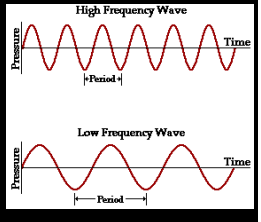
Hearing

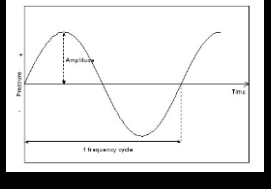
The Sound

- **Frequency** (Tone) = The number of cycles per second (Hertz)
- Human can hear the frequency between 20-20,000 Hz
- **PITCH** (Perception of sound frequency)
- High frequency = High pitch (Trebel)
- Low frequency = Low pitch (Bass)



The Sound

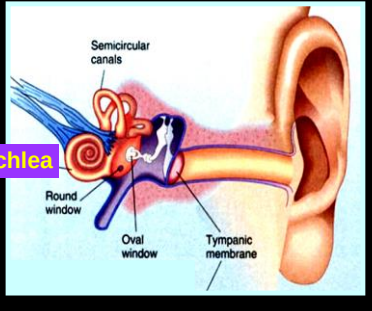
- **Amplitude** = The intensity of the sound (Decibel)
- **Loudness** (Perception of sound Amplitude)



The Sound

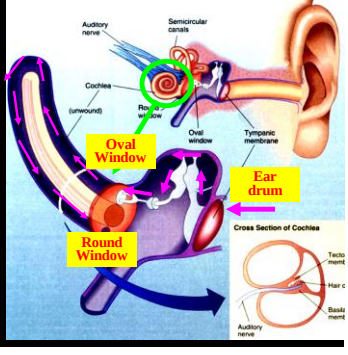
- 140 dB = Threshold of pain
- 130 dB = Jet taking off
- 120 dB = Rock Concert
- 70 dB = Noisy restaurant
- 30 dB = A whisper in a quiet place
- **Consistent exposure to sound levels at or above 100 dB is associated with permanent hear loss.**

The Ear



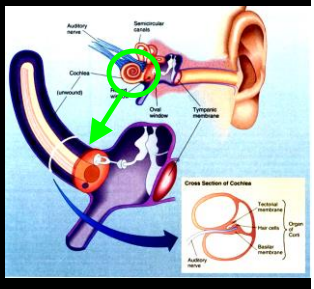
The Ear

Vibrations in the air are transmitted through the tympanic membrane (ear drum), ossicles (3 small bones), and oval window →into the fluid in the cochlea



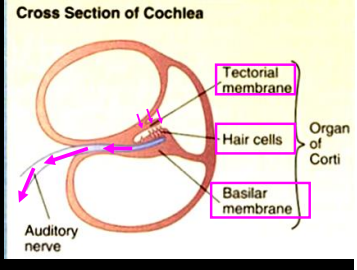
The Cochlea

- The internal membrane of cochlea is the **Organ of Corti**



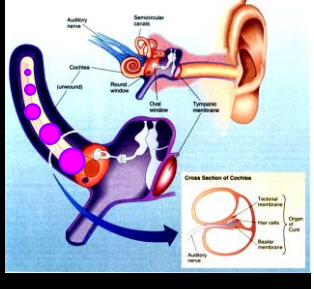
Organ of Corti

- Tectorial membrane, hair cells, basilar membrane
- **Auditory Receptor = Hair cells**
- The Vibrations bend the **Tectorial membrane** and excite **Hair Cells** on the **Basilar Membrane**
- Send information to **Auditory Nerve**



The Cochlea

- Human are more sensitive to sound of **intermediate frequency**
- **The Place Theory of Pitch Perception:** The organization of the receptors on the basilar membrane in the organ of Corti is **tonotopic** (organized by frequency)
- **Higher frequency receptors** = near Oval Window
- Thus, **damage to high frequency R** occurs first

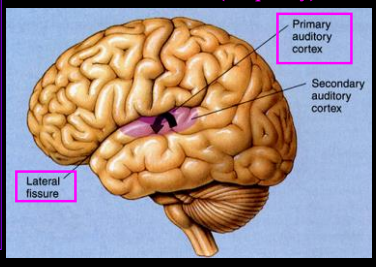


Auditory Cortex

DAMAGE:

- Bilateral lesion of auditory cortex **DO NOT cause deafness**
- Extensive damage of auditory cortex = Dificulty **localizing** brief stimuli or **recognizing** rapid complex sequences of sounds

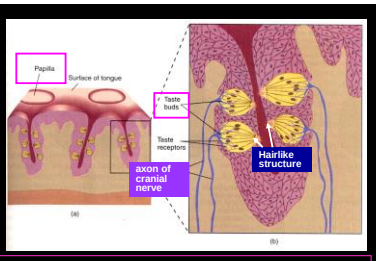
Tonotopical column (frequency)



Taste

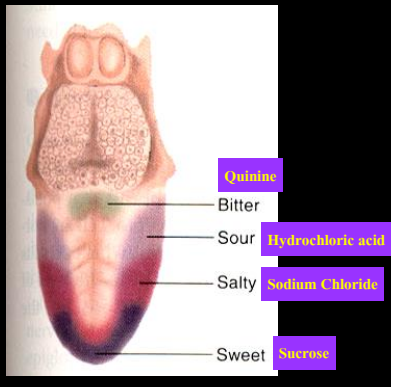
Humans vary in their sensitivity to different tastes

Taste Buds



- The taste receptors occur in clusters, called **Taste Buds.**
- Taste receptors are located on the **tongue, throat, and roof of mouth.**
- At the end of the taste buds are **short, hairlike structures** that extend outward and make contact with the saliva in the mouth
- The contact results in **electrical impulse**, the transduction, then travel to the brain via axon of cranial nerve

- Any substance can be detected anywhere on the tongue, **except in the center.**
- However, different areas on the tongue are maximally sensitive to different tastes.



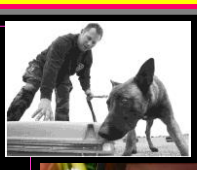
Factors affect taste:

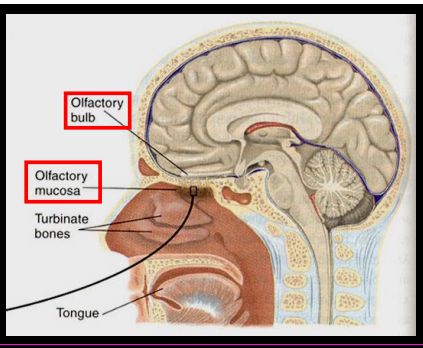
- Ability to smell
- Our genetics
- Our experience

Smelling

Smelling

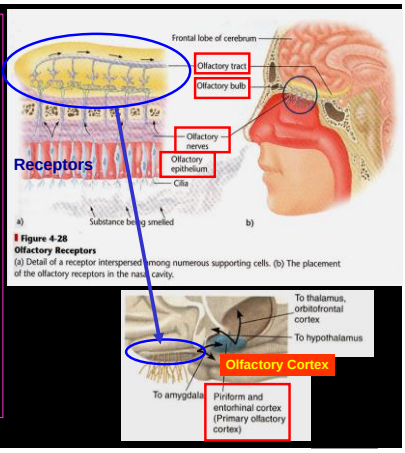
- **Smell helps the survival of the species.**
- **Dogs = olfactory cortex is about 33% of the whole cortex**
- **Human = olfactory cortex is about 5% of the whole cortex**



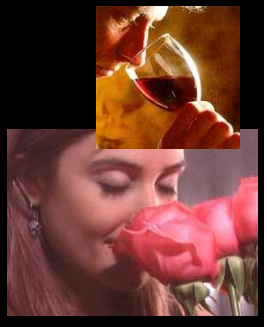


- **Olfactory receptors are in the nasal passage, on the Olfactory mucosa or Olfactory epithelium.**
- **There are about 10 million receptors in human.**

- The **volatile molecules** of a substance are the stimuli for smell
- When the **cilia** of the **Olfactory receptors** contact volatile molecules, resulting in an electrical impulse of that receptor (Transduction).
- The electrical impulse travels along nerve fiber to the **Olfactory Bulb.**
- The Olfactory Bulb connect via Olfactory tract to **Olfactory Cortex in temporal lobe**



- A healthy person is able to distinguish among **10,000-40,000** different odors (Cain, 1988)
- **Women** are better than men (Cain, 1988)
- Professional Perfumers and Whiskey Blenders can discriminate among **100,000 odors** (Dobb, 1989).



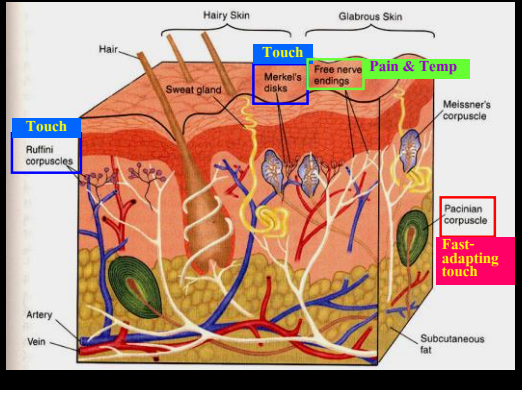
Tactual Sense

The Tactual Sense (Skin Sense)

- Pressure
- Temperature
- Pain

A 6-feet tall person has about 3,000 sq. inches of skin area.

Receptors



Pressure

- The sensitivity of the skin for pressure is the number of receptors.
- The lips, nose, and cheek are the most sensitive area
- The big toe is the least sensitive area.
- In the sensitive areas, we can feel the force as small as 5 mg.

Pressure

- **Adaptation:** if we feel some pressure for several minutes (wearing glasses, a watch), you will become **insensitive** to its pressure and stop the feeling of it.

Pressure

- **Exploring:** We actively explore the environment by touch.
- Without seeing the objects,, we can identify familiar objects through **active touch**, such as key phone, etc.

Temperature

- Temperature of our skin
- **Cold receptors** – generate neural impulse when there is a decrease in skin temperature.
- **Warm receptors** - generate neural impulse when there is an increase in skin temperature.
- **Very hot temp** can activate both cold and warm receptors

Temperature

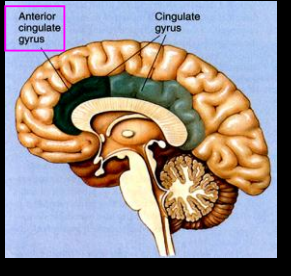
- **Cold Receptors** – when the skin is at its normal temperature, we can detect the cooling of **0.15° C**
- **Warm Receptors** - when the skin is at its normal temperature, we can detect the warming of **0.40 °C**
- **Adaptation –** Human can adapt completely to **moderate changes in temperature** after a few minutes.

After being in a swimming pool for a while, our temperature sense adapts to the change in temperature. However, when first dangling a foot into the water, we can detect the cooler temperature.

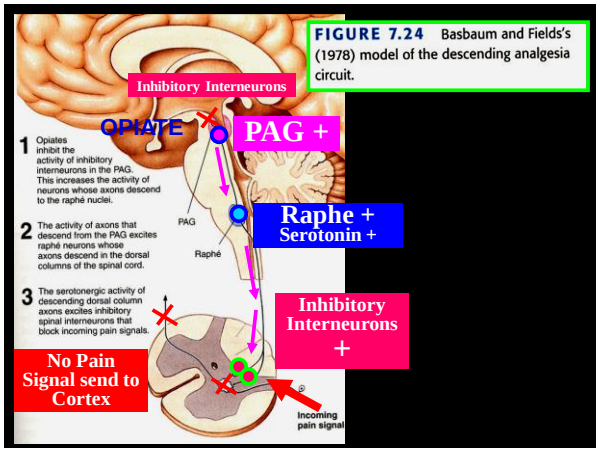
Pain

- **Pain is adaptive.**
  - We can be at risk without a sense of pain
  - Some people with a rare genetic disorder "***congenital insensitivity to pain***" typically die at young age because of tissue deterioration because of wound and infection.

- PET scan suggested that **Anterior Cingulate Cortex** is responsible for perception of pain
- NOW is believed to be **Emotional Response to Pain** rather than perception of pain
- Melzack & Wall (1965) proposed "**Gate Control Theory**" Cognitive and Emotion can block Pain

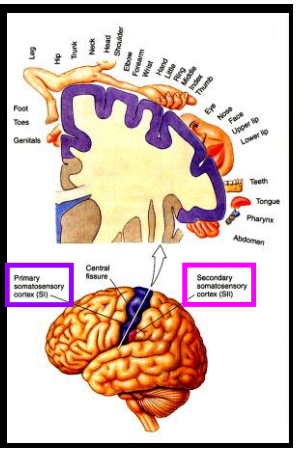


- **PAG stimulation in rats → Analgesia** (can perform operation in rats under PAG-induced analgesia)
- **Opiate Receptors in brain = The body can produce endogenous opiates**



Homunculus

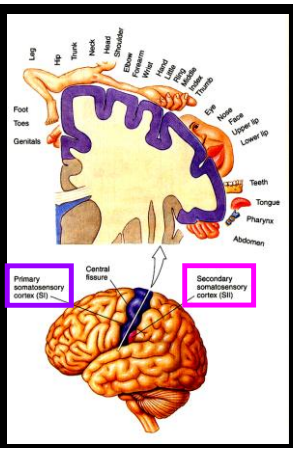
Primary Somatosensory Cortex is organized *somatotopically*



4 stripes of **Somatosensory Homunculus** (pain, temp, touch, chronic pain)

Primary Somatosensory Cortex

- Postcentral Gyrus



Phantom Limb

- **Chronic severe pain** that is experienced by about 50% of amputees
- Paradoxically, **surgical treatments** have proven ineffective

Assignment

- **Report**
- **2-page report about "Phantom Limb and Mirror box treatment"**
  - ***Dr. Ramachandran, M.D.***
  - **No cut and paste, No Plagiarisms**
  - **No direct copy from text, website, friends, etc. (Plagiarisms)**
  - ***Reference list***