

# CNV Trigeminal Nerve

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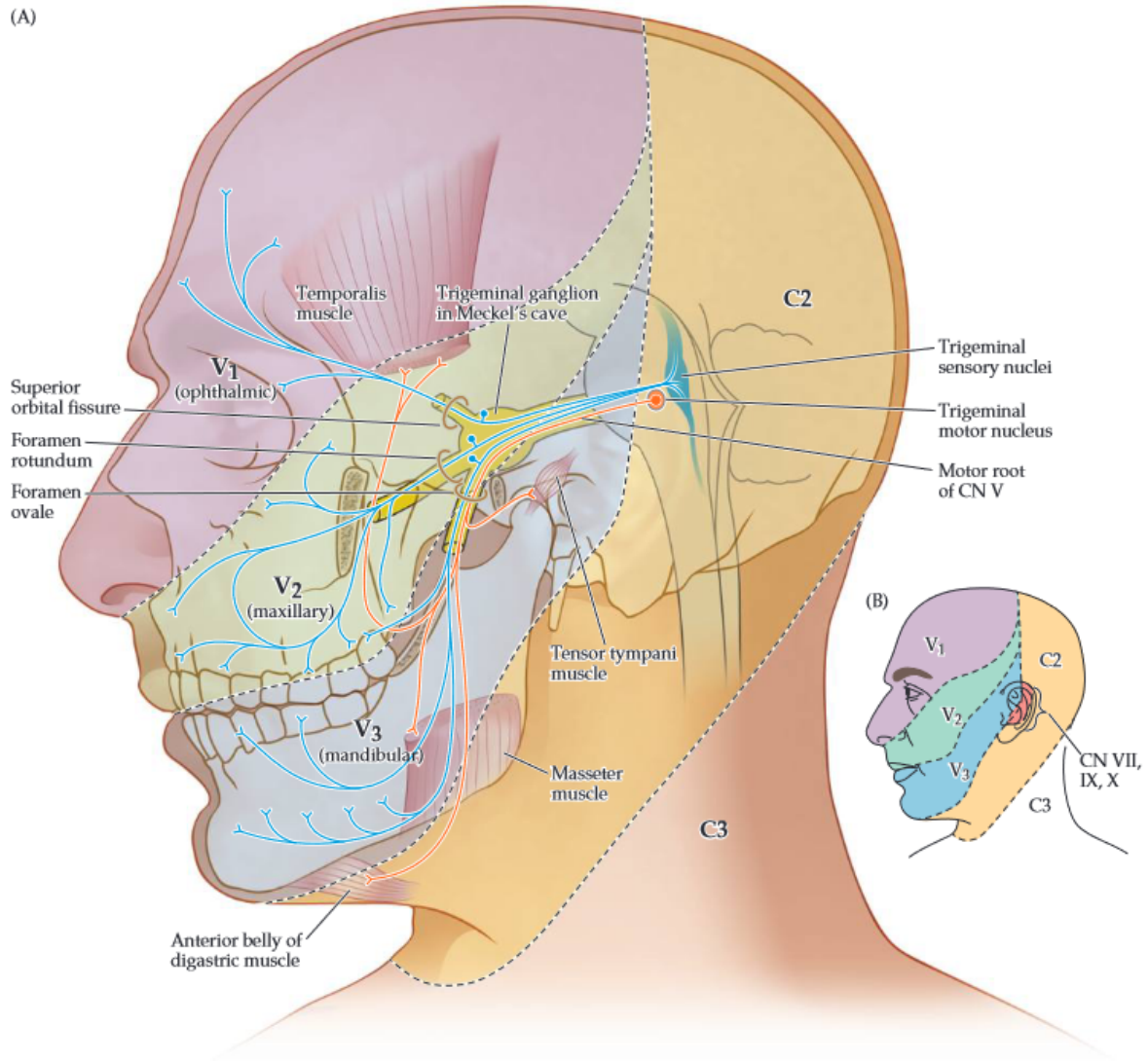


Figure 1: Trigeminal Nerve Sensory and Motor pathways (from Blumenfeld figure 12.7<sup>1</sup>)

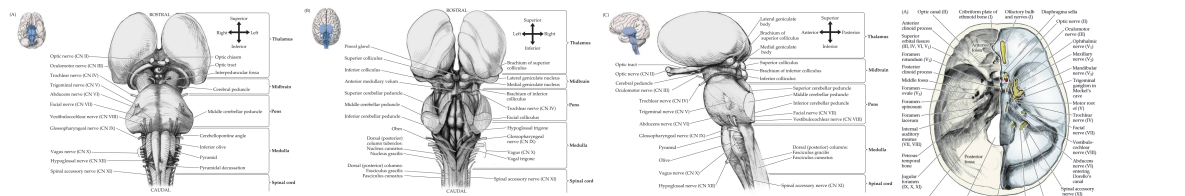


Figure 2: “Ventral view of Surface Anatomy of the brain-stem and cranial nerves (from fig12.2 of Blumenfeld<sup>1</sup>)”

Figure 3: “Dorsal view of Surface Anatomy of the brain-stem and cranial nerves (from fig12.2 of Blumenfeld<sup>1</sup>)”

Figure 4: “Lateral view of the surface Anatomy of the brain-stem and cranial nerves (from fig12.2 of Blumenfeld<sup>1</sup>)”

Figure 5: “Skull foramina serving as cranial nerve exit points (from fig12.3 of Blumenfeld<sup>1</sup>)”

FIGURE 12.3 Skull Foramina Serving as Cranial Nerve Exit Points. (A) Inside view of the cranial base, with cranial nerves shown on the right and cranial foramina shown on the left. (B) View of the base of the skull, with cranial nerves shown on the right and cranial foramina shown on the left. (C) Anterior view of the skull and foramina.

## 1 Overview

CN V Trigeminal nerve is the largest cranial nerve and provides general somatic sensory to the scalp, teeth, oral and nasal cavity as well as branchial motor functions to the muscles of mastication and some surrounding musculature<sup>1,2</sup>.

Additional functions

- Additionally, The trigeminal system plays a role in facial and dural sensitivity and has also been considered a component in brain nociceptive innervation<sup>3</sup>.
- “Proprioceptive nerve fibers from the masticatory muscles and (probably) extraocular muscle”<sup>2</sup>.

The Trigeminal nerve’s course can be broken down into: - Brainstem - Cisternal segment - Meckel’s cave segment - Trigeminal ganglion - Pperipheral divisions: Ophthalmic division ( $V_1$ ), Maxillary division ( $V_2$ ), and Mandibular division ( $V_3$ ).

Why should I care about this nerve? - The trigeminal nerve is the anatomical substrate of several pathologies or conditions, including: Headaches (primary or secondary), trigeminal neuralgia, and alternate types of orofacial pains<sup>3</sup>. - Understanding the complex anatomical arrangement of CN V’s pathway is crucial to understand these conditions’ pathophysiology and treatment<sup>3</sup>.

## 2 Trigeminal Nuclei

There are 4 trigeminal nuclei (3 sensory and 1 motor):

- **Mesencephalic nucleus** (Conveys afferent proprioceptive fibers from extraocular and masticatory muscles and allows for bite modulation<sup>2</sup>)
- **Trigeminal sensory nucleus**
  - Conveys touch and proprioception of the jaw area -ninjanerd
  - Conveys tactile and pressure sense<sup>2</sup>
- **Trigeminal motor nucleus** (Modulates degree of bite)
- **Spinal trigeminal nucleus** Conveys touch, pain, pressure, and proprioception from the entire face
  - **Spinal Trigeminal tract**

## 3 Anatomy

### 3.1 Brainstem

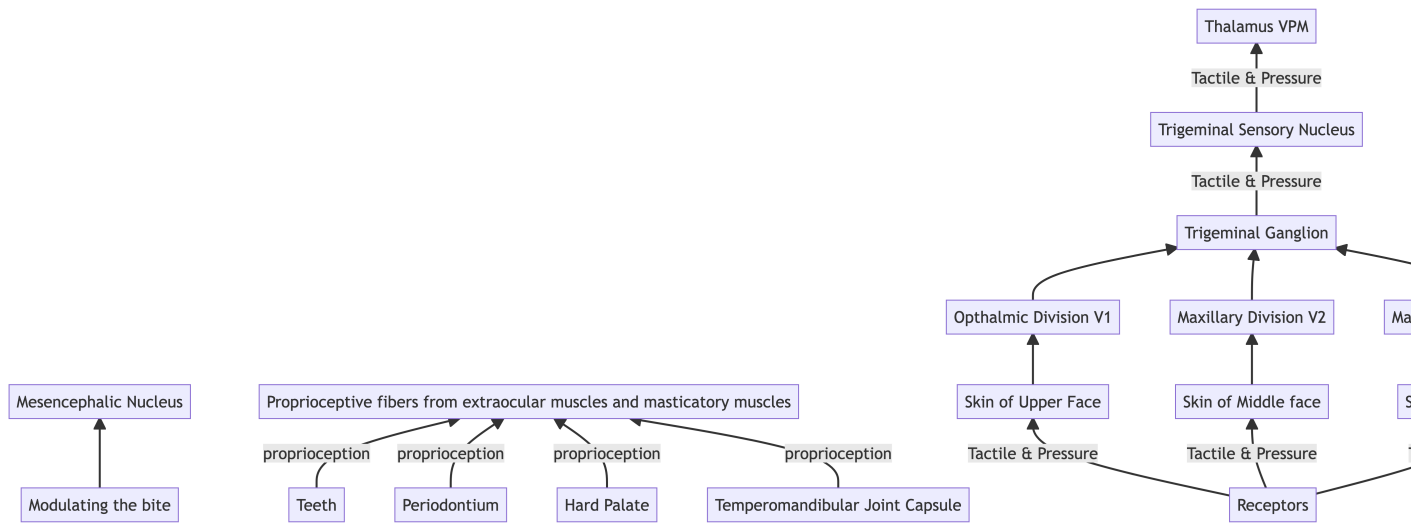
### 3.2 Trigeminal Root (Cisternal Segment)

- The 4 trigeminal nuclei (3 sensory, 1 motor) extend throughout most of the brain stem<sup>2</sup>
- “The trigeminal root is composed of the large sensory root and the small motor root”<sup>2</sup>
- “The sensory root receives somatosensory sensation from the entire face , temple, external acoustic meatus, and the anterior scalp as far posterior as the vertex of the skull”<sup>2</sup>

#### **i** Note

The trigeminal nerve supplies somatosensation to the entire face except the angle of the jaw innervated by the cervical plexus<sup>2</sup>

The proprioceptive impulses from the masticatory muscle run through the motor root to enter the mesencephalic nucleus<sup>2</sup>



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## 4 Sensory Root (Portio Major)

### 4.1 Sensory Pathway

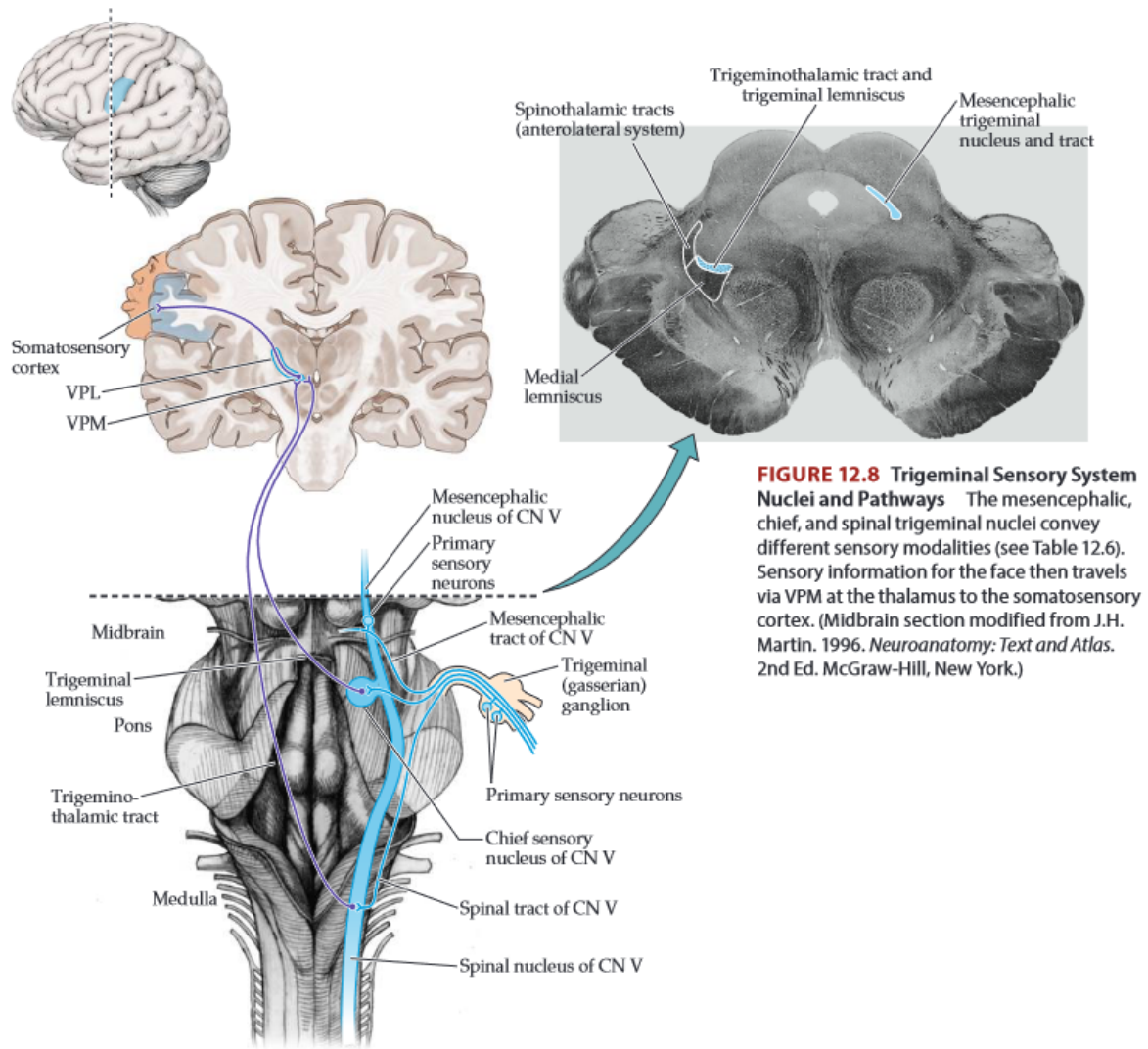


Figure 6: Trigeminal Sensory System Nuclei and Pathways (from Blumenfeld figure 12.8<sup>1</sup>)

- Somatosensory afferent nerves convey crude touch, pain, and temperature sensation from the face and mouth to the lateral pons<sup>1</sup>.
- These nerve fibers then descend the spinal trigeminal tract to synapse in the [spinal trigeminal nucleus](#)<sup>1</sup>.

- . Similarly, the spinal trigeminal tract is analogous to Lissauer's tract (see Figures 6.4 and 7.2). Secondary sensory neurons from the spinal trigeminal nucleus cross the brainstem to ascend as the trigeminothalamic tract (or ventral trigeminothalamic tract). The trigeminothalamic tract is analogous to the spinothalamic tract (see Table 12.6), and the pathways travel together to the thalamus (see Figures 12.8 and 14.3). Trigeminothalamic tract fibers synapse in the thalamic ventral posterior medial nucleus (VPM), and tertiary sensory neurons then travel in the internal capsule to the primary somatosensory cortex. Like the anterolateral systems in the spinal cord, there are also pathways from the spinal trigeminal nucleus to intralaminar thalamic nuclei, the reticular formation, and other areas, to mediate the affective and arousal aspects of facial pain.

In summary, it is generally believed that sensory fibers involved in the conduction of pain and temperature spread over the trigeminal sensory nucleus complex (TSNC) and then cross over to the contralateral thalamus and cerebral cortex<sup>4</sup>

## 4.2 Sensory Function

- V<sub>1</sub> Ophthalmic supplies the upper face
- V<sub>2</sub> Maxillary supplies the middle face
- V<sub>3</sub> Mandibular supplies the lower face

The trigeminal nerve also provides touch and pain sensation for the nasal sinuses, inside of the nose, mouth, and anterior two-thirds of the tongue.

## 4.3 Dysfunction

- [Trigeminal neuralgia](#)

# 5 Motor Root (Portio Minor)

## 5.1 Motor Pathway

- The motor plan is sent from the cerebrum/cerebellum inferiorly to the [trigeminal motor nucleus](#)
- From there, the motor signal exits the [trigeminal motor nucleus](#) and passes anteriorly in the pons<sup>5</sup>
- The motor root emerges from the ant-lat aspect of the pons<sup>5</sup>
  - The motor root is anterior and medial relative to sensory root<sup>5</sup>

- Next, the motor root passes through the posterior fossa and then through the dura mater below the attachment of the tentorium<sup>5</sup>
- The motor root then enters Meckel Cave<sup>5</sup>
  - travels *beneath* the trigeminal ganglia<sup>5</sup>
  - Exits the skull through foramen ovale<sup>5</sup>
- Upon its exodus from the skull, the motor root joins the sensory fibers in the mandibular (V<sub>3</sub>) division to form the mandibular nerve
- The mandibular nerve (V<sub>3</sub>) connects the motor root to the masticatory muscles (masseter, temporalis, and medial and lateral pterygoid muscles)<sup>5</sup>
  - In addition, motor fibers are given off to the tensor tympani, tensor veli palatini, and mylohyoid muscles, and to the anterior belly of the digastric muscle”<sup>5</sup>

## 5.2 Motor Function

## 6 Meninges Sensitivity

The trigeminal system not only supports sensation to the face, but also the dura and pia<sup>3</sup>.

## 7 Brain innervation

## 8 Pathways

- The trigeminal nerve exits the brainstem from the ventrolateral pons<sup>1</sup>.
- Next CN V enters Meckel’s Cave (a small fossa posterior and inferolateral to the cavernous sinus)<sup>1</sup>.
- CN V synapses on the trigeminal ganglion (sensory ganglion) in Meckel’s cave<sup>6</sup>.
- The ophthalmic division (V<sub>1</sub>) travels through an inferior section of the cavernous sinus and exits the skull through the superior orbital fissure<sup>1</sup>.
- The maxillary division (V<sub>2</sub>) exits via the foramen rotundum<sup>1</sup>
- The mandibular division (V<sub>3</sub>) via the foramen ovale<sup>1</sup>



### Mnemonic

A way to remember the exit points of each trigeminal division is “Standing Room Occupancy”, or SRO (for Superior, Rotundum, Ovale)



In addition, pain sensation for the supratentorial dura mater is supplied by the trigeminal nerve, while the dura of the posterior fossa is innervated by CN X and upper cervical nerve roots.

Skin of face -> Receptor -> fine touch/dental pressure -> DIVISION -> Chief trigeminal sensory nucleus -> Trigeminal lemniscus -> VPM of thalamus

Skin of face -> Receptor -> Proprioception -> DIVISION -> Mesencephalic trigeminal nucleus -> ?

Skin of face -> Receptor -> Crude touch / Pain / Temperature -> DIVISION -> trigeminothalamic tract -> VPM of Thalamus

## 9 Trigeminal Ganglion

(AKA “semilunar ganglion” or “gasserian ganglion”)

Table 1: Analagous Trigeminal and Spinal Somatosensory Systems

Nucleus	Sensory Modalities	Main pathway to thalamus	Main thalamic nucleus
Mesencephalic trigeminal nucleus	Proprioception	-	-
Chief trigeminal sensory nucleus	fine touch; dental pressure	Trigeminal Lemniscus	VPM
Spinal trigeminal nucleus	Crude touch; Pain; Temperature	Trigeminothalamic tract	VPM
Posterior column nuclei	Fine touch; proprioception	Medial lemniscus	VPL
Dorsal horn	Crude touch; Pain; Temperature	Spinothalamic Tract	VPL

## 10 External Resources

- Ninja Nerd’s Trigeminal Nerve video
- Brazis’s localization in neurology contains a solid overview and really good DDX<sup>5</sup>

1. Blumenfeld H. *Neuroanatomy Through Clinical Cases*. 3rd ed. Oxford university press; 2022.
2. Joo W, Yoshioka F, Funaki T, Mizokami K, Rhoton AL. Microsurgical anatomy of the trigeminal nerve. *Clinical Anatomy*. 2014;27(1):61-88. doi:[10.1002/ca.22330](https://doi.org/10.1002/ca.22330)
3. Terrier LM, Hadjikhani N, Destrieux C. The trigeminal pathways. *Journal of Neurology*. 2022;269(7):3443-3460. doi:[10.1007/s00415-022-11002-4](https://doi.org/10.1007/s00415-022-11002-4)
4. Henssen DJHA, Kurt E, Kozicz T, van Dongen R, Bartels RHMA, van Cappellen van Walsum AM. New Insights in Trigeminal Anatomy: A Double Orofacial Tract for Nociceptive Input. *Frontiers in Neuroanatomy*. 2016;10:53. doi:[10.3389/fnana.2016.00053](https://doi.org/10.3389/fnana.2016.00053)
5. Brazis PW, Masdeu JC, Biller J. *Localization in Clinical Neurology*. 8th ed. Wolters Kluwer Health; 2022.
6. Blumenfeld H. Neuroanatomical Basis of Consciousness. In: *The Neurology of Consciousness*. 2nd ed. Elsevier; 2016:3-29. doi:[10.1016/B978-0-12-800948-2.00001-7](https://doi.org/10.1016/B978-0-12-800948-2.00001-7)