

CHAPTER



Otology and Neurotology

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ANATOMY, EMBRYOLOGY, AND PHYSIOLOGY OF HEARING AND BALANCE

External Ear and Temporal Bone Anatomy and Embryology

Auricle

- **Embryology:** around the sixth week of gestation, the external ear arises from the proliferation of mesenchymal cells from the first and second branchial clefts
 1. **First Branchial (Pharyngeal) Arch (Mandibular Arch/Meckel's Cartilage):** derives **Hillock of His 1–3** (1. tragus; 2. helical crus; 3. helix)
 2. **Second Branchial (Pharyngeal) Arch (Hyoid Arch/Reichert's Cartilage):** derives **Hillock of His 4–6** (4. antihelix crus; 5. antihelix; 6. lobule and antitragus)
- auricle is 85% of adult size at 3 years, full adult size at 5 years
- auricle is constructed from a framework of elastic cartilage and perichondrium with tightly adherent skin anteriorly and more loosely adherent skin posteriorly
- attachment of the auricle to the skull is by ligaments (anterior, posterior, and superior ligaments), muscles (anterior, posterior, and superior auricular muscles), skin, and the cartilage of the EAC
- **Darwin's Tubercle:** small protuberance that may arise from the posterosuperior helix around 6 months of gestation

External Auditory Canal (EAC)

- **Embryology:** **first branchial groove (cleft)** forms the EAC; in the embryo the EAC fills with epithelial cells that recannulize by apoptosis in a medial to lateral direction around the seventh month (failure of recannulization results in aural atresia, arrest of canalization may result in a normal bony EAC but an atretic membranous EAC with canal cholesteatoma due to trapped squamous debris)
- **Cartilaginous EAC:** lateral 1/3, fibrocartilage, contains pilosebaceous units (cerumen glands, hair follicles, sebaceous glands; thus furuncles and sebaceous cysts may develop)
- **Osseous EAC:** medial 2/3, periosteum, is tightly adherent to the skin, contains no subcutaneous tissue
- **Boundaries:** infratemporal fossa, bony wall of the mastoid cavity, parotid and temporomandibular joint (TMJ), tympanic membrane (TM), epitympanum
- **Sensory Contributions to the Auricle and EAC:** **CN V₃** (EAC, TM, middle ear), **CN VII** (posterior concha, EAC), **CN IX** (Jacobson's nerve, with Arnold's nerve forms tympanic plexus on the promontory), **CN X** (Arnold's nerve, concha, and antihelix), **great auricular nerve** (cervical plexus), and **lesser occipital nerve**
- **Fissures of Santorini:** lymphatic channels that connect the **lateral** cartilaginous EAC to the parotid and glenoid fossa region, allow for extension of infection and malignant tumors
- **Foramen of Huschke:** embryologic remnant that forms a defect that connects the **medial** EAC to the parotid and glenoid fossa region, allows for extension of infection and malignant tumors outside the temporal bone

Tympanic Membrane (TM, Figure 8–1)

- **Embryology and the Formation of the Three Layers**
 1. **First Branchial Groove (Cleft) (Ectoderm):** forms the **outer epidermal squamous** layer of the TM and the EAC
 2. **Mesoderm:** forms the **middle fibrous** layer of the TM (subdivided further into a radial outer and circular inner layer)
 3. **First Branchial Pouch (Endoderm):** forms the **inner mucosal** layer of the TM, eustachian tube, and middle ear space
- **Pars Flaccida (Shrapnell's Membrane):** superior portion of the TM, located in the notch of Rivinus, less stiff, sparse disorganized middle fibrous layer
- **Pars Tensa:** larger, stiff, vibrating surface of the TM, organized middle fibrous layer

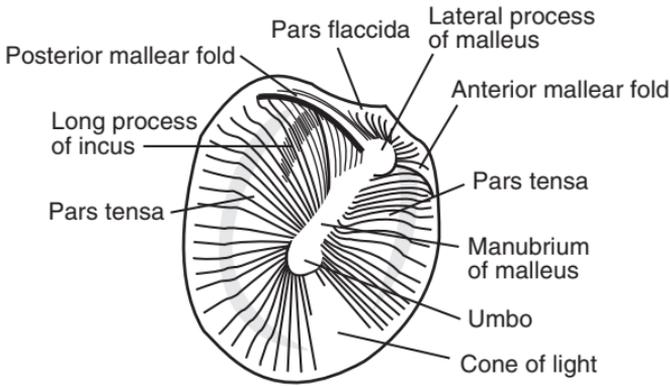


FIGURE 8-1. Anatomy of the tympanic membrane.

- **Malleolar Folds (Tympanic Striae):** run from the lateral (short) process of the malleus to the tympanic spine, composed of anterior and posterior components, divides the pars flaccida from the pars tensa
- **Fibrous Annulus:** thickened circumference of the pars tensa forming a fibrous outer ring for attachment to the temporal bone, lies within tympanic sulcus except where superiorly deficient at the notch of Rivinus
- **Notch of Rivinus:** notch of the squamous portion of the temporal bone located superiorly, within which the pars flaccida attaches directly to the squamous temporal bone

Mastoid Cavity

- **Development:** antrum present at birth, increases in size during first year; pneumatization continues into childhood; mastoid fully developed by 3 years
- **Tegmen Mastoidium:** thin plate of bone that serves as the roof of the mastoid cavity, separating it from the middle fossa dura
- **Sinodural (Citelli's) Angle:** region between the sigmoid sinus and the tegmen mastoidium
- **Koerner's (Petrosquamous) Septum:** bony plate that separates the squamous and petrous air cells
- **Mastoid Antrum:** first air cell that allows communication between the middle ear and the mastoid air cells
- **Facial Recess:** triangular space bounded by the short process of the **incus** (fossa incudis) superiorly, **facial nerve** medially, and **chorda tympani** laterally (from its branching off of the facial nerve); potential route to the mesotympanum

- **Donaldson's Line:** imaginary line from the lateral semicircular canal bisecting perpendicularly the posterior semicircular canal, marks the superior limit of where the endolymphatic sac is found
- **Trautmann's Triangle:** bordered by the bony labyrinth, sigmoid sinus, and tegmen mastoideum

Surface Anatomy of the Temporal Bone

- Four Major Parts of the Temporal Bone
 1. **Petrous:** houses inner ear, medially ends in an apex
 2. **Mastoid:** houses air cells
 3. **Squamous (Squama):** large superolateral plate, includes posterior zygomatic arch
 4. **Tympanic:** includes majority of bony EAC

Lateral Surface

- **Temporal Line:** bony ridge for the attachment of the temporalis muscle fascia, important landmark in mastoid surgery as it identifies the superior limit of the mastoid dissection and suggests the level of the tegmen
- **Spine of Henle:** eminence located near the posterosuperior wall of the EAC to which the soft tissue of the EAC attaches, important anterior landmark in mastoid surgery as it identifies the beginning of the bony EAC
- **Tympanomastoid Suture Line (Fissure):** located posteriorly in the EAC, divides the tympanic and mastoid portions of the temporal bone, reliable landmark used in finding CN VII exit the skull during parotidectomy
- **Tympanosquamous Suture Line (Fissure):** embryonic fusion plane oriented anterosuperiorly in the EAC, divides tympanic and squamous portions of the temporal bone
- **Macewen's (Suprameatal) Triangle (Fossa Mastoidea):** bordered by the temporal line, spine of Henle, and a line connecting the two; aids in identifying the antrum, which lies deep beneath

Superior Surface (Floor of Middle Cranial Fossa)

- **Arcuate Eminence:** bulging landmark of the superior semicircular canal
- **Foramen Lacerum:** contains the internal carotid artery
- **Facial Hiatus:** contains the greater (superficial) petrosal nerve
- **Tympanic Canaliculus:** superior part contains the lesser (superficial) petrosal nerve, inferior part contains Jacobson's nerve