# **OLFACTION** The Sense of Smell



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- 1. Olfactory Bulb
- 2. Mitral Cells
- 3. Bone
- 4. Nasal Epithelium
- 5. Glomerulus
- 6. Olfactory receptors neurons



# **Primary Smell Sensation**

- 1. Camphoraceous
- 2. Musky
- 3. Floral
- 4. Pepperminty
- 5. Ethereal
- 6. Pungent
- 7. Putrid

#### - 100 primary sensations of smell

# Threshold of Smell

- the **minute quantity** of stimulating agent in the air can elicit a smell sensation.
- the substance **methylmercaptan** can be smelled when only one 25 trillionth of a gram is present in each milliliter of air.
- Because of this very **low threshold**, this substance is **mixed with natural gas** to give the gas an odor that can be detected when even small amounts of **gas leak** from a cylinder.

### How is perception affected by odor

Odor enhances our experience of the world (food, surroundings, people).

We associate memories with certain odorants.

We lose the ability to experience "flavors" if our sense of smell is impaired.

Most universally-rated "pleasant" odorant is vanilla

### Nasal Epithelium



## **Olfactory Epithelium**

- lies in the **superior part of each nostril**
- In each nostril, the olfactory membrane has asurface area of about 2.4 square centimeters
- Olfactory Cells The receptor cells for the smell sensation bipolar nerve cells derived originally from the CNS
- about 100 million of these cells in the olfactory epithelium interspersed among sustentacular cells

## **Olfactory Epithelium**

- The mucosal end of the olfactory cell forms a knob
  from which 4 to 25 olfactory hairs (also called olfactory cilia),
  project into the mucus that coats the inner surface of the nasal cavity
- **cilia react to odors** in the air and stimulate the olfactory cells
- Spaced among the olfactory cells **Bowman's glands that secrete mucus** onto the surface of the olfactory membrane.
- Olfactory cells are **constantly being replaced** with a half-time of a few weeks

### Nasal Epithelium



### **Excitation of Olfactory cells**

- The portion of each olfactory cell that responds to the olfactory chemical stimuli is the **olfactory cilia**.
- The odorant substance, on coming in contact with the olfactory membrane surface, first **diffuses into the mucus** that covers the cilia.
- Then it binds with **receptor proteins** in the membrane of each cilium **OBP**
- Receptor protein G protein cAMP pathway opening of Na channels action potential exciting the olfactory neuron olfactory nerve CNS

### **Excitation of Olfactory cells**

- **Only volatile substances** that can be sniffed into the nostrils can be smelled
- Substance must be at least **slightly water soluble** so that it can pass through the mucus to reach the olfactory cilia.
- substance to be at least **slightly lipid soluble**, presumably because lipid constituents of the **cilium** itself are a weak barrier to non-lipid-soluble odorants.

### **Olfactory Receptor Neurons**



### **Olfactory Bulb**







# Smell Pathway

- Olfactory bulb olfactory tract olfactory nerve 1<sup>st</sup> cranial nerve
- both the tract and the bulb are an anterior outgrowth of brain tissue from the base of the brain
- olfactory bulb lies over the **cribriform plate**, separating the brain cavity from the upper nasal cavity
- The cribriform plate has multiple **small perforations** through which an equal number of small nerves pass upward **from the olfactory membrane** in the nasal cavity **to enter the olfactory bulb** in the cranial cavity



- **short axons** from the olfactory cells terminating in multiple globular structures within the olfactory bulb called **glomeruli**
- Each glomerulus is the terminus for dendrites from about 25 large mitral cells and about 60 smaller tufted cells, the cell bodies of which lie in the olfactory bulb superior to the glomeruli granule cells Periglomerular cells
- mitral and tufted cells send axons through the olfactory tract to transmit olfactory signals to higher levels in the CNS
- Mucus cilia Axons of olfactory cells glomeruli in **bulb** dendrites of mitral, tufted cells in **bulb** axons of mitral, tufted cells in **tract** CNS

# Smell CNS pathway

- Olfactory tract divides into
- medially into the medial olfactory area (stria) of the brain stem – very old olfactory system
- other passing laterally into the lateral olfactory area
  (stria) a newer & less old system
- The Medial Olfactory Area (very old) septal nuclei hypothalamus – limbic system – removal – not much effect
- The Less Old Lateral Olfactory Area prepyriform and pyriform cortex plus portion of the amygdaloid nuclei – limbic system (hippocampus) – learning & aversion

- lateral olfactory area anteromedial portion of the temporal lobe (cerebral cortex)
- \*This is the only area of the entire cerebral cortex where sensory signals pass directly to the cortex without passing first through the thalamus
- **The Newer Pathway** passes through the **thalamus**, passing to the dorsomedial thalamic nucleus orbitofrontal cortex
- conscious analysis of odor

#### - Granule cells, Periglomerular cells – lateral inhibition





Thank you