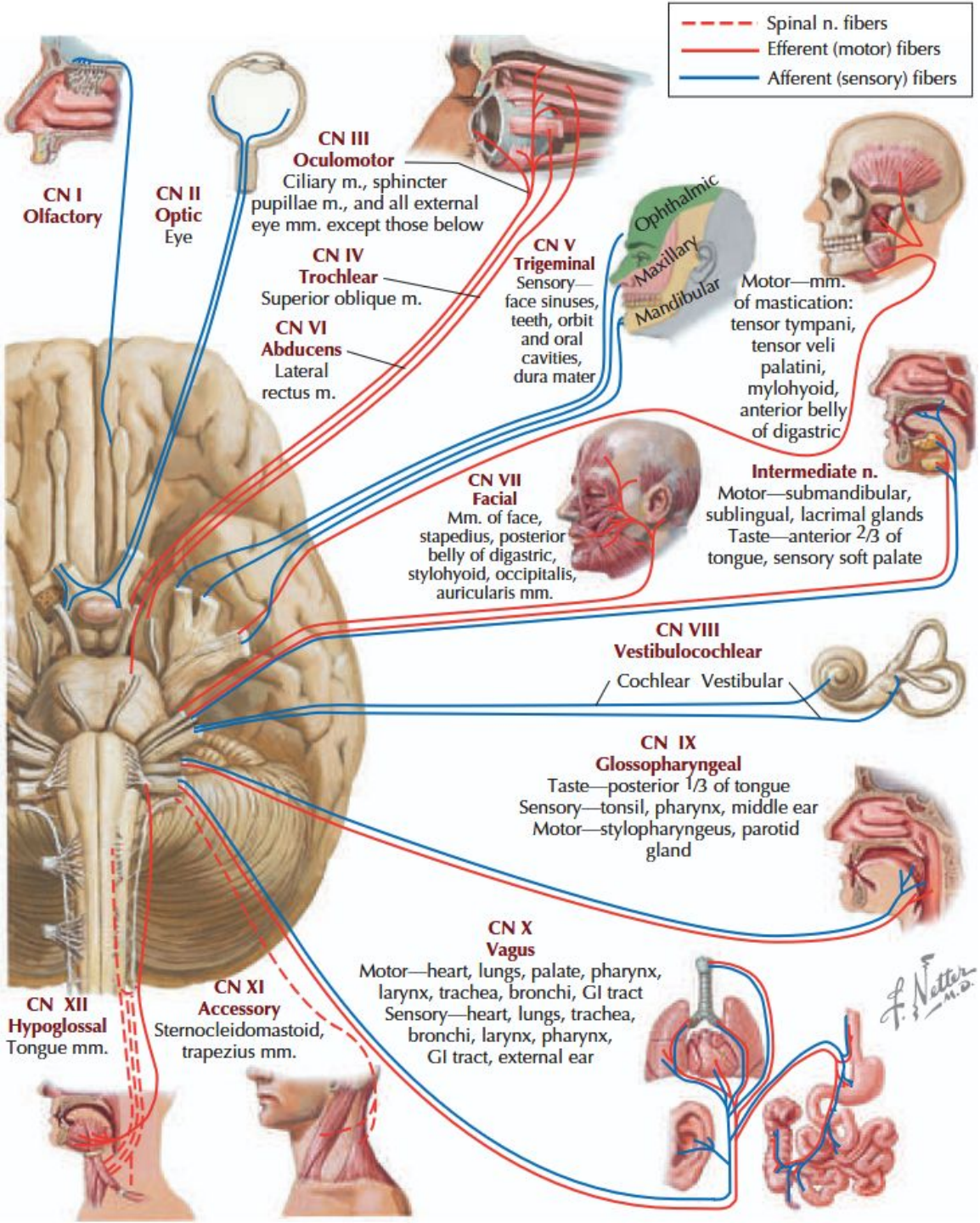
Cranial nerves

- 12 pairs (+ n. terminalis – n. 0)
- Upon exiting the CNS, the anterior and posterior roots are not distinguished
- They innervate the head and neck; the vagus nerve also innervates the thoracic and abdominal organs
- Nuclei in the brainstem (except for I and II)
- the autonomic component is parasympathetic
    - ganglia are located between the brainstem and the point where the nerve exits/enters the skull base
    - ciliary, pterygopalatine, otic, and submandibular ganglia (here, synaptic contact between pre- and postganglionic cholinergic neurons)
- the sympathetic component enters the cranial nerve from the nearest parietal sympathetic plexus
- acetylcholine is the neurotransmitter for the cranial somatomotor and parasympathetic nerves
- glutamate is the neurotransmitter for the cranial somatosensory and viscerosensory neurons
- the following do not strictly belong to the cranial nerves, but are associated with them
    - hypoglossal nerve – arises from the fusion of cranial spinal nerves
    - optic nerve – a projection of the diencephalon
    - olfactory nerve – a projection of the telencephalon
- the parent cells of somato- and visceromotor fibers are located in the brainstem nuclei (nucleus origins, or nucleus parasympathicus (dorsalis))
- Parent cells (T-cells) of somatosensory and viscerosensory fibers are located in the sensory ganglion of the corresponding cranial nerve (ganglia in the basal region: V, VII, VIII, IX, X); the axon terminates in the brainstem at the nucleus terminationis

- I. n. olfactorius
- II. n. oculomotorius
- III. n. opticus
- IV. n. trochlearis
- V. n. trigeminus
- VI. n. abducens
- VII. n. facialis
- VIII. n. vestibulocochlearis
- IX. n. glosopharyngeus
- X. n. vagus
- XI. n. accessorius
- XII. n. hypoglossus



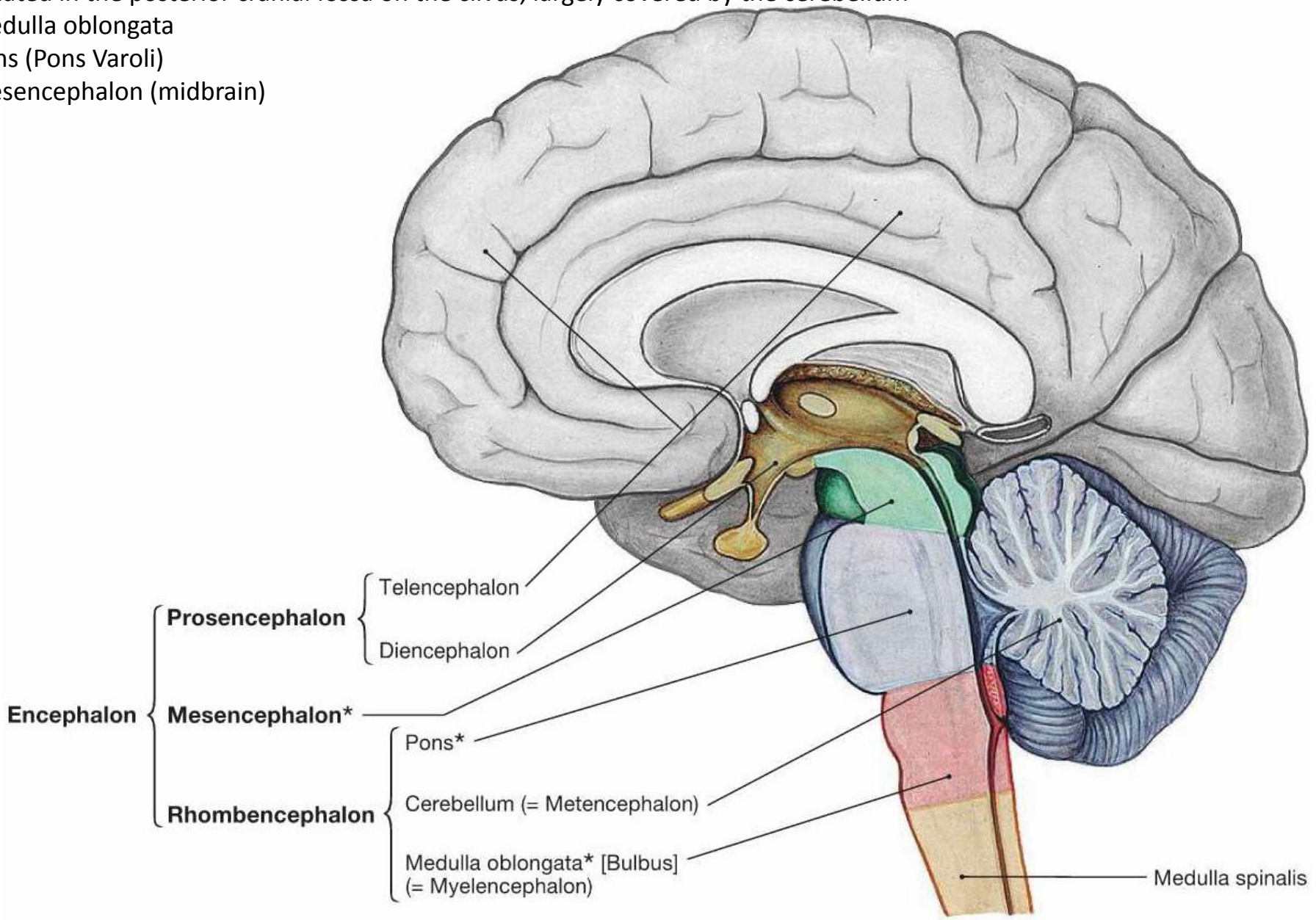
THE QUALITY OF CRANIAL NERVE FIBERS

- **I. n. olfactorius** – passes through the lamina cribrosa of the ethmoid bone
- **II. n. opticus** – passes through the optic canal together with the ophthalmic artery
- **III. n. oculomotorius** – passes through the superior orbital fissure
- **IV. n. trochlearis** – passes through the superior orbital fissure
- **V. n. trigeminus**
  - V/1 n. ophtalmicus – passes through the superior orbital fissure
  - V/2 n. maxillaris – passes through the foramen rotundum into the pterygopalatine fossa
  - V/3 n. mandibularis – passes through the foramen ovale
- **VI. n. abducens** – passes through the superior orbital fissure
- **VII. n. facialis** – passes through the internal auditory meatus, then the stylomastoid foramen
- **VIII. n. vestibulocochlearis** – does not emerge from the base of the skull; remains within the internal auditory meatus
- **IX. n. glossopharyngeus** – at the base of the skull, passes through the jugular foramen
- **X. n. vagus** – passes through the jugular foramen
- **XI. n. accessorius** – passes through the jugular foramen
- **XII. n. hypoglossus** – passes through the hypoglossal canal

special senzory
somatomotor and visceromotor
somatomotr
somatomotor and somatosenory
all types of fibers

BRAINSTEM

- Continuation of the spinal cord beginning at the pyramidal decussation / exit of C1 rootlets
- Located in the posterior cranial fossa on the clivus, largely covered by the cerebellum
- Medulla oblongata
- Pons (Pons Varoli)
- Mesencephalon (midbrain)



BRAINSTEM

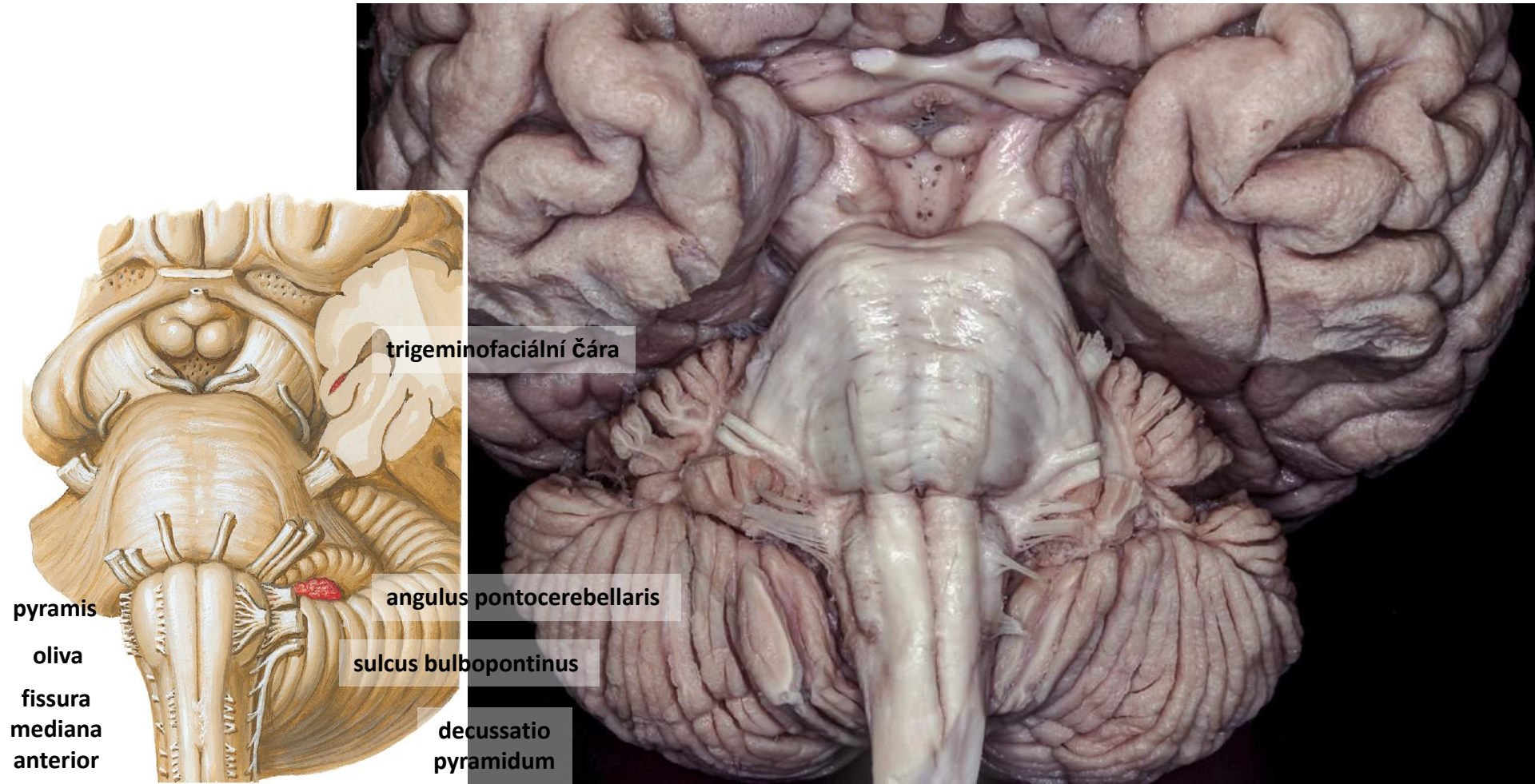
- Continuation of the spinal cord at the level of the pyramidal decussation / C1 rootlets
- In the posterior cranial fossa on the clivus, mostly covered by the cerebellum

Ventral view:

- Medulla oblongata — from the decussation to the sulcus bulbopontinus; contains the olive
- Pons (Varoli) — the trigemino-facial line separates the cerebellar peduncles
- Mesencephalon — ventrally: crura/pedunculi cerebrales with the interpeduncular fossa; dorsally: lamina quadrigemina

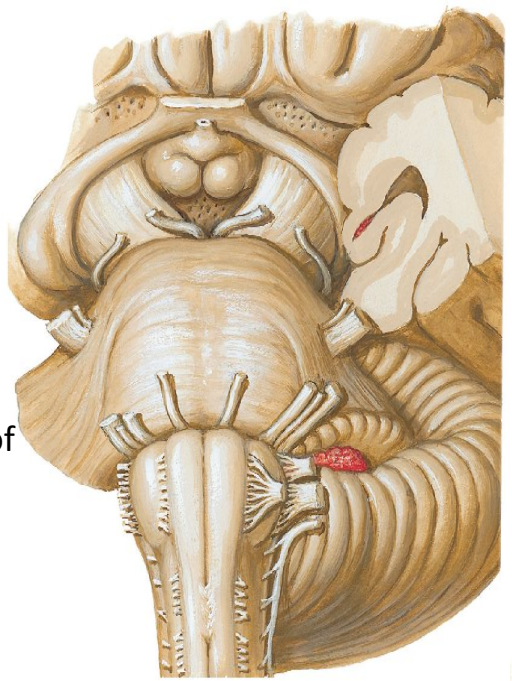
Dorsal view:

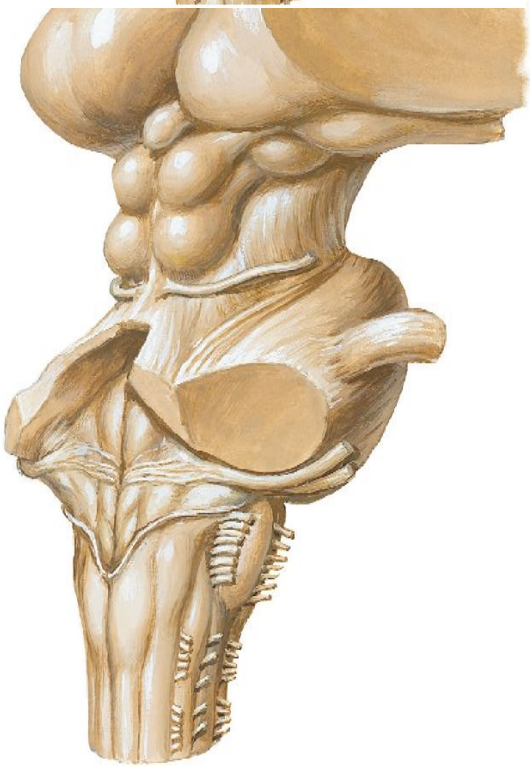
- Fossa rhomboidea (floor of the 4th ventricle)



MEDULLA OBLONGATA

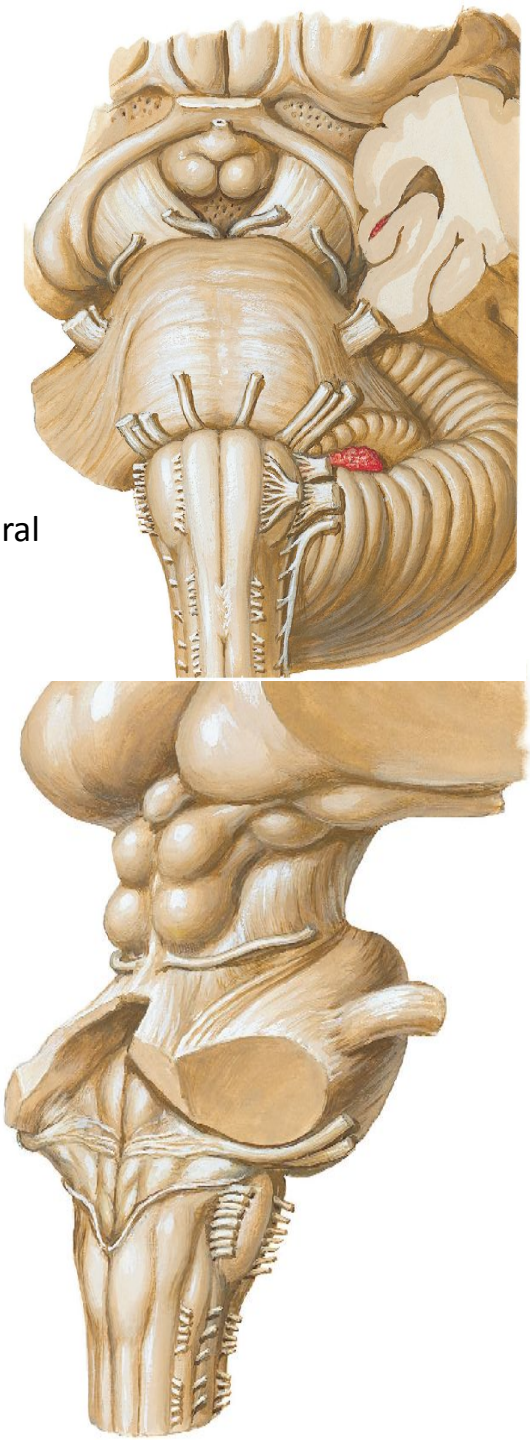
- Cranial continuation of the spinal cord; the boundary is defined by the exit of C1 rootlets (fila radicularia C1) and the pyramidal decussation
- Ventral surface rests on the clivus
- Ventral surface:
    - Pyramid of the medulla oblongata
    - Fissura mediana anterior
    - Sulcus bulbopontinus
    - Pyramidal decussation, laterally the sulcus ventrolateralis (anterolateralis) — exit of cranial nerve XII
    - Olive — located between the ventrolateral and dorsolateral (retro-olivary) sulci
    - Lateral to the olive emerge cranial nerves IX, X, and XI
- Dorsal surface:
    - Sulcus medianus dorsalis (posterior)
    - Fasciculus gracilis (Goll) medially → tuberculum gracile (clava)
    - Fasciculus cuneatus (Burdach) laterally → tuberculum cuneatum
    - Tuberculum trigeminale (lateral to the cuneate tubercle)
    - Inferior part of the rhomboid fossa with the attachment of the inferior medullary velum (taenia ventriculi quarti)
    - Inferior cerebellar peduncles





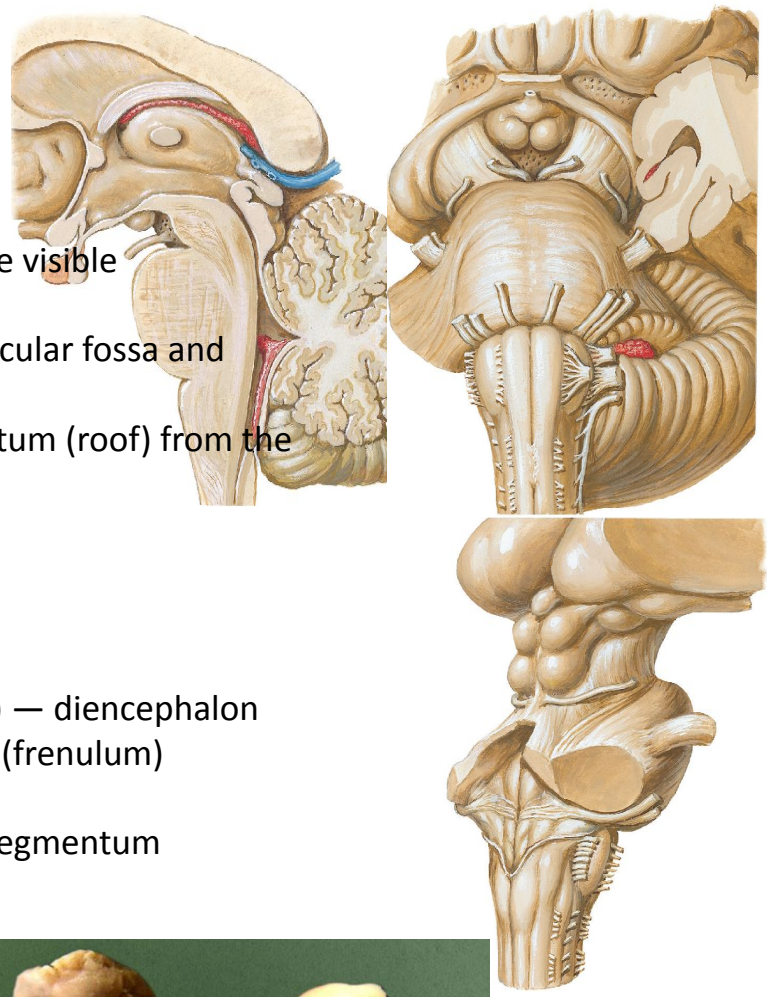
PONS VAROLI

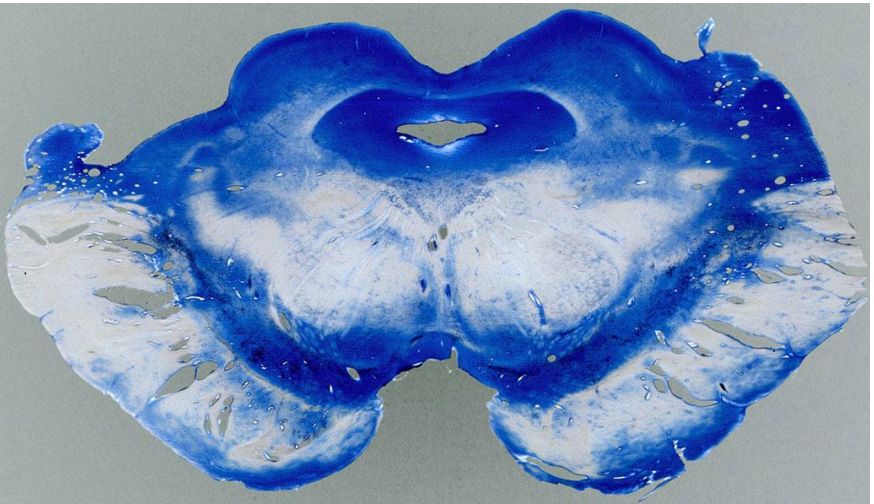
- A transverse prominence on the ventral surface of the brainstem
- Ventrally faces the junction of the temporal bone with the sphenoid bone
- Structures:
    - Sulcus bulbopontinus — exit of cranial nerves VI and VII (two rootlets + nervus intermedius) and VIII
    - Sulcus basilaris
    - Trigeminal nerve (V)
    - Trigeminofacial line
    - Middle cerebellar peduncles (pedunculi cerebellares medii)
    - Dorsal side continues from the medulla oblongata; opening of the embryonic neural tube results in the formation of the rhomboid fossa



MESENCEPHALON

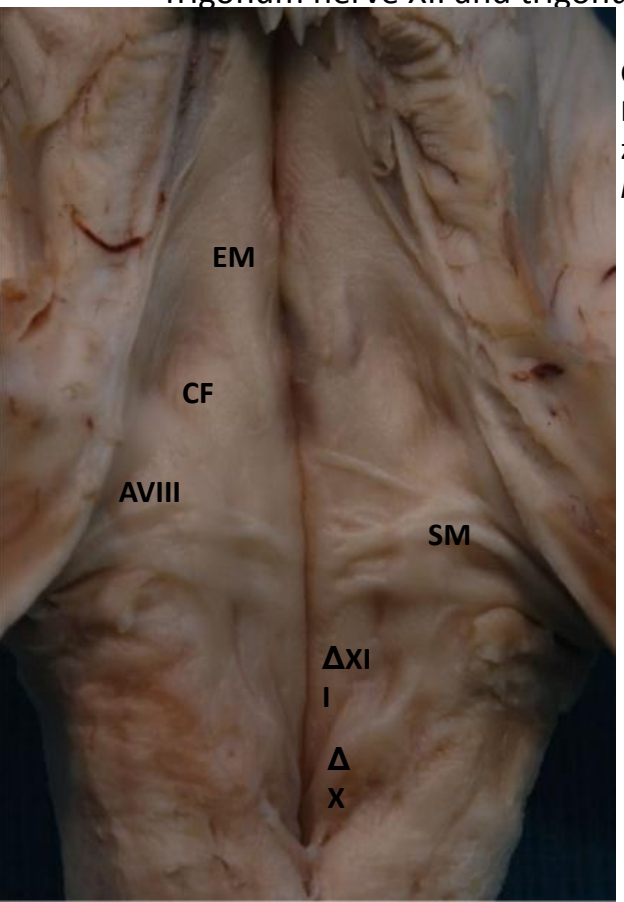
- Caudally connected to the pons, cranially to the diencephalon
- Dorsal and lateral surfaces are covered by the cerebral hemispheres
- Rostral end terminates at the corpora mamillaria (hypothalamus)
- On the ventral brain base, only the cerebral peduncles (crura cerebri) are visible
- Structures:
    - Cerebral peduncles (pedunculi/crura cerebri) with the interpeduncular fossa and substantia perforata interpeduncularis
    - Aqueductus mesencephali (cerebral aqueduct) separating the tectum (roof) from the tegmentum
    - Tectal plate (lamina tecti)
        - Superior colliculi — visual pathway
        - Inferior colliculi — auditory pathway
        - Rostral to the superior colliculi: area praetectalis
        - Between the superior colliculi: pineal body (corpus pineale) — diencephalon
    - Superior cerebellar peduncles with the superior medullary velum (frenulum)
    - Tegmentum mesencephali
    - Sylvian aqueduct visible in cross-section; separates tectum from tegmentum



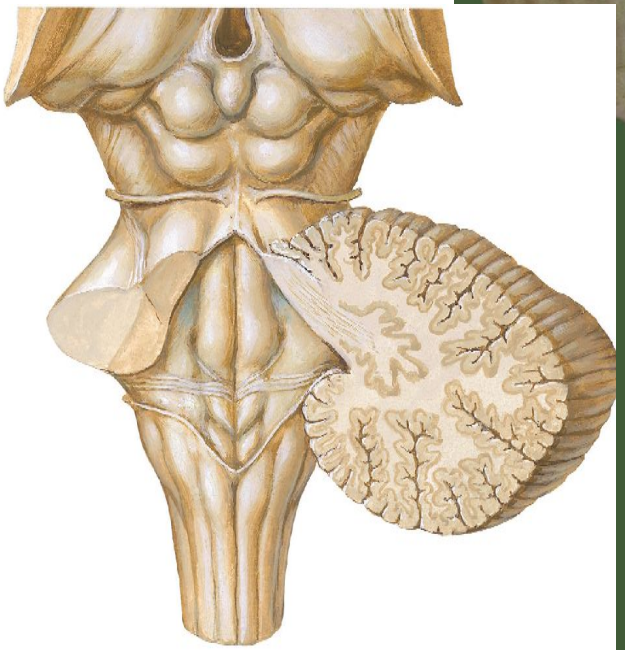


FOSA RHOMBOIDEA

- The rhomboid fossa is the floor of the fourth ventricle
- Boundaries of the 4th ventricle: Dorsal surfaces of the medulla, pons, and part of the midbrain, cerebellar peduncles and the medullary vela (inferior velum with the choroid plexus); The cerebellum — the apex of the velum = fastigium
    - Recessus lateralis ventriculi quarti with the lateral aperture (foramen of Luschka); Caudal tip: obex and median aperture (foramen of Magendie)
    - Sulcus medianus and Sulci limitantes — define motor/sensory regions
    - Eminentia medialis and Colliculus facialis
    - Striae medullares
    - Area vestibularis laterally
    - Trigonum nerve XII and trigonum nerve X caudally

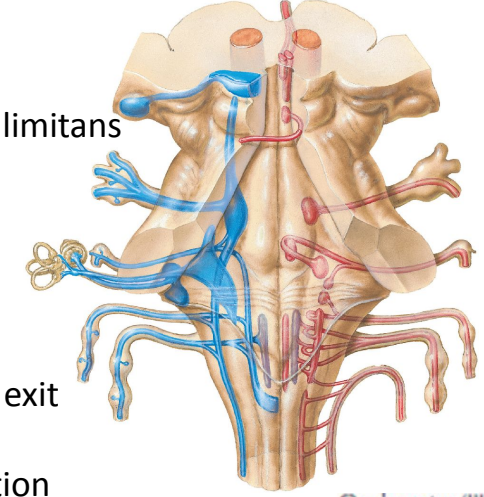


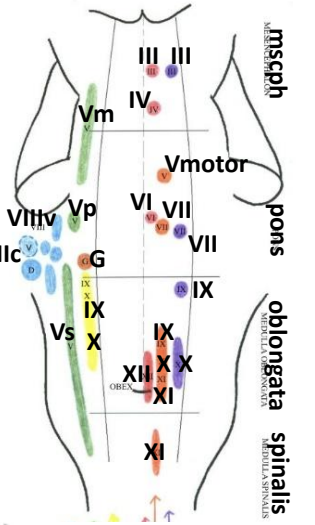
Cavalcanti et al. (2016). Microsurgical anatomy of safe entry zones to the brainstem. *Journal of neurosurgery*, *124*(5), 1359–1376.

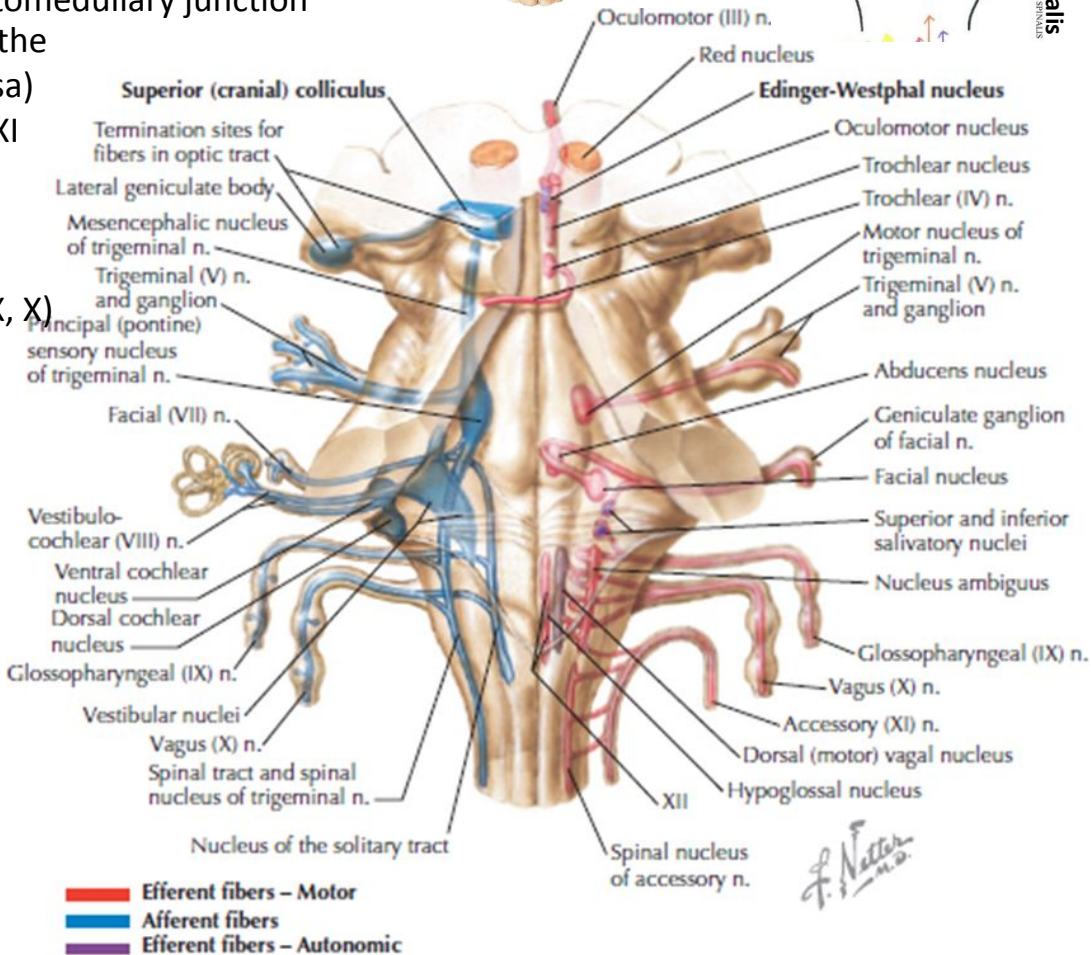


CRANIAL NERVES NUCLEI

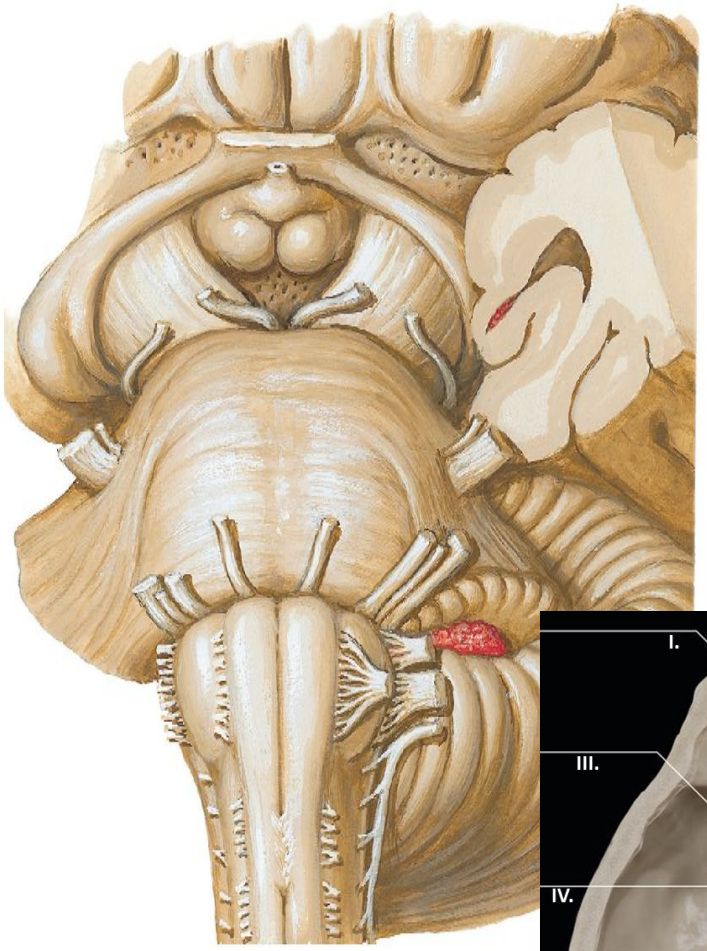
- the alar (sensory) and basal (motor) plates, separated by the sulcus limitans
- Nucleus of CN III (somatomotor) — level of the superior colliculi
- E-W nucleus (visceromotor → ciliary ganglion) — superior colliculi
- Nucleus of CN IV (somatomotor) — inferior colliculi
- nc. V.
  - M+P+S – span the lateral part of the entire brainstem
  - Motor nucleus — lateral in the pons, at level of trigeminal nerve exit
- CN VI nucleus — deep within the facial colliculus
- CN VII nucleus — dorsolateral to CN VI, at the pontomedullary junction
- CN VIII. nuclei (ncc. vestibulares a cochleares) – in the vestibular area (lateral recces of the rhomboid fossa)
- Nucleus ambiguus (somatomotor) — for CN IX, X, XI (cranial root)
- nc. tractus solitarii (viscerosensory) — receives information from heart, GIT, RS, baroreceptors, chemoreceptors; gustatory nucleus → taste (VII, IX, X)
- Superior salivatory nucleus (visceromotor) → pterygopalatine & submandibular ganglia (CN VII)
- Inferior salivatory nucleus (visceromotor) → otic ganglion (CN IX)
- Dorsal nucleus of the vagus — preganglionic parasympathetic fibers (for the GIT until Cannon–Boehm point)
- Spinal accessory nucleus
- Hypoglossal nucleus

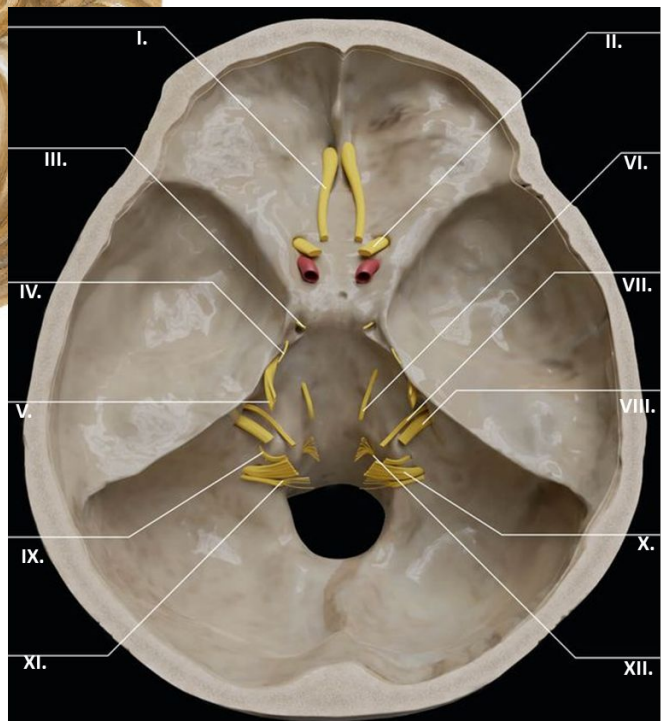


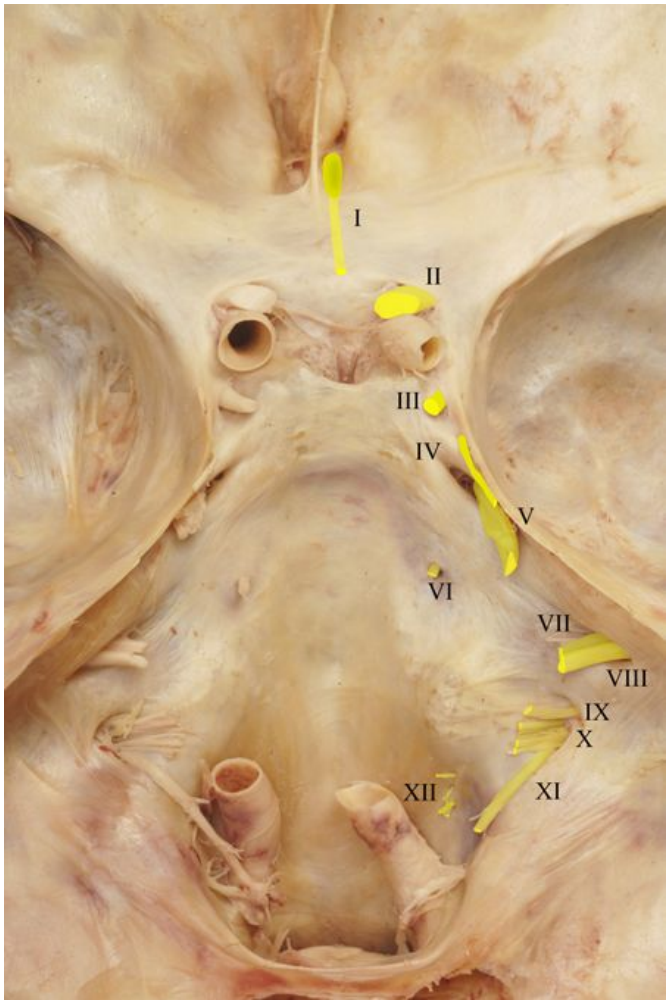




CN EXIT




I.
II.
III.
VI.
IV.
VII.
V.
VIII.
IX.
X.
XI.
XII.


I
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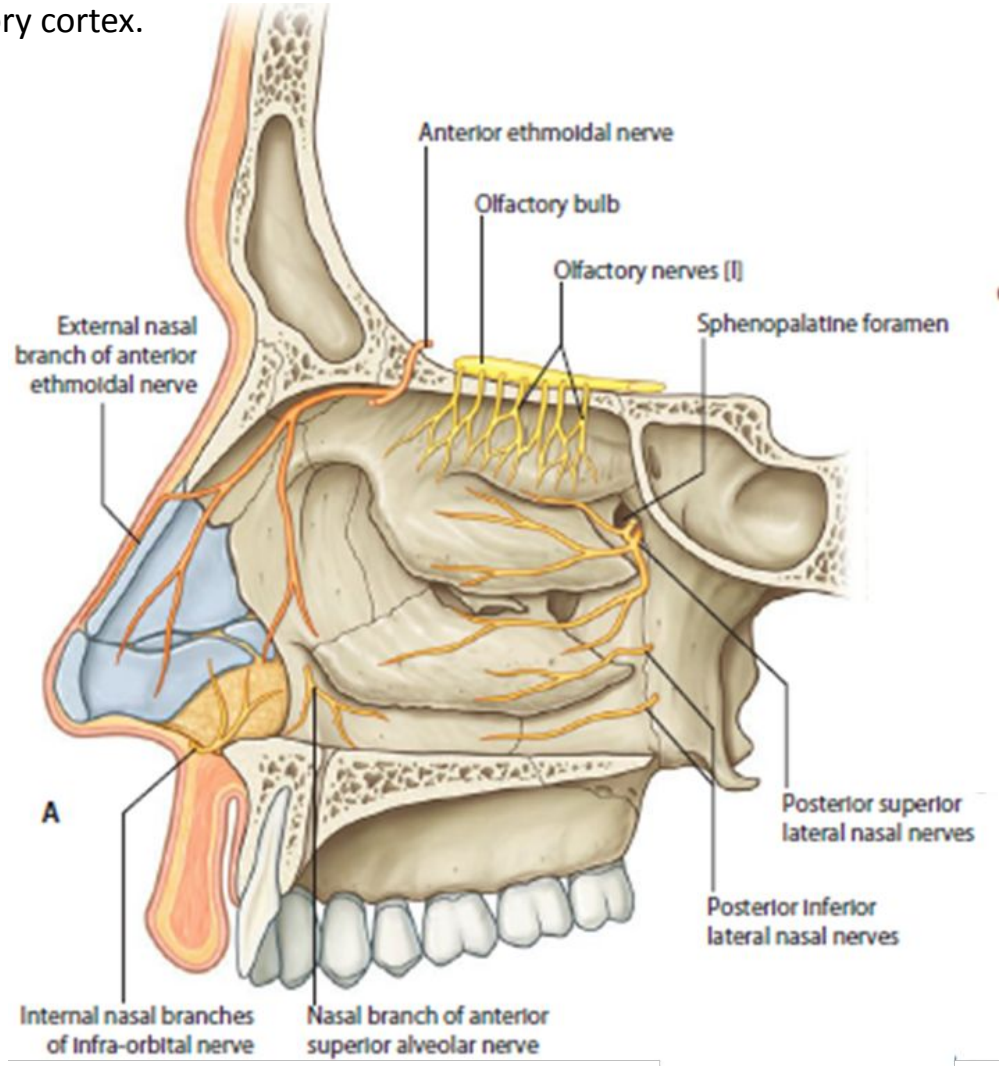
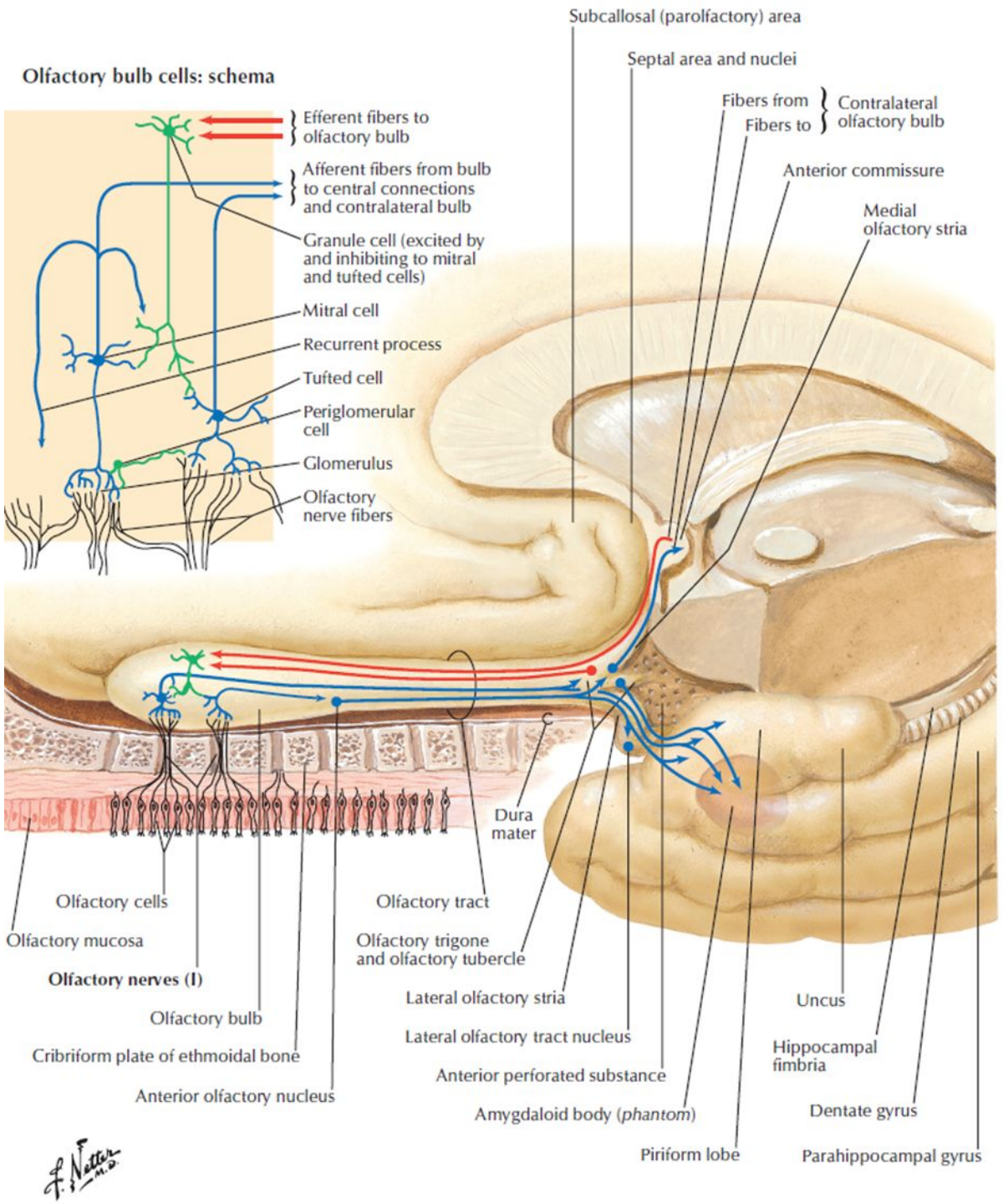
XI

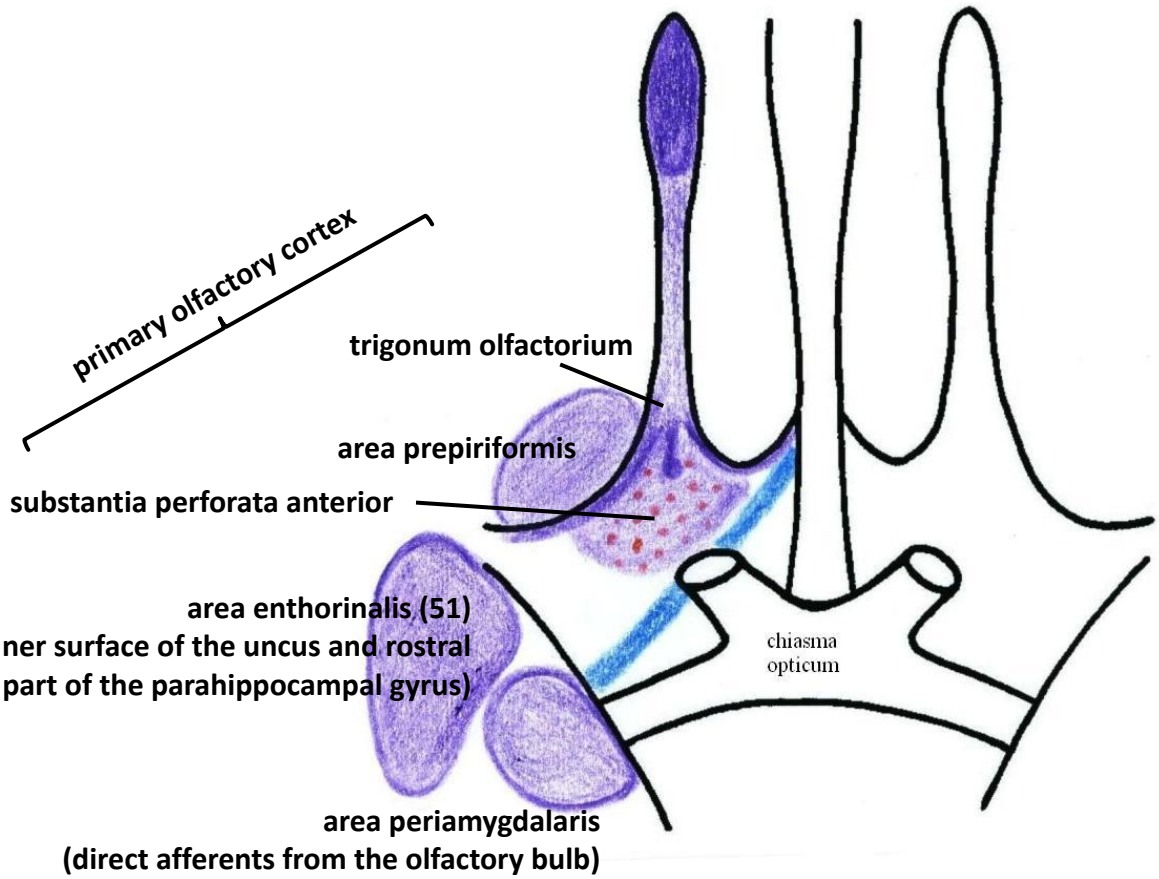
N. OLFACTORIUS (I.)

- Olfactory receptor cells are located in the nasal mucosa (regio olfactoria — the roof of the nasal cavity, superior nasal concha, and upper part of the nasal septum), their dendrites extend cilia into a thin mucus layer on the epithelial surface, where odorant molecules dissolve.
- Axons carry information about odorants into the submucosal nerve plexus.
- The olfactory filaments (fila olfactoria) pass through tiny openings in the cribriform plate (lamina cribrosa) of the ethmoid bone and enter the paired olfactory bulb (bulbus olfactorius), here, they synapse with the dendrites of mitral cells, which transmit signals to the primary olfactory cortex.




Olfactory bulb cells: schema
Efferent fibers to olfactory bulb
Afferent fibers from bulb to central connections and contralateral bulb
Granule cell (excited by and inhibiting to mitral and tufted cells)
Mitral cell
Recurrent process
Tufted cell
Periglomerular cell
Glomerulus
Olfactory nerve fibers
Subcallosal (parolfactory) area
Septal area and nuclei
Fibers from
Fibers to
Contralateral olfactory bulb
Anterior commissure
Medial olfactory stria
Dura mater
Olfactory cells
Olfactory mucosa
Olfactory nerves (I)
Olfactory bulb
Cribriform plate of ethmoidal bone
Anterior olfactory nucleus
Olfactory tract
Olfactory trigone and olfactory tubercle
Lateral olfactory stria
Lateral olfactory tract nucleus
Anterior perforated substance
Amygdaloid body (phantom)
Piriform lobe
Uncus
Hippocampal fimbria
Dentate gyrus
Parahippocampal gyrus

PRIMARY OLFACTORY CORTEX

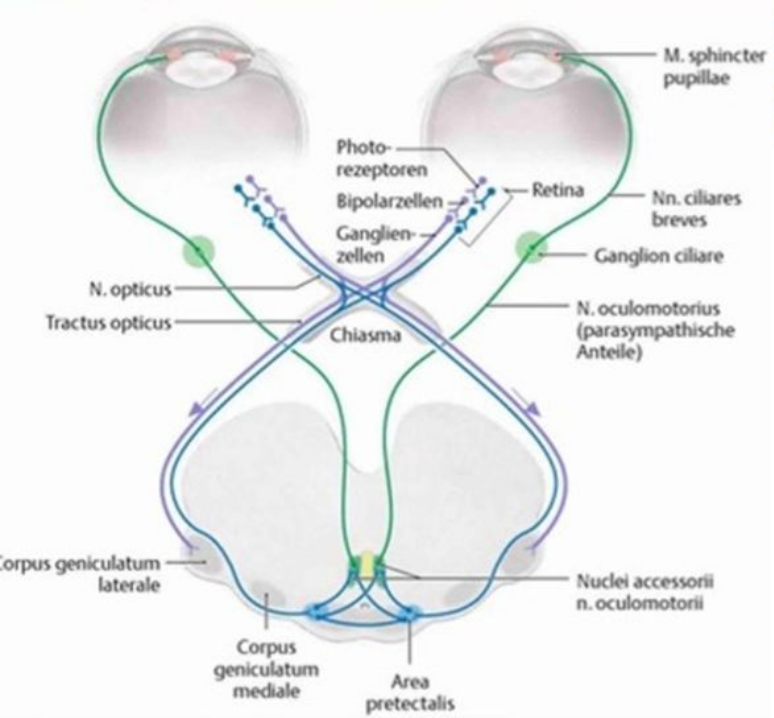


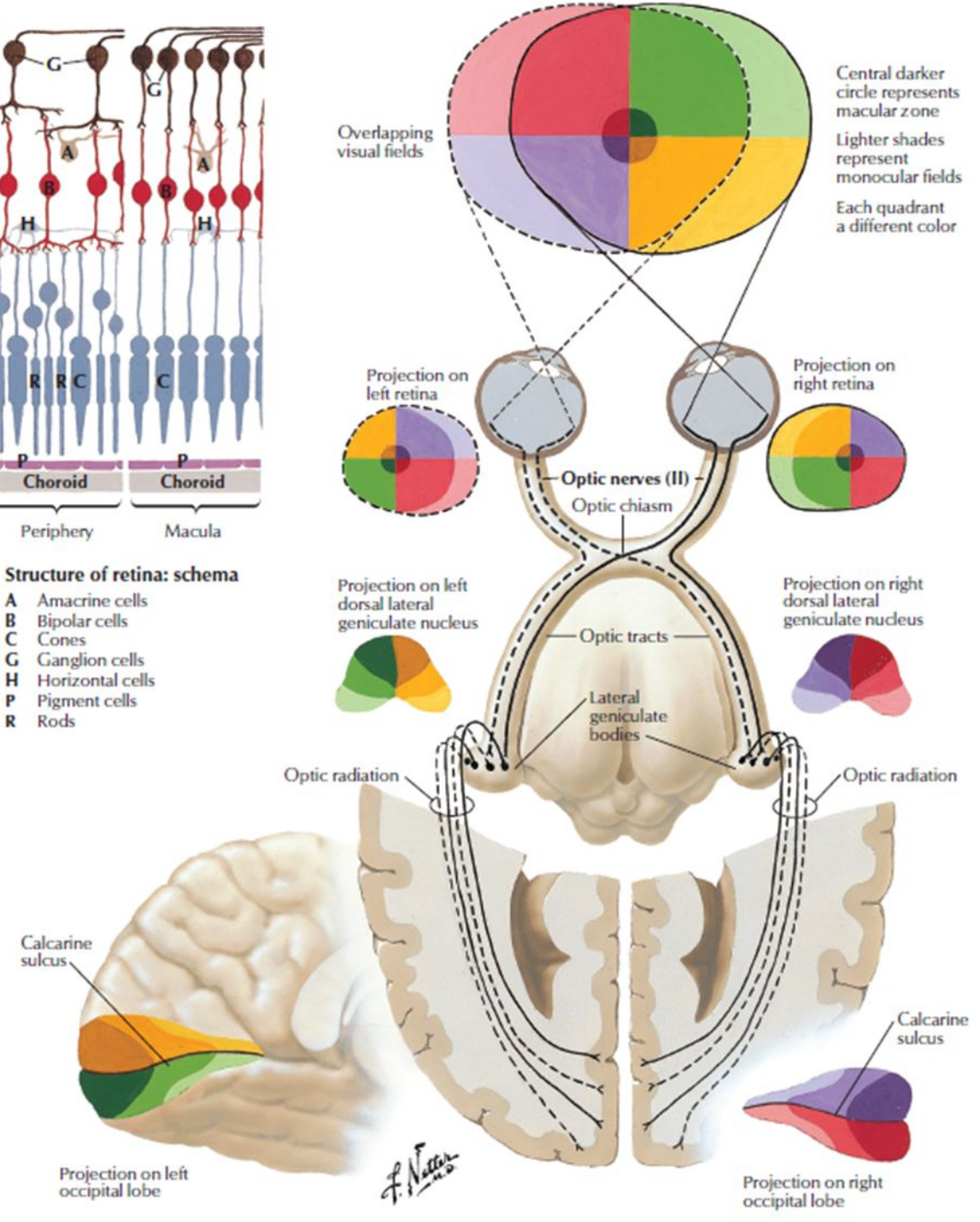
N. OPTICUS (II.)

- Efferent fibers (axons) of retinal ganglion cells (the 3rd neuron of the visual pathway) converge at the optic disc (papilla n. optici) and pass through the lamina cribrosa sclerae, acquiring a myelin sheath.
- The nerve runs in an S-shaped course through the optic canal (canalis opticus) into the cranial cavity.
    - Within the orbit, the central retinal artery (a. centralis retinae) enters the optic nerve.
- Optic chiasm — located anterior to the sella turcica; axons from the nasal (medial) halves of the retinas cross here.
- The fibers continue as the optic tract, which terminates in the lateral geniculate body (corpus geniculatum laterale) — the 4th neuron of the visual pathway.
- Axons of the 4th-order neurons form the optic radiation (radiatio optica) projecting to the occipital lobe near the calcarine sulcus (areas 17, 18, 19).
- The optic nerve is surrounded by three sheaths derived from the meninges (Vagina externa, Vagina intermedia, Vagina interna nervi optici)

Structure of retina: schema

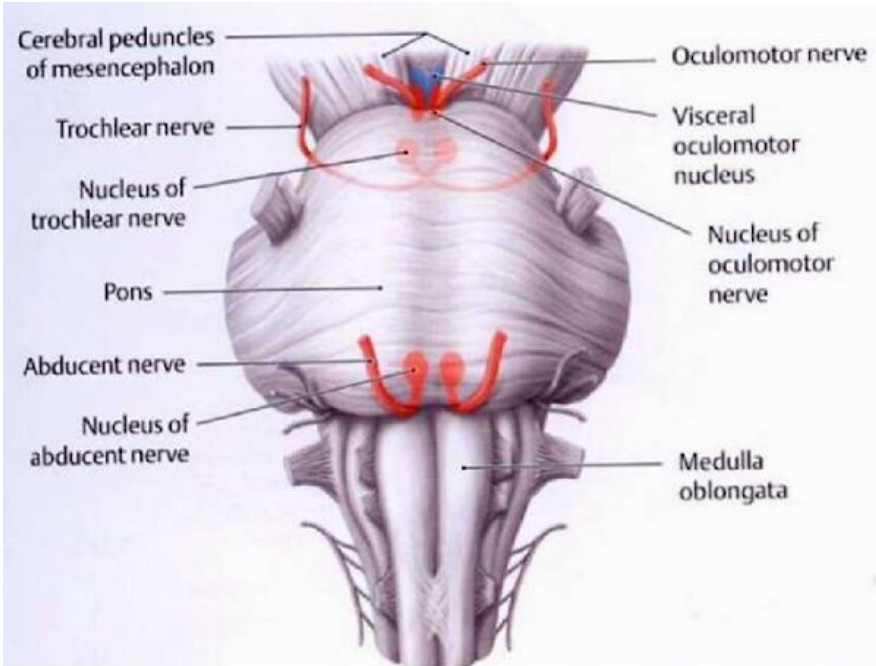
- **A** Amacrine cells
- **B** Bipolar cells
- **C** Cones
- **G** Ganglion cells
- **H** Horizontal cells
- **P** Pigment cells
- **R** Rods





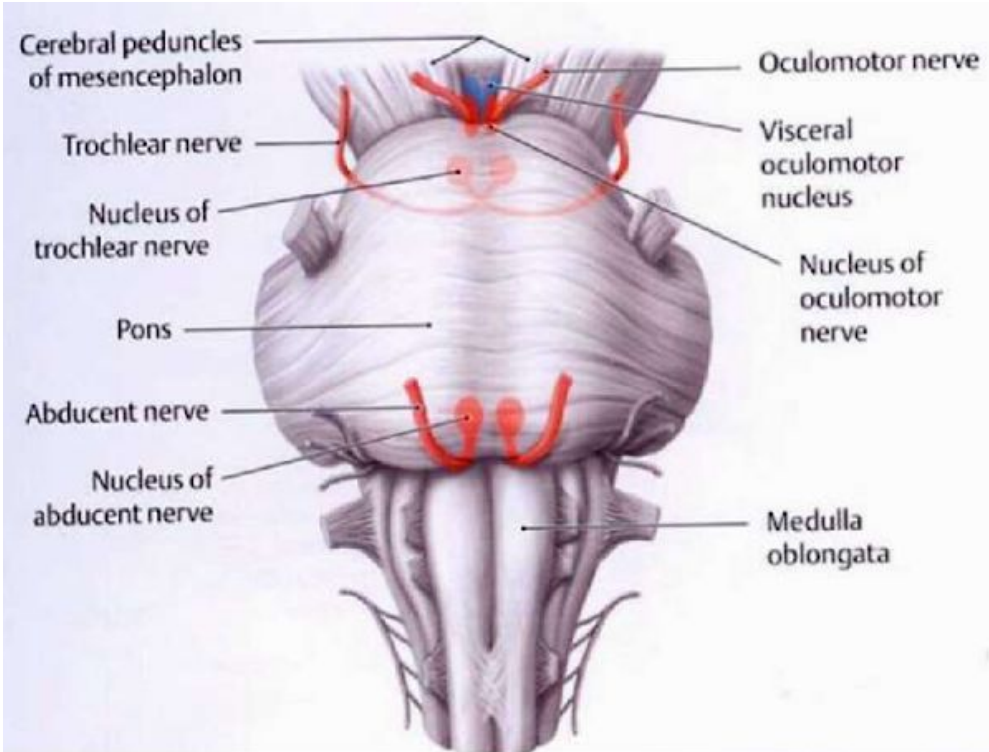
N. OCULOMOTORIUS (III.)

- Nucleus oculomotorius (somatomotor) is located in the mesencephalon near the midline.
- Edinger–Westphal nucleus (parasympathetic) provides preganglionic fibers for the ciliary ganglion.
- The nerve emerges from the interpeduncular fossa at the caudal end of the midbrain.
- It travels in the subarachnoid space, lateral to the circle of Willis.
- It pierces the dura mater lateral to the posterior clinoid process.
- It enters the cavernous sinus, running in its lateral wall, and continues toward the superior orbital fissure
- Enters the orbit through the annulus tendineus communis, dividing into the superior and inferior division.
- Ciliary ganglion – The oculomotor nerve carries preganglionic parasympathetic fibers to the ciliary ganglion.
- Postganglionic fibers exit as short ciliary nerves (nn. ciliares breves) → m. sphincter pupillae (pupil constriction), m. ciliaris (accommodation)
- In the cavernous sinus, the nerve receives sympathetic fibers from the internal carotid plexus → these innervate the dilator pupillae muscle.
- Motor: all extraocular muscles except m. rectus lateralis (VI) and m. obliquus superior (IV)
- Parasympathetic: constriction of the pupil, accommodation
- Proprioception: from extraocular muscles via n. ophthalmicus (branch of V1)



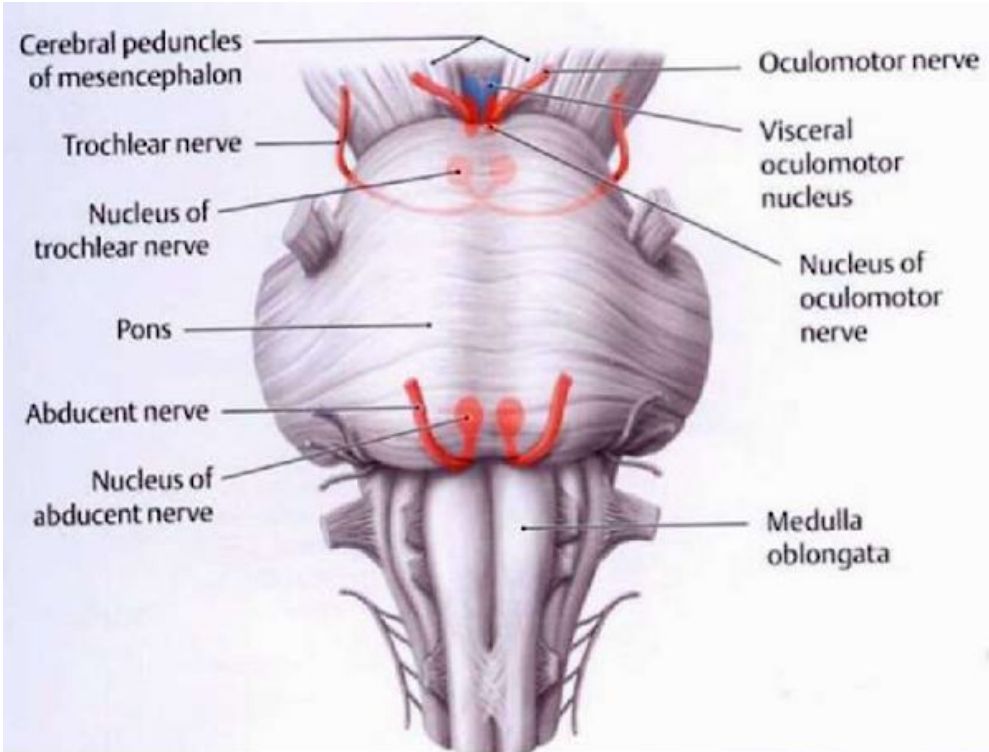
N. TROCHLEARIS (IV.)

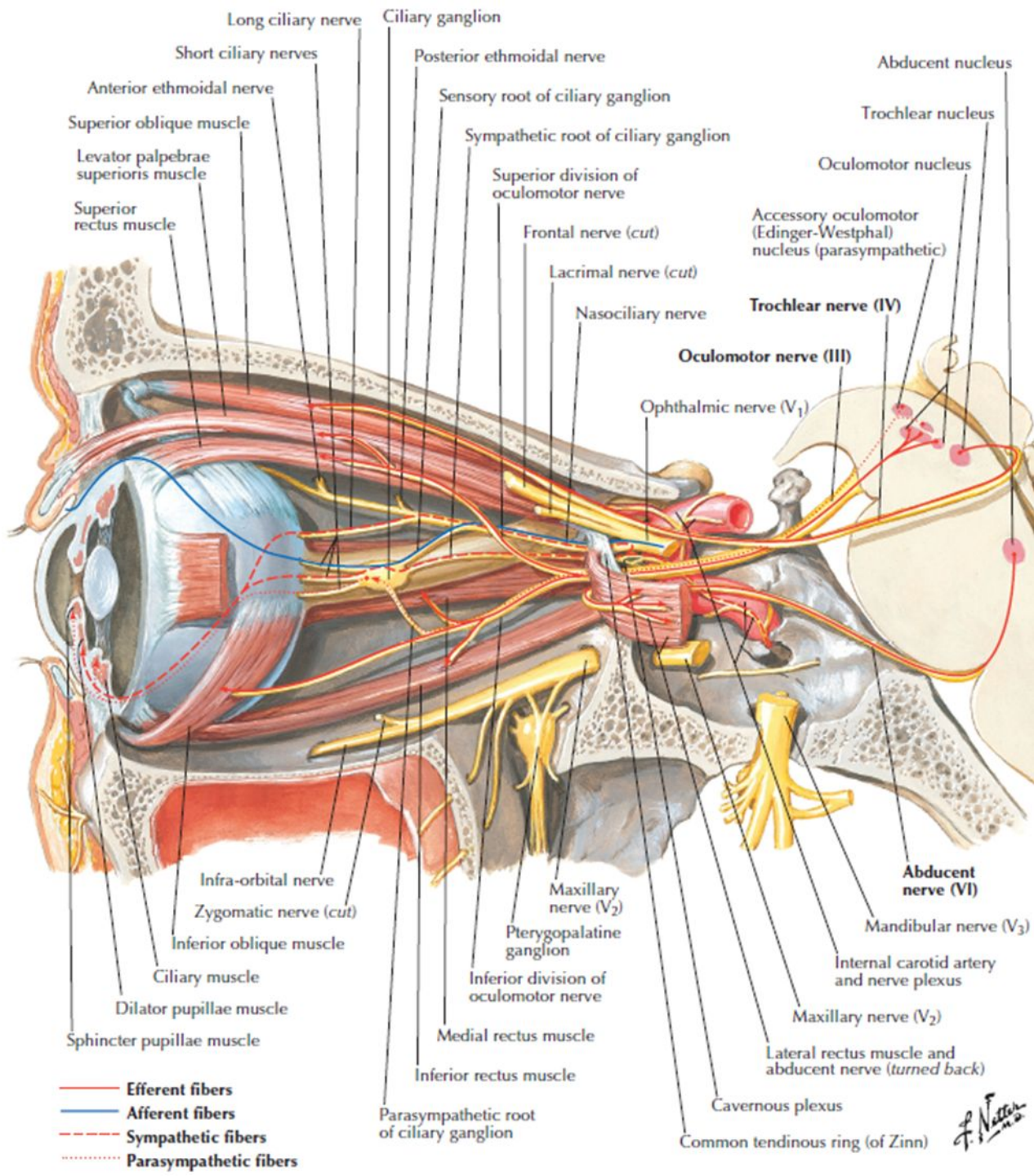
- Nucleus trochlearis is located in the mesencephalon at the level of the inferior colliculi.
- It is the only cranial nerve that exits the brainstem dorsally.
- Fibers decussate (cross) before emerging → each nerve innervates the contralateral superior oblique muscle.
- The nerve winds around the brainstem to the ventral side and pierces the dura mater near the petrous apex.
- It enters the lateral wall of the cavernous sinus.
- It enters the orbit through the superior orbital fissure, but outside the annulus tendineus communis.
- Motor: innervates m. obliquus superior (superior oblique)

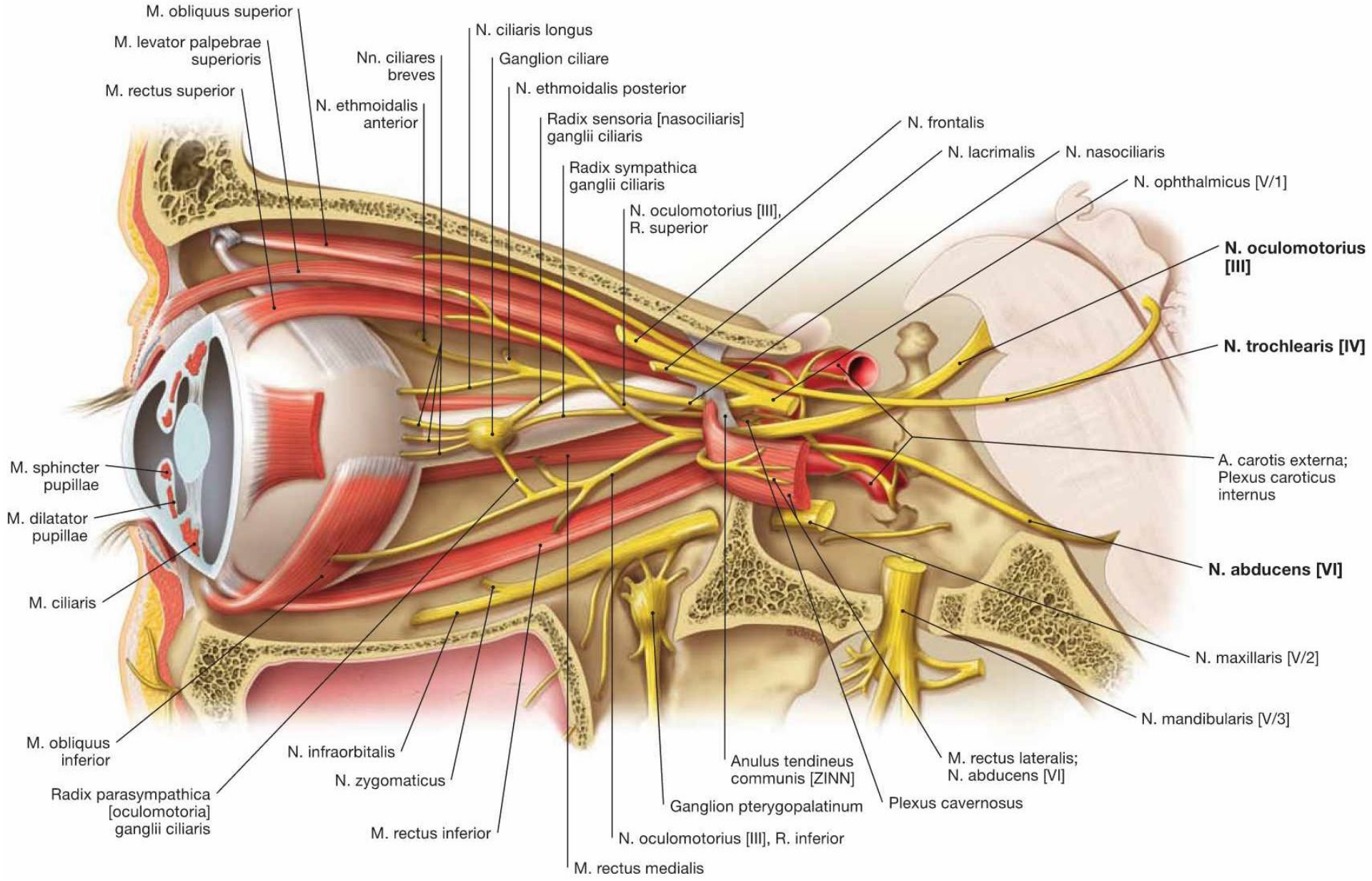


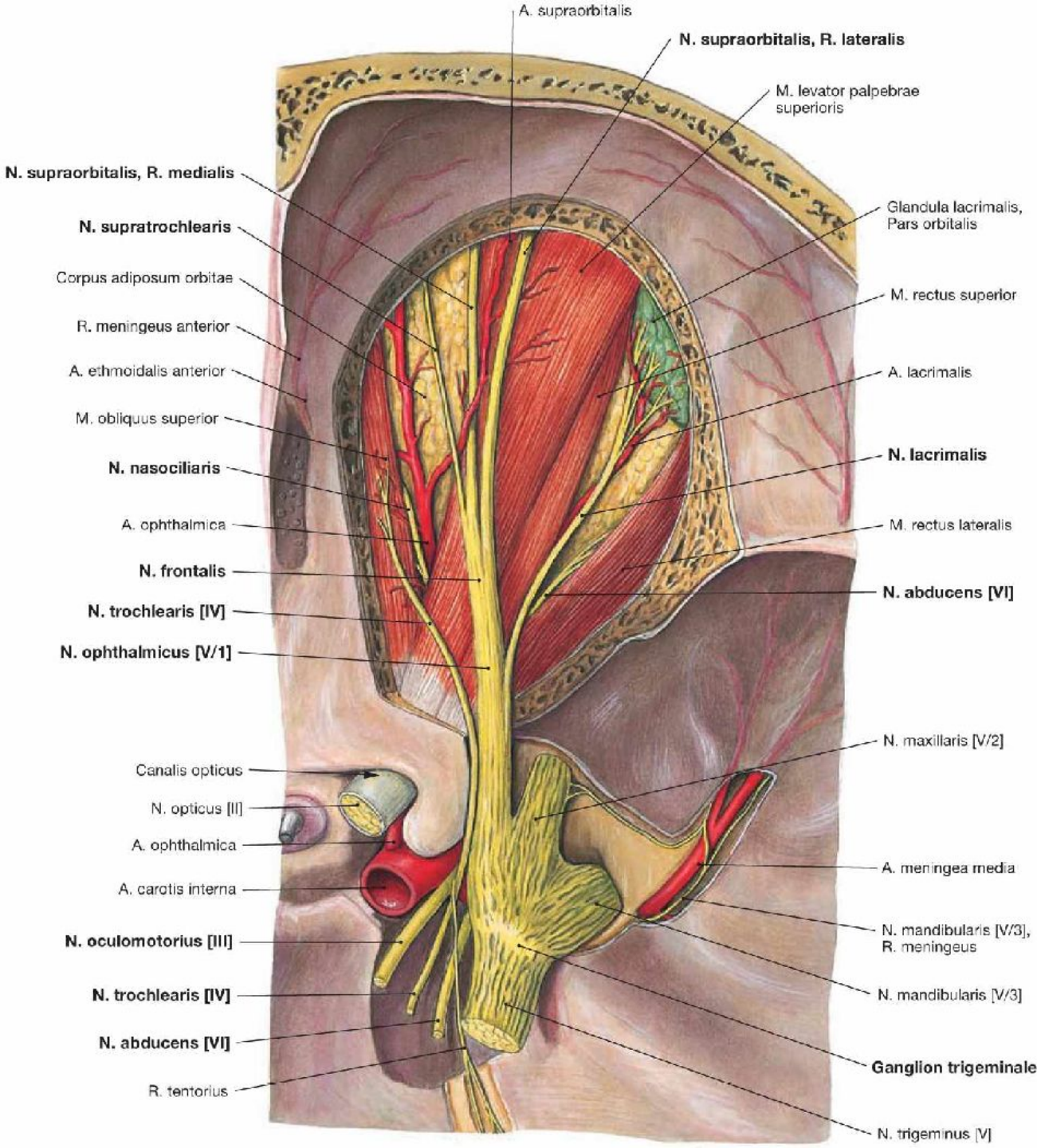
N. ABDUCENS (VI.)

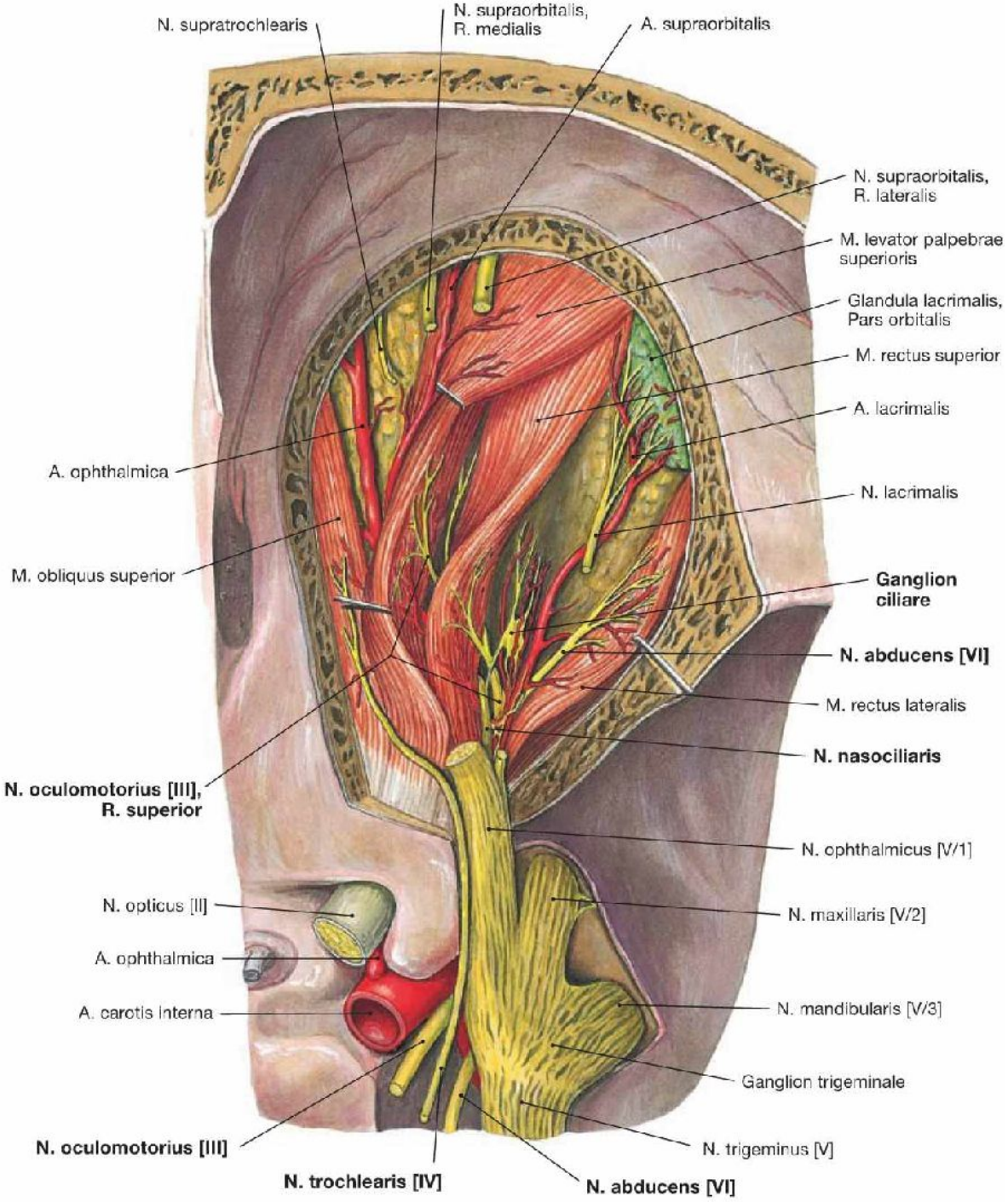
- Nucleus abducentis is located in the lower pons beneath the facial colliculus.
- The nerve exits at the sulcus bulbopontinus and runs forward toward the petrous apex.
- At the petrous apex, it pierces the dura mater and enters the cavernous sinus (running near the internal carotid artery).
- It enters the orbit through the superior orbital fissure, passing through the annulus tendineus communis, and goes to the m. rectus lateralis.
- Motor: innervating m. rectus lateralis.

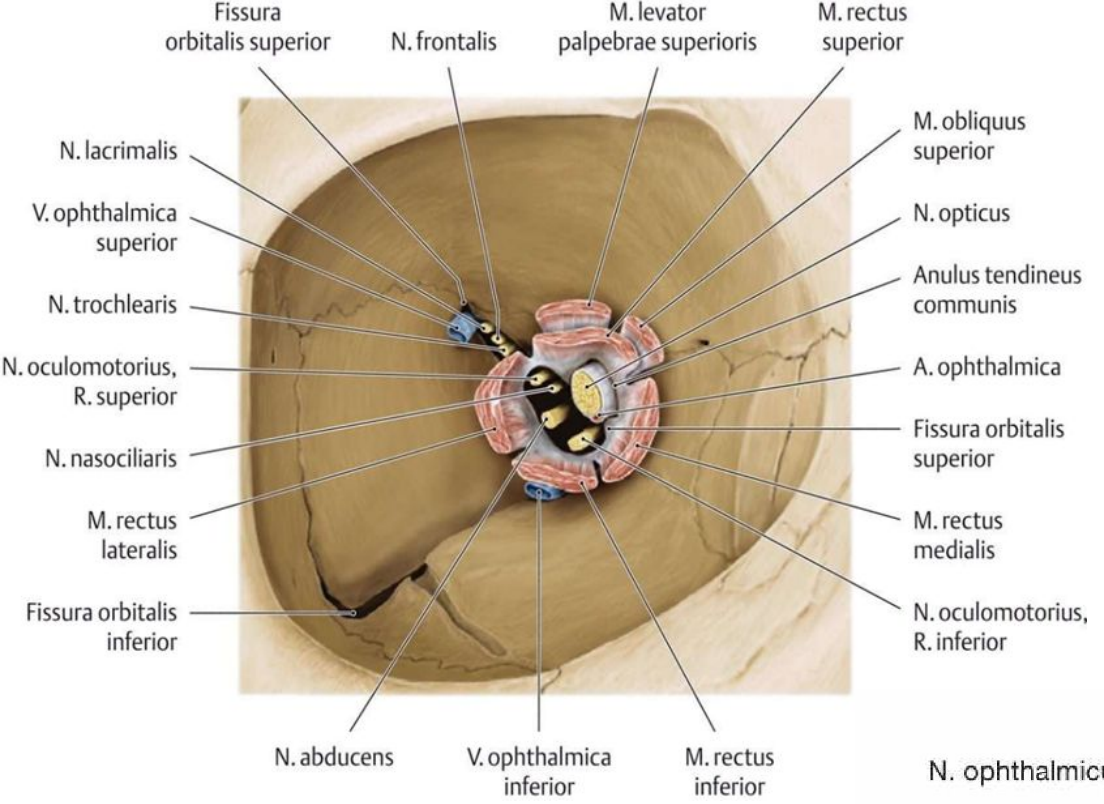


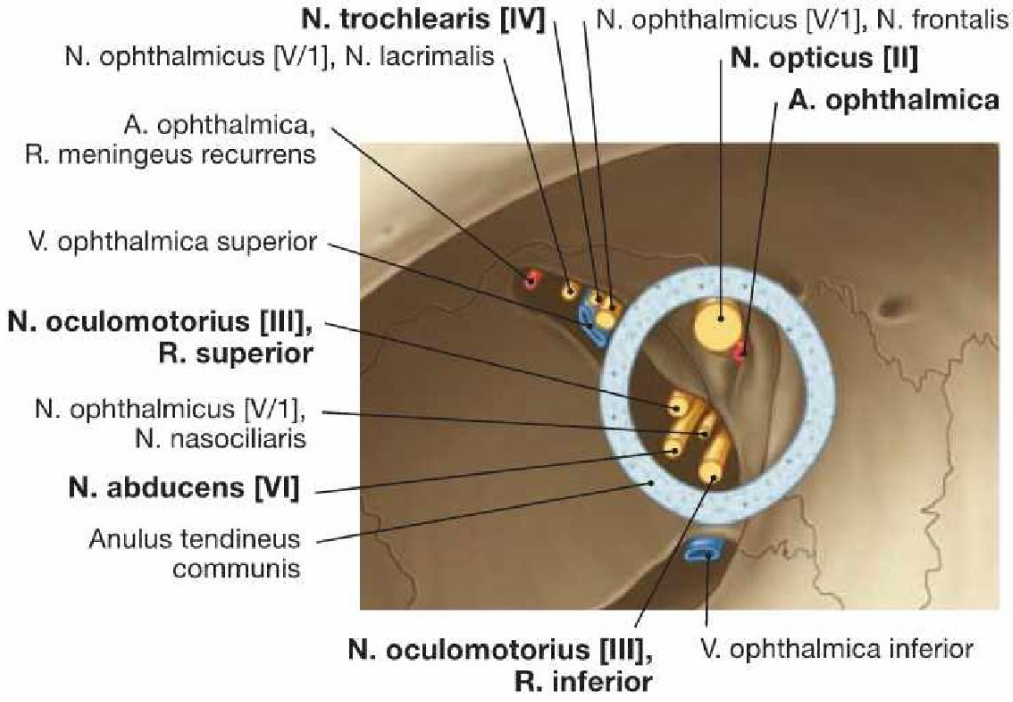

Long ciliary nerve
Ciliary ganglion
Short ciliary nerves
Posterior ethmoidal nerve
Abducent nucleus
Anterior ethmoidal nerve
Sensory root of ciliary ganglion
Trochlear nucleus
Superior oblique muscle
Sympathetic root of ciliary ganglion
Levator palpebrae superioris muscle
Superior division of oculomotor nerve
Oculomotor nucleus
Superior rectus muscle
Frontal nerve (cut)
Accessory oculomotor (Edinger-Westphal) nucleus (parasympathetic)
Lacrimal nerve (cut)
Trochlear nerve (IV)
Nasociliary nerve
Oculomotor nerve (III)
Ophthalmic nerve (V1)
Abducent nerve (VI)
Infra-orbital nerve
Maxillary nerve (V2)
Zygomatic nerve (cut)
Mandibular nerve (V3)
Pterygopalatine ganglion
Inferior oblique muscle
Internal carotid artery and nerve plexus
Ciliary muscle
Inferior division of oculomotor nerve
Maxillary nerve (V2)
Dilator pupillae muscle
Medial rectus muscle
Lateral rectus muscle and abducent nerve (turned back)
Sphincter pupillae muscle
Inferior rectus muscle
Cavernous plexus
Parasympathetic root of ciliary ganglion
Common tendinous ring (of Zinn)
Efferent fibers
Afferent fibers
Sympathetic fibers
Parasympathetic fibers


M. obliquus superior
M. levator palpebrae superioris
M. rectus superior
N. ethmoidalis anterior
Nn. ciliares breves
N. ciliaris longus
Ganglion ciliare
N. ethmoidalis posterior
Radix sensoria [nasociliaris] ganglii ciliaris
Radix sympathica ganglii ciliaris
N. oculomotorius [III], R. superior
N. frontalis
N. lacrimalis
N. nasociliaris
N. ophthalmicus [V/1]
N. oculomotorius [III]
N. trochlearis [IV]
A. carotis externa; Plexus caroticus internus
N. abducens [VI]
N. maxillaris [V/2]
N. mandibularis [V/3]
M. sphincter pupillae
M. dilatator pupillae
M. ciliaris
M. obliquus inferior
Radix parasympathica [oculomotoria] ganglii ciliaris
N. infraorbitalis
N. zygomaticus
M. rectus inferior
M. rectus medialis
N. oculomotorius [III], R. inferior
Ganglion pterygopalatinum
Anulus tendineus communis [ZINN]
M. rectus lateralis; N. abducens [VI]
Plexus cavernosus

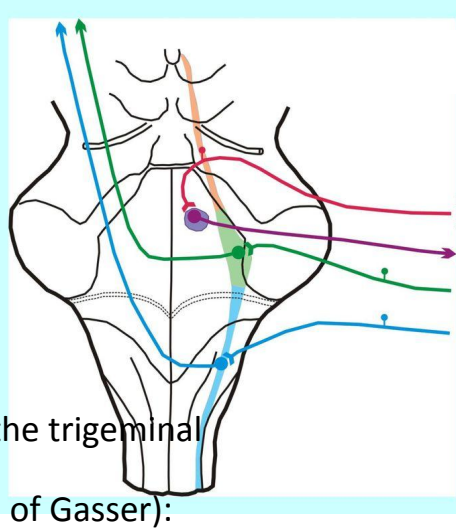

A. supraorbitalis
N. supraorbitalis, R. lateralis
M. levator palpebrae superioris
N. supraorbitalis, R. medialis
N. supratrochlearis
Corpus adiposum orbitae
R. meningeus anterior
A. ethmoidalis anterior
M. obliquus superior
N. nasociliaris
A. ophthalmica
N. frontalis
N. trochlearis [IV]
N. ophthalmicus [V/1]
Canalis opticus
N. opticus [II]
A. ophthalmica
A. carotis interna
N. oculomotorius [III]
N. trochlearis [IV]
N. abducens [VI]
R. tentorius
Glandula lacrimalis, Pars orbitalis
M. rectus superior
A. lacrimalis
N. lacrimalis
M. rectus lateralis
N. abducens [VI]
N. maxillaris [V/2]
A. meningea media
N. mandibularis [V/3], R. meningeus
N. mandibularis [V/3]
Ganglion trigeminale
N. trigeminus [V]


N. supratrochlearis
N. supraorbitalis, R. medialis
A. supraorbitalis
N. supraorbitalis, R. lateralis
M. levator palpebrae superioris
Glandula lacrimalis, Pars orbitalis
M. rectus superior
A. lacrimalis
A. ophthalmica
N. lacrimalis
M. obliquus superior
Ganglion ciliare
N. abducens [VI]
M. rectus lateralis
N. nasociliaris
N. oculomotorius [III], R. superior
N. ophthalmicus [V/1]
N. opticus [II]
N. maxillaris [V/2]
A. ophthalmica
A. carotis interna
N. mandibularis [V/3]
Ganglion trigeminale
N. oculomotorius [III]
N. trigeminus [V]
N. trochlearis [IV]
N. abducens [VI]


Fissura orbitalis superior
N. frontalis
M. levator palpebrae superioris
M. rectus superior
N. lacrimalis
V. ophthalmica superior
N. trochlearis
N. oculomotorius, R. superior
N. nasociliaris
M. rectus lateralis
Fissura orbitalis inferior
M. obliquus superior
N. opticus
Anulus tendineus communis
A. ophthalmica
Fissura orbitalis superior
M. rectus medialis
N. oculomotorius, R. inferior
N. abducens
V. ophthalmica inferior
M. rectus inferior


N. trochlearis [IV]
N. ophthalmicus [V/1], N. frontalis
N. ophthalmicus [V/1], N. lacrimalis
N. opticus [II]
A. ophthalmica
A. ophthalmica, R. meningeus recurrens
V. ophthalmica superior
N. oculomotorius [III], R. superior
N. ophthalmicus [V/1], N. nasociliaris
N. abducens [VI]
Anulus tendineus communis
N. oculomotorius [III], R. inferior
V. ophthalmica inferior

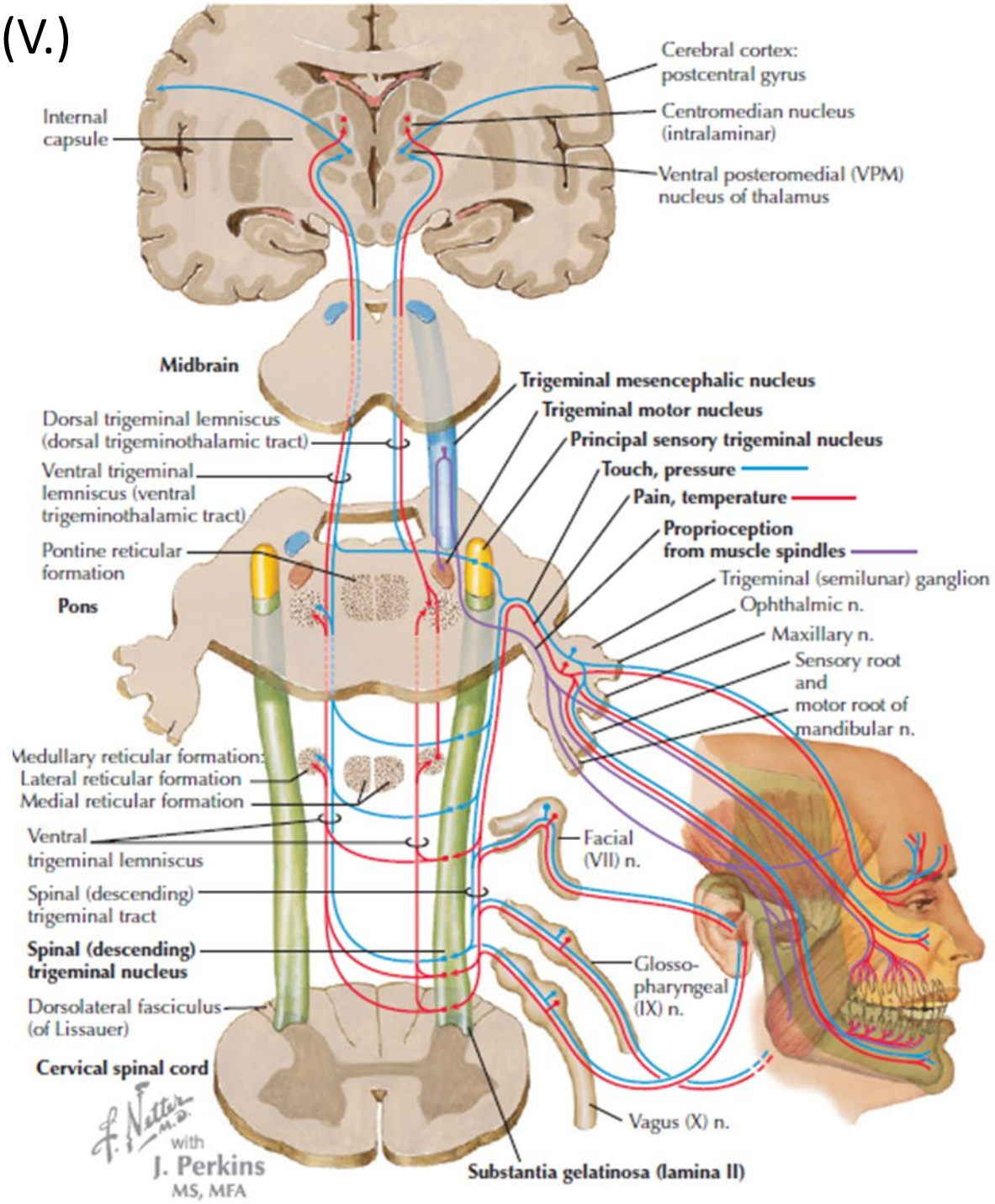
N. TRIGEMINUS (V.)



- Nuclei located in the lateral part of the brainstem
  - **nc. motorius trigeminalis** (somatomotor)
  - **nc. mesencephalicus** (sensory; proprioception from gums, masticatory muscles, and extraocular muscles)
  - **nc. pontinus** (sensory; touch)
  - **nc. spinalis** (sensory; pain and temperature)
- The nerve emerges from the pons (Pons Varoli).
- It runs beneath the dura toward the apex of the petrous part of the temporal bone, where the trigeminal impression (impressio trigemini) is located.
- In the trigeminal cave (cavum trigeminale) lies the trigeminal ganglion (ganglion trigeminale of Gasser):
  - Contains sensory pseudounipolar neurons receiving afferent impulses from the three divisions
  - Axons from these cells form the sensory root (**radix sensoria**) entering the brainstem
  - **Radix motoria** (=portio minor) passes beneath the ganglion and joins the mandibular nerve (V3)
  - From the ganglion arise the three major branches: **n. ophtalmicus, n. maxillaris, n. mandibularis**
- Sensory components
  - Entire face (V1/V2 — eyelid fissure; V2/V3 — oral fissure), Oral and nasal cavity, Entire orbital contents, Most of the dura mater
  - Part of the external earcelý obličej (V1/V2 – štěrbina víčková, V2/V3 – štěrbina ústní), dutina ústní a nosní, celý obsah orbity, většinu dura mater, část ušního boltce
  - Boundary line of innervation: vertex – external acoustic meatus – chin (separates trigeminal innervation from cervical spinal nerves)
  - Proprioceptive afferents from extraocular muscles via CN III and IV within the cavernous sinus
- Motor components
  - Travel in the main trunk of CN V, join V3 after passing beneath the ganglion
  - Include “foreign” fibers originating from CN VII and CN IX nuclei (already within brainstem)
  - Through foramen ovale and as muscular branches innervates masticatory muscles (masseter, temporalis, medial & lateral pterygoids), m. mylohyoideus, m. digastricus (venter anterior)

NUCLEI OF N. TRIGEMINUS (V.)

- lateral part of the brainstem



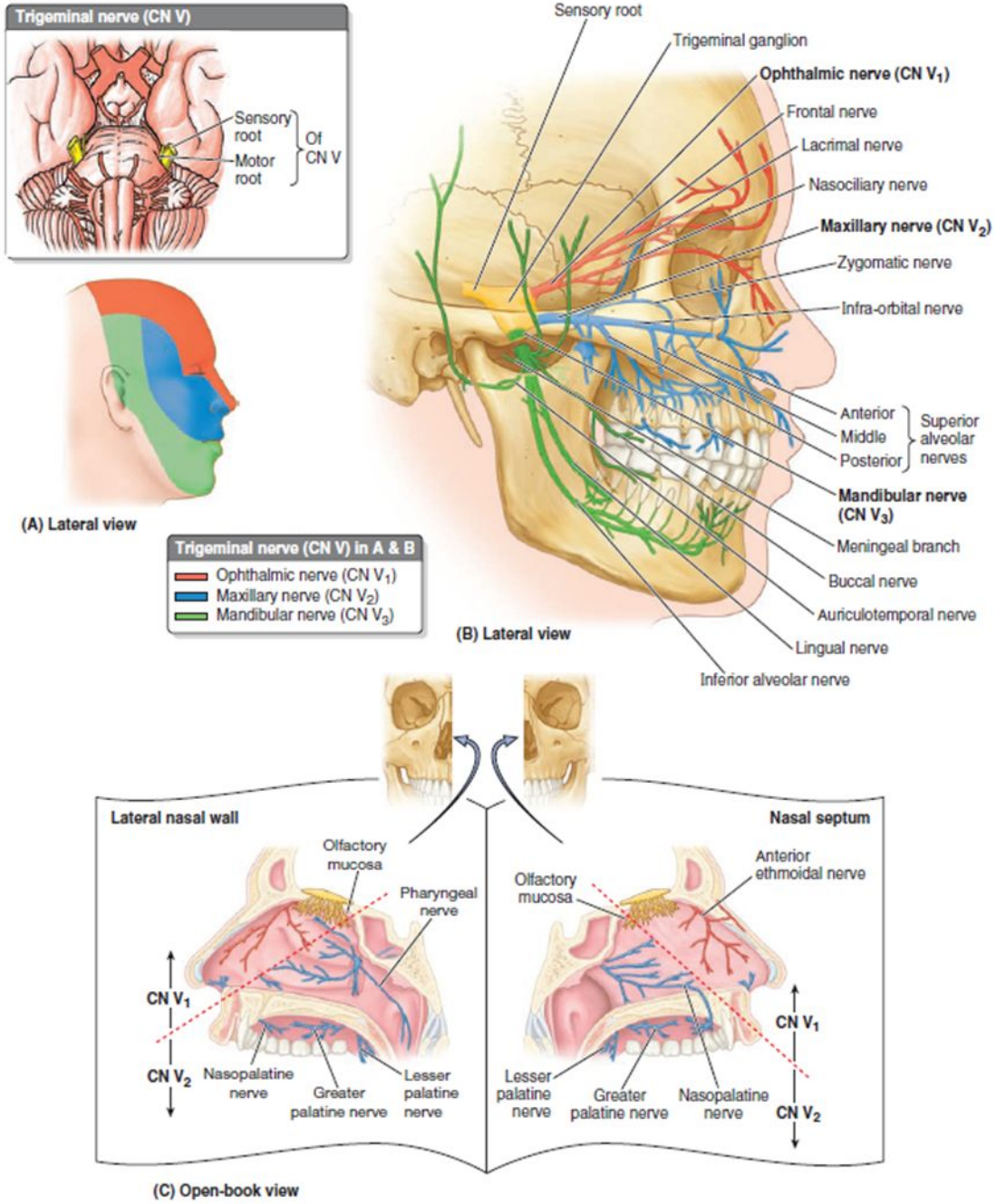
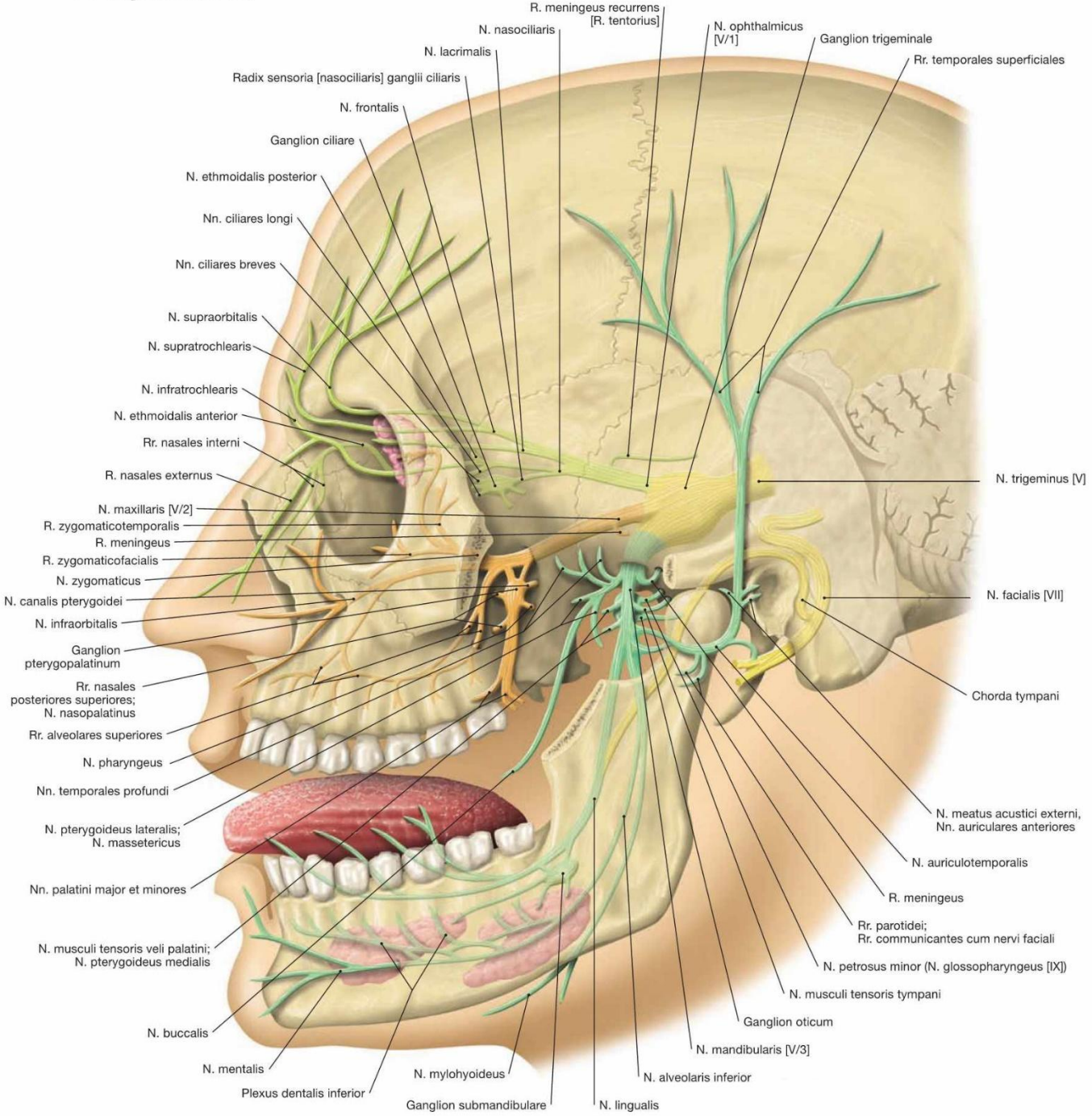
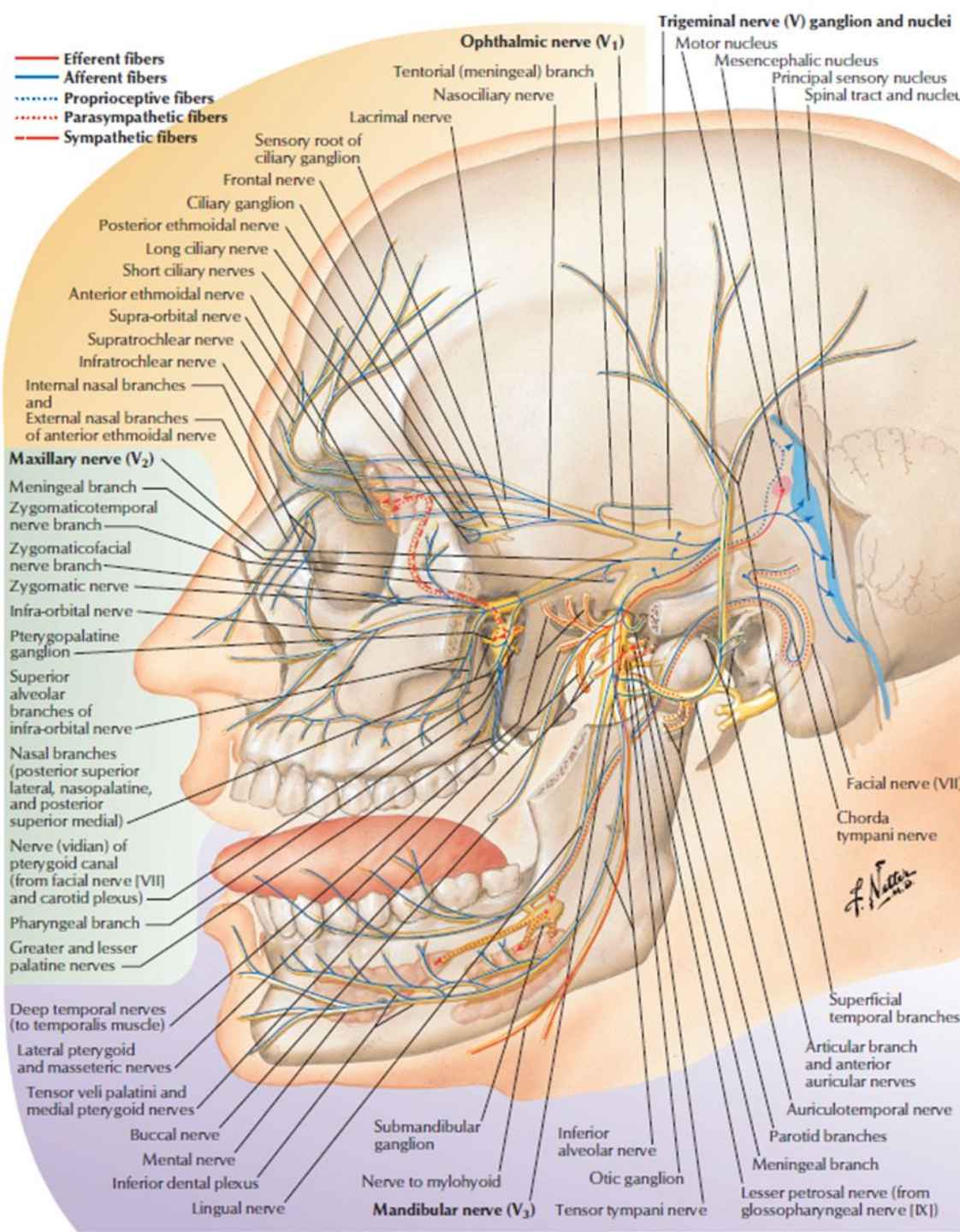


FIGURE 9.10. Distribution of trigeminal nerve (CN V). A. Cutaneous (sensory) distribution of the three divisions of the trigeminal nerve. **B.** Branches of the ophthalmic (CN V_1), maxillary (CN V_2), and mandibular divisions (CN V_3). **C.** CN V_1 and CN V_2 innervation of the palate and lateral wall and septum of the nasal cavity.

N. trigeminus [V]




Efferent fibers
Afferent fibers
Proprioceptive fibers
Parasympathetic fibers
Sympathetic fibers
Trigeminal nerve (V) ganglion and nuclei
Motor nucleus
Mesencephalic nucleus
Principal sensory nucleus
Spinal tract and nucleu
Ophthalmic nerve (V1)
Tentorial (meningeal) branch
Nasociliary nerve
Lacrimal nerve
Sensory root of ciliary ganglion
Frontal nerve
Ciliary ganglion
Posterior ethmoidal nerve
Long ciliary nerve
Short ciliary nerves
Anterior ethmoidal nerve
Supra-orbital nerve
Supratrochlear nerve
Infratrochlear nerve
Internal nasal branches and External nasal branches of anterior ethmoidal nerve
Maxillary nerve (V2)
Meningeal branch
Zygomaticotemporal nerve branch
Zygomaticofacial nerve branch
Zygomatic nerve
Infra-orbital nerve
Pterygopalatine ganglion
Superior alveolar branches of infra-orbital nerve
Nasal branches (posterior superior lateral, nasopalatine, and posterior superior medial)
Nerve (vidian) of pterygoid canal (from facial nerve [VII] and carotid plexus)
Pharyngeal branch
Greater and lesser palatine nerves
Facial nerve (VII)
Chorda tympani nerve
Deep temporal nerves (to temporalis muscle)
Lateral pterygoid and masseteric nerves
Tensor veli palatini and medial pterygoid nerves
Buccal nerve
Mental nerve
Inferior dental plexus
Lingual nerve
Submandibular ganglion
Nerve to mylohyoid
Mandibular nerve (V3)
Inferior alveolar nerve
Otic ganglion
Tensor tympani nerve
Superficial temporal branches
Articular branch and anterior auricular nerves
Auriculotemporal nerve
Parotid branches
Meningeal branch
Lesser petrosal nerve (from glossopharyngeal nerve [IX])

N. OPHTALMICUS (V1)

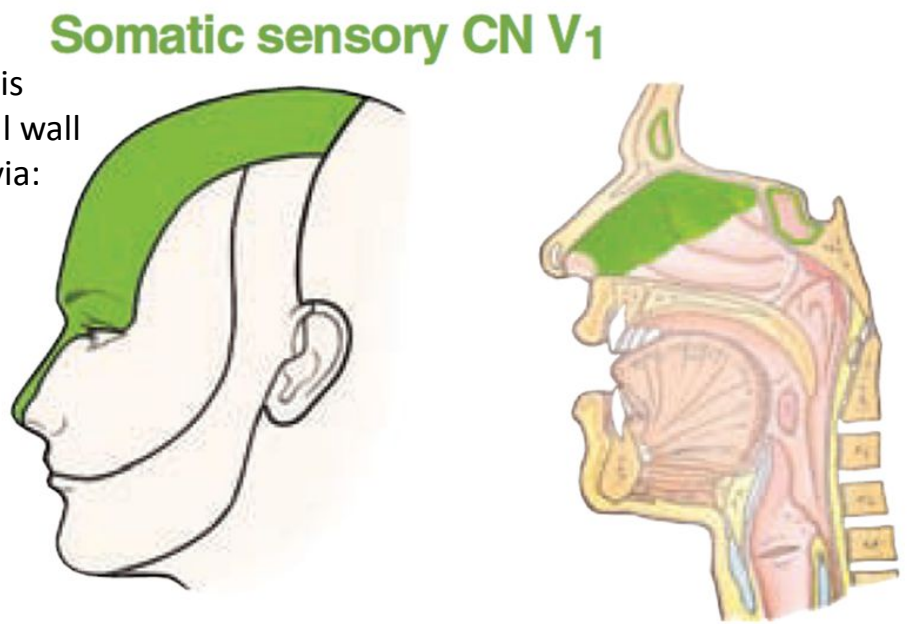
- Enters the lateral wall of the cavernous sinus (together with CN III, IV, VI) on its way to the superior orbital fissure.

Branches within the cavernous sinus

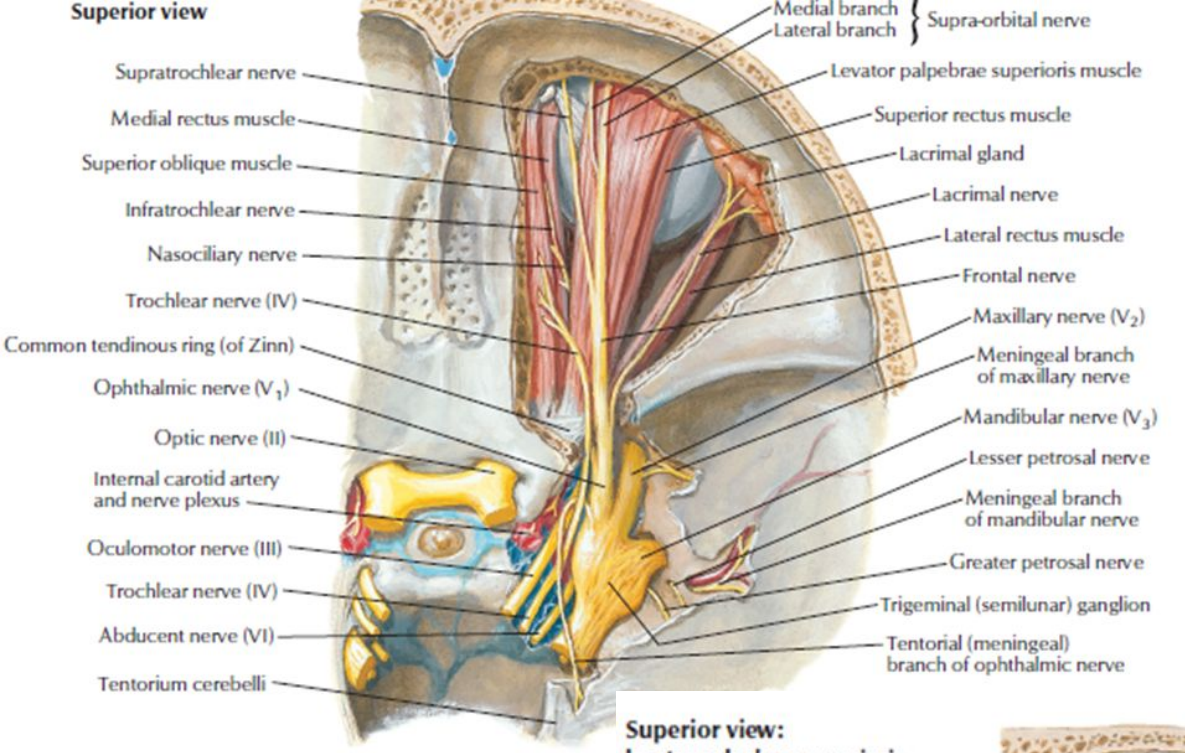
- Sympathetic connections from the internal carotid plexus
- Connections to extraocular motor nerves — afferent proprioception
- Ramus tentorii — sensory innervation to the tentorium cerebelli and venous sinuses

Branches before entering the orbit

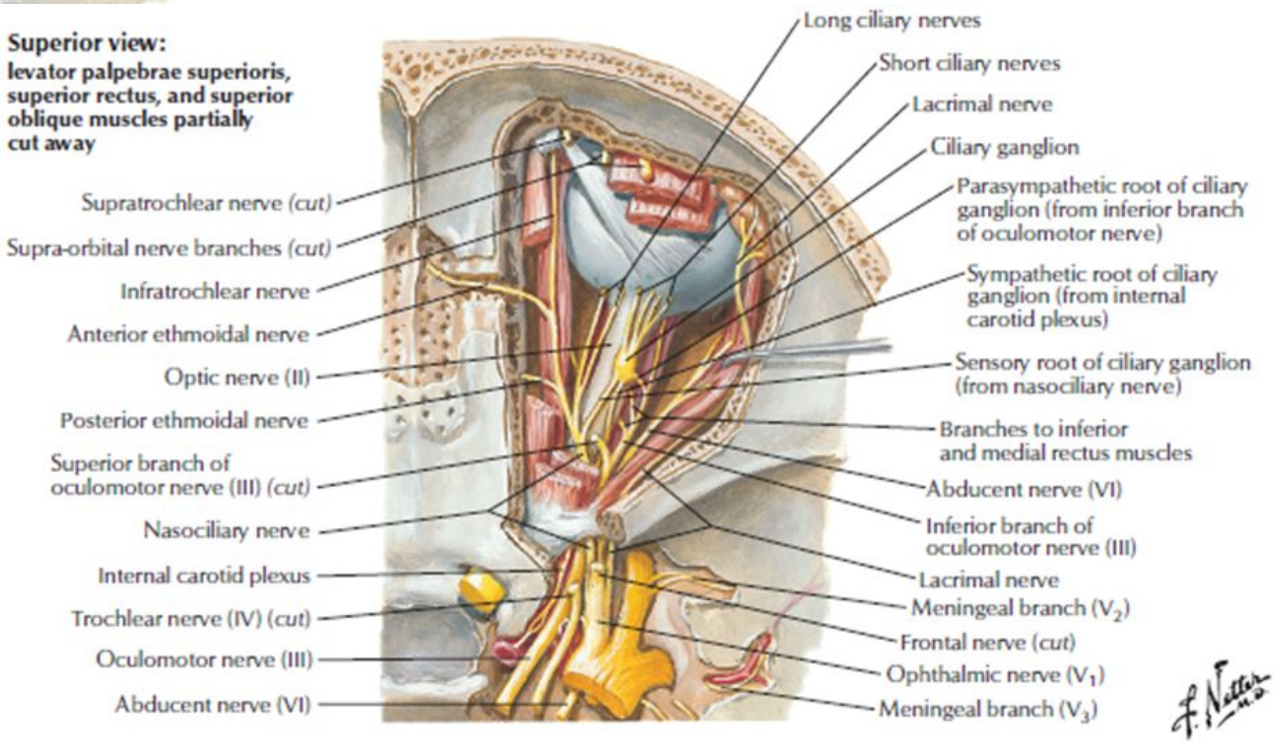
- N. frontalis
  - Enters the orbit lateral to the annulus tendineus communis
  - Runs beneath the roof of the orbit, divides into:
    - N. supratrochlearis — skin of the glabella, root of the nose, medial canthus
    - N. supraorbitalis — forehead, scalp, frontal sinus
- N. lacrimalis
  - Runs laterally in the orbit toward the lacrimal gland
  - Receives the communicating branch from n. zygomaticus (parasympathetic fibers from the pterygopalatine ganglion for lacrimal secretion)
- N. nasociliaris
  - Enters the orbit through the annulus tendineus communis
  - Crosses above the optic nerve to reach the medial orbital wall
  - Carries parasympathetic fibers for nasal mucous glands via:
    - R. ethmoidalis anterior
    - R. ethmoidalis posterior



Superior view

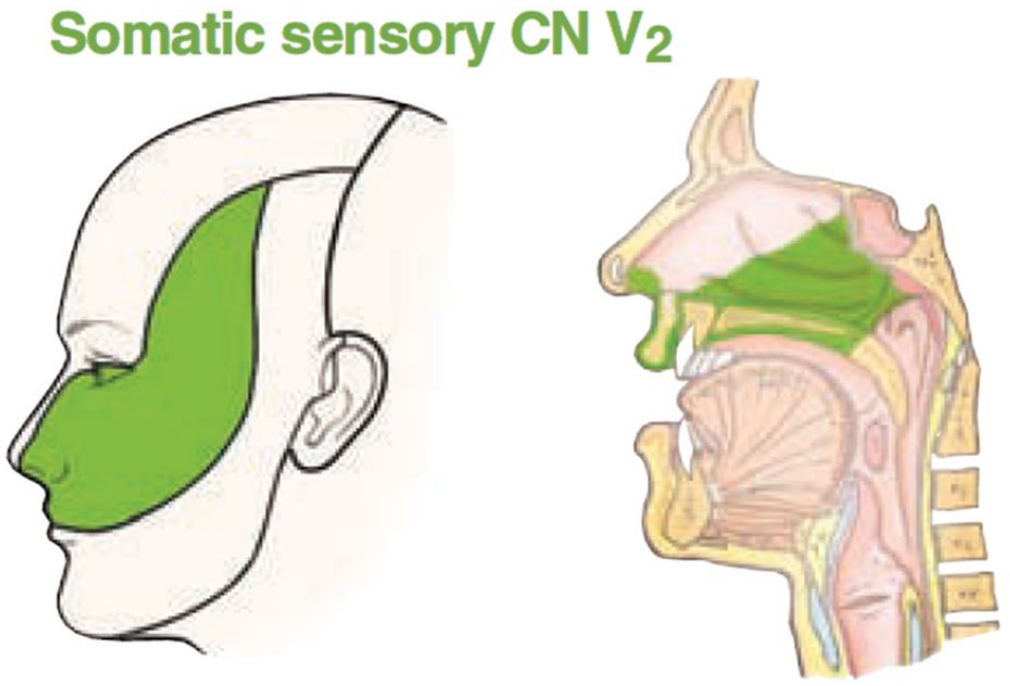


Superior view:
levator palpebrae superioris, superior rectus, and superior oblique muscles partially cut away



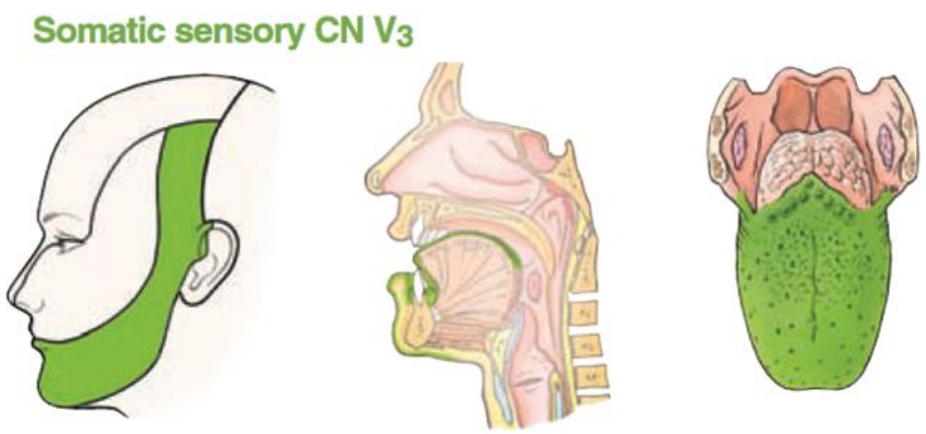
N. MAXILLARIS (V2)

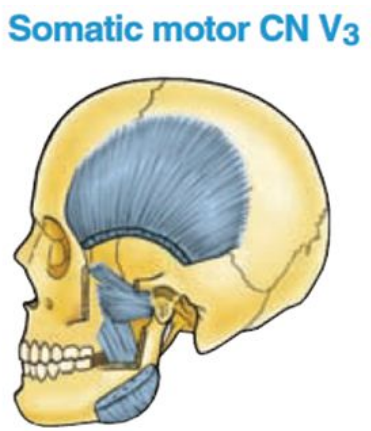
- Travels in the lateral wall of the cavernous sinus, exits through the foramen rotundum, and enters the pterygopalatine fossa
- Branches
  - R. meningeus – Runs with the anterior branch of the middle meningeal artery; Sensory fibers to the dura mater
  - Nn. pterygopalatini (rr. ganglionares) – Connect to the pterygopalatine ganglion (sensory fibers pass through without synapsing); Supply: posterior nasal cavity, palate, nasopharynx
  - N. infraorbitalis – Continuation of V2; Enters the orbit via the inferior orbital fissure, Runs in the infraorbital sulcus and infraorbital canal, Gives off:
    - Rr. cutanei — skin of the midface
    - Rr. alveolares — maxillary sinus mucosa, upper teeth, gingiva
  - N. zygomaticus – From the pterygopalatine fossa through the inferior orbital fissure into the orbit, Runs along the lateral orbital wall, Sends a communicating branch to the lacrimal nerve (parasympathetics to the lacrimal gland)

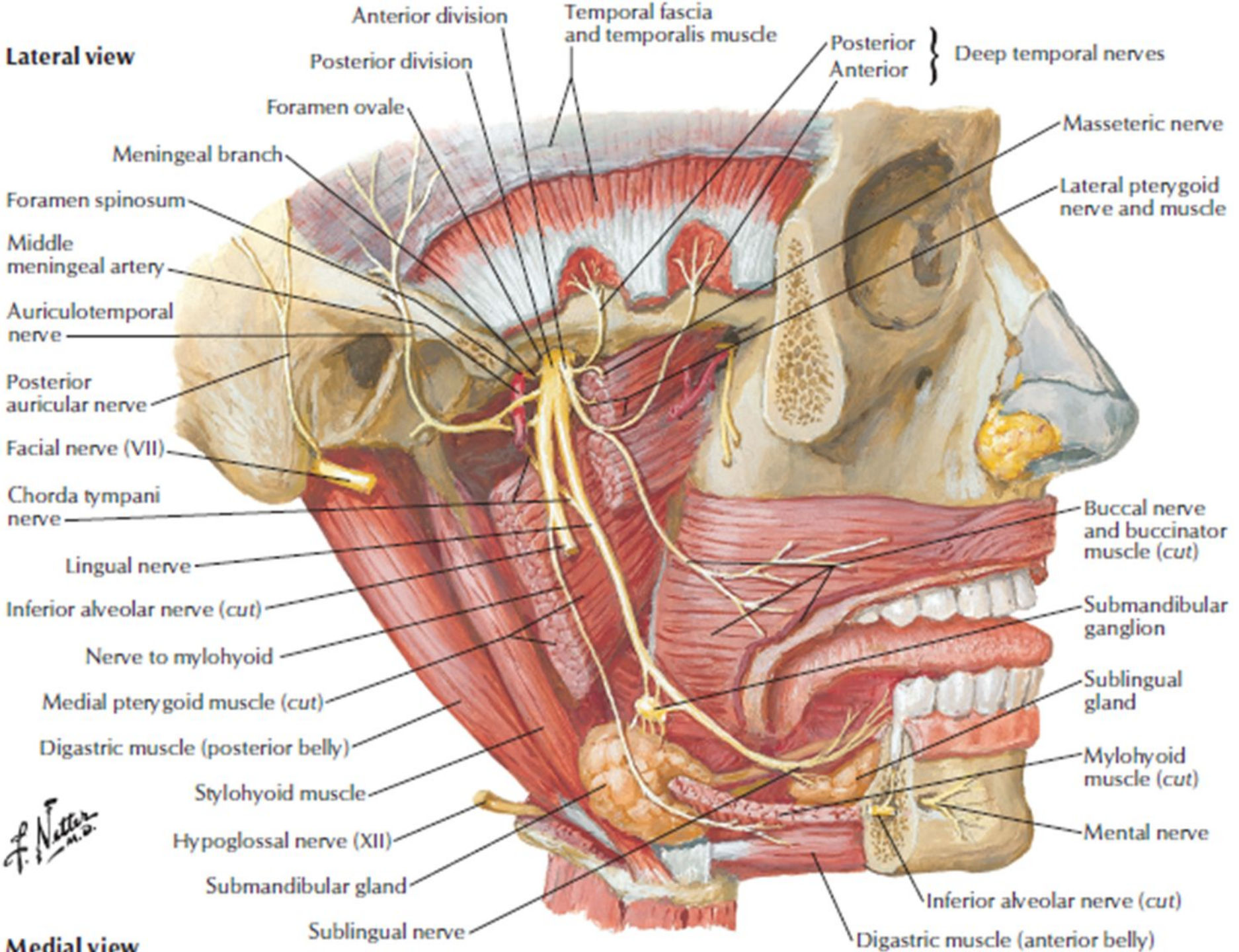


N. MANDIBULARIS (V3)

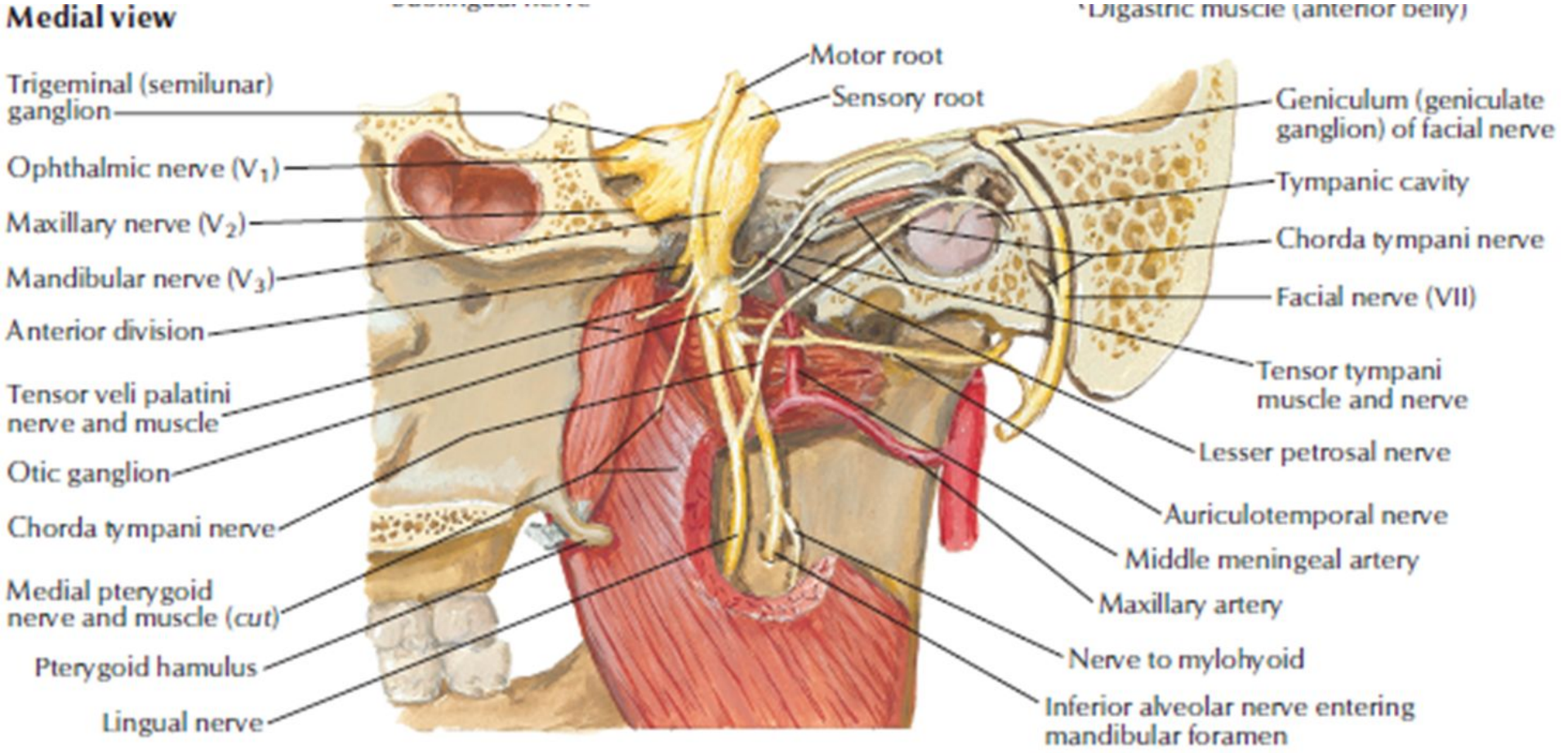
- A mixed nerve (sensory + motor); Enters the infratemporal fossa through the foramen ovale, passing through the pterygoid venous plexus.
- Medial to it lies the otic ganglion (parasympathetic).
  - sensory: Skin, mucosa, teeth, and gingiva of the mandible; Skin of the temporal region
  - special sensory: Taste fibers from the anterior two-thirds of the tongue travel via chorda tympani → n. facialis (VII)
  - motor: masticatory muscles, m. mylohyoideus, m. digastricus (venter anterior), m. tensor tympani (nc. VII), m. tensor veli palatini (nc. IX), m. masseter, mm. pterygoidei, m. temporalis
- Branches
  - R. meningeus – Re-enters the skull via foramen spinosum with the middle meningeal artery → dura mater
  - Rr. musculares – Motor branches to the masticatory muscles
  - N. buccalis – Sensory only; Supplies buccal mucosa near m. buccinator (but does not innervate the muscle); Carries parasympathetic fibers to mucosal glands via connections from the otic ganglion (CN IX)
  - N. auriculotemporalis – Forms a loop around the middle meningeal artery, Ascends behind the temporomandibular joint and in front of the ear, Carries parasympathetic fibers to the parotid gland
  - N. lingualis – Runs between the lateral and medial pterygoid muscles, Reaches the lateral side of m. hyoglossus, Loops under the submandibular duct; Sensory to tongue mucosa, mouth floor, isthmus faucium
    - Chorda tympani (branch of CN VII) – Joins the lingual nerve, Carries parasympathetic fibers to submandibular ganglion, Taste fibers (cell bodies in geniculate ganglion) to anterior 2/3 of tongue
  - N. alveolaris inferior – Gives off motor branches before entering the mandibular canal, Continues as n. mentalis after emerging from the mental foramen; Supplies lower teeth, gingiva, chin, and lower lip



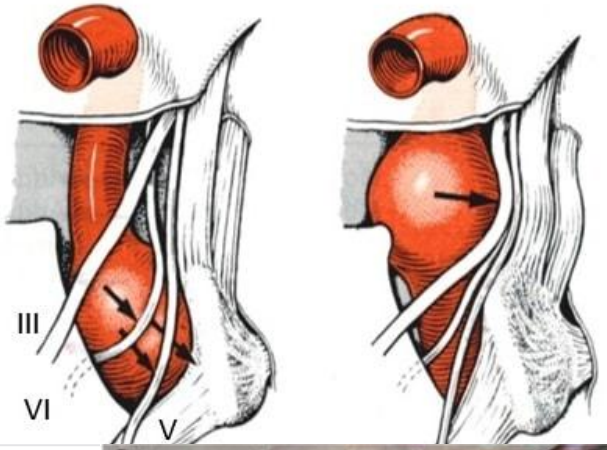



Lateral view
Anterior division
Posterior division
Temporal fascia and temporalis muscle
Posterior
Anterior
Deep temporal nerves
Foramen ovale
Meningeal branch
Foramen spinosum
Middle meningeal artery
Auriculotemporal nerve
Posterior auricular nerve
Facial nerve (VII)
Chorda tympani nerve
Lingual nerve
Inferior alveolar nerve (cut)
Nerve to mylohyoid
Medial pterygoid muscle (cut)
Digastric muscle (posterior belly)
Stylohyoid muscle
Hypoglossal nerve (XII)
Submandibular gland
Sublingual nerve
Masseteric nerve
Lateral pterygoid nerve and muscle
Buccal nerve and buccinator muscle (cut)
Submandibular ganglion
Sublingual gland
Mylohyoid muscle (cut)
Mental nerve
Inferior alveolar nerve (cut)
Digastric muscle (anterior belly)
Medial view

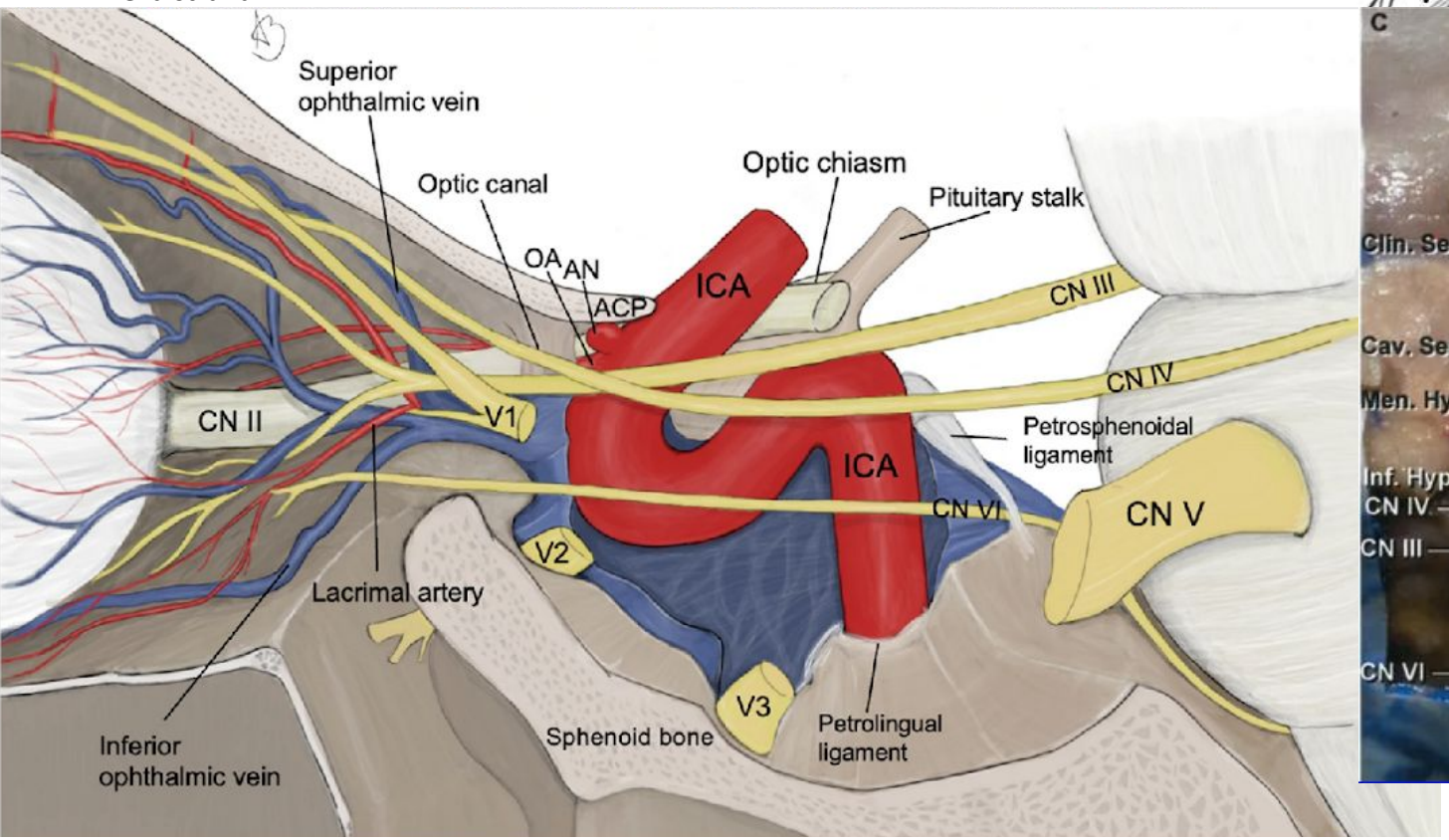
Medial view

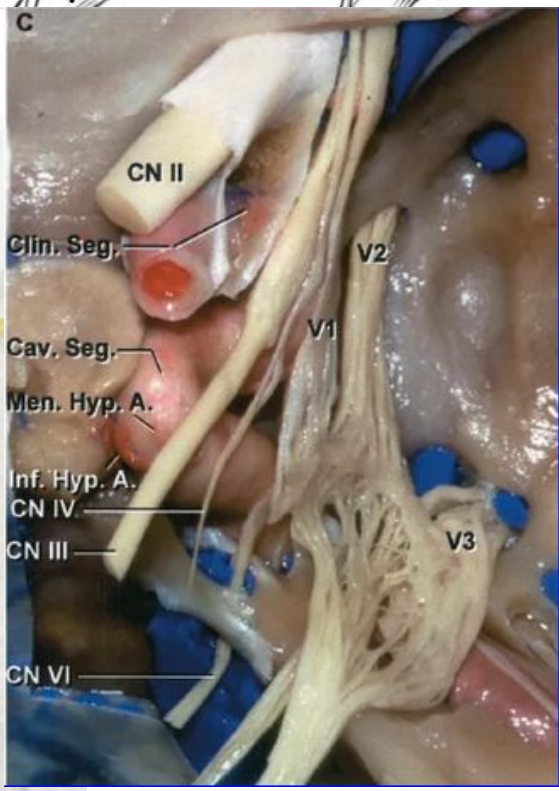

Digastric muscle (anterior belly)
Motor root
Sensory root
Trigeminal (semilunar) ganglion
Ophthalmic nerve (V_1)
Maxillary nerve (V_2)
Mandibular nerve (V_3)
Anterior division
Tensor veli palatini nerve and muscle
Otic ganglion
Chorda tympani nerve
Medial pterygoid nerve and muscle (*cut*)
Pterygoid hamulus
Lingual nerve
Geniculum (geniculate ganglion) of facial nerve
Tympanic cavity
Chorda tympani nerve
Facial nerve (VII)
Tensor tympani muscle and nerve
Lesser petrosal nerve
Auriculotemporal nerve
Middle meningeal artery
Maxillary artery
Nerve to mylohyoid
Inferior alveolar nerve entering mandibular foramen

COURSE THROUGH THE SINUS CAVERNOSUS



Levá strana





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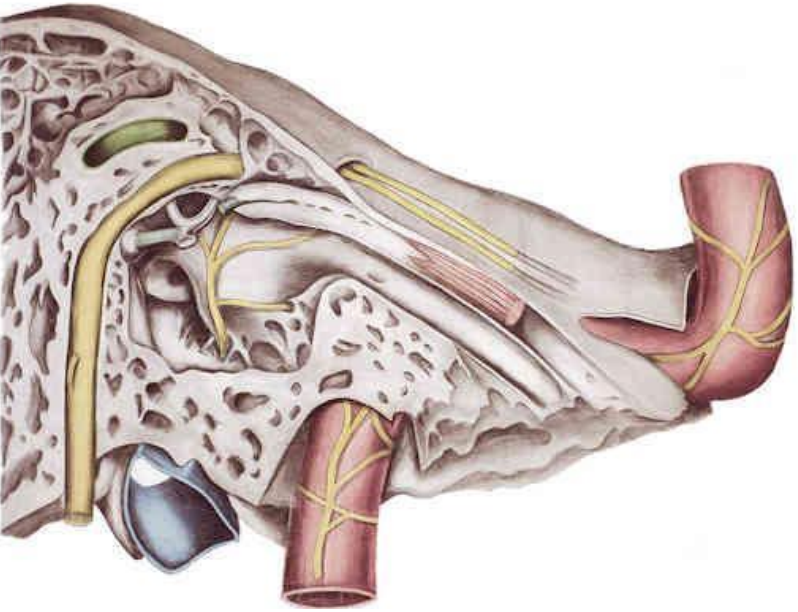
Bubeníková et al. (2022). Partial medial clinoidectomy with optic canal roof drilling for clipping of ophthalmic artery aneurysms: how I do it. *Acta neurochirurgica*, *164*(11), 2893–2898.

N. FACIALIS (VII.)

- N. facialis — somatomotor
- N. intermedius — visceromotor (parasympathetic), viscerosensory, somatosensory
- Nuclei
  - Nucleus facialis — somatomotor, Nucleus salivatorius superior — parasympathetic
  - Located in the lateral caudal pons
  - Somatosensory fibers terminate in spinal nucleus of CN V (VII has no dedicated sensory termination nucleus)
  - Viscerosensory (taste) fibers project to the gustatory nucleus (part of nucleus tractus solitarii)
- Exits at the cerebellopontine angle as two roots (N. facialis, N. intermedius)
- Enters the internal acoustic meatus with CN VIII
- Roots merge in the fundus and enter the facial canal (canalis n. facialis)
- Leaves the skull via the stylomastoid foramen
- Enters the parotid gland and forms the parotid plexus (plexus parotideus)
- Terminal branches radiate to all muscles of facial expression
- ganglion geniculi nervi facialis
  - Located at the sharp bend (geniculum) of the facial canal
  - Contains pseudounipolar sensory neurons of the facial nerve
- Branches:
  - N. petrosus major – From the geniculate ganglion, Through hiatus canalis n. petrosi majoris, Enters the cranial cavity → runs toward foramen lacerum (via sphenopetrosal synchondrosis), Enters the pterygoid canal → reaches the pterygopalatine ganglion
  - R. communicans cum plexu tympanico (parasympathetic fibers)
  - R. stapedius – Motor supply to m. stapedius
  - Chorda tympani – Mixed (parasympathetic + taste), Passes through the middle ear between malleus and incus, Exits via fissura petrotympanica into the infratemporal fossa, Joins n. lingualis → parasympathetic supply to submandibular ganglion, taste fibers back to VII
  - N. auricularis posterior – After exiting the stylomastoid foramen, Ascends behind the auricle
  - R. digastricus
  - R. stylohyoideus
  - Rr. musculares –Terminal motor branches to facial expression muscles from the anterior border of the parotid gland



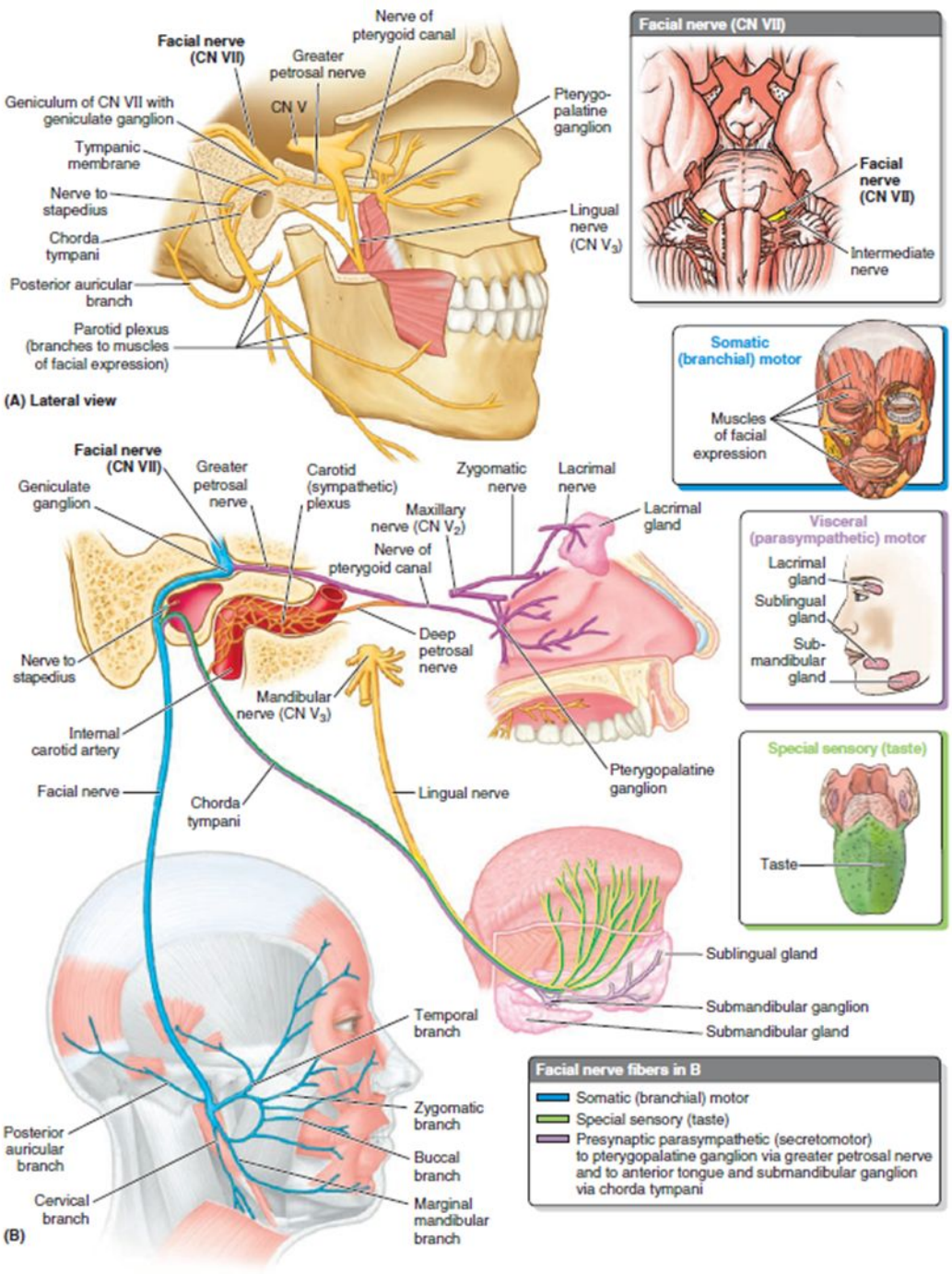
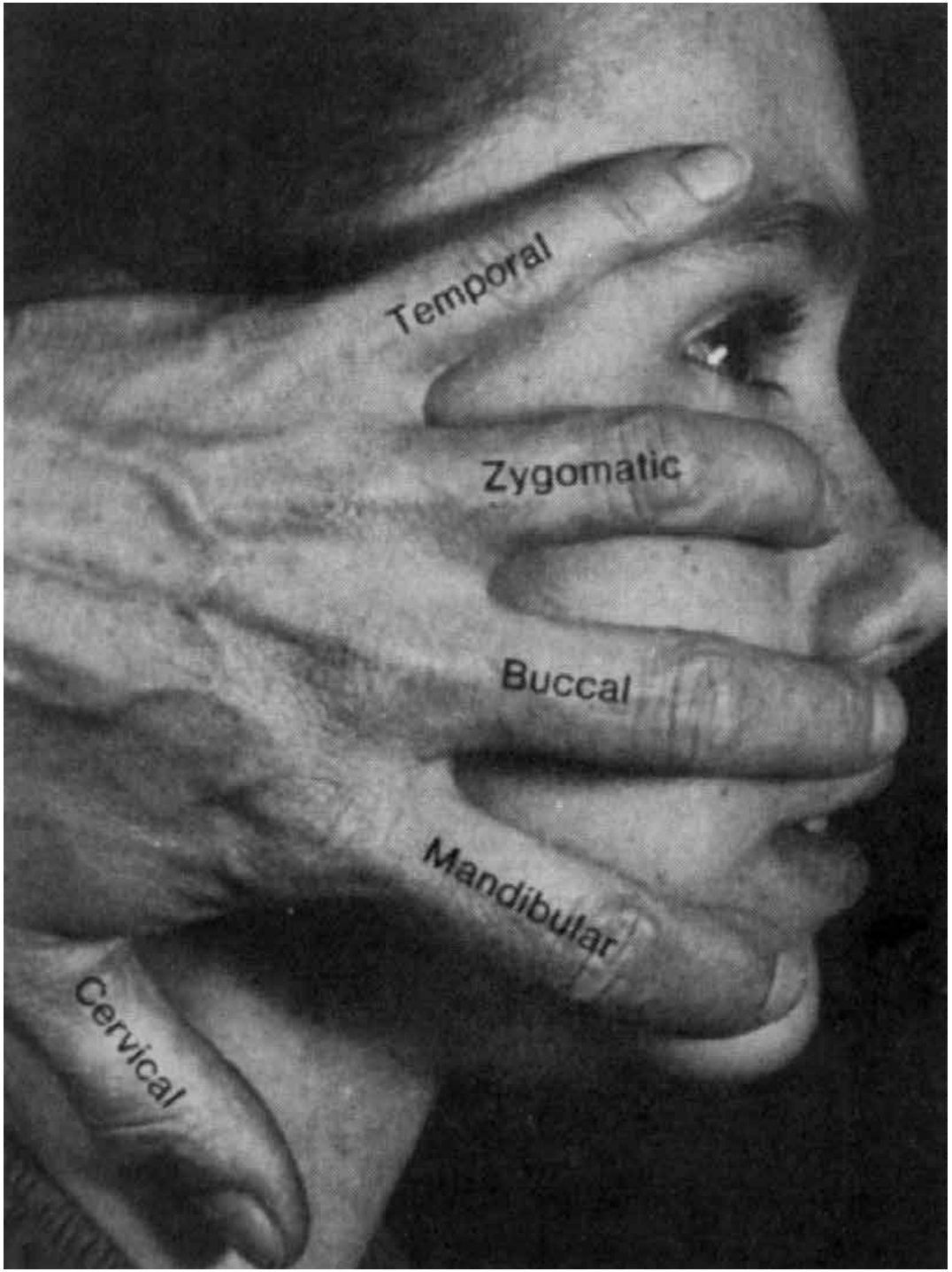
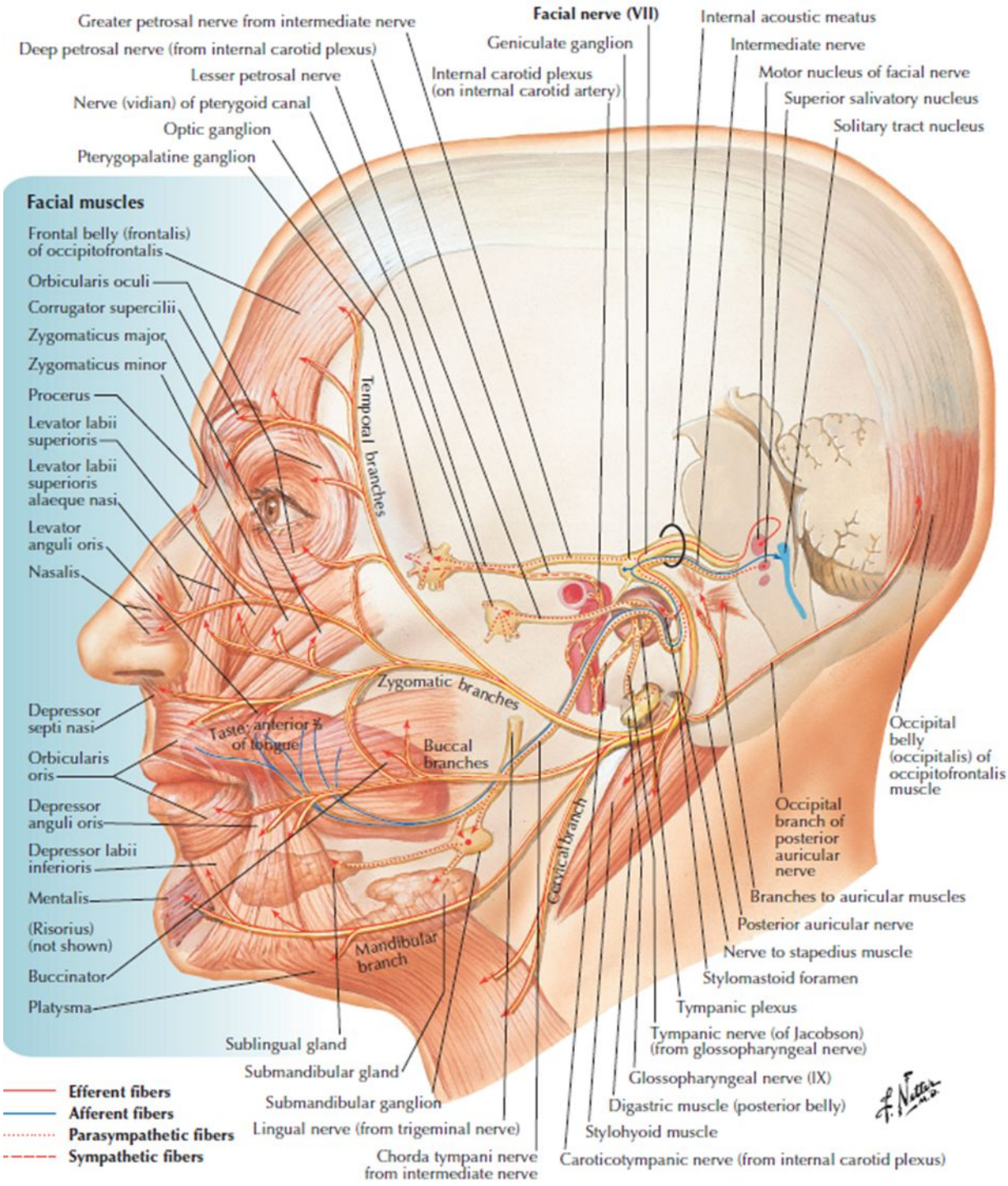


FIGURE 9.11. Distribution of facial nerve (CN VII). A. Facial nerve in situ; intra-osseous course and branches. **B.** Regional distribution of facial nerve.


Temporal
Zygomatic
Buccal
Mandibular
Cervical


Facial muscles
Frontal belly (frontalis) of occipitofrontalis
Orbicularis oculi
Corrugator supercilii
Zygomaticus major
Zygomaticus minor
Procerus
Levator labii superioris
Levator labii superioris alaeque nasi
Levator anguli oris
Nasalis
Depressor septi nasi
Orbicularis oris
Depressor anguli oris
Depressor labii inferioris
Mentalis
(Risorius) (not shown)
Buccinator
Platysma
Greater petrosal nerve from intermediate nerve
Deep petrosal nerve (from internal carotid plexus)
Lesser petrosal nerve
Nerve (vidian) of pterygoid canal
Optic ganglion
Pterygopalatine ganglion
Facial nerve (VII)
Geniculate ganglion
Internal carotid plexus (on internal carotid artery)
Internal acoustic meatus
Intermediate nerve
Motor nucleus of facial nerve
Superior salivatory nucleus
Solitary tract nucleus
Temporal branches
Zygomatic branches
Buccal branches
Taste: anterior ⅔ of tongue
Cervical branch
Occipital belly (occipitalis) of occipitofrontalis muscle
Occipital branch of posterior auricular nerve
Branches to auricular muscles
Posterior auricular nerve
Nerve to stapedius muscle
Stylomastoid foramen
Tympanic plexus
Tympanic nerve (of Jacobson) (from glossopharyngeal nerve)
Glossopharyngeal nerve (IX)
Digastric muscle (posterior belly)
Stylohyoid muscle
Caroticotympanic nerve (from internal carotid plexus)
Mandibular branch
Sublingual gland
Submandibular gland
Submandibular ganglion
Lingual nerve (from trigeminal nerve)
Chorda tympani nerve from intermediate nerve
Efferent fibers
Afferent fibers
Parasympathetic fibers
Sympathetic fibers

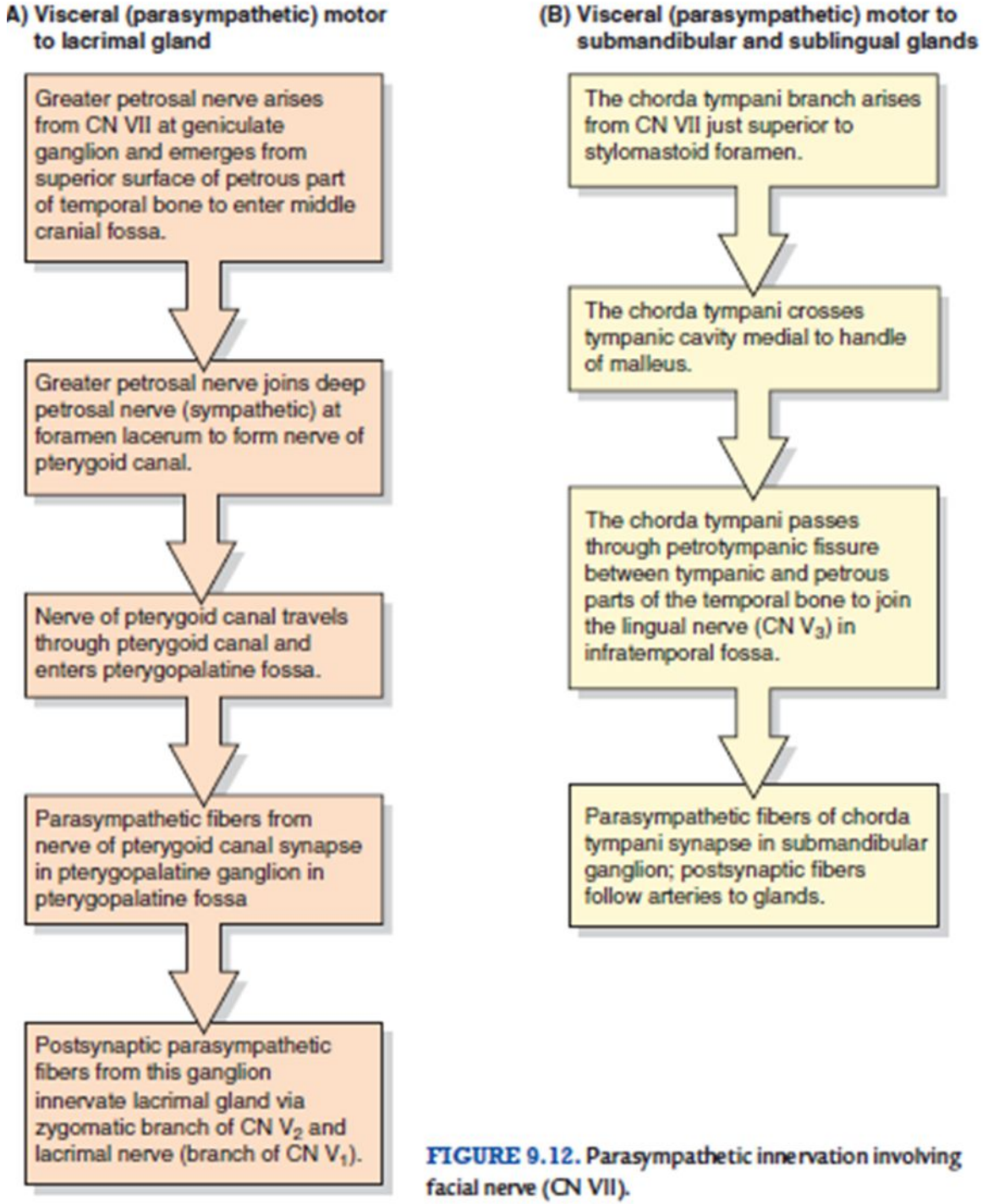
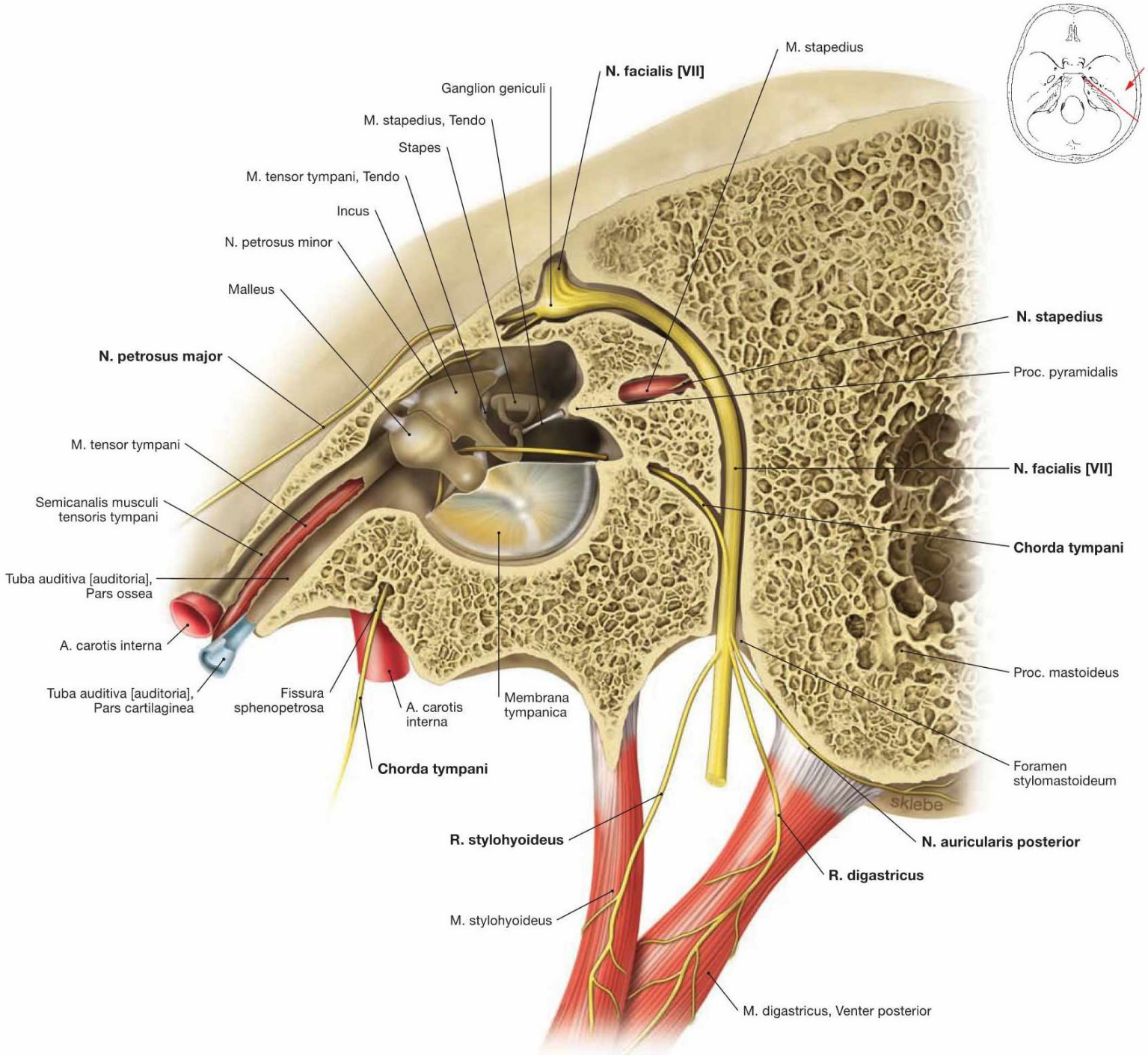


FIGURE 9.12. Parasympathetic innervation involving facial nerve (CN VII).


M. stapedius
N. facialis [VII]
Ganglion geniculi
M. stapedius, Tendo
Stapes
M. tensor tympani, Tendo
Incus
N. petrosus minor
Malleus
N. petrosus major
M. tensor tympani
Semicanalis musculi tensoris tympani
Tuba auditiva [auditoria], Pars ossea
A. carotis interna
Tuba auditiva [auditoria], Pars cartilaginea
Fissura sphenopetrosa
A. carotis interna
Membrana tympanica
Chorda tympani
N. stapedius
Proc. pyramidalis
N. facialis [VII]
Chorda tympani
Proc. mastoideus
Foramen stylomastoideum
N. auricularis posterior
R. digastricus
R. stylohyoideus
M. stylohyoideus
M. digastricus, Venter posterior
sklebe

Frontalis

Orbicularis oris

Mentalis

Depressor anguli oris

Zygomaticus major

Risorius

Corrugator supercilii

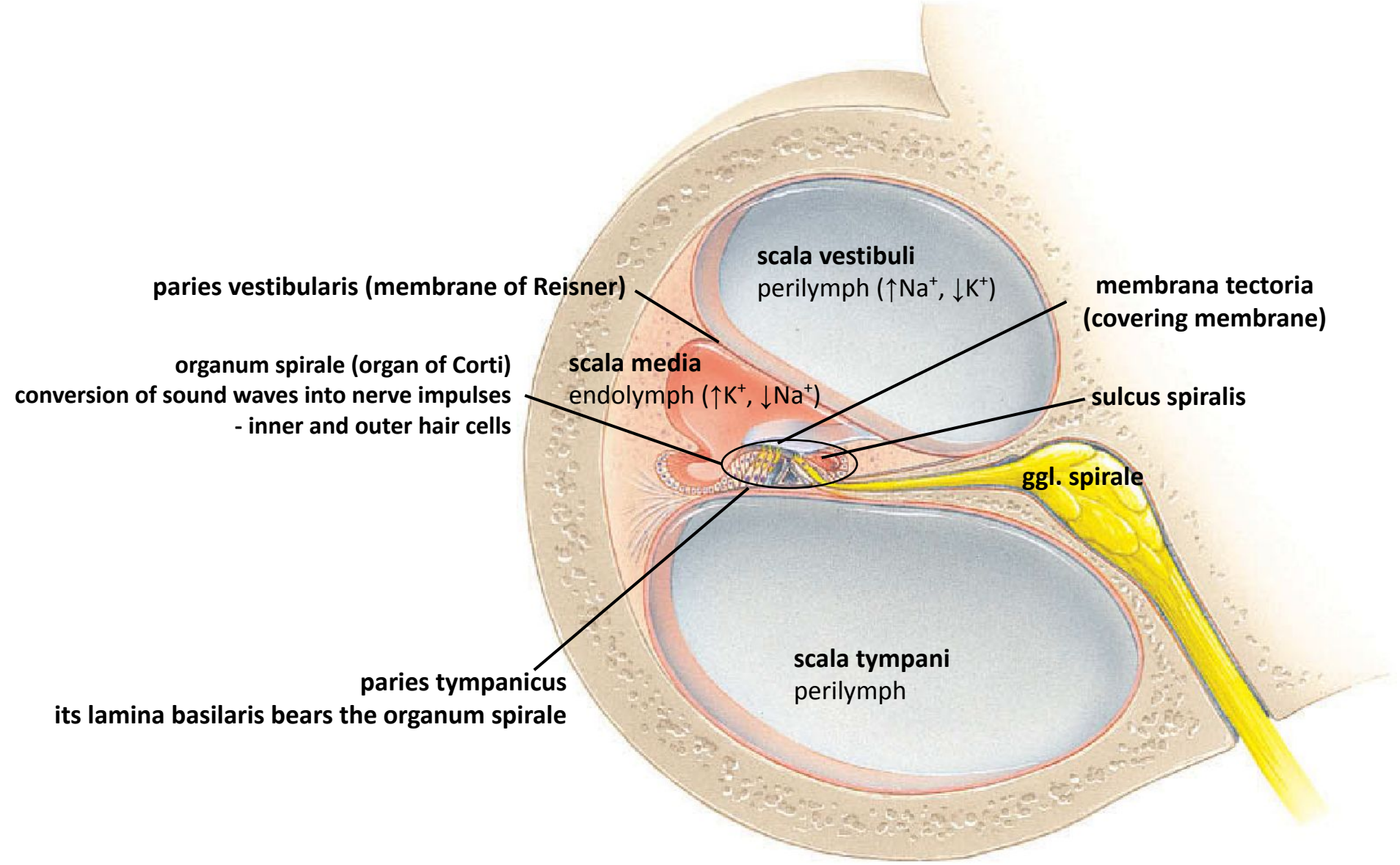
Nasalis

Procerus

N. VESTIBULOCOCHLEARIS (VIII.)

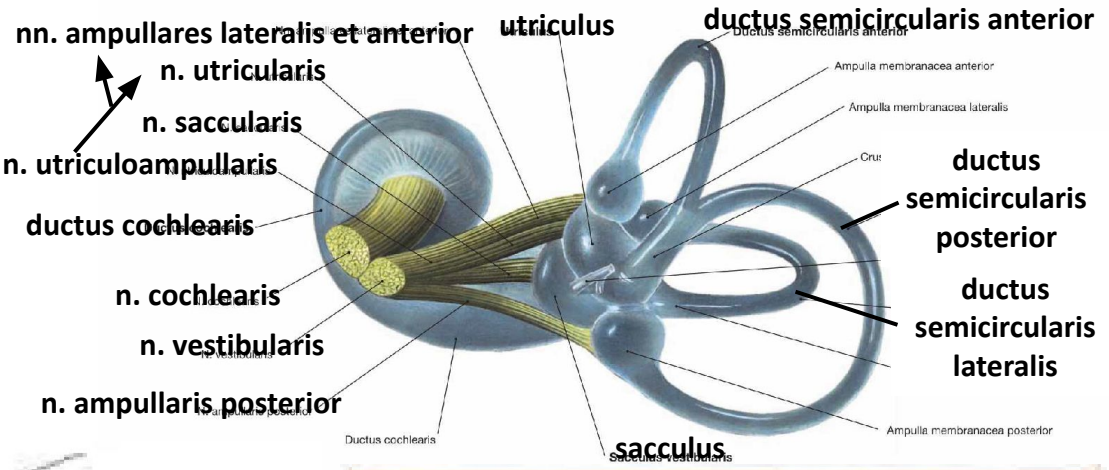
- Nucleus vestibularis medialis, lateralis, cranialis, caudalis (Located beneath the lateral part of the floor of the 4th ventricle)
- Nucleus cochlearis dorsalis et ventralis (Located beneath the tuberculum acusticum on the floor of the 4th ventricle)
- Exits at the cerebellopontine angle, Enters the internal acoustic meatus (meatus acusticus internus), At its fundus, the nerve divides into the vestibular and cochlear parts
- n. vestibularis
    - Dendrites arise from the receptor cells of the membranous labyrinth – Maculae (static linear acceleration); Cristae ampullares (angular acceleration); These sensory inputs travel to the vestibular ganglion (ganglion vestibulare)
- n. cochlearis
    - Dendrites arise from the organ of Corti (organum spirale), Receive signals from inner and outer hair cells, Sensory neurons lie in the cochlear ganglion, perception of sounds
- ganglion vestibulare et cochleare
    - Bipolar neurons; dendrites go to hair cells, axons form the CN VIII
    - ganglion vestibulare located on the floor of the internal acoustic meatus
    - ganglion cochleare located within the bony lamina spiralis of the cochlea

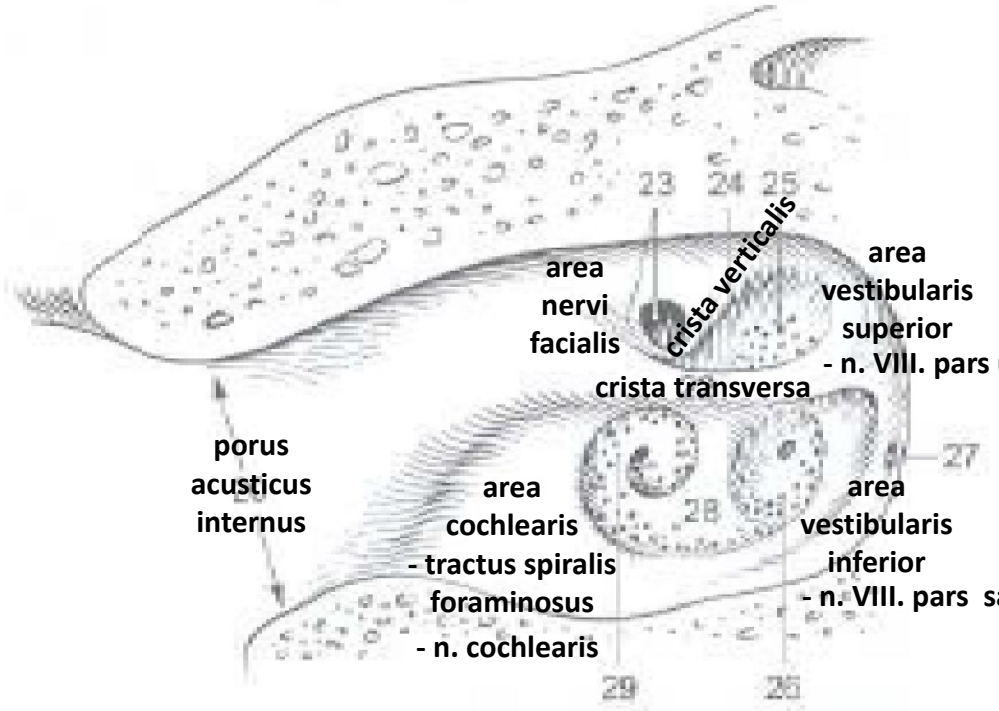
ORGANUM SPIRALE (CORTIHO ORGÁN)

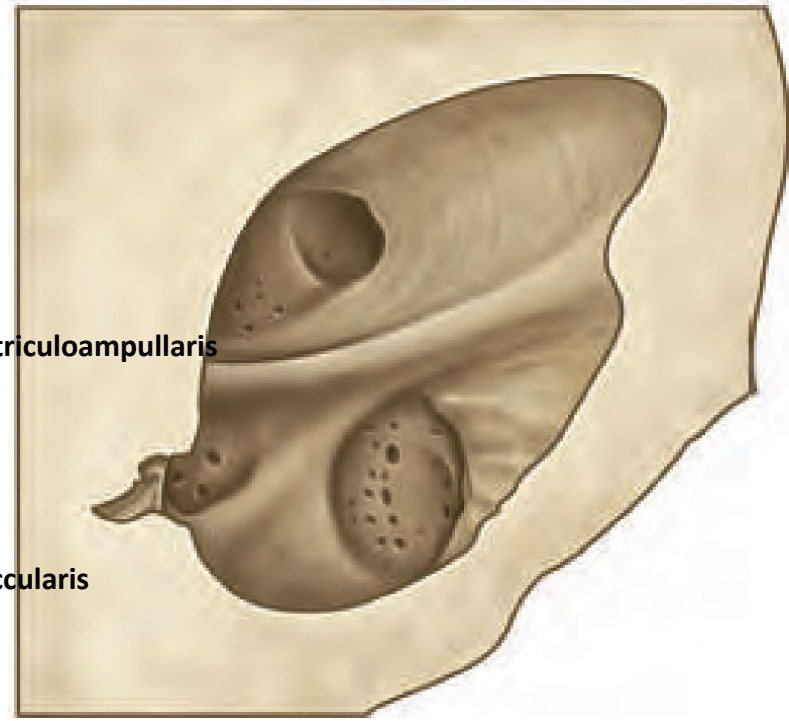


FUNDUS MEATUS ACUSTICI INTERNI

- meatus acusticus internus
  - cca 1 cm
  - n. vestibularis, n. facialis, a. et v. labyrinthi







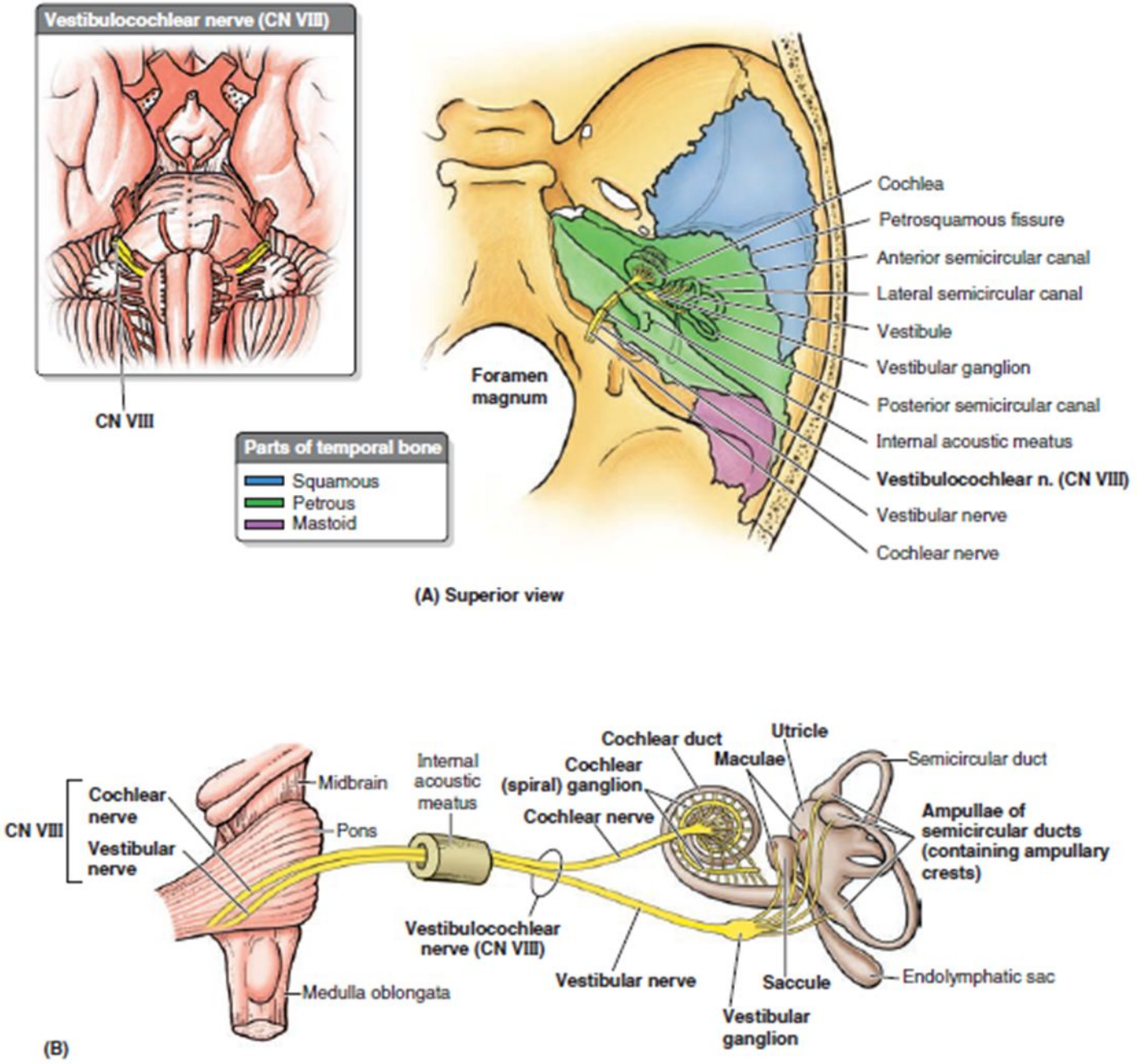
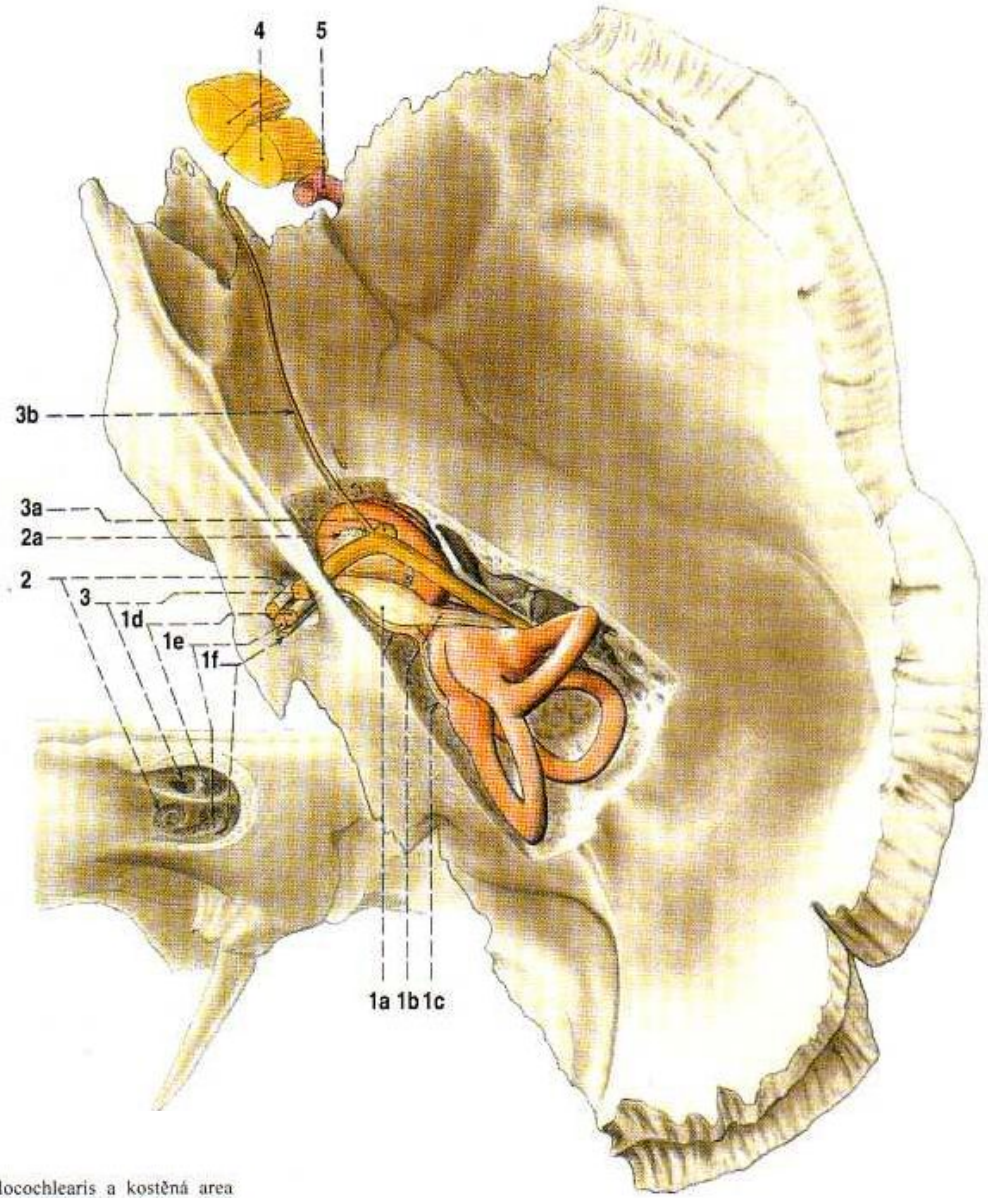


FIGURE 9.13. Distribution of vestibulocochlear nerve (CN VIII). A. Internal surface of cranial base showing the location of the bony labyrinth of the internal ear within the temporal bone and the internal acoustic meatus for CN VIII. **B.** Schematic overview.



Obr. 275. NERVUS VESTIBULOCOCHLEARIS A NERVUS FACIALIS; pohled shora do otevřené pyramidy na vnitroušní labyrint a na jeho nervy; detail kostěného fundus meatus acustici interni (pohled na zadní plochu pyramidy)

1 nervus vestibularis
- 1a ganglion vestibulare – pars superior et inferior

dendrity buněk vestibulárního ganglia, jdoucí od smyslových buněk v maculae staticae a v cristae ampullares:
- 1b n. utriculoampullaris
- 1c n. sacculoris

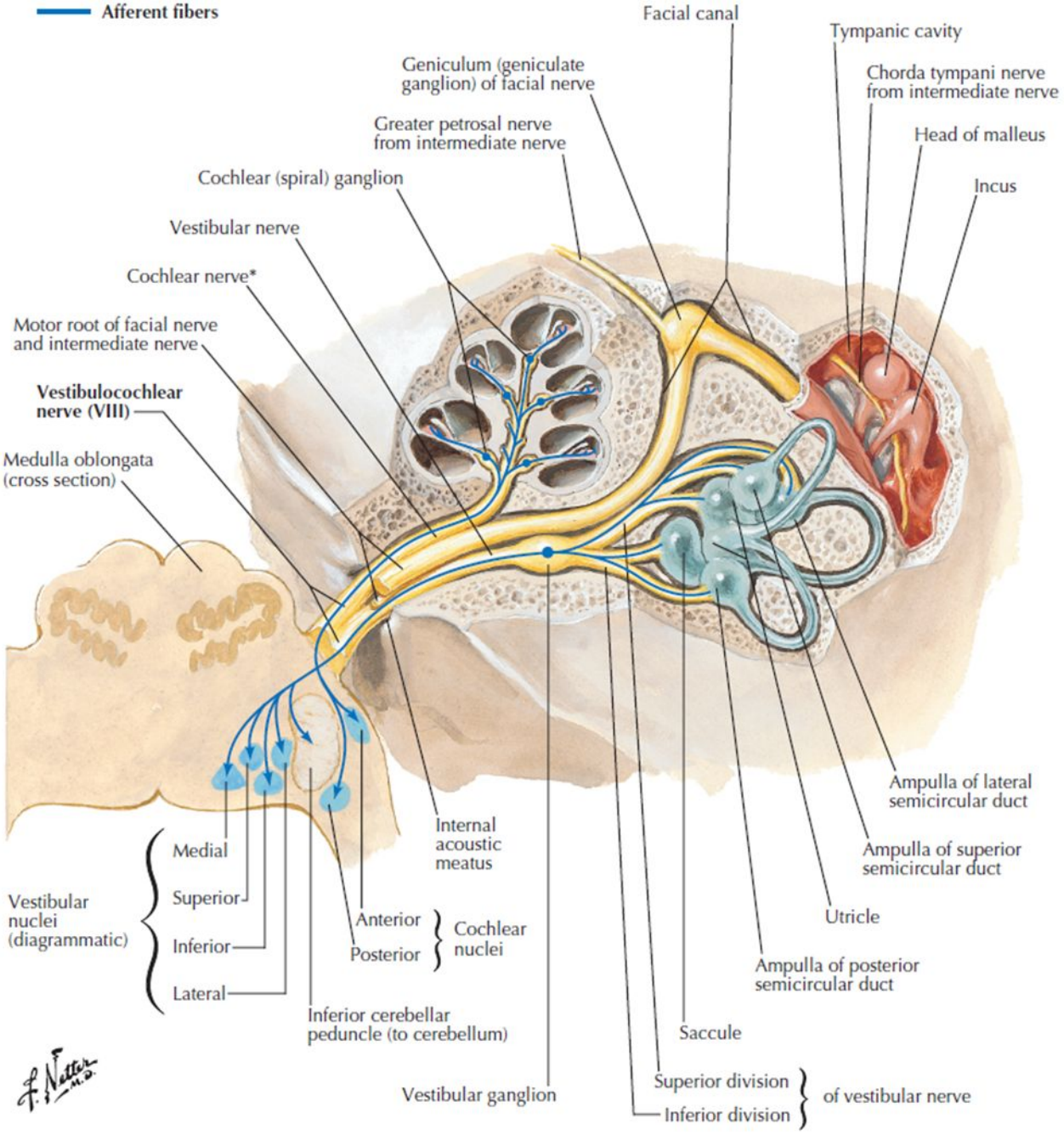
axony buněk vestibulárního ganglia:
- 1d pars utriculoampullaris nervi vestibularis a kostěná area vestibularis superior
- 1e pars sacculoris nervi vestibulocochlearis a kostěná area vestibularis inferior
- 1f n. ampullaris posterior a kostěné foramen singulare

2 n. cochlearis a kostěný tractus spiralis foraminosus
- 2a ganglion cochleare

3 n. facialis a kostěná area nervi facialis
- 3a ganglion geniculi
- 3b n. petrosus major

4 n. mandibularis

5 a. meningea media



*Note: The cochlear nerve also contains efferent fibers to the sensory epithelium. These fibers are derived from the vestibular nerve while in the internal auditory meatus.

LATERAL MIXED SYSTEM

- cranial nerves IX.–XI.
  - emerge as fila radicularia from the lateral margin of the medulla oblongata
  - All contain multiple fiber types (motor, sensory, parasympathetic)
- shared motor nuclei
  - nc. ambiguus – shared by CN IX and X, and gives the cranial root of XI, Located deep within the brainstem, Axons exit lateral to the olive, The most caudal fibers form the cranial root of CN XI, which later rejoins CN X after exiting the skull; Innervates striated muscles – of the pharyngeal arches,larynx, Upper esophagus, Pharyngeal constrictors
  - Dorsal nucleus of the vagus – Preganglionic parasympathetic fibers for CN IX and X, Upper portion merges into nucleus salivatorius inferior (→ parotid gland via CN IX → otic ganglion); myocardium, smooth muscle of trachea, bronchi, esophagus, and GIT organs
- mother cells of the sensory fibers
  - Ganglion superius & inferius of CN IX and CN X
  - pseudounipolar neurons
  - solitary nucleus– Lateral to the dorsal motor nucleus, Extends into the upper cervical spinal cord, Cranial portion = gustatory nucleus; viscerosensory input from Larynx, pharynx, Heart, lungs, GIT, Baroreceptors, chemoreceptors
  - spinal trigeminal nucleus – somatosensory input from auricle and external acoustic meatus, posterior third of tongue, palatine tonsil, soft palate
  - CN XI – motor fibers only!

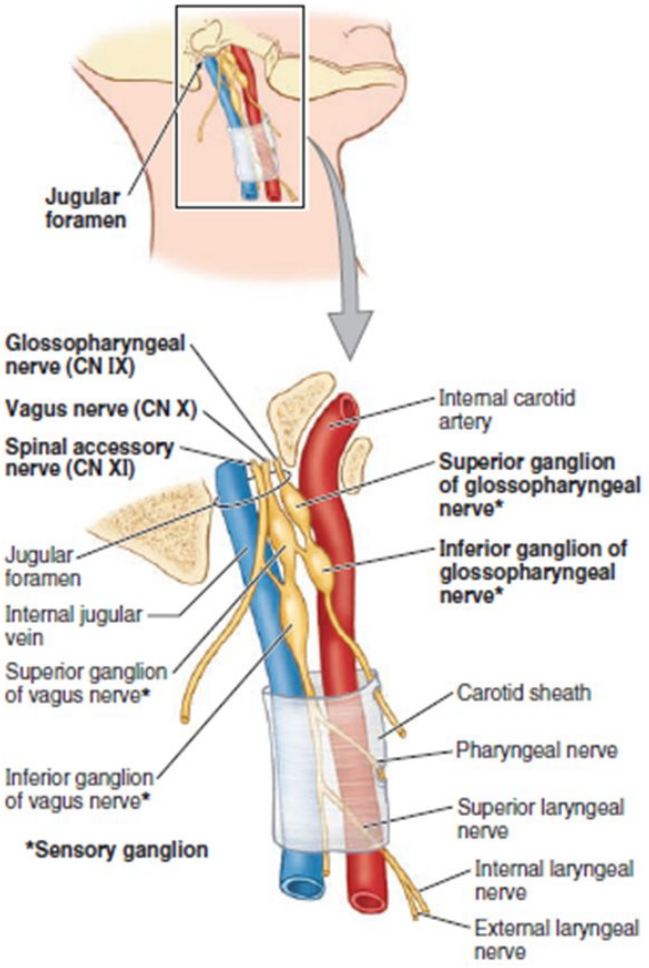
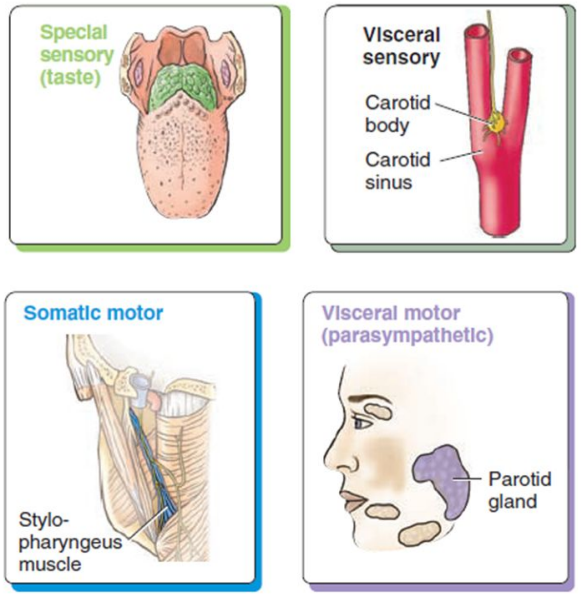
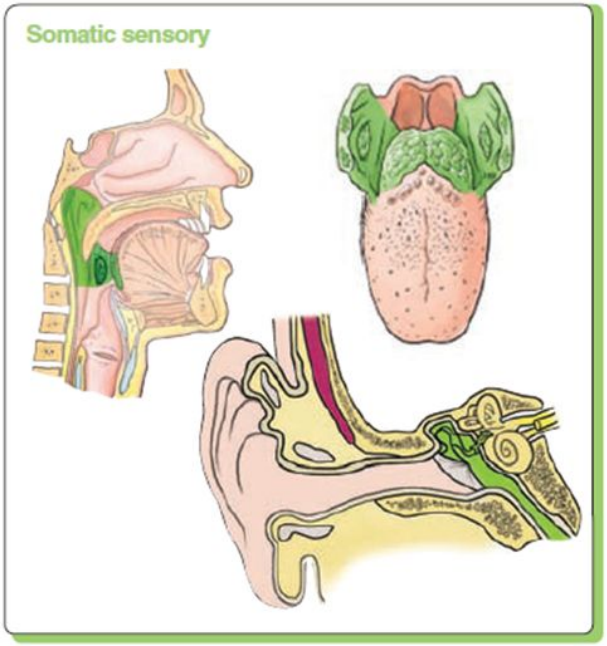


FIGURE 9.15. Relationship of structures traversing jugular foramen. CN IX, CN X, and CN XI are in numerical order, anterior to the internal jugular vein.

N. GLOSOPHARYNGEUS (IX.)

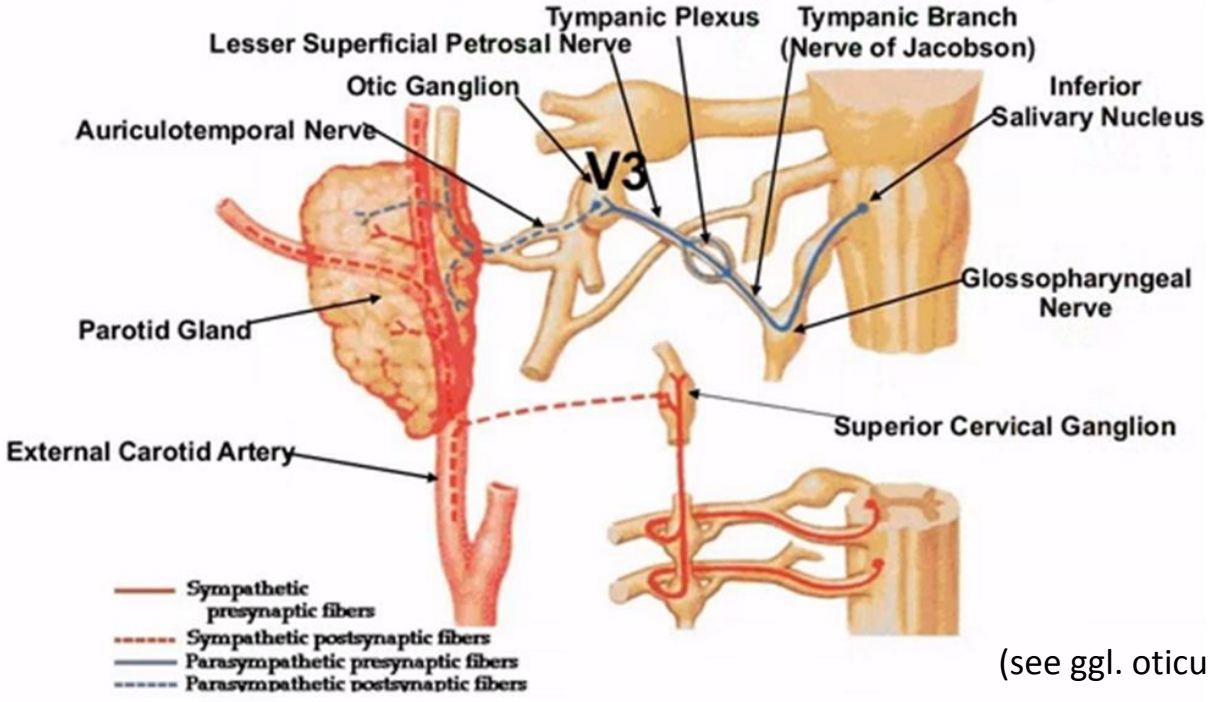
- Exits the medulla lateral to the olive, travels in the subarachnoid space toward the jugular foramen
- After exiting the skull, descends anterior to the internal jugular vein and internal carotid artery, medial to the styloid process
- Continues along m. stylopharyngeus toward the tongue root
- Ganglion superius and ganglion inferius
    - Located at the jugular foramen, Contain sensory neurons
- sensory innervation
    - Pharynx, Palatine tonsils, Posterior third of the tongue, Middle ear cavity and the auditory tube (Eustachian tube)
- motor innervation
    - Muscles of the soft palate and upper pharynx, Important for swallowing



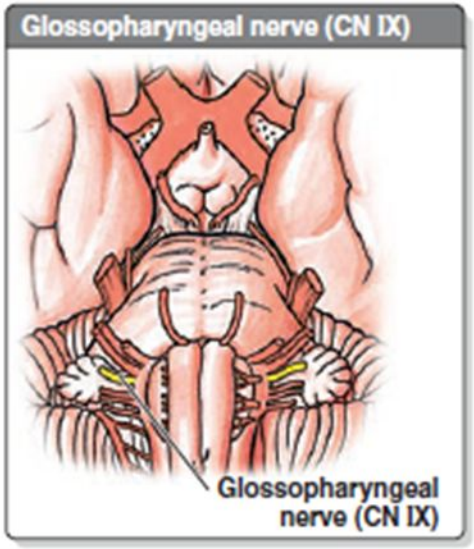


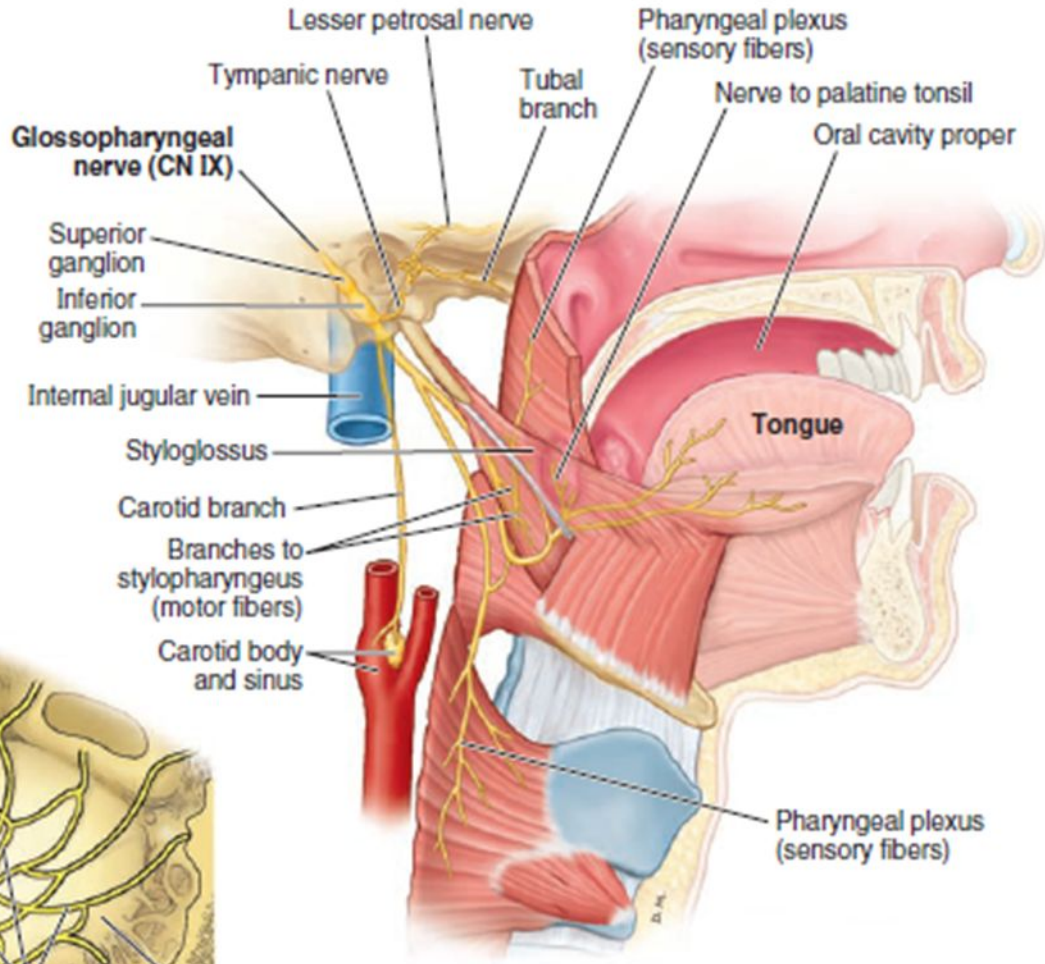
N. GLOSOPHARYNGEUS (IX.)

- branches:
  - n. tympanicus – Arises below the inferior ganglion, Enters the fossula petrosa → canaliculus tympanicus → middle ear cavity, Forms the tympanic plexus, Sensory fibers to the middle ear mucosa, Parasympathetic fibers continue as n. petrosus minor, passing through foramen ovale to the otic ganglion → parotid gland
  - R. communicans cum ramo auriculari nervi vagi
  - R. communicans cum trunco sympathico – Sympathetic connection from the superior cervical ganglion between IX and X
  - R. stylopharyngeus – Motor branch to m. stylopharyngeus
  - Rr. pharyngei – Enter the pharyngeal plexus, Connections with CN X and sympathetic fibers
  - R. sinus carotici – Descends along the internal carotid artery, Sensory fibers to the carotid sinus (baroreceptors) and carotid body (chemoreceptors)
  - Rr. tonsillares – To the tonsillar plexus on the outer surface of palatine tonsils
  - Rr. linguales – Sensory (touch + taste) to the posterior one-third of the tongue



(see ggl. oticum)





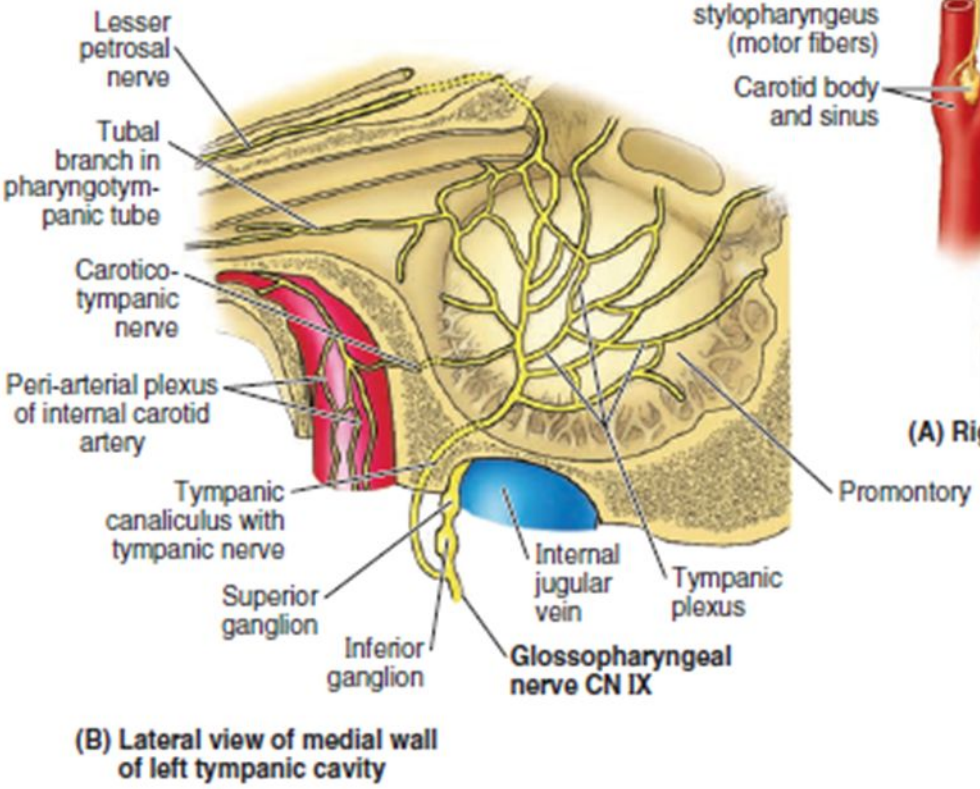
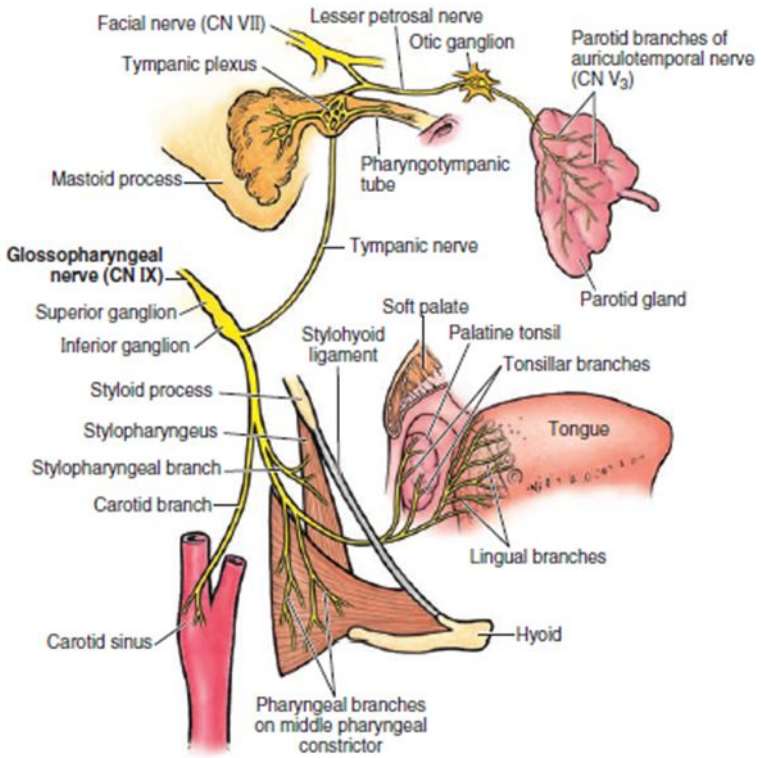
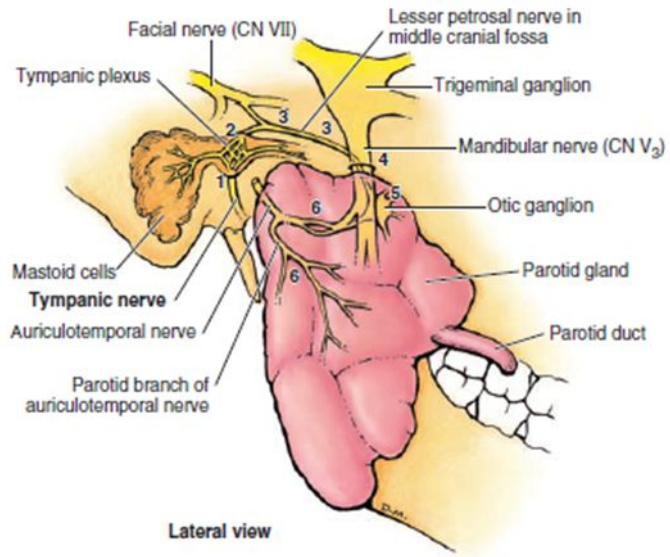


FIGURE 9.14. Distribution of glossopharyngeal nerve (CN IX). A. Pharynx. B. Middle ear (tympanic cavity and pharyngotympanic tube).





Visceral (parasympathetic) motor

Tympanic nerve arises from CN IX and emerges with it from jugular foramen.

1 Tympanic nerve enters middle ear via the tympanic canaliculus in petrous part of temporal bone.

2 Tympanic nerve forms tympanic plexus on promontory of middle ear.

3 Lesser petrosal nerve arises as a branch of tympanic plexus.

3 Lesser petrosal nerve penetrates roof of tympanic cavity (tegmen tympani) to enter middle cranial fossa.

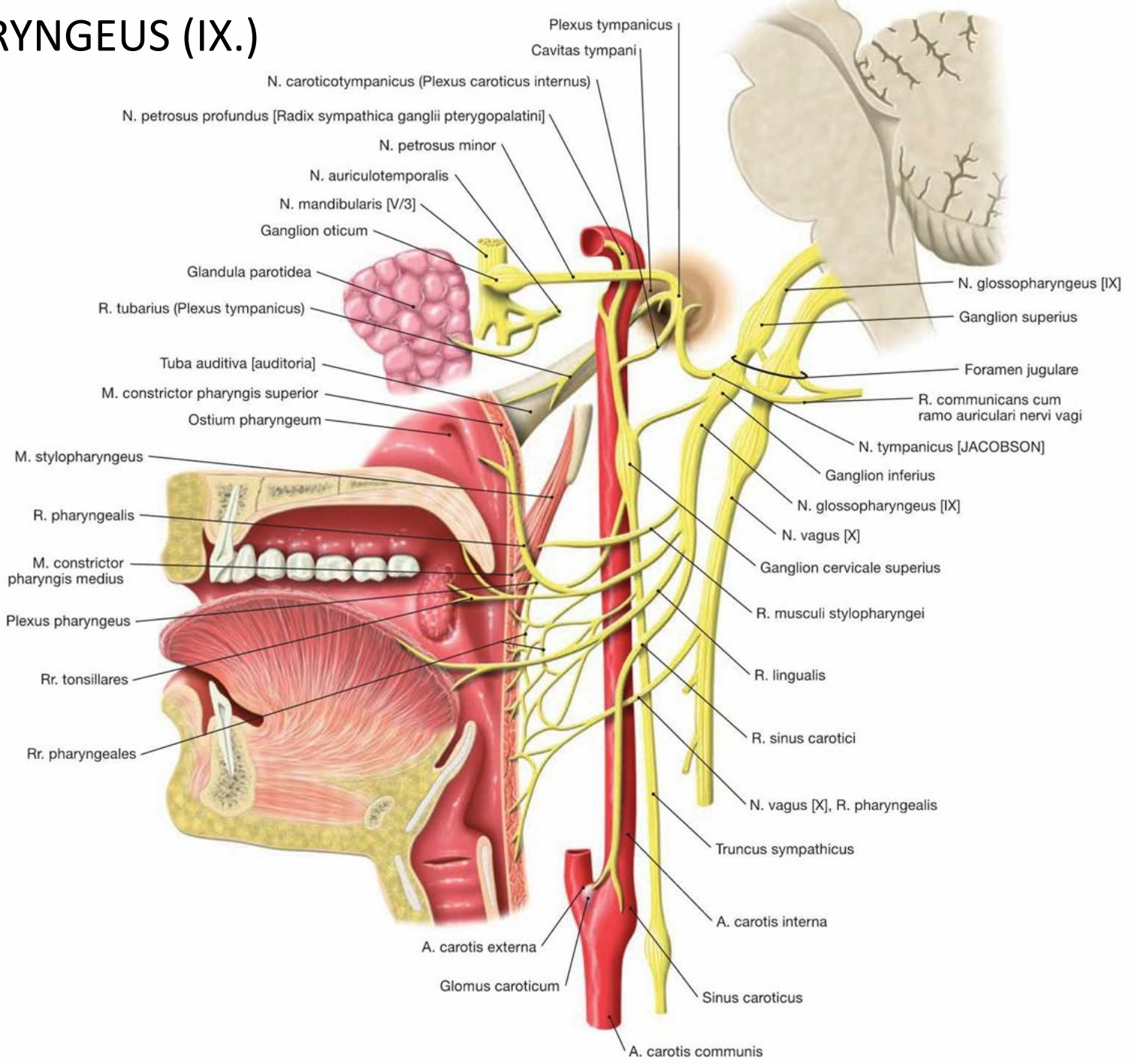
4 Lesser petrosal nerve leaves cranium through foramen ovale.

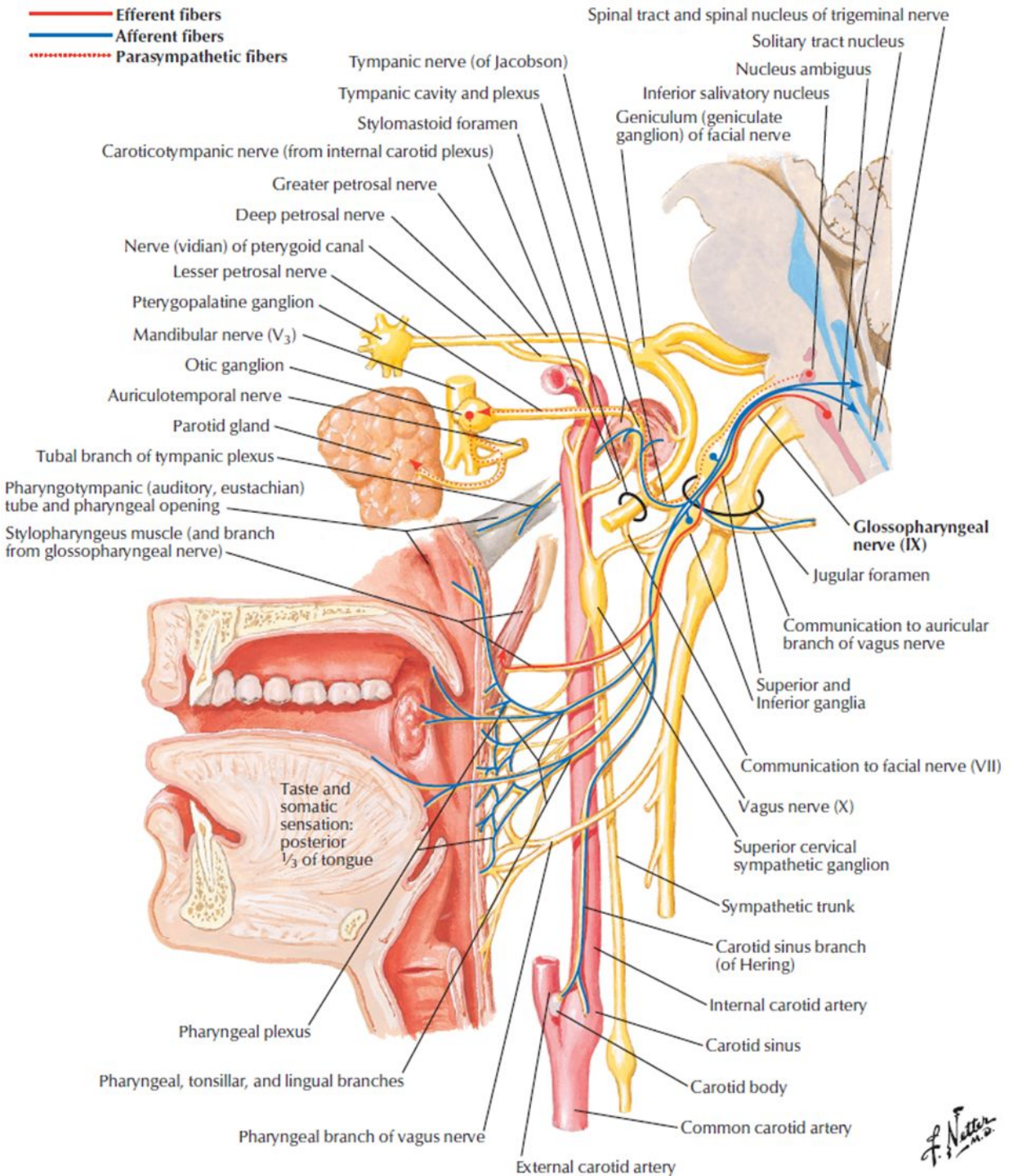
5 Parasympathetic fibers synapse in otic ganglion.

6 Postsynaptic fibers pass to parotid gland via branches of auriculotemporal nerve (CN V_3).

FIGURE 9.16. Parasympathetic innervation of parotid gland involving glossopharyngeal nerve (CN IX).

N. GLOSOPHARYNGEUS (IX.)




Efferent fibers
Afferent fibers
Parasympathetic fibers
Spinal tract and spinal nucleus of trigeminal nerve
Solitary tract nucleus
Nucleus ambiguus
Inferior salivatory nucleus
Geniculum (geniculate ganglion) of facial nerve
Tympanic nerve (of Jacobson)
Tympanic cavity and plexus
Stylomastoid foramen
Caroticotympanic nerve (from internal carotid plexus)
Greater petrosal nerve
Deep petrosal nerve
Nerve (vidian) of pterygoid canal
Lesser petrosal nerve
Pterygopalatine ganglion
Mandibular nerve (V_3)
Otic ganglion
Auriculotemporal nerve
Parotid gland
Tubal branch of tympanic plexus
Pharyngotympanic (auditory, eustachian) tube and pharyngeal opening
Stylopharyngeus muscle (and branch from glossopharyngeal nerve)
Glossopharyngeal nerve (IX)
Jugular foramen
Communication to auricular branch of vagus nerve
Superior and Inferior ganglia
Communication to facial nerve (VII)
Vagus nerve (X)
Superior cervical sympathetic ganglion
Sympathetic trunk
Carotid sinus branch (of Hering)
Internal carotid artery
Carotid sinus
Carotid body
Common carotid artery
External carotid artery
Taste and somatic sensation: posterior 1/3 of tongue
Pharyngeal plexus
Pharyngeal, tonsillar, and lingual branches
Pharyngeal branch of vagus nerve

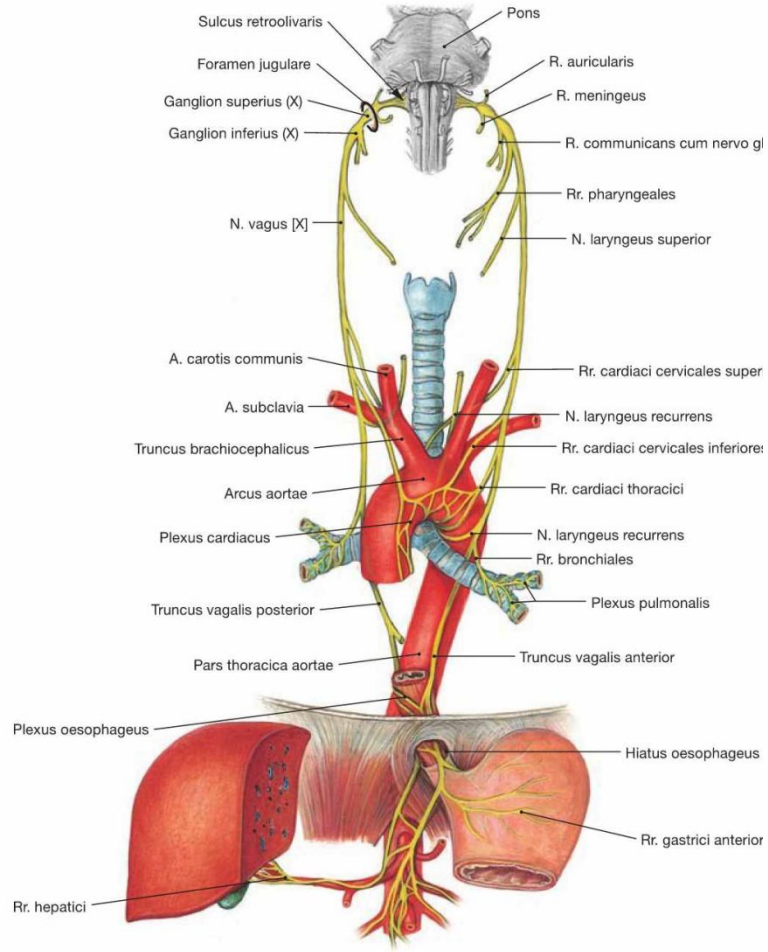
N. VAGUS (X.)

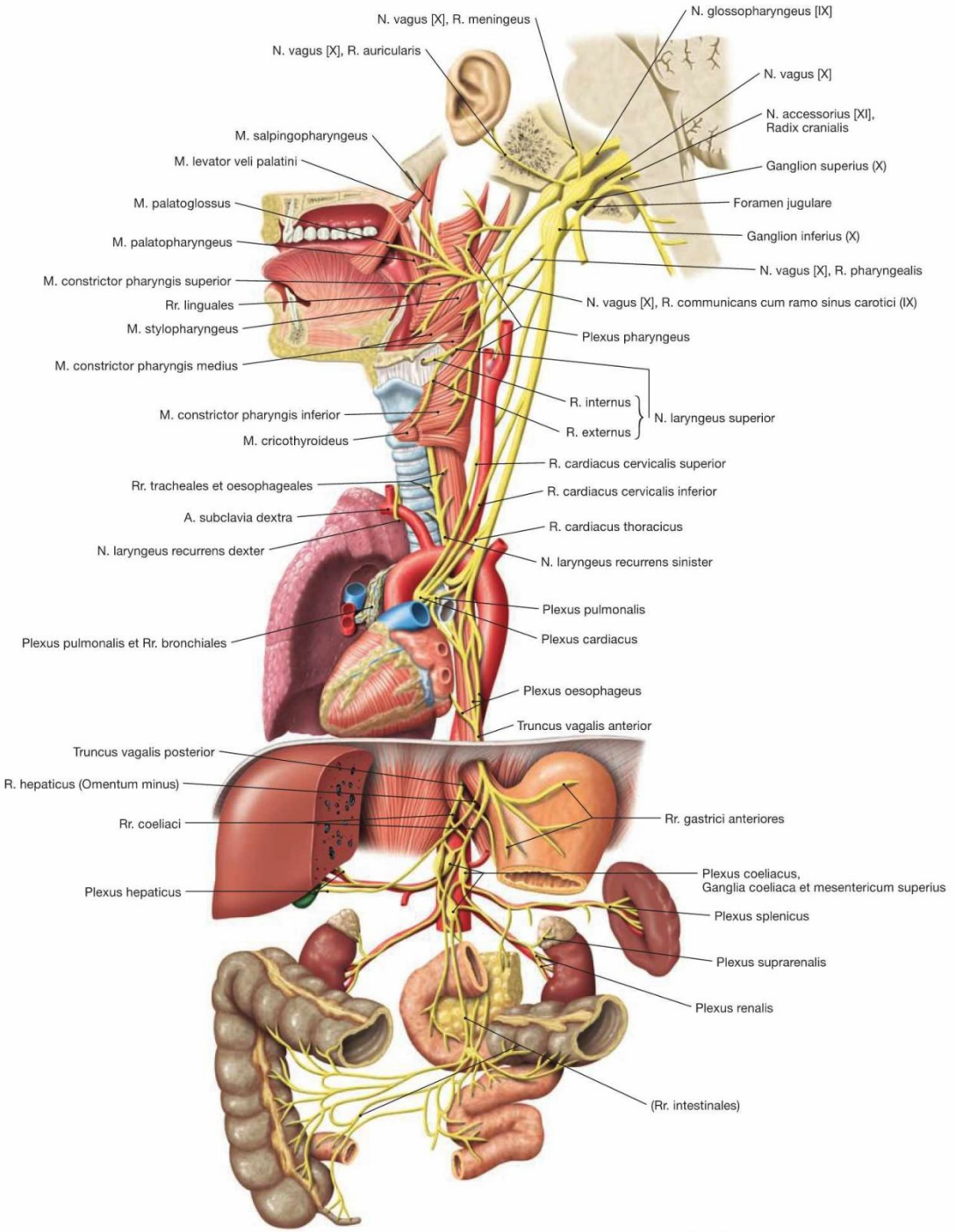
- Contains primarily **viscerosensory** fibers (From thoracic and abdominal organs, Chemoreceptors and baroreceptors in the aortic arch
- Also contains **somatomotor** fibers → striated muscles of the larynx, soft palate, and upper esophagus, **Visceromotor** (parasympathetic) fibers → preganglionic fibers synapsing in organ ganglia, **Somatosensory** fibers → skin of the external acoustic meatus and auricle, **Special sensory** fibers (taste) → epiglottis and base of the
- Exits the medulla lateral to the olive, Passes through the jugular foramen (Here lies the superior ganglion, sensory neurons for r. auricularis)
- Descends anterior to the internal jugular vein and lateral to CN XII and the superior cervical sympathetic ganglion, Here lies the inferior ganglion (viscerosensory neurons)
- Cervical region – Courses in the carotid sheath between the internal jugular vein and the carotid arteries
- Thoracic region – Right vagus: anterior to the subclavian artery; Left vagus: anterior to the aortic arch, Both pass posterior to the lung roots, forming the esophageal plexus, Exchange fibers → forming: Anterior vagal trunk (mostly from left vagus) and Posterior vagal trunk (mostly from right vagus)
- Abdominal region (via esophageal hiatus)
    - Anterior vagal trunk – Enters omentum minus, sends R. hepaticus → liver, Rami gastrici anteriores → anterior stomach wall, Contributes to the coeliac plexus
    - Posterior vagal trunk – Branches into Rami gastrici posteriores → posterior stomach wall and R. coeliacus → coeliac plexus

N. VAGUS (X.)

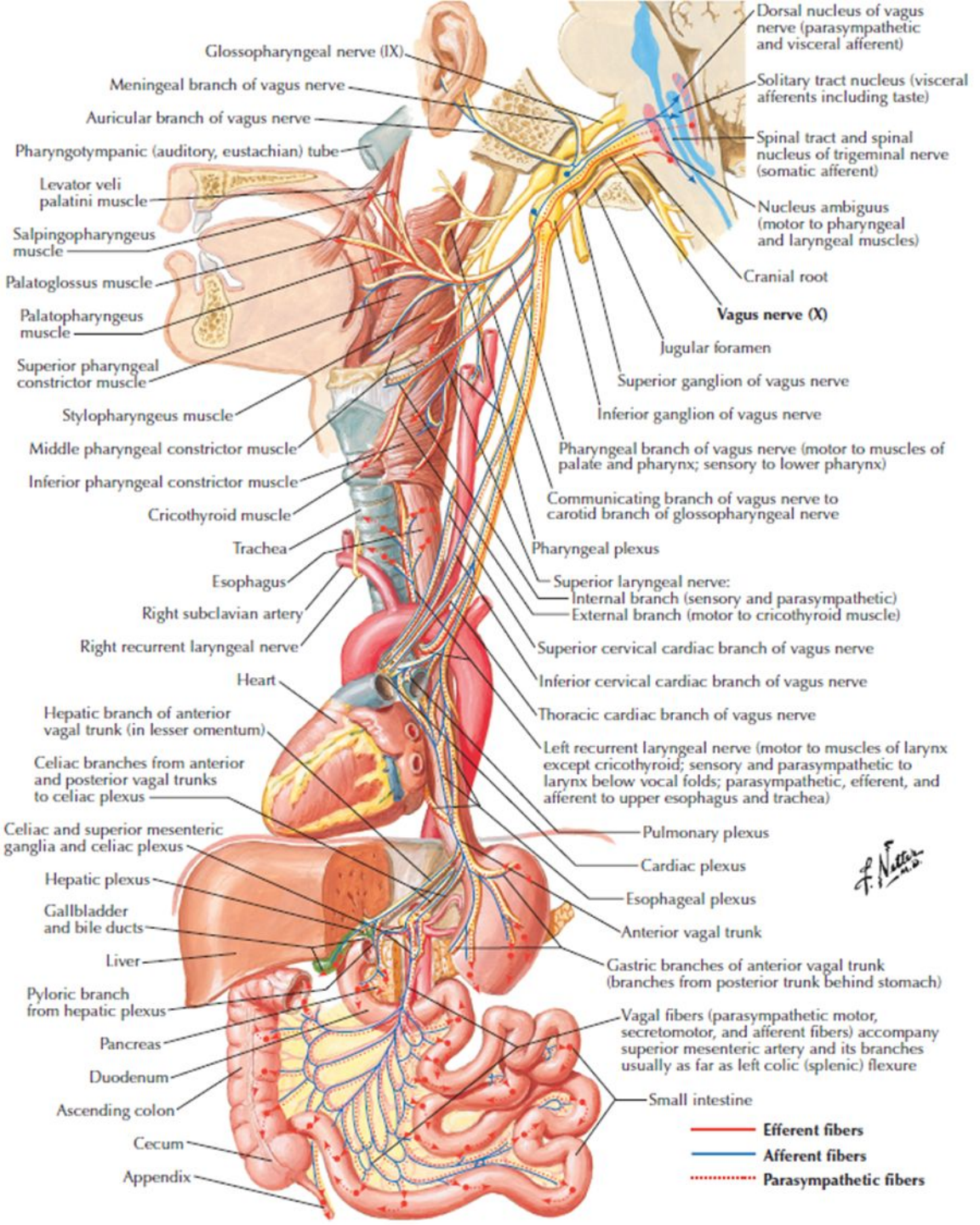
- Vagus nerve fibers emerge from the celiac plexus along with sympathetic fibers and run alongside blood vessels in the periarterial plexuses toward the organs of the abdominal cavity
- From the superior ganglion
    - R. meningeus – Sensory innervation of dura mater of the posterior cranial fossa
    - R. auricularis – Courses through the mastoid canaliculus to the fissura tympanomastoidea
- From the inferior ganglion
    - Rr. pharyngei – Motor branches to the pharynx, Form the pharyngeal plexus (with CN IX and sympathetic fibers)
    - R. glomi carotici – To the carotid body (chemoreception)
    - N. laryngeus superior – Runs toward the greater horn of the hyoid, Receives sympathetic fibers from superior cervical ganglion, Divides into R. externus — motor to m. cricothyroideus, and R. internus — sensory above the vocal folds
- N. laryngeus recurrens – Originates in the upper mediastinum, Right: loops under a. subclavia, Left: loops under aortic arch; Ascends along the trachea back to the neck, Final somatomotor branch before the vagus becomes mostly visceral, Continues as n. laryngeus inferior
- Rr. cardiaci – To cardiac plexuses (superior and deep), ending in cardiac ganglia
- Rr. bronchiales
- Rr. pulmonales
- Rr. oesophagei → form plexus oesophageus
- Rr. gastrici ant. et post.
- Abdominal branches via coeliac plexus – Visceral innervation (parasympathetic) of Liver (rr. hepatici), Pancreas (rr. pancreatici), Spleen (rr. lienales), Kidneys (rr. renales), Adrenal glands (rr. suprarenales), Intestines (rr. intestinales)
- The vagal parasympathetic territory ends at the left colic flexure (Cannon–Boehm point).

N. VAGUS (X.)


Sulcus retroolivaris
Pons
Foramen jugulare
R. auricularis
Ganglion superius (X)
R. meningeus
Ganglion inferius (X)
R. communicans cum nervo gl
Rr. pharyngeales
N. vagus [X]
N. laryngeus superior
A. carotis communis
Rr. cardiaci cervicales super
A. subclavia
N. laryngeus recurrens
Truncus brachiocephalicus
Rr. cardiaci cervicales inferiores
Arcus aortae
Rr. cardiaci thoracici
Plexus cardiacus
N. laryngeus recurrens
Rr. bronchiales
Truncus vagalis posterior
Plexus pulmonalis
Pars thoracica aortae
Truncus vagalis anterior
Plexus oesophageus
Hiatus oesophageus
Rr. gastrici anterior
Rr. hepatici


N. vagus [X], R. meningeus
N. glossopharyngeus [IX]
N. vagus [X], R. auricularis
N. vagus [X]
N. accessorius [XI], Radix cranialis
M. salpingopharyngeus
M. levator veli palatini
Ganglion superius (X)
M. palatoglossus
Foramen jugulare
M. palatopharyngeus
Ganglion inferius (X)
N. vagus [X], R. pharyngealis
M. constrictor pharyngis superior
N. vagus [X], R. communicans cum ramo sinus carotici (IX)
Rr. linguales
M. stylopharyngeus
Plexus pharyngeus
M. constrictor pharyngis medius
R. internus
N. laryngeus superior
M. constrictor pharyngis inferior
R. externus
M. cricothyroideus
R. cardiacus cervicalis superior
Rr. tracheales et oesophageales
R. cardiacus cervicalis inferior
A. subclavia dextra
R. cardiacus thoracicus
N. laryngeus recurrens dexter
N. laryngeus recurrens sinister
Plexus pulmonalis
Plexus pulmonalis et Rr. bronchiales
Plexus cardiacus
Plexus oesophageus
Truncus vagalis anterior
Truncus vagalis posterior
R. hepaticus (Omentum minus)
Rr. gastrici anteriores
Rr. coeliaci
Plexus coeliacus, Ganglia coeliaca et mesentericum superius
Plexus hepaticus
Plexus splenicus
Plexus suprarenalis
Plexus renalis
(Rr. intestinales)

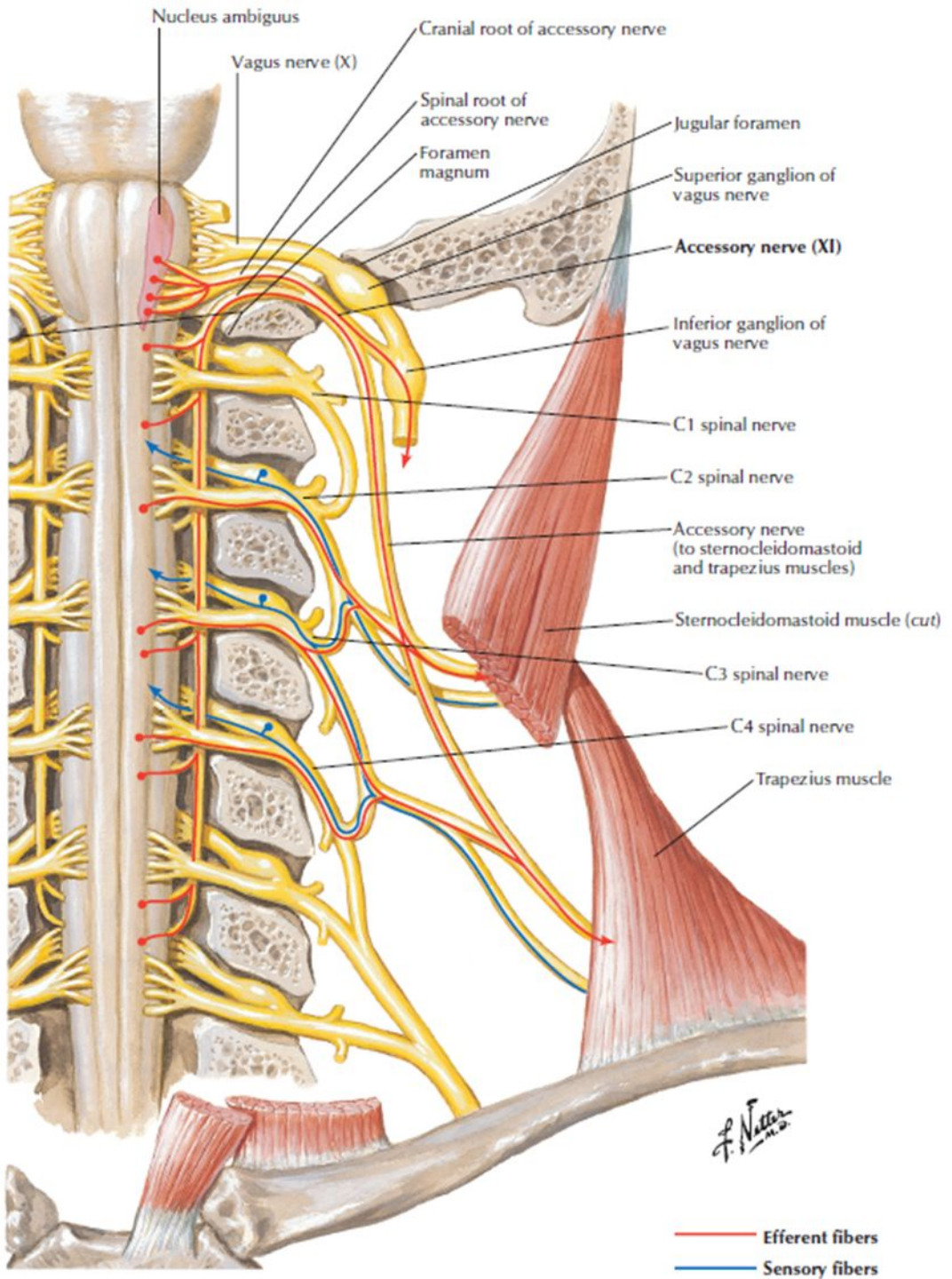
N. VAGUS (X.)


Glossopharyngeal nerve (IX)
Meningeal branch of vagus nerve
Auricular branch of vagus nerve
Pharyngotympanic (auditory, eustachian) tube
Levator veli palatini muscle
Salpingopharyngeus muscle
Palatoglossus muscle
Palatopharyngeus muscle
Superior pharyngeal constrictor muscle
Stylopharyngeus muscle
Middle pharyngeal constrictor muscle
Inferior pharyngeal constrictor muscle
Cricothyroid muscle
Trachea
Esophagus
Right subclavian artery
Right recurrent laryngeal nerve
Heart
Hepatic branch of anterior vagal trunk (in lesser omentum)
Celiac branches from anterior and posterior vagal trunks to celiac plexus
Celiac and superior mesenteric ganglia and celiac plexus
Hepatic plexus
Gallbladder and bile ducts
Liver
Pyloric branch from hepatic plexus
Pancreas
Duodenum
Ascending colon
Cecum
Appendix
Dorsal nucleus of vagus nerve (parasympathetic and visceral afferent)
Solitary tract nucleus (visceral afferents including taste)
Spinal tract and spinal nucleus of trigeminal nerve (somatic afferent)
Nucleus ambiguus (motor to pharyngeal and laryngeal muscles)
Cranial root
Vagus nerve (X)
Jugular foramen
Superior ganglion of vagus nerve
Inferior ganglion of vagus nerve
Pharyngeal branch of vagus nerve (motor to muscles of palate and pharynx; sensory to lower pharynx)
Communicating branch of vagus nerve to carotid branch of glossopharyngeal nerve
Pharyngeal plexus
Superior laryngeal nerve:
Internal branch (sensory and parasympathetic)
External branch (motor to cricothyroid muscle)
Superior cervical cardiac branch of vagus nerve
Inferior cervical cardiac branch of vagus nerve
Thoracic cardiac branch of vagus nerve
Left recurrent laryngeal nerve (motor to muscles of larynx except cricothyroid; sensory and parasympathetic to larynx below vocal folds; parasympathetic, efferent, and afferent to upper esophagus and trachea)
Pulmonary plexus
Cardiac plexus
Esophageal plexus
Anterior vagal trunk
Gastric branches of anterior vagal trunk (branches from posterior trunk behind stomach)
Vagal fibers (parasympathetic motor, secretomotor, and afferent fibers) accompany superior mesenteric artery and its branches usually as far as left colic (splenic) flexure
Small intestine
Efferent fibers
Afferent fibers
Parasympathetic fibers

N. ACCESORIUS (XI.)

- Cranial root (nucleus ambiguus), Spinal root (spinal cord segments C1–C6)
- Both roots join and exit through the jugular foramen, then iImmediately split into
- Ramus internus – Joins the vagus nerve, Contributes to the recurrent laryngeal nerve, Motor supply to soft palate and laryngeal muscles
- Ramus externus – Continues as the main accessory nerve, descends laterally and anteriorly to the transverse process of the atlas, Enters the deep surface of m. sternocleidomastoideus, Continues beneath m. trapezius, Divides into muscular branches (rr. musculares)
- Motor innervation of M. sternocleidomastoideus and M. trapezius

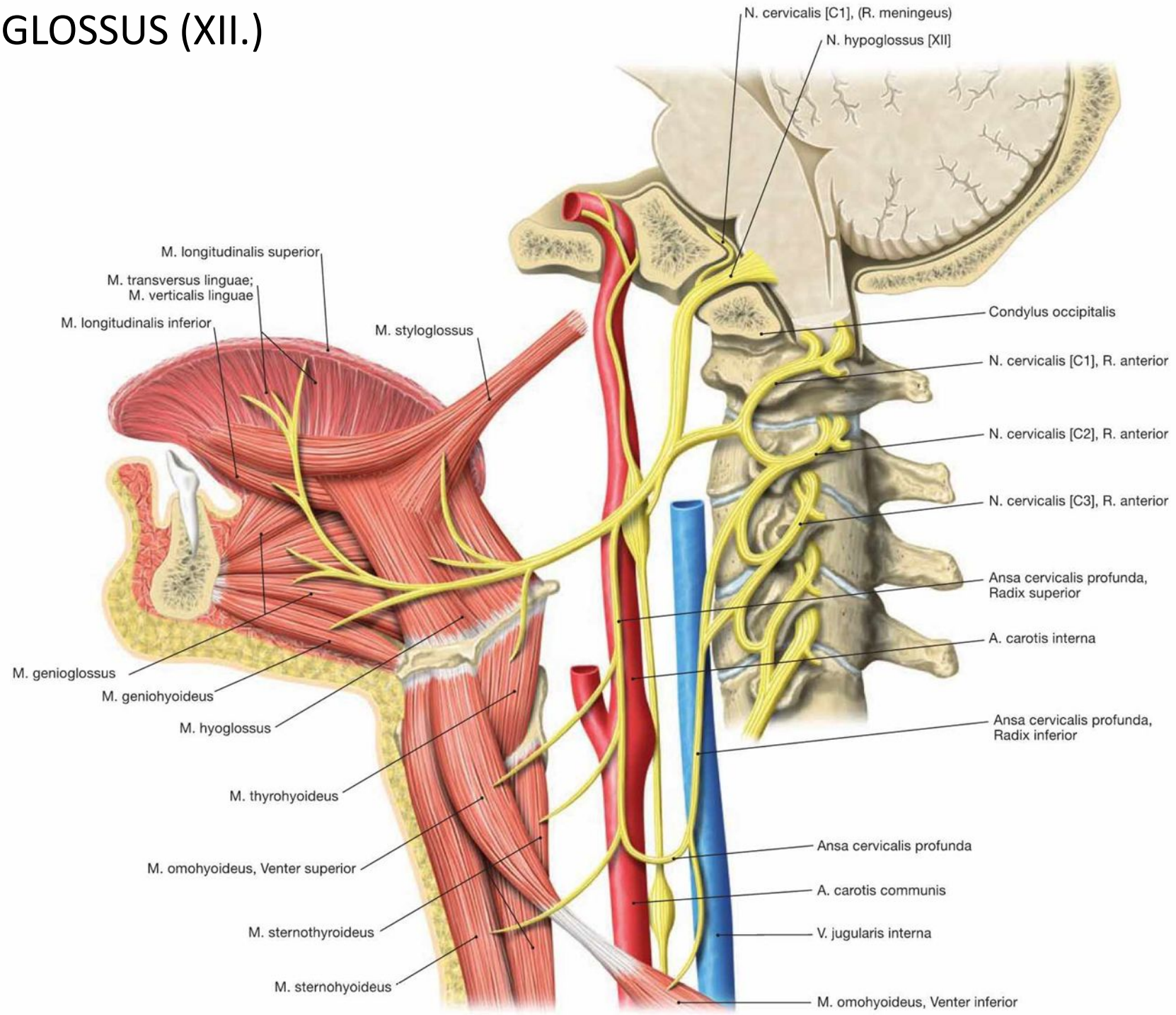
N. ACCESORIUS (XI.)



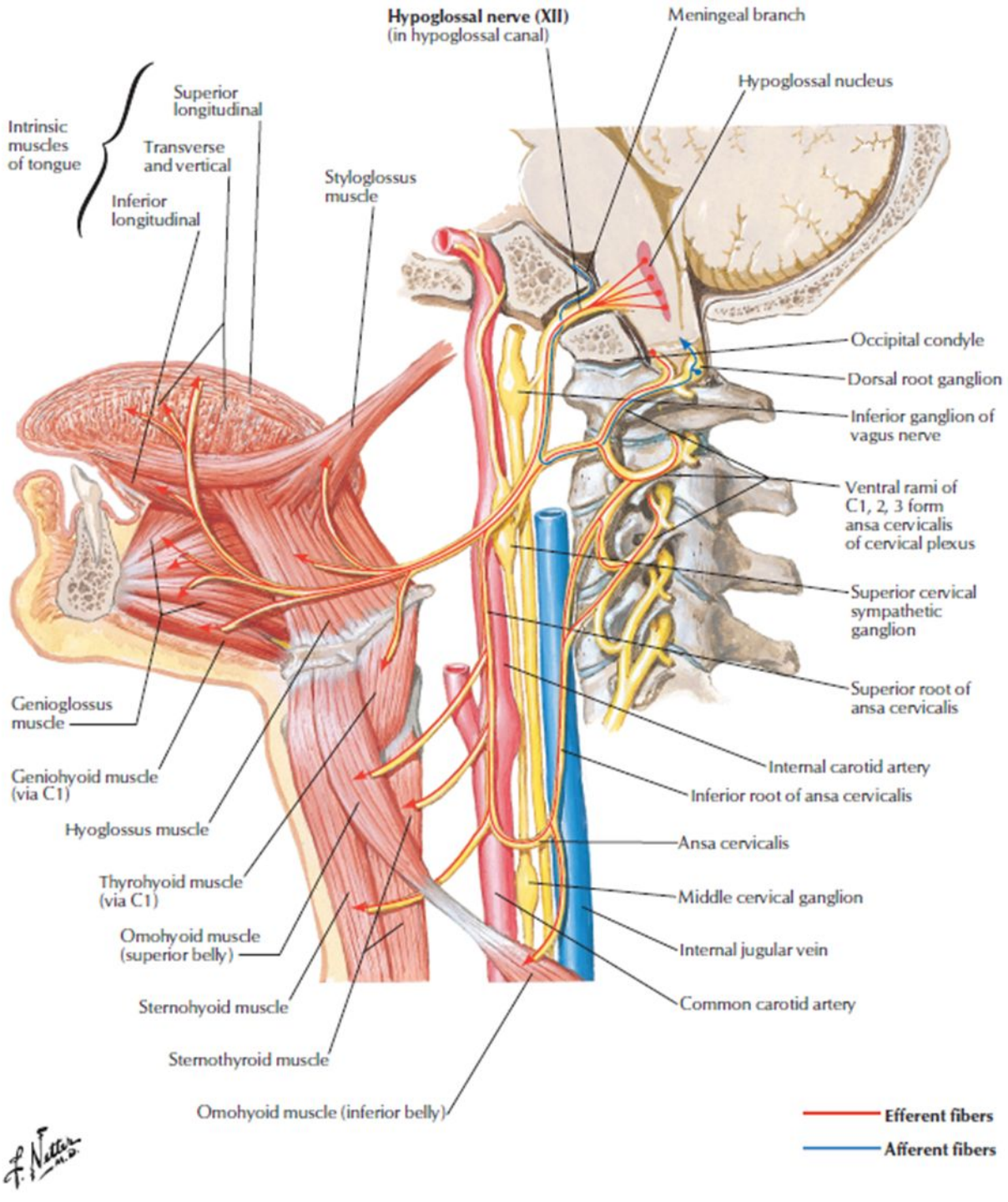
N. HYPOGLOSSUS (XII.)

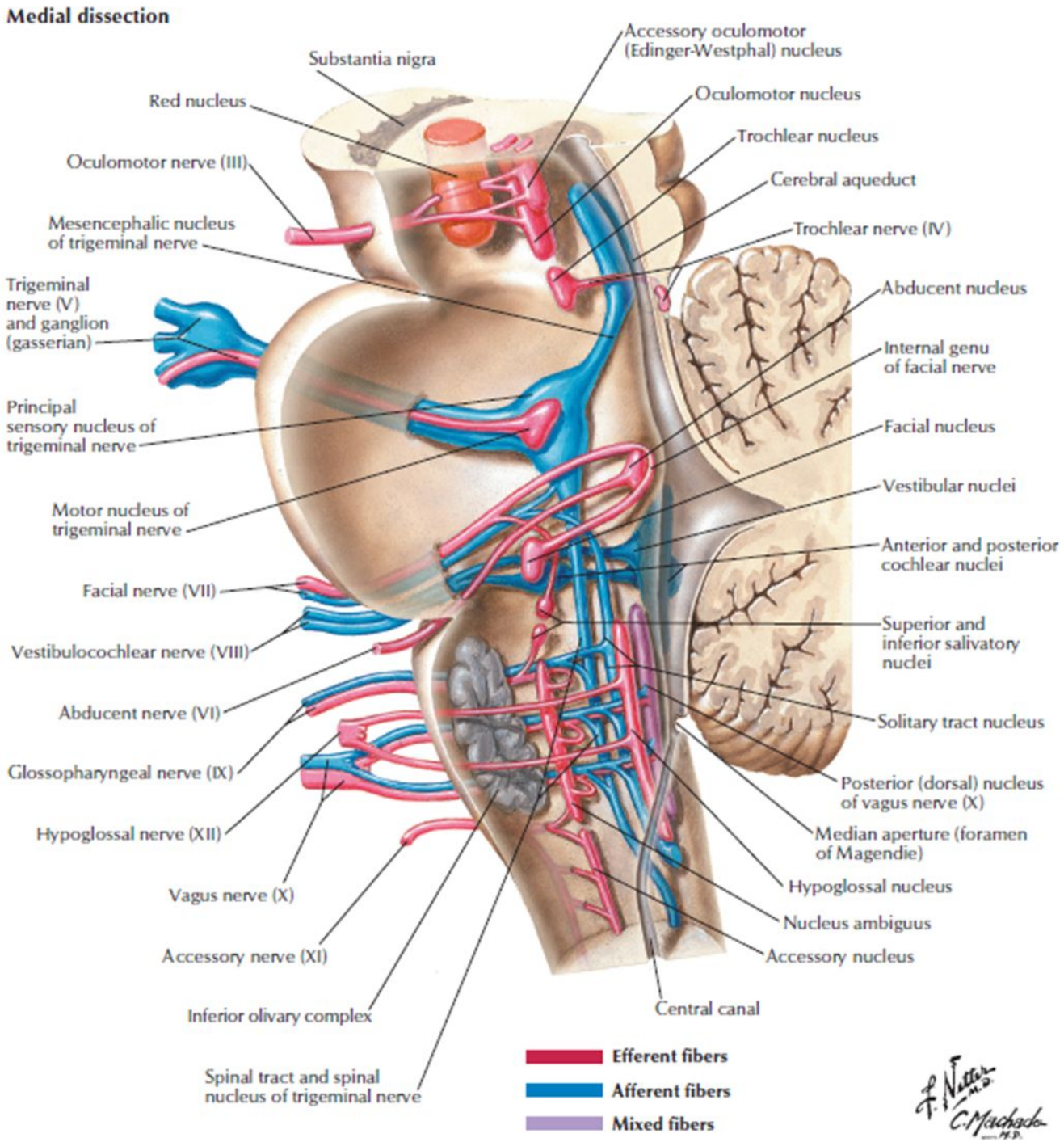
- Nucleus nervi hypoglossi Located beneath the trigonum hypoglossi
- Exits the medulla between the inferior olive and the pyramid
- Leaves the skull through the hypoglossal canal
- Descends lateral to CN X and the carotid arteries
- Loops forward beneath the posterior belly of m. digastricus and m. stylohyoideus forming the arcus n. hypoglossi
- Continues into the space between m. mylohyoideus and m. hyoglossus
- All intrinsic tongue muscles and M. genioglossus, M. hyoglossus, M. styloglossus

N. HYPOGLOSSUS (XII.)



N. HYPOGLOSSUS (XII.)




Medial dissection
Substantia nigra
Red nucleus
Oculomotor nerve (III)
Mesencephalic nucleus of trigeminal nerve
Trigeminal nerve (V) and ganglion (gasserian)
Principal sensory nucleus of trigeminal nerve
Motor nucleus of trigeminal nerve
Facial nerve (VII)
Vestibulocochlear nerve (VIII)
Abducent nerve (VI)
Glossopharyngeal nerve (IX)
Hypoglossal nerve (XII)
Vagus nerve (X)
Accessory nerve (XI)
Inferior olivary complex
Spinal tract and spinal nucleus of trigeminal nerve
Accessory oculomotor (Edinger-Westphal) nucleus
Oculomotor nucleus
Trochlear nucleus
Cerebral aqueduct
Trochlear nerve (IV)
Abducent nucleus
Internal genu of facial nerve
Facial nucleus
Vestibular nuclei
Anterior and posterior cochlear nuclei
Superior and inferior salivatory nuclei
Solitary tract nucleus
Posterior (dorsal) nucleus of vagus nerve (X)
Median aperture (foramen of Magendie)
Hypoglossal nucleus
Nucleus ambiguus
Accessory nucleus
Central canal
Efferent fibers
Afferent fibers
Mixed fibers
F. Netter M.D.
C. Machado M.D.

In the clinic

Cranial nerve lesions

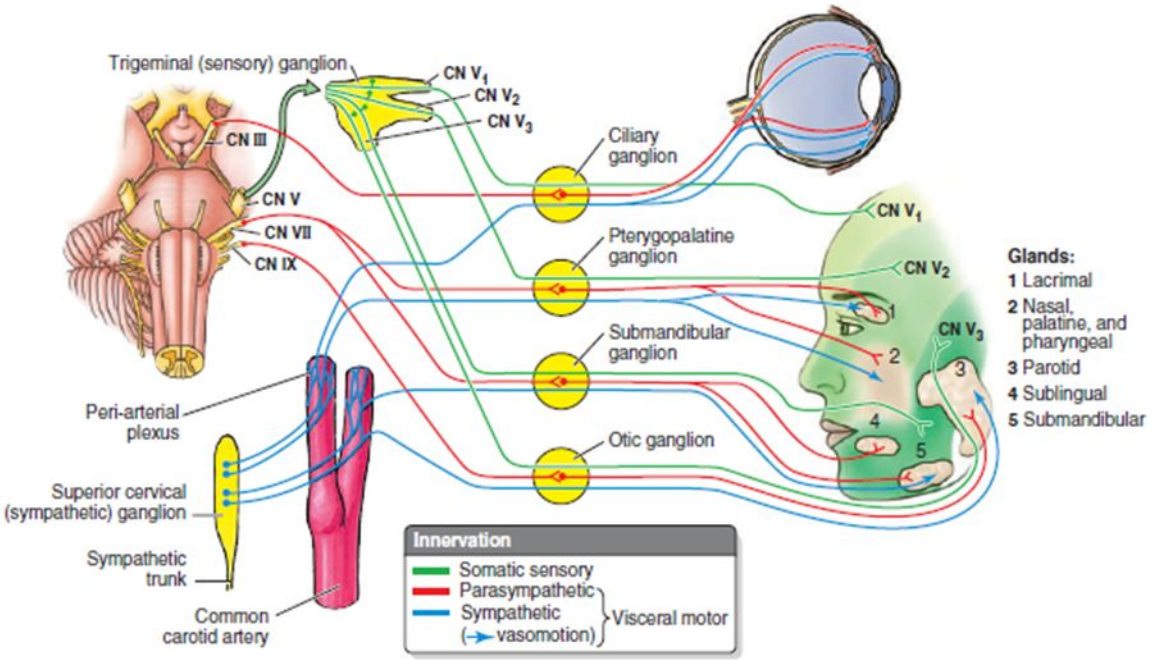
Cranial Nerve	Clinical Findings	Example of Lesion
Olfactory nerve [I]	Loss of smell (anosmia)	Injury to the cribriform plate; congenital absence
Optic nerve [II]	Blindness/visual field abnormalities, loss of pupillary constriction	Direct trauma to the orbit; disruption of the optic pathway
Oculomotor nerve [III]	Dilated pupil, ptosis, loss of normal pupillary reflex, eye moves down inferiorly and laterally (down and out)	Pressure from an aneurysm arising from the posterior communicating, posterior cerebral, or superior cerebellar artery; pressure from a herniating cerebral uncus (false localizing sign); cavernous sinus mass or thrombosis
Trochlear nerve [IV]	Inability to look inferiorly when the eye is adducted (down and in)	Along the course of the nerve around the brainstem; orbital fracture
Trigeminal nerve [V]	Loss of sensation and pain in the region supplied by the three divisions of the nerve over the face; loss of motor function of the muscles of mastication on the side of the lesion	Typically, in the region of the trigeminal ganglion, though local masses around the foramina through which the divisions pass can produce symptoms
Abducent nerve [VI]	Inability of lateral eye movement	Brain lesion or cavernous sinus lesion extending onto the orbit
Facial nerve [VII]	Paralysis of facial muscles Abnormal taste sensation from the anterior two-thirds of the tongue and dry conjunctivae Paralysis of contralateral facial muscles below the eye	Damage to the branches within the parotid gland Injury to temporal bone; viral inflammation of nerve Brainstem injury
Vestibulocochlear nerve [VIII]	Progressive unilateral hearing loss and tinnitus (ringing in the ear)	Tumor at the cerebellopontine angle
Glossopharyngeal nerve [IX]	Loss of taste to the posterior one-third of the tongue and sensation of the soft palate	Brainstem lesion; penetrating neck injury
Vagus nerve [X]	Soft palate deviation with deviation of the uvula to the normal side; vocal cord paralysis	Brainstem lesion; penetrating neck injury
Accessory nerve [XI]	Paralysis of sternocleidomastoid and trapezius muscles	Penetrating injury to the posterior triangle of the neck
Hypoglossal nerve [XII]	Atrophy of ipsilateral muscles of the tongue and deviation toward the affected side; speech disturbance	Penetrating injury to the neck and skull base pathology

Cranial parasympathetic ganglia

- Located in regions associated with branches of the trigeminal nerve
- Contain postganglionic parasympathetic neurons supplying Secretomotor fibers to glands or Fibers to smooth muscle
- Afferent roots
    - Radix parasympathica – Preganglionic fibers from parasympathetic brainstem nuclei
    - Radix sympathica – Sympathetic fibers from cervical sympathetic ganglia along vessels, Pass through the ganglion without synapsing
    - Radix sensitiva – Sensory fibers carried by trigeminal branches, Also pass through without synapsing
- Efferent branches
    - Contain all three fiber types

- ganglion ciliare
- ganglion pterygopalatinum
- ganglion oticum
- ganglion submandibulare

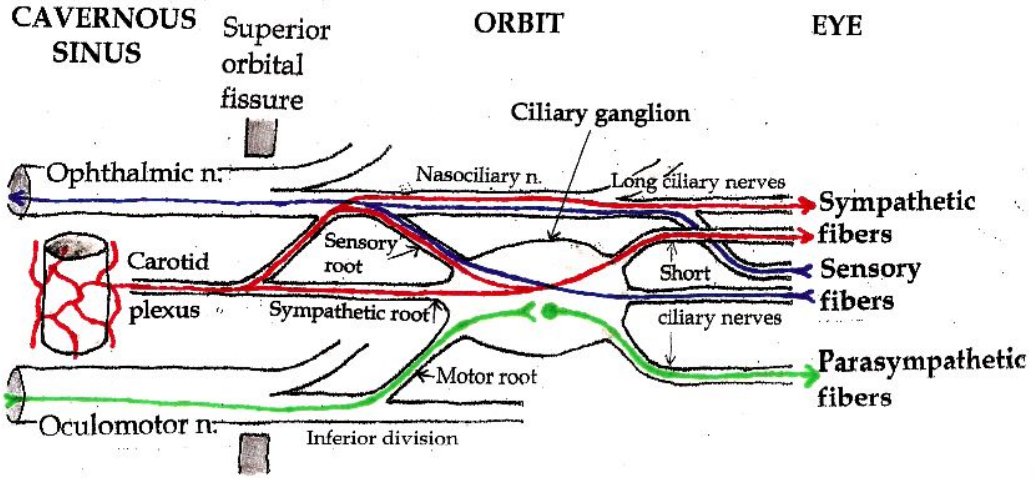
TABLE 9.4 SUMMARY OF THE CRANIAL PARASYMPATHETIC GANGLIA



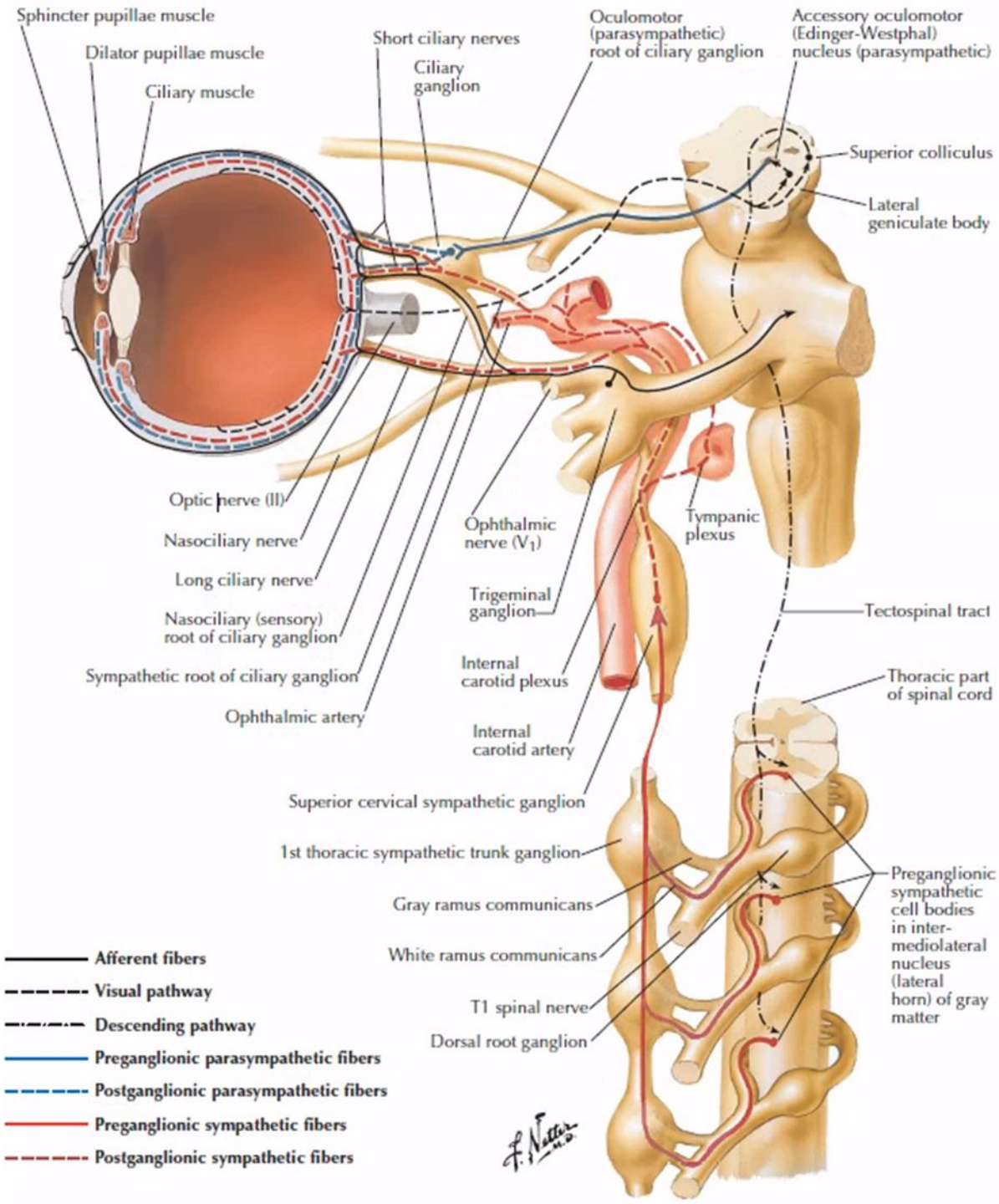
Ganglion	Location	Parasympathetic Root	Sympathetic Root	Main Distribution
Ciliary	Between optic nerve and lateral rectus, close to apex of orbit	Inferior branch of oculomotor nerve (CN III)	Branches from peri-arterial plexus on internal carotid artery in cavernous sinus	Parasympathetic postsynaptic fibers from ciliary ganglion pass to ciliary muscle and sphincter pupillae of iris; sympathetic postganglionic fibers from superior cervical ganglion pass to dilator pupillae and blood vessels of eye
Pterygopalatine	In pterygopalatine fossa, where it is suspended by ganglionic branches of maxillary nerve (sensory roots of pterygopalatine ganglion); just anterior to opening of pterygoid canal and inferior to CN V_2	Greater petrosal nerve from facial nerve (CN VII) via nerve of pterygoid canal	Deep petrosal nerve, a branch of peri-arterial plexus on internal carotid artery that is a continuation of postsynaptic fibers of cervical sympathetic trunk; fibers from superior cervical ganglion pass through pterygopalatine ganglion and enter branches of CN V_2	Parasympathetic postsynaptic (secretomotor) fibers from pterygopalatine ganglion innervate lacrimal gland via zygomatic branch of CN V_2; sympathetic postsynaptic fibers from superior cervical ganglion accompany branches of pterygopalatine nerve that are distributed to blood vessels of nasal cavity, palate, and superior parts of pharynx
Otic	Between tensor veli palatini and mandibular nerve (CN V_3); lies inferior to foramen ovale of sphenoid bone	Tympanic nerve from glossopharyngeal nerve (CN IX); from tympanic plexus, tympanic nerve continues as lesser petrosal nerve	Fibers from superior cervical ganglion come from peri-arterial plexus on middle meningeal artery	Parasympathetic postsynaptic fibers from otic ganglion are distributed to parotid gland via auriculotemporal nerve (branch of CN V_3); sympathetic postsynaptic fibers from superior cervical ganglion pass to parotid gland and supply its blood vessels
Submandibular	Suspended from lingual nerve by two ganglionic branches (sensory roots); lies on surface of hyoglossus muscle inferior to submandibular duct	Parasympathetic fibers join facial nerve (CN VII) and leave it in its chorda tympani branch, which unites with lingual nerve	Sympathetic fibers from superior cervical ganglion via peri-arterial plexus on facial artery	Parasympathetic postsynaptic (secretomotor) fibers from submandibular ganglion are distributed to sublingual and submandibular glands; sympathetic fibers supply sublingual and submandibular glands and appear to be secretomotor

GANGLION CILIARE

- Located in the orbit, lateral to the optic nerve.
- Afferent roots
  - radix parasympathica: From Edinger–Westphal nucleus (accessory oculomotor nucleus) → via oculomotor nerve (n. oculomotorius) → inferior division of CN III → parasympathetic root of the ciliary ganglion
  - radix sympathica: From intermediolateral cell column C8–Th1 (ciliospinal center of Budge) → spinal nerve → white rami communicantes → superior cervical sympathetic ganglion → internal carotid plexus → sympathetic root of the ciliary ganglion (passes through without synapsing)
  - radix sensitiva: Sensory fibers from the bulbus oculi (eyeball) → Pass through the ganglion unchanged → Connect to n. nasociliaris via r. communicans cum ganglio ciliare
- Efferent branches
  - nervi ciliares breves



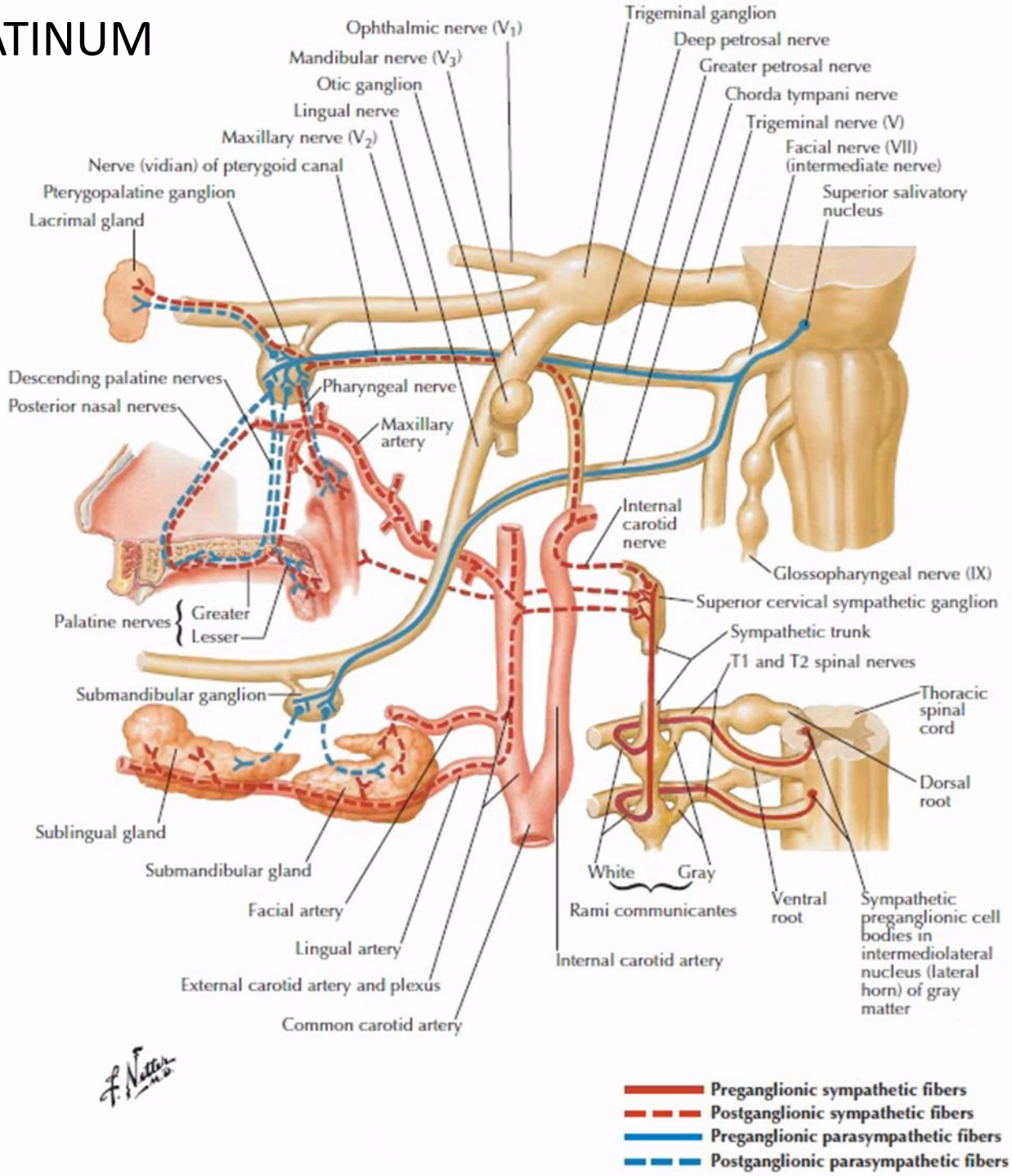
GANGLION CILIARE



GANGLION PTERYGOPALATINUM

- Located in the pterygopalatine fossa, caudal to the mandibular nerve and lateral to the sphenopalatine foramen
- Afferent roots
  - radix parasympathica: From nucleus salivatorius superior → facial nerve (VII) → greater petrosal nerve (n. petrosus major) → joins sympathetic fibers → nerve of the pterygoid canal (n. canalis pterygoidei) → enters the ganglion
  - radix sympathica: From intermediolateral cell column (Th1–Th2) → spinal nerve → superior cervical sympathetic ganglion → deep petrosal nerve (n. petrosus profundus) → joins parasympathetic fibers in n. canalis pterygoidei
  - radix sensitiva: Sensory branches of posterior nasal nerves (rr. nasales) and palatine nerves (nn. palatini) pass through the ganglion without synapsing → nn. pterygopalatini (rr. ganglionares) → n. maxillaris
- Efferent branches
  - rr. nasales posteriores superiores laterales et mediales → foramen sphenopalatinum → cavitas nasi (septum, dorsal part of lateral nasal wall)
  - n. nasopalatinus (branch from rr. nas. post. sup. mediales) → canalis incisivus → mucosa of the anterior palate
  - n. palatinus major → canalis palatinus major → foramen palatinum majus → mucosa of the hard palate
  - nn. palatini minores → canales palatini minores → foramina palatina minora → mucosa of the soft palate
  - rr. nasales posteriores inferiores – branch off from n. palatinus major (inside the canalis palatinus major) → cavitas nasi → mucosa of the inferior nasal concha and inferior and middle nasal meatus
  - ncl. salivatorius superior → n. facialis → n. petrosus major → n. canalis pterygoidei → ganglion pterygopalatinum → rr. nasales palatini et rr. pterygopalatini → nasal and palatine glands; via the ramus communicans cum nervo lacrimali to the lacrimal gland
  - rr. orbitales → fissura orbitalis superior → joins with the n. ethmoidalis posterior (sinus ethomidales posteriores et sinus sphenoidalis); sympathetic for m. orbitalis

GANGLION PTERYGOPALATINUM

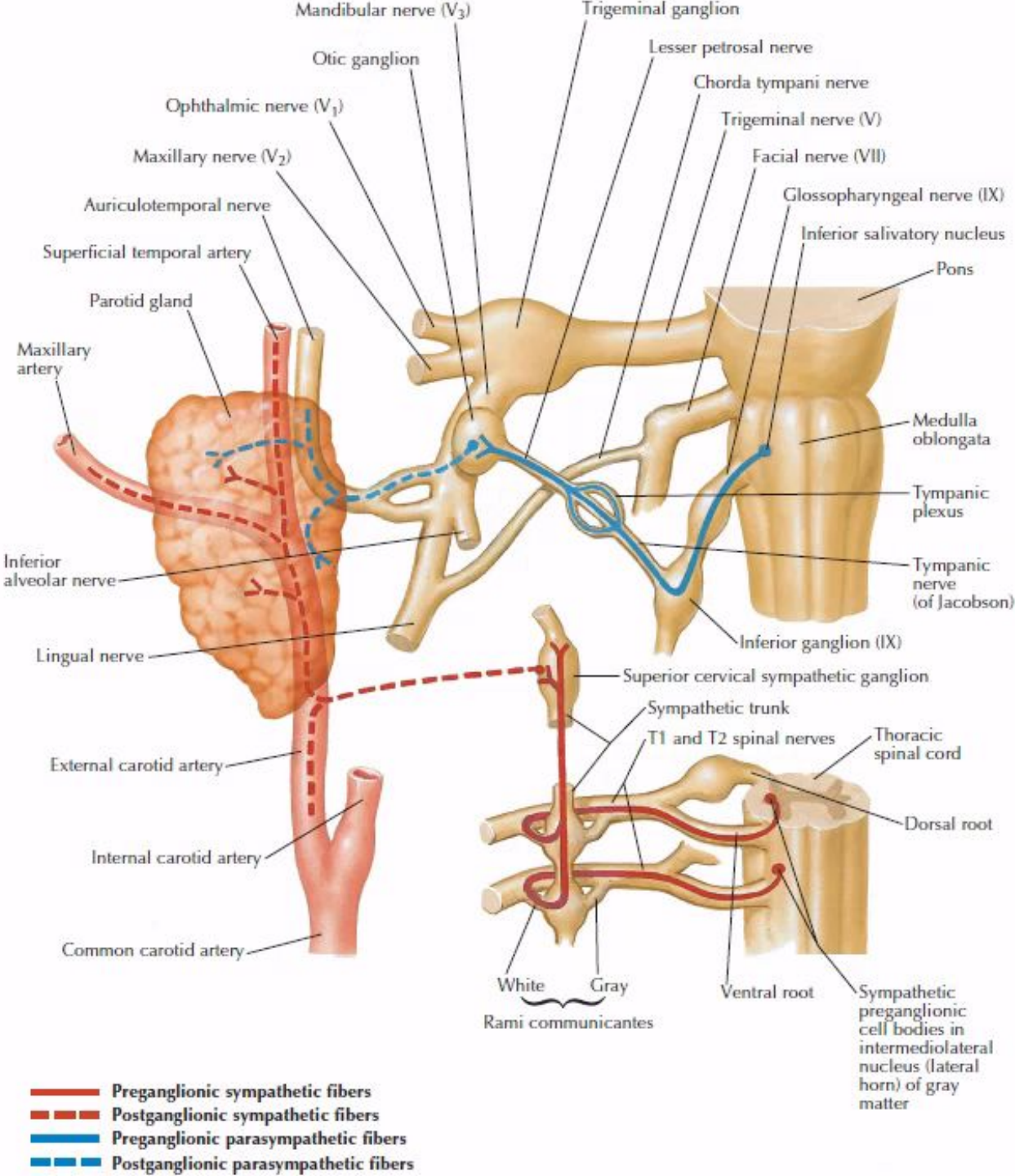


GANGLION OTICUM

- Located medial to the mandibular nerve (V3) at the foramen ovale exit
- Afferent roots
  - radix parasympathica: **nc. salivatorius inferior** → n. glossopharyngeus → n. tympanicus → plexus tympanicus → n. petrosus minor → ganglion oticum (parasympathetics for the parotid gland and vestibular (oral) mucosal glands)
  - radix sympathica: ncl. intermediolateralis → n. spinalis → r. communicans albus gangliorum cervicalium trunci sympathici → gangl. cervicale superius → plexus caroticus internus → plexus a. meningeae mediae
  - radix sensitiva: communication with n. mandibularis
- Efferent branches
  - rr. communicantes cum nervo auriculotemporali → n. auriculotemporalis → rr. glandulares nervi auriculotemporalis (parasymp. for parotid gland)
  - r. communicans cum nervo buccali

  - parasympathetic pathway to hte parotid gland
  - Ncl. salivatorius inferior → CN IX → n. tympanicus → tympanic plexus → n. petrosus minor → otic ganglion → r. communicans → n. auriculotemporalis → rr. glandulares → parotid gland

GANGLION OTICUM



GANGLION SUBMANDIBULARE

- Located near the lingual nerve, at the upper border of the submandibular gland.
- Afferent roots
  - radix parasympathica: **nc. salivatorius superior** → n. facialis → chorda tympani → n. lingualis → ganglion submandibulare
  - radix sympathica: ncl. intermediolateralis → n. spinalis → r. communicans albus gangliorum cervicalium trunci sympathici → gangl. cervicale superius → plexus caroticus internus → plexus a. facialis
  - radix sensitiva: communication with n. lingualis
- Efferent branches
  - rr. glandulares (submandibular and sublingual glands (parasymp.))
  - communicating branches to n. lingualis (small mucosal glands of the tongue)

GANGLION SUBMANDIBULARE