

# HEAD AND NECK EMBRYOLOGY AND ANATOMY

Kenneth Alonso, MD, FACP

# Embryology

- Parietal and occipital bones derived from paraxial mesoderm.
- All other bones of skull and face are derived from neural crest.
- The pharyngeal arches arise from the dorsal and most cephalic portion of the embryo.
- Each pharyngeal arch is lined externally by ectoderm and internally by endoderm.
- Each arch contains a core of mesenchyme derived from mesoderm and neural crest tissue.

# Embryology

- By the end of the 4<sup>th</sup> week of development, four pairs of pharyngeal arches are visible
- The fifth quickly regresses
- 1-4 and 6 form, but 6 is not visible
- Pharyngeal clefts are found on the ventral surface of the embryo, opposite the arches.
- They arise from ectoderm.
- The first pharyngeal cleft forms the external auditory meatus.
- The second through fourth clefts develop as a communicating invagination of the embryo.
- This will later close as mesenchyme fills the sinus.

# Embryology

- The oropharyngeal membrane develops in a cleft between the two parts of the first arch .
- It is composed of an outer layer of ectoderm and an inner layer of endoderm.
- This membrane eventually ruptures and produces an opening from the pharynx to the amniotic cavity.
- The first membrane forms the tympanic membrane.  
The other membranes regress.

# Embryology

- Pharyngeal pouches arise from the endoderm.
- The first of four pouch pairs gives rise to the tympanic cavity, mastoid antrum, and the auditory tube.
- After birth the tympanic cavity invades the mastoid process.
- The apex of the pharyngo-tympanic tube is attached to the bone, fixed to the base of the skull between the greater wing of the sphenoid and the petrous temporal bone.
- The tensor veli palatini separates it from infra-temporal fossa.
- Some fibers of tensor are attached to the tube.

# Embryology

- The second pouch gives rise to the epithelial lining of the palatine tonsil.
- The third gives rise to the thymus (ventral wings of the pouches) and inferior parathyroid glands (dorsal wings of the pouches).
- The fourth gives rise to the superior parathyroid gland (dorsal wings of the pouches).

# Embryology

- The structures of the pharyngeal arches arise from the mesoderm.
- The first pair of arches receives CN V<sub>3</sub>.
- Muscles of mastication, anterior belly of digastric, myohyoid, tensor tympani, tensor veli palatini muscles; maxillary artery; malleus and incus.
- The second pair of arches receives CN VII.
- Muscles of facial expression, stapedius, posterior belly of digastric, stylohyoid muscles
- Hyoid and stapedial arteries
- Stapes, styloid process, lesser horn and superior portion of the body of the hyoid bone.

# Embryology

- The third pair of arches receives CN IX.
  - Stylopharyngeus muscle
  - Common and internal carotid arteries
  - Greater horn and inferior portion of the body of the hyoid bone.
- The fourth pair of arches receives CN X.
  - Palatal and pharyngeal muscles as well as the cricothyroid muscle.
  - Aortic arch (left) and first portion of subclavian artery (right)
  - Laryngeal cartilage



# Embryology

- The sixth pair of arches receives CN X.
- Muscles of the larynx
- Inferior constrictor, cricopharyngeus muscles
- Superior portion of the esophagus
- Pulmonary artery and ductus (left)
- Laryngeal cartilage.

# Cervical plexus

- Ventral rami of C1-C4.
- Communicate with CN X-CN XII and the sympathetic chain.
- The ansa cervicalis is the loop formed by the cutaneous branches of C1-C3 (great auricular, lesser occipital, transverse cervical, and supraclavicular nerves).
- Muscular branches innervate the diaphragm and pre-vertebral muscles.

# Embryology

- The neural crest within the arches gives rise to cartilage and arteries.
- At the first arch pair, Meckel's cartilage gives rise to the malleus and incus.
- The maxillary artery is at the first arch.
- At the second arch pair, Reichert's cartilage gives rise to the stapes.
- At the third arch pair arise the common carotid arteries.
- The fourth arch pair results in the right subclavian artery and the arch of the aorta on the left.

# Embryology

- The sixth arch pair give rise to the pulmonary arteries.
- The ductus arteriosus arises from the left arch only.

# Embryology

- The tongue arises from the floor of the pharynx.
- Innervation of the tongue is explained by its derivation from the first four arch pairs.
- The thyroid arises from the foramen cecum, located in the midline of the terminal sulcus between the anterior two-thirds and posterior one-third.
- The thyroid migrates along the path of the thyroglossal duct.

# Palate

- The palate arises from the maxillary bone.
- The primary palate is the area of fusion of floor of the maxilla.
- It comprises the philtrum and the four incisor teeth.
- Fusion of the palatine shelf (plates) forms the secondary palate.
- CN V<sub>2</sub> innervates the maxillary teeth; CN V<sub>3</sub>, mandibular teeth.

# Palatal muscles

- The tensor veli palatini tense the soft palate and opens the mouth of the pharyngotympanic tube during yawning and swallowing.
- The levator veli palatini elevate the soft palate during yawning and swallowing. (Say “ah”)
- The palatoglossus elevates the posterior part of the tongue and draws the soft palate onto the tongue.
- The palatopharyngeus tenses the soft palate and pulls the walls of the pharynx superiorly, anteriorly, and medially during swallowing.
- The musculus uvulae shortens the uvula and pulls it superiorly.

# Major fascial layers of the neck

- Investing fascia functions as a collar around the entire neck. Invests the sternocleidomastoid and trapezius muscles.
- Infrahyoid fascia surrounds the four strap muscles.
- Pre-vertebral fascia surrounds the muscles of the vertebral column.
- Alar fascia is the anterior layer of the pre-vertebral fascia (creating a potential space).
- Peri-tracheal fascia lies anterior to the trachea and surrounds the thyroid gland.
- Buccopharyngeal fascia lies posterior to the trachea.



# Major fascial layers of the neck

- The paired carotid sheaths contain the common and internal carotid arteries, the vagus nerves, internal jugular vein, and deep cervical lymph nodes.
- The sympathetic trunk lies posterior to the sheath; the ansa cervicalis lies anterior to the sheath.

# Posterior triangle

- Bounded by the sternocleidomastoid, trapezius, and middle third of the clavicle.
- From the apex, inferiorly, are the semispinalis capitis, splenius capitis, levator scapulae, posterior scalene, middle scalene, and anterior scalene muscles as the triangle floor.
- The inferior belly of the omohyoid forms small supraclavicular and occipital triangles.
- The spinal accessory nerve (CN XI) emerges from behind the sternocleidomastoid in the posterior triangle.
- It innervates both the sternocleidomastoid and the trapezius muscles.

# Posterior triangle

- The great auricular (cutaneous) nerve (C1-C2) parallels the external jugular vein.
- The lesser occipital and transverse cervical (cutaneous nerves) arise from C2-C3.
- The supraclavicular (cutaneous) nerve arises from C3-C4.
- Between the anterior and middle scalene muscles lies the brachial plexus and the subclavian artery.
- Anterior to the anterior scalene muscle lies the phrenic nerve, subclavian vein, and the branches of the thyrocervical artery (suprascapular, transverse cervical, and ascending cervical).

# Anterior triangle

- The midline, mandible, and sternocleidomastoid muscle bound the anterior triangle.
- The sternocleidomastoid, omohyoid, and posterior belly of the digastric form the carotid triangle.
- The sternocleidomastoid, omohyoid, and midline form the muscular triangle.
- The digastric (posterior and anterior bellies) and midline form the digastric triangle.
- The submental triangle is formed by the hyoid bone and the paired anterior bellies of the digastric.

# Anterior neck

- The ascending cervical artery may also arise from the inferior thyroid artery.
- The suprahyoid muscles elevate the hyoid bone and larynx with swallowing.
- The anterior belly of the digastric pulls the hyoid anterior (CN III).
- The posterior belly of the digastric pulls the hyoid posterior (CN VII).
- The stylohyoid (CN VII), geniohyoid (C1 from CN XII), and the mylohyoid muscle of the floor of the mouth (CN V<sub>3</sub>) also insert on the hyoid.

# Anterior neck

- The strap muscles lower the hyoid bone and larynx.
- The thyrohyoid is innervated by C1 from CN XII.
- The sternohyoid, sternothyroid, and omohyoid muscles are innervated by the ansa cervicalis.

# Arterial supply

- The right common carotid arises from the brachiocephalic trunk.
- The left, from the aortic arch.
- The trachea alone lies between the right and left arteries inferiorly.
- Superiorly they are separated by the larynx, thyroid, and pharynx.
- The common carotid usually bifurcates at the level of C3.
- The carotid body and sinus are innervated by CN IX and CN X.

# External carotid

- The superior thyroid gives off the superior laryngeal artery as well as supplying the thyroid gland.
- The ascending pharyngeal also supplies the superior portion of the thyroid.
- The lingual may arise with the facial artery.
- It runs deep to the stylohyoid and hyoglossus muscles.
- Its branches supply the tongue and floor of the mouth.
- The facial supplies the submandibular gland, palatine tonsil, and face.
- The ascending palatine branch also supplies the pharynx.



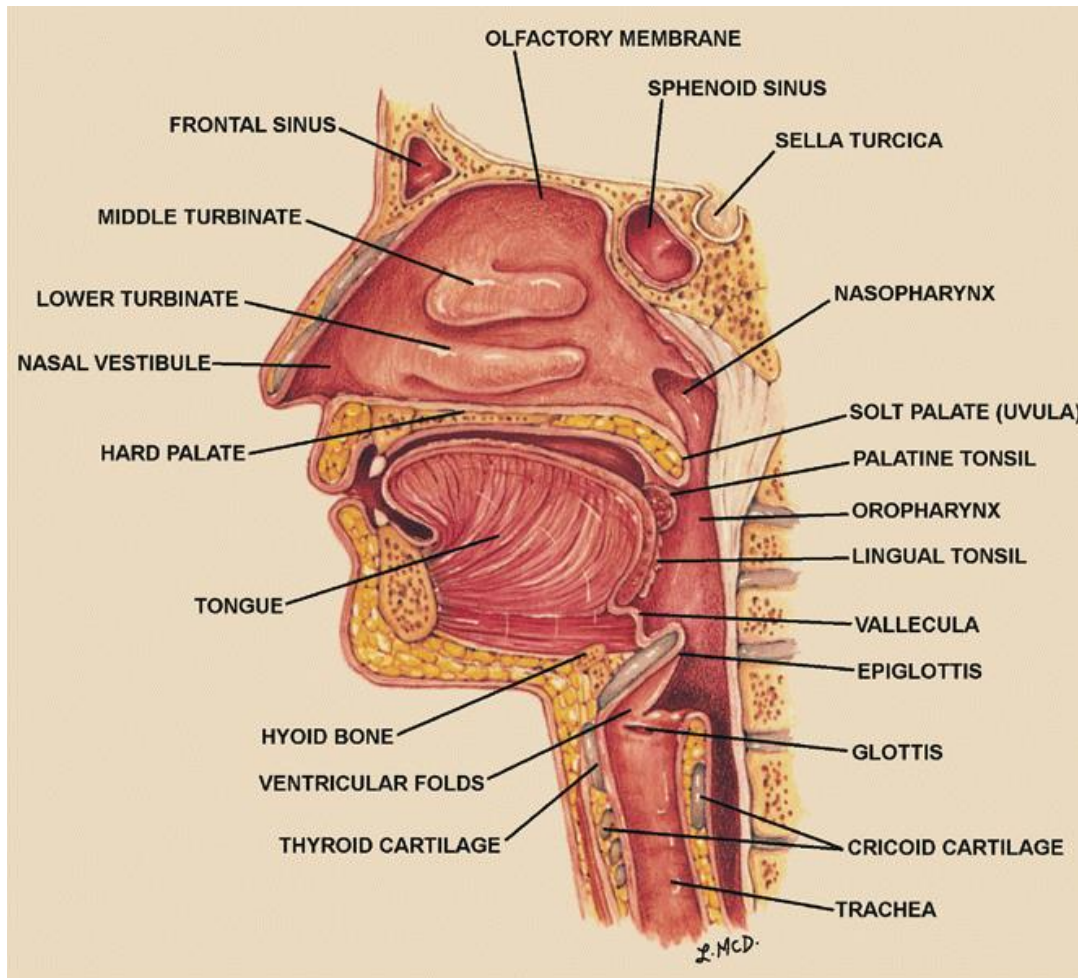
# External carotid

- The occipital artery supplies the posterior scalp; the posterior auricular supplies the scalp and ear.
- The superficial temporal also sends a branch to the scalp.
- The maxillary artery is the chief branch of the external carotid and supplies the deep structures of the head.
  - It runs deep to the mandible.
  - Its descending palatine branch supplies the pharynx.

# Internal jugular vein

- The vein is a continuation of the sigmoid sinus and forms at the inferior aspect of the jugular foramen.
- The vein runs within the carotid sheath.
- The vein receives the pharyngeal, facial, lingual, superior and middle thyroid veins.
- The internal jugular vein ends by joining the subclavian vein to form the brachiocephalic vein.

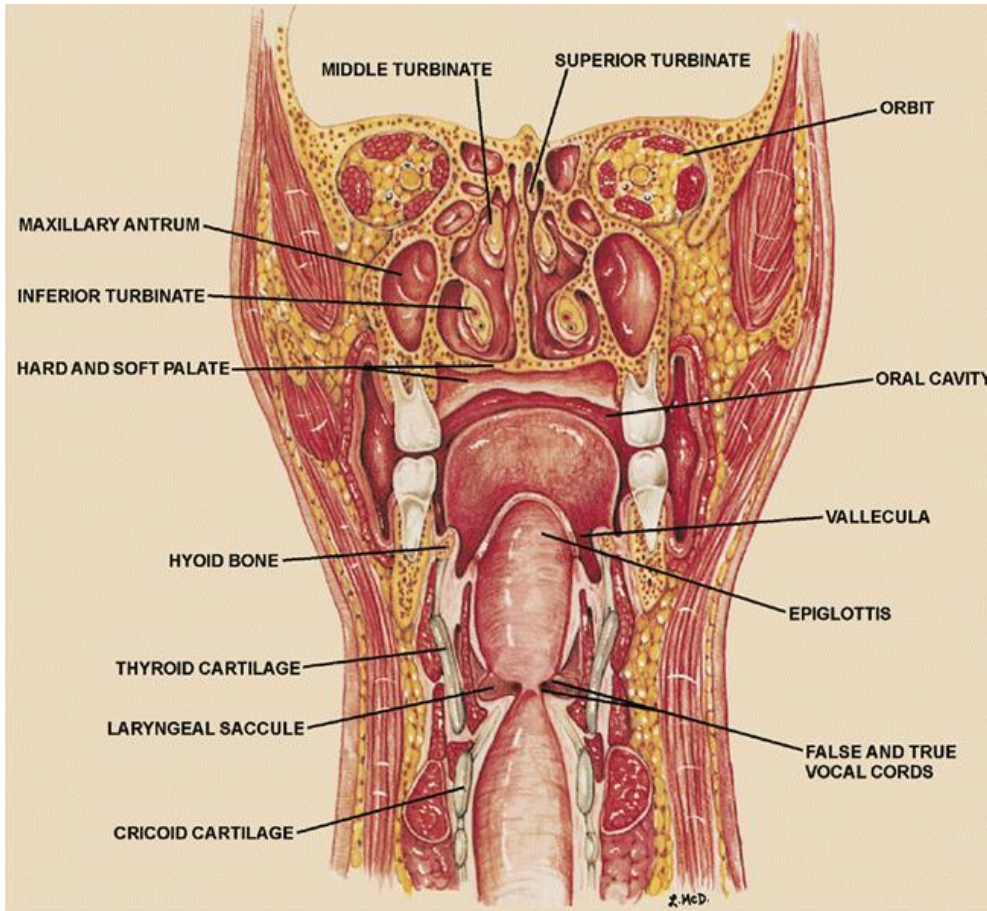
# Anatomy



A sagittal section through the head at the level of the molar teeth.

Mills, SE, Gaffey, MJ, Frierson, HF. , "Tumors of the upper aerodigestive tract and ear." Atlas of Tumor Pathology, Third Series, Fascicle 26. Fig. 1-1. Armed Forces Institute of Pathology, Washington, D.C. 2006.

# Anatomy



A coronal section through the head at the level of the molar teeth.

Mills, SE, Gaffey, MJ, Frierson, HF. ,  
"Tumors of the upper aerodigestive tract and ear." Atlas of Tumor Pathology, Third Series, Fascicle 26. Fig. 1-2  
Armed Forces Institute of Pathology, Washington, D.C. 2006.

# Anatomic limits

- The oral cavity extends from the skin-vermilion junctions of the anterior lips to the junction of the hard and soft palates above and to the line of circumvallate papillae below and is divided into the following specific areas:
  - Lip.
  - Anterior two thirds of tongue.
  - Buccal mucosa.
  - Floor of mouth.
  - Lower gingiva.
  - Retromolar trigone.
  - Upper gingiva.
  - Hard palate.

# Anatomic limits

- The oropharynx is divided into the following parts:
- Base of the tongue, which includes the pharyngoepiglottic folds and the glosso-epiglottic folds.
- Vallecula.
- Tonsillar region, which includes the fossa and the anterior and posterior pillars.
- Soft palate, which includes the uvula.
- Posterior and lateral pharyngeal walls.

# Anatomic limits

- The hypopharynx extends from the plane of the hyoid bone above to the plane of the inferior border of the cricoid cartilage below.
- The hypopharynx is composed of:
  - The pyriform sinus.
  - The postcricoid area.
  - The posterior pharyngeal wall.
- It does not include the larynx

# Anatomic limits

- The larynx is divided into the following three anatomical regions:
- The supraglottic larynx includes the epiglottis, false vocal cords, ventricles, aryepiglottic folds, and arytenoids.
- The glottis includes the true vocal cords and the anterior and posterior commissures.
- The subglottic region begins about 1 cm below the true vocal cords and extends to the lower border of the cricoid cartilage or the first tracheal ring.



# Pharynx

- The nasopharynx is bounded by the base of the skull to the soft palate (level of C2).
- It communicates with the paired nasal cavities, eustachian tubes, and oropharynx.
- The oropharynx communicates as well with the laryngopharynx.
- The laryngopharynx communicates with the larynx and esophagus as well.
- Extends to level of C6.

# Waldeyer's ring

- The palato-glossal and palato-pharyngeal arches form the palatine tonsil, located between the anterior and posterior tonsillar pillars.
- The lingual tonsil is found on the dorsum of the tongue.
- The pharyngeal tonsil is found in the posterior nasopharynx (adenoids).
- The lateral pharyngeal band (tubal) tonsils are near the opening of the eustachian tube.

# Muscles of the pharynx

- The stylopharyngeus (CN IX), salpingopharyngeus, and palatopharyngeus muscles are longitudinal muscles of the pharynx.
- The superior constrictor arises from sphenoid and mandible.
- Above the muscle is the auditory tube and levator palatini.
- CN IX and the styloglossus are inferior to the superior and middle constrictor muscles.
- The middle constrictor arises from the hyoid.

# Muscles of the pharynx

- Between the middle and inferior constrictor muscles, through the thyrohyoid membrane runs the superior laryngeal artery and the internal laryngeal nerve.
- The inferior constrictor arises from the thyroid and cricoid cartilages.
- The cricopharyngeus muscle is innervated by the recurrent laryngeal nerve.
- The inferior laryngeal artery and the recurrent laryngeal nerve are found below the inferior constrictor.
- The pharyngobulbar fascia lies deep to the submucosa of the pharynx.
- The muscles are covered by the bucco-pharyngeal fascia.

# Tongue

- The hyoglossus depresses the tongue.
- The styloglossus elevates and retracts the tongue.
- The anterior fibers of the genioglossus protrude the tongue; the posterior fibers retract the tongue.
- All are innervated by CN XII.
- The palatoglossus elevates the tongue (CN X).
- The lingual nerve (CN V<sub>3</sub>) provides general sensation to the anterior two-thirds of the tongue while the chorda tympani (CN VII) provides taste sensation.
- All sensation to the posterior third of the tongue is from CN IX. All sensation to the area about the epiglottis is from CN X.

# Suprahyoid muscles

- The mylohyoid elevates the hyoid, floor of mouth, and tongue during swallowing and speaking. (CN V)
- The geniohyoid pulls the hyoid antero-superiorly, shortening the floor of the mouth and widening the pharynx. (CN XII)
- The stylohyoid elevates and retract the hyoid, elongating the floor of the mouth. (CN VII)
- With the infrahyoid muscles, the digastric depresses the mandible against resistance.
- It elevates and steadies the hyoid during swallowing and speaking. (anterior, CN V; posterior, CN VII)

# Infrahyoid muscles

- The sternohyoid depresses the hyoid after elevation during swallowing. (ansa cervicalis)
- The omohyoid depresses, retracts, and steadies the hyoid. (ansa cervicalis)
- The sternohyoid depresses the hyoid and larynx. (ansa cervicalis)
- The thyrohyoid depresses the hyoid and elevates the larynx. (CN XII)

# Larynx

- Thyroid cartilage is unpaired.
- Vocal cords attached to posterior surface.
- Cricoid cartilage is unpaired.
- Shaped as a signet ring.
- The only complete ring.
- The arytenoid cartilage is paired. Articulates with cricoid.
- The internal branch of the superior laryngeal nerve pierces the thyrohyoid membrane and provides sensory innervation to the larynx superior to the vocal cords.
- The recurrent laryngeal nerve provides sensory innervation to the infraglottic area.



# Larynx

- The conus elasticus is a fibro-elastic membrane that unites cricoid, thyroid, and arytenoid cartilages.
- It includes the medial and lateral cricothyroid ligaments as well as the vocal cords.
- The vestibule is the region superior to the false cords.
- The ventricle is the region between the false and true cords.
- The rima glottidis is the opening between the vocal cords.

# Muscles of the larynx

- Cricothyroid muscle only muscle to increase tension on vocal cords.
- Motor innervation by external branch of superior laryngeal nerve (CN X).
- The thyroarytenoid relaxes the vocal ligament.
- The lateral cricoarytenoid adducts the vocal folds.
- The posterior cricoarytenoid muscle is the only muscle to abduct the vocal cords.

# Muscles of the larynx

- The transverse and oblique arytenoid muscles adduct the arytenoid cartilages, closing the posterior rima glottidis.
- Antagonize cricothyroid muscle.
- Innervated by recurrent laryngeal nerve.
- The vocalis relaxes the posterior vocal ligament while tensing the anterior part.