Special senses

1. SMELL (OLFACTION)

1.1 Overview

Smell is the least Understood sense. It is mainly subjective. In dogs and other animals, it is more developed than humans.

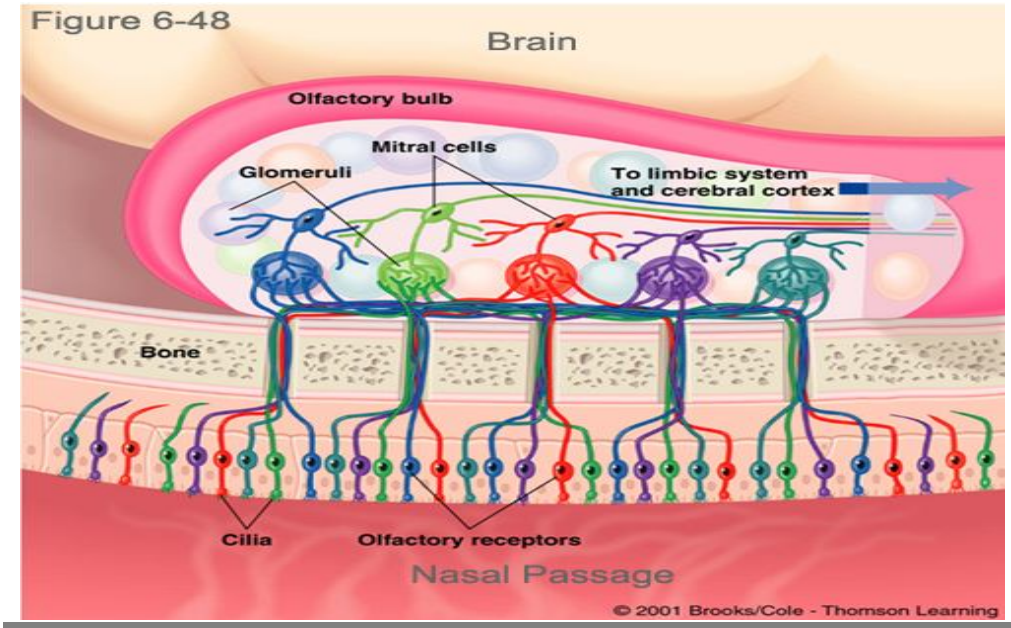
- **There are dfferent stimuli that can be smelled such as**: camphoraceous, musky, flora (flower), pepperminty, ethereal, pungent, putrid

1.2 Structure of Olfactory epithelium and bulb

See the figure on the next page!

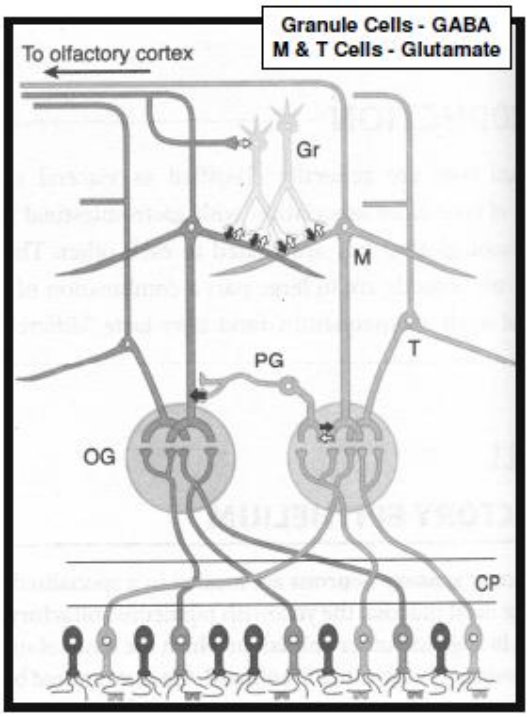
1.2.1 Olfactory mucous membrane

- It is the upper lining of the nasal cavity (near the septum), containing **olfactory** (odorant) **receptors** that are responsible for smelling.
  - **Olfactory receptors** are *bipolar* *neurons* which receive stimuli in the nasal cavity *(through cilia)* and transmits them through axons, leave the olfactory epithelium and travel into CNS (olfactory bulb).
  - Although they are nerve cells, olfactory receptor cells are replaced every 60 days or so, and they grow their axon into the correct place in CNS.
- **Olfactory epithelium** contains three types of cells (the olfactory receptors cells discussed) as well as two other types of cells:
  - **Olfactory (Bowman's) glands:** produce mucus that dissolves odorants
  - **Supporting cell**
  - **Basal cells:** regenerate olfactory receptor cells.



1.2.2 Olfactory bulb

- The olfactory bulb is made up of nerves that receive olfactory signals from axons of olfactory receptor cells. These nerves are of two cell types:
  - **Mitral cells** (most important) (M)
  - **Tufted cells** (smaller than mitral cells) (T)
- Mitral and tufted cells release <u>glutamate</u>
- The synapse between the axons of olfactory receptor cells and dendrites of mitral cells occur in clusters called **olphactory glomeruli** (OG)
- In a glomerulus, about 1000 olfactory receptor axons converge onto 1 mitral cell.
- Glomeruli also contain:
  - **periglomerular cells**: <u>*inhibitory*</u> neurons connecting glomeruli to each other. (PG)
  - **Granule cells:** reciprocal synapses that are excited by one mitral or tufted cell to inhibit another mitral or tufted cell. (Gr)
    - Granule cells act to **sharpen** the smell stimulus.
    - Granule cells are excited by **<u>Glutamate</u>** from mitral and tufted cells. They produce inhibition by releasing **<u>GABA</u>**



1.3 Olfactory pathway

- Axons of mitral and tufted cells come out from the bulb and pass posteriorly in the **olfactory tract** *(CN 1)*.
- Then the fibers in the olfactory tract divide into 3 fibers:
  - **Medial olfactory area:** primitive simple actions. (present in lower animals)
    e.g. licking the lips, salivation and other feeding responses,.
  - **Lateral olfactory area:** concerns learning what to like or dislike in smells, with experiences and emotions.
    for example, in food, you learn that this smell belongs to a type of food that is delicious, so you like the smell ^_^ !
  - **Orbitofrontal cortex:** helps in conscious analysis of odor. (developed)
- Medial and lateral olfactory areas terminate in <u>limbic system</u> (**hippocampus, amygdale, hypothalamus**) involved in memory and emotional behavior

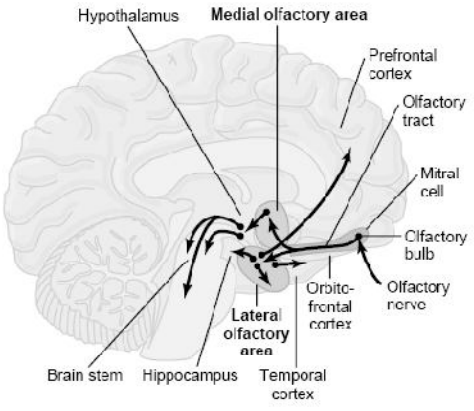
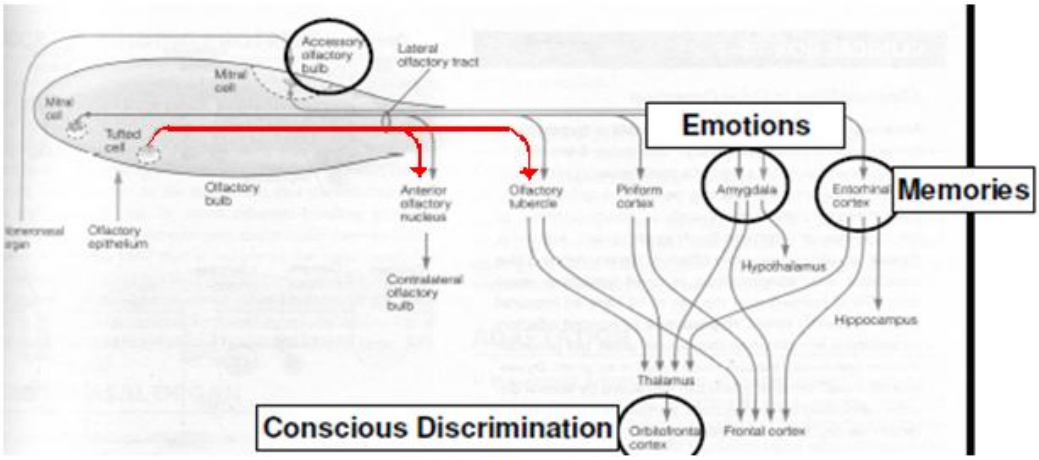


Figure 53–4

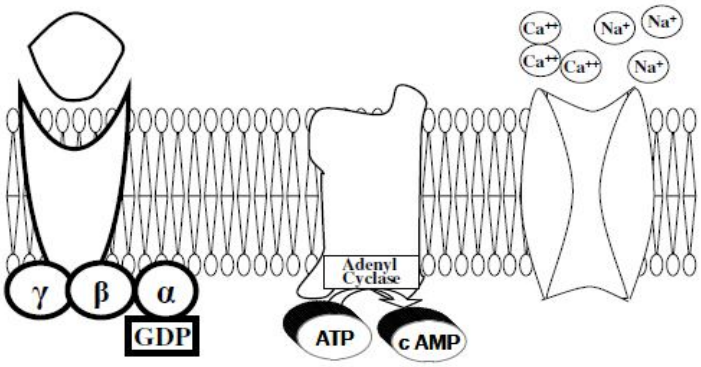
- So olfactory tracts terminate in:
  - Limbic system
  - Orbitofrontal cortex (olfactory cortex) (neocortex)



Axons from mitral cells terminate in all these destinations, while axons from tufted cells terminate in **anterior olfactory nucleus** and **olfactory tubercle**

1.4 Mechanism of smell receptor stimulation:

- The chemical coming into the nasal cavity (through air) dissolves in olfactory mucusa and combines with receptors on cilia there leading to stimulation of the receptor through 2 ways:
  1. Stimulation of adenylat cyclise by G-protein → ↑intracellular cAMP → open of Na channels (influx) → receptor potential → action potential in olfactory pathway (by depolarization).
  2. Action through phospholipase C.



GTP

1.5 Vomeronasal Sensation and Pheromones

- **Pheromones:** a chemical signal that triggers a natural sexual response in another member of the same species
- Human body secretions have non-developed pheromone effects.
- But there is a pit of the anterior third of the nasal septum which is responsible for this effect.
- Their receptors project into accessory olfactory bulb, and then into areas in the amygdale and hypothalamus and are concerned with sexual function.
- There is close relation between smell and sexual function

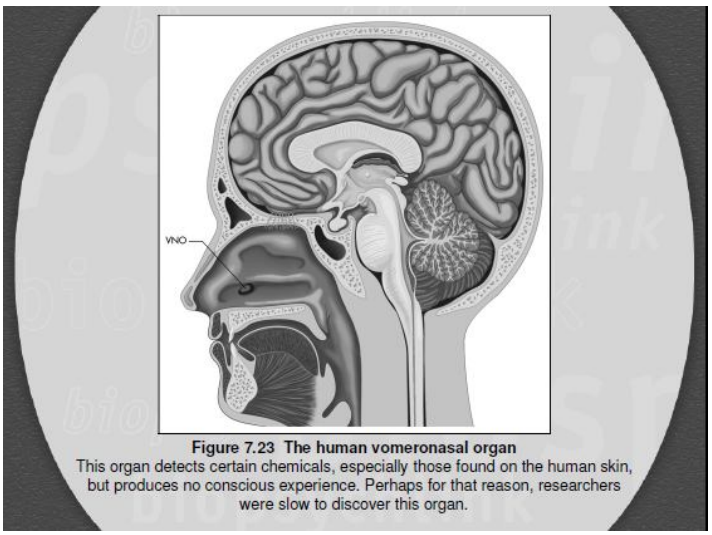


Figure 7.23 The human vomeronasal organ
This organ detects certain chemicals, especially those found on the human skin, but produces no conscious experience. Perhaps for that reason, researchers were slow to discover this organ.

1.6 Abnormalities in odor detection

1. **Anosmia:** Loss of smell sensation
   - due to damage to olfactory epithelium or nerve damage & nasal congestion
   - It can also be a genetic disease, or happening to a hypogonadism patient.
2. **Hyposmia:** Decrease smell sensation
   - **Possible causes:** Nerve Damage, Nasal cavity Congestion, vit. A deficiency, common cold
3. **Hyperosmia:** Increase smell sensation
   - Due to adrenal insufficiency
   - Happens in pregnancy
4. **Dysosmia:** Alteration in smell sensation
   - Due to Sinusitis & Dental Hygeine

2. TASTE (GUSTATION)

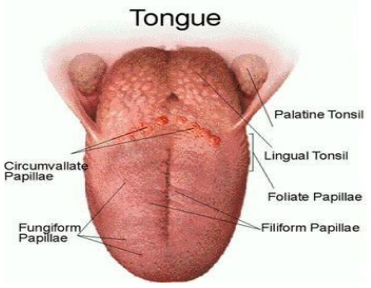
2.1 Overview

- Sense of taste is important in the selection and enjoyment of food
- Taste is mainly a function of **TASTE BUDS**
- However, not only taste is the factor acting for selecting and enjoying food, we use other things such as:
  - Olfactory input
  - Tactile input
  - Visual input
  - Pain input
  - Thermal input
  - Metabolic need of tissues for specific nutritive substances

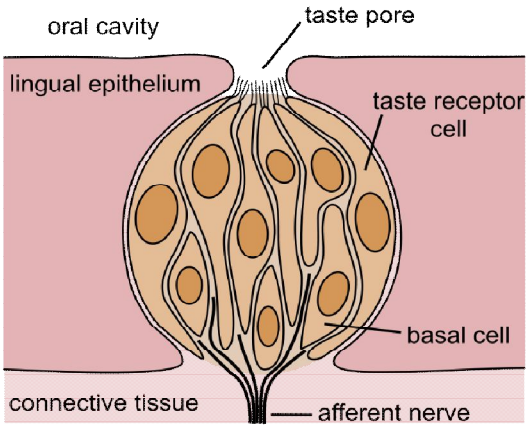
2.2 TASTE BUDS

- **Taste buds**: Spindle shaped structures with an opening known as taste pore.
- They are specialized receptors
- 3000 to 10000 in number.
- **Location of taste buds** (in oral cavity) :
  - Mainly on the tongue, on its **DORSUM** surface. On papillae:
    - Papillae are projections on the tongue containing taste buds
    - They are 4 types
      - Filiform
      - Fungiform
      - Foliate
      - *Circumvallate (vallate)*
      - N.B. all of the papillae above have taste buds except Filiform .
  - Taste buds can also be found on Tonsillar pillars, palate, pharynx, epiglottis, proximal esophagus.

NO taste sensation on the **midline** of the dorsum of tongue



- A taste buds contains 4 types of cells:
  1. basal
  2. dark
  3. light (most mature)
  4. intermediate cells.
  - **Taste cells** are epithelial cells which have a half life of 10 -14 days, and have taste hair or microvilli (sensitive part of receptor cell).
  - **(Taste receptor cells are EPITHELIAL CELLS, unlike smell receptors which were bipolar nerve cells)**



2.3 primary sensations of taste

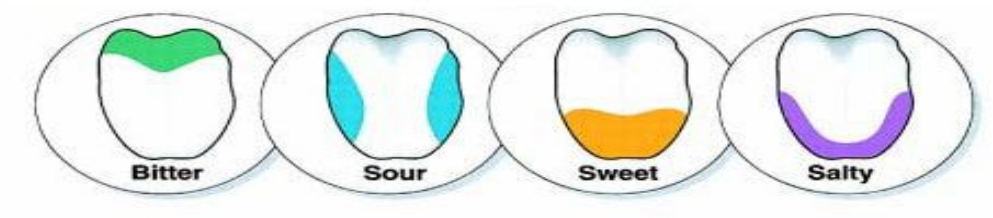
- There are 4 basic taste modalities
  - Sour [Acids]
  - Salty [Ionized Salts]
  - Sweet [Organic Chemicals]
  - Bitter [Organic Chemicals]
  - An additional fifth taste *(umami)*
- Each taste is in a specific site and is sensitive to specific stimuli.
- The threshold of a taste is the least concentration of the taste stimuli that will be felt by our taste receptors.
  - Thresholds for tastes are shown in the box above
  - The bitter taste is the most sensitive. It has the lowest threshold.

- **HCl 0.0009 N**
- **NaCl 0.01 M**
- **Sucrose 0.01 M**
- **Quinine 0.000008 M**

For food to have a taste, it must be dissolved in water. Five basic tastes:

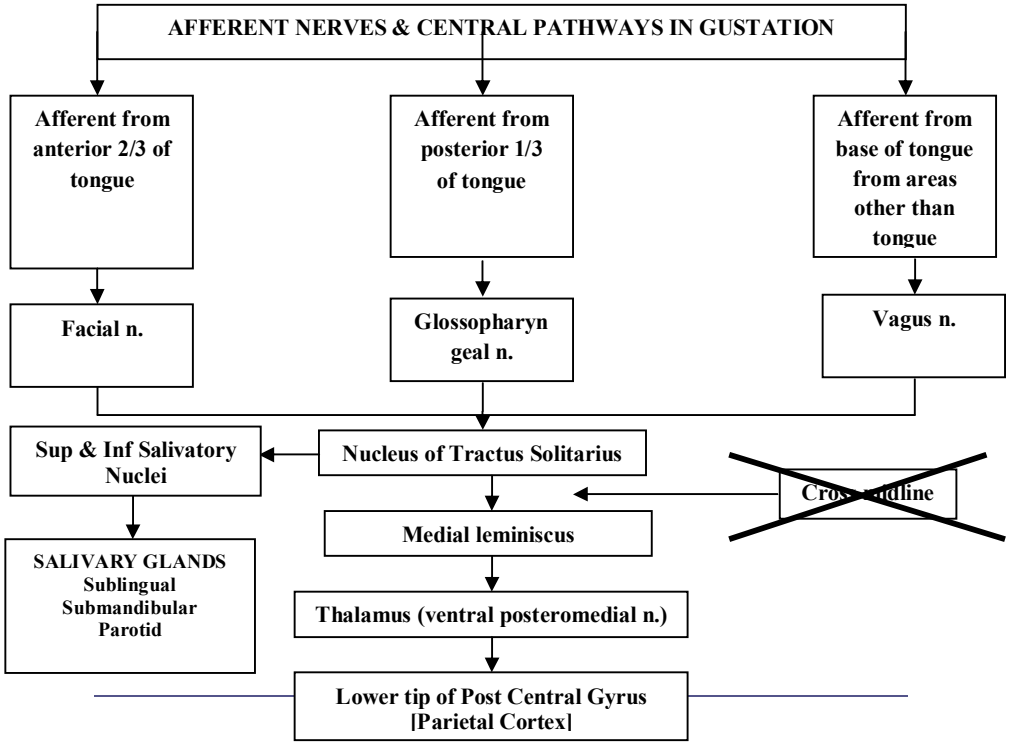
BITTER	SOUR	SWEET	SALTY
Like a cup of bad coffee	Like a Lemon	Like a piece of cake	Like salt

A fifth basic taste called "UMAMI" has recently been discovered. Umami is a taste that occurs when foods with glutamate are eaten.



- **ACIDS** ------- depolarize sour receptor cells by activating H+-gated cations channels
- **Na+ SALTS**----- depolarize salt receptor cells via Na+ channels *(EnaC)*
- **SWEET & BITTER SUBSTANCES** ----- depolarize their receptors by binding to G-protein & 2nd messengers (camp, IP3/DAG) that gate ion channels

2.4 Taste Pathway



2.5 Adaptation of taste

- ☒ Some occur at level of taste buds
- ☒ Mostly occur at CNS

2.6 Taste abnormalities (pathophysiology)

1) **AGEUSIA** → complete loss of taste
2) **DYSGEUSIA** → disturbed taste → in pregnant women
3) **HYPOGEUSIA** → decrease taste sensation → duo to Nerve Damage - aging – common cold – Drugs - Tobacco use – inflammation – infection – vit. A deficiency
4) **Hypergeusia** → increase taste sensation → duo to adrenal insufficiency