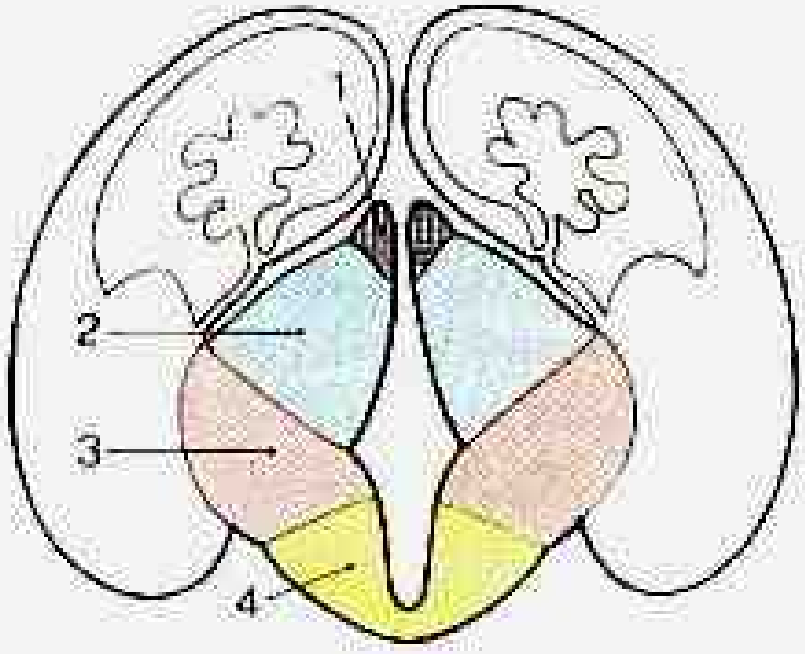
THE DIENCEPHALON

Inst. of Anatomy, 1st Medical Faculty

R. Druga

THE DIENCEPHALON

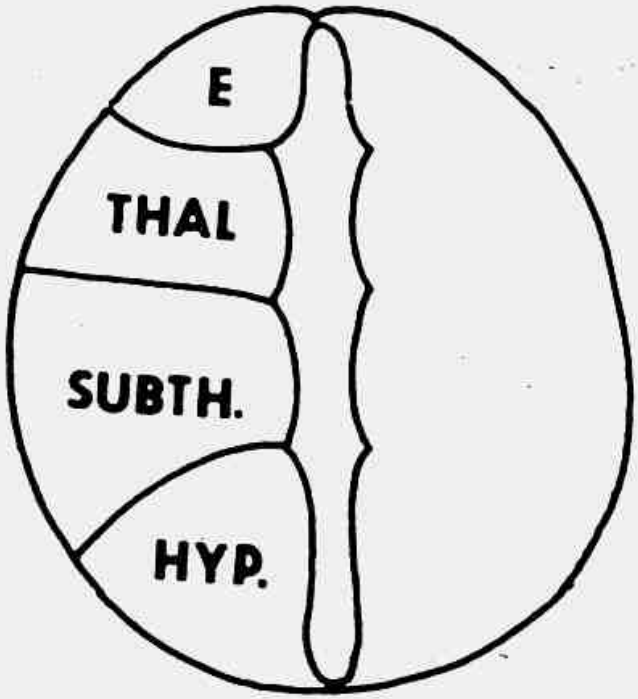
- EPITHALAMUS
- THALAMUS
- SUBTHALAMUS
- HYPOTHALAMUS



B Structure of the diencephalon in an embryonic brain

AMPHIBIANS

MAMMALS



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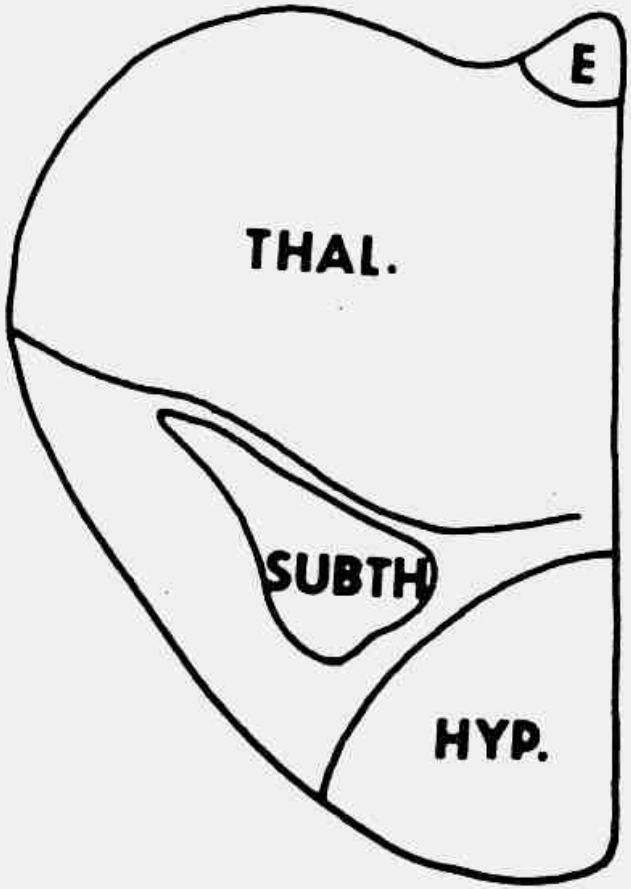
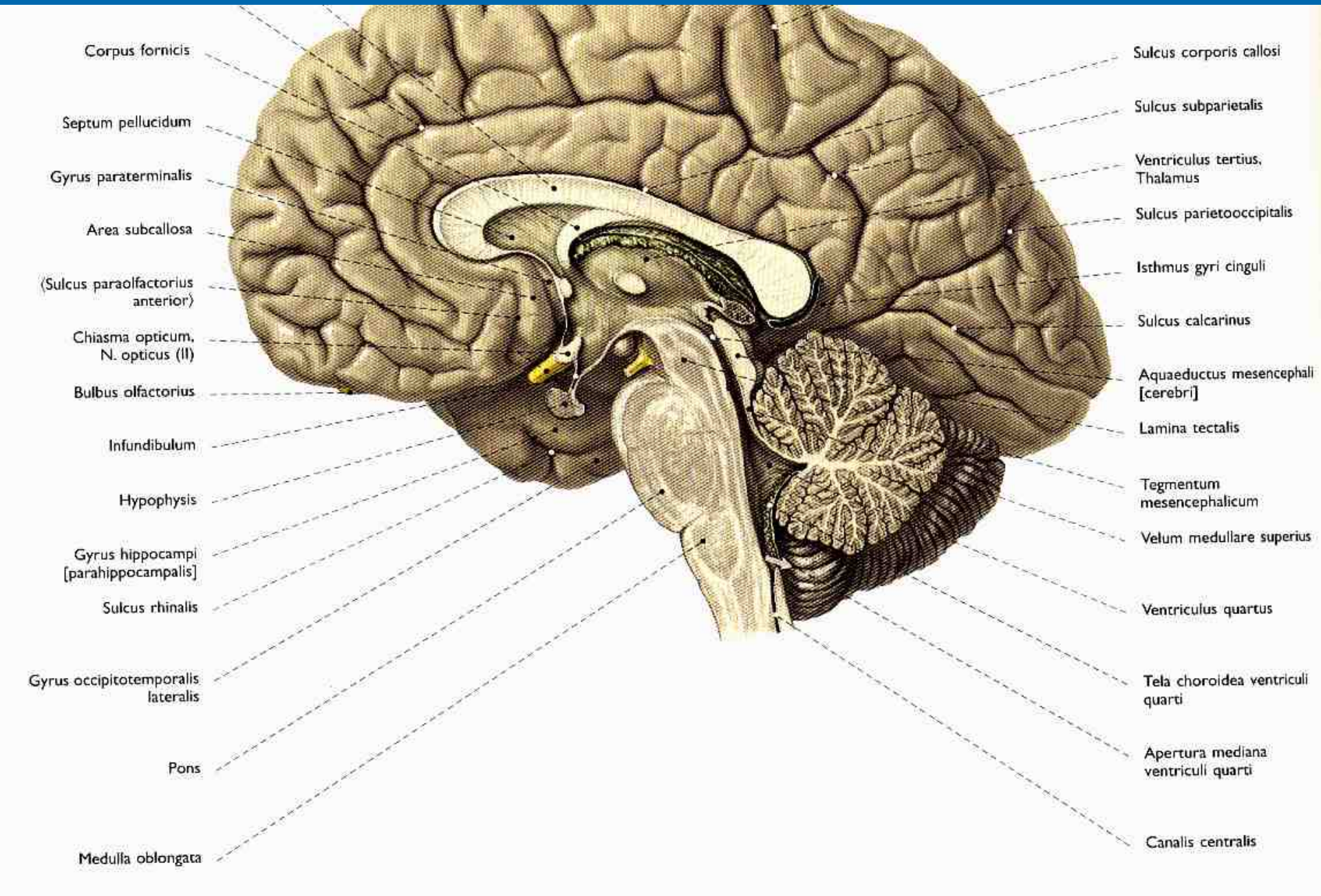


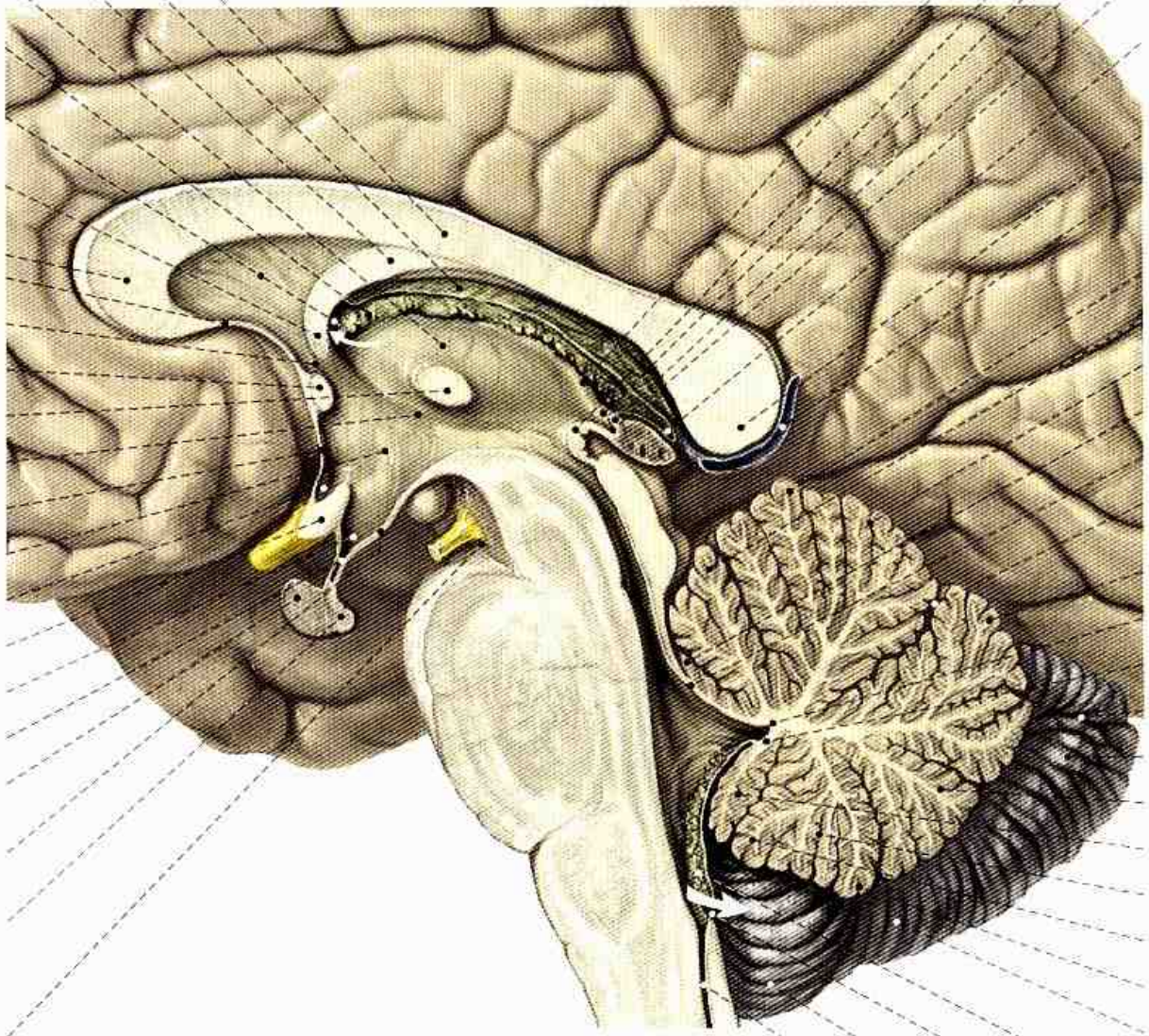
b

AMFIBIA

MAMMALIA


Corpus fornicis
Septum pellucidum
Gyrus paraterminalis
Area subcallosa
(Sulcus paraolfactorius anterior)
Chiasma opticum, N. opticus (II)
Bulbus olfactorius
Infundibulum
Hypophysis
Gyrus hippocampi [parahippocampalis]
Sulcus rhinalis
Gyrus occipitotemporalis lateralis
Pons
Medulla oblongata
Sulcus corporis callosi
Sulcus subparietalis
Ventriculus tertius, Thalamus
Sulcus parietooccipitalis
Isthmus gyri cinguli
Sulcus calcarinus
Aquaeductus mesencephali [cerebri]
Lamina tectalis
Tegmentum mesencephalicum
Velum medullare superius
Ventriculus quartus
Tela choroidea ventriculi quarti
Apertura mediana ventriculi quarti
Canalis centralis

DIENCEPHALON – medial aspect



Truncus corporis callosi
Tela choroidea ventriculi tertii
Corpus fornicis
Thalamus
Plexus choroideus ventriculi tertii
Septum pellucidum, ramen interventriculare
Columna fornicis
Corpus callosum
Genu –
Rostrum –
(Recessus triangularis)
Commissura anterior
Adhaesio interthalamica
Sulcus hypothalamicus
Lamina terminalis
Hypothalamus
Recessus opticus
Chiasma opticum
Recessus infundibuli
Infundibulum
Adenohypophysis
Tuber cinereum
Neurohypophysis
Fossa interpeduncularis

Stria medullaris thalami
Commissura epithalamica
Habenula
Commissura habenularum
Recessus pinealis
Recessus suprapinealis
Splenium corporis callosi
V. magna cerebri
Culmen
Lobulus centralis
Declive
Lingula
Velum medullare superius
Fissura prima
Folium vermis
(Fastigium)
Velum medullare inferius
Fissura horizontalis
Lobulus semilunaris inferior
Tuber vermis
Nodulus
Fissura secunda
Uvula vermis
Pyramis vermis
Lobulus biventer

BRAIN STEM AND DIENCEPHALON

Superior aspect

Pulvinar - cushion

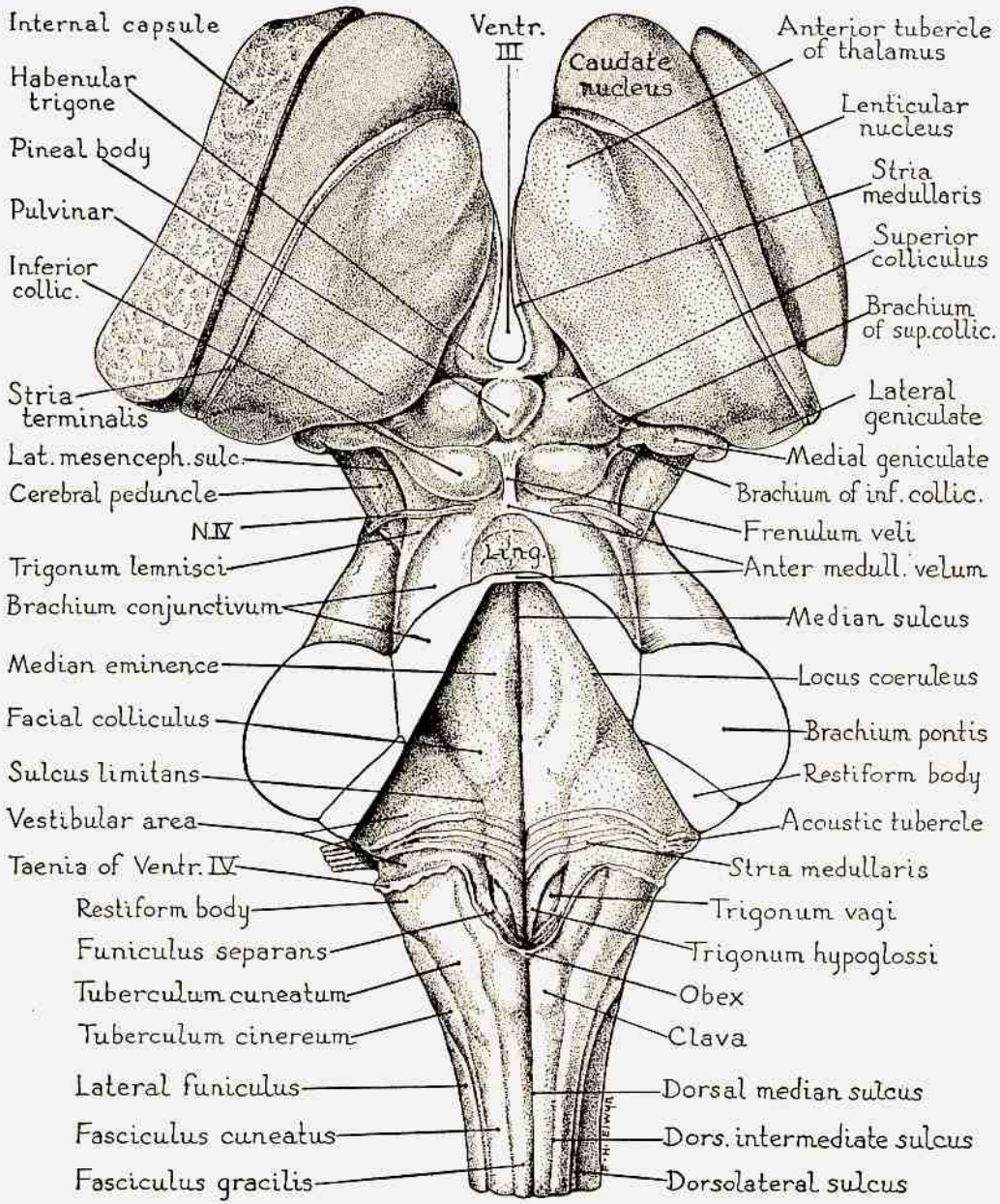
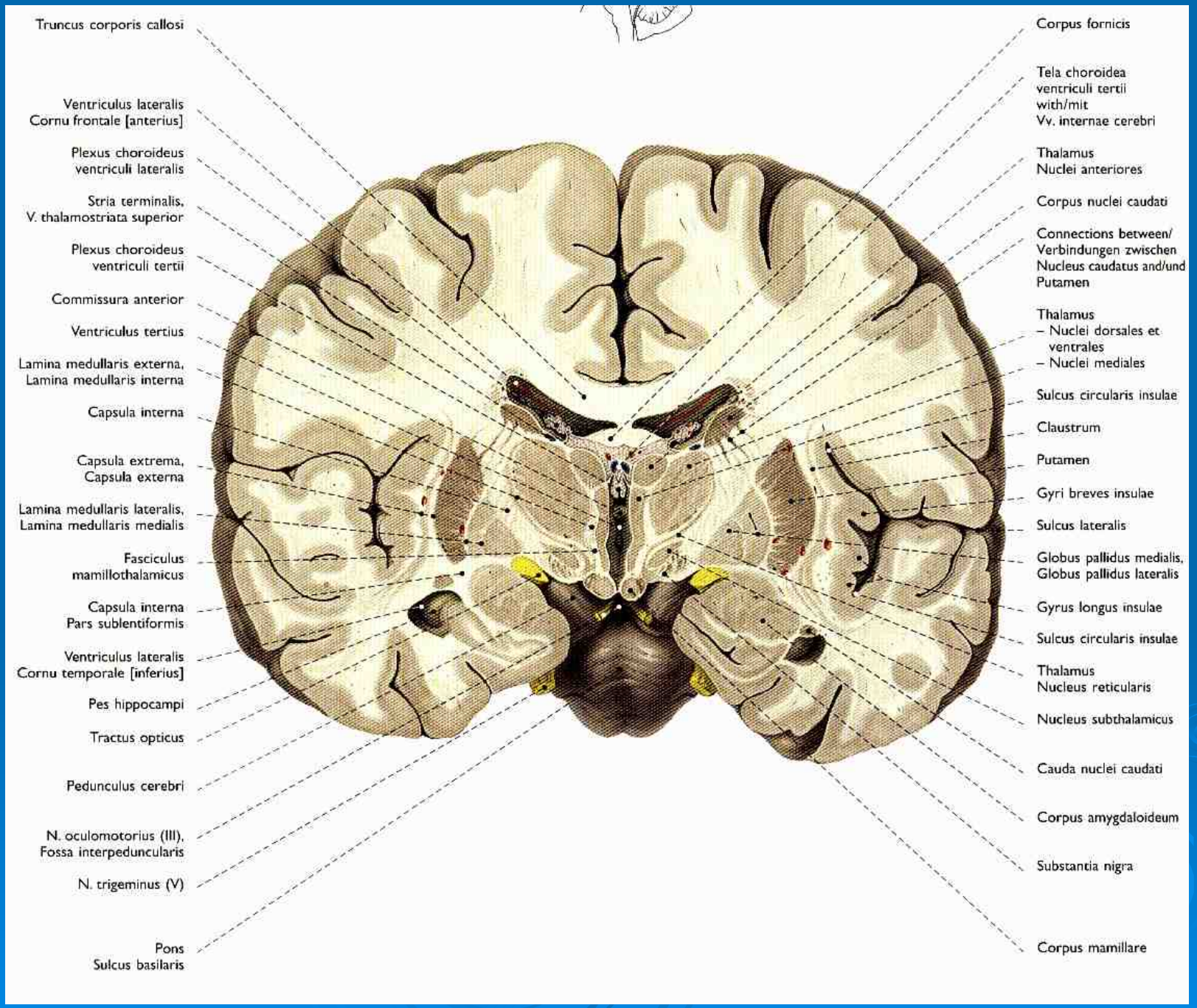
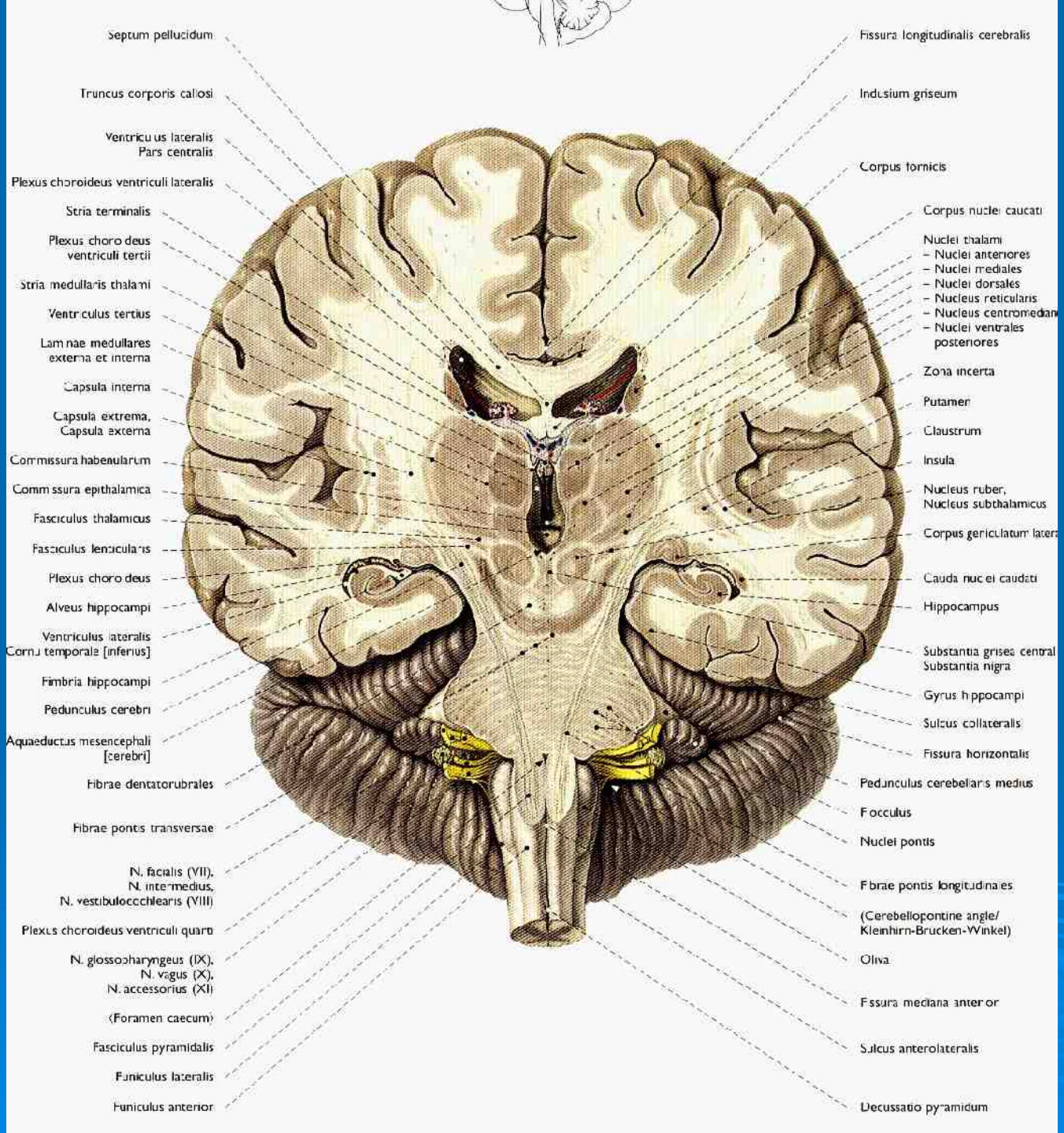


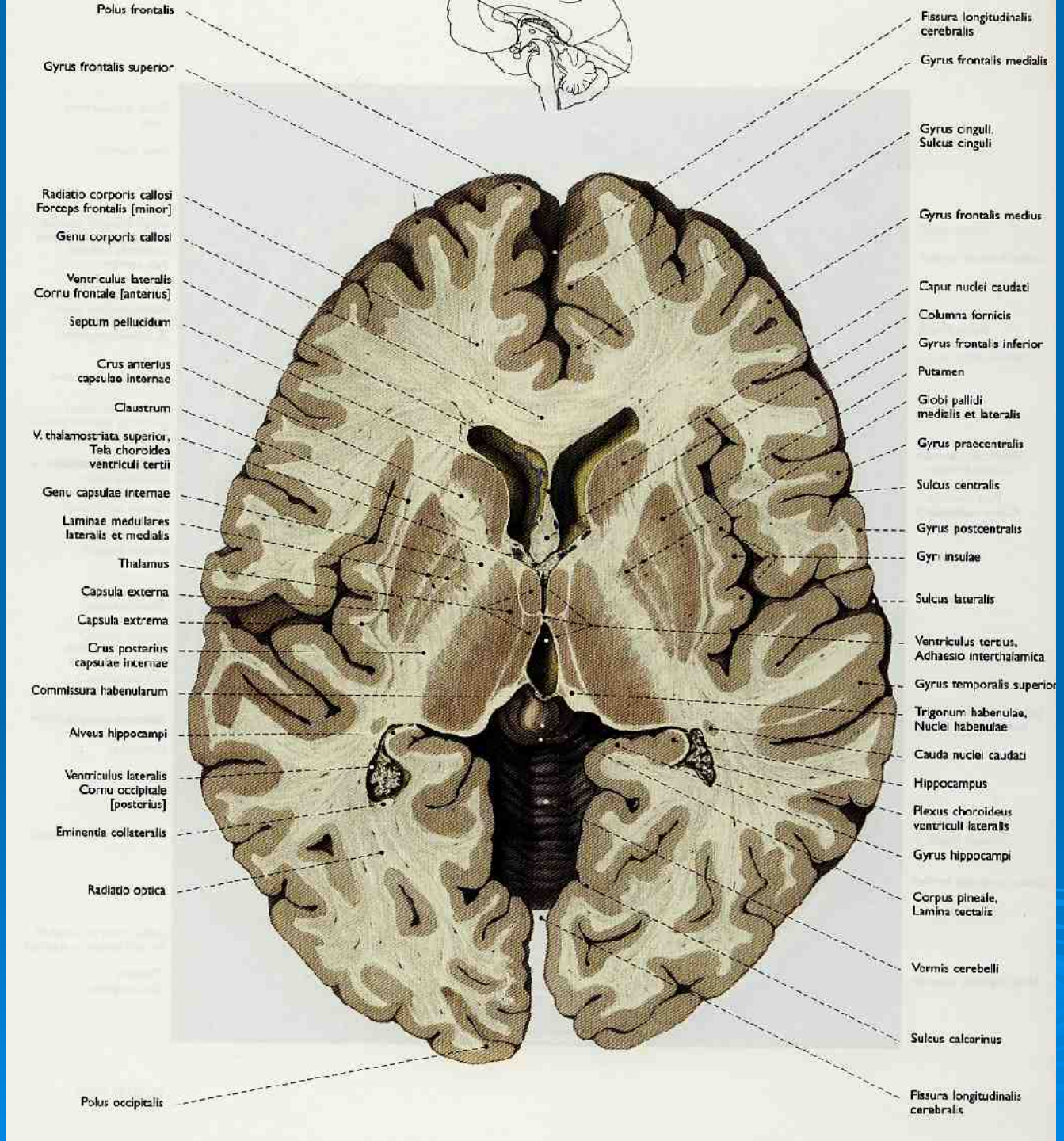
FIG. 260. Dorsal view of the brain stem. *Ling.*, lingula

later found a fiber bundle known as the *stria terminalis* or *stria semicircularis* (Figs. 260, 15). At first the corpus striatum appears as

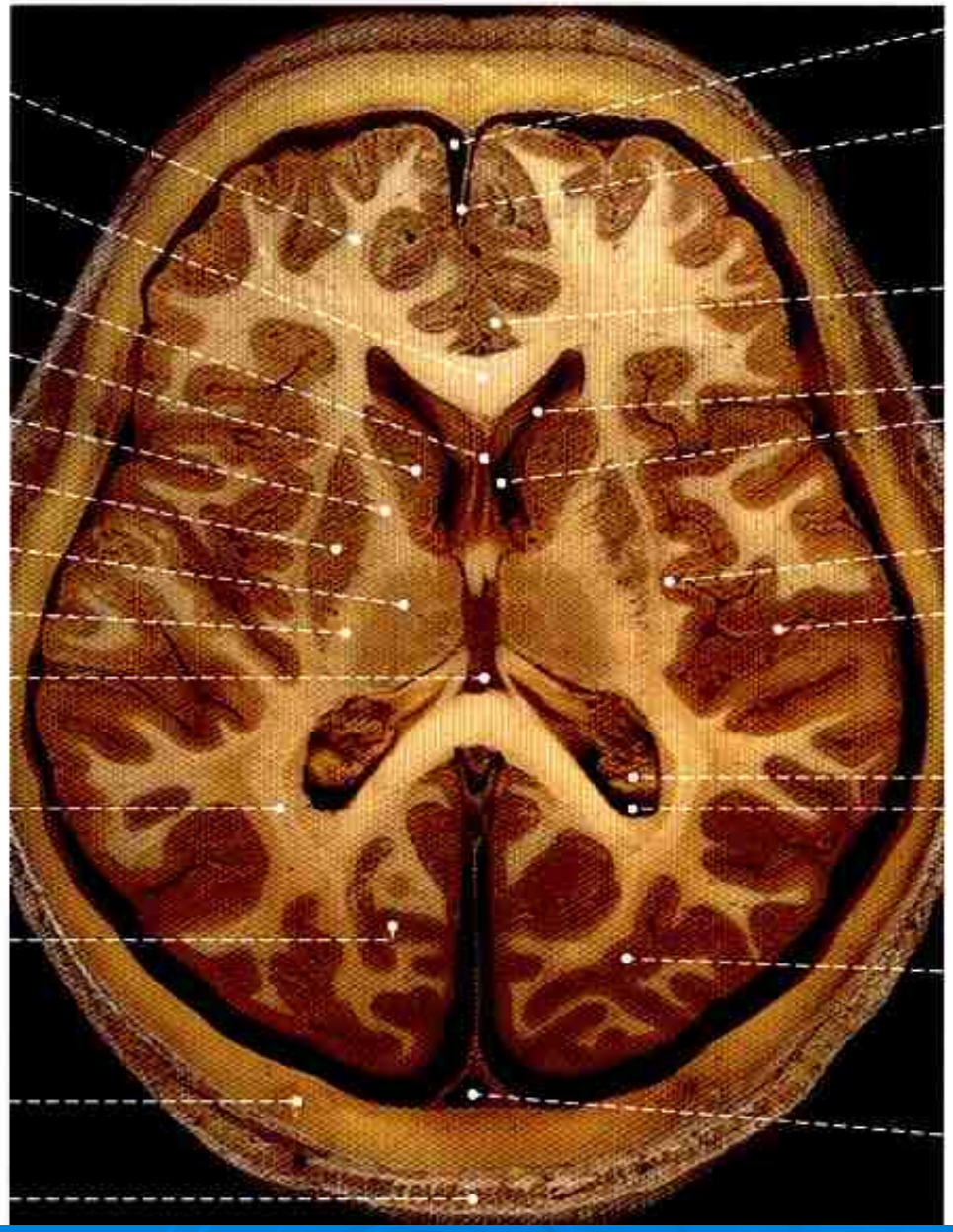
cortex. These fibers increase in number and finally form a massive bundle, the *internal capsule*, containing all the projection fibers


Truncus corporis callosi
Ventriculus lateralis
Cornu frontale [anterius]
Plexus choroideus
ventriculi lateralis
Stria terminalis,
V. thalamostriata superior
Plexus choroideus
ventriculi tertii
Commissura anterior
Ventriculus tertius
Lamina medullaris externa,
Lamina medullaris interna
Capsula interna
Capsula extrema,
Capsula externa
Lamina medullaris lateralis,
Lamina medullaris medialis
Fasciculus
mamillothalamicus
Capsula interna
Pars sublentiformis
Ventriculus lateralis
Cornu temporale [inferius]
Pes hippocampi
Tractus opticus
Pedunculus cerebri
N. oculomotorius (III),
Fossa interpeduncularis
N. trigeminus (V)
Pons
Sulcus basilaris
Corpus fornicis
Tela choroidea
ventriculi tertii
with/mit
Vv. internae cerebri
Thalamus
Nuclei anteriores
Corpus nuclei caudati
Connections between/
Verbindungen zwischen
Nucleus caudatus and/und
Putamen
Thalamus
– Nuclei dorsales et
ventrales
– Nuclei mediales
Sulcus circularis insulae
Claustrum
Putamen
Gyri breves insulae
Sulcus lateralis
Globus pallidus medialis,
Globus pallidus lateralis
Gyrus longus insulae
Sulcus circularis insulae
Thalamus
Nucleus reticularis
Nucleus subthalamicus
Cauda nuclei caudati
Corpus amygdaloideum
Substantia nigra
Corpus mamillare


Septum pellucidum
Truncus corporis callosi
Ventriculus lateralis
Pars centralis
Plexus choroideus ventriculi lateralis
Stria terminalis
Plexus choroideus
ventriculi tertii
Stria medullaris thalami
Ventriculus tertius
Lamnae medullares
externa et interna
Capsula interna
Capsula extrema,
Capsula externa
Commissura habenularum
Commissura epithalamica
Fasciculus thalamicus
Fasciculus lenticularis
Plexus choroideus
Alveus hippocampi
Ventriculus lateralis
Cornu temporale [inferius]
Fimbria hippocampi
Pedunculus cerebri
Aquaeductus mesencephali
[cerebri]
Fibrae dentatorubrales
Fibrae pontis transversae
N. facialis (VII),
N. intermedius,
N. vestibulocochlearis (VIII)
Plexus choroideus ventriculi quarti
N. glossopharyngeus (IX),
N. vagus (X),
N. accessorius (XI)
(Foramen caecum)
Fasciculus pyramidalis
Funiculus lateralis
Funiculus anterior
Fissura longitudinalis cerebralis
Indusium griseum
Corpus fornicis
Corpus nuclei caudati
Nuclei thalami
– Nuclei anteriores
– Nuclei mediales
– Nuclei dorsales
– Nucleus reticularis
– Nucleus centromedianus
– Nuclei ventrales
posteriores
Zona incerta
Putamen
Claustrum
Insula
Nucleus ruber,
Nucleus subthalamicus
Corpus geniculatum lateral
Cauda nuclei caudati
Hippocampus
Substantia grisea centralis
Substantia nigra
Gyrus hippocampi
Sulcus collateralis
Fissura horizontalis
Pedunculus cerebellaris medius
Flocculus
Nuclei pontis
Fibrae pontis longitudinales
(Cerebellopontine angle/
Kleinhirn-Brücken-Winkel)
Oliva
Fissura mediana anterior
Sulcus anterolateralis
Decussatio pyramidum


Polus frontalis
Gyrus frontalis superior
Radiatio corporis callosi
Forceps frontalis [minor]
Genu corporis callosi
Ventriculus lateralis
Cornu frontale [anterius]
Septum pellucidum
Crus anterius
capsulae internae
Claustrum
V. thalamostriata superior,
Tela choroidea
ventriculi tertii
Genu capsulae internae
Laminae medullares
lateralis et medialis
Thalamus
Capsula externa
Capsula extrema
Crus posterius
capsulae internae
Commissura habenularum
Alveus hippocampi
Ventriculus lateralis
Cornu occipitale
[posterius]
Eminentia collateralis
Radiatio optica
Polus occipitalis
Fissura longitudinalis
cerebralis
Gyrus frontalis medialis
Gyrus cinguli,
Sulcus cinguli
Gyrus frontalis medius
Caput nuclei caudati
Columna fornicis
Gyrus frontalis inferior
Putamen
Globi pallidi
medialis et lateralis
Gyrus praecentralis
Sulcus centralis
Gyrus postcentralis
Gyri insulae
Sulcus lateralis
Ventriculus tertius,
Adhaesio interthalamica
Gyrus temporalis superior
Trigonum habenulae,
Nuclei habenulae
Cauda nuclei caudati
Hippocampus
Plexus choroideus
ventriculi lateralis
Gyrus hippocampi
Corpus pineale,
Lamina tectalis
Vermis cerebelli
Sulcus calcarinus
Fissura longitudinalis
cerebralis

a



Lobus frontalis cerebri

Genu corporis callosi

Septum pellucidum

Caput nuclei caudati

Crus anterius capsulae internae

Putamen

Thalamus

Crus posterius capsulae internae

Ventriculus tertius

Radiatio optica

Sulcus calcarinus

Calvaria
Os occipitale

Galea aponeurotica

Fissura longitudinalis cerebralis

Falx cerebri

Gyrus cinguli

Ventriculus lateralis
– Cornu frontale [anterius]
– Pars centralis

Insula

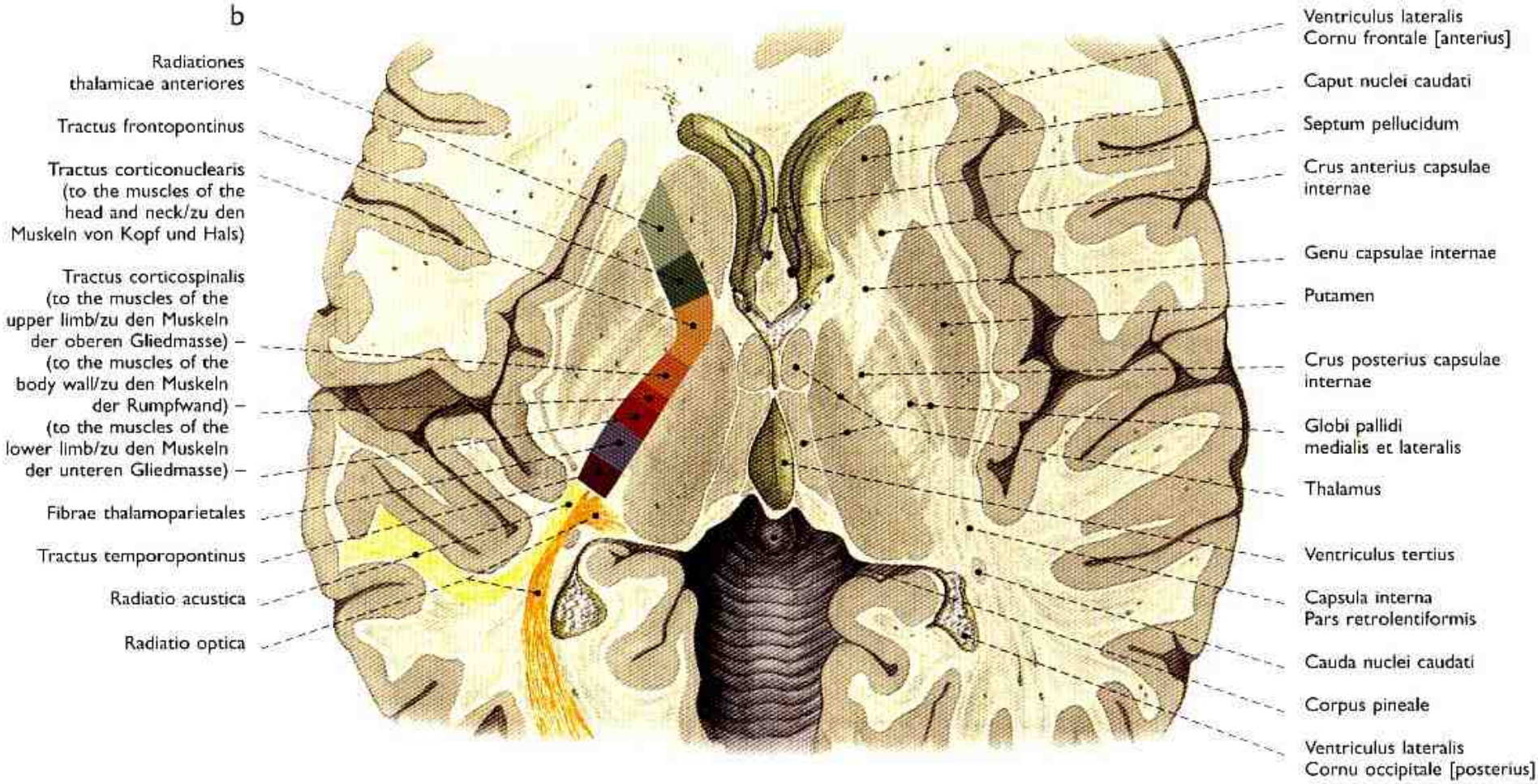
Sulcus lateralis

Ventriculus lateralis
– Plexus choroideus ventriculi latera
– Cornu occipitale [posterius]

Lobus occipitalis cerebri

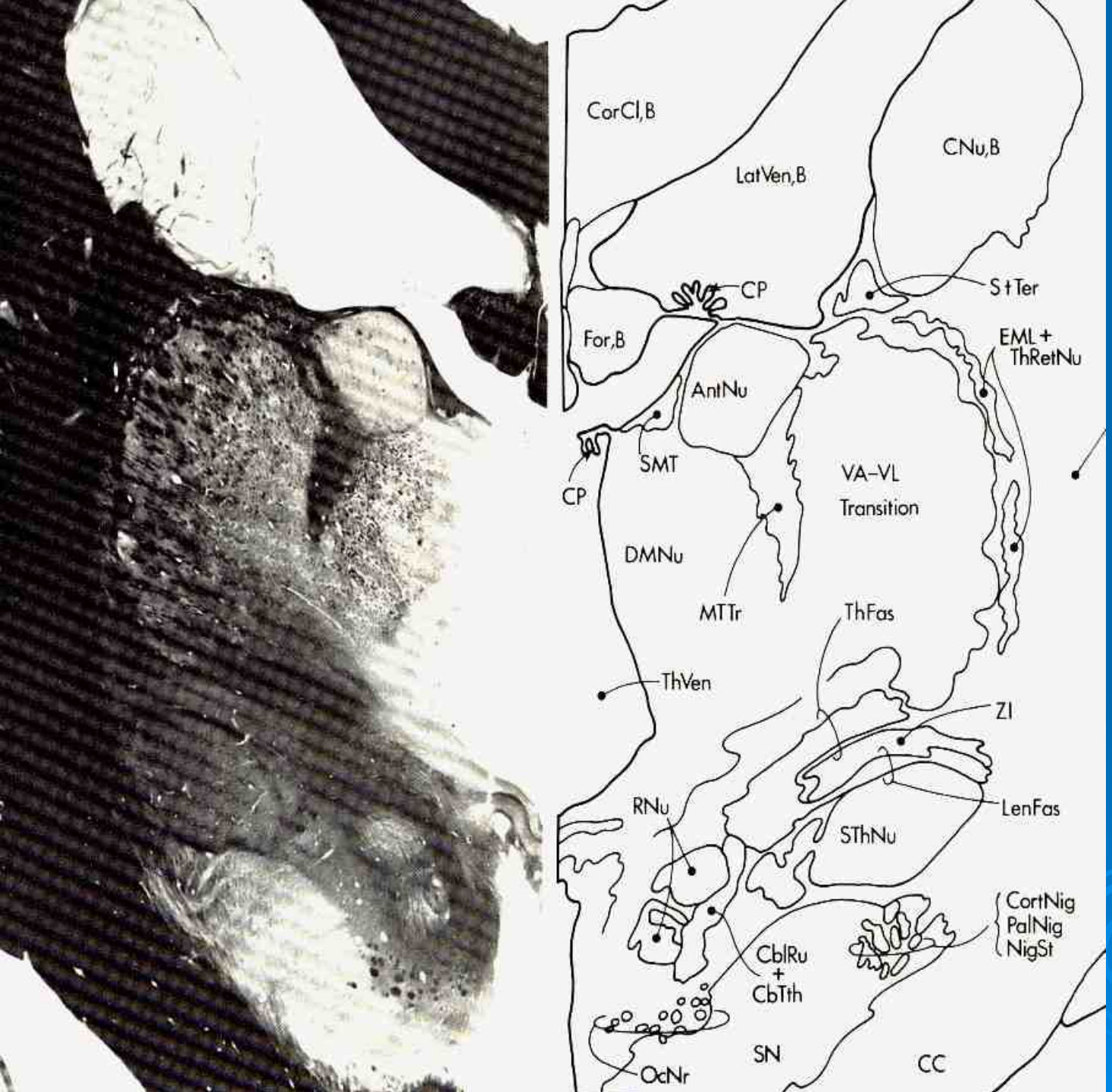
Sinus sagittalis superior

THALAMUS AND BASAL GANGLIA – *horizontal section*



THE THALAMUS - NUCLEI

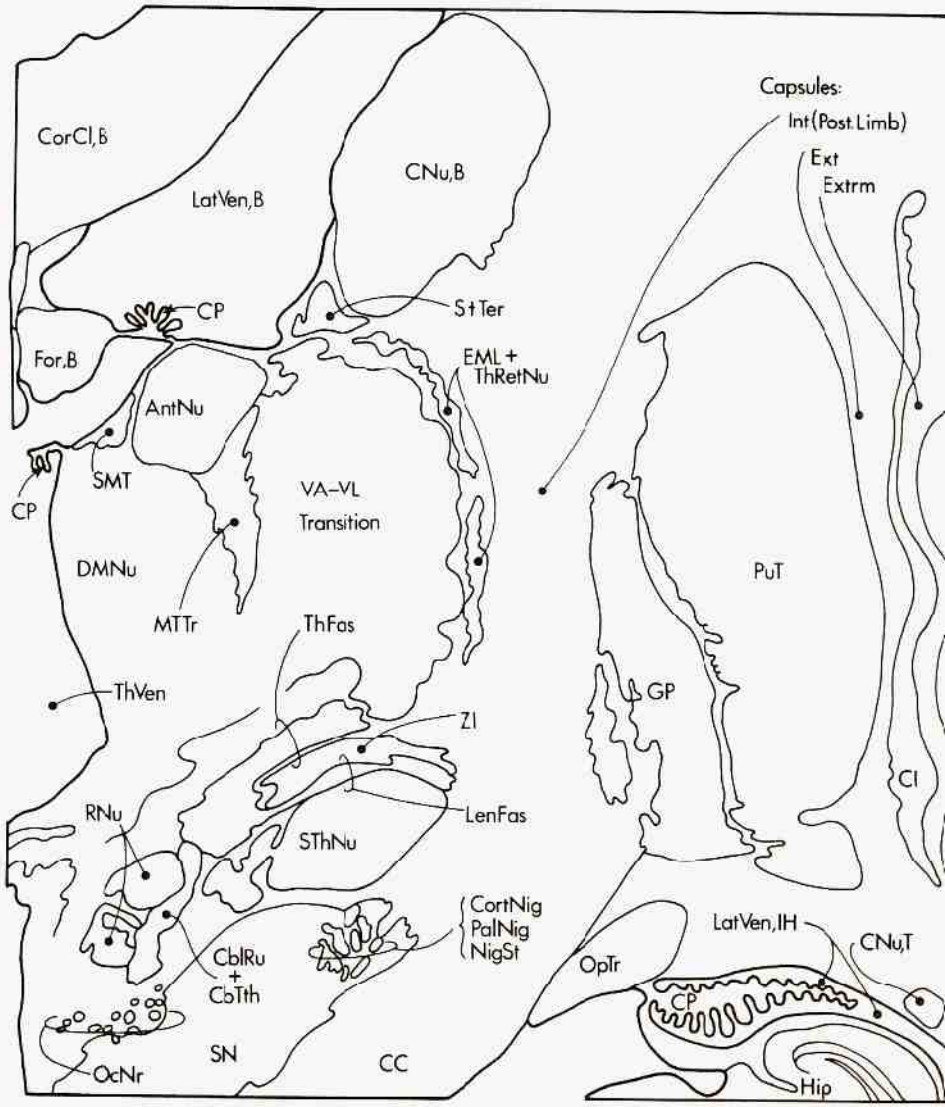
- Anterior nuclei
- Medial nuclei (mediodorsal nc.)
- Lateral nuclei – dorsal tier (lateral dorsal nc., lateral posterior nc.,posterior ncc.,(ncc. of pulvinar)
- **ventral tier** (ventral anterior – VA, ventral lateral – VL, ventral posterolateral- VPL, ventral posteromedial – VPM, ventral intermediate - VIM,
- Medial geniculate nc.,
- Lateral geniculate nc.,
- Intralaminar nuclei
- Midline nuclei
- Reticular nucleus



SUBTHALAMUS

Zona incerta

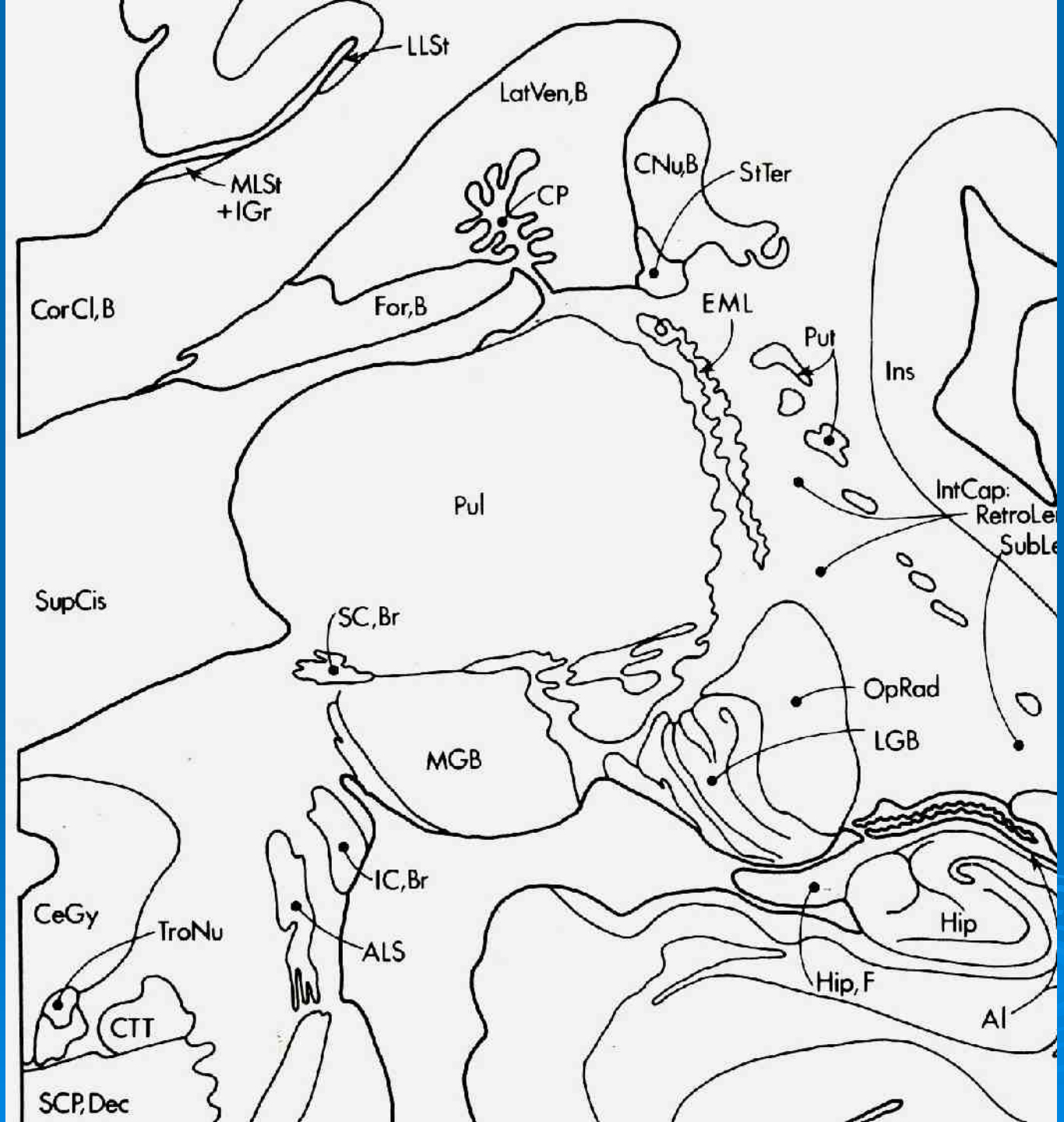
Subthalamic nc.

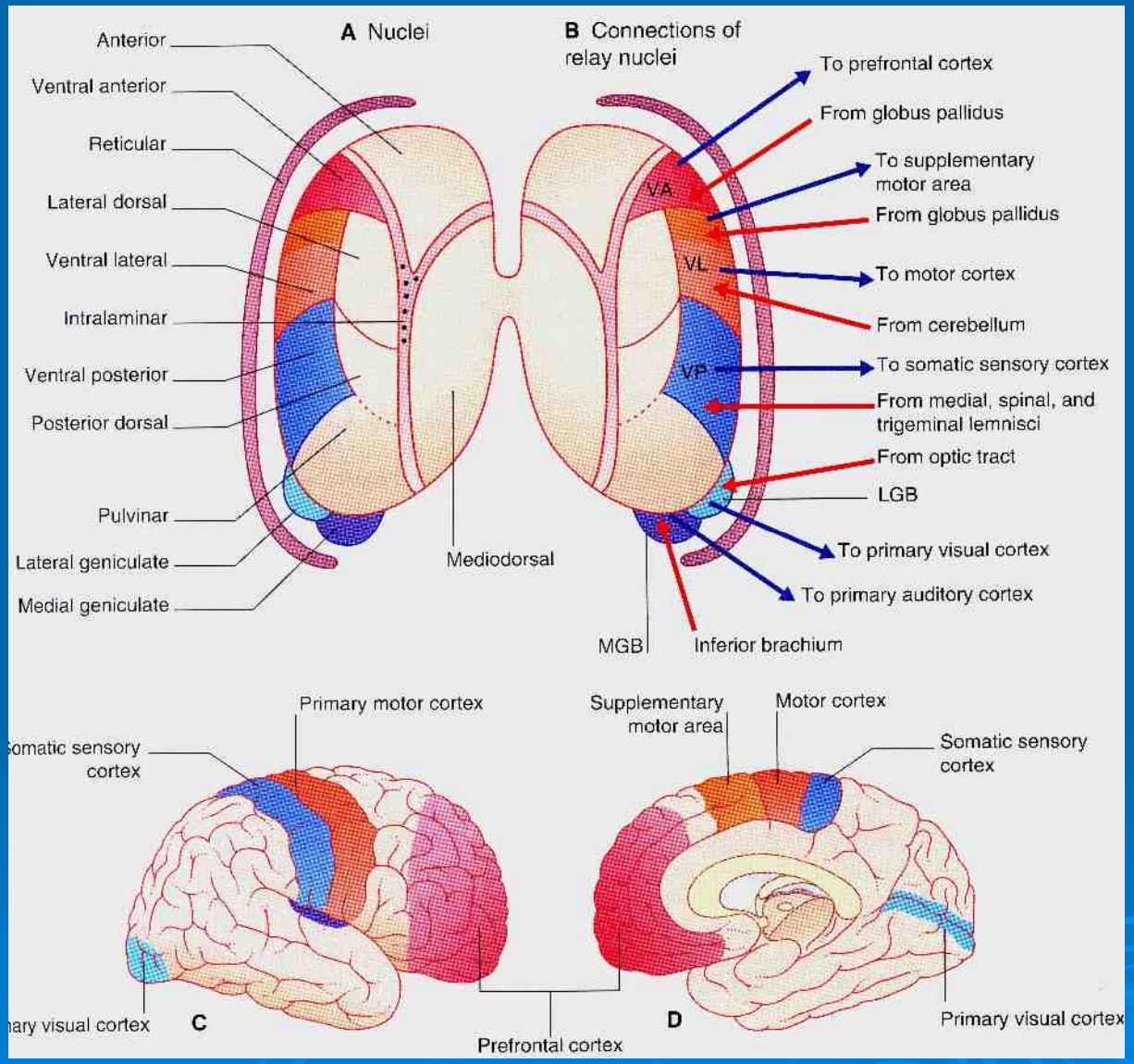

CorCl,B
LatVen,B
CNu,B
CP
St Ter
For.B
EML +
ThRetNu
AntNu
SMT
CP
VA–VL
Transition
DMNu
MTTr
ThFas
ThVen
ZI
RNu
LenFas
SThNu
CortNig
PalNig
NigSt
CblRu
+
CbTth
OcNr
SN
CC
Capsules:
Int (Post. Limb)
Ext
Extrm
PuT
GP
Cl
LatVen,IH
CNuT
OpTr
CP
Hip

PULVINAR – posterior nuclei

METATHALAMUS=

Medial and lateral geniculate bodies

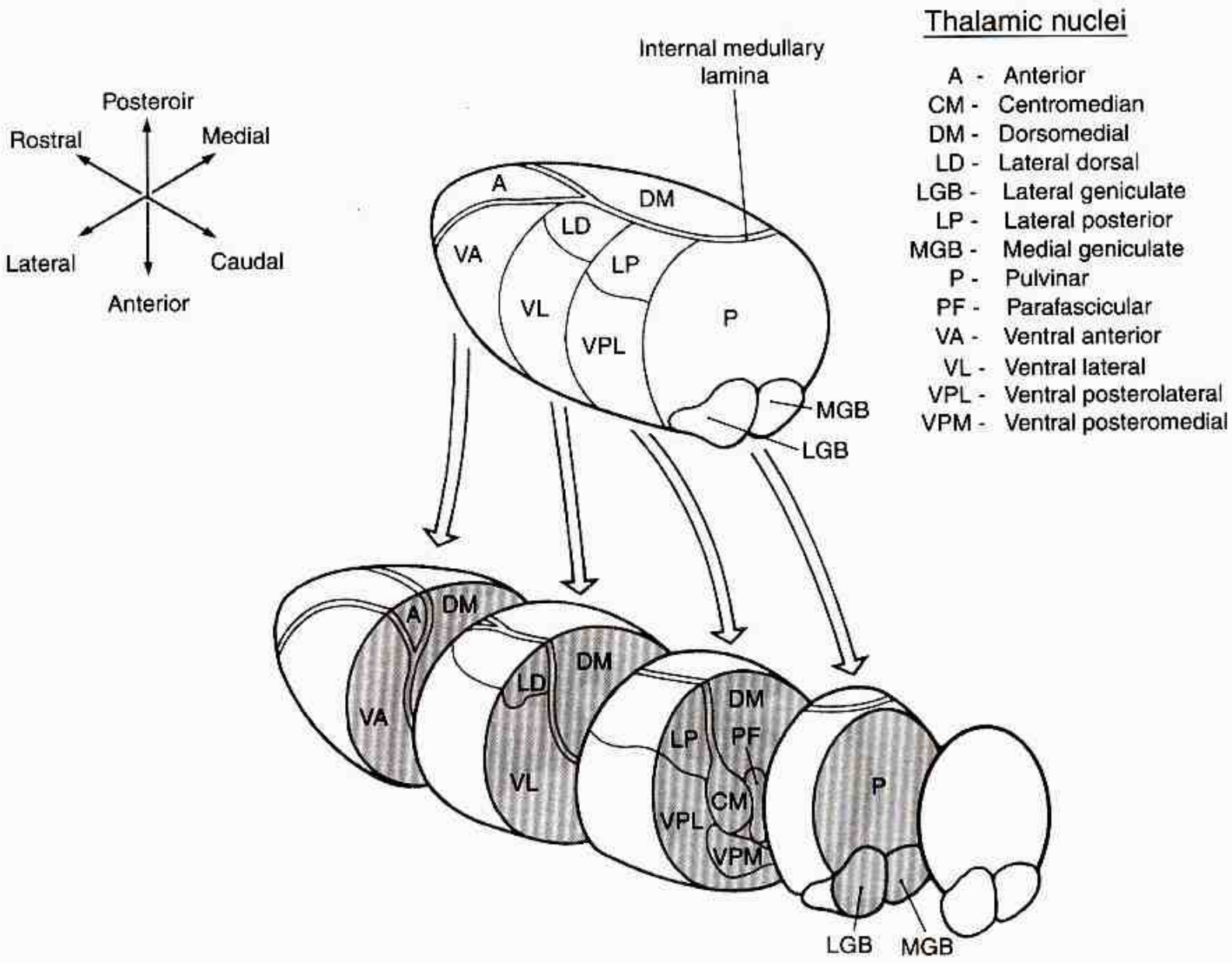

LLSt
LatVen,B
MLSt
+IGr
CP
CNu,B
StTer
CorCl,B
For,B
EML
Put
Ins
Pul
IntCap:
SupCis
SC,Br
OpRad
LGB
MGB
IC,Br
CeGy
TroNu
ALS
Hip
Hip,F
CTT
SCP,Dec


A Nuclei
B Connections of relay nuclei
Anterior
Ventral anterior
Reticular
Lateral dorsal
Ventral lateral
Intralaminar
Ventral posterior
Posterior dorsal
Pulvinar
Lateral geniculate
Medial geniculate
Mediodorsal
VA
VL
VP
MGB
To prefrontal cortex
From globus pallidus
To supplementary motor area
From globus pallidus
To motor cortex
From cerebellum
To somatic sensory cortex
From medial, spinal, and trigeminal lemnisci
From optic tract
LGB
To primary visual cortex
To primary auditory cortex
Inferior brachium
Primary motor cortex
Somatic sensory cortex
ary visual cortex
C
Prefrontal cortex
Supplementary motor area
Motor cortex
Somatic sensory cortex
D
Primary visual cortex

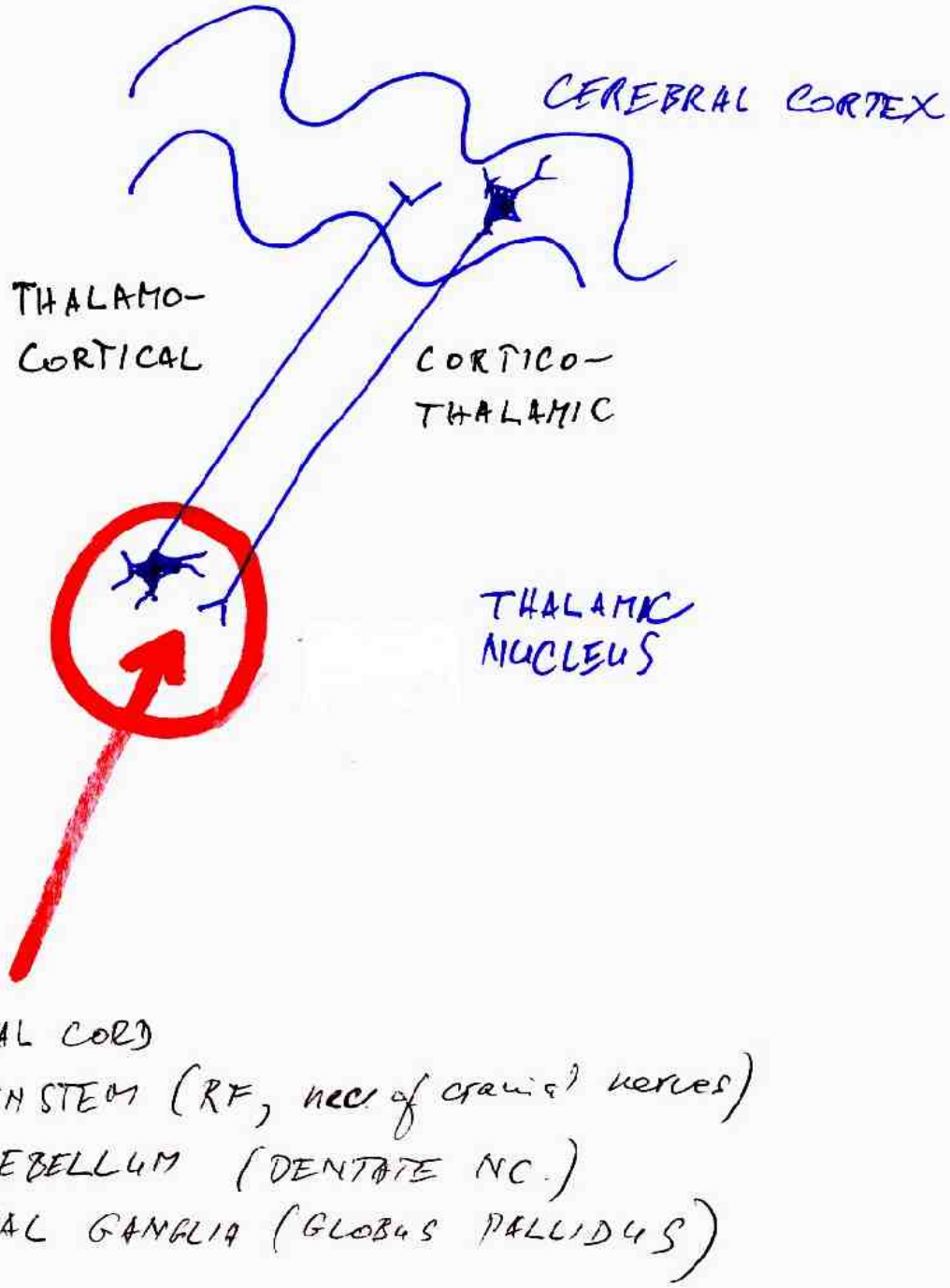
Parcellation of thalamic nuclei according Michigan ´s school

Table 16-1 Topographical Subdivisions of the Thalamus and Their Principal Nuclei

Subdivision	Principal nucleus or nuclei	Common abbreviation
Anterior division	Anterior	
Medial division	Dorsomedial	DM
Lateral division	Dorsal tier	
	Lateral dorsal	LD
	Lateral posterior	LP
	Pulvinar	
	Ventral tier	
	Ventral anterior	VA
	Ventral lateral	VL
	Ventral posterior	
	Ventral posterolateral	VPL
	Ventral posteromedial	VPM
	Medial geniculate	MGN
	Lateral geniculate	LGN
Intralaminar nuclei	Centromedian	CM
	Parafascicular	PF
	Others	
Reticular nucleus	Reticular nucleus	


Posteroir
Rostral
Medial
Lateral
Caudal
Anterior
Internal medullary lamina
A
DM
LD
VA
LP
VL
P
VPL
MGB
LGB
Thalamic nuclei
A - Anterior
CM - Centromedian
DM - Dorsomedial
LD - Lateral dorsal
LGB - Lateral geniculate
LP - Lateral posterior
MGB - Medial geniculate
P - Pulvinar
PF - Parafascicular
VA - Ventral anterior
VL - Ventral lateral
VPL - Ventral posterolateral
VPM - Ventral posteromedial
PF
CM
VPM

Neuronal connections of thalamic nuclei



Thalamic nuclei

- **Relay nuclei (relé jádra, přepojovací jádra)** – MGN, LGN, VPL, VPM, VL, VA
- Receives input predominantly from a single source
- Processed information is sent to a localized region of cortex
- Are modality specific
- Specific nuclei (after stimulation sharply localized cortical response)

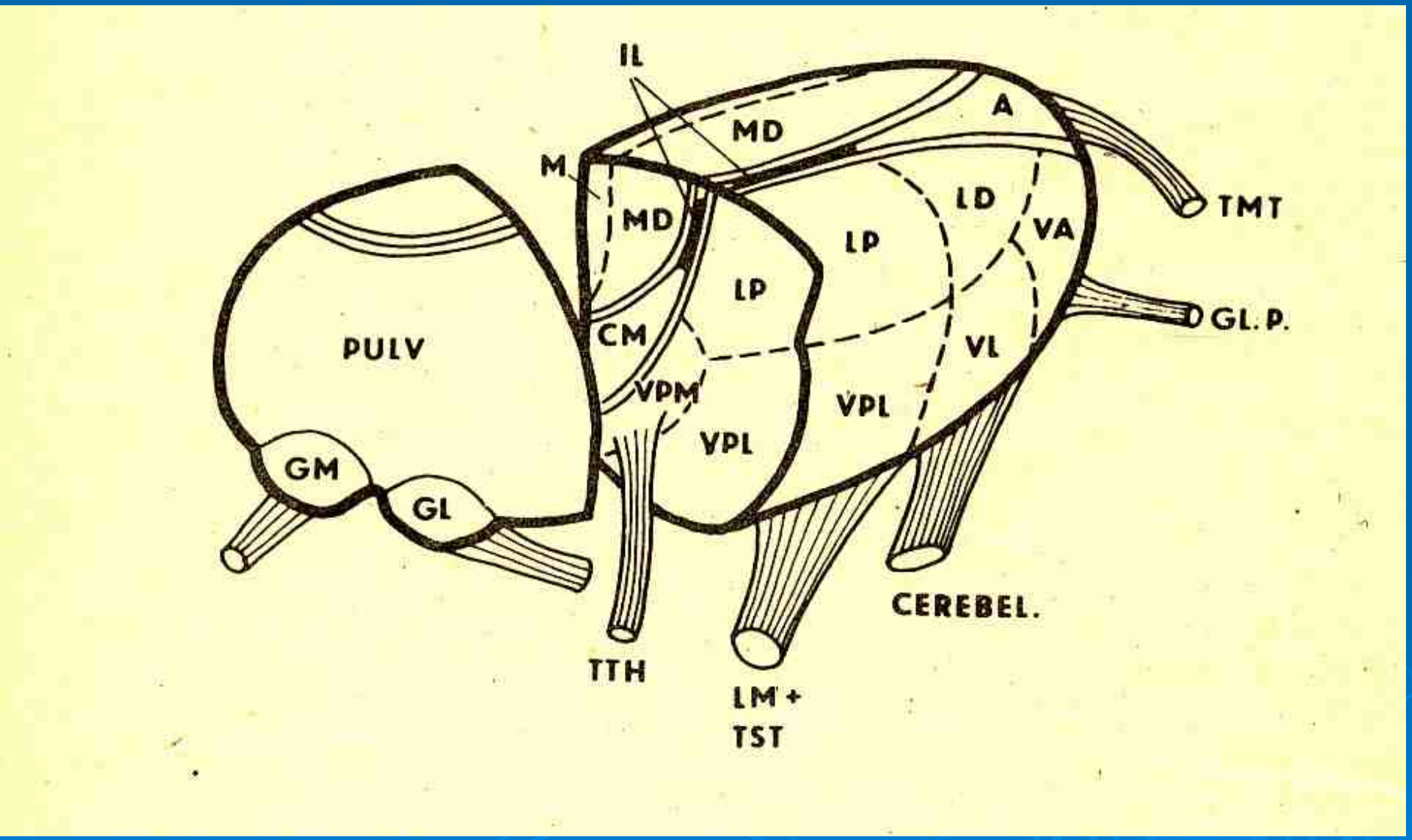
Association nuclei

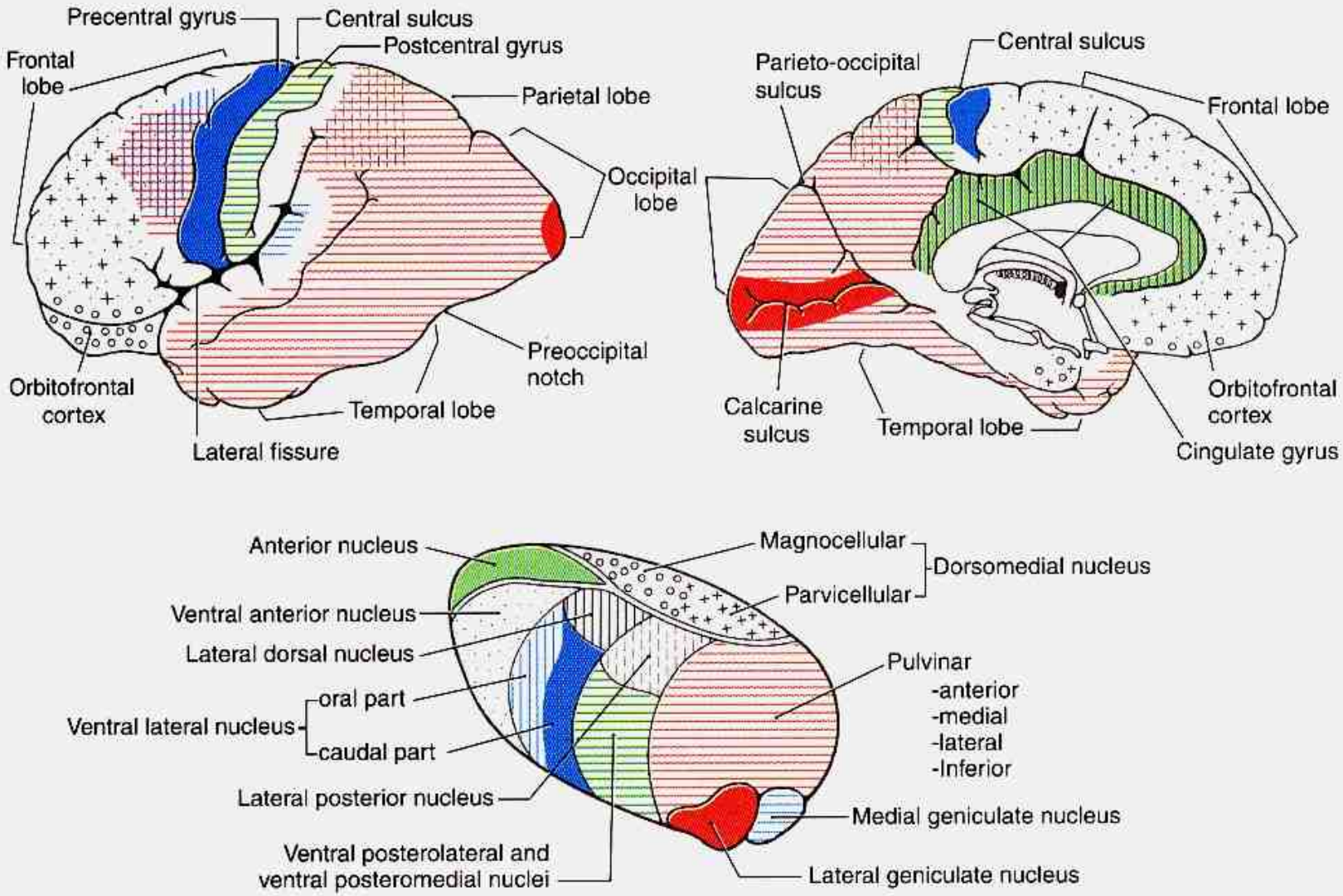
- MD, LD, LP, Posterior ncc.,
- Receives input from a number of structures or cortical areas
- Sends fibers to the association cortical areas
- Specific nuclei (after stimulation sharply localized response in the cortex)

Nonspecific nuclei

- Intralaminar nuclei (centromedian, parafascicular)
- **Afferents** - from RF, spinothalamic fibers, cerebellum, BG
- **Efferents** – extensive areas of the frontal and parietal lobes, basal ganglia (striatum)
- **Function** – influence levels of consciousness and degrees of alertness

Termination of subcortical projections in the thalamus





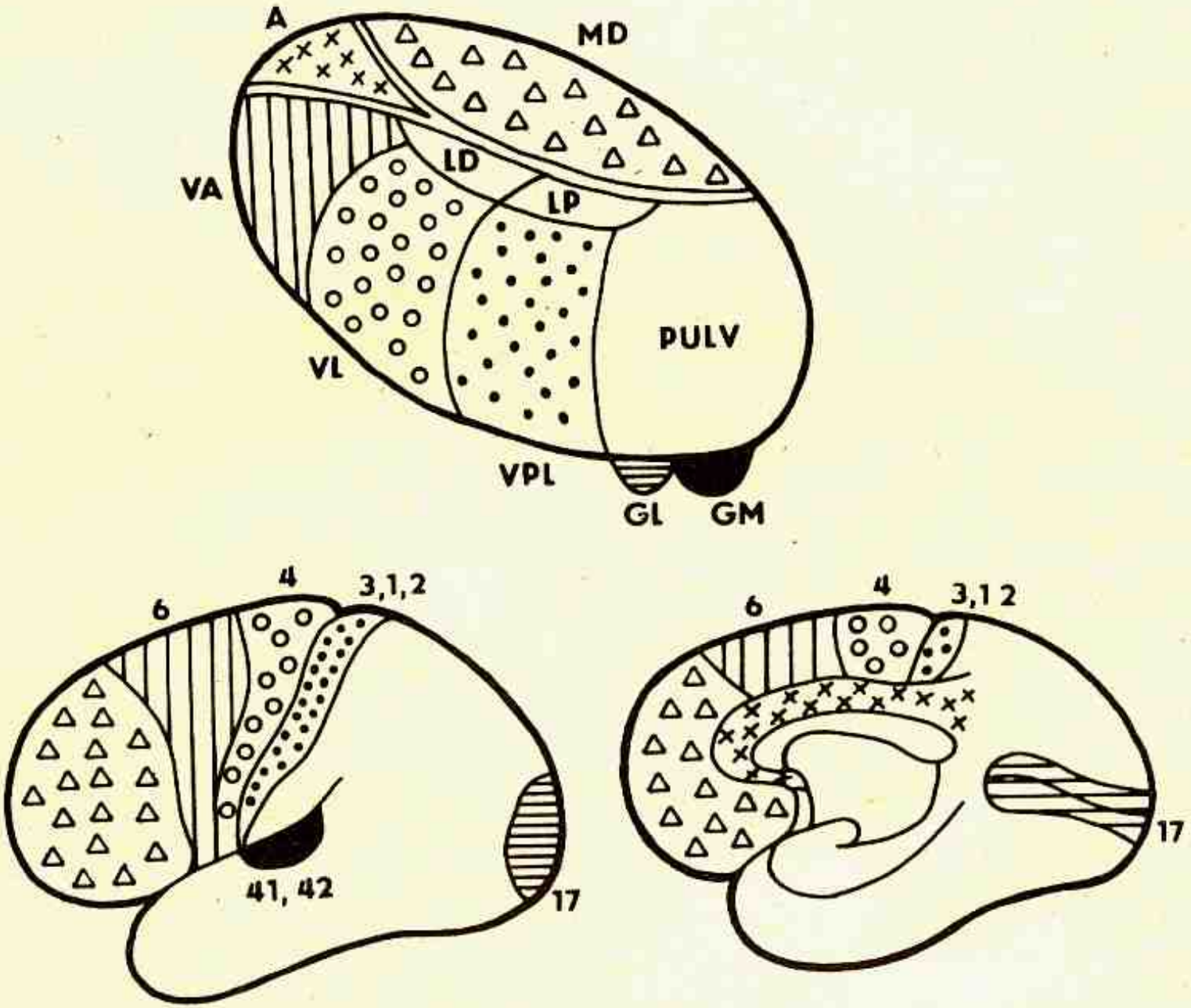
gure 15–10. Relationship of the thalamic nuclei with the cerebral cortex as depicted by the patterns of thalamocortical nnections. Each thalamic nucleus is pattern-coded or color-coded to match its target area in the cerebral cortex.

Table 16-2 Specific Inputs to and Cortical Outputs From Thalamic Relay and Association Nuclei

Type	Nucleus	Specific inputs	Cortical output
Relay	Anterior	Mammillothalamic tract, hippocampus	Cingulate gyrus
	Lateral dorsal (LD)	Hippocampus	Cingulate gyrus
	Ventral anterior, ventral lateral (VA/VL)*	Basal ganglia, cerebellum	Motor areas
	Ventral posterolateral (VPL)	Medial lemniscus (body), spinothalamic tract (body)	Somatosensory cortex
	Ventral posteromedial (VPM)	Medial lemniscus (face), spinothalamic tract (face)	Somatosensory cortex
		Central tegmental tract (taste)	Insula
	Medial geniculate (MGN)	Brachium of the inferior colliculus	Auditory cortex
	Lateral geniculate (LGN)	Optic tract	Visual cortex
Association	Dorsomedial† (DM)	Prefrontal cortex, olfactory and limbic structures	Prefrontal cortex
	Lateral posterior (LP)	Parietal lobe	Parietal lobe
	Pulvinar	Parietal, occipital, and temporal lobes	Parietal, occipital, and temporal lobes

*Basal ganglia outputs go mostly to VA and cerebellar outputs mostly to VL, but the two are considered together as a combined motor relay nucleus in this account.

†Also commonly referred to as the *mediodorsal nucleus (MD)*.


A
MD
LD
VA
LP
PULV
VL
VPL
GL
GM
6
4
3,1,2
41, 42
17
6
4
3,1 2
17

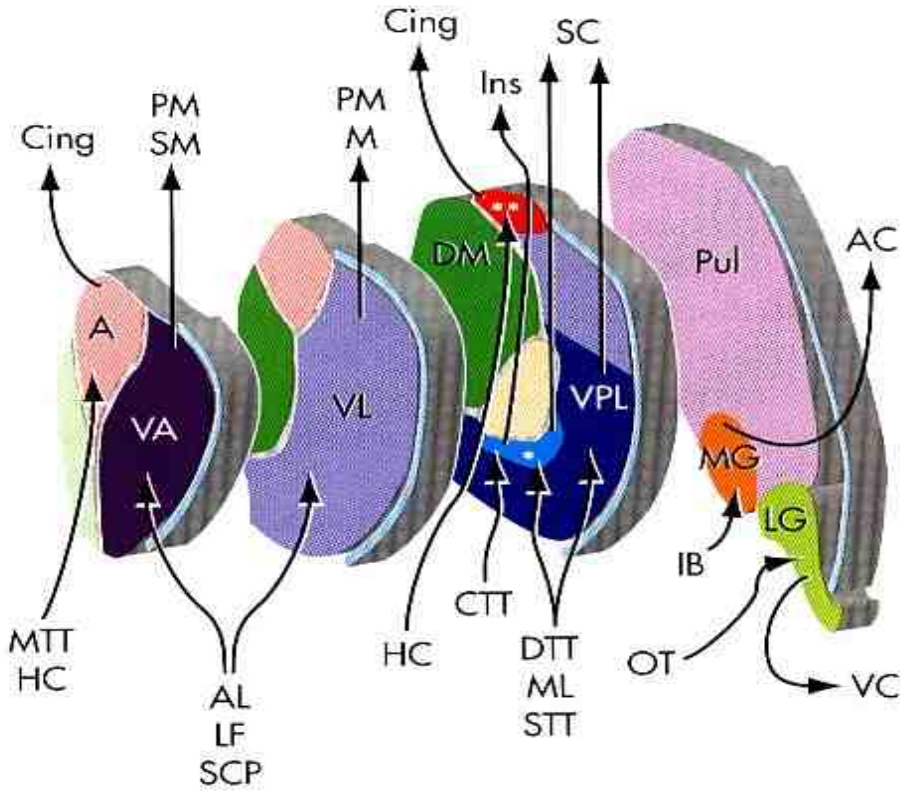


FIGURE 16-18

Major specific inputs to and outputs from relay nuclei. Thalamic nuclei: *, Ventral posteromedial nucleus; **, lateral dorsal nucleus; *A*, anterior nucleus; *DM*, dorsomedial nucleus; *LG*, lateral geniculate nucleus; *MG*, medial geniculate nucleus; *Pul*, pulvinar; *VA*, ventral anterior nucleus; *VL*, ventral lateral nucleus; *VPL*, ventral posterolateral nucleus. Input pathways and structures: *AL*, Ansa lenticularis (see Chapter 19); *CTT*, central tegmental tract; *IB*, brachium of the inferior colliculus; *DTT*, dorsal trigeminal tract; *HC*, hippocampus; *LF*, lenticular fasciculus (see Chapter 19); *ML*, medial lemniscus; *MTT*, mammillothalamic tract; *OT*, optic tract; *SCP*, superior cerebellar peduncle (see Chapter 20); *STT*, spinothalamic tract. Cortical destinations: *AC*, Auditory cortex; *Cing*, cingulate gyrus; *Ins*, insula; *M*, primary motor cortex (precentral gyrus); *PM*, premotor cortex (see Chapter 18); *SC*, somatosensory cortex; *SM*, supplementary motor area (see Chapter 18); *VC*, visual cortex.

Somatotopic organization of the VPL and VPM ncc. =

termination of the lemniscal systém and trigeminothalamic pathway

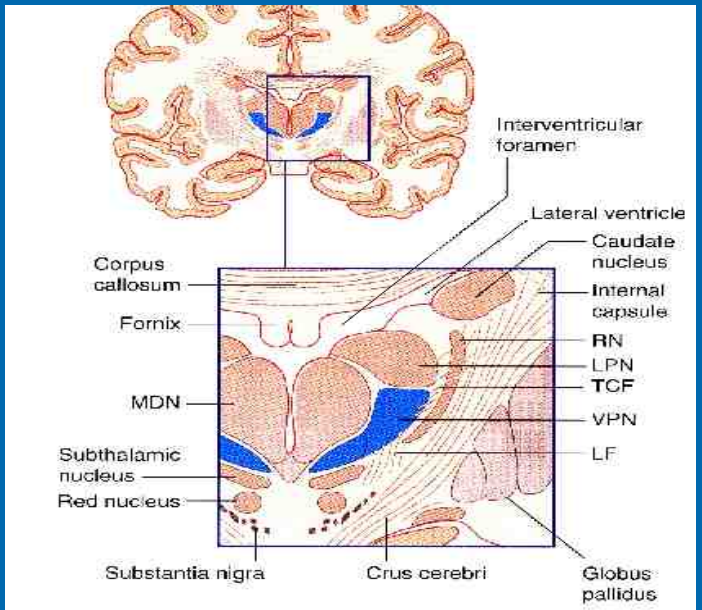
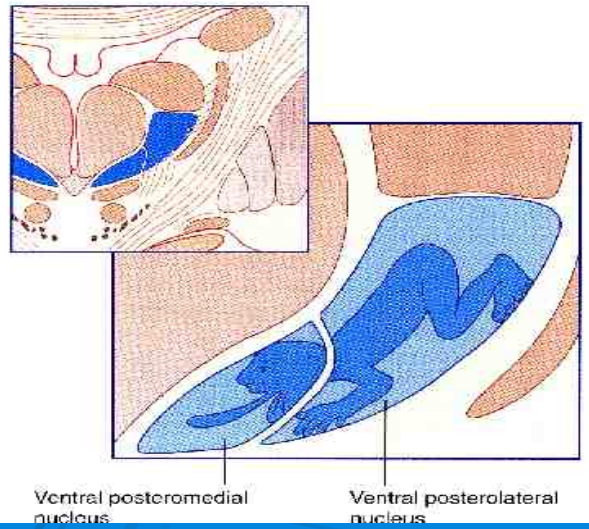
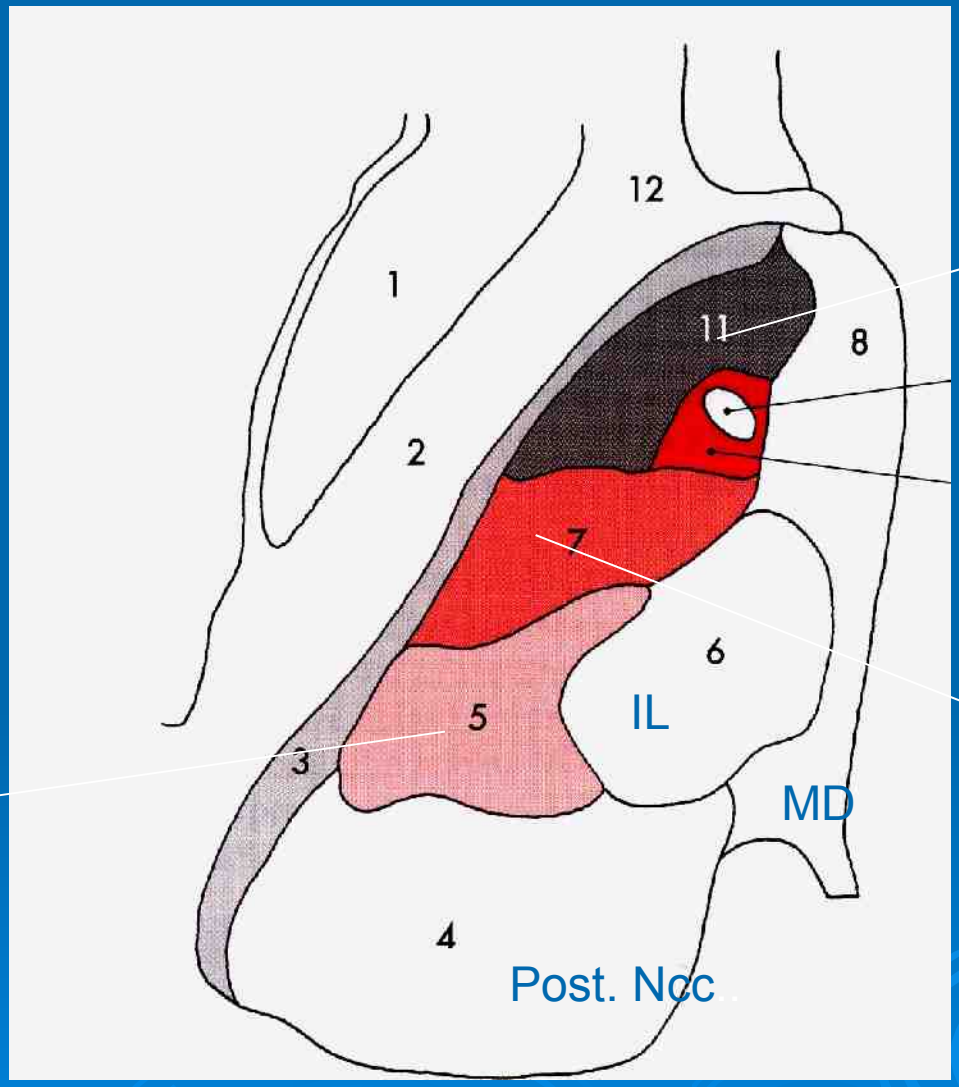


Figure 27.2 Coronal section through the thalamus and related structures. LF, lemniscal fibers; LPN, lateral posterior nucleus; MDN, mediodorsal nucleus; RN, reticular nucleus; TCF, thalamocortical fibers; VPN, ventral posterior nucleus.



Termination of subcortical fibers in the thalamus – horizontal section



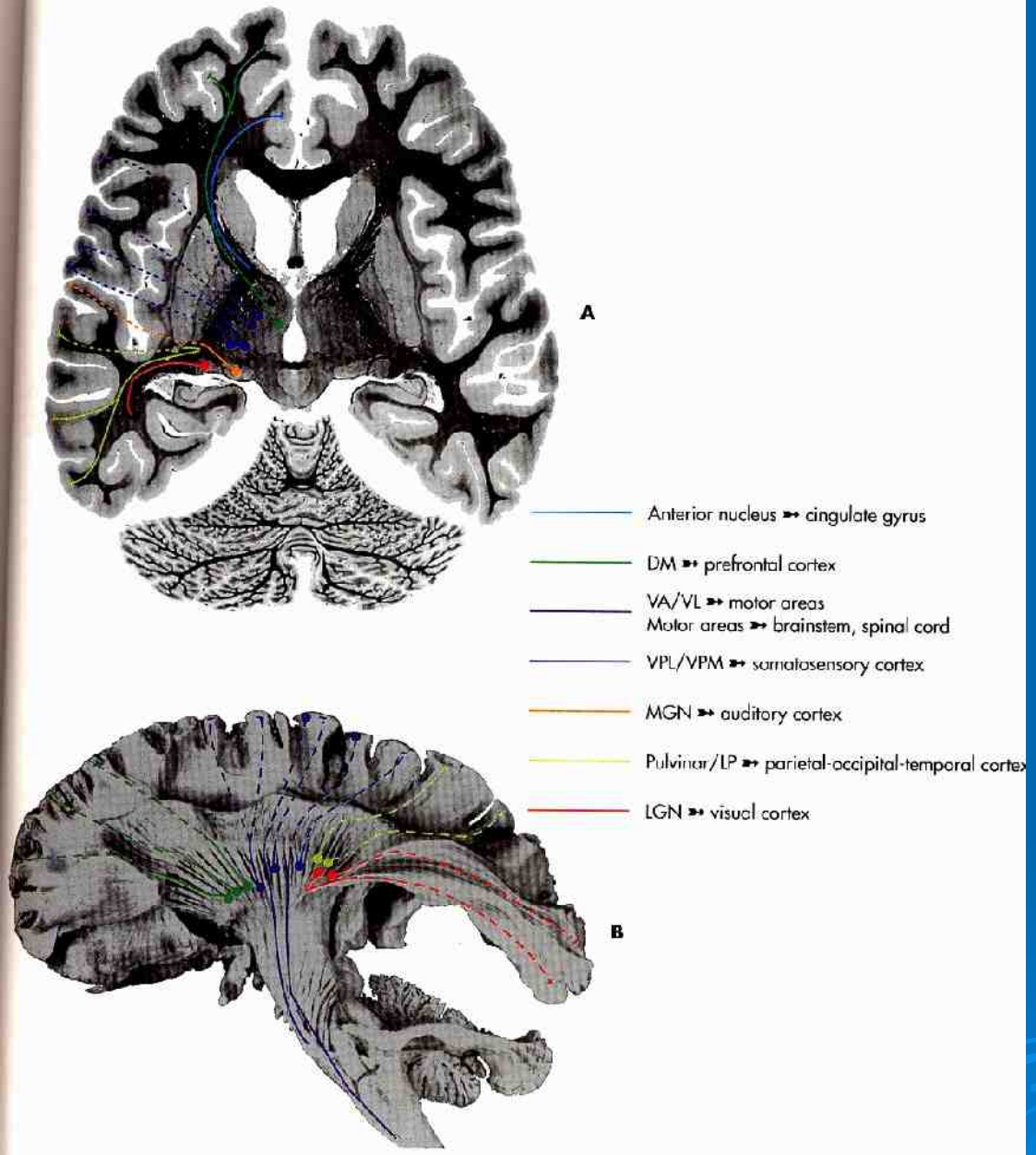
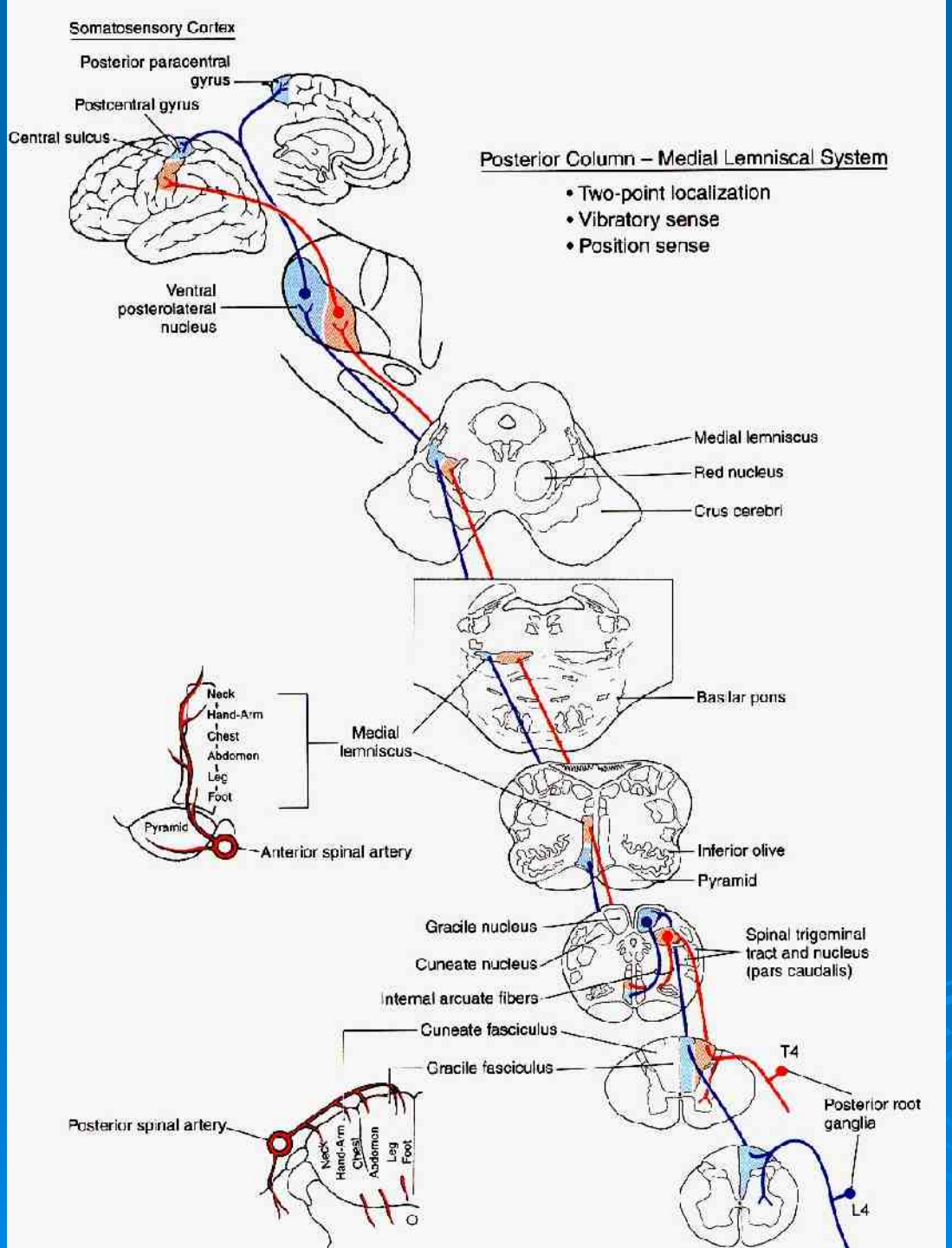
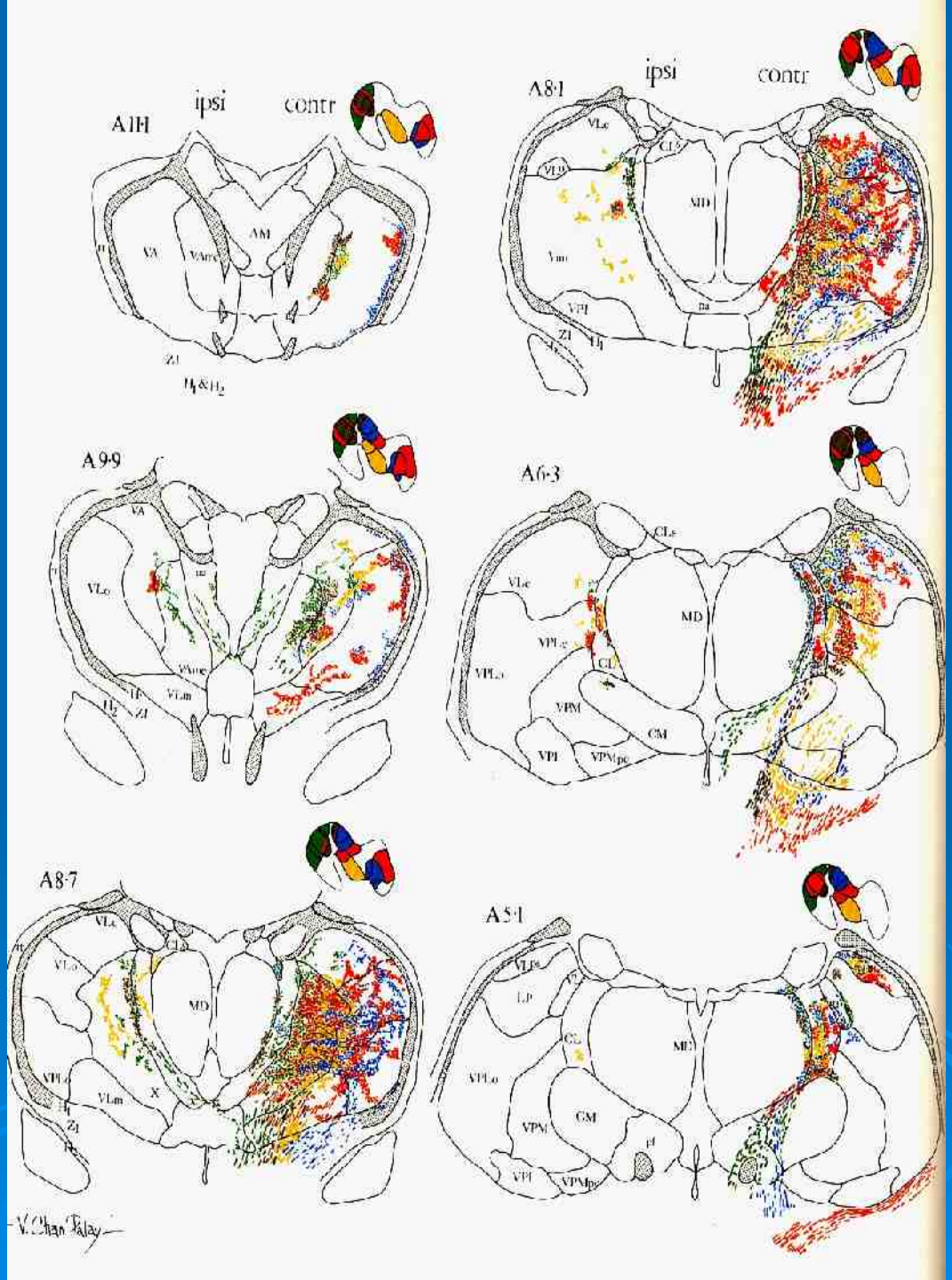


FIGURE 16-25

Principal components of the various parts of the internal capsule, as seen in a horizontal section (**A**) and in the dissection from Figure 16-24. The thalamic cell bodies indicated schematically in **B** would actually be on the other side of the internal capsule. Not all elements can be seen in both parts of the figure. For example, the anterior nucleus and the pulvinar are not present in the plane of section shown in **A**, so no cell bodies are indicated; neither cingulate nor auditory cortex is present in the dissection shown in **B**, so no projections to them are indicated. (**A** modified from Nolte J, Angevine JB Jr: *The human brain in photographs and diagrams*, ed 2, St. Louis, 2000, Mosby. **B** modified from Ludwig E, Klingler J: *Atlas cerebri humani*, Boston, 1956, Little, Brown.)


Somatosensory Cortex
Posterior paracentral gyrus
Postcentral gyrus
Central sulcus
Posterior Column – Medial Lemniscal System
• Two-point localization
• Vibratory sense
• Position sense
Ventral posterolateral nucleus
Medial lemniscus
Red nucleus
Crus cerebri
Basilar pons
Neck
Hand-Arm
Chest
Abdomen
Leg
Foot
Pyramid
Medial lemniscus
Anterior spinal artery
Inferior olive
Pyramid
Gracile nucleus
Cuneate nucleus
Internal arcuate fibers
Spinal trigeminal tract and nucleus (pars caudalis)
Cuneate fasciculus
Gracile fasciculus
T4
Posterior root ganglia
Posterior spinal artery
L4

Dentato-thalamic projection



EPITHALAMUS

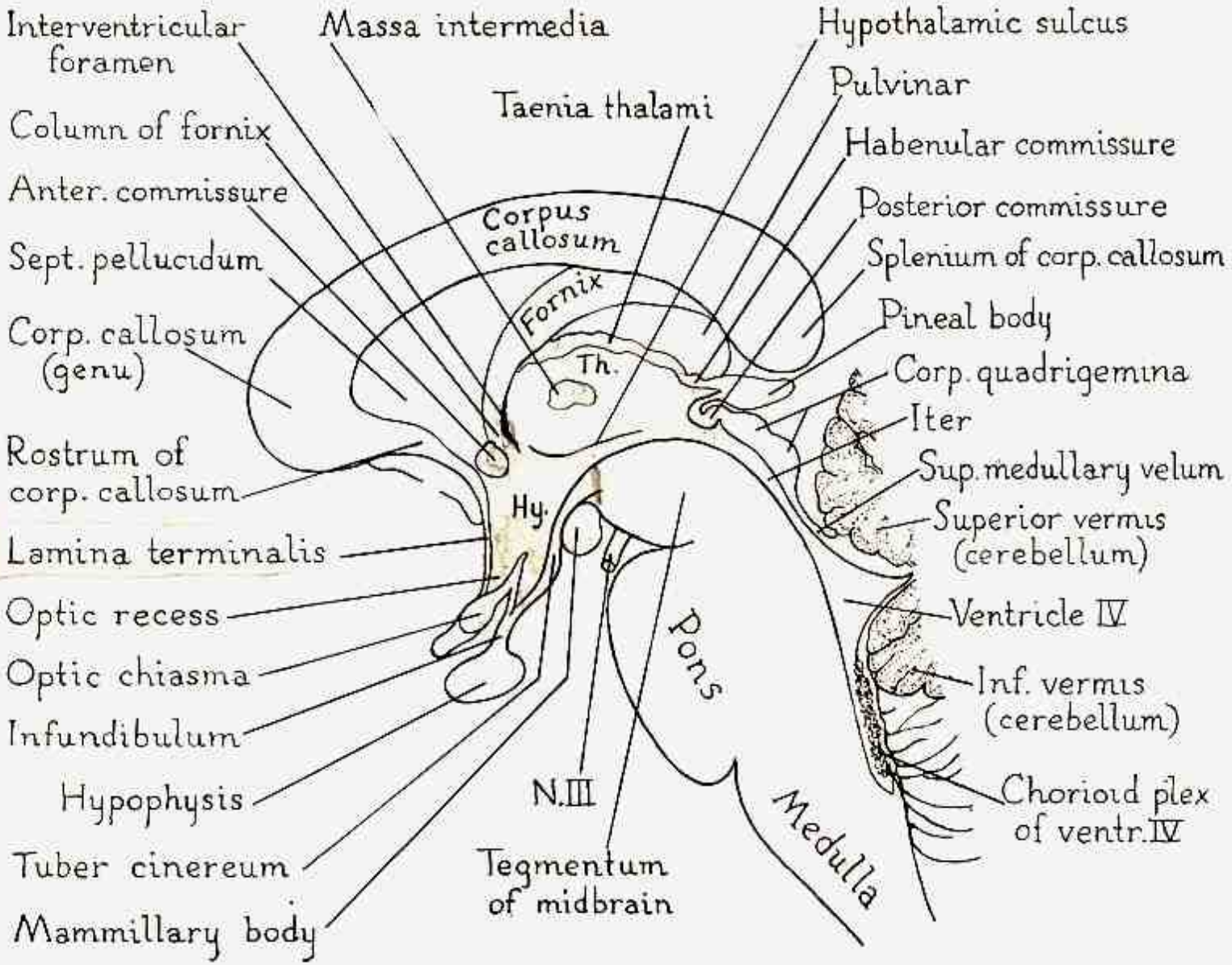


FIG. 262. Median sagittal section of brain stem. *Hy*, hypothalamus; *Th*, thalamus

EPITHALAMUS

- Habenular nuclei
- **Afferent fibers** – stria medullaris thalami (septum verum, olfactory cortex, hippocampus, hypothalamus, basal ganglia (globus pallidus)
- Efferent fibers – tractus habenulointerpeduncularis (RF, hypothalamus, ANS)
- Pineal gland- in amphibian and fishes contains light-sensitive cells. In mammals transformed to the endocrine gland
- Afferent fibers – superior cervical ganglion, hypothalamus, colliculus superior, LGB
- Pinealocytes produce serotonin – melatonin (night↑),
- Supresses development of gonads (pinealectomy stumulates growth of of the reproductive organs

SUBTHALAMUS – later, next week

HYPOTHALAMUS

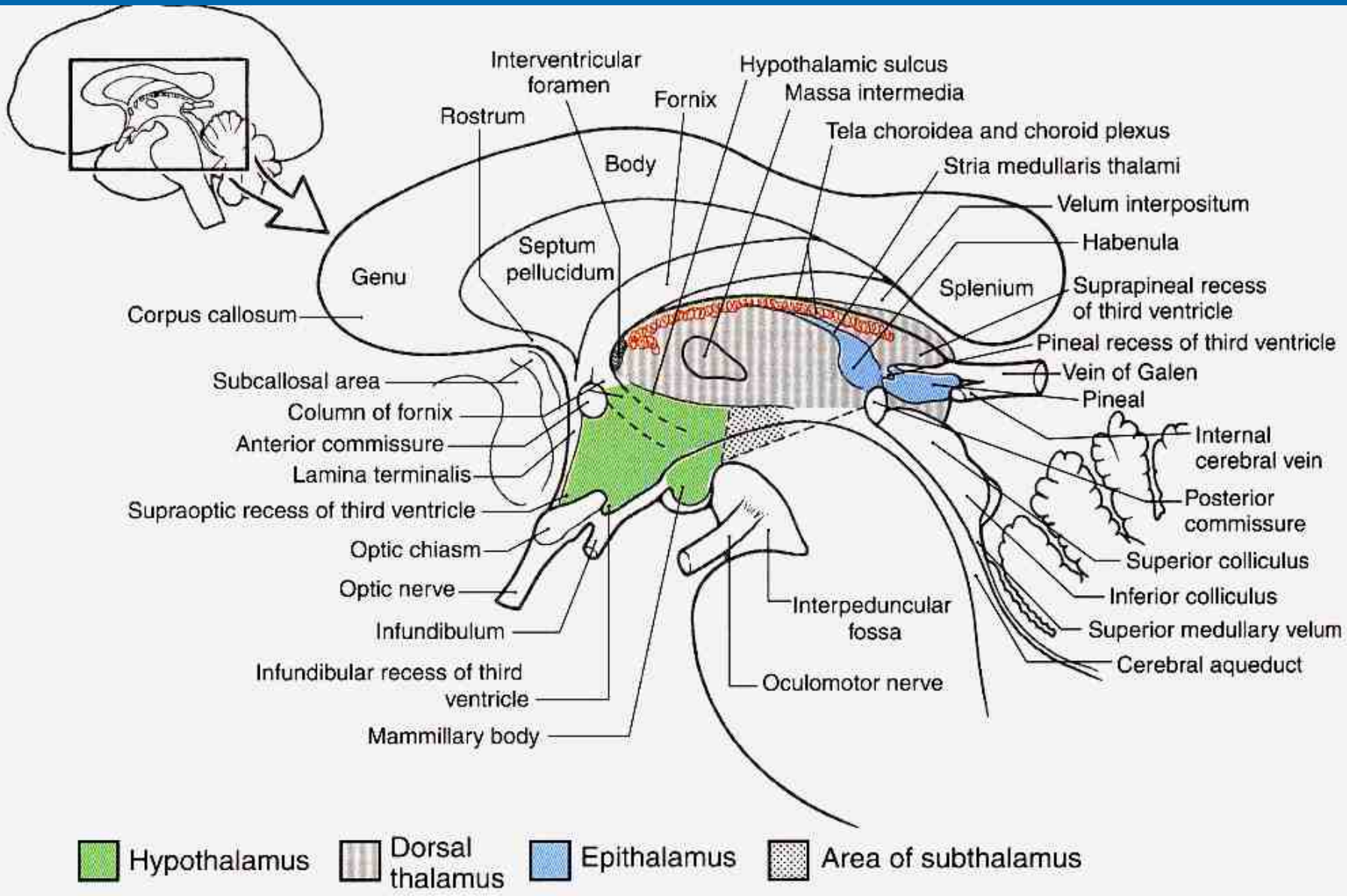


Figure 15–3. Mid-sagittal view of the diencephalon and closely related structures. This is a drawing of the specimen shown Figure 15–5.

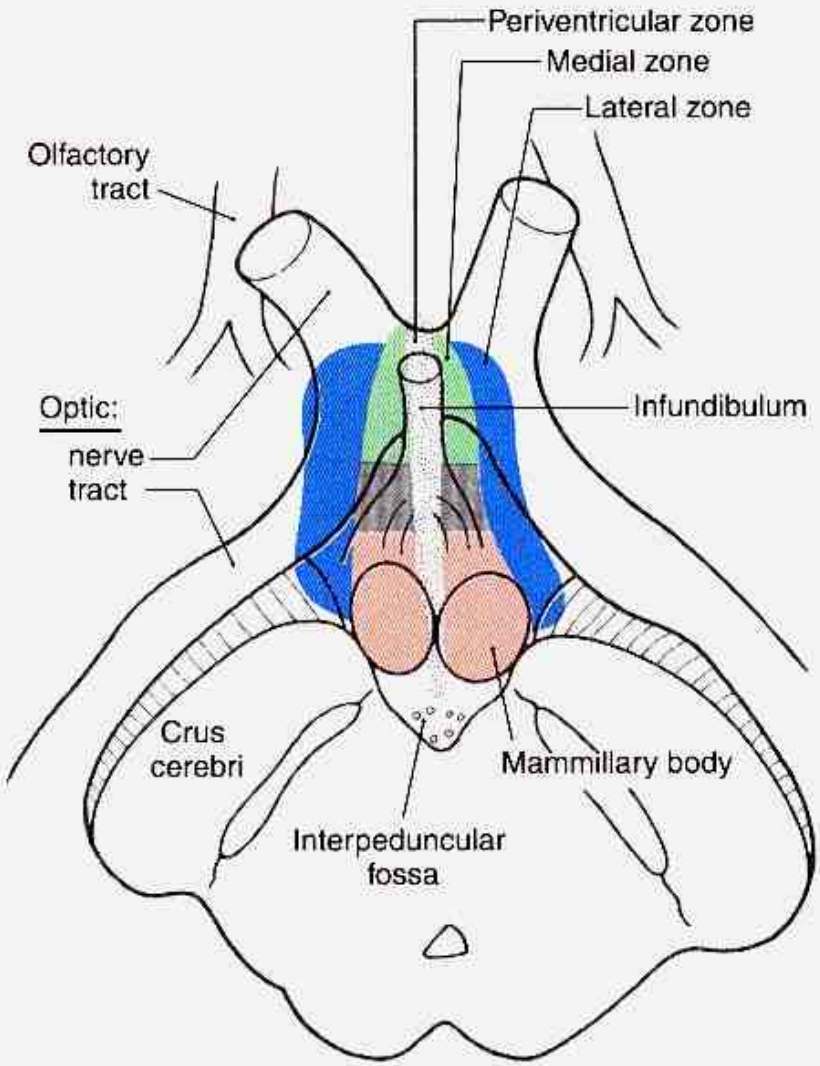
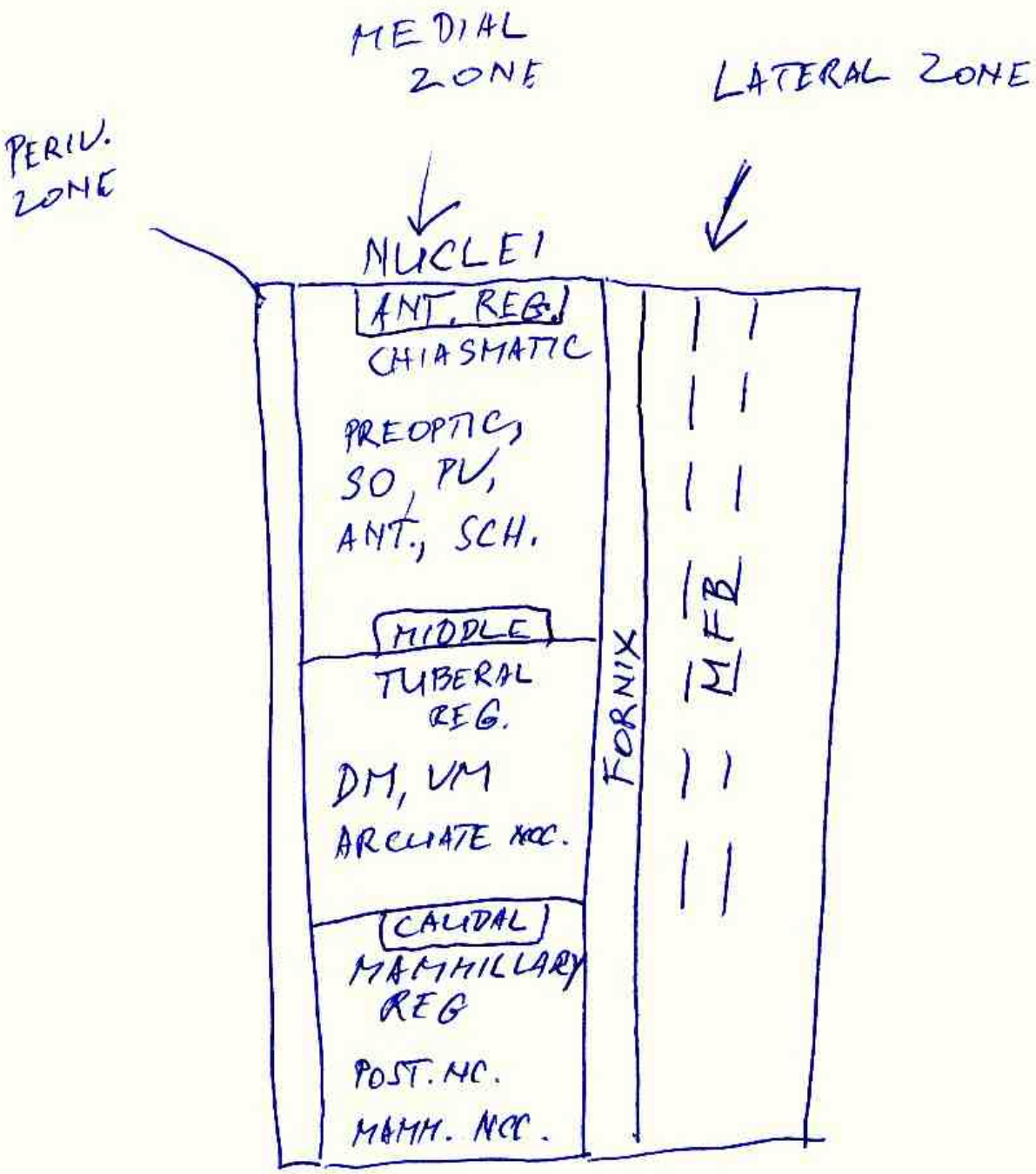


Figure 15–12. Anterior (ventral) view of the diencephalon illustrating the three zones of the hypothalamus as superimposed on external structures. The colors used for medial and lateral zones correlate with those in Figure 15–13.


MEDIAL ZONE
LATERAL ZONE
PERIV. ZONE
NUCLEI
ANT. REG.
CHIASMATIC
PREOPTIC, SO, PV, ANT., SCH.
MIDDLE
TUBERAL REG.
DM, VM
ARCUATE NCC.
CAUDAL
MAMMILLARY REG
POST. NC.
MAMM. NCC.
FORNIX
MFB

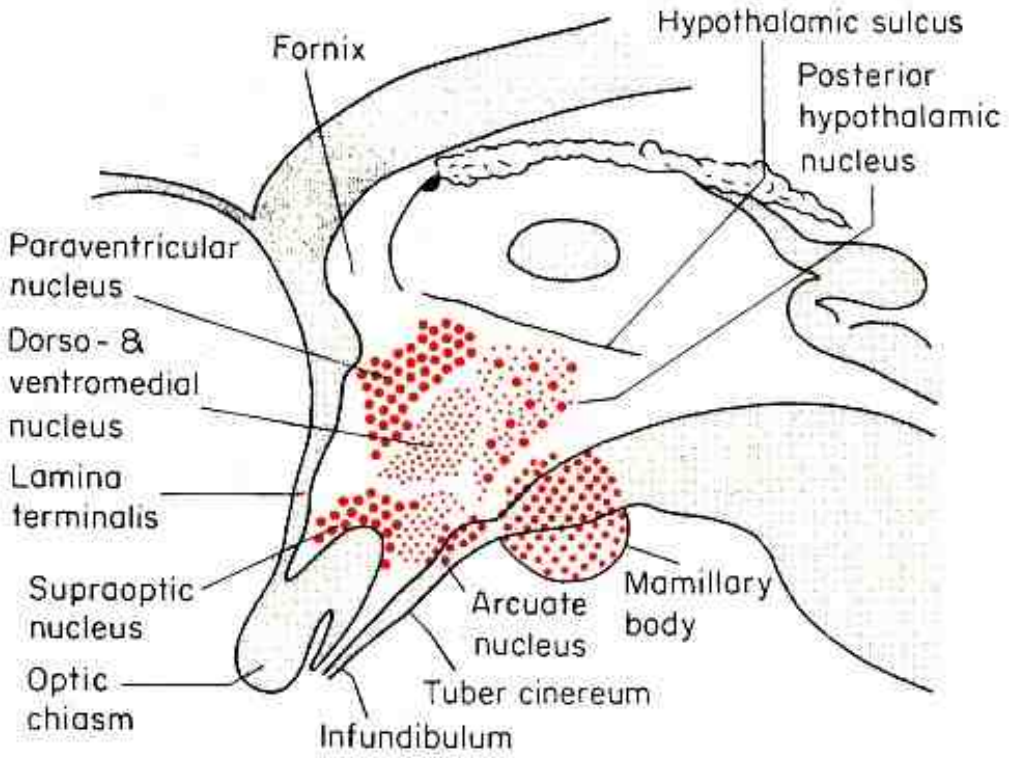
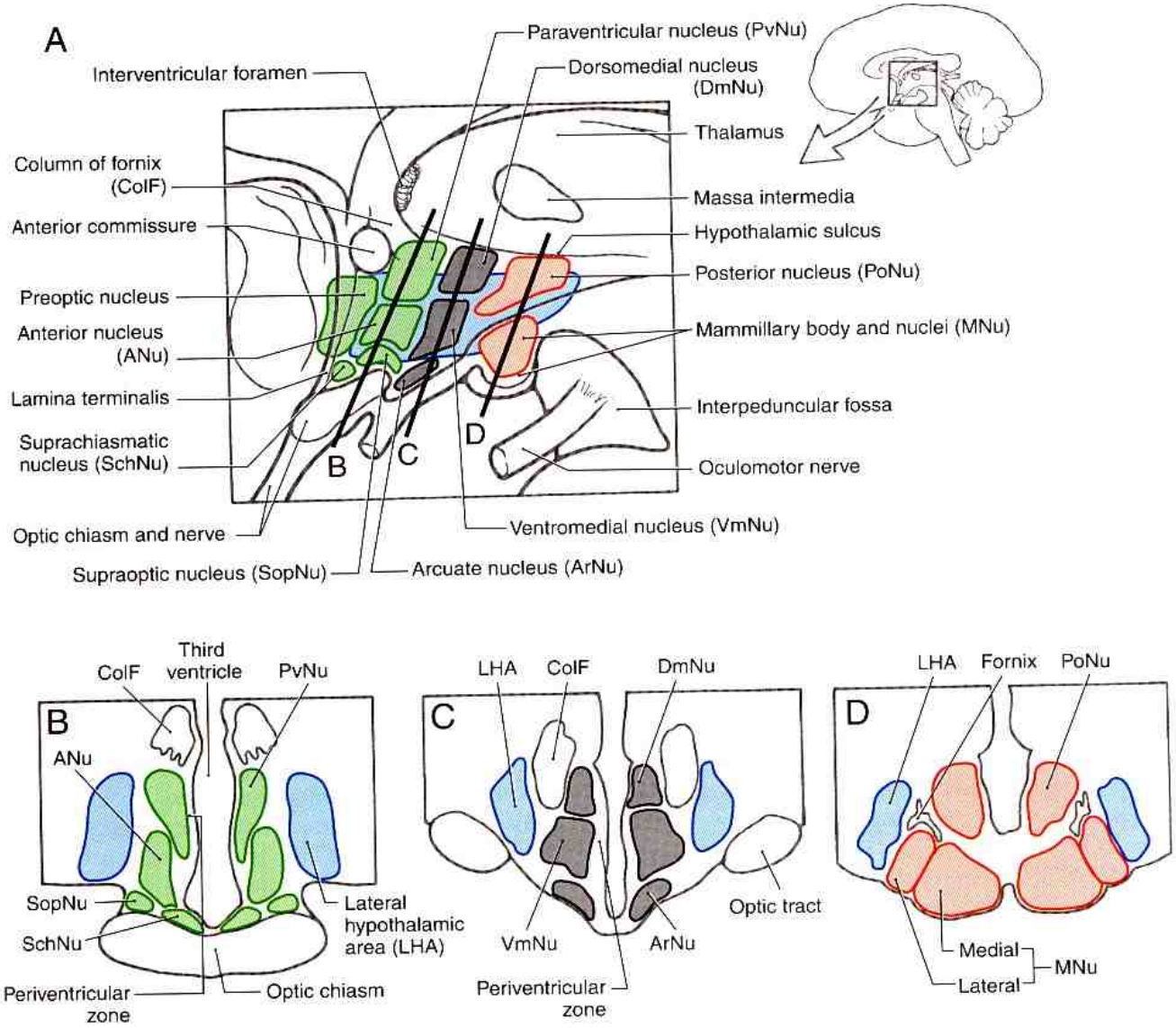


Fig. 15.1. *The hypothalamus.* Median section through the third ventricle. Some of the major hypothalamic nuclei are shown with red dots. The size of the dots indicates the relative size of the neurons of the various nuclei. Redrawn after Le Gros Clark et al. (1936).



igure 15–13. Mid-sagittal (*A*) and cross-sectional (*B–D*) views illustrating the nuclei of medial and lateral hypothalamic zones nd the nuclei associated with chiasmatic (*B*), tuberal (*C*), and mammillary (*D*) regions. The colors used here correlate with ose in Figure 15–12. (*A* adapted from Haymaker W, Anderson E, Nauta WJH: The Hypothalamus. Charles C Thomas, pringfield, Ill., 1969, with permission.)

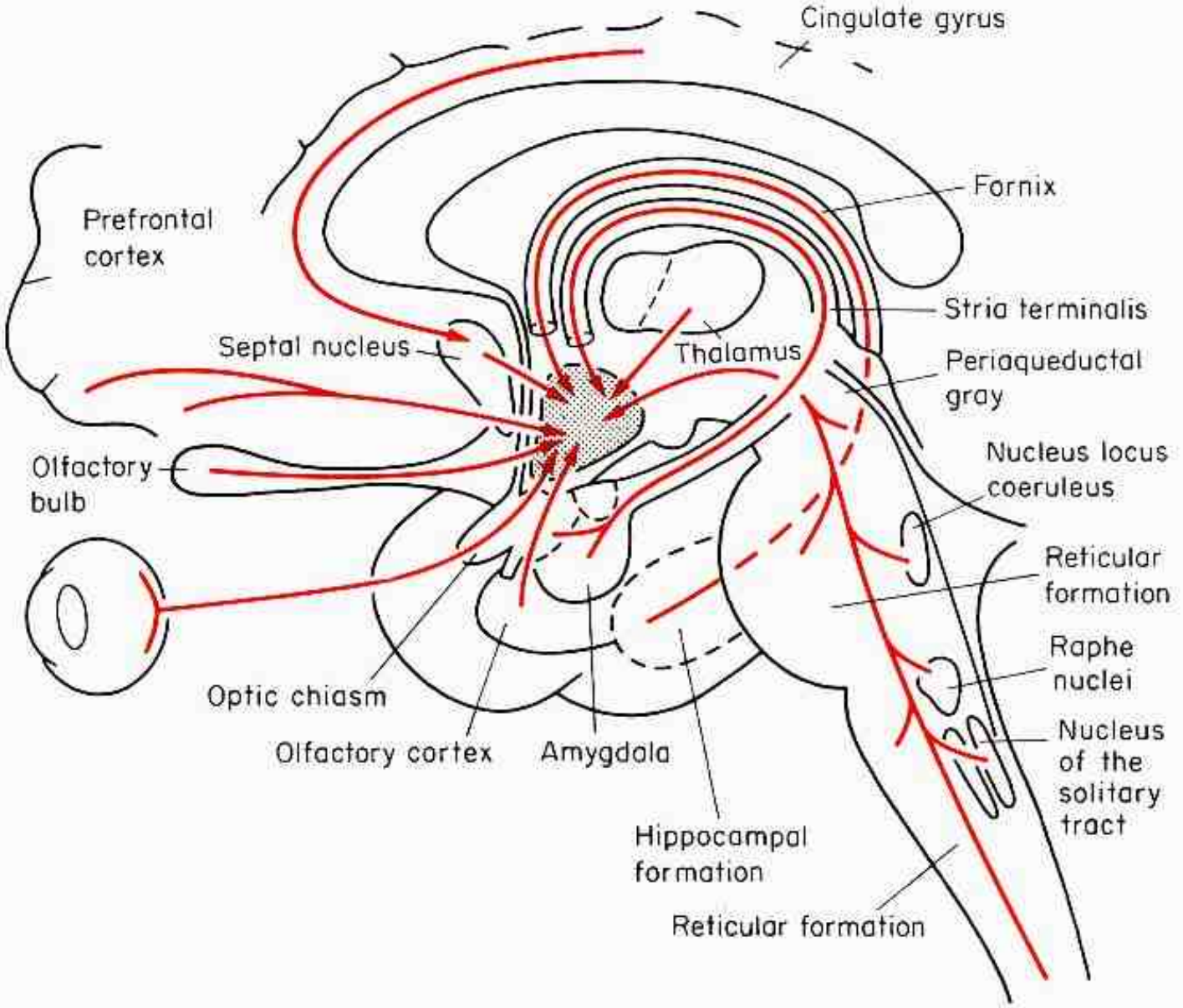


Fig. 15.2. *Main afferent connections of the hypothalamus.* Arrows indicate the direction of impulse conduction.

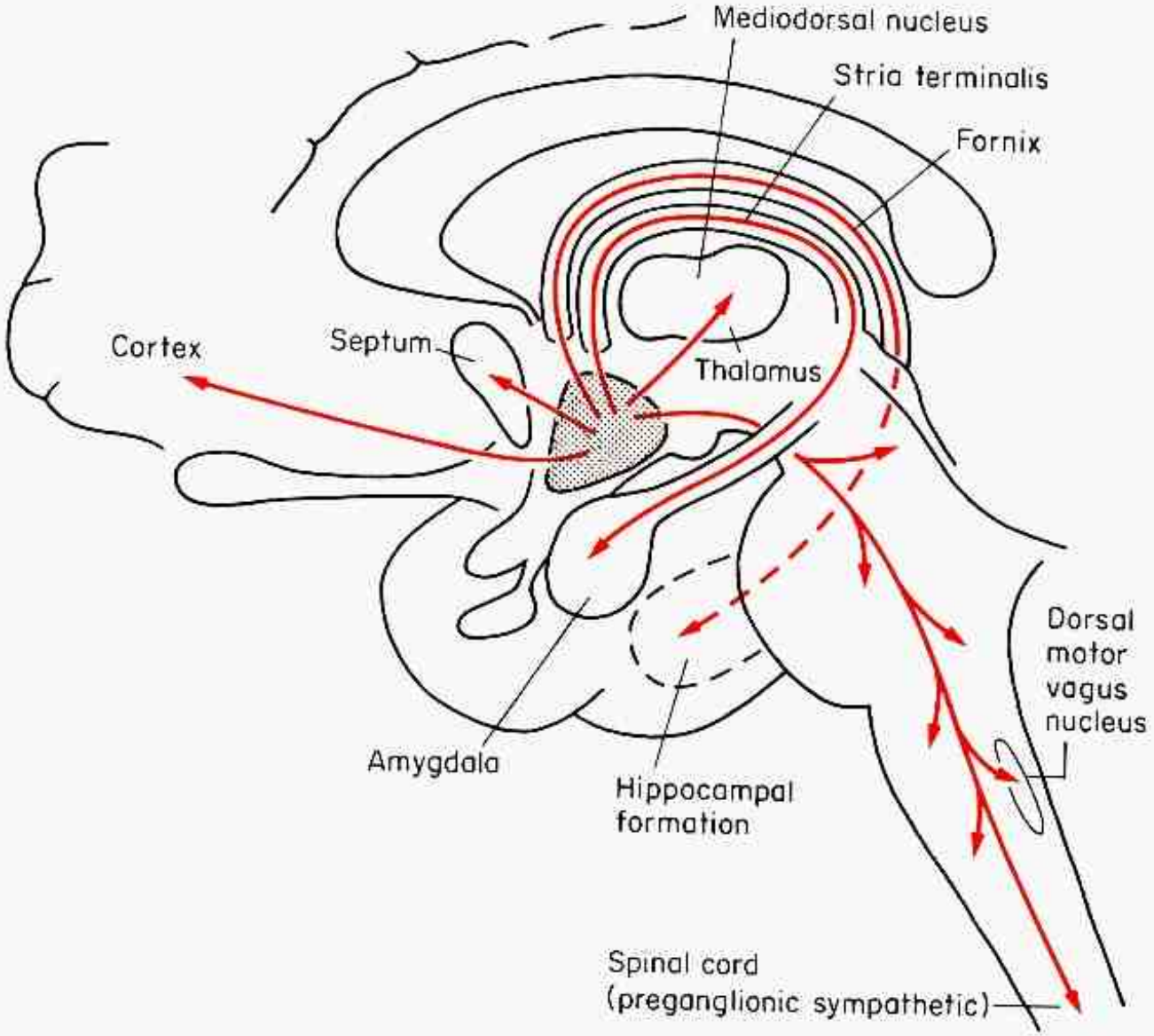


Fig. 15.3. *Main efferent connections of the hypothalamus.* The connections to the pituitary gland are not included, nor are the efferent connections of the mammillary nucleus.

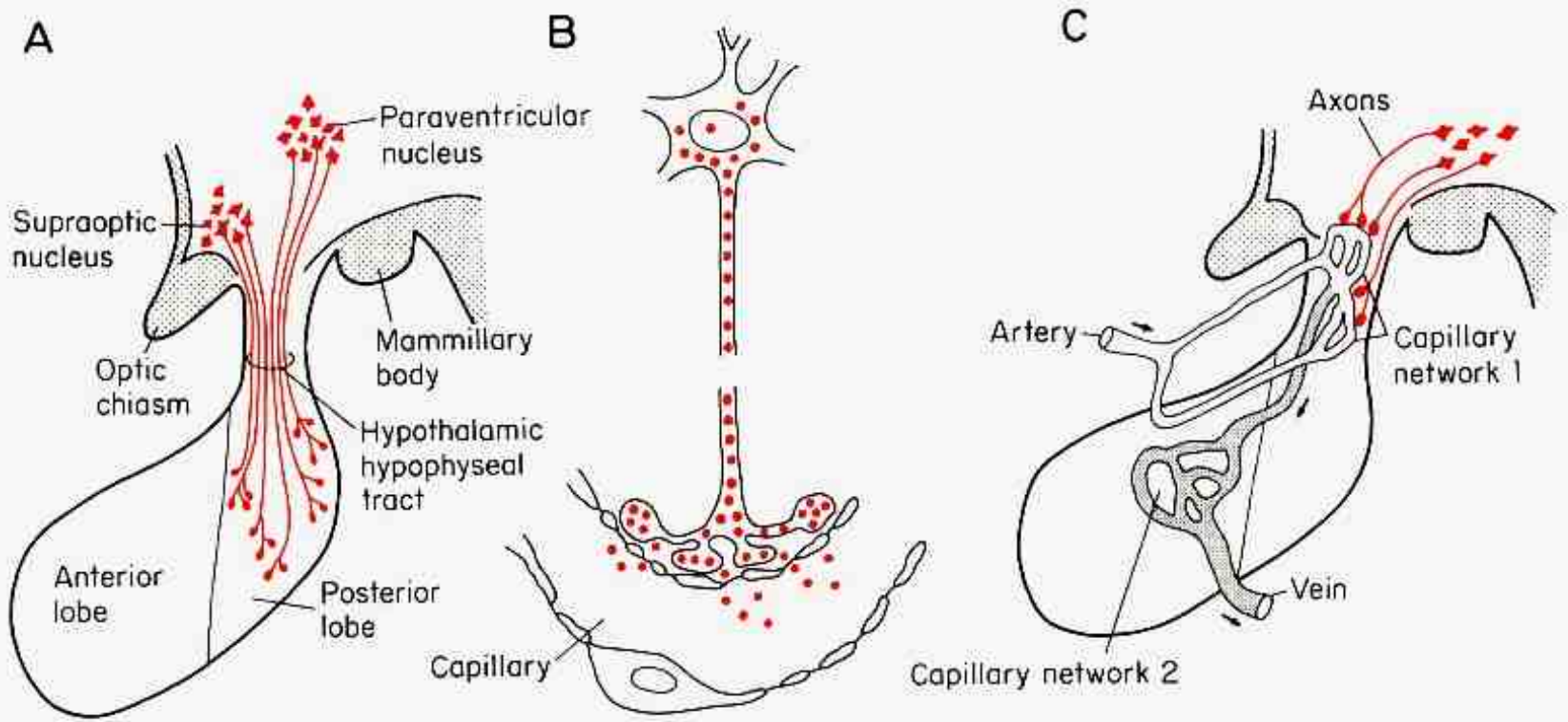


Fig. 15.5. *The relationship between the hypothalamus and the pituitary gland.* **A.** Connections from the hypothalamus to the posterior lobe. **B.** Axonal transport of peptide hormones (neuropeptides) from the hypothalamus to the pituitary. **C.** The portal vessels of the pituitary stalk ensure that releasing hormones (factors) are transported from the median eminence in the upper part of the stalk to the epithelial cells of the anterior lobe.

Posterior lobe **Anterior lobe**

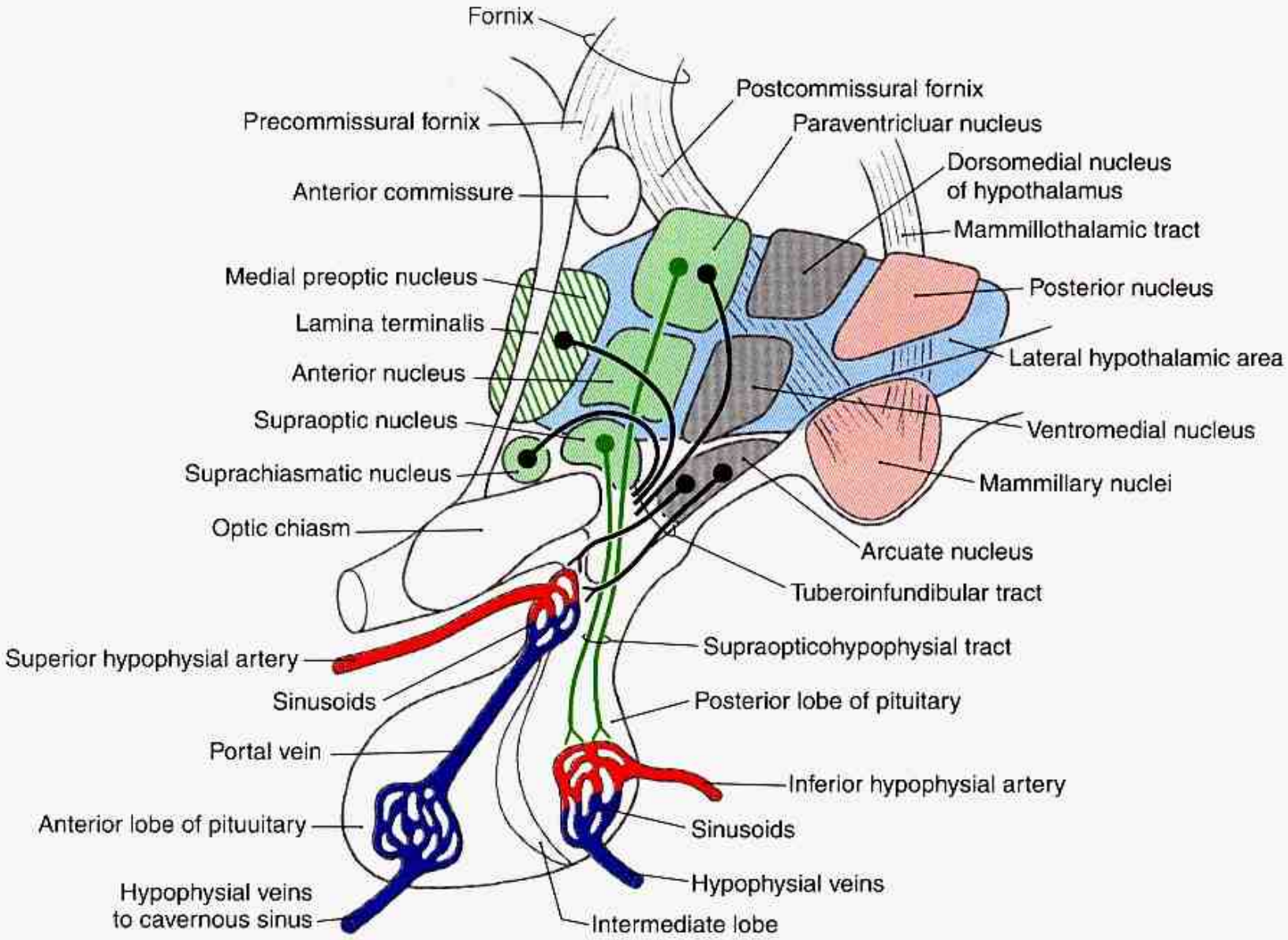


Figure 30–4. Midsagittal view of the hypothalamus emphasizing the nuclei, which contribute to the tuberoinfundibular supraopticohypophysial tracts, the hypophysial portal system, and the general relations of the fornix and mammillothal tract.

THE HYPOTHALAMUS

- **Lateral zone**

- No discrete nuclei
- Regulation of food and water intake

- **Medial zone**

- Well defined nuclei

- ***Chiasmatic region***

- **(SO,PV – hormone release)**
- **Cardiovascular function (Ant.)**
- **Circadian rhytms (SCH)**
- **Body temperature (Preoptic nc.)**

- ***Tuberal region***
- VM – satiety center (lesion produces hyperphagia + obesity)
- Arcuate nc. - delivers peptides to the portal vessels

- ***Mamillary region***
- Posterior nc.- elevating of blood pressure, pupillary dilatation, body heat conservation
- Mammillary ncc. – memory formation !!!

Abbreviations

Al	Alveus of Hippocampus
CblTh	Cerebellothalamic Fibers
CC	Crus Cerebri
Cing	Cingulum
CinGy	Cingulate Gyrus
Cl	Claustrum
CNu, B	Caudate Nucleus, Body
CNu, T	Caudate Nucleus, Tail
CorCl, B	Corpus Callosum, Body
CP	Choroid Plexus
DMNu	Dorsomedial Nucleus of Thalamus
EML	External Medullary Lamina
Ext	External Capsule
Extrm	Extreme Capsule
For, B	Fornix, Body
GP	Globus Pallidus
Hip	Hippocampal Formation
IGr	Indusium griseum
IML	Internal Medullary Lamina
Ins	Insula
Int	Internal Capsule
LatVen, B	Lateral Ventricle, Body
LatVen, IH	Lateral Ventricle, Inferior Horn
LDNu	Lateral Dorsal Nucleus of Thalamus
LenFas	Lenticular Fasciculus
LLSt	Lateral Longitudinal Stria
MI	Massa Intermedia
MLSt	Medial Longitudinal Stria
OpTr	Optic Tract
Put	Putamen
SMT	Stria Medullaris Thalami
SN	Substantia Nigra
SThNu	Subthalamic Nucleus
StTer	Stria Terminalis
ThFas	Thalamic Fasciculus
ThRetNu	Thalamic Reticular Nucleus
VL	Ventral Lateral Nucleus of Thalamus
ZI	Zona Incerta