THE LIMBIC SYSTEM

Institute of Anatomy, 2nd and 1st Medical Faculty

R. Druga

LIMBIC SYSTEM

- **Limbic cortex** = g. cinguli + g. parahippocampalis + hippocampal formation (***gyrus dentatus, hippocampus, subiculum)***

- **Subcortical structures =** amygdala, septum verum, habenula, hypothalamus

Funkce limbického systému

- Emoční reakce a jejich kontrola (Papez 1937)
- Viscerální mozek (MacLean 1949)
- Paměťové mechanizmy, Emoce

Functions of the limbic system

- Control of emotional reactions (Papez 1937)
- Visceral brain (MacLean 1949)
- Memory, emotions

Limbic brain = limbic cortex + subcortical structures

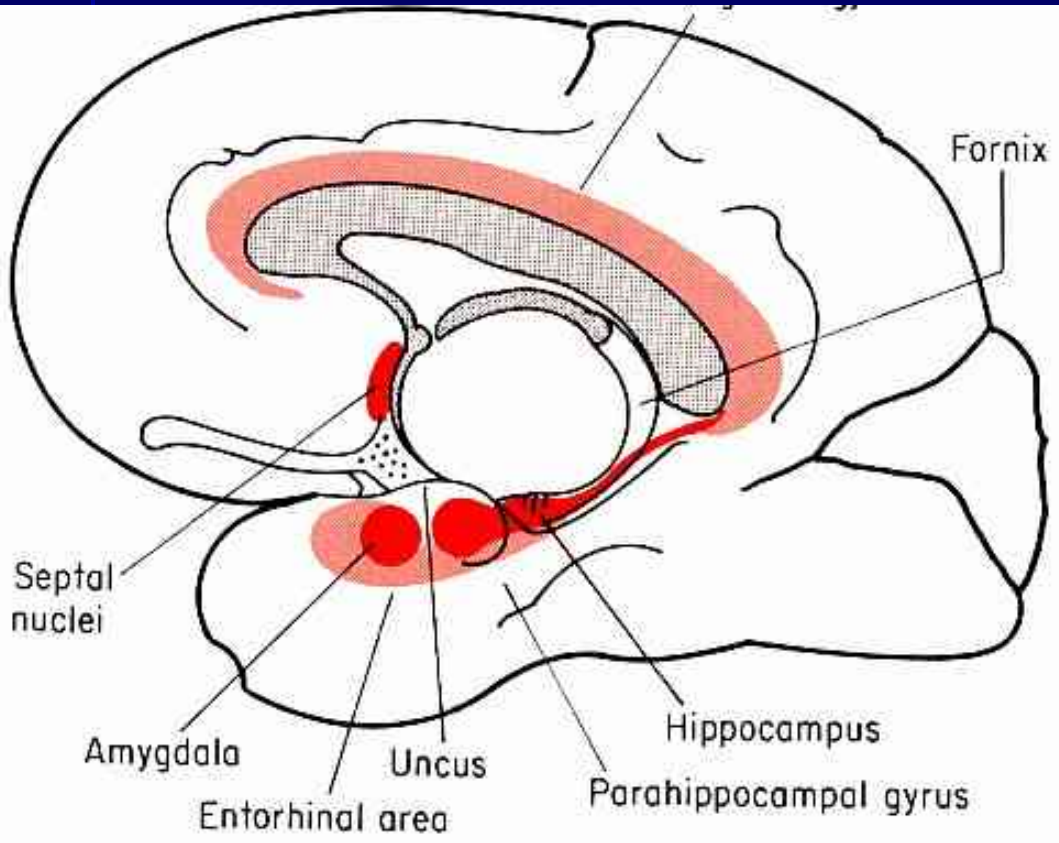


Fig. 16.1. *The limbic structures.* The right hemisphere seen from the medial aspect. The regions and cell groups indicated in red are usually included in the term "limbic system."

Hippokampální formace

Amygdala

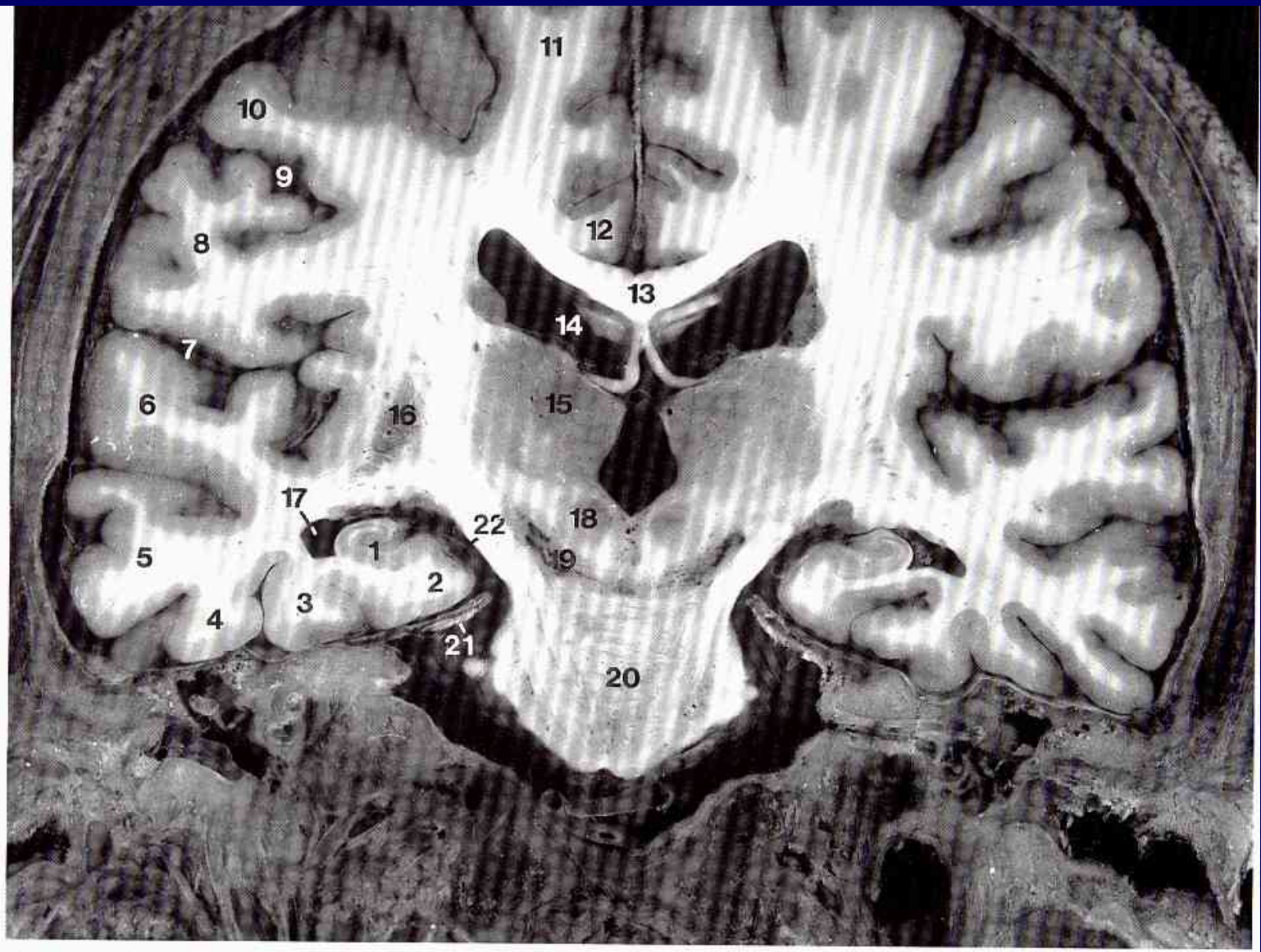
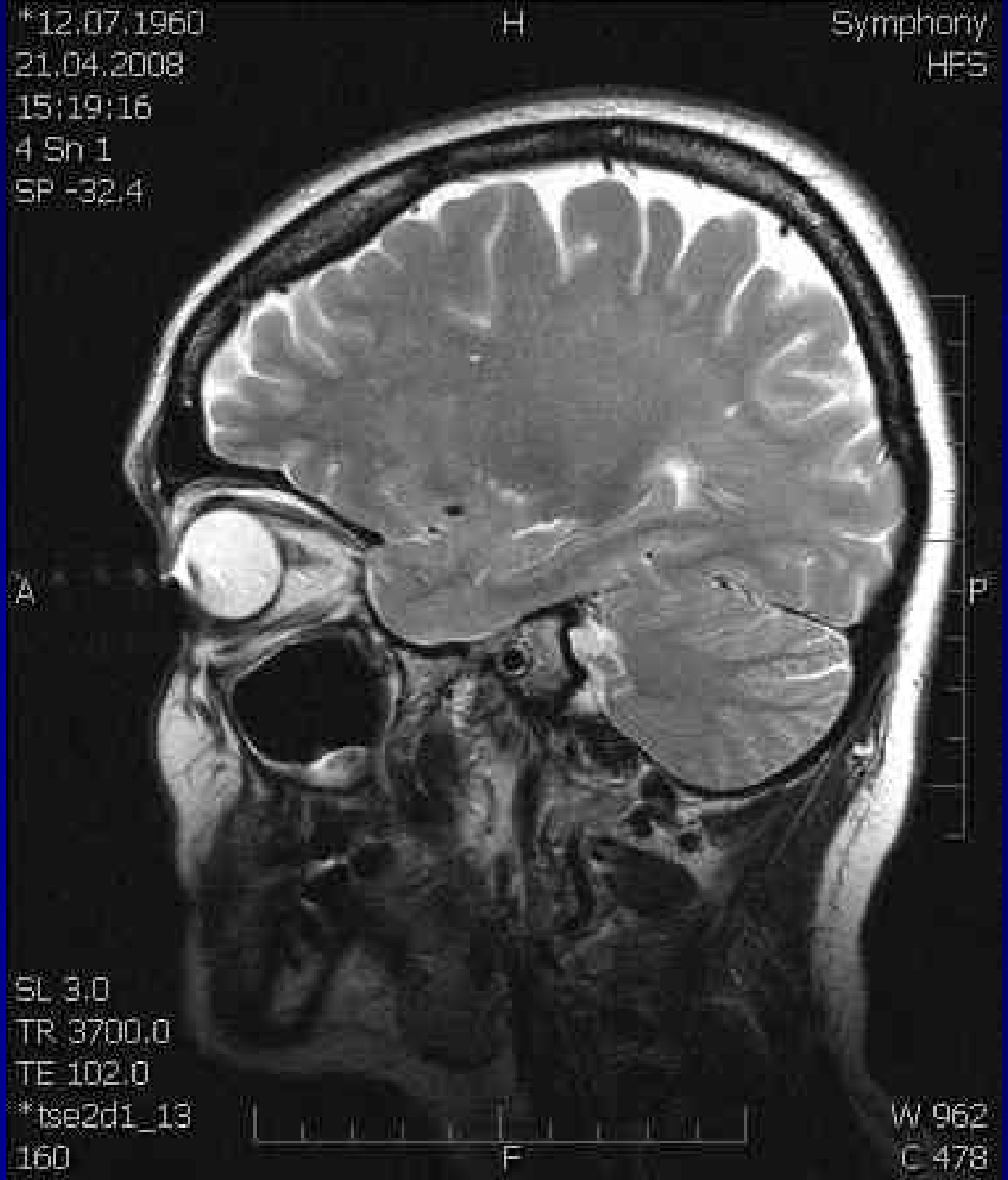


Fig. 2. A, B Coronal section of the brain. **A** Head section. Bar, 10 mm. **B** MRI view, T^1-weighted image
1, hippocampus; **2**, parahippocampal gyrus; **3**, fusiform gyrus; **4**, inferior temporal gyrus; **5**, middle temporal gyrus; **6**, superior temporal gyrus; **7**, lateral fissure; **8**, postcentral gyrus; **9**, central sulcus; **10**, precentral gyrus; **11**, superior frontal gyrus; **12**, cingulate gyrus; **13**, corpus callosum; **14**, lateral ventricle; **15**, thalamus; **16**, putamen; **17**, temporal (inferior) horn of the lateral ventricle; **18**, red nucleus; **19**, substantia nigra; **20**, pons; **21**, tentorium cerebelli; **22**, ambient cistern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1- hippocampal body

2 – head and digitationes hippocampi

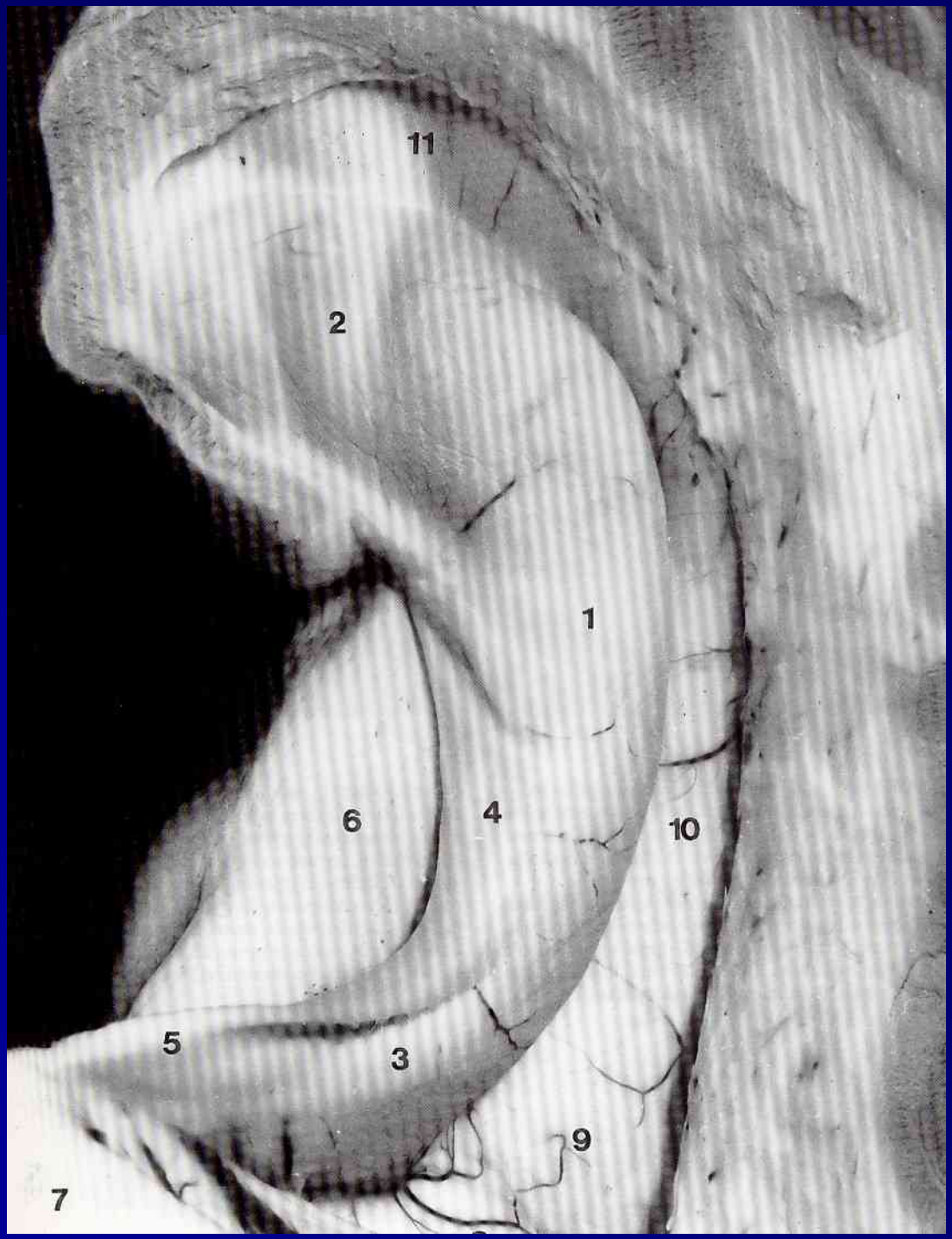
3 – hippocampal tail

4 – fimbria (fornix)

5 – fornix

6 – subiculum

10 – collateral eminence



Intraventricular aspect of the hippocampus

(hippocampus from above)

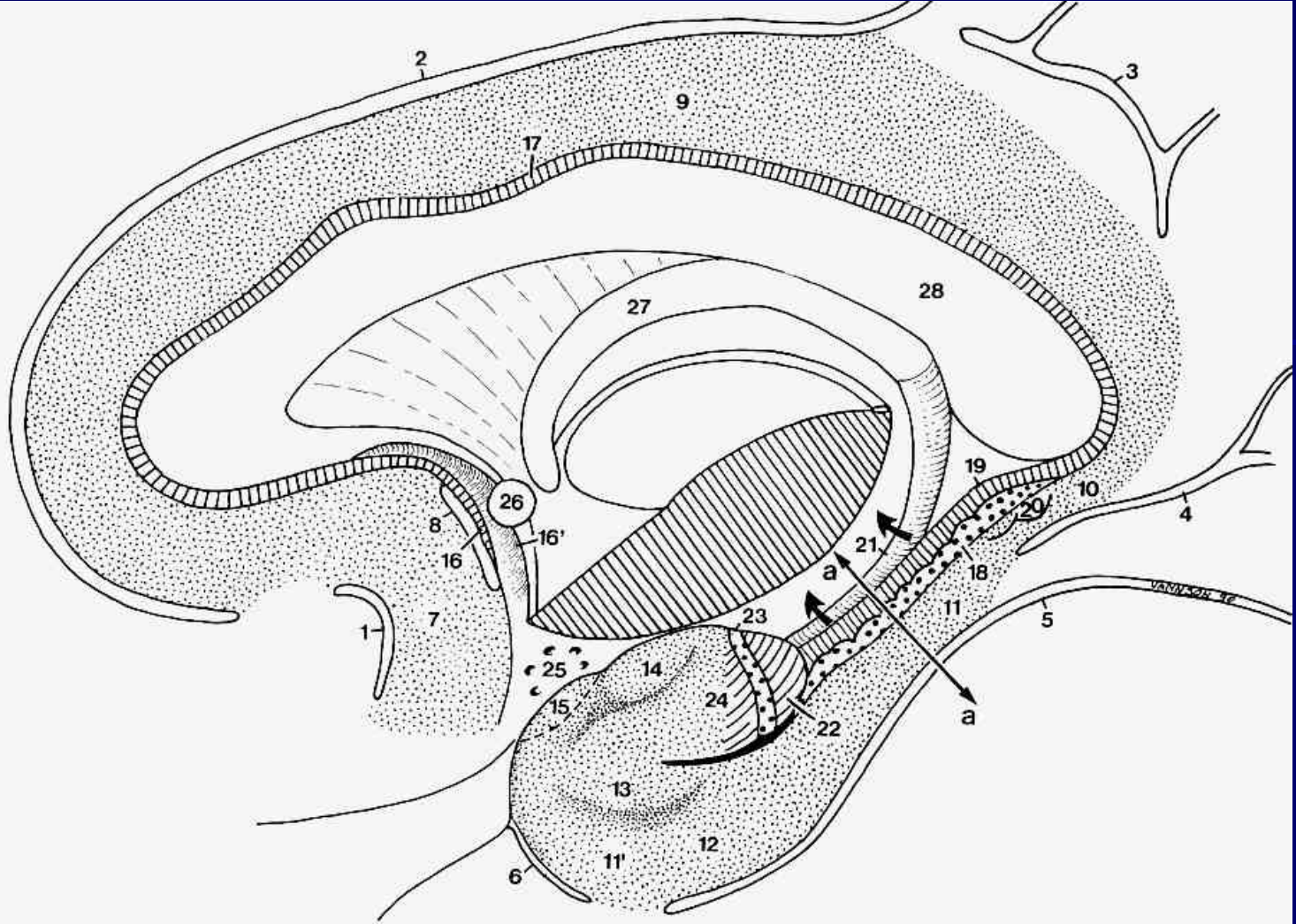
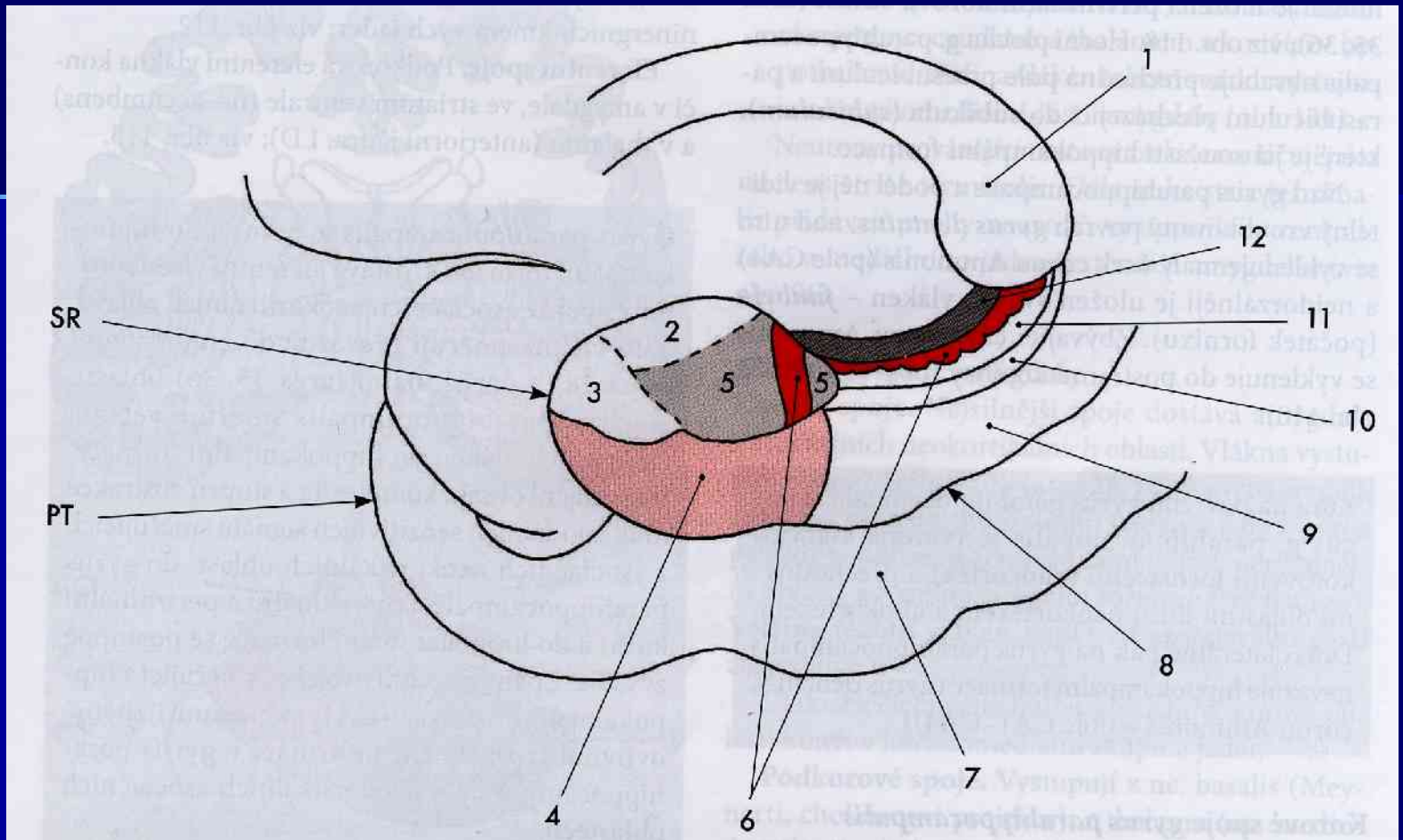


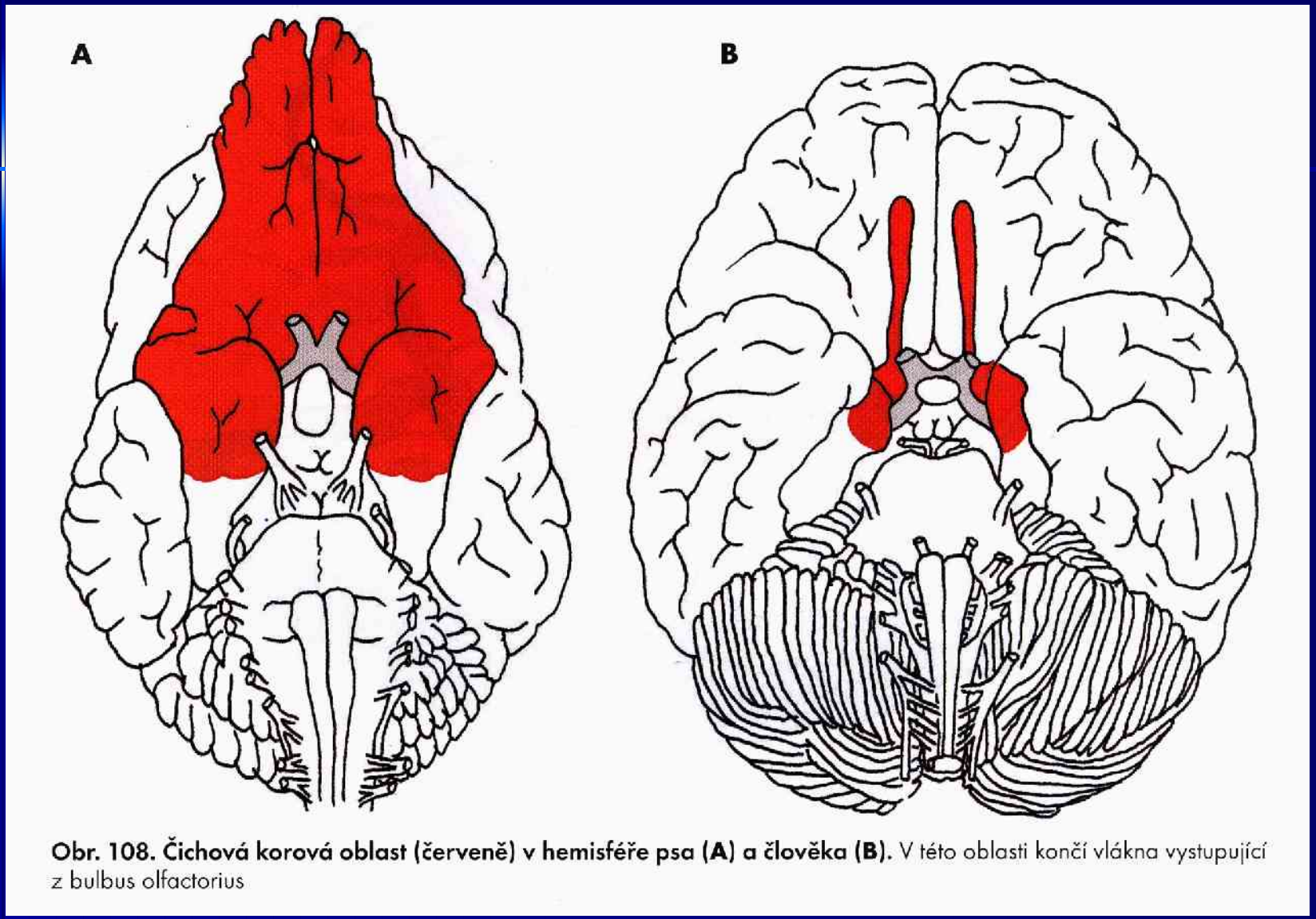
Fig. 4. A Drawing and **B** dissection showing a sagittal section, right hemisphere. The limbic lobe is separated from the isocortex by the limbic fissure and may be divided into two gyri: the limbic and intralimbic gyri. The line a – a indicates the plane of the section on Fig. 5. Bar, 7.7 mm
Limbic fissure: 1, anterior paraolfactory sulcus (subcallosal sulcus); 2, cingulate sulcus; 3, subparietal sulcus; 4, anterior calcarine sulcus; 5, collateral sulcus; 6, rhinal sulcus. Limbic gyrus: 7, subcallosal gyrus; 8, posterior paraolfactory sulcus; 9, cingulate gyrus; 10, isthmus; 11, parahippocampal gyrus, posterior part; 11′, parahippocampal gyrus, anterior part (piriform lobe). Piriform lobe: 12, entorhinal area; 13, ambient gyrus; 14, semilunar gyrus; 15, prepiriform cortex. Intralimbic gyrus: 16, prehippocampal rudiment; 16′, paraterminal gyrus; 17, indusium griseum. Hippocampus: 18, gyrus dentatus; 19, cornu Ammonis; 20, gyri of Andreas Retzius; 21, fimbria (displaced upwards, arrows); 22, uncal apex; 23, band of Giacomini; 24, uncinate gyrus; 25, anterior perforated substance; 26, anterior commissure; 27, fornix; 28, corpus callosum

Parahippocampal gyrus + Uncus Hippocampal formation



Obr. 129. Členění uncus a gyrus parahippocampalis na jednotlivá pole. 1 – corpus callosum, 2 – gyrus semilunaris (nc. amygdalaris corticalis), 3 – gyrus ambiens (piriformní korová oblast, area 51), 4 – entorhinální korová oblast (area 28), 5 – hippocampus (cornu ammonis), 6 – Giacominiho proužek (gyrus dentatus), 7 – gyrus occipitotemporalis lateralis, 8 – sulcus collateralis, 9 – gyrus parahippocampalis, 10 – praesubiculum, 11 – subiculum, 12 – fimbria (počáteční úsek fornixu). PT = polus temporalis, SR = sulcus rhinalis

Olfactory cortical area



Obr. 108. Čichová korová oblast (červeně) v hemisféře psa (A) a člověka (B). V této oblasti končí vlákna vystupující z bulbus olfactorius

Dog

Human

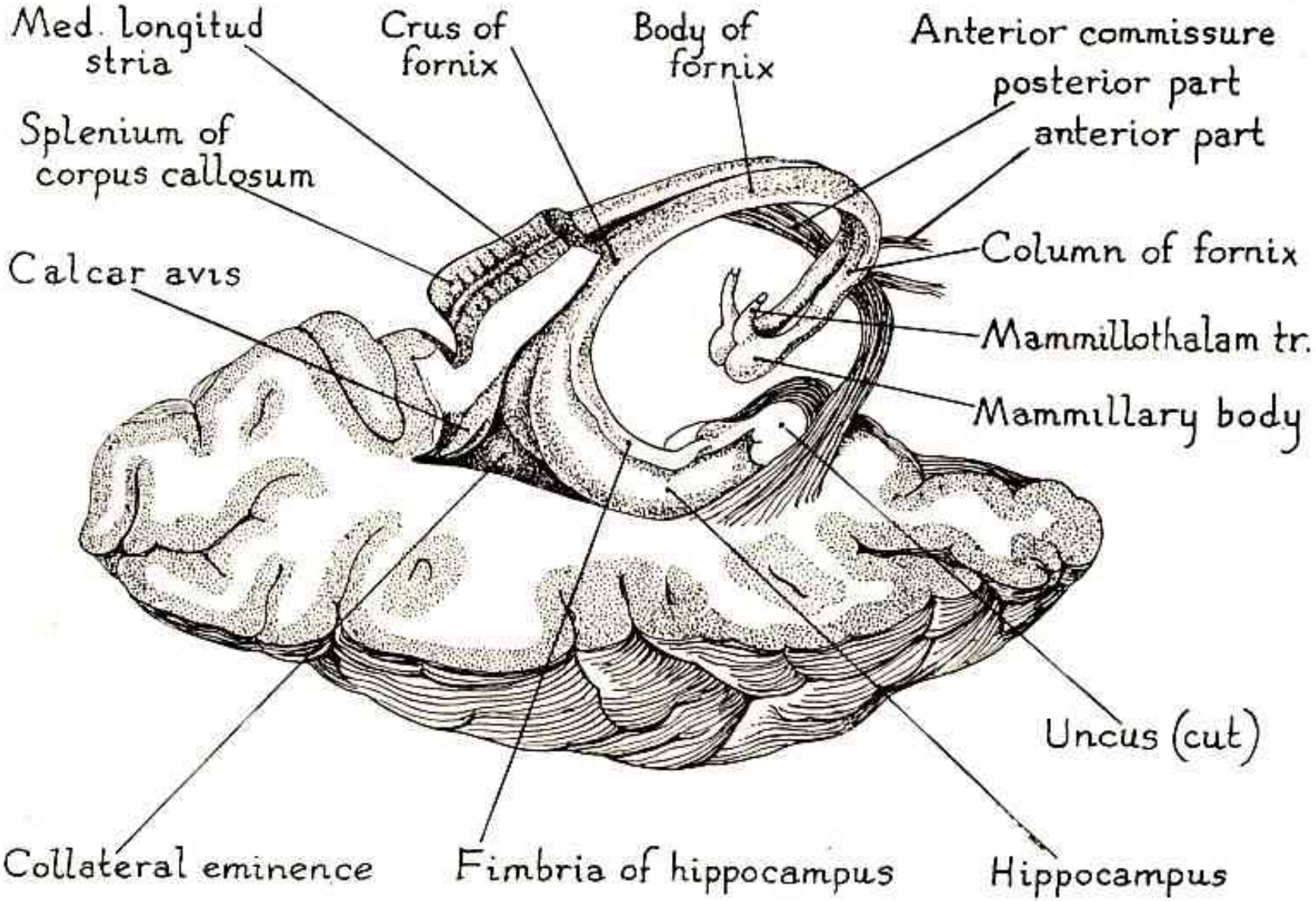


FIG. 310. Dissection of right hemisphere showing inferior and posterior horns of the lateral ventricle, hippocampus, fornix and anterior commissure. (After Rauber-Kopsch.)

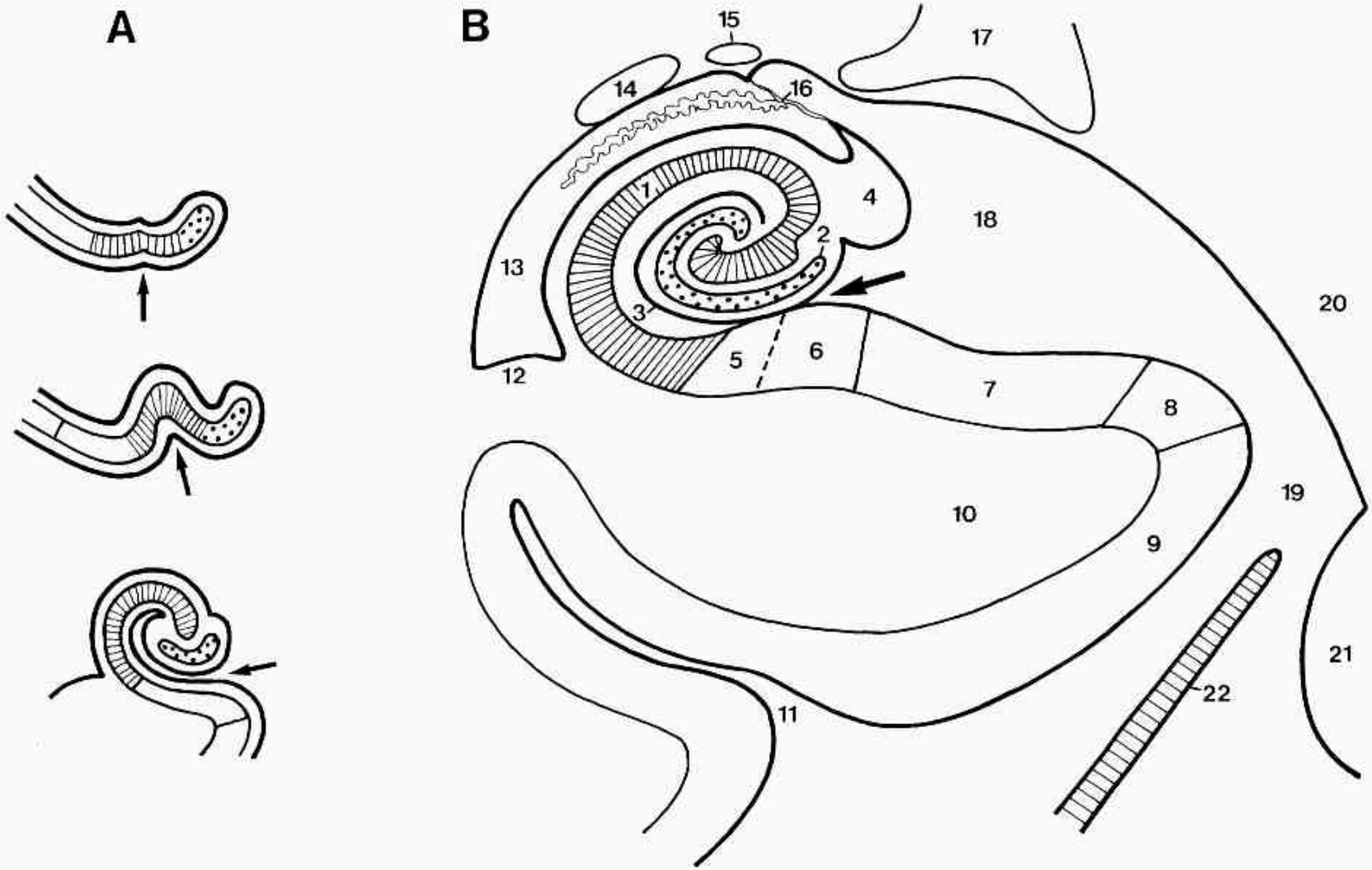
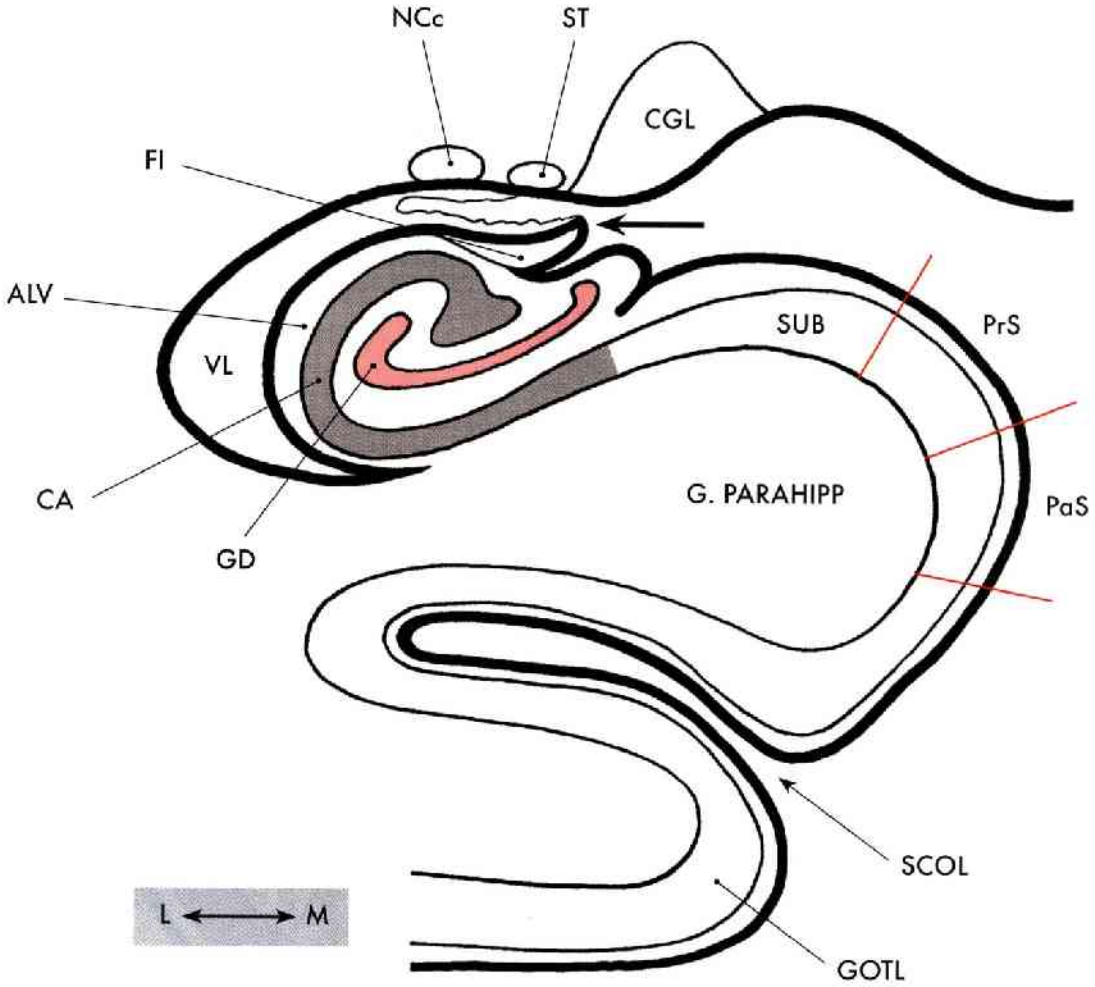
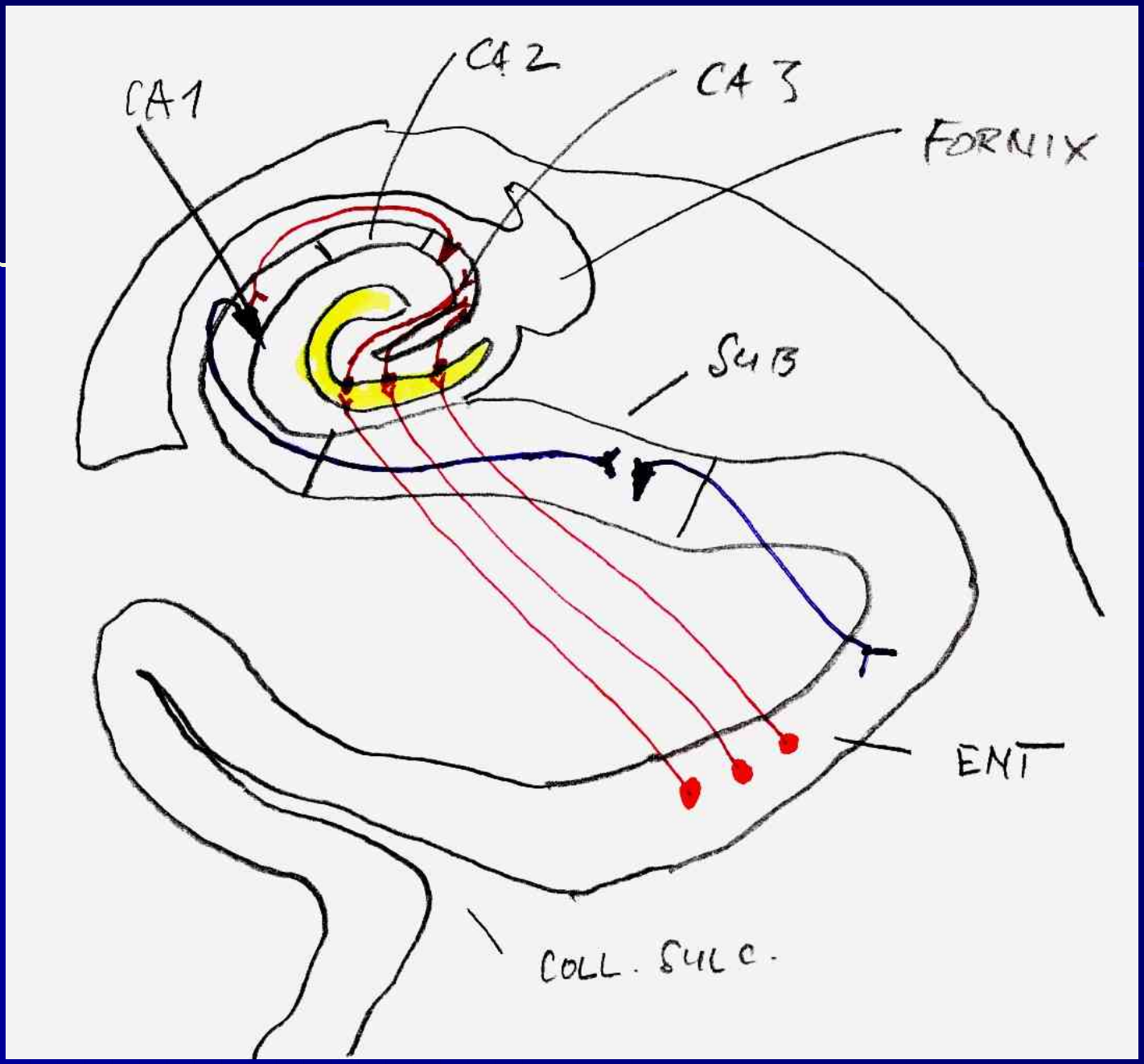


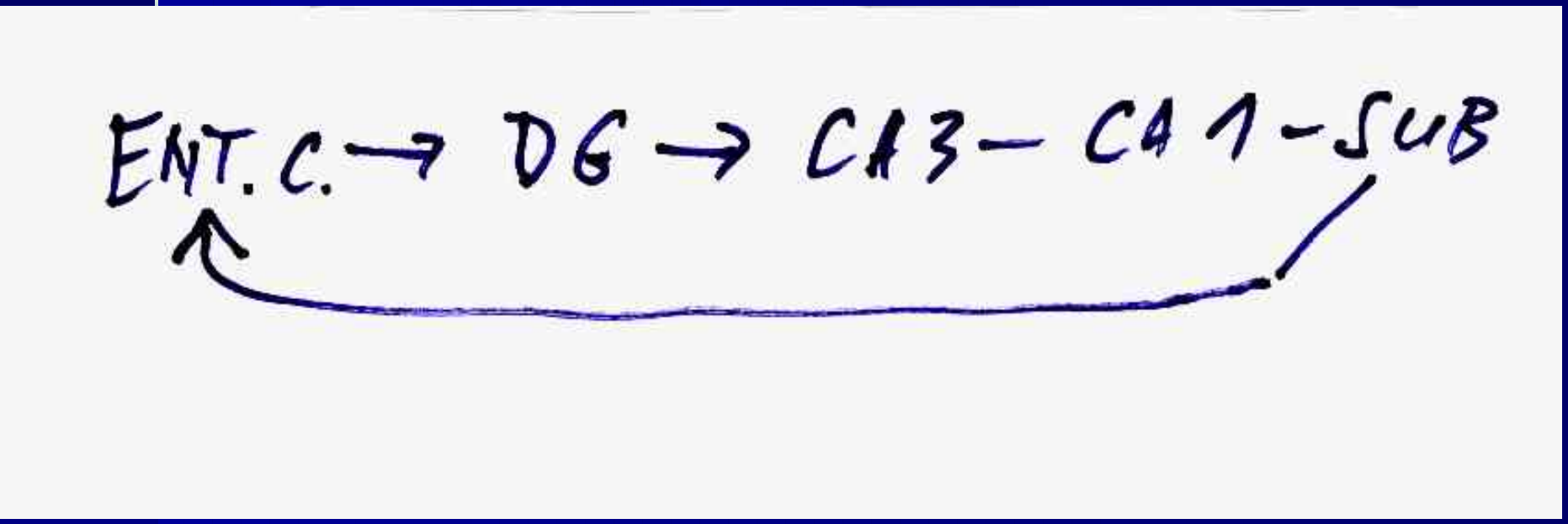
Fig. 5. A Development of the gyrus dentatus (**dotted area**) and of the cornu Ammonis (**hatched area**) towards **B** their definitive disposition. **Arrows** indicate the hippocampal sulcus (superficial part). (Modified after Williams 1995)
1, cornu Ammonis; **2**, gyrus dentatus; **3**, hippocampal sulcus (deep or vestigial part); **4**, fimbria; **5**, prosubiculum; **6**, subiculum proper; **7**, presubiculum; **8**, parasubiculum; **9**, entorhinal area; **10**, parahippocampal gyrus; **11**, collateral sulcus; **12**, collateral eminence; **13**, temporal (inferior) horn of the lateral ventricle; **14**, tail of caudate nucleus; **15**, stria terminalis; **16**, choroid fissure and choroid plexuses; **17**, lateral geniculate body; **18**, lateral part of the transverse fissure (wing of ambient cistern); **19**, ambient cistern; **20**, mesencephalon; **21**, pons; **22**, tentorium cerebelli



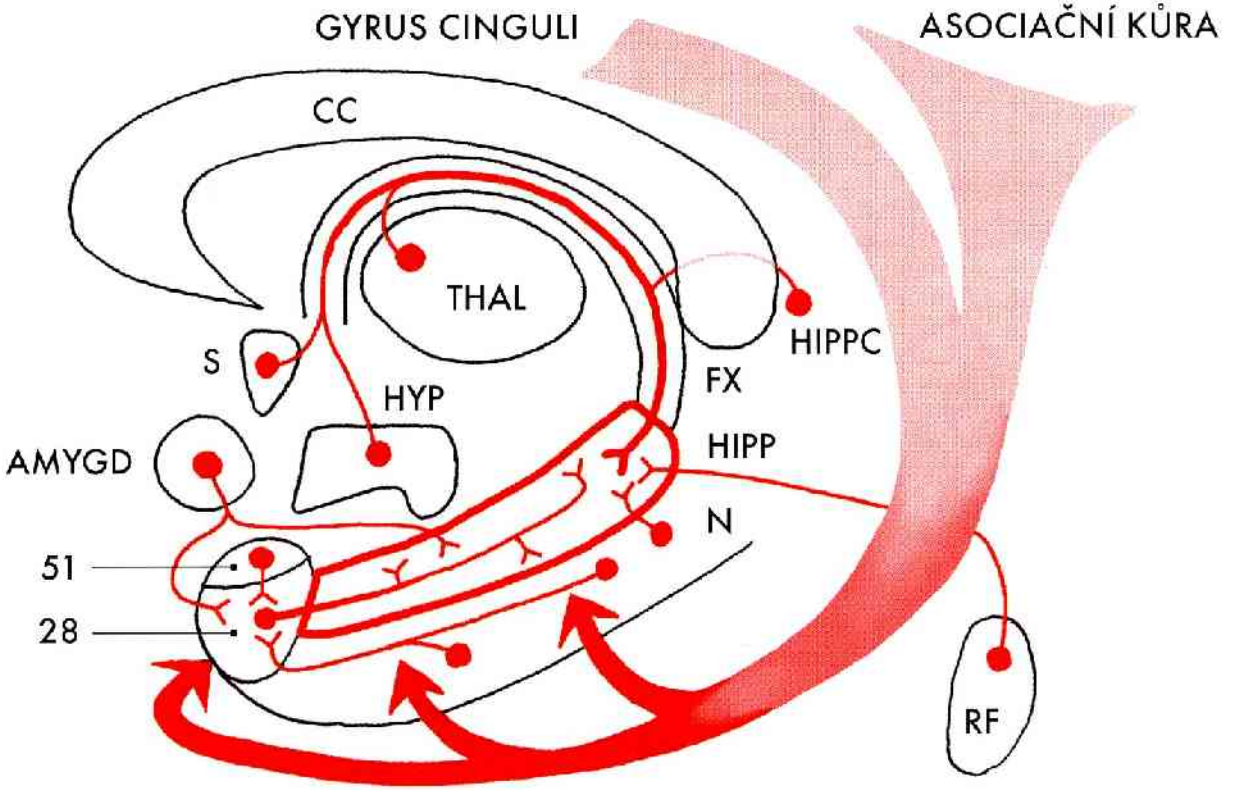
Obr. 110. Gyrus parahippocampalis a hippokampální formace na frontálním řezu. CGL = corpus geniculatum laterale, ST = stria terminalis, NCc = cauda nc. caudati, Fl = fimbria (počátek fornixu) a tela choroidea ventriculi lateralis, VL = ventriculus lateralis (cornu temporale), ALV = alveus, CA = hippocampus (cornu ammonis), GD = gyrus dentatus, GOTL = gyrus occipitotemporalis lateralis, SCOL = sulcus collateralis, G. PARAHIPP = gyrus parahippocampalis, PaS = parasubiculum, PrS = praesubiculum, SUB = subiculum. L = laterálně, M = mediálně. Šipka ukazuje do fissura choroidea


CA1
CA2
CA3
FORNIX
SUB
ENT
COLL. SULC.

Andersen ´s circuit **Andersenův okruh**

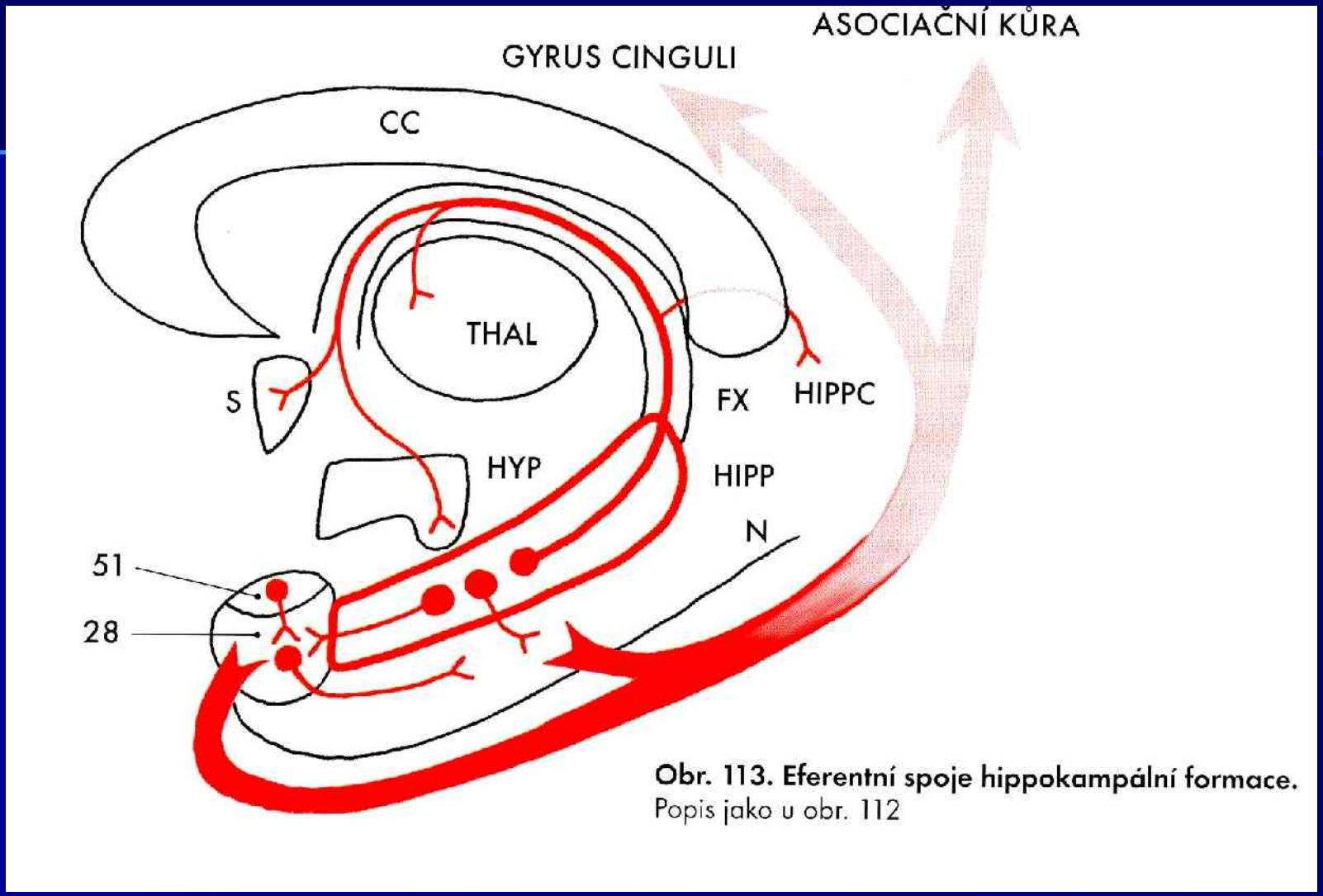


Afferent connections of tjhe hippocampal formation

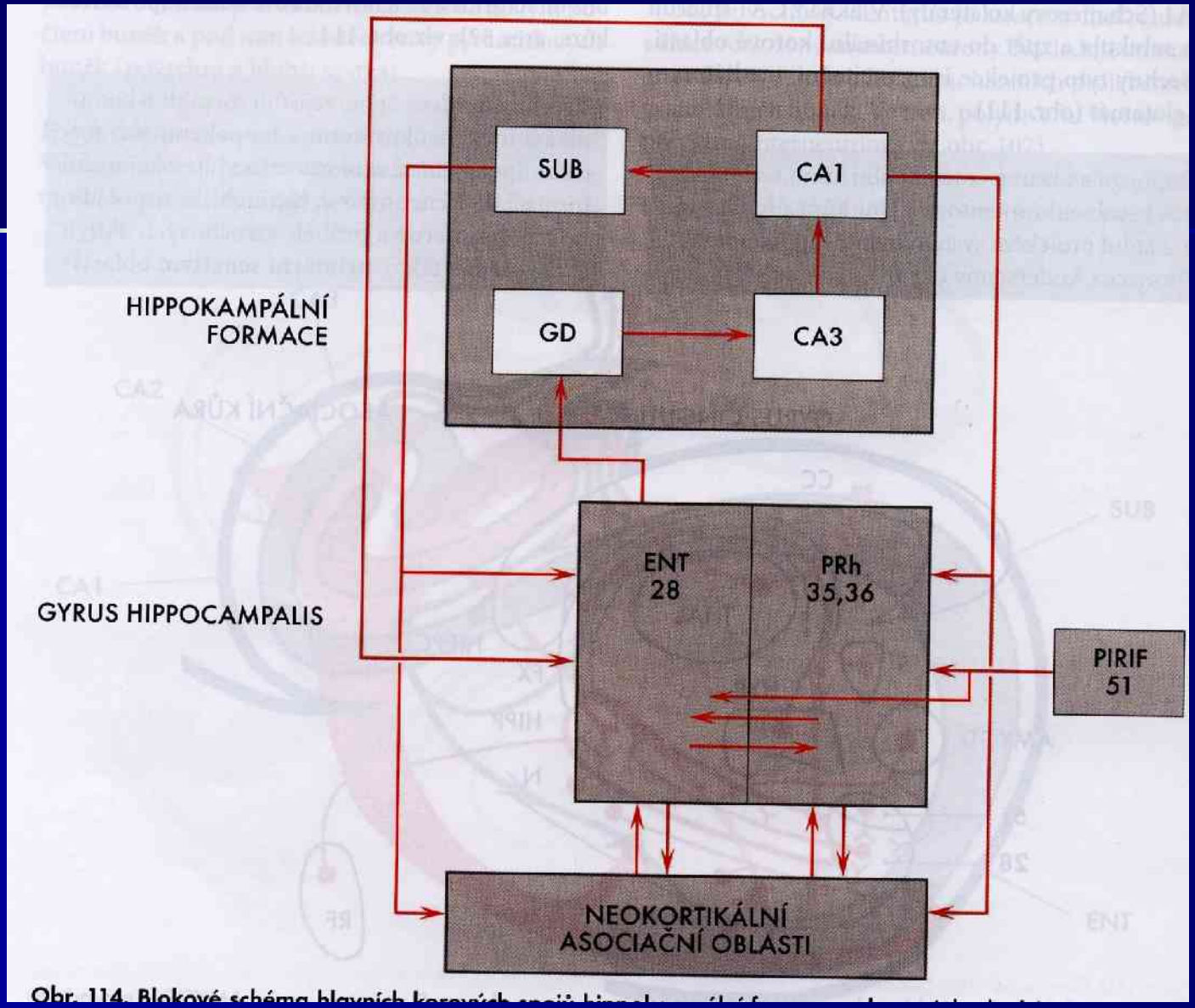


Obr. 112. Aferentní spoje hippokampální formace. CC = corpus callosum, S = septum verum, AMYGD = amygdala, HYP = hypothalamus, N = neokortikální část gyrus parahippocampalis, RF = retikulární formace, HIPP = hippokampální formace, FX = fornix, HIPPC = commissura hippocampi, THAL = thalamus, 51 = piriformní kůra (čichová korová oblast, area 51), 28 = entorhinální korová oblast (area 28)

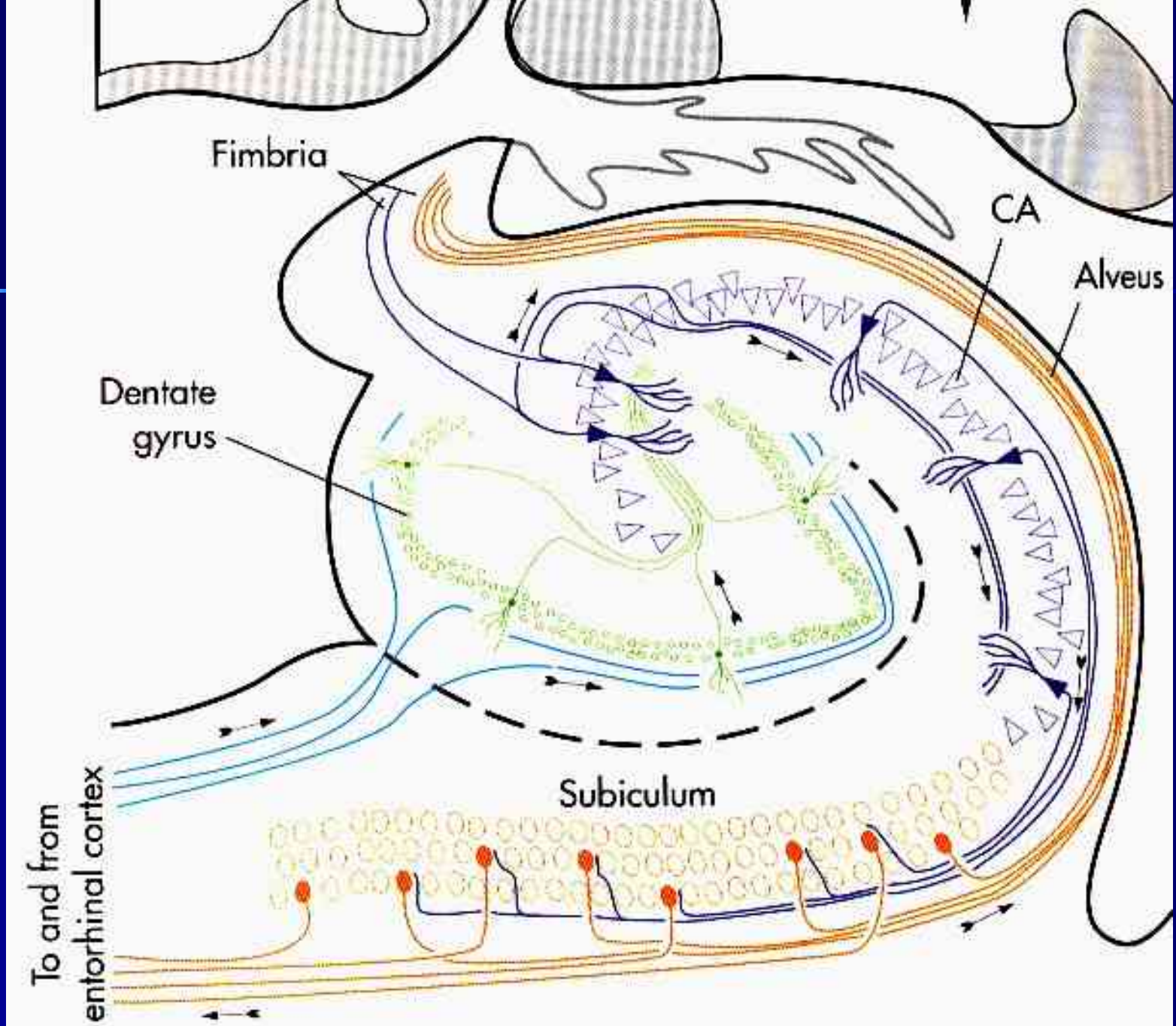
Efferent connenctions of the hippocampal formation



Obr. 113. Eferentní spoje hippokampální formace.
Popis jako u obr. 112



Obr. 114. Blokové schéma hlavních kortikálních spojů hippokampální formace


Fimbria
CA
Alveus
Dentate
gyrus
Subiculum
To and from
entorhinal cortex

Papez circuit

Papezův okruh

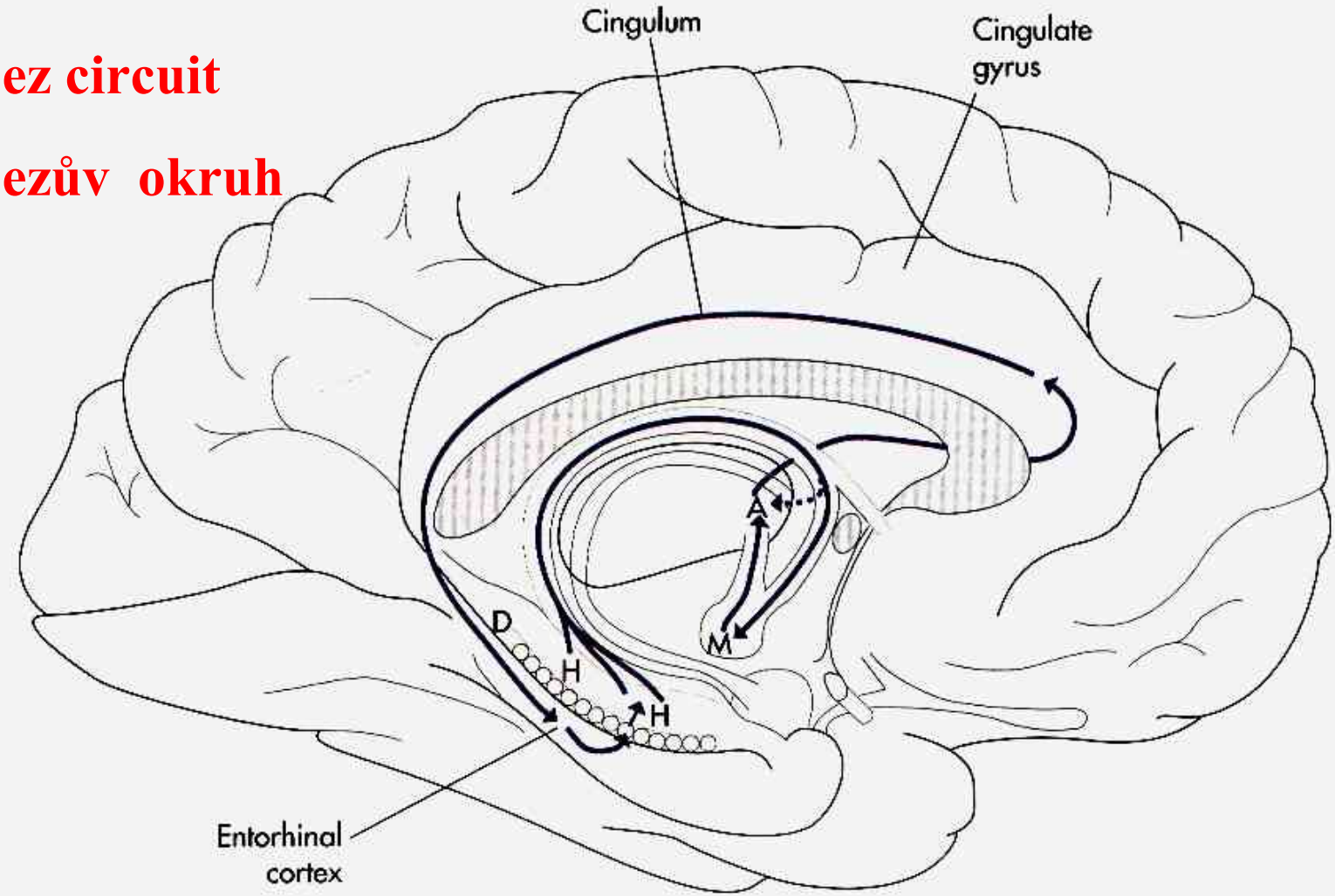


FIGURE 23-16
The Papez circuit. The shortcut from the hippocampus directly to the anterior thalamic nucleus, not part of the circuit as originally proposed, is indicated by a dashed line. *A*, Anterior thalamic nucleus; *D*, dentate gyrus; *H*, hippocampus; *M*, mammillary body.

Papez circuit Papezův okruh

- **Hippocampal formation** – fornix – **hypothalamus** (mamillary ncc.) – tr. mamillothalamicus - **thalamus** (ant. ncc.) – **gyrus cinguli** – **gyrus p*arahippocampalis*** (entorhinal area, 28) – **hippocampal formation**

Spoje hippokampální formace
Connections of the hippocampal formation

- **Afferentní korové**
- Associative neocortex
- Parahippocampal and cingular gyrus, entorhinal cortex (area 28)
- Olfactory cortex
- **Afferentní podkorové**
- Amygdala
- Thalamus (MD, ncc. mediani)
- Hypothalamus
- Septum verum

- **Efferentní korové**
- Subiculum – area 28, parahippocampal gyrus – associative cortical areas
- **Efferentní podkorové**
- Fornix
- Hypothalamus (mamillary nuclei)
- Thalamus (ant. ncc.)
- Septum verum
- Ventral striatum
- amygdala

Neocortex – hippokampal formation

- Primary sensory areas (SI, AI, VI)
- Associate cortical areas (SII, A II, V II)
- Gyrus cinguli , g. parahippocampalis (area 28, 35, 36)
- **Hippocampus** (hippocampal formation)

Funkce hippokampální formace

- Korové asociační oblasti - **hippokampální formace** – limbické struktury (septum, hypothalamus, amygdala)
- Učení a paměť
- Schopnost se učit a pamatovat si slova, čísla, fakta, místa, tváře
- Poškození – ztráta paměti (amnesia, anterográdní, CA 1)
- Hippokampální formace – proces učení a vytváření paměťových stop
- Nemá význam pro uchovávání dlouhodobé paměti (neocortex, thalamus ?)
- Hippokampální „ place cells „ - mění aktivitu v souvislosti se změnami v okolí
- Intrahippokampální navigační mapy
- Přední a zadní hippokampus (zrakové signály do zadního hipp.)
- **Prostorová orientace a navigace**

Functions of the hippocampal formation

- Learning and memory
- The ability to learn and remember words, faces, places, events
- Damage = Loss of memory (amnesia, anterograde, CA 1)
- Hippocampal formation is important for the process of learning or forming of the memory traces
- Hippocampus is not important for the long-term storage of informations (long-term memory) – neocortex, thalamus ?
- Hippocampal „ place cells" – the firing of single hippocampal cells changes with position of animal in relation to its surroundings (different corners of the cage)
- Intrahippocampal navigation maps

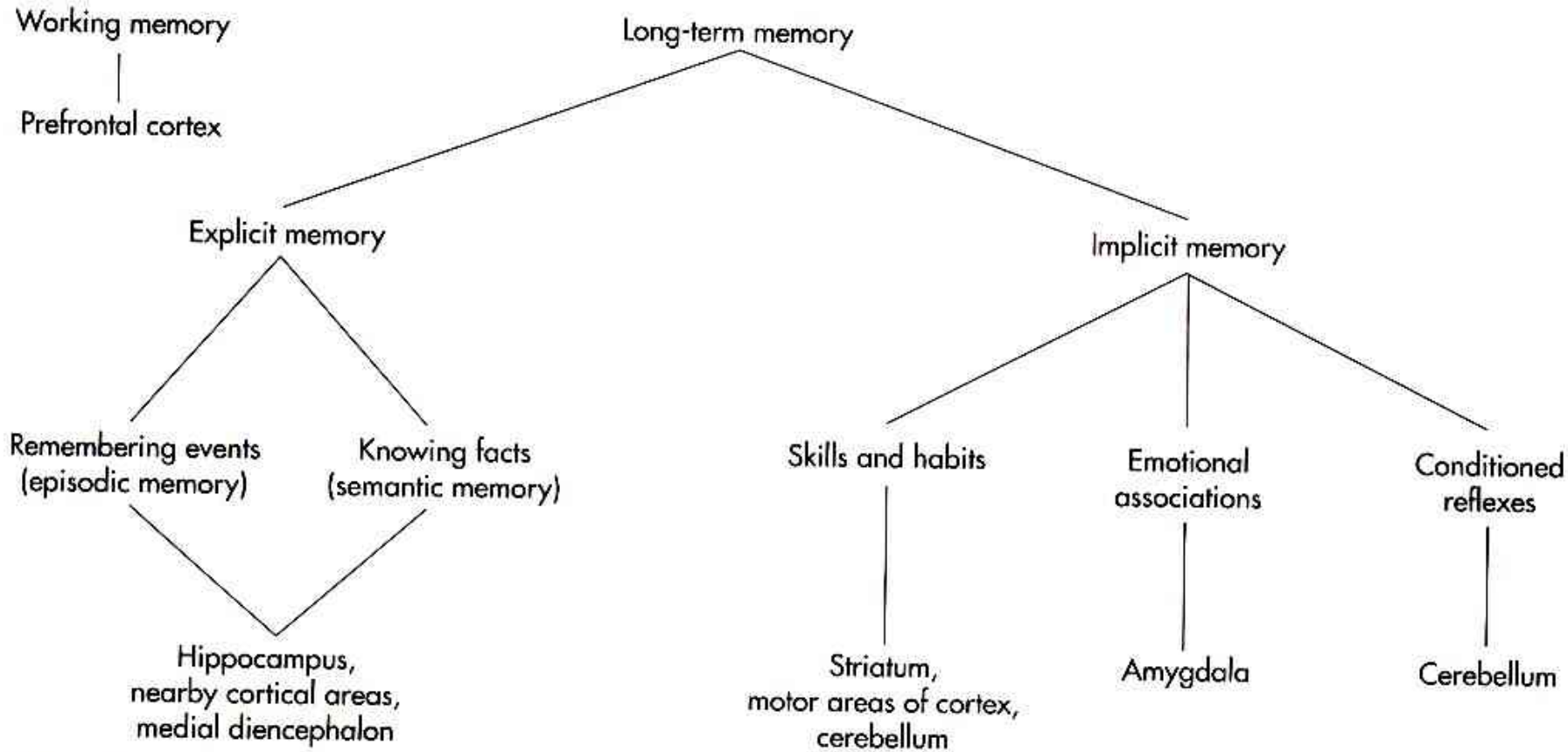
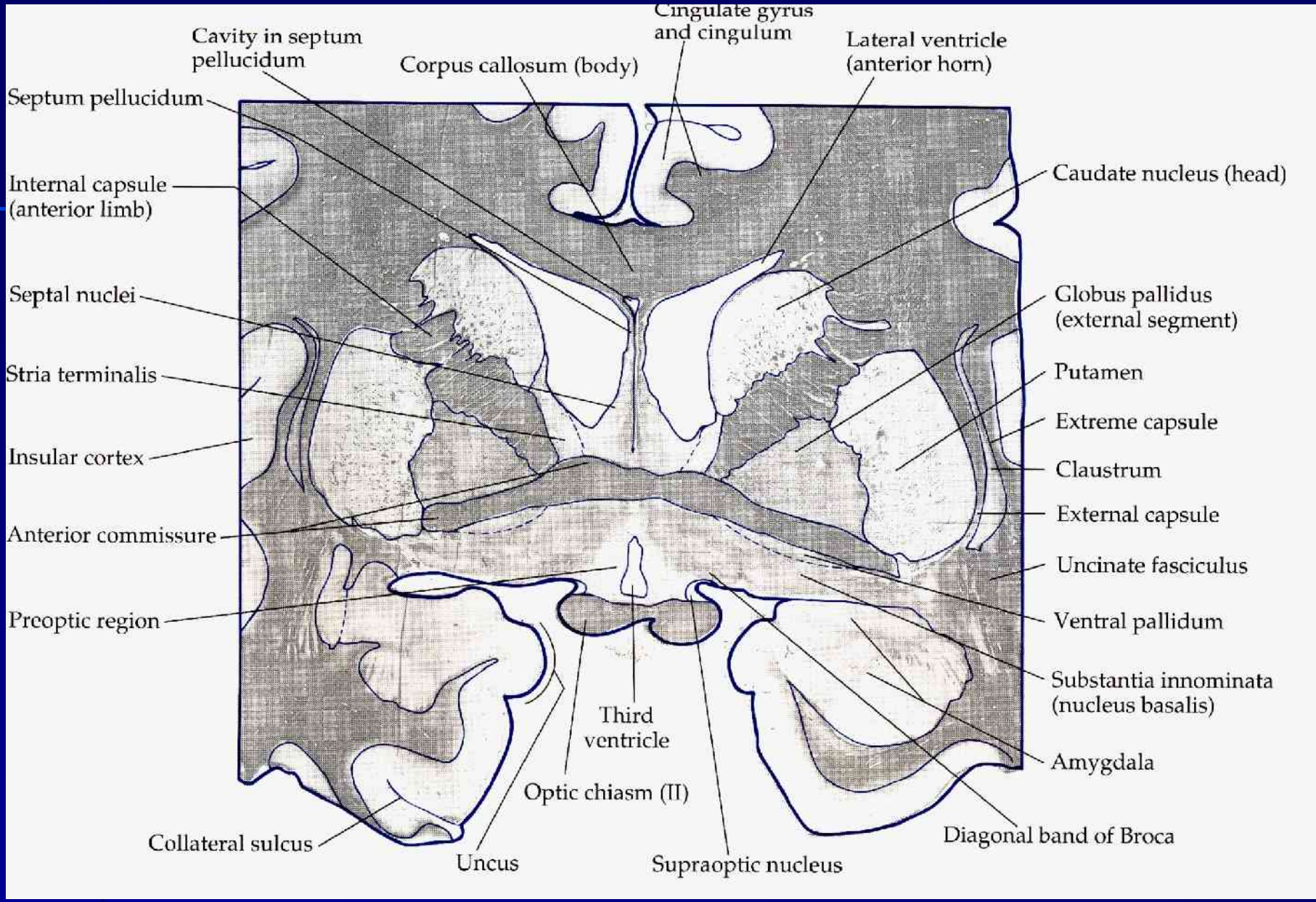


FIGURE 23-17

Different types of learning and memory and their probable anatomical correlates. Other types of memory have been described, and there is no universally accepted nomenclature. In addition, some of the anatomical correlates are speculative (e.g., the relative roles of the striatum, neocortex, and cerebellum in the learning of skills and habits are not known).

SEPTUM VERUM

AMYGDALA, NUCLEUS BASALIS



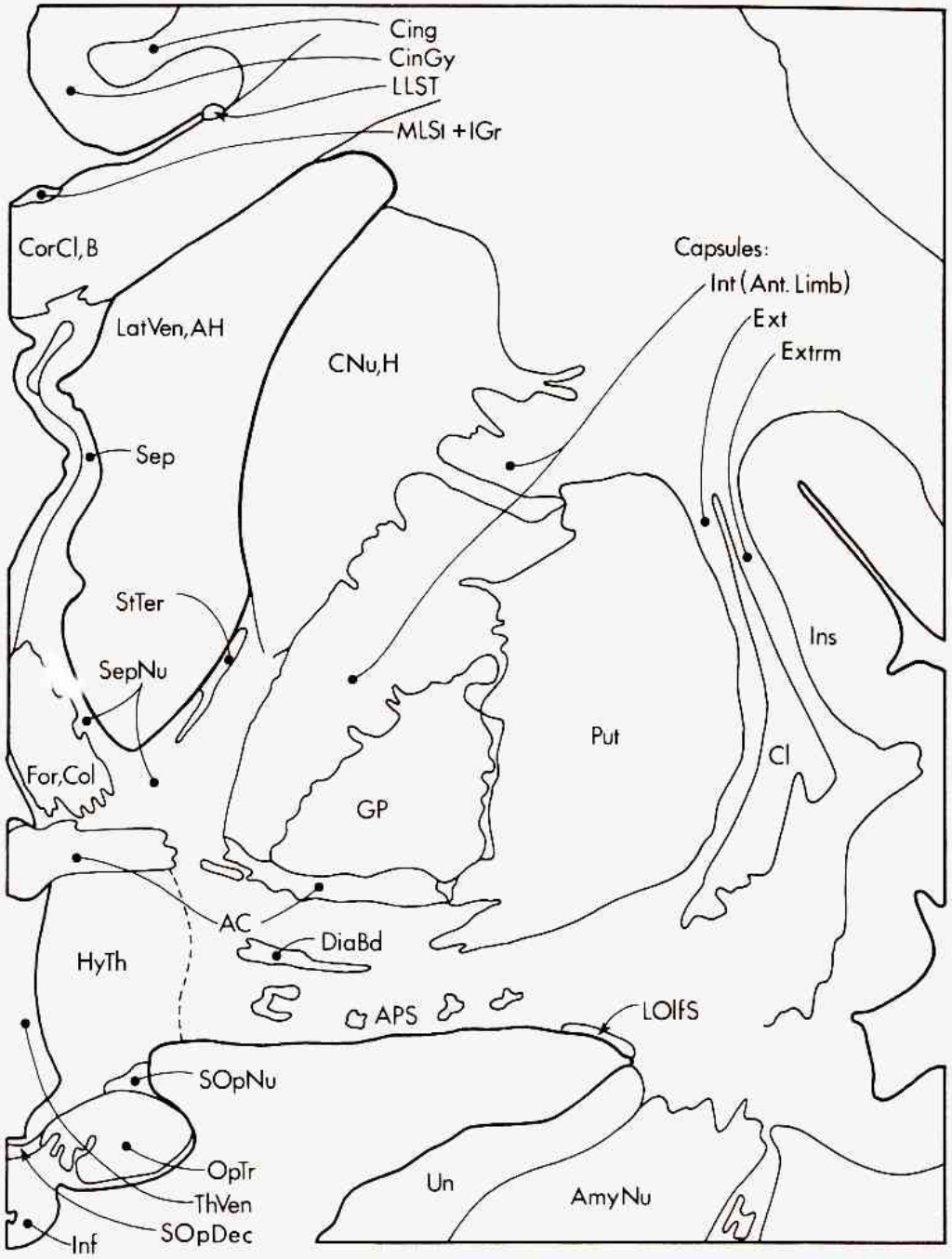
SEPTUM PELLUCIDUM

SEPTUM VERUM

(septal nuclei Ch 1, Ch 2)

NC. BASALIS

Ch 4 – group of cholinergic neurons projecting to the neocortex and to the amygdala

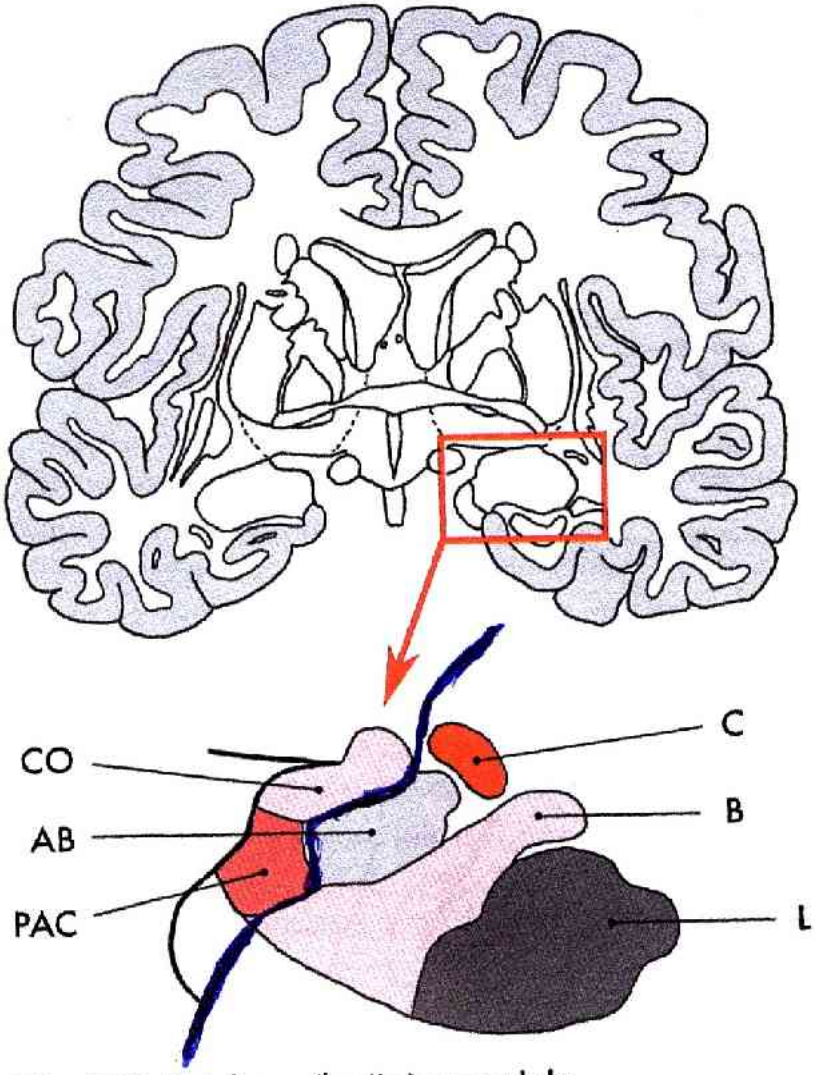


SEPTUM VERUM

- Reciprocal connections - hippocampus, hypothalamus, gyrus cinguli
- Efferent projections to the thalamus and amygdala
- Cholinergic neurons (Ch1, Ch2) project to hippocampus
- Stimulation – aggressive behavior
- Lesion - reduction of aggressive behavior

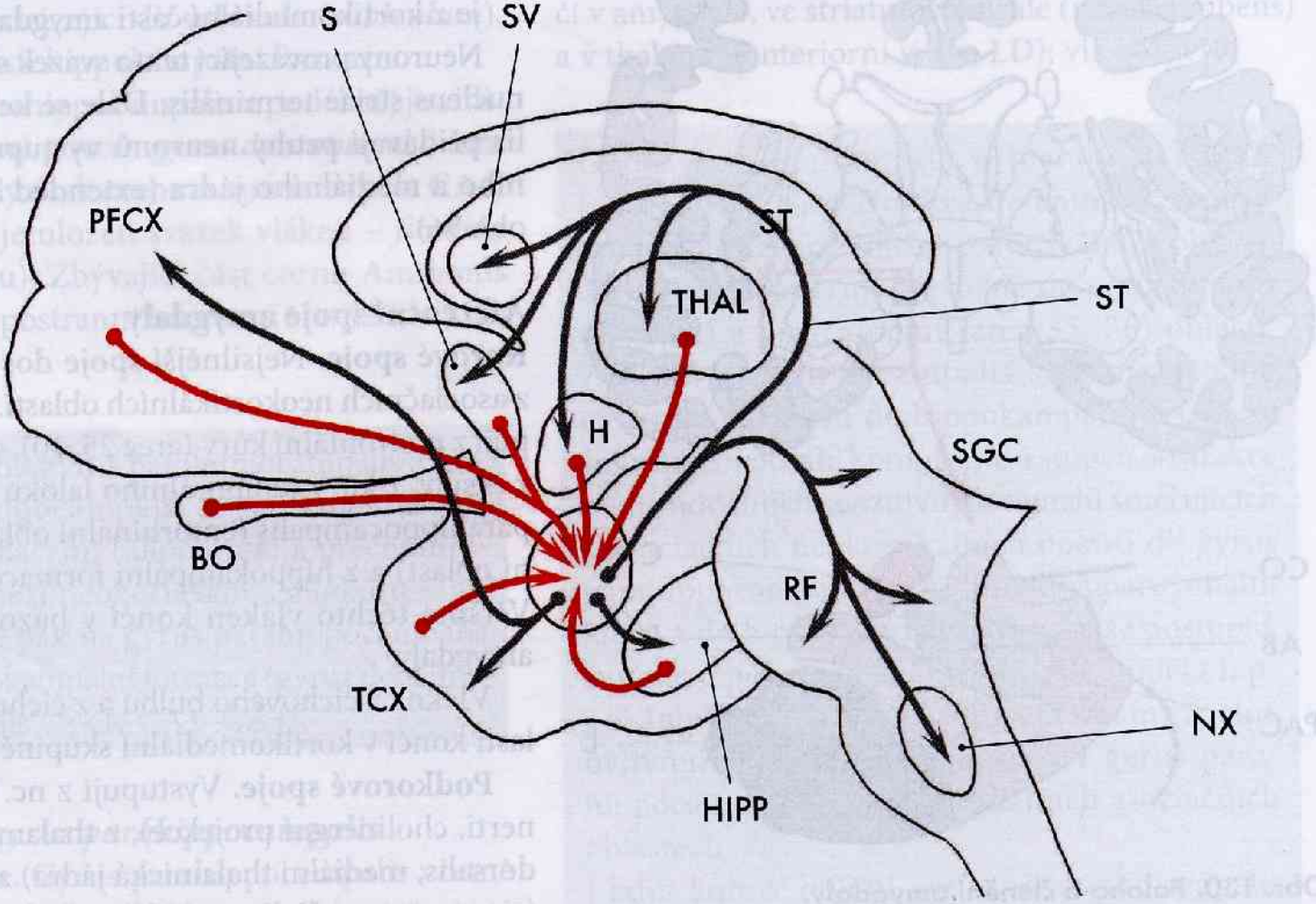
AMYGDALA

Basolateral and corticomedial groups of amygdalar nuclei



Obr. 130. Poloha a členění amygdaly.
A: Uložení amygdaly v temporálním laloku
B: Hlavní amygdalární jádra. L = laterální jádra, B = bazální jádra, AB = akcesorní bazální jádra, PAC = periamygdalární kůra, CO = kortikomediální jádra, C = centrální jádra

Amygdala – afferent and efferent connenctions



Obr. 131. Hlavní aferentní (červeně) a eferentní (šedě) spoje amygdaly. PFCX = prefrontální korová oblast, BO = bulbus olfactorius a čichová korová oblast, TCX = temporální korová oblast, HIPP = hippokampální formace, RF = retikulární formace, NX = n. vagus (nc. dorsalis), SGC = substantia grisea centralis, ST = stria terminalis, THAL = thalamus, H = hypothalamus, S = septum verum, SV = striatum ventrale

Amygdala - spoje

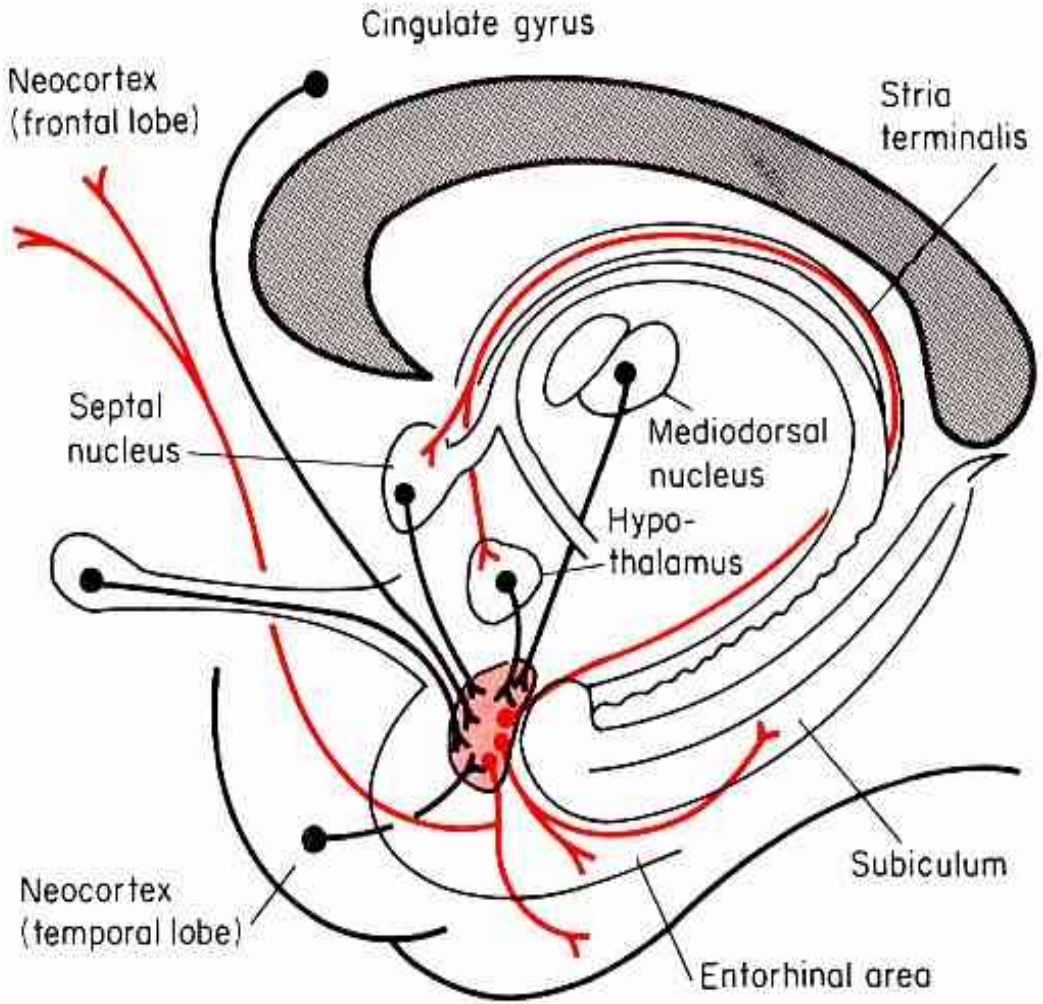
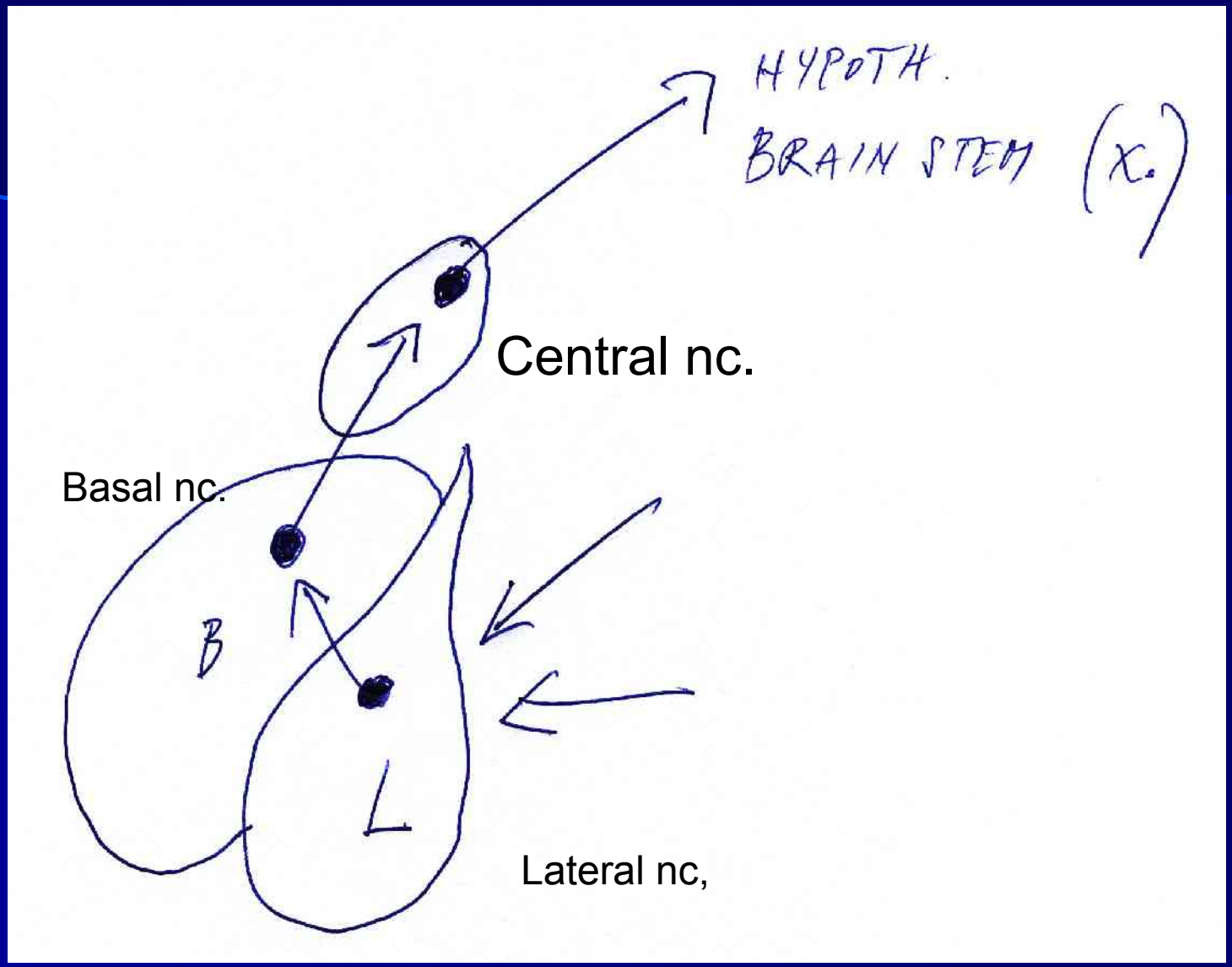


Fig. 16.4. *Main connections of the amygdaloid nucleus.* Note the close connections with the hypothalamus and with association areas in the temporal and frontal lobes.

Intraamygdaloid connections Intraamygdalární spoje



Amygdala (amygdalar nuclei) - connections

Corticomedialní jádra - aferenty z čichové korové oblasti, z hypothalamu ze septa

- **Basolateralní jádra** - afferenty z thalamu a z mozkové kůry (prefrontalní, temporalní)

- **Efferentní spoje** – **hypothalamus** (stria terminalis, VM), t**halamus** (MD), **hippocampal formation** (28, subiculum), **septal nuclei, ventral striatum, prefrontal and temporal cortex, brain stem nuclei (**SGC, RF, parasympathetic cranial nerve nuclei (n. vagus).

Amygdala – functions I.

- **Stimulation**
  - Corticomedial group – salivation, licking, chewing, emptying of the rectum and the bladder
  - Basolateral group – increased attention, stopping of motor activity, arousal, fear (+ autonomic reactions), rage
  - In humans – feeling of anxiety, fear, hallucinations
  - Amygdala is frequently focus of epileptic seizures !!
- **Destruction**
  - Reduction of aggressivity and defensive reactions
  - Reduction or loss of emotional reactions

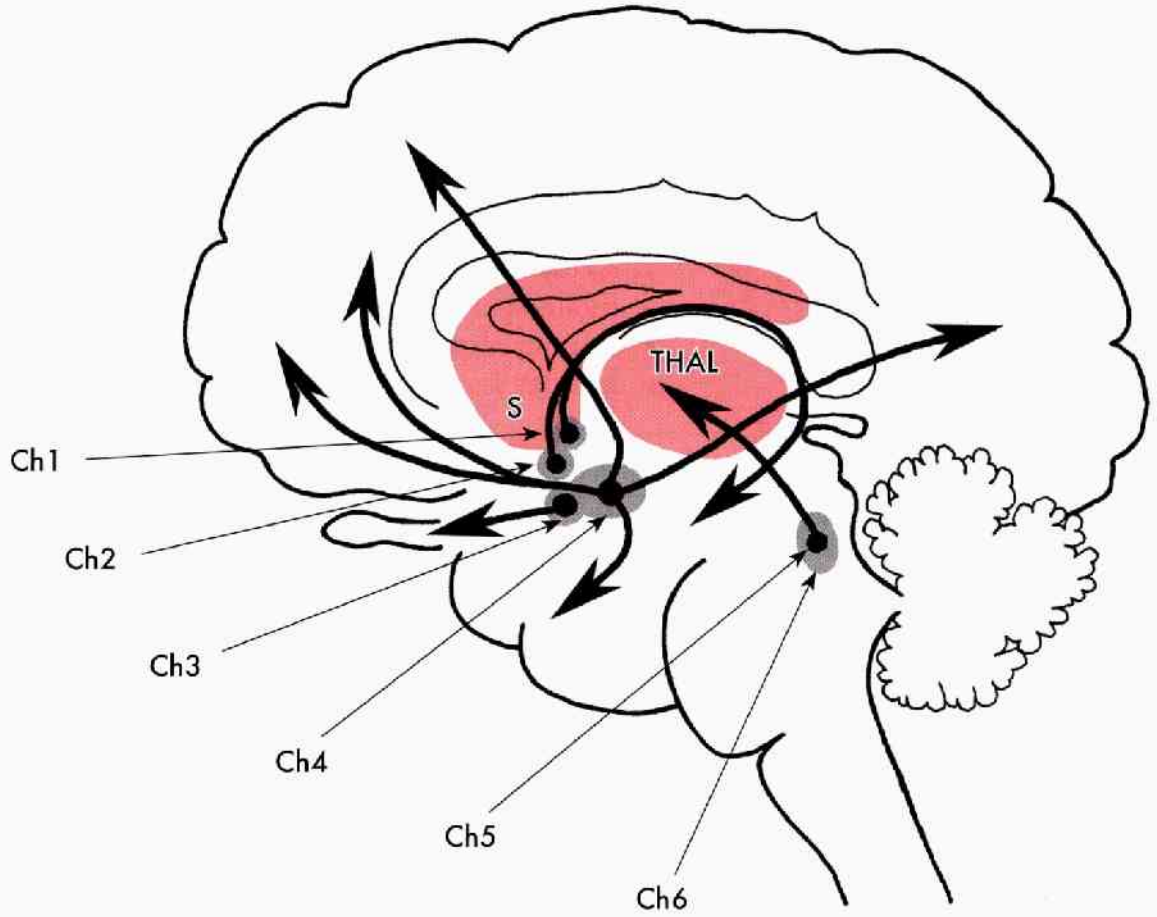
Amygdala functions II.

- Amygdala is involved in learning (remembering) whether something is „ good „ or „ bad “.
- Amygdala differenciates a dangerous and nondangerous signals.

VELKÉ MEDIÁTOROVÉ SYSTÉMY

MAJOR NEUROTRANSMITTER SYSTEMS

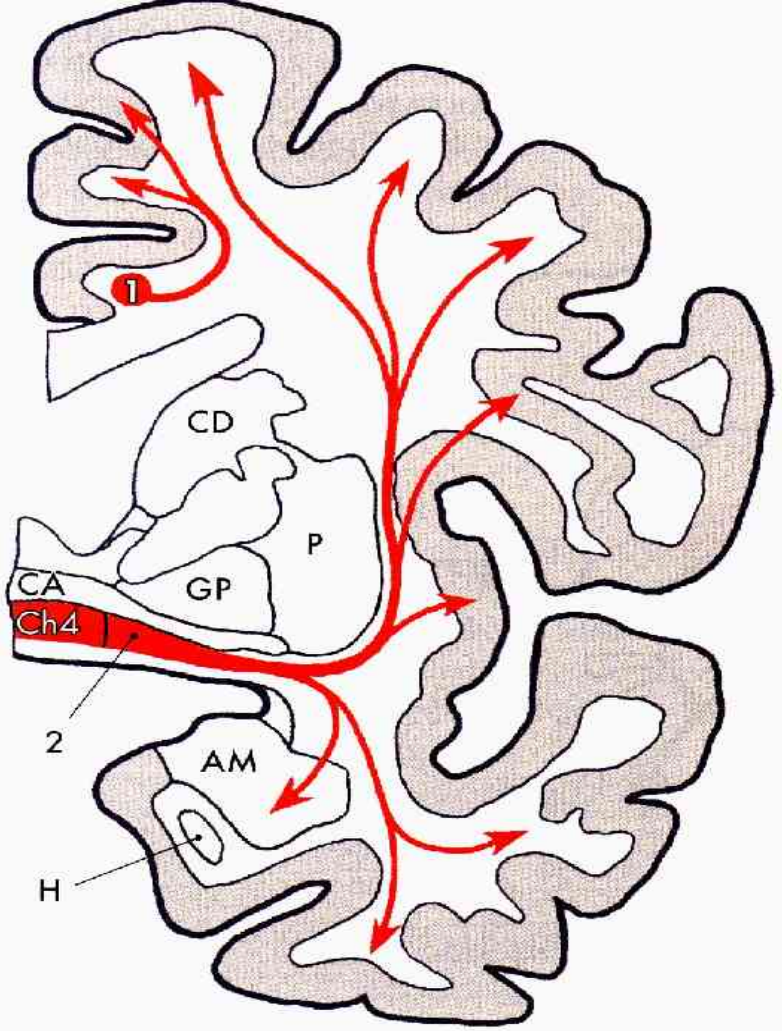
Cholinergic systém, Ch 1 – Ch6, Cholinergic nucle, produce acetylcholine



Obr. 184. Poloha neuronů cholinergního systému (schéma). Šipky označují terminační oblasti cholinergních vláken vystupujících z jednotlivých jader. Ch1 a Ch2 = cholinergní neurony v septum verum, Ch3 = cholinergní neurony v diagonální oblasti, Ch4 = nc. basalis (Meynerti), Ch5 a Ch6 = cholinergní neurony v nc. pedunculopontinus a v nc. laterodorsalis. S = striatum, THAL = thalamus

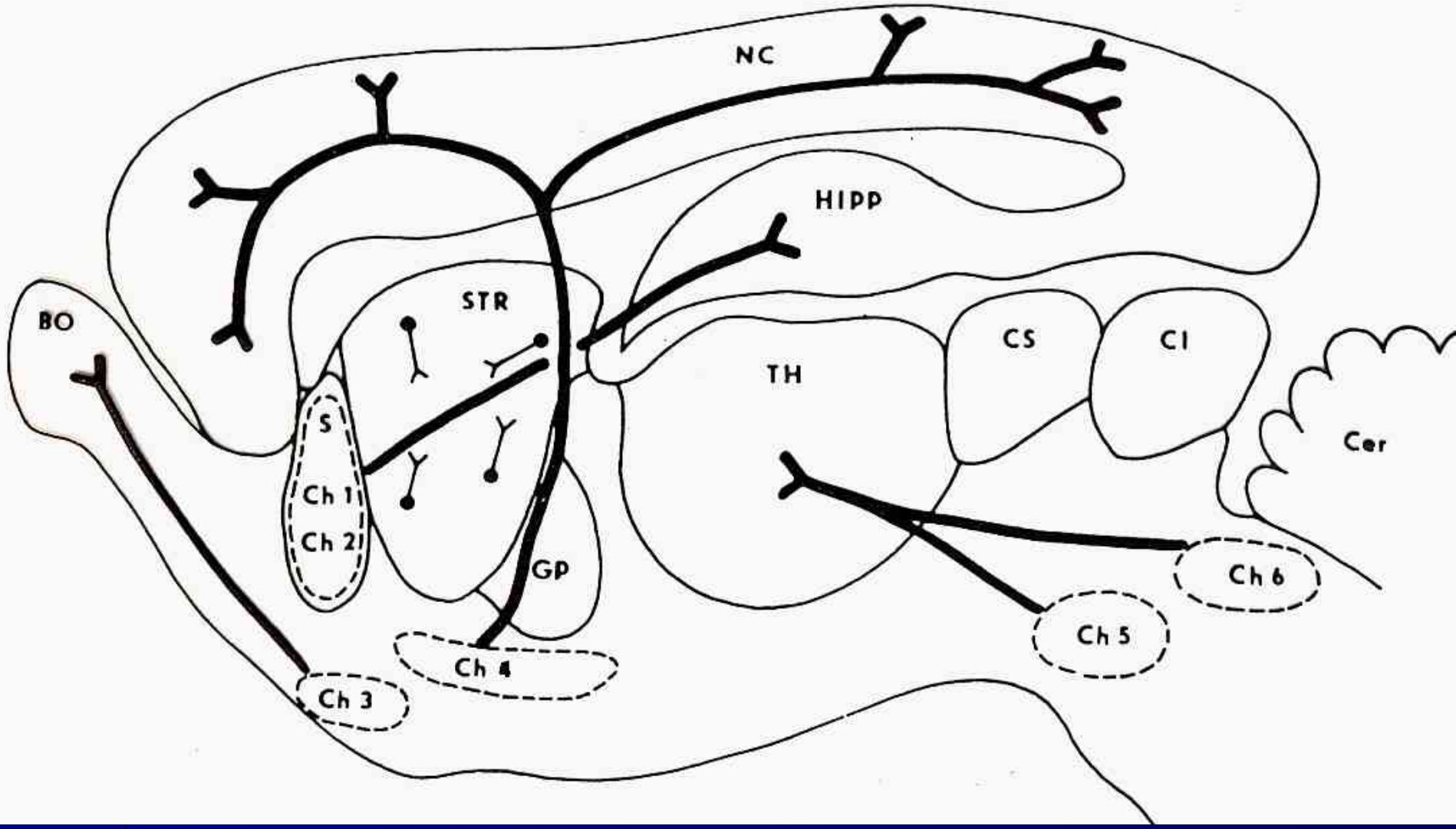
Cholinergic group Ch 4 (Basal nucleus of Meynert)

Supplies neocortex + amygdala



Obr. 185. Průběh cholinergních vláken vystupujících z jádra Ch4 (nc. basalis Meynerti). 1 – mediální svazek probíhá skrze cingulum a zásobuje kůru na mediální ploše hemisféry, 2 – laterální svazek prochází bazálním telencefalem; ze svazku se oddělují cholinergní vlákna pro kůru temporálního laloku a pro amygdalu. Zbývající vlákna procházejí skrze capsula externa a zásobují kůru na konvexitě hemisféry. Upraveno podle M. Mesulama (2004). CA = commissura anterior, CD = nc. caudatus, GP = globus pallidus, P = putamen, AM = amygdala, H = hippocampus

Cholinergic system



Cholinergic system

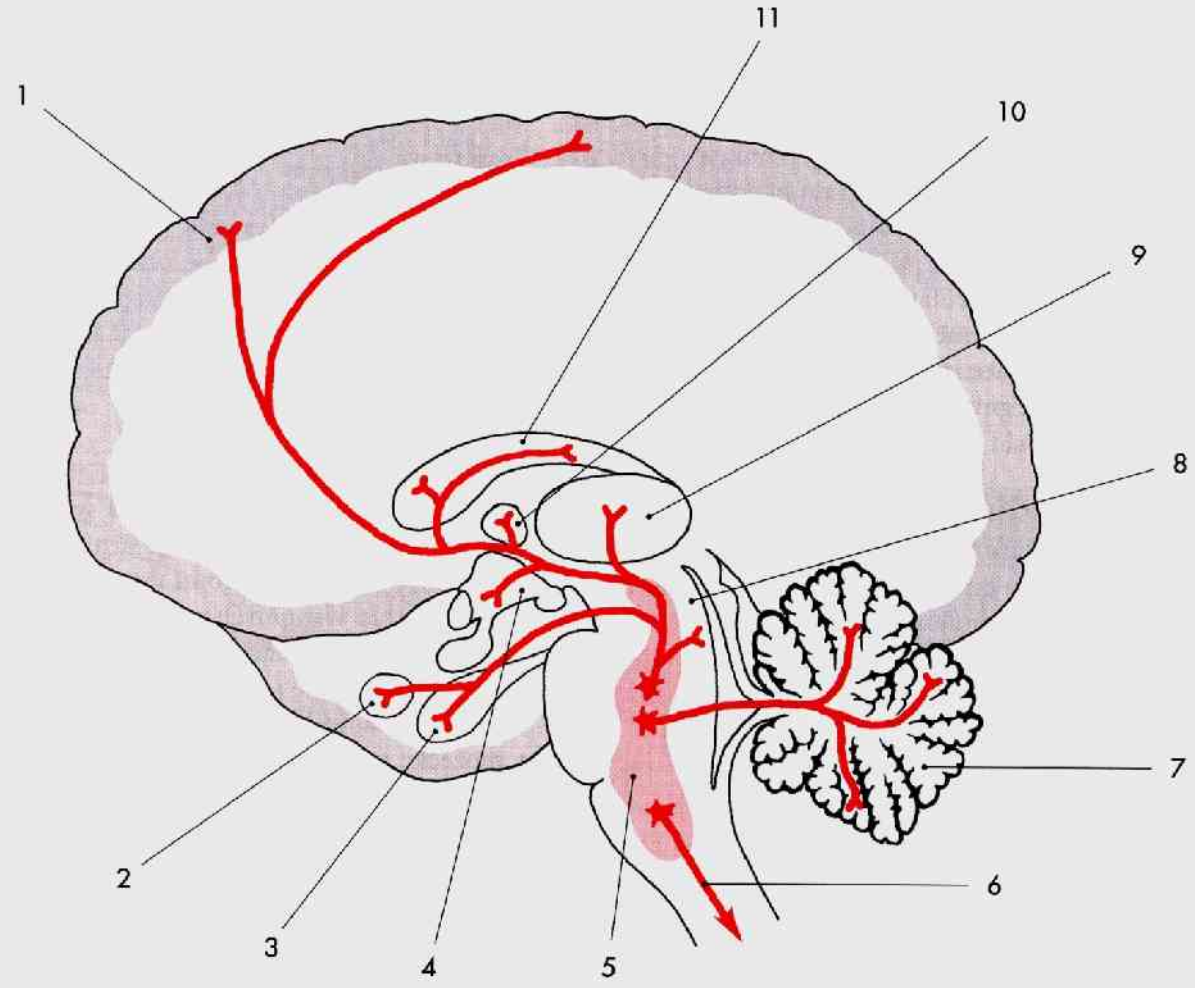
- **Cholinergní group — Target structure**
  Cholinergní skupina — Cílová struktura

Ch 1, Ch 2 — hippokampus

- **Septum verum**
- **Ch 3 — bulbus olfactorius**
- **Area diagonalis**
- **Ch 4 — neocortex, amygdala**
- **Nucleus basalis**
- **Ch 5, Ch 6 — thalamus**

- **RF**
- **Ach augments the excitability of cortical neurons, improves circulation, supports memory mechanism**
- **Zvyšuje excitabilitu korových neuronů, zlepšuje cirkulaci, podporuje paměťové mechanizmy**

Serotoninergic system



Obr. 186. Schéma serotoninergních projekcí vystupujících z rafeálních jader retikulární formace. 1 – neocortex, 2 – amygdala, 3 – hippokampální formace, 4 – hypothalamus, 5 – rafeální jádra retikulární formace, 6 – serotoninergní vlákna směřující do míchy, 7 – mozeček, 8 – substantia grisea centralis, 9 – thalamus, 10 – striatum, 11 – septum verum. Upraveno podle P. Brodala (1998)

Monoaminergic systems

- Noradrenergic system
- A1- A7, locus coeruleus
- Spinal cord
- Sensory ncc. of cranial nerves (n.V)
- Cerebellum
- Hypothalamus
- Thalamus (VPL, VPM, LGB
- Neocortex
- Hippocampal formation
- Striatum 0

- Serotoninergic system
- Rapheal nuclei RF
- Spinal cord
- Brain stem
- Cerebellum
- Thalamus
- Hypothalamus
- Striatum
- Neocortex
- Hippocampal formation

Dopaminergic pathways A9, A 10

Noradrenergic pathways Serotoninergic pathways

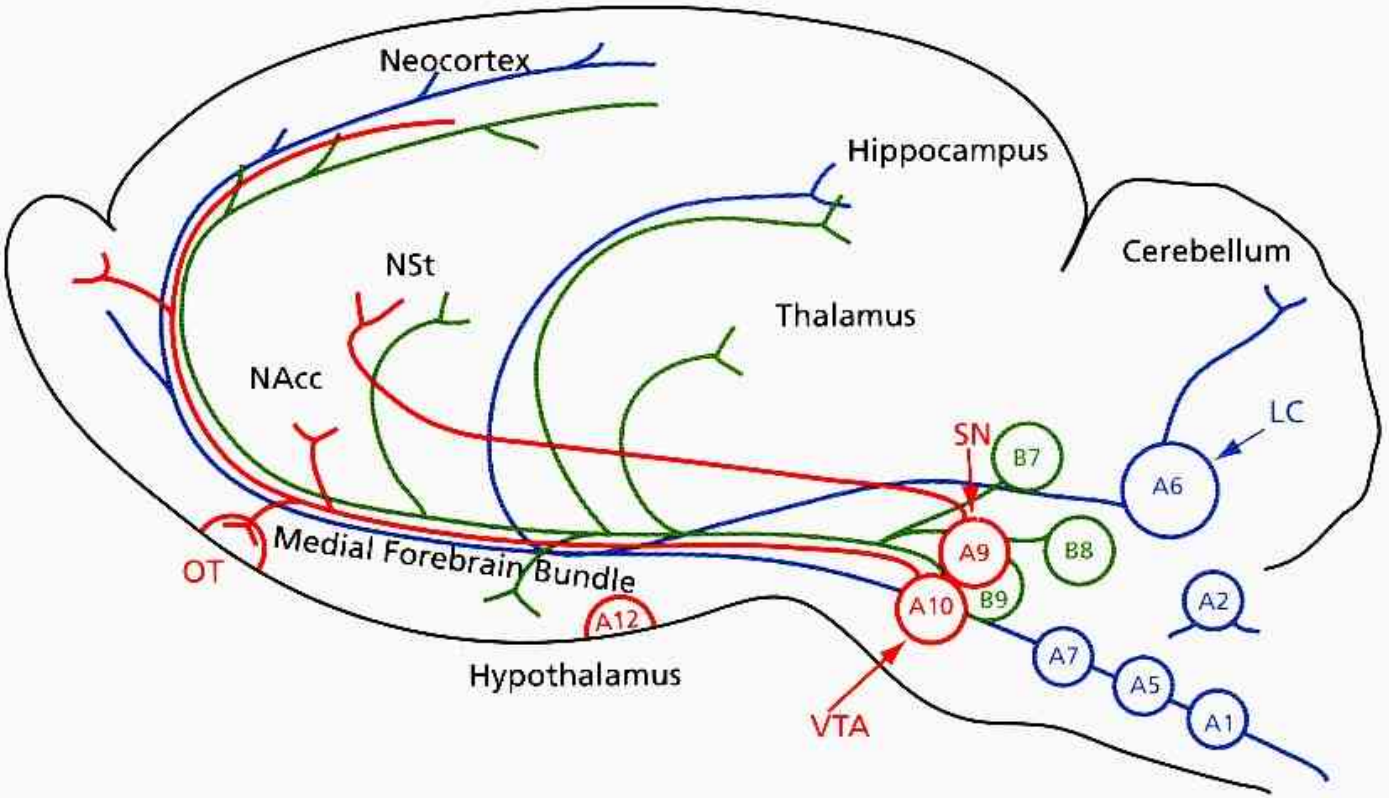


Figure 1. The major noradrenergic (blue), dopaminergic (red) and serotonergic (green) pathways in the central nervous system. LC (A6), locus coeruleus; SN (A9), substantia nigra; VTA (A10), ventral tegmental area; OT, olfactory tubercle; NSt, neostriatum; NAcc, nucleus accumbens. Noradrenergic nuclei include A1, A2, A5, A6 and A7; dopaminergic nuclei are contained in A9, A10 and A12; serotonergic (raphe) nuclei are designated as B7, B8 and B9.

Dopaminergic system

- Substantia nigra, pars compacta - A 9
- Area tegmentalis ventralis (VTA), - A 10

- Striatum
- Globus pallidus
- Neocortex
- Decrease - Parkinsonismus

Noradrenergic system

- **Locus coeruleus - A 6**
- Spinal cord
- Brain stem – cranial nerves sensitive nuclei (nc. V.)
- Cerebellum – Purkyně cells
- Hypothalamus
- Thalamus (nc. VPL, nc. VPM, corpora geniculata
- Neocortex, Hippocampal formation
- Part of the ascending activation system of the RF
- Regulation of transmision of sensory signbals (pain, posterior horns of the spiunal cord)
- Regulation of circulation
- Essential to feel emergized
- Without NA – you feel exhausted, tired, without energy

Serotoninergní systém

- **Rapheální jádra RF**
- **Vzestupný a sestupný systém**
- **Všechny korové formace, Limbický systém, Striatum, thalamus, hypothalamus, mozkový kmen, mícha**
- **Aktivita vzestupného systému –změny nálady**
- **Aktivita sestupného systému – analgesie**
- **Snížení synthésy - deprese, podrážděnost, poruchy spánku, insomnie**
- **Nadměrně zvýšená hladina (serotoninový syndrom – třes, zvýšení TK, zrychlení akce srdeční, zmatenost, bezvědomí)**
- **Sluneční osvit – zvyšuje produkci (v zimě deprese, podráždění, úzkostné stavy)**

SEROTONINERGIC SYSTEM

- Reticular formation (rapheal nuclei)
- Ascending and descending systems
- All cortical formations, Limbic system, Basal ganglia, Thalamus, Hypothalamus , Brain stem, Spinal cord
- Activity in descending system = analgesia
- Decrease of synthesis- depression, irritability, sleep disorders, insomnia
- Increase of synthesis – tremor, increase of blood pressure and heart rate, confusion, unconsciousness
- Sun lighting – increases production (winter depression, irritability, anxiety)

Glutamatergic system

- **Excitatory neurotransmitter**
- Majority of ascending and descending pathways
- All descending cortical pathways (corticostriatal, corticothalamic, corticospinal)
- Descending brain stem pathways
- Efferent cerebellar pathways (dentato – thalamic)
- Commissural pathways (corpus callosum)
- Associative cortical pathways

GABAergic system

- **GABA - Inhibitory neurotransmitter**

- **Local interneurons (neocortex, hippocampus, thalamic nuclei, cerebellar cortex)**
- **Striatal efferent projections**
- **Globus pallidus – efferent projections**
- **Purkyně cells projections**

Nitric oxide

Gaseous neurotransmitter

Produced by NOSynthasis

- Neuronal, endothelial, inducible
- 200 μm = 2 millions of synaptic contacts
- Local interneurons
- NO – increases releasing of neurotransmitters
- Vasodilatation !!! (endothelial NOS)
- Damage of neurons (neurodegenerative diseases)

Cévní zásobení mozku

Vasculature of the CNS

Vertebrobasilar system

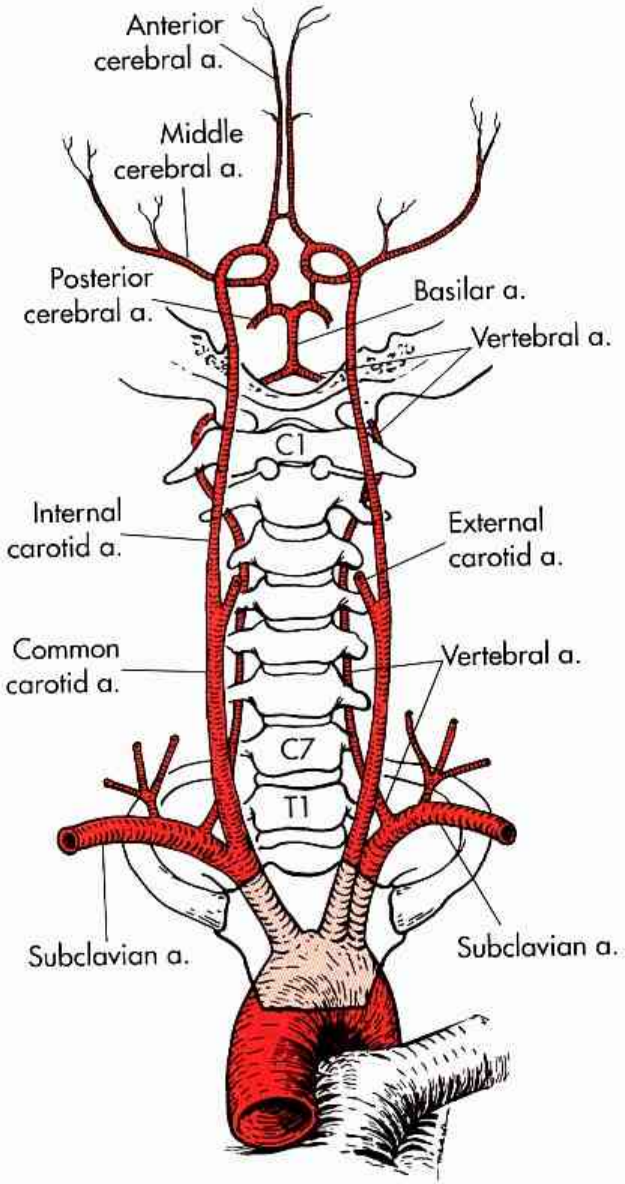


FIGURE 6-2
Origins of the arterial supply of the brain. a, Artery. (From Osborn AG: *Introduction to cerebral angiography*, Hagerstown, 1980, Harper & Row.)

Circle of Willis

Vertebrobasilary + carotic systems

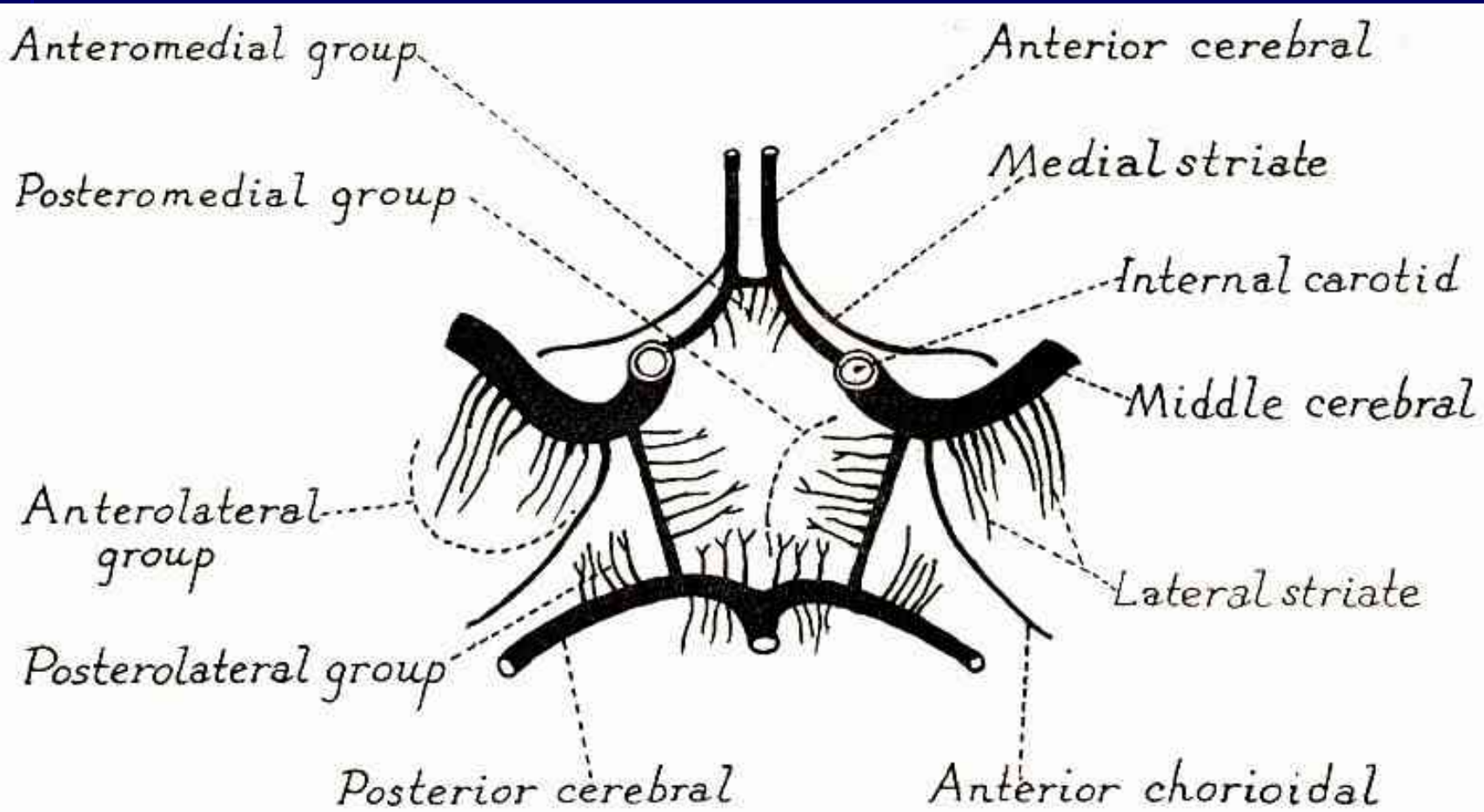
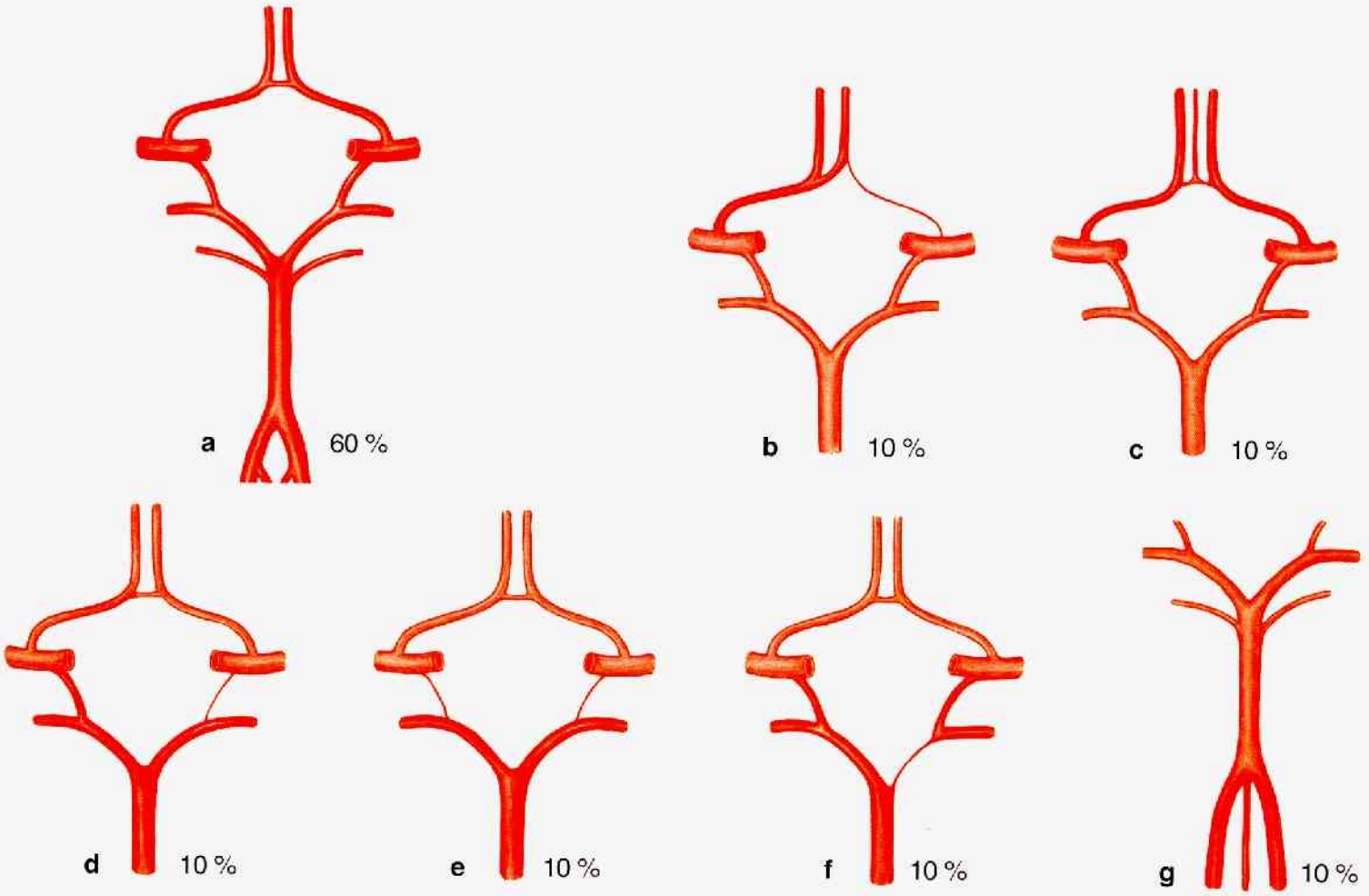


FIG. 327. Diagram showing arterial circle of Willis and origin of the ganglionic arteries

Korové a bazální větve

The Circle of Willis

- 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)



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

CT – AG, 3-D

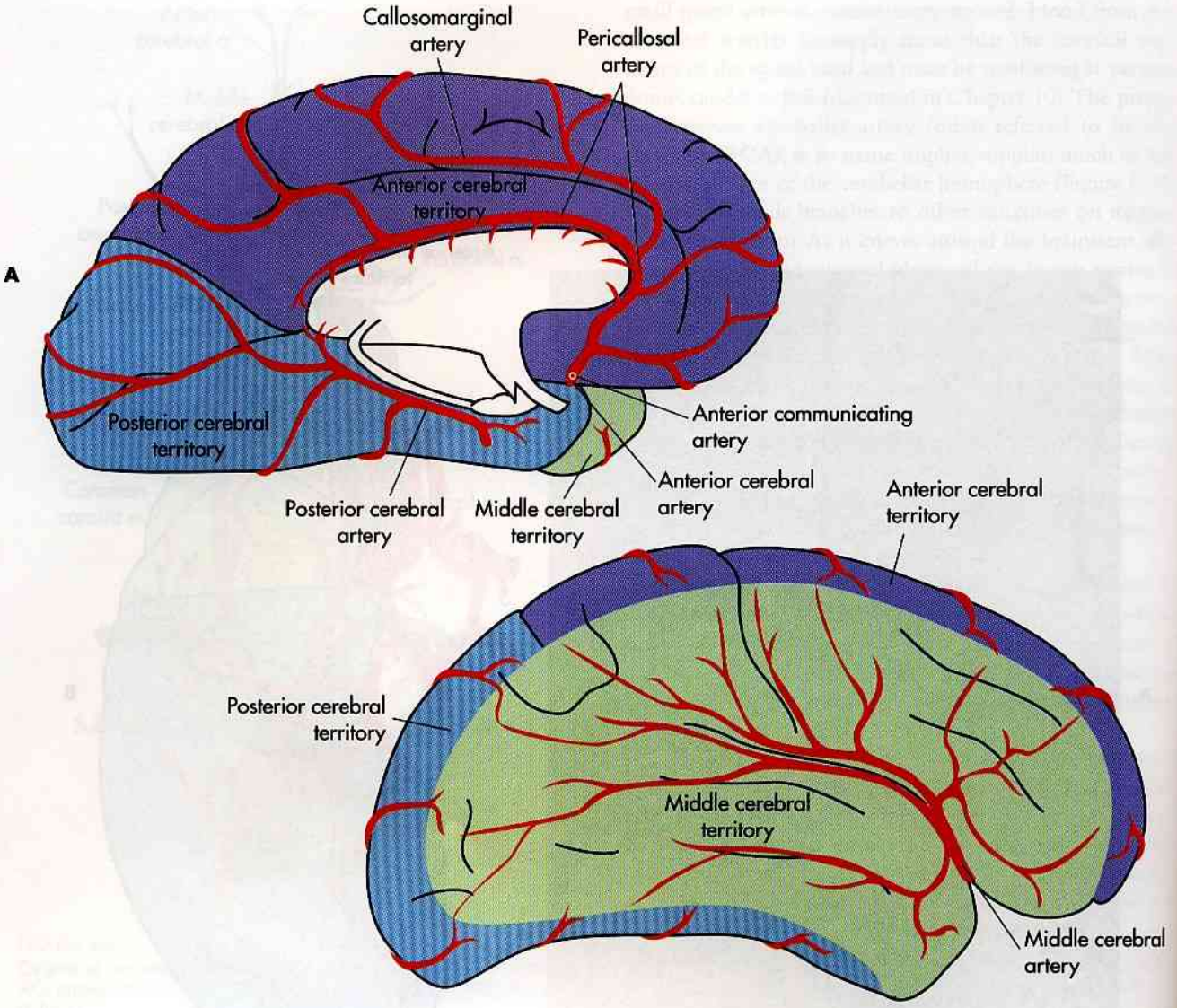
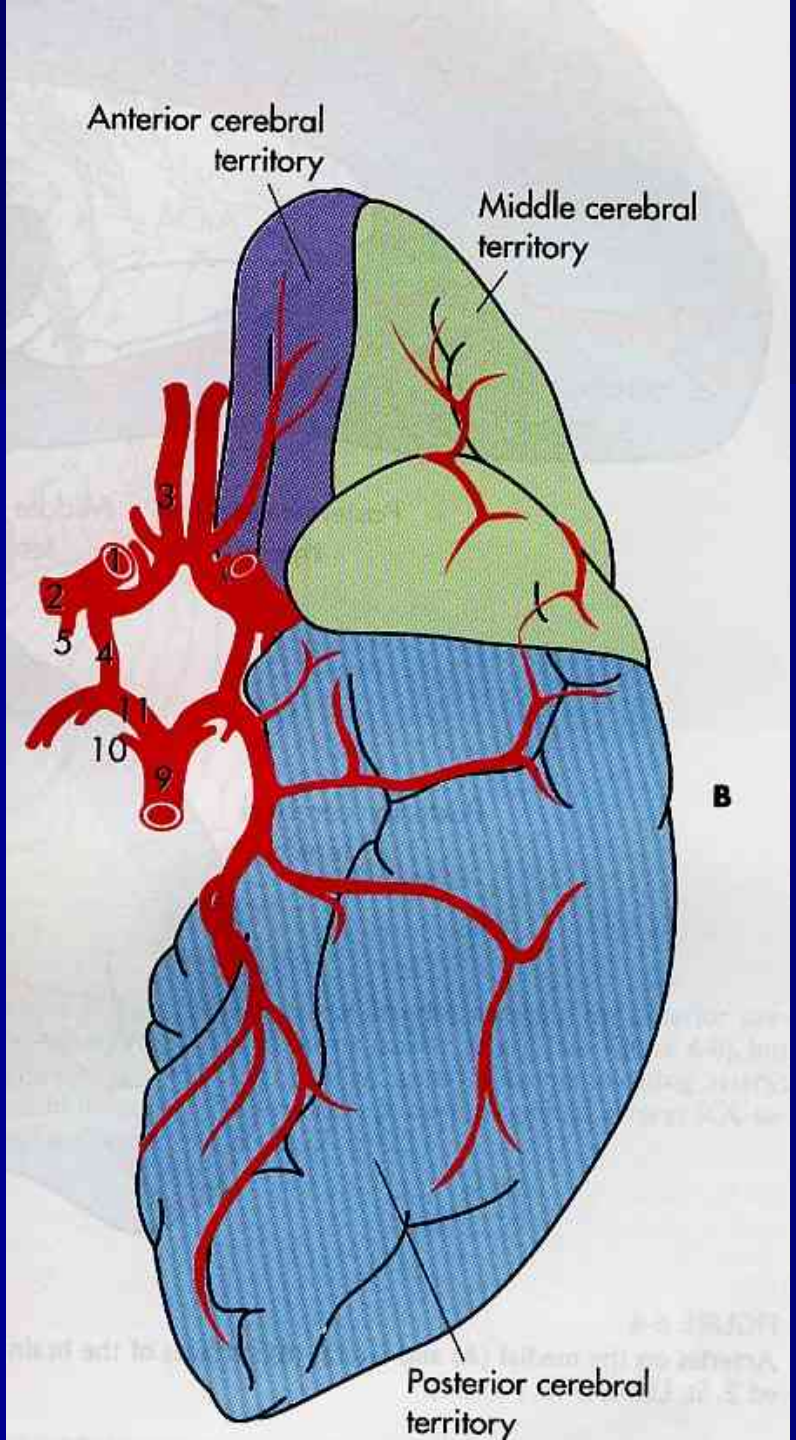
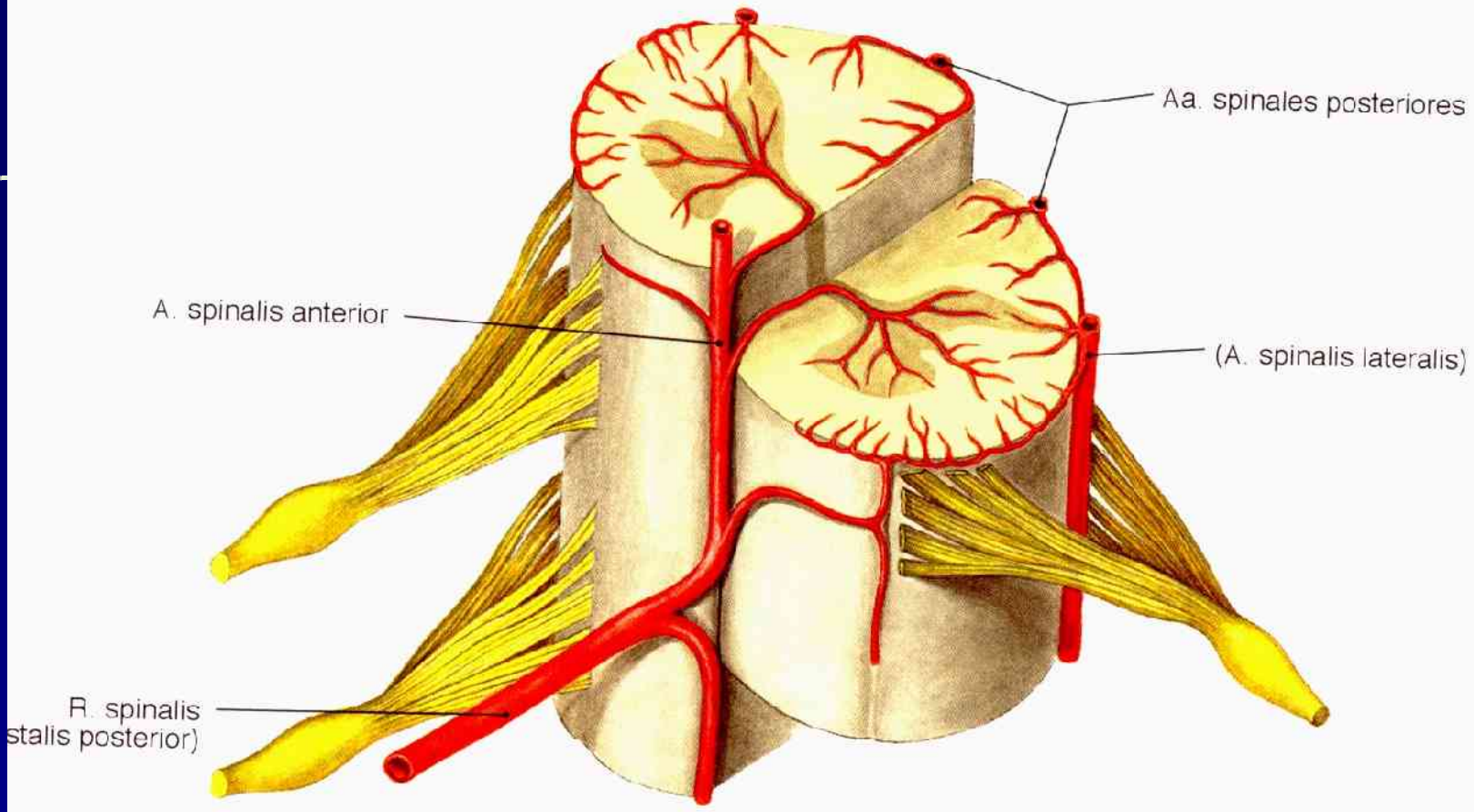


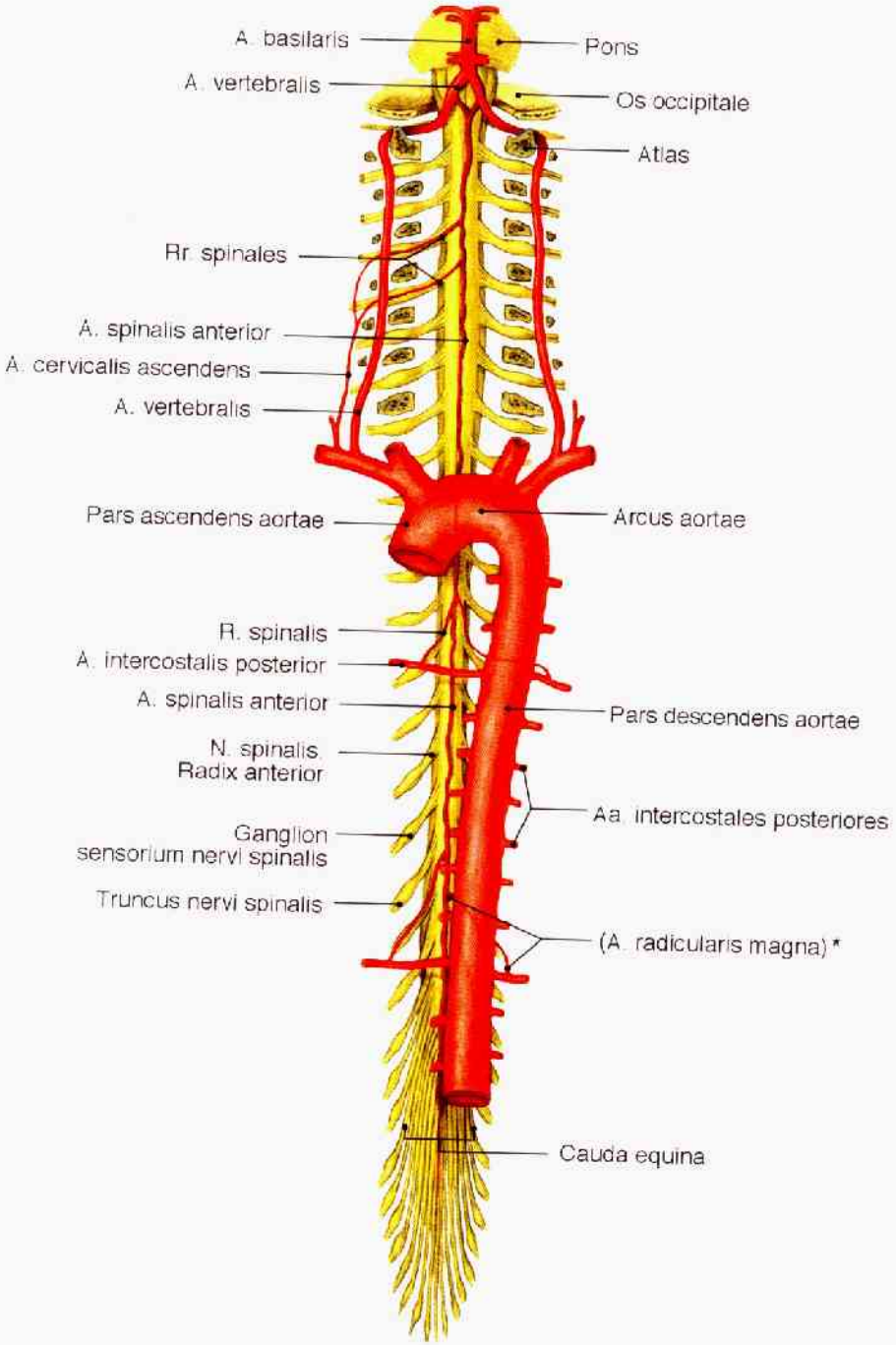
FIGURE 6-4

Arteries on the medial (A) and lateral (B) surfaces of the brain, with their areas of supply indicated. [Modified from Mettler FA: *Neuroanatomy*, ed 2, St. Louis, 1948, Mosby.]


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

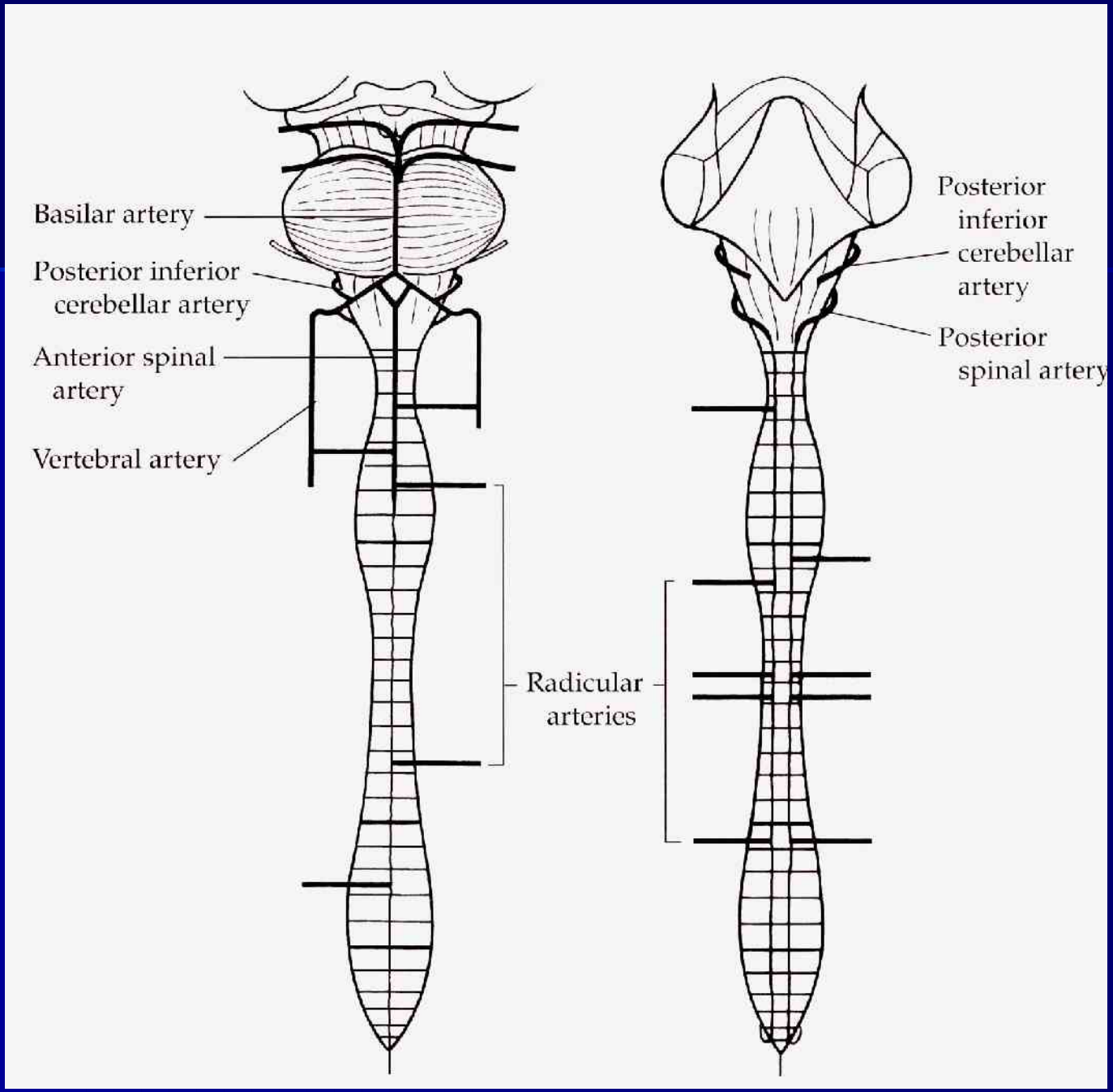


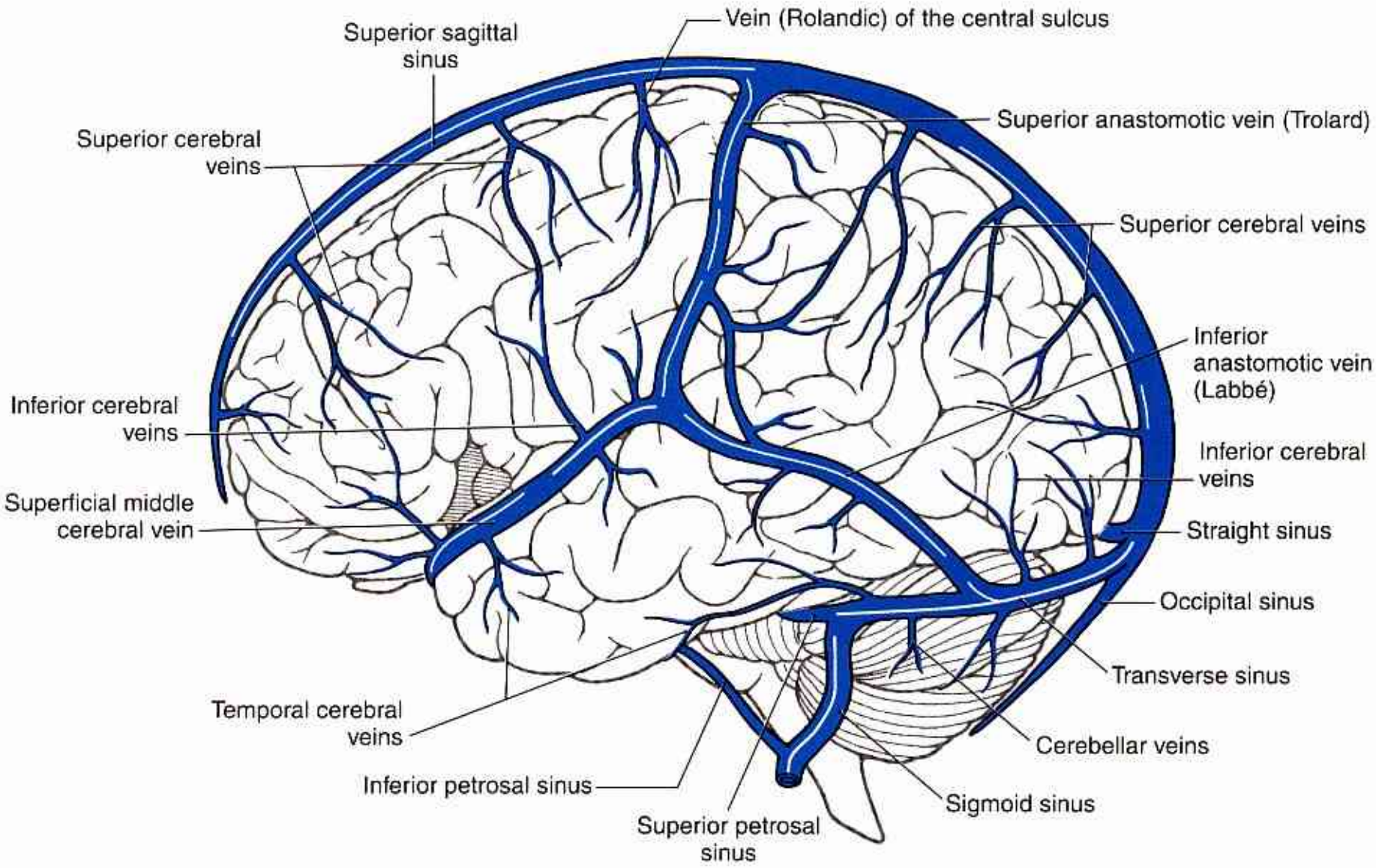
Obr. 608 Míšní tepny, medulla spinalis.

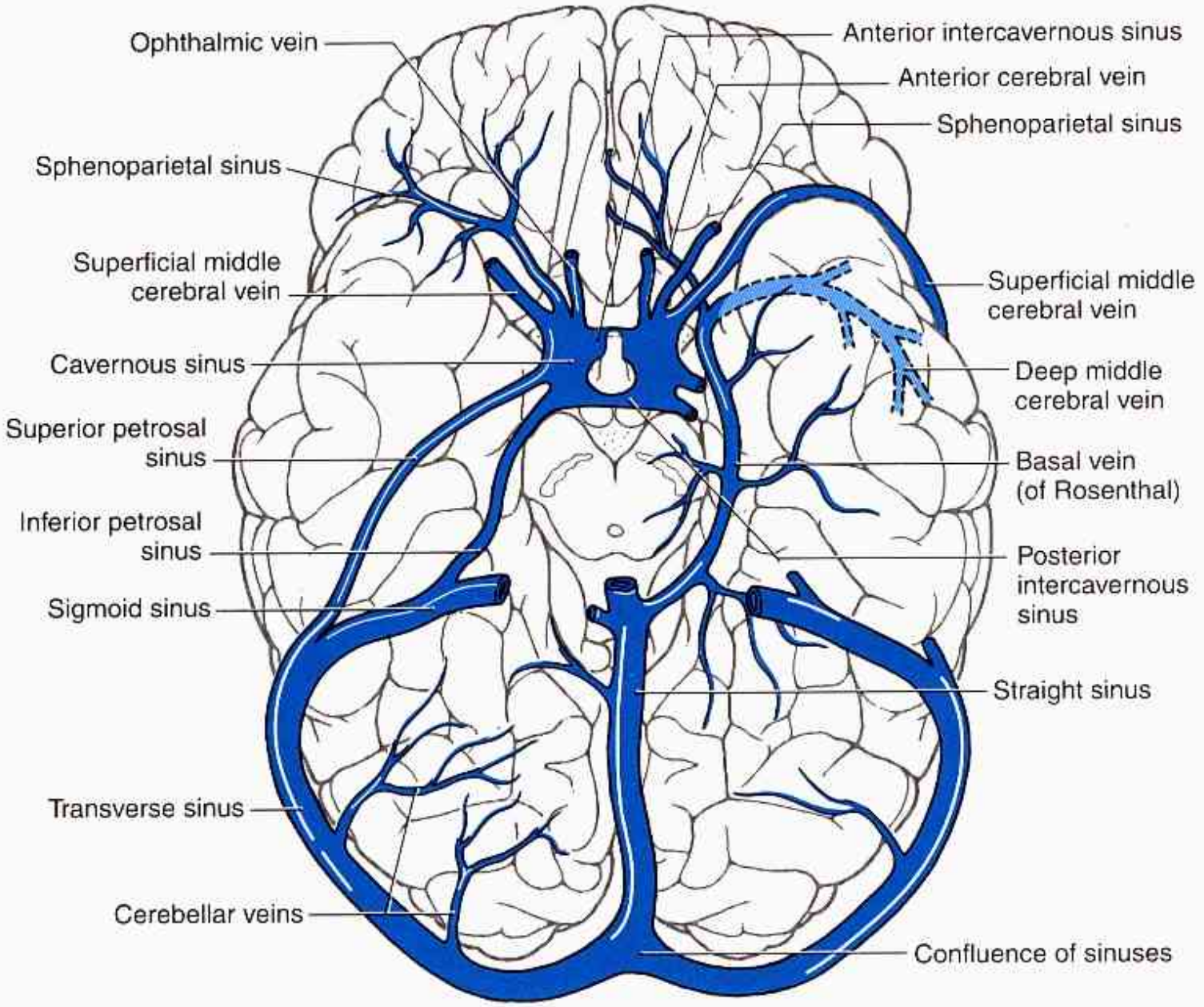

A. basilaris
Pons
A. vertebralis
Os occipitale
Atlas
Rr. spinales
A. spinalis anterior
A. cervicalis ascendens
A. vertebralis
Pars ascendens aortae
Arcus aortae
R. spinalis
A. intercostalis posterior
A. spinalis anterior
Pars descendens aortae
N. spinalis
Radix anterior
Aa. intercostales posteriores
Ganglion
sensorium nervi spinalis
Truncus nervi spinalis
(A. radicularis magna) *
Cauda equina

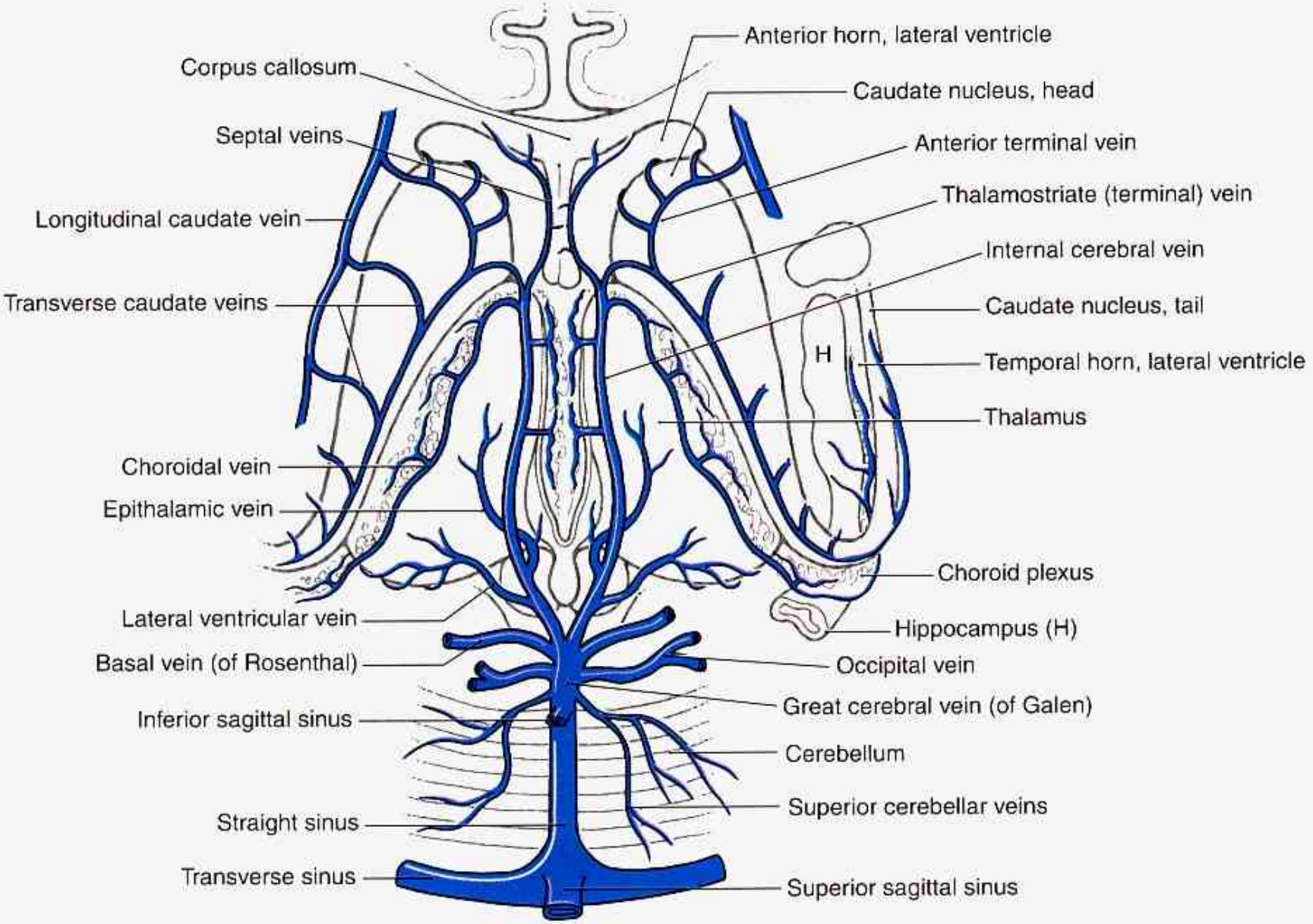
Longitudinal system

Segmental (radicular) system

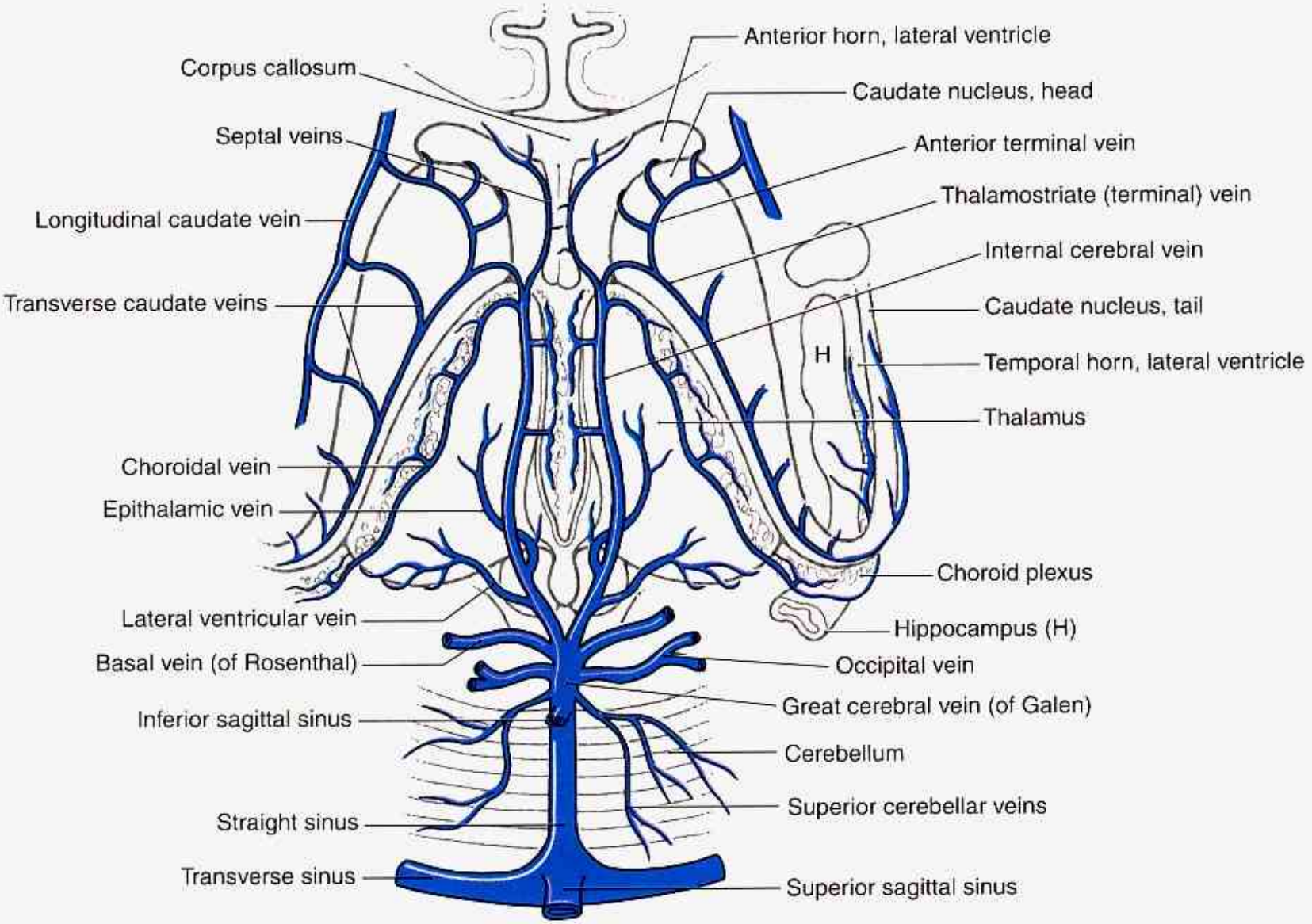



Superior sagittal sinus
Vein (Rolandic) of the central sulcus
Superior anastomotic vein (Trolard)
Superior cerebral veins
Superior cerebral veins
Inferior anastomotic vein (Labbé)
Inferior cerebral veins
Inferior cerebral veins
Superficial middle cerebral vein
Straight sinus
Occipital sinus
Transverse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


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



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



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

Liquor cerebrospinalis

Produced by the choroid plexus

Ventricles and subarachnoid space 140 ml

Physical support of the brain (floats within the fluid)

Channel for chemical communication within the CNS (neurons- fluid- walls of ventricles – neurons)

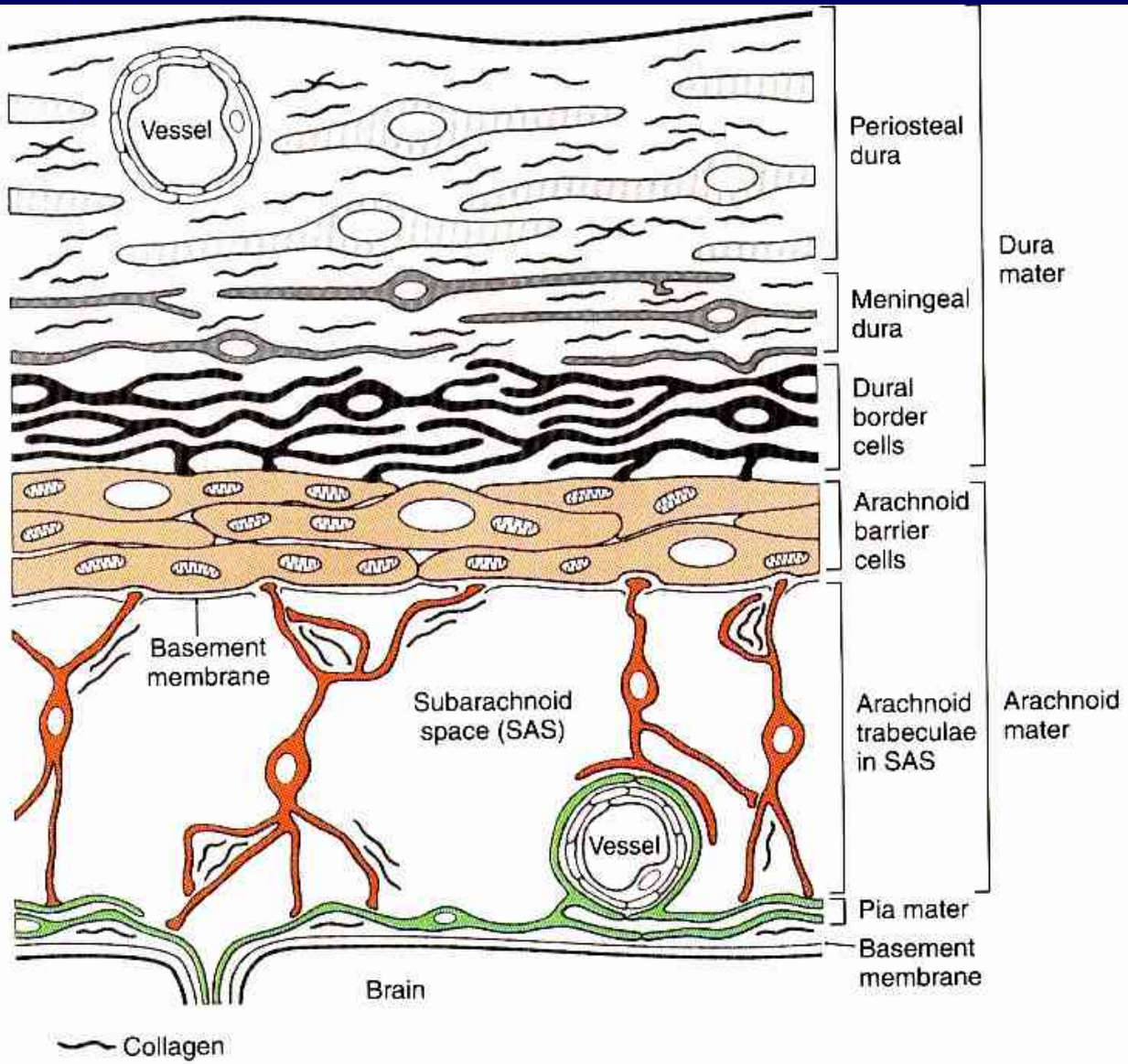


Figure 7–3. The structure of the meninges. Layers of the dura are shown in shades of black, the arachnoid in shades of red, and the pia in green.

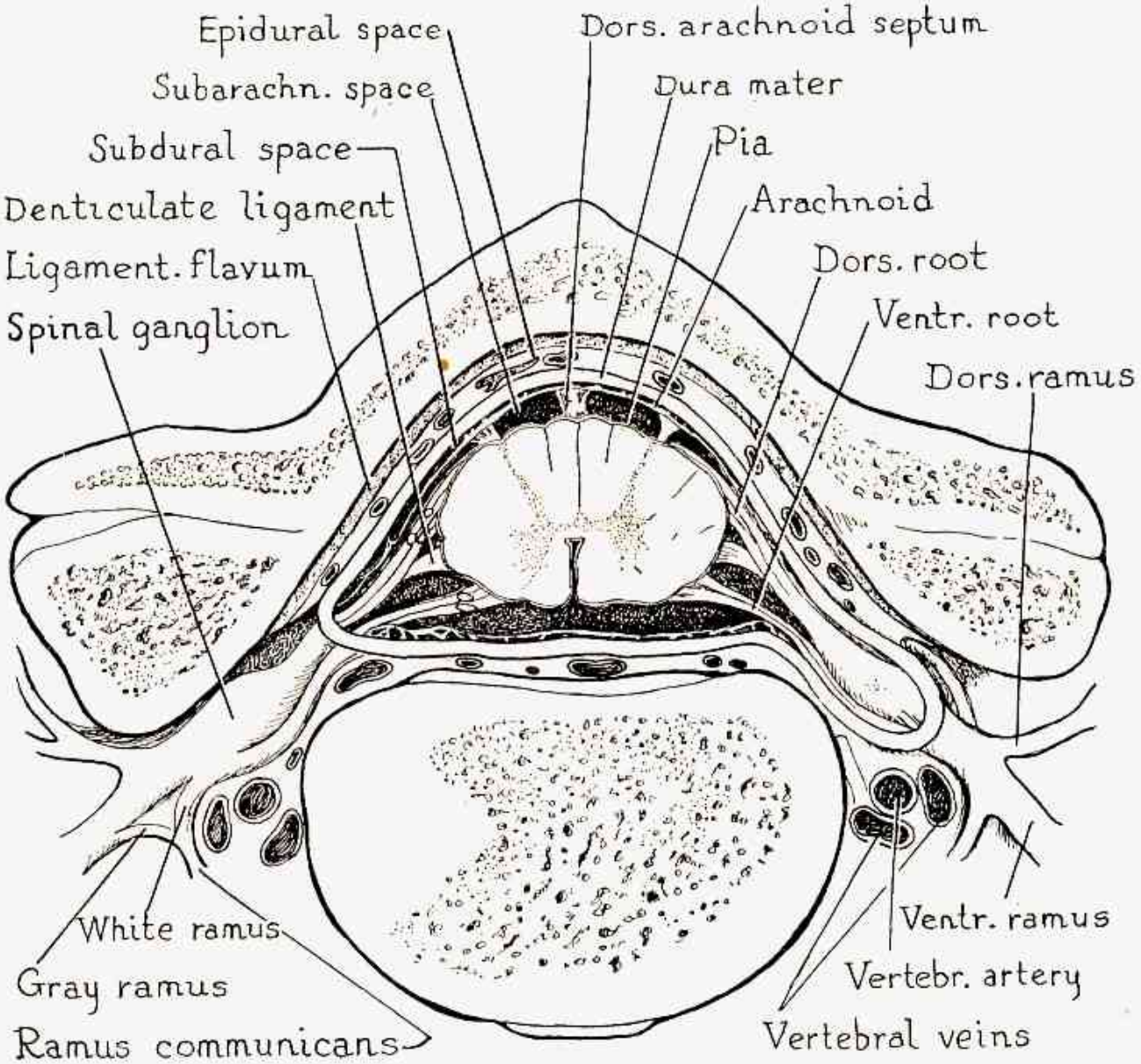
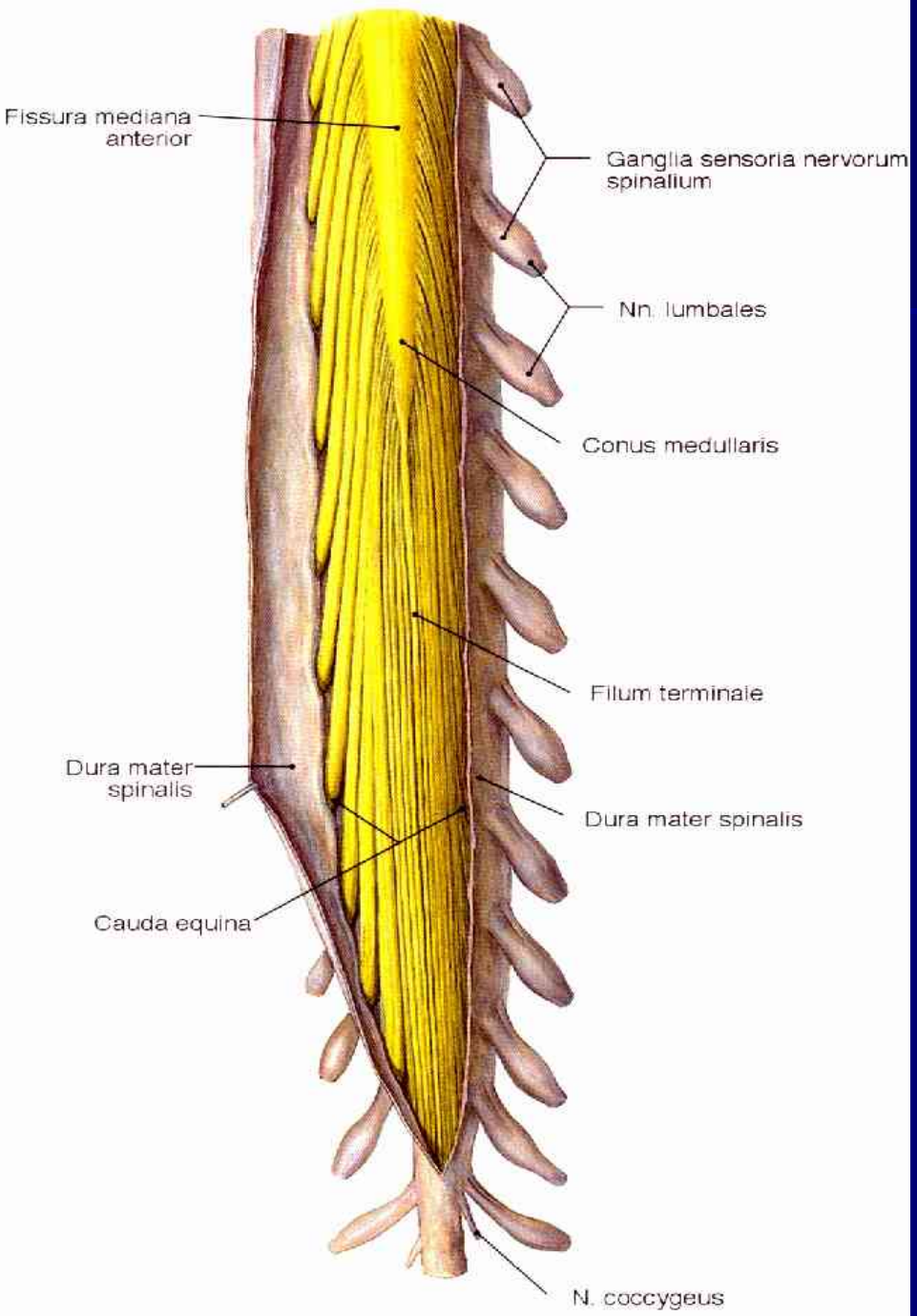


FIG. 99. Transverse section through first thoracic vertebra, showing spinal cord and its coverings. (After Rauber-Kopsch.)

Dural sheaths

Kořenové pochvy



Dural sheaths

CEREBRAL VENTRICLES

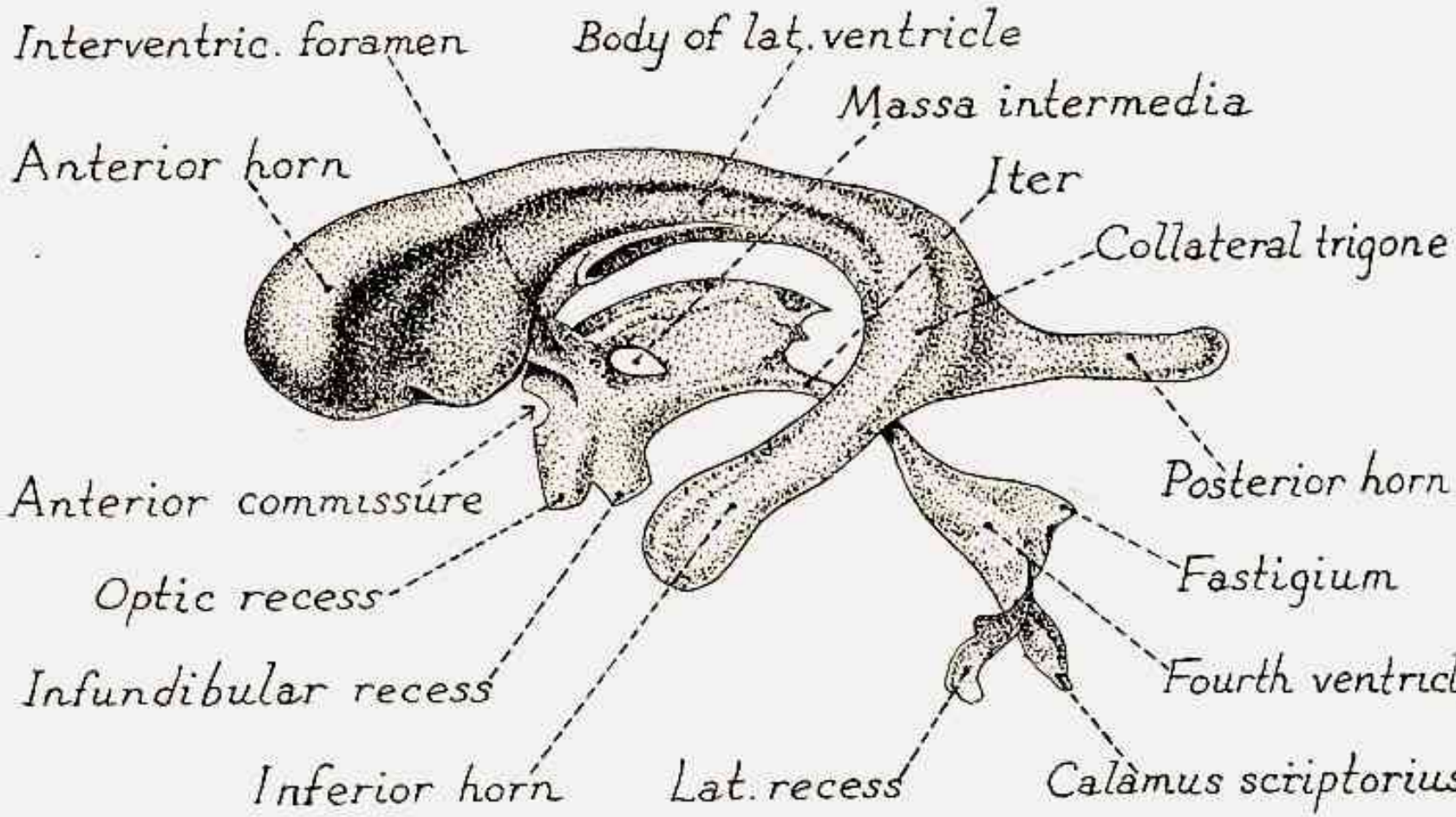
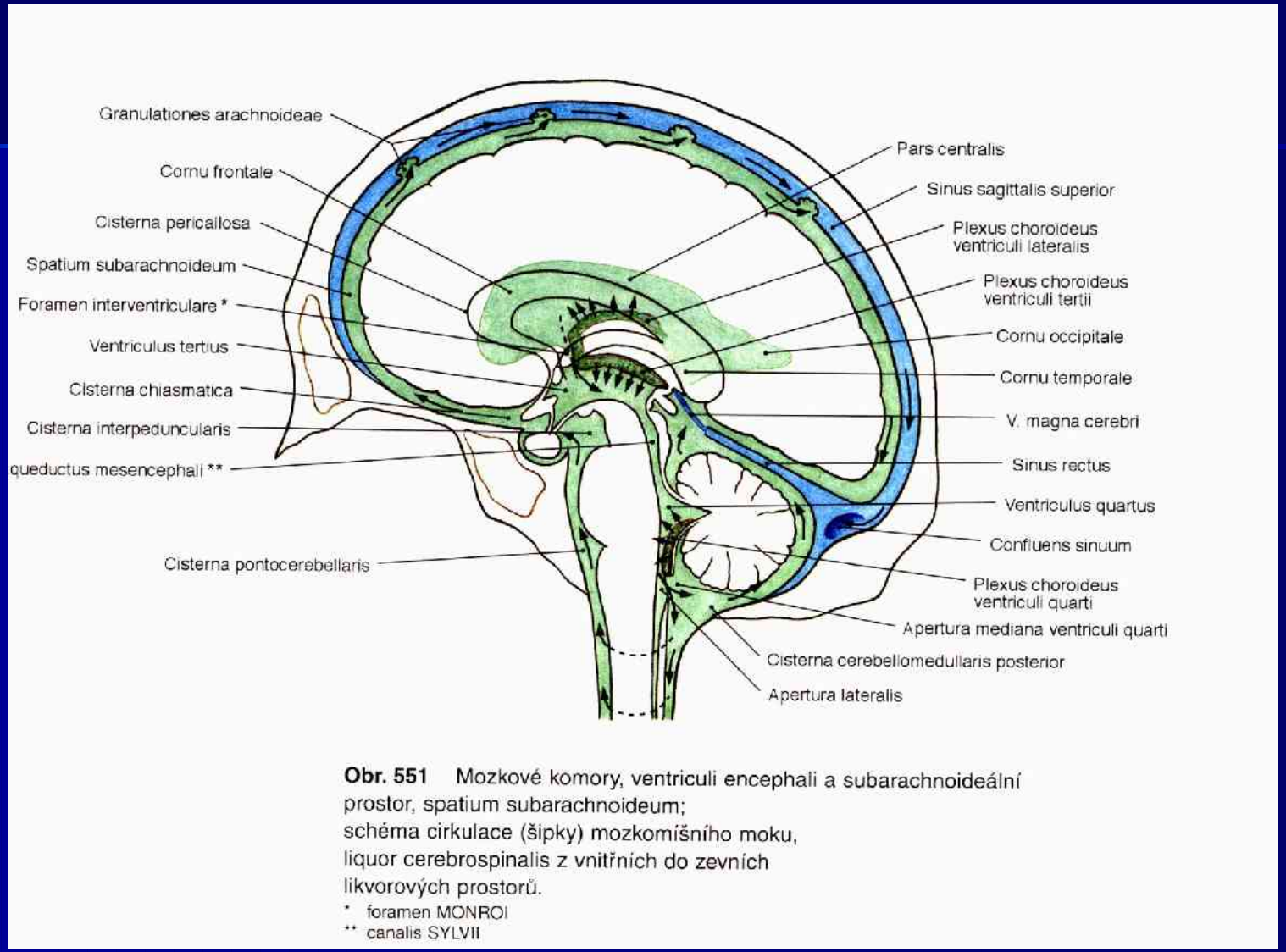


FIG. 305. Cast of the brain ventricles, viewed from the side. Only the left lateral ventricle is represented. (After Rauber-Kopsch.)

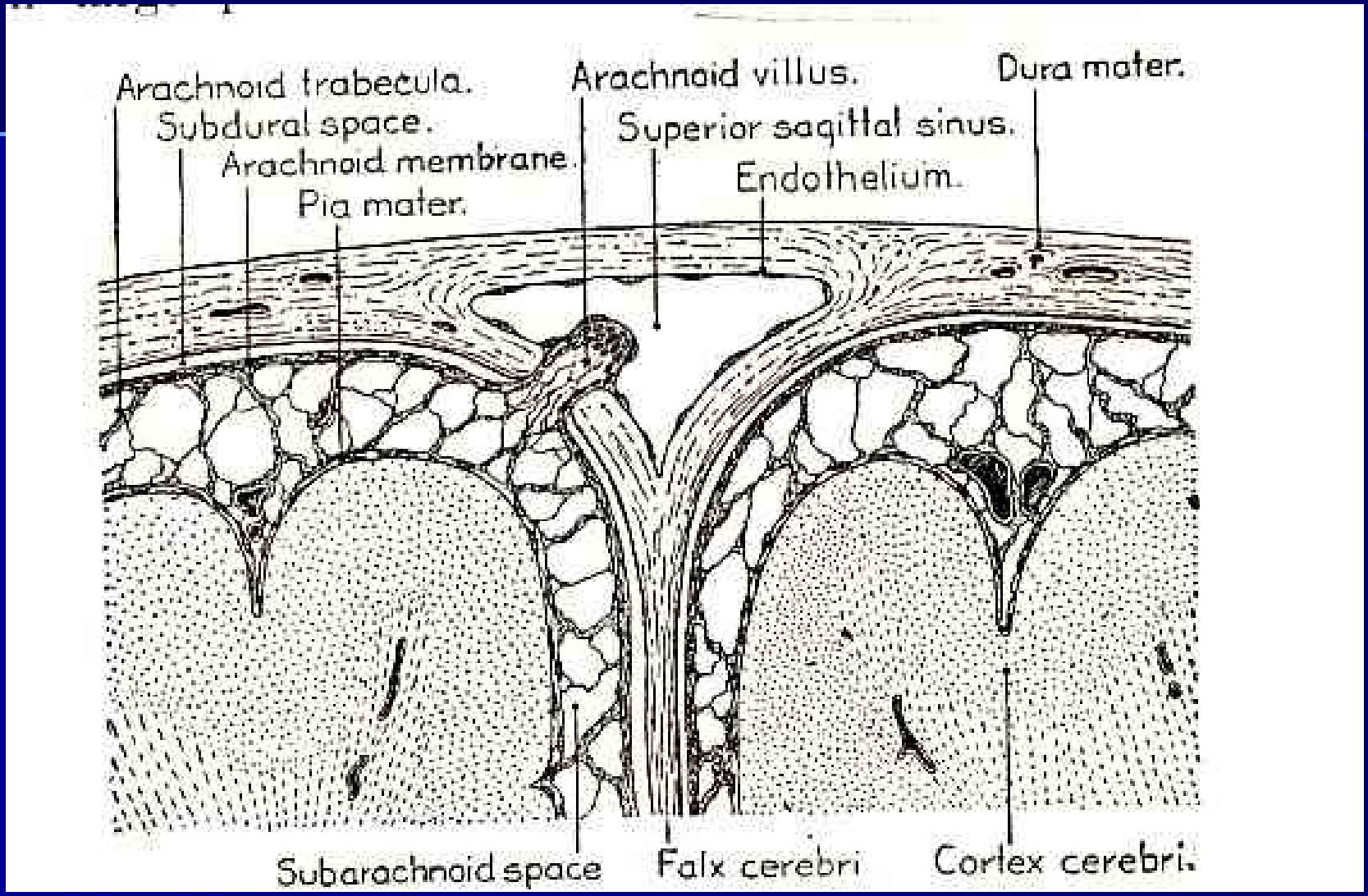
Choroidal plexus – lateral ventricles, 3rd ventricle, 4th ventricle



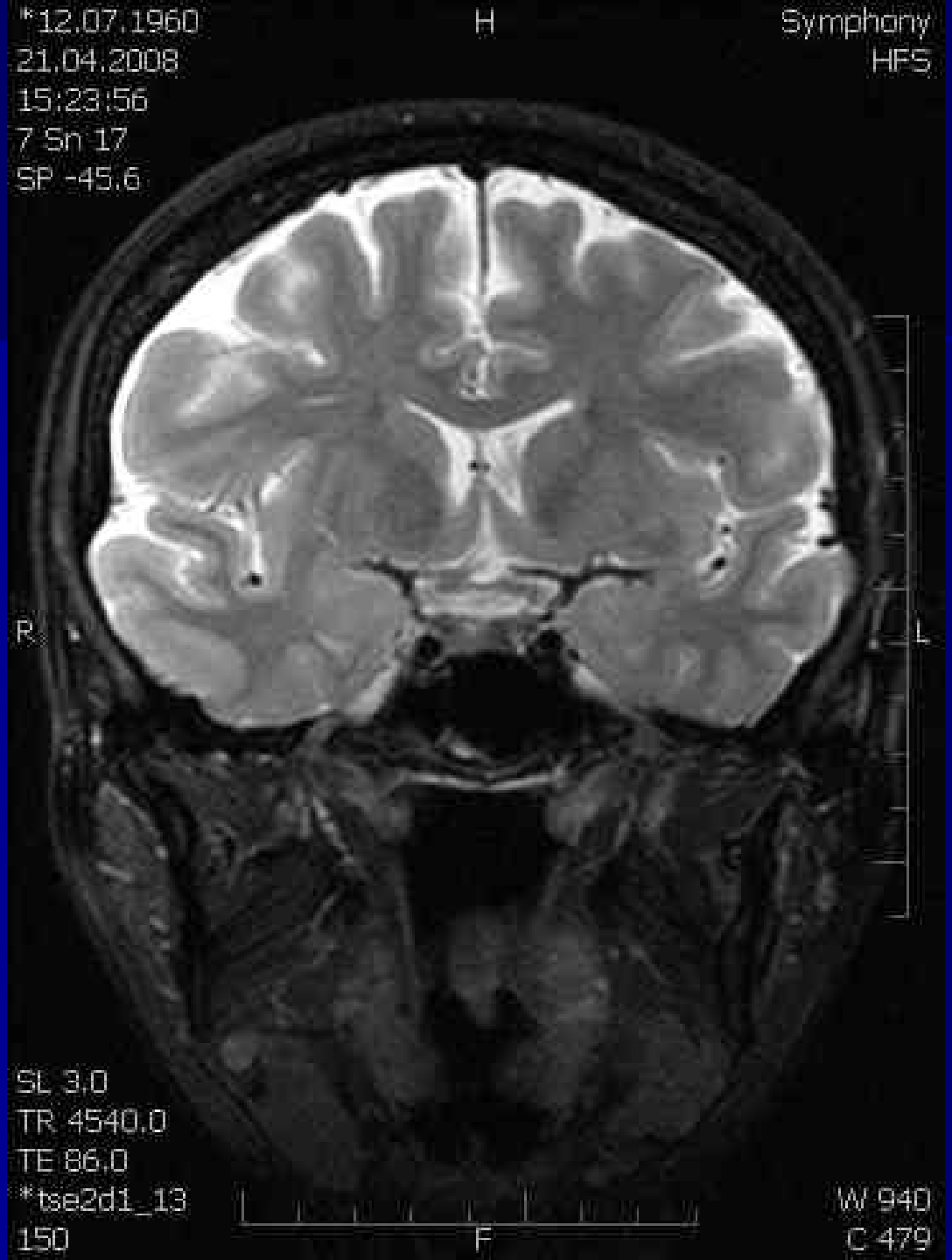
Obr. 551 Mozkové komory, ventriculi encephali a subarachnoideální prostor, spatium subarachnoideum;
schéma cirkulace (šipky) mozkomíšního moku, liquor cerebrospinalis z vnitřních do zevních likvorových prostorů.

* foramen MONROI
** canalis SYLVII

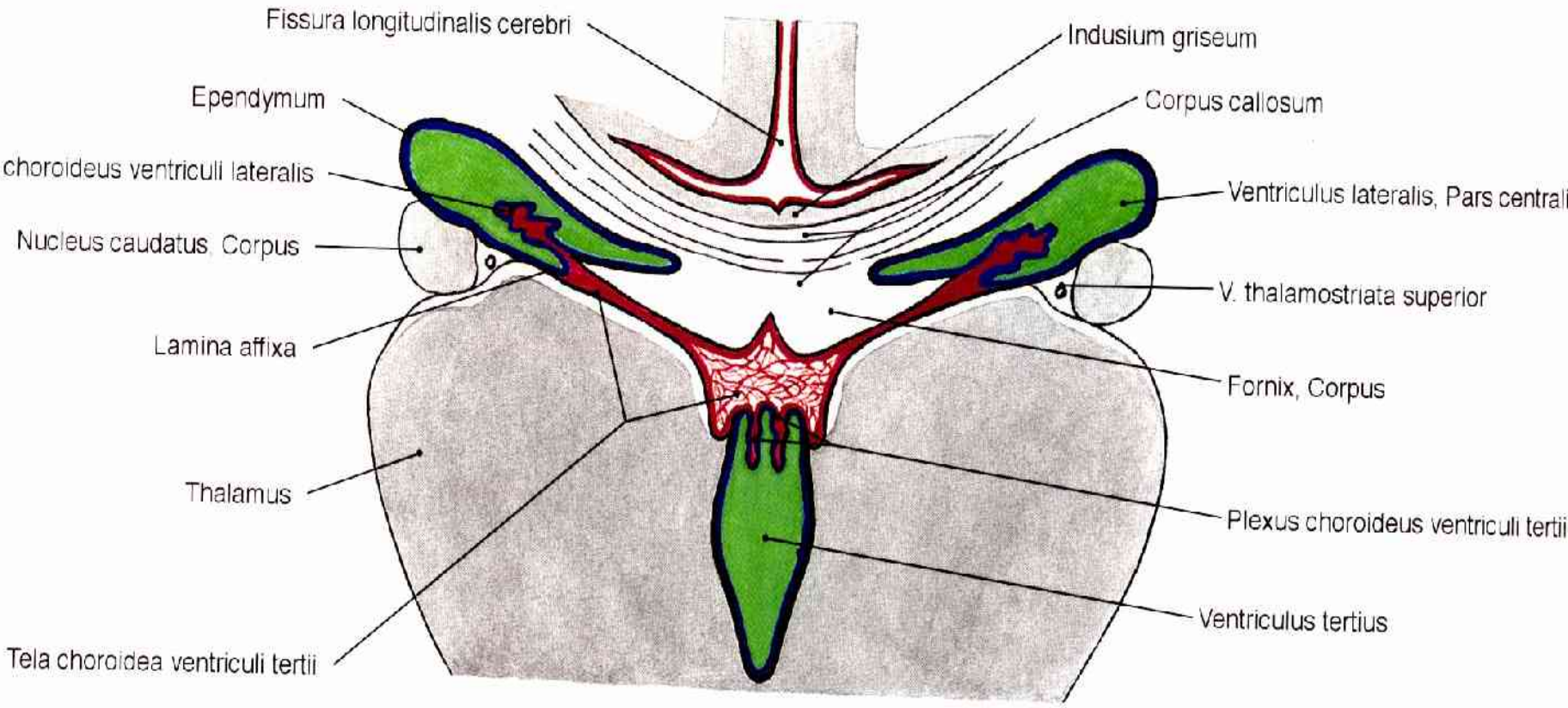
Absorbtion of liquor



MRI – T2

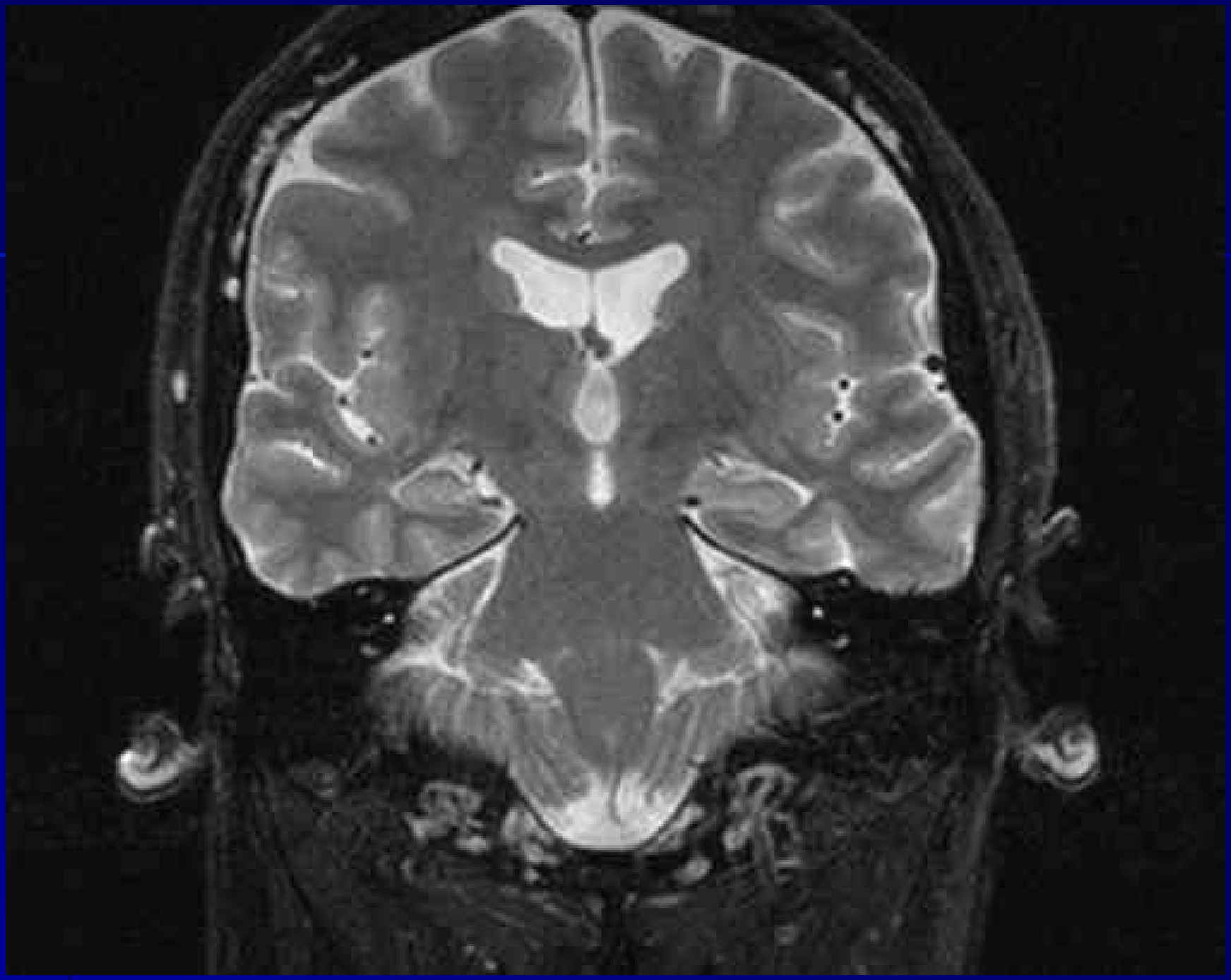

*12.07.1960
21.04.2008
15:23:56
7 Sn 17
SP -45.6
H
Symphony
HFS
R
L
SL 3.0
TR 4540.0
TE 86.0
*tse2d1_13
150
F
W 940
C 479

Ventriculus lateralis – pars centralis

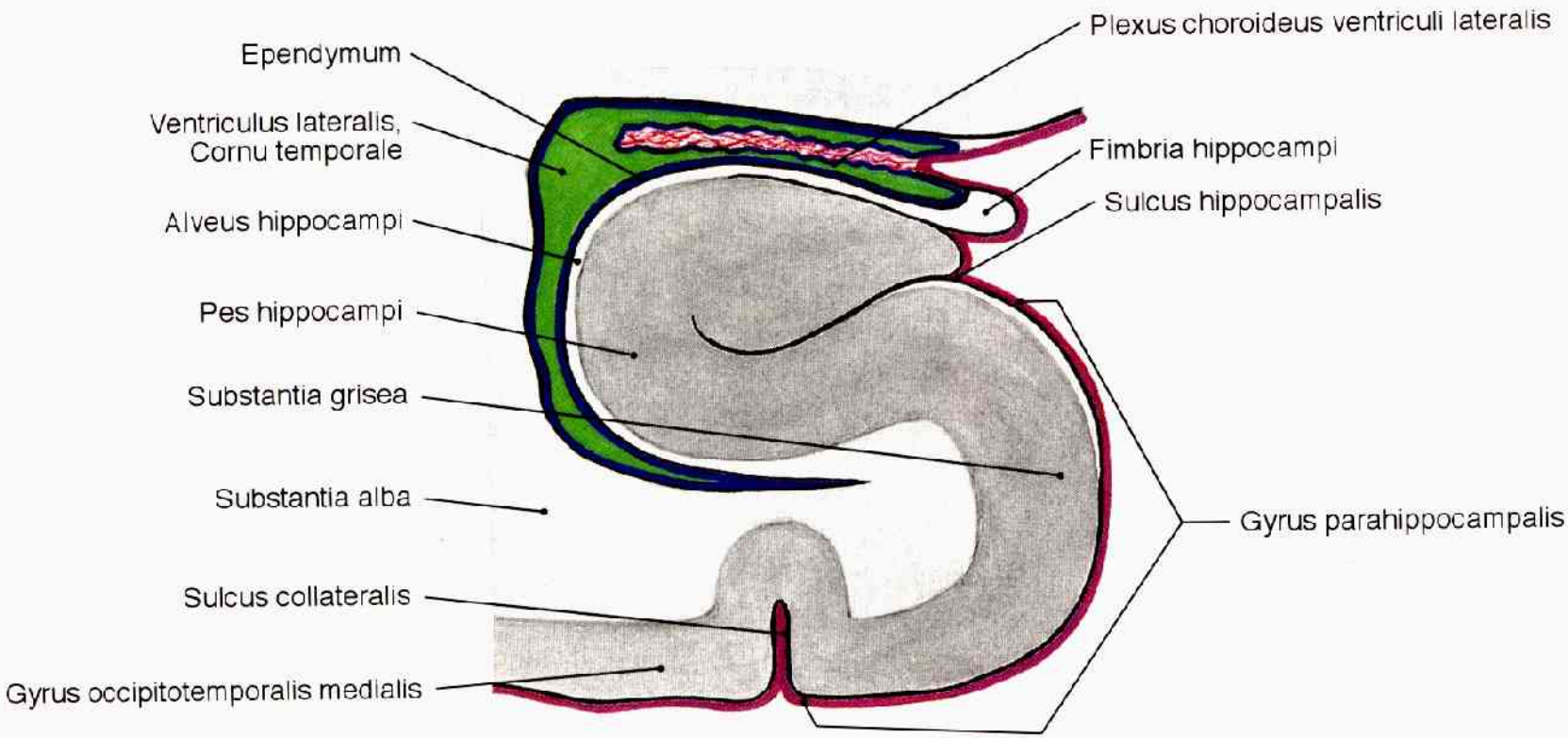


Obr. 559 Partes centrales postranních komor a třetí komora (ventriculus tertius); schematický frontální řez.

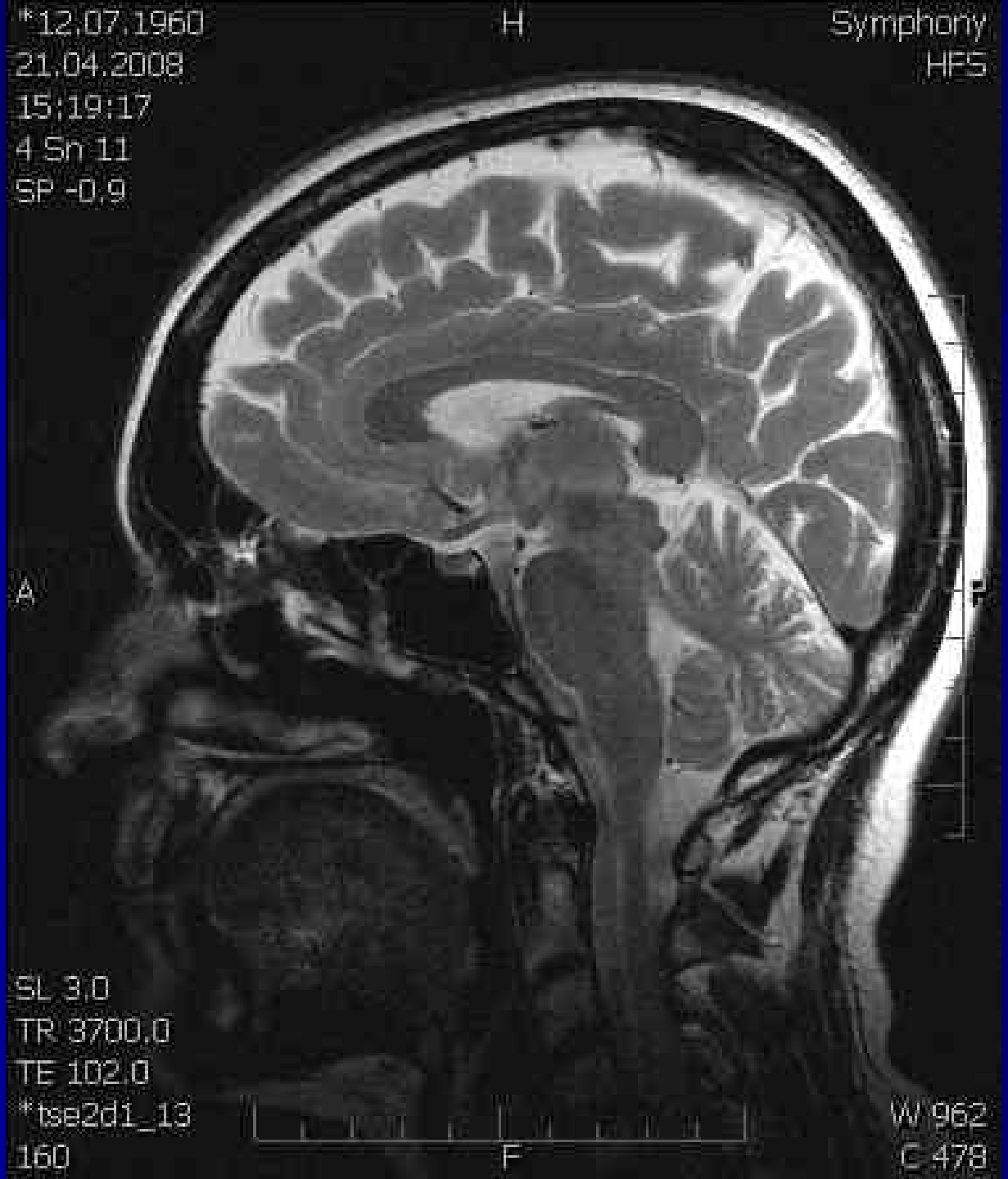
3rd ventricle



Ventriculus lateralis – cornu temporale



Obr. 557 Spánkový roh postranní komory, cornu temporale ventriculus lateralis; schematický frontální řez.


*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

DRÁHY CENTRÁLNÍHO NERVOVÉHO SYSTÉMU

Dráhy CNS

- Ascendentní (sensitivní)
- Descendentní (motorické, sest. složky sensitivníchj drah)
- Dráhy snyslových orgánů (čichová, chuťová, vestibulární, sluchová, zraková)
- Dráhy RF
- Dráhy mozečku
- Dráhy BG
- Zapojení thalamu a hypothalamu
- Zapojení limbického systému
- Asociační a komisurální korová vlákna

Ascendentní (sensitivní dráhy)

- Lemniskální systém
- Anterolaterální systém (tr. spinothalamicus, tr. spinoreticularis, tr. spinotectalis)
- Tr. spinocerebellares, tr. spinoolivaris
- Sensitivní dráhy hlavových nervů (jádra n. trigeminus, nc. solitarius)

Sestupné, motorické dráhy I

- Motorické korové dráhy
- **Tr. corticospinalis !!**
- **Tr. corticopontinus !!**
- **Tr. corticonuclearis (V., VII., ncc. vestibulares, nc. ambiguus, nc. accessorius, nc. hypoglossus)**
- **Tr. corticotectalis**
- **Tr. corticointerstitialis (area praetectalis, nc. Cajali)**
- **Tr. corticorubralis**
- **Tr. corticoreticularis**

Sestupné, motorické dráhy II

- Motorické kmenové dráhy
- **Tr. interstitiospinalis**
- **Tr. tectospinalis**
- **Tr. rubrospinalis**
- **Tr. reticulospinalis**
- **Tr. vestibulospinalis**
- **Mediální a laterální motorický míšní systém !!**

Dráhy smyslových orgánů

- Zraková dráha
- Sítnice – n. opticus - chiasma- tr. opticus – CGL – area 17 (18, 19, where and what systém)
- Odbočky (hypothalamus, CS, pretektální oblast)
- Dráhy pupilárního reflexu (miosis + akomodace čočky, mydriasis !!!)

Sluchová dráha

- Ganglion cochleare
- Nc. cochlearis (dors., ventr.)
- Oliva superior, ncc. corp. Trapezoidei
- Coliculus inferior
- CGM
- Cortex - area 41- 42, 22 (where and what dráha)

Čichová dráha

- Čichová sliznice (receptorové buňky) – fila olfactoria – bulbus olfactorius- piriformní kůra (area 51), area 28, amygdala - hippokampální formace, hypothalamus, thalamus (MD) – orbitofrontální čichová oblast

Chuťová dráha

- T – buňky v gangl. geniculi a v gangl. n. IX. a X.
- Nc. solitarius (nc. gustatorius)
- Thalamus (nc. VPM)
- Cortex (area 43, přední insula)

Vestibulární dráha

- Receptorové buňky (macula sacculi, utriculi – statický labyrint, lineární změny)
- Receptorové buňky (cristae ampullares, dynamický labyrint, rotační pohyby)
- Ganglion vestibulare
- **Nuclei vestibulares**
- Tr. vestibulocerebellaris
- Jádra okohybných nervů (III., IV., VI.)
- Tr. vestibulospinalis
- Tr. vestibulothalamicus (nc. VPM, post. jádra)
- Korové vestibulárni oblasti (zadní insula, 2, 3, 7, 8, 6)
- Vestibulookulární, šíjové a labyrintové reflexy !!

Spoje striata a pallida

- Aferentní a eferentní spoje striata a pallida, subst. Nigra, nc. subthalamicus
- Okruh bazálních ganglií (mediátory, dopamin)

Zapojení mozečku

- Aferentní spoje mozečku
- Spoje mozečková kůra – jádra
- Eferentace mozečkových jader
- (Mechová a šplhavá vlákna)
- Mediátory

Zapojení RF

- Aferentní spoje
- Eferentní spoje
- Ascendentní aktivační systém RF
- Mediátorové systémy v RF

Zapojení thalamických jader

- Podkorový vstup – jádro – korová oblast
- VA, VL, VPL, VPM, CGM, CGL
- Intralaminární jádra, Pulvinar, Nc. mediodorsalis

Limbický systém

- Aferentace a eferentace hippokampu a amygdaly
- Neokortex – limbický systém
- Papezův okruh
- Andersenův okruh

Hypothalamus

- Aferentí spoje
- Eferentní spoje
- Hypothalamo-hypof. systém

Děkuji za pozornost

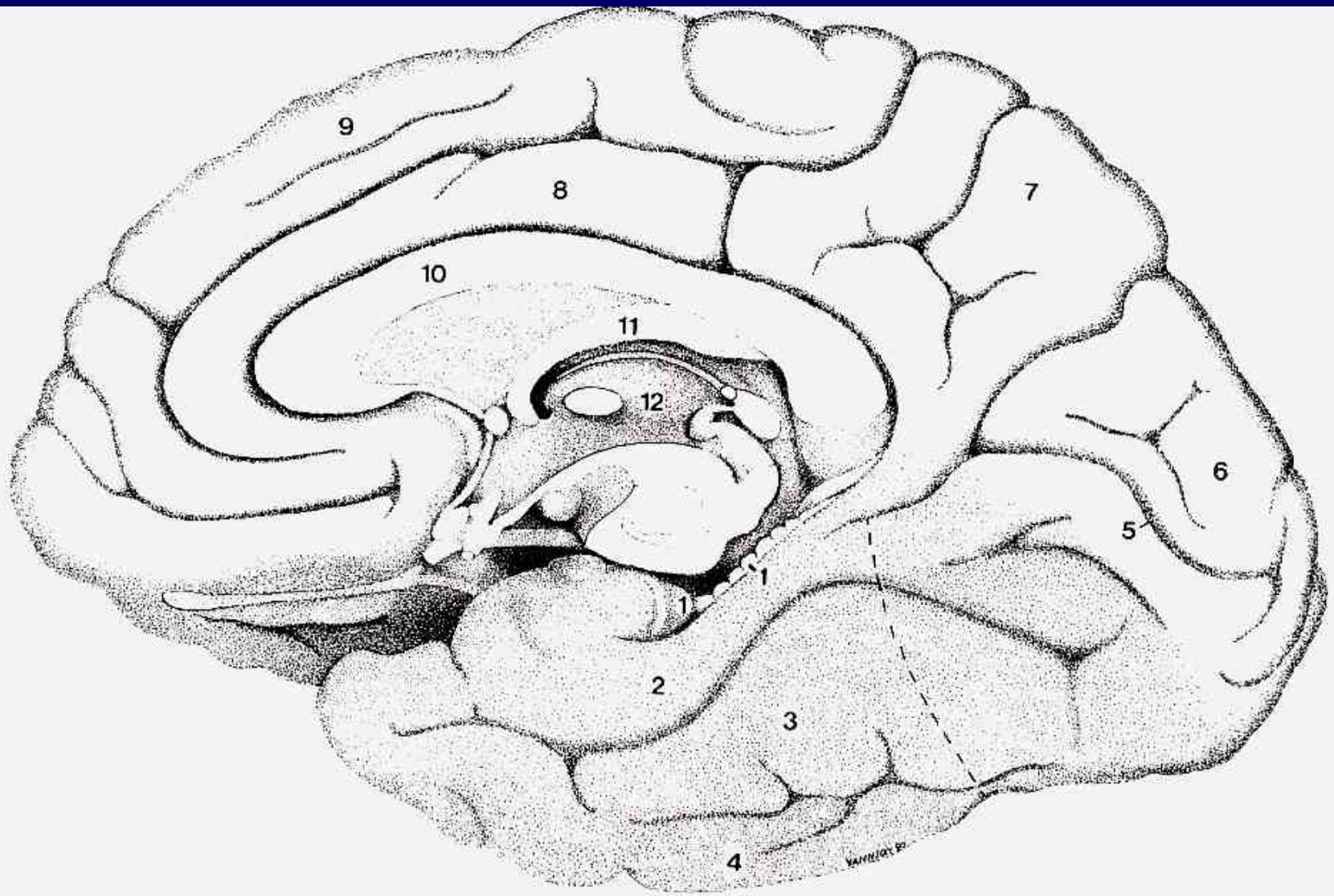


Fig. 1. A Drawing and **B** dissection showing the inferomedial aspect of the right hemisphere. **Bar**, 10 mm
1, hippocampus, only partly visible on the inferomedial surface of the temporal lobe; **2**, parahippocampal gyrus (T_5); **3**, fusiform gyrus (T_4); **4**, inferior temporal gyrus (T_3); **5**, calcarine sulcus; **6**, occipital lobe (cuneus); **7**, parietal lobe, medial aspect (precuneus); **8**, cingulate gyrus; **9**, frontal lobe, medial aspect (superior frontal gyrus); **10**, corpus callosum; **11**, fornix; **12**, third ventricle

Sensitivní dráhy

- **Anterolaterální systém - Tr. spinothalamicus,**
- **Tr. spinoreticularis, Tr. spinotectalis**
- **Lemniskální systém**
- **Tr. spino-bulbo-thalamo- corticalis (dráha zadních míšních provazců**

- **Tr. spinocerebellares**
- **Tr. spinoolivaris**

TRACTUS CEREBRI

Přehled drah

Motorické dráhy -kmenové

- Tr. reticulo-spinalis
- Tr. rubro-spinalis
- Tr. tecto-spinalis
- Tr. vestibulo-spinalis
- Tr. interstitio-spinalis
- Mediální x laterální systém motorických míšních drah

Motorické dráhy -korové

- Tr. cortico-spinalis
- Tr. cortico-reticularis
- Tr. cortico-nuclearis
- Tr. cortico-rubralis
- Tr. cortico-tectalis

Sensorické dráhy - smyslové

- Čichová dráha
- Zraková dráha
- Sluchová dráha
- Chuťová dráha
- Vestibulární dráha