

# UNIVERSITY OF ZAMBIA

## SCHOOL OF MEDICINE

- HUMAN ANATOMY

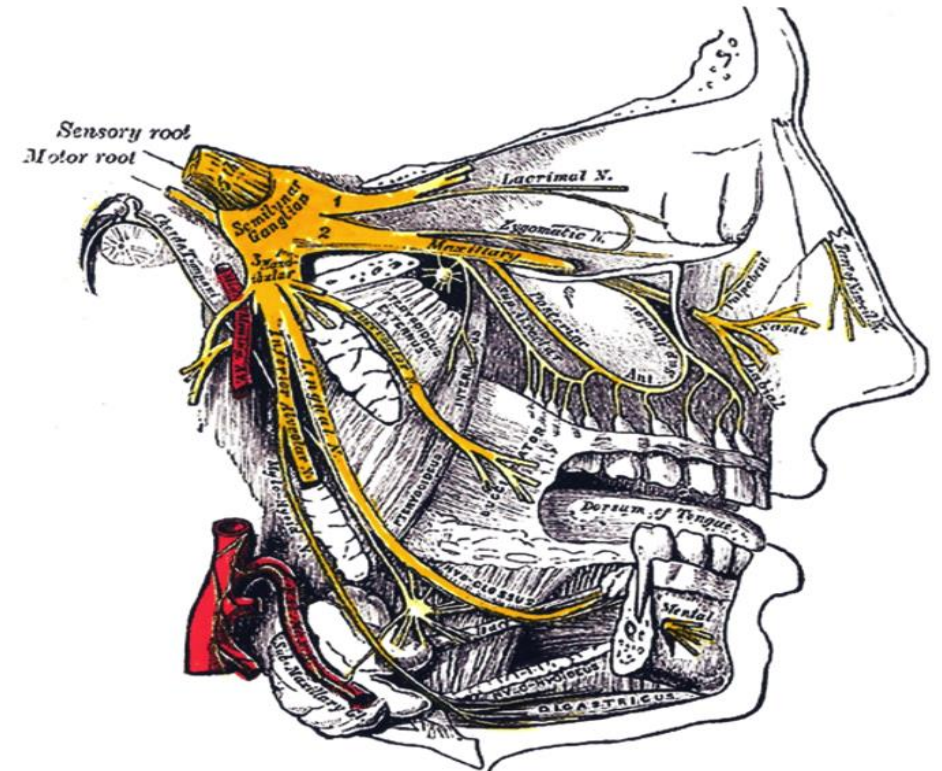
- Trigeminal Nerve

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# Introduction

- Fifth (5th) cranial nerve
- Three (3) divisions:
  - **Two (2) purely sensory: Ophthalmic nerve (V1) and maxillary nerve (V2)**
  - **One (1) sensory and motor: mandibular nerve (V3)**
- Provides sensory innervation to the face and should be distinguished from the facial nerve, which controls muscles of facial expression.
- Also has a small branchial motor root, which travels with the mandibular division and is responsible for controlling muscles of mastication and some other smaller muscles

# Introduction

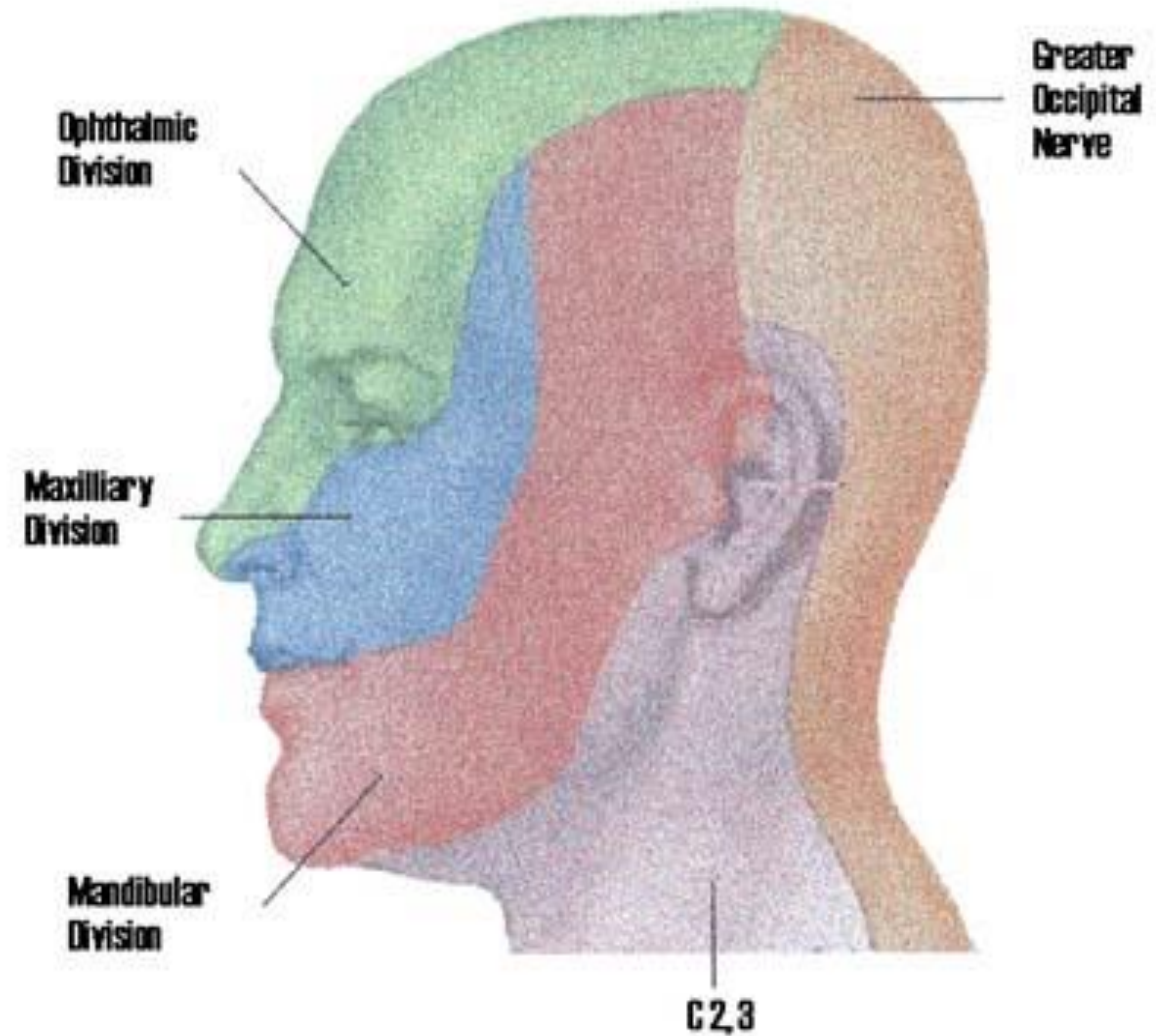
Functional Category	Function
General somatic sensory	Sensations of touch, pain, temperature, joint position, and vibration for the face, mouth, anterior 2/3rd of tongue, nasal sinuses, and meninges
Branchial motor	Muscles of mastication, tensor tympani, tensor palatini, mylohyoid, anterior belly of digastric

# Introduction

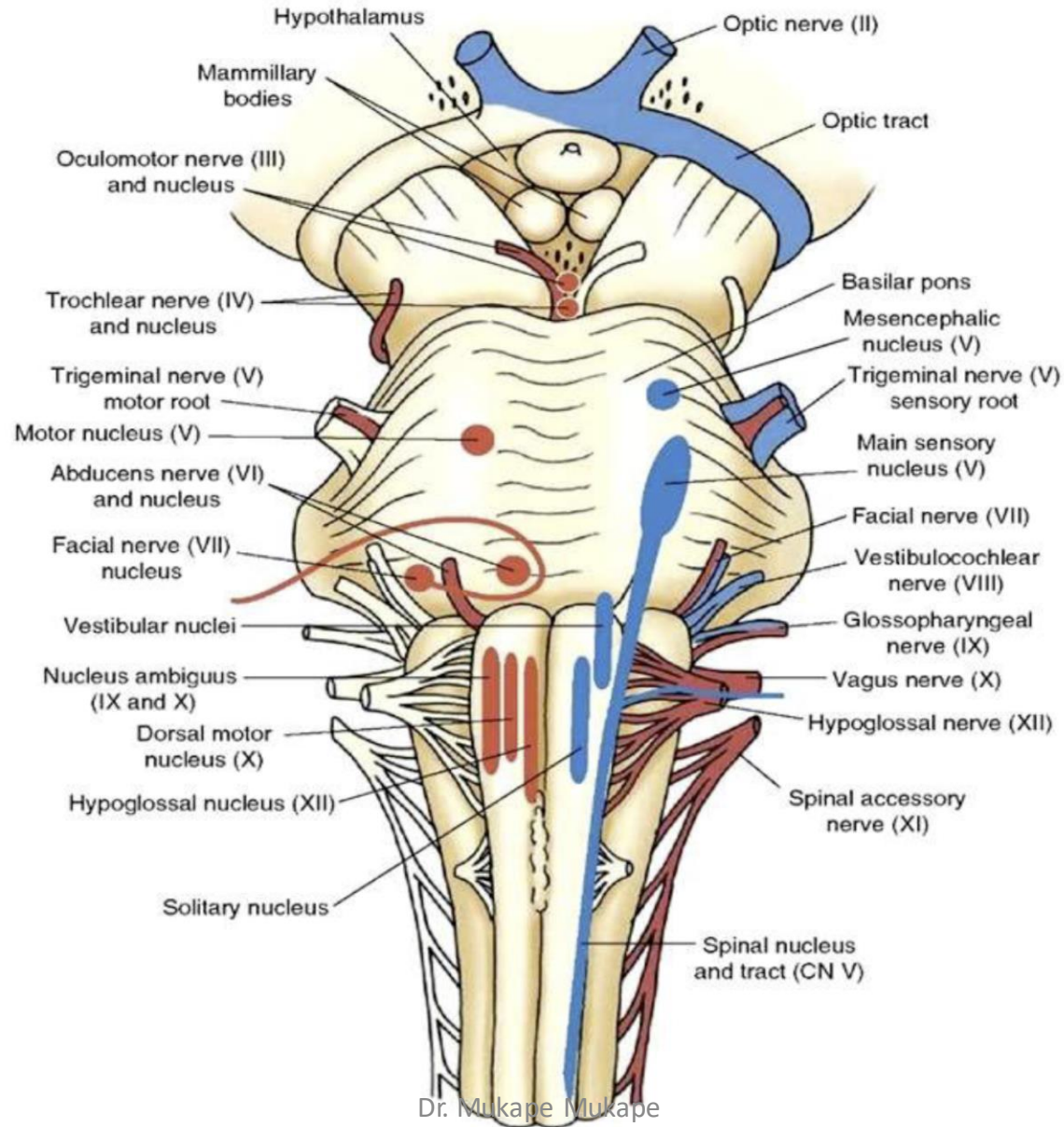
- Trigeminal nerve exits the brainstem from the **ventrolateral pons** near the middle cerebellar peduncle.
- It then enters a small fossa just posterior and inferolateral to the cavernous sinus called the **Meckel's cave**.
- The **trigeminal ganglion**, also called the **semilunar or Gasserian ganglion**, lies in the Meckel's cave and is the **sensory ganglion** of the trigeminal nerve.
- CNV1 travels via the inferior part of the cavernous sinus to exit the skull via the **superior orbital fissure**.
- CNV2 exists via the **foramen rotundum** and CNV3 via the **foramen ovale**.
- Mnemonic for exit points: Single Room Occupancy (SRO): Superior, Rotundum, Ovale

# Introduction

- Sensory territories of V1, V2 and V3 are shown in next picture.
- Sensation to occiput are conveyed via C2 (**greater occipital nerve**)
- CN V also provides touch and pain sensation for the nasal sinuses, inside of the nose, mouth, and anterior 2/3rd of the tongue.
- 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.

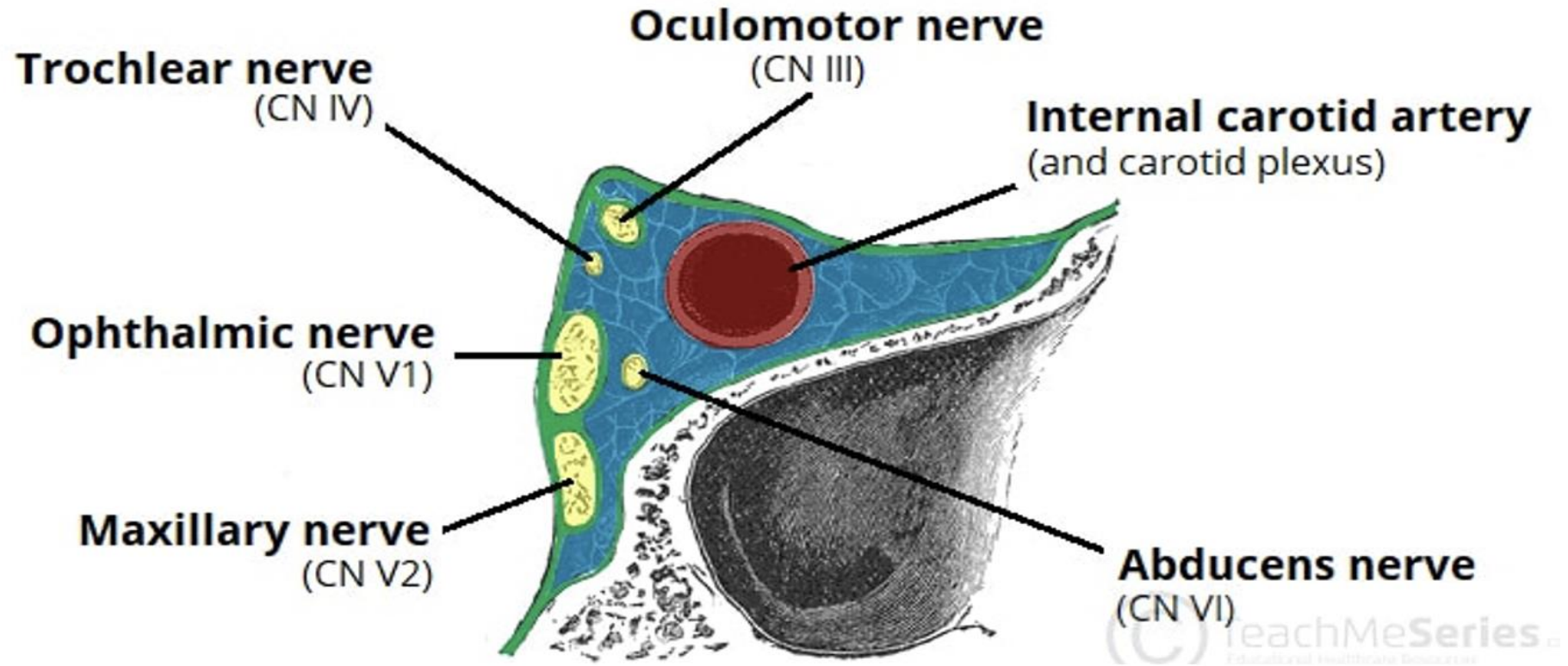


# Introduction



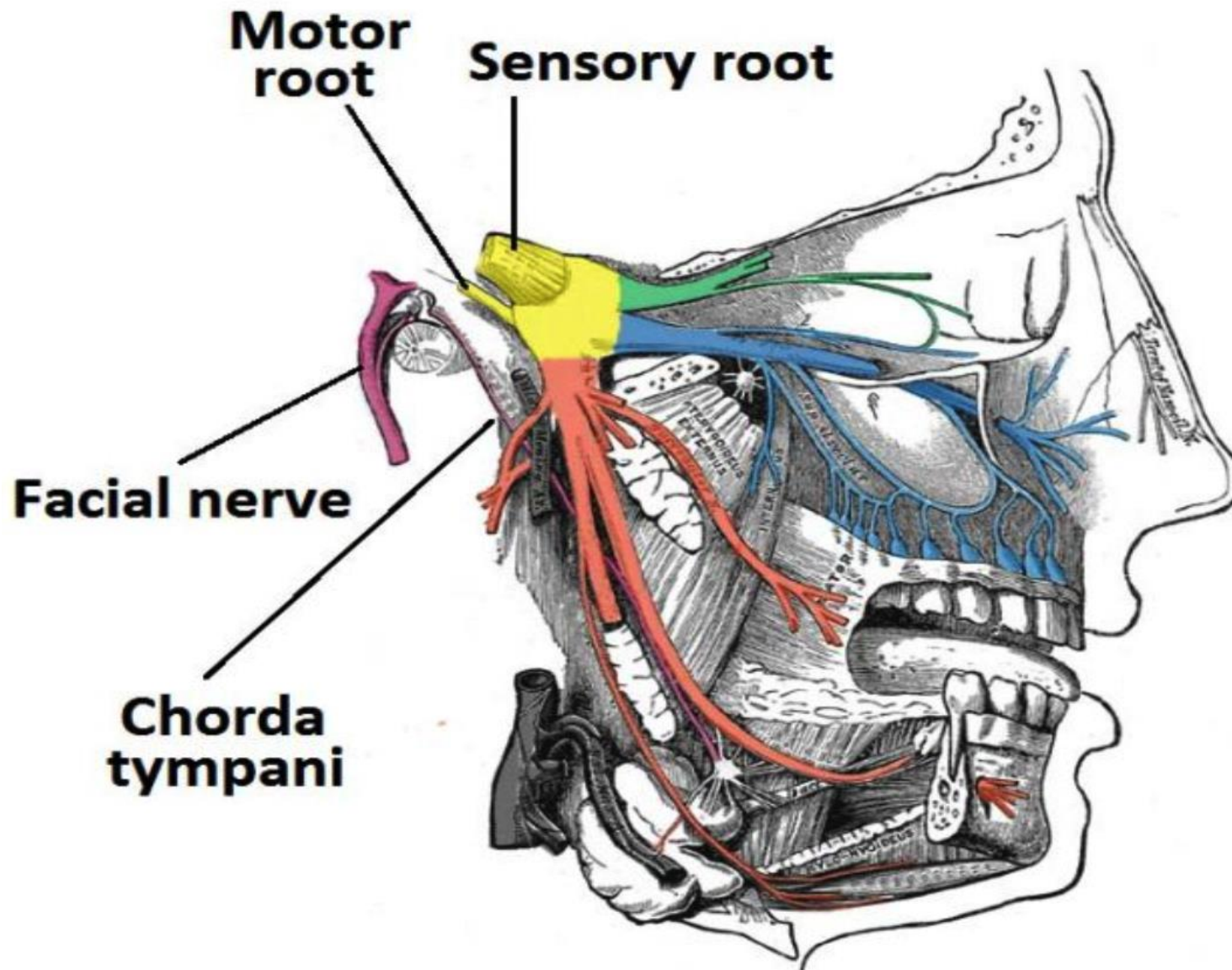
# Introduction

## - Cavernous sinus



*A useful mnemonic to remember the contents and their relation to one another is: **O TOM CAT**, where **OTOM** (oculomotor nerve, trochlear nerve, ophthalmic branch, maxillary branch) refers to the lateral wall contents from superior to inferior, and **CAT** (internal carotid artery, abducens nerve, trochlear nerve) refers to the horizontal contents, from medial to lateral.*

# Introduction



- Ophthalmic (V1)
- Maxillary (V2)
- Mandibular (V3)

# Trigeminal Somatic Sensory Functions

- Trigeminal nuclei receive general somatic sensory inputs from CN V (main input) and minor input from other cranial nerves: CN VII, CN IX and CN X
- Smaller input from CN VII, IX and X provide sensation for part of external ear
- CN IX additionally provides sensation to middle ear, posterior 1/3rd of tongue, and pharynx
- CN X additionally provides sensation to infratentorial dura and pharynx
- Trigeminal sensory systems are analogous to the posterior column-medial lemniscal system and anterolateral systems of spinal cord.

# Trigeminal Somatic Sensory Functions

- Trigeminal sensory nuclear complex runs from midbrain to the upper cervical spinal cord (specifically C3) and consists of three (3) nuclei:
  1. **Mesencephalic nucleus; together with mesencephalic trigeminal tract run along the lateral edge of the periaqueductal gray mater of midbrain**
  2. **Chief (main or principal) sensory nucleus; located in lateral pons**
  3. **Spinal trigeminal nucleus; located in the lateral pons and medulla, extends down to the upper cervical spine.**
- The **chief sensory trigeminal nucleus** provide sensory systems for the face and head that are analogous to the **posterior columns system**.
- Trigeminal lemniscus crosses to the opposite side of the brainstem to ascend with the medial lemniscus toward the thalamus
- While the medial lemniscus travels to the ventral posterior lateral nucleus (VPL), the trigeminal lemniscus travels to the ventral posterior medial nucleus (VPM). From there, tertiary sensory neurons travel to the face area of the primary somatosensory cortex.
- The **spinal trigeminal nucleus** provide sensory systems for the face and head that are analogous to the anterolateral systems.
- The primary sensory neurons for these trigeminal nuclei lie mainly in the trigeminal ganglion
- Some also lie in the peripheral sensory ganglia of CN VII, IX and X

# Trigeminal Somatic Sensory Functions

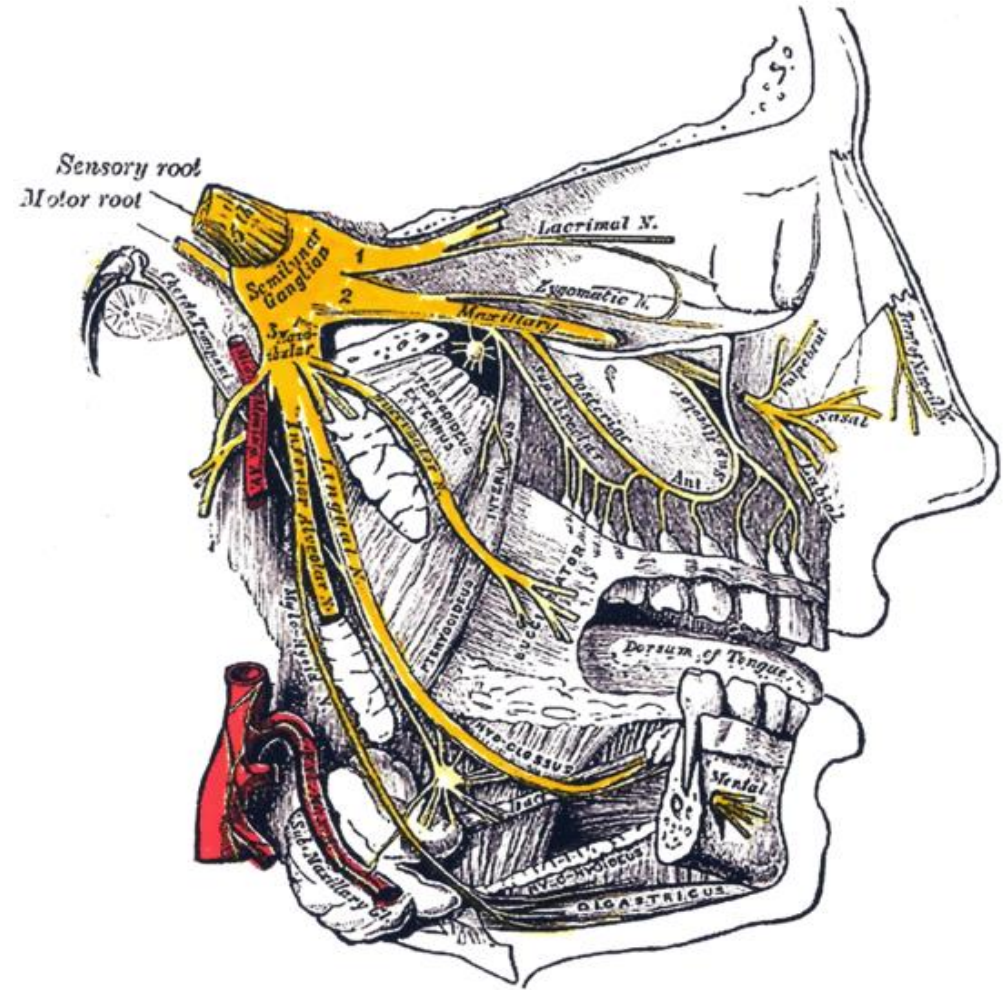
Nucleus	Sensory Modalities	Main Pathway to Thalamus	Main Thalamic Nucleus
<p><b>Trigeminal sensory nucleus:</b></p> <p>Mesencephalic trigeminal nucleus</p> <p>Chief trigeminal sensory nucleus</p> <p>Spinal trigeminal nucleus</p>	<p>Proprioception</p> <p>Fine touch; dental pressure</p> <p>Crude touch; pain; pressure</p>	<p>Trigeminal lemniscus</p> <p>Trigeminothalamic tract</p>	<p>VPM</p> <p>VPM</p>
<p><b>Spinal sensory systems:</b></p> <p>Posterior column nuclei</p> <p>Dorsal horn</p>	<p>Fine touch; proprioception</p> <p>Crude touch; pain; temperature</p>	<p>Medial lemniscus</p> <p>Spinothalamic tract</p>	<p>VPL</p> <p>VPL</p>

# Trigeminal Branchial Motor Functions

- **Trigeminal motor nucleus** mediates branchial motor functions of CN V
- Nucleus located in the upper to mid pons, near the level where the CN V exits brainstem
- Branchial motor root of CN V runs inferomedial to trigeminal ganglion along the floor of Meckel's cave and then joins CN V3 to exit via the foramen ovale
- It then supplies the muscles of mastication as well as several other muscles
- The upper motor neuron control reaching the trigeminal motor nucleus is predominately bilateral, so unilateral lesions in the motor cortex or corticobulbar tract usually cause no deficit in the jaw movement.
- Bilateral upper motor neuron lesions, however, can cause hyperflexia manifested in a brisk jaw jerk reflex

# Functions

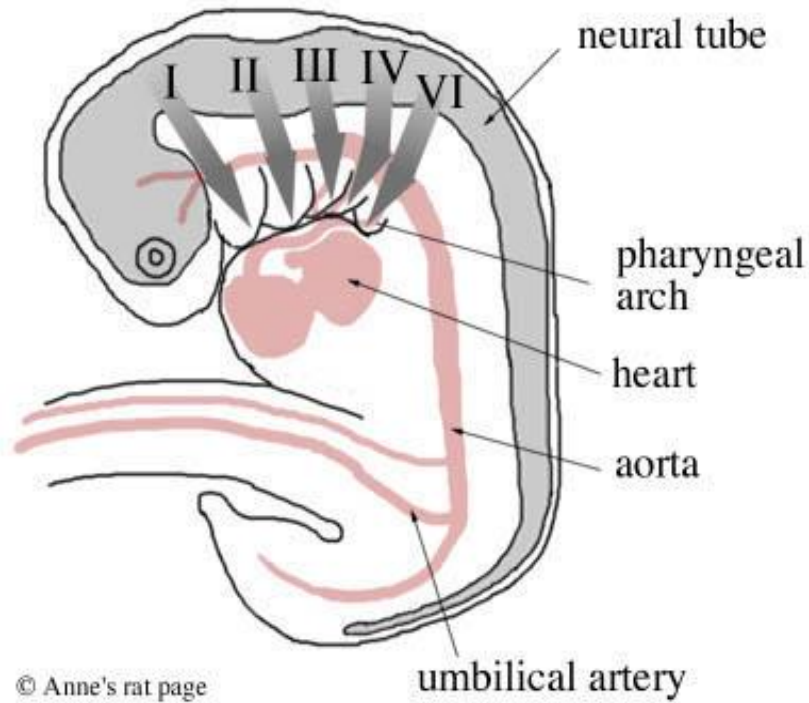
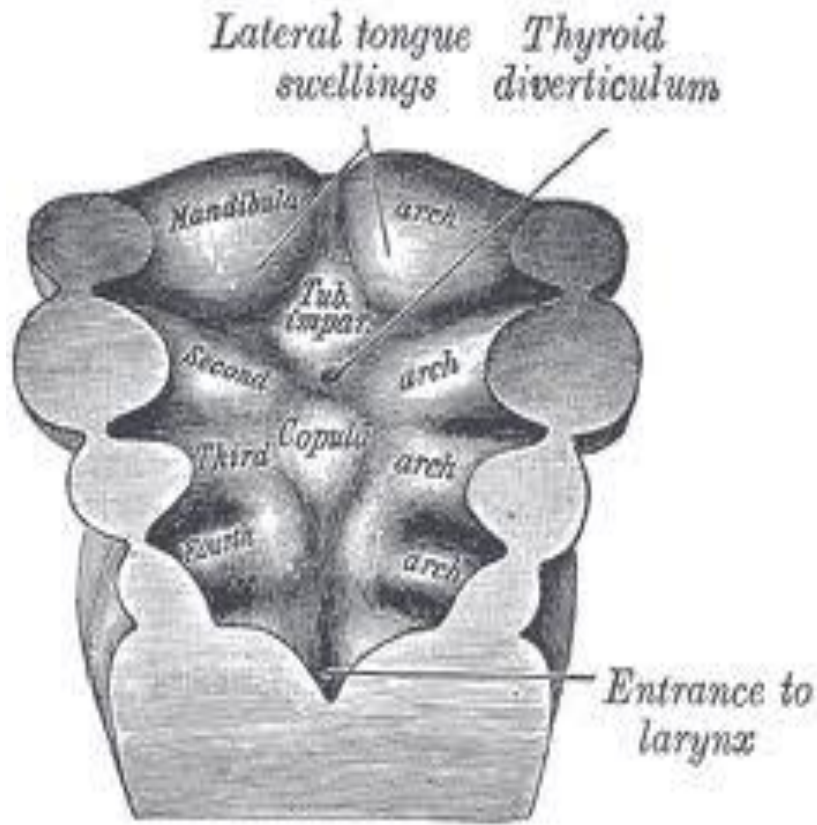
- The sensory function of the trigeminal nerve is to provide the tactile, proprioceptive, and nociceptive afference of the face and mouth.
- The motor function activates the muscles of the mastication, the tensor tympani, tensor veli palatini, mylohyoid, and anterior belly of the digastric.



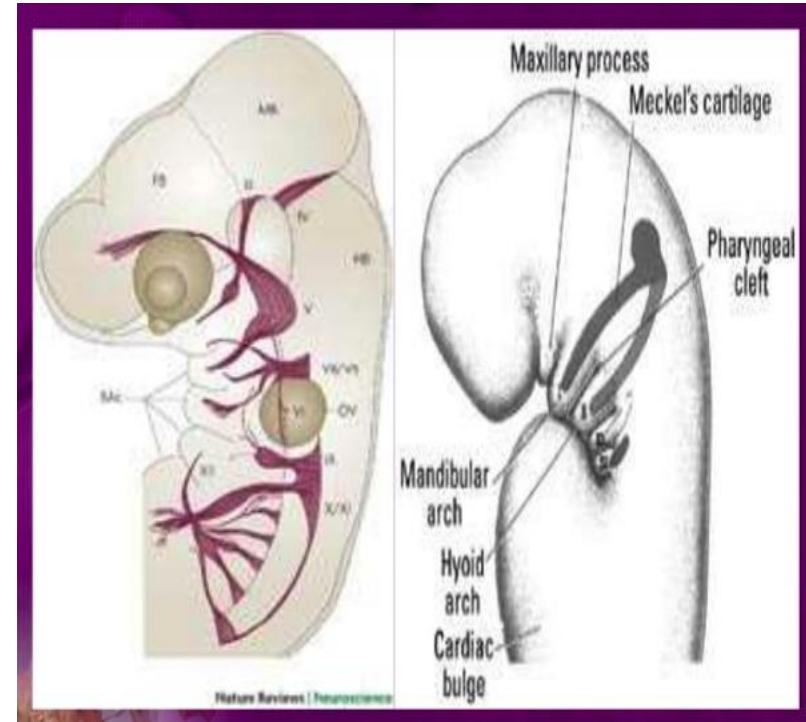
# Embryology of the trigeminal nerve

- Trigeminal nerve is derived from 1<sup>st</sup> pharyngeal arch
- *Musculature of the first pharyngeal arch includes:*
  - Muscles of mastication :temporalis, masseter, pterygoids
  - Anterior belly of digastric
  - Mylohyoid
  - Tensor tympani
  - Tensor palatini
- The nerve supply to these muscles is provided by mandibular division of trigeminal nerve

# Embryology of the trigeminal nerve

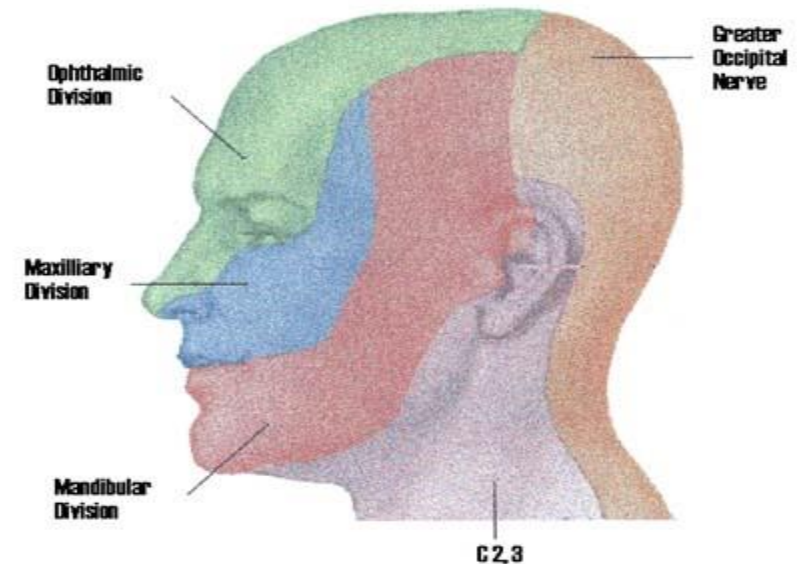


© Anne's rat page



# Embryology of the trigeminal nerve

- Mesenchyme from the 1<sup>st</sup> arch also contributes to the dermis of the face, hence sensory supply to the skin of the face is provided by ophthalmic, maxillary and mandibular branches of the trigeminal nerve.

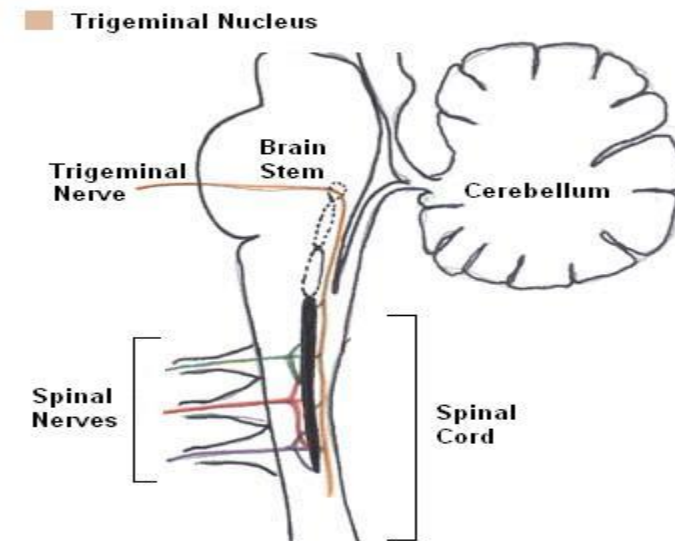
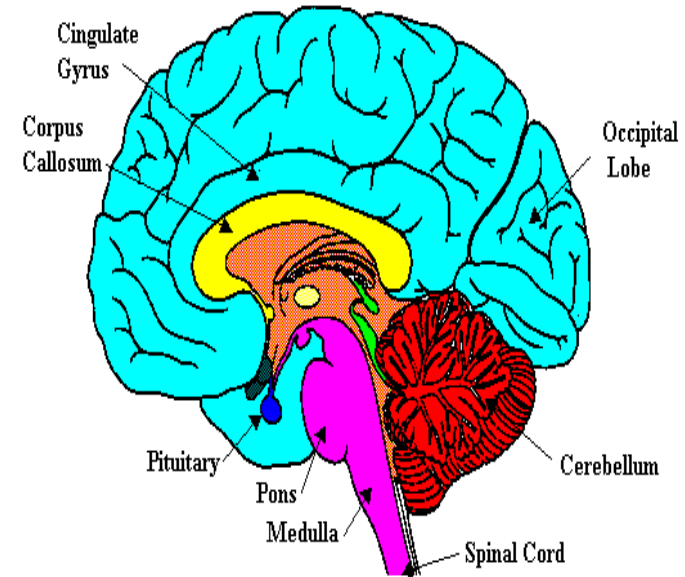


# Nuclei of trigeminal nerve

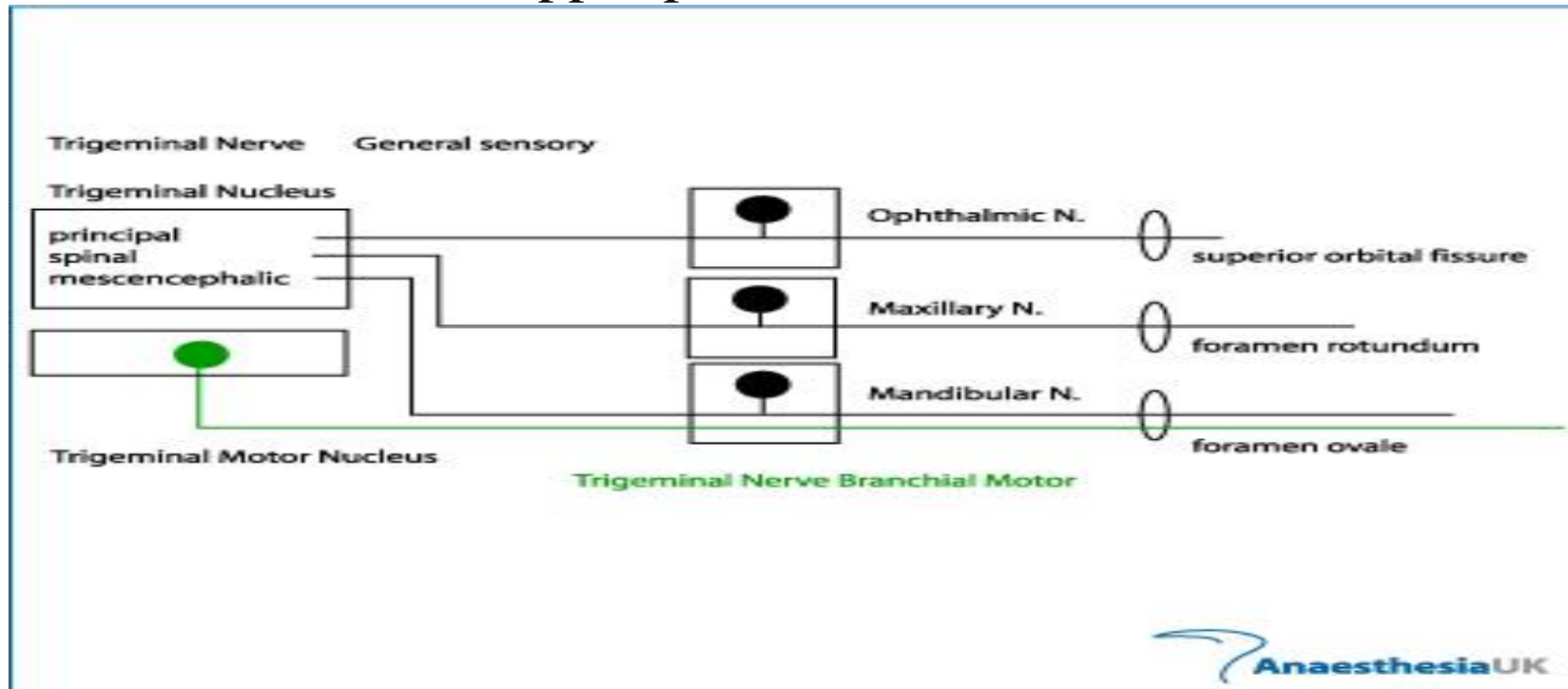
Nuclei of trigeminal nerve:-

It has got 4 nuclei :

- 1) Main sensory nuclei
- 2) Spinal nuclei
- 3) Mesencephalic nuclei
- 4) Motor nuclei



- 1. Mesencephalic nucleus in midbrain.
- 2. Main sensory nucleus situated in upper pons.
- 3. Spinal nucleus in upper pons to C2 segment of spinal cord.
- 4. Motor nucleus situated in upper pons.

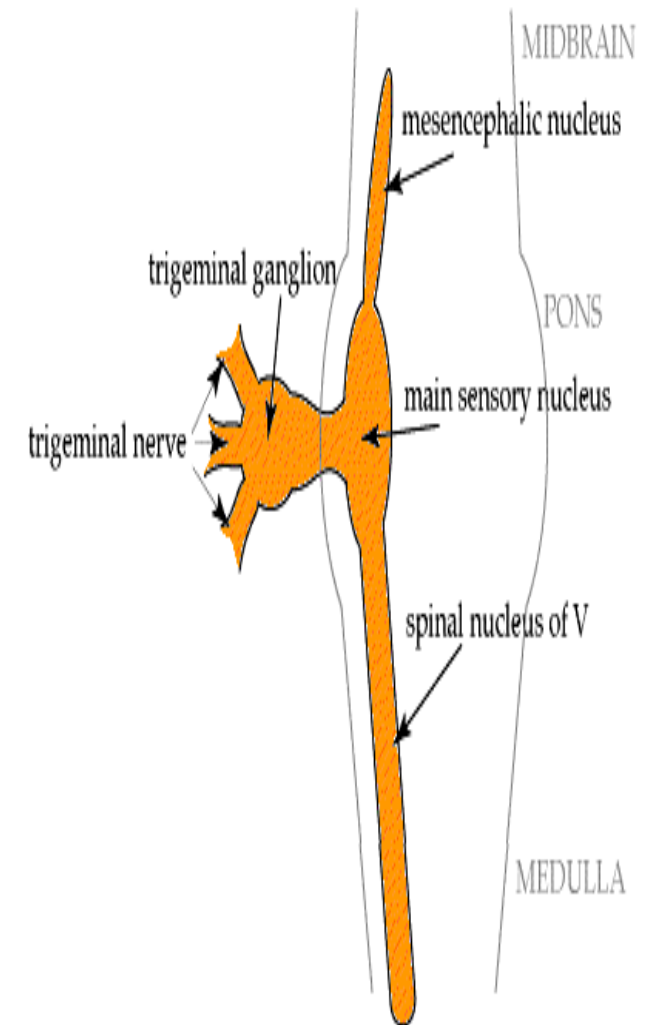


- **SENSORY NUCLEI :**

- 1. *Mesencephalic nucleus.*

- Situated in midbrain.

- First order sensory nucleus.
- Cell body of pseudounipolar neurons.
- Receives general somatic afferent fibres.
- Relay proprioception from :
  - muscles of mastication
  - facial muscles
  - eye

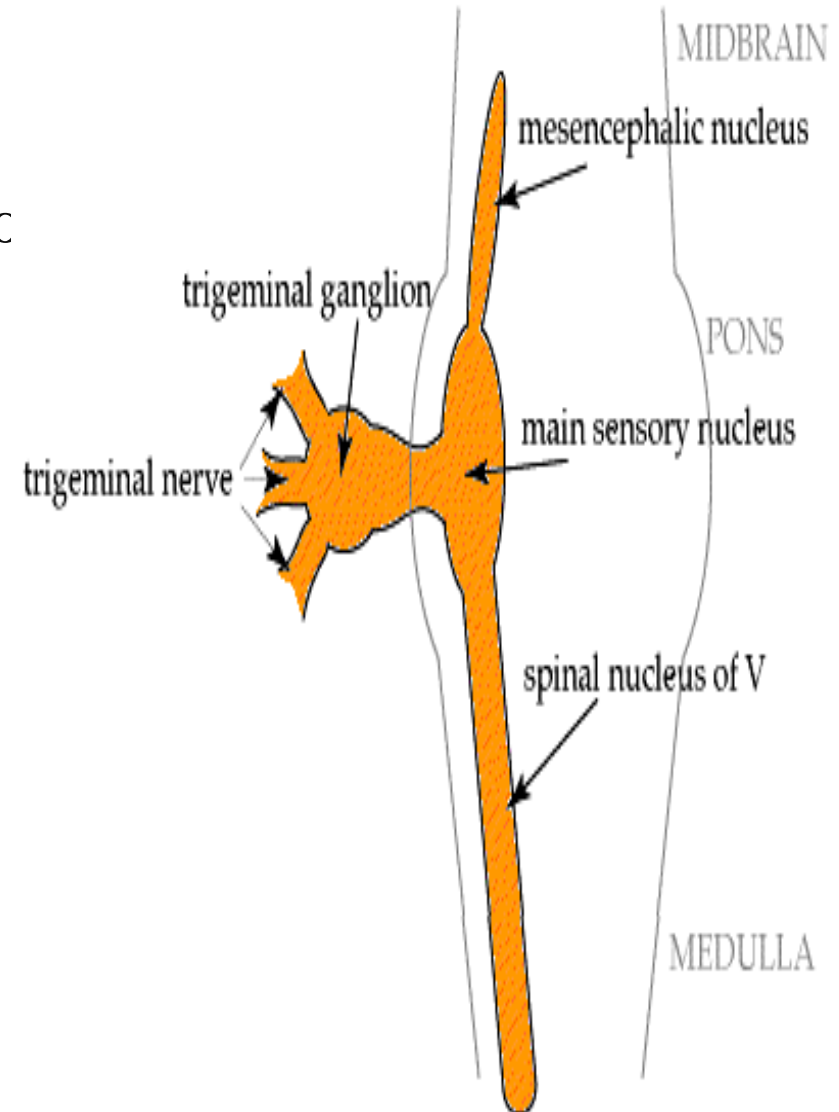


- ***2.PRIMARY SENSORY NUCLEUS***

Situated in upper part of pons lateral to motor nucleus.

Receives general somatic afferent fibres.

Relays impulses of touch and pressure from skin and mucous membrane of facial region.



- ***3. The spinal nucleus:***

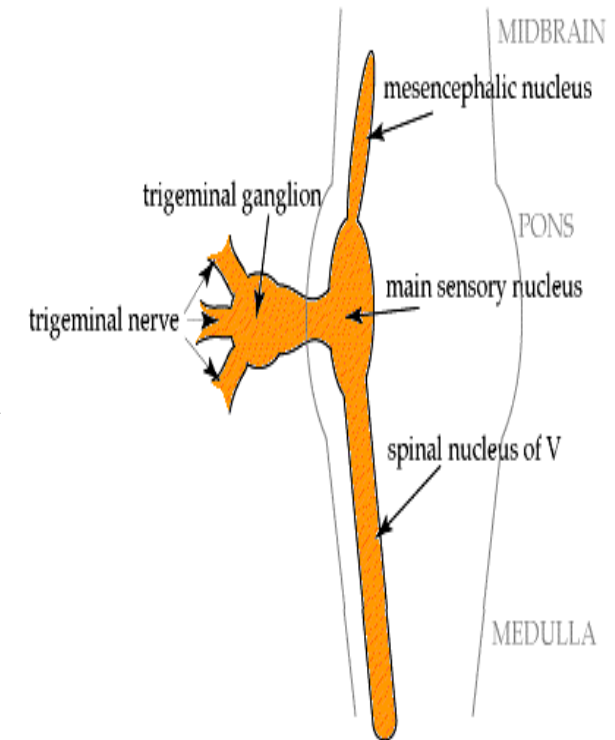
it extends from caudal end of principal sensory nucleus in pons to 2<sup>nd</sup> or 3<sup>rd</sup> spinal segment where it continues with Sub. Gelatinosa

Divided into three parts :-

1. Subnucleus oralis
2. Subnucleus interpolaris
3. Subnucleus caudalis

It receives general somatic afferent fibres

Relays the impulses of pain and temperature

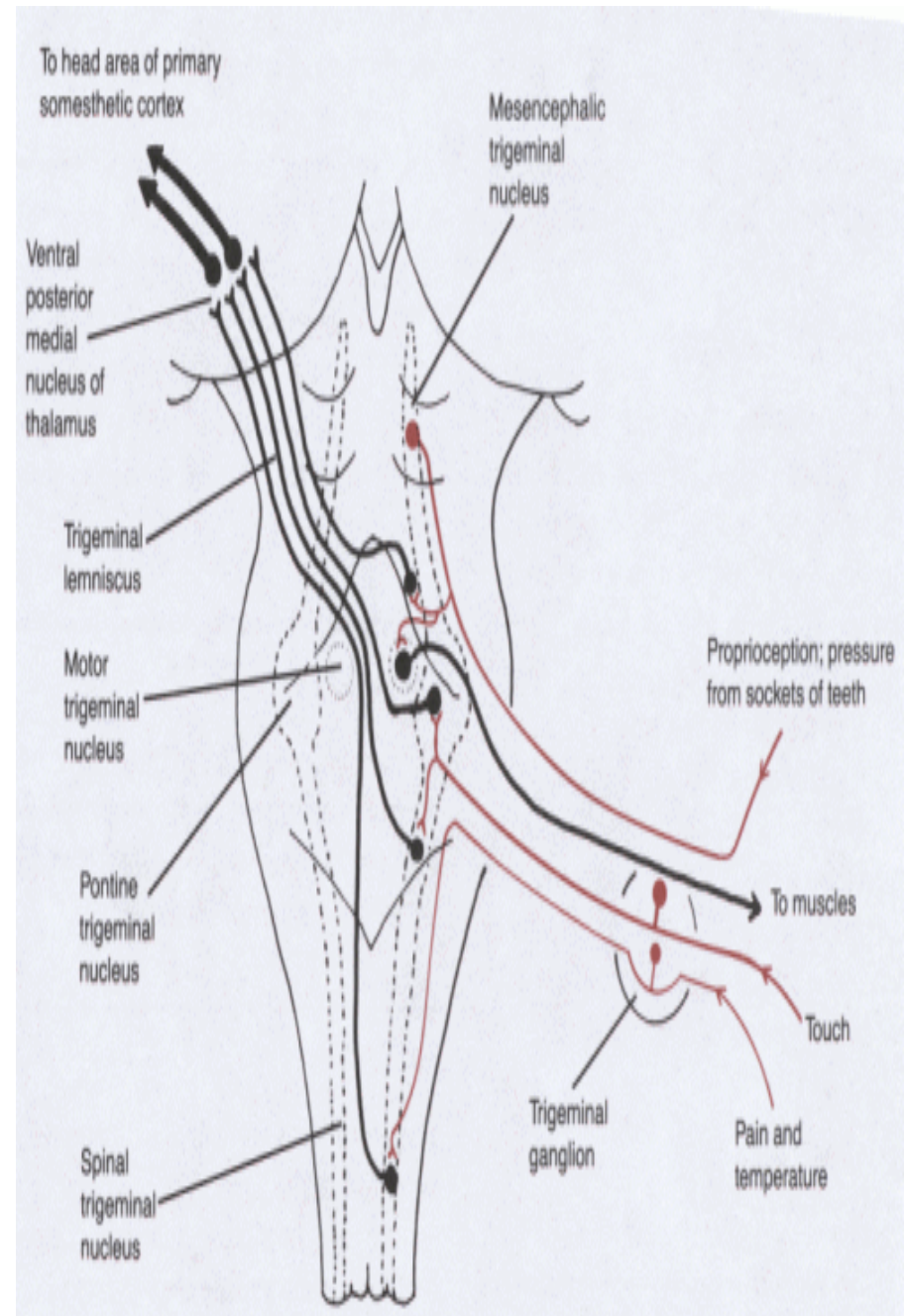


## ***1. THE MOTOR NUCLEUS***

It is situated in upper pons medial to principal sensory nucleus

Contains efferent fibres

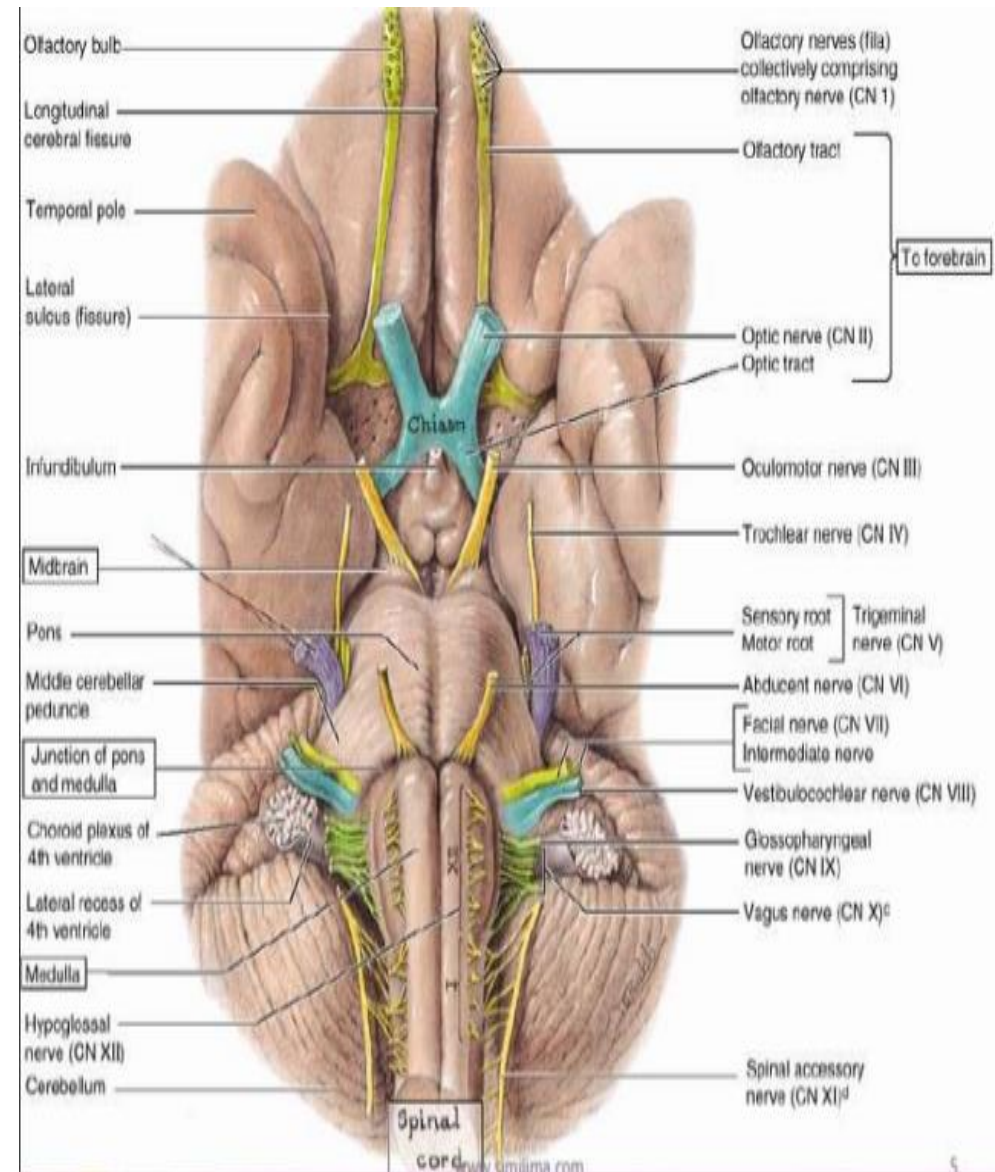
• Innervates muscles of mastication and tensor tympani and tensor palatini.



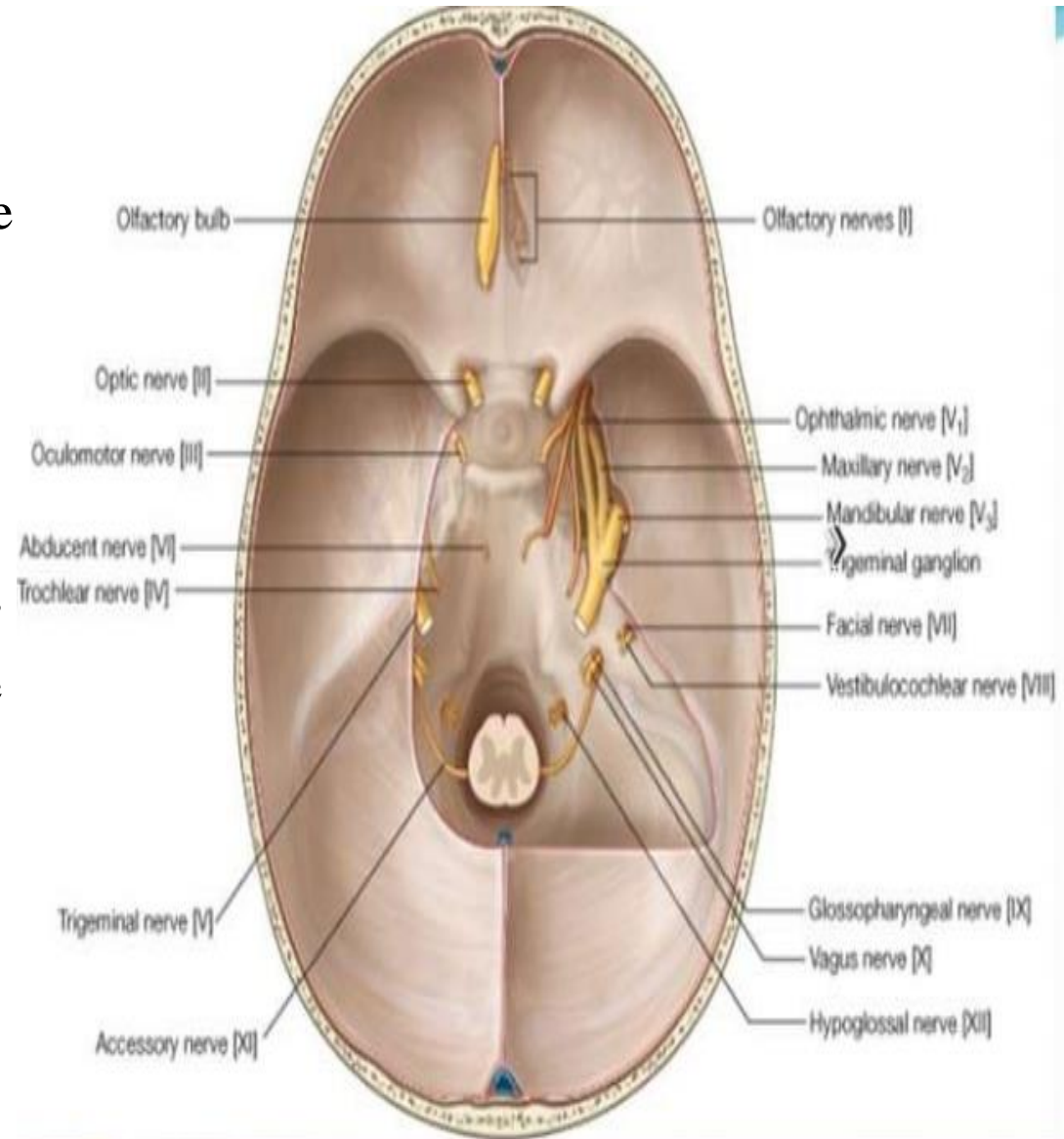
# COURSE OF NERVE

The trigeminal nerve exits from the anterolateral surface of the pons as a large sensory root and a small motor root. These roots continue forward out of the posterior cranial fossa and into the middle cranial fossa by passing over the medial tip of the petrous part of the temporal bone.

In the middle cranial fossa the sensory root expands into the trigeminal ganglion. The ganglion is in a depression (the trigeminal depression) on the anterior surface of the petrous part of the temporal bone, in a dural cave (the trigeminal cave). The motor root is below and completely separate from the sensory root at this point.

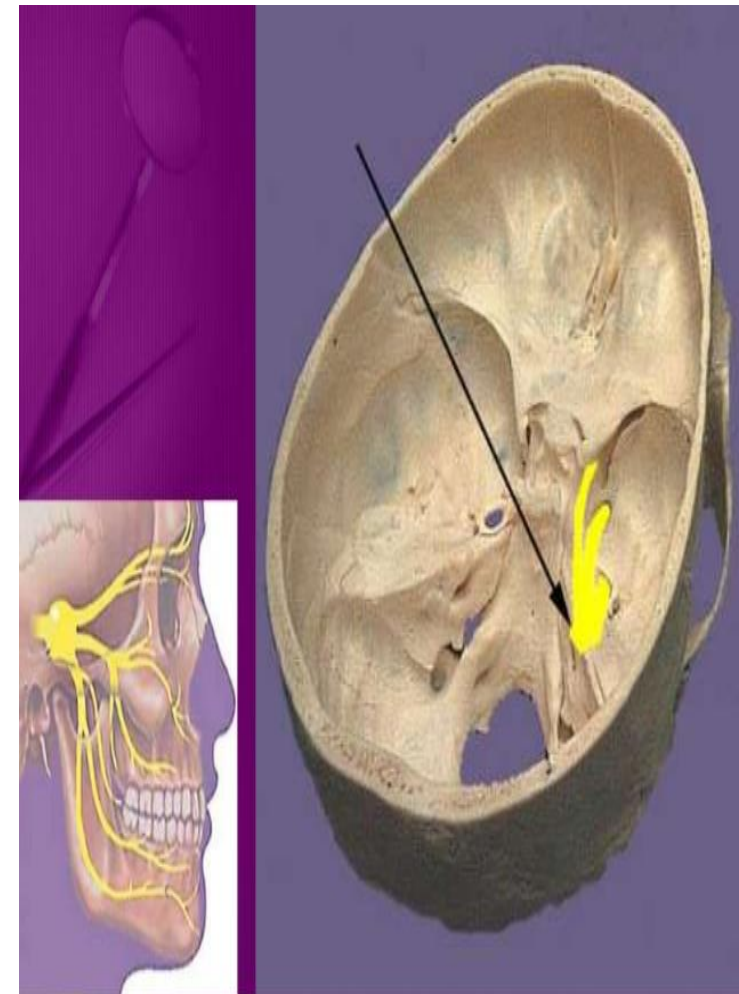


- Arising from the anterior border of the trigeminal ganglion are the three terminal divisions of the trigeminal nerve, which in descending order are:
- Ophthalmic ( $V_1$ ), Maxillary ( $V_2$ ), and Mandibular ( $V_3$ )
- Fibers run from the face to the pons via the superior orbital fissure ( $V_1$ ), the foramen rotundum ( $V_2$ ), and the foramen ovale ( $V_3$ )
- Conveys sensory impulses from various areas of the face ( $V_1$ ) and ( $V_2$ ), and supplies motor fibers ( $V_3$ ) for mastication

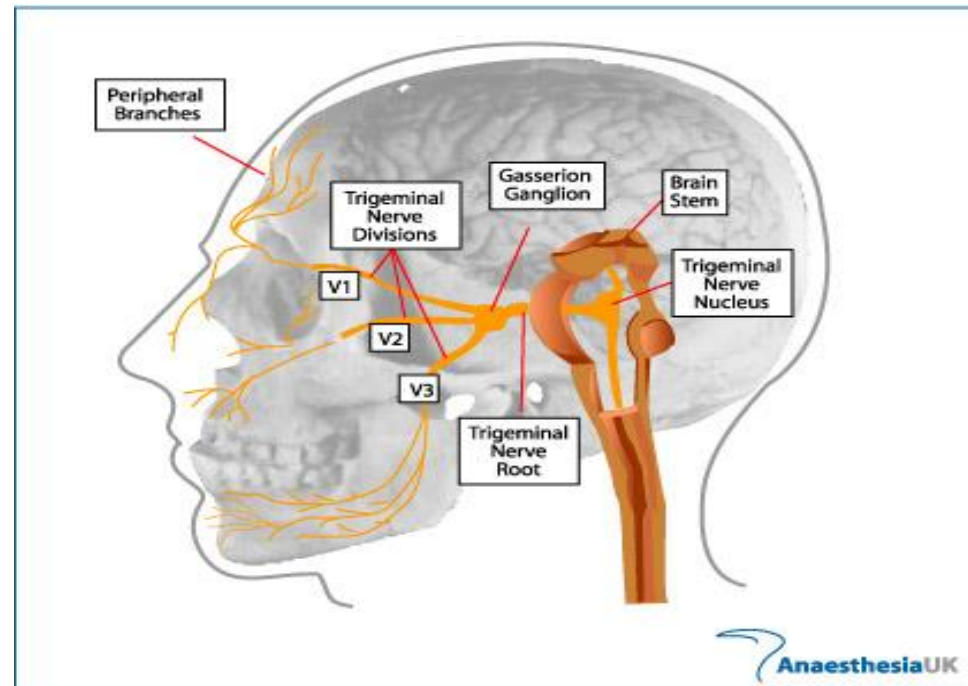


- *THE TRIGEMINAL GANGLION :-*

Also known as Gasserian ganglion, or semilunar ganglion, is a sensory ganglion of the trigeminal nerve that occupies a cavity (Meckel's cave) in the dura mater, covering the trigeminal impression near the apex of the petrous part of the temporal bone.



- It is somewhat crescentic or semilunar in shape, with its convexity directed anteriomedially.  
The three divisions of the trigeminal nerve emerges from this convexity.



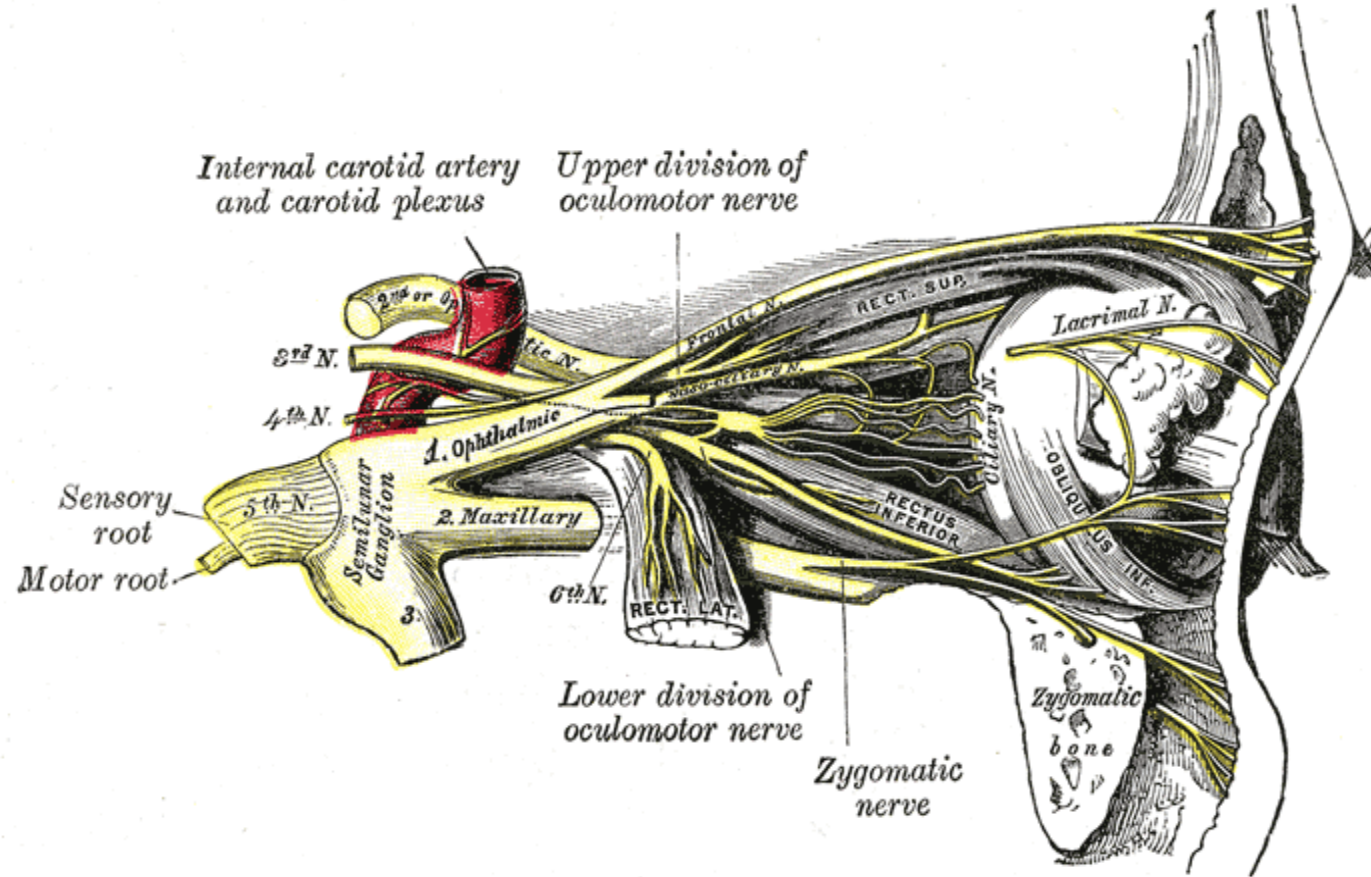
### *ASSOCIATED ROOTS AND BRANCHES:-*

The central processes of the ganglion cells form the large sensory root of the trigeminal nerve, which is attached to pons at its junction with the

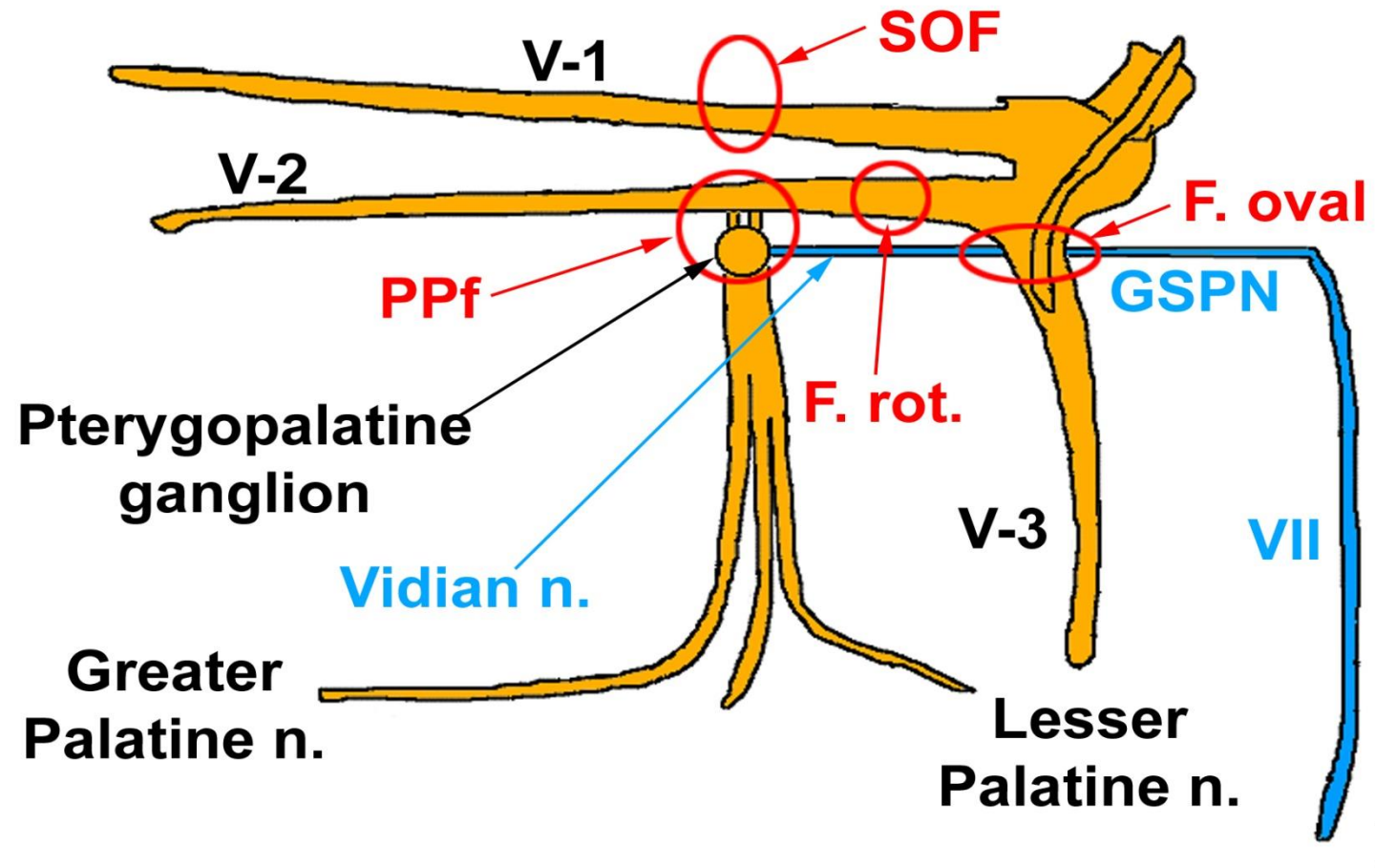
1. Middle cerebellar peduncle.

2. The peripheral processes form the three divisions of the trigeminal nerve.

# THE TRIGEMINAL GANGLION



# THE TRIGEMINAL NERVE



- **The Ophthalmic division:-**

Superior and smallest division.

Sensory Nerve

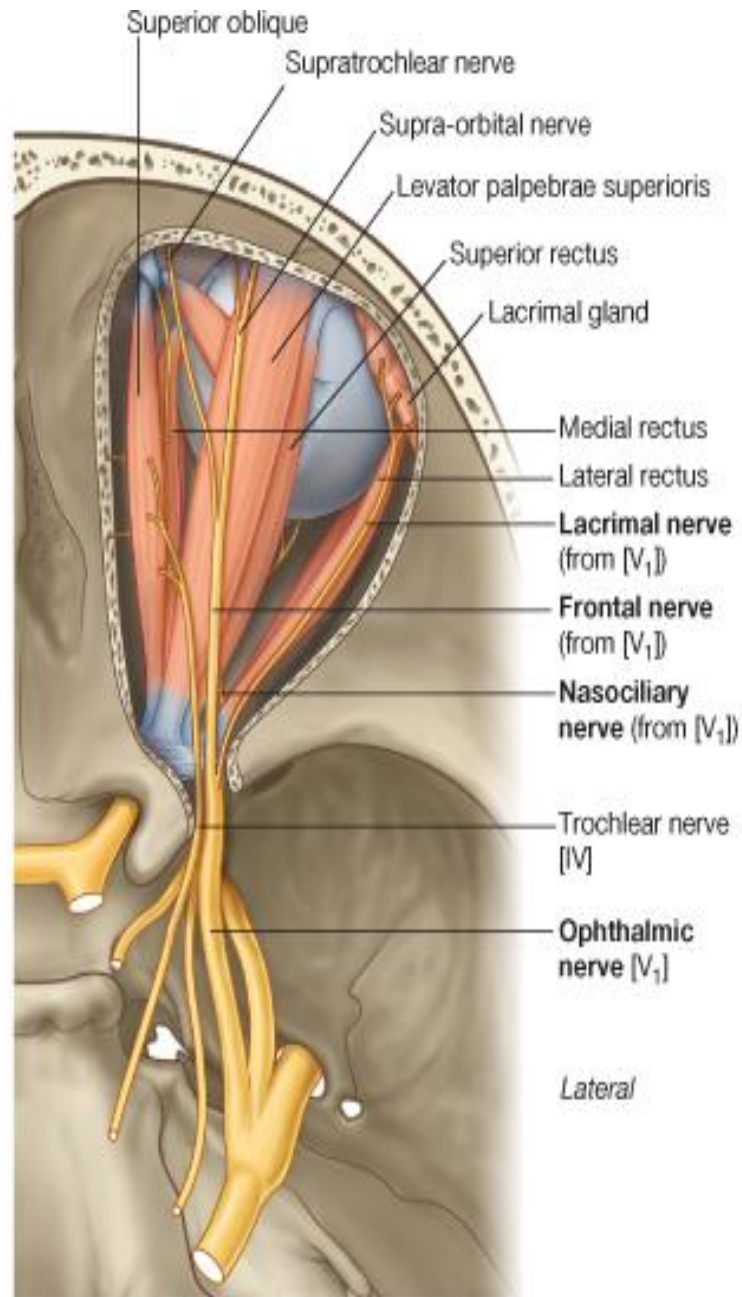
Arises from the anteriomedial end of trigeminal ganglion as a flat band, 2.5cm long.

Passes forward in the lateral wall of the cavernous sinus, below the oculomotor and trochlear nerves

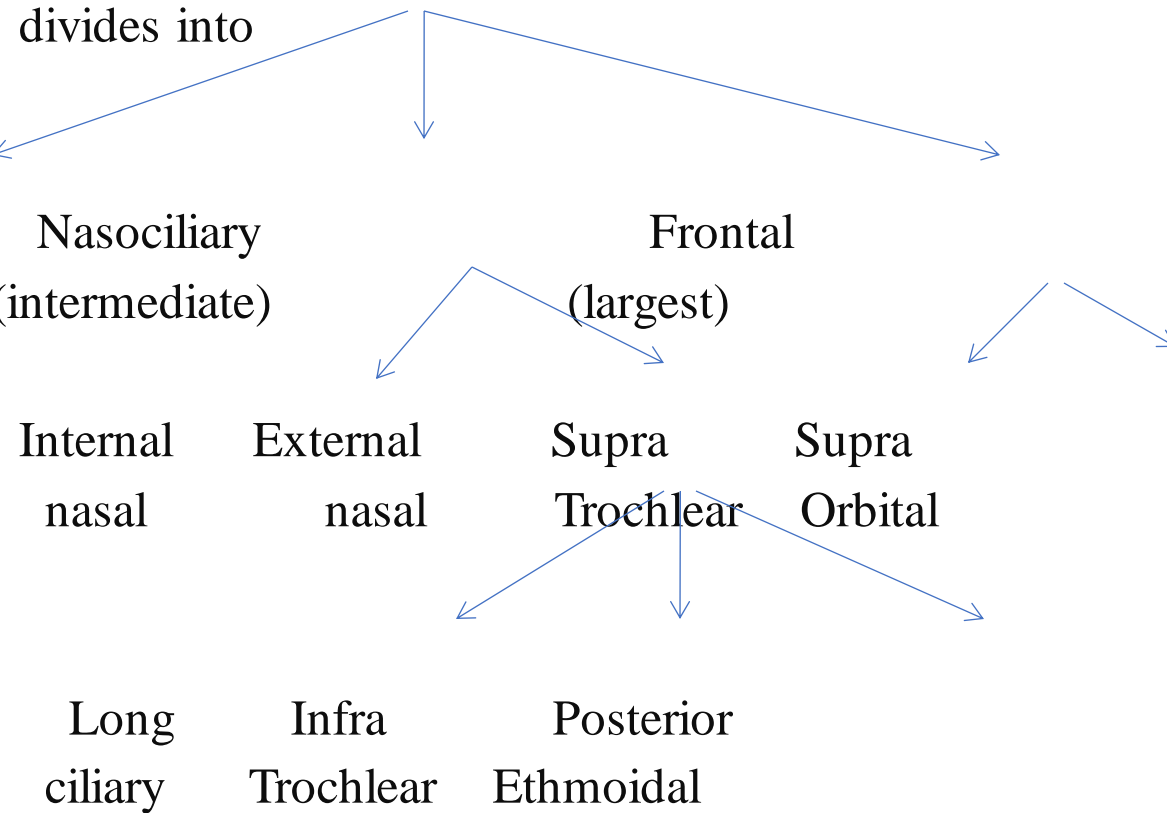
Nerve is joined by the filaments from the internal carotid sympathetic plexus.

It communicates with the oculomotor, trochlear and abducent nerve.

The latter communication may be the route by which proprioceptive fibres from extraocular muscles enter the trigeminal nuclear complex.



- Before entering the orbit by the **superior orbital fissure** it



Lacrimal  
(smallest)

Nasociliary  
(intermediate)

Frontal  
(largest)

Internal  
nasal

External  
nasal

Supra  
Trochlear

Supra  
Orbital

Long  
ciliary

Infra  
Trochlear

Posterior  
Ethmoidal

- **The Maxillary Nerve:**

It is intermediate division of trigeminal nerve.

Whole sensory.

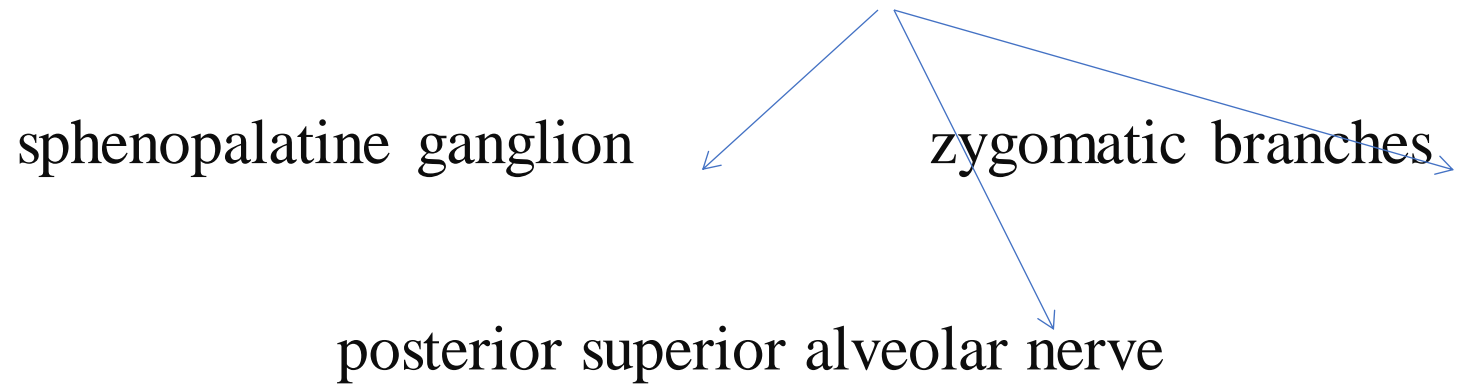
- **ORIGIN:**

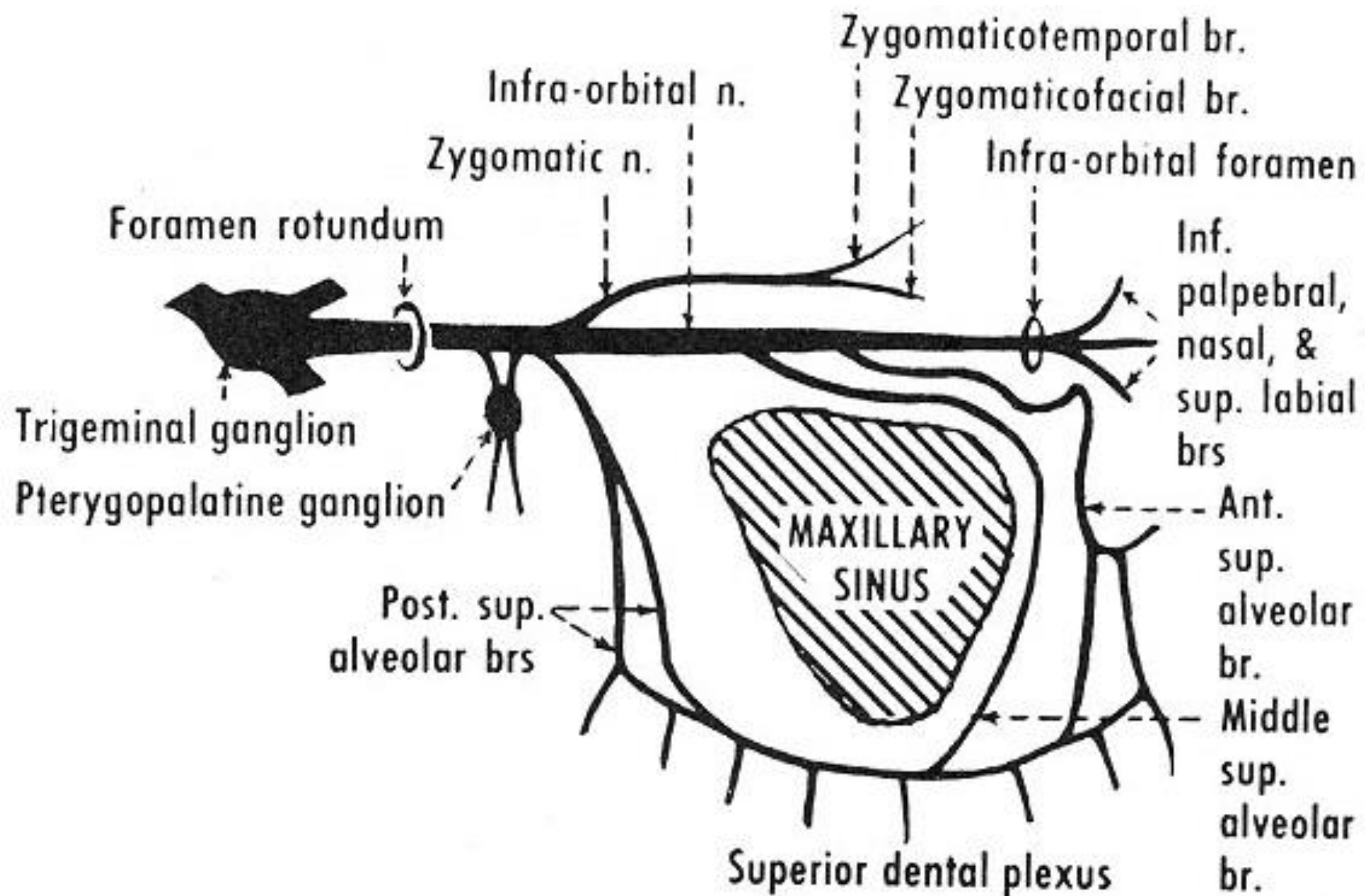
It leaves the trigeminal ganglion between the ophthalmic and mandibular divisions as a flat plexiform band

Passes slightly medial to lateral wall of cavernous sinus

Leaves the cranium through foramen rotundum, which is located in the greater wing of sphenoid bone.

- Once outside the cranium, it crosses the uppermost part of the pterygopalatine fossa, between the pterygoid plates of sphenoid bone and the palatine bone  
As it crosses the pterygopalatine fossa it gives off  
branches

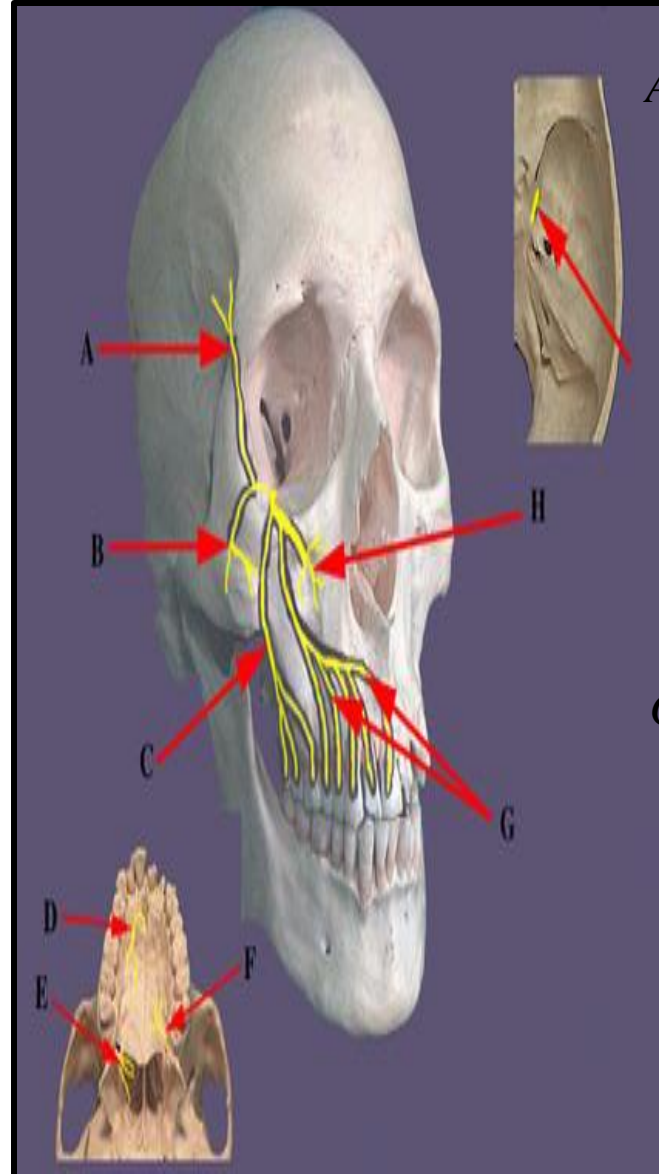




- It then angles laterally in a groove on the posterior surface of the maxilla, entering the orbit through the inferior orbital fissure.

Within the orbit it occupies the infraorbital groove and becomes the infraorbital nerve, which courses anteriorly into the infraorbital canal.

The maxillary division emerges on the anterior surface of face through the infraorbital foramen, where it divides into its terminal branches, supplying the skin of the face, nose, lower eyelid and upper lip.



A. *Zygomaticotemporal*

B. *Zygomaticofacial*

C. *Post. Sup. Alveolar*

D. *Nasopalatine*

E. *Greater Palatine*

F. *Lesser Palatine*

G. *Mid. & Ant. Alveolar*

H. *Infraorbital*

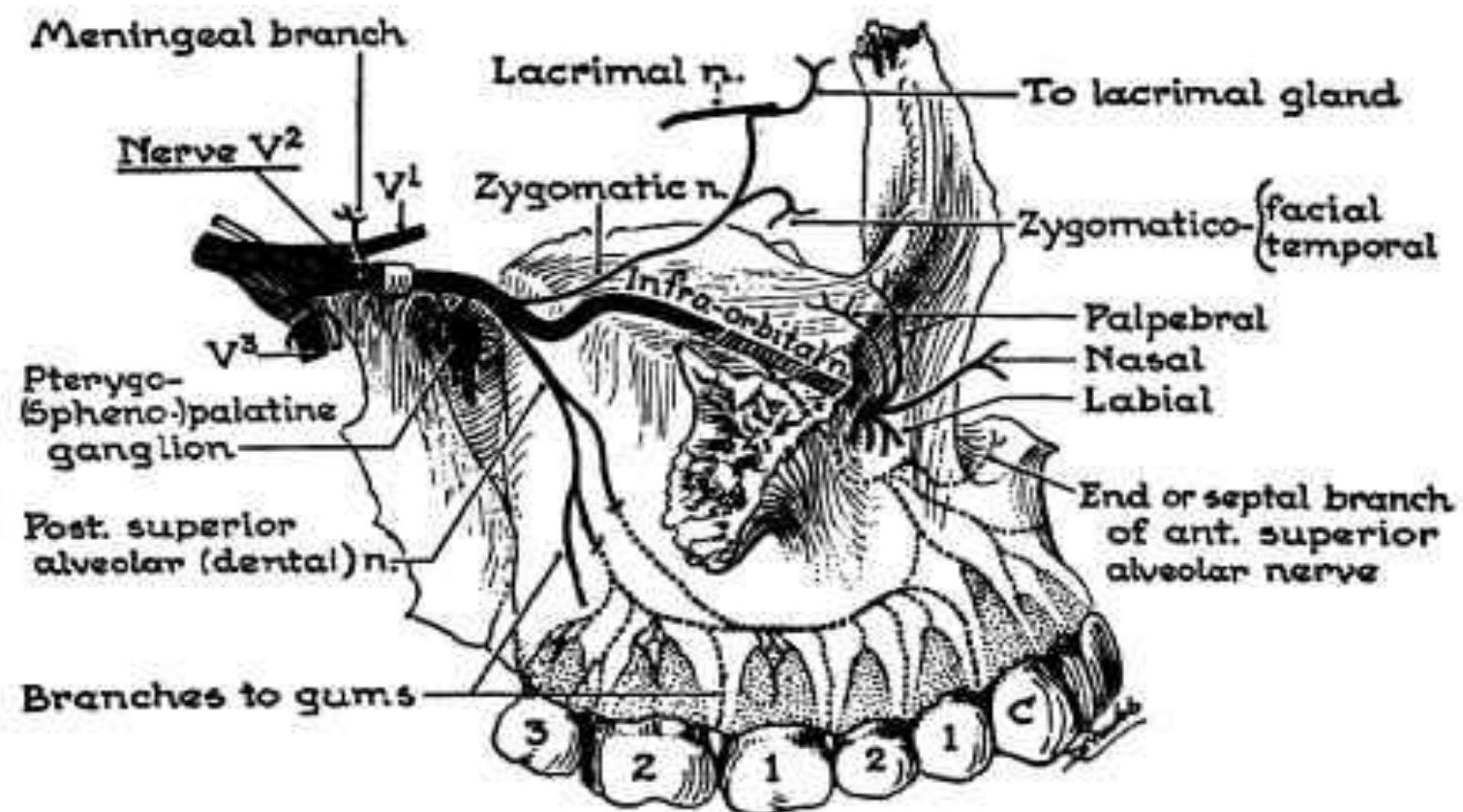
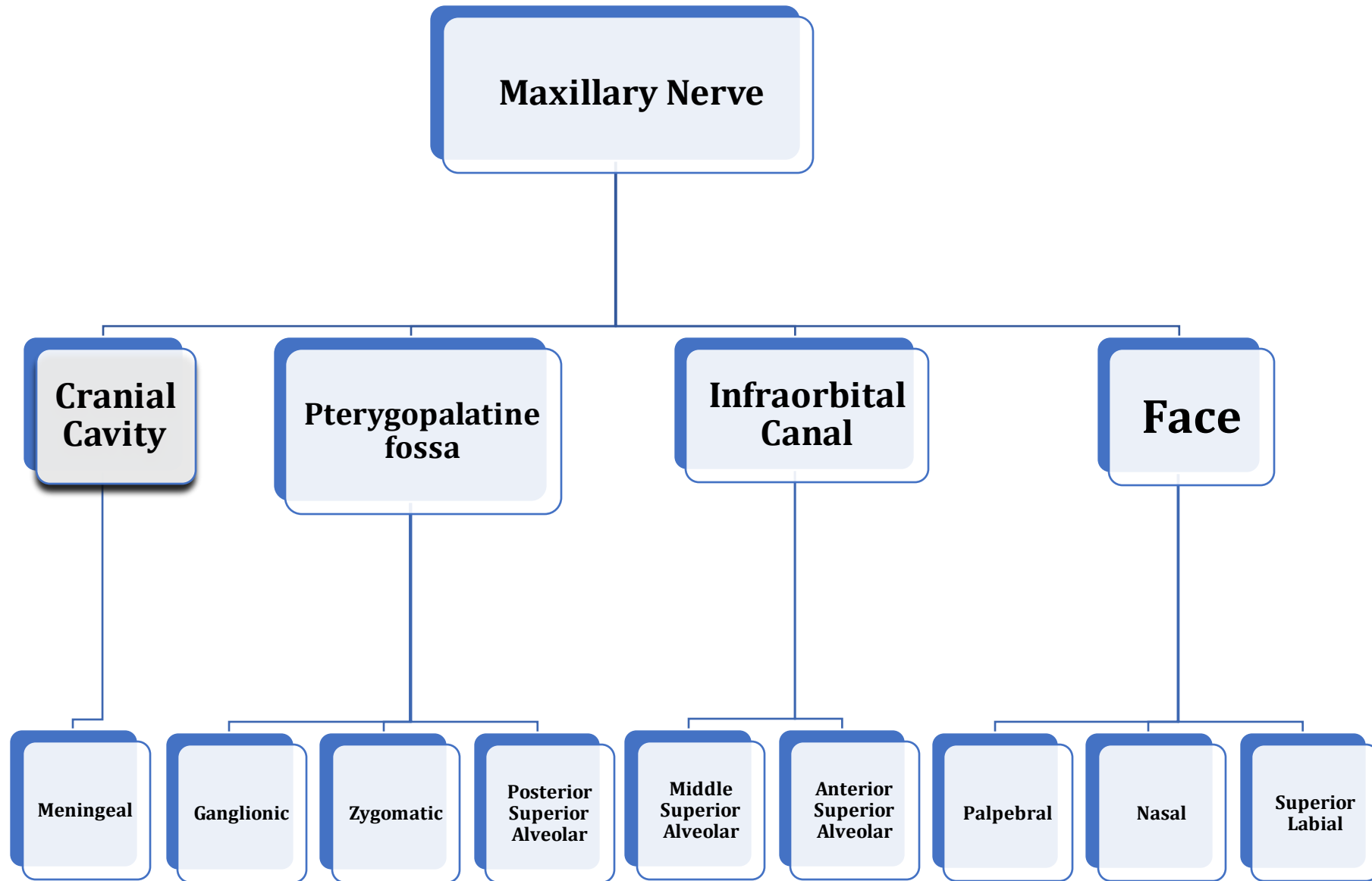


FIG. 795. Distribution of the maxillary (V<sup>2</sup>) nerve



# Mandibular Nerve

✓ The mandibular nerve supplies:

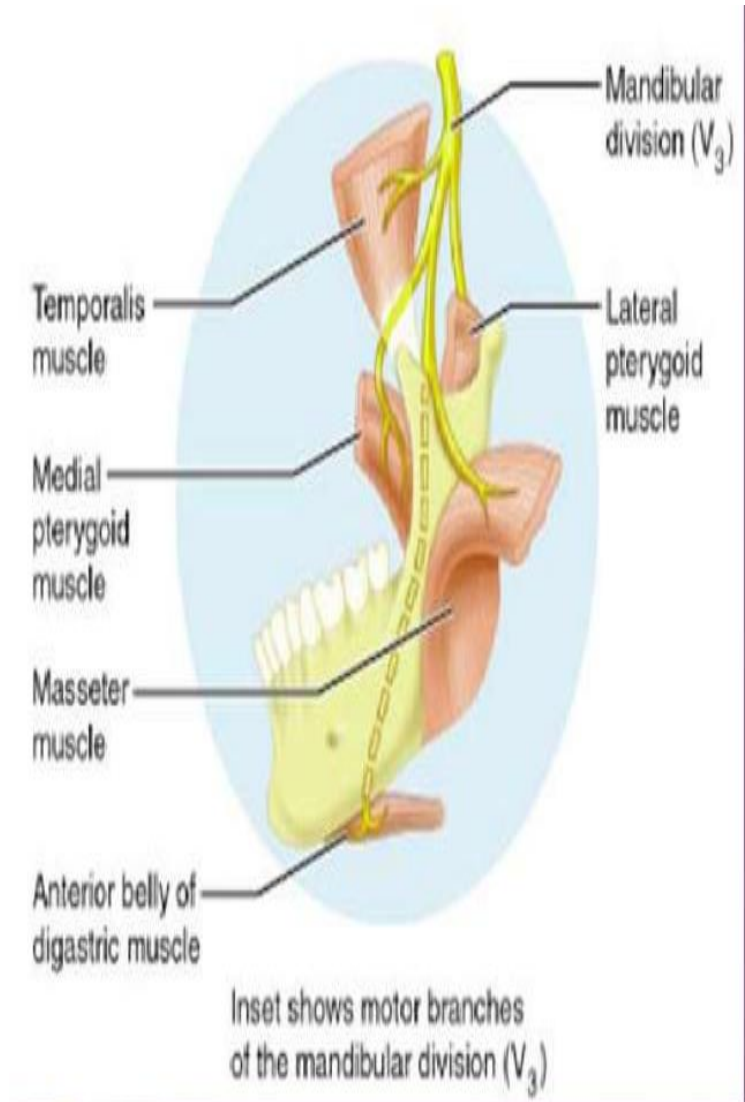
The teeth and gums of the mandible.

The skin in the temporal region, part of the auricle, including the external meatus and tympanum.

The lower lip, the lower part of the face.

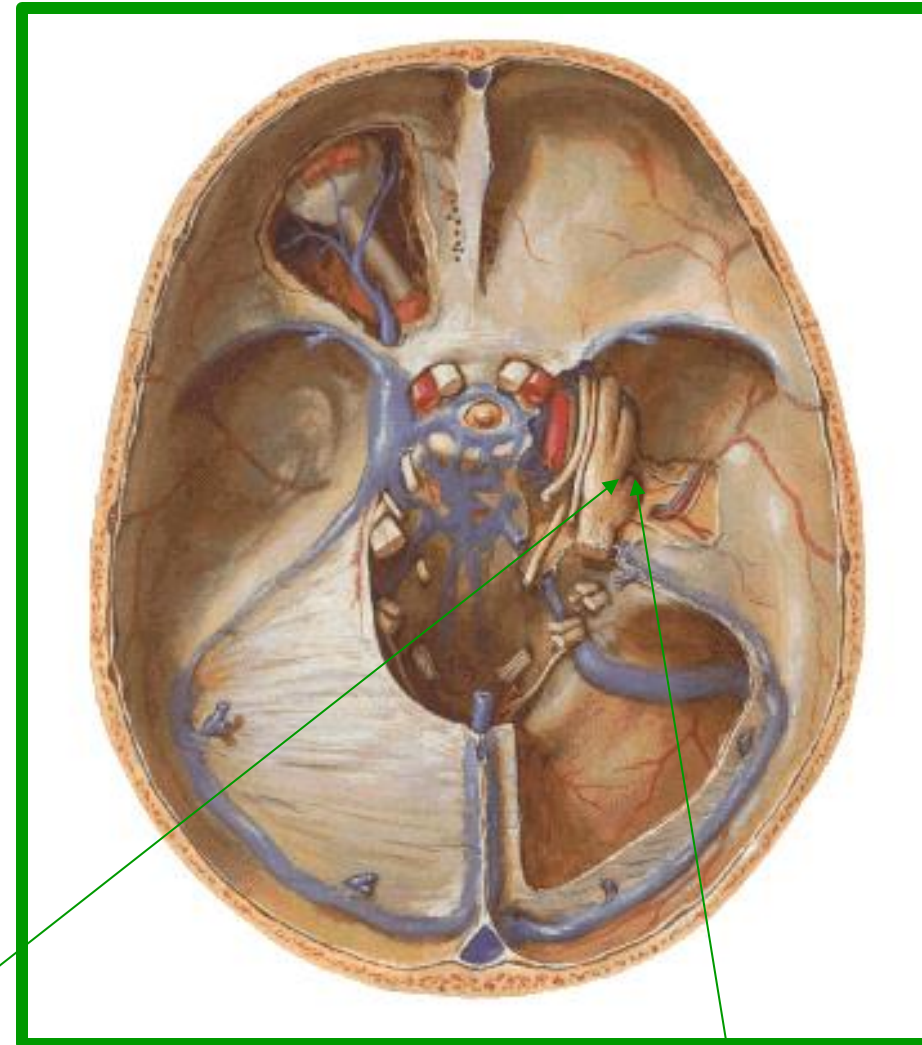
The muscles of mastication.

The mucosa of the anterior two-thirds (presulcal part) of the tongue and the mucosa of the floor of the oral cavity.



## Mandibular nerve: Origin and course

- ❖ Branch of trigeminal (V cranial) nerve. It Has
- ❖ **A small motor root** : which passes under the ganglion to unite with the sensory root just outside the skull.
- ❖ **A Large Sensory root**: Arises from lateral part of trigeminal ganglia in middle cranial fossa



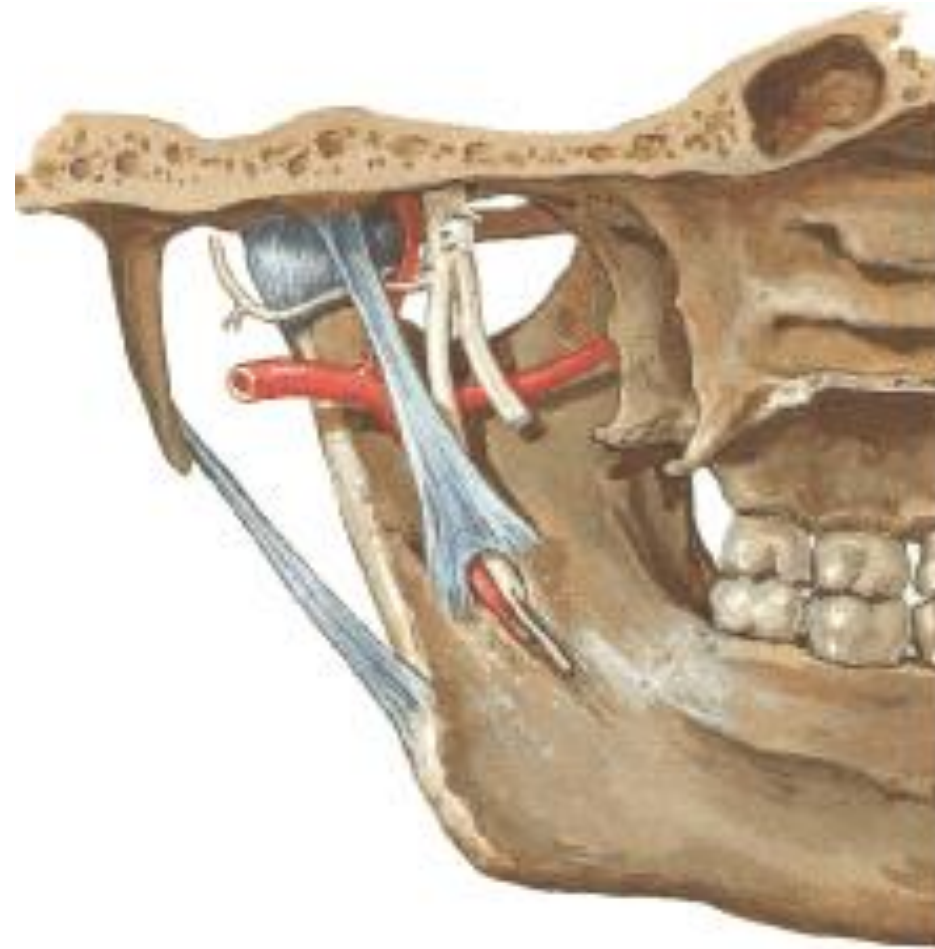
Trigeminal ganglia

Mandibular nerve

# Mandibular nerve

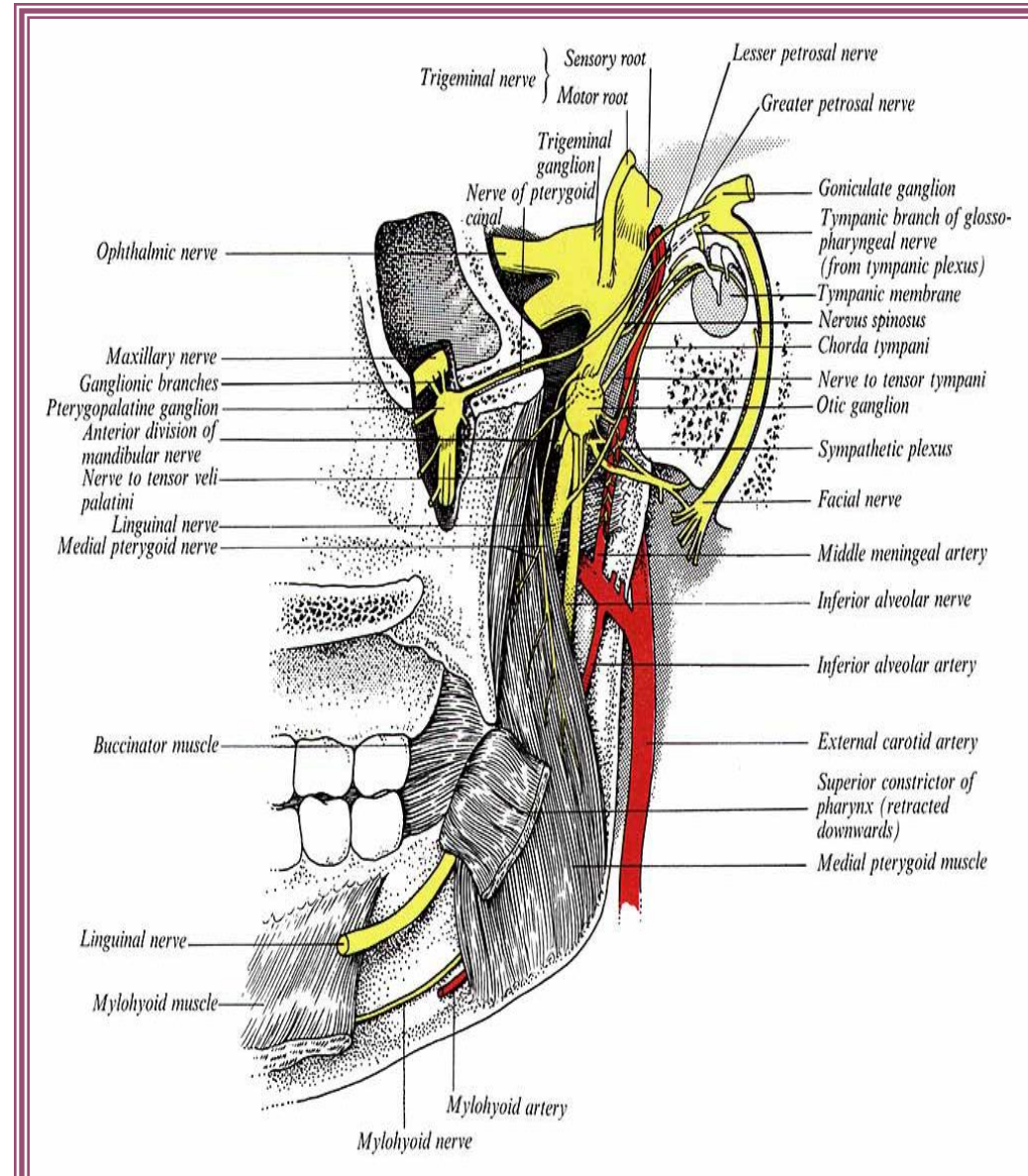
Passes through foramen ovale to infratemporal fossa

Here it lies between the tensor veli palatini (medial) and the lateral pterygoid.

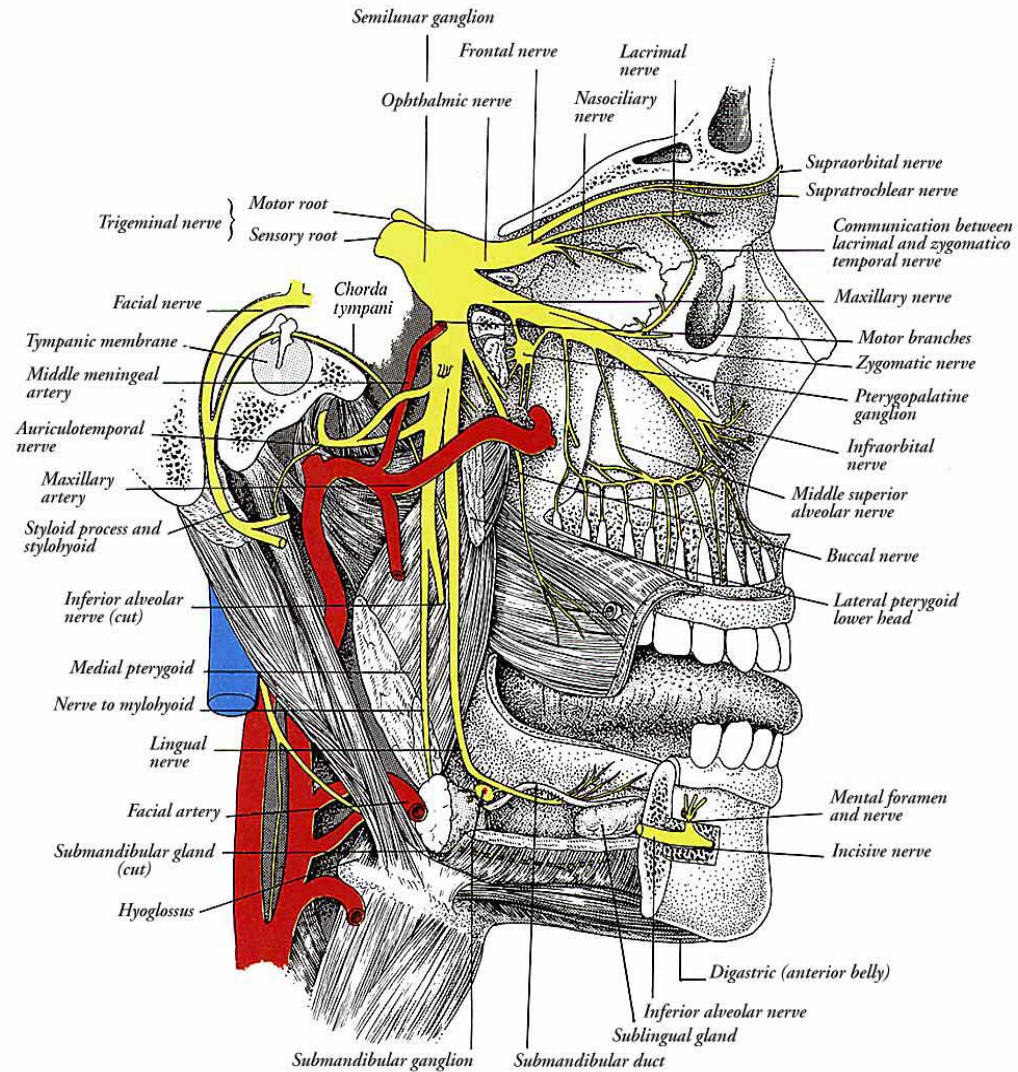


# Mandibular nerve

- Just beyond this junction a meningeal branch and the nerve to the medial pterygoid leaves the medial side of the nerve.
- The nerve then divides into a small anterior and large posterior trunk.



- As it descends from the foramen ovale, the nerve is about 4 cm from the surface and a little anterior to the neck of the mandible.



# Mandibular Nerve ( in infratemporal fossa)

## Branches:

### From trunk:

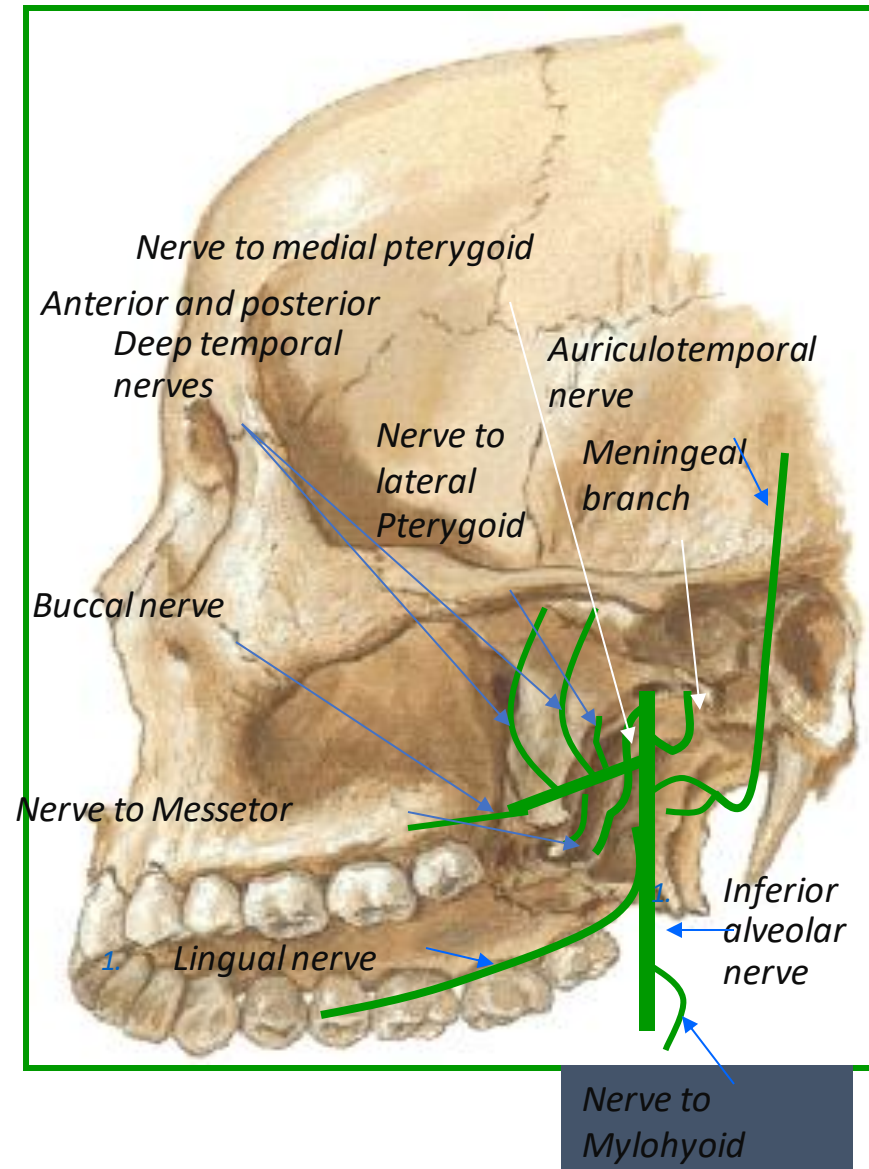
1. Meningeal branch
2. Nerve to medial pterygoid muscle

### From Anterior Division:

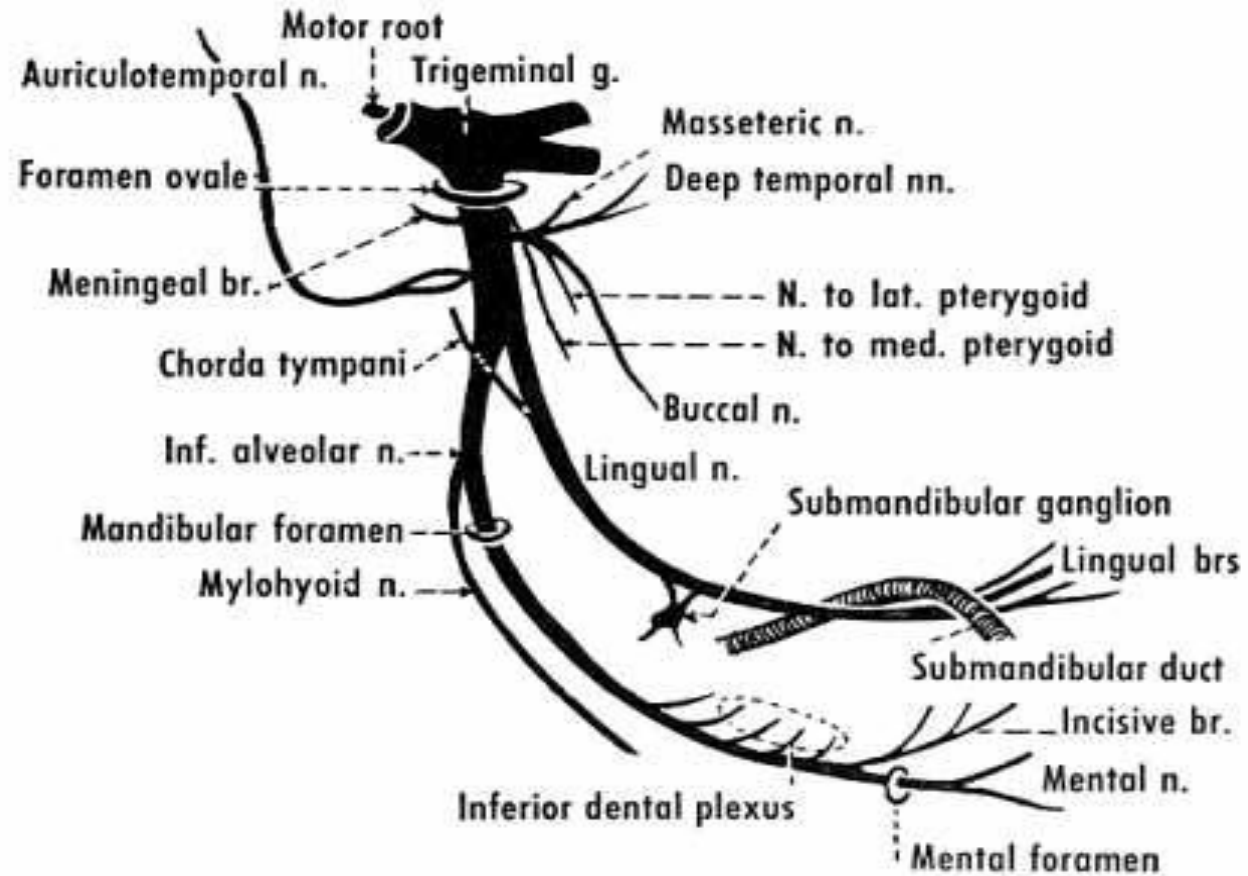
1. Anterior and posterior Deep temporal nerves
2. Nerve to lateral Pterygoid muscle
3. Nerve to Masseter muscle
4. Buccal nerve ( only sensory nerve)

### From Posterior Division:

1. Auriculotemporal nerve
2. Lingual nerve
3. Inferior alveolar nerve



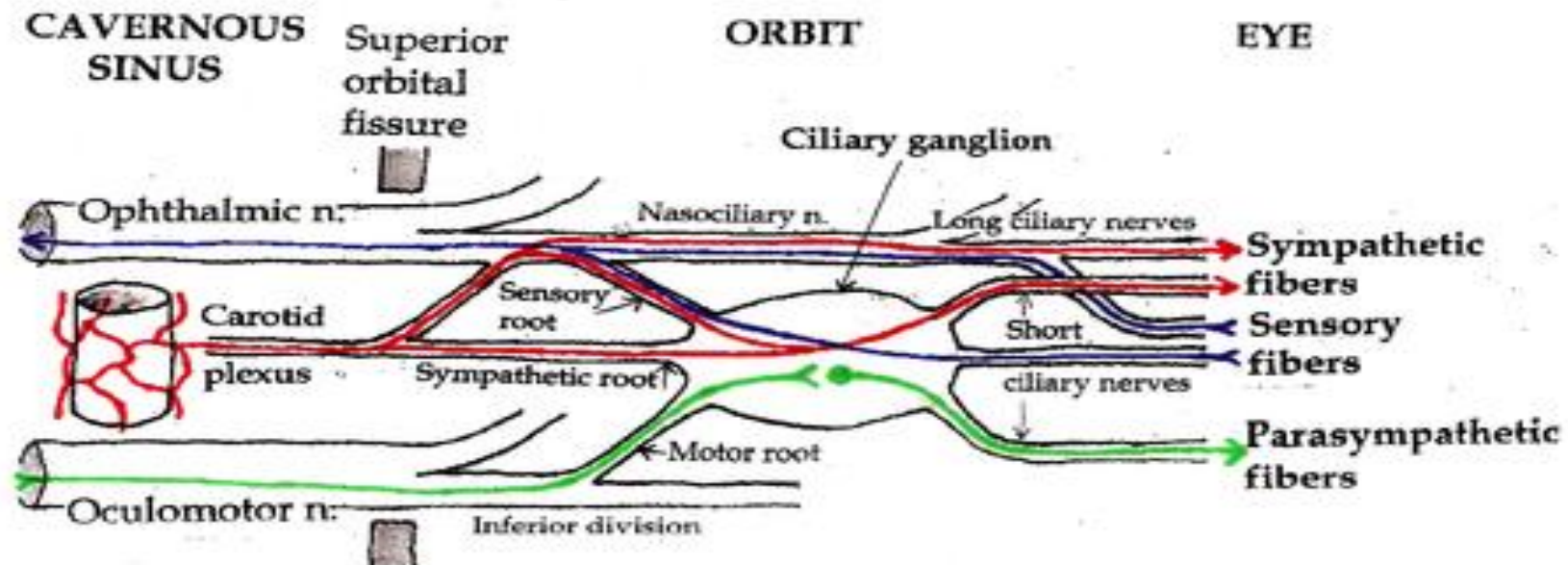
# THE MANDIBULAR NERVE



# *GANGLIA ASSO WITH THE TRIGEMINAL NERVE*

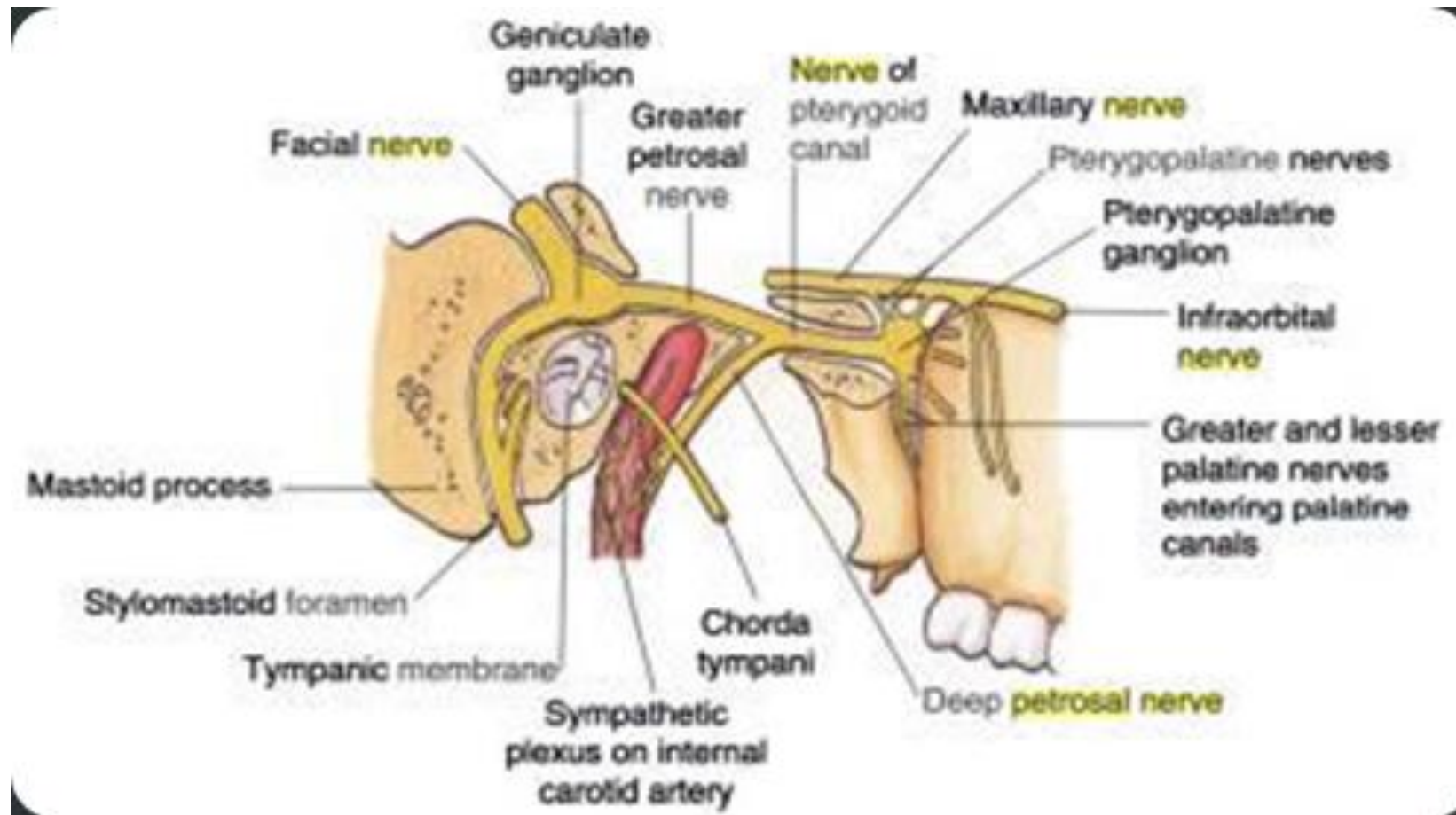
## **1.CILLIARY GANGLION**

- ➔ connected with nasocilliary nerve by ganglionic branches in orbit, non synapsing
- ➔ sensory for orbit

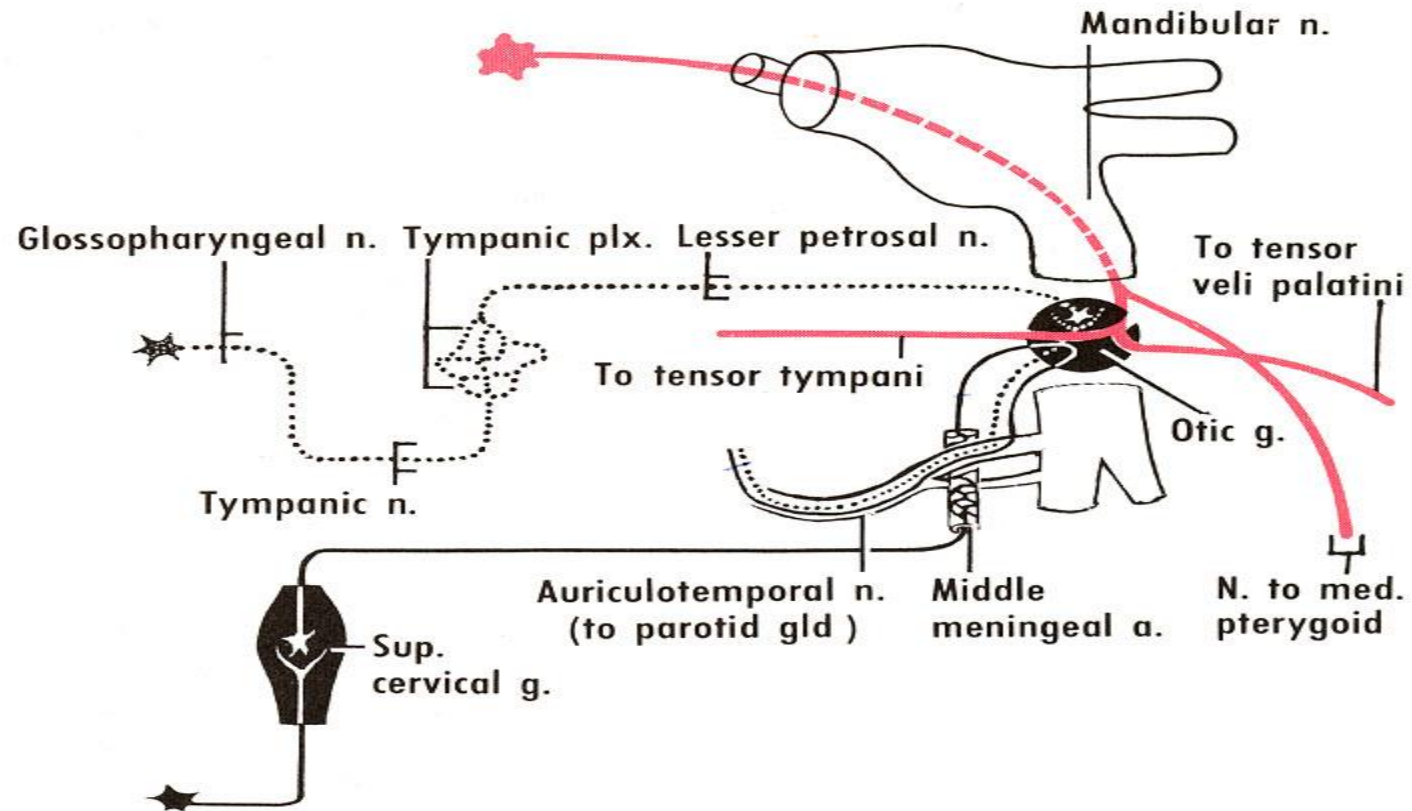


## 2.PTERYGOPALATINE GANGLION:

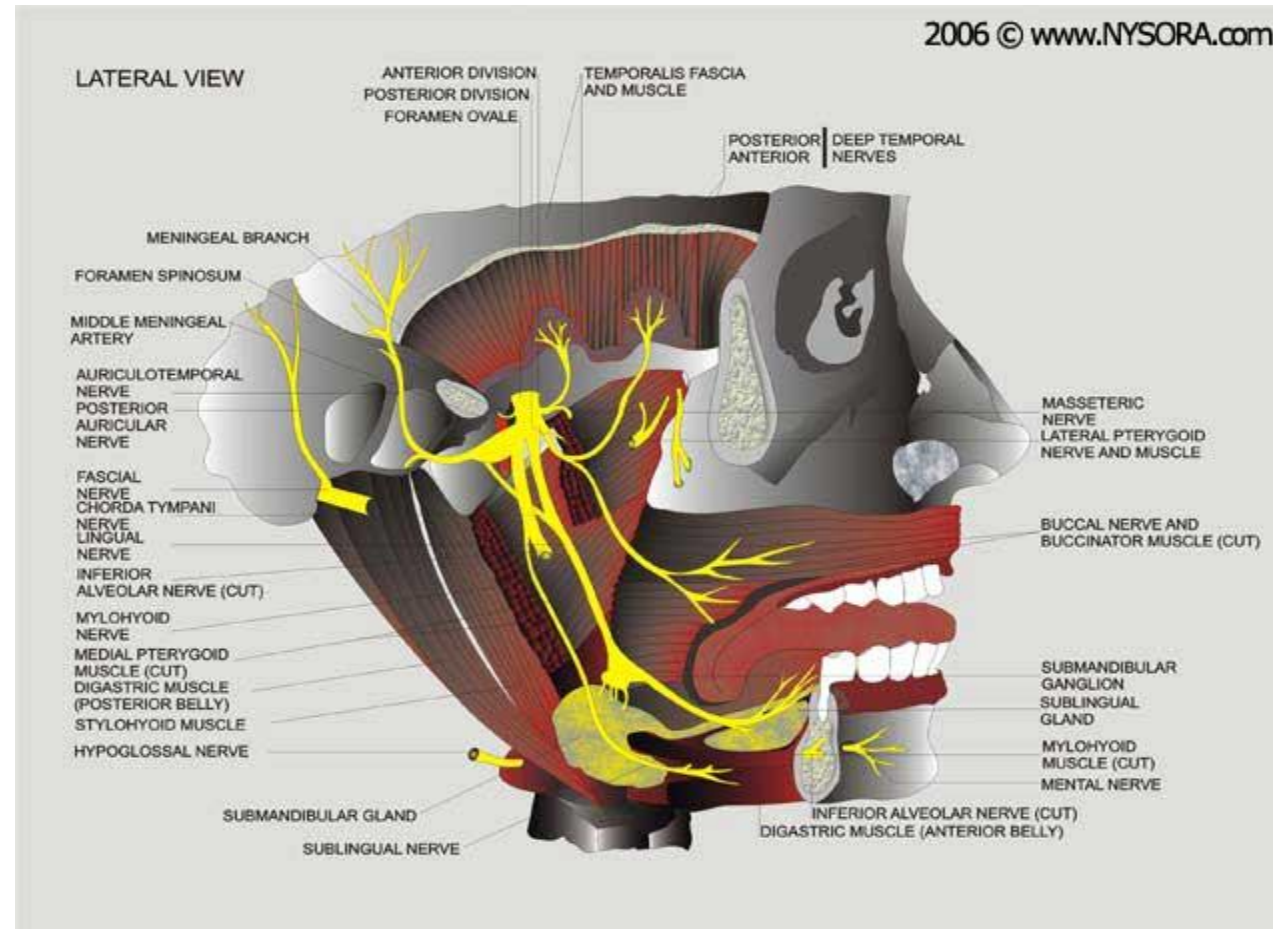
connected to maxillary nerve in infratemporal fossa  
sensory to orbital septum, orbicularis and nasal cavity,  
maxillary sinus , palate , nasopharynx.



**3. OTIC GANGLION:** lies between trunk of mandibular nerve. The tensor palatini nerve and nerve to med pterygoid passes through but does not synapse in the ganglion.



**4.SUBMANDIBULAR GANGLION:** related to lingual nerve, rest on hypoglossus  
 supplies posterior ganglionic Parasympathetic secretomotor fibres to submandibular and sublingual gland.



# ***APPLIED ANATOMY***

1. Trigeminal neuralgia.

2. Herpes zoster ophthalmicus.

3. Wallenberg Syndrome.

## ***Trigeminal Neuralgia:***

**also known as** Fothergill's disease

Tic douloureux (painful jerking)

it is defined as  
sudden, usually, unilateral, severe, brief, stabbing,  
lancinating, recurring pain in the distribution of one or  
more branches of trigeminal nerve.

Mean age: 50 y onwards

Female predominance (male : female = 1:2 ~2:3)

- **Pathogenesis of trigeminal neuralgia**

It is usually idiopathic.

The probable etiologic factors are:-

1. Intra cranial tumors:- Traumatic compression of the trigeminal nerve by neoplastic (cerebellopontine angle tumor) or vascular anomalies eg arteriovenous malformations

2. Infections :- granulomatous and non granulomatous infections involving 5<sup>th</sup> cranial nerve.

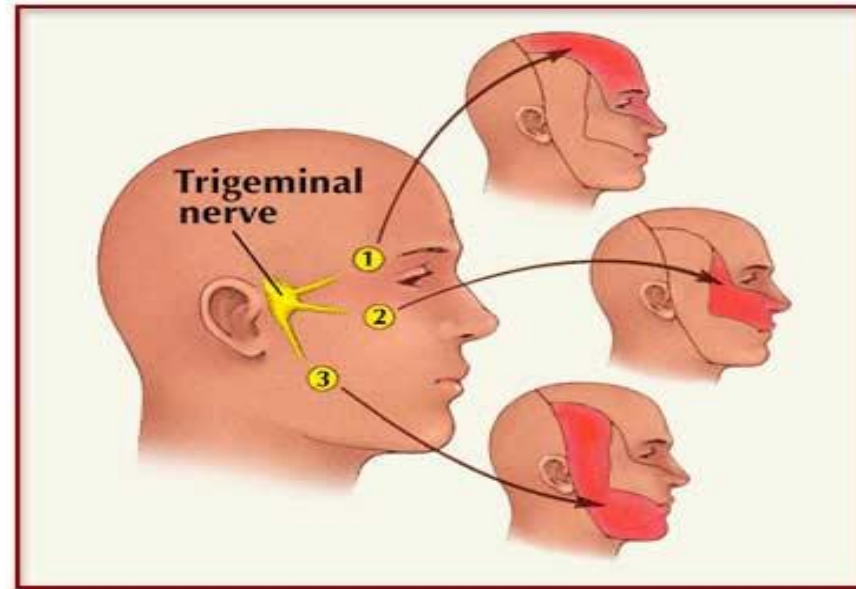
3. postherpetic neuralgia

4. Demyelinating conditions

5. Multiple sclerosis (MS)

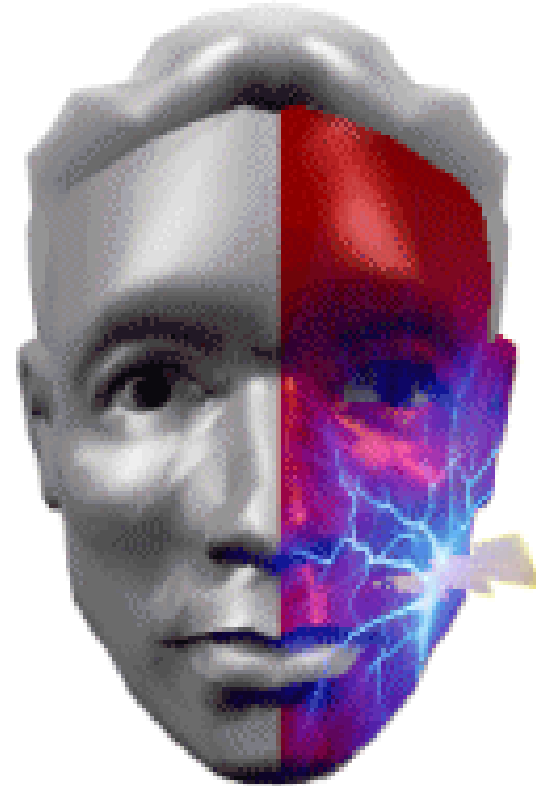
6. Petrous ridge compression

7. Intracranial vascular abnormalities



*Clinical characteristics:-*

- 1.sudden
- 2.unilateral
- 3.intermittent paroxysmal
- 4.sharp shooting
- 5.lancinating shock like pain elicited by slight touching



- 1.superficial trigger points which radiates across the distribution of one or more branches of the trigeminal nerve
- 2.pain rarely crosses the midline
- 3.pain is of short duration and last for few seconds to minutes
- 4.in extreme cases patient has a motionless face called the frozen or mask like face
- 5.presence of intraoral or extraoral trigger points

- Provocated by obvious **stimuli** like

Touching to face at particular site

Chewing

Speaking

Brushing

Shaving

Washing the face

The characteristic of the disorder being that the attacks do not occur during sleep.

- *DIAGNOSIS:-*

CLINICAL EXAMINATION with HISTORY is mandatory.

Response to treatment with tablet of carbamazepine is universal.

Injections of local anaesthetic agents into patients trigger zone gives temporarily relief from pain.

## *TREATMENT:-*

➔ Medical treatment

➔ Surgical treatment:-

➔ Peripheral injections

➔ Peripheral neurectomy

➔ Cryotherapy

➔ Peripheral radiofrequency

➔ Neurolysis(thermocoagulation)

➔ Gasserian ganglion procedures

## HERPES ZOSTER OPHTHALMICUS:-

Caused by Varicella zoster

Predilection for nasociliary branch of ophthalmic division of the trigeminal nerve

### CLINICAL FEATURES:-

Cutaneous lesions:-

- ➔ Rash
- ➔ Vesicle
- ➔ Pustule crust permanent scar



- Ocular lesions:-

Eyelid:- Periorbital pain

Oedema

Hyperaesthesia

Conjunctivitis

Scleritis

Corneal scarring

Glaucoma

- *TREATMENT:-*

Acyclovir 800mg 5 times /day within 4 days of onset of rash

Analgesics

Antibiotic ointments

Systemic steroids 60mg/day

Corneal grafting

# Wallenberg syndrome:-

A stroke which causes loss of pain/temperature sensation from *one* side of the face and the *other* side of the body.

## ETIOLOGY:-

In the medulla, the Ascending Spinothalamic Tract (which carries pain/temperature information from the *opposite* side of the body) is adjacent to the

Descending

Spinal Tract of the fifth nerve (which carries pain /temperature information from the *same* side of the face)

- ➔ A stroke cuts off the blood supply to this area
- ➔ Destroys *both* tracts simultaneously.
- ➔ Results in loss of pain/temperature sensation in a unique “checkerboard” pattern (ipsilateral face, contralateral body)
- ➔ Characteristic diagnostic feature.

# REFERENCES

- Scott and Brown, Head & neck surgery, 7<sup>th</sup> edition.
- Gray's anatomy for student 4<sup>th</sup> edition.

Thank you