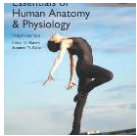




ANATOMY OF NOSE OLFACTORY NERVE

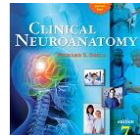
Khaleel Alyahya, PhD, MEd
www.khaleelalyahya.com

RESOURCES



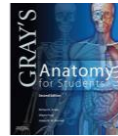
Essential of Human Anatomy & Physiology

By Elaine Marieb and Suzanne Keller



Clinical Neuroanatomy

By Richard Snell



Gray's Anatomy

By Richard Drake, Wayne Vogl & Adam Mitchell



Cranial Nerves

By Khaleel Alyahya



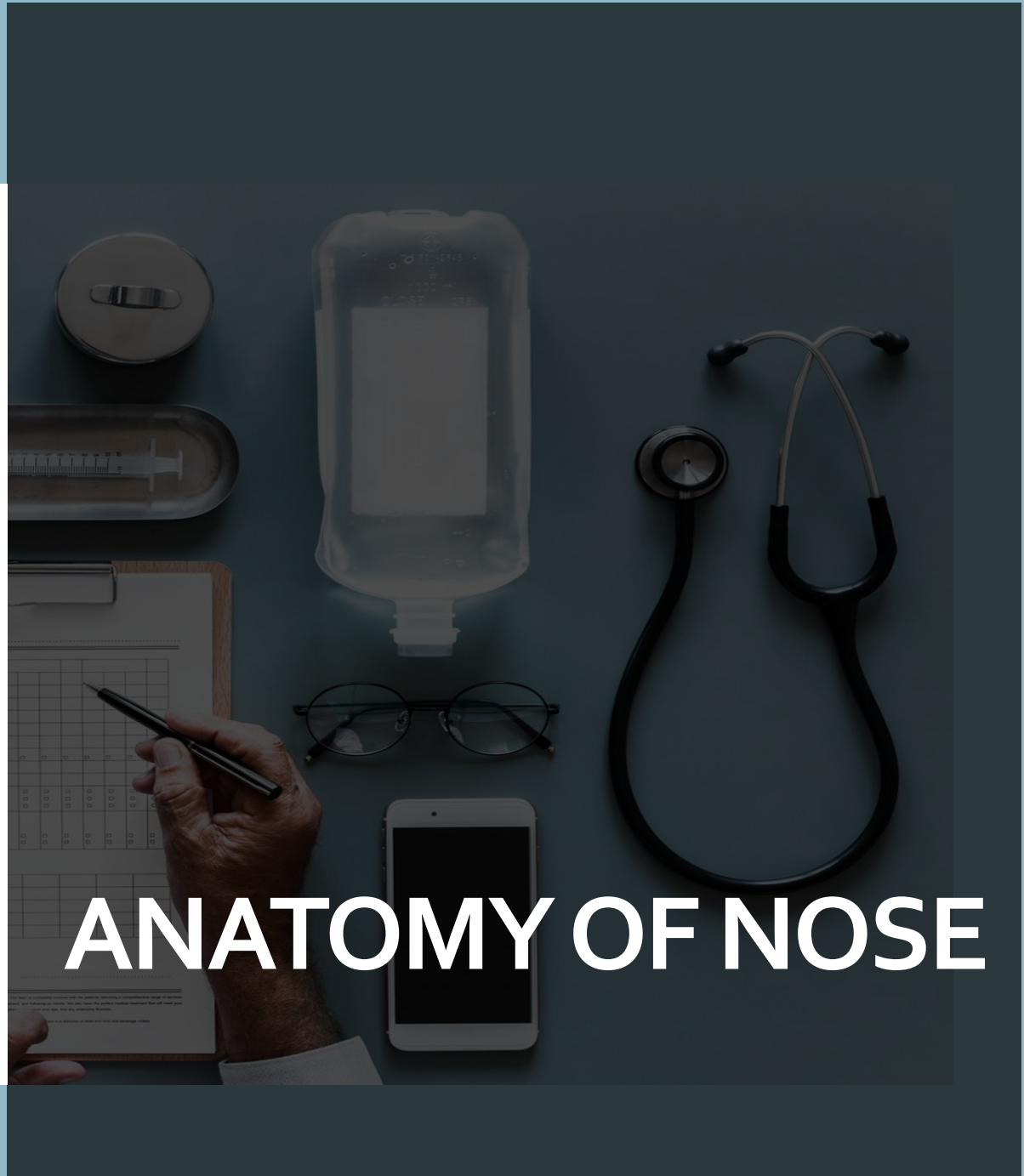
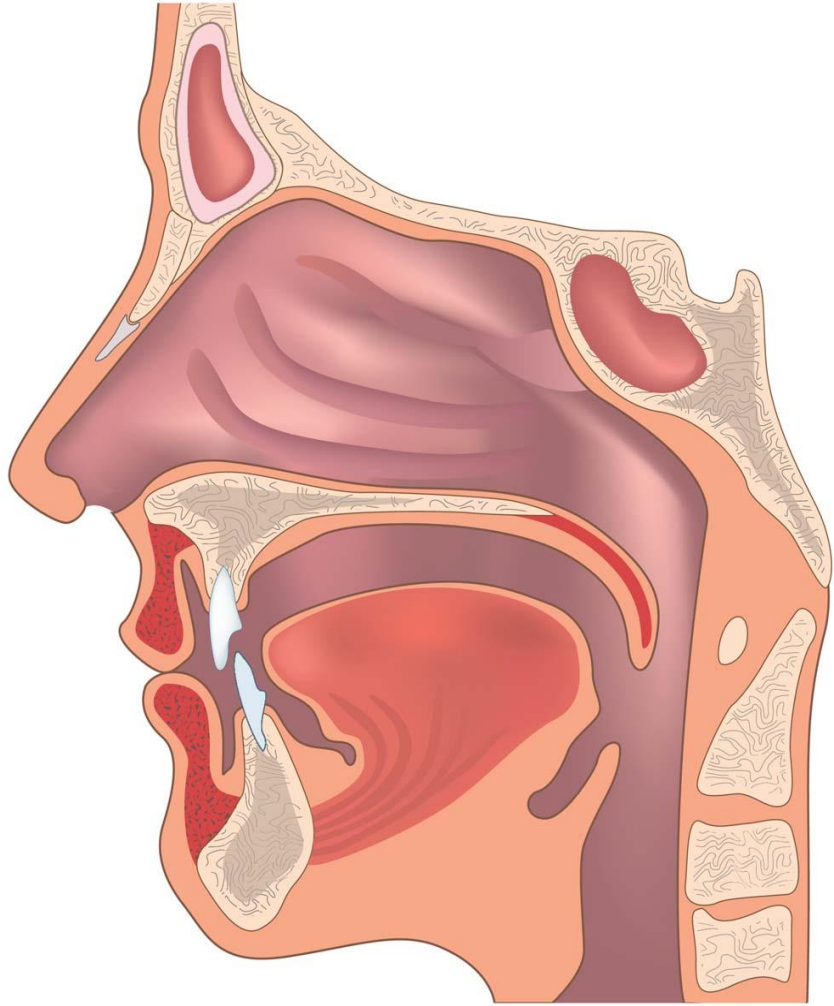
Teach Anatomy

www.teachanatomy.net

- Describe the structures forming the walls of the nasal cavity.
- List the main structures draining into the lateral wall of the nasal cavity.
- Differentiate between the respiratory and olfactory regions of the nasal cavity.
- List the main sensory and blood supply of the nose.
- Describe the olfactory pathway.
- Clinical Anatomy



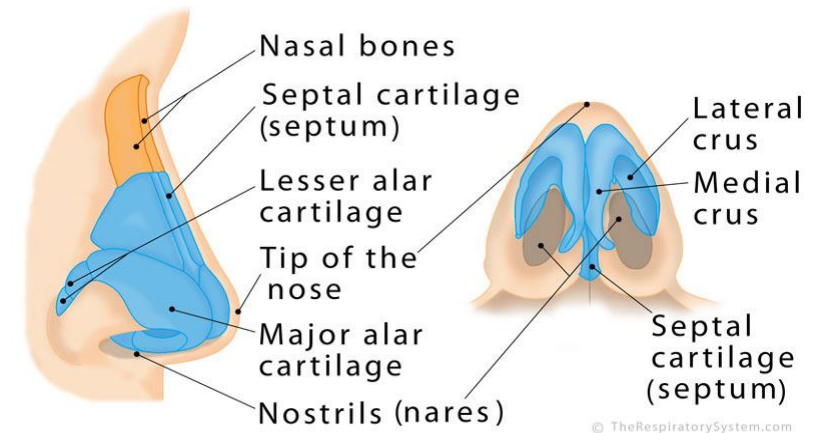
Objectives



ANATOMY OF NOSE

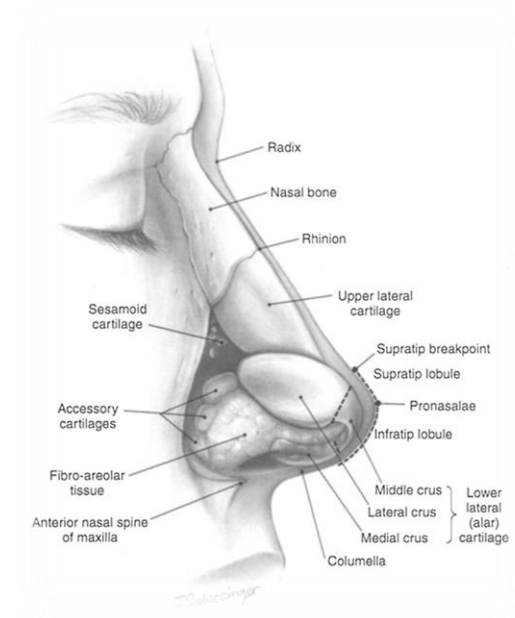
INTRODUCTION

- The external (anterior) nares or nostrils, lead to the nasal cavity.
- Formed above by bony skeleton.
- Formed below by plates of hyaline cartilage.
- Smell is considered chemical senses (Chemoreceptors).
 - Stimulated by chemicals in solution.
 - Smell can differentiate a wider range of chemicals.
 - Taste has five types of receptors.
- Both senses complement each other and respond to many of the same stimuli.



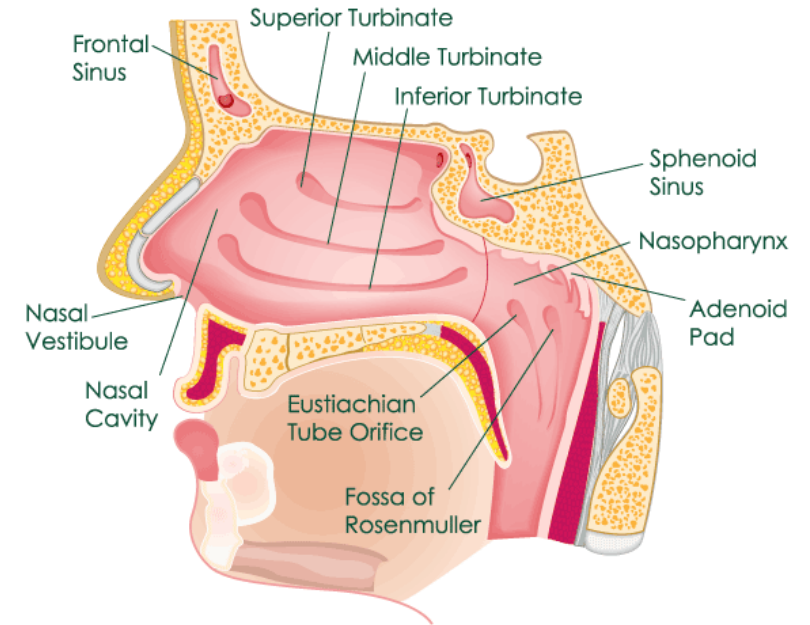
FUNCTIONS

- Olfaction
 - smell
- Respiration
 - breathing
- Warming the inspired air
 - submucous venous plexus
- Filtration of dust
- Humidification of the inspired air
 - Mucous
- Reception of secretions from the paranasal sinuses and nasolacrimal duct.



NASAL CAVITY

- It is a large air-filled space above and behind the nose in the middle of the face.
- Each cavity is the continuation of one of the two nostrils.
- It extends from nostrils anteriorly to turbinates (Choanae) posteriorly.
- It is divided into right and left parts by the nasal septum.
- It communicates with the nasopharynx posteriorly.
- It consists of **Vestibule**, **Respiratory** and **Olfactory** regions.
- Each contains, roof, floor, lateral and medial walls.



REGIONS

▪ Vestibule Region

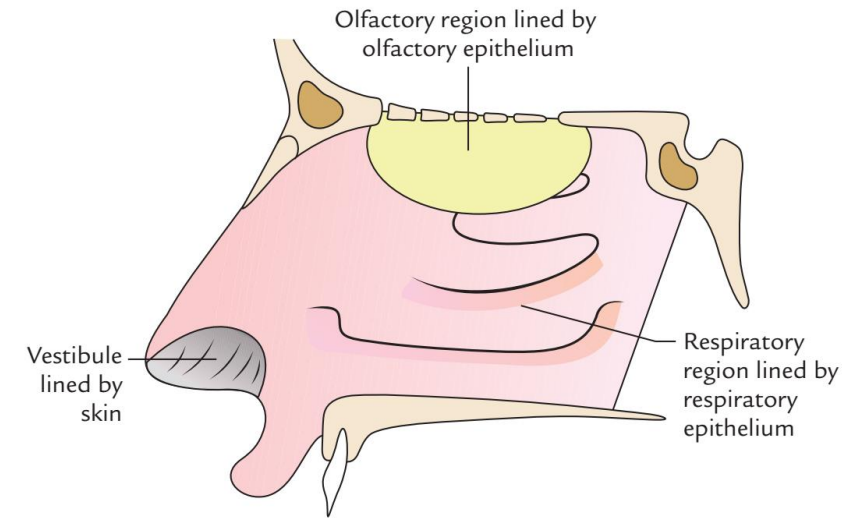
- The area surrounding the external opening to the nasal cavity
- Lined by modified skin, provided with hairs, and sebaceous glands, to filter the incoming air.

▪ Respiratory Region

- The largest and lined with mucous that is continuous with that of Nasal Sinuses, Lacrimal sac, Conjunctiva, and Nasopharynx.

▪ Olfactory Region

- Located at the apex of the nasal cavity.
- It is lined by olfactory cells with olfactory receptors.



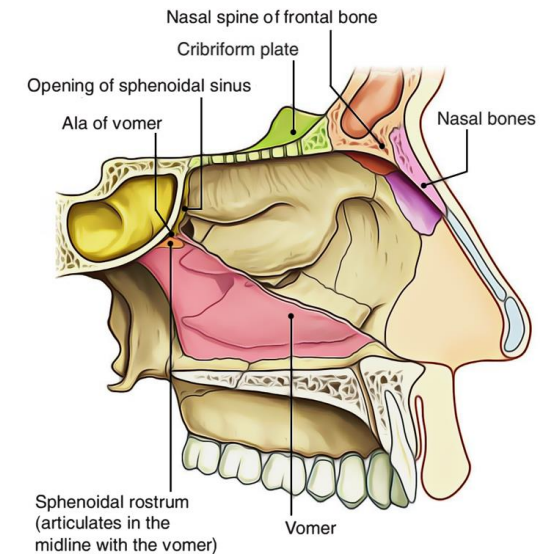
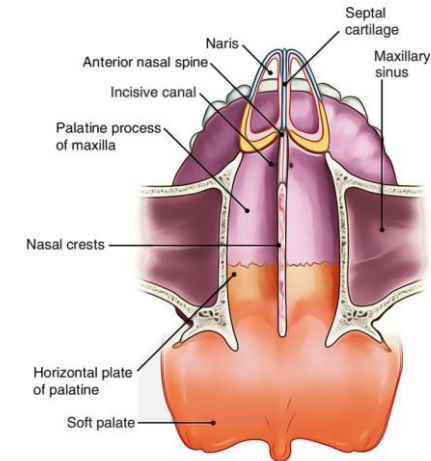
BOUNDARIES

■ Floor

- It is formed by nasal surface of the hard palate:
 - Palatine process of maxilla.
 - Horizontal plate of palatine bone.

■ Roof

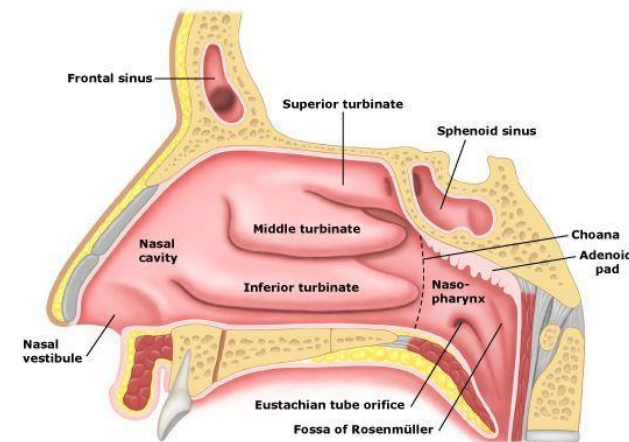
- It is formed by:
 - Body of sphenoid.
 - Cribriform plate of ethmoid.
 - Frontal bone.
 - Nasal bones.



BOUNDARIES

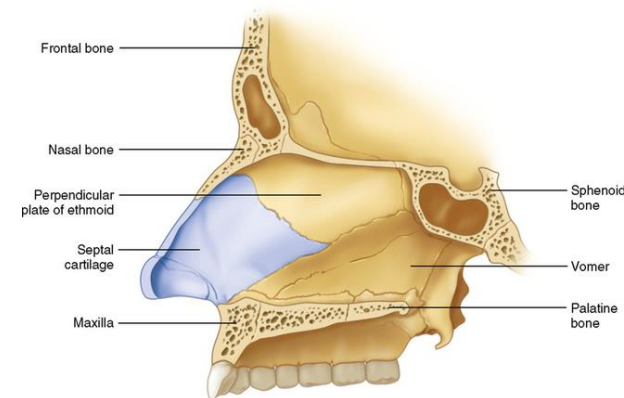
■ Lateral Wall

- It is marked by three projections; (nasal conchae)
 - Superior, middle, and inferior nasal conchae
- The space below each concha is called (meatus);
 - Superior, middle, and inferior meatuses.
- Sinuses opening in this wall:
 - Sphenoethmoidal recess opening of sphenoid air sinus
 - Superior meatus receives openings of posterior ethmoidal sinuses.
 - Middle meatus for opening of middle ethmoidal sinus.
 - Hiatus semilunaris for openings of maxillary sinus.
 - Infundibulum for frontal and anterior ethmoidal sinus.
 - Inferior meatus receives opening of nasolacrimal duct.
 - All sinuses open into the middle meatus **except**:
 - *Sphenoidal sinus: in sphenoethmoidal recess.*
 - *Posterior ethmoidal sinus: in superior meatus.*
 - The mucosal lining of these sinuses is continuous with that in the nose and the throat, so infection in this area tends to migrate into the sinuses causing sinusitis.

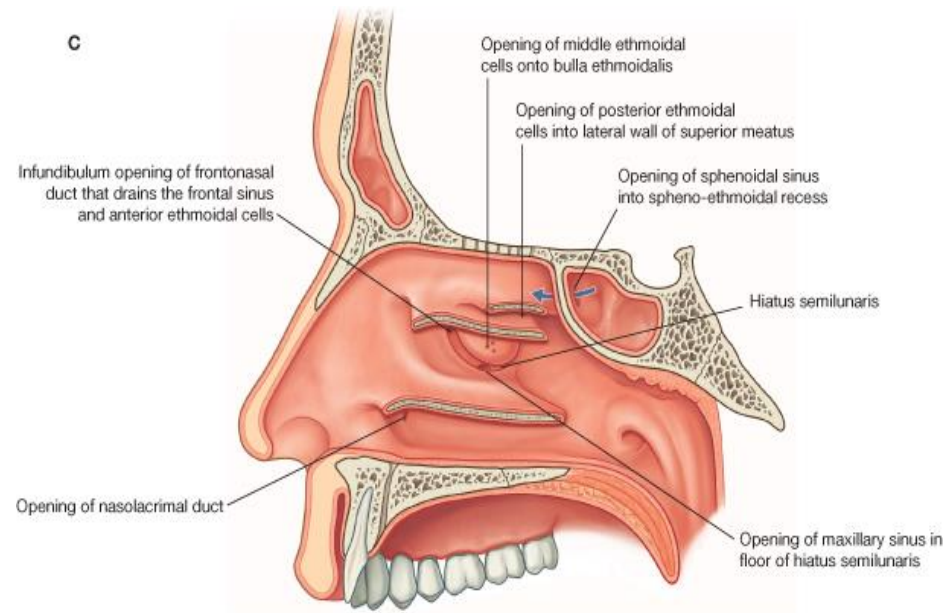


■ Medial Wall

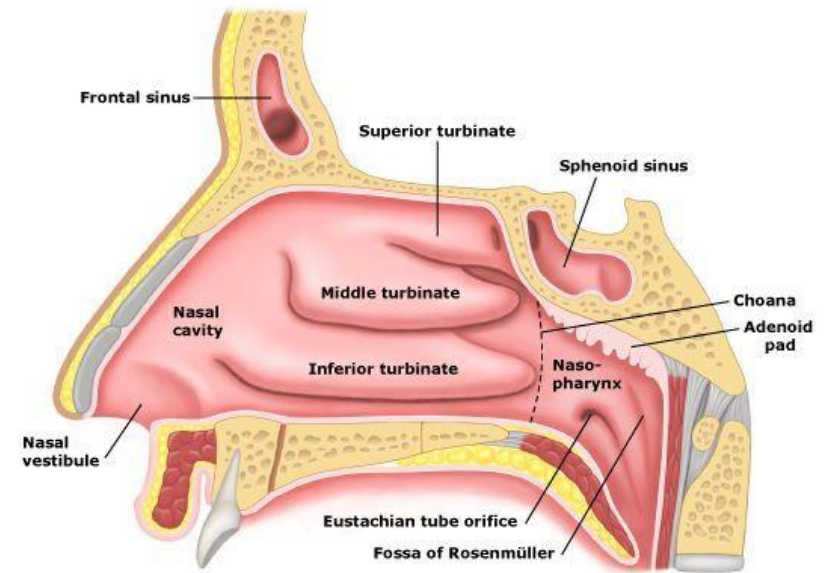
- It is formed by:
 - The nasal septum.
 - Vertical plate of ethmoid.
 - Vomer.
 - Septal cartilage.



OPENINGS AT LATERAL WALL

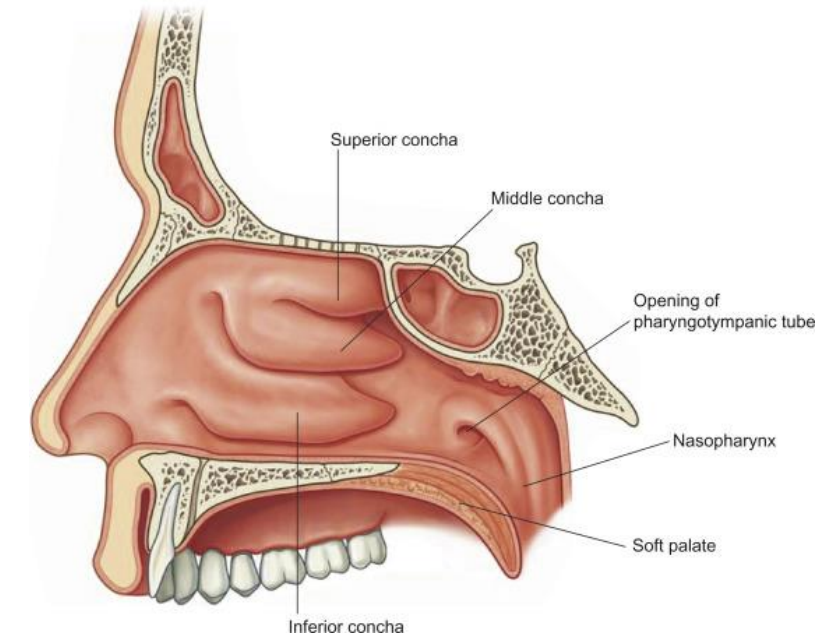


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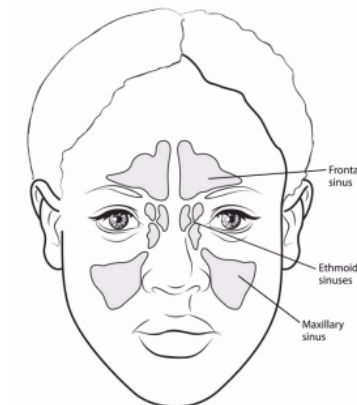
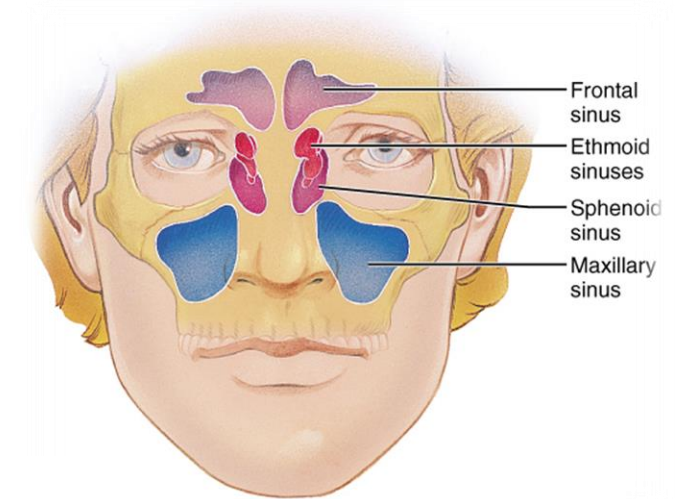
NASAL CONCHAE

- Projecting out of the lateral walls of the nasal cavity are curved shelves of bone.
- They project into the nasal cavity, creating four pathways for the air to flow. These pathways are called meatuses:
 - Inferior meatus: Lies between the inferior concha and floor of the nasal cavity.
 - Middle meatus: Lies between the inferior and middle concha.
 - Superior meatus: Lies between the middle and superior concha.
 - Spheno-ethmoidal recess: Lies superiorly and posteriorly to the superior concha.
- The function of the conchae is to increase the surface area of the nasal cavity to increase the amount of inspired air that can come into contact with the cavity walls.
- They also disrupt the fast, laminar flow of the air, making it slow and turbulent.
- The air spends longer in the nasal cavity, so that it can be humidified.



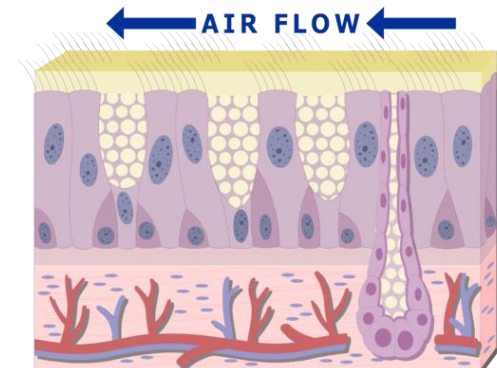
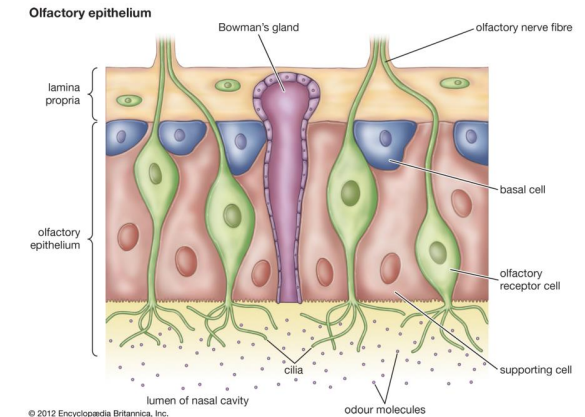
PARANASAL SINUSES

- They are a group of four paired air-filled spaces that surround the nasal cavity.
 - **Maxillary Sinuses:** the largest of the paranasal sinuses, located under the eyes in the maxillary bones.
 - **Frontal Sinuses:** superior to the eyes in the frontal bone, which forms the hard part of the forehead.
 - **Ethmoidal Sinuses:** formed from several discrete air cells within the ethmoid bone between the nose and the eyes.
 - **Sphenoidal Sinuses:** in the sphenoid bone.
- Characteristics:
 - **Lined** with mucoperiosteum.
 - **Filled** with air.
 - **Communicate** with the nasal cavity.
 - **Open** in the lateral wall of the nasal cavity
- Functions:
 - **Decreasing** the relative weight of the front of the skull, and especially the bones of the face.
 - **Increasing** resonance of the voice.
 - **Providing** a buffer against facial trauma.
 - **Insulating** sensitive structures like dental roots and eyes from rapid temperature fluctuations in the nasal cavity.
 - **Humidifying** and heating of inhaled air because of slow air turnover in this region.



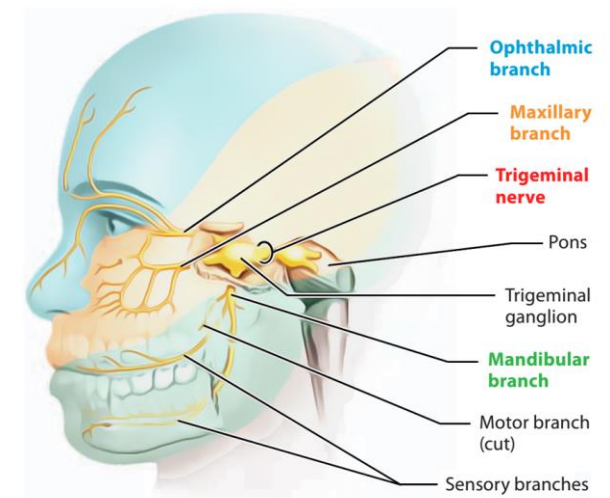
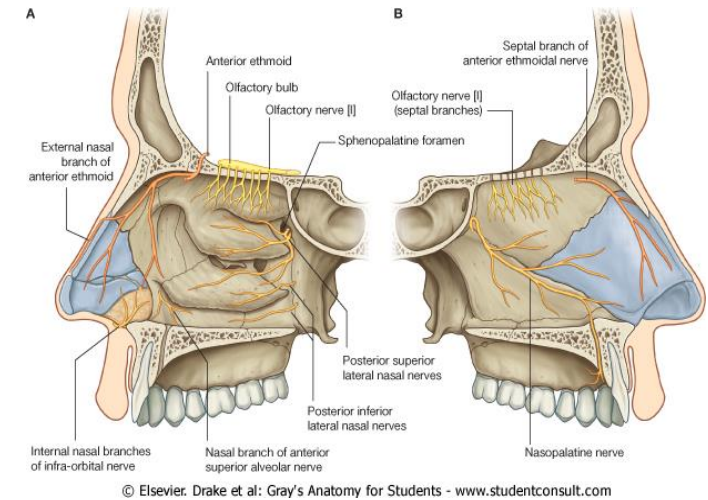
NASAL MUCOSA

- **Olfactory Mucosa:**
 - It is delicate and contains olfactory nerve cells.
 - It is present in the upper part of nasal cavity.
 - On the lateral wall, it lines the upper surface of the superior concha and the sphenoidal recess.
 - On the medial wall, it lines the superior part of the nasal septum.
- **Respiratory Mucosa:**
 - It is thick, ciliated, highly vascular and contains mucous glands & goblet cells.
 - It lines the lower part of the nasal cavity (from skin of vestibule to the superior concha).
 - It functions to moisten, clean and warm the inspired air.
 - The air is moistened by the secretion of numerous serous glands.
 - It is cleaned by the removal of the dust particles by the ciliary action of the columnar ciliated epithelium that covers the mucosa.
 - The air is warmed by a submucous venous plexus.



INNERVATION

- Nerves of smell:
 - Olfactory Nerves (Cr 1).
- Nerves of general sensation:
 - Ophthalmic and Maxillary divisions of Trigeminal nerve (Cr 5).
 - Anterior part is supplied by anterior ethmoidal nerve.
 - Posterior part is supplied by branches of the pterygopalatine ganglion:
 - Nasopalatine
 - Nasal
 - Palatine



BLOOD SUPPLY

■ Arterial supply

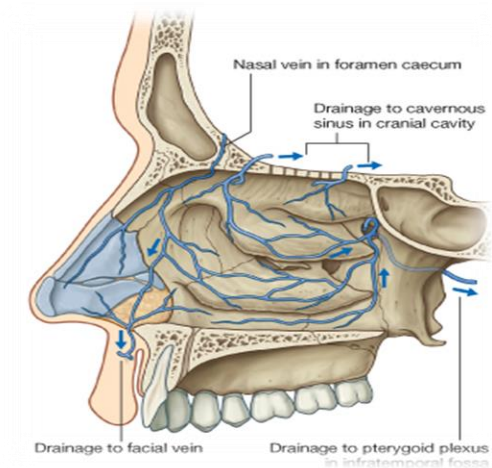
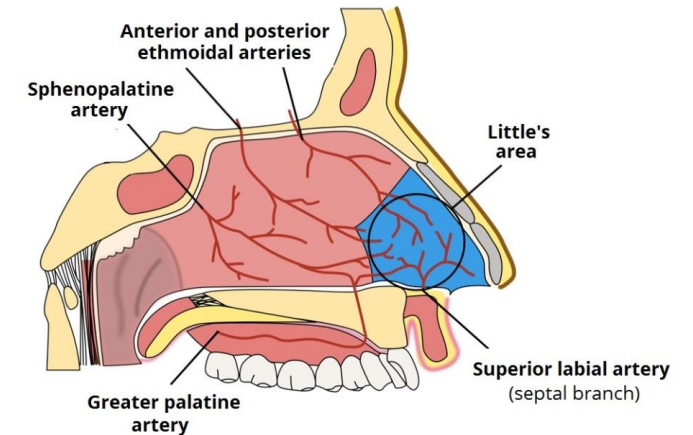
- **Internal carotid branches:**
 - Anterior ethmoidal artery
 - Posterior ethmoidal artery
 - The ethmoidal arteries are branch of the ophthalmic artery.
 - The ophthalmic artery is a branch of internal carotid artery.
- **External carotid branches:**
 - Sphenopalatine artery
 - Greater palatine artery
 - Superior labial artery
 - Lateral nasal arteries

■ Venous drainage

- Plexus in submucosa by veins accompany the arteries.
- They drain into cavernous sinus & pterygoid venous plexus.

■ Lymph drainage

- Submandibular and upper deep cervical nodes.



- **NOSEBLEED**

- It is common case due to rich blood supply of the nose.
- Most likely occur in anterior third of nasal cavity.
- Cause could be local due to trauma or systemic due to hypertension.

- **DISEASES OF THE NASAL CAVITY INCLUDE:**

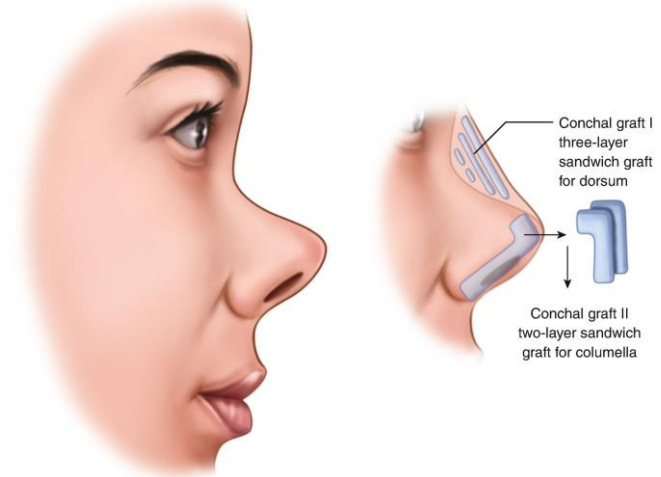
- Viral
- Bacterial
- Fungal infections
- Nasal cavity tumors
- Inflammations of the nasal mucosa



CLINICAL NOTES

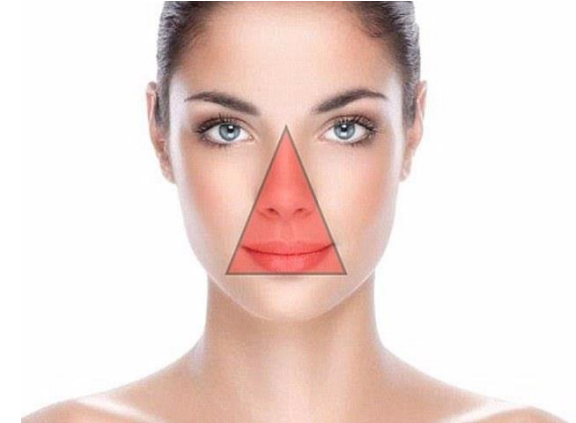
SADDLE NOSE DEFORMITY

- The saddle nose deformity occurs primarily as a result of nasal trauma; whereby septal support to the nose is lost, and subsequently the middle part of the nose appears sunken.
- This is either a result of direct damage to the septal bone or cartilage, or a consequence of nasal septal haematoma.
- As cartilage has no blood supply of its own, it relies on oxygen and nutrients diffusing from blood vessels in the surrounding perichondrium.
- A haematoma between these two structures can result in destruction of the septum, and therefore deformity of the nose.



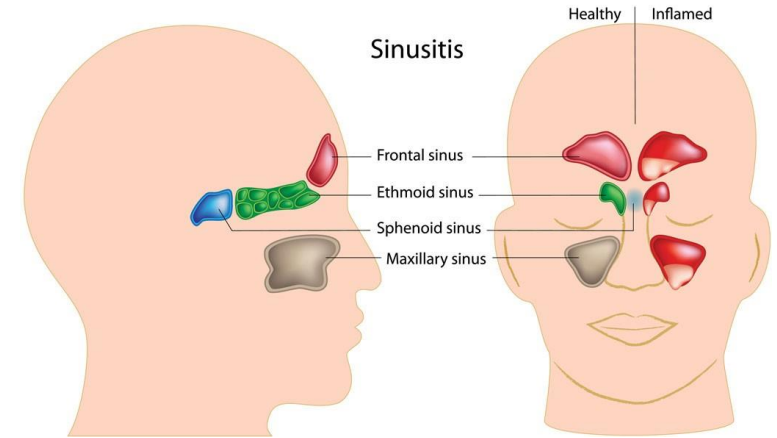
DANGER TRIANGLE OF THE FACE

- The venous drainage of the nose and surrounding area is unique as a result of communication between the facial vein and cavernous sinus, via the ophthalmic vein.
- As the cavernous sinus lies within the cranial cavity, this enables infections from the nasal area to spread to the brain.
- This retrograde spread of infection can therefore cause cavernous sinus thrombosis, meningitis or brain abscess.



SINUSITIS

- As the paranasal sinuses are continuous with the nasal cavity, an upper respiratory tract infection can spread to the sinuses.
- Infection of the sinuses causes inflammation (particularly pain and swelling) of the mucosa and is known as sinusitis.
- If more than one sinus is affected, it is called pansinusitis.
- The maxillary nerve supplies both the maxillary sinus and maxillary teeth, and so inflammation of that sinus can present with toothache.



SPREAD OF INFECTION

- As the auditory tube connects the middle ear and upper respiratory tract, it is a path by which infection can spread from the upper respiratory tract to the ear.
- Infection of the auditory tube causes swelling of the mucous linings, and the tube becomes blocked. This results in diminished hearing.



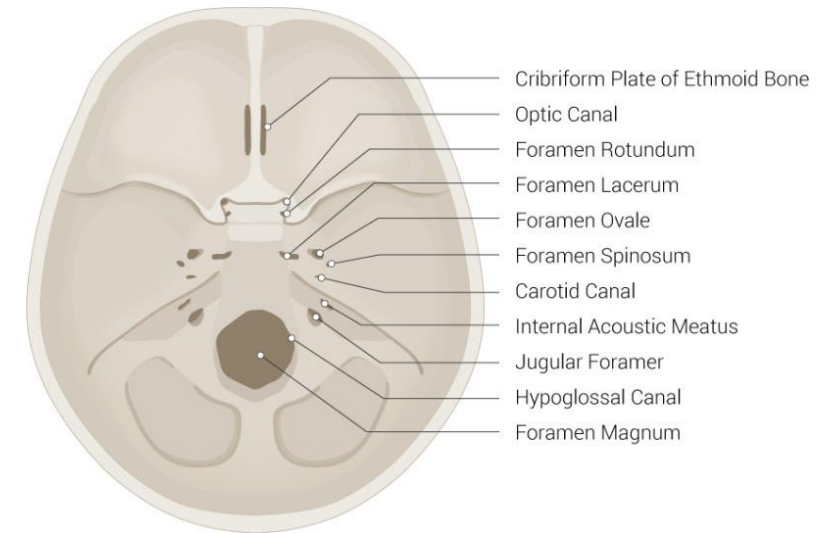
EPISTAXIS

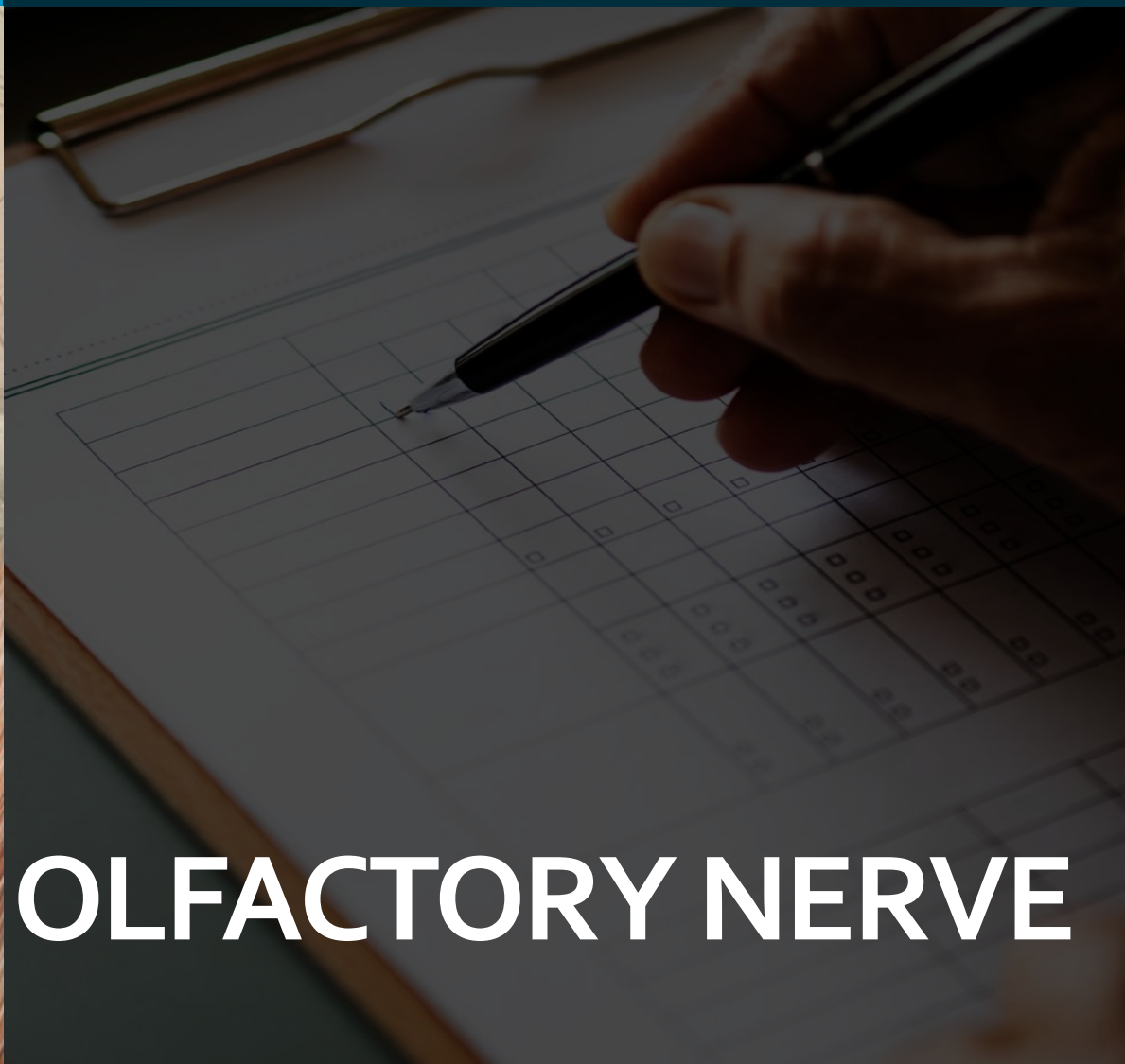
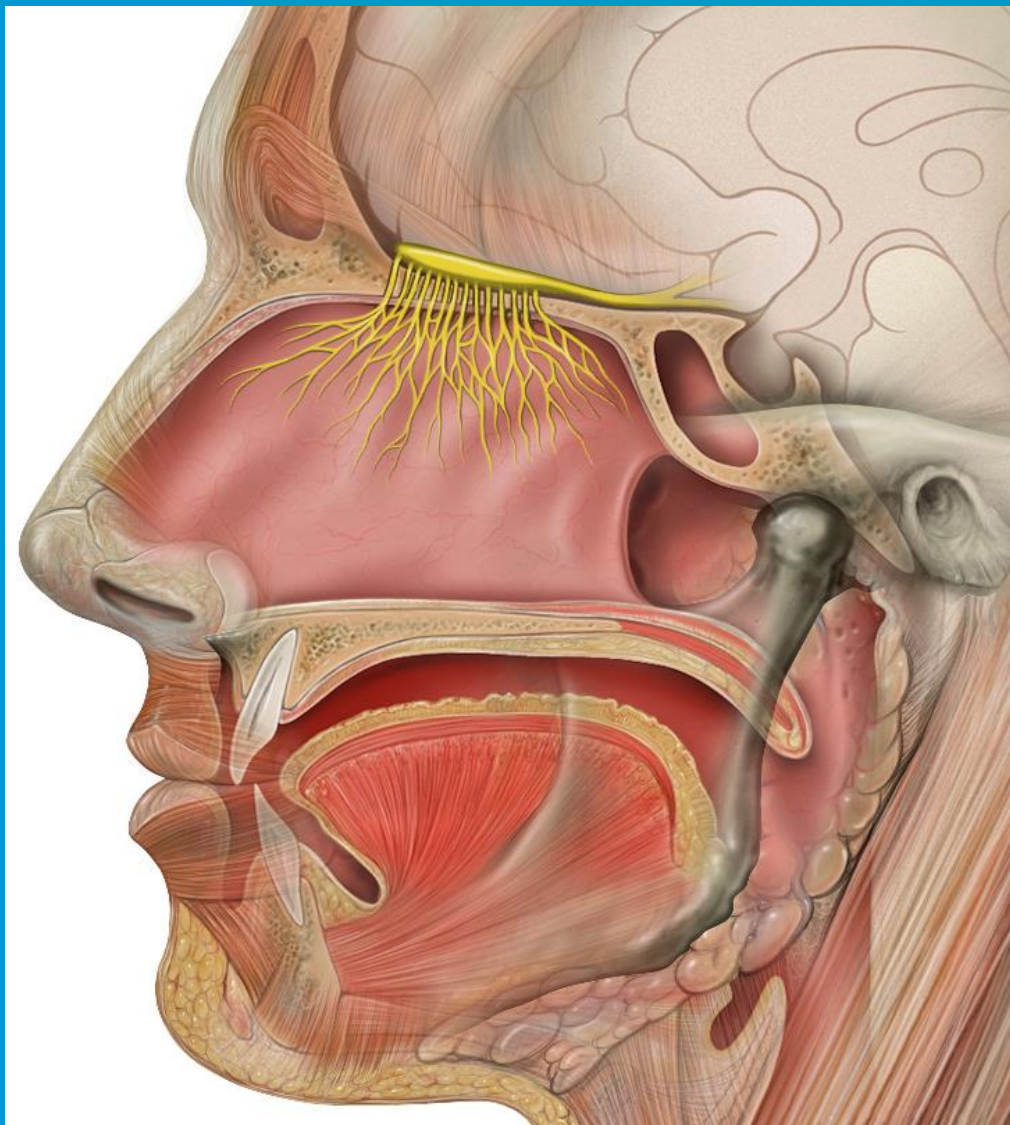
- Epistaxis is the medical term for a nosebleed.
- It is a common case due to the rich blood supply of the nose.
- It is most likely to occur in the anterior third of the nasal cavity.
- The cause can be local (such as trauma), or systemic (such as hypertension).



CRIBRIFORM PLATE FRACTURE

- A fracture of the cribriform plate can occur as a result of nose trauma.
- It is either fractured directly by the trauma, or by fragments of the ethmoid bone.
- A fractured cribriform plate can penetrate the meningeal linings of the brain, causing leakage of cerebrospinal fluid.
- Exposing the brain to the outside environment like this increases the risks of meningitis, encephalitis and cerebral abscesses.
- The olfactory bulb lies on the cribriform plate and can be damaged irreversibly by the fracture.
- In this case, the patient may present with anosmia (loss of smell).

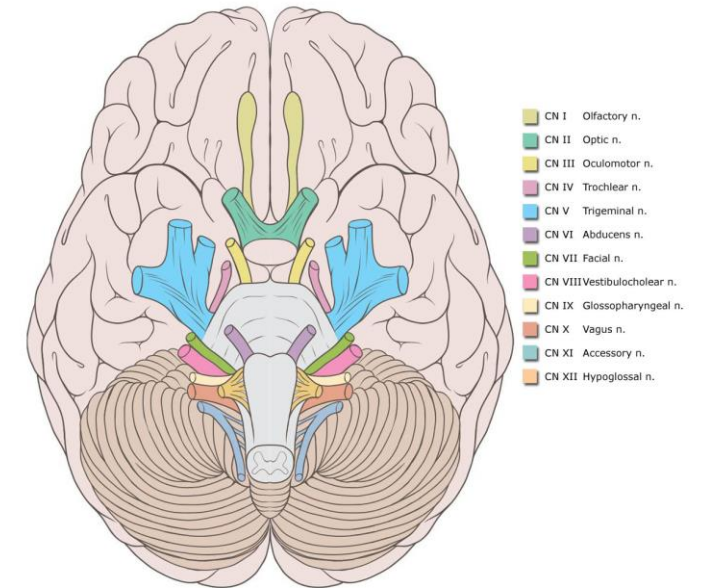




OLFACTORY NERVE

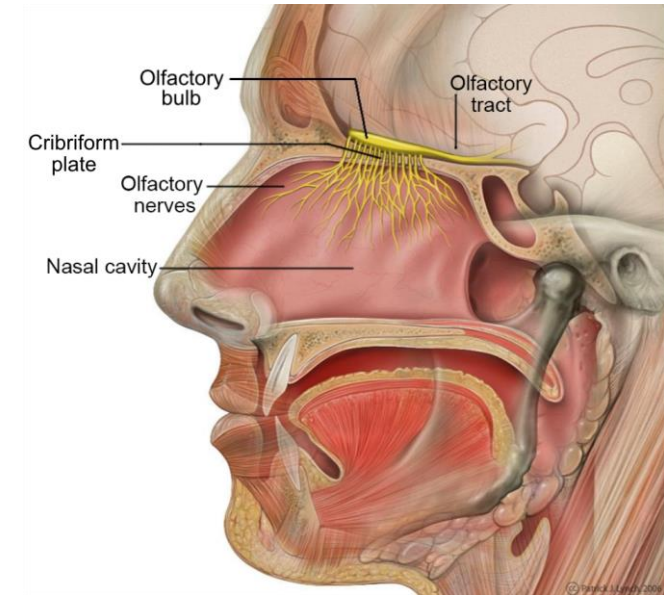
CRANIAL NERVES

- There are 12 pairs of cranial nerves in our body (I-XII).
- They are called cranial nerve because they originated directly from the brain.
- They communicate and relay information between the brain and parts of the body, primarily to and from regions of the head and neck.
- They are generally named from anterior to posterior based on structure or function.
- For example, the olfactory nerve (I) provides smell, and the facial nerve (VII) provides motor innervation to the face.



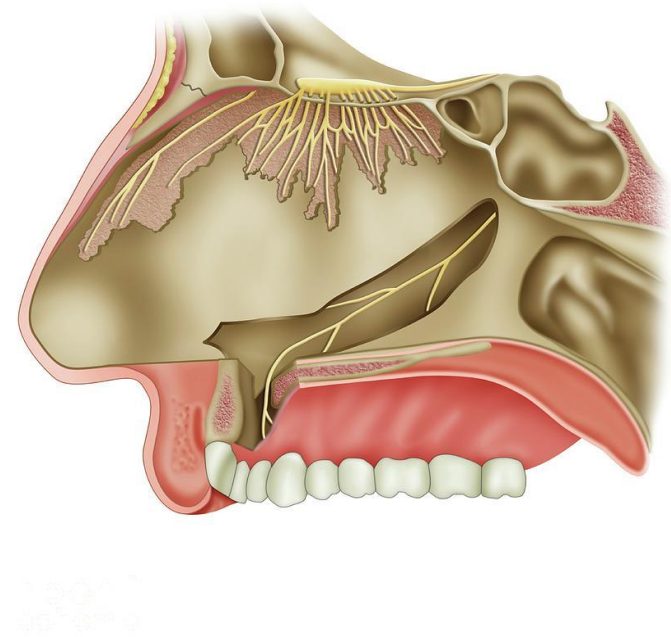
OLFACTORY NERVE

- The first and shortest cranial nerve.
- It is the nerve to transmits special sensory information to have a sense of smell.
- It is one of two nerves that DO NOT emerge from brainstem,
- Elderly people usually have less sensation of smell probably because of progressive reduction in number of olfactory cells.



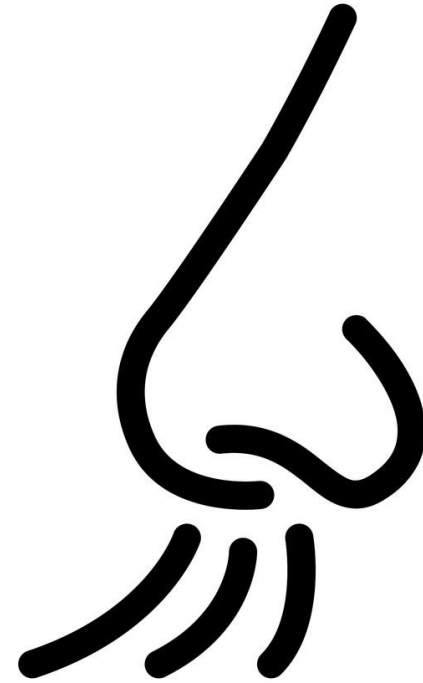
IMPORTANCE

- We will ever appreciate the smell of morning cup of coffee or the odor an authentic brand perfume if we perform great function of olfactory nerve.
- The secretion of the saliva in the mouth will be increased if the smell of a great meal of chicken touches the cilia in olfactory region located in the top of nasal cavity to transmit that smell to the brain.
- Moreover, great memories are connected to the sense of smell.



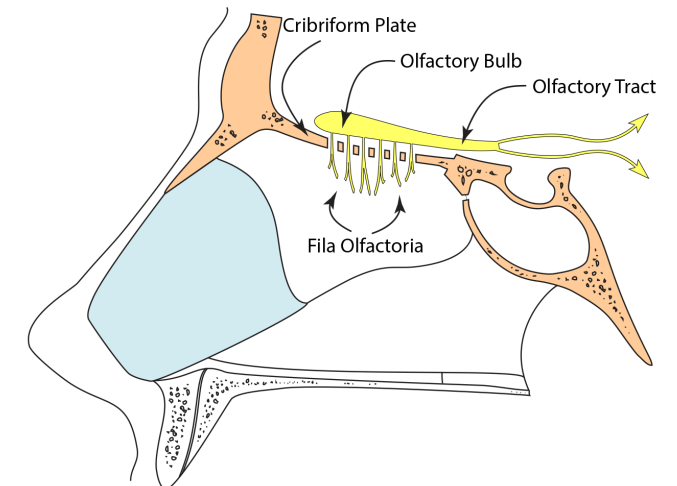
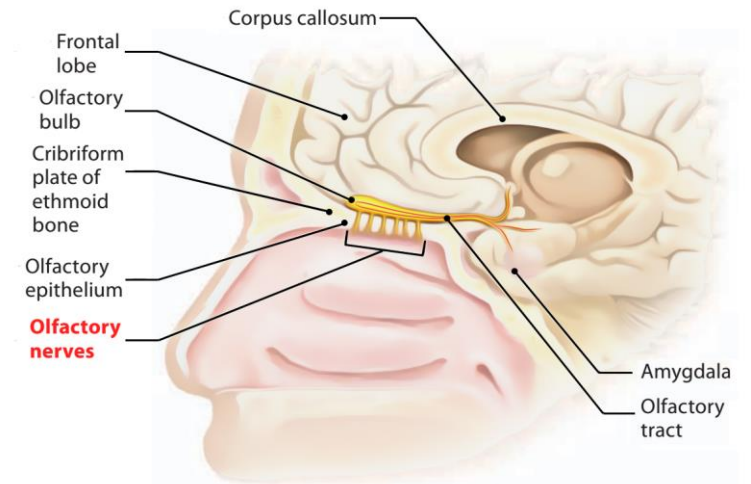
FUNCTIONS

- It is only sensory.
- Function is to carry afferent impulses for the sense of smell.



NERVE COURSE

- At the top of nasal cavity, the olfactory receptors are embedded into the olfactory epithelium to detect chemicals that activate the sense of smell.
- The axons of those cells form fila olfactoria where they are collected into small bundles of true olfactory nerves.
- Through the puncture of small foramina in cribriform plate of the ethmoid bone, the axons pass into the cranial cavity.
- Immediately after reaching the cranial cavity, those fibres access the olfactory bulb found in the olfactory groove within the anterior cranial fossa.
- The nerve fibers run withing the olfactory bulb as olfactory tracts to reach the olfactory cortex in the temporal lobe.
- The olfactory tract, on the posterior and anterior sides of the optic chiasm, is divided into lateral and medial olfactory striae.
- The lateral stria continues on to structures associated with the olfactory cortex.
- The medial stria protrudes to the anterior commissure to contralateral olfactory structures



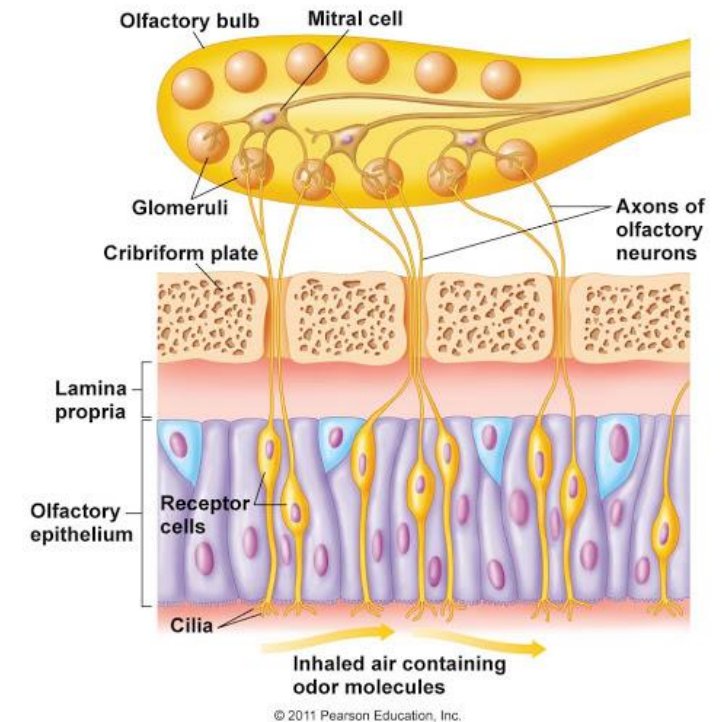
OLFACTORY PATHWAY

■ First neurons:

- Olfactory receptors are specialized, ciliated nerve cells that lie in the olfactory epithelium.
- The axons of these bipolar cells 12-20 fibers form the true olfactory nerve fibers, which passes through the cribriform plate of ethmoid.
- They join the olfactory bulb.
- Preliminary processing of olfactory information is within the olfactory bulb, which contains interneurons and large Mitral cells; axons from the latter leave the bulb to form the olfactory tract.

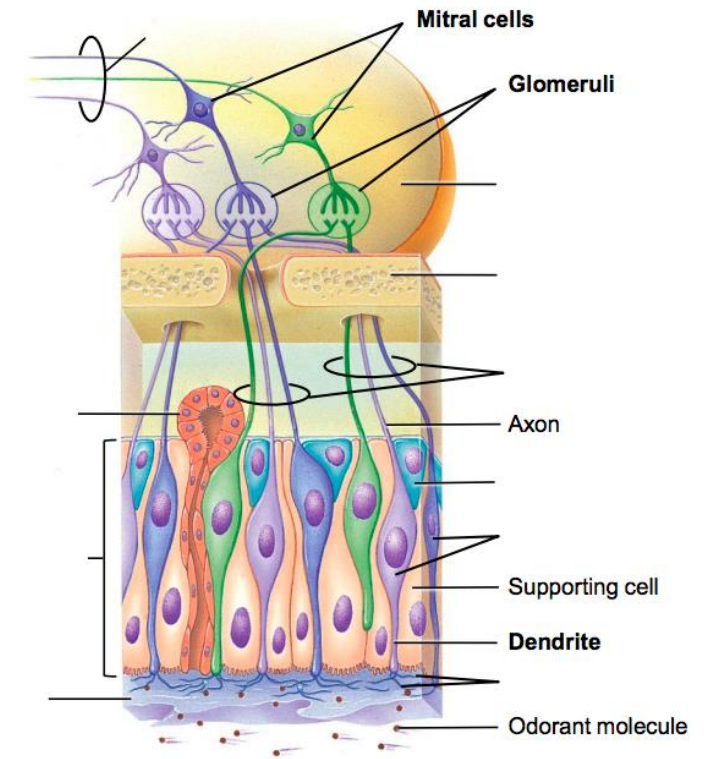
■ Second neurons:

- It is formed by the Mitral cells of olfactory bulb.
- The axons of these cells form the olfactory tract.
- Each tract divides into two roots at the anterior perforated substance:
- Lateral root carries olfactory fibers to end in cortex of the Uncus & adjacent part of Hippocampal gyrus (center of smell).
- Medial root crosses midline through anterior commissure and joins the uncrossed lateral root of opposite side.
- It connects olfactory centers of two cerebral hemispheres. Thus, each olfactory center receives smell sensation from both halves of nasal cavity.
 - *NB. Olfactory pathway is the only sensory pathway which reaches the cerebral cortex without passing through the Thalamus.*



OLFACTORY BULB

- In the cranial cavity, the fibers enter the olfactory bulb, which lies in the olfactory groove, within the anterior cranial fossa.
- The olfactory bulb is an ovoid structure which contains specialized neurons, called mitral cells.
- The olfactory nerve fibers synapse with the mitral cells, forming collections known as synaptic glomeruli.
- From the glomeruli, **second order nerves** then pass posteriorly into the olfactory tract.



OLFACTORY TRACT

- The olfactory tract runs inferiorly to the frontal lobe to reaches the anterior perforated substance to divides into medial and lateral stria:
 - The lateral stria carry the axons to the olfactory area of the cerebral cortex (also known as the primary olfactory cortex).
 - The medial stria carry the axons across the medial plane of the anterior commissure where they meet the olfactory bulb of the opposite side.
- The primary olfactory cortex sends nerve fibers to many other areas of the brain, like piriform cortex, amygdala, olfactory tubercle and the secondary olfactory cortex.
- These areas are involved in the memory and appreciation of olfactory sensations.

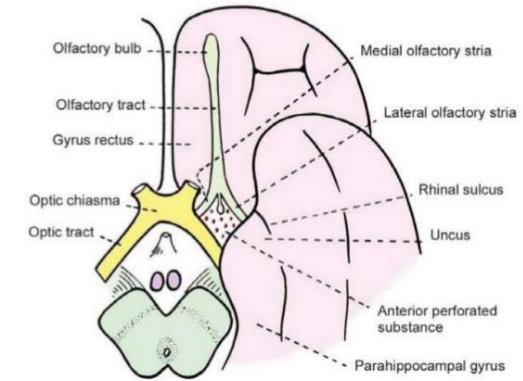
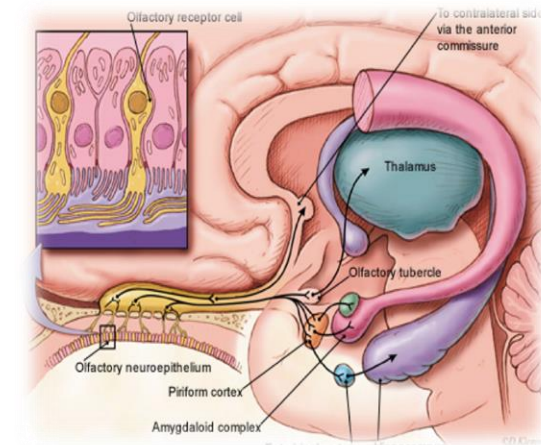
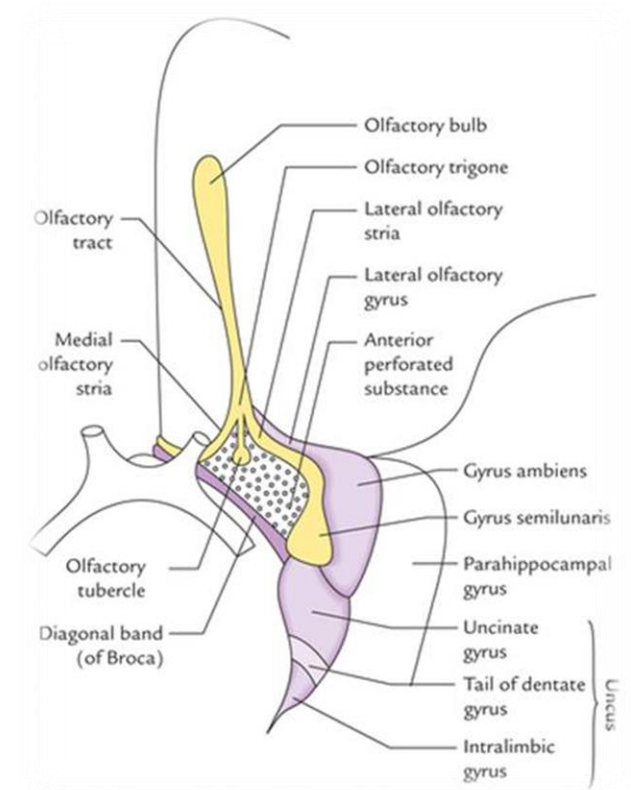


Fig. 16.1. Some structures related to the anterior part of the base of the brain.



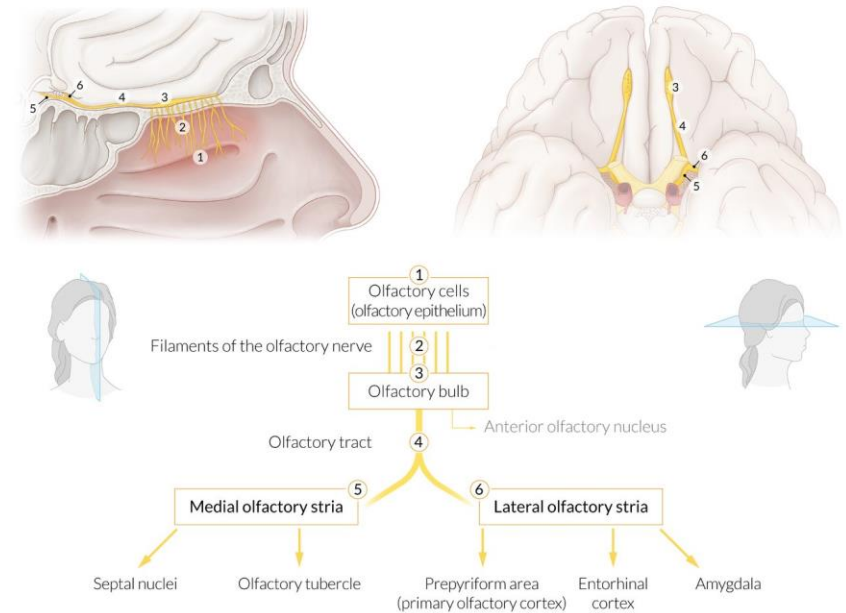
OLFACTORY STRIAE

- Posterior and anterior to the optic chiasm, the olfactory tract on both sides divides into medial and lateral olfactory striae.
- The medial stria projects to the anterior commissure, and then to contralateral olfactory structures.
- The lateral stria continues to structures associated with the olfactory cortex.



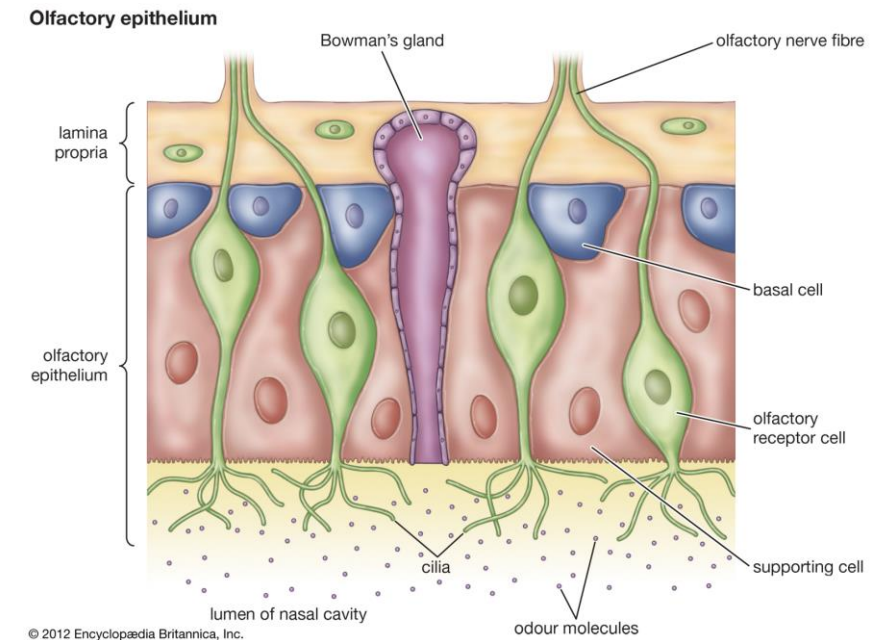
NERVE PATHWAY

- It is important to note that the olfactory nerve is made up of multiple nerve fibers/rootlets coming from the receptor's cells.
- The pathway can be summarized as follows:
 - olfactory receptor cells
 - olfactory nerves
 - olfactory bulb
 - olfactory tract
 - olfactory striae
 - olfactory cortex



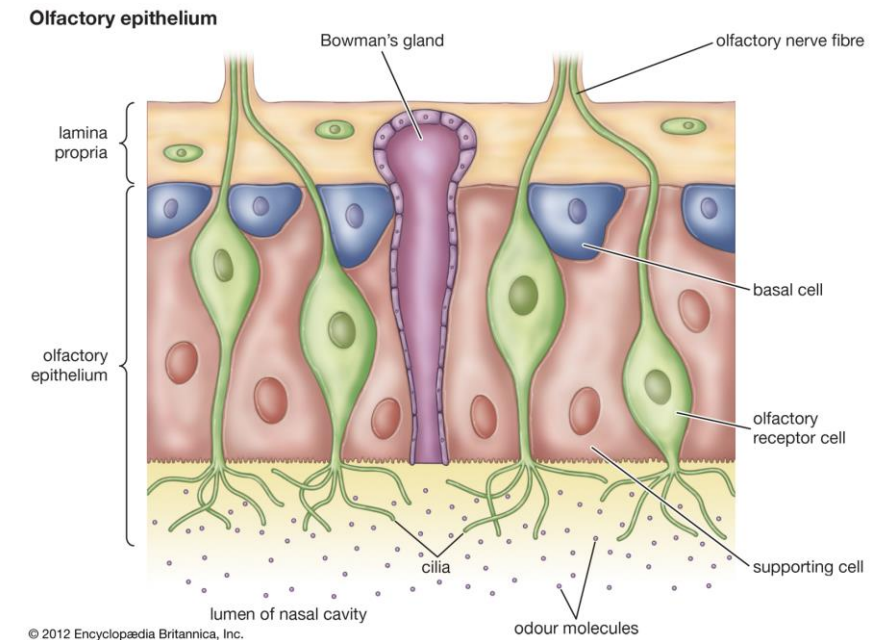
OLFACTORY MUCOSA

- The olfactory mucosa is a very important structure as it not only senses smell, but also the more advanced aspects of taste.
- It is located in the roof of the nasal cavity and is composed of pseudostratified columnar epithelium which contains a number of cells.



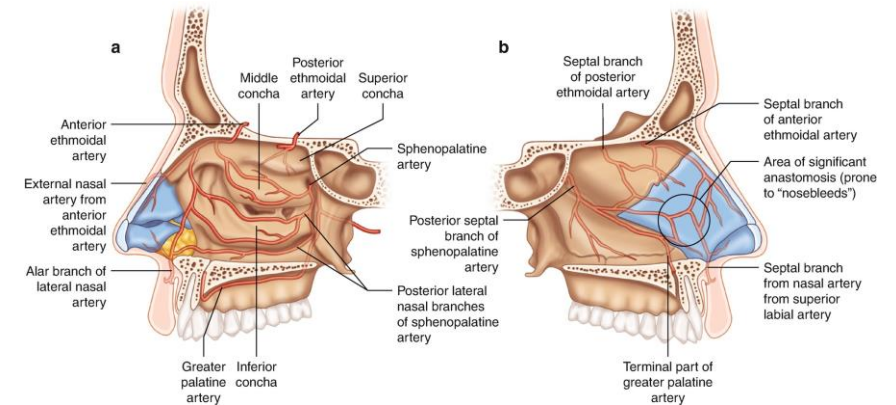
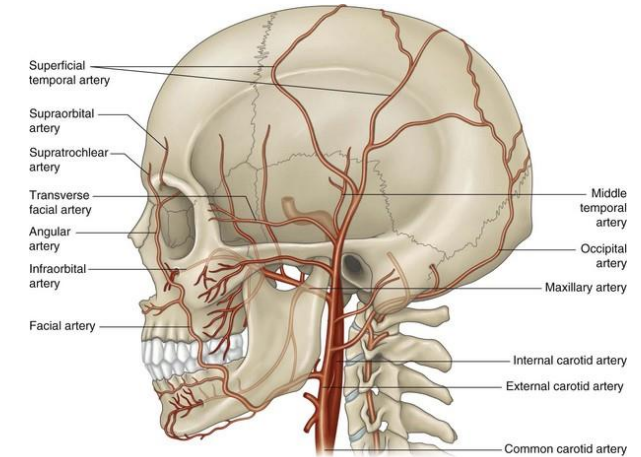
MUCOSA CELLS

- **Basal cells:** form the new stem cells from which the new olfactory cells can develop.
- **Sustentacular cells:** tall cells for structural support. These are similar to the glial cells located in the CNS.
- **Olfactory receptor cells:** bipolar neurons which have two processes, a dendritic process and a central process. The dendritic process projects to the surface of the epithelium, where they project a number of short cilia, the olfactory hairs, into the mucous membrane. These cilia react to odors in the air and stimulate the olfactory cells. The central process (also known as the axon) projects in the opposite direction through the basement membrane.
- There are also **Bowman's glands** present in the mucosa, which secrete mucus.



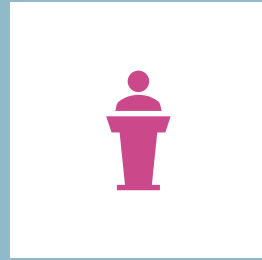
BLOOD SUPPLY

- The nasal cavity, including the olfactory epithelium receives blood supply from several branches including the carotid (external and internal) arteries, the sphenopalatine artery and the ethmoidal (anterior and posterior) arteries.
- The external carotid artery gives off the maxillary artery which it then gives off the sphenopalatine artery.
- The sphenopalatine artery within pterygopalatine fossa reaches the upper nasal cavity posterosuperior to the middle nasal conchae to form extensive network of major branches include the posterior lateral nasal and nasal septal arteries.
- The ophthalmic artery, which is a branch of the internal carotid artery gives off two branches, the anterior and posterior ethmoidal arteries.

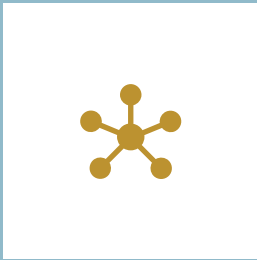




Anosmia



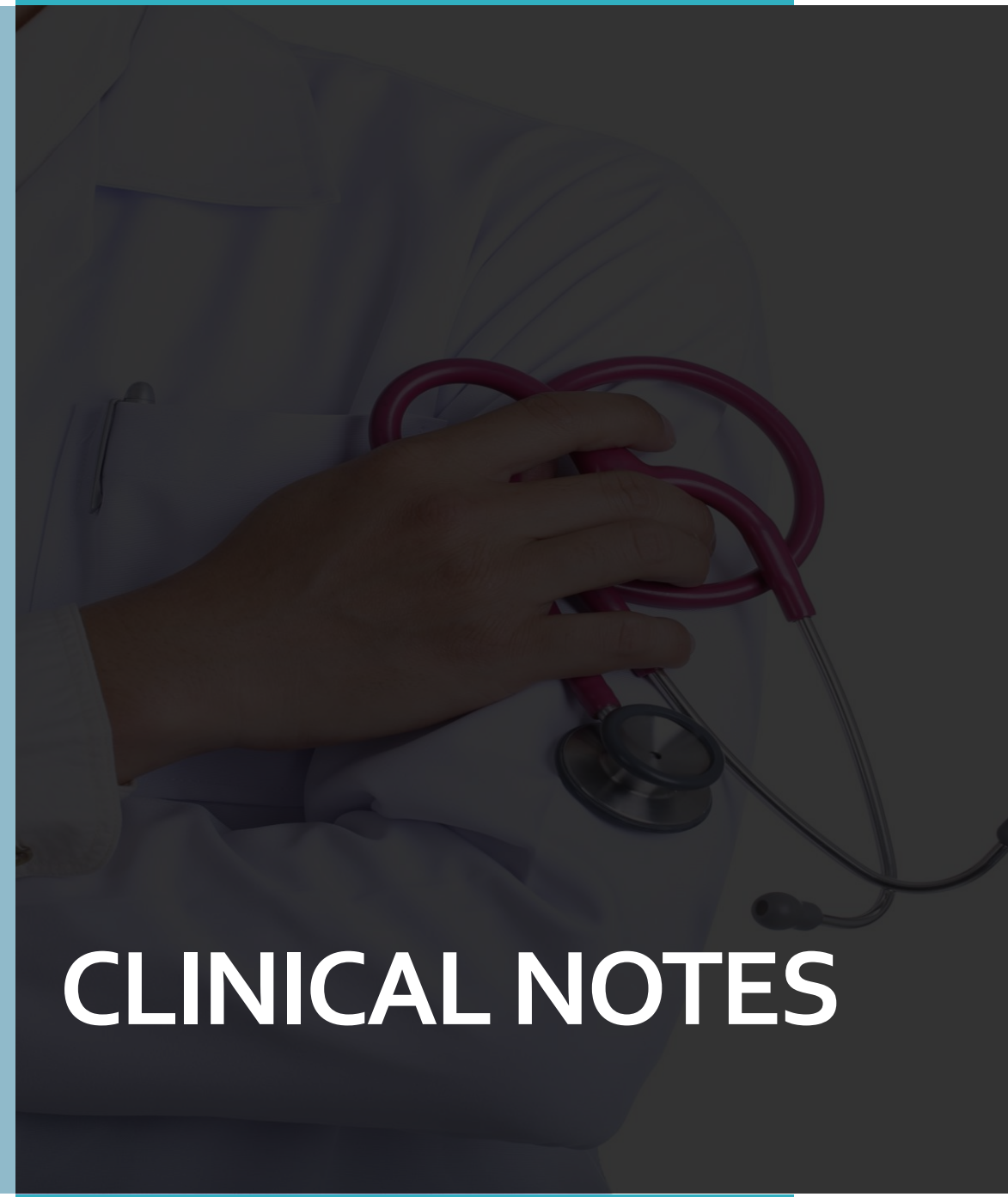
Dysosmia



Hyposmia



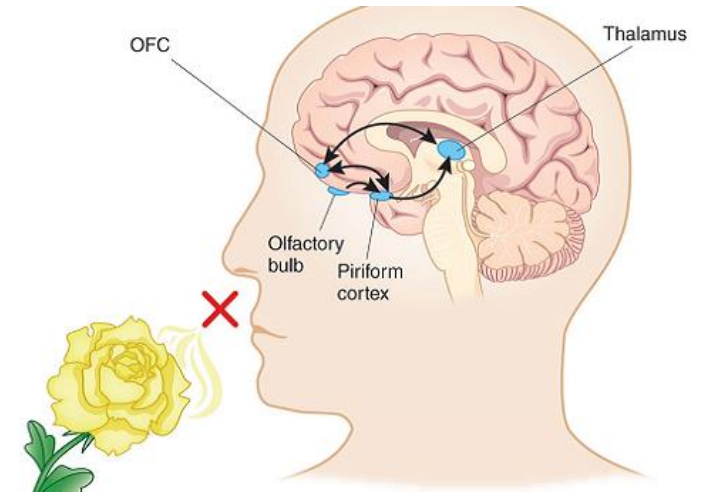
Hyperosmia



CLINICAL NOTES

ANOSMIA

- The complete absence of the sense of smell.
- It can be temporary or permanent.
- Temporary anosmia can be caused by infection or by local disorders of the nose.
- Permanent anosmia can be caused by head injury, or tumours which occur in the olfactory groove (e.g. meningioma).
- Anosmia can also occur as a result of neurodegenerative conditions, such as Parkinson's or Alzheimer's disease.



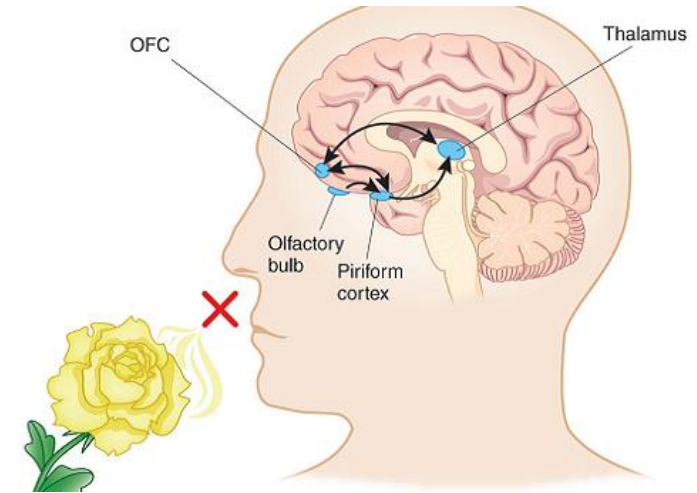
DYSOSMIA

- A distortion in the quality of the perception of an odor.
- Sometimes, the perception of an odor when no odor is present.
- Damage to olfactory nerve fibers can occur as a complication of upper respiratory tract infections.
- A decrease in the number of nerve fibers from these infections mean that there are not enough different fibers to accurately differentiate odors resulting in parosmia.



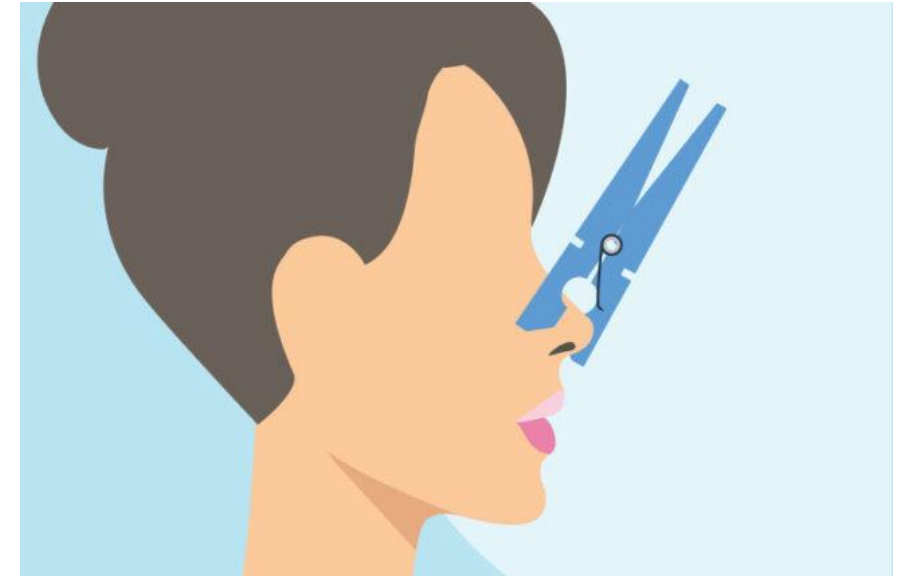
HYPOSMIA

- It is the reduction of the ability to smell and to detect odors.
- The causes include allergies, nasal polyps, viral infections and head trauma.
- Older people are subjected to have hyposmia.
- Hyposmia might be a very early sign of Parkinson's disease.
- Lifelong hyposmia could be caused by Kallmann syndrome or Autistic Spectrum Disorder.



HYPEROSMIA

- Hyperosmia is an increased olfactory sharpness with increased sense of smell.
- This perceptual disorder arises when there is an abnormally increased signal at any point between the olfactory receptors and the olfactory cortex.
- The causes may include genetic, hormonal or environmental.
- When odorants enter the nasal cavity, they bind to odorant receptors at the base of the olfactory epithelium.
- These receptors are bipolar neurons that connect to the glomerular layer of the olfactory bulb, traveling through the cribriform plate.
- The hyperosmic person may need to be removed from strong odorants for a period of time if the sensation becomes unbearable.



NERVE ASSESSMENT


- Testing the sense of smell can easily be conducted through using well and strong odors, such as menthol, coffee or peppermint.
- This test can be done in the alterations of odor perception or if there is damage to any sinus or nasal cavity issues.





QUESTIONS?

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