Physiology Team 439

MED439
KING SAUD UNIVERSITY

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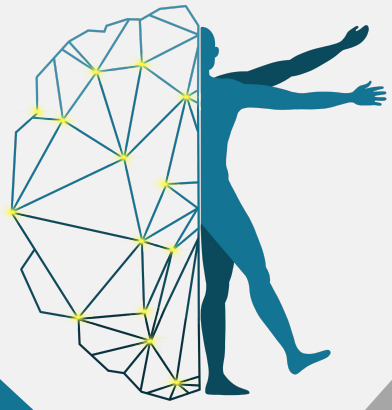


Physiology of the Smell and Taste

Objectives:

- Appreciate the physiology of olfaction & taste
- Describe the olfactory & taste pathways
- Appreciate some pathophysiological conditions related to olfaction & taste

Color index:

- Important.
- Girls slide only.
- Boys slide only.
- Dr's note.
- Extra information.

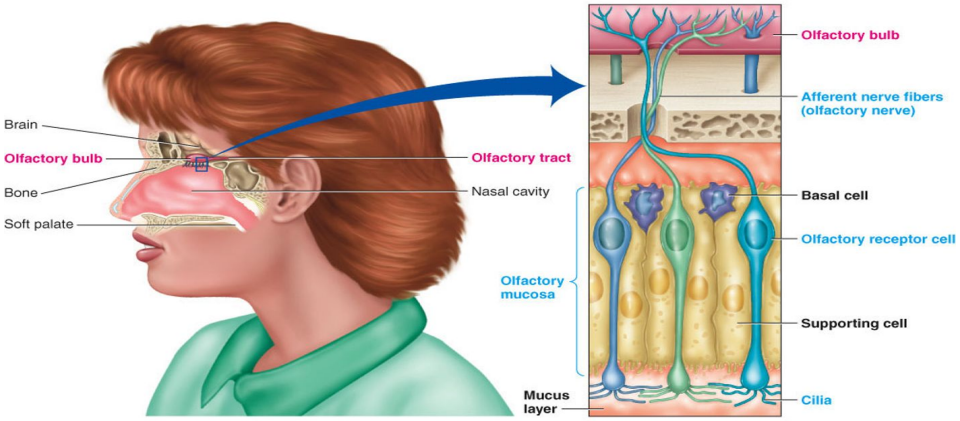
Editing File

Smell

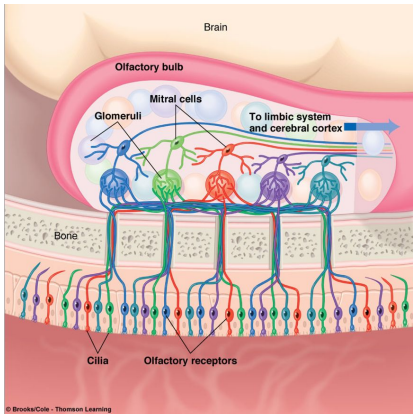
Anatomy*

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

- Smell takes place in the nasal cavity
- 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

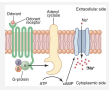


Physiology of smell (olfaction)



- 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

Olfactory Mechanism

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

Olfactory Pathway

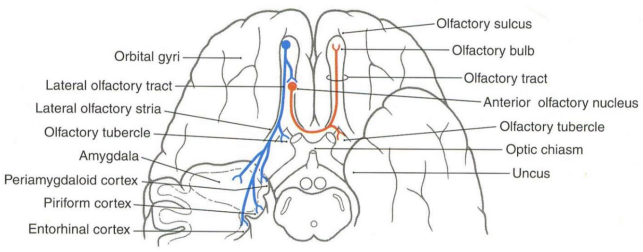
As in the boys slides

Olfactory Receptors → Olfactory nerve → Olfactory bulb → Olfactory Tract

Click to see the original pic

From the Olfactory tract

Lateral olfactory area



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

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

Medial olfactory area

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

Olfactory Pathway

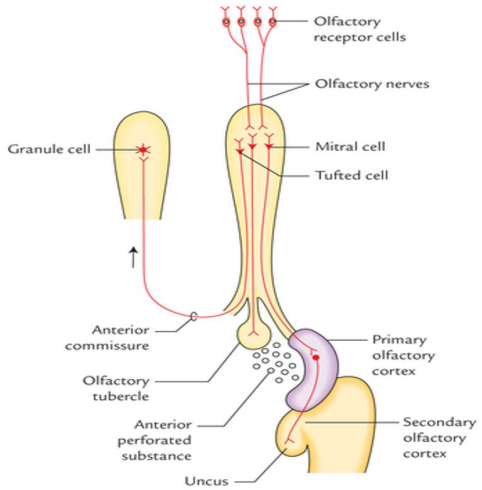
As in boys slides

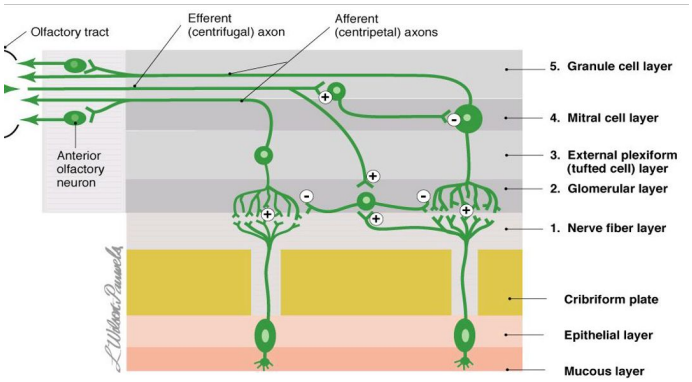
1. **First order neuron**
   From olfactory epithelium to glomerulus
2. **Second order neuron**
   The olfactory bulb. (Mitral and tufted cells)
   The axons of these second order neurons pass centrally as the olfactory tract
3. **Third order neuron**
   The prepiriform area (area 28) is considered the primary olfactory cortex which contains the third order neurons.

Olfactory Pathway

As in girls slides

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**)



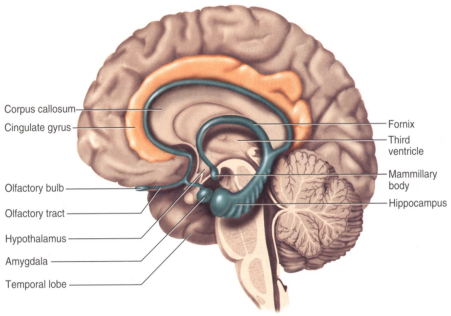


ure I–3 Olfactory pathway from olfactory epithelium to the olfactory tract. Numbers 1 to 5 represent the layers olfactory bulb. The olfactory tract includes afferent (second order) axons of tufted and mitral cells; neurons of t erior olfactory nucleus; and efferent axons from the olfactory cortex and 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
- -The system is involved in emotions and memory Impulses which 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 .

Pathophysiology

1. **Anosmia:** loss of smell sensation

   Due to damage to olfactory epithelium (**E.g.** genetic, trauma , inflammation, Covid-19)

   COVID -19 patients completely loss of smell sensation but after months they regain the smell sensation (temporary anosmia)

2. **Hyperosmia** (increase in smell sensation)

   Adrenal insufficiency (all sensations are exaggerated)

3. **Parosmia (dysosmia)**

   Alteration in smell sensation (E.g. hormonal effects due to pregnancy and oral contraceptives)

4. **Hyposomia** (decreased smell sensation)

   Vitamin A deficiency and common cold

Taste

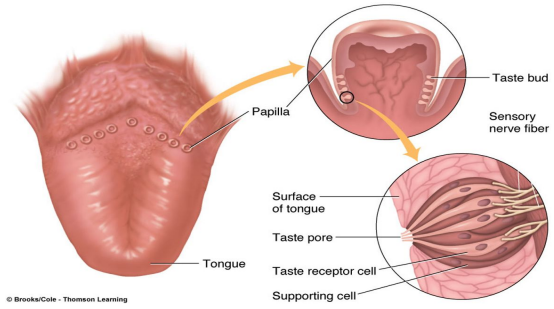
L13

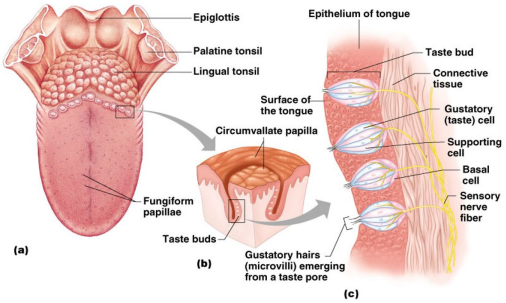
Definition*

Taste is the sensation produced when a substance in the mouth reacts chemically with taste receptor with help of saliva

Taste buds (Gustatory Cells)

- Taste buds are specialized receptors on the sides of the papilla, widely scattered throughout the oral cavity:
  - Tongue (mainly in the tongue and few scattered in palate and the pharynx)
  - Soft palate
  - Inner surface of cheeks
- with long microvilli (gustatory hair)
- They are receptors cells with cilia projected through taste pore in between there are supporting cells. epithelial 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



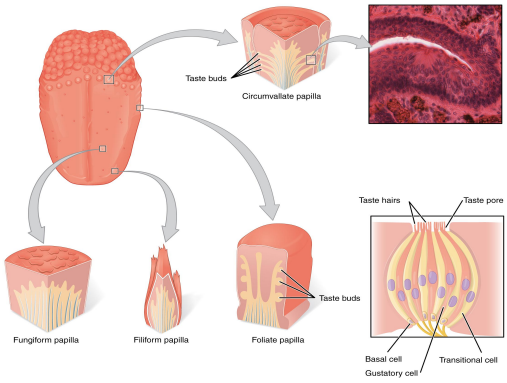


Types of papillae (projection)

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



Distribution

- there are 5 established taste buds
- Distribution of taste buds on the tongue is not uniform
- There are no taste buds at the mid dorsum of the tongue

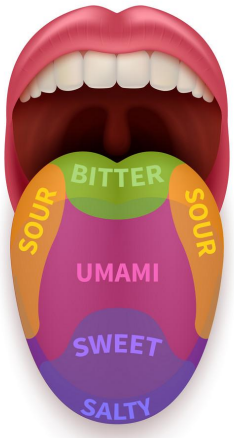
Sweet tongue tip

Sour tongue margins

Bitter back of tongue

Salt widely distributed on the edges.

Umami "Beef taste" of steak, widely distributed all over the tongue.



Taste Sensation

When the taste buds are stimulated they produce nerve impulse to specific brain area through:

- Anterior 2/3 of the tongue → VII Facial
- Posterior 1/3 of the tongue → IX Glossopharyngeal
- Receptors on the palate, pharynx, epiglottis → X Vagus

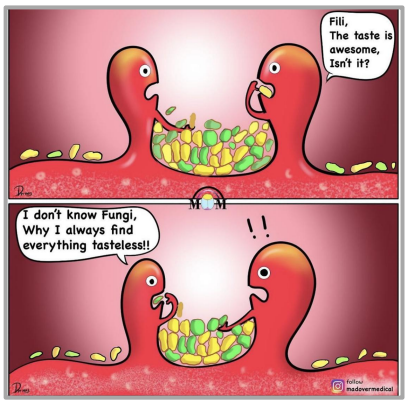
Taste Mechanism

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 week (since taste can be easily abolished by washing mouth with water)
3	receptors potential
4	action potential

Taste receptors

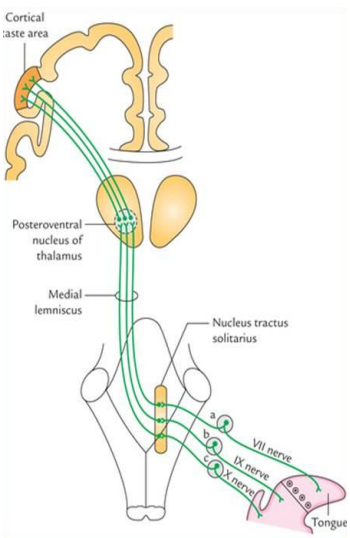
Respond to:

- **Sweet** sugar, saccharine, some amino acids
- **Sour** H ion , acids
- **Bitter** Alkaloids
- **Salty** salts, ions , metal
- **Umami** monosodium glutamate



Taste pathway

1. **First order neuron**
   Taste fibres from the three cranial nerves form (one small tract) tractus solitarius → 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 it project to the cerebral cortex through thalamic radiation then to the taste area near to insula and interpretation will happen there



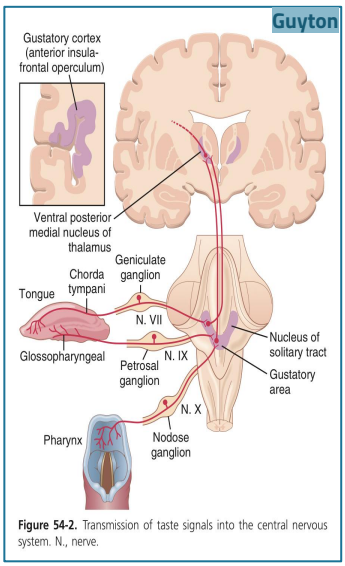
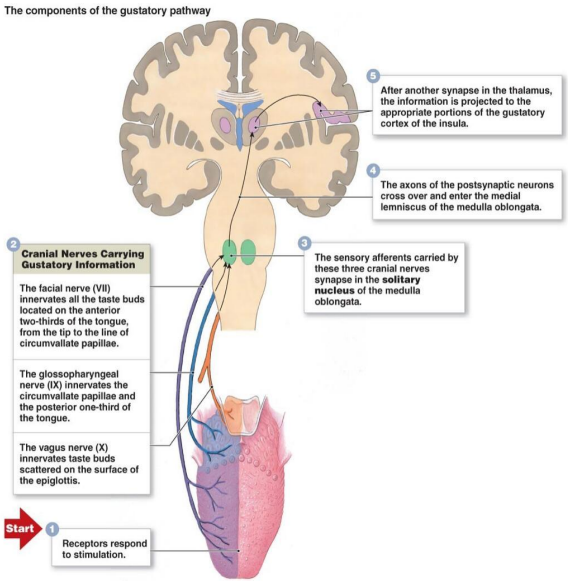


Figure 54-2. Transmission of taste signals into the central nervous system. N., nerve.



Pathophysiology

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

2. **Hypergeusia**
Adrenal insufficiency

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

4. **Hypogeusia**
Due to Common cold and Vitamin A deficiency

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.

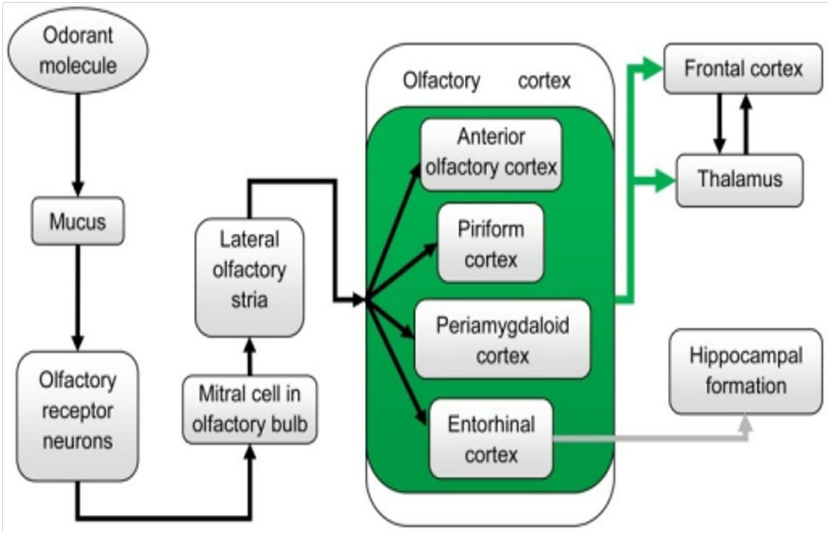
6. Many diseases can produce hypogeusia. In addition, drugs such as captopril and penicillamine, which contain sulfhydryl groups, cause temporary loss of taste sensation.

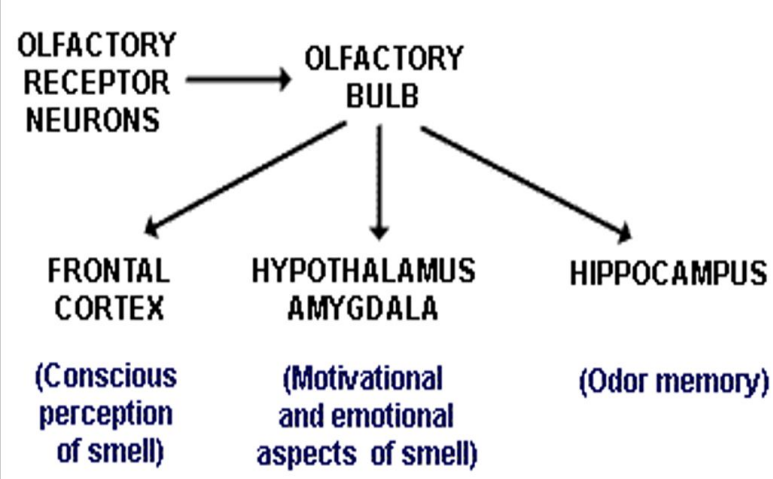
Taste and smell sensations are usually affected together because both have the same embryological originations.

Click here to know more about how COVID-19 effects taste and smell

Picture of Olfactory Mechanism

Slide 4





MCQ & SAQ:

Q1: Which of the following systems is related to the olfactory pathway?
A. Limbic system
B. RAS
C. The lateral motor system
D. Vestibulo-reticulospinal system

Q2: Where are the olfactory receptors located within the nasal cavity?

A.Lateral wall
B.Medial wall
C.Floor
D.Roof

Q3: Adrenal insufficiency can lead to?

A.Anosmia
B.Parosmia
C.Hyperosmia
D.Hyposomia

Q4: where can we taste sour foods?

A.At the tip of the toung
B.Tongue margins
C.Back of tongue
D.widely distributed

Q5: Which one of the following can lead to loss of taste?
A.Common cold
B.Covid-19
C.Hormonal effect
D.Adrenal insufficiency

Q6: Sour receptors respond to?
A. H ion
B. Salt
C. Saccharine
D. Monosodium glutamate

answer key:
1: A
2: D
3: C
4: B
5: B
6: A

1-Describe Mitral cells' olfactory pathway

2-Describe the olfactory mechanism

3-Describe the First order neuron of the taste pathway

4-Mention all types of papillae found on surface of the tongue

A1: from Mitral cells lateral and intermediate stria start to end on ipsilateral cortex

A2: Molecules dissolve in mucus layer → combine with receptors on cilia → stimulate adenylate cyclase → increase intracellular cAMP → opening of Na channels → receptors potential → AP in olfactory pathway

A3: Taste fibres from the three cranial nerves form tractus solitarius that end in the nucleus of tractus solitarius (medulla)

A4: Filiform , Fungiform , Circumvallate

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