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Hearing Loss and the Structure of the Ear

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Hearing Loss and the Structure of the Ear



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BIO 141-003

11-25-14

Part I: the Equipment



**AN OVERVIEW OF THE STRUCTURE OF THE
MIDDLE AND INNER EAR**

Tympanic Membrane



Separates middle ear
from outside world

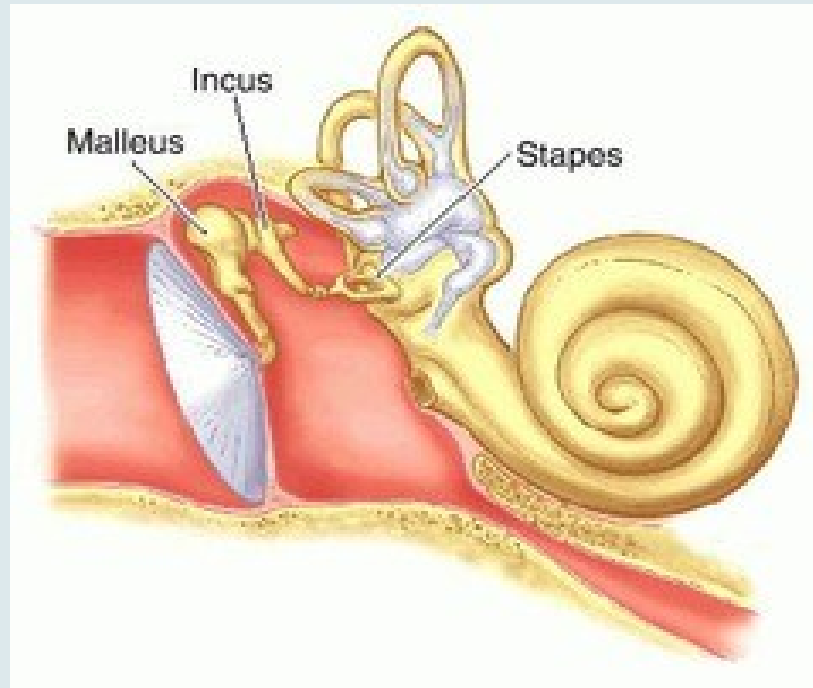
Sound waves enter ear
canal and vibrate
tympanic membrane

<http://www.drmmotoscope.com/images/normal%20TM.JPG>

Auditory Ossicles



- Carry vibrations from tympanic membrane to inner ear
- Malleus
- Incus
- Stapes

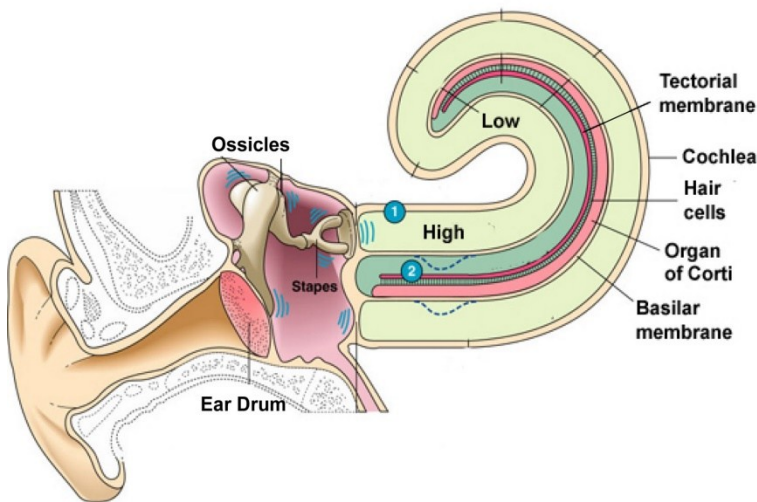


http://o.quizlet.com/i/sc8enDqIaxB-eAJJosgDjQ_m.jpg

Cochlea



- Fluid-filled spiral where sound waves converted to electrical signals (Naff 17)
- Three compartments separated by basilar membrane
 - Vestibular canal
 - Tympanic canal
 - Cochlear duct



http://3.bp.blogspot.com/-vBtZGQpFyuU/TsPhxLPDHoI/AAAAAAAAAFA/gSRnsWiBuOM/s1600/ear_edit.jpg

Cochlea



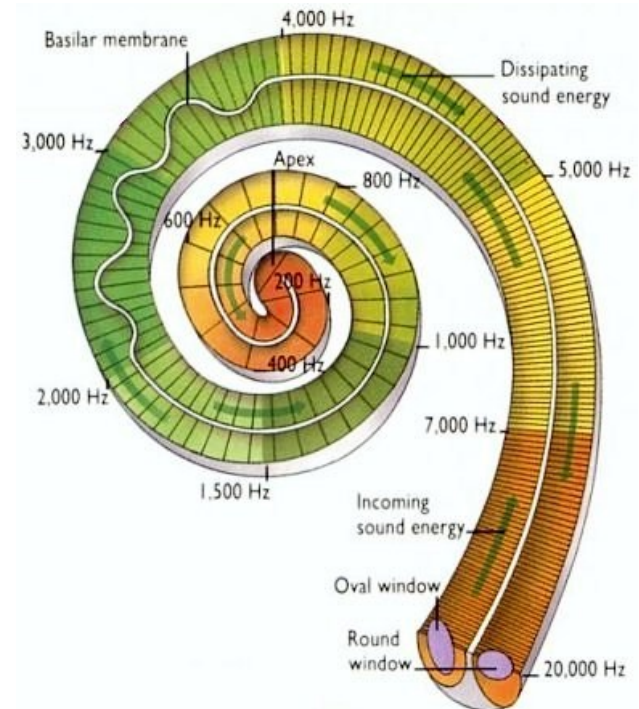
- Cochlear duct
 - Tectorial membrane
 - Organ of Corti
 - Hair cells (cilia)



cochlea-lg.mov

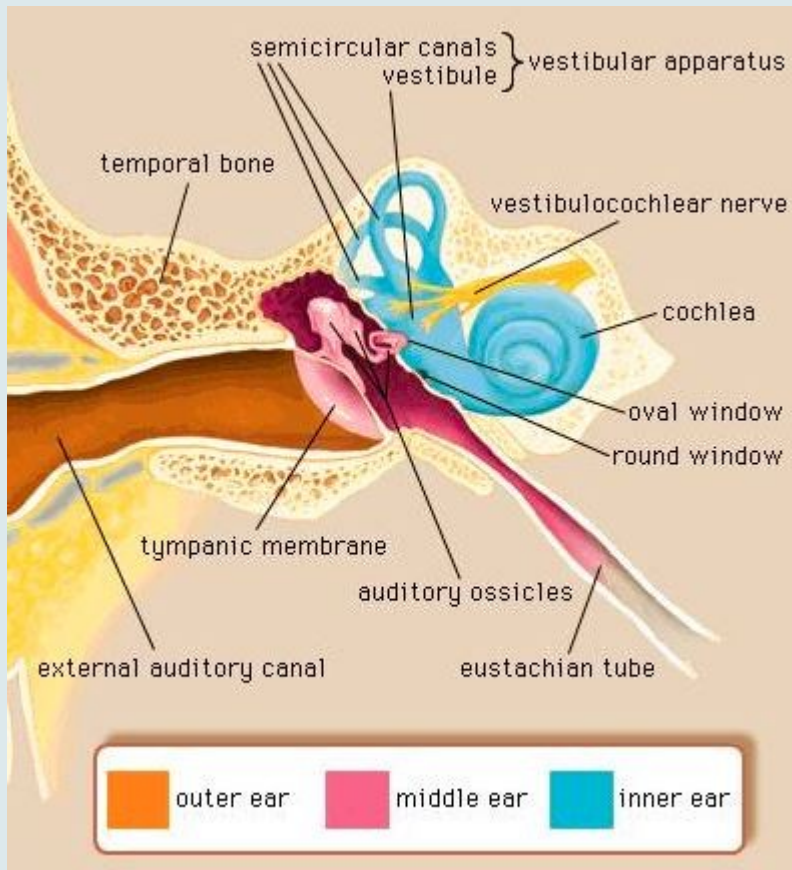
<http://www.hhmi.org/biointeractive/cochlea>

- Basilar membrane movement stimulates cilia



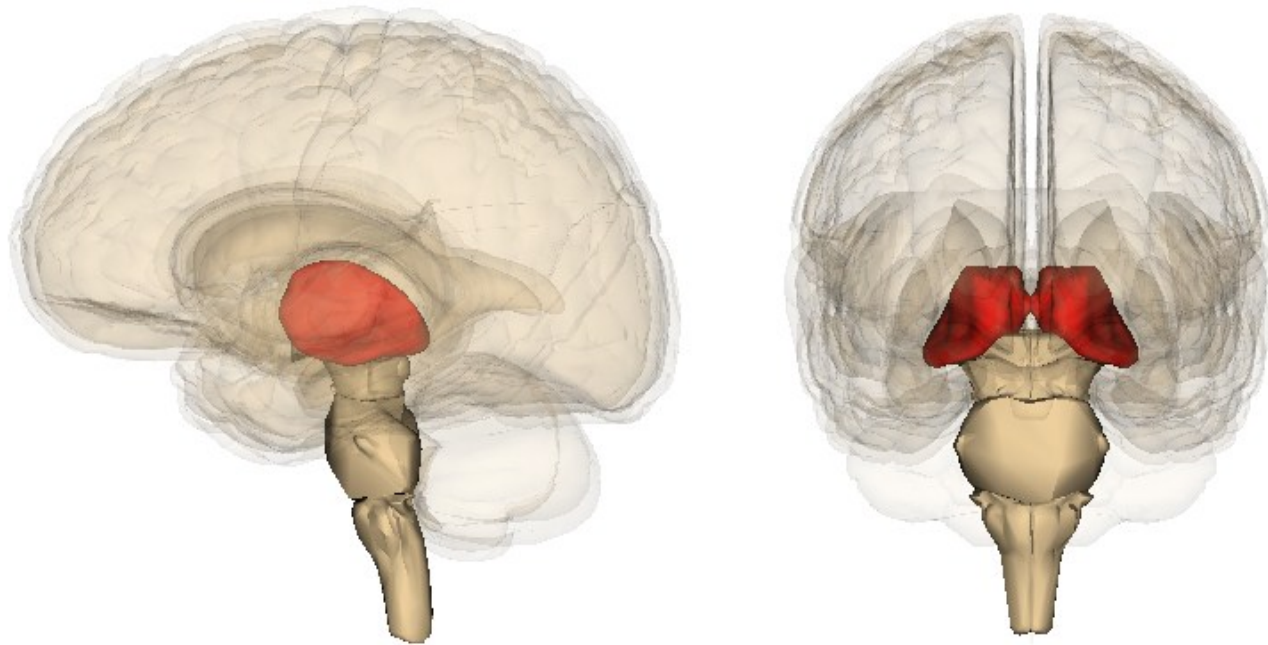
<http://wikis.lib.ncsu.edu/images/d/d6/110-85-cochlea2.jpg>

Auditory Nerve



- Vestibulocochlear nerve has two branches
- Vestibular branch
- Cochlear branch

<http://media-1.web.britannica.com/eb-media/04/14304-004-6C1B7EB1.jpg>



<http://static.squarespace.com/static/52ec8c1ae4b047ccc14d6f29/t/53c6do74e4b08a64ba1e33a0/1405538421430/thalamus.png>

Part II: the Problems



**A SAMPLE OF CONDITIONS WHICH CAN
RESULT IN HEARING IMPAIRMENT**

Presbycusis and Conductive

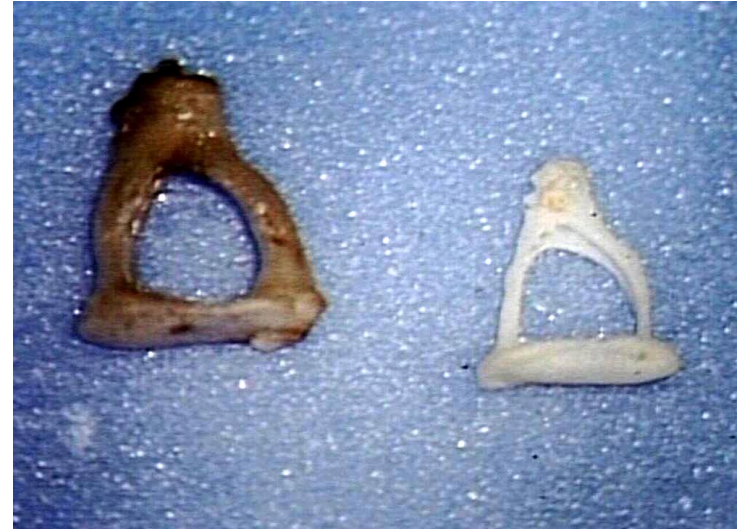


- Presbycusis: gradual hearing loss from aging
- Contributing factors
 - Excessive sound exposure
 - Changes to nerve pathways
 - Genetics
 - Deterioration of inner ear (Department of Medicine)
- Conductive: inefficient transmission of sound
- Common causes
 - Allergies/ear infections
 - Perforated ear drum
 - Benign tumors
 - Impacted earwax
 - Malformation of structures in outer and middle ear

Otosclerosis



- Abnormal growth of stapes
- Bones fused together
- Vibration impairment
- Causes unknown, but thought to be genetic
- Middle aged, white women most at risk

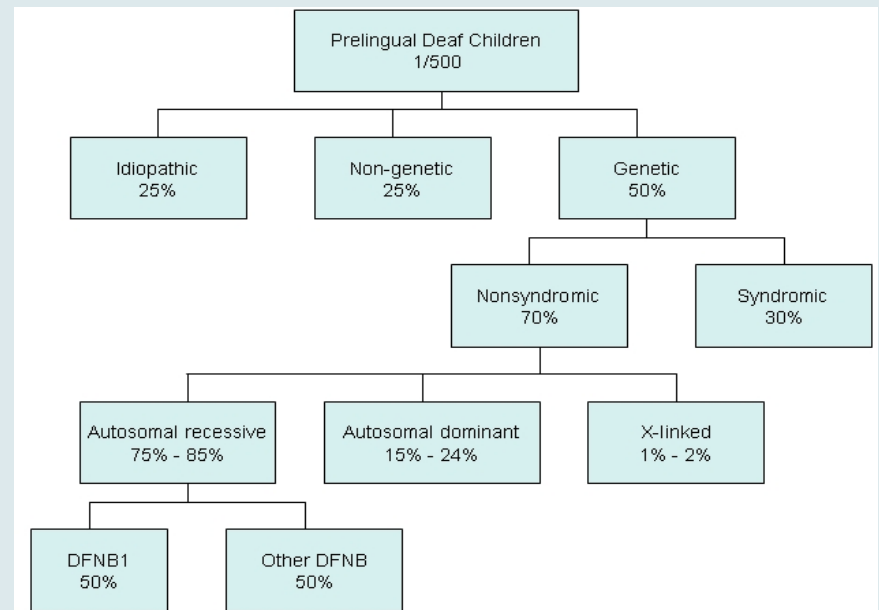


<http://www.pathguy.com/sol/13168.jpg>

Congenital



- “Present from birth” (Naff 19)
- Wide range of symptoms
- Causes
 - Genetics
 - Malformation of structures during fetal development
 - Pre-birth infection



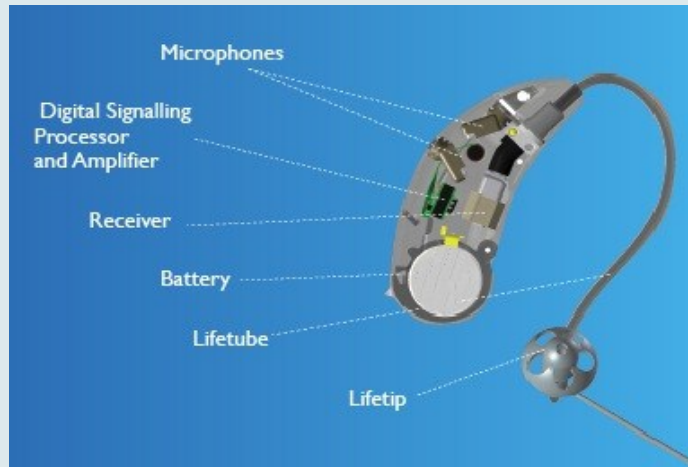
http://www.clivir.com/pictures/hearing_loss/hereditary.bmp

Part III: the Solutions



HOW CAN LOSS OF HEARING BE IMPROVED?

Hearing Aids Galore!



<http://www.austar-hearing.net/upload/img/20120806/20120806144716208.jpg>

- ✦ Behind-the-ear
- ✦ In-the-ear
- ✦ In-the-canal
- ✦ Completely-in-the-canal

- Digital hearing aids
 - Contain microphone, amplifier, and receiver
 - Computer chip converts sound waves into digital signals
 - Amplify and transmit sound
 - Highly programmable



<https://us.hearing.siemens.com/media/2014/04/BTE.jpg>

<http://cdn.gajitz.com/wp-content/uploads/2010/02/hearing-aid-deafinite.jpg>

<http://media-cache-ako.pining.com/236x/37/61/9e/37619ee1717994ca9288983219d5140f.jpg>

Cochlear Implants



- **Traditional cochlear implants**

- Restore hearing in totally deaf patients
- Electronics placed in inner ear via hole in skull
- Stimulate vestibulocochlear nerve directly

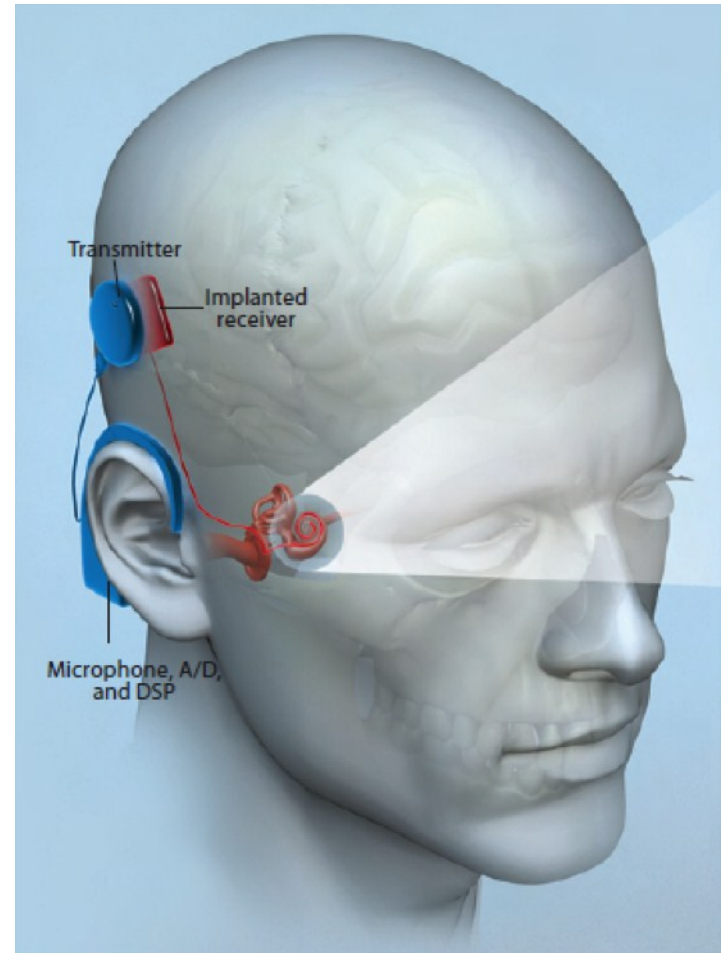
- **Hybrid cochlear implants**

- Ski-slope hearing loss
- High frequencies near entrance of cochlea
- Place electrode at opening of cochlea to selectively stimulate nerves



http://upload.wikimedia.org/wikipedia/commons/0/04/Infant_with_cochlear_implant.jpg

http://hplusmagazine.com/wp-content/uploads/CI_Device1.png



Next Generation Hearing Aids



- **Earlens**

- Lens photoreceptor placed on eardrum
- Laser probe in ear canal
- Behind-the-ear receiver sends energy to probe
- Light energy transmitted as vibrations on eardrum

- **Bone-anchored**

- Small screw implanted into skull behind ear
- External receiver
- Sound waves transmitted as vibrations through skull

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