Anatomy, Functions, and Histology of the Human Nose

The nose is the human body's primary organ of smell, and it functions as part of the olfactory and respiratory systems. The nose, paranasal sinuses, mouth, larynx (voice box), and pharynx (throat) comprise the upper respiratory tract. While the nose may be best known for inhaling oxygen and exhaling carbon dioxide, it also contributes to other important functions such as tasting and hearing.

Functions of the Nose

The functions of the nose include:

- Regulating respiratory airflow
- Warming the air which is facilitated by the various epithelia lining the passageways of the respiratory system
- Humidifying inspired air by moisturizing it with mucosal secretions
- Providing some defensive functions
- Serving as an organ for smell
- Resonating voice production and facilitating the sneeze reflex

Structure of the Nose

The external nose is visible and is pyramidal in shape, with the root located in the upper region and the base located in the lower region. The variance in shape depends on the shape of the ethmoid bone which is an anterior cranial bone located between the eyes. The internal nose is divided into the left and right nasal cavities by the nasal septum. The internal nose also consists of the skin-lined region known as the vestibule and the
The nasal cavity proper is a mucosa-lined region known as the nasal cavity proper.

**Nose and Nasal Cavities**

The nasal or piriform aperture is situated on the bony skull and represents a bony outline of the nasal cavity, which is the beginning of the respiratory tract. The nasal pyramid is located here with each side consisting of the frontal process of the maxilla and medial to the nasal bone which is linked to the frontal bone.

The nasal cartilage

The front of the nose consists of connective tissue with embedded small pieces of cartilage. This includes the nasal septum and the nasal tip cartilage (lesser alar cartilage and lateral greater alar cartilage). Whatever impression the nose makes as an aesthetically significant element of the face – high, broad, or even crooked – is largely determined by these small cartilages and the cartilaginous portions of the nasal septum. Frequently, the bony portion of the nose is affected by midfacial fractures (e.g., a nasal bone fracture).

A common cause of nasal fractures is blunt trauma. Manual alignment through the application of strong thumb pressure with anesthesia followed by repair may be necessary to prevent lasting misalignments. Injuries that lead to functional impairments may be corrected through nasal surgery or rhinoplasty.

Internal nose

The inner part of the nose is formed by the main nasal cavity which includes the nasal concha, nasal passages (nasal meatus), and paranasal sinus. The nasal septum comprises bone and cartilage in the nose and separates the nasal cavity into two fossae, which are continuations of the nostrils and jointly form their medial border. The nasal septum consists of four structures:

- Vomer bone
Clinically, deviations of the nasal septum occur quite frequently. These deviations may be present at birth or may result from an accident. A deviated nasal septum can lead to nasal congestion and breathing difficulties which may require surgical correction.

Nasal cavity

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

The cribriform plate of the ethmoid bone forms the roof of the nasal cavity (the ethmoid bone is the part of the cranial base, where the fibers of the olfactory nerve pass through), which borders above with the nasal bone 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 conchae. The medial walls are formed by the nasal septum on each side.

The main nasal cavity extends from the inner nostril all the way to the back till it reaches the choanae. The outer nostril (nares) and nasal vestibule communicate with the internal nose.

Note: The nasal cavity has a close anatomical connection with the medial cranial fossa and oral cavity.

Nasal passages

The medial wall of the nasal cavity is smooth. The lateral wall is hallmarked by three nasal conchae or turbinates (superior, middle, and inferior) that separate the three nasal passages (superior, middle, and inferior meatuses) from each other (where the inferior nasal meatus is found below the inferior turbinate, etc.). They are the established
openings with several important anatomical structures, and the inhaled airstream can be heated and moistened more effectively because of the increased surface area.

The location of the various openings in the nasal passages is a popular exam topic

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Paranasal Sinus

The four paranasal sinuses include the maxillary, ethmoid, sphenoid, and frontal sinuses.
These air-filled cavities are lined with respiratory epithelium and are all connected to the main nasal cavity. They serve as the ventilation of the sinuses as well as a discharge path for any produced secretion. It is important to identify whether inflammation of the sinuses is present. A mucosal swelling or polyp can obstruct the pathways of this system, and sinusitis can become prolonged because of the lack of drainage.

Knowledge of the anatomical relationship between the individual sinuses and the cranial structures is crucial in terms of surgical access methods because of the danger of injury and infection concerning pathologies in the field of otolaryngology (ear-nose-throat medicine).

**Maxillary sinus**

The pyramid-shaped maxillary sinus is the largest paranasal sinus, and it drains into the middle meatus of the nose. The medial wall of the maxillary sinus corresponds to the lateral wall of the main nasal cavity. Over the elevated ostium (excretory duct), secretions can drain off by way of the funnel-shaped passage referred to as the ethmoidal infundibulum (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 the place where the infraorbital nerve passes through (sometimes even without any bony cover). This nerve can get injured from maxillary sinusitis and surgical interventions. The anterior wall of the maxillary sinus contains the infraorbital foramen through which the nerves pass.

In close anatomic proximity to the roots of the four molars is the floor of the maxillary sinus which contains the alveolar recess. If during tooth extraction, the maxillary sinus is accidentally opened or root residue is pushed into the maxillary sinus, and odontogenic sinus inflammation may result. In the case of non-healing, unilateral maxillary sinusitis, possibly due to dental problems should always be ruled out first. The maxillary sinus is
Ethmoid sinus

The ethmoid sinus, or ethmoid air cells of the ethmoid bone, consists of numerous thin-walled cavities that are situated in the ethmoidal labyrinth and completed by the maxilla, frontal, lacrimal, sphenoidal, and palatine bones. The ethmoidal air cells receive sensory fibers from the posterior and anterior ethmoidal nerves and the orbital branches of the pterygopalatine ganglion which carry the postganglionic parasympathetic nerve fibers for mucous secretion from the facial nerve. The ethmoidal cells (sinuses) are not immediately present at birth. By 2 years of age, these cells are recognizable with computed tomography.

Frontal sinus

The frontal sinus is found within the frontal bone and is often very large and chambered but can also be entirely non-existent (aplasia). The orbital roof forms the lower boundary. In the case of sinusitis, there is a danger of perforation into the orbits. 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.

Sphenoid sinus

Image: "X-ray of the human skull in the frontal view with the paranasal sinuses. The paranasal sinuses and main nasal cavity are marked with
The sphenoid 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 since it provides surgical access to the pituitary gland, which is located behind the sphenoid sinus in the hypophysial fossa. In addition, it borders the sella turcica with the front and middle cranial fossa. The sidewall lies close to the internal carotid artery, the optic canal, and the cavernous sinus.

Possible infection can trigger cavernous sinus thrombosis. In surgery, the anatomical features of the sphenoid sinus must be strictly considered because injuries to the sinus or its surrounding structures can lead to life-threatening complications.

Image: Nasal cavity and paranasal sinuses highlighted in an x-ray using different colors. Nasal cavity = orange; maxillary sinus = green; ethmoid sinus = yellow; frontal sinus = purple; sphenoidal sinus = blue; mastoid process = cyan.

Pathways of the Nose

Nose vessels

The blood supply of the nose is derived from:

- The internal carotid artery which supplies the lateral nasal wall (ethmoidal arteries from the ophthalmic artery)
- The external carotid artery which supplies the dorsal aspect of the nose (nasal posterolateral arteries from the sphenopalatine artery)

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

In very severe nosebleeds, which cannot be stopped with tamponade or compression, it may be necessary to obstruct blood flow from one of the major arterial vessels (maxillary artery, external carotid artery, or one of the two ethmoidal arteries).

Nerves of the nose

Sensory innervation of the inner nose is via the branches of the trigeminal nerve (branches of the ophthalmic nerve [V1] in the front and upper parts and branches of the maxillary nerve [V2] in the other sections). The perception of smell is via the olfactory nerve.

The nose as a sensory organ

The olfactory nerve, the first cranial nerve (CN1), transmits the sensory perception of
smell that originates from the olfactory mucosa, which is an area that is approximately 2 cm² in size and is located on the roof of each nasal cavity. The olfactory nerve fibers pass through the cribriform plate of the ethmoid bone in the bony skull and merge to form the olfactory bulb.

The **olfactory fibers** 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 to an electrical signal within the cell, and the “coded” information concerning the scent quality is transported through the olfactory tract into the cerebral cortex.

Olfactory nerve fibers > olfactory bulb > olfactory tract > medial and lateral olfactory striae > primary olfactory cortex > amygdala.

Humans can detect about 10,000 different scents. A basilar skull fracture could damage the olfactory nerve fibers resulting in a loss of the sense of smell (anosmia). After such an injury, only “strong” smells such as that of ammonia are perceived, since the trigeminal nerve is responsible for sensory perception.

### Histology of the Nose

The **nasal mucous membrane** consists of respiratory and sensory epithelium with olfactory cells. The mucosa is well supplied with blood and has numerous mucus-producing goblet cells; thus, effective heating and humidifying of the air can be ensured. The drainage of the nasal secretions from the nasal cavities guided by the cilia of the ciliated epithelium is an important component of the non-specific immune defense system. A 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 understand the mechanisms of ear, nose, and throat medications as well as to succeed in medical exams. A synoptic view of the important nose and paranasal sinus pathologies include:

- **Image**: “Sinusitis maxillaris (Kieferhöhlenentzündung) rechts also links im Röntgenbild. Man erkennt deutlich den Luft-Flüssigkeitsspiegel.” by Hellerhoff. License: [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0)
• Sinusitis
• Rhinitis
• Epistaxis
• Nasal septum deviation
• Tumors of the nose
• Foreign substances
• Fractures
• Smell disorders

Important Exam Facts

Important exam topics include but are not limited to the ducts of the paranasal sinuses, the arterial supply of the nose, important anatomical boundaries and relations of the paranasal sinuses, and the components and course of the olfactory tract.

References


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