

Doctor.021

no. 2

RS ANATOMY



Writer: Doaa Sharawi

Corrector: Jana Alhittawe

Doctor: Mohammed Al Muhataseb



*Anything written in grey was written in the slides but not mentioned by the doctor during the lecture.

-You might notice a little difference from the sequence of the slides, as I tried to put the relevant topics together.

The Larynx

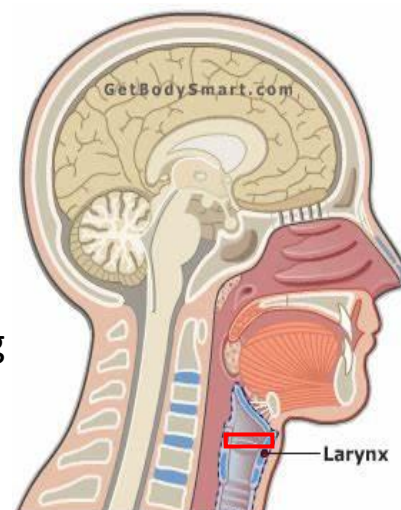
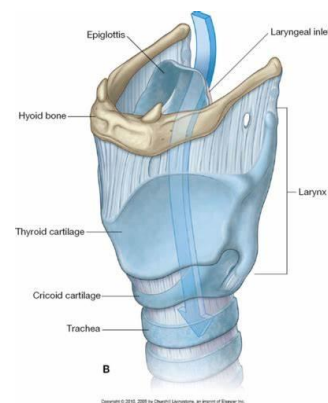
The larynx is basically a box of cartilages connected by ligaments, membranes, and muscles.

- Extends from the middle of C3 vertebra till the level of the lower border of C6. Remember, the trachea starts at the level of C6, so it continues as trachea.
- Above it opens into the laryngo-pharynx
- Suspended from the hyoid bone above and attached to the trachea below by membranes and ligaments

*The end of the larynx is the lower border of the cricoid cartilage.

Functions

1. Acts as an open valve in respiration.
2. Acts as a closed valve in deglutition. During deglutition, the epiglottis moves backwards and downwards (refer to the previous photo), and the larynx elevates by the action of its muscles, which results in the closure of the inlet of the larynx to prevent any solid particle to enter (if any solid particle entered the larynx, it will cause a cough reflex to get it out immediately).
3. Acts as a partially closed valve in the production of voice. The larynx contains true vocal cords (red box in the picture), which are v shaped and are attached anteriorly to the angle of thyroid cartilage, and posteriorly to the arytenoid cartilage. These true vocal cords adduct and abduct producing vibrations. When the air passes between them,



it gets partitioned, producing voice (speaking). This happens during expiration, which is a passive process (doesn't need action of muscles), while inspiration is an active one.

*False vocal cords don't have a role in speaking, however they adduct with the true vocal cords but don't cause complete closure. A comparison between the two will be mentioned shortly.

4. During cough it is first closed and then open suddenly to

release compressed air. Coughing happens as a result of complete adduction of vocal cords, which blocks the passage of the expired air. This compresses the air, which then causes sudden opening of the cords, causing the air to leave strongly resulting in a cough.

5. True vocal cords aid in lifting heavy objects: they get adducted when you lift a heavy object, but abducted as soon as you release it, resulting in a deep expiration.

Parts

The larynx consists of:

1. Cartilages which will be discussed in detail in this lecture.

2. Mucosa which is covered by common respiratory epithelium (ciliated pseudostratified columnar with goblet cells) except the true vocal cords, which are covered by oral epithelium (stratified squamous non-keratinized) because they are subject to injury and need continuous mitosis to regenerate. That's why after shouting for a long time the voice becomes hoarse as the vocal cords get injured.

3. Ligaments and membranes, which connect the cartilages together. A ligament is basically a thickening of the membrane, usually in the midline or lateral side.

4. Muscles: muscles of the larynx act on:

-The inlet: cause closure and opening.

-The true vocal cord: cause > abduction and adduction
> tense and laxation

True and false vocal cords:

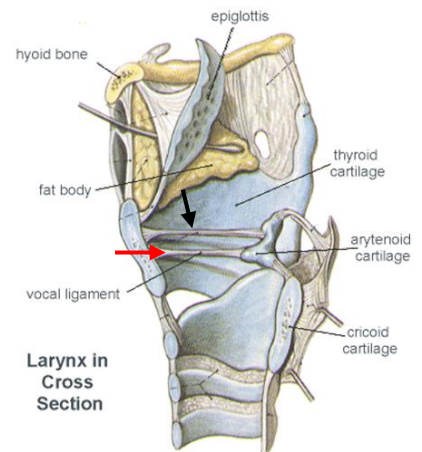
The true vocal cord mainly constitutes of the vocal ligament and vocalis muscle. It has a mucosa consisting of stratified squamous non-keratinized epithelium as mentioned earlier. However, it doesn't have a submucosa or lymphatics, as that prevents edema from happening if it gets injured, which (the edema) causes adduction of the cords and suffocation.

Comparison with the false vocal cord:

As you can see in the picture, the false vocal cord (black arrow) is located above and lateral, while the true one (red arrow) is below and more adducted.

The false vocal cord acquires a red color due to the presence of blood vessels, while the true one is white because it lacks blood vessels.

Another difference is that the false vocal cord constitutes mainly of a ligament called the vestibular ligament, while the true one is mainly composed of the vocal ligament.



True vocal cord	False vocal cord
Below & medial	Above & lateral
white	Red
Vocal ligament	Vestibular ligament
Oral epithelium	Respiratory epithelium

Now let's start talking about the parts that the larynx is made of in more detail:

Cartilage

The larynx consists of a total of 9 cartilages, 3 of which are single, and 3 pairs (present on each side, right and left).

- **Single:** (ordered from superior to inferior, refer to the picture below)

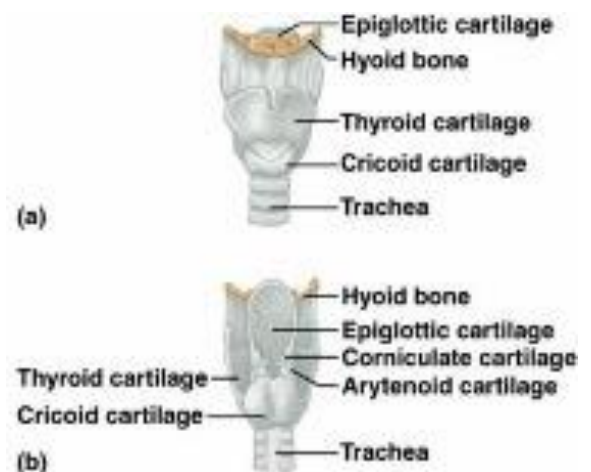
- **Epiglottis, Thyroid, Cricoid**

- **Pairs:**

- Cuneiform** which lies in aryepiglottic fold (a fold between arytenoid cartilage and the epiglottis, which aids in closure of the inlet)

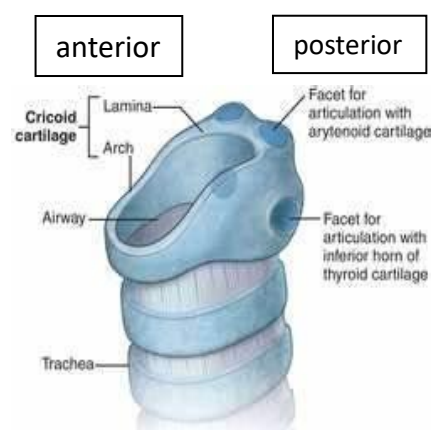
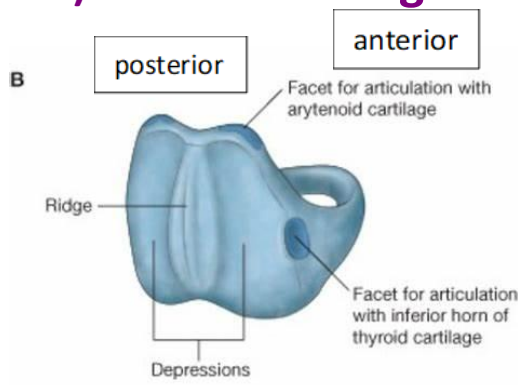
- Corniculate** which articulates with the apex of arytenoid cartilage inferiorly.


- Arytenoid** which lies above the lamina of cricoid cartilage.



Let's start by talking about the single ones:

1) Cricoid cartilage



As you can see in the picture above, the cricoid cartilage consists of an arch anteriorly and a square lamina posteriorly, which is why it's **shaped like a 'signet ring'**. 

- **The most inferior of the laryngeal cartilages**, its lower border marks the end of the larynx, and is attached to trachea by cricotracheal membrane.

- **Completely encircles the airway**, the air passes through its lumen.
- **Broad lamina of cricoid cartilage posteriorly**
- **Much narrower arch of cricoid cartilage circling anteriorly.**

The posterior part (the lamina):

-Has two oval depressions separated by a ridge:

The esophagus is attached to the ridge, the ridge attaches to the oesophagus posteriorly by connective tissue.

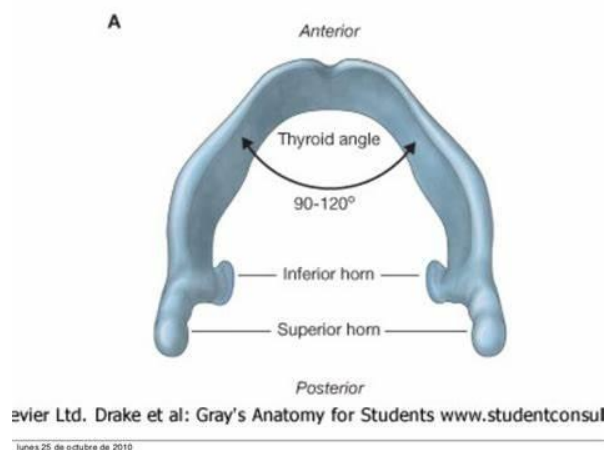
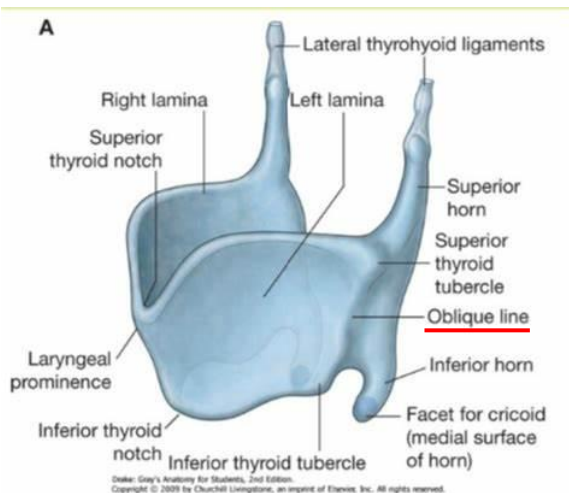
Depressions are for attachment of the posterior crico-arytenoid muscles: the two depressions provide attachment for the posterior cricoarytenoid muscles, which abduct the true vocal cords.

-The lateral side of the lamina provides attachment for the lateral cricoarytenoid muscle, which adducts the true vocal cords.

-Contains two facets for articulation with arytenoid cartilage on its upper border, and two facets for articulation with thyroid cartilage on its lower border. **(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.)**

To sum up, the cricoid cartilage has an arch anteriorly and a lamina posteriorly. The lamina consists of a ridge and two depressions, has 2 pairs of facets, and provides attachment for 2 muscles.

2) Thyroid cartilage



It consists of 2 lamina: right and left, forms anteriorly an acute angle, and it's open posteriorly.

- The largest of the laryngeal cartilages
- **It is formed by a right and a left lamina**
- **Widely separated posteriorly, but converge and join anteriorly, most superior point of the site of fusion between the two laminae is the laryngeal prominence ('Adam's apple'), angle between the two laminae is more acute in men (90°) than in women (120°)**
(explanation below)

The acute angle anteriorly is also known as the laryngeal prominence or Adam's apple. It's more prominent in males because of the hormonal secretion of testosterone, which has an effect on bones (makes them heavier), muscles (makes them stronger), but here we're interested about its effects on the laryngeal prominence, as it becomes more of an acute angle (around 90°). This makes the vocal cords longer, which explains the low-pitched voice of males after puberty.

The exact opposite effect happens in females by the hormones (progesterone and estrogen), as the angle becomes larger (around 180°) and Adam's apple becomes less evident, which results in shorter vocal cords that produce high-pitched voice.

- **Posterior margin of each lamina is elongated to form a superior horn and an inferior horn:** (refer to picture) the medial surface of the inferior horn has a facet for articulation with the cricoid cartilage, the superior horn is connected by a ligament to the posterior end of **the greater horn of the hyoid bone**. So simply, the superior horn articulates with the greater horn of the hyoid bone, while the inferior one articulates with the cricoid cartilage.
- Superior to the laryngeal prominence, the superior thyroid notch separates the two laminae
- **Superior thyroid notch and the laryngeal prominence are palpable landmarks in the neck**
- Less distinct inferior thyroid notch in the midline along the base of the thyroid cartilage.

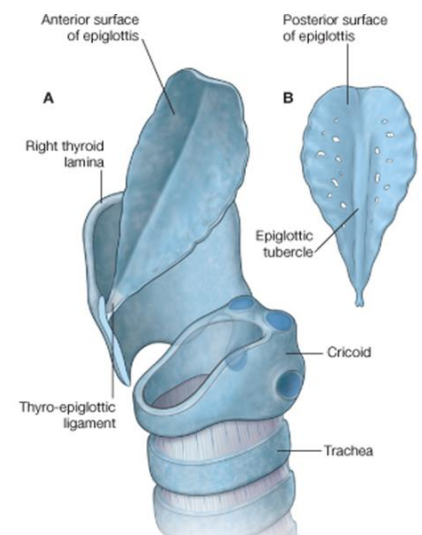
- **Lateral surface of lamina is marked by a ridge (the oblique line),** which curves anteriorly from the base of the superior horn to the inferior margin of the lamina.
- Ends of the oblique line are expanded to form superior and inferior thyroid tubercles
- **The oblique line (refer to photo) is a site of attachment for the extrinsic muscles of the larynx (sternothyroid, thyrohyoid, and inferior constrictor).**

3) Epiglottis

It is an important structure because it forms the boundaries of the inlet.

It is composed of two surfaces:

- 1- Outer surface (superio-anterior): covered by oral epithelium (stratified squamous non-keratinized) as it's directed toward the oral cavity.
- 2- Inner surface (postero-inferior): covered by respiratory epithelium (ciliated pseudostratified columnar with goblet cells), this surface contains a ridge and tubercles (the right photo).



- **Is a 'leaf-shaped' cartilage attached by its stem to the angle of the thyroid cartilage.** It has an upper free edge, and an apex directed downwards, which attaches to the inner part of the angle of the thyroid cartilage.

- **Projects posteriosuperiorly from its attachment to the thyroid cartilage.**

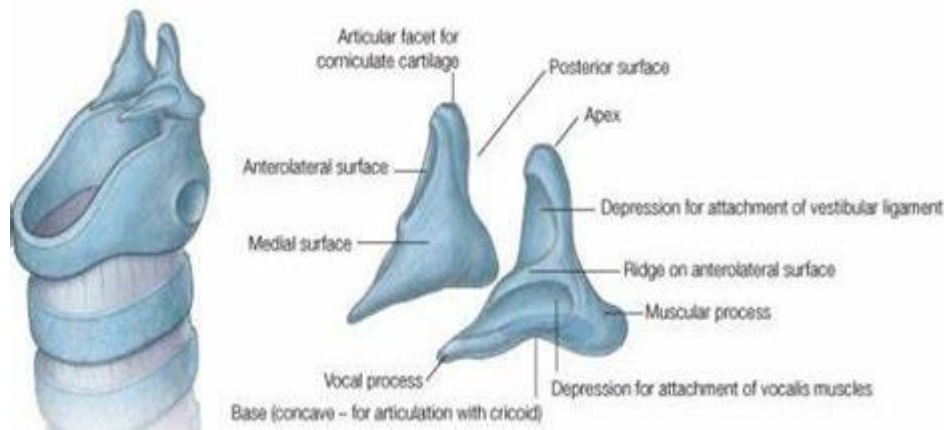
- The attachment is via the thyro-epiglottic ligament in the midline between the laryngeal prominence and the inferior thyroid notch

- **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.

Now we're done with the single cartilages, let's start with the pair ones:

1) Arytenoid cartilages



- **Two arytenoid cartilages are pyramid-shaped cartilages with three surfaces:** medial, lateral, and posterior.

The anterolateral surface has two depressions, separated by a ridge, for muscle (vocalis) and ligament (vestibular ligament) attachment:

-The medial surface is smooth, while the lateral one has a ridge and two depressions: 1- a superior one: attaches to the vestibular ligament, which as you recall is the main component of the false vocal cord. And 2- an inferior one: attaches to the vocalis muscle which constitutes the true vocal cord. Remember, the false vocal cord is superior to the true one, that explains the site of their attachments.

- **Base of arytenoid cartilage and an apex of arytenoid cartilage** (each arytenoid cartilage has a base and an apex):

The base of arytenoid cartilage is concave and articulates with the facet on the superolateral surface of the cricoid cartilage, this is a synovial joint with rotatory movement.

The base has two processes:

- 1- the muscular process: attaches to two muscles: the posterior cricoarytenoid, and the lateral cricoarytenoid, which if you recall were attached to the lamina of cricoid cartilage (hence the name!). **The lateral angle is similarly elongated into a muscular process for attachment of the posterior and lateral crico-arytenoid muscles.**

2- the vocal process: which attaches to true vocal cord especially the vocal ligament (which is its main part). **The anterior angle of the base of arytenoid cartilage is elongated into a vocal process to which the vocal ligament is attached.**

The apex of arytenoid cartilage articulates with a corniculate cartilage.

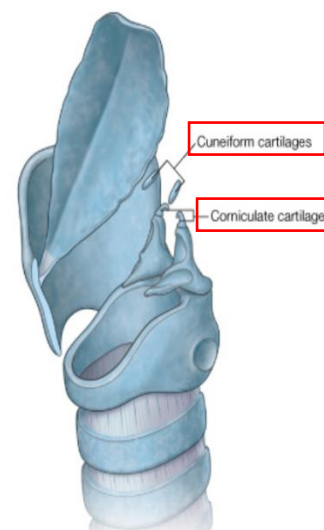
- The medial surface of each cartilage faces the other.

2) Corniculate

- The corniculate cartilages are two small conical cartilages
- Bases articulate with the apices of the arytenoid cartilages (which is a synovial joint).
- Their apices project posteromedially towards each other.

3) Cuneiform

- The Cuneiform are two small club- shaped cartilages
- Lie anterior to the corniculate cartilages
- Suspended in the part of the fibroelastic membrane that attaches the arytenoid the epiglottis, which is called the aryepiglottic membrane.
- it aids muscles in closure of the inlet.



Now let's move to the second part that the larynx is made of:

Ligaments and membranes that connect the cartilages together.

The ligaments are either extrinsic or intrinsic.

Their names indicate the two cartilages -or cartilage and bone that they connect together.

-Extrinsic ligaments:

1- Thyrohyoid membrane

2-Hyo-epiglottic ligament

3- Cricotracheal ligament / membrane.

-Internal ligaments:

1- cricothyroid ligament

2-quadrangular membrane

Let's start with the extrinsic ones:

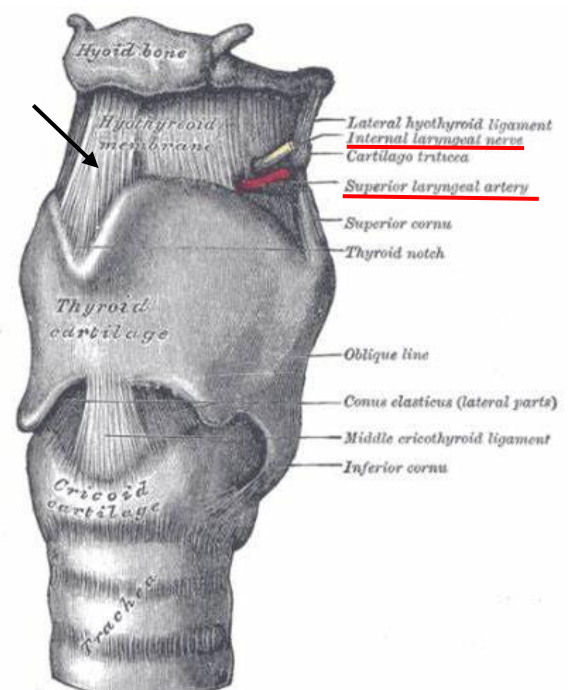
1) Thyrohyoid membrane

Expands from the inner thyroid membrane inferiorly and the hyoid bone superiorly.

- **Tough fibroelastic ligament that spans between the superior margin of the thyroid cartilage below and the hyoid bone** (the hyoid bone is located above the larynx).
- **Attached to the thyroid laminae** and adjacent anterior margins of the superior horns
- **Ascends medial to the greater horns and posterior to the body of the hyoid bone to attach to the superior margins of these structures.**

The importance of this membrane is mainly due to the presence of a foramen on its side, which provides passage for a blood vessel and a nerve: the superior laryngeal artery, a branch of the superior thyroid artery, which is a branch from the external carotid. And the internal laryngeal nerve, which provides sensory innervation to the larynx above the vocal cords. (The sensory nerve for the lower part of the larynx is the recurrent laryngeal.)

- **An aperture in the lateral part of the thyrohyoid membrane on each side is for the superior laryngeal arteries, nerves, and lymphatics.**
- **The posterior borders of the thyrohyoid membrane are thickened to form the lateral thyrohyoid ligament**
- **Also thickened anteriorly in the midline to form the median thyrohyoid ligament.** (arrow on picture)
- **Occasionally, there is a small cartilage**



(triticeal cartilage) in each lateral thyrohyoid ligament.

2) Cricotracheal Ligament

Runs from the lower border of the cricoid cartilage to the adjacent upper border of the first tracheal cartilage (first ring of trachea)

It has two clinical implications:

1- Surgical tracheostomy:

When the recurrent laryngeal nerve is cut during a surgery (for thyroid tumor for example), and if the cut was bilateral, it results in the adduction of true vocal cords leading to suffocation. If this happens the surgeon should make a cut in the cricotracheal ligament and insert a tube of air in it so the air passes directly to trachea without having to pass through the closed vocal cords.

2- Emergency tracheostomy:

This happens in emergency situations where a person is suffocating and you have to act fast before the ambulance arrives, because if the brain was deprived of oxygen for about 2-5 minutes it will lead to death. If this happens you have to locate the trachea with your hand (the first tracheal ring is palpable above the suprasternal notch), take any sharp object, and make a cut in the cricotracheal membrane (or any membrane below the vocal cords) to open the obstructed airway.

3) The hyo-epiglottic ligament

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

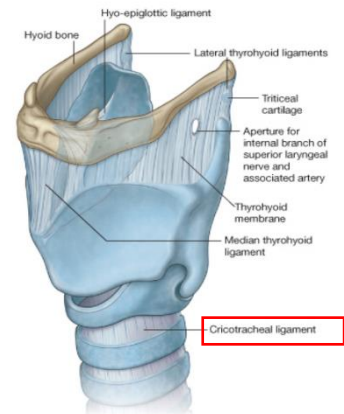
Now let's move on to the intrinsic ones:

The fibro-elastic membrane of larynx links together the cartilages and completes the architectural framework of the laryngeal cavity

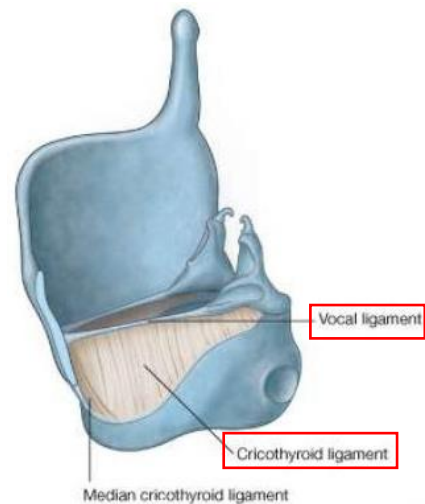
- It is composed of two parts-a lower cricothyroid ligament and an upper quadrangular membrane.

1) Cricothyroid ligament

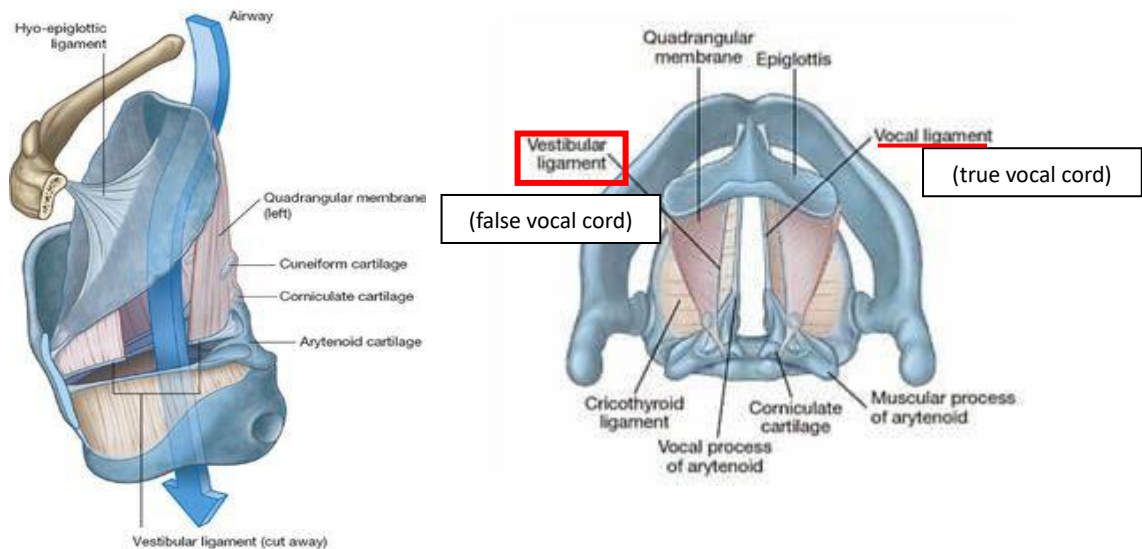
Surgeons refer to it as “conus elasticus”



- **Cricovocal membrane or cricothyroid membrane**
 - **Attached to the inner surface of arch of cricoid cartilage and extends superiorly, end in a free upper margin within the space enclosed by the thyroid cartilage.**
 - **The upper free margin is thickened to form the vocal ligament, which is under the vocal fold (true 'vocal cord') of the larynx.**
 - **Upper free margin attaches:** anteriorly to the thyroid cartilage, posteriorly to the vocal processes of the arytenoid cartilages
 - **The cricothyroid ligament is also thickened anteriorly to form a median cricothyroid ligament**
 - **In emergency situations, the median cricothyroid ligament can be perforated to establish an airway**



2) **Quadrangular membrane**



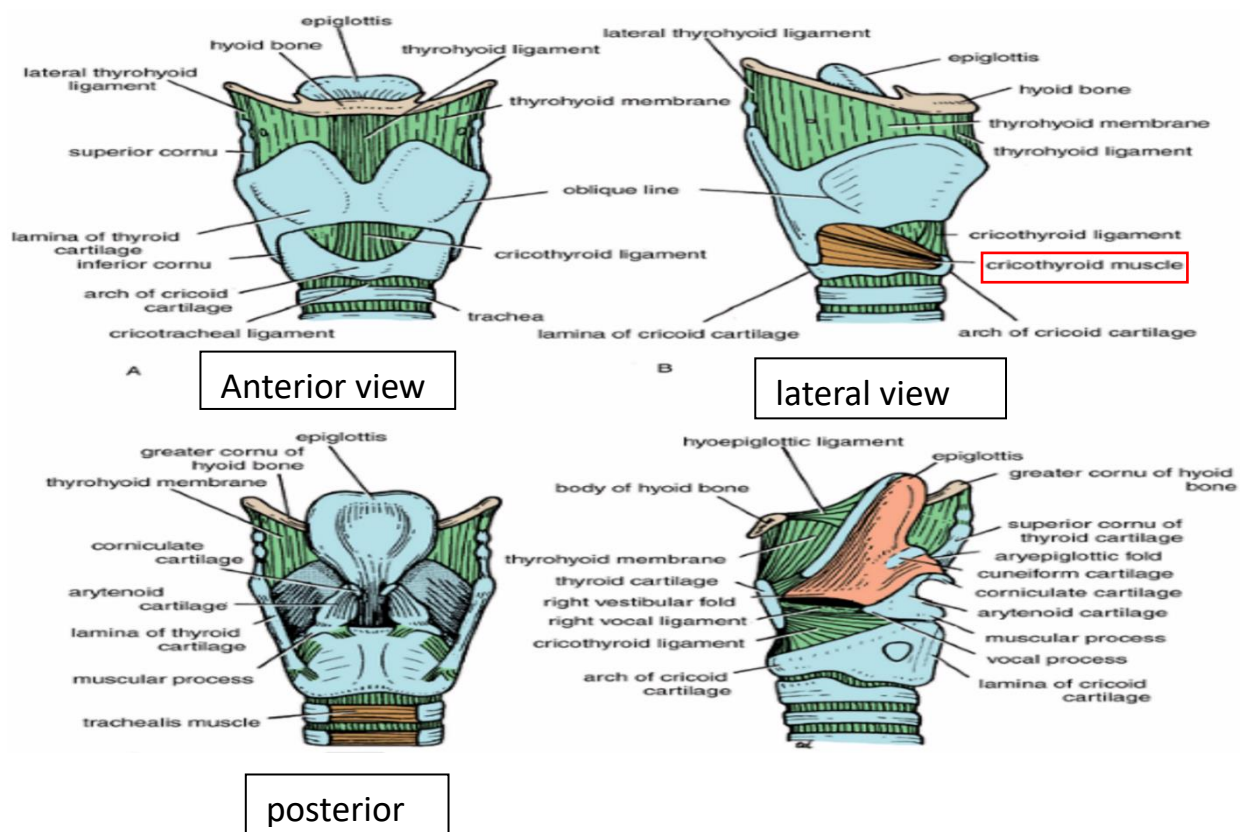
Simply, it has an upper free edge that attaches to epiglottis, and a lower free edge that is attached to the vestibular ligament, which is the main component of the false vocal cord, and which, if you recall, was attached to the upper depression of the lateral surface of the arytenoid cartilage. That means it **runs between**

the lateral margin of the epiglottis and the anterolateral surface of the arytenoid cartilage.

- Attached to the corniculate cartilage
- Free upper margin and a free lower margin, free lower margin is thickened to form the vestibular ligament under the vestibular fold (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

Cartilage and Ligaments

The following picture sums up all the parts mentioned in this lecture in different views:



On the lateral view you can see the cricothyroid muscle, the only extrinsic muscle attached to the larynx, and the only laryngeal muscle supplied by the external laryngeal nerve (a branch of the vagus), all

the others are supplied by the recurrent laryngeal. It will be discussed in detail in the next lecture.

Good luck

V2

Added this row on page 3

Oral epithelium	Respiratory epithelium
-----------------	------------------------

Page 11:

(or any membrane below the vocal cords)