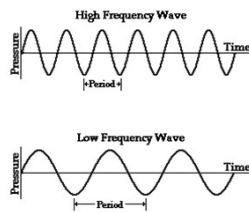


Hearing

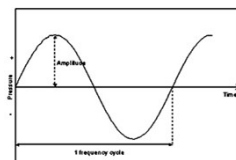
The Sound

- **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)

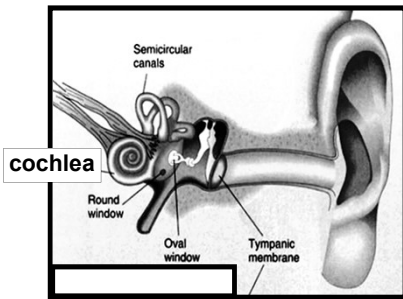


The Sound

- 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.

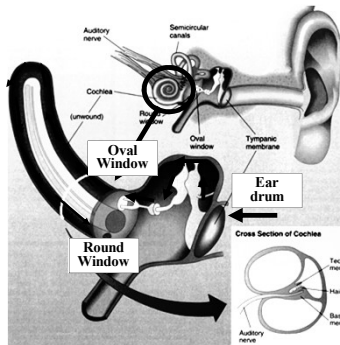


The Ear



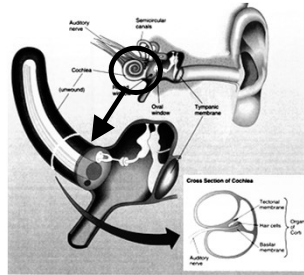
The Ear

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



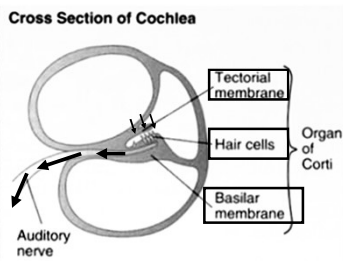
The Cochlea

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



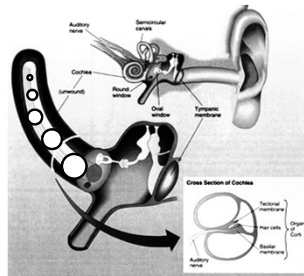
Organ of Corti

- 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

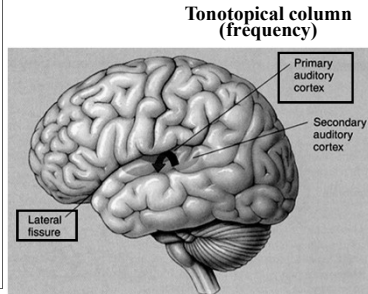
- Human are more sensitive to sound of intermediate frequency
- **The Place Theory of Pitch Perception:** The organization of the receptors on the basilar membrane in the organ of Corti is **tonotopic** (organized by frequency)
- Higher frequency receptors = near **Oval Window**
- Thus, **damage to high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



Auditory Cortex

DAMAGE:

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

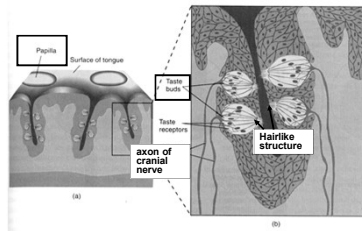


Taste

Humans vary in their sensitivity to different tastes

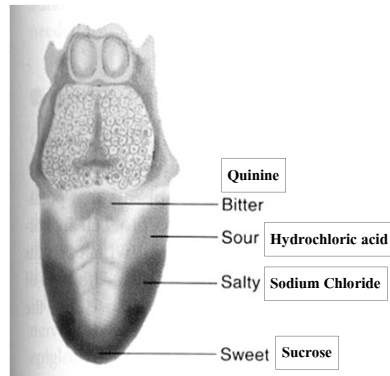


Taste Buds



- 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

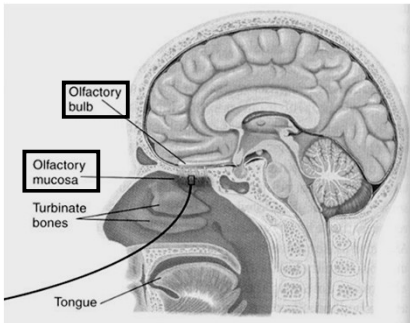
Smelling

• 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

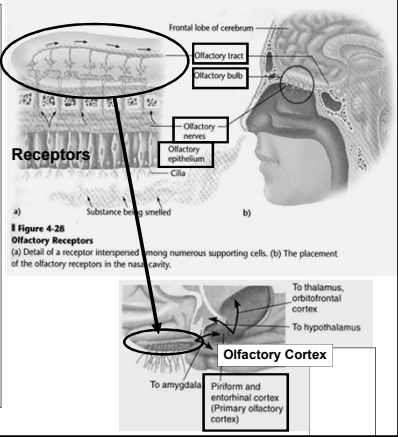




• Olfactory receptors are in the nasal passage, on the Olfactory mucosa or Olfactory epithelium.

• 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

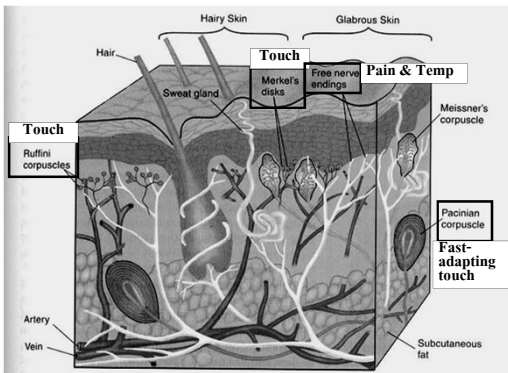
The Tactual Sense (Skin Sense)

- Pressure
- Temperature
- Pain



A 6-foot 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.



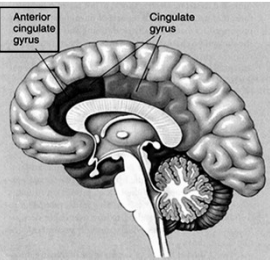
After being in a swimming pool for a while, our temperature sense adapts to the change in temperature. However, when first dangling a foot into the water, we can detect the cooler temperature.

Pain

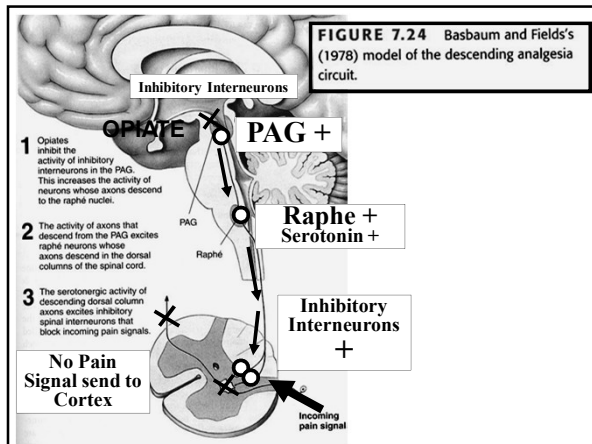
- **Pain is adaptive.**
- We can be at risk without a sense of pain
- Some people with a rare genetic disorder "**congenital insensitivity to pain**" typically die at young age because of tissue deterioration because of wound and infection.

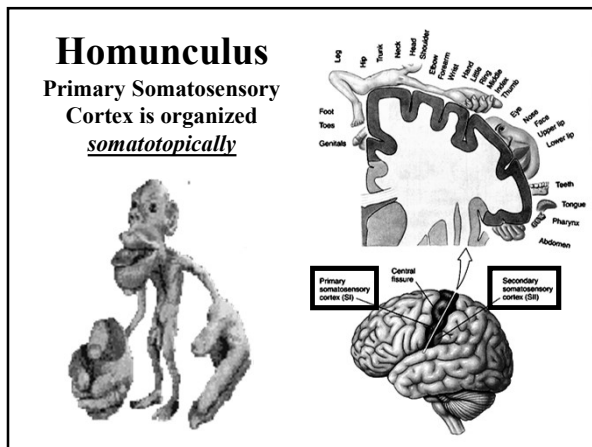


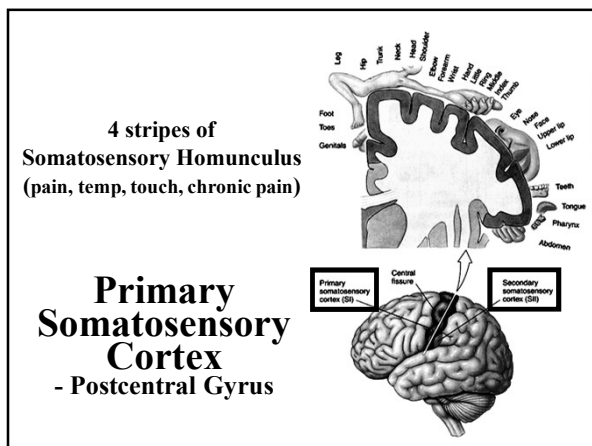
- PET scan suggested that **Anterior Cingulate Cortex** is responsible for perception of pain
- NOW is believed to be **Emotional Response to Pain** rather than perception of pain
- Melzack & Wall (1965) proposed "**Gate Control Theory**" Cognitive and Emotion can block Pain



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







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*