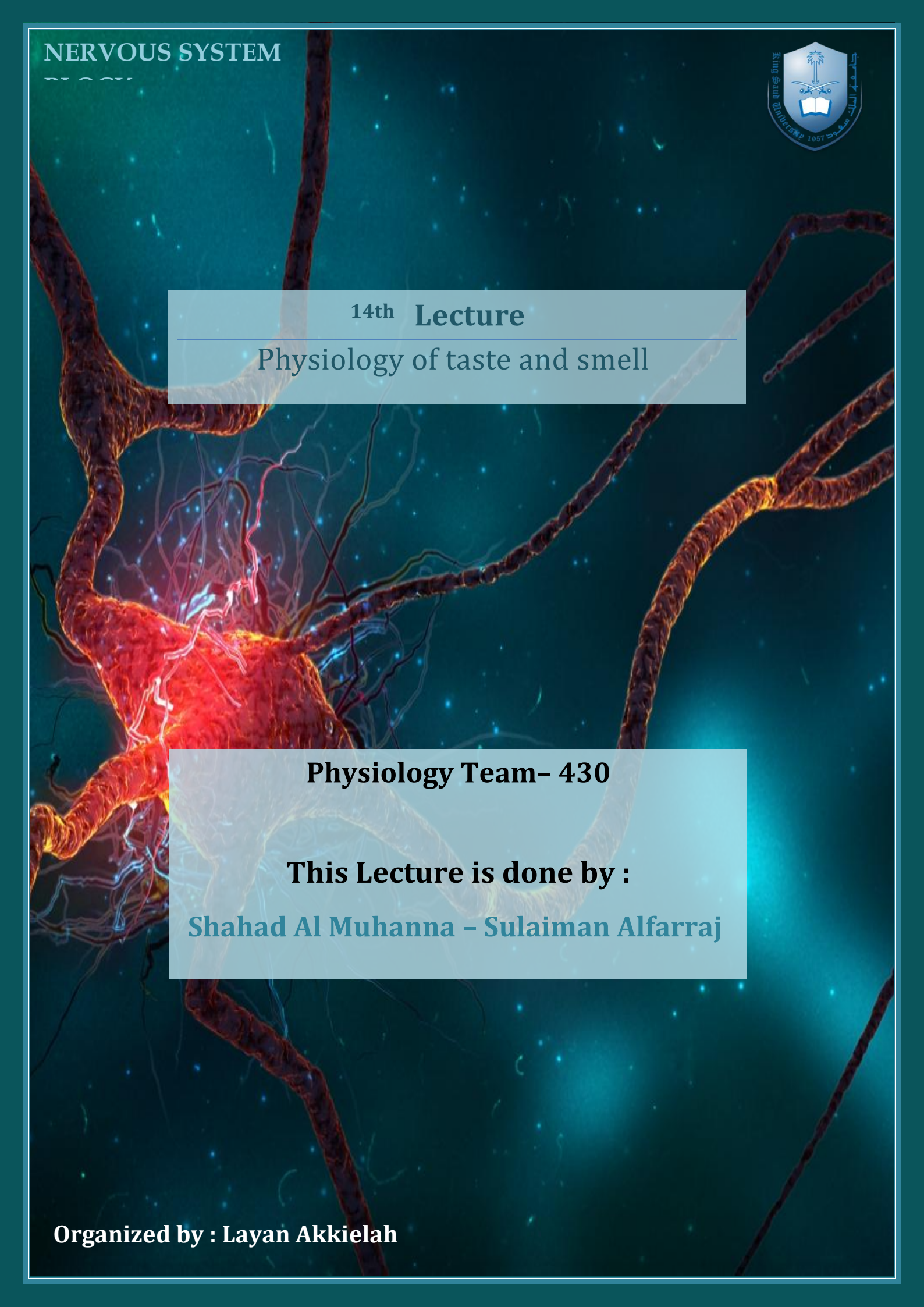
NERVOUS SYSTEM

BLOCK



14th **Lecture**

Physiology of taste and smell

Physiology Team– 430

This Lecture is done by :

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Organized by : Layan Akkielah

Physiology of Smell

- Olfaction, sense of smell, the ability of humans and other animals to perceive odors.
- **Smell :**

– **Macrosmatic (dog):**
Highly developed sense of smell / reliance on olfactory system.
– **Microsmatic (human):**
Weakly developed sense of smell / less reliance on olfactory system.

Dog Has 10 sq inches of epithelium compared to 1 sq inch in humans.

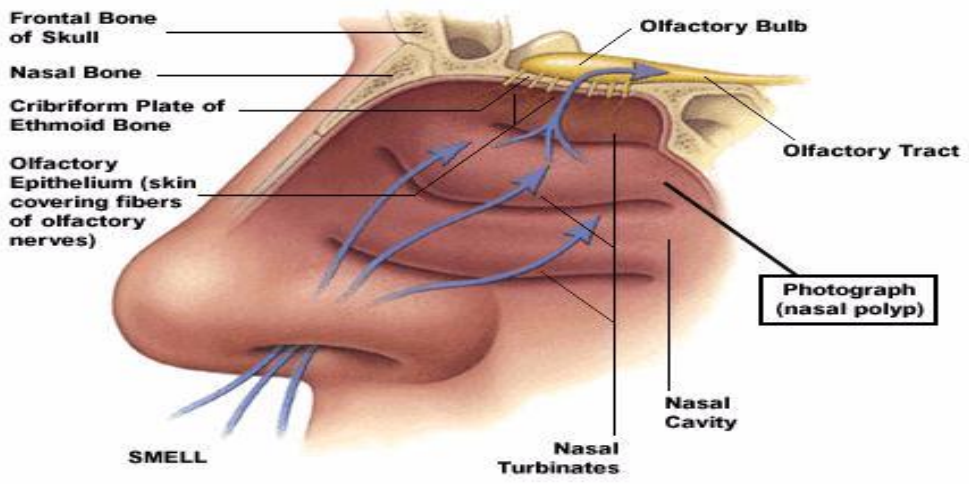
- **Nasal Anatomy:**

– **Olfactory mucus:**

located in the roof of nasal cavity near the septum Contain olfactory receptors (bipolar neuron with cilia) their Axons collected in bundles called Fila olfactoria.

– **Olfactory epithelium made up of three types of cells:**

1. **Olfactory receptors :** bipolar neurons with olfactory hairs.
2. **Supporting cells :** columnar epithelium.
3. **Basal stem cells :** replace receptors monthly.
4. **Olfactory (Bowman's) glands :** Produce mucus .



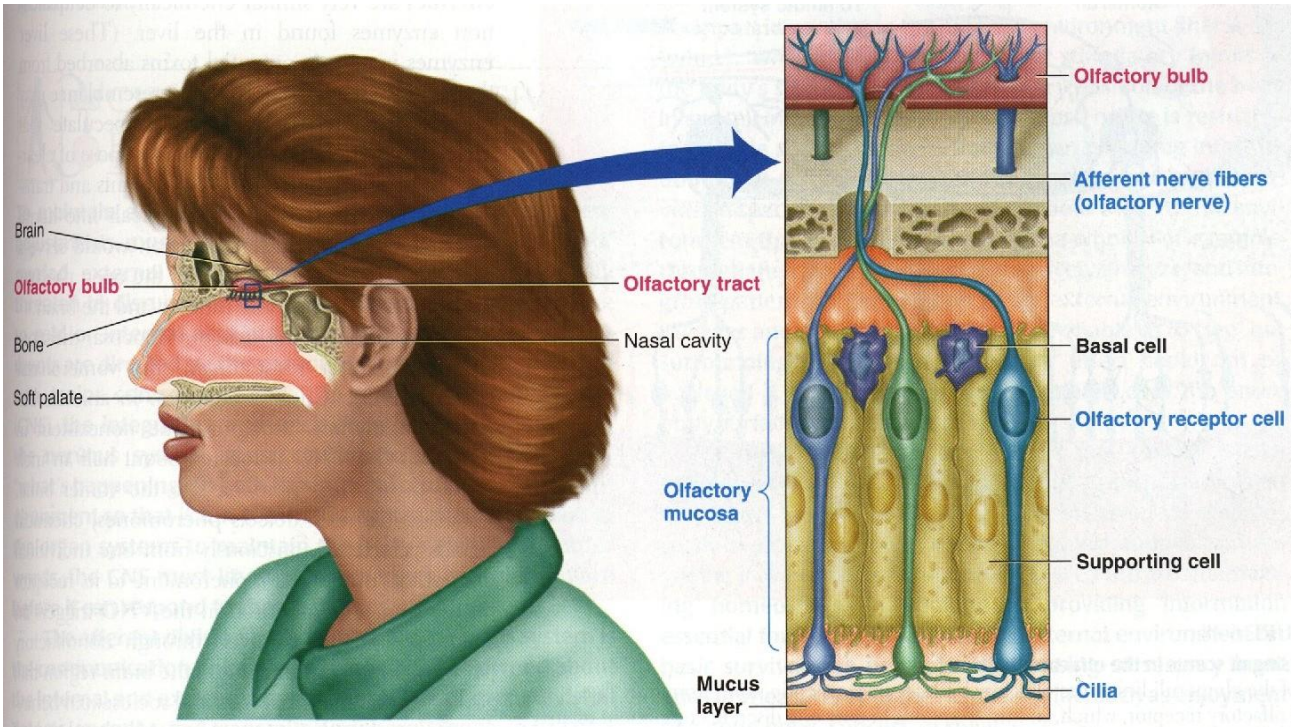


FIGURE 6-47
Location and structure of the olfactory receptors

Olfactory receptors unlike other neurons, receptors are continually regenerated (have stem cells).

- **Olfactory pathway:**

- **1st order neurons:**

  Olfactory receptors are specialized, ciliated nerve cells that lie in the olfactory epithelium. The axons of these bipolar cells 12-20 fibers form the true olfactory nerves fibers. Which pass through the cribriform plate of ethmoid.Then they join the olfactory bulb.

- **2nd order neurons:**

  It is formed by the Mitral cells of olfactory bulb. The axons of these cells form the olfactory tract, Each tract divides into 2 roots

  Lateral root carries olfactory fibers to end in **ipsilateral** cortex. Medial root crosses midline and joins the uncrossed lateral root of opposite side**(contralateral).**

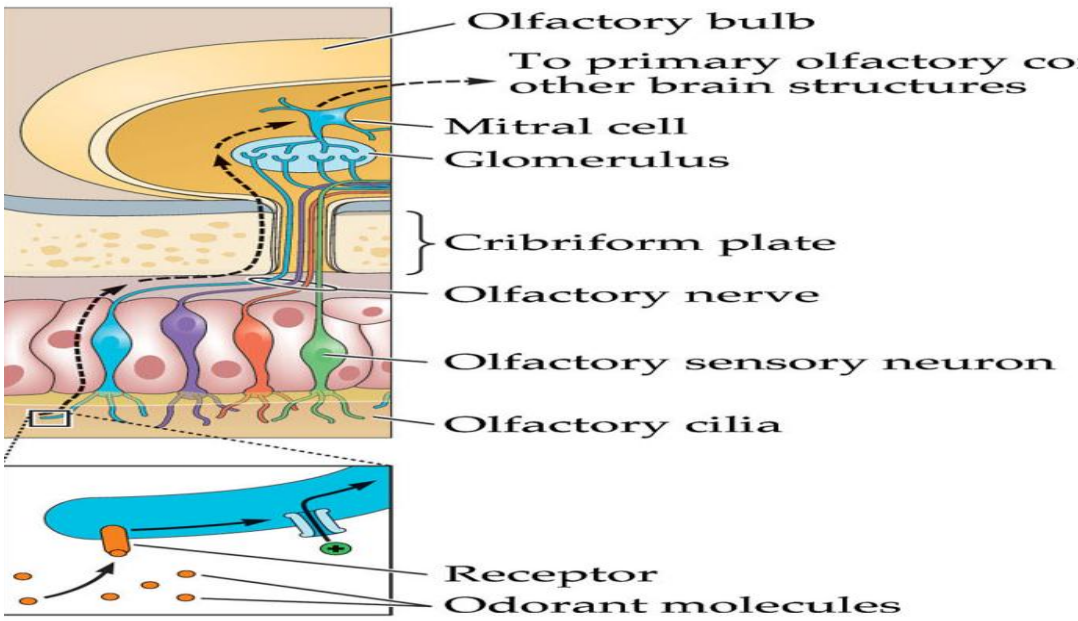
Crossing connects olfactory centers of 2 cerebral hemispheres. So each olfactory centre receives smell sensation from both halves of nasal cavity (that's mean if one bulb is damaged there is no loss of smell sensation).

- **3rd order neurons:**

olfactory tracts synapses on primary olfactory area of temporal lobe (conscious awareness of smell begins) .

Other pathways lead to the frontal lobe where identification of the odor occurs.

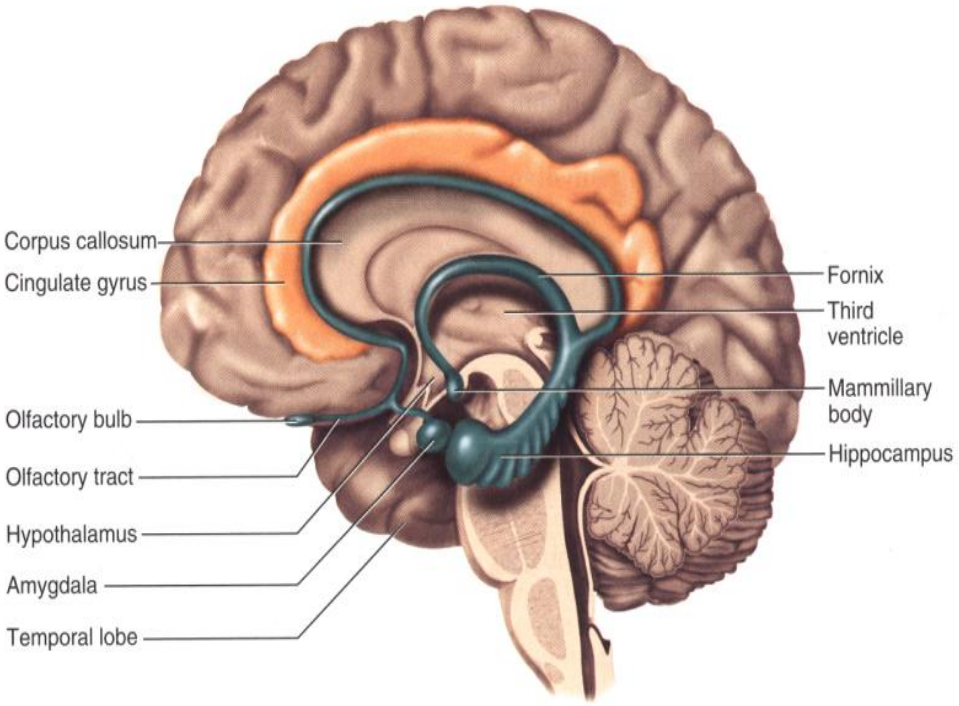
Note: Olfactory pathway is the only sensory pathway which reaches the cerebral cortex without passing through the Thalamus. (This direct connection to brain may lead to spreading of infection to the brain)



- **Some Impulses travel along the olfactory tracts to the limbic system :**

A smell can bring on a flood of memories, influence people's moods and even affect their work performance. Because the olfactory bulb is part of the brain's limbic system.

The limbic system (or Paleomammalian brain) is a set of brain structures including the hippocampus, amygdala, anterior thalamic nuclei, septum, limbic cortex and fornix, which seemingly support a variety of functions including emotion, behavior, long, and olfaction.

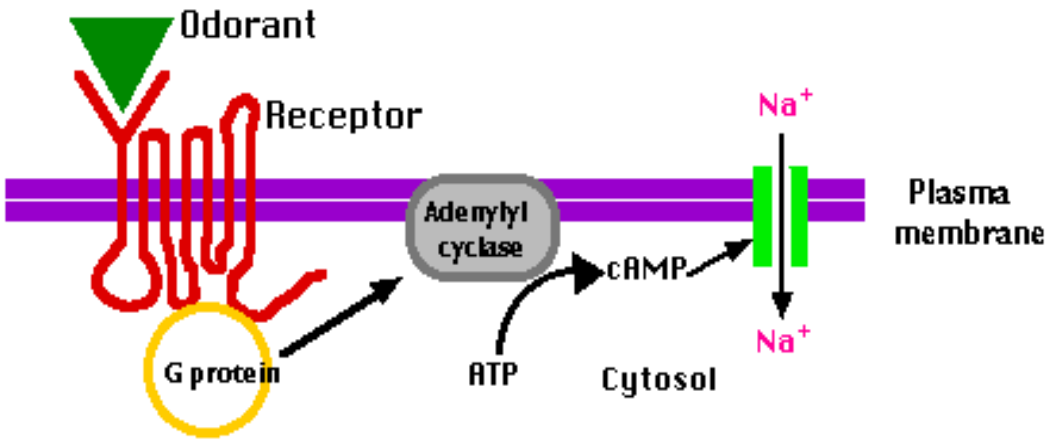


- **Physiology of olfaction:**

  Molecules must dissolve in mucus → Combine with receptors on the cilia→

  Stimulation of a G-Protein → Activation of Adenyl Cyclase →

  Increase I.C. cAMP → Opening of Na Channels→ Na influx → Depolarization (Receptor Potential).



- **Threshold to Different Substances :**

Substance	Threshold concentration mg/ Lair
Ethyl ether	**5.83**
Chloform	**3.30**
Oil of peppermint	**0.02**
Propyl mercepation	**0.006**
Methyl mercepation thom	**0.0000004**

You can smell (Garlic) very easly because low threshold.

- **Discrimination of Intensity :**

- **Poor**
- **Requires 30% increase of intensity**
- **Human can differentiate between 2000-4000 odours.**

- **Adaptation to Smell :**

- **Peripheral.**
- **Central.**
- **Adaptation can occur to pleasant and nasty smells due to changes both in receptors and central connections**.

- **Pathophysiology:**

- **Anosmia:**
  loss of smell sensation, due to damage to olfactory epithelium.
- **Parosmia (dysosmia):**
  Alteration in smell sensation, like pregnancy because of hormonal changes.
- **Hyperosmia:**
  increase in smell sensation, due to Adrenal insufficiency.
- **Hyposomia**:
  decreased smell sensation, due Vitamin A deficiency or hypogonadism.

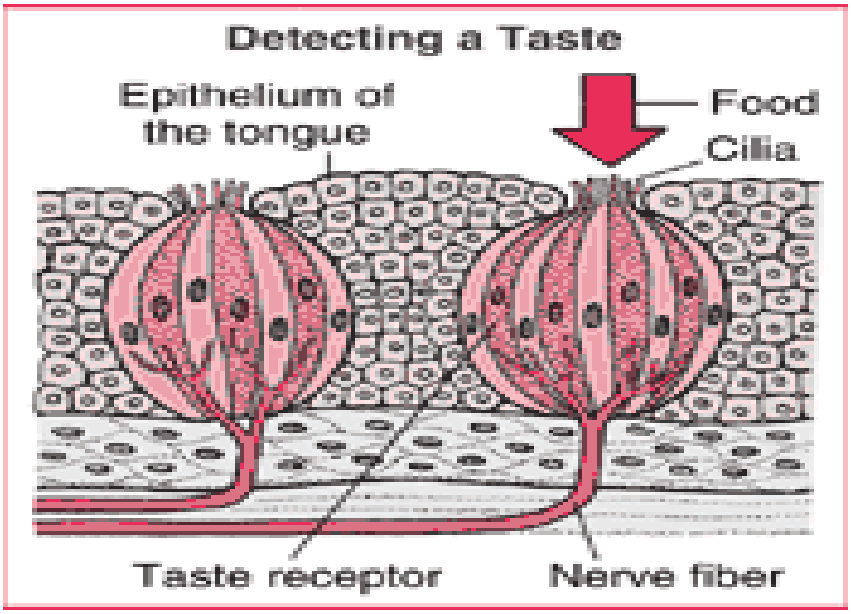
Taste

- Chemical Senses .
- determine the flavour of food
- Taste and smell are closely linked even though they involve different receptors and receptive processes.

- **Anatomy of Taste Sensation**

- Taste buds are specialized receptors for taste. They are in:
  - Tongue mainly
  - Epiglottis
  - Soft Palate
  - Pharynx

Detecting of the taste by: cilia at the tip of the bud



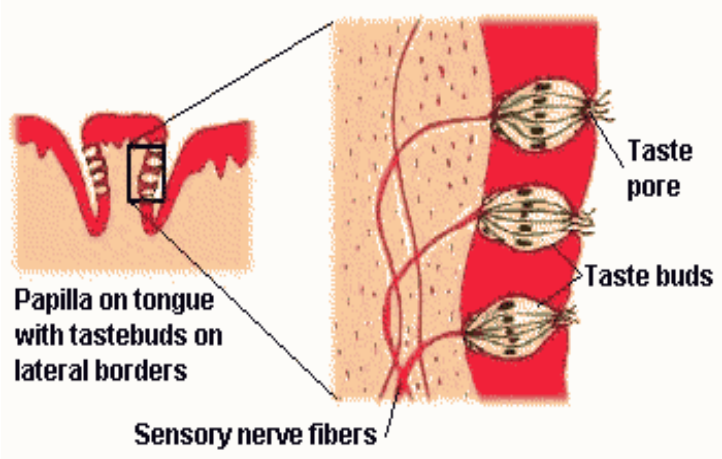
- There are about 4500 taste buds per average tongue.
- Taste buds consist of:
  - 50 receptor cells surrounded by supporting cells
  - **Gustatory** hairs project through the taste pore
  - Life span of 10 days
  - Basal cells develop into supporting cells then receptor cells

- **Nerve supply of tongue**

– anterior 2/3 of tongue → Facial nerve

– Posterior 1/3 of the tongue → glossopharyngeal nerve

Receptors on the palate, pharynx, epiglottis → Vagus nerve

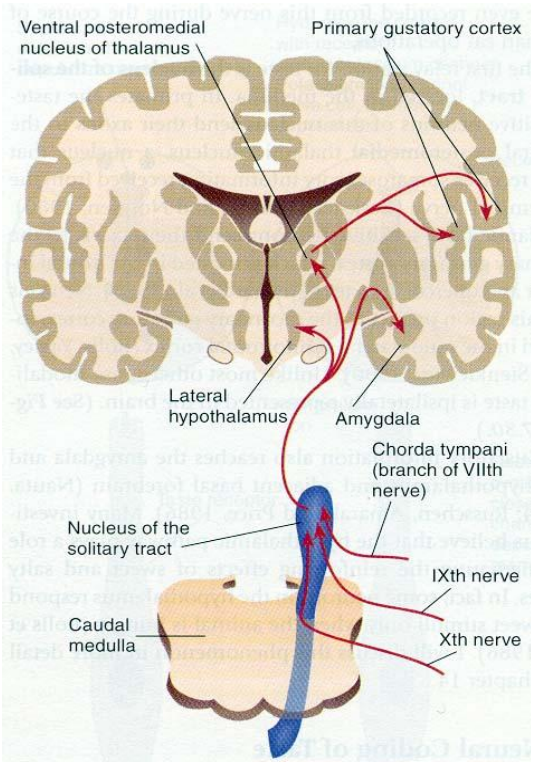


Taste pathway :

– **First order neurone :**
Taste fibres from the three Cranial nerves 7th ,9th and 10th nerves form tractus solitarius end in the taste nucleus -Tractus Solitarius (medulla)

– **Second order neurone:**
From TS cross the midline to ascend in the medial lemniscus to the thalamus.

– **Third order neuron:**
from thalamus project the cerebral cortex through thalamic radiation



- **Physiology of Taste**

– **In order:**
Dissolution in Saliva (Must dissolve in saliva so can recognize) →Attachment to Receptors on cilia of the **of gustatory cells** → Generator Potential → Action Potential
– Combination between molecules and receptors are weak (since taste can be easily abolished by washing mouth with water)
– Sweet receptors respond to sugar, saccharine, some amino acids
Sour receptors respond to H ion
Salt receptors respond to salts

- **Primary modalities of taste:**
Sensitivity differs in different areas, but all tastes can be perceived at most areas of the tongue.

– Sour → **tongue margins**
– Salt → **widely distributed**
– Sweet→ **tongue tip**
– Bitter → **back of tongue**
– umami (deliciousness),(special) a taste associated with glutamate & other nucleotides has receptors located at the back of the pharynx

- **Evidence for 4 modalities :**

1. **Cocaine on the tongue: (Pharmacoligical substance)**

Sensations disappear in the following order
Pain → sweet → sour → bitter → salt → touch **(In order)**

2. **Gymnemic acid on tongue:**

· Bitter & sweet → disappear
· Sour & salt → remain

3. Chemical structure and taste

- Sour → Acidity by {H+} – HCL , pH = 3.5
- Salt → Sodium chloride 0.02 M
- Sweet →Sucrose 0.01 M
- Bitter → Quinine Sulphate 0.000000M

(the doctor didn't mentioned the numbers)

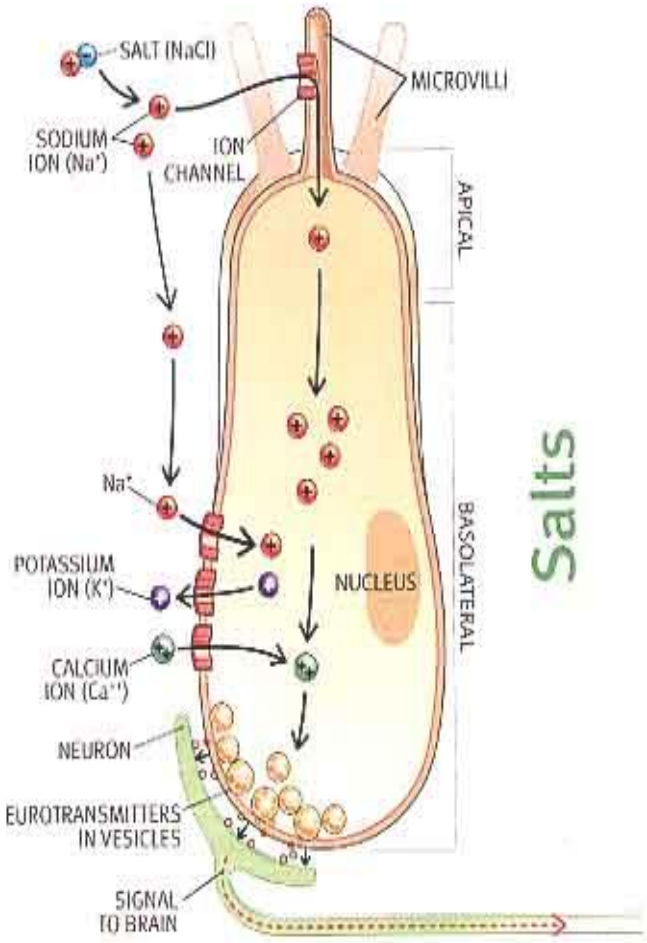
Artificial sweeteners :

Saccharine, Cyclamates, Aspartame .

Give you the taste but no glucose no harm

4. Mechanism of stimulation of taste sensation:

- **Sour:**
  - Acids (H+)
  - Blocks K+ channels
  - Sourness receptors operate by closing potassium channels, which allows a positive charge to build up, thereby causing depolarization of the cell.



- **Salt taste**
  - Na+
  - Depolarization
  - Saltiness or sodium receptors allow sodium ions to cross the membrane, thereby causing depolarization.

- **Sweet**

  G protein → activation of adenyl cyclase → c-AMP → K conductance

- **Bitter**

  G protein → activation of phospholipase C → increase IC –insitol (PO4)3 → Ca2 release

G protein : First messenger

cAMp : Second messenger

- **Saltiness and sourness are transduced directly by sodium and hydrogen ions respectively.**
- **The transduction process for sweetness and bitterness involve second messengers.**

- **Discrimination of intensity of taste:**

– Poor (like smell)
– Requires 30% change to allow discrimination of intensity (vision requires only 1%)

- **Adaptation to taste:**

– Decreased sensation from repeated stimulus
– Entirely peripheral at the receptors

- **Clinical considerations**

– Ageusia: Absence of sense of taste
– Dygeusia: Disturbed sense of taste
– Hypogeusia: Diminshed sense of taste
– Hypergeusia: increased sense of taste

Adrenal insufficiency: means that there's no Aldesterone → so (no Na^+) → then increase taste sensation.