Anatomy of the Ear, Nasal Cavity, Pharynx and Larynx

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Objectives

1. Describe the nasal cavity, its general morphology including the walls, openings, nasal septum, conchae, and meatuses.

2. Describe and identify the named portions of the pharynx, and important anatomical features of each.

3. Describe the important anatomical features and innervation of the external, middle, and inner ear.

4. Describe the sensory innervation of the nasal cavity, and the sensory and motor innervation of the glossopharyngeal and vagus nerves related to the pharynx and larynx.
The Ear

- **External**
  - Auricle
  - External acoustic meatus

- **Middle**
  - Tympanic cavity
  - Pharyngotympanic tube

- **Internal**
  - Bony labyrinth
  - Membranous labyrinth
External Acoustic Meatus

- Extends from auricle to tympanic membrane
- Length ≈ 1 inch (2.5 cm)
- Cartilage externally (⅓), then bone (⅔)
- Ceruminous (modified sweat glands) glands secrete cerumen
- Not straight in adults
- Need to pull ear superiorly, posteriorly, and laterally
- Sensory – auriculotemporal n. (CN V₃) and vagus (CN X)
• Tilted anteriorly and inferiorly
• Skin (stratified squamous epithelium) on outside
• Mucous membrane (simple cuboidal) on inside
• Handle of malleolus is attached to inner surface
• Flaccid area superiorly
• Sensory innervation of surfaces:
  • Outer – auriculotemporal (V₃), facial (VII), and vagus (X)
  • Inner – Glossopharyngeal (IX)
Middle Ear

Auditory Ossicles
- Malleus – attached to tympanic membrane
- Incus
- Stapes – footplate attached to oval window

Pharyngotympanic Tube
- AKA auditory tube, Eustachian canal
- Connects anterior part of middle ear cavity with nasopharynx
Middle Ear Ossicles

- Ossicles are suspended from walls of tympanic cavity by ligaments
- Ossicles articulate with each other through synovial joints
- Footplate of stapes articulates with temporal bone at the oval window – stabilized by the annular ligament
Pharyngotympanic Tube

- Connects tympanic cavity with nasopharynx
- Lateral ⅓ – bony; medial ⅔ – cartilaginous
- Lined by mucous membrane
- Enables middle ear cavity to equalize pressure with atmospheric pressure
Children more prone to middle ear infections (Otitis Media)

- Thought to be due to auditory tube being shorter and in a more horizontal position
- Fluids from nasopharynx can more easily flow into tympanic cavity
Mastoid Air Cells
Middle Ear Muscles

Attached to malleus
Innervation - V₃

Attached to stapes
Innervation - VII

Function is to reduce the vibration of the ossicles to dampen (decrease) the intensity of the pressure waves going to the inner ear.
Middle Ear Innervation

• Tympanic branch of CN IX enters floor of middle ear
• Forms plexus on medial wall – *tympanic plexus*
• Innervates all the mucous membrane of middle ear, mastoid air cells, pharyngotympanic tube
• *Lesser petrosal n.* leaves cavity to provide parasympathetic innervation of parotid gland
Facial Nerve (CN VII) Relationship to Ear

- Facial n. travels in bony canal between middle and inner ear
- Gives off greater petrosal n. – parasympathetic to lacrimal gland
- Gives off branch to stapedius m.
- Gives off chorda tympani n.
- Chorda tympani n. travels through middle ear cavity
  - Parasympathetic to salivary glands
  - Taste from anterior 2/3 tongue
- Exits skull through stylomastoid foramen
Middle Ear Cavity

Middle cranial fossa

Epitympanic recess

Tegmen tympani

Malleus
Incus
Stapes

Chorda tympani

Tensor tympani

Tympanic membrane

Lesser petrosal nerve

Prominence of lateral semicircular canal

Facial nerve

Aditus to mastoid antrum (forming posterior wall)

Prominence of canal for facial nerve

Tympanic plexus on promontory of labyrinthine wall

Stapedius

Pyramidal eminence

Tympanic nerve (from CN IX)

Walls of tympanic cavity:

- Tegmental wall (roof)
- Jugular wall (floor)
- Membranous (lateral) wall
- Labyrinthine (medial) wall
- Mastoid (posterior) wall

Carotid (anterior) wall was removed to provide this view

Moore Fig 7.114
Located in petrous portion of temporal bone, lateral and posterior to internal acoustic meatus
Inner Ear

- **Bony labyrinth**
- **Membranous labyrinth**
- **VII and VIII cranial nn.**

- **Auditory** – converts sound waves to action potentials that are sent to CNS

- **Vestibular**- senses gravity and head movement, converts to action potentials sent to CNS
Bony Labyrinth

Hollowed-out areas of temporal bone
Contains membranous labyrinth
- Semicircular canals
- Semicircular ducts
- Vestibule
  - Utricle
  - Saccule
- Bony cochlea
  - Cochlear duct
Bony Cochlea

Located in the petrous portion of the temporal bone

Gilroy Fig 43.20C, p. 596
Membranous Labyrinth

Semicircular ducts connected to utricle; utricle connected to saccule; saccule connected to cochlear duct – contains **endolymph**

**Perilymph** is in bony cavity surrounding membranous labyrinth
Membranous Labyrinth - Vestibular

- Ampullae are swellings in semicircular ducts
- Ampullae contain **cristae** – sensory receptors

Utricle and saccule contain **maculae** – sensory receptors

Gilroy Fig 43.20A, p. 596
Vestibular Inner Ear

Two sets of sensory receptors:

- **Semicircular Ducts (3)** – sense rotation of head in all planes
  - Receptors – **cristae**

- **Utricle** and **Saccule** – sense linear acceleration and deceleration of the head, sensitive to force of gravity
  - Receptors - **maculae**
Ampullary crest (crista) contains hair cells with cilia embedded in gelatinous cupula attached to roof of duct.

Head movement causes fluid (endolymph) to push against cupula, which is deformed like a sail.

Movement of cupula bends cilia on hair cells.
Maculae are the specialized portion of the wall of utricle and saccule.
Cilia of hair cells project into gelatinous otoconial membrane.
Small calcium crystals (otoconia) on surface of the membrane.
Sense gravity and linear movements of head.
Cochlear Duct

- Contains endolymph
- Lies between scala tympani and scala vestibuli
- Pressure waves travel up and down the scala and vibrate the basilar membrane
- Organ of Corti (spiral organ) sits on basilar membrane
Inner Ear Cross Section

- Organ of Corti sits on basilar membrane
- Tectorial membrane – gelatinous membrane over hair cells
- Cilia on surface of hair cells project into tectorial membrane
• Vibration of basilar membrane causes stereocilia to bend on hair cells
• Deflection of stereocilia initiates receptor potential in hair cells
• Hair cells depolarize cochlear nerve endings on hair cells
• Action potential sent to brainstem cochlear nuclei
Organ of Corti Frequency Sensitivity

Highest frequency sounds – vibrate base of basilar membrane
Lowest frequency sounds – vibrate apical region of membrane
Sound Conduction to Inner Ear

External Ear - collects sound waves
Middle Ear - converts to vibrations
Inner Ear - converts vibrations to action potentials
Transmission of Sound

- Stapes moves in and out at oval window
- Sound waves transmitted up scala vestibuli toward helicotrema
- Frequency of sound wave causes specific portion of basilar membrane to vibrate
- Hair cells at that location create action potentials
- Pressure wave travels down scala tympani and pressure released at round window
Nasal Cavity – Nasal Conchae

Conchae divide each nasal cavity into 4 air channels:
- Spheno-ethmoidal recess
- Superior, middle, and inferior meatuses

All sinuses and nasolacrimal duct open into these recesses

Gray’s Fig 8.235B, p. 1079
Nasal Cavity – Sinus Openings

Gray’s Fig 8.235C, p. 1079
Nasal Septum

- Separates nasal cavity into two equal parts
  - Septal cartilage
  - Perpendicular plate of ethmoid bone
  - Vomer bone
- Covered with mucous membrane

Gray’s Fig 8. 232, p. 1076
Deviated Nasal Septum
Roof and Floor of Nasal Cavity

Nasal, frontal, ethmoid, sphenoid bones

Gray’s Fig 8.234, p. 1077

• Maxillary and palatine bones
• Soft palate

Gray’s Fig 8.233, p. 1077
Lateral Walls of Nasal Cavity

Three nasal conchae: Superior and middle (ethmoid bone); Inferior nasal concha – AKA turbinate bones

Gray’s Fig 8.235, p. 1078
Innervation of Nasal Cavity

Gray’s Fig 8.241, p. 1085
Pharynx – Mid-sagittal

Divisions:
- **Naso** – posterior apertures of nasal cavity (choanae) to edge of soft palate
- **Oro** – soft palate to tip of epiglottis
- **Laryngo** – epiglottis to lower edge of cricoid cartilage

Gray’s Fig 8.201A, p. 1047
Floor of Nasal Cavity
Pharynx
Posterior

- Choanae
- Oropharyngeal isthmus
- Laryngeal inlet
- Nasal septum
- Soft palate
- Epiglottis

Gilroy Fig 44.27, p. 613
Larynx – Regions

Superior

- Rima vestibuli – triangular opening between vestibular folds
- Rima glottidis – triangular opening between vocal folds
All innervation is by branches of Vagus n. (CN X)

**Superior laryngeal n.**
- *Internal br.* – sensory innervation of larynx above vocal folds
- *External br.* – motor to cricothyroid m.

**Recurrent laryngeal n.**
- *Sensory* to larynx inferior to vocal folds
- *Motor* to all other intrinsic muscles
- May be referred to as inferior laryngeal n.
Larynx Nerve Supply

- Hyoid bone
- Thyrohyoid membrane
- Cricothyroid
- Thyroid gland
- Superior laryngeal n., internal branch
- Superior laryngeal a. and v.
- Inferior pharyngeal constrictor
- Inferior thyroid a.
- Esophagus
- Left recurrent laryngeal n.

Gilroy Fig 45.28 A & B, p. 635