بِسْمِ اللَّهِ الرَّحْمَـٰنِ الرَّحِيم

The Larynx

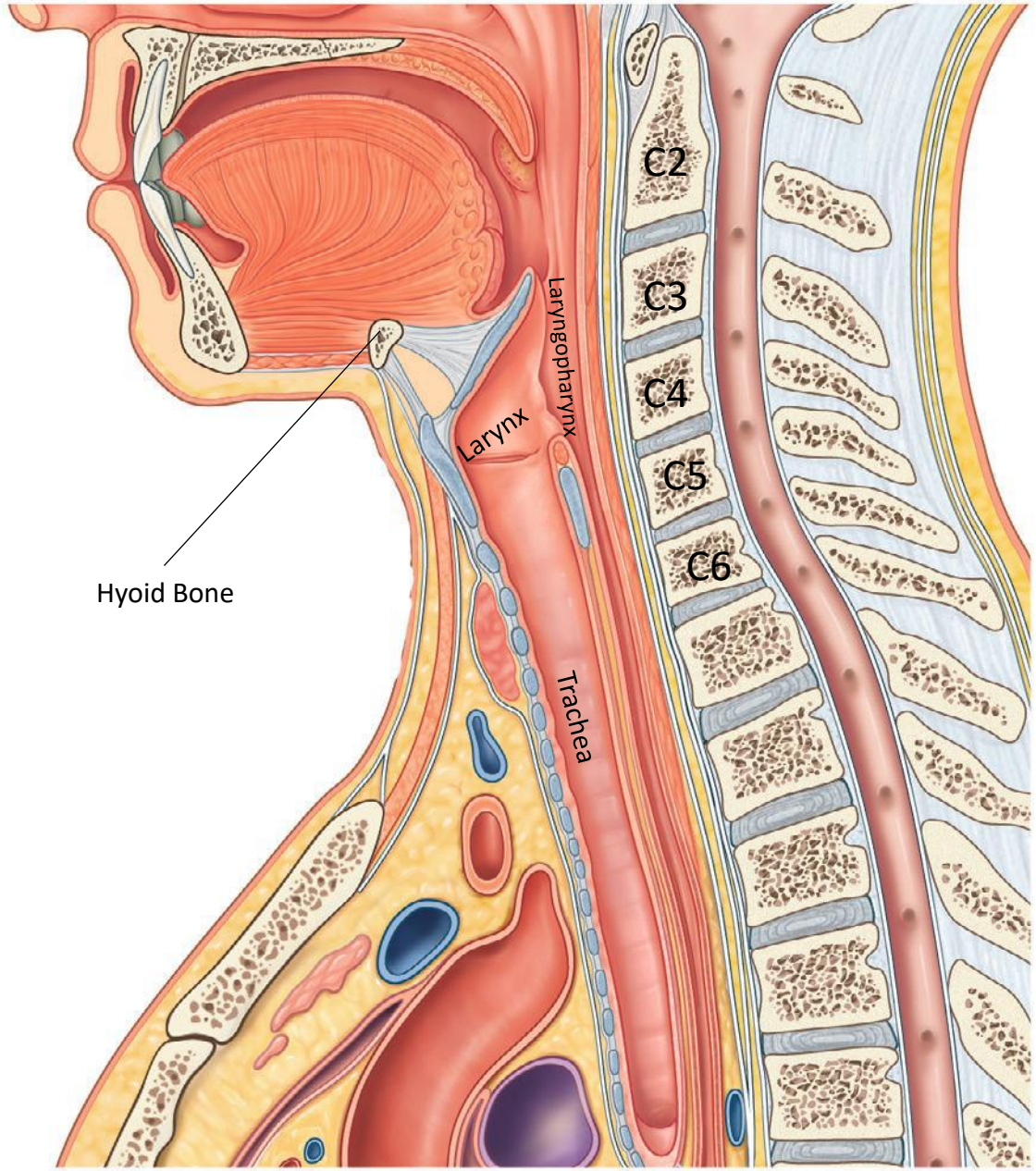
Done by: Ahmad Ayman

This lecture is the hardest one in the anatomy of this system, but please have faith in God 💙

عن أبي الدرداء -رضي الله عنه- عن النبي -صلى الله عليه وسلم- قال: «مَنْ سَلَكَ طَريقا يَبْتَغي فيه عِلْما سَهَّل الله له طريقا إلى الجنة، وإنَّ الملائكةَ لَتَضَعُ أَجْنِحَتها لطالب العلم رضًا بما يَصنَع، وإنَ العالم لَيَسْتَغْفِرُ له مَنْ في السماوات ومَنْ في الأرض حتى الحيتَانُ في الماء، وفضْلُ العالم على العَابِدِ كَفَضْلِ القمر على سائِرِ الكواكب، وإنَّ العلماءِ وَرَثَة الأنبياء، وإنَّ الأنبياء لم يَوَرِّثُوا دينارا ولا دِرْهَماً وإنما وَرَّثُوا العلم، فَمَنْ أَخَذَهُ أَخَذَ بحَظٍّ وَافِرٍ».

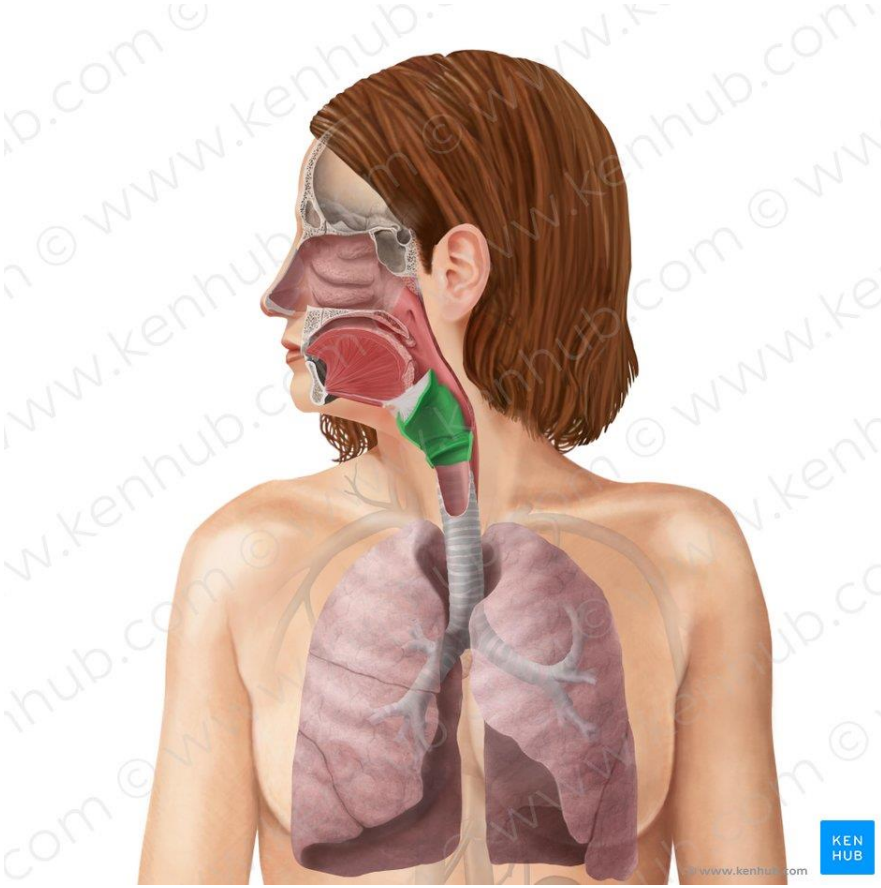
INTRO

- The larynx is a cartilaginous box that extends form the level of middle C3 to the level of the inferior border of C6 vertebra.
- It opens above into the laryngopharynx and continues at the level of C6 at the trachea.
- It is suspended معلّقة from the hyoid bone above and attached to the hyoid bone below by membranes and ligaments.



FUNCTIONS OF THE LARYNX

1- Acts as an **open valve in respiration.**
2- Acts as a closed valve in deglutination (swallowing), when we eat, the food bolus pushes the epiglottis لسان المزمار downward and backward against the laryngeal inlet, thus closing the laryngeal inlet and preventing food from entering the laryngeal cavity, moreover, when the pharynx senses the presence of food, the sensations are carried to the brain, which in turn triggers reflex contractions in the muscles that elevate the larynx, thus putting the larynx in proximity with the epiglottis and closing it. (please don't get panic as we'll explain this in pics shortly 😅).
3- Acts as a **partially closed valve in the production of voice (this occurs because the vocal cords vibrate, this vibration produces a sounds that is our voice 🕺 🕺).**
4- cough, cough is mediated as following: firstly, air is inhaled, then the epiglottis closes the larynx to trap air inside the lung, then expiratory muscles contract so pressure increases greatly inside the lungs, then the epiglottis opens suddenly, resulting in what is like an explosion through the mouth that is the cough, sneezing occurs in a similar mechanism, however, in sneezing the soft palate is depressed so air is expelled through the nasal cavity rather than the oral cavity.

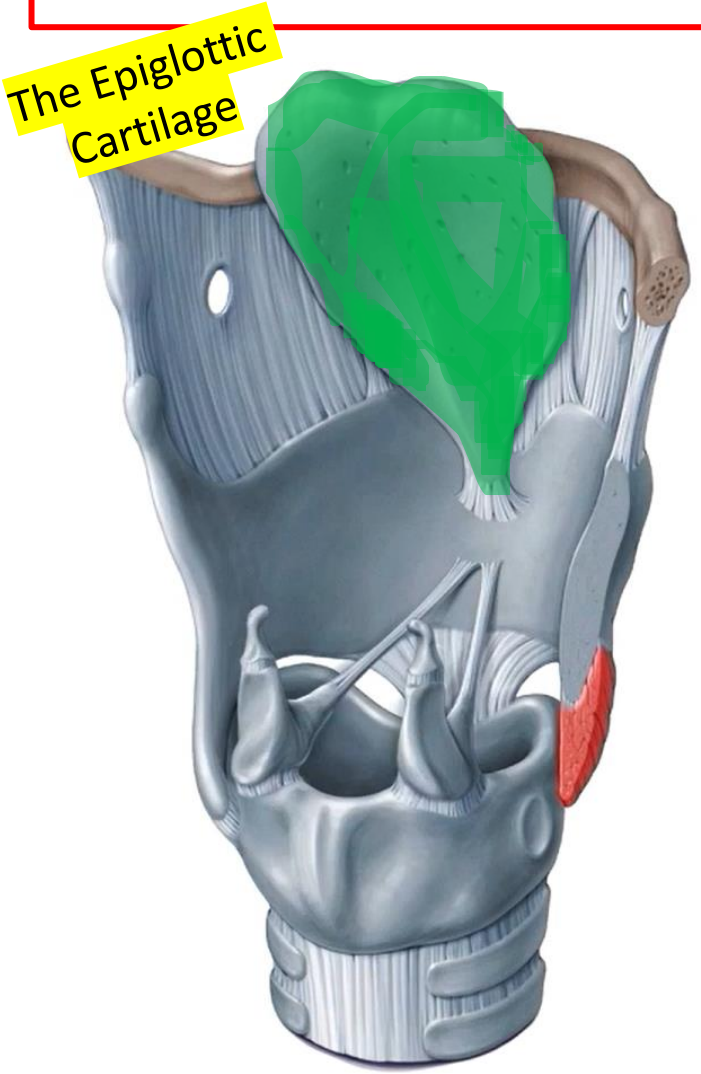


COMPONENTS OF THE LARYNX

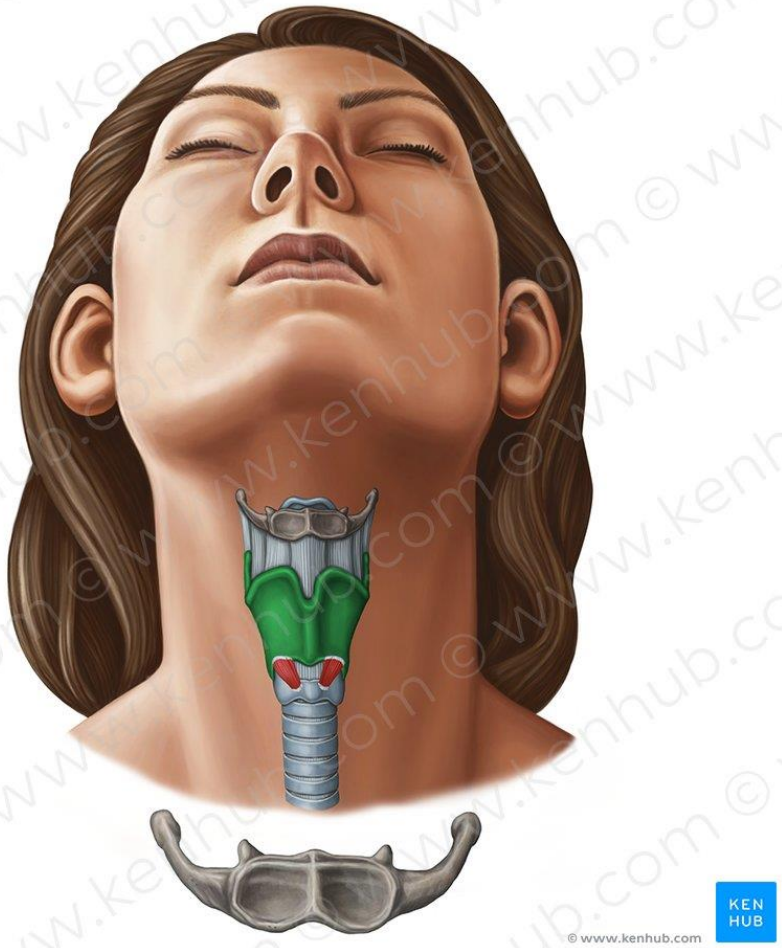
- Cartilage (cartilaginous framework).
- Mucosa (mucosal lining)
- Ligaments
- Muscles

CARTILAGES OF THE LARYNX

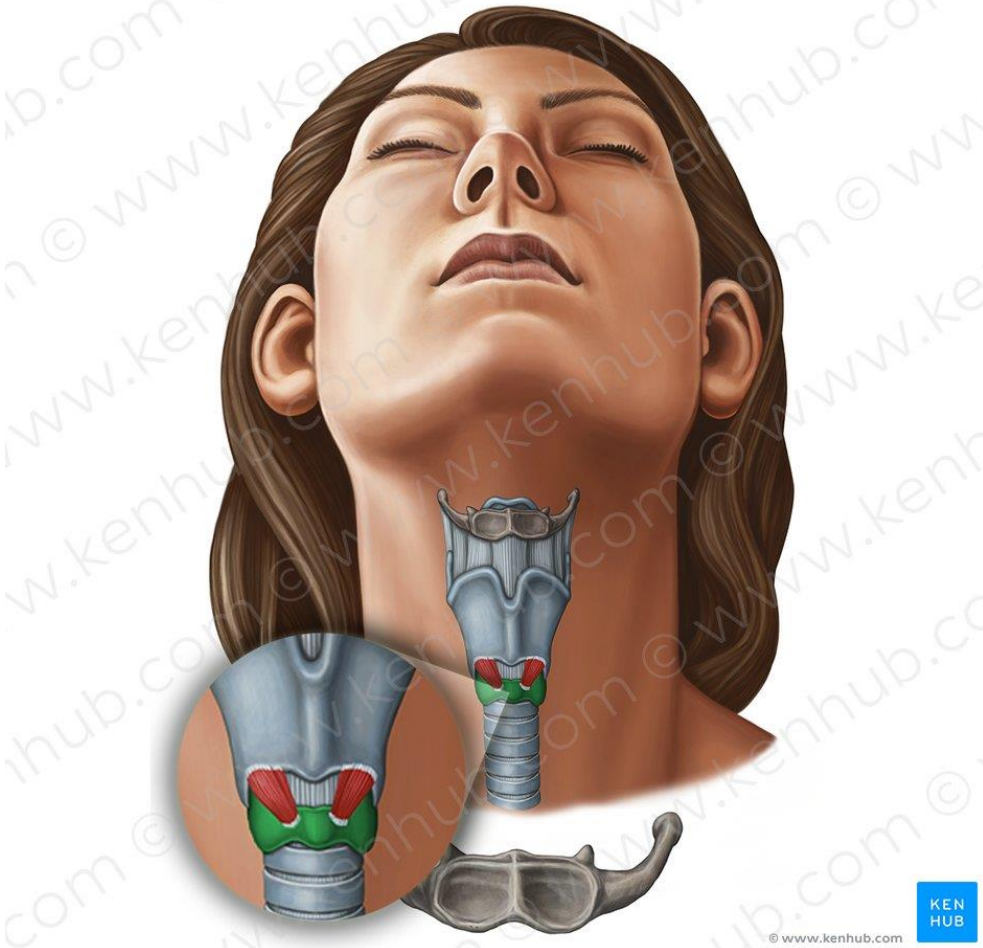
The cartilaginous framework of the larynx is composed of three solitary (single) cartilages and three paired cartilages, the solitary (single) cartilages are:



Note: in these sections, the mucosa and muscles are removed.



Thyroid Cartilage



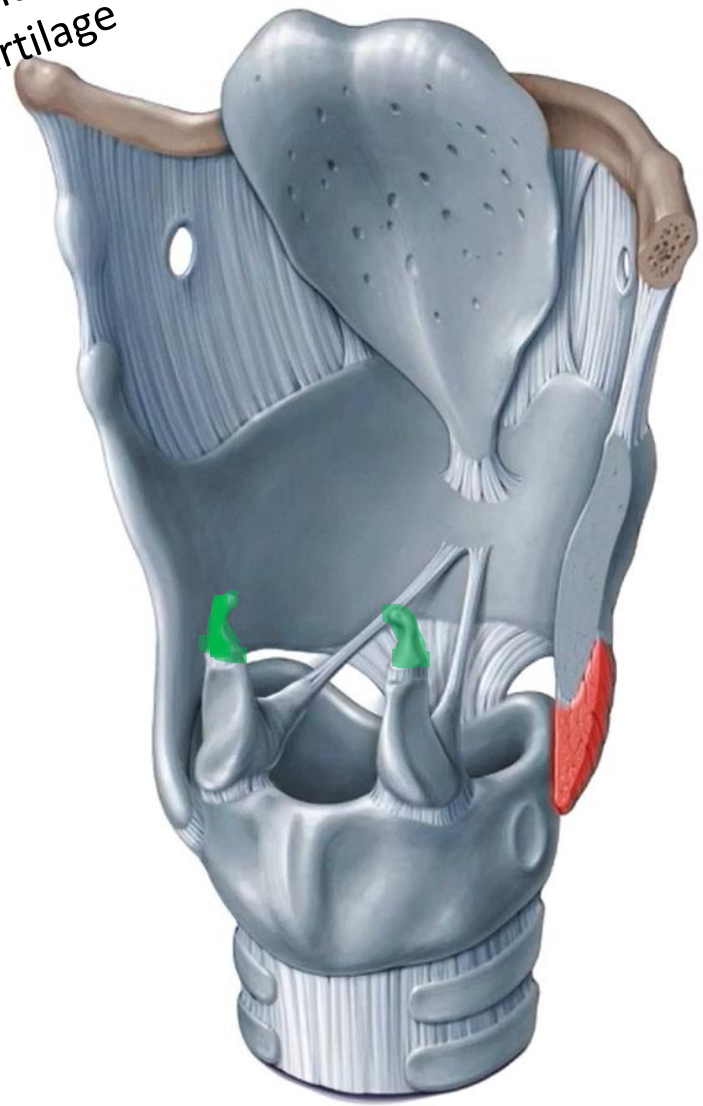
Cricoid Cartilage

These are anterior views!!

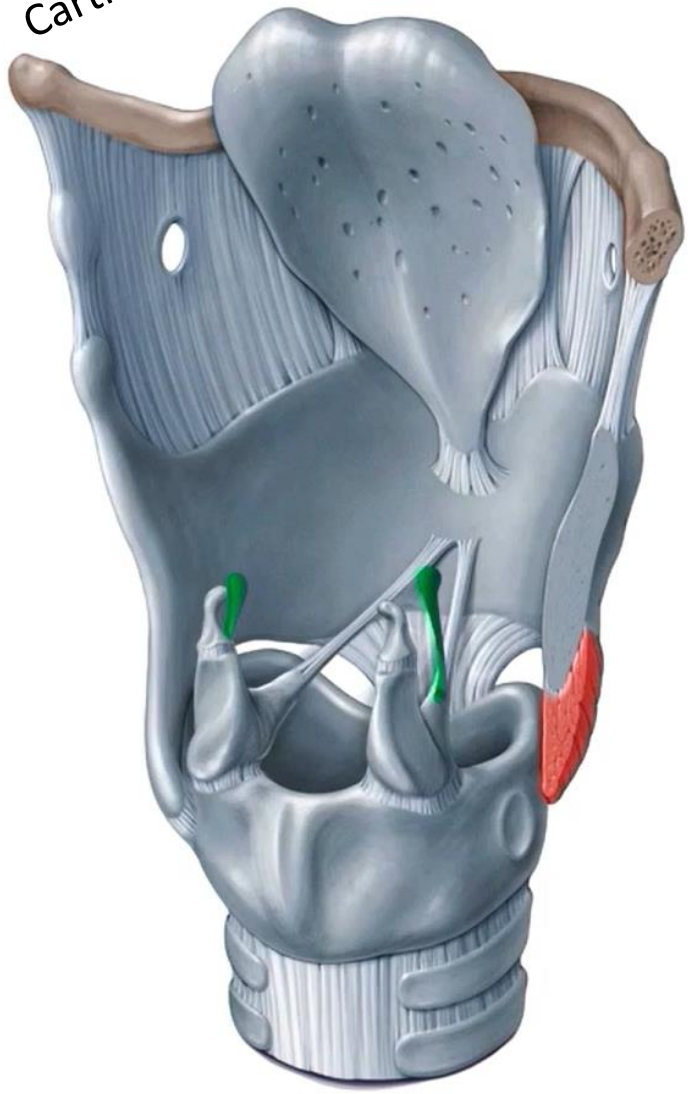
The paired cartilages are:

Arytenoid cartilage

Corniculate Cartilage

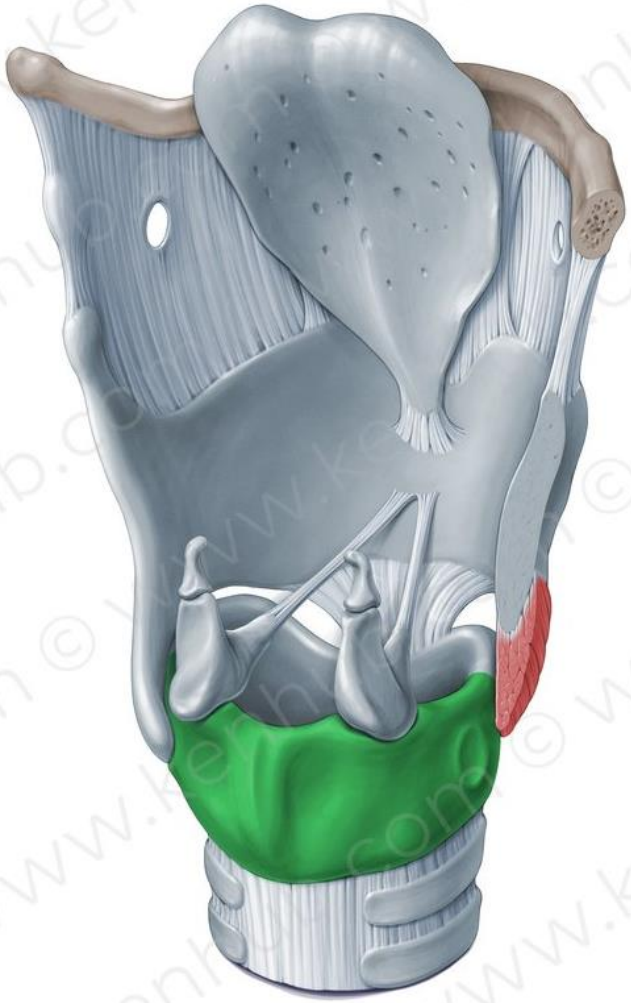


Cuneiform Cartilage

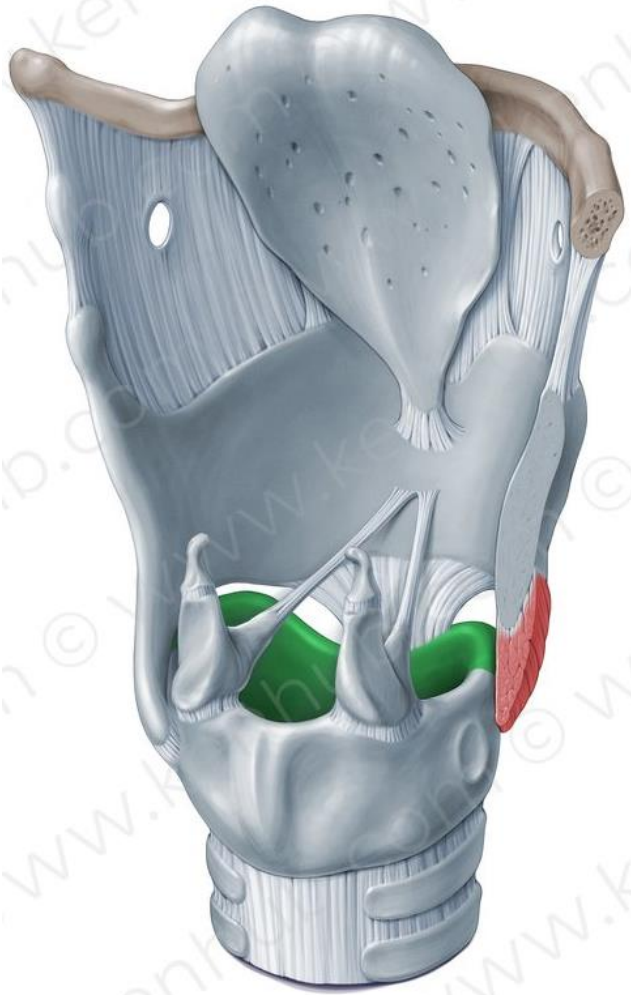


CRICOID CARTILAGE.

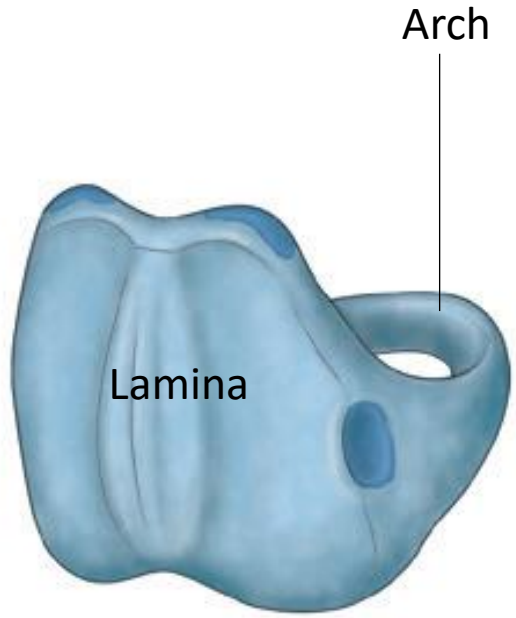
The cricoid cartilage is most inferior of the laryngeal cartilages, it is shaped like a signet ring and it completely encircles the airway, it is composed of two parts: a broad quadrangular lamina posteriorly, and a much narrower arch anteriorly.



Lamina of Cricoid Cartilage



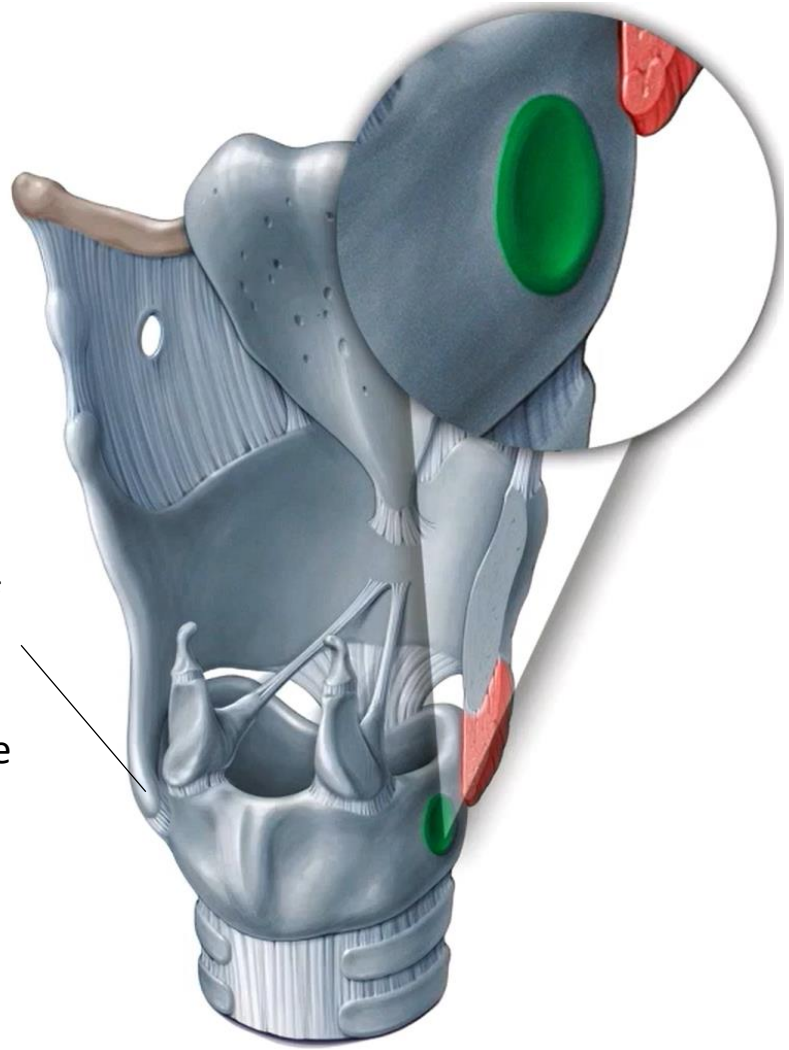
Arch of Cricoid Cartilage



An isolated cricoid cartilge

The cricoid cartilage has two articular facets on each side:

- One facet is on the sloping superolateral surface and articulates with the base of an arytenoid cartilage;
- The other facet is on the lateral surface near its base and is for articulation with the inferior horn of the thyroid cartilage



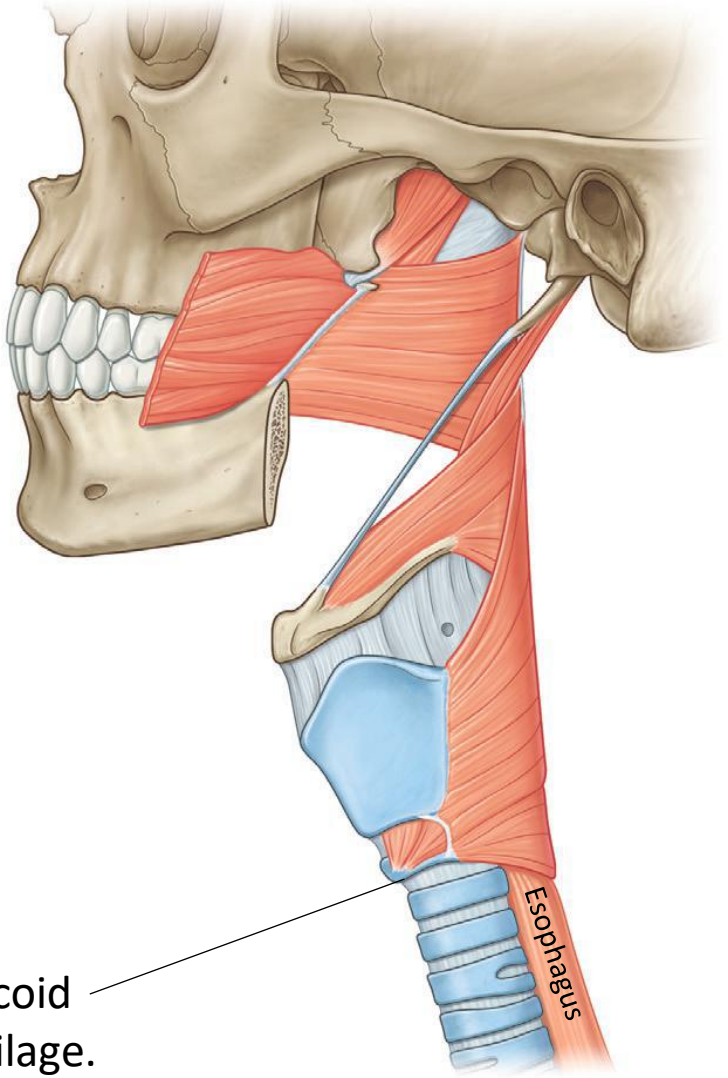
Facet for Articulation with the Thyroid Cartilage

Facet for articulation with the arytenoid cartilage

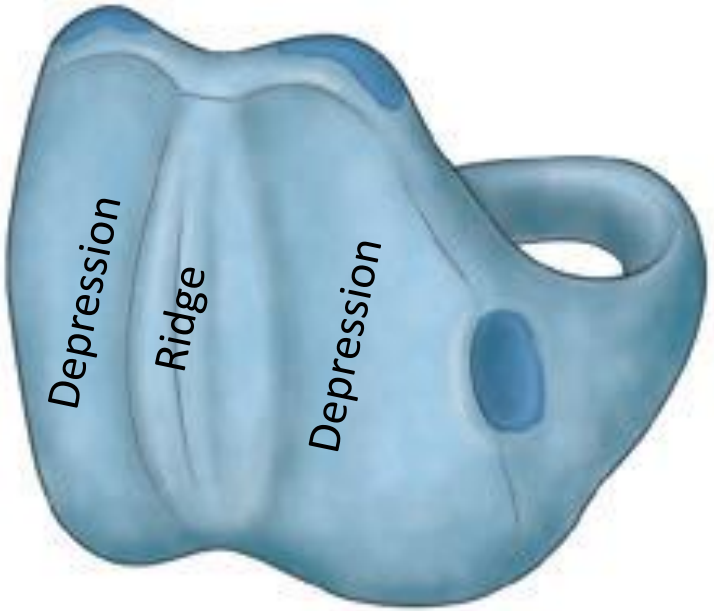
The Posterior surface of the lamina has two oval depressions separated by a ridge, the esophagus is attached to the ridge while the depressions are for attachment of the posterior cricoarytenoid muscles.

Ridge of Cricoid cartilage

Depressions of Cricoid cartilage

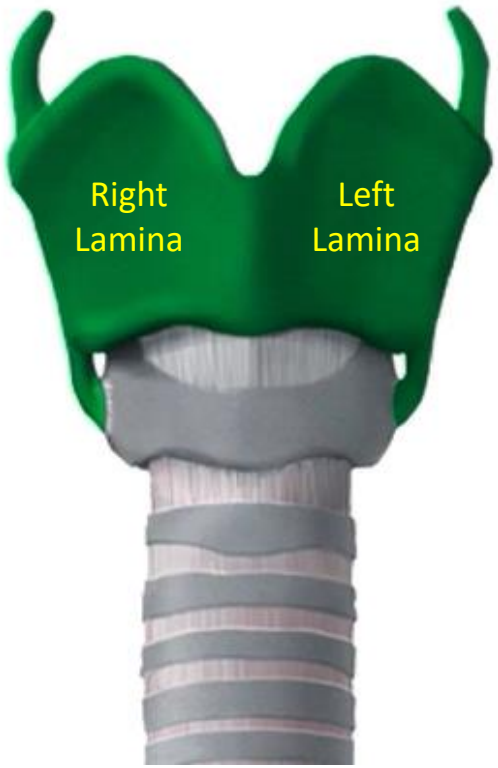


Cricoid Cartilage.

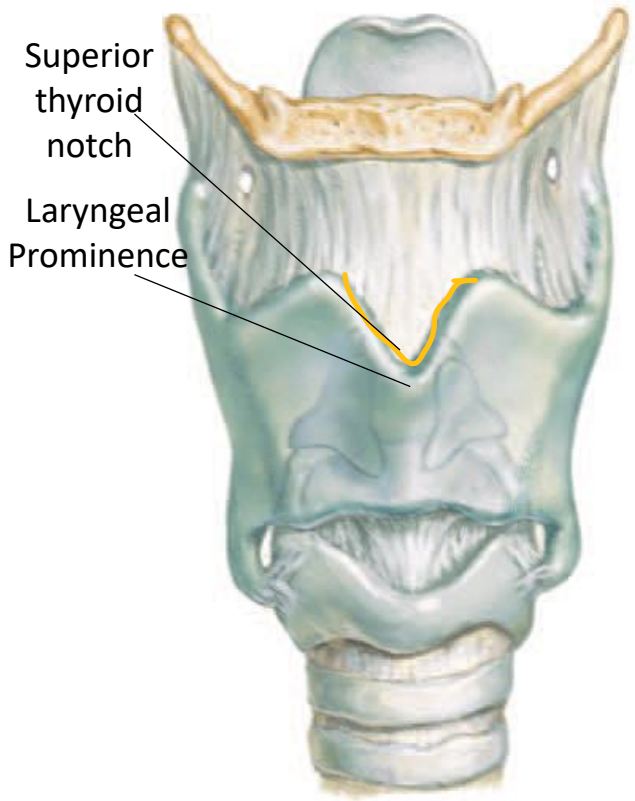

Depression
Ridge
Depression

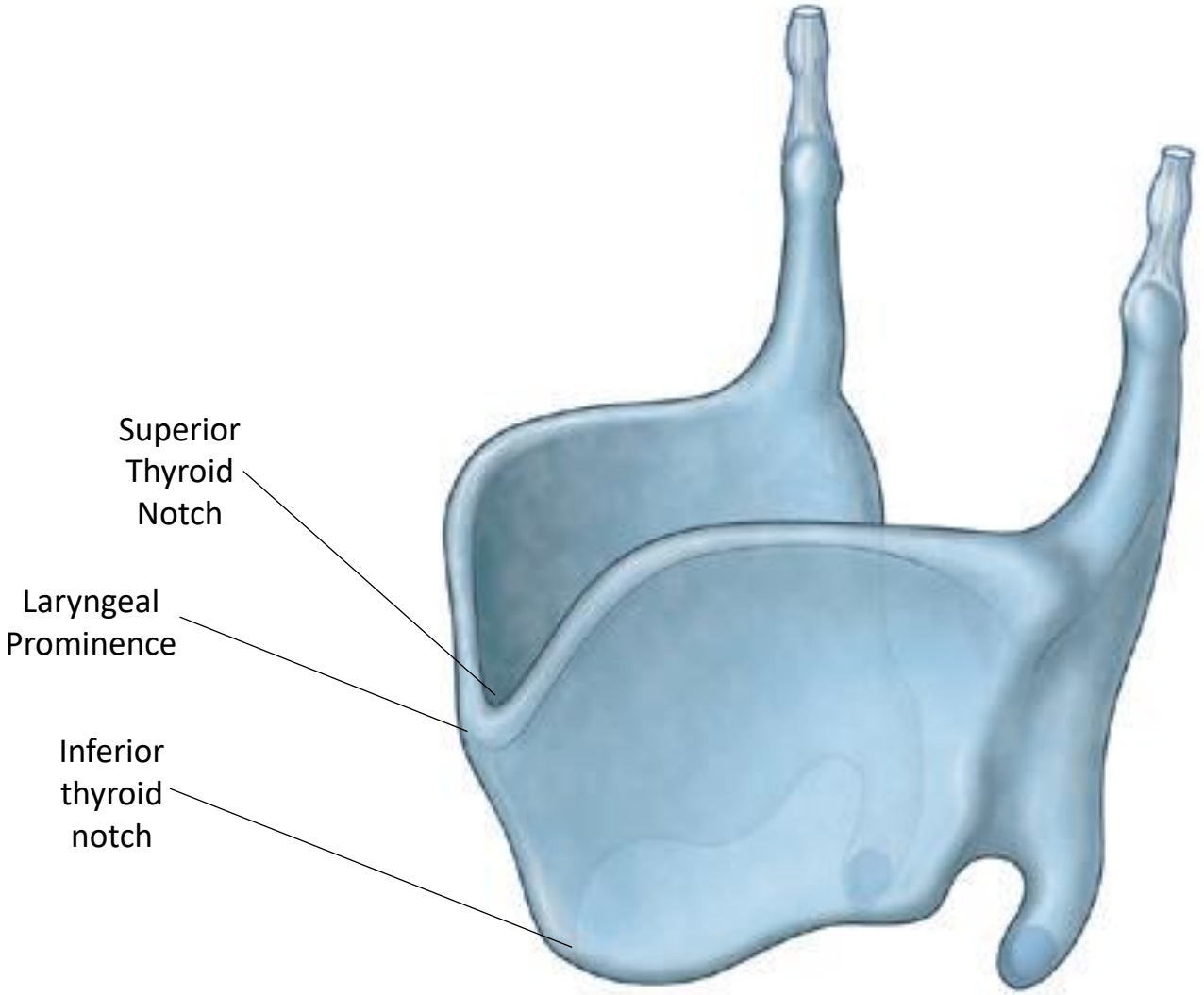
THYROID CARTILAGE.

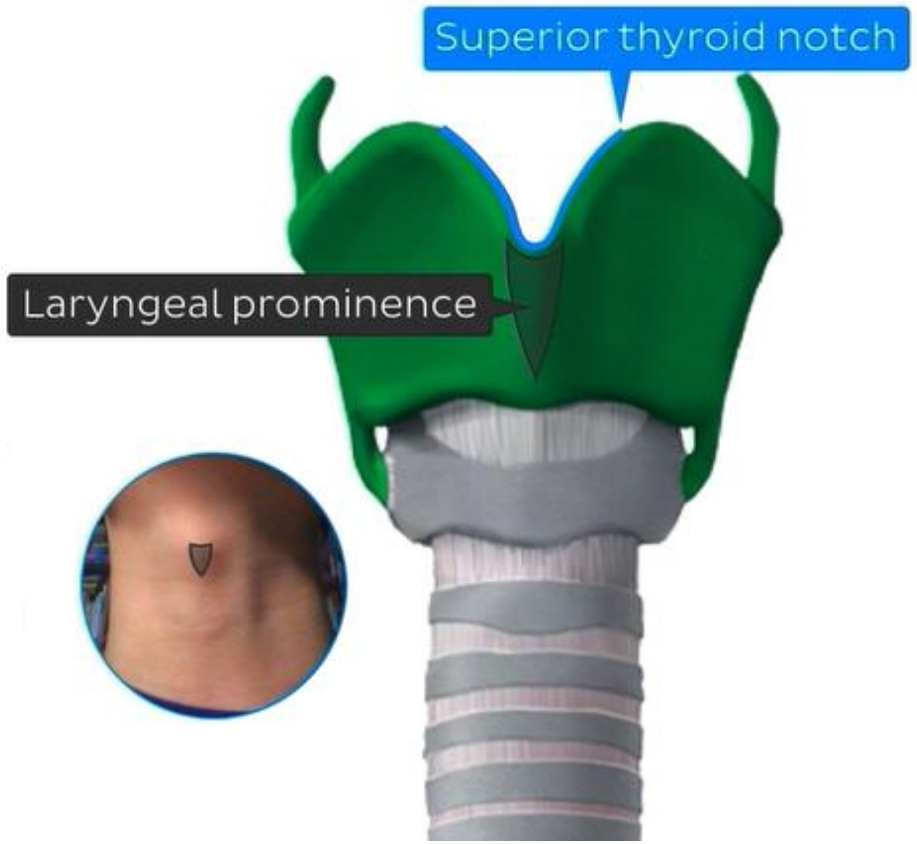
The largest of the laryngeal cartilages, it is formed by a right and a left lamina that are widely separated posteriorly, but converge and join anteriorly.
Posterior margin of each lamina is elongated to form a superior horn (cornu) and an inferior horn (cornu).

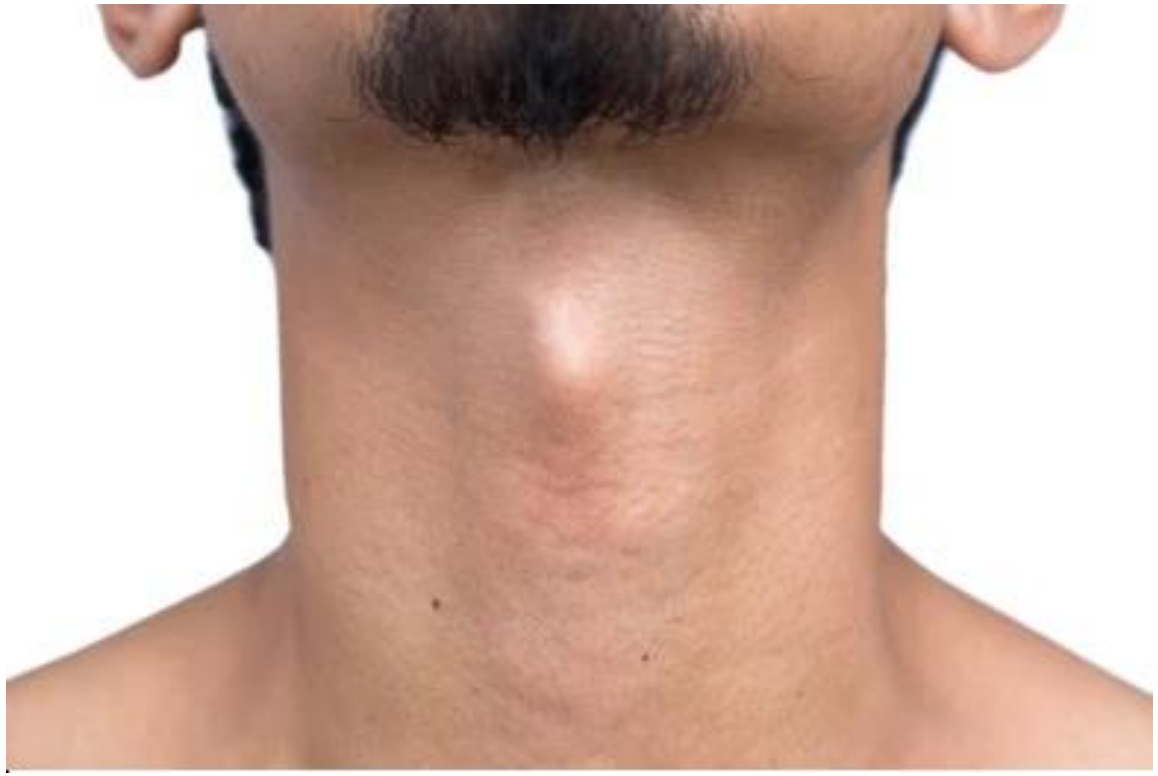


- Most superior point of the site of fusion between the two laminae is the laryngeal prominence ('Adam's apple').
- Superior to the laryngeal prominence, the superior thyroid notch separates the two laminae.
- Superior thyroid notch and the laryngeal prominence are palpable (you can touch them) landmarks in the neck.
- A Less distinct inferior thyroid notch is in the midline along the base of the thyroid cartilage.



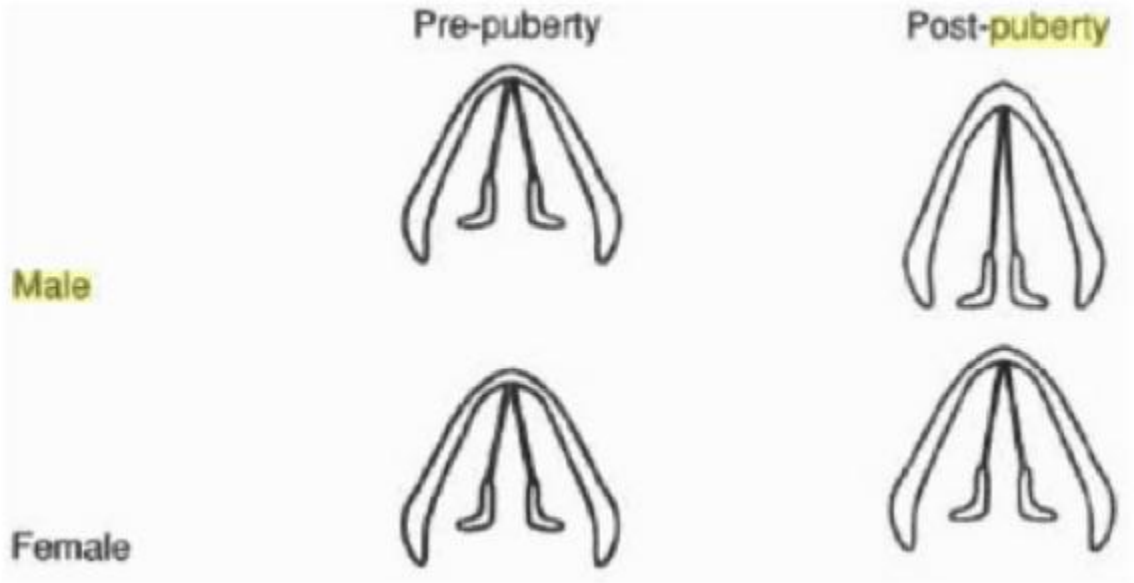


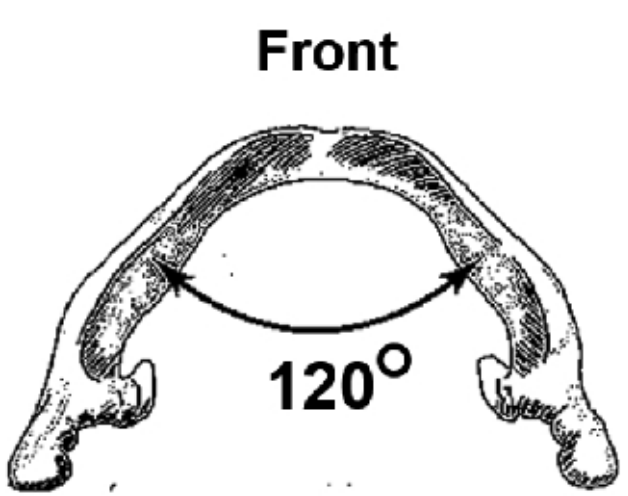




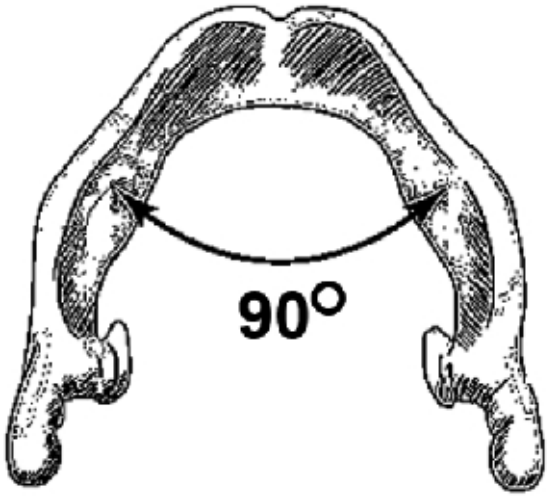
You can obviously see that the laryngeal prominence is more prominent in males.

- The angle between the two laminae of the thyroid cartilage is more acute أكثر حدّة in men (90°) than in women (120°), this is due to the hormonal effect of sex hormones (e.g. testosterone in males and estrogen and progesterone in women) on chondrogenesis, the same hormones also affects ossification and muscle growth, that's why males have wider shoulders while females have wider pelvises or whatever.
- the different shape of thyroid cartilages between males and females account for the difference in sound pitch between the two genders, wider angle of thyroid cartilage in females makes their vocal cords shorter, which makes their voice a high-pitch sound due to higher tension in their vocal cords, in contrast, the vocal cords of men are longer, which makes their voice a low-pitch sound due to relatively low tension in their vocal cords.



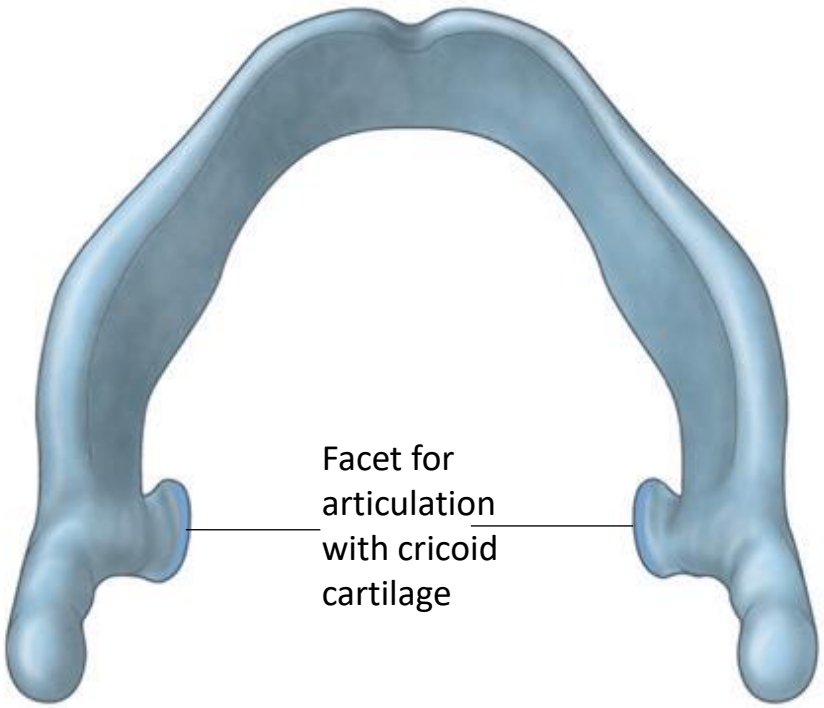


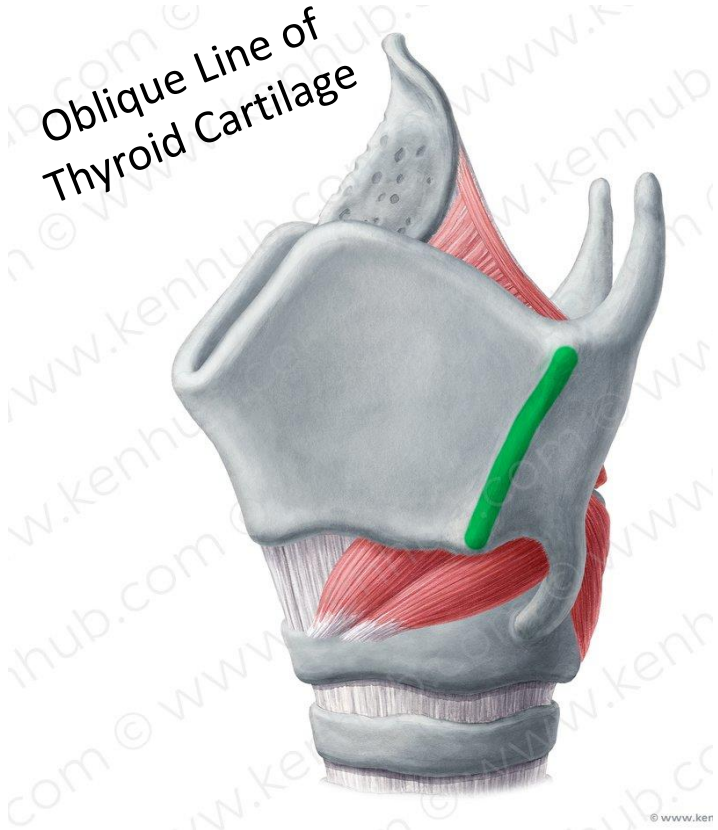
Female thyroid cartilage

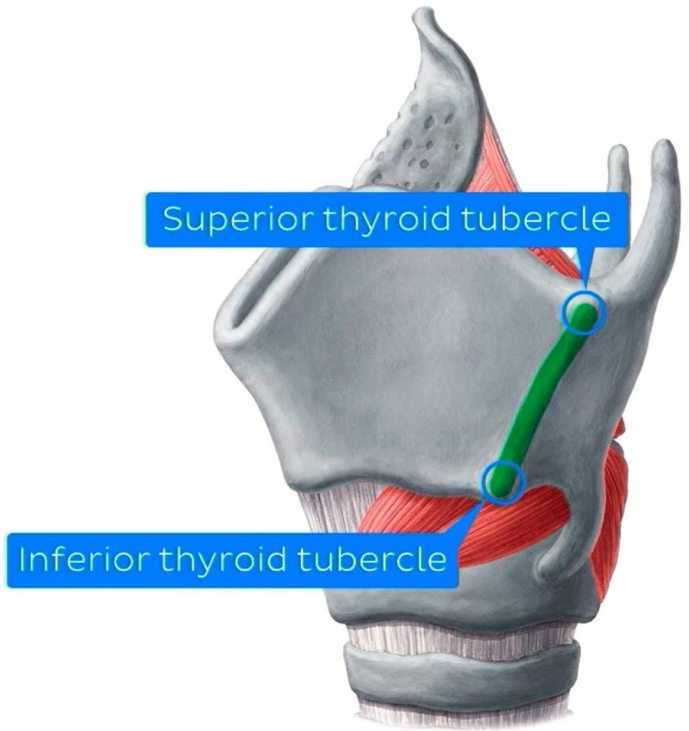


Male thyroid cartilage

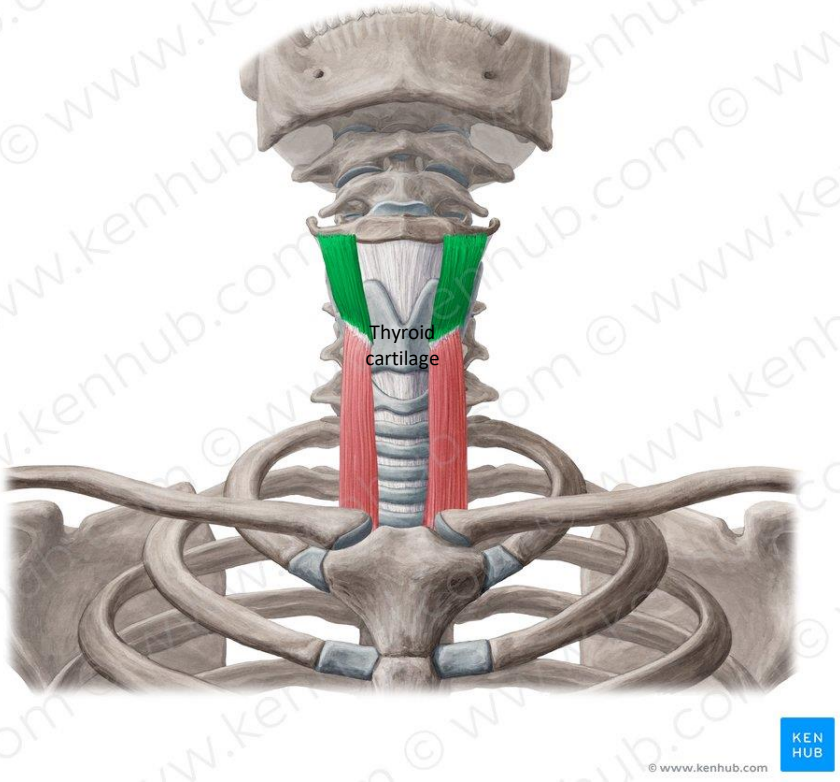
- The medial surface of the inferior horn of the thyroid cartilage has a facet for articulation with the cricoid cartilage.
- Lateral surface of lamina is marked by a ridge called the oblique line, which curves anteriorly from the base of the superior horn to the inferior margin of the lamina.
- Ends of the oblique line are expanded to form superior and inferior thyroid tubercles.



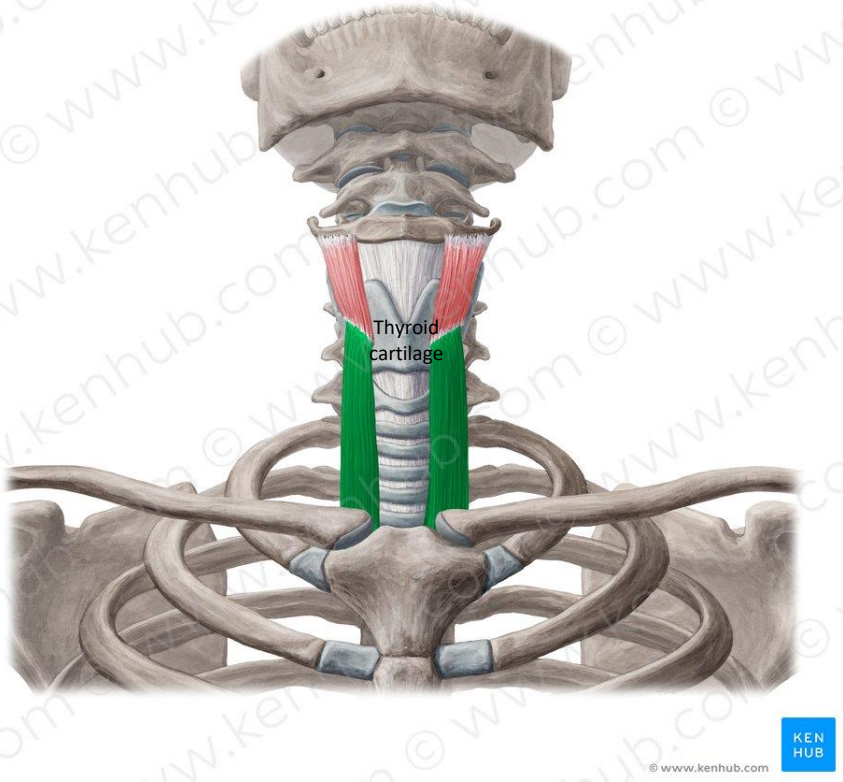




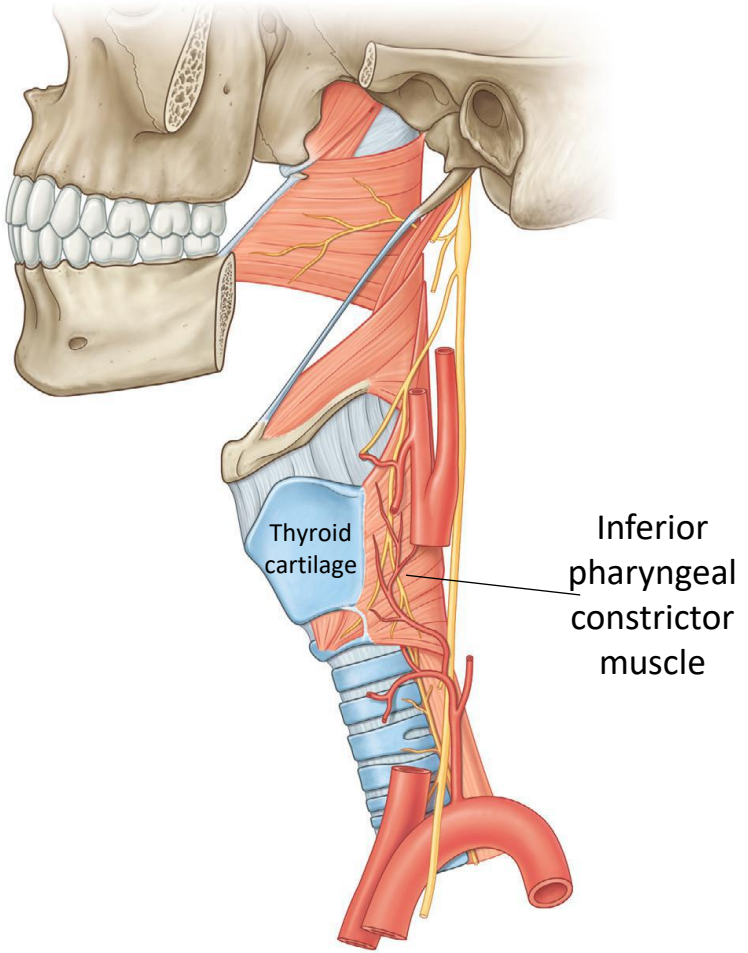
The oblique line of the thyroid cartilage is a site of attachment (either origin or insertion) for the extrinsic muscles of the larynx, including sternothyroid, thyrohyoid, and the inferior pharyngeal constrictor.



Thyrohyoid.



Sternohyoid.



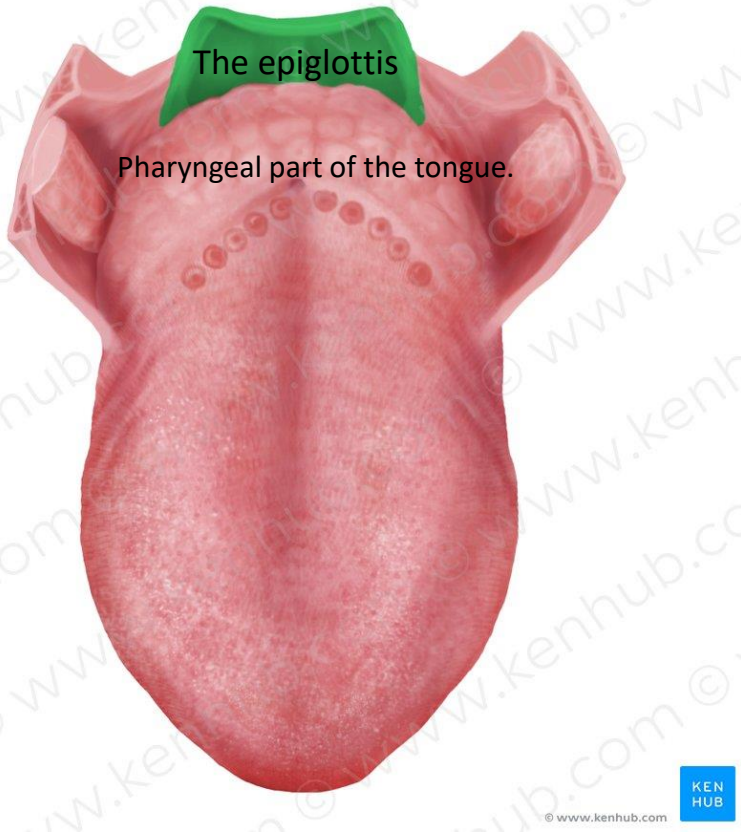
THE EPIGLOTTIC CARTILAGE.

- The epiglottic cartilage is a 'leaf-shaped' cartilage attached by its stem (apex) to the angle of the thyroid cartilage, an upper free edge and an apex, it projects postero-superiorly from its attachment to the angle of the thyroid cartilage.
- The attachment is via the thyro-epiglottic ligament in the midline between the laryngeal prominence and the inferior thyroid notch.

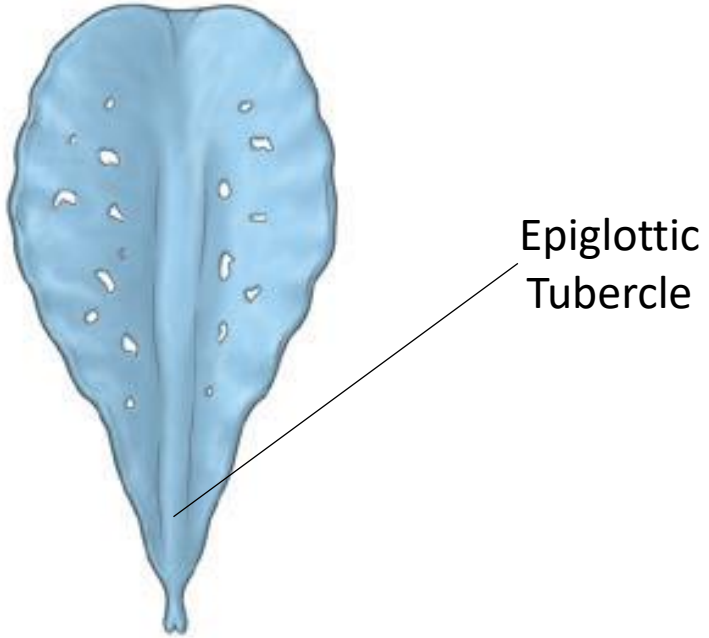
Stem (apex) of The Epiglottic Cartilage.

Upper Free Edge of Epiglottic cartilage.

Thyroepiglottic Ligament

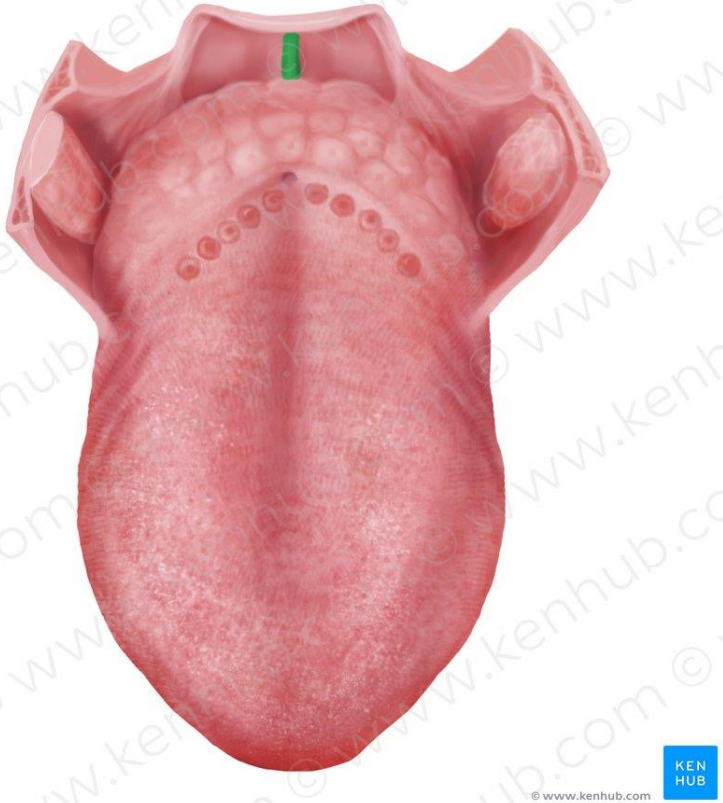


The upper margin of the epiglottis is behind the pharyngeal part of the tongue.

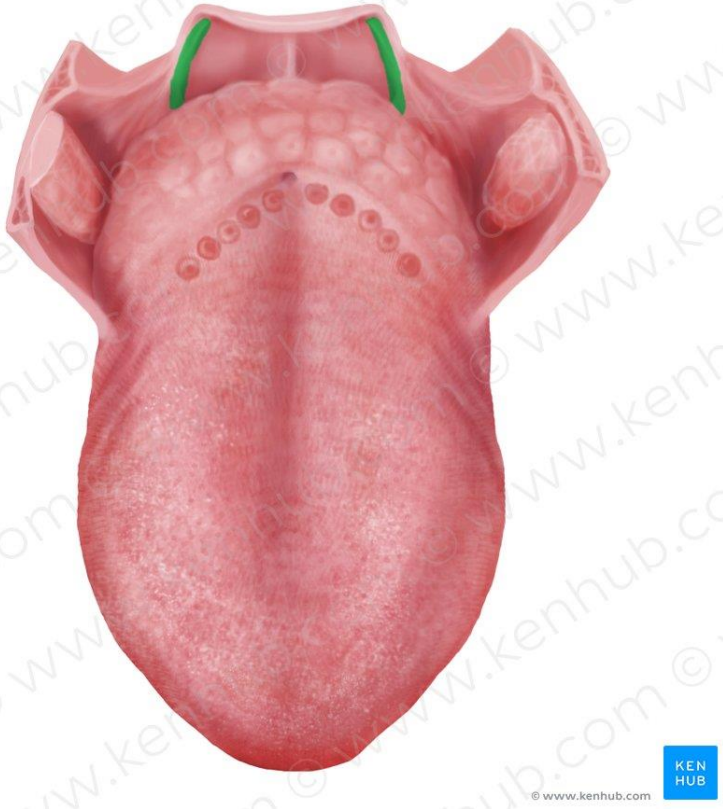


The inferior half of the posterior surface of the epiglottis is raised slightly to form an epiglottic tubercle.

The Epiglottis is attached to the tongue by the medial and lateral glossoepiglottic folds.



Medial glossoepiglottic fold.



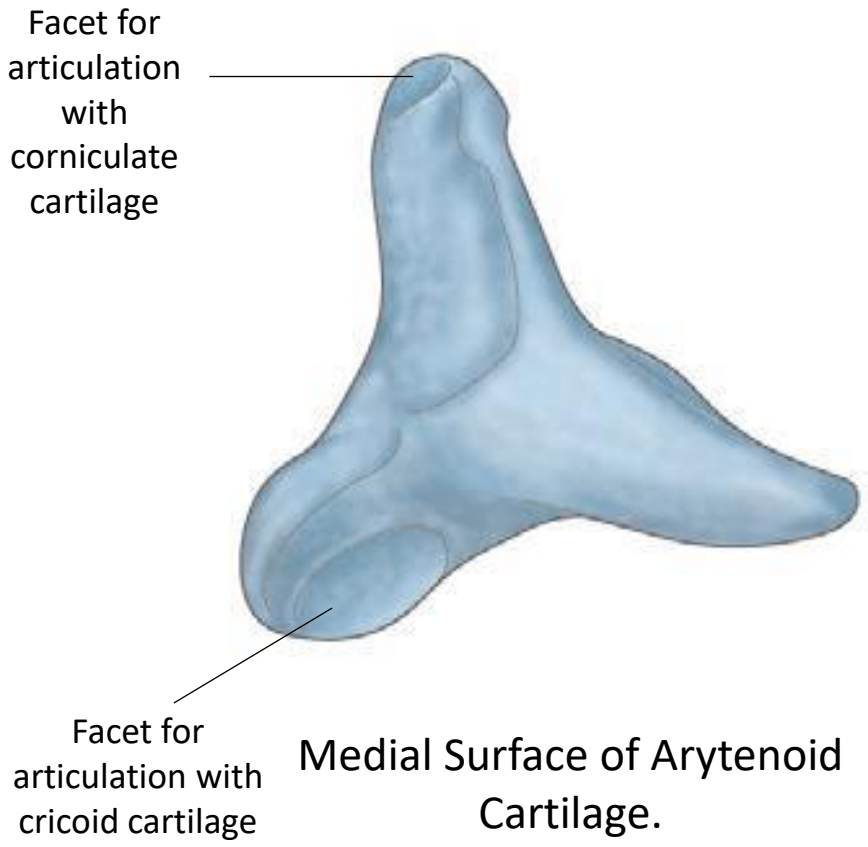
Lateral glossoepiglottic fold.

Note: The epiglottis has an anterior and posterior surfaces that have different types of epithelium, the anterior surface's mucosa is similar to that of the tongue it is lined with stratified squamous nonkeratinized epithelium, and contains taste buds, however, the posterior surface is lined with respiratory epithelium.

ARYTENOID CARTILAGES

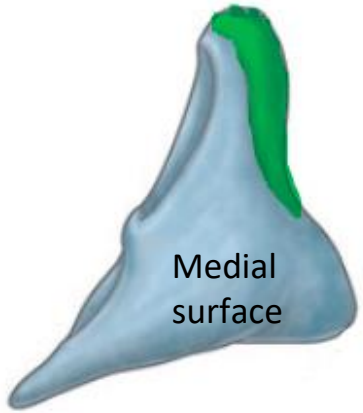
- The two arytenoid cartilages are pyramid- shaped cartilages with three surfaces: a medial surface, an anterolateral surface, and a posterior surface, it also has an apex and a base.
- The base of arytenoid cartilage is concave (it contains a facet) and articulates with the facet on the superolateral surface of the cricoid cartilage.
- The apex of arytenoid cartilage articulates with a corniculate cartilage.

The medial surface of each arytenoid cartilage faces the medial surface of the other one.



Medial Surface of Arytenoid Cartilage.

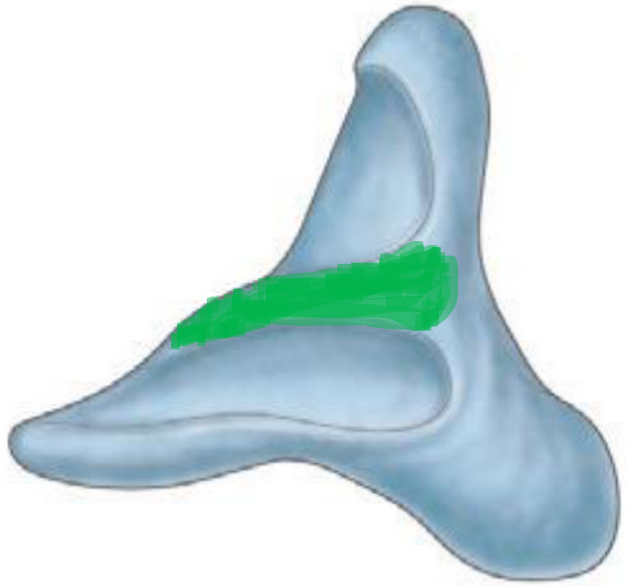
Anterolateral Surface of Arytenoid cartilage



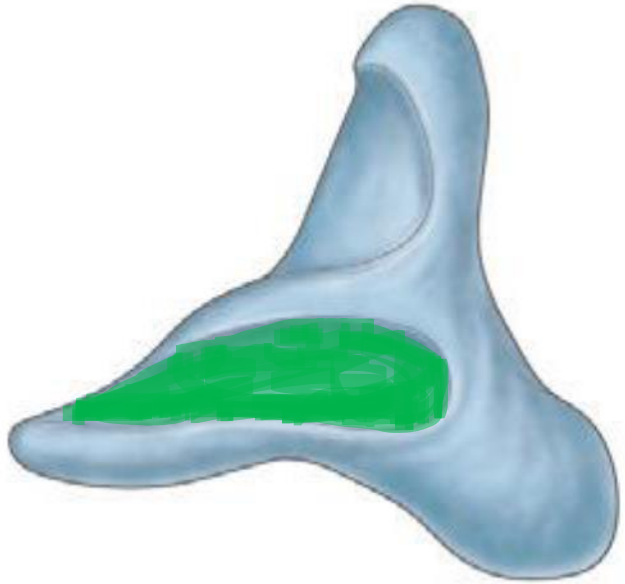
Posterior Surface of Arytenoid cartilage (highlighted in green)

The anterolateral surface of the arytenoid cartilage has two depressions, separated by a ridge, the lower depression is for vocalis muscle and the upper depression is for vestibular ligament.

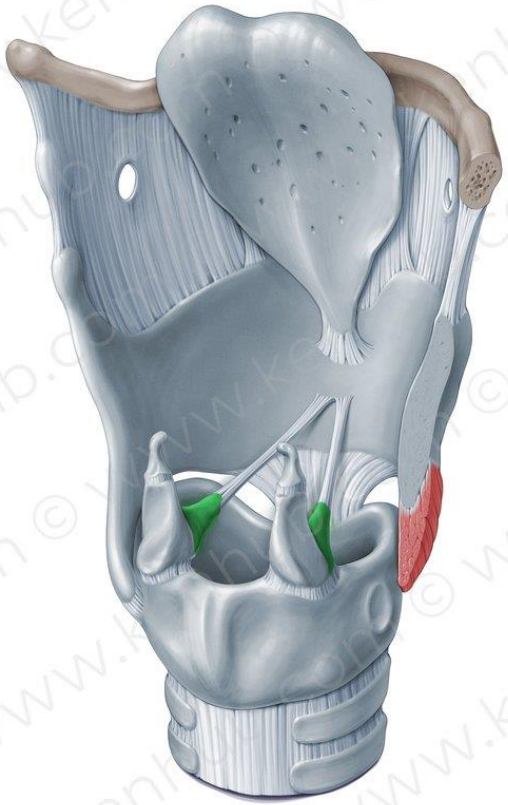
Depression for Vestibular Ligament



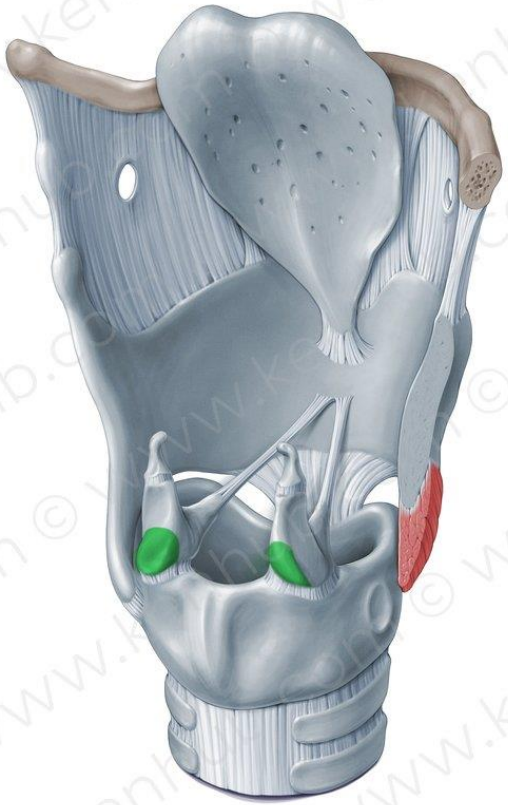
The Ridge



Depression for Vocalis muscle



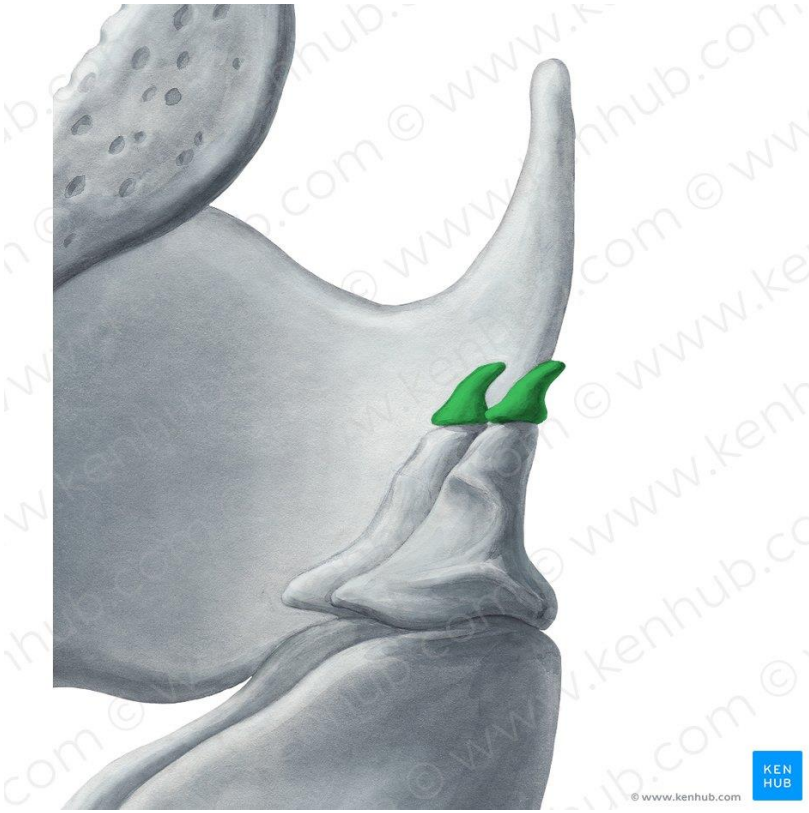
The anterior angle of the base of arytenoid cartilage is elongated into a vocal process to which the vocal ligament is attached.

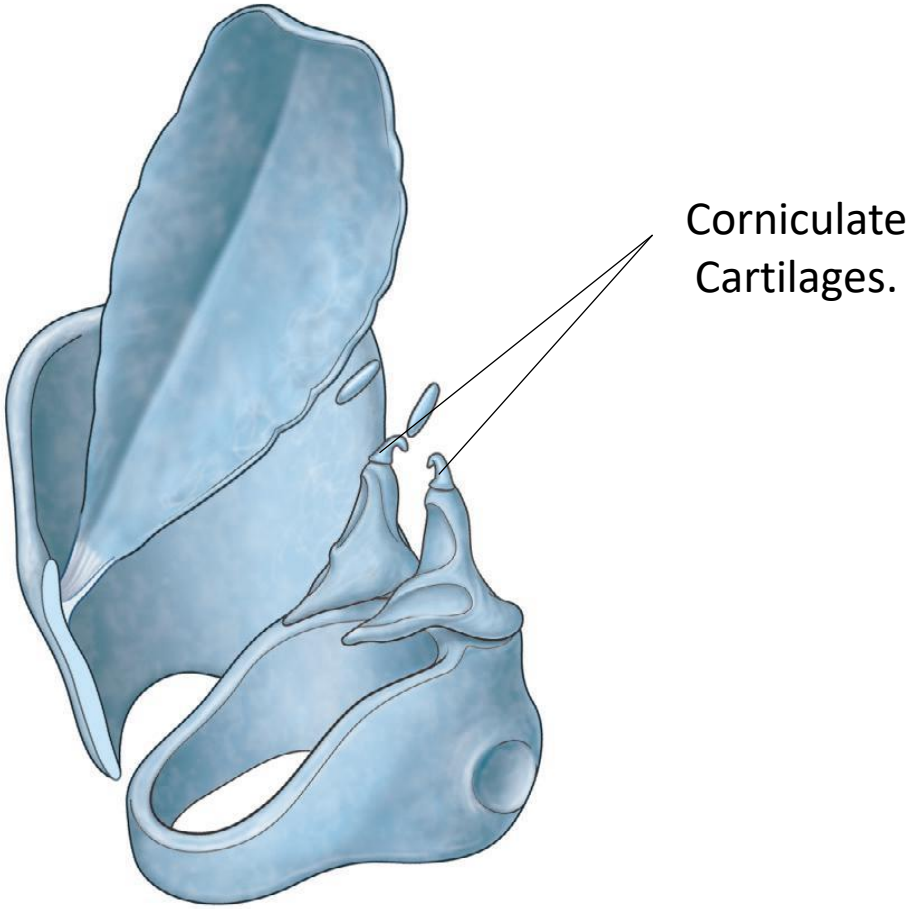


The lateral angle is similarly elongated into a muscular process for attachment of the posterior and lateral crico-arytenoid muscles

CORNICULATE CARTILAGES

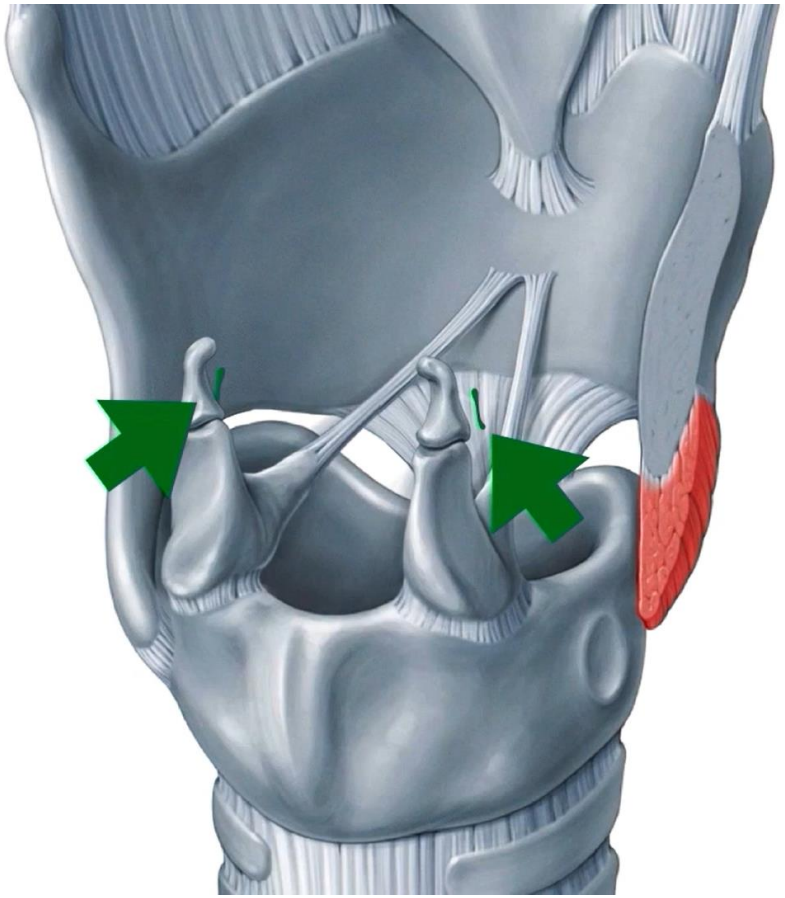
The corniculate cartilages are two small conical cartilages, their bases articulate with the apices of the arytenoid cartilages while their apices project postero-medially towards each other.

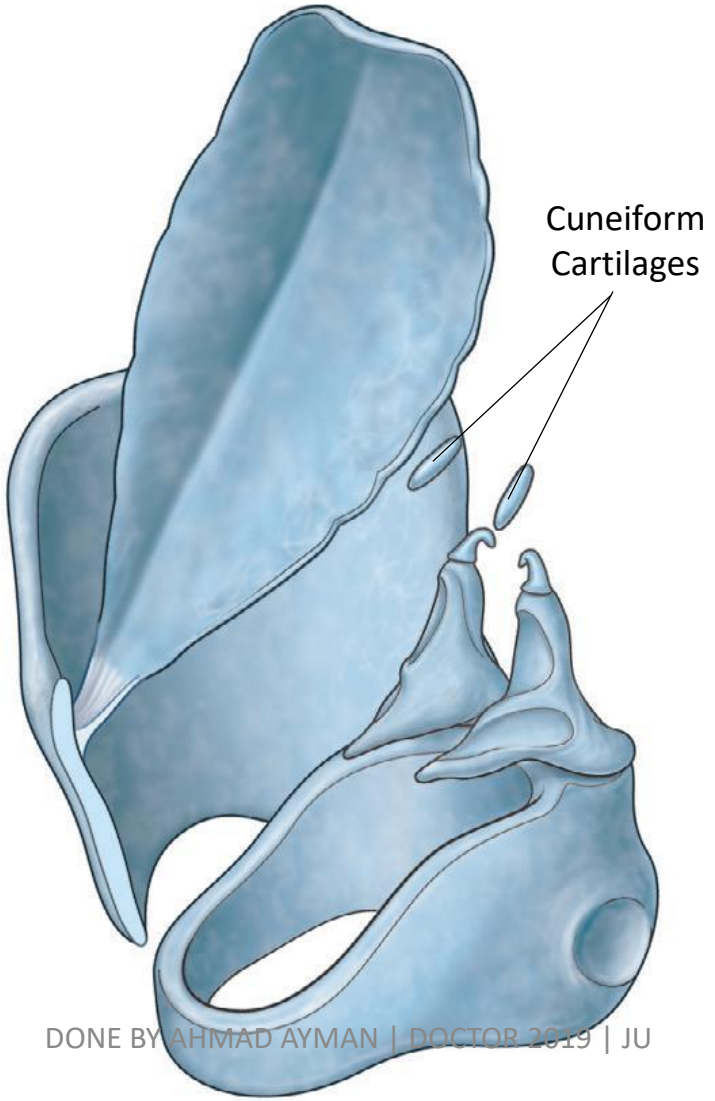


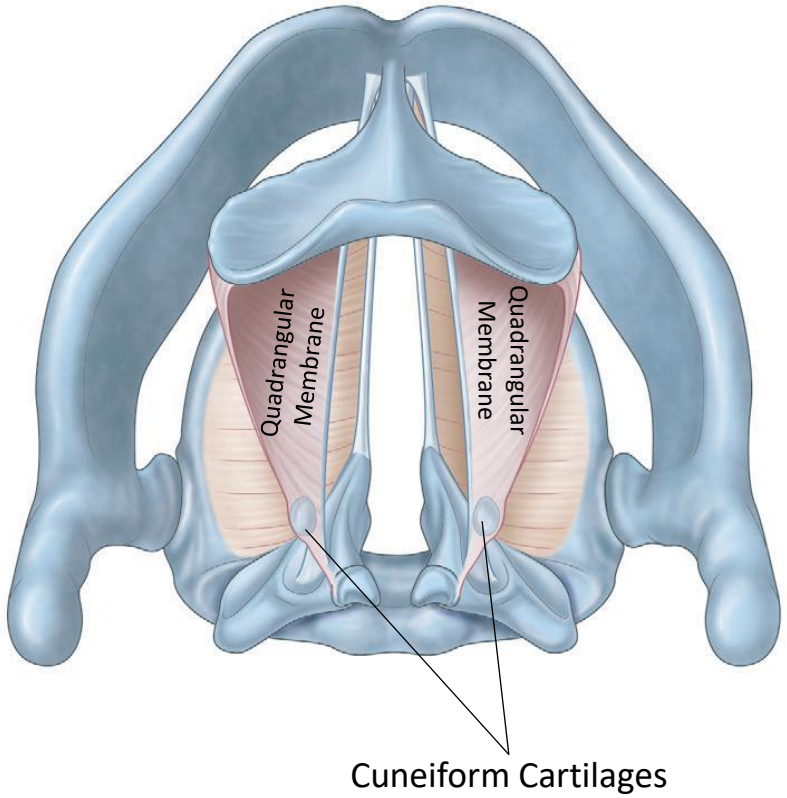


CUNEIFORM CARTILAGES.

The Cuneiform Cartilages are two small club- shaped cartilages, they lie anterior to the corniculate cartilages, and they are suspended in the part of the fibroelastic membrane that attaches the arytenoid the epiglottis (the quadrangular membrane).

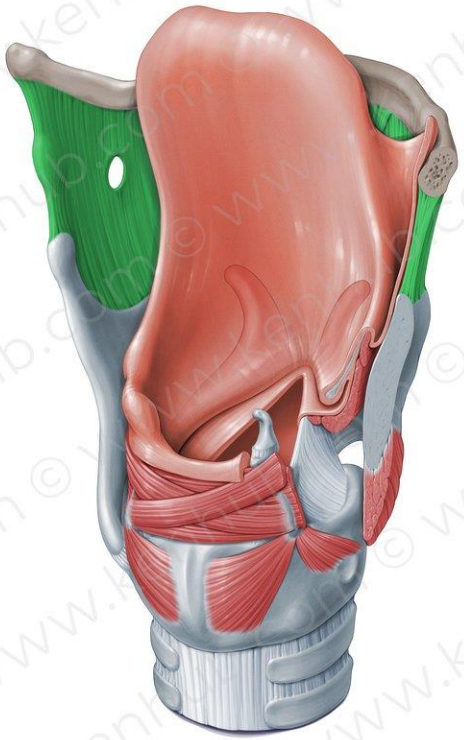




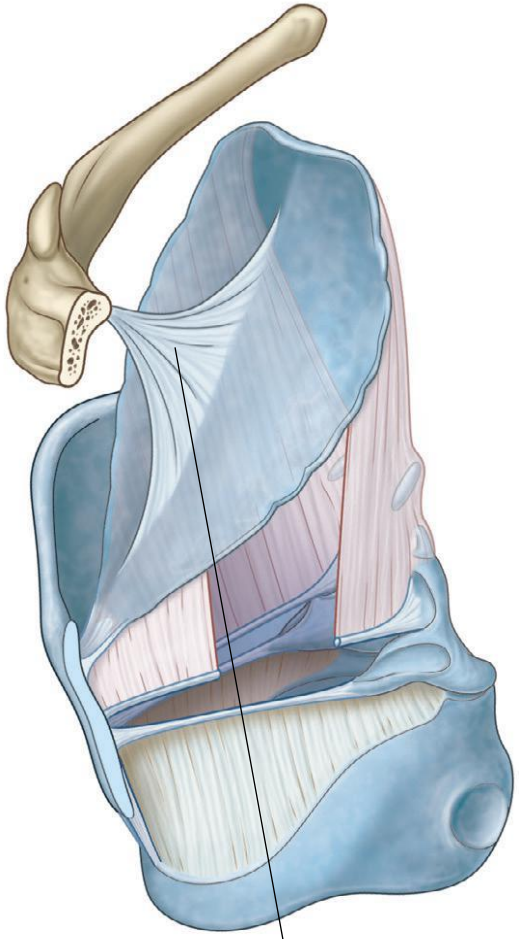


LIGAMENTS OF THE LARYNX

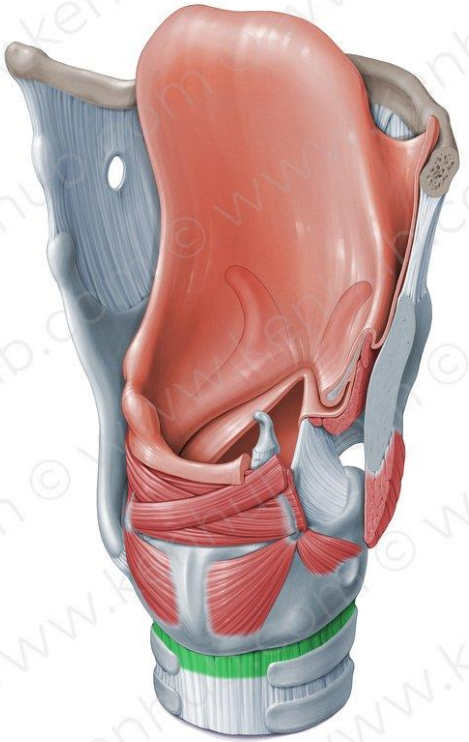
The laryngeal ligaments are divided into two groups: the extrinsic ligaments of the larynx and the intrinsic ligaments, the intrinsic ligaments are collectively referred to as the fibroelastic membrane of the larynx.
The Extrinsic ligaments of the larynx include:



The Thyrohyoid Membrane

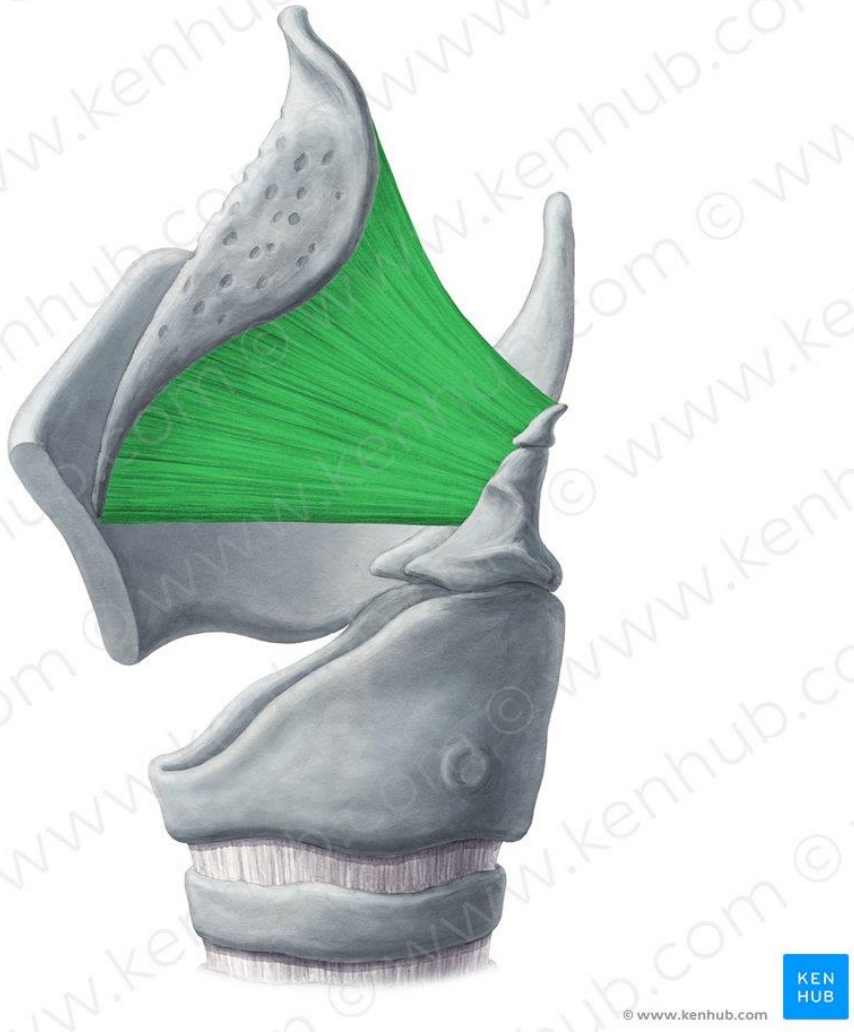


The Hyoepiglottic Ligament

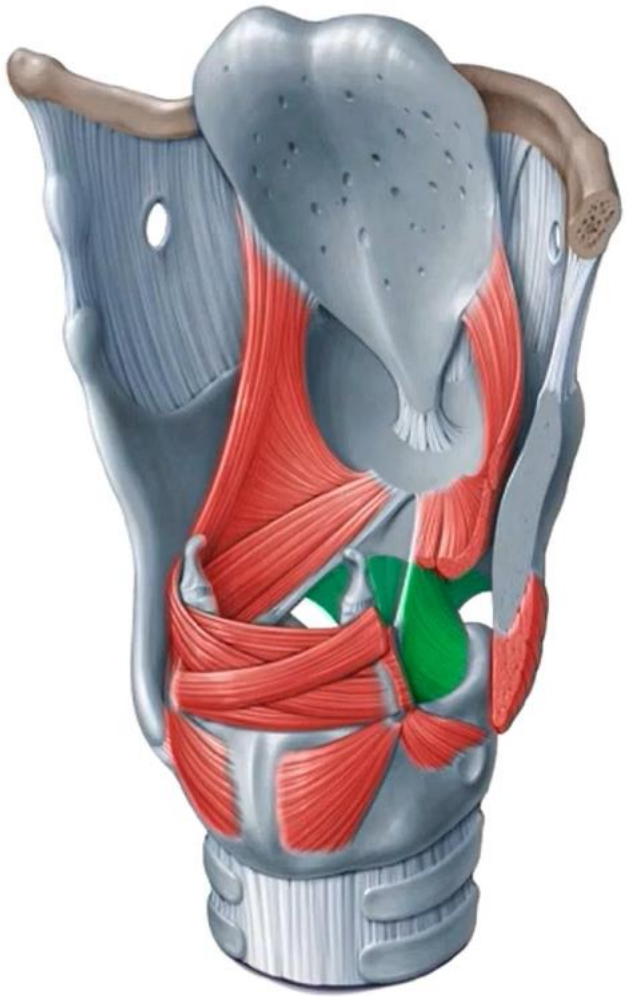


The Cricotracheal Ligament

The intrinsic ligaments of the larynx, also referred to collectively as the fibroelastic membrane of the larynx, include:



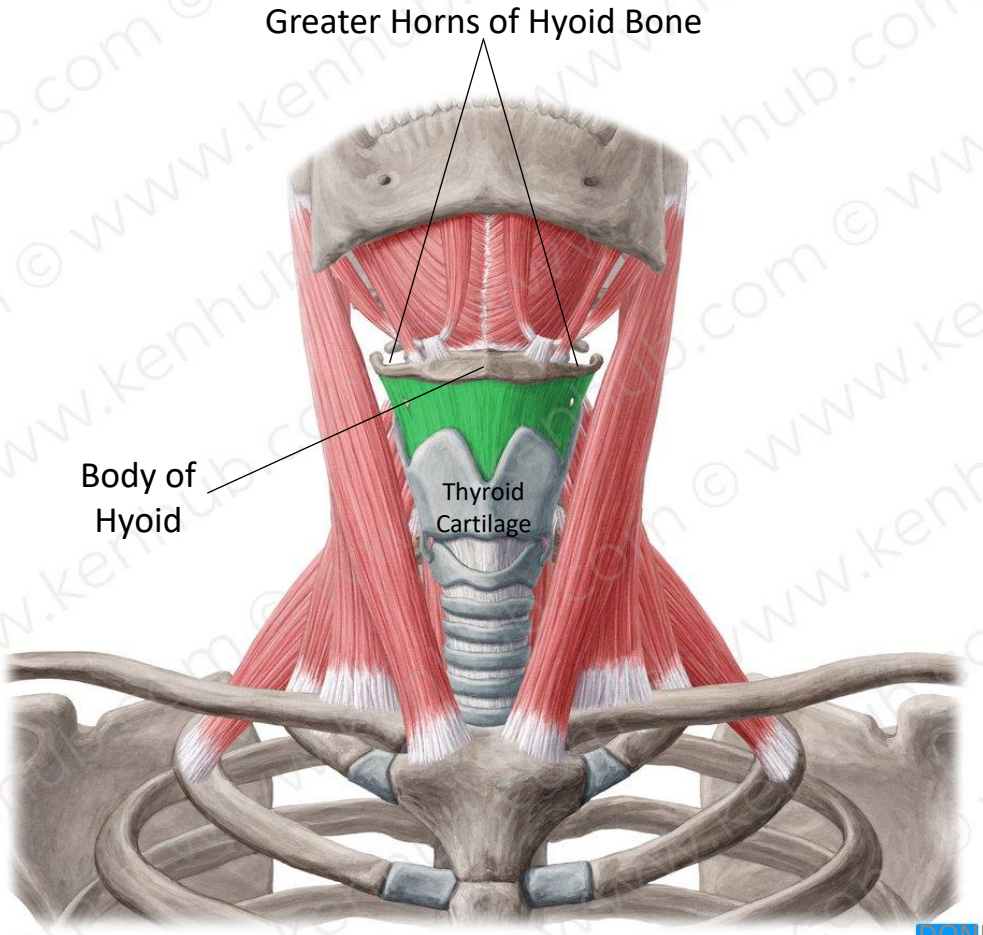
Quadrangular Membrane of the Larynx



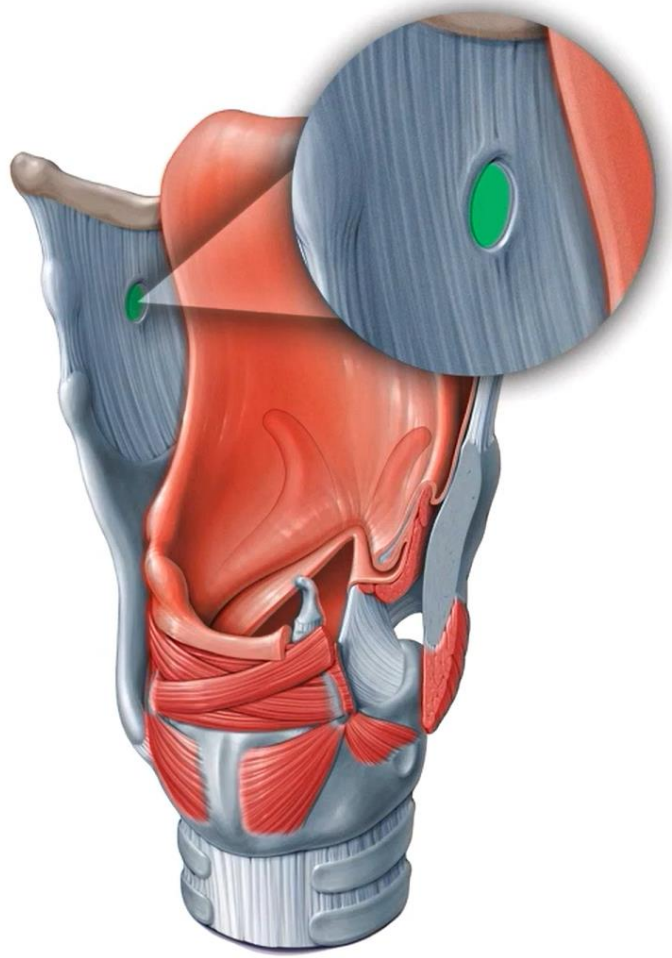
Cricothyroid Membrane.

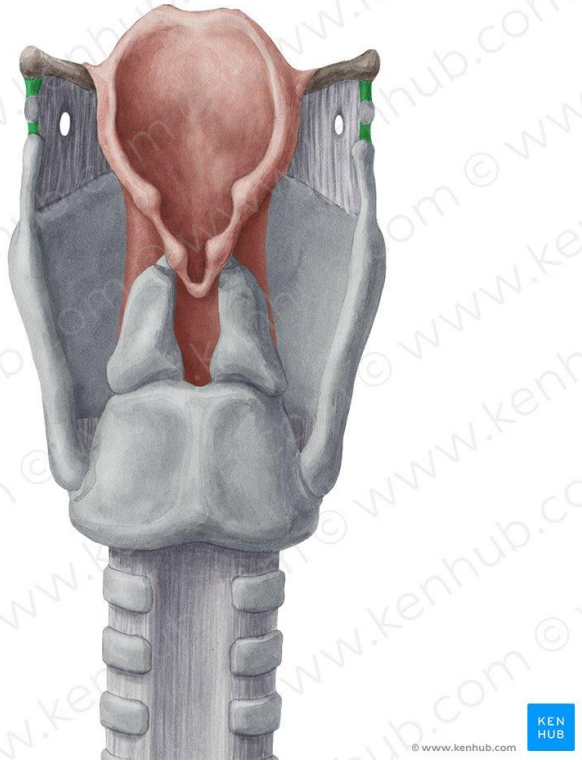
THE THYROHYOID MEMBRANE

- The thyrohyoid membrane is a tough fibroelastic ligament that spans between the superior margin of the thyroid cartilage below and the hyoid bone above.
- It is attached to the thyroid laminae and adjacent anterior margins of the superior horns of the thyroid cartilage inferiorly, then it ascends medially to the greater horns and posteriorly to the body of the hyoid bone to attach to the superior margins of these structures.



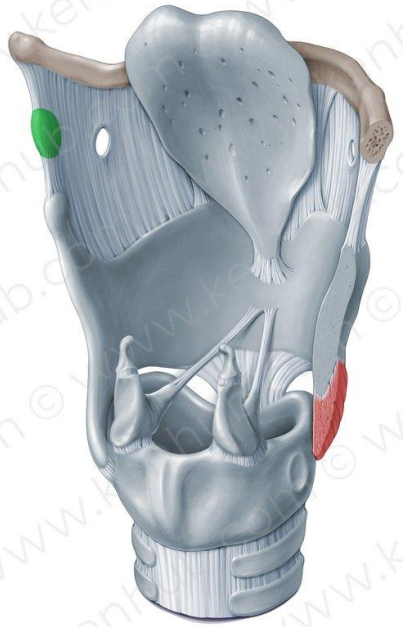
An aperture in the lateral part of the thyrohyoid membrane on each side is for the superior laryngeal vessels, nerve, and lymphatics.
It transmits these structures to the interior of the laryngeal cavity.





The posterior borders of the thyrohyoid membrane are thickened to form the lateral thyrohyoid ligaments.

The thyrohyoid membrane is also thickened anteriorly in the midline to form the median thyrohyoid ligament.



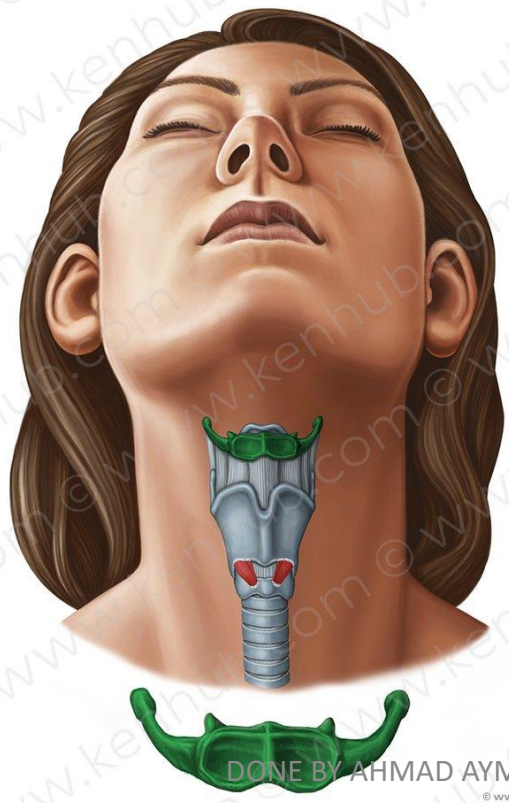
Occasionally, there is a small cartilage called the triticeal cartilage in each lateral thyrohyoid ligament.

Remember: the hyoid bone is a bone that is located in the upper neck, it is composed of a body, greater horns (cornu) and lesser horns (cornu).

Body of Hyoid bone

Greater horns of Hyoid Bone

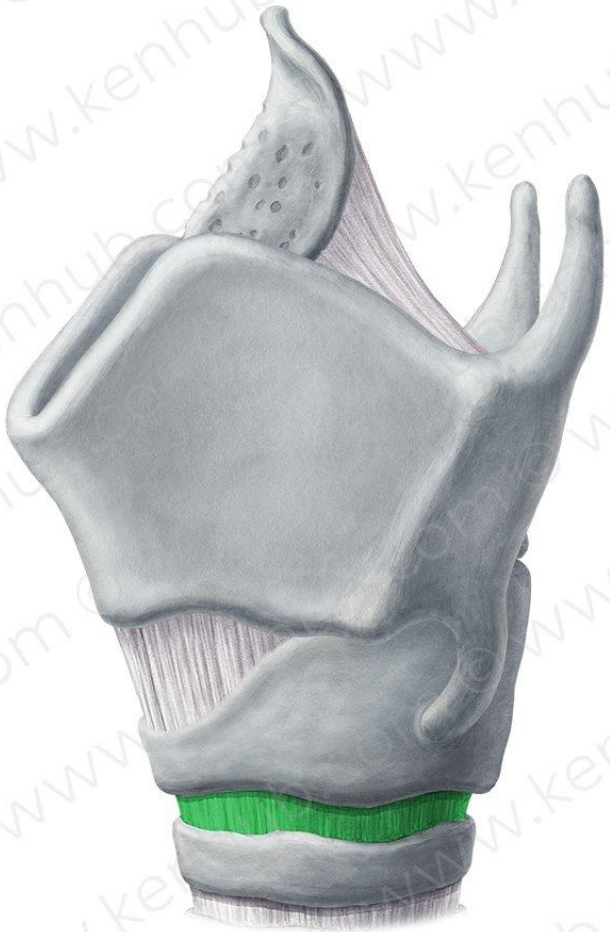
Lesser horns of Hyoid Bone



The hyoid bone in situ

CRICOTRACHEAL LIGAMENT

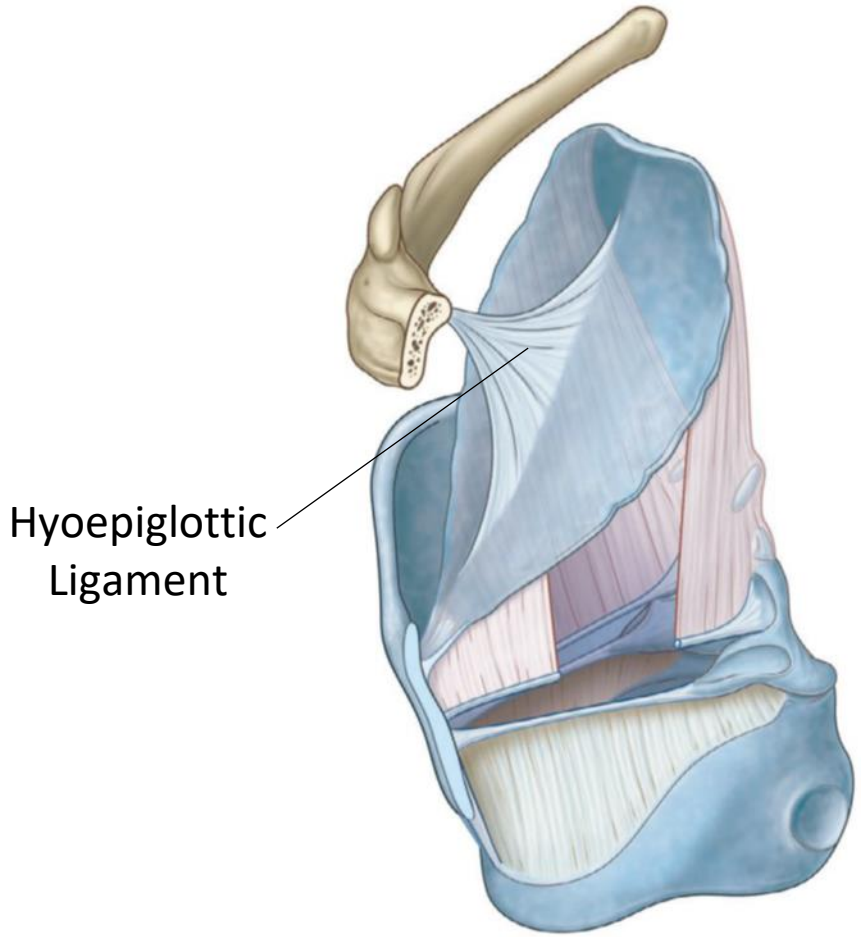
Cricotracheal ligament runs from the lower border of the cricoid cartilage to the adjacent upper border of the first tracheal cartilage.



Note: the cricotracheal ligament is the site of high tracheostomy, the term "tracheostomy" means a hole that is induced in the trachea in ensue breathing when the upper airway is obstructed, when the Cricotracheal ligament is pierced, it is known as a high tracheostomy.

HYOEPIGLOTTIC LIGAMENT

The hyoepiglottic ligament extends from the midline of the epiglottis, anterosuperiorly to the body of the hyoid bone.



INTRINSIC LIGAMENTS OF THE LARYNX

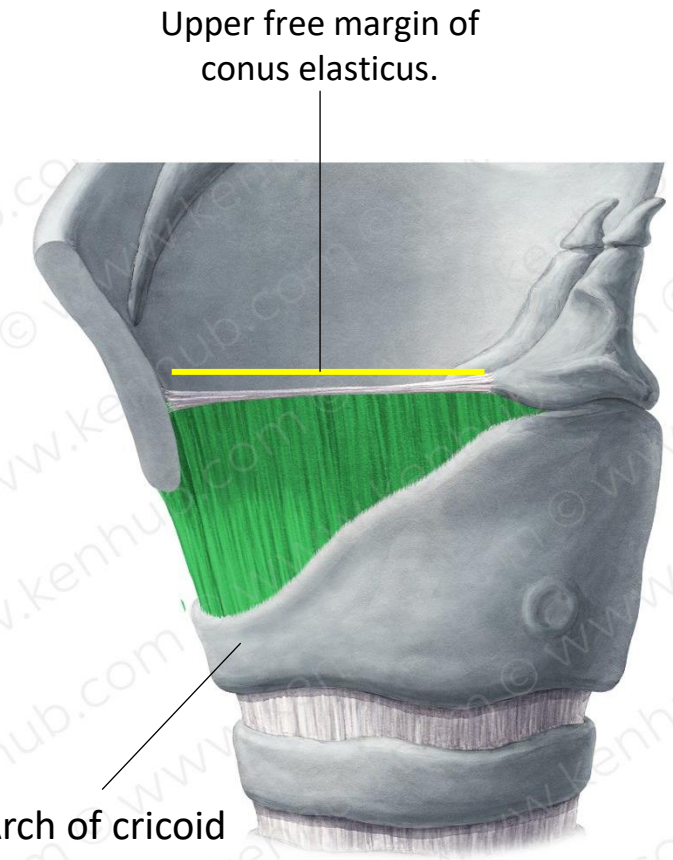
- The intrinsic ligaments of the larynx are collectively referred to as the fibroelastic membrane of larynx, it links together the laryngeal cartilages and completes the architectural framework of the laryngeal cavity
- The fibroelastic membrane of the larynx is composed of two parts: a lower cricothyroid ligament and an upper quadrangular membrane.

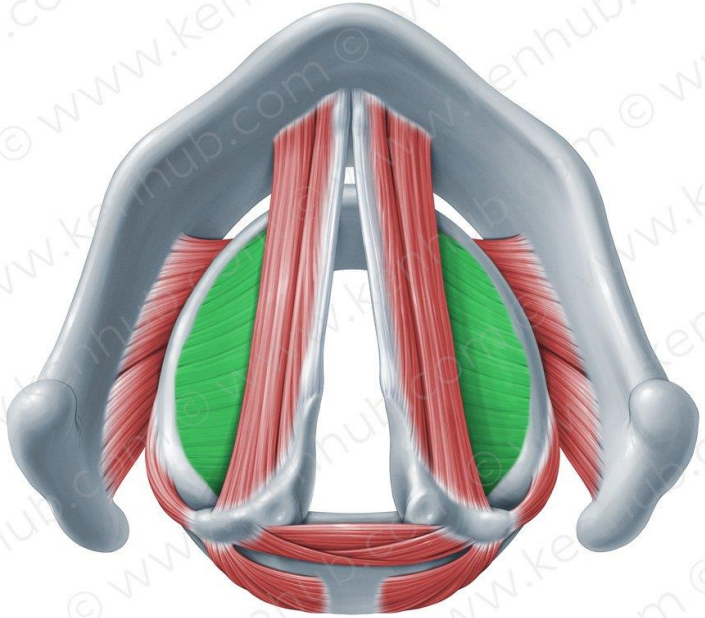
Quadrangular Membrane of the Larynx

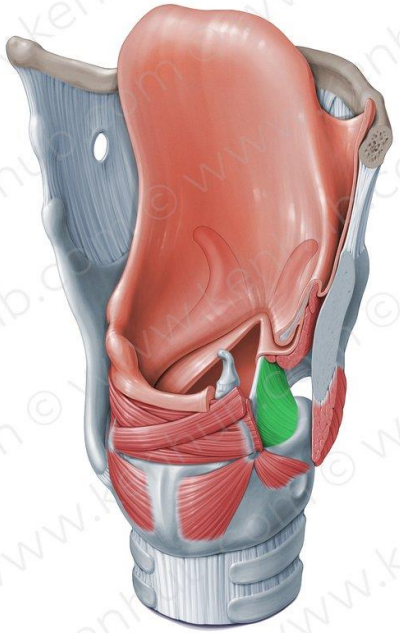
Cricothyroid Membrane.

CRICOTHYROID LIGAMENT (A VERY IMPORTANT ISSUE)

The cricothyroid ligament (membrane) -also referred to as the cricovocal ligament or the conus elasticus- is attached inferiorly to the arch (anterior part) of cricoid cartilage and extends superiorly until it ends in a free (unattached) upper margin within the space enclosed by the thyroid cartilage.

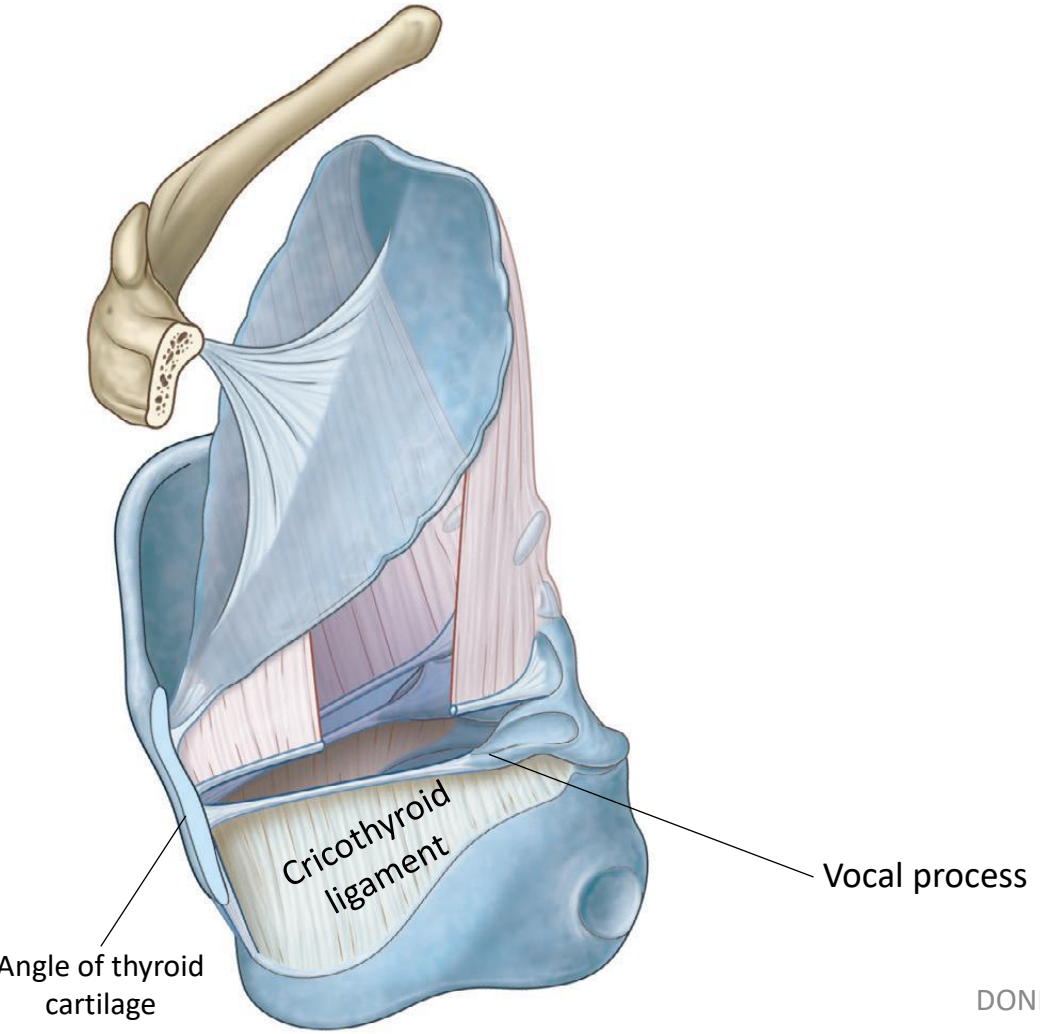


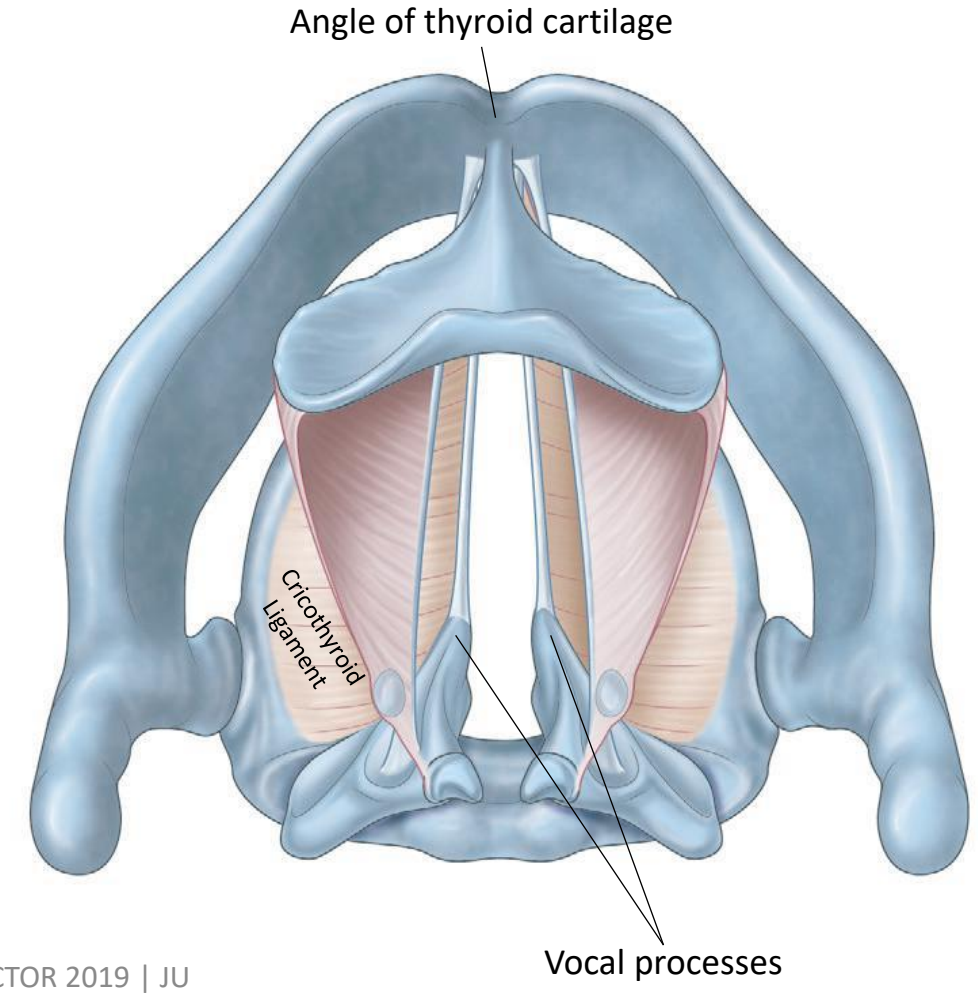




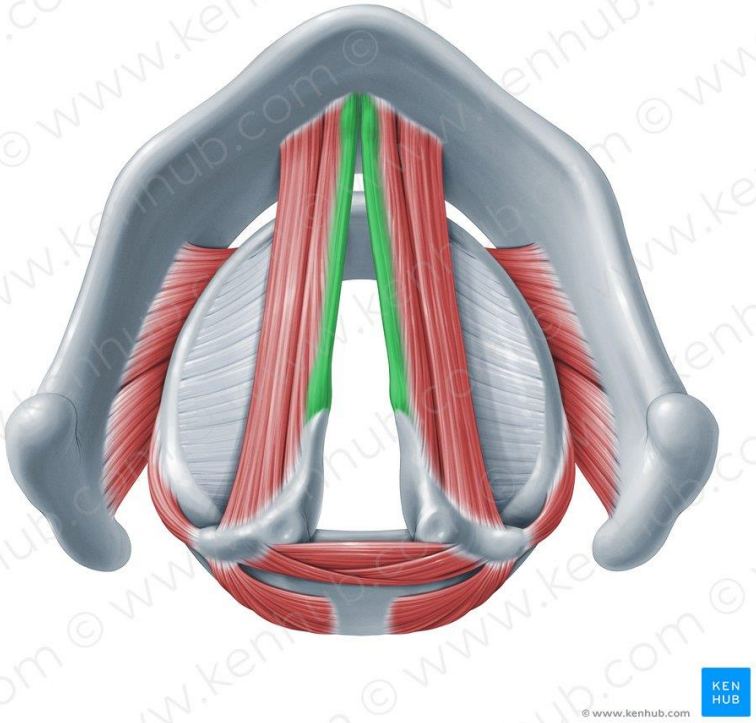
The upper free margin of cricothyroid ligament attaches:

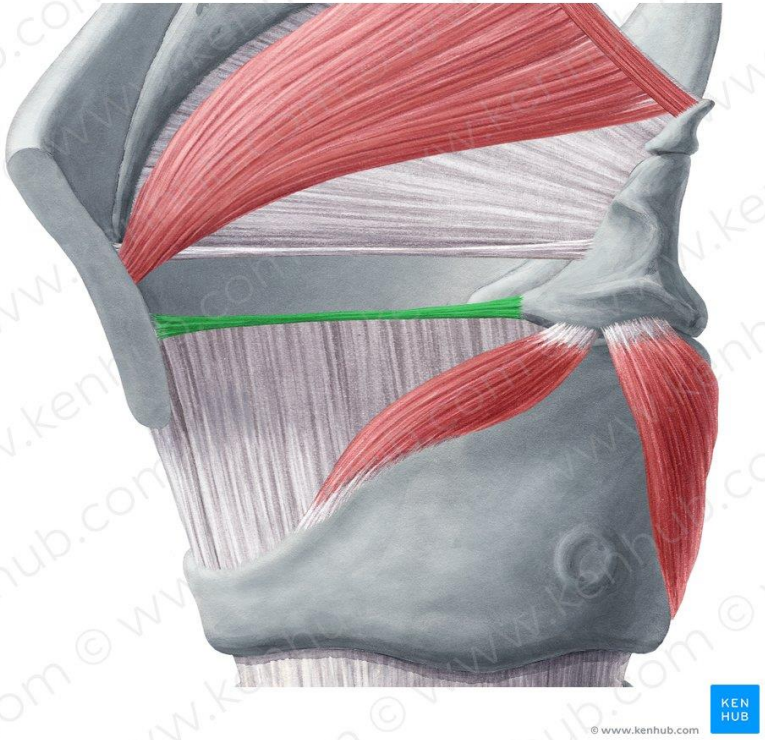
- Anteriorly to the angle of thyroid cartilage.
- Posteriorly to the vocal processes of the arytenoid cartilages.

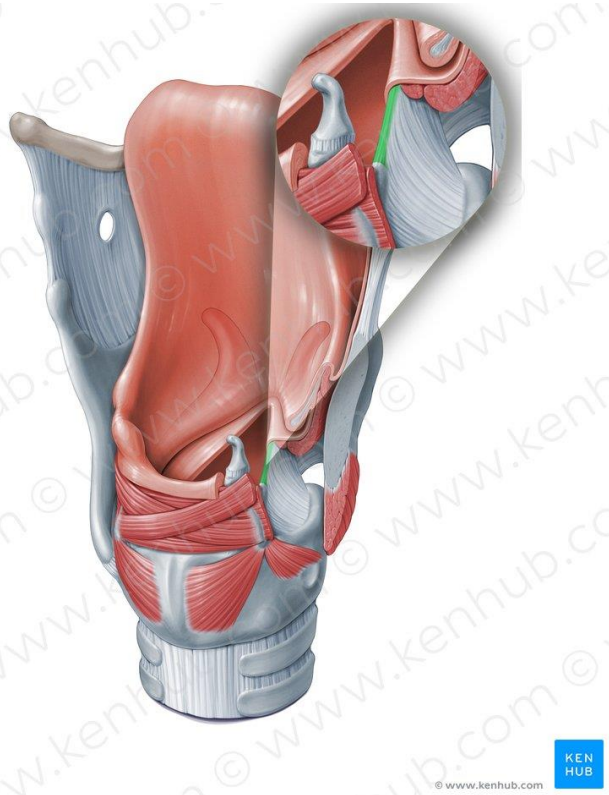




The upper free margin of the cricothyroid ligament is thickened to form the vocal ligament, which is under the vocal fold (true vocal cord) of the larynx. (vocal cord = vocal ligament + vocalis muscle + mucosa).





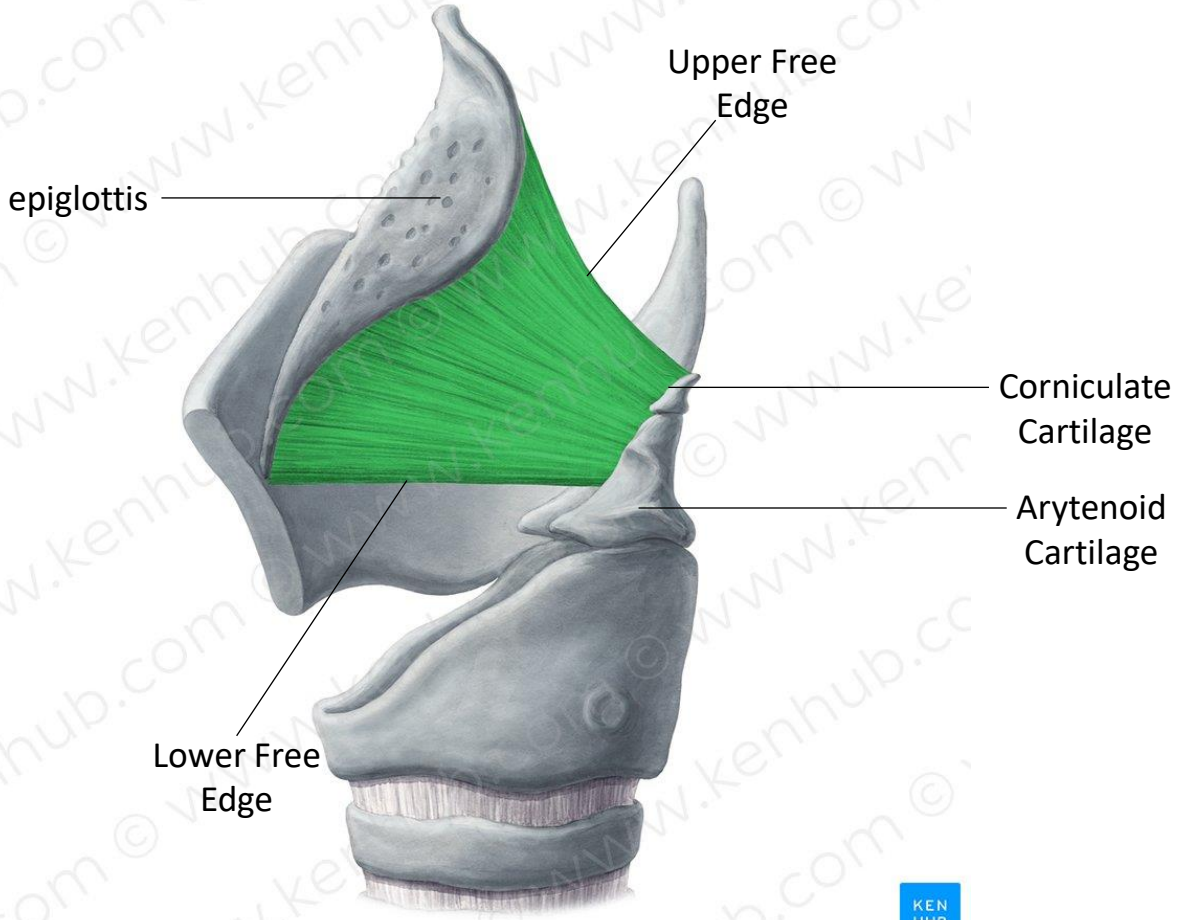


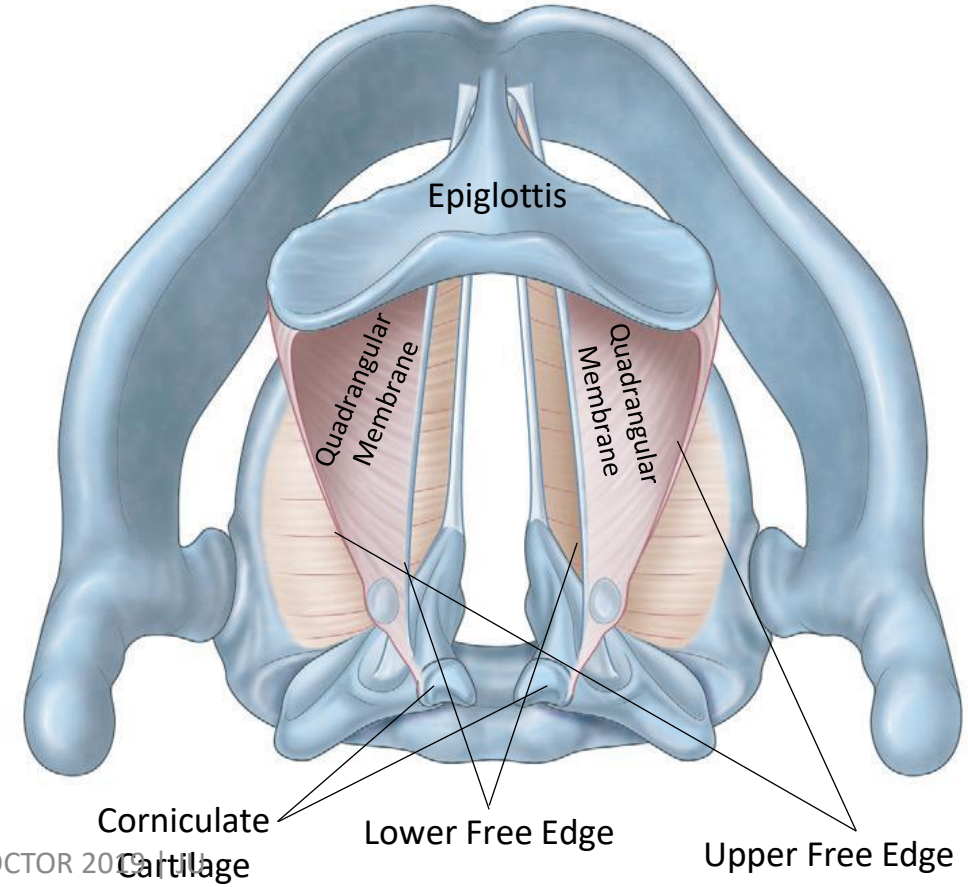
The cricothyroid ligament is also thickened anteriorly to form a median cricothyroid ligament.

Note: in cricothyrotomy or laryngotomy, this ligament can also be cut to open the airways.

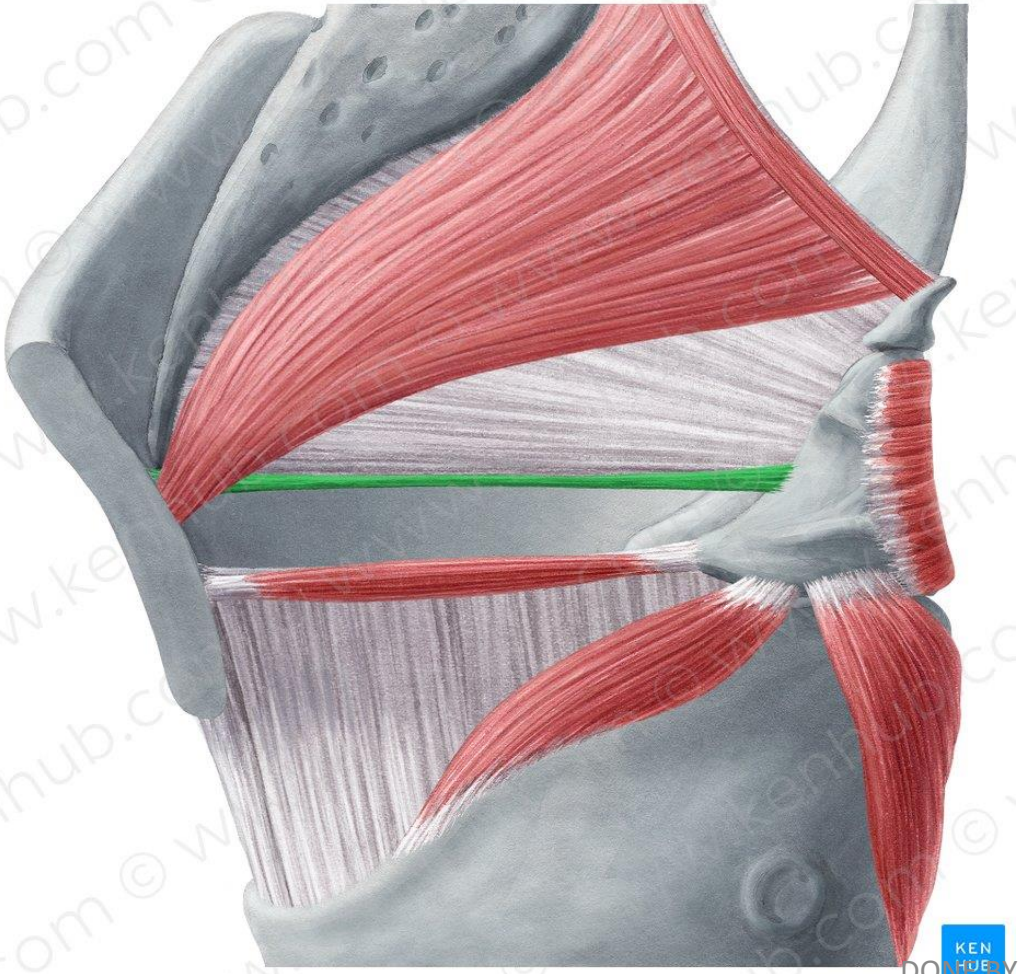
QUADRANGULAR MEMBRANE OF THE LARYNX

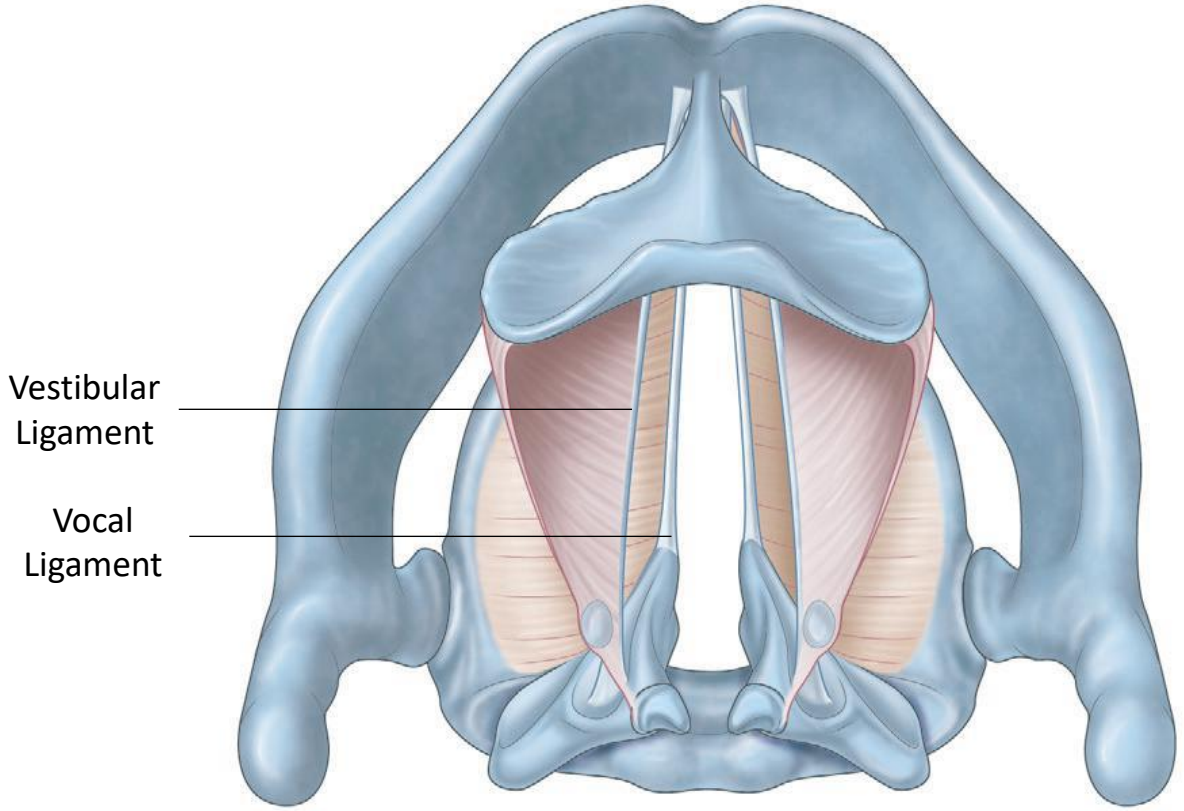
The quadrangular membrane runs between the lateral margin of the epiglottis and the anterolateral surface of the arytenoid cartilage, it is also attached to the corniculate cartilage and it covers the cuneiform cartilage, it has a free upper margin and a free lower margin.





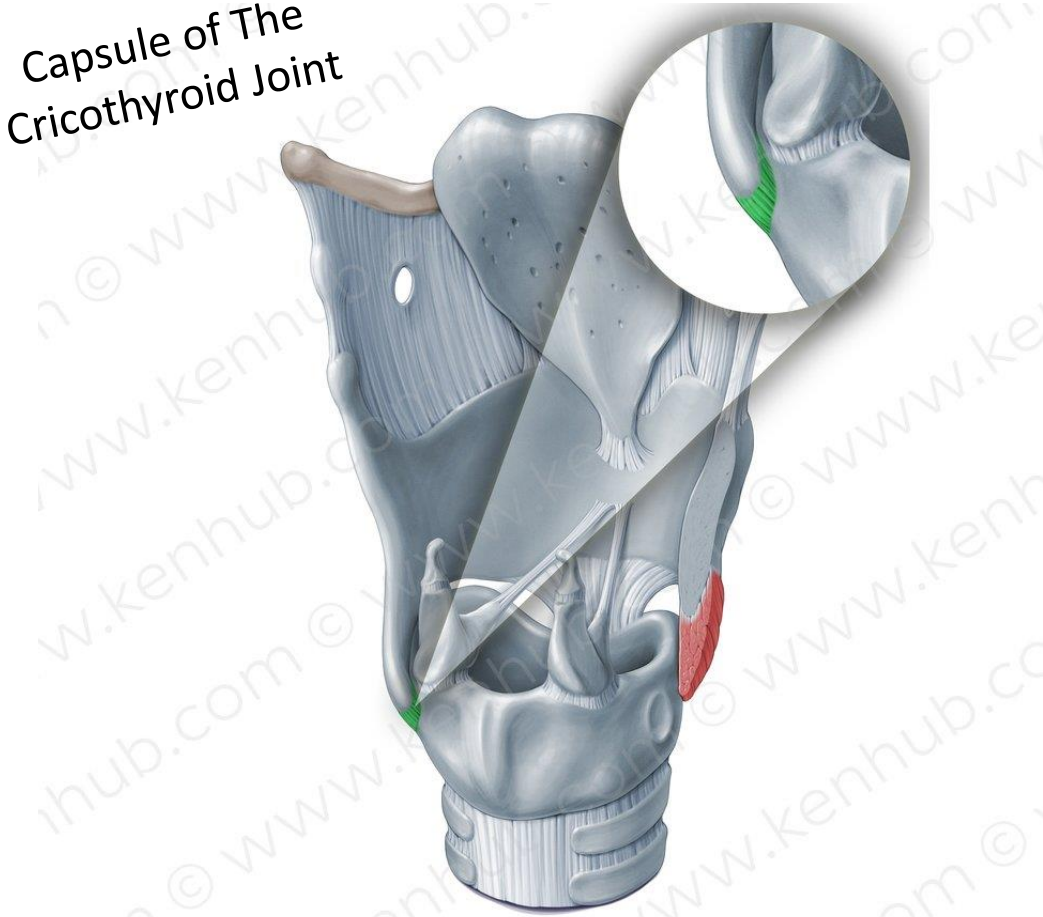
- The free lower margin of the quadrangular membrane is thickened to form the vestibular ligament under the vestibular fold (also called the false vocal cord)
- Vestibular ligament is separated from the vocal ligament below by a gap.
- When viewed from above, the vestibular ligament is lateral to the vocal ligament.



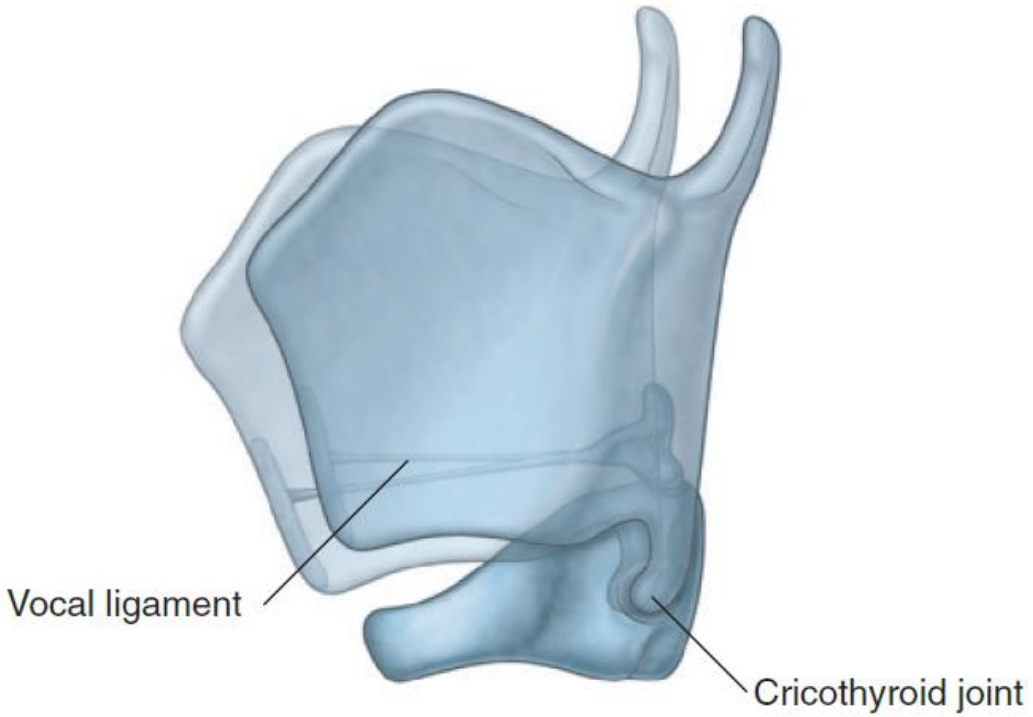


LARYNGEAL JOINTS : CRICOTHYROID JOINT

The cricothyroid joint is the joint between the inferior horns of the thyroid cartilage and the facets on the lateral surface of cricoid cartilage , this joint is synovial, so its allows movement. , the cricothyroid joint is surrounded by a capsule and is reinforced by associated ligaments

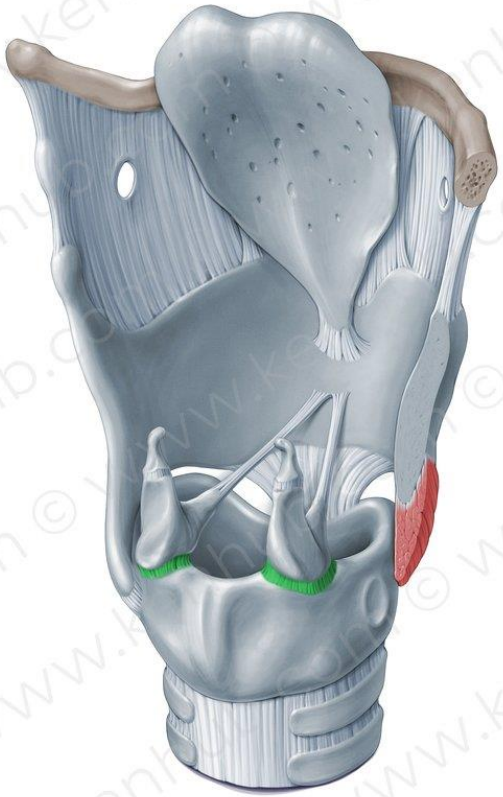


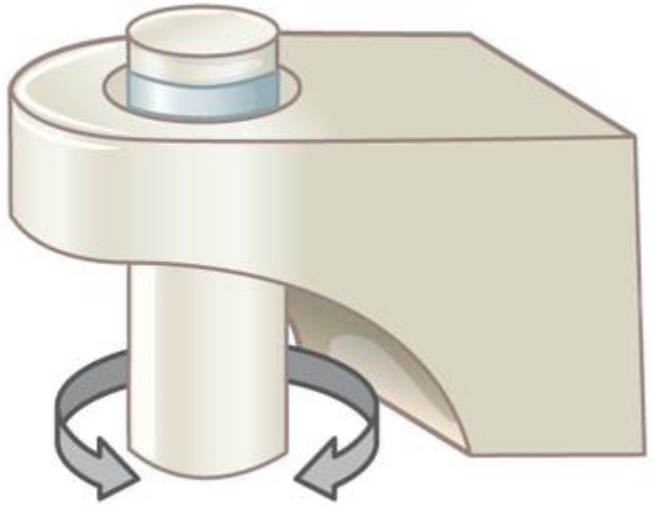
- The cricothyroid joint enables the thyroid cartilage to move forward and tilt downwards on the cricoid cartilage
- Forward movement and downward rotation of the thyroid cartilage effectively lengthens and puts tension on the vocal ligaments (increasing the sound pitch), this action is preformed by cricothyroid muscle.



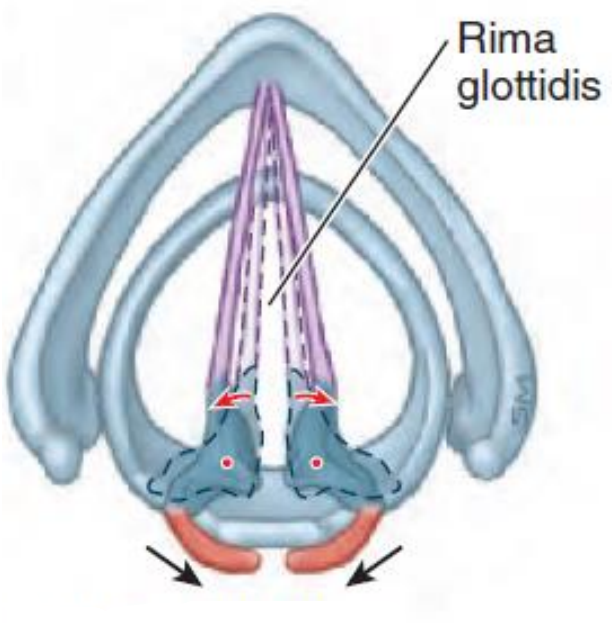
CRICROARYTENOID JOINTS

- The cricoarytenoid joints are formed between the articular facets on the superolateral surfaces of the cricoid cartilage and the bases of the arytenoid cartilages.
- the cricoarytenoid joints are pivot joints, meaning that they enable the arytenoid cartilages to rotate externally away form each other or internally towards each other.

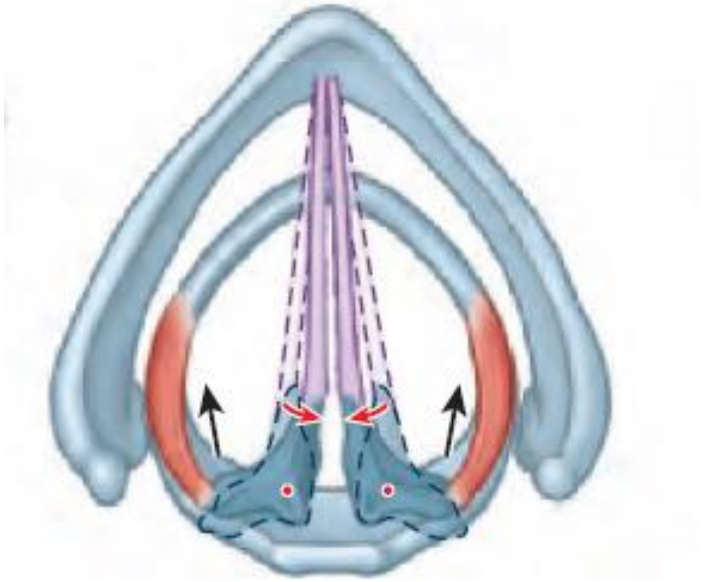




- Movements of cricoarytenoid cartilages abduct and adduct the vocal ligaments.
- Posterior cricoarytenoid muscle abducts the vocal cords through rotating the muscular process of the arytenoid cartilage externally, while the lateral cricoarytenoid muscle rotates the muscular processes internally, adducting the vocal cords.



Posterior crico-arytenoid

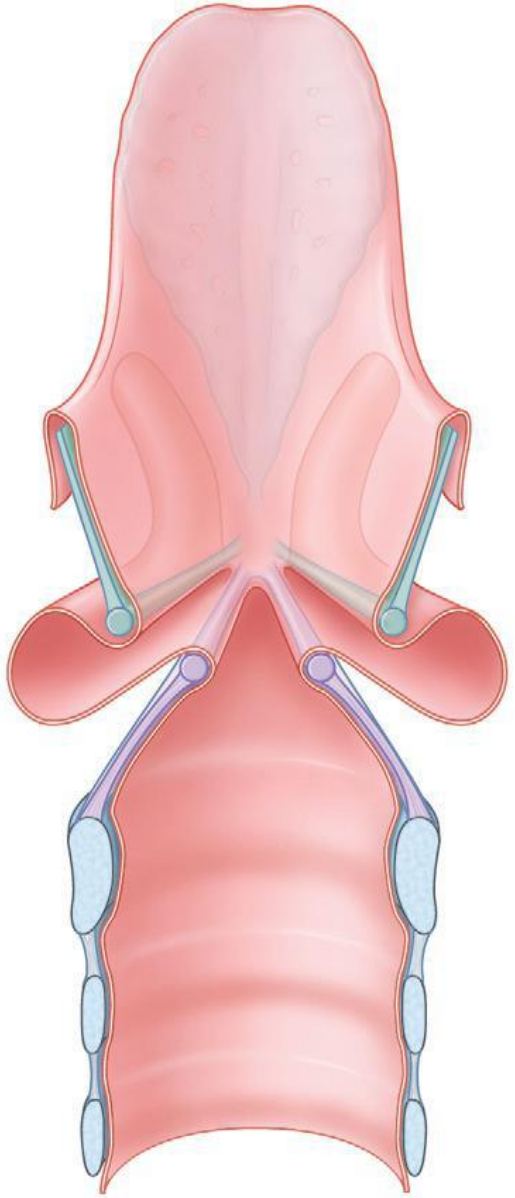


Lateral crico-arytenoid

LARYNGEAL CAVITY.

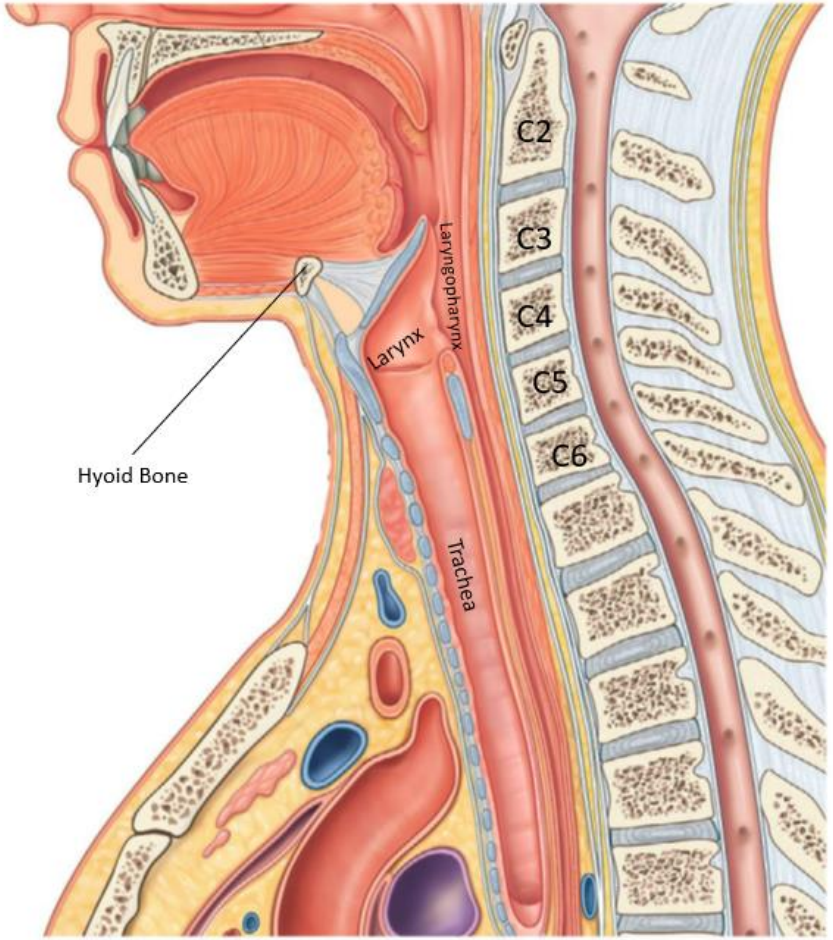
- The central cavity of the larynx is tubular in shape and is lined by mucosa (notice that it is bordered superiorly by the free edge of the epiglottis).

- The laryngeal cavity's support is provided by the fibroelastic membrane of larynx and by the cartilages to which it is attached.



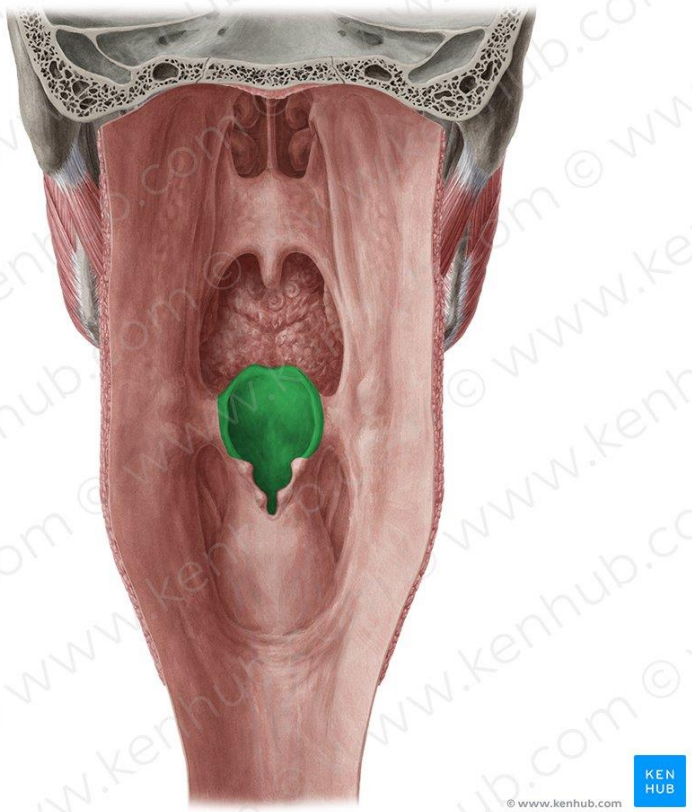
- The superior aperture of the laryngeal cavity, the laryngeal inlet, opens into the anterior aspect of the pharynx just below and posterior to the tongue.
- laryngeal inlet is oblique and points posterosuperiorly.

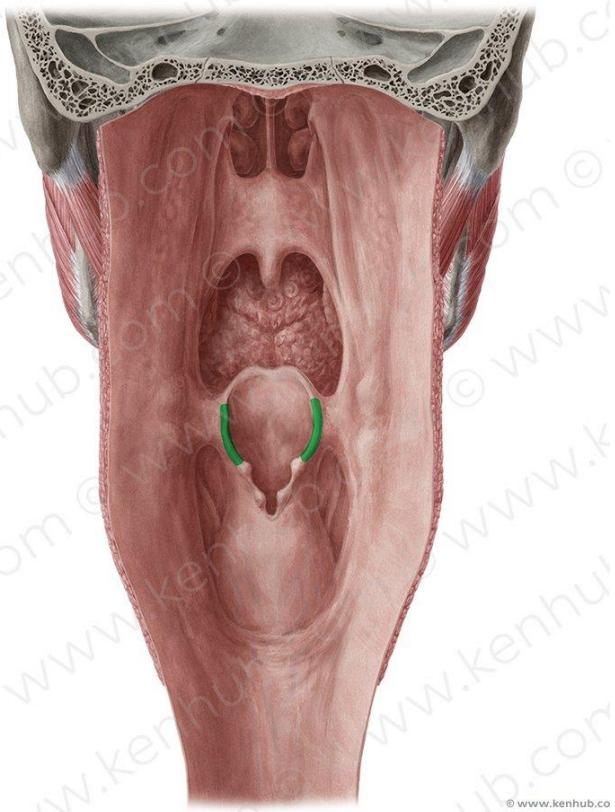
The laryngeal inlet as viewed form the inferior of the pharynx.

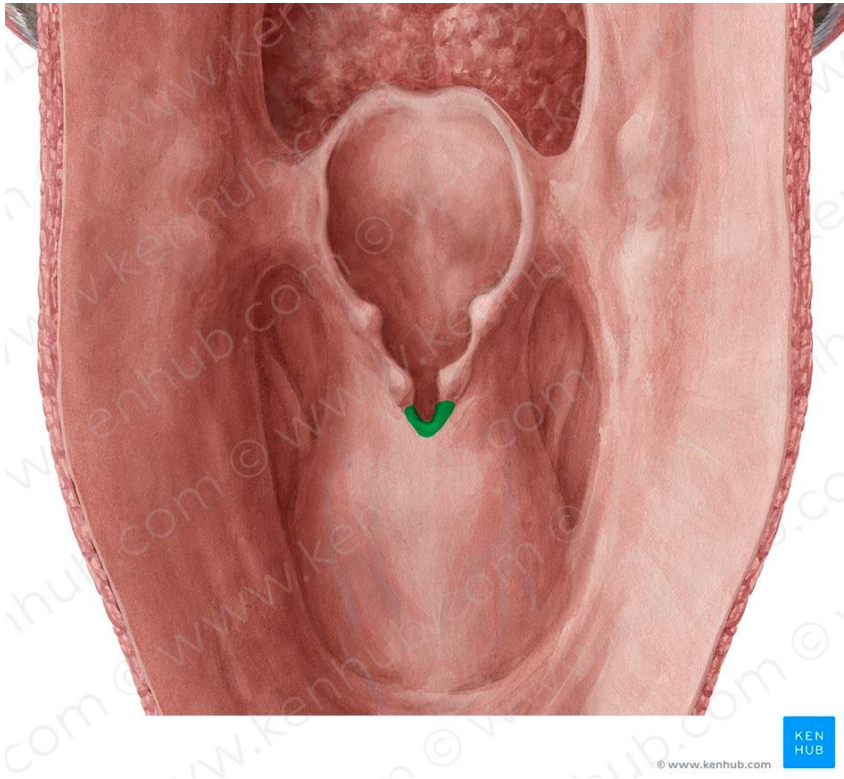


Notice the orientation of the laryngeal inlet

BOUNDARIES OF THE LARYNGEAL INLET





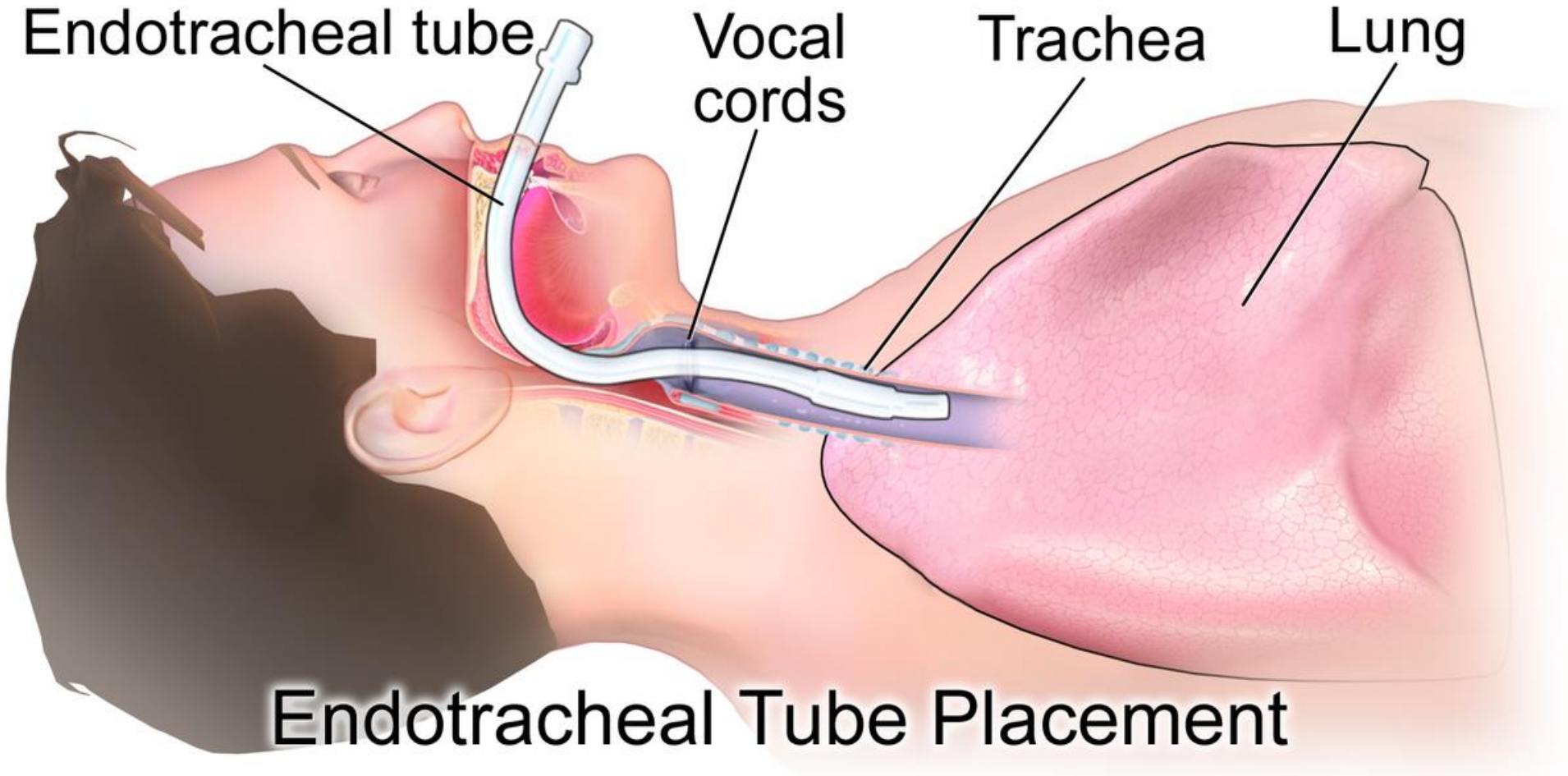


Anterior border of the laryngeal inlet is formed by mucosa covering the superior margin of the epiglottis.

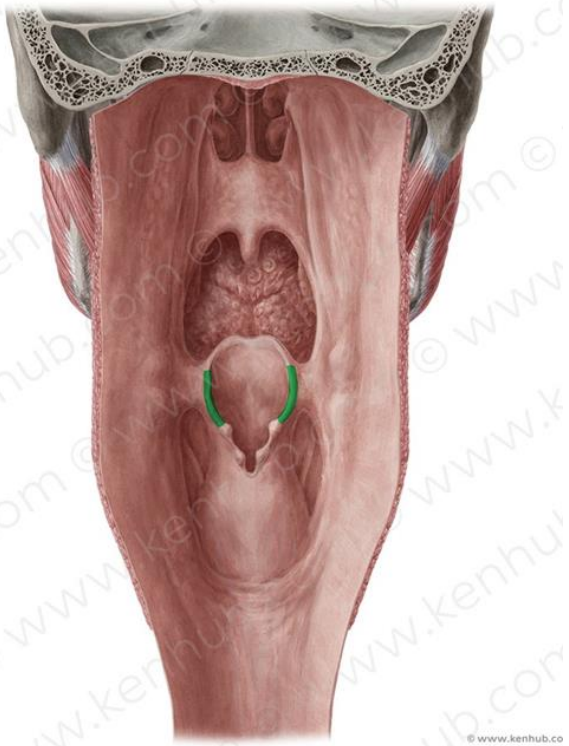
Lateral borders of the laryngeal inlet are formed by mucosal folds called the aryepiglottic folds, these folds are formed by the upper free border of the quadrangular membrane and the aryepiglottic muscle.

Posterior border in the midline is formed by a mucosal fold that forms a depression, it is called interarytenoid notch and it is located between the two corniculate tubercles (contains the transverse arytenoid muscle)

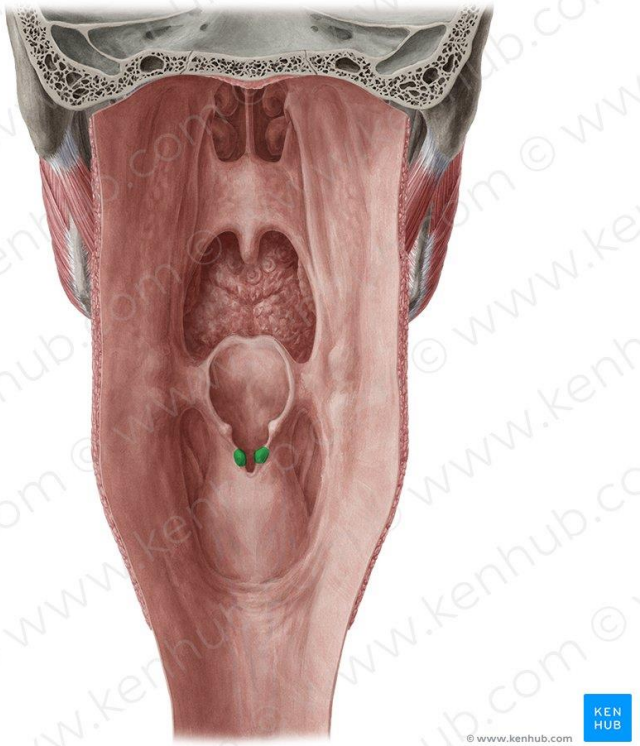
clinical note: you must memorize the boundaries of the laryngeal cavity carefully if you wanna become an anesthesiologist, this is because of the endotracheal tube, anesthesiologist insert an endotracheal tube in patients before anesthesia to maintain the airway, this is because anesthesia might result in adduction of vocal cords and closure of the laryngeal inlet, so you insert a tube from the oral cavity through the laryngeal inlet to reach the trachea.



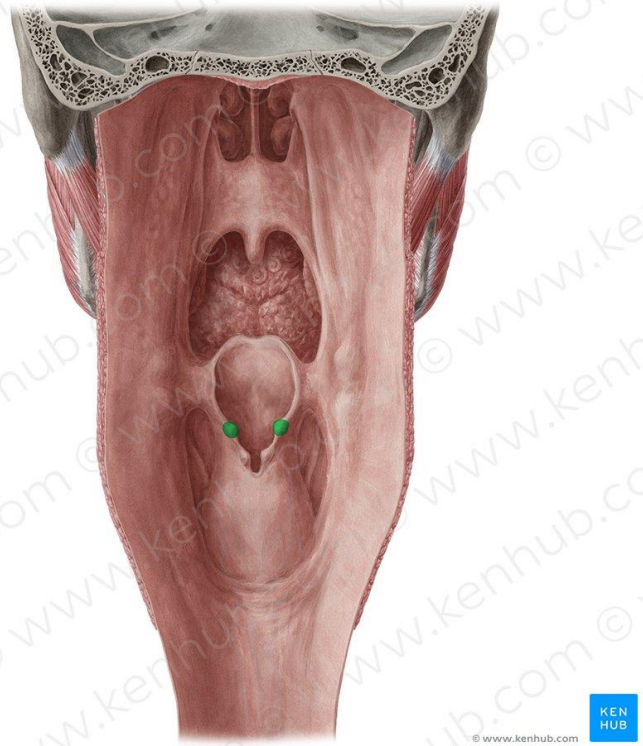
- The aryepiglottic folds enclose the superior margins of the quadrangular membranes and adjacent soft tissues
- Two tubercles on the more posterolateral margin side mark the positions of the underlying cuneiform and corniculate cartilages.



Aryepiglottic fold

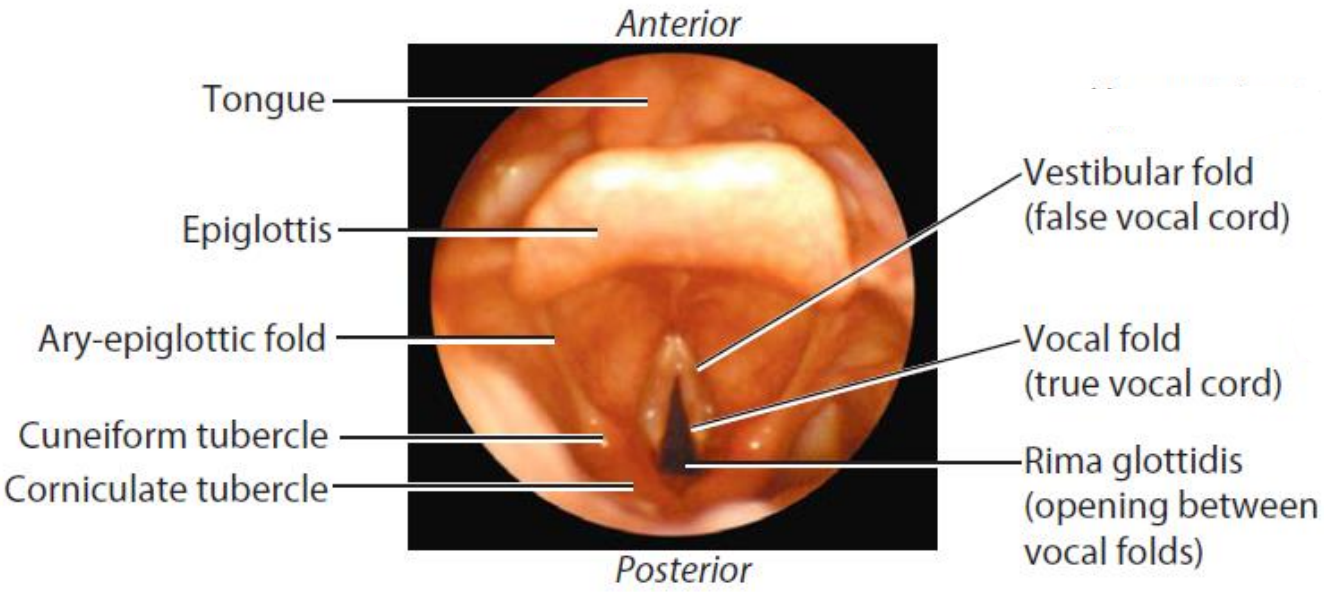


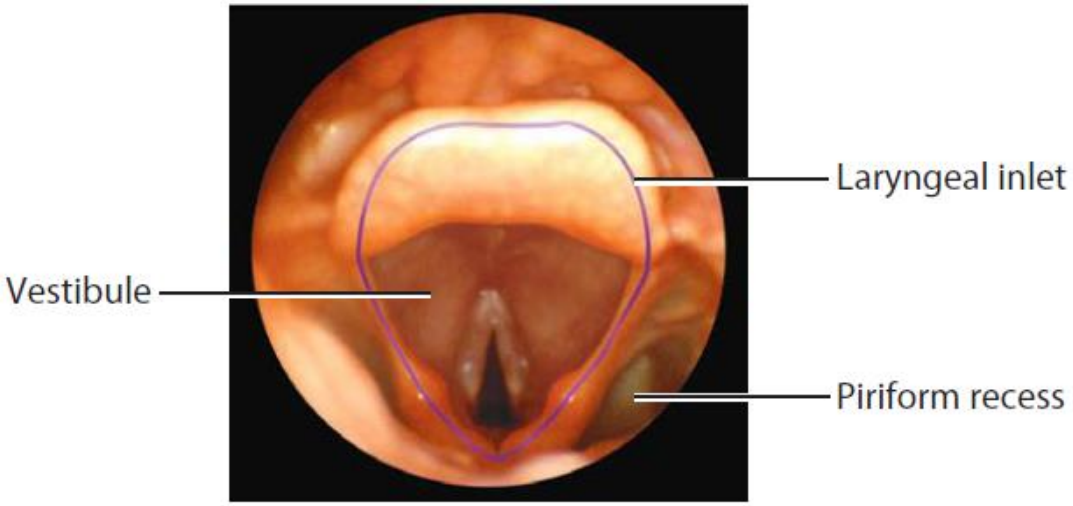
Corniculate Tubercles



Cuneiform Tubercles

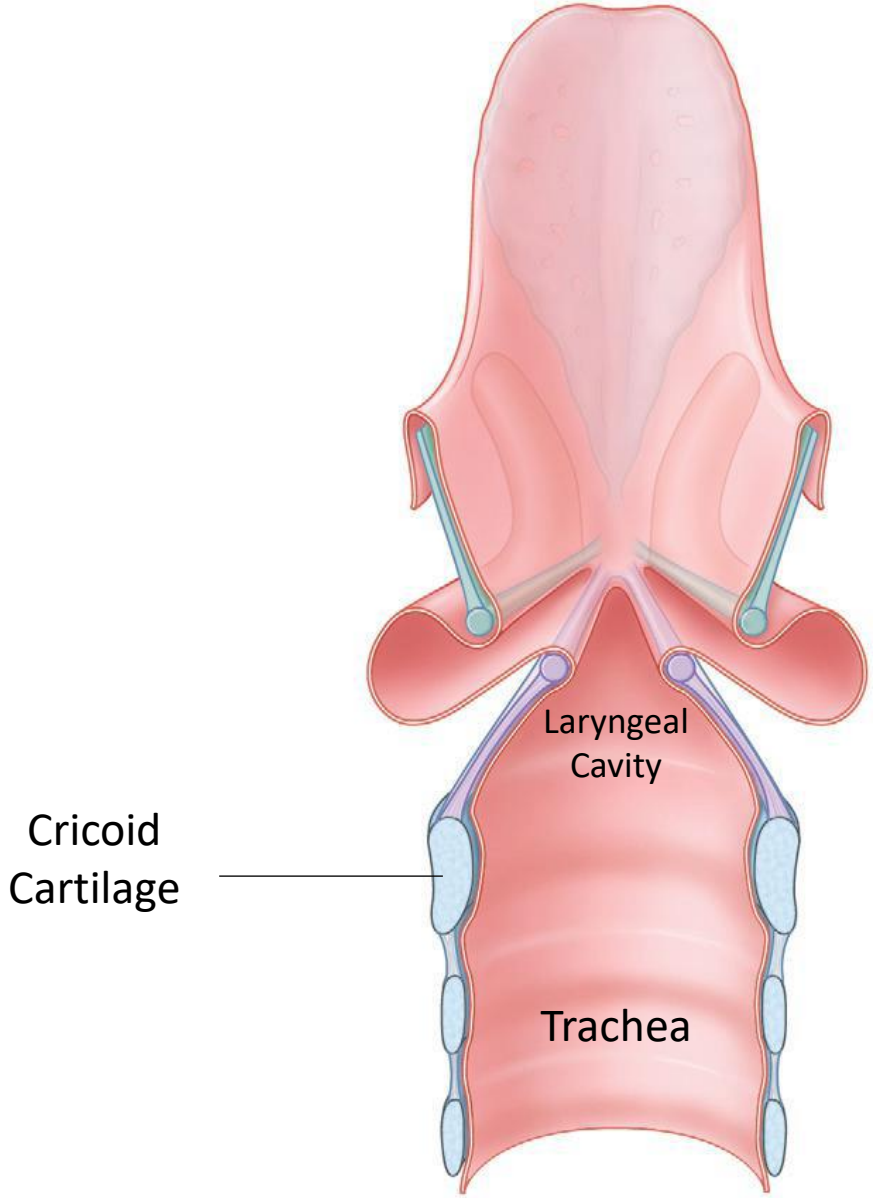
LARYNGOSCOPY





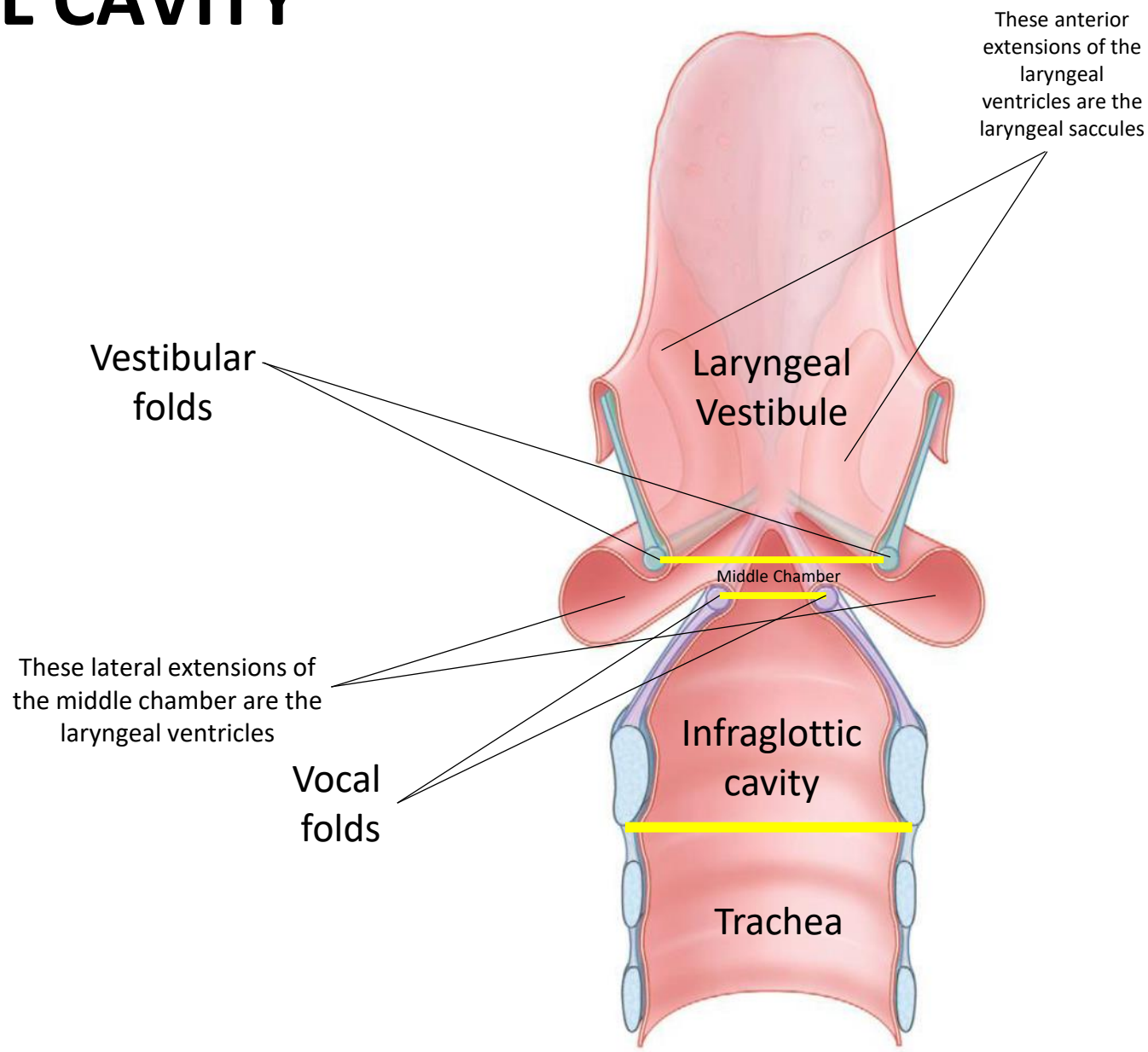
INFERIOR OPENEING OF THE LARYNGEAL CAVITY.

- The inferior opening of the laryngeal cavity is continuous with the lumen of the trachea.
- It is Completely encircled by the cricoid cartilage and it is horizontal in position unlike the laryngeal inlet.
- The inferior opening is continuously open whereas the laryngeal inlet can be closed by downward movement of the epiglottis



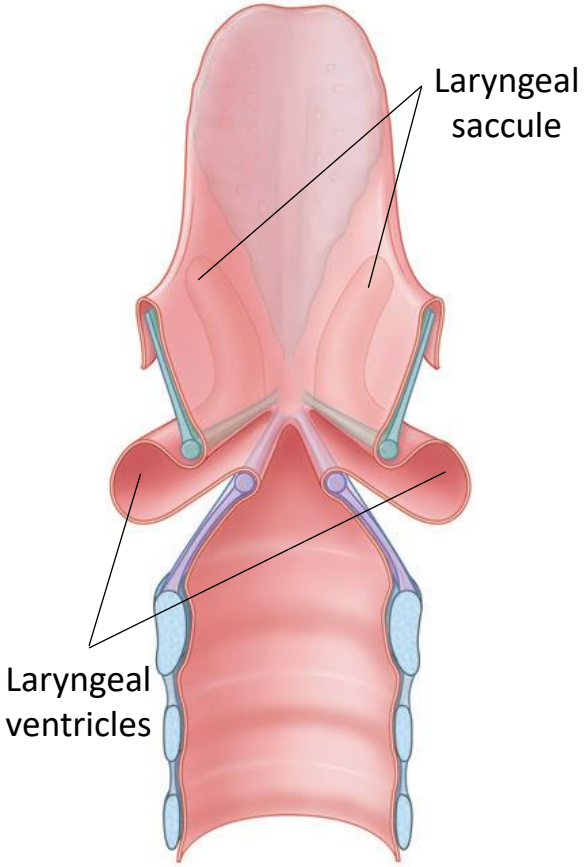
DIVISIONS OF THE LARYNGEAL CAVITY

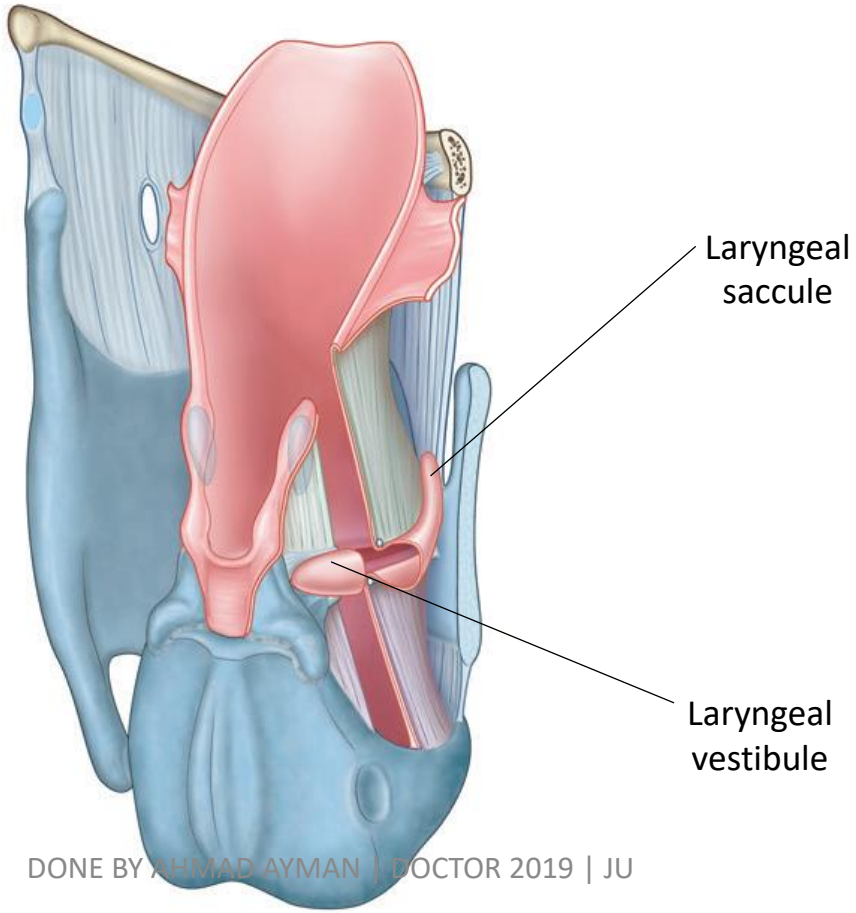
- The vestibular and vocal folds divide the laryngeal cavity into three major regions: the laryngeal vestibule, the middle chamber, and the infraglottic cavity.
- The vestibule is the upper chamber of the laryngeal cavity between the laryngeal inlet (epiglottis) and the vestibular folds.
- The middle part of the laryngeal cavity is very thin and is between the vestibular folds above and the vocal folds below (the middle chamber is also called the glottic compartment).
- The infraglottic space is the most inferior chamber and is between the vocal folds and the inferior opening of the larynx, (inferior border of cricoid cartilage).

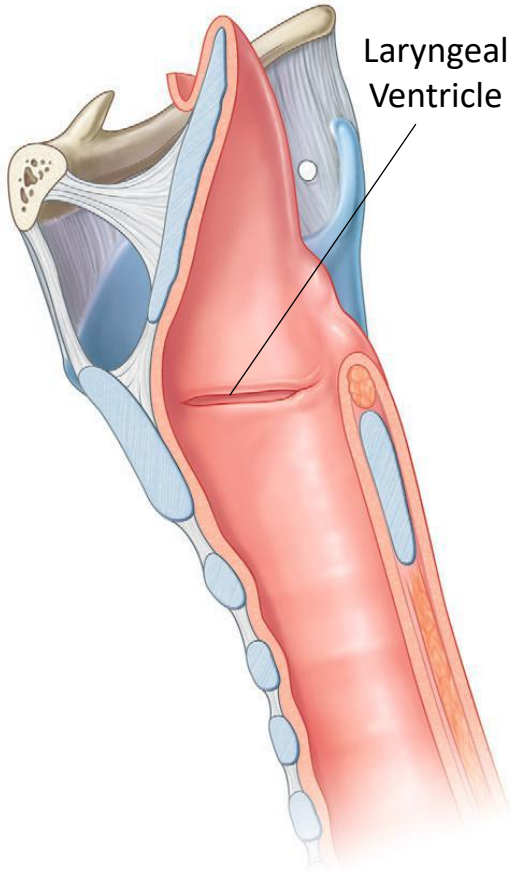


LARYNGEAL VENTRICLES AND SACCULES

- On each side, the mucosa of the middle chamber bulges laterally through the gap between the vestibular and vocal ligaments to produce the laryngeal ventricle.
- A Tubular extension of each ventricle called laryngeal saccule projects anterosuperiorly between the vestibular fold and thyroid cartilage.
  - The mucosa of the wall of the laryngeal saccule contains seromucous glands, these gland secrete a fluid that lubricates the vocal cords.



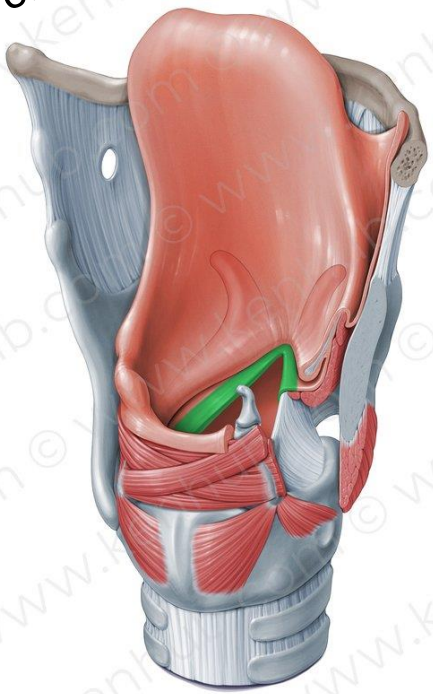




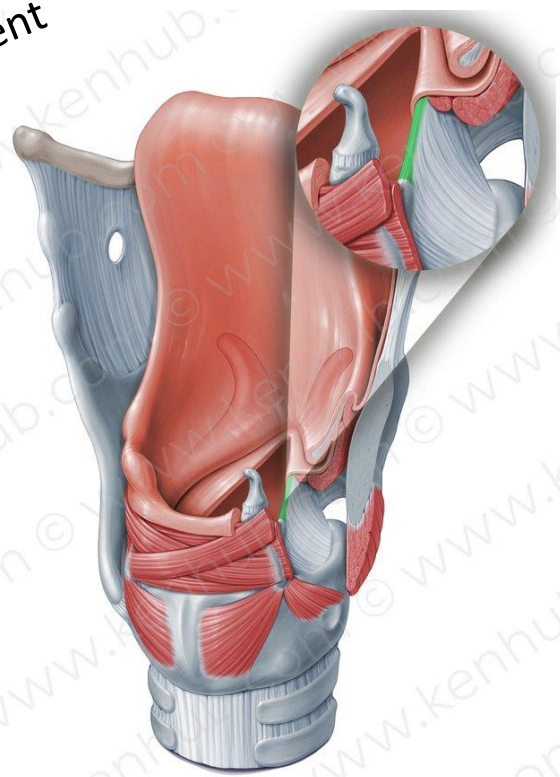
THE VOCAL FOLDS (TRUE VOCAL CORDS)

The vocal folds contains the vocal ligament and the vocalis muscle, in contrast to all of the laryngeal cavity, the vocal folds are lined with nonkeratinized stratified squamous epithelium rather than the regular respiratory epithelium.

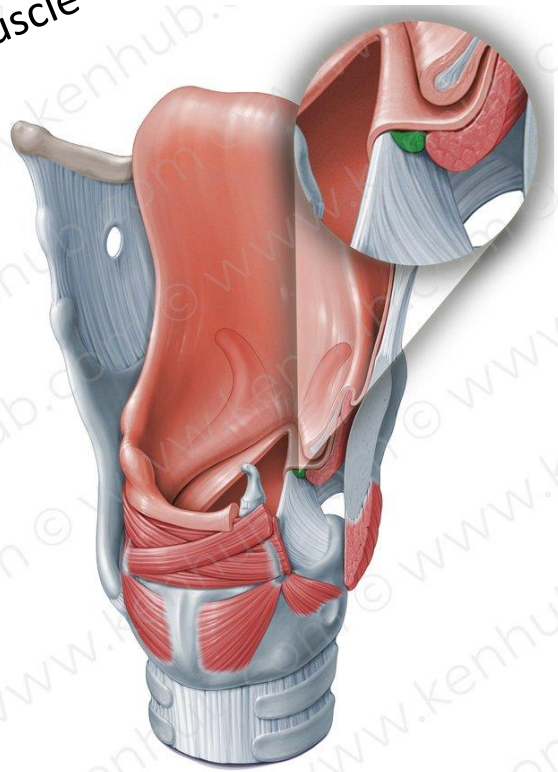
Vocal Fold



Vocal Ligament

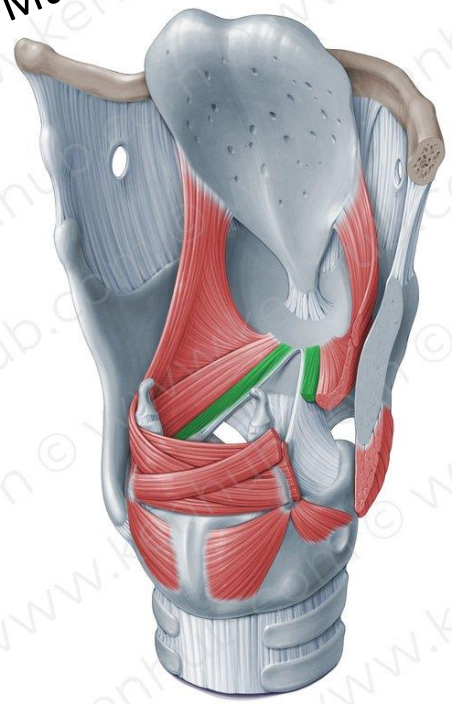


Vocalis Muscle

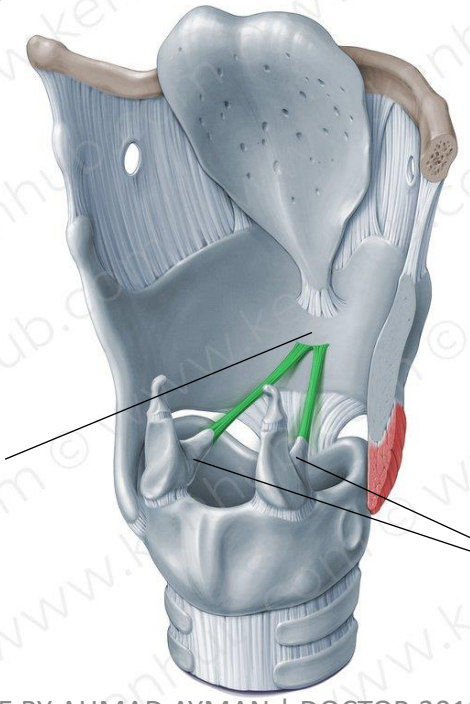


- The vocal cords are avascular and devoid of lymphathic drainage and submucosa (vascularity or lymphatic drainage would result in accumulation in fluid which would interfere with their function.
- They extend between the vocal process of arytenoid cartilage posteriorly and the interior of the anterior laminae of thyroid cartilage.
- The difference in their length, as we mentioned, accounts for difference in sound pitch between genders.

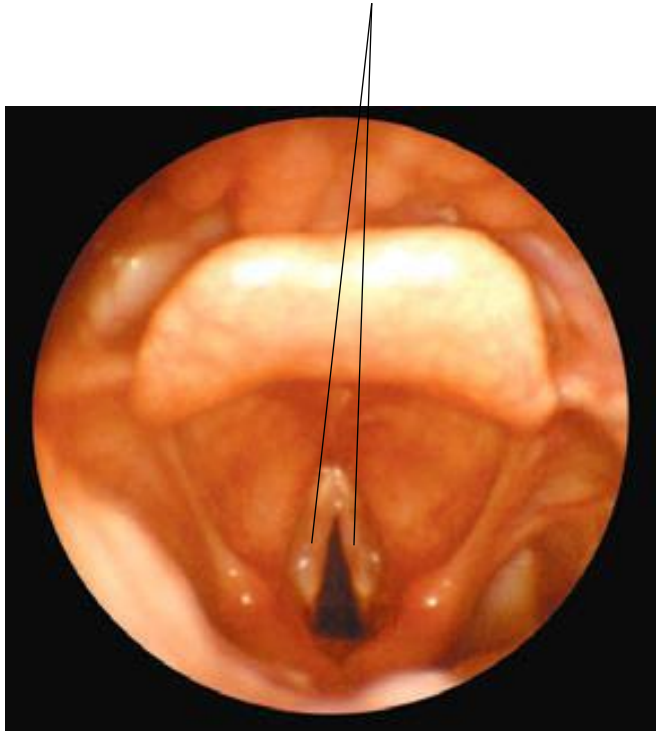
Vocalis Muscle



Vocal Ligaments



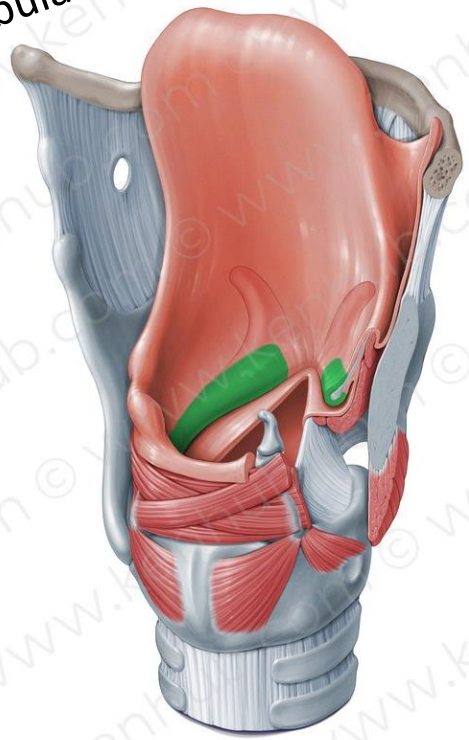
Note that the true vocal cords appear lighter and more whitish in color compared to their red surroundings (like vestibular folds) due to their avascularity.



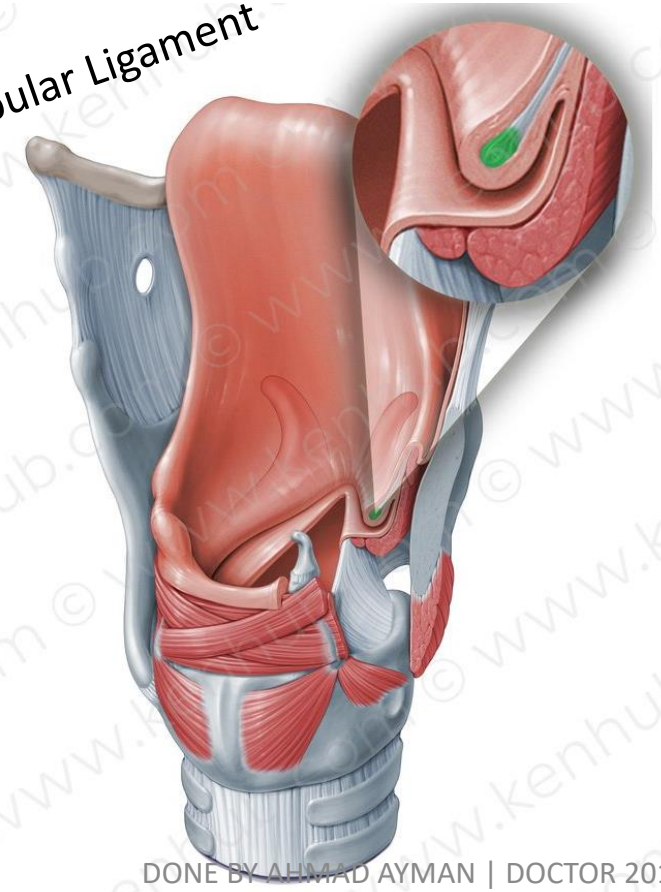
VESTIBULAR FOLDS (FALSE VOCAL CORDS)

- Vestibular folds enclose the vestibular ligaments and associated soft tissues
- Unlike the vocal cords, they are more reddish in color because they are vascular.
- The vestibular folds are generally immobile, however, they can be adducted to close the laryngeal inlet when carrying a heavy object, thus trapping the air in the lungs and stabilizing the intrathoracic and intraabdominal pressure during weight lifting.

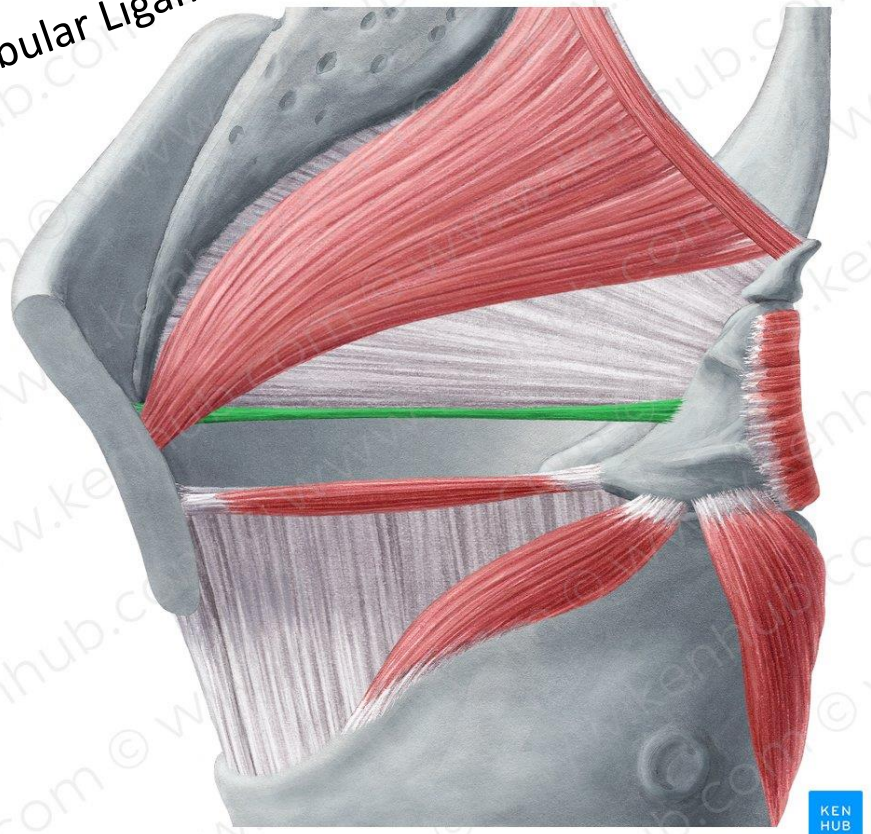
Vestibular Folds



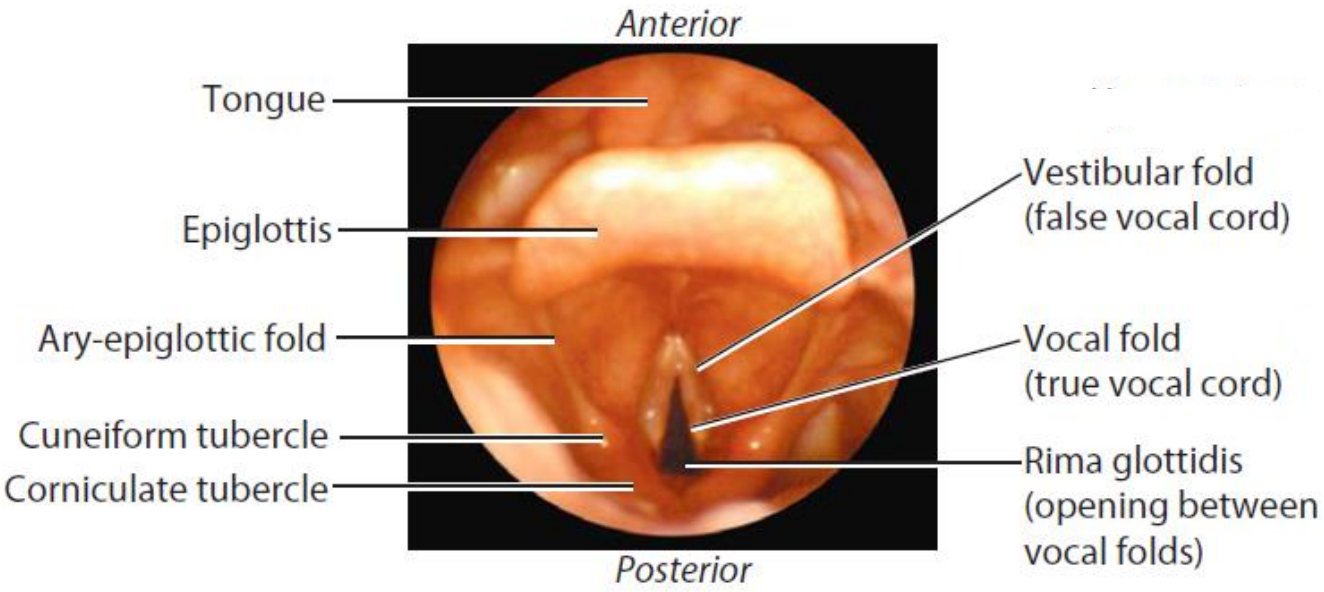
Vestibular Ligament

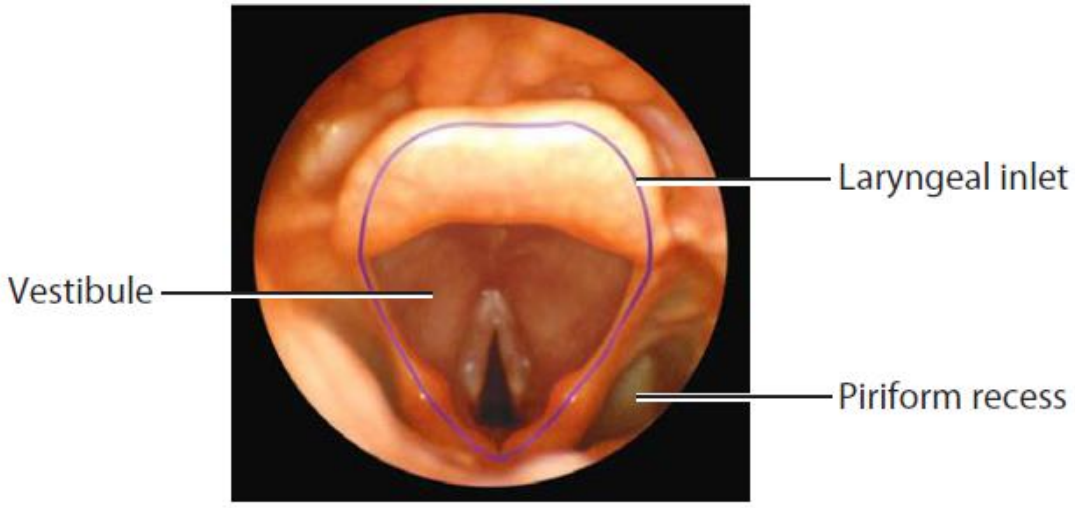


Vestibular Ligament



LARYNGOSCOPY

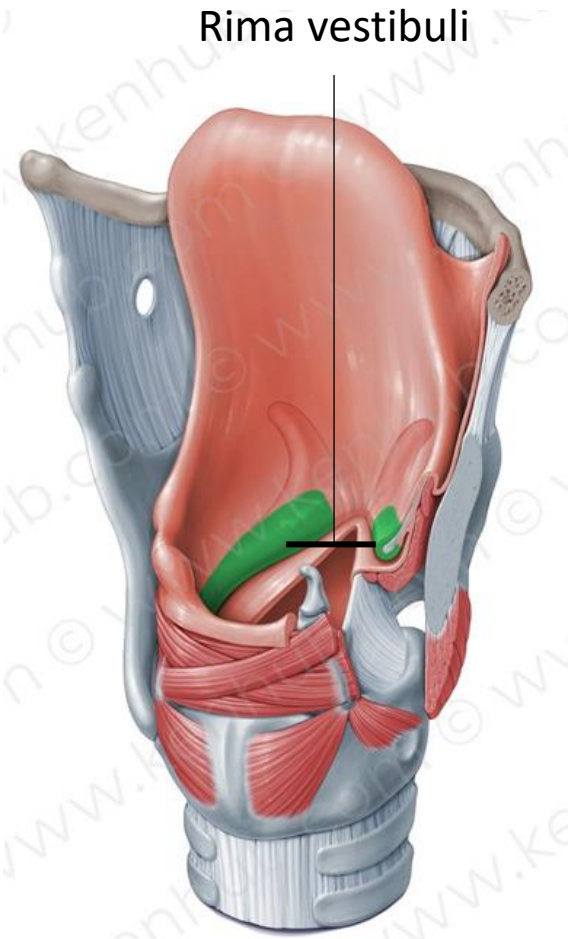


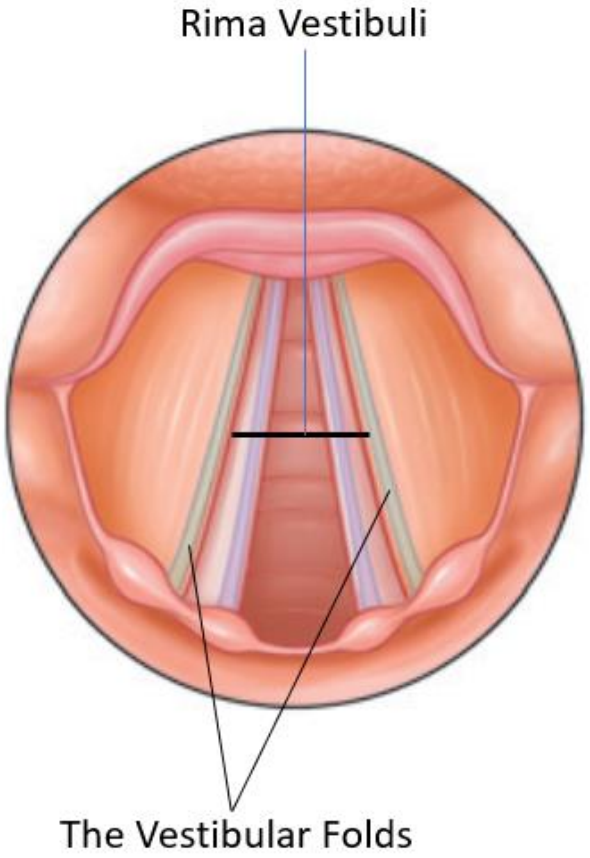


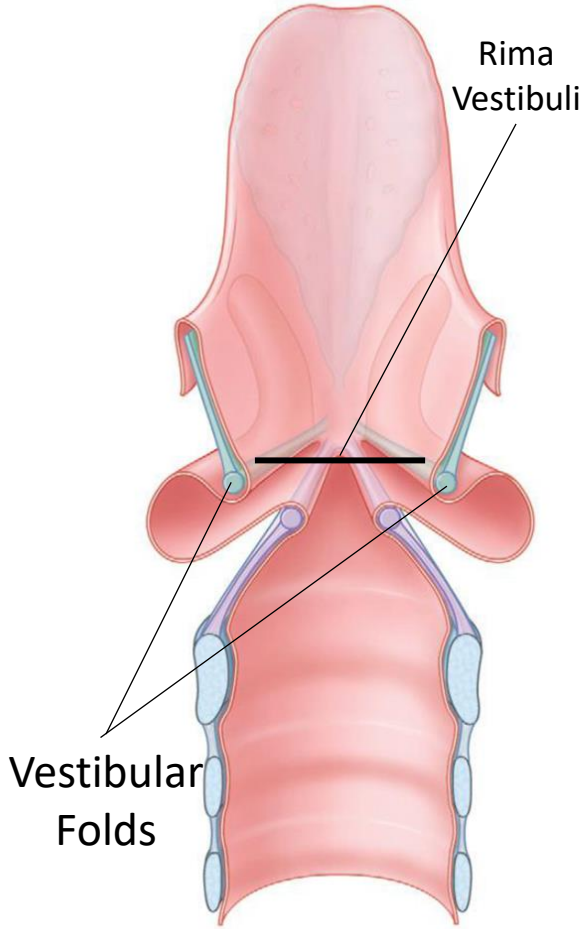
RIMA VESTIBULI

- Rima vestibuli is a triangular-shaped opening between the two adjacent vestibular folds at the entrance to the middle chamber (glottic cavity).
- Apex of the opening is anterior and its base is posterior

The vestibular folds are highlighted in green

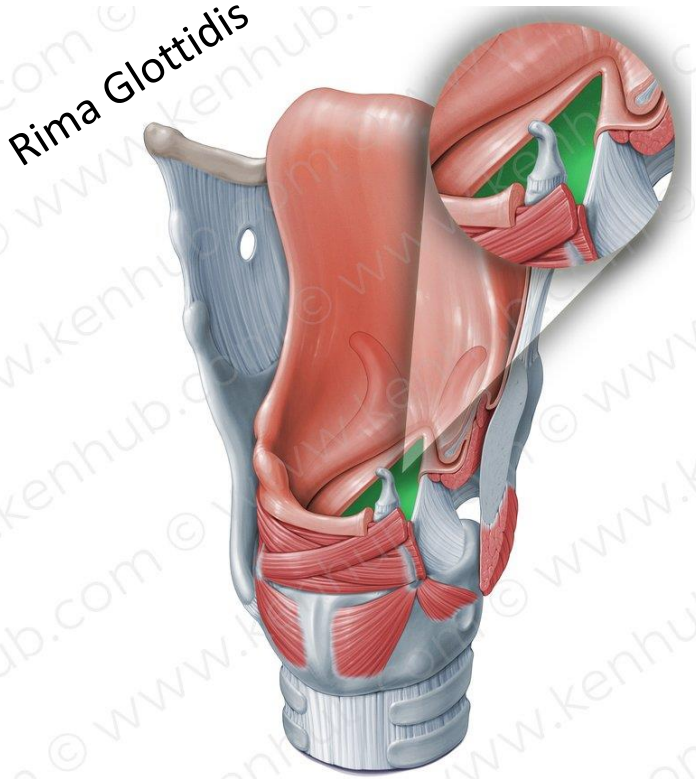


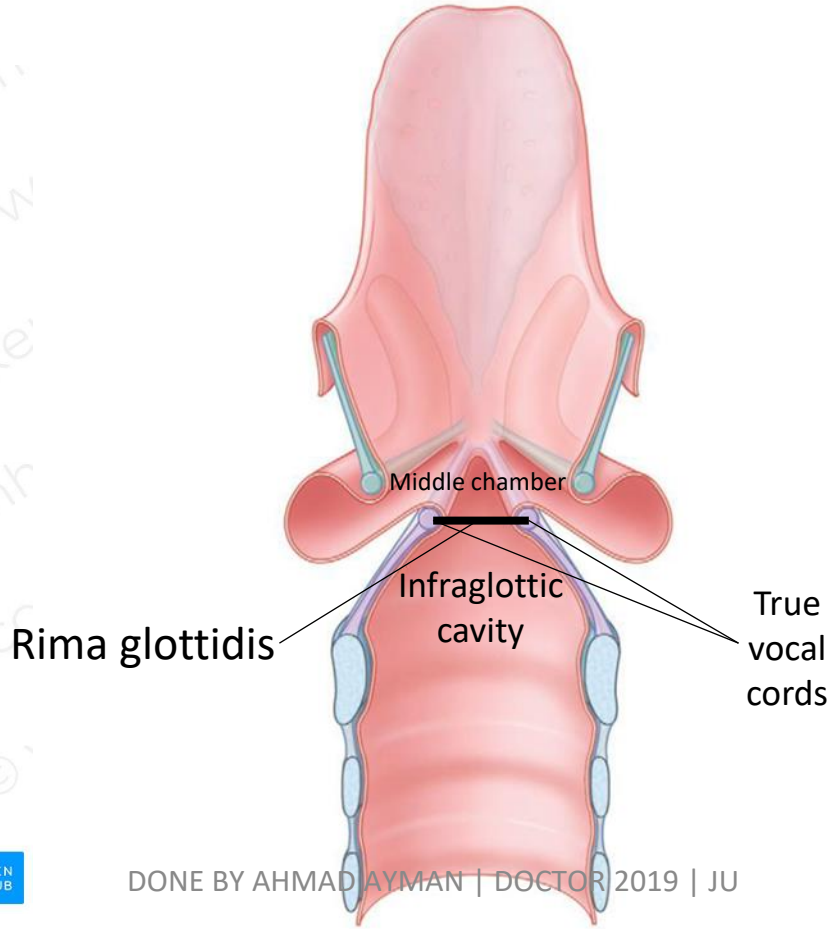


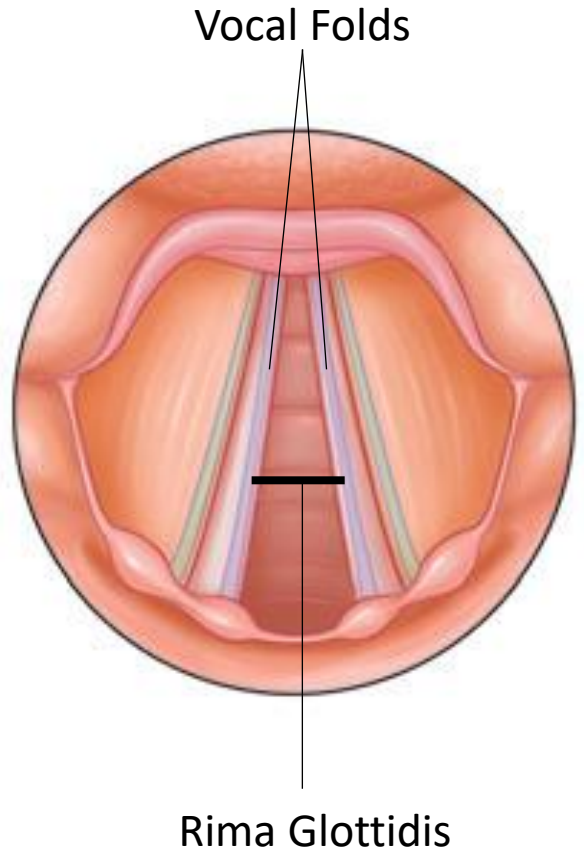


RIMA GLOTTIDIS

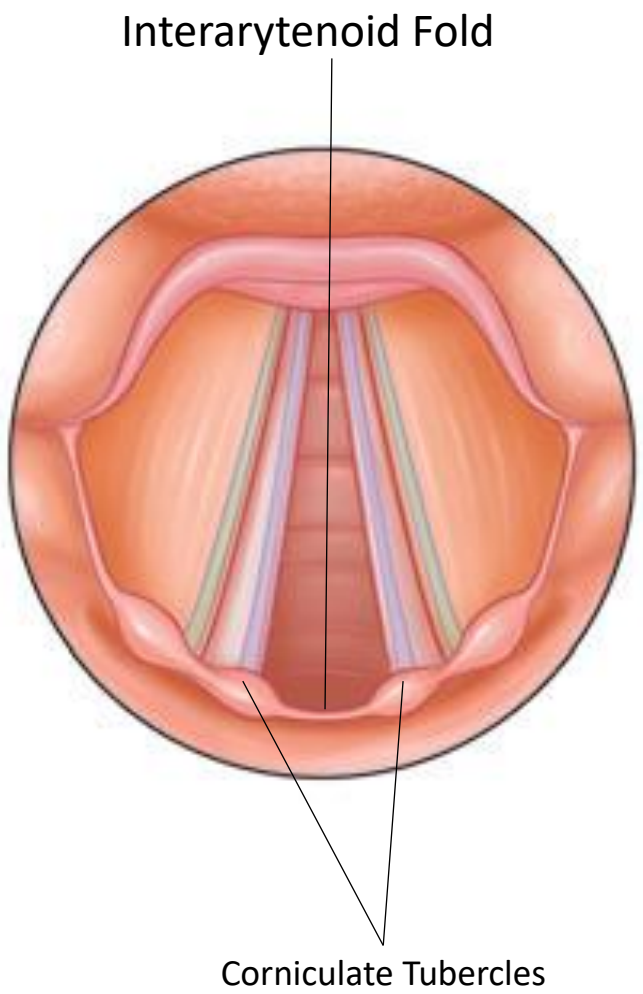
- The Rima glottidis is formed by the vocal folds (true vocal cords) and adjacent mucosa-covered parts of the arytenoid cartilages
- Rima glottidis opening separates the middle chamber above from the infraglottic cavity, it is the narrowest part of the laryngeal cavity

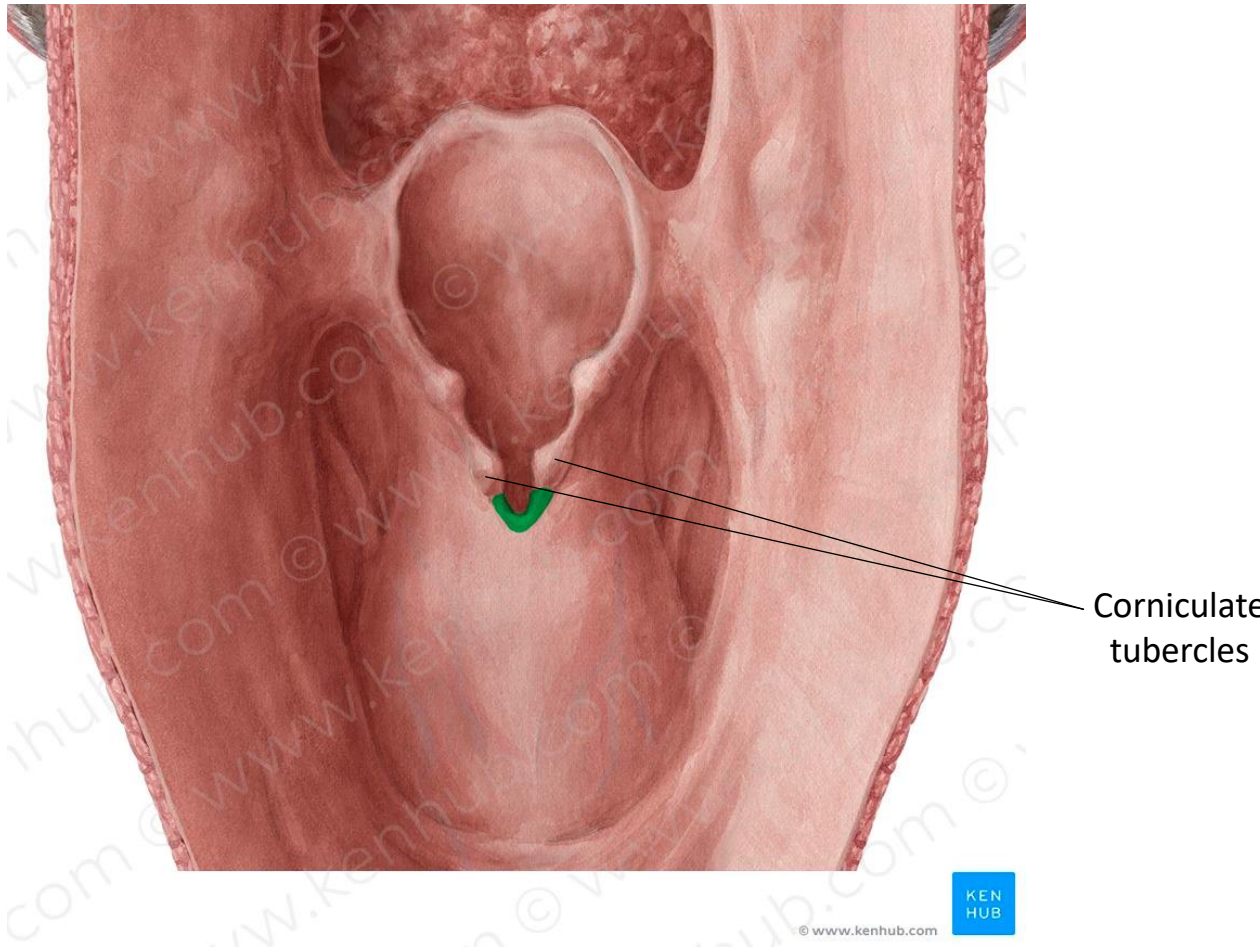






- The base of the rima glottidis is formed by the fold of mucosa (interarytenoid fold) at the bottom of the interarytenoid notch.
- Both the rima glottidis and the rima vestibuli can be opened and closed by movement of the arytenoid cartilages and associated membranes.



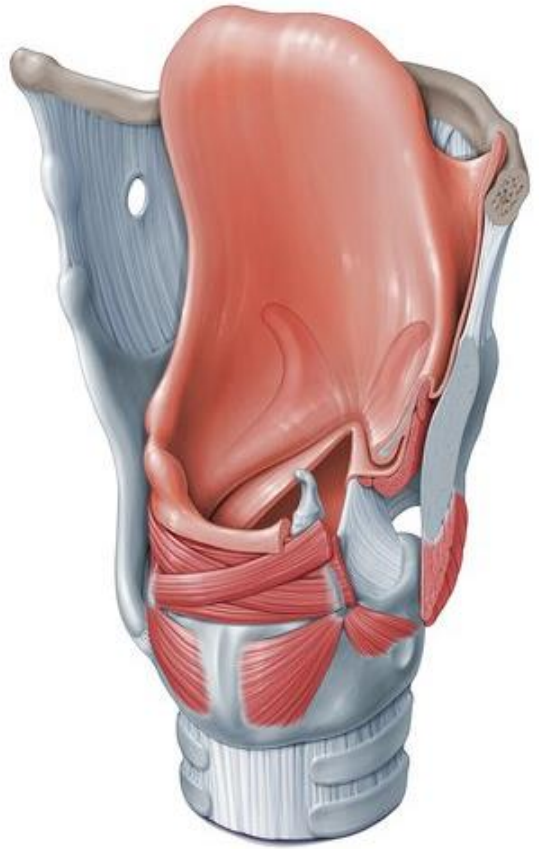


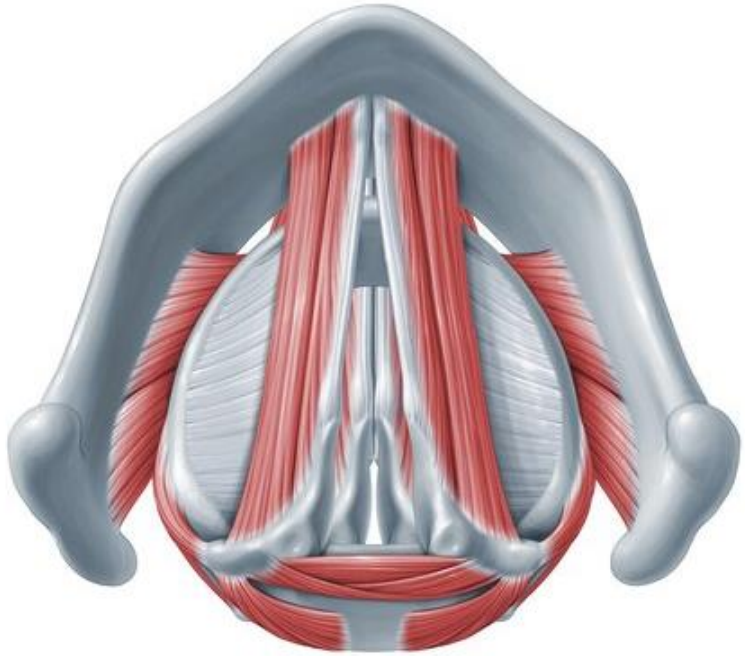
Interarytenoid notch

MUSCLES OF THE LARYNX

Functions:

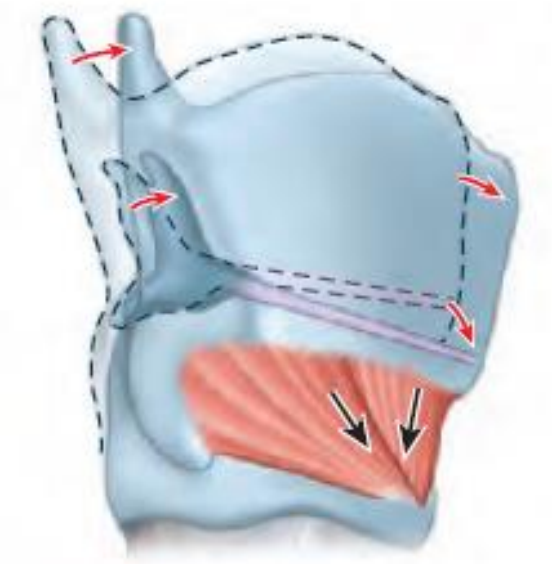
- Adjust tension in the vocal ligaments.
- Open and close the rima glottidis.
- Control the inner dimensions of the vestibule.
- Close the rima vestibuli.





CRICOTHYROID MUSCLE

- Origin: Anterolateral aspect of arch of cricoid cartilage
- Insertion: the oblique part runs in a posterior direction to insert on the inferior horn of the thyroid cartilage while the straight part runs more vertically to insert on the posteroinferior margin of the thyroid lamina.
- Nerve supply: external branch of superior laryngeal nerve, which is itself a branch of the vagus nerve (CN X).
- Action: Pull the thyroid cartilage forward and rotate it down relative to the cricoid cartilage, this action tenses vocal cords increasing pitch.



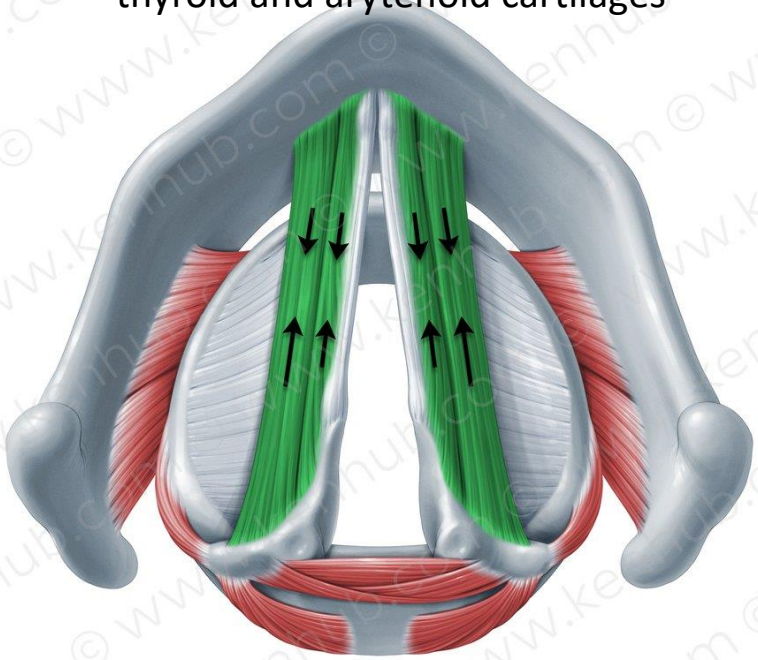
Action of cricothyroid muscle.

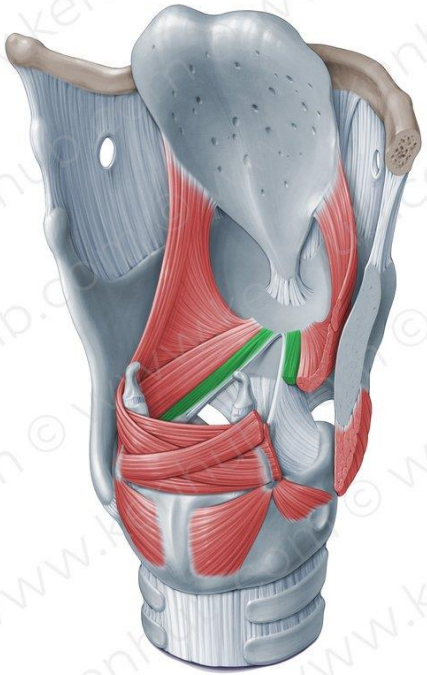
VOCALIS MUSCLE

- Origin: inner surface of thyroid cartilage
- Insertion: arytenoid cartilage
- Action: relaxes vocal cords, decreasing sound pitch, so it antagonizes cricoarytenoid muscle.
- Nerve supply: Recurrent laryngeal nerve, which is a branch of the vagus nerve (CN X).

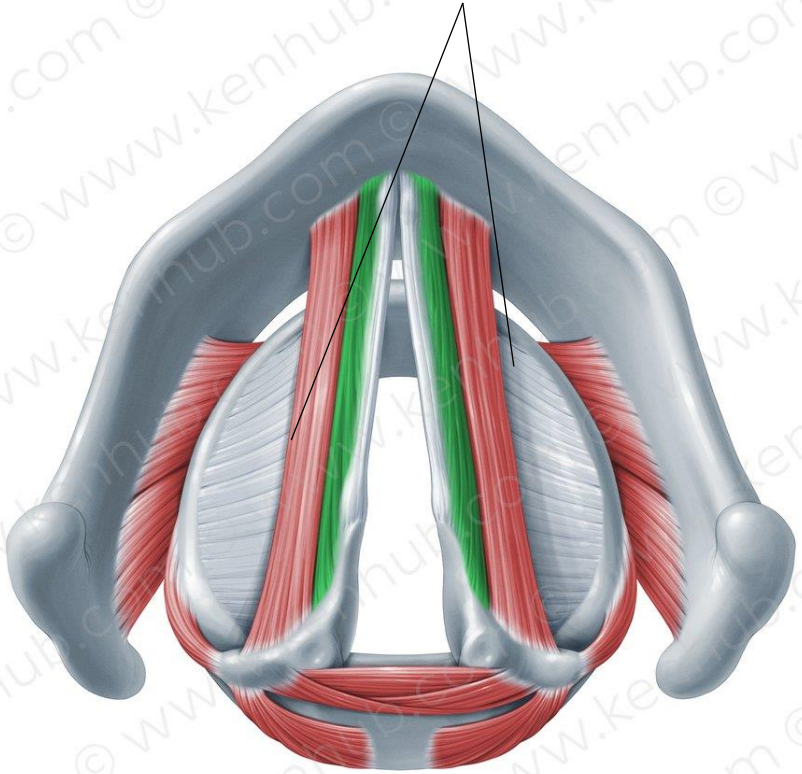
Note: the doctor have considered vocalis and thyroarytenoid muscles as the same muscle, but they are actually different muscles 🙃

Action of vocalis and thyroarytenoid muscle, relaxing the vocal cord by approximating the thyroid and arytenoid cartilages



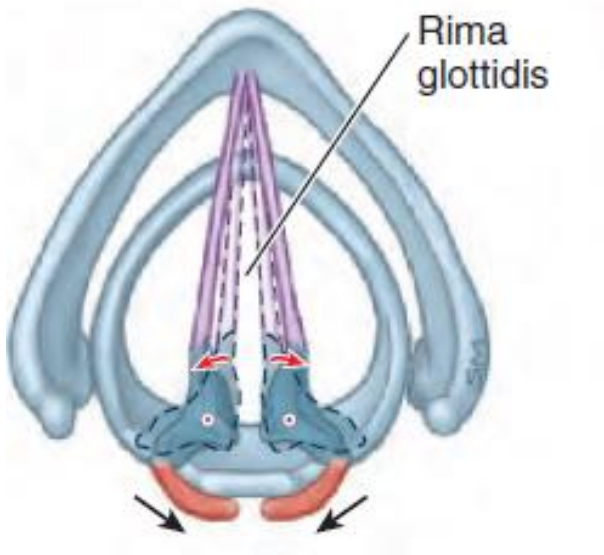


This is the actual thyroarytenoid muscle

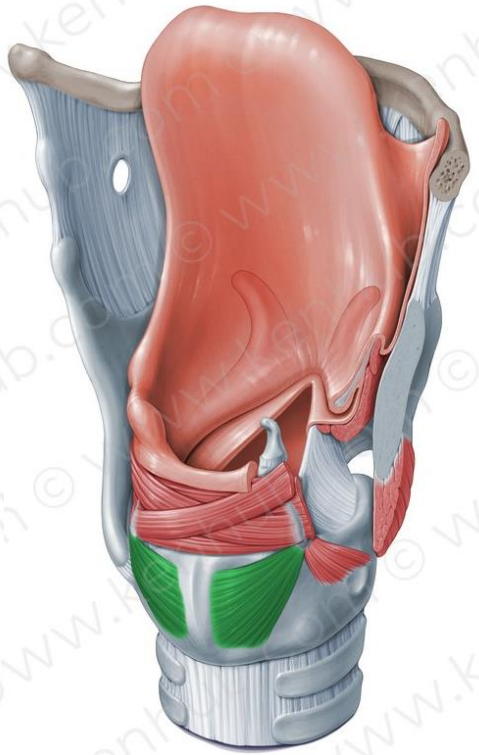


POSTERIOR CRICOARYTENOID MUSCLE

- Origin: the fibers of each muscle originate from the back of cricoid cartilage
- Insertion: run superiorly and laterally to the insert on the muscular processes of the arytenoid cartilage
- Nerve supply: the recurrent laryngeal nerve, a branch of the vagus nerve (CN X).
- **Action: Abducts the vocal cords** by rotating arytenoid cartilage outwards and backward

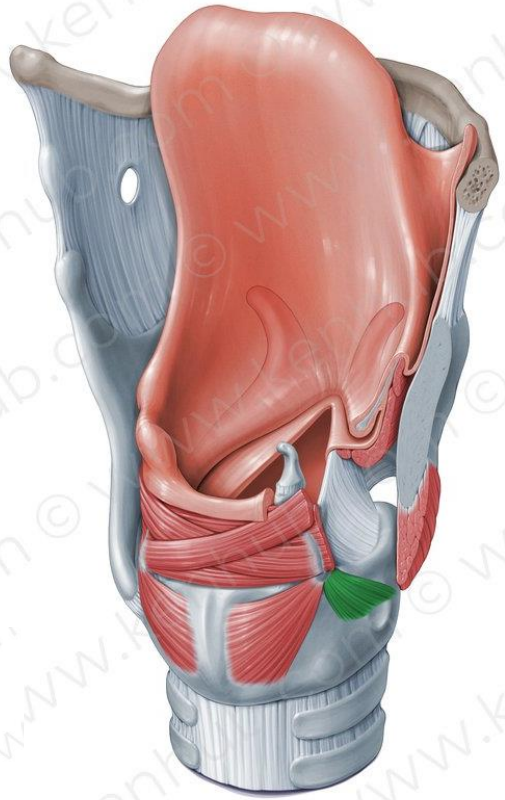


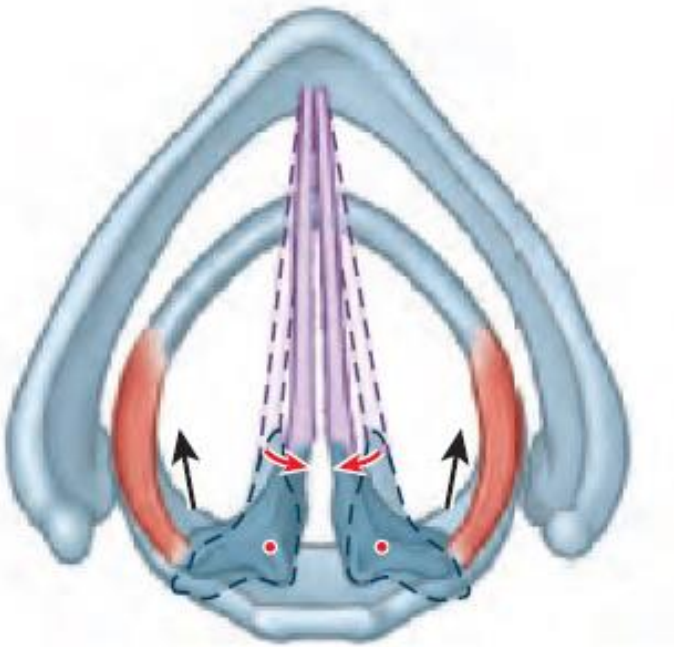
Action of posterior cricoarytenoid muscle.



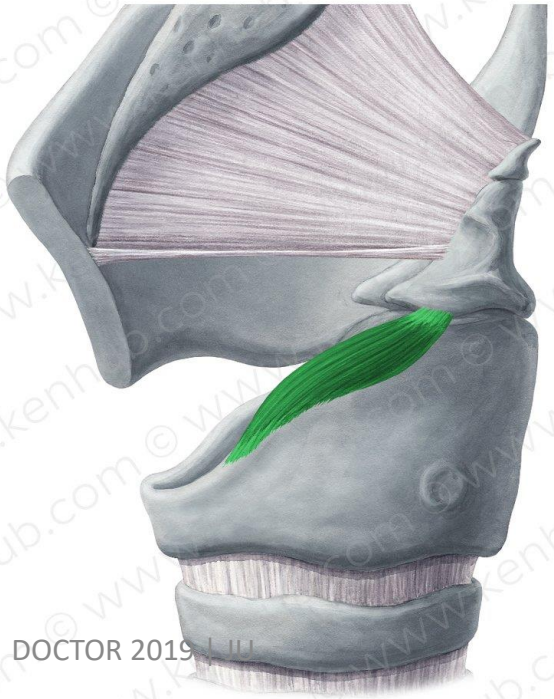
LATERAL CRICOARYTENOID MUSCLE

- Origin: Upper border of cricoid cartilage.
- Insertion: runs posteriorly and superiorly to insert on the muscular process of the arytenoid.
- Nerve supply: recurrent laryngeal nerve, a branch of the vagus nerve.
- Action: Adducts the vocal cords by internally rotating arytenoid cartilage inward and forward.





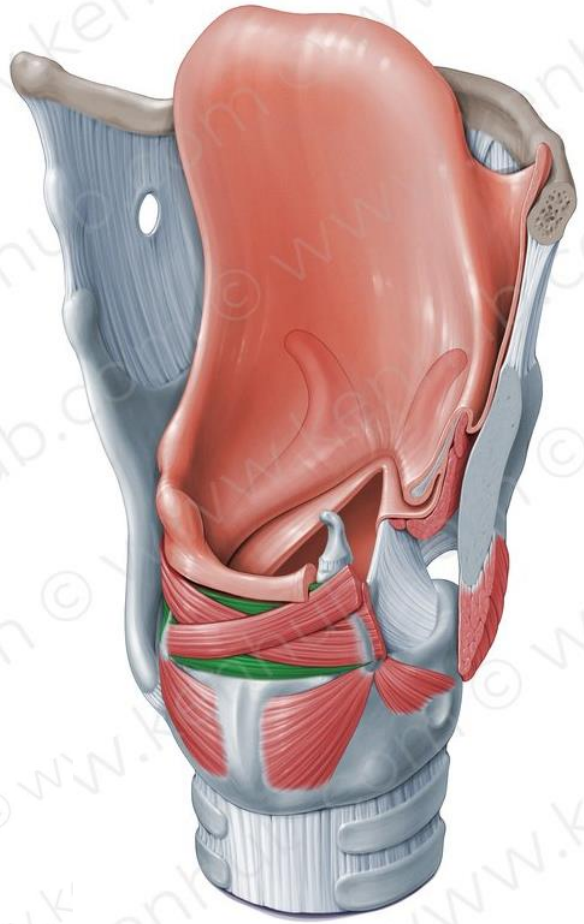
The action of lateral cricoarytenoid exactly antagonizes that of posterior cricoarytenoid.

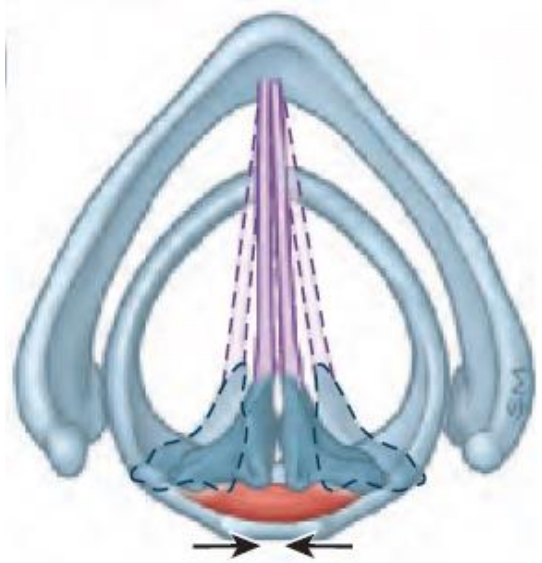


TRANVERSE ARYTENOID MUSCLE

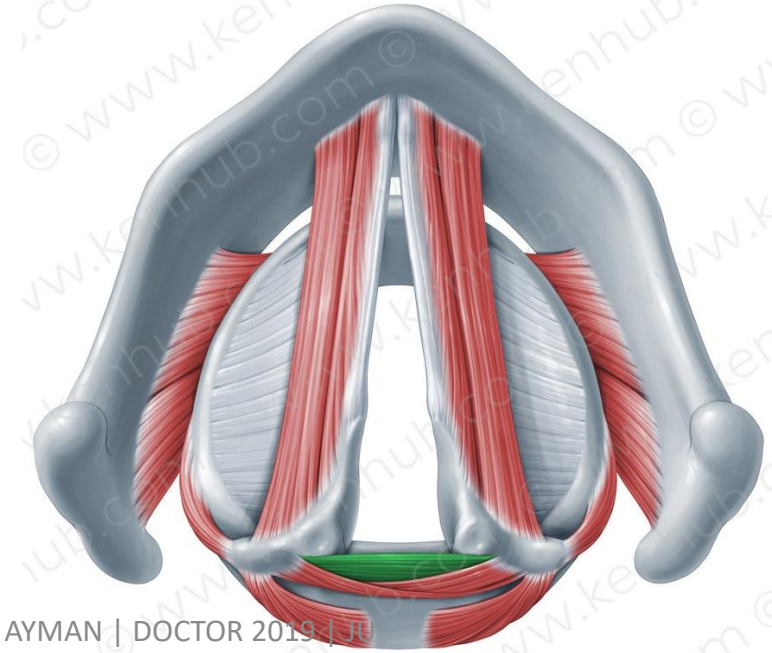
- Origin: Back and medial surface of arytenoid cartilage.
- Insertion: in the back and medial surface of opposite arytenoid cartilage.
- Action: closes posterior part of rima glottidis by approximating arytenoid cartilages.
- Nerve supply: Recurrent laryngeal nerve, which is a branch of the vagus nerve (CN X).

Note: this muscle lies in the interarytenoid fold.



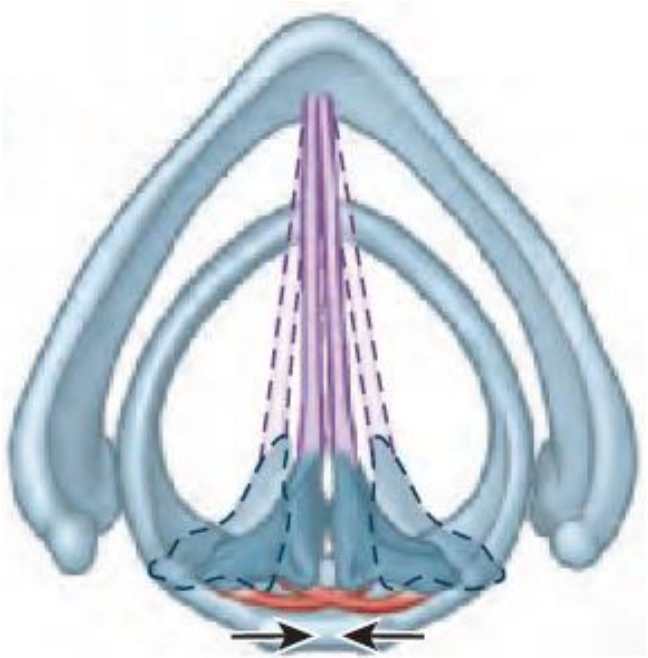


The action of transverse arytenoid muscle.

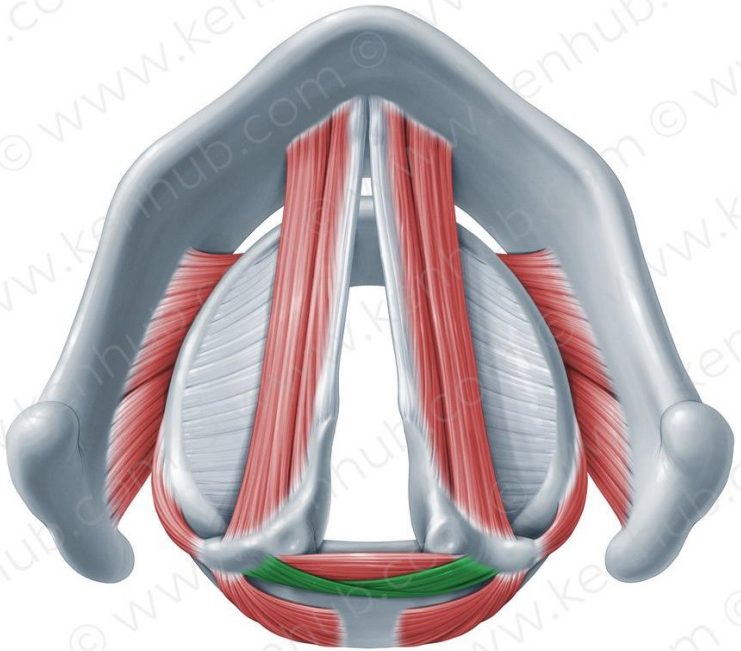


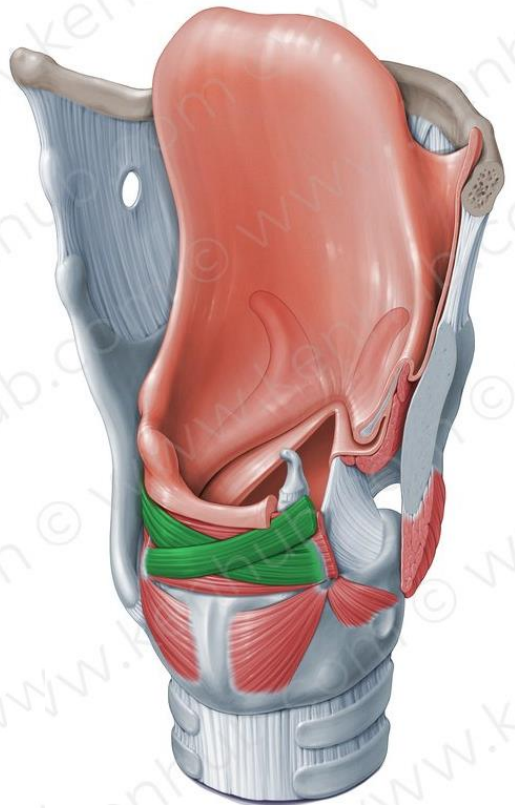
OBLIQUE ARYTENOID MUSCLE

- Origin: muscular process of arytenoid cartilage
- Insertion: the Apex of opposite arytenoid cartilage and extends into the aryepiglottic fold.
- Action: narrows the inlet by bringing the aryepiglottic folds together (it is a sphincter of the laryngeal inlet)
- Nerve supply: Recurrent laryngeal nerve, which is a branch of the vagus nerve (CN X).



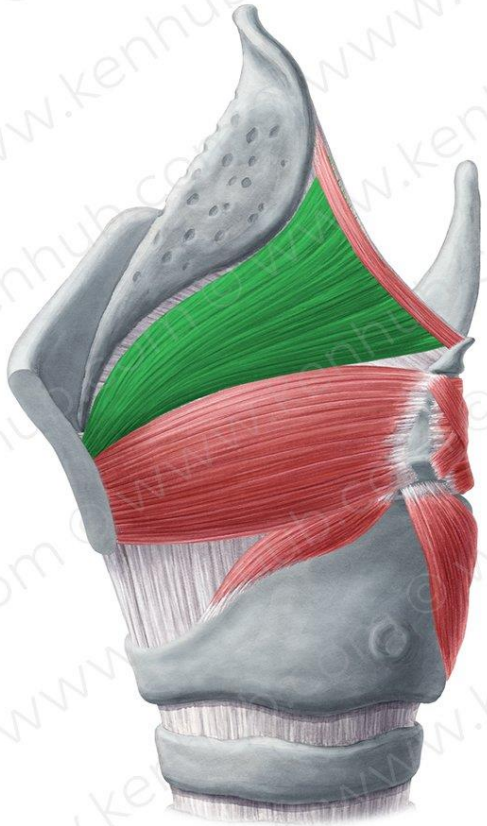
Action of oblique arytenoid

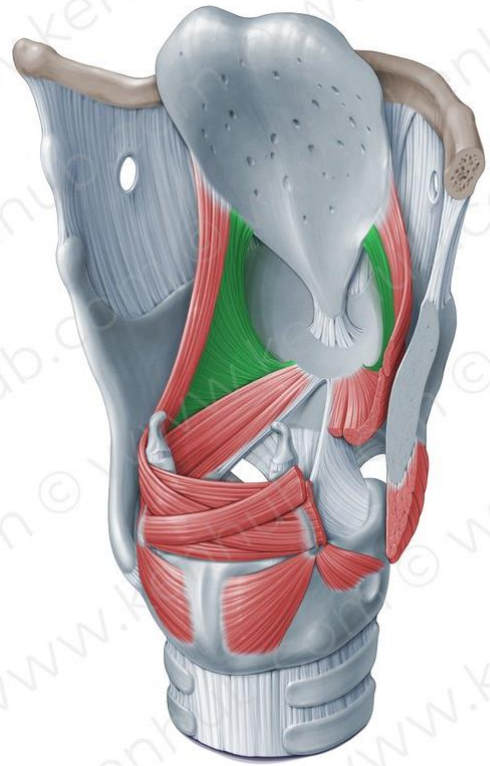




THYROIEPIGLOTTIC (ARYEPIGLOTTIC) MUSCLE

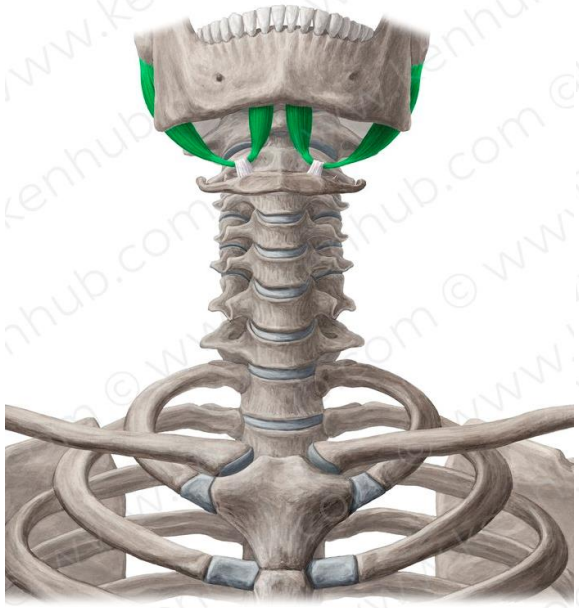
- Origin: medial surface of thyroid cartilage
- Insertion: lateral margin of epiglottis and aryepiglottic fold.
- Action: widens the laryngeal inlet by pulling the aryepiglottic folds apart. (so it antagonizes oblique arytenoid)
- Nerve supply: Recurrent laryngeal nerve, which is a branch of the vagus nerve (CN X).



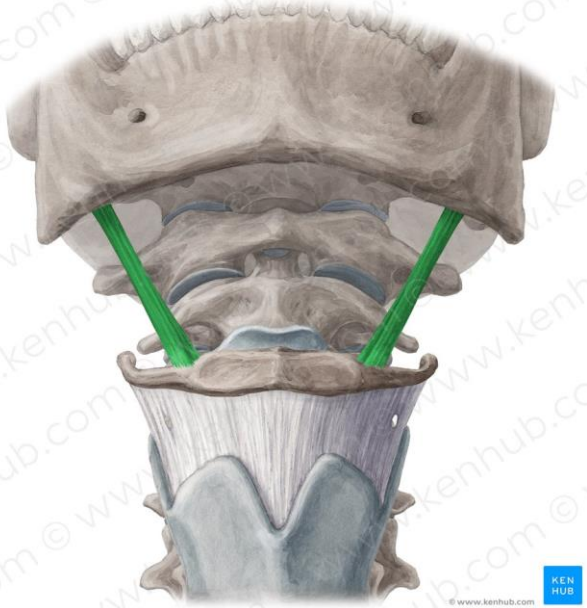


EXTRINSIC MUSCLES OF THE LARYNX

These muscles control the position of the larynx, elevators of the larynx are:

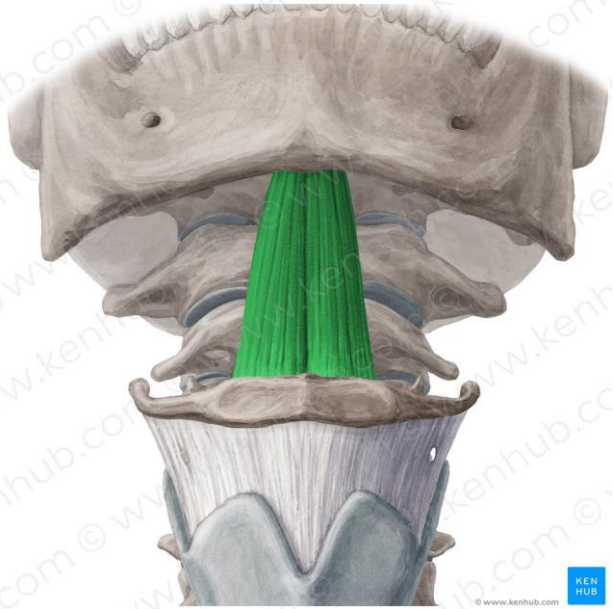


Digastric Muscle



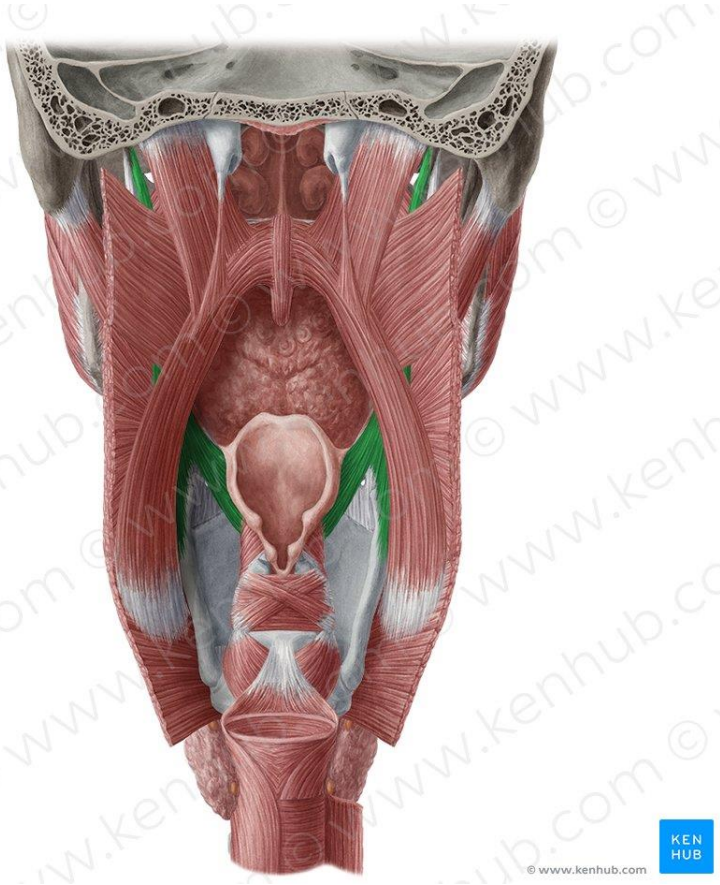
Stylohyoid Muscle

Mylohyoid

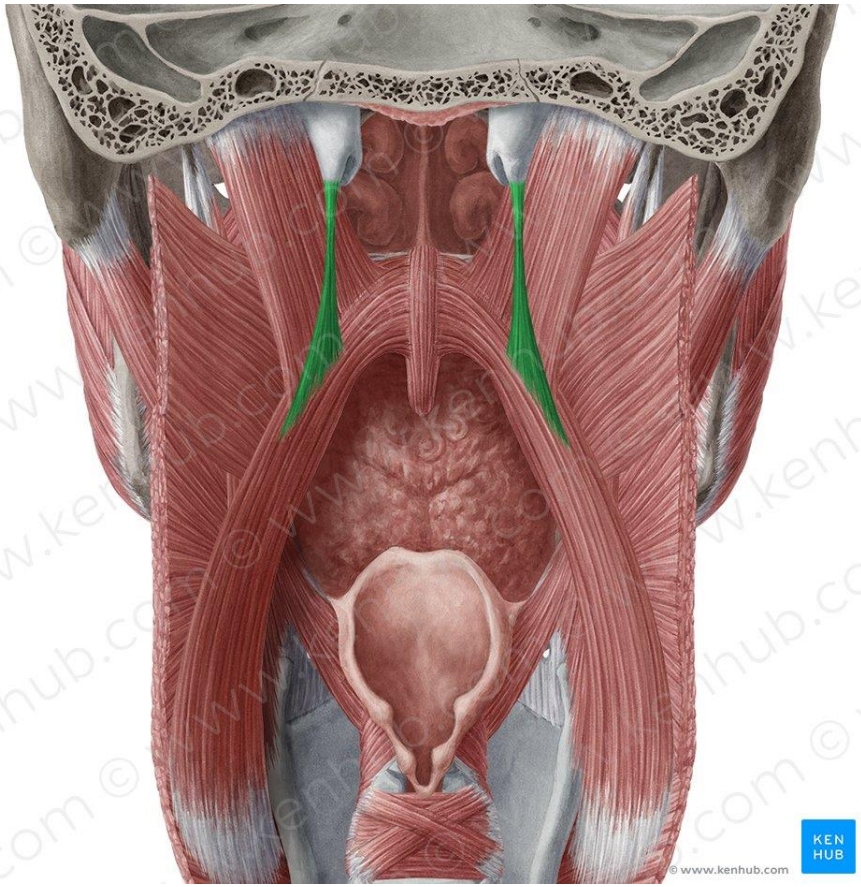


Geniohyoid

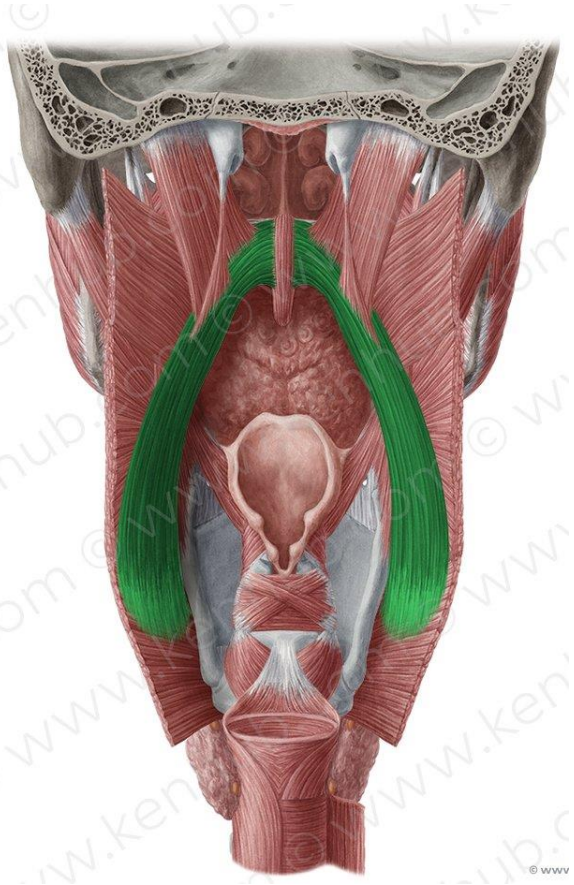
The larynx moves up in swallowing by the action of elevators of the larynx, assisted by: stylopharyngeus, salpingopharyngeus, and palatopharyngeus.



Stylopharyngeus

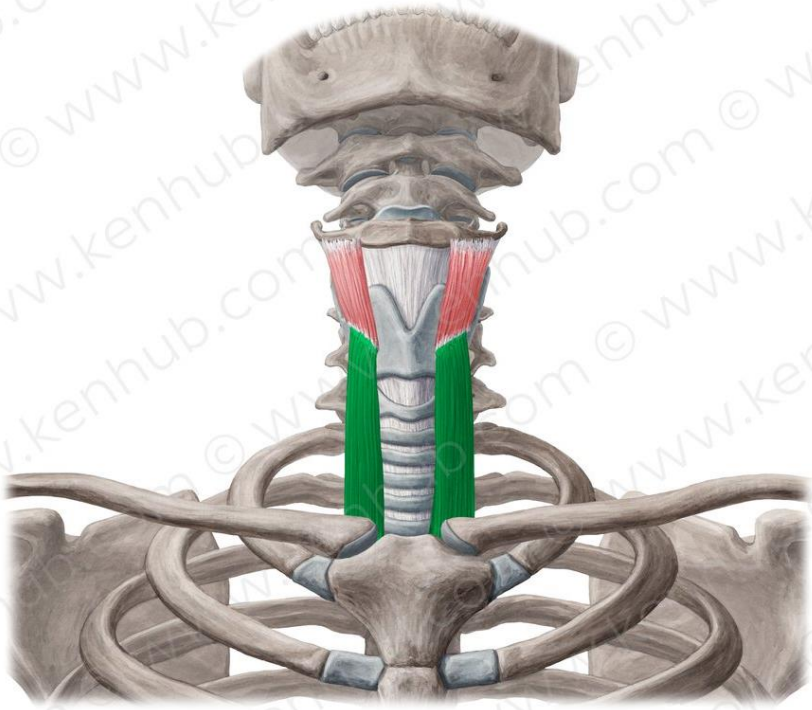


Salpingopharyngeus

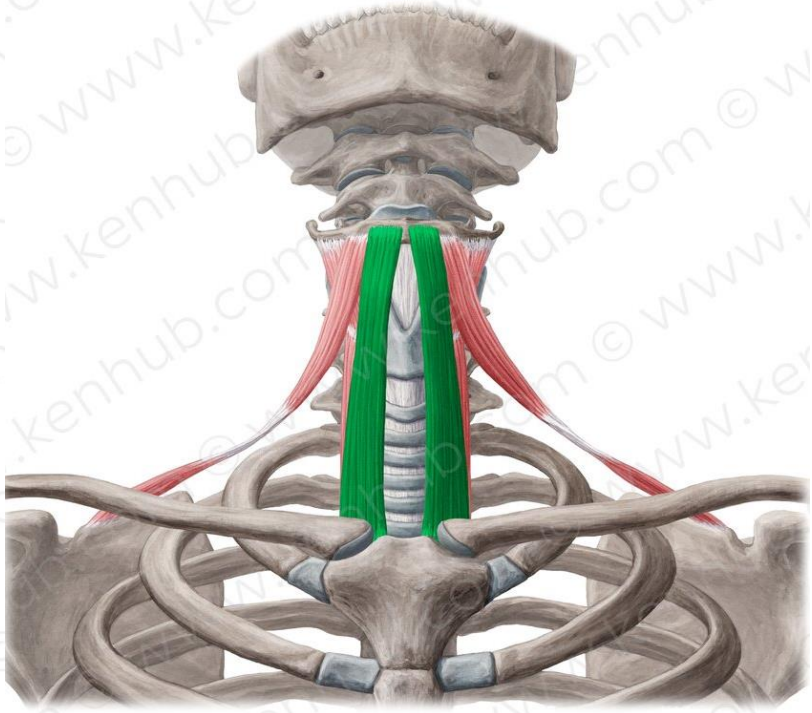


Palatopharyngeus

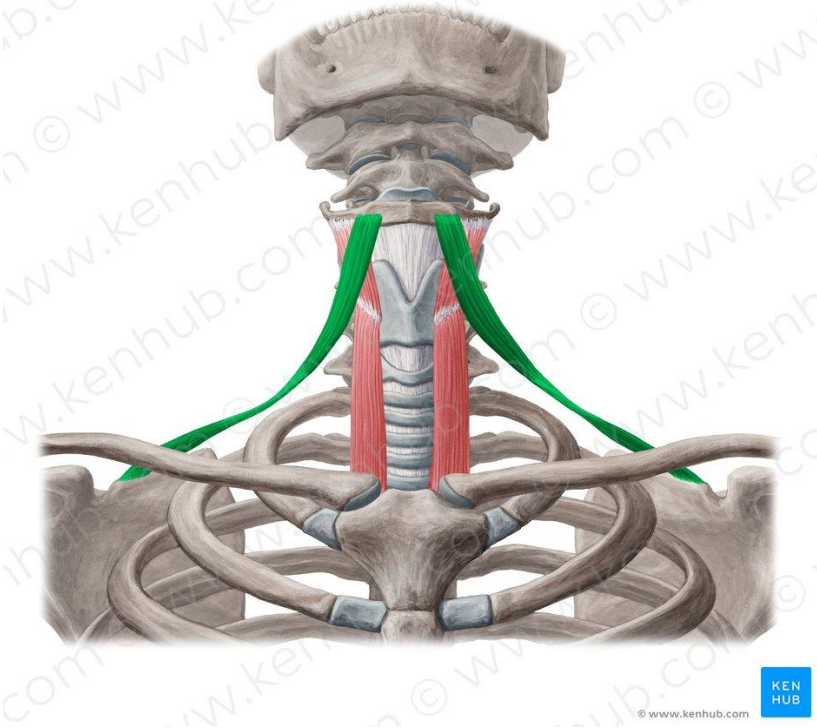
Muscles that depress the larynx are:



Sternothyroid



Sternohyoid

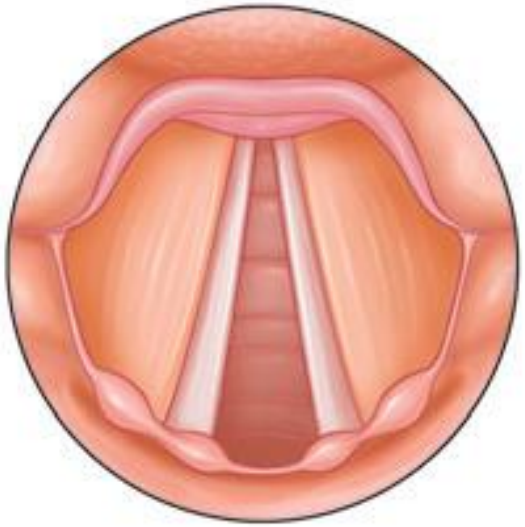


Omohyoid

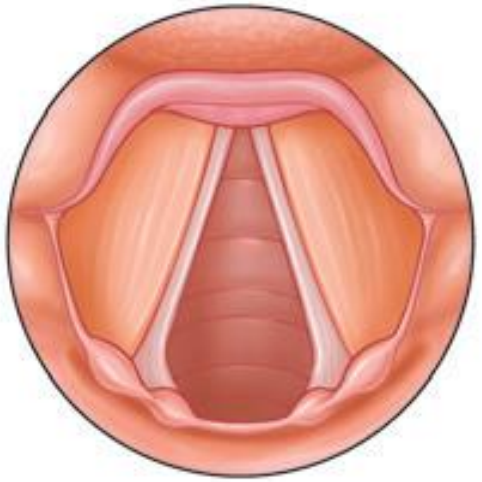
POSITIONS OF THE LARYNX WHILE PREFORMING ITS SUNFTIONS

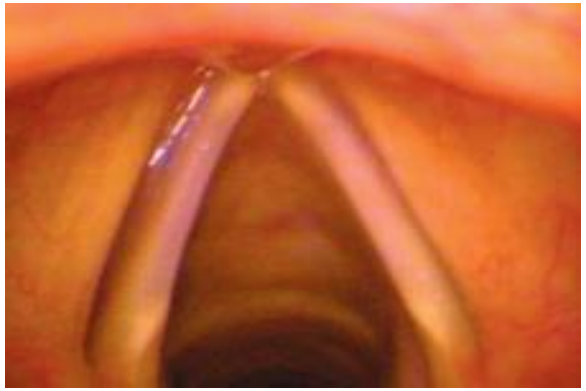
Respiration:

- During quiet respiration, the laryngeal inlet, vestibule, rima vestibuli, and rima glottidis are open.
- During forced inspiration the arytenoid cartilages are rotated laterally, mainly by the action of the posterior cricoarytenoid muscles.
- As a result, the vocal folds are abducted, and the rima glottidis widens into a rhomboid shape, effectively increases the diameter of the laryngeal airway.



Shape of the larynx during quiet respiration.

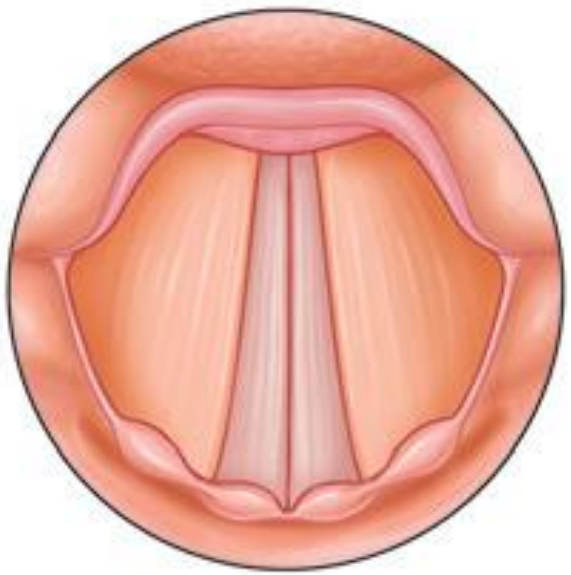




Shape of the larynx during forced respiration, notice that the vocal cords are fully abducted

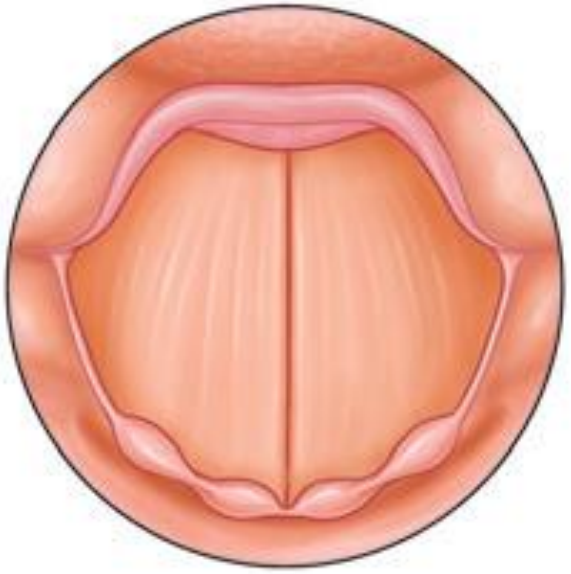
Phonation إصدار الصوت :

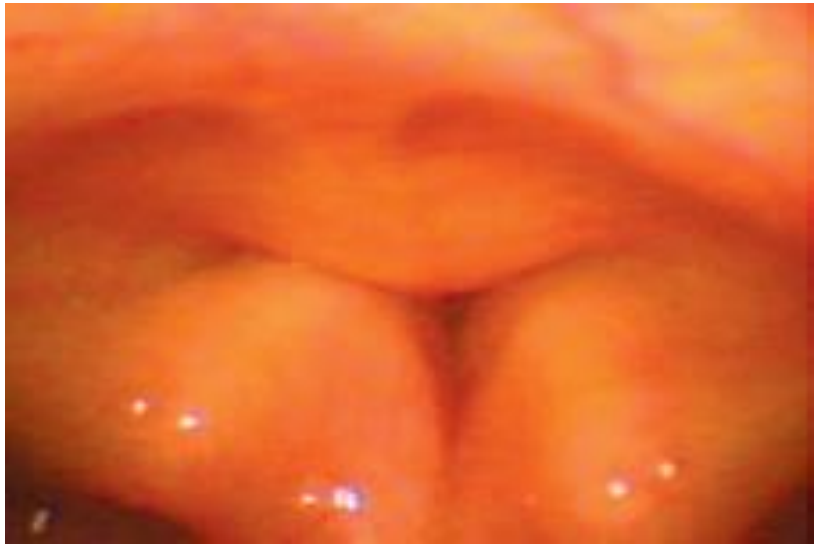
- When phonating, the arytenoid cartilages and vocal folds are adducted and air is forced through the closed rima glottidis.
- This action causes the vocal folds to vibrate against each other and produce sounds
- Can then be modified by the upper parts of the airway and oral cavity (this process of modification of sounds by the tongue, lips, the nose and the pharynx is called articulation)
- Tension in the vocal folds can be adjusted by the vocalis and cricothyroid muscles.



Effort closure:

- Effort closure of the larynx occurs when air is retained in the thoracic cavity to stabilize the trunk that occurs For example during heavy lifting, or as part of the mechanism for increasing intra-abdominal pressure
- The rima glottidis is completely closed, as is the rima vestibuli and lower parts of the vestibule
- The result is to completely and forcefully shut the airway.





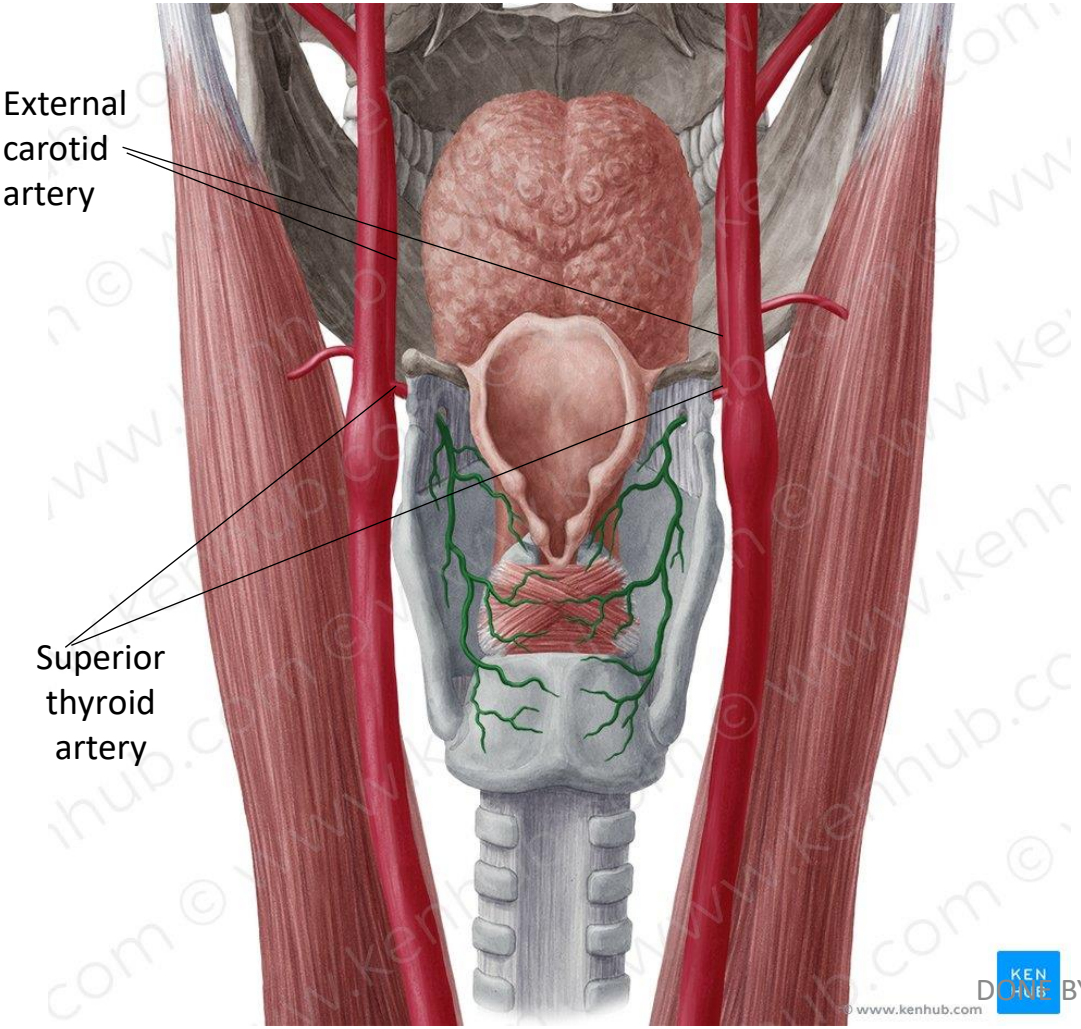
This is similar to the shape of the larynx during phonation, however, notice that here we cannot see the whitish vocal cords because the vestibular cords are adducted.

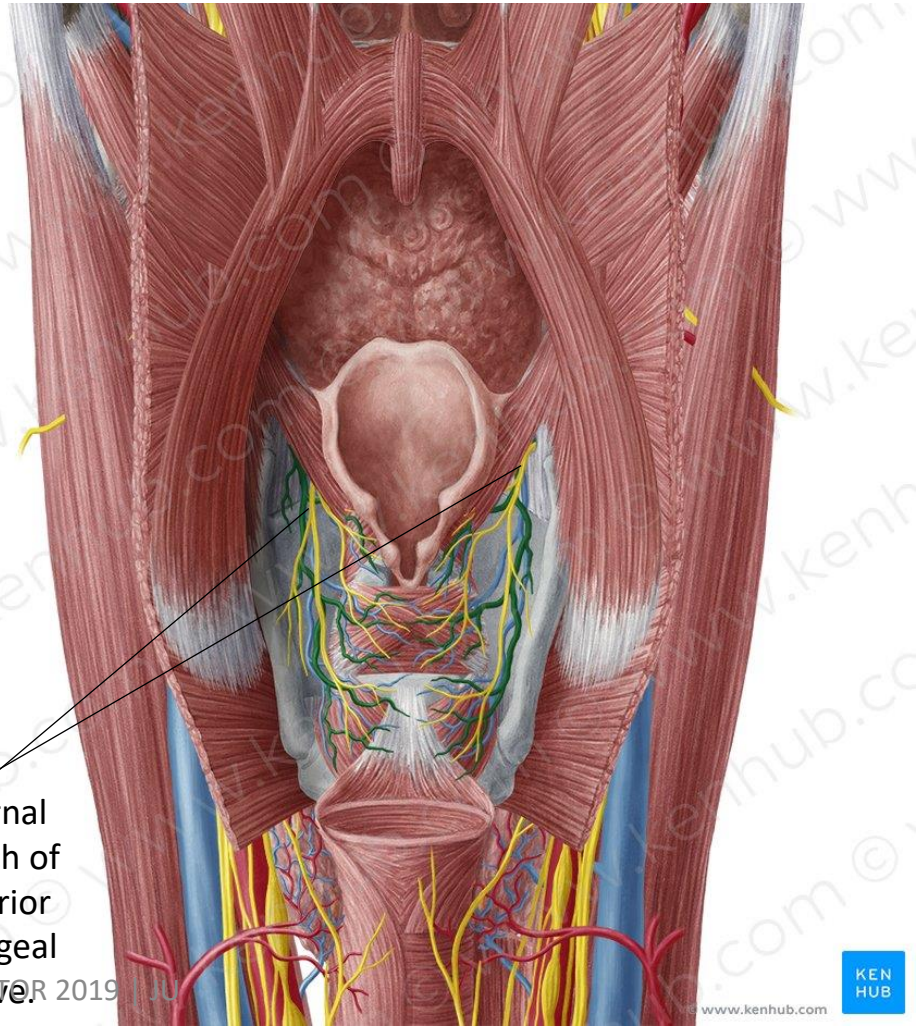
Swallowing:

- During swallowing, the rima glottidis, the rima vestibuli, and vestibule are closed and the laryngeal inlet is narrowed
- The larynx moves up and forward.
- This action causes the epiglottis to swing downward to effectively narrow or close the laryngeal inlet.
- The up and forward movement of the larynx also opens the esophagus (remember: the esophagus is attached to the posterior aspect of the cricoid cartilage).
- All these actions together prevent solids and liquids from entry into the airway.

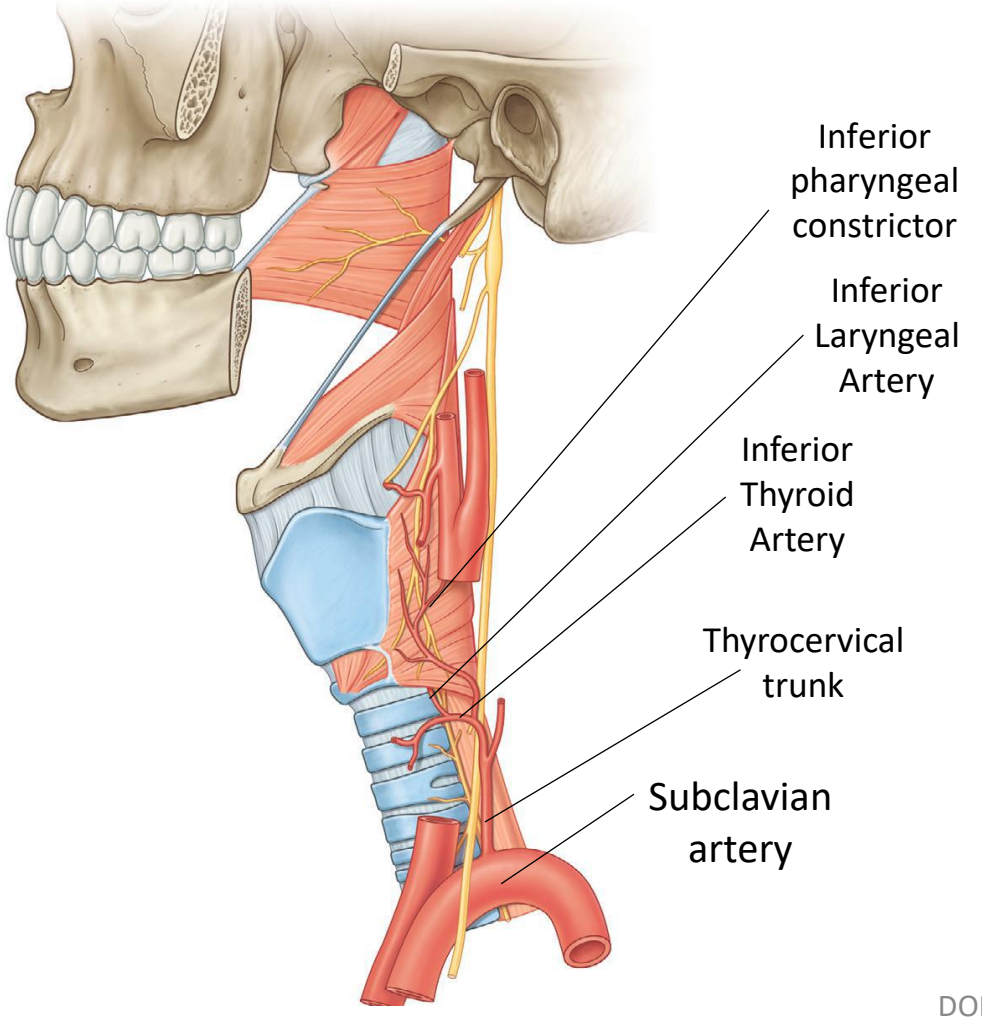
ARTERIAL SUPPLY OF THE LARYNX

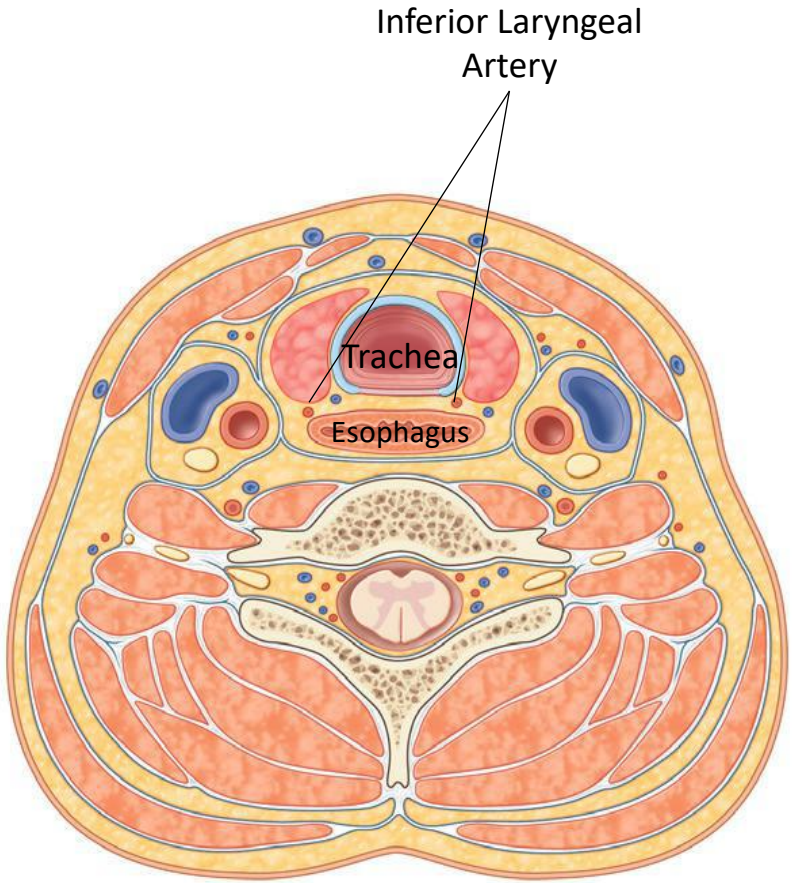
- The superior laryngeal artery originates from the superior thyroid branch of the external carotid artery.
- Accompanies the internal branch of the superior laryngeal nerve through the thyrohyoid membrane to reach the larynx.





- The inferior laryngeal artery originates from the inferior thyroid branch of the thyrocervical trunk of the subclavian artery.
- Together with the recurrent laryngeal nerve, ascends in the groove between the esophagus and trachea.
  - It enters the larynx by passing deep to the margin of the inferior constrictor muscle of the pharynx.

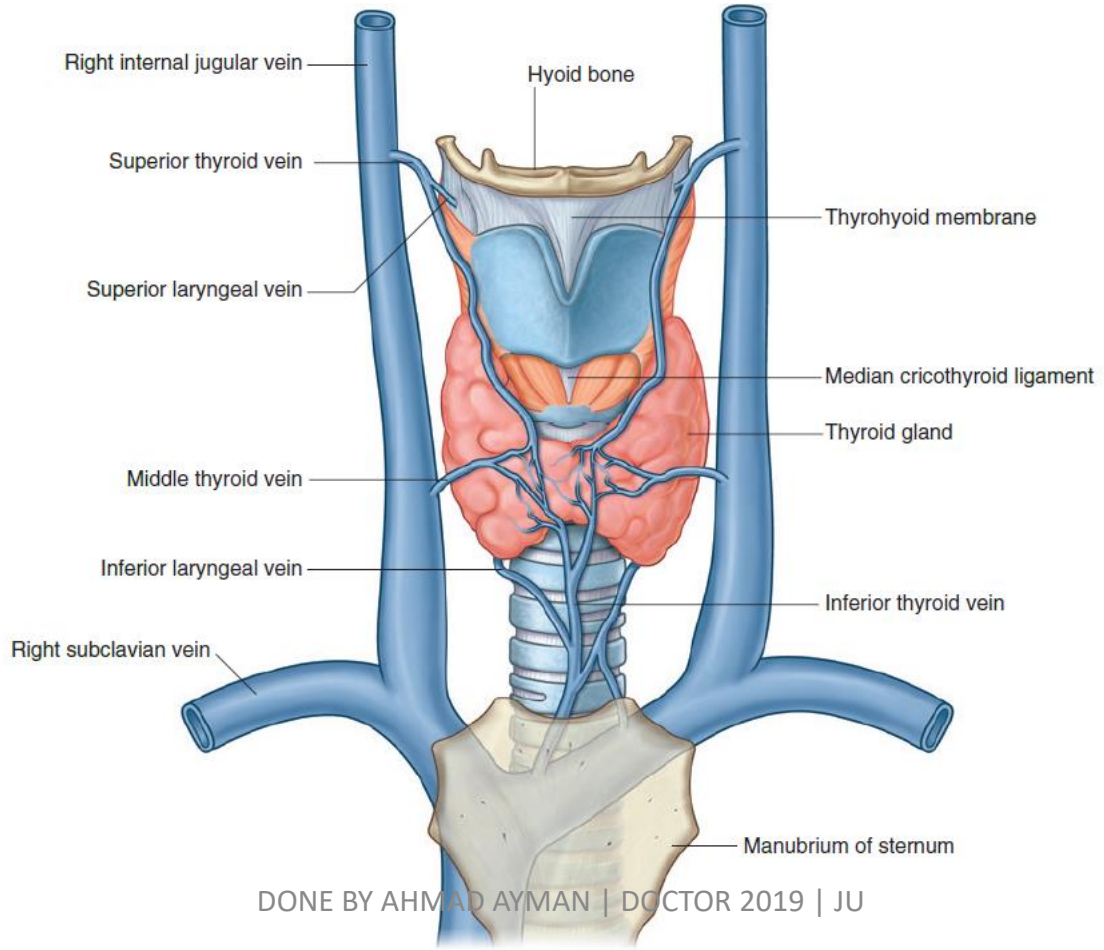




VENOUS DRAINAGE OF THE LARYNX

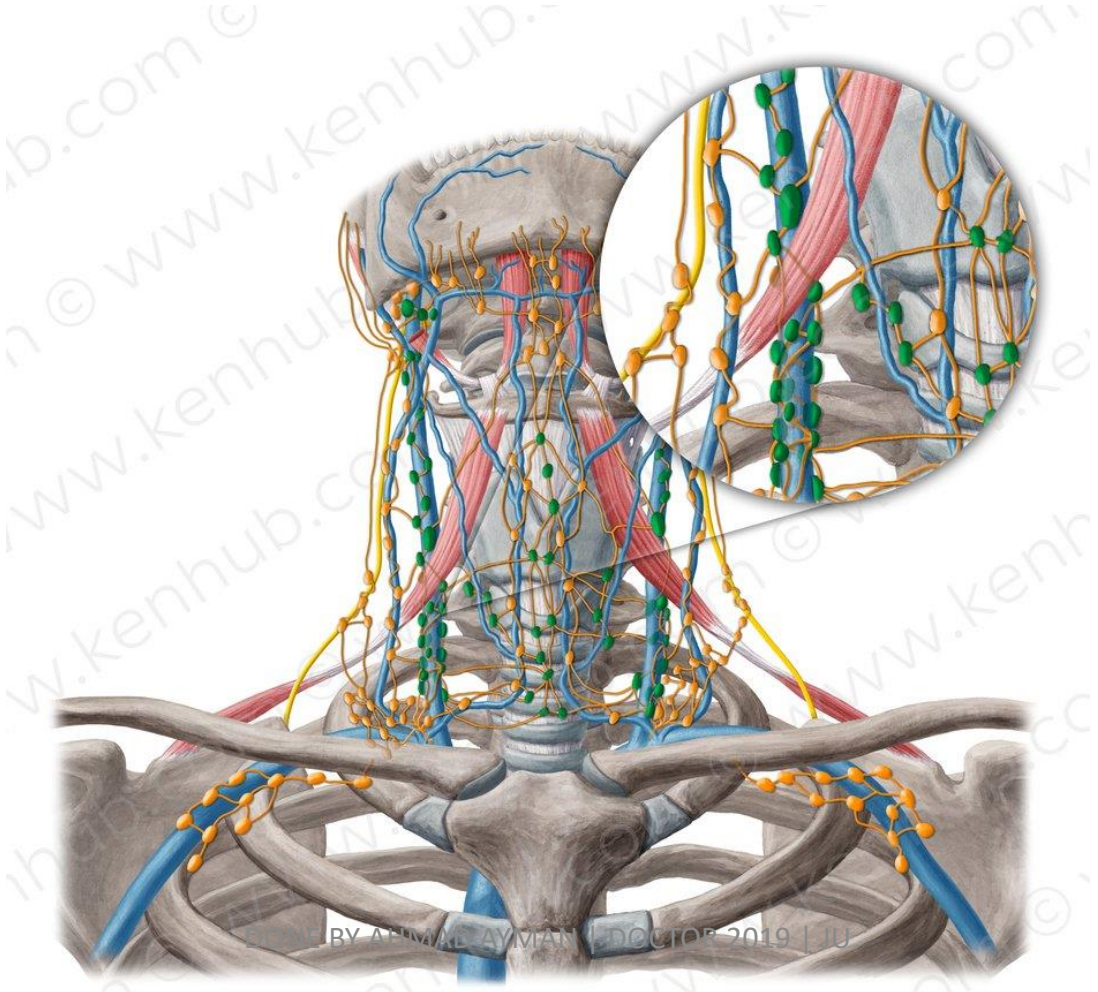
- Veins draining the larynx accompany the arteries:
- Superior laryngeal veins drain into superior thyroid veins, which in turn drain into the internal jugular veins
- Inferior laryngeal veins drain into inferior thyroid veins, which drain into the left brachiocephalic (innominate) veins.

Note: the inferior thyroid vein is a solitary (not paired) vein, it might drain into the left or right brachiocephalic (innominate) veins, but usually it drains to the left one.



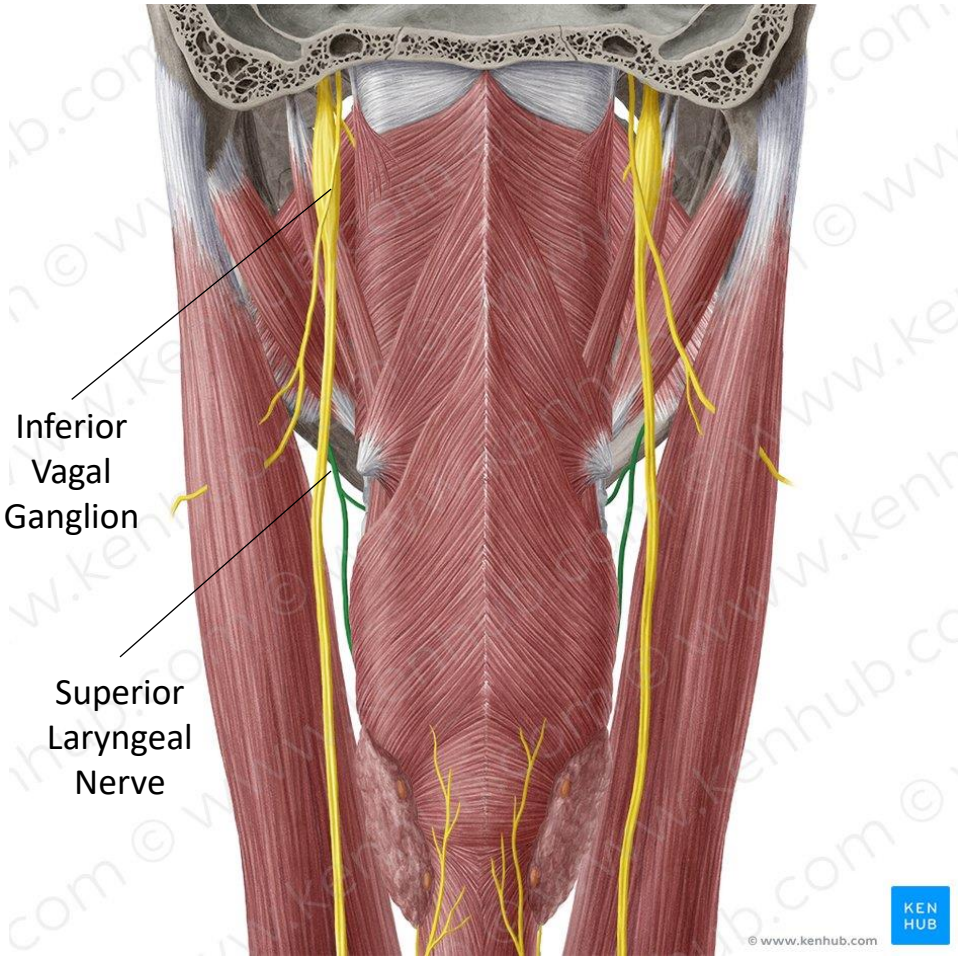
LYMPHATIC DRAINAGE OF THE LARYNX

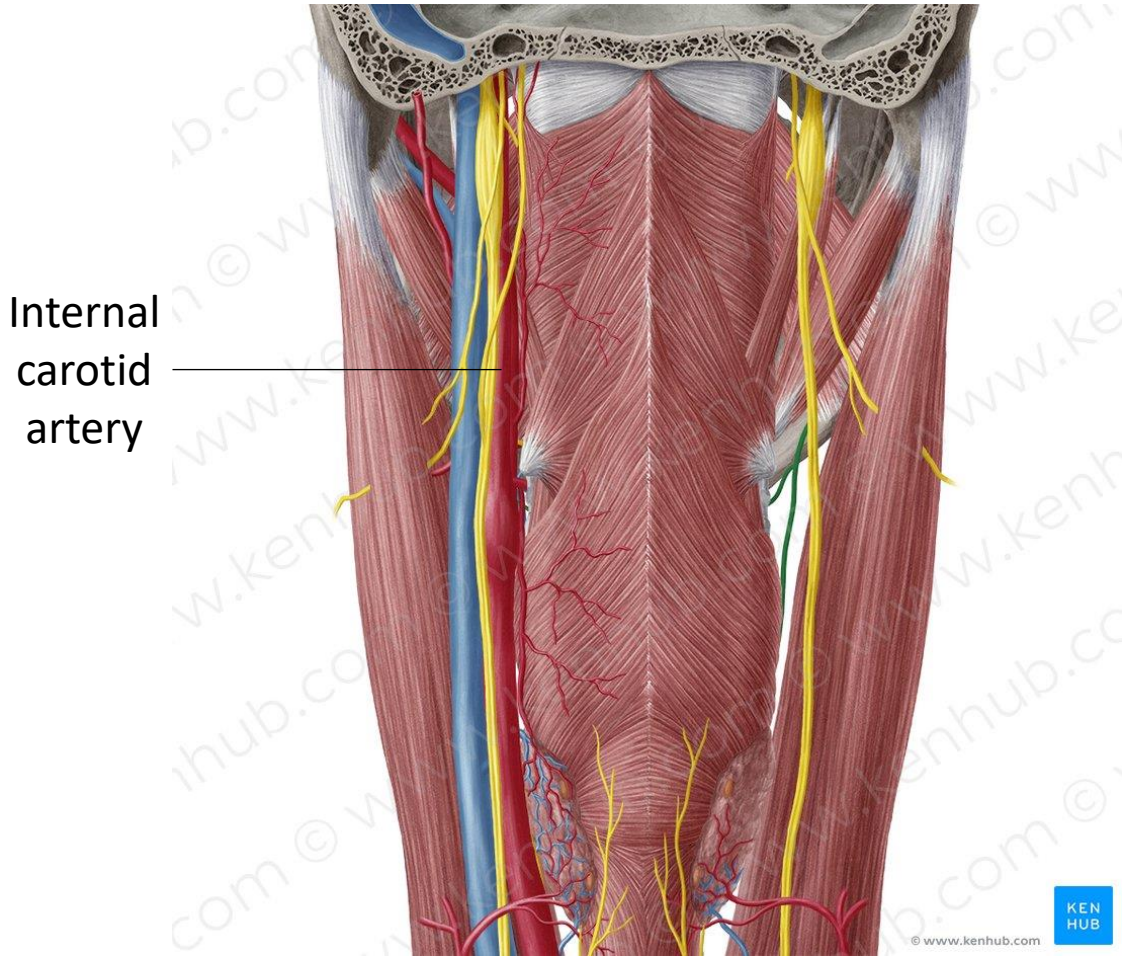
- Lymphatics draining regions above the vocal folds follow the superior laryngeal artery and terminate in upper deep cervical nodes.
- Lymphatic draining regions below the vocal folds drain into lower deep nodes associated with the inferior thyroid artery or with nodes associated with the front of the cricothyroid ligament or upper trachea.



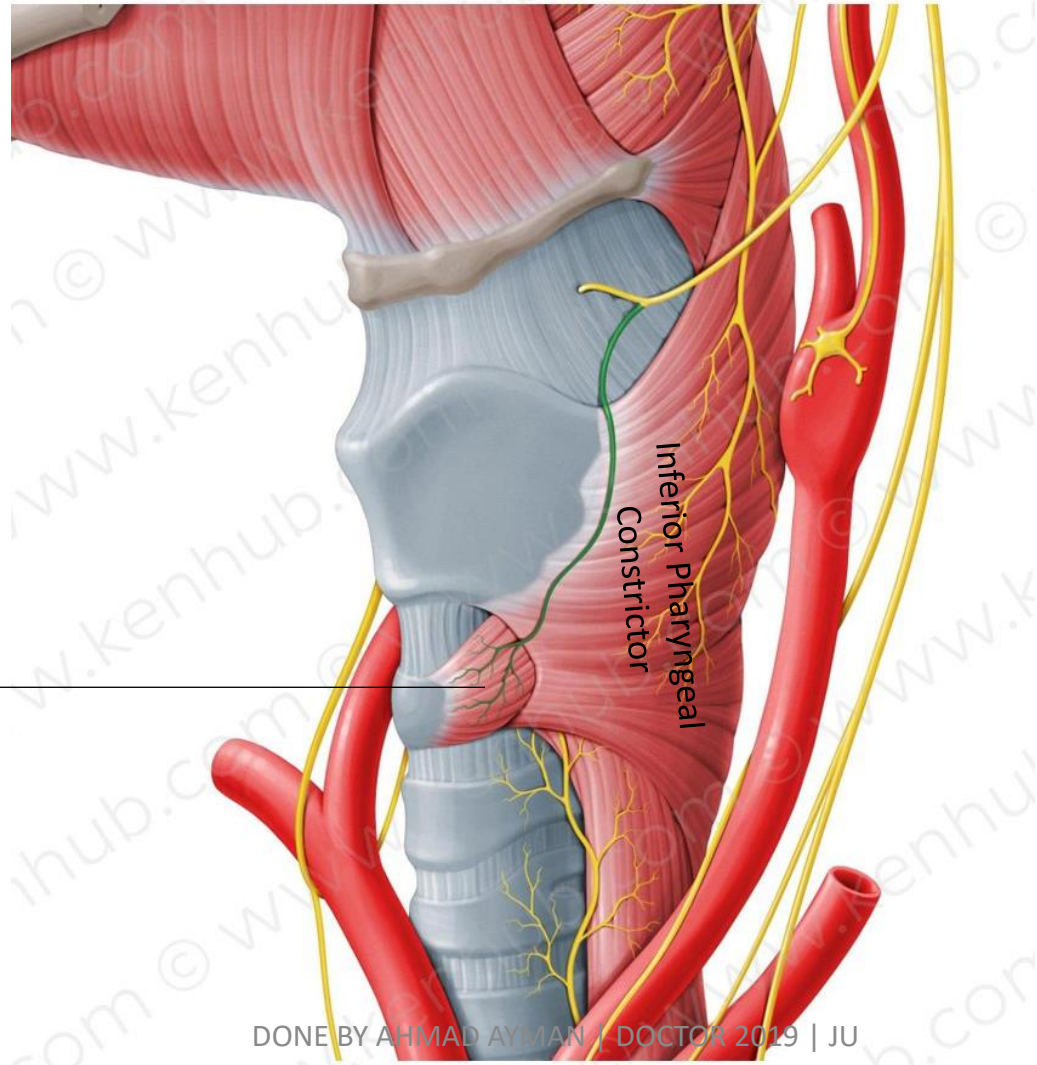
NERVOUS INNERVATION OF THE LARYNX

- The superior laryngeal nerves originate from the inferior vagal ganglia high in the neck.
- They descend medial to the internal carotid artery and divide into internal and external branches above the hyoid bone.

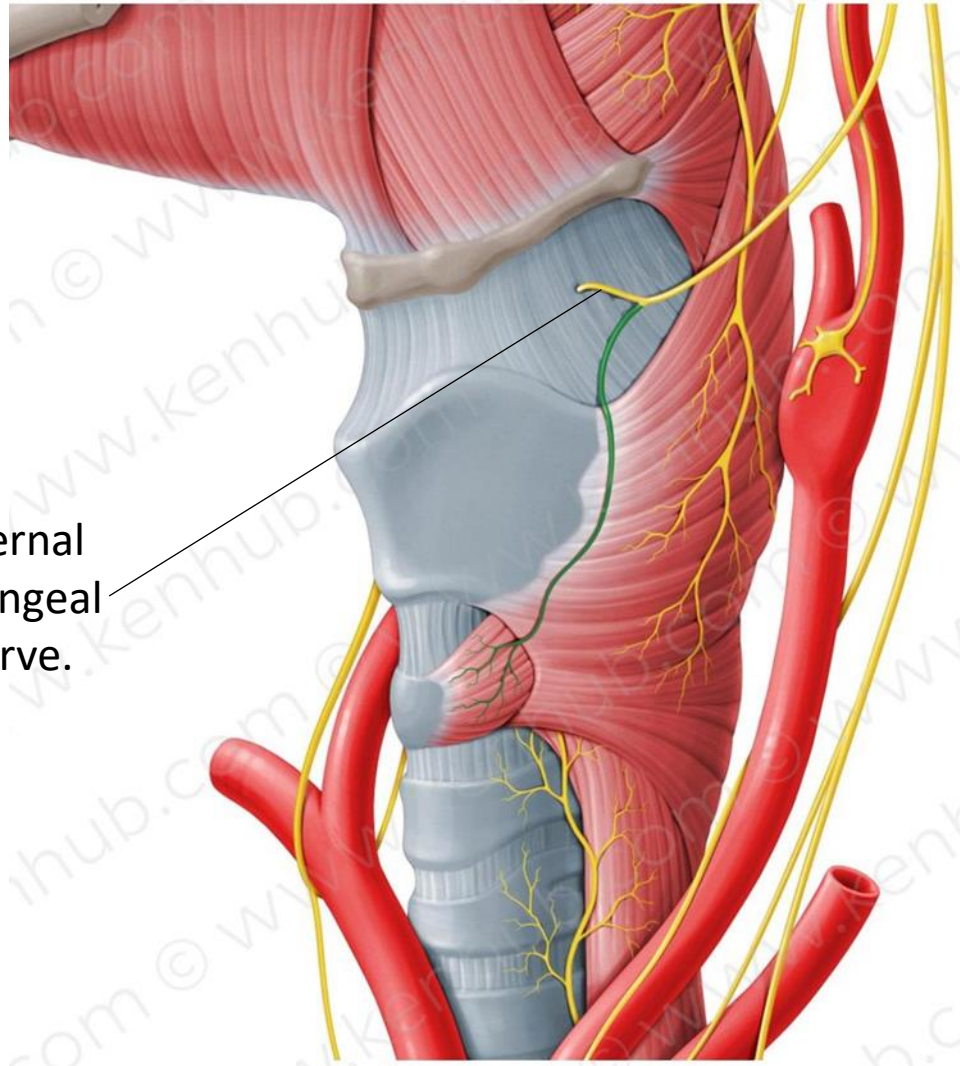


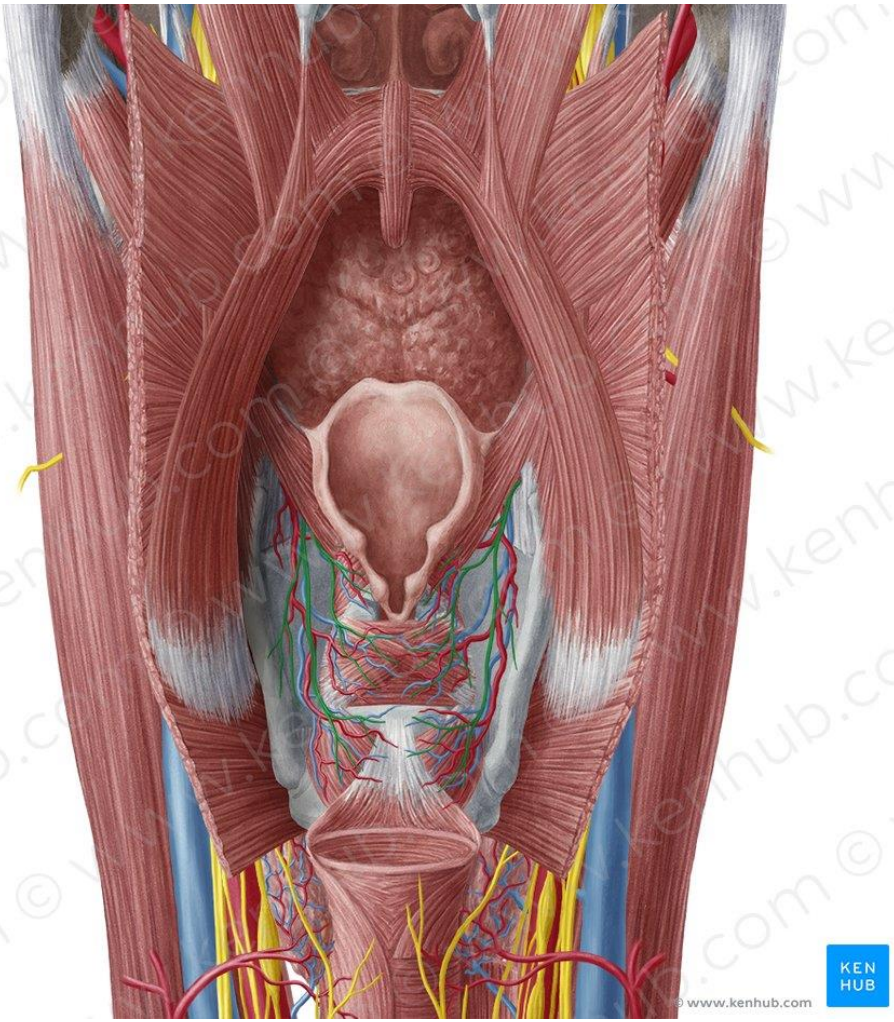


The external branch of the superior laryngeal nerve, also called the external laryngeal nerve, descends along the lateral wall of the pharynx to supply the inferior constrictor of the pharynx and ends by supplying the cricothyroid muscle.

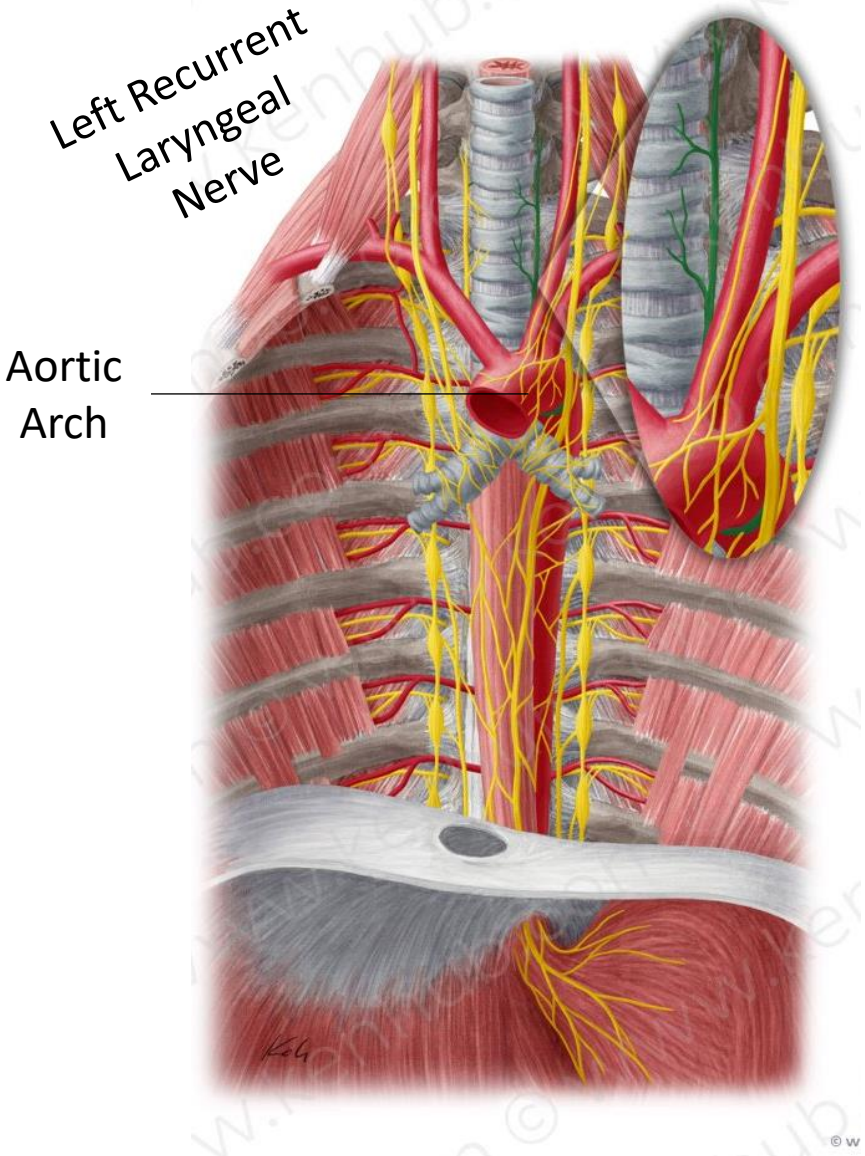


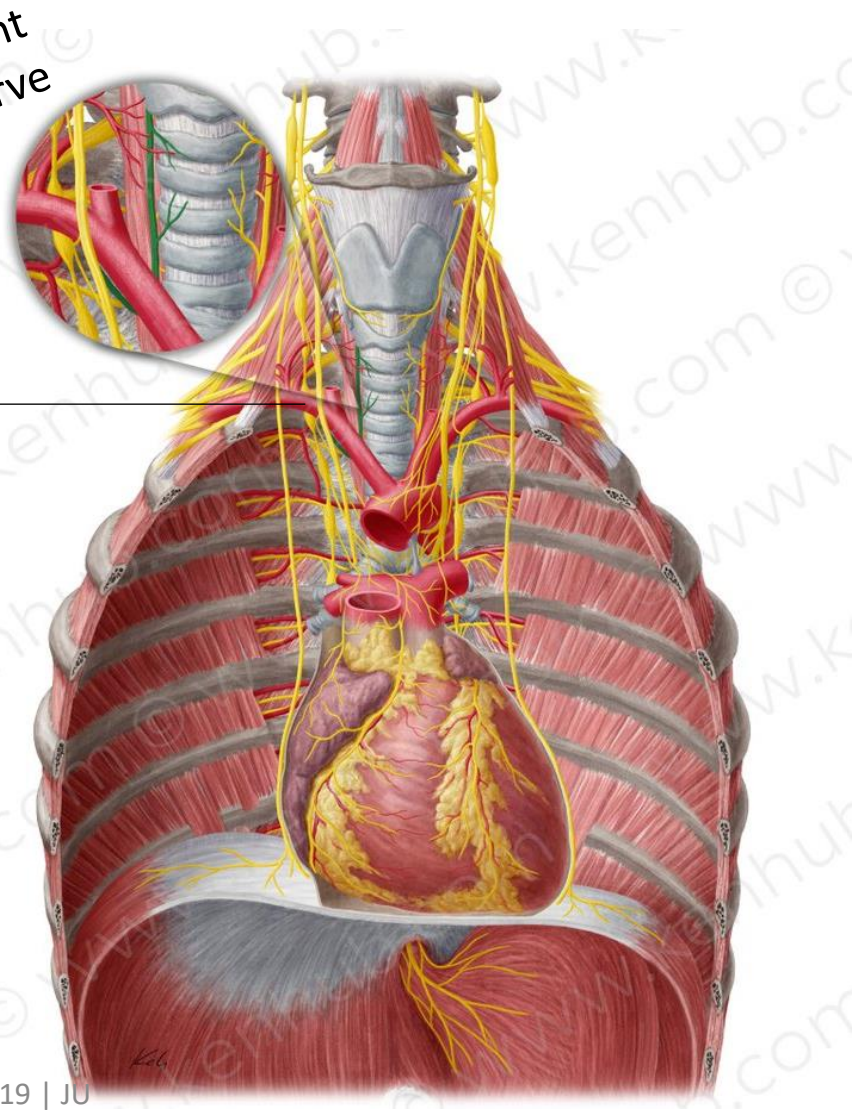
- The internal laryngeal nerve (internal branch of superior laryngeal nerve) passes anteroinferiorly to penetrate the thyrohyoid membrane, it is mainly a sensory nerve and supplies the laryngeal cavity down to the level of the vocal folds.

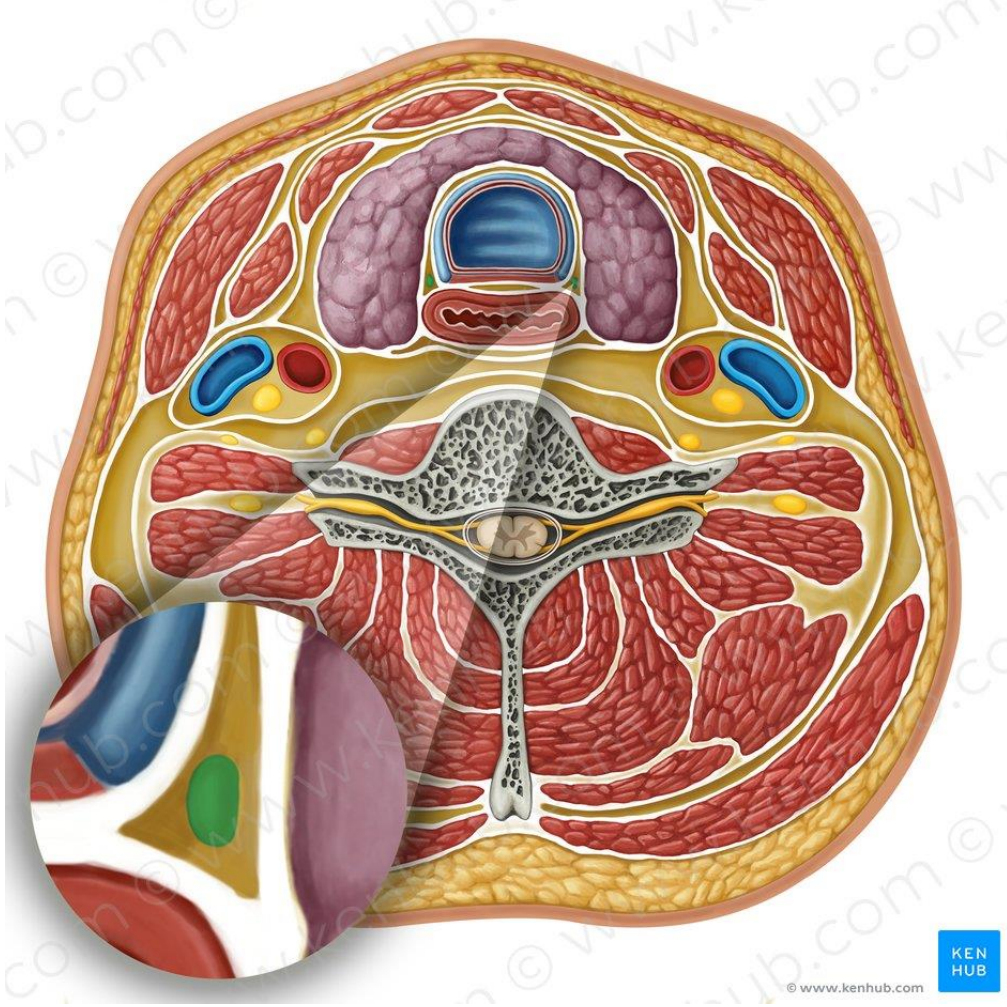


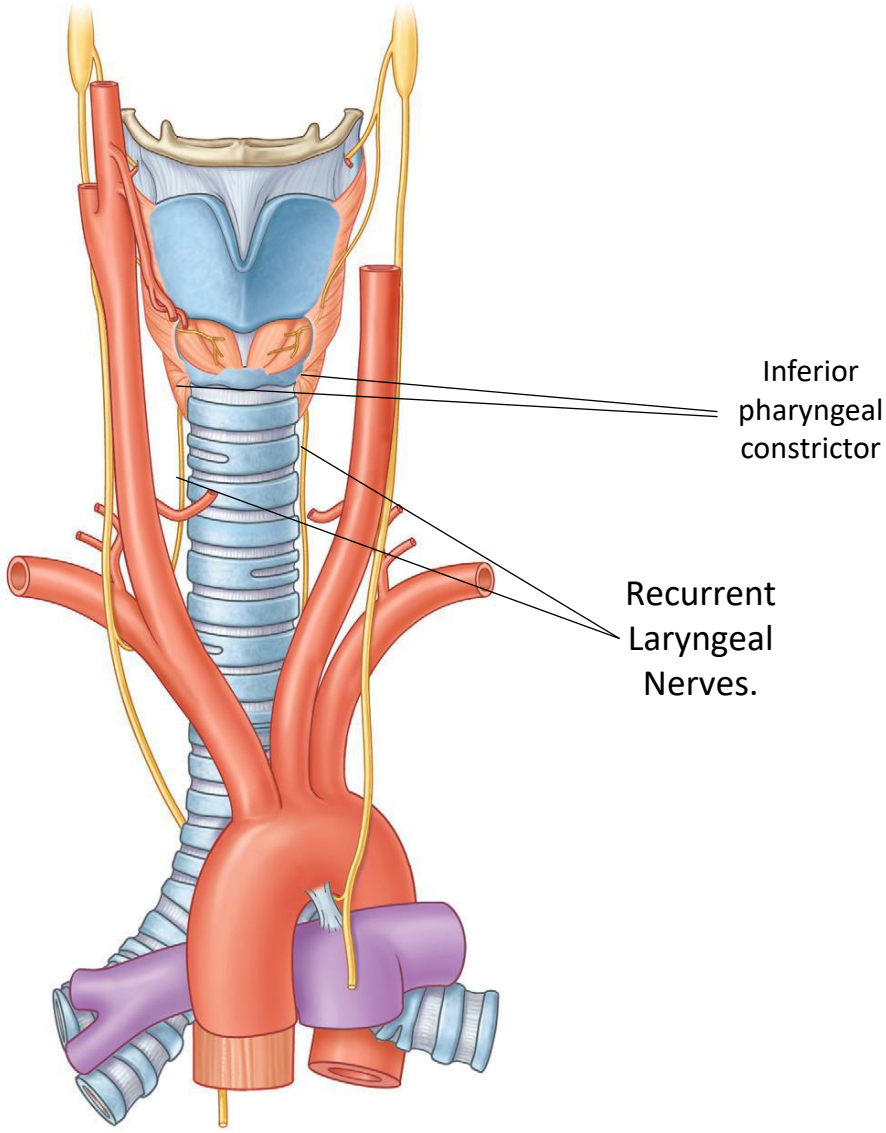


- The left recurrent laryngeal nerve originates in the thorax and wraps around the aortic arch to ascend into the larynx, while the right recurrent laryngeal nerve originates in the root of the neck and wraps around the right subclavian artery to ascend into the larynx.









Both recurrent laryngeal nerves generally ascend in the neck in the groove between the esophagus and trachea.

Both recurrent laryngeal nerve enter the larynx deep to the margin of the inferior constrictor

RELATIONS OF THE LARYNX

- Laterally on each side :

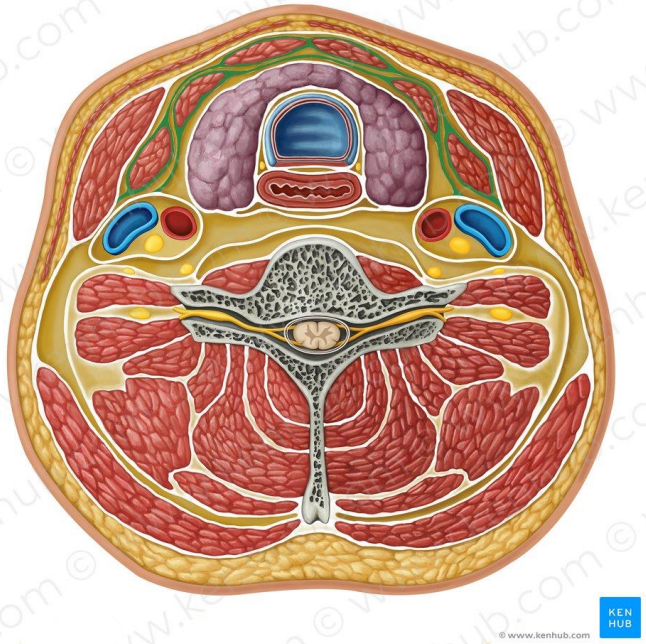
Carotid sheath (contents: the vagus nerve, common and internal carotid arteries and internal jugular vein), and lateral lobe of the thyroid gland

- Posteriorly:

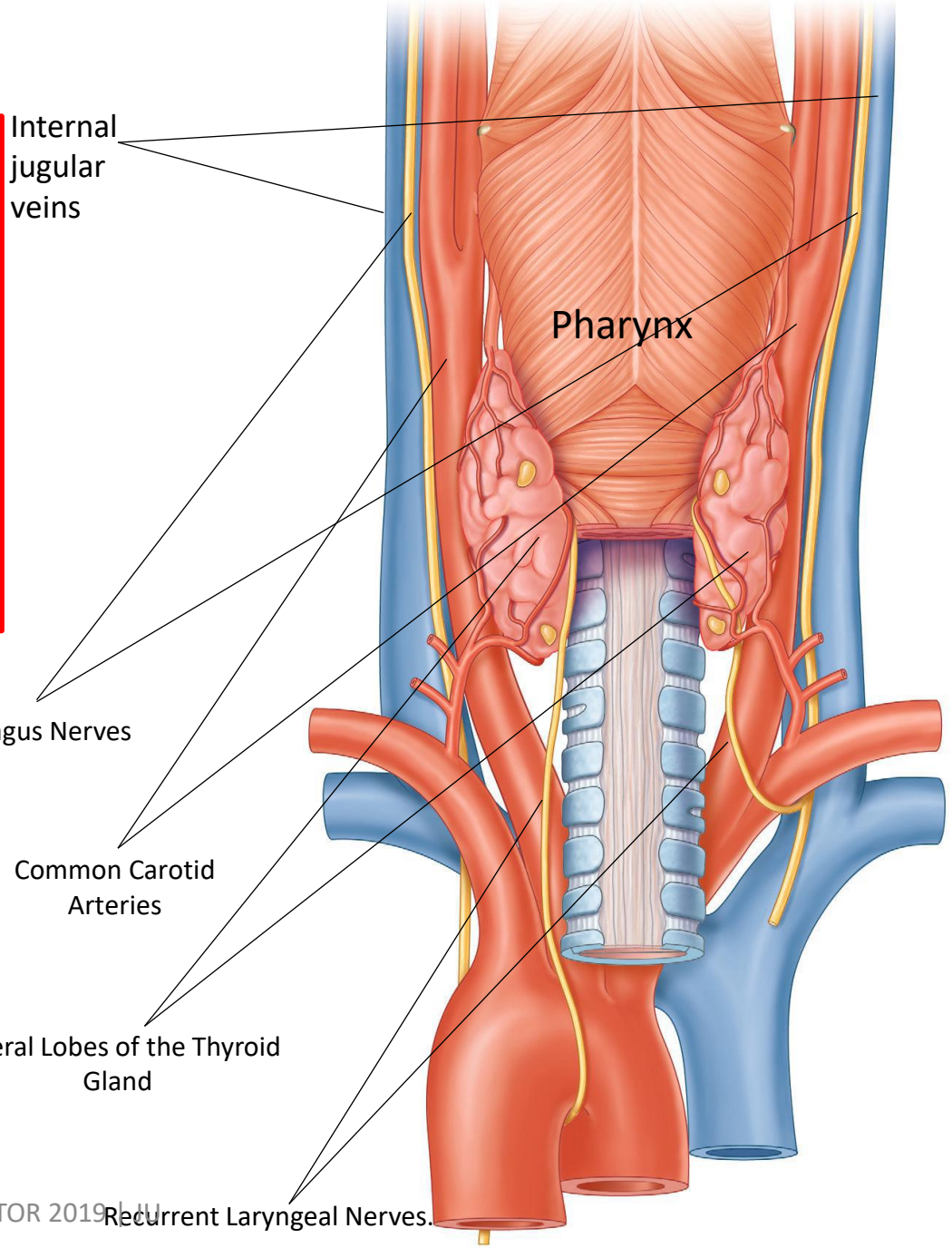
Pharynx and the right recurrent laryngeal nerve

- Anteriorly:

Skin, fascia and its contents, 4 infra-hyoid muscles (thyrohyoid, omohyoid, sternohyoid, sternothyroid)

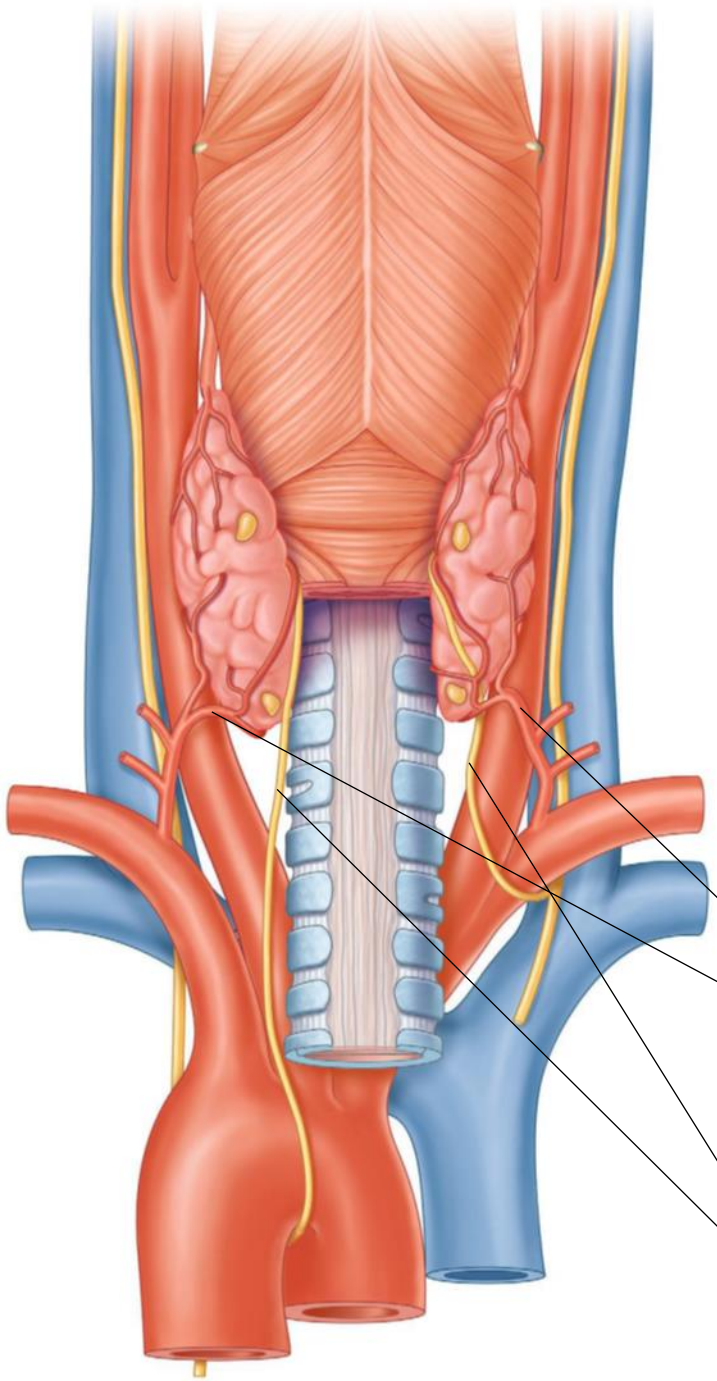


Infrahyoid Muscles



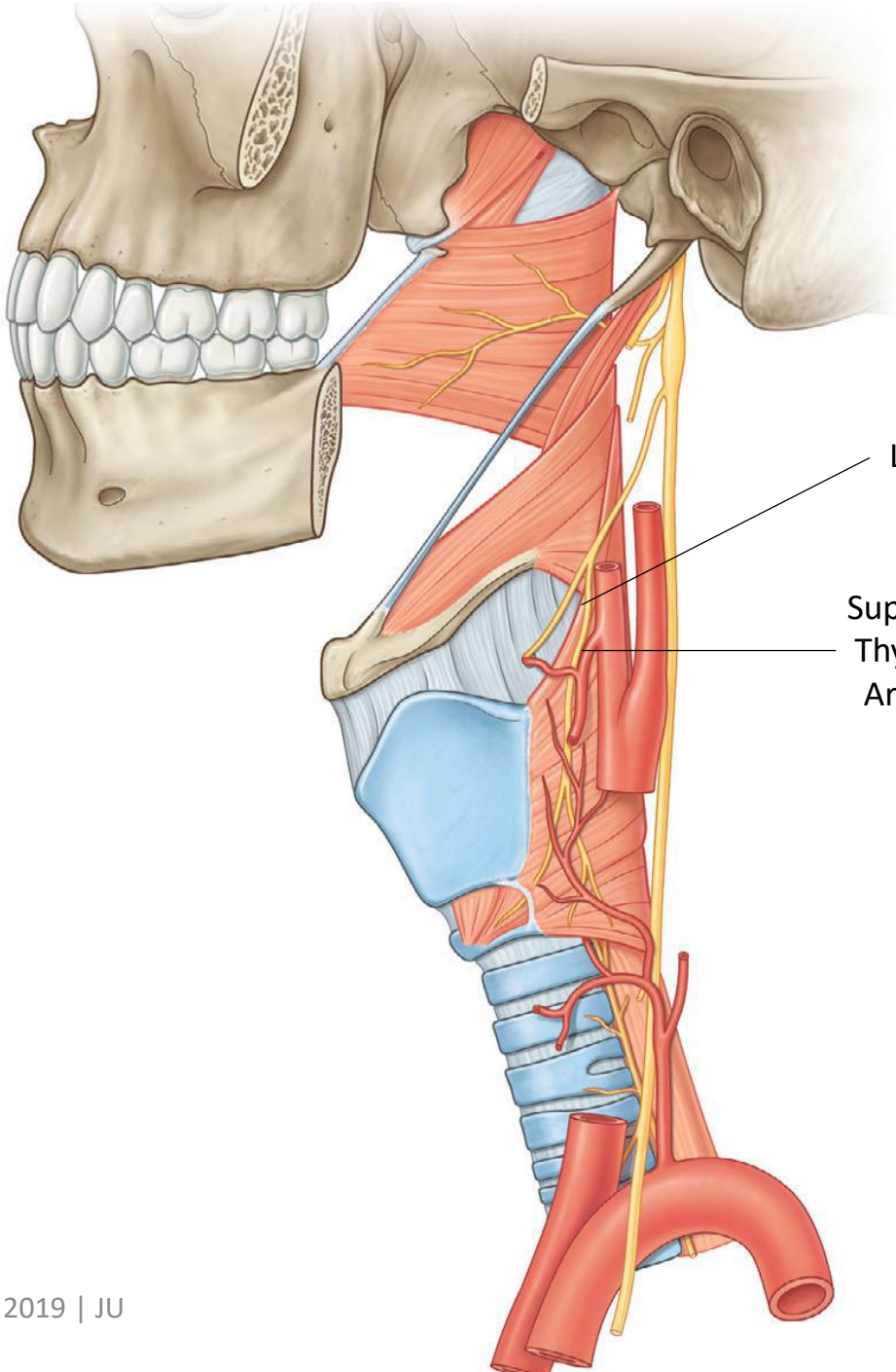
NERVE INJURIES OF THE LARYNX.

- Nerve injuries of the larynx commonly during thyroidectomy, that is, surgical removal of the thyroid gland, this is because this procedure involves ligature and cutting of the superior thyroid artery, which is very close to the external branch of laryngeal nerve, thus the external laryngeal nerve can be cut mistakenly if the surgeon has studied online 🤭, cutting (complete section) of this nerve would result in paralysis of cricothyroid muscle, which results in weakness of voice if it was unilateral and hoarseness of voice if it was bilateral.
- Moreover, this procedure also involves ligature and cutting the inferior thyroid artery, and this artery is very close to the recurrent laryngeal nerve, thus, the surgeon could cut the nerve mistakenly, that would result in complete section of the nerve and paralysis of all laryngeal muscles except cricothyroid muscle.



Inferior Thyroid Arteries

Recurrent Laryngeal Nerve



External Laryngeal Nerve

Superior Thyroid Artery

- Even without cutting the nerves directly, the nerves might be damaged by the tension شدّ and tearing that occurs during the procedure, this would result in damage to the superficial fibers within the nerves, this is called partial section.
- Unfortunately, it has been found that the superficial fibers of the recurrent laryngeal nerves are responsible for innervating the posterior cricoarytenoid muscle, which is the only abductor of the vocal cords, if the posterior arytenoid muscle was paralyzed while the adductors of the vocal cords (lateral cricoarytenoid) were preserved (like what occurs in partial section), the unopposed tone of the adductors would line to closure of the laryngeal inlet and difficulty in breathing, even suffocation if the section was bilateral (involving both nerves).
- That's why partial section (paralysis of posterior arytenoid and preservation of lateral arytenoid) is more dangerous than complete section (paralysis of both muscles).

Remember that a nerve is a collection of nerve fibers surrounded by a sheath, fibers at the periphery are more likely to be injured than fibers at the middle.

PATTERNS OF RECURRENT LARYNGEAL NERVE INJURY

1- Unilateral complete section:

- One vocal fold (on the affected side) in the position midway between abducted and adducted (so the vocal cord on the affect side in on the cadaveric position)
- Speech not greatly affected as the other vocal cord compensate for the action, respiration is mildly impaired.

Inspiration

Phonation

This is what the larynx of a person with right recurrent laryngeal nerve injury would look like during different activity, compare these to the normal pictures which we've seen previously.

- **Bilateral complete section:**
- Both vocal folds in position midway between abducted and adducted
- Breathing is impaired since the rima glottis is partially closed (it cannot be opened wider that the cadaveric position) and speech is lost (aphonia, because the vocal cords are away form each other and they cannot get closer so vibration wouldn't occur), but there is no suffocation (because the rima glottidis is partially open and it allows some air to enter).

Inspiration

Phonation

There is no difference !!!!

3- Unilateral partial section :

- This results in a paralysis of the abductor muscles and preserving adductor muscle, so the action of adductor muscles is unopposed .
- Therefore the affected cord is in the adducted midline position
- Hoarseness of the voice (the other vocal fold compensates the action), and there is difficulty of breathing (the rima glottidis becomes narrower).

Inspiration Phonation

Right recurrent laryngeal nerve partial section.

4. Bilateral partial section:

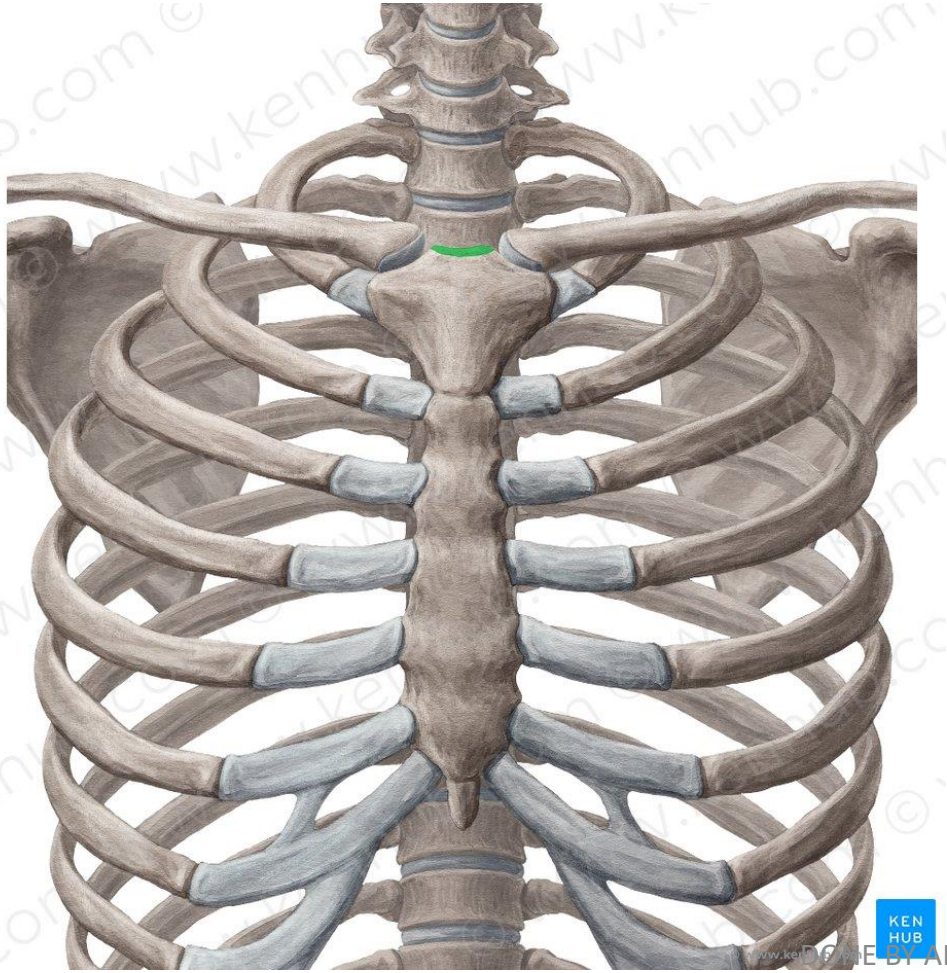
- The most severe form
- This results in bilateral paralysis of the abductor muscles
- Therefore the vocal folds are adducted together in the midline and the rima glotiddis is very narrow.
- Acute breathlessness (Dyspnea) and stridor follow
- Lead to suffocation so a tracheostomy is necessary, it is done in any membrane below the vocal cord.

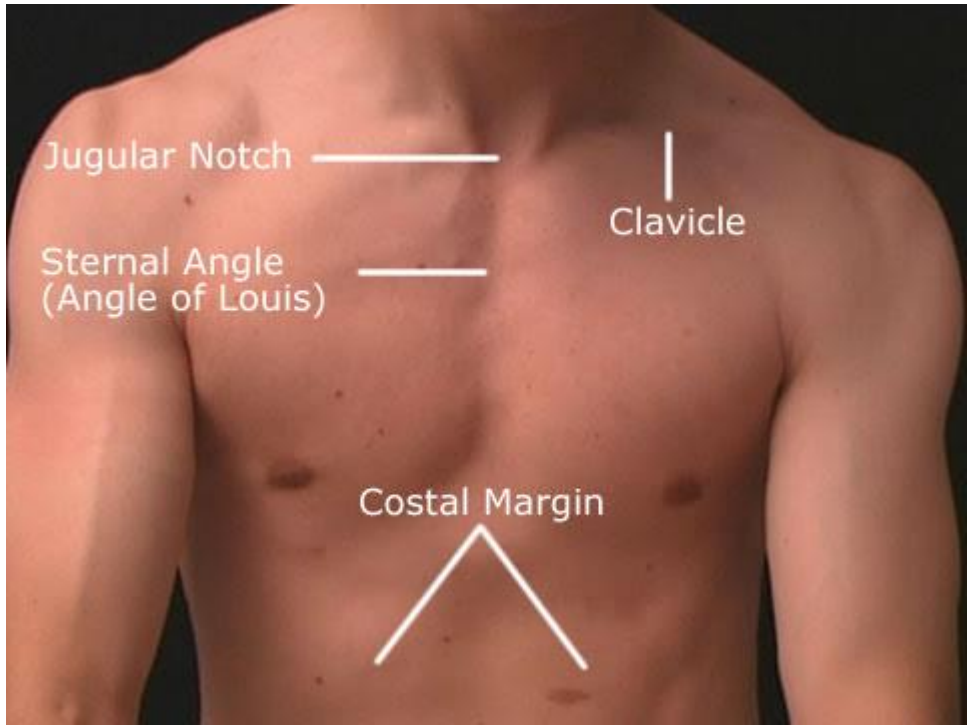
Inspiration

Phonation

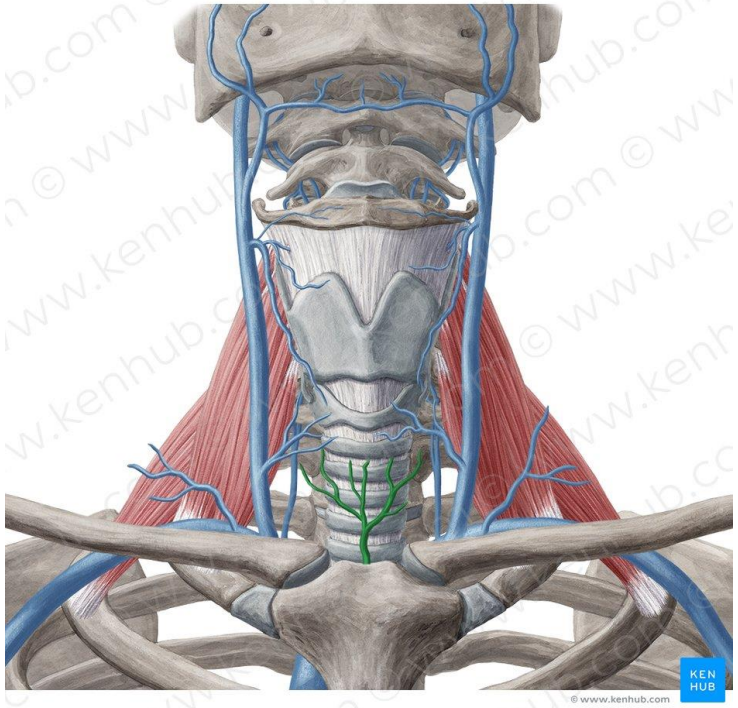
LAST BUT NOT LEAST: LOW TRACHEOSTOMY

If you faced a person who shows the symptoms of suffocation, and you were not in a medical institution, you can just you any sharp object and stap him above the jugular notch which is a palpable landmark in the root of the neck, this would open his airways, this procedure is known as low tracheostomy.

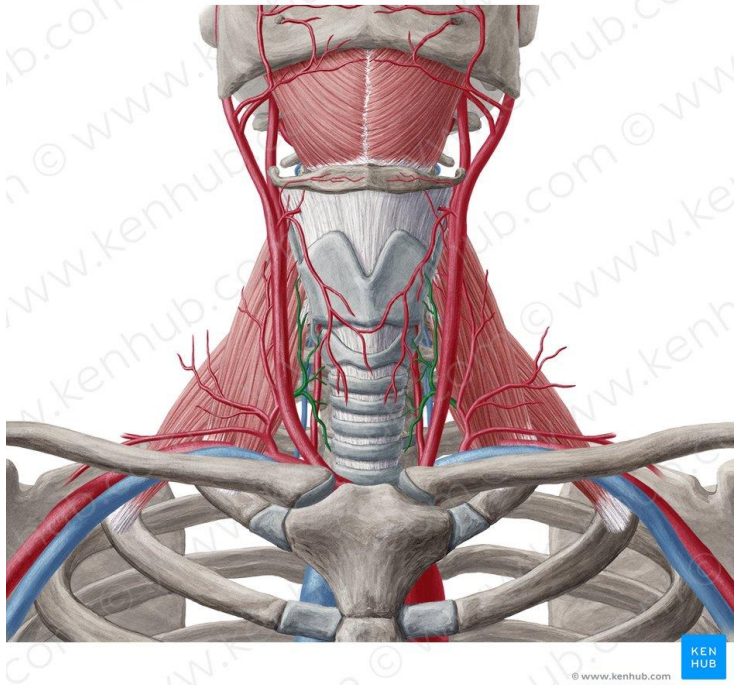




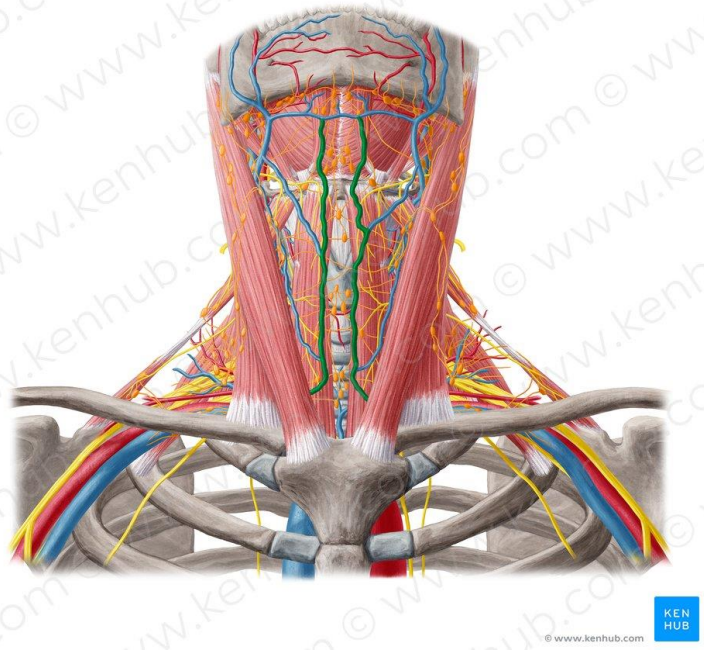
STRUCTURES TO AVOID INJURY DURING LOW TRACHEOSTOMY



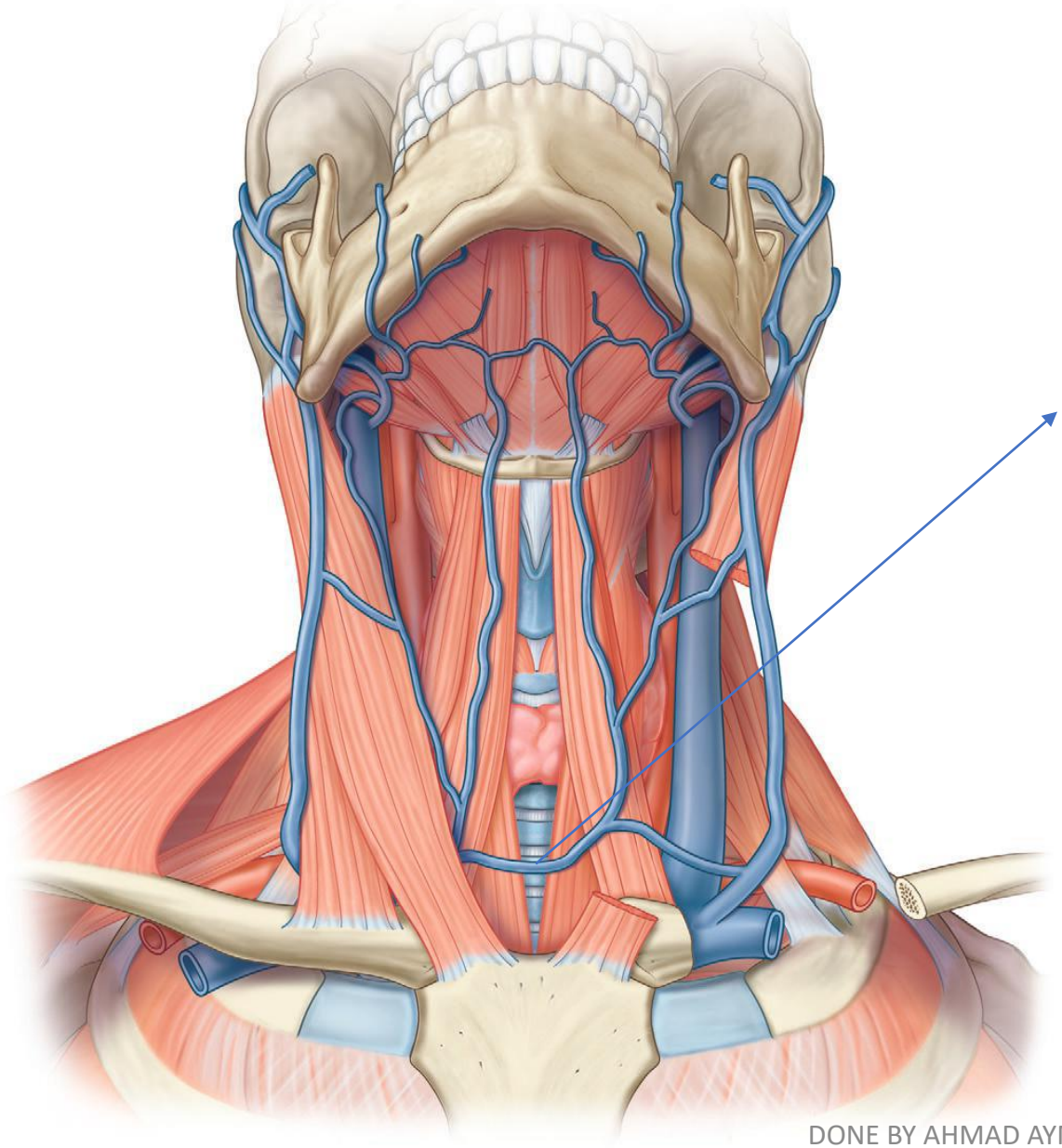
Inferior Thyroid Vein (most commonly)



Inferior Thyroid Arteries



Anterior Jugular Veins



In addition, you must be careful not to injure the thyroid ima artery, which is an artery that arises from the brachiocephalic trunk and presents in only 15% in people.