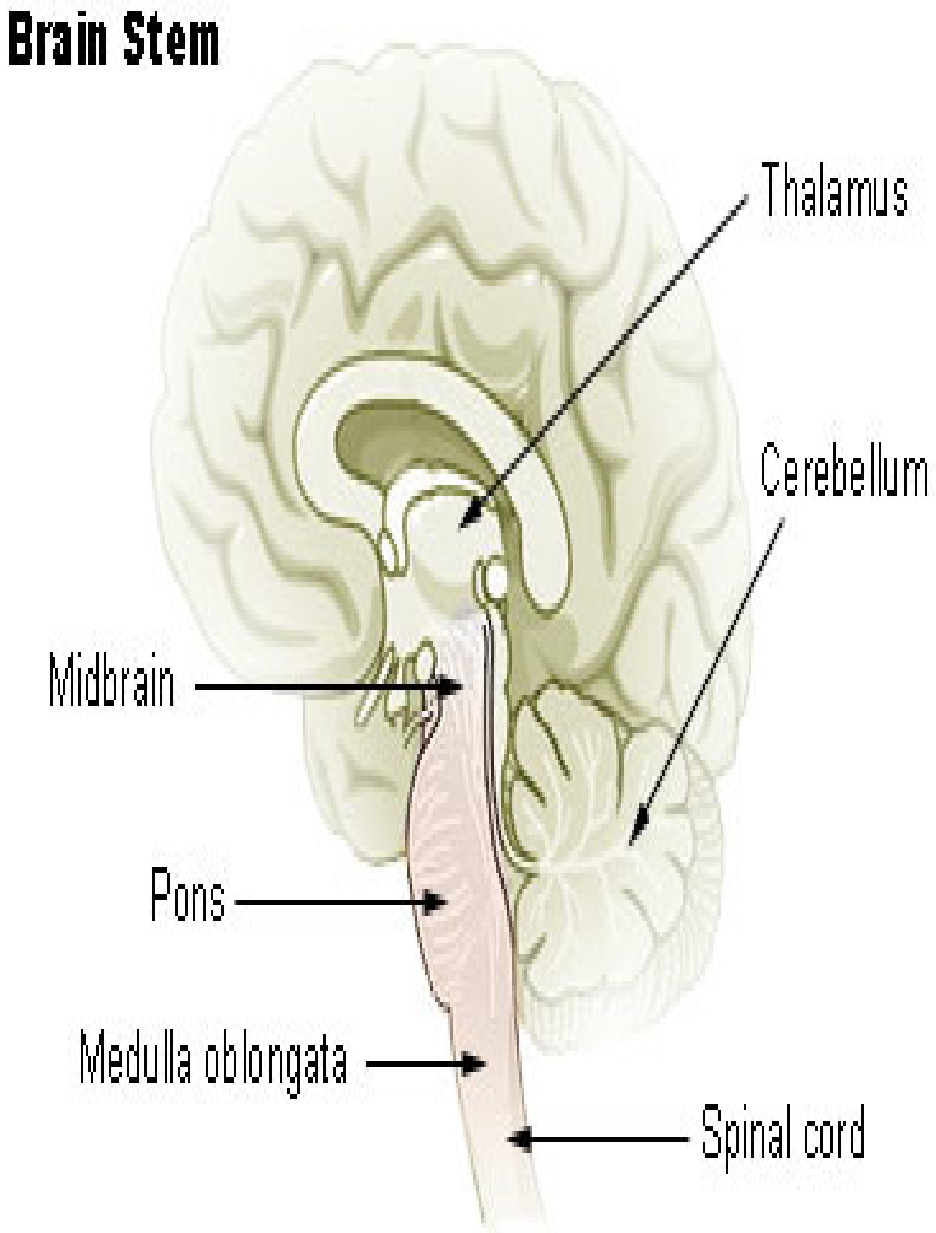
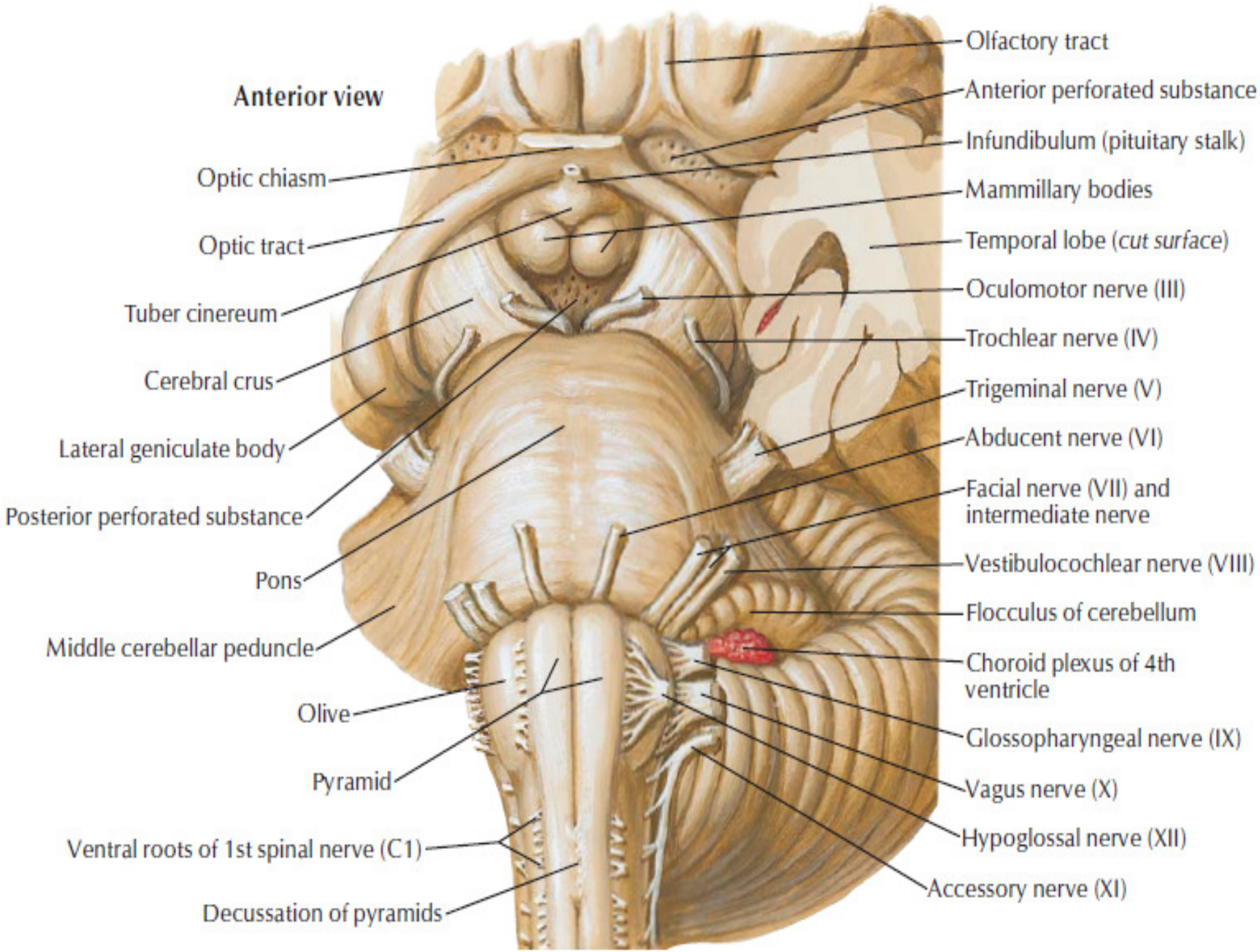
Brain stem

- Stalk like in shape
- Connects spinal cord forebrain

Parts:

1. Medulla oblongata
2. Pons
3. Midbrain



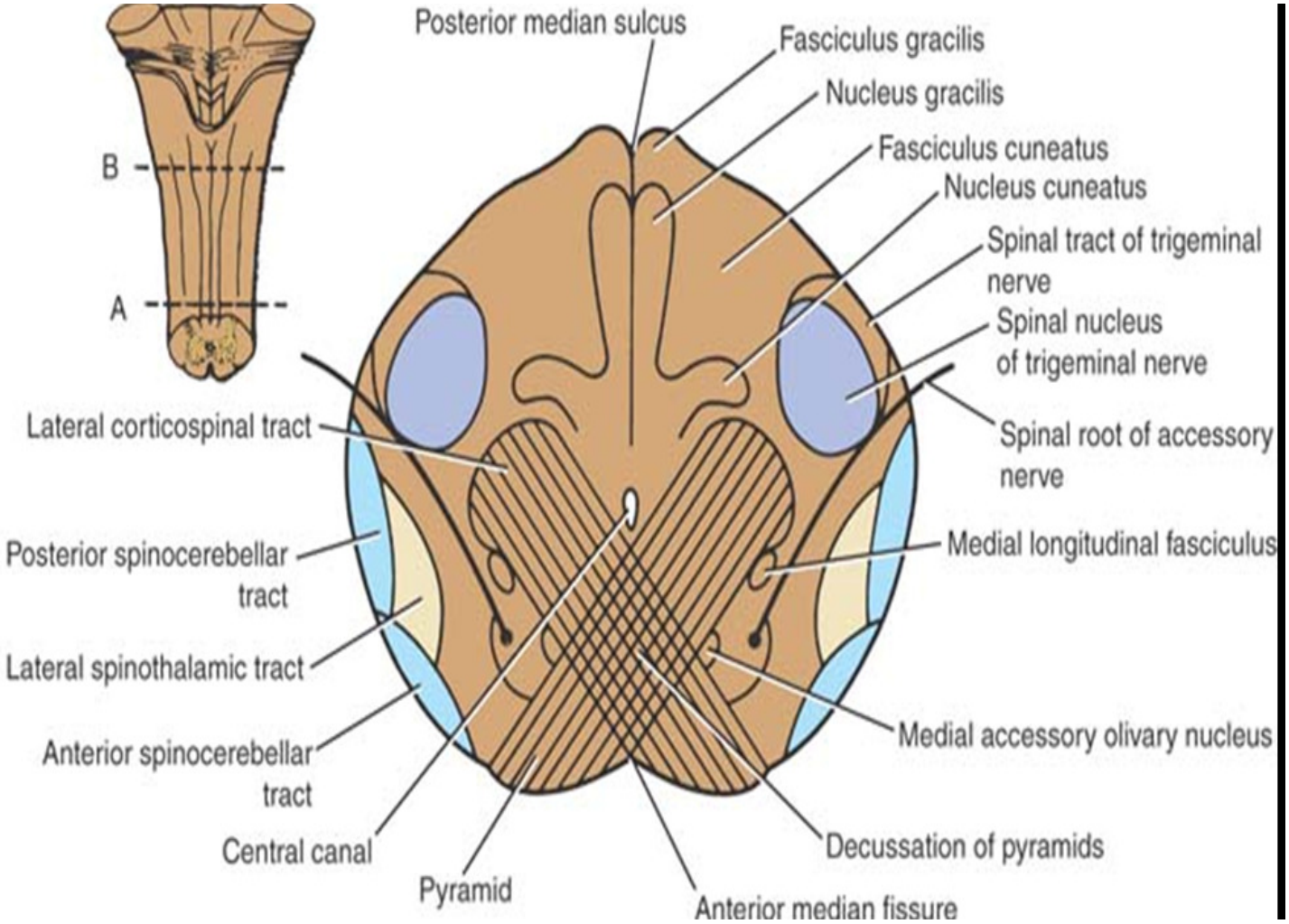

Anterior view
Optic chiasm
Optic tract
Tuber cinereum
Cerebral crus
Lateral geniculate body
Posterior perforated substance
Pons
Middle cerebellar peduncle
Olive
Pyramid
Ventral roots of 1st spinal nerve (C1)
Decussation of pyramids
Olfactory tract
Anterior perforated substance
Infundibulum (pituitary stalk)
Mammillary bodies
Temporal lobe (cut surface)
Oculomotor nerve (III)
Trochlear nerve (IV)
Trigeminal nerve (V)
Abducent nerve (VI)
Facial nerve (VII) and intermediate nerve
Vestibulocochlear nerve (VIII)
Flocculus of cerebellum
Choroid plexus of 4th ventricle
Glossopharyngeal nerve (IX)
Vagus nerve (X)
Hypoglossal nerve (XII)
Accessory nerve (XI)

Internal structure of medulla

1. Level of decussation of pyramids(motor / close medulla)
2. Level of decussation of leminisci (sensory/ close medulla)
3. Level of olives (open medulla)
4. Level Just Inferior to the Pons

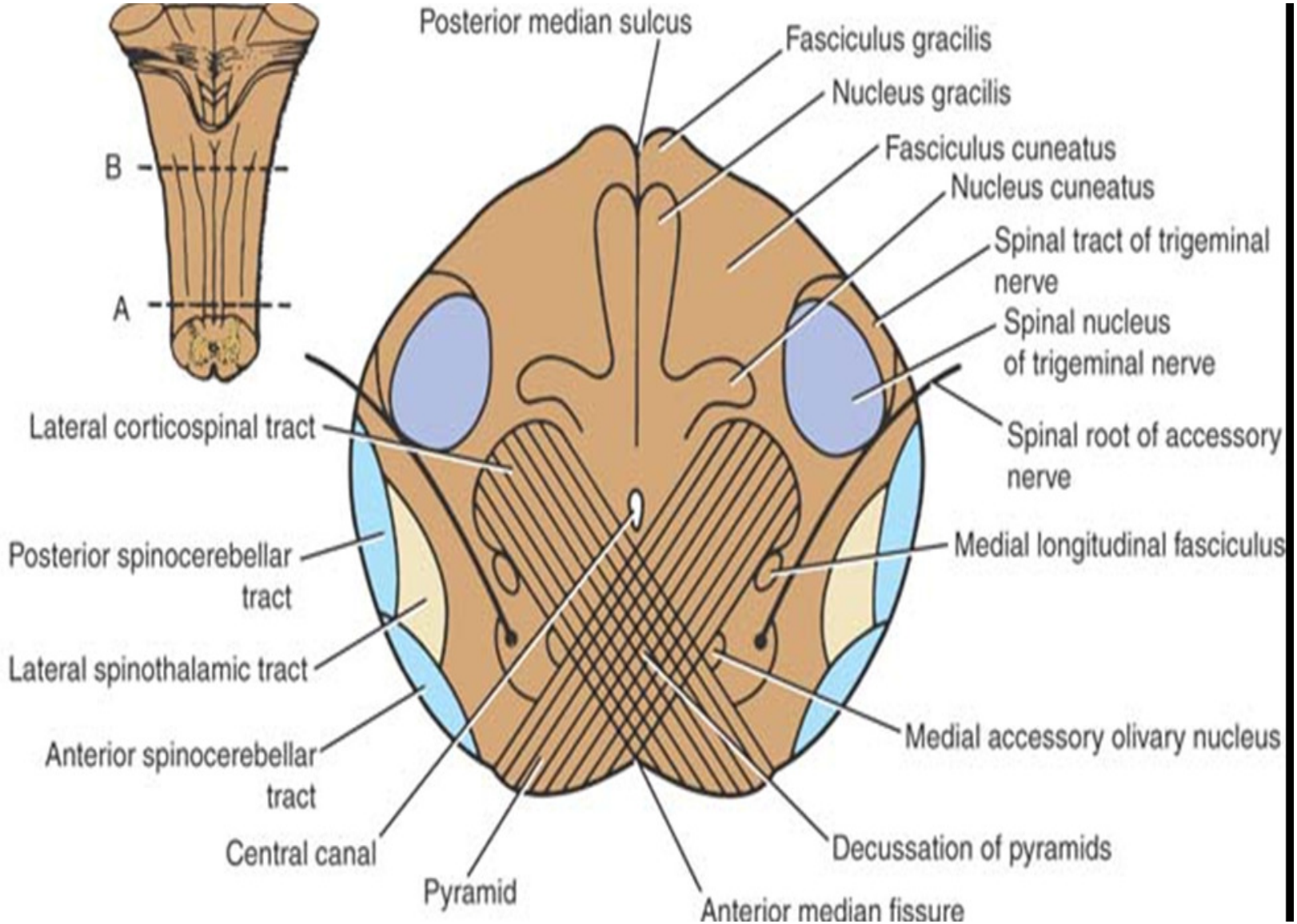
Level of decussation of pyramids

- Decussation of pyramids
- Fasciculus gracilis and the fasciculus cuneatus
- nucleus gracilis and the nucleus cuneatus (posterior to the central gray matter)
- Spinal nucleus of the trigeminal nerve
- Central canal



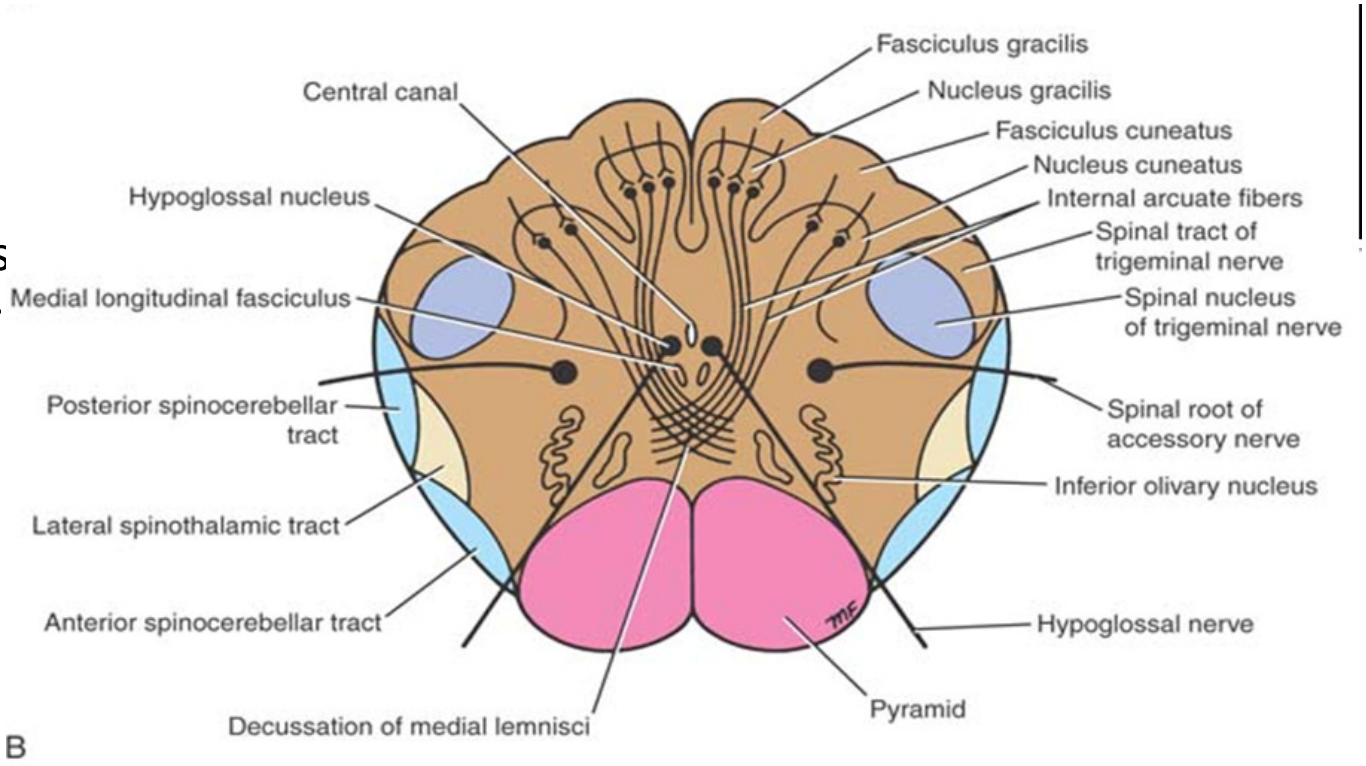
- The lateral and anterior white columns of the spinal cord is unchanged

Level of decussation of pyramids



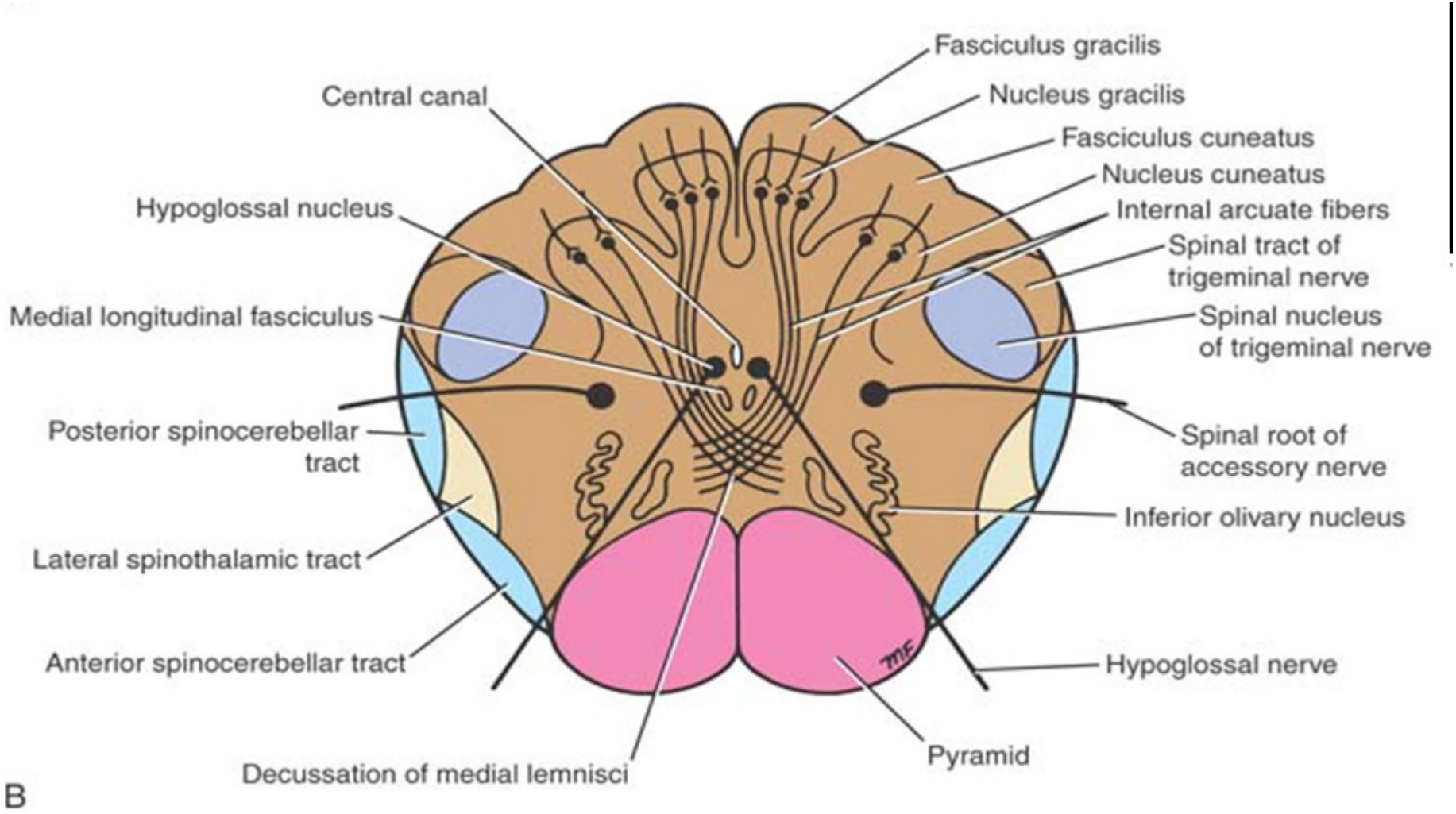
Level of decussation of leminsci

- Sensory decussation
- Leminisci are formed by internal arcuate fibers
- internal arcuate fibers emerge from anterior aspect of nucleus gracilis and nucleus cuneatus
- Decussation takes place posterior to pyramids
- Spinal nucleus of the trigeminal nerve (lateral to the internal arcuate fibers)
- spinal lemniscus lateral to the decussation of the lemnisci



- The spinocerebellar vestibulospinal, and the rubrospinal tracts (anterolateral)
- Central canal

Level of sensory decussation



Level of sensory decussation

1----ant. Median fissure

2-----post. Median sulcus

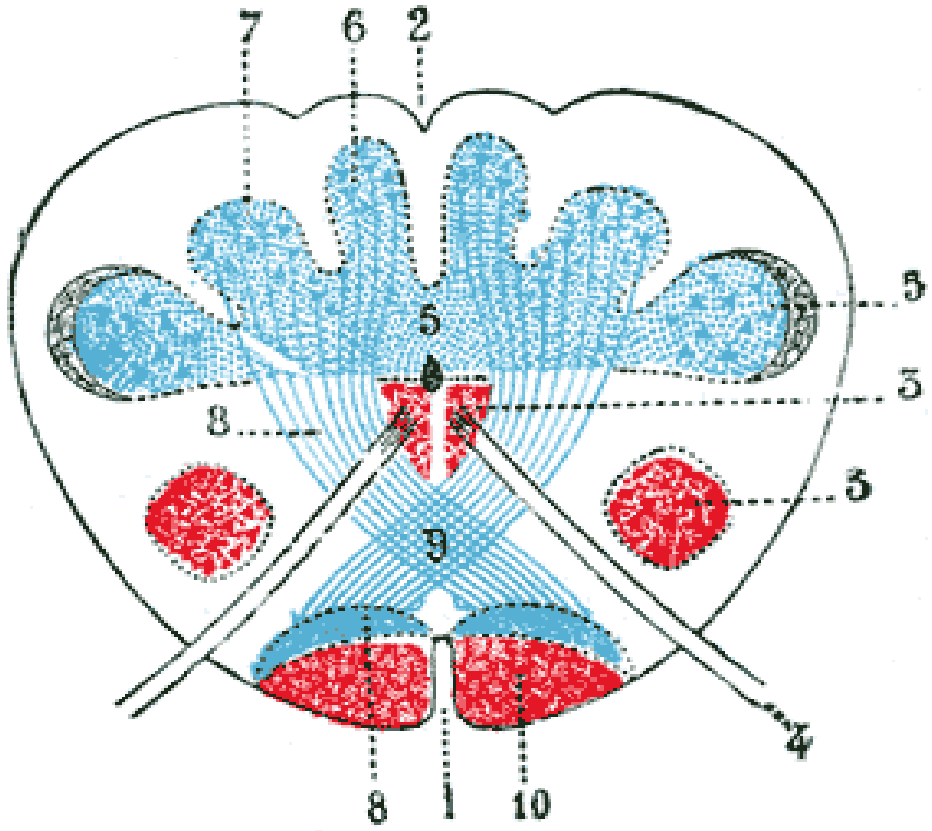
6-----nucleus gracile

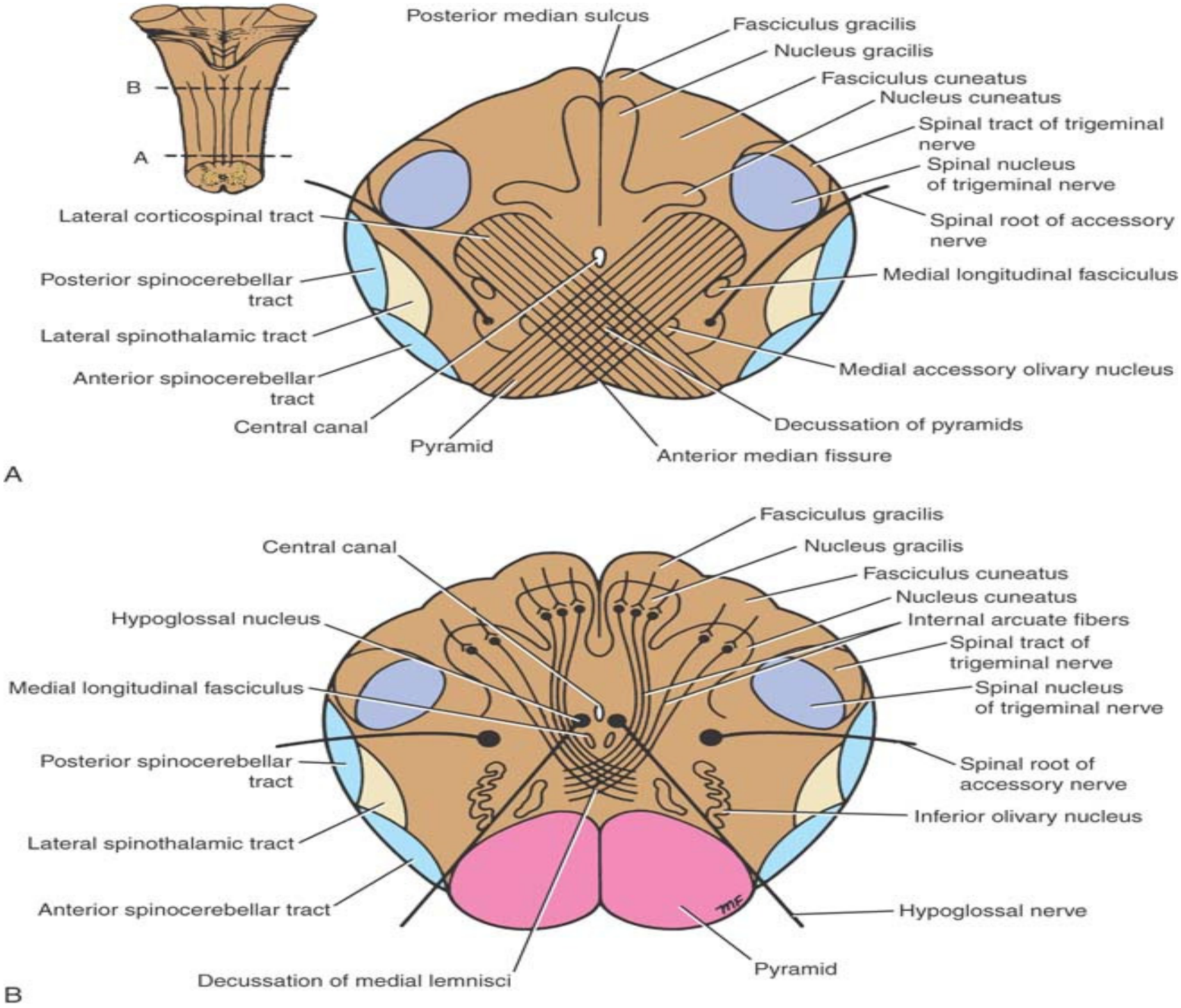
7-----nucleus cuneatus

8-----int. arcute fibers

9---- decussation of medial leminiscus

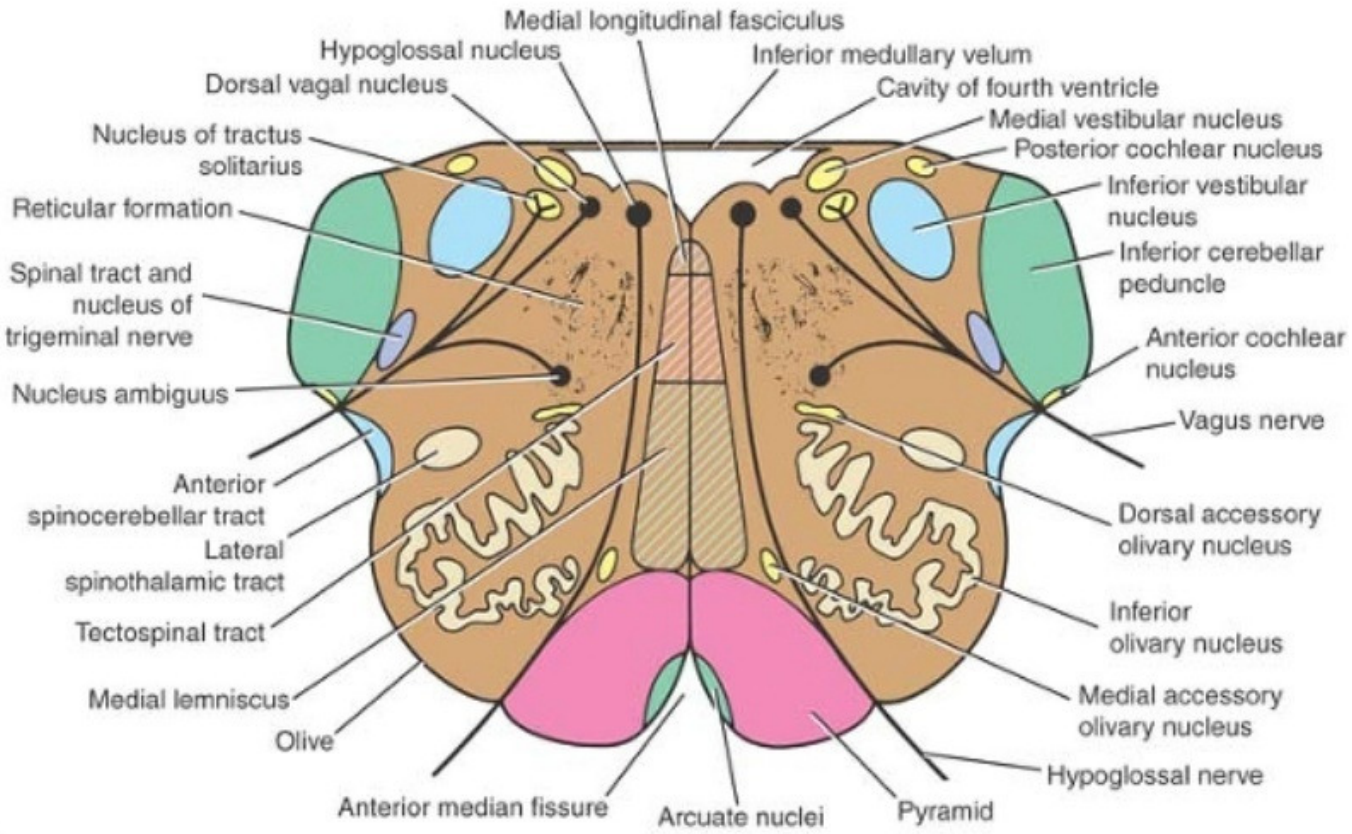
10----pyramids




B
A
Posterior median sulcus
Fasciculus gracilis
Nucleus gracilis
Fasciculus cuneatus
Nucleus cuneatus
Spinal tract of trigeminal nerve
Spinal nucleus of trigeminal nerve
Spinal root of accessory nerve
Medial longitudinal fasciculus
Medial accessory olivary nucleus
Decussation of pyramids
Anterior median fissure
Pyramid
Central canal
Anterior spinocerebellar tract
Lateral spinothalamic tract
Posterior spinocerebellar tract
Lateral corticospinal tract
A
Fasciculus gracilis
Nucleus gracilis
Fasciculus cuneatus
Nucleus cuneatus
Internal arcuate fibers
Spinal tract of trigeminal nerve
Spinal nucleus of trigeminal nerve
Spinal root of accessory nerve
Inferior olivary nucleus
Hypoglossal nerve
Pyramid
Decussation of medial lemnisci
Anterior spinocerebellar tract
Lateral spinothalamic tract
Posterior spinocerebellar tract
Medial longitudinal fasciculus
Hypoglossal nucleus
Central canal
B

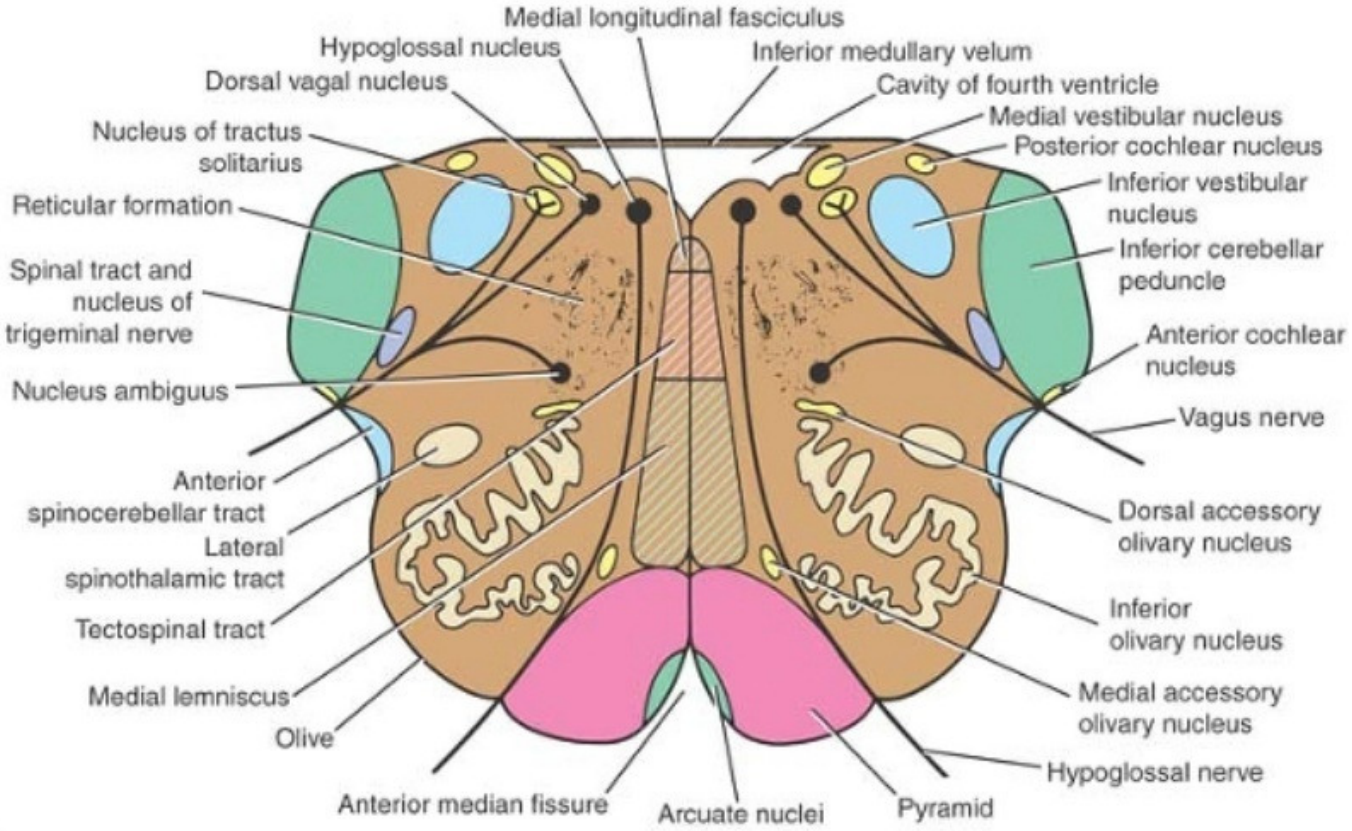
Level of olives (open medulla)

- inferior part of 4th ventricle
- Pyramids
- ICP (posterolateral corner)
- Medial leminiscus
- RF
- Spinal nucleus of trigeminal and its tract (anteriomedial to ICP)
- Nuclei of 12th 11th 10th & 9th
- Inf Olivary nucleus
- Medial longitudinal fasciculus



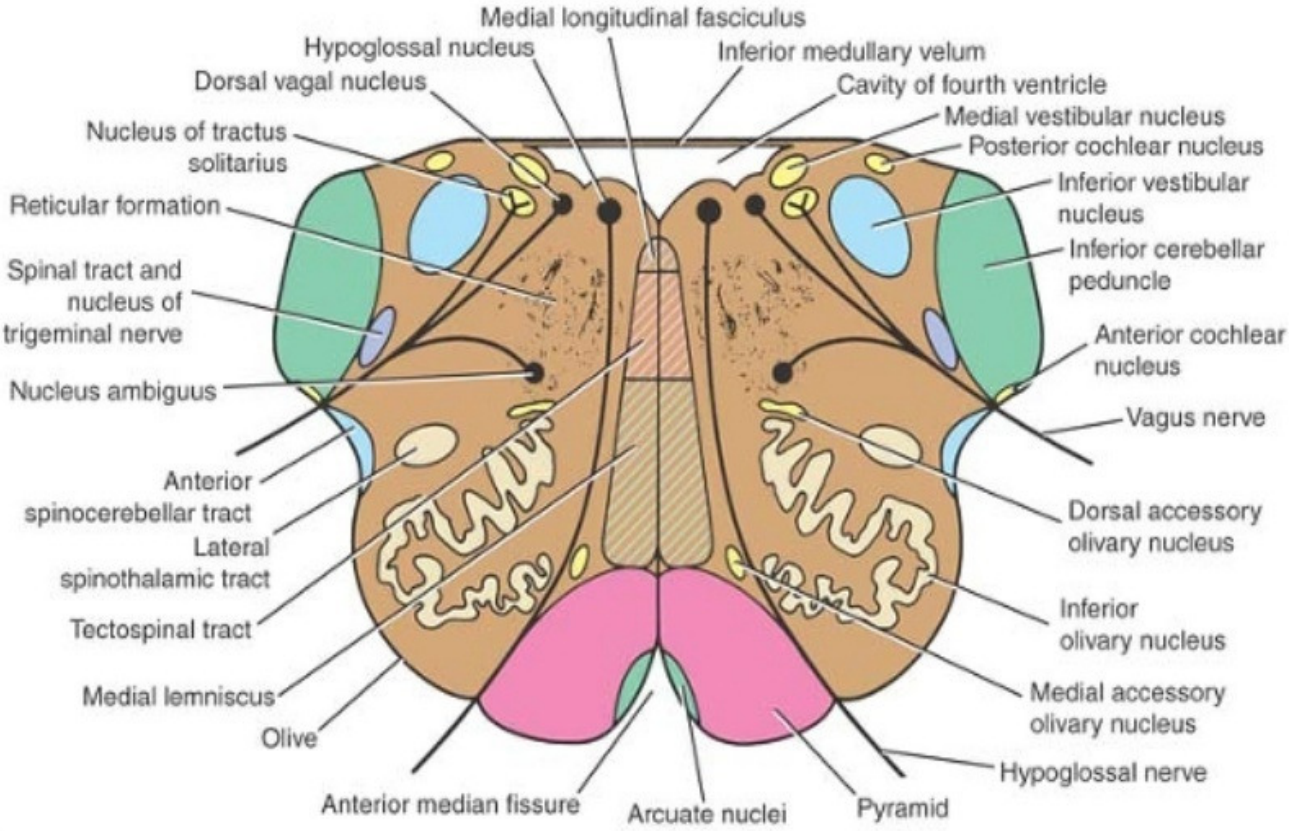
Olivary nuclear complex

- Mainly Inf. Olivary nucleus
- Gray matter is shaped like a crumpled bag with its mouth directed medially
- Responsible of the elevation olive
- Has communications with spinal cord, cerebellum & cortex
- Function is associated with voluntary muscle movement



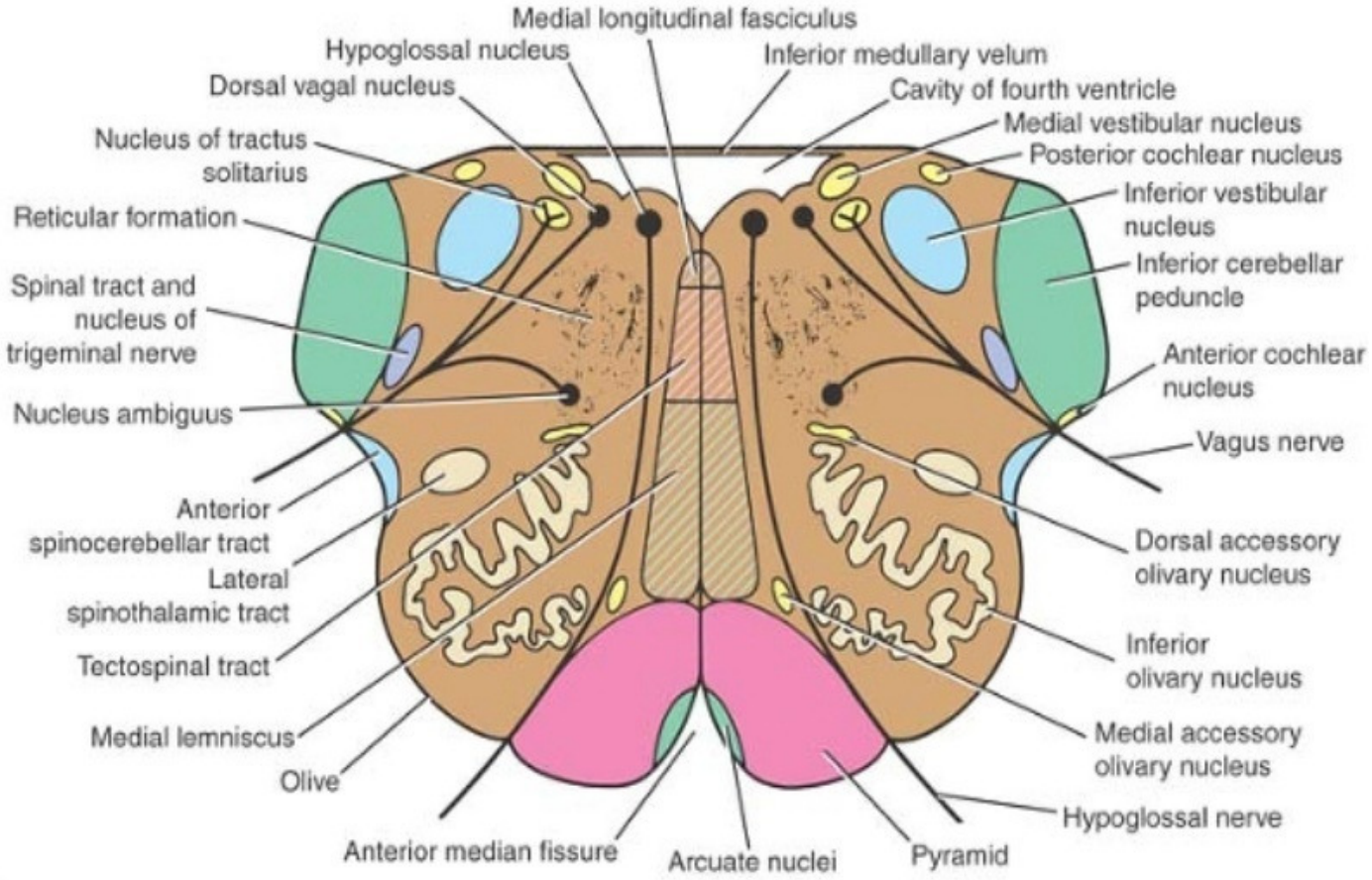
Nucleus ambiguus

- Large motor neurons
- Situated deep in RF
- Emerging fibers join 9th, 10th and 11th (cranial root of accessory)
- An elongated nucleus in the medulla oblongata that gives rise to the motor fibers of the glossopharyngeal, vagus, and accessory (cranial) nerves supplying striated muscle of the larynx and pharynx and soft palat



Medial longitudinal fasciculus

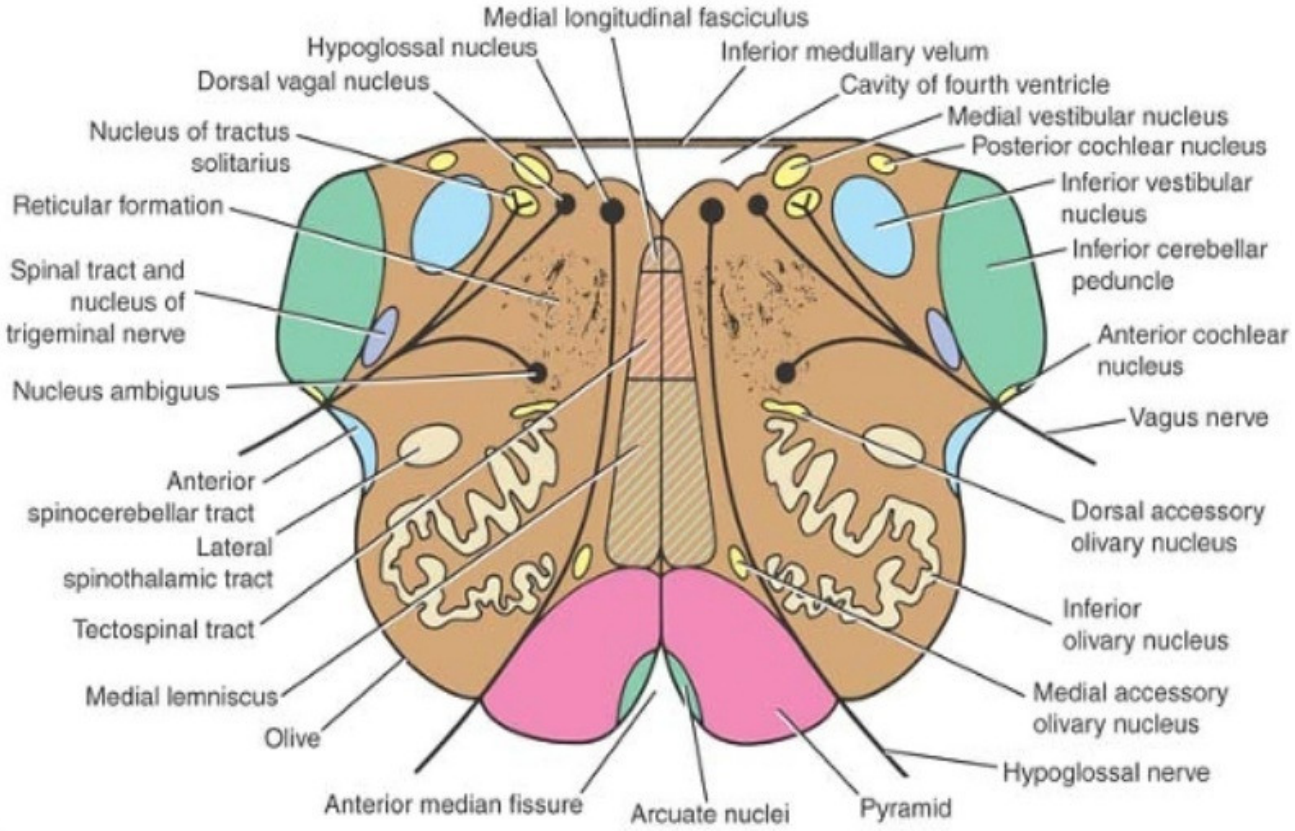
- Small tract of nerve fibers
- situated on each side of the midline
- Posterior to med. Leminiscus
- Anterior to 12th nucleus
- It is composed largely of ascending fibers from the vestibular nuclei and cochlear nuclei ascending to the motor nuclei (third, fourth and sixth)



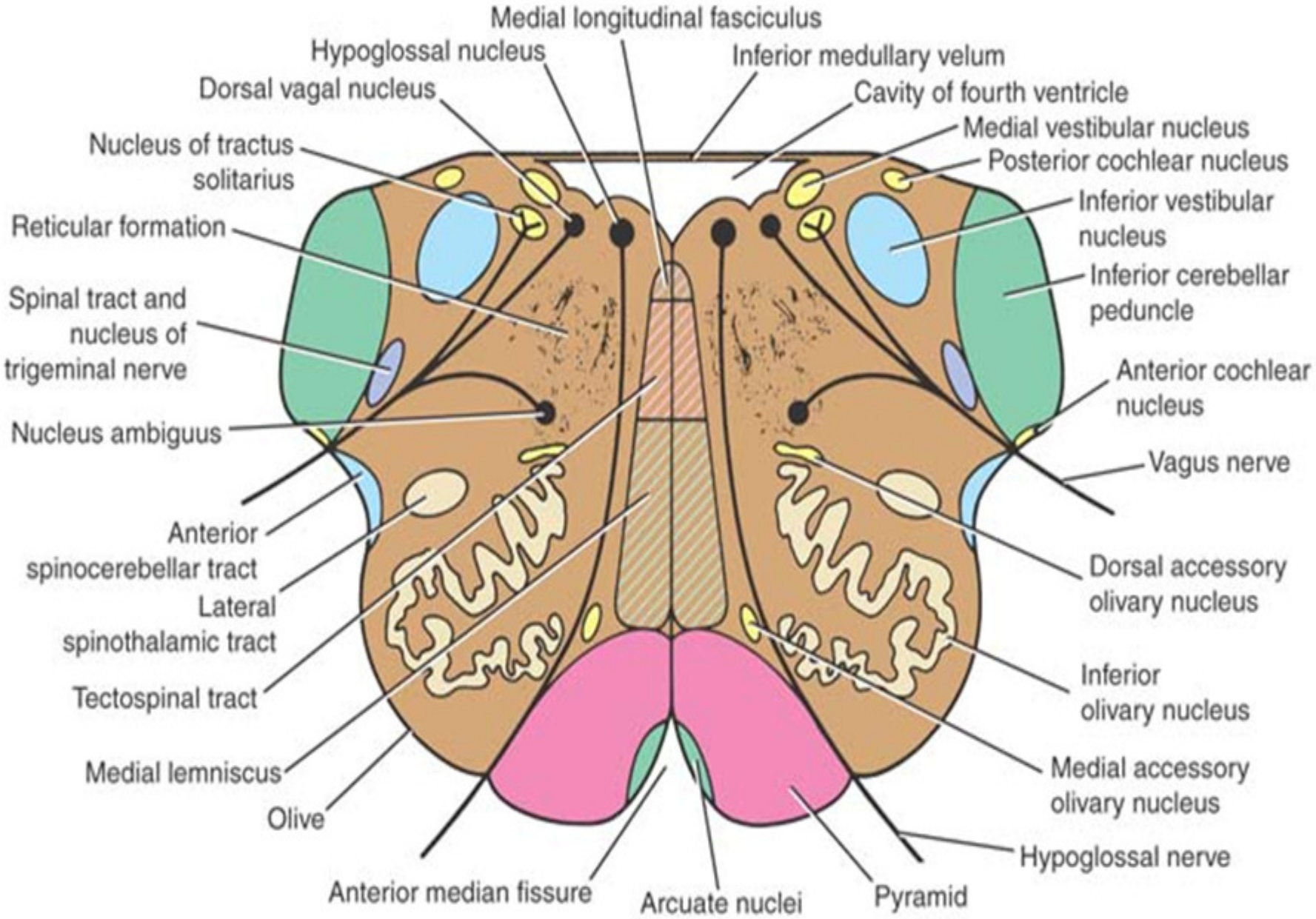
Central gray matter

- Lies beneath the floor of 4th ventricle
- Passing from M to L:

1. Hypoglossal nucleus
2. Dorsal nucleus of vagus
3. Solitary nucleus
4. Vestibular nuclei (medial and inferior)

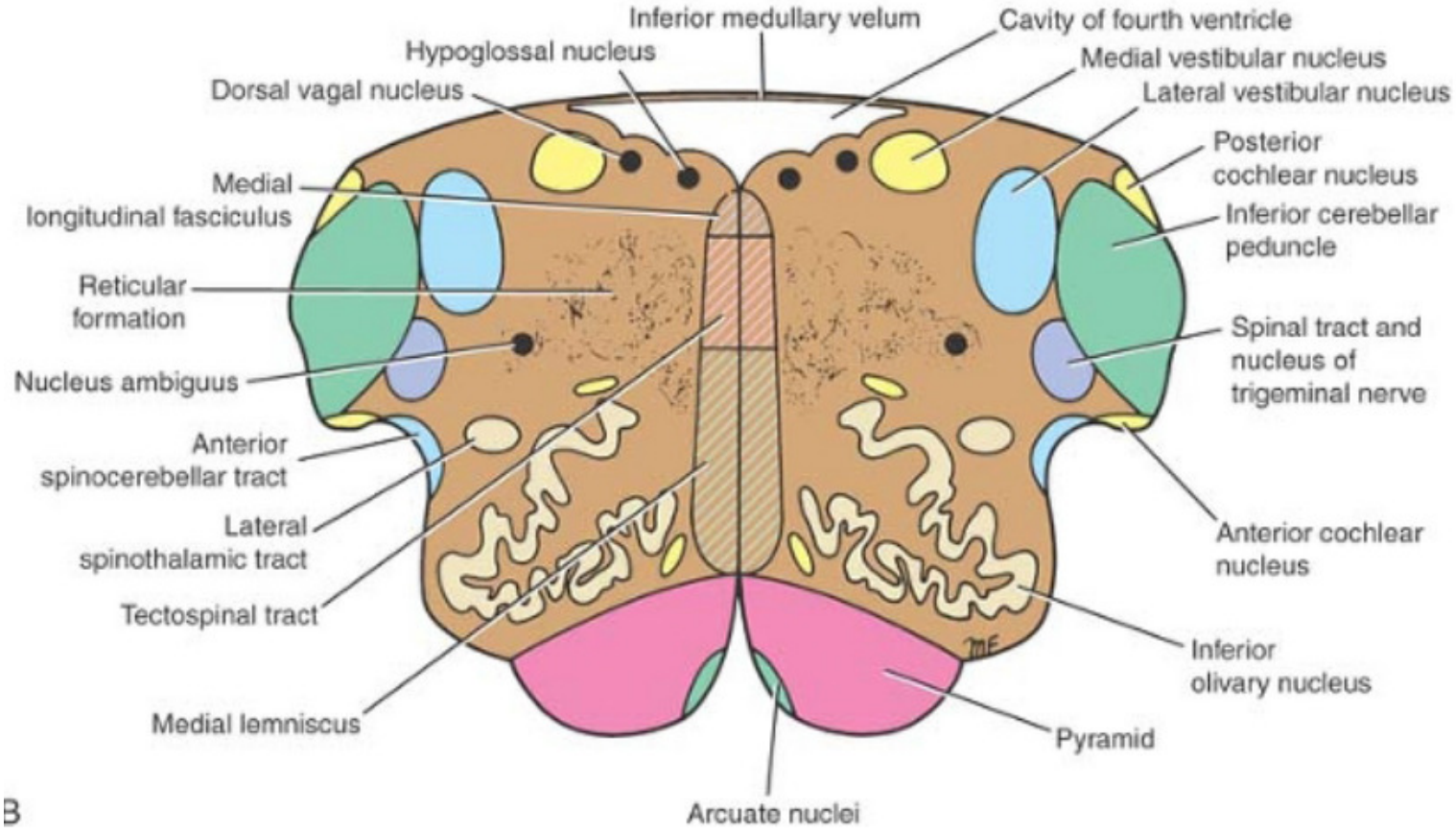


Medulla oblongata at the level of olives



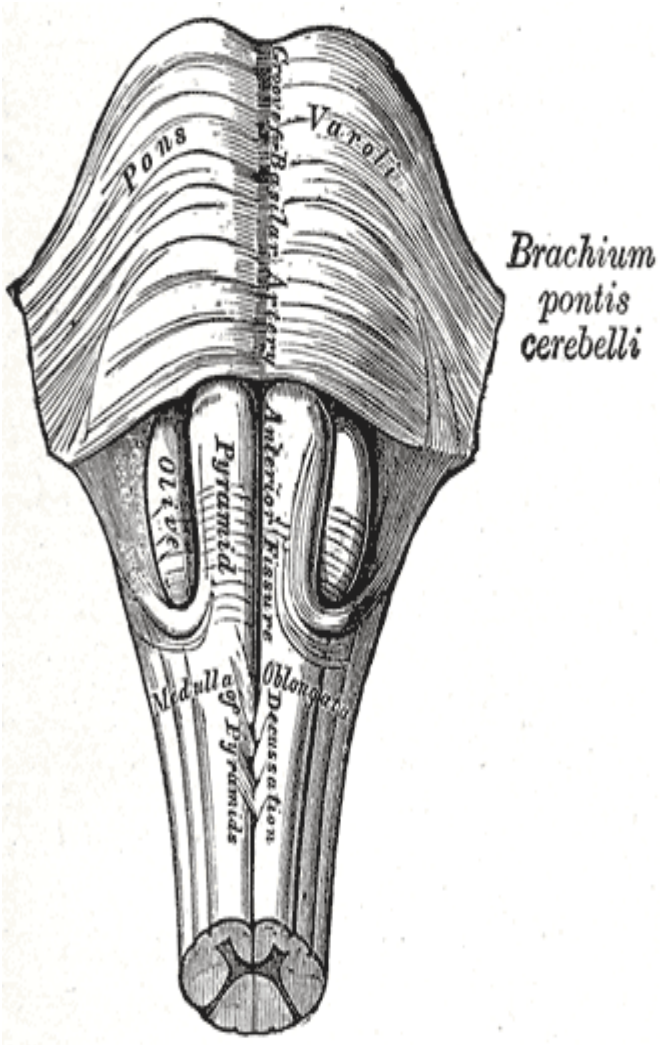
Level Just Inferior to the Pons

- No major changes
- **Lateral vestibular nucleus** replaced the inferior vestibular nucleus
- **Cochlear nuclei** visible on the anterior and posterior surfaces of the inferior cerebellar peduncle.



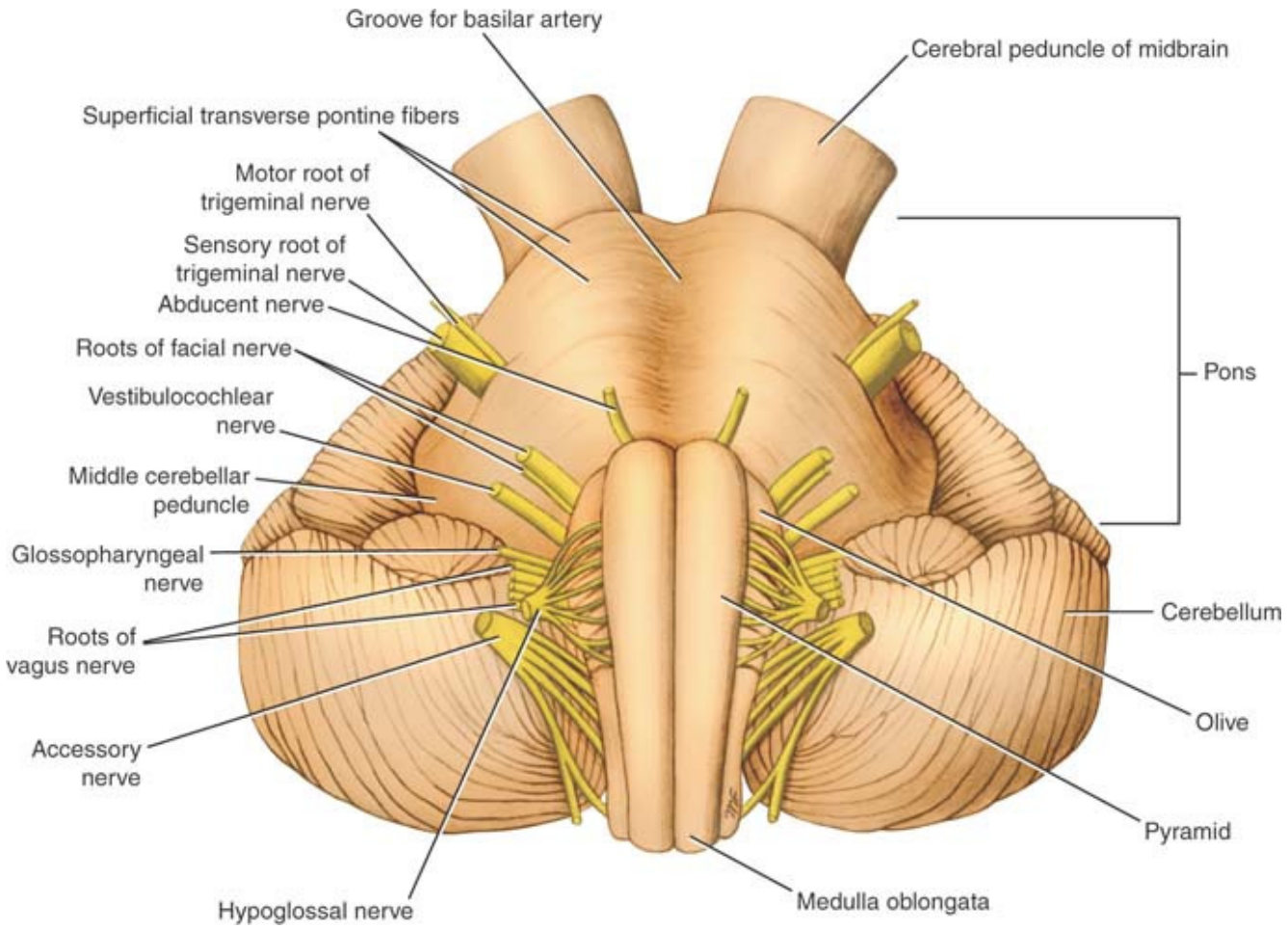
Pons

- Located anterior to cerebellum
- 1 inch long
- Anterior surface is convex & shows transverse fibers that converge on each side to form middle cerebellar peduncle
- Located between the midbrain and medulla oblongata
- Contains the nuclei of cranial nerves V, VI, VII and VIII

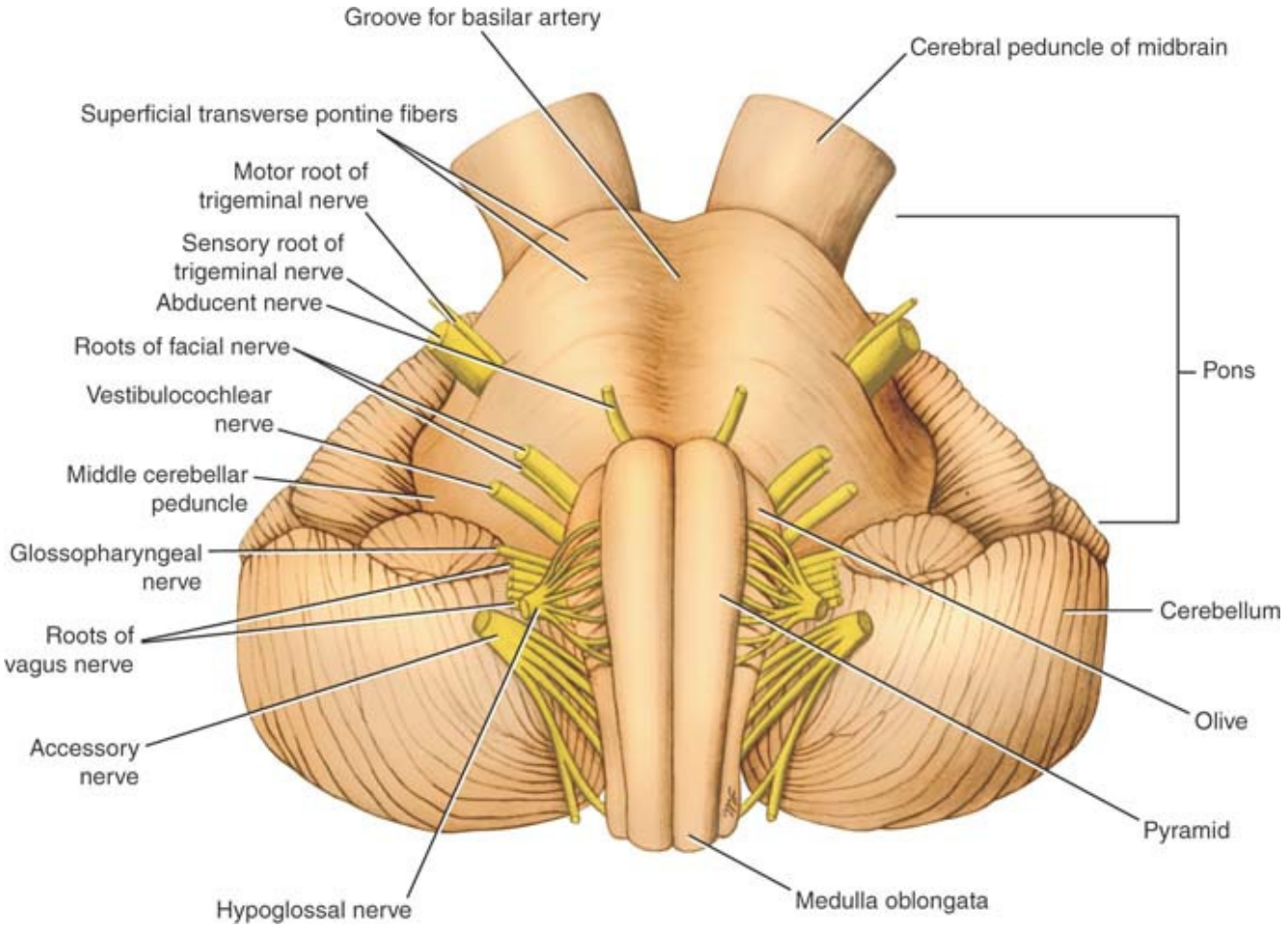


Gross appearance (anterior surface)

- Basilar groove (midline)..lodges basilar artery
- 5th nerve emerges from anterolateral surface (small motor (medial) and large sensory (lateral)
- 6th 7th & 8th emerges at pontomedullary junction M→L

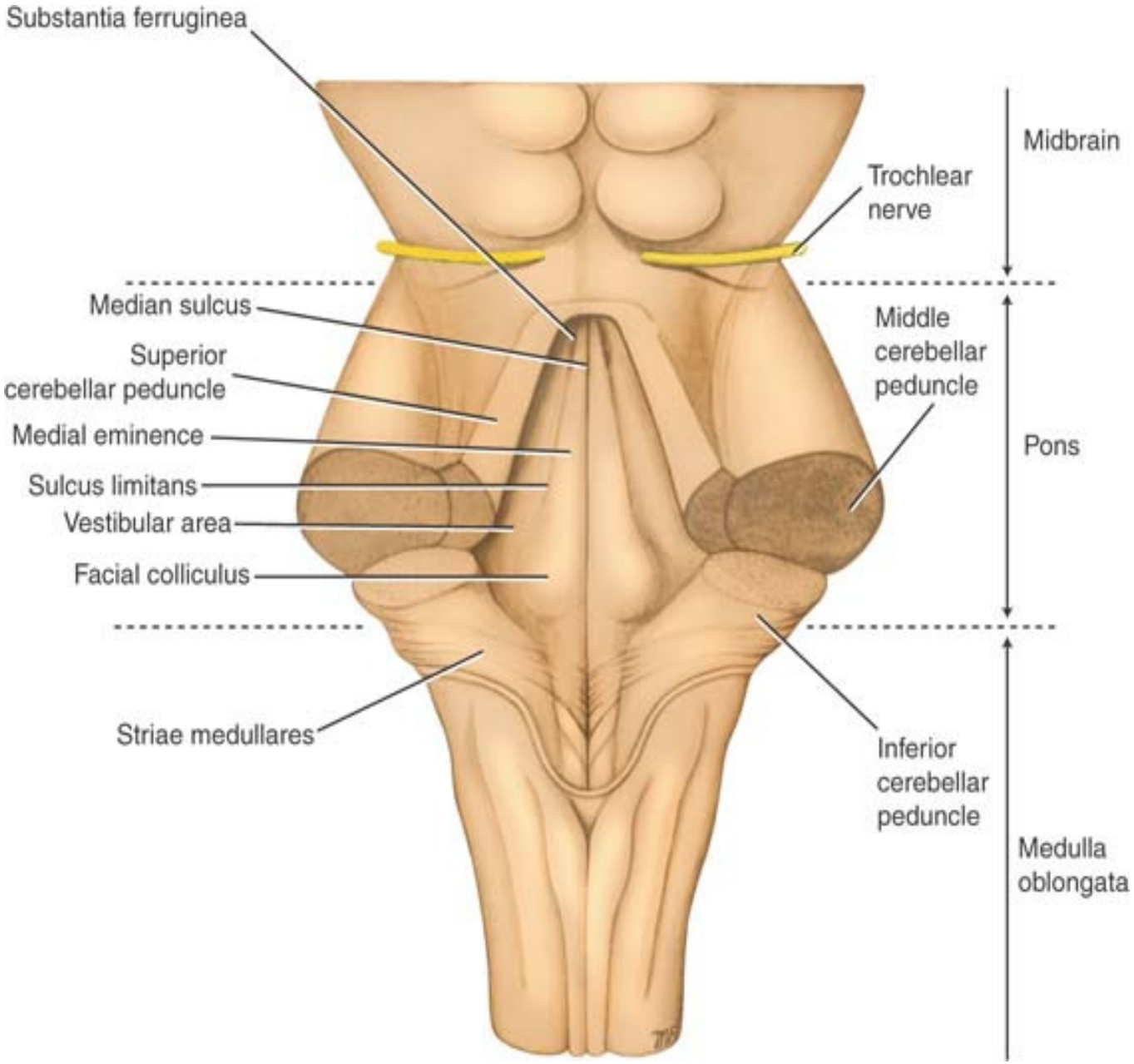


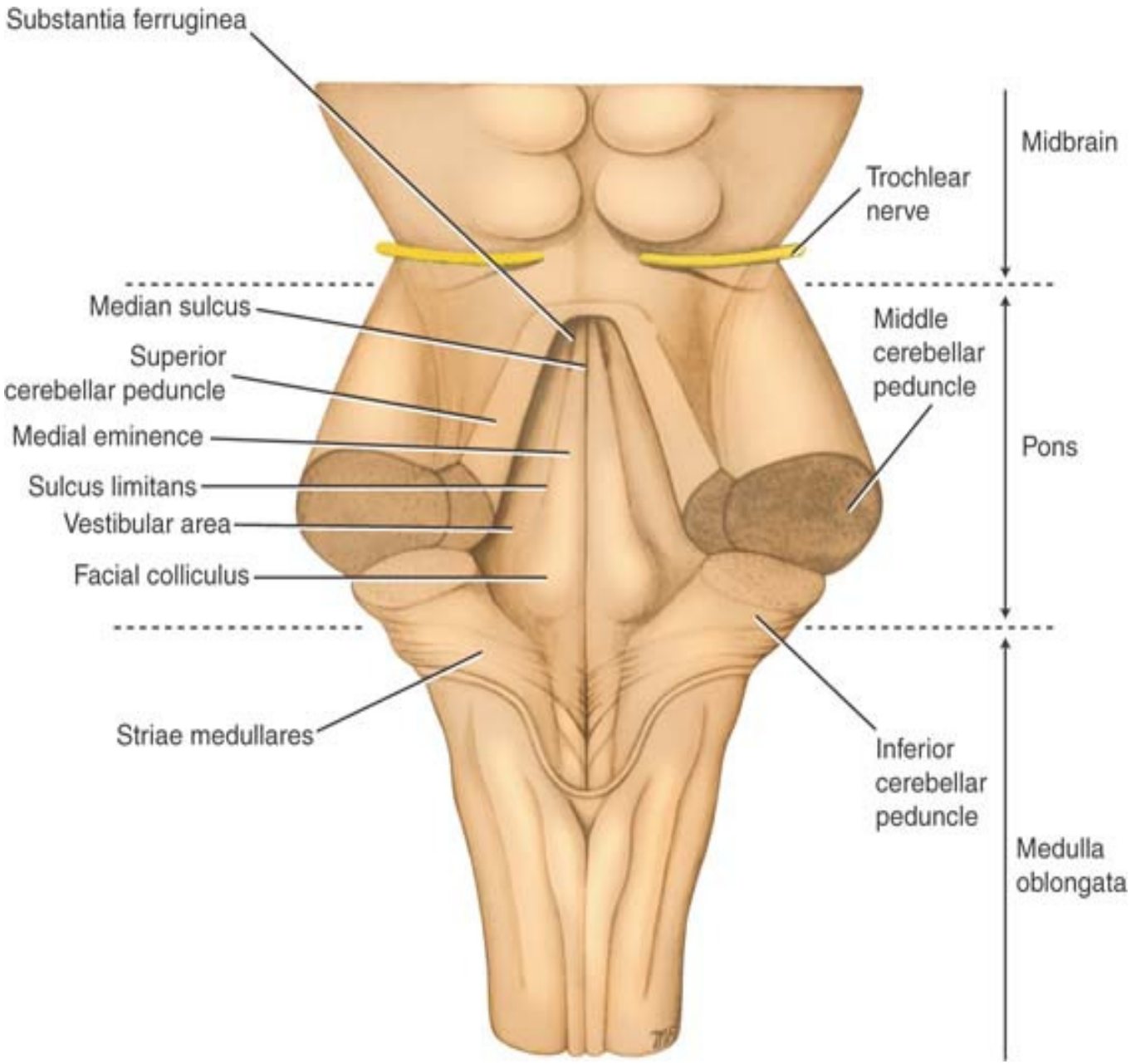
Pons – anterior view



Pons (posterior view)

- Its hidden by from view by cerebellum
- Forms the upper half of floor of 4th ventricle
- Triangular in shape
- Median sulcus
- Medial eminence
- Sulcus limitans
- Facial colliculus (inf end of medial eminence)
- Area vestibuli (Lateral to sulcus limitans)

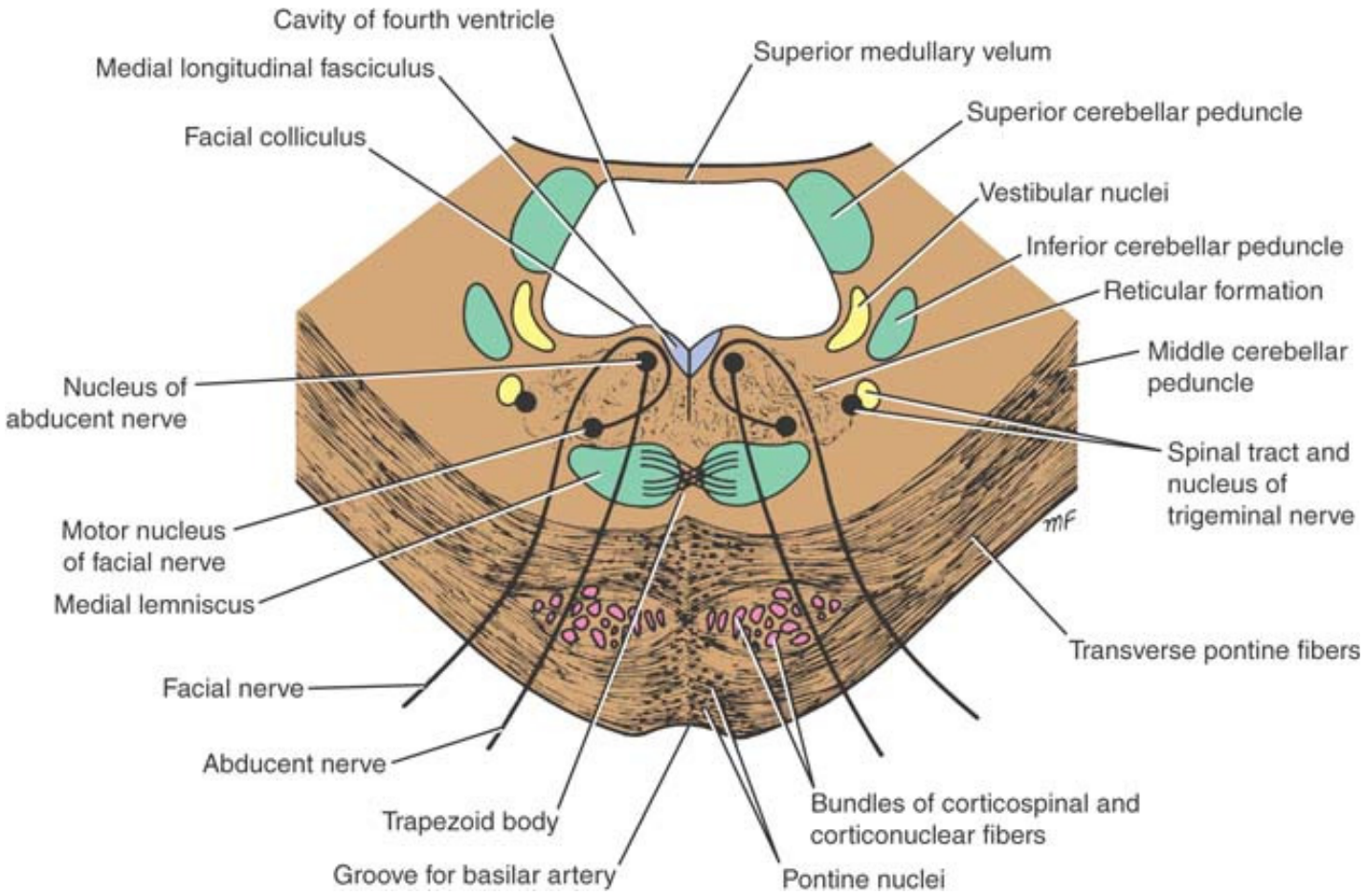



Substantia ferruginea
Trochlear nerve
Midbrain
Median sulcus
Superior cerebellar peduncle
Middle cerebellar peduncle
Medial eminence
Pons
Sulcus limitans
Vestibular area
Facial colliculus
Striae medullares
Inferior cerebellar peduncle
Medulla oblongata

Internal structure of pons

- Its divided by transversely running fibers of trapezoid body into:

1. Tegmentum (post part)
2. Basal part (ant part)

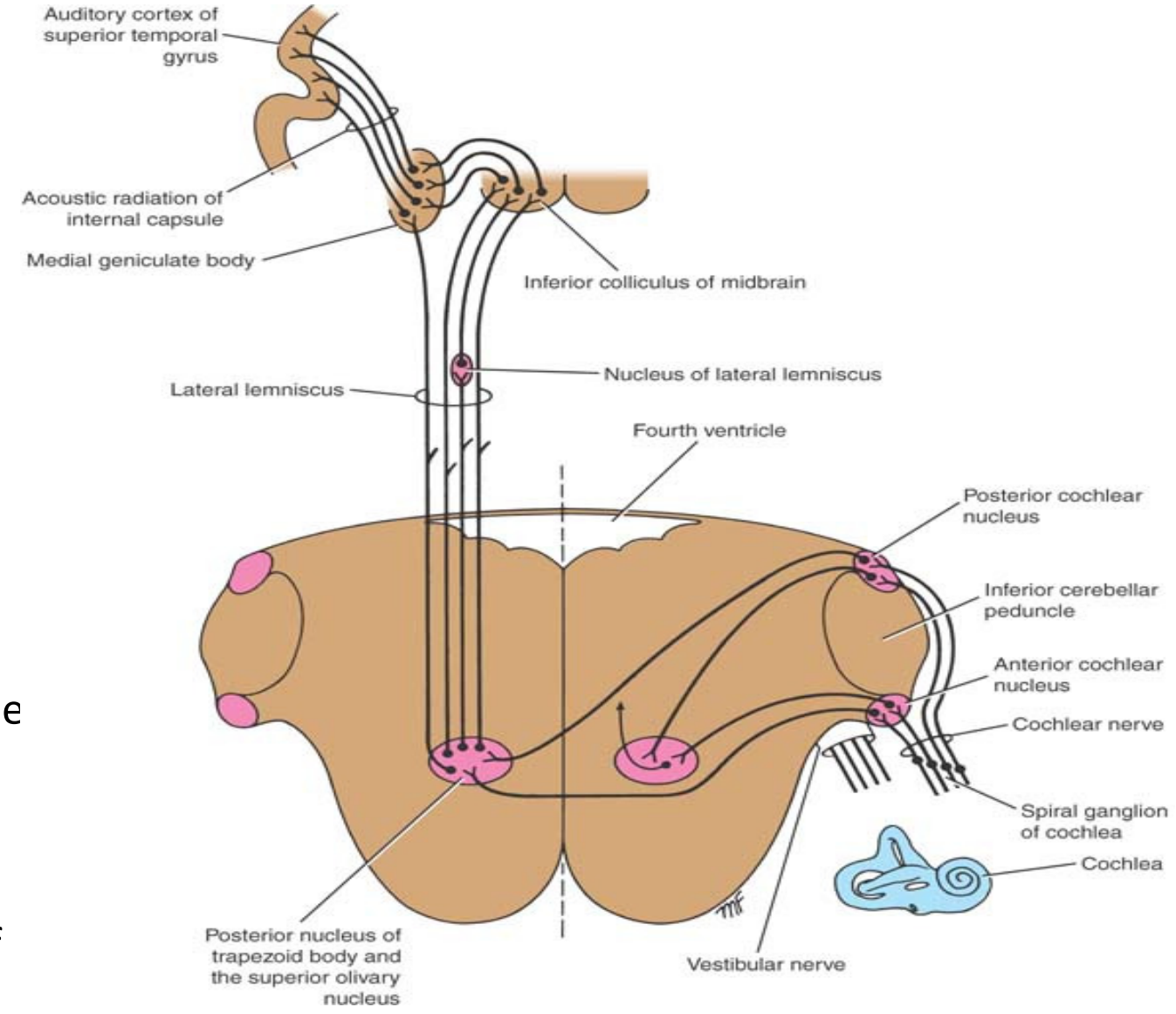


levels

- Level through caudal part (facial colliculus)
- Level through cranial part (trigeminal nuclei)

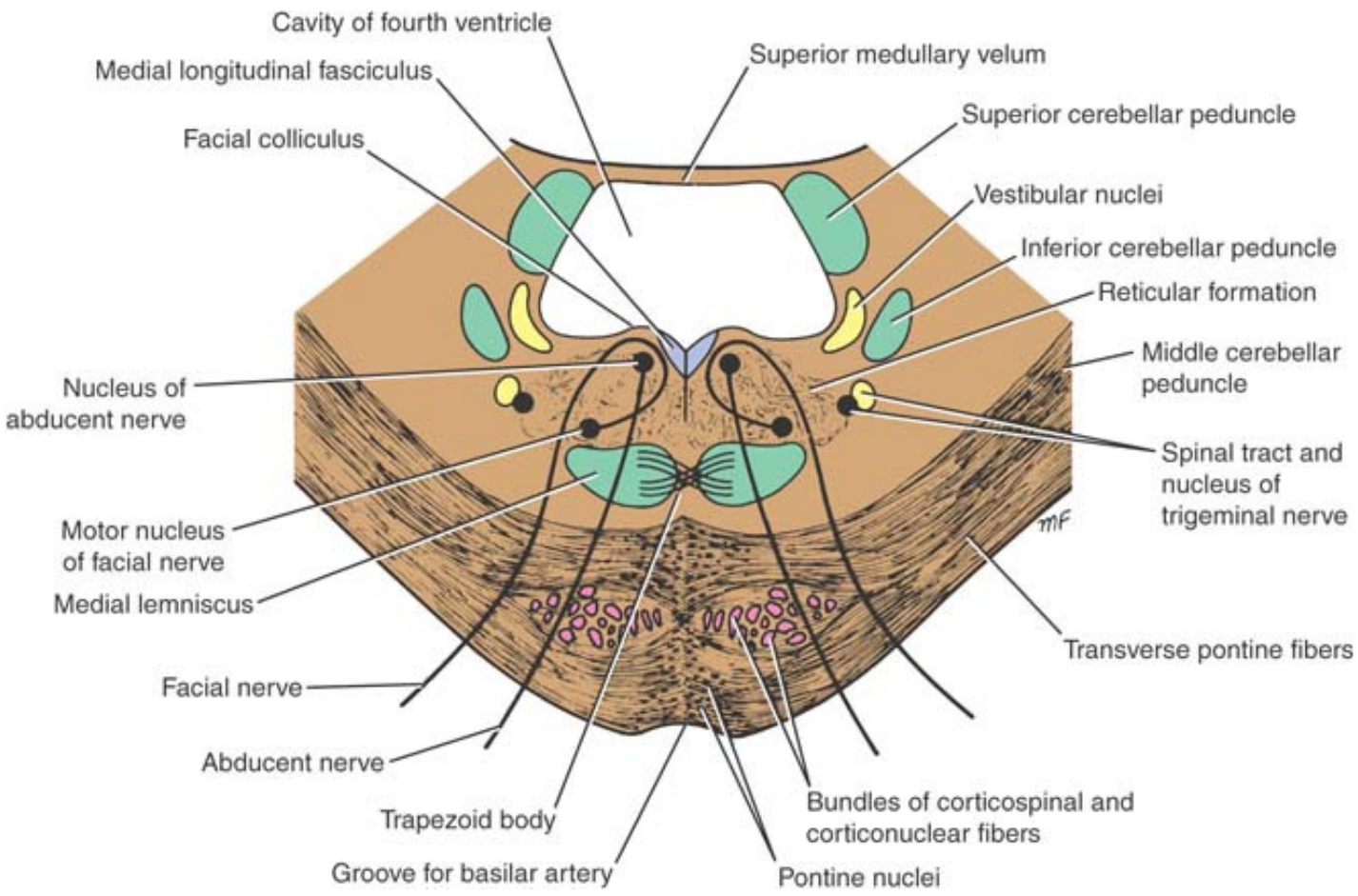
The trapezoid body

- is part of the acoustic pathway
- Made up of fibers derived from cochlear nuclei
- **lateral lemniscus**: tract of axons in the brainstem that carries information about sound from the cochlear nucleus to the contralateral inferior colliculus of the midbrain
- Cochlear nuclei---- trapezoid body---- lateral lemniscus----inf colliculus-----medial geniculate body----- auditory cortex



Level through caudal part (facial colliculus)

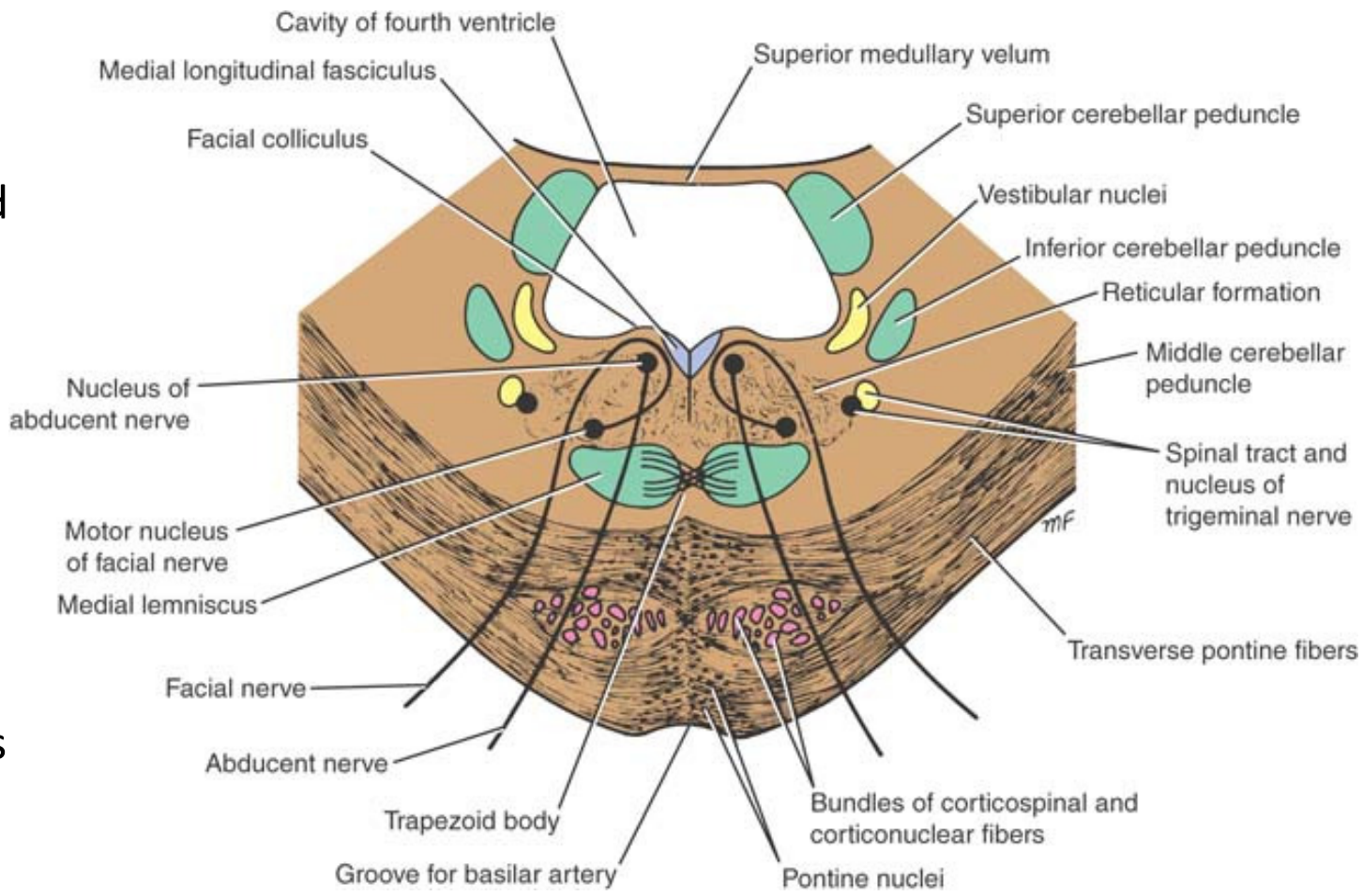
- **Medial lemniscus** most anterior part of the tegmentum, long axis running transversely
- **Facial nucleus** posterior to the lateral part of the medial lemniscus
- **MLF**: beneath the floor of the fourth ventricle on either side of the midline



- **Abducent nucleus:** beneath the floor of the upper part of the fourth
- **Spinal nucleus** of trigeminal and its tract: anteromedial aspect of ICP
- **Medial vestibular nucleus:** lateral to the abducent nucleus

Level through caudal part (facial colliculus)

- Basilar part of pons contain small masses of nerve cells called pontine nuclei
- Corticopontine fibers terminate in pontine nuclei
- Axons of these cells give origin to transverse fibers of the pons which cross the midline and intersect the corticospinal & corticonuclear tracts, breaking them into small bundles



- Transverse fibers enter MCP to cerebellum
- This connection is the main pathway linking cerebellum to cerebral cortex

Facial Nerve Nuclei

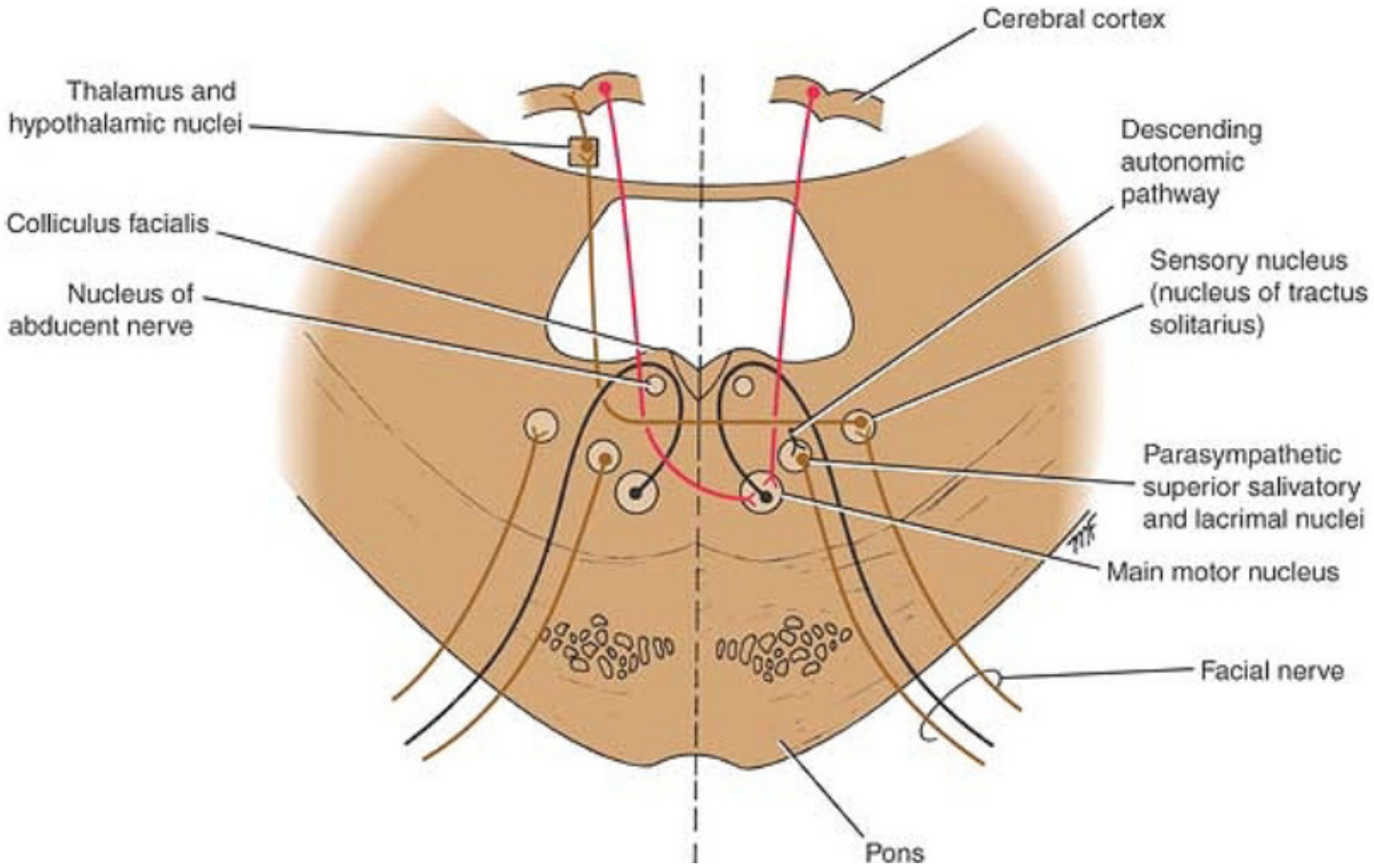
Parasympathetic Nuclei:

- **Location**: Posterolateral to the main motor nucleus

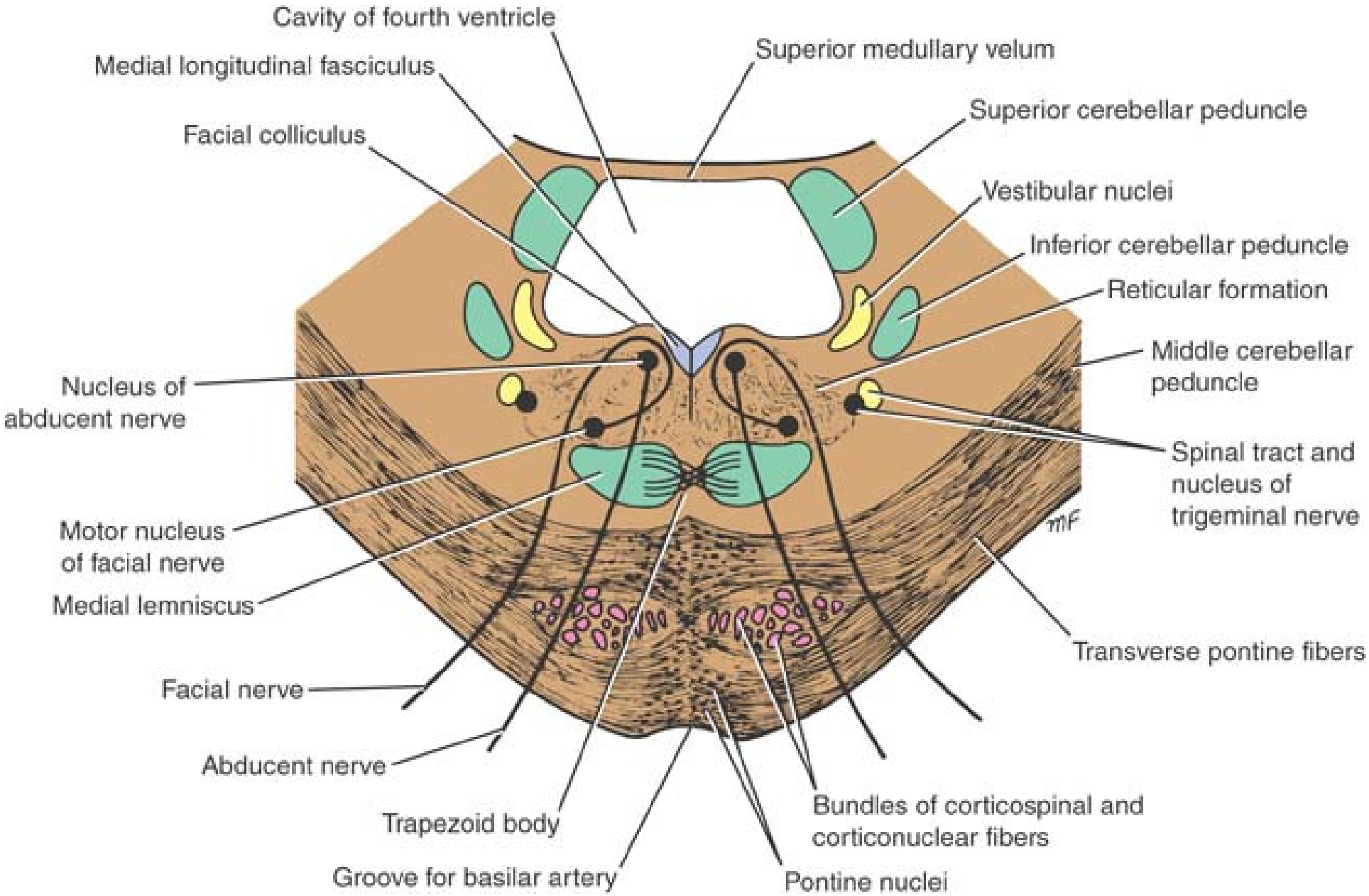
- superior salivatory: receives from the hypothalamus

- Lacrimal nucleus: receives from

  - hypothalamus (Emotional)
  - sensory nuclei of the trigeminal (reflex)

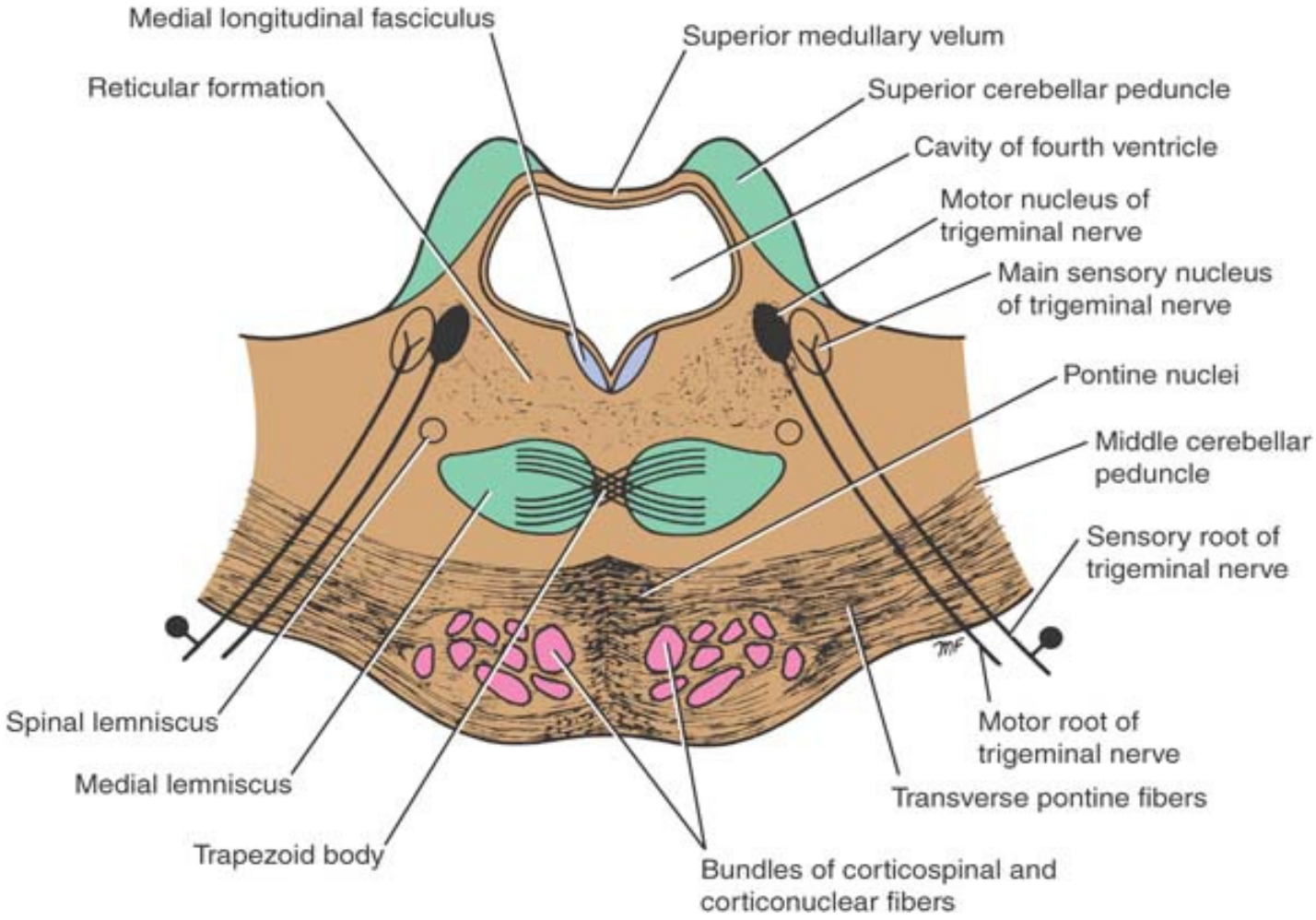


Level through caudal part (facial colliculus)

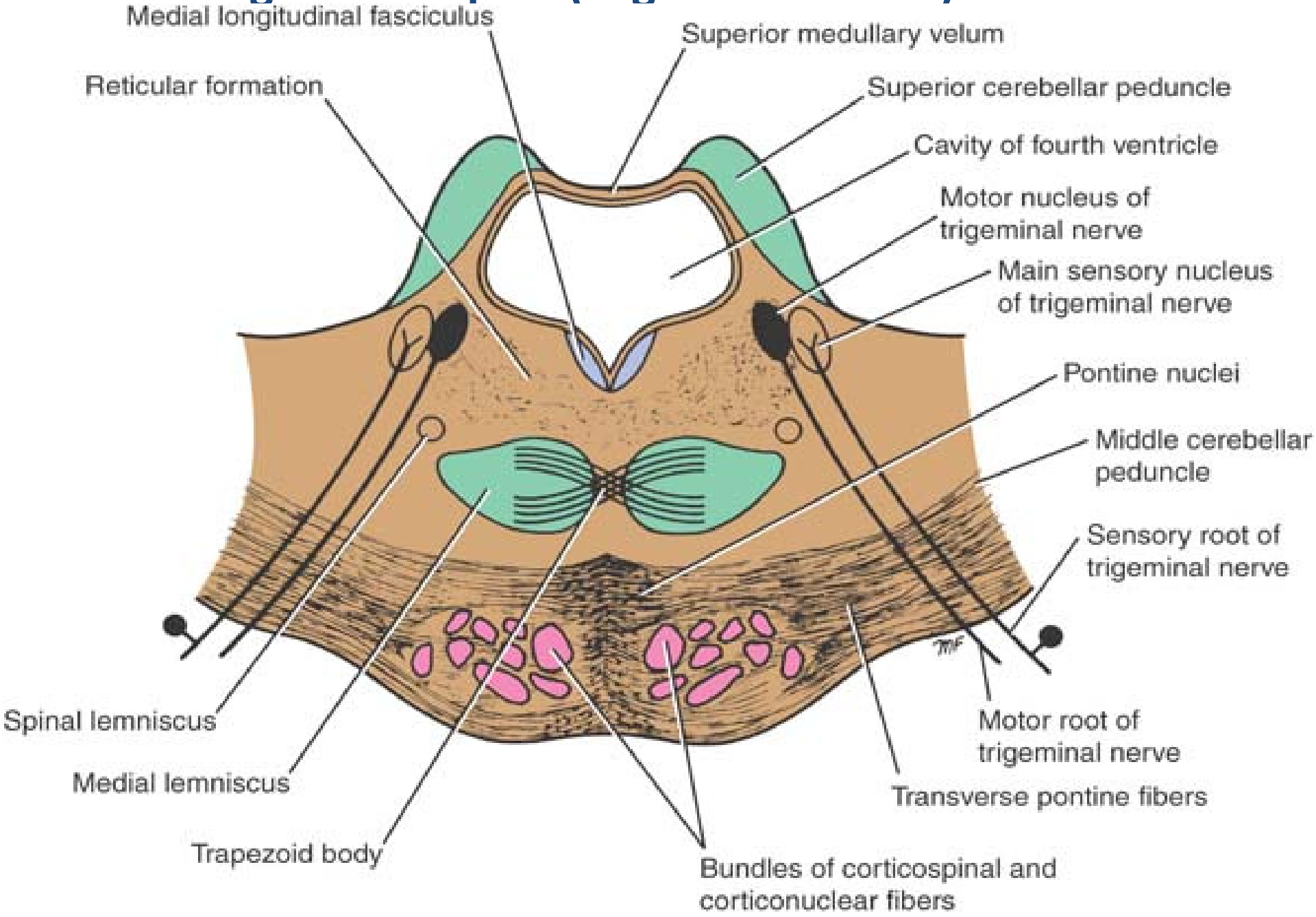


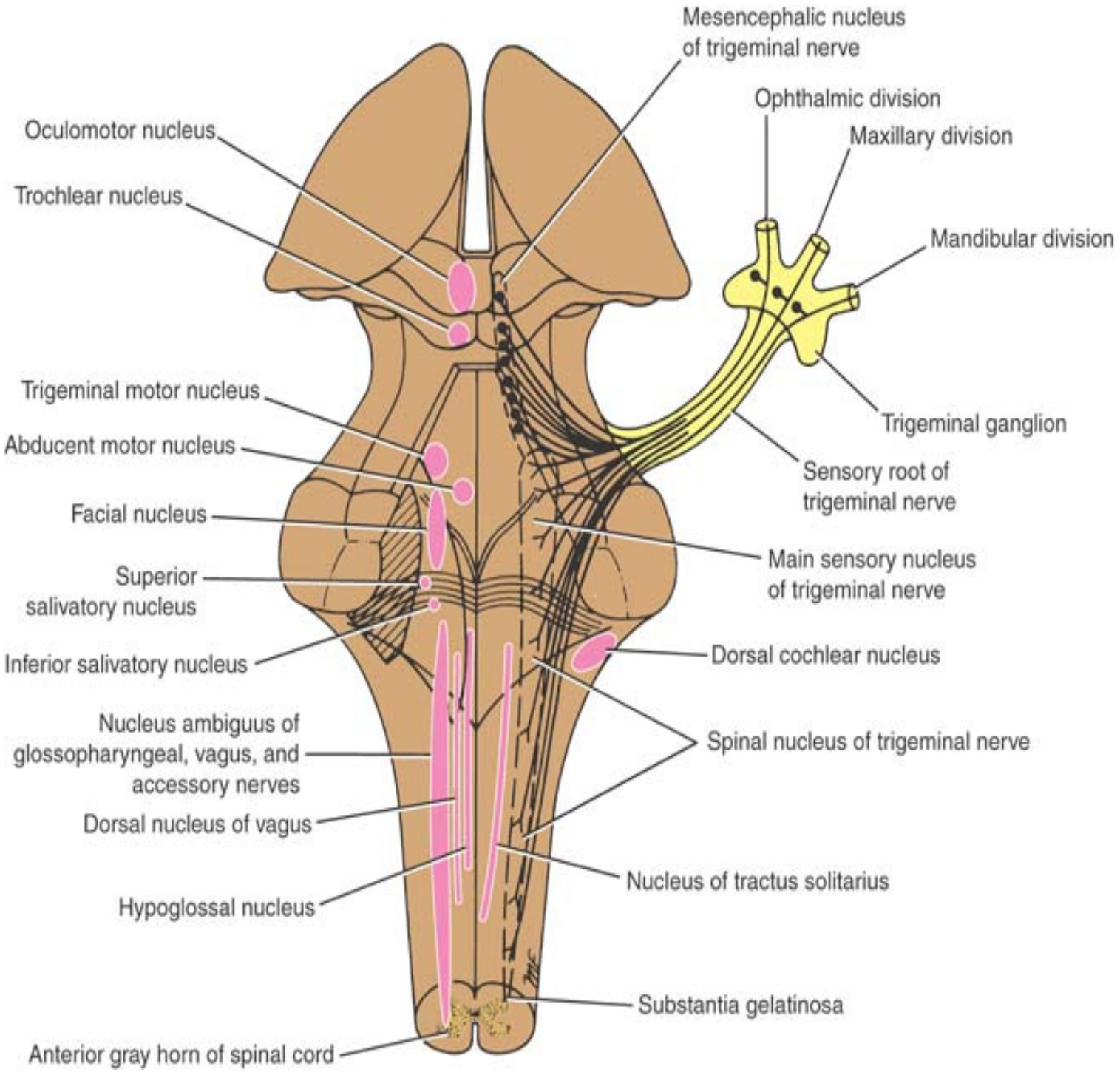
Level through cranial part (trigeminal nuclei)

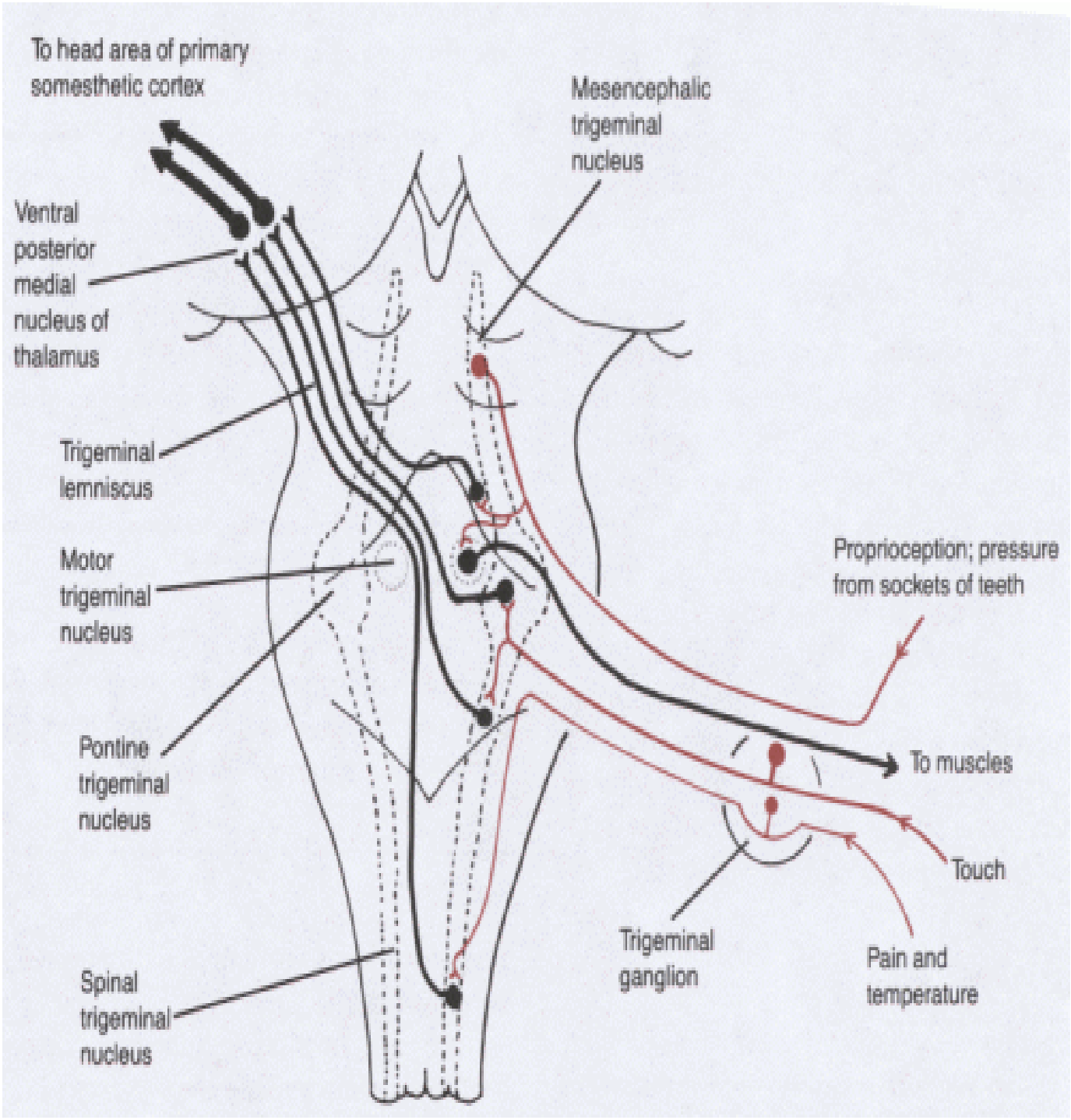
- **Motor nucleus** of trigeminal n: beneath the lateral part of thefourth ventricle within the reticular formation
- **Main Sensory** nucleus of trigeminal n (*lateral*)
- **SCP:** posterolateral to the motor nucleus of V
- **Trapezoid body**
- **Medial leminiscus**
- **Lateral leminiscus, Spinal leminiscus**: lateral extremity of the medial lemniscus



Level through cranial part (trigeminal nuclei)

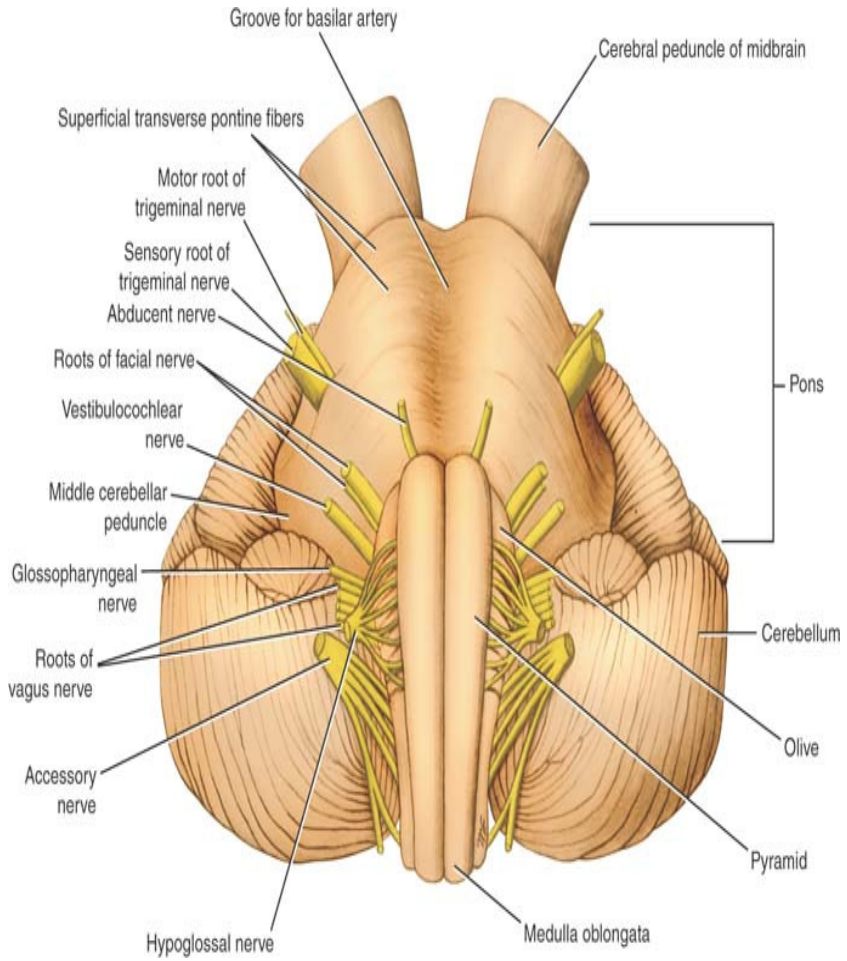



Mesencephalic nucleus of trigeminal nerve
Ophthalmic division
Maxillary division
Mandibular division
Oculomotor nucleus
Trochlear nucleus
Trigeminal motor nucleus
Abducent motor nucleus
Facial nucleus
Superior salivatory nucleus
Inferior salivatory nucleus
Nucleus ambiguus of glossopharyngeal, vagus, and accessory nerves
Dorsal nucleus of vagus
Hypoglossal nucleus
Anterior gray horn of spinal cord
Trigeminal ganglion
Sensory root of trigeminal nerve
Main sensory nucleus of trigeminal nerve
Dorsal cochlear nucleus
Spinal nucleus of trigeminal nerve
Nucleus of tractus solitarius
Substantia gelatinosa

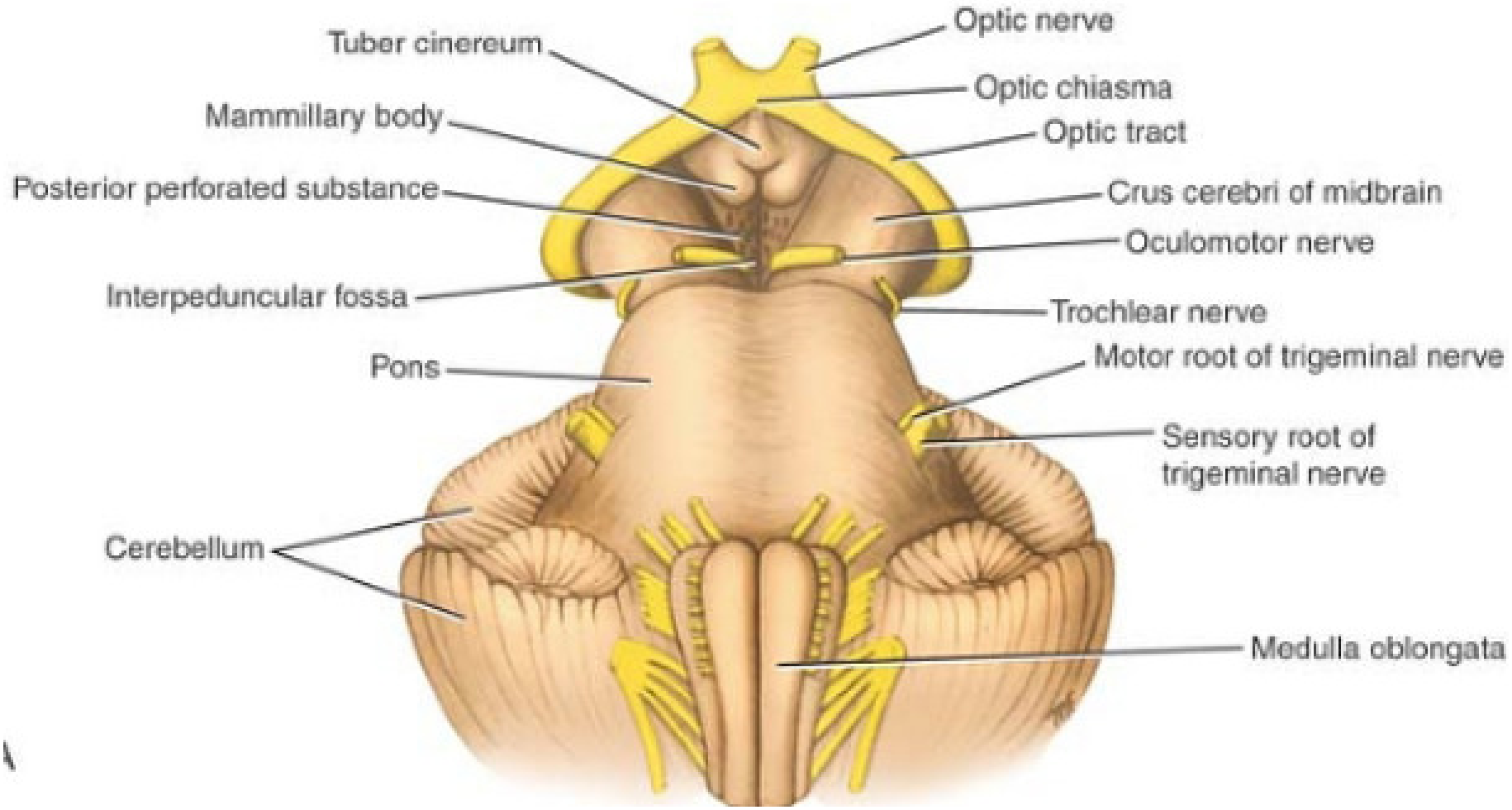

To head area of primary somesthetic cortex
Mesencephalic trigeminal nucleus
Ventral posterior medial nucleus of thalamus
Trigeminal lemniscus
Motor trigeminal nucleus
Pontine trigeminal nucleus
Spinal trigeminal nucleus
Proprioception; pressure from sockets of teeth
To muscles
Touch
Trigeminal ganglion
Pain and temperature

The Brain Stem – The Midbrain

- Lies between the diencephalon and the pons
- Central cavity – the **cerebral aqueduct**
- Cerebral peduncles located on the ventral surface of the brain divided by the **substantia nigra** into**:**
- **Crus cerebri: Anterior**
- **Tegmentum: Posterior**
  - Contain pyramidal (corticospinal) tracts
- Superior cerebellar peduncles
  - Connect midbrain to the cerebellum



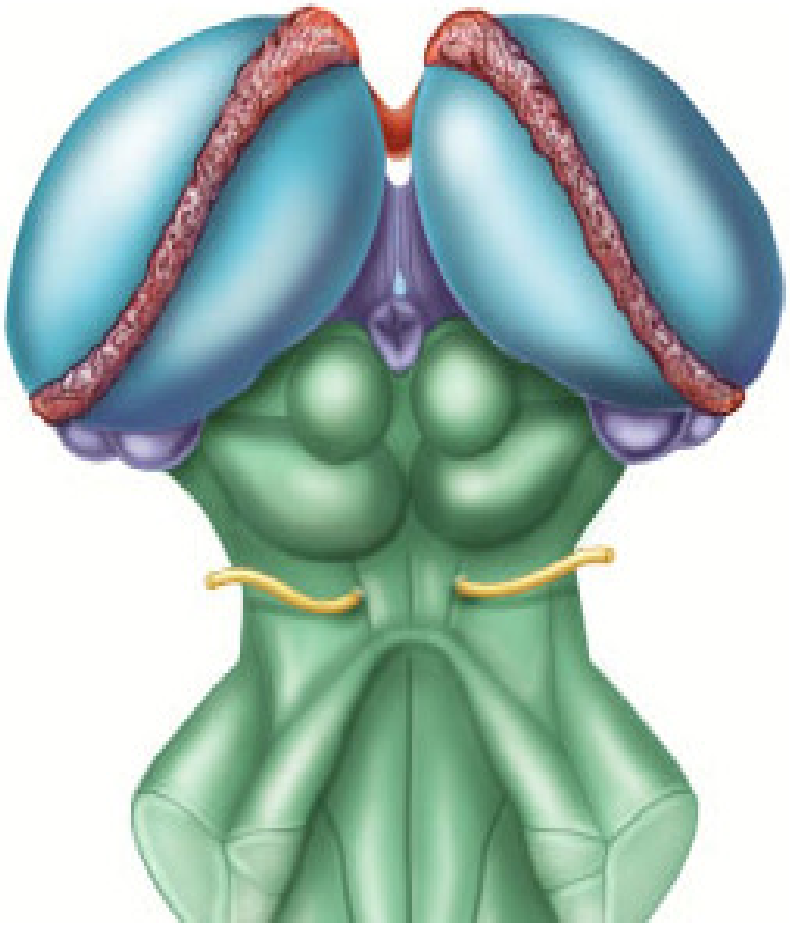
Midbrain ant. View



- Interpeduncular fossa
- Crus cerebri
- 3rd nerve emerges from medial side of crus cerebri in the interpeduncular fossa

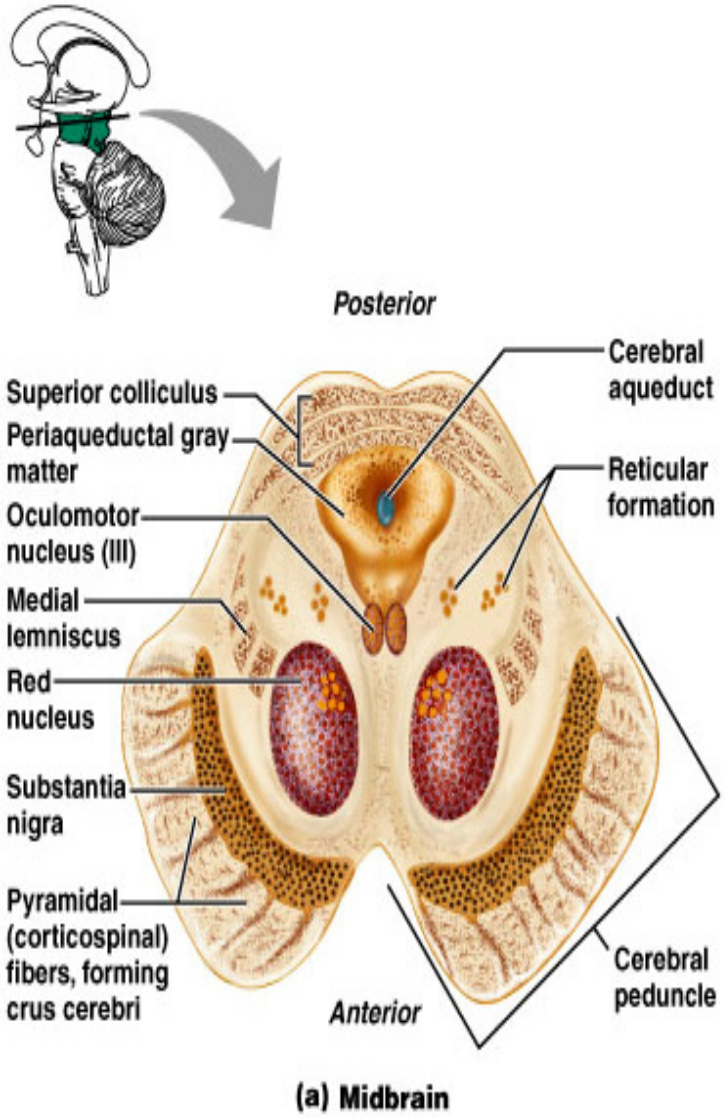
The Midbrain-posterior view

- Corpora quadrigemina – the largest nuclei
  - Divided into the superior and inferior colliculi
    - Superior colliculi – nuclei that act in visual reflexes
    - Inferior colliculi – nuclei that act in auditory reflexes
- Trochlear nerve emerges below the level of inf. Colliculus (from posterior surface)
- Occulomotor nerve emerges at the level of sup. colliculus
- Sup.brachium (to lateral geniculate body)
- Inf. Brachium (to medial geniculate body)
- 4^{th} emerges



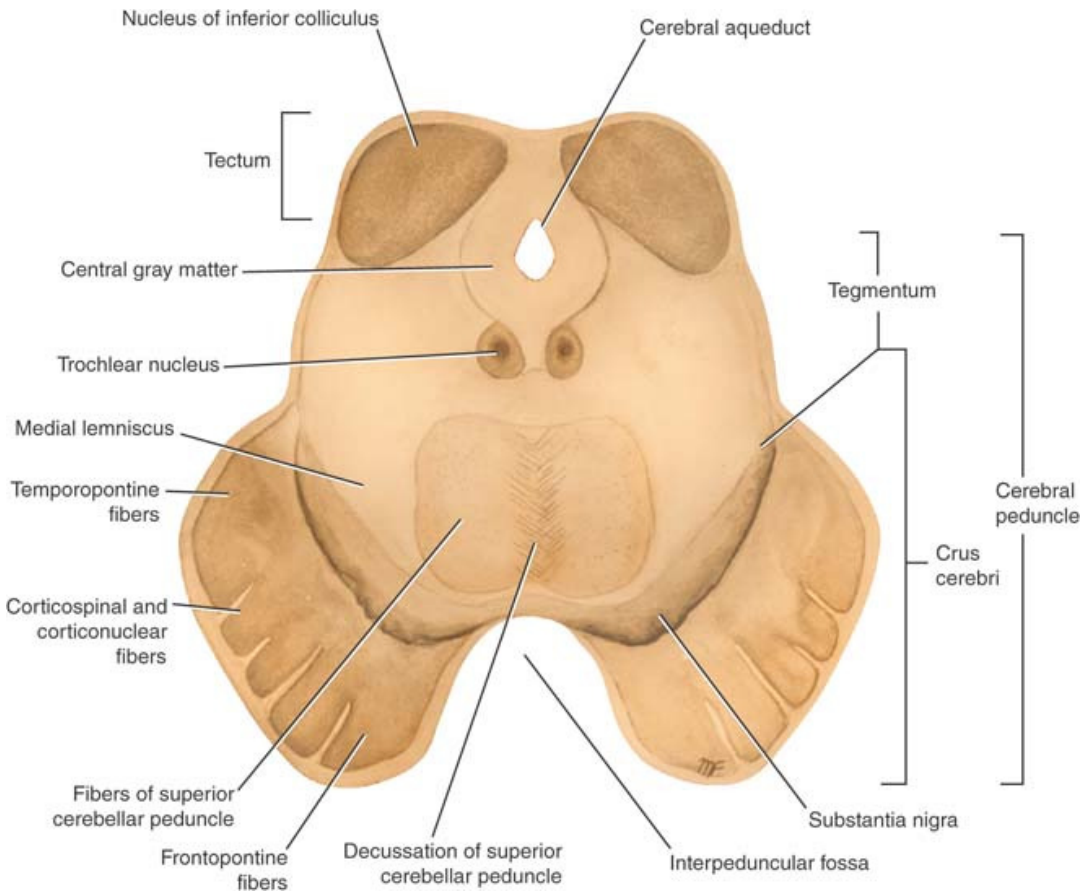
The Brain Stem – The Midbrain

- Imbedded in the white matter of the midbrain
  - Two pigmented nuclei
  - Substantia nigra – neuronal cell bodies contain melanin
    - Functionally linked to the basal nuclei
  - Red nucleus – lies deep to the substantia nigra
    - Largest nucleus of the reticular formation



Cerebral peduncle is divided into crus cerebri (ant) & tegmentum (post)

Tectum is post to cerebral aqueduct

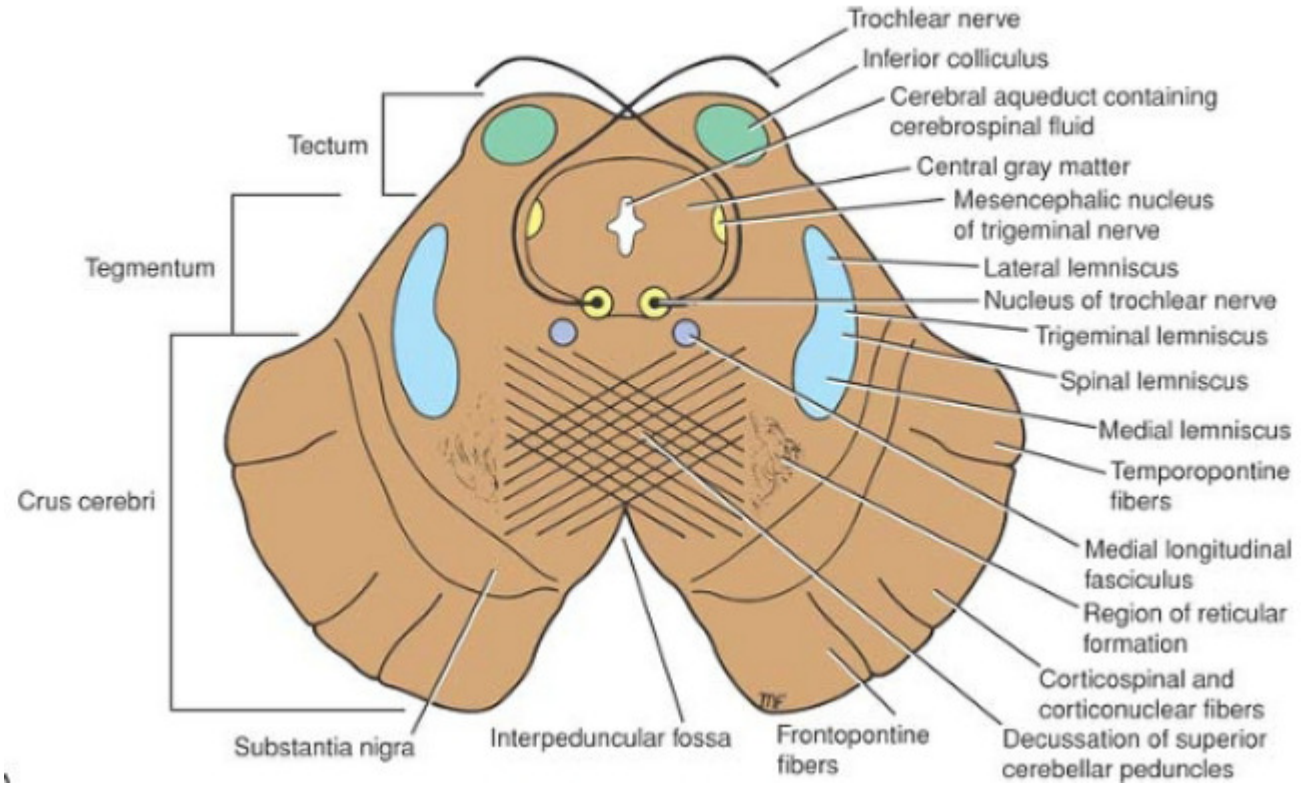


Substantia nigra is situated between the tegmentum and crus cerebri

- Trochlear nucleus lies close to midline in the central gray matter (posterior to MLF)
- Trochlear nerves decussate in the superior medullary velum

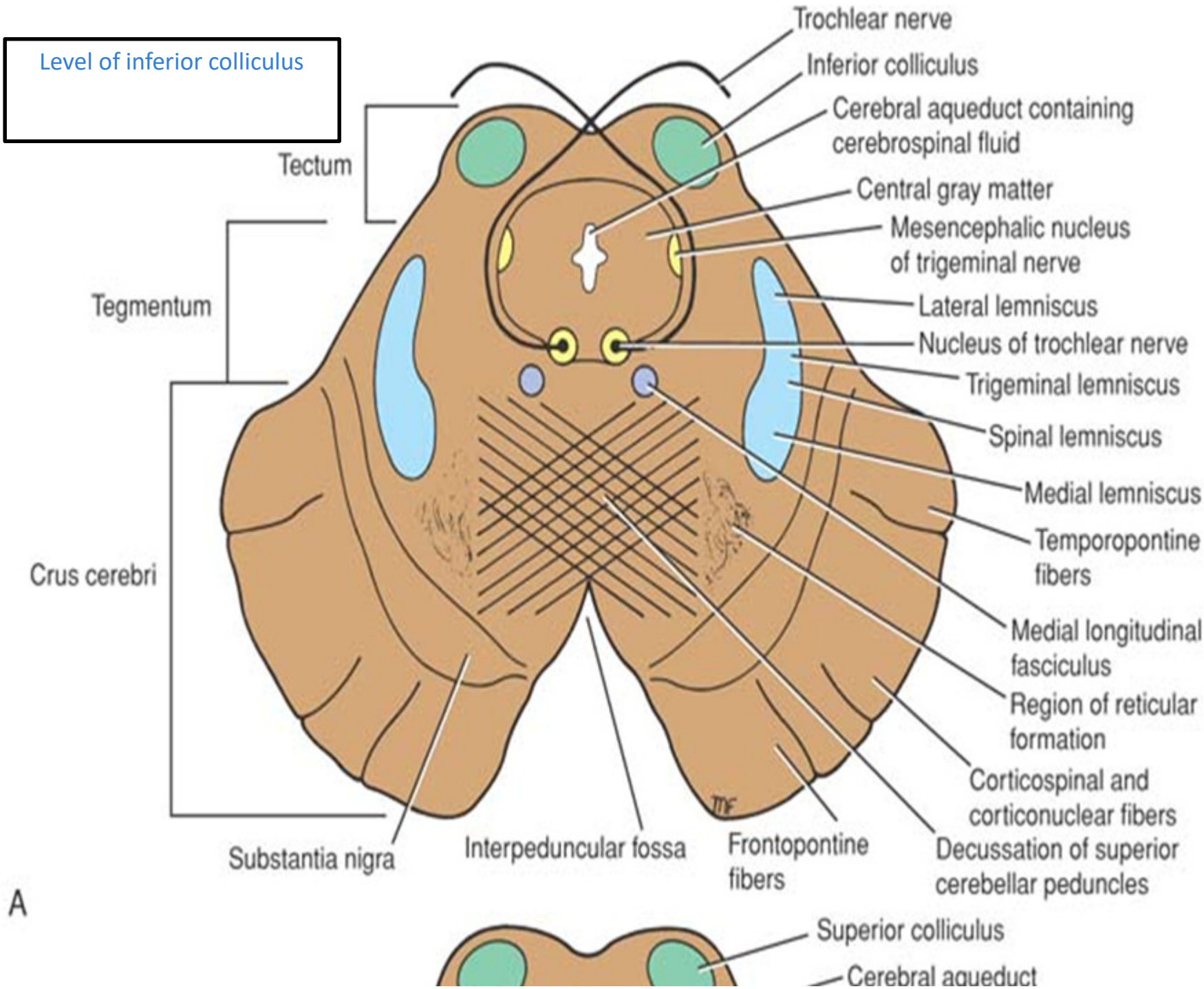
- Decussation of sup. cerebellar peduncles (central part of the tegmentum anterior to the cerebral aqueduct)
  - RF is lateral to decussation
  - Medial, spinal ,trigeminal & lateral leminisci (Posterior to Substantia nigra)

Level of inf. colliculus



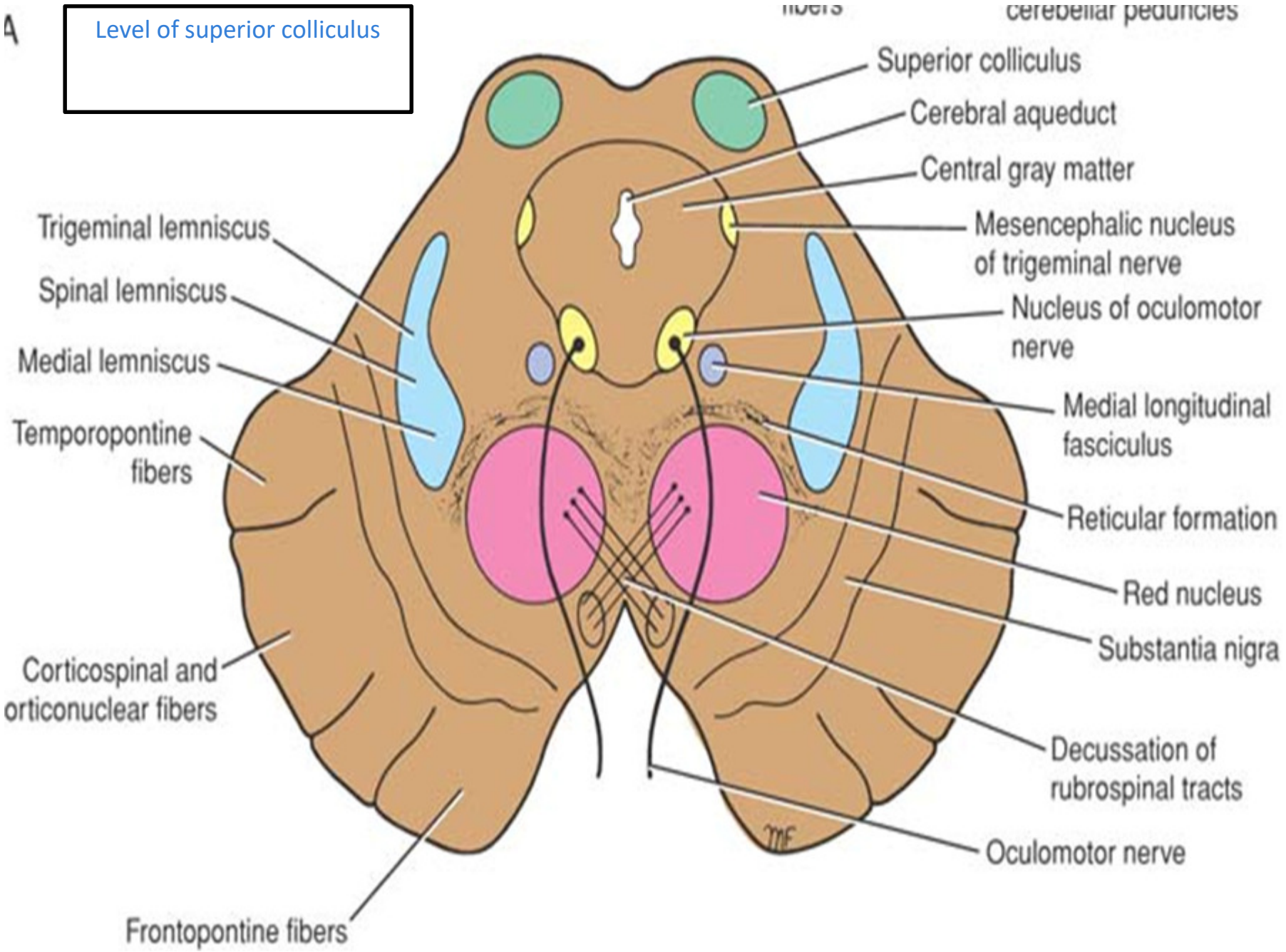
- Substantia nigra
- Crus cerebri
- Mesencephalic nucleus of trigeminal *(lateral to cerebral aqueduct)*
- MLF

Level of inferior colliculus

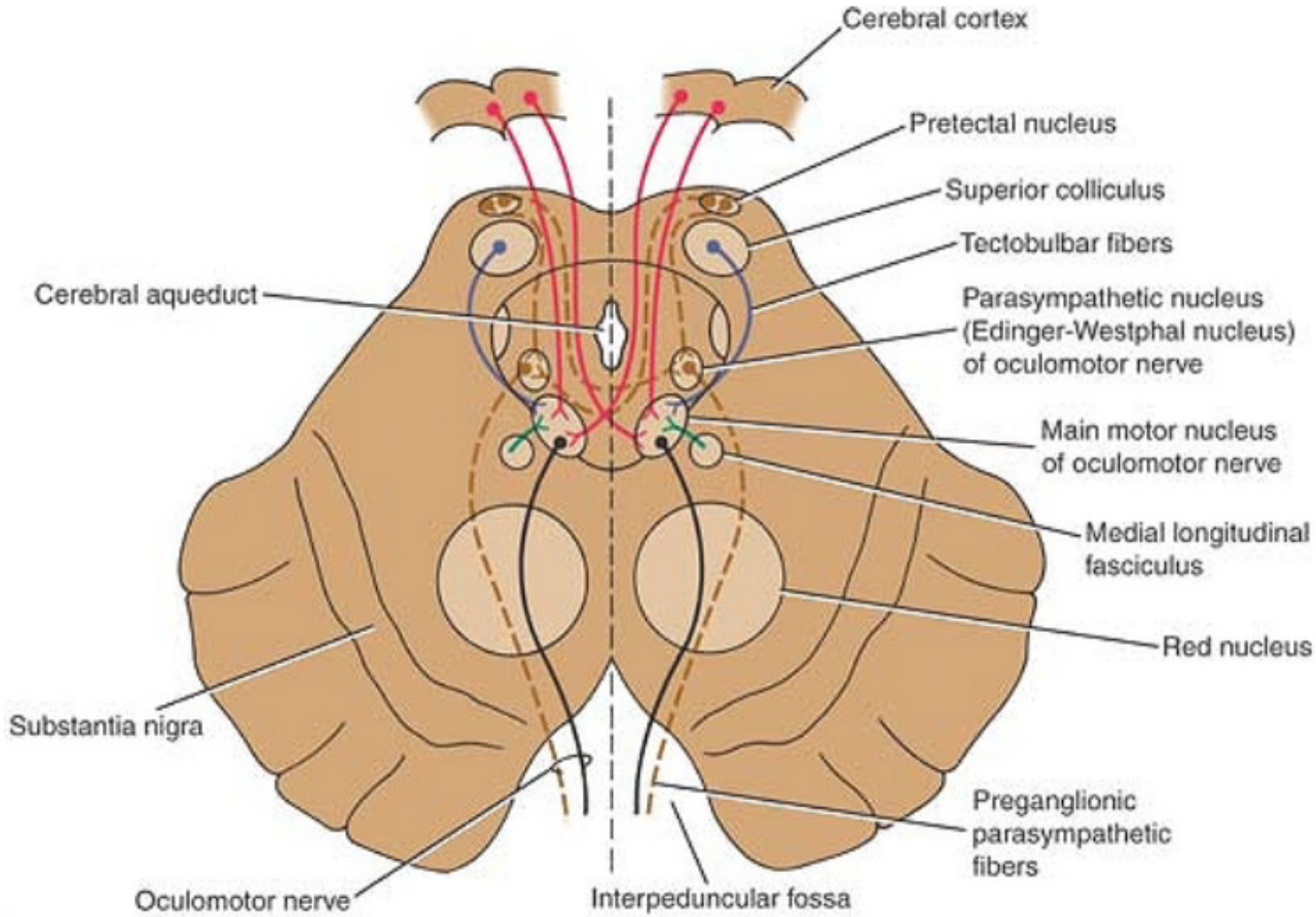


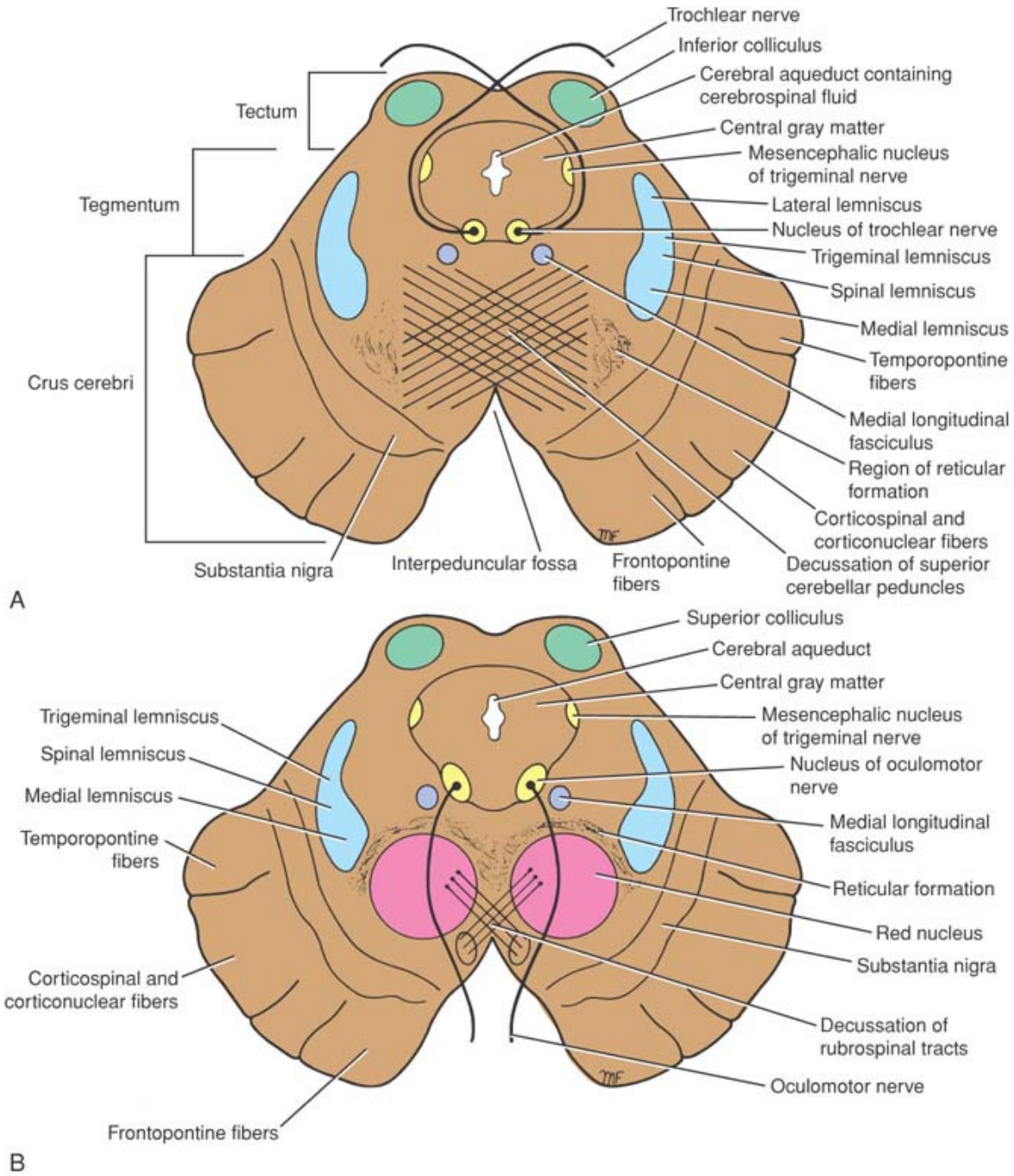
A

Level of superior colliculus



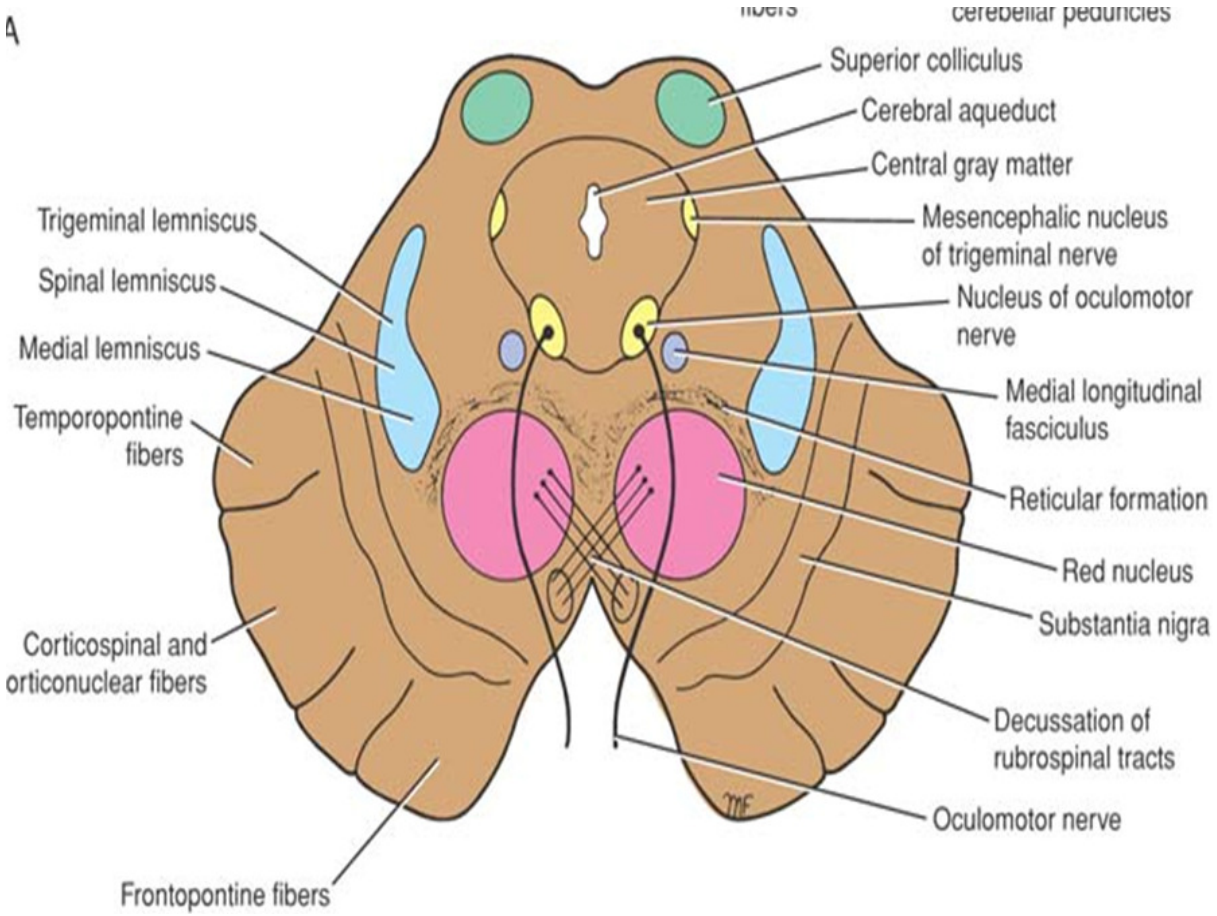
- Edinger-Westphal nucleus
- **pretectal nucleus:** close to the lateral part of the superior colliculus.




Trochlear nerve
Inferior colliculus
Cerebral aqueduct containing cerebrospinal fluid
Tectum
Central gray matter
Mesencephalic nucleus of trigeminal nerve
Tegmentum
Lateral lemniscus
Nucleus of trochlear nerve
Trigeminal lemniscus
Spinal lemniscus
Medial lemniscus
Temporopontine fibers
Crus cerebri
Medial longitudinal fasciculus
Region of reticular formation
Corticospinal and corticonuclear fibers
Decussation of superior cerebellar peduncles
Substantia nigra
Interpeduncular fossa
Frontopontine fibers
A
Superior colliculus
Cerebral aqueduct
Central gray matter
Trigeminal lemniscus
Mesencephalic nucleus of trigeminal nerve
Spinal lemniscus
Nucleus of oculomotor nerve
Medial lemniscus
Medial longitudinal fasciculus
Temporopontine fibers
Reticular formation
Red nucleus
Substantia nigra
Corticospinal and corticonuclear fibers
Decussation of rubrospinal tracts
Oculomotor nerve
Frontopontine fibers
B

Red nucleus

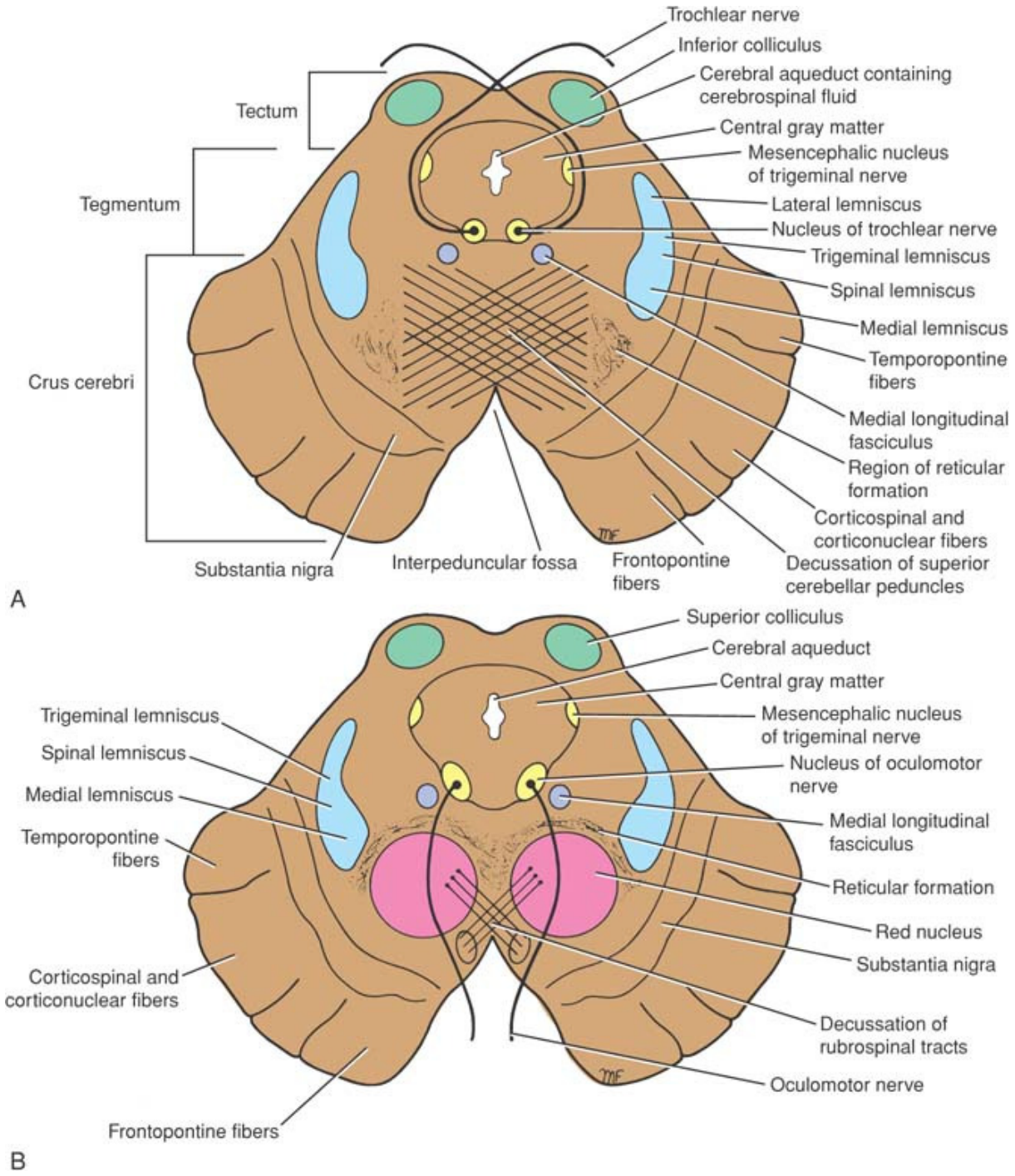
- Rounded mass of gray matter
- Situated bt cerebral aqueduct and substantia nigra
- Reddish blue(vascularity & iron containing pigment)
- Afferents from: cerebral cortex,cerebellum,substantia nigra, thalamic nuclei, spinal cord
- Efferent to: spinal cord, reticular formation. thalamus and substantia nigra
- involved in motor coordination.



Crus cerebri

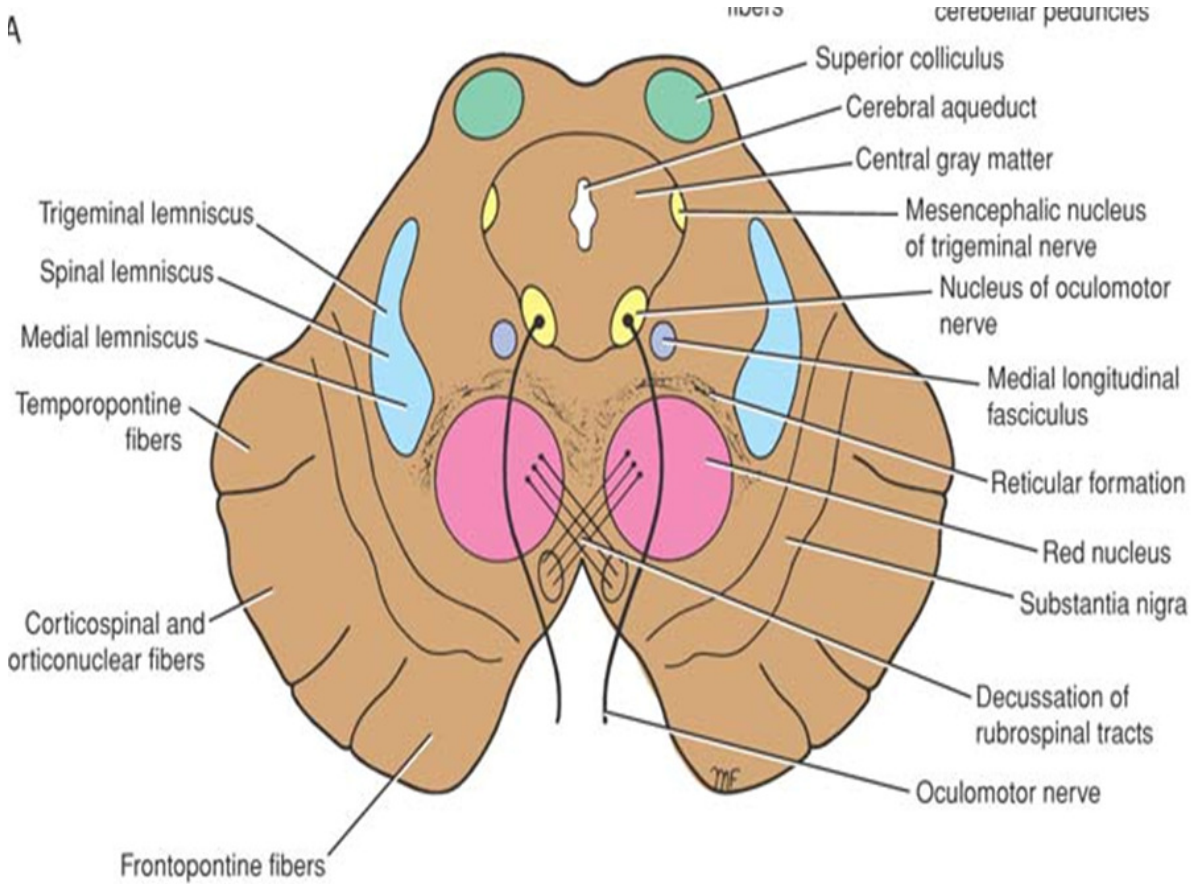
- Corticospinal & corticonuclear fibers (middle)
- Frontopontine fibers (medial)
- Temporopontine fibers (lateral)

these descending tracts connect the cerebral cortex with spinal cord, cranial nerves nuclei, pons & cerebellum



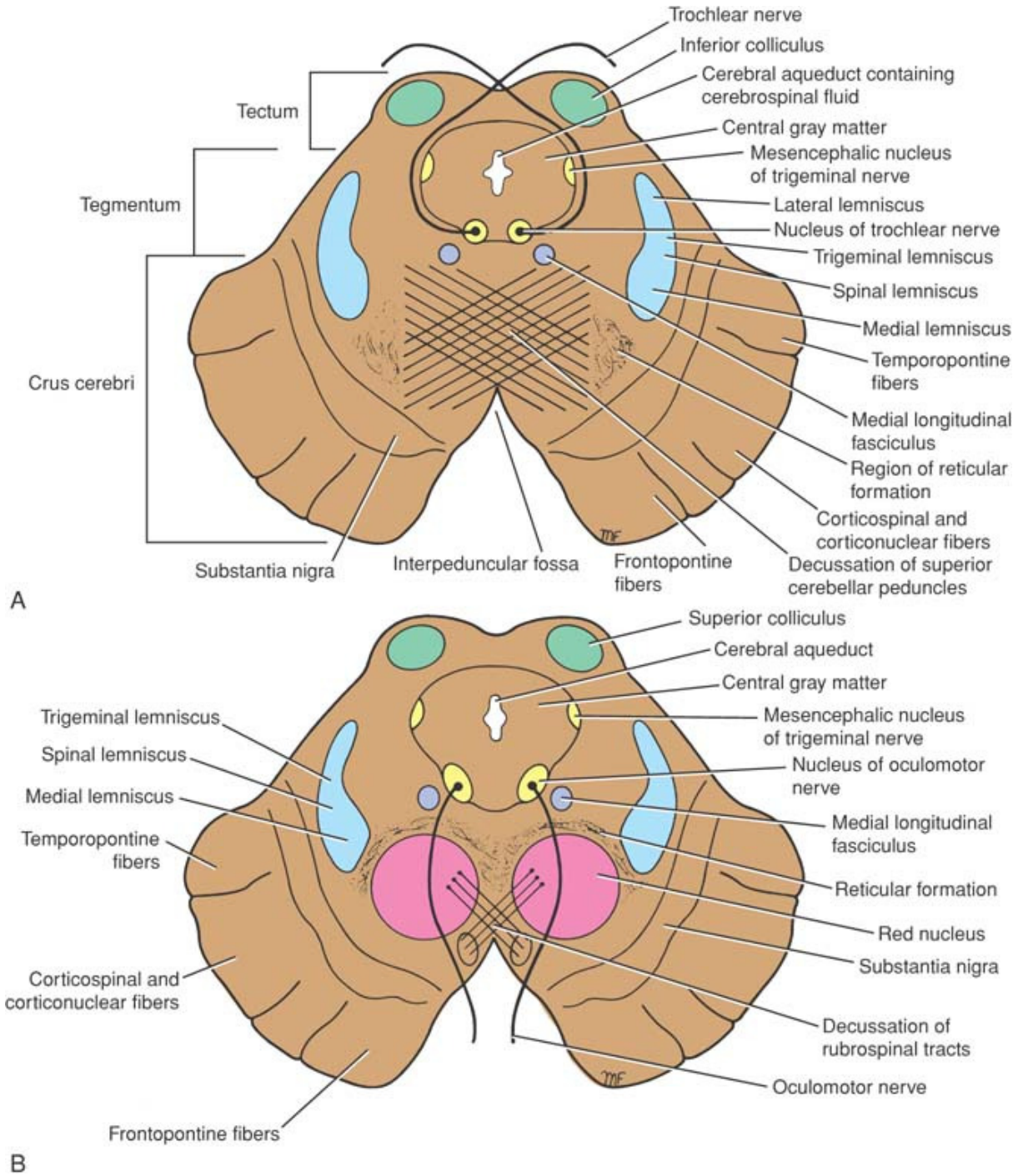
Level at superior colliculus

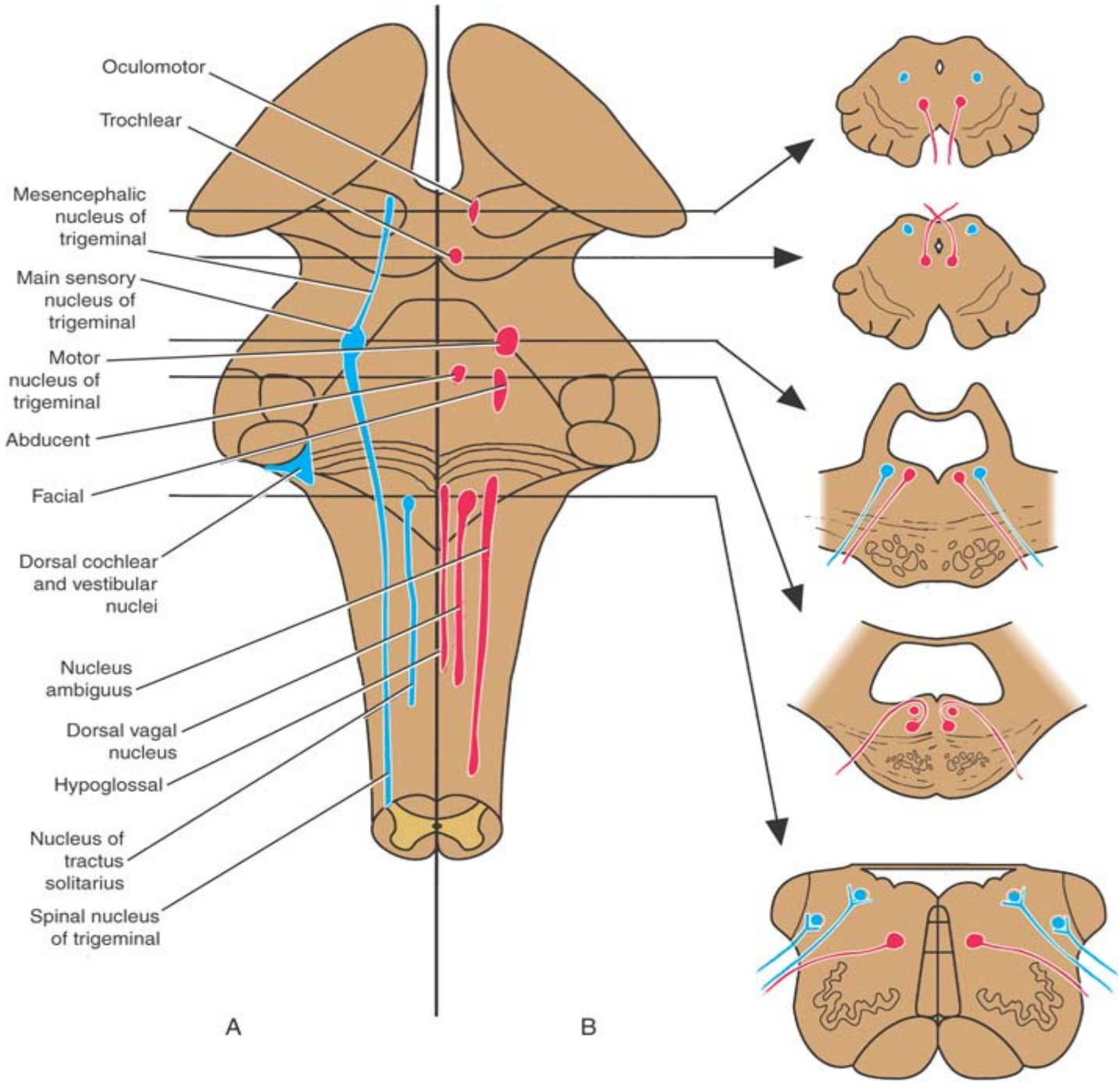
- Superior colliculus
- Occulomotor nucleus (posterior to MLF)
- Occulomotor n emerges through red nucleus
- Edinger-Westphal nucleus
- **pretectal nucleus:** close to the lateral part of the superior colliculus.
- MLF
- Medial , trigeminal, spinal leminiscus (**no** lateral leminiscus)
- Red nucleus
- Substantia nigra
- Crus cerebri
- RF



Substantia nigra

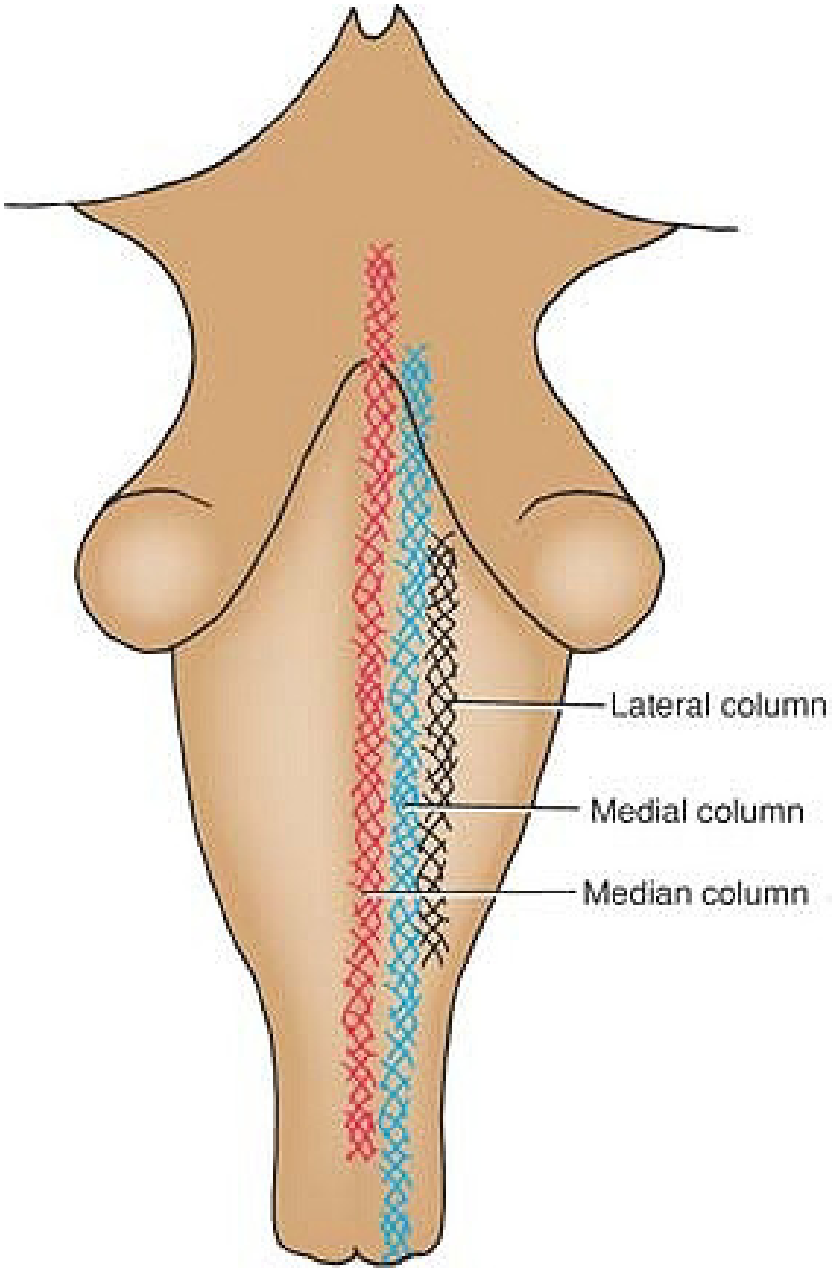
- Large motor nucleus
- is a brain structure located in the midbrain
- plays an important role in reward, addiction, and movement.
- *Substantia nigra* is Latin for "black substance" due to high levels of melanin
- has connections with basal ganglia ,cerebral cortex
- Concerned with muscle tone
- Parkinson's disease is caused by the death of neurons in the substantia nigra




Oculomotor
Trochlear
Mesencephalic nucleus of trigeminal
Main sensory nucleus of trigeminal
Motor nucleus of trigeminal
Abducent
Facial
Dorsal cochlear and vestibular nuclei
Nucleus ambiguus
Dorsal vagal nucleus
Hypoglossal
Nucleus of tractus solitarius
Spinal nucleus of trigeminal
A
B

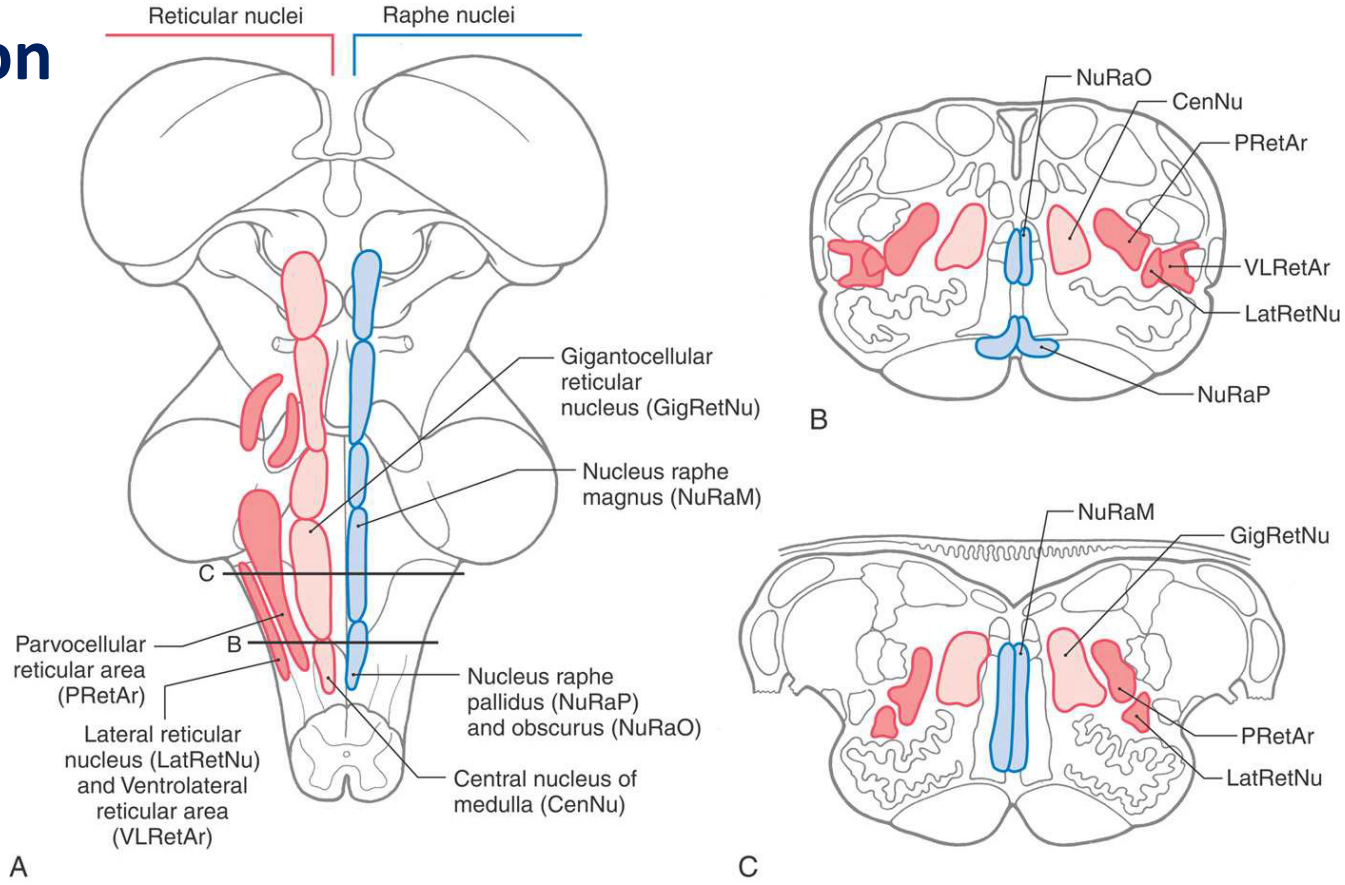
Reticular Formation

- Deeply placed continuous network of nerve cells and fibers that extend from the spinal cord through the medulla, the pons, the midbrain, the subthalamus, the hypothalamus, and the thalamus
- Divided into three longitudinal columns:
  - **Median column:** intermediate-size neurons
  - **Medial column:** large neurons
  - **Lateral column:** small neurons
- **General function:**
  - Control of skeletal muscle
  - Control of somatic and visceral sensations
  - Control of the autonomic nervous system
  - The reticular activating system.



Reticular Formation In Medulla

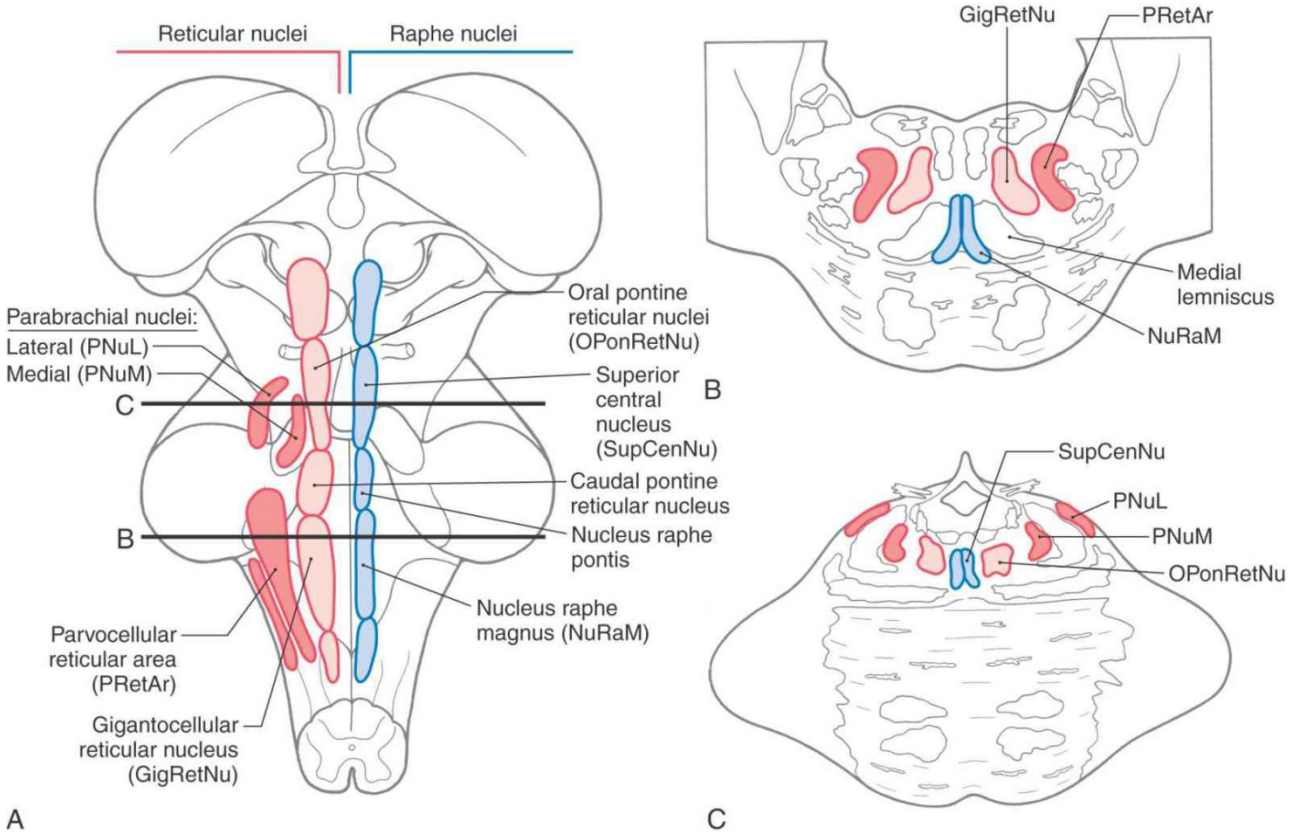
- **Raphe nuclei**
  - Pallidus
  - Obscurus
  - Magnus
- **Medial medullary reticular area**
  - Central nucleus of the medulla
  - Gigantocellular reticular nucleus



- **Lateral medullary reticular area**
  - **Ventrolateral reticular area**
  - Lateral reticular nucleus
  - Parvocellular nucleus

Reticular Formation In Pons

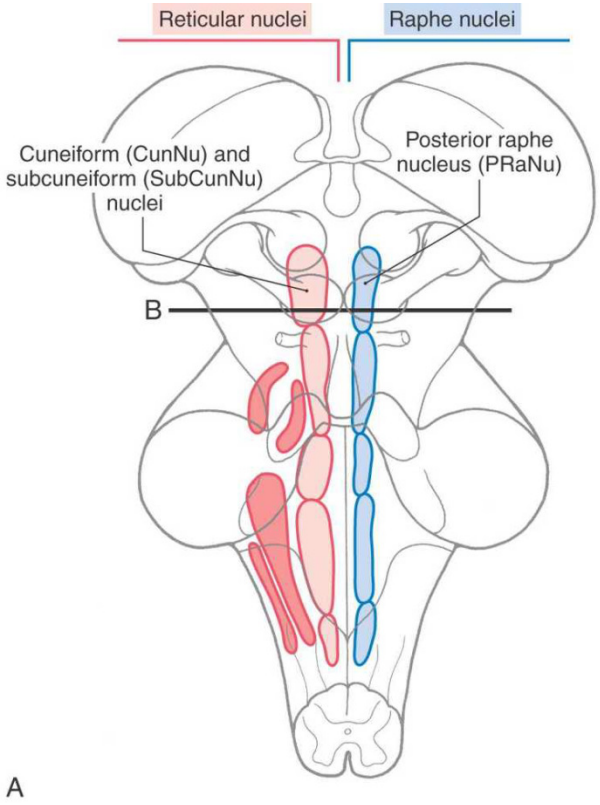
- **Raphe nuclei**
  - Magnus
  - Pontis
  - Superior central
  - Dorsal
- **Medial reticular area**
  - Gigantocellular reticular nucleus
  - Caudal
  - Oral

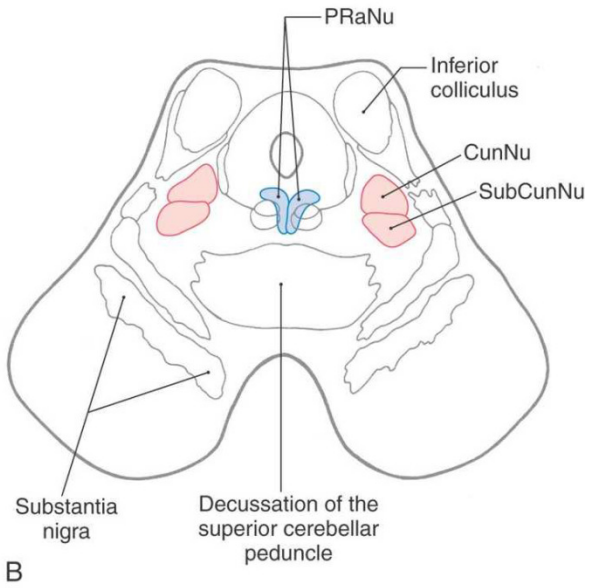


- **Lateral reticular area**
  - Parvocellular nucleus
  - Medial parabrachial nucleus
  - Lateral parabrachial nucleus

Reticular Formation In Midbrain

- **Raphe nuclei**
  - Posterior (dorsal) raphe nucleus: anterior PAG
- **Medial reticular area**
  - Cuneiform nucleus
  - Subcuneiform nucleus

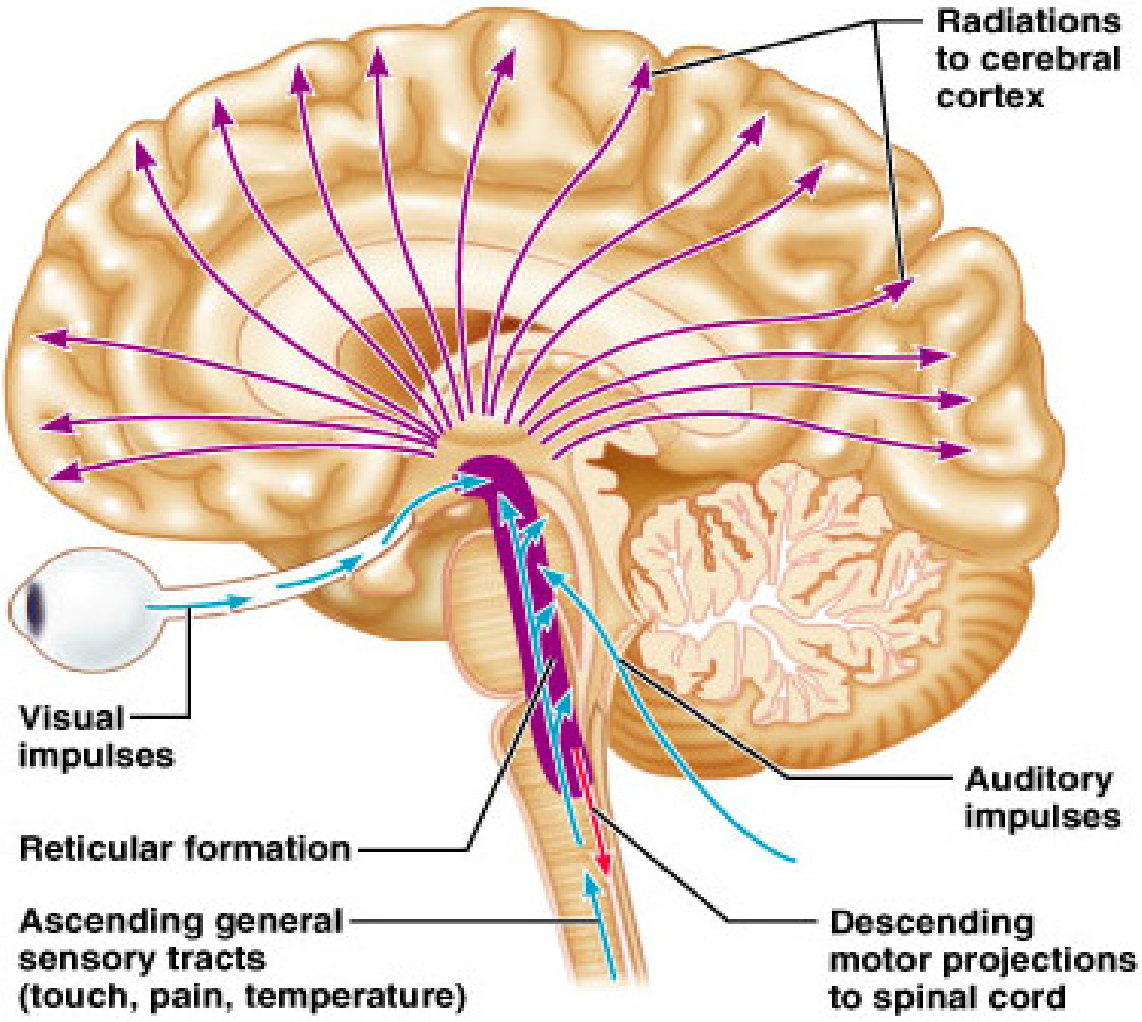




- Participates in the ascending systems that:
  - Regulate states of consciousness.
  - Project to the thalamus (thalamic reticular nucleus)
- Ascending fiber system is largely responsible for maintaining an alert, wakeful state and thus forms part of the **ascending reticular activating system**

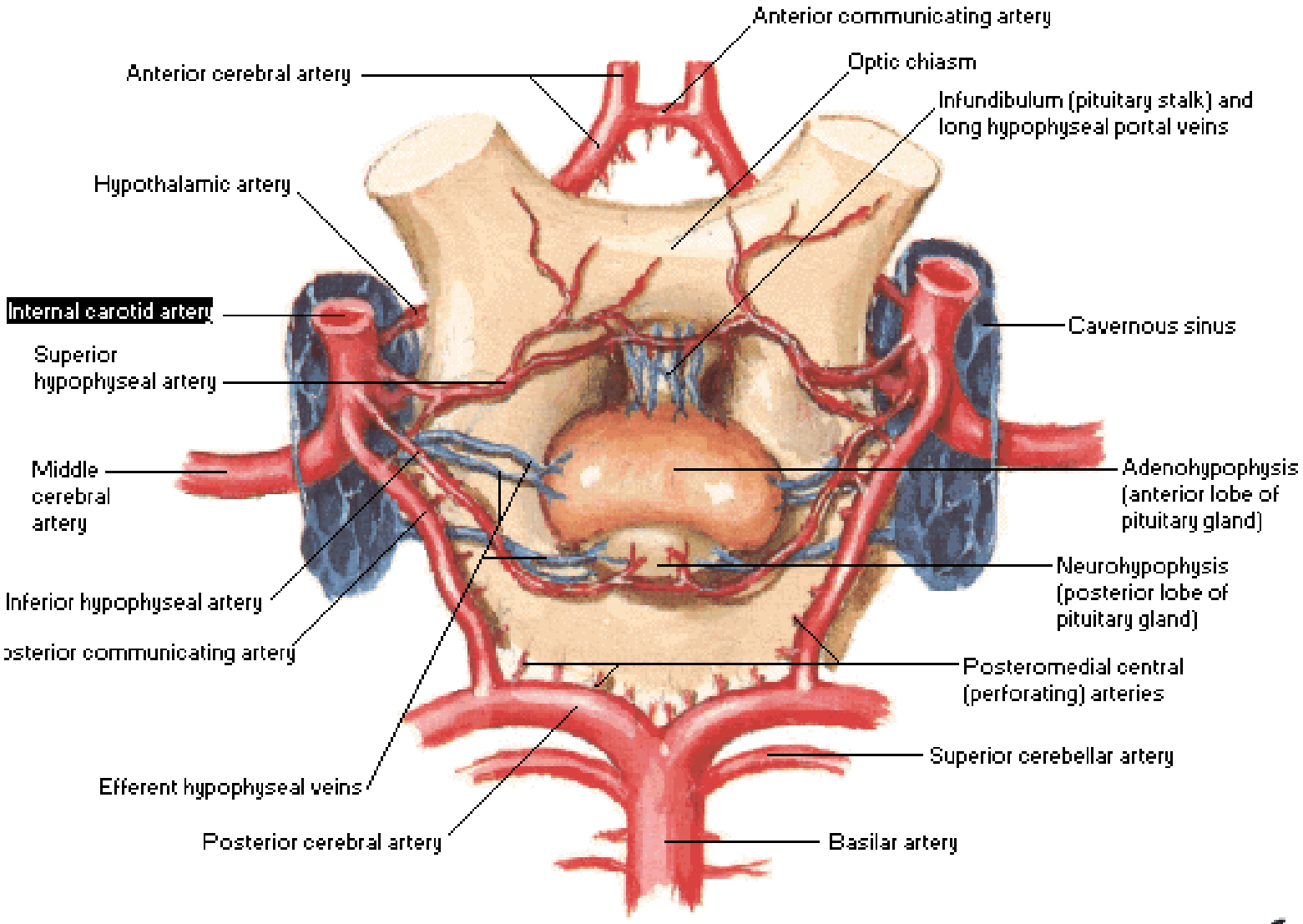
Reticular Formation

- Deeply placed posterior to the olivary nucleus
- Widespread connections
  - Arousal of the brain as a whole
- Reticular activating system (RAS)
  - Maintains consciousness and alertness



Cerebral Arterial Circle [Willis] - Vessels in Situ

Inferior View



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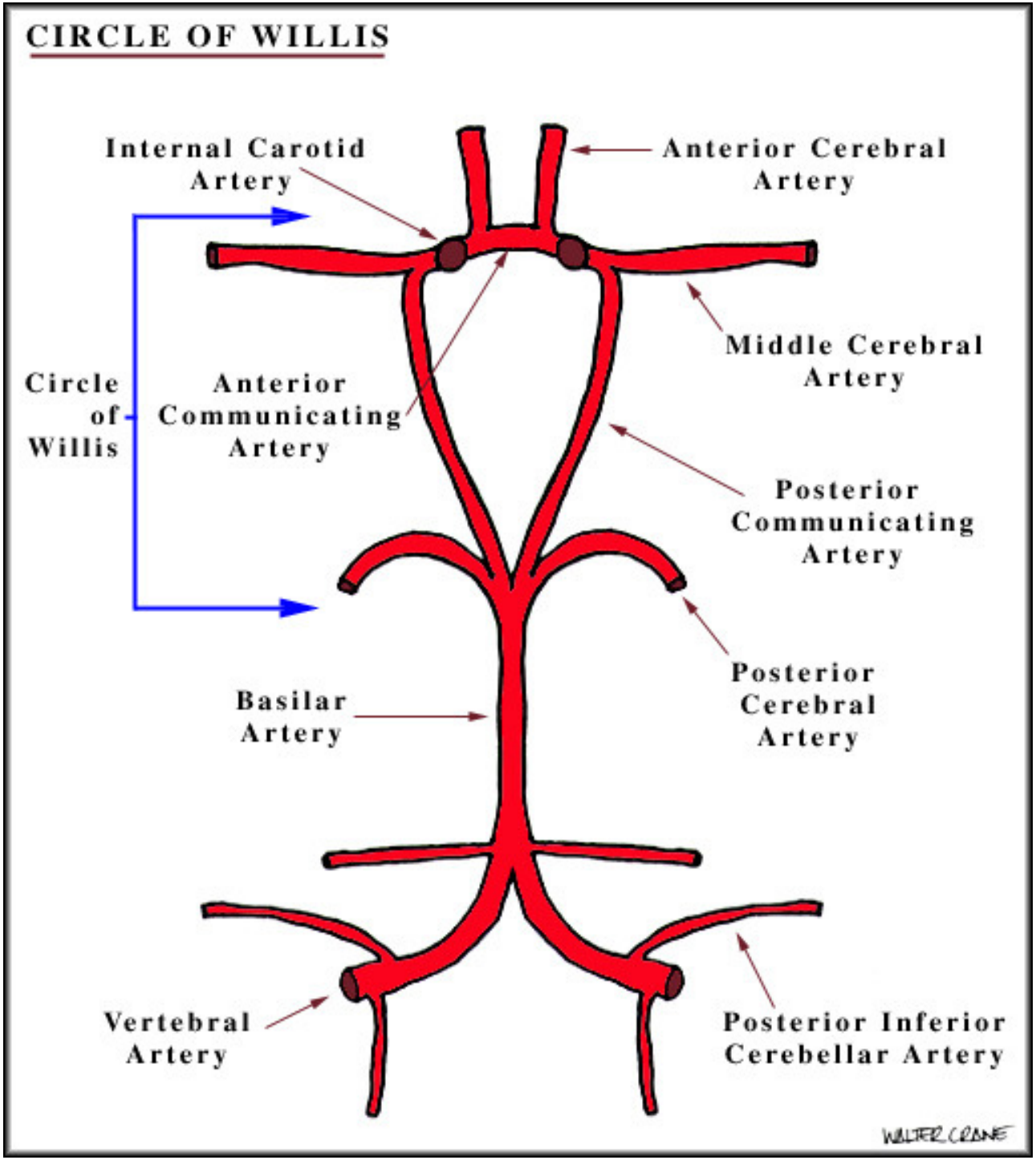
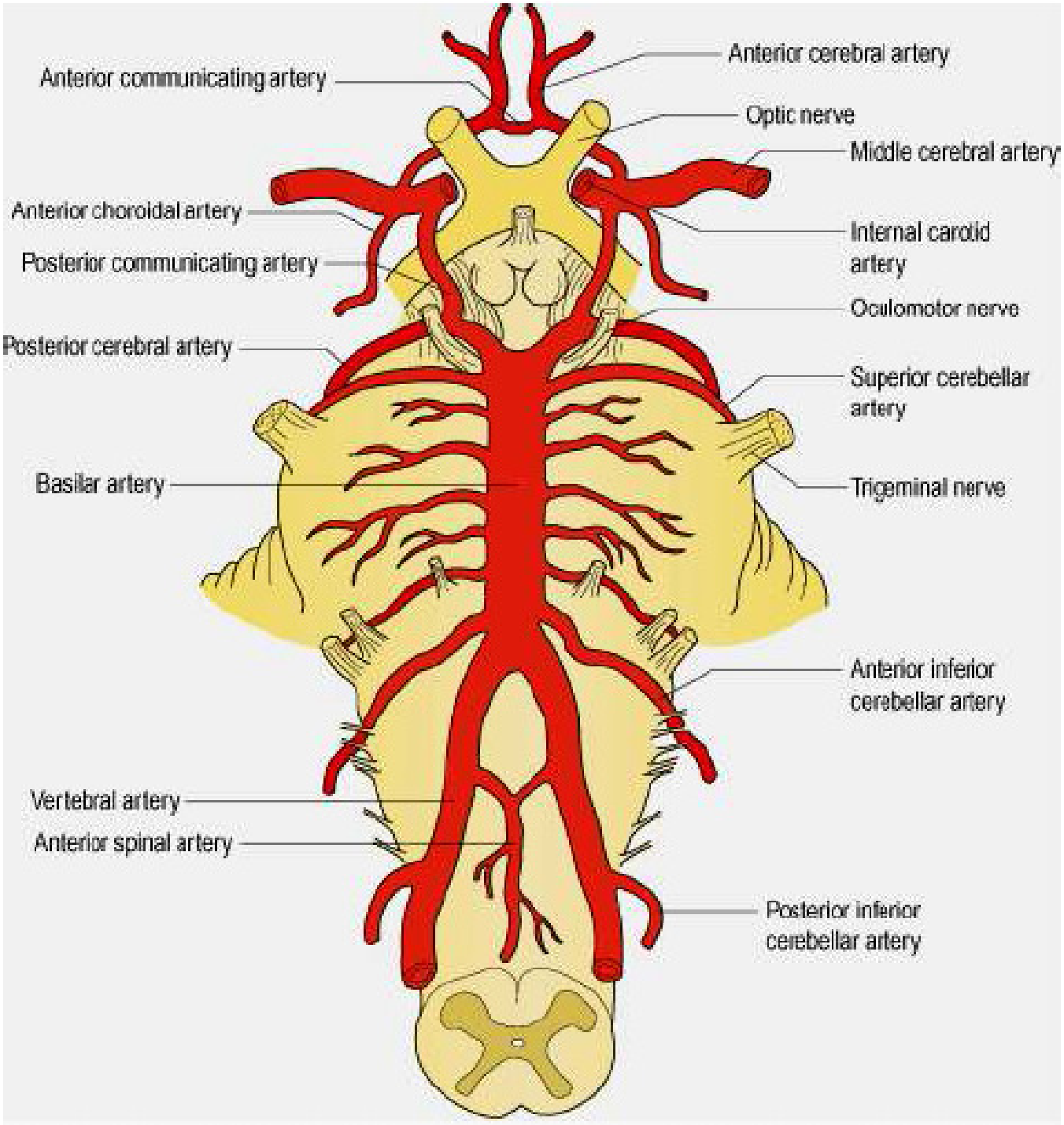
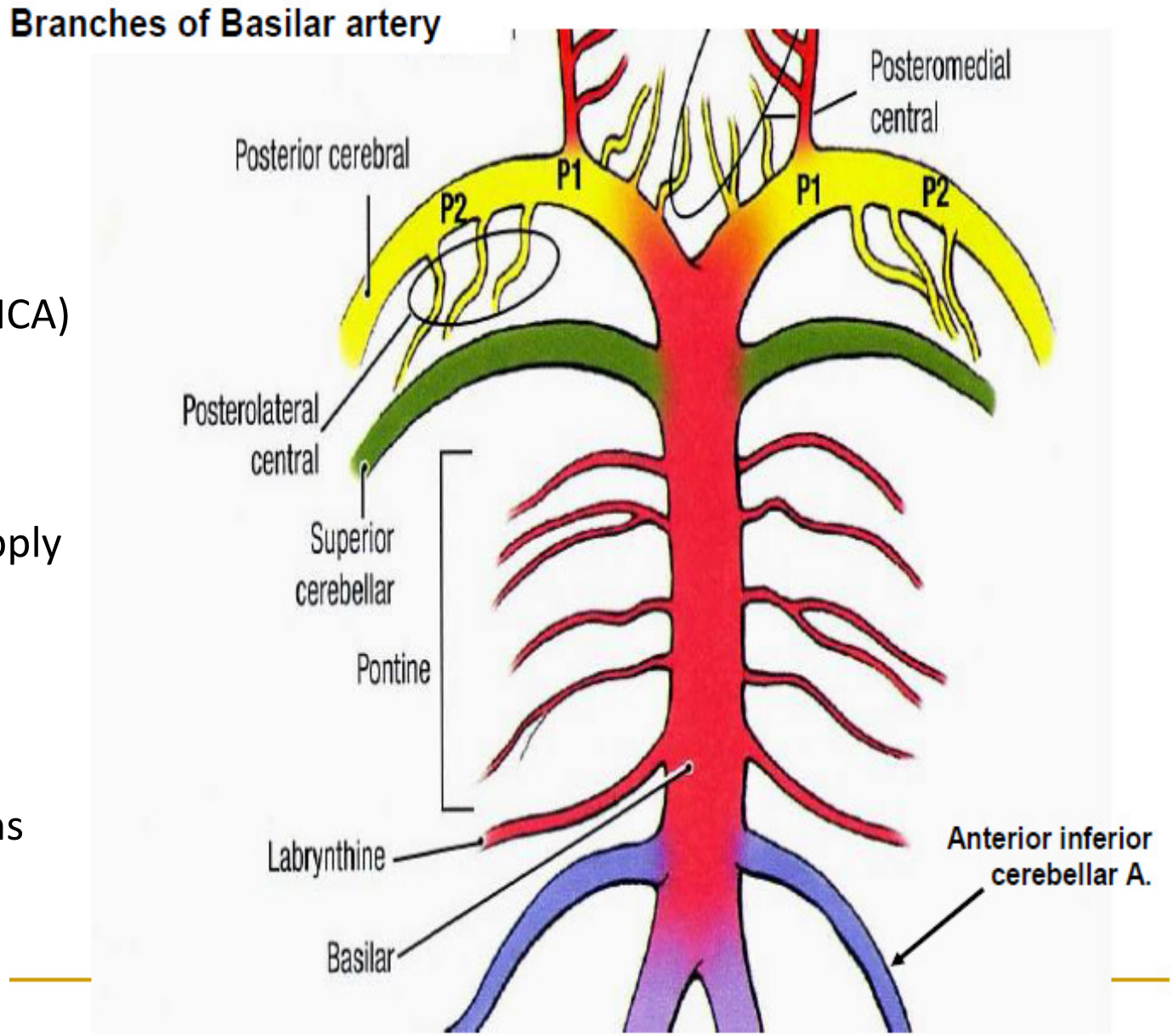

CIRCLE OF WILLIS
Internal Carotid Artery
Anterior Cerebral Artery
Middle Cerebral Artery
Circle of Willis
Anterior Communicating Artery
Posterior Communicating Artery
Posterior Cerebral Artery
Basilar Artery
Vertebral Artery
Posterior Inferior Cerebellar Artery
WALTER CRANE

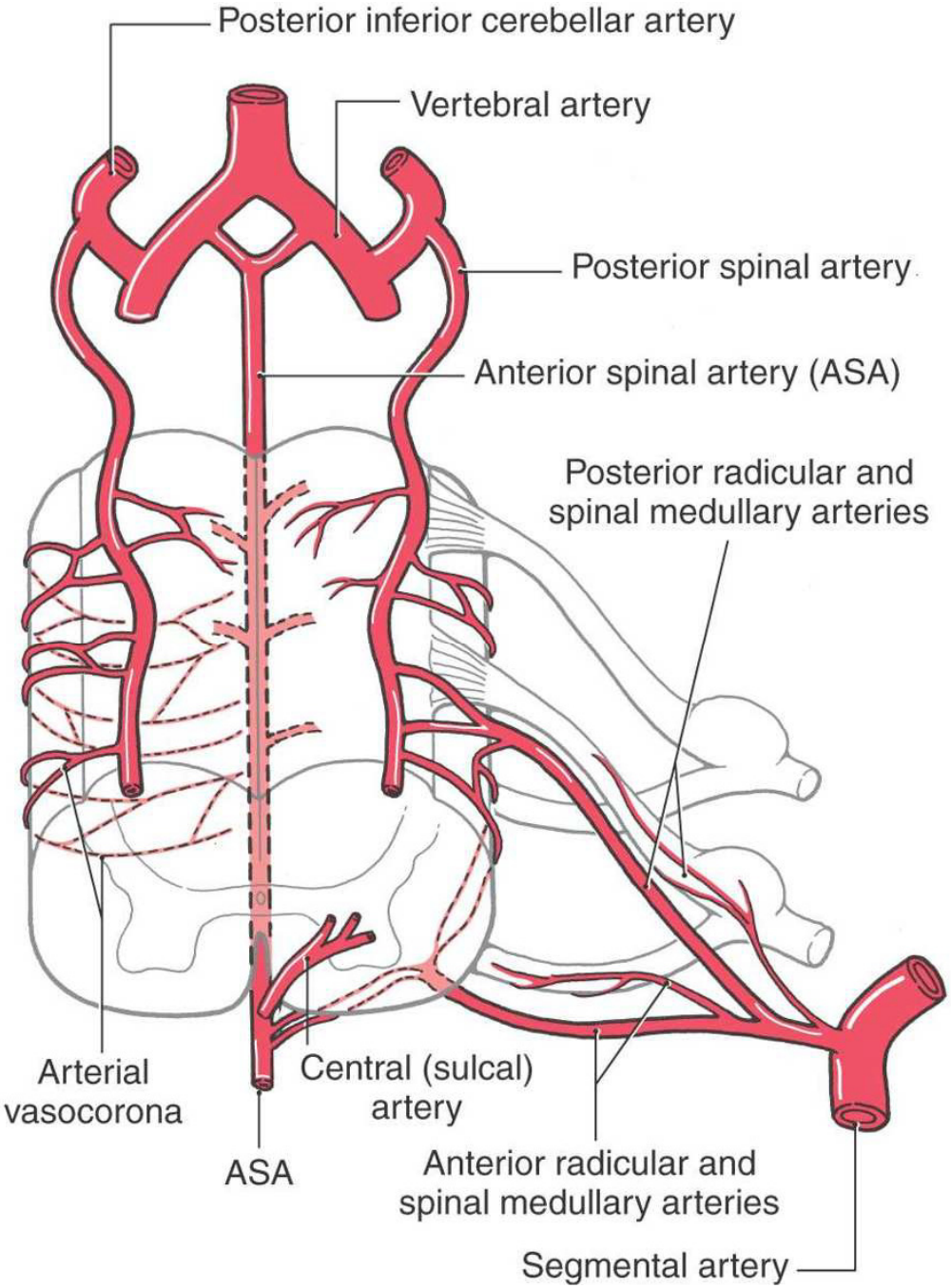

Anterior communicating artery
Anterior cerebral artery
Optic nerve
Middle cerebral artery
Anterior choroidal artery
Internal carotid artery
Posterior communicating artery
Oculomotor nerve
Posterior cerebral artery
Superior cerebellar artery
Basilar artery
Trigeminal nerve
Anterior inferior cerebellar artery
Vertebral artery
Anterior spinal artery
Posterior inferior cerebellar artery

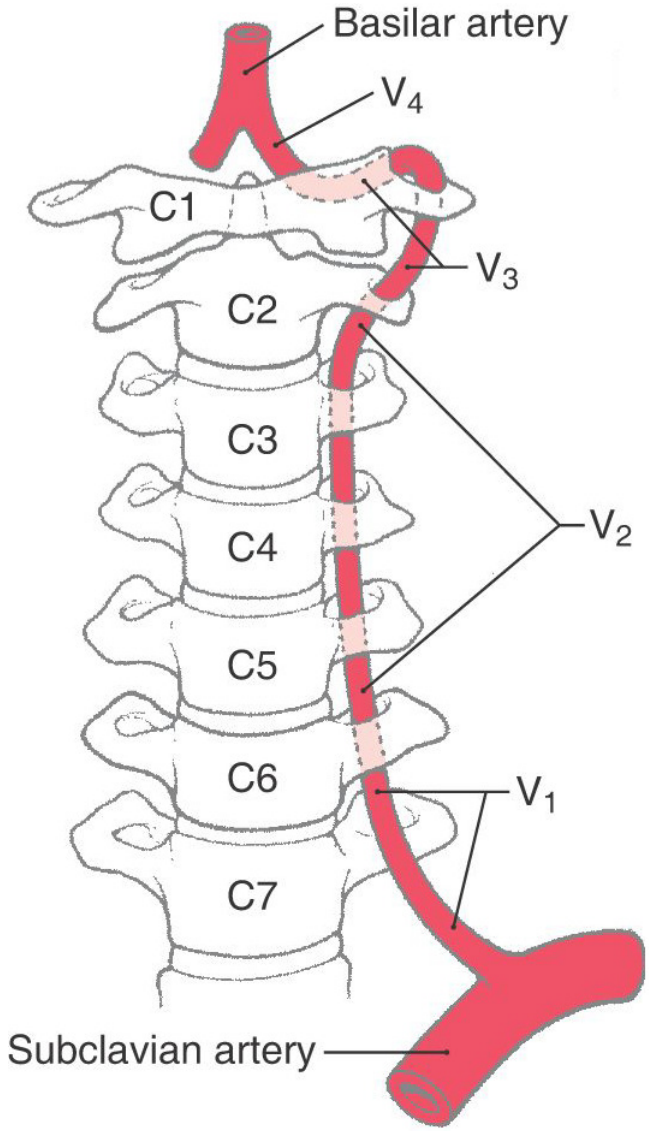
Basilar artery

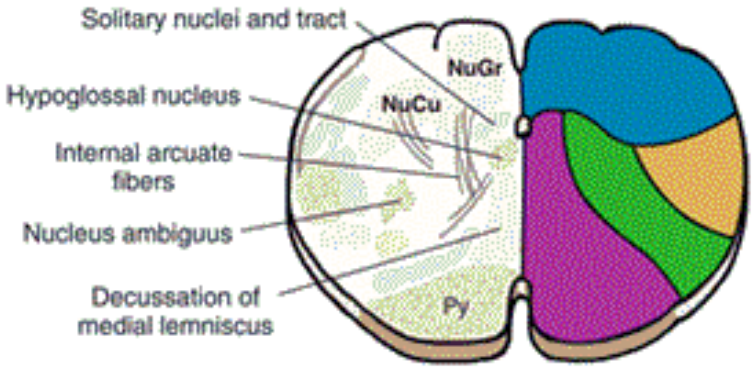
- Branches of basilar artery
- ➢ anterior inferior cerebellar artery (AICA) supplies inferior surface of the cerebellum
- ➢ Pontine arteries supply pons
- ➢ superior cerebellar artery supplies superior surface of cerebellum and pons



Blood supply of spinal cord





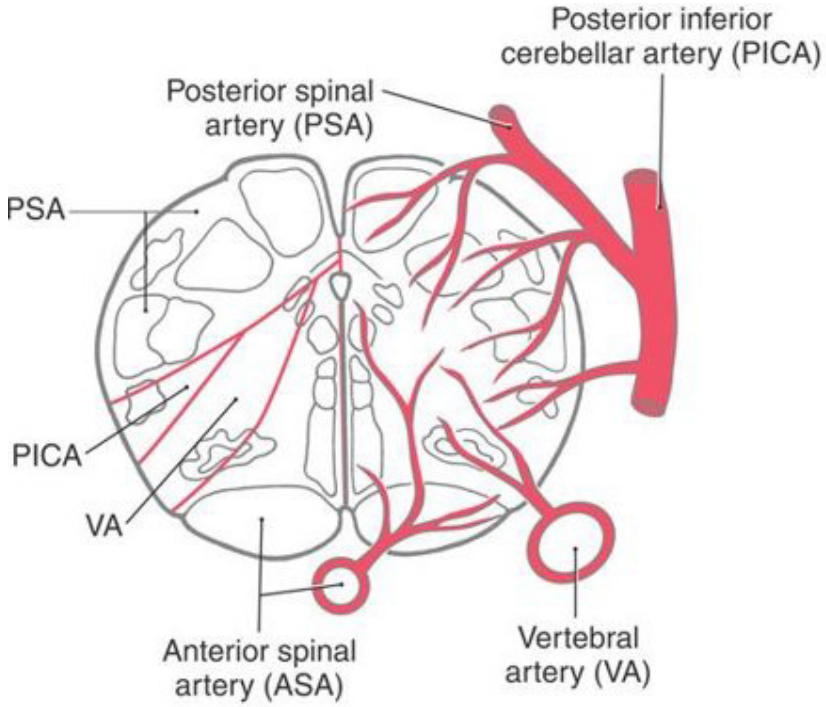


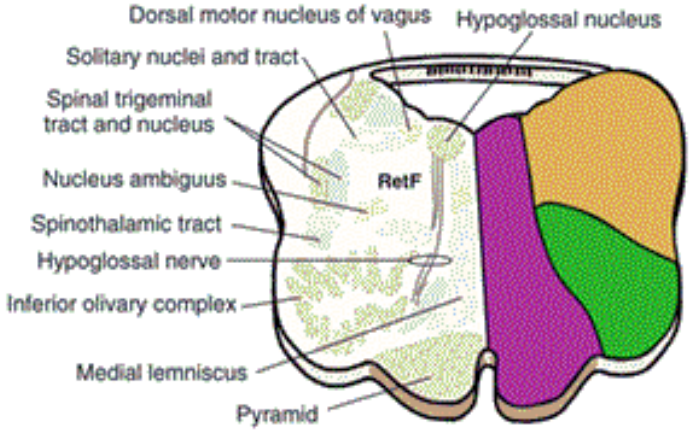
Anterior spinal artery

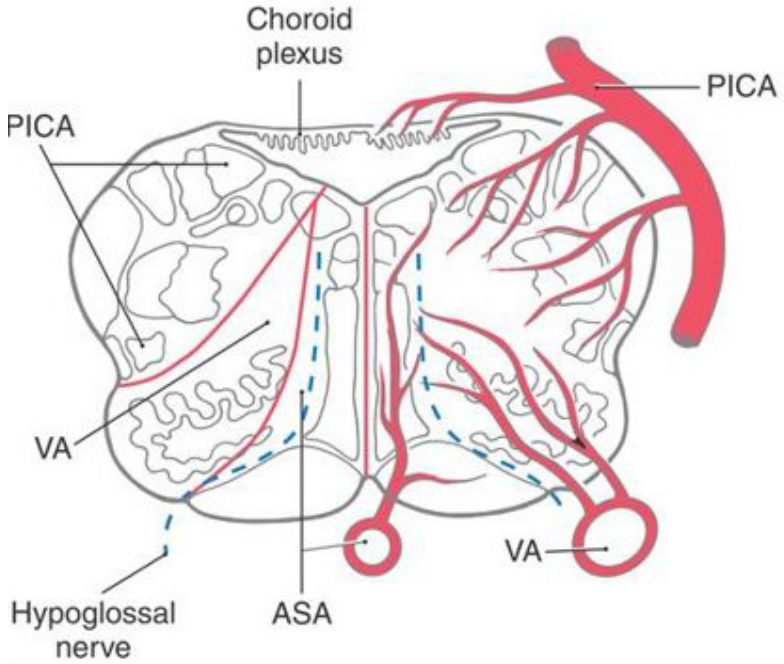
Posterior spinal artery

Vertebral artery

Posterior inferior cerebellar artery

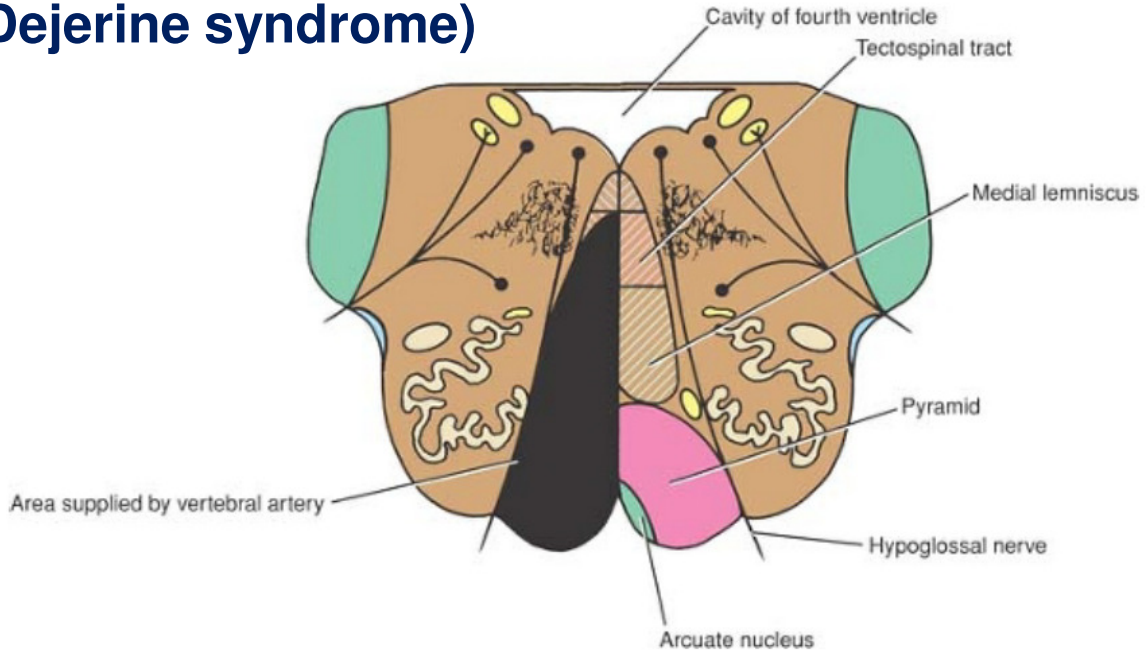


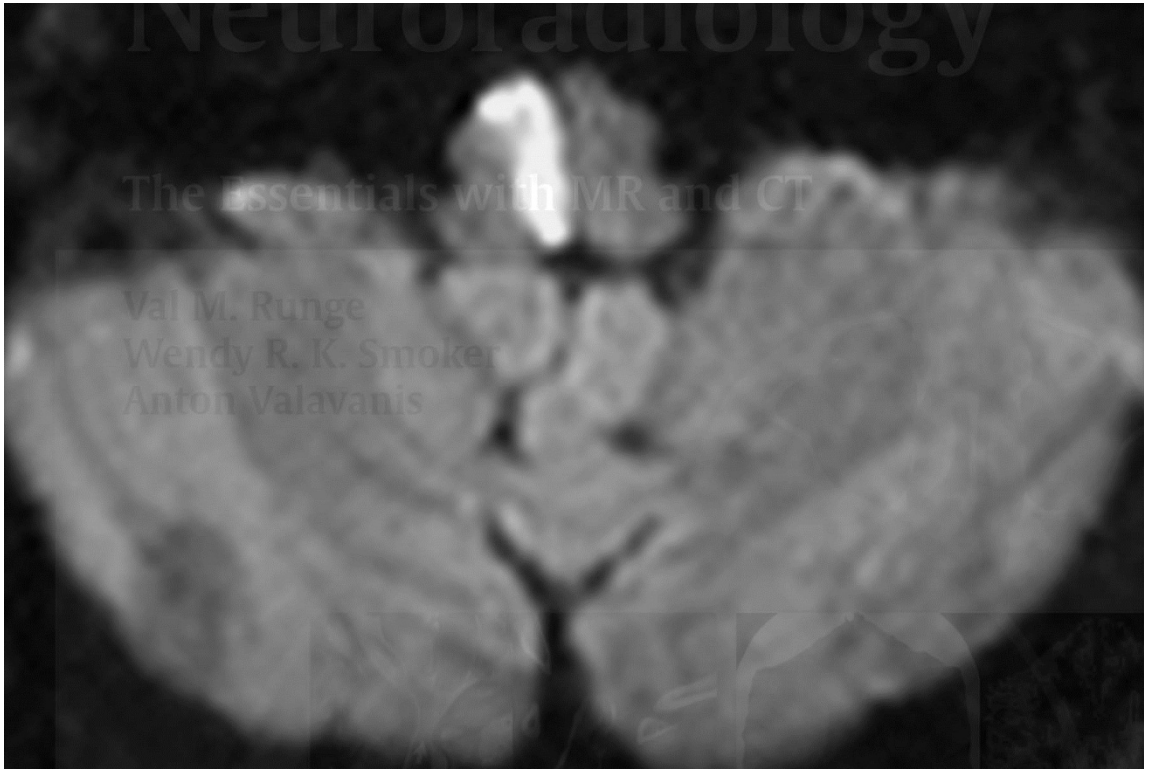




Medial medullary syndrome (Dejerine syndrome)

- Symptoms
- ➢ Contralateral hemiparesis(pyramidal and corticospinal damage)
- ➢ Contralateral loss of proprioception and vibratory sense (medial lemniscus)
- ➢ Deviation of the tongue to the ipsilateral side when it is protruded (hypoglossal root or nucleus injury)

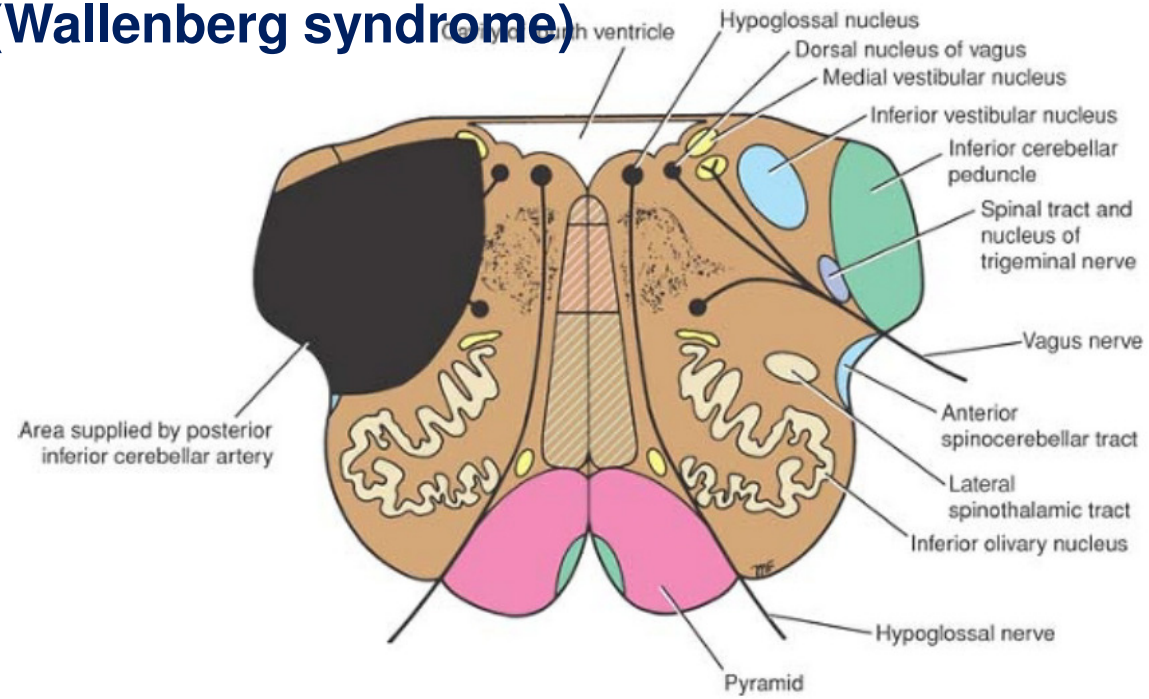


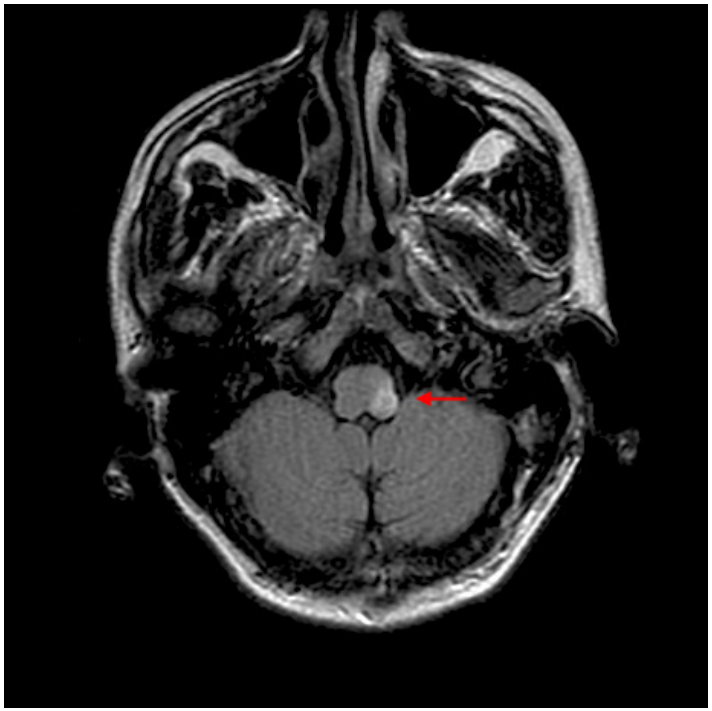


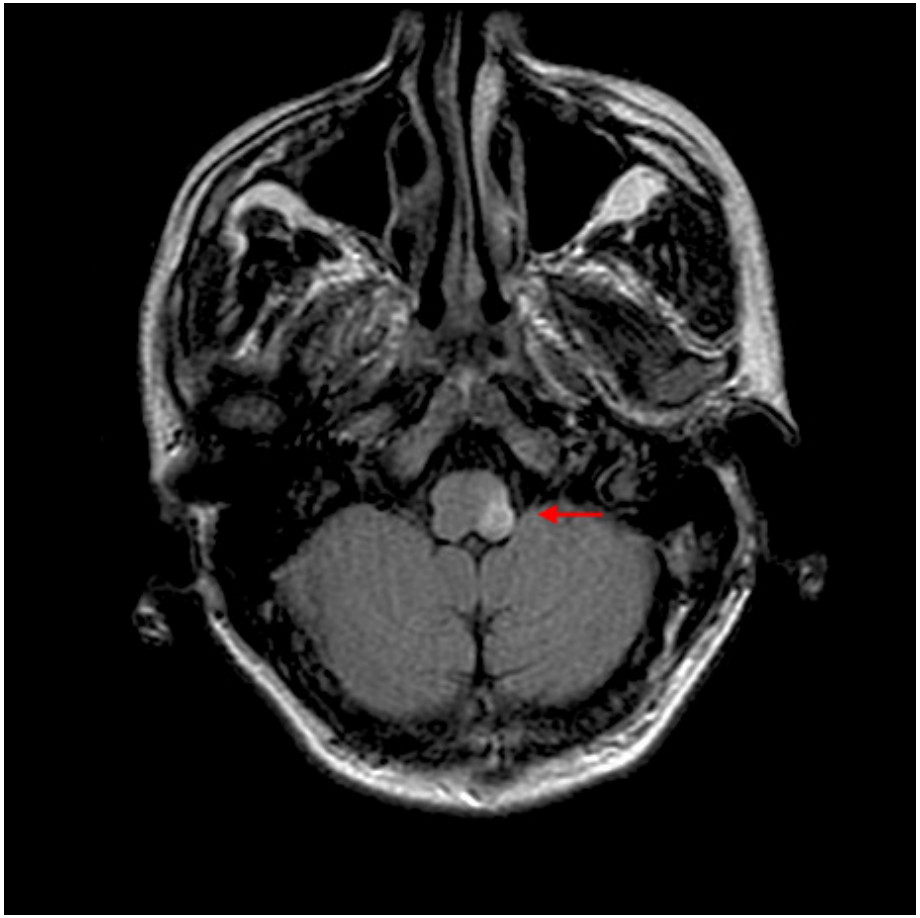
Lateral medullary syndrome (Wallenberg syndrome)

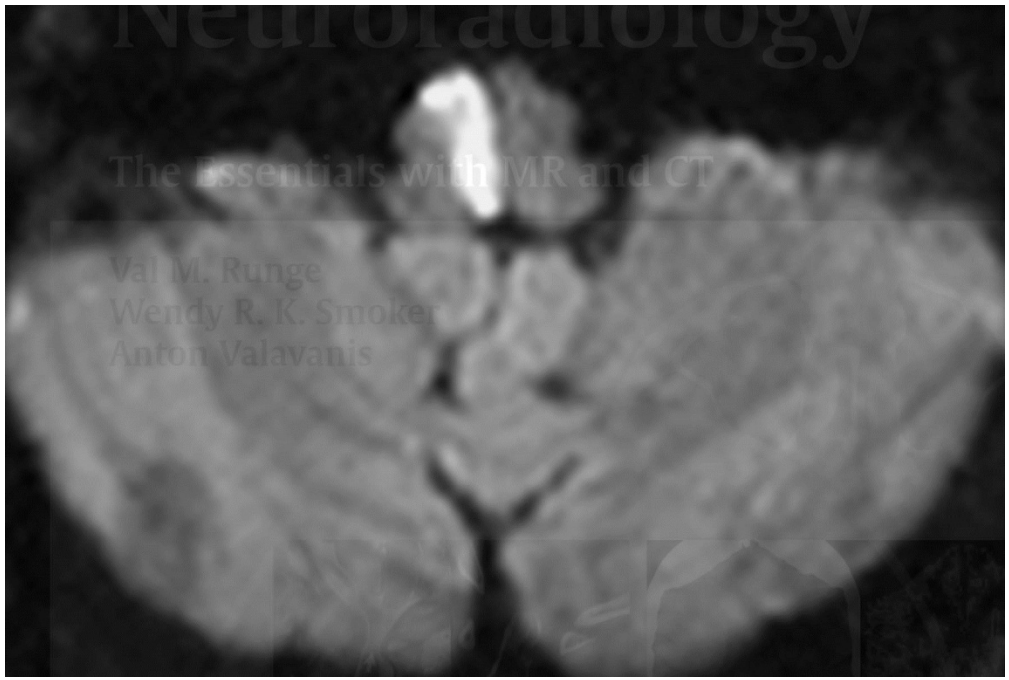
- Symtoms

- contralateral loss of pain and temperature sensation from the body (anterolateral system)
- ipsilateral loss of pain and temperature sensation from the face (spinal trigeminal tract and nucleus),
- vertigo and nystagmus (vestibular nuclei),
- loss of taste from the ipsilateral half of the tongue (solitary tract and nucleus),
- hoarseness and dysphagia (nucleus ambiguus or roots of cranial nerves IX and X)
- **Ipsilateral Horner syndrome:** hypothalamospinal fibers



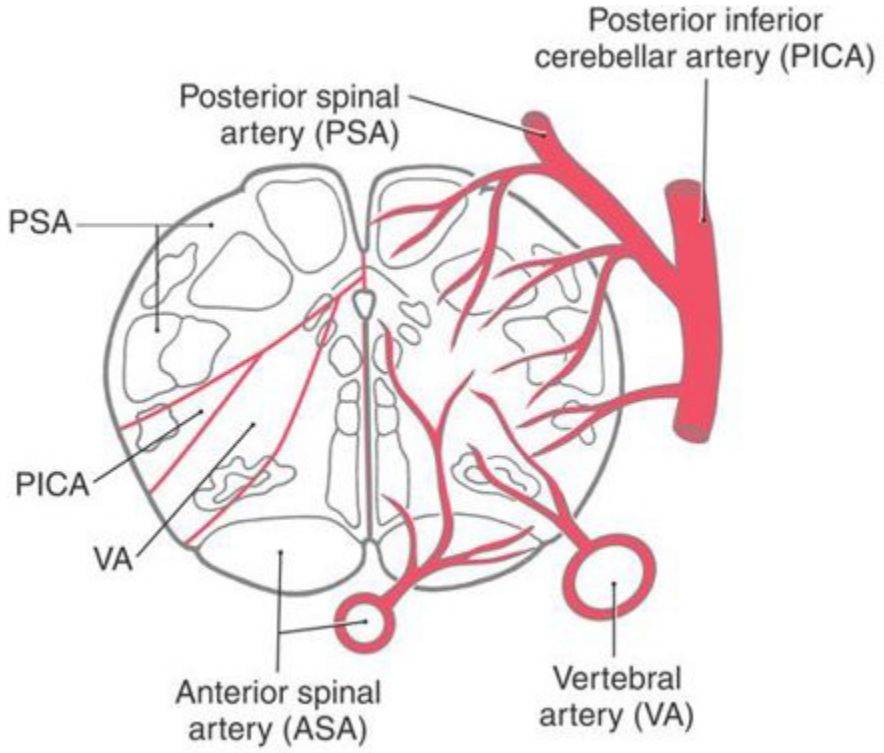


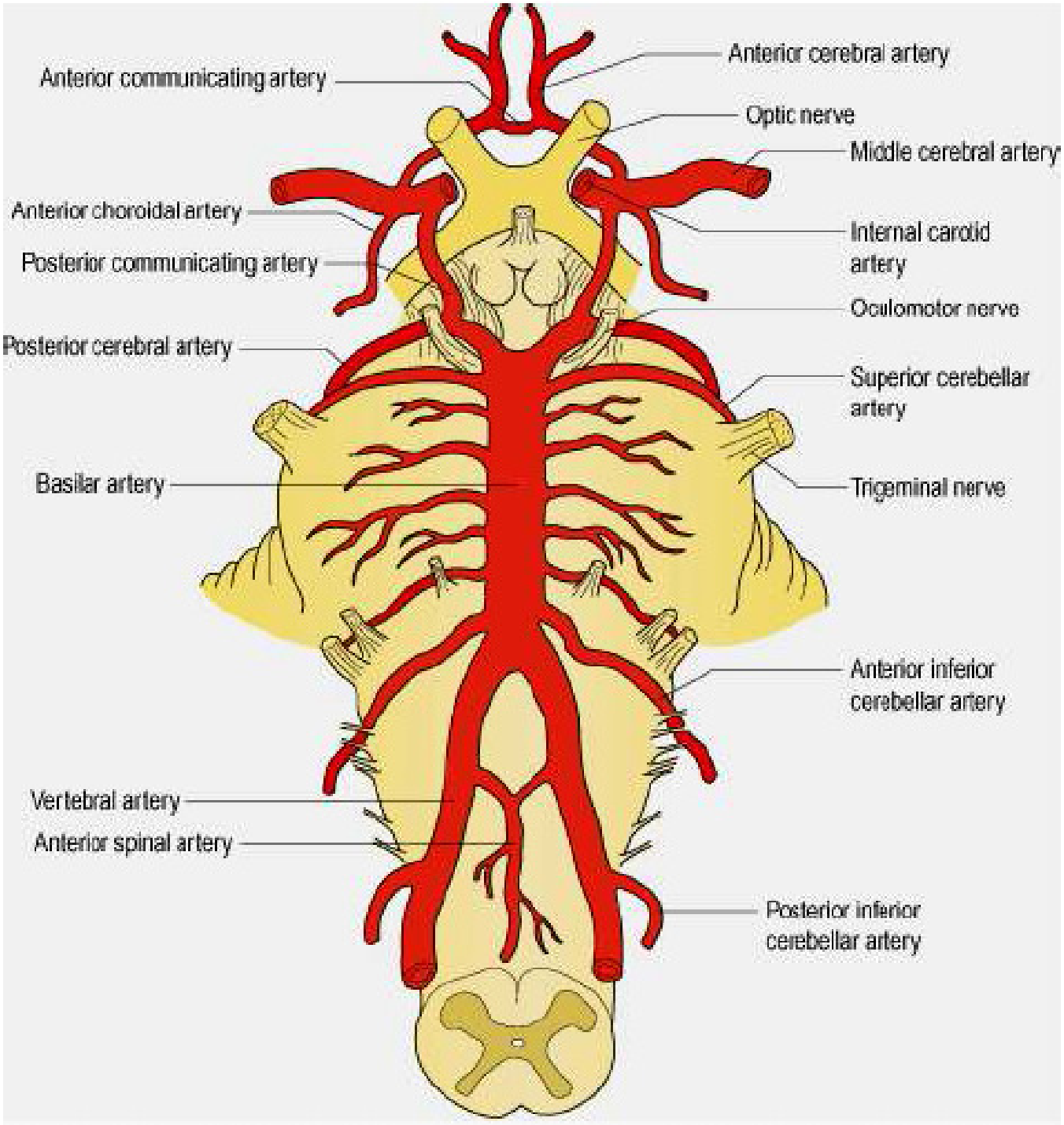


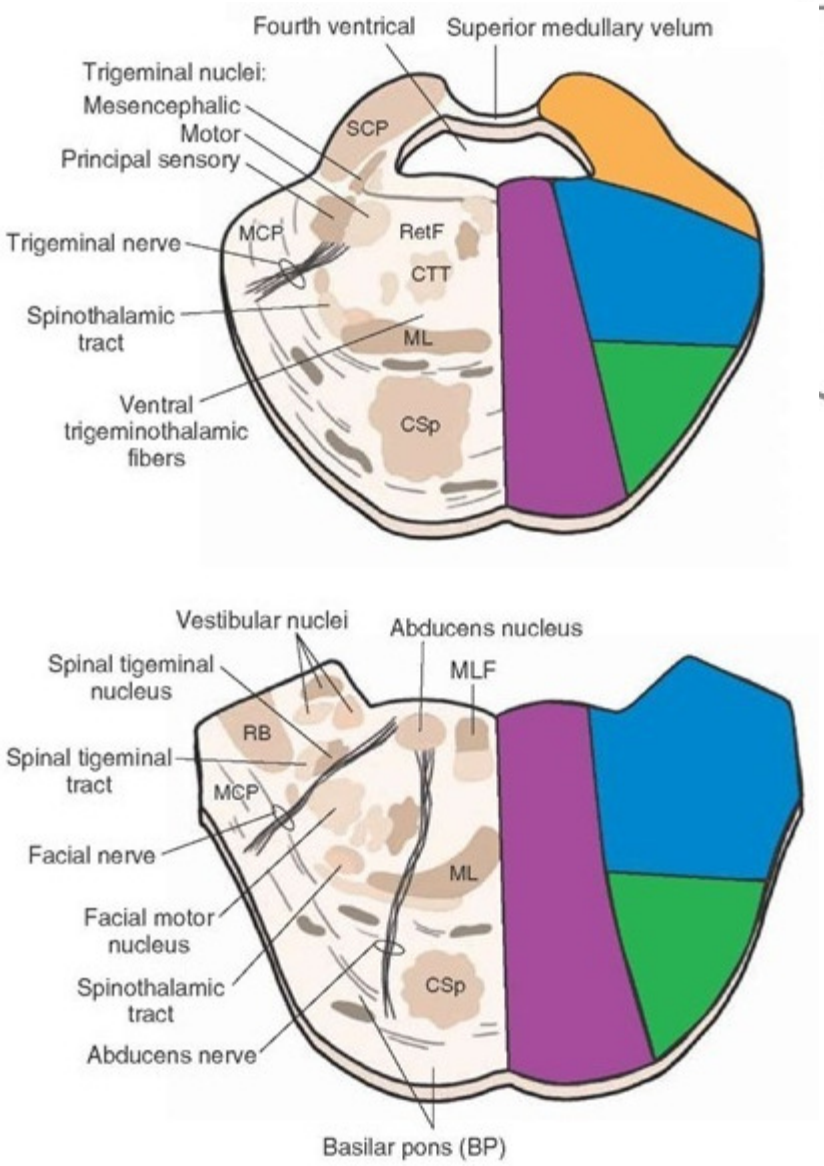

Neuroradiology
The Essentials with MR and CT
Val M. Runge
Wendy R. K. Smoker
Anton Valavanis

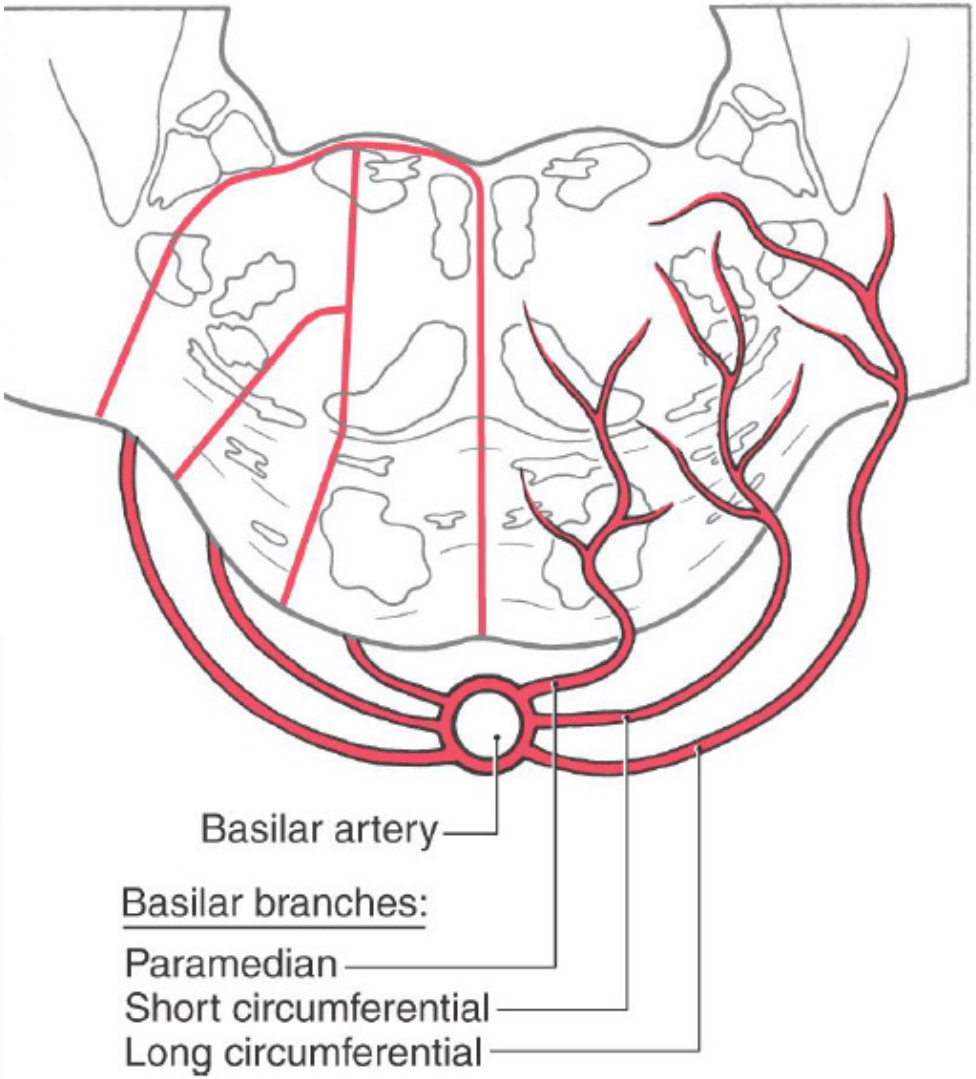
Vascular lesions of the posterior spinal artery

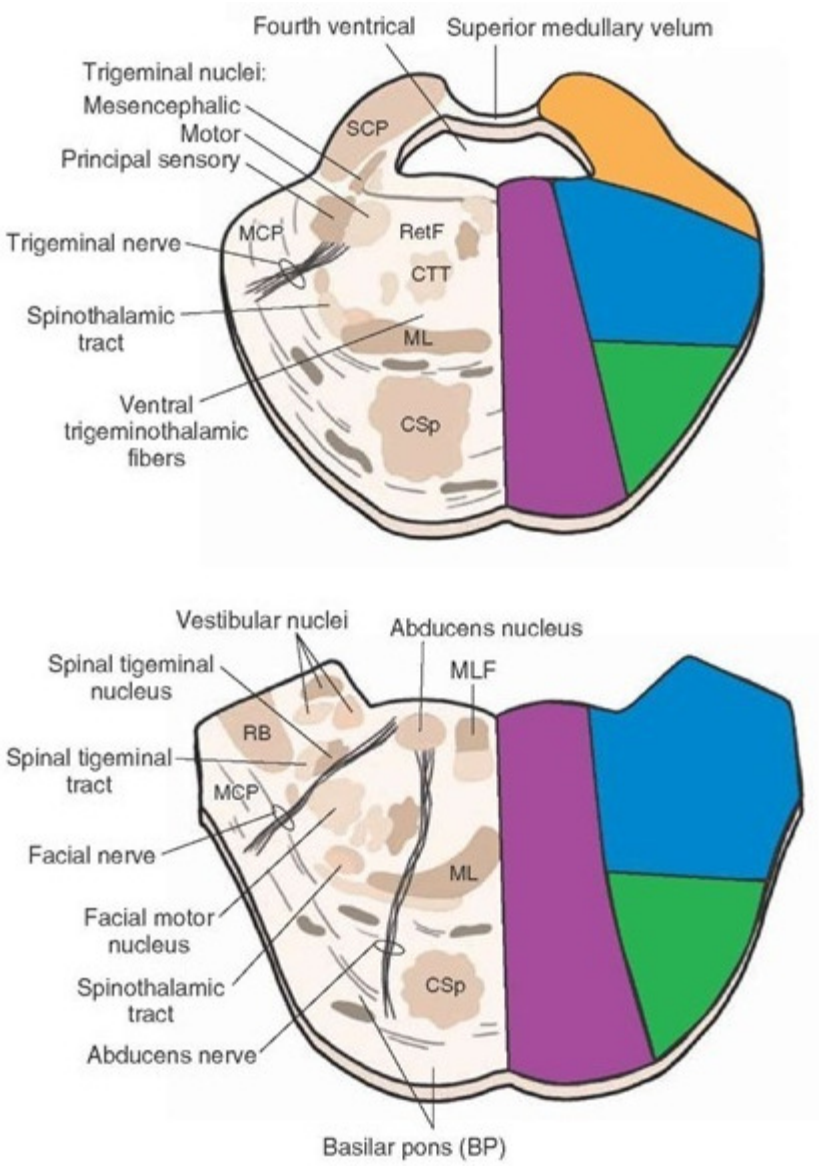
- Symptoms
  - ipsilateral loss of proprioception and vibratory sense
  - ipsilateral loss of pain and temperature sensation from the face




Anterior communicating artery
Anterior cerebral artery
Optic nerve
Middle cerebral artery
Anterior choroidal artery
Internal carotid artery
Posterior communicating artery
Oculomotor nerve
Posterior cerebral artery
Superior cerebellar artery
Basilar artery
Trigeminal nerve
Anterior inferior cerebellar artery
Vertebral artery
Anterior spinal artery
Posterior inferior cerebellar artery


Fourth ventrical
Superior medullary velum
Trigeminal nuclei:
Mesencephalic
Motor
Principal sensory
SCP
Trigeminal nerve
MCP
RetF
CTT
Spinothalamic tract
ML
Ventral trigeminothalamic fibers
CSp
Vestibular nuclei
Abducens nucleus
Spinal tigeminal nucleus
MLF
RB
Spinal tigeminal tract
MCP
Facial nerve
ML
Facial motor nucleus
Spinothalamic tract
CSp
Abducens nerve
Basilar pons (BP)


Basilar artery
Basilar branches:
Paramedian
Short circumferential
Long circumferential



Paramedian branches of basilar artery

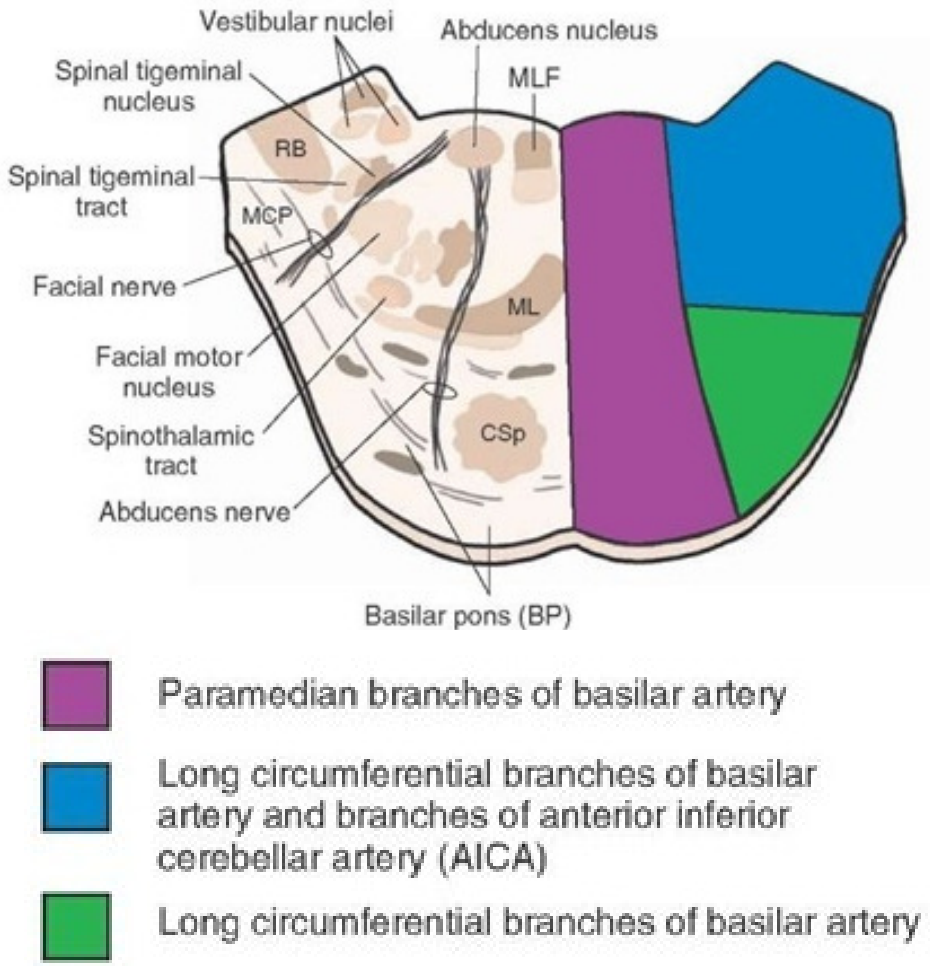
Long circumferential branches of basilar artery and branches of anterior inferior cerebellar artery (AICA)

Long circumferential branches of basilar artery

Long circumferential branches of basilar artery and branches of superior cerebellar artery (SCA)

Foville syndrome

- Due to: Occlusion of the paramedial branches
- ipsilateral abducens nerve paralysis
- contralateral hemiparesis
- variable contralateral sensory loss reflecting various degrees of damage to the medial lemniscus



Millard-Gubler syndrome

- If the area of damage is shifted somewhat laterally to include the root of the **facial nerve along with corticospinal fibers, the patient has a contralateral** hemiparesis and an ipsilateral paralysis of the facial muscles