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Trigeminal Pathways

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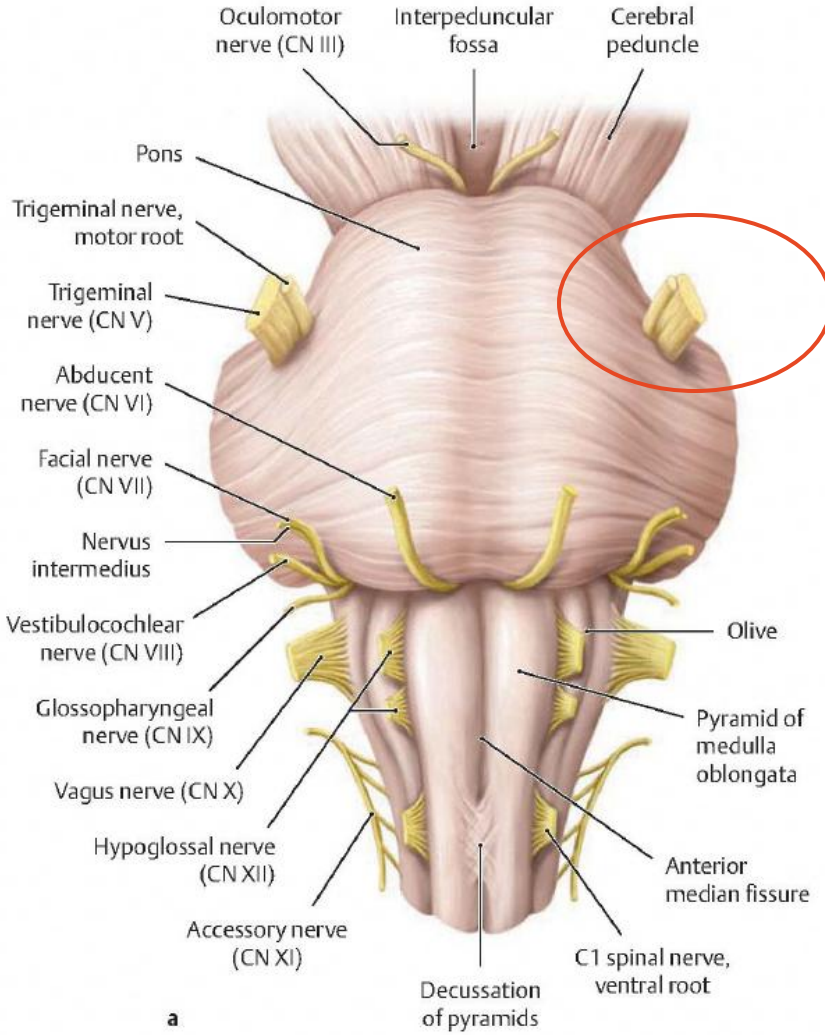
Learning Objectives

1. Indicate the location where trigeminal nerve attaches to the CNS and tell its general function
2. Name the brainstem nuclei associated with the trigeminal nerve, tell their location in the brainstem and their function
3. Indicate the sensory modalities transmitted by the trigeminal lemniscal, trigemino-thalamic and proprioceptive pathways
4. Describe the trigeminal lemniscal and trigemino-thalamic tract pathways from fiber origin to cortical perception
5. Explain the pathway for conscious and unconscious proprioception from the face
6. Describe the pathways for the jaw jerk and corneal reflexes: afferent and efferent arms, and integration centers **READ – Key Clinical Concept in Blumenfeld Chapter 12,** page 518
7. Correlate the effects of a lesion at different brainstem levels with clinical exam findings - cases



E Brainstem

a Anterior view.

Illustrator: Markus Voll pp. 226-227

Schuenke et al. THIEME Atlas of Anatomy • Head and Neuroanatomy

Thieme

OBJ. # 1

The trigeminal nerve attaches to the brainstem at the level of the mid pons. It has a large sensory root and a small motor root

2 roots

Trigeminal Nerve, CN V

OBJ. # 1

Function

Sensory innervation for the face, mucous membranes of the mouth, and nasal sinuses, joints, gums, supratentorial dura matter, blood vessels, ant. 2/3 of tongue	Motor innervation of the muscles of mastication

OBJ. # 2

Trigeminal Nerve, CN V

4 Nuclei:

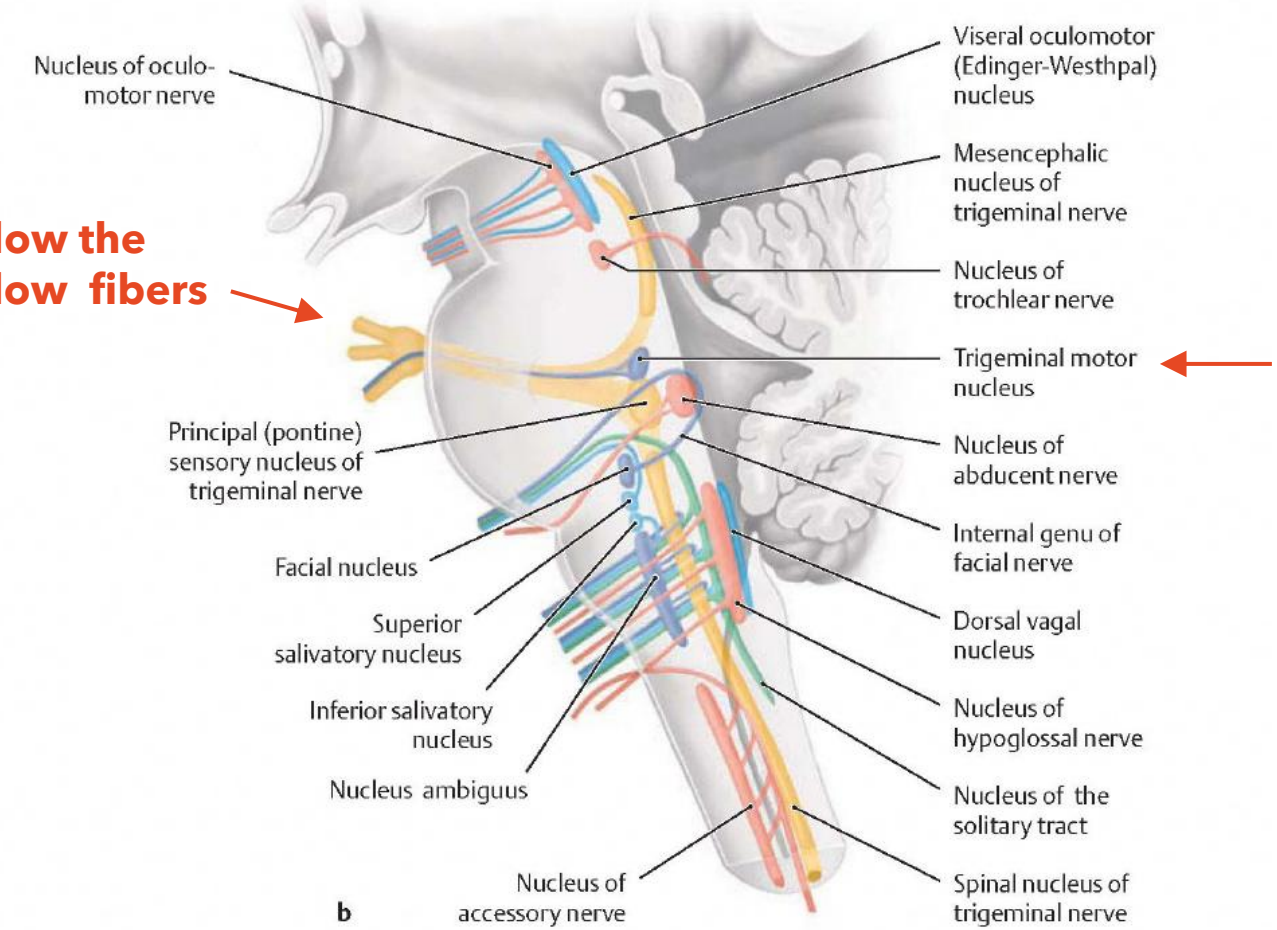
- **Principal sensory nucleus** (mid pons) smaller
- **Spinal nucleus of V** (long column of neurons, medulla and caudal pons)
  analogous to rexed laminae where ALS synapse
- **Mesencephalic nucleus** (from mid pons to midbrain)
  exceptions to rules for sensory nuclei

Sensory information from the face

- **Motor nucleus** (mid pons) → Motor innervation for masticatory muscles

Location Of CN V Nuclei In The Brainstem

Follow the Yellow fibers



A Cranial nerve nuclei in the brainstem

b Midsagittal section of the right half of the brainstem viewed from the left side.

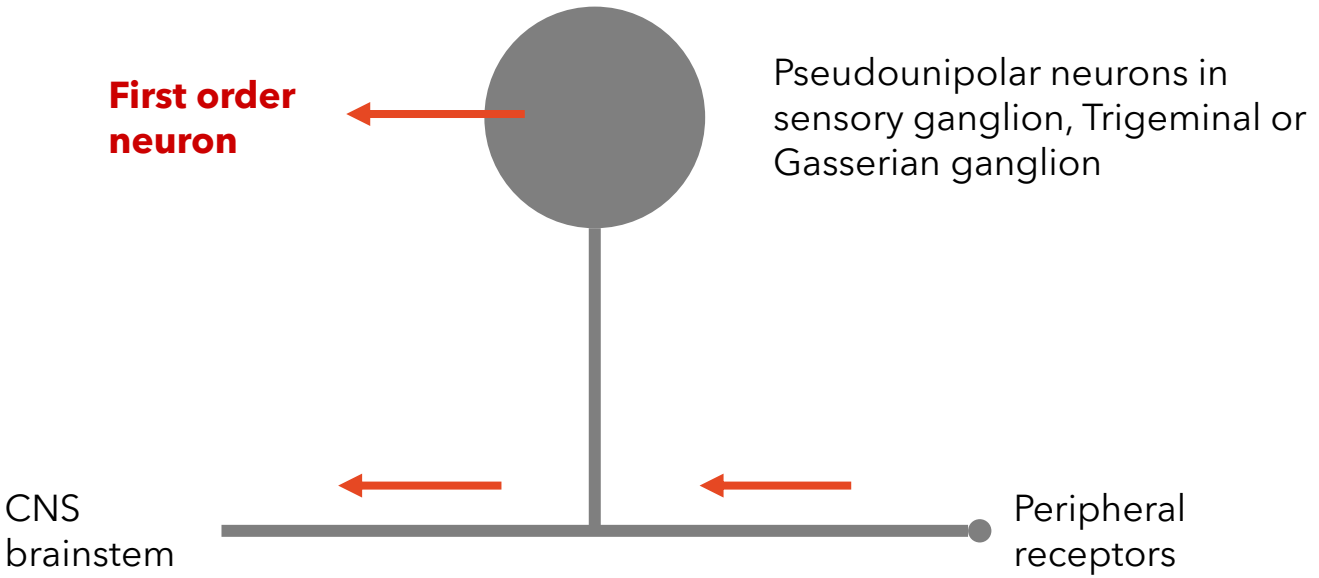
Illustrator: Markus Voll pp. 228-229

OBJ. # 2

Somatic Sensation From The Face

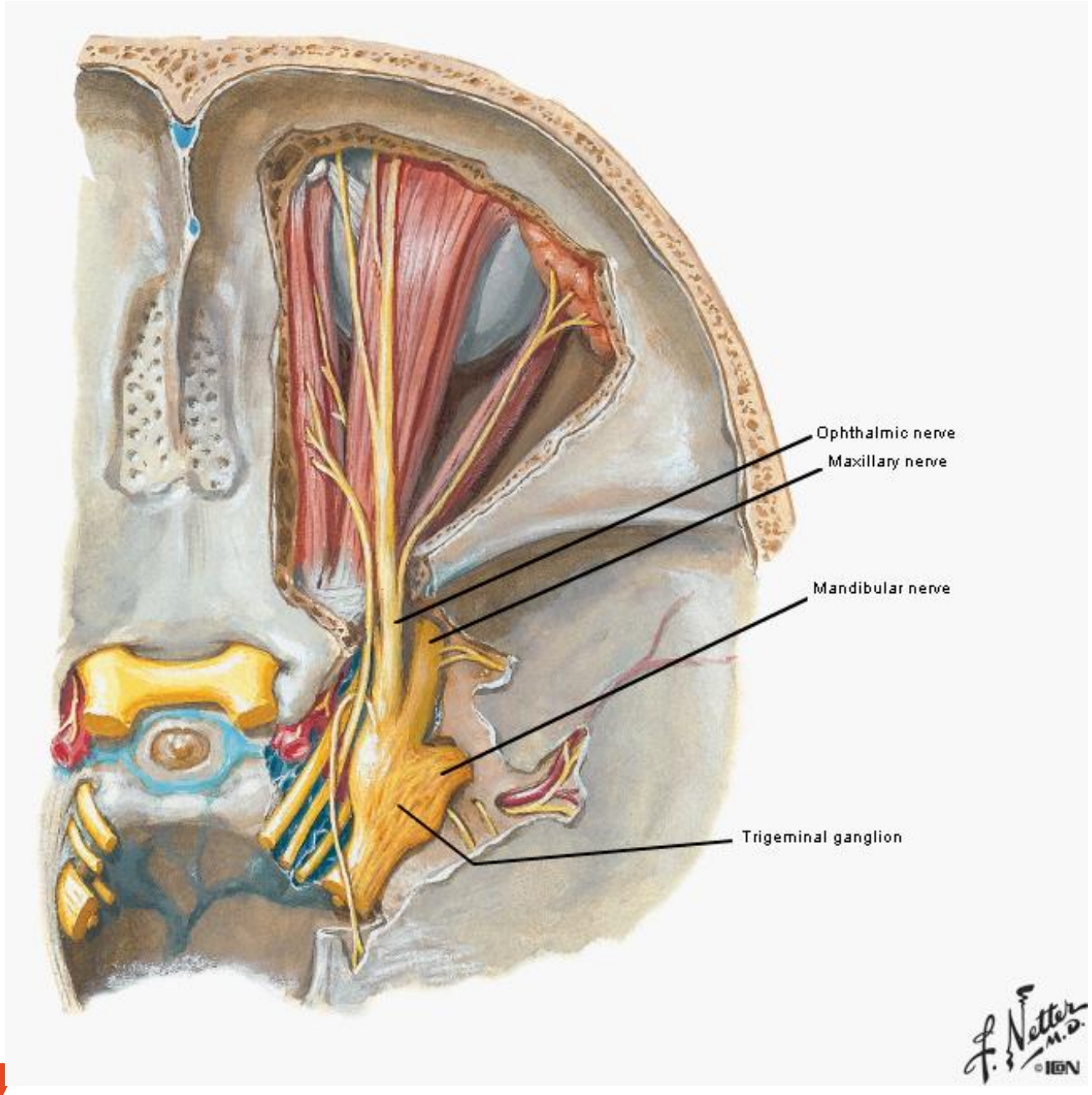
OBJ. # 3

- The trigeminal nerve transmits sensation from the face
- 3 pathways can be described:
  1. Transmits light touch / discriminative touch, vibration and SOME proprioception
  2. Transmits deep touch, thermal sensation and nociception
  3. Transmits most of the proprioception: from the muscles of mastication and eye muscles mesecephalic nucleus



OBJ. # 3

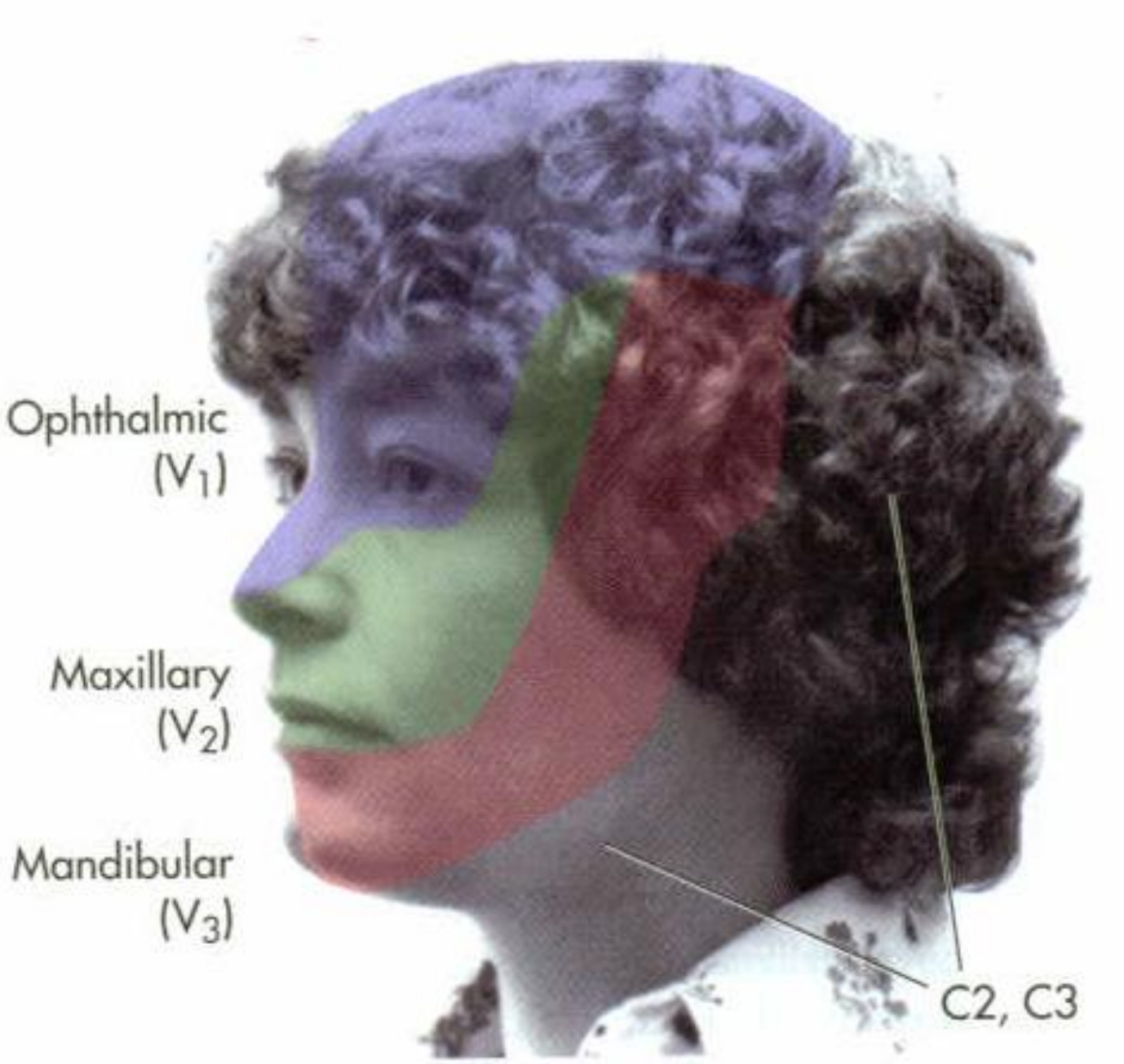
pseudounipolar neurons exist - but there is an exception



Nerves of the orbit and the ciliary ganglion: dorsal view and cross-section through the cavernous sinus

OBJ. # 3

Trigeminal Dermatomes



angle of jaw NOT part of CN V

OBJ. # 4

Trigeminal Lemniscus
And
Trigeminothalamic Tract

Light Touch, Vibration And Some Proprioception

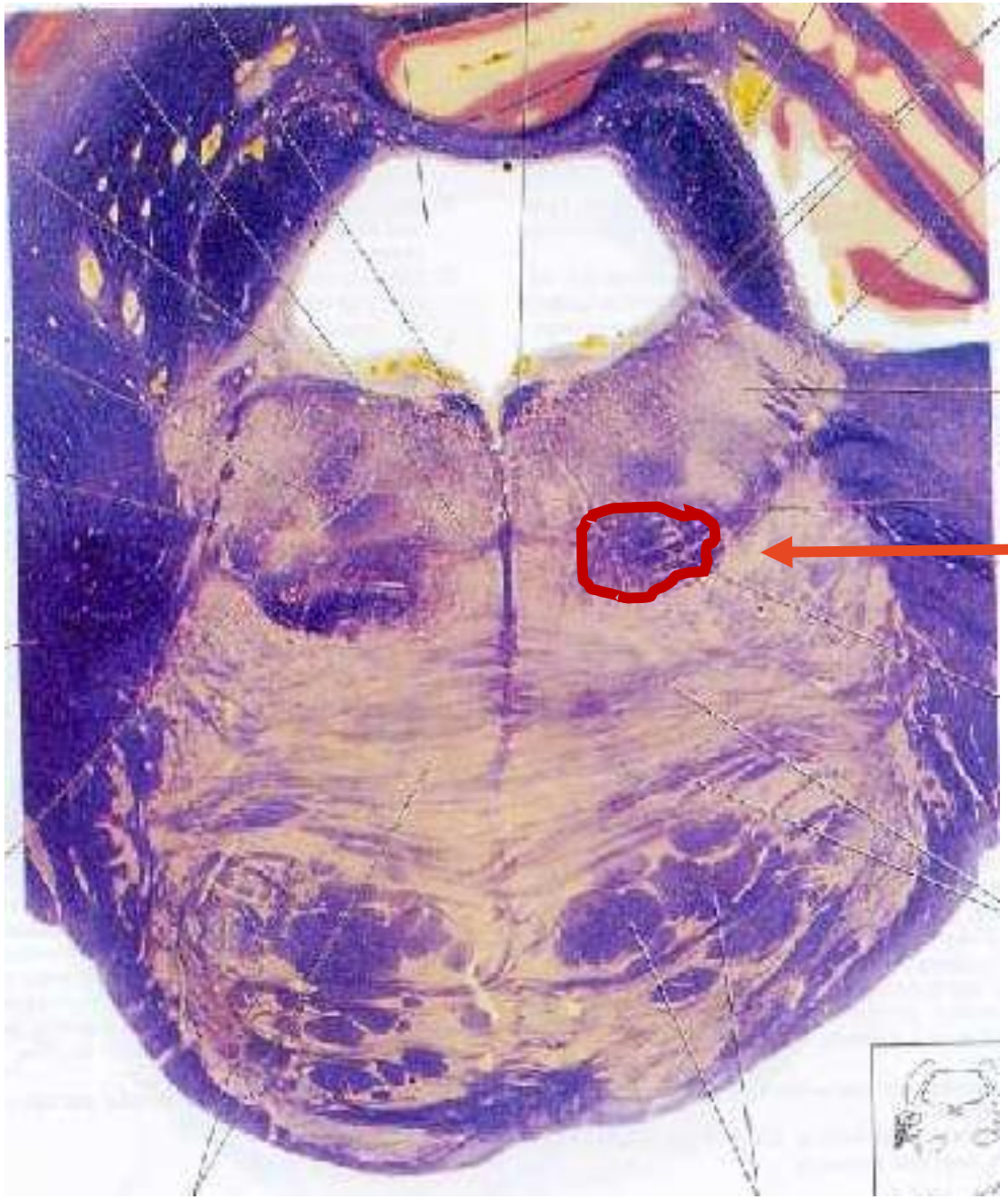
DCML pathways

VPL - somatic sensation from bo
VPM - somatic sensation from fa
both run contralateral

OBJ. # 4

- Fibers originate from pseudounipolar neurons in the trigeminal ganglion
- Peripheral fibers make up the 3 facial dermatomes
- Central fibers enter the brainstem at mid-pons
- Fibers for this pathway synapse with neurons mainly in the **principal sensory** nucleus of V
- The principal sensory nucleus projects to the contralateral thalamus through a fiber tract known as the **trigeminal lemniscus.**
- The fibers from the principal sensory nucleus **decussate in the mid-pons,** join the medial lemniscus (fibers from the body) and ascend to synapse with neurons in the **VPM nucleus** of the thalamus
- Thalamocortical fibers from the VPM nucleus project to the face area of the **primary sensory cortex** in the parietal lobe

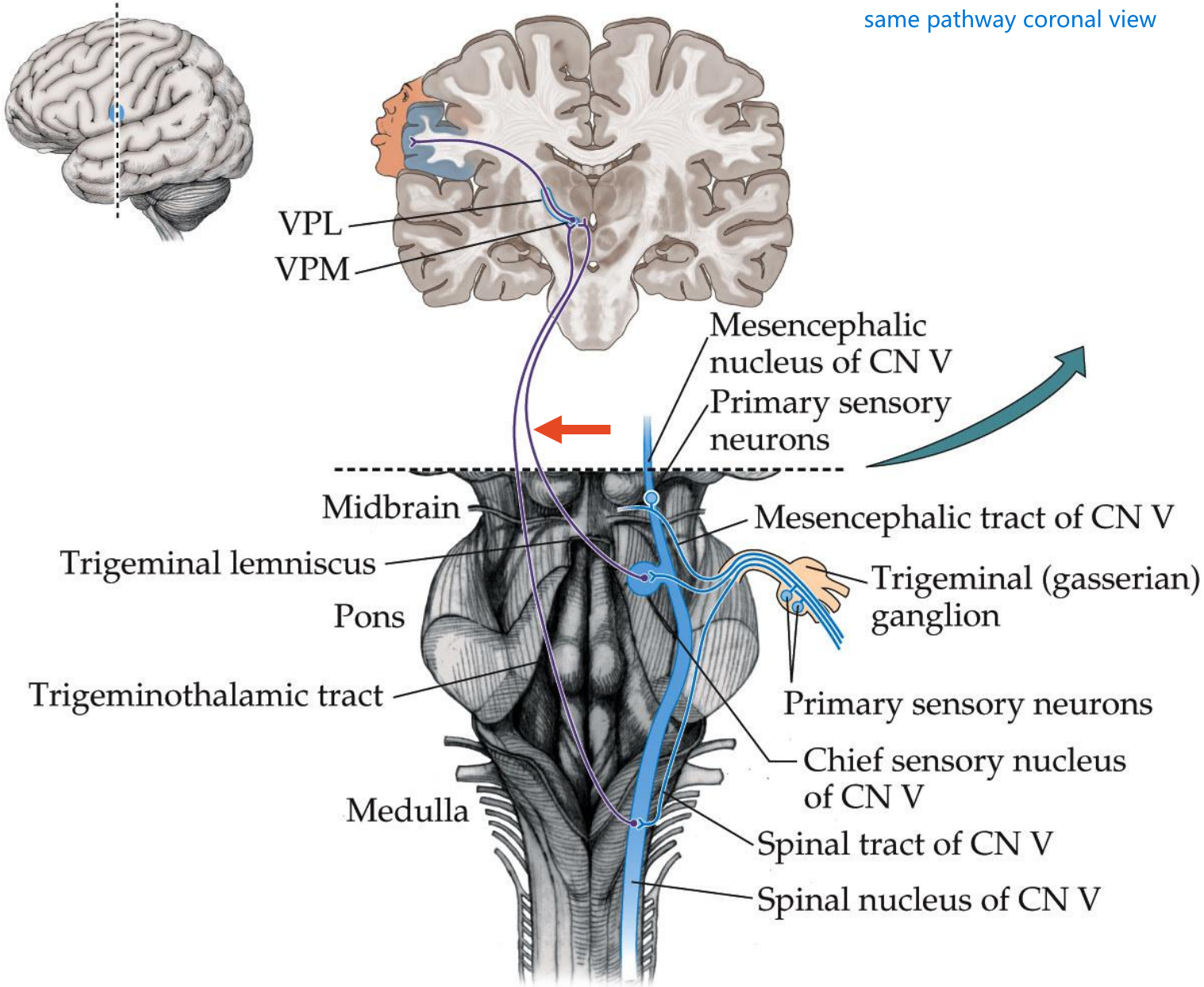
OBJ. #4



The medial lemniscus Trigeminal fibers start to join this pathway as they cross from the contralateral side

same pathway coronal view

OBJ. # 4



***NEUROANATOMY 2e*, Figure 12.8 (Part 1)**

Deep Touch, Thermal Sensation And Nociception

like ALS pathway from body

OBJ. # 4

- Fibers originate from pseudounipolar neurons in the trigeminal ganglion
- Peripheral fibers make up the 3 facial dermatomes
- Central fibers enter the brainstem at mid-pons and **descend along the pons and medulla – Spinal tract of V**

analogous to Lissauer's tract in ALS pathway - need to ascend/descend a level before synapse

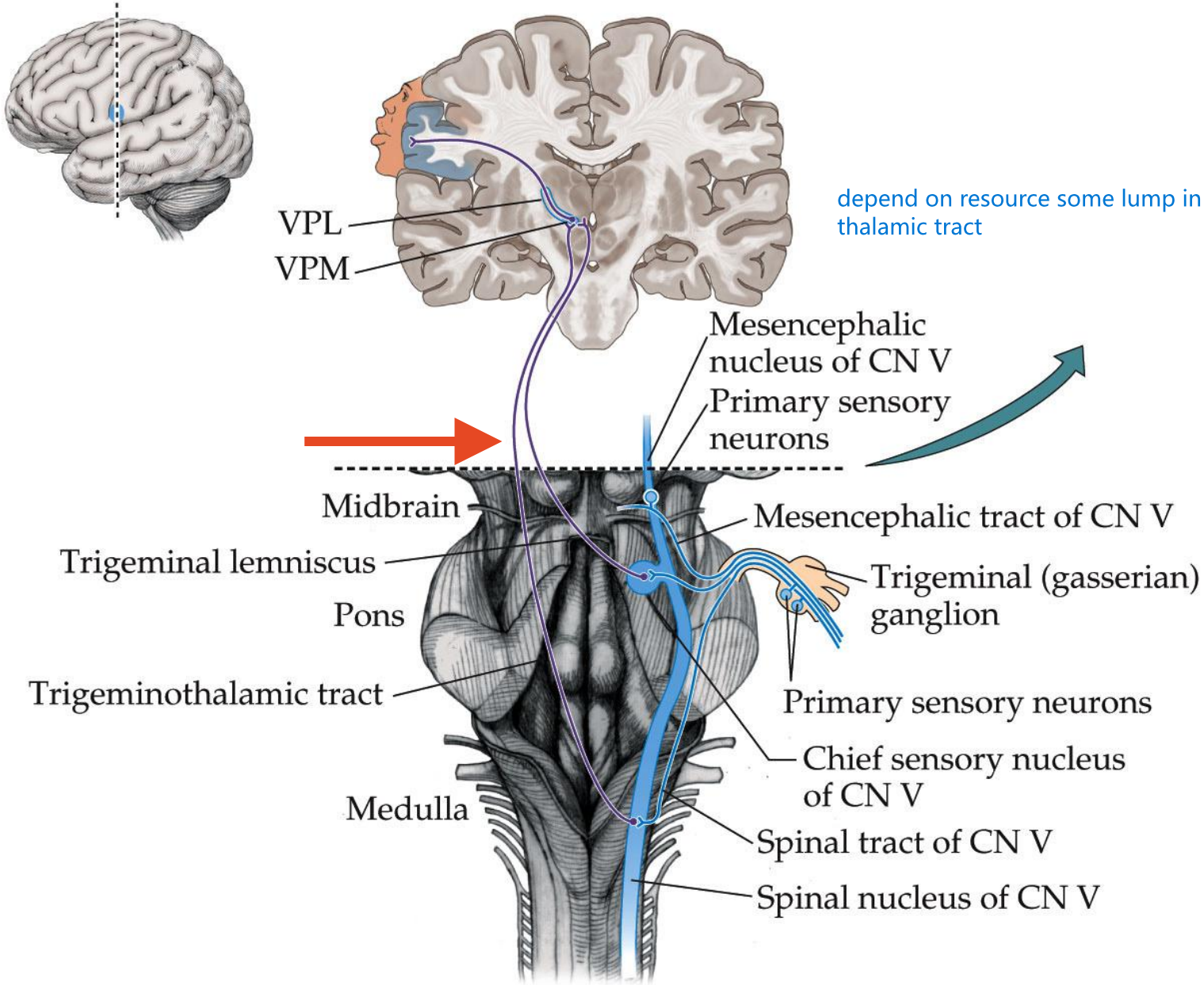
- Fibers for this pathway synapse with neurons in the **spinal nucleus of V**
- Neurons in the spinal nucleus project to the contralateral thalamus through a fiber tract known as the **trigeminothalamic tract**

project to contralateral VPM of thalamus

- Spinal trigeminal fibers decussate at all medullary levels, join the other sensory pathways and ascend to the **VPM nucleus** of the thalamus
- Thalamocortical fibers from the VPM terminate in the face area of the **primary sensory cortex** in the parietal lobe

OBJ. # 4

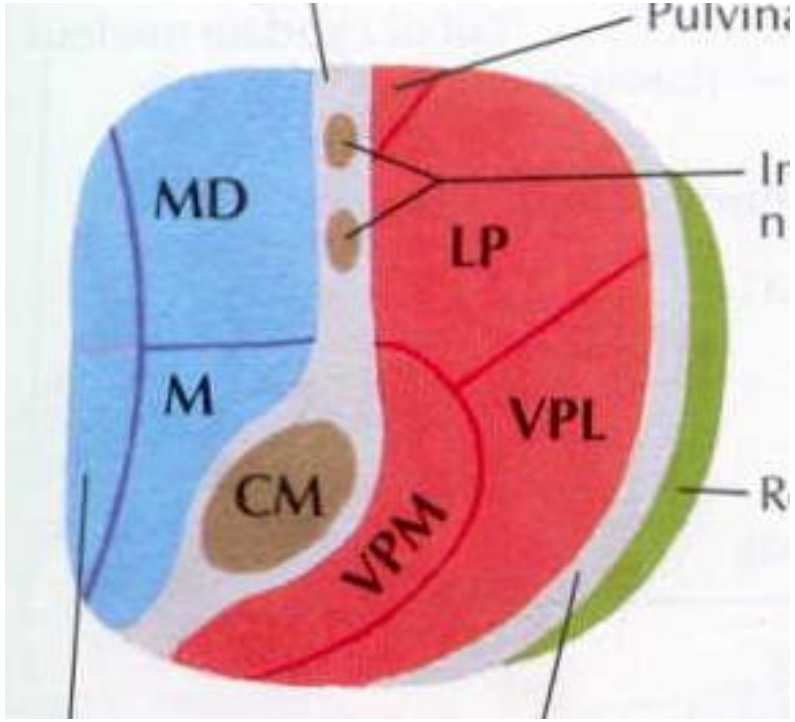
depend on resource some lump in trigeminal lemniscus and trigeminal thalamic tract

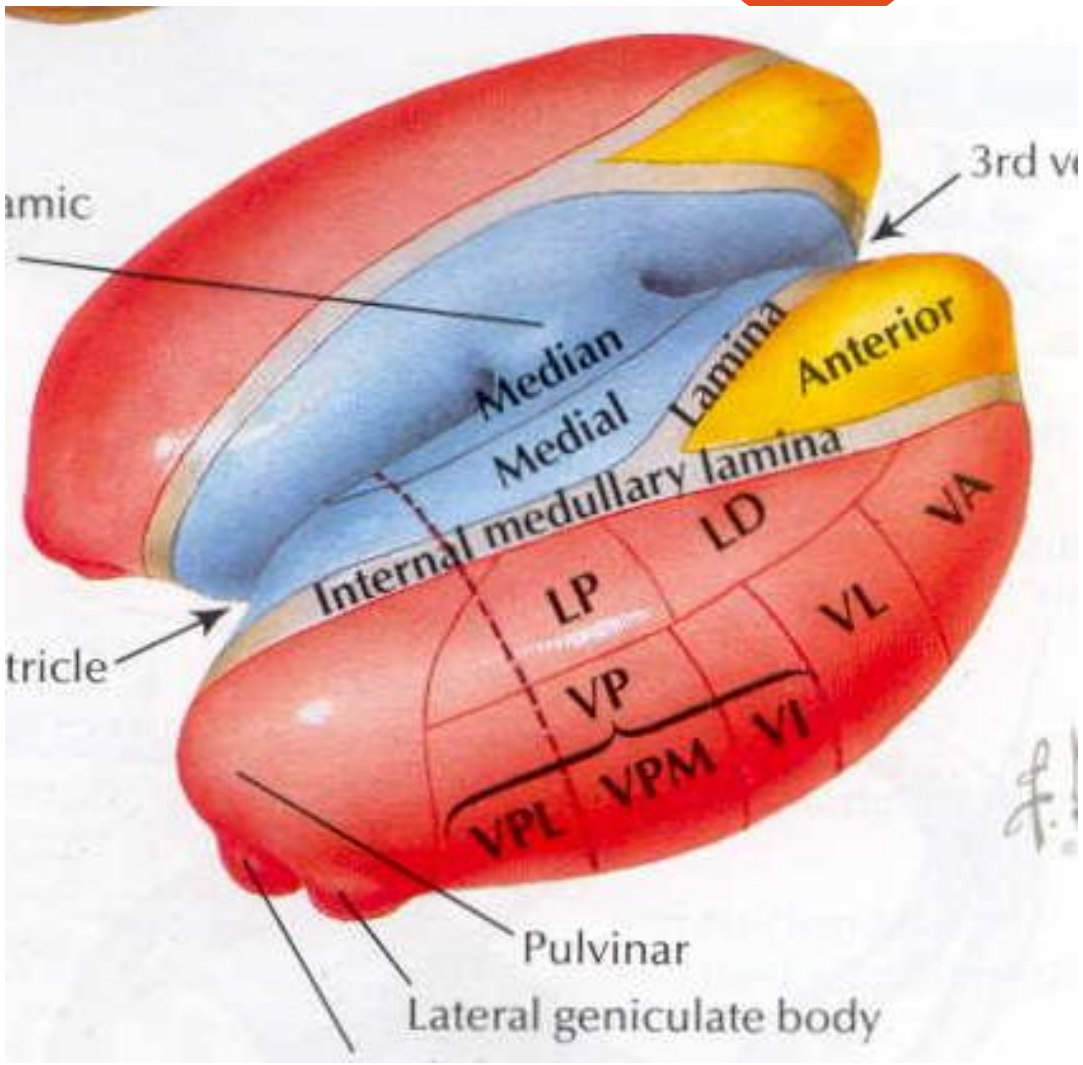


***NEUROANATOMY 2e*, Figure 12.8 (Part 1)**

The Thalamus

OBJ. # 4





VPM - face
VPL - body

Proprioceptive Pathways

OBJ. # 5

mesencephalic is exception to rule that all cell bodies is in peripheral

- Fibers ORIGINATE in the **mesencephalic nucleus** in CNS

usually comes up on exam

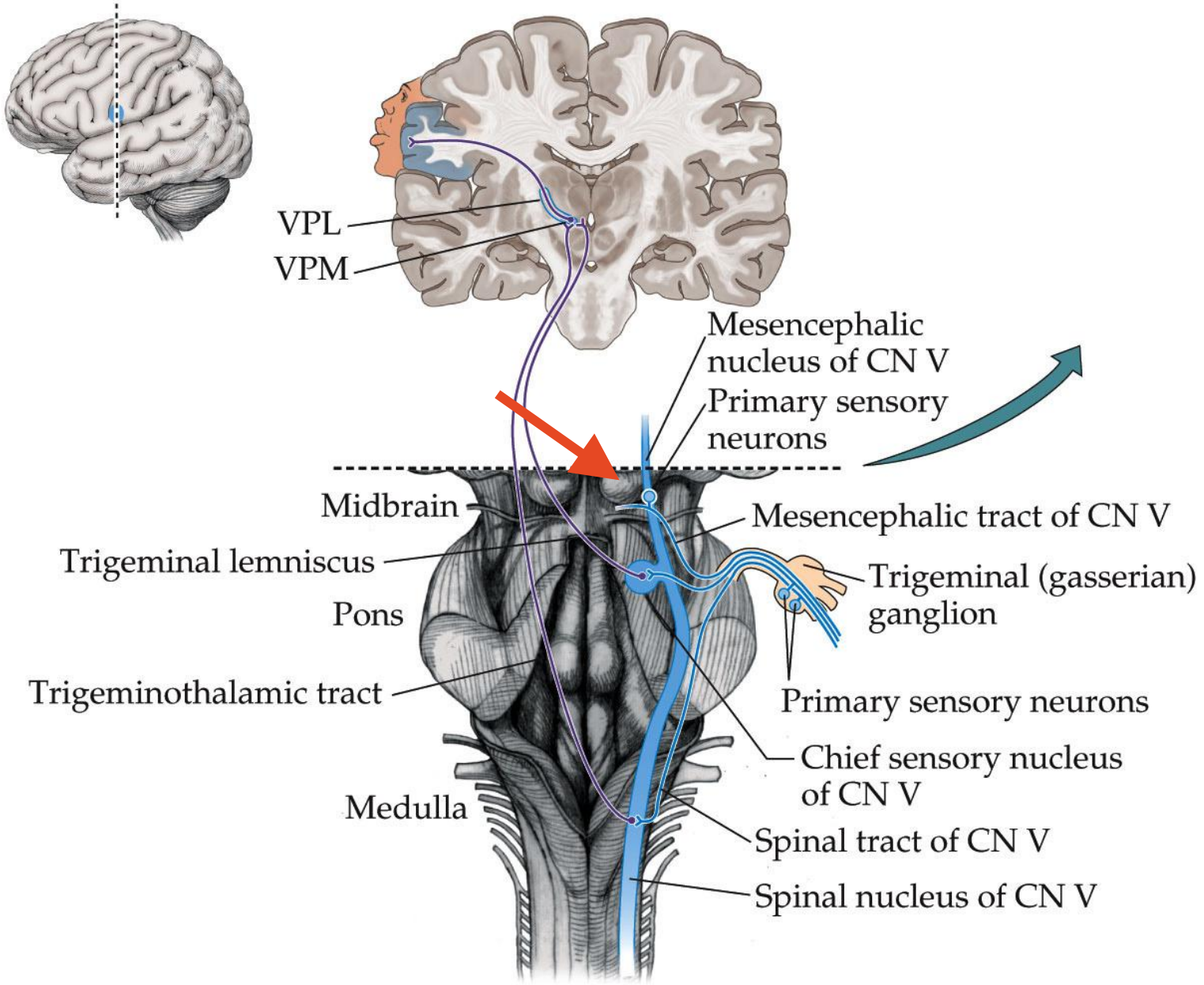
- Peripheral fibers exit with V1 and V3 to contact the muscle spindles of the appropriate muscles
- **The flow of information is towards the CNS** and enters the brainstem with the peripheral fibers of mesencephalic neurons
- Proprioceptive information is then transmitted through the central fiber of the mesencephalic neurons to different CNS locations

carrying sensory info from muscles of mastication and eye muscles

- Proprioceptive fibers reach the **ipsilateral thalamus** (conscious prorioception), the **cerebellum** (unconscious proprioception) and the **trigeminal motor nucleus**
- Thalamocortical fibers from VPM terminate in the face area of the **primary sensory cortex**
- The **motor nucleus** uses the proprioceptive information to produce a motor response – the Jaw Jerk Reflex

muscle spindle reflex of jaw muscles

OBJ. # 5



***NEUROANATOMY 2e*, Figure 12.8 (Part 1)**

Nuclei Associated With CN V

- Spinal nucleus of V
- Principal sensory nucleus
- Motor nucleus
- Mesencephalic nucleus

Ganglia Associated With CN V

- Trigeminal ganglion
- Mesencephalic nucleus

mesencephalic on both bc ganglia in cns

Trigeminal Nerve, CN V

OBJ. # 6

- Reflexes
  - Corneal reflex:
    - Afferent limb → CN V
    - Efferent limb → Facial nerve blinking reflex
  - Jaw Jerk reflex
    - Afferent limb → CN V, proprioceptive fibers
    - Efferent limb → CN V, motor fibers

what is the only reflex that is carried in and out thorugh the same CN?

Jaw Jerk Reflex

OBJ. # 6

- Afferent limb → Proprioceptive fibers from mesencephalic nucleus
- Efferent limb ← Motor fibers from trigeminal motor nucleus

pseudounipolar neurons so no synapse
receive and project all in one cell
bilaterally
don't need/want only one side of the jaw contracting in response to a suddens stretch

Both motor nuclei of V coordinate and integrate this bilateral reflex

Blink Reflex / Corneal Reflex

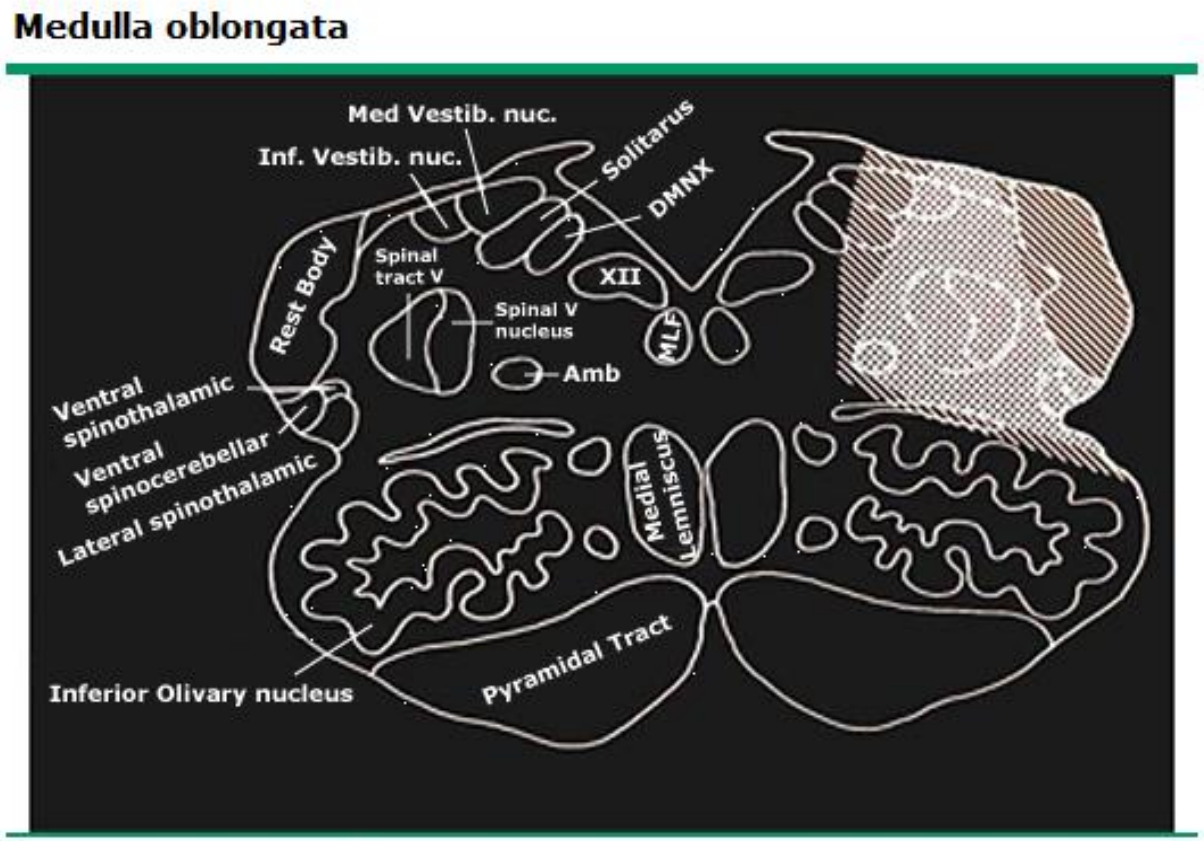
OBJ. # 6

- Afferent limb → Pain receptor on the cornea
  corneal stimulation not sclera
  ↓ Trigeminal nerve
  Spinal nucleus of V & Principal sensory
  ↓ Bilaterally
  Neurons in the reticular formation
- Efferent limb → Motor fibers from both facial motor nuclei (blink bilaterally)

The pontine reticular formation is the reflex integration center

use a cotton swab, sterile and testing in a patient who is not very alert - touch cornea gently and want to see that both eyes blink
if absent on one side - afferent prob
absent on both sides - pontine/medullary injury
see reflex but only see contraction on one side - efferent prob

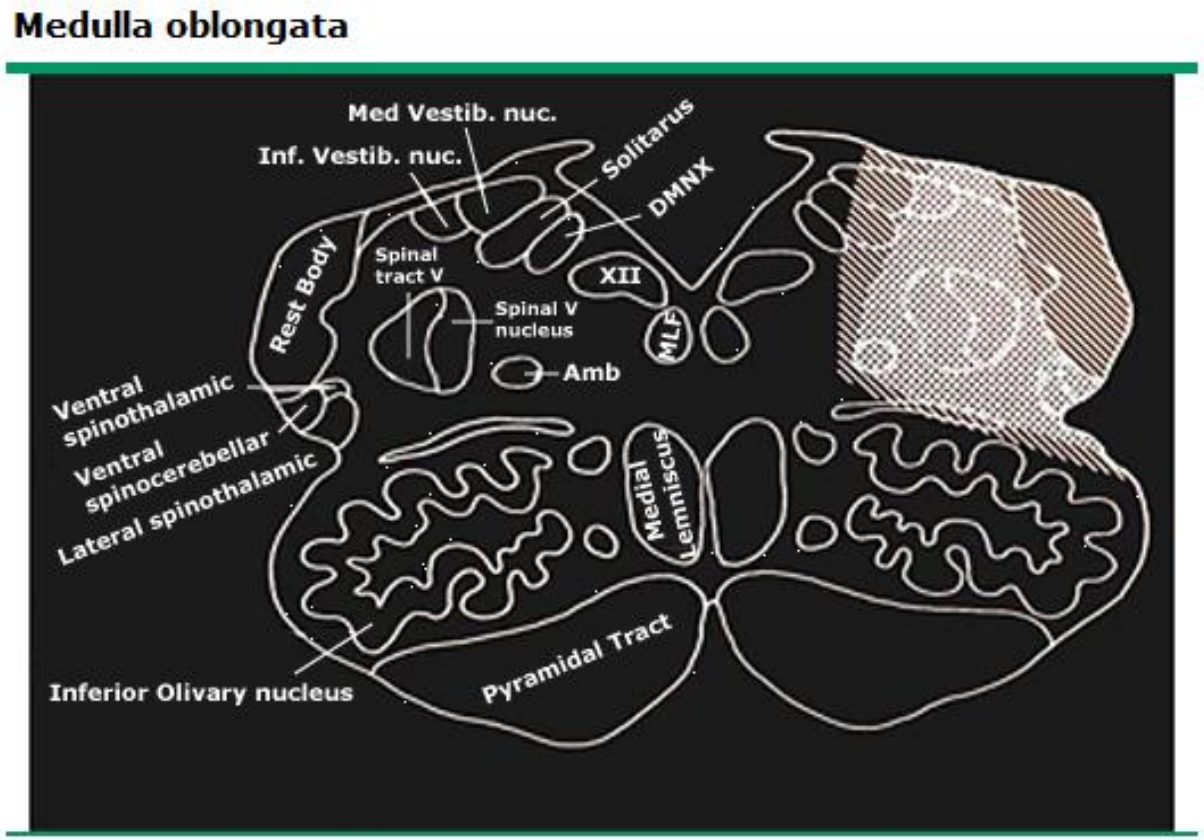
Clinical Correlate: Lateral Medullary Syndrome



The usual location of lateral medullary infarcts is hatch-marked in the upper right of the figure. The anatomical structures are labeled on the diagram.

- Also called Wallenberg's Syndrome
- Usually due to thrombosis of vertebral artery, PICA, or a perforating medullary branch
- Of the structures you've learned, which do you predict would be injured?
- What sensory deficits would you anticipate?

Clinical Correlate: Lateral Medullary Syndrome



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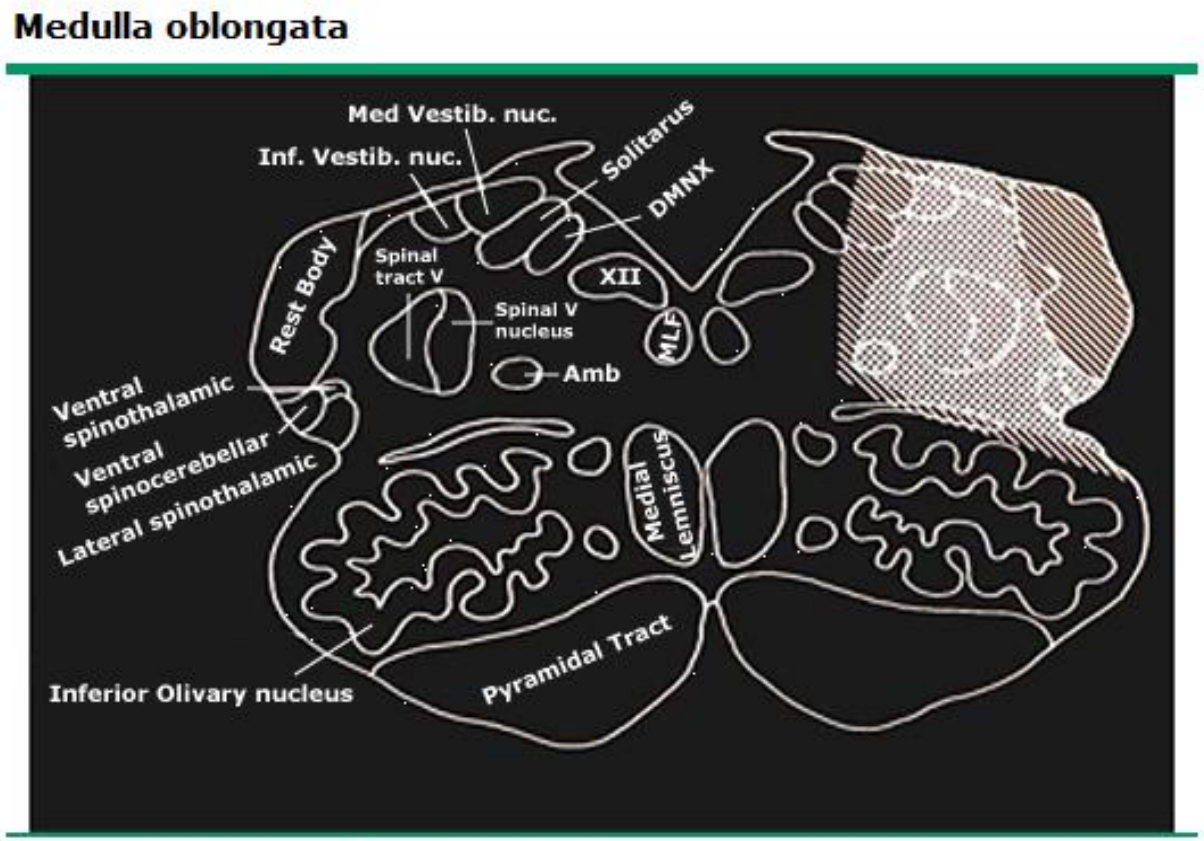
UpToDate

Structures:

- Spinal nucleus/tract of V
- Nucleus Ambiguous
- Ventral/lateral spinocerebellar tracts
- Lateral spinothalamic tract
- Vestibular nuclei

Clinical Correlate: Lateral Medullary Syndrome

split of sensory loss



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UpToDate

Deficits: injury of spinal tract and nucleus CN V

- Ipsilateral facial sensory loss for pain and temp
- Contralateral body sensory loss for pain and temperature ALS system already decussated
- Vertigo, tendency to fall towards ipsilateral side, nystagmus vestibular nuclei
- Dysphagia, dysarthria nucleus ambiguous
- Ipsilateral Horner's syndrome (ptosis, anhidrosis, miosis)

involvement of sympathetic fibers