Anatomy and Physiology of Hearing

Introduction

The ears are paired sensory organs comprising the **auditory system**, involved in the detection of sound, and the **vestibular system**, involved with maintaining body balance/ equilibrium. The ear divides anatomically and functionally into three regions: the **external ear**, the **middle ear**, and the **inner ear**. All three regions are involved in hearing. Only the inner ear functions in the vestibular system



OUTER EAR

<u>AURICLE-/</u> framework of cartilaginous fibers except lobule -capture sound & funnel it

<u>E.A.M.</u>

- □ 2.5cm.
- Direction
- □ Histology : cart.2/3 X bone 1/3
 - hair /skin
 - seb.&cerumucinous gl.
- Isthmus
- □ Channel , tubal resonator, amplifying sound pr.







Function of Middle Ear

1-Conduction

Conduct sound from the outer ear to the inner ea-

2) Protection

Creates a barrier that protects the middle and inner areas from foreign objects Middle ear muscles may provide protection from loud sounds

<u>3) Transducer</u>

Converts acoustic energy to mechanical energy Converts mechanical energy to hydraulic energy

<u>4) Amplifier</u> Transformer action of the middle ear (traveling wave)

Eustachian Tube

- The eustachian tube connects the front wall of the middle ear with the nasopharynx
- The eustachian tube also operates like a valve, which opens during swallowing and yawning



This equalizes the pressure on either side of the eardrum, which is necessary for optimal hearing. Without this function, a difference between the static pressure in the middle ear and the outside pressure may develop, causing the eardrum to displace inward or outward and this reduces the efficiency of the middle ear and less acoustic energy will be transmitted to the inner ear.

Inner ear

- Bony labyrinth ____ perilymph
- Membranous labyrinth ___endolymph
- Cochlea
- Vestibule(utricle ,saccule ,s.c.c.)



Function of Inner Ear

- Convert mechanical sound waves to neural impulses that can be recognized by the brain for:
 - Hearing
 - Balance

Cochlea

The cochlea is a spiral structure, like a snail shell containing two and one half turns from its base at the oval window to its apex taken along the central pillar or modiolus,

*Small opening Scala v.&scala t. communicate through, at apex called helicotrema





Organ of corti

- Located on the basilar membrane
- Contains the hair cells covered by tectorial membrane

-Outer h. c.

-Inner h. c.





OHC vs. IHC Function

Sound conduction pathways

- I. Through Ossicular chain to oval window
- II. Directly cross middle ear to round window (large perforation)
- III. Bone conduction (vibration of skull bones)

Traveling waves

The impedance of the fluid in the cochlea is about 30 times greater than that of air, and if the sound were applied directly to the oval window, most of it (\sim 97%) would be reflected, leaving only 3% transmission.

Transformer/Amplifier

- The middle ear enhances the transfer of acoustical energy in two ways:
 - The area of the eardrum is about 17 times larger than the oval window
 - The effective pressure (force per unit area) is increased by this amount.
 - The ossicles produce a lever action that further amplifies the pressure
 - Without the transformer action of middle ear energy in air transmitted to (about 30 dB loss).
- Malleus and incus vibrate together, transmitting the sound waves from the eardrum to the footplate of the stapes (this pushes the oval window in and out)(mechanical energy)

Lever system

Areal ratio =18:1

Lever ratio=1.3:1

Transformer ratio=21:1

Fig. 8-5. Schematic drawing of ossicle system to illustrate the lever arms and the position of the fulcrum. Relative areas of the tympanic membrane and the membrane of the oval window are shown .

When the stapes moves inward at the oval window pressure waves are transmitted to the perilymph of the scala vestibuli and thence through Reissner's membrane and the

basilar membrane to the scala tympani. In the scala tympani, the vibrations pass again through perilymph to the round window at the base of the cochlea. The membranous covering of the round window bulges into the middle ear and forms the ultimate "give".The "give" at the round window is necessary to prevent pressure-wave reflections within the cochlea.

Movement of the cilia to kinocillium side results in a depolarization of the hair cell's receptor that in turn releases a transmitter substance that finally depolarizes the afferent fibers that contact it.resulting in generation of action potential & transmission of the impulses







- C. Consists of 1 layer of tissue
- D. Consists of 3 layers of tissue
- E. Consists of 5 layers of tissue

Question :3/ The Eustachian tube:

- A. Opens when one yawns
- B. Opens when one smiles
- C. Opens when one blinks
- D. It is always open
- E. Never opens

Question :4/ The middle ear:

- A. Converts acoustic energy to hydraulic
- B. Converts hydraulic energy to mechanical
- C. Converts acoustic energy to mechanical
- D. Converts acoustic energy to electrical
- E. Converts mechanical to electrical

Question : 5/ The middle ear amplifies sound:

- A. About 15 dB
- B. About 25 dB
- C. About 35 dB
- D. About 20 dB
- E. About 30 dB

Question 6:/ The function of the inner ear:

- A. Balance
- B. Hearing
- C. Touch
- D. All the above
- E. A and B

Question : 7/ The channel that houses the organ of Corti:

- A. Scala tympani
- B. Scala media
- C. Scala vestibuli
- D. Semicircular canals
- E. B and D

Thank you,,,