Peripheral Para-sympathetic ganglia

Contents

- Introduction
- Types
- Location
- Boundaries
- connections

Autonomic nervous system

Controls involuntary activities of the body such as the

activities of smooth muscle, cardiac muscle & glands

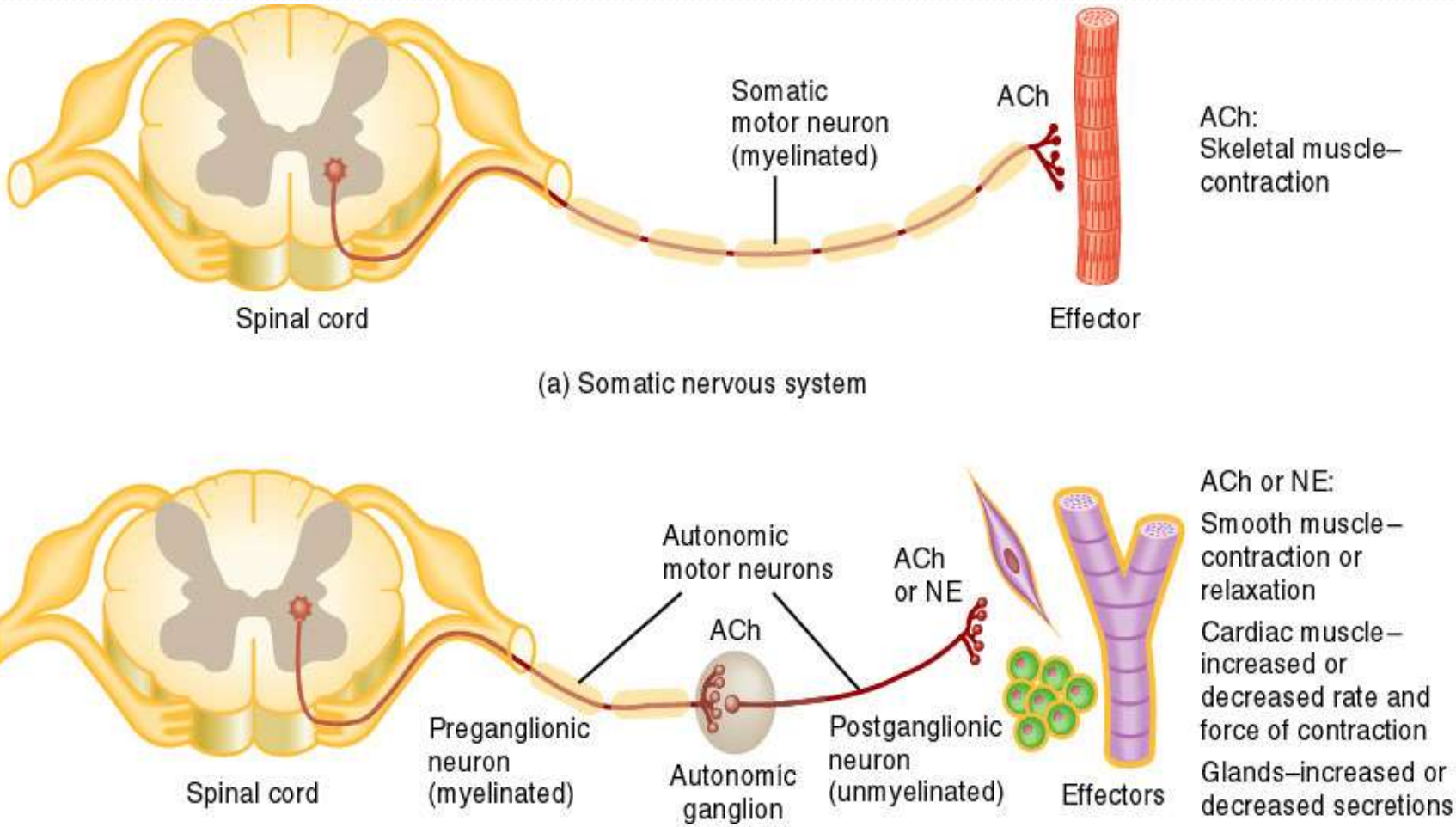
Subdivisions

Sympathetic and parasympathetic.

Each division possess **motor** and **sensory** components.

- **Motor components** consists of two sets of neurons
- Preganglionic neurons – located in the CNS
- Postganglionic neurons – in the ganglia

Somatic and autonomic nervous



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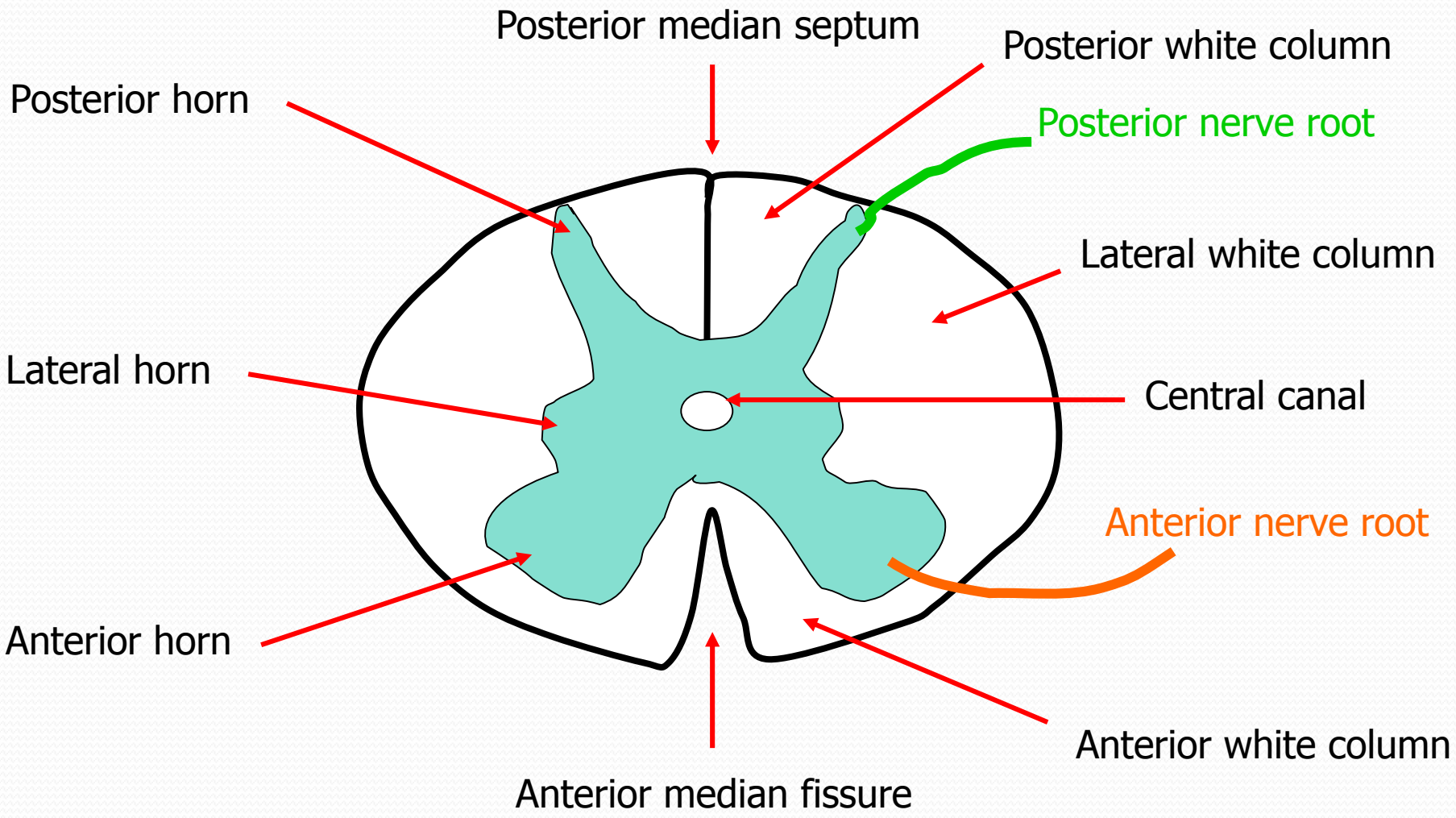
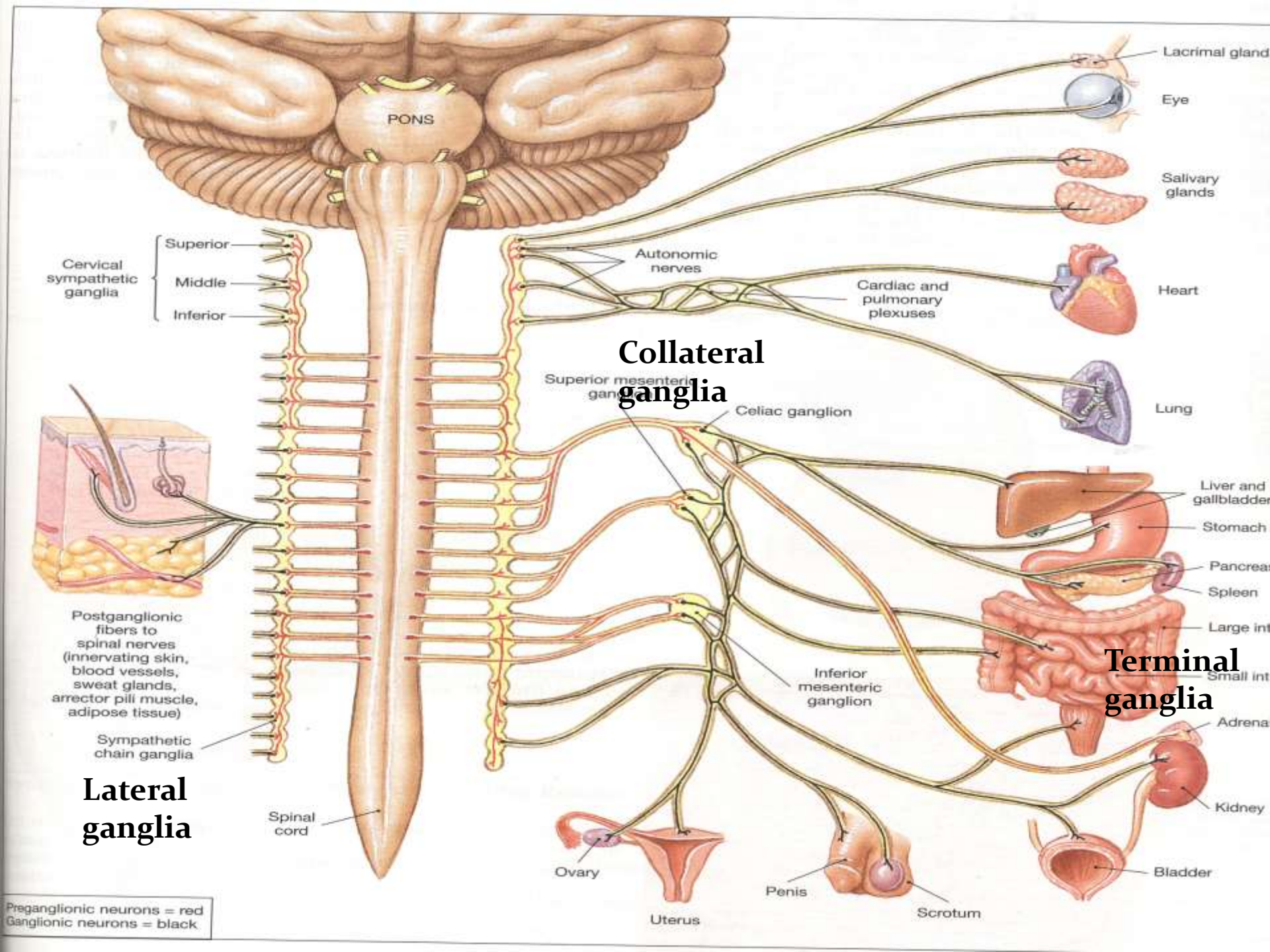
Sympathetic nervous system

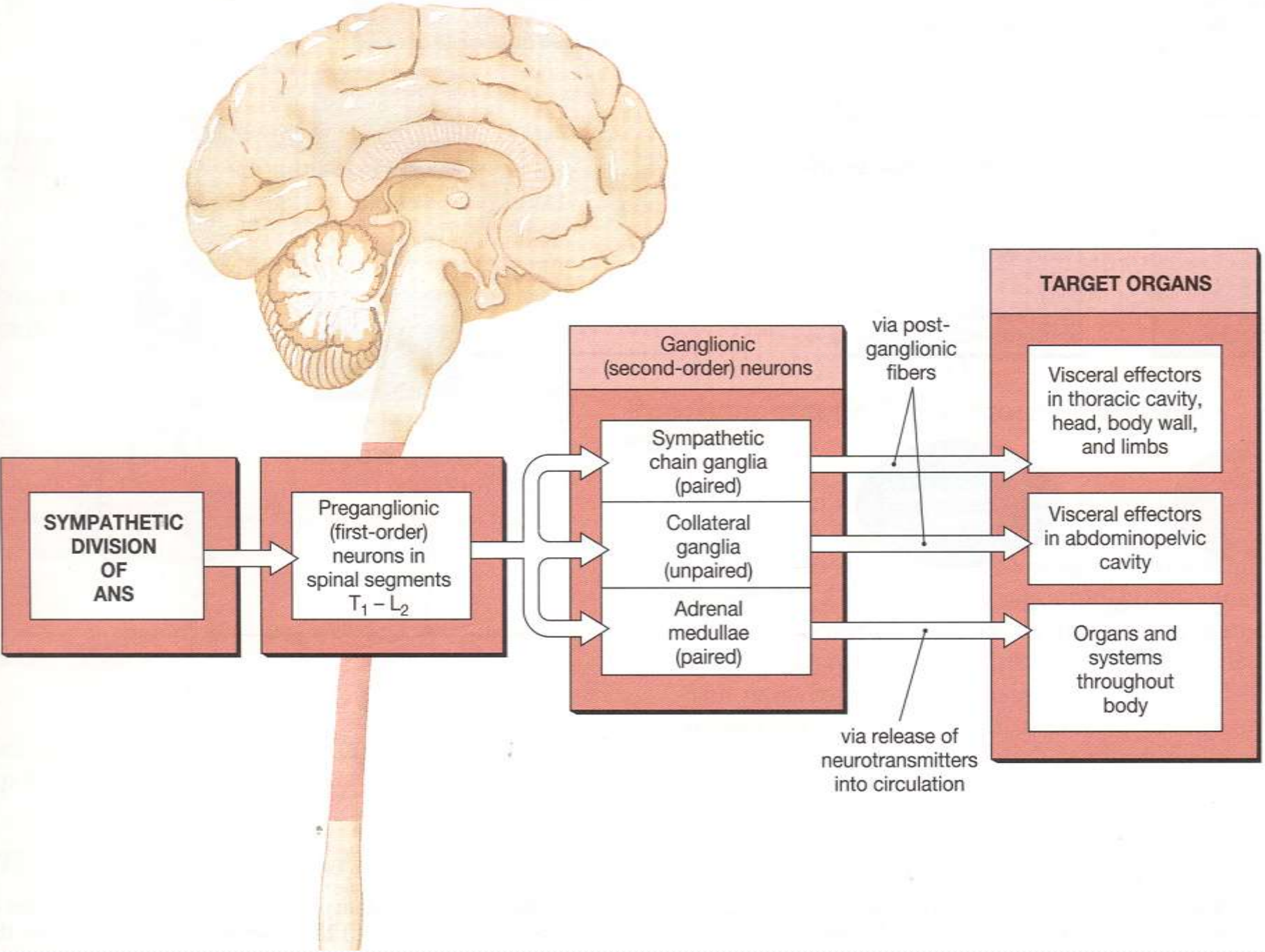
- **Preganglionic neurons**: located in the lateral horn cells of the spinal cord (from T1 – L2 segments of the spinal cord) (**Thoraco-lumbar outflow**)
- One pre-ganglionic fiber synapse with 20 postganglionic neurons

Structure of a spinal cord segment



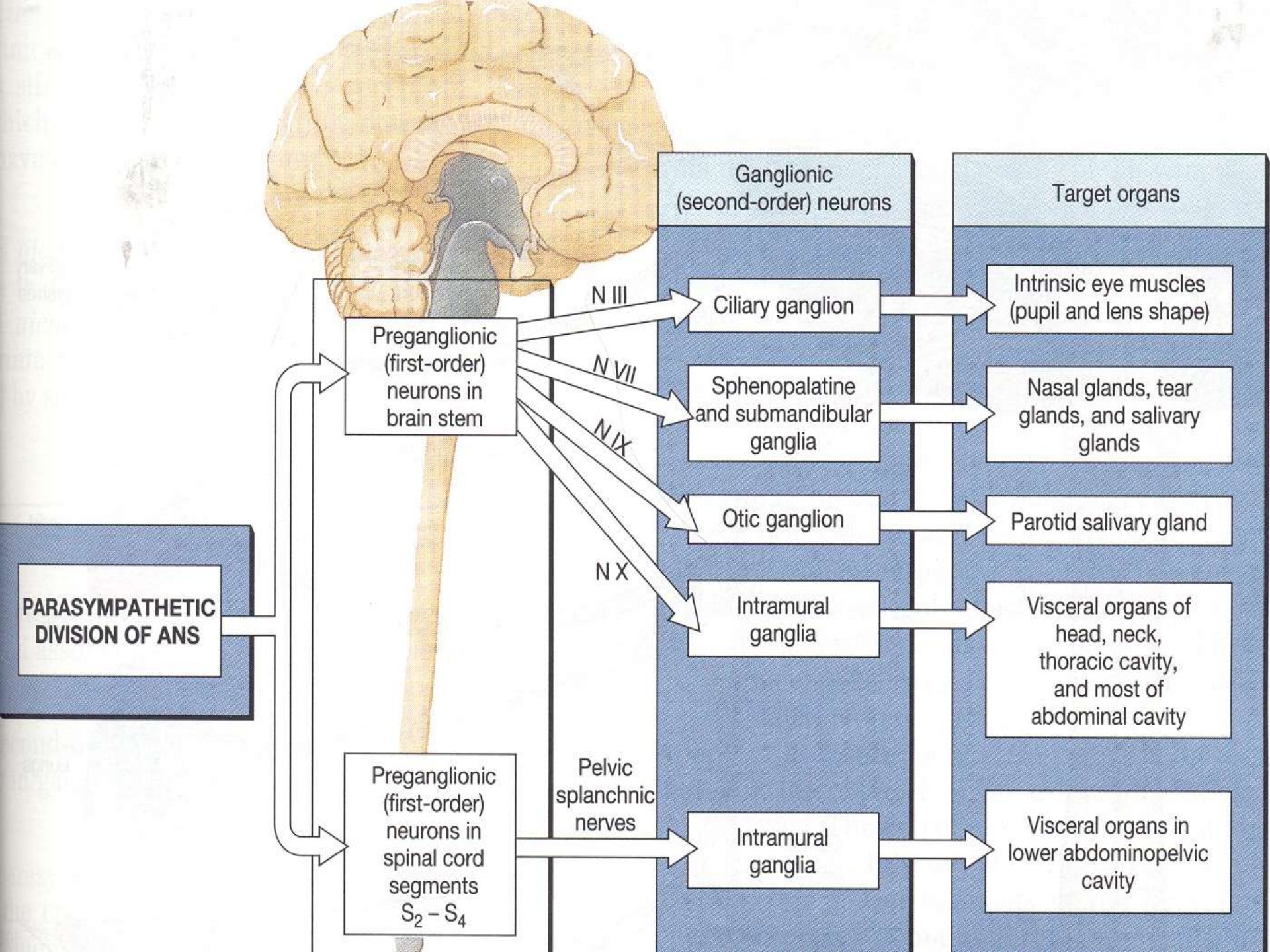
- Post ganglionic neurons: located in the
  - Lateral ganglia
  - Collateral ganglia
  - Terminal ganglia (cells of adrenal medulla)
- Nor-adrenaline secretion (adrenergic fibers) exception: sweat glands and limb vessels.
- All structures are supplied by postganglionic neurons except medulla of supra renal gland supplied by pre-ganglionic fibers

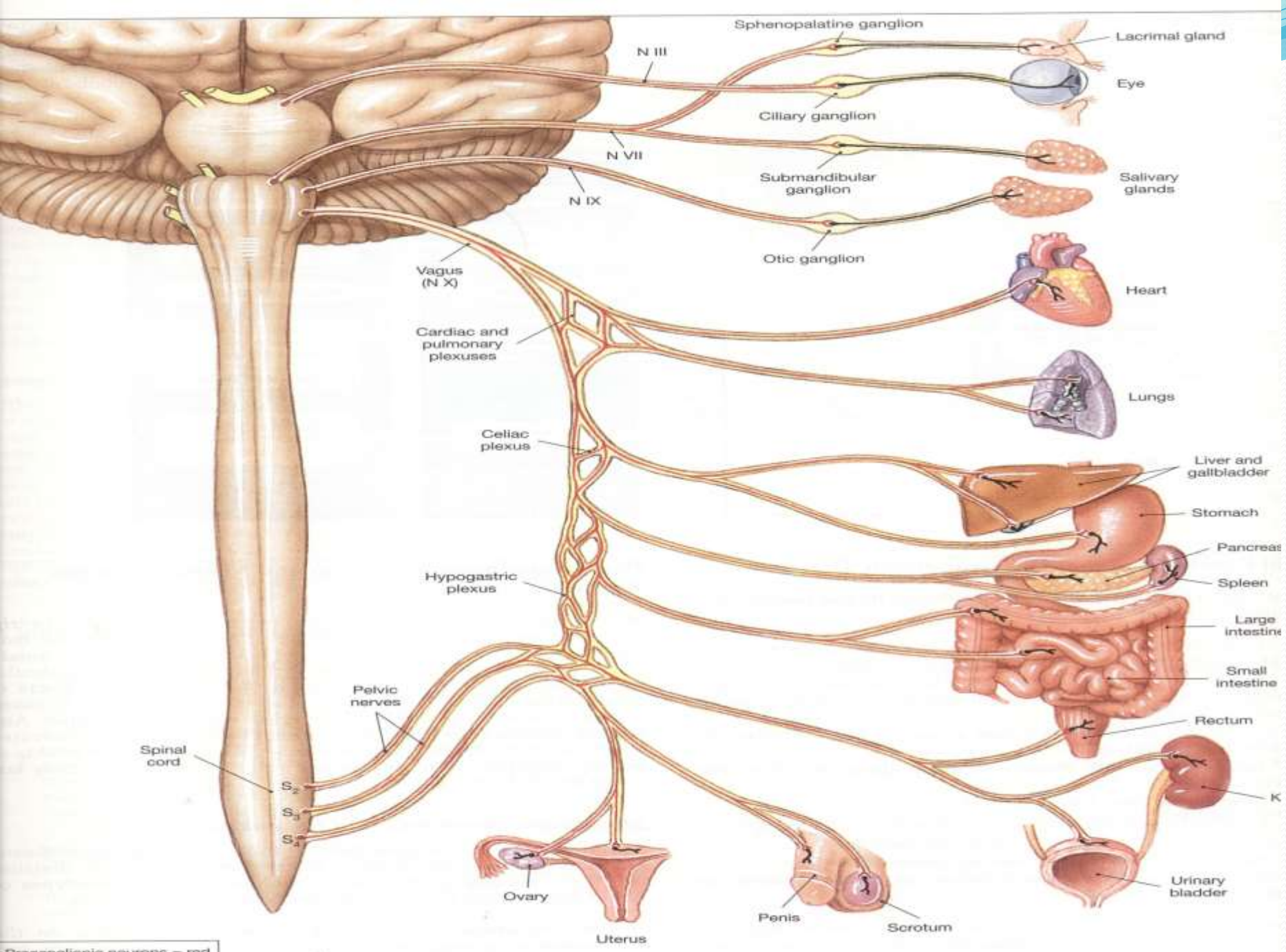

PONS
Lacrimal gland
Eye
Salivary glands
Superior
Middle
Inferior
Cervical sympathetic ganglia
Autonomic nerves
Cardiac and pulmonary plexuses
Heart
Lung
Collateral ganglia
Superior mesenteric ganglion
Celiac ganglion
Liver and gallbladder
Stomach
Pancreas
Spleen
Large int
Small int
Terminal ganglia
Adrena
Kidney
Bladder
Inferior mesenteric ganglion
Postganglionic fibers to spinal nerves (innervating skin, blood vessels, sweat glands, arrector pili muscle, adipose tissue)
Sympathetic chain ganglia
Lateral ganglia
Spinal cord
Ovary
Uterus
Penis
Scrotum
Preganglionic neurons = red
Ganglionic neurons = black


SYMPATHETIC DIVISION OF ANS
Preganglionic (first-order) neurons in spinal segments $T_1 - L_2$
Ganglionic (second-order) neurons
Sympathetic chain ganglia (paired)
Collateral ganglia (unpaired)
Adrenal medullae (paired)
via post-ganglionic fibers
via release of neurotransmitters into circulation
TARGET ORGANS
Visceral effectors in thoracic cavity, head, body wall, and limbs
Visceral effectors in abdominopelvic cavity
Organs and systems throughout body

Parasympathetic nervous system

- Partly located in the brain stem and partly in the spinal cord
- Cranio-sacral outflow (3^{rd}, 7^{th}, 9^{th} & 10^{th} cranial nerves and S2 – S4 spinal segments

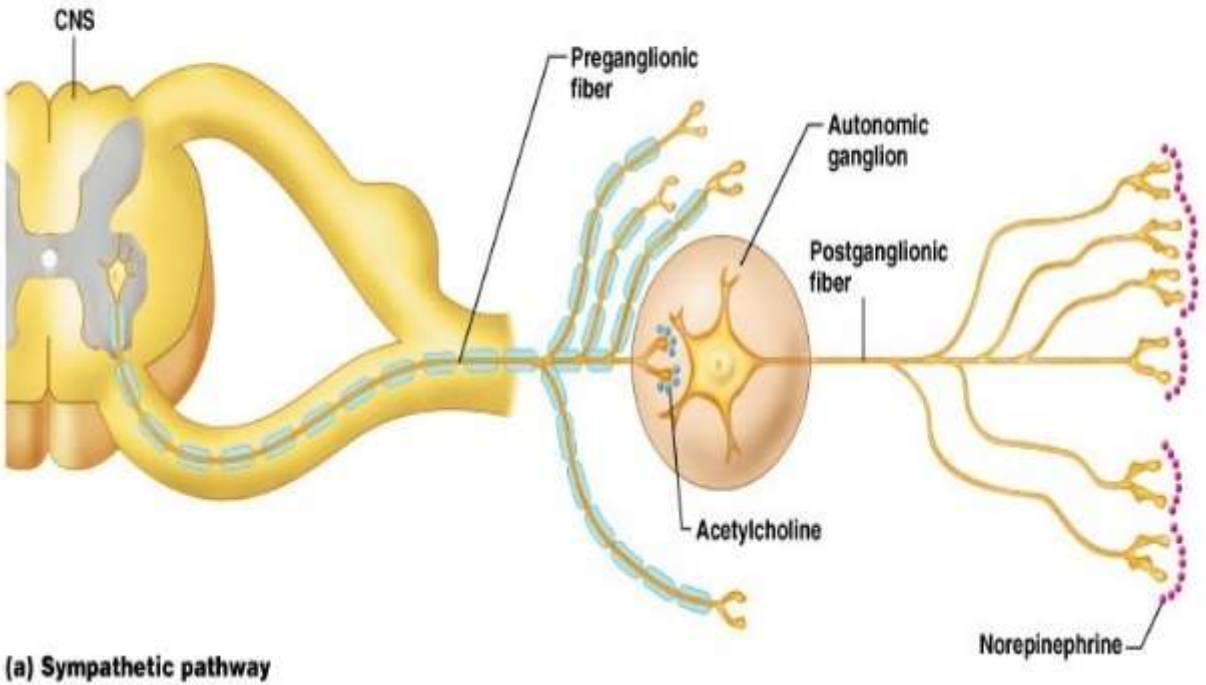

Ganglionic (second-order) neurons
Target organs
PARASYMPATHETIC DIVISION OF ANS
Preganglionic (first-order) neurons in brain stem
N III
N VII
N IX
N X
Ciliary ganglion
Sphenopalatine and submandibular ganglia
Otic ganglion
Intramural ganglia
Intrinsic eye muscles (pupil and lens shape)
Nasal glands, tear glands, and salivary glands
Parotid salivary gland
Visceral organs of head, neck, thoracic cavity, and most of abdominal cavity
Preganglionic (first-order) neurons in spinal cord segments $S_2 - S_4$
Pelvic splanchnic nerves
Intramural ganglia
Visceral organs in lower abdominopelvic cavity


Sphenopalatine ganglion
N III
Lacrimal gland
Eye
Ciliary ganglion
N VII
Submandibular ganglion
Salivary glands
N IX
Otic ganglion
Vagus (N X)
Heart
Cardiac and pulmonary plexuses
Lungs
Celiac plexus
Liver and gallbladder
Stomach
Pancreas
Hypogastric plexus
Spleen
Large intestine
Small intestine
Pelvic nerves
Rectum
Spinal cord
S_2
S_3
S_4
K
Urinary bladder
Ovary
Penis
Scrotum
Uterus
Preganglionic neurons = red
Ganglionic neurons = black

ANS Anatomy

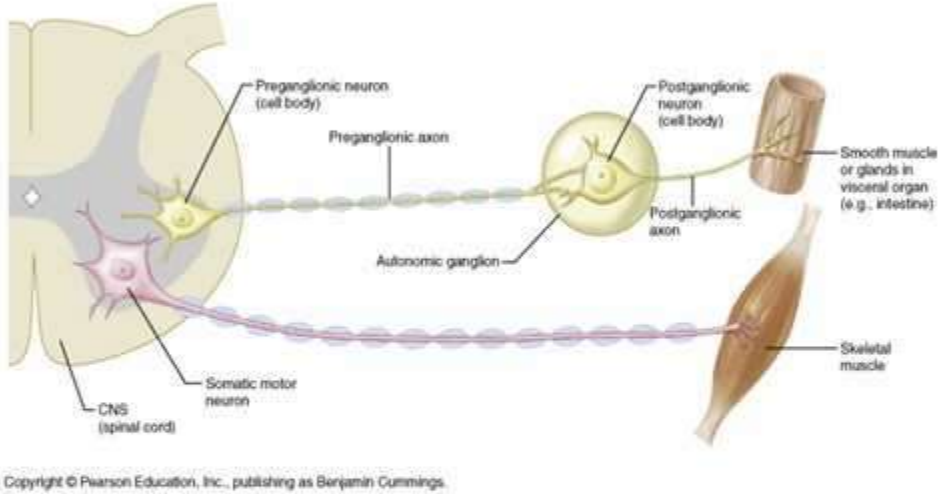
Division	Origin of Fibers	Length of Fibers	Location of Ganglia
Sympathetic	Thoracolumbar region of the spinal cord	Short preganglionic and long postganglionic	Close to spinal cord
Parasympathetic	Brain and sacral spinal cord (craniosacral)	Long preganglionic and short postganglionic	In visceral effector organs

Anatomical Differences in Sympathetic and Parasympathetic Divisions



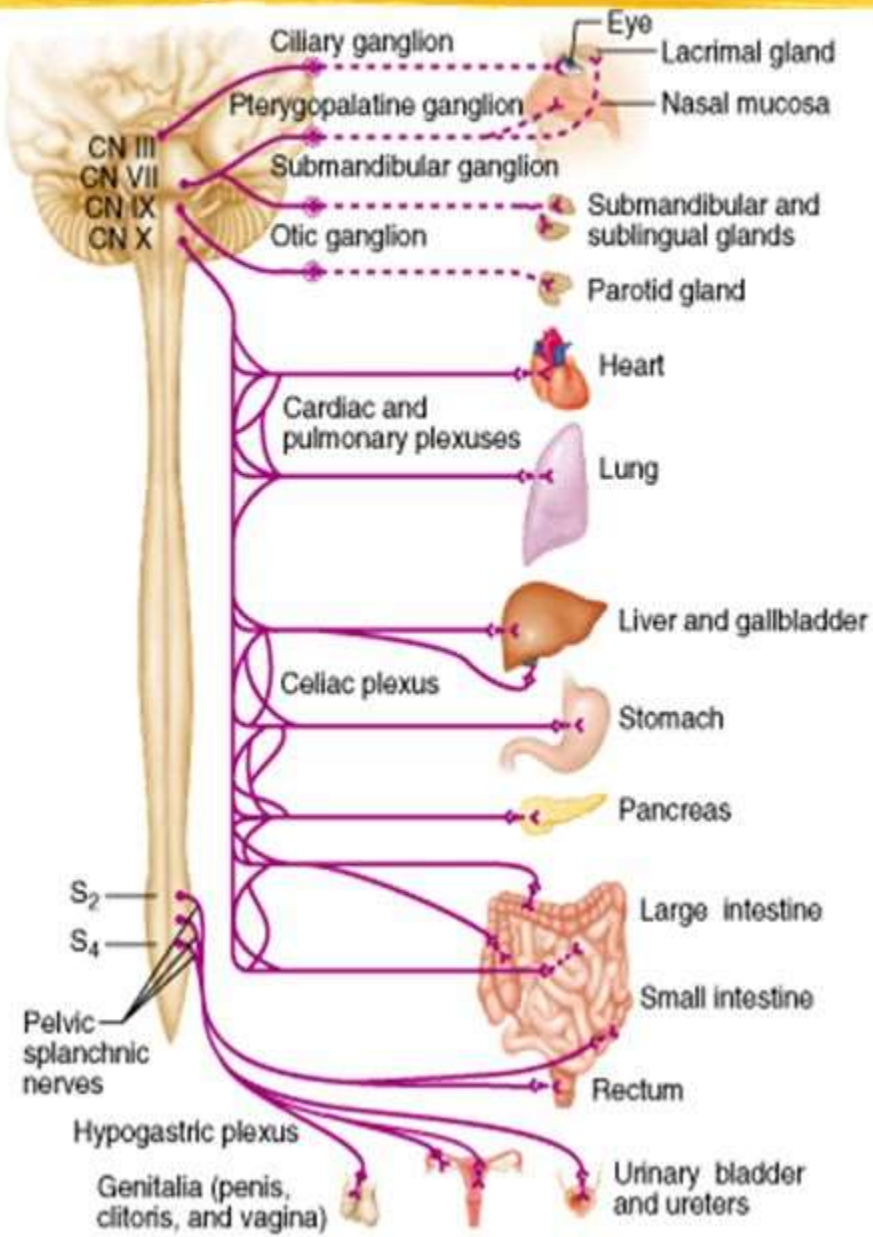
Comparison of ANS and Somatic Motor Pathways

- Somatics
  - Single neuron from spinal cord to effector
  - One neuron innervates the effector cell
  - NTS is acetylcholine (ACh)
- Autonomics
  - Two neurons relay (ganglion) to effector
  - Dual innervation of effectors
  - NTS at ganglia (ACh); NTS at effector can be ACh or norepinephrine



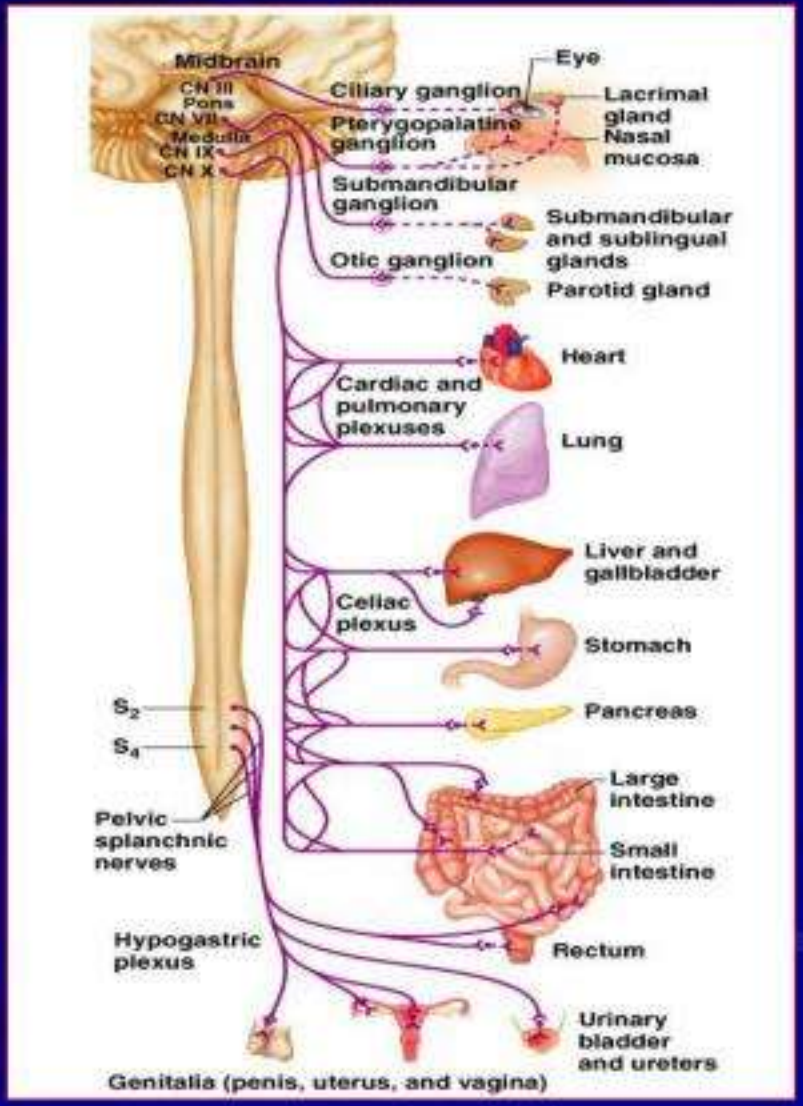
Parasympathetic Ganglia

- parasympathetic terminal ganglia = intramural ganglia
  - ganglia are located very close to or in the wall of the visceral organs
  - each preganglionic neuron synapses with a only few postganglionic neurons
- parasympathetic preganglionic fibers are long
- parasympathetic postganglionic fibers are short



Parasympathetic Ganglia

- Multiple, small, located nearer the viscera
- Ganglia supplying structures in head & neck: (**ciliary**, **otic**, **pterygopalatine** & **submandibular**).
- Ganglia supplying thoracic, abdominal & pelvic viscera.



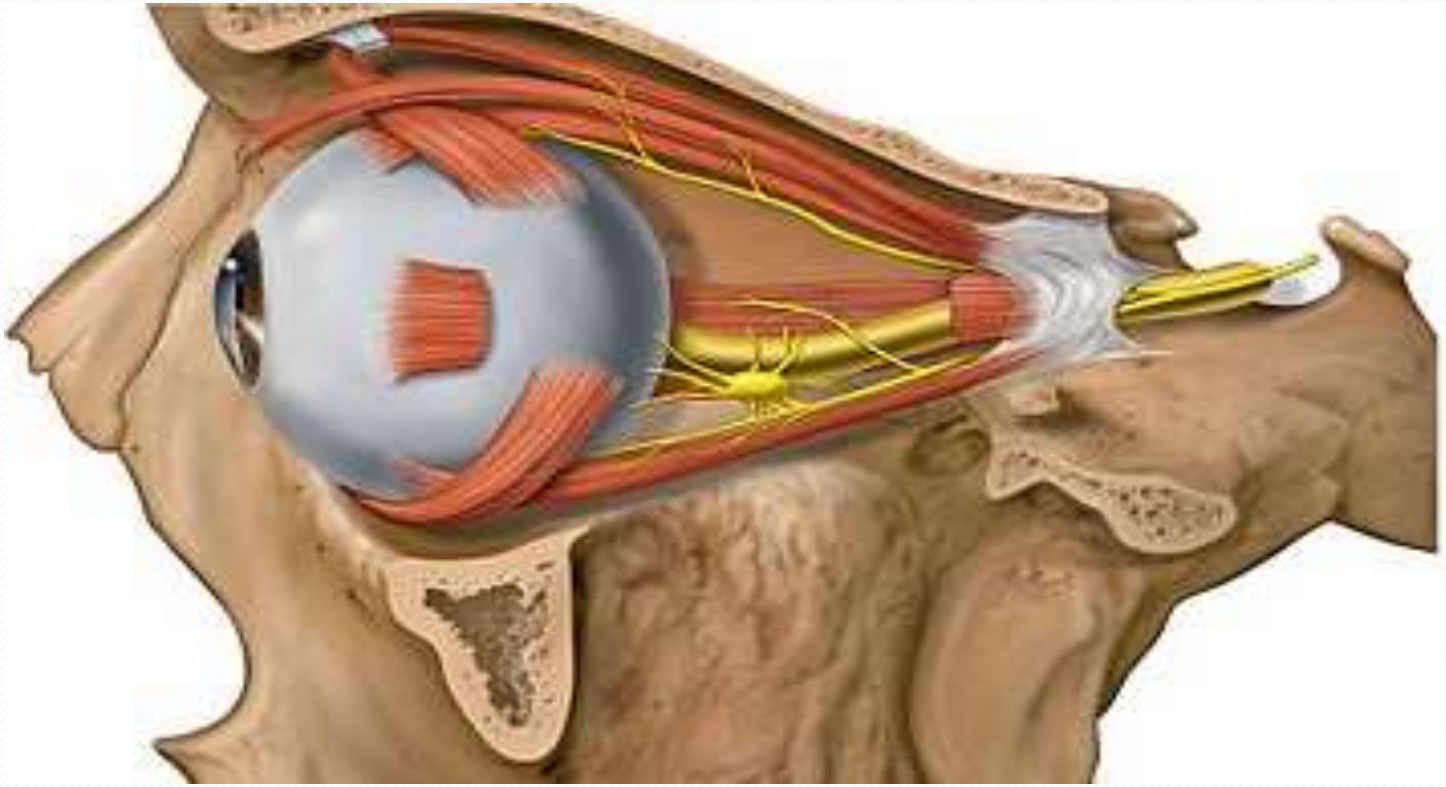
Parasympathetic ganglia in head & neck

- **Ciliary ganglion**
- **Otic ganglion**
- **Submandibular ganglion**
- **Sphenopalatine ganglion/**
  Pterygo-palatine ganglion

Peripheral parasympathetic ganglia

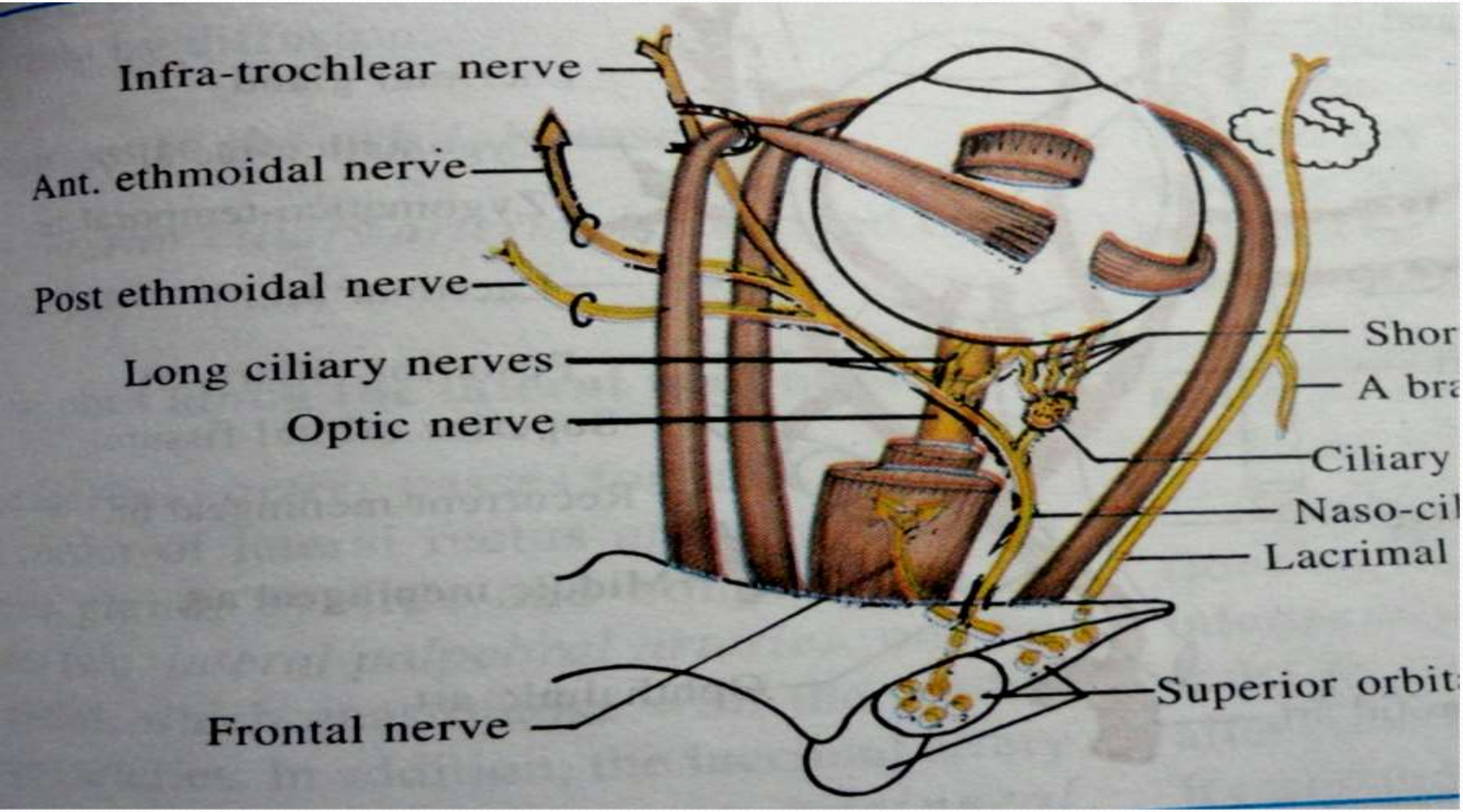
- Location
- Topographically related nerve
- Functionally related nerve
- Nucleus
- **Roots** - Parasympathetic(preganglionic fibres relay), Sympathetic & sensory(without relay)
- Trace preganglionic fibres from the nucleus to the ganglion
- Branches of distribution

Ciliary ganglion

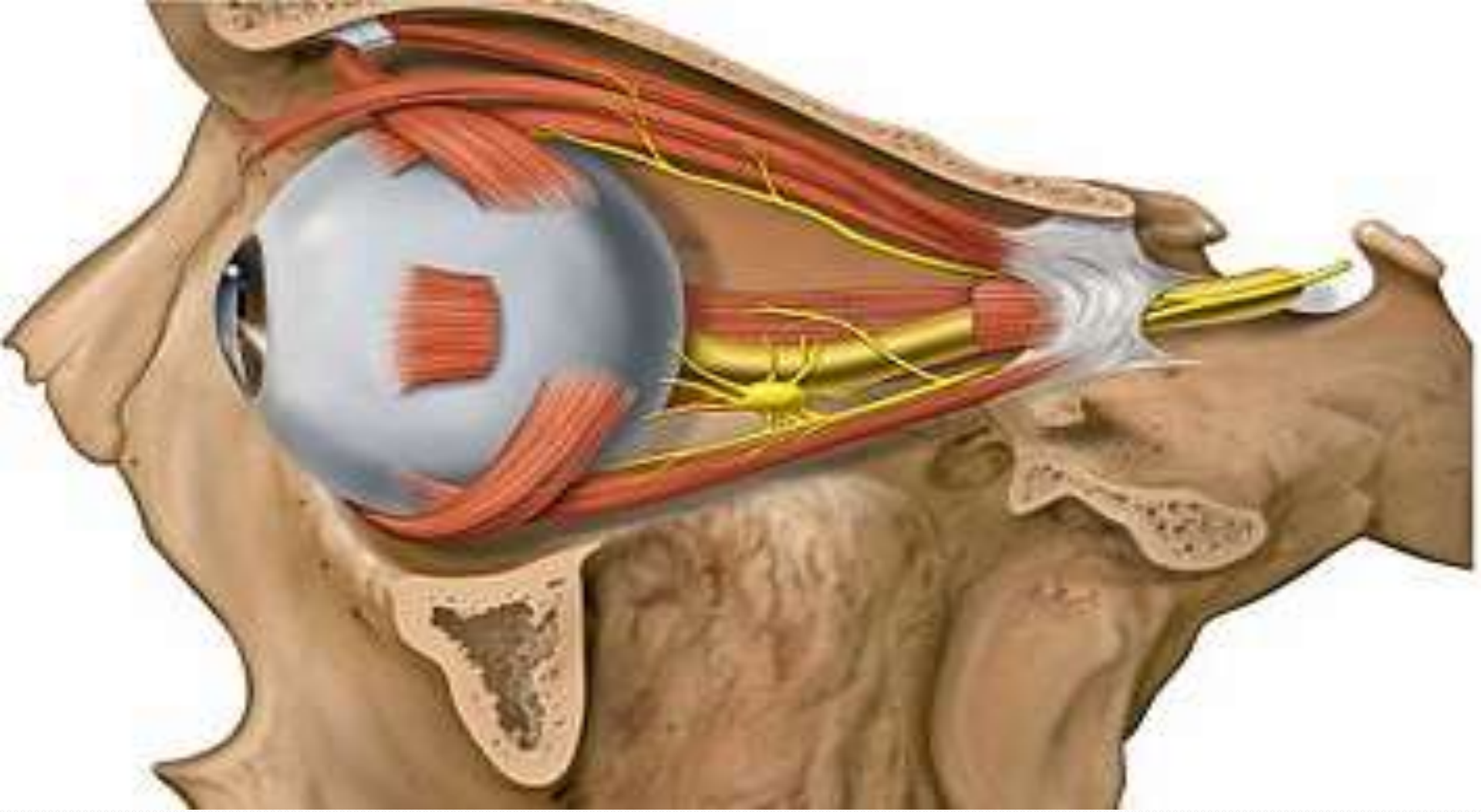


- Smallest peripheral parasympathetic ganglion
- The **ciliary ganglion** is a parasympathetic ganglion concerned with the innervation of **intraocular muscles**

Ciliary ganglion

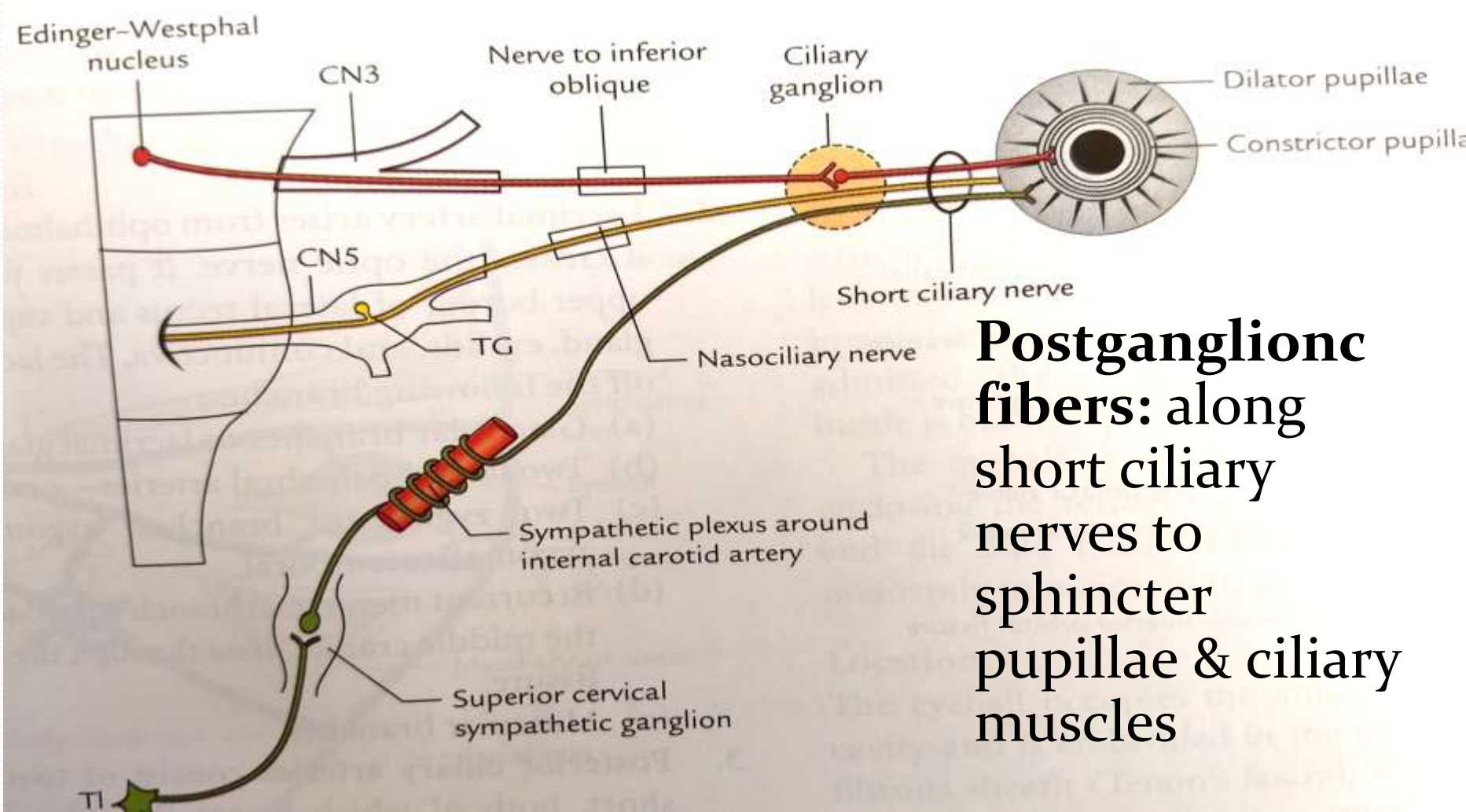


- **Site:** in the fat between optic nerve & lateral rectus muscle



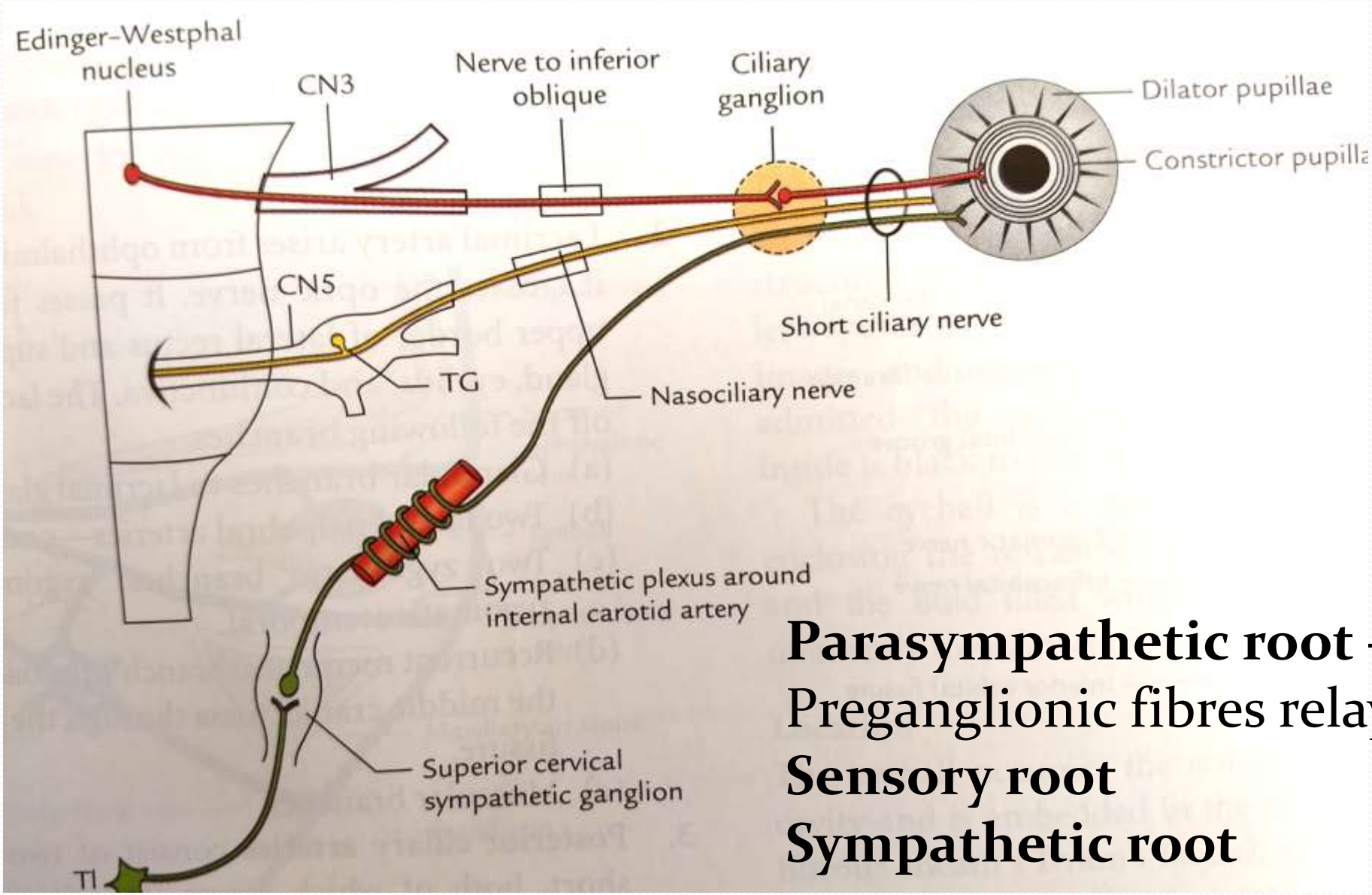
•It is a small, flat, reddish-grey swelling, 1–2 mm in diameter, located near the apex of the orbit between optic nerve and lateral rectus
•Connected to the **nasociliary nerve(topographically**), and
•**Functionally** connected to **occulomotor nerve**

- **Nucleus:** Edinger Westphal nucleus of occulomotor N(midbrain)
- **Preganglionic fibers:** along occulomotor through nerve to inferior oblique



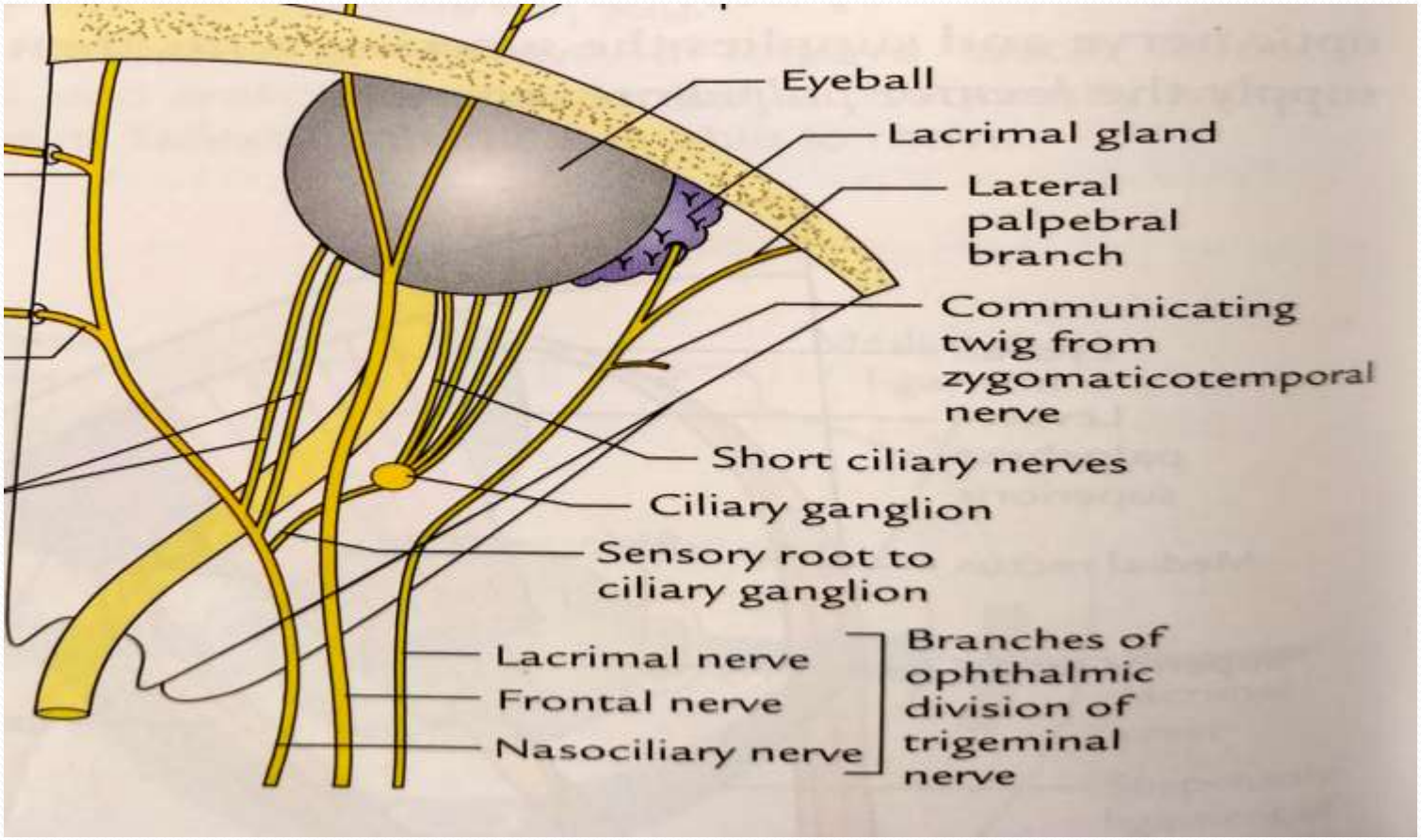
Postganglionc fibers: along short ciliary nerves to sphincter pupillae & ciliary muscles

Roots of parasympathetic ganglia

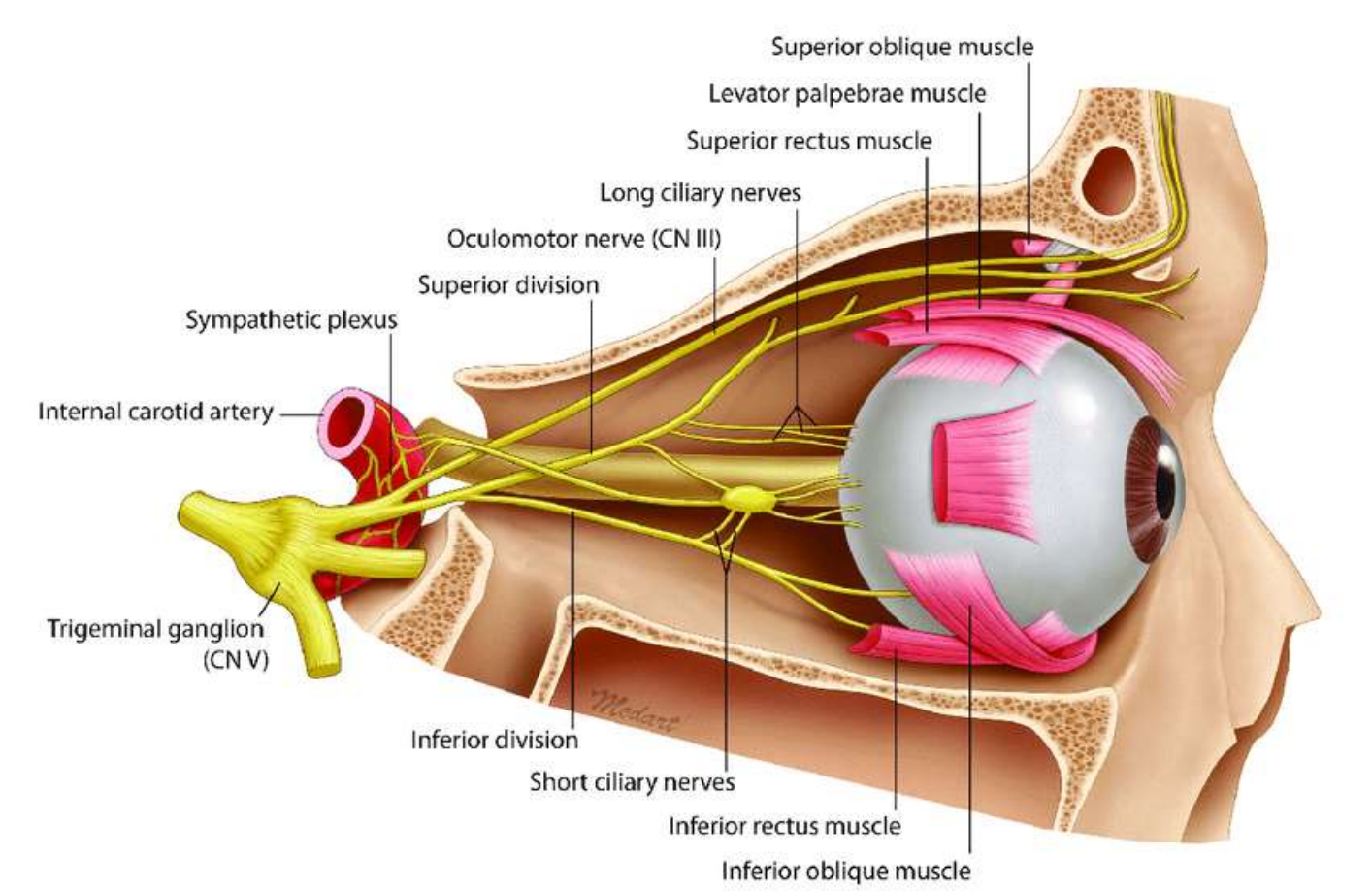


Parasympathetic root – Preganglionic fibres relay
Sensory root
Sympathetic root

Branches of ciliary ganglion



- 8 to 10 Short ciliary nerves
- Contain fibres from all the 3 roots of the ganglion


Superior oblique muscle
Levator palpebrae muscle
Superior rectus muscle
Long ciliary nerves
Oculomotor nerve (CN III)
Superior division
Sympathetic plexus
Internal carotid artery
Trigeminal ganglion
(CN V)
Inferior division
Short ciliary nerves
Inferior rectus muscle
Inferior oblique muscle

Ciliary ganglion

Short ciliary nerves:

- Number: 8 – 10
- Destination: connect ciliary ganglion to eyeball
- Type of fibers:

1. **Postganglionic parasympathetic fibers** to sphincter pupillae & ciliary muscles
2. **Postganglionic sympathetic fibers** from internal carotid plexus (pass through ganglion without relay) distributed to the blood vessels of the eyeball & dilator pupillae
3. **Sensory fibers** from eyeball carry sensation from the cornea, the ciliary body and the iris (pass through ganglion without relay)

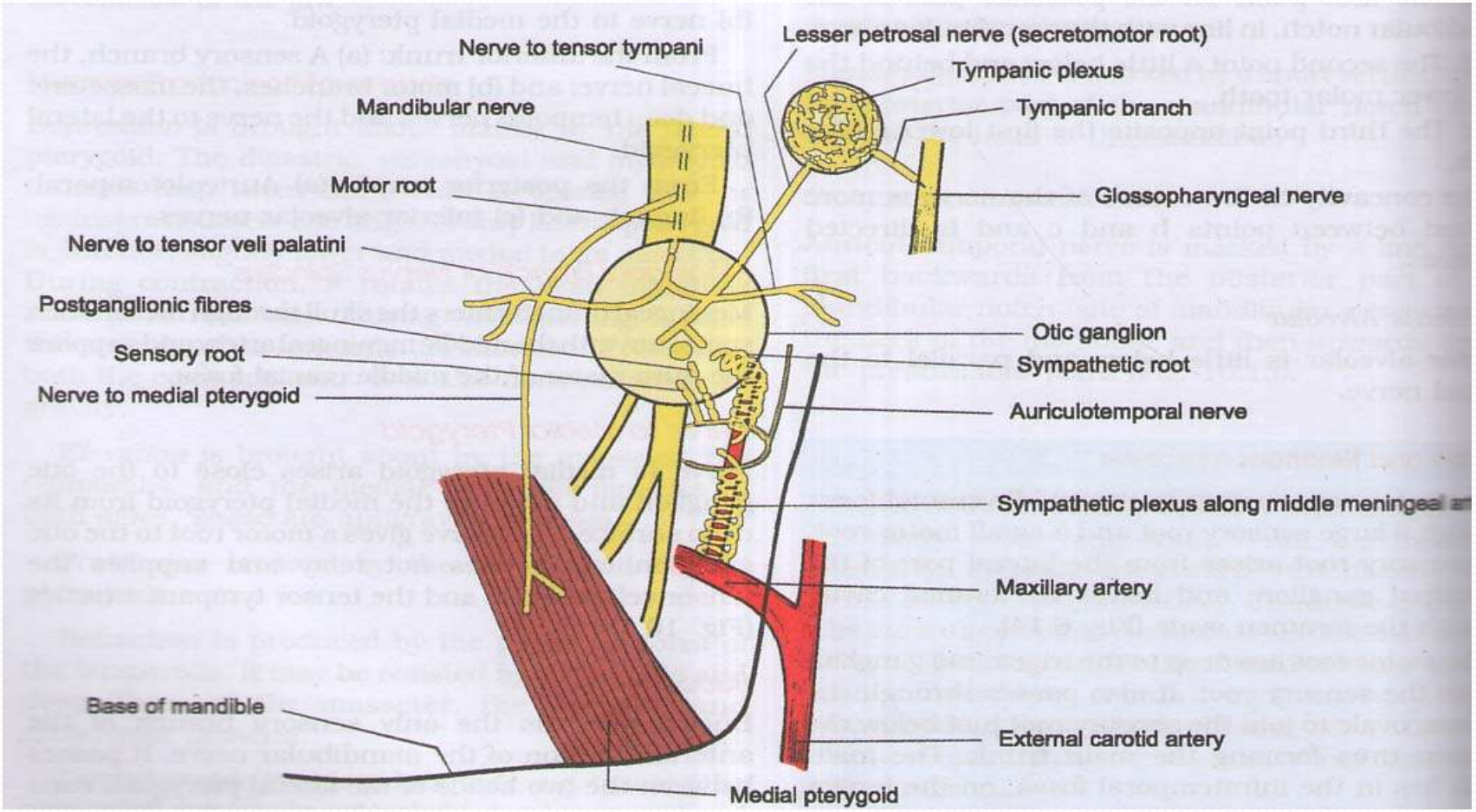
OTIC ganglion(Arnold's ganglion)

- **Friedrich Arnold**
- **Introduction:-**

  A peripheral parasympathetic ganglion which supply secretomotor fibres to parotid gland
- **Topographically :-**

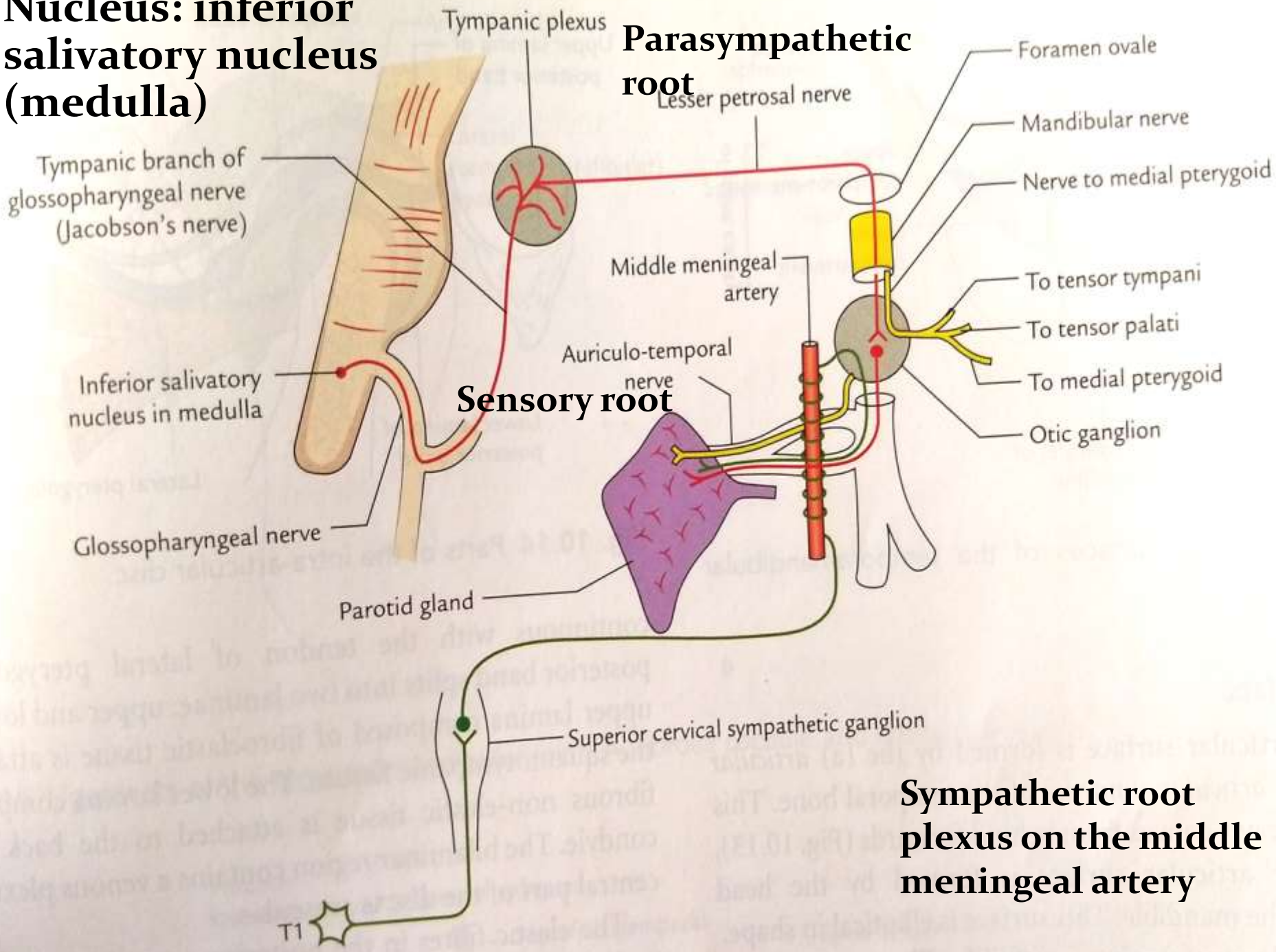
  It is connected to Mandibular nerve but functionally to Glossopharyngeal Nerve

Otic ganglion



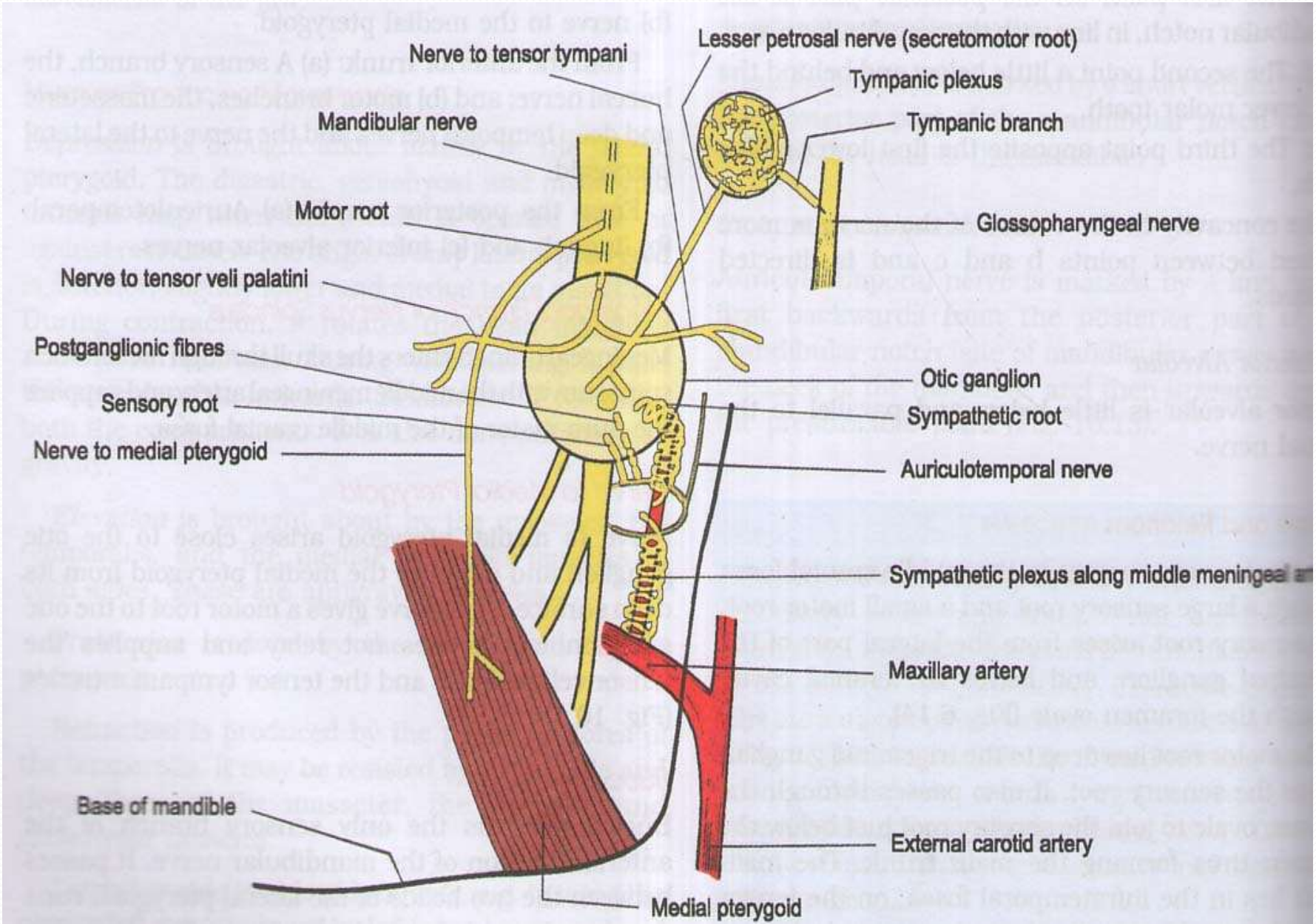
- **Situation** - 2-3 mm in size & is situated in infratemporal fossa just below the foramen Ovale between Mandibular nerve [lateral side]& Tensor Veli Palatini muscle [medial side]

Nucleus: inferior salivatory nucleus (medulla)



Sympathetic root plexus on the middle meningeal artery

Otic ganglion:-its connections



Branches –

1. Post ganglionic parasympathetic fibres through auriculotemporal nerve – secretomotor to parotid gland
2. Post ganglionic sympathetic fibres through auriculotemporal nerve – Vasomotor to parotid gland

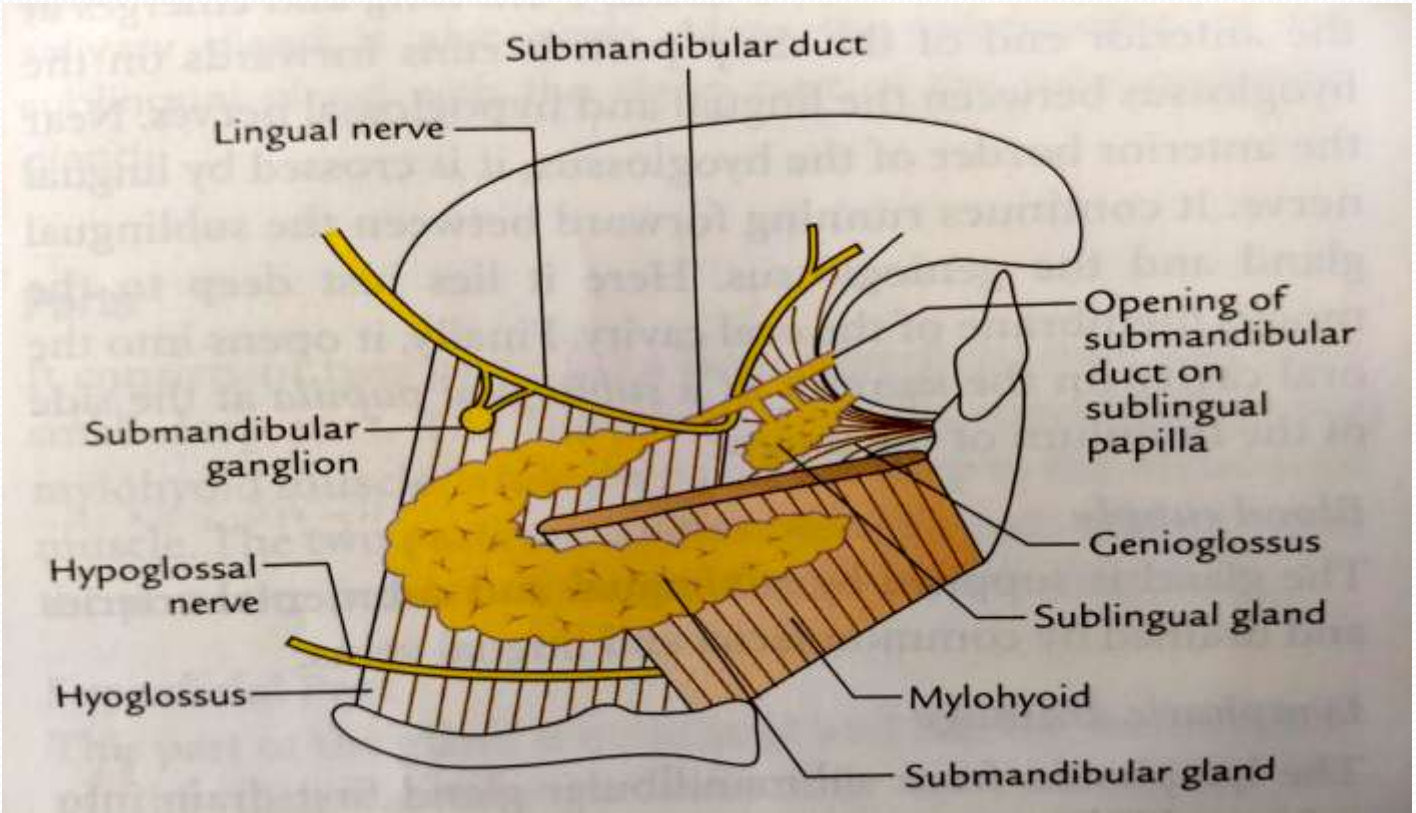
Other Connections to otic ganglion:-

1. A branch from nerve to medial pterygoid which passes as such through otic ganglion to supply tensor veli palatini & tensor tympani

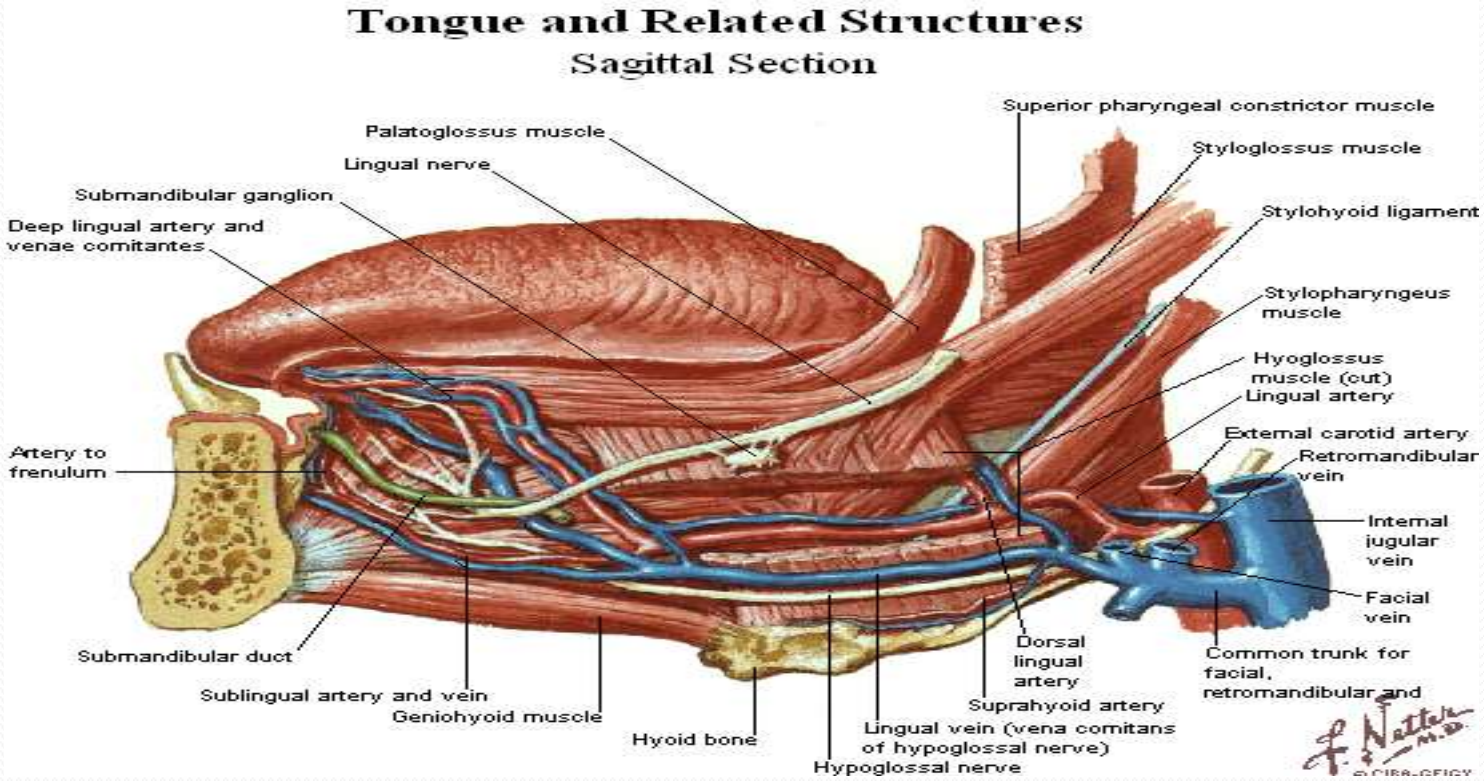
2. The Chorda tympanic nerve is connected to otic ganglion. this connection provide an alternate pathway of taste from ant.2/3 of the tongue.

Submandibular ganglion

- **Site** - Small parasympathetic ganglion lying superficial to **Hyoglossus** in submandibular region & to supply secretomotor fibres to submandibular & sublingual salivary glands



Submandibular ganglion (langley's ganglion)



Topographically, connected to trigeminal nerve(through lingual nerve)

Functionally, related to facial nerve(through chorda tympani nerve)

Submandibular ganglion

- **Nucleus**: superior salivatory nucleus (pons)
- **Preganglionic fibers**: Facial nerve - along chorda tympani of facial nerve → joins lingual nerve → posterior root → ganglion
- **Postganglionc fibers**:

1. Pass directly to submandibular gland
2. Pass along anterior root → lingual nerve → sublingual gland

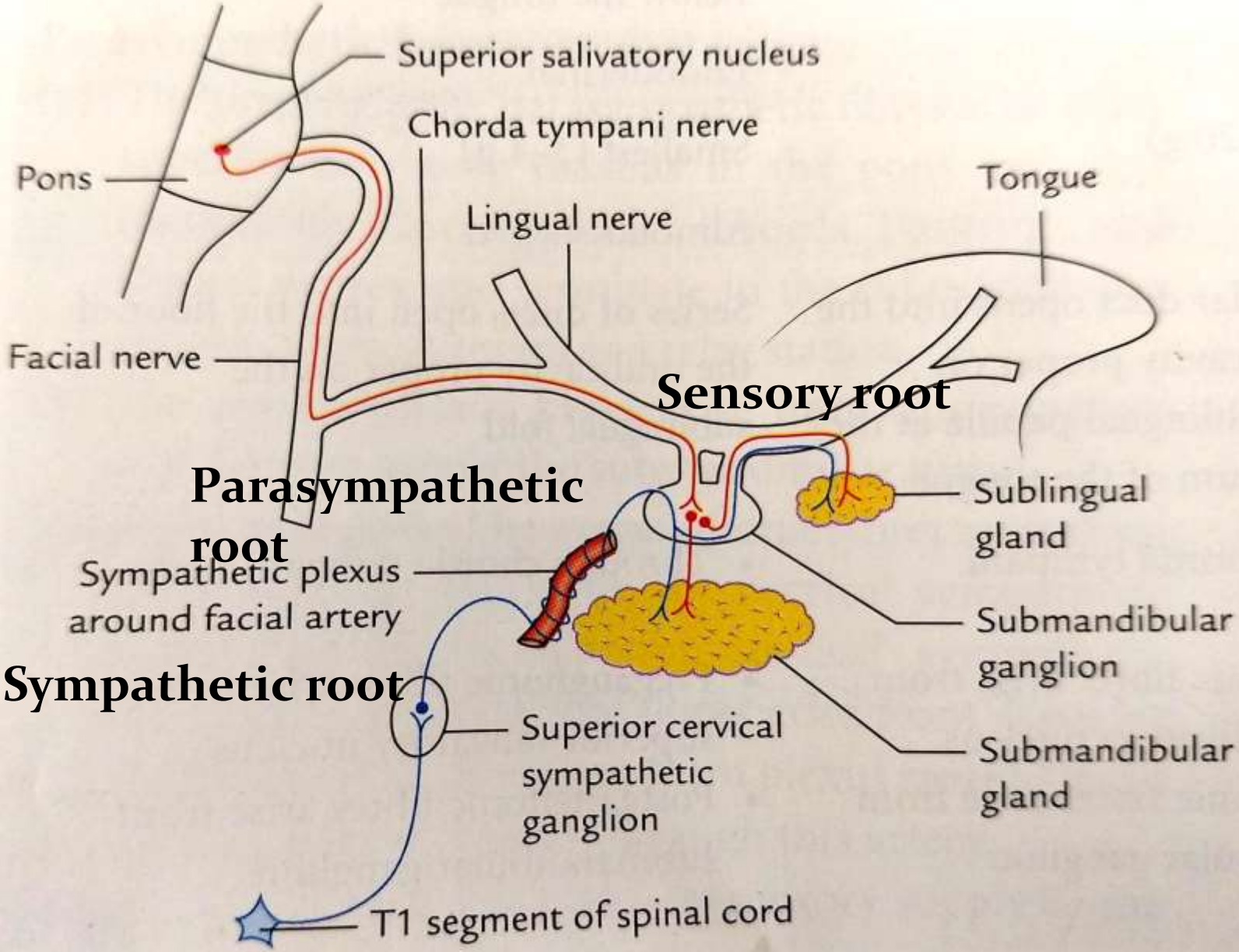
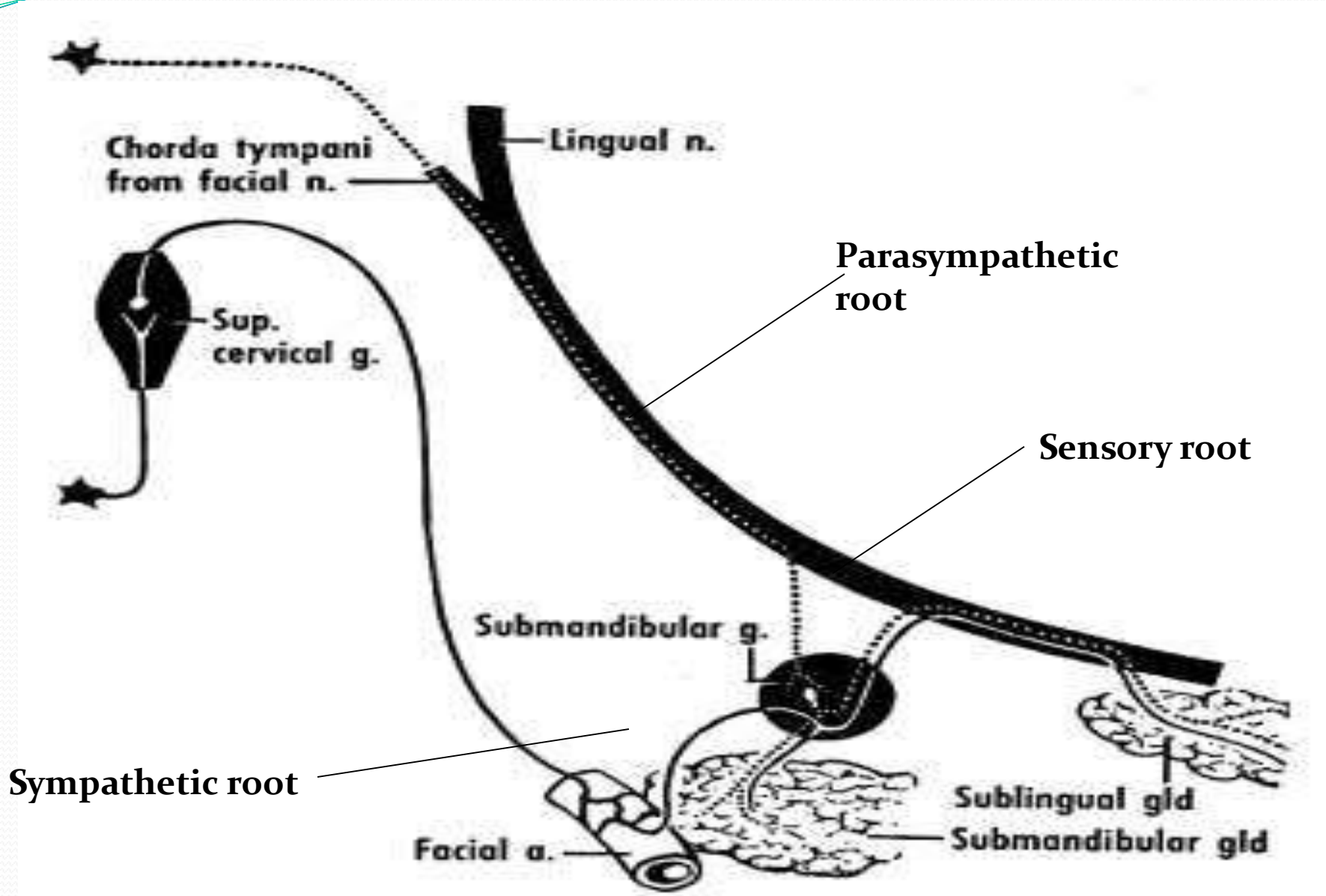
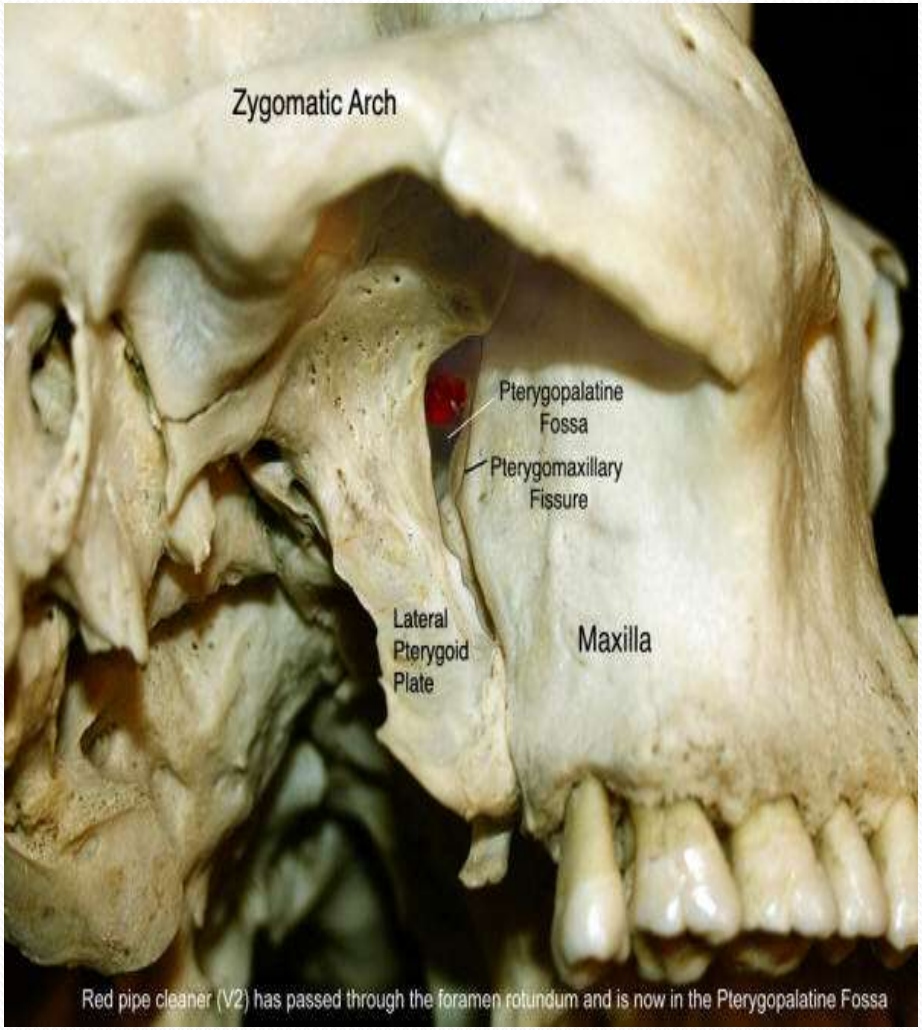


Fig. 9.21 Submandibular ganglion and its connections.


Chorda tympani
from facial n.
Lingual n.
Parasympathetic
root
Sup.
cervical g.
Sensory root
Submandibular g.
Sympathetic root
Sublingual gld
Facial a.
Submandibular gld

The Pterygopalatine fossa

- Inverted '**tear-drop**' shaped space
- Between bones on the lateral side of the skull
- Immediately posterior to the maxilla

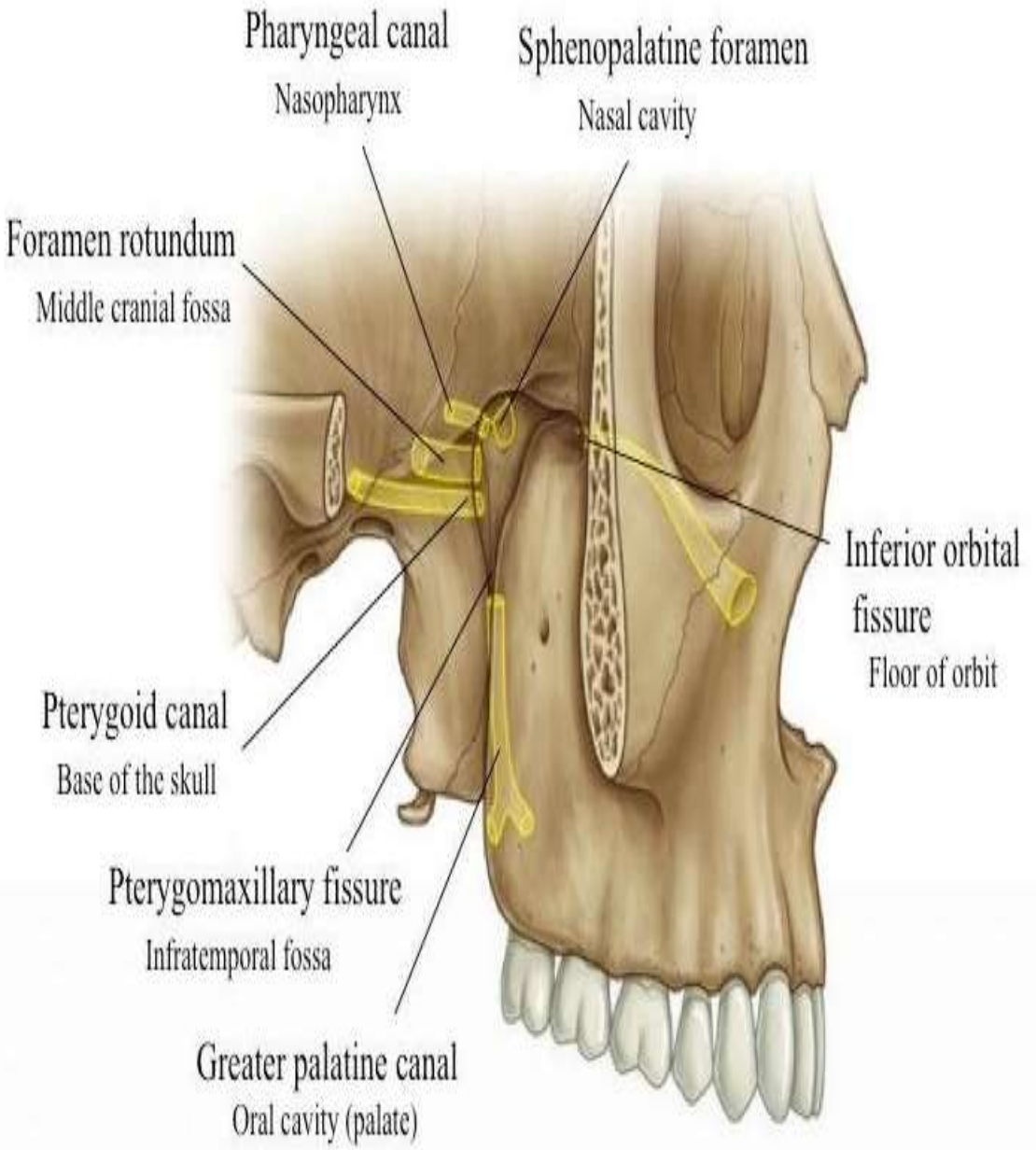


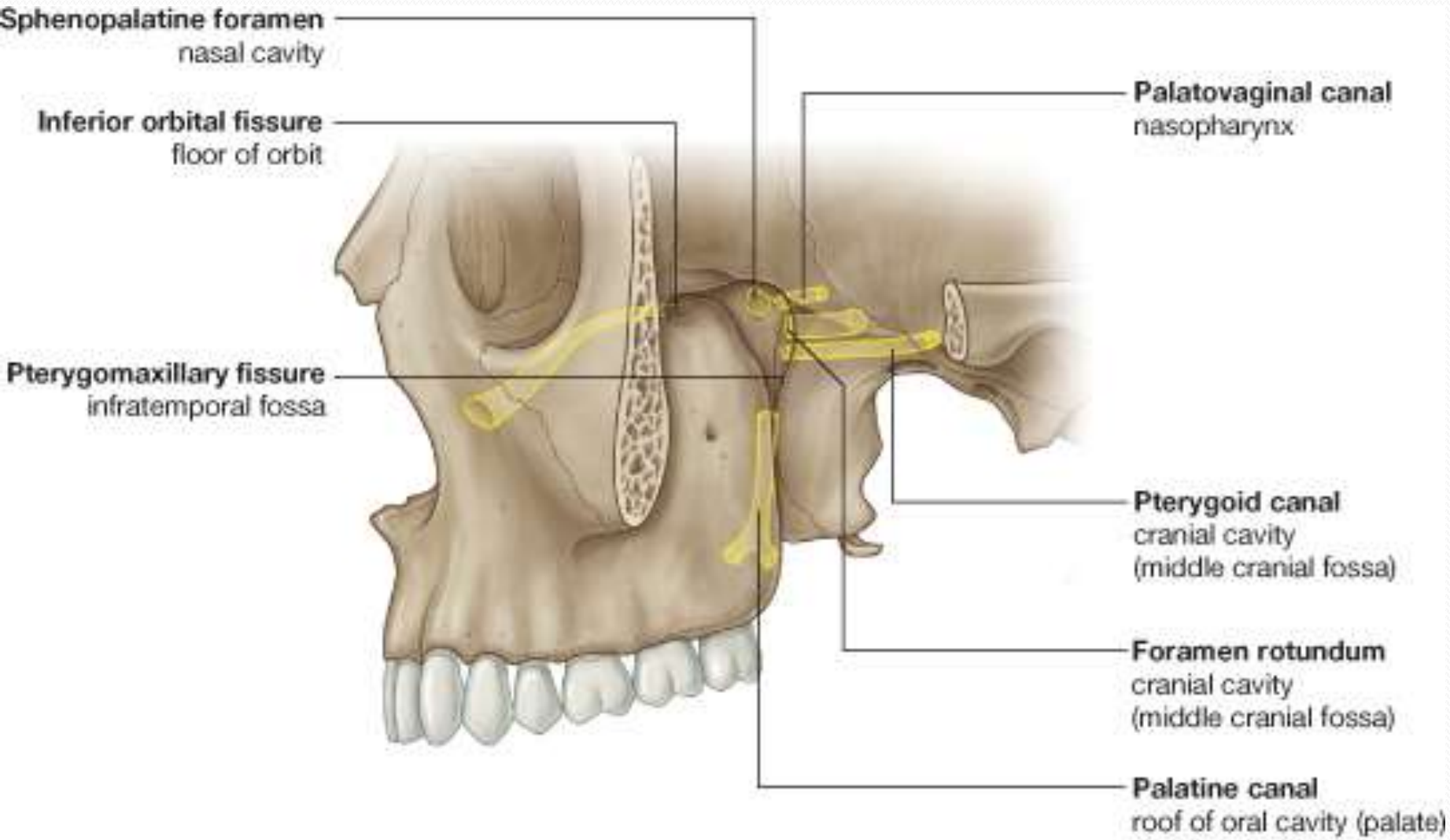
Pterygopalatine fossa

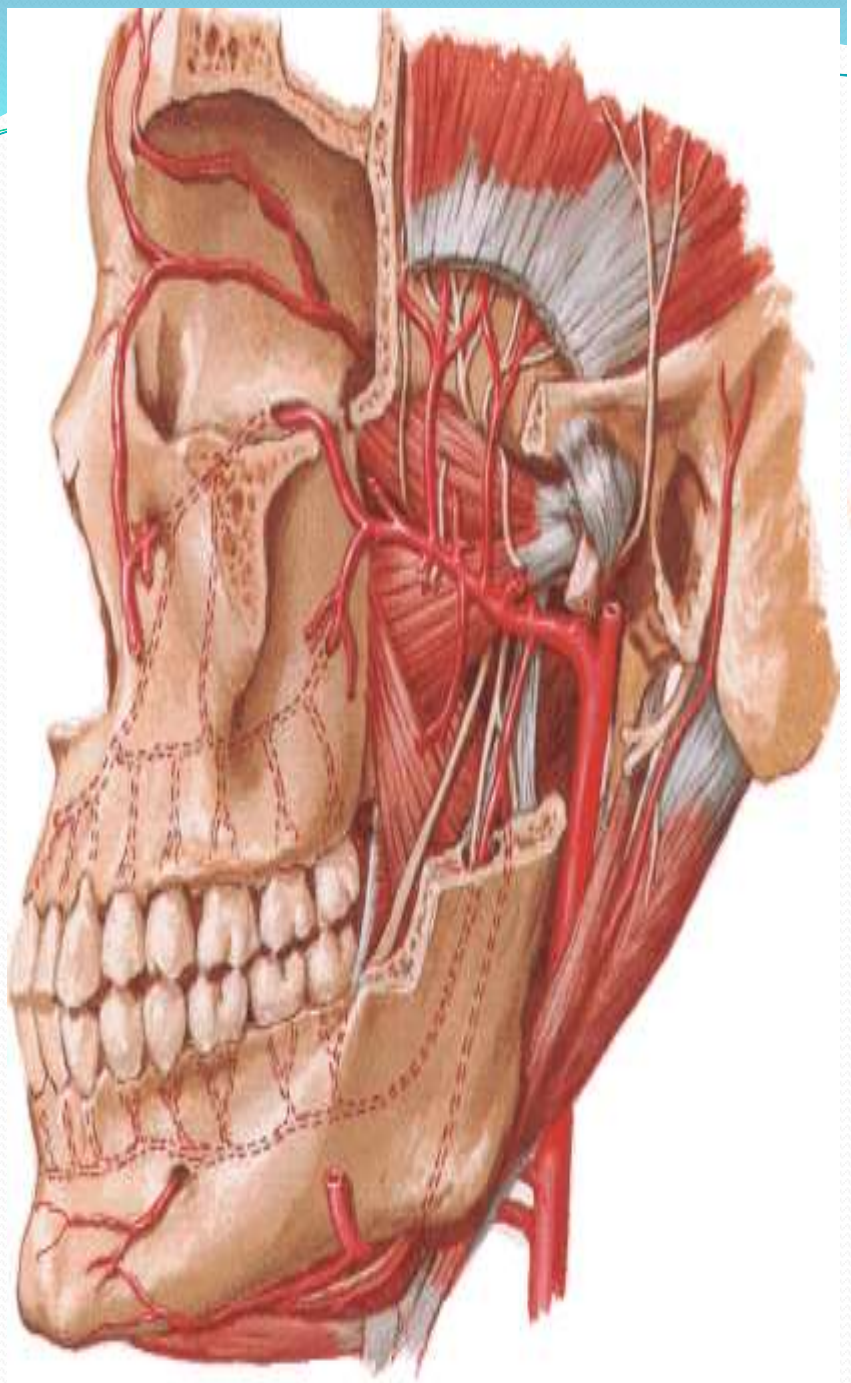
- **Boundaries:**
  - **Anterior:** posterior surface of maxilla.
  - **Posterior:** pterygoid process.
  - **Medial:** perpendicular plate of palatine bone.
  - **Lateral:** infratemporal fossa (through pterygomaxillary fissure).
  - **Superiorly**: greater wing of sphenoid

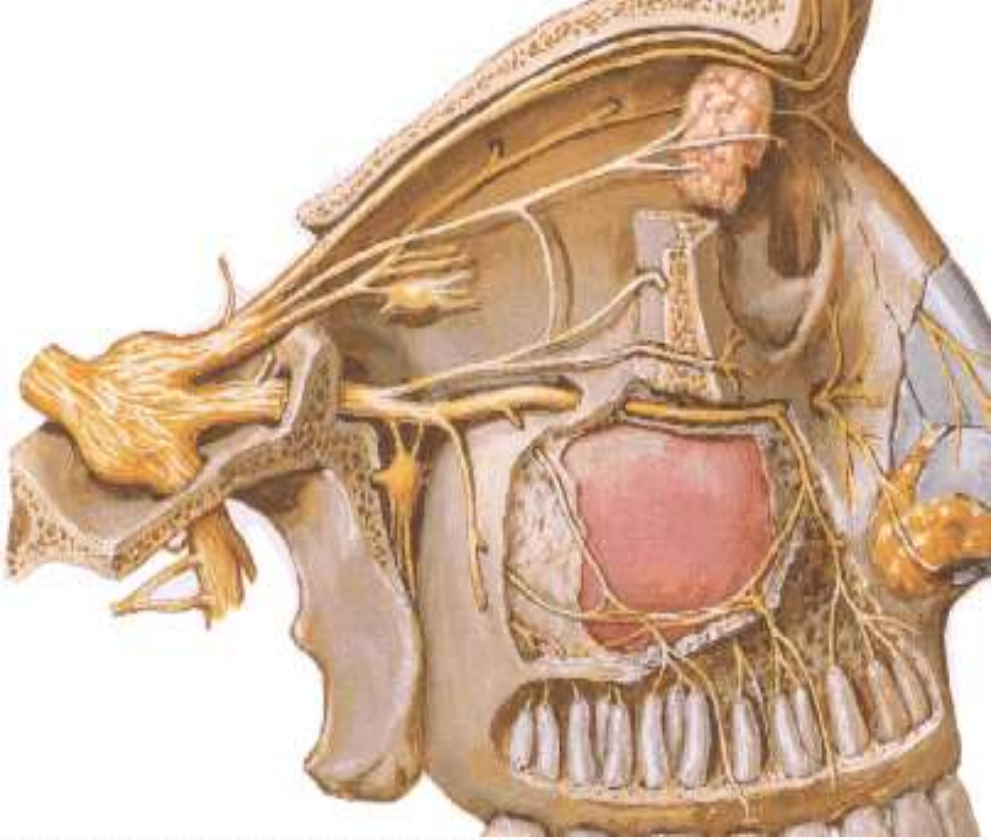
Communications:

1. Ptergomaxillary fissure ⇨ infratemporal fossa.
2. Foramen rotundum ⇨ middle cranial fossa.
3. Sphenopalatine foramen ⇨ nasal cavity.
4. Inferior orbital fissure ⇨ orbital cavity.
5. Greater palatine canal ⇨ palate.
6. Palatinovaginal canal ⇨ nasopharynx.
7. Pterygoid canal ⇨ foramen lacerum









<u>Contents</u>:

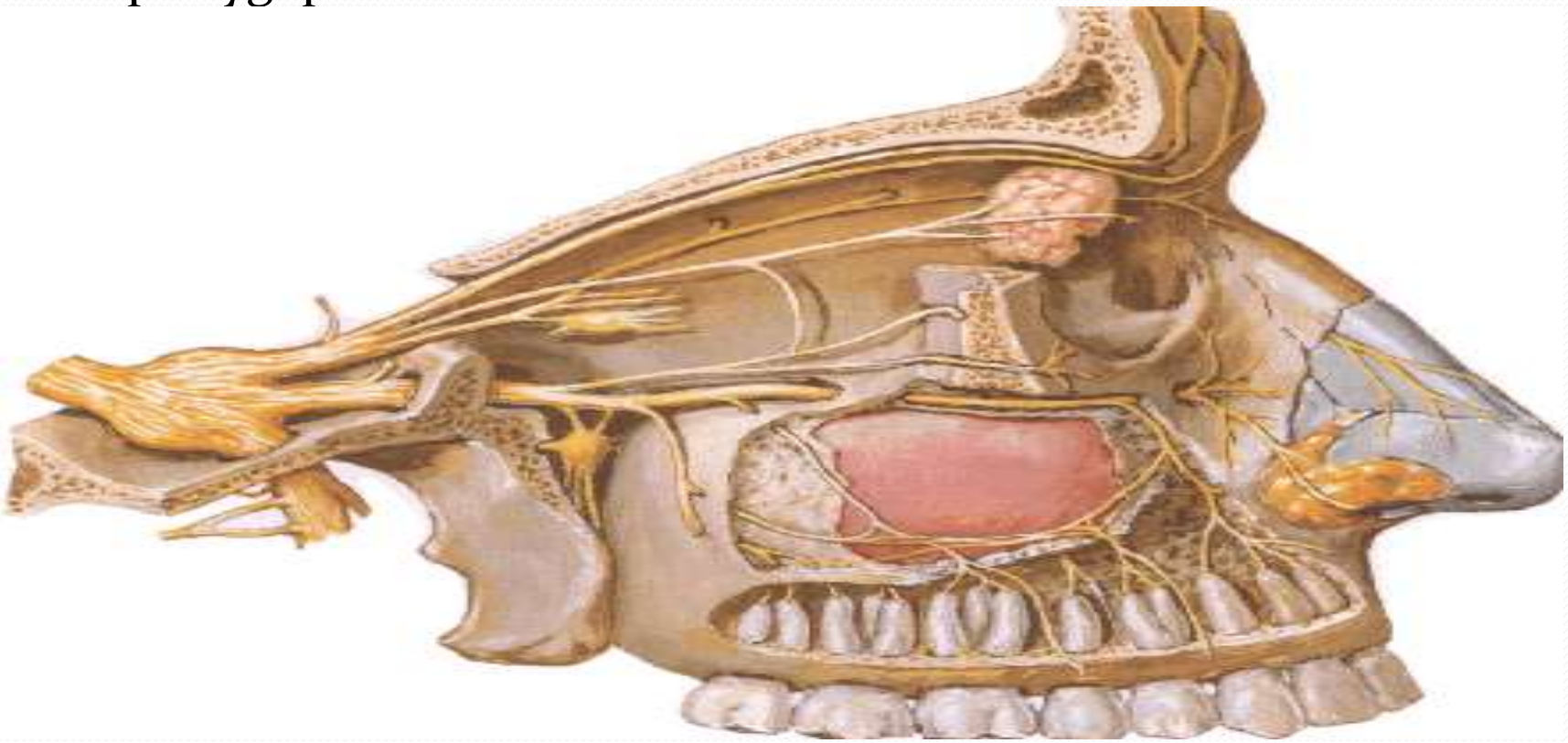
Maxillary nerve and branches.

Sphenopalatine ganglion and branches.

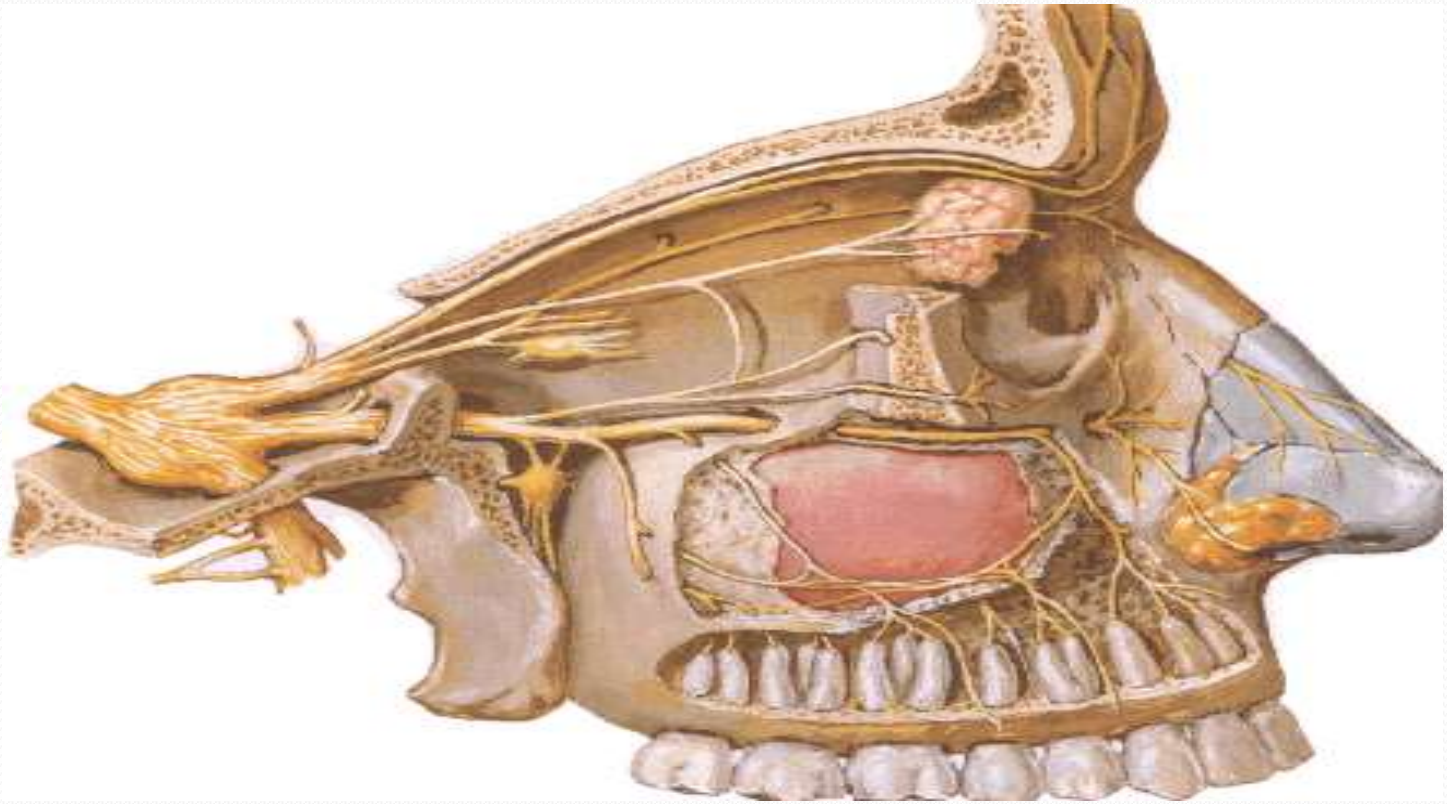
3rd part of maxillary artery and branches.

Maxillary nerve

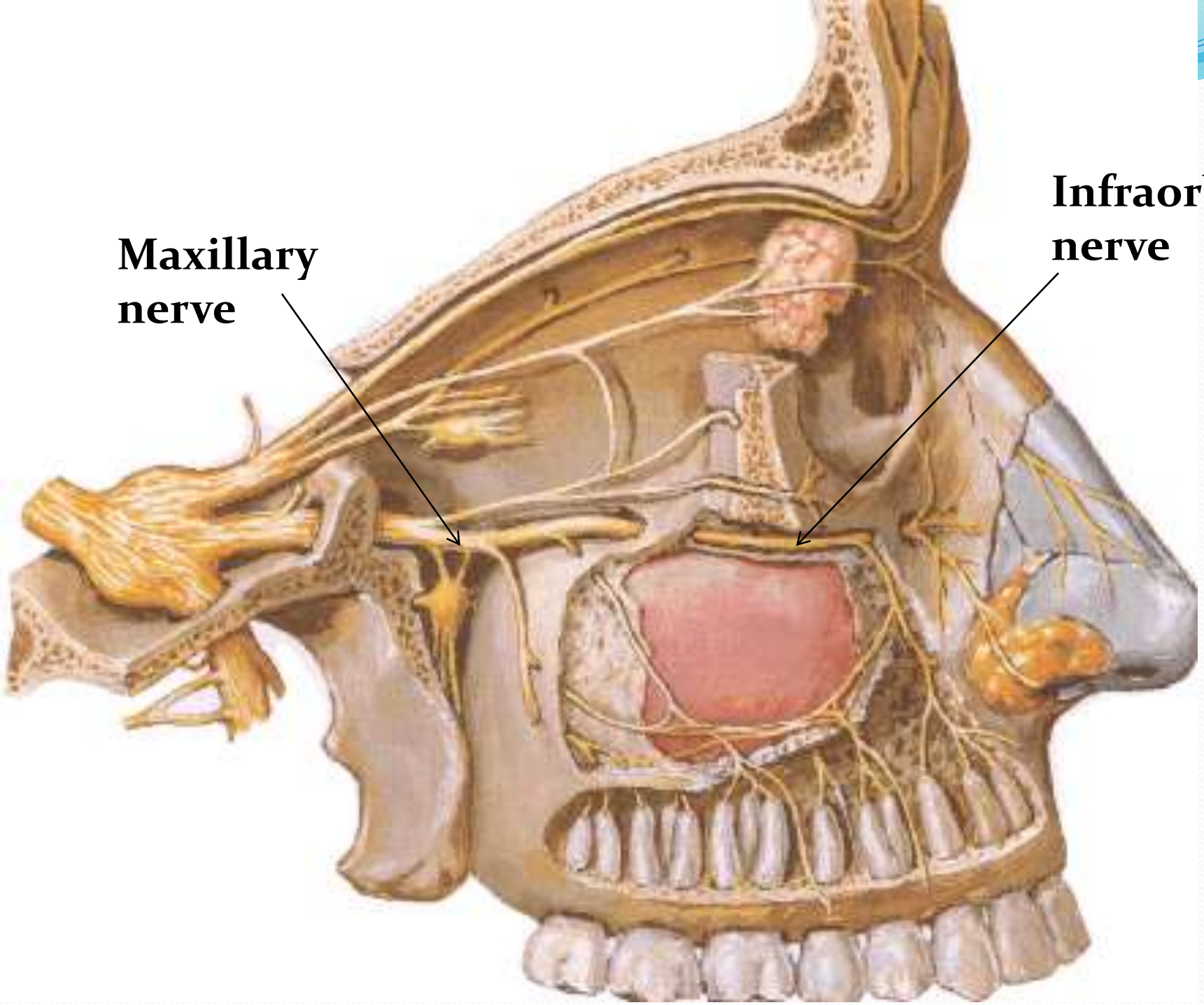
- One of the divisions of the trigeminal nerve
- It is a pure sensory nerve.
- It passes in the lateral wall of the cavernous sinus.
- Then leaves the skull through foramen rotundum to enter the pterygopalatine fossa.



Maxillary nerve



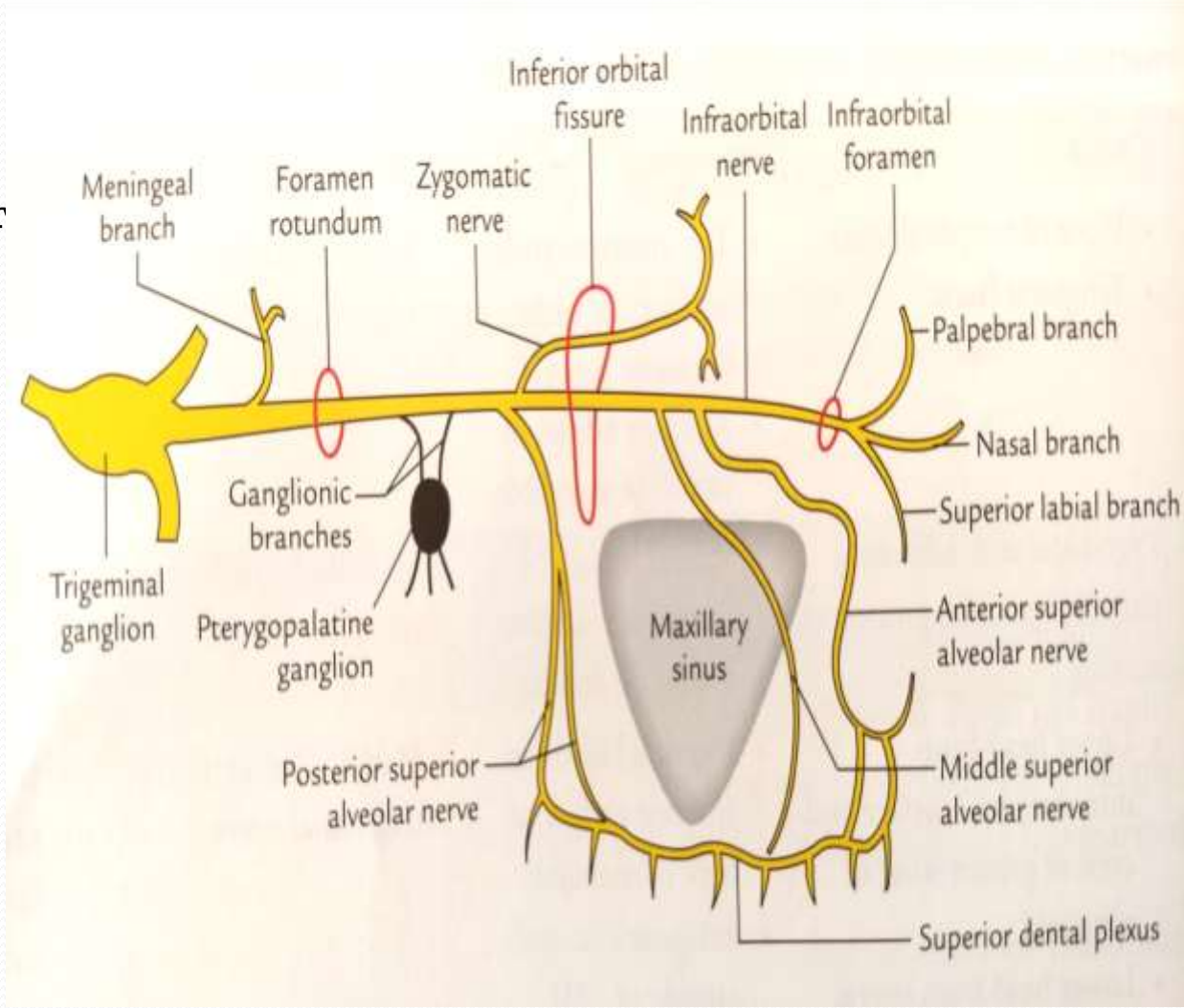
- It curves laterally through the pterygomaxillary fissure to lie deep in the pterygopalatine fossa.
- Through the inferior orbital fissure, it enters the floor of the orbit and continues as infraorbital nerve, which runs in the infraorbital groove, canal then foramen and terminates in the face.

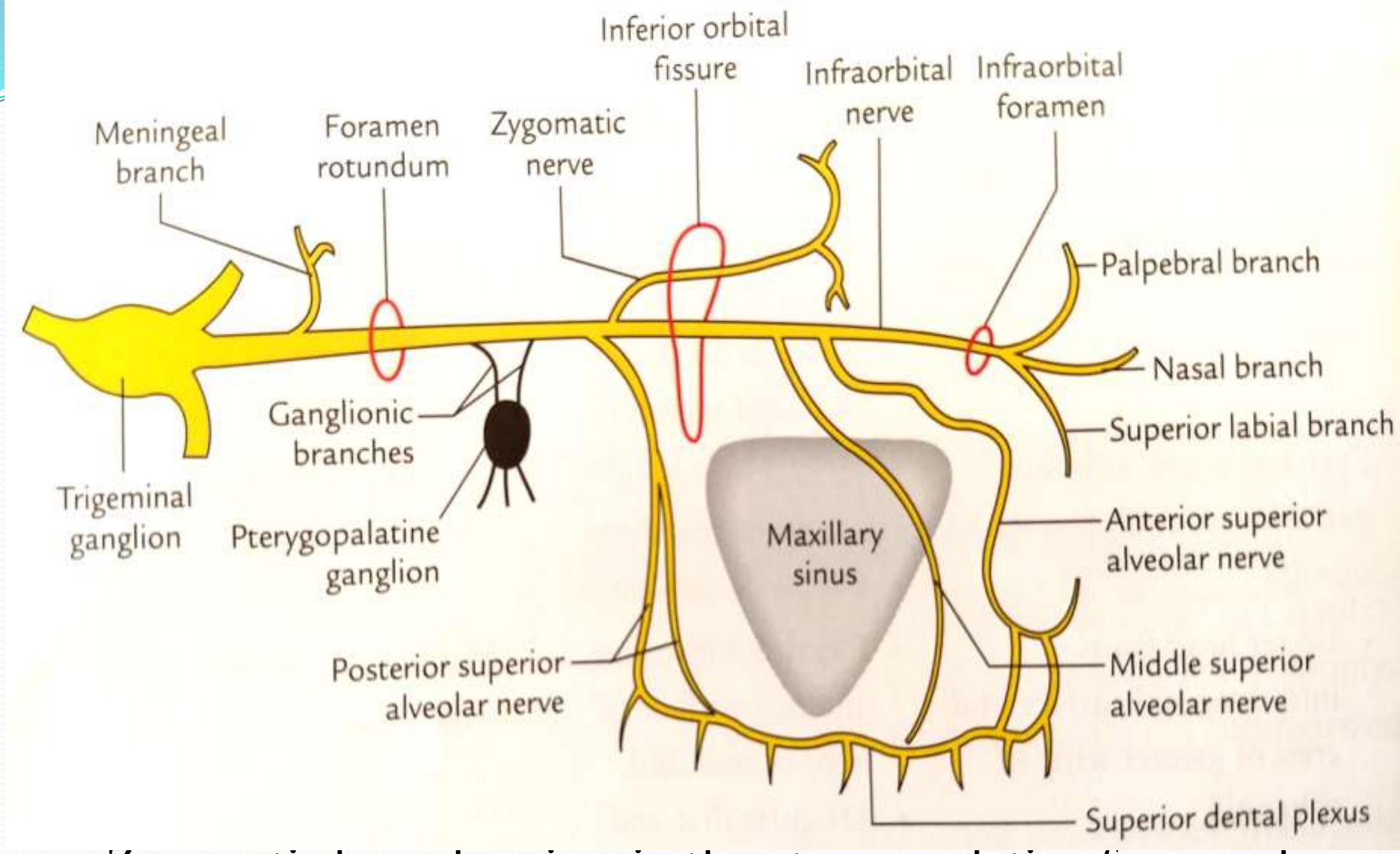

Maxillary nerve
Infraorbital nerve

Branches

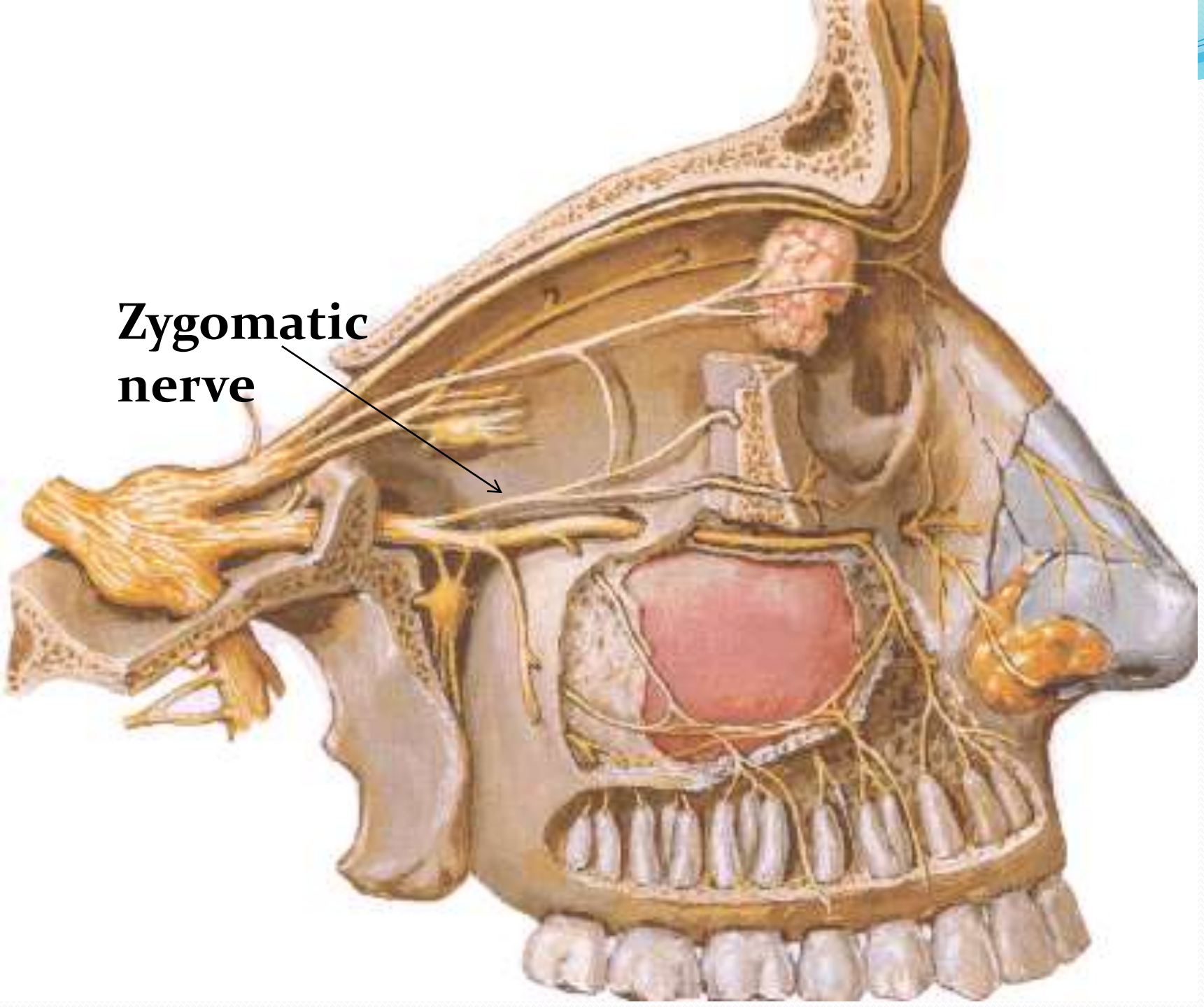
- From of maxillary nerve:

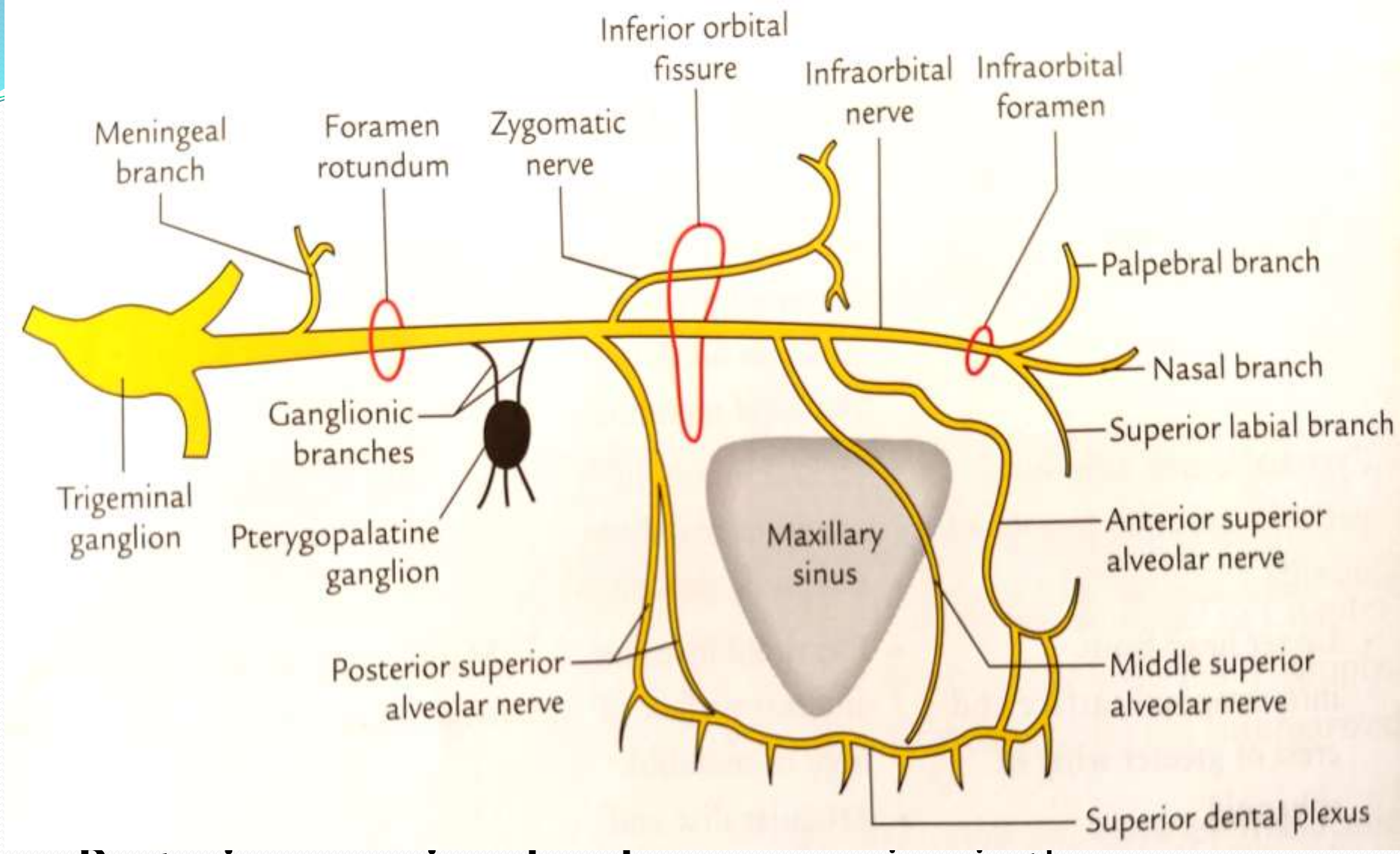
1. Meningeal branch: supplies the dura of the middle cranial fossa.
2. Two ganglionic branches: which hang the sphenopalatine ganglion, they contain sensory fibers coming from nose, palate and pharynx and postganglionic fibers going to the lacrimal gland.



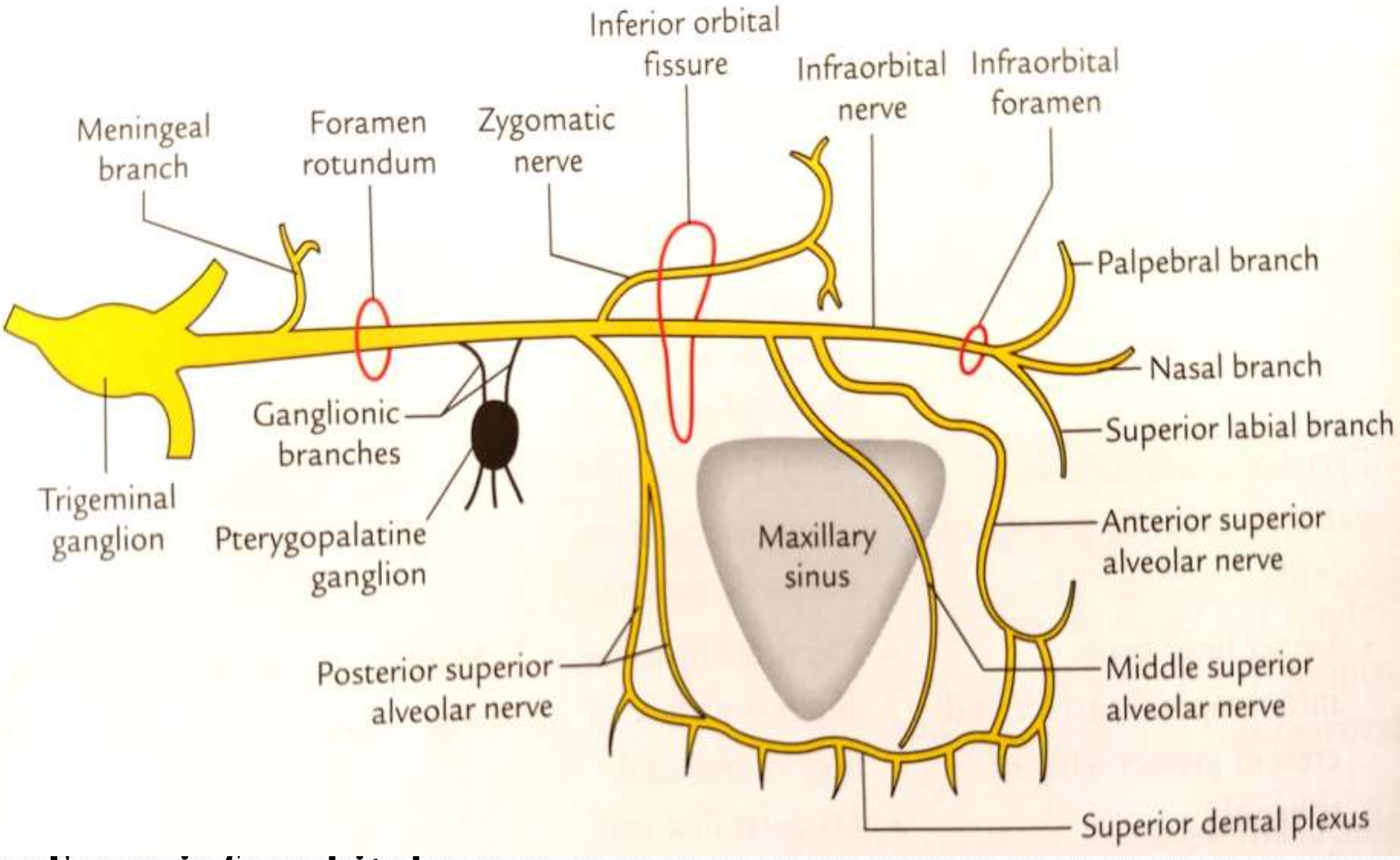


3. Zygomatic branch: arises in the pterygopalatine fossa and enters the orbit through the inferior orbital fissure. It divides into zygomatico-temporal and zygomatico-facial branches that supply skin of the face.


Zygomatic
nerve

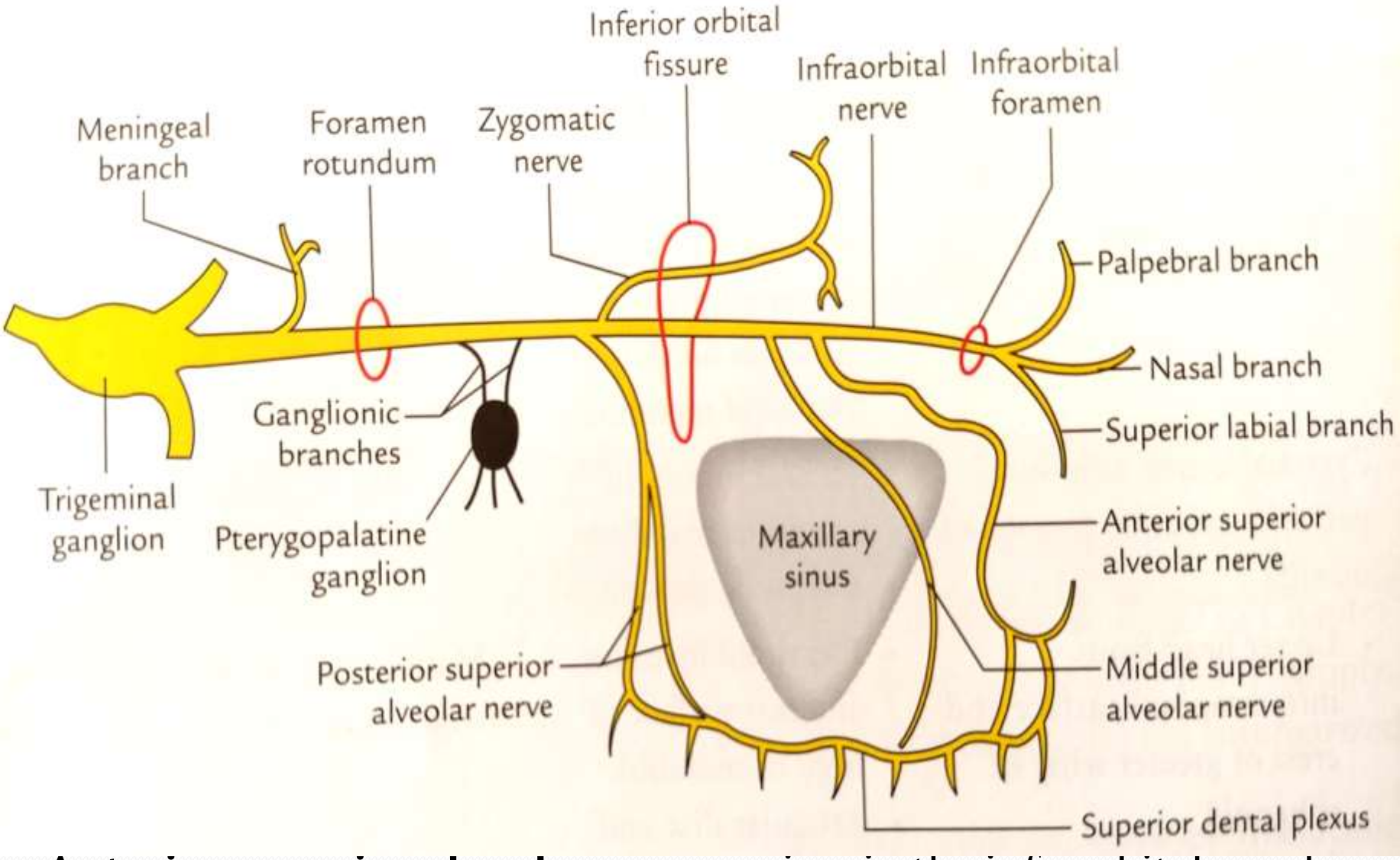


4. **Posterior superior alveolar nerve:** arises in the pterygopalatine fossa and pierces the posterior surface of the maxilla to supply the maxillary sinus, the upper molar teeth and adjoining parts of the gum and cheek

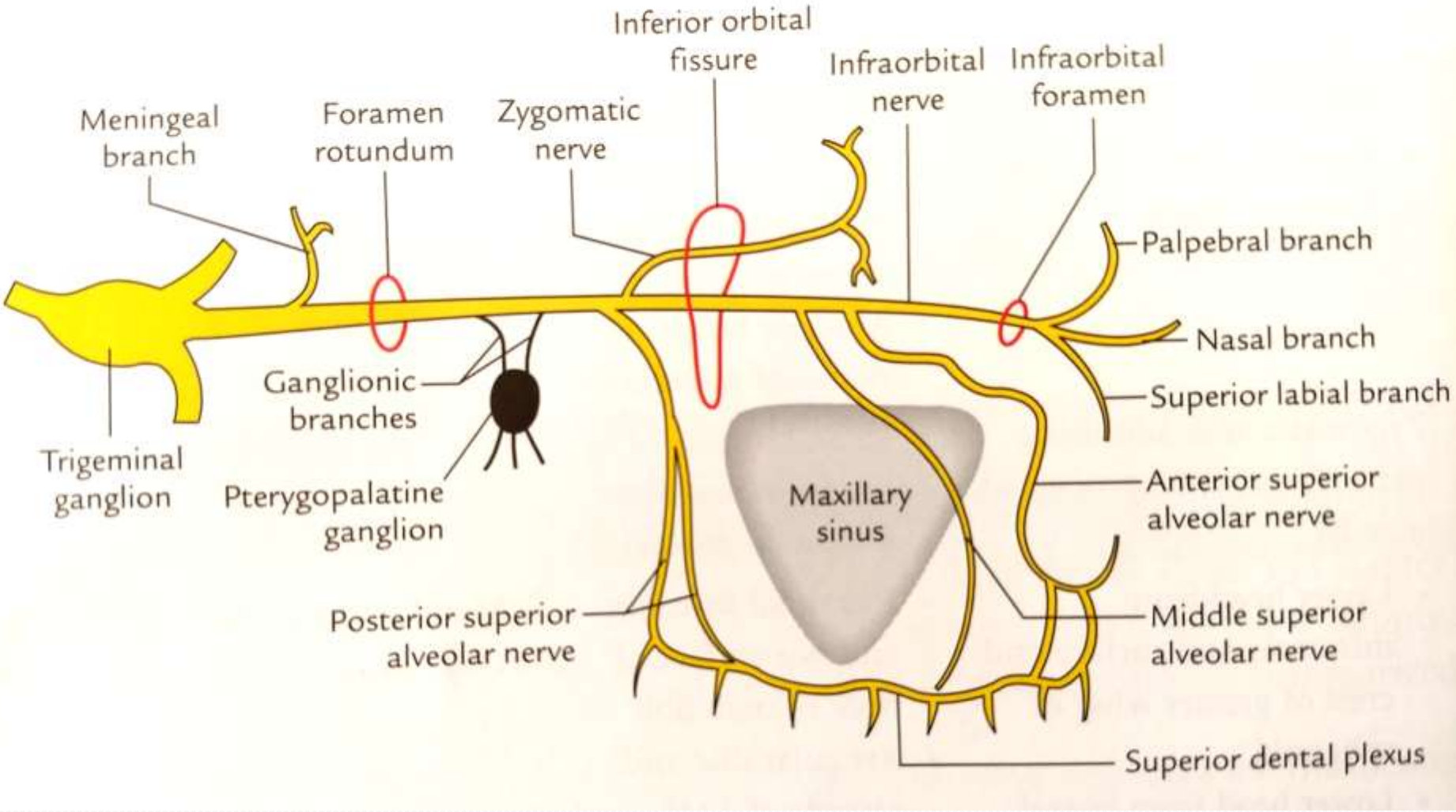


- **From infraorbital nerve:**

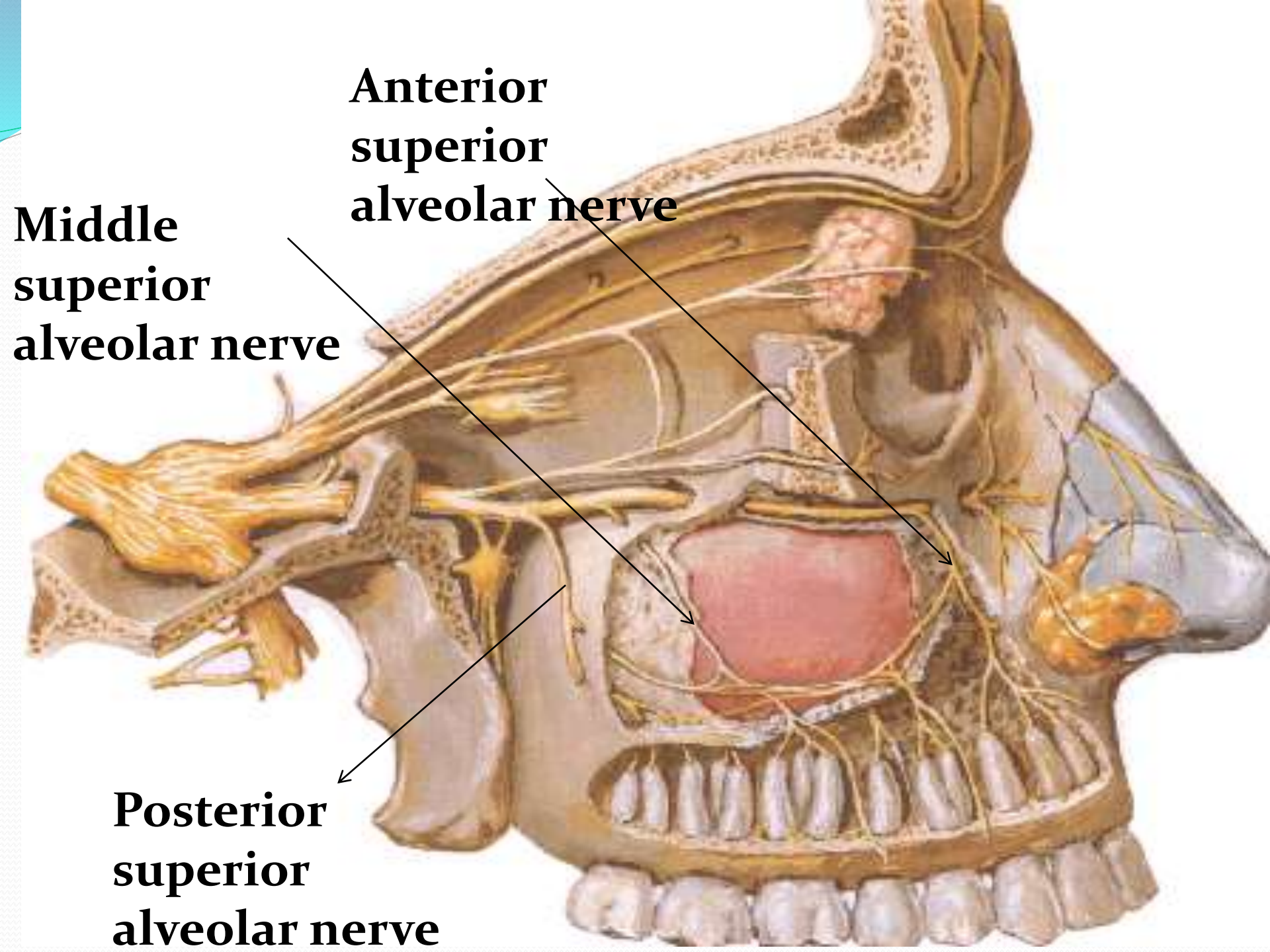
5. **Middle superior alveolar nerve:** arises in the infraorbital groove and descends on the lateral wall of the maxillary sinus to supply the upper premolar teeth and adjoining parts of the gum and cheek.



6. **Anterior superior alveolar nerve:** arises in the infraorbital canal and descends on the anterior wall of the maxillary sinus to supply the upper canine and incisor teeth and adjoining parts of the gum and a small part of the lateral wall and floor of the nasal cavity



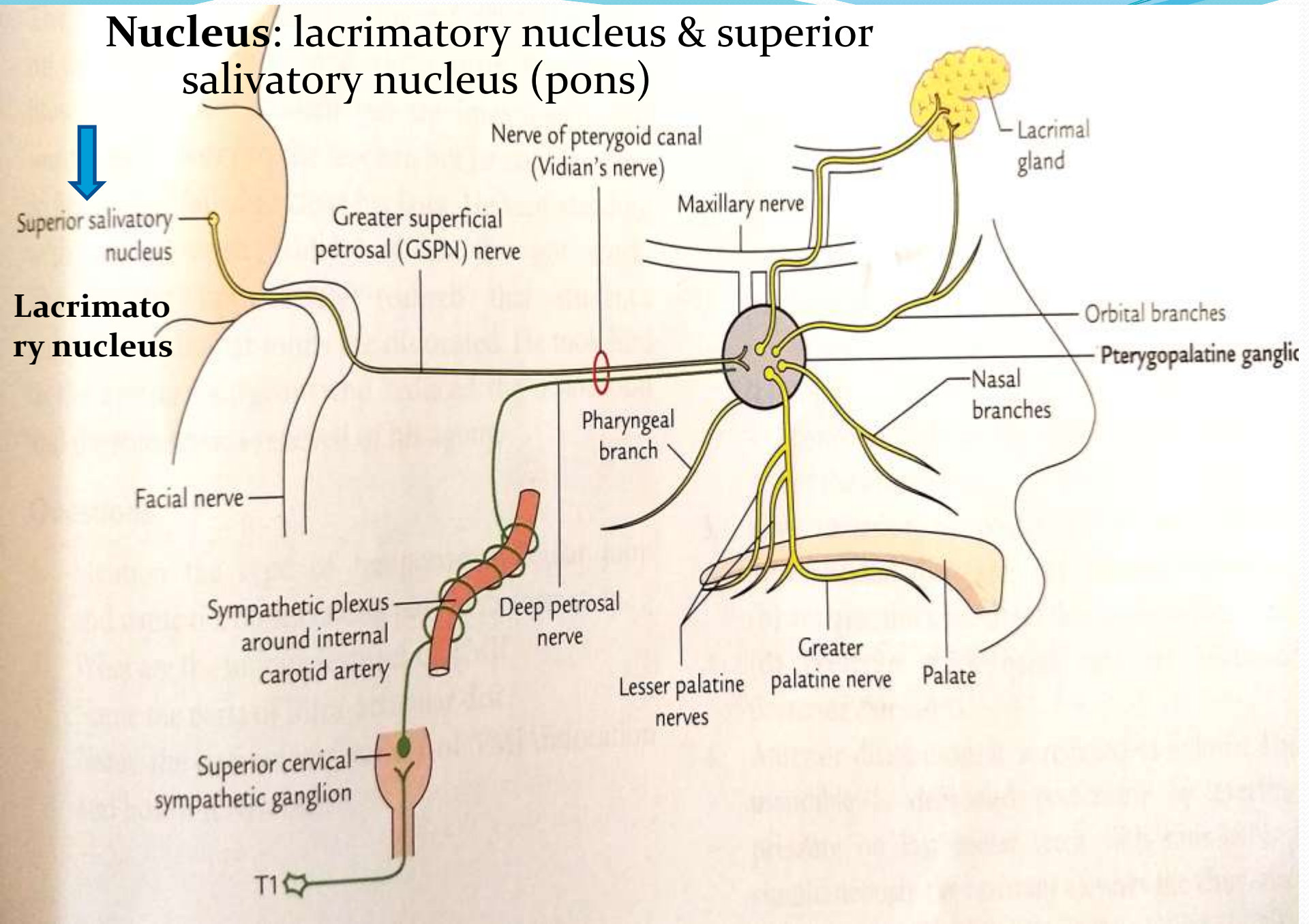
7. **Terminal Branches in the face:** after its exit through the infraorbital foramen it divides into palpebral, nasal and labial branches which supply skin of the face.


Anterior
superior
alveolar nerve
Middle
superior
alveolar nerve
Posterior
superior
alveolar nerve

Pterygopalatine ganglion(sphenopalatine) (Meckel's ganglion)

- Largest peripheral parasympathetic ganglion
- **Site:** in the pterygopalatine fossa, below maxillary nerve, connected to it by 2 ganglionic branches
- Topographically to Maxillary nerve(5^{th} CN)
- Functionally to Facial nerve
- To supply secretomotor fibres to lacrimal gland & glands of nose, palate, sinuses & pharynx (**Ganglion of hay fever**)
- **Running nose and eyes.**

Nucleus: lacrimatory nucleus & superior salivatory nucleus (pons)

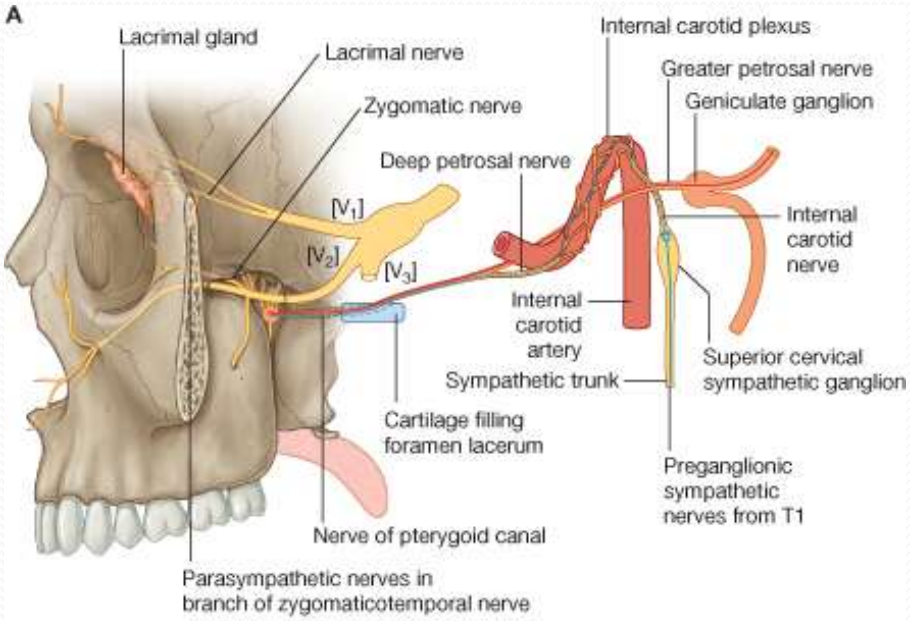


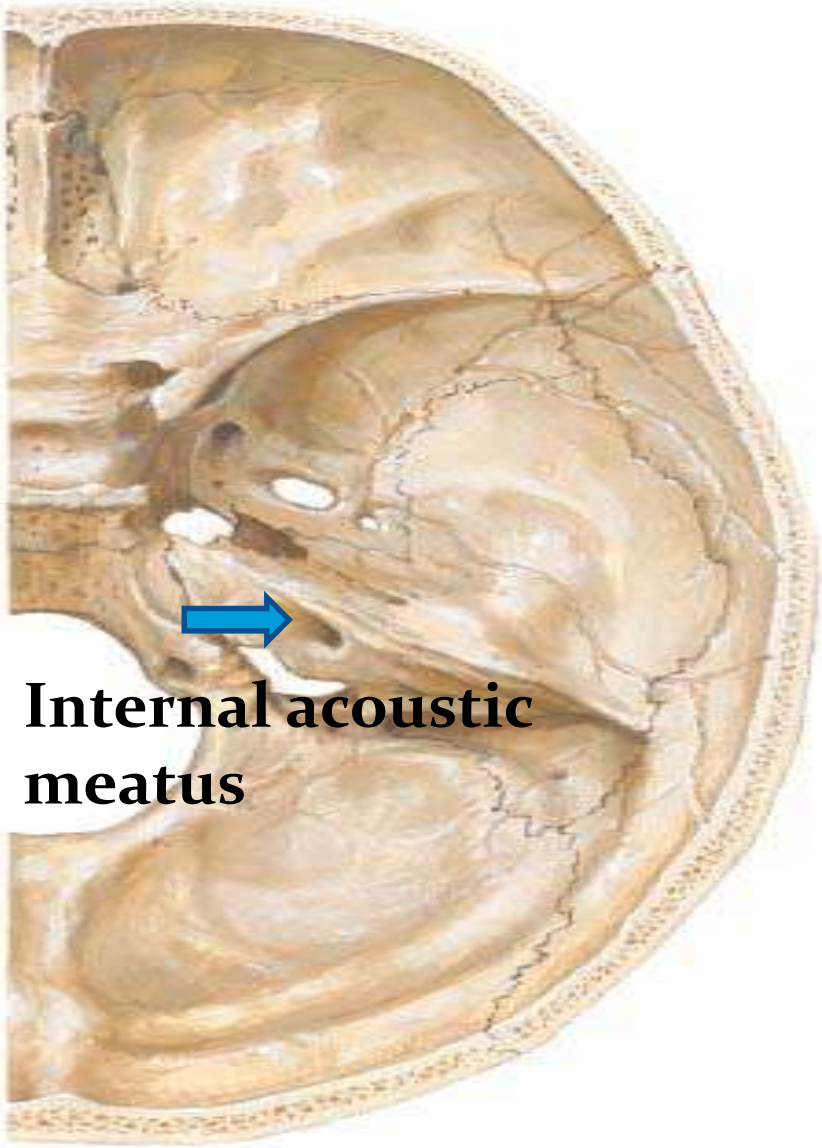
Pterygopalatine ganglion

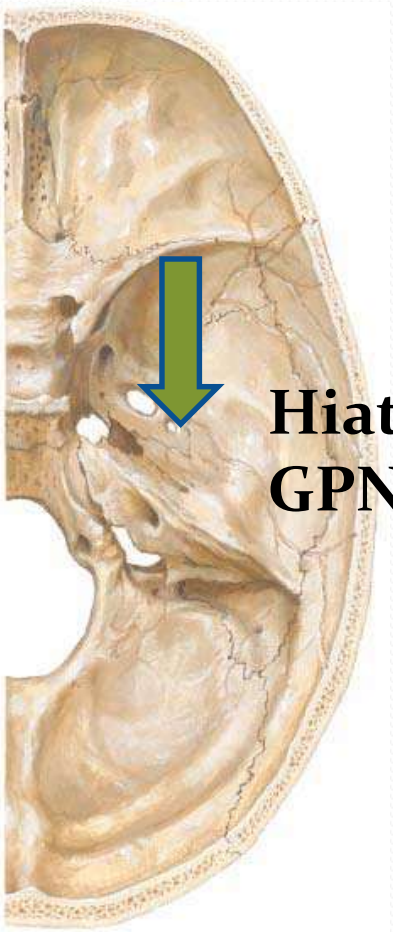
- **Parasympathetic root – nerve of pterygoid canal (greater petrosal nerve)**
- **Sympathetic root – Deep petrosal nerve**
- **Sensory root – Derived from maxillary nerve**
- **Preganglionic fibers**: along greater petrosal branch of facial nerve → joins deep petrosal (postganglionic sympathetic fibers) → both nerves form nerve to pterygoid canal → ganglion

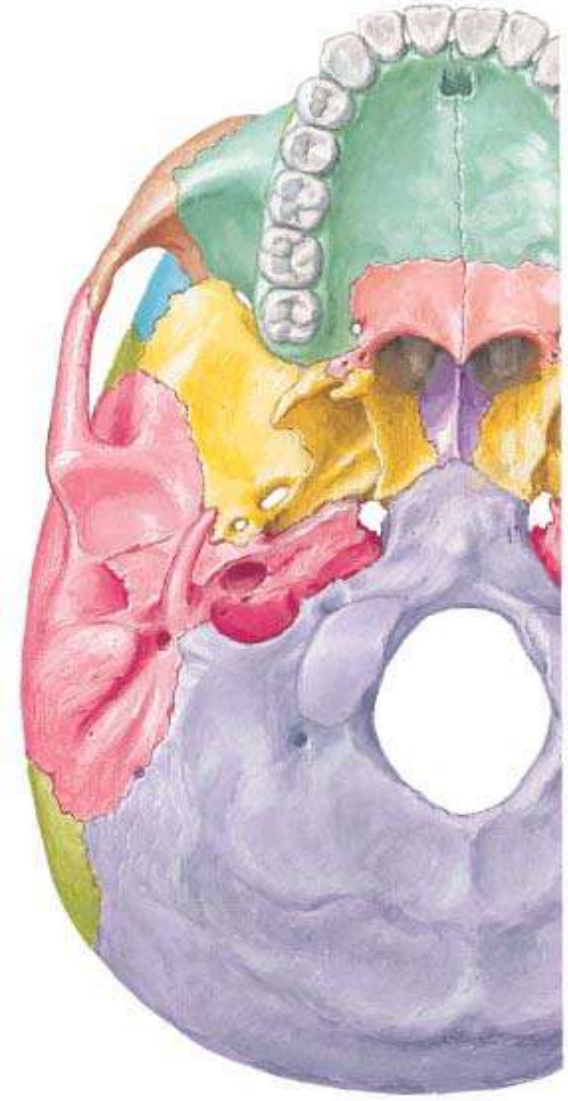
Nerve of the pterygoid canal

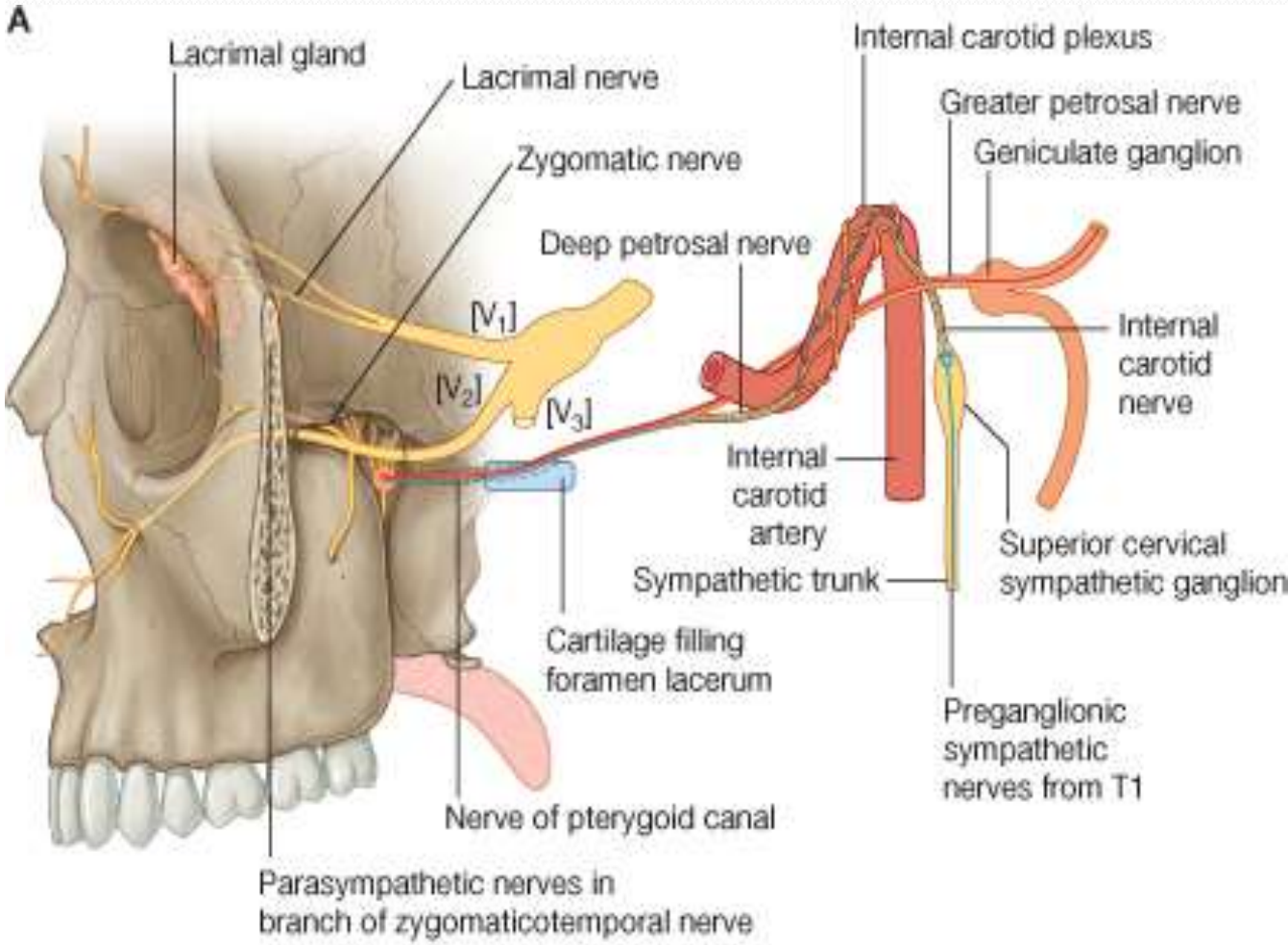
- Formed in the middle cranial fossa by the union of:
- 1. The greater petrosal nerve (a branch of the facial nerve [VII]);
- 2. The deep petrosal nerve (a branch of the internal carotid plexus).
- Joins the pterygopalatine ganglion
- Carries mainly **preganglionic parasympathetic** (great petrosal) and **postganglionic sympathetic** (deep petrosal) fibers.

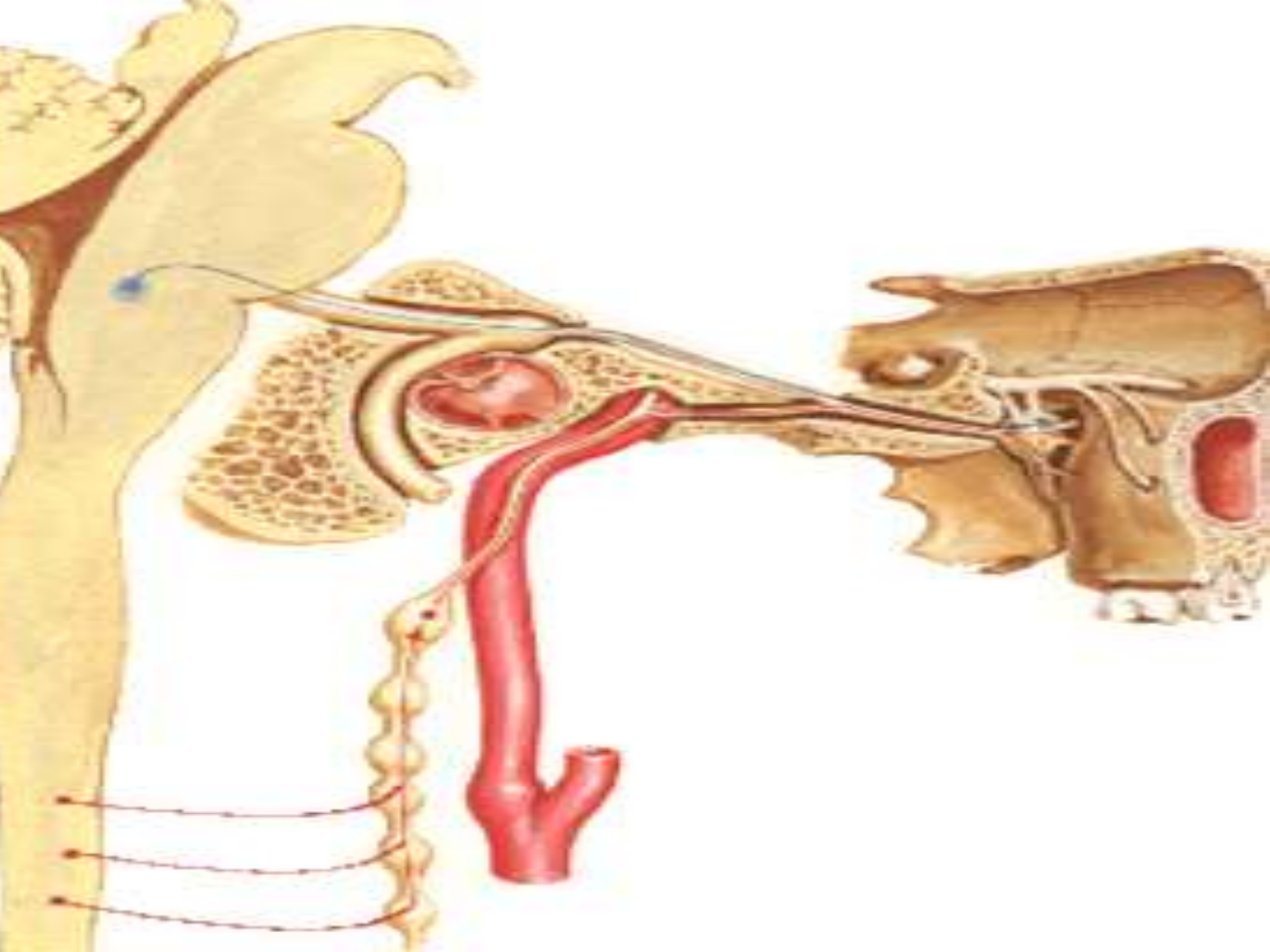



Internal acoustic meatus

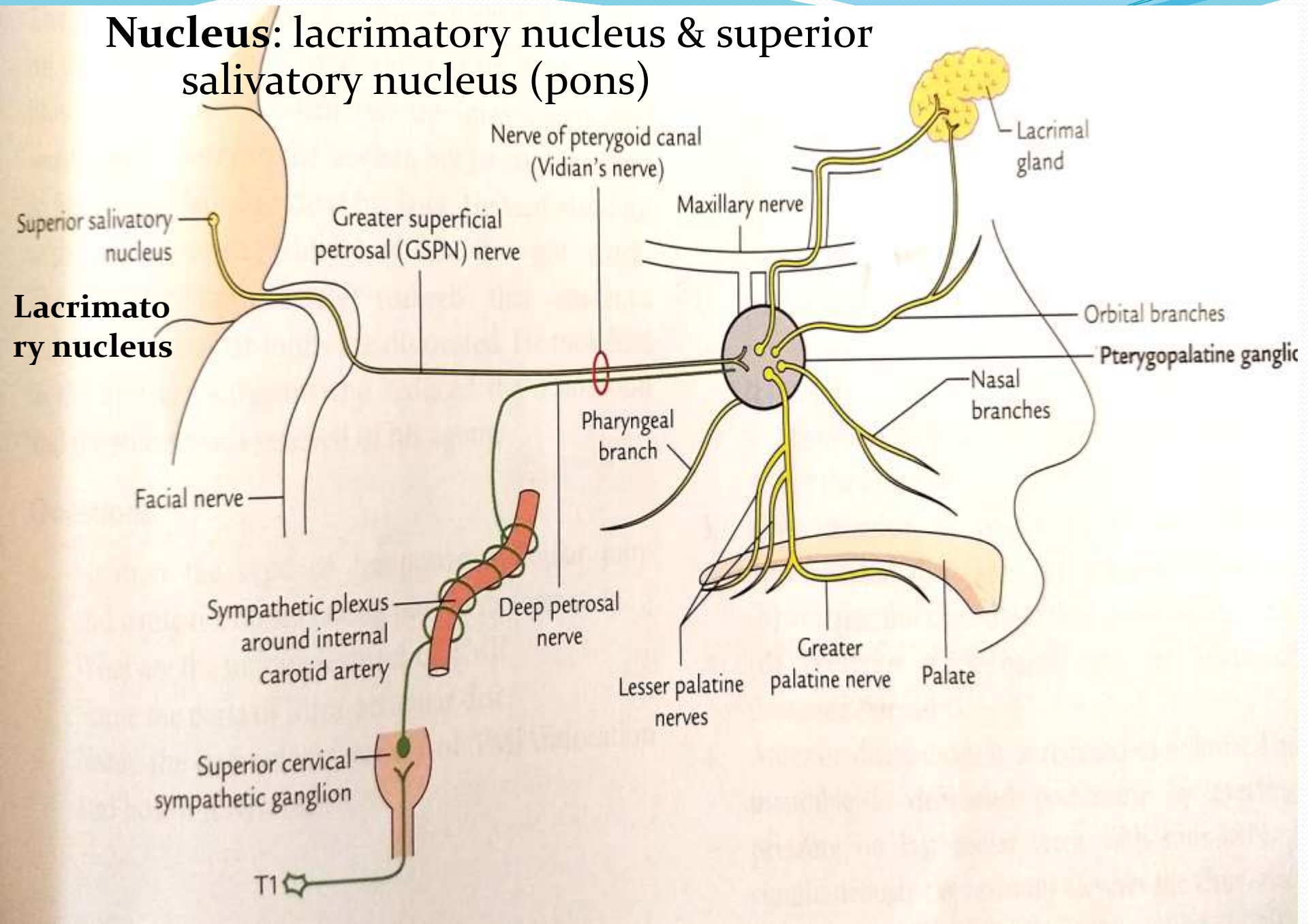

Hiatus for GPN & LPN







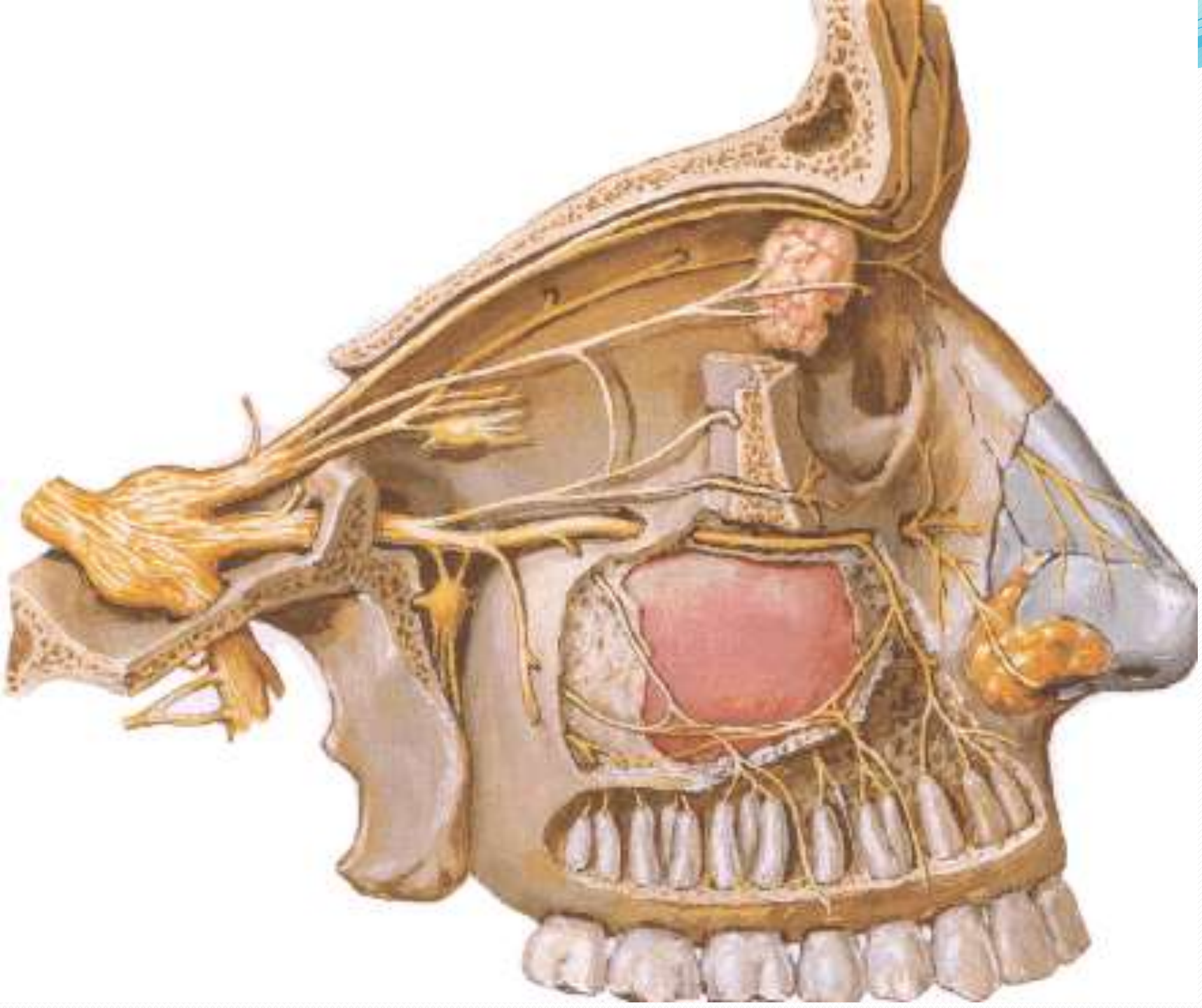
Nucleus: lacrimatory nucleus & superior salivatory nucleus (pons)



Pterygopalatine ganglion

- **Postganglionic fibers:**

1. Along ganglionic branches → maxillary nerve → zygomatic branch of maxillary nerve → zygomaticotemporal nerve → lacrimal nerve → lacrimal gland
2. Along greater & lesser palatine branches → palatine glands
3. Along nasal branches → nasal glands
4. Along pharyngeal branch – Pharyngeal glands

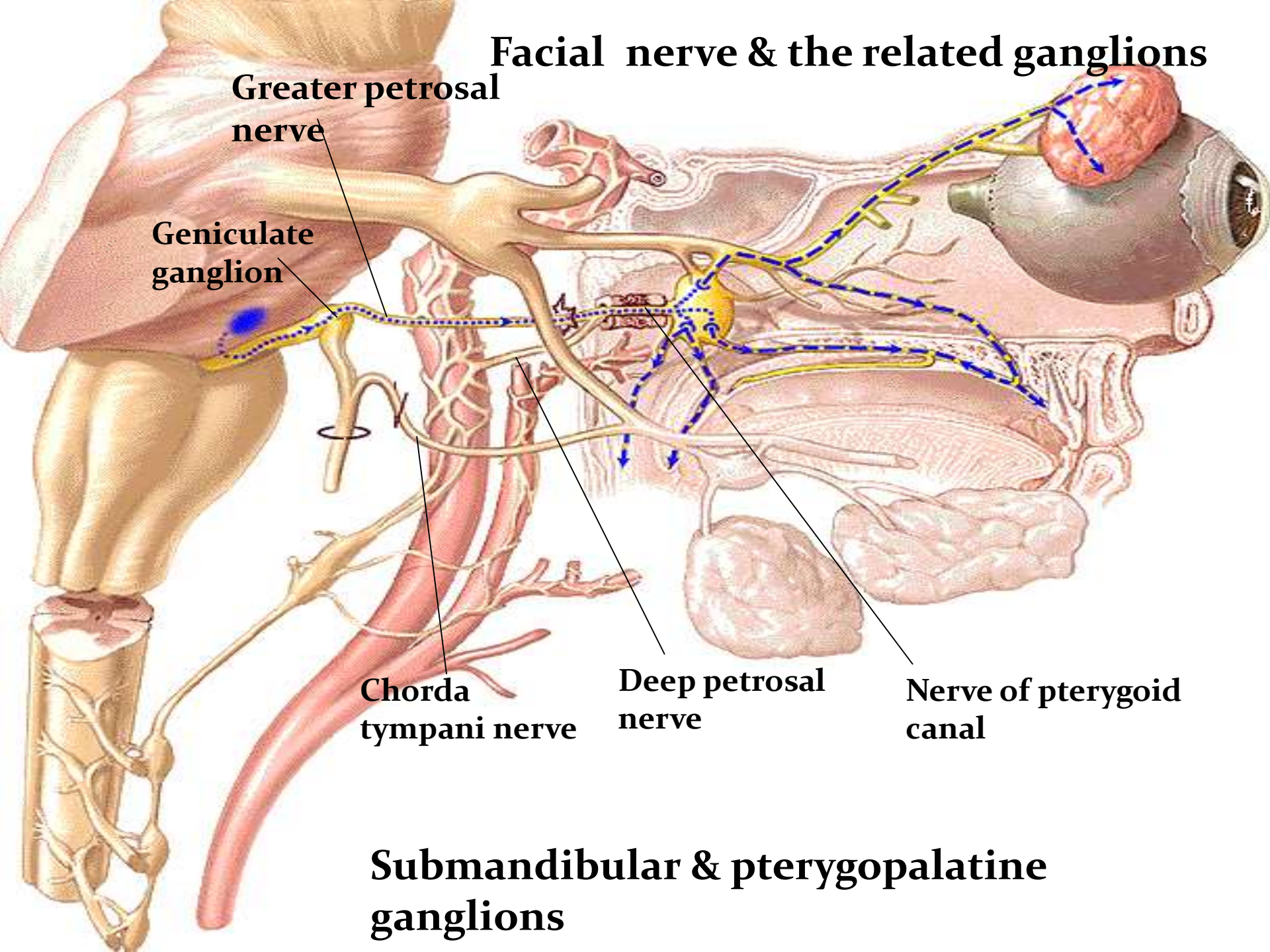


Pterygopalatine ganglion

N.B.:

- Taste fibers from soft palate pass along lesser palatine nerve → ganglion (without relay) → nerve to pterygoid canal → greater petrosal nerve
- Sensory fibers from nose, palate & pharynx pass along nasal, palatine & pharyngeal branches of ganglion → ganglion (without relay) → ganglionic branches → maxillary nerve
- Sympathetic fibers from deep petrosal nerve → ganglion (without relay) → orbital branches → orbitalis muscle

Facial nerve & the related ganglions

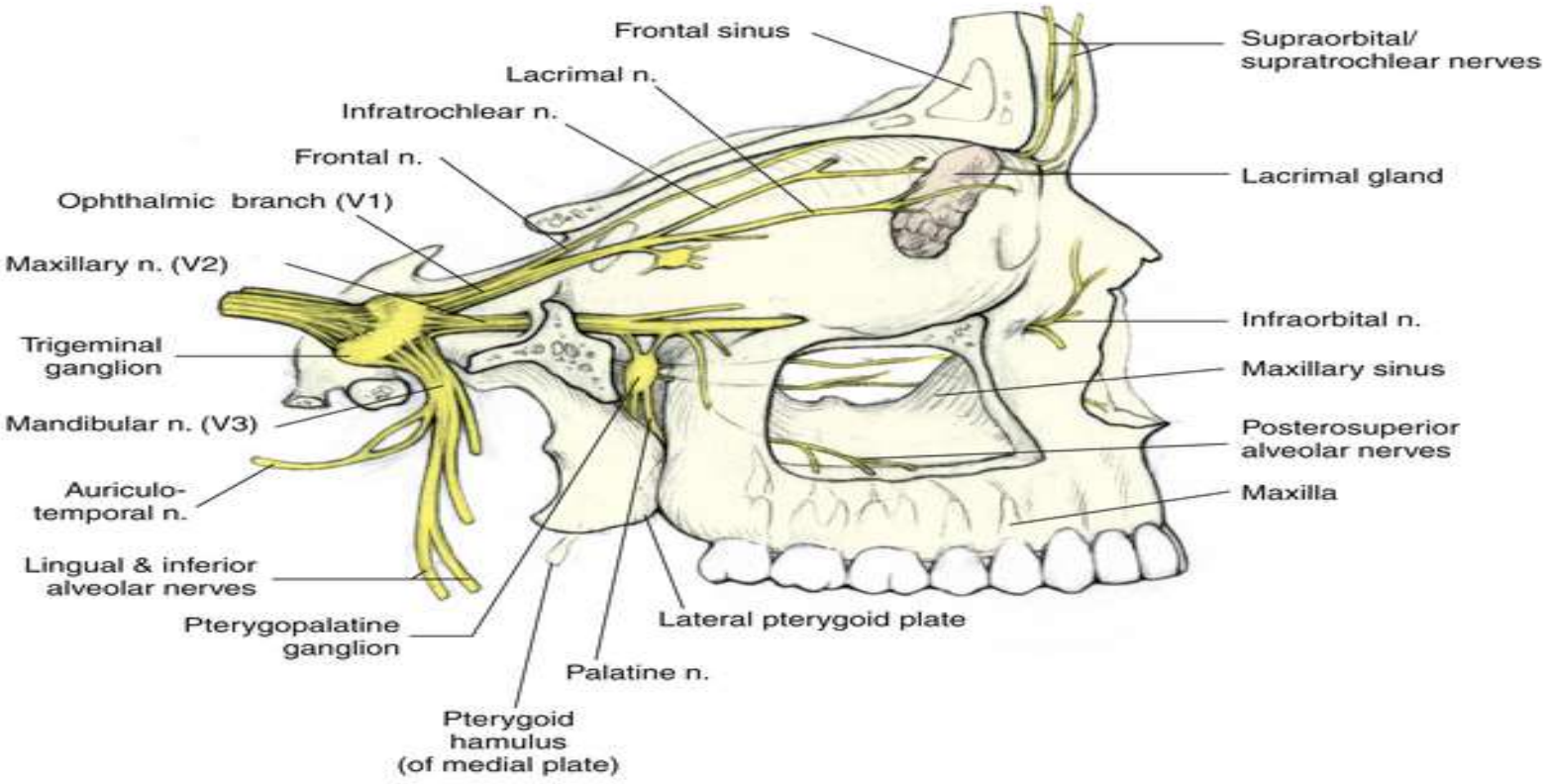


Submandibular & pterygopalatine ganglions

- Branches from the pterygopalatine ganglion :

1. **Orbital nerve**

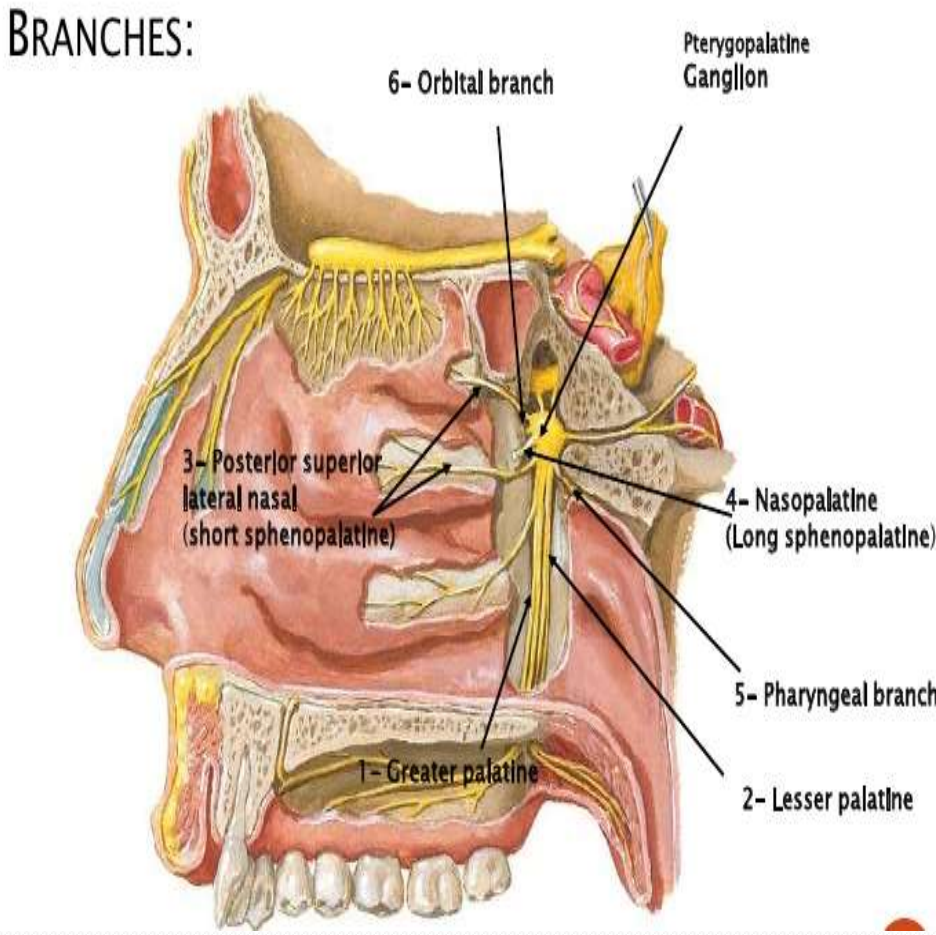
- This passes from the pterygopalatine ganglion into the orbit through the inferior orbital fissure. It supplies periosteum and , via sympathetic fibers , the orbitalis muscle. The orbital nerve also supply part of the maxillary sinus and ethmoidal air cells and the sphenoid air sinus.



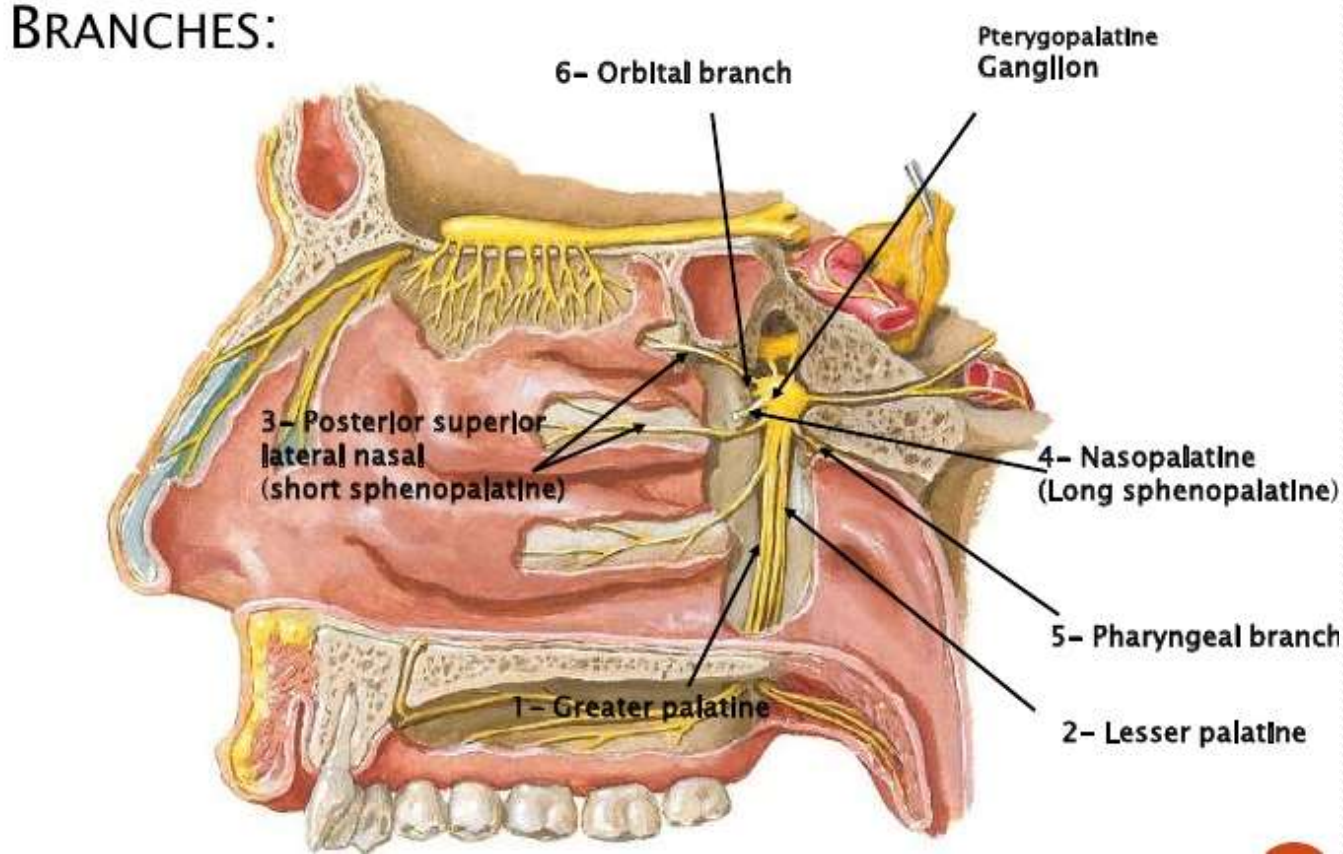
- Nasal branches
- Pass through Sphenopalatine foramen
- Divide into posterior superior Lateral nasal &

  posterior superior medial nasal branches

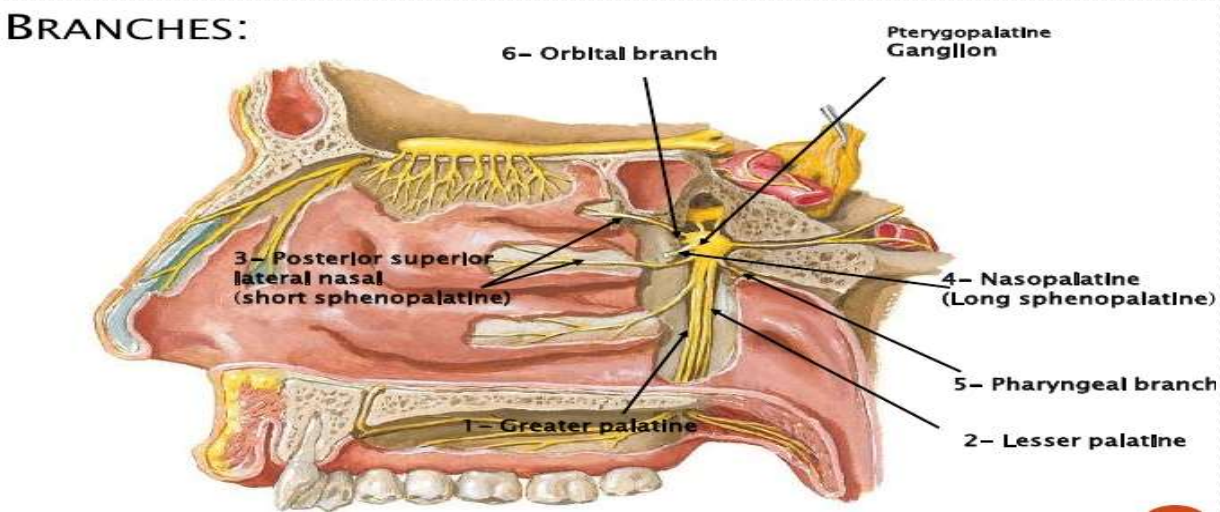
One of the medial branch is long – Nasopalatine nerve



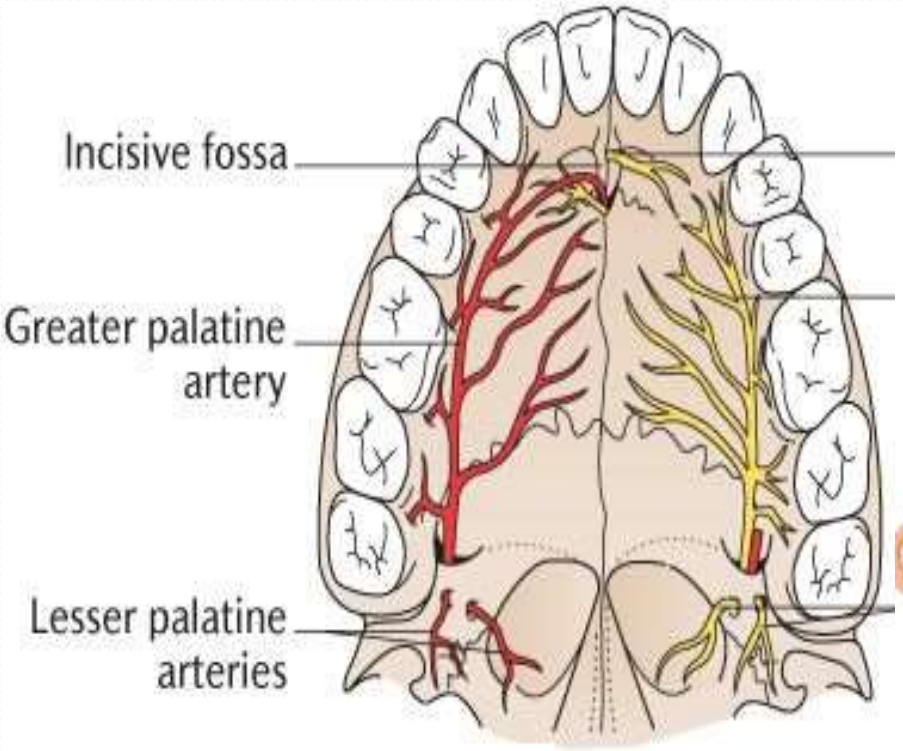
- **The Posterior superior nasal nerve**
- This nerve enters the back of the nasal cavity through the sphenopalatine foramen. It divides into lateral and medial branches.
- The lateral branches supply the posterosuperior part of the lateral wall of the nasal fossa . the medial branches cross the roof of the nasal cavity to supply the nasal septum overlying the posterior part of the perpendicular plate of the ethmoid .

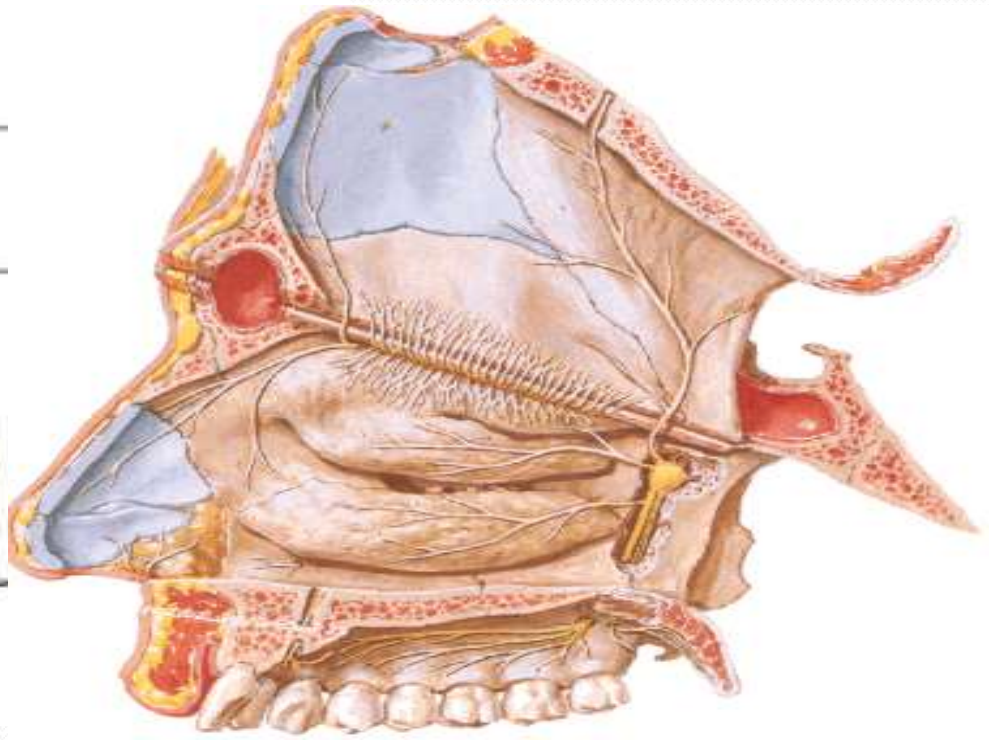


- **. The nasopalatine nerve**
- This nerve runs medially from the pterygopalatine ganglion into the nasal cavity through the sphenopalatine foramen. It passes the roof of the nasal cavity to reach the back of the nasal septum. The nasopalatine nerve then passes downwards and forwards within a groove on the vomer to supply the **posteroinferior part of the nasal septum**. It passes through the incisive canal , where it usually forms a single nerve with its fellow of the opposite side, and emerges on the hard palate at the incisive fossa to supply the oral mucosa around the incisive papilla and palatal gingiva of the anterior teeth.

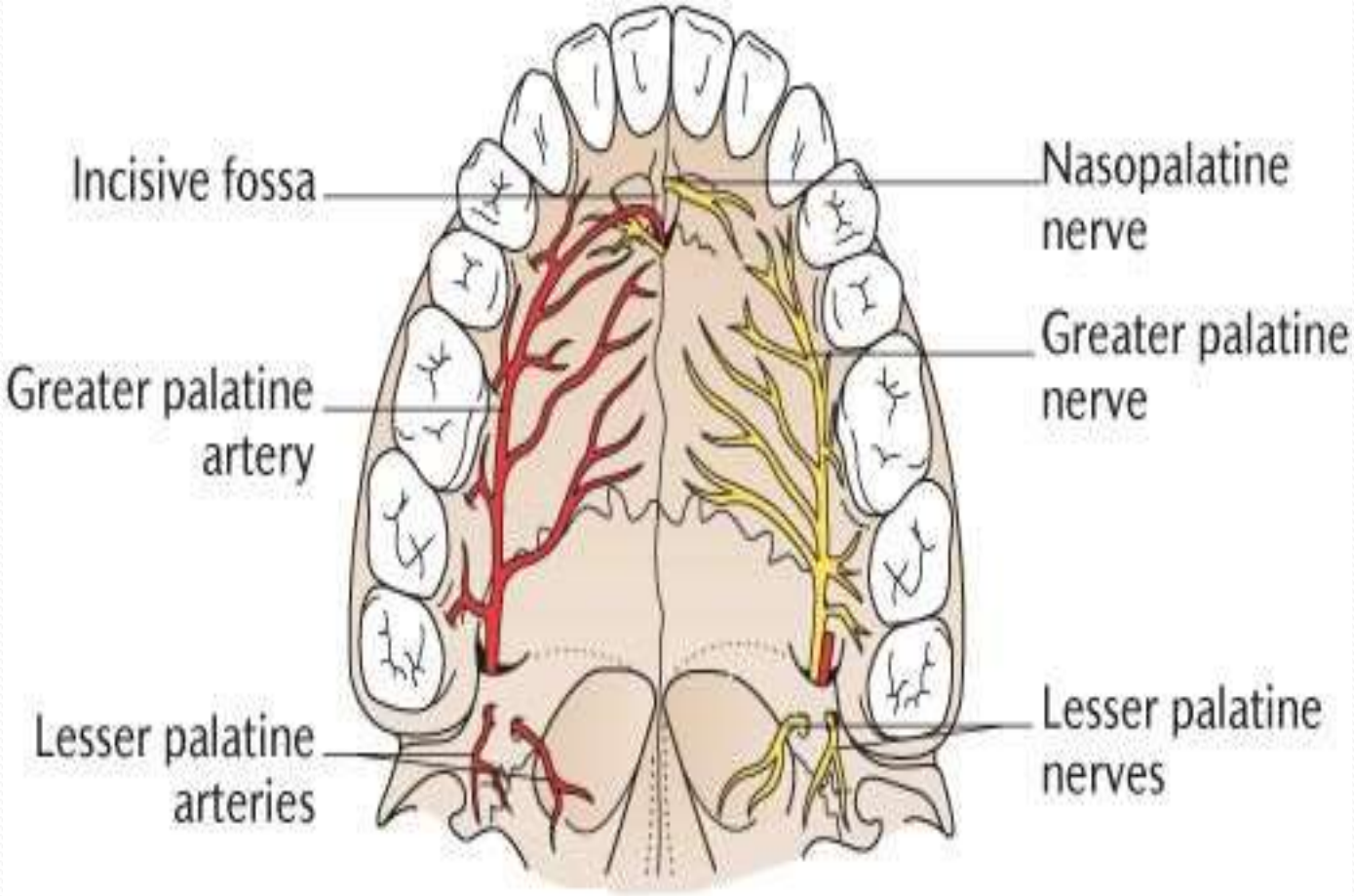


- **The greater (anterior) palatine nerve**
- This nerve passes downwards from the pterygopalatine ganglion, through the palatine canal, and onto the hard palate at the palatine foramen. On the palate, it runs forwards at the interface between the palatine process and the alveolar process of the maxilla to supply much of the mucosa of the hard palate and palatal gingivae (except around the incisive papilla).



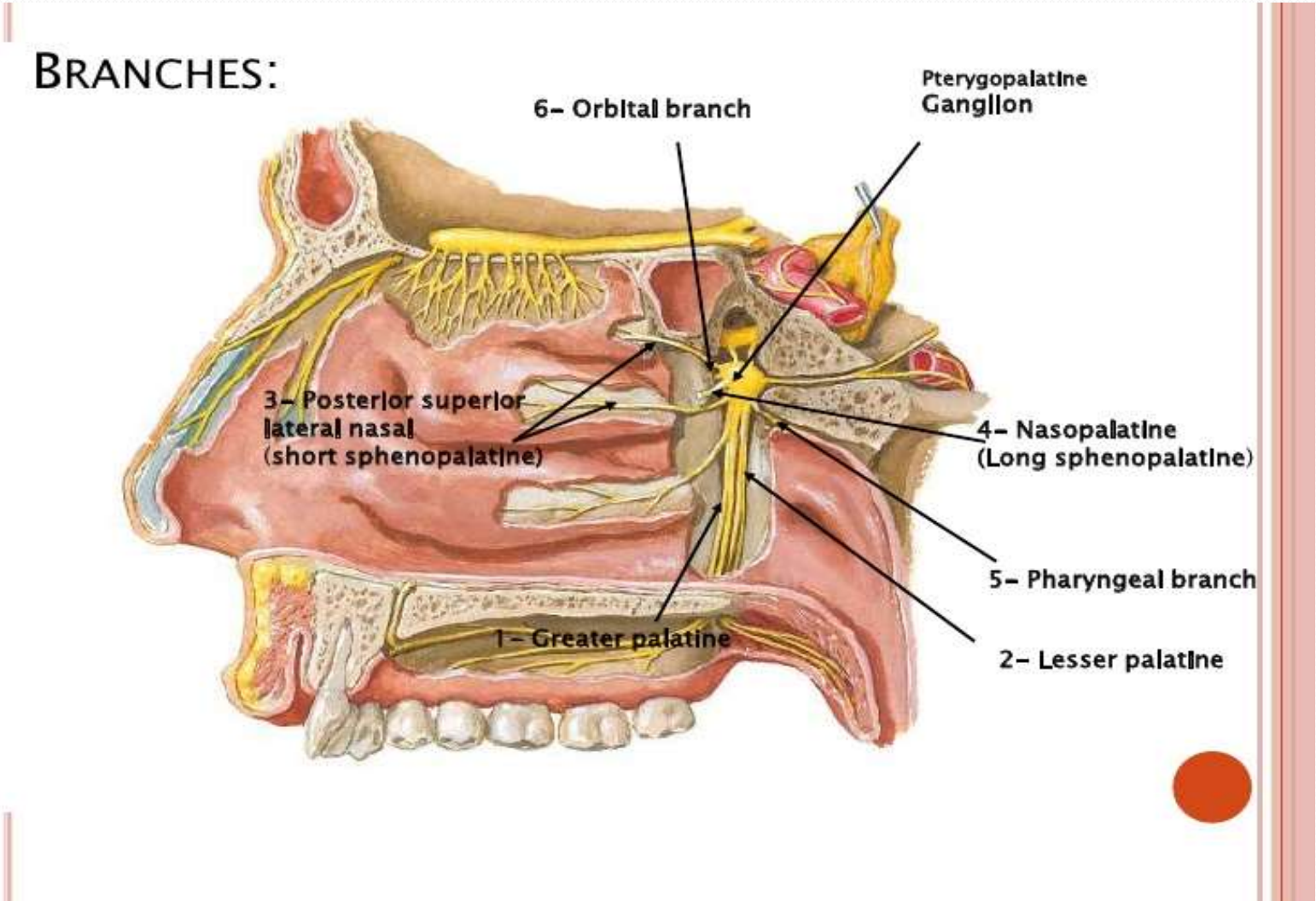


- **The lesser (posterior) palatine nerve (s)**
- This passes downwards from the pterygopalatine ganglion initially through the palatine canal . it then passes through the lesser palatine canal in the pyramidal process of the palatine bone and onto the palate at the lesser palatine foramen (or foramina). It runs backwards to supply the soft palate



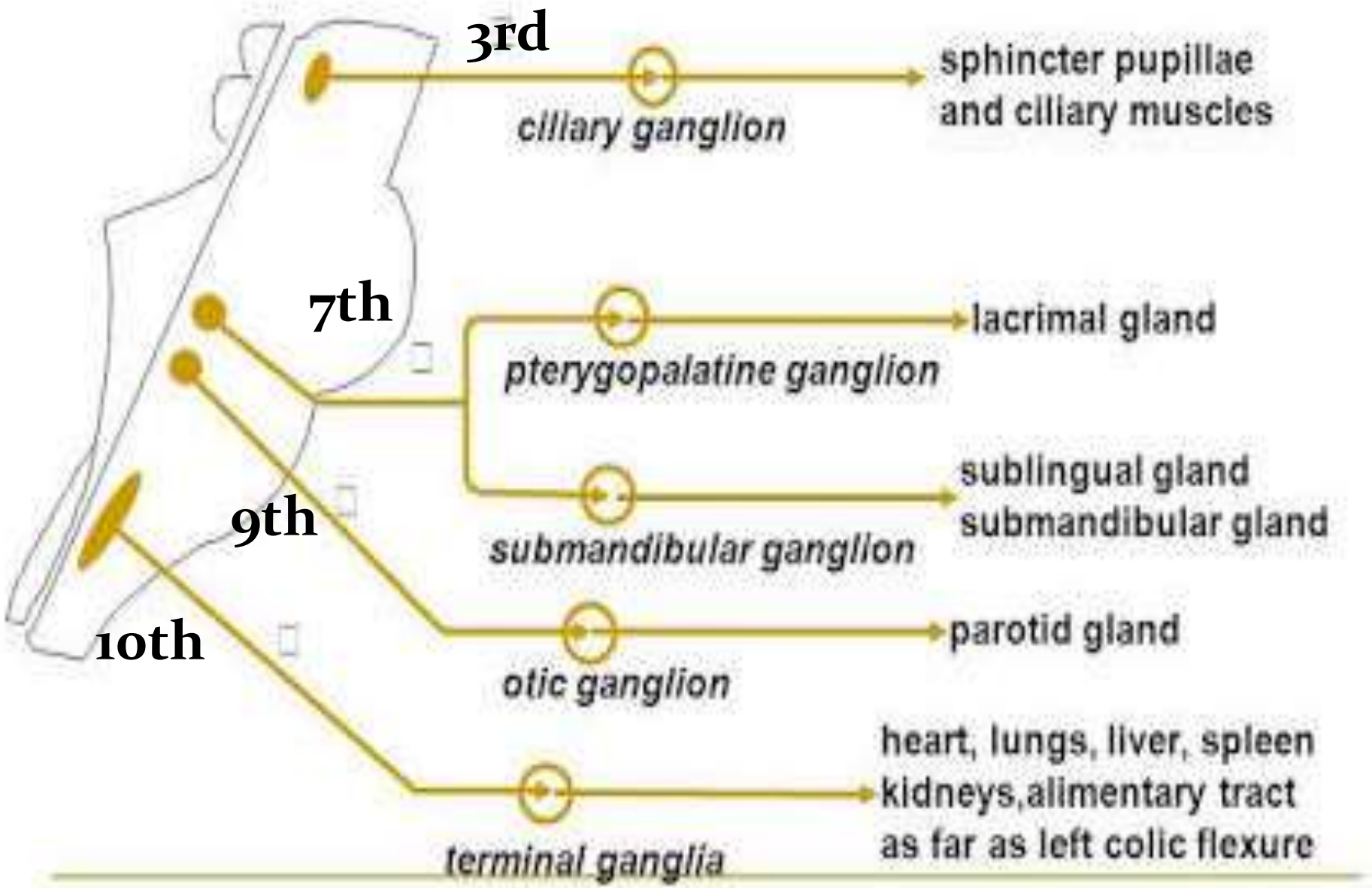
The pharyngeal branch

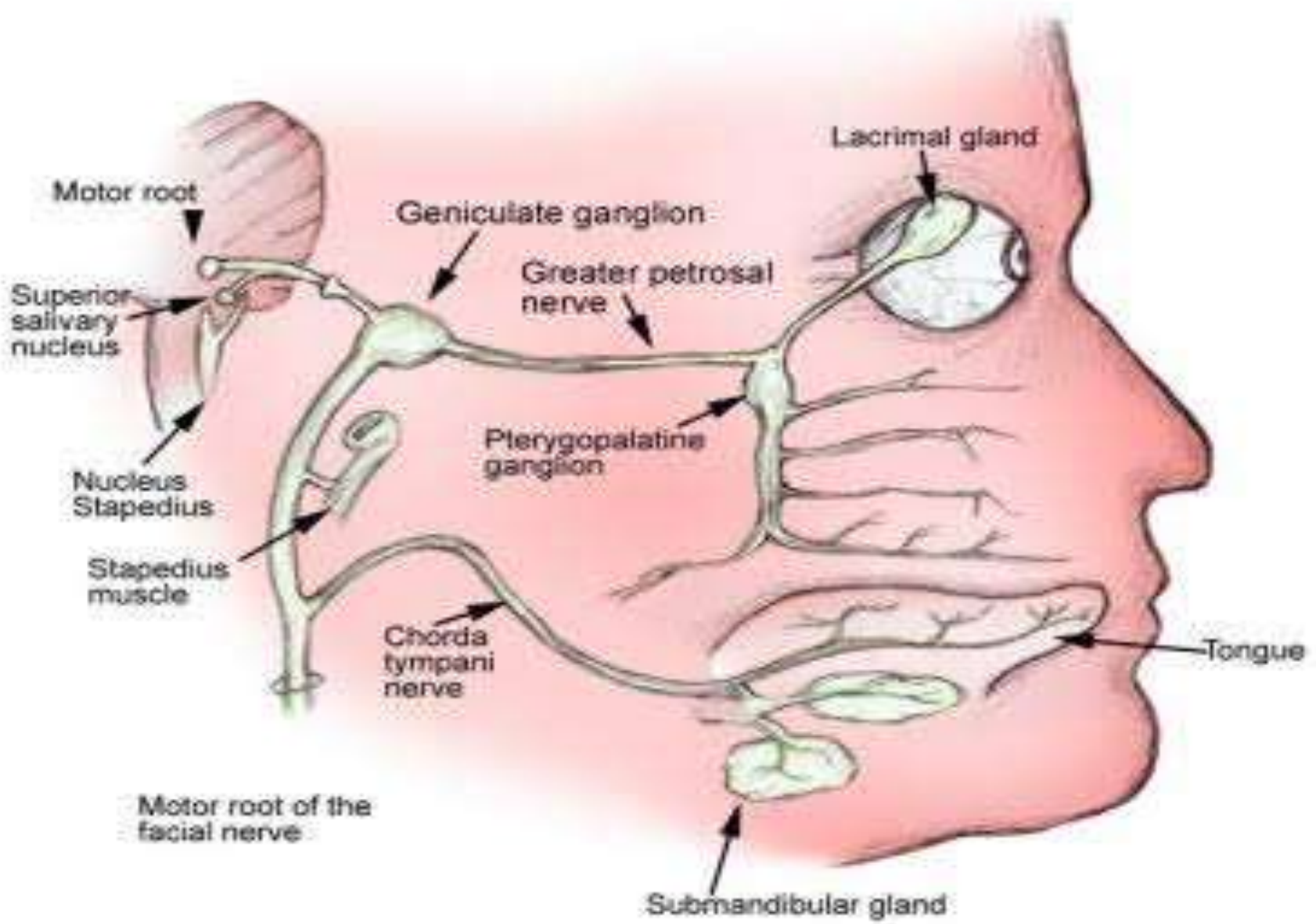
- This originates from the pterygopalatine ganglion and passes through the palatovaginal canal to supply the mucosa of the nasopharynx.



The four parasympathetic ganglia are related anatomically to the trigeminal nerve, but functionally are related to another cranial nerve, they are:

Ganglion	*Branch of trigeminal related to it*	*Motor root (parasympathetic root)of ganglion*
Ciliary	**nasociliary**	**Oculomotor(Nerve to inferior oblique)**
Sphenopalatine	**maxillary**	**Greater petrosal nerve of facial**
Otic ganglion	**mandibular**	**Lesser petrosal nerve (glossopharyngeal nerve)**
Submandibular	**lingual**	**Chorda tympani of facial**


3rd
ciliary ganglion
sphincter pupillae
and ciliary muscles
7th
pterygopalatine ganglion
lacrimal gland
sublingual gland
submandibular gland
9th
submandibular ganglion
parotid gland
otic ganglion
10th
heart, lungs, liver, spleen
kidneys,alimentary tract
as far as left colic flexure
terminal ganglia

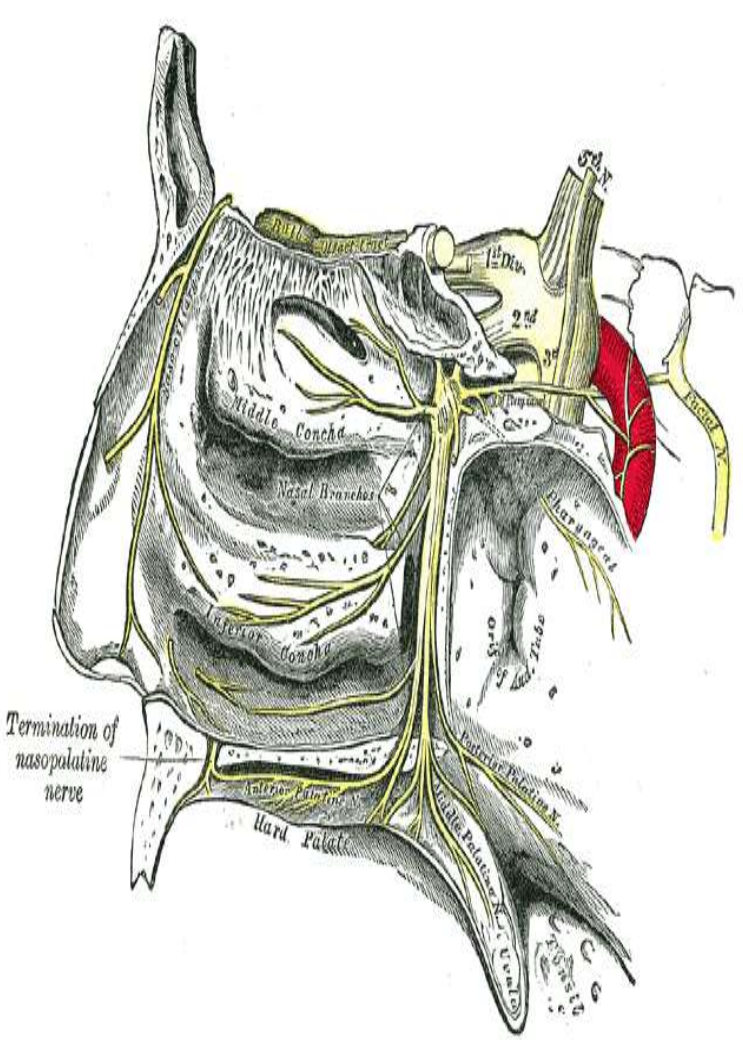

Lacrimal gland
Motor root
Geniculate ganglion
Greater petrosal nerve
Superior salivary nucleus
Pterygopalatine ganglion
Nucleus Stapedius
Stapedius muscle
Chorda tympani nerve
Tongue
Motor root of the facial nerve
Submandibular gland

Orbital branches

- Pass through the inferior orbital fissure
- Supply of the orbital wall (periosteum) and lacrimal gland
- Supply the sphenoidal and ethmoidal sinuses.

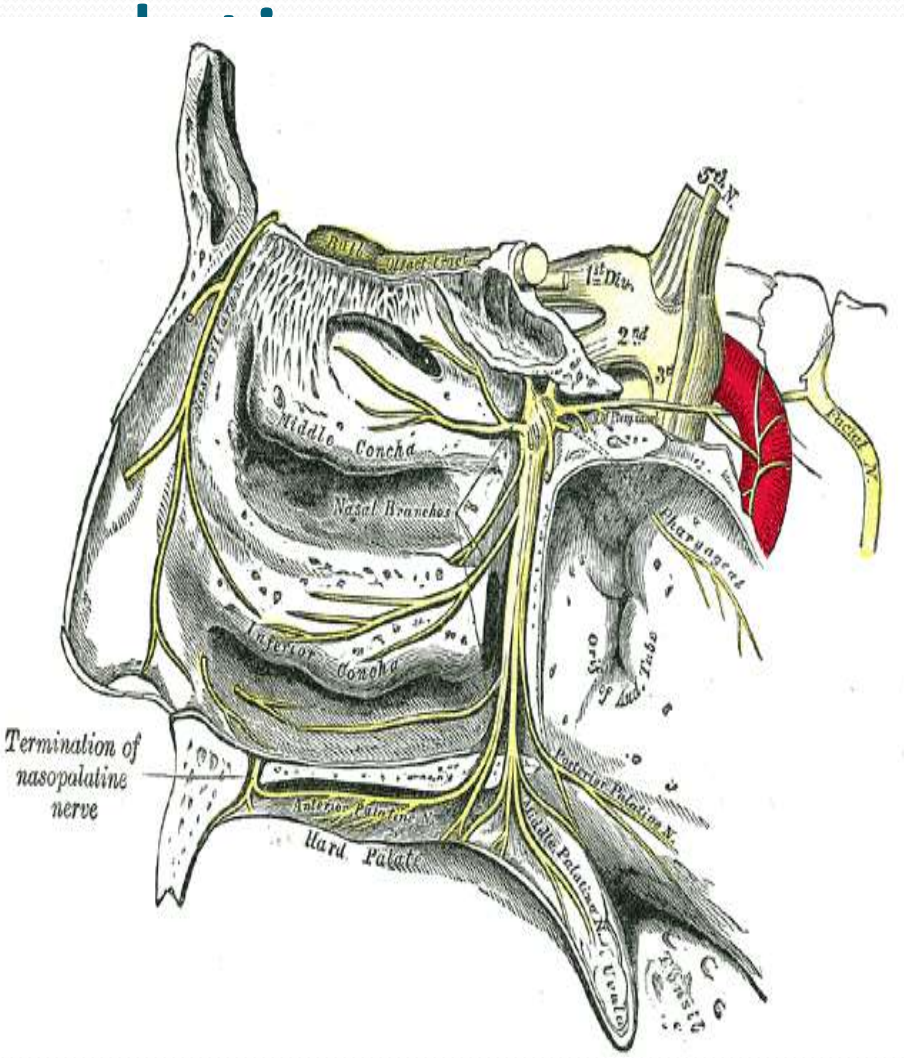
Pharyngeal nerve

- Passes posteriorly from the pterygopalatine ganglion
- Leaves the fossa through the palatovaginal canal
- Supply the mucosa and glands of the nasopharynx.



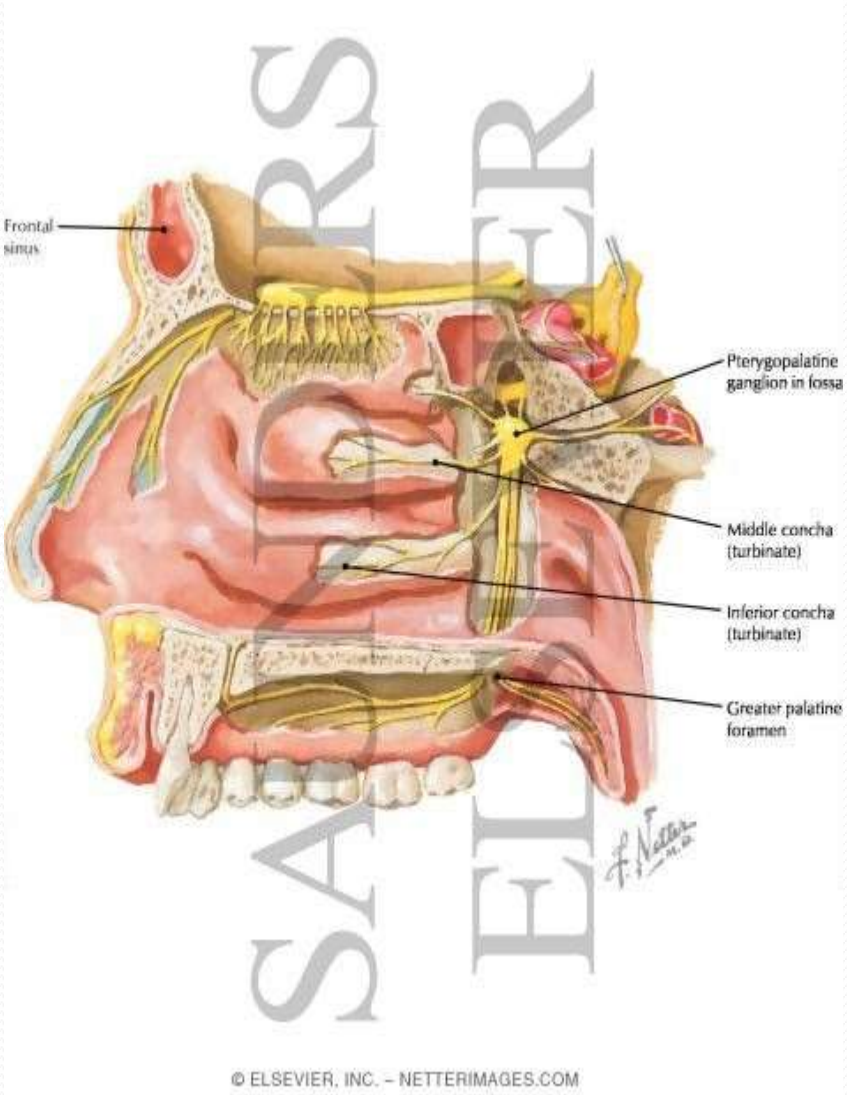
Greater and lesser

- Pass through the palatine canal
- Enter the oral surface of the palate through the greater and lesser palatine foramina.
- **Lesser palatine (Middle, Post, palatine)** nerve passes posteriorly to supply the soft palate.



Greater and lesser palatine nerves

- **The Greater palatine (Ant.palatine)** nerve passes forward on the roof of the oral cavity
- Innervate mucosa and glands of the hard palate and the adjacent gingiva, almost as far forward as the incisor teeth
- Also supply the mucosa over the middle and lower part of the lateral wall of the nasal cavity
- Joins the long sphenopalatine nerve

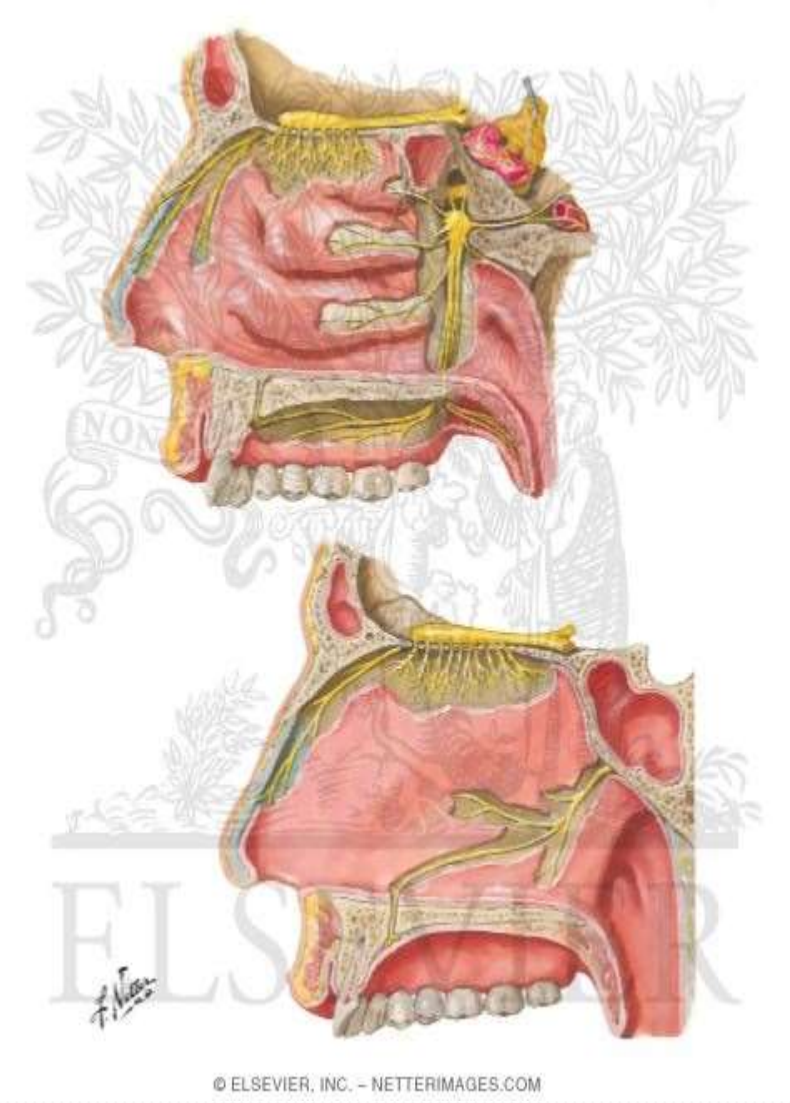


Nasal nerves

- Seven in number
- Pass medially through the sphenopalatine foramen to enter the nasal cavity

- **Short spheno-palatine** (Post.Sup. Lateral nasal) supply the mucosa of the Post,Sup. quadrant of the nasal cavity.

- The **Nasopalatine nerve (long Spheno-palatine)** is the largest of the nasal nerves
- Passes anteriorly grooving down the nasal septum
- Through the incisive canal and fossa in the hard palate
- Supply mucosa, gingiva, and glands adjacent to the incisor teeth.
- Join the greater palatine nerve.



Ganglion	Otic	Submandibular	Sphenopalatine
Site	just below foramen ovale, deep to trunk of mandibular nerve	superficial to hyoglossus muscle, suspended from lingual nerve	in the pterygopalatine fossa, suspended from maxillary nerve
Sensory root	Mandibular N.	Lingual N.	Maxillary N.
Sympathetic root	Plexus around middle meningeal artery (External petrosal N.)	Plexus around facial artery	Plexus around internal carotid artery (deep petrosal N)
Parasympathetic root PREGANGLIONIC FIBERS	Inferior salivary nucleus ⟶ lesser petrosal branch of tympanic of 9th N. → passes in foramen ovale to the ganglion	Superior salivary nucleus ⟶ chorda tympani of facial nerve → joins lingual nerve → ganglion	Superior salivary nucleus ⟶ greater petrosal branch of 7th N. → joins deep petrosal → both nerves form nerve of pterygoid canal → ganglion
Distribution POST-GANGLIONC FIBERS	Passes along auriculotemporal nerve → secretomotor fibers to parotid gland	1.Pass directly to submandibular gland 2.Pass along lingual nerve after rejoining → sublingual gland	1.Zygomaticotemporal nerve → lacrimal nerve → lacrimal gland 2.Along greater & lesser palatine branches → palatine glands 3.Along nasal branches → nasal glands

The Parasympathetic Ganglia in the Head and Neck

Ganglion	Nucleus	Parasympathetic root	Sensory root	Sympathetic root	Organs supplied
Ciliary	Edinger-Westphal	Oculomotor nerve	Nasociliary	Nasociliary nerve from internal carotid plexus	Sphincter pupillae and ciliary muscles
Sphenopalatine	Superior salivary	Greater superfacial petrosal nerve from VII nerve	Maxillary	Deep petrosal nerve from internal carotid plexus	Lacrimal glands; glands of nose, palate, mouth and pharynx
Submandibular	Superior salivary	Chorda tympani nerve from VII nerve	Lingual	Plexus around facial artery	Submandibular and sublingual glands
Otic	Inferior salivary	Lesser superfacial petrosal nerve from IX nerve	Mandibular "Motor "	Plexus around middle meningeal artery	Parotid gland
Many ganglion in the different organs	Dorsal motor nucleus of vagus	Vagus nerve	Many nerves	Many plexus	Heart, Respiratory system, Abd. viscera

Thank you