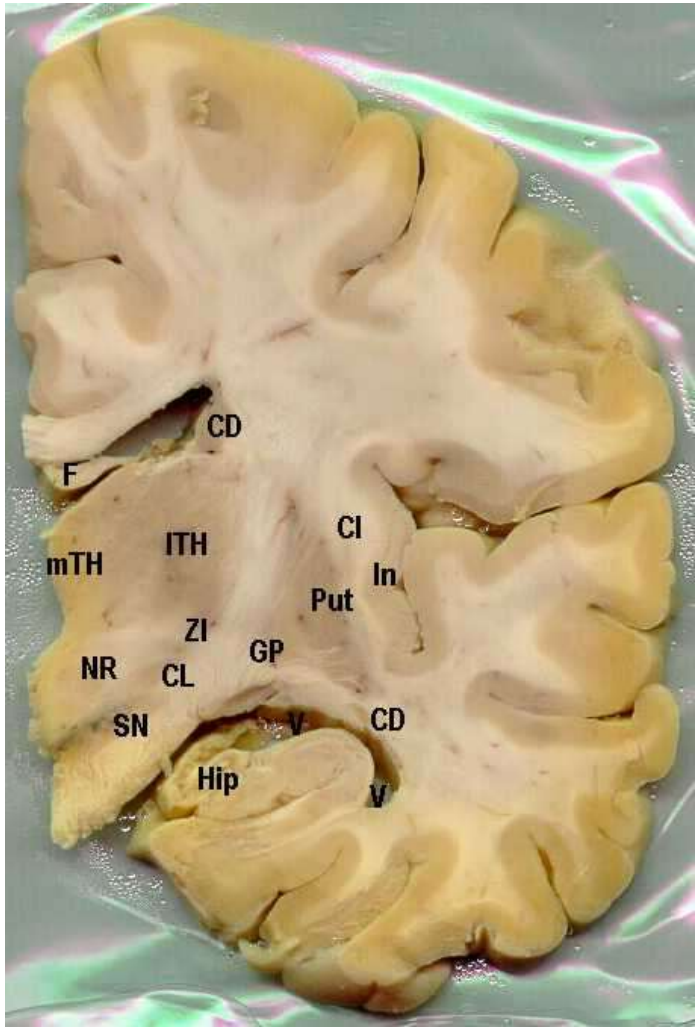




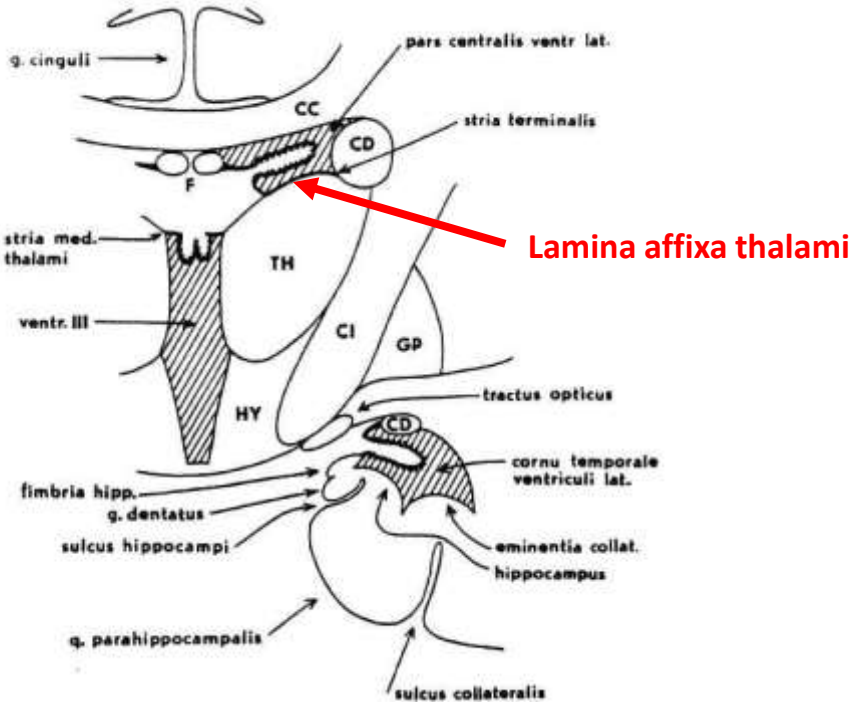


Pars centralis and cornu temporale

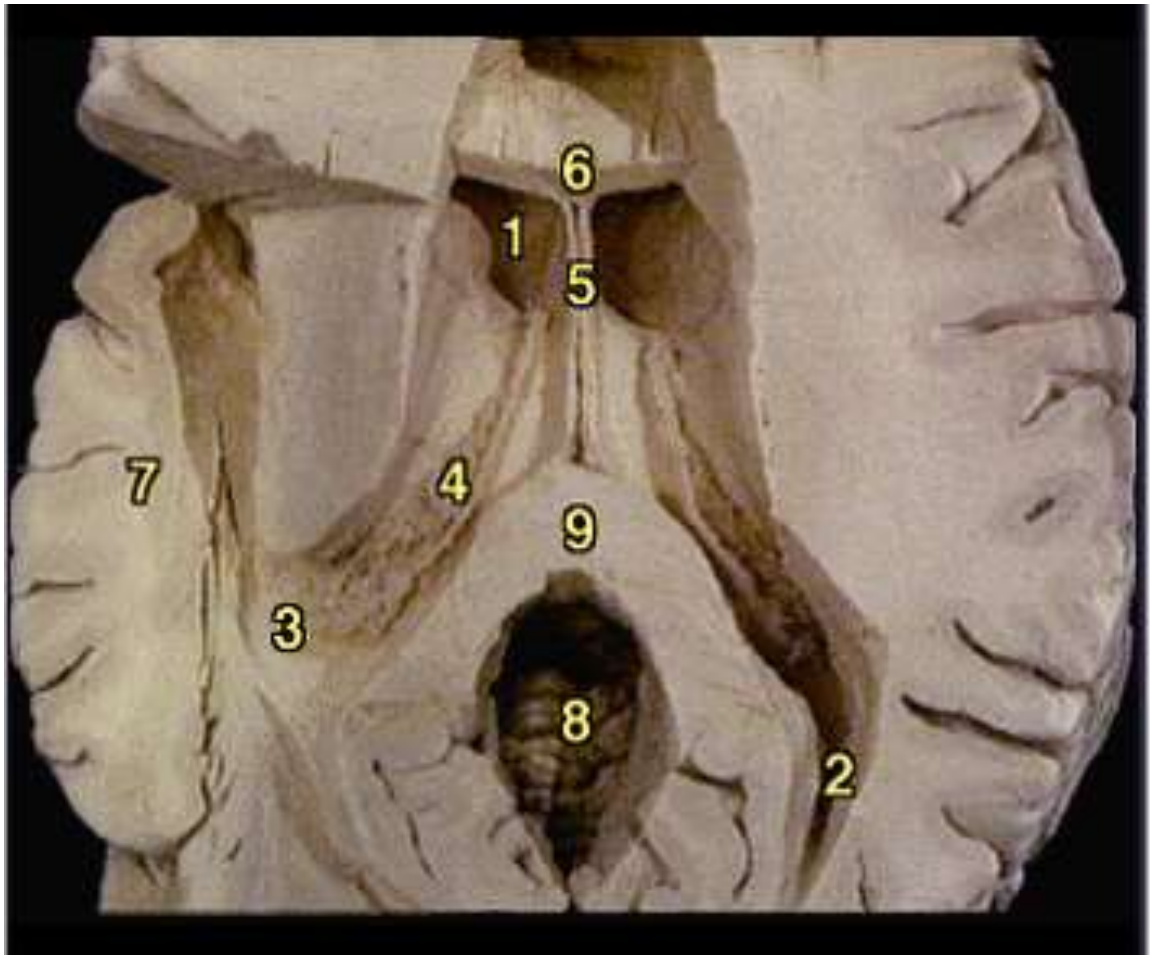
B



Tela choroidea between fornixem and ncl. caudatus

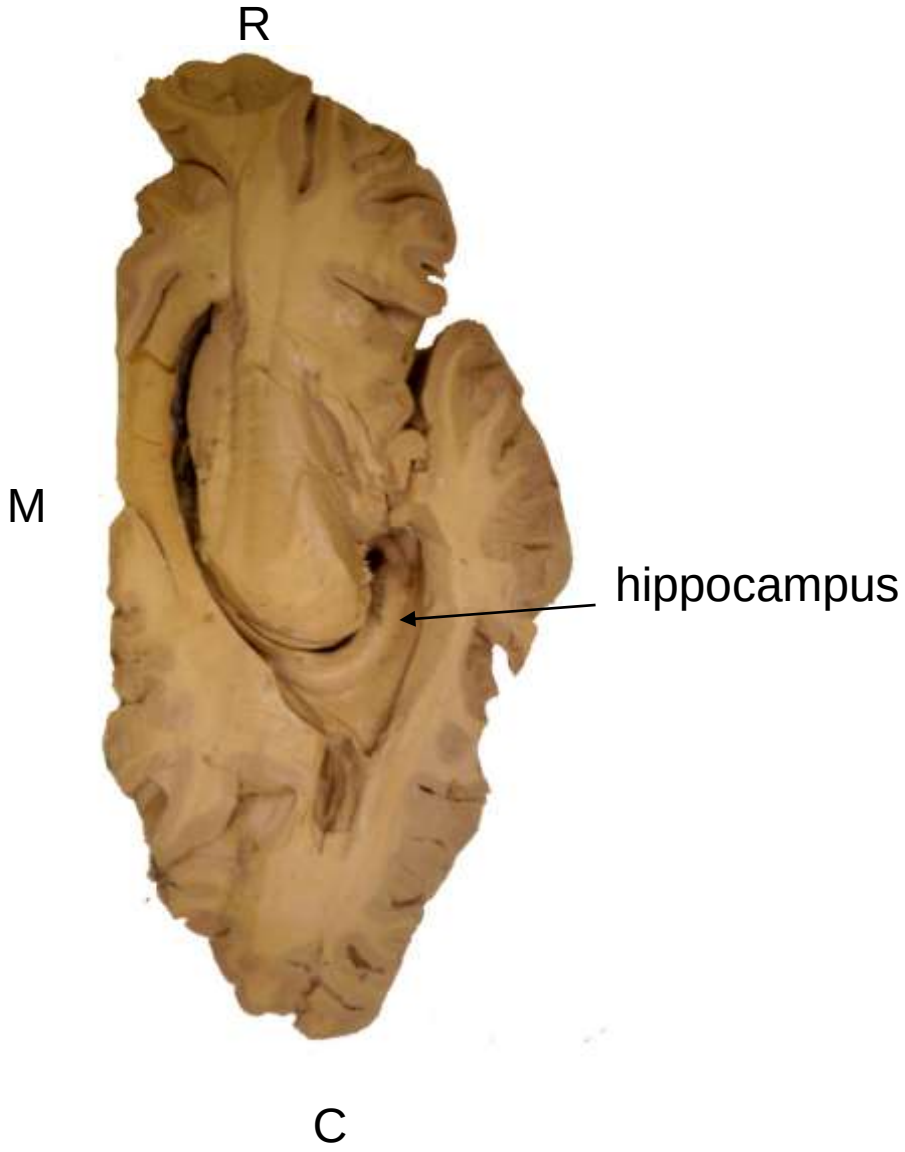


Dorsal aspect of ventricles

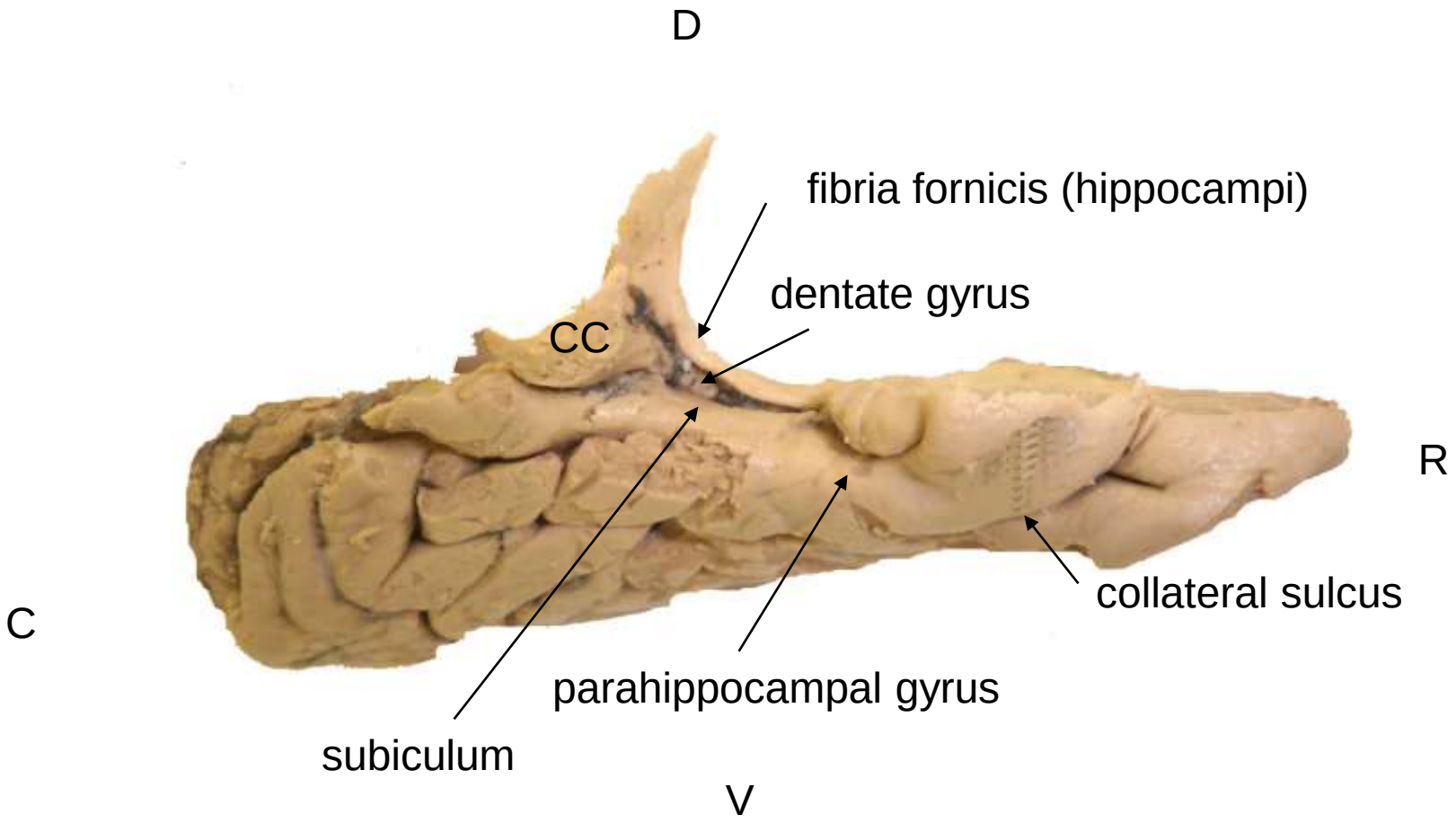


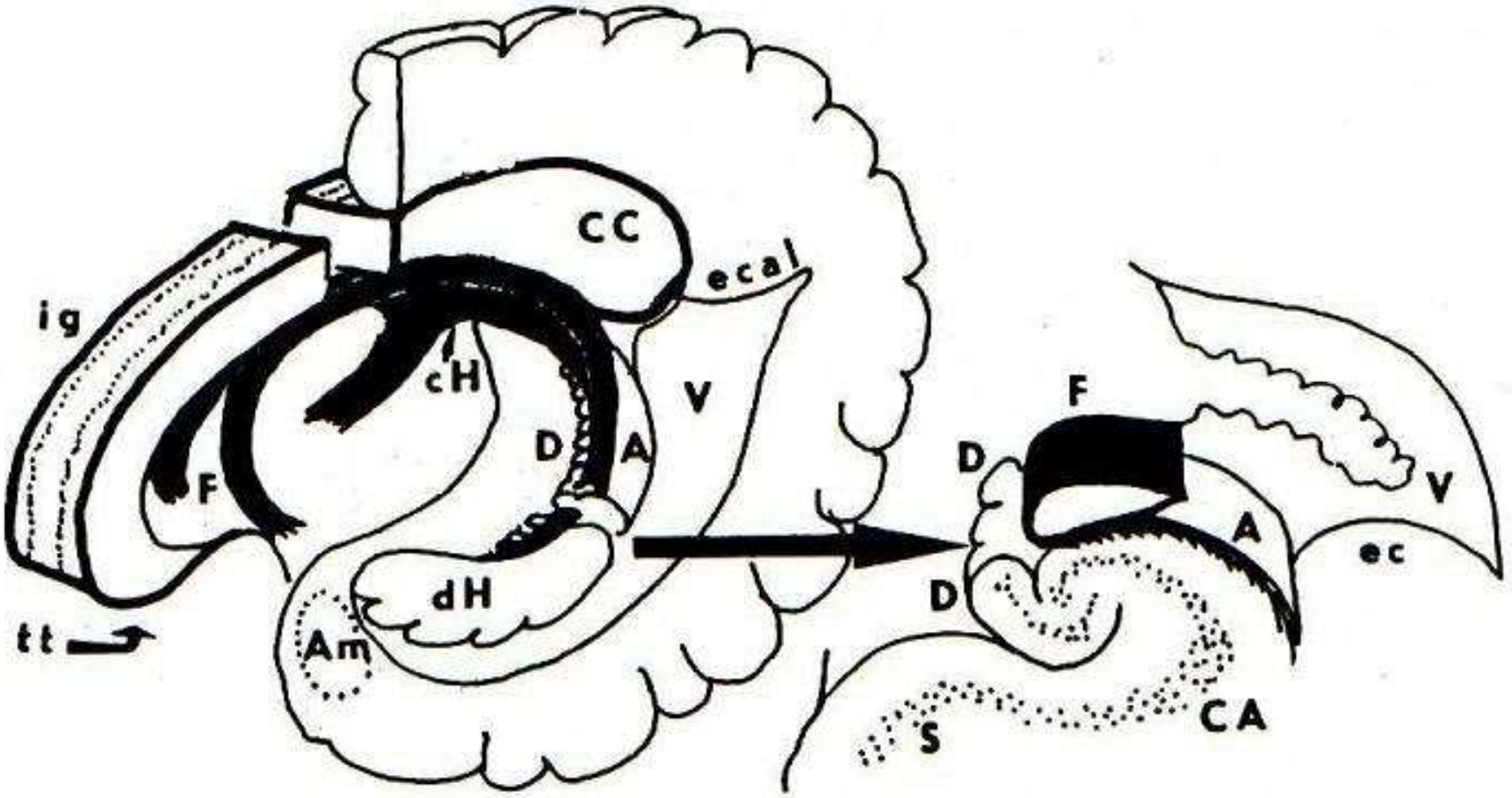
1- cornu frontale
2-cornu occipitale
3-fornix+ hippocampus
4-plexus choroideus VL
5-septum pellucidum
6- forceps ant
7-temporal lobe
8-cerebellum
9-forceps post

Lateral ventricle – dorsal aspect,



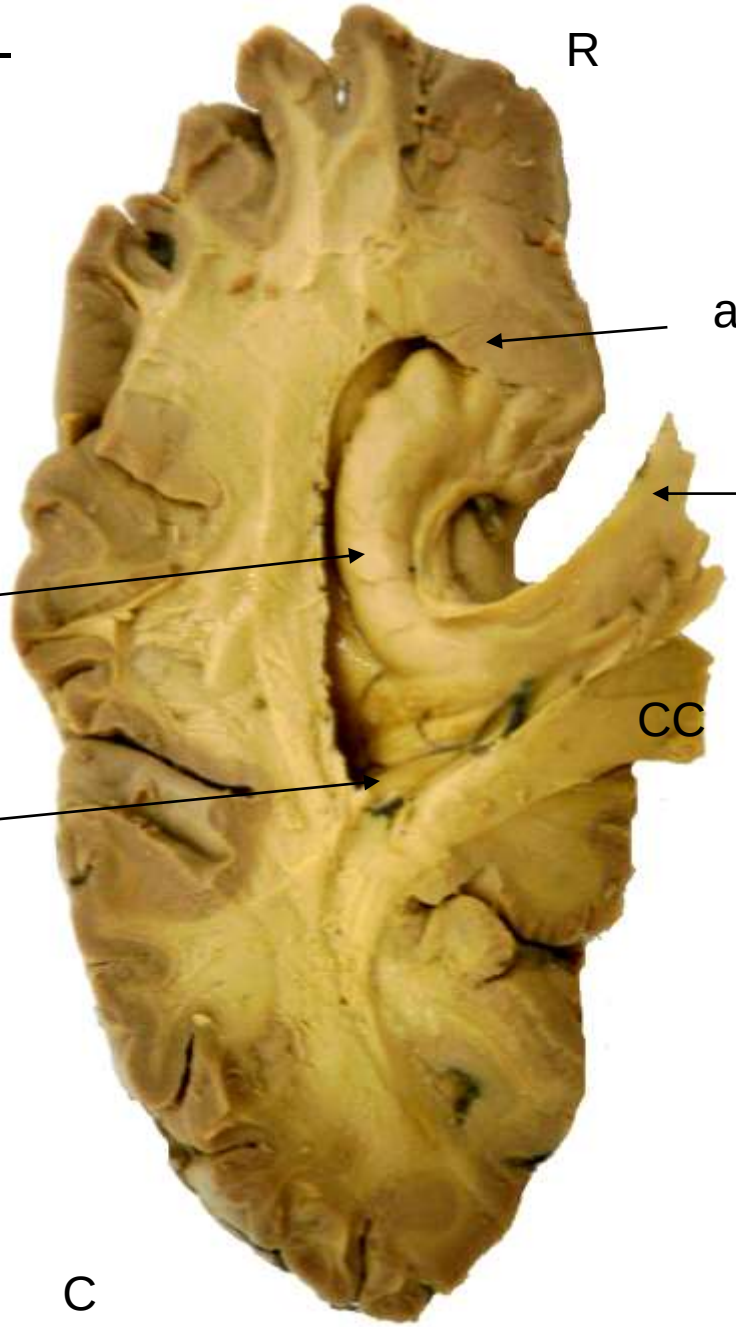
Temporal lobe medial aspect



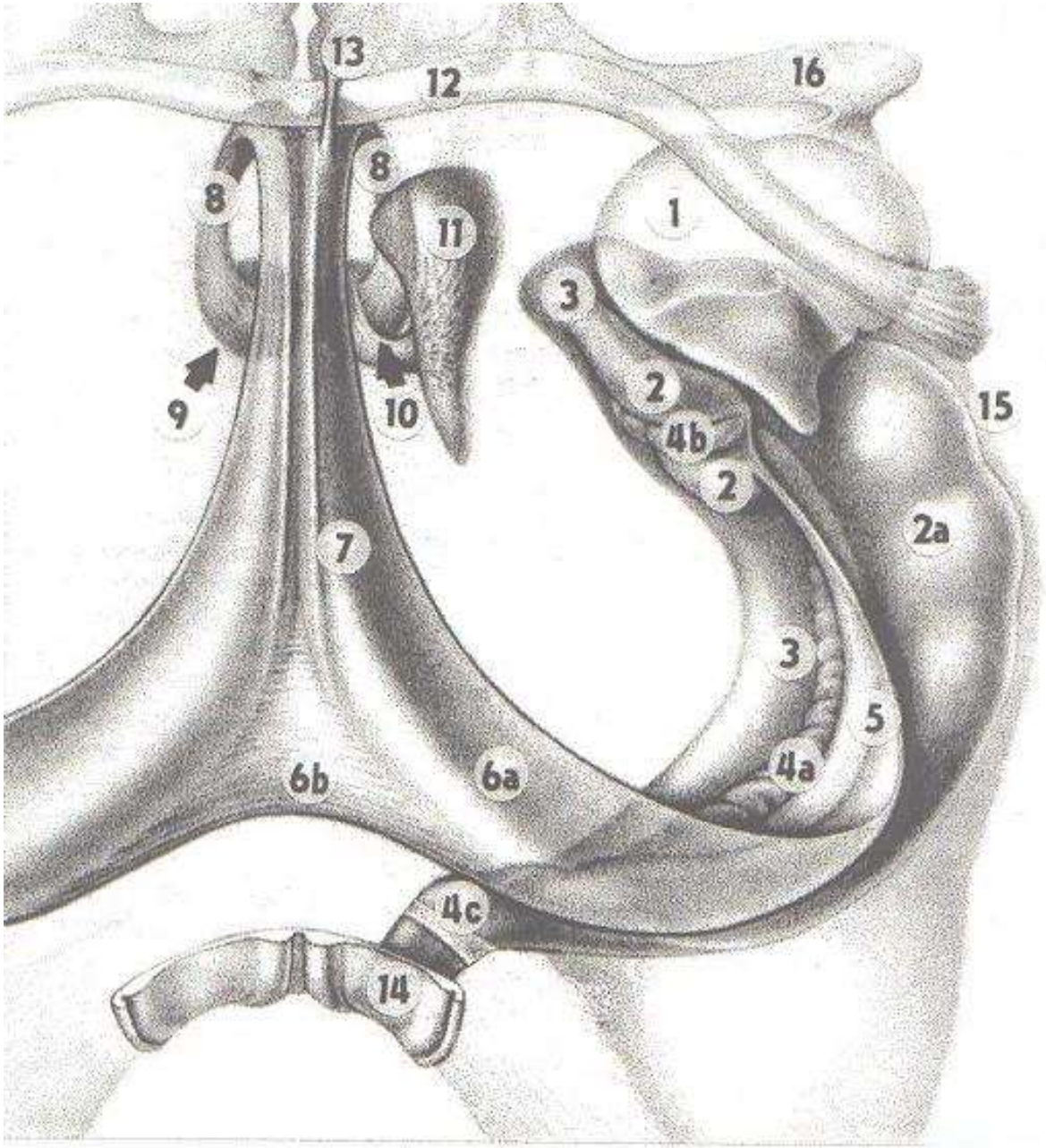


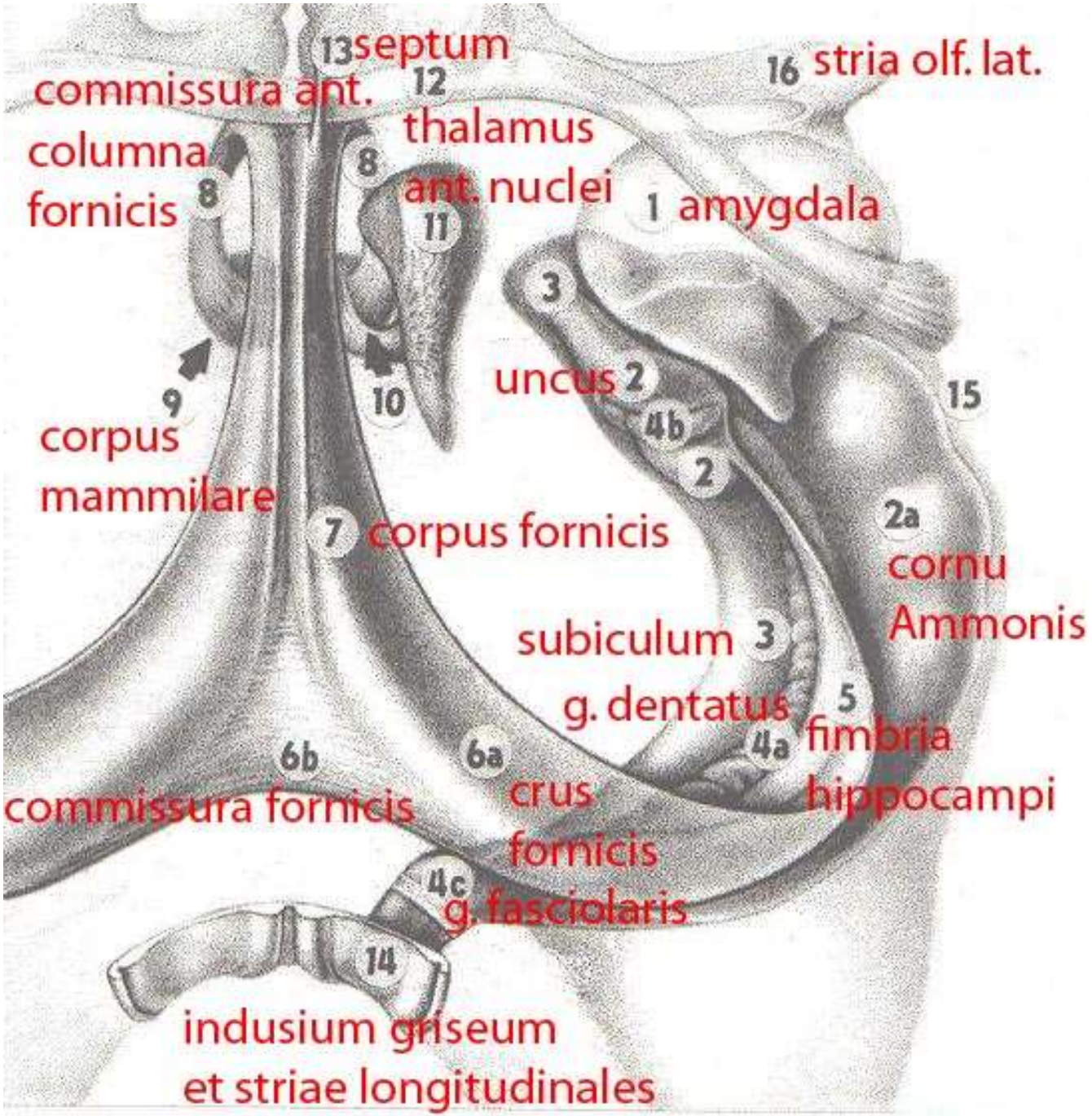
- View of excised hippocampus and its cutout

Lateral ventricle - temporal horn

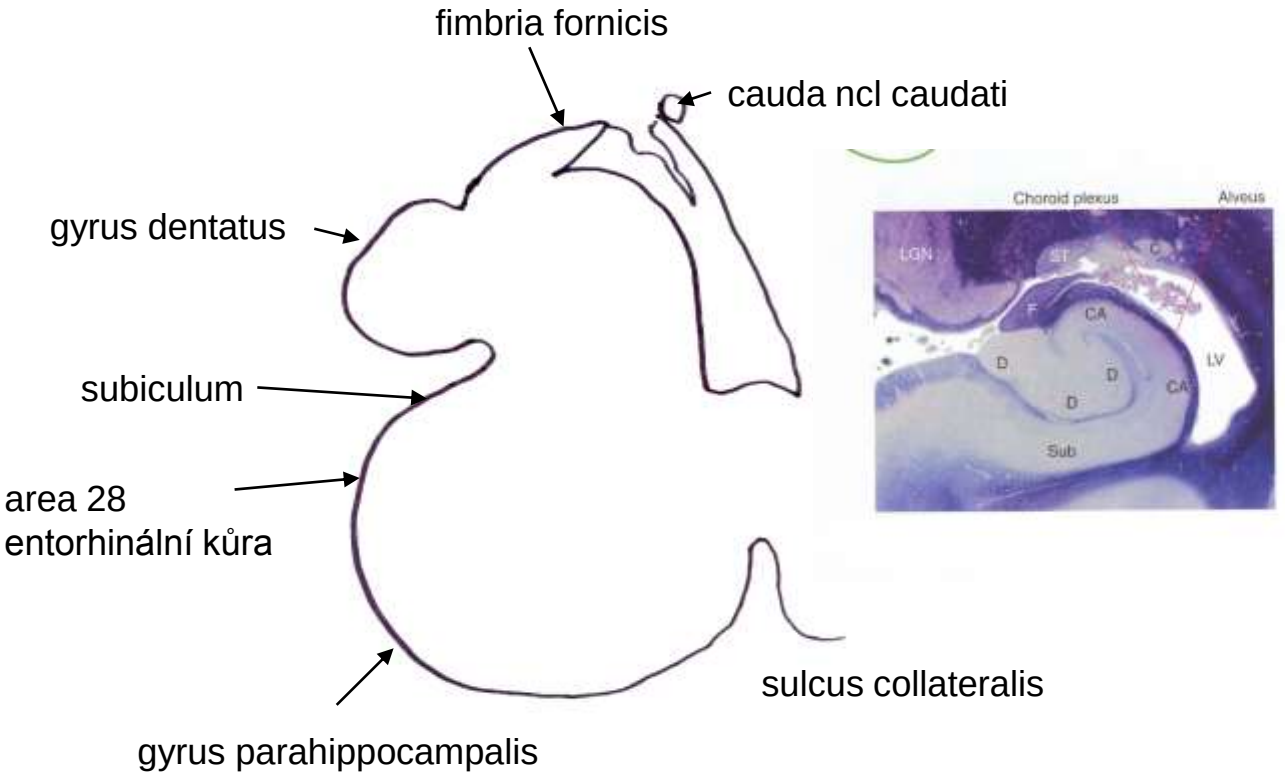


Hippocampus
and fornix
Dorsal aspect



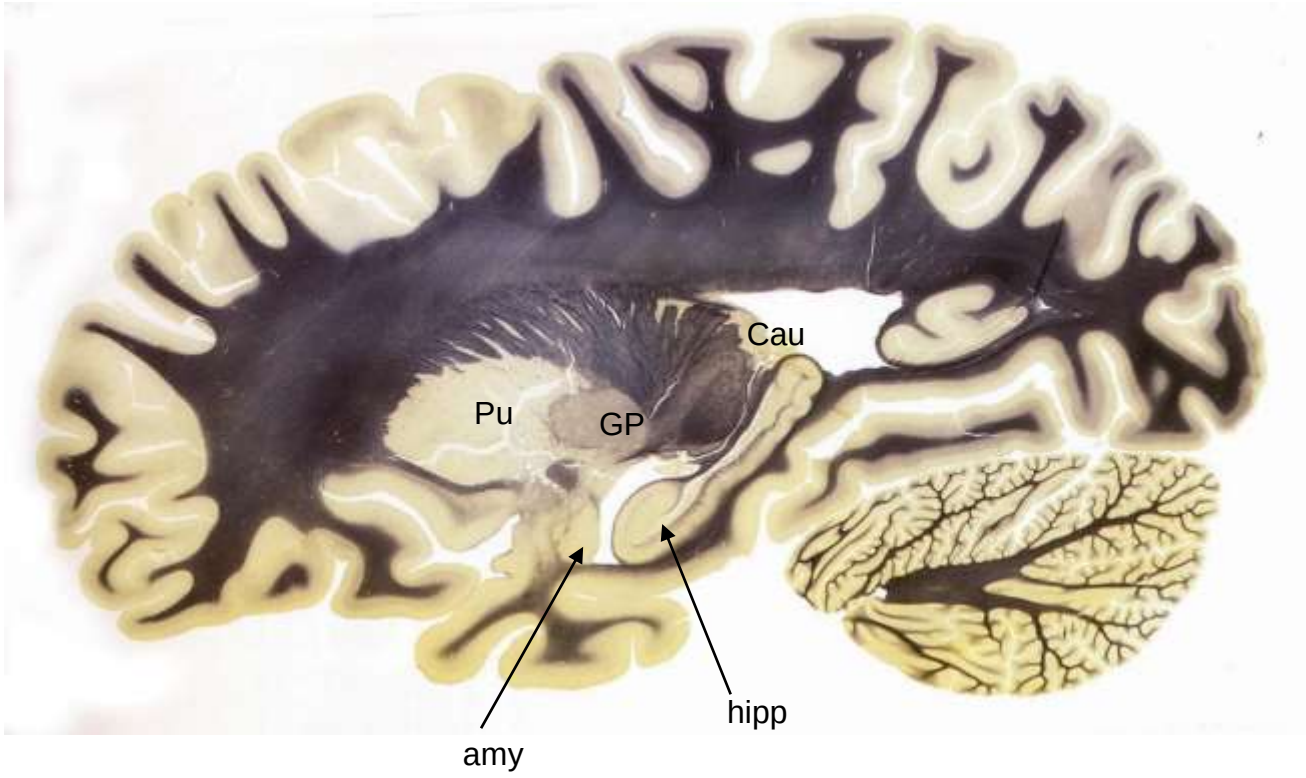

13 septum
commissura ant.
12 thalamus
16 stria olf. lat.
columna fornicis
8
8
ant. nuclei
11
1 amygdala
3
9
10
uncus
2
15
4b
corpus mammilare
2
2a
7 corpus fornicis
cornu Ammonis
subiculum
3
g. dentatus
5
4a
fimbria hippocampi
6b
6a
commissura fornicis
crus fornicis
4c
g. fasciolaris
14
indusium griseum
et striae longitudinales

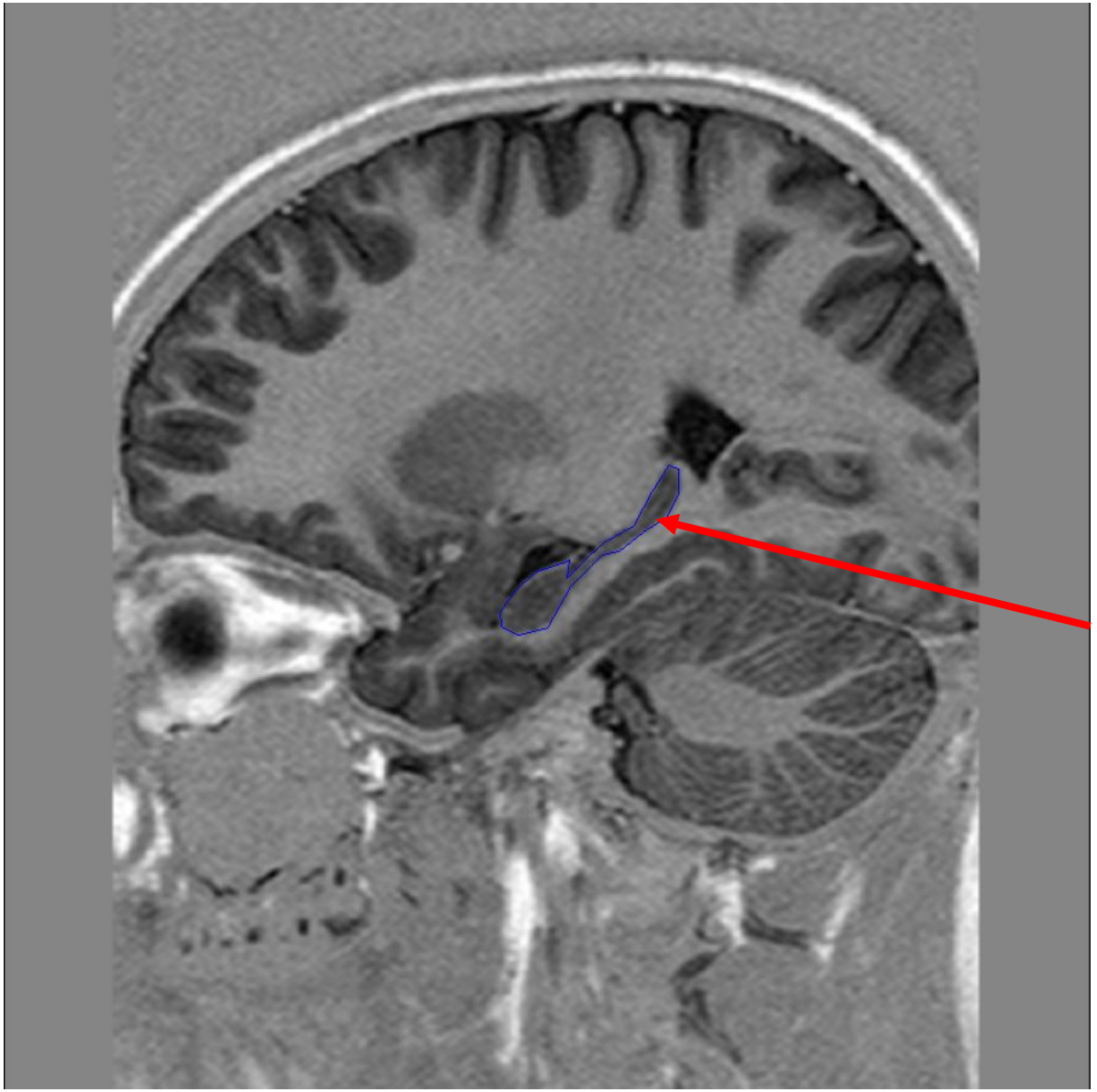
Frontal section of the hippocampus



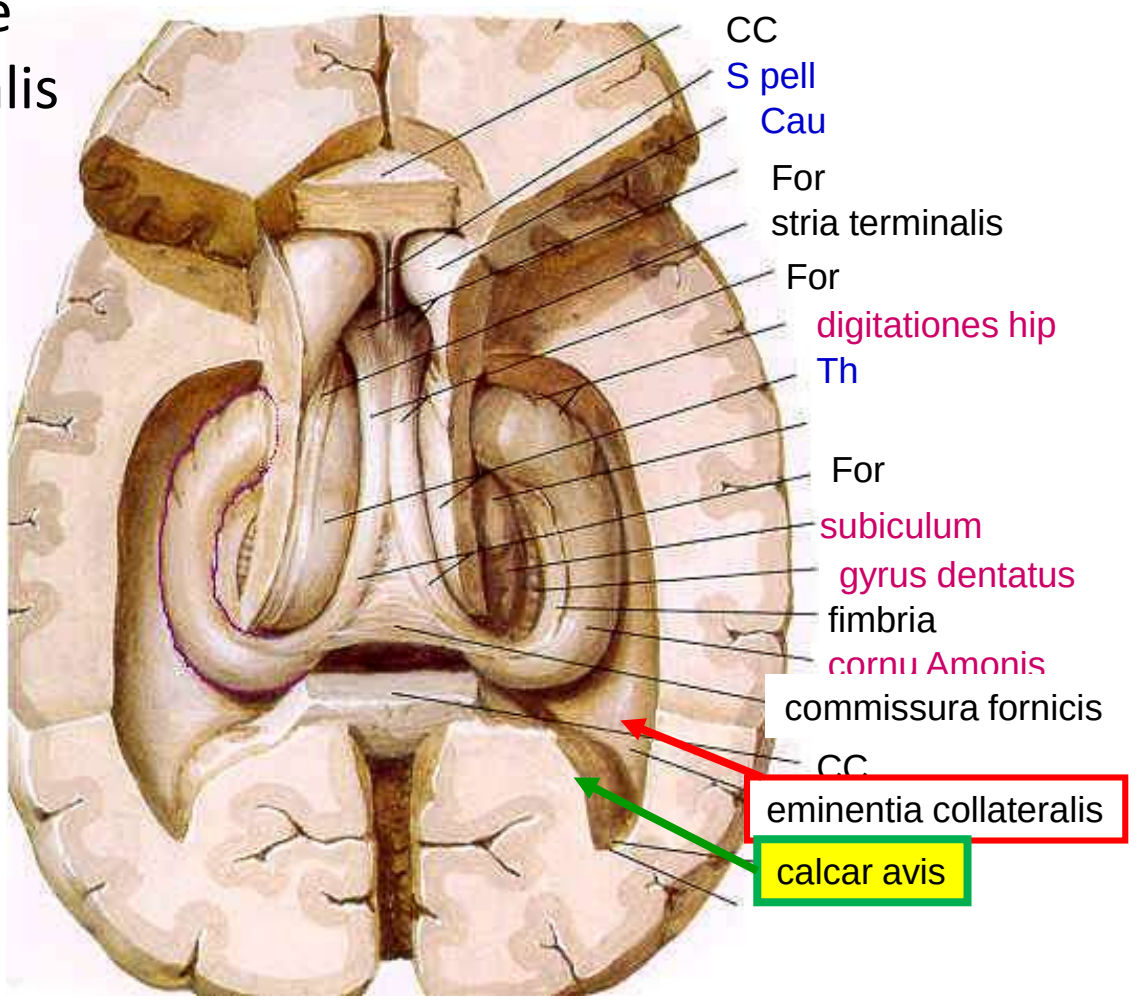
???

Sagittal section of the brain – silver impregnation

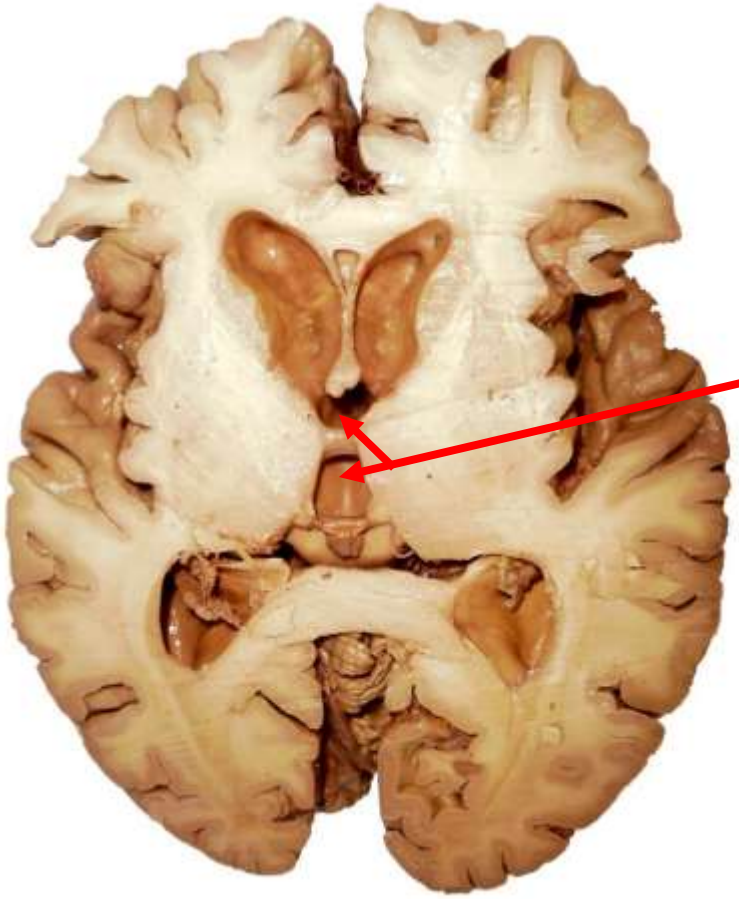



HIPPOCAMPUS

Cornu temporale and cornu occipitale ventriculi lateralis



Horizontal section through the interventricular foramen



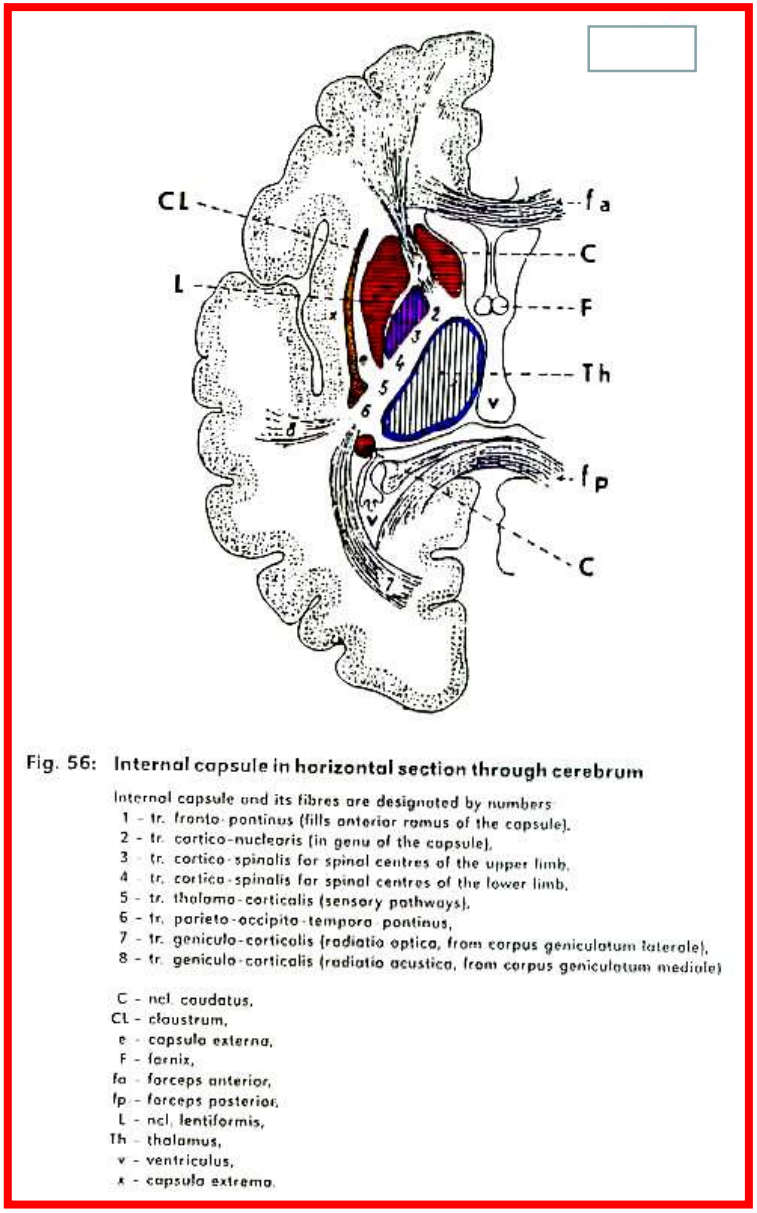
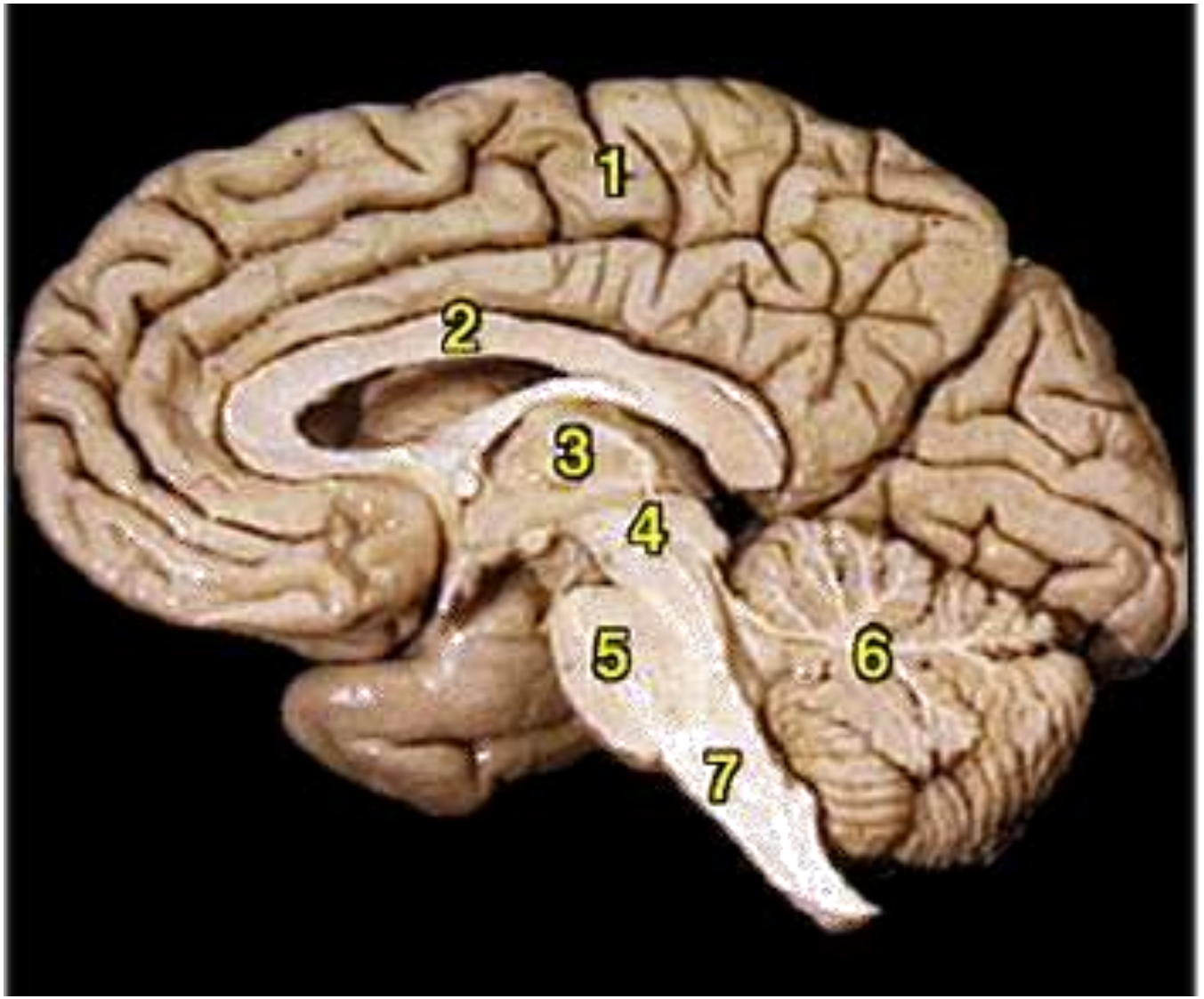


Fig. 56: Internal capsule in horizontal section through cerebrum

Internal capsule and its fibres are designated by numbers
1 - tr. fronto-pontinus (fills anterior ramus of the capsule),
2 - tr. cortico-nuclearis (in genu of the capsule),
3 - tr. cortico-spinalis for spinal centres of the upper limb,
4 - tr. cortico-spinalis for spinal centres of the lower limb,
5 - tr. thalamo-corticalis (sensory pathways),
6 - tr. parieto-occipito-tempora pontinus,
7 - tr. geniculo-corticalis (radiatio optica, from corpus geniculatum laterale),
8 - tr. geniculo-corticalis (radiatio acustica, from corpus geniculatum mediale)

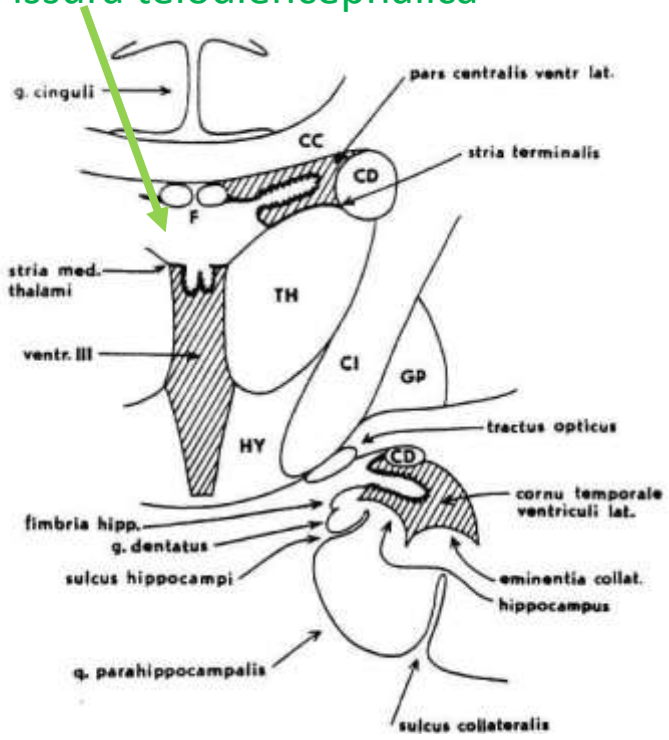
C - ncl. caudatus,
CL - claustrum,
e - capsula externa,
F - fornix,
fa - forceps anterior,
fp - forceps posterior,
L - ncl. lentiformis,
Th - thalamus,
v - ventriculus,
x - capsula extrema.

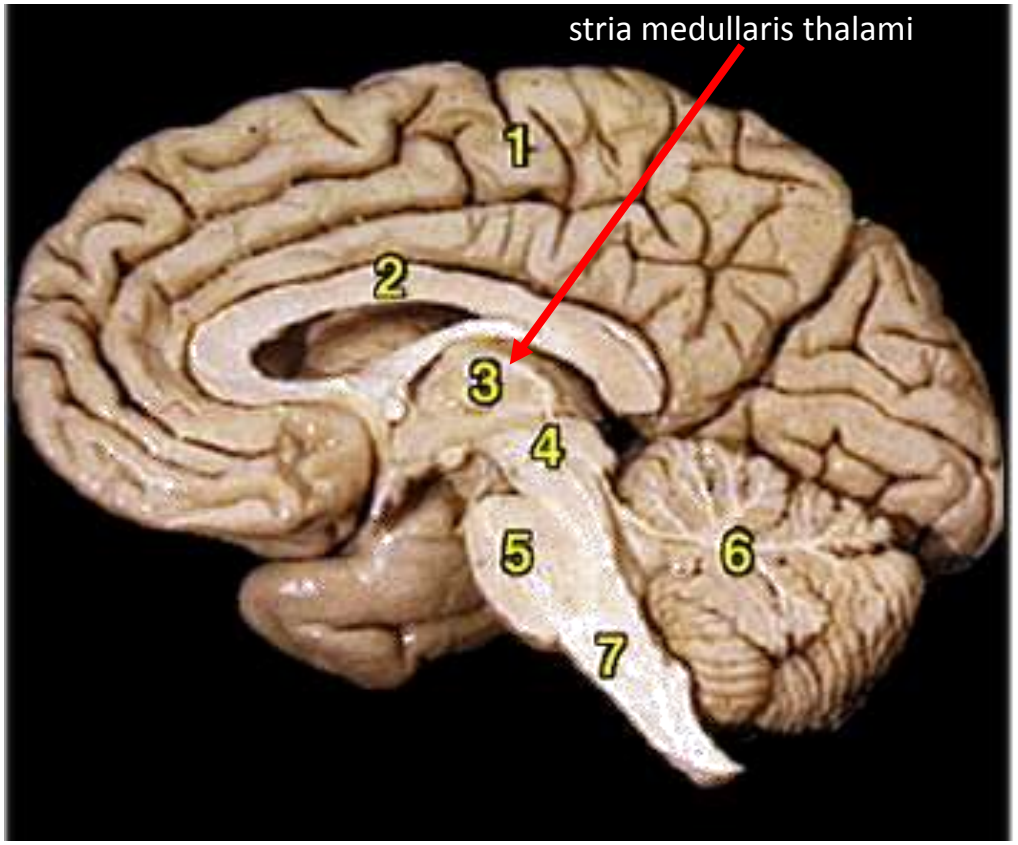
III. ventricle - inside of diencephalon



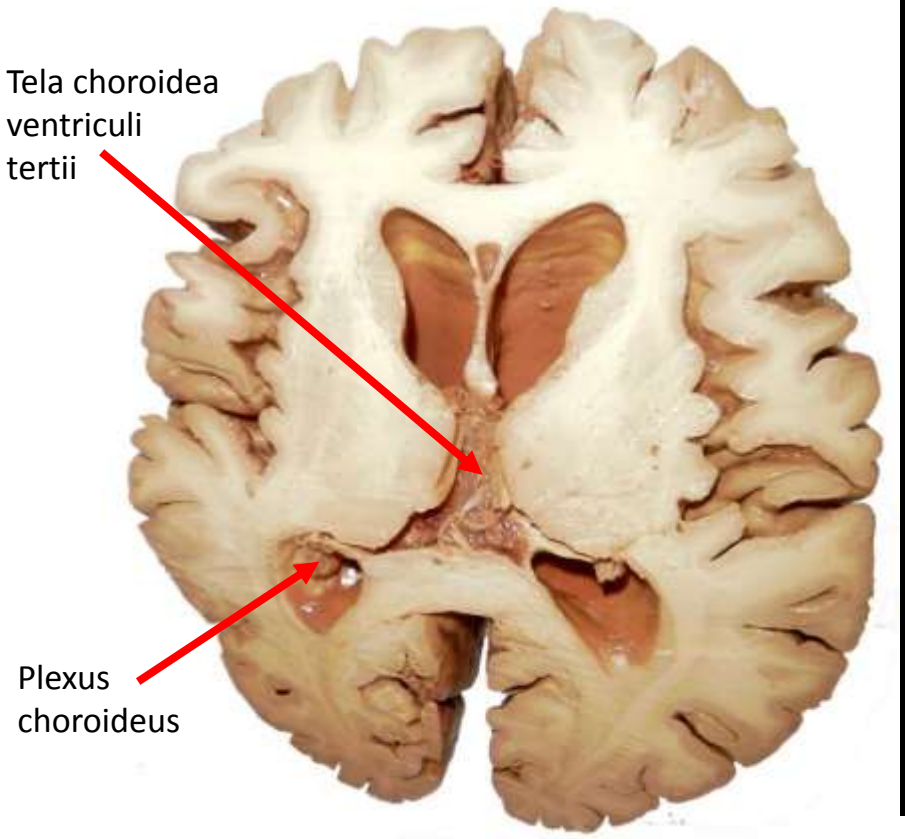
III. ventricle – sagittal fissure, a roof of it is attached to stria medullaris thalami

Fissura telodiencephalica



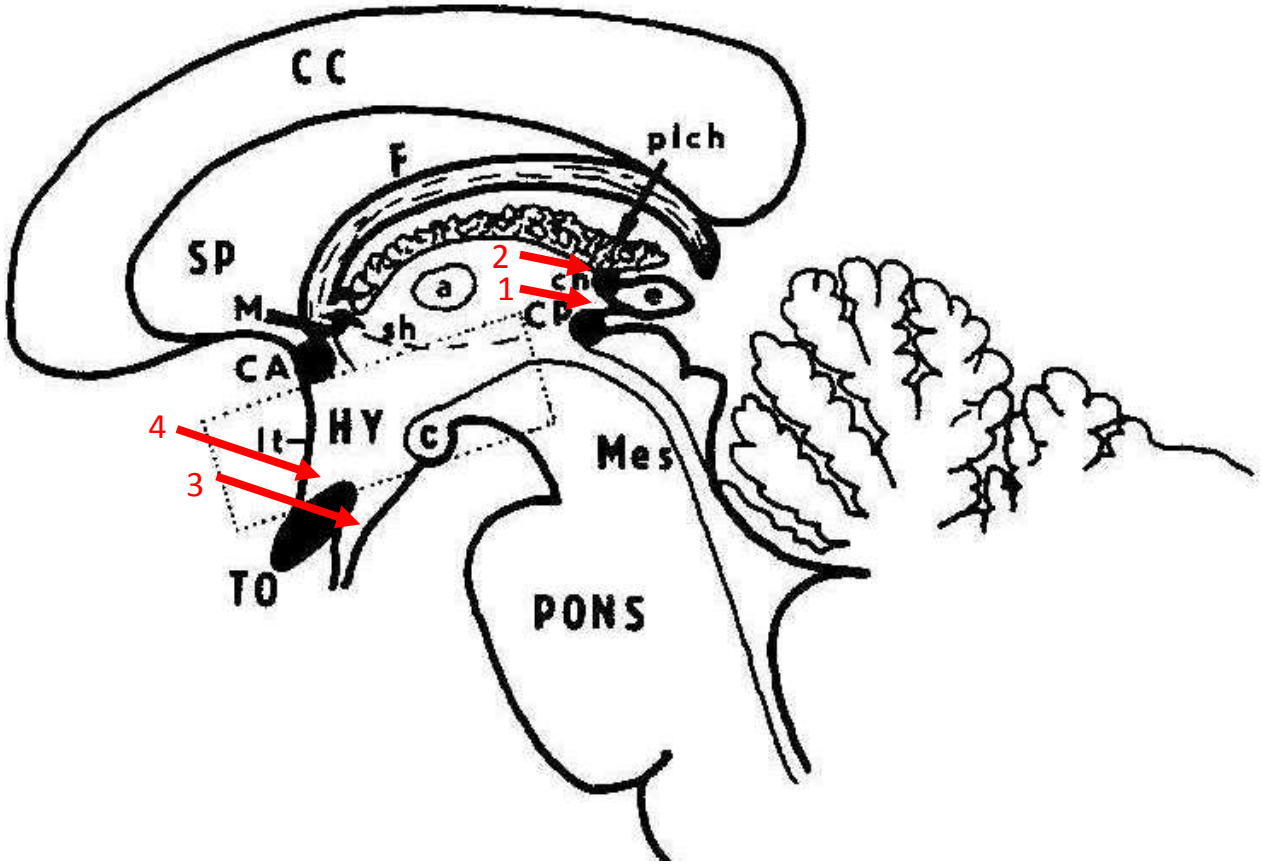


Horizontal section

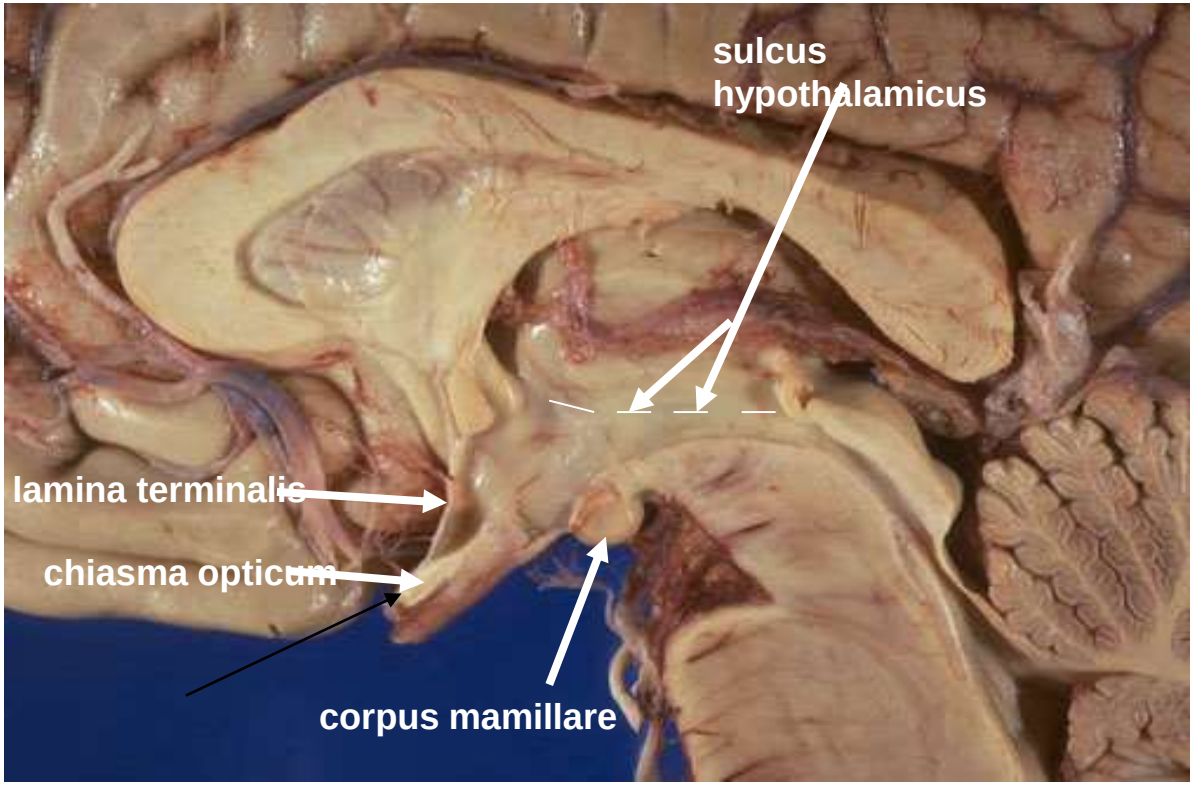


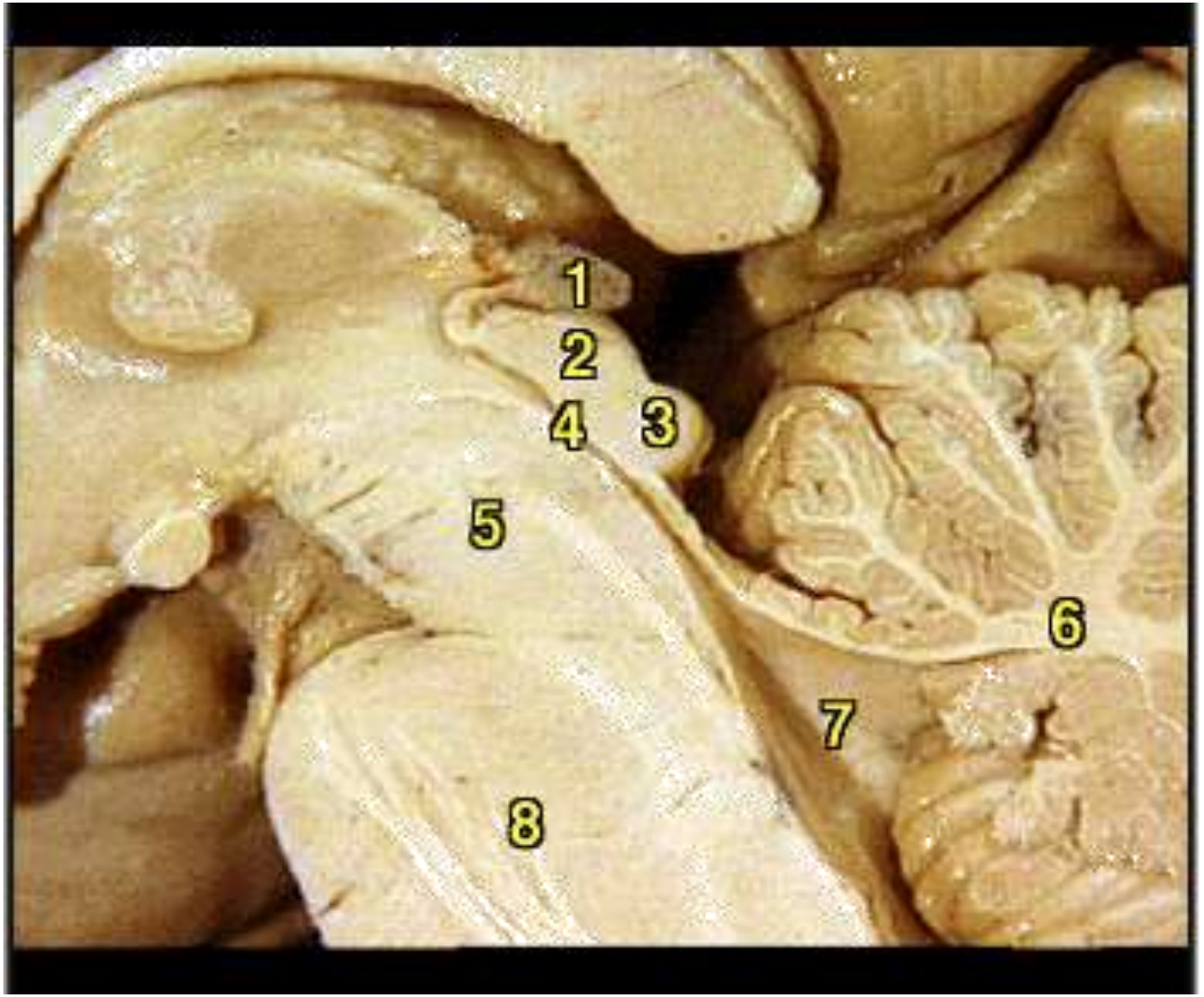
Recesses of the III. ventricle

- 1 pineal 2 suprapineal, 3 infundibular, 4 suprachiasmatic

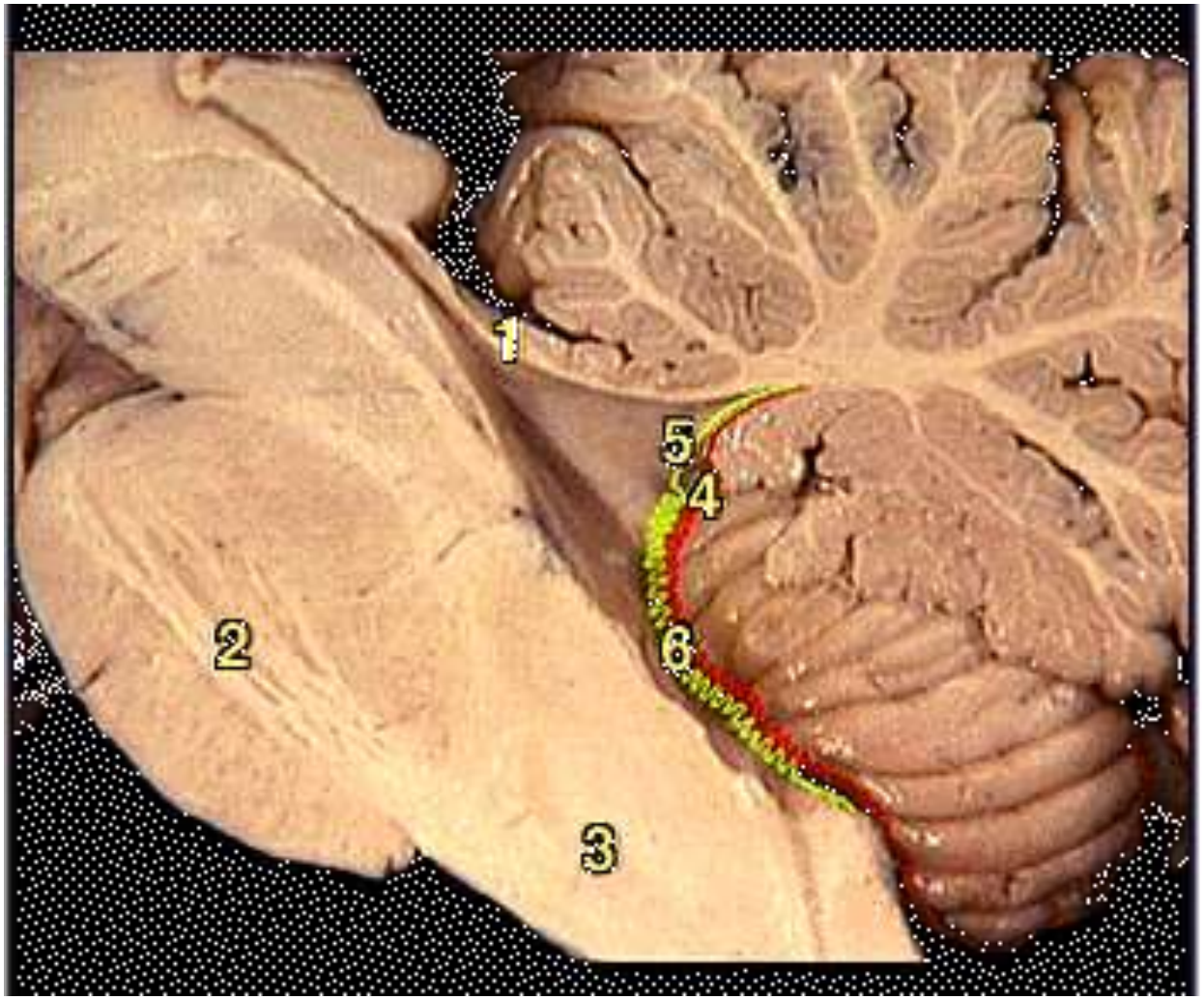


III. ventricle



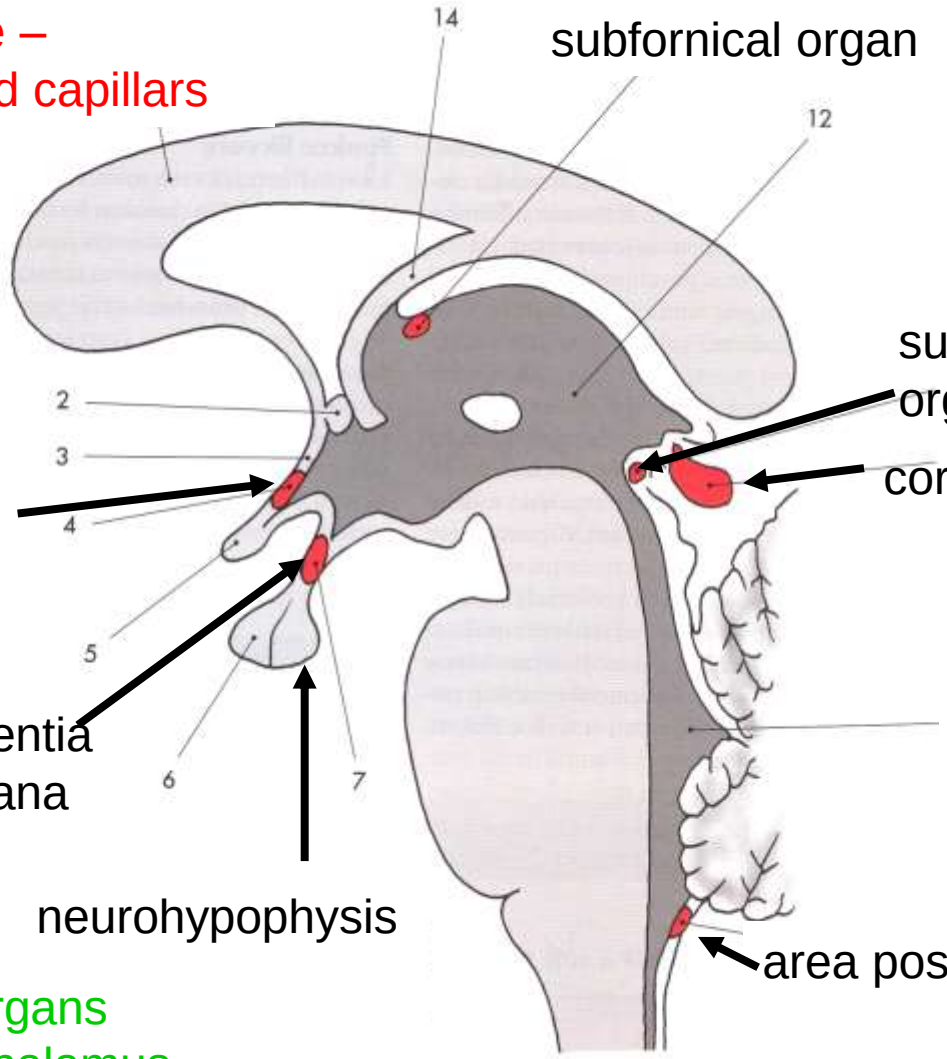

1
2
3
4
5
6
7
8

Aquaeduct + IV. ventricle



Circumventricular organs

Blood-brain barrier is permeable – fenestrated capillars



subfornical organ

chemoreceptors

subcommissural organ

corpus pineale

vascular organ of the lamina terminalis

eminentia mediana

neurohypophysis

area postrema

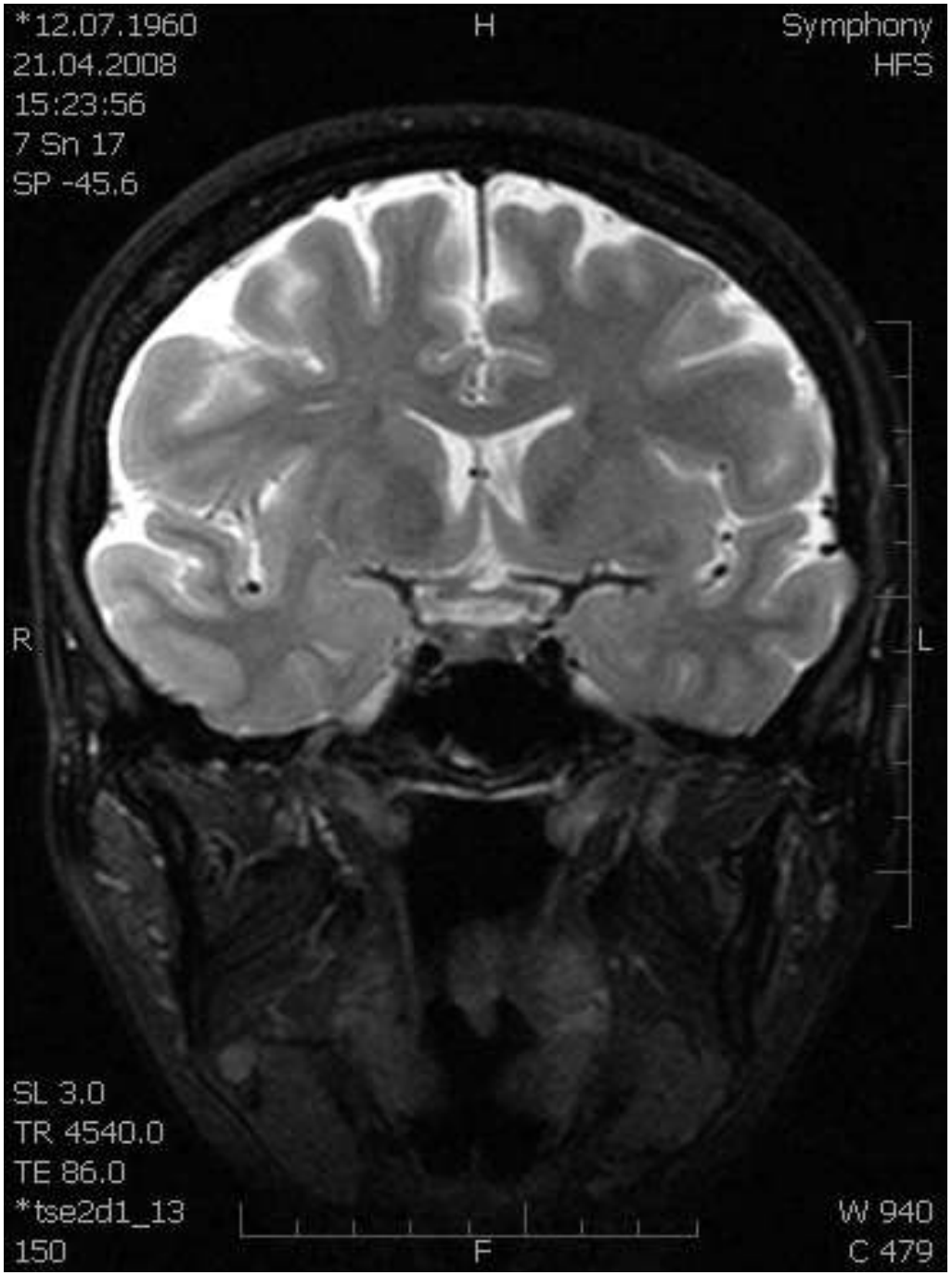
Neurons of these organs project to the hypothalamus

Circumventricular organs in the rat brain

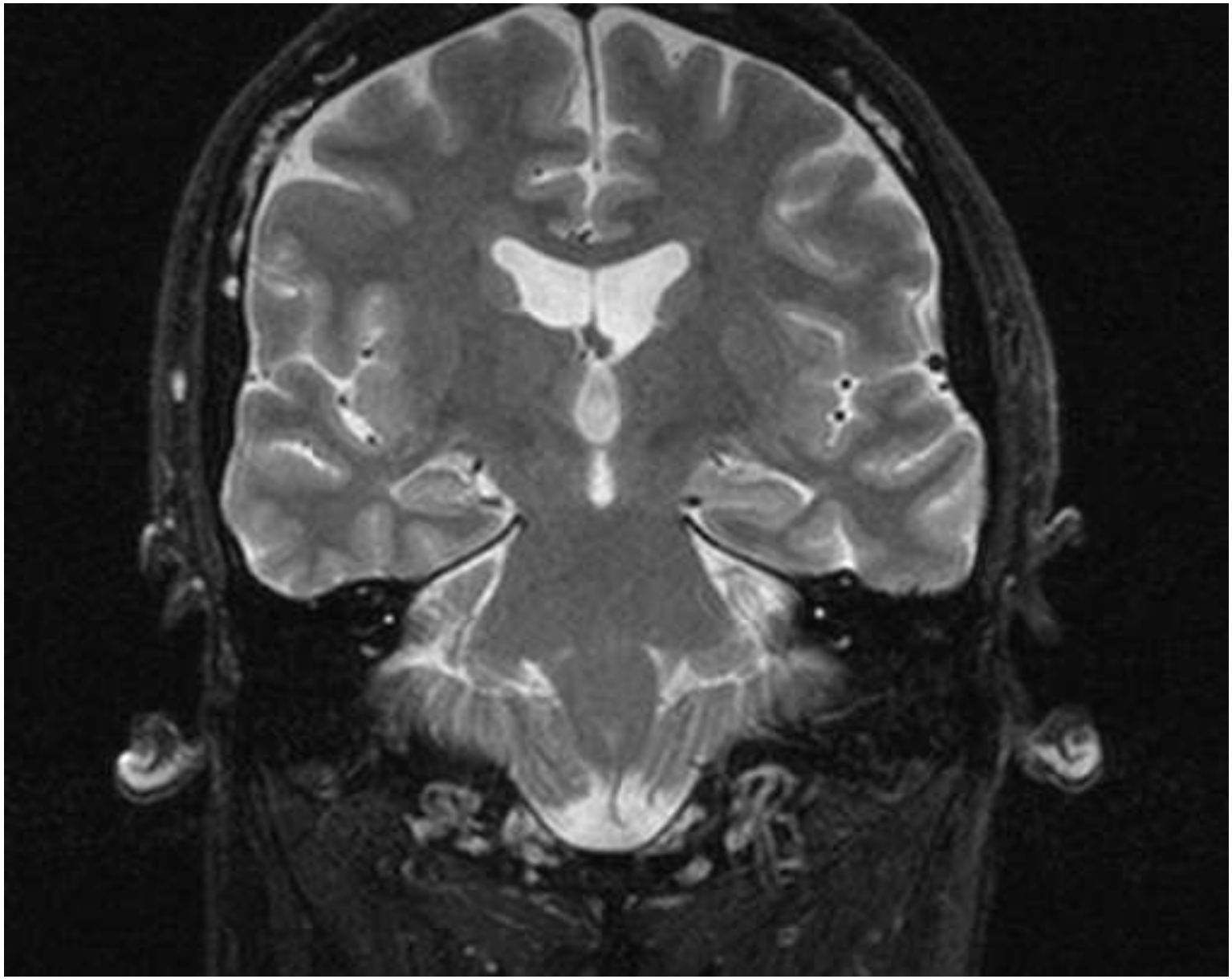
chemoreception

area postrema
organum subfornicale
organum subcomissurale
eminentia mediana
neurohypophysis
corpus pineale
organum vasculosum laminae terminalis

MR – T2


*12.07.1960
21.04.2008
15:23:56
7 Sn 17
SP -45.6
H
Symphony
HFS
R
L
SL 3.0
TR 4540.0
TE 86.0
*tse2d1_13
150
F
W 940
C 479

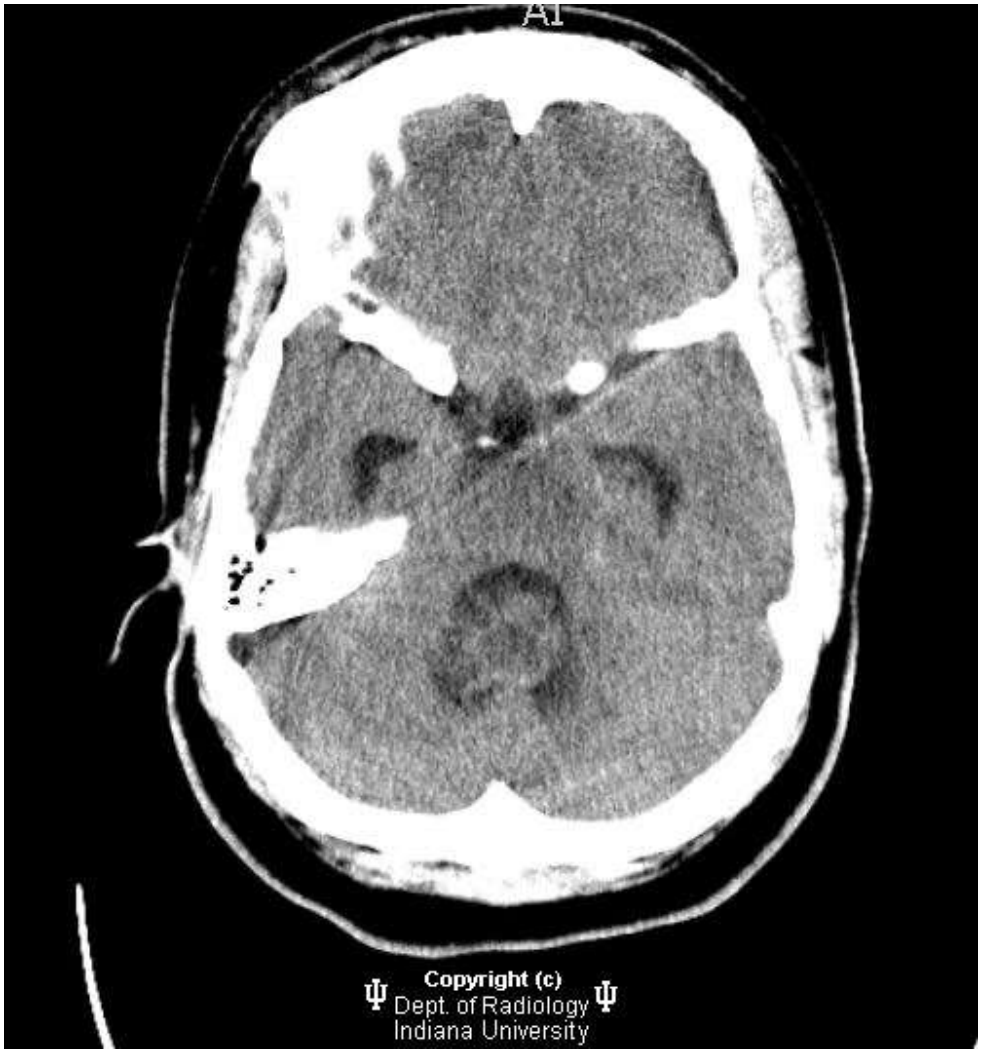
MR – T2



MR – T2

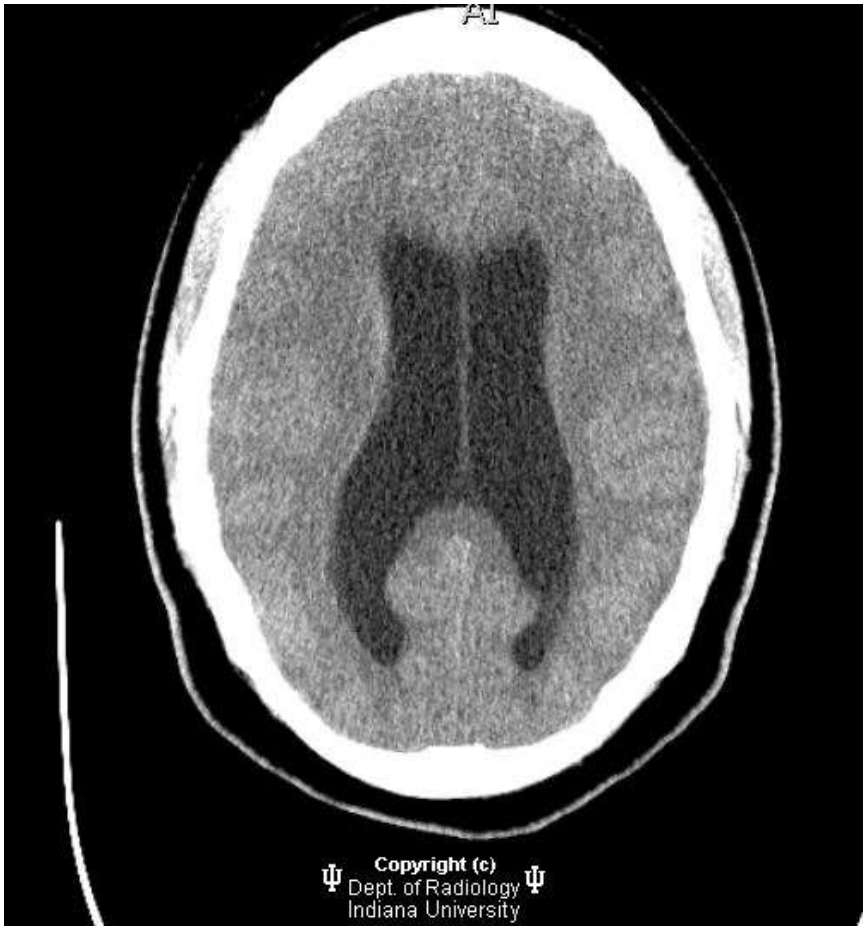

*12.07.1960
21.04.2008
15:19:17
4 Sn 11
SP -0.9
H
Symphony
HFS
A
P
SL 3.0
TR 3700.0
TE 102.0
*tse2d1_13
160
F
W 962
C 478

Woman with headaches

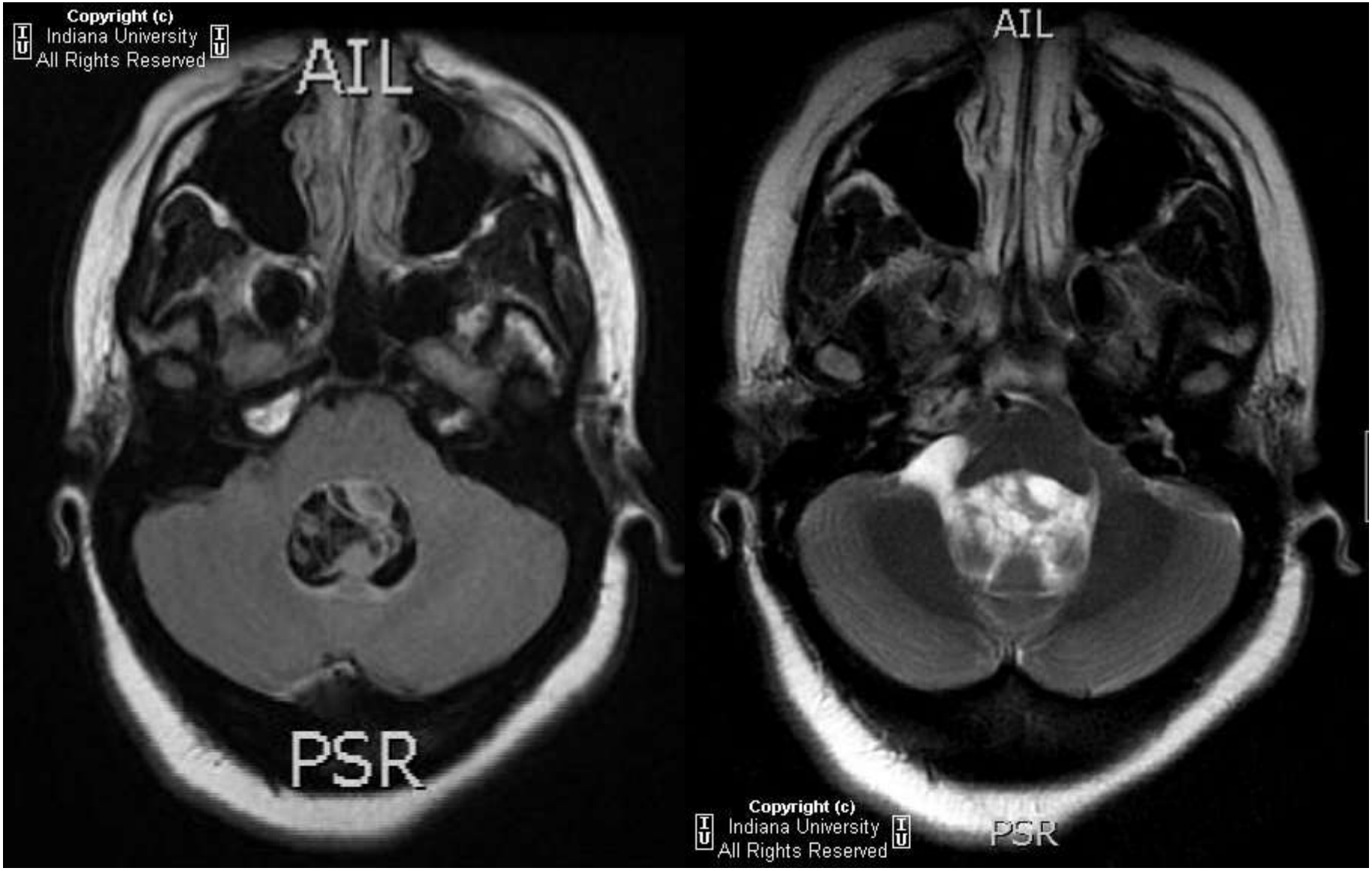


- **CT: Heterogeneous 2 cm mass within the fourth ventricle causing hydrocephalus**

Significant dilation of the bilateral lateral ventricles and third ventricles secondary to the tumor filling the distended fourth ventricle and outlet foramina



MRI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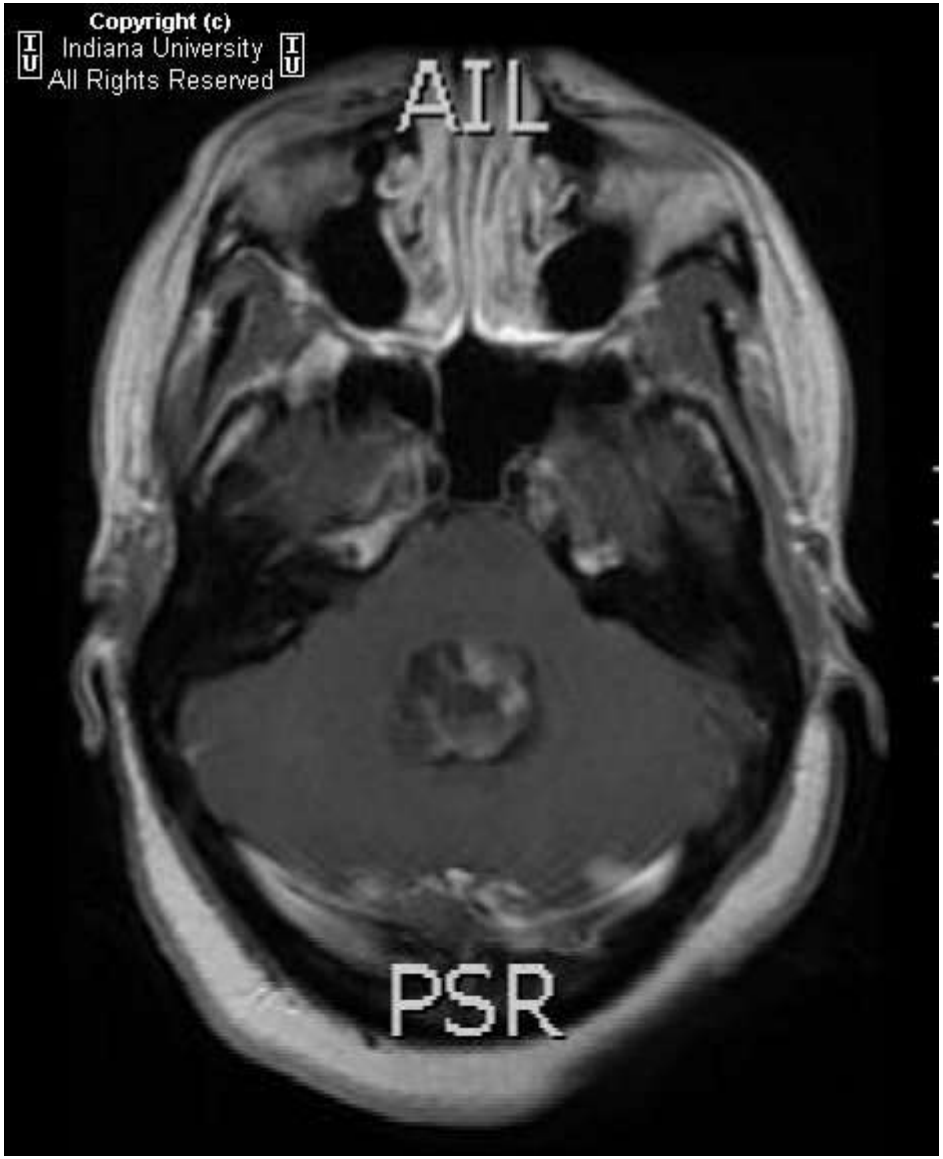
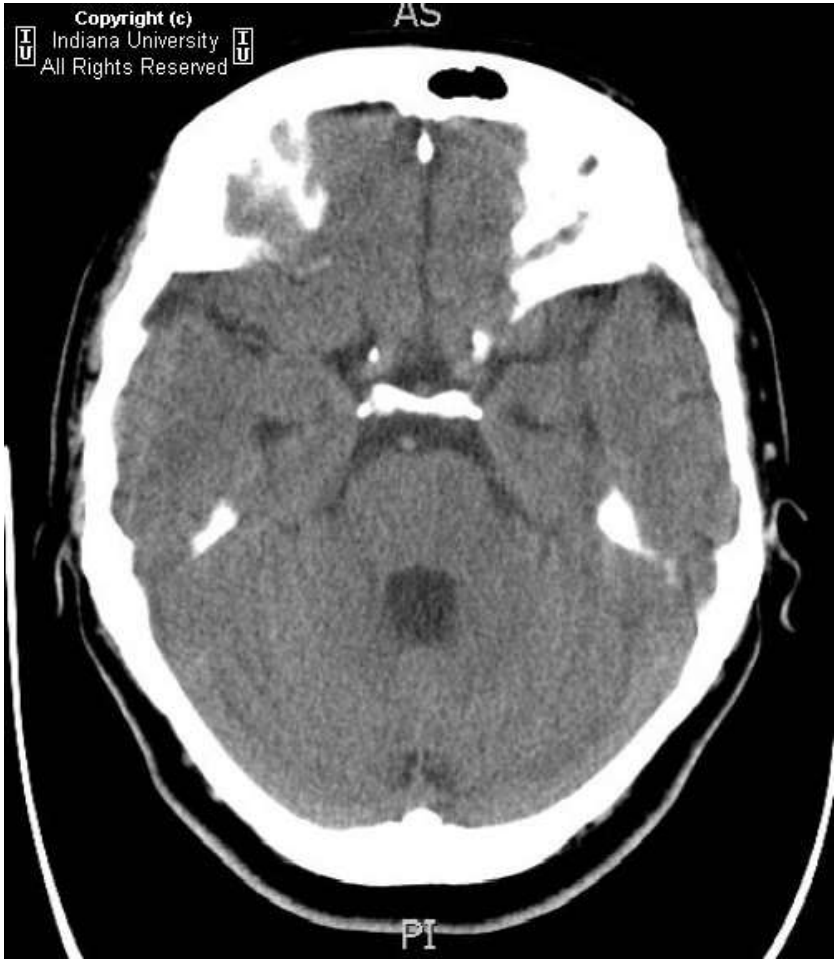


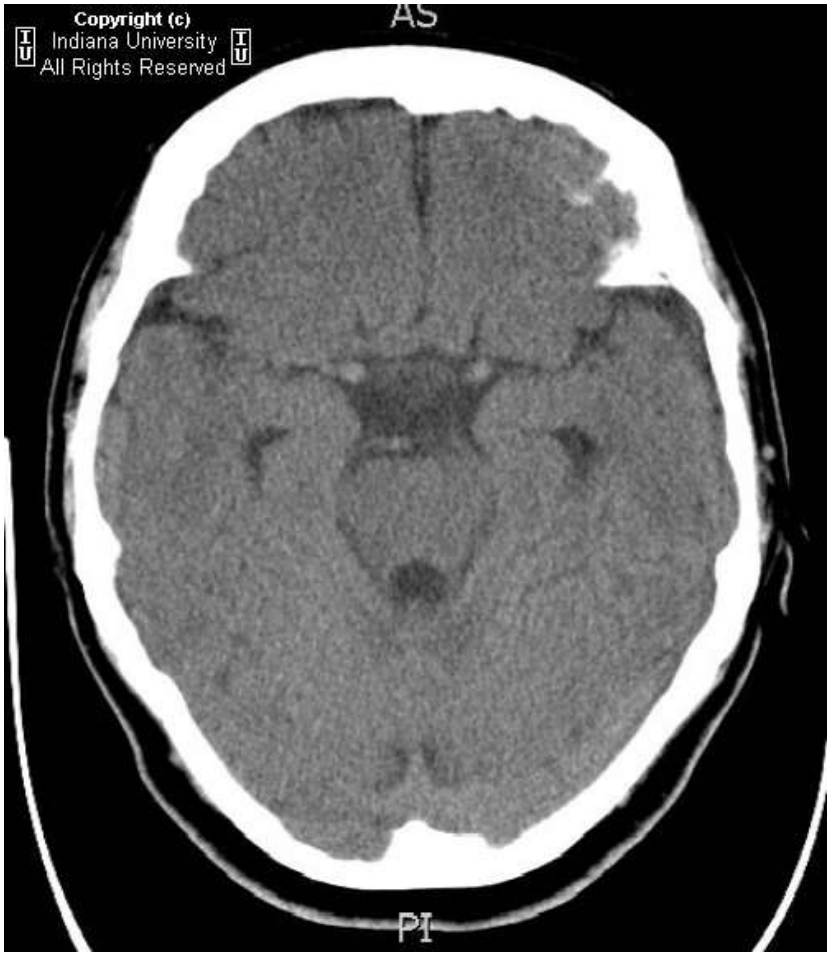
MRI: Large mixed solid and cystic mass predominantly T1 isointense and T2 hyperintense) centered within the fourth ventricle with indistinct interface along the 4th ventricular floor. The small solid components of the intraventricular mass enhance avidly. A moderate degree of obstructive hydrocephalus is present, with significant dilation of the bilateral lateral ventricles and third ventricles secondary to the tumor filling the distended fourth ventricle and outlet foramina.

Ependymoma:

- **Arise from ependymal cells or ependymal cell rests.**
- **> 60% are located in the fourth ventricle**
- **More common in children than adults**
- **"Soft" tumor which accommodates to shape of cisterns or ventricles and often extends into cerebellar pontine angle or cisterna magna.**
- **Heterogeneous on CT often with calcifications**
- **On MRI is T1 isointense and T2 hyperintense**
- **Generally contains enhancing portions, but variable**
- **Can be associated the NF2 (chromosome 22 defect)**
- **Most common presentation is child with headache and vomiting.**
- **Bimodal age distribution: 5 and 30.**
- **Treatment: surgical resection +/- chemo/radiation therapy**
- **5 year survival 60-70%.**
-

60-year woman with worsening cognitive impairment and gait disturbance



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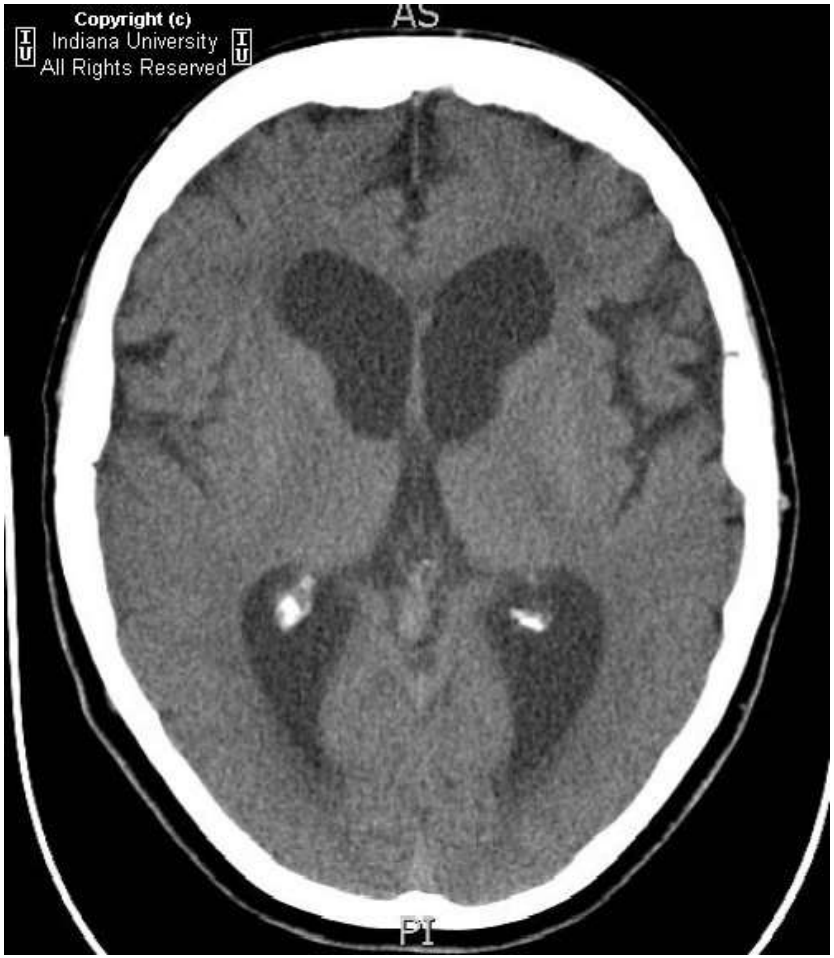
AS
PI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AS
PI

Substantial enlargement of the 3rd, 4th, and lateral ventricles.
Relative normal appearance of sulci for age.
No evidence of substantial vascular pathology.

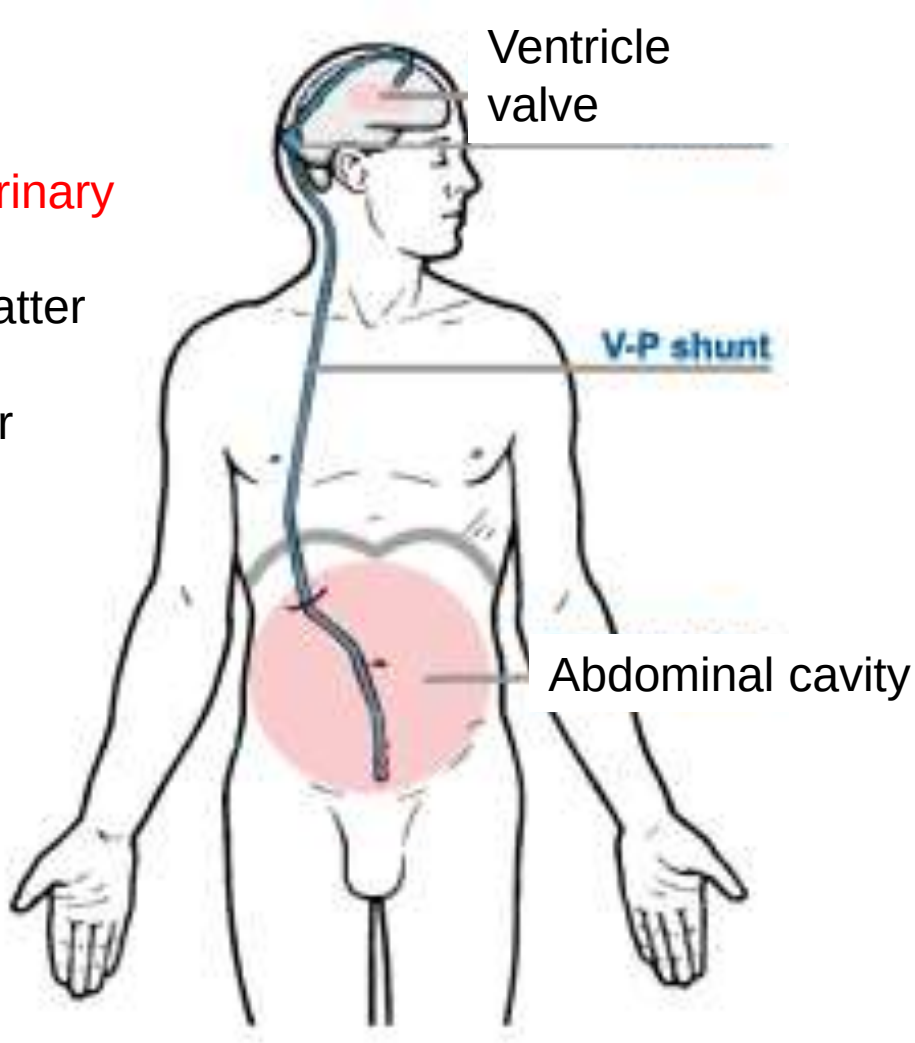
Normal pressure hydrocephalus

- Classical clinical triad of **dementia, gait disturbance, and urinary incontinence** is seen with normal pressure hydrocephalus.
- Symptoms result from distortion of white matter by distended ventricles.
- Patients commonly have a history of prior SAH or meningeal infection.
- Gradient between ventricular system and subarachnoid space due to incomplete subarachnoid block.
- **Radiographic key: Diffuse ventriculomegaly out of proportion to sulcal prominence.**
- **Not a radiographic diagnosis. Diagnosis made by improvement of symptoms after shunting.**
- **Radioisotope cisternogram shows early entry into the lateral ventricles with persistence at 24-48 hours and delayed ascent to parasagittal regions.**
- **Flow void can be seen through the aqueduct of Sylvius on MR due to increased flow velocity**

Normal pressure hydrocephalus

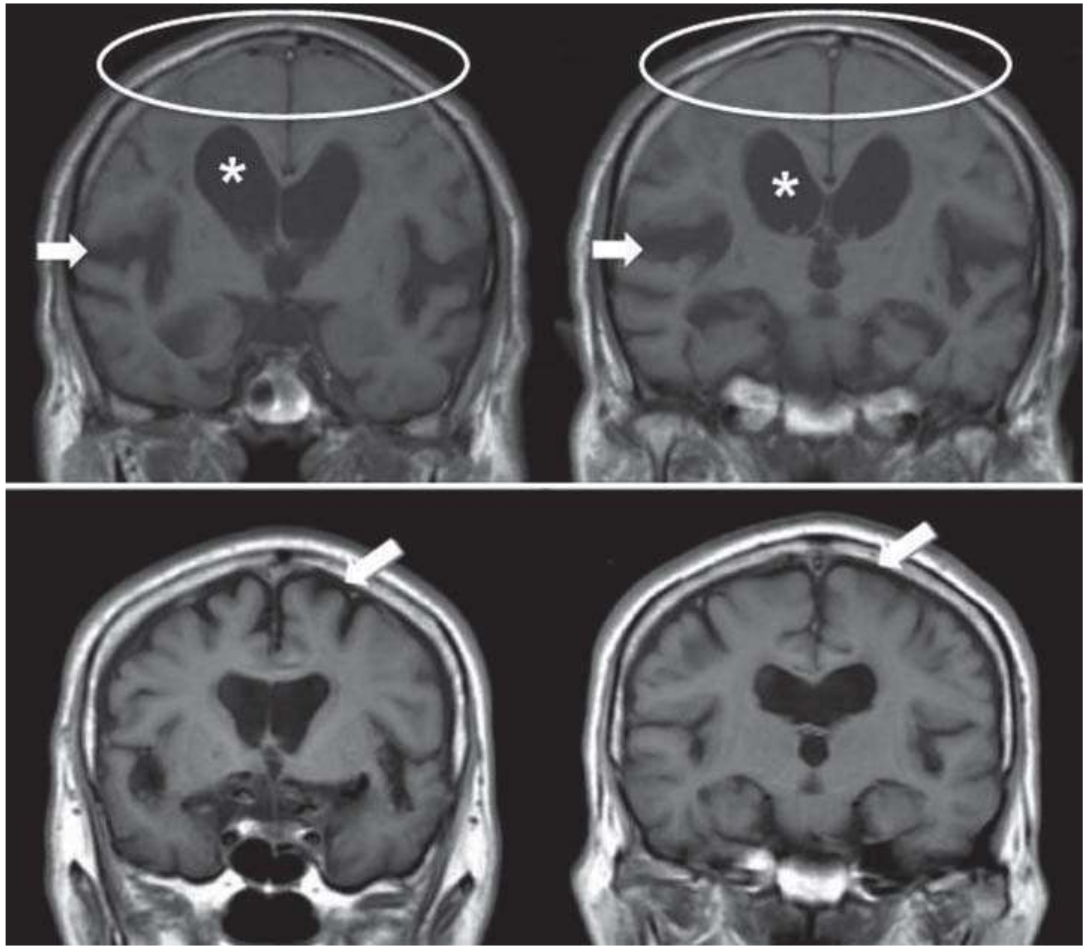
From decreased absorbtion
Trias: Dementia, gait abnormalities, urinary incontinence
From the compression of the white matter by enlarged ventricles
Often after subrachnoid hemorhage or meningitis

The only treatable dementia



Sameš, Ústí nad Labem

Normal pressure hydrocephalus (NPH)



MUDr. Václav Vybíhal
Neurochirurgická klinika, LF MU a FN Brno

Upper figures

Typical MRI in NPH coronal plane T1W

Dilateted ventricles (*), flattened gyri and no sulci (oval) and increased Sylvian fissura (arrow).

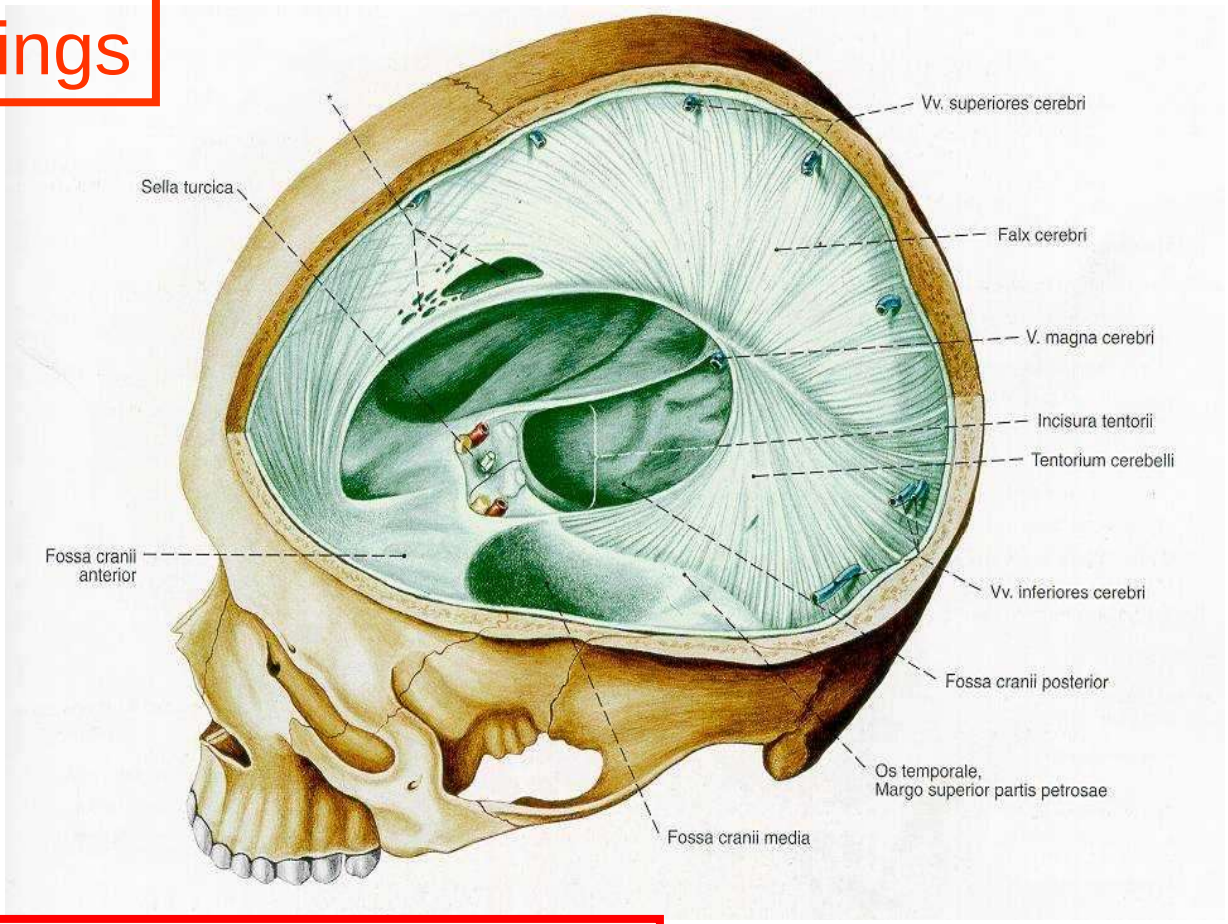
Lower figures

difuse dilatation of subarachnoid spaces (arrow) and enlarged ventricles

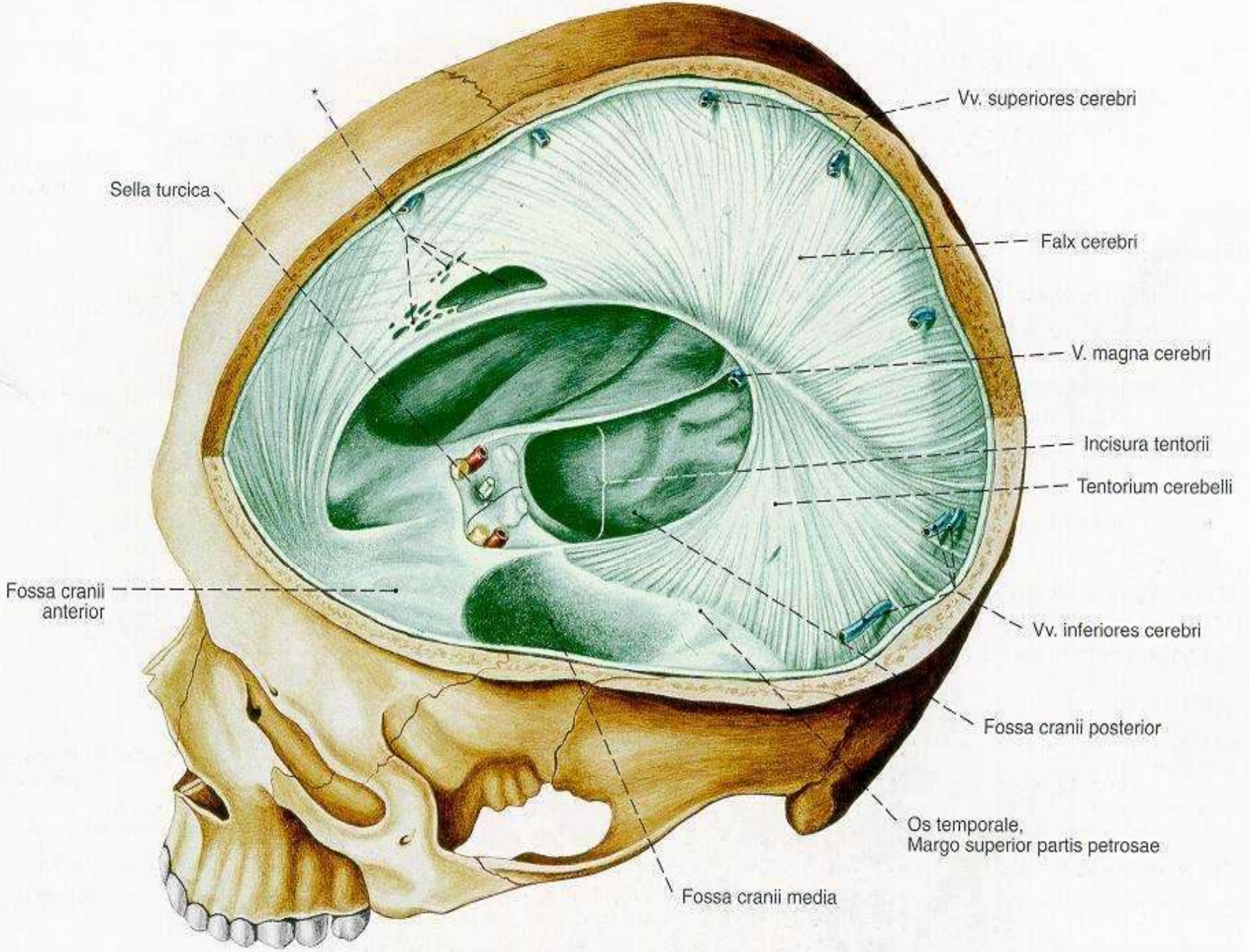
Brain atrophy

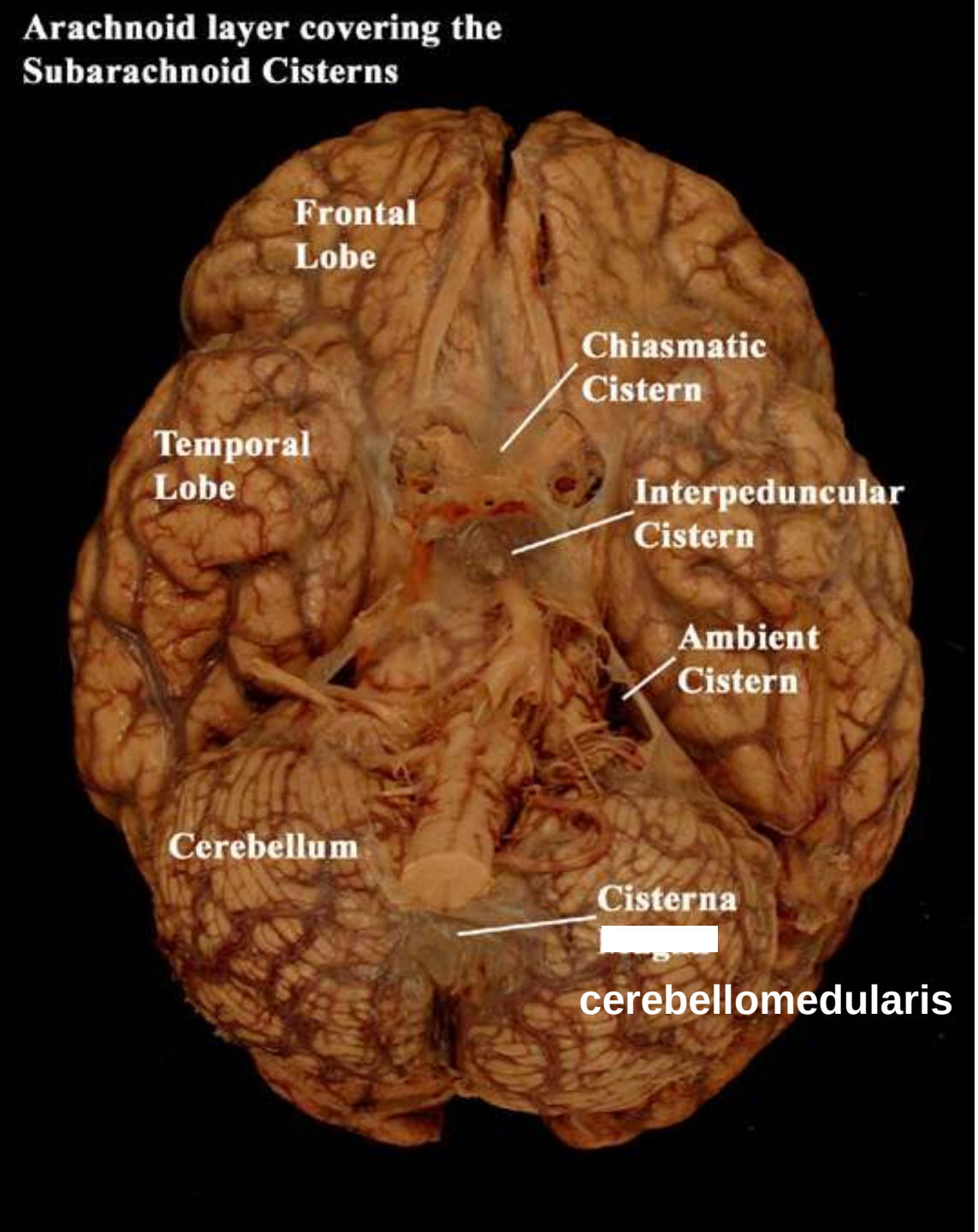
http://www.neurologiepropraxi.cz/pdfs/neu/2011/06/09.pdf

Coverings



Dura mater outermost layer
closely attached to the periosteum
Makes a wall of sinuses
Divides the hemispheres
Divides the cerebellum and occipital lobes
Divides subdural and epidural space


Vv. superiores cerebri
Sella turcica
Falx cerebri
V. magna cerebri
Incisura tentorii
Tentorium cerebelli
Fossa cranii anterior
Vv. inferiores cerebri
Fossa cranii posterior
Os temporale,
Margo superior partis petrosae
Fossa cranii media



ARACHNOID
thin avascular membrane
not reaching the deeper fissures
Divides subdural and
subarachnoidal space

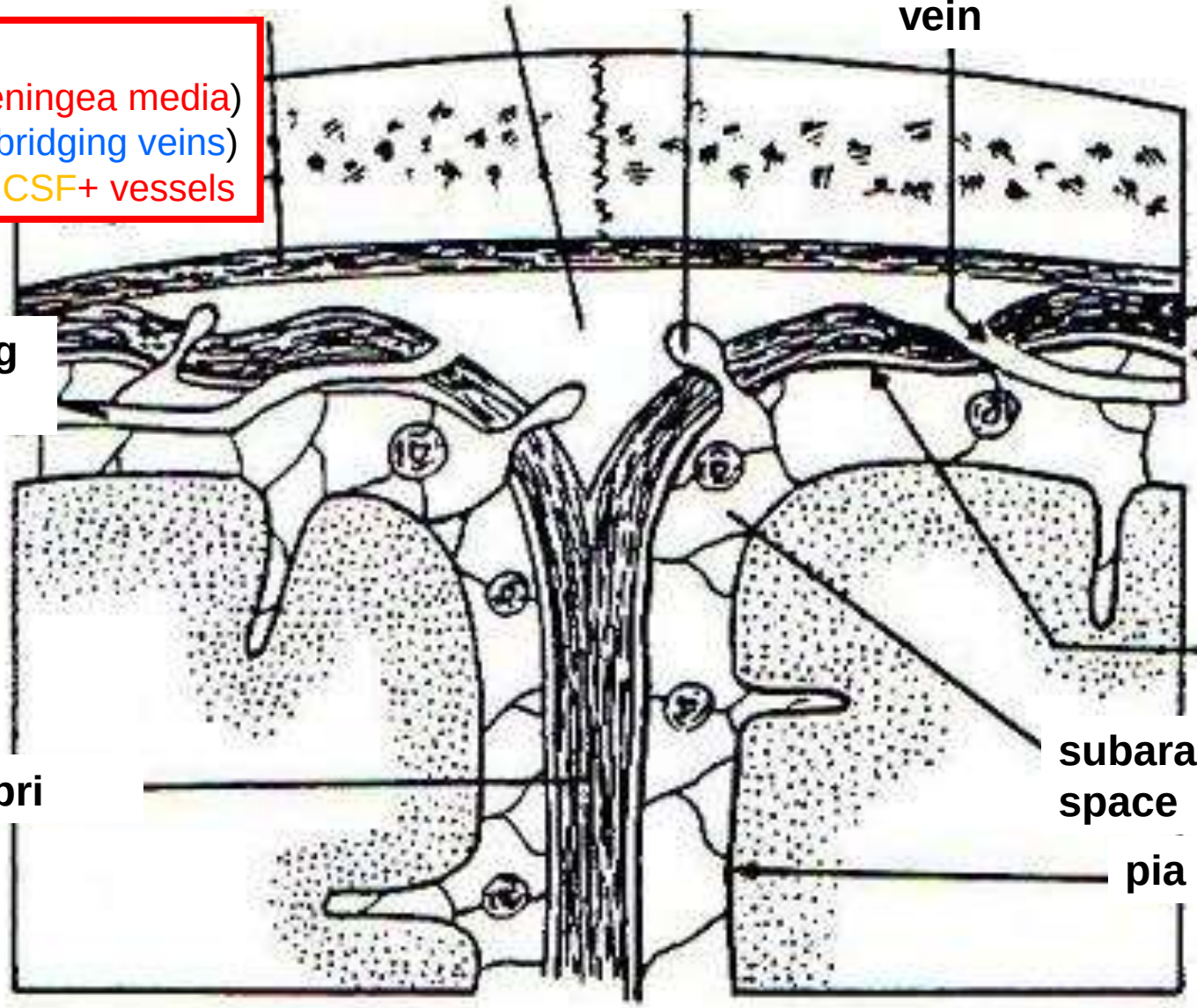
PIA MATER
Vascular layer closlely attached to
the brain surface

Cisternae subarachnoidales

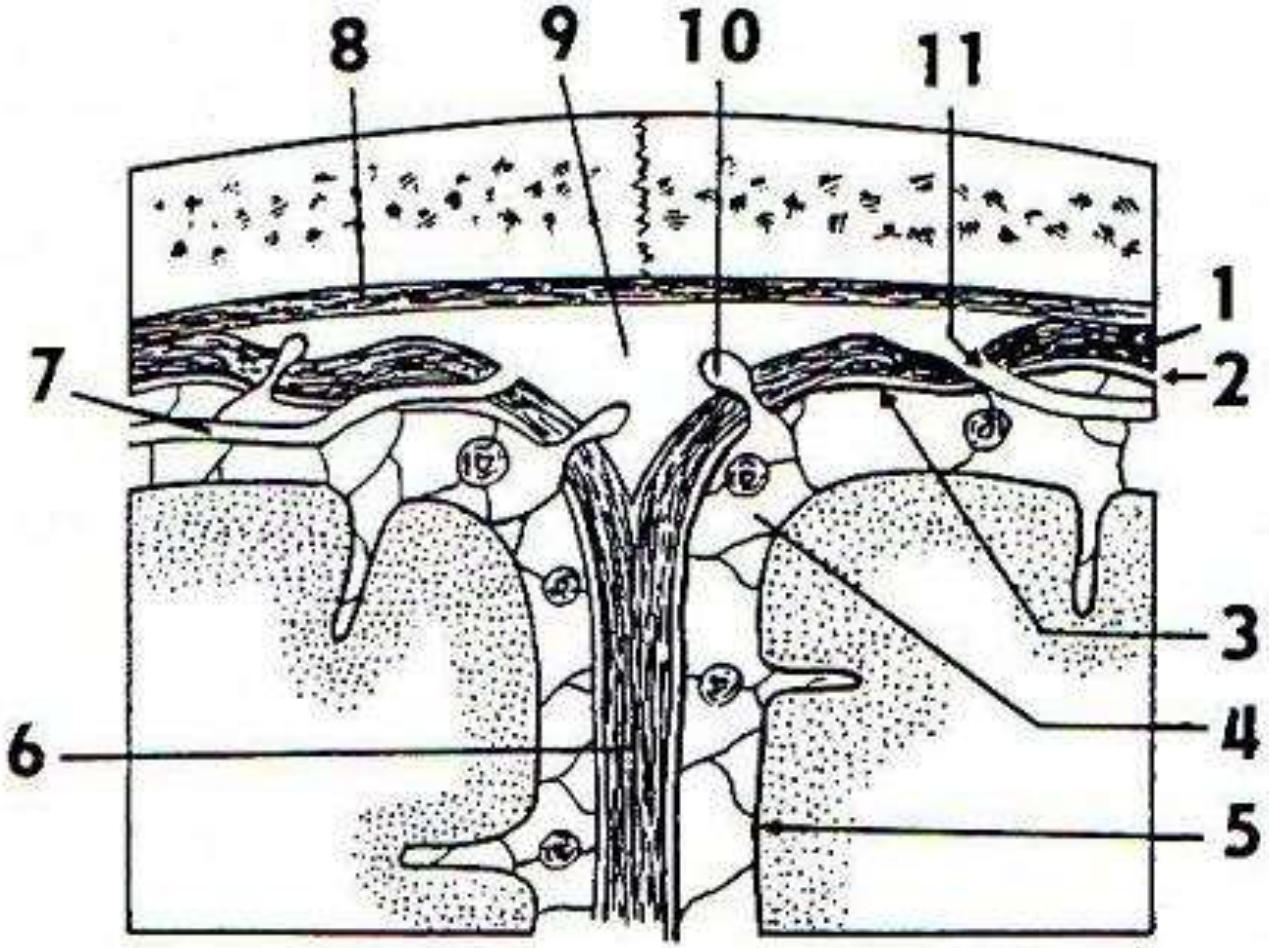
Cisterna fossae lateralis cerebri
Cisterna pontis
Cisterna laminae quadrigeminae
Cisterna corporis callosi

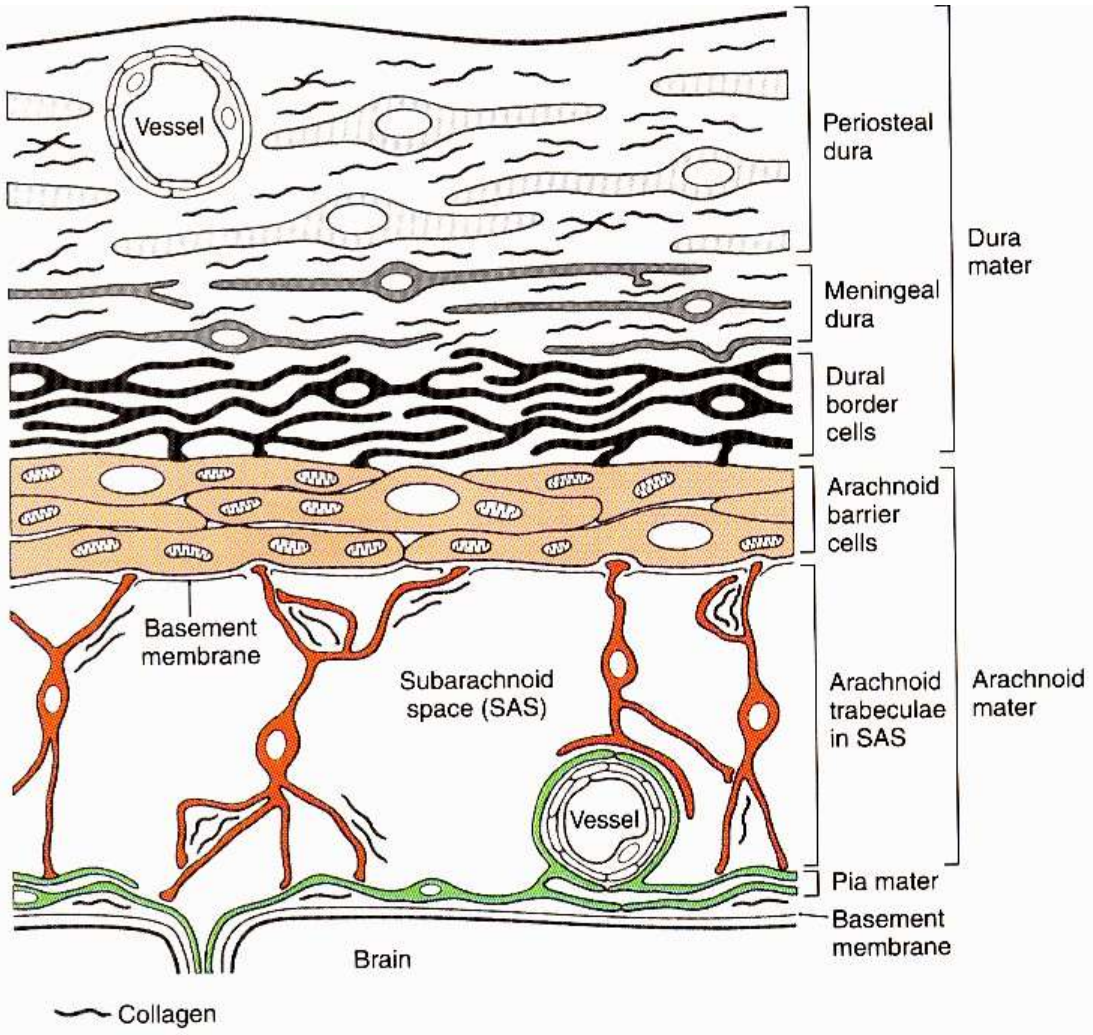
Granulationes arachnoidales

Spaces:
Epidural (a.meningea media)
Subdural (ovebridging veins)
Subarachnoid CSF+ vessels



Repetition





Dura mater

Arachnoidea

Pia mater

Spinal cord - meninges

Endorhachis

Cavitas epiduralis – žilní pleteně

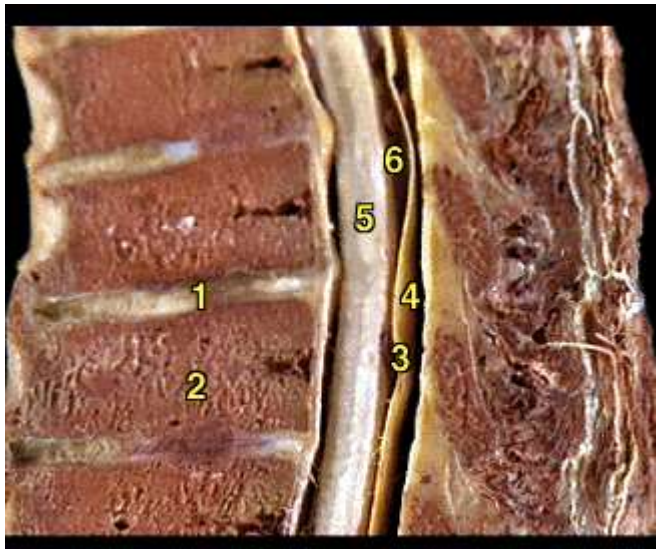
Dura mater spinalis

Cavum subdurale

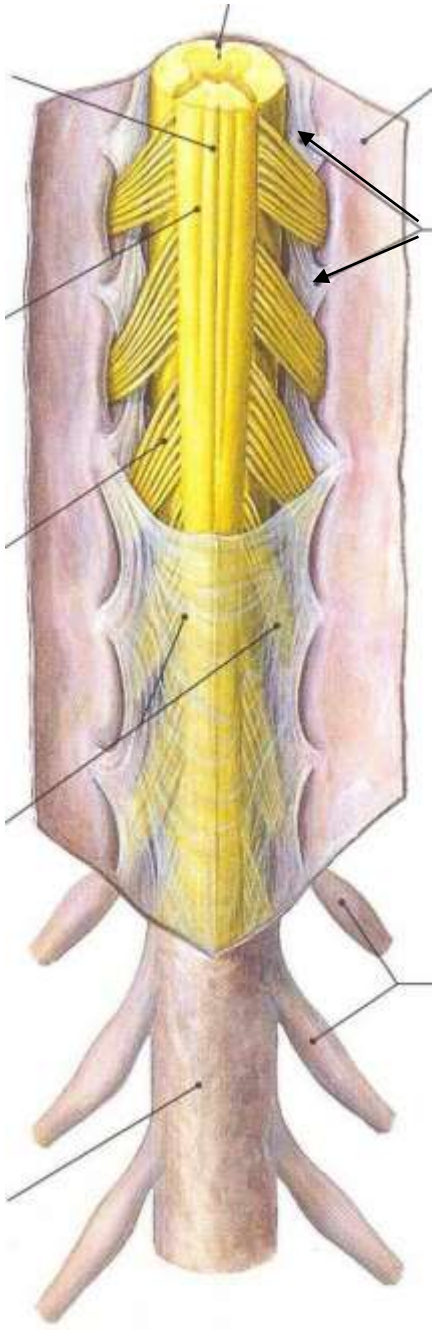
Arachnoidea – lig. denticulatum

Cavitas subarachnoidalis

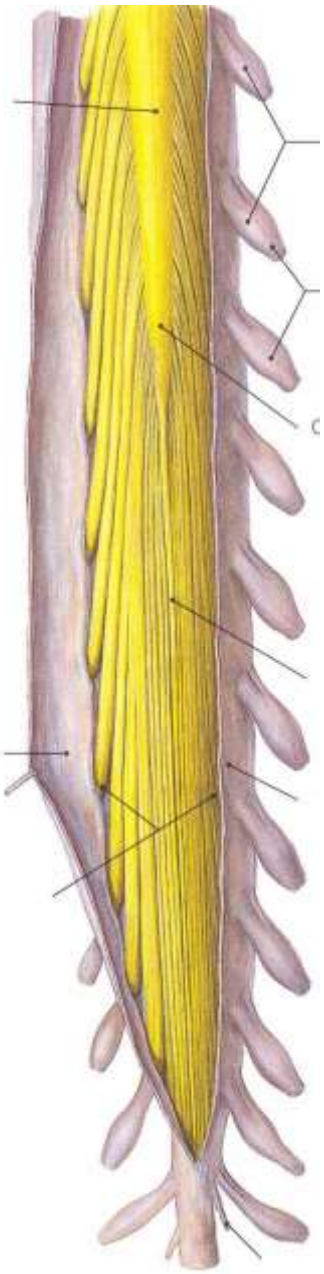
Pia mater spinals



Spinal cord meninges

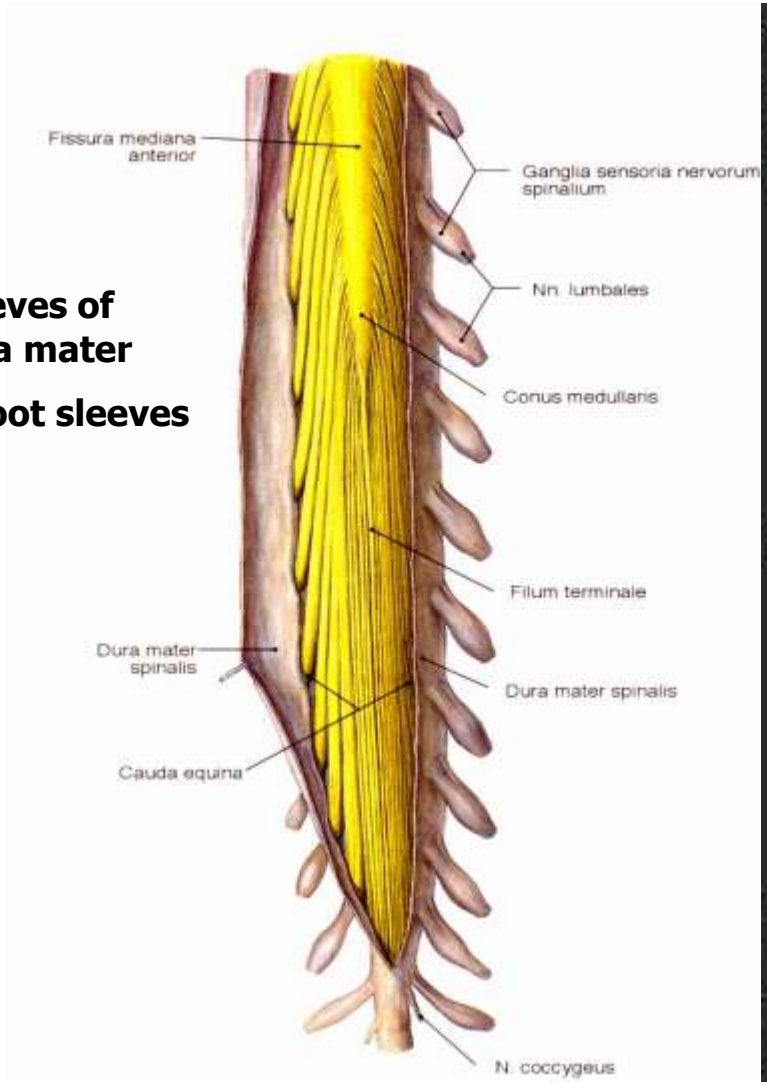


Denticulate ligament



Sleeves of dura mater

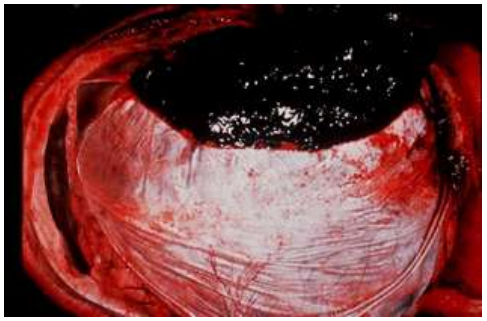
= root sleeves

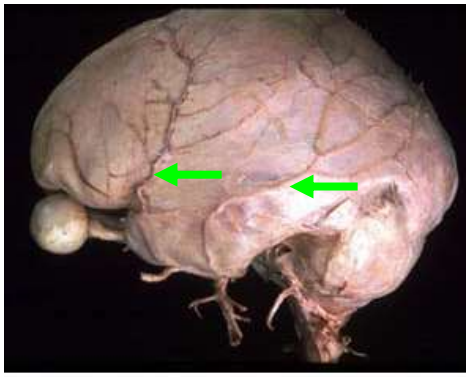


Intracranial hemorhage

Epidural

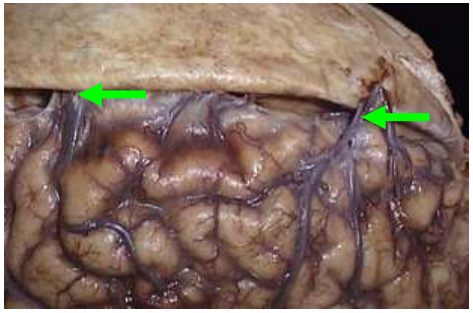
From middle meningeal artery.





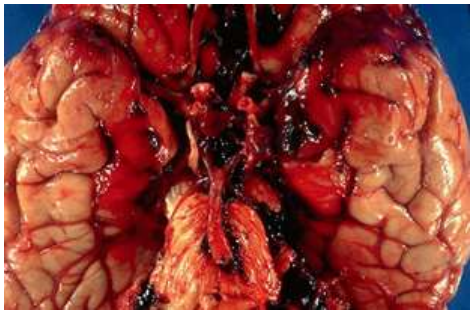
Subdural

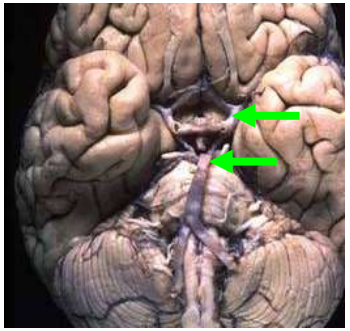
From bridging veins



Subarachnoid

From Willis circuit





Blood supplying

Vertebrobasilar system

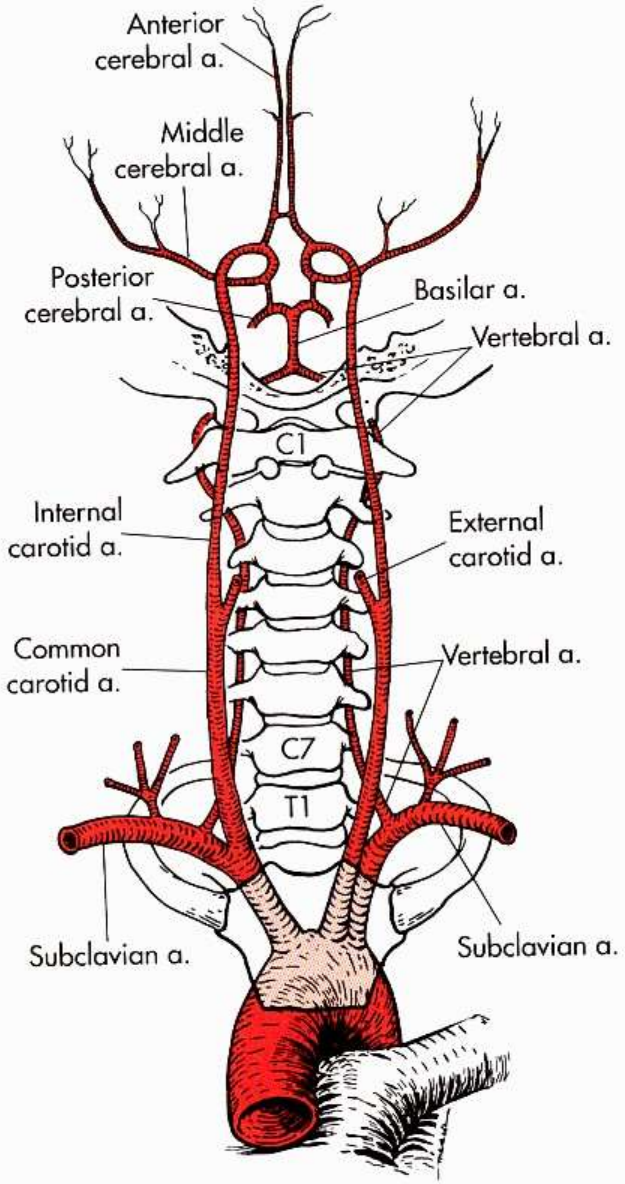
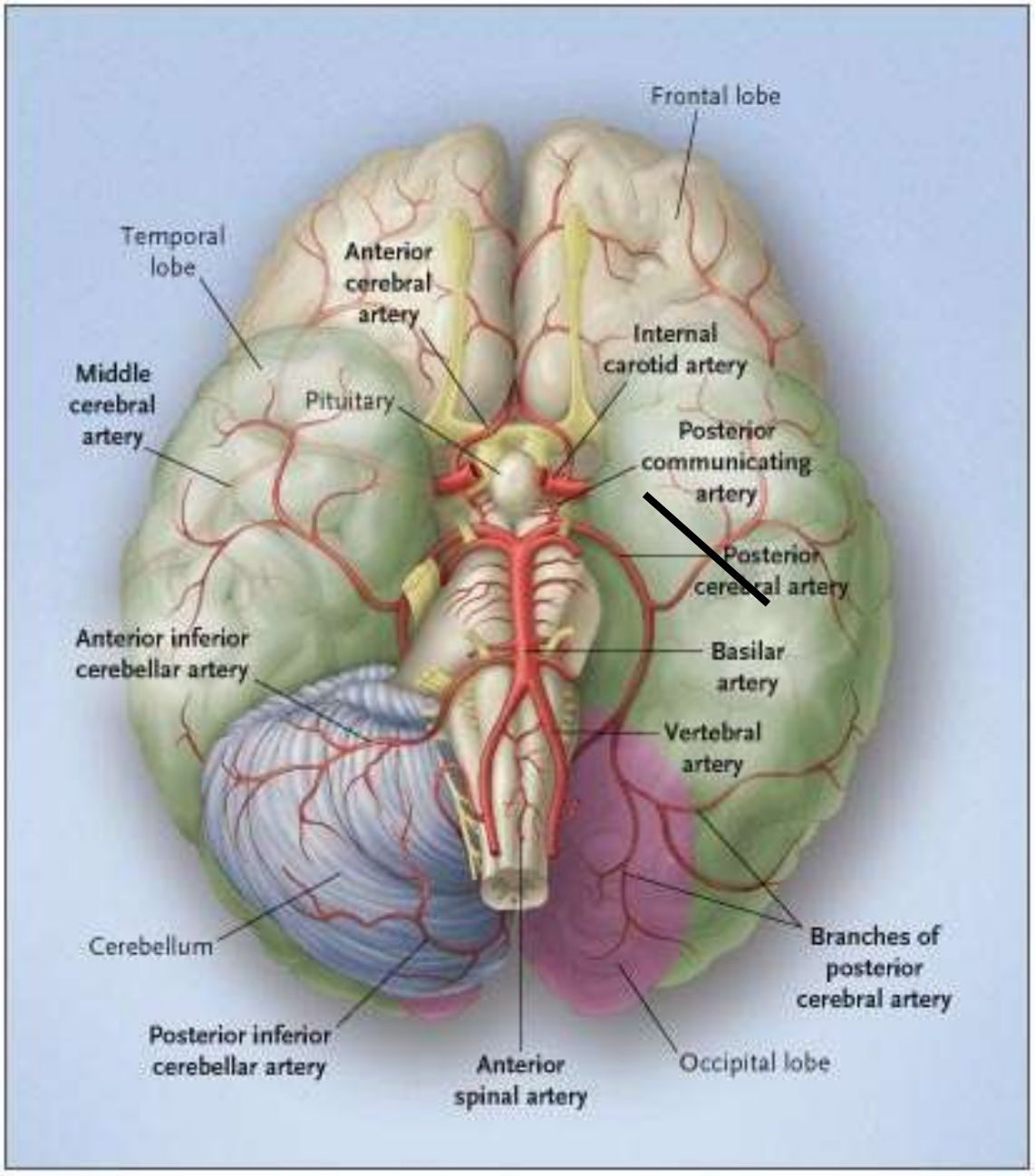


FIGURE 6-2
Origins of the arterial supply of the brain. a, Artery. (From Osborn AG: *Introduction to cerebral angiography*, Hagerstown, 1980, Harper & Row.)

Brain arteries

Willis circuit

- Communication between vertebral and a. carotis interna systems
- Anterior and posterior communicating arteries allow blood to flow between both systems (PCA) or between right and left vessels (ACA)

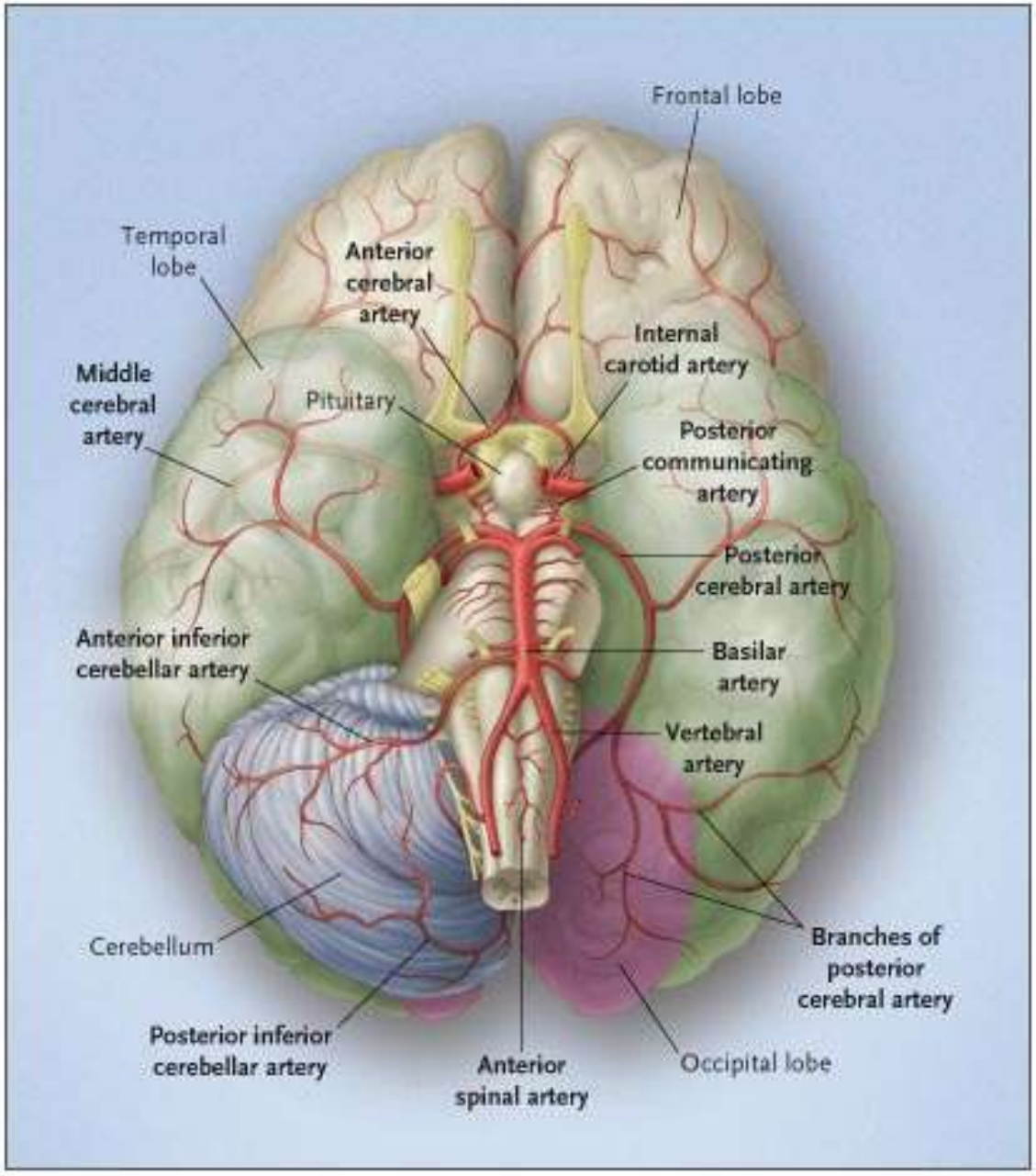


ARTERIA CAROTIS INTERNA

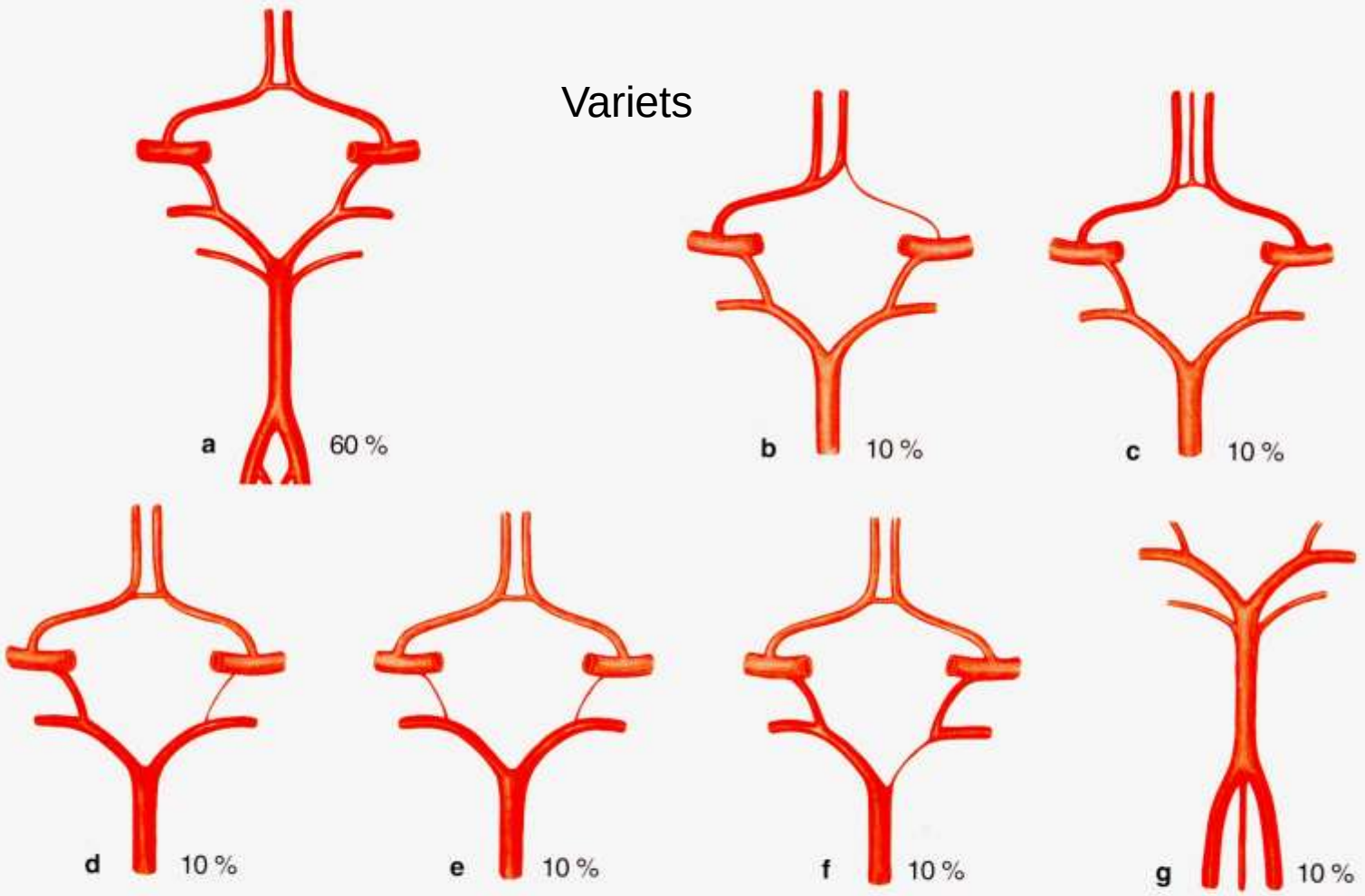
ARTERIA VERTEBRALIS

Willis circuit

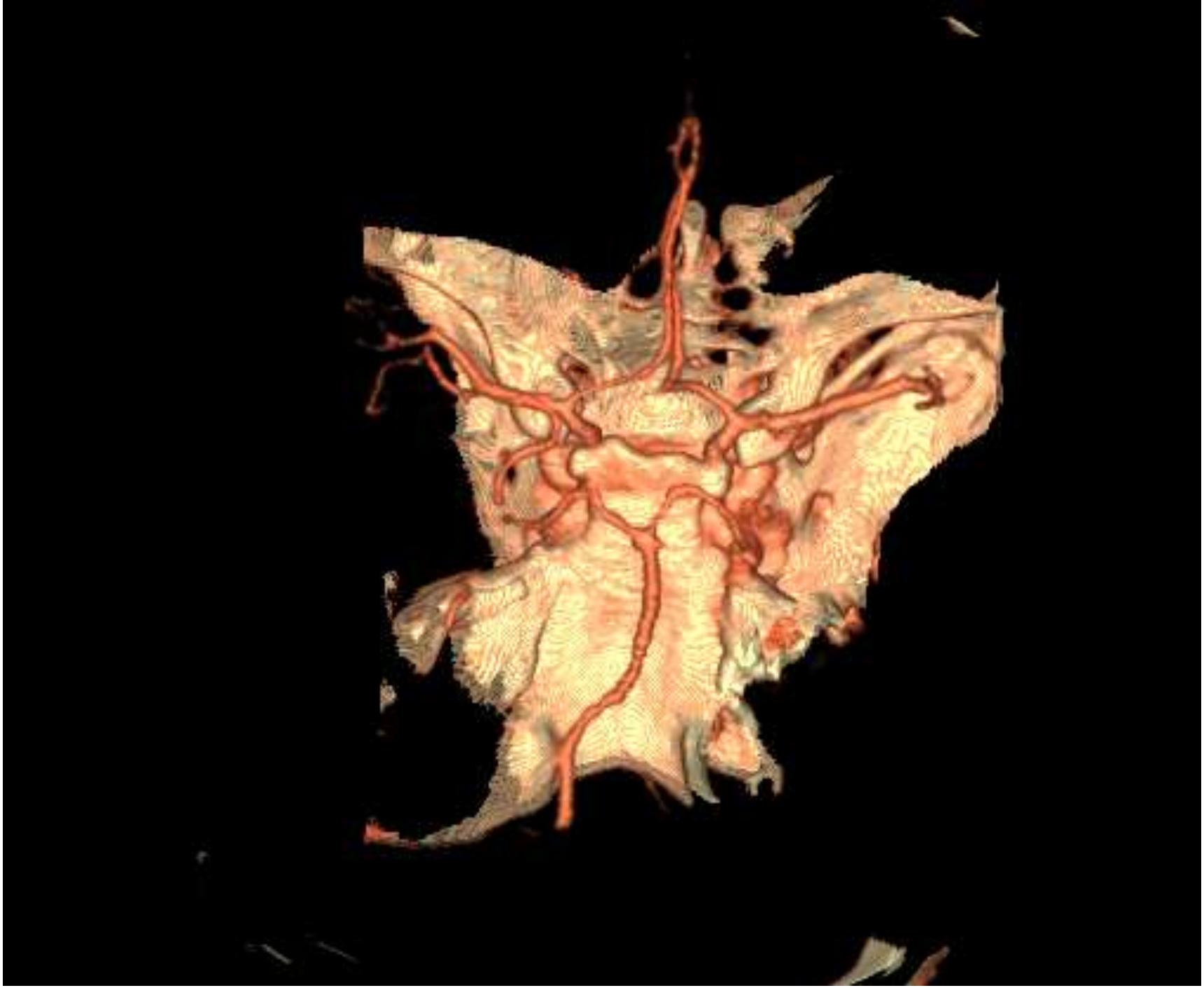
Arteriae centrales (peforatores)- groups:
Anteromedial
Anterolateral
Posteromedial
Posterolateral



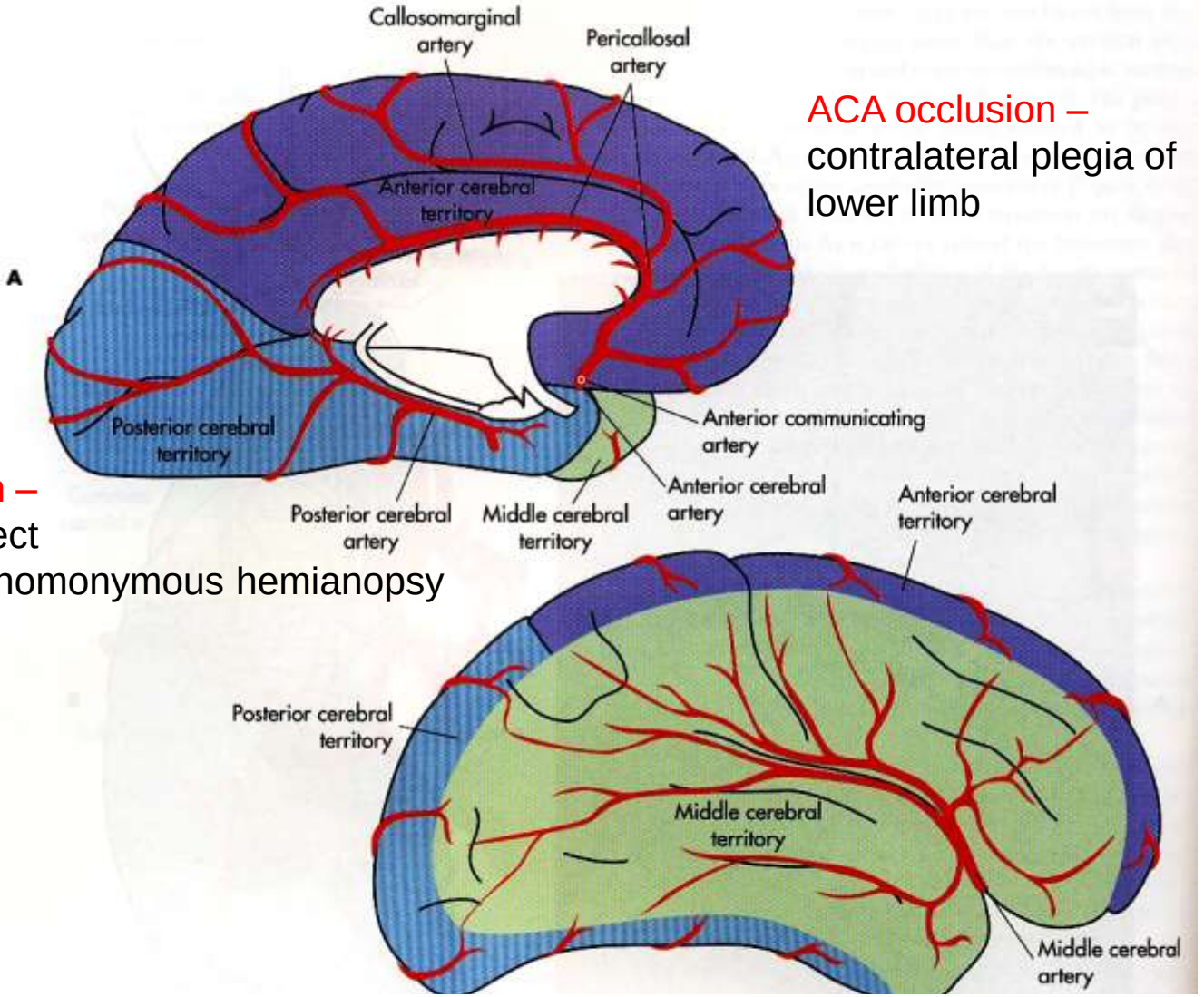
Variets



Obr. 564 a-g Willisův arterielní okruh, circulus arteriosus cerebri.
a-c variety předního oddílu
d-f variety zadního oddílu
g kaudální spojení vertebrálních arterií

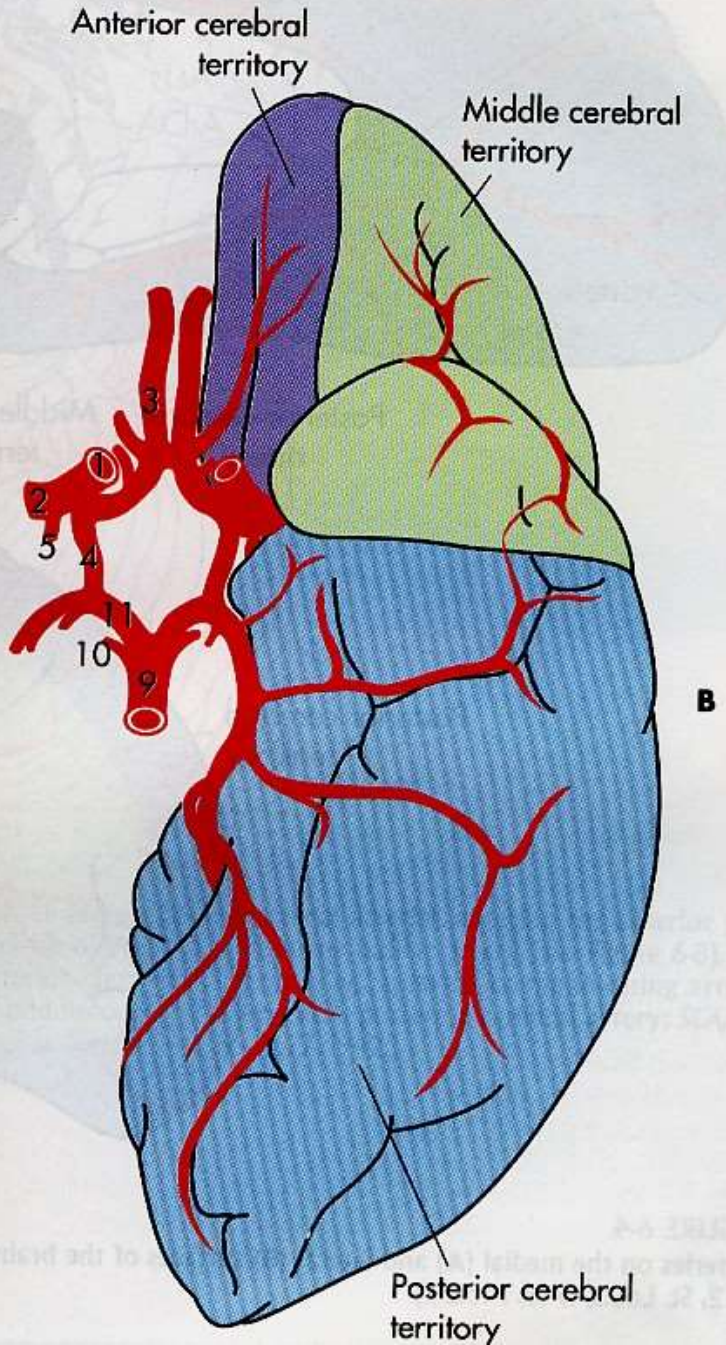


ACA occlusion –
contralateral plegia of lower limb



PCA occlussion –
Visual field defect
- Contralateral homonymous hemianopsy

MCA occlusion
Contralateral hemiplegia more expressed on upper limbs and face, can be aphasia

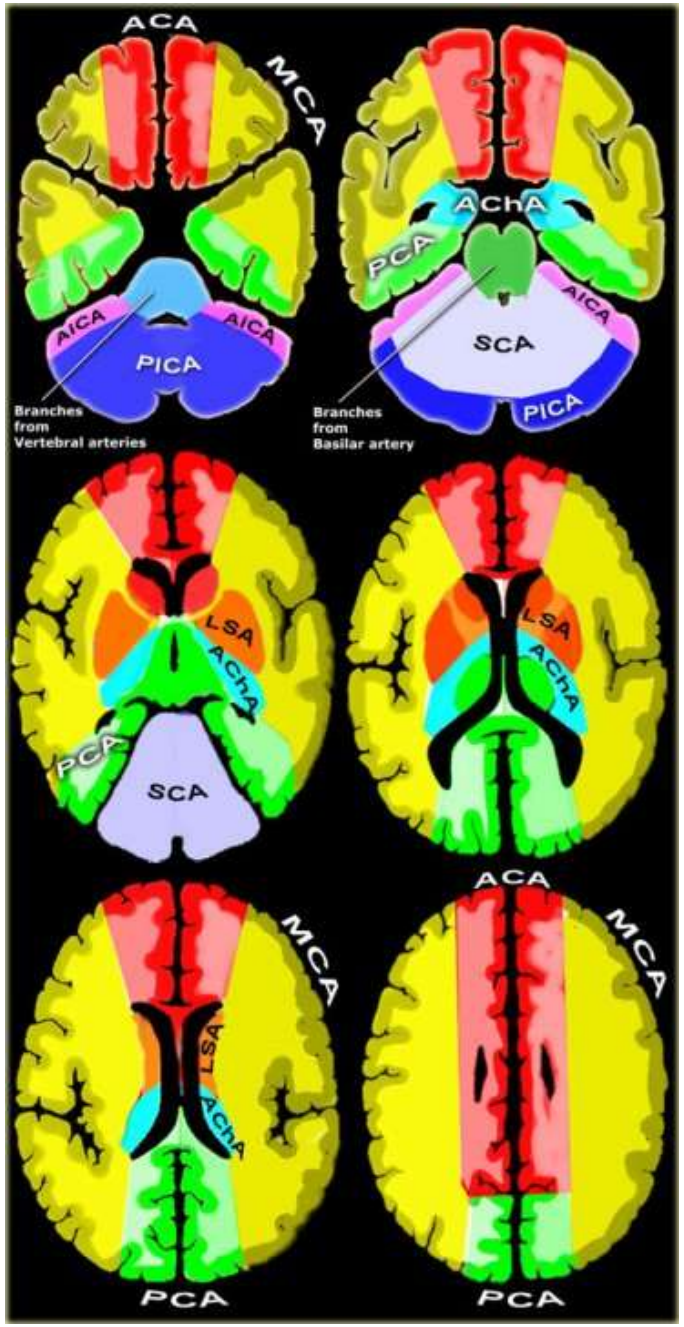

Anterior cerebral territory
Middle cerebral territory
Posterior cerebral territory
1
2
3
4
5
9
10
11
B

Cerebral arterial territories

a.cerebri anterior

a.cerebri media

a. cerebri posterior



a.cerebellaris inferior anterior

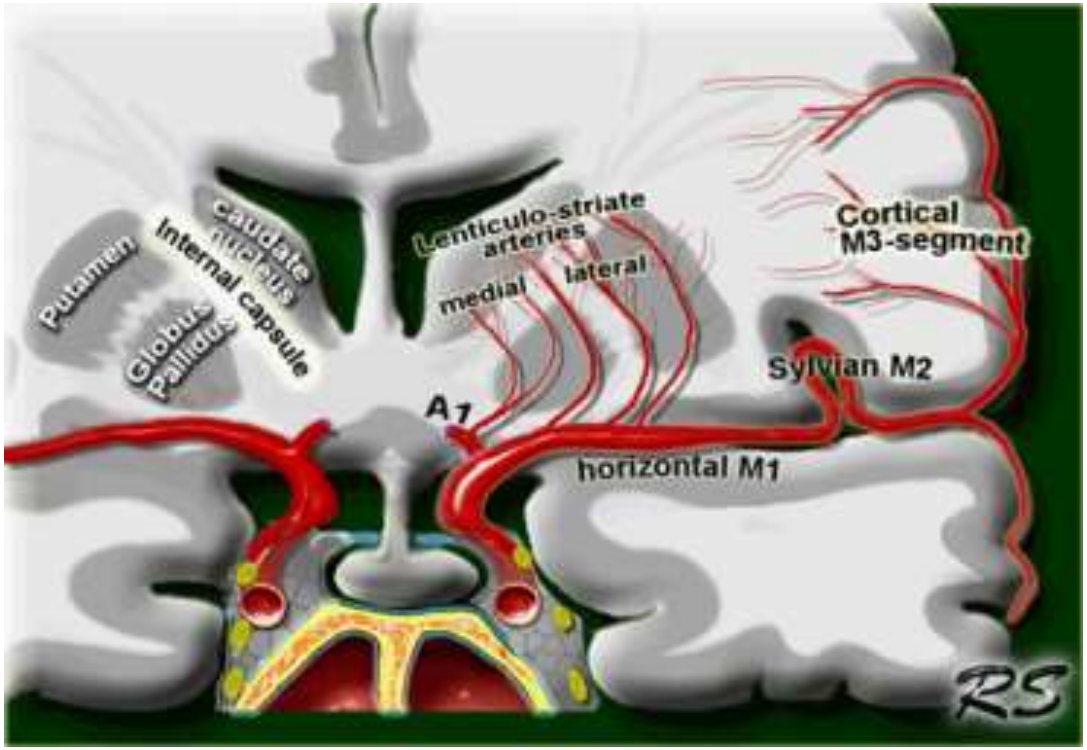
a.cerebellaris inferior posterior

a.cerebellaris superior

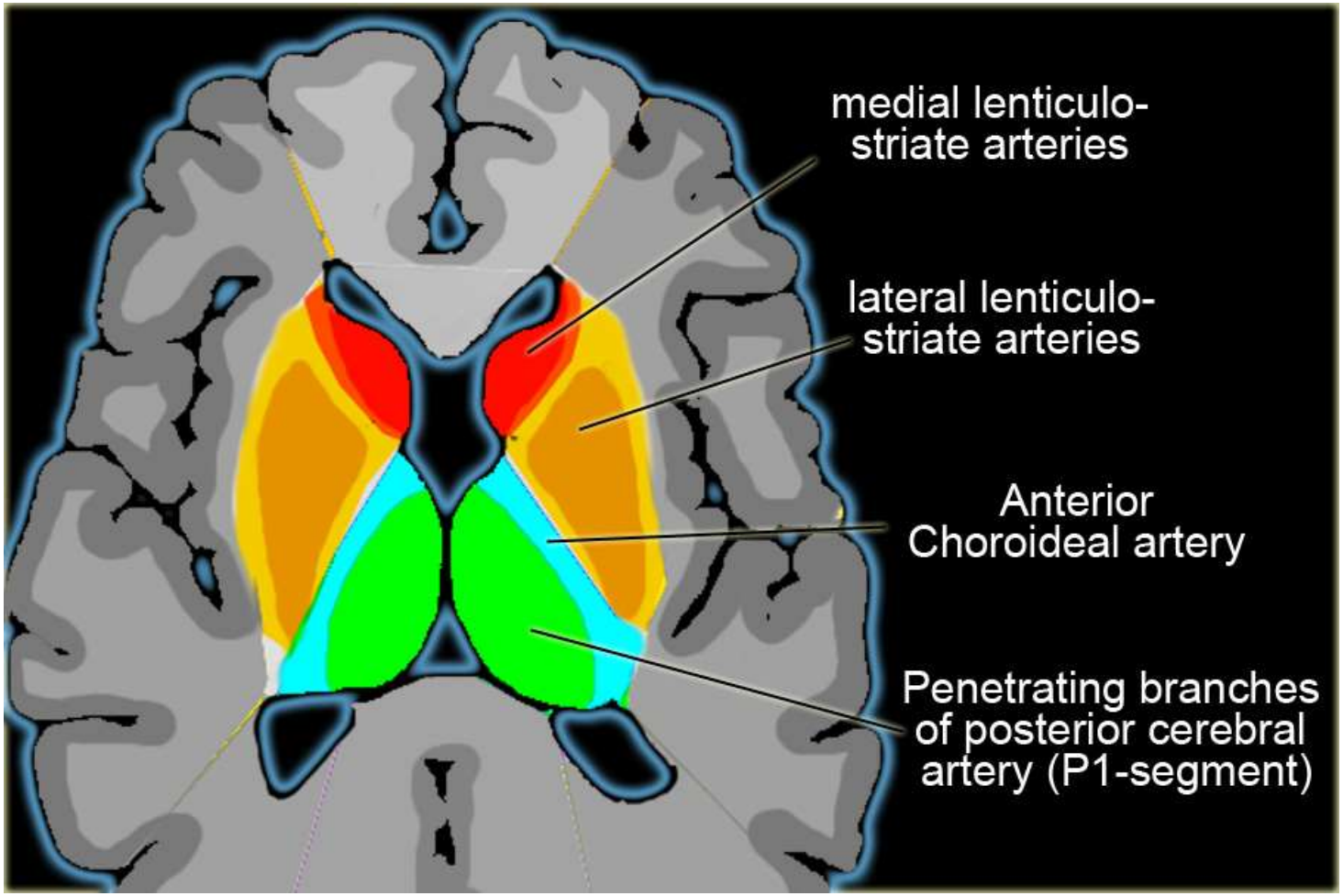
a. choroidea anterior

Blood supplying of basal ganglia

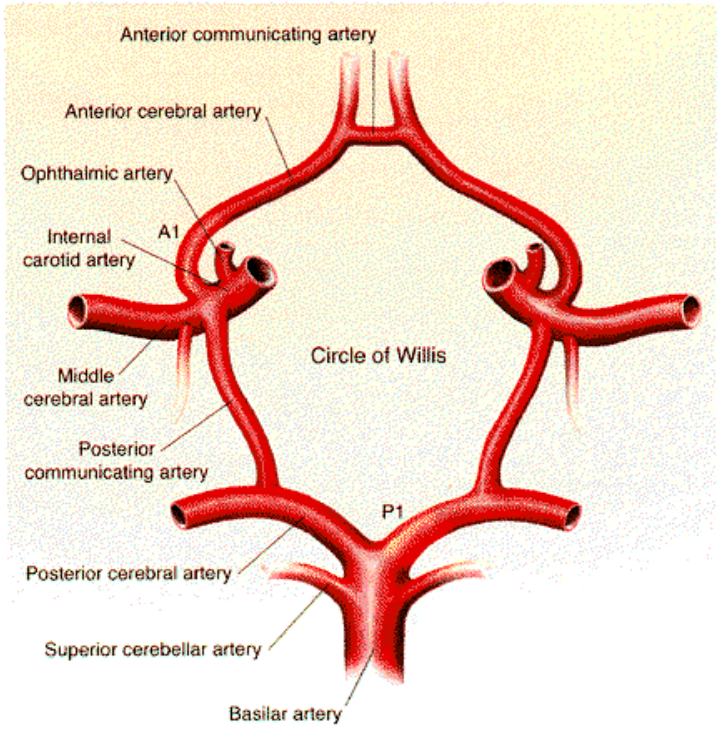
arterie lenticulostriaticae

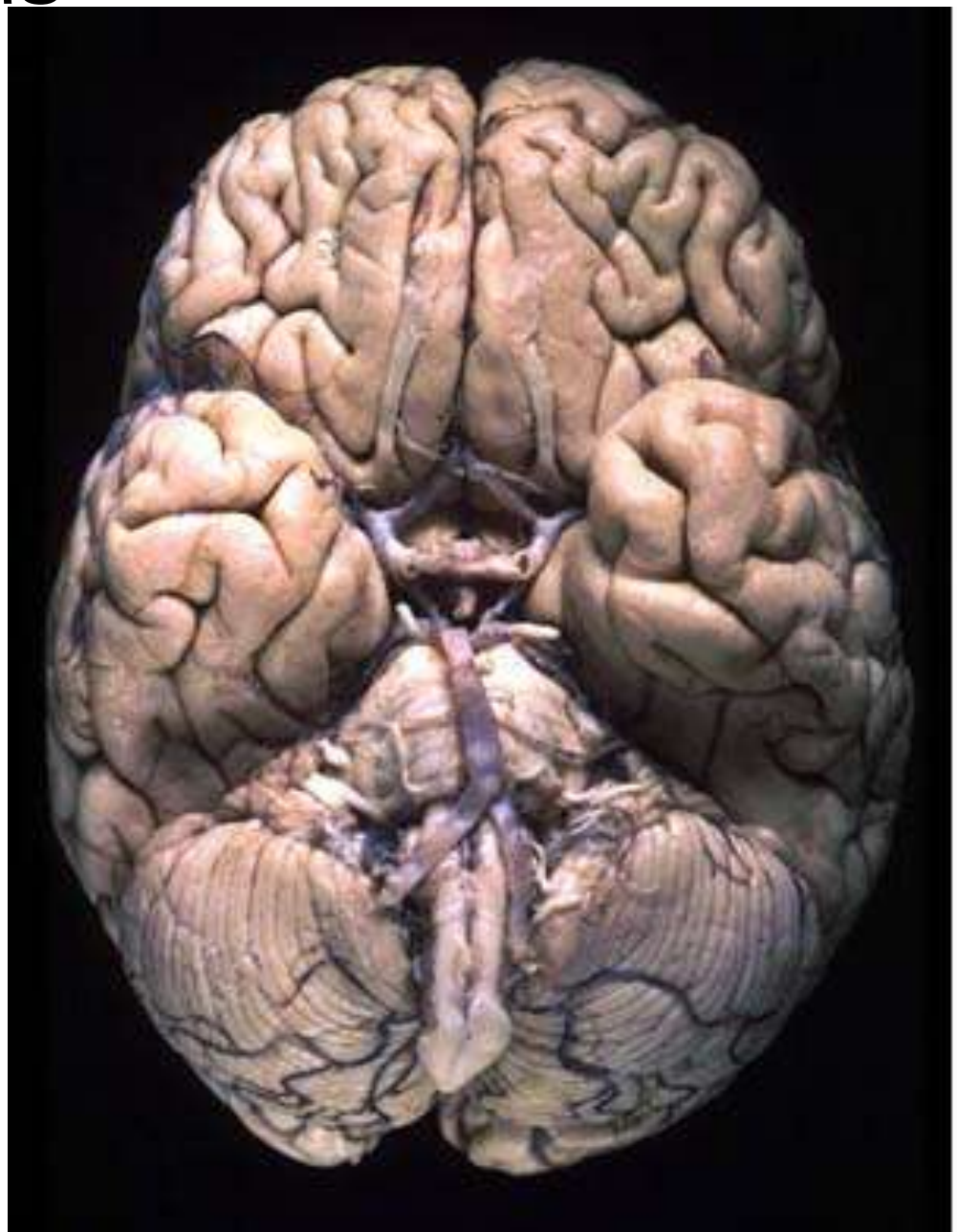


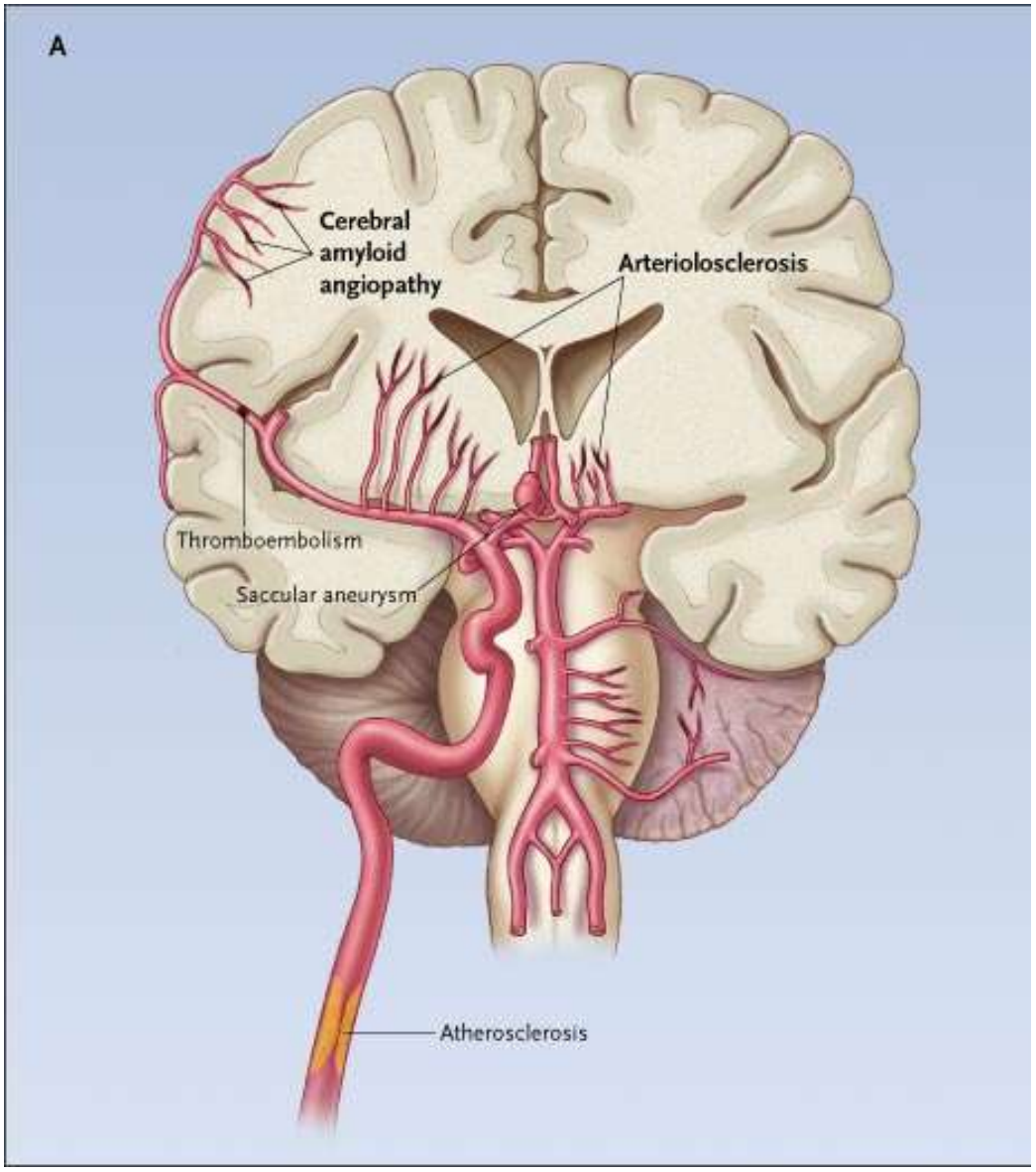
Blood supplying of basal ganglia, thalamus and capsula interna



Circulus arteriosus

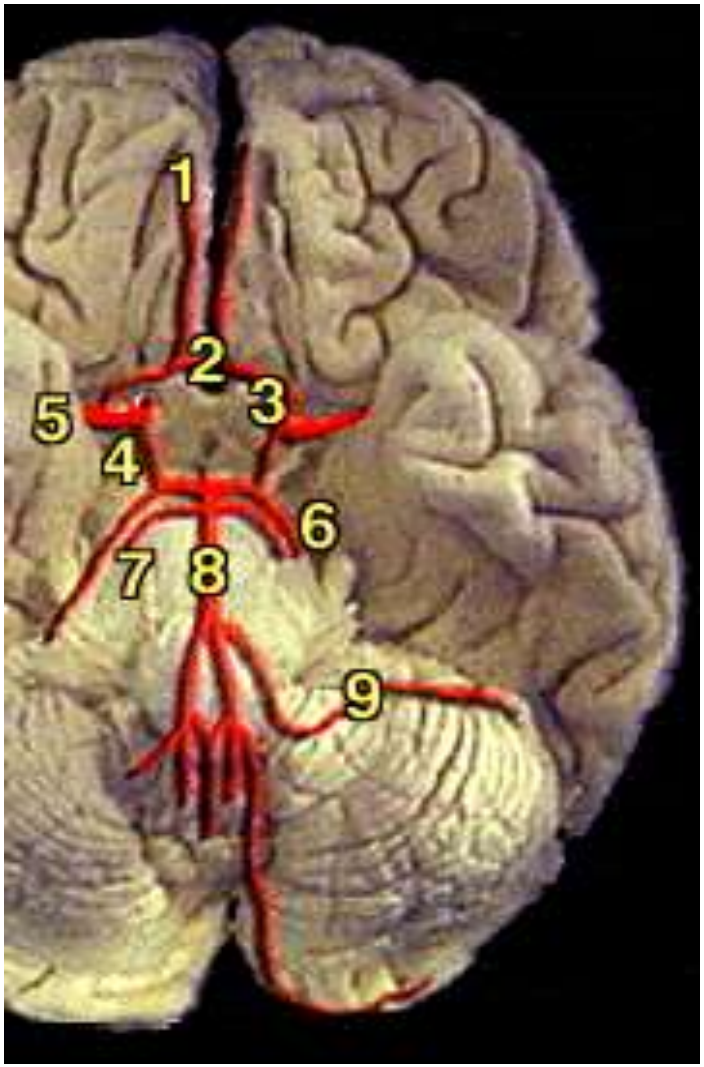


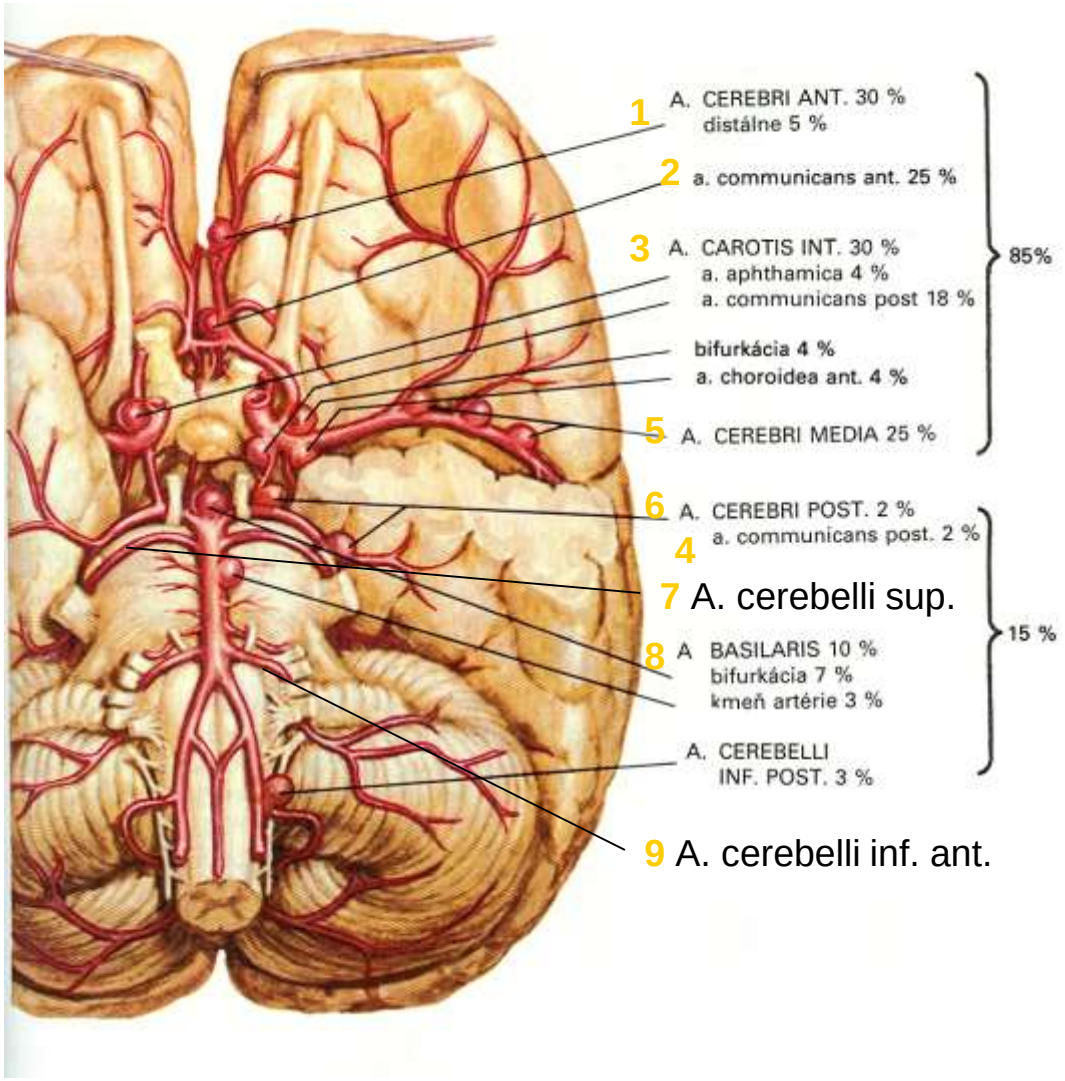




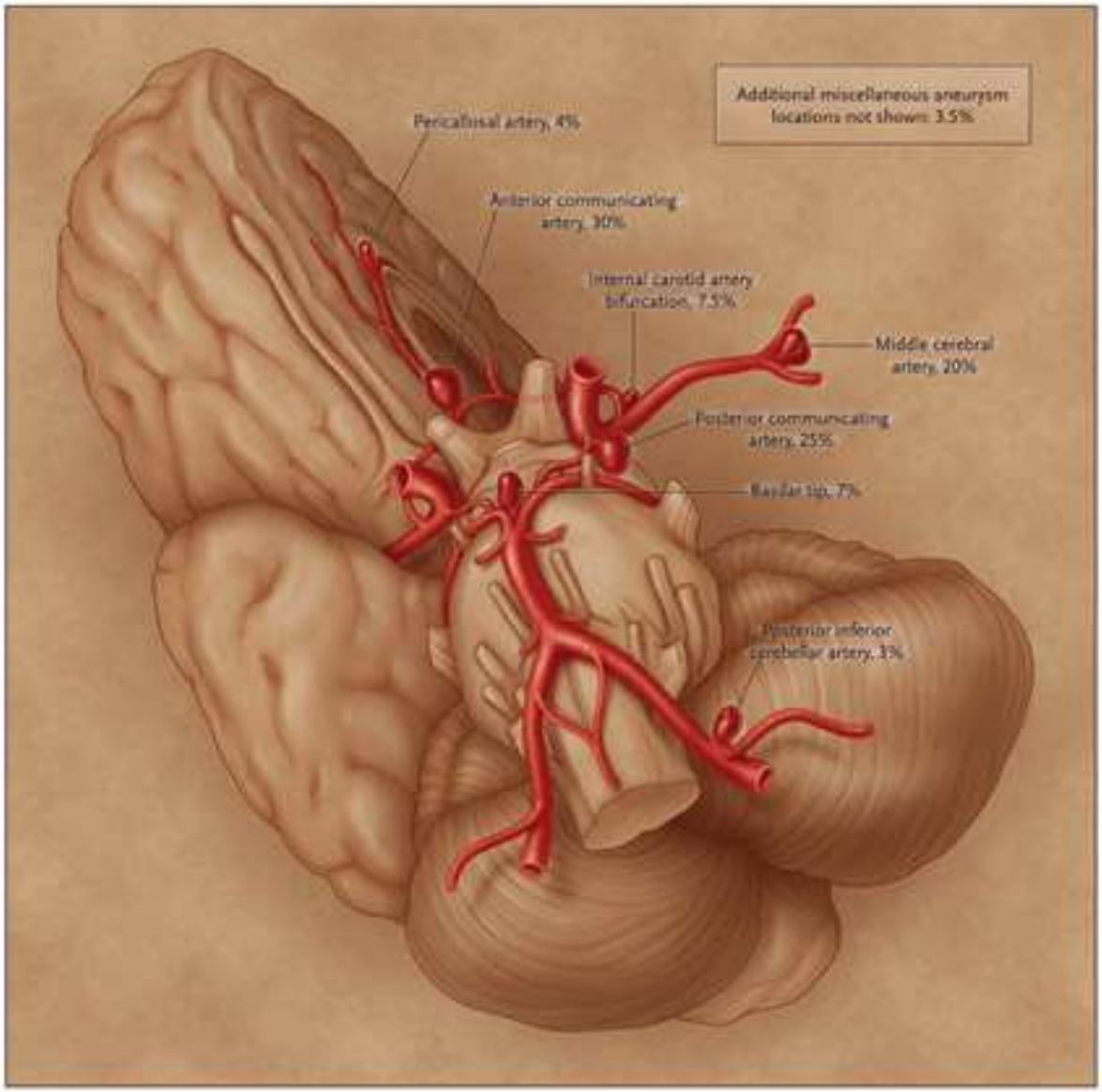
Most common diseases of brain vessels

Circulus arteriosus Willisi –aneurysma



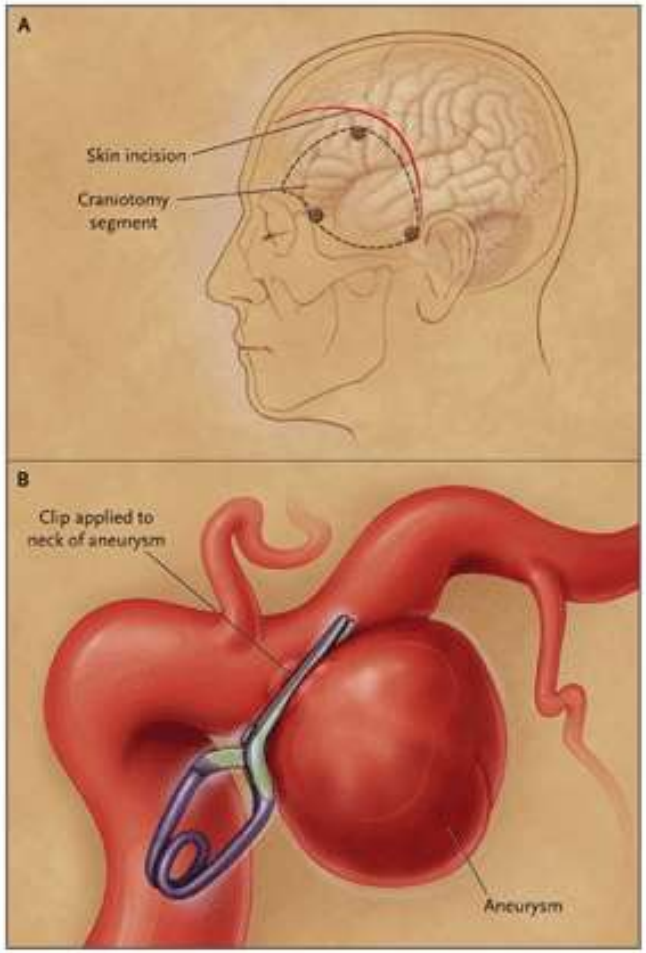


Aneurysma lokalization

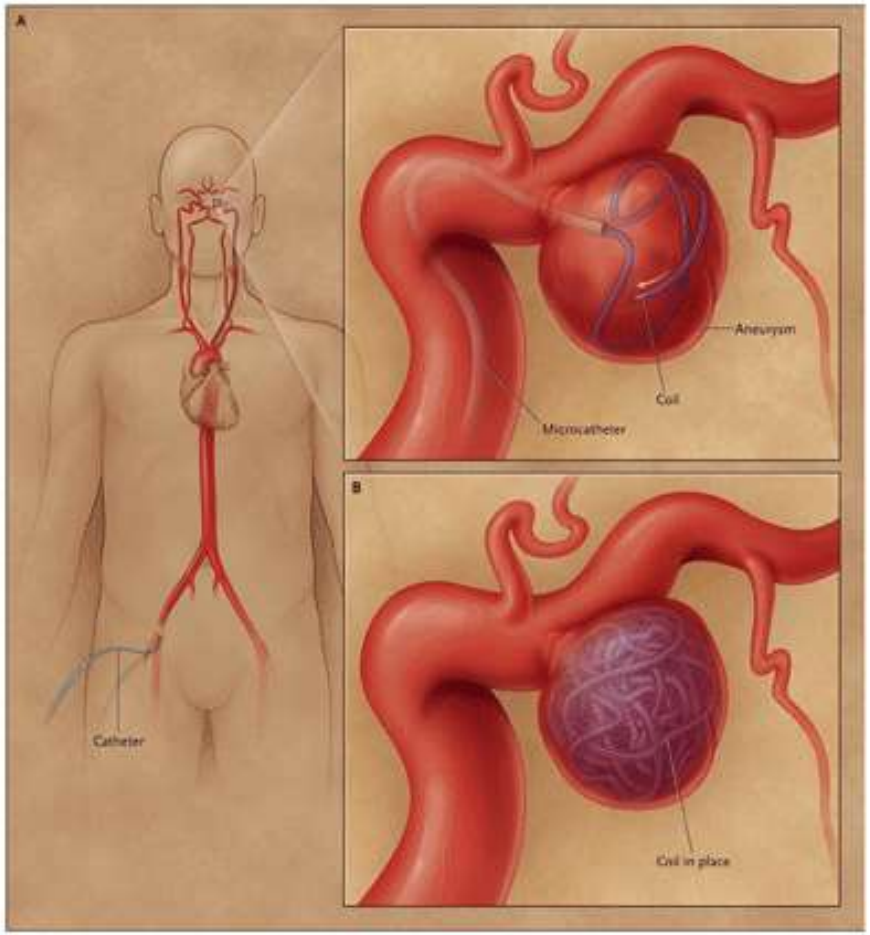


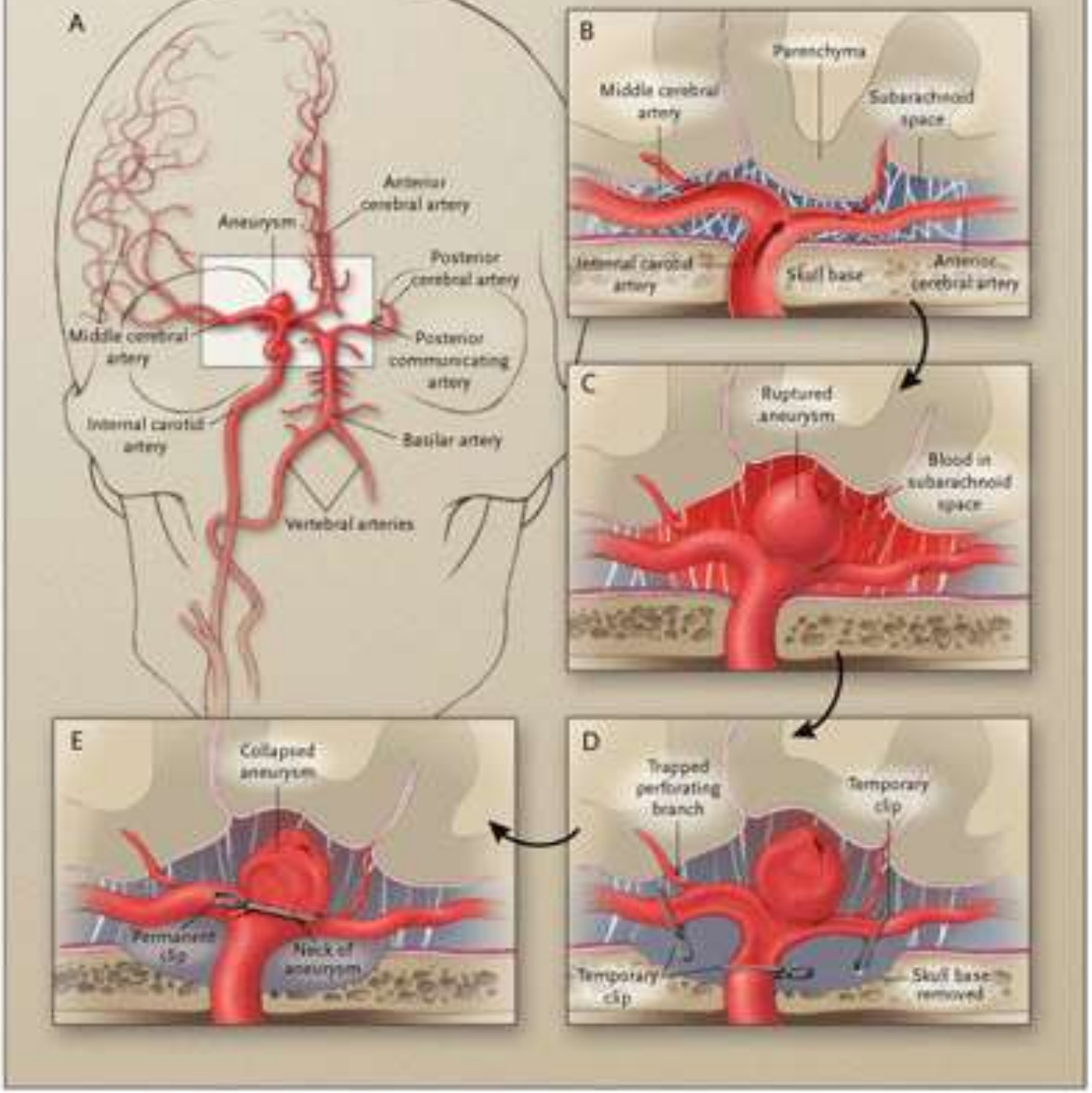
Aneurysma - treatment

Clip

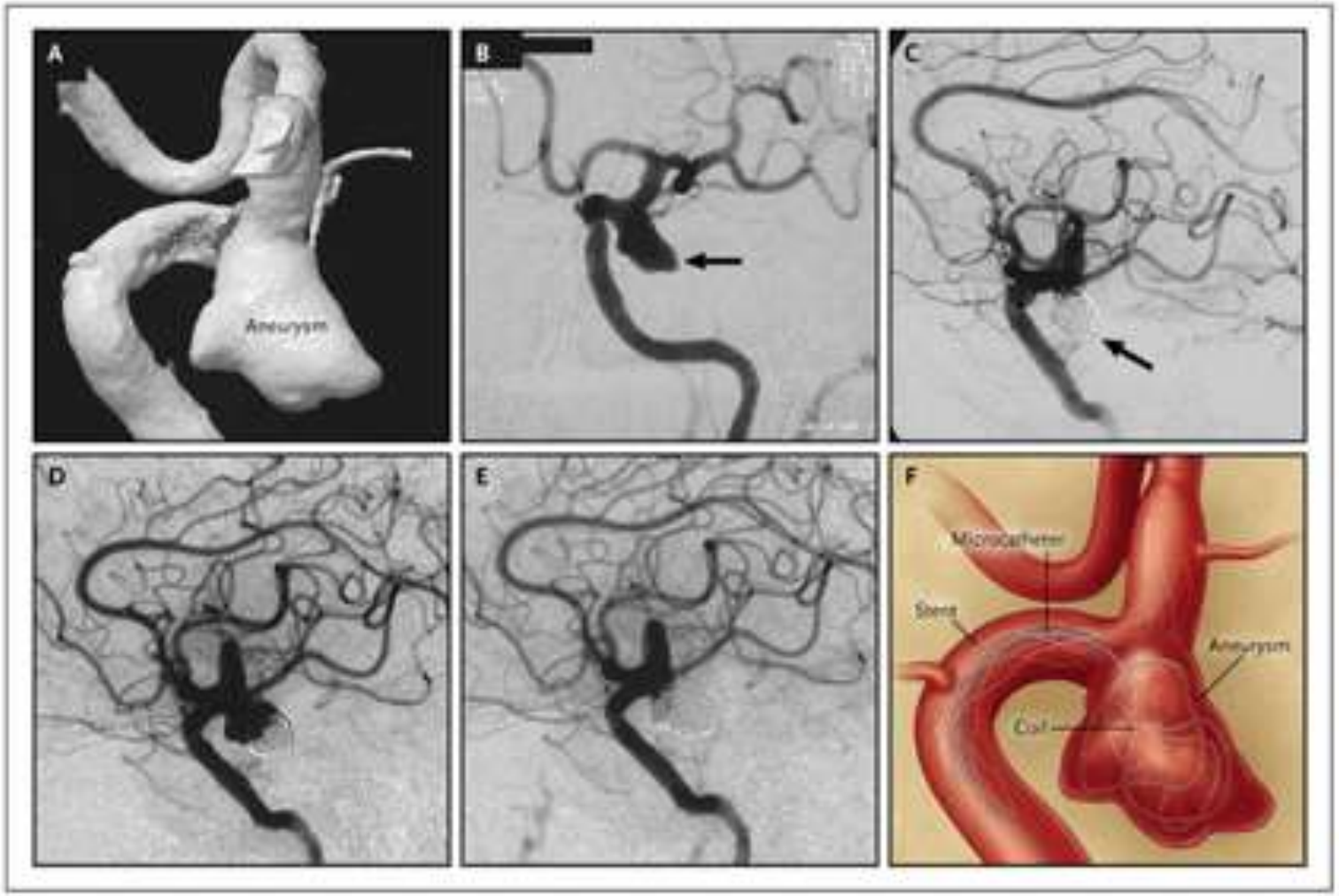


Endovascular occlussion

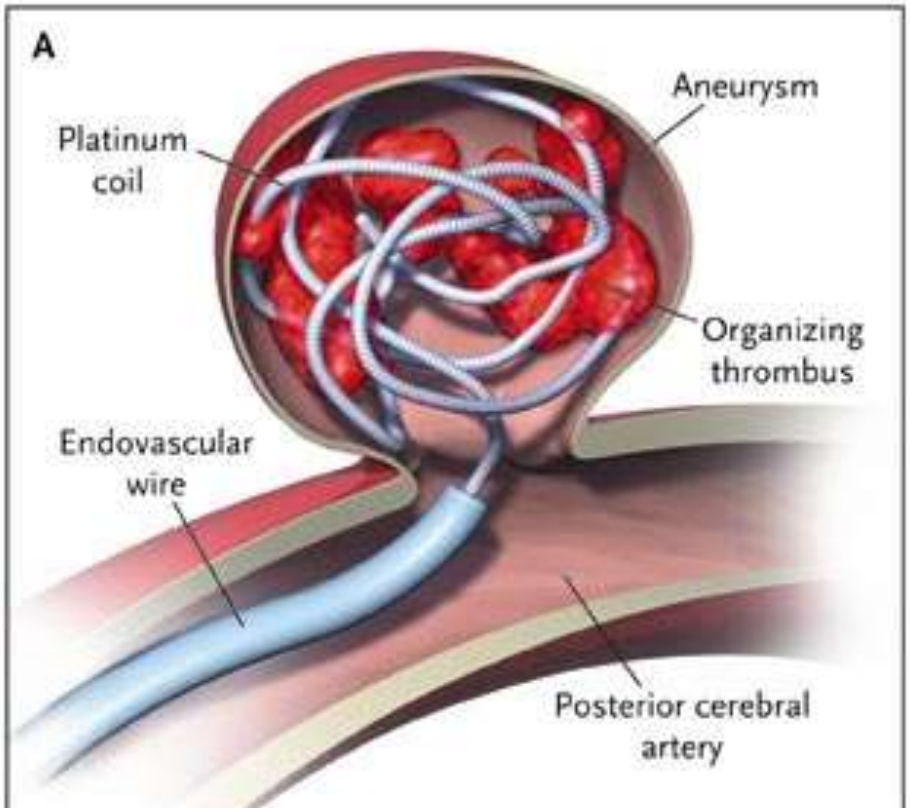


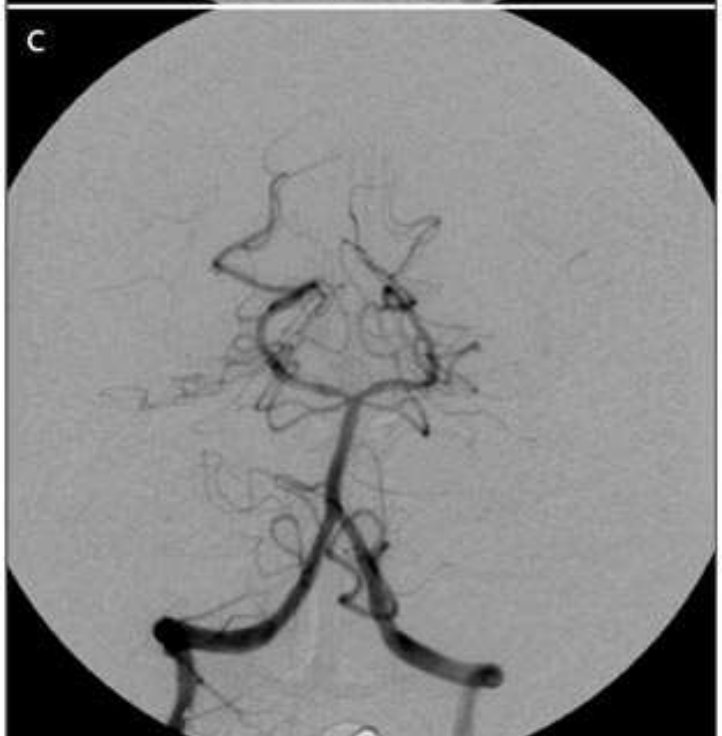

A
Aneurysm
Anterior cerebral artery
Posterior cerebral artery
Middle cerebral artery
Posterior communicating artery
Internal carotid artery
Basilar artery
Vertebral arteries
B
Parenchyma
Middle cerebral artery
Subarachnoid space
Internal carotid artery
Skull base
Anterior cerebral artery
C
Ruptured aneurysm
Blood in subarachnoid space
D
Trapped perforating branch
Temporary clip
Temporary clip
Skull base removed
E
Collapsed aneurysm
Permanent clip
Neck of aneurysm

Aneurysma – stent, recoiling

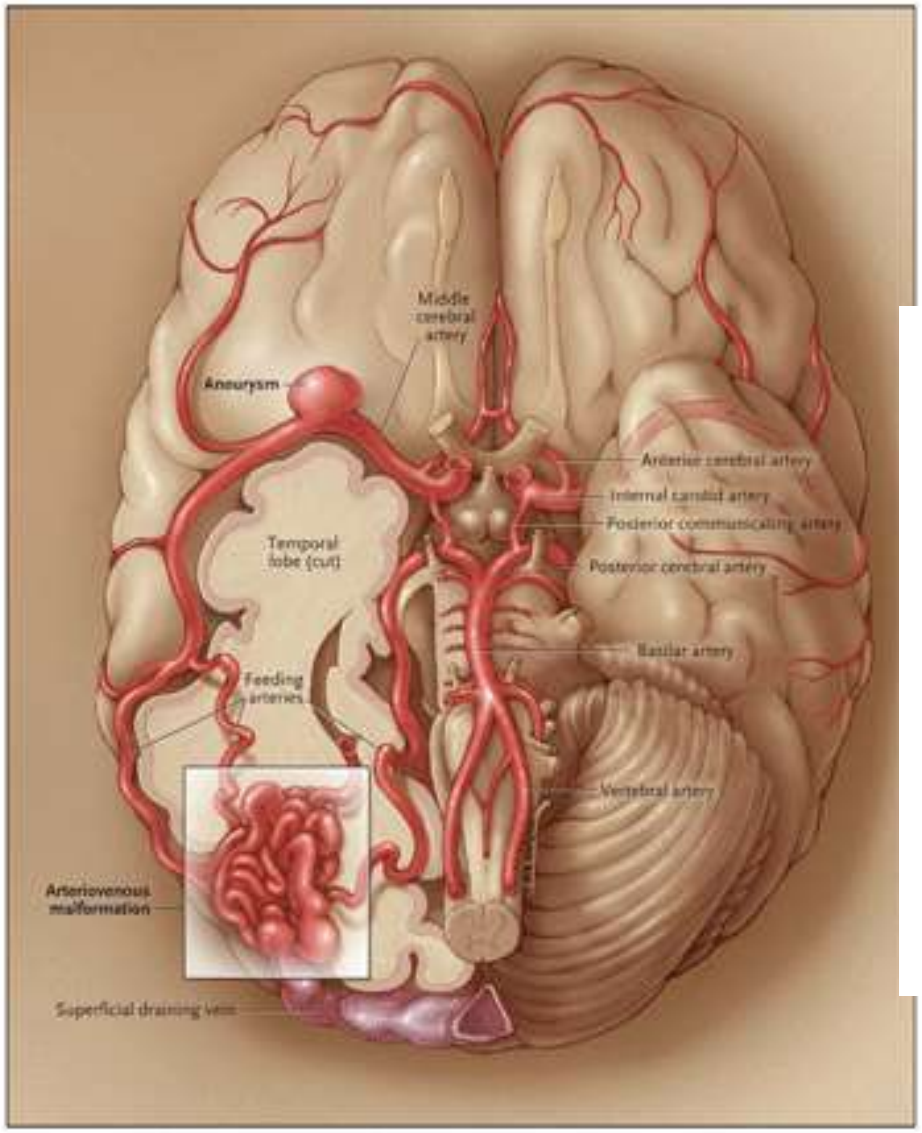


Intravascular coiling



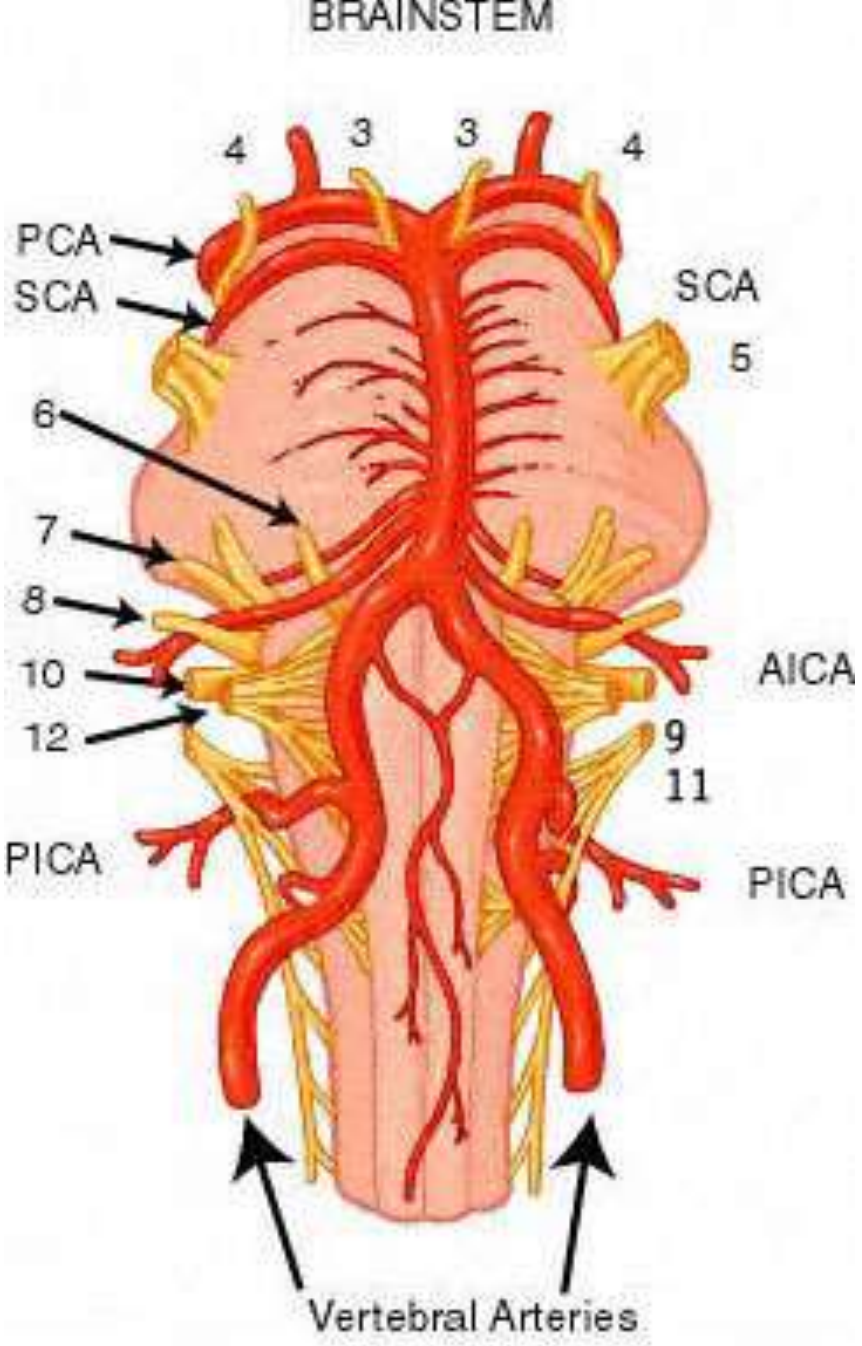


A-V malformation

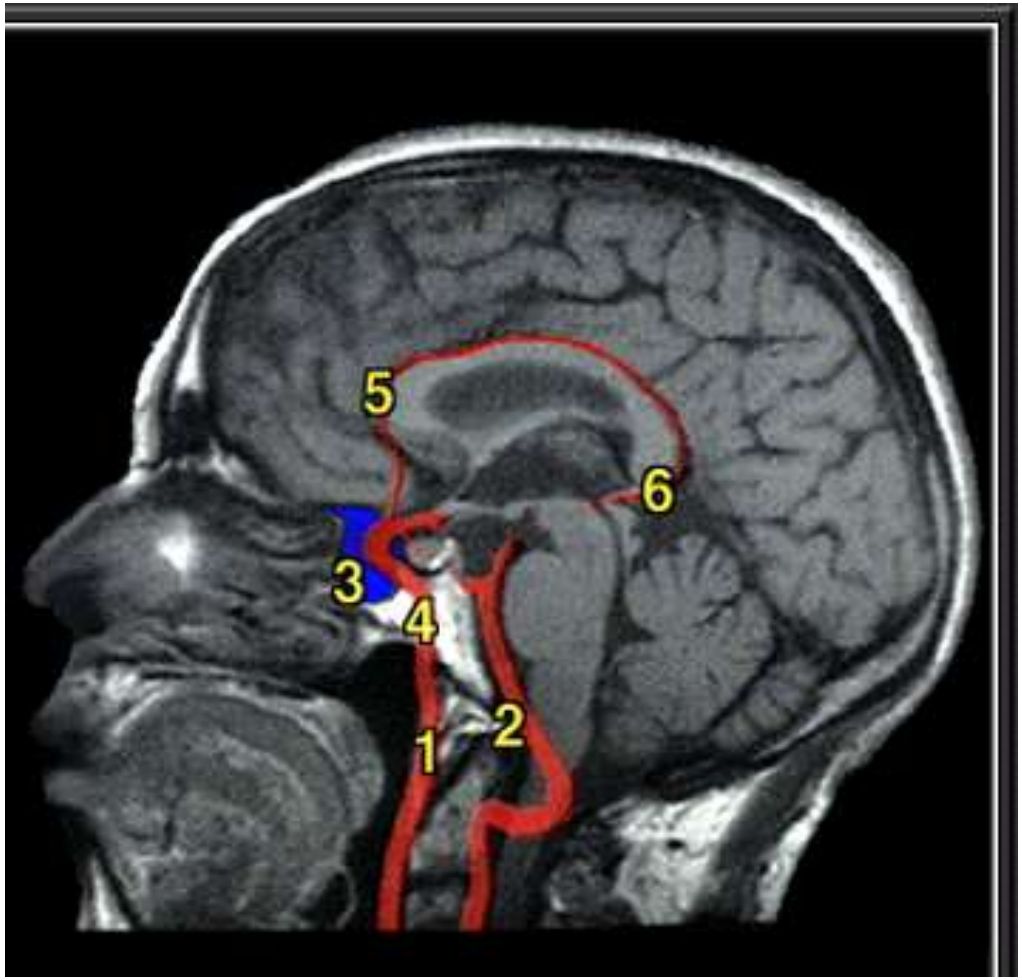


peroperačně

Cranial nerve origins and arteries on the ventral part of the brainstem



NMR – angoigraphy



1 - a.carotis interna

2 - a.vertebralis

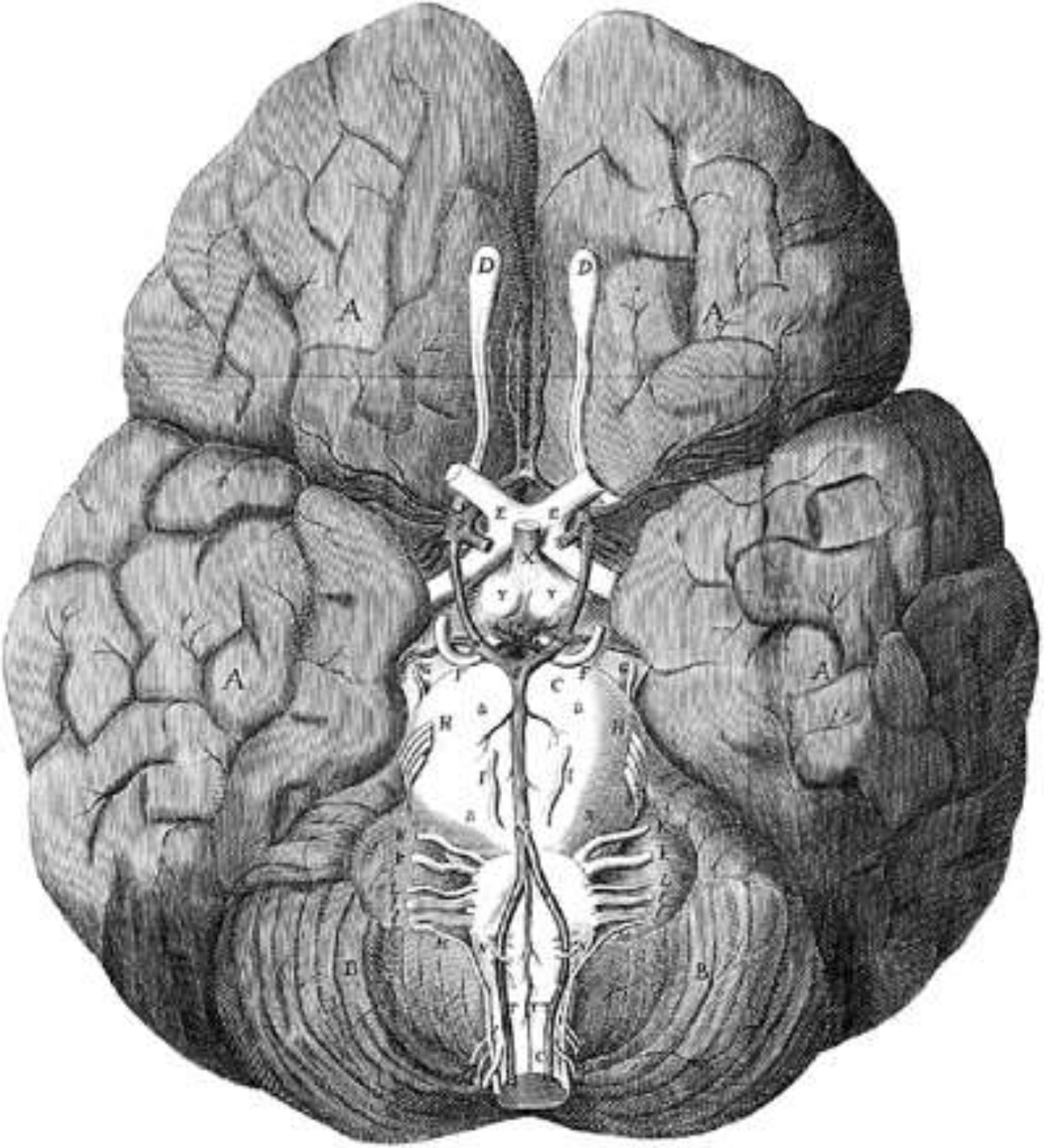
3 - sinus cavernosus

4 - canalis caroticus

5 - a.cerebri anterior

6 - a.cerebri posterior

Thomas Willis
(1621–1675)


D
D
A
A
A
A
B
B

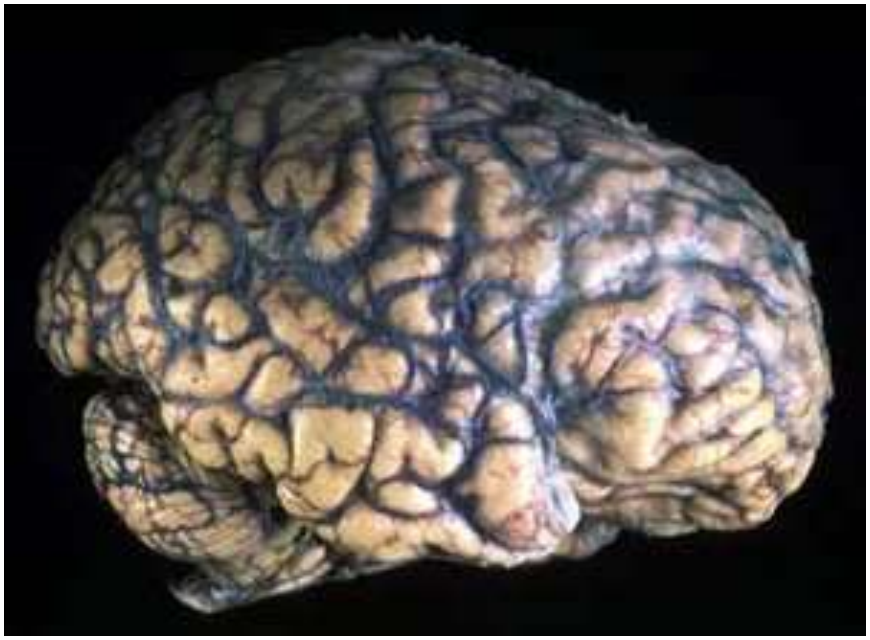
The home of Thomas Willis from 1657 to 1667

Oxford, Beam Hall

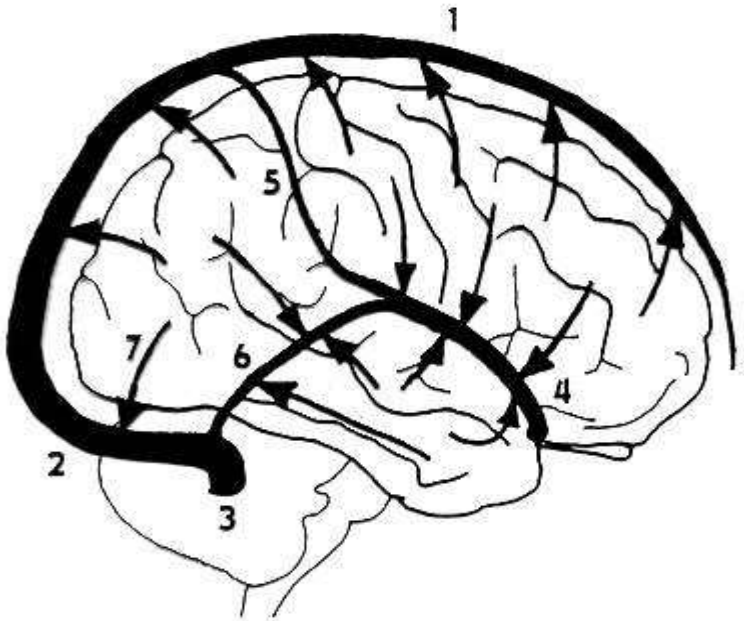
Thomas Willis

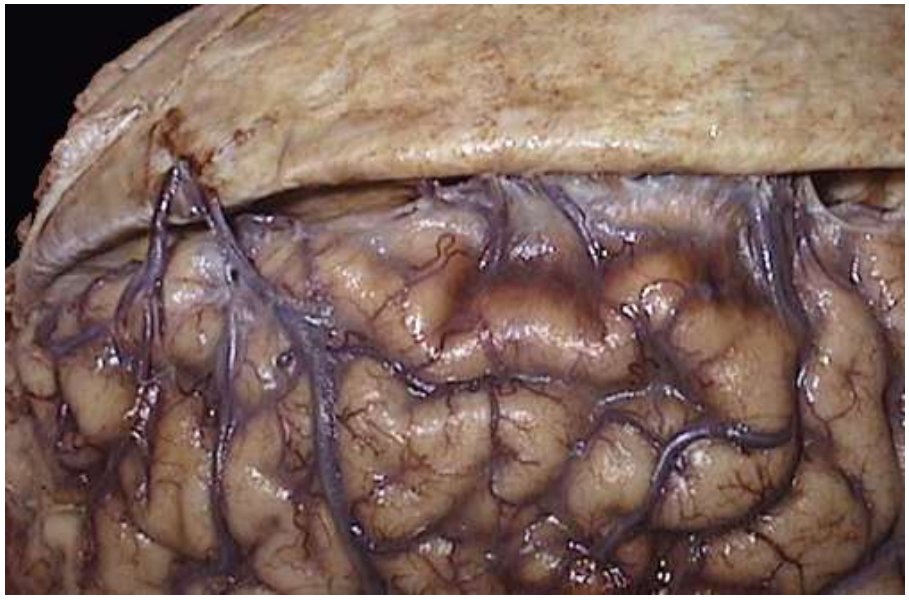
- **Neuroanatomical terms coined by Willis**
- Anterior commissure | Cerebellar peduncles | Claustrum | Corpus striatum | Inferior olives (corpora teretia) | Internal capsule | Medullary pyramids | Nervus ophthalmicus | The word 'neurology' | Optic thalamus | Spinal accessory nerve | Stria terminalis (taenia cornua) | Striatum | Vagus nerve
- **Pathologies recognized by Willis**
- Achalasia of the cardia (achalasia of the oesophagus) | Akathisia (restless legs syndrome, Ekbom's syndrome) | Symptoms of myasthenia gravis | Paracusis Willisii. Occurs in deaf patients whose hearing improves in the presence of noise, indicating osteosclerosis | Diabetes mellitus | Abnormalities of the brains of patients with congenital mental retardation | Unilateral degeneration of the cerebral peduncle in a case of long-standing unilateral paralysis | Symptoms of malaria | Distinctions between typhoid and puerperal fevers

Superficial veins



Superior cerebral veins

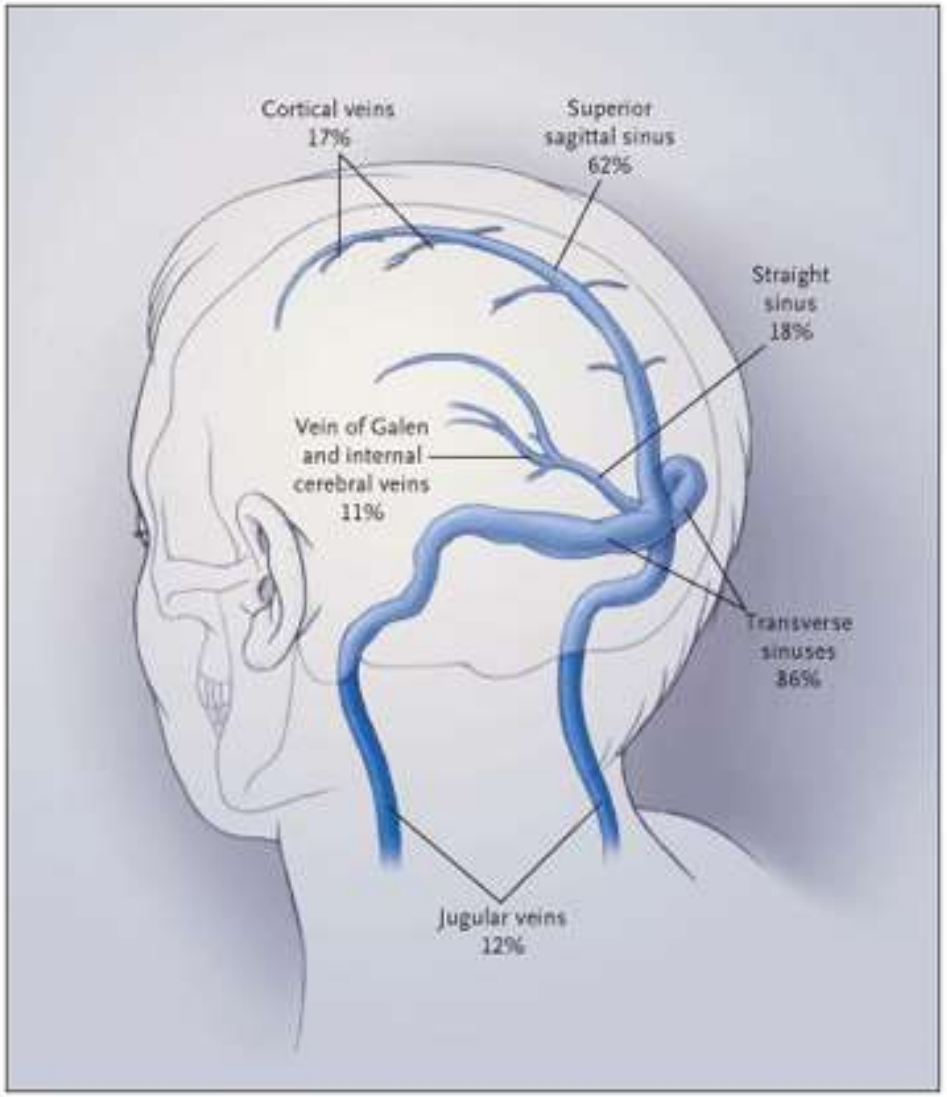




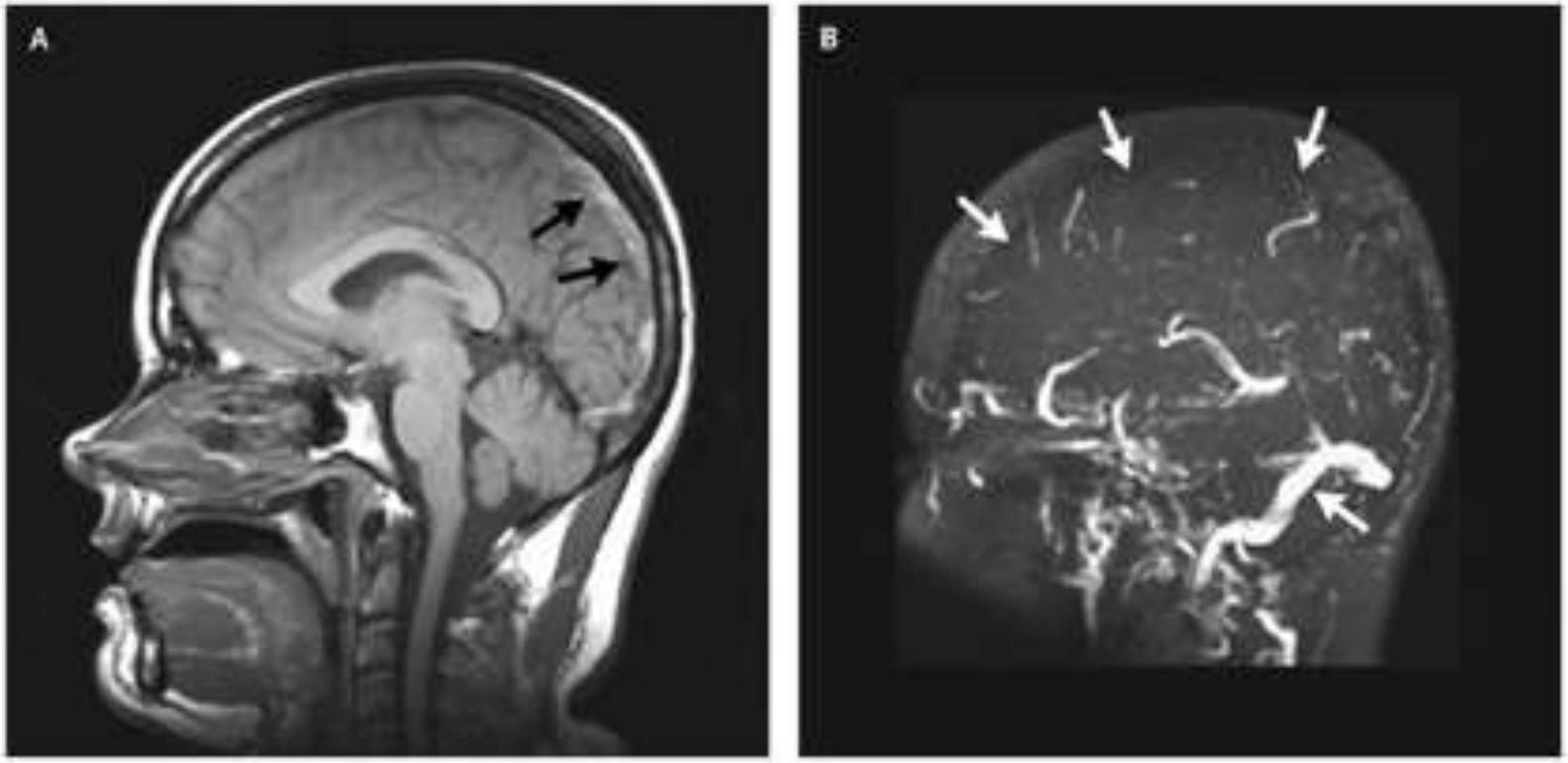
5 Vena anastomotica sup. (Trolard)

6 Vena anastomotica post. (Labbé)

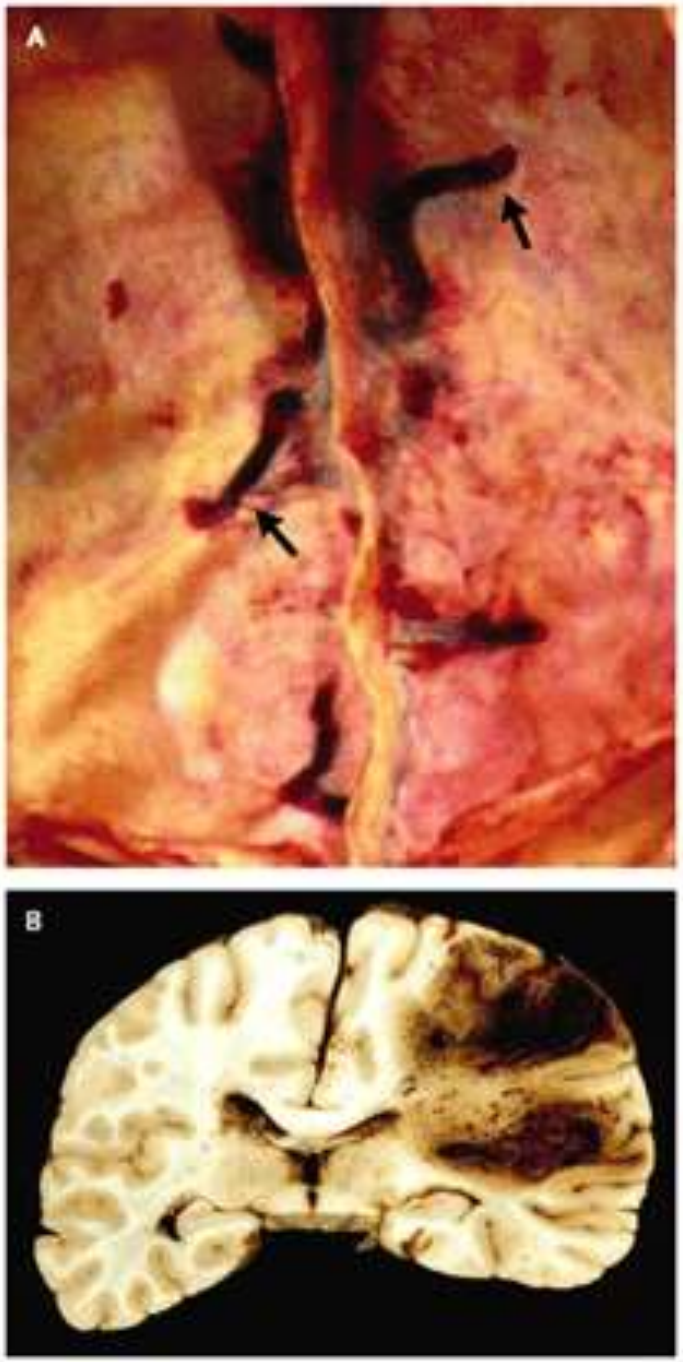
Brain veins - % of thrombosis

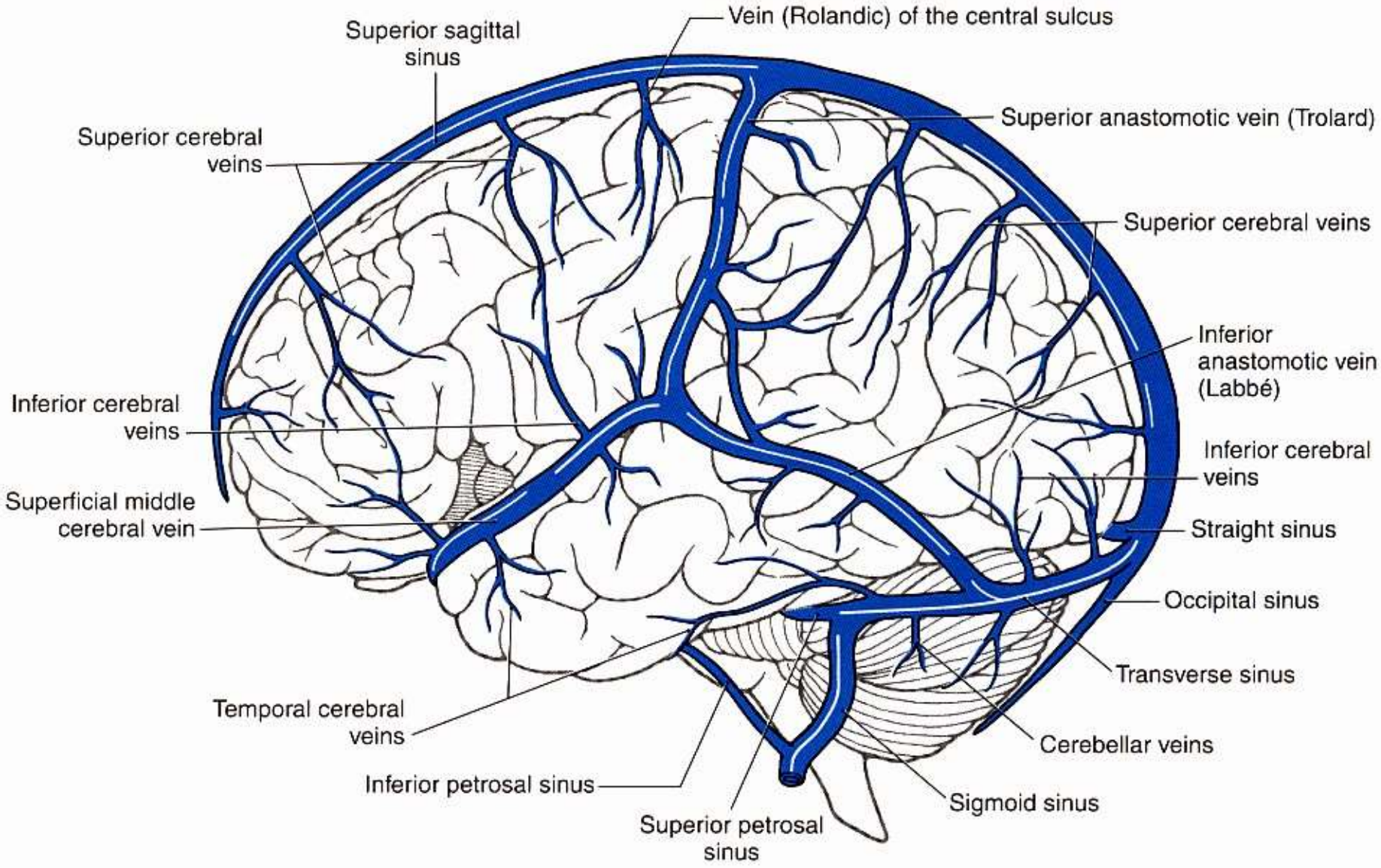


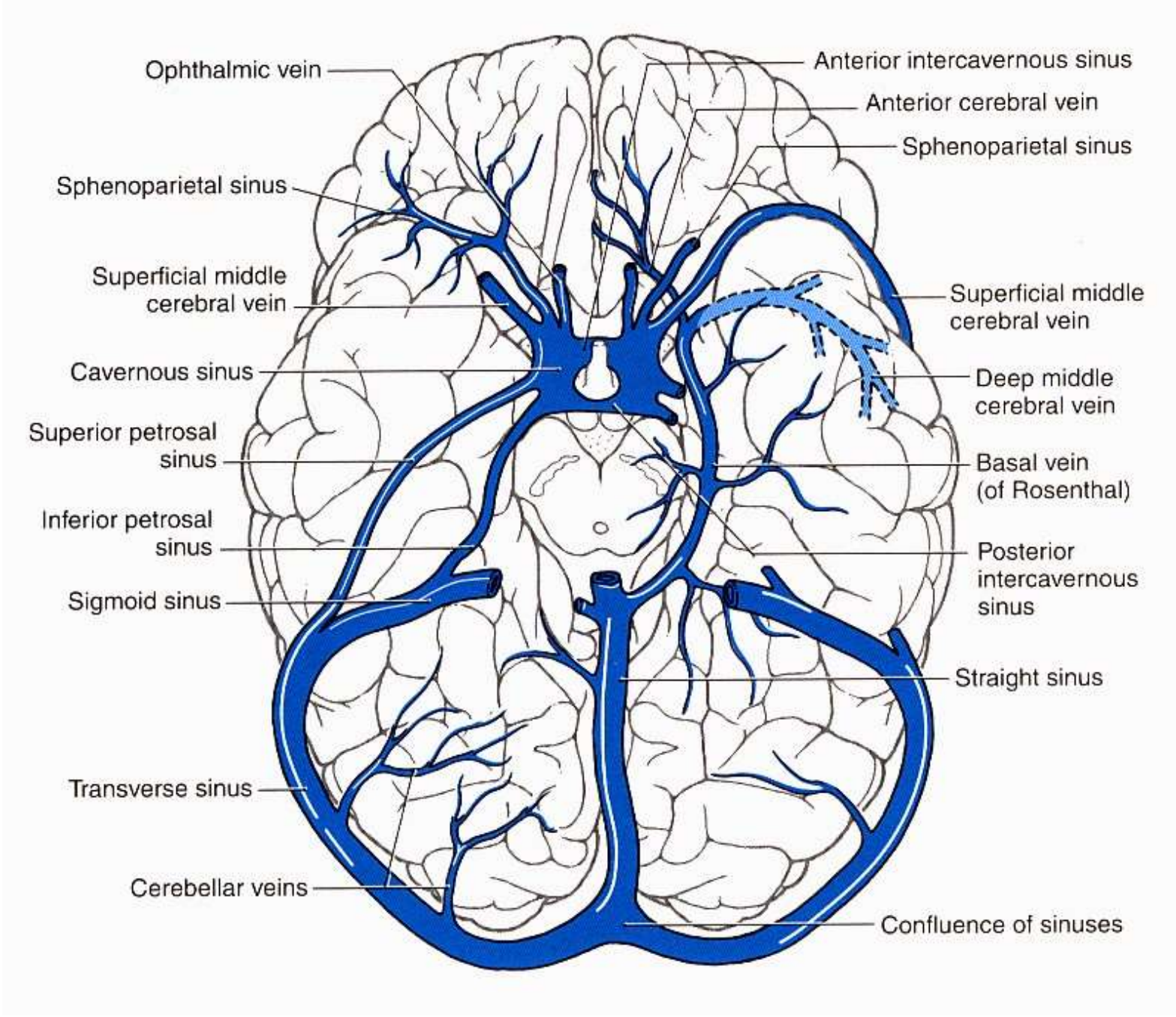
Trombosis sinus sagittalis superior



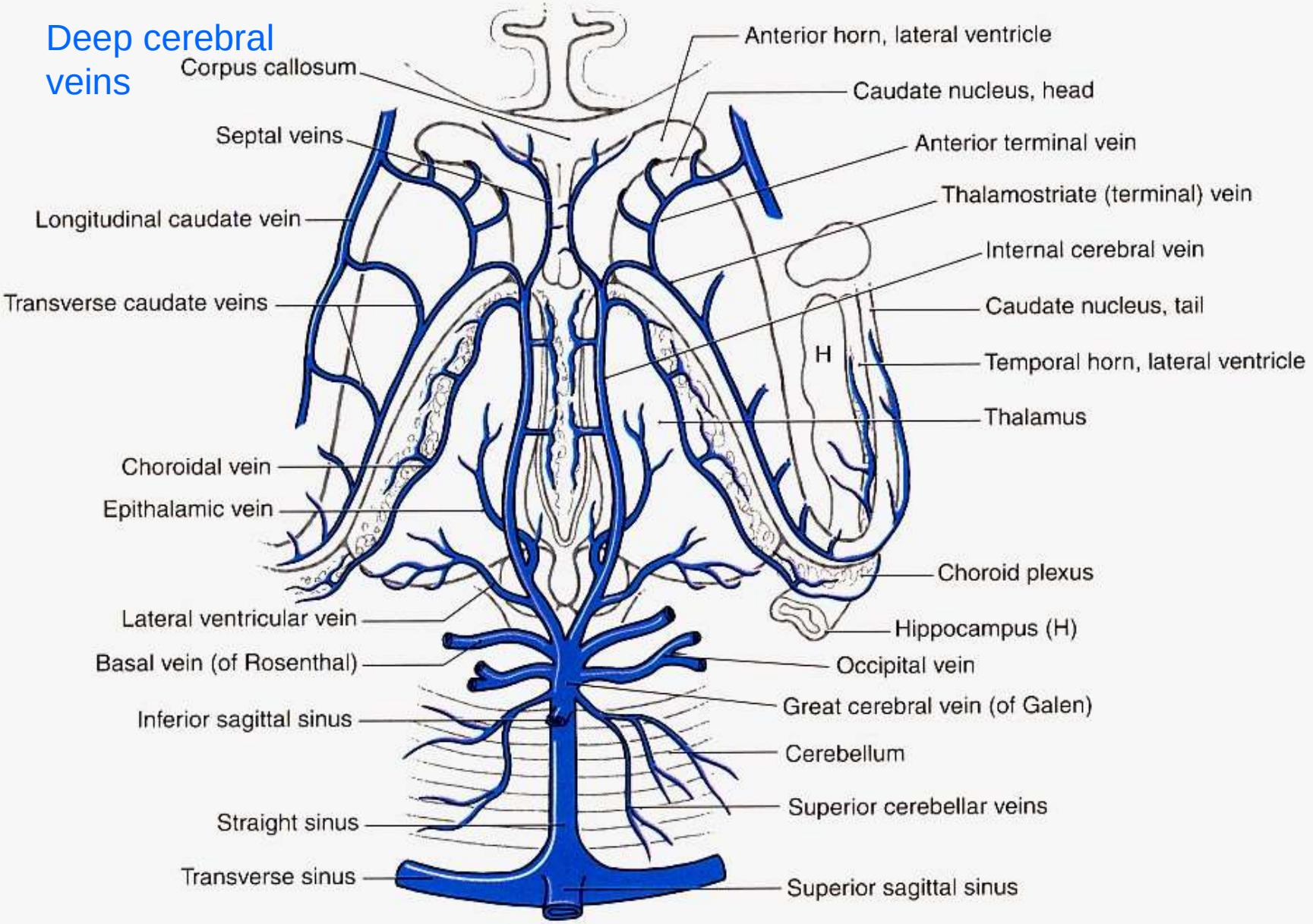
Tromboses vv. cerebri superiores



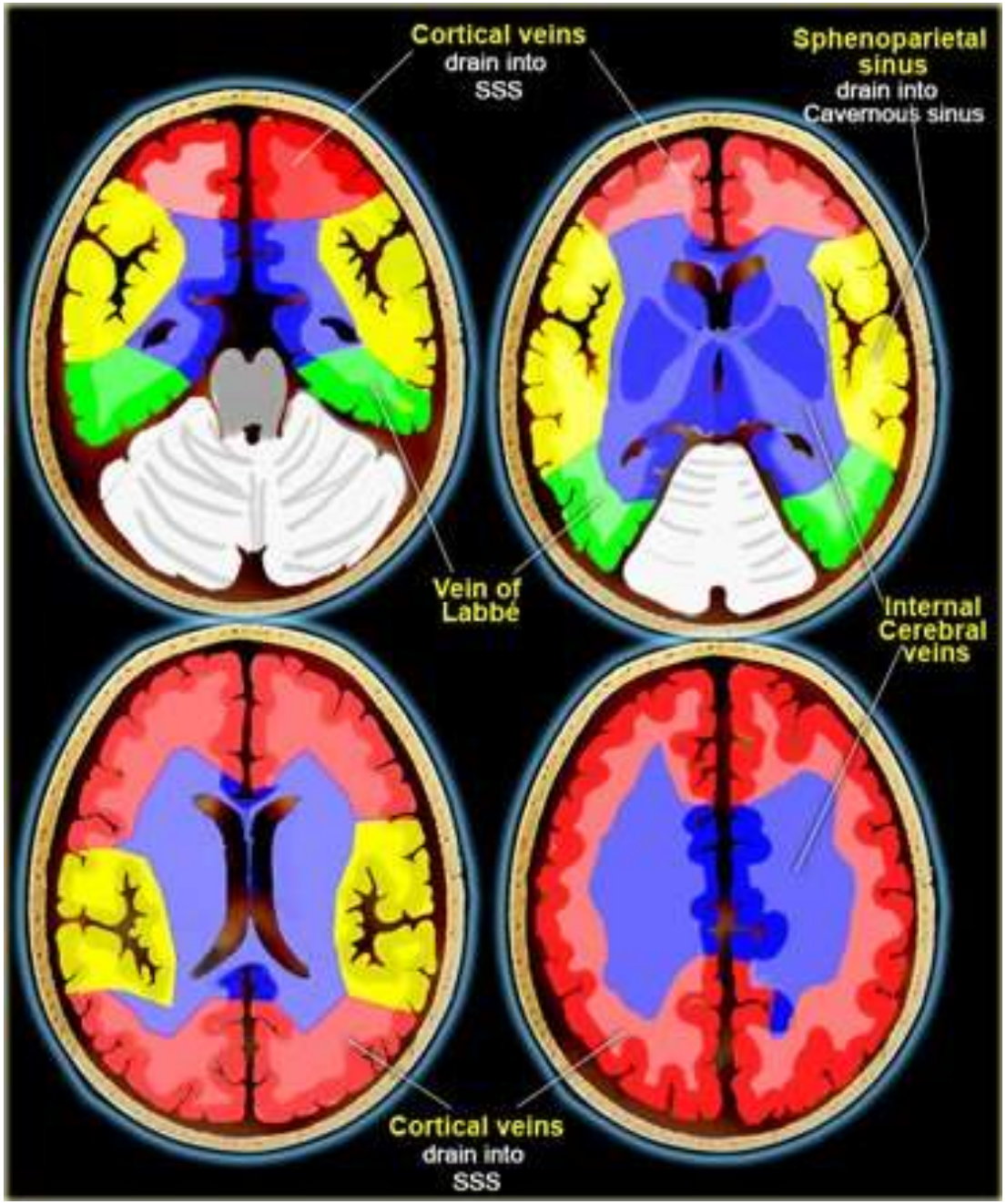

Superior sagittal sinus
Vein (Rolandic) of the central sulcus
Superior anastomotic vein (Trolard)
Superior cerebral veins
Superior cerebral veins
Inferior anastomotic vein (Labbé)
Inferior cerebral veins
Inferior cerebral veins
Superficial middle cerebral vein
Straight sinus
Occipital sinus
Transverse sinus
Temporal cerebral veins
Cerebellar veins
Inferior petrosal sinus
Sigmoid sinus
Superior petrosal sinus


Ophthalmic vein
Sphenoparietal sinus
Superficial middle cerebral vein
Cavernous sinus
Superior petrosal sinus
Inferior petrosal sinus
Sigmoid sinus
Transverse sinus
Cerebellar veins
Anterior intercavernous sinus
Anterior cerebral vein
Sphenoparietal sinus
Superficial middle cerebral vein
Deep middle cerebral vein
Basal vein (of Rosenthal)
Posterior intercavernous sinus
Straight sinus
Confluence of sinuses

Deep cerebral veins



igure 8–17. Veins draining internal areas of the hemisphere and the tributaries of the great cerebral vein and straight sinu
I, hippocampus.



Cerebral Venous territories
„rough guide“

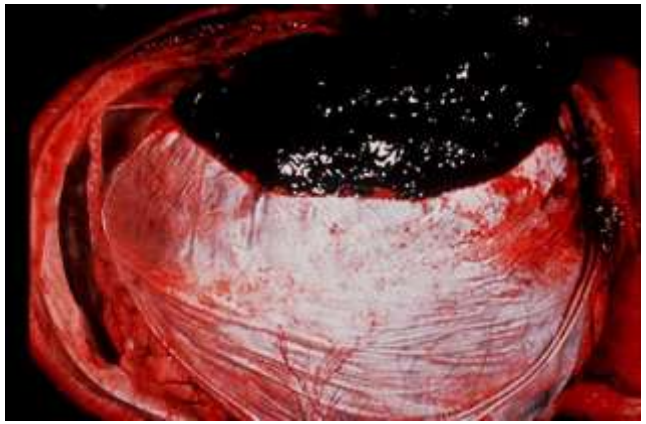
superior sagittal sinus

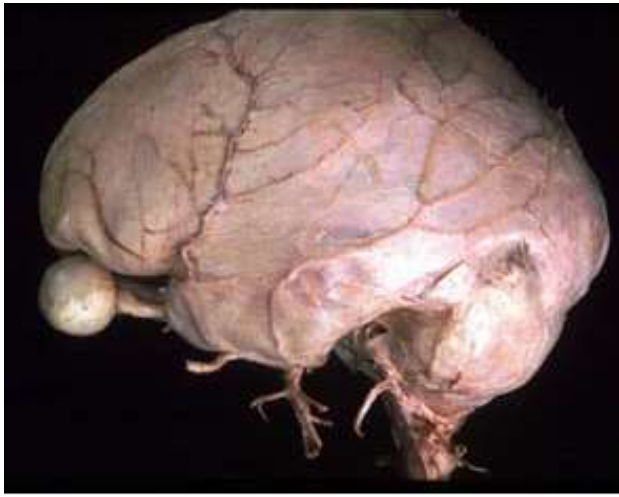
internal cerebral veins

sphenoparietal sinus

vein of Labbé

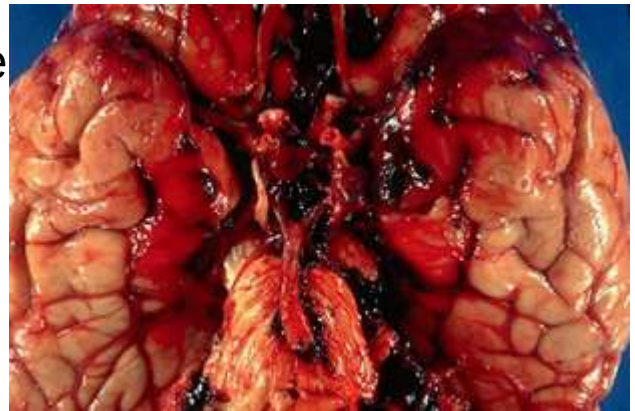
1. Epidural hemorhage

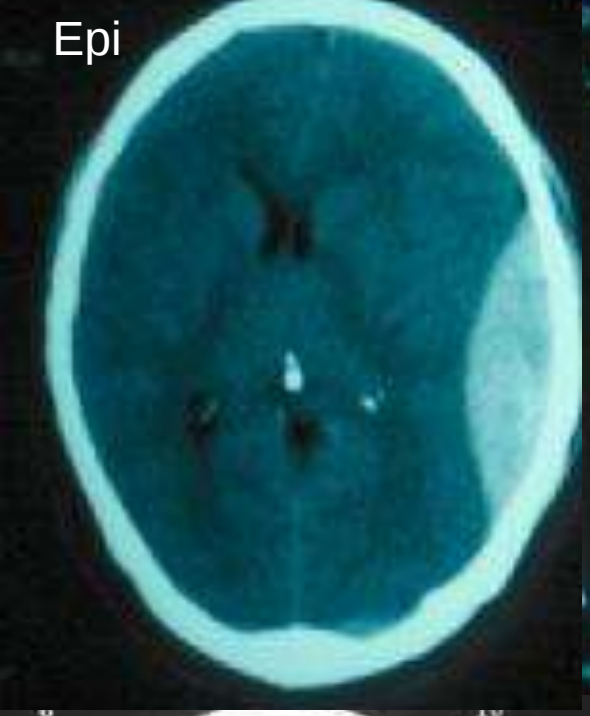


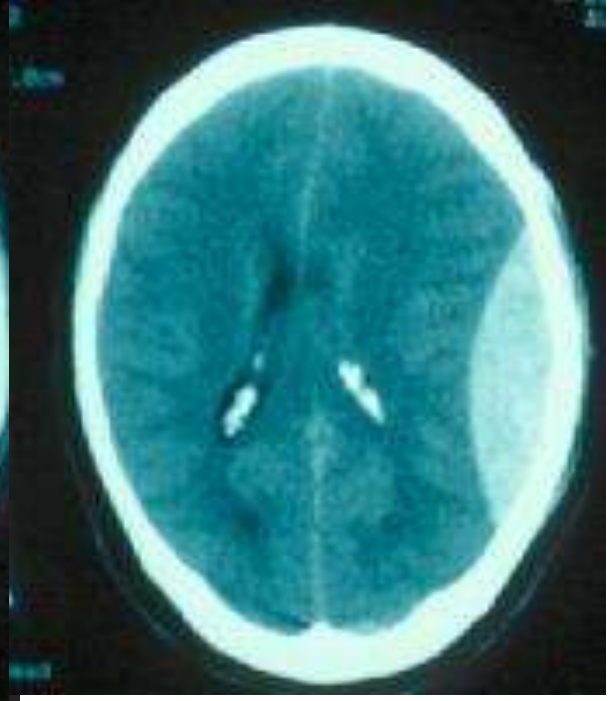


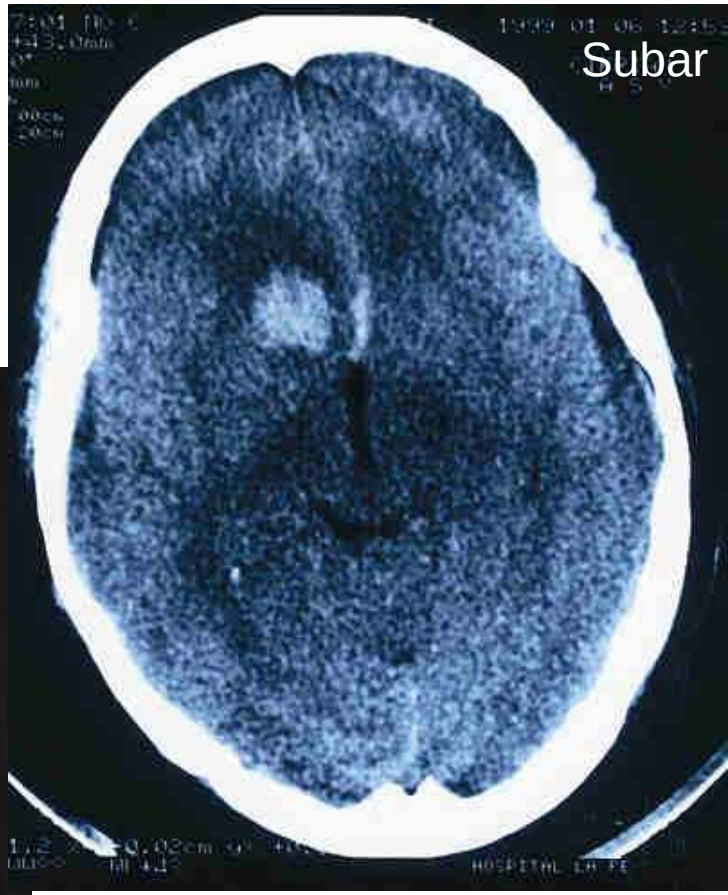
2. Subdural hemorhage

3. Subarachnoidal hemorhage




Epi

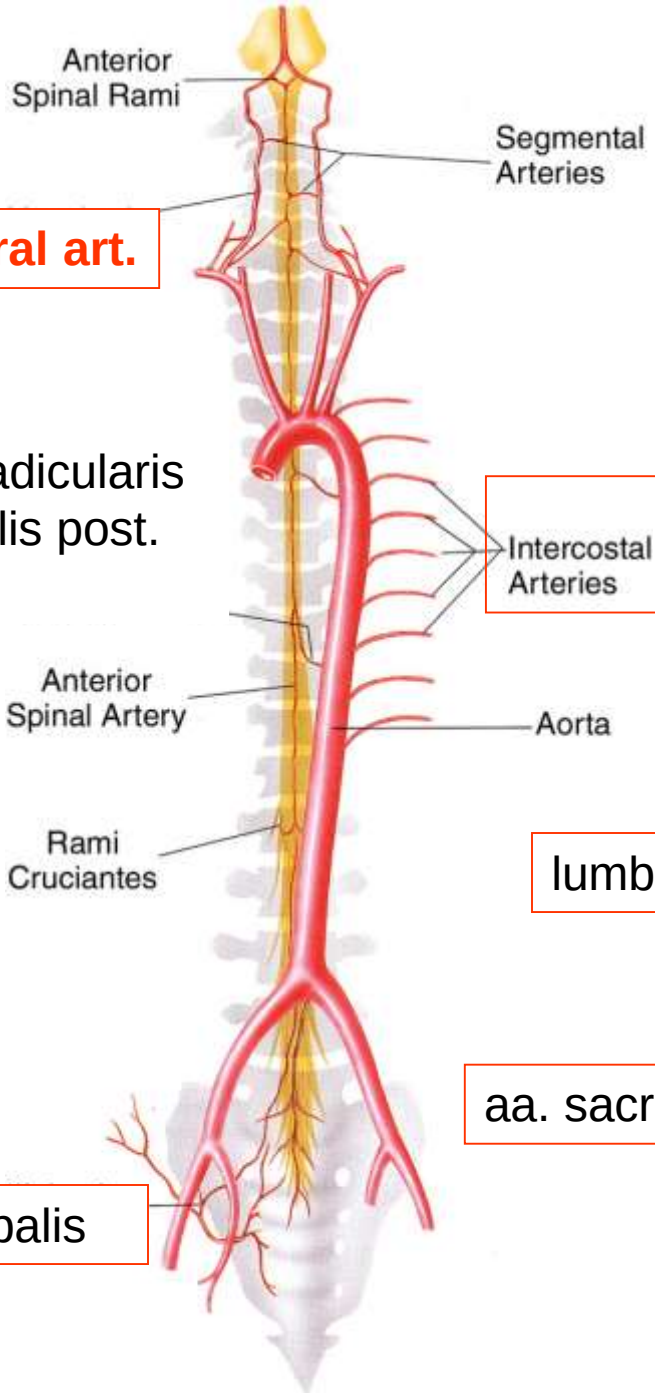



Subar


Subd

Spinal cord arteries

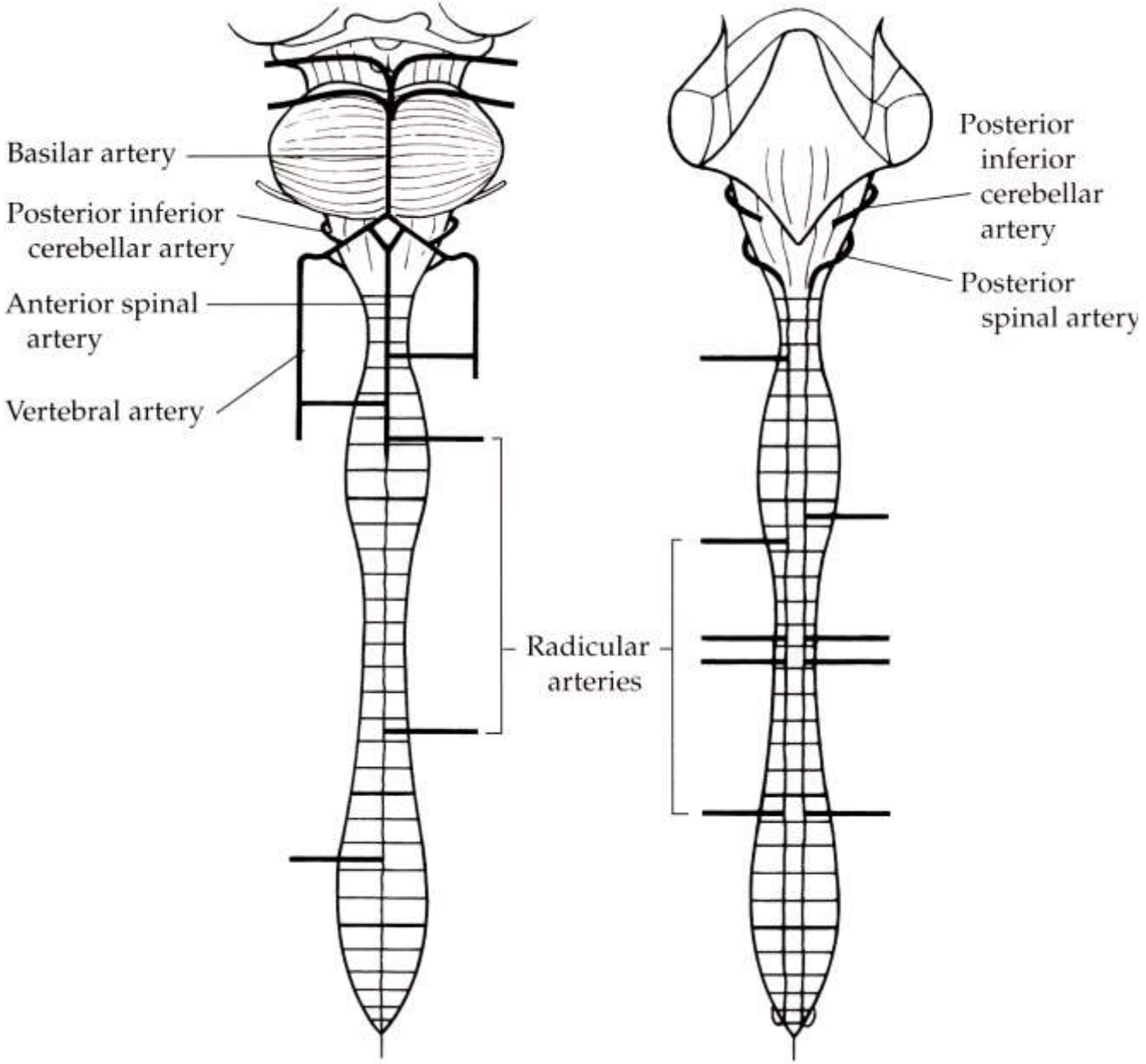
Artery of Adamkiewicz (a. radicularis magna) from the a. intercostalis post. at the level Th9–L1



Yoshioka K et al. Radiographics 2003;23:1215-1225

Longitudinal system

Segmental (radicular) system



Spinal cord -arteries

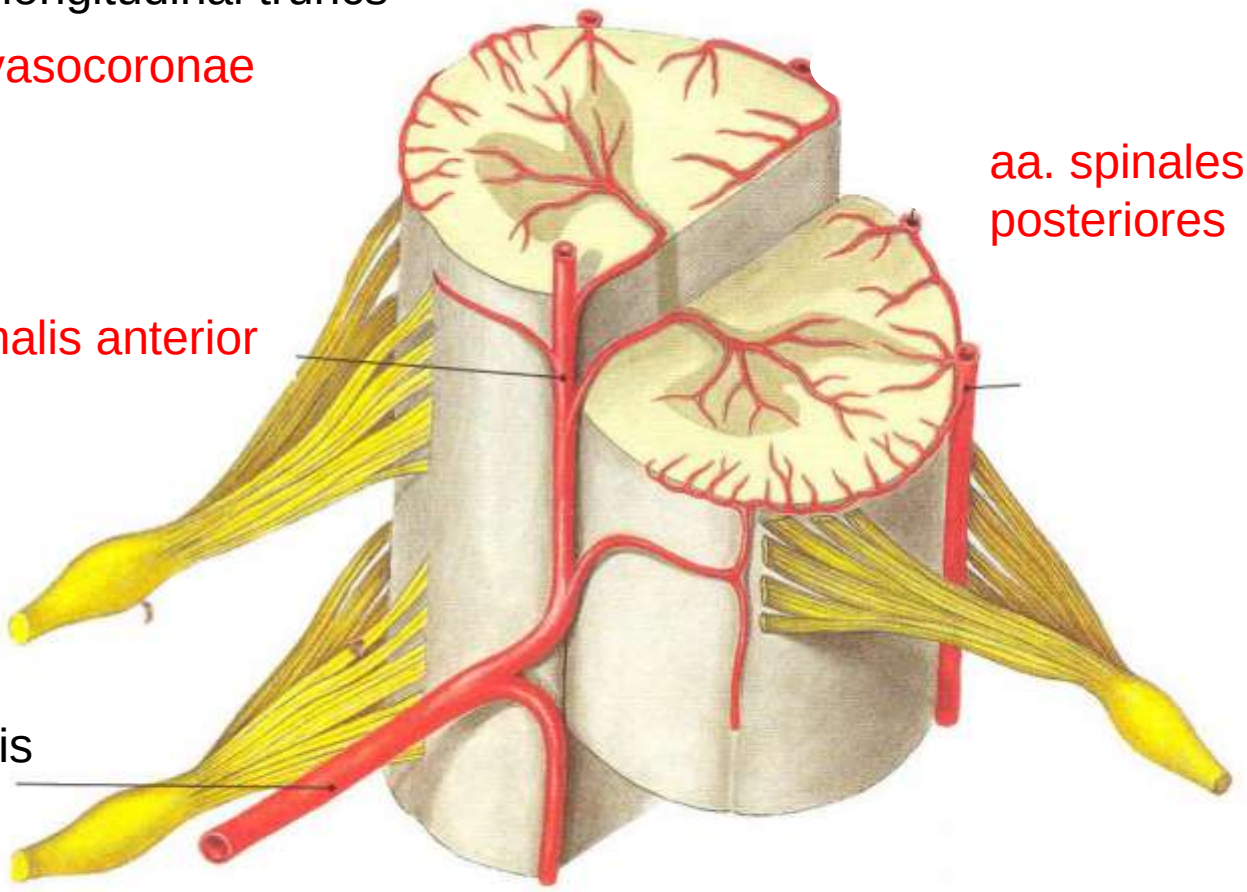
5 longitudinal truncs

vasocoronae

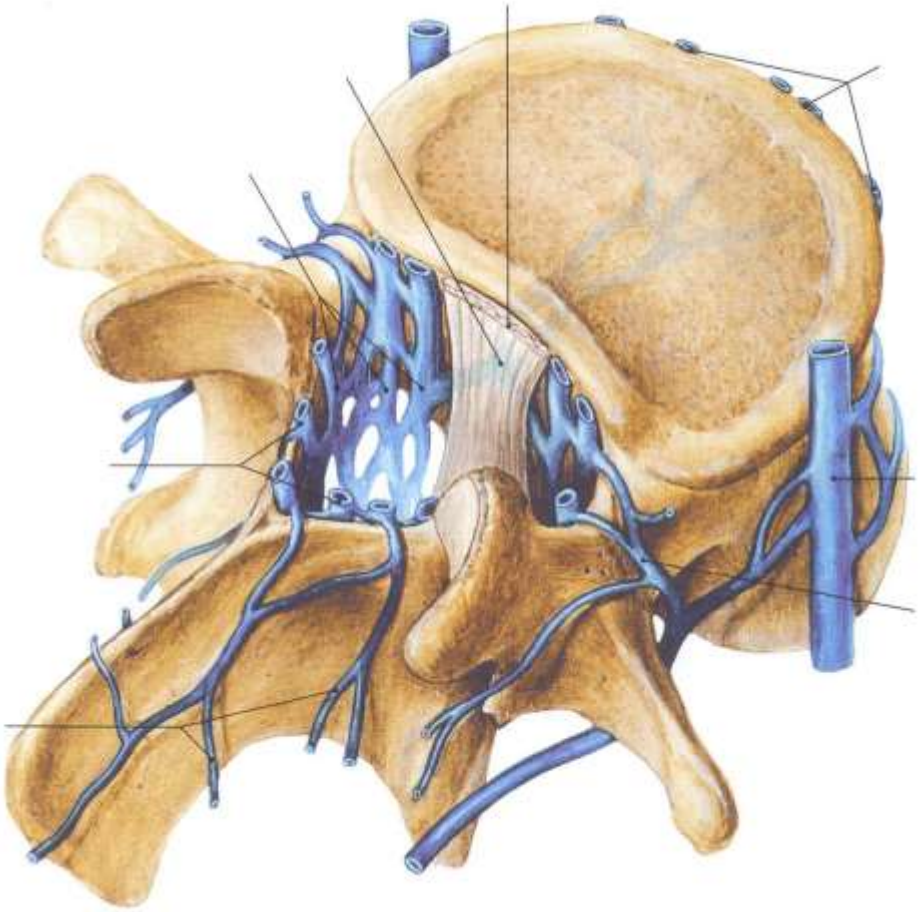
aa. spinales posteriores

a. spinalis anterior

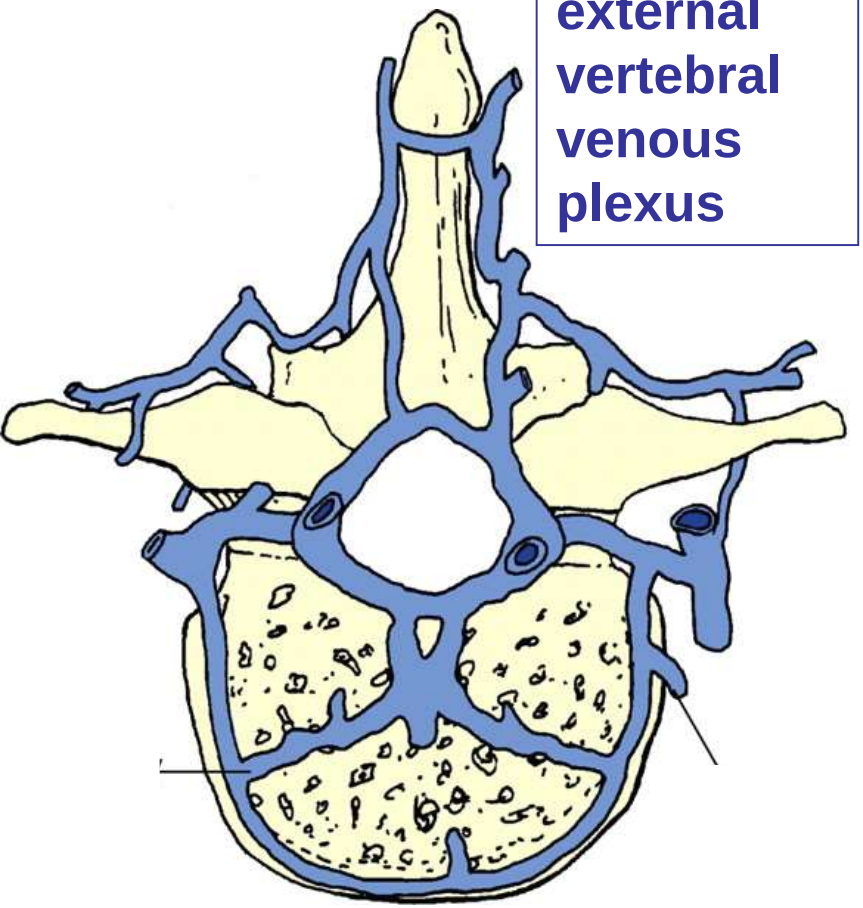
r. spinalis



Vertebral veins

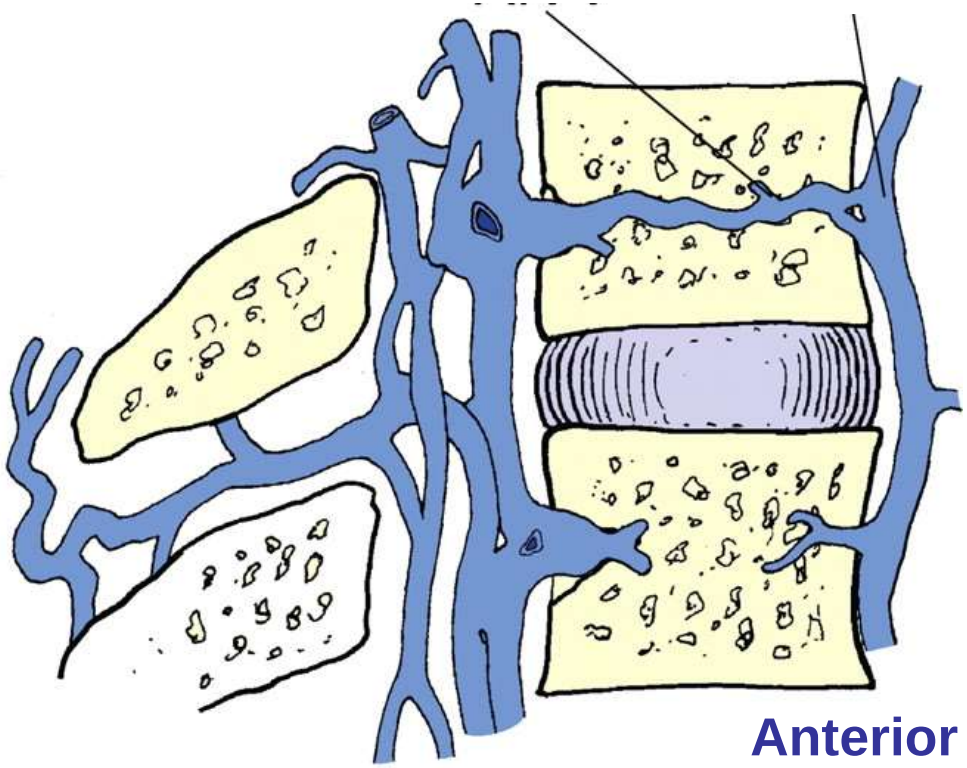


Posterior external vertebral venous plexus



basivertebral veins

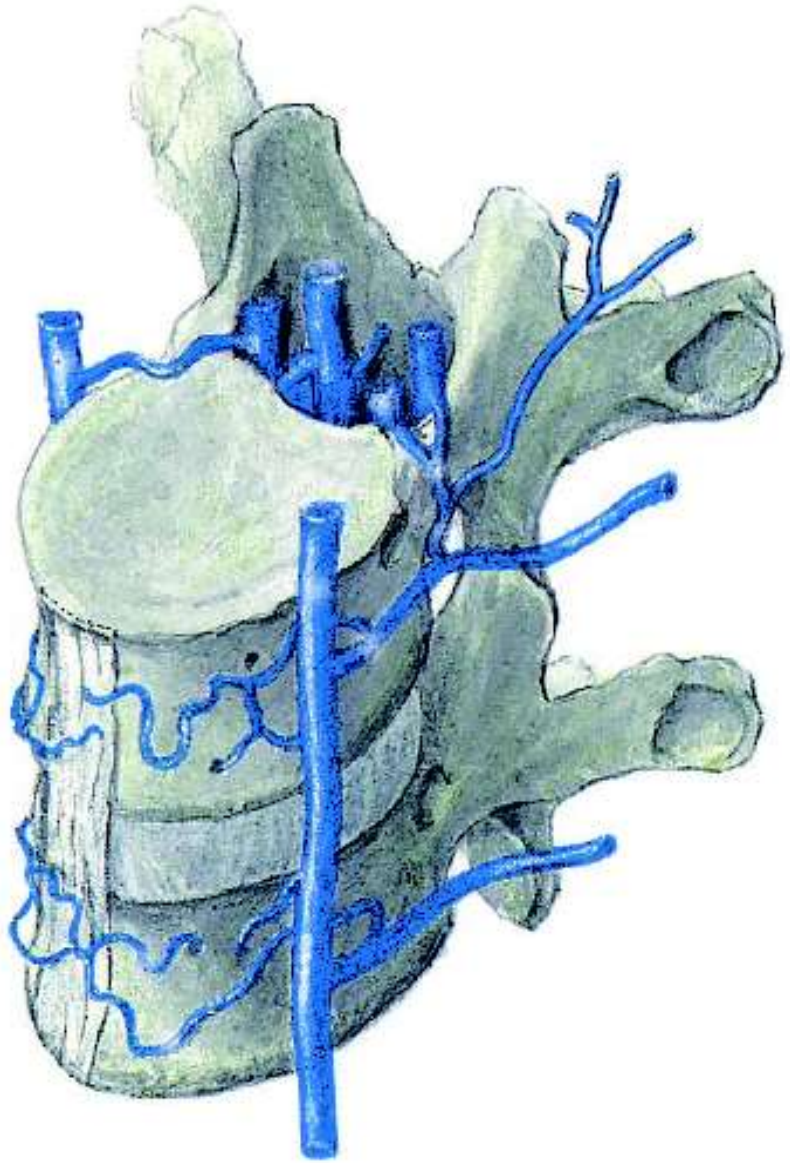
basivertebral vein



Internal vertebral venous plexus

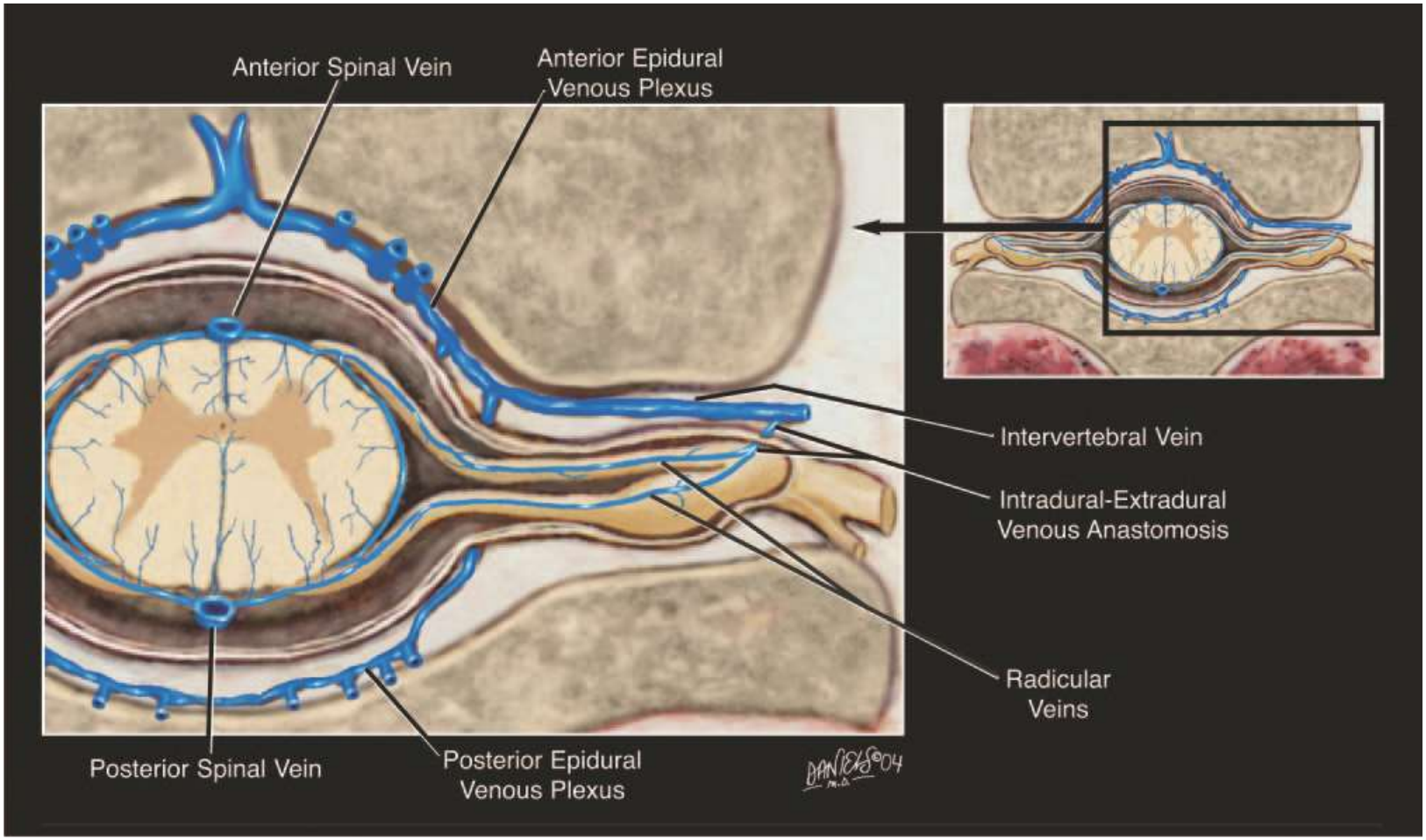
Anterior external vertebral venous plexus

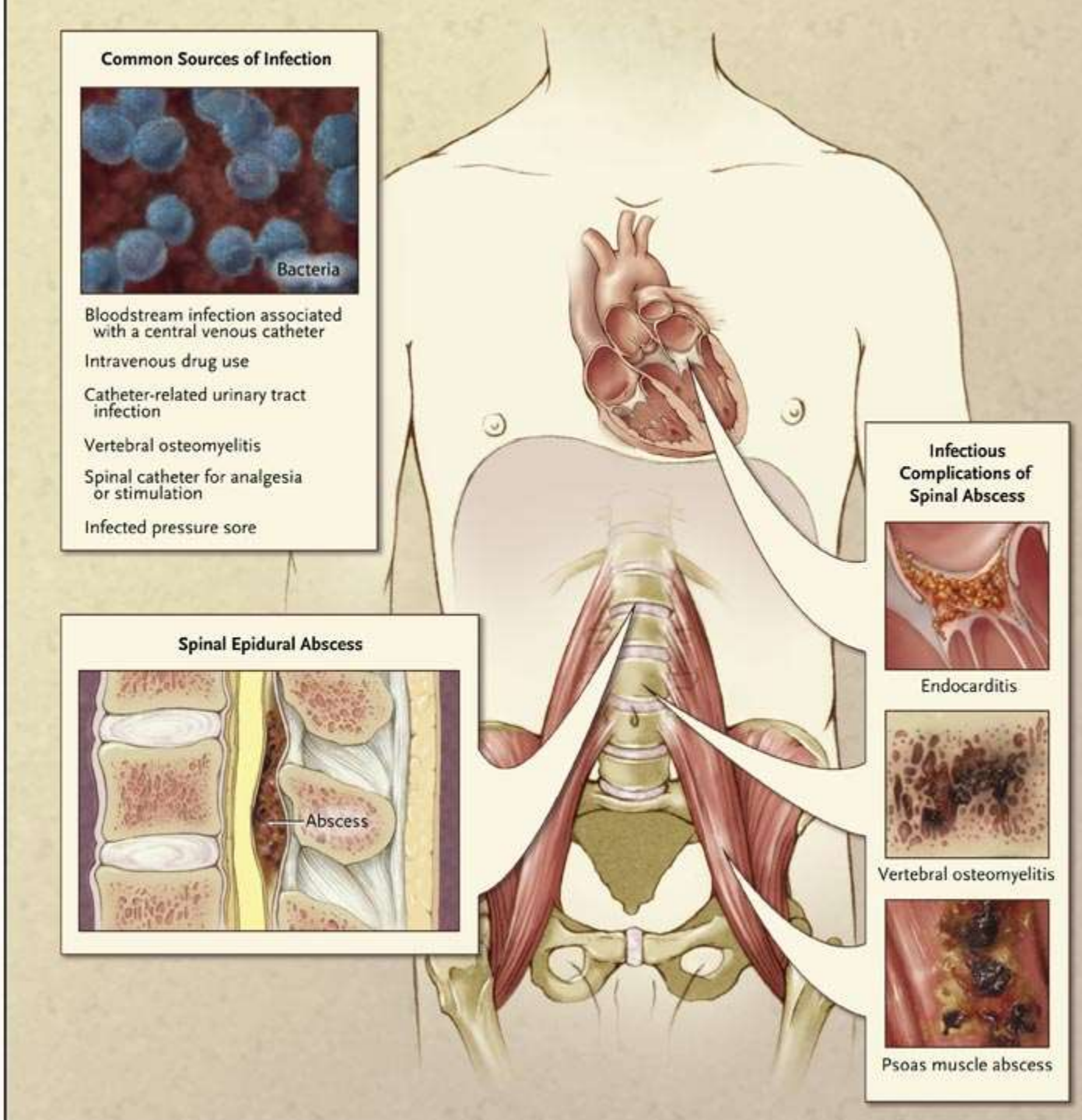
Vertebral veins



no valves
anastomoses
spreading of infection and cancer

Illustration of intradural-extradural venous anastomosis. *Daniels after Netter.*




Common Sources of Infection
Bacteria
Bloodstream infection associated with a central venous catheter
Intravenous drug use
Catheter-related urinary tract infection
Vertebral osteomyelitis
Spinal catheter for analgesia or stimulation
Infected pressure sore
Spinal Epidural Abscess
Abscess
Infectious Complications of Spinal Abscess
Endocarditis
Vertebral osteomyelitis
Psoas muscle abscess

Vertebral venous plexuses

- no valves, a lot of anastomoses
- anastamoses with venous plexus around sacrum and pelvis
- 1) in the vertebral canal in the epidural space (plexus venosi vertebrales interni)
- 2) outside the spine (plexus venosi vertebrales externi)
- 3) in the bodies of vertebrae (venae basivertebrales)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