Hearing Loss and the Structure of the Ear

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AN OVERVIEW OF THE STRUCTURE OF THE MIDDLE AND INNER EAR

Part I: the Equipment
Tympanic Membrane

Separates middle ear from outside world

Sound waves enter ear canal and vibrate tympanic membrane

http://www.drmomotoscope.com/images/normal%20TM.JPG
Auditory Ossicles

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

http://o.quizlet.com/i/sc8enDqIaxB-eAJJ0sgDjQ_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)

- Basilar membrane movement stimulates cilia

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

Auditory Nerve

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

http://media-1.web.britannica.com/eb-media/04/14304-004-6C1B7EB1.jpg
Part II: the Problems

A SAMPLE OF CONDITIONS WHICH CAN RESULT IN HEARING IMPAIRMENT
Presbycusis and Conductive

- **Presbycusis**: gradual hearing loss from aging

- **Conducting 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
Congenital

- “Present from birth” (Naff 19)

- Wide range of symptoms

- Causes
  - Genetics
  - Malformation of structures during fetal development
  - Pre-birth infection

Part III: the Solutions

How can loss of hearing be improved?
Hearing Aids Galore!

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

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

http://www.austar-hearing.net/upload/img/20120806/20120806144716208.jpg
https://us.hearing.siemens.com/media/2014/04/BTE.jpg
http://media-cache-ak0.pinimg.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

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


