



# CNS PHYSIOLOGY

- Text
- **Important**
- Formulas
- Numbers
- Doctor notes
- Notes and explanation

Lecture  
No.13

"There Is A Crack In Everything.  
That's How The Light Gets In"

# Physiology of Taste and Smell

## Objectives:

1. Appreciate the physiology of olfaction.
2. Describe the olfactory pathway.
3. Appreciate some pathophysiological conditions related to olfaction as anosmia, parosmia hypo and hyperosmia.

I - SMELL

# Special senses

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Extra

• Vision

• Hearing

• Smell

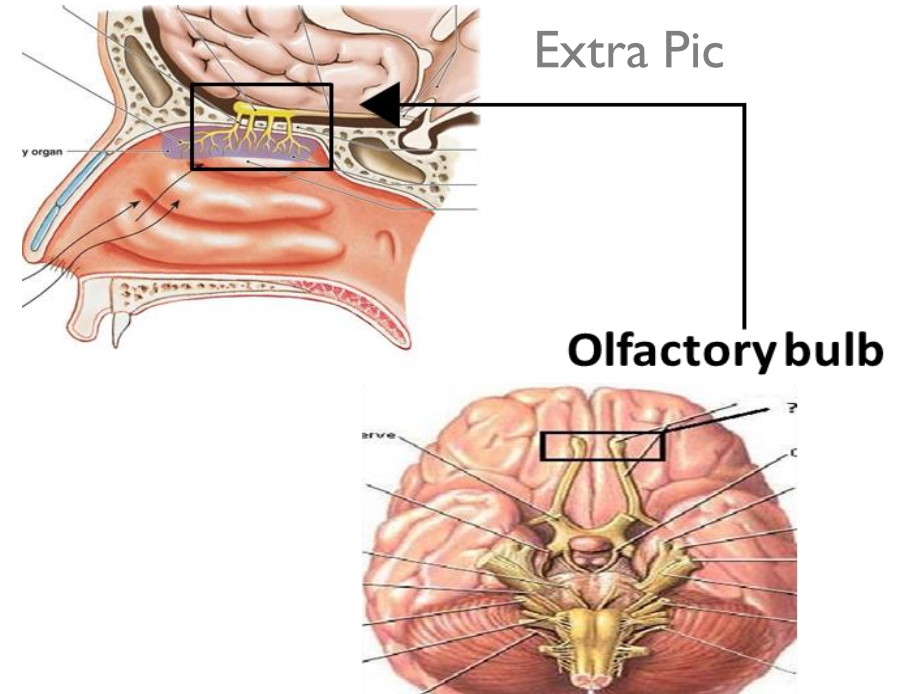
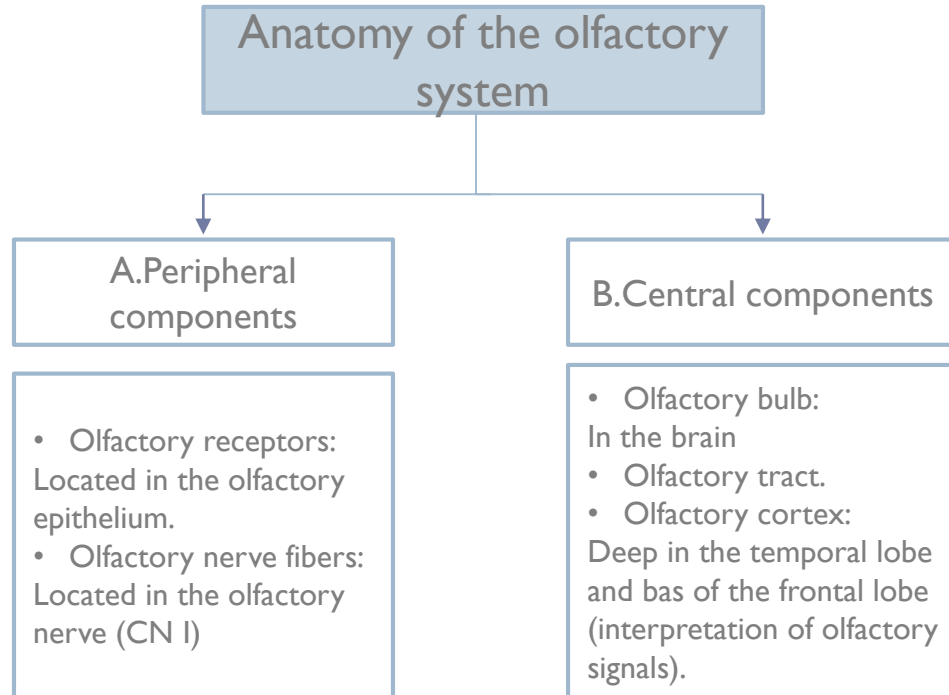
• Taste



▶ The olfactory (smell) system:

- The olfactory system is the least understood sensory system.
- It helps us enjoy life (e.G. Perfume, and food).
- Smell can be a powerful stimulant of human emotions.
- It is also a warning system alerting us to dangerous signals (e.G., Gas leak, spoiled food).
- It helps in choosing mates in some mammals (release of pheromones).
- Minute quantity of an odorant in the air can elicit a smell sensation.
- Methylmercaptan can be smelled when only  $25 \times 10^{-12}$  g is present in each ml of air.
- This substance is mixed with natural gas so that even a small amount of gas leak can be detected.

# Anatomy of the olfactory system



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

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# Olfactory epithelium

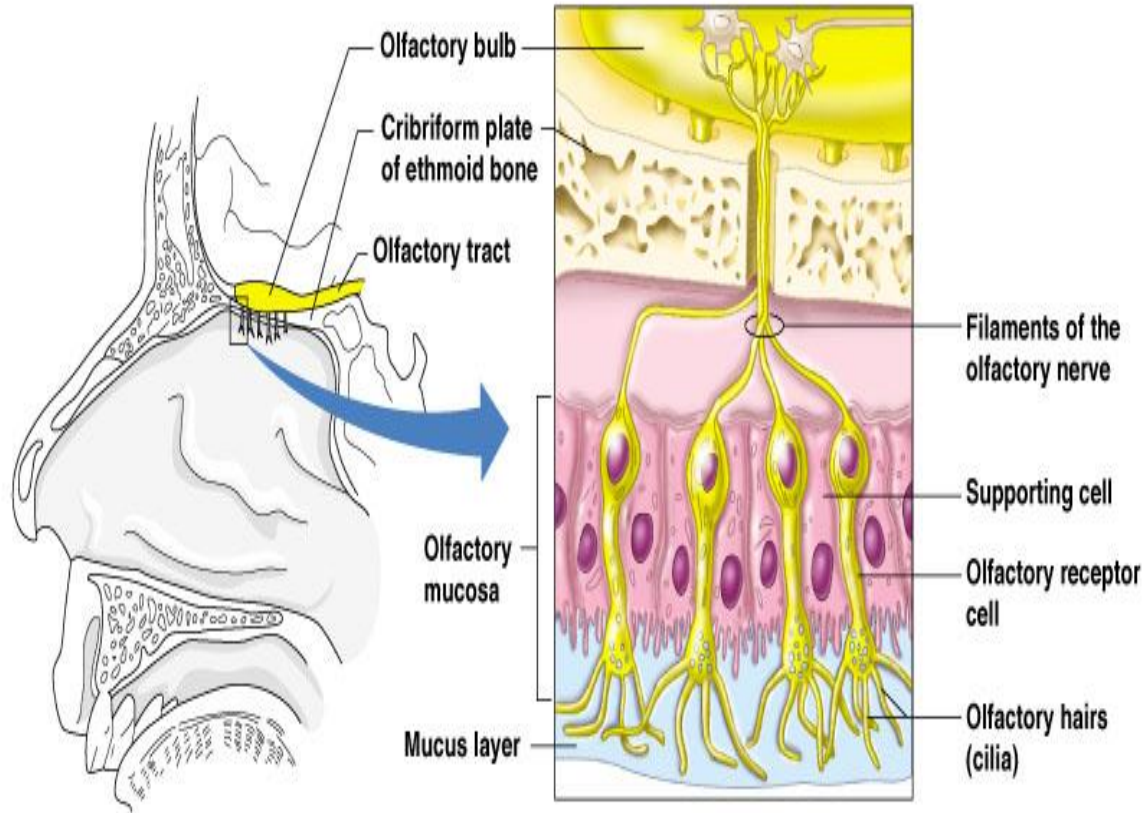
# Physiology of smell

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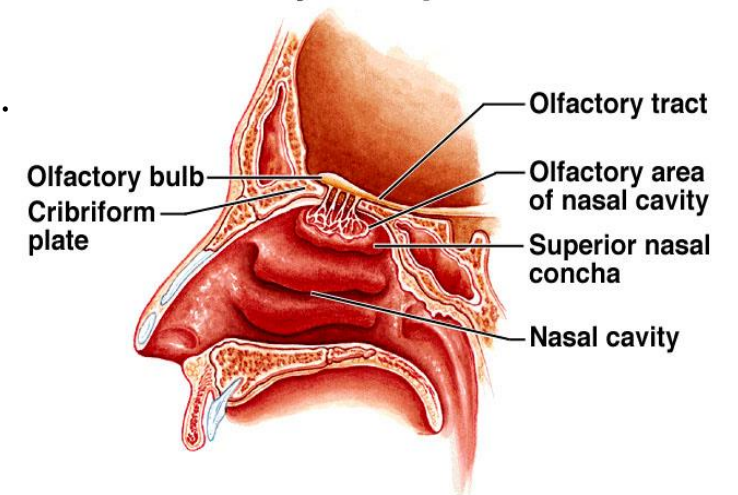
- ▶ Power of perceiving odors is called smell.
- ▶ Olfactory receptors present in the roof of nasal cavity.
- ▶ Neurons with long cilia (olfactory hairs).
- ▶ Chemicals must dissolved in mucus for detection.

- ▶ Impulses transmitted via the olfactory nerve.

- ▶ Interpretation of smells is made in the olfactory cortex of the brain.

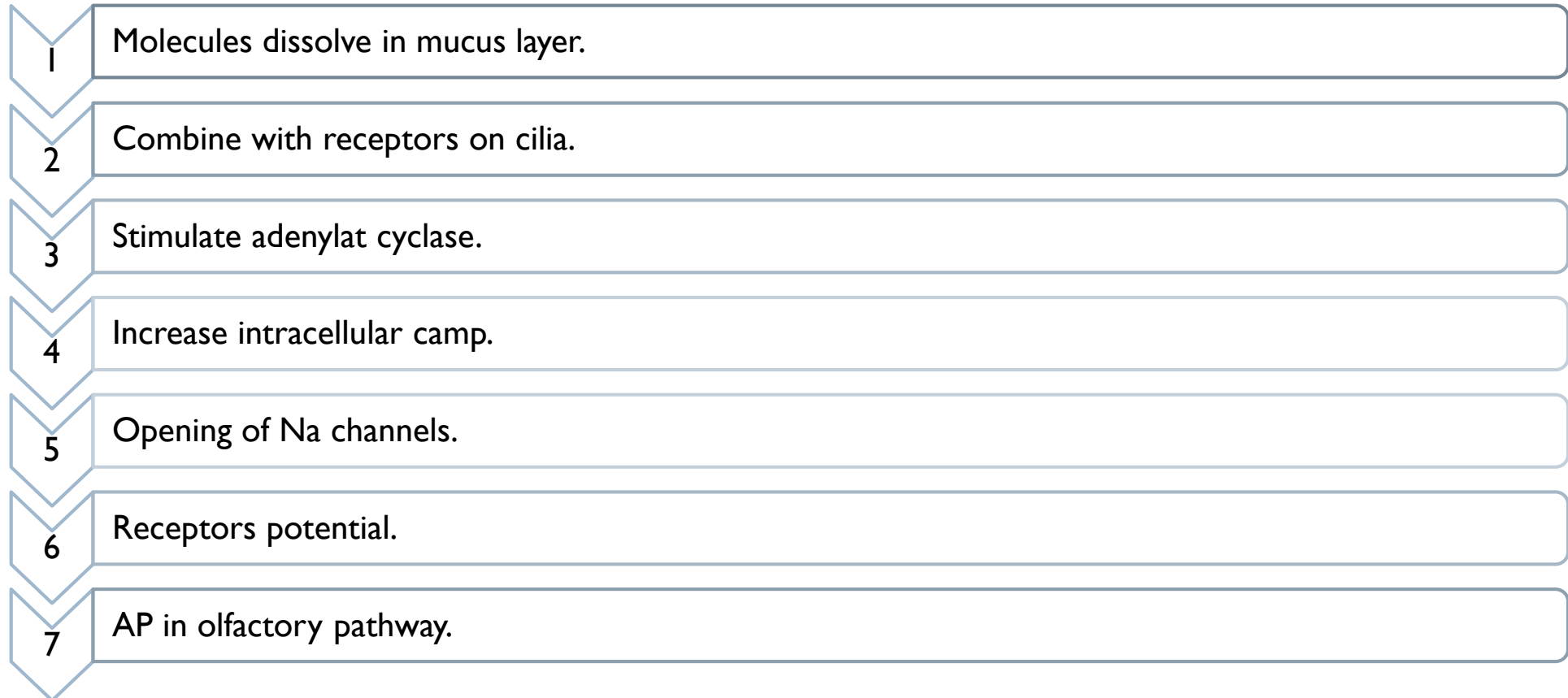


## Olfactory Receptor Cells



# Physiology of olfaction

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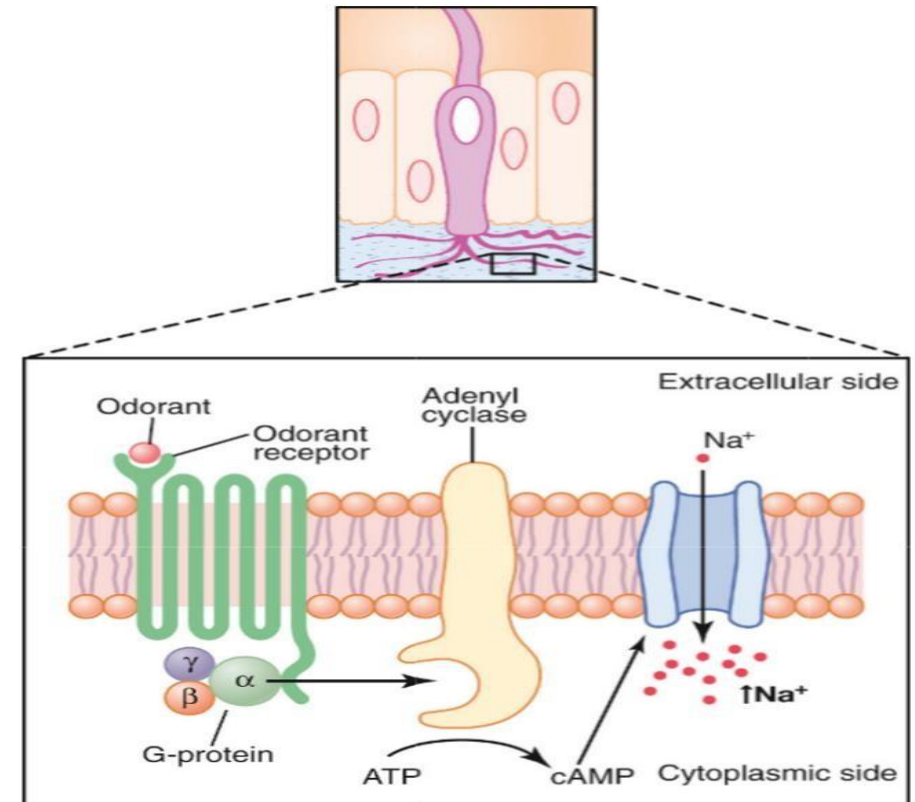


- ▶ Human can differentiate between **2000-4000 odours**.
- ▶ Adaptation can occur to pleasant and nasty smells due to changes both in receptors and central connections.
- ▶ **The connection between olfactory epithelium and air molecules is easily abolished.**

# Mechanism of Excitation of the Olfactory Cells

## Mechanism of Olfactory Cell Stimulation

- ▶ Diffusion of the **odorant substance**, into the mucus.
- ▶ Odorant binds and activates the **receptor protein**, resulting in activation of **G-protein complex**.
- ▶ This causes activation of **adenyl cyclase** in the cell membrane.
- ▶ This enzyme converts ATP into cAMP (a second messenger).
- ▶ This causes activation of **sodium ion channels** resulting in Na influx.
- ▶ **Depolarization and excitation** of the olfactory neuron.
- ▶ Transmission of nerve impulses into CNS by the olfactory nerve.





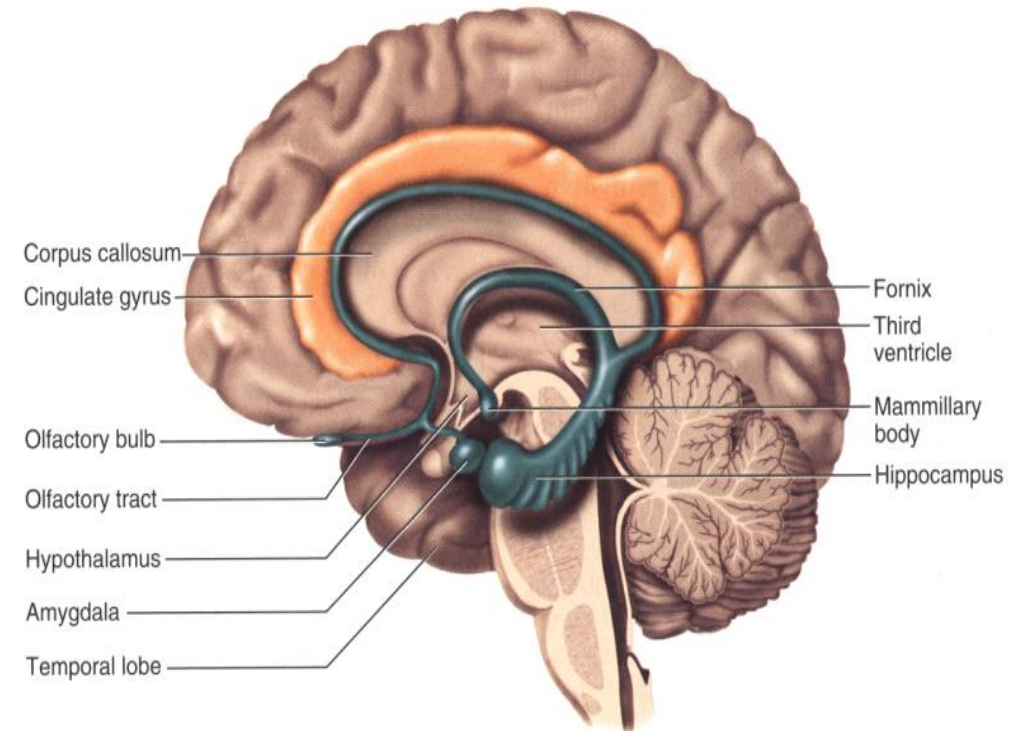
# Olfactory pathway

Fila olfactoria enter olfactory bulb → synapse with mitral and tufted cells:

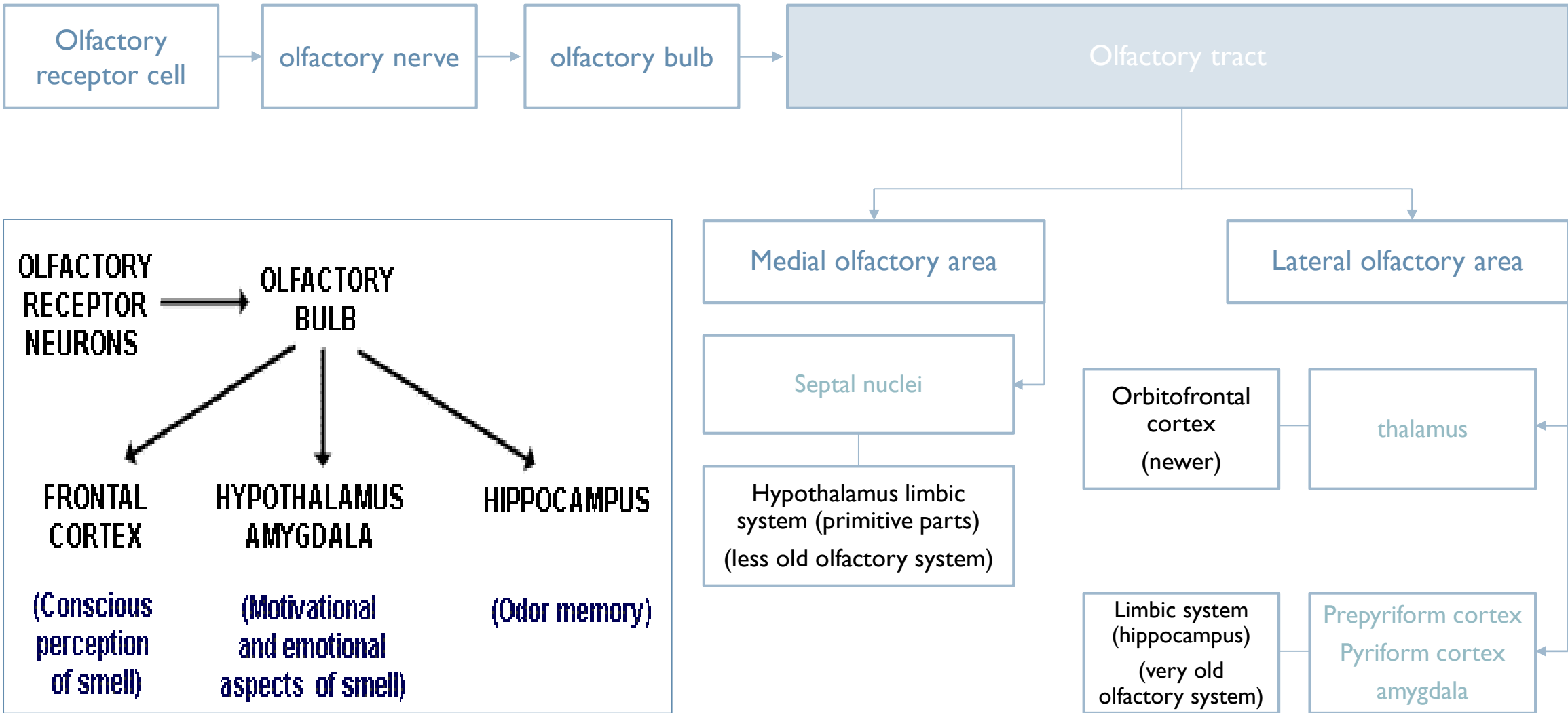
- ▶ From mitral cells lateral and intermediate stria start → end on ipsilateral cortex.
- ▶ From tufted cells medial stria start then cross the midline & end on granular cells in opposite side (contralateral).

- Impulses travel from olfactory tracts to the limbic system (also involved in emotions and memory).
- Impulses are interpreted in olfactory cortex deep in temporal lobe and base of frontal lobe

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# Olfactory pathway



# Cont.

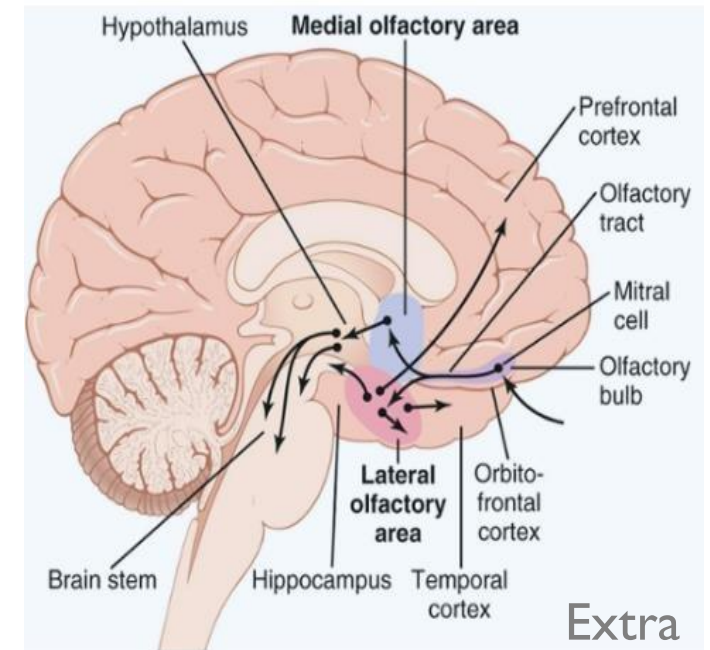
# Neuronal connections of the olfactory system

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- ▶ **First order neuron:**
  - ▶ From olfactory epithelium to glomerulus.
- ▶ **Second order neuron:**
  - ▶ The olfactory bulb, where the second neurons of the olfactory pathway (mitral and tufted cells) are located.
  - ▶ The axon of these second order neurons pass centrally as the olfactory tract.
- ▶ **Third order neuron:**
  - ▶ The prepiriform area (area 28) is considered the primary olfactory cortex which contains the third order neurons.

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- ▶ Impulses travel along the olfactory tracts to the limbic system:
  - ▶ Also involved in emotions and memory.
- ▶ Impulses are interpreted in olfactory cortex:
  - ▶ Deep in temporal lobe and base of frontal lobe.



# Pathophysiology of smell

## This slide is very important

- ▶ **Anosmia:** loss of smell sensation.
  - Due to damage of olfactory epithelium.
  - Some brain operation
  - genetic
- ▶ **Hyposmia:** decreased ability to smell.
  - Due to Vitamin A deficiency.
  - Inflammation
  - age
- ▶ **Dysosmia:** distorted identification of smell.
- ▶ **Parosmia (dysosmia):**
  - Alteration in smell sensation
  - Altered perception of smell in the presence of an odor, usually unpleasant.
- ▶ **Phantosmia:** Perception of smell without an odor present.
- ▶ **Agnosia:** Inability to classify or contrast odors, although able to detect odors.
- ▶ **Hyperosmia:** increase in smell sensation adrenal insufficiency.

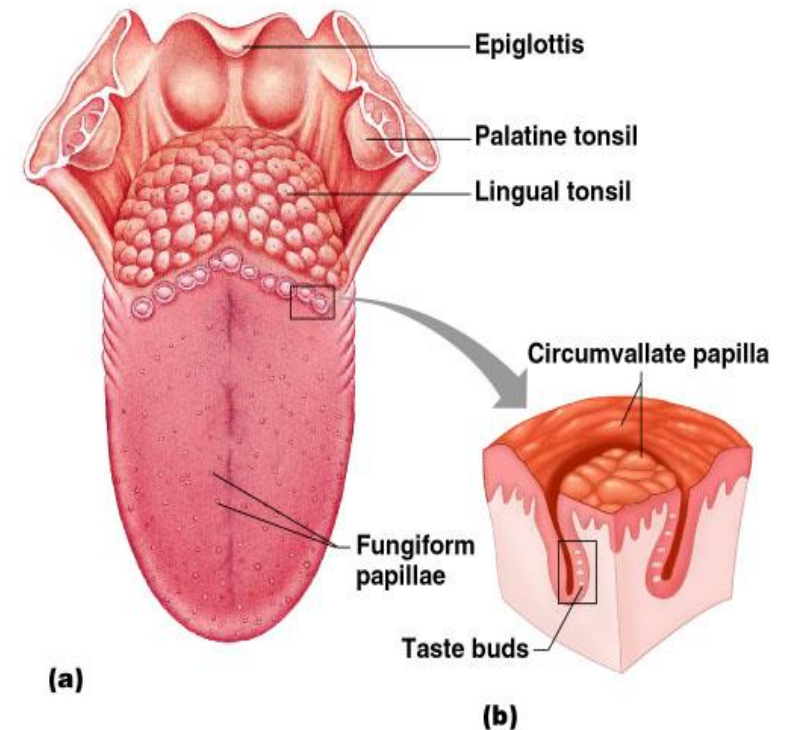
# 2-TASTE (Gustation)

# Taste sensations

- ▶ Taste is the sensation produced when a substance in the mouth reacts chemically with taste receptor.
- ▶ Taste buds are specialized receptors widely scattered throughout the oral cavity.
  - Tongue
  - Soft palate
  - Inner surface of cheeks

- ▶ A Taste bud is a specialised receptors in the oral cavity, but mainly on the tongue, some on the palate.

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# Cont.

1. Sweet (sweet receptors respond to sugar, sacchrine, amino acids).
2. Sour (salt receptors respond to acids -free H ions-).
3. Bitter (alkaloids, other substances).
4. Salty (chemical salts (NaCl) m ions . Mental.
5. Umami (glutamate-“meat (beef) taste of steak”).

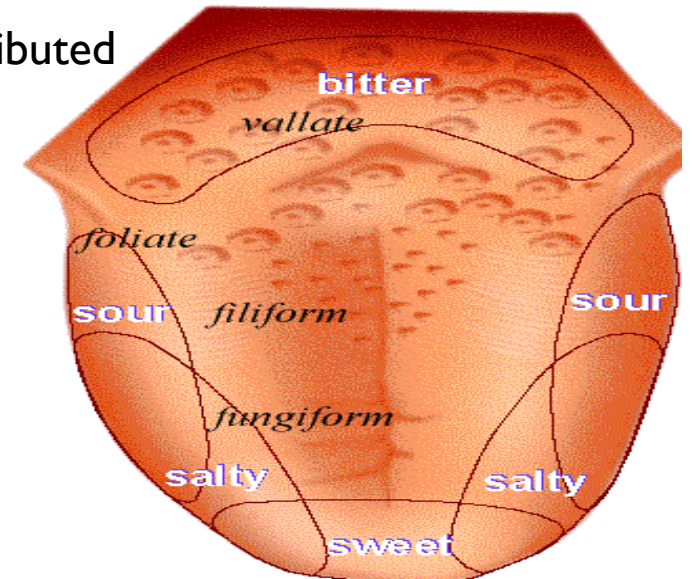
We will talk about how the first 4 tastes are transmitted.

- 5 established taste
- Taste buds on tongue not uniform

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Distribution of taste buds on tongue (not uniform):

1. Sweet - tongue tip
2. Sour - tongue margins
3. Bitter - back of tongue
4. Salty - widely distributed



# Taste buds

▶ Barrel shaped structures that contain taste receptors.

▶ Types of papillae:

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

They are found in small protrusions (bumps, projections) called papillae

1. Foliate papillae
2. Circumvallate
3. Fungiform
4. Filiform

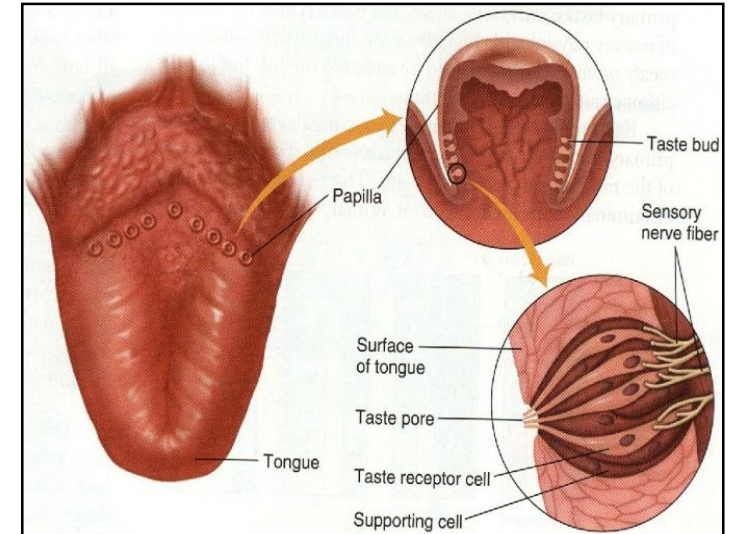
(no taste buds on the mid dorsum of the tongue)

Filiform: Sharp - no taste buds

Fungiform: Rounded with taste buds

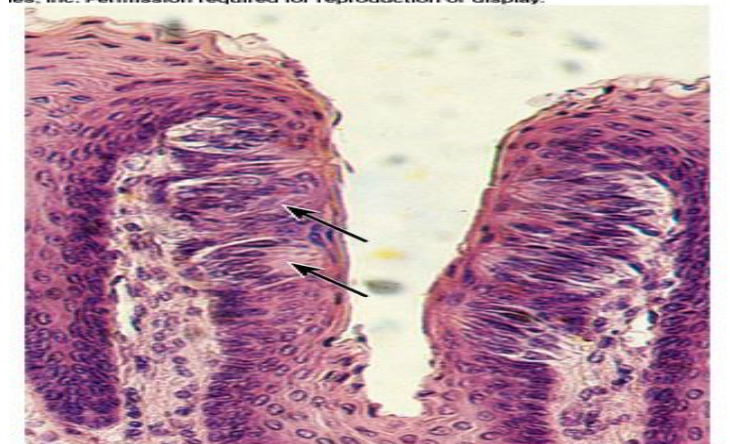
Circumvallate: Large papillae with taste buds

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## Taste Receptors:

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# Anatomy of taste buds

## Structure of Taste bud:

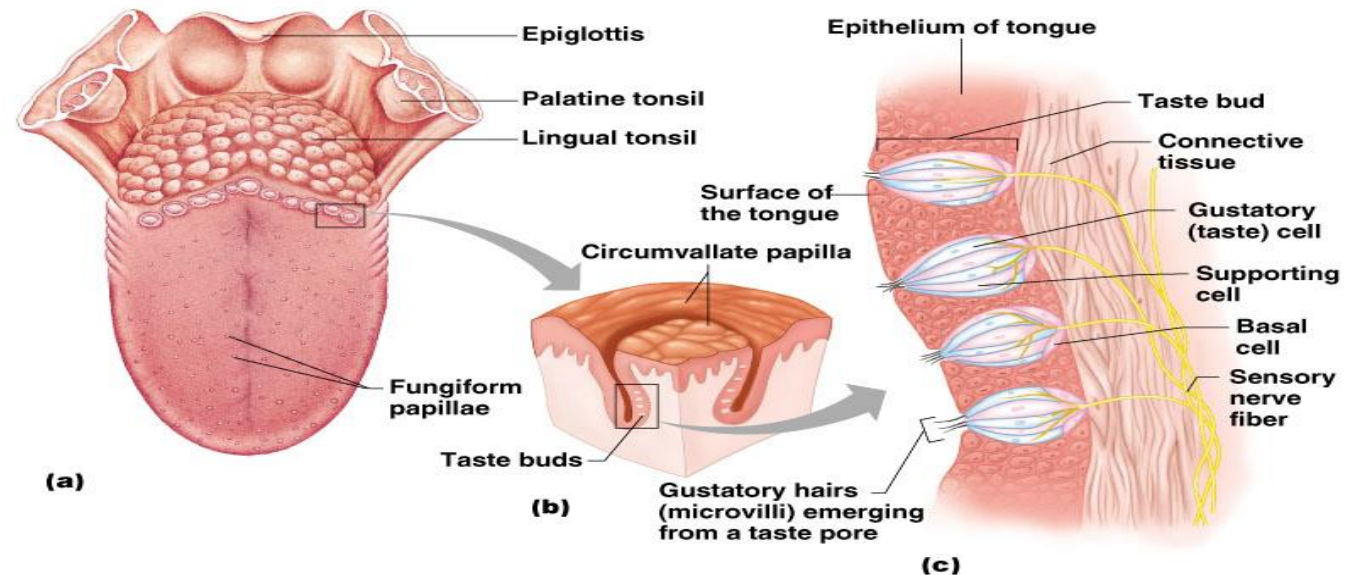
- ▶ Gustatory cells with microvilli (gustatory hair).
- ▶ They are receptors cells with cilia projected through taste pore in between there are supporting cells.
- ▶ Hairs are stimulated by chemicals dissolved with saliva and transmit impulses to the brain.

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

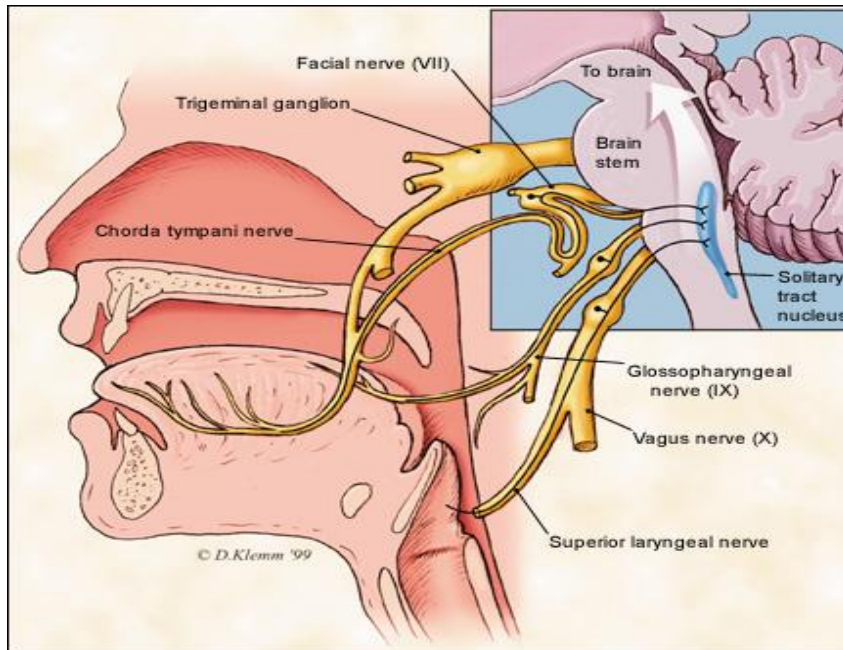
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- Facial nerve
- Glossopharyngeal nerve
- Vagus nerve



# Taste sensation

- ▶ Molecules dissolve in the saliva » attached to receptors on cilia of gustatory cells » receptors potential » action potential.
- ▶ Combination between molecules and receptors are weak (since taste can be easily abolished by washing mouth with water).



# The taste pathway

## Taste Pathway

### First order neurons:

Taste fibres from the three cranial nerves form tractus solitarius » end in the nucleus of tractus solitarius (medulla).

### Second order neurons:

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

### Third order neurons:

From thalamus project the cerebral cortex through thalamic radiation

# Pathophysiology of taste sensation

1. Ageusia (complete loss of taste).
  - Genetic
2. Dysgeusia (disturbed taste).
  - Sexual hormonal effect (metallic taste)
3. Hypergeusia (adrenal insufficiency)
  - Common cold
  - inflammation
4. Hypogeusia: it can be caused by many diseases, and drugs such as penicillamine

Many diseases can produce hypogeusia.

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

- Taste sensation can be modified by **Meraculin** (from Miracle fruit):
- When Meraculin is applied to tongue, it makes **acids** taste **sweet**.



# Doctors' notes

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- ▶ Dr mentioned for taste to be registered by brain, food particles have to dissolve in saliva.
- ▶ Taste is condensed in the tip, back and periphery of tongue. Mid dorsum has an insignificant amount so it's dismissable.
- ▶ Gustatory cells = Taste cells (they're the same thing).
- ▶ Dr mentioned he might bring a picture of the tongue and ask which areas of the tongue have a condensation for which taste (for example: tip of tongue → Sweet).
- ▶ There are 4 main taste sensations (Sweet, sour, bitter, salty) and 1 extra called "Umami" (Umami works on the sour and salty regions, it's the "Beef taste" receptors).
- ▶ The Receptor-Molecule bond is weak → taste of something can be washed off from mouth.

يعني لأن الرابطة ضعيفة بين المستقبل و الأكل نفسه لو نغسل فمنا بالموية بس يروح الطعم

- ▶ For smell to be registered, molecules **HAVE TO BE DISSOLVED IN MUCUS**.
- ▶ Adaptation is when a person gets used to a smell so he no longer feels it.

زي مثلا لما واحد يروح سوق السمك، بالبداية الريحه ما تطاق كريهة بعدين بعد ربع ساعه تسوق يصير ما يشمها

- ▶ Olfactory pathways:

- A. Frontal cortex
- B. Hypothalamus amygdala
- C. Hippocampus

- ▶ Smell is registered in Area 28 of the brain.



# Thank you!

اعمل لترسم بسمة، اعمل لتمسح دمة، اعمل و أنت تعلم أن الله لا يضيع أجر من أحسن عملا.

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QUIZ



اقتراحات وشكاوي

## References:

- Girls' and boys' slides.
- Guyton and Hall Textbook of Medical Physiology (Thirteenth Edition.)