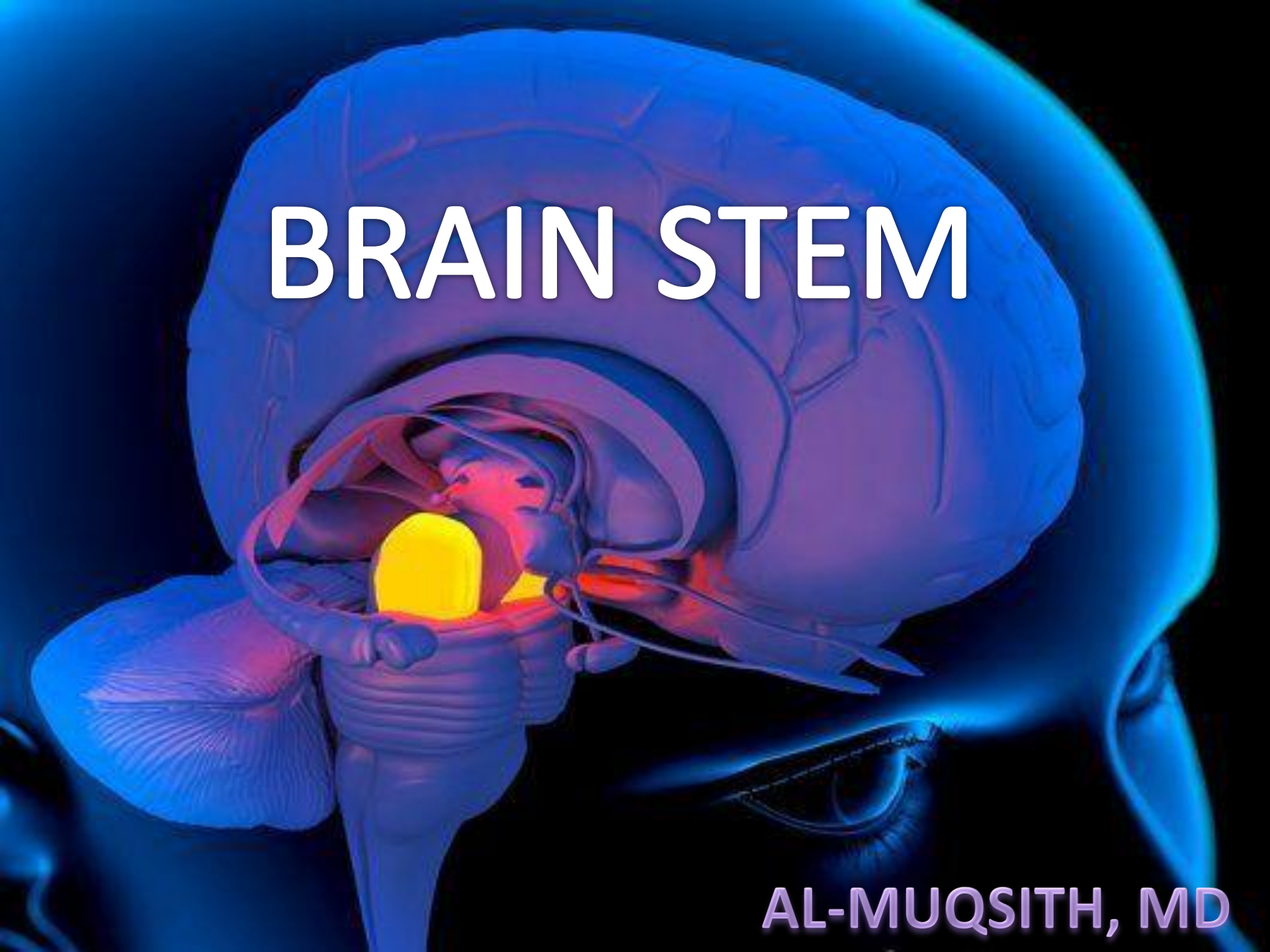

BRAIN STEM
AL-MUQSITH, MD

Brain Stem

- Consists:
  - Medulla oblongata
  - Pons
  - Midbrain (Mesencephalon)

- Lies upon the basal portion of occipital bone (clivus) and is connected to cerebellum

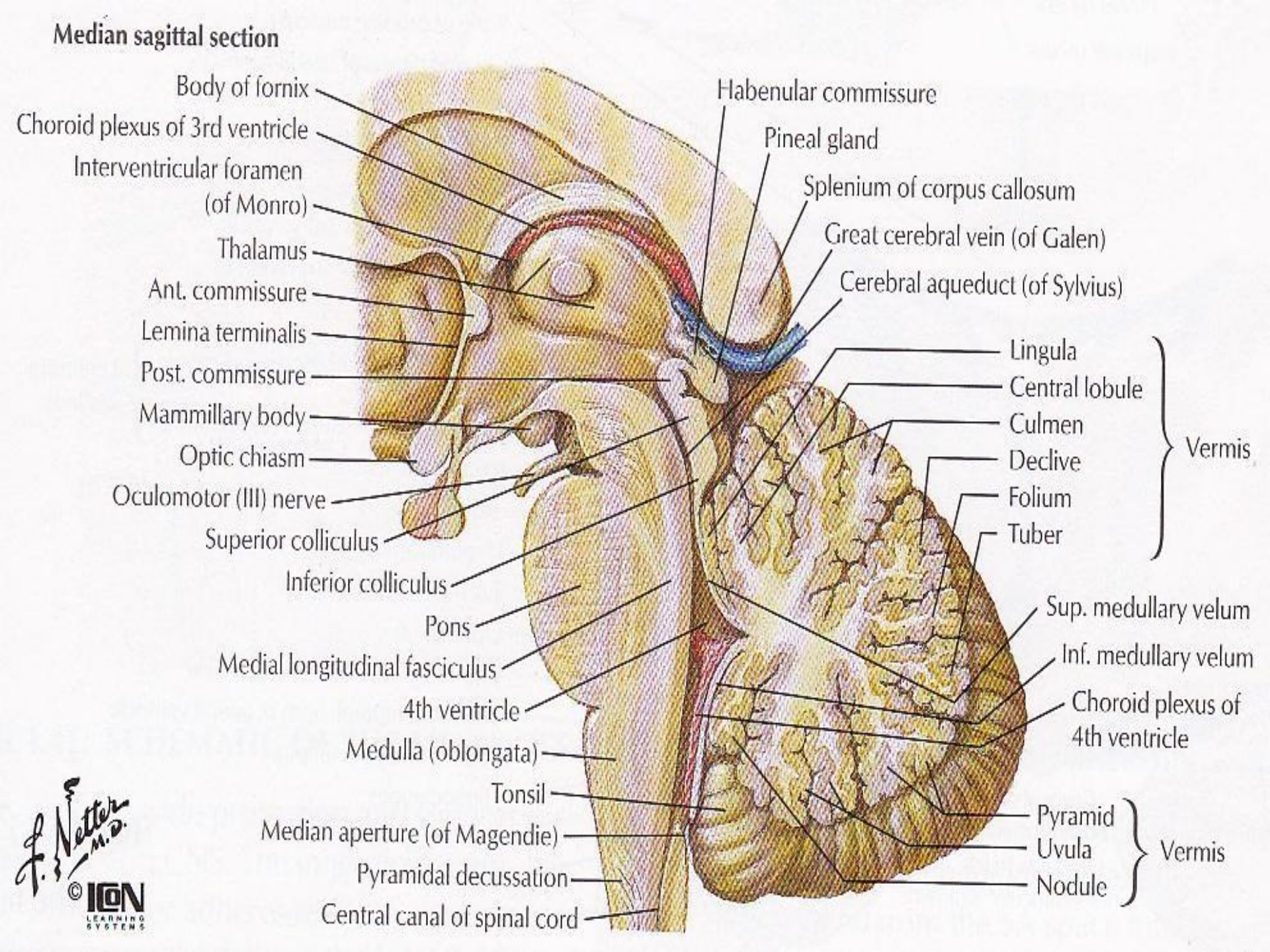
  rostral : diencephalon

  caudal : spinal cord

- Contains numerous ascending and descending fibre tracts

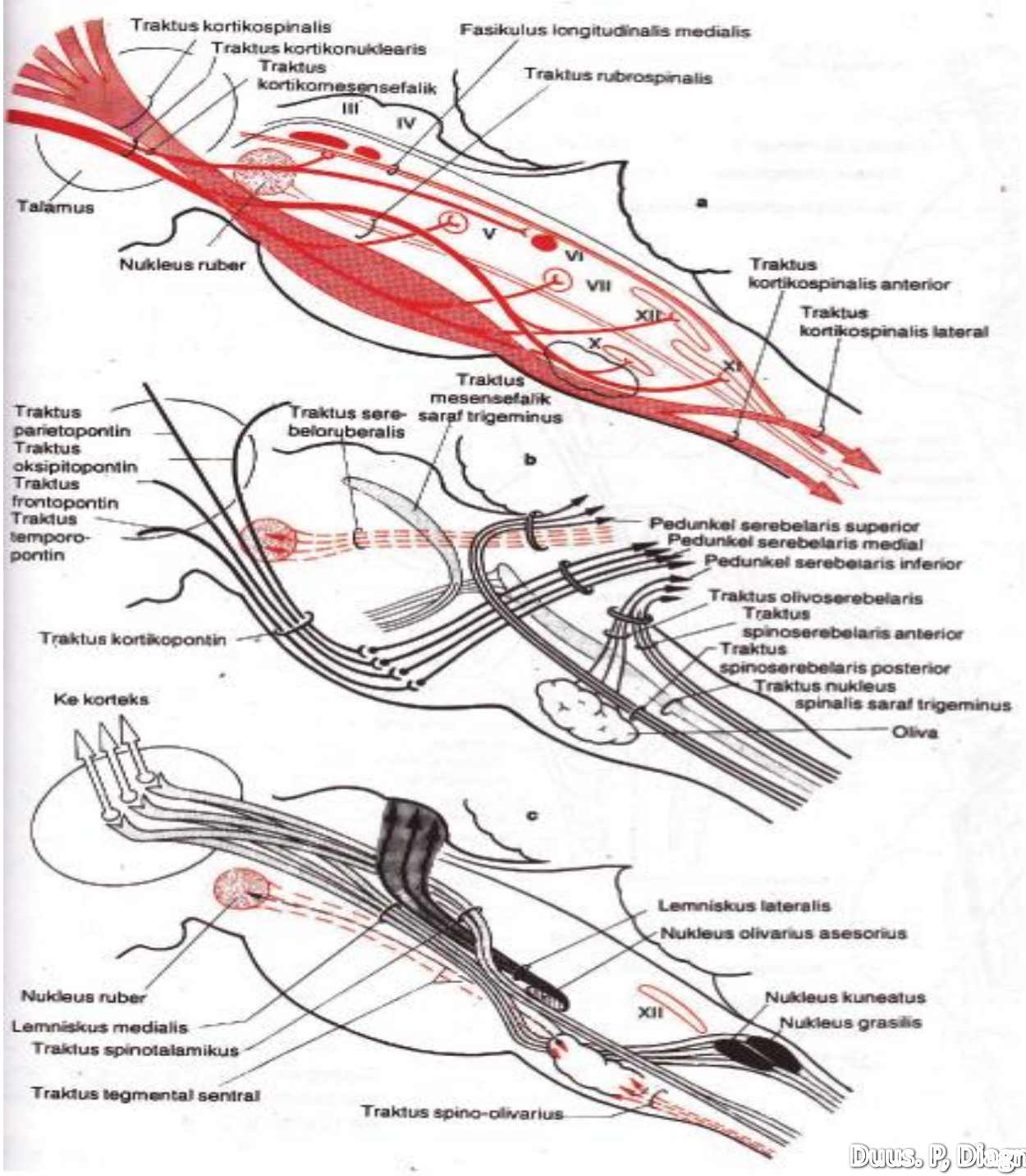
- Brain stem nuclei receive fibres from or sent fibres into cranial nerves (III-XII) attach to the surface of the brain stem → cranial nerve nuclei

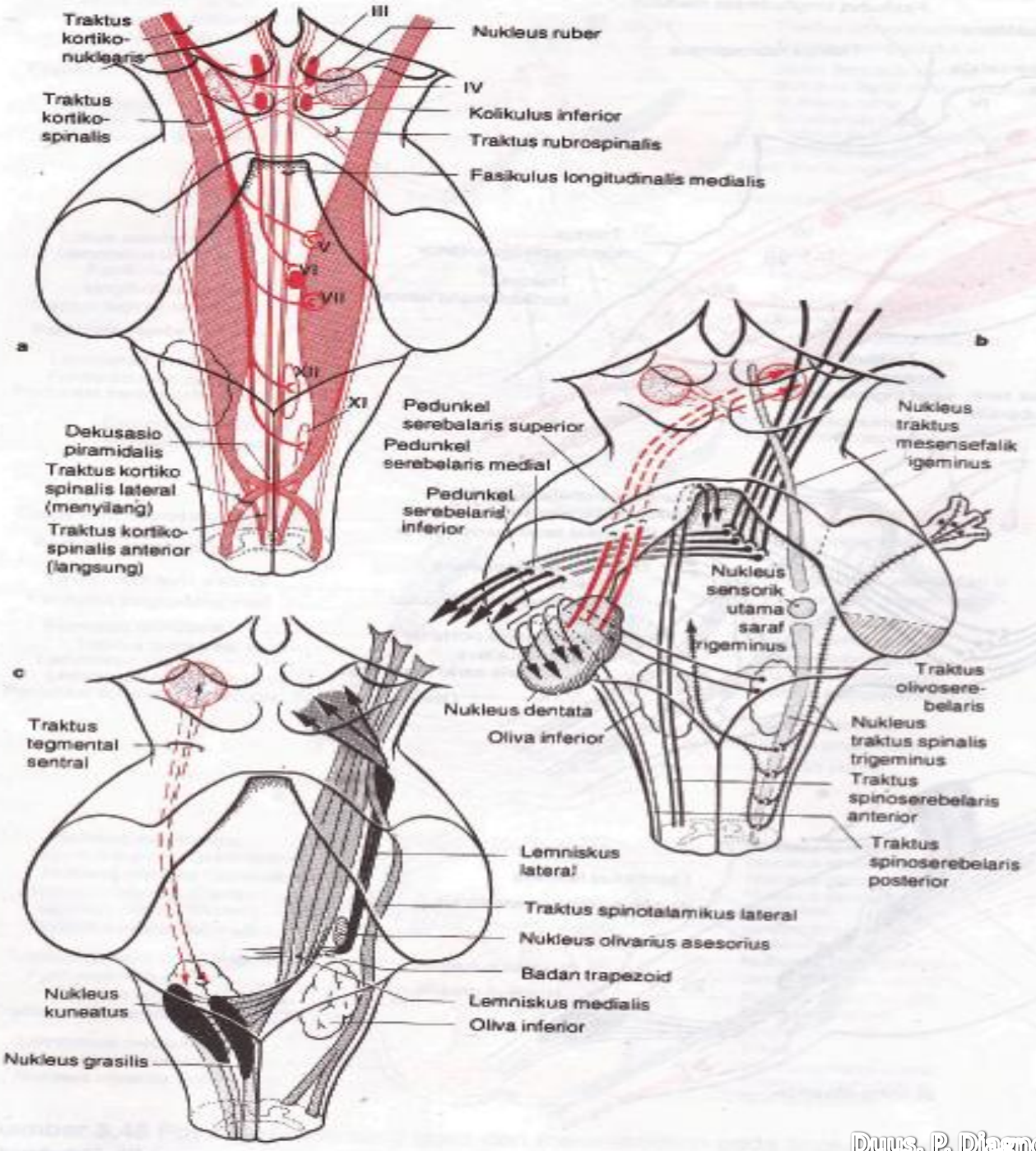
Median sagittal section

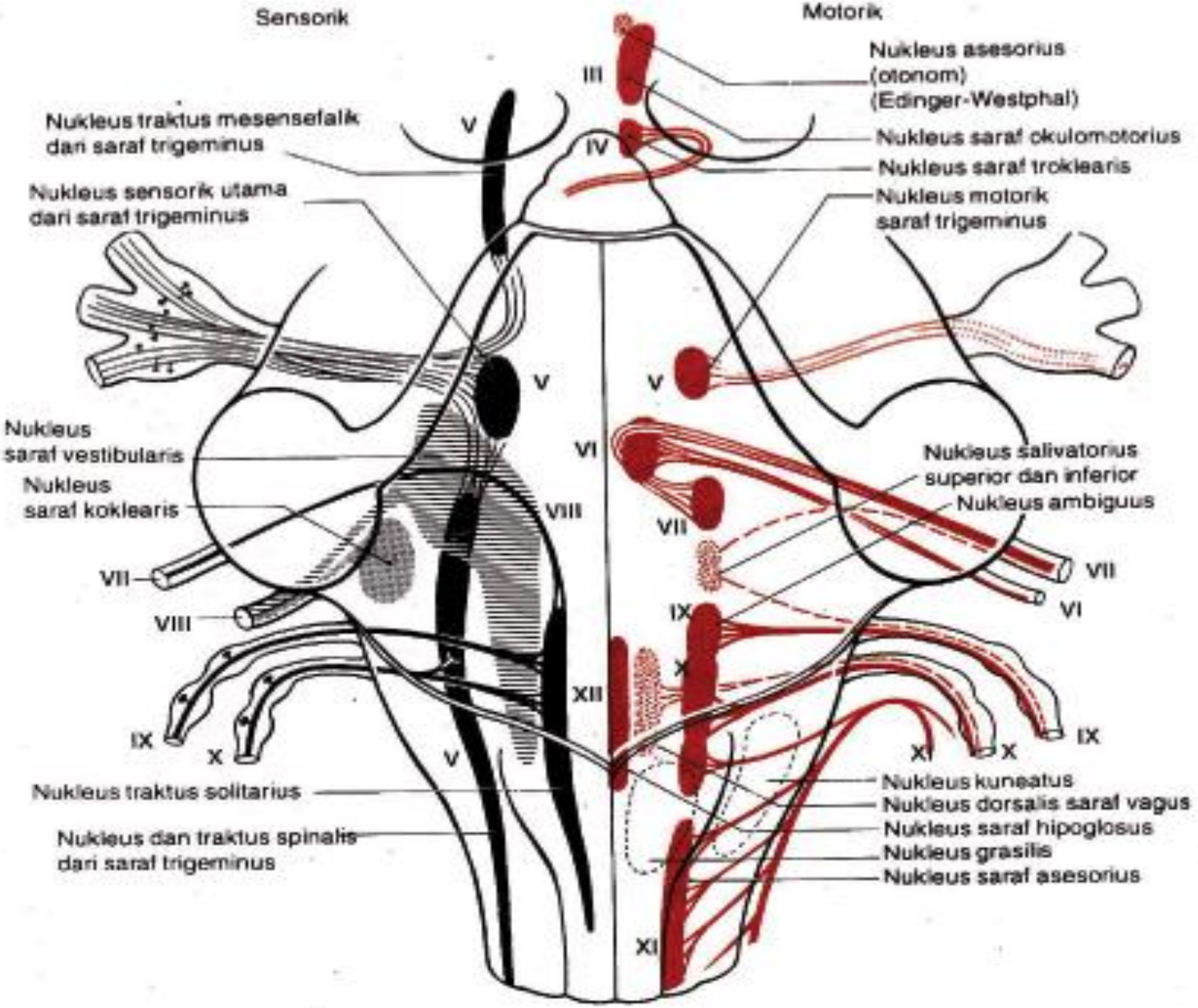


Ascenden and Descenden Pathway of Brain Stem

Ascenden	Descenden
Lemniscus medialis	Traktus corticospinalis
Tractus spinothalamicus	Tractus corticonuclearis
Lemniscus trigeminalis	Corticopontine fibres
Lemniscus lateralis	Tractus rubrospinalis
Reticularis fibres system	Tractus tectospinalis
Fasciculus longitudinalis medialis	Fasciculuc longitudinal medialis
Pedunculus cerebellaris superior	Tractus vestibulospinalis
Pedunculus cerebellaris inferior	Tractus reticulospinalis
Secondary vestibularis fibres	Tractus tegmentalis centralis
Secondary gustatorius fibres	Tractus descenden N.V







Duus. P, Diagnosis Topik Neurologi

Brain Stem

- Contains a complex and heterogeneous matrix of neurones → reticular formation

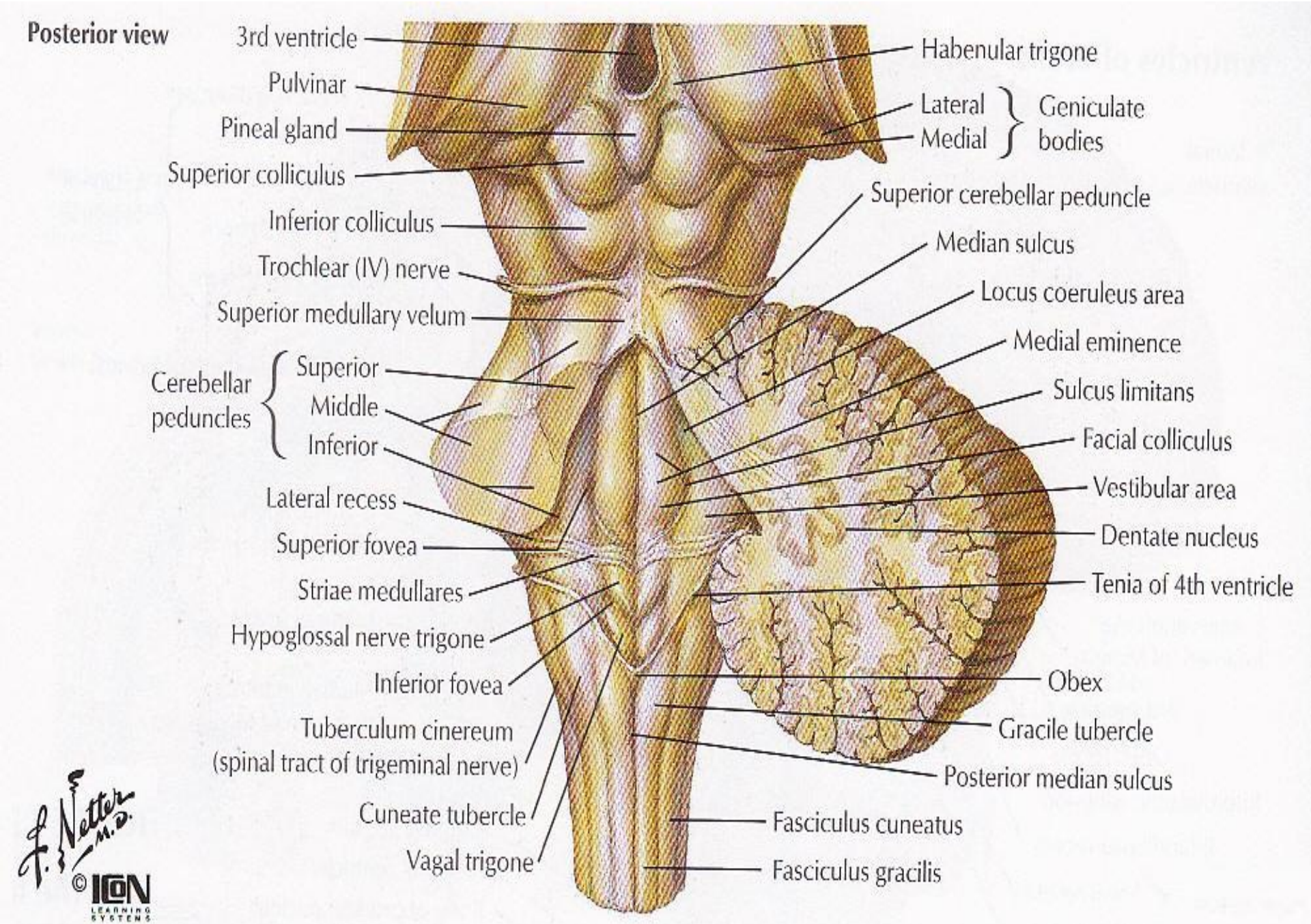
  functions :

- control over the level of consciousness
- the perception of pain
- regulation of the cardiovascular and respiratory systems

- It also has extensive connections with cranial nerve nuclei, cerebellum, brain stem and spinal motor mechanisms → movement, posture and muscle tone

Dorsal Surface (External Feature)

- Peduncles
- Dorsal median sulcus
- Dorsal columns (fasciculi gracilis and cuneatus)
- Gracile and cuneate tubercles (nuclei gracilis and cuneatus)
- Fossa rhomboidea (floor of fourth ventricle)
- Lateral aperture (foramen of Luschka)
- Superior, inferior cerebellar peduncles
- Cerebral aquaduct
- Superior and inferior colliculi
- Trochlear nerve (IV cranial nerve)


Posterior view
3rd ventricle
Pulvinar
Pineal gland
Superior colliculus
Inferior colliculus
Trochlear (IV) nerve
Superior medullary velum
Cerebellar peduncles
Superior
Middle
Inferior
Lateral recess
Superior fovea
Striae medullares
Hypoglossal nerve trigone
Inferior fovea
Tuberculum cinereum (spinal tract of trigeminal nerve)
Cuneate tubercle
Vagal trigone
Habenular trigone
Lateral
Medial
Geniculate bodies
Superior cerebellar peduncle
Median sulcus
Locus coeruleus area
Medial eminence
Sulcus limitans
Facial colliculus
Vestibular area
Dentate nucleus
Tenia of 4th ventricle
Obex
Gracile tubercle
Posterior median sulcus
Fasciculus cuneatus
Fasciculus gracilis
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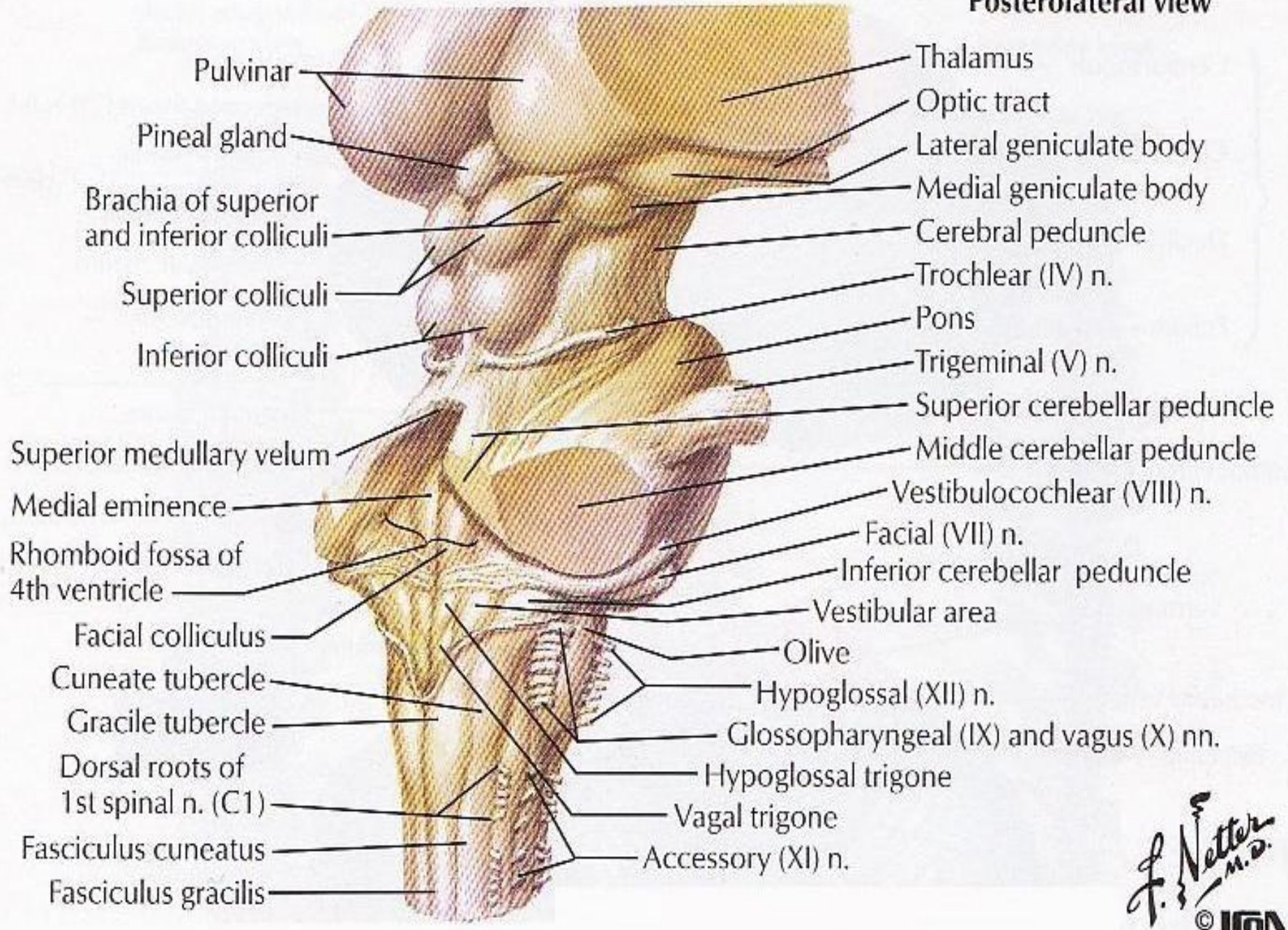
Posterolateral view



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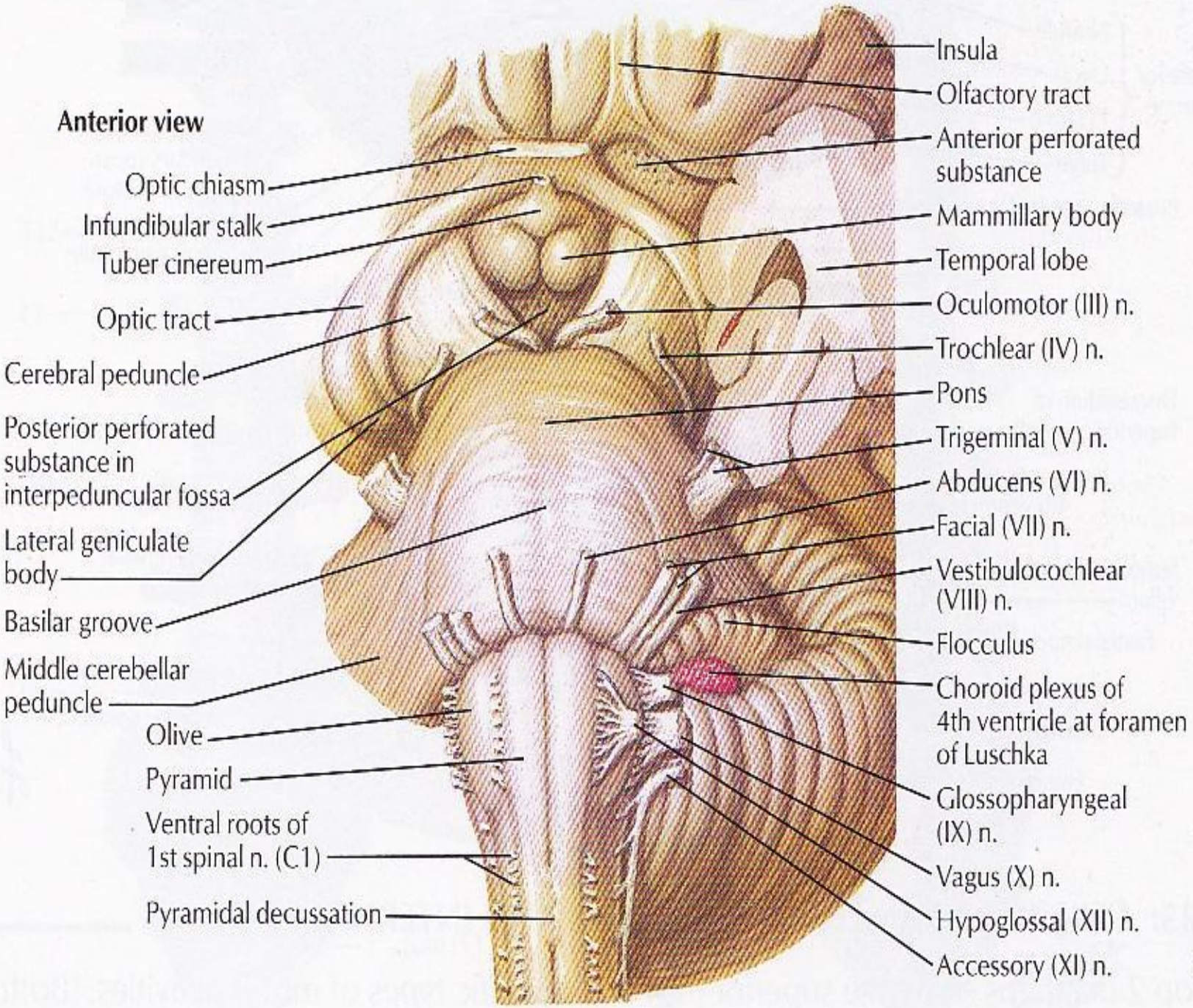
Vental Surface (External future)

- Pyramids
- Decussation of the pyramids
- Olive (inferior olivary nucleus)
- Middle cerebellar peduncle
- Crus cerebri / basis pedunculi
- Interpeduncular fossa


Anterior view
Optic chiasm
Infundibular stalk
Tuber cinereum
Optic tract
Cerebral peduncle
Posterior perforated substance in interpeduncular fossa
Lateral geniculate body
Basilar groove
Middle cerebellar peduncle
Olive
Pyramid
Ventral roots of 1st spinal n. (C1)
Pyramidal decussation
Insula
Olfactory tract
Anterior perforated substance
Mammillary body
Temporal lobe
Oculomotor (III) n.
Trochlear (IV) n.
Pons
Trigeminal (V) n.
Abducens (VI) n.
Facial (VII) n.
Vestibulocochlear (VIII) n.
Flocculus
Choroid plexus of 4th ventricle at foramen of Luschka
Glossopharyngeal (IX) n.
Vagus (X) n.
Hypoglossal (XII) n.
Accessory (XI) n.
F. Netter M.D.
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Caudal Medulla (Internal Structure)

- The pattern of grey and white matter undergoes considerable rearrangement at the transition from spinal cord to medulla :

  - the ventral horn becomes much attenuated

  - the dorsal horn replaced by the caudal part of the trigeminal sensory nucleus (nucleus of the spinal tract of the trigeminal nerve)

- Caudal part of the trigeminal nucleus → particularly associated with the modalities of pain and temperature

- Ventral medulla :

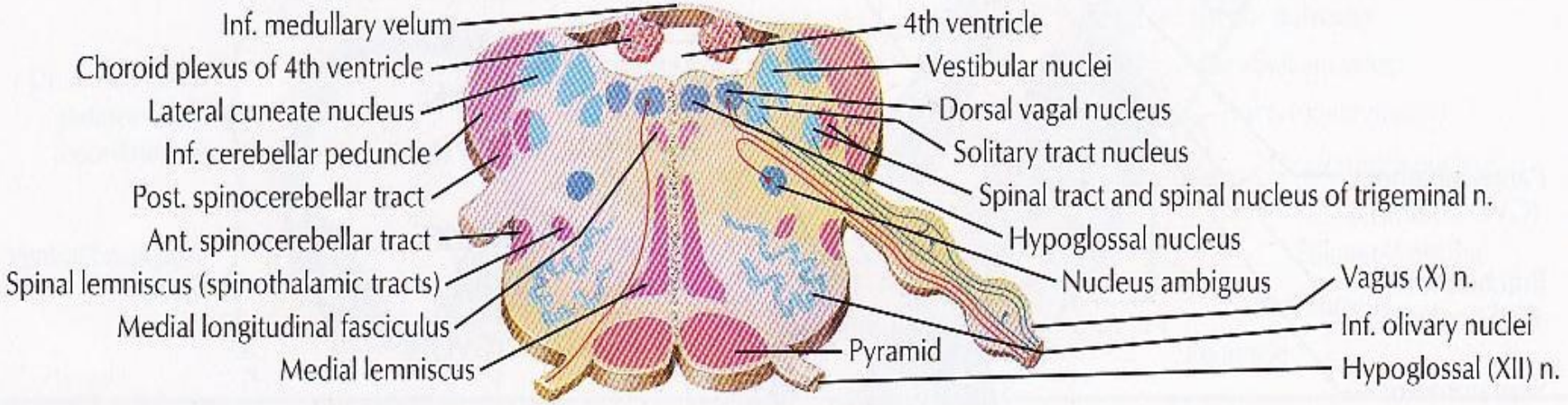
  the majority of fibres of the pyramid →

  - decussation : tractus corticospinalis lateral

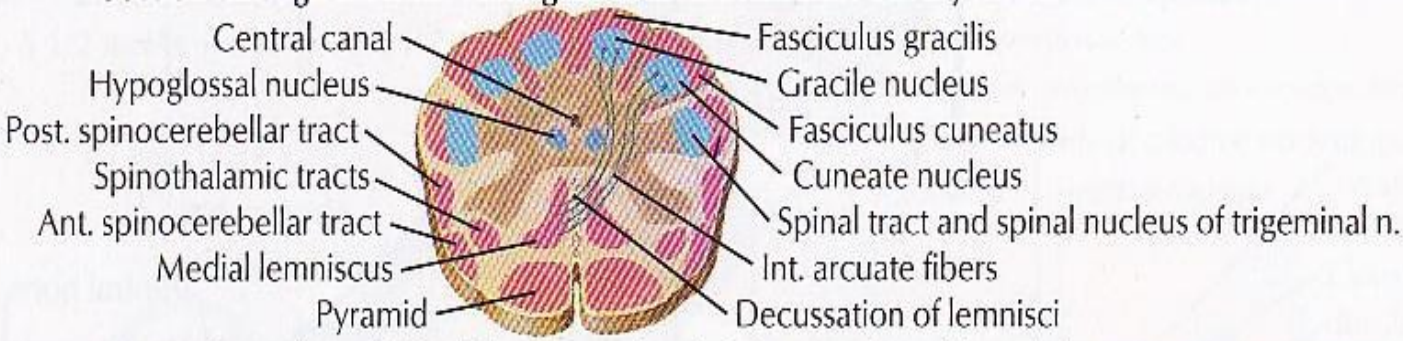
  - direct : tractus corticospinal medial

Mid-Medulla (Internal Structure)

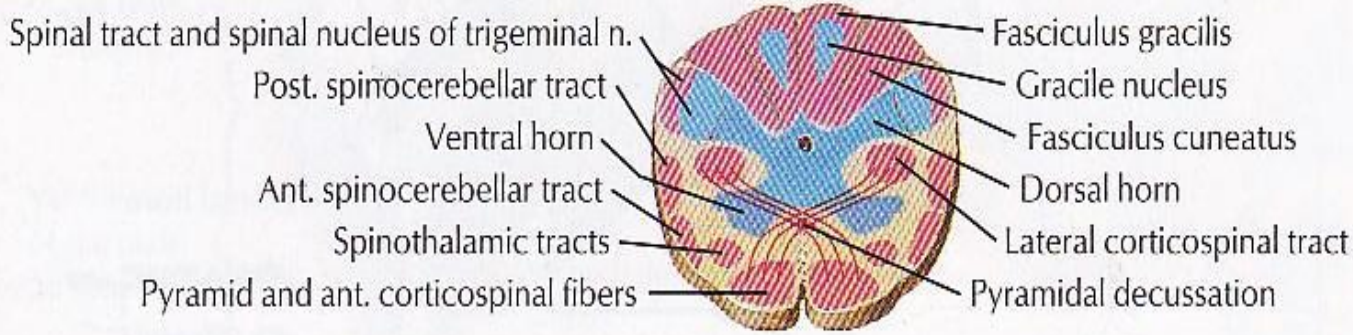
- Ventral surface → **pyramids** are prominent (above their decussation)
- Dorsal surface → **the gracile and cuneate nucleus** (the terminal of ascending fibres of the dorsal column)
- The dorsal columns consist : first order sensory neurones → terminate in the nuclei gracilis and cuneatus → Second-order neurons (internal arcuate fibres) → medial lemniscus → Third-order neurones (ventral posterior nucleus of the thalamus)



Section through medulla oblongata at level of inferior olivary nuclei



Section through medulla oblongata at level of decussation of lemnisci



Section through medulla oblongata at level of pyramidal decussation

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Rostral Medulla (Internal Structure)

- Ventral surface : descending fibres of the pyramids remain conspicuous

- dorsomedial of pyramids : **Medial lemniscus**

- Dorsolateral to pyramids, lateral to medial lemniscus : **Inferior olivary nucleus** (Olive):

- control the movement
- receives afferents from motor and sensory cortices of cortex cerebri and nucleus rubra (red body)

- Hilum of Inferior olivary nucleus (facing medially) through which afferent and efferent fibres pass.

Rostral Medulla (Internal Structure)

- Hilum of Inferior olivary nucleus (facing medially) through which afferent and efferent fibres pass.
- Efferent fibres (Inferior olivary nucleus) → inferior cerebellar peduncle → dentate nucleus and upon purkinje cells of the cerebellar cortex
- Dorsal to Inferior olivary nucleus, lateral to medial lemniscus : trigeminothalamic tract / trigeminal lemniscus and spinal lemniscus / spinothalmic fibres

Rostral Medulla (Internal Structure)

- Dorsal surface : **floor of the fourth ventricle**

- Hypoglossal nucleus

motor neurones innervating the muscle of the tongue via N.XII

- Dorsal motor nucleus of the vagus

preganglion parasympathetic neurones that run in N.X

- Area postrema

central site of action of substances that cause vomiting (emetics)

Rostral Medulla (Internal Structure)

- **Vestibular nuclei**

receive primary afferent fibres from the vestibular nerve

- **Medial longitudinal fasciculus**

*consists of both ascending and descending fibres.

*links vestibular nuclei with the nuclei supplying the extra ocular muscles.

*subserves the coordination of head and eye movements.

Rostral Medulla (Internal Structure)

- **Inferior cerebellar peduncle (restiform body)**

  - consist of fibres passing between medulla and cerebellum

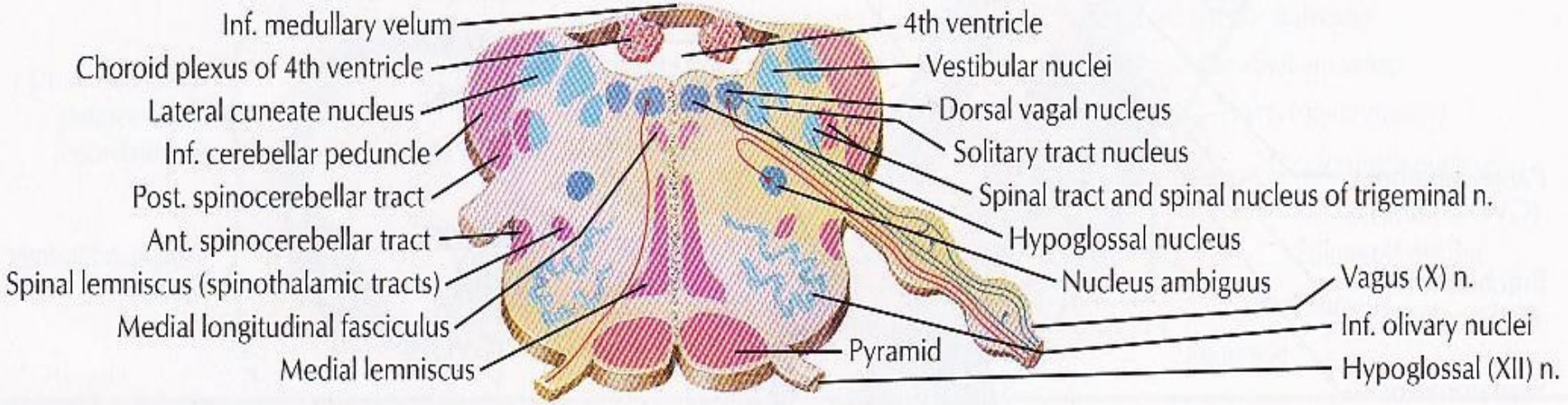
  - conveying proprioceptive information from the limbs → connections between vestibular nuclei and cerebellum (olivocerebellar fibres), the fibres of the dorsal spinocerebellar tract

- **Cochlear nuclei**

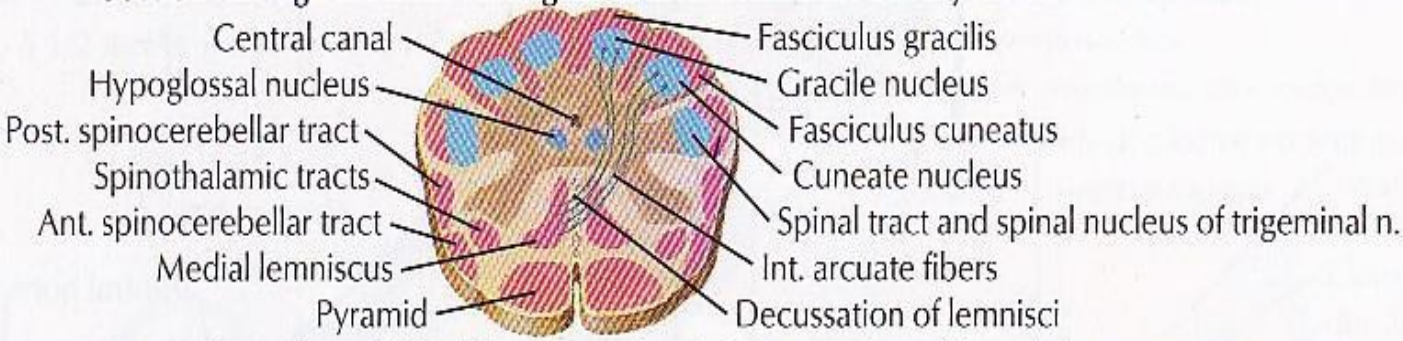
  receive afferent fibres from the cochlear nerve

- **Nucleus ambiguus**

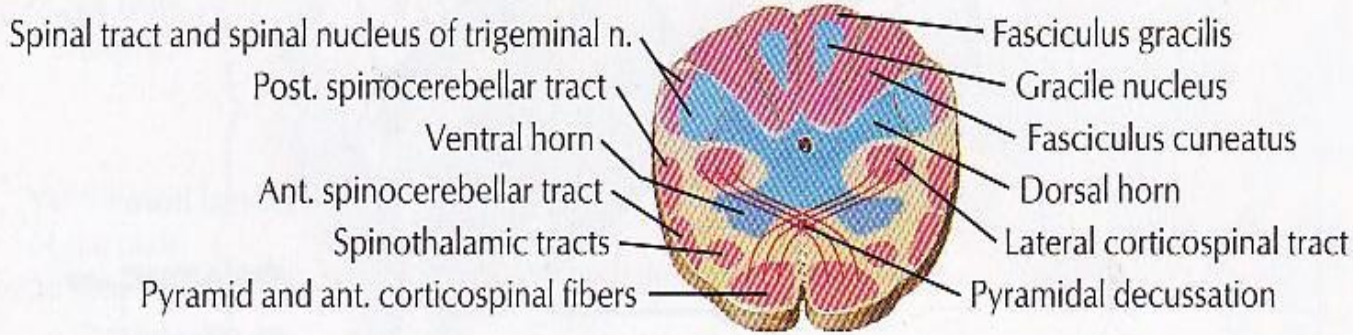
  sends motor fibres into N.IX, X and XI to muscle of pharyng and laryng



Section through medulla oblongata at level of inferior olivary nuclei



Section through medulla oblongata at level of decussation of lemnisci



Section through medulla oblongata at level of pyramidal decussation

Pons

- Devided into ventral/basal and dorsal portion (tegmentum)
- Ventral portion

- marked by numerous transversely oriented fscicles of pontocerebellar fibres

- pontine nuclei

- middle cerebellar peduncle (brachium pontis)

- **Trapezoid body**

consist of acoustic fibres crossing the brain stem from the cochlear nuclei

- acoustic fibres ascend into midbrain as the **Lateral lemniscus** and terminate in the inferior colliculi

Pons

- In pontine tegmentum

  - **Abducens nucleus**

    innervating the lateral rectus muscle

  - **Facial motor nucleus**

    innervating the muscles of the facial expression

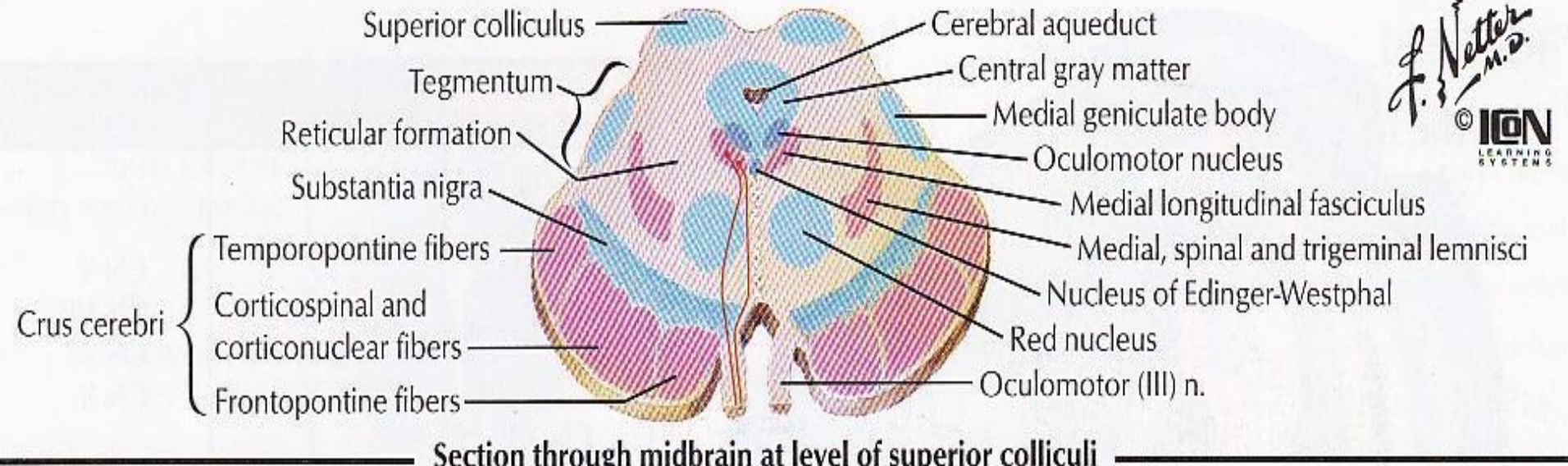
  - **Trigeminal motor nucleus**

    innervating the muscles of mastication

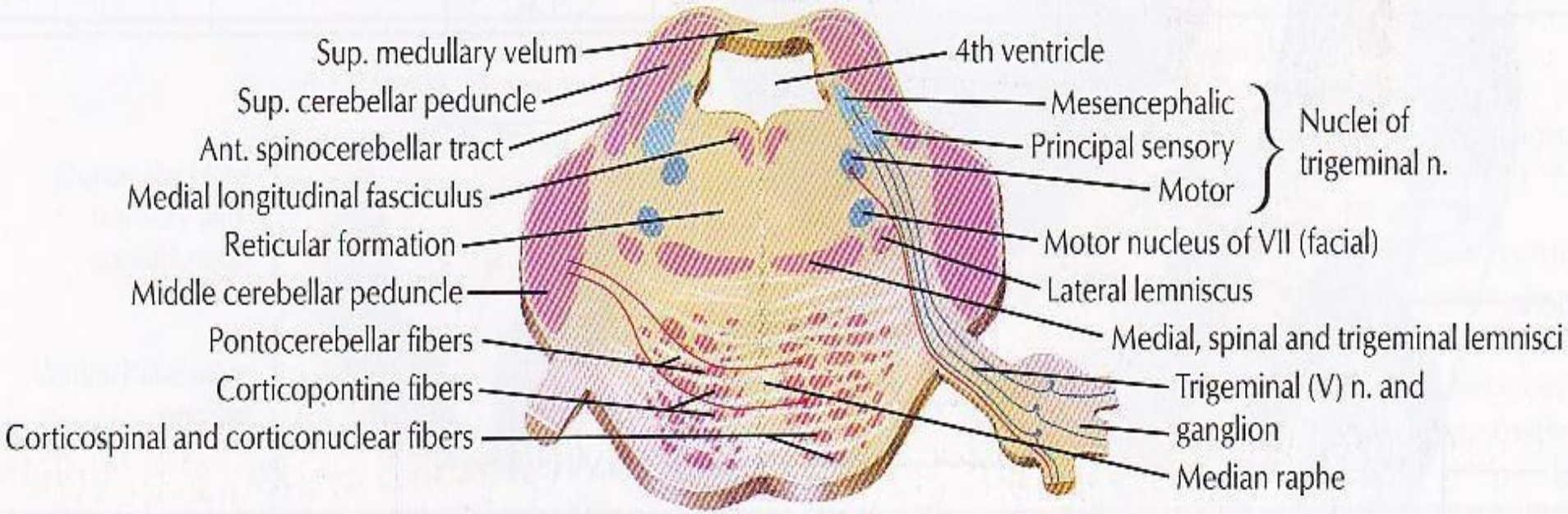
- Rostral part of the pons

  - superior cerebellar peduncle (brachium conjunctivum), contain ventral spinocerebellar tract.

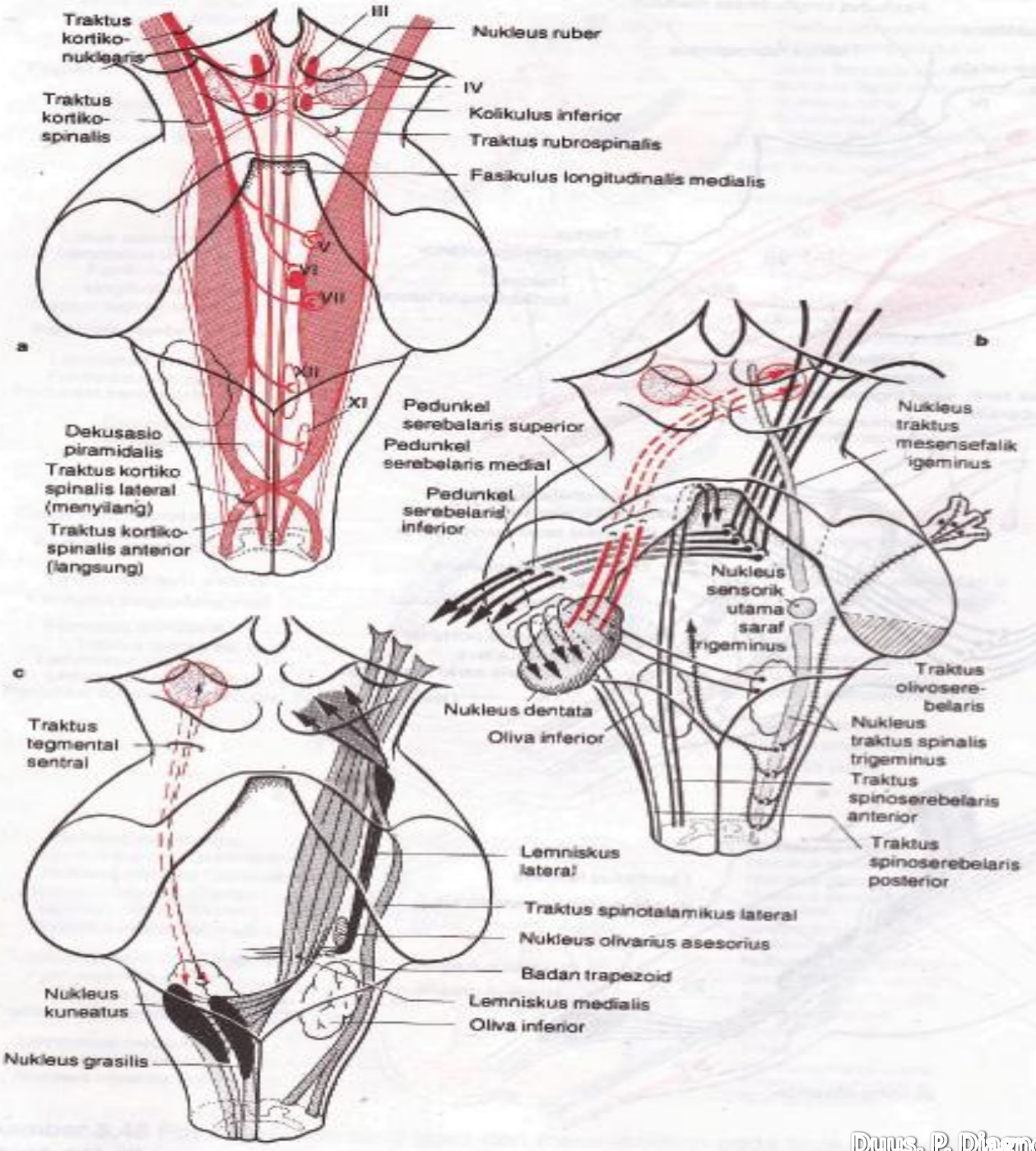
  - superior medullary velum



Section through midbrain at level of superior colliculi



Section through pons at level of trigeminal nerves



Midbrain

- Divided into dorsal and ventral portions at the level of the cerebral aquaduct

- Dorsal portion (tectum)

- inferior and superior colliculi (**corpora quadrigemina**)
- **inferior colliculus** (part of ascending acoustic/auditory projection)

Ascending auditory fibres (lateral lemniscus) → inferior colliculus → efferent fibres → medial geniculate nucleus (thalamus) → auditory cortex (temporal lobe).

Midbrain

- **Superior colliculus** (part of the visual system)

main efferents :

corticotectal fibres from the visual cortex of occipital lobe and from frontal eye field of the frontal lobe.

Concern with :

*controlling movements of eyes → when the moving object is followed (smooth pursuit) or direction of the gaze is altered (saccadic eye movements)

*In addition, these involved in the accommodation reflex

Midbrain

- A small number of visual fibres (optic tract) → superior colliculus, in the **pretectal nucleus**.

  Its connections with parasympathetic neurones :

  - controlling the smooth muscle of the eye
  - part of the circuit mediating the pupillary light reflex.

Midbrain

- **Cerebral aqueduct** : ventral the colliculi

- **Periaqueductal/central grey** : grey matter surrounding the cerebral aqueduct

- **Trochlear and occulomotor nuclei** :

- at ventral of periaqueductal grey, at the level of inferior and superior colliculi

- innervate the extraocular muscles controlling eye movements)

- close to the nuclei runs **medial longitudinal fasciculus** (links them to abducens nucleus in pons and is important in the control of gaze)

Midbrain

- **Superior cerebellar peduncle (brachium conjunctivum)**

  - at the level of the inferior colliculi

  - beneath the inferior colliculus, its decussate in the midline

- **Red body/nucleus rubra**

  - the terminal of superior cerebellar peduncle fibres

  - Involved in motor control

  - Efferent fibres of red body cross in the ventral tegmental decussation and descend to the spinal cord in the **rubrospinal tract**

  - projects to inferior olivary nucleus via **central tegmental tract**

Midbrain

- **Substantia nigra**

- ventral part of the midbrain tegmentum

- subdivision of substansia nigra :

pars compacta :

consists of the pigmented, melanin containing neurones that synthesise dopamine as their transmitter.

Project to the caudate nucleus and putamen of the basal ganglia in the forebrain.

Degeneration of the part compacta → parkinson's disease.

pars reticulate :

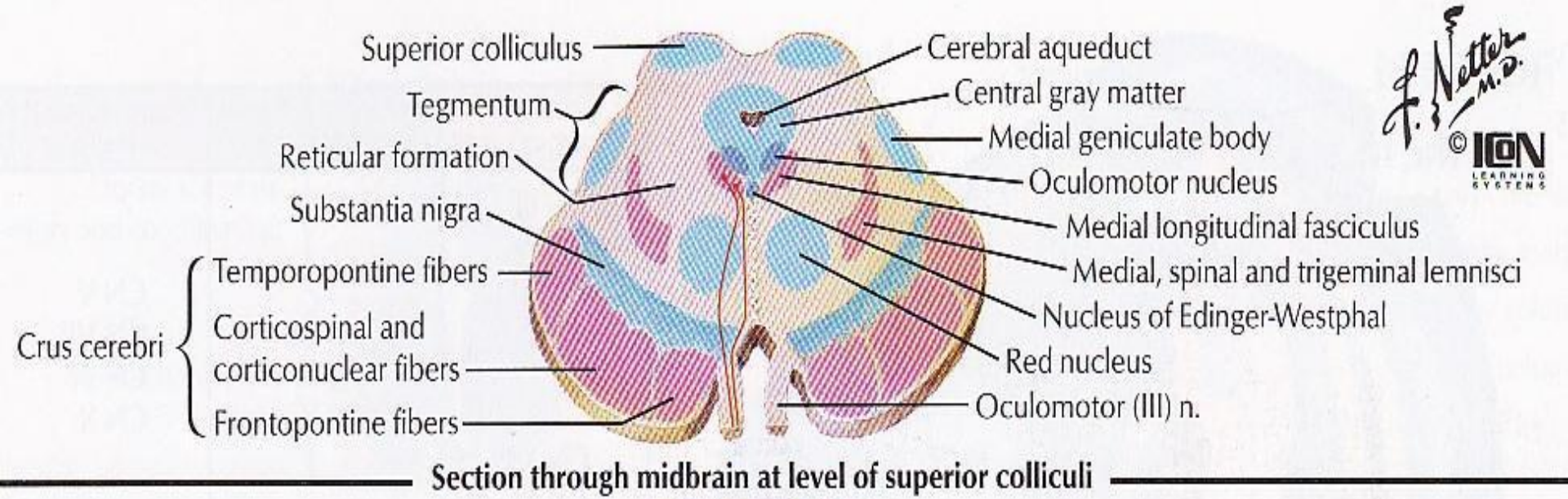
non-pigmented.

It is considered to be a functional homologue of the medial segmen of the globus pallidus

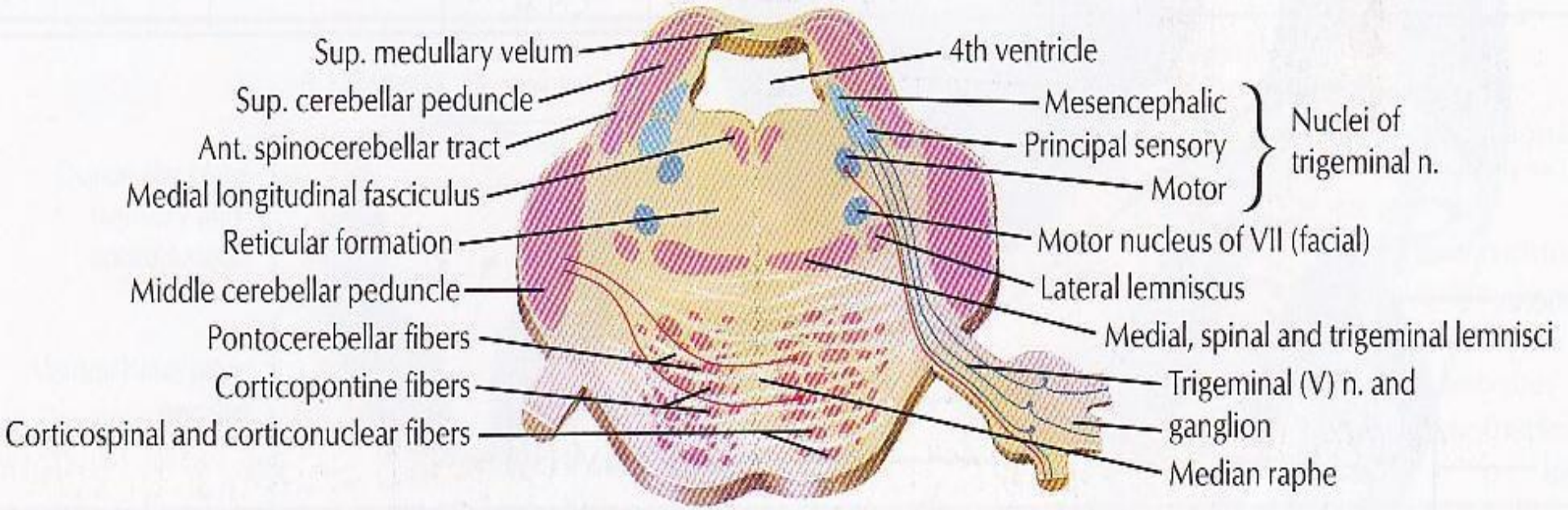
Midbrain

- **Crus cerebri**

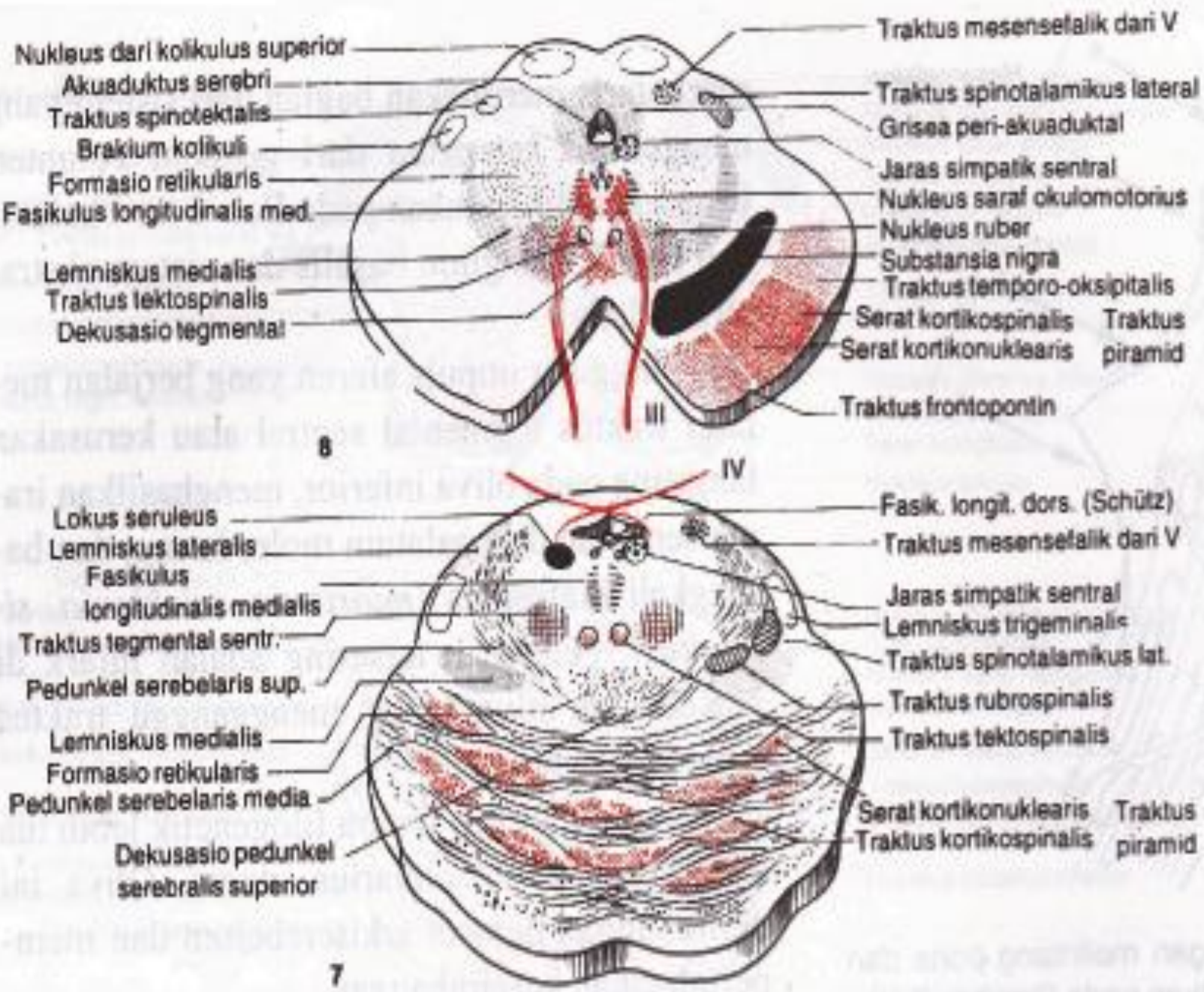
* Ventral to the substantia nigra
* consists entirely descending cortical efferent fibres that have left the cerebral hemisphere (by traversing internal capsule)
* Approximately middle 50% of crus cerebri consists of corticobulbar and corticospinal fibres
* On the other side of corticobulbar and corticospinal fibres → corticopontine fibres (frontopontine and temporopontine fibres)



Section through midbrain at level of superior colliculi



Section through pons at level of trigeminal nerves



Reticular Formation

- Consists of the complex matrix of neurones that extends throughout the length of the brain stem.

- its neurones fulfil a number of important functions, some of which are necessary for survival, such as respiratory and cardiovascular system.

- Some functions are subserved, however, by more dispersed networks that do not correspond exactly to anatomically identified nuclei. The latter applies to the so-called respiratory and cardiovascular centres.

Reticular Formation

- Descending reticulospinal tracts

- originate from the medullary and pontine reticular formation

- predominantly influence muscle tone and posture

- Some of the ascending fibres of the reticular formation constitude the reticular activating system

- These neurones receive input, either directly or indirectly, from multiple sensory sources

Reticular Formation

- **Raphe nuclei**

- group of midline nuclei that extend throughout the length of the brain stem

- utilizing serotonin(5-hydroxytryptamine, 5-HT) as their transmitter

- ascending fibres to forebrain structures are involved in the neural mechanisms of sleep

- descending fibres to the spinal cord are involved in the modulation of nociceptive mechanisms

Reticular Formation

- **locus coeruleus**

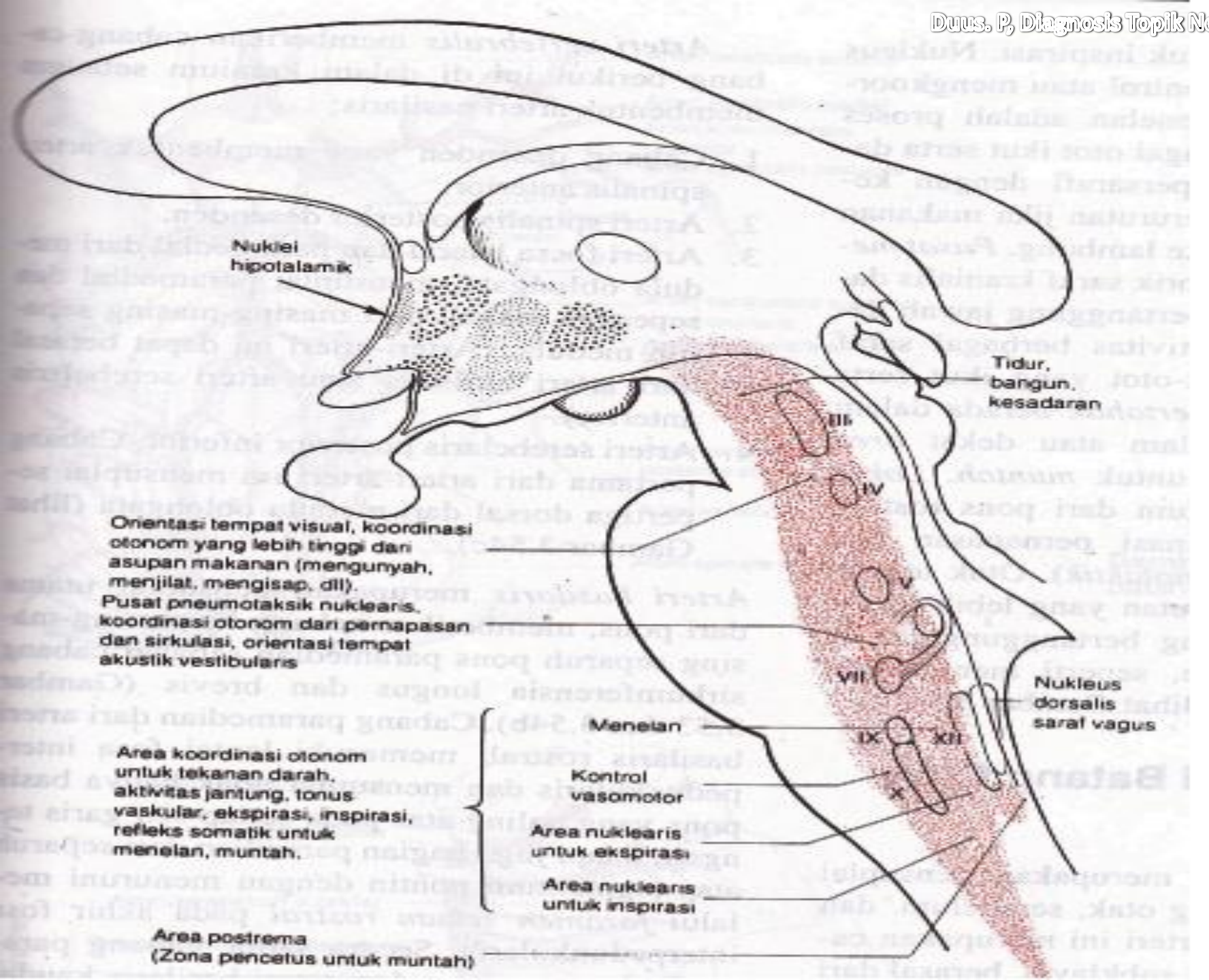
- group of pigmented neurones that lies in the brain stem tegmentum of the caudal midbrain and rostral pons

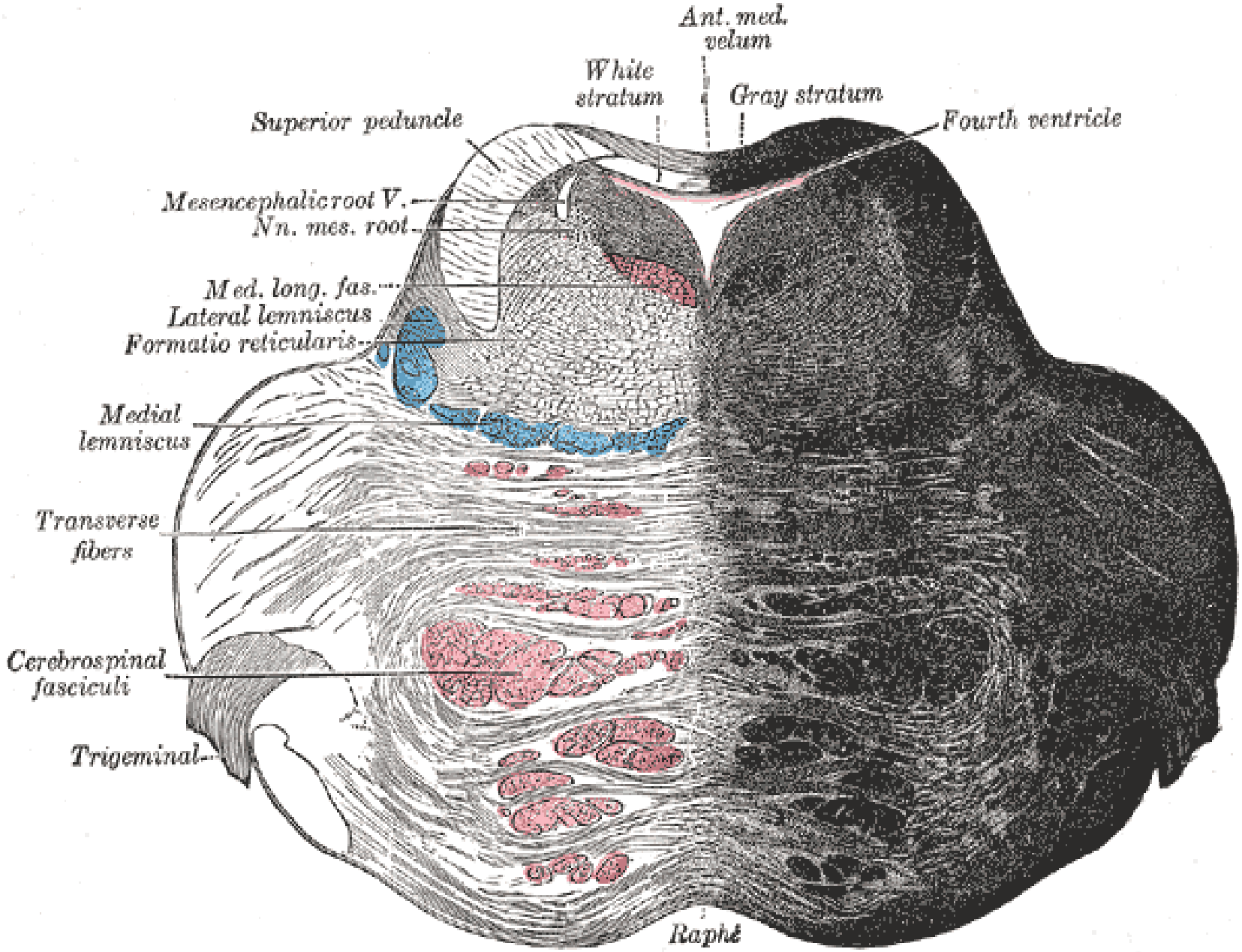
- the principal noradrenergic cell group of the brain

- Ascending fibres → cerebellum, hypothalamus, thalamus, limbic structures and cerebral cortex

- Descending fibres project widely throughout the brain stem and spinal cord

- implicated in the neural mechanisms regulating sleep, particularly REM (rapis eye movement) sleep





Brain Stem Lesion

- A unilateral brain stem lesion caused by stroke, tumour or multiple sclerosis cause:
  - Ipsilateral cranial nerve dysfunction
  - Contralateral spastic hemiparesis
  - Hyperreflexia and extensor plantar response (UMN lesion)
  - Contralateral hemisensory loss
  - Ipsilateral incoordination

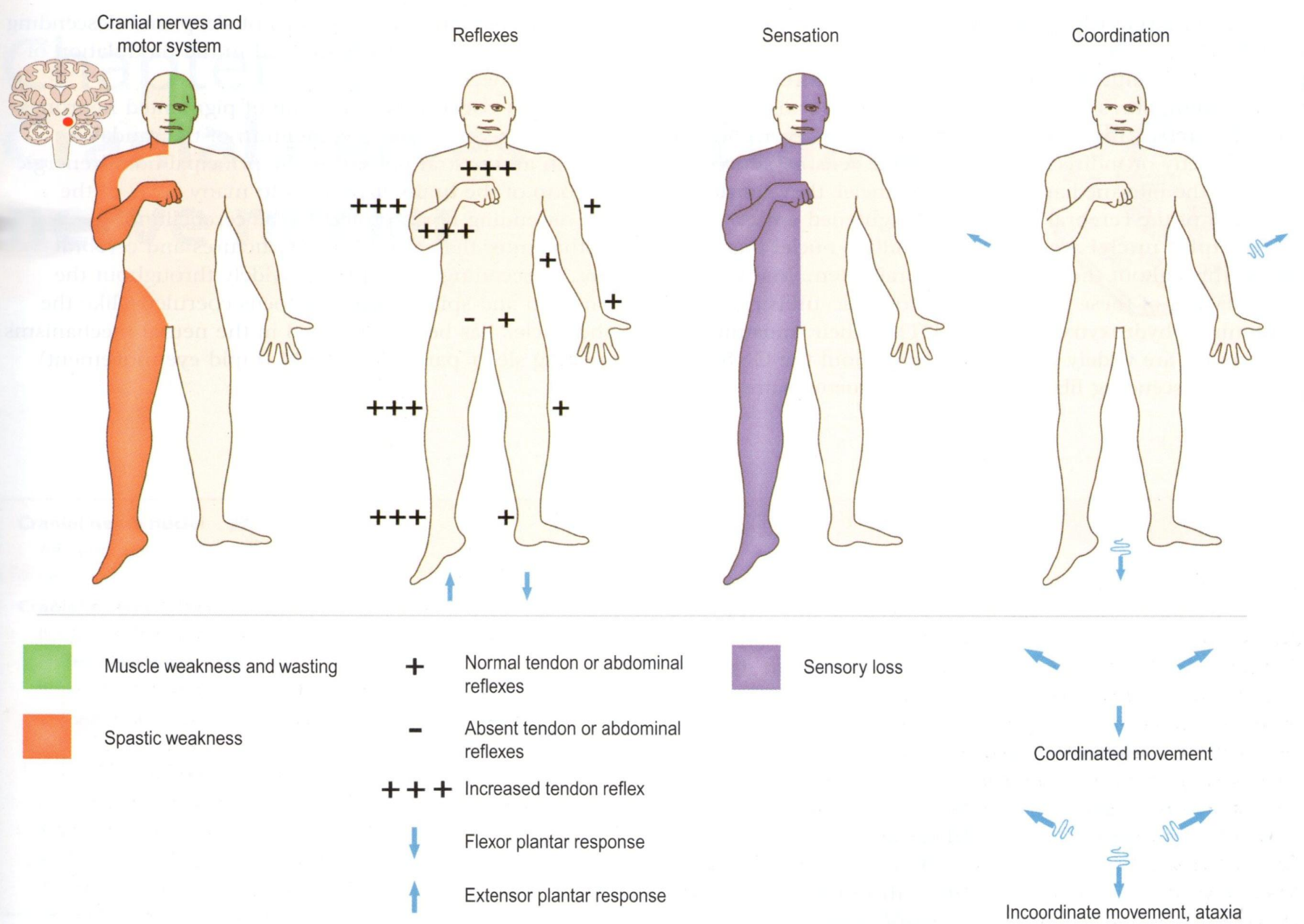


Figure 9.14 **Brain stem lesion.**

Brain Stem Lesion

- A bilateral lesion destroys the “vital centres” for respiration and the circulation, leading to coma and death.
- Multiple sclerosis can affect eye movements through demyelination of the medial longitudinal fasciculus, which interferes with conjugate ocular deviation

Brain Stem Lesion

- Typically, on horizontal gaze, the abducting eye moves normally but the adducting eye fails to follow. Adduction is preserved on convergence. Internuclear opthalmoplegia is the term used to describe this disorder

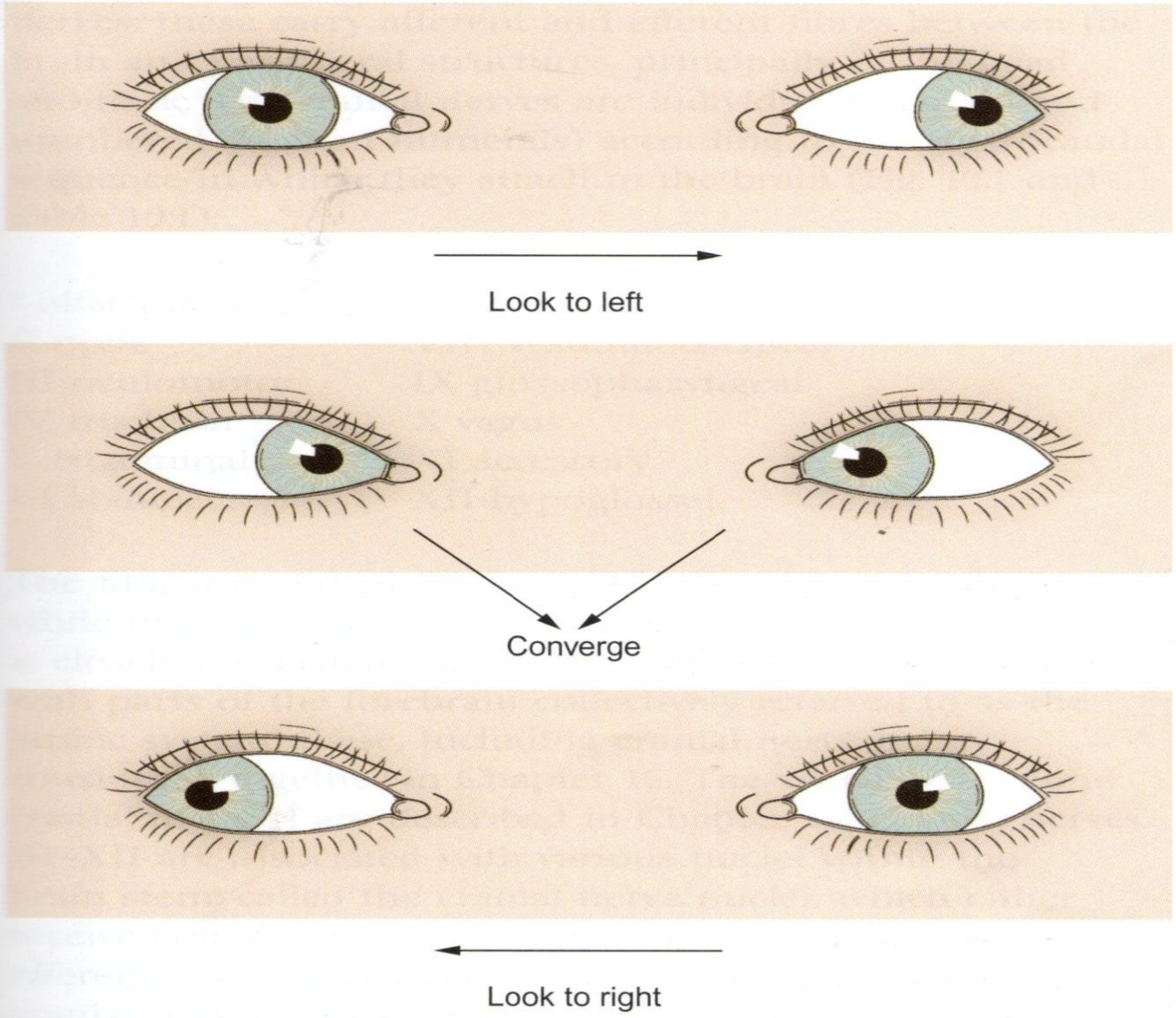


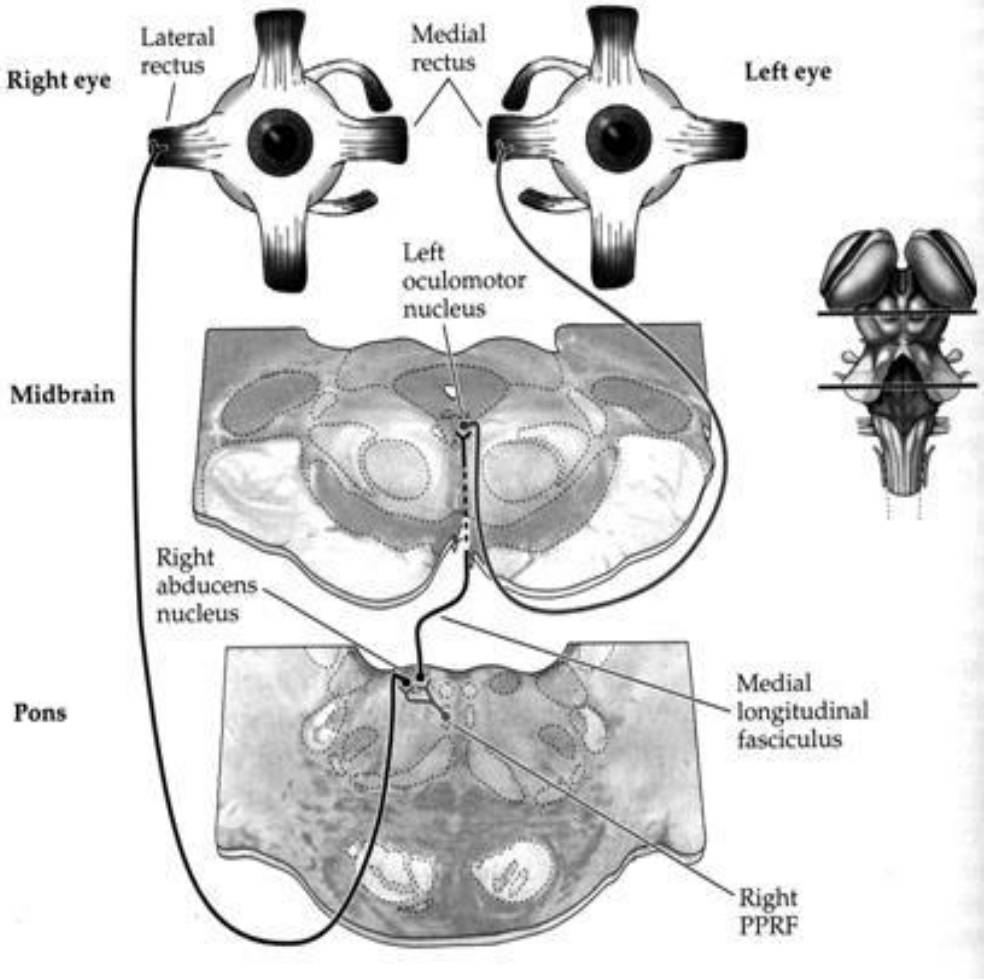
Figure 9.15 **Internuclear ophthalmoplegia.**

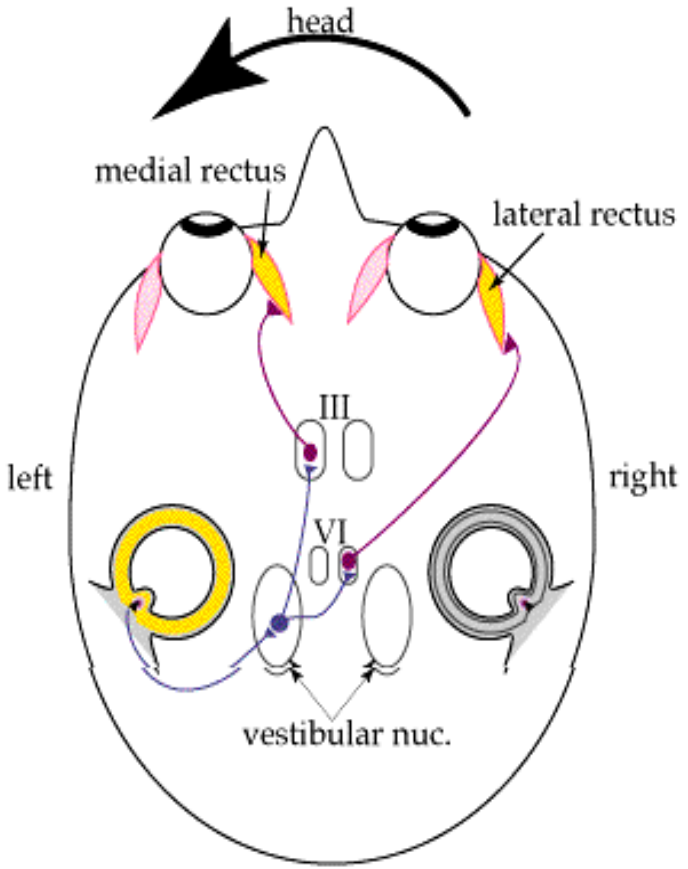
Internuclear ophthalmoplegia (INO)

- To produce synchronous eye movements :

  N. III, IV and VI communicate through the medial longitudinal fasciculus (MLF) in the dorsomedial brainstem tegmentum of either the pons or the midbrain
- (INO) → specific gaze abnormality characterized by impaired horizontal eye movement with :
  - weak adduction of the affected eye
  - abduction nystagmus of the contralateral eye

Internuclear ophthalmoplegia (INO)





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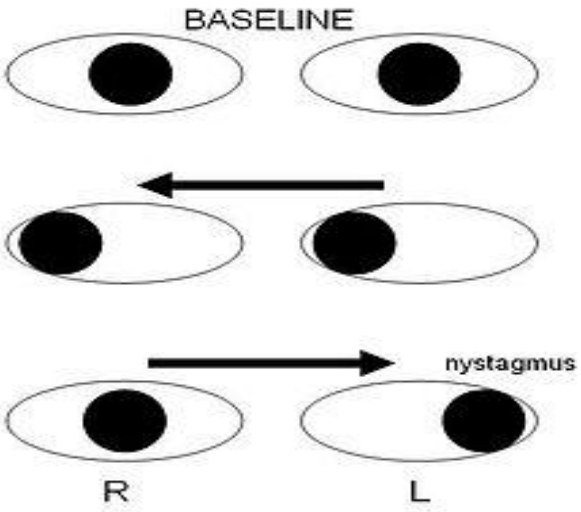
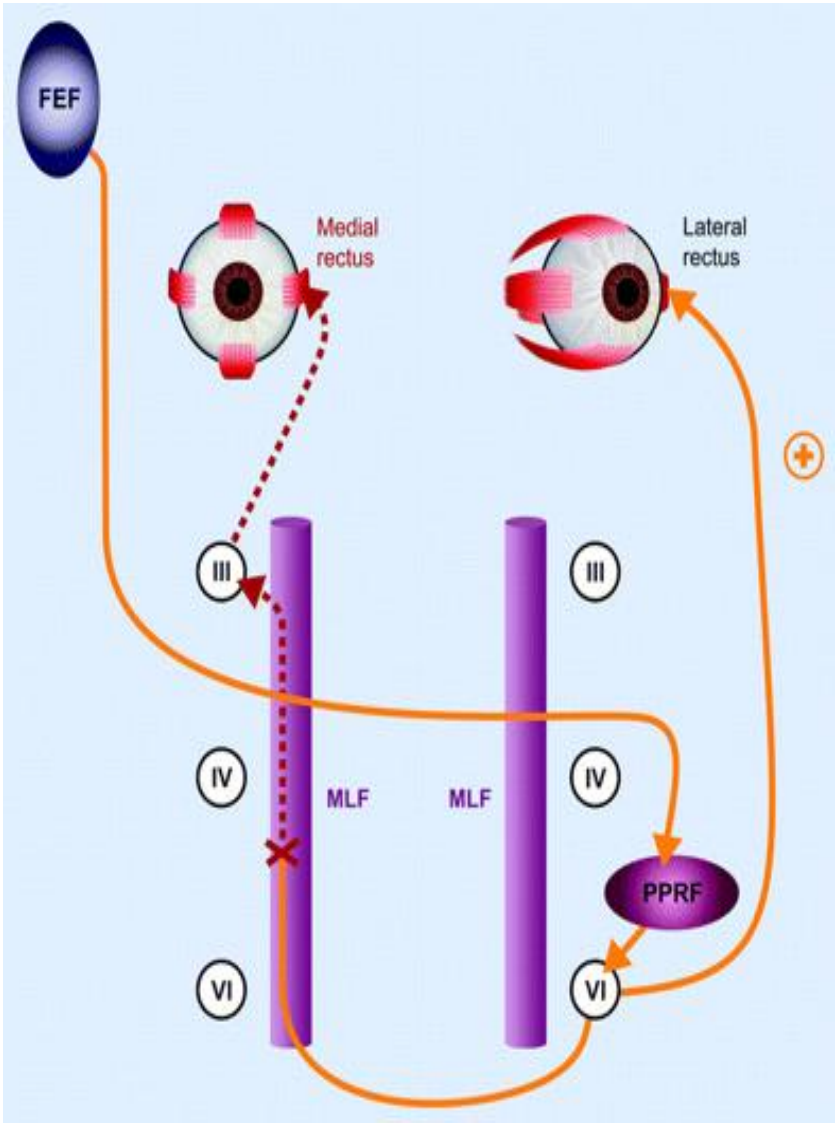
Internuclear ophthalmoplegia (INO)

- A lesion of the right MLF would not allow the neural impulse to reach the right medial rectus.

- the left eye would abduct.

- the right eye would not adduct. Further, the left eye would go into an abducting nystagmus.





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