RESPIRATORY SYSTEM
ANATOMY

Title: Sheet 4 – Larynx 2

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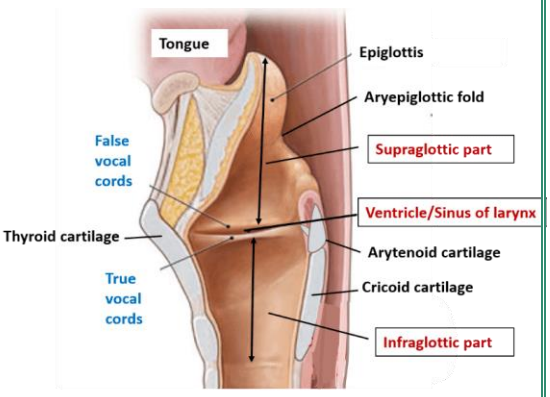
Larynx 2

• LARYNX:

Is a **box** of 9 cartilages, with 3 single and 3 paired cartilages

- › It's important for passage of air, production of voice, coughing, lifting of heavy objects and others.
- › It has a **cavity**, that we'll study in the coming pages.



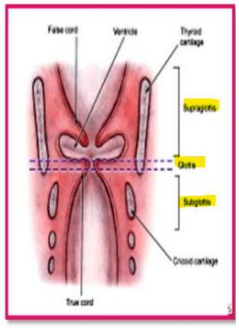
Sagittal section of Larynx

1. The **vestibular and vocal folds** [more about them throughout this sheet] divide the **larynx** into three major regions:
    1. **Vestibule:** begins with the **inlet of larynx** to the **false vocal cords**.
    2. **Middle (glottic) part**: continues from the **false** vocal cords to the **true** vocal cords. On its lateral side there is a **ventricle** [more about it in the coming discussion]
    3. **Infraglottic part:** starts from the **true** vocal cords and leads to the **trachea**.

Internal cavity of the larynx

divided into 3 spaces:

- Supraglottic,
- Glottic, And
- Subglottic spaces



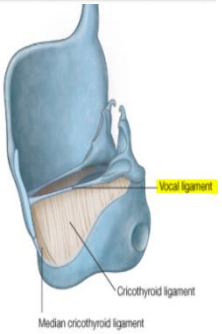
• *TRUE VOCAL CORDS (A.K.A VOCAL FOLDS):*

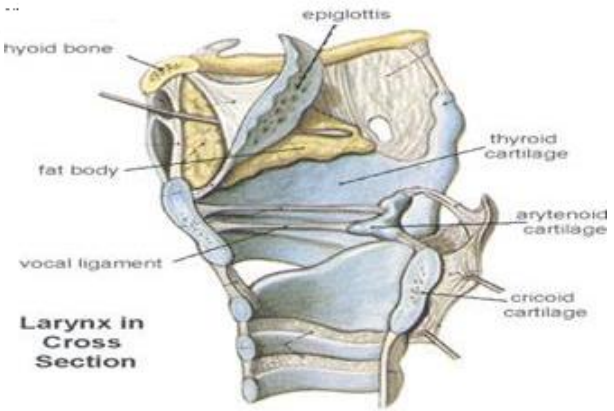
let's go through their characteristics ➲

› They consist of a **Vocal ligament**: What is that and where does it come from?

remember: It's the **thickened, upper free edge of the cricothyroid membrane** (*conus elasticus*)!!

It extends on each side of the larynx, between **the vocal process of the arytenoid** and the **back of the anterior lamina of thyroid cartilage** <angle of thyroid cartilage> try to follow on the pic

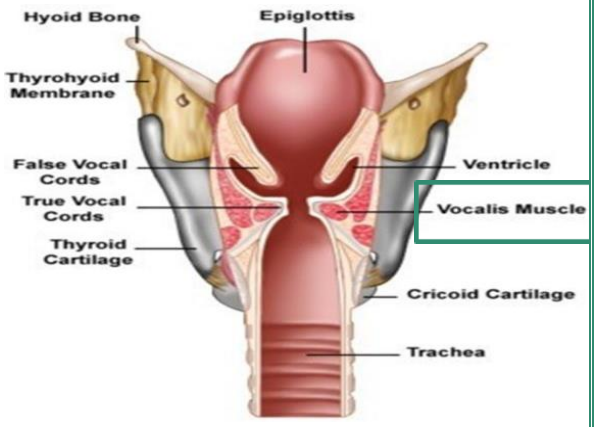




- The lining epithelium of vocal cords' mucous membranes is **stratified squamous non-kertatenized**

  < This is of Allah's creativeness, as we humans need this cord to be mitotic and ***regenerable*** because it is prone to injury by speech or excessive use بالعامية لما يروح صوتك >

  So, because of the stratified squamous epithelium, loss of voice is temporal.



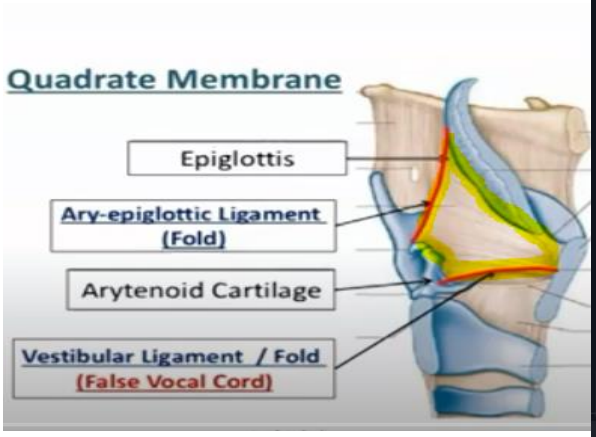
- They have a **Vocalis muscle** (thyroarytenoid muscle): to be discussed later in this sheet :D
- They have **no submucosa**: all respiratory tissue does have submucosa but it's absent here; that's to *prevent* accumulation of fluid in them which cause *edema* that could lead to adduction of vocal cords and suffocation. So, absence of submucosa is an *advantage* here ☺
- **white in color:** vocal folds have **no blood vessels** and are supplied by **diffusion** from the surrounding connective tissue.

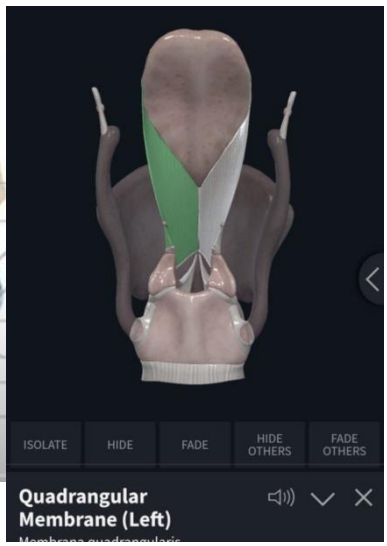
Remember! Difference of voice pitch between genders: females have **shorter** length of vocal cords, more obtuse angle and high pitch of voice while males have **longer** length with an acute angle and lower pitch of voice

VESTIBULAR FOLDS (AKA FALSE VOCAL CORDS):

They are the false vocal cords, which are formed by the lower free edge of **quadrangular membrane**. Have a look at the beautiful pictures!

2. Unlike the true vocal cords, vestibular folds are:
   - Vascularized (i.e. red in color)
   - Fixed and not movable

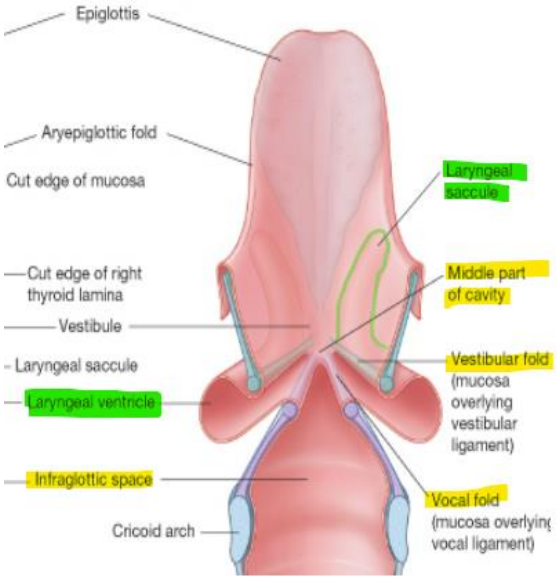




› **Superior to the vocal cords**

› Are covered by respiratory mucosa (pseudostratified columnar)

• LARYNGEAL VENTRICLES AND SACCULES

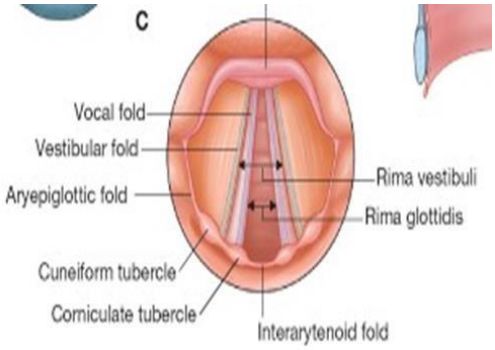


Between the vestibular folds (false vocal cords) and true vocal folds we have the **VENTRICLE** which is a space that ascends upward leading to a **saccule.** It is located in the middle cavity.

The importance of this ventricle is that it has a **tubular extension** (like a diverticulum) that will form the **laryngeal saccule** which projects antero-superiorly between the **vestibular fold** and **thyroid cartilage**

➲ Here's the catch: Within the walls of these laryngeal saccules are **numerous seromucous glands** from which secretions flow down to lubricate the true vocal folds (cords).

• RIMA VESTIBULI AND RIMA GLOTTIDIS



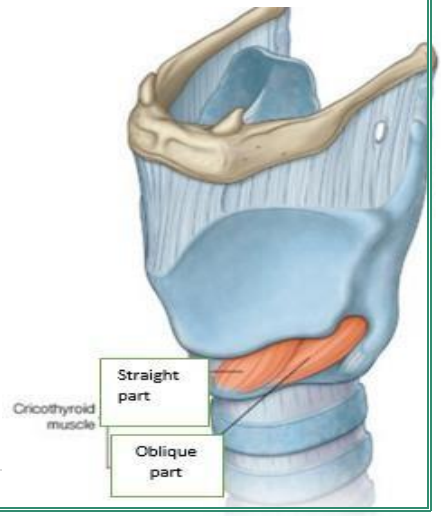
The Rima vestibuli: is the space between the **false** vocal cords.

The Rima glottides: it is the space between the **true** vocal cords and the **narrowest** point in the laryngeal cavity. Also, it is **the opening which separates the middle chamber above from the infra-glottic cavity below.**

• INTRINSIC MUSCLES OF THE LARYNX:

1. Cricothyroid muscle: (usual EXAM QUESTION)

Remember, It is the only EXTERNAL muscle.

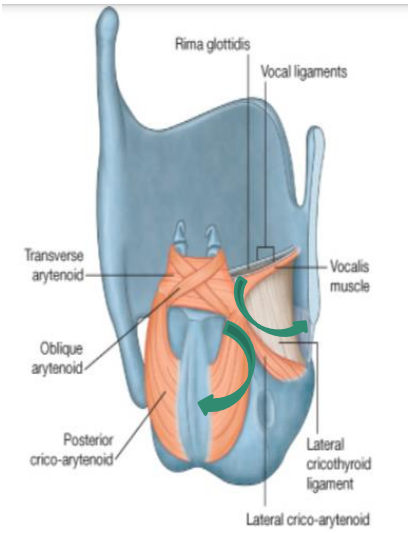


Origin and insertion: In general, this muscle moves from the cricoid to the thyroid. It has two parts, oblique① and straight②.

- The oblique part runs in a posterior direction from the arch of cricoid to the inferior horn of thyroid. [notice them on the picture above]
- The straight part runs more vertically and upward from the arch of the cricoid to the posteroinferior margin of the thyroid lamina

Nerve supply: **THE ONLY MUSCLE SUPPLIED BY the EXTERNAL LARYNGEAL N.**
All other muscles are supplied by RECURRENT LARYNGEAL N.

Action: Pulls the thyroid cartilage forward and rotate it down relative to the cricoid cartilage. These actions **Tense vocal cords.**

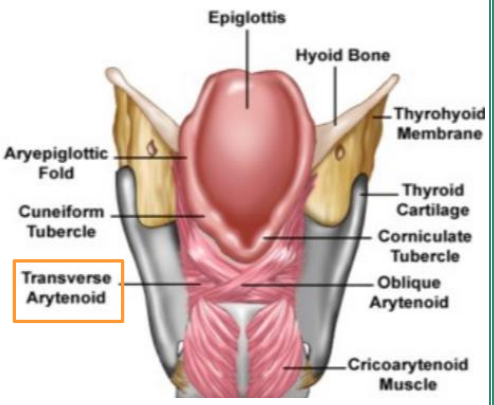


2. Posterior and lateral cricoarytenoid muscles:

Origin: posterior cricoarytenoid originate from the **posterior surface** of cricoid lamina.
The lateral cricoarytenoid muscle originates from **lateral surface** of cricoid lamina.

Insertion: both bind to the muscular process of arytenoid

Nerve supply: recurrent laryngeal nerve.
Action: pulling the **lateral** cricoarytenoid muscles **internally** adducts the vocal cords, while pulling the **Posterior** cricoarytenoid **externally** backwards and upwards and by so abducts the vocal cords
notice the curved arrows in this additional picture to the right to help you imagine the action

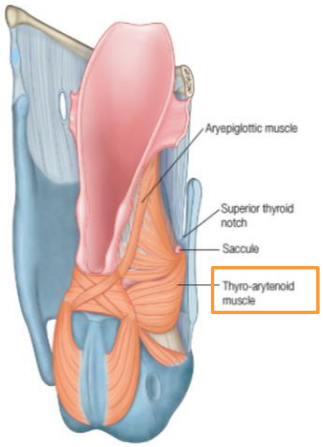


3. Transverse arytenoid

Origin: runs transversely from one arytenoid to the other arytenoid. <slides: Originates from Back and medial surface of arytenoid cartilage and insert in the Back and medial surface of opposite arytenoid cartilage>

Action: **Closes posterior part of rima glottidis** by approximating arytenoid cartilages (interaretenoid area).

Now check out this cool animation about previous muscles <3
https://youtu.be/DXZZpMwPeJ4



4. Thyroarytenoid (vocalis muscle)

It's a striated muscle and a part of true vocal cords, it **relaxes (elongates) the true vocal cords**

- opposing cricothyroid muscle effect (cricothyroid is a TENSOR, vocalis is a RELAXATOR of the vocal cord)
  - This muscle is responsible for low pitch of voice while cricothyroid is responsible for the high pitch

5. Oblique arytenoid <see above pictures>

Origin: from the muscular process of one arytenoid to the apex of the opposite arytenoid.
Action: narrow the inlet by adducting aryepiglottic folds.

6. Aryepglotticus muscle

Origin: between arytenoid and epiglottis, it lies within the aryepiglotticus fold
Action: widening of the laryngeal inlet by the abduction the aryepiglottic folds when acting ALONE, but it narrows the inlet when acting with oblique arytenoid i.e. its normal physiological action is aiding in closure of the inlet

• CLOSURE OF THE INLET OF THE LARYNX IN DEGLUTITION:

- The food bolus pushes the **epiglottis** downward and backward, the larynx moves upward, and **aryepiglotticus muscles along with interarytenoid muscle contracts.** These events result in adduction of the aryepiglottic folds together and closure of the laryngeal inlet.

The table below summarizes some of the muscles actions:

Adjust tension in the vocal ligaments	Open and close the rima glottidis	Closure of the inlet of the larynx
Tensor- cricothyroid muscle	Adduction- lateral cricoaretenoid	Interaretynoid (transversus) muscle
Relaxation- Thyroareytenoid muscle(vocalis)	Abduction- posterior cricoarytenoid	Right and left aryepiglotticus muscles

• EXTRINSIC MUSCLES OF THE LARYNX

Remember from GI system, they are classified into **suprahyoid and infrahyoid** muscles → Suprahyoid muscles pull the larynx upward and aid in closure of inlet.
→ Infrahyoid muscles depress the larynx downward.

Suprahyoid muscles:

- Digastric
- Stylohyoid
- Myelohyoid
- Geniohyoid
- Assisted by Stylopharngeus, Salpingo-pharngeus, and Palatopharngeus

Infrahyoid muscles:

- sternothyroid
- sternohyoid
- omohyoid

Remember: Functions of the larynx:

- Deglutition or swallowing < closure of the inlet during swallowing>
- Respiration < through which the larynx is relaxed>
- Phonation < vibration of true vocal cords during expiration as the two vocal cords are adducted causing compressed column of air to be partitioned>
- Effort closure: during heavy lifting, vocal cords are adducted completely, thus a column of air is formed beneath the vocal cords and it gives efforts for lifting heavy objects then after lifting there would be a deep expiration

• BLOOD SUPPLY OF THE LARYNX:

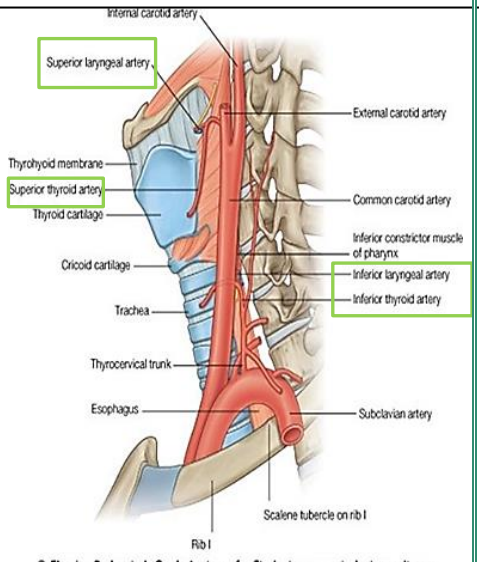
1. **Superior laryngeal artery:** which pierces the thyrohyoid membrane with the **internal laryngeal nerve –** the latter is sensory to the larynx above vocal cords and a branch of the vagus.

   ➲ chain: external carotid A. → superior thyroid A. (runs with ext. laryngeal N.)→ superior laryngeal A.

2. **Inferior laryngeal artery:**

chain: Subclavian artery→ thyrocervical trunk→ inferior thyroid →inferior laryngeal.

↳ **Recurrent laryngeal nerve** passes between the branches of the inferior thyroid artery and then with the inferior laryngeal artery. Together, they **ascend in the groove between the esophagus and trachea, entering the larynx by passing deep to the margin of the inferior constrictor muscle of the pharynx.**



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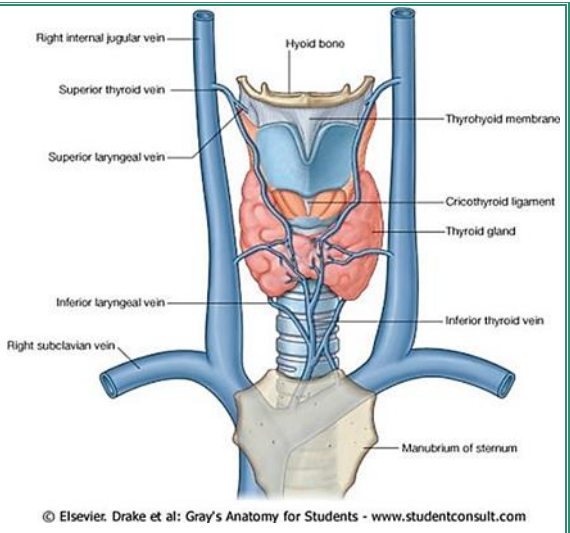
VENOUS DRAINAGE OF LARYNX



- **Superior laryngeal vein**→ drains into superior thyroid vein→ internal jugular vein
- **Inferior laryngeal vein** → inferior thyroid vein→ left brachiocephalic vein.
- **The inferior thyroid vein** ends in the left brachiocephalic and notin the right because the left is more oblique and longer

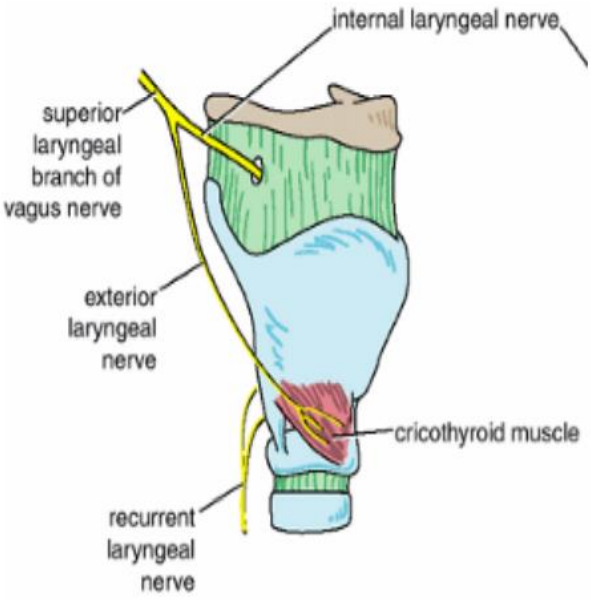
LYMPHATIC DRAINAGE OF THE LARYNX

The lymphatic drainage is divided to above and below the true vocal cords:

i. **Above** the true vocal cords, lymphatics end in the deep cervical lymph nodes through the lymph nodes associated with superior laryngeal artery.

ii. **Below** the true vocal cord, lymphatics drain into the lymph nodes associated with inferior thyroid artery and ends in paratracheal lymph nodes (on the cricothyroid ligament or upper trachea)

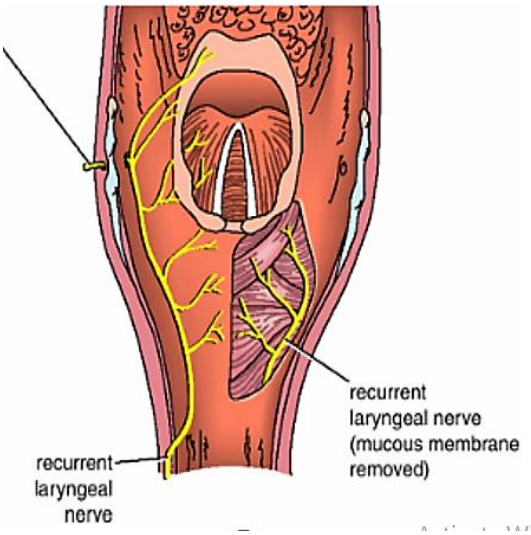
INNERVATION OF THE LARYNX



Generally speaking, the innervation of the larynx is divided to motor and sensory; above and below the true vocal cords:

- **Sensory** innervation to the mucosa **above** the true vocal cords by **internal laryngeal nerve.**
- **Sensory** innervation **below** the true vocal cords by the **recurrent laryngeal nerve**.
- **Motor** innervation to **all** laryngeal muscles is by the **RECURRENT LARYNGEAL NERVE** [**exception**: cricothyroid which is supplied by the external laryngeal nerve a branch of the superior laryngeal of the vagus]

Recurrent laryngeal nerves: branches of the vagus



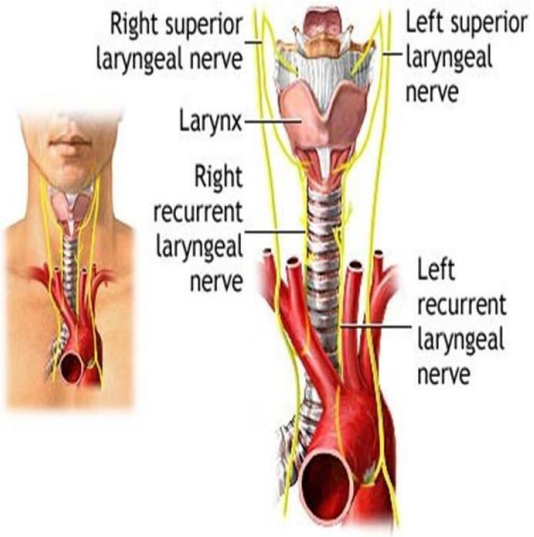
The left recurrent nerves are longer [take a wild guess why, does CVS remind you of sth here? :P]:

The left vagus nerve (which is longer) descends to the thorax and gives the left recurrent laryngeal nerve **below the arch of aorta** which then ascends between trachea and oesophagus to the larynx.

The right vagus nerve gives the **right** recurrent nerve at the root of the neck, **below the subclavian vessels**.

- **So, the right recurrent nerve isn't found in the chest and it's not related to the pleura and lung.**

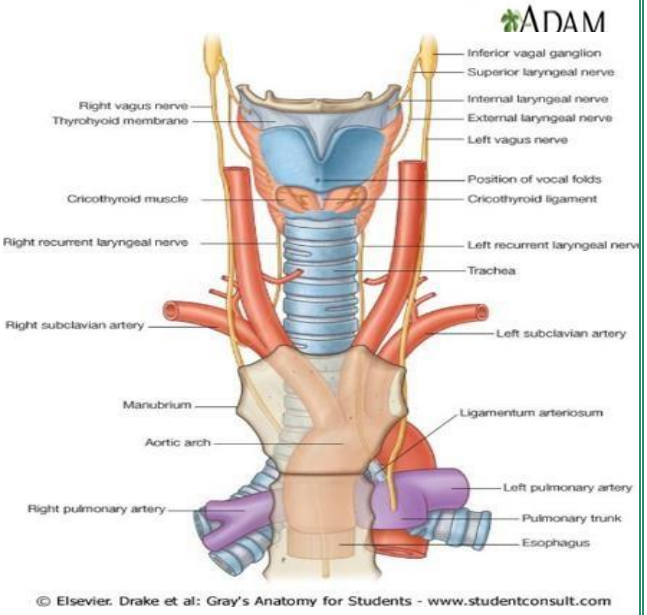
Remember for the thousand time as the doctor kept repeating it , they innervate all the muscles except the cricothyroid, they are also sensory to the mucosa below true vocal cord



This picture to the right is a previous lab question, it's important to differentiate between the right and left recurrent nerve ----------→

• RELATIONS OF THE LARYNX

- **Laterally:** The carotid sheath and its contents which are: the common carotid artery, internal jugular vein and vagus nerve. In addition to the lateral lobes of thyroid.
- **Posteriorly:** pharynx and right recurrent laryngeal nerve
- **Anteriorly:** Skin, fascia and 4 infrahyoid muscles.



• CLINICAL NOTES

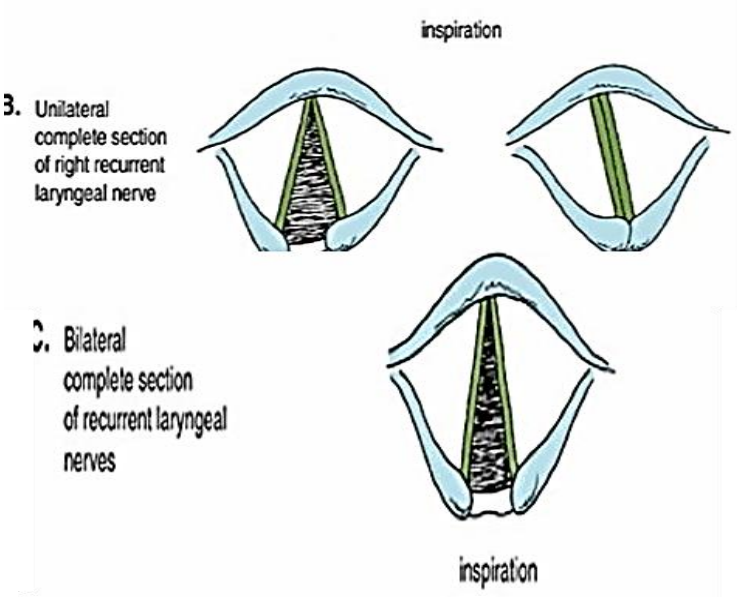
NOTE 1: During thyroidectomy and ligation of **superior thyroid artery** the **external laryngeal nerve** could be injured. Bilateral injury to the external laryngeal nerve result in bilateral paralysis of cricothyroid muscle and hoarseness and unilateral causes weakness of the voice (due to loss of the ability to tense vocal cords completely).

NOTE 2: Injury to the recurrent laryngeal nerve could be **bilateral complete** section, **bilateral partial** section, **unilateral complete** section or **unilateral partial** section (section as in cut). As discussed in the following:

General notes on recurrent laryngeal nerve injury:

- **Logically, there are two important things to look at after recurrent nerve injury: respiration and speech.**
- **Partial injury:** injury to *superficial fibers* (deep fibers are spared) that supply the *abductor* muscles due to manipulation or tension. *Partial injury results in adduction* of vocal folds and causes suffocation if it was bilateral. It is more dangerous than complete because in complete injury vocal cords are neither adducted nor abducted.
  SO, most dangerous form is partial bilateral due to suffocation, tracheostomy should be performed.
- Unilateral partial of recurrent causes hoarseness of voice, while unilateral complete injury of recurrent doesn't affect speech

Forms of recurrent laryngeal nerve injury:



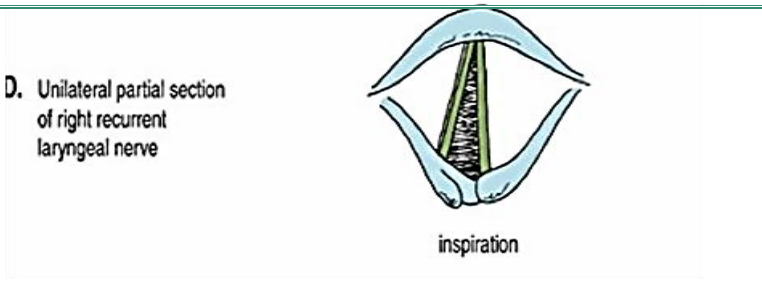
› **Unilateral Complete section:**

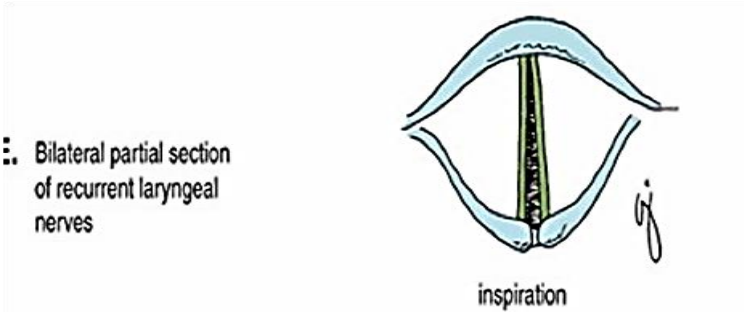
One vocal fold (on the affected side) would be stuck in the position midway between abducted and adducted states

Speech and respiration **aren't much affected** because the *other side* compensates.

› **Bilateral complete section: difficulty in breathing without suffocation**, rima glottidis is partially closed and the **speech is lost as both cords are affected**.

- Unilateral partial section: hoarseness in voice with **difficulty in respiration.**
- Bilateral partial section: **dyspnea, stridor (snoring) and suffocation**. Most serious, here the tracheostomy is a necessity





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