

Ear Anatomy and Physiology Review

1) Auditory Systems and Functions:

- a) Peripheral Auditory System: external, middle, and inner ear
 - i) External and Middle ear: receives and perceives sound
 - ii) Inner: responsible for sending information about both hearing and equilibrium
- b) Central Auditory System: acoustic nerve and auditory cortex of the brain (temporal lobe)
 - i) Transmits and processes impulses for sound and maintaining equilibrium

External, Middle, and Internal

2) External Ear

- a) Consists of: auricle or pinna and the external auditory canal
 - i) pinna is made of cartilage and connective tissue covered with epithelium (skin)
 - (1) this layer of epithelium extends into the external auditory canal which is slightly s shaped. These structures collect and transmit sound waves to the tympanic membrane
 - ii) the external auditory canal is lined with fine hairs, sebaceous (oil) glands and ceruminous glands.
 - (1) Ear is the only place in the body ceruminous glands are found
- b) the cerumen is protective by helping to keep debris from entering and works to kill bacteria-a first defense from infection
- c) so all those cool sebaceous oil glands, hairs, and ceruminal glands move old skin cells and wax to the outer part of the ear. Work like a conveyer belt moving debris externally
 - i) this inner half of the external ear is more vascular and is easily traumatized

3) Middle Ear Anatomy

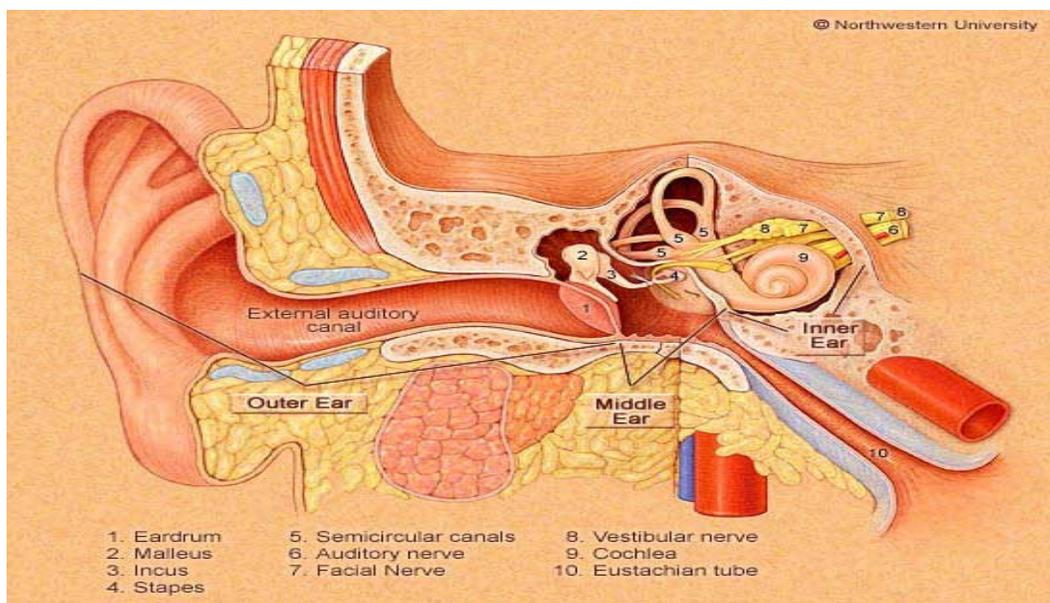
- a) Located in the temporal bone
- b) Much of the middle and inner ear are inaccessible to direct exam
 - i) **What do you think is blocking the view? The tympanic membrane**
- c) Eardrum Aka.... the tympanic membrane

- i) Tympanic membrane normally is a shiny, translucent, pearly-grey membrane
- ii) Slightly concave because it is pulled in by the malleus



(Image of a Normal TM)

- iii) External ear collects sound waves and transmits them to the tympanic membrane
- iv) The sound waves are then conducted by the tympanic membrane to the ossicle bones (incus, stapes, malleus)



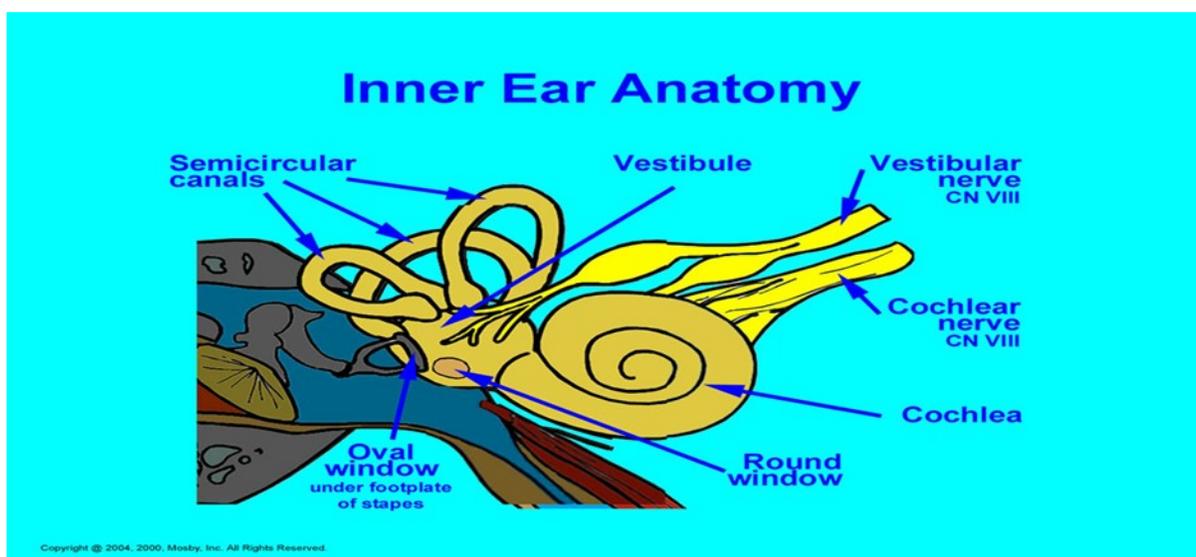
- v) The tympanic membrane works as a dividing wall between the external and middle ear

(1) In this image above we can clearly see how the tympanic membrane separates the external from middle ear

- d) Middle ear is connected to the nasopharynx (throat) by the eustachian tubes
- e) This part of the ear is full of air

- f) Eustachian tube lies in the middle ear and helps to equalize pressure between outer and inner ear
 - g) when pressure is symmetrical w outer and inner ear then sound is properly transmitted
 - i) this equalizing of pressure helps to prevent the tympanic membrane from rupturing and allows for proper transfer of sound waves
 - ii) the eustachian tube is normally closed but will open with yawning or swallowing
 - (1) blockage of the eustachian tube impedes ability to equalize pressure and tympanic membrane may bulge
 - h) besides the tympanic membrane the middle ear includes the 3 ossicles (smallest bones of the body)
 - i) incus, malleus, and stapes-these directly connect the tympanic membrane with the oval window
 - ii) these three bones move as a result of the tympanic membrane vibrating and this transmits sound by causing the oval window to vibrate which causes fluid in the inner ear to move and stimulate the receptors of hearing in the inner ear
- 4) Inner Ear
- a) Inner Ear is also located in the temporal bone beside the middle ear on the other side of the oval window
 - b) includes the vestibule, cochlea, semicircular canals, membranous labyrinth which are all housed and protected by the bony labyrinth
 - c) Bony Labyrinth
 - i) is a series of bony canals in the inner ear that contain fluid that protects and cushions the organs of balance and hearing
 - d) Membranous Labyrinth
 - i) Holds the semicircular canals and the organ of corti which are surrounded by endolymph fluid
 - ii) endolymph allows these structures to float and protects them from sudden head movements
 - e) Vestibule
 - i) Bony chamber separating cochlea and semicircular canals
 - ii) Located at entrance just past the oval window (like the foyer of a home)
 - iii) communicates with the cochlea and the semicircular canals

- f) Semicircular Canals contain sensory organs that help with equilibrium
 - i) they are stimulated by change in rate (how fast you are moving forward) or direction of movement (think of how some people feel very sick after a roller coaster)
 - ii) if there is excess fluid in the membranous labyrinth pressing on the semicircular canals then balance will be effected (ie Meniere's disease)
- g) Cochlea which is a receptor organ for hearing
 - i) unique snail shape
 - ii) Within the cochlea is the organ of corti
 - (1) hairs inside the organ of corti respond to stimulation associated with pitch
 - iii) this stimulus is converted into a electrochemical impulse and is transmitted by CN VIII-acoustic nerve to the brain for further processing...so all along there was either vibration or fluid movement (mechanical energy) and now this is finally converted into an electrical impulse picked up by the acoustic nerve

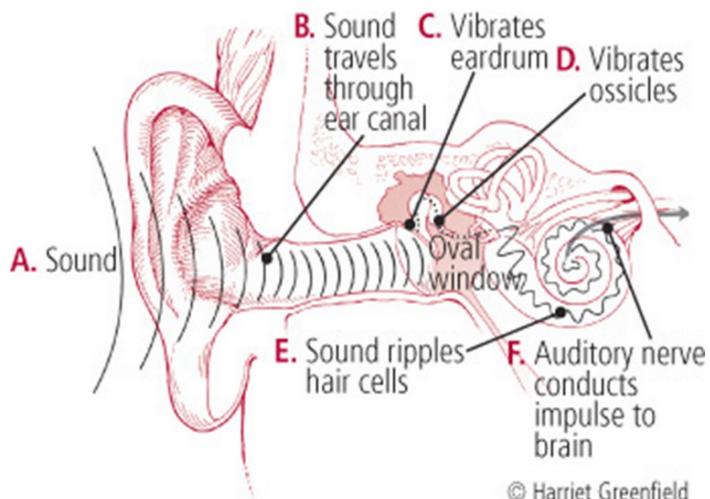


- 5) The ear connection
 - a) CN VII- The facial nerve crosses by the oval window and can be easily damaged because it is protected only by thin bone
 - b) CN VIII-The vestibulocochlear nerve
 - i) 2 parts to this nerve
 - (1) Vestibule portion receives impulses from the semicircular canals so the brain can direct muscles to contract and maintain balance

(a) Maintaining balance is a cerebellar function

(2) Cochlear portion receives impulses from the cochlea in the inner ear so the brain can interpret sound

6) Transmission of sound-how do we hear sound?



- Sound and air conduction are transmitted through the air and picked up by the outer ear.
- Sound travels through the ear canal
- Sound waves vibrate the tympanic membrane
- This then vibrates the ossicles (malleus, stapes, incus) they then move
- The oval window is pushed in & out-produces waves in perilymph fluid
- Vibration is picked up by the tiny hairs in the organ of corti (cochlea)
- And then the nerve impulse is initiated in CN VIII (vestibulocochlear)
- Then we hear sound!