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**COURSE CODE:** ANA 301

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## ASSIGNMENT

1. Discuss the anatomy of the tongue and comment on its applied anatomy.
2. Write an essay on the air sinuses.

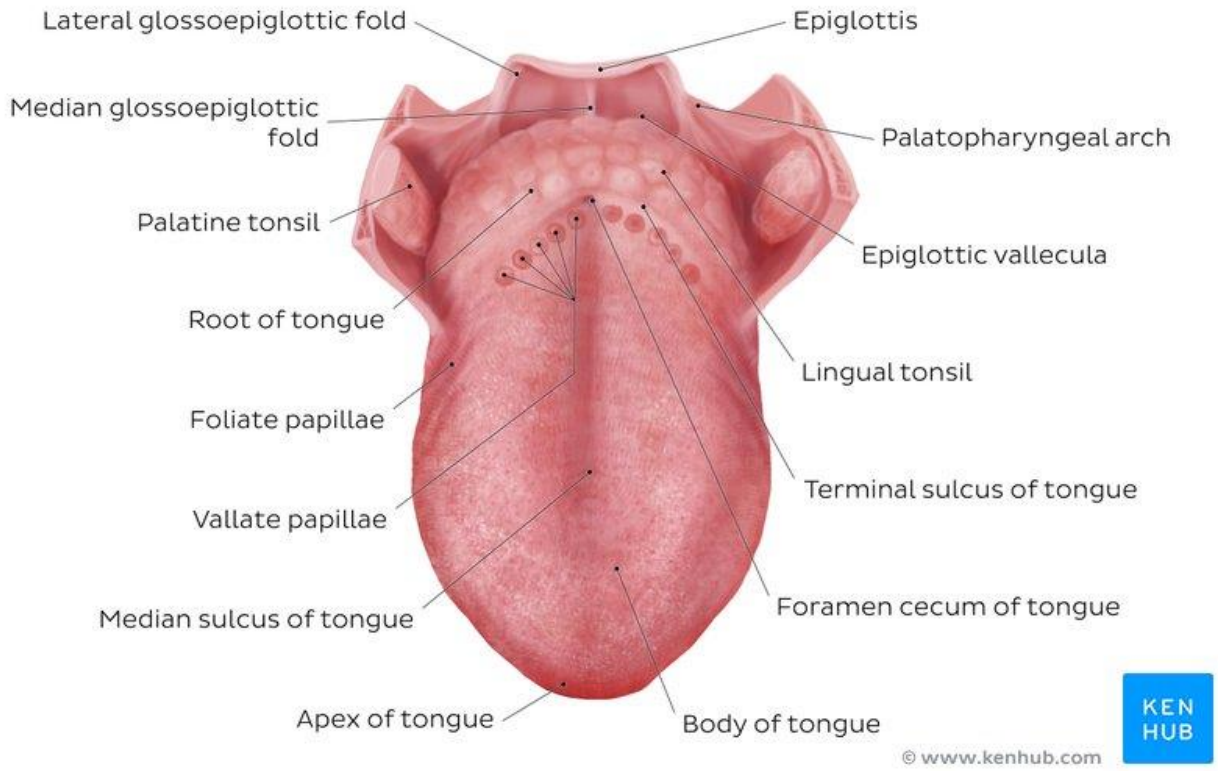
## 1. THE TONGUE

The tongue is a fleshy, muscular organ in the mouth of a mammal used for tasting, licking, swallowing and in humans, articulating speech. It is a mobile muscular organ that can assume a variety of shapes and positions. The tongue is involved with mastication, taste, deglutition (swallowing), articulation, and oral cleansing.

The mammalian tongue consists of a mass of striate muscles interspaced with glands and fat and covered with a mucous membrane.

The tongue is located partly in the oral cavity and partly in the oropharynx.

## STRUCTURE OF THE TONGUE




The tongue is a muscular hydrostat that forms part of the floor of the oral cavity. The left and right sides of the tongue are separated by a vertical section of fibrous tissue known as the lingual septum. This division is along the length of the tongue save for the very back of the pharyngeal part and is visible as a groove called the median sulcus. The human tongue is divided into anterior and posterior parts by the terminal sulcus which is a V-shaped groove. The apex of the terminal sulcus is marked by a blind foramen, the foramen cecum, which is a remnant of the median thyroid diverticulum in early embryonic development. The anterior oral part is the visible part situated at the front and makes up roughly two-thirds the length of the tongue. The

posterior pharyngeal part is the part closest to the throat, roughly one-third of its length. These parts differ in terms of their embryological development and nerve supply.

The average length of the human tongue from the oropharynx to the tip is 10 cm. The average weight of the human tongue from adult males is 70g and for adult females 60g.

## PARTS AND SURFACES OF THE TONGUE

The tongue is divided into different parts;

- The tip or apex
- The body or main part
- The root or base
- The dorsum
- Septum of the tongue

1. **The tip or apex:** The tip or apex of the tongue accounts for one-third of the anterior surface of the organ. It is highly movable and rests against the incisor teeth in the mouth cavity. The tip also plays its role in the production of labiodental and alveolar sounds.
2. **The body or main part:** The anterior two-thirds of the tongue form its body. The presence of lingual papillae on the upper side makes the surface rough to touch.
3. **The Root or Base:** The root is that part of the tongue that attaches it to the bottom or floor of the mouth cavity. The base appears between the mandible and the hyoid bone. The primary job of the hyoid bone is to provide anchorage to the tongue. The dorsal portion of the root lies in the oropharynx.
4. **The Dorsum ( Dorsal Portion):** This is the posterior superior surface, which is located partly in the oral cavity and partly in the oropharynx
5. **The Septum of the Tongue:** A fibrous septum – also called the septum linguae – is present in the middle line of the tongue. It separates the organ into 2 symmetrical halves. Arranged in various directions, there are muscle fibers in each half of the tongue.

The dorsum is characterized by a V-shaped groove called the terminal sulcus or groove (sulcus terminalis).

- The terminal sulcus divides the dorsum of the tongue into the:
- anterior (oral) part in the oral cavity proper
- posterior (pharyngeal) part in the oropharynx

## TYPES OF PAPILLAE

The mucous membrane on the anterior part of the tongue is rough because of the presence of numerous small lingual papillae (small nipple like process);

1. **Filiform papillae:** Filiform papillae are the most numerous of the lingual papillae. They are fine, small, cone-shaped papillae covering most of the dorsum of the tongue. They are responsible for giving the tongue its texture and are responsible for the sensation of touch. Unlike the other kinds of papillae, filiform papillae do not contain taste buds. They cover most of the front two-thirds of the tongue's surface. They appear as very small, conical or cylindrical surface projections, and are arranged in rows which lie parallel to the sulcus terminalis. At the tip of the tongue, these rows become more transverse.

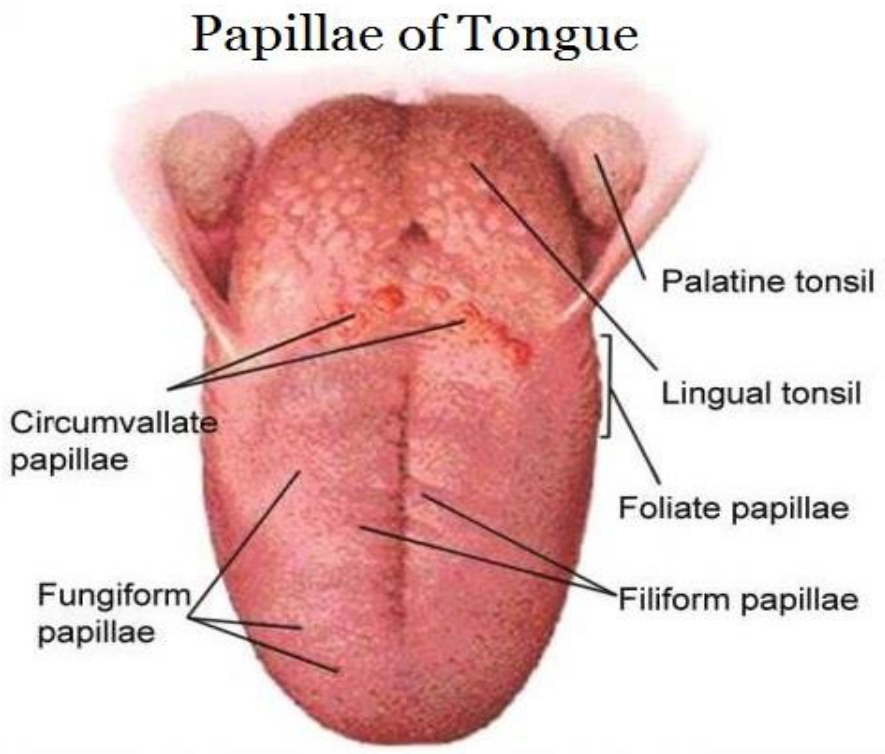
2. **Fungiform papillae:** The fungiform papillae are club shaped projections on the tongue, generally red in color. They are found on the tip of the tongue, scattered amongst the filiform papillae but are mostly present on the tip and sides of the tongue. They have taste buds on their upper surface which can distinguish the five tastes: sweet, sour, bitter, salty, and umami. They have a core of connective tissue. The fungiform papillae are innervated by the seventh cranial nerve, more specifically via the submandibular ganglion, chorda tympani, and geniculate ganglion ascending to the solitary nucleus in the brainstem.

3. **Foliate papillae:** Foliate papillae are short vertical folds and are present on each side of the tongue. They are located on the sides at the back of the tongue, just in front of the palatoglossal arch of the fauces, There are four or five vertical folds, and their size and shape is variable. The foliate papillae appear as a series of red colored, leaf–like ridges of mucosa. They are covered with epithelium, lack keratin and so are softer, and bear many taste buds. They are usually bilaterally symmetrical. Taste buds, the receptors of the gustatory sense, are scattered over the mucous membrane of their surface. Serous glands drain into the folds and clean the taste buds.

4. **Circumvallate papillae:** The circumvallate papillae (or vallate papillae) are dome-shaped structures on the human tongue that vary in number from 8 to 12. They are situated on the surface of the tongue immediately in front of the foramen cecum and sulcus terminalis, forming a row on either side; the two rows run backward and medially, and meet in the midline. Each papilla consists of a projection of mucous membrane from 1 to 2 mm. wide, attached to the bottom of a circular depression of the mucous membrane; the margin of the depression is elevated to form a wall (vallum), and between this and the papilla is a circular sulcus termed the fossa. The papilla is shaped like a truncated cone, the smaller

end being directed downward and attached to the tongue, the broader part or base projecting a little above the surface of the tongue and being studded with numerous small secondary papillæ and covered by stratified squamous epithelium.

All except the filiform papillae are associated with taste buds.




The mucous membrane over the anterior part of the dorsum of the tongue is thin and closely attached to the underlying muscle. A shallow midline groove of the tongue divides the tongue into right and left halves called the median sulcus. The mucous membrane of the posterior part of the tongue is thick and freely movable. It has no lingual papillae, but the underlying lymphoid nodules give this part of the tongue an irregular, cobblestone appearance. The lymphoid nodules are known collectively as the lingual tonsil. The pharyngeal part of the tongue constitutes the anterior wall of the oropharynx. The inferior surface of the tongue is covered with a thin, transparent mucous membrane through which one can see the underlying veins. This surface is connected to the floor of the mouth by a midline fold called the frenulum of the tongue. The frenulum allows the anterior part of the tongue to move freely. On each side of the frenulum, a deep lingual vein is visible through the thin mucous membrane,

There are 5 taste sensations found in the tongue;

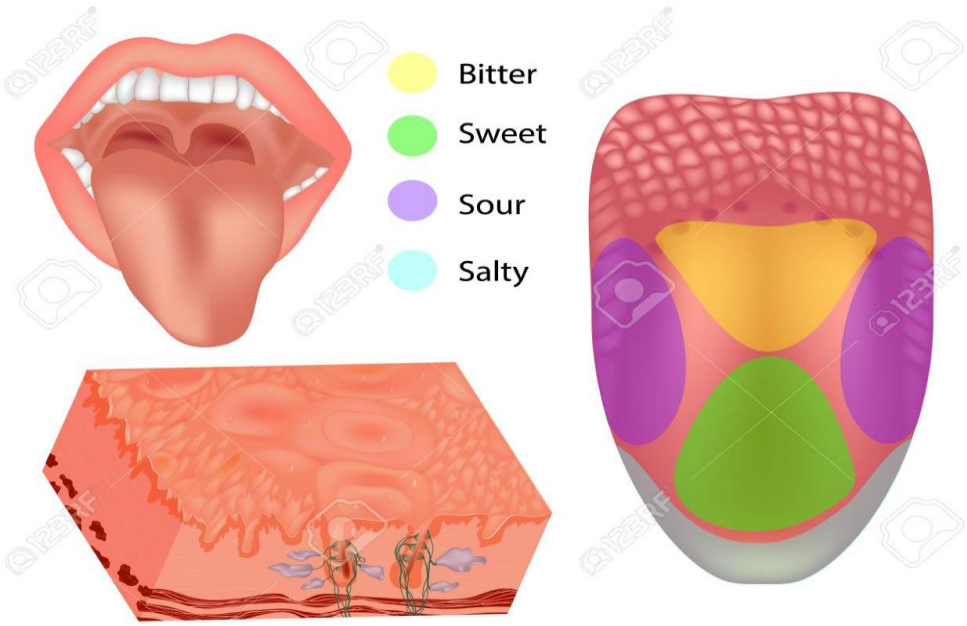
1. **Sweetness:** This is detected at the region of the apex. Sweetness is usually regarded as a pleasurable sensation, is produced by the presence of sugars and substances that mimic sugar. Sweetness may be connected to aldehydes and ketones, which contain a carbonyl group. Sweetness is detected by a variety of G protein coupled receptors (GPCR) coupled to the G protein gustducin found on the taste buds.

2. **Sourness:** It is dectected at the posterolateral margins. Sourness is the taste that detects acidity. The sourness of substances is rated relative to dilute hydrochloric acid, which has a sourness index of 1. Sour taste is detected by a small subset of cells that are distributed across all taste buds in the tongue. Sour taste cells can be identified by expression of the protein PKD2L1,[26] although this gene is not required for sour responses. The most common foods with natural sourness are fruits, such as lemon, grape, orange, tamarind, and bitter melon. Fermented foods, such as wine, vinegar or yogurt, may have sour taste.

3. **Saltiness:** It is detected at the anterolateral margins. Saltiness is a taste produced primarily by the presence of sodium ions. The simplest receptor found in the mouth is the sodium chloride (salt) receptor. Other ions of the alkali metals group also taste salty, but the further from sodium, the less salty the sensation is. A sodium channel in the taste cell wall allows sodium cations to enter the cell. This on its own depolarizes the cell, and opens voltage-dependent calcium channels, flooding the cell with positive calcium ions and leading to neurotransmitter release.

4. **Bitterness:** It is found at the posterior part of the tongue. Bitterness is one of the most sensitive of the tastes, and many perceive it as unpleasant, sharp, or disagreeable, but it is sometimes desirable and intentionally added via various bittering agents. Common bitter foods and beverages include coffee, unsweetened cocoa. Research has shown that TAS2Rs (taste receptors, type 2, also known as T2Rs) such as TAS2R38 coupled to the G protein gustducin are responsible for the human ability to taste bitter substances.

5. **Savoriness or Umami:** Savory, or savoriness is an appetitive taste and is occasionally described by its Japanese name, umami or "meaty". It can be tasted in cheese and soy sauce. The amino acid glutamic acid is responsible for savoriness, but some nucleotides (inosinic acid and guanylic acid) can act as complements, enhancing the taste. Glutamic acid binds to a variant of the G protein-coupled receptor, producing a savory taste.




## MUSCLES OF THE TONGUE

There are eight muscles of the human tongue which are classified as either intrinsic or extrinsic. The four intrinsic muscles act to change the shape of the tongue, and are not attached to any bone. The four extrinsic muscles act to change the position of the tongue, and are anchored to bone. The four intrinsic and four extrinsic muscles in each half of the tongue are separated by a median fibrous lingual septum, which merges posteriorly with the lingual aponeurosis.

### Intrinsic Muscles

There are four paired intrinsic muscles of the tongue and they are named in the direction in which they travel;

- Superior longitudinal
- Inferior longitudinal
- Transverse muscles
- Vertical muscles

These muscles affect the shape and size of the tongue and play key roles in facilitating speech, eating and swallowing.

## Extrinsic Muscles

They originate outside of the tongue and attach to it. They mainly function in the movement of the tongue but they can also alter its shape as well. They are:

### Genioglossus

- Attachments: Arises from the mandibular symphsis. Inserts into the body of the hyoid bone and the entire length of the tongue.
- Function: Inferior fibres protrude the tongue, middle fibres depress the tongue, and superior fibres draw the tip back and down
- Innervation: Motor innervation via the hypoglossal nerve (CNXII).

### Hyoglossus

- Attachments: Arises from the hyoid bone and inserts into the side of the tongue
- Function: Depresses and retracts the tongue
- Innervation: Motor innervation via the hypoglossal nerve (CNXII).

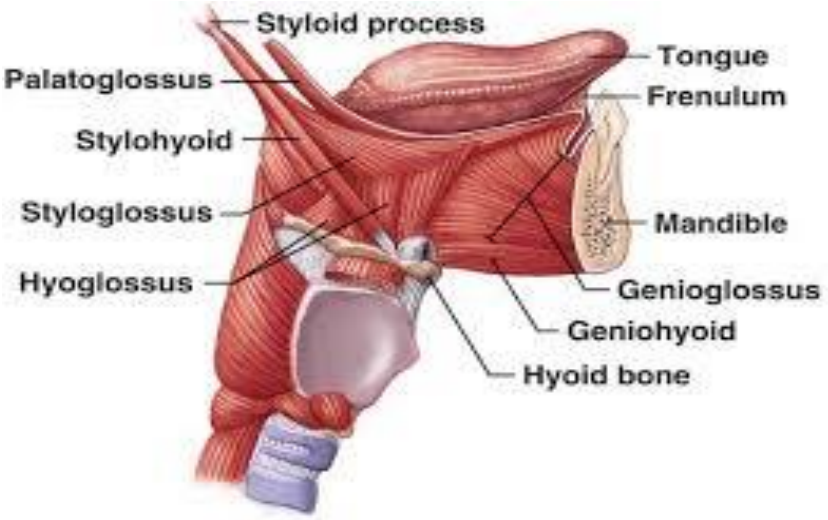
### Styloglossus

- Attachments: Originates at the styloid process of the temporal bone and inserts into the side of the tongue
- Function: Retracts and elevates the tongue
- Innervation: Motor innervation via the hypoglossal nerve (CNXII).

### Palatoglossus

- Attachments: Arises from the palatine aponeurosis and inserts broadly across the tongue
- Function: Elevates the posterior aspect of the tongue
- Innervation: Motor innervation via the vagus nerve (CNX).

All of the intrinsic and extrinsic muscles are innervated by the hypoglossal nerve (CN XII), except palatoglossus, which has vagal innervation (CN X).



## ARTERIAL SUPPLY OF THE TONGUE

The arteries of the tongue are derived from the lingual artery, which arises from the external carotid artery. On entering the tongue, the lingual artery passes deep to the hyoglossus muscle and give rise to the:

- The dorsal lingual arteries which supply the posterior part (root);
- the deep lingual arteries supply the anterior part.

The deep lingual arteries communicate with each other near the apex of the tongue. The dorsal lingual arteries are prevented from communicating by the lingual septum.

## VENOUS DRAINAGE

The veins of the tongue are the dorsal lingual veins, which accompany the lingual artery. The deep lingual veins, which begin at the apex of the tongue, run posteriorly beside the lingual frenulum to join the sublingual vein. The sublingual veins in elderly people are often varicose (enlarged and tortuous) All these lingual veins terminate, directly or indirectly, in the Inferior Jugular Vein.

## LYMPHATIC DRAINAGE

Lymph from the posterior third of the tongue drains into the **superior deep cervical lymph nodes.** Lymph from the medial part of the anterior two thirds drains directly to the **inferior deep cervical lymph nodes.** Lymph from the lateral parts of the anterior two thirds drains to the **submandibular lymph nodes.** The apex and frenulum drain to the **submental lymph nodes.** The posterior third and the medial part of the anterior two thirds drain bilaterally.

## INNERVATION

### Motor innervation

All muscles of the tongue, except the palatoglossus (actually a palatine muscle supplied by the vagus nerve(X) of the pharyngeal plexus), receive motor innervation from the hypoglossal nerve (CN XII).

### Sensory innervation

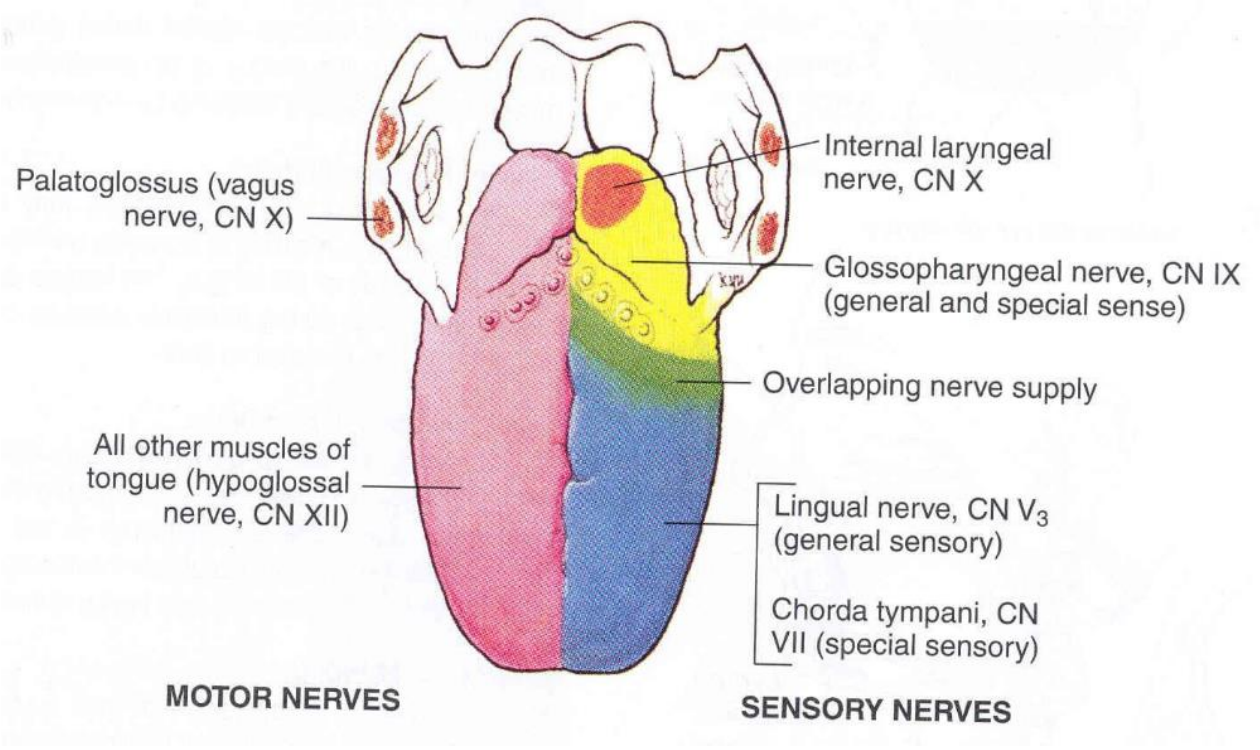
The anterior two thirds of the tongue are supplied by:

- the lingual nerve (CN $V_3$) for general sensation
- the chorda tympani, a branch of the facial nerve (CN VII) transferring nerve fibers to the lingual nerve, for taste

The posterior third of the tongue and the vallate papillae are supplied by:

- the lingual branch of the glossopharyngeal nerve (CN IX) for both general sensation and taste.
- Another contribution is made by the internal laryngeal branch of the vagus (CN X) for general sensation and taste.

Hence CN VII, CN IX, and CN X provide nerve fibers for taste; those from CN VII are ultimately conveyed by CN $V_3$.




## CLINICAL ANATOMY

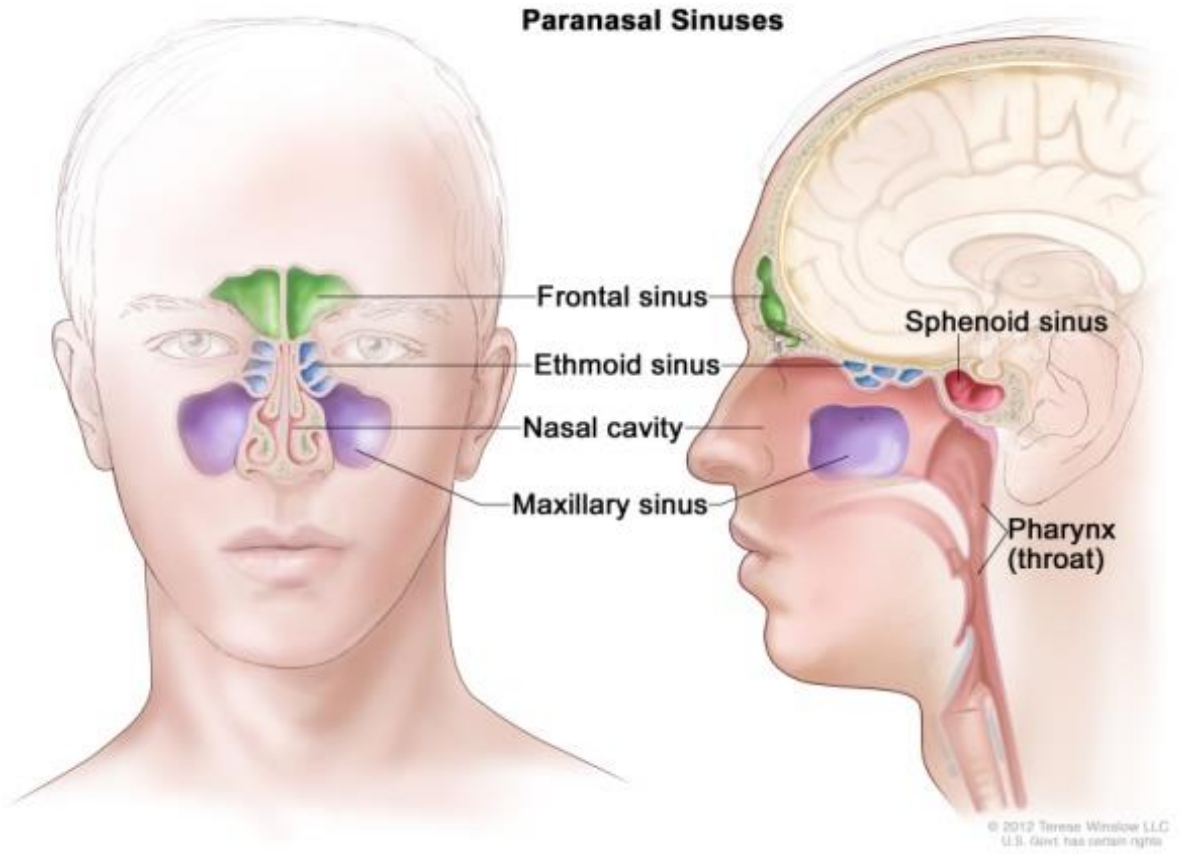
1. **Thrush (candidiasis):** *Candida albicans* (a yeast) grows over the surface of the mouth and tongue. Thrush can occur in almost anyone, but it occurs more often in people taking steroids or with suppressed immune systems, the very young, and the elderly.
2. **Oral cancer:** A growth or ulcer appears on the tongue and grows steadily. Oral cancer is more common in people who smoke and/or drink alcohol heavily. It can also be referred to as a lingual carcinoma.
3. **Genioglossus Muscle Paralysis:** When the genioglossus muscle becomes paralysed, the tongue falls backwards, potentially obstructing the airway and this increases the risk of suffocation. Total relaxation of the muscle occurs during

general anesthesia. As such, this shift of the tongue must be prevented to avoid blocking the airway. This is usually accomplished by inserting a temporary breathing tube during surgery.

4. **Hypoglossal Nerve Injury:** Trauma to the lower jaw ( mandible) may cause a fracture that injures the hypoglossal nerve, resulting in paralysis and eventually shrinking of one side of the tongue. After the injury, the tongue deviates to the paralysed side when protruded.
5. **Macroglossia (big tongue):** This can be broken down into various categories based on the cause. These include congenital, inflammatory, traumatic, cancerous, and metabolic causes. Thyroid disease, lymphangiomas, and congenital abnormalities are among some of the causes of an enlarged tongue.
6. **Geographic tongue:** Ridges and colored spots migrate over the surface of the tongue, periodically changing its appearance. Geographic tongue is a harmless condition.
7. **Burning mouth/burning tongue syndrome:** a relatively common problem. The tongue feels burned or scalded, or strange tastes or sensations develop. Apparently harmless, burning mouth syndrome may be caused by a mild nerve problem.
8. **Atrophic glossitis (bald tongue):** The tongue loses its bumpy texture, becoming smooth. Sometimes this is due to anemia or a B vitamin deficiency.
9. **Canker sores (aphthous ulcers):** Small, painful ulcers appear periodically on the tongue or mouth. A relatively common condition, the cause of canker sores is unknown; they are unrelated to the cold sores caused by herpes viruses. Canker sores are not contagious.
10. **Oral leukoplakia:** White patches appear on the tongue that can't be scraped off. Leukoplakia may be benign, or it can progress to oral cancer.
11. **Hairy tongue:** Papillae can overgrow the surface of the tongue, giving it a white or black appearance. Scraping off the papillae corrects this harmless condition.
12. **Herpes stomatitis:** The herpes virus can uncommonly cause cold sores on the tongue. Herpes virus cold sores are usually on the lip.
13. **Lichen planus:** A harmless condition that can affect the skin or the mouth. The cause is unknown; however, it is believed to be caused by the immune system attacking the skin and lining of the mouth.
14. **Frenectomy:** An overly large lingual frenulum (tongue-tie/ ankyloglossa) interferes with tongue movements and may affect speech. In unusual cases, a frenectomy (cutting the frenulum) in infants may be necessary to free the tongue for normal movement and speech.

## 2. THE PARANASAL SINUS

The paranasal sinuses are air-filled **extensions** of the respiratory part of the nasal cavity. There are **four** paired sinuses, named according to the bone in which they are located; maxillary, frontal, sphenoid and ethmoid. The maxillary sinuses are located under the eyes; the frontal sinuses are above the eyes; the ethmoidal sinuses are between the eyes and the sphenoidal sinuses are behind the eyes.




Sinuses are formed in childhood by the nasal cavity eroding into surrounding bone. As they are outgrowths of the nasal cavity, they all drain back into it – openings to the paranasal sinuses are found on the roof and lateral walls of the nasal cavity. The inner surface is lined by a respiratory mucosa.

### Development

Paranasal sinuses form developmentally through excavation of bone by air-filled sacs (pneumatic diverticula) from the nasal cavity. This process begins prenatally (intrauterine life), and it continues through the course of an organism's lifetime.The results of experimental studies suggest that the natural ventilation rate of a sinus with a single sinus ostium (opening) is extremely slow. Such limited ventilation may be protective for the sinus, as it would help prevent drying of its mucosal surface and maintain a near-sterile environment with high carbon dioxide concentrations and

minimal pathogen access. Thus composition of gas content in the maxillary sinus is similar to venous blood, with high carbon dioxide and lower oxygen levels compared to breathing air.

At birth only the maxillary sinus and the ethmoid sinus are developed but not yet pneumatized; only by the age of seven they are fully aerated. The sphenoid sinus appears at the age of three, and the frontal sinuses first appear at the age of six, and fully develop during adulthood.

## FUNCTIONS OF THE PARANASAL SINUSES

The function of the paranasal sinuses is debated. However, they are implicated in several roles:

- Decreasing the relative weight of the skull
- Increasing the resonance of the voice
- Providing a buffer against facial trauma
- Insulating sensitive structures from rapid temperature fluctuations in the nose
- Humidifying and heating inspired air
- Immunological defense

## THE PARANASAL SINUSES

1. **Frontal Sinuses**: These are the most superior in location, found under the forehead. The frontal sinuses are variable in size, but always triangular-shaped. They drain into the nasal cavity via the frontonasal duct, which opens out at the hiatus semilunaris on the lateral wall. The typical volume at the adult stage is 4 to 7 mL. The frontal sinus vasculature consists of the supraorbital and supratrochlear arteries and ophthalmic and supraorbital veins. Similarly, it's innervation is provided by the supraorbital and supratrochlear nerves (CNV1).

2. **Sphenoid Sinuses:** The sphenoid sinuses also lie relatively superiorly, at the level of the spheno-ethmodial recess. They are found more posteriorly, and are related superiorly and laterally to the cranial cavity. The sphenoid sinuses drain out onto the roof of the nasal cavity. The relationships of this sinus are of clinical importance – the pituitary gland can be surgically accessed via passing through the nasal roof, into the sphenoid sinus and through the sphenoid bone. The sphenopalatine artery supplies the sinus, and venous drainage is via the maxillary vein. Innervation is provided by the sphenopalatine nerve, which is comprised of parasympathetic fibers and CN V2. The typical adult size is 0.5 to 8 mL.

3. **Ethmoidal Sinuses:** There are three ethmoidal sinuses; anterior, middle and posterior. They empty into the nasal cavity at different places:

   - Anterior – Hiatus semilunaris
   - Middle – Ethmoid bulla
   - Posterior – Superior meatus

   The ethmoid sinuses are supplied by the anterior and posterior ethmoid arteries, respectively. These arteries are branches of the ophthalmic artery, which is a branch off of the internal carotid artery. Ethmoid sinus venous drainage is by the maxillary and ethmoid veins. The anterior and posterior ethmoid nerves provide innervation, they branch from the nasociliary nerve of the trigeminal nerve.

4. **Maxillary Sinuses:** The largest of the sinuses. It is located laterally and slightly inferiorly to the nasal cavities. It drains into the nasal cavity at the hiatus semilunaris, underneath the frontal sinus opening. This is a potential pathway for spread of infection – fluid draining from the frontal sinus can enter the maxillary sinus. Adjacent structures include the lateral nasal wall, the orbital floor, and the posterior maxillary wall which contains the pterygopalatine fossa. The maxillary sinus is innervated by the trigeminal nerve (CN V2). The maxillary and facial arteries supply the sinus, and the maxillary vein supplies venous drainage. The size of the maxillary sinus at adult stage is approximately 15 mL, making it the largest paranasal sinus.

## CLINICAL ANATOMY

### 1. CANCER

Malignancies of the paranasal sinuses comprise approximately 0.2% of all malignancies. About 80% of these malignancies arise in the maxillary sinus. Men are much more often affected than women. They most often occur in the age group between 40 and 70 years. Carcinomas are more frequent than sarcomas. Metastases are rare. Tumours of the sphenoid and frontal sinuses are extremely rare.

### 2. 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.