13

Physiology of taste and smell

PHYSIOLOGY
CNS Block
Team 443

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Color Index:

- Main text
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Editing File

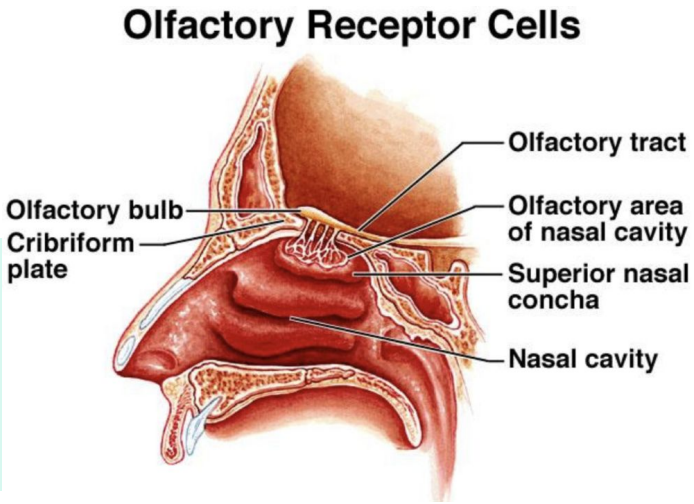
Objectives :

We didn‘t find the Objectives of the lecture, not even in the **guide**

Smell

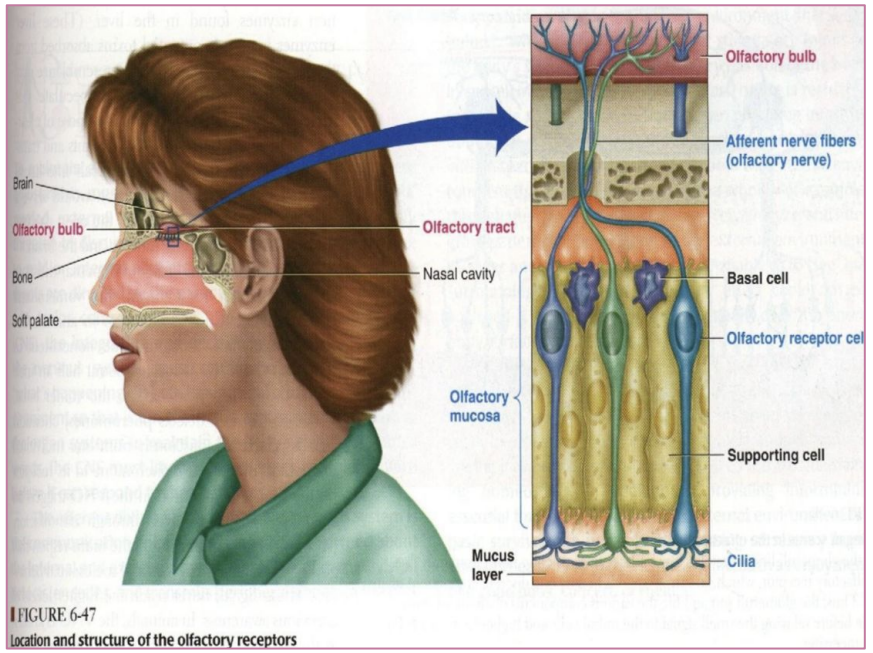
Anatomy

- Olfactory mucus: in the roof of nasal cavity near the septum
- Contain olfactory receptors **(bipolar neurons)**
- Axons collected in bundles called **fila olfactoria**



(439)

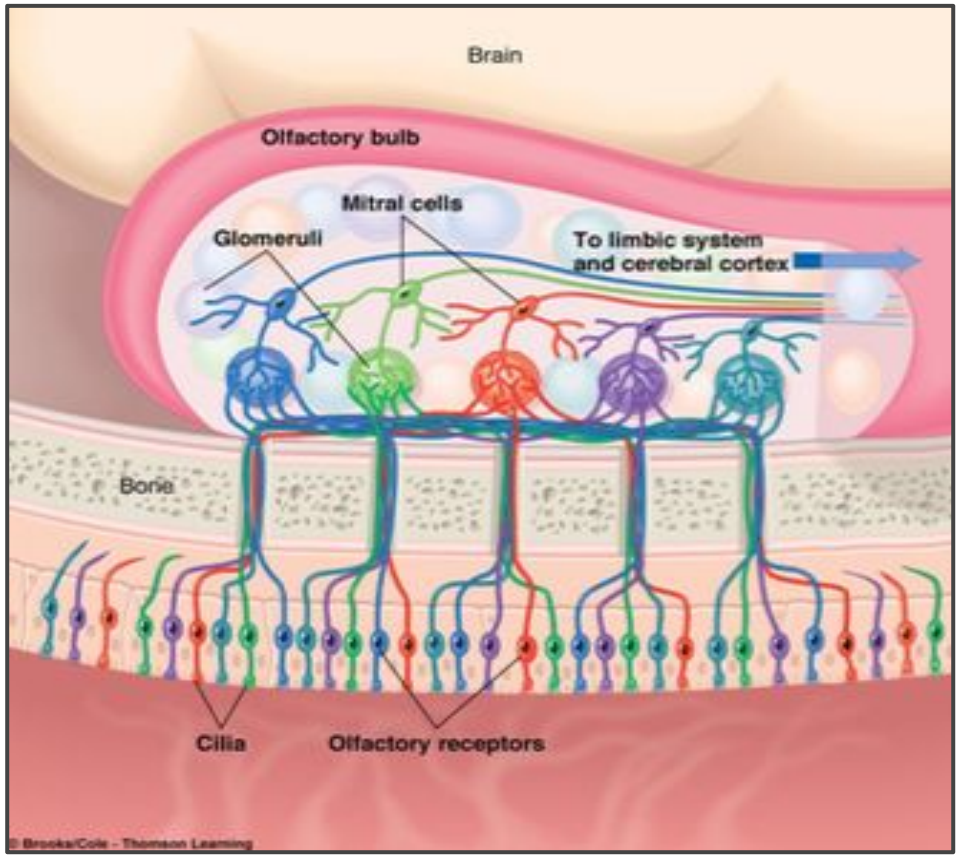
- The nasal cavity has a close relation to the brain which increases the risk of infections spreading to the brain leading to meningitis.
- The is no BBB between the cavity and the brain
- The olfactory bulb is found on the base of the brain
- The olfactory nerve pass through the cribriform plate



- Smell takes place through specialized epithelium in the nasal cavity.
- Olfactory epithelium consist of : (olfactory receptor cells , Bipolar nerve fibers toward the brain , Cillia)

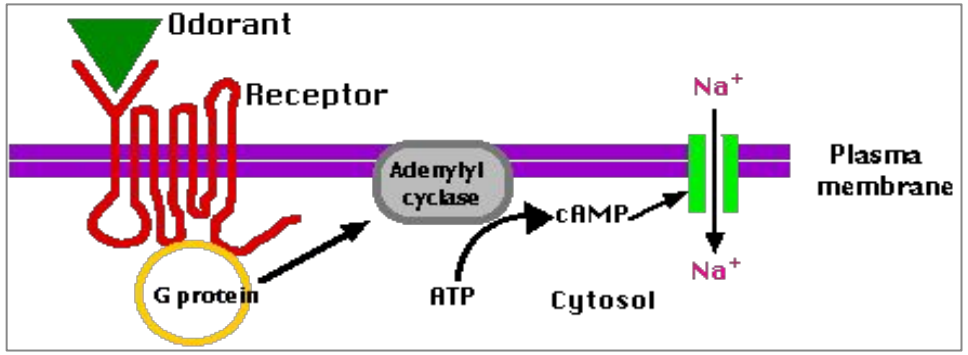
physiology of smell

- Power of perceiving odors is called **smell**
- Olfactory receptors present in the **roof of nasal cavity**
- Neurons with long cilia **(olfactory hairs)**
- Chemicals **must dissolved** in mucus for detection
- Impulses transmitted via the **olfactory nerve**
- Interpretation of smells is made in the **olfactory cortex** of the brain
- Human can differentiate between **2000-4000** odours
- **Adaptation** can occur to pleasant and nasty smells due to changes both in receptors and central connections



(Local adaptation) down regulation of the receptor so no connection between the molecules and the receptor of olfactory epithelium , and (central adaptation) central changes in brain will block the reception of action potential(439)

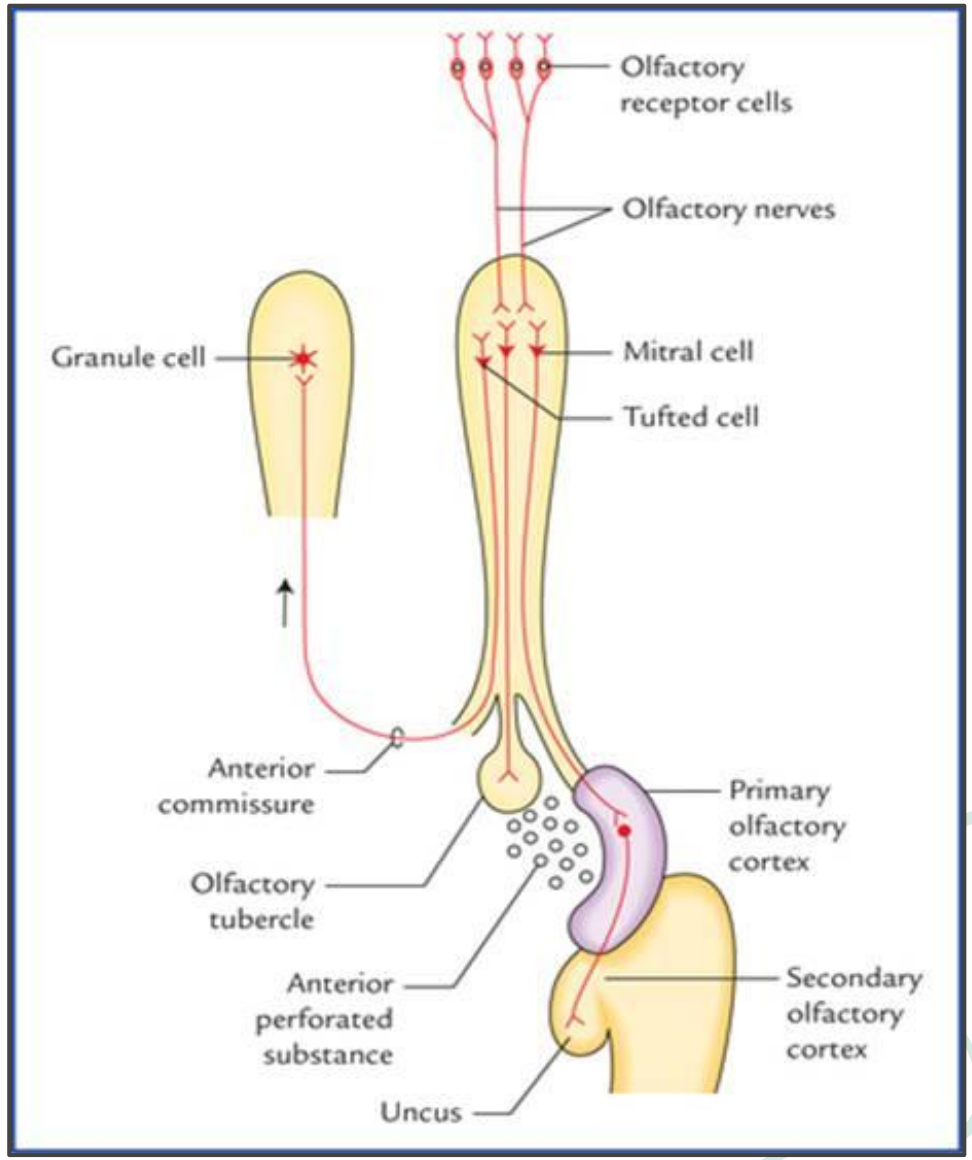
physiology of olfaction



1. Molecules dissolve in mucus layer
2. combine with receptors on cilia (Odorant + receptor protein)
3. stimulate adenylate cyclase (activation of G protein → activation of adenylate cyclase)
4. increase intracellular cAMP (ATP → cAMP)
5. opening of Na channels receptors→ Na influx
6. receptors potential (depolarization)
7. AP in olfactory pathway

olfactory pathway

1. Fila olfactoria inter olfactory bulb
2. synapse with mitral and tufted cells
3. from mitral cells lateral and intermediate stria start → end on ipsilateral cortex
4. from tufted cells medial stria start then cross the midline & end on granular cells in opposite side **(contralateral)**



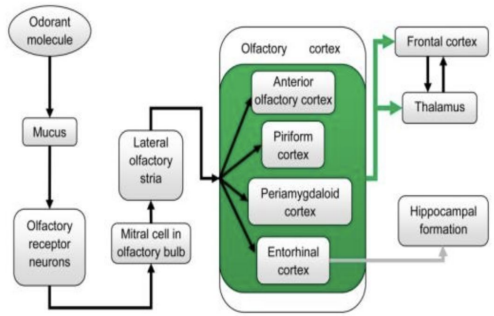
olfactory pathway

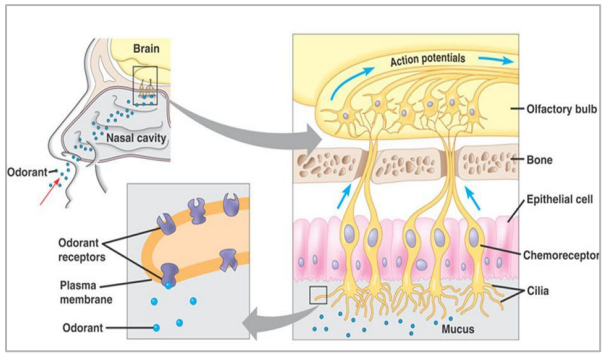
Olfactory Receptors

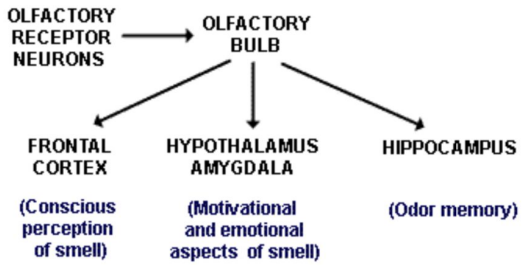
Olfactory Bulb

Olfactory nerve

Olfactory tract



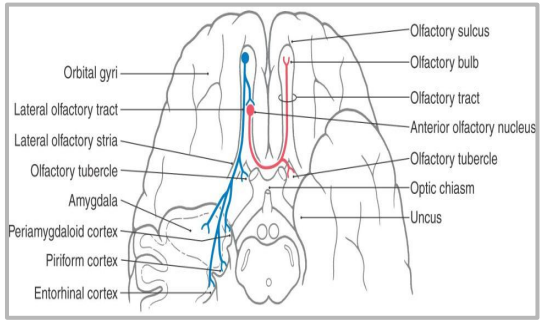




Thalamus → Orbitofrontal cortex (newer system) for conscious perception of smell

Lateral olfactory area

Prepyriform cortex, Piriform cortex , Amygdala → limbic system (Hippocampus) (less old factory system) For odor memory



Medial olfactory area

Septal nuclei → Hypothalamus limbic system (primitive parts,very old olfactory system) for motivational and emotional aspects of smell

olfactory pathway

1. **First order neuron**

   -From olfactory epithelium to glomerulus

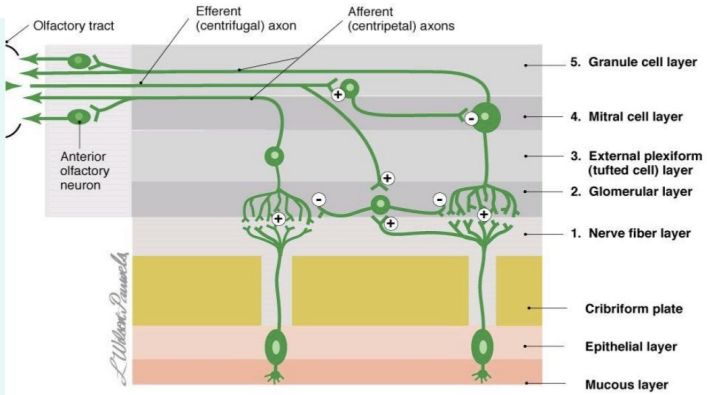
2. **Second order neuron**

   -The olfactory bulb where the second neurons of the olfactory pathway(Mitral and tufted cells)are located

   -The axons of these second order neurons pass centrally as the olfactory tract

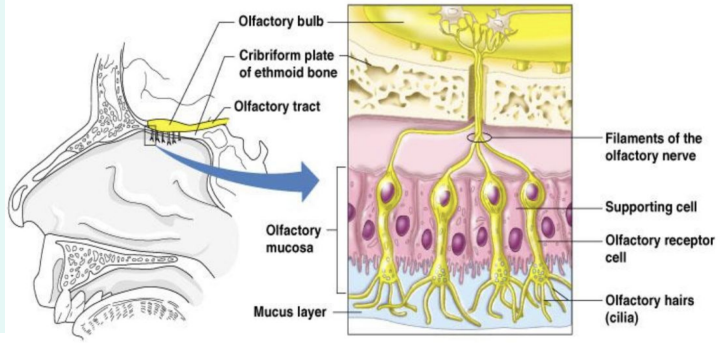
3. **Third order neuron**

   The prepiriform area (area 28) is considered the primary olfactory cortex which contains the third order neurons.

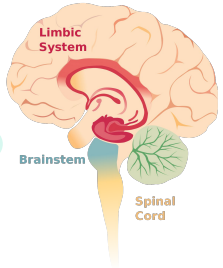


ure I–3 Olfactory pathway from olfactory epithelium to the olfactory tract. Numbers 1 to 5 represent the layers olfactory bulb. The olfactory tract includes afferent (second order) axons of tufted and mitral cells; neurons of t erior olfactory nucleus; and efferent axons from the olfactory cortex and from the contralateral olfactory nucleus

n "Cranial Nerves in Health and Disease" 2002, © Wilson-Pauwels, Akesson, Stewart, Spacey, B C Decker In

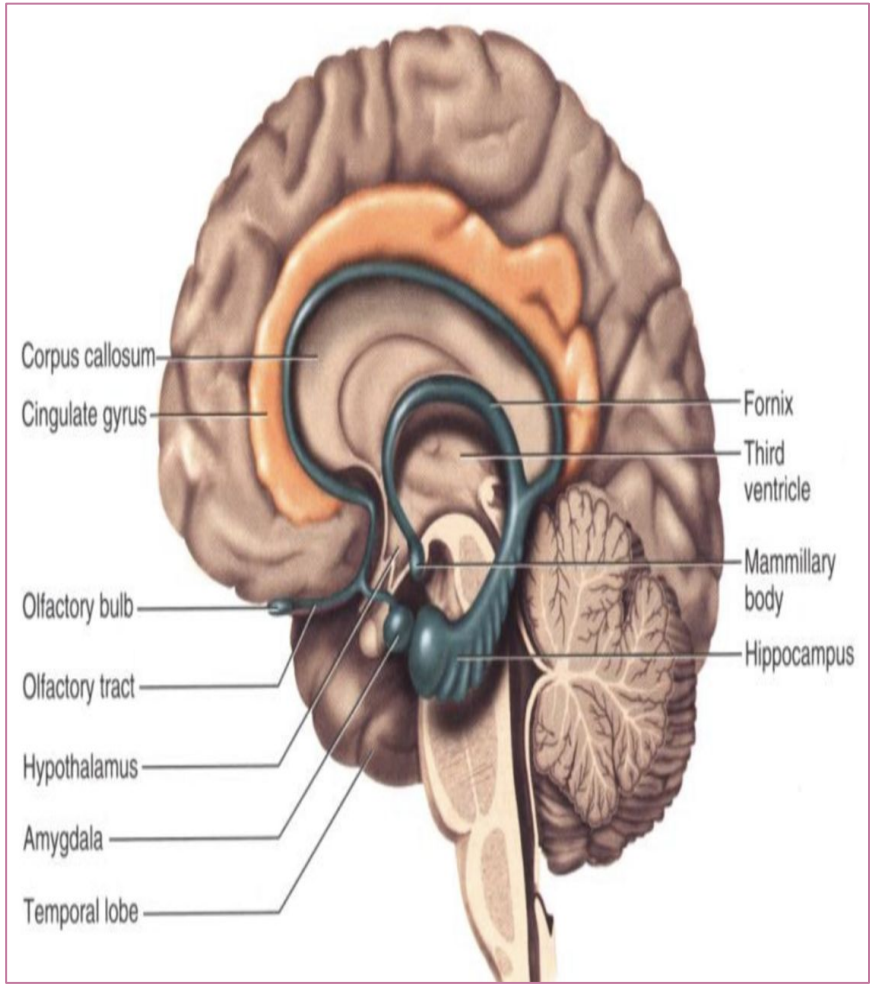


The Limbic System



- Impulses travel along the **olfactory tracts** to **the limbic system(Also involved in emotions and memory) -Impulses** are interpreted in olfactory cortex
- Located Deep in **temporal lobe** and **base of frontal lobe**

-when you smell a specific smell this will trigger a memory related to that smell Due to the close contact between olfactory function and the limbic system .
-Olfactory bulb connected with the limbic system .
-limbic system include the amygdala, hippocampus, thalamus, hypothalamus .(439)



Pathophysiology

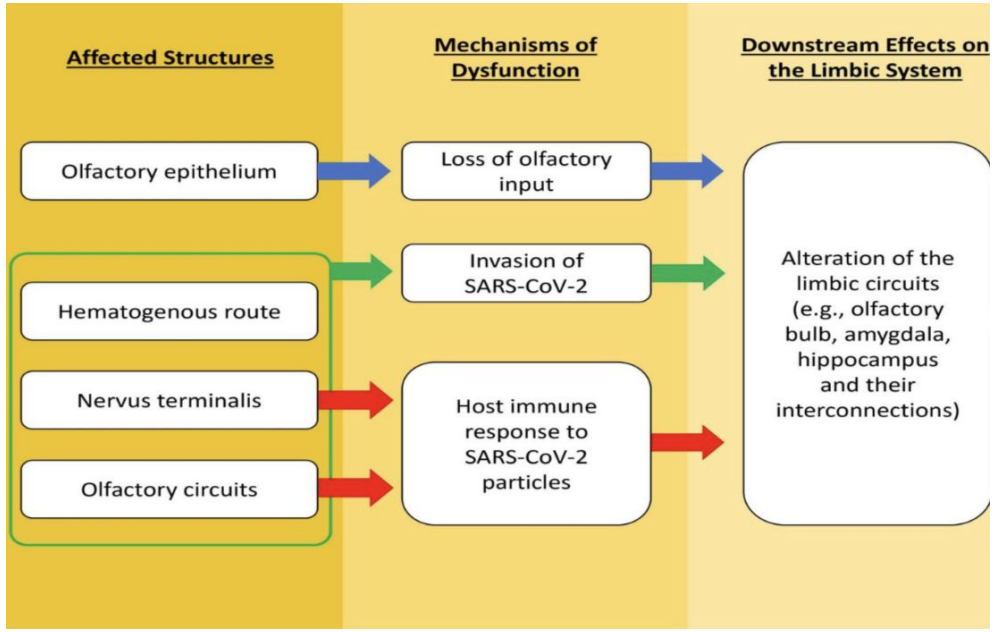
Anosmia	**loss** of smell sensation Due to damage to olfactory epithelium E.g: (Repeated infection , trauma , Genetic changes) -permanent loss -
Hyperosmia	(**increase** in smell sensation) E.g : Adrenal insufficiency
Parosmia (dysosmia)	**Alteration** in smell sensation E.g: (Hormonal changes: pregnant women , Covid-19 patients) -Temporary loss-
Hyposomia	(**decreased** smell sensation) E.g: Vitamin A deficiency

Pathophysiology

-The mechanism with which SARS-CoV-2 could impair smell and taste has been determined, two hypotheses appear to be plausible:

- Damage to the olfactory epithelium, **due to cell expression of angiotensin-converting enzyme 2 (ACE2) receptors** which act as a **binding point for** the **virus**, or a direct assault on the olfactory neurons.

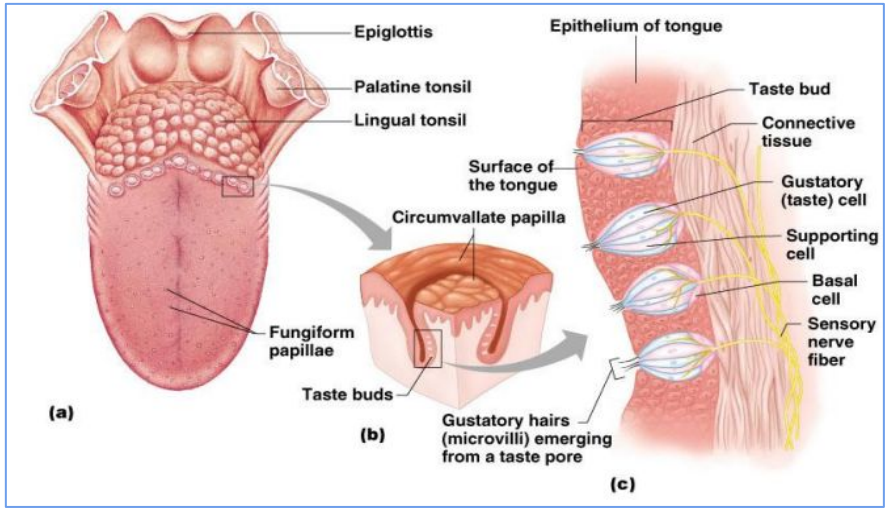
However, epithelium rapidly restore its functions after damage.



Taste

Definition

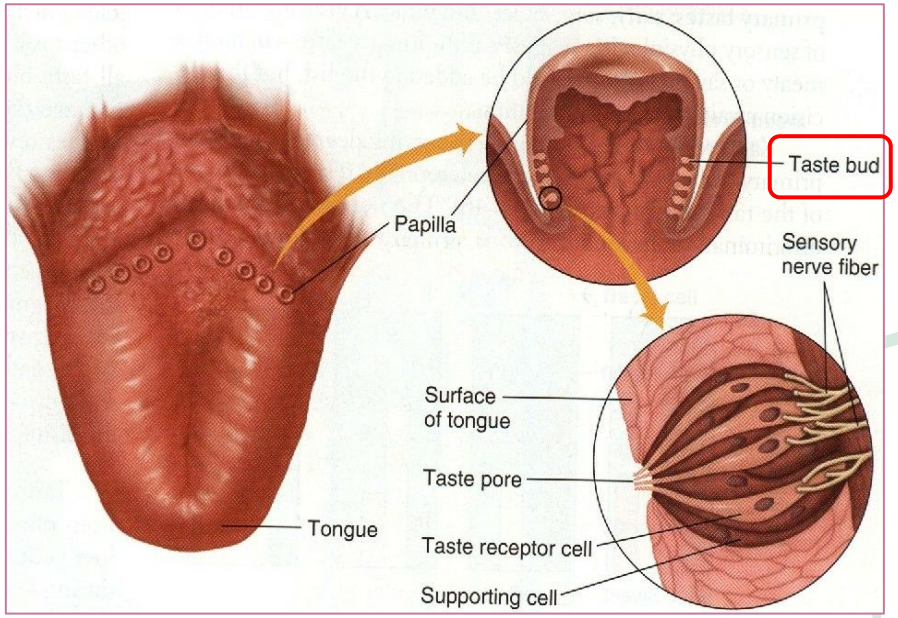
Taste is the sensation produced when a substance in the mouth **reacts chemically** with taste receptor.



Taste Buds

Taste buds are specialized receptors on the side of the papilla in the oral cavity(widely scattered throughout the oral cavity) but mainly on :

- The Tongue (mainly in the tongue and few scattered in palate and the pharynx)
- Some on the Soft Palate
- Inner surface of cheeks



Structure of Taste Buds

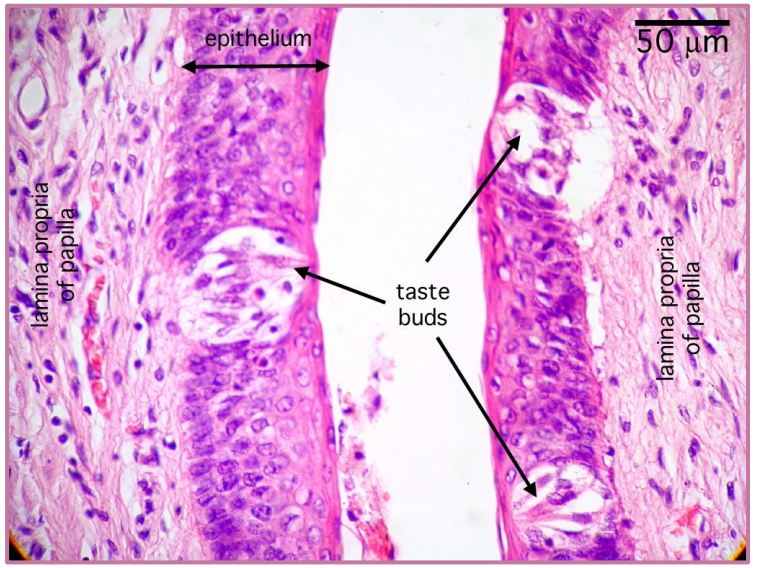
Taste bud : gustatory cells with long microvilli (gustatory hair cells)

They are receptors cells with cilia projected through taste pore **between** the supporting cells

Hairs are stimulated by chemicals dissolved with saliva and transmit impulses to the brain

Impulses are carried to the gustatory complex by cranial nerves as taste buds are found in different areas

- Facial nerve
- Glossopharyngeal nerve
- Vagus nerve

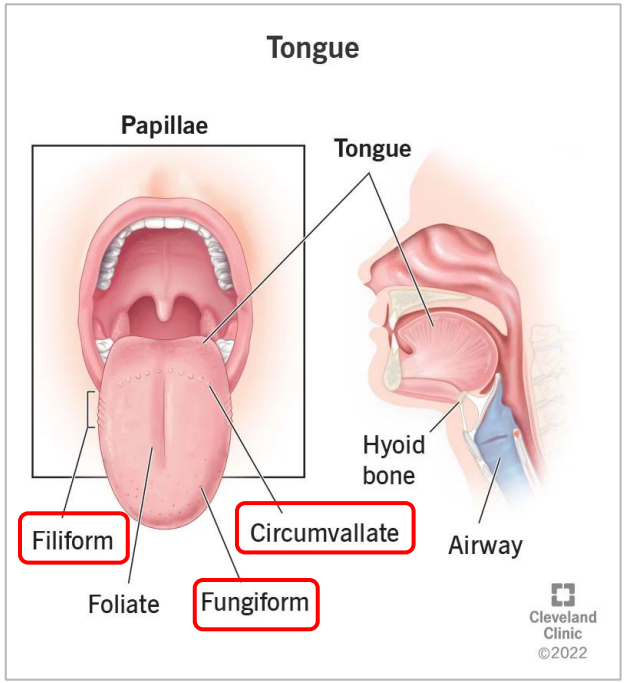


Taste bud: • When stimulated produce nerve impulse to specific brain area through:	
Anterior 2/3 of the tongue	Facial Nerve (VII)
Posterior I/3 of the tongue	Glossopharyngeal Nerve (IX)
Receptors on the palate, pharynx, epiglottis	Vagus Nerve (X)

Types of papillae (projection)

The tongue is covered with **3 types** of projections called papillae:

Filiform	**Sharp – no taste buds** there are taste buds but it's not significant
Fungiform	**Rounded with taste buds**
Circumvallate	**Large papillae with taste buds**



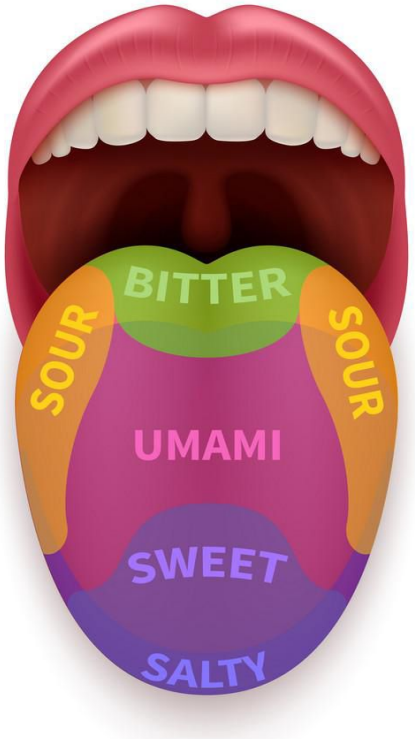
Fun Fact!

Did you know that taste sensation is influenced by factors beyond just our taste buds? Our sense of taste is actually a combination of taste buds, smell, and even our visual perception. When we eat, the aroma of the food plays a significant role in how we perceive its taste. In fact, studies have shown that if our sense of smell is compromised, such as during a cold or sinus infection, our ability to taste is also affected.

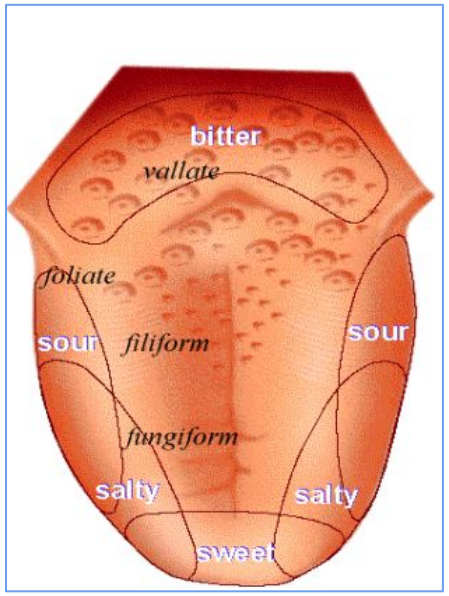
Distribution

- Distribution of taste buds on tongue **not uniformed**

1. **Sweet**
   tongue tip
2. **Sour**
   tongue margins
3. **Bitter**
   back of tongue
4. **Salt**
   widely distributed on the edges.
5. **Umami**
   widely distributed
   all over the tongue.



- There are 5 established taste,Taste buds on tongue not uniform
- **No taste buds on the mid dorsum of the tongue**



Taste Receptors

Receptors Responds to:

1. **Sweet**
   sugar,saccharine,some amino acids
2. **Sour**
   H ion , acids
3. **Bitter**
   Alkaloids
4. **Salt**
   salts, ions , metal
5. **Umami**
   monosodium glutamate ("Beef taste" of steak,)

Taste sensation

1. Molecules dissolve in the saliva without it? less taste
2. Attached to receptors on cillia of gustatory cells. Combination between molecules and receptors are weak (since taste can be easily abolished by washing mouth with water)
3. receptors potential
4. action potential

Taste pathway

1

First order neuron

Taste fibres from the three cranial nerves form **tractus solitarius** (one small tract) → end in the nucleus of tractus solitarius (medulla)

2

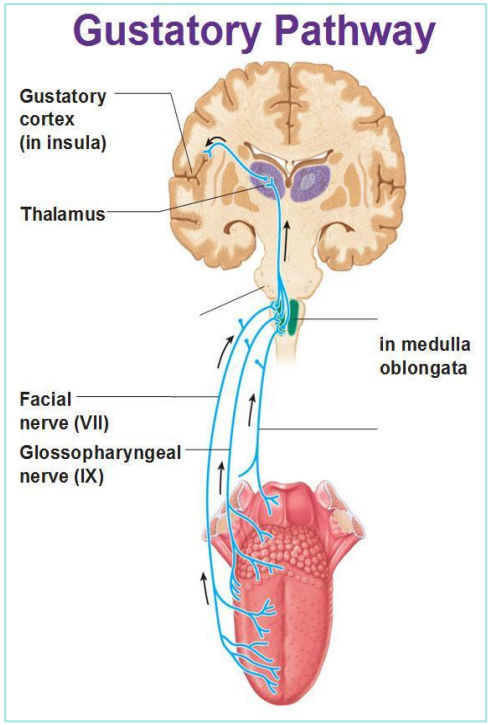
Second order neuron

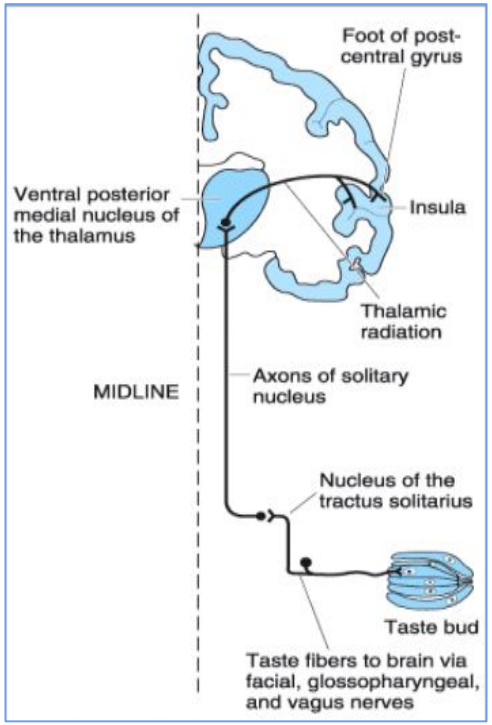
From TS cross the midline to ascend in the medial lemniscus to the thalamus

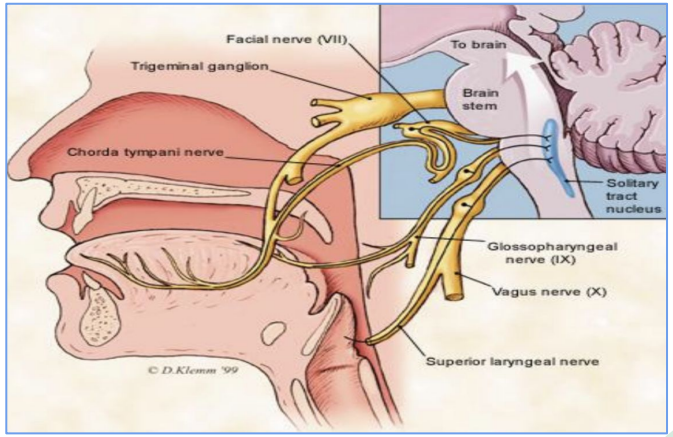
3

Third order neuron

from thalamus through the internal capsule project the cerebral cortex through thalamic radiation then to the taste area near to insula and interpretation will happen there







Pathophysiology

1. **Ageusia: complete loss of taste**
   (E.g. Covid-19), Genetic

2. **Hypergeusia**
   E.g Adrenal insufficiency

3. **Dysgeusia (disturbed taste)**
   E.g hormonal effect (e.g pregnancy and oral contraceptive , diabetic patients)

4. **Hypogeusia**
   E.g Common cold and Vitamin A deficiency

   Many diseases can produce hypogeusia. In addition, drugs such as captopril and penicillamine, which contain sulfhydryl groups, cause temporary loss of taste sensation.

5. **Tooth extraction (loss of taste if nerve damage during extraction)**
   E.g : **wisdom tooth extraction** due to the close relation of the nerve position to it, the damage can be reversible or irreversible depending on the degree of damage.

TEST YOURSELF !

The intensity of smell depends on :

A) adaptation of smell in olfactory receptors

B)Frequency of nerve impulses

C) Type of neurotransmitters released by neurons

D)dissolving of the molecules in the saliva

Which nerve supplies the anterior ⅔ of the tongue ?

A) V

B) VII

C) X

D) XI

There are No taste buds are on the __ of the tongue

A) Ventral Side

B) Mid dorsum

C) back

D) margins

Which of following is the definition of anosmie ?

A) loss of smell sensation

B) decrease in smell sensation

C) loss of taste sensation

D) decrease in smell sensation

Answers: B,B, B, A

SAQ

Q1- Explain the physiology of olfaction ?

Q2- Name the three Types of papillae of the tongue?

Q3- What are the five taste receptors of the mouth?

Q1: Slide 5
Q2: Slide 13
Q3: Slide 14

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