بسم الله الرحمن الرحيم

ANATOMY

MID | Lecture 3

The Larynx

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Leen Mamoon

﴿وَلَقَدْ نَعْلَمُ أَنَّكَ يَضِيقُ صَدْرُكَ بِمَا يَقُولُونَ ۝٩٧ فَسَبِّحْ بِحَمْدِ رَبِّكَ وَكُن مِّنَ السَّاجِدِينَ﴾

سبحان الله وبحمده، سبحان الله العظيم

وَلِلَّهِ الْأَسْمَاءُ الْحُسْنَى فَادْعُوهُ بِهَا

المعنى: واسع صفات الكمال ومتعلقاتها، العظيم وأفعاله عظيمة، واسع الكرم، مجّدَه خلقه لعظمته.

الورود: ورد مرتين في القرآن.

الشاهد: ﴿ إِنَّهُۥ حَمِيدٌ مَّجِيدٌ ﴾ [هود :٧٣].

٥٣

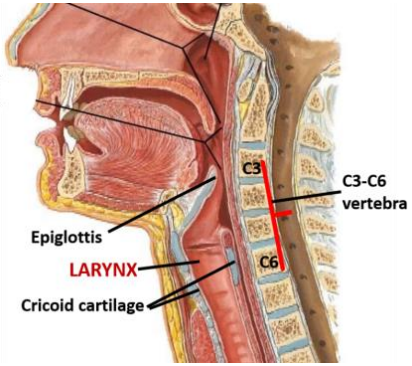
اضغط هنا لشرحٍ أكثر تفصيلًا

Prof. Dr.Mohammed Hisham Al-Muhtaseb

The Larynx

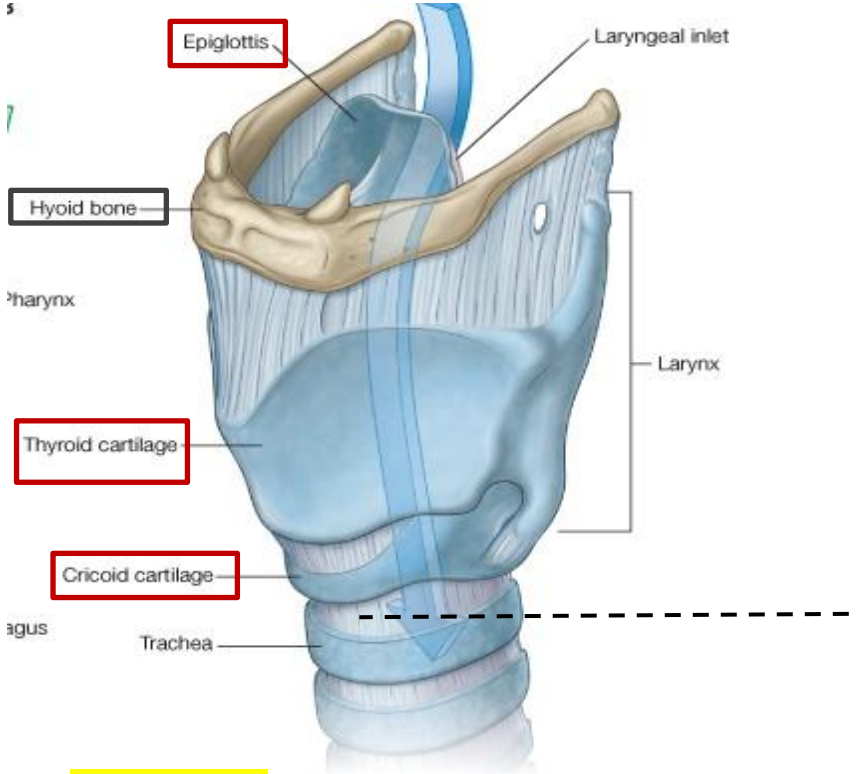
"اللهم إني أسألك فهم النبيين، وحفظ المرسلين، وإلهام الملائكة المقربين، اللهم اجعلنا من الذين
يستمعون القول فيتبعون أحسنه، ويسّر علينا حفظ ما نتعلمه وفهمه والعمل به"

1- Anatomy of the Larynx – Overview



- Extends from the level of the **middle** of the **third cervical vertebra (C3)** to the level of the **lower border of the sixth cervical vertebra (C6).**

- The **upper** boundary is the **hyoid bone**, which lies at the **upper border of the larynx.**
- *Note: The hyoid bone is not part of the laryngeal skeleton but is related to it superiorly.*



Dr.'s figure:

- The single cartilages of the larynx include: (Epiglottis, Thyroid cartilage, Cricoid cartilage)

- Inferiorly, the larynx **ends at the lower border of the cricoid cartilage,** below the cricoid cartilage, the rings of the trachea begin.
- Layers of the larynx include: Mucosa , Cartilage , Ligaments , Muscles and external connective tissue.

1- Anatomy of the Larynx – Overview

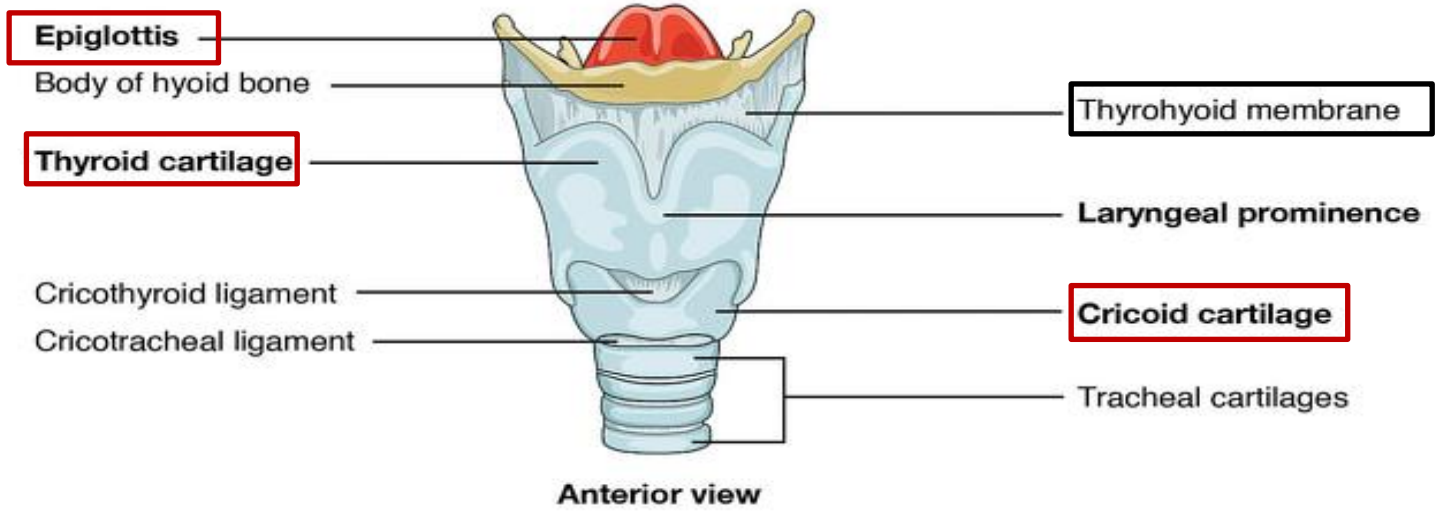
➢ Related to HISTOLOGY :

- The larynx is lined by mucosa, specifically respiratory mucosa, which is **pseudostratified ciliated columnar epithelium**, except the true vocal cords, which are not covered by respiratory epithelium.

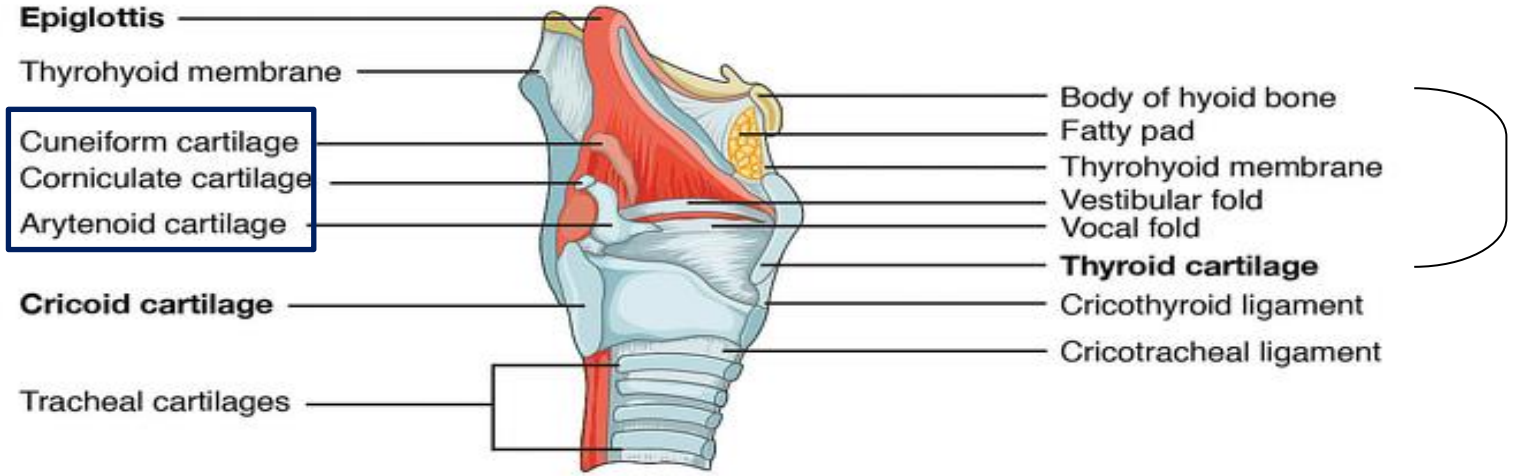
➢ The laryngeal cartilages are classified into **paired cartilages** which include the arytenoid, cuneiform, and corniculate cartilages, and **single cartilages.** These **cartilages are connected to each other by membranes and ligaments.**

➢ The **thyrohyoid membrane** connects the **thyroid cartilage** to the **hyoid bone**, this membrane shows a thickening in the midline and laterally - where the membrane becomes **ligamentous** - as the thickened parts form ligaments.

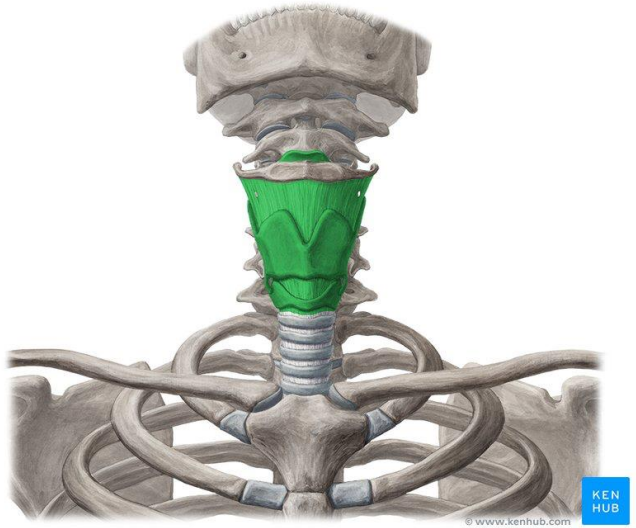
1- Anatomy of the Larynx – Overview



Anterior view



Right lateral view



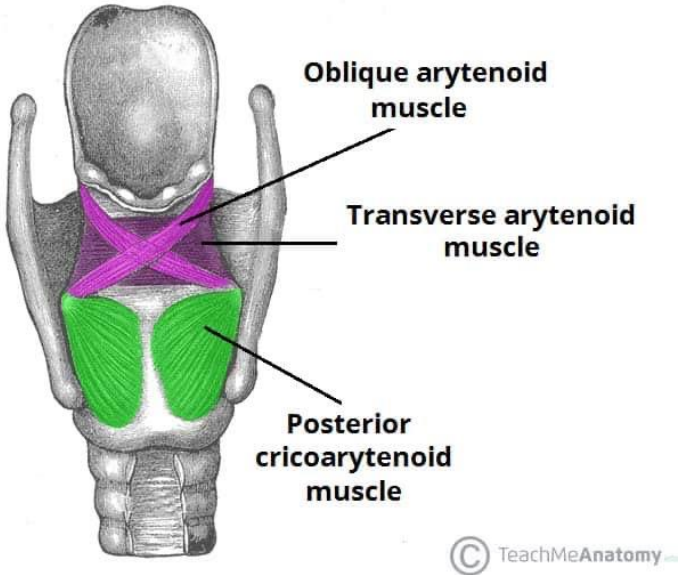
Note that the thyrohyoid membrane connects the thyroid cartilage to the hyoid bone.

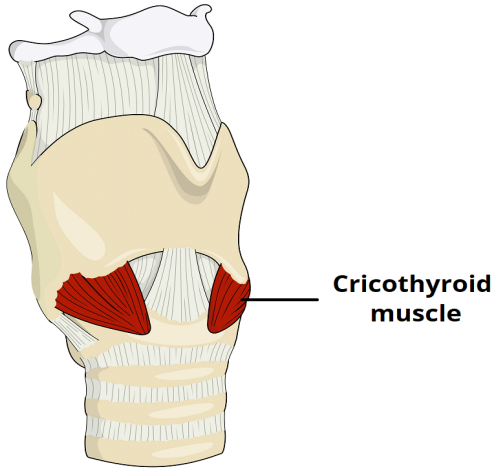
1- Anatomy of the Larynx – Overview

- Inside the larynx, there are muscles that act on the larynx, they are called the **intrinsic muscles of the larynx.**

- There is **only one muscle** that lies externally, connect the **thyroid cartilage to the cricoid cartilage,** which is the **cricothyroid muscle (from cricoid to thyroid).**

- The larynx is covered externally by **connective tissue.**

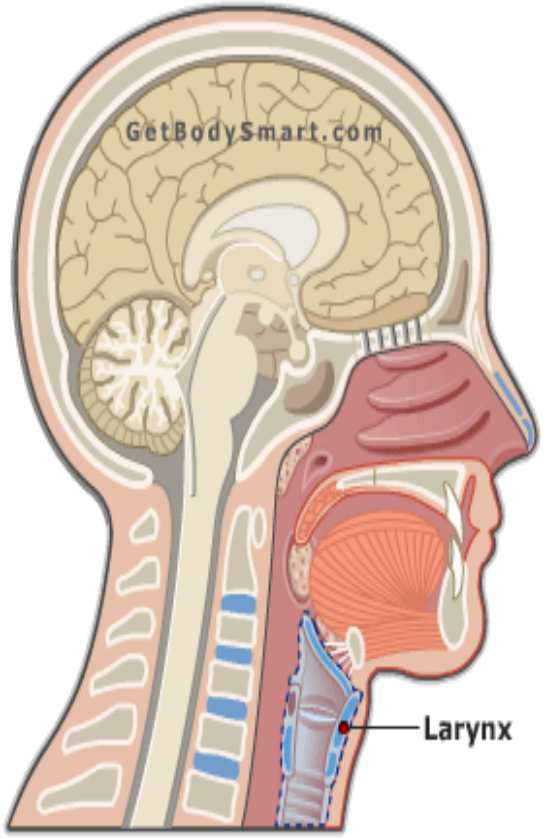




2- Function of the Larynx

- During **respiration**, the laryngeal inlet is **open**, allowing air to pass from the nose to the pharynx and then into the larynx. (It acts as an **open valve**)

- During **swallowing (deglutition)**, the laryngeal inlet must **close** to prevent food or liquid from entering the airway. (It acts as a **closed valve**)
  - The bolus passes from the pharynx into the esophagus, passing over the inlet of the larynx.



Dr.'s figure:

✓ **Mechanism of closure:**

- The **epiglottis** is **pushed downward** by the bolus, the larynx elevates, and the muscles of the laryngeal inlet contract to achieve complete closure.

2- Function of the Larynx

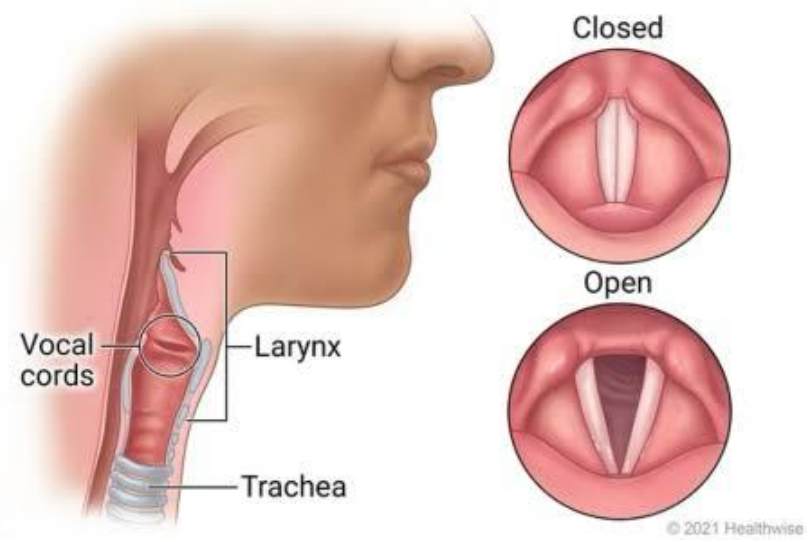
➢ Related to CLINICAL :

- If closure is **incomplete** (e.g., due to nervous system interruption), some particles may enter the laryngeal inlet, triggering coughing.
- The **true vocal cords** are primarily responsible for **coughing**:

✓ Adduction of the true vocal cords closes the larynx internally.

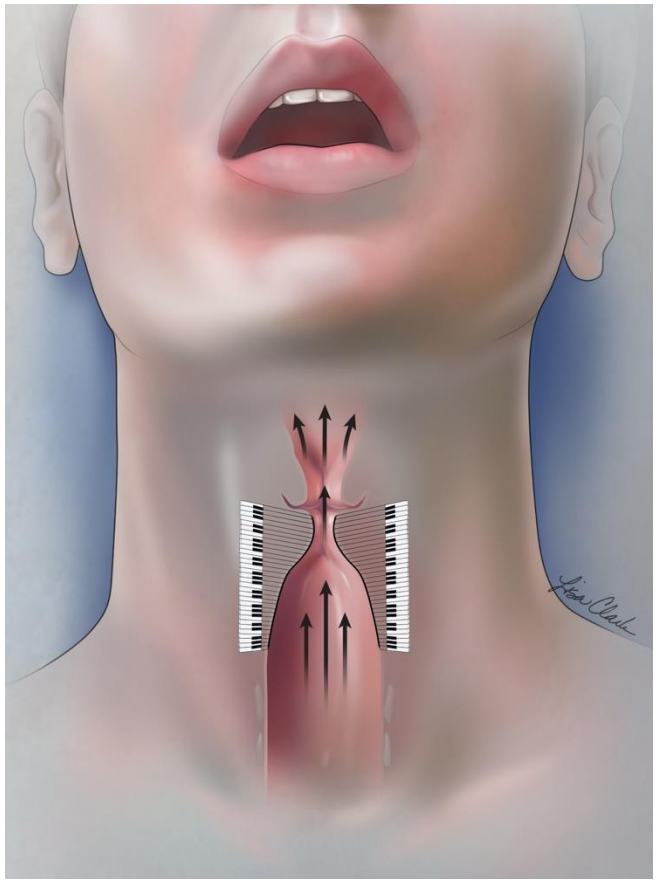
✓ During expiration, air is compressed below the adducted vocal cords.

✓ Sudden opening of the vocal cords expels air forcefully, producing the cough reflex, which clears the airway from any foreign body and returns it to the digestive tract.



2- Function of the Larynx

- True vocal cords are responsible for **voice production** through adduction.
- During expiration, a column of air passes through the **adducted** vocal cords, causing them to **vibrate**.
- This vibration **partitions** the column of air, producing sound.
- The sound is **modulated by the muscles** of the pharynx, mouth, tongue, and nose, shaping it into speech.
- For example, when the tongue contacts the teeth, it helps to further partition and articulate the air in a process called phonation, forming distinct letters and sounds.

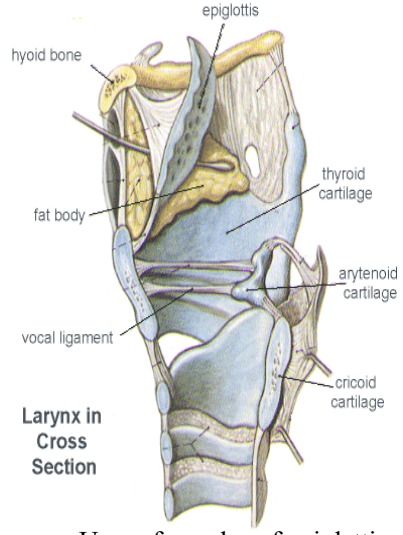


3- Cartilage

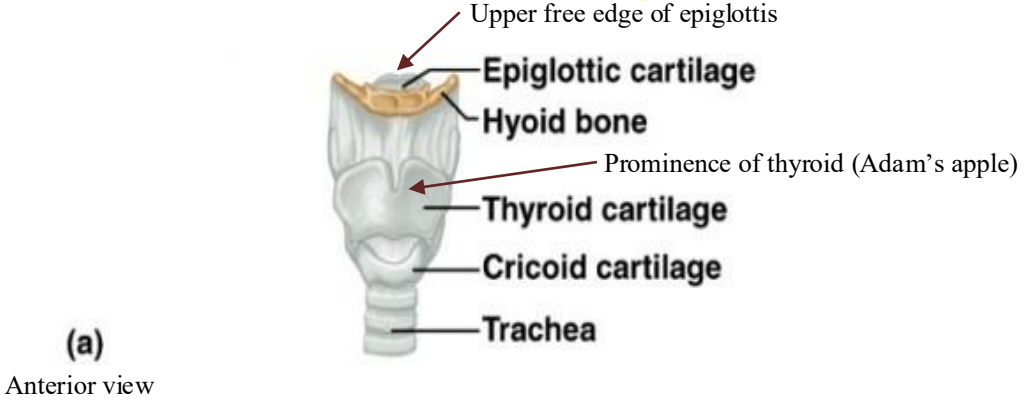
- The larynx is composed of **cartilage, mucosa, ligaments, and muscles.**

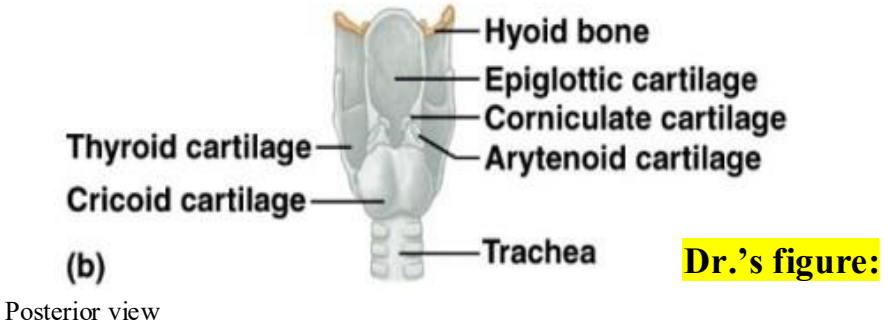
- There are three **unpaired** (single) cartilages:
  - ✓ Epiglottis
  - ✓ Cricoid cartilage
  - ✓ Thyroid cartilage

- There are three **paired** cartilages:
  - ✓ Arytenoid cartilages
  - ✓ Cuneiform cartilages
  - ✓ Corniculate cartilages



Dr.'s figure:





Dr.'s figure:

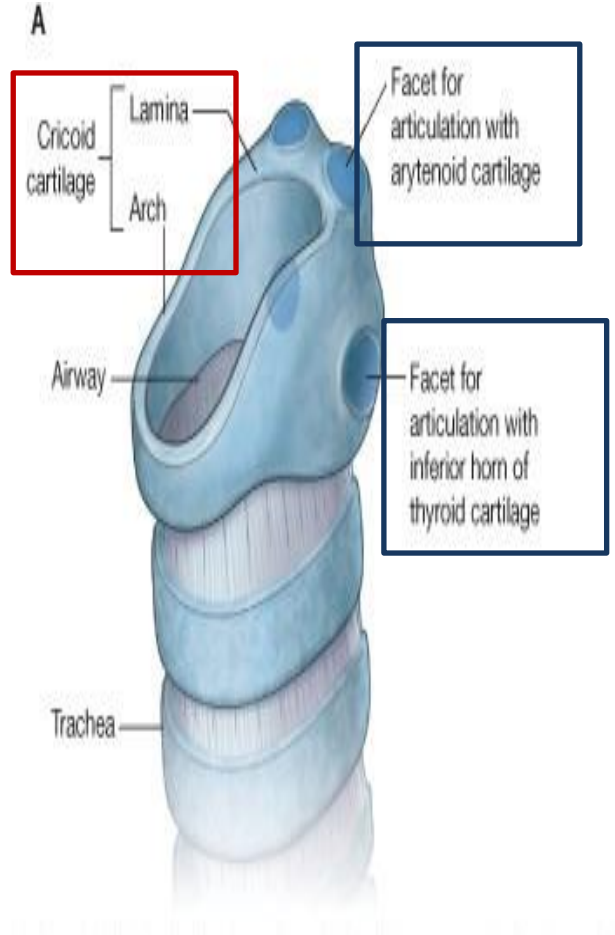
3- Cartilage – Cricoid Cartilage

- The cricoid cartilage marks the **lower** end of the larynx.

- It is connected to the first ring of the trachea by the **cricotracheal membrane.**

- The cricoid cartilage consists of **Anterior arch** and **Posterior lamina**
- Together, the arch and lamina form a signet-ring shape.

- **The posterior lamina** has:
- ✓ **Lateral facets** for articulation with the inferior horns of the thyroid cartilage.
- ✓ **Superior facets** for articulation with the arytenoid cartilages.

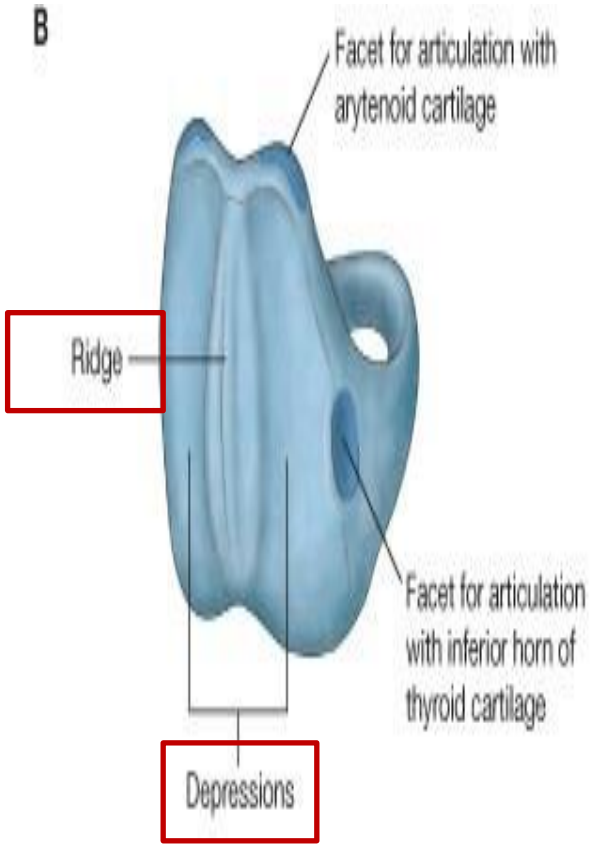


Dr.'s figure:

3- Cartilage – Cricoid Cartilage

- The lamina also has a **ridge** which provides attachment for ligaments connecting the **cricoid cartilage to the esophagus**, which lies posterior to the trachea.

- On the sides of this ridge, there are two depressions for attachment of the **posterior cricoarytenoid muscles,** which arise from the posterior aspect of the cricoid lamina.



Dr.'s figure:

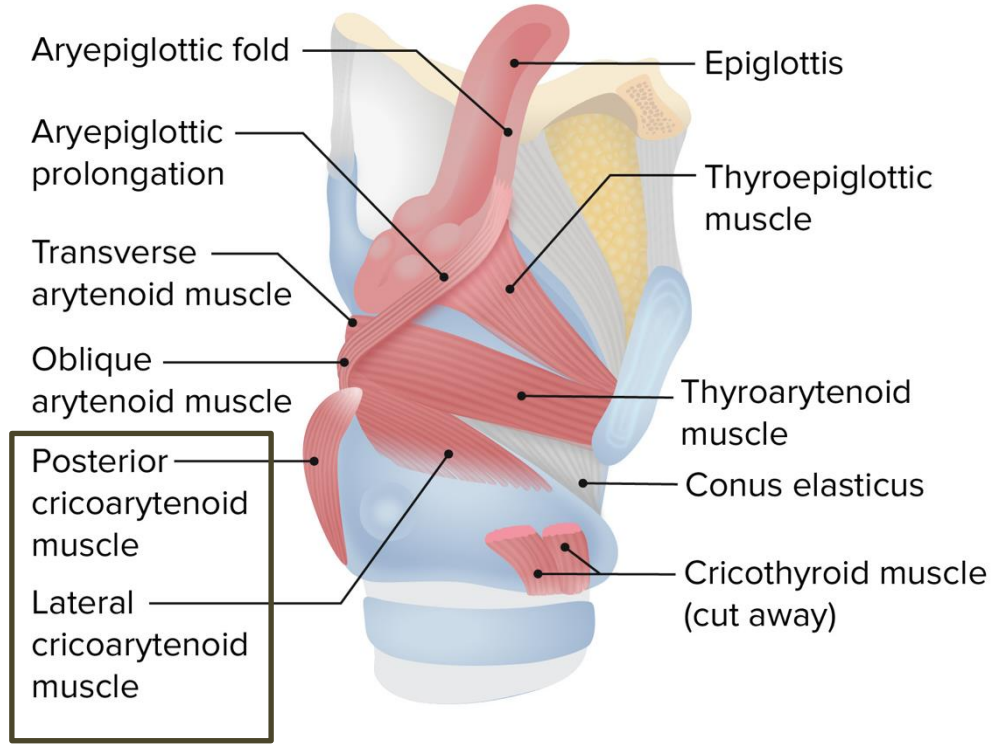
3- Cartilage – Cricoid Cartilage

➢ Muscles associated with the cricoid cartilage:

✓ **Posterior cricoarytenoid muscle**: arises from the **posterior lamina**; responsible for ***abduction*** of the true vocal cords.

✓ **Lateral cricoarytenoid muscle**: arises from the **lateral side** of the cricoid; responsible for ***adduction*** of the true vocal cords.

○ **Nerve supply: recurrent laryngeal nerve**



﴿وَلَا تَخَافِي وَلَا تَحْزَنِي﴾

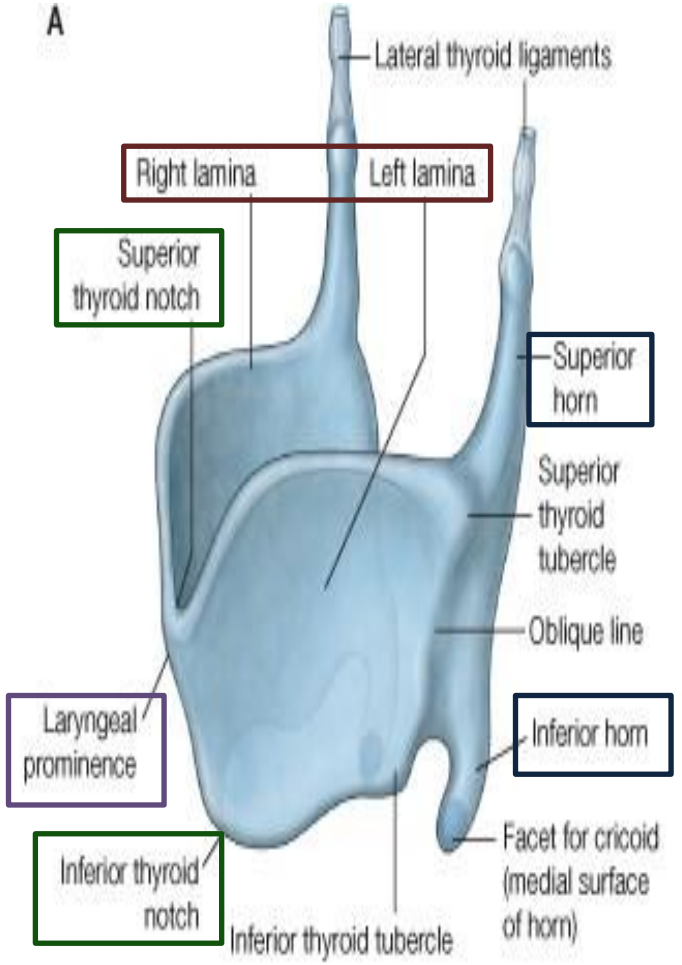
3- Cartilage – Thyroid Cartilage

- The thyroid cartilage consists of two laminae, a **right** and a **left lamina**.
- **Anteriorly**, the laminae meet at an angle called the **thyroid angle**, which forms superiorly the **laryngeal prominence (Adam's apple)**.
- Above the prominence is the **superior thyroid notch,** and below is the **inferior thyroid notch.**
- The thyroid angle is important because it serves as the **anterior attachment for the true vocal cords**, **which connect posteriorly to the vocal process of the arytenoid cartilages**.
- **Posteriorly**, the thyroid cartilage is ***open***.

• It has superior and inferior horns:

✓ The **superior horn** articulates with the greater horn of the hyoid bone.

✓ The **inferior horn** articulates with the lamina of the cricoid cartilage.

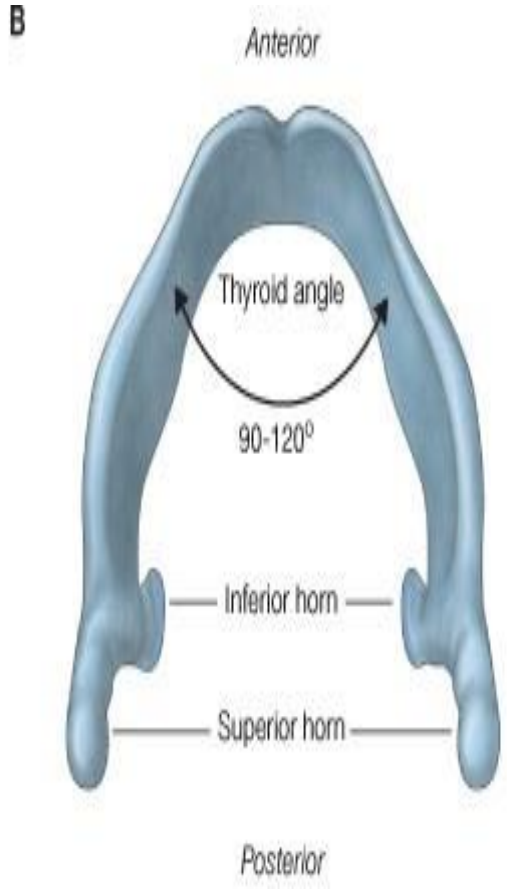


Dr.'s figure:

3- Cartilage – Thyroid Cartilage

➢ Related to PHYSIOLOGY :

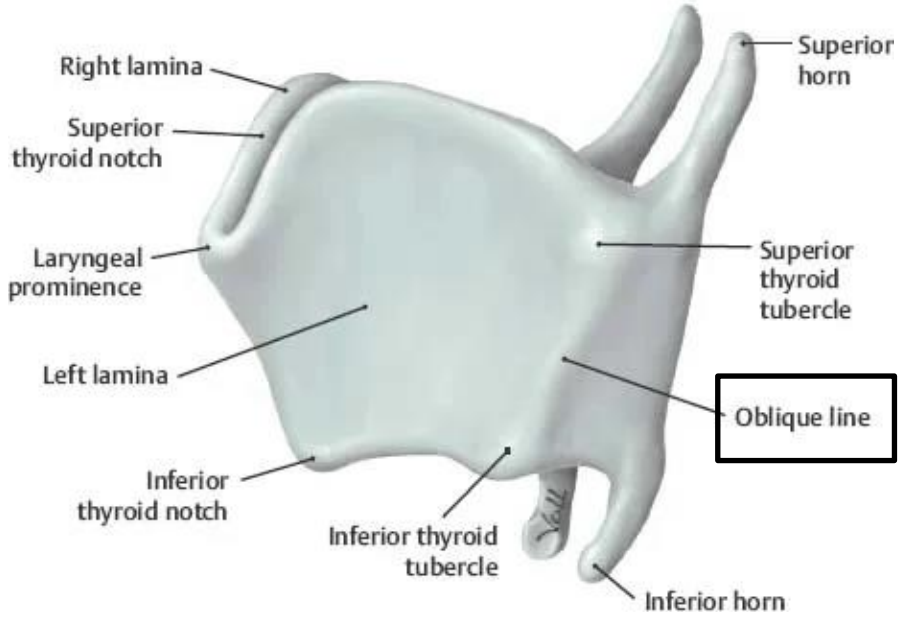
- In **adult males**, the thyroid angle is **acute** due to **testosterone**, which:
  - Increases bone density (heavy bones).
  - Thickens muscles (bulky and strong muscles).
  - Results in a longer and more lax vocal cord, producing a low-pitched, rough voice.
- In **adult females**, the thyroid angle is **more obtuse** due to **estrogen** and **progesterone**, which:
  - Produce lighter bones.
  - Maintain smooth, less bulky muscles.
  - Result in shorter and tense vocal cords, producing a high-pitched voice.



Dr.'s figure:

3- Cartilage – Thyroid Cartilage

- On the lamina of the thyroid cartilage, there is an **oblique line.**
- The oblique line serves as a muscular ridge for attachment.
- Several muscles attach to this line, including **extrinsic infrahyoid muscles** of the larynx (**sternothyroid, thyrohyoid, and inferior constrictor muscle of the pharynx**).



- ﴿ فَإِنِّي قَرِيبٌ ﴾ .

3- Cartilage – Epiglottis

- The epiglottis has a **free upper edge,** and an **apex -** which attaches to the inner surface of the angle of the thyroid cartilage.
- The epiglottis has two surfaces:

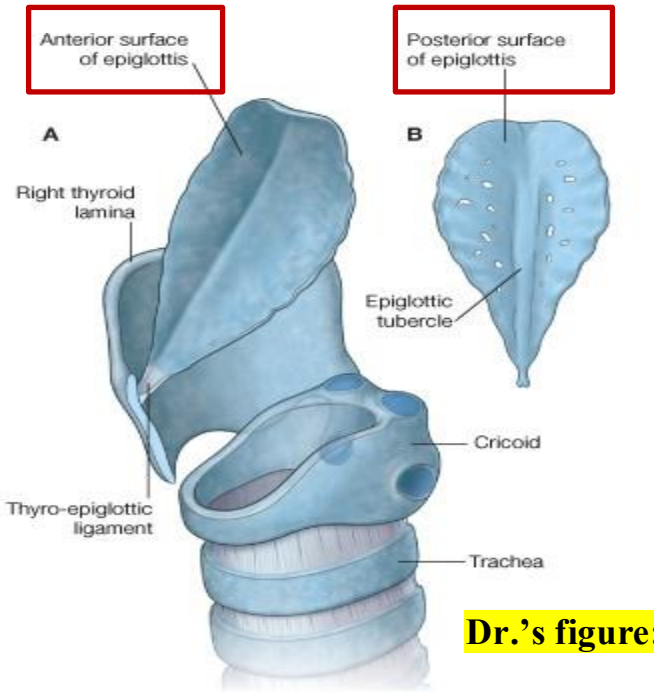
✓ **Superior- Anterior (lingual) surface:**

- Faces the tongue
- Covered by **stratified squamous non-keratinized epithelium**.

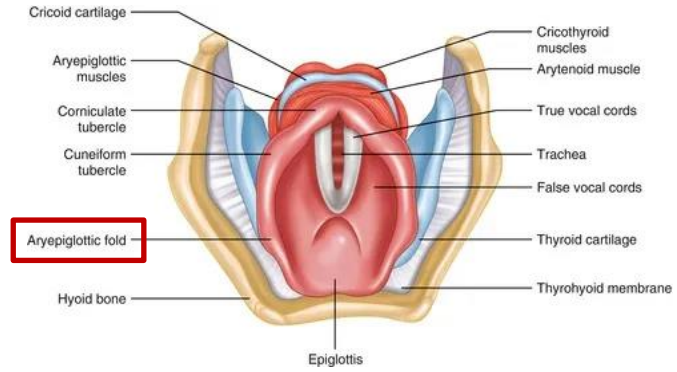
✓ **Inferior- Posterior (laryngeal) surface:**

- Faces the larynx
- Contains tubercles on its surface
- Covered by **pseudostratified ciliated columnar epithelium with goblet cells.**

- Part of the epiglottis is continuous with the aryepiglottic folds, which extend from the edges of the epiglottis to the arytenoid cartilages.
- These folds form the boundaries of the **laryngeal inlet.**



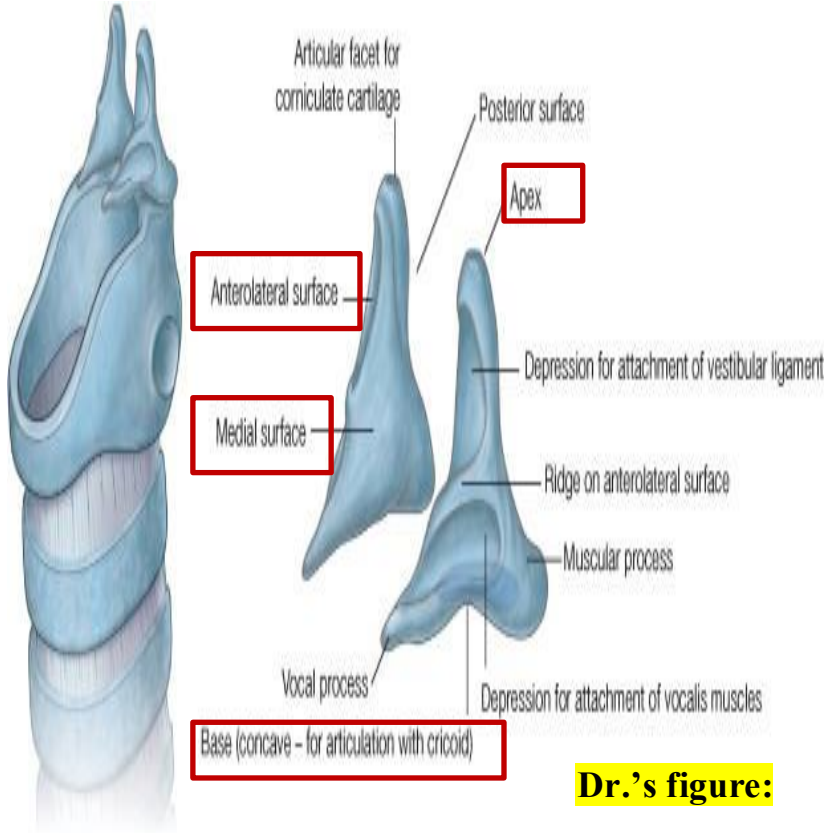
Dr.'s figure:



3- Cartilage – Arytenoid Cartilages

- The **arytenoid cartilage** consists of two main parts, **the base**, which articulates with the cricoid cartilage, and **the apex**, which articulates with the corniculate cartilage via a facet.

- The arytenoid has two surfaces:
- ✓ **Medial surface:** smooth
- ✓ **anteroLateral surface:** has a ridge dividing superior and inferior depressions (fossae):
  - **Superior depression:** attachment of the vestibular ligament, which forms the vestibular fold (false vocal cord).
  - **Inferior depression:** attachment of the vocalis muscle, which connects to the true vocal cord (important).



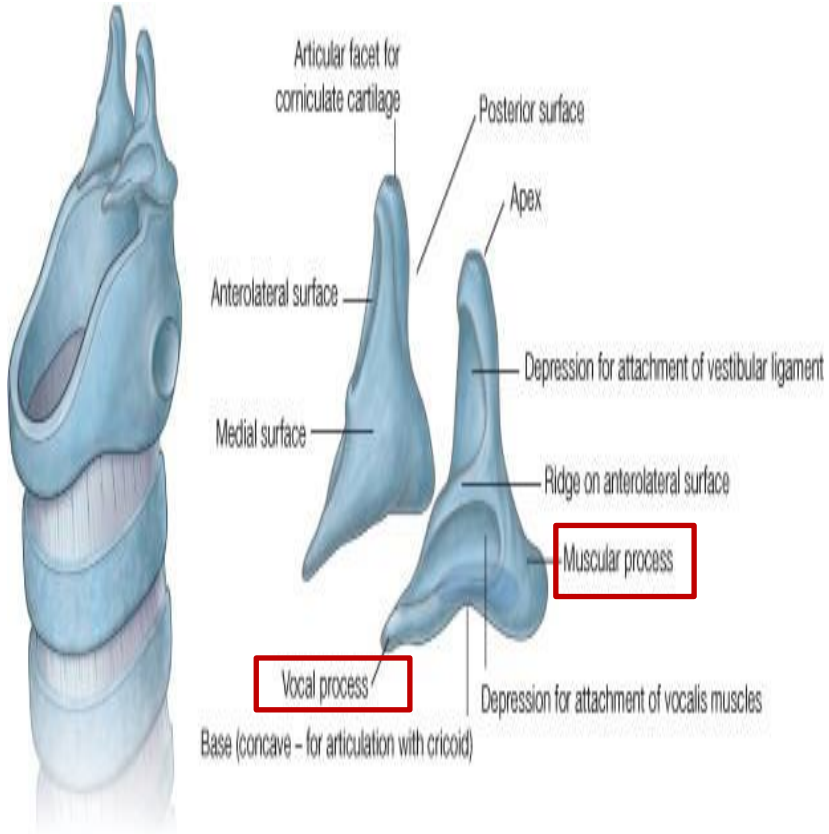
Dr.'s figure:

3- Cartilage – Arytenoid Cartilages

- The arytenoid cartilage has two processes at its base, including the **vocal process**, which projects anteriorly and **musclar process.**

- The vocal process serves as the attachment for the ***true*** vocal cord.

- Consequently, the **true vocal cords extend from the vocal processes of the arytenoid cartilages to the thyroid cartilage. The vocalis muscle arises from the lateral depression of the arytenoid cartilage and inserts into the true vocal cord, running along it.**



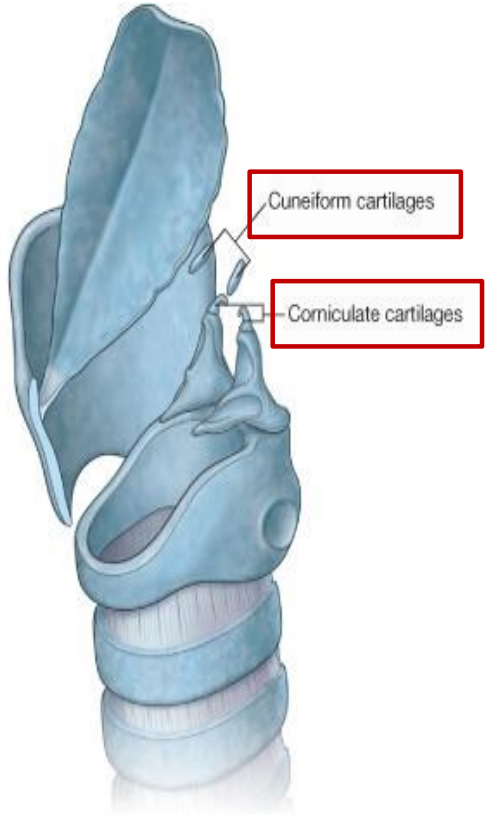
Dr.'s figure:

3- Cartilage – Corniculate & Cuneiform Cartilages

- The **Corniculate cartilages** are two small conical cartilages. Their **Bases** articulate with the **apices** of the **arytenoid cartilages.**

- The **Cuneiform cartilage** are two small club-shaped cartilages.

- They are both suspended in the membrane that attaches the **aryepiglottic fold.**



Dr.'s figure:

- ✓ **Corniculate:** Located at the **posterior end** of the aryepiglottic fold, sitting directly on top of the arytenoids.
- ✓ **Cuneiform:** Located anterior to the corniculate cartilages, embedded in the **middle** of the fold to provide structural support.

4- Ligaments

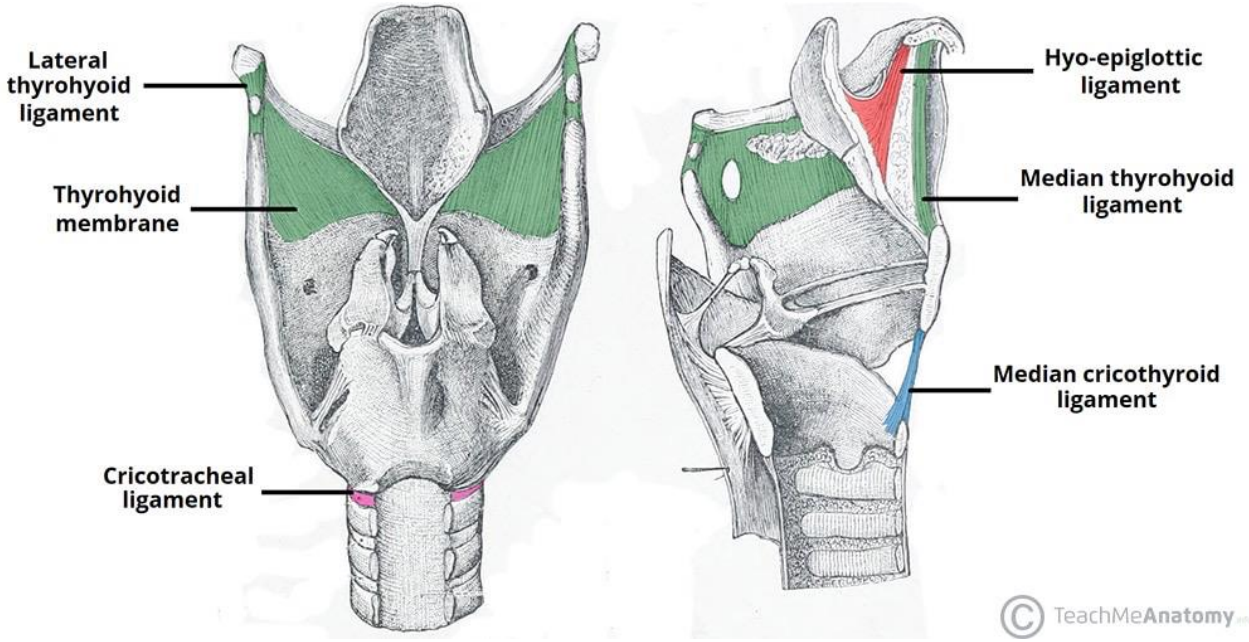
➢ **There are membranes and fibroelastic ligaments that connect cartilages.**

✓ **Extrinsic ligaments:**

- **Thyrohyoid membrane**
- **Hyo-epiglottic ligament**
- **Cricotracheal ligament**

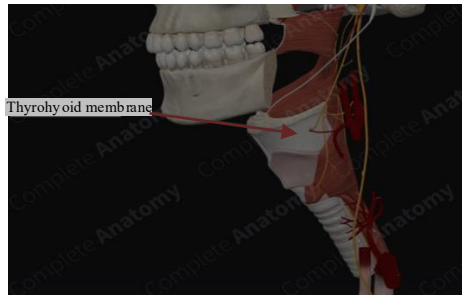
✓ **Intrinsic ligaments**

- **Cricothyroid ligament**
- **quadrangular membrane**



Note: The name of each structure typically reflects its points of attachment.

4- Ligaments – Thyrohyoid Membrane



- Tough ligament that spans between the **superior margin of the thyroid cartilage** (thyroid laminae and adjacent **anterior** margins of the superior horns).

- Ascends to the **greater horns and posterior to the body of the hyoid bone** to attach to the superior margins of these structures.

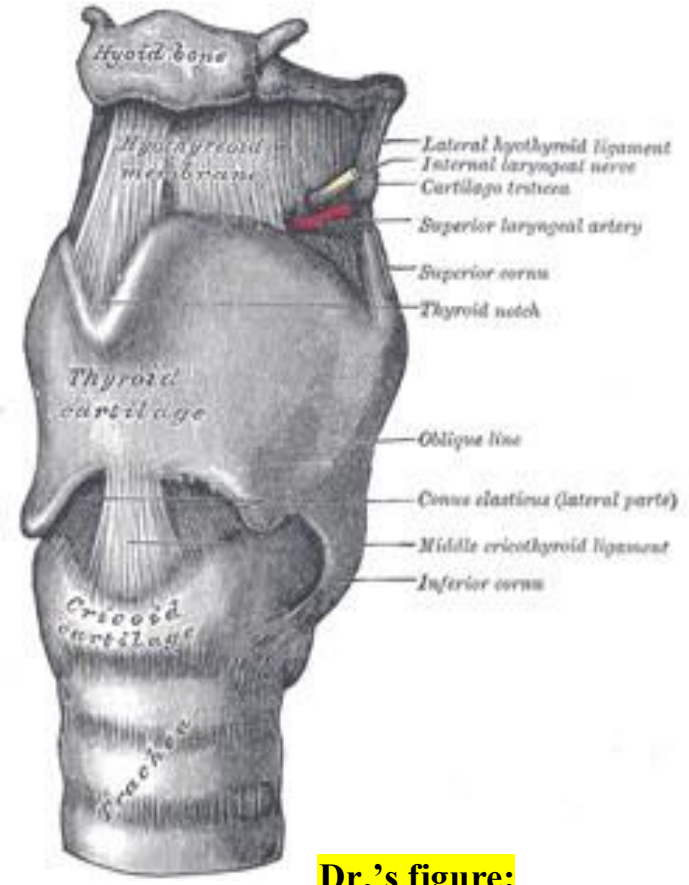
- An **aperture** in the lateral part of the thyrohyoid membrane on each side is for the passage of:

✓ **Inernal laryngeal nerve** (which is a branch from the superior laryngeal nerve from vagus) that gives sensory innervation to the larynx above the true vocal cords.

✓ **Superior laryngeal arteries** which is a branch from superior thyroid artery**.**

✓ **Lymphatics.**

- **Recurrent laryngeal nerve is senseory to larynx below true vocal cords.**

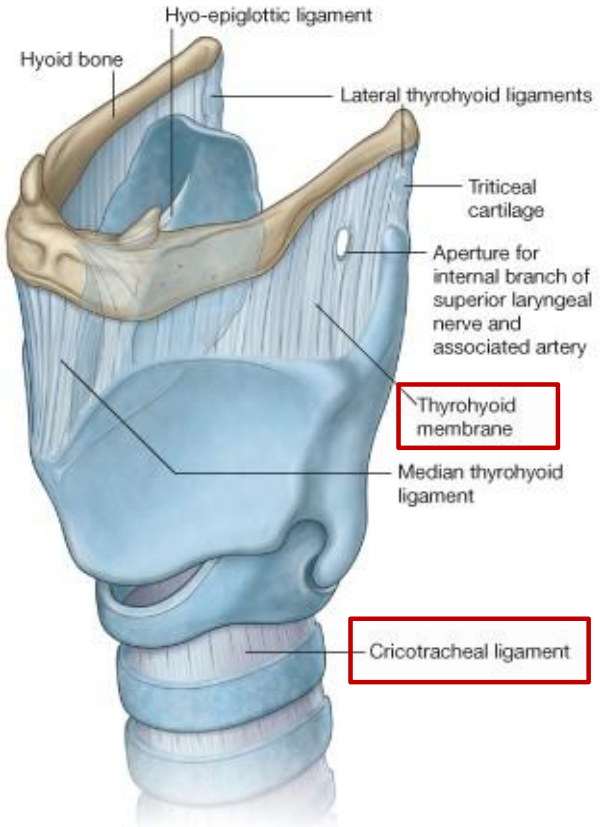


Dr.'s figure:

4- Ligaments - Thyrohyoid and Cricotracheal

- The **thyrohyoid membrane** is thickened **posteriorely** to form the **lateral thyrohyoid ligaments** and **anteriorly** in the midline to form the **median thyrohyoid ligament.**

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



Dr.'s figure:

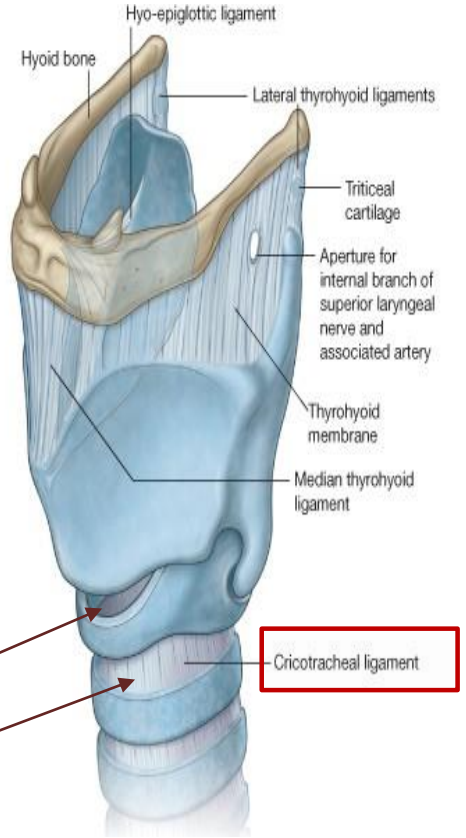
4- Ligaments - Thyrohyoid and Cricotracheal

➢ Related to CLINICAL:

✓ In **trauma patients**, such as those involved in motor vehicle accidents, assessment of airway and respiration is the first priority. If the patient becomes cyanotic and airway obstruction is suspected, immediate medical intervention is required, one possible life-saving procedure is a **tracheostomy**. The tracheostomy opening is usually created at the level of the **suprasternal notch**, corresponding to the 5th and 6th tracheal rings, allowing direct entry of air into the lower respiratory tract.

✓ During **thyroidectomy**, accidental injury to the recurrent laryngeal nerve may occur. Damage to this nerve can result in paralysis and adduction of the true vocal cords, leading to airway obstruction. In such cases, a tracheostomy should be performed **below the level of the adducted true vocal cords**, as air cannot pass through the airway above them due to vocal cord closure.

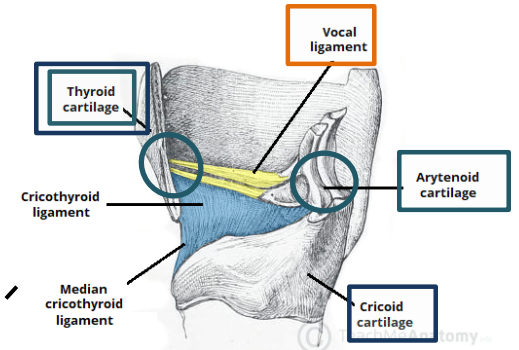
✓ Since the patient is already under anesthesia and the surgical site is exposed, I can perform the airway access either between the thyroid and cricoid cartilages (Cricothyroidotomy) or right here at the first and second tracheal rings, which is located just below the cricoid cartilage.

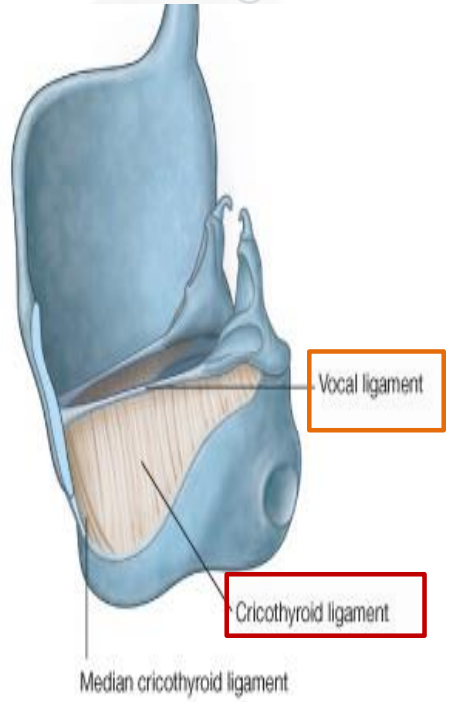


Dr.'s figure:

4- Ligaments – Cricothyroid Cartilage

- The **cricothyroid** (Cricovocal/ conus elasticus) **membrane** arises from the **inner surface of the cricoid cartilage** and extends upward toward the **thyroid cartilage**, but its upper edge is free.
- The free upper edge forms the **vocal ligament**, which is:
  - Attached **posteriorly** to the vocal process of the arytenoid cartilage
  - Attached **anteriorly** to the angle of the thyroid cartilage
- The vocal ligament is covered by **stratified squamous non-keratinized epithelium**, which is resistant to mechanical injury (important during voice use, yelling, etc.).
- It contains the vocalis muscle, forming the true vocal cord.



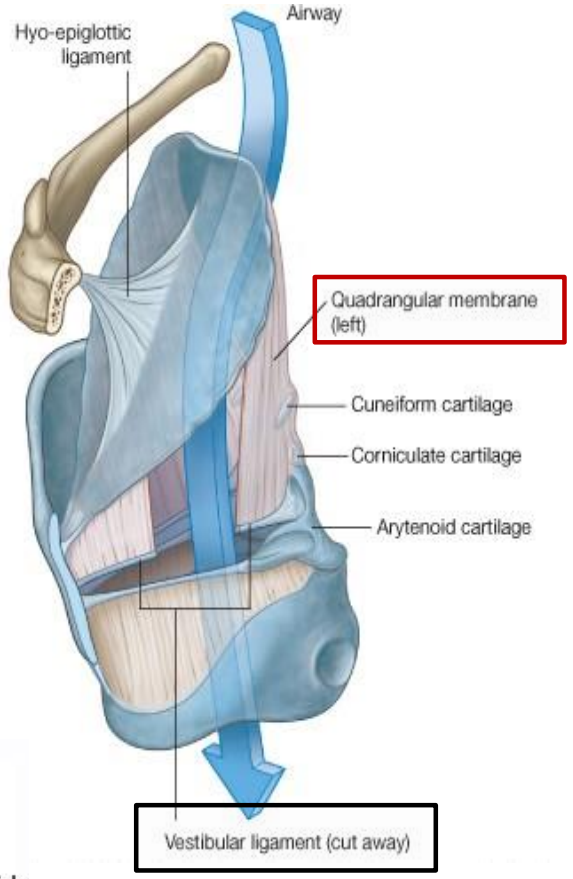


Vocal ligament = true vocal cord, contains vocalis muscle, covered by stratified squamous epithelium

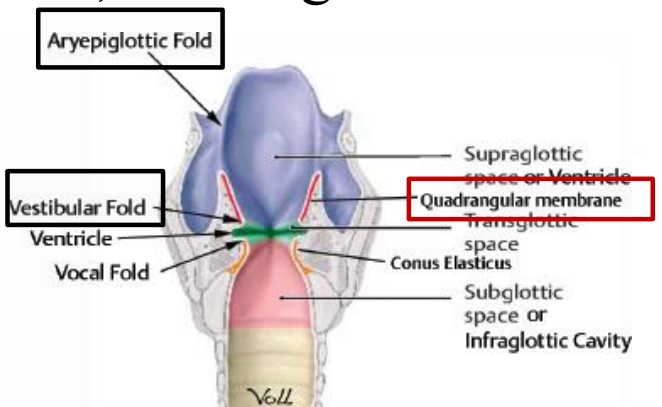
Dr.'s figure:

4- Ligaments – Quadrangular Cartilage

- **Quadrangular membrane** arises from the **lateral** margins of the **epiglottis** and descends to the **arytenoid** and **thyroid cartilages**.
- Its **free upper edge** forms the **aryepiglottic fold.**
- Its **free lower edge** forms the **vestibular ligament**, which is covered by **respiratory epithelium**, forming the **false vocal cords.**

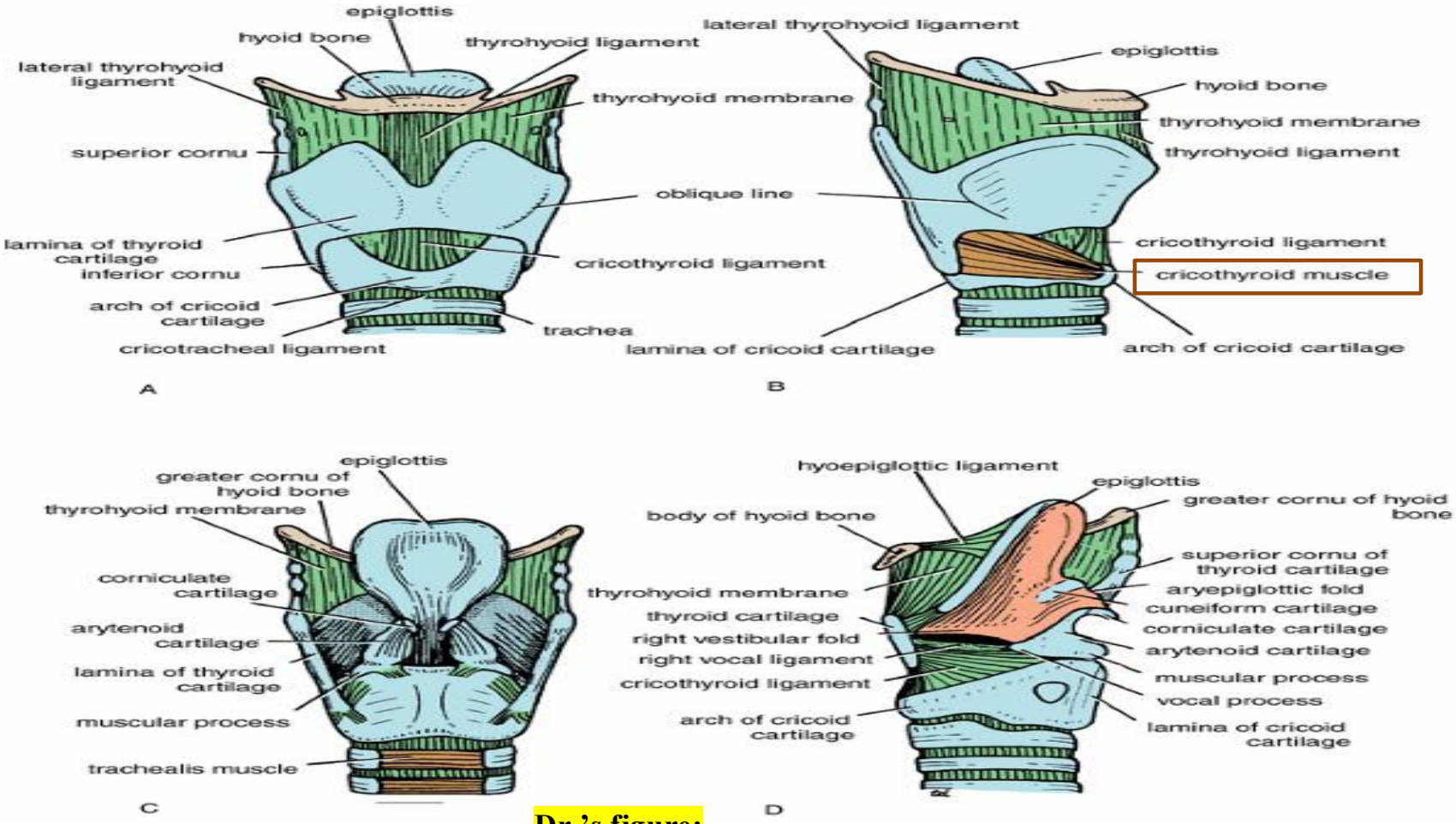


Dr.'s figure:



True vocal cord = vocal fold
False vocal cord = vestibular fold

4- Ligaments



Dr.'s figure:

- The **cricothyroid muscle i**s the only **intrinsic** laryngeal muscle that **tenses** the vocal cords, its action increases the tension of the true vocal cords, **producing a higher pitch**, which is especially important for **female voice**.
- **Nerve supply: external laryngeal nerve**
- In contrast, other intrinsic laryngeal muscles that adduct or abduct the vocal cords are supplied by **the recurrent laryngeal nerve**.

5- Laryngeal Joints

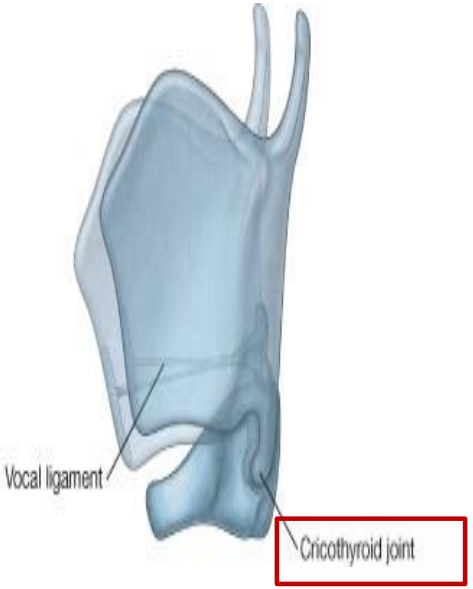
➢ **The larynx has two synovial joints, allowing rotatory movements of the cartilages:**

✓ **Cricothyroid joint**

Next slide

- **Articulation**: **inferior horn of the thyroid cartilage** with the **cricoid cartilage**
- **Function**: tenses the true vocal cords (cricothyroid muscles) by internal rotatory movement, tilting forward and inward movement.

Dr.'s figure:

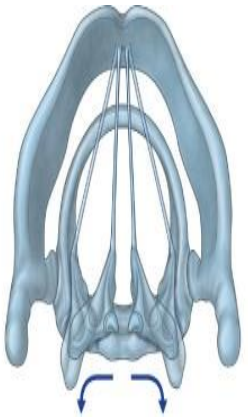


✓ **Cricoarytenoid joint**

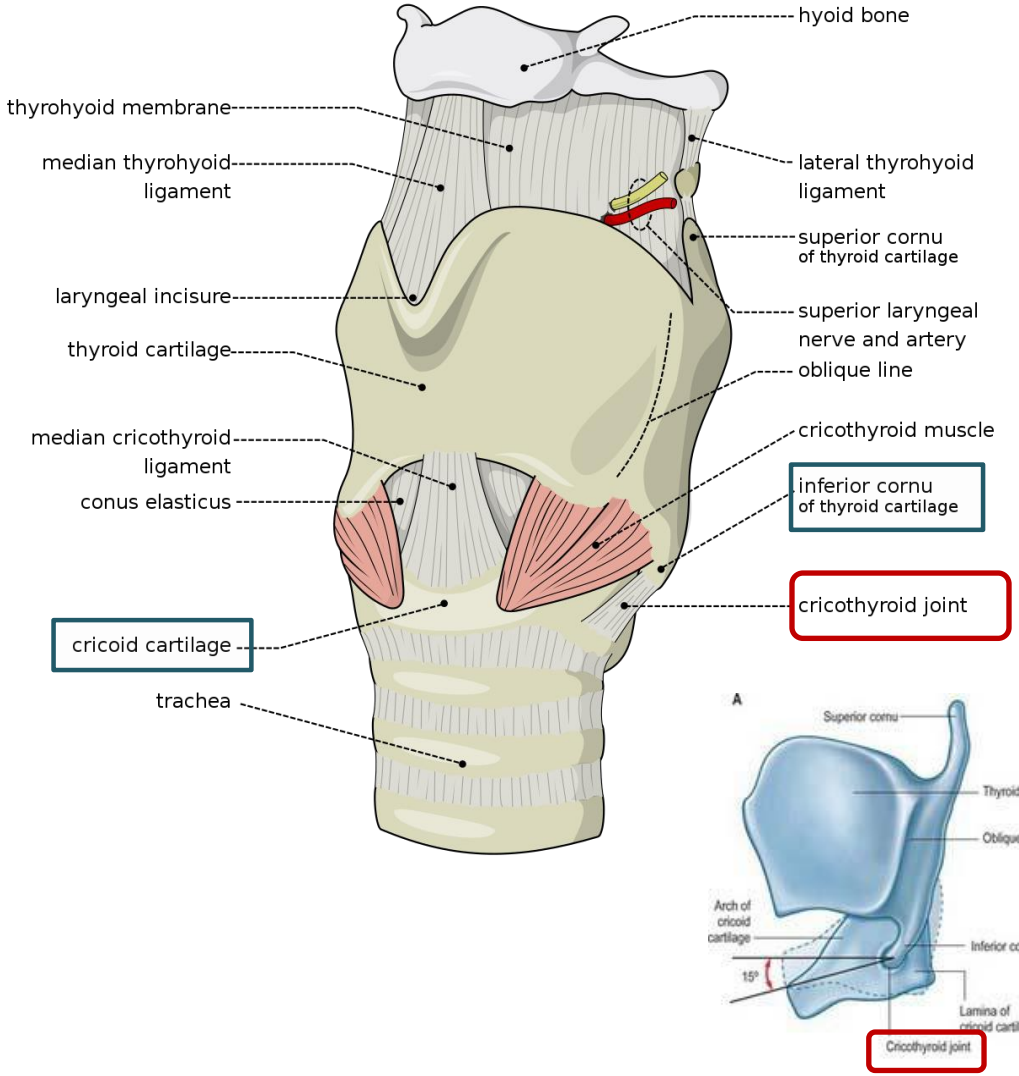
Next slide

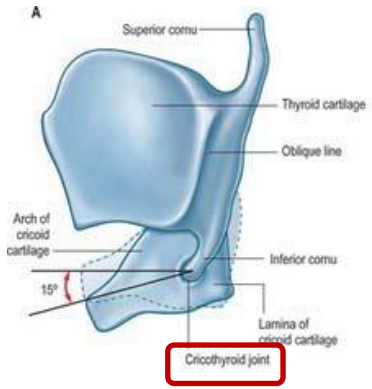
- **Articulation**: **arytenoid cartilage** with the **cricoid cartilage**
- **Function**: Allows rotatory and gliding movements, which control abduction and adduction of the vocal cords
- Movements are influenced by the **posterior** cricoarytenoid (abduction) and **lateral** cricoarytenoid (adduction) muscles

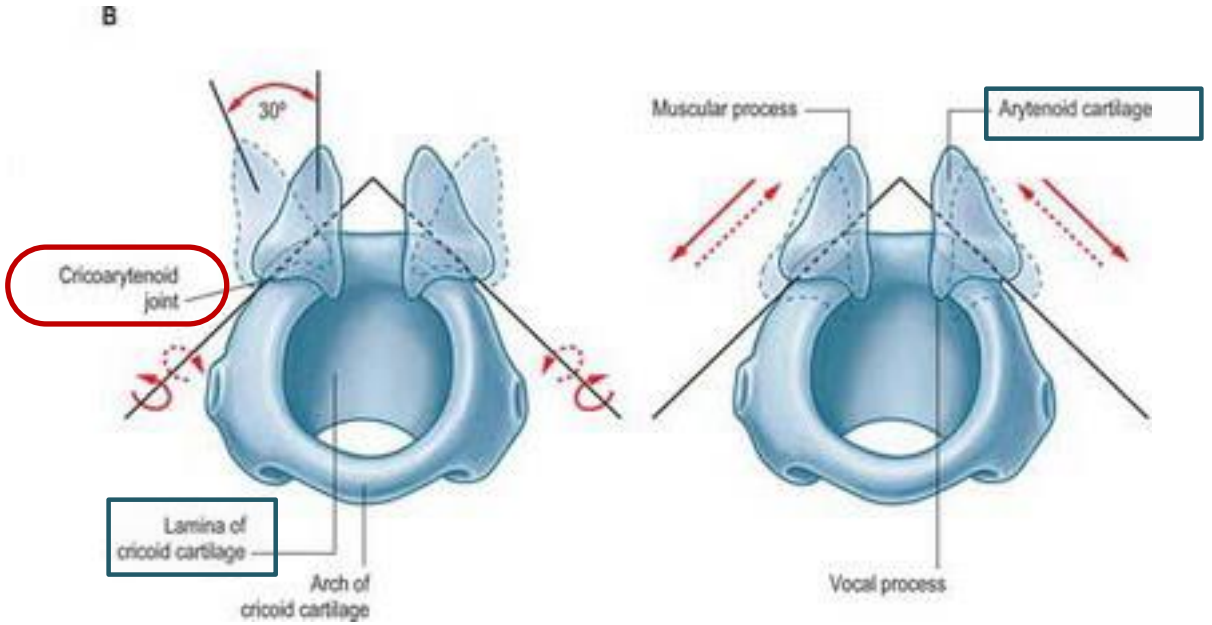
Dr.'s figure:



5- Laryngeal Joints



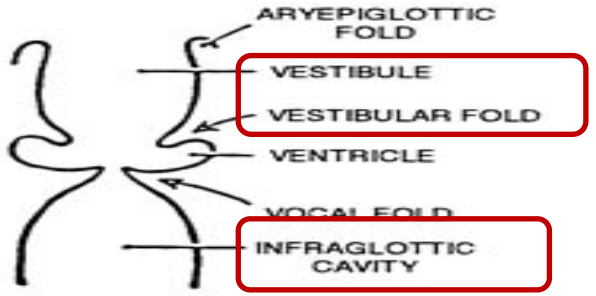




سيجعل الله بعد عسر يسراً

6- Cavity of the Larynx

Dr.'s figure:



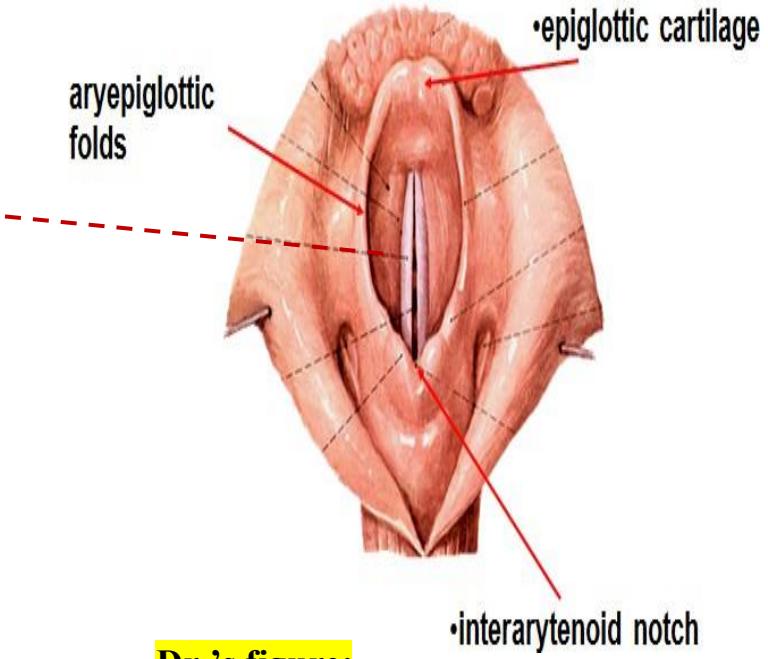
Laryngeal cavity

inlet of larynx –bounded by upper border epiglottic cartilage, aryepiglottic folds and interarytenoid notch

- The **laryngeal inlet** is the opening of the larynx and is divided internally into three compartments:

- **Vestibule** (upper) compartment: extends from the laryngeal inlet to the vestibular folds.
- **Vocal** /glottic (Middle) compartment: located between the vestibular fold and the true vocal folds, it contains the laryngeal saccule, which extends upward and contains glands, these glands produce seromucous secretions that lubricate the true vocal cords, allowing phonation.
- **Infraglottic** (lower) compartment: extends from the true vocal folds down to the trachea

Slide 33



Dr.'s figure:

- **Boundaries of the laryngeal inlet:**

- **Anterior**: Free edge of the epiglottis
- **Lateral:** Aryepiglottic folds
- **Posterior:** Interarytenoid notch between the arytenoid cartilages

6- Cavity of the Larynx

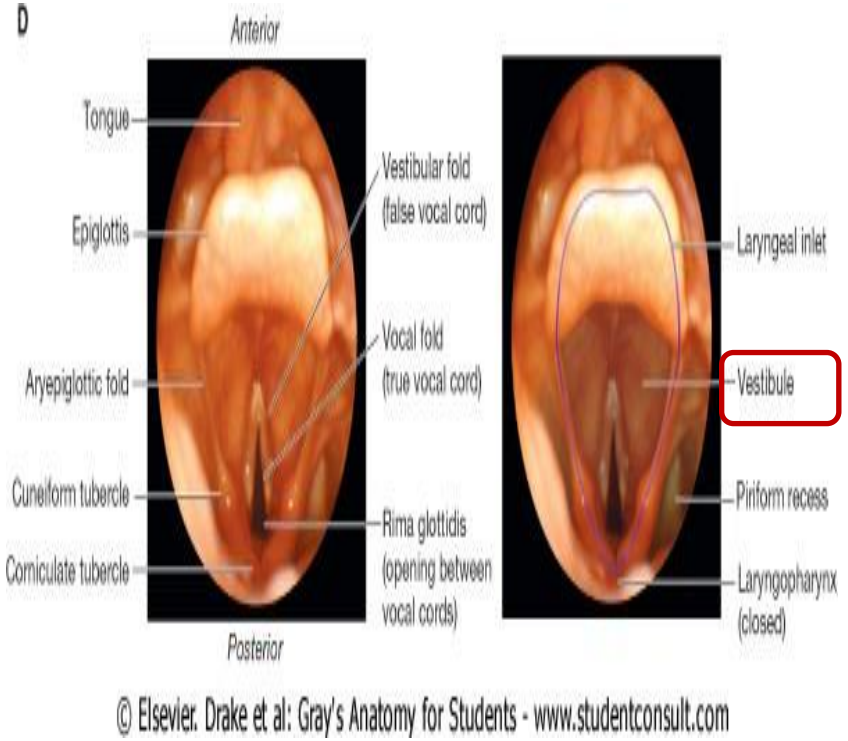
➢ Related to CLINICAL :

✓ For procedures performed under anesthesia, airway control is achieved by advancing an **endotracheal tube** orally through the larynx, guiding it between the true vocal cords until it reaches the trachea. Placement must be **below** the true vocal cords, as they come together (adduct).

➢ **Muscles controlling the laryngeal inlet:**

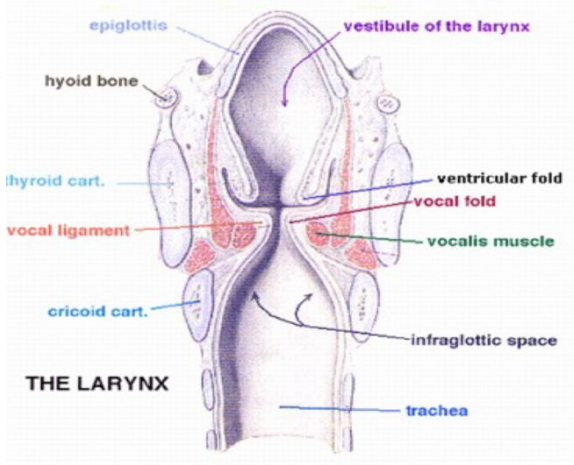
- **Aryepiglottic muscles:** within the aryepiglotic folds ,open the inlet
- **Oblique arytenoid muscles:** assist in closing the **posterior** part of the inlet
- **Transverse arytenoid muscle**: closes the **posterior** part of the inlet.

✓ **Epiglottis:** closes the anterior part during swallowing

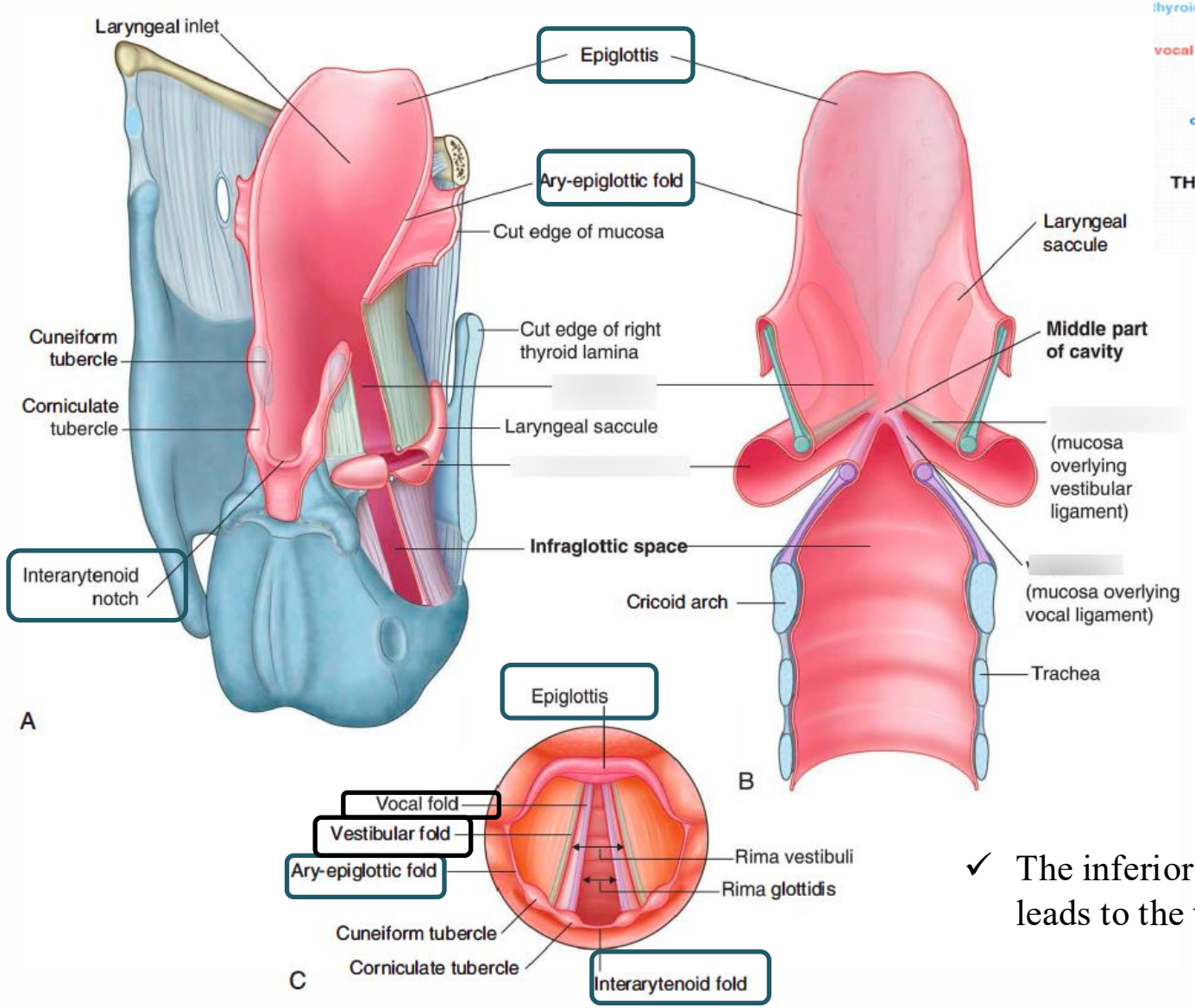


Dr.'s figure:

6- Cavity of the Larynx



Dr.'s figure:

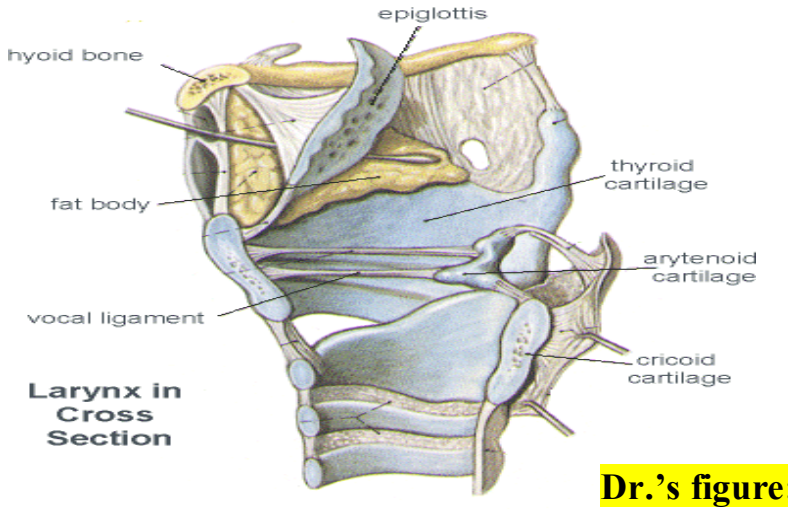


- ✓ The inferior opening of the larynx leads to the trachea.

6- Cavity of the Larynx

➢ True Vocal Folds (Vocal Cords):

- ✓ Contain vocal ligament and vocalis muscles
- ✓ Covered by stratified squamous non-keratinized epithelium
- ✓ No submucosa & No blood vessels (white in color)
- ✓ Mucosa allows mitosis and regeneration

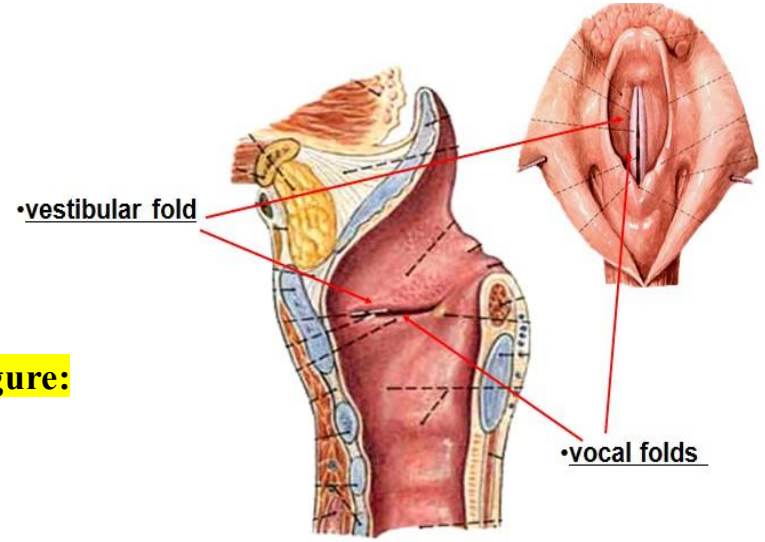


Dr.'s figure:

➢ Vestibular Folds (False Vocals Cords)

- ✓ Vestibular folds enclose the vestibular ligaments and associated soft tissues
- ✓ Vascularised (red in color)
- ✓ Fixed (no action specially in articulation) and not movable unlike the vocal cord
- ✓ Superior to the vocal cord

Dr.'s figure:



7- Rima Vestibuli & Glottidis

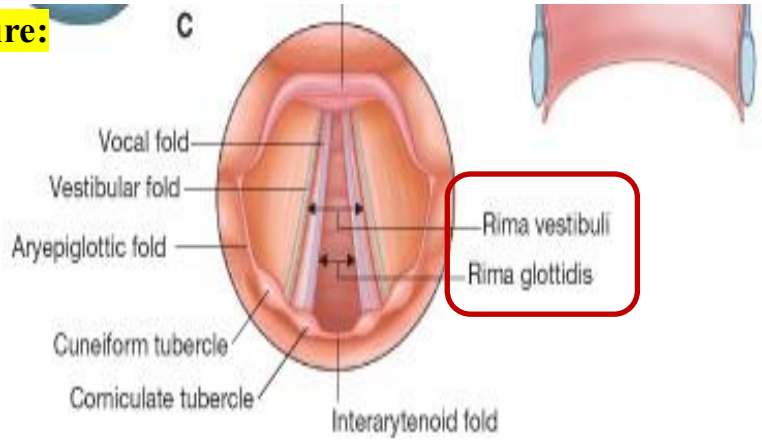
- **Rima vestibuli** is a triangular-shaped opening between the two adjacent **vestibular folds, isn't clinically important.**

- **Rima glottidis** is formed by the **vocal folds (true vocal cords), important clinically:**

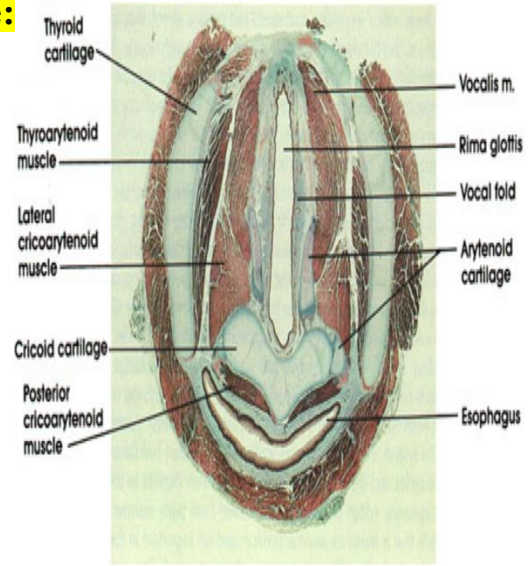
✓ **adducted vocal cords = narrow.**

✓ **abducted vocal cords = wide.**

Dr.'s figure:



Dr.'s figure:



8- Intrinsic Muscles Revesion

- **Muscles of inlet:**
  - ✓ **Open**: aryepiglottical muscle.
  - ✓ **Close**: oblique and transversus arytenoid.

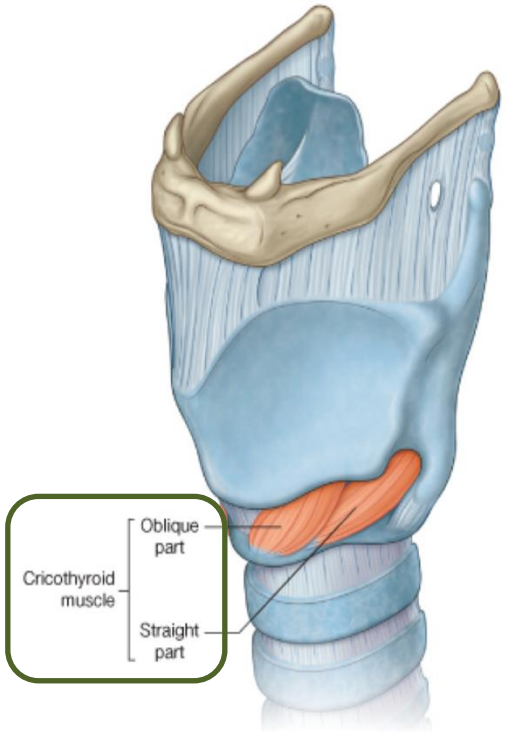
Superior laryngeal nerve is a branch from vagus nerve. It gives two branches:
External: that is motor to cricothyroid muscle.
Internal: that is sensory to larynx above true vocal cords.

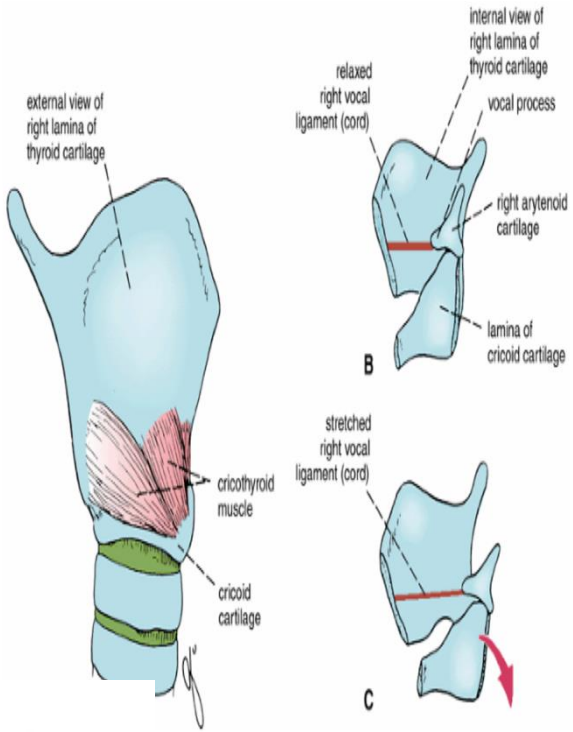
- **Muscles for tension and laxation of vocal cords:**
  - ✓ **Tense**: cricothyroid muscle.
  - ✓ **Laxation**: vocalis/thyroarytrnoid.

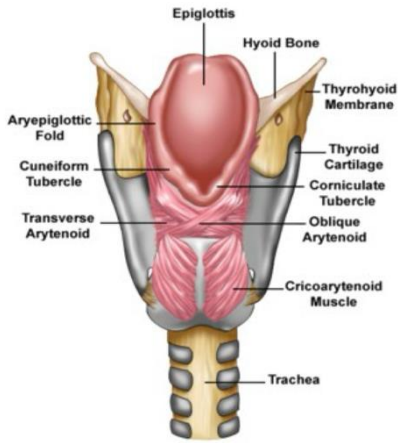
- **Muscles for adduction and abduction of vocal cords (rima glottidis):**
  - ✓ **Adduction**: lateral cricoarytrnoid.
  - ✓ **Abduction**: posterior cricoarytenoid.

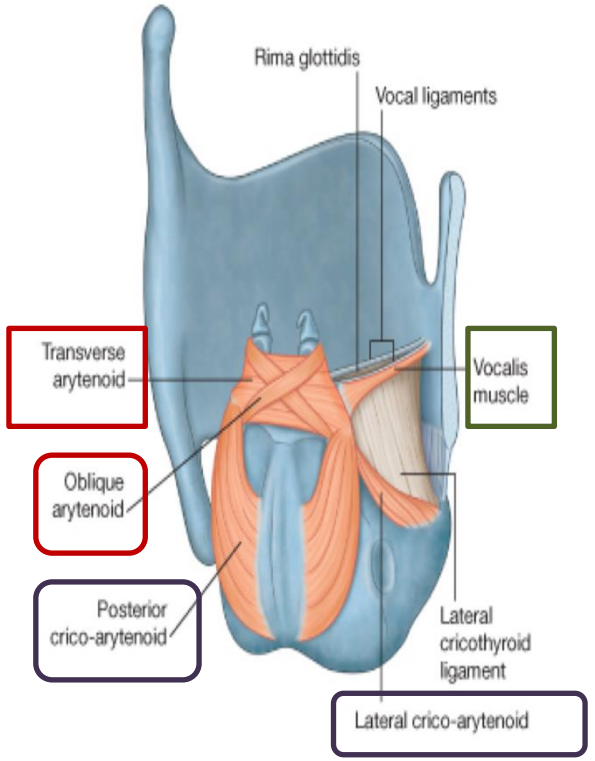
- **They are ALL supplied by recurant laryngeal nerve EXCEPT for CRICOTHYROID which has two origins straight and oblique by external laryngeal that is a branch from superior laryngeal nerve.**

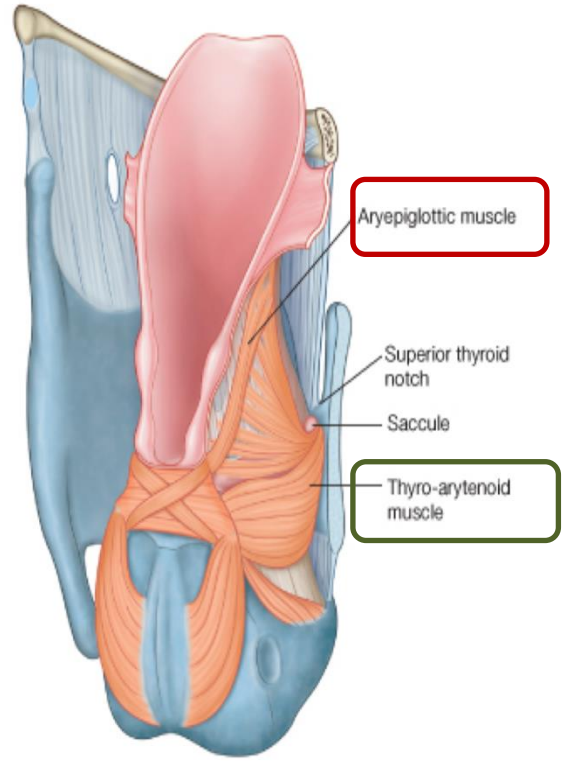
8- Intrinsic Muscles Revesion **Dr.'s figure:**











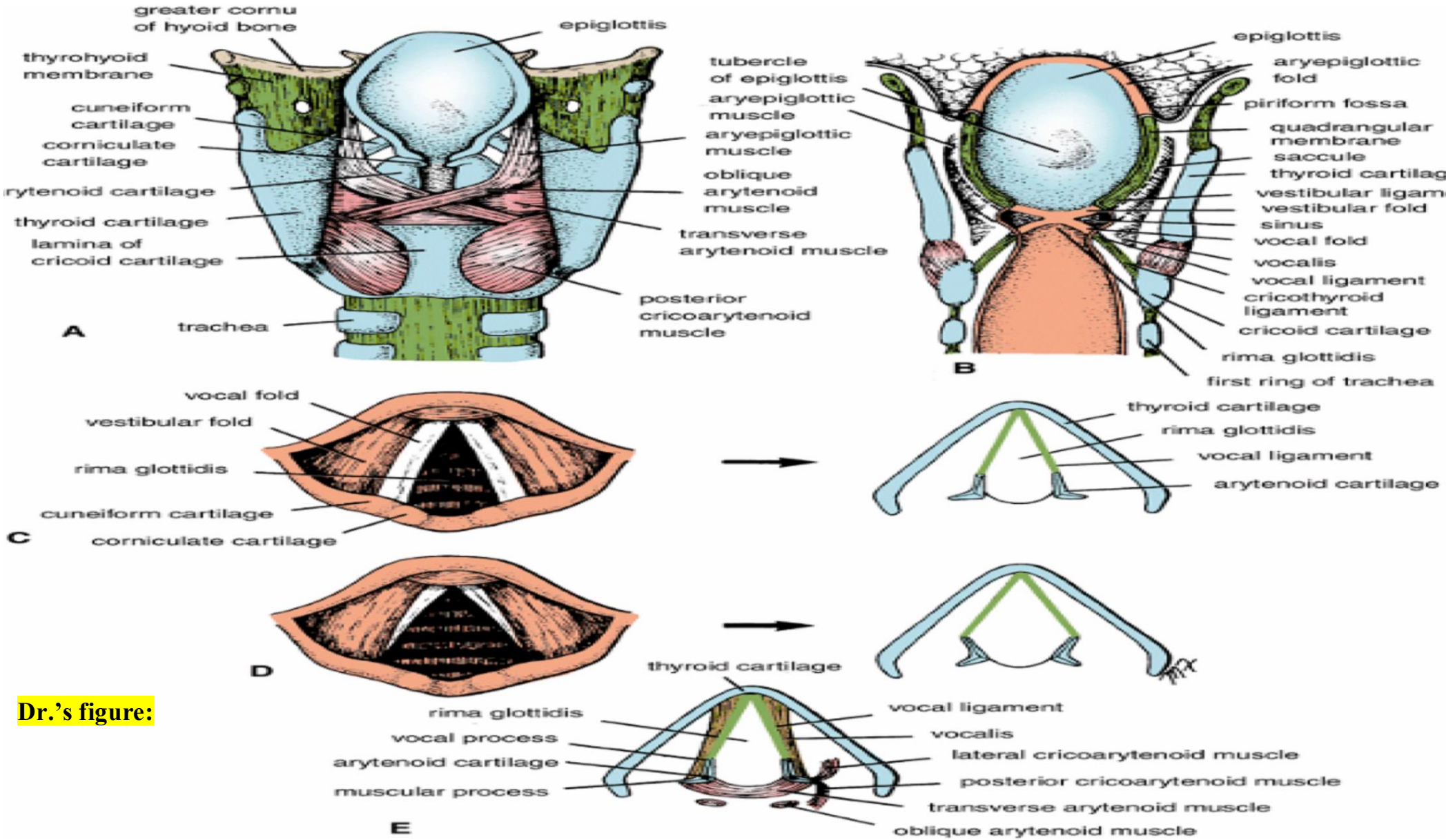
9- Extrinsic Muscles

➢ **Elevators of the larynx:**

1. Digastric muscle
2. Stylohyoid
3. Myelohyoid
4. Geniohyoid

➢ **Depressors (infrahyoid muscles) of the larynx :**

1. Sternothyroid
2. Sternohyoid
3. Omohyoid


greater cornu of hyoid bone
epiglottis
thyrohyoid membrane
cuneiform cartilage
corniculate cartilage
arytenoid cartilage
thyroid cartilage
lamina of cricoid cartilage
trachea
A
tubercle of epiglottis
aryepiglottic muscle
aryepiglottic muscle
oblique arytenoid muscle
transverse arytenoid muscle
posterior cricoarytenoid muscle
epiglottis
aryepiglottic fold
piriform fossa
quadrangular membrane
saccule
thyroid cartilage
vestibular ligament
vestibular fold
sinus
vocal fold
vocalis
vocal ligament
cricothyroid ligament
cricoid cartilage
rima glottidis
first ring of trachea
B
vocal fold
vestibular fold
rima glottidis
cuneiform cartilage
corniculate cartilage
C
thyroid cartilage
rima glottidis
vocal ligament
arytenoid cartilage
D
thyroid cartilage
rima glottidis
vocal process
arytenoid cartilage
muscular process
E
vocal ligament
vocalis
lateral cricoarytenoid muscle
posterior cricoarytenoid muscle
transverse arytenoid muscle
oblique arytenoid muscle

Dr.'s figure:

ANATOMY QUIZ LECTURE 3

External Resources

رسالة من الفريق العلمي

1. *Kenhub video*

﴿وَاصبِر عَلى ما أَصابَكَ إِنَّ ذٰلِكَ مِن عَزمِ الأُمور﴾

And be patient over what befalls you. Indeed, that is of the matters [requiring] determination

نحن في هذه الدنيا نسير وفق قدر الله سبحانه وتعالى، المرض الذي أصابك لم يكن في استطاعتك تجنبه، والموت الذي أخذ حبيبًا لك كان سيحدث مهما حاولت منعه، حتى الوظيفة التي فقدتها، كنت ستفقدها، ولو بذلت كل الجهد وأظهرت الولاء والتفاني.

In this world, we live according to the decree of Allah, the Almighty. The illness that afflicted you was beyond your ability to avoid. The death that took a loved one from you would have happened no matter how hard you tried to prevent it. Even the job you lost — you would have lost it, even if you had given your utmost effort and shown loyalty and dedication

For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	19 20		The sentences related to the depressions have been reversed. Last sentence has been rephrased
V1 → V2			