Anatomy Team
MED 439

Revised & Approved

Abdullah Alsubaihi
Rania Almutiri

MED439
KING SAUD UNIVERSITY

Anatomy of the Nose & Olfactory Nerve

CNS Block

Don't forget to check the Editing File

Color index:

Content
Male slides
Female slides
Important
Doctors notes
Extra information, explanation

Contact us:
Anatomy439@gmail.com

Objectives

At the end of the lecture, students should be able to:

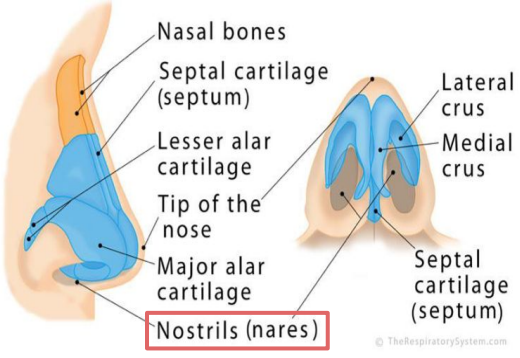
- Describe the boundaries and functions of the nose and nasal cavity.
- Describe the nasal conchae and meati.
- Demonstrate the openings in each meatus.
- Describe the arterial supply and innervation of the nose.
- Describe the paranasal sinuses and their functions
- Describe the clinical significances of the nose and nasal cavity.

Introduction and functions

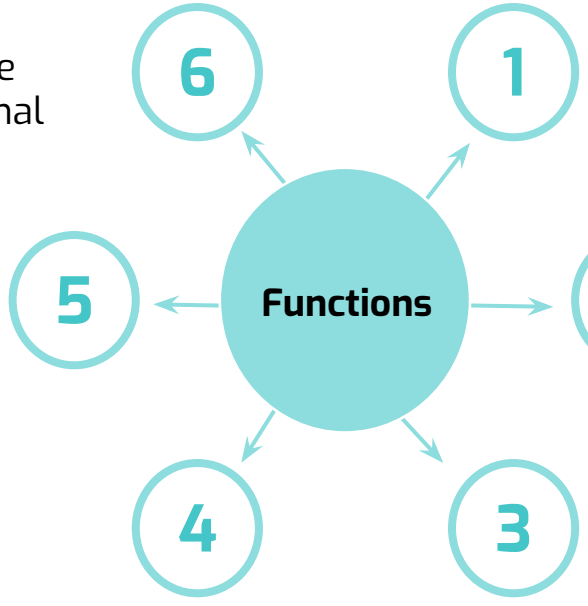
The nose :

*Male slides

- 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:

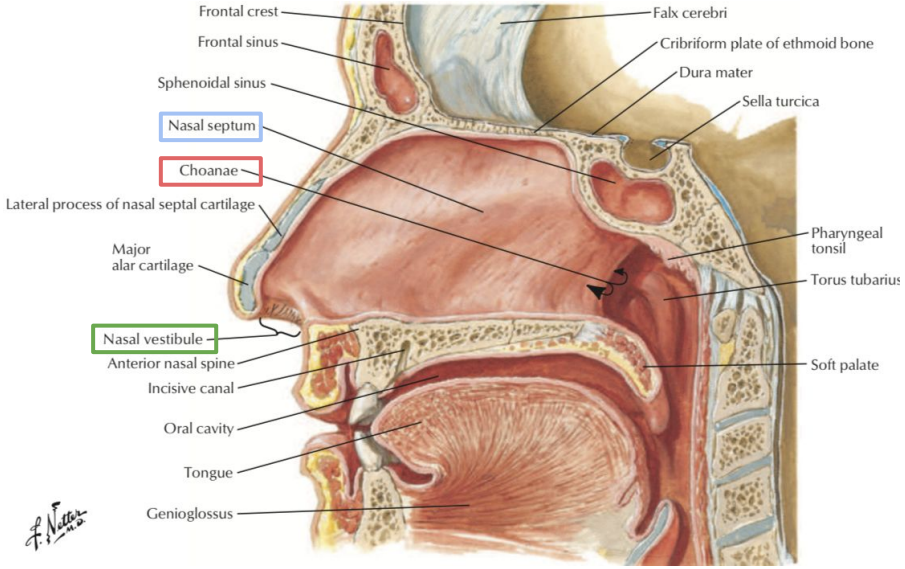


1. ▪ Olfaction
   · smell
2. ▪ Respiration
   · breathing
3. ▪ Warming the inspired air
   · submucous venous plexus
4. ▪ Filtration of dust
5. ▪ Humidification of the inspired air .
   · Mucous
6. ▪ Reception of secretions from the paranasal sinuses and nasolacrimal duct.

Nasal Cavity

Nasal Cavity:

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



Divisions of Nasal cavity:

Each contains roof, floor, lateral, & medial walls

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.

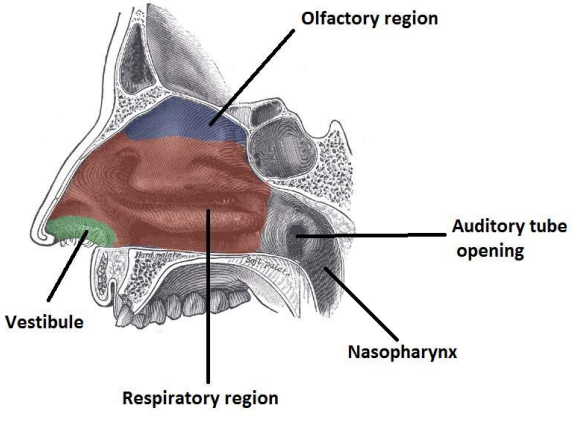
Respiratory Region

- 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.

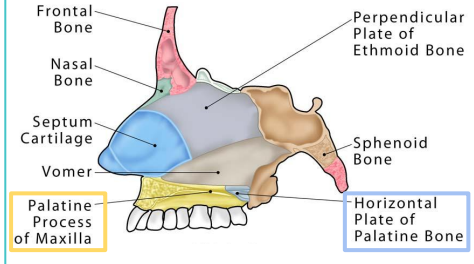
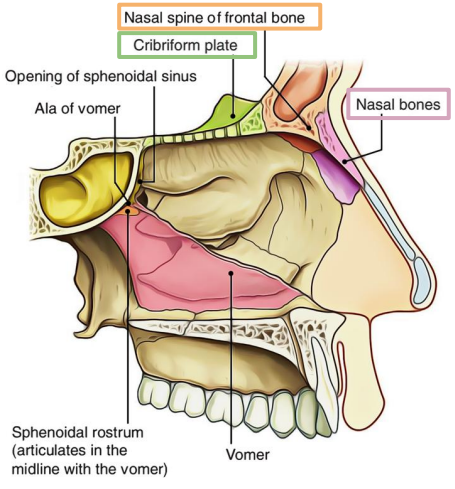
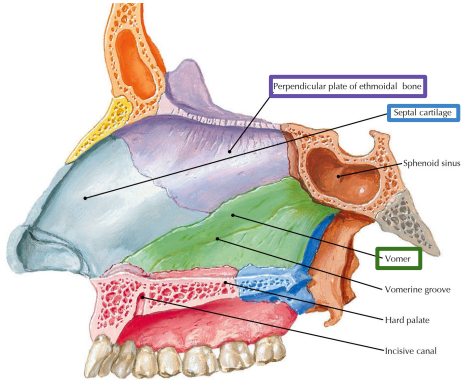
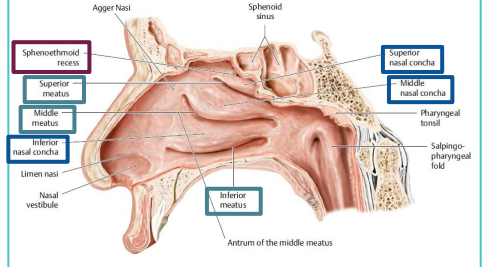
- It is lined by olfactory cells with olfactory receptors.



*Male slides

Nasal Cavity:

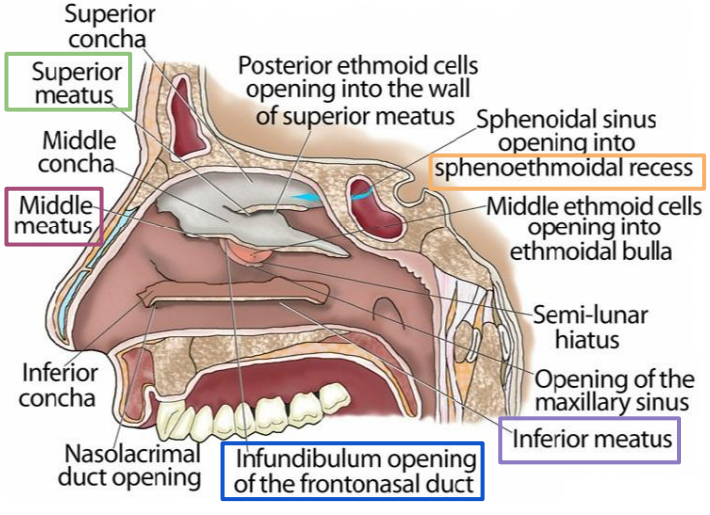
It is divided into right and left parts by the nasal septum Each part has:

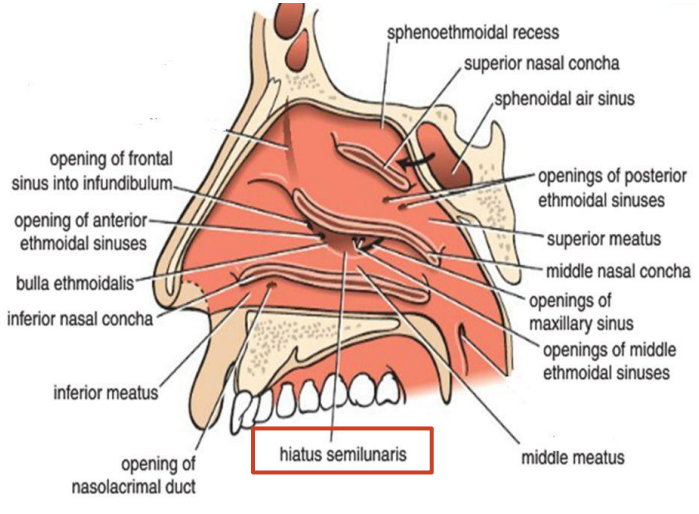
Floor	Roof	Medial Wall	Lateral Wall
It is formed by nasal surface of the hard palate: - **Palatine process of maxilla** (anteriorly). - **Horizontal plate of palatine bone** (posteriorly).	It is formed by: - Body of sphenoid (posteriorly). - **Cribriform plate** of ethmoid (in the middle) . - **Frontal bone** and **Nasal bones** (anteriorly)	It is formed by: - The nasal septum. - **Vertical plate of ethmoid**. - **Vomer**. - **Septal cartilage**.	**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.** **·The space (fossa) above the superior concha is the Sphenoethmoidal recess.**(female slides)
			

Openings at Lateral Wall

Sinuses opening in the lateral wall:

Sinus	Drains through
Sphenoid air sinus	Sphenoethmoidal recess
Posterior ethmoidal sinuses.	Superior meatus
Middle, frontal, anterior ethmoidal & maxillary sinus	**Middle meatus** contains bulla ethmoidalis and hiatus semilunaris
Maxillary sinus.	**Hiatus semilunaris**
Frontal and anterior ethmoidal sinus.	**Infundibulum**
Nasolacrimal duct.	Inferior meatus





o All sinuses open into the middle meatus **except**:

- **Sphenoidal sinus:** in sphenoethmoidal recess.
- **Posterior ethmoidal sinus:** in superior meatus

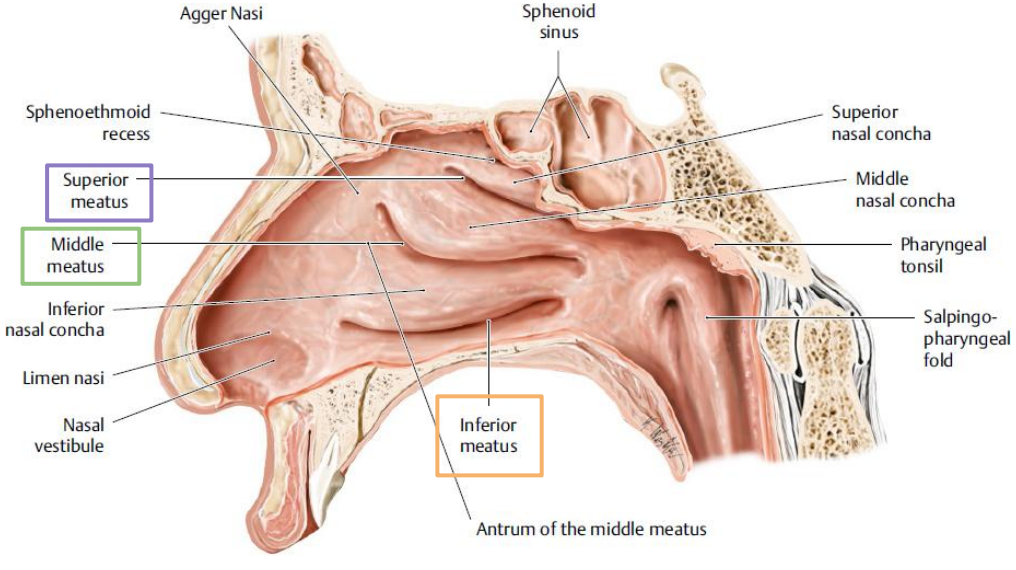
o The mucosal lining of these sinuses is continuous with that in the nose and the throat, so **infection** in this area tends to migrate into the sinuses causing sinusitis.

Openings at Lateral Wall

Nasal Conchae (Only in male slides):

- 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.
Sphenoethmoidal recess	Lies superiorly and posteriorly to the superior concha.

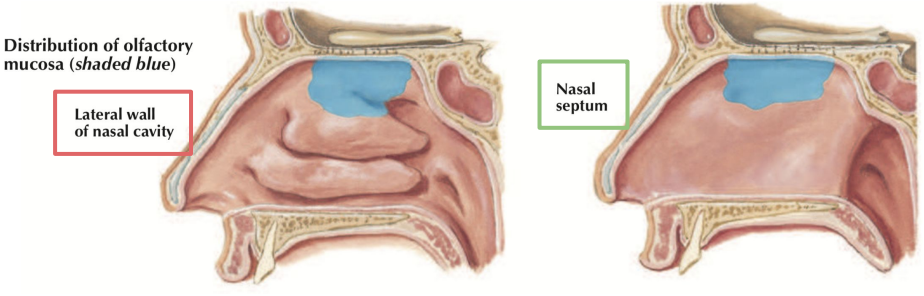
- The function of the conchae is to increase the surface area of the nasal cavity to increases the amount of inspired air that can come into contact with the cavity walls.
- They also disrupt the fast, laminar flow of the air, making it slow and turbulent.
- The air spends longer in the nasal cavity, so that it can be humidified. **(Important)**



Nasal Cavity Mucosa

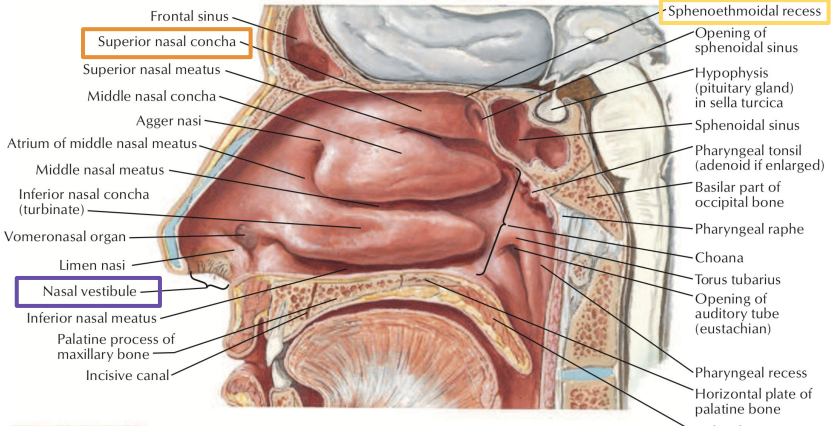
Olfactory Mucosa

- It is delicate and contains olfactory nerve cells.
- It is present in the upper part of nasal cavity. (Roof)
- **On the lateral wall**, it lines the upper surface of the **superior concha** and the **sphenoethmoidal recess**.
- On the medial wall, it lines the superior part of the **nasal septum.**



Respiratory Mucosa

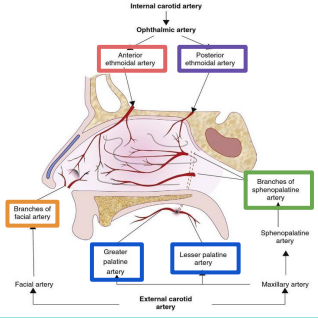
- It is thick, ciliated, highly vascular and contains mucous glands & goblet cells.
- It lines the lower part of the nasal cavity (from skin of **vestibule** to the **superior concha**).
- It functions to moisten, clean and warm the inspired air.
- The air is moistened by the secretion of numerous serous 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.



Supply and innervation of the Nose

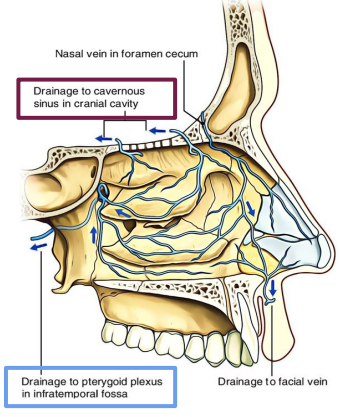
Arterial supply

Internal carotid branch:
Anterior and Posterior Ethmoidal (ophthalmic).
Note: notice the sequence Internal carotid gives rise to ophthalmic artery & ophthalmic artery gives rise to ethmoidal branches
External carotid branch:
Superior labial (facial).
Sphenopalatine artery (maxillary) .
Greater palatine artery(male slides)
Lateral nasal arteries(male slides)
Applied anatomy / The most common site for epistaxis is at the anterior & inferior part of nasal septum (Little's area) because of the rich arterial anastomosis
Cause could be local due to trauma or systemic due to hypertension.



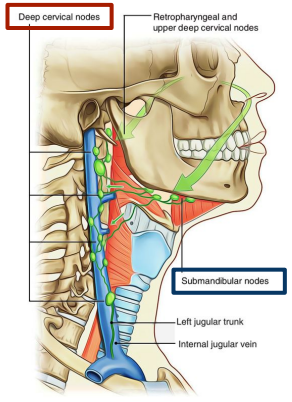
Venous drainage

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



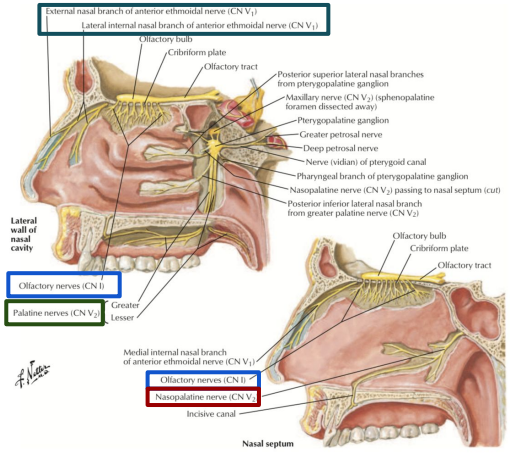
Lymphatic drainage

Submandibular and **upper deep cervical nodes.**



Nervous supply

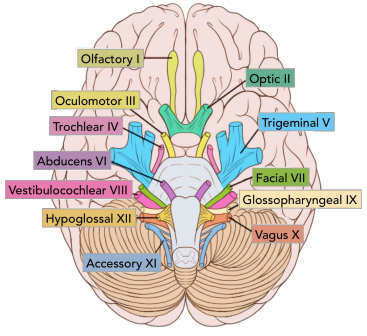
Nerves of smell:
1- **Olfactory Nerves (CN 1).** (male slides)
Nerves of general sensation:
1- Ophthalmic
2- Maxillary divisions of Trigeminal nerve (CN 5).
Anterior part is supplied by
- **anterior ethmoidal nerve.**
Posterior part is supplied by
- branches of the pterygopalatine ganglion:
▪ **Nasopalatine**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



Olfactory pathway

*Male slides only

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.
- It is only sensory carry afferent impulses for the sense of smell and made up of multiple nerve fibers/rootlets coming from the receptor cells.

Olfactory nerve course:

It passes through the cribriform plate of the ethmoid bone and attached to olfactory bulb.

The fibers enter the olfactory bulb, which lies in the olfactory groove, within the anterior cranial fossa.

The olfactory tract runs inferiorly to the frontal lobe.

The axon penetrates through the basement membrane, it joins other non-myelinated processes to form the fila olfactoria(bundles of olfactory axons).

They enter the cranial cavity through the cribriform plate of the ethmoid bone.
the roof of the nasal cavity.

Nerve pathway

It's important to note that the olfactory nerve is made up of multiple nerve fibers/rootlets from the receptors cells.

The pathway can be summarized as follows:

1. Olfactory receptor cells
2. Olfactory nerves
3. Olfactory bulb
4. Olfactory tract
5. Olfactory striae
6. Olfactory cortex

Cont.. Olfactory pathway

1-Olfactory receptors :

- **First order neuron**

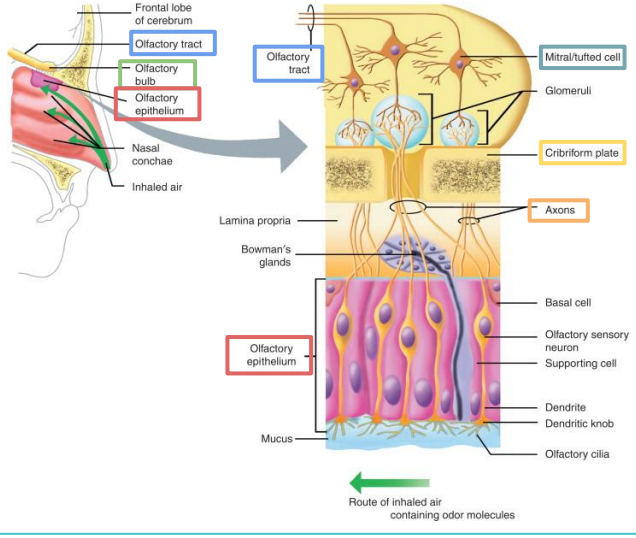
They are specialized, ciliated nerve cells that lie in the **olfactory epithelium.**
The **axons** of these bipolar cells 12-20 fibers form the true olfactory nerve fibers.
Which passes through the **cribriform plate** of ethmoid. They join the **olfactory bulb.**
Preliminary processing of olfactory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

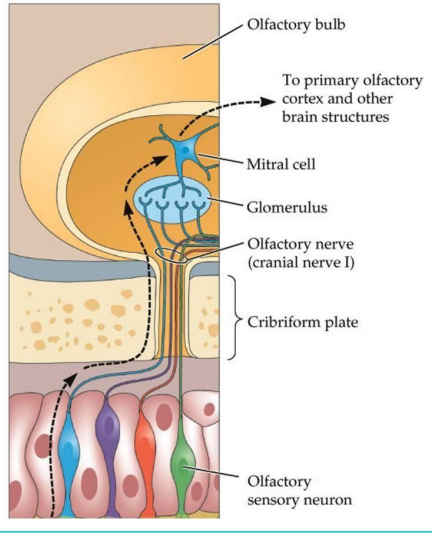
- **Second order neuron**

Its formed by the mitral cells of olfactory bulb.
The axons of these cells form the olfactory tract.
Each tract divides into 2 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 & joins the uncrossed lateral root of opposite side.
It connects the olfactory centers of the 2 cerebral hemispheres.
So each olfactory center receives smell sensation from both halves of nasal cavity.

2- Olfactory bulb:

Preliminary processing of olfactory information is within the olfactory bulb , which contains interneurons and large Mitral cells - second order neuron - axons from the latter leave the bulb to form the olfactory tract.
The axons Mitral cells form the olfactory tract.
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.
N.B. Olfactory pathway is the only sensory pathway which reaches the cerebral cortex without passing through the Thalamus

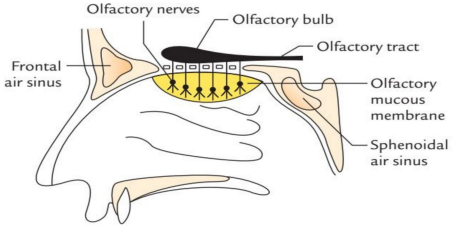




Cont.. Olfactory pathway

3- Olfactory tract:

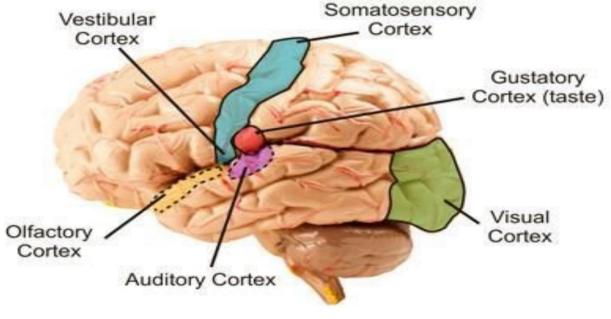
Formed by Mitral cells
Each tract divides into 2 roots(stria) at the anterior perforated substance to divide into medial and lateral roots.



5- Olfactory primary cortex:

(male slides only)

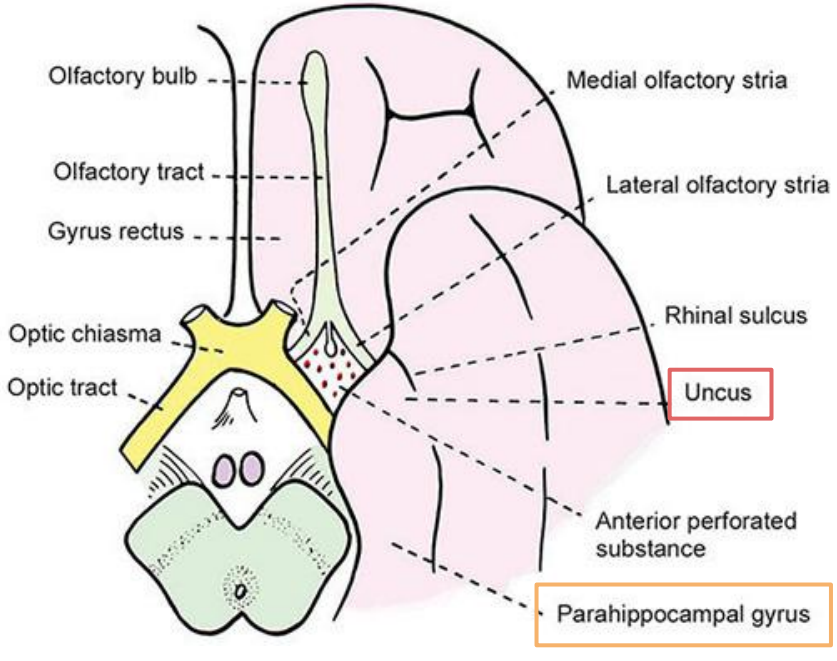
It sends nerve fibers to many other areas of the brain, like piriform cortex, amygdala, olfactory tubercle and the secondary olfactory cortex. These areas are involved in the memory and appreciation of olfactory sensations.



4- Olfactory roots (stria):

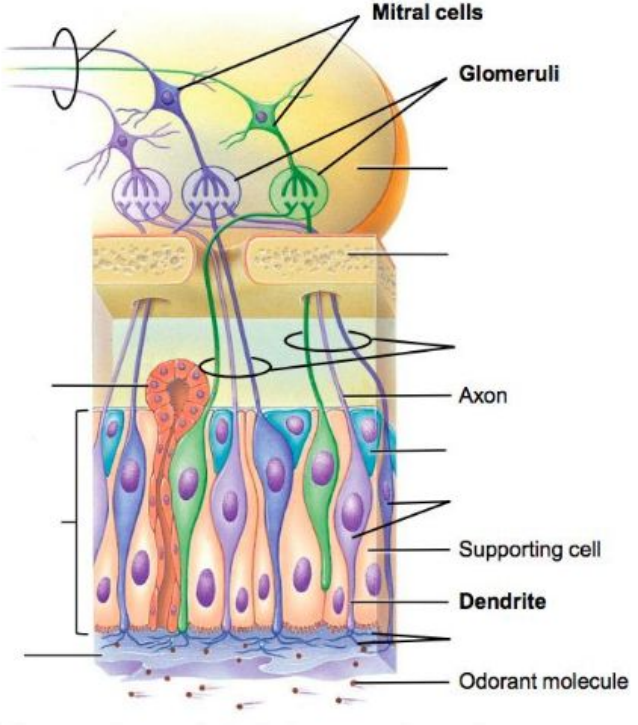
Lateral root:
- Carries olfactory fibers to end in cortex of the **Uncus** & adjacent part of **Hippocampal gyrus** (center of smell).

Medial root :
- Crosses midline through anterior commissure and joins the uncrossed lateral root of opposite side
(to contralateral olfactory structures.)
- It connects olfactory centers of 2 cerebral hemispheres.
- So each olfactory centre receives smell sensation from both halves of nasal cavity.



Brief explanation for the olfactory pathway (EXTRA)

1. The nasal cavity contains the **1st order neurons**
2. Its dendrites emerges to the roof of the olfactory region
3. The dendrites contains **cilia** which are responsible for odor detections (via chemoreceptors)
4. The chemicals (the odor) will go to the cell body of the 1st neuron and then to its axons eventually passing through the cribriform plate
5. The 1st neuron will synapse with the 2nd neuron (the mitral cells) in a place called the **glomeruli**
6. Finally the axons of the **2nd order neuron will divide into lateral and medial strea.**

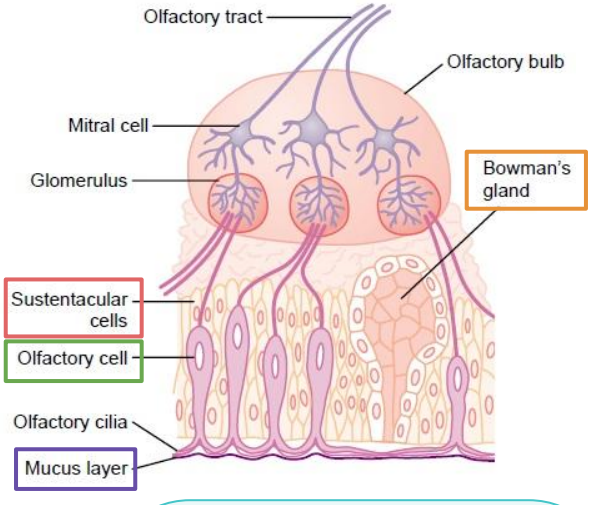


Olfactory Mucosa

*Male slides only

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.



Olfactory 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 analogous to the glial cells located in the CNS.

There are also **Bowman's glands** present in the mucosa, which secrete mucus.

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.

The paranasal sinuses and their functions

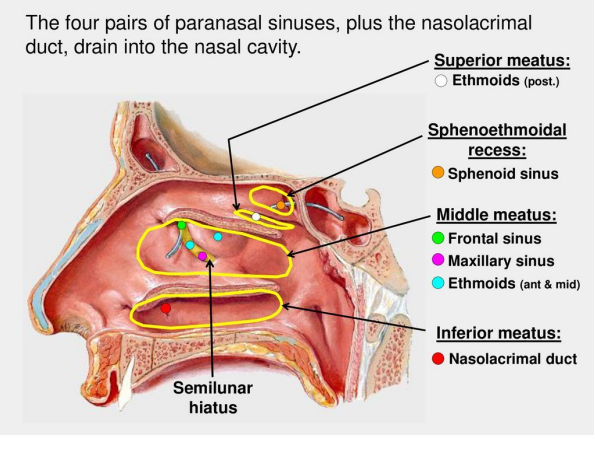
*Male slides only

Definition paranasal sinuses:

They are four groups air-filled cavities surrounding the nasal cavity.
1- **Maxillary Sinuses**: the largest of the paranasal sinuses, located under the eyes in the maxillary bones.
2- **Frontal Sinuses**: superior to the eyes in the frontal bone, which forms the hard part of the forehead.
3- **Ethmoidal Sinuses**: formed from several discrete air cells within the ethmoid bone between the nose
4- **Sphenoidal Sinuses**: in the sphenoid bone.

They open in the lateral wall of the nasal cavity. Lined with mucoperiosteum, Filled with air, Communicate with the nasal cavity.(**In both slides**)

Paranasal opening:	Paranasal sinuses:
Sphenoethmoidal recess	Sphenoidal air sinus
Superior meatus	**Posterior ethmoidal sinus.**
Middle meatus	Maxillary, frontal, anterior ethmoidal, middle ethmoidal sinuses
Inferior meatus	Nasolacrimal duct



The paranasal sinuses and their functions

Functions paranasal sinuses:

Humidifying and **heating** of inhaled air because of slow air turnover in this region.

Providing a **buffer** against facial trauma.

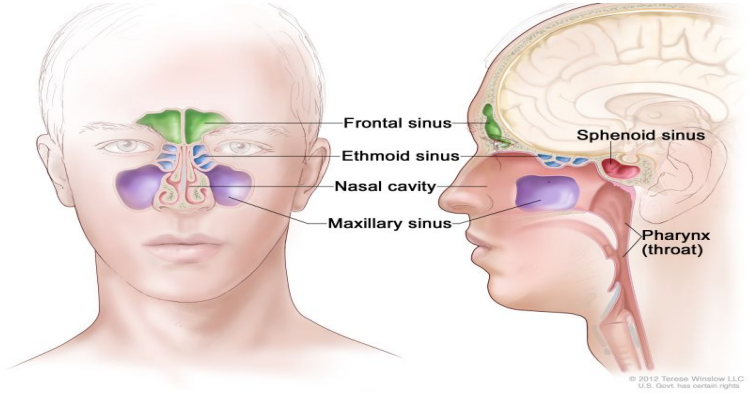
Decreasing the relative weight of the front of the skull, and especially the bones of the face.

Amplify sound as we speak

Insulating sensitive structures like dental roots and eyes from rapid temperature fluctuations in the nasal cavity.

Increasing resonance of the voice.

Lighten the skull weight



clinical significances of the nose and nasal cavity.

(only in male slides)

Dysosmia:

It is 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.

Anosmia:

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

Hyperosmia:

It is 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.

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 syndrome or Autistic Spectrum Disorder.

MCQ

Q1: The roof of the nasal cavity composed of:			
A: Cribriform plate of ethmoid.	B: Vomer.	C: Vertical plate of ethmoid.	D: Septal Cartilage.

Q2: The floor of the nasal cavity composed of all the following except:			
A: The nasal surface of the hard bony palate.	B: Palatine process of maxilla.	C: Body of sphenoid.	D: Horizontal plate of the palatine.

Q3: The openings of posterior ethmoidal sinuses located in:			
A: Sphenoethmoidal recess.	B: Superior meatus.	C: Middle meatus.	D: Inferior meatus.

Q4: The medial wall of the nasal cavity composed of:			
A: Body of sphenoid.	B: Vomer.	C: Frontal bone.	D: Nasal bone.

Q5: Anterior nasal floor is composed of:			
A: Horizontal plate of the palatine bone.	B: Palatine process of maxilla.	C: Vomer.	D: Inferior meats.

Q6: Which sinus doesn't open into the middle meatus:			
A: Maxillary.	B: Sphenoidal sinus.	C: Frontal.	D: Middle ethmoidal.

Answer key:
1 (A) , 2 (C) , 3 (B) , 4 (B) , 5 (B) , 6 (B)

MCQ

Q7: is a disorder of the olfactory nerve that results in a total loss of the sense of smell.			
A: Dysosmia	B: Anosmia	C: Hyposmia	D: Hyperosmia

Q8: Which of these is a possible cause of damage to the olfactory nerve?			
A: Toxins	B: Viruses	C: Head trauma	D: All of these answers are correct

Q9: What is the olfactory bulb?			
A: The region of the brain where the olfactory nerve sends nerve impulses	B: The region inside the nasal cavity that first senses smells by detecting chemicals in the air	C: The part of the skull that has many tiny holes in it for the axons of the olfactory nerve to pass through	D: The structure where all the individual axons coming from the epithelial cells

Q10: What carries the sensory information from the nose to the brain?			
A: Olfactory bulb	B: Olfactory nerve	C: Thalamus	D: Optic nerve

Q11: The type of receptor involved in smell and taste is			
A: Chemoreceptor	B: Mechanoreceptor	C: Photoreceptor	D: Tastebud

Q12: The vessel which has a direct relation to intracranial infection.			
A: Vein of foramen caecum	B: Ophthalmic artery	C: Maxillary artery	D: Greater palatine artery

Answer key:
7(B) , 8(D) , 9(C) , 10(B) , 11(A) , 12(A)

SAQ

Q1: What are the projections that marked the lateral wall of Nasal septum ?

Q2:list sinuses that don't open into the middle meatus?

Q3: Mention the innervation of nasal cavity.

Q4: Mention the function of olfactory mucosa.

Answers

1 : Superior, middle, and inferior nasal conchae

2 : -Sphenoidal sinus.

-Posterior ethmoidal.

3 : The anterior part is supplied by Anterior Ethmoidal nerve (a branch of the ophthalmic nerve).
The posterior part is supplied by branches of pterygopalatine ganglion (a branch of maxillary nerve):
Nasopalatine,
Nasal, and Palatine.
Both ophthalmic and maxillary are branches of trigeminal nerve

4: The olfactory mucosa is a very important structure as it not only senses smell, but also the more advanced aspects of taste.

Team leaders
Rayan jabaan
Abeer Awwad

A special thanks to Mohamed Alquhidan

Reviser
Norah Alasheikh

Organizer
Shaden Alsaiedan

Note taker
Mohammed Aldehaim

Team Members

- Alaa Assulmi
- Albandari Alanazi
- Aljoud Algazlan
- Afnan Almohsen
- Arwa Alqahtani
- Aseel Alshehri
- Asma Alamri
- Bodoor Almubarak
- Deemah Alotaibi
- Fatimah Saad
- Ghada Alabdi
- Ghaida Alassiry
- Joud Alnujaidi
- May Barakah
- Norah Alasheikh
- Nouf Alsubaie
- Raghad Alasiri
- Raghad Soaeed
- Renad Alosaimi
- Sara Alharbi
- Sarah Almuqati
- Sarah Alqahtani
- Shaden Alsaiedan
- Shahad Almezel
- Shayma Alghanoum
- Sumo Alzeer
- Abdullah Alburikan
- Abdullah Aldosari
- Abdulaziz Alghuligah
- Abdulaziz Alkraida
- Abdulaziz Alomairy
- Abdulaziz Alrabiah
- Abdulaziz Alsuhaim
- Abdulrahman Almugren
- Ahmed Alkhayatt
- Bader Alrayes
- Basel Fakeeha
- Fahad Alajmi
- Faisal Alotaibi
- Fayez Altabbaa
- Feras Alqaidi
- Hadi Alhemsi
- Hesham Alsqabi
- Mohammed Aldehaim
- Mohamed Alquhidan
- Mohammed Beyari
- Mubarak Alanazi
- Musab Alamri
- Nawaf Alghamdi
- Osama Alharbi
- Raed Alnutaifi
- Saad Aldohaim
- Saleh Algarni