

430 Teams

Diseases of the Ear, Nose and Throat



ear 1 (anatomy and physiology)

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-429 team

Important Notes in red
Copied slides in black
additional notes in green/ blue

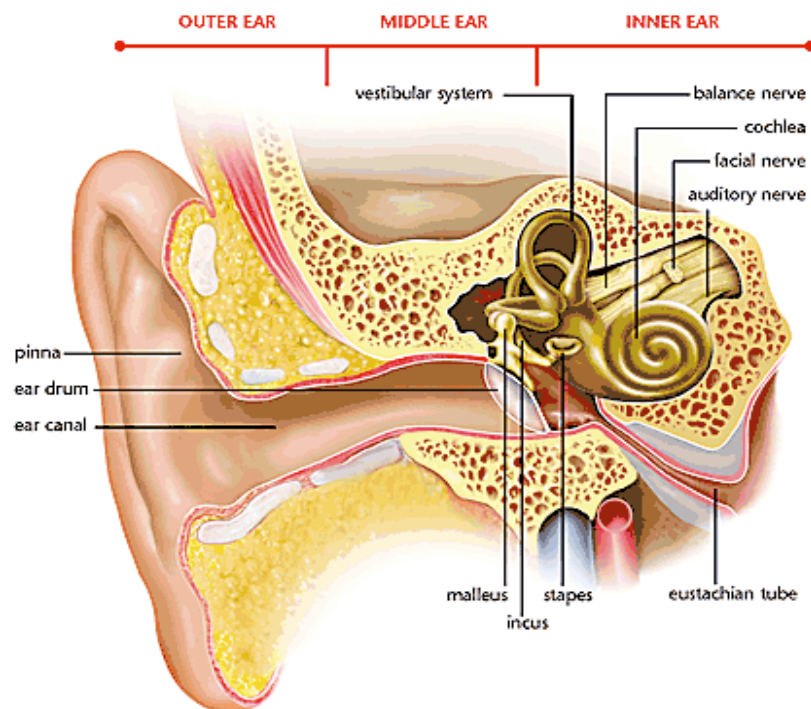
Objectives of the lecture:

- Anatomy of: external, middle and internal ear. Including structures, relations, and nerve supply.
- Brief embryology of the ear.
- Physiology of the ear. Including hearing and balance.
- Earache

Anatomy of the ear:

The ear consists of

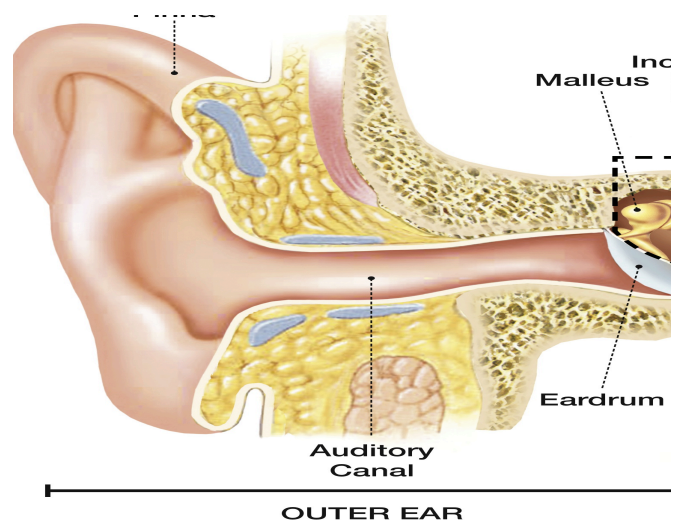
- 1) External ear: from the outer part till the eardrum (tympanic membrane)
- 2) Middle ear (tympanic cavity): from the eardrum till the stapes footplate
- 3) Internal ear: cochlea and semicircular canals.

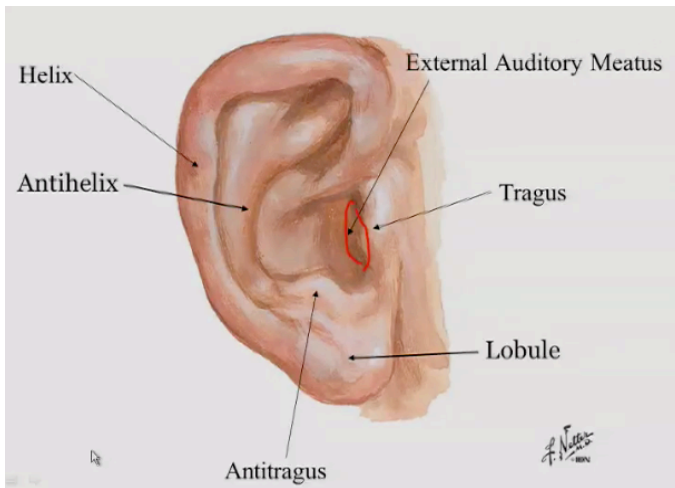
**1) External ear: (outer ear)**

External ear is formed by:

- 1) Auricle
- 2) External auditory meatus (auditory canal).

Both of them are lined by skin.





The external auditory meatus (2.5 cm) is an S shape canal (to protect the ear drum and middle ear). And it consists of:

1) Cartilaginous part (outer 1/3): formed by **elastic cartilage** and contains hair follicles, sebaceous and ceruminous glands (**secrete wax**).

2) Bony part (inner 2/3):

The narrowest portion is at the bony-cartilaginous junction.

-Tympanic membrane (ear drum) considered part of the external ear.

The doctor said that tympanic membrane is part of the external ear, but in other resources it considered as part of the middle ear.

2) Middle ear: (tympanic cavity)

The middle ear is a sterile air-containing cavity communicates with the nasopharynx through the Eustachian tube (Auditory tube).

Tympanic membrane:

Is a thin fibrous membrane that is pearly gray in color.

- 1) Umbo: Tip of handle of Malleus
- 2) Cone of light (reflex from otoscope): anteriorly and inferiorly from the Umbo.
- 3) Pars Flaccida: slack part bounded by posterior and anterior malleolar folds.
- 4) Pars tensa: the reminder tense part of the membrane.

Tympanic membrane is formed of 3 parts:

1. Outer layer → stratified squamous epithelium (skin). "ectoderm"
2. Middle layer → fibrous layer. "mesoderm"
3. Inner layer → mucous membrane. "endoderm"

Auditory ossicles:

- 1) Malleus مطرقة
- 2) Incus سندان
- 3) Stapes ركب

The stapes ends up with footplate which then communicates with the inner ear through the oval window to vibrate the fluid in the cochlea.

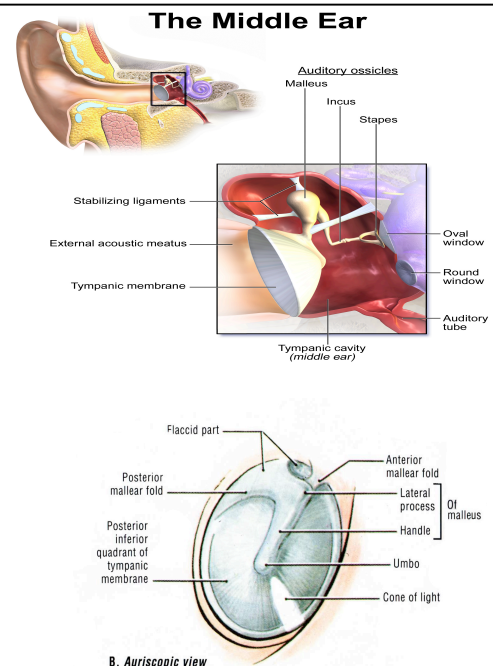
-The Stapes receives the insertion of stapedius muscle.

-Handle of Malleus receives the insertion of Tensor tympani muscle.

Contraction of the stapedius muscle restrict the movement of the stapes (this consider a physiologic reflex that protects the inner ear from very loud sounds (Attenuation reflex)).

Eustachian tube (Auditory tube):

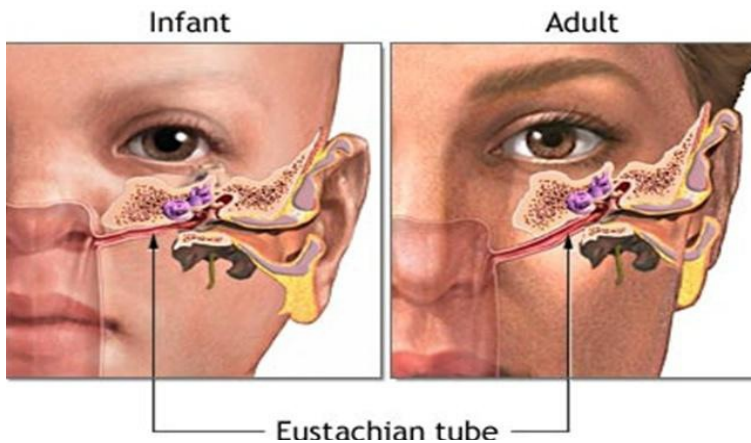
Eustachian tube connects the anterior wall of the tympanic cavity to the nasopharynx. It is lined by ciliated mucosa which helps in clearing the middle ear secretions. It also serves to equalize the pressure in the tympanic cavity with the nasopharynx. It is normally closed at rest, but it opens during swallowing, sniffing and yawning by the action of Tensor veli palatini muscle.



Clinical notes:

- Folliculitis can develop in the cartilaginous part of the auditory canal.
- Otitis externa (OE) causes very severe pain in the bony part because it is very thin and sensitive.
- To examine the ear in adult pull the auricle upward, backward and outward. In children pull the auricle downward, backward and outward.
- The cartilaginous part of the auricle is avascular (no blood vessels), it gets its blood supply from skin's blood vessels. Hence separation of skin from the cartilage will lead to deprivation of cartilage from blood supply, which will cause necrosis very easily.

4 Ear anatomy and physiology (ear 1)



There are differences between the Eustachian tube in kids and adults:
In Children:

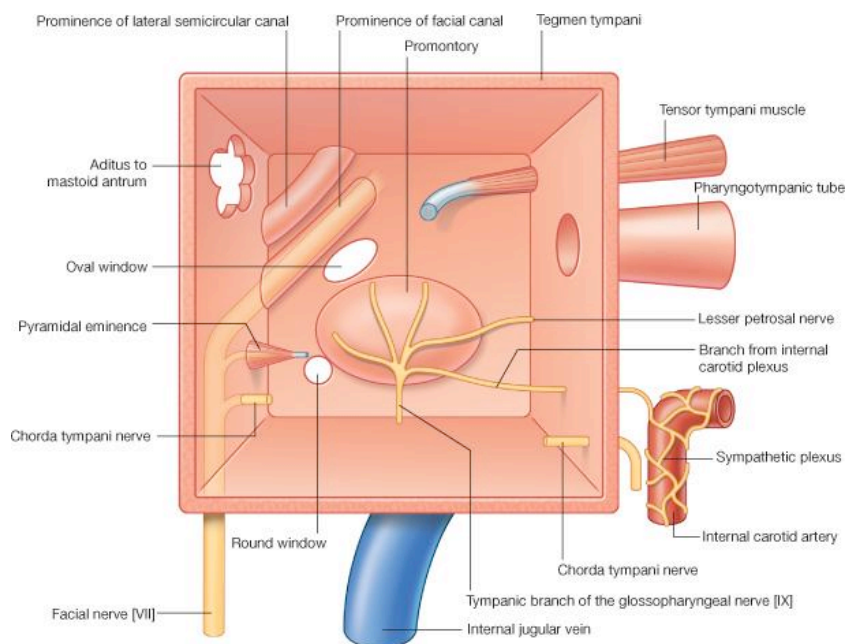
- Longer bony portion
- 10 degree angle (Horizontal)
- Larger isthmus
- Nasopharyngeal orifice
 - Relatively large
 - Obstructed by adenoid
 - Supine (opens)
 - Crying & Sniffing (opens → secretions get in)

Clinical notes:

- The more horizontal the tube is the easier the fluid moves from the nasopharynx to the middle ear (increase incidence of OM in children).
- Adenoid hypertrophy can block the Eustachian tube.

Relations of the middle ear:

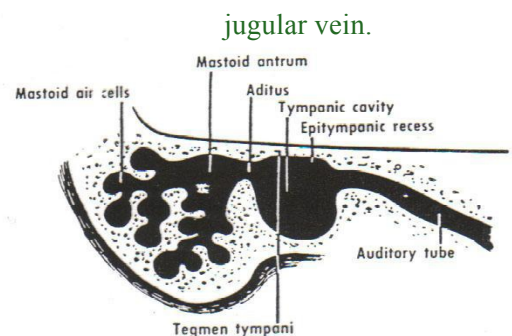
- lateral wall: Tympanic membrane
- Posterior wall: aditus to the mastoid antrum (which communicates with mastoid air cells), tendon of stapedius muscle.
- Medial wall: lateral wall of inner ear, which shows the promontory from the first turn of the cochlea. It also contains the oval window (fenestra vestibule) closed by the footplate of stapes, and the round window (fenestra cochleae) closed by secondary tympanic membrane. Above the promontory there is the prominence of facial nerve canal.
- Anterior wall: thin plate of bone that separates the tympanic cavity from internal carotid artery. It has two opening; the Eustachian tube and canal for the tensor tympani muscle.
- Roof: temporal bone (tegmen tympani), which separates the cavity from the temporal lobe.
- Floor: thin plate of bone which separates the cavity from internal



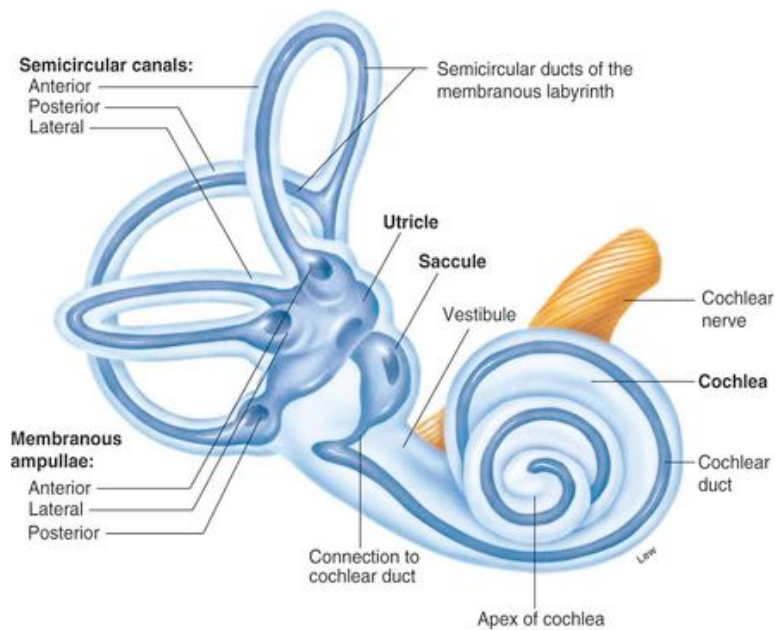
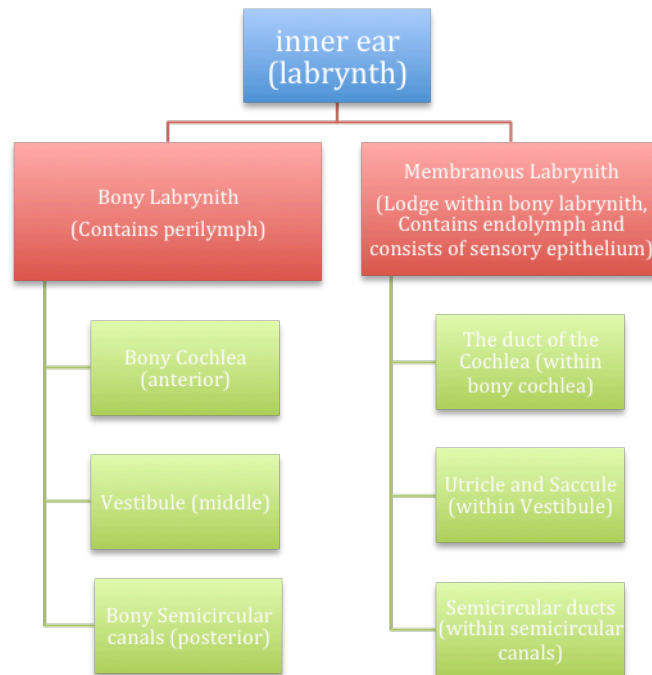
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Mastoid Antrum and Mastoid Air cells:

The mastoid air cells are a series of communicating cavities within mastoid process that continues above with the antrum and the middle ear. They are lined with mucous membrane.



Inner ear: (Labyrinth)



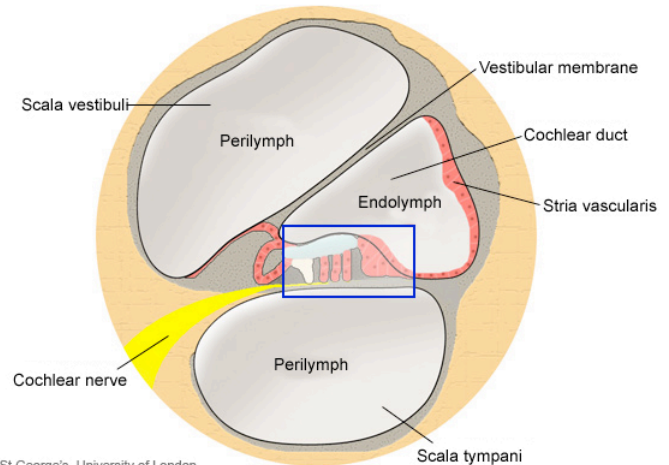
The cochlea lies within the petrous bone which is the strongest bone in our body

Cochlea:

The Cochlea consists of cochlear canals and one cochlear duct (scala media).

There are partitions inside the cochlea: (basilar membrane) that separate it into two parts; upper (Scala Vestibuli) and lower (Scala Tympani).

The perilymph of scala vestibuli is separated from the middle ear by the base of stapes at the fenestra vestibule. The perilymph of scala tympani is separated from the middle ear by the secondary tympanic membrane at the fenestra cochleae.



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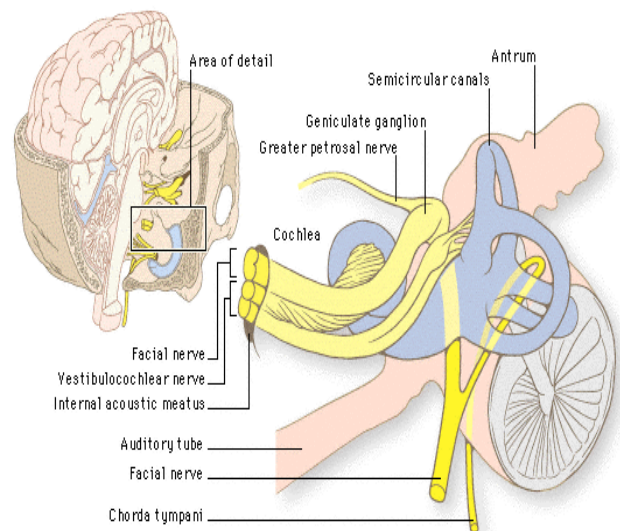
Semicircular canals and duct:

The three semicircular canals (superior, posterior and lateral) are perpendicular to each other and parallel to the other ear. They contain the ducts which open in the posterior part of the vestibule and each one ends with a swelling called the ampulla. Whenever there is a movement of the head (accelerate or decelerate), the endolymph in the semicircular ducts changes its speed of movement relative to that of the walls of semicircular ducts this change is detected in the sensory receptors in the ampulla.

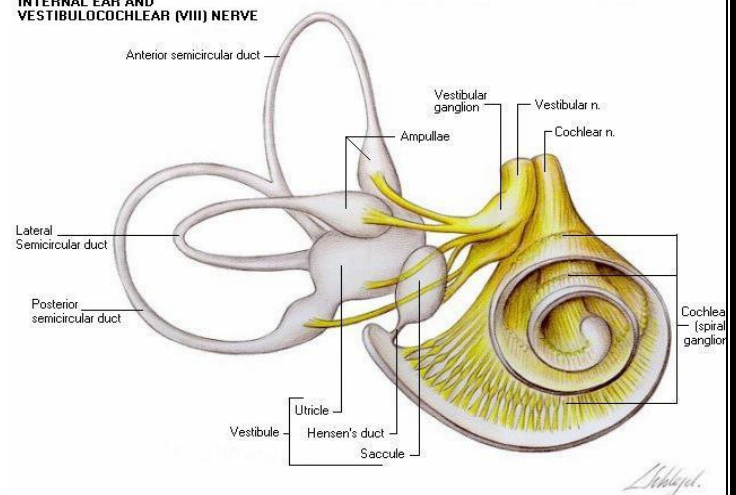
Vestibule, utricle and saccule:

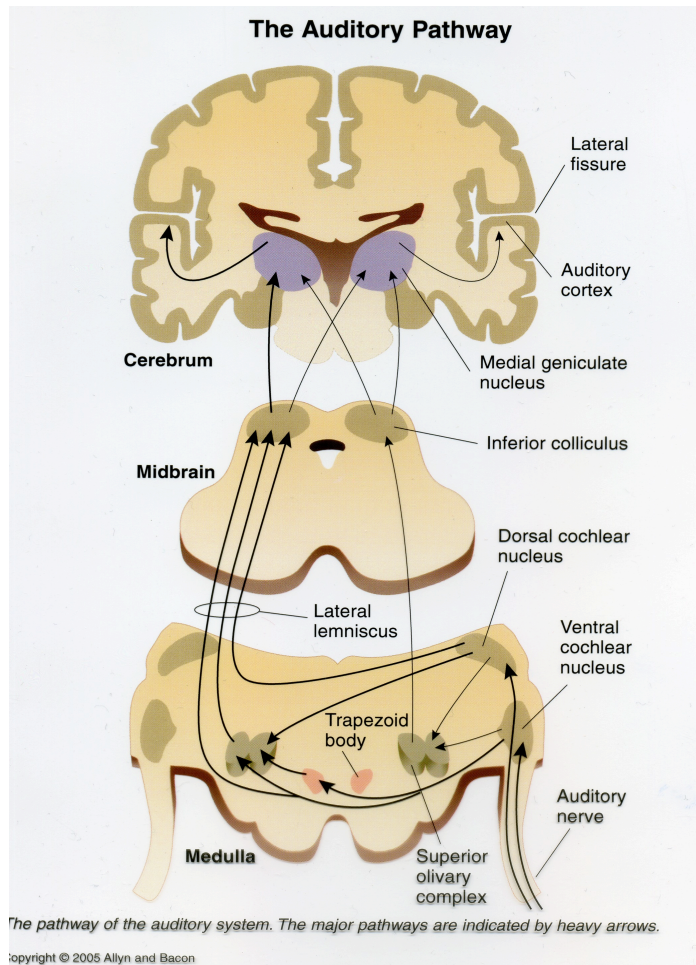
Utricle and saccule are lodged within the vestibule. They are directly connected to each other. They contain specialized sensory receptors which are sensitive to the orientation of the head to gravity or other acceleration forces.

Facial nerve is very close to the inner ear. There is a high risk of facial nerve paralysis in some surgeries such as cochlear implant. It comes out from the pons (cerebellopontine angle) then it enters the external auditory canal after that it enters the middle ear and runs through the parotid.

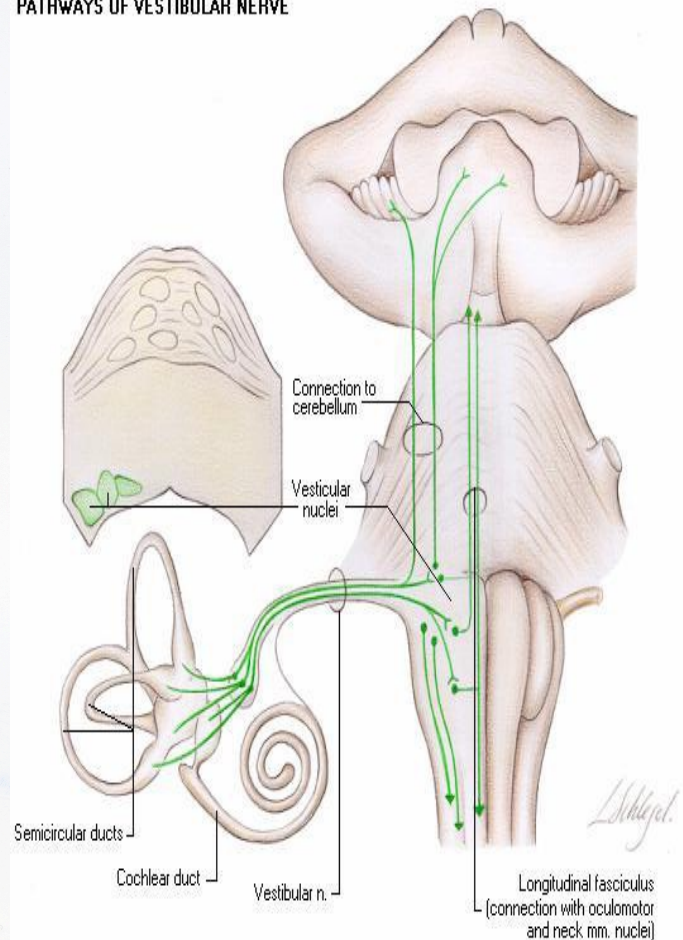
**vestibulocochlear nerve (CN VIII):****Clinical notes:**

- Itching in the nose from allergy can refer to the distribution of the trigeminal nerve involving the ear
- While examining the ear the patient may cough because of the stimulation of CN IX. Or he may have Vaso-Vagal attack because of the stimulation of CN X, that's why the patient usually has to lie down during cleaning or dewaxing.
- Great auricular nerve passes through the parotid gland which may be injured during parotid surgery (parotidectomy) resulting in loss of sensation of the lobule of the auricle which can lead to frostbite in cold weather.

INTERNAL EAR AND VESTIBULOCOCHLEAR (VIII) NERVE



PATHWAYS OF VESTIBULAR NERVE



Cochlear nucleus → midbrain → cochlear cortex (bilaterally)

Clinical notes:

When someone has brain tumor in one side of the auditory cortex the other side will still work and hearing will not be affected.

Nerve supply:

Motor:

- Tensor tympani muscle → trigeminal nerve (CN V)
- Stapedius muscle → facial nerve (CN VII)

Sensory:

External ear:

- Auriculotemporal nerve → trigeminal nerve CN V
- Auricular → vagus CN X
- Great auricular and lesser occipital → cervical II & III

Middle ear:

- Tympanic nerve → glossopharyngeal nerve CN IX

Arterial supply:

- Superficial temporal
- Posterior auricular

Venous drainage:

- Superficial temporal
- Posterior auricular veins

Lymphatic drainage:

- External ear: Parotid, deep cervical lymph nodes.
- Middle ear: Retropharyngeal lymph nodes.

Physiology of the ear:

Functions of the external ear:

1- Auditory functions → Sound collection & conduction

2- Protection of the middle ear:

- Curvature

- Cerumen (Wax)

- Hairs

Functions of the middle ear:

1. Conduction and amplification of sound

2. Protection of the inner ear (Stapedius reflex)

Functions of the inner ear:

1- Hearing Function (Cochlea): Transduction of sound to action potentials.

2- Vestibular Function (semicircular canals, Utricle and saccule): Participate in maintaining body balance

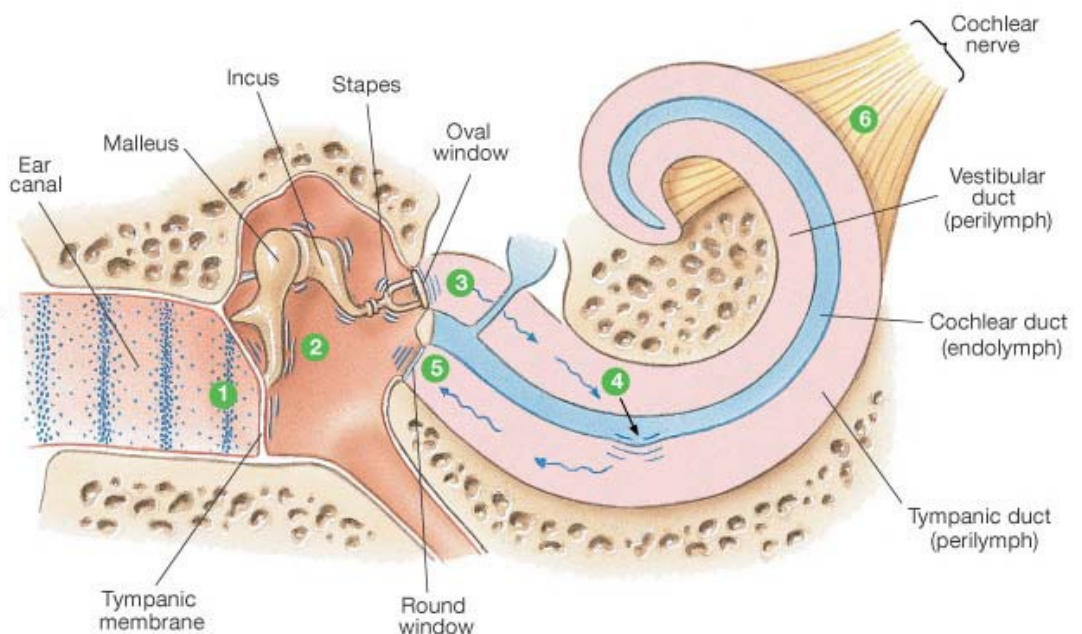
Types of Spatial Movement:

Rotational -3 degrees of freedom → Semicircular Canals

Translational -3 degrees of freedom → Otolith Organs (utricle+ saccule)

The vestibular nerve is always in a firing level but it goes up with acceleration and down with deceleration.

- 1 Sound waves strike the tympanic membrane and become vibrations.
- 2 The sound wave energy is transferred to the three bones of the middle ear, which vibrate.
- 3 The stapes is attached to the membrane of the oval window. Vibrations of the oval window create fluid waves within the cochlea.
- 4 The fluid waves push on the flexible membranes of the cochlear duct.
- 5 Energy from the waves transfers across the cochlear duct into the tympanic duct and is dissipated back into the middle ear at the round window.
- 6 Hair cells within the cochlear duct create action potentials in the sensory neurons of the cochlear nerve.

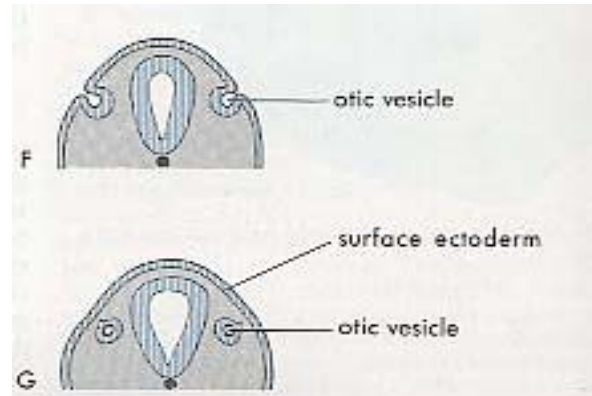
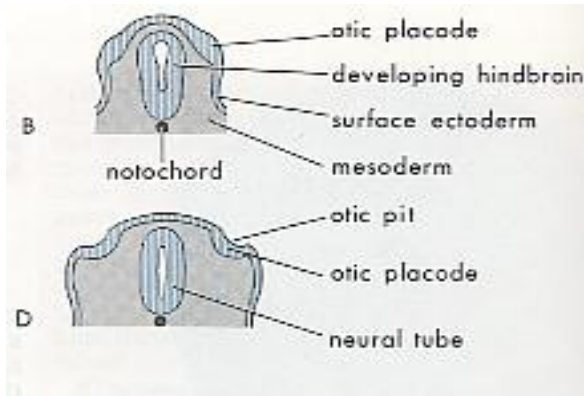


Embryology of the ear:

The ear starts to develop in the 4th week.

Clinical notes:

-ingestion of Drugs such as Antibiotics after the 9th week will not affect the development of the ear because it will be



External ear development:

6 auricular hillocks

- The pinna
 - Initially develops in the neck.
 - The growth of the Mandible ascends the ear to the level of the eyes.
- Part of the auricle originating from
 - 1st branchial arch (innervated by CN V)
 - 2nd branchial arch (innervated by CN VII)

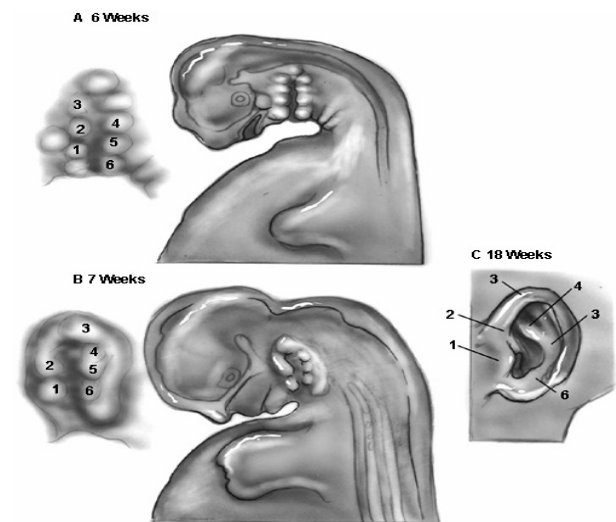
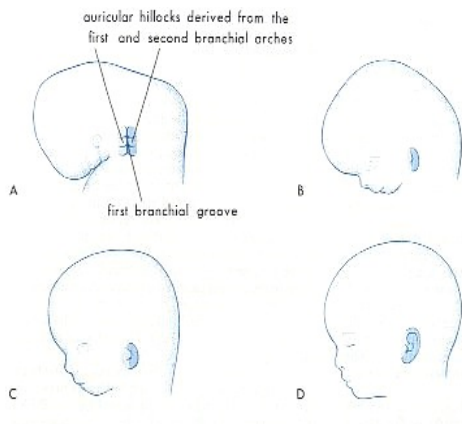
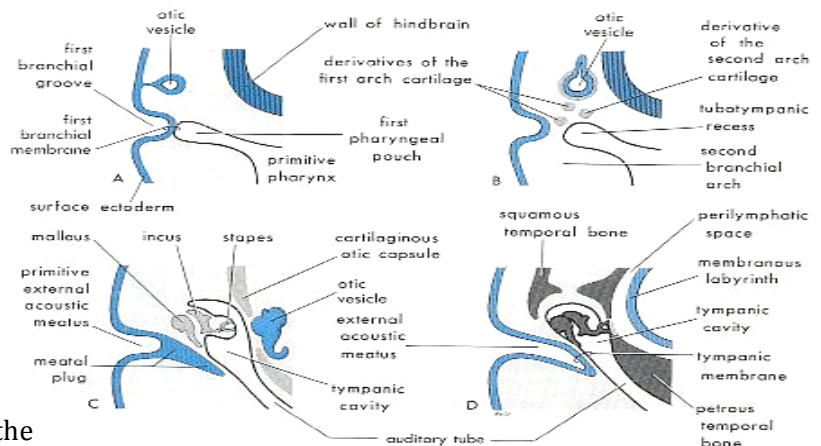


FIG. 5-1. Development of the auricle. A: Six hillocks form on the first and second branchial arches, all are identifiable at 6 weeks. B: Seven-week stage. C: By 18 weeks, the adult form is recognizable.

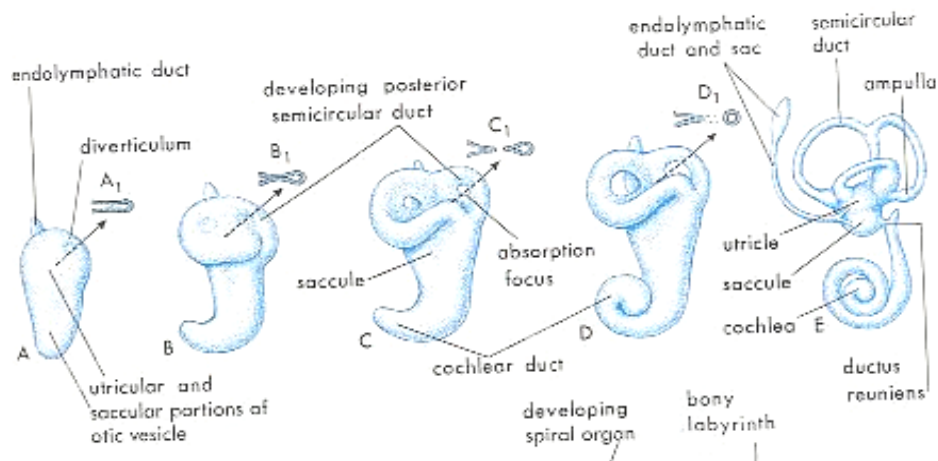
Middle ear development:

1st pharyngeal pouch elongates into the tubotympanic recess. The tubotympanic recess becomes the tympanic cavity and mastoid antrum.

- Distally contacts the 1st pharyngeal cleft
 - TM
- Proximally connects the pharynx → Eustachian tube
 - The tympanic membrane is ectoderm from the outside, endoderm from the inside and mesoderm in between.



Inner ear development:



It is an ectoderm which is thickened and migrates. First it starts as a sac that develops until it forms the cochlea and semicircular canals, this development can stop at any stage and can be detected by CT scan.

Otic vesicle:

- Invaginates of mesenchyme - Detaches from ectoderm
- Divides into 2 regions:
 - 1) Utricular portion
 - Utricle - Semicircular canals
 - 2) Saccular portion
 - Saccule - Cochlea

Good luck =)