

RESPIRATORY SYSTEM

Anatomy



Sheet



Slide

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Done by:

Mousa suboh

Corrected by:

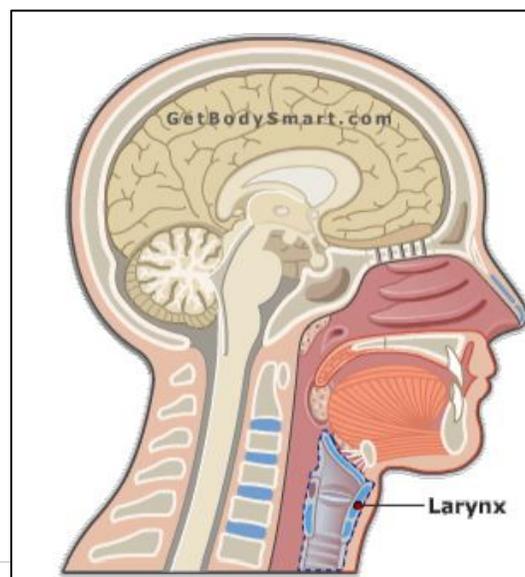
Dania Alkouz

Doctor:

Mohammad Almohtaseb

Larynx

- Extends from the third cervical vertebra C3 to the lower border of the sixth cervical vertebra C6 (at the level of the lower border of the cricoid cartilage).
- The larynx begins with the laryngopharynx opening and ends with the trachea.
- The larynx considered as a box of cartilage, it consists of layers that are arranged according to the following:
 - 1- **Mucosa:** the larynx is covered from the inside by respiratory mucosa (pseudostratified ciliated columnar epithelium) except the true vocal cords and anterior (upper) surface of the epiglottis which are both lined by stratified squamous non-keratinized .
 - 2- **Submucosa:** connective tissue
 - 3- **membranes and ligaments:** connect the cartilage together.
 - 4- **Cartilage:** the skeleton of the larynx.
 - 5- **Muscle:** intrinsic muscles of the larynx.
 - 6- **Adventitia:** connective tissue



Functions of the larynx

- 1- **Acts as an open valve in respiration:** the respiration process can be divided into:
 - Inspiration: the air goes from the larynx to the trachea and at the end it inflates the lungs. It is an active process.
 - Expiration: it is a passive process; the diaphragm gets relaxed and goes upward which causes the intrathoracic pressure to increase so the lungs get deflated.

- 2- **Acts as a closed valve in deglutition:** when we swallow food, the bolus goes from the oral cavity to the oropharynx and then to the esophagus, so in order for the food not to enter the inlet of the larynx during deglutition, the epiglottis moves downward (contracted) and the larynx moves upward and by that the inlet of the larynx will be completely closed.

- 3- **Acts as a partially closed valve in the production of voice (speech):** the production of voice happens during expiration (passive process) due to the vibration of the true vocal cord, so when expiration happens it causes the adduction of the true vocal cord, when the true vocal cord adducts a column of compressed air forms below it, this compressed air vibrates the true vocal cord in order to produce voice (speech).

- 4- **During cough it is first closed and then open suddenly to release compressed air:** the process of coughing happens to expel foreign bodies and dust, this process basically is the closure of the true vocal cord followed by a sudden opening, by that the true vocal cord adducts forming below it the column of compressed air and then it abducts making the compressed air exit suddenly and by that the person coughs. So, the coughing is the sudden opening of the true vocal cord.

Cartilages of the larynx

We said that the larynx is a box of cartilage, it contains single and paired cartilages:

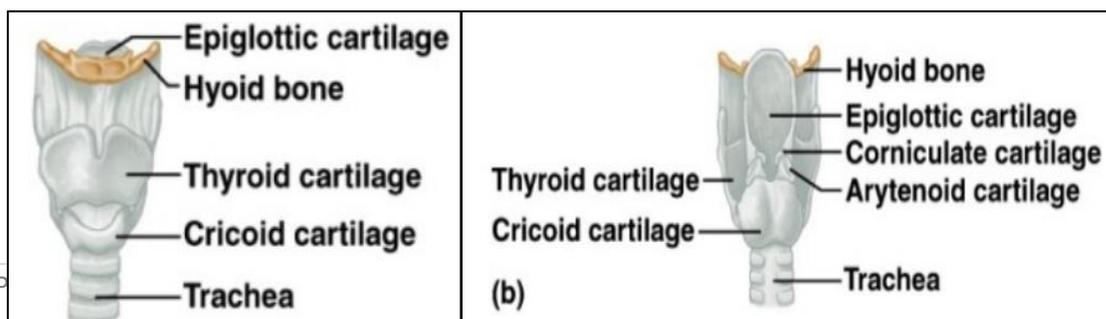
1. Single:

- Epiglottis
- Cricoid
- Thyroid

2. Pairs:

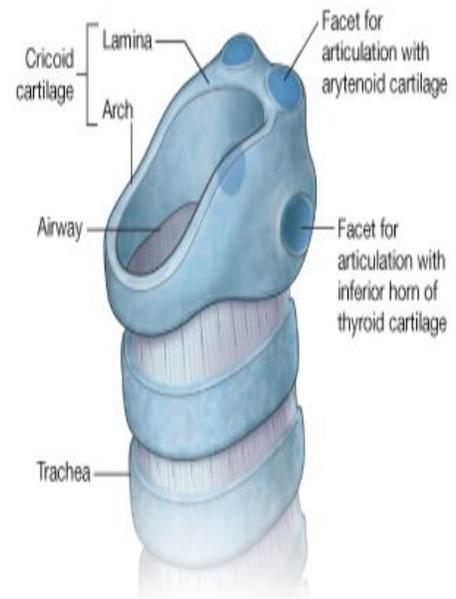
- Arytenoid: the most important cartilages in the larynx, there is one on the right and one on the left and they connect to the upper border of the lamina of cricoid cartilage.
 - Cuneiform
 - Corniculate: pair of corniculate cartilage connect with the apex of arytenoid, and they form a joint together.
- Between the arytenoid and the epiglottis there is a fold of fibroelastic membrane we call it **aryepiglottic fold**, because it extends from the arytenoid to the epiglottis, this fold is very important because:
- 1- It contains the aryepiglotticus muscle.
 - 2- It contains the cuneiform cartilage.
 - 3- It helps in the closure of the inlet of the larynx

This fold is the lateral boundary of laryngeal inlet.



Cricoid

- Shaped like a 'signet ring'
- It has an arch anteriorly and it has a lamina posteriorly.
- The lower border of the cricoid cartilage is the end of the larynx, which connects with the trachea by the cricotracheal membrane, this membrane in some cases could be thickened so it becomes a ligament we call it the cricotracheal ligament.



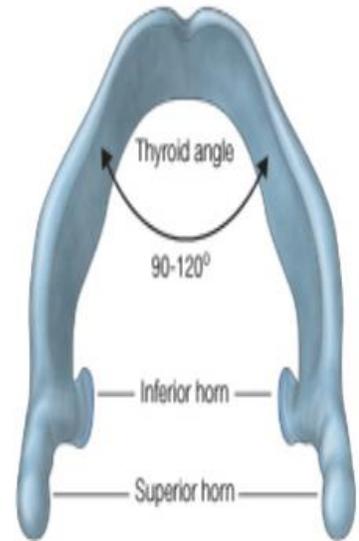
- It has **two facets on each side**, these facets are for articulation.
- The **upper two facets** articulate with the arytenoid cartilage, and they form a synovial joint. The **last facet** articulates with the inferior horn of the thyroid cartilage.
- The posterior surface of the lamina has two oval depressions separated by a ridge, the ridge is for the attachment of the esophagus and the Depressions are for attachment of the posterior crico-arytenoid muscles (from the depression to the arytenoid cartilage, abduction of true vocal cords).

Thyroid cartilage

- It has two laminae, one to the right and one to the left, and they fuse together and form an **angle anteriorly**.

– Posteriorly it is open, it is closed by a fascia and a membrane.

– It has **superior and inferior horns**. As we said the **inferior horn** articulate with the cricoid cartilage, on the other hand the **superior horn** connects with the greater horn of the hyoid bone by the thyrohyoid ligament.



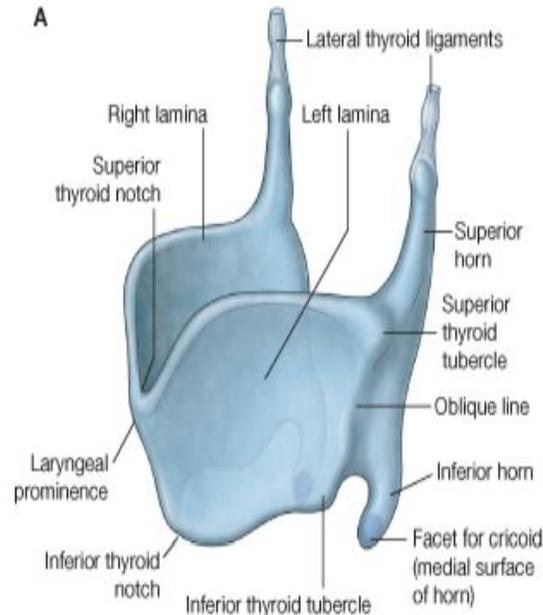
– Anteriorly at the most superior point of the site of fusion between the two laminae (the superior angle) is the **laryngeal prominence (Adam's apple)**, it is prominent in males and less prominent in females because the angle between the two laminae is more acute in men (90°) than in women (120°), this difference in the angle between the two genders is due to the hormonal secretions, in males testosterone is secreted which causes the bones to be heavy and bulky, the muscles are large and strong so this leads to the formation of an acute angle that causes the voice to be a low pitched voice (the true vocal cord is longer in males than in females).

In contrast, in females estrogen and progesterone are secreted, which causes the muscles and bones to be smooth and light, so the muscles do not affect the angle of the thyroid and it stays obtuse, and the voice in females becomes high pitched voice (the true vocal cord is shorter in females than in males).

– Superior to the laryngeal prominence, the **superior thyroid notch** separates the two laminae.

– Less distinct **inferior thyroid notch** in the midline along the base of the thyroid cartilage.

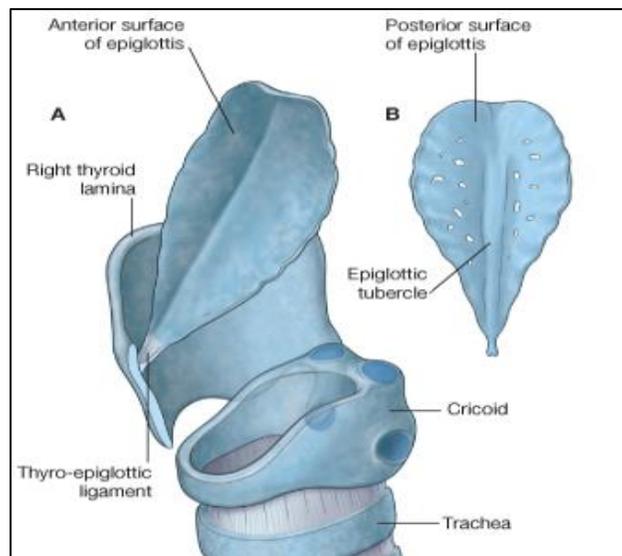
- Lateral surface of lamina is marked by a ridge (**the oblique line**), which curves anteriorly from the base of the superior horn to the inferior margin of the lamina.
- Ends of the oblique line are expanded to form **superior and inferior thyroid tubercles**.
- **The oblique line is very important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



Epiglottis

- It is a 'leaf-shaped' cartilage
- It has a superior free edge and an **apex** that attaches to the angle of the thyroid cartilage internally.

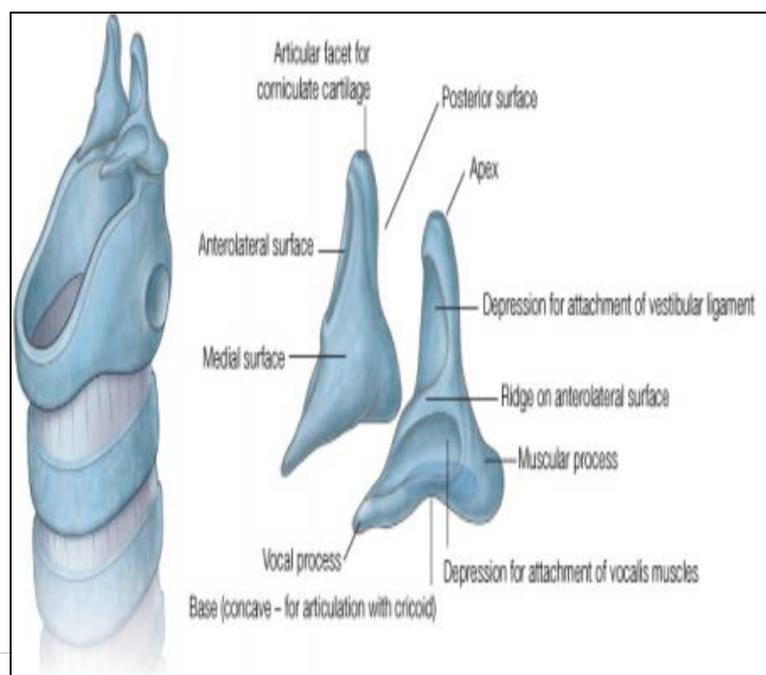
- It has **two surfaces**, superoanterior and posteroinferior surfaces.
- **The posteroinferior surface** contains the epiglottic tubercle and ridge.
- The epithelium in superoanterior surface is different than in the posteroinferior surface, the superoanterior has the same as the oral cavity which is stratified squamous nonkeratinized, on the other hand the posteroinferior surface has respiratory epithelium.
- It is attached with the thyroid cartilage via **thyo-epiglottic ligament**.
- It is very important in the closure of the inlet of the larynx.



Arytenoid cartilages

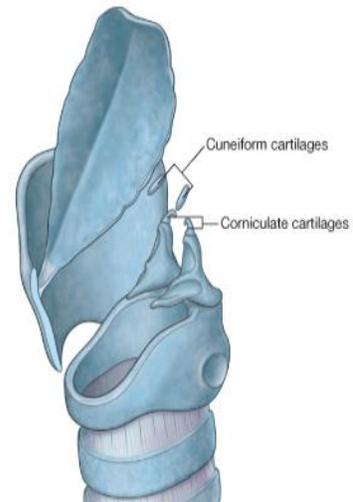
- Two arytenoid cartilages are pyramid-shaped cartilages each one has an apex and a base.
- **The apex** of arytenoid cartilage has a facet that articulates with a corniculate cartilage.

- **The base** of arytenoid cartilage is concave (has a depression) that articulates with the facet on the superolateral surface of the cricoid cartilage.
- Each arytenoid cartilage has **two surfaces**, a medial surface which is smooth and a lateral surface which has **two depressions** and between them a ridge.
- The **upper depression** of the lateral surface is for the attachment of the vestibular vocal cord (false vocal cord) by the vestibular ligament (false vocal ligament) and the **lower depression** is for the attachment of vocalis muscle which is a part of the true vocal cord.
- The base of arytenoid cartilage has **anteriorly a vocal process** to which the vocal ligament of true vocal cord is attached and has **posteriorly a muscular process** that attach to it the posterior cricoarytenoid which abducts the vocal cord and lateral cricoarytenoid which adducts the vocal cord, this opposite actions of the two muscles is due to the rotatory movement of the arytenoid cartilage . Posterior cricoarytenoid muscle abducts (lateral or outside rotation of the muscular process of the aretenoid cartilage) vocal cords while lateral cricoarytenoid muscle adducts them (medial or inside rotation of the muscular process of the aretenoid cartilage)



Corniculate and Cuneiform

- The corniculate cartilages are two small conical cartilages.
- The corniculate articulates with the apex of arytenoid and they mark the end of aryepiglottic fold (membrane)
- Their apices project posteromedially towards each other.
- The Cuneiform are two small club- shaped cartilages
- The Cuneiform as we said before exists in the aryepiglottic fold (fibroelastic membrane).



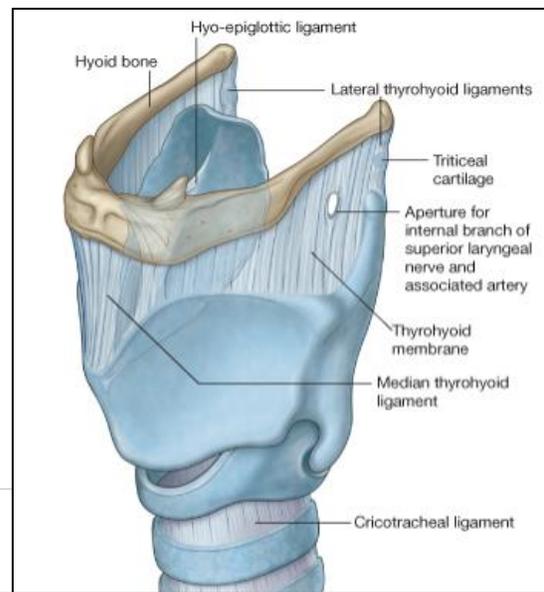
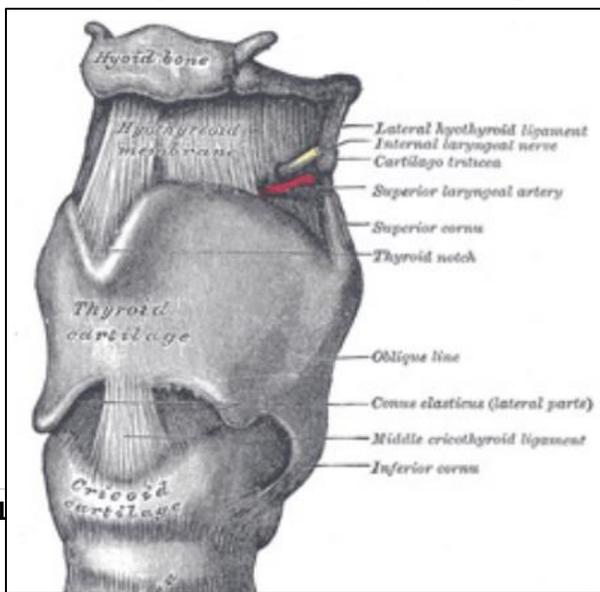
Ligaments (membranes) of the larynx

We can divide them into extrinsic and intrinsic membranes or ligaments. From the name of the ligament we can know its attachment.

Extrinsic ligaments

1- Thyrohyoid membrane

- Tough fibroelastic ligament that spans between the superior margin of the thyroid cartilage below and the hyoid bone
- Attached to the thyroid laminae and adjacent anterior margins of the superior horns of hyoid bone.
- The middle part of thyrohyoid we call it ligament and the lateral part we call it membrane.
- There is an opening in the lateral part of the thyrohyoid membrane on each side, **each opening makes a passage** for:
 1. **Superior laryngeal artery:** branch of the superior thyroid artery of the external carotid artery
 2. **Internal laryngeal nerve:** branch of the superior laryngeal of the vagus nerve, it is a sensory branch to the internal surface of the larynx above the true vocal cord.
 3. lymphatic vessels.
- The **posterior** borders of the thyrohyoid membrane are thickened to form the lateral thyrohyoid ligaments. Also thickened **anteriorly** in the midline to form the median thyrohyoid ligament. Occasionally, there is a small cartilage (triticeal cartilage) in each lateral thyrohyoid ligament to give strength to the ligament.
- **Triticeal cartilage:** a small cartilage inside the thyrohyoid ligament between the greater horn of hyoid bone and superior horn of thyroid cartilage, it strengthens the thyrohyoid ligament.



2- Cricotracheal ligament

- Runs from the lower border of the cricoid cartilage to the adjacent upper border of the first tracheal cartilage.
- as we said earlier if it is thickened in its midline we call it ligament but if it has no thickening and is placed on the lateral side we call it membrane.

3- The hyo-epiglottic ligament: extends from the midline of the epiglottis, anterosuperiorly to the body of the hyoid bone.

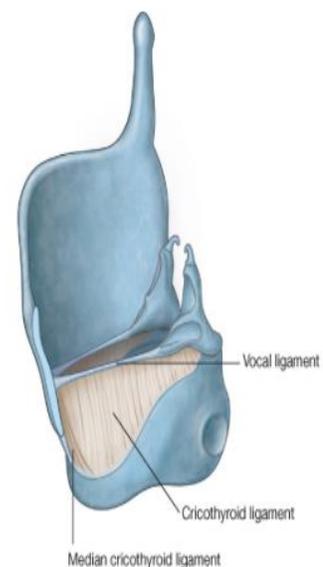
Intrinsic ligament

It is the fibro-elastic membrane of larynx that links together the cartilages.

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

1- Cricothyroid ligament

- Also named cricovocal membrane, cricothyroid membrane or **conus elasticus**.
- originates from upper border of the internal surface of cricoid cartilage and extends superiorly until it thickens in the **upper free edge** to form **vocal ligament** (part of the true vocal cord) between the vocal process of arytenoid cartilage and the angle of thyroid cartilage.
- 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



** Side note: the true vocal cord consists of:*

1- Mucosa

2- Vocalis muscle

3- Ligament

Notice that there is no submucosa in the true vocal cord

2- Quadrangular membrane

- Originates from the edge of the aryepiglottic fold of epiglottis, also it attaches to the edge of arytenoid and ends in its **lower free edge** which forms the **vestibular fold (ligament)** which is a part of the false vocal cord.

*** side note: all of the muscles of the larynx are intrinsic and innervated by recurrent laryngeal nerve, except for cricothyroid muscle which is innervated by external laryngeal nerve*

Cricothyroid muscle

Origin: cricoid cartilage

Insertion: thyroid cartilage

function: tension of the vocal cord and it is responsible for the high-pitched voice.

Innervation: external laryngeal nerve which is different from the other laryngeal muscles which are innervated by the recurrent laryngeal nerve.

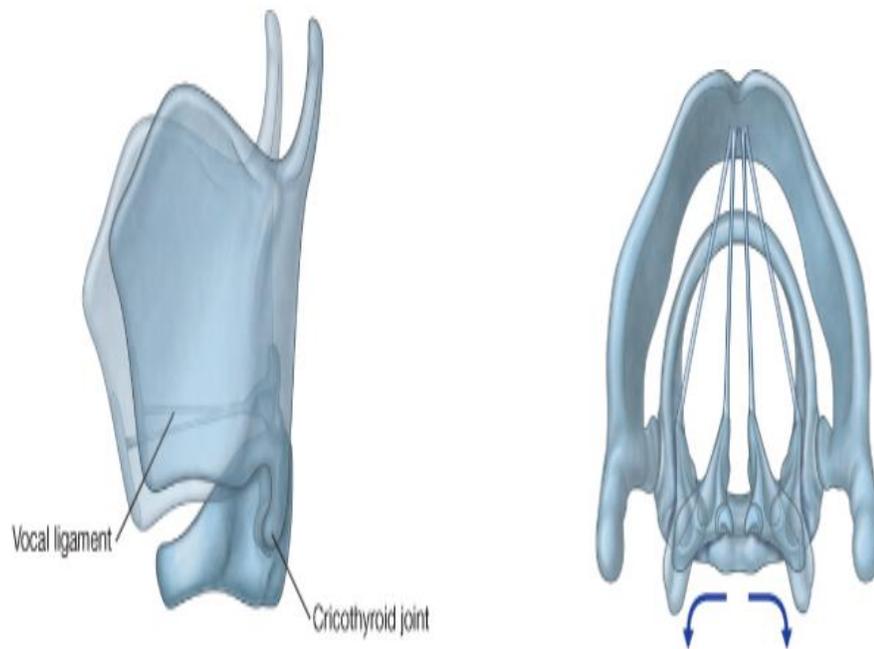
Laryngeal joints (synovial joints)

Cricothyroid joints

- Between the cricoid cartilage and the inferior horn of thyroid cartilage.
- Forward movement and downward rotation of the thyroid cartilage effectively lengthens and puts tension on the vocal ligaments

Crico-arytenoid joints

The crico-arytenoid joint is a synovial pivot joint and it has a rotatory movement for arytenoid over cricoid cartilage, so if the joint moves **internally** (toward the midline) the vocal cord (lateral cricoarytenoid muscle) adducts and if it moves **externally** the vocal cord (posterior cricoarytenoid muscle) abducts.



Best of luck 😊