

Neturi cortex! (vs. cerebrum, cerebellum)

Tseina darvini kranialiniai nervai

Midbrain + pons + medulla oblongata  
rhombencephalon (hindbrain)

**DEVELOPMENT**

Filogenetiškai brain stem yra spinal cord bulbous expansion - vystymasis embriologiškai panašus.

Sienelės (kaip ir spinal cord) sudaro roof, floor and paired basal, alar plates.

Šie patys ir sienelių sluoksniai - ependymal, mantle, marginal layers  
Tačiau atsiranda ir papildomos funkcijos ir struktūros - SSA, SVE, SVA

u. rhombencephalon: <sup>s. rhombic lips</sup> dorsal lips of alar plates prasidėja

į šalis: (NA) 147 (7-4) (LANG) 389 (20.17)

- central canal išplateja → 4<sup>th</sup> ventricle
- roof plate išploneja → superior and inferior medullary vela
- 4-to skilvelio dugnas tampa rombo fossa - RHOMBOID FOSSA

Skilvelių stogus sudarančios roof plates tampa membraninės:

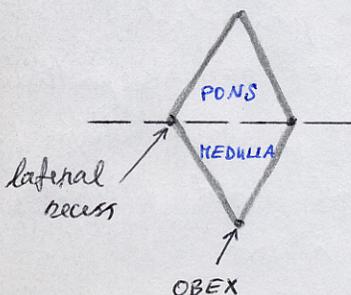
- a) išorinis sluoksnis (mekenchiminis lūmis) - pia mater
- b) vidinis sluoksnis (neural ectoderm lūmis) - ependymal cells } tela choroidea

15-ą vėstumo savaitę 4-to skilvelio stogas perforuoja:

- a) inferior velum in midline - median foramen of MAGENDIE
- b) rombinis duobės kampos - lateral foramina of LUSCHKA

Sutrikus perforacijai - noncommunicating hydrocephaly

Rhomboid fossa:



transverse plane across lateral recesses:

- riba tarp pons ir medulla
- ventraliai atitinka pontomedullary sulcus
- dorsaliai atitinka fastigium (NA) 148

Neuroblastai in rhombic lips of alar plates proliferuoja ir:

- a) lieka in situ dorsaliai → cerebellum, vestibulocochlear nuclei
- b) migruoja ventralyn:
  - ir pontine basis → pontine nuclei
  - ir pontine segmentum → superior olivary nuclei
  - ir medullary segmentum → inferior olivary nuclei

### COMPOSITION

Any cross section of brain stem exhibits three laminae: (NA) 149  
tectum, segmentum, basis

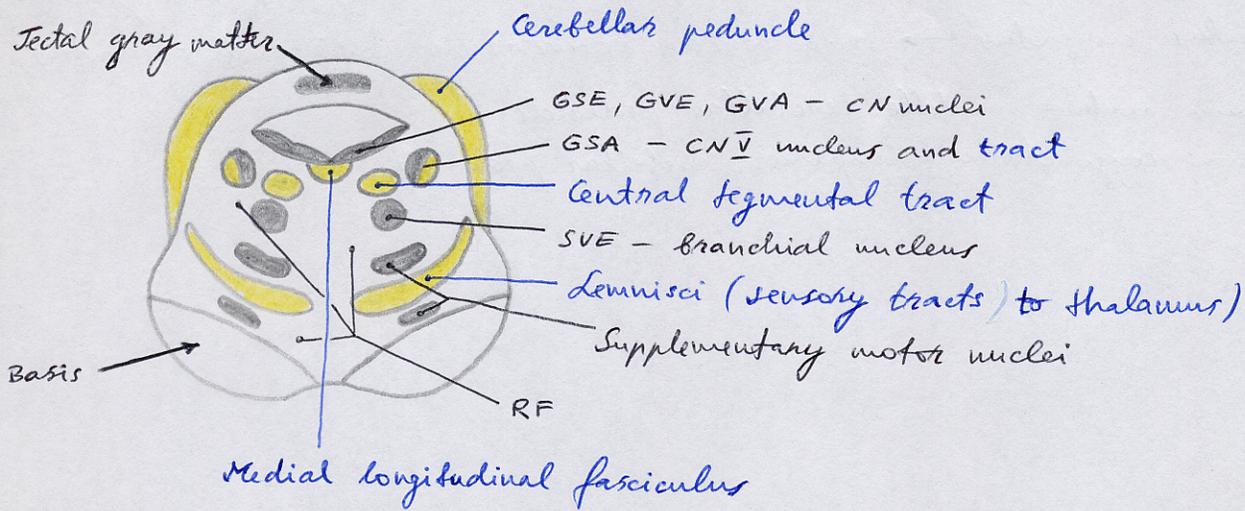
### TECTUM (roof of neural canal)

- develops from roof plate (dorsal to original neural canal)
- consists of:
  - quadrigenital plate (midbrain)
  - meet at — superior medullary velum (pons)
  - FASTIGIUM — inferior medullary velum (medulla ob)
- contains:
  - no cranial nerve nuclei
  - no RF
  - no long pathways course longitudinally

### BASIS

- contains CORTICOFUGAL (cortical efferent motor) tracts:
  - 1) corticopontine tracts
  - 2) pyramidal (corticobulbar + corticospinal) tracts
- differences:
  - midbrain** - no nuclei
  - pons**: - contains masses of nuclei (largest basis!), ant  
hurry baigiasi corticopontine tracts ir prasideda  
aksonai ir sinapsės (CORTICO-PONTO-CEREBELLAR pathway);  
- dalis corticobulbar skaidulų prasuka ir segmentum
  - medulla** - galiausiai lieka tik corticospinal tract (smallest  
basis!) - motomas paviršinijs kaip PYRAMIDS

**TEGMENTUM** (covering of basis) - esti tarp tectum ir basis, struktūra suditingiausia:



### Pathways of tegmentum:

- 1) long sensory tracts (spinal cord → nuclei, RF, cerebellum, diencephalon)
- 2) medial longitudinal fasciculus (ground bundle of brainstem) belongs to optomotor system
- 3) cerebellar pathways
- 4) hypothalamic pathways (to RF)
- 5) central tegmental tract (tegmentum ↔ diencephalon, forebrain basal nuclei)
- 6) gausis trumpi ir ilgi, bylantys ir nesileidžiantys unnamed pathways

### Neuronal arrangement in tegmentum:

- a) nuclei of CN III-XII (išsk. XI) - general (GSA, GSE, GVA, GVE) nuclei esti dorsaliausiai, special nuclei esti ventraliau
- b) RF - užpildo tarpus
- c) supplementary motor nuclei - esti ventraliausiai:
  - midbrain - red nucleus, subst. nigra
  - pons - nuclei basis (!) pontis
  - medulla - inferior olivary nuclei

External anatomy of brain stem~~CORE~~ 68-69

NA-152

- Inferior olivary complex isthelia OLIVARY EMINENCE (OLIVE)
- Fasciculus gracilis → TUBERCULUM GRACILE (CLAVA) (niss incl. gracilis)
- Fasciculus cuneatus → TUBERCULUM CUNEATUM (niss incl. cuneatus)
- Brachium pontis = middle cerebellar peduncle
- Brachium conjunctivum = superior cerebellar peduncle

RAPHE - midline decussations of axons of brain stem pathways

MEDULLA OBLONGATA in cross-sections

central gray matter (lyginant su ungaros em.) sustojivisi del RF, supplementary nuclei

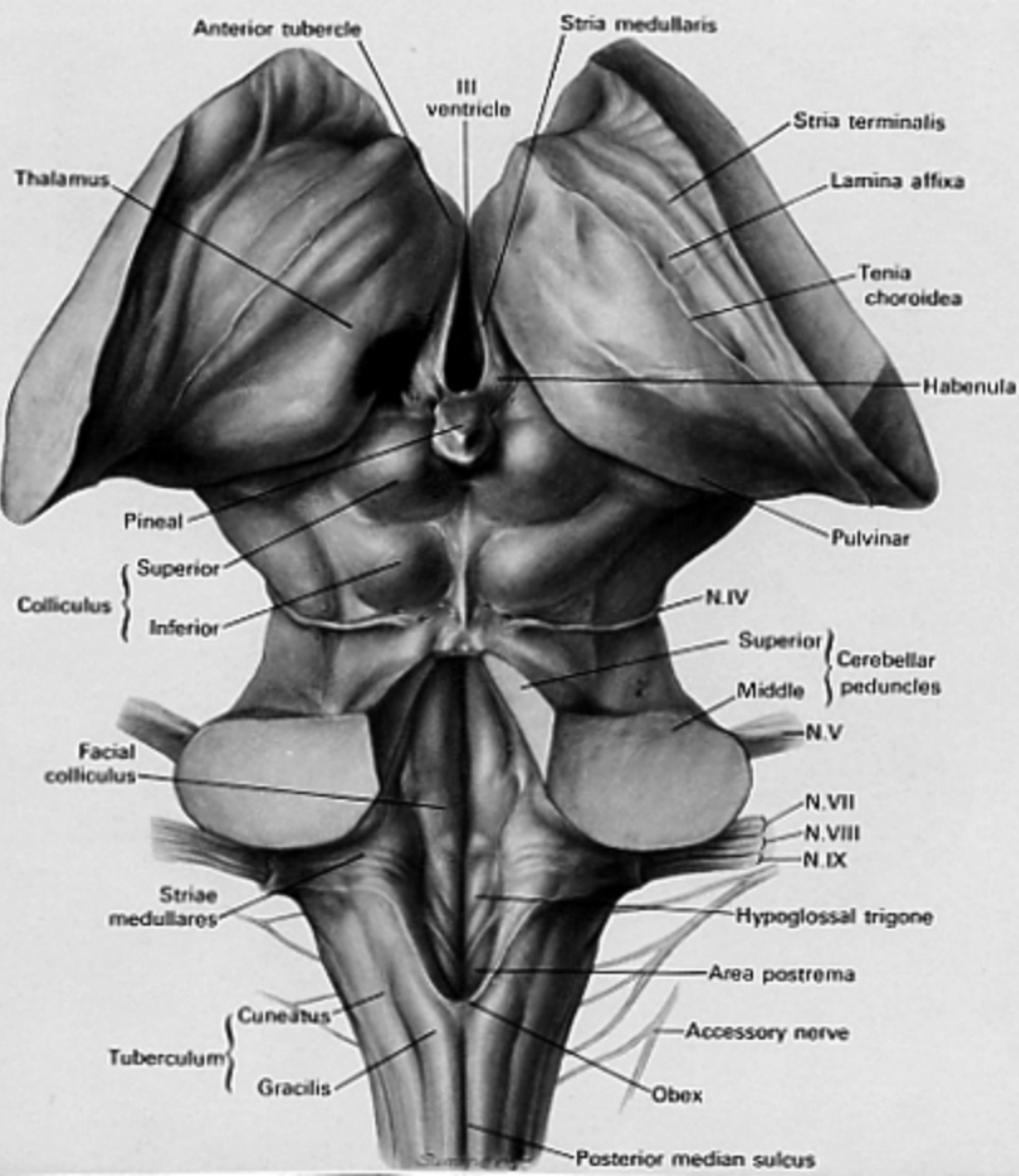
periferijoi issidesto white matter - long tracts

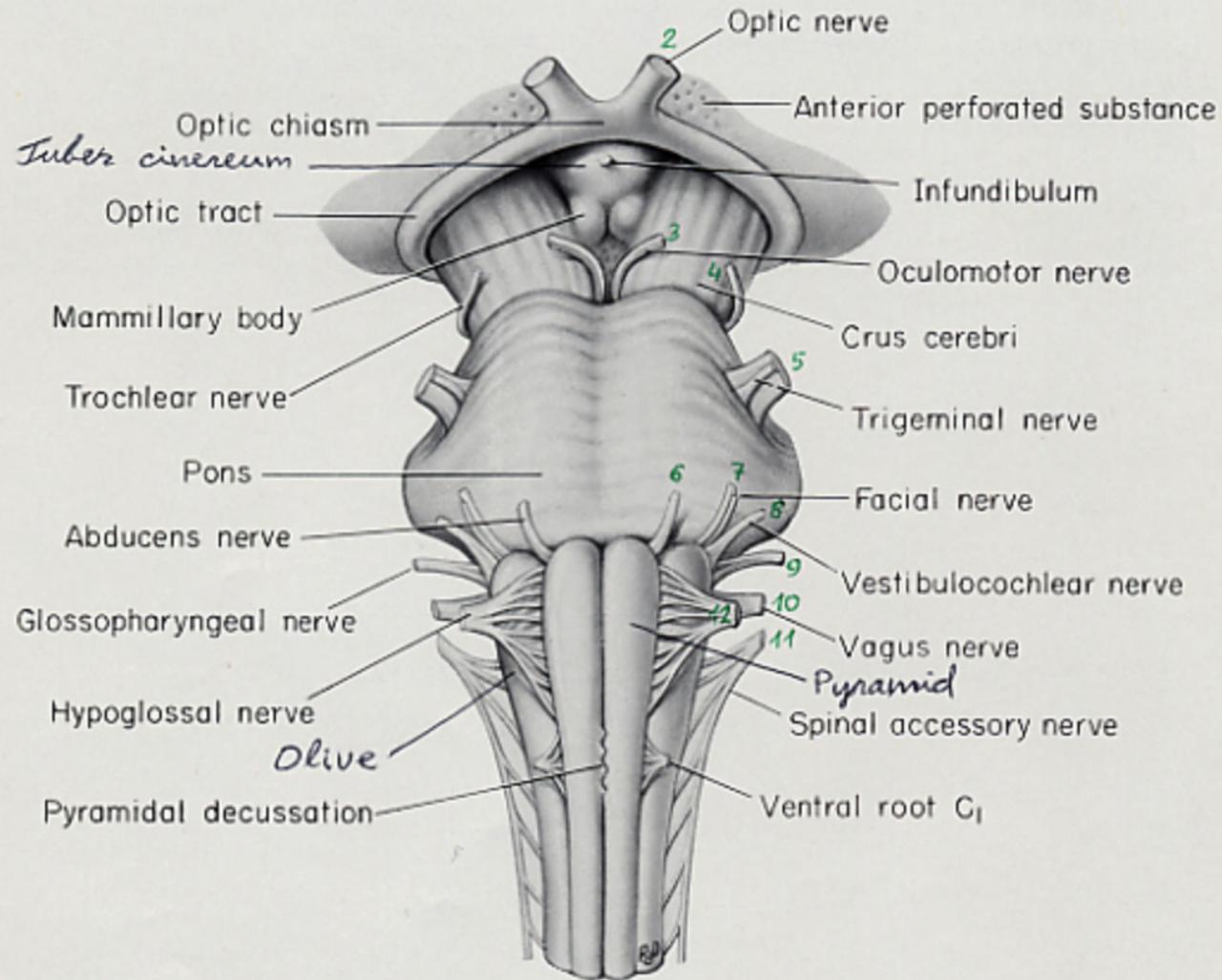
AREA POSTREMA - paraventricular organelle (in the wall of inferior recess of 4<sup>th</sup> ventricle - <sup>just caudally</sup> OBEX):

- blood-brain barrier is lacking
- chemoreceptor area associated with vomiting (emetic chemoreceptor)
- venimus aferentiv taip pat atcina is nucl. tractus solitarii

Homologai in analogai tarp spinal cord in medulla obl.

1. Central canal - 4<sup>th</sup> ventricle
2. Roof plate - inferior medullary velum
3. Anterior horn motoneurons - nucl. n. hypoglossi
4. Nucl. n. accessorii - nucl. ambiguus
5. Nucl. intermediolateralis S<sub>2-4</sub> - nucl. posterior (dorsalis) n. vagi
6. Nucl. reticularis - RF
7. Subst. gelatinosa, fasciculus dorsolateralis of Lissauer - nucl. and tractus spinalis n. trigemini





III Ventricle

Stria medullaris

Pineal body

Habenula

Pulvinar

Brachium

Lateral geniculate body

Superior colliculus

Inferior colliculus

Colliculus

Superior

Inferior

Cerebellar peduncles

Superior

Middle

Inferior

Trochlear n.

Vestibular area

Medial eminence

Facial colliculus

Lateral aperture

Stria medullaris (IV vent.)

Tuberculum

Cuneatus

Gracilis

*Sulcus limitans*

Trigonum

Fasciculus

Cuneatus

Gracilis

*Ala cinerea* = 1 Vagi

2 Hypoglossi

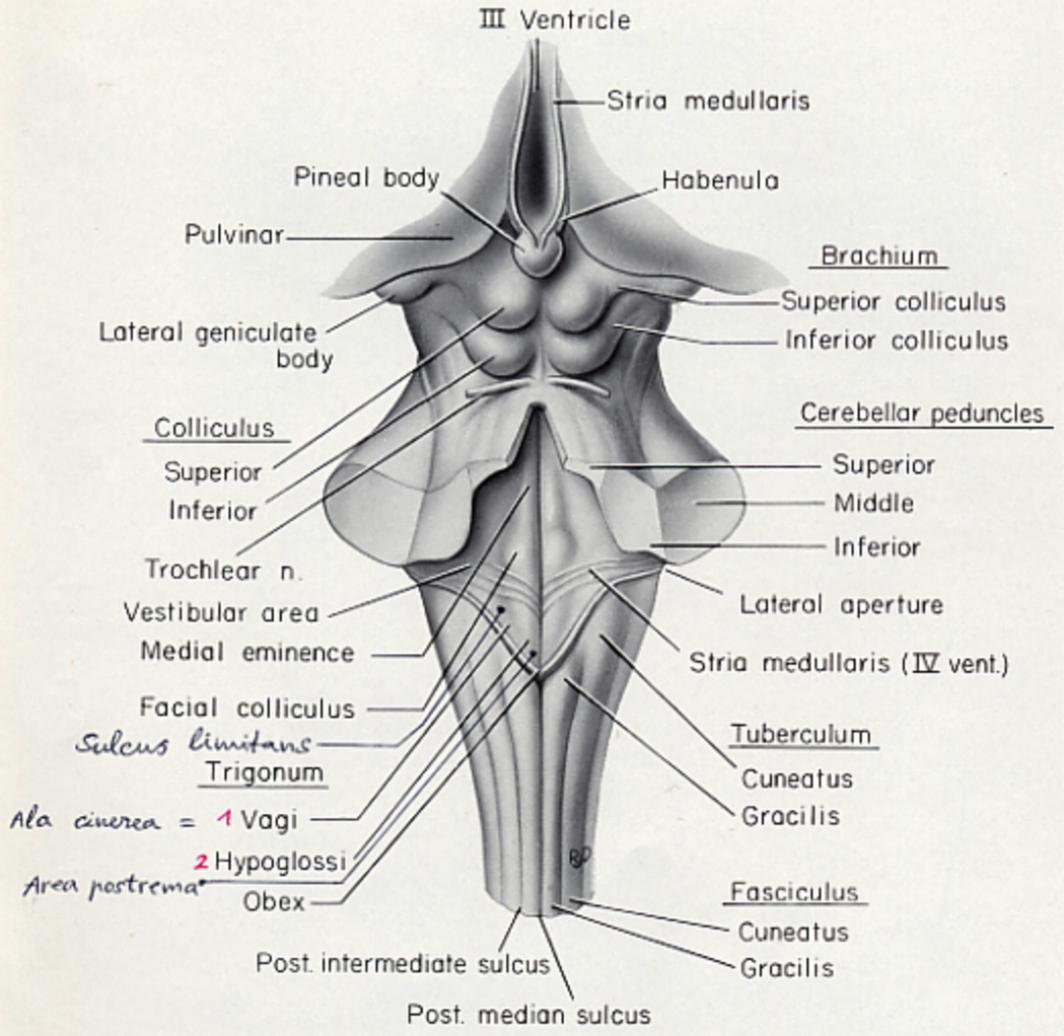
*Area postrema*

Obex

Post. intermediate sulcus

Post. median sulcus

BP



8. Nucl. thobacicus post - nucl. cuneatus accessorius (lateralis) (dorsalis Clarke)
9. Fasciculi proprii (ground bundles) - fasciculus longitudinalis medialis
10. Lemniscus spinalis - prisitlieja pie lemniscus medialis
11. Fasciculi gracilis, cuneatus - lemniscus medialis

Gray matter in medulla obl.

① Nuclei of cranial nerves:  
V, VII, VIII IX, X, XII

② Nuclei gracilis, cuneatus, cuneatus accessorius - isteklia tuberculum gracile (clava), tuberculum cuneatum

③ Nucleus olivaris inferior (s. inferior olivary complex)

• susideda is triju branduoliu, kurie sudaro leisenis formos kompleksa: (NA) 153-154

- nucl. olivaris principalis
- nucl. olivaris accessorius posterior (dorsalis)
- nucl. olivaris accessorius medialis

- isteklia OLIVARY EMINENCE (OLIVE)
- esti segmentum medullae ventral. dalyje
- sudaro TR. OLIVOCEREBELLARIS (somatomotor system) - fully crossed

White matter in medulla obl.

Five clinically important decussations (at cervicomedullary zone):

- ① Pyramidal tract decussation (NA) 153 (7-11)
- ② Tb. reticulospinalis for automatic breathing - just ventral to obex
- ③ Trigeminal lemniscus - is nuclei spinalis et principalis n. V
- ④ Medial lemniscus - is nuclei gracilis et cuneatus
- ⑤ Olivocerebellar tracts - is nucl. olivaris inf.

sudaro  
FIBRAE ARCUATAE  
INTERNAE

↑  
dekusacija vyksta  
per visa medulla ilgį

FIBRAE ARCUATAE EXTERNAE - skaidulos is:

1) nucl. cuneatus lateralis 2) nuclei arcuati (piramides priekinis pavirtus; aukscian pereina i nuclei basis pontis)  
skaidulos eina medulla obl. pavirtimi is sudaro restiform body of inferior cerebellar peduncle

LEMNISCUS MEDIALIS

- Sudarytas is nucl. gracilis in nucl. cuneatus susiberyžiarusis alsonu (fibrae arcuatae internae in caudal medulla obl.) -  
- veša fasc. gracilis et cuneatus informacija (discriminative touch, proprioception)
- pakelimi išlaikęs somatotopic lamination order (kaip in fasc. gracilis, cuneatus)
- byla smegenų kamieno segmentine dalimi: (NA) 153-156  
in medulla - centrine (paramediane) zona  
in pons - flattens out laterally (eina pontine nuclei dorsal. paviršiumi)  
in midbrain - displaced laterally by red nucleus (eina subst. nigra dorsal. paviršiumi) and contacts lateral lemniscus
- pakelimi prisijungia kitų sistemų skaidulos:  
trigeminal lemniscus  
spinal lemniscus is lateral. pusės  
dalis unsileidžiančių (!) corticobulbar fibers
- visi šys lemnisci (medial, spinal, trigeminal) baigiasi in THALAMUS -  
- nucl. ventralis post.

PONS in cross-sections

FIVE TRIADS

① LONGITUDINAL triad

- 1) TECTUM - superior medullary velum
- 2) TEGMENTUM - relatively thin
- 3) BASIS - bulging (nuclear masses, corticofugal fibers)

② CEREBELLAR PEDUNCULAR triad

③ MOTOR NUCLEI triad - CN V, VI, VII

- Internal loop of VII around nucleus of VI

④ SENSORY NUCLEI triad: cochlear nuclei  
vestibular nuclei  
principal nucleus of n. V

⑤ DECUSSATIONAL triad:  
1) auditory pathways (TRAPEZOID BODY) (in tegmentum)  
2) pontocerebellar pathways (nuclei basis pontis → middle cerebellar peduncle (in basis))  
3) cerebellovestibular pathways (in velum sup.)

**PONTOMEDULLARY JUNCTION**

- in pontomedullary sulcus, ventrodorsaline (skersine) tranka išsidėsto:
  - CN VI - ventraliančiai (špinis SOMITINIS nervas)
  - CN VII - tarpe (špinis BRANCHIALINIS nervas)
  - CN VIII - dorsolateraliančiai (špinis SENSORINIS nervas)
- atitinka 4-to skilvelio antžiausia (fastigium) ir plocianisiai (lateral recesses) vietas
- aa. vertebrales konverguoja į A. BASILARIS

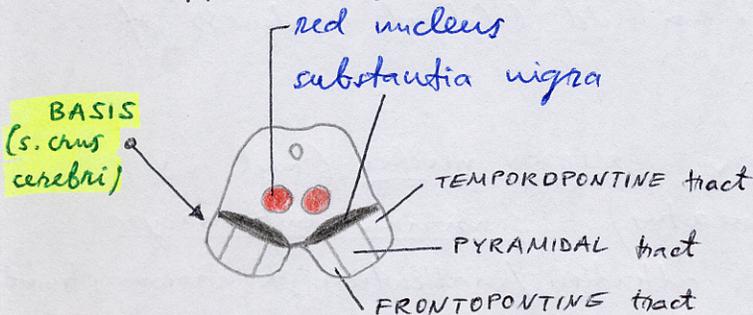
**PONTO-MIDBRAIN JUNCTION**

- bulging belly of pons abruptly replaces the midbrain (which forms a narrow isthmus between it and diencephalon)
- 4th ventricle → aqueduct
- dorsaliniame (!) paviršiuje įėjina CN IV
- a. basilaris diverguoja į AA. CEREBRALES POST.

**MIDBRAIN**

**TEGMENTUM**

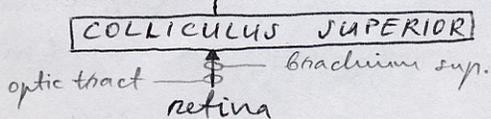
- nuclei of CN III ir IV
- supplementary nuclei:



Cerebral peduncle =  
 = crus cerebri + midbrain tegmentum  
 ↓  
 skėria SUBST. NIGRA

**TECTUM (QUADRIGEMINAL PLATE)**

accessory nuclei of optic system, RF



lateral lemniscus → **COLLICULUS INF.** →  $\begin{matrix} \text{brachium inf.} \\ \text{medial geniculate body} \end{matrix}$

Colliculi - integrating centers for optic and auditory reflexes  
(tačiau specifinių quadrigeminal plote pažėidimo sindromų nėra!)

### Decussations in midbrain tegmentum:

- corticobulbar fibers (for volitional horizontal eye movements)
- tt. dentatothalamicus, tt. dentatothalamicus, tt. subspinalis & -bulbaris
- tt. colliculi, tt. tectospinalis & -bulbaris

POSTERIOR (S. DORSAL)  
tegmental decussation (of MEYNERT); S. FOUNTAIN decussation

ANTERIOR (S. VENTRAL)  
tegmental decussation (of FOREL)

### **TR. CORTICOBULBARIS**

- pagal dabartinę nomenklaturą - fibrae cortico-nucleares bulbi, pontis, mesencephali

- prasideda in PARACENTRAL (SENSORIMOTOR) cortex
- leidžiasi in BRAIN STEM BASIS (tt. corticopontine tracts):
  - pirmi skaidulų susikryžioja (vs. tt. pyramidalis - beveik visos)
  - pabelini skaidulų sruka dorsalyje & TEGMENTUM (kur kai kurios dalys inoliau leidžiasi medial lemniscus sudėtyje kol pasiekia tikslą)
  - baigiasi ant <sup>1</sup>RF (didėmė dalis) in <sup>2</sup>cranial nerve nuclei (vs. corticopontine tracts - ant nuclei basis pontis)

### ① Corticobulbar fibers to cranial nerve MOTOR nuclei: valingi jūdesiai

a) optomotor nuclei - žr. "EYE"

b) motor nuclei n. V, VII, IX, X, XI, XII - receive equal number of decussated and nondecussated fibers (išsk. n. VII apat. dalis) -  
- unilateral tt. corticobulbaris → mild bilateral weakness of bulbar muscles

### ② Corticobulbar fibers to cranial nerve SENSORY nuclei (incl. n. V, incl. tt. solitarii, incl. gracilis et cuneatus) - sensorinės informacijos transmisijos moduliacija (selective attention/inattention to various stimuli)

### ③ Corticoreticular fibers

- atikuria nuo tt. pyramidalis iš lygiuose
- per RF projektuojasi į visas CNS dalis (pvz.: cortico-reticulo-cerebellar system kaip alternatyva cortico-ponto-cerebellar system)



FIGURE 7-10. Key to the levels of the brain stem illustrated in Figures 7-11 through 7-21.

**TRACTS, LEMNISCI,  
FASCICULI**

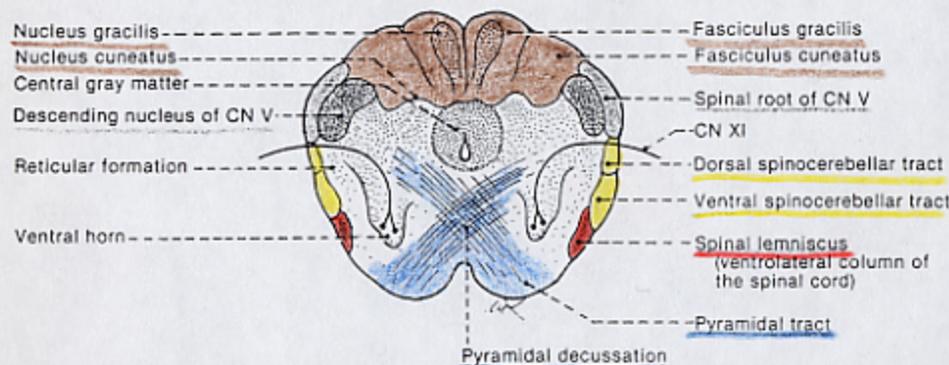


FIGURE 7-11. Transverse section of the cervicomedullary junction.

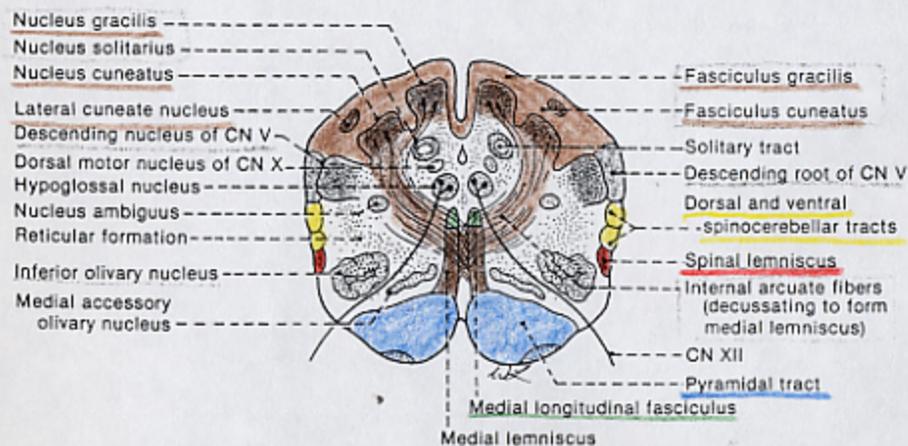


FIGURE 7-12. Caudal-most transverse section of the medulla oblongata.

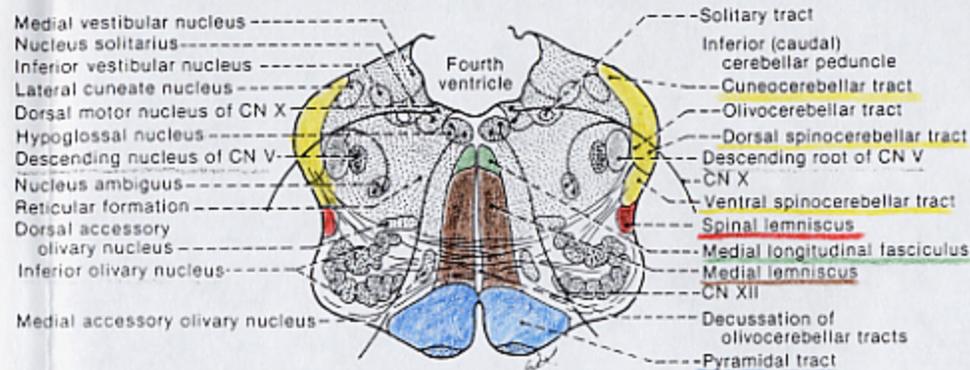


FIGURE 7-13. Caudal transverse section of the medulla oblongata.

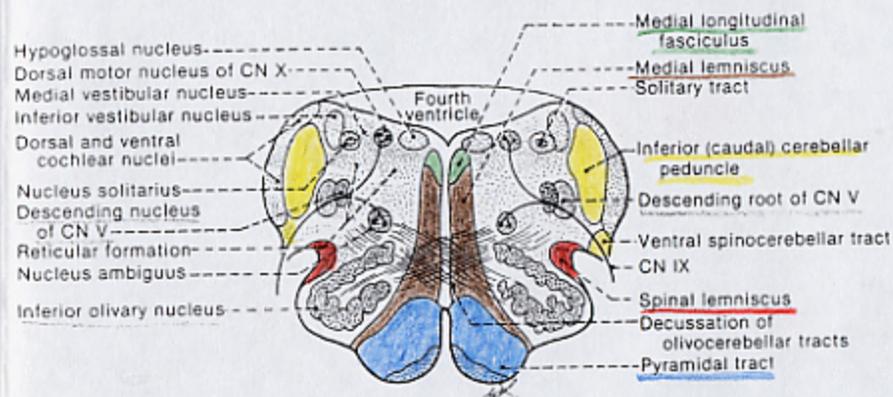


FIGURE 7-14. Midlevel transverse section of the medulla oblongata.

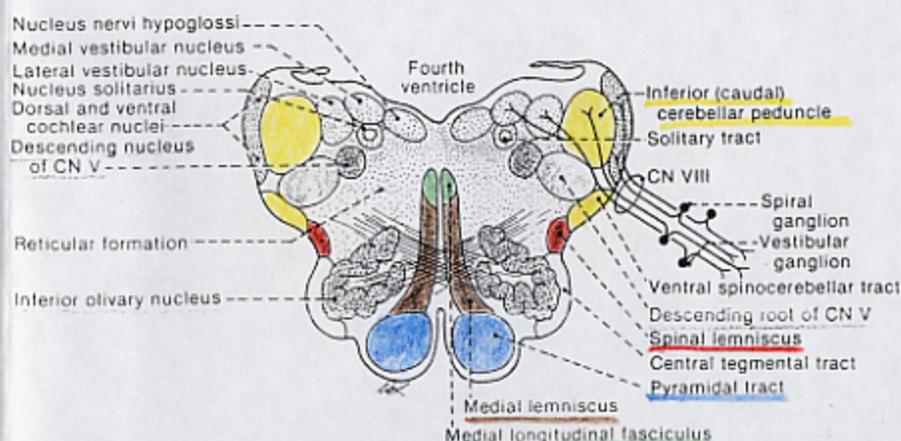


FIGURE 7-15. Rostral-most transverse section of the medulla oblongata.

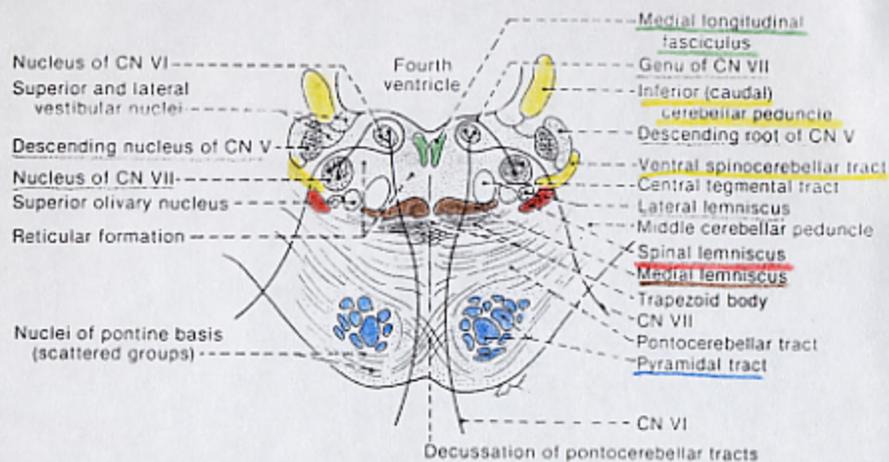


FIGURE 7-16. Caudal transverse section of the pons.

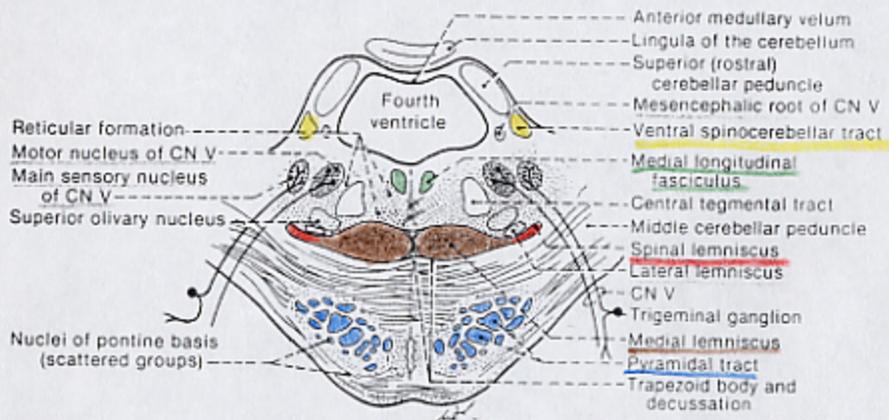


FIGURE 7-17. Rostral transverse section of the pons.

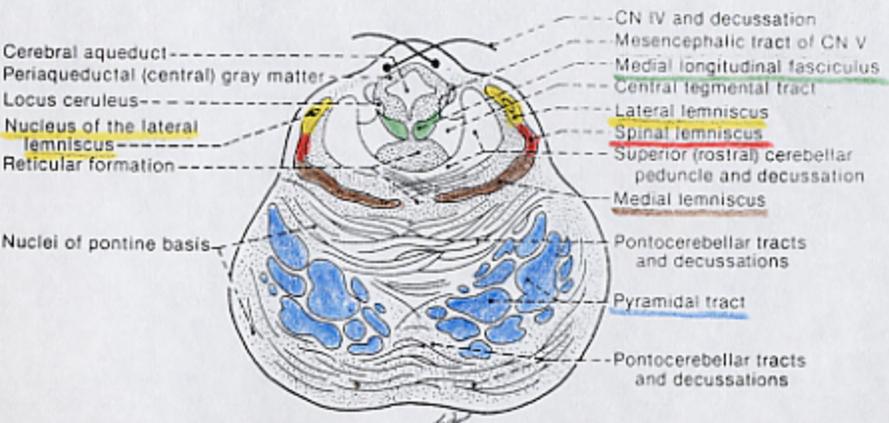


FIGURE 7-18. Transverse section of the pontomesencephalic junction.

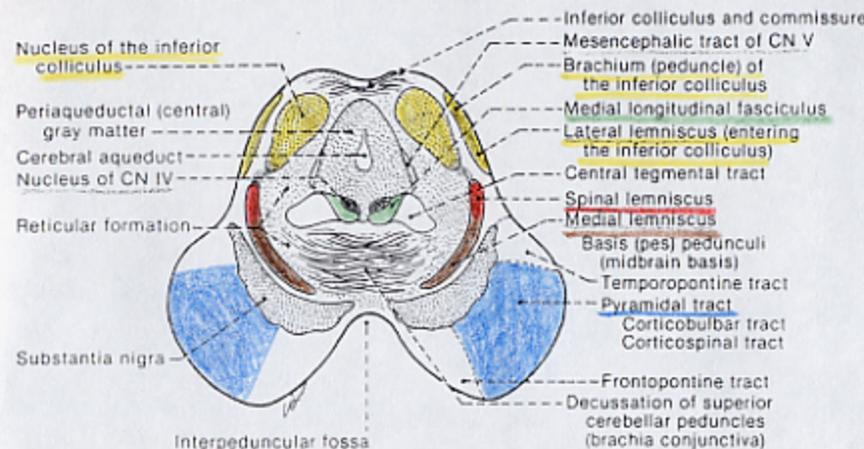


FIGURE 7-19. Caudal transverse section of the midbrain.

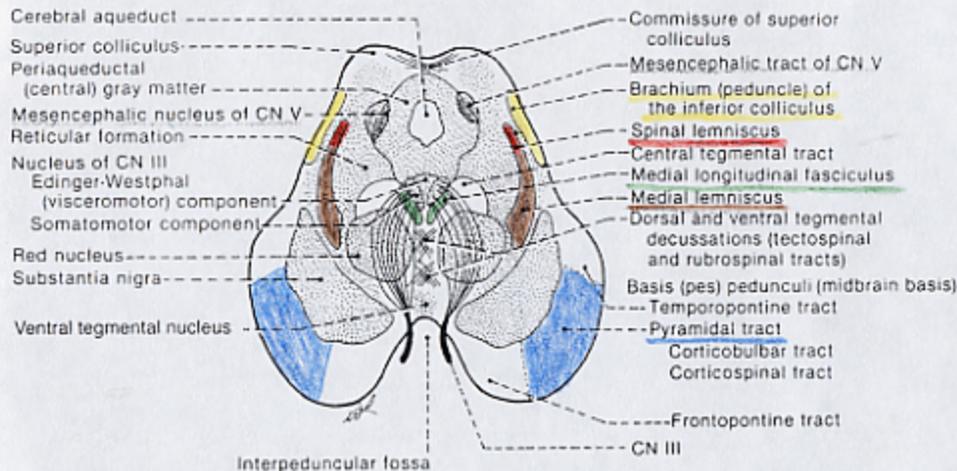


FIGURE 7-20. Rostral transverse section of the midbrain.

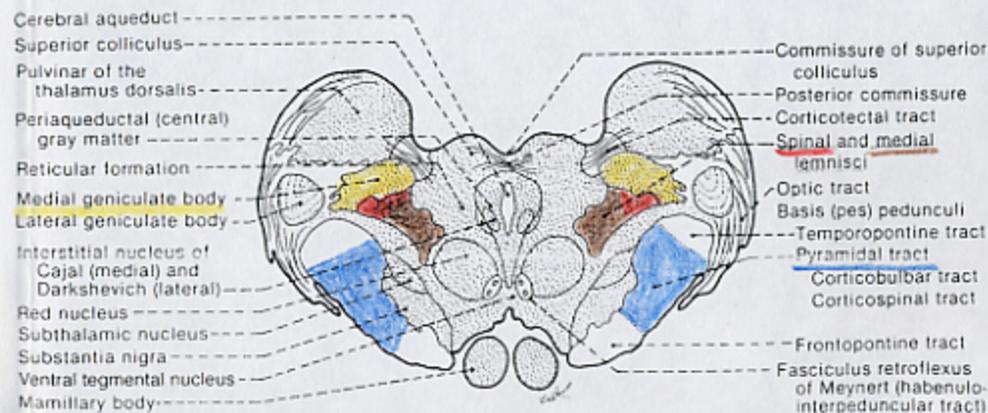


FIGURE 7-21. Rostral-most transverse section of the midbrain at the midbrain-diencephalic junction.

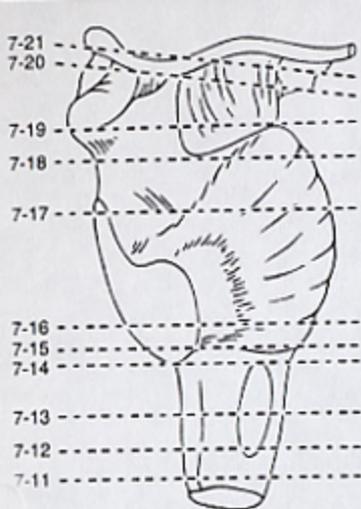


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## NUCLEI

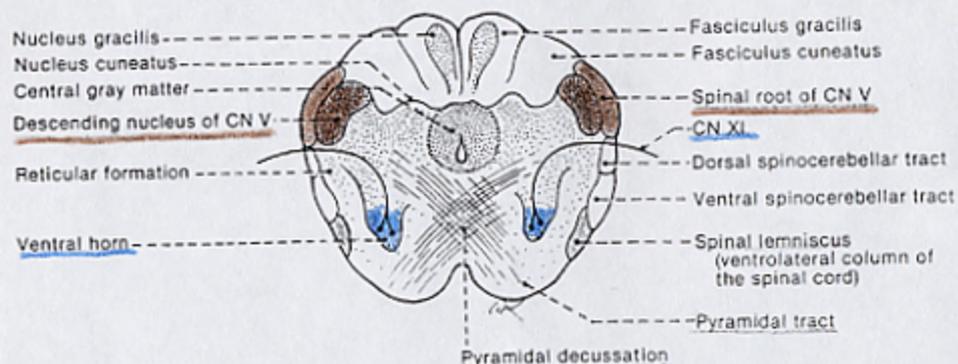


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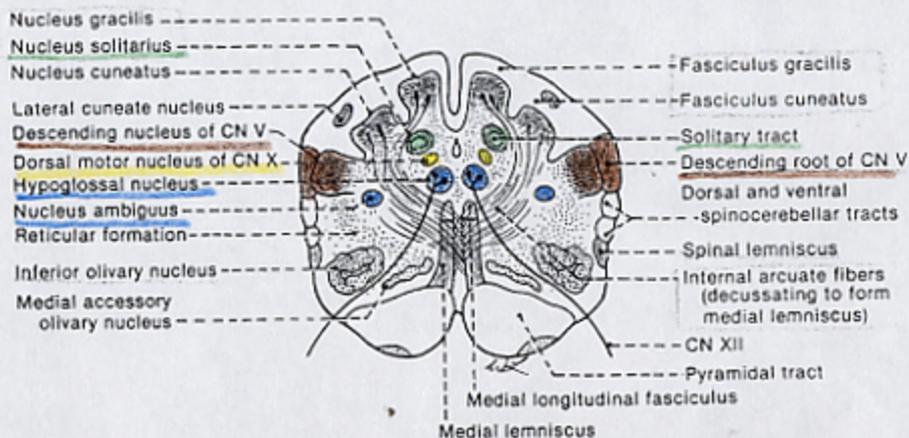


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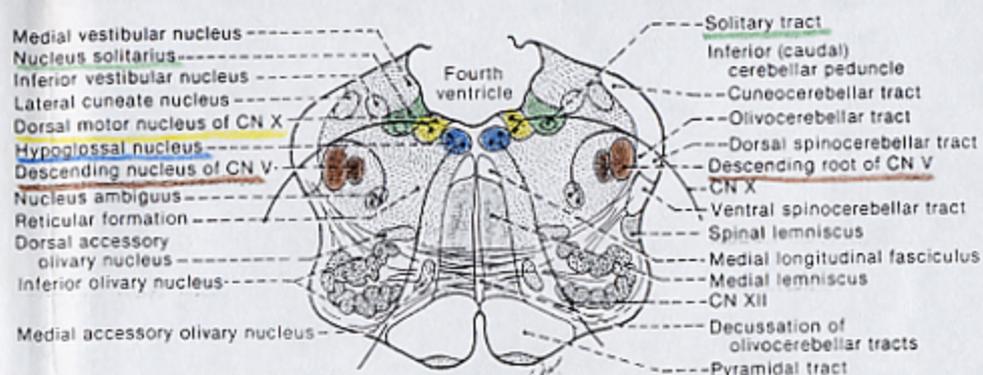


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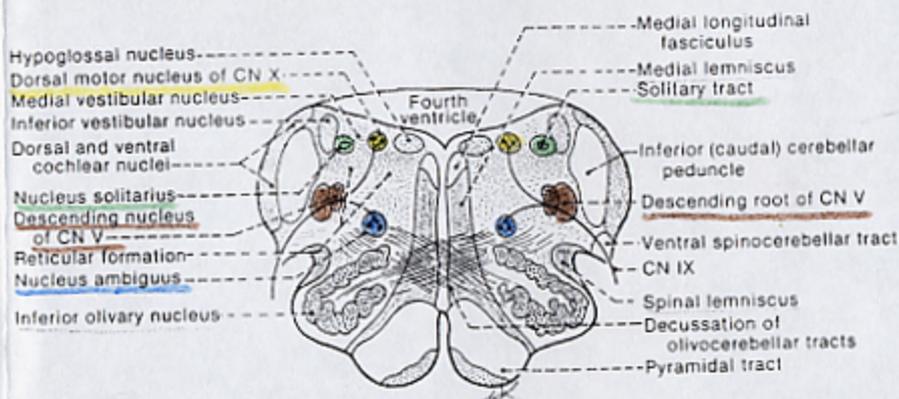


FIGURE 7-14. Midlevel transverse section of the medulla oblongata.

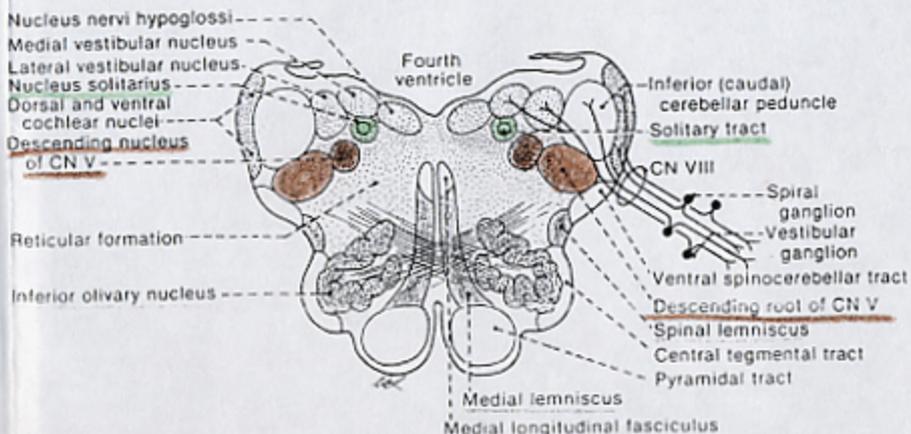


FIGURE 7-15. Rostral-most transverse section of the medulla oblongata.

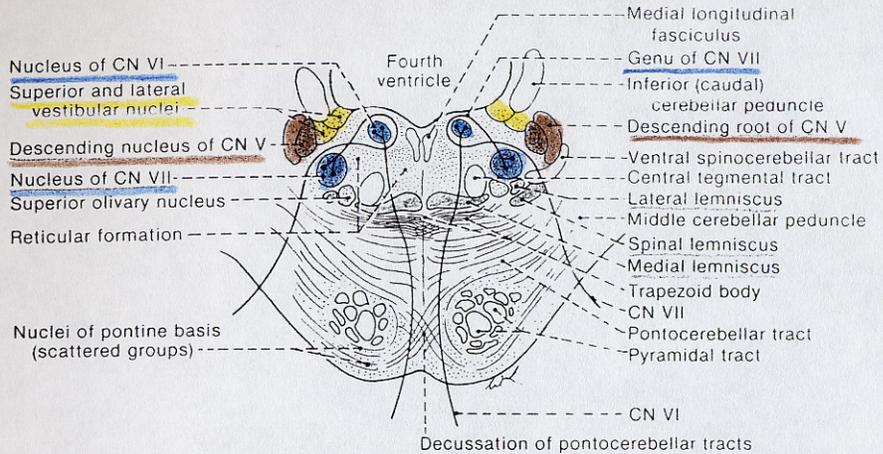


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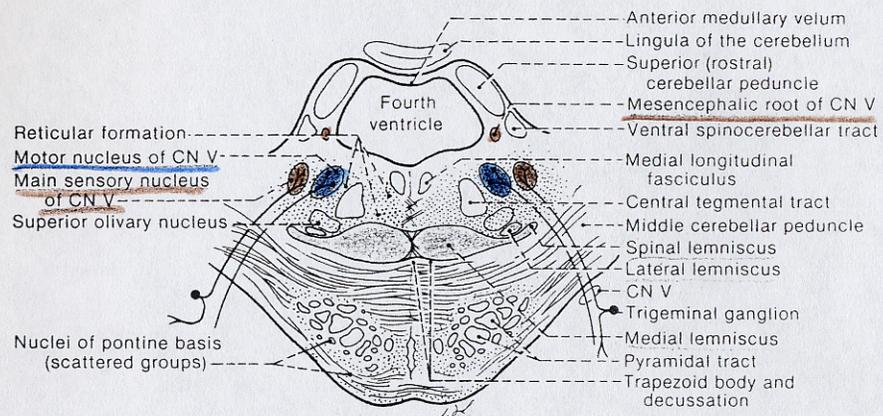


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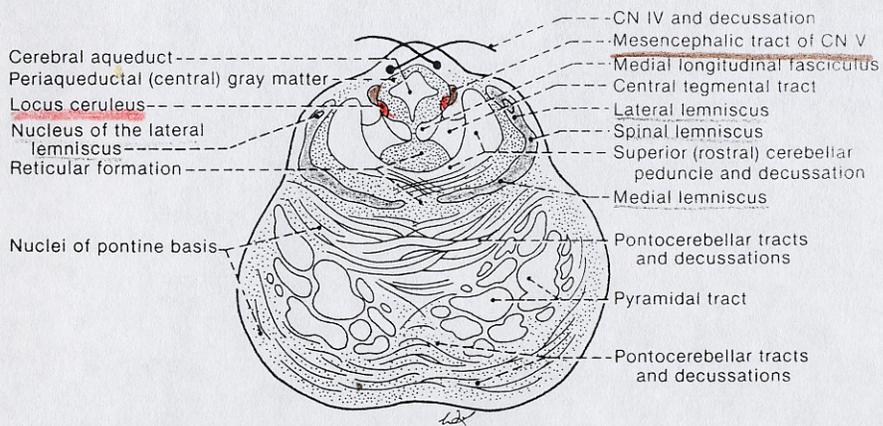


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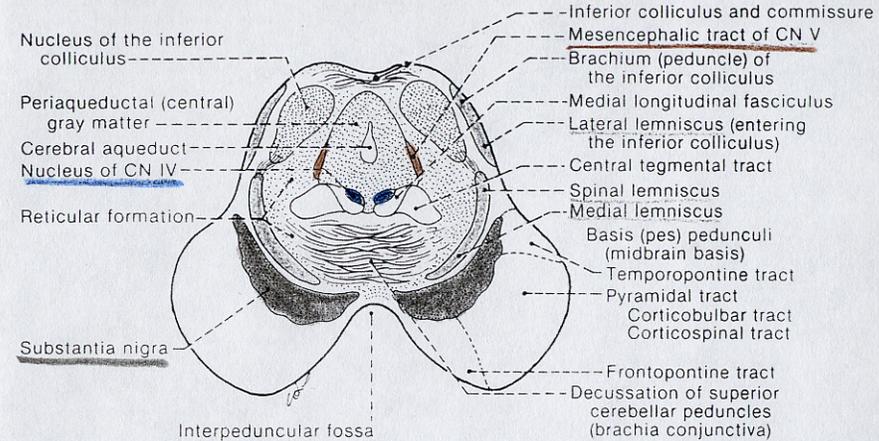


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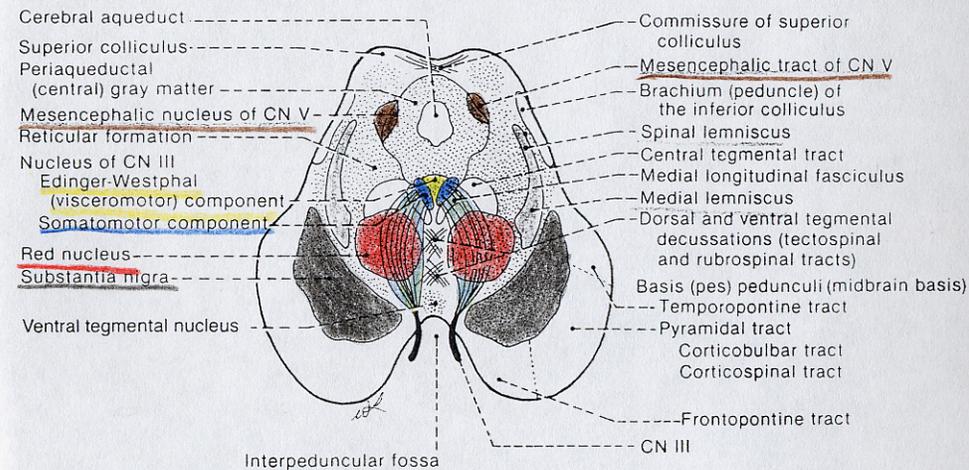


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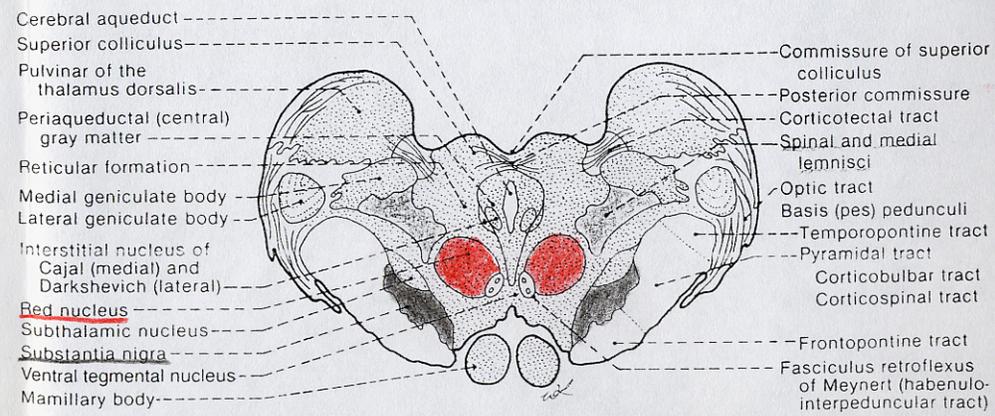


FIGURE 7-21. Rostral-most transverse section of the midbrain at the midbrain-diencephalic junction.

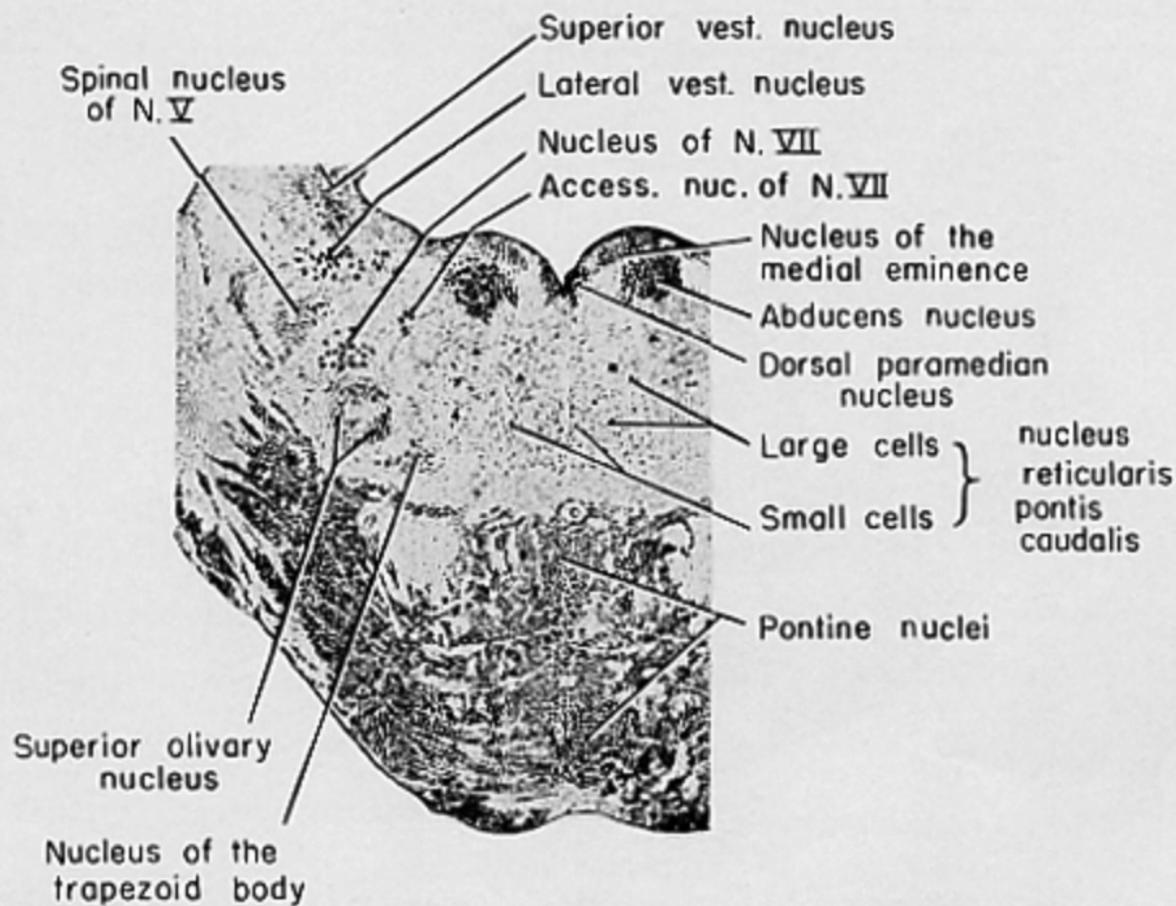


Fig. 5-3. Section through pons and pontine tegmentum of 3-month infant at about same level as Figure 5-2. Cresyl violet. Photograph, with schematic representation of cell groups. (From Truex and Carpenter, *Human Neuroanatomy*, 1969; courtesy of The Williams & Wilkins Company.)

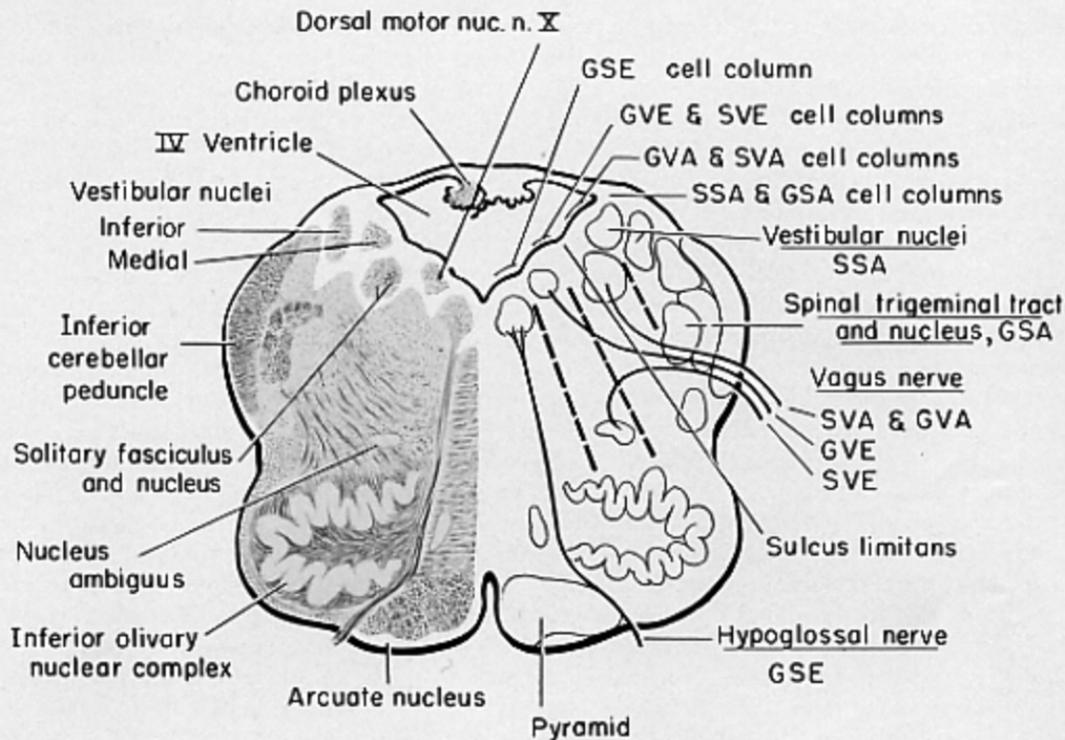


Fig. 4-11. Schematic transverse section of the medulla showing its basic features. Cell columns related to functional components of the cranial nerves are indicated on the *right*. Functional components of cranial nerves are both general and special. The vestibular nuclei shown at this level (and auditory nuclei at higher levels) form the special somatic afferent (SSA) cell columns. The spinal trigeminal nucleus forms the general somatic afferent (GSA) cell column and receives fibers from cranial nerves with this functional component (i.e., N.V, N.VII, N.IX, N.X). Functional components of the vagus nerve (except GSA) are shown in relation to particular nuclei. The hypoglossal nucleus (and the nuclei of N.VI, N.IV and N.III at higher brain stem levels) gives rise to general somatic efferent (GSE) fibers. *Heavy dashes* separate the nuclei of the various cell columns on the *right* side. (From Truex and Carpenter, *Human Neuroanatomy*, 1969; courtesy of The Williams & Wilkins Company.)

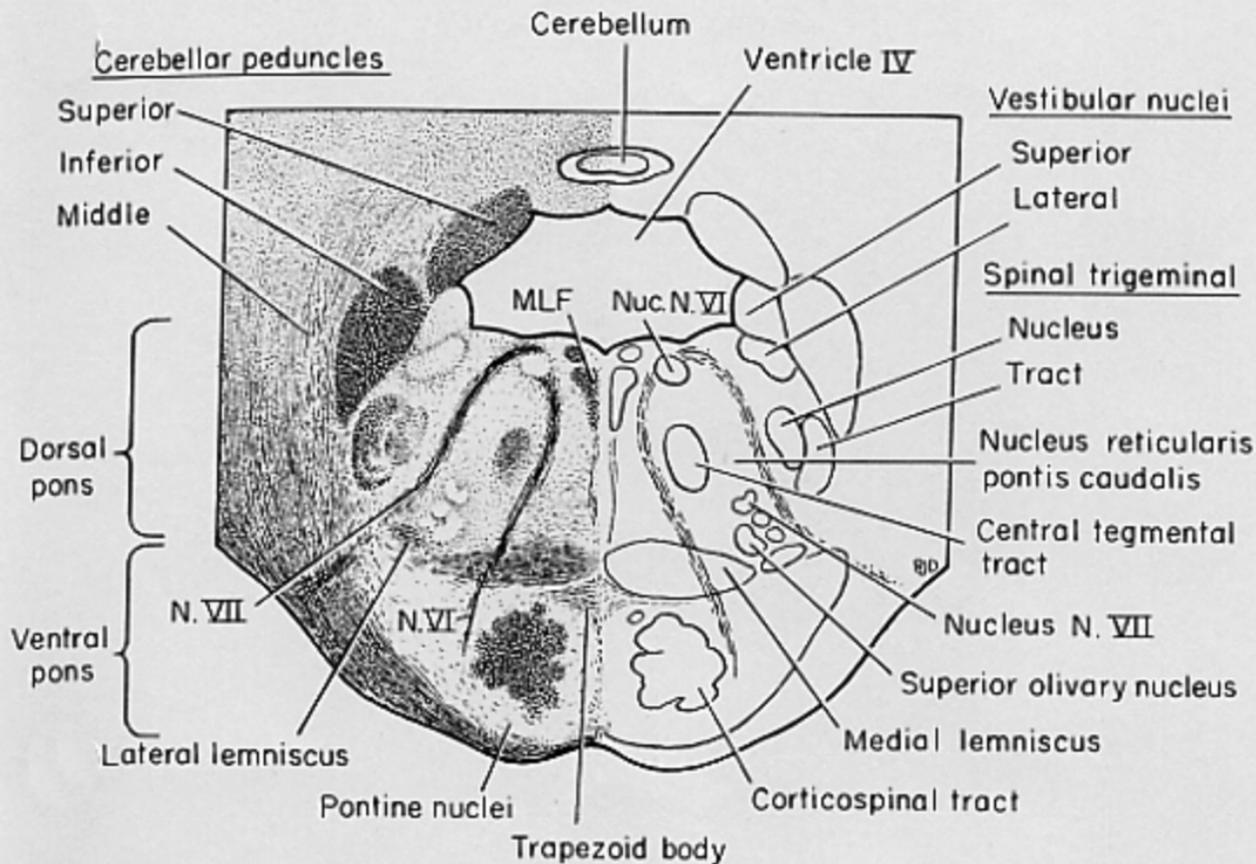


Fig. 5-1. Semidiagrammatic drawing of a transverse section of the pons at the level of the abducens nucleus. The dorsal portion of the pons, constituting the tegmentum, contains the reticular formation, cranial nerve nuclei and ascending and descending tracts. The ventral portion of the pons contains the pontine nuclei, massive bundles of corticofugal fibers and the transverse fibers of the pons which form the middle cerebellar peduncle. (From Truex and Carpenter, *Human Neuroanatomy*, 1969; courtesy of The Williams & Wilkins Company.)

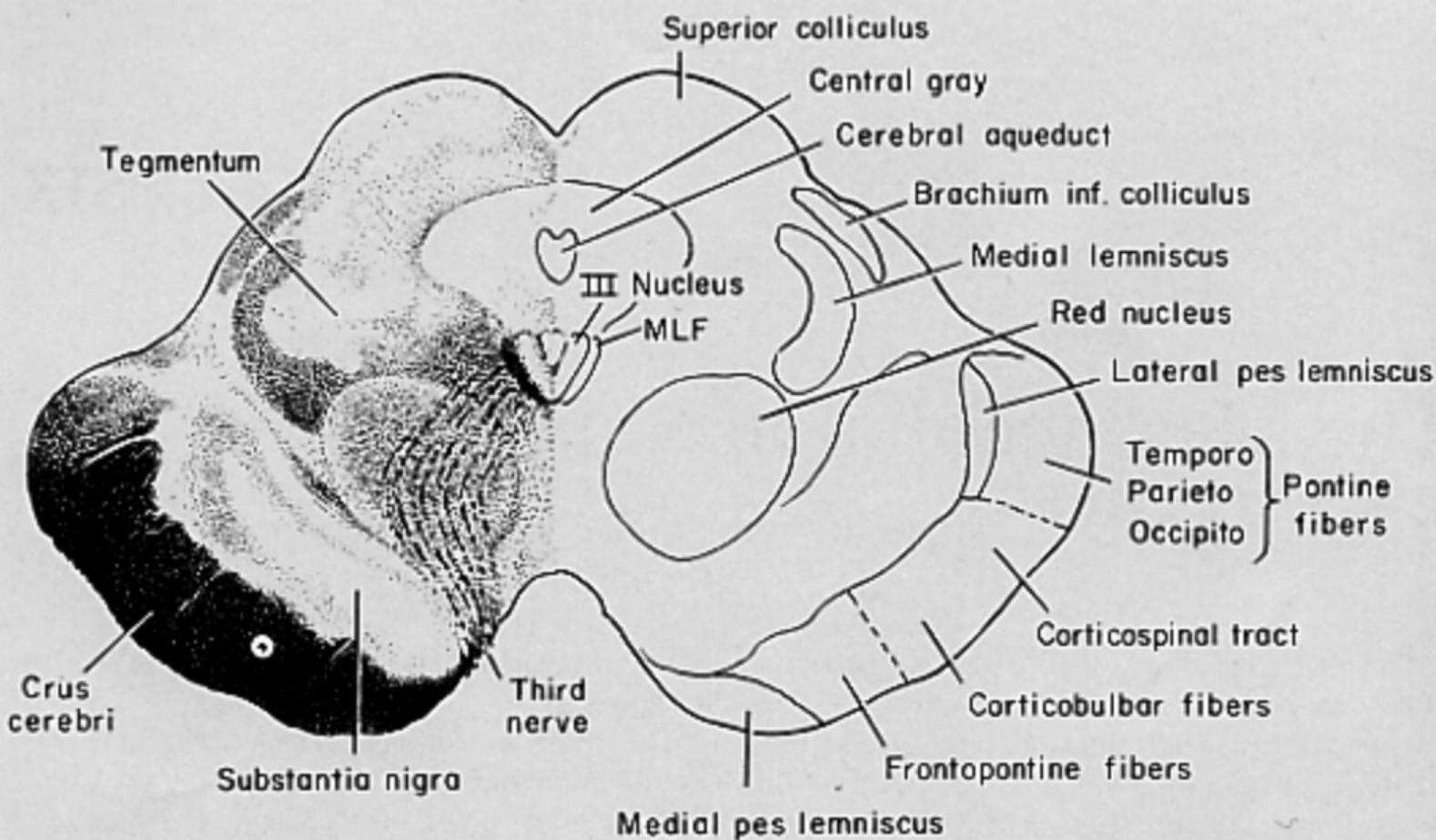


Fig. 6-1. Schematic transverse section through upper portion of midbrain. (From Truex and Carpenter, *Human Neuroanatomy*, 1969; courtesy of The Williams & Wilkins Company.)