RESPIRATORY SYSTEM

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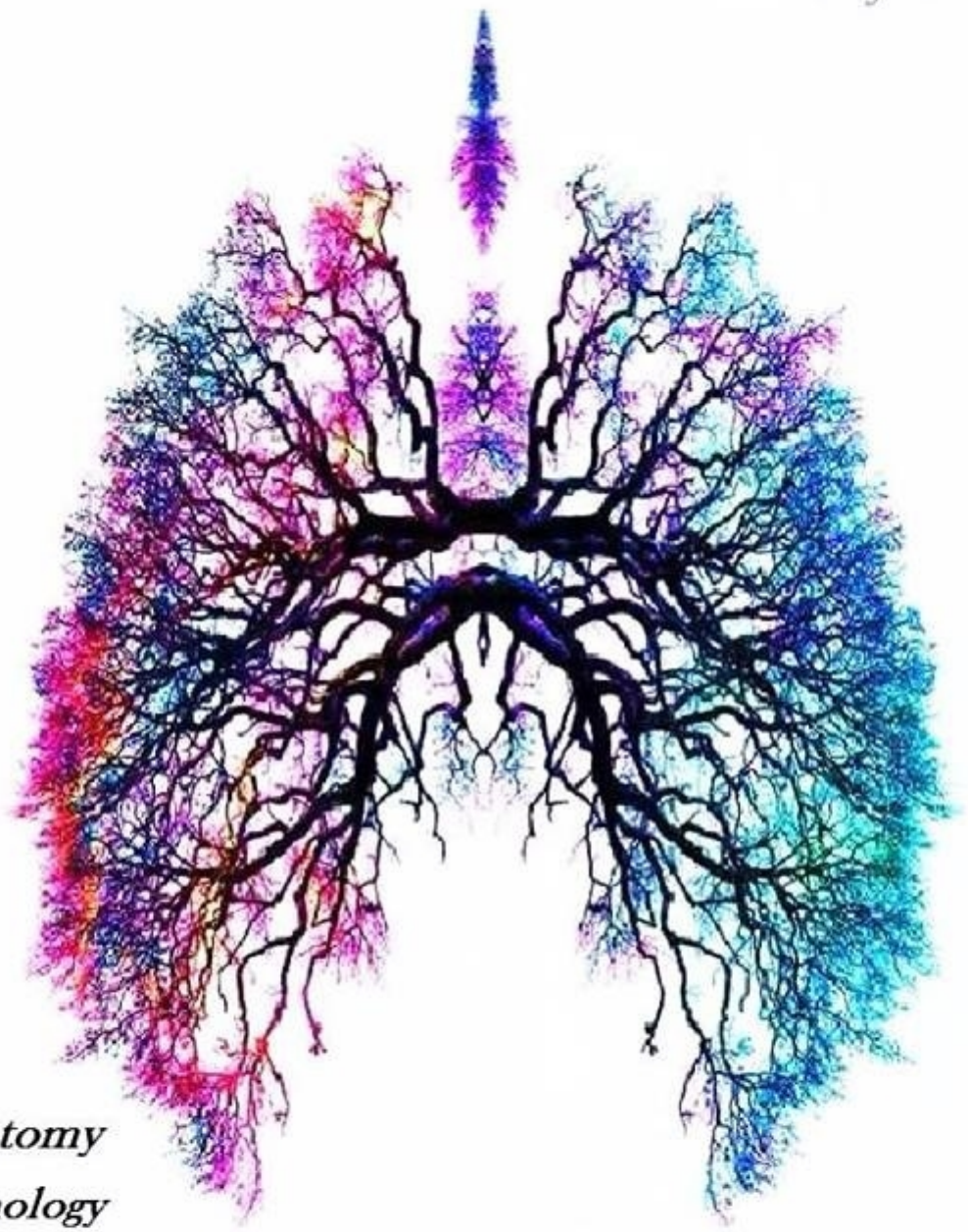

- ● Anatomy
- ○ Pathology
- ○ Physiology
- ○ Pharmacology
- ○ Microbiology
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Lecture # 2 (1-anatomy)
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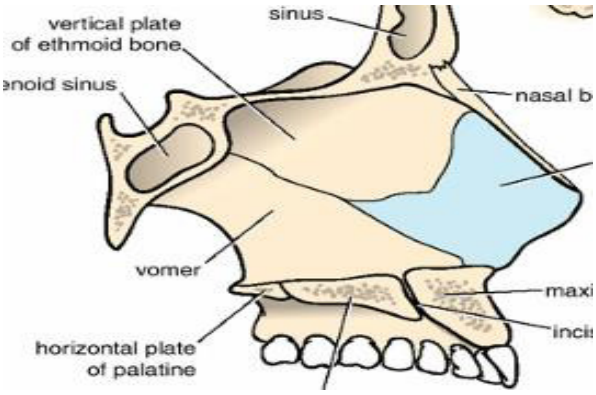
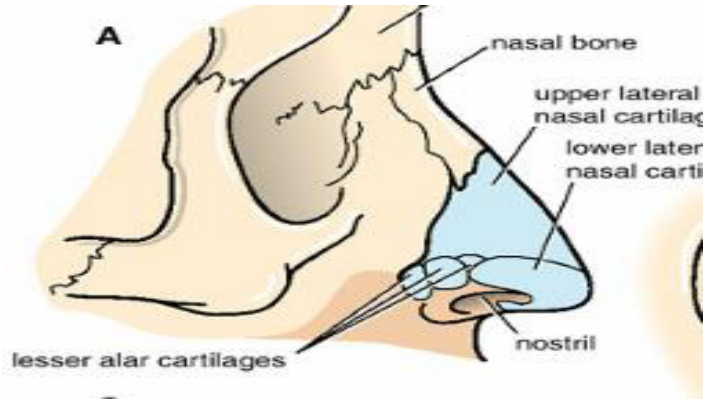
The Nasal Cavity

Today's lecture is about the gross anatomy of the nose and paranasal sinuses. The functions of the respiratory system (including the nose) include gas exchange, regulating the blood pH (when a patient is delivered to the hospital having an infection in the respiratory tract, a blood-gases test is needed to check the percentages of O2 and CO2 in the arterial blood), filtration of the inspired air (eg. vibrissae in the vestibule), receptors for smell sensation (by olfactory region in the upper part of the nasal cavity), vocal cords in the larynx for phonation and speech, excretion of water and heat from mucoserous glands in the submucosa to warm and moisten the passing air (a protective mechanism to the brain).

External nose

The nose is anatomically divided into **external nose** (from outside) and internal nose (**nasal cavity**). The external part shows the nasal septum where the anterior part is cartilaginous (the deep part is the nasal bone), and the nostrils (anterior nares).





The cartilaginous part of the anterior nose is composed of the upper lateral nasal cartilage, lower lateral nasal cartilage, and an area on the lateral sides of nares called 'ala of the nose' contains **alar cartilage** and two muscles, one is a dilator and the other is a constrictor. All are **hyaline cartilage**.

The bony framework of external nose is formed by the nasal bone, maxillary process /(nasal part) of the frontal bone, and frontal process of the maxilla bone.

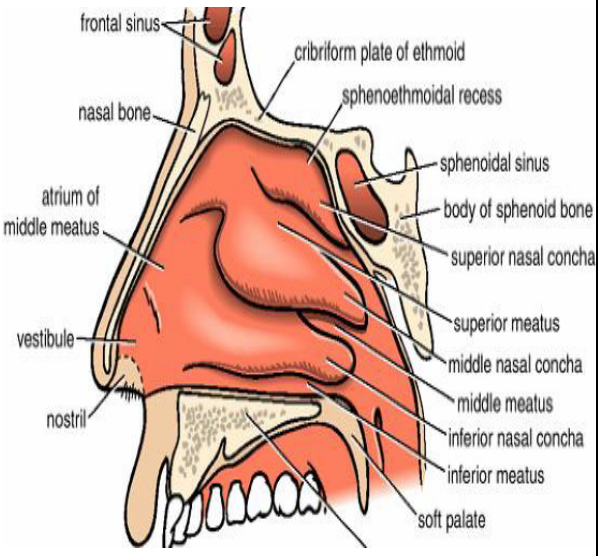
Blood supply and nerve supply of the External Nose

The blood supply of the upper jaw and nose is mainly derived from the **maxillary artery (**a branch of **external carotid artery)** andthe **ophthalmic artery** (a branch of **internal carotid artery**). The ophthalmic gives **anterior** and **posterior ethmoidal arteries**. The **facial artery** (called superior labial artery) supplies both internally and externally.

The nerve supply to the external part of the nose by **infratrochlear nerve** (a branch from the nasociliary nerve), **external nasal** (a terminal branch), **ophthalmic nerve**. Also the infraorbital branch of **maxillary nerve** (terminal branch), which passes in the infraorbital foramen and supplies the nose.

The nasal cavity

Starts with the **vestibule** and **anterior nares**, the atrium (or antrum) then three conchae, three **meatuses** below them and one recess (**sphenoethmoidal recess**) in which the sphenoid air sinus opens (these structures are on the lateral wall).



The **floor** is formed by the **hard palate**. The roof is formed by cribriform plate of ethmoid, nasal bone anteriorly, and sphenoid bone posteriorly.

The nasal cavity is divided into two cavities by the septum. Each nasal cavity has a roof, a lateral wall and a medial wall (by the septum). The septum is formed by cartilage, perpendicular (vertical) plate of ethmoid and vomer.

The functions of the nasal cavity

The conchae increase the surface area of the nasal cavity esp. the lateral wall. And this is explained by histology of the conchae which is pseudostratified epithelium and goblet cells. Also the submucosa is rich in blood supply (more venous supply compared to the arterial).

Nasal cavity also includes respiratory and olfactory functions (smell sensation), the resonance of the voice by the paranasal sinuses, the nasolacrimal duct (which starts at the lacrimal sac at the medial angle of the eye) drains the lacrimal fluid to the inferior meatus and then outside through nostrils. It also functions in protection by sneezing, filtration of air, proteolytic enzymes (secreted by the glands to digest the bacteria and foreign bodies), warming and moistening the air (which is considered a protection mechanism to the brain cells).

**Note, olfactory region is located in the roof and the septum and contains bipolar cells for smelling.*

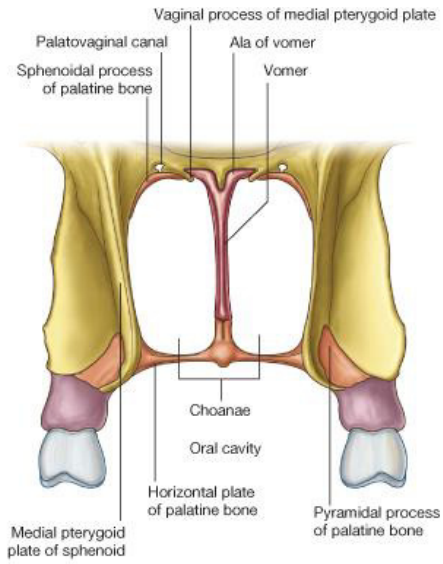
The Nares

We previously mentioned the anterior opening starting with the vestibule whose lining epithelium is of skin (keratinized stratified squamous epithelium, sweat glands,

sebaceous glands and hair follicles). Ala of the nose contains a dilator and a constrictor muscles of the nose

Boundaries of the choanae (the posterior nares)

The **choanae** (posterior nares) lead to the nasopharynx. It's separated by **vomer** to left and right choanae and on its upper part there is alar process (**ala of vomer**) and inferiorly by the horizontal plate of the palatine bone. Superiorly bounded by the sphenoidal process of palatine bone and palatovaginal canal. On the lateral side of both choanae is medial pterygoid plate.



Boundaries of the Nasal Cavity

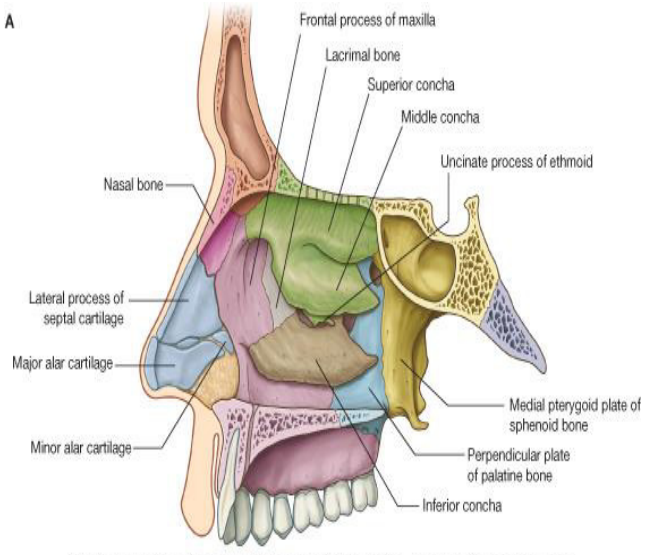
A floor, a roof, a lateral wall and a medial wall (the septal wall). The **floor** is formed by the **hard palate** (the soft palate lies posterior to the floor of the nasal cavity in the floor of nasopharynx). **Palatine process of maxilla** and **horizontal plate of palatine bone** form the hard palate

The **roof** is formed mainly by three structures, **nasal bone** (and nasal spine of frontal bone) anteriorly, **cribriform plate of ethmoid** (in the middle) and **sphenoid bone** posteriorly (sphenoid air sinus is in the body of the sphenoid). Posteriorly, we add to them the vaginal process of palatine and ala of vomer.

The **medial wall** formed by the septum which is formed anteriorly by **cartilage** , in the middle, by the perpendicular plate of **ethmoid** , and posteriorly by **vomer.**

The **lateral wall** is formed by three conchae, three meatuses and one recess. Also, bones share in the formation of the lateral wall are themedial pterygoid plate, perpendicular plate of palatine bone, lacrimal bone and frontal process of maxilla.

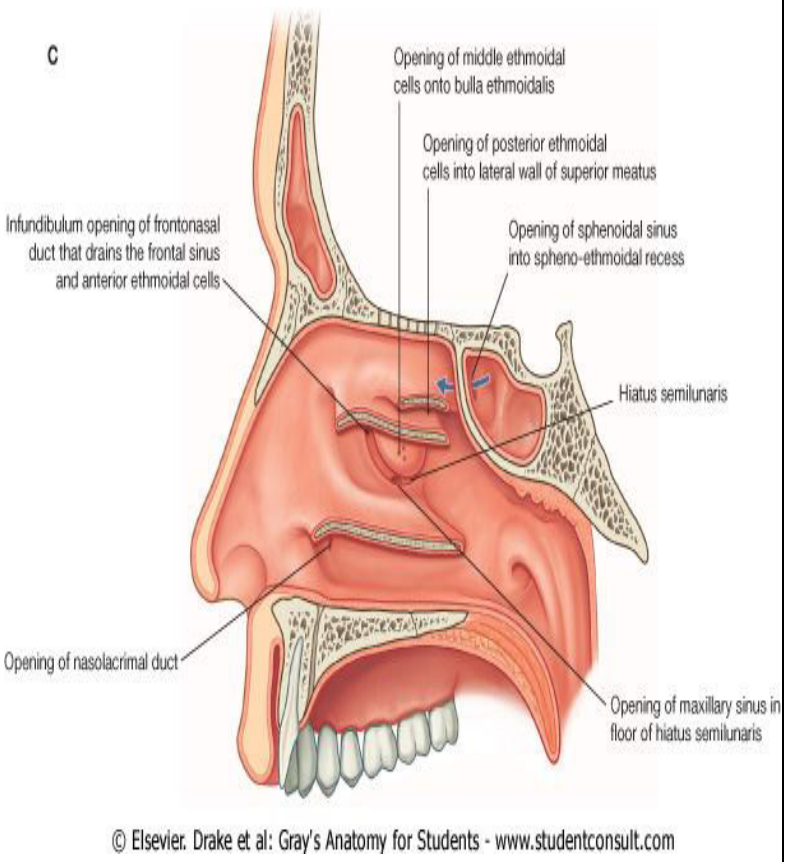
Note, superior and middle conchae arise from ethmoidal bone while the inferior concha arise from the maxilla.



We conclude that the parts of the lateral wall include the **vestibule,** the **antrum** (atrium), and forming the posterior parts are three **conchae**, three **meatuses** and one **recess.**

The Paranasal Sinuses and their site of drainage into the lateral wall

We previously mentioned that all ducts of the paranasal sinuses descend downwards which indicates easy drainage with no complications, except the **maxillary air sinus** in which the opening is directed upwards, explaining its bad drainage that may cause problems.{paranasal sinuses are maxillary, frontal, sphenoid and ethmoidal}



Openings of the air sinuses (clarified in the figure)

The **sphenoidal sinuses** open into the sphenoethmoidal recess while the **maxillary sinus** opens into the posterior part of hiatus semilunaris. The **anterior ethmoidal sinuses** open into the anterior part of hiatus semilunaris (infundibulum).*Note that the middle meatus contains two important structures*, **the bulla ethmoidalis** *and, below it, a groove called* **hiatus semilunaris**.

The **middle etmoidal air sinus** is located in the bulla ethmoidalis (in the middle meatus) and opensinto it. The **frontal air sinus** opens in the **infundibulum.**

The ethmoidal air sinuses are located in the ethmoidal bone, they are very small in size (one cell each), lined by thin mucosa and contain air.

{**Note,** there is a plexus of veins open in the submucosa of the nose functioning in warming and moistening of the air (a protective function) and trapping foreign bodies and bacteria}

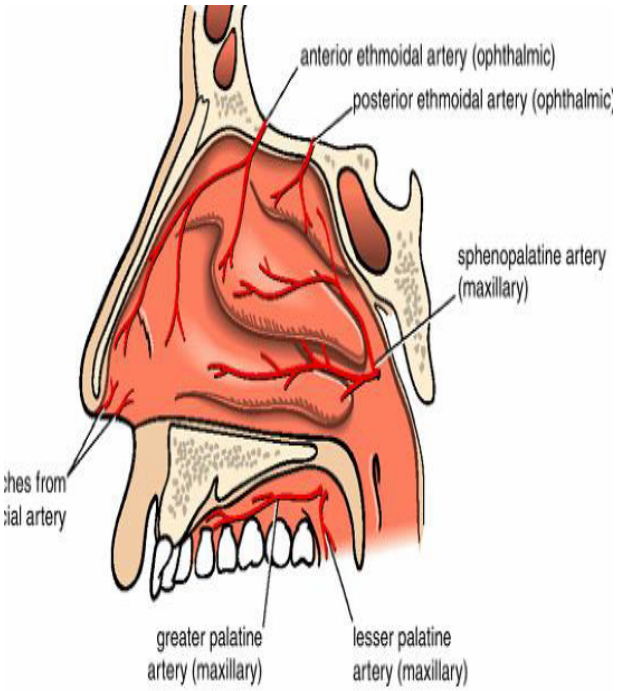
*Notice the three conchae and, below them, the three meatuses.

Blood supply and nerve supply of the Nasal Cavity (*frequent questions in the exam)*

Generally, the **blood supply** is derived from **external carotid artery** by **maxillary and facial arteries.** The **facial artery** gives off the **superior labial artery** which supplies the septal and lateral walls. And the **internal carotid artery** (shares in blood

supply by its branch, the **ophthalmic artery** which gives **anterior** and **posterior ethmoidal arteries**).

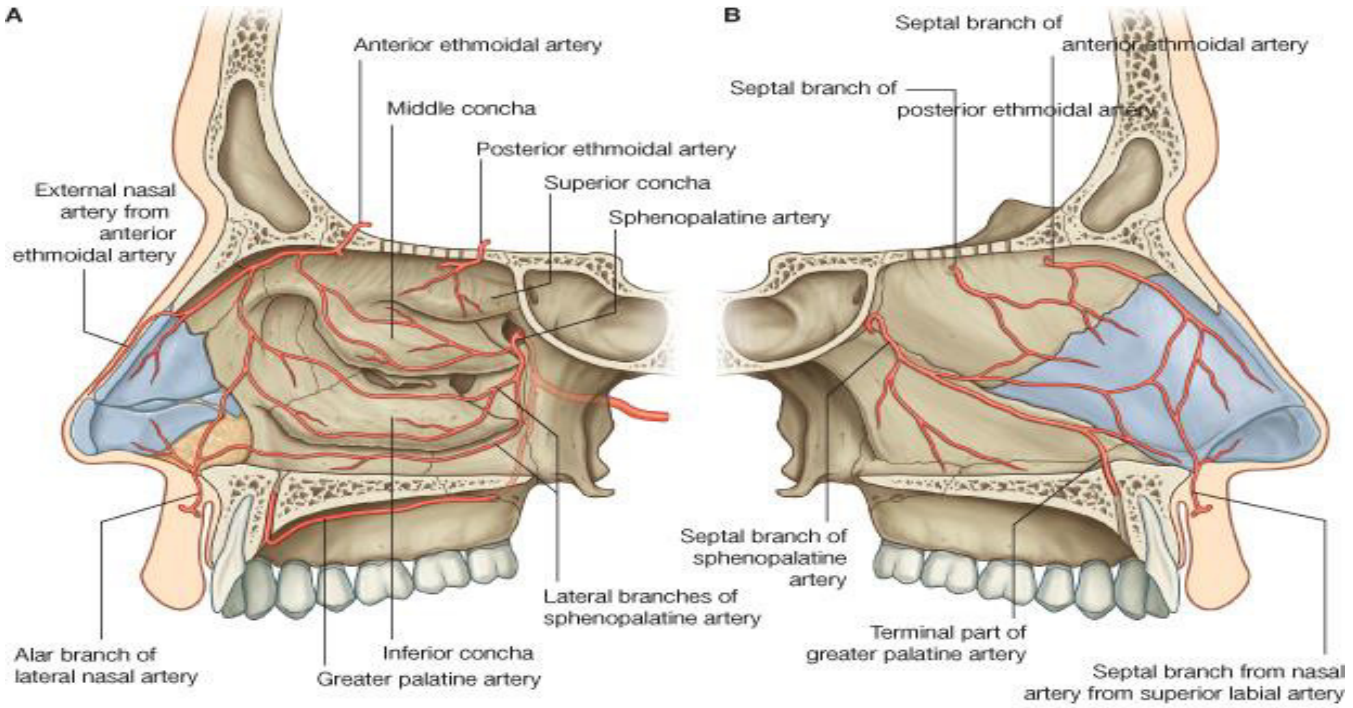
Branches of maxillary artery supplying the nasal cavity include **sphenopalatine artery** (divides to **short sphenopalatine and long sphenopalatine**). The **long sphenopalatine** is more significant in supplying the lateral and, especially, the septal wall and it has a role in epistaxis (bleeding in the nose) as we will discuss later.



Another branch of maxillary, the **palatine artery** descends in the palatine canal and divides in the oral cavity to **greater** and **lesser palatine arteries** in the roof of the oral cavity, the greater palatine to the hard palate and the lesser palatine to the soft palate. The greater palatine artery passes through the **incisive foramen** and supplies the nose.

Blood supply to the lateral and septal walls of the nose (summarized in the figure below)

In some books, branches are named according to the area, so the lateral wall of the nose can be divided into **four quadrants,** upper anterior, upper posterior, lower anterior and lower posterior. Each quadrants gains its blood supply from the branches we mentioned earlier.



The short sphenopalatine artery supplies a large part of the lateral wall (posterior superior (upper posterior) quadrant).

The septum is supplied by the septal branches of anterior and posterior ethmoidal arteries and **septal branch of sphenopalatine artery** (mostly the **long**) (**sphenopalatine artery** is called **nasopalatine artery** in some books). Anteriorly, its supplied by the septal branch of facial (superior labial).

The **greater palatine** runs in the incisive foramen and supplies posterior and anterior inferior quadrant (i.e. lower part of the lateral wall of the nose).

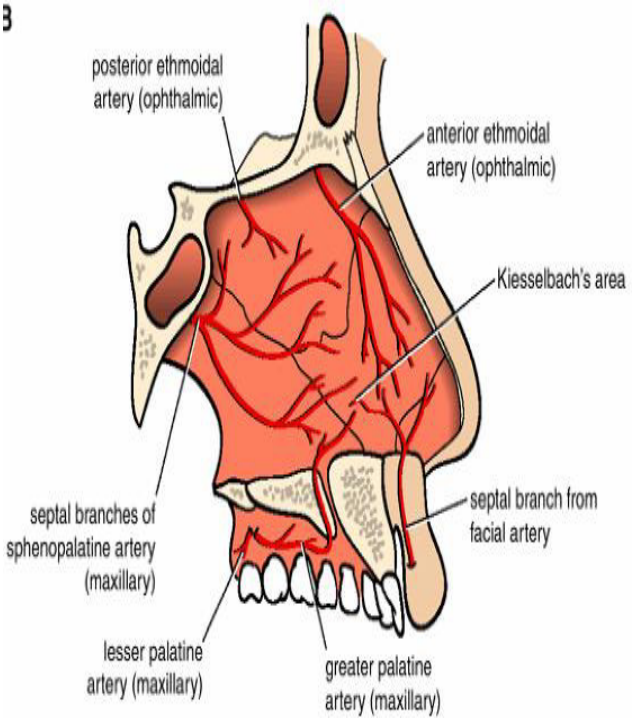
The **anterior and posterior ethmoidal arteries** from ophthalmic which is a branch from internal carotid mainly supply the upper part of the lateral wall, mostly the **anterior ethmoidal** (terminates as **external nasal artery**)**.** Both anterior and posterior give septal branches.

The **superior labial** (from facial) supplies ala of the nose **externaly** and the septum **internally** and causes epistaxis as we will discuss later.

Note, *two arteries are responsible for* **epistaxis** *(bleeding from the nose)***,** *a branch from facial and the long sphenopalatine. Both reach the septum (Kiesselbach's area) between upper two thirds and lower one third of the septum.*

A clinical case

Many children bleed after receiving a trauma on the nose (epistaxis occurs). We stop the bleeding not by putting him in a supine position i.e lying on the back, because the blood will pass backwards and will be swallowed. But by closing the two ala with pressure so that the blood will clot. Or by pushing a piece of gauze inside to close the vestibule and to stop the bleeding.



Epistaxis originates from long sphenopalatine or labial branch of facial (**more common**). Treated by performing cauterization or by silver nitrate to stop the bleeding.

Venous supply

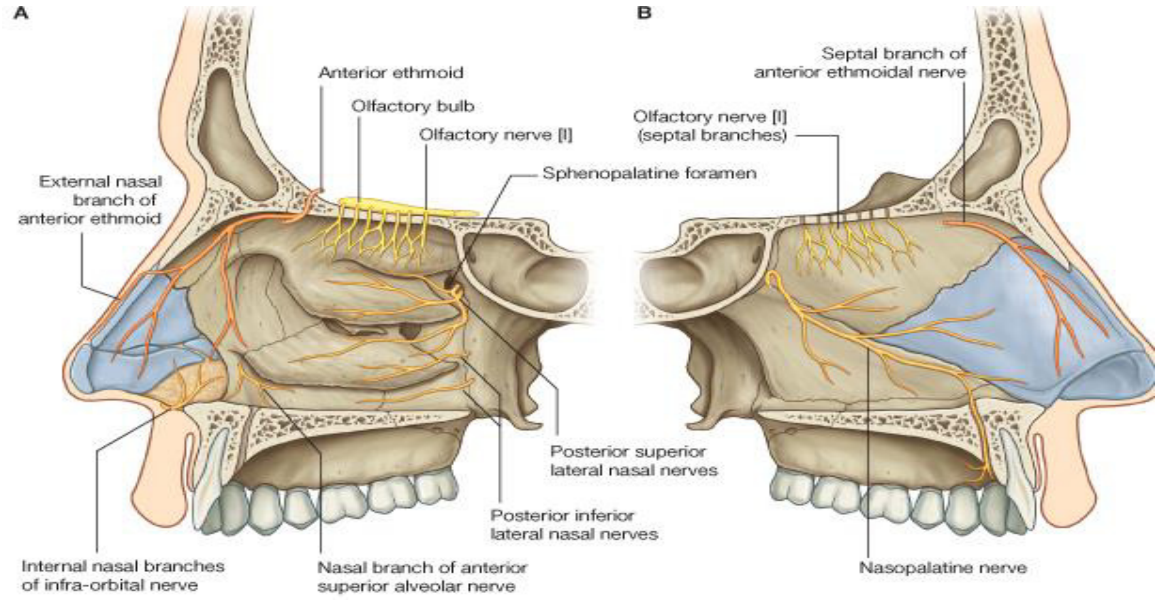
Veins run opposite to the arteries and are named accordingly (same names as the arteries). The anterior part drains in the **facial vein**. The posterior part drains in the **pterygoid plexus** of veins which forms the beginning of the **maxillary vein**.

The upper part, a part of the dangerous area at the roots of the nose, drains in the **ophthalmic veins** which can reach the cavernous sinus (a dangerous area, if the infection reaches this area, it causes thrombosis).

The lymphatic drainage

The tip of the nose and the midline drain in the **submental lymph nodes.** The remaining parts drain in the **submandibular lymph nodes** then they drain in the **deep cervical lymph nodes.**

Innervation of the nose *(summarized in the figure below)*



The **olfactory nerve** (1st cranial nerve) arises from the **bipolar cell** at the olfactory region of the nose. The bipolar cell gives off 12-20 olfactory filaments. These filaments penetrate the cribriform plate of ethmoid i.e. enter the anterior cranial fossa where they form the olfactory bulb and the olfactory tract that ends in the **olfactory center** in the temporal lobe of the brain. This center contains all the experienced smells during lifetime. Any stimulation to this center is recognized (like distinguishing bad smells from good smells). This will be further explained in the CNS.

The **ophthalmic** and **maxillary branches** of the **trigeminal nerve** are responsible for general sensation (touching, temperature and pain).

The parasympathetic innervation is provided by the **facial nerve** (secretomotor innervation to the glands).

The anterior and posterior ethmoidal nerves

The posterior ethmoidal does not innervate the nose. It innervates the posterior ethmoidal air sinus.

The **anterior ethmoidal** innervates the upper anterior area and terminates as **external nasal nerve** (like the corresponding artery) to supply the skin of the nose.

Note, nerves share the same names with the accompanied arteries and take the same routes as them. E.g. the sphenopalatine (long and short) and palatine (greater and lesser).

The postero-superior quadrant is supplied by the **Posterior superior lateral nasal nerves** (from **short sphenopalatine**)

The **posterior inferior nasal nerve** branches from **the greater palatine nerve** and supplies the postero-inferior quadrant.

The **maxillary nerve** terminates as **infraorbital nerve** which innervates the maxillary air sinus and the anterior part of the nose.

As we mentioned earlier, the sphenopalatine nerve branches from the maxillary nerve and gives off long sphenopalatine nerve and short sphenopalatine nerve (supplies the postero-superior quadrant as mentioned upove).

Note that the long sphenopalatine forms **nasopalatine** *nerve which mainly supplies the* **septum** *and then enters the incisive canal to supply the mucosa of the oral cavity.*

The septum is mainly innervated by **the nasopalatine** and septal branch of **anterior ethmoidal** (see the figure above).

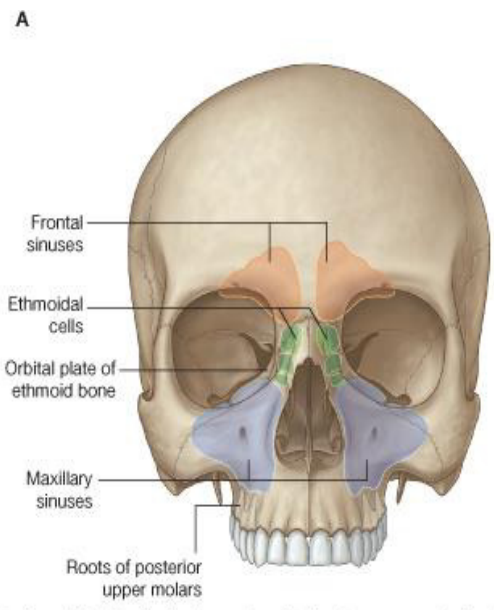
The lateral wall is innervated by anterior ethmoidal, long and short sphenopalatines, greater palatine and **infraorbital branch of -** most important **-**maxillary nerve (see the figure upove).

Also middle, and anterior superior alveolar nerves and nasal branch of alveolar innervate the lateral wall and reach upper teeth. All from **the maxillary nerve.**

The Paranasal Sinuses

Two frontal sinuses, six ethmoidal (anterior, middle and posterior), two sphenoid and two maxillary are located in some bones in the skull.

An **air sinus** is a space in the bone lined by thin respiratory mucosa with a few goblet cells and glands. The mucosa is firmly adherent to the periosteum. As we mentioned earlier, these air sinuses function in the resonance of the voice and also cause the variation in individuals' voices. Change in voice



indicates an infection (**sinusitis**). Also the paranasal sinuses decrease the weight of the skull and protect the brain cells.

The Frontal Air Sinus

It lies in the frontal bone in the skull and is triangular in shape. It drains in the infundibulum at the level of middle meatus. Innervated by supraorbital nerve (from ophthalmic) which arises from the supraorbital foramen.

The Ethmoidal Air Sinuses (ethmoidal cells)

Six in number, very small and each one is composed of one cell covered by mucosa (ethmoidal air cell).

Divided into anterior, middle and posterior ethmoidal cells. The posterior cell drains in the superior meatus while the anterior and middle cells drain in the middle meatus (the middle drains in bulla ethmoidalis and the anterior drains in the anterior part of hiatus semilunaris.

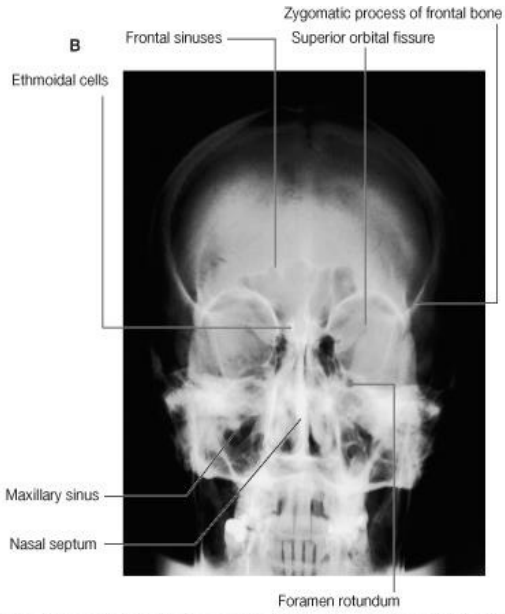
Are innervated by anterior and posterior ethmoidal branches from the nasociliary nerve (a branch from ophthalmic nerve).

The Maxillary Air Sinus

Its shadow can be shown in X-ray. Located in maxilla and is pyramidal in shape. At delivery it is rudimental then becomes relatively large by the age of eight years along with the enlargement of the bones of the face.

Its apex is directed laterally towards the zygomatic arch while the base is located on the lateral wall of the nose.

It has a bad venous drainage because its opening is directed high-up. It opens into the middle meatus.



Clinical case

When sinusitis in maxillary air sinus is not treated, it may evolve into a dangerous chronic infection which forms puss. So when the patient hangs their head low, a throbbing pain is felt in the maxilla. It's caused by the extraction of one molar tooth causing a **fistula** to form and drain the maxillary sinus. Treated by an incision anterior to the lower part of the maxillary air sinus. *Note that this fistula is a tract between the maxillary air sinus and the molar tooth.*

The maxillary sinus is innervated by infraorbital nerve and anterior superior alveolar (branches from maxillary nerve)

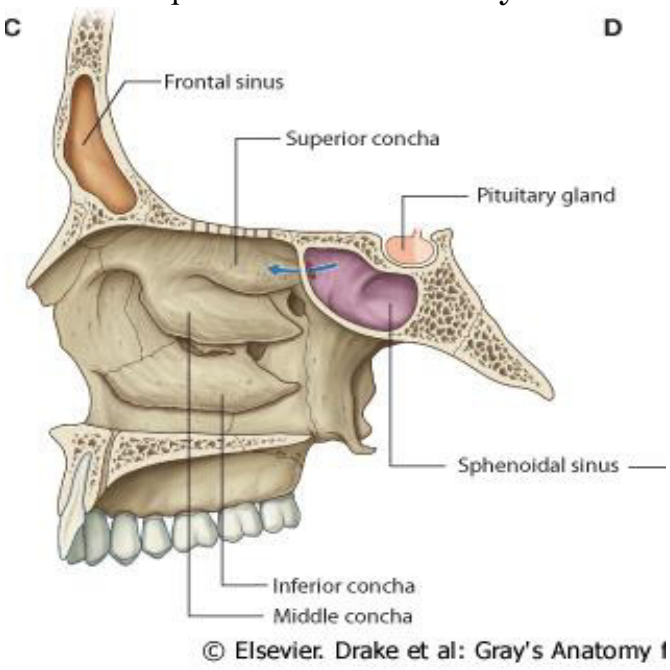
Relations

Related above to the orbital plate. Below to the upper molar teeth and premolar. Behind to the infratemporal fossa. Medially to the lower part of the nasal cavity.

The Sphenoid Air Sinus

It drains in the recess (sphenoethmoidal recess). It's located in the body of the sphenoid bone and above it is the pituitary gland which lies in the sella turcica.

A tumor in the pituitary gland causes it to enlarge in the sella turcica and to affect the sphenoid air sinus.



Innervation

By posterior ethmoidal branch of ophthalmic and from the maxillary via orbital branches.

Relations

Above by the **pituitary gland** and **optic chiasma** (crossing of the fibers of the optic nerve). Laterally by the cavernous sinus which contains nerves (like abducens nerve) and internal carotid artery. Below and in front by the nasal cavity.

-Thank You