



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

DNS DEPARTMENT OF NEUROSCIENCE



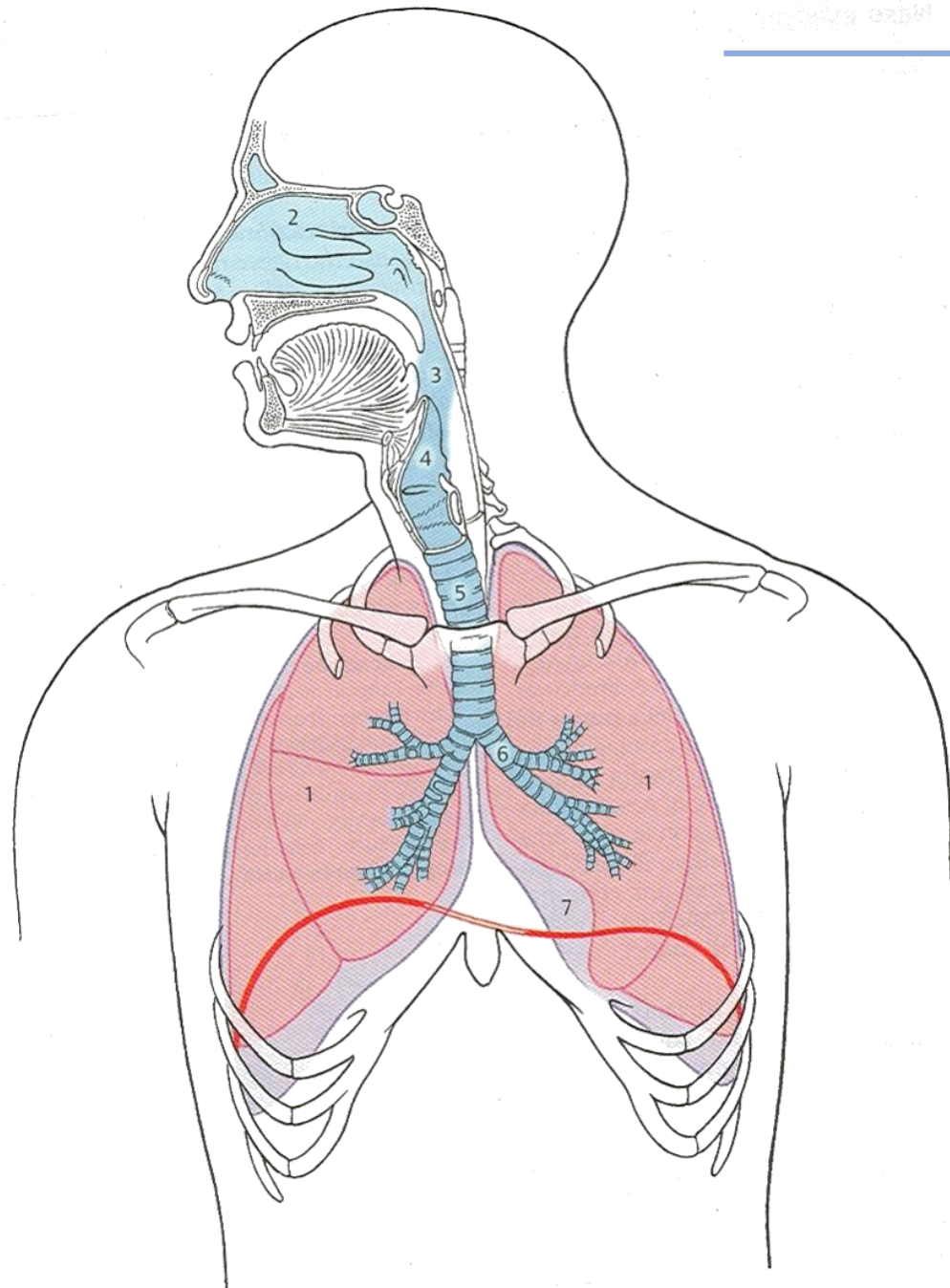
ANATOMY AND PHYSIOLOGY (C.I.)

HUMAN ANATOMY
(Mod. A)

THE RESPIRATORY SYSTEM

INTRODUCTION TO THE RESPIRATORY SYSTEM

INTRODUCTION TO THE RESPIRATORY SYSTEM



The figure schematically represents the anatomical components of the respiratory system

RESPIRATORY SYSTEM

↓
consists of organs that serve
to **BLOOD OXYGENATION (HEMATOSIS)**

The respiratory system allows the exchange of AIR between the environment and the lungs, which are the organs in which gas exchange (oxygen/carbon dioxide) occurs

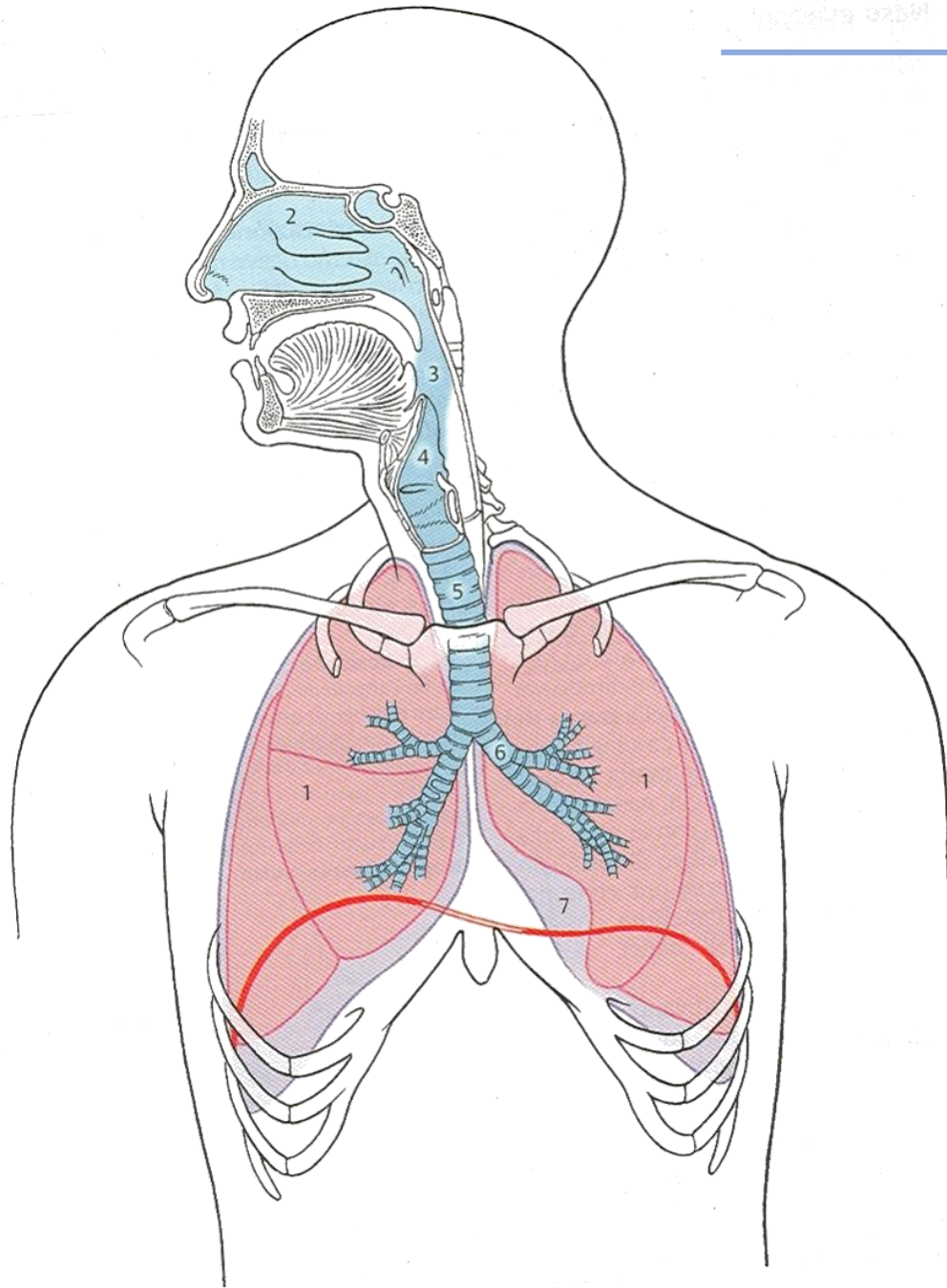
In particular, the air breathed in from the environment is rich in oxygen, which reaches the lungs

Blood poor in oxygen and rich in carbon dioxide reaches the lungs

The oxygen present in the lungs enters the blood

Carbon dioxide exits the blood, enters the air spaces of the lungs and will eventually be expelled/exhaled through the airways

RESPIRATORY SYSTEM



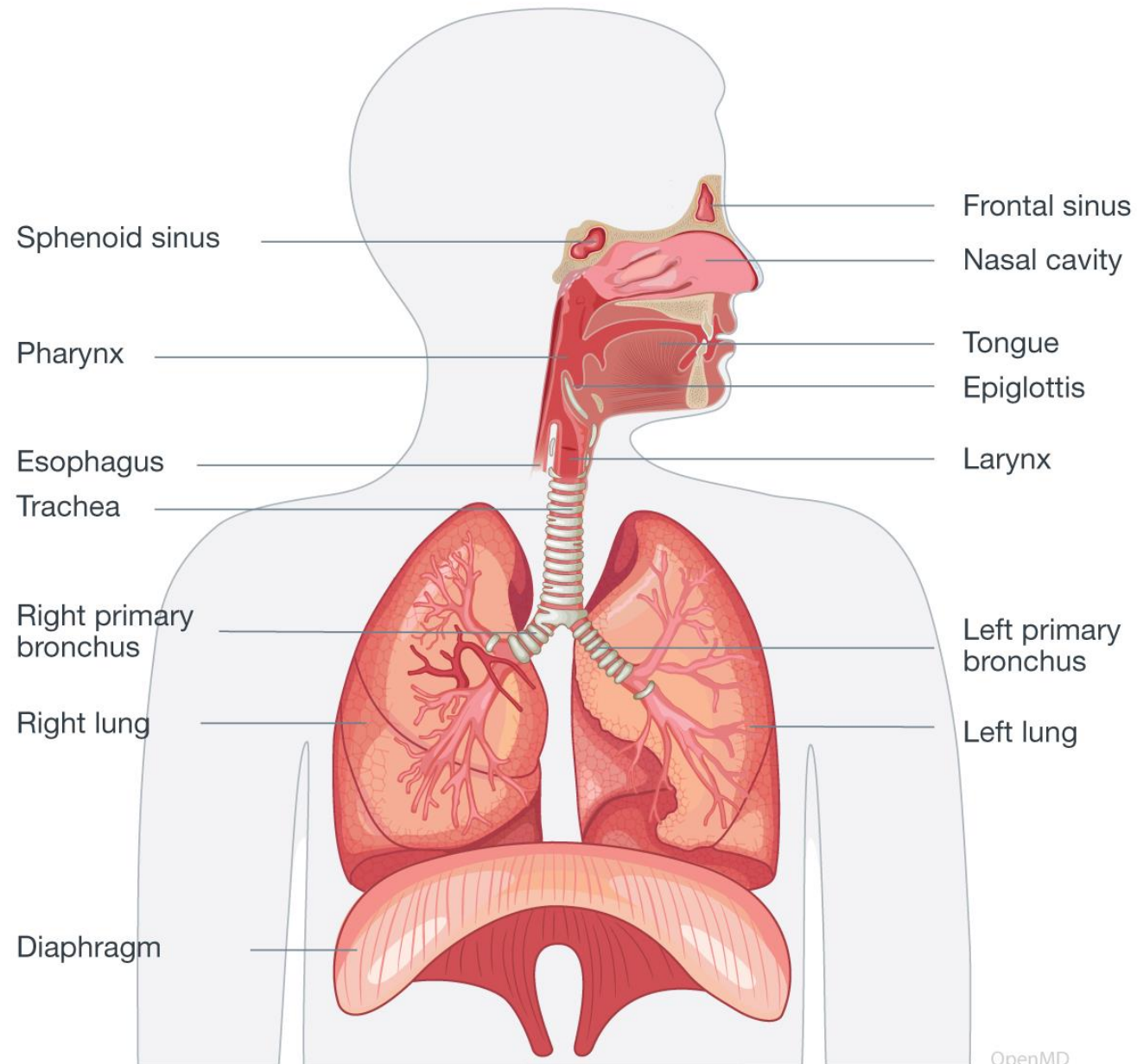
Its anatomical structures are:

1. LUNGS

AIRWAYS:

2. Nasal cavities
3. Pharynx
4. Larynx
5. Trachea
6. Bronchi (right bronchus and left bronchus)

RESPIRATORY SYSTEM



The **NASAL CAVITIES** communicate with the outside through the **NOSTRILS**

Posteriorly, the nasal cavities have orifices called **NASAL CHOANAE** (posterior nasal apertures), through which they communicate with a space located behind the nasal cavities and the oral cavity, which is the **PHARYNX**

The air passing through the pharynx enters the **LARYNX**, through which it enters the **TRACHEA**

The air travels along the trachea until it reaches, through the tracheal bifurcation, the two **BRONCHI**

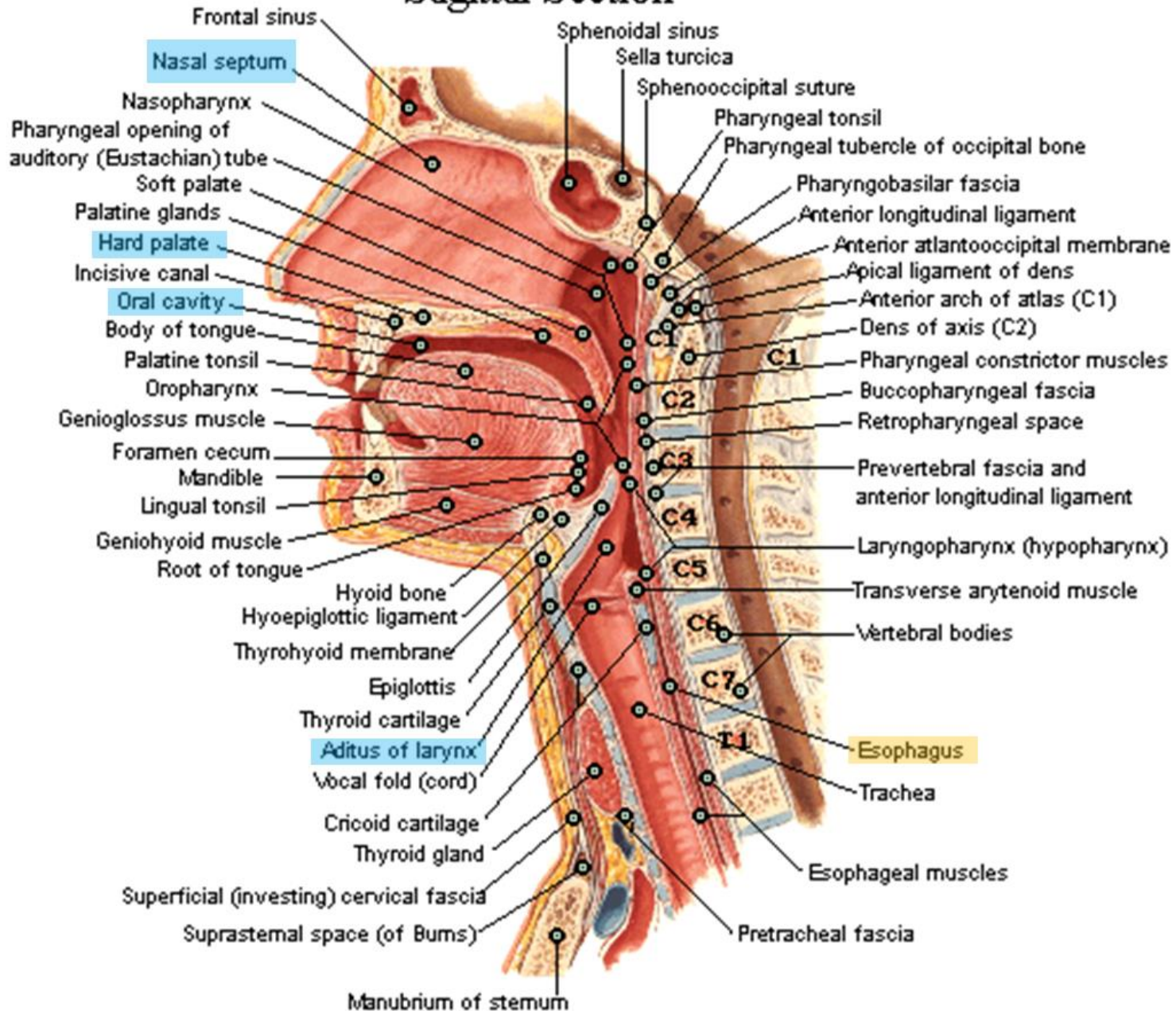
The main **RIGHT** and **LEFT bronchi** are divided into smaller **BRONCHIAL BRANCHES** called **INTRAPARENCHIMAL BRONCHI** because they enter the lung parenchyma

Finally, the **LUNGS** are the central organs of the respiratory system, where gas exchange between oxygen and carbon dioxide take place

PHARYNX

Pharynx

Sagittal Section



NASAL CAVITIES

- they are separated from each other by the nasal septum
- they are separated inferiorly from the oral cavity by the **HARD PALATE**
- they communicate posteriorly with the **PHARYNX**

PHARYNX

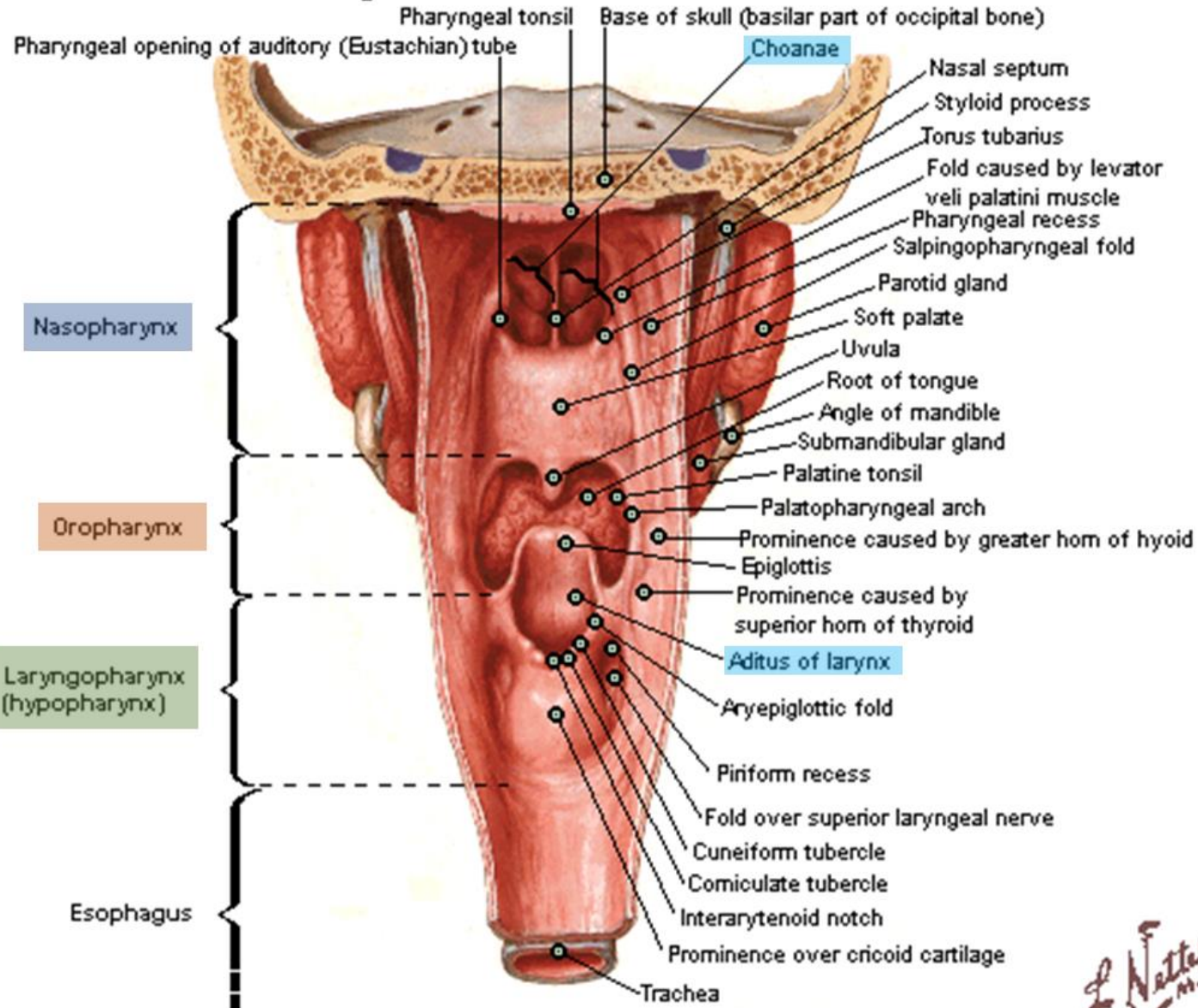
- it is located behind the nasal cavities, the oral cavity and the larynx
- it communicates with the aforementioned structures via the **nasal choanae**, the **oropharyngeal isthmus** or **isthmus of fauces** and the **aditus of larynx** (or laryngeal inlet)
- in the terminal portion, it is also connected with the esophagus

The pharynx carries:

- the **AIR**, that is inhaled, and which passes through the nasal cavities and the pharynx itself to arrive into the larynx and the other airways, towards the lungs;
- the **FOOD BOLUS** which, introduced into the oral cavity, is pushed posteriorly, enters the pharynx through the oropharyngeal isthmus and from here descends into the esophagus

Pharynx

Opened Posterior View



The ANTERIOR WALL is actually made up of 3 communications:

- the 2 nasal choanae
- the oropharyngeal isthmus or isthmus of fauces
- the aditus of larynx

Below it continues with the esophagus

The 3 PORTIONS of the PHARYNX which are located behind the nasal cavity, behind the oral cavity and behind the larynx have different names:

NASOPHARYNX

behind the nasal cavities

OROPHARYNX

behind the oral cavity

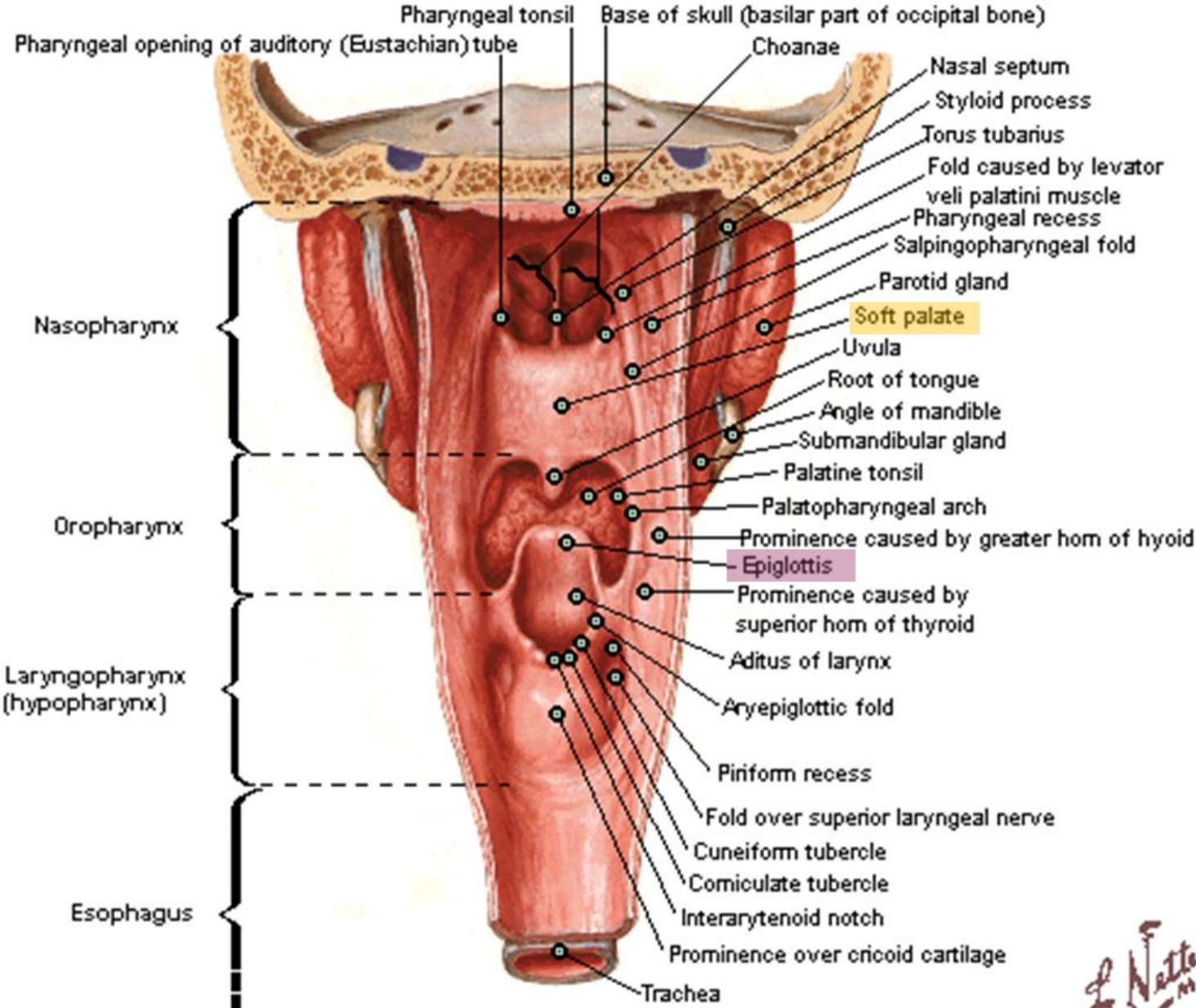
LARYNGOPHARYNX or HYPOPHARYNX

behind the larynx

Pharynx

PHARYNX

Opened Posterior View



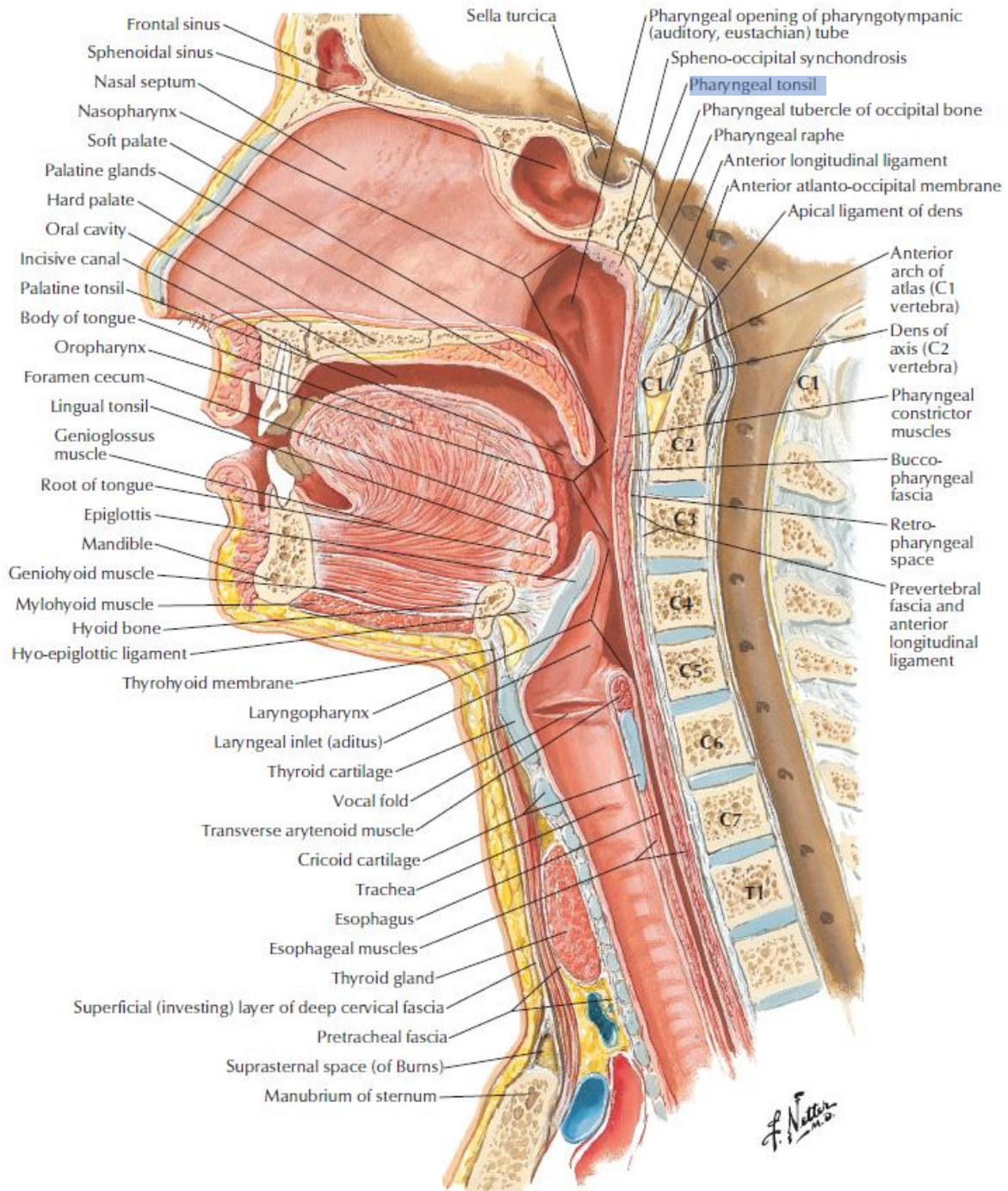
During SWALLOWING (i.e., deglutition), there are 2 safety structures:

1. the **SOFT PALATE**

which is the posterior muscular-mucosal continuation of the hard palate. The soft palate rises when the food bolus passes and separates the nasopharynx from the oropharynx, so food won't go up to the nasal cavity

2. the **EPIGLOTTIS**

which drops downward and closes the laryngeal opening to prevent the food bolus from entering the laryngeal cavity



An aggregate of lymphoid reticular tissue similar to a lymph node lies at the superior portion of the nasopharynx. It is called the

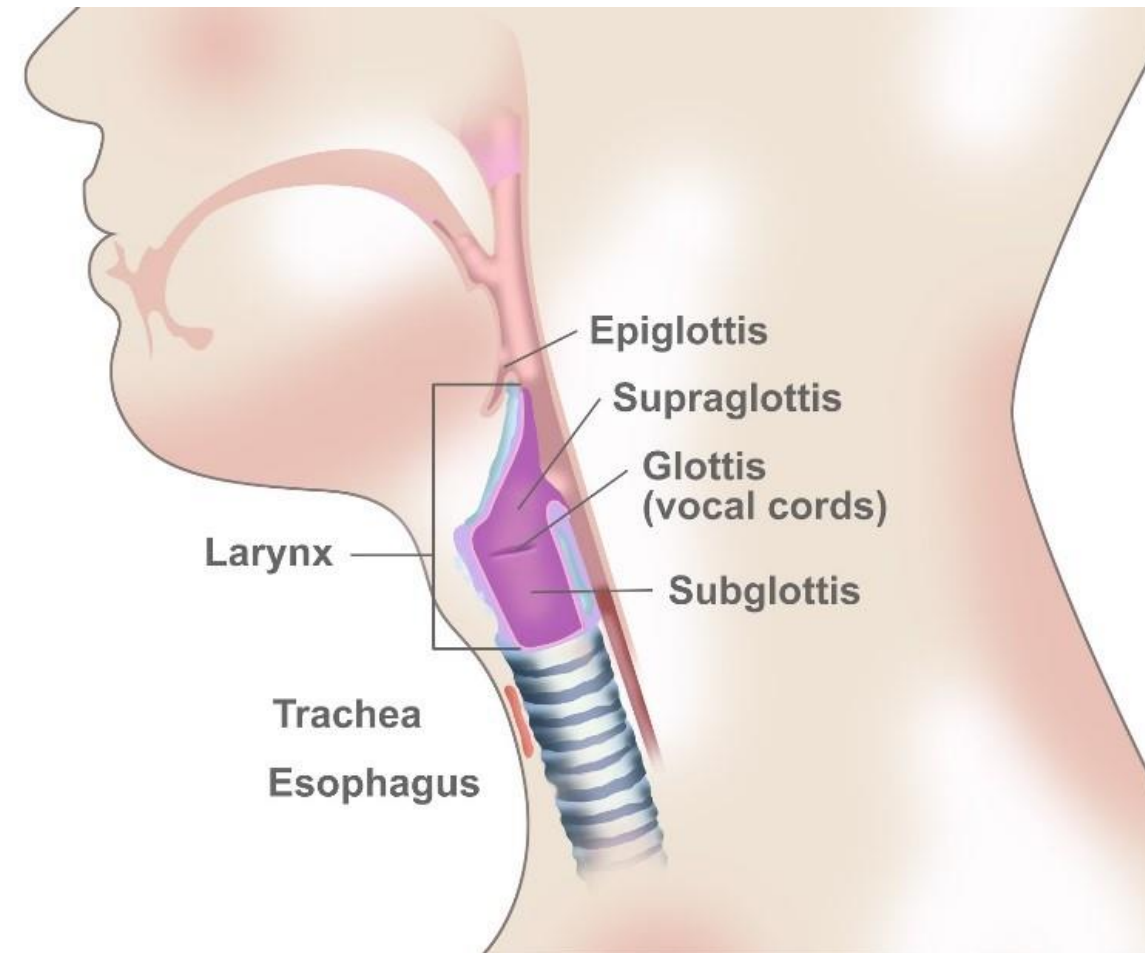
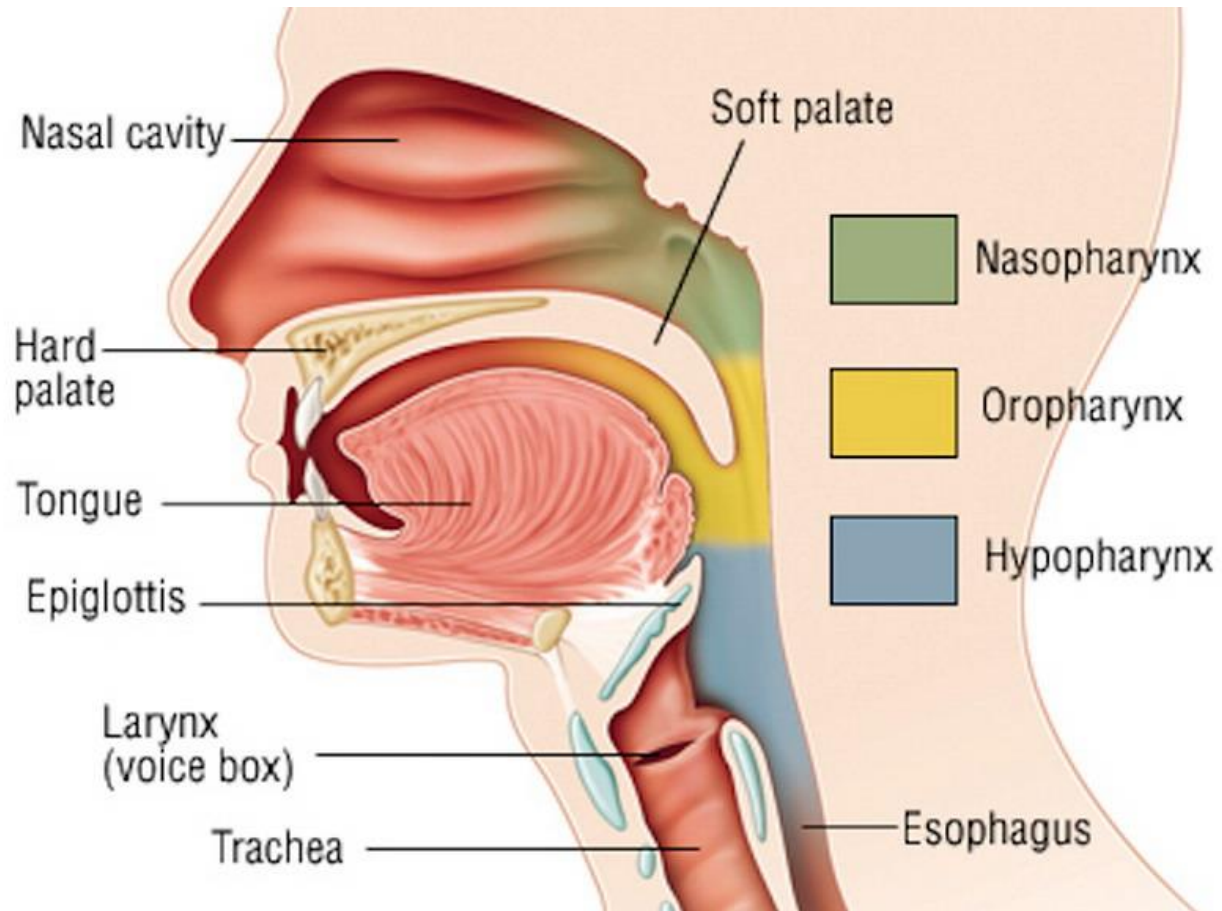
PHARYNGEAL TONSIL



also called the ADENOID

The function of the pharyngeal tonsil is not well understood, but it contains a rich supply of lymphocytes and is covered with ciliated epithelium that traps and destroys invading pathogens that enter during inhalation.

LARYNX

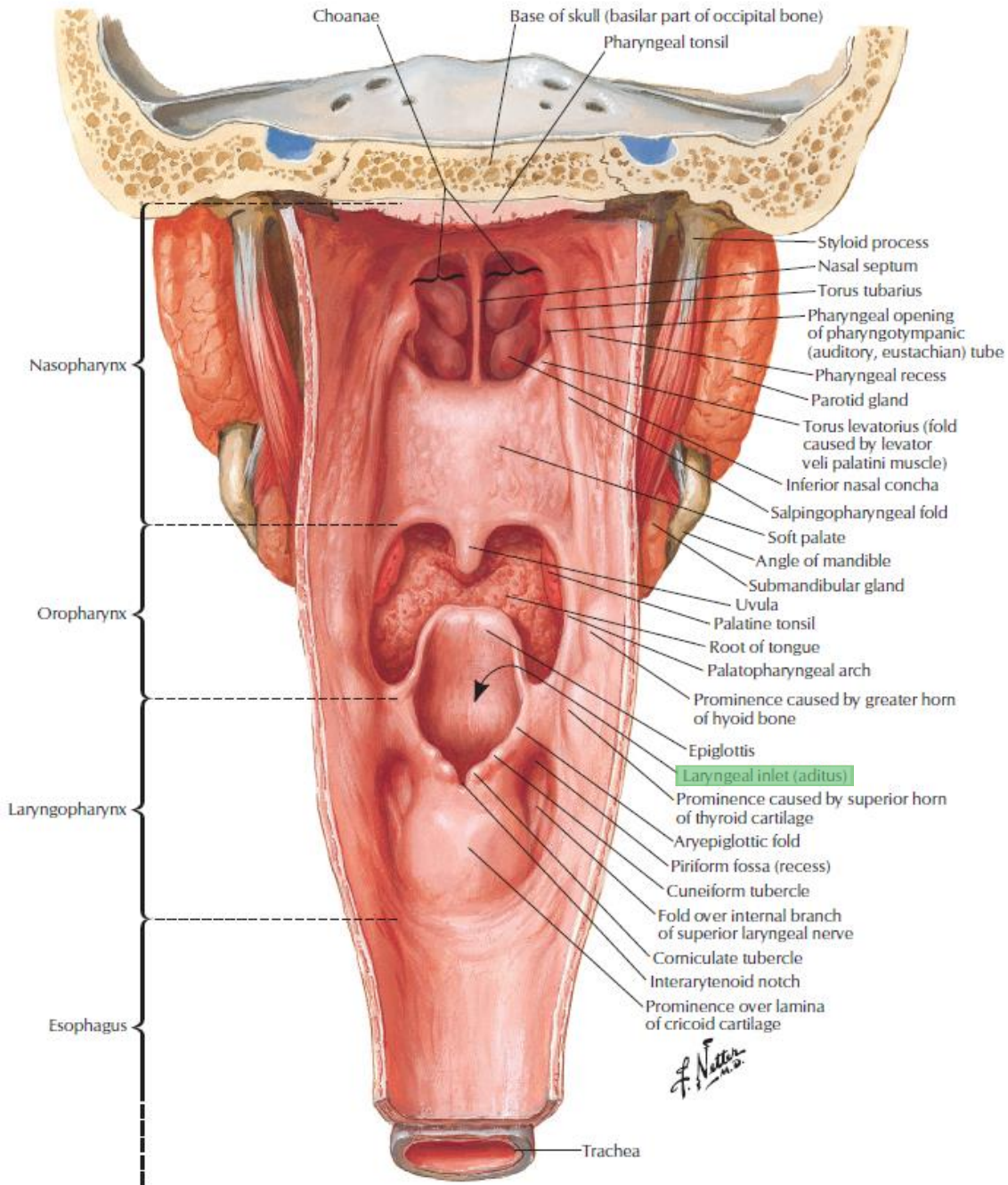


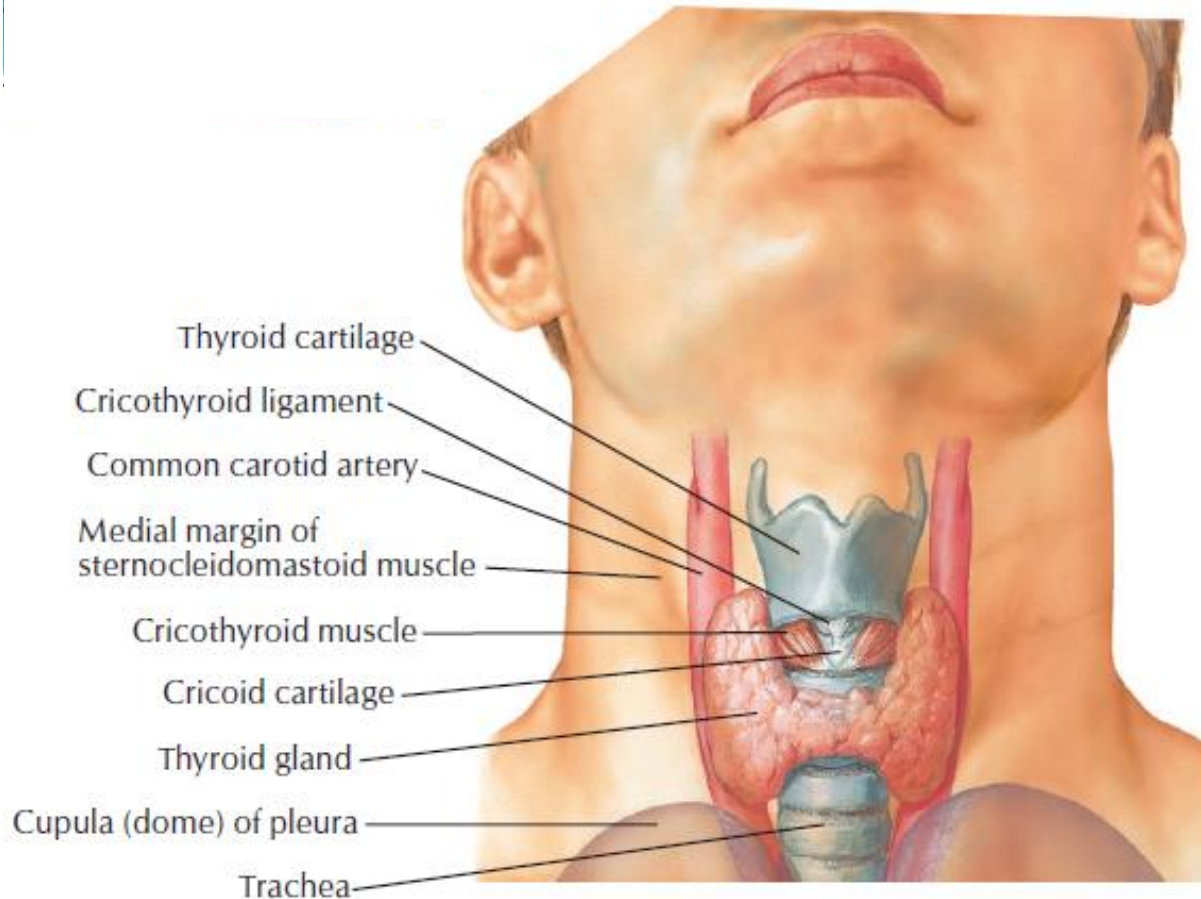
It is the airway that communicates with the **HYPOPHARYNX** (lowest portion of the pharynx) and continues downwards with the **TRACHEA** = *the laryngeal cavity continues downwards with the tracheal lumen*

THE LARYNX

Posterior view:
(from the pharynx)

The access to the laryngeal cavity is identifiable → **ADITUS OF LARYNX** or **LARYNGEAL INLET**





The larynx is an **anatomical structure of the neck** located rather superficially and made up of:

CARTILAGES IN SUPERFICIAL POSITION
that can be touched and seen externally

(especially in men where the **laryngeal prominence** within the thyroid cartilage constitutes the so called “Adam's apple”

THE LARYNX

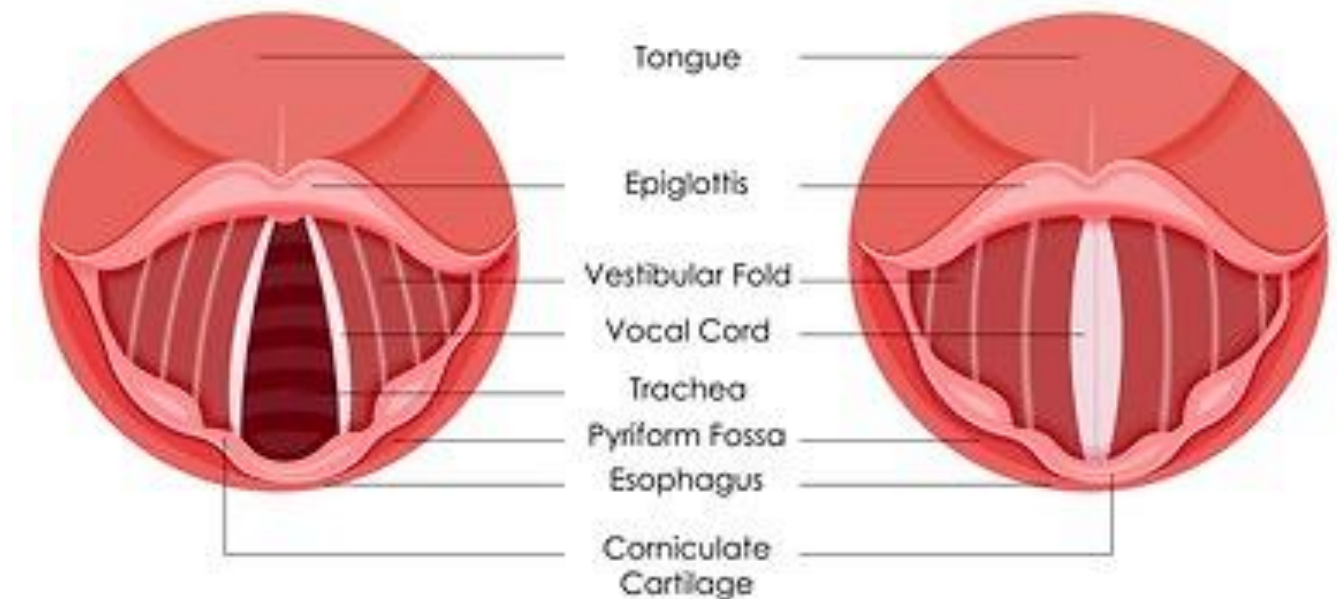
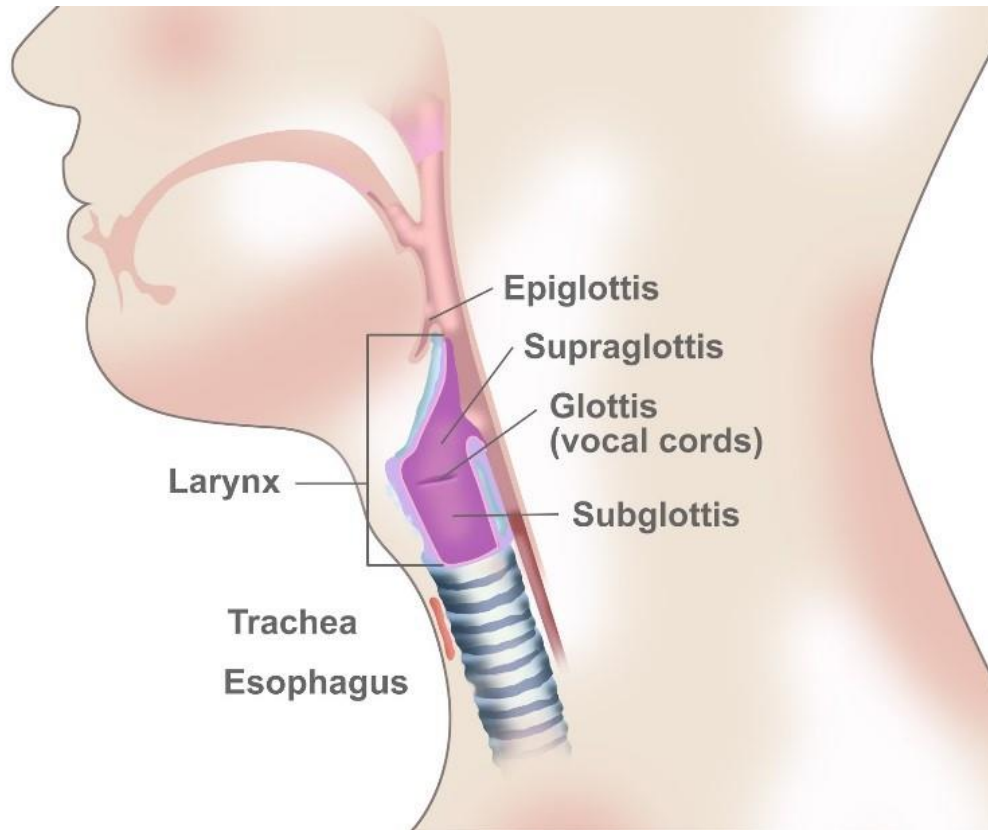
- FUNCTIONS -

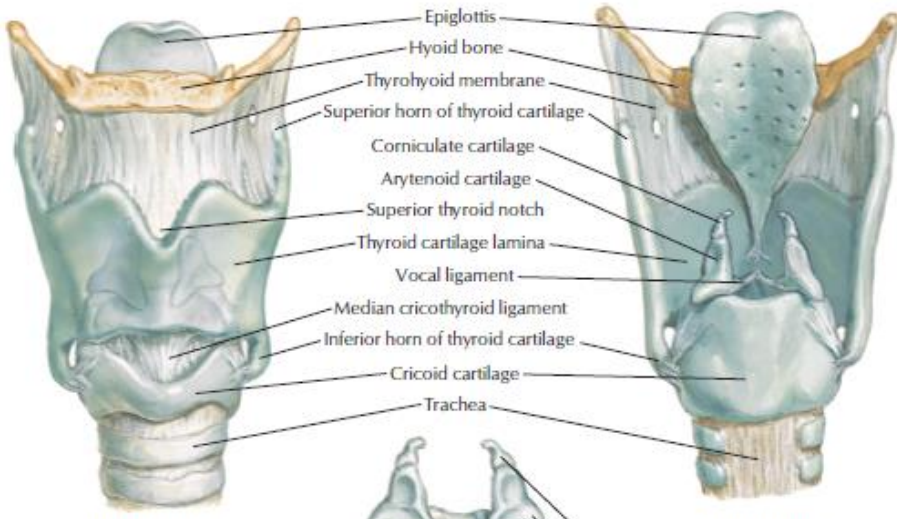
1. **To carry the air** entered from the nasal cavity towards the lungs
This function is shared with all other airway structures

2. **PHONATION**

Vocal cords are found within the larynx, which so it is involved in sounds production

This is its peculiar function!



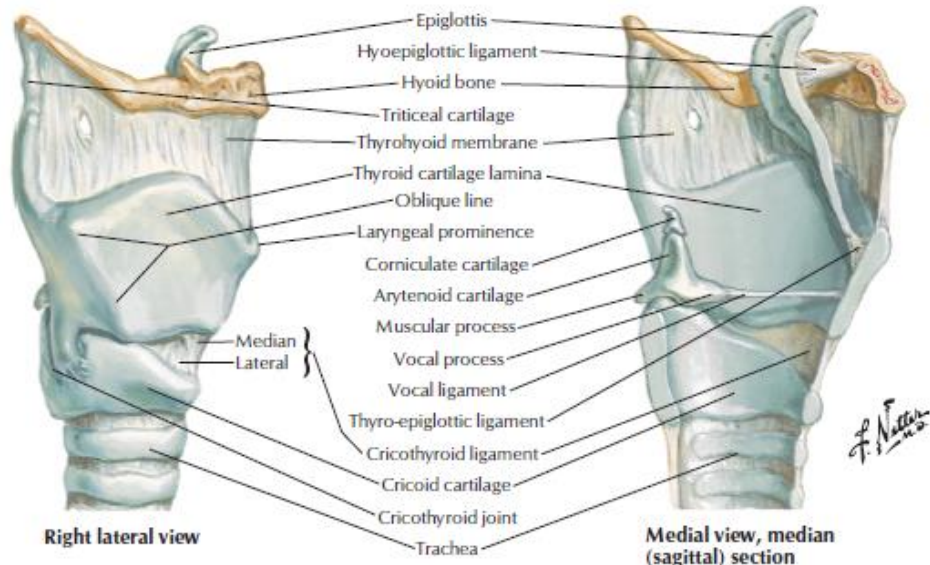


Anterior view

Posterior view



Anterosuperior view



Right lateral view

Medial view, median (sagittal) section

THE LARYNX - STRUCTURE -

- CARTILAGE SKELETON:** it is the main structure of the larynx
- INTRINSIC MUSCLES OF LARYNX:** they insert into the cartilage structures and mediate their movements
- ELASTIC MEMBRANES**
- INTERNAL MUCOSAL LINING** (i.e., internal mucosal membranes): it delimits/covers the laryngeal cavity



IT IS NOT PART OF THE LARYNX
BUT IS STRICTLY RELATED TO IT



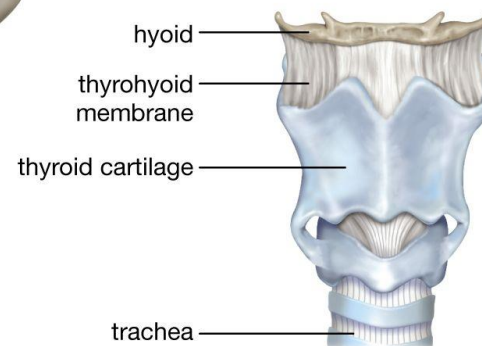
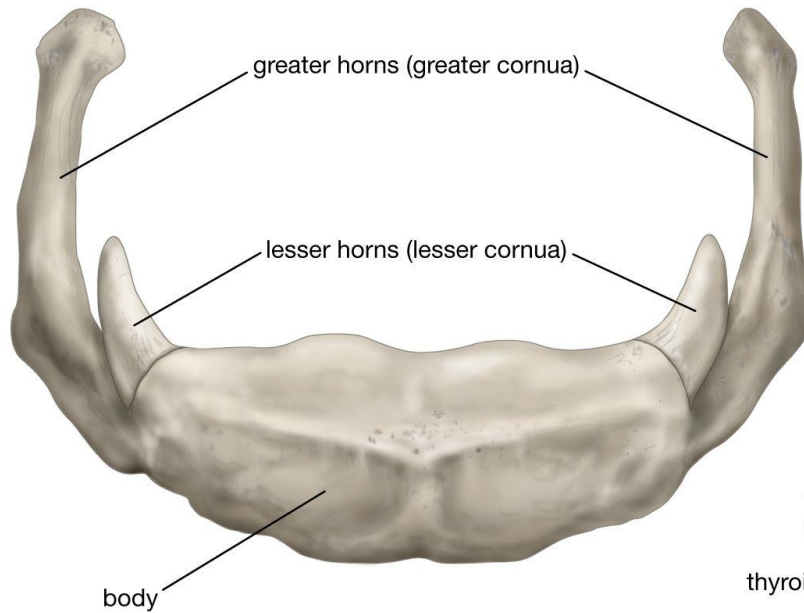
HYOID BONE

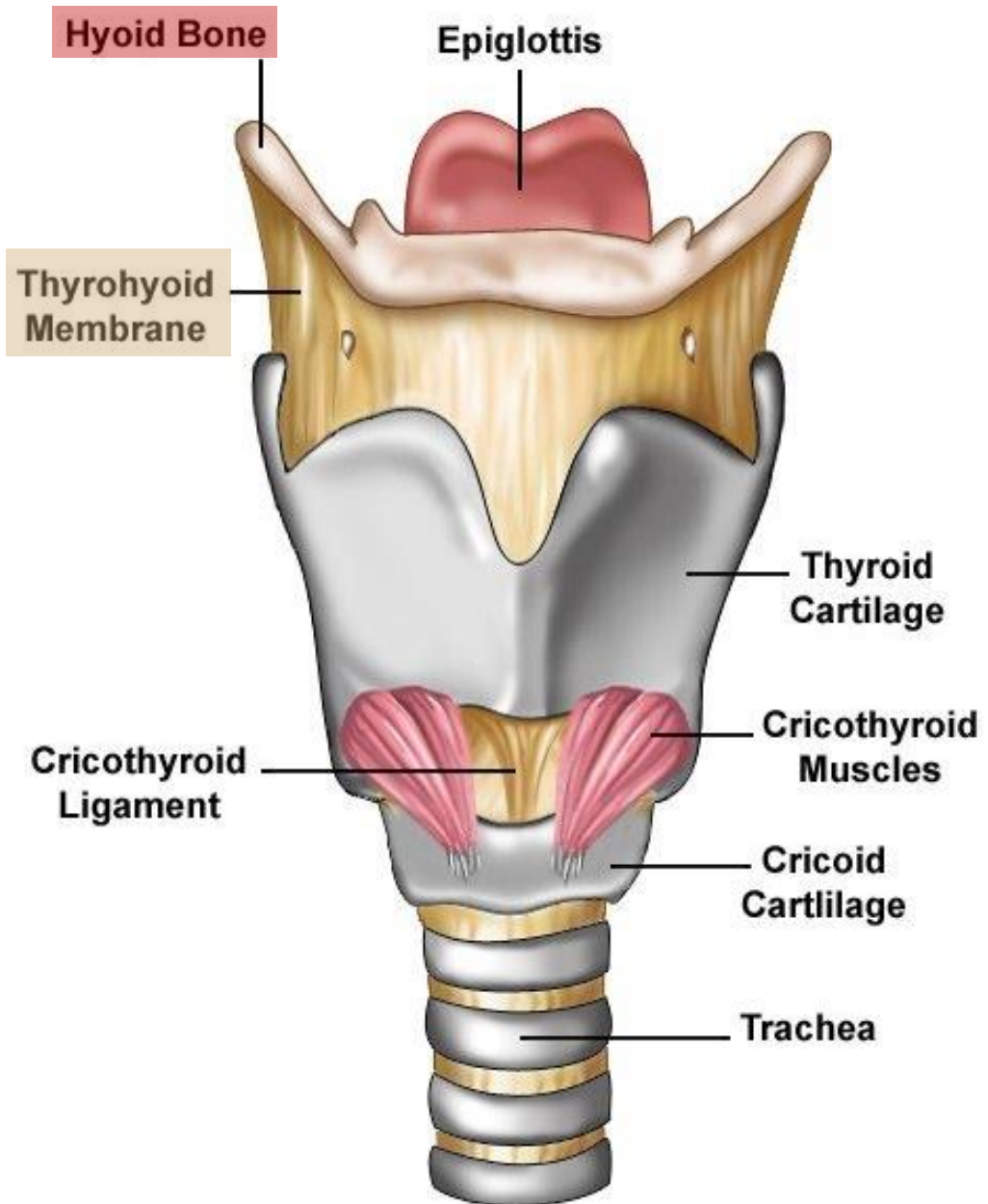
It is one of the rare bones that is not directly articulated with another bone, but is connected to other structures through muscles and ligaments

It consists of a **BODY** which extends bilaterally and upwards with:

- a) the **GREATER HORN**
- b) the **LESSER HORN**

Human hyoid bone



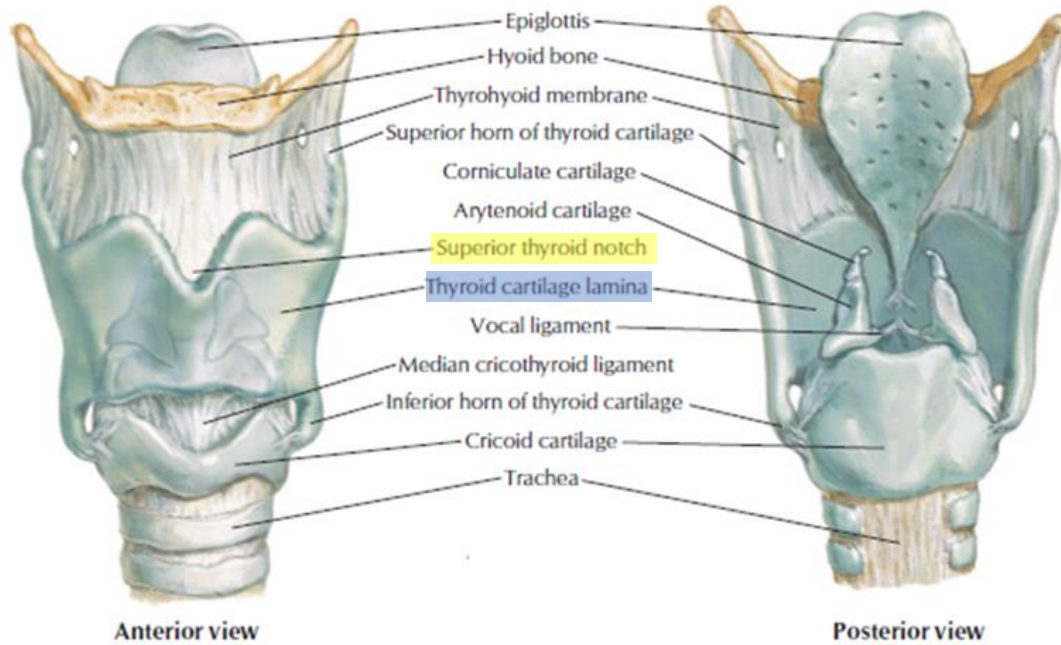


IT IS NOT PART OF THE LARYNX
BUT IS STRICTLY RELATED TO IT

▼
HYOID BONE

It is connected to the thyroid cartilage of the larynx through a
CONNECTIVE MEMBRANE

▼
THYROHYOID MEMBRANE

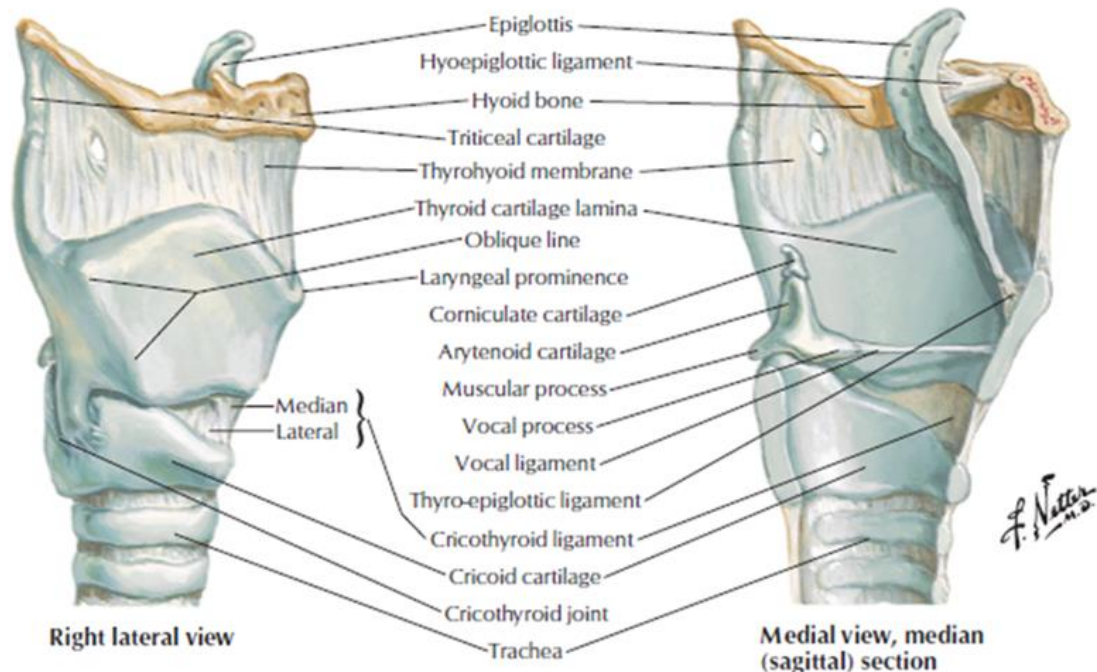


a) THYROID CARTILAGE

it is made up of two **CARTILAGINE LAMINAE** which are not parallel, but converge and fuse with each other on the anterior side; being connected on the front side, they delimit an open space on the posterior side

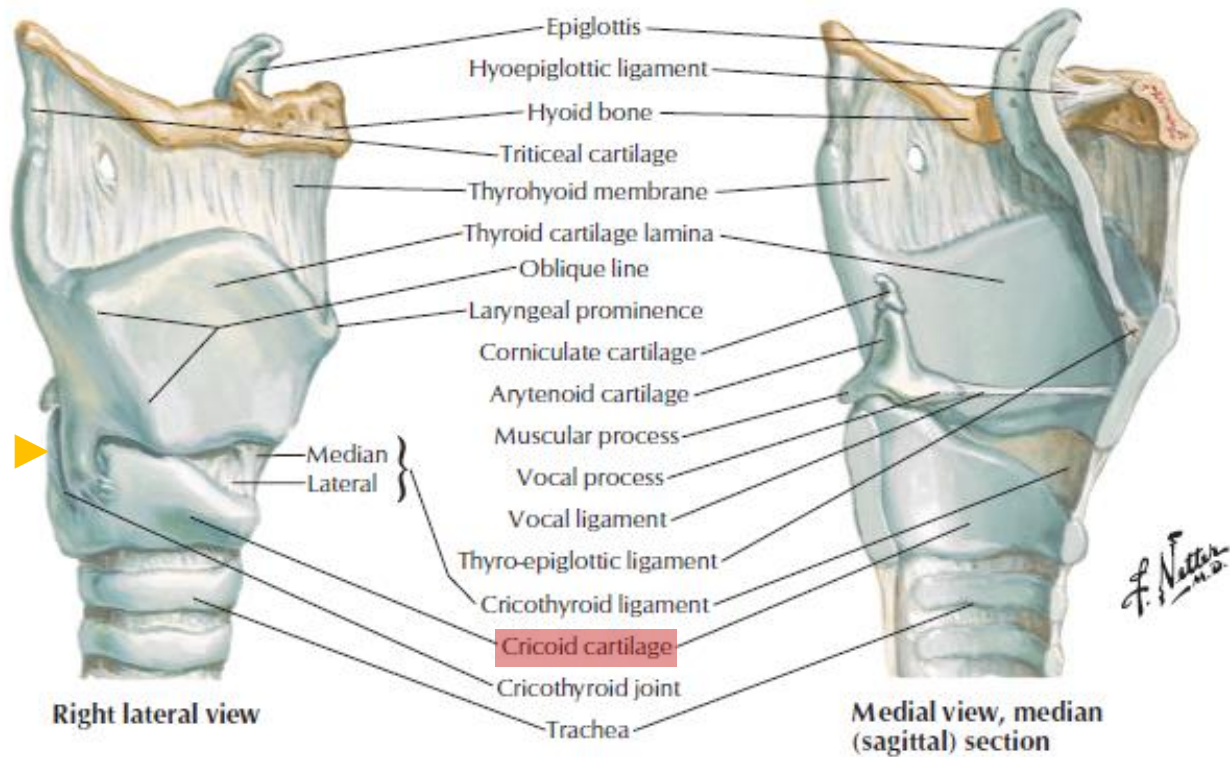
The **profile of the lower margin** of the thyroid cartilage is relatively **linear**;

The **upper margin** has a wavy profile; in each plate we distinguish a profile **with convexity directed upwards**.



Medially, the **SUPERIOR THYROID NOTCH** is present, which is given by the upper margin of the two laminae which on the anterior side deepens into the notch.

The thyroid notch is the most protruding portion of the thyroid cartilage, the most evident, and gives the "Adam's apple"

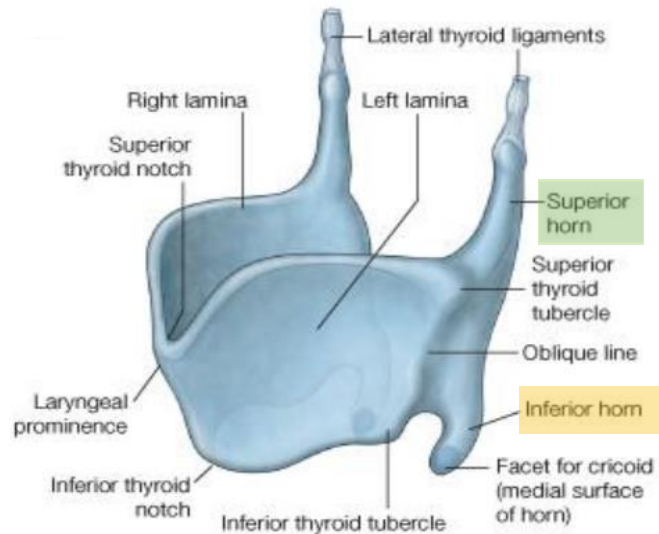


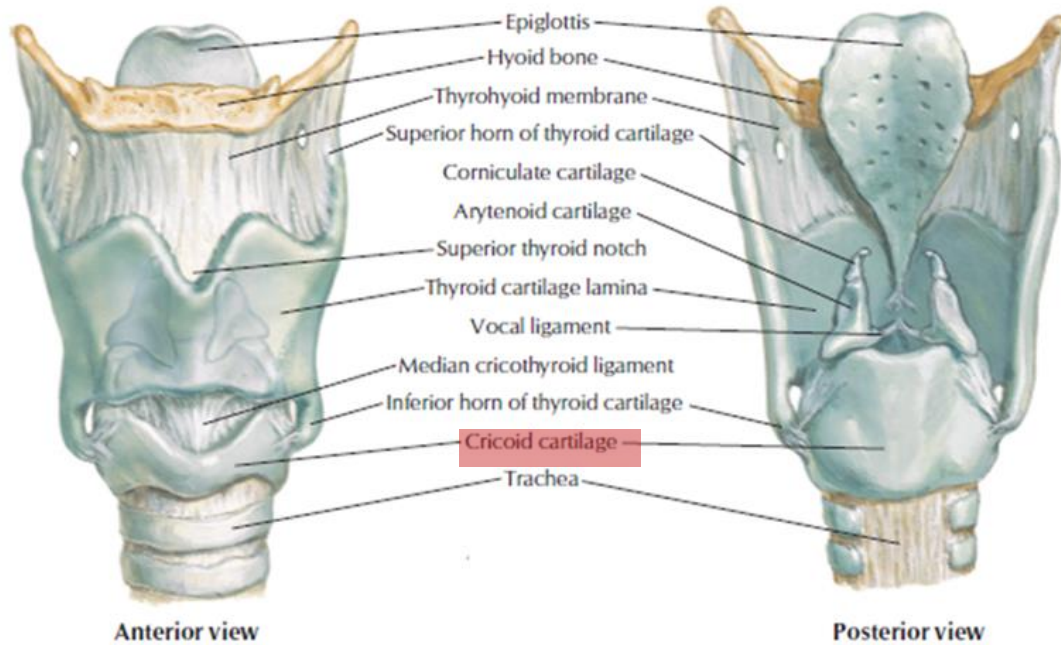
a) THYROID CARTILAGE

The posterior margin of each lamina extends:

- upwards, with the **SUPERIOR HORN of the thyroid cartilage**
- downwards, with the **INFERIOR HORN of the thyroid cartilage**

The two inferior horns of the thyroid cartilage articulate with the cartilage structure which is located immediately below and which is called **CRICOID CARTILAGE**





b) CRICOID CARTILAGE

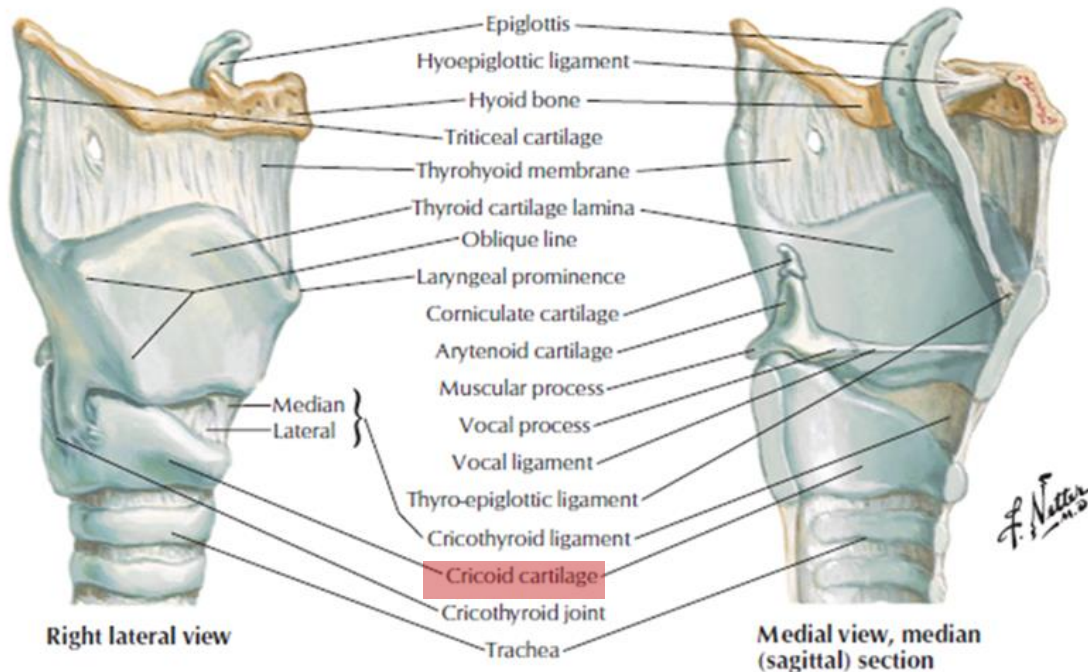
It is a complete, circumferential cartilaginous ring that presents a **much greater height on the posterior side**

On the posterior side, the **LAMINA OF THE CRICOID CARTILAGE** is recognizable, with a bigger height

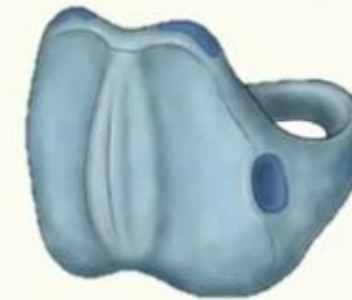
As we proceed anteriorly, the height of the cricoid cartilage decreases, therefore on the anterior side it is much less high



To describe the morphology of the cricoid cartilage it is compared to a SIGNET RING



- Inferior-most laryngeal cartilage



Posterior View

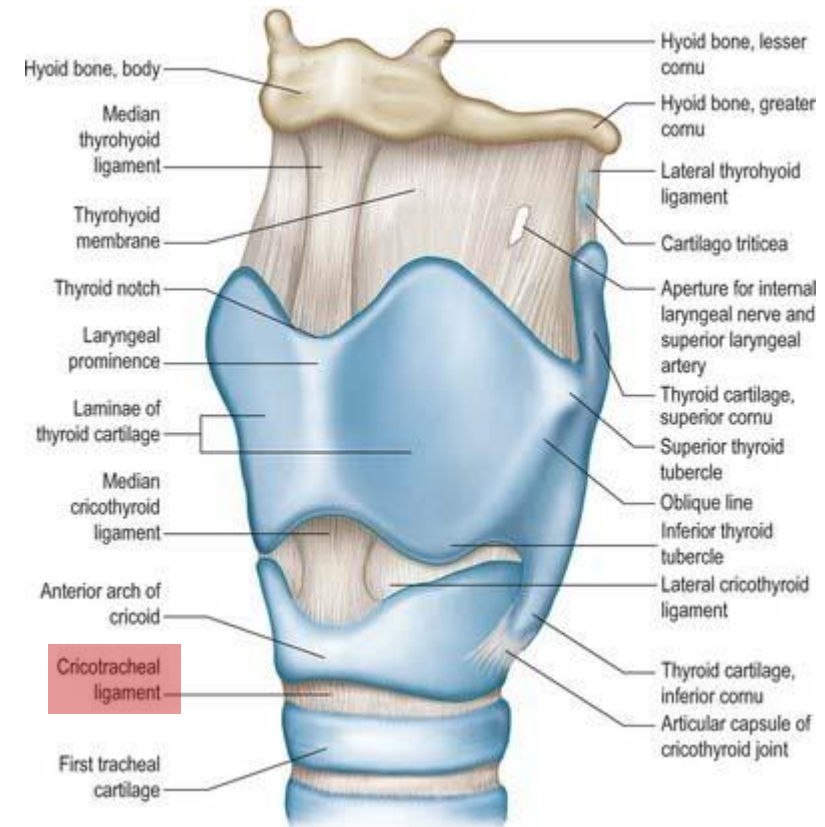
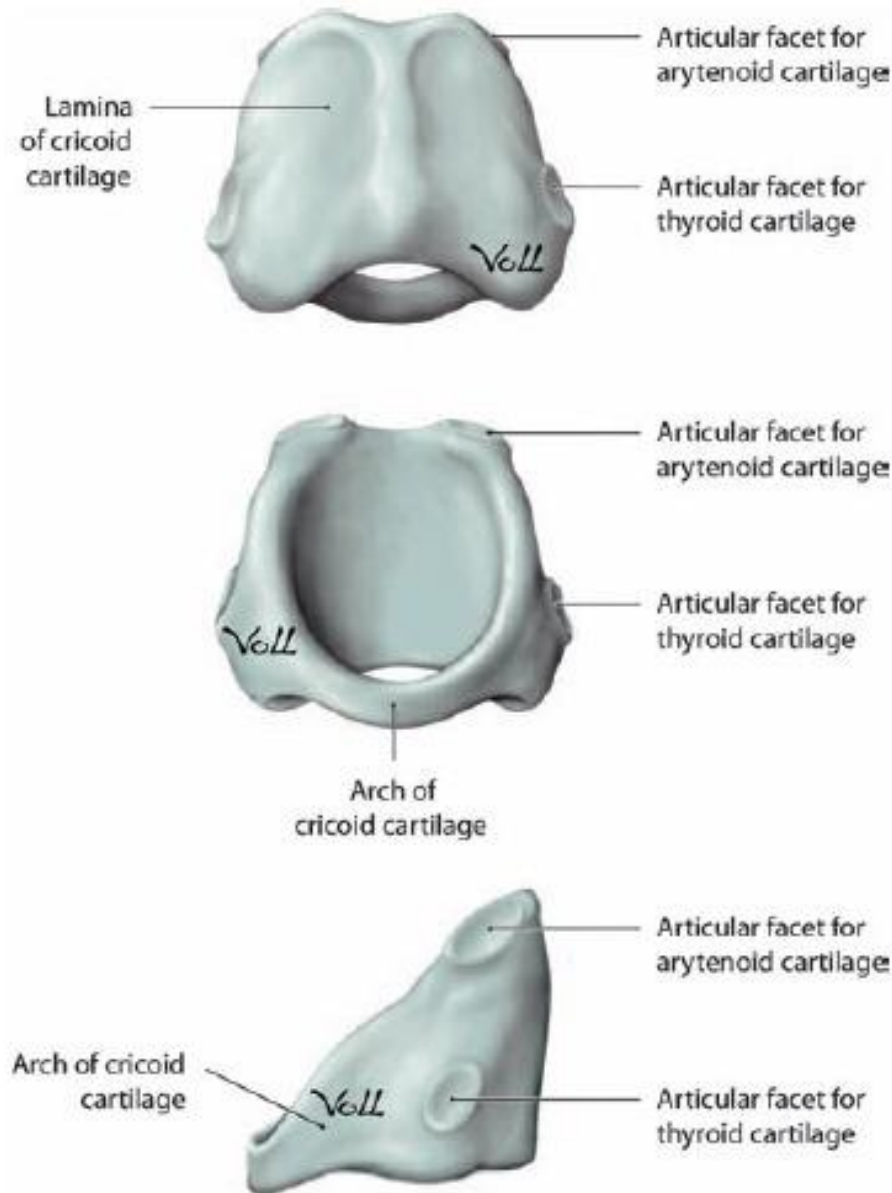


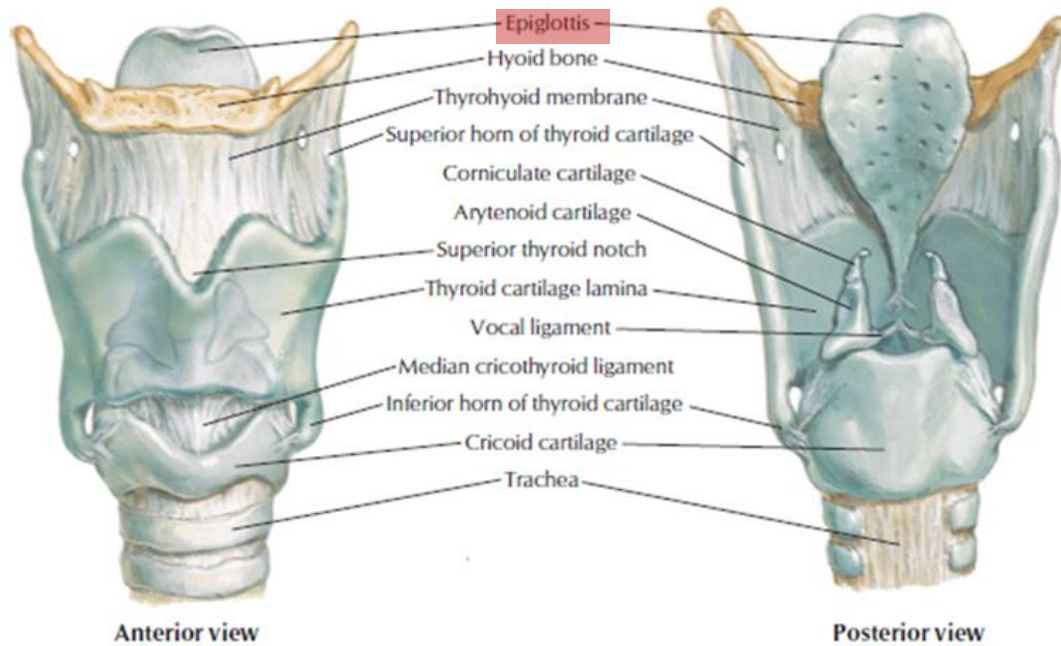
b) CRICOID CARTILAGE

The right and left inferior horns of the thyroid cartilage articulate on the posterolateral side of the cricoid cartilage

The cricoid cartilage is connected inferiorly with the first TRACHEAL RINGS through CRICOTRACHEAL LIGAMENT

(Tracheal rings: they are incomplete on the posterior side!)





c) EPIGLOTTIS

It has the shape of a LEAF with the narrowest portion directed downwards and forwards. This portion connects with the thyroid cartilage of the larynx on the posterior side of confluence line of the two laminae

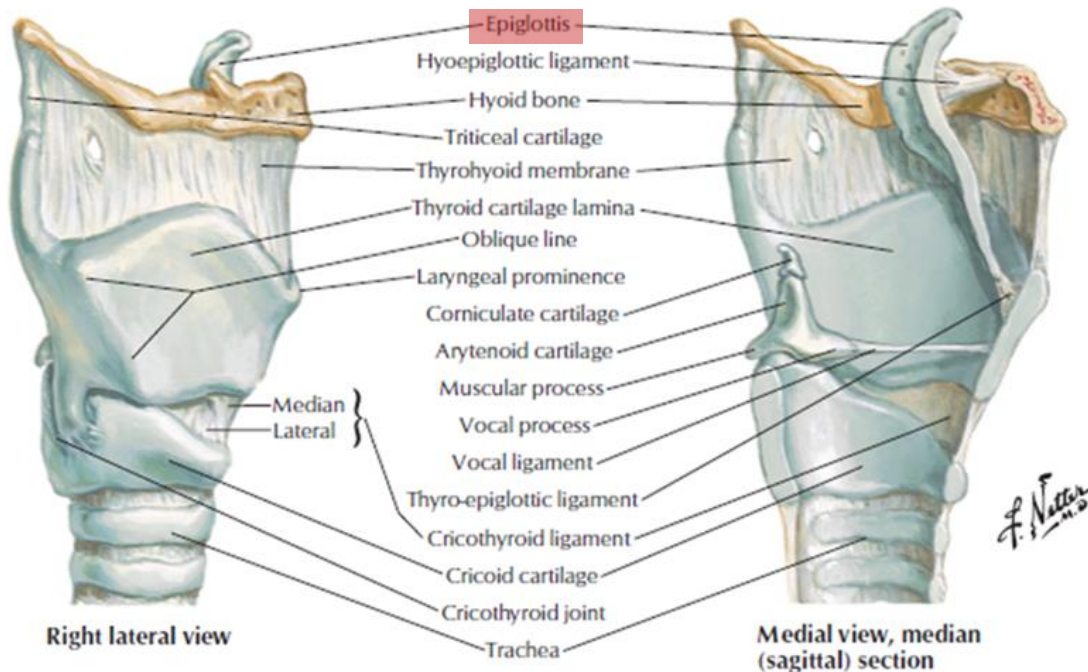
The connection is not a true joint!



it is mediated by a short, very elastic ligament which is called
THYRO-EPIGLOTTIC LIGAMENT

It assures for maximum elasticity and the possibility of dropping downward the epiglottis

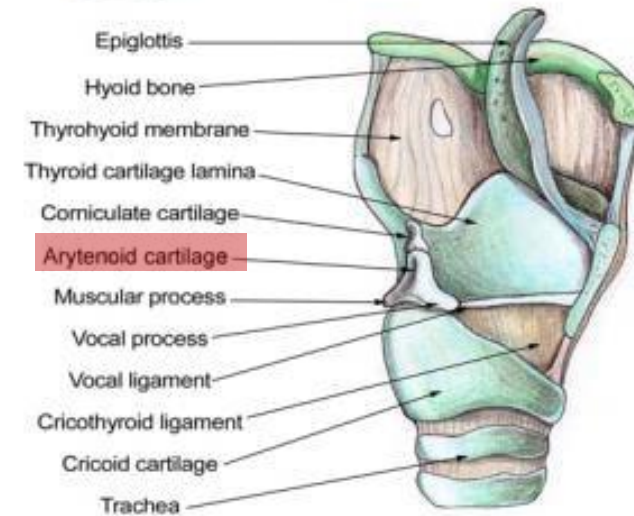
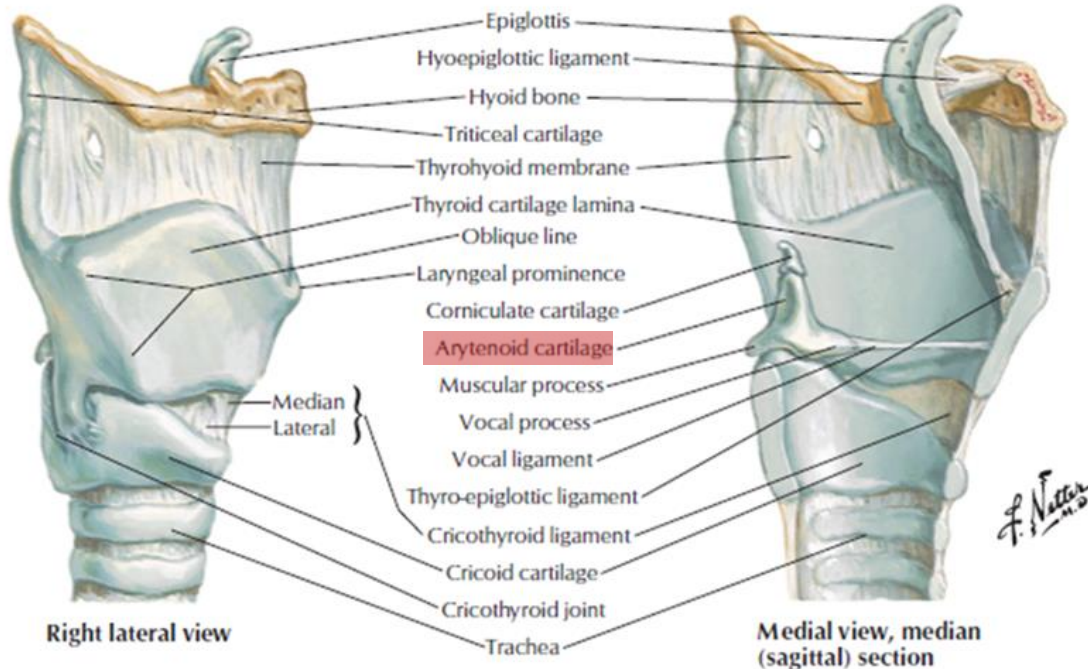
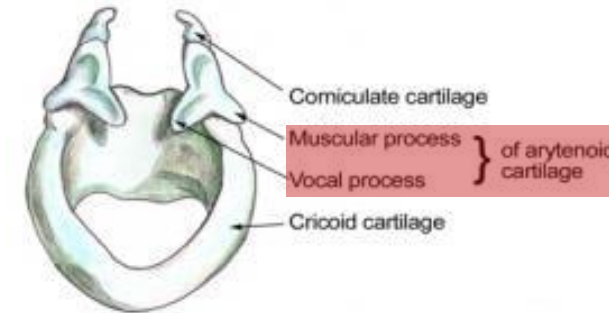
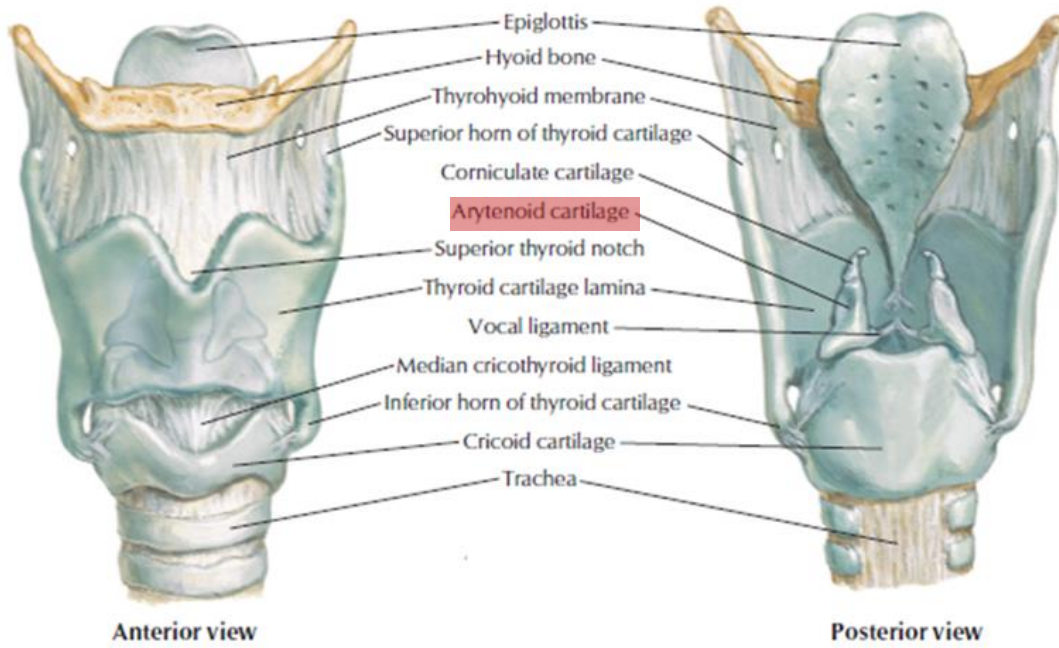
On the posterior side there are depressions which are given by GLANDS present in the submucosa and which imprint the posterior surface of the epiglottis

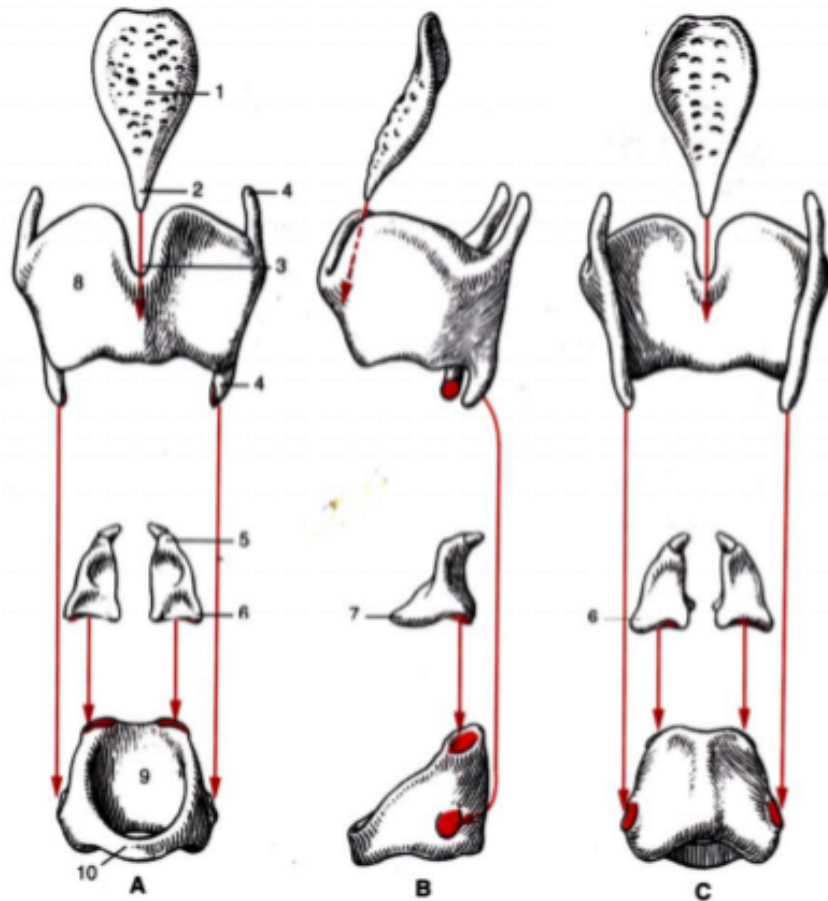


d) ARYTENOID CARTILAGES

They are **ARTICULATED** (i.e., connected with joints) on the upper margin of the cricoid cartilage lamina

They have a **PYRAMIDAL** shape with a **TRIANGULAR BASE**





A. Anterior View
 B. Lateral View
 C. Posterior view

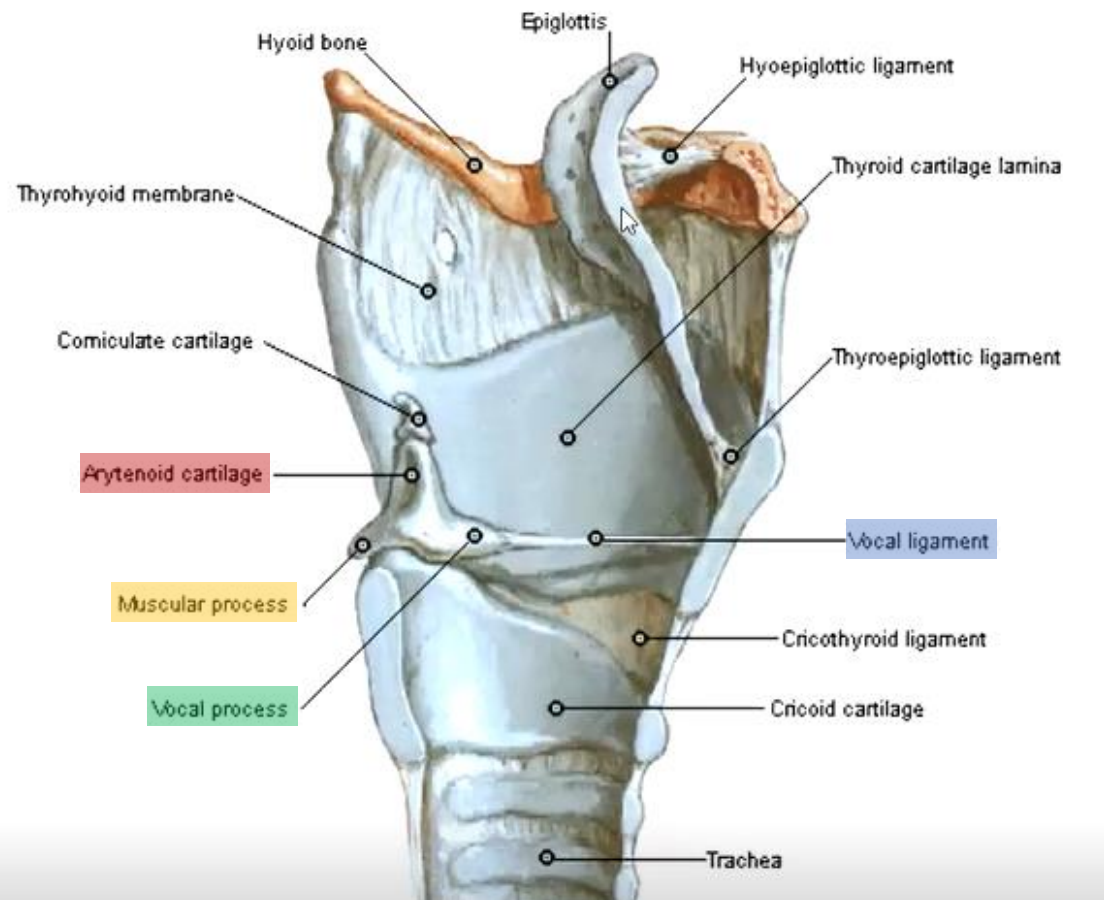
d) ARYTENOID CARTILAGES

They have a **PYRAMIDAL** shape with a **TRIANGULAR BASE**

That is, they have a PYRAMIDAL SHAPE, with:

- a larger lower surface which is considered the **BASE** of the pyramid
- a narrower upper portion, which corresponds to the **APEX** of the arytenoid
- **3 SURFACES**, which give them the appearance of a triangular pyramid
 - ↓
 - **POSTERIOR SURFACE**
 - **ANTERO-MEDIAL SURFACE**
 - **ANTERO-LATERAL SURFACE**

Cartilages of Larynx Sagittal Section



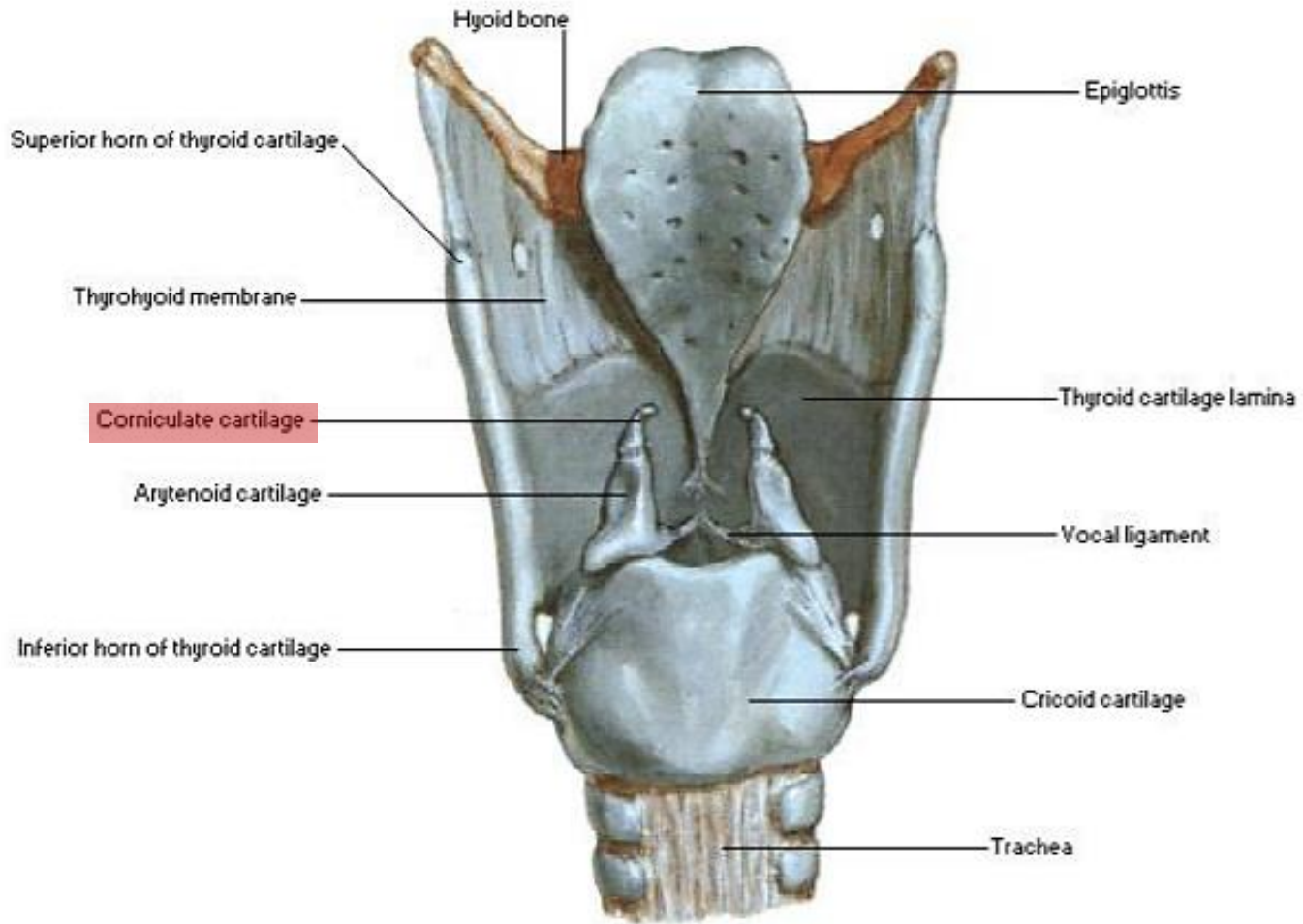
d) ARYTENOID CARTILAGES

The base is formed by 2 cartilagineous processes:

1. the **MUSCULAR PROCESS**, which is directed posteriorly and laterally
2. the **VOCAL PROCESS**, directed anteriorly, which is named after the **VOCAL LIGAMENT** that extends forward starting from this process

- The vocal ligament inserts on the posterior side of the the thyroid cartilage, at the convergence of the two laminae
- This ligament represents the **supporting structure of the vocal cords**, and it is covered by a mucosa which does not allow the ligament itself to be seen directly
- Deep within the vocal ligament the **VOCAL MUSCLE** is present

Posterior View



e) CORNICULATE CARTILAGES

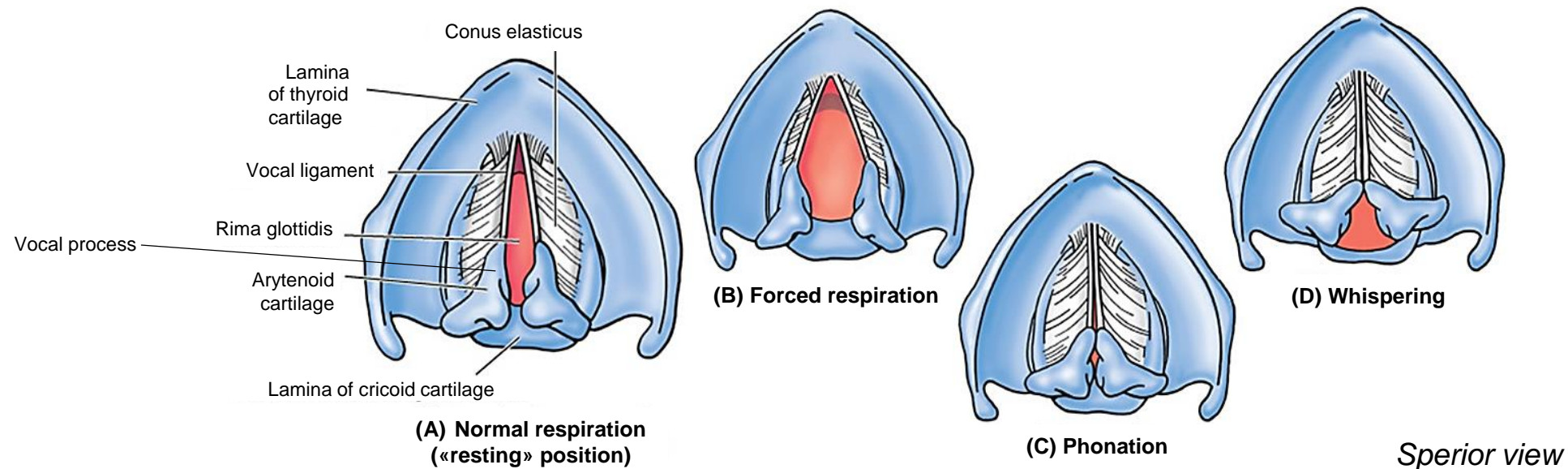
It is a small cartilage located on the apex of each arytenoid cartilage

ARYTENOID CARTILAGE: functional meaning

The arytenoid cartilages have an important functional significance with respect to the functionality of the vocal cords and vocal ligaments

The vocal cords and vocal ligaments produce sounds by vibrating when air passes through the space between the two vocal cords
 → *RIMA GLOTTIDIS: space between the two vocal ligaments and the two arytenoid cartilages*

When air passes through the rima glottides it causes the vocal cords to vibrate



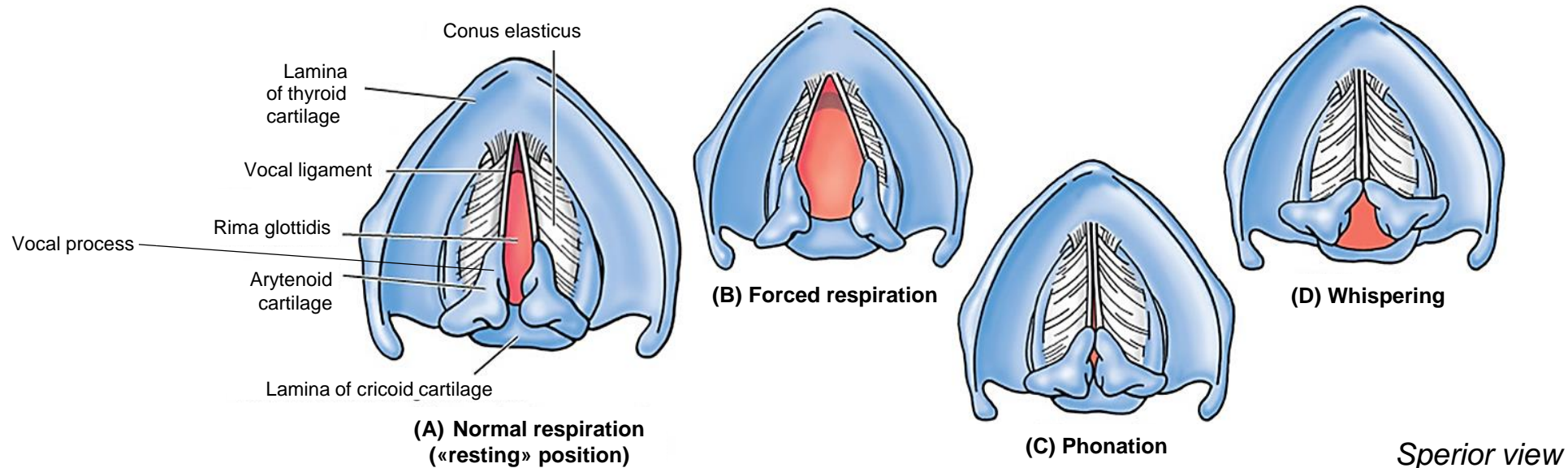
ARYTENOID CARTILAGE: functional meaning

Situation changes depending on the functional state

During RESPIRATION, air must pass through the rima glottidis (which is the narrowest point of the larynx), so there must be space between the vocal cords

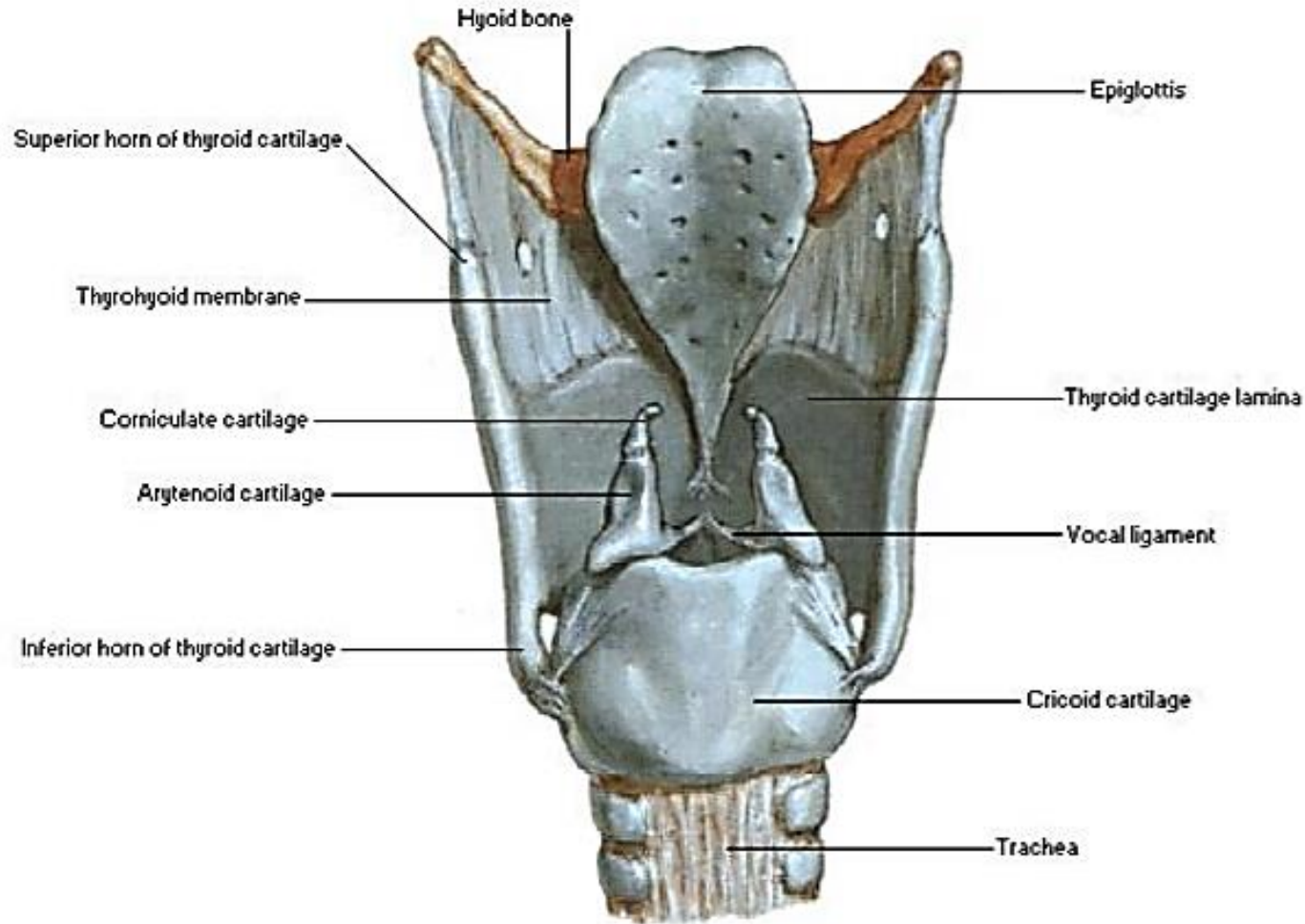
During forced respiration a higher amount of air needs to pass through the rima glottidis, so the vocal cords must be even more far from each other

During PHONATION, vocal cords need to be close to each other, so that the air passes in a very narrow space (rima glottidis) making the cords vibrate and causing sound production



Superior view

Posterior View



Vocal cords get closer or far thanks to

MOVEMENTS of the TWO ARYTENOID CARTILAGES on their cranio-caudal or vertical axis

These movements are produced by INTRINSIC MUSCLES of larynx that insert onto the MUSCLE PROCESSES of the arytenoids

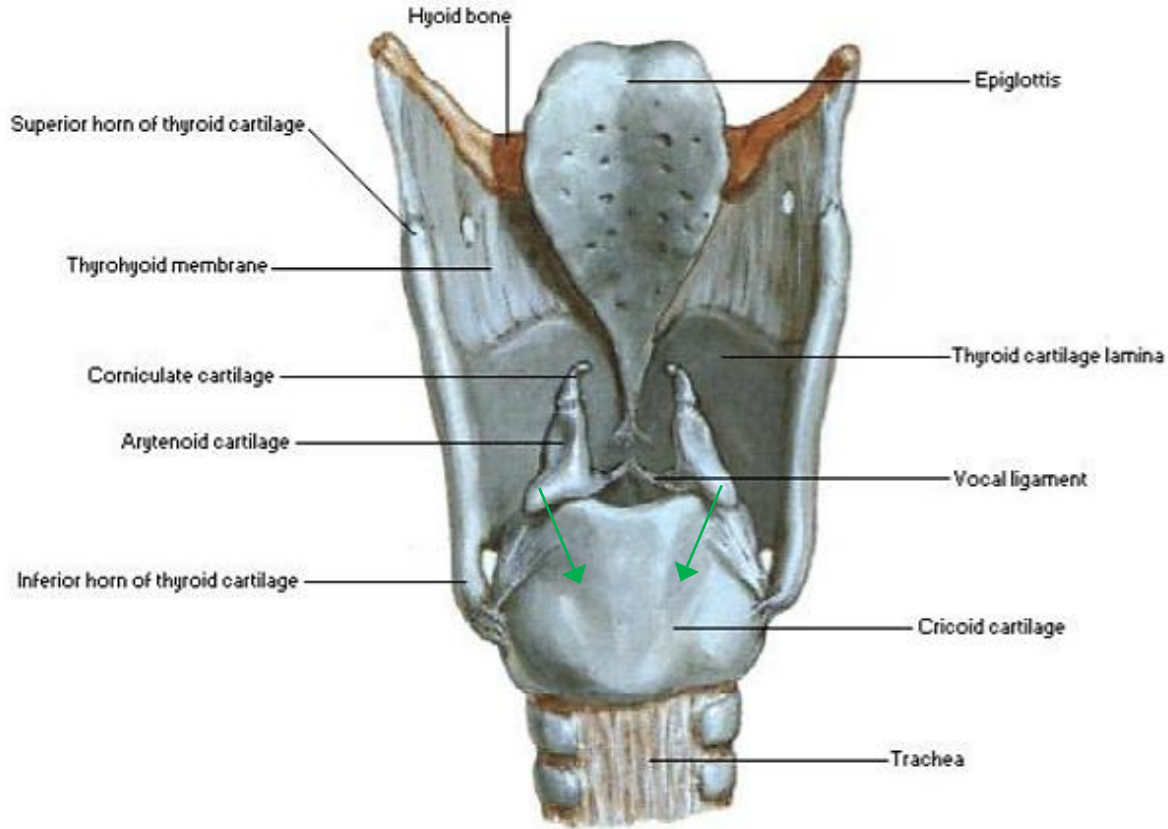
Posterior view of arytenoid cartilages:

It is possible to identify the muscular processes and, anteriorly, the vocal processes connected to the vocal ligaments, which insert into the thyroid cartilage

On the muscular process, muscles are connected and move the process:

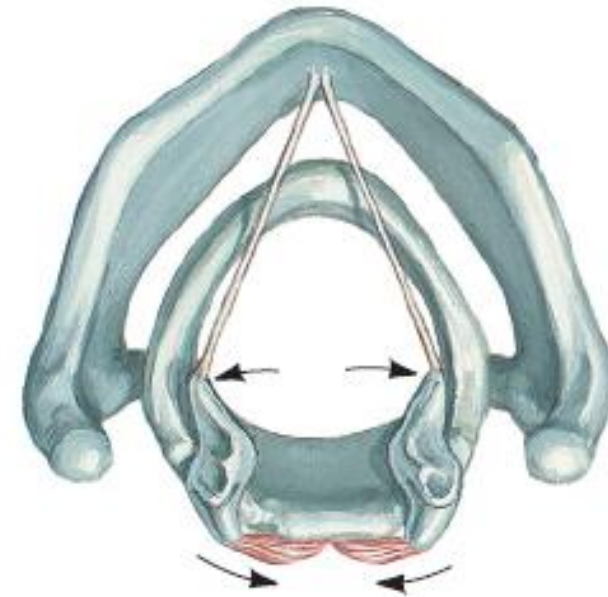
- **MEDIALY**
- **LATERALLY**

Posterior View



If the muscular process is pulled **medially**, the arytenoid cartilage rotates around its axis, causing the vocal process (located on the opposite side to the muscular process) to **deviate laterally** and vocal cords move far from each other

↓
ABDUCTION OF VOCAL CORDS
during normal or forced respiration



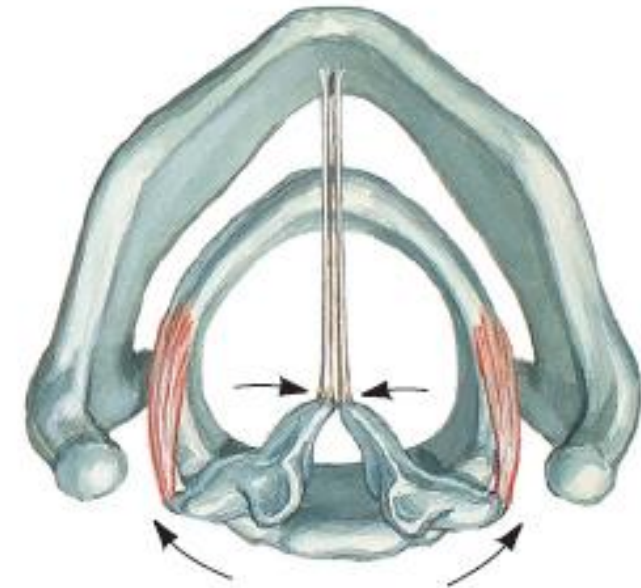
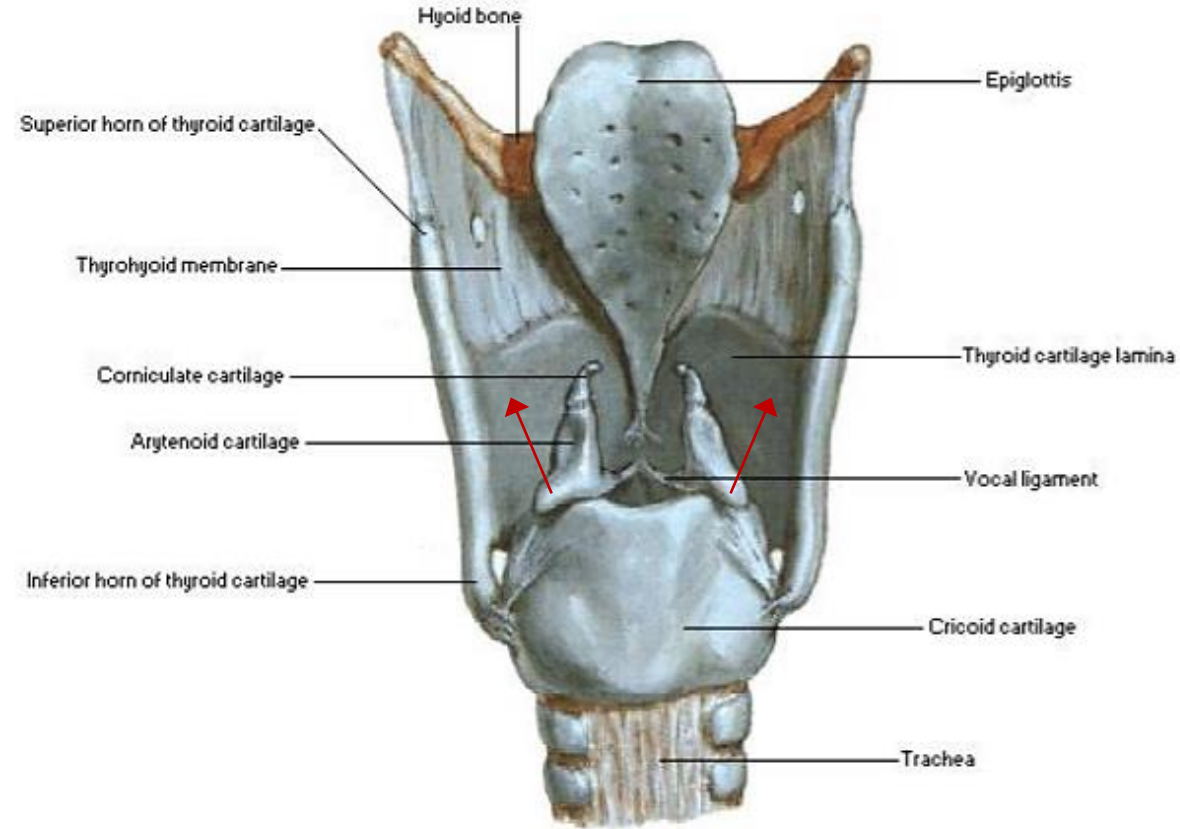
Action of posterior crico-arytenoid muscles
Abduction of vocal ligaments

INTRINSIC MUSCLES OF LARYNX

If the muscular process is pulled in the opposite direction, i.e. **laterally** and **anteriorly**, the **vocal processes come closer to each other**, the vocal ligaments and the vocal cords also come closer to each other

↓
ADDUCTION OF VOCAL CORDS
during phonation

Posterior View



Action of lateral crico-arytenoid muscles
Adduction of vocal ligaments

The larynx is also made up of ELASTIC MEMBRANES that connect the cartilage portions and which represent the load-bearing structure that delimits the laryngeal cavity on the two lateral sides

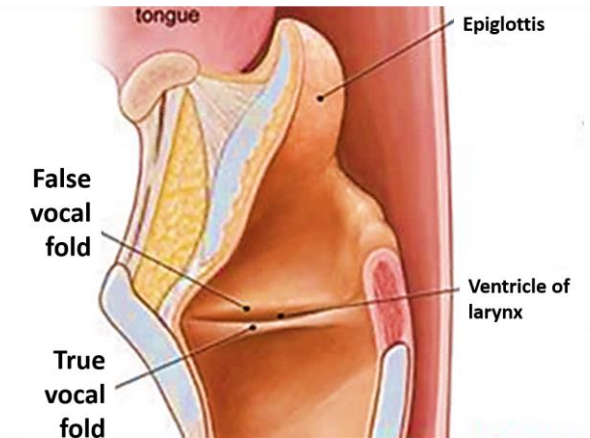
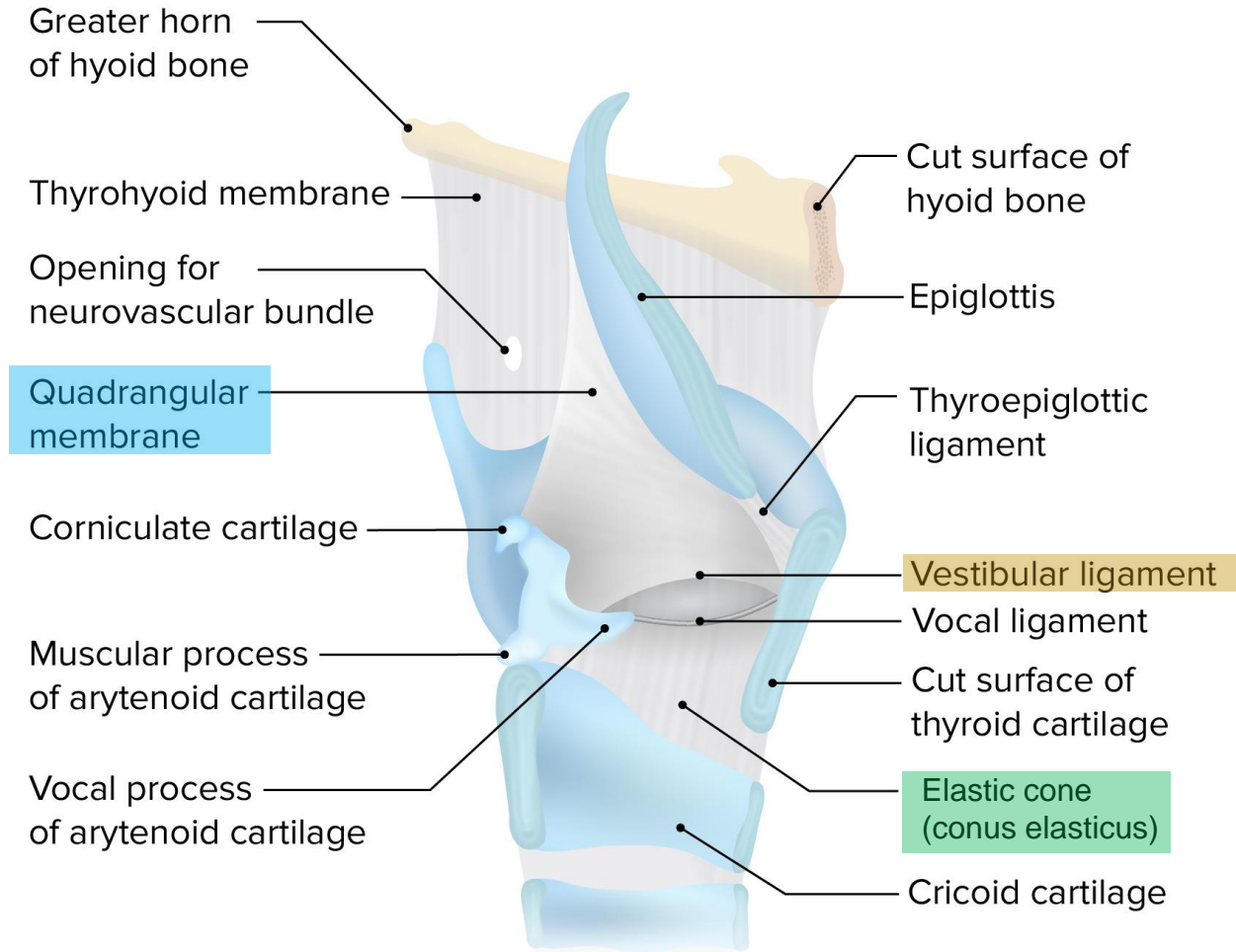
On the LOWER SIDE:

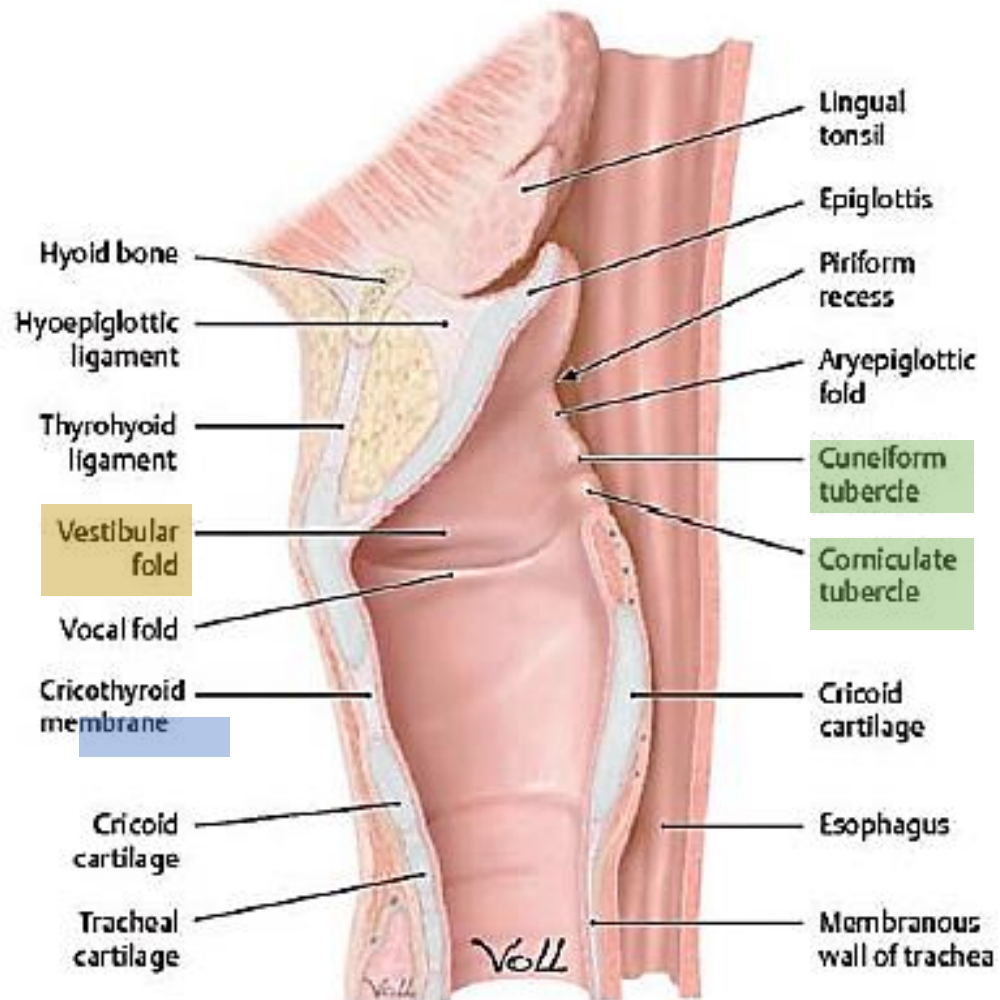
ELASTIC CONE: membrane that extends from the vocal ligament and vocal process to the upper margin of the cricoid cartilage. It is the lateral portion of the cricothyroid ligament

QUADRANGULAR MEMBRANE: it inserts posteriorly onto the corniculate cartilage and the arytenoid cartilage; anteriorly along the lateral margin of the epiglottis

The lower edge of the quadrangular membrane constitutes the **VESTIBULAR LIGAMENT**, which is the structure of the false vocal cord

There are, in fact, 2 TRUE VOCAL CORDS and 2 FALSE VOCAL CORDS



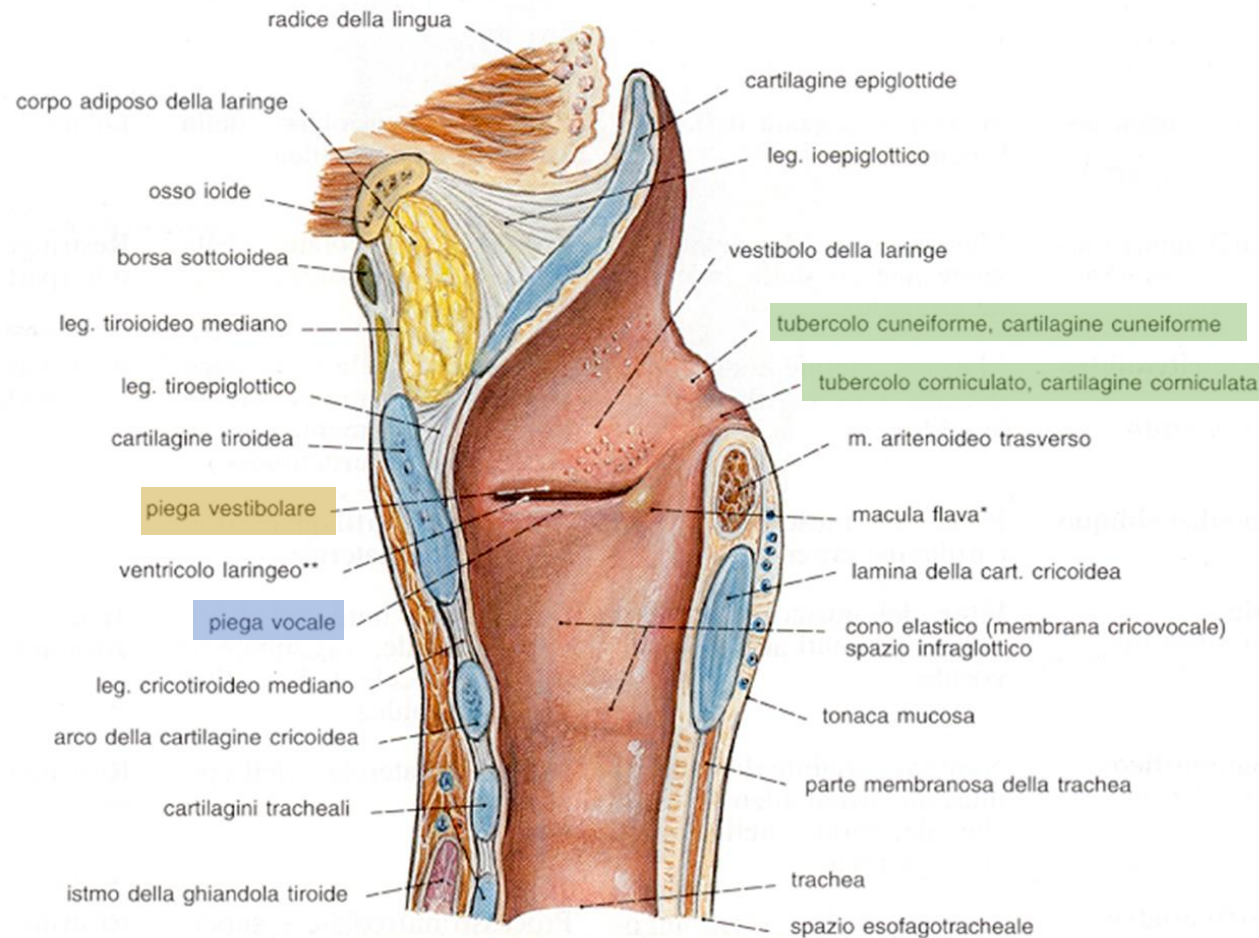


In the laryngeal cavity, in sagittal section we recognize the mucous lining that covers the described structures

From the image the true vocal cord and the false vocal cord are recognizable, between which there is a fissure that leads to the LARYNGEAL VENTRICLE

In the context of the mucous lining of the quadrangular membrane the following are distinguished:

- the **corniculate tubercle**, which covers the CORNICULATE cartilage
- the **cuneiform tubercle**, which covers another cartilage called CUNEIFORM cartilage, placed immediately anterior to the arytenoid cartilage



In the laryngeal cavity, in sagittal section we recognize the mucous lining that covers the described structures

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