Anatomy, Functions, and Histology of the Human Nose

Our nose, paranasal sinuses, as well as the throat (pharynx) are part of the upper respiratory tract, which consists of two parts. Anatomically, the external and internal parts of the nose can be illustrated. The first consists of nasal bones and nasal cartilages and the internal nose are formed by the nasal cavity and the nasal concha also known as turbinates (choanae), are separated by the nasal septum (septum nasi) with their openings and the paranasal sinuses.

Functions of the Nose

The functions of the nose are:

- Regulation of the respiratory airflow
- Warms the air with the help of thin mucosal membrane and warm blood beneath it.
- Humidifies inspired air via moisturizing it with mucosal secretions.
- It also has some defensive functions.
- It serves as an organ of the sense of smell.
- It is also a resonator for voice production and conveys the sneeze reflex.

The anatomical knowledge of the paranasal sinuses is essential in view of their topographical proximity to Meninges and important nerves in the bony skull.

Structure of the Nose

The visible external nose that is pyramidal in shape with the root pointed upwards and the base downwards. The variance in shape is dependent on the shape of the ethmoid bone and males have larger nostrils than females. It is made up of the osseocartilaginous framework made up of muscles and skin with the cartilaginous part making up the lower third.
The internal nose divided into the left and right nasal cavities by the nasal septum. It is made up of a skin-lined portion known as the vestibule and the mucosa lined portion known as the nasal cavity proper.

The inner nose constitutes of the main nasal cavity and its structure, as well as the paranasal sinuses.

**Nose and Nasal Cavities**

![Illustration of the nasal cavities](image)

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The nasal framework

The nasal aperture or piriform aperture, situated on the bony skull represents, as a bony outline of the nasal cavity, the beginning of the respiratory tract. Located here, is the commonly named nasal pyramid, with each side consisting of the frontal process of the maxilla (proc. frontalis of the os maxillare), medial to the nasal bone (os nasale), which is linked to the frontal bone (os frontale) of the forehead.

The nasal cartilage

The front nose section consists of connective tissue with embedded small pieces of cartilage. These include the nasal septum (cartilago septi nasi) and the nasal tip cartilage (lesser alar cartilage and the lateral greater alar cartilage). Whatever impression our nose, as a significant optical element of our face, makes – be it a high, broad or even crooked nose – is largely determined by these small cartilages as well as the cartilage portions of the nasal septum.

Very frequently, the bony portion of the nose is affected by midfacial fractures e.g. a nasal bone fracture. Common causes of nasal fracture can be due to a stump impact during sports or accidents which appear clinically as a deformed nose. A manual alignment by applying strong thumb pressure involving anesthesia, followed by a fixation, is necessary in order to avoid lasting misalignments. Injuries which lead to functional or optical impairments can be corrected through nose surgery or rhinoplasty.

Internal nose

The inner part of the nose is formed by the main nasal cavity that constitutes the nasal
**concha**, nasal passages (nasal meatus) and paranasal sinus. The nasal septum (septum nasi) divides our main nasal cavity (cavitas nasi) into two nasal cavities and jointly forms their medial border. The nasal septum constitutes a front cartilaginous part and a bony part.

Clinically, the so-called septum deviations (deviation of the nasal septum) are quite frequent and may be present at birth or may result from an accident. This can lead to nasal congestion, which means that surgical correction is required.

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### Nasal cavity

Each nasal cavity has a lateral wall, medial wall, roof, and floor as follows.

The cribriform plate of the ethmoid bone forms the roof of the nasal cavity (os ethmoidale – is the part of the cranial base, where the fila olfactoria of the N. olfactorius passes through), which borders above with the nasal bone (os nasale) and the body of the sphenoid bone.

The horizontal plate of the palatine bone and the palatine process of the maxilla form the floor. The lateral walls are formed by the turbinates or chonchae. The medial walls are formed by the nasal septum on each side.

The main nasal cavity (cavitas nasi) extends from the inner nostril (= nose flap Limen nasi) all the way to the back till it reaches the choanae. The nasal vestibule (vestibulum nasi) in casual terms, our outer nostril (nares), communicates with the internal nose.

**Important:** The nasal cavity has a close topographical connection to the medial cranial fossa and the oral cavity.

### Nasal passages

The medial wall of the nasal cavity is smooth. The respective lateral wall is hallmarked by three nasal conchae or turbinates (superior, middle, and inferior) that separate the three nasal passages (nasal meatus superior, middle and inferior) from each other (the inferior nasal meatus is found below the inferior turbinate, etc.). On one hand are the established openings, with a number of important anatomical structures and on
the other hand, the inhaled airstream can be heated and moistened more effectively, due to the increased surface area.

The location of the various openings in the nasal passages is a popular topic among auditors and in the IMPP (Institute for Medical and Pharmaceutical Exam Questions)

<table>
<thead>
<tr>
<th>Nasal passage</th>
<th>Opening structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recessus sphenethmoidal</td>
<td>Sphenoidal sinus (sinus sphenoidalis)</td>
</tr>
<tr>
<td>Superior nose passage (Meatus nasi superior)</td>
<td>Posterior ethmoidal cells (cellulae ethmoidales posterior)</td>
</tr>
<tr>
<td>Middle nose passage (Meatus nasi medius)</td>
<td>Anterior ethmoidal cells (cellulae ethmoidales anterior) maxillary sinus (Sinus maxillaris) frontal sinus cavity (Sinus frontalis) the excretory duct of the frontal sinus cavity (ductus nasofrontalis) ends in the so-called semilunar hiatus (hiatus semilunaris).</td>
</tr>
<tr>
<td>Inferior nose passage (Meatus nasi inferior)</td>
<td>The nasolacrimal duct (ductus nasolacrimalis)</td>
</tr>
</tbody>
</table>

Paranasal Sinus

The four paranasal sinuses (sinus paranasales) include the frontal sinus (sinus frontalis), the respectively paired ethmoid sinuses (cellulae ethmoidales), the maxillary sinus (sinus maxillaris) and the sphenoid sinuses (sinus sphenoidalis).
The so-called air-filled cavities are lined with respiratory epithelium and are all connected to the main nasal cavity. This serves as the ventilation of the sinuses, as well as a discharge path for any produced secretion. It is important to know whether inflammation of the sinuses is present. A mucosal swelling or polyps can obstruct the pathways of this system and due to the missing drainage, sinusitis can become prolonged.

Knowledge of the anatomical relation of the individual sinuses to the cranial structures is particularly of importance, in terms of surgical access methods, the danger of injury and infection in pathologies of the otolaryngology (ear-nose-throat medicine) and surgical interventions.

Maxillary sinus (Sinus maxillaris)

The medial wall of the maxillary sinus corresponds to the lateral wall of the main nasal cavity. Over the elevated ostium (excretory duct), secretion can drain off via the funnel-shaped passage referred to as the infundibulum ethmoidale (groove in the ethmoid bone) and the semilunar hiatus into the middle meatus.

The roof of the maxillary sinus is formed by the floor of the orbit. This is where the infra orbitalis nerve passes through (sometimes even without any bony cover), which can get injured due to maxillary sinusitis and surgical interventions. The anterior wall of the maxillary sinus accordingly contains the infraorbital foramen, through which the nerves pass.

A close anatomic proximity to the roots of the four molars is present on the floor of the maxillary sinus which contains alveolar recess. If during tooth extraction the maxillary sinus is accidentally opened or root residues are pushed into the maxillary sinus, an odontogenic sinus inflammation may result. In the case of non-healing unilateral maxillary sinusitis, possible cause due to dental problems should therefore always be ruled out first. The maxillary sinus borders with its posterior wall on to the
pterygopalatine fossa.

Ethmoid sinus (Sinus ethmoidalis)

The so-called ethmoid cells consist of eight to ten ethmoidal air cells of the ethmoid bone (ethmoidal labyrinth). They border at the top with the frontal sinus and the base of the skull in the form of the cribriform plate (lamina cribrosa). As for anatomic proximity, there is the risk of increasing intracranial infections. The lateral boundary is formed by the orbital, medial to the lateral nasal wall.

Posterior, the ethmoidal cells border the sphenoid sinus below and laterally to the maxillary sinus. The ethmoidal bulla (large blister) is the largest of the anterior ethmoid cells. The anterior ethmoidal cells open into the middle and the posterior open into the superior meatus (nasal passage).

Frontal sinus (Sinus frontalis)

The frontal sinus is found within the frontal bone and is often very large and chambered, but can under certain circumstances be entirely non-existent (aplasia). The orbital roof forms the lower boundary. Through this part, passes the ophthalmic nerve as the first branch of the trigeminal nerve.

In the case of sinusitis, there is the danger of perforation into the orbital. Since the posterior wall belongs to the base of the skull, there is an additional danger of complications from an intracranial infection. The front wall is formed by the supraorbital forehead.

Sphenoidal sinus (Sinus sphenoidalis)
The sphenoidal sinus is found within the sphenoid bone. The floor is formed by the roof of the nasopharynx and from the front wall, there is a connection to the upper nasal passage (meatus).

The roof of the sphenoid sinus is an anatomically important area: in this location lies surgical access to the pituitary gland, which is located behind the sphenoid sinus in the fossa hypophysalis. In addition, it borders the sella turcica with the front and middle cranial fossa. The side wall lies close to the internal carotid artery (a. carotis interna), the optic canal (canalis opticus) and the cavernous sinus.

Possible infection can trigger cavernous sinus thrombosis. In surgery, the anatomical features of the sphenoid sinus must be strictly observed, as this can otherwise lead to life-threatening complications.


Pathways of the Nose
**Nose vessels**

The blood supply of the nose is derived from:

- Internal carotid artery that supplies the lateral nasal wall (**Aa. ethmoidales** from the ophthalmic artery).
- The external carotid artery that supplies the dorsal aspect of the nose (**Aa. nasal posterior lateral** from the sphenopalatine artery).

The vascular supply of the nasal septum is fundamental. It is fed from both carotids (external and internal) in the front area of the **Kiesselbach’s plexus**. This vessel rich area is usually the source of bleeding in locally induced nosebleeds (**epistaxis**).

In very severe nosebleeds, which can neither be stopped with a tamponade or compression, it may be necessary to locally obstruct one of the major arterial vessels (the **A. maxillary** the external carotid artery or one of the two **Aa. ethmoidales** in the orbital).

**Nerves of the nose**

The sensory innervation of the inner nose is carried out by branches of the trigeminal nerve (the branches of the **ophthalmic nerve (V1)** in the front upper part, the branches of the **maxillary nerve (V2)** in the other sections). The sensory perception of smell is carried out by the function of the olfactory nerve.

**The nose as a sensory organ**

The olfactory nerve, considered the first cranial nerve (CN I), transmits the sensory perception of smell and originates from the **olfactory mucosa (regio olfactoria)**, an approx. 2 cm² large area on the roof of each nasal cavity. Here the fila olfactory passes through the **cribriform plate (lamina cribrosa)** of the **ethmoid bone (os ethmoidale)** in the bony skull and merges to form the olfactory bulb.

The fila olfactoria are primary sensory cells. Scent molecules bind to the olfactory receptor cells located in the nasal mucosa and trigger a change in potential. This change is converted into an electrical signal within the cell and the “coded” information concerning the scent quality is transported through the **olfactory tract** into the **cerebral cortex**.

During the course of studies, this process is discussed extensively in the area of physiology of senses, while the stages of the olfactory tract already belong to the special field of neuroanatomy. In oral tests, the structure of the nose nonetheless, offers a perfect exam template to question the course of the olfactory pathway:

Olfactory cells with fila **olfactoria > olfactory bulb > tractus olfactorius > striae olfactoriae medial and lateral > primary olfactory cortex (area prepiriformis)** and **amygdala**.

Humans can detect about 10,000 different scents. After having suffered a basilar skull fracture, the result could be damaging to the fila olfactoria and as a consequent, loss of sense of smell (**anosmia**). After critical damage, only “strong” smells such as ammonia are perceived, since the trigeminal nerve is responsible for sensory perception.
Histology of the Nose

The nasal mucous membrane consists of respiratory epithelium (regio respiratoria) and sensory epithelium with olfactory cells (regio olfactoria). The mucosa is well supplied with blood and has numerous mucus-producing goblet cells – an effective heating and humidifying of the air can thereby be ensured. The drainage of the nasal secretions from the nasal cavities aimed from the cilia of the ciliated epithelium is an important component of the non-specific immune defense system. The large part of the secretion reaches the nasopharynx and is then swallowed.

Dysfunction of the nose

The pathologies of the nose and paranasal sinuses are important to clinically understand the areas of the ear, nose and throat medication as well as to succeed in medical exams. Relevant facts for the preclinical and preliminary medical examination can be found in the text. A synoptic view of the important nose and paranasal sinus pathologies:

- Polyps
- Sinusitis
- Rhinitis
- Epistaxis
- Nasal Septum Deviation
- Tumors of the Nose
- Foreign Substances
- Fractures
- Disturbances of Smell (Neurology)

Important Exam Facts

The ducts of the paranasal sinuses, the arterial supply of the nose and important anatomical boundaries and relations of the paranasal sinuses. In neuroanatomy, the components and the course of the olfactory tract most likely will be examined.
References


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