

Cranial Nerves

By

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The twelve cranial nerves all contribute to the innervations of the skin, viscera and muscles of the head and neck. Nerves derived from the cervical plexus innervate a portion of the skin of the region. It is essential to understand that cranial nerves can distribute not only sensory and motor fibres like, but also autonomic nerves involved with special sensation like vision, taste, etc.

1.The olfactory is distributed to the uppermost part of the nasal cavity and is concerned with smell; it contains only special sensation fibres. It reaches the nose via the cribriform plate of the ethmoid bone and fractures of the ethmoid involving the dura mater may be associated with leakage of CSF from the nose

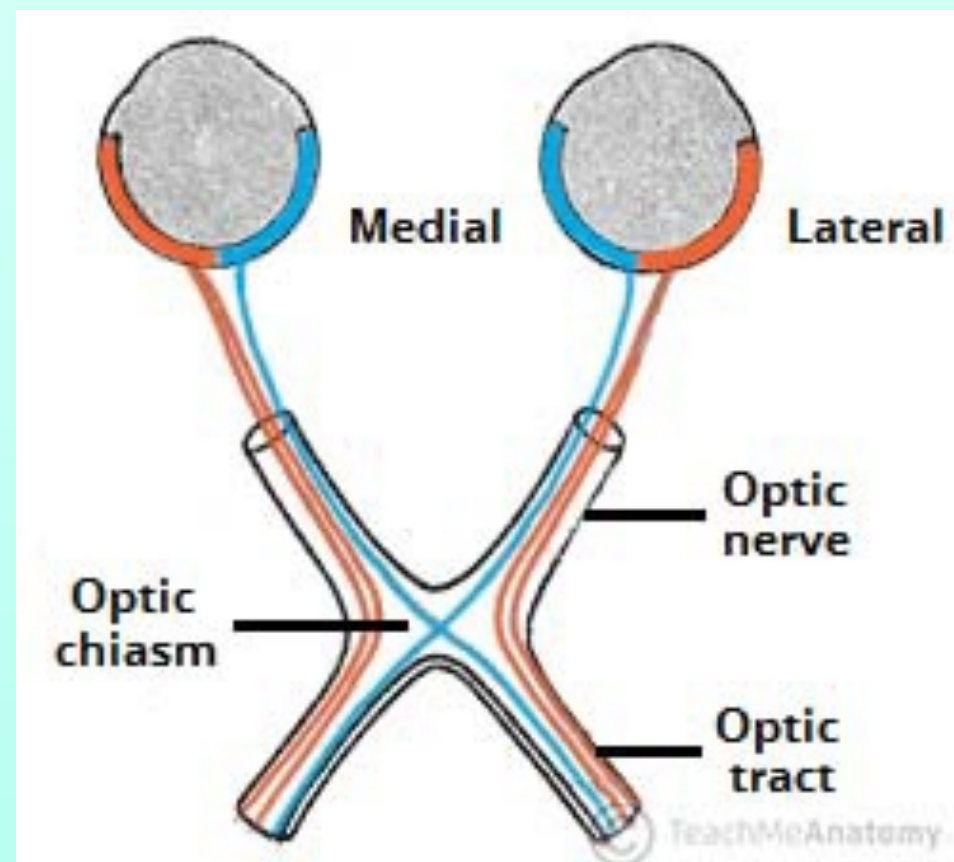
2.The optic nerve (CN II) is the second cranial nerve, responsible for transmitting the special sensory information for vision.considered part of the central nervous system, and examination of the nerve enables an assessment of intracranial health.

The course of the optic nerve can be divided into extracranial (outside the cranial cavity) and intracranial components.the nerve leaves the bony orbit via the optic canal, a passageway through the sphenoid bone. It enters the cranial cavity, running along the surface of the middle cranial fossa (in close proximity to the pituitary gland).

Within the middle cranial fossa, the optic nerves from each eye unite to form the optic chiasm. At the chiasm, fibres from the nasal (medial) half of each retina cross over to the contralateral optic tract, while fibres from the temporal (lateral) halves remain ipsilateral:

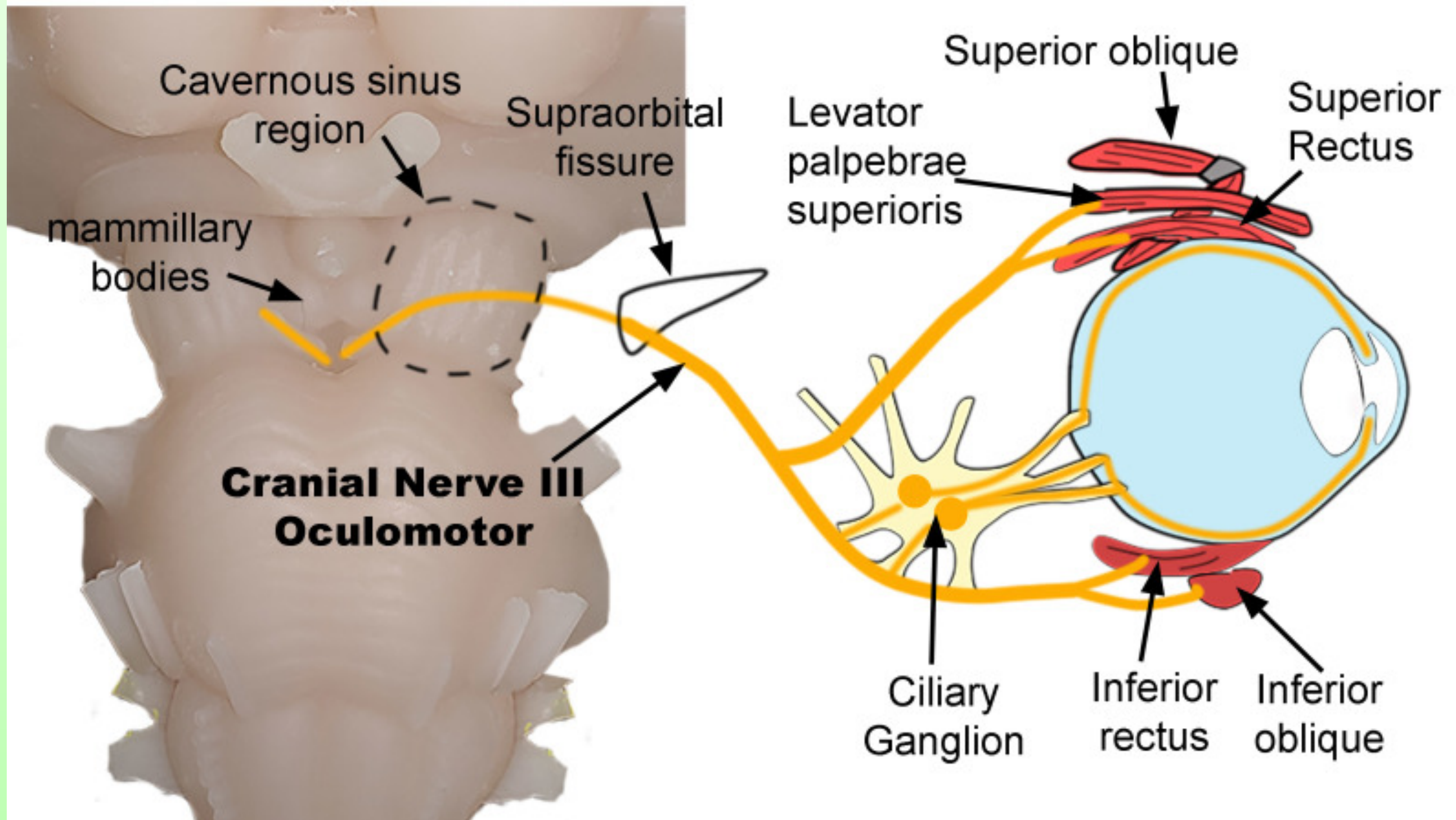
Left optic tract – contains fibres from the left temporal (lateral) retina, and the right nasal (medial) retina.

Right optic tract – contains fibres from the right temporal retina, and the left nasal retina.



3.The oculomotor nerve is the third cranial nerve (CN III). It enters the orbit via the superior orbital fissure and innervates extrinsic eye muscles except lateral rectus muscle and superior oblique .it originated from midbrain and it is a mixed cranial nerve containing motor and parasympathetic fibers.The general somatic efferent fibers of the oculomotor nerve supply the levator palpebrae superioris and four of the six extraocular muscles: the medial, superior, and inferior recti, and the inferior oblique muscles. The oculomotor nerve also conveys preganglionic parasympathetic fibers to synapse in the ciliary ganglion, which then provides postganglionic parasympathetic fibers to intraocular muscles enabling pupillary constriction and accommodation.

Oculomotor Nerve (III) Pathway

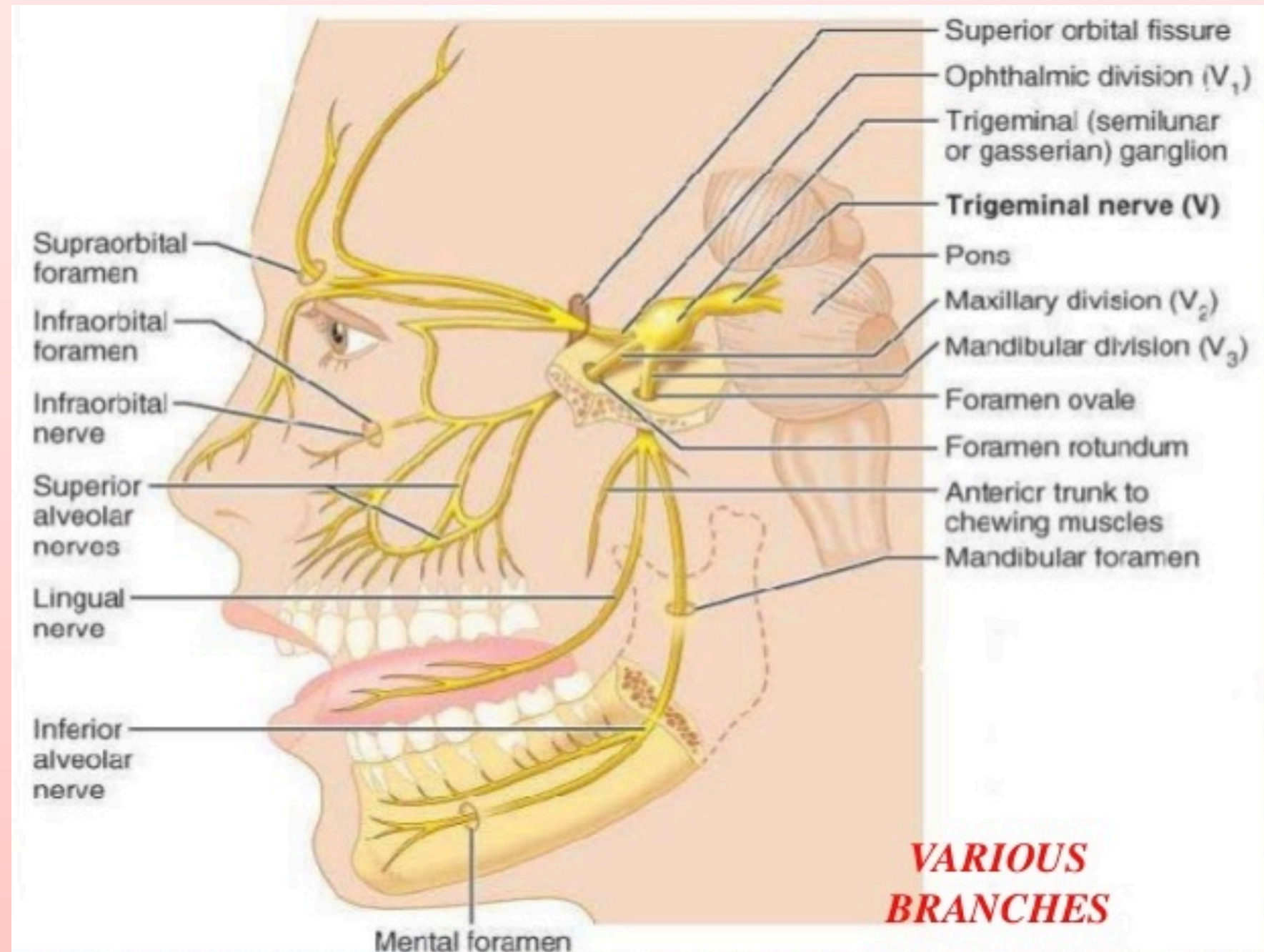


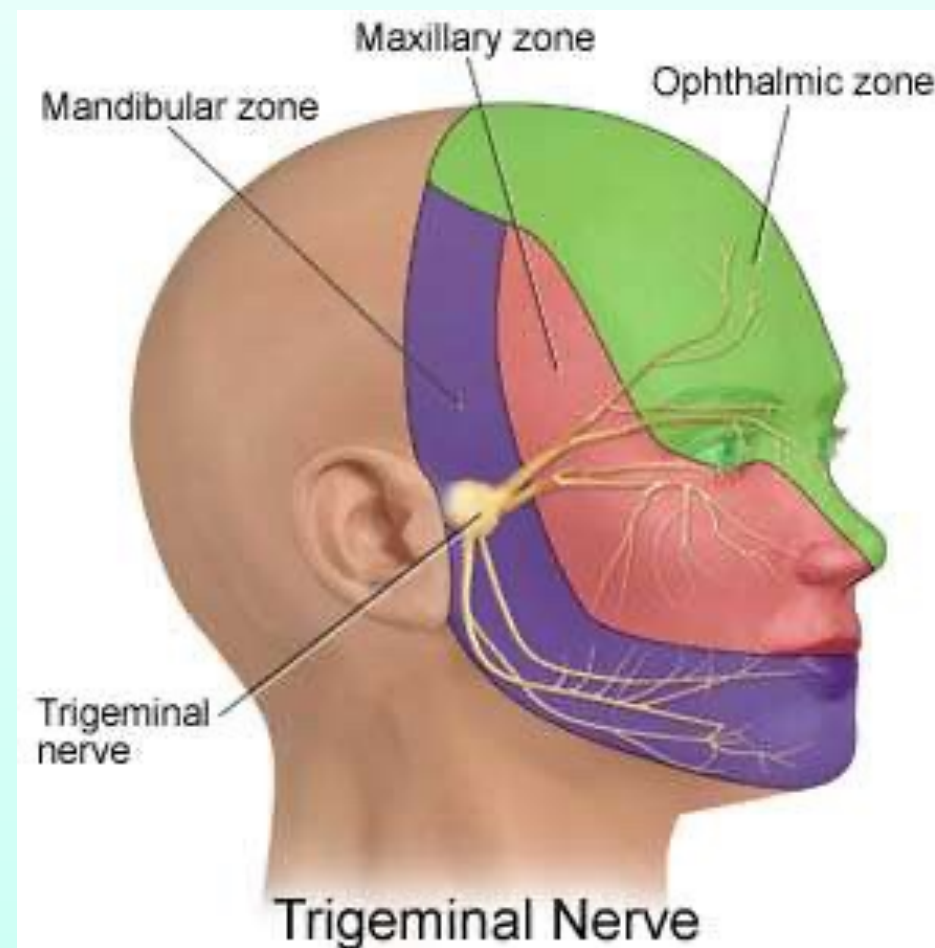
4.The trochlear nerve, also called the fourth cranial nerve or CN IV, is a motor nerve (a somatic efferent nerve) that innervates only a single muscle: the superior oblique muscle of the eye.

It emerges from the posterior aspect of the midbrain (it is the only cranial nerve to exit from the posterior midbrain).The nerve travels in the lateral wall of the cavernous sinus and then enters the orbit via the superior orbital fissure.

5. The Trigeminal Nerve Cranial nerve V, is the great sensory nerve of the head and neck. It is divided into three divisions ophthalmic, maxillary and mandibular nerves. The first two are entirely sensory but the mandibular nerve also contains motor fibres which innervate the muscles of mastication. The large sensory root and smaller motor root leave the pons. The motor root is distributed to the muscles of mastication, the mylohyoid muscle and the anterior belly of the digastric. The mandibular nerve also innervates the tensor veli palatini and tensor tympani muscles

The ophthalmic branch travels through the superior orbital fissure and passes through the orbit to reach the skin of the forehead and top of the head. The maxillary nerve enters the cranium through the foramen rotundum





Mandibular division

Sensory

Gums
 Buccal mucosa
 Anterior $\frac{2}{3}$ tongue
 Floor of mouth
 Lower teeth
 Lower jaw
 Chin

Motor

Muscles of mastication
 Tensor tympani

Maxillary division

Sensory

Lateral aspect of nose
 Upper teeth
 Cheek
 Maxillary sinuses
 Hard palate
 Uvula
 Nasopharynx

Ophthalmic division

Sensory

Scalp (up to vertex)
 Forehead
 Frontal sinuses
 Conjunctiva
 Cornea
 Upper eyelid
 Bridge of nose

Assessment of the Trigeminal Nerve

The assessment consists of testing the corneal reflex, testing the sensory division and testing the motor division

The Corneal Reflex

The corneal reflex, also known as the blink reflex, is an involuntary blinking of the eyelids elicited by stimulation of the cornea. Stimulation should elicit both a direct and consensual response (response of the opposite eye)

The sensory limb of the corneal reflex is the ophthalmic nerve while the motor limb is conducted through the facial nerve.

Testing the Sensory components of the Trigeminal Nerve

testing the three subdivisions of the trigeminal nerve.

Testing the Motor component of the Trigeminal Nerve

The motor component is tested by having the patient bite down or clench his teeth while the masseter and temporalis muscle are palpated bilaterally. Unilateral weakness will cause the jaw to deviate towards the side of the lesion.

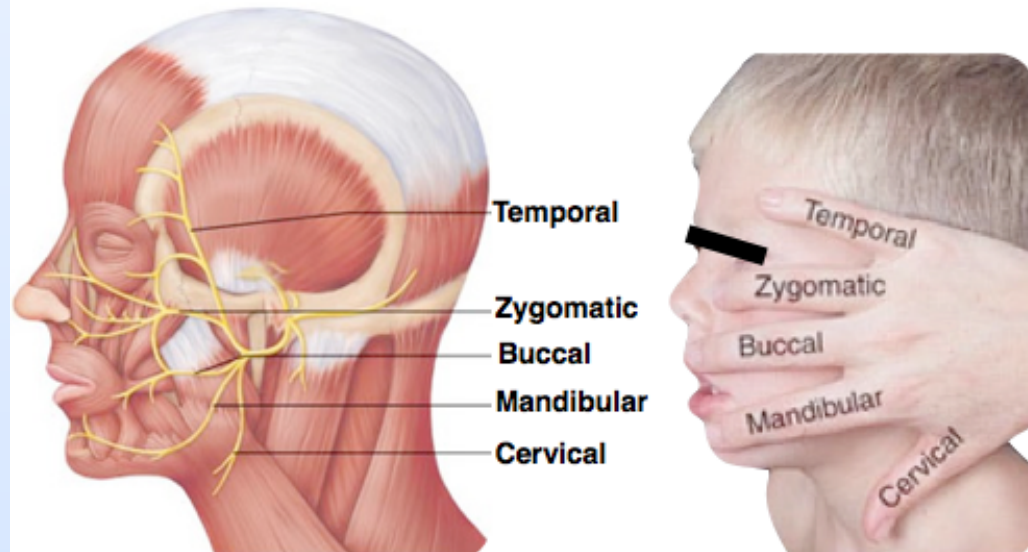
The trigeminal nerve may be injured by trauma, aneurysms or meningeal infections. Injury to the nerve may cause paralysis of the muscles of mastication (mandibular division), loss of ability to appreciate tactile, thermal or painful sensations in face, cornea, conjunctiva and the loss of the corneal reflex.

6.the abducens nerve (CNVI)arises from the abducens nucleus in the pons of the brainstem. It exits the brainstem at the junction of the pons and the medulla.It travels through the cavernous sinus and enters the bony orbit via the superior orbital fissure.

Within the bony orbit, the abducens nerve terminates by innervating the lateral rectus muscle.

The facial nerve (VII) is a complex nerve as it contains motor, general & special sensory and parasympathetic fibres. It emerges from the pons of the brainstem and leave the skull at the stylomastoid foramen Its motor fibres are distributed to the muscles of facial expression as well as the posterior belly of digastrics, stylohyoid and stapedius muscles. General sensory fibres supply part of the external acoustic meatus and auricle. Special sensory fibres supply taste the anterior two thirds of the tongue whilst parasympathetic fibres are widely distributed to the glands of the nose, palate and to the submandibular and sublingual salivary glands.

Facial Nerve (CN VII)



Facial Nerve Branch

Muscle Innervation

Temporal

- Frontalis
- Orbicularis oculi

Zygomatic

- Orbicularis oculi
- Zygomaticus major
- Zygomaticus minor
- Levator labii superioris
- Levator labii superioris alaeque nasi

Buccal

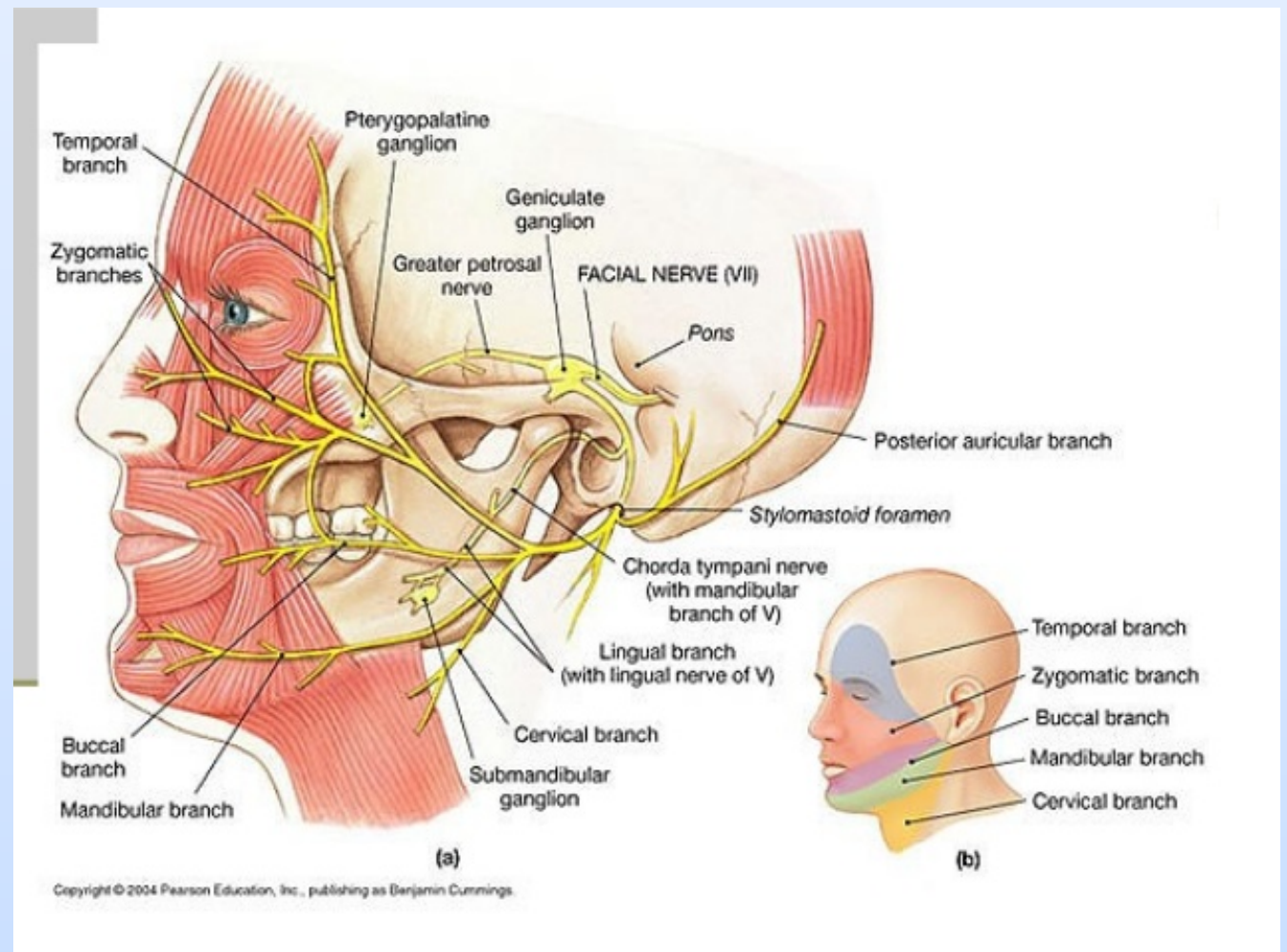
- Buccinator
- Orbicularis oris

Mandibular

- Depressor anguli oris
- Depressor labii inferioris
- Mentalis muscles

Cervical

- Platysma



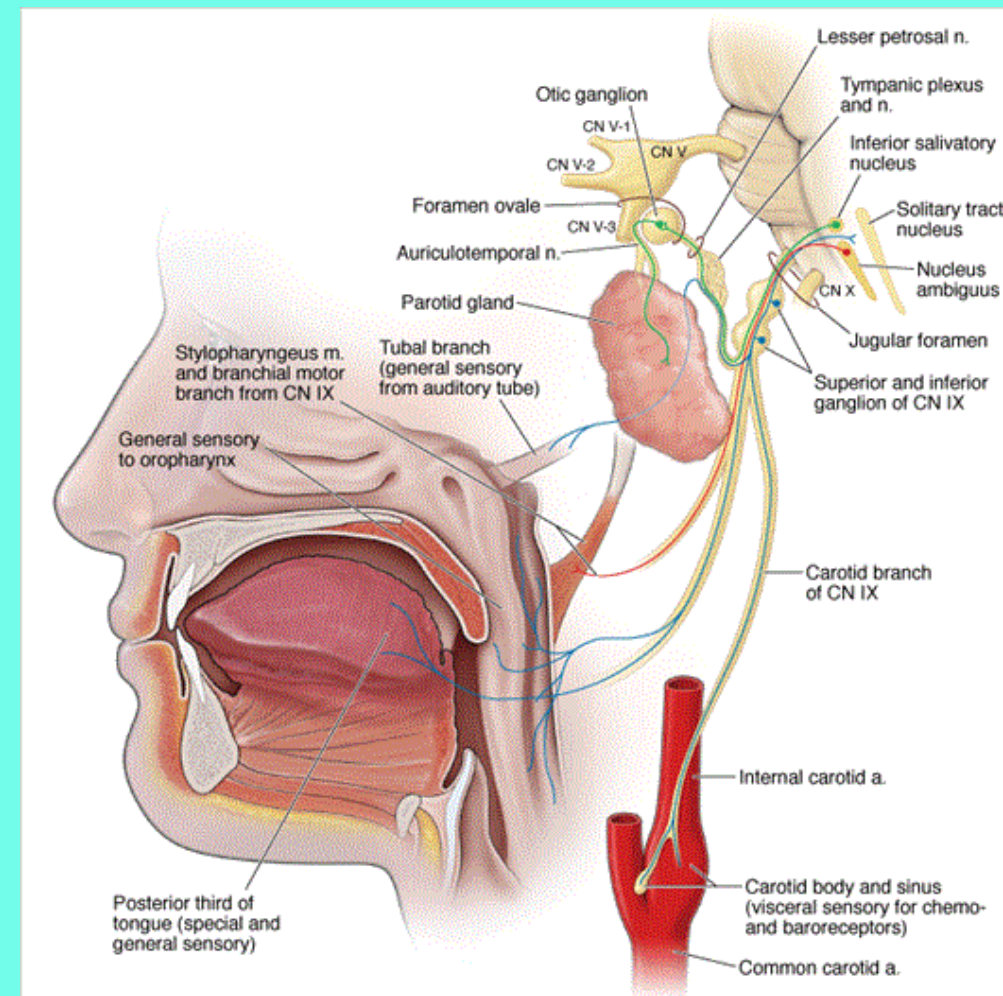
8. vestibulocochlear nerve CN VIII (auditory vestibular nerve), known as the eighth cranial nerve, transmits sound and equilibrium (balance) information from the inner ear to the brain.

It composed of two divisions, the vestibular and cochlear nerve, both purely sensory in function. The vestibulocochlear nerve carries special somatic afferent fibers from structures of the inner ear.

The cochlear nerve enables the sense of hearing, while the vestibular nerve is responsible for the sense of balance.

The cochlear nerve arises from the organ of Corti, which lies in the cochlea of the inner ear, the cochlear nerve enters the internal acoustic meatus where it joins with the vestibular nerve, and they form the vestibulocochlear nerve and then enters the brainstem in the cerebellopontine angle along with the facial nerve (CN VII).

9. The glossopharyngeal nerve (IX) it exits from medulla oblongata also contains **four types of nerve fibres**. **Motor fibres** supply the stylopharyngeus muscle, **parasympathetic fibres** innervate the parotid gland and **fibres of special sensation** innervate the posterior third of the tongue. **General sensory fibres** are widely distributed to the pharynx and oropharyngeal isthmus, the dorsum of the palate, the auditory tube and associated structures, the mastoid antrum and mastoid cells. **Finally, via its sinus nerve branch**, it supplies the carotid sinus and carotid body that monitor blood pressure and arterial oxygen levels respectively.



10.The vagus (X) nerve has an enormous territory extending into the abdomen. In the head and neck it is sensory to the lower part of the pharynx, the airways and oesophagus. It provides general sensation, parasympathetic fibres and motor fibres to the lower parts of the pharynx (motor to all of the pharynx except stylopharyngeus), the larynx, trachea and oesophagus. In addition, it supplies all of the palate muscles except tensor veli palatine. It supplies taste fibres to taste buds associated with the epiglottis and is sensory to the external auditory meatus and back of the auricle.

It leaves the skull through jugular foramen

11.the accessory nerve (XI) has a cranial part and a spinal part. The cranial root is accessory to the vagus by providing part of its motor component. The spinal root of the nerve contains fibres from C2, C3 and C4. It innervates the sternocleidomastoid and trapezius muscles. Current evidence suggests that the spinal root contains both sensory and motor fibres. It pass through jugular foramen

12.The hypoglossal nerve (XII) is the motor supply to all of the muscles of the tongue with the exception of palatoglossus muscle. Some cervical nerves from C1, C2 and C3 are looped onto the hypoglossal nerve forming the ansa cervicalis. These fibres are distributed to the strap muscles of the neck . It leaves the skull through the hypoglossal canal near the magnum foramen

The hypoglossal nerve then passes inferiorly to the angle of the mandible, crossing the internal and external carotid arteries, and moving in an anterior direction to enter the tongue.

The hypoglossal nerve is responsible for motor innervation of the vast majority of the muscles of the tongue (except for palatoglossus). These muscles can be subdivided into two groups:

i) Extrinsic muscles

Genioglossus (makes up the bulk of the tongue)

Hyoglossus

Styloglossus

Palatoglossus (innervated by vagus nerve)

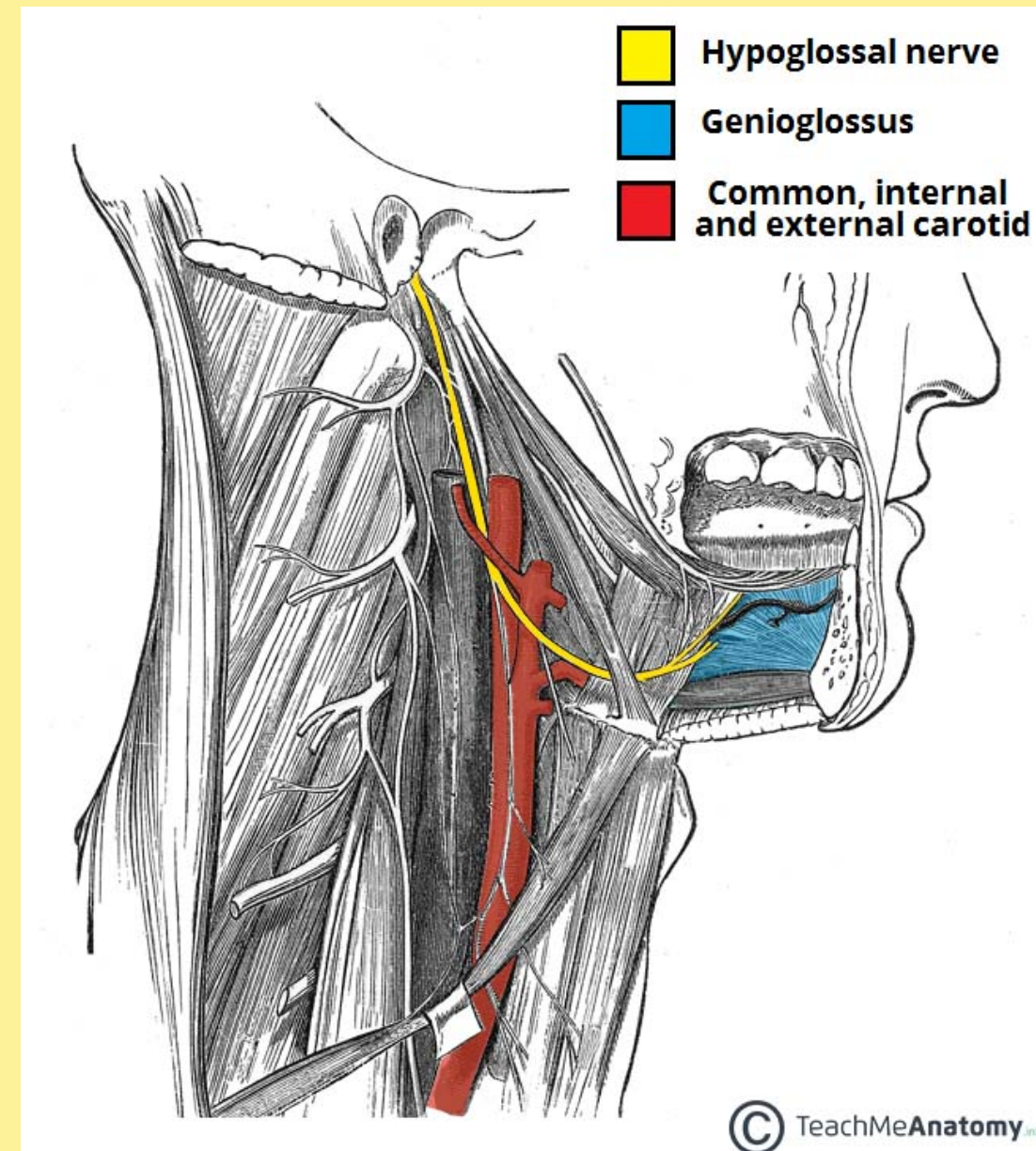
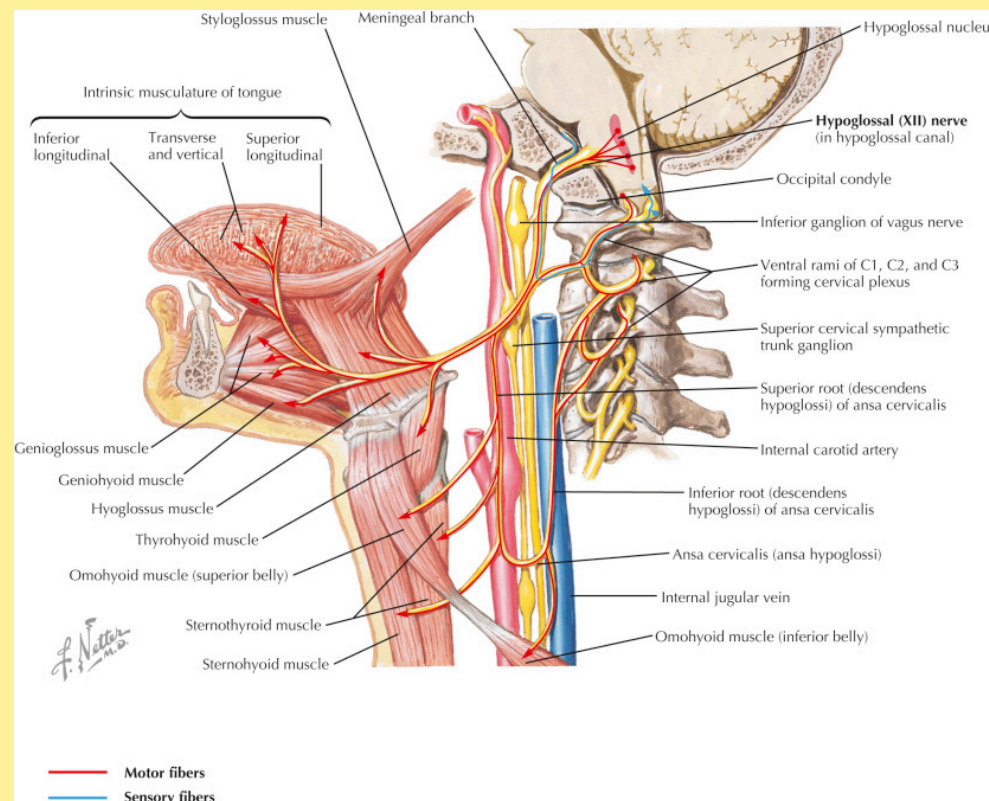
ii) Intrinsic muscles

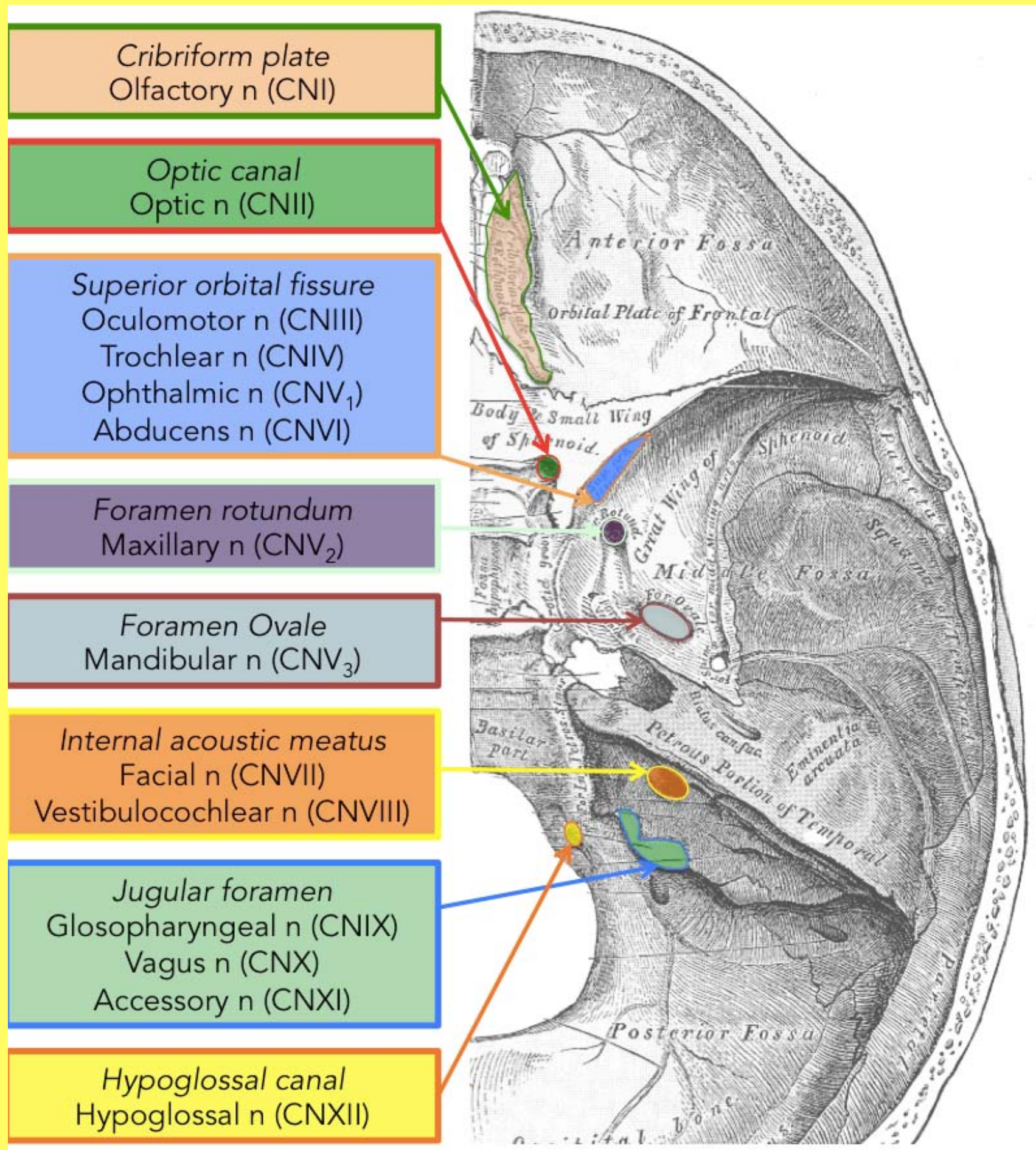
Superior longitudinal

Inferior longitudinal

Transverse

Vertical

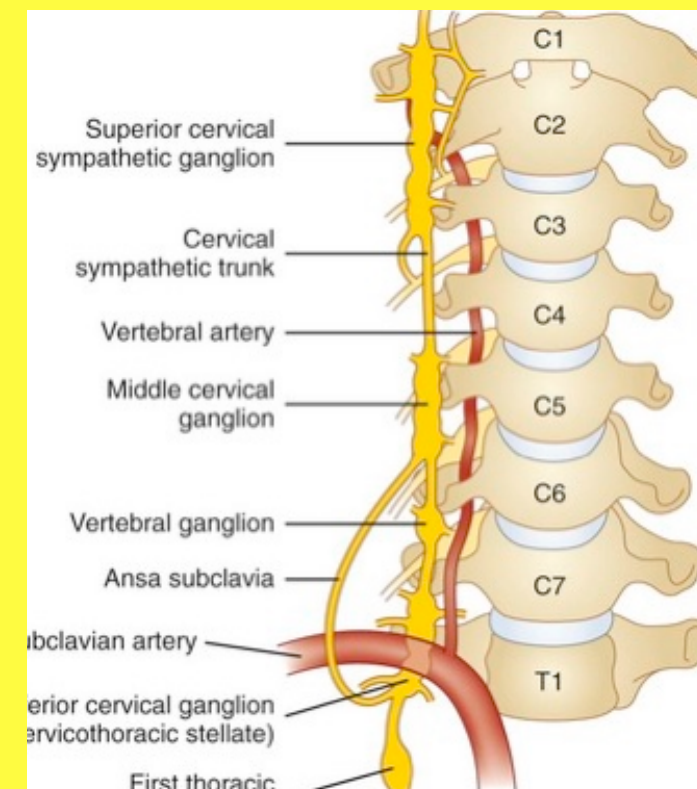




Autonomic Innervation of the Head and neck

Sympathetic system

The actions of the sympathetic nervous system are associated with the ‘fight or flight’ response. 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-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



Superior Cervical Ganglion : Several important post-ganglionic nerves originate from here

Internal carotid nerve

External carotid nerve

Nerve to pharyngeal plexus

Superior cardiac branch

Nerves to cranial nerves II, III IV, VI and IX

Gray rami communicantes distributes sympathetic fibres to the anterior rami of C1-C4.

Middle Cervical Ganglion

Gray rami communicantes distributes sympathetic fibres to the anterior rami of C5 and C6.

Thyroid branches

Middle cardiac branch

Inferior Cervical Ganglion

Gray rami communicantes – distributes sympathetic fibres to the anterior rami of C7, C8 .and T1

Branches to the subclavian and vertebral arteries

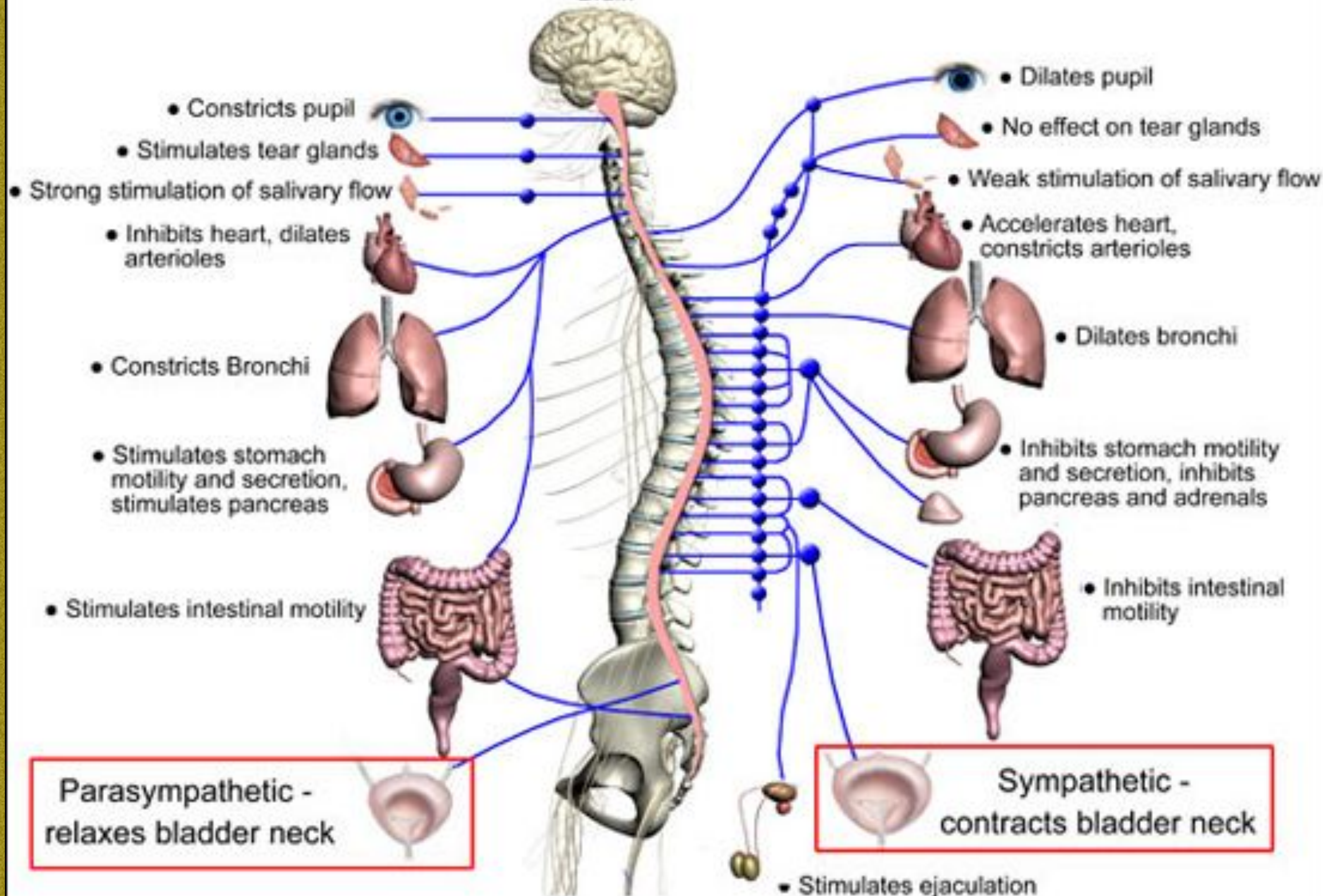
Inferior cardiac nerve

*****The inferior cervical ganglion is a small ganglion and may combine with the 1st thoracic ganglion to form the stellate ganglion.***

Parasympathetic

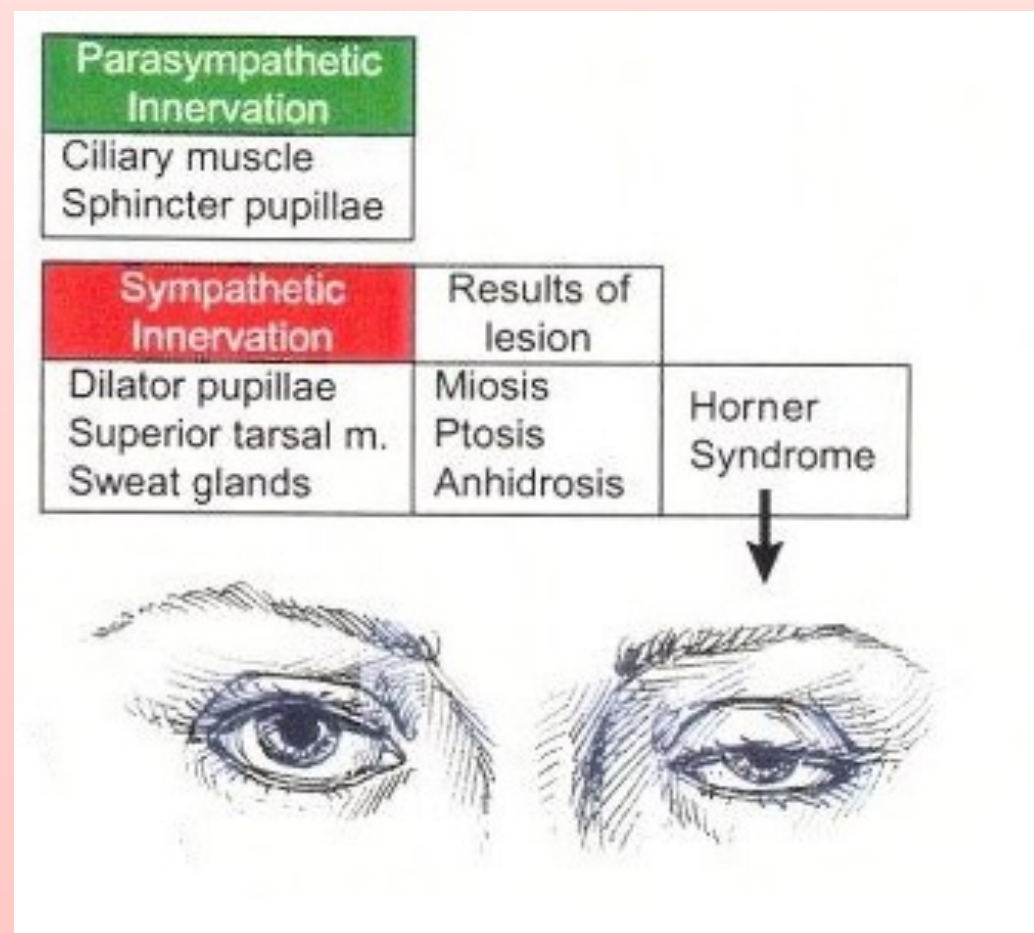
Sympathetic

Brain



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, Miosis, Anhidrosis**



Ganglia	Vertebral Level	Arteries Involved	Effector Organ(s)
Superior cervical ganglion	C1-C4	Common, external and internal carotid arteries	<ul style="list-style-type: none"> • 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
Middle cervical ganglion	C6	Inferior thyroid artery	<ul style="list-style-type: none"> • Larynx • Trachea • Pharynx • Upper oesophagus • Heart • Arterial smooth muscle
Inferior cervical ganglion	C7	Vertebral and subclavian arteries	<ul style="list-style-type: none"> • Heart • Arterial smooth muscle

Parasympathetic innervation of the head and neck

The actions of the parasympathetic nervous system are associated with the ‘rest and digest’ response

There are 4 pairs of parasympathetic ganglia in the head. Four cranial nerves (oculomotor, facial, glossopharyngeal and vagus) have brainstem nuclei containing preganglionic parasympathetic neurons, but only three of these nerves have branches that reach these ganglia; the vagus nerve does not have

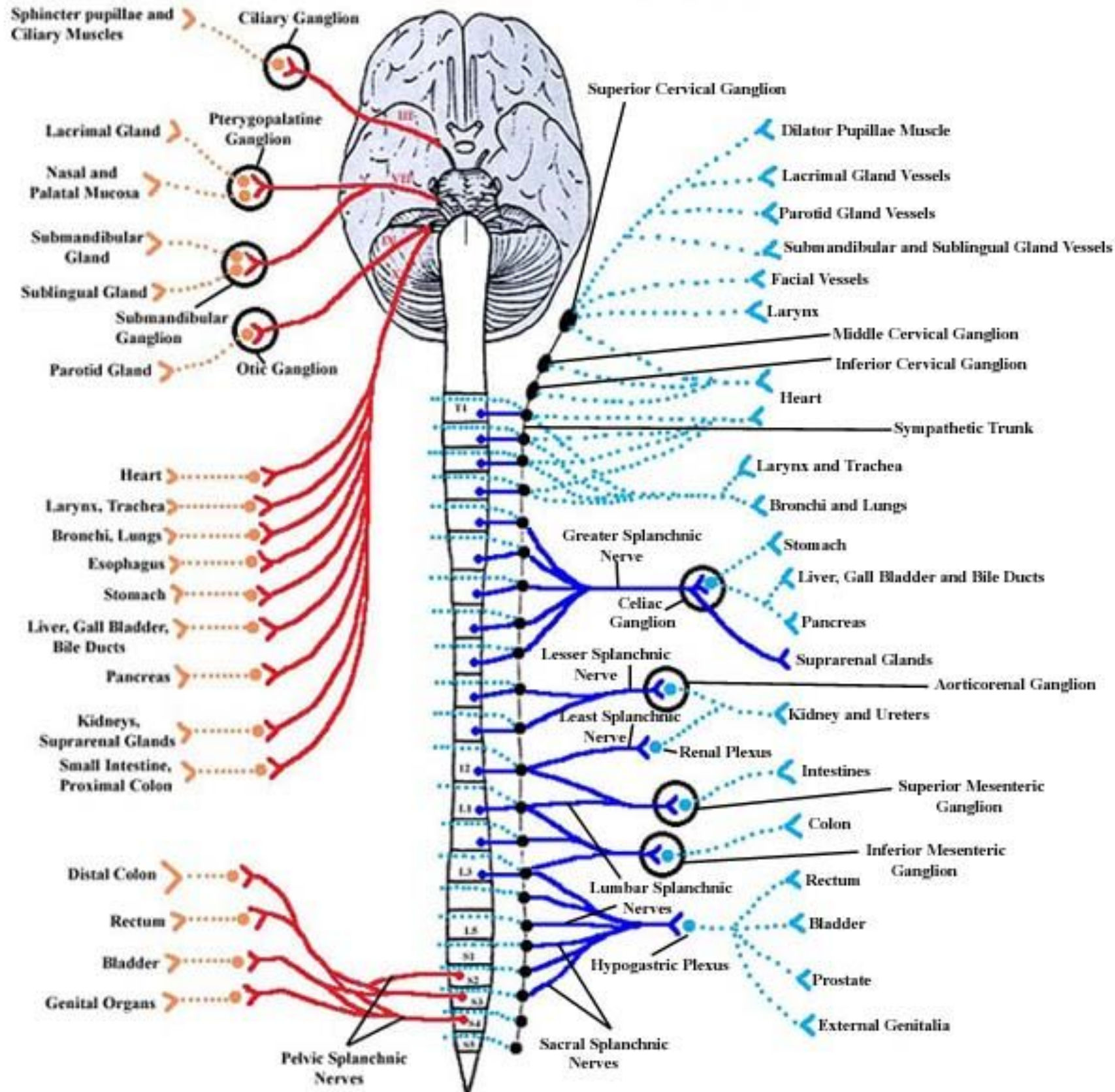
Ciliary ganglion (Oculomotor nerve CIII)

- **Pterygopalatine ganglion (Facial nerve CVII)**
- **Submandibular ganglion (Facial nerve CVII)**
- **Otic ganglion (Glossopharyngeal nerve CIX)**

The ciliary ganglion lies in the orbital cavity, lateral to the optic nerve. The parasympathetic fibres are derived from the oculomotor nerve and pass to the sphincter papillae and ciliary muscles. Sympathetic fibres come from the superior cervical ganglion via the plexus on the ophthalmic artery and are distributed to the eyeball. Sensory fibres from the eyeball pass to the nasociliary nerve.

Parasympathetic

Sympathetic



The pterygopalatine ganglion lies in the pterygopalatine fossa .The parasympathetic fibres are derived from the facial nerve via the greater pterosal nerve. Postganglionic fibres supply the lacrimal gland and glands of the nose, palate and nasopharynx. Sympathetic fibres come from the superior cervical ganglion via the plexus on the internal carotid artery. The fibres are distributed to the nose, palate and nasopharynx; sensory fibres from these areas pass in the branches of the ganglion to the maxillary nerve(CVii).

The submandibular ganglion is suspended from the lingual nerve by small branches. Its parasympathetic fibres come from the facial nerve via its chorda tympani branch and then along the lingual nerve to the ganglion. Postganglionic fibres supply the submandibular and sublingual glands and other glands in the floor of the oral cavity. Sympathetic fibres come from the superior cervical ganglion along the facial artery and pass to the glands in the floor of the oral cavity. Taste fibres may pass through the ganglion.

The parasympathetic fibres to the otic ganglion come from the glossopharyngeal nerve and pass with the auriculotemporal nerve to the parotid gland. Sympathetic fibres come from the superior cervical ganglion along the middle meningeal artery and pass to the parotid gland. The parasympathetic fibres to the otic ganglion come from the glossopharyngeal nerve and pass with the auriculotemporal nerve to the parotid gland. Sympathetic fibres come from the superior cervical ganglion along the middle meningeal artery and pass to the parotid gland. Motor branches from the mandibular nerve (CViii) pass through the ganglion without synapsing. Parasympathetic fibres from the glossopharyngeal nerve supply directly, or through the pharyngeal plexus, the glands of the oropharynx and the posterior third of the tongue.

Parasympathetic fibres from the vagus supply the glands of the laryngopharynx, larynx, oesophagus and trachea; in all these cases, the ganglion cells are on the viscus.

Injury to the sympathetic trunk or ganglia in the neck or upper thorax result in the following disorder on the affected side :

***pupillary constriction**

***drooping of the upper eyelid (ptosis) *flushing of the face -**

***lack of sweating**