ANATOMY

ANATOMY

HEAD

HEAD

Nerves Of the Head

NERVES OF THE HEAD

NERVES

- **SYMPATHETIC INNERVATION**
- **PARASYMPATHETIC INNERVATION**
- **OPHTHALMIC NERVE**
- **MANDIBULAR NERVE**
- **MAXILLARY NERVE**

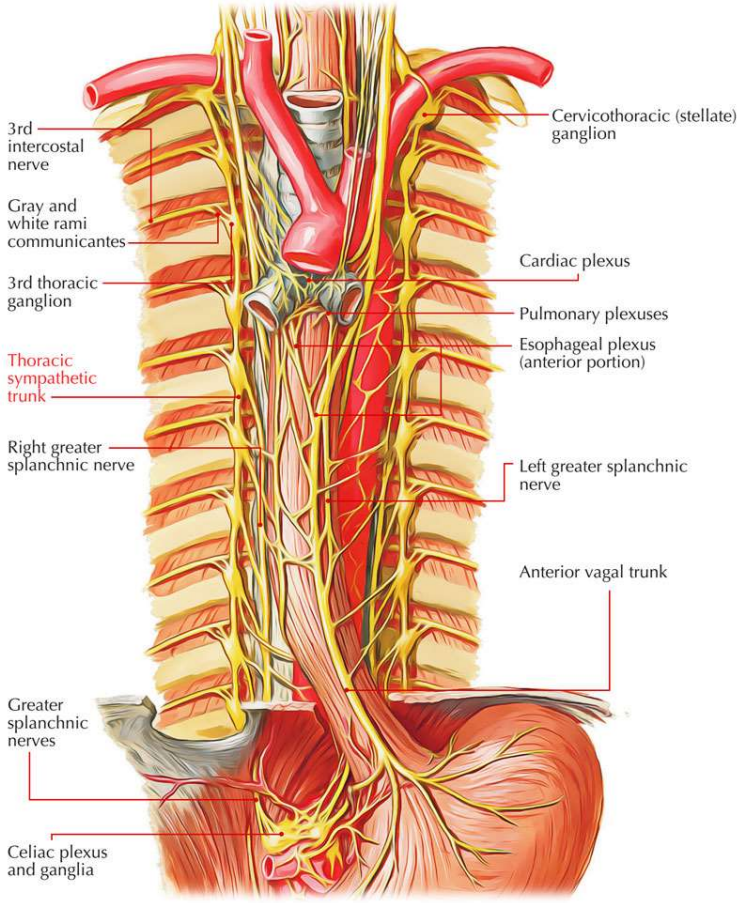
Sympathetic Innervation

Contents

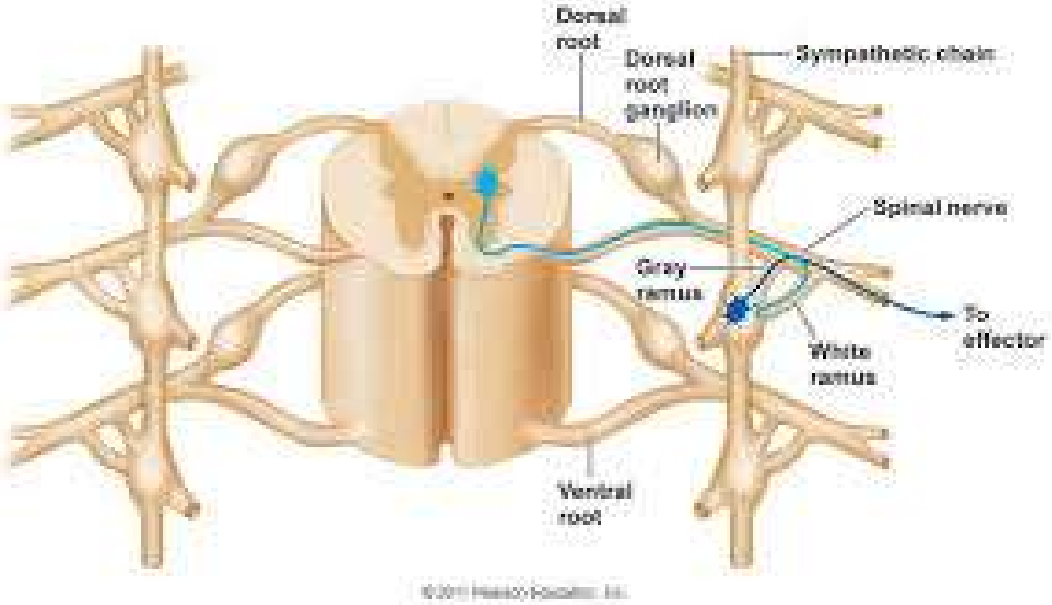
Sympathetic Innervation

- The **sympathetic nervous** system is a division of the autonomic nervous system. It is involuntary, and acts with the parasympathetic system to maintain body homeostasis.
- The actions of the sympathetic nervous system are associated with the 'fight or flight' response.
- In this article, we shall look at the anatomy of the **sympathetic innervation to the head and neck** – its structure, anatomical course, and its clinical correlations

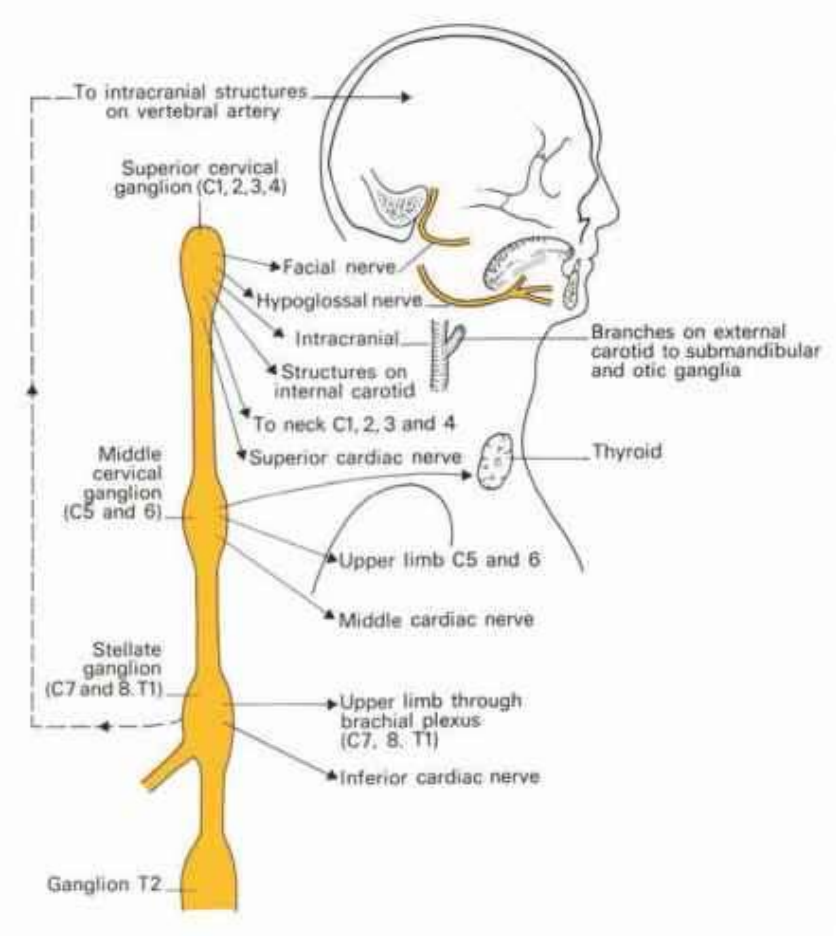
Anatomy


3rd intercostal nerve
Gray and white rami communicantes
3rd thoracic ganglion
Thoracic sympathetic trunk
Right greater splanchnic nerve
Greater splanchnic nerves
Celiac plexus and ganglia
Cervicothoracic (stellate) ganglion
Cardiac plexus
Pulmonary plexuses
Esophageal plexus (anterior portion)
Left greater splanchnic nerve
Anterior vagal trunk

Anatomy


Dorsal root
Dorsal root ganglion
Sympathetic chain
Spinal nerve
Gray ramus
To effector
White ramus
Ventral root

Superior Cervical Ganglion



Sympathetic Innervation

Anatomical Structure and Course

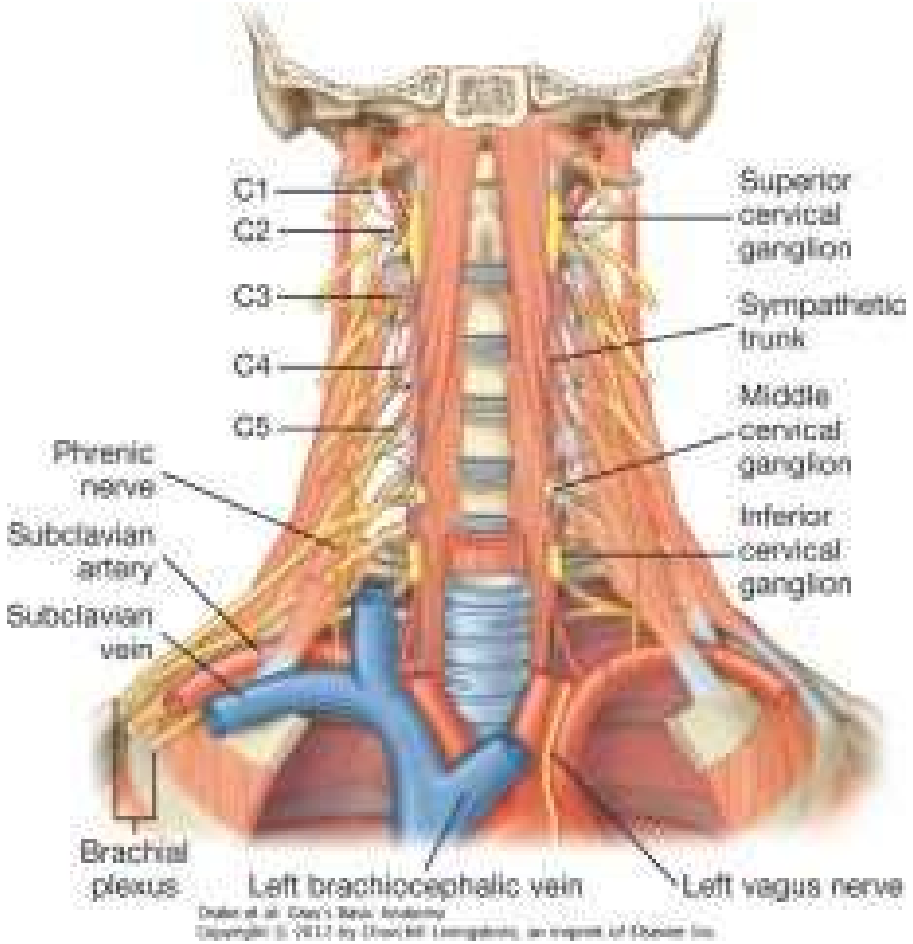
- The sympathetic fibres to the head and neck begin in the spinal cord. They originate from the thoracic region (T1-6), and therefore need to ascend to reach the structures in the head and neck.
- After leaving the spinal cord, the fibres enter the **sympathetic chain**. This structure spans from the base of the skull to the coccyx, and is formed by nerve fibres and ganglia (collections of nerve cell bodies). There are three ganglia within this chain that are of interest – the **superior, middle and inferior cervical ganglia**. The sympathetic fibres synapse with these ganglia, with post ganglionic branches continuing into the head and neck.
- Each of the three ganglia are related to specific arteries in the head and neck. The post-ganglionic fibres **hitch-hike** along these arteries (and their branches) in order to reach their target organs.
- We shall now look at the structure and function of the ganglia in more detail.

Sympathetic Innervation

Superior Cervical ganglion

- The superior cervical ganglion is located posteriorly to the carotid artery, and anterior to the C1-4 vertebrae. Several important post-ganglionic nerves originate from here:
- **Internal carotid nerve** – hitch-hikes along the internal carotid artery, forming a network of nerves. Branches from the internal carotid plexus innervate structures in the eye, the pterygopalatine artery and the internal carotid artery itself.
- **External carotid nerve** – hitch-hikes along the common and external carotid arteries, forming a network of nerves. It innervates the smooth muscle of the arteries.
- **Nerve to pharyngeal plexus –** combines with branches from the Vagus and glossopharyngeal nerves to form the pharyngeal plexus.
- **Superior cardiac branch** – contributes to the cardiac plexus in the thorax.
- **Nerves to cranial nerves II, III IV, VI and IX**.
- **Gray Rami Communicantes** –distributes sympathetic fibres to the anterior rami of C1-C4.

Superior Cervical ganglion



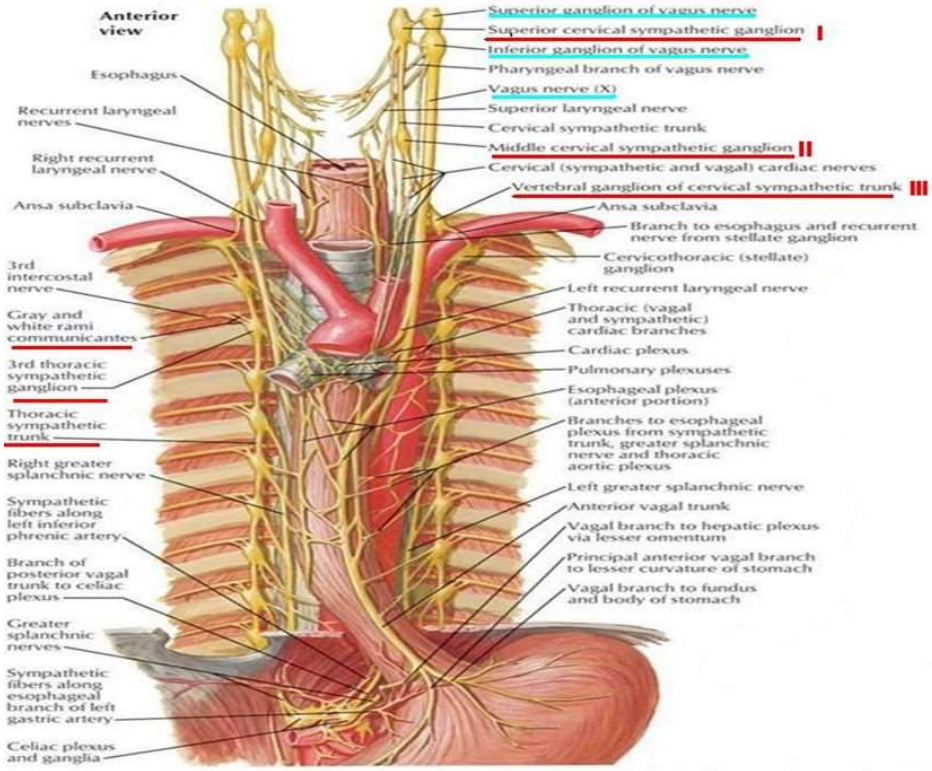
Sympathetic Innervation

Middle Cervical Ganglion

The middle cervical ganglion is absent in some individuals. When present, it is located anteriorly to the inferior thyroid artery and the C6 vertebra. Its postganglionic fibres are:

- **Gray Rami Communicantes** – distributes sympathetic fibres to the anterior rami of C5 and C6.
- **Thyroid branches** – travel along the inferior thyroid artery, distributing fibres to the larynx, trachea, pharynx and upper oesophagus.
- **Middle cardiac branch** – contributes to the cardiac plexus in the thorax.

Middle Cervical Ganglion



Sympathetic Innervation

Inferior Cervical Ganglion

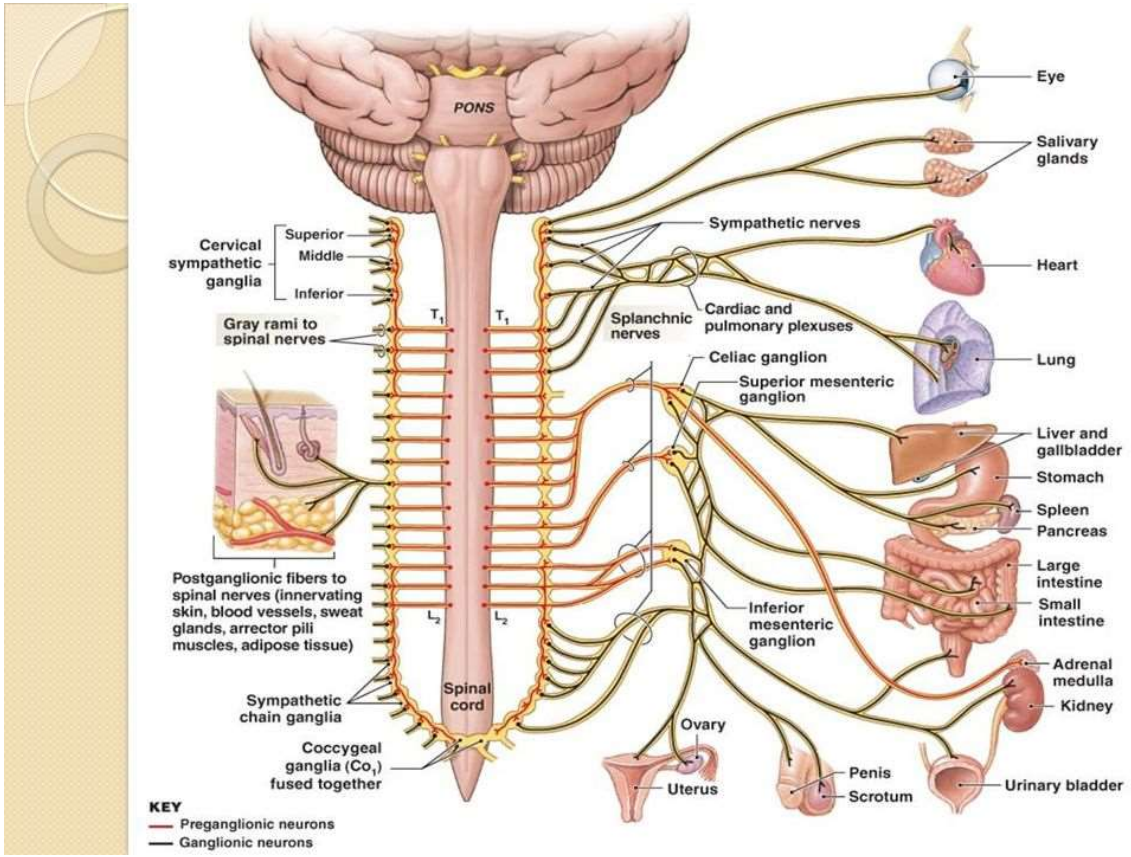
- The inferior cervical ganglion is situated anteriorly to the C7 vertebra. It is occasionally fused with the first thoracic vertebrae, forming the cervicothoracic ganglion. There are three post-ganglionic fibres that arise from this ganglion:
- **Gray rami communicantes** – distributes sympathetic fibres to the anterior rami of C7, C8 and T1.
- **Branches to the subclavian and vertebral arteries –** These innervate the smooth muscle present in the arteries.
- **Inferior cardiac nerve** – contributes to the cardiac plexus in the thorax.

Sympathetic Innervation

Clinical Relevance: Horner's Syndrome

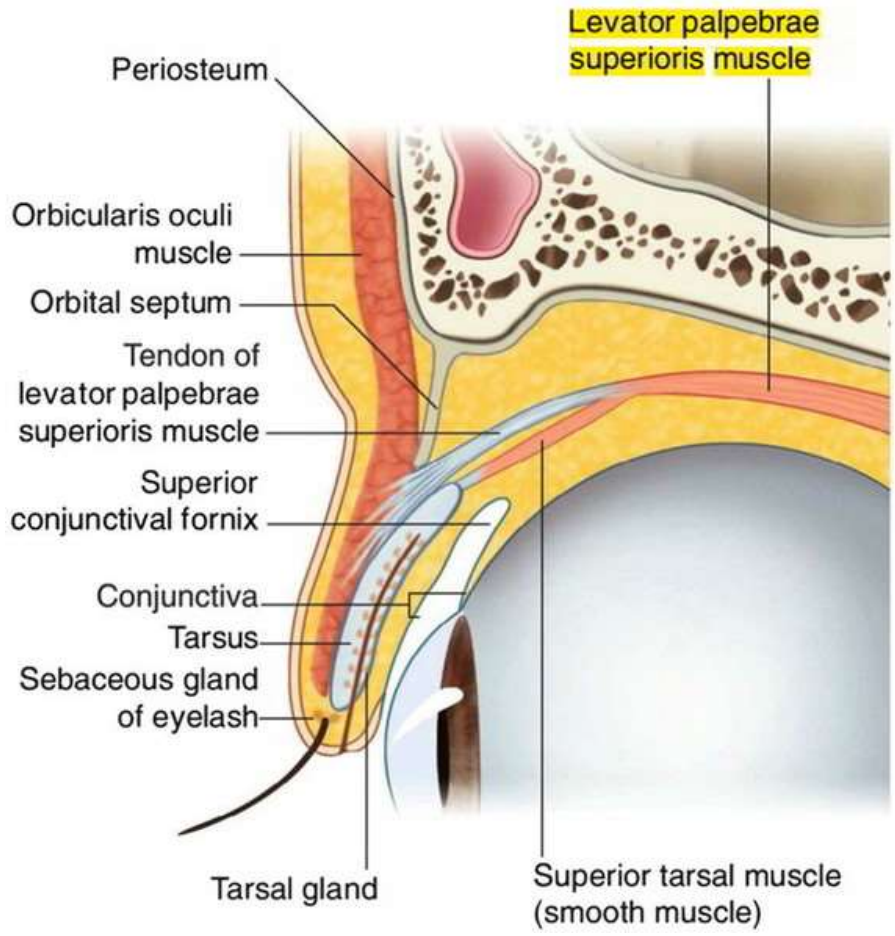
- The sympathetic fibres can be stretched or damaged along their course to the head and neck. If these nerves are unilaterally disturbed, it produces a triad of main symptoms known as Horner's syndrome:
- **Partial Ptosis** – drooping of the upper eyelid. This is due to paralysis of the superior tarsal muscle, which acts to help open the eyelid.
- **Miosis** – constriction of the pupil. This is due to paralysis of the dilator pupillae, a muscle located within the eye that acts to dilate the pupil.
- **Anhydrosis** – decreased sweating (affecting the same side of the face as the lesion). This is due to a loss of innervation to the sweat glands of the face.
- Horner's syndrome has a multitude of causes. These include spinal cord lesions, traumatic injury and a Pancoast tumour (a cancer affecting the apex of the lung, which can involve the ganglia).

Sympathetic Innervation



Horner Syndrome

Superior Tarsal muscle



Autonomic Nervous system

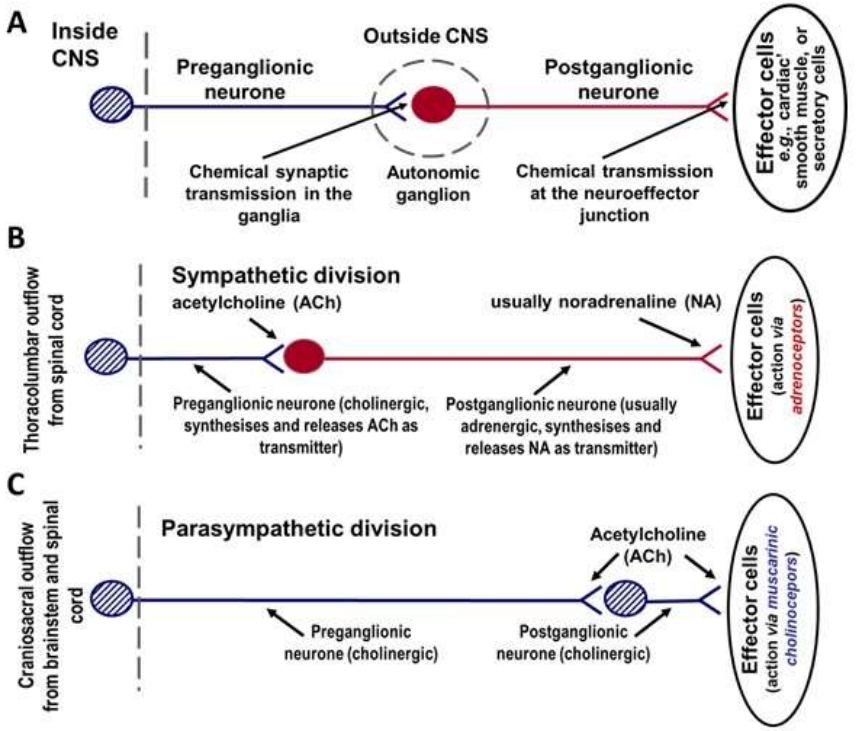
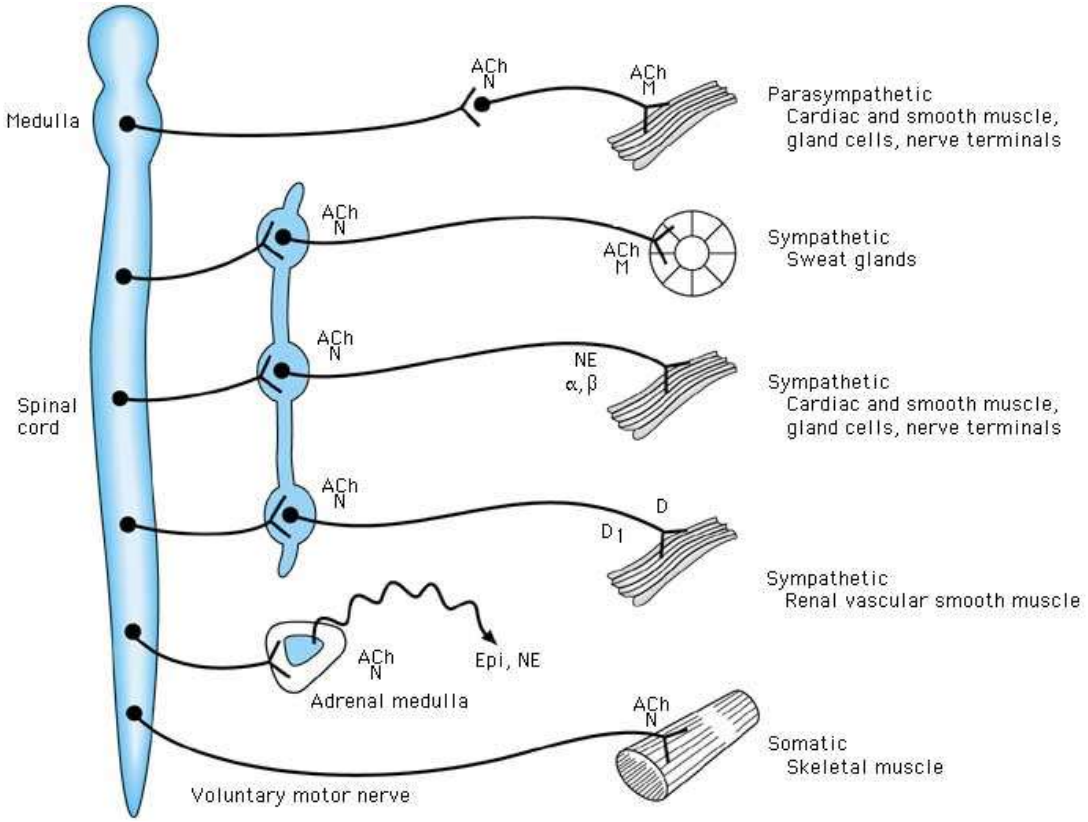


Figure 2. The organisation of the motor autonomic nervous system. A) Anatomically, the motor output comprises two neurones in series (the only exception being the innervation of the adrenal medulla). B) In the sympathetic division preganglionic neurones are cholinergic, whereas postganglionic neurones are usually adrenergic. C) In the parasympathetic division, both pre- and post-ganglionic neurones are cholinergic. See text for further details.

Sympathetic Innervation



Sympathetic Innervation

Superior Cervical Ganglion

Ganglia	Vertebral Level	Arteries Involved	Effector Organ(s)
Superior cervical ganglion	C1-C4	Common, external and internal carotid arteries	•Eyeball •Face •Nasal glands •Pharynx •Glands of the palate and nasal cavity •Salivatory glands •Lacrimal glands •Sweat glands •Pineal gland •Dilator pupillae •Superior tarsal muscle •Carotid body •Heart •Arterial smooth muscle

Sympathetic Innervation

Middle and Inferior Cervical Ganglion

Middle cervical ganglion	C6	Inferior thyroid artery	•Larynx •Trachea •Pharynx •Upper oesophagus •Heart •Arterial smooth muscle
Inferior cervical ganglion	C7	Vertebral and subclavian arteries	•Heart •Arterial smooth muscle

Parasympathetic Innervation

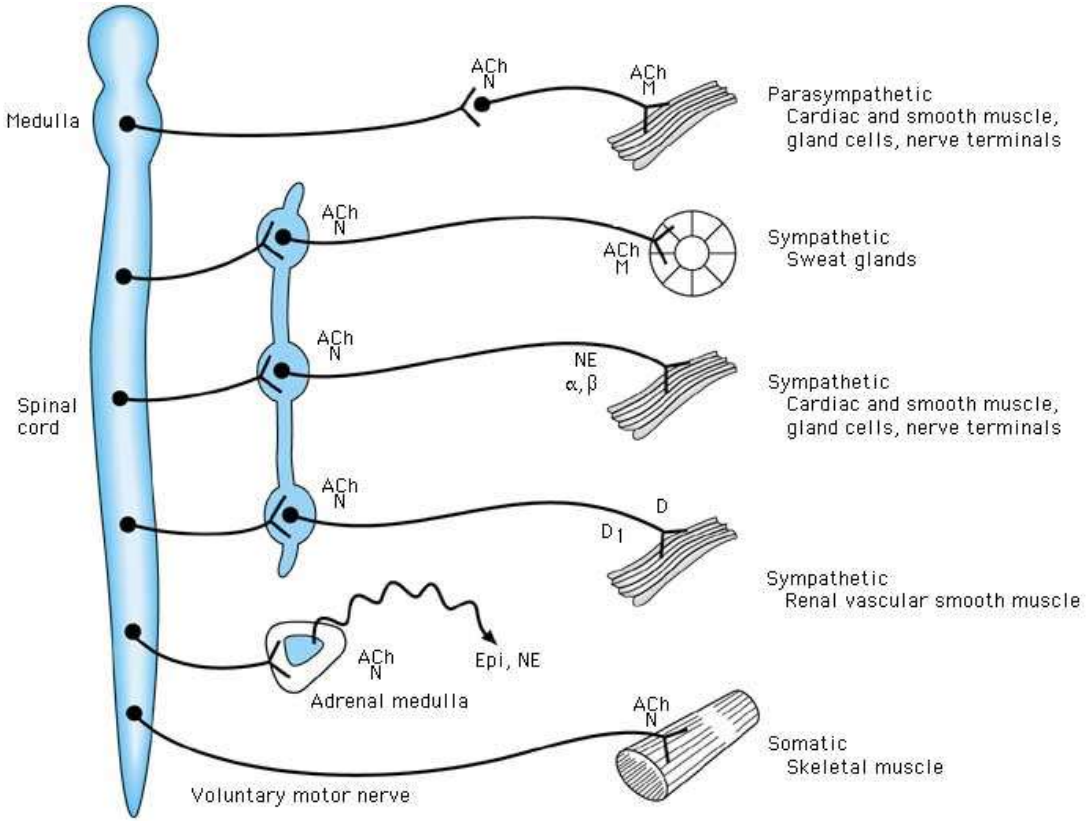
Contents

Parasympathetic Innervation

- The parasympathetic nervous system is a division of the autonomic nervous system. It is involuntary, and acts with the sympathetic system to maintain body homeostasis.
- The actions of the parasympathetic nervous system are associated with the ‘rest and digest’ response.
- In this article, we shall look anatomy of the parasympathetic innervation to the head and neck – its structure, anatomical course, and its clinical correlations

Parasympathetic Innervation

PARASympathetic Innervation



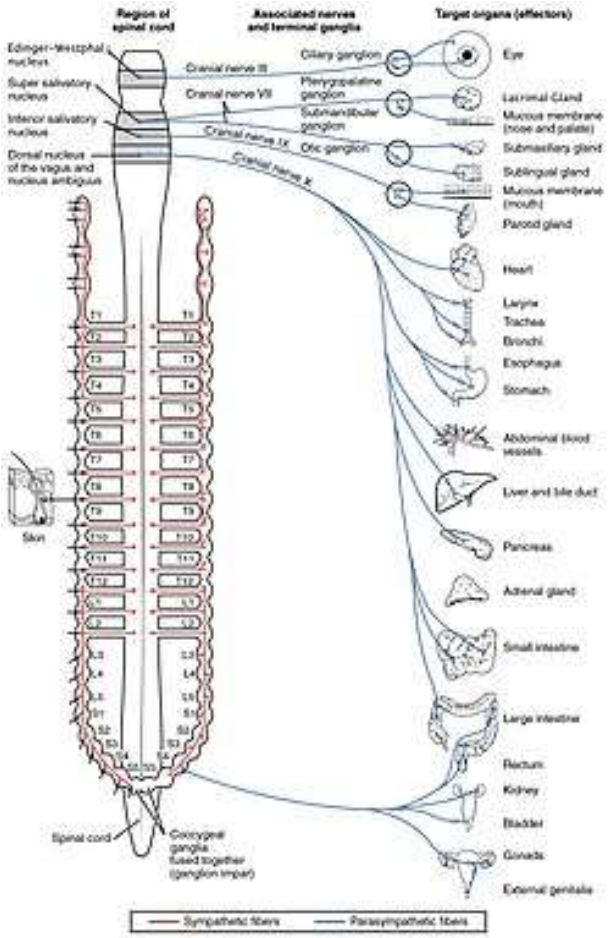
Parasympathetic Innervation

Anatomical Course and Structure

- The parasympathetic fibres begin in the central nervous system. The nerves supplying the head and neck are situated within four **nuclei**, located within the brainstem. Each nucleus is associated with a **cranial nerve** (the oculomotor, facial, glossopharyngeal and vagus nerves) – these nerves carry the parasympathetic fibres out of the brain.
- After leaving the brain, the parasympathetic fibres from each nuclei synapse in a **peripheral ganglion** (a collection of neurone cell bodies outside the CNS). These ganglia are typically located near to the target viscera. From the ganglia, post-ganglionic parasympathetic fibres continue to the organs in the head and neck, providing parasympathetic innervation.

Parasympathetic Innervation

Structure



Parasympathetic Innervation

Anatomical Course and Structure

- There are four parasympathetic ganglia located within the head – the **ciliary, otic, pterygopalatine and submandibular**. They receive fibres from the oculomotor, facial and glossopharyngeal nerves (the vagus nerve only innervates structures in the thorax and abdomen). We shall now examine these ganglia in more detail.
- *Note: Most ganglia are associated with some sensory and sympathetic nerves – these do not synapse in the ganglia, they merely travel through it.*

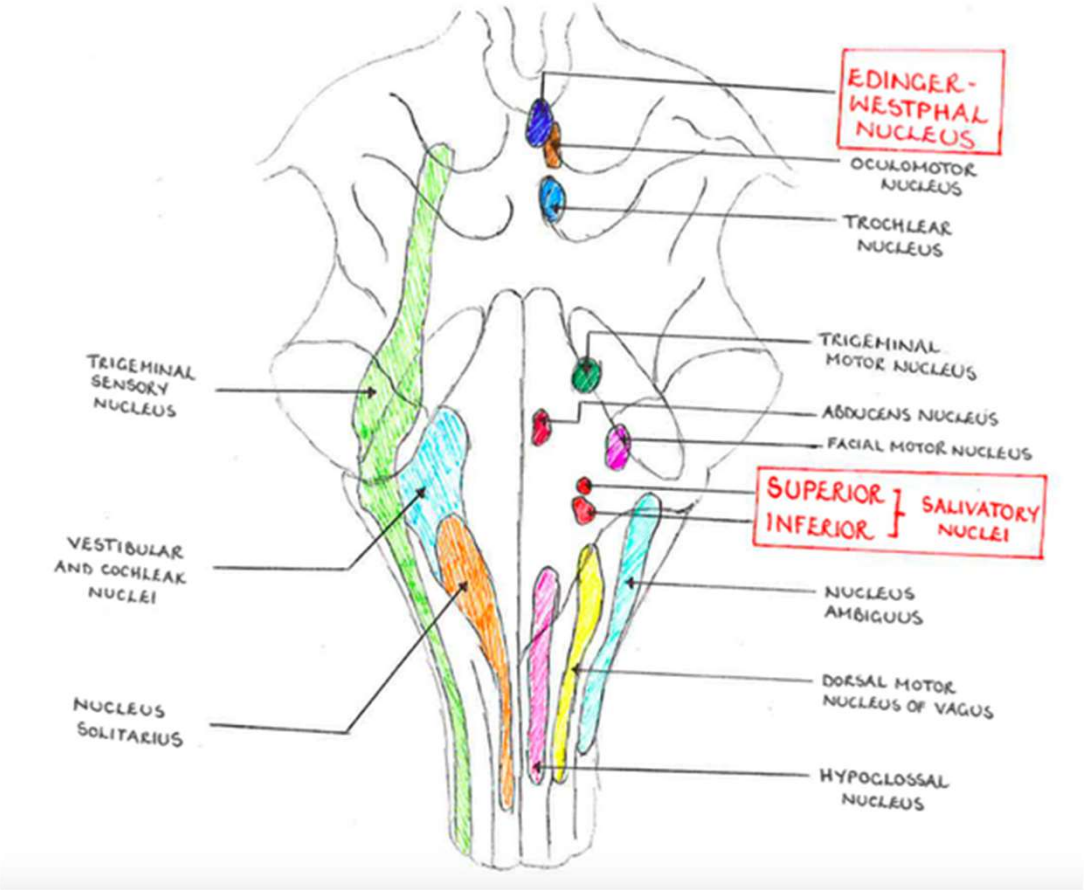
Parasympathetic Innervation

Ciliary Ganglion

- The **ciliary ganglion** is located within the bony orbit. It is situated anteriorly to the superior orbital fissure, between the lateral rectus muscle and the optic nerve.
- **Pre-ganglionic fibres**: The ciliary ganglion is supplied by fibres from the Edinger-Westphal nucleus (associated with the oculomotor nerve).
- **Post-ganglionic fibres**: The parasympathetic fibres leave the ganglion via the short ciliary nerves. These fibres continue into the orbit to innervate structures of the eye.
- **Target Organs**: The post-ganglionic fibres from the ciliary ganglion innervate the sphincter pupillae (contracts the pupil) and the ciliary muscles (accommodates for near vision).
- In addition, two sets of nerve fibres pass through the ciliary ganglion without synapsing:
- **Sympathetic nerves from the internal carotid plexus** – innervate the dilator pupillae muscle
- **Sensory fibres from the Nasociliary nerve** (a branch of the ophthalmic division of the trigeminal nerve) – innervate the cornea, ciliary body and iris.

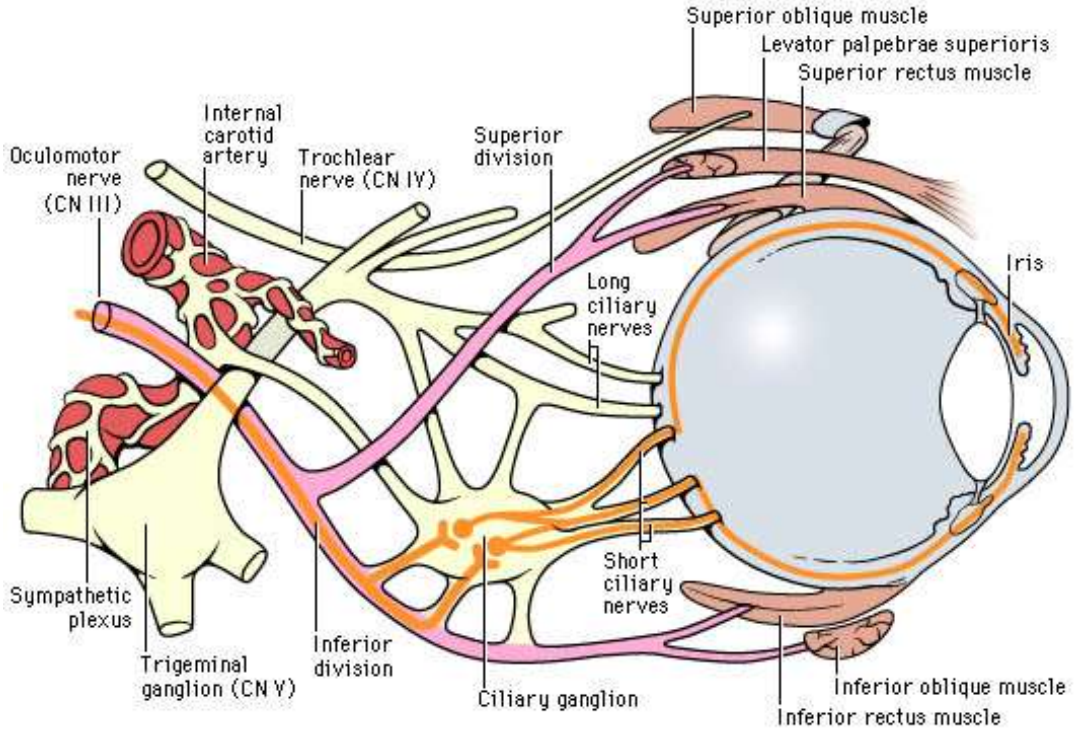
Parasympathetic Innervation

Edinger Westphal nucleus



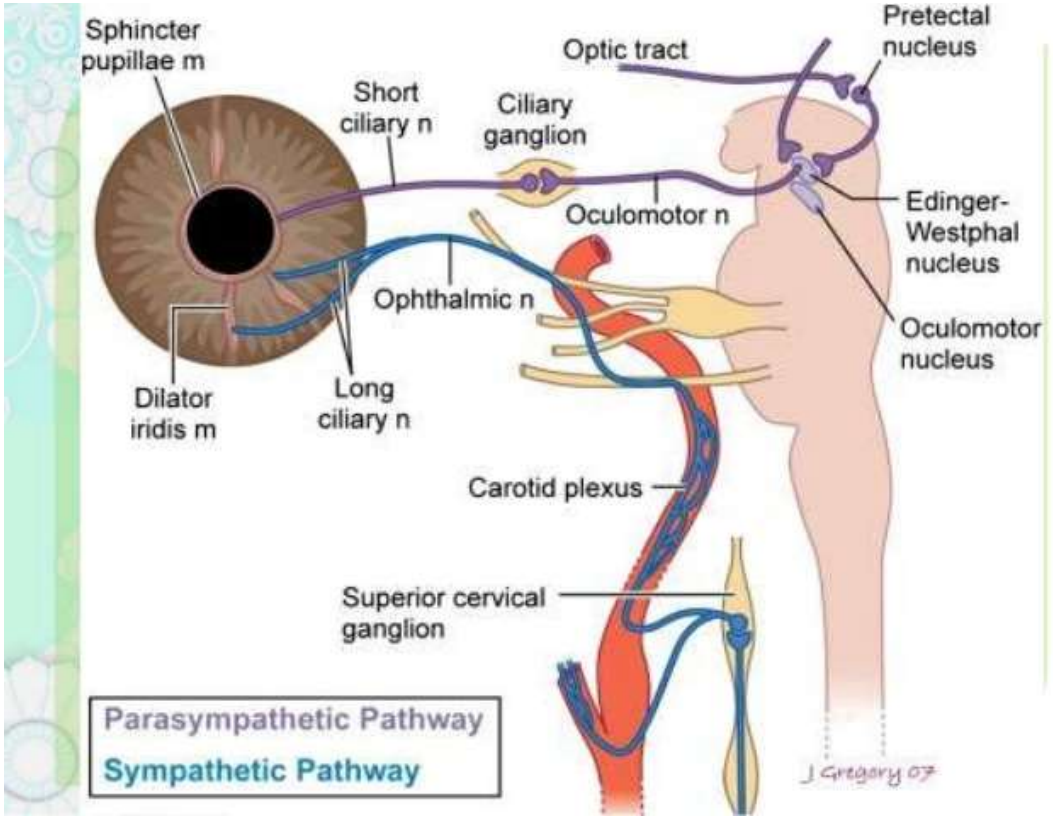
Parasympathetic Innervation

Ciliary Ganglion



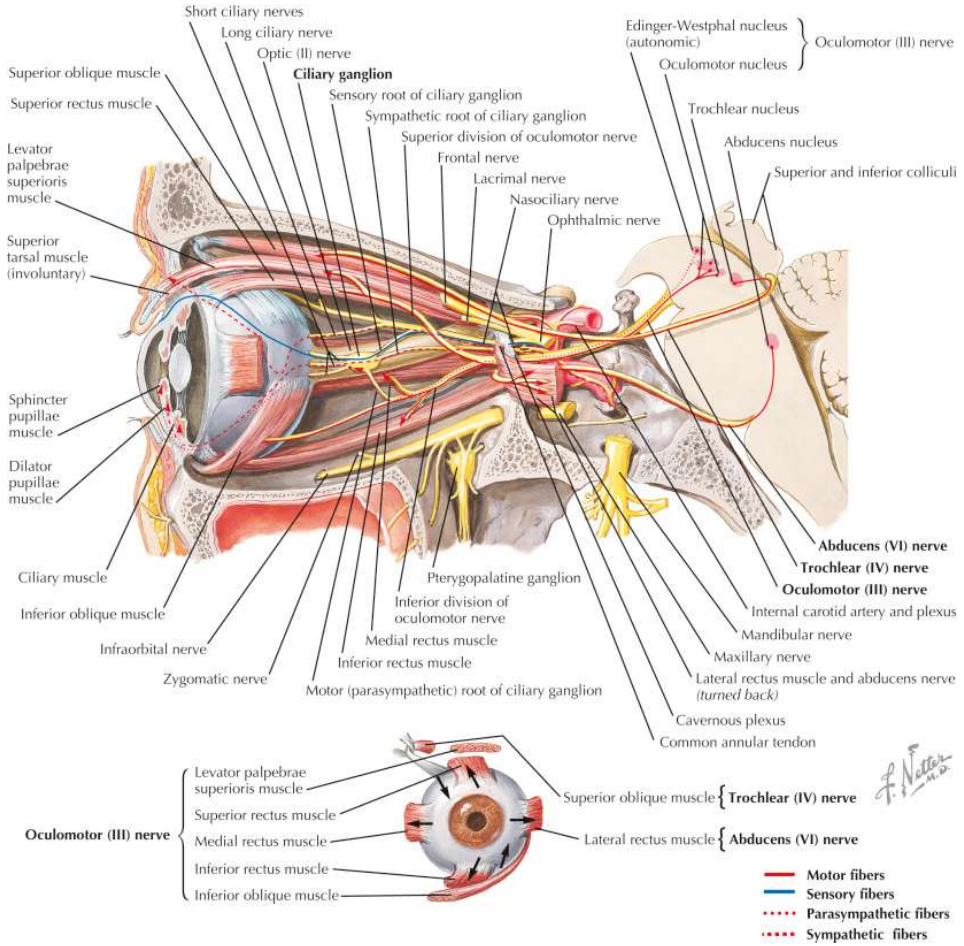
Parasympathetic Innervation

Ciliary Ganglion



Parasympathetic Innervation

Ciliary Ganglion



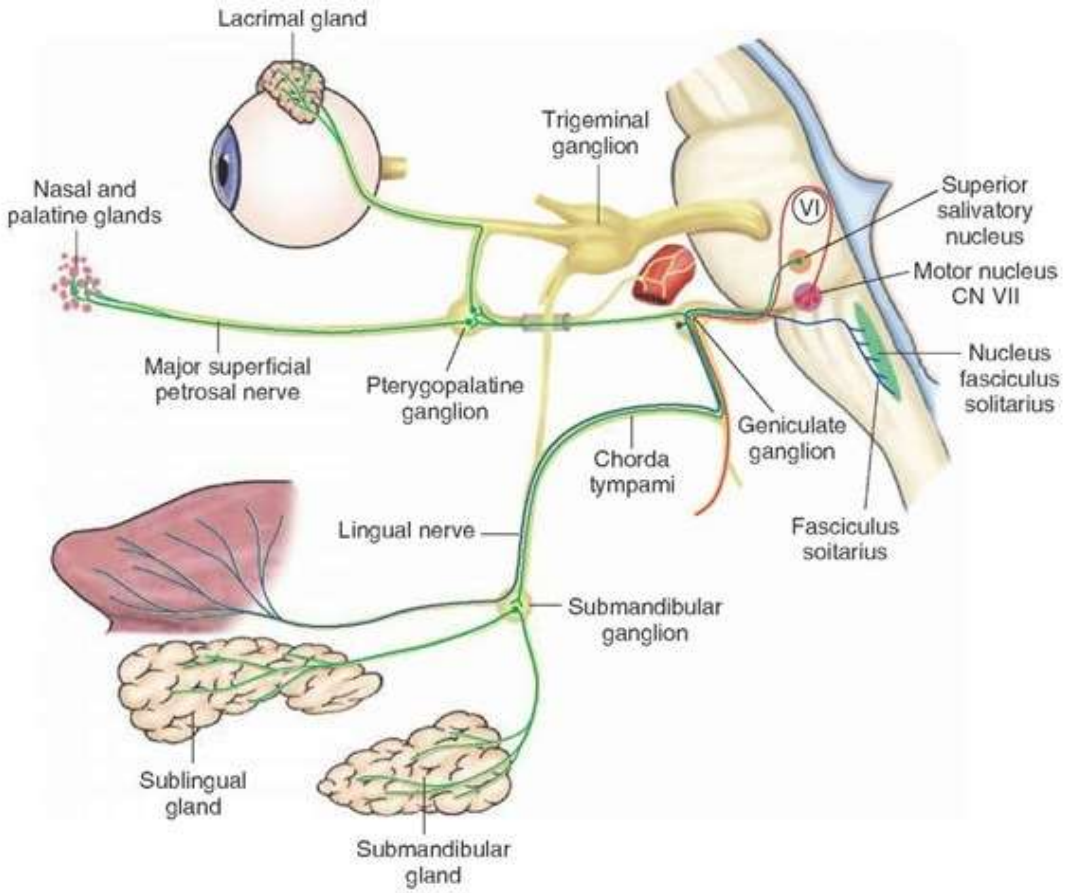
Parasympathetic Innervation

Pterygopalatine Ganglion

- The pterygopalatine ganglion (also known as sphenopalatine) is the largest of the four parasympathetic ganglia. It is located within the pterygopalatine fossa – a space located inferiorly to the base of the skull, and posteriorly to the maxilla.
- **Pre-ganglionic fibres**: The pterygopalatine ganglion is supplied by fibres from the superior salivatory nucleus (associated with the facial nerve). These fibres travel within the greater petrosal nerve and the nerve of the pterygoid canal to reach the ganglion.
- **Post-ganglionic fibres**: The parasympathetic fibres leave the ganglion by hitch-hiking on branches of the maxillary nerve (derived from the trigeminal nerve).
- **Target organs**: The post-ganglionic fibres from the pterygopalatine ganglion provide secretomotor innervation to lacrimal gland, mucous glands of posterosuperior nasal cavity, nasopharynx, and the palate.
- Sympathetic fibres from the internal carotid plexus and sensory branches from the maxillary nerve pass through the pterygopalatine ganglion without synapsing.

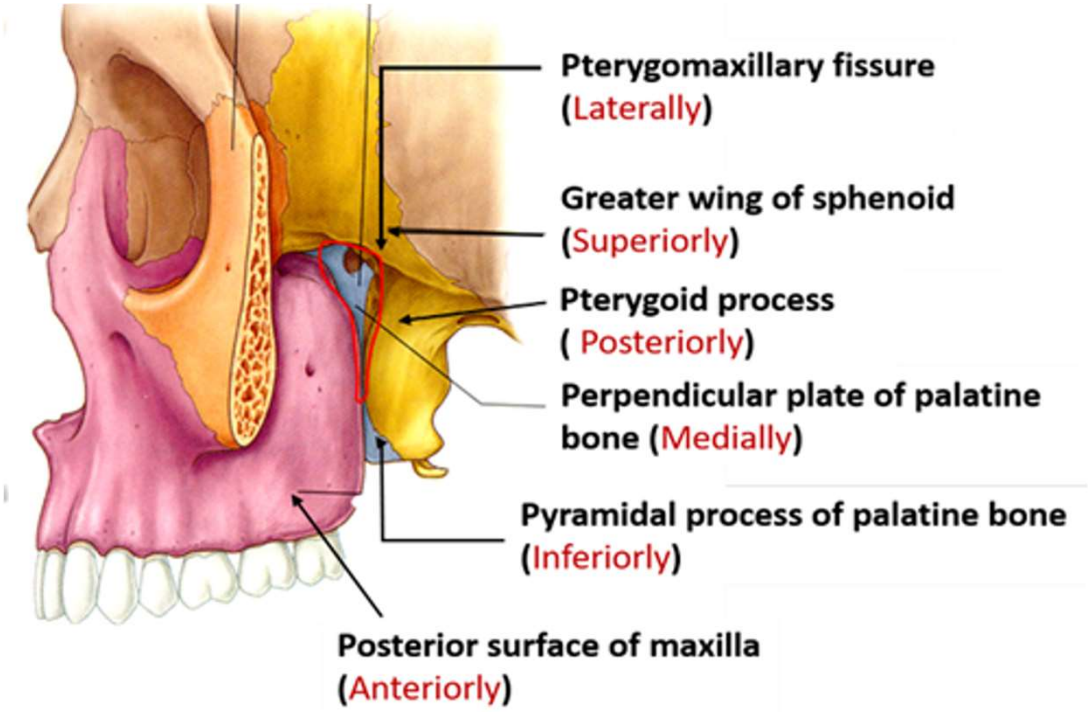
Parasympathetic Innervation

Pterygopalatine Ganglion



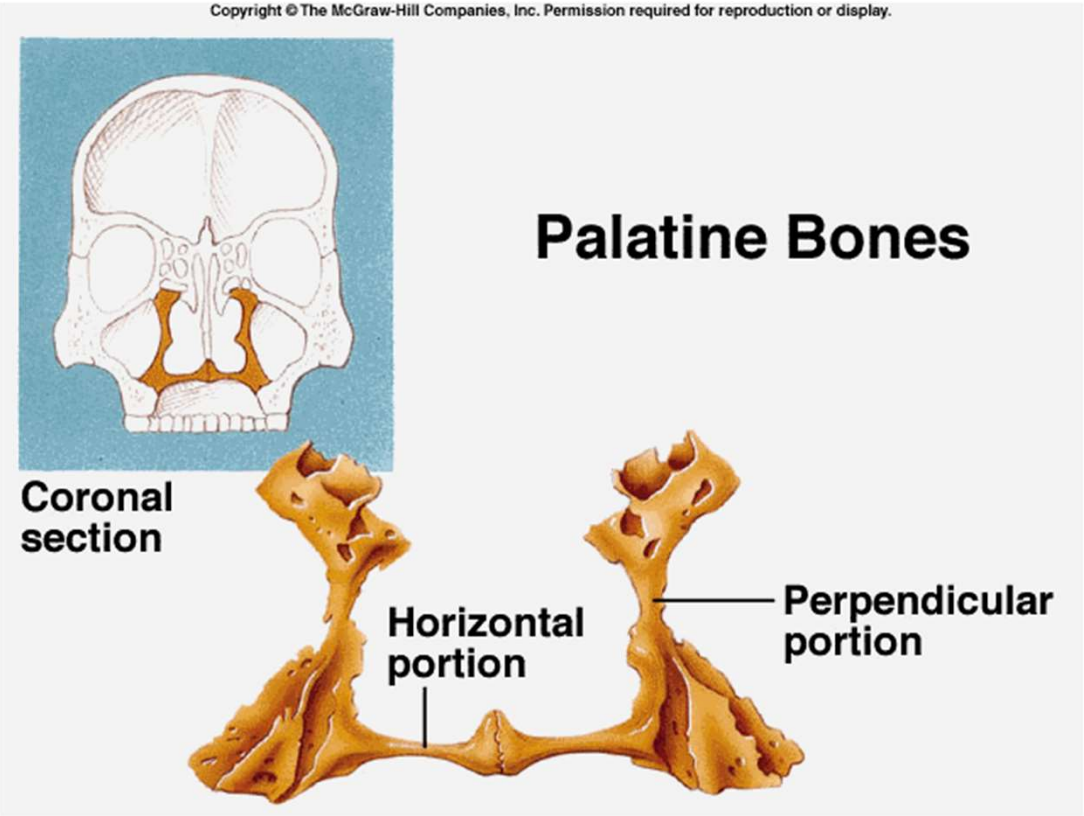
Parasympathetic Innervation

Pterygopalatine Ganglion



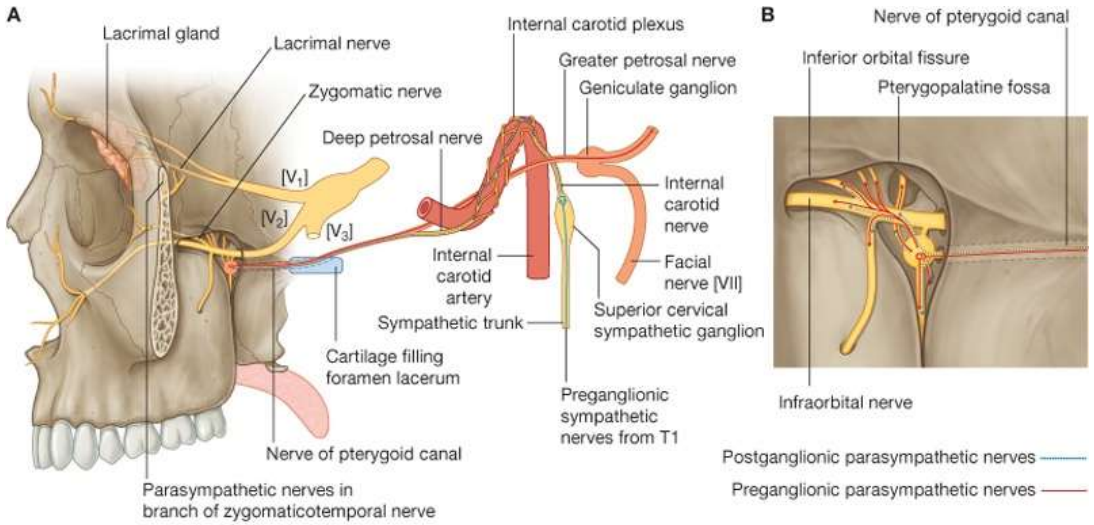
Parasympathetic Innervation

Pterygopalatine Ganglion



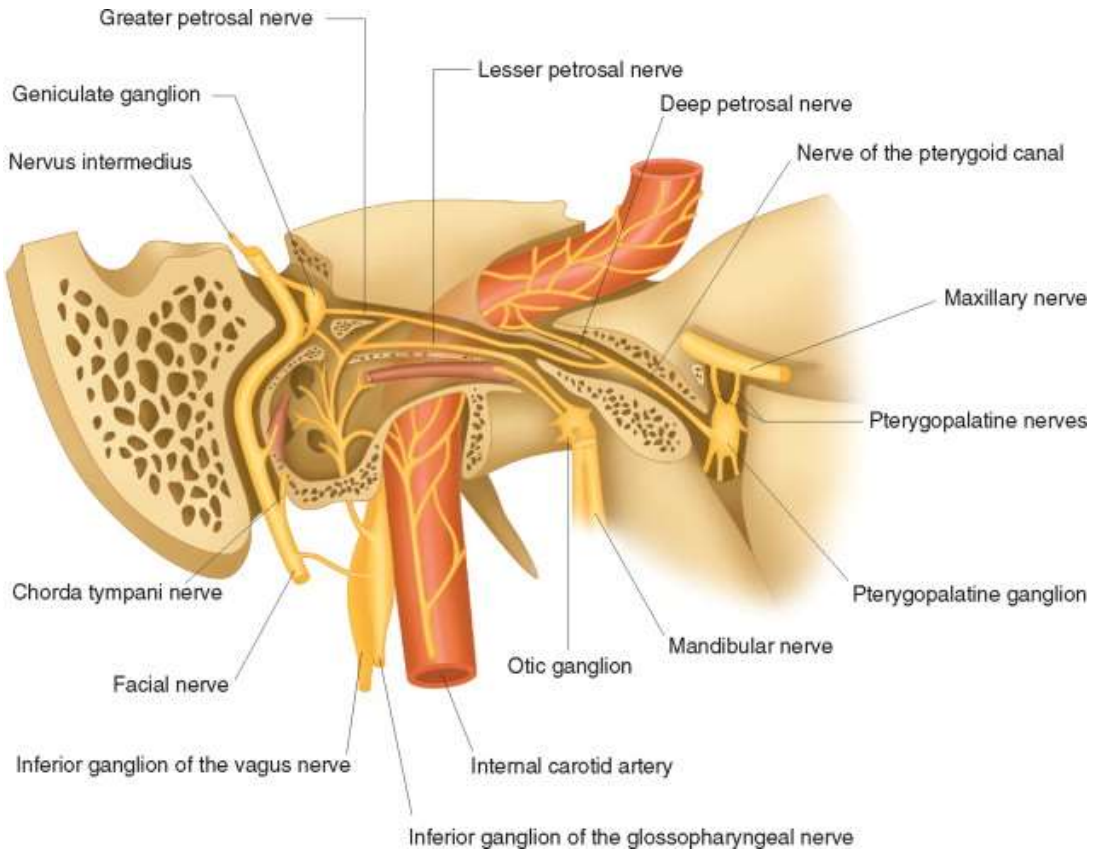
Parasympathetic Innervation

Pterygopalatine Ganglion



Parasympathetic Innervation

Pterygopalatine ganglion



Parasympathetic Innervation

Submandibular Ganglion

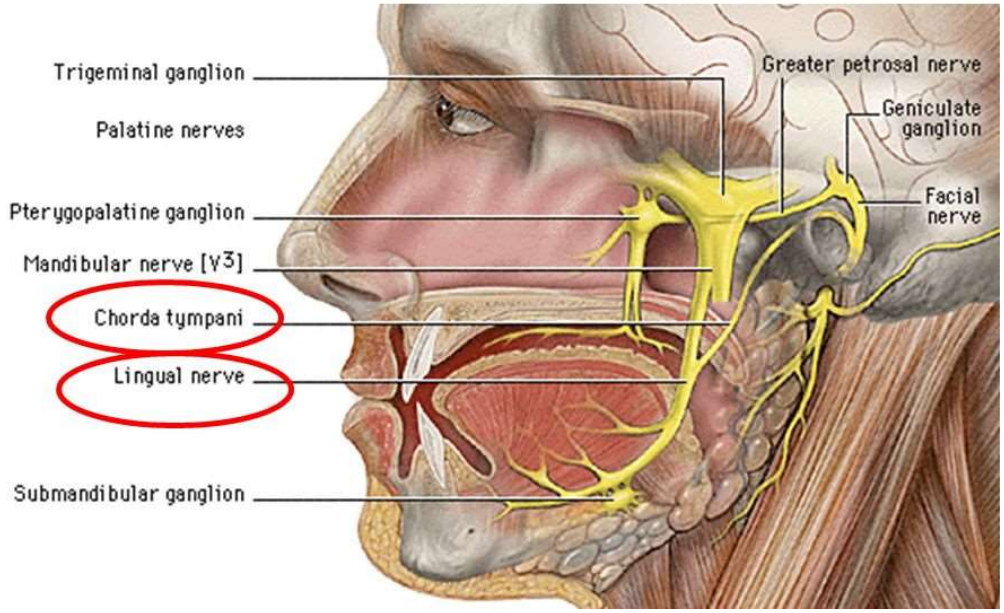
- The **submandibular ganglion** is located inferiorly to the lingual nerve, from which it is suspended.
- **Pre-ganglionic fibres**: The ganglion is supplied by fibres from the superior salivatory nucleus (associated with the facial nerve). These fibres are carried within a branch of the facial nerve, the chorda tympani. This nerve hitch-hikes along the lingual branch of the mandibular nerve to reach the ganglion.
- **Post-ganglionic fibres**: Fibres leave the ganglion and travel directly to the submandibular and sublingual glands.
- **Target Organs**: Secretomotor innervation to the submandibular and sublingual salivary glands.
- Sympathetic fibres from the facial artery plexus pass through the submandibular ganglion. They are thought to innervate glands in the base of the oral cavity.

Parasympathetic Innervation

Submandibular Ganglion

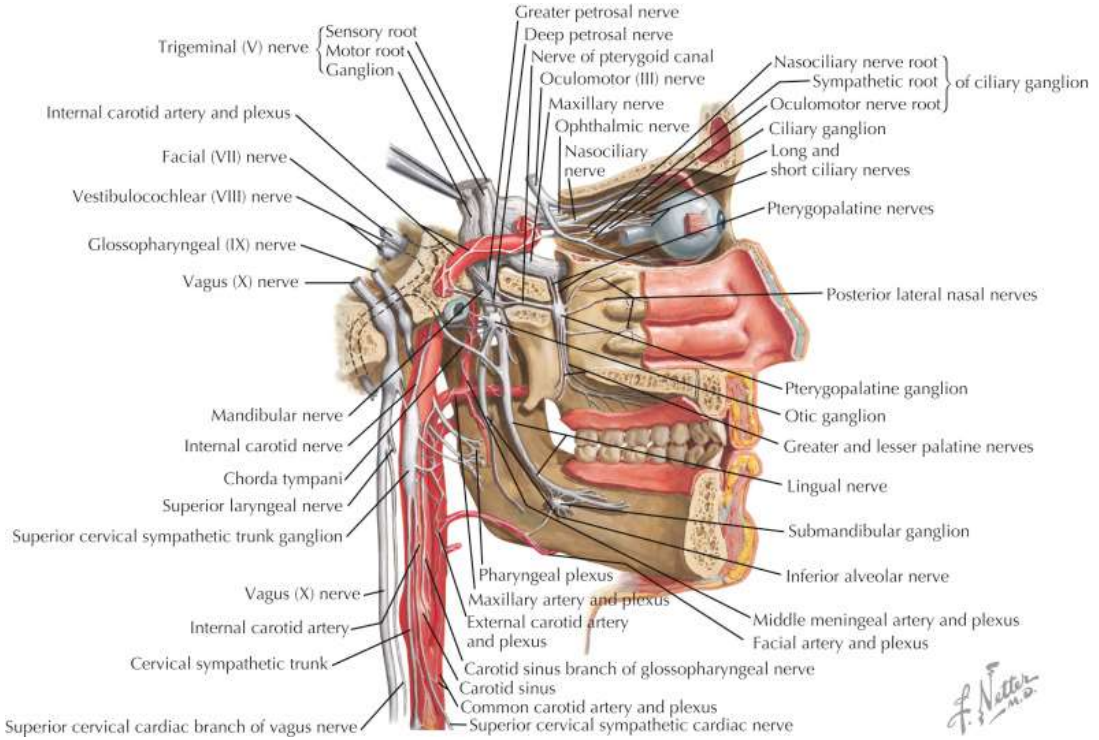
Innervation of the Tongue

- chorda tympani nerve - branch of CN VII
- The chorda tympani joins the lingual nerve and runs anteriorly in its sheath.



Parasympathetic Innervation

Submandibular ganglion



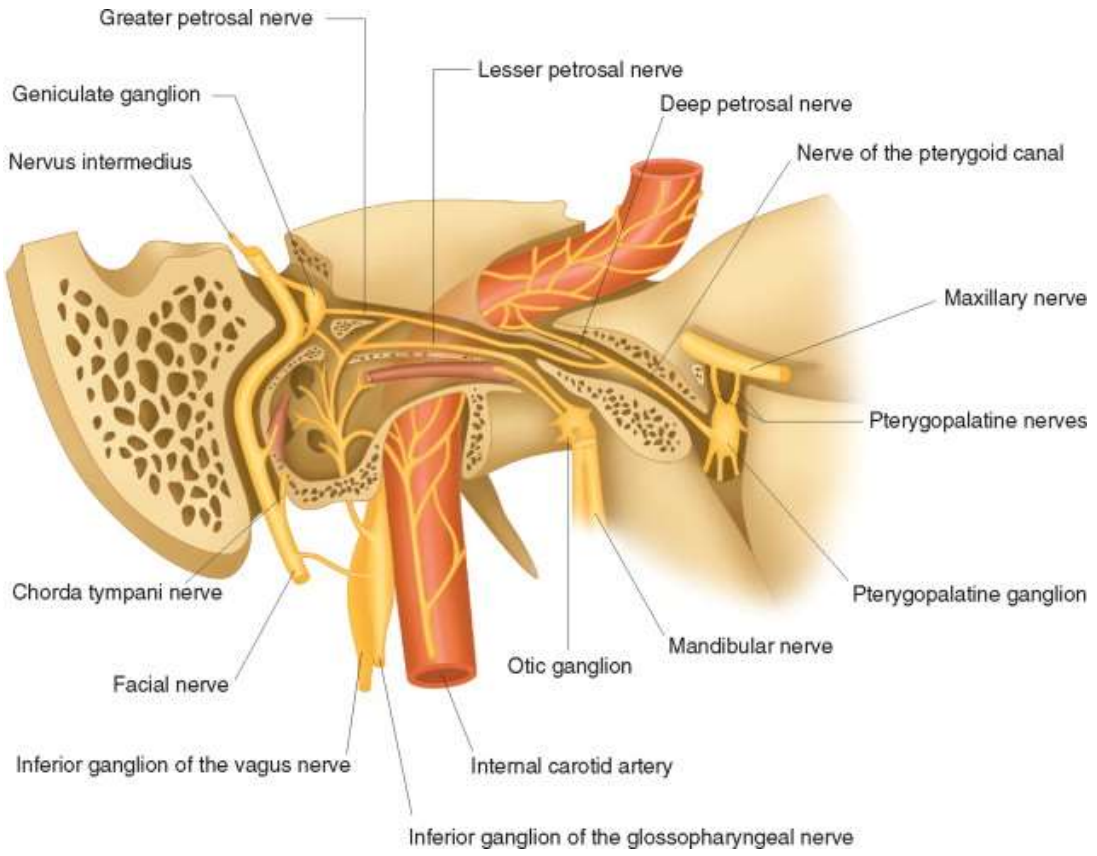
Parasympathetic Innervation

Otic Ganglion

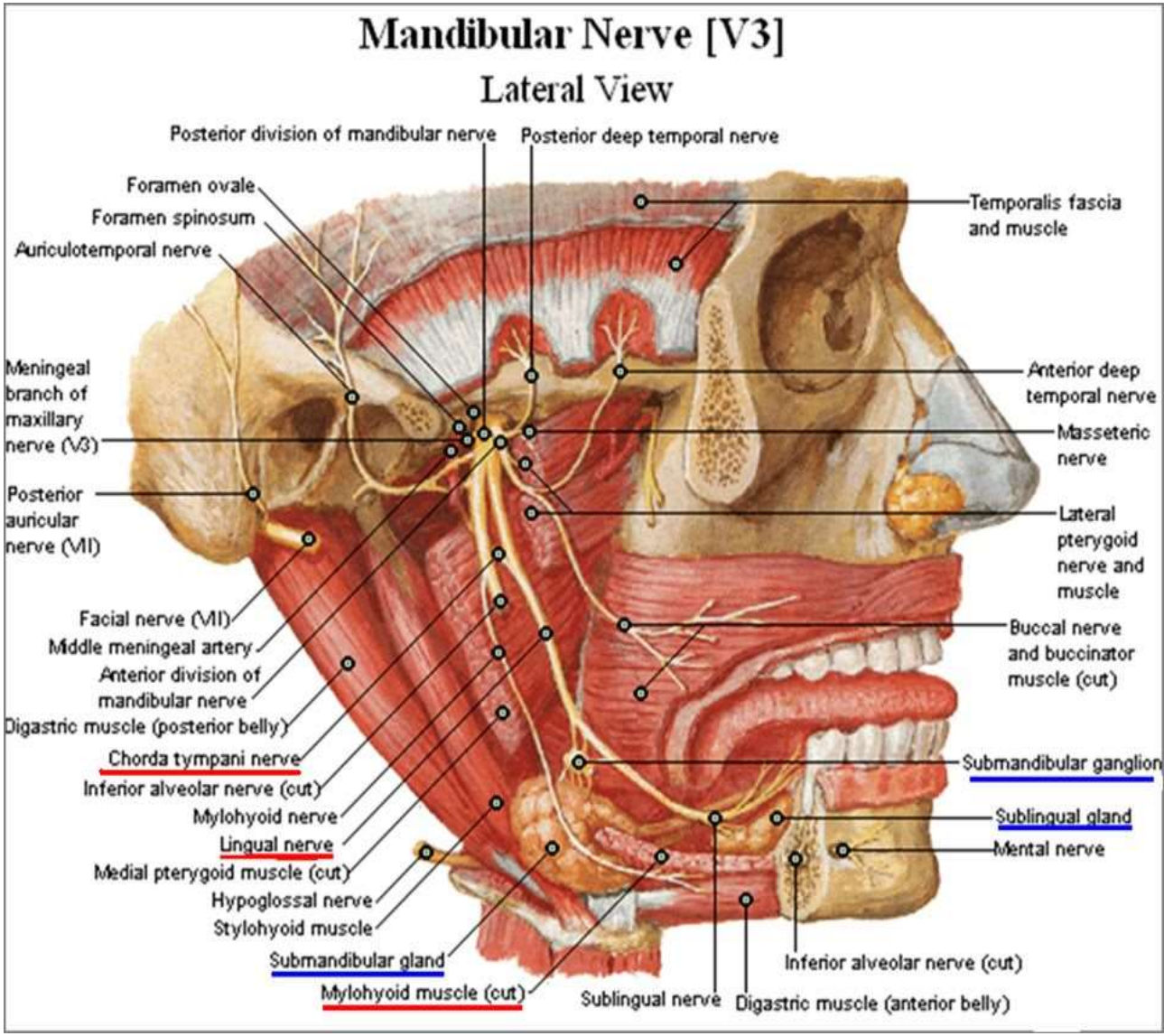
- The **otic ganglion** is located inferiorly to the foramen Ovale, within the infratemporal fossa. It is medial to the mandibular branch of the trigeminal nerve.
- **Pre-ganglionic fibres**: The ganglion is supplied by fibres from Inferior salivatory nucleus (associated with the glossopharyngeal nerve). Parasympathetic fibres travel within a branch of the glossopharyngeal nerve, the lesser petrosal nerve, to reach the Otic ganglion.
- **Post-ganglionic fibres**: The parasympathetic fibres hitchhike along the auriculotemporal nerve (branch of the mandibular division of the trigeminal nerve) to provide secretomotor innervation to the parotid gland.
- **Target Organs**: The post-ganglionic fibres from the otic ganglion provide innervation to the parotid gland.
- Sympathetic fibres from the superior cervical chain pass through the otic ganglion. They travel with the middle meningeal artery to innervate the parotid gland.

Parasympathetic Innervation

Pterygopalatine ganglion



Otic Ganglion



Parasympathetic Innervation

Clinical Relevance: Adie's Pupil

- The ciliary ganglion provides innervation to the **sphincter pupillae** muscle, which acts to constrict the pupil.
- If the ciliary ganglion is damaged, there is a loss of innervation to the sphincter pupillae. This results in a permanently **dilated** pupil that does not constrict in the presence of light. This is known as Adie's pupil – named after the British neurologist William John Adie.
- Adie's pupil is thought to result from inflammation caused by a viral or bacterial infection.

Parasympathetic Innervation

Nucleus	Pre-ganglionic	Ganglion	Post-ganglionic	Target organs
Edinger-Westphal (Oculomotor nerve)	Travels with the motor root of the oculomotor nerve	Ciliary ganglion	Travels via the short ciliary nerves	Sphincter pupilliae Ciliary muscles
Superior salivatory nucleus (Facial nerve)	Travels with the greater petrosal nerve and the nerve of the pterygoid canal	Pterygopalatine ganglion	Hitchhikes on branches of the maxillary nerve	Lacrimal gland Nasopharynx Palate Nasal cavity
	Travels within the chorda tympani, a branch of the facial nerve	Submandibular ganglion	Fibres travel directly to target organs	Sublingual and submandibular glands
Inferior salivatory nucleus (Glossopharyngeal nerve)	Travels within the lesser petrosal nerve	Otic ganglion	Hitchhikes on the auriculotemporal nerve	Parotid gland
Dorsal vagal motor nucleus (vagus nerve)	Travels within the vagus nerve	Many – located within the target organs	n/a	Smooth muscle of the trachea, bronchi and gastro-intestinal tract

THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

Contents

THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

- The **ophthalmic nerve** (CNV1) is a terminal branch of the trigeminal nerve (along with the maxillary and mandibular nerves).
- It provides **sensory innervation** to the skin, mucous membranes and sinuses of the upper face and scalp.
- In this article, we will look at the anatomy of the ophthalmic nerve – its anatomical course, sensory functions and autonomic functions.

THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

Anatomical Course

Trigeminal Nerve

- The trigeminal nerve originates from **four nuclei**, which extend from the midbrain to the medulla (a nucleus refers to a collection of nerve cell bodies within the central nervous system):

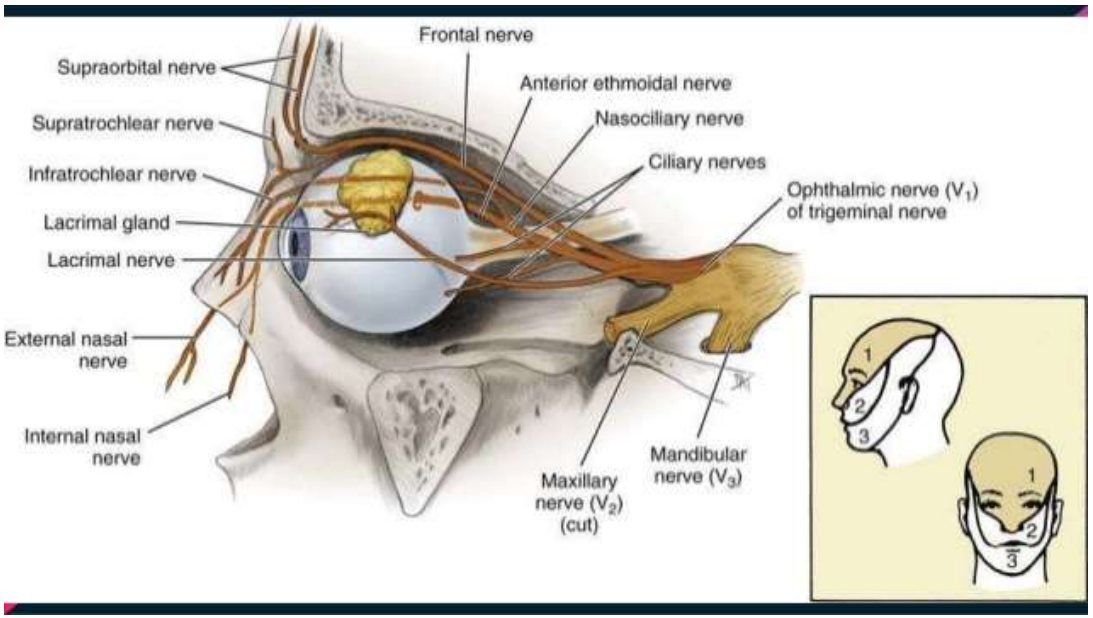
Three sensory nuclei:

  - Mesencephalic nucleus
  - Principle sensory nucleus
  - Spinal nucleus

- Motor nucleus of the trigeminal nerve
- At the level of the **pons**, the sensory nuclei merge to form a sensory root. The motor nucleus continues to form a separate motor root. These roots are analogous with the dorsal and ventral roots of the spinal cord.

THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

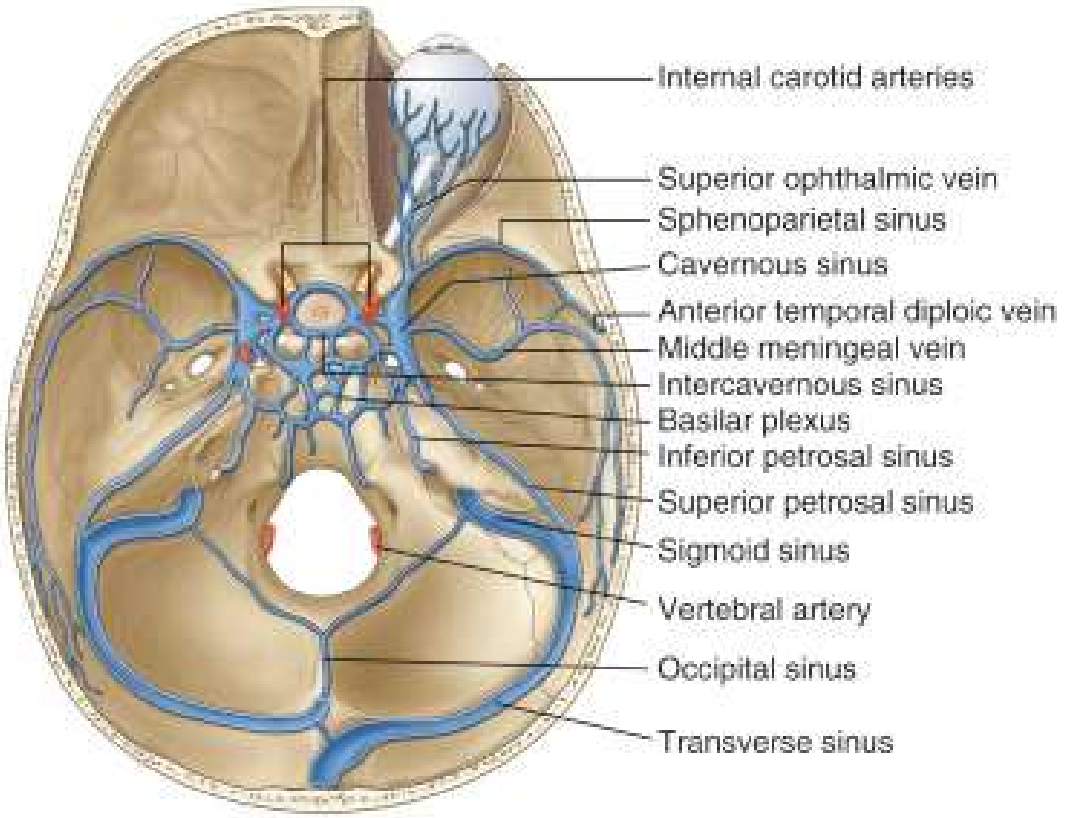
Division



THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

- Within the middle cranial fossa, the sensory root expands into the **trigeminal ganglion** (a ganglion refers to a collection of the nerve cell bodies outside the central nervous system).
- The trigeminal ganglion is located lateral to the cavernous sinus, in a depression of the temporal bone known as the **trigeminal cave** or Meckel's cave.
- The motor root passes inferiorly to the sensory root, along the floor of the trigeminal cave. Motor fibres are only distributed to the **mandibular division** (V3).
- From the trigeminal ganglion, the **three terminal divisions** of the trigeminal nerve arise; the ophthalmic (V1), maxillary (V2) and mandibular (V3) nerves.

Cavernous sinus



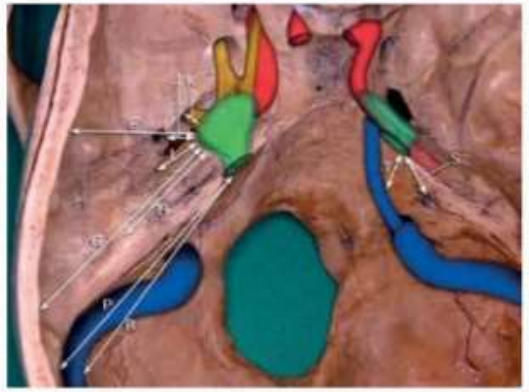
Mekel’s cave

Meckel's Cave

Source -
Turkish Neurosurgery
Official journal of neurological society 2012, Volume 22, Number 3, Page(s) 317-323
Anatomy of Meckel's Cave and the Trigeminal Ganglion: Anatomical Landmarks for a Safer Approach to Them

- **The average height of this oval mouth was found to be 4.2 mm (range 3-5 mm)**
- **the average width was 7.6 mm (range 6-8 mm).**
- **located**

- 12 mm
(range 10-15 mm)



THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

Ophthalmic Nerve

After arising from the trigeminal ganglion, the ophthalmic nerve travels laterally to the cavernous sinus and gives rise to the **recurrent tentorial branch** (which supplies the tentorium cerebelli).

The nerve then then exits the cranium via the **superior orbital fissure**, where it divides into its three main branches:

- **Frontal nerve**
- **Lacrimal nerve**
- **Nasociliary nerve**
- These three branches provide sensory innervation to the skin and mucous membranes of the structures derived from the **frontonasal prominence**.

THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

Sensory Function

The ophthalmic division of trigeminal nerve provides **sensory innervation** to the following structures:

- Forehead and scalp
- Frontal, ethmoid and sphenoid sinuses
- Upper eyelid and its conjunctiva
- Cornea
- Dorsum of the nose
- Lacrimal gland
- Parts of the meninges and tentorium cerebelli (recurrent tentorial branch)
- The table below outlines the structures innervated by branches of CNV1.

Maxillary Nerve

Nerve	Branches	Innervation
Frontal (largest of three terminal branches of CNV1)	Supraorbital	Upper eyelid and conjunctiva Scalp
	Supratrochlear	Upper eyelid and conjunctiva Forehead
Lacrimal (smallest of three terminal branches of CNV1)	Receives branch from zygomatic nerve of CNV2 containing parasympathetic fibres	Sensory innervation of lacrimal gland, upper eyelid and conjunctiva Contains parasympathetic fibres to lacrimal gland.
Nasociliary	Anterior ethmoid nerve	Sensory innervation of mucous membranes of frontal, ethmoid and sphenoid sinuses. Nasal cavity
	Posterior ethmoid nerve	Absent in approximately 30% of people Sensory innervation to mucous membranes of sphenoid sinus
	Infratrochlear nerve	Bridge of nose Upper eyelid and conjunctiva
	Long ciliary nerves	Sensory innervation to eye (cornea, ciliary bodies, iris) Contains sympathetic fibres to dilator pupillae muscle.

THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

Mapping Cutaneous Innervation

- The cutaneous innervation to the face and scalp by the three branches of the trigeminal nerve have sharp borders and little overlap. The cutaneous innervation of CNV1 can be seen in the image below:

THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

Autonomic Functions

- The ophthalmic nerve itself does not contain any autonomic fibres. However, nerves from the sympathetic and parasympathetic system **'hitchhike'** on CNV1:
- **Sympathetic fibres** (from the superior cervical ganglion) hitchhike on branches of the nasociliary nerve (long ciliary nerves) to reach the dilator pupillae in the eye.
- **Parasympathetic fibres** (from the pterygopalatine ganglion) hitchhike along the zygomatic branch of the maxillary nerve (CNV2) and then the lacrimal branch of the ophthalmic nerve (CNV1) to reach the lacrimal gland. The lacrimal branch itself provides sensory innervation to the lacrimal gland.

THE OPHTHALMIC DIVISION OF THE TRIGEMINAL NERVE (CNV1)

Clinical Relevance: Corneal Reflex

- The corneal reflex is the involuntary **blinking** of the eyelids – stimulated by tactile, thermal or painful stimulation of the cornea.
- In the corneal reflex, the ophthalmic nerve acts as the **Afferent** limb – detecting the stimuli. The facial nerve is the efferent limb, causing contraction of the orbicularis oculi muscle.
- If the corneal reflex is absent, it is a sign of **damage** to the trigeminal/ophthalmic nerve or the facial nerve.

THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE (CNV2)

Contents

THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE (CNV2)

- The **maxillary nerve** is the second branch of the trigeminal nerve, which originates embryologically from the first pharyngeal arch.
- Its primary function is **sensory supply** to the mid-third of the face.
- In this article, we shall look at the anatomy of the **maxillary nerve** – its anatomical course, sensory and parasympathetic functions.

THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE (CNV2)

Anatomical Course

Trigeminal Nerve

- The trigeminal nerve originates from **four nuclei**, which extend from the midbrain to the medulla (a nucleus refers to a collection of nerve cell bodies within the central nervous system):
- Three sensory nuclei:
  - Mesencephalic nucleus
  - Principle sensory nucleus
  - Spinal nucleus
- Motor nucleus of the trigeminal nerve
- At the level of the **pons**, the sensory nuclei merge to form a sensory root. The motor nucleus continues to form a separate motor root. These roots are analogous with the dorsal and ventral roots of the spinal cord.

THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE (CNV2)

- Within the middle cranial fossa, the sensory root expands into the **trigeminal ganglion** (a ganglion refers to a collection of the nerve cell bodies outside the central nervous system).
- The trigeminal ganglion is located lateral to the cavernous sinus, in a depression of the temporal bone known as the **trigeminal cave** or Meckel's cave.
- The motor root passes inferiorly to the sensory root, along the floor of the trigeminal cave. Motor fibres are only distributed to the **mandibular division** (V3).
- From the trigeminal ganglion, the **three terminal divisions** of the trigeminal nerve arise; the ophthalmic (V1), maxillary (V2) and mandibular (V3) nerves.

THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE (CNV2)

Maxillary Nerve

After arising from the trigeminal ganglion, the **maxillary nerve** passes through the lateral wall of the cavernous sinus, before leaving the skull through the foramen rotundum. It gives rise to numerous sensory branches:

- Superior alveolar nerve (anterior, posterior and middle)
- Middle meningeal nerve
- Infraorbital nerve
- Zygomatic nerve
- Inferior palpebral nerve
- Superior labial nerve
- Pharyngeal nerve
- Greater and lesser palatine nerves
- Nasopalatine nerve

THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE (CNV2)

Sensory Function

The maxillary nerve's terminal branches innervate the skin, mucous membranes and sinuses of derivatives of the **maxillary prominence** of the 1st pharyngeal arch:

- Lower eyelid and its conjunctiva
- Inferior posterior portion of the nasal cavity (superior anterior is CNV1)
- Cheeks and maxillary sinus
- Lateral nose
- Upper lip, teeth and gingiva
- Superior palate

THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE (CNV2)

Parasympathetic Function

- Post ganglionic fibres from the Pterygopalatine anglion (derived from the facial nerve) travel **with** the maxillary nerve to:
- Lacrimal gland
- Mucous glands of the nasal mucosa

THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE (CNV2)

Clinical Relevance: Trigeminal Neuralgia

- Trigeminal neuralgia is a disorder characterised by chronic pain over the trigeminal distribution of the face. This is an example of neuropathic pain, whereby there is damage to the nerves causing:
- Hyperalgesia – increased sensitivity to pain
- Allodynia – pain from a usually non-painful stimulus
- As such, light touch can often trigger episodes of excruciating pain.
- Its cause is unknown but it is thought to be the result of damage to trigeminal nerve due to conditions such as multiple sclerosis, stroke or trauma.
- The pain is usually unresponsive to typical analgesics including opioids. As a result an anticonvulsant such as carbamazepine is often used to reduce nervous transmission of the pain by blocking active voltage gated sodium channels. If unresponsive to pharmacological agents, surgical destruction of the nerve is possible, but that understandably results in loss of sensation over the face.

MANDIBULAR NERVE

Contents

MANDIBULAR NERVE

- The **mandibular nerve** is a terminal branch of the trigeminal nerve (along with the maxillary and ophthalmic nerves).
- It has a sensory role in the head, and is associated with parasympathetic fibres of other cranial nerves. However unlike the other branches of the trigeminal nerve, the mandibular nerve also has a **motor function**.
- In this article, we shall look at the anatomy of the **mandibular nerve** – its anatomical course, branches, sensory, motor and autonomic functions.

MANDIBULAR NERVE

Anatomical Course

- The mandibular nerve contains both sensory and motor axons, arising from three **sensory nuclei** (mesencephalic, principal sensory and spinal nuclei of trigeminal nerve) and one motor nucleus (motor nucleus of the trigeminal nerve) respectively.
- The motor root runs along the floor or the **trigeminal cave**, beneath the ganglion, joining the sensory root before leaving the cranium through the foramen ovale.
- Once the mandibular branch has emerged from the cranium, it courses through the infratemporal fossa, branching into four tributaries which are described below.

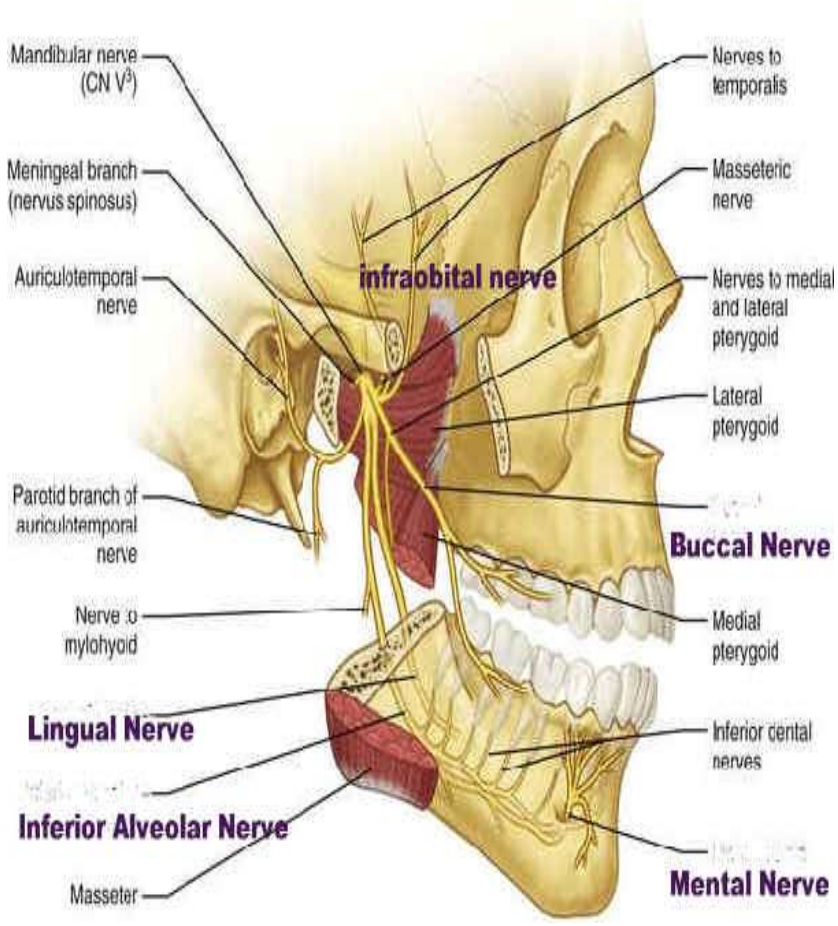
MANDIBULAR NERVE

Auriculotemporal Nerve

The auriculotemporal branch arises from the trigeminal nerve as two roots:

- **Superior root** – comprises sensory fibers.
- **Inferior root** – carries secretory-motor parasympathetic fibers, originating from CN IX, to the parotid gland.
- The two roots converge in close proximity to the middle meningeal artery. After converging, the secretory-motor fibers run to synapse in the otic ganglion, while the sensory fibers pass through the ganglion without synapsing to eventually innervate:
- Anterior part of the auricle
- Lateral part of the temple
- Anterior external meatus
- Anterior tympanic membrane

Auriculotemporal nerve

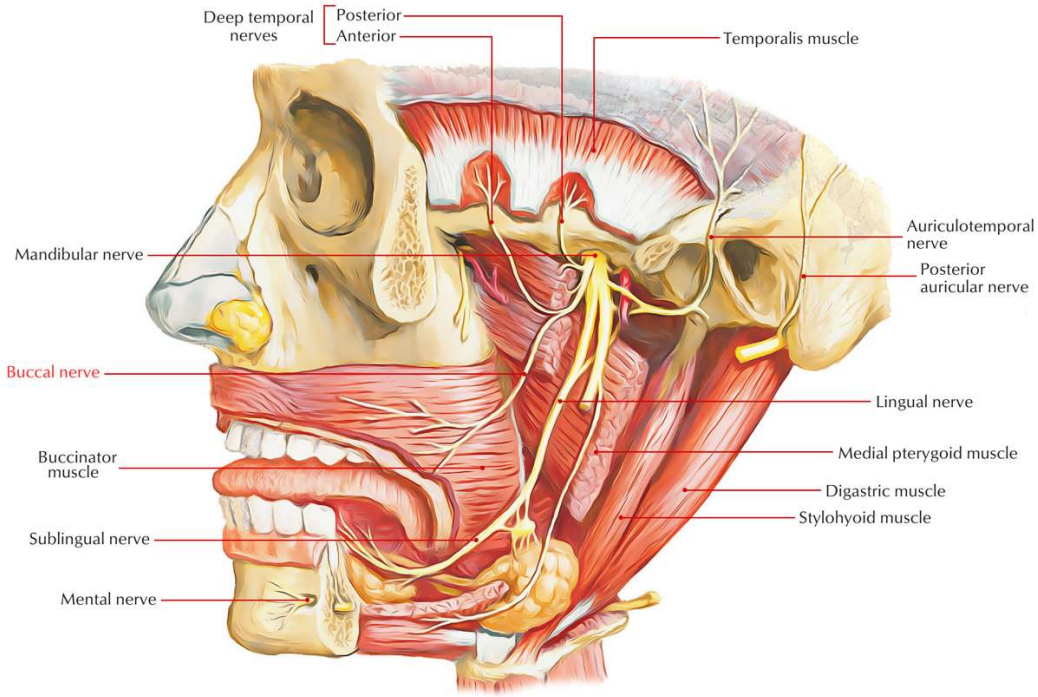


MANDIBULAR NERVE

Buccal Nerve

- The buccal branch of the mandibular nerve contains **sensory** fibres. As it emerges from the mandibular nerve, it passes between the two heads of the lateral pterygoid muscle before heading to its target sites.
- The nerve provides general sensory innervation to the **buccal membranes** of the mouth (i.e. the cheek). It also branches to supply the second and third molar teeth, which is important when performing dental work on those structures.

Buccal Nerve



MANDIBULAR NERVE

Inferior Alveolar Nerve

- The inferior alveolar nerve carries both **sensory** and **motor** axons to and from the respective trigeminal nuclei.
- After branching from its parent nerve it gives rise to the **mylohyoid nerve**, a motor nerve to the mylohyoid and anterior digastric muscles.
- The remaining sensory axons enter the **mandibular canal**, a narrow tunnel running through the mandible bone. Within this canal the nerve provides branches to the mandibular teeth.
- The nerve emerges through the **mental foramen** as the **mental nerve**. This provides sensory innervation to the lower lip and chin.

MANDIBULAR NERVE

Lingual Nerve

- This branch of the trigeminal nerve carries general **sensory** axons. It also acts as a conduit for **special sensory** and **autonomic** fibers belonging to the **chorda tympani**, a branch of the facial nerve (CN VII).
- General sensory fibers innervate the **anterior two-thirds** of the tongue, as well as the mucus membrane lining its undersides.
- The special sensory fibers carry on with the lingual nerve to provide taste to the **anterior two-thirds of the tongue**.
- The autonomic fibers branch to synapse in the **submandibular ganglion**, eventually innervating the submandibular and sublingual glands.

MANDIBULAR NERVE

Sensory Functions

The sensory fibres associated with the mandibular branch of CN V provide innervation to:

- The facial skin in the lower third of the face, including the chin and lower lip
- Inferior row of teeth and gingiva
- The anterior two thirds of the tongue
- These functions are distributed between the four branches of the nerve, as described above.

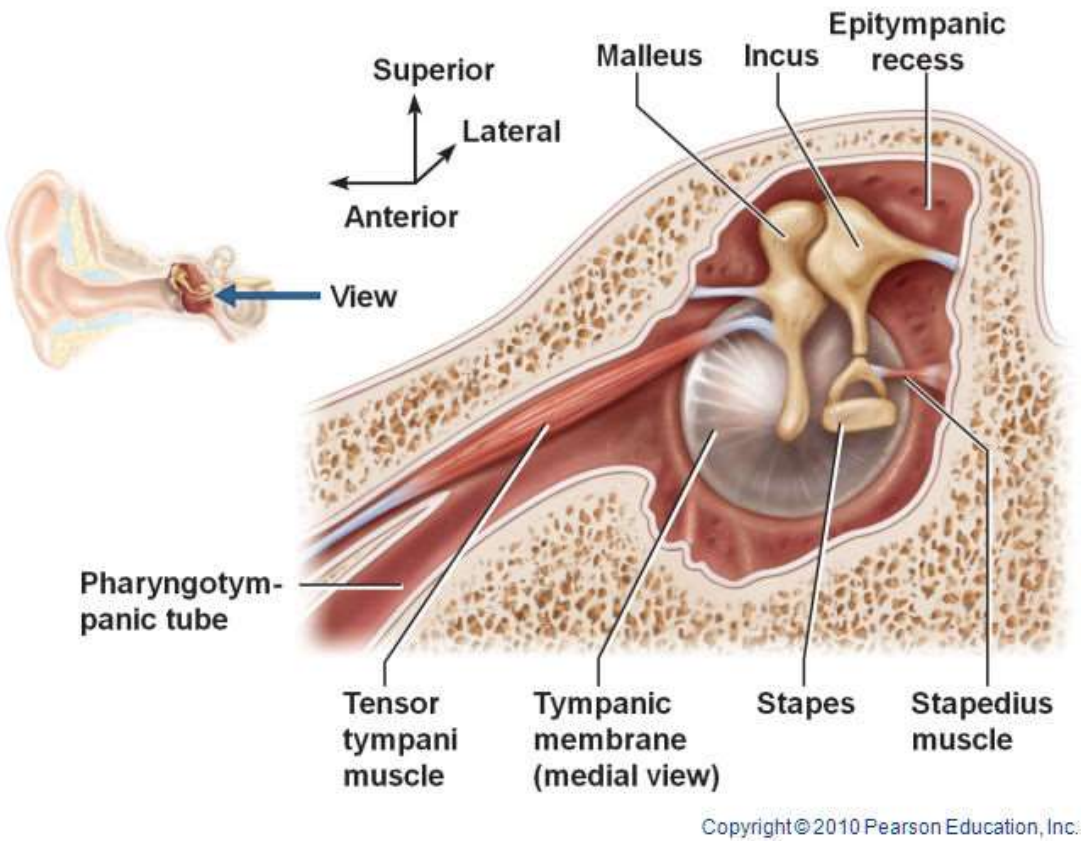
MANDIBULAR NERVE

Motor Functions

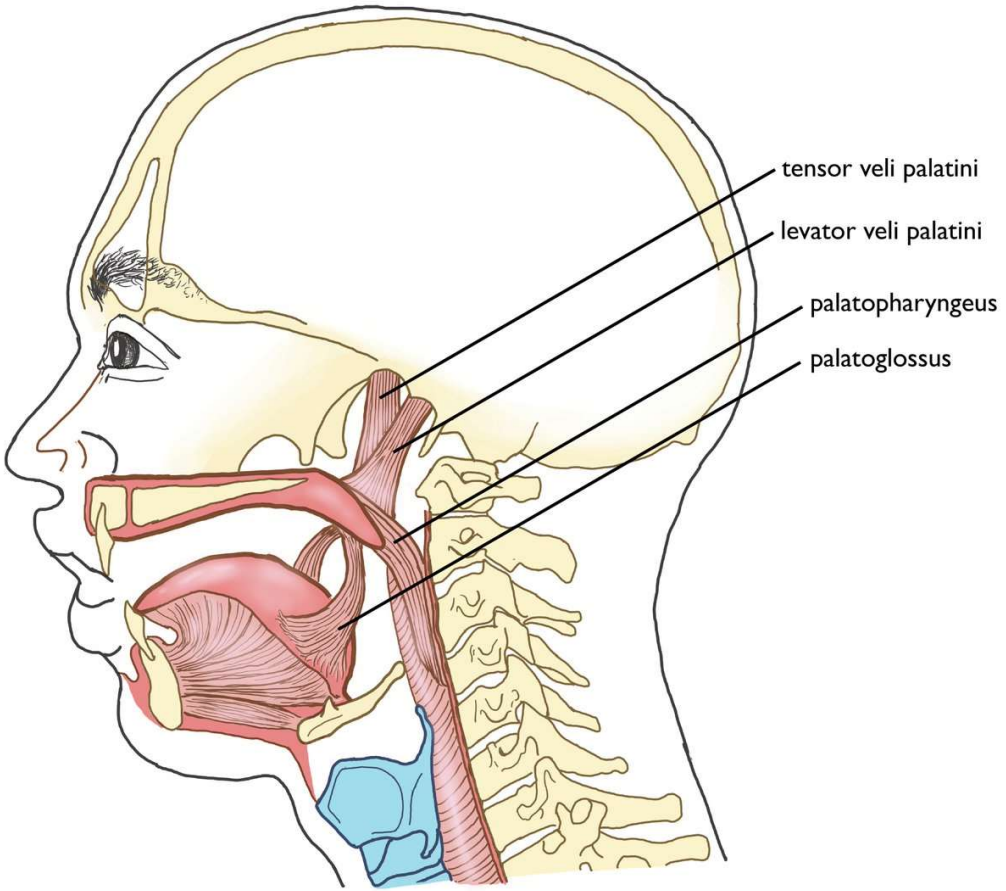
- The mandibular nerve is the only branch of CN V to conduct motor axons to the muscles of the head and neck.
- The motor root of the trigeminal nerve joins the sensory component distal to the trigeminal ganglion and distributes its axons to the **muscles of mastication**:
- Masseter
- Medial and lateral pterygoids
- Temporalis
- In addition to enabling mastication, the mandibular nerve also innervates muscles involved in several other processes:
- **Tensor tympani:** Dampens sounds, such as those created by chewing, by stabilizing the malleus bone in the middle ear
- **Tensor veli palatini:** helps elevate the soft palate to prevent regurgitation of food and liquid into the nasopharynx.
- **Anterior belly of digastric:** a suprahyoid muscle involved in elevation of the hyoid bone during swallowing
- **Mylohyoid:** a suprahyoid muscle involved in elevation of the hyoid bone during swallowing

MANDIBULAR NERVE

Tensor Tympani



Levetor veli paltine



MANDIBULAR NERVE

Autonomic Functions

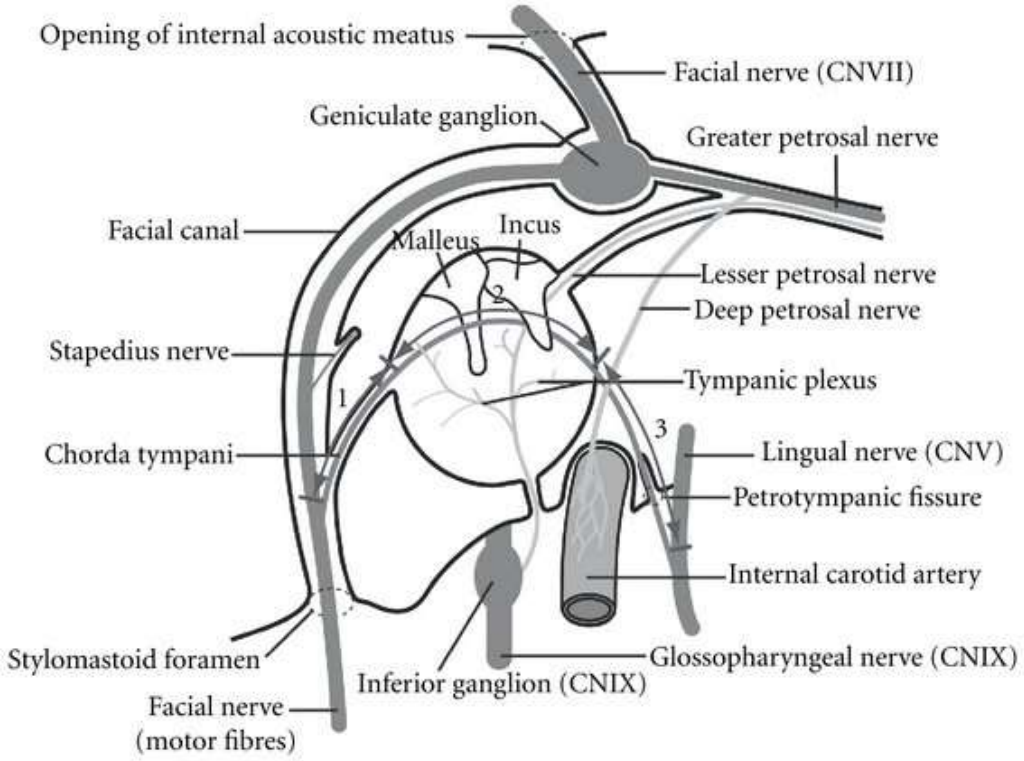
- The trigeminal nerve **does not** have an autonomic nucleus and, as such, does not give rise to any autonomic axons directly. However, all three branches of CN V take on autonomic fibers of other cranial nerves to provide a passage to their respective targets.
- The mandibular nerve is associated with parasympathetic secretory-motor fibers from two other cranial nerves.

MANDIBULAR NERVE

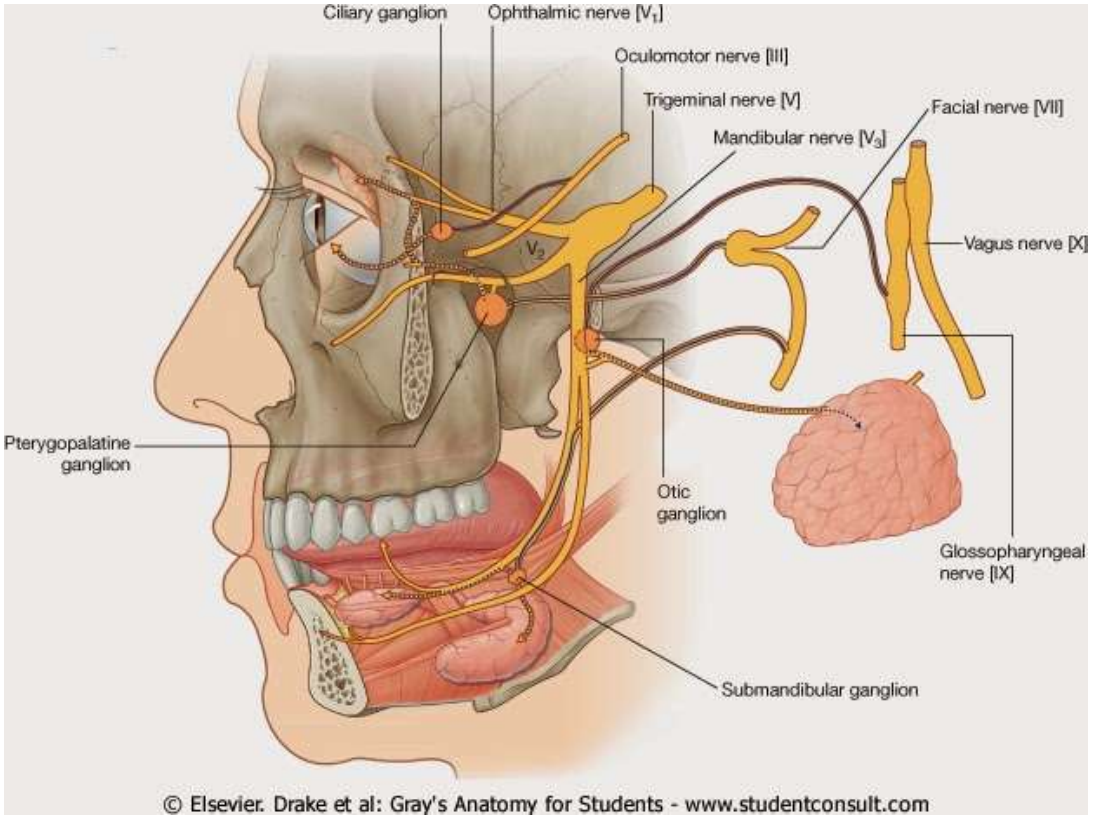
Facial Nerve

- The **chorda tympani** nerve branches from the facial nerve in the region of the middle ear. It carries **pre-synaptic parasympathetic fibers** which join the **lingual branch** of the mandibular nerve, before branching to synapse in the **submandibular ganglion**. These fibers go on and innervate the submandibular and **sublingual salivary glands**.

Facial Nerve



Trigeminal Nerve



MANDIBULAR NERVE

Glossopharyngeal Nerve

- Autonomic innervation of the parotid gland originates from CN IX, however the auriculotemporal nerve transmits the post-synaptic axons from the Otic ganglion to the gland. They pass through the inferior of the two founding roots of the branch.

MANDIBULAR NERVE

Clinical Relevance – Mandibular Nerve Blocks

- The use of local anesthetic in the region of the mandibular nerve, and its tributaries, is a common procedure used in dental surgery. The principle behind the block is to remove general sensation from the ipsilateral **mandibular row of teeth**. In doing so however, anesthesia can also spread over the buccal membranes, chin and jaw.
- The technique involves injecting the blocking agent into the region of the mandibular nerve from inside the mouth, guided by the second molar tooth.
- A more specific option involves an **inferior alveolar nerve block.** This allows anesthesia of the inferior row of teeth while sparing the sensory distribution of the rest of the nerve. Here, the blocking agent is injected from inside mouth further along the mandibular nerve.
- The more specific option is often used, however where it does not provide adequate anesthesia, for instance due to an accessory nerve, a mandibular nerve block is used.