

Anatomy

The larynx

It is specialized organ that provides a protective sphincter at the inlet of air passage and responsible for voice production. It continuous superiorly with the laryngo-pharynx, and inferiorly with the trachea.

The larynx is supported by number of cartilages which are:

1. Unpaired cartilages:
 - Ring like cricoid cartilage
 - V-shaped thyroid cartilage
 - Leaf-shaped epiglottis
2. paired cartilages:
 - Pyramidal-shaped arytenoid cartilages
 - Cuneiform and corniculate cartilages

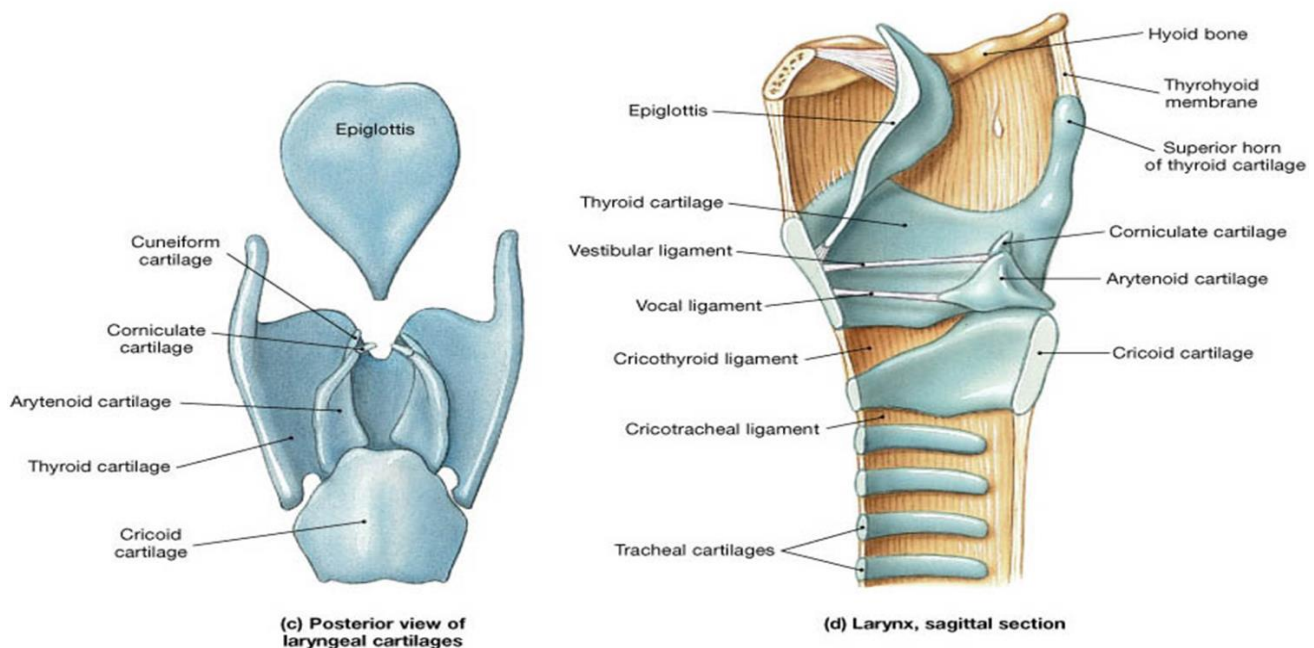
The cartilages of the larynx are connected by the membranes and ligaments, and are moved by muscles at two joints.

The cavity of the larynx cavity is lined by a mucous membrane and is narrowed at its middle part by two pairs of folds [the vocal and the vestibular folds]

The cartilages of the larynx

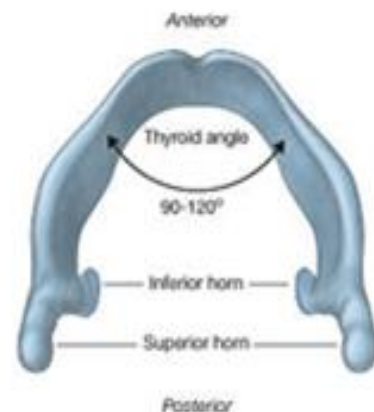
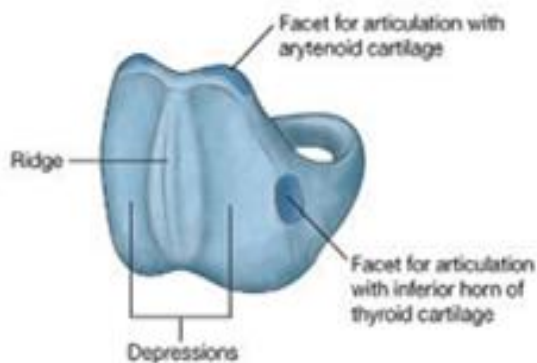
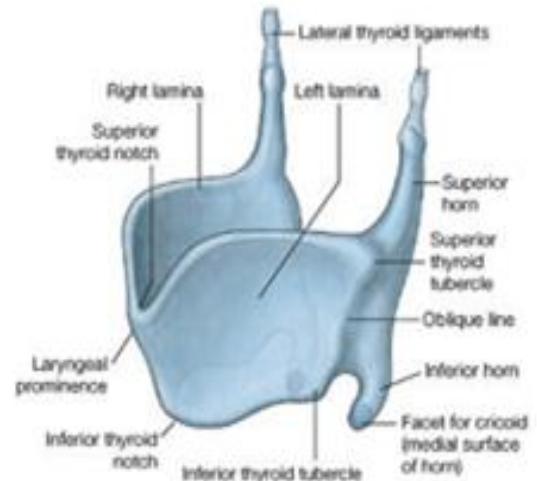
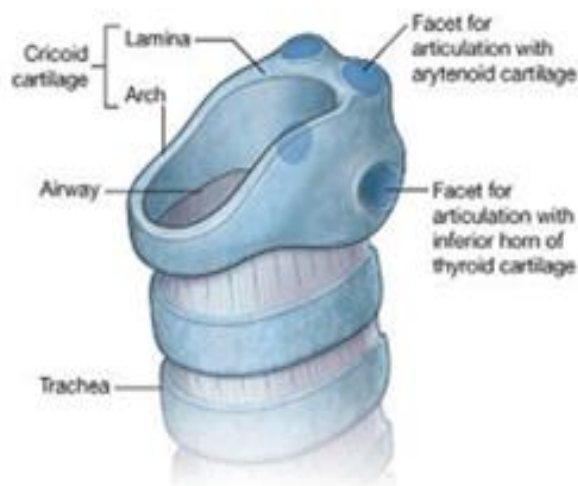
Cricoid cartilage:

1. It is a ring like hyaline cartilage lies below the thyroid cartilage and above the trachea [to which it is attached by the cricotracheal ligament].
2. Has a narrow arch anteriorly and broad lamina posteriorly.
3. The upper border of the lamina articulates with the base of the arytenoid cartilages at the crico-arytenoid joint.
4. The inferolateral angle of the lamina articulates with the inferior horn of the thyroid cartilage at the crico-thyroid joint.



Thyroid cartilage

1. It is a V shaped hyaline cartilage and is largest of the laryngeal cartilages.
2. It consists of two laminae. Each lamina has anterior and posterior borders.
3. The anterior borders are fused in its lower two third [at 90 degrees in males and 120 degrees in females] but separated above by the superior thyroid notch. In males the most superior point of the site of fusion between the two broad flat laminae projects forward as the laryngeal prominence (Adam's apple)
4. The posterior borders are free and project upward and downward as the superior horn and inferior horn.
5. The superior horn is attached to the tip of greater horn of the hyoid bone by the lateral thyro-hyoid ligaments.
6. The inferior horn articulates with the lamina of the cricoid cartilage at the crico-thyroid joint.
7. The lateral surface of the thyroid cartilage is flat.
8. On each side there is a raised line called the oblique line which extends from the inferior tubercle to superior tubercle.
9. The sternothyroid muscle, the thyrohyoid muscle, the inferior constrictor and the pretracheal fascia are attached to the oblique line.
10. The upper margin of the thyroid cartilage is attached to the thyrohyoid membrane.



The epiglottis

1. It is a leaf-shaped elastic fibrocartilage that forms the antero-superior wall of the laryngeal inlet.
2. It lies posterior to the:
 - Base of the tongue and the epiglottis is attached to it by the median glossoepiglottic fold and two lateral glossoepiglottic folds.
 - Body of the hyoid bone and the epiglottis is attached to it by hyo-epiglottic ligament.
 - Thyro-hyoid membrane.
 - Thyroid cartilage [the epiglottis tapers inferiorly and is attached to the posterior surface of the thyroid cartilage by the thyro-epiglottic ligament.
3. The margins of the epiglottis are attached to the arytenoid cartilages by the quadrate membrane.

Arytenoid cartilages

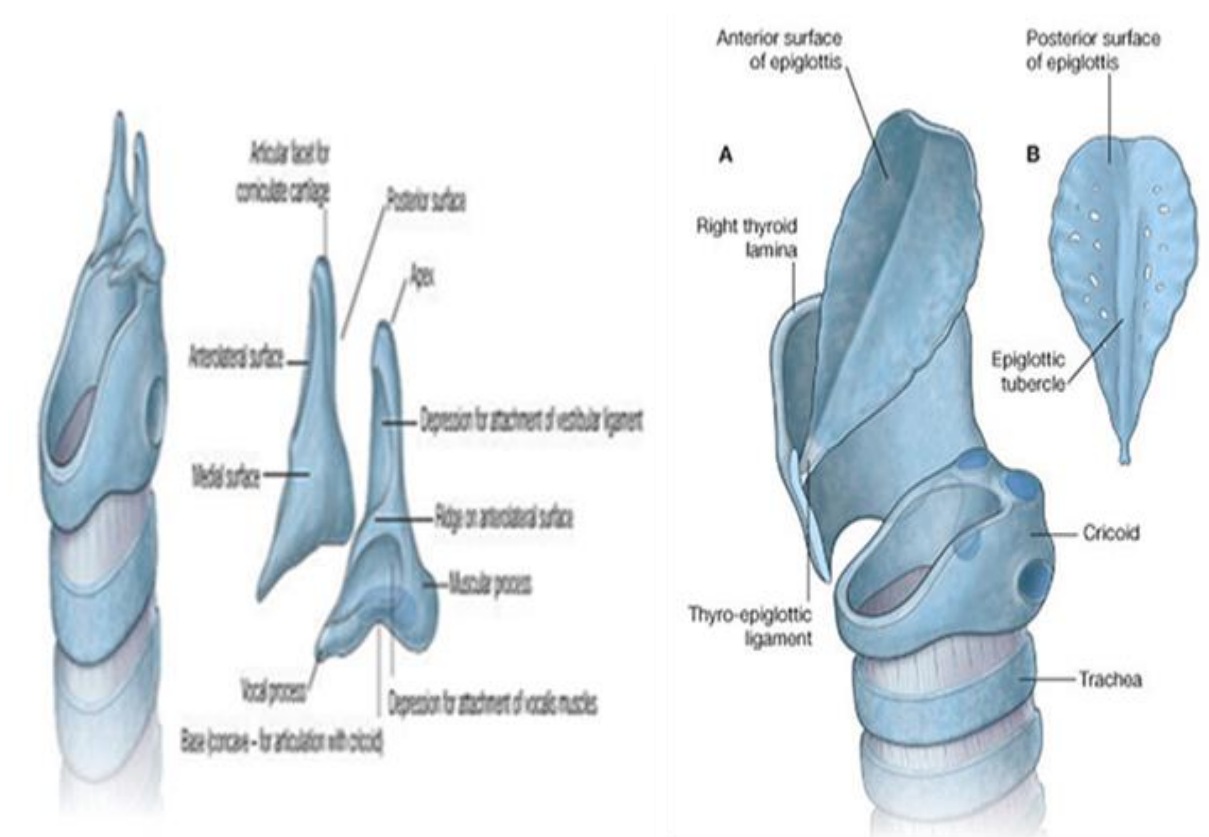
1. They are pair of three sided pyramids, placed side by side on the superior border of the lamina of the cricoid cartilage.
2. It has apex and base.
3. The apex extends upwards, curving posteromedially and is attached to the corniculate cartilage.
4. The base articulates with the lamina of the cricoid cartilage and has two projections:
 - Lateral process [the muscular process]: to which the lateral crico-arytenoid, posterior crico-arytenoid, and oblique arytenoid muscles are attached
 - Anterior process [the vocal process]: to which the vocal fold is attached.
5. The apex and the vocal process are elastic fibrocartilage while the remainders are hyaline cartilage.

Corniculate cartilages

Are two small cartilages articulate with the arytenoids cartilages and give attachment to the aryepiglottic folds

Cuneiform cartilages

Two small pieces of cartilages that support the aryepiglottic folds.

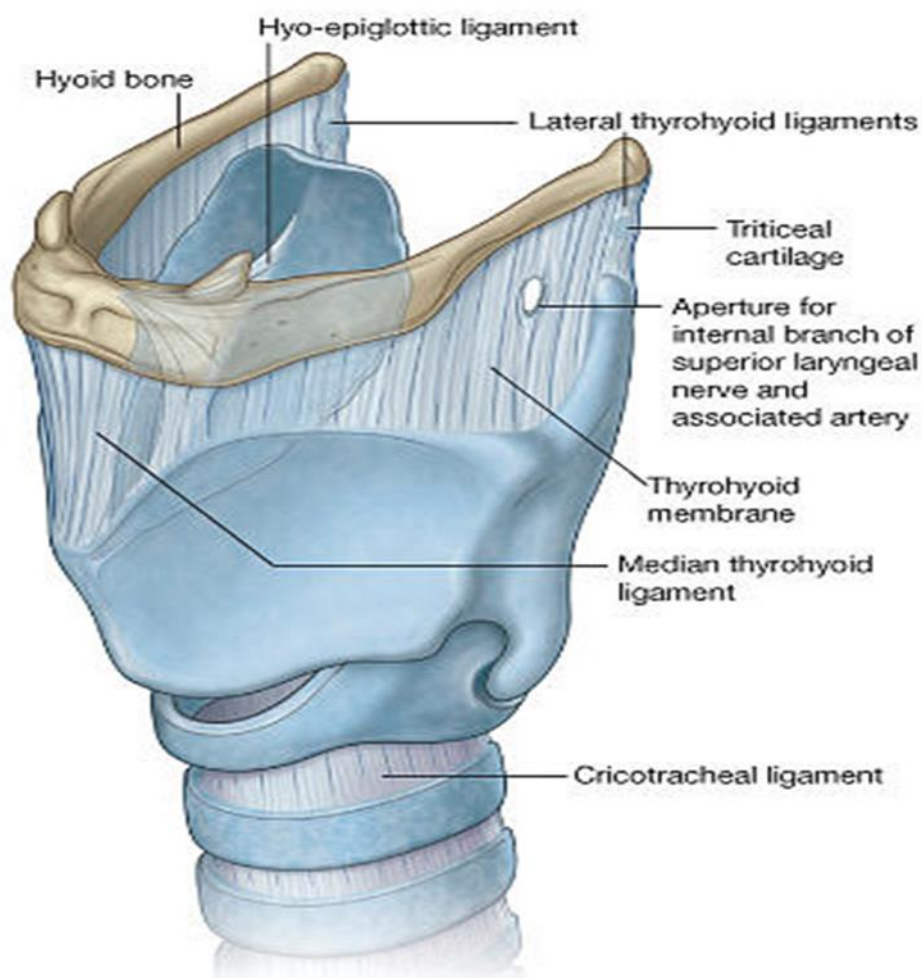


Laryngeal ligaments and membranes

They are two types; the extrinsic and the intrinsic membranes:

The extrinsic membranes

1. The thyro-hyoid membrane: it is a membrane that connects the upper margin of the thyroid cartilage to the upper margin of the posterior surface of the body of the hyoid bone and its greater horns. It is pierced by the internal laryngeal nerve and the superior laryngeal vessels. It is thickened in the midline anteriorly to form the median thyrohyoid ligament. Posteriorly, it is thickened to form the lateral thyrohyoid ligaments that extend from the superior horns of the thyroid cartilage to the greater horns of the hyoid bone.
2. Hyo-epiglottic ligament.
3. Thyro-epiglottic ligament.
4. Cricotracheal ligament.



The intrinsic membranes

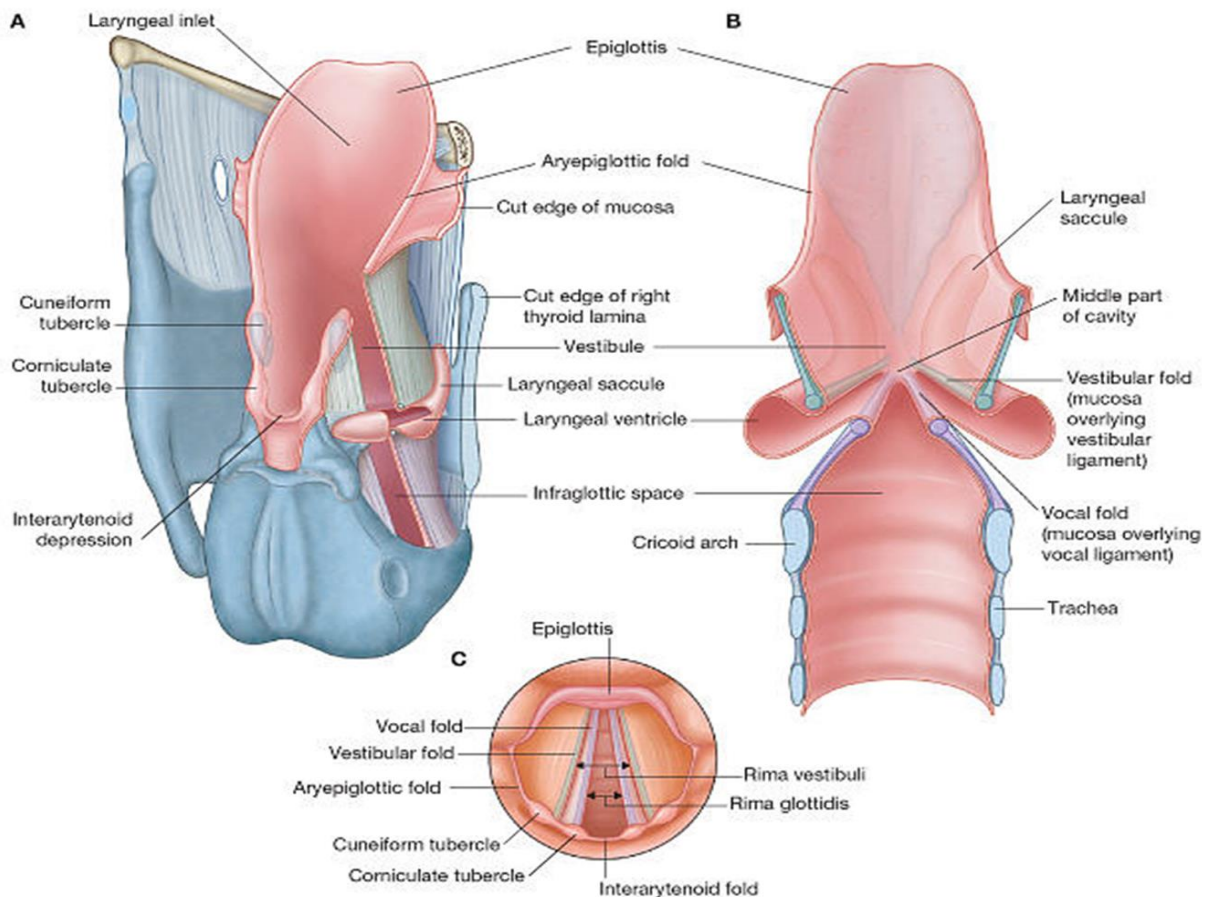
Are formed by sheet of fibroelastic tissue, lies beneath the mucous membrane of the larynx and is interrupted on each side by the ventricle of the larynx that divides it into two parts:

1. The upper part [the quadrate membrane]:

It is a fibroelastic membrane extends from the sides of the epiglottis to the arytenoid cartilages. Its superior border forms the aryepiglottic ligament while the inferior border forms the vestibular ligament.

2. The lower part [the conus elasticus]:

It is a thin layer of fibroelastic membrane. It is attached to the superior border of the cricoid cartilage and slope superomedially to end as free edge [thick edge] that is called the vocal ligament. The vocal ligament extends from the posterior surface of the thyroid cartilage close to the midline to the vocal process of the arytenoids cartilage.



Interior of the larynx

It extends from the inlet of the larynx to the lower border of the cricoid cartilage. The cavity of the larynx is narrowed at its middle part by two pairs of folds [vestibular folds and vocal folds]. These folds divide the cavity into three parts: superior part, middle part and inferior parts.

Superior part [the vestibule]:

It extends from the inlet to the vestibular folds and has three walls

- long anterosuperior wall: formed by the mucous membrane covering the epiglottis and the thyroepiglottic ligament
- short posterior wall :formed by the mucous membrane covering the apex of the arytenoid cartilages and the interarytenoid fold
- Lateral wall: formed by the inner surface of quadrangle membrane and the aryepiglottic fold which is a thin deep fold extends from the margins of the epiglottis to the arytenoid cartilage.

Inferior part [the infraglottic part]:

It extends from the vocal folds to the lower part of the cricoid cartilage. Its wall is formed by the inner surfaces of the conus elasticus and the cricoid cartilage.

The middle part:

It consists of the vestibular folds and the vocal folds with the ventricle between them

The ventricle: is narrow horizontal groove lies between vestibular fold and the vocal fold on each side

The saccule: is a narrow blind diverticulum which passes posteriosuperior between the vestibular fold and the thyroid cartilage. It contains mucous glands which lubricate the vocal folds.

The vestibular folds [false vocal cords]:

- Soft and pink folds of the mucous membrane that extend from the thyroid cartilage to the sides of arytenoid cartilages.
- Each fold is separated from corresponding vocal fold by the ventricle.
- The space between the two folds is called the rima vestibule.
- Has no role in voice production.
- It contains the vestibular ligament [which is lower border of the quadrangle membrane] and few muscle fibers.

The vocal folds [true vocal cords]

- Wedge-shaped, white in color folds extend from the posterior surface of the thyroid cartilage close to the midline to the vocal processes of the arytenoid cartilages.
- The space between two vocal folds is called the rima glottides.
- It contains the vocal ligament [thickened upper free border of the conus elasticus] and the vocalis muscle [deep medial fibers of the thyroarytenoid muscle].

Joints of the larynx

1. The cricothyroid joint:

It is a synovial joint between the inferior horn of the thyroid cartilage and the inferolateral angle of the lamina of the cricoid cartilage. It permits a rotatory movement of the thyroid and cricoid cartilages around horizontal axis. So the lamina of the cricoid and the attached arytenoid cartilages move toward or away from the anterior part of the thyroid cartilage and thus slackening or tightening the vocal folds.

The cricothyroid and the thyro-arytenoid muscles act on this joint.

2. The cricoarytenoid joint:

It is a synovial joint between the base of the arytenoid and the upper border of the lamina of the cricoid cartilage. It permits a rotatory movement of the arytenoid cartilages around vertical axis also sliding movements in all directions.

The posterior cricoarytenoid muscle, lateral cricoarytenoid muscle and the transverse arytenoids muscle act on this joint.

Muscles of the larynx

A. extrinsic muscles : divide into two groups

The elevator of the larynx includes the:

- digastric muscle
- stylohyoid
- mylohyoid
- geniohyoid
- longitudinal muscles of the pharynx

The depressor of the larynx:

- sternothyroid
- sternohyoid
- omohyoid

B. intrinsic muscles: divide into two groups:

Muscles that control the laryngeal inlet:

1. Oblique arytenoid and aryepiglottic muscles

Origin: muscular process of the arytenoid cartilage

Insertion: into the apex of the opposite arytenoid cartilage. Some of its fibers continue beyond the apex into the aryepiglottic fold to reach the side of epiglottis [called the aryepiglottic muscle]

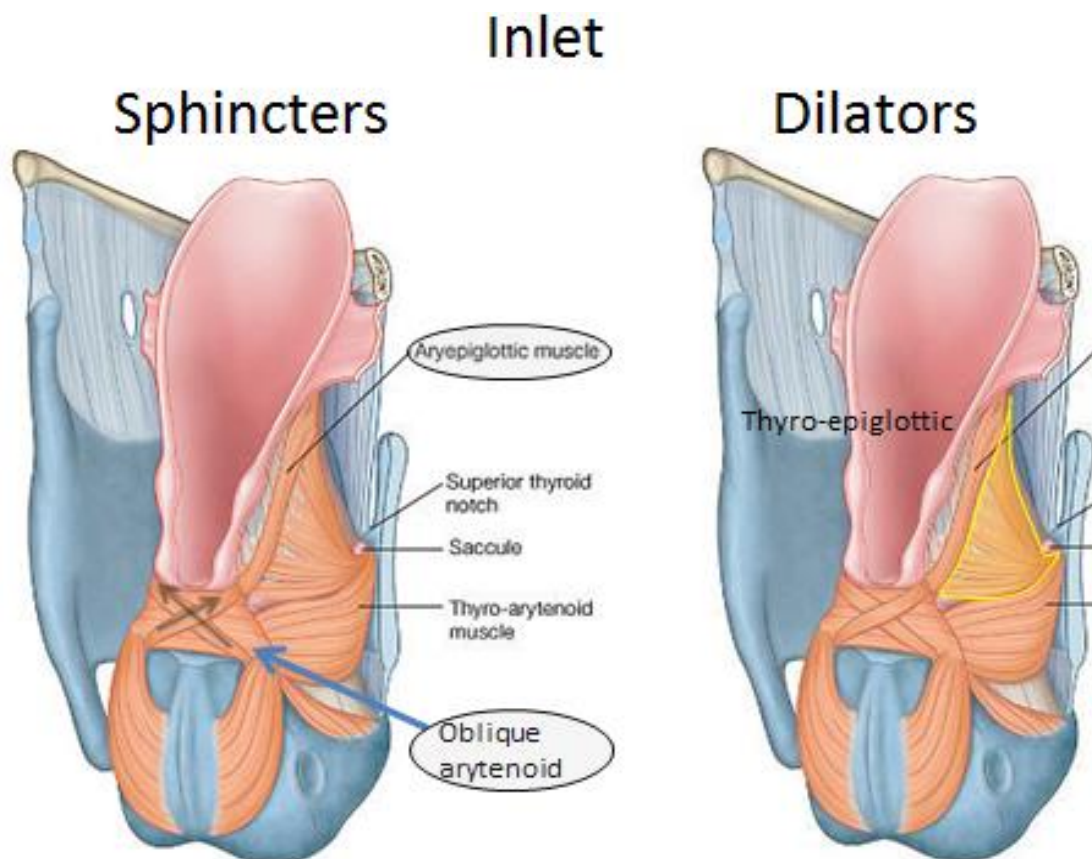
Action: they act as sphincter to the laryngeal inlet by approximates the arytenoids cartilages and the aryepiglottic folds.

2. Thyroepiglottic muscle

Origin: it is the upper lateral part of the thyroarytenoid muscle arises from the posterior part of thyroid cartilage

Insertion: it passes upwards to the sides of the epiglottis and the aryepiglottic fold

Action: it opens and widens the inlet.



Muscles that control the movements of the vocal folds

1. Cricothyroid muscle [the tensor muscle]

Origin: it is a triangular muscle arises from the side of cricoid cartilage

Insertion: it is inserted into the lower border of the lamina of the thyroid cartilage and its inferior horn

Action: this muscle tightens the vocal folds by increasing the distance between the thyroid cartilage and the vocal process of the arytenoid cartilage. This occurs at the cricothyroid joint by:

- rotating the thyroid forwards
- rotating the lamina of the cricoid and the attached arytenoid cartilages backwards

2. *Thyroarytenoid muscle [the relaxer muscle]*

Origin: posterior surface of the thyroid cartilage close to the midline

Insertion: anterolateral surface of the arytenoid cartilages

Some of its fibers [deep and medial fibers] arise from the vocal ligament and pass to vocal process of arytenoid cartilage [called the vocalis muscle]

Some of its fibers [upper lateral fibers] pass upward to the epiglottis and the aryepiglottic fold [called the thyroepiglottic muscle].

Action: the main muscle relaxes and slackening the vocal folds by rotating the thyroid cartilage posteriorly and the cricoid cartilage and the attached arytenoid anteriorly [decreasing the distance between them] .

The vocalis muscle slackening the posterior part and tightening the anterior part of the vocal folds [in whispering].

The thyroepiglottic muscle opens the inlet of the larynx.

3. *Lateral crico-arytenoid muscle [the adductor muscle]*

Origin: upper border of lateral part of the arch of the cricoid cartilage

Insertion: muscular process of the arytenoid cartilage

Action: it moves the muscular process anteriorly causing rotation of the vocal process medially so the vocal folds are adducted.

4. *Transverse arytenoid muscle (the adductor muscle)*

Origin: back and medial surface of the arytenoid cartilage

Insertion: back and medial surface of the opposite arytenoid cartilage

Action: pulls the arytenoid cartilage medially [sliding movement medially] so it close the posterior part of the vocal folds

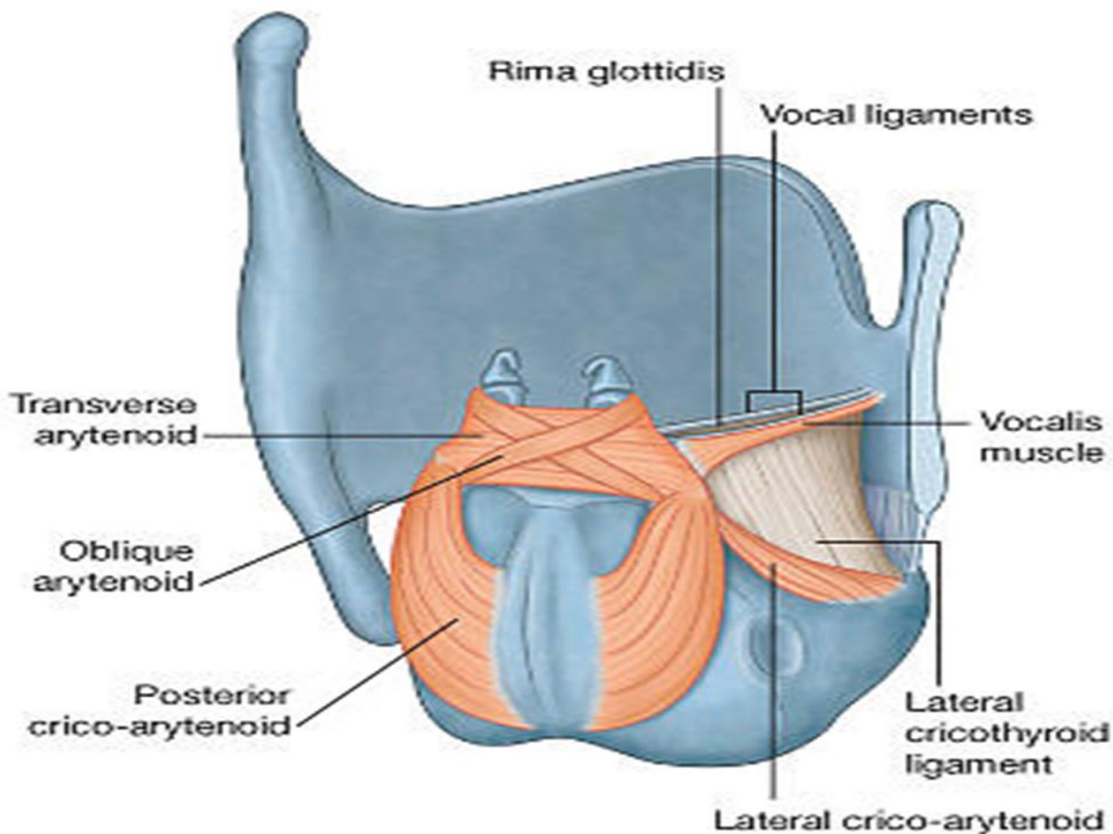
5. *Posterior crico-arytenoid muscle [abductor muscle]*

Origin: posterior surface of the lamina of the cricoid cartilage

Insertion: its fibers pass upward and laterally to be inserted into the muscular process of the arytenoid cartilage. It has upper horizontal fibers and lower vertical fibers

Action: the upper horizontal fibers rotate the vocal process laterally so the vocal folds are abducted [wide opening of the rima]

The lower vertical fibers pull the arytenoid cartilage laterally [sliding movement laterally], so it opens the posterior part of the rima



Rima glottidis

It is anteroposterior fissure or gap separating the vocal folds and the vocal processes of the arytenoid cartilages. It consists of two parts

1. Anterior 2/3 or intermembranous part lies between the vocal folds
2. Posterior 1/3 or intercartilagenous part lies between the vocal processes.

The shape of these parts is changing due to the movements of the cartilages at the joints of the larynx.

- A. In quiet breathing: the anterior part is triangular and the posterior part is quadrangular.
- B. During the forced inspiration: the anterior and posterior part are triangular [to allow free passage of air]. this achieved by horizontal fibers of the posterior cricoarytenoid muscle [that rotates the arytenoids cartilage medially] and the thyroarytenoid muscle [caused slackening of the vocal folds].
- C. During whispering: the anterior part is closed and the posterior part is widely opened. This achieved by vocalis muscle [tighten the anterior part] and the vertical fibers of the posterior cricoarytenoid muscle [pulls the vocal process laterally so it opens the posterior part of the rima].
- D. During speech [which is intermittent release of air between adducted vocal folds]: the rima is closed but the vestibular folds are open .this achieved by the lateral cricoarytenoid muscles and the transverse arytenoids muscles.

- E. Additional tightening of the vocal folds is achieved by the cricothyroid muscles (the vestibular folds are closed). This movement occurs in sneezing and coughing or in raising the pitch of voice.

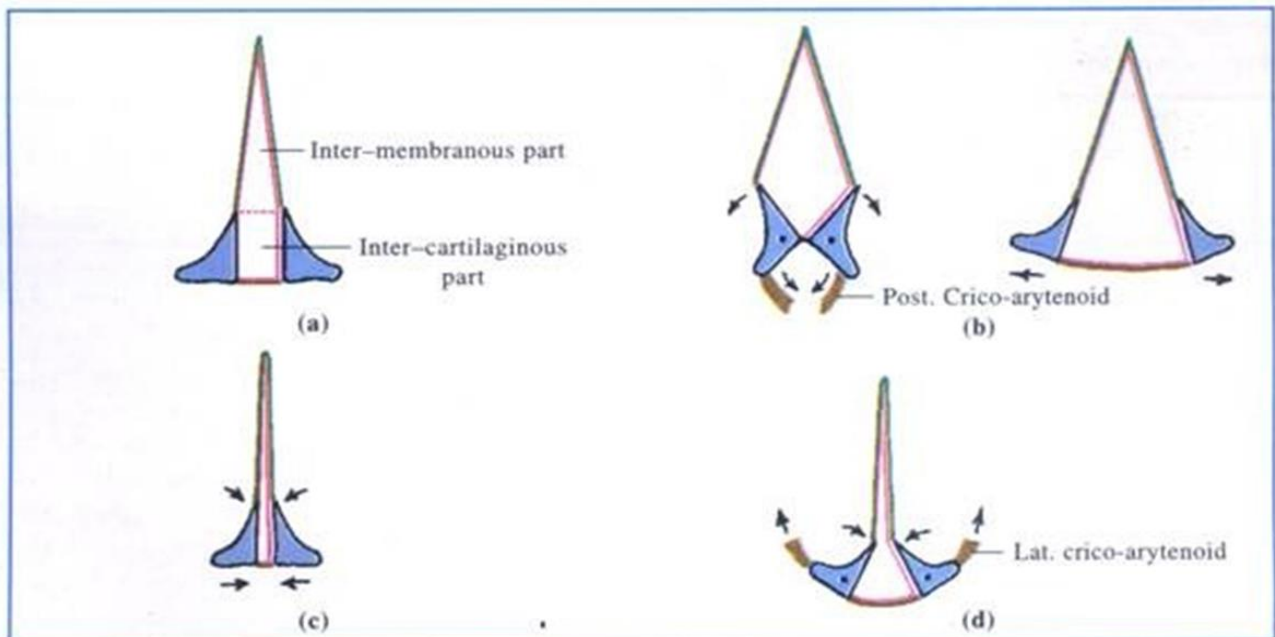
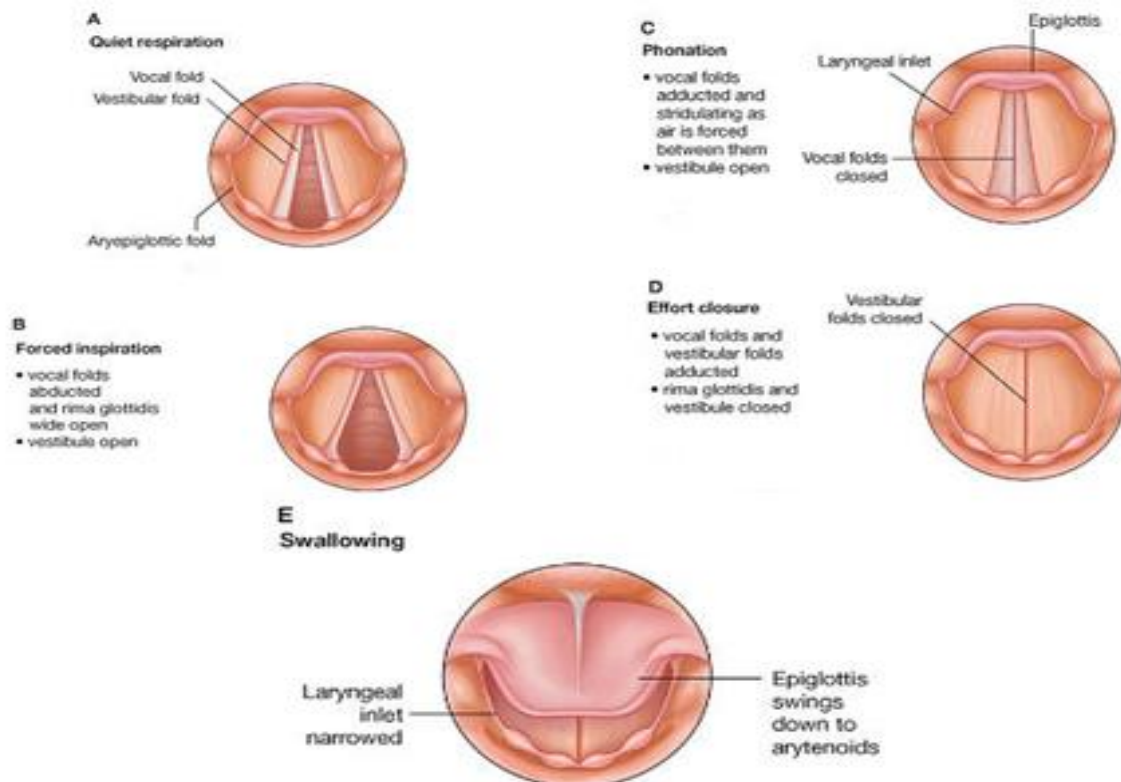


Fig. 13.12(a) *Rima glottidis in quiet breathing*, (b) *Rima glottidis in full inspiration (Diamond shaped) (Enlarged triangular)*, (c) *Rima glottidis in high-pitched voice*, (d) *Rima glottidis in whispering voice*.



Blood supply of the larynx

1. Superior laryngeal artery from superior thyroid artery.
2. Inferior laryngeal artery from inferior thyroid artery.

Nerve supply of the larynx

1. Superior laryngeal nerve: it is branch from the vagus nerve and has two branches
 - external laryngeal nerve: it supply the cricothyroid muscle
 - Internal laryngeal nerve: this nerve pierces the thyrohyoid membrane with the superior laryngeal artery. it supply
 - A. the piriform recess
 - B. base of the tongue and the epiglottis
 - C. mucous membrane covering the posterior surface of the arytenoids and cricoid cartilages
 - D. mucous membrane of the internal surface of the larynx above the vocal folds
2. Recurrent laryngeal nerve: it is branch o the vagus nerve ascends between the trachea and the esophagus and enters the larynx deep to inferior constrictors with inferior laryngeal artery. It supplies:
 - all the muscles of the larynx except the cricothyroid muscle
 - The mucous membrane of the internal surface of the larynx below the vocal folds.

