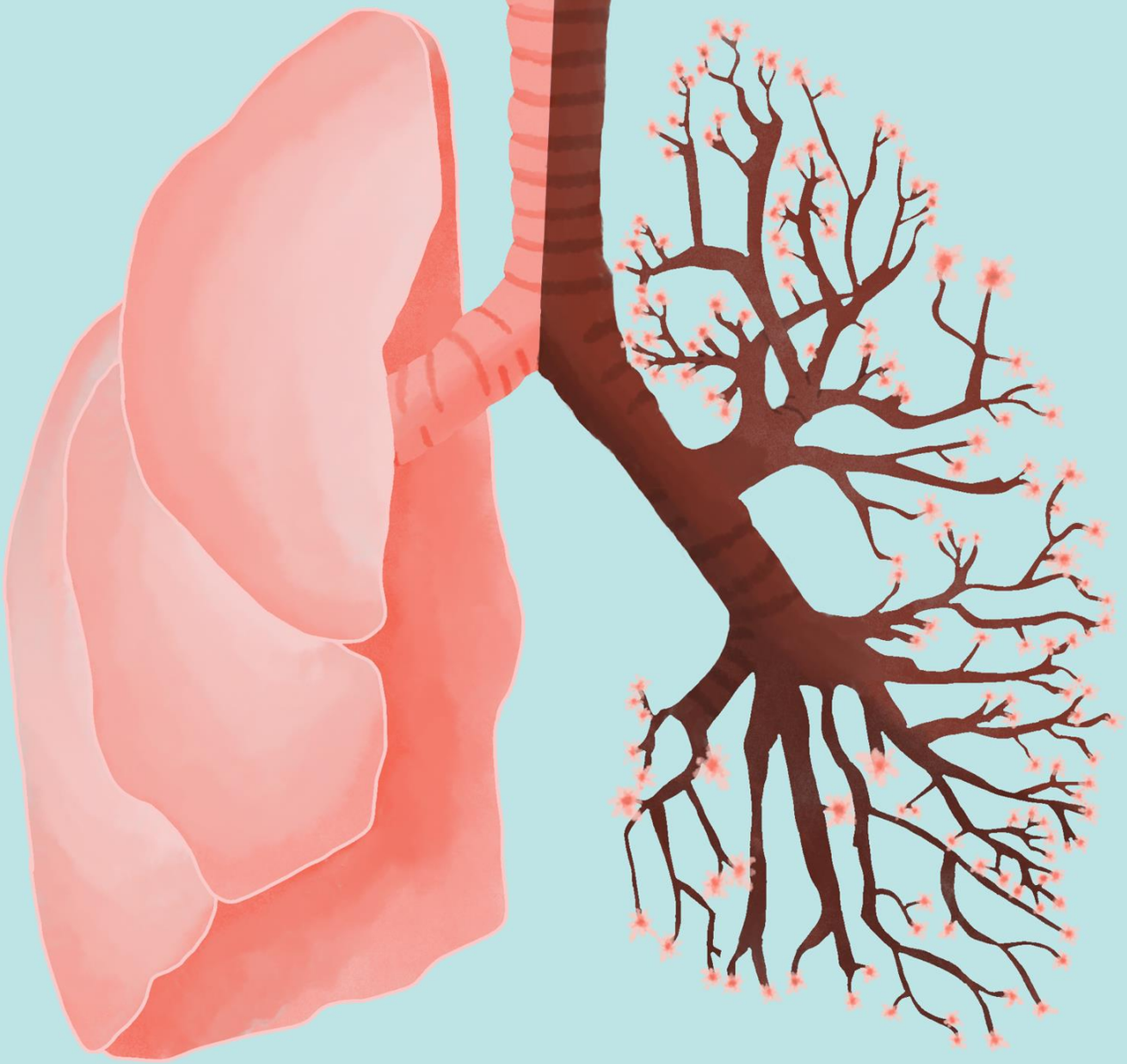
RESPIRATORY SYSTEM
ANATOMY



Title: Sheet 2

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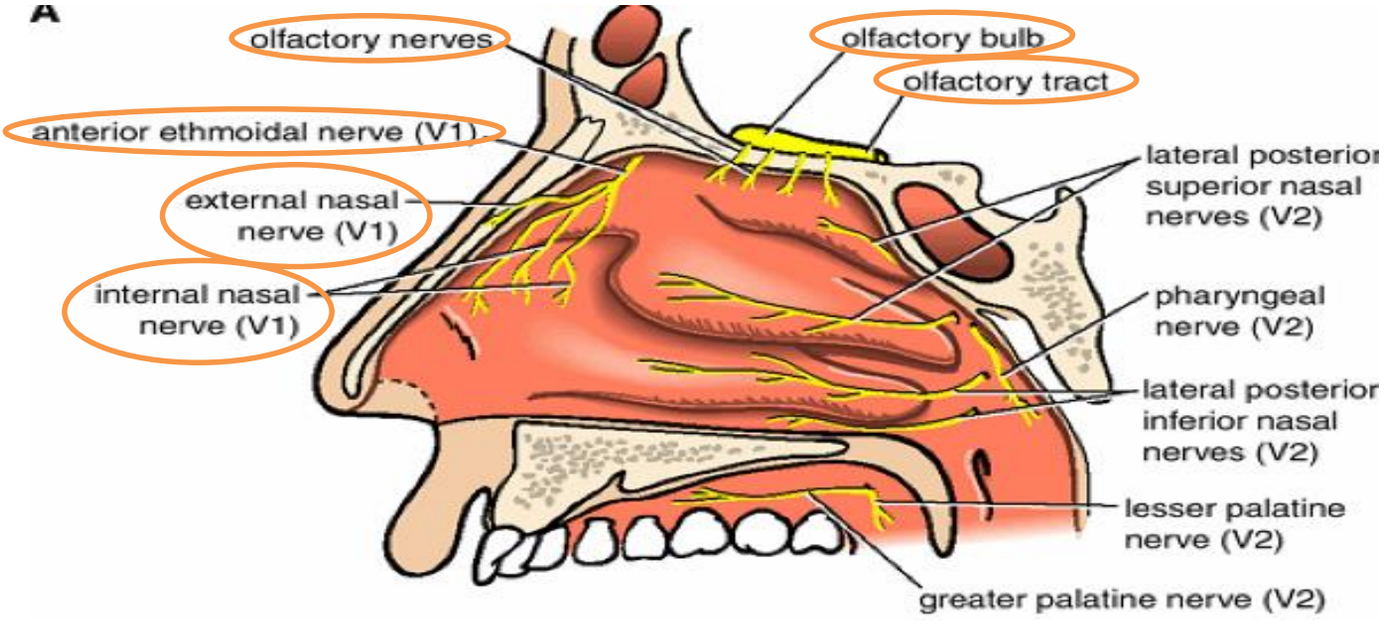
Doctor:

Innervation of the nasal cavity:

A. The **olfactory nerve: starts as bipolar cells in the roof,** responsible for special **smell sensation**/olfaction, *composed of axons from receptors in the olfactory epithelium at the top of each nasal cavity, olfactory filaments pass superiorly through the cribriform plate to synapse within the olfactory bulb of the brain.*

Bipolar cells → olfactory filaments → olfactory bulb → olfactory tract → smell center in the temporal lobe.

B. Branches of ophthalmic nerve through **nasociliary nerve in the orbit:**
Anterior ethmoidal N → sensory to lateral & medial walls → *continues on the undersurface of the nasal bone to → the external surface of the nose by traveling between the nasal bone and lateral nasal cartilage, terminates as the external nasal N*.
Posterior ethmoidal N → through a canal (post. Ethmoidal foramen) in the medial wall of the orbit **→** supplies the mucosa of the ethmoidal & sphenoid **air sinuses.** (Normally does not extend into the nasal cavity itself).



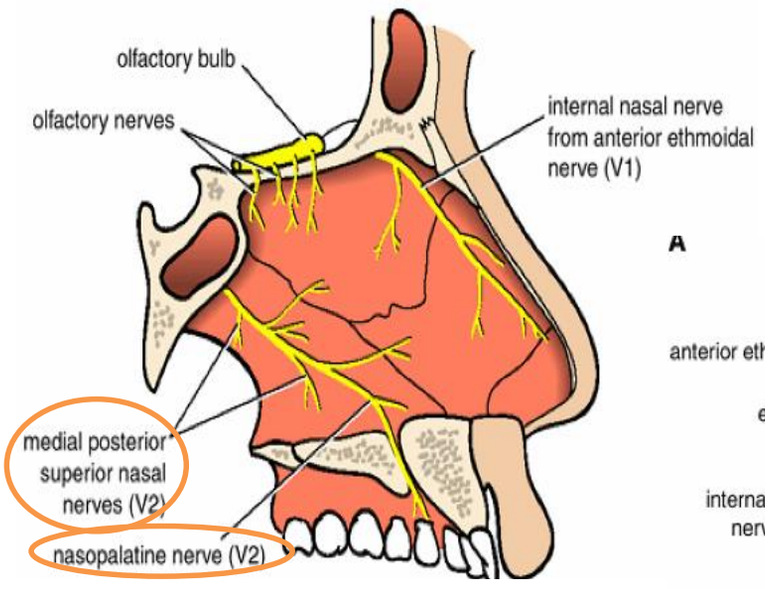
Branches of the **ophthalmic** and **maxillary** nerves: supply **general sensation** to the nose (sensory).

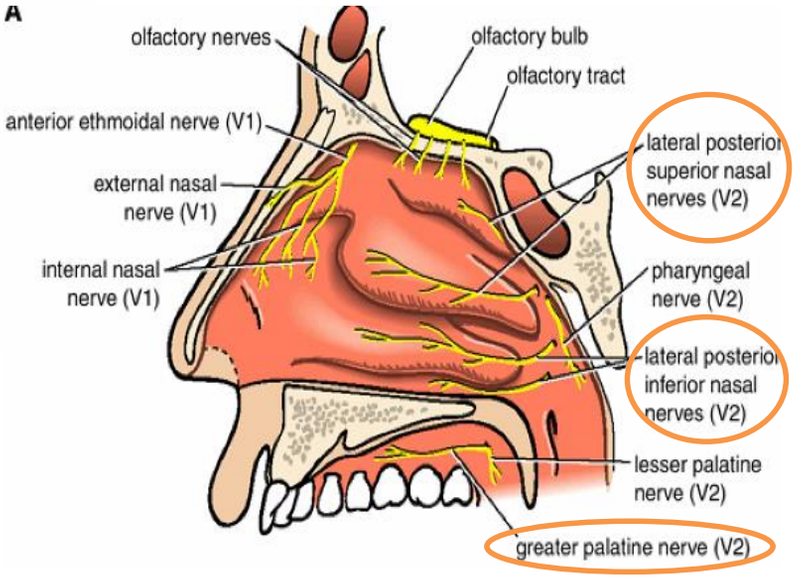
M**axillary nerve:** has branches that supply the **lateral wall and the septum** and their names **correspond to the names of the arteries. (The doctor didn't read the following, but he explained them in the second lecture).**

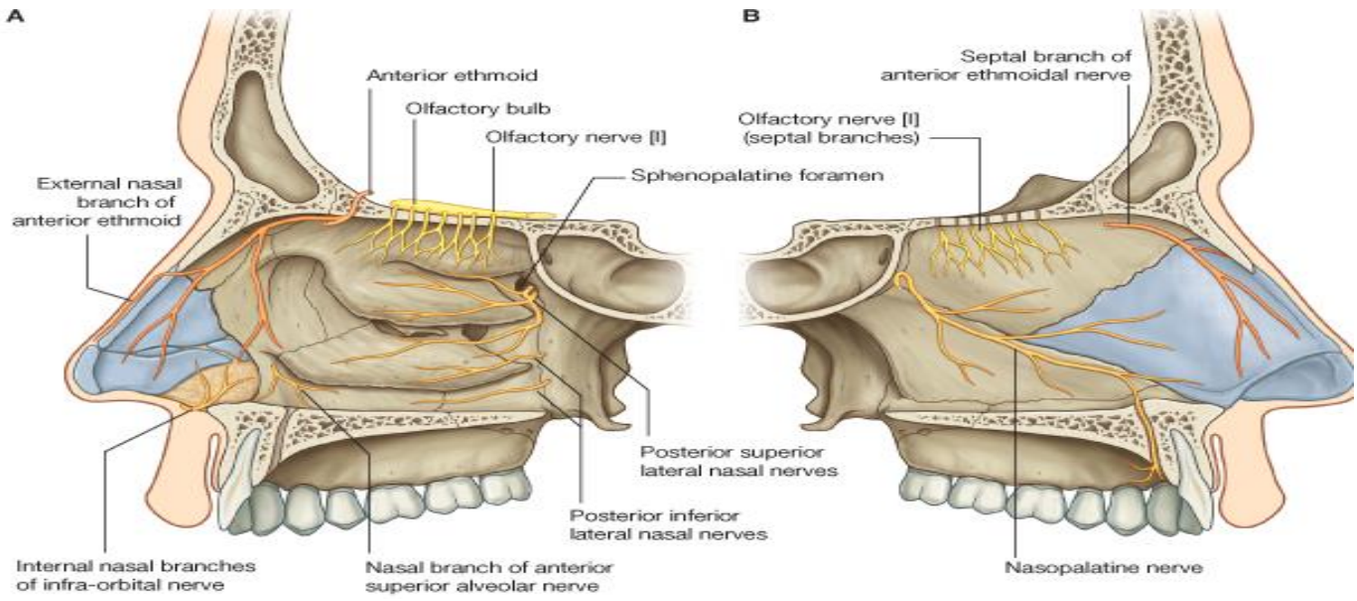
- *Originates in the pterygopalatine fossa just lateral to the lateral wall of the nasal cavity*
- *Leaves the fossa to enter the nasal cavity by passing medially through the sphenopalatine foramen*

*1. **Posterior superior** lateral nasal nerves: pass forward on and supply the lateral wall of the nasal cavity.*
*2. **Posterior inferior** nasal nerves: originate from the **greater palatine nerve**, innervate the lateral wall of the nasal cavity.*
*3. **Anterior superior alveolar** branch of the **infra-orbital nerve:** supplies the lateral wall near the anterior end of the **inferior concha**.*
*4. **Largest** of these nerves is the **nasopalatine** nerve : passes through the **incisive canal** onto the **roof** of the oral cavity and terminates by supplying the oral mucosa posterior to the incisor teeth.*
*5. **Posterior superior medial** nasal nerves: cross the **roof** to the nasal septum and supply both these regions*.

C. **Parasympathetic** (**secretomotor**) comes through the **facial nerve** so the facial gives the secretomotor innervation for the **mucous glands** of the nose.

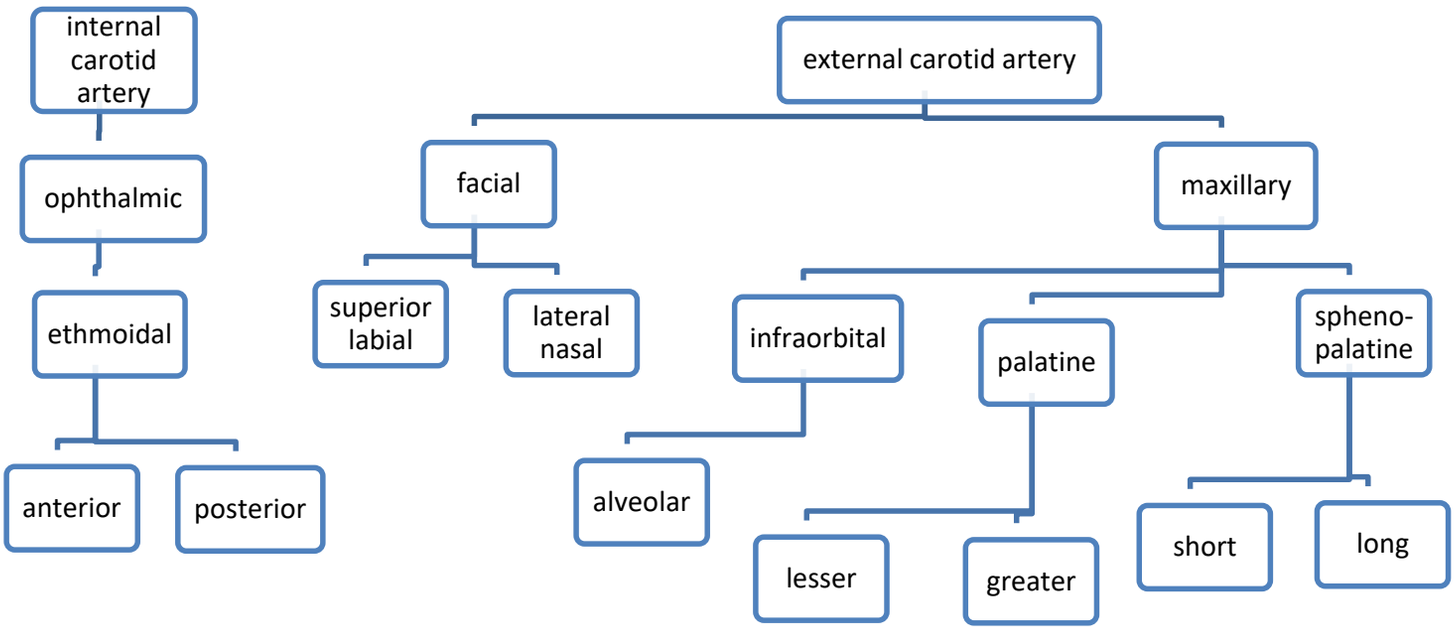






Summary for blood supply and innervations:

Postero-superior quadrant:	Posterior-superior lateral nerve and vessels (**short spheno palatine**)
Postero-inferior quadrant:	**Greater palatine** nerve and vessels
Antero-superior quadrant:	**Ant. Ethmoidal** nerve (internal and external nerve) and artery
Antero-inferior quadrant:	**Ant. Superior alveolar** nerve and branches from the **facial** and **greater palatine** artery
Nasal septum:	Lower posterior part by the **long sphenopalatine nerve** Upper anterior part by the septal branch of the **anterior ethmoidal nerve**. Blood supply by the **long sphenopalatine artery.**



Superior meatus	Middle meatus	Inferior meatus	Sphenoethmoidal recess
Posterior ethmoidal sinus	Anterior ethmoidal sinus Middle ethmoidal sinus Maxillary air sinus Frontal air sinus	Nasolacrimal duct	Sphenoidal air sinus

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Questions from sheet 2017:

1) pseudostratified ciliated columnar epithelium lining all of the following except:

A-infraepiglottis

B- Lateral wall of nasal cavity

C- Conducting bronchiole

D- Superior part of nasal cavity (or olfactory part/roof)

E- Nasopharynx

2) All of the following nerves supply the lateral wall of the nasal cavity except:

A- anterior ethmoidal nerve

B- Posterior ethmoidal nerve

C- Anterior palatine nerve (greater)

D- Posterior superior lateral nasal nerve

E- Anterior superior alveolar

3) Epistaxis in the kiesselbach's area most common artery?

A- short sphenopalatine artery

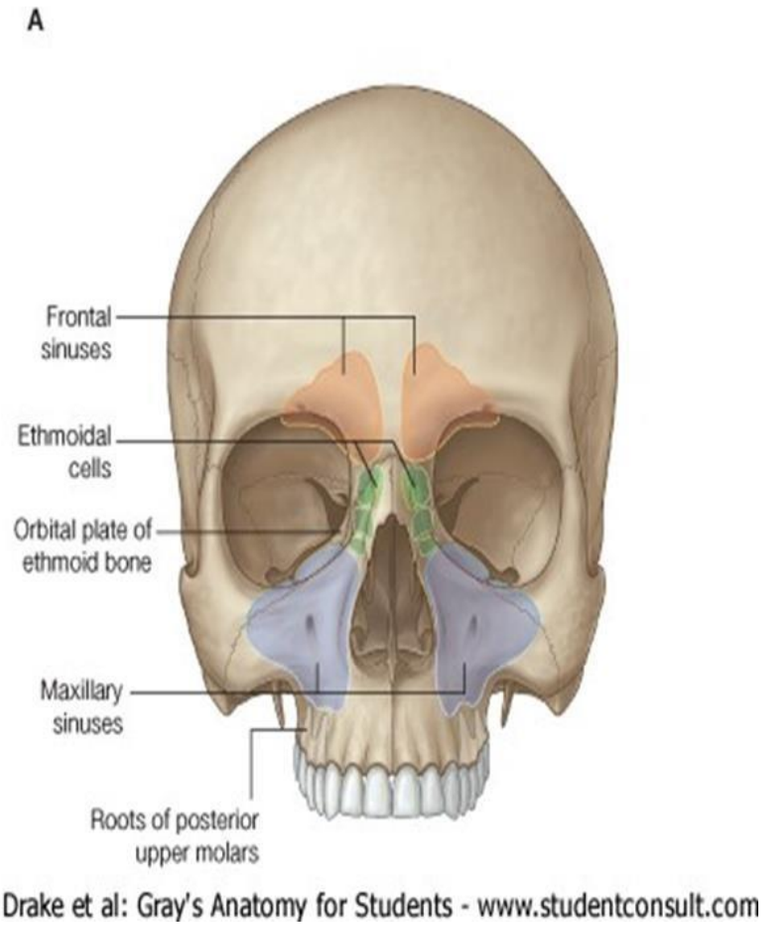
B- anterior ethmoidal artery

C- posterior ethmoidal artery

D- lateral nasal artery

E- superior labial artery

Answers: 1) D , 2) B , 3) E



The paranasal sinuses are spaces inside some of the skull bones. They're all lined with respiratory mucosa which is **pseudostratified ciliated columnar epithelium,** but the mucosa here is thin.

- All sinuses open by ducts into the lateral wall of the nose.
- The innervation is branches from the **Trigeminal nerve** (the Trigeminal gives rise to three branches: ophthalmic, maxillary and mandibular).
- In the paranasal sinuses we're interested in the first two branches, the mandibular nerve doesn't innervate these sinuses.
- There are 6 ethmoidal sinuses, 2 sphenoidal sinuses, 2 maxillary sinuses, and 2 frontal sinuses.

Functions:

1- resonance of the voice.
2- decreased weight of the skull.

3- Protection (by moisturizing and modifying of the temperature and reduction of intracranial pressure).

Paranasal sinuses:

1- The **Frontal** air sinus is present in frontal bone and it is triangular in shape. (rudimentary at birth, but grows as the skull grow).

Drainage: frontonasal duct into infundibulum (a space in the middle hiatus)

Innervation: it is innervated by the supraorbital nerve, a branch of the ophthalmic nerve that passes through supraorbital foramen.

2- The **Ethmoidal** air sinuses/cells are three pairs of sinuses; anterior, middle and posterior (3 on the right and 3 on the left). Lying in the anterior cranial fossa.

each sinus represents one cell that has its own duct. The middle sinus is in the bulla ethmoidalis and opens into it. The anterior sinus opens in the anterior part of hiatus semilunaris and the posterior sinus opens in the superior meatus.

Nerve supply: Innervated by the anterior and posterior ethmoidal branches of nasociliary nerve, a branch of ophthalmic nerve

Ophthalmic nerve→ nasocilliary nerve →anterior and posterior ethmoidal nerves

3- The **Maxillary** sinus in maxilla. It is the largest sinus. It has bad drainage (because the duct is located high up) and opens in hiatus semilunaris posteriorly. It has apex and base. The apex is directed laterally, and the base is in the wall of nasal cavity.

It is innervated by the infraorbital and alveolar branches of the maxillary nerve.

Molars and premolars are directly inferior to the maxillary sinus.
Extraction of one of the upper molars will form a fistula between maxillary sinus and oral cavity, and if there is sinusitis, there would be discharge of the sinus content into the oral cavity which is bad.

Relations of the **maxillary sinus**:

above: orbit.

Below: upper molars and premolars.

Laterally: infratemporal fossa.

Medially: lower part of nasal cavity.

4-The **sphenoidal** sinuses in the body of the sphenoid bone.

The duct opens into the sphenoethmoidal recess.

It is innervated by the posterior ethmoidal nerve of the ophthalmic nerve AND the orbital branches of the maxillary nerve.

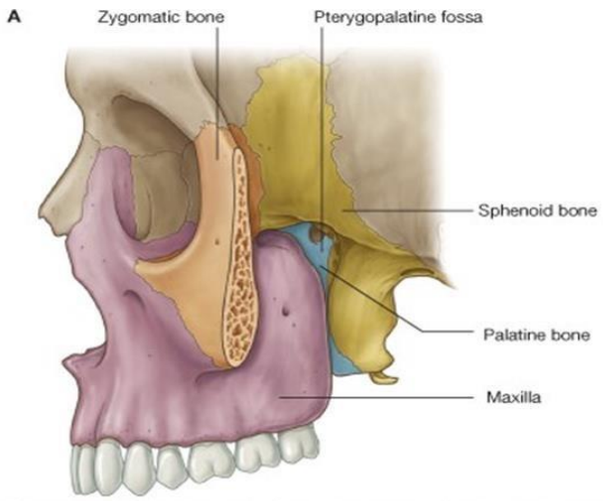
Relations of the **sphenoidal sinus**:

Above: the pituitary gland in the Sella turcica and the optic chiasma.
Note: If there is an invasive tumor in the pituitary gland, it causes changes in the underlying bone and compresses the sphenoidal sinus. (these changes can be observed in X-ray).

Laterally: the cavernous sinuses

Below and Infront: the nasal cavity.

The pterygopalatine fossa (sphenopalatine fossa):



It is very important since all nerves and blood supply of the nose, nasopharynx and the orbit come from the pterygopalatine fossa.

It has a shape of an Inverted teardrop and it lies Between the bones on the lateral side of the skull.

The **walls** of the pterygopalatine fossa:

The **anterior** wall: is formed by the posterior surface of the maxilla.

The **medial** wall: is formed by the lateral surface of the palatine bone (there is a foramen in the palatine bone called Sphenopalatine foramen where sphenopalatine vessels and nerves pass).

The **posterior** wall: pterygoid plate (part of sphenoid bone).

The **roof**: is formed by greater wing of sphenoid bone.

The **Lateral** wall: formed by infratemporal fossa

Note: The posterior wall and roof are formed by parts of **the sphenoid bone.**

There are two important foramina in sphenoid bone:

1- The Foramen Rotundum (for maxillary nerve).
2- The Pterygoid canal: comes from the middle cranial fossa as a groove then goes to the roof of foramen lacerum and makes a groove in its cartilage (remember that foramen lacerum is covered by cartilage) to reach pterygopalatine fossa. The nerve of pterygoid canal passes through it and it is composed of two types of fibers; greater petrosal nerve (parasympathetic part) and deep petrosal nerve (the sympathetic part). The difference between the two parts is that the parasympathetic is preganglionic and synapses in the pterygopalatine ganglia (part of facial nerve) while the deep petrosal (sympathetic) is postganglionic and passes through the ganglia without synapsing.

These two foramina connect the middle cranial fossa with pterygopalatine fossa.

Remember that the trigeminal nerve is in the middle cranial fossa and gives us three branches; ophthalmic, maxillary (pure sensory nerve that enters the pterygopalatine fossa through foramen rotundum) and the mandibular nerves.

Gateways between pterygopalatine fossa and the surrounding areas (very important clinically):

Seven foramina and fissures provide apertures through which structures enter and leave the pterygopalatine fossa

1. **Foramen rotundum** and **pterygoid canal** communicate with the middle cranial fossa. (explained above).

2. **Palatovaginal canal** opens into the posterior wall and leads to the nasopharynx to give blood and nerve supply.

3. **Palatine canal:** small canal leads to the roof of the oral cavity (hard palate) and opens inferiorly through greater and lesser palatine foramina. palatine artery and nerve pass through it. Palatine nerve divides into two branches: greater and lesser palatine nerves. Greater palatine nerve passes through the greater palatine foramina (located on the hard palate) to reach the hard palate and then to the nose by passing through incisive foramina. The lesser palatine nerve passes through the lesser palatine foramina to reach the soft palate.

4. **Sphenopalatine** foramen on the medial wall and opens into the lateral wall of the nasal cavity. Gives blood supply and innervation to the nose.

5. **Pterygomaxillary** fissure between lateral aspect of the pterygopalatine fossa and the infratemporal fossa. The maxillary artery (branch from the external carotid) starts from the parotid gland then enter the pterygopalatine fossa through this fissure (pterygomaxillary fissure). The direction of the artery is opposite to the direction of the branch of maxillary nerve (middle cranial fossa > pterygopalatine fossa>infratemporal fossa)

6. **Inferior orbital fissure** between the superior aspect of the fossa into the floor of the orbital cavity. For maxillary nerve and vessels, they pass from the pterygopalatine fossa into orbital cavity and then in the floor of the orbit then groove then canal and then exit through infraorbital foramen. Some books name them (maxillary N and V) the infraorbital nerve and vessels after the entry of the orbit and others called them infraorbital N and V when they exit the foramen. (The nomenclature is not important but what you have to know is that when they exit from infraorbital foramen they’re called infraorbital N and V).

The contents of pterygopalatine fossa (sphenopalatine fossa):

1 .The maxillary nerve: the second branch of trigeminal nerve, it is a **pure sensory** nerve for upper teeth and the skin of facial and temporal bones and reaches the pterygopalatine fossa from the middle cranial fossa through foramen rotundum.

2 .Terminal part of the maxillary artery (maxillary artery is one of the terminal branches of external carotid artery in the parotid gland, then it goes medially to the infratemporal fossa. (lateral pterygoid muscle divides maxillary artery into three parts. Third part is the terminal branch of maxillary artery located in the pterygopalatine fossa. There it will give **sphenopalatine** artery (long & short), **palatine** artery (greater & lesser), **orbital branches and branches to the nasopharynx.**

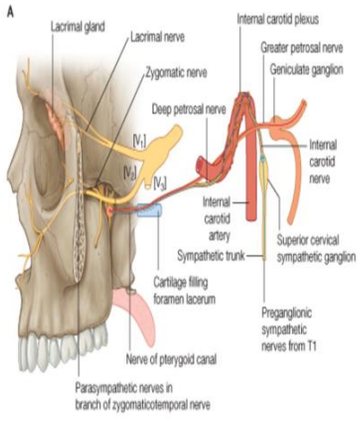
The first is before the muscle, the second is behind or anterior to muscle and the third is in the pterygopalatine fossa.

3 .Nerve of the pterygoid canal: it contains sympathetic and parasympathetic fibers.

4 .The pterygopalatine ganglion (**parasympathetic ganglia** in which parasympathetic fibers make synapses) gives fibers (parasympathetic and the associated sympathetic (without synapse) to the glands in the nose, nasopharynx, orbit and the oral cavity.

5 .Veins and lymphatics also pass through the pterygopalatine fossa.

The Pterygopalatine ganglia: In the head and neck we have 4 parasympathetic ganglia: otic ganglia, submandibular ganglia, ciliary ganglia in the eye and pterygopalatine ganglia (largest). The sympathetic is already post ganglionic so it passes without synapsing and both end up in the glands.



Here we have geniculate ganglia of facial nerve. It's exclusive for parasympathetic so it gives us greater petrosal nerve (preganglionic), it passes through pterygoid canal. While sympathetic fibers come from superior cervical

sympathetic ganglia and pass around internal carotid artery then give us deep petrosal nerve. The two fibers (greater and deep petrosal) when they are in the pterygoid canal collectively called nerve of pterygoid canal. They reach the ganglia, and as we said only the parasympathetic synapses and sympathetic just pass through. After that, they distribute with branches of maxillary nerve.

Ganglia give branches to the palate, nasal cavity, nasopharynx and orbit. Other fibers pass superiorly through the ganglionic branches of the maxillary nerve to enter the main trunk of the maxillary nerve and then distributed with the zygomatic, posterior superior alveolar, and infra-orbital nerves.

These ganglionic branches are:

1) sympathetic: to the blood vessels.

2) parasympathetic to the glands in the submucosa in the nasal cavity, oral cavity and nasopharynx (secretomotor to the glands).

Maxillary nerve gives sensory fibers and two branches to the ganglia (twigs) So, if there is an inflammation in the ganglia the sensation is carried by maxillary nerve.

Pterygopalatine ganglion branches:

- ✓ Pharyngeal branch through palatovaginal canal to the mucosa and glands in the nasopharynx.
- ✓ Palatine nerve (greater and lesser): it descends through the palatine canal to the oral cavity to give:

1.Lesser palatine (Middle, Post, palatine) to the soft palate.

2.Greater palatine (Ant.palatine) to hard palate and then through the incisive foramen to the nose.

- ✓ Nasal nerves: nasopalatine nerve (long) mainly to the septum, and short to the nasal wall.

- ✓ Orbital branches: to the orbit through the inferior orbital fissure to supply the periosteum (orbital wall), lacrimal gland, sphenoidal and ethmoidal air sinuses.

✓ Zygomatic branch: zygomaticofacial and zygomaticotemporal (**it also carries parasympathetic fibers to lacrimal gland**)

Maxillary nerve:

Purely sensory. It originates from the trigeminal ganglion in the cranial cavity and exits the middle cranial fossa and enters the pterygopalatine fossa through the foramen rotundum. After reaching the pterygopalatine fossa**, it passes to the infratemporal fossa by pterygomaxillary fissure to give posterior superior alveolar nerve** (sensory to the last three molars and the surrounding gingiva and maxillary air sinuses) opposite to the direction of maxillary artery (which passes from the infratemporal fossa to pterygopalatine fossa through pterygomaxillary fissure). And then, maxillary nerve enters the inferior orbital fissure (groove → canal) and then continues as infraorbital nerve (the terminal end of maxillary nerve).

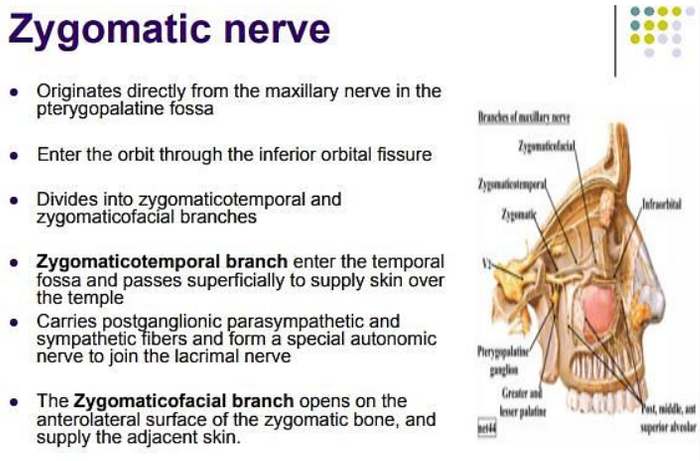
Maxillary nerve branches:

1.Meningeal (before it enters the Fossa)

2.Two ganglionic branches pass through the pterygopalatine ganglion (Postganglionic parasympathetic fibers and sensory).

3.Zygomatic nerve.

4.Posterior superior alveolar nerve (last three molars): Passes laterally out of the fossa through the pterygomaxillary fissure then enters the posterior surface of the maxilla approximately midway between the last molar tooth and the inferior orbital fissure. It Supplies the molar teeth and adjacent buccal gingivae and contributes to the supply of the maxillary sinus.



5.Infra-orbital nerve. (gives palpebral, labial and nasal nerves).

Upper jaw contains incisors, canine, premolars and molars.

Molars: posterior superior alveolar nerve

Premolars: middle superior alveolar nerve

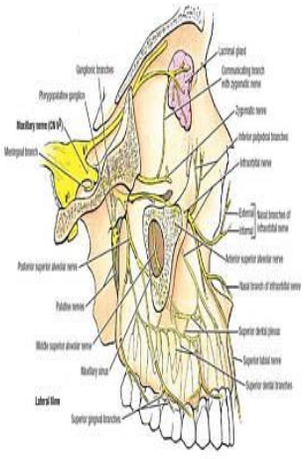
Incisors and canine: anterior superior alveolar nerve.

Infra-orbital nerve

- Anterior continuation of the maxillary nerve
- Leaves the pterygopalatine fossa through the inferior orbital fissure
- First in the **infra-orbital groove** in the floor of the orbit and then continues forward in the **infra-orbital canal.**
- While in the infra-orbital groove and canal, the infra-orbital nerve gives origin to **middle** and **anterior superior alveolar nerves:**
- They Join the **superior alveolar plexus** to supply the upper teeth
- Middle superior alveolar nerve also supplies the maxillary sinus
- Anterior superior alveolar nerve also gives origin to a small nasal branch

Infra-orbital nerve

- The infra-orbital nerve exits the infra-orbital canal through the **infra-orbital foramen**
- Divides into nasal, palpebral, and superior labial branches
- Nasal branches supply skin over the lateral aspect of the external nose and part of the nasal septum;
- Palpebral branches supply skin of the lower eyelid;
- Superior labial branches supply skin over the cheek and upper lip, and the related oral mucosa.



Maxillary Nerve and Pterygopalatine ganglion