# LARYNX, VAGUS AND PHRENIC NERVES

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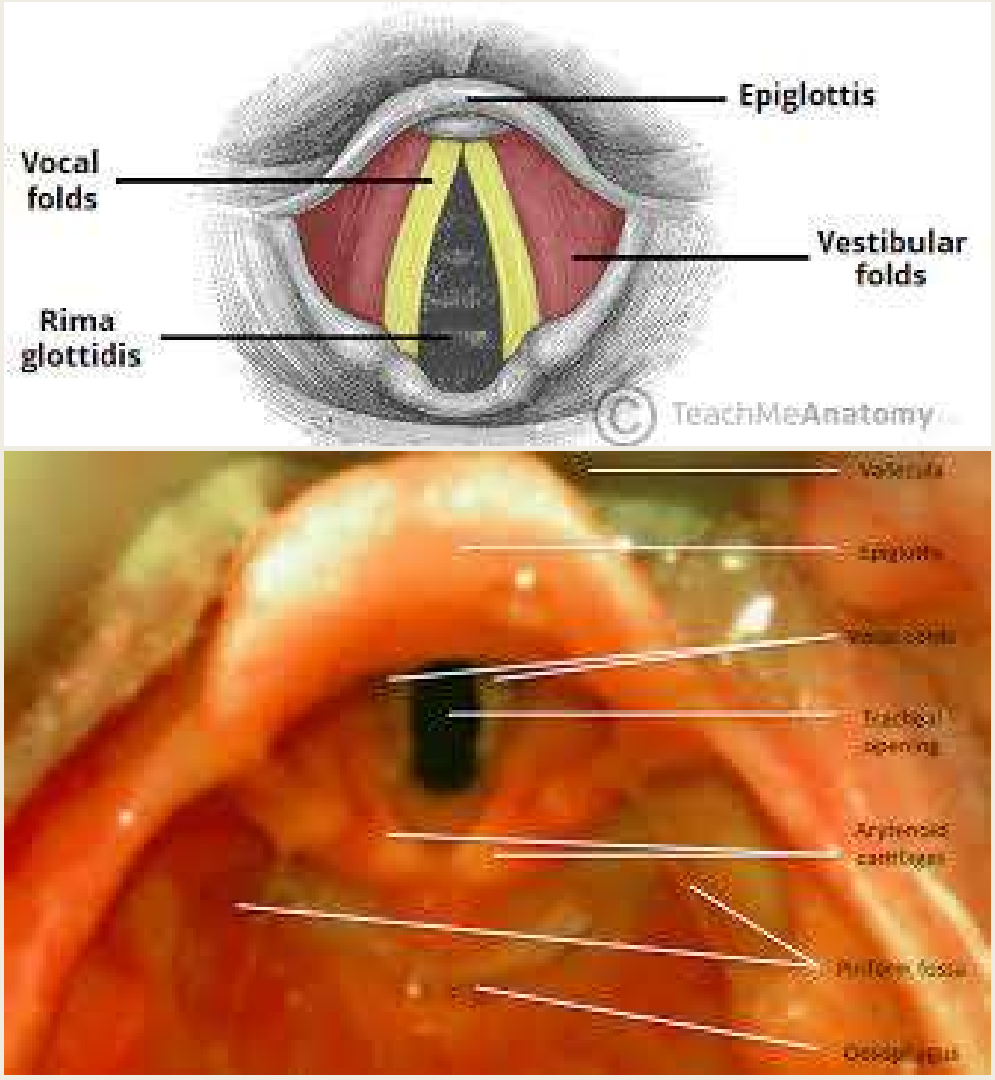
Epiglottis
Vocal folds
Vestibular folds
Rima glottidis
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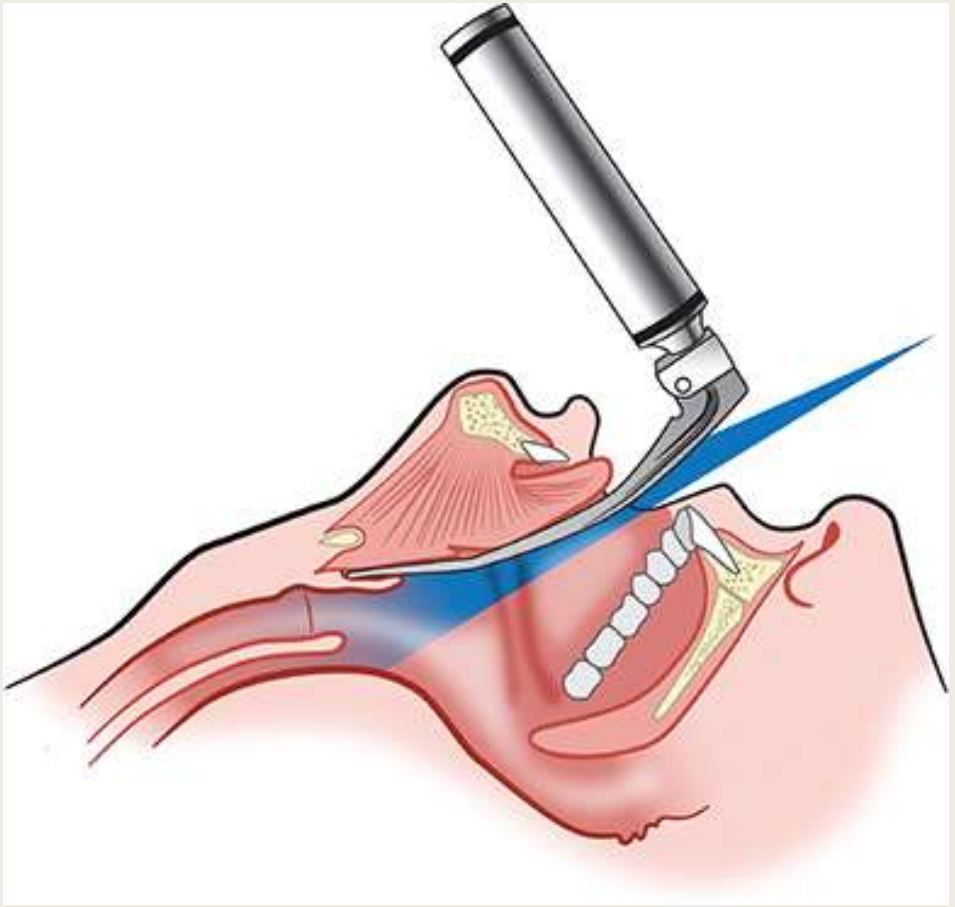
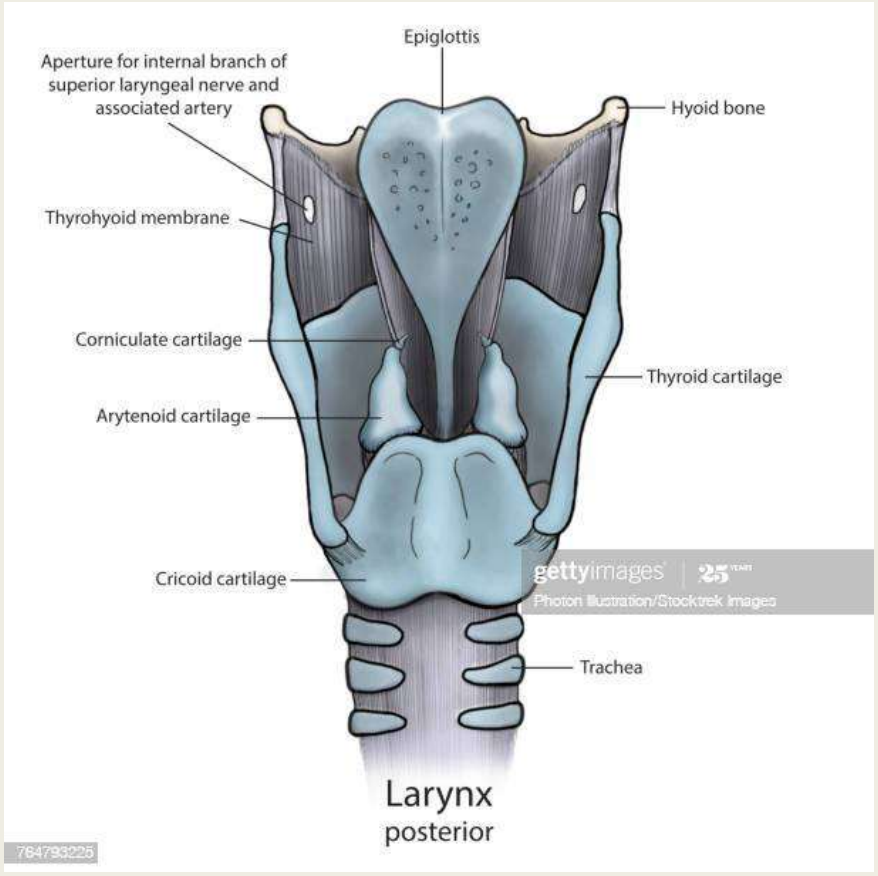


# EPIGLOTTIS


Epiglottis
Aperture for internal branch of superior laryngeal nerve and associated artery
Hyoid bone
Thyrohyoid membrane
Corniculate cartilage
Thyroid cartilage
Arytenoid cartilage
Cricoid cartilage
Trachea
Larynx
posterior
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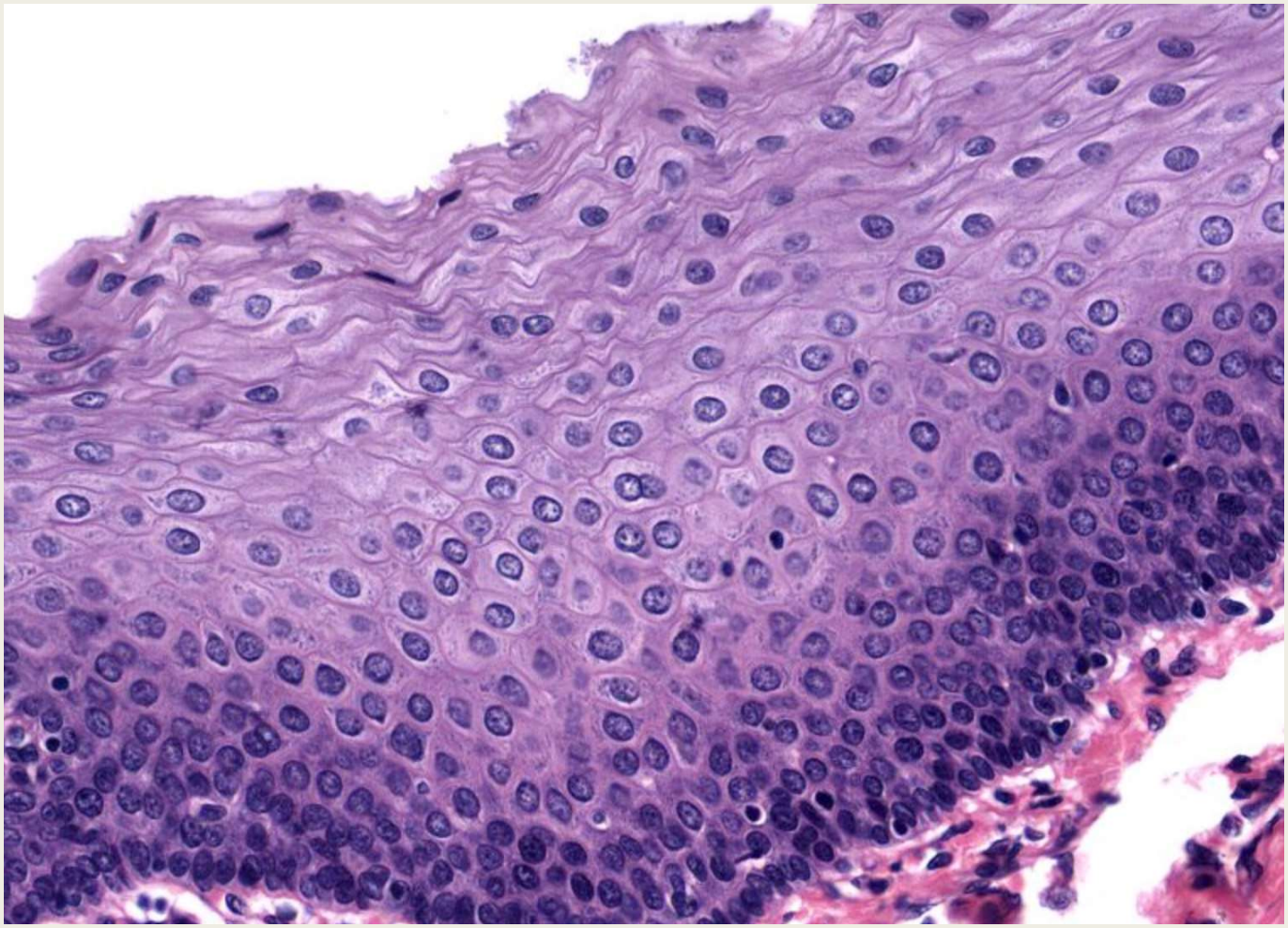
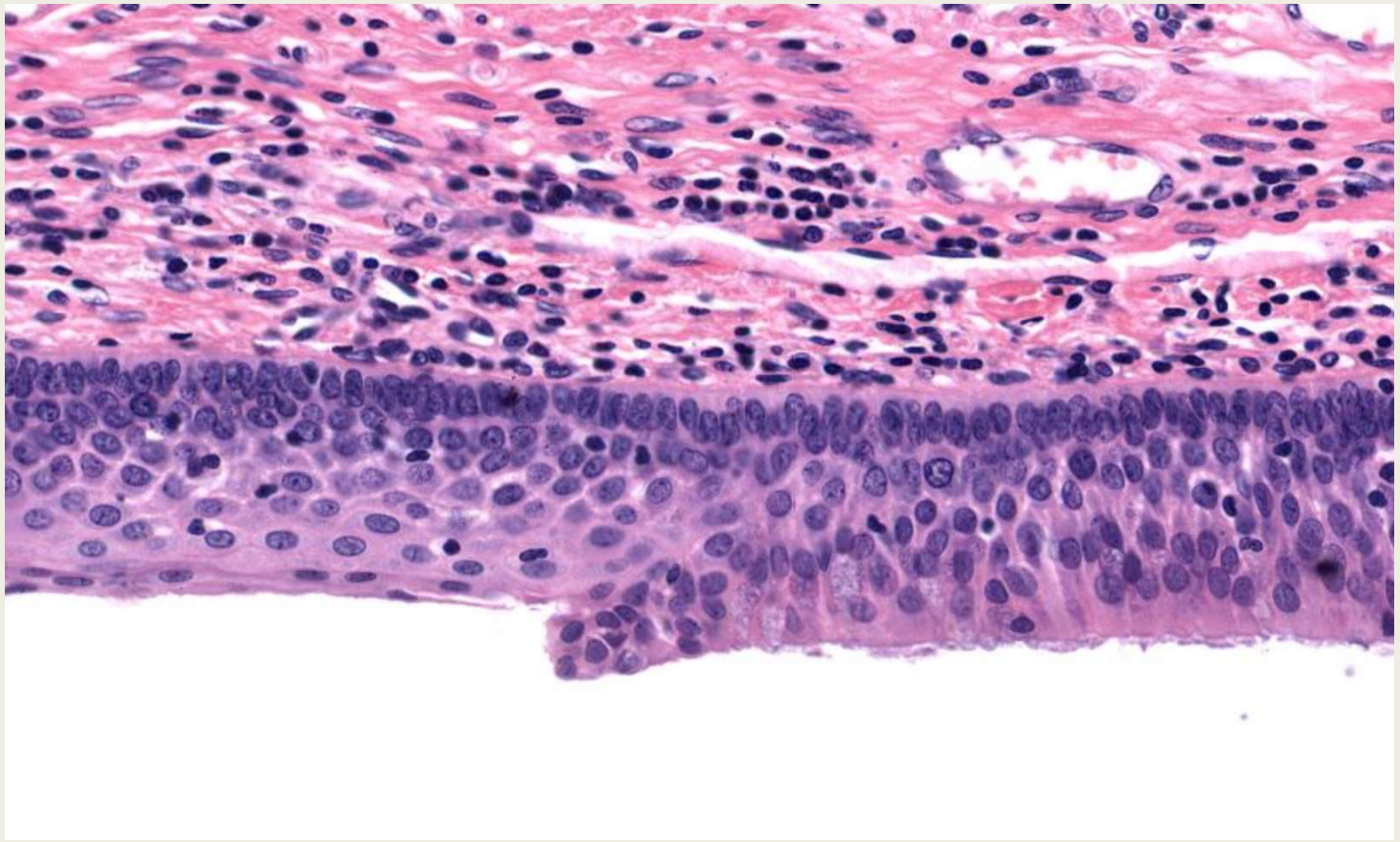
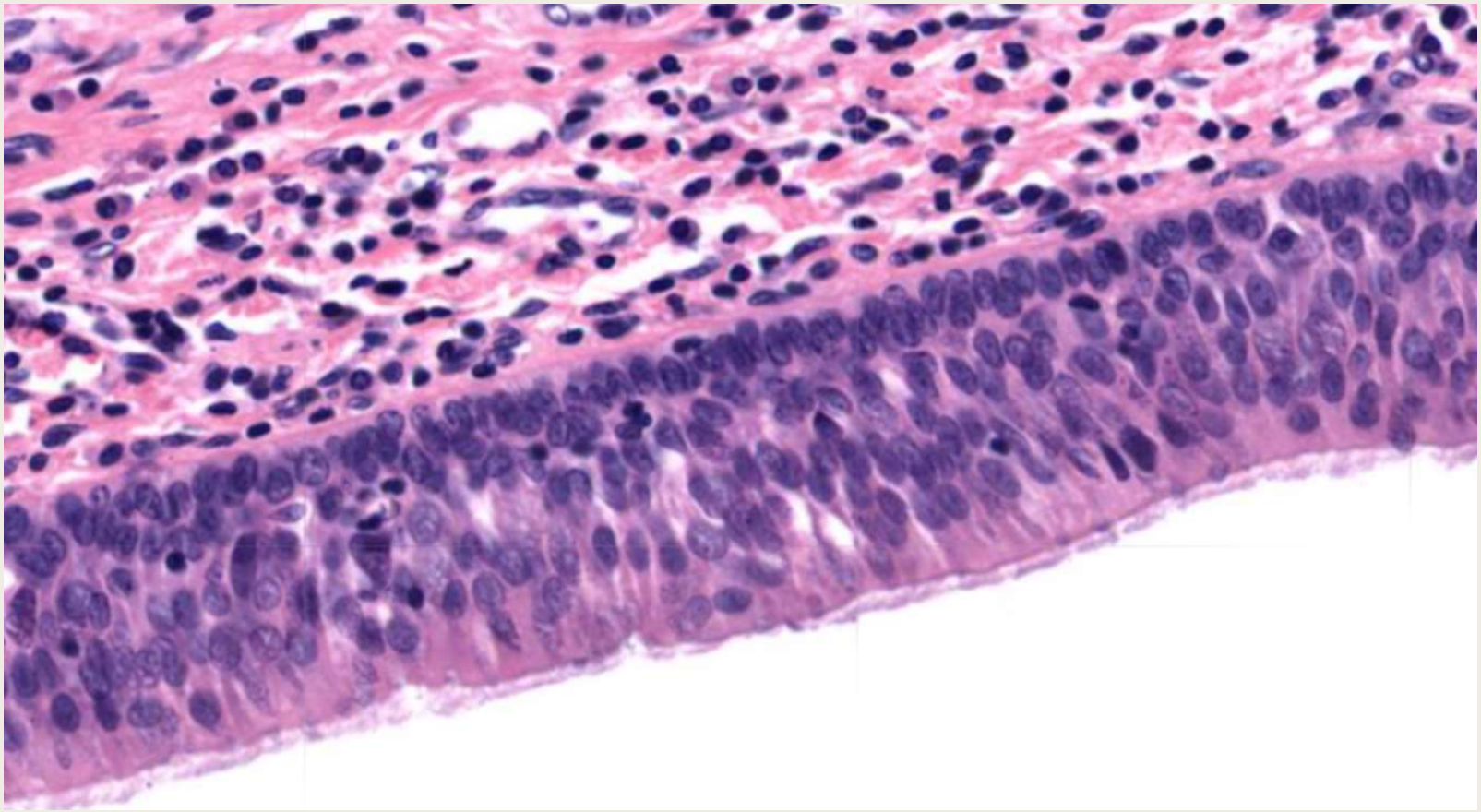
- ANTERIOR SURFACE (faces the tongue).
  - Stratified Squamous Non-Keratinized Epithelium
- POSTERIOR SURFACE (faces the opening of the trachea)
  - Respiratory Epithelium - pseudostratified epithelium with cilia and goblet cells and Transition zone



- Stratified Squamous Non-Keratinized Epithelium

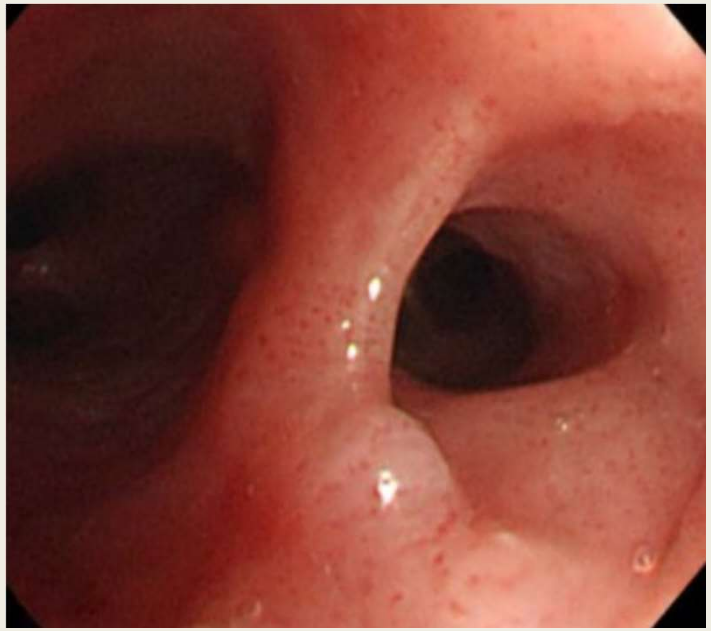


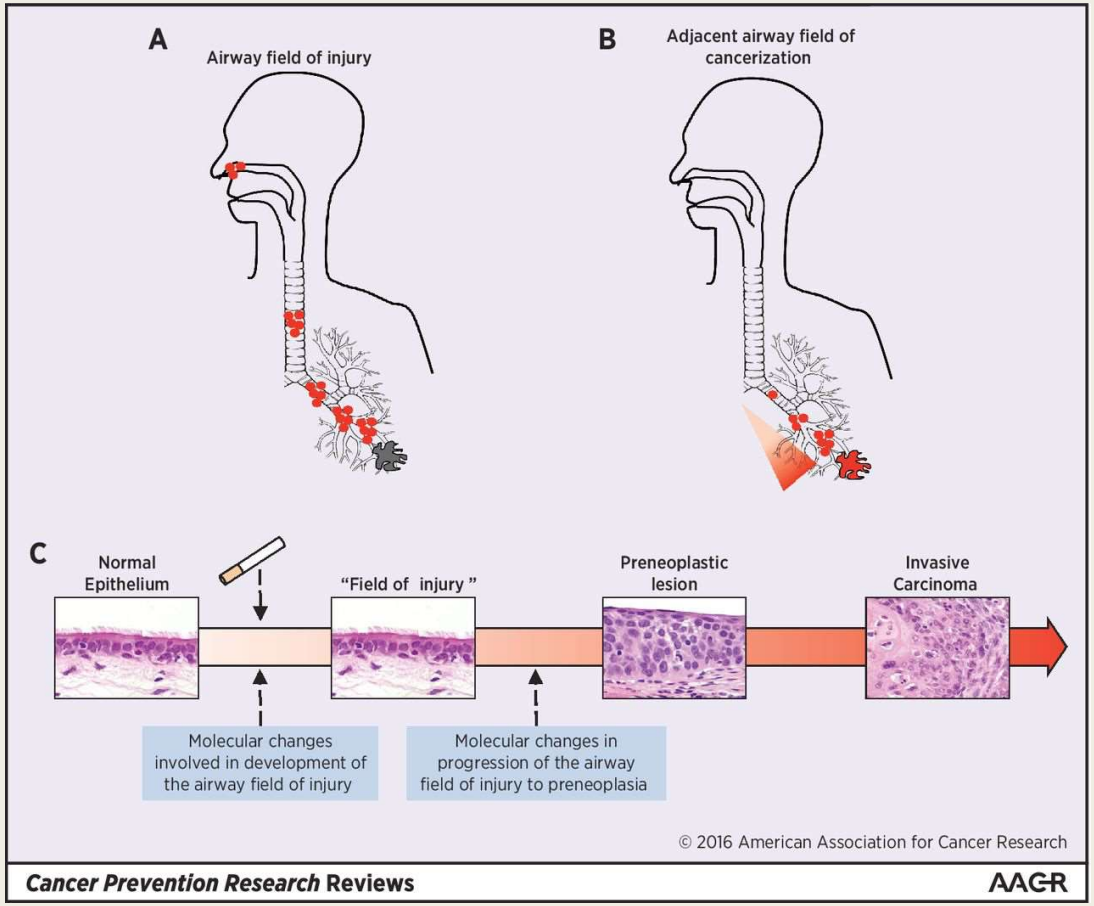
- Transition zone

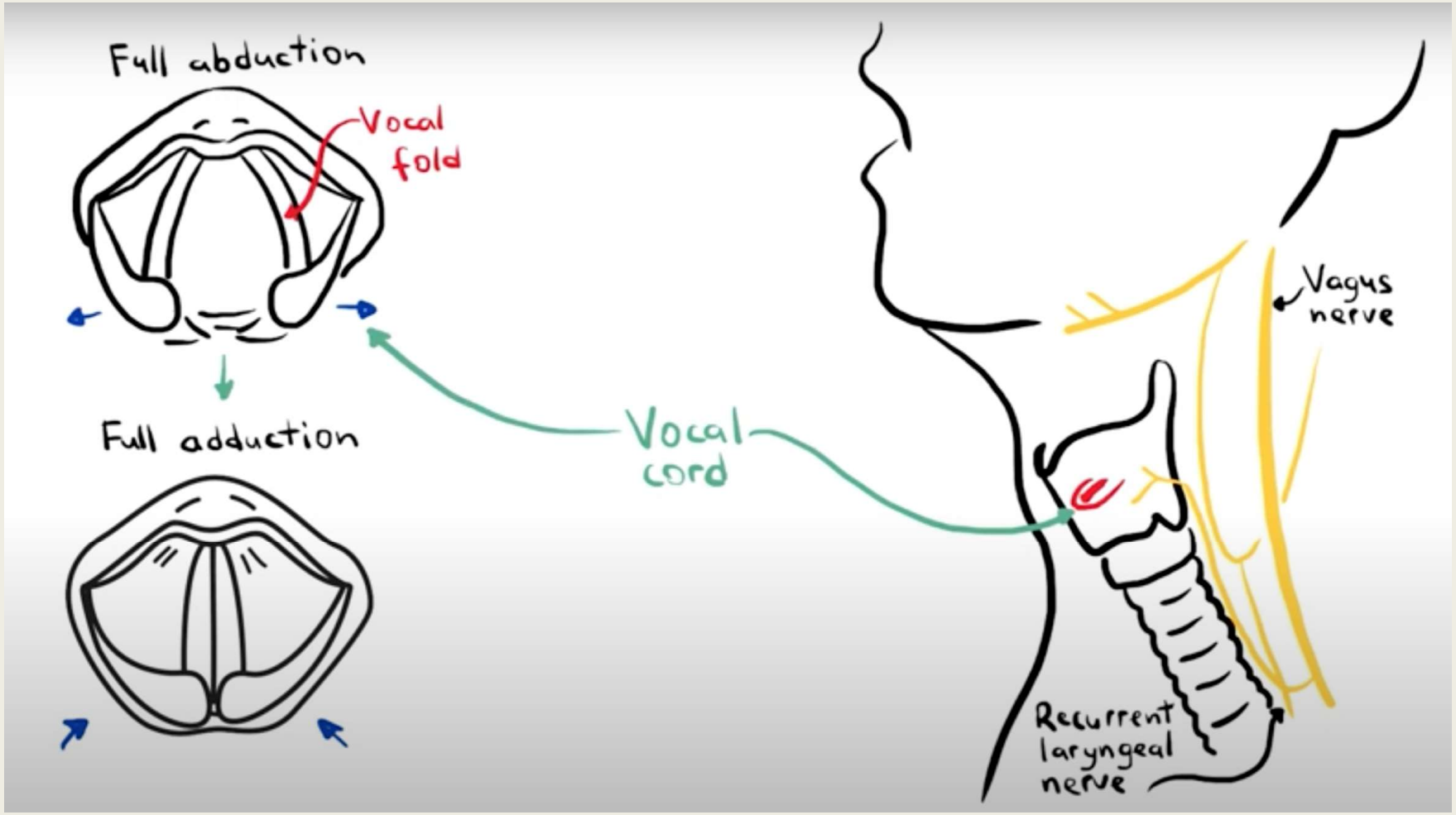


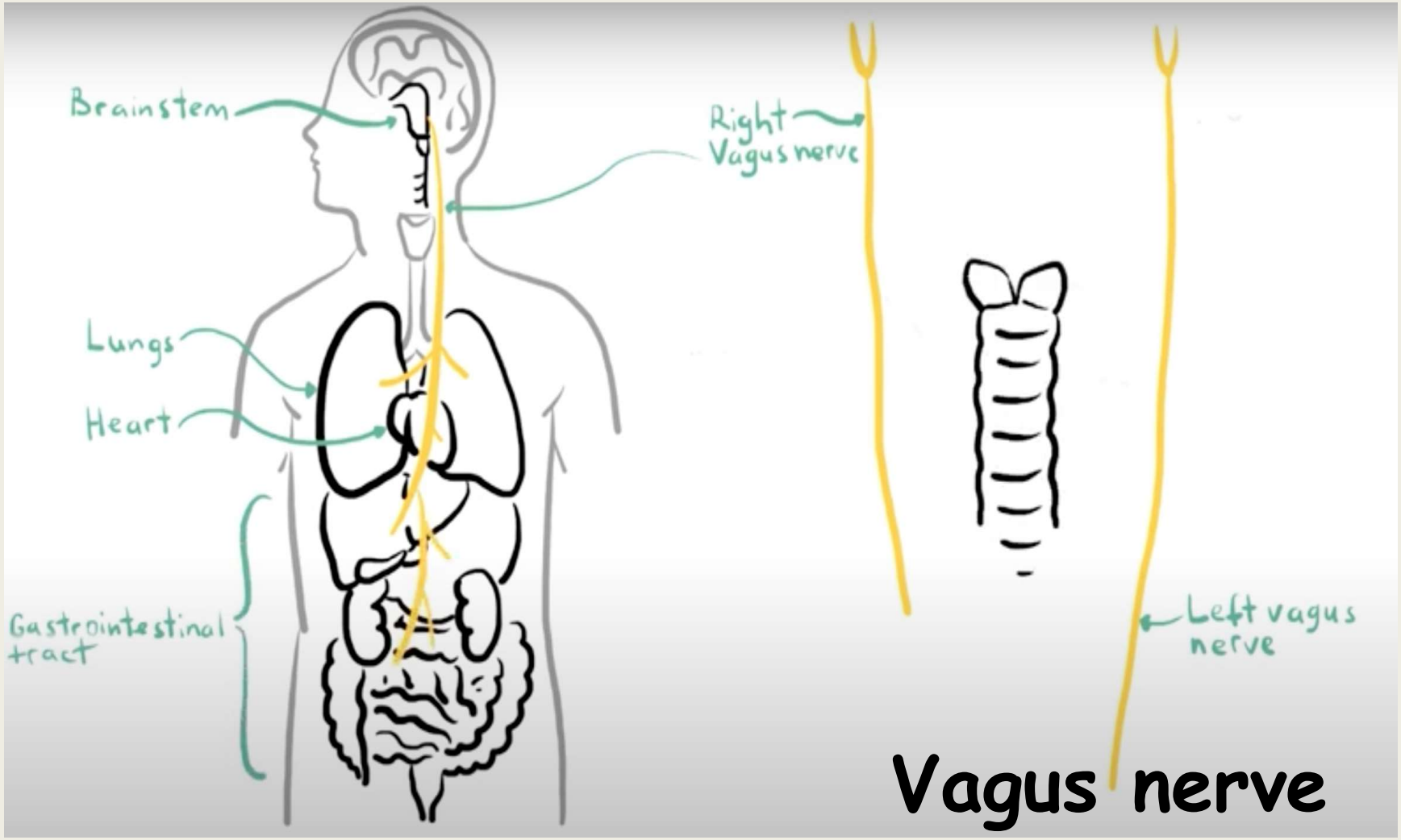
- Respiratory Epithelium

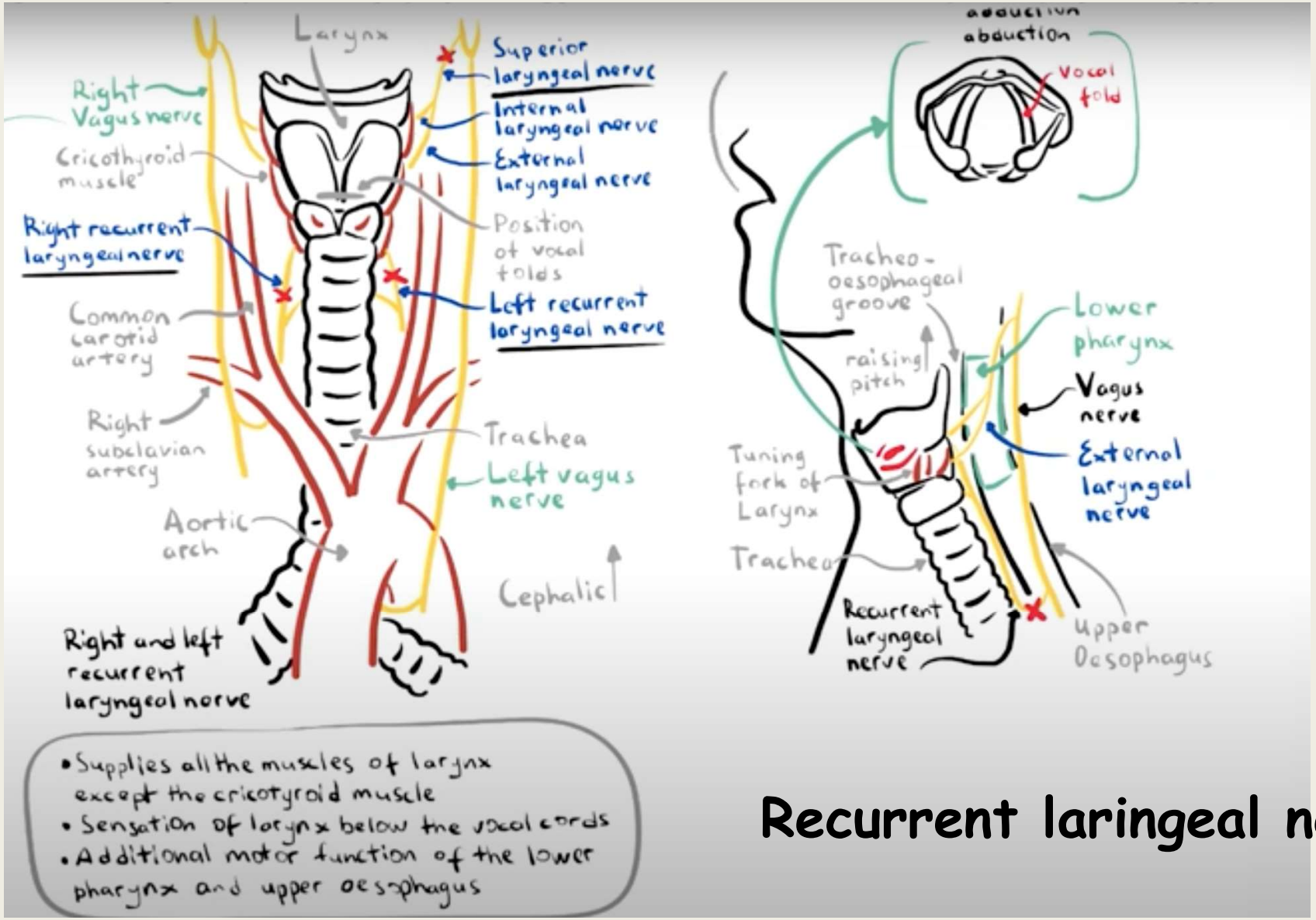
# Smoke and Tracheobronhchial histology



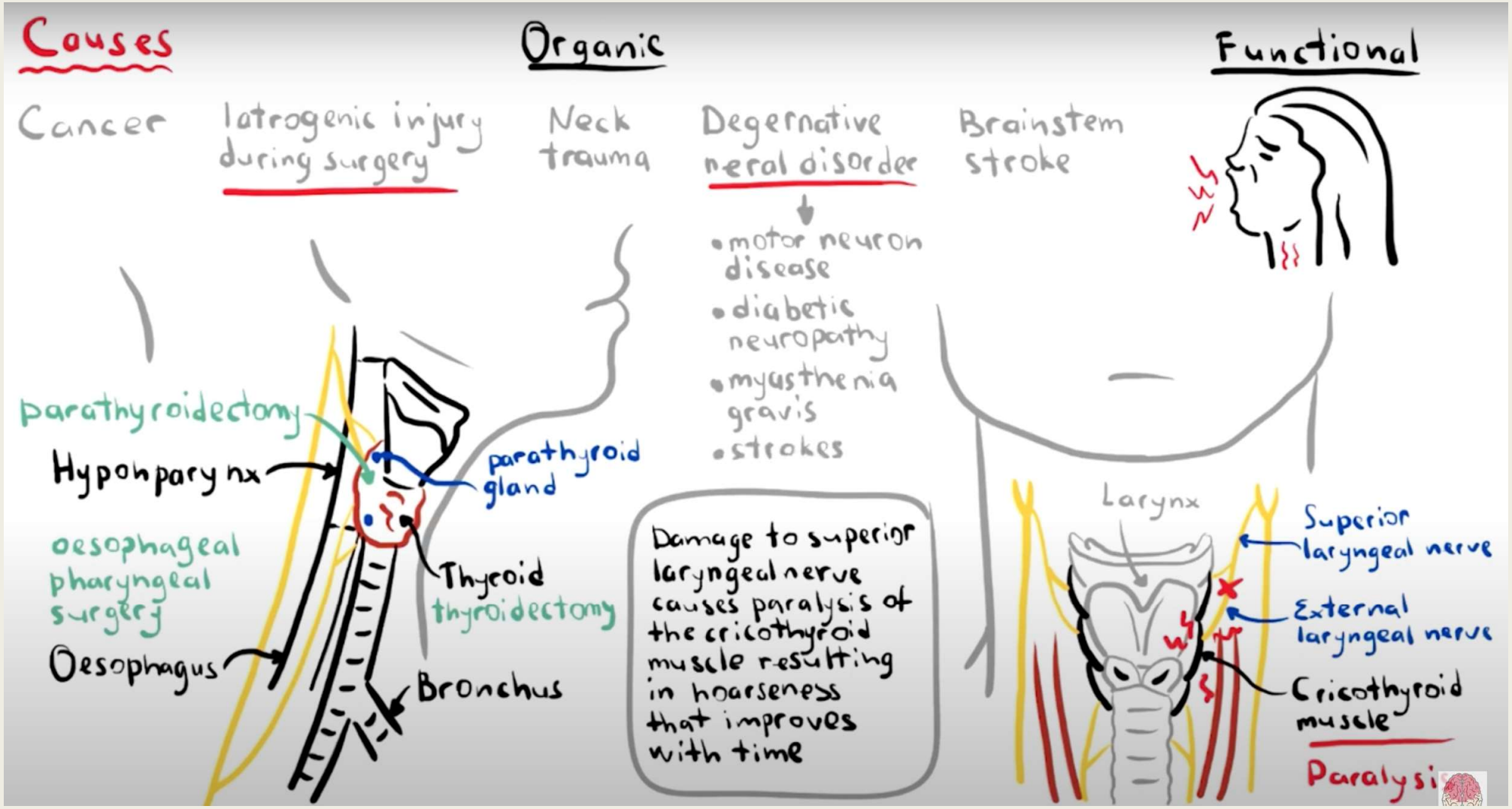



Full abduction
Vocal fold
Full adduction
Vocal cord
Vagus nerve
Recurrent laryngeal nerve


Brainstem
Lungs
Heart
Gastrointestinal tract
Right Vagus nerve
Left vagus nerve
Vagus nerve

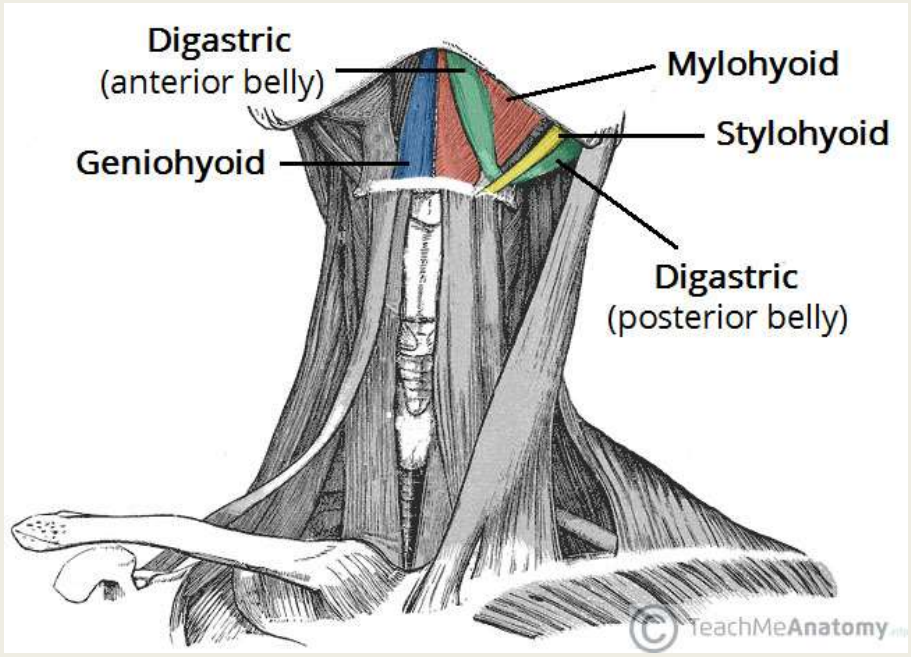



# Recurrent laringeal nerve


Causes
Organic
Functional
Cancer
Iatrogenic injury during surgery
Neck trauma
Degernative neral disorder
Brainstem stroke
• motor neuron disease
• diabetic neuropathy
• myasthenia gravis
• strokes
parathyroidectomy
Hypopharynx
oesophageal pharyngeal surgery
Oesophagus
parathyroid gland
Thyroid thyroidectomy
Bronchus
Damage to superior laryngeal nerve causes paralysis of the cricothyroid muscle resulting in hoarseness that improves with time
Larynx
Superior laryngeal nerve
External laryngeal nerve
Cricothyroid muscle
Paralysi

# Extrinsic muscles of Larynx

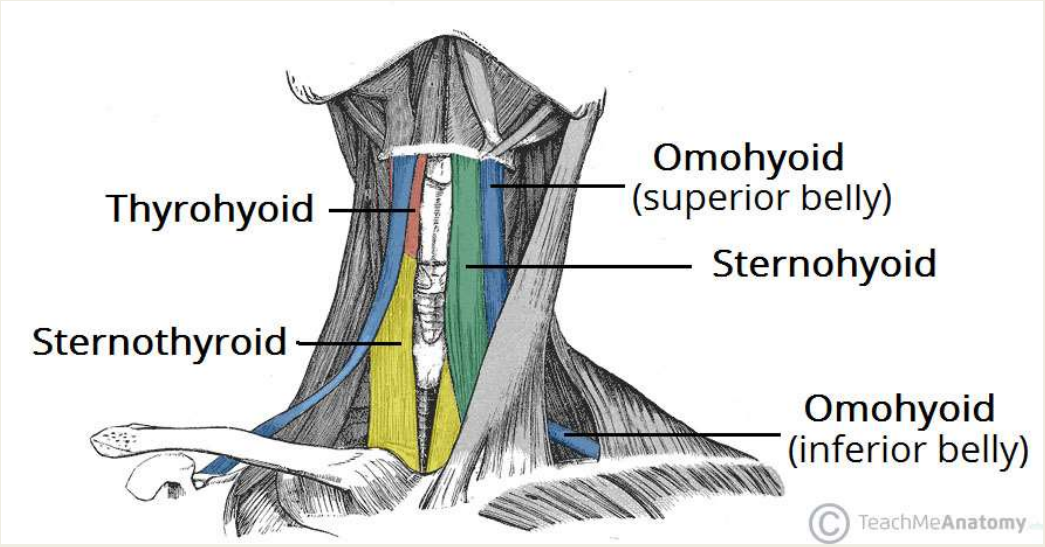
The extrinsic muscles act to move the larynx superiorly and inferiorly




**SUPRAHYOID MUSCLES**

Elevate Larynx

(together with stylopharyngeus muscle)

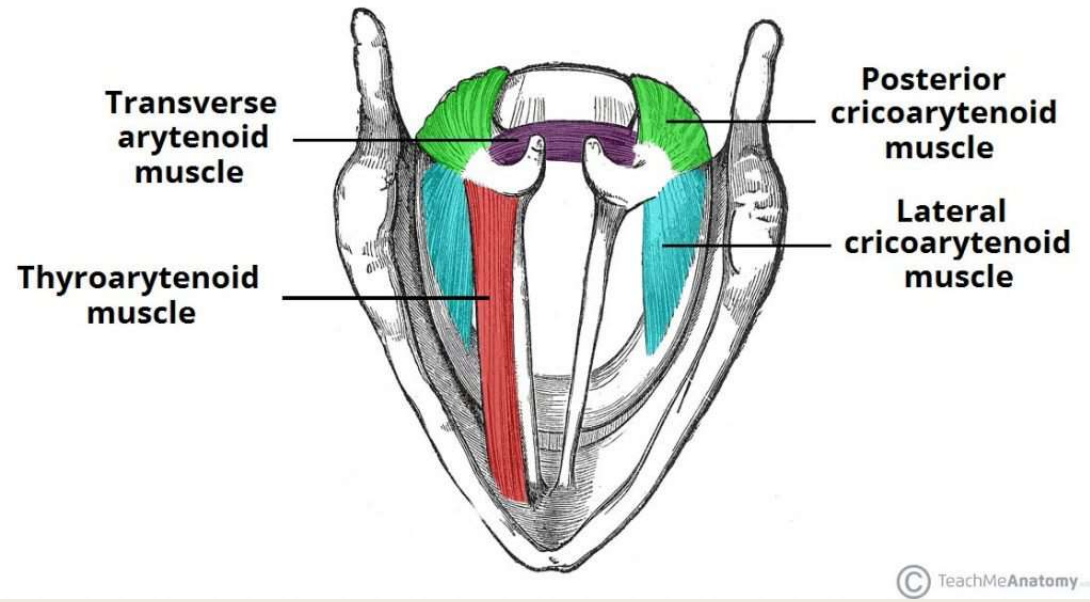


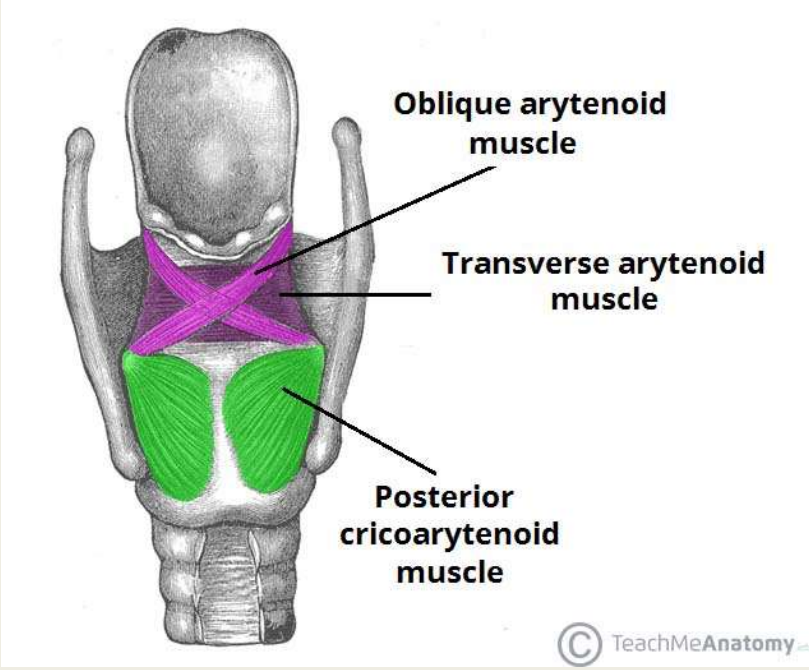

**INFRAHYOID MUSCLES**

Depress Larynx

# Intrinsic muscles of Larynx

Act on the individual components of the larynx. They control the shape of the **rima glottidis** (opening between the vocal folds and the arytenoid cartilages), and the length and tension of the vocal folds



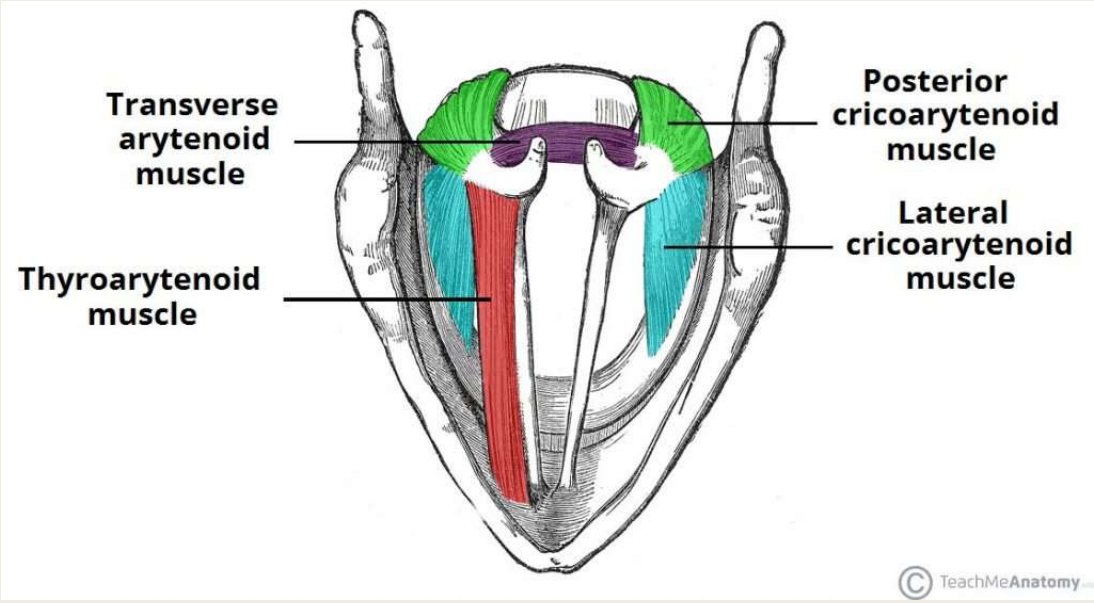



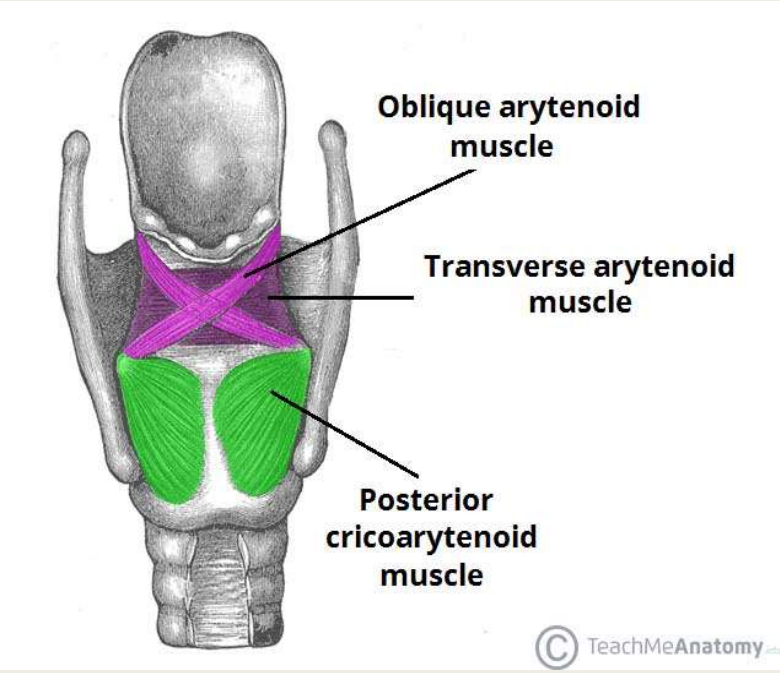
## Cricothyroid

The cricothyroid muscle stretches and tenses the vocal ligaments, and so is important for the creation of forceful speech. It also has a role in altering the tone of voice (along with the thyroarytenoid muscle), hence its colloquial name 'singer's muscle'.

## Thyroarytenoid

The thyroarytenoid muscle acts to relax the vocal ligament, allowing for a softer voice






**Posterior cricoarytenoid**

The posterior cricoarytenoid muscles are the sole abductors of the vocal folds, and thus the only muscle capable of widening the rima glottidis

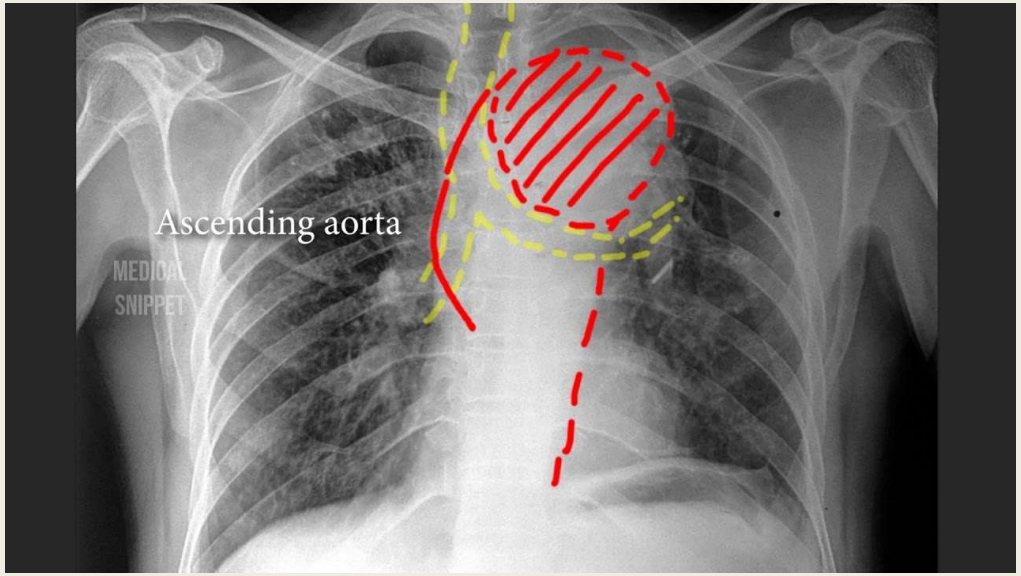
**Lateral cricoarytenoid**

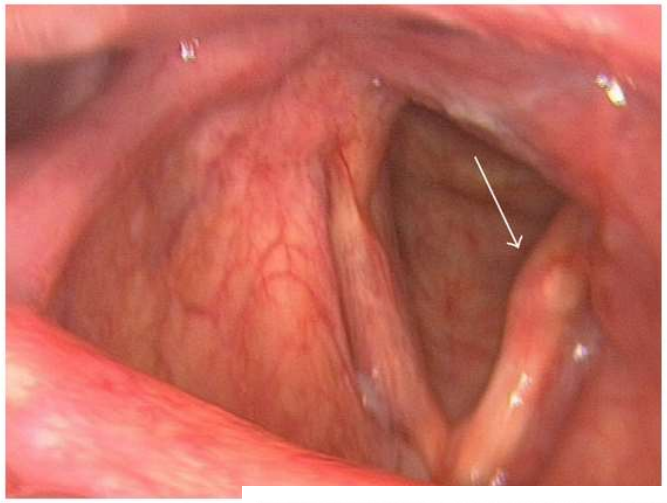
The lateral cricoarytenoid muscles are the major adductors of the vocal folds. This narrows the rima glottidis, modulating the tone and volume of speech

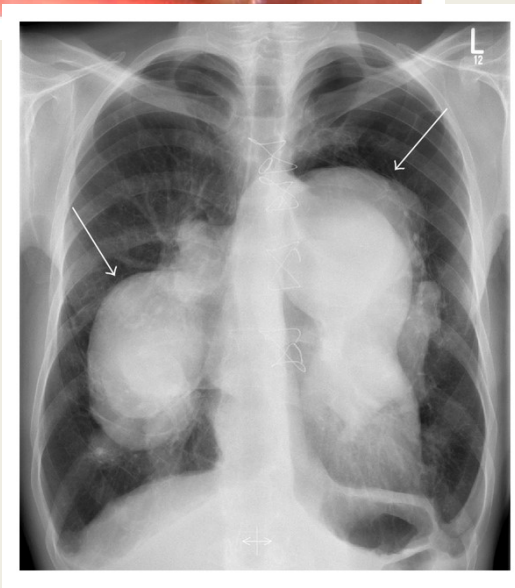
**Transverse and Oblique Arytenoids**

The transverse and oblique arytenoids muscles adduct the arytenoid cartilages, closing the posterior portion of rima glottidis. This narrows the laryngeal inlet

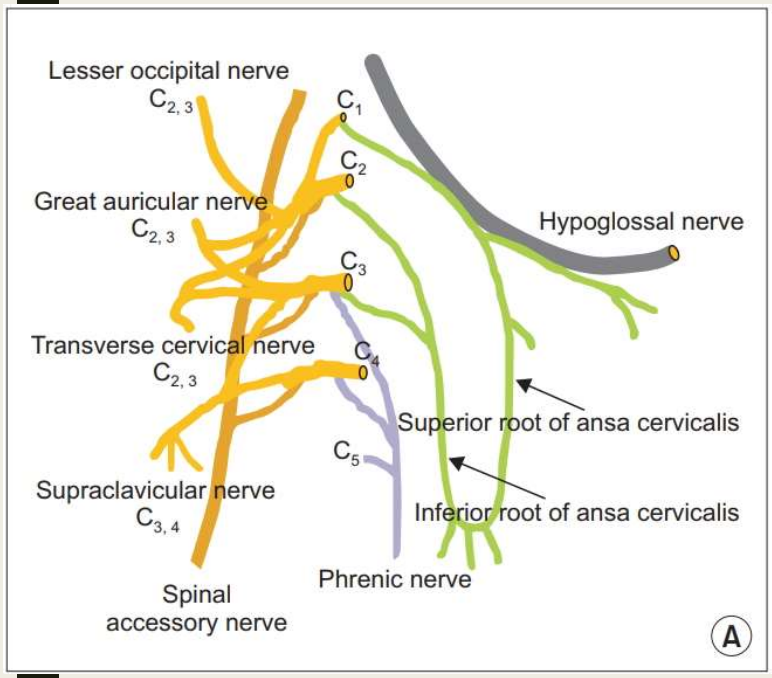
# Ortner's syndrome

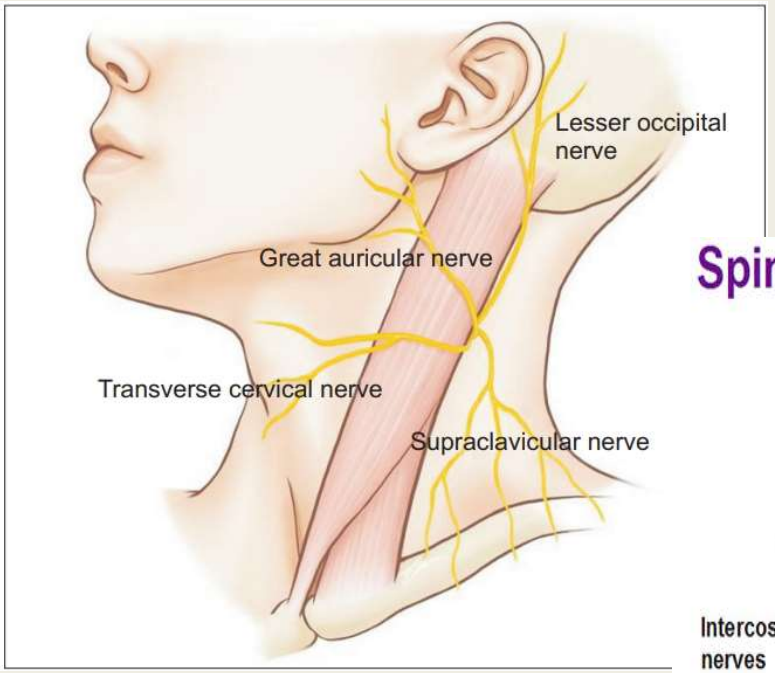


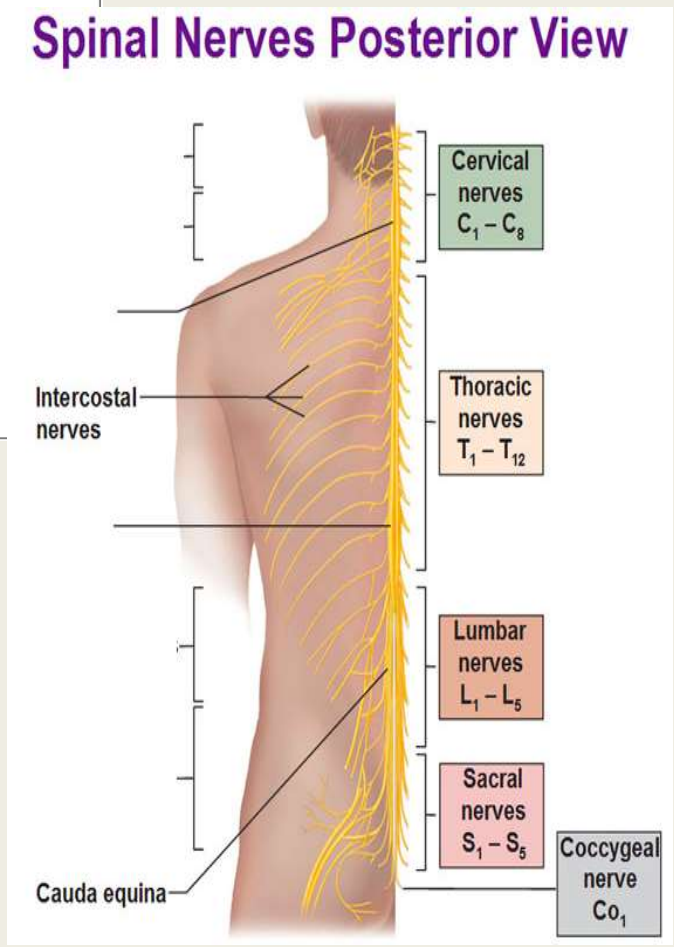



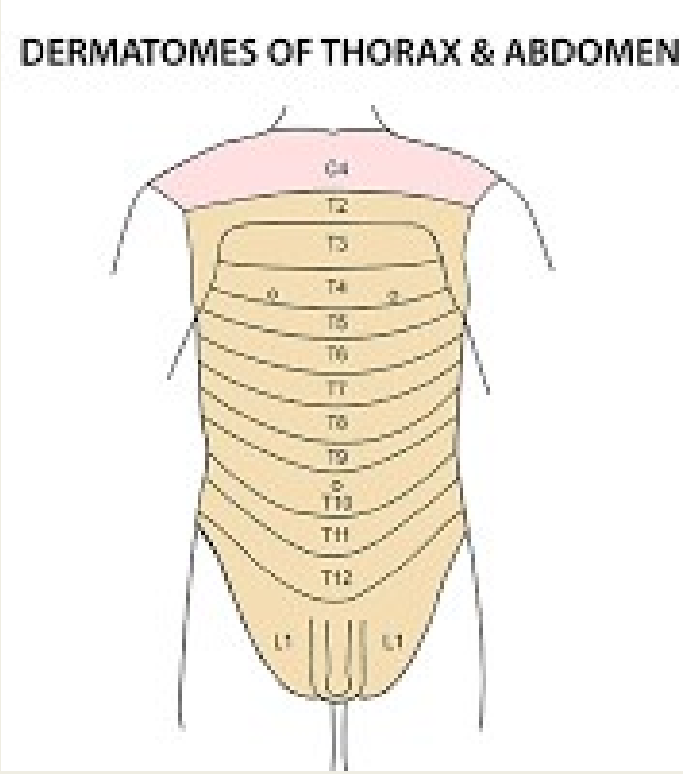


Cardiovocal syndrome and refers to recurrent laryngeal nerve palsy due to vascular o cardiac etiology

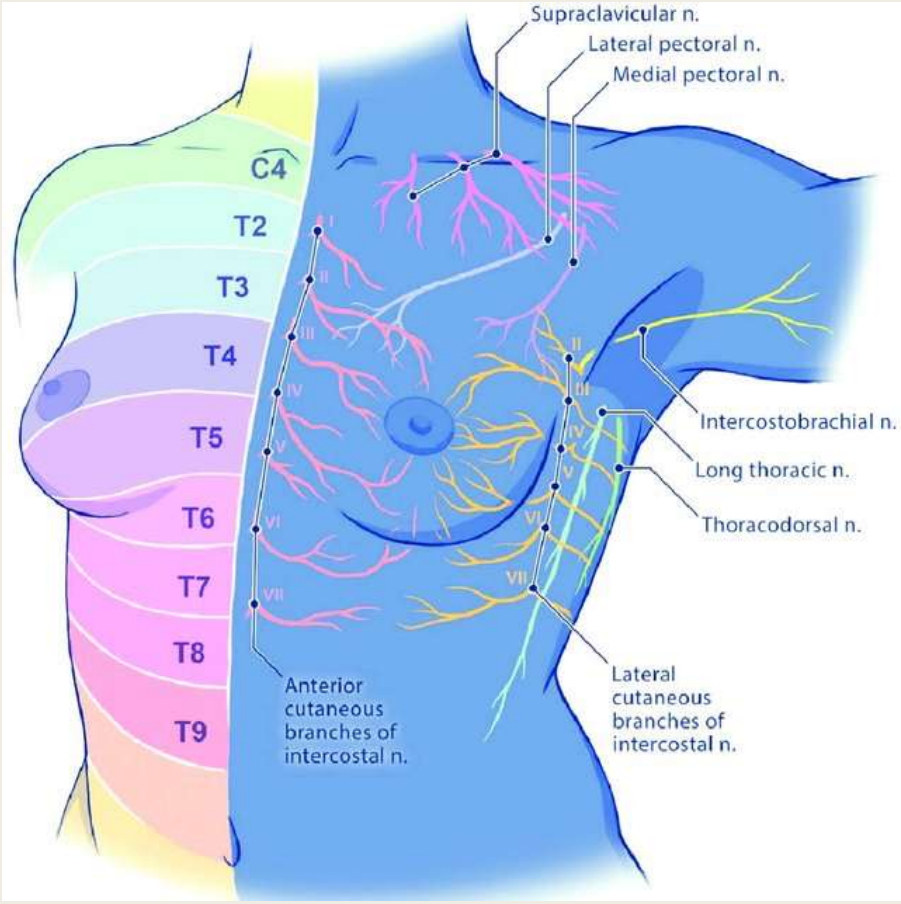

Lesser occipital nerve
C2, 3
C1
C2
Great auricular nerve
C2, 3
Hypoglossal nerve
C3
Transverse cervical nerve
C2, 3
C4
Superior root of ansa cervicalis
C5
Supraclavicular nerve
C3, 4
Inferior root of ansa cervicalis
Phrenic nerve
Spinal
accessory nerve
A

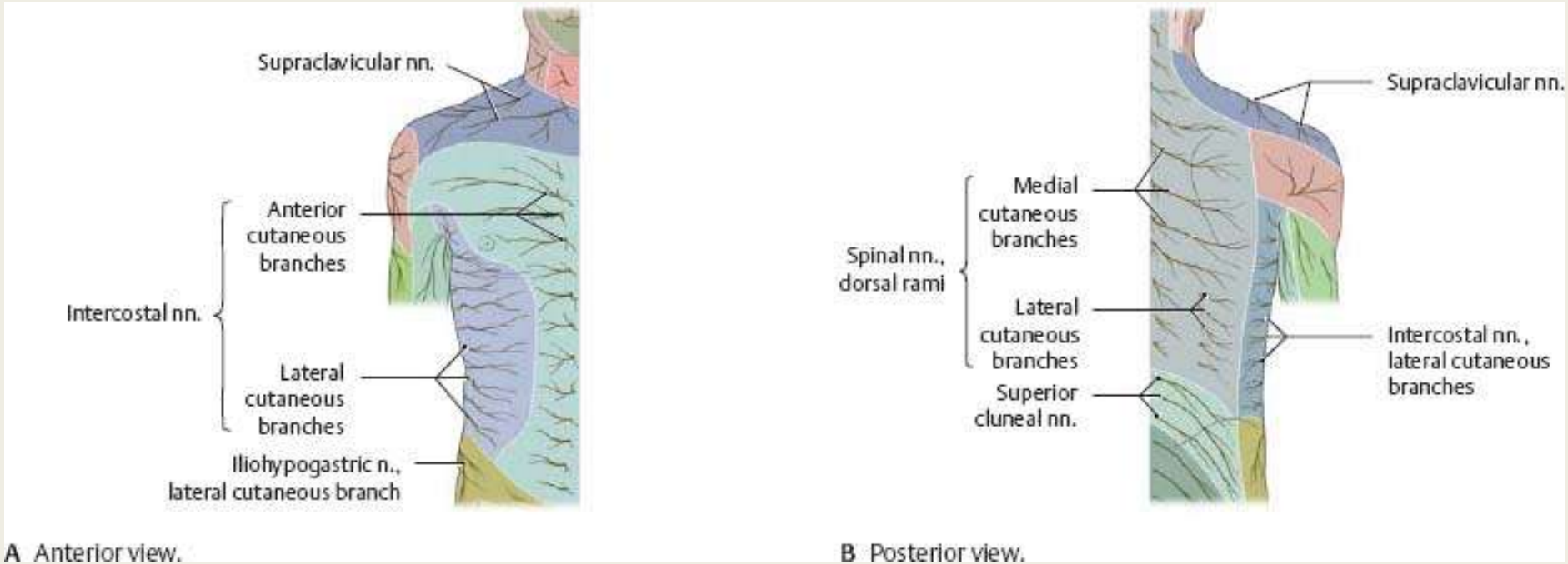

Lesser occipital
nerve
Great auricular nerve
Transverse cervical nerve
Supraclavicular nerve


Spinal Nerves Posterior View
Cervical
nerves
C1 – C8
Intercostal
nerves
Thoracic
nerves
T1 – T12
Lumbar
nerves
L1 – L5
Sacral
nerves
S1 – S5
Coccygeal
nerve
Co1
Cauda equina




A **dermatome** is an area of skin that is mainly supplied by afferent nerve fibres from the dorsal root of any given spinal nerve





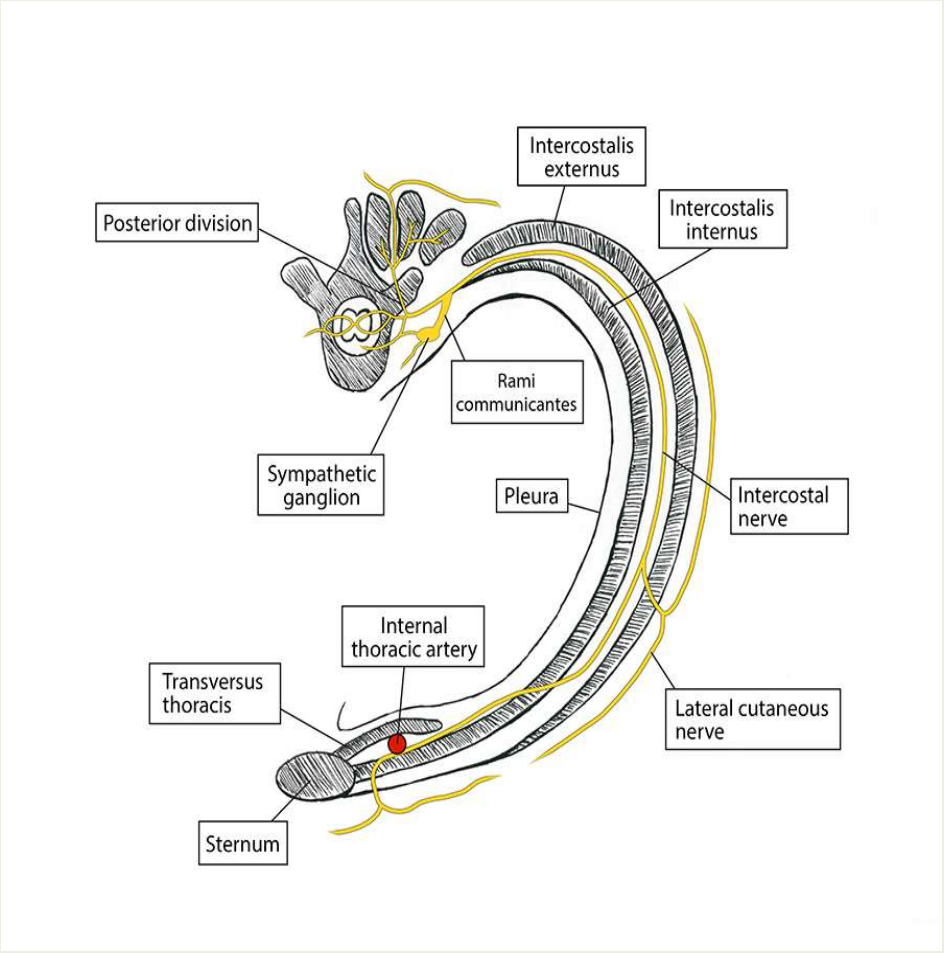

**A** Anterior view. **B** Posterior view.

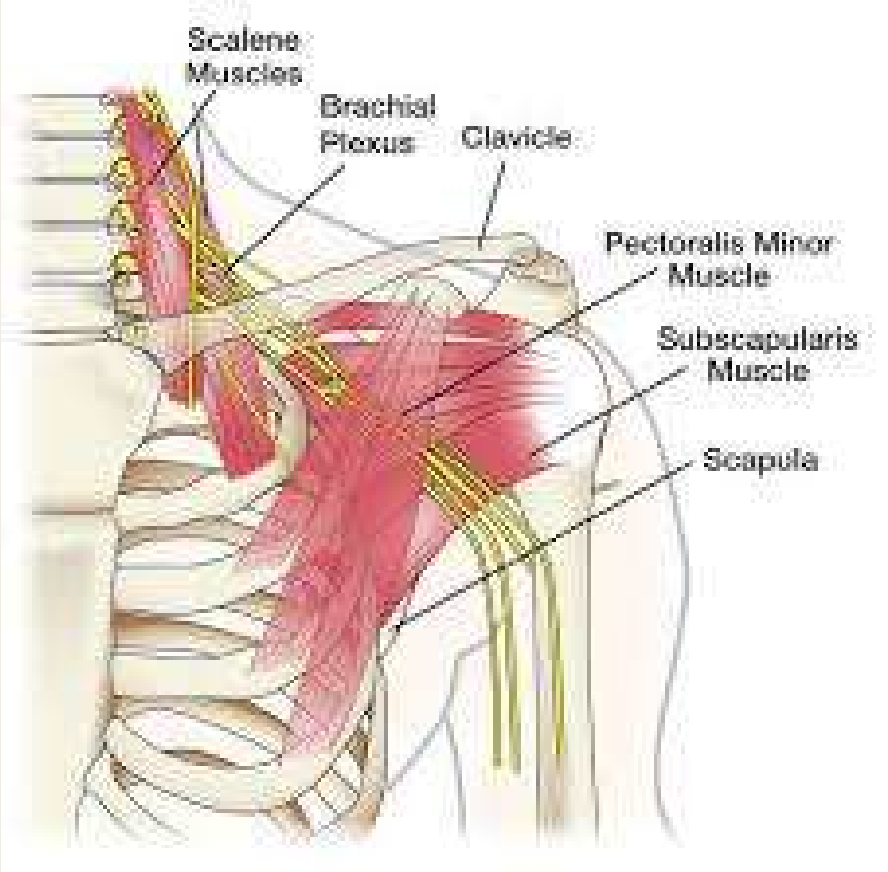
The **intercostal nerves** are part of the somatic nervous system, and arise from the anterior rami of the thoracic spinal nerves from T1 to T11

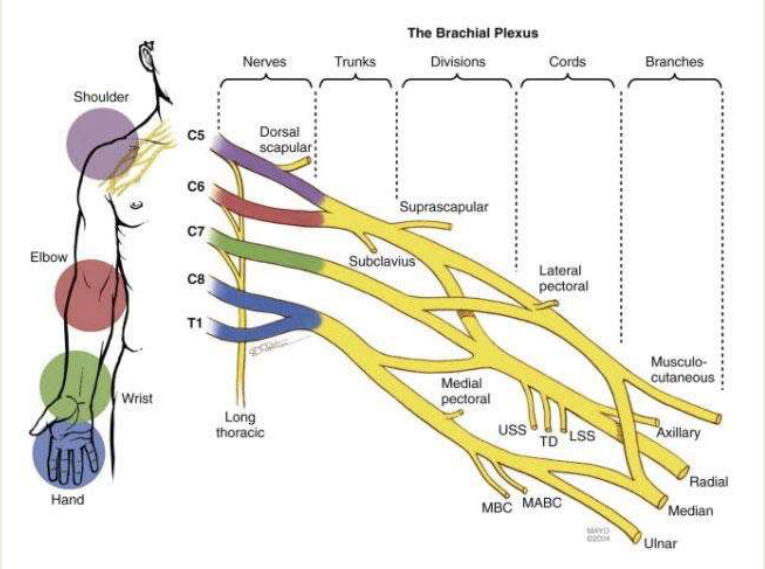
The 7th intercostal nerve terminates at the xyphoid process

The 10th intercostal nerve terminates at the navel

The twelfth (subcostal) thoracic is distributed to the abdominal wall and groin





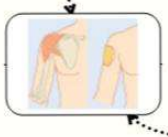




# Brachial plexus

# Branches of Brachial plexus

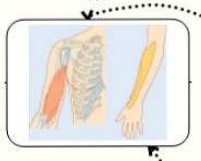
## Ulnar
- Origin: Medial cord
- Spinal segments: (C7),C8,T1
- Function: motor — All intrinsic muscles of the hand (except three thenar muscles and two lateral lumbricals); also flexor carpi ulnaris and the medial half of flexor digitorum profundus in the forearm
- Function: sensory — Skin over the palmar surface of the medial one and one-half digits and associated palm and wrist, and skin over the dorsal surface of the medial one and one-half digits

## Axillary
- Origin: Posterior cord
- Spinal segments: C5,C6
- Function: motor — Deltoid, teres minor
- Function: sensory — Skin over upper lateral part of arm



## Radial
- Origin: Posterior cord
- Spinal segments: C5 to C8, (T1)
- Function: motor — All muscles in the posterior compartments of arm and forearm
- Function: sensory — Skin on the posterior aspects of the arm and forearm, the lower lateral surface of the arm, and the dorsal lateral surface of the hand

## Musculocutaneous
- Origin: Lateral cord
- Spinal segments: C5 to C7
- Function: motor — All muscles in the anterior compartment of the arm
- Function: sensory — Skin on lateral side of forearm



## Medial cutaneous of arm
- Origin: Medial cord
- Spinal segments: C8,T1
- Function: sensory — Skin on medial side of distal one-third of arm

## Thoracodorsal
- Origin: Posterior cord
- Spinal segments: C6 to C8
- Function: motor — Latissimus dorsi

## Inferior subscapular
- Origin: Posterior cord
- Spinal segments: C5,C6

## Branches of Brachial plexus

- segmental branches from C5 to C8 to muscles of the neck
- contribution of C5 to the phrenic nerve

## Medial pectoral
- Origin: Medial cord
- Spinal segments: C8,T1
- Function: motor — Pectoralis major, pectoralis minor

## Dorsal scapular
- Origin: C5 root
- Function: motor — Rhomboid major, rhomboid minor

## Long thoracic
- Origin: C5 to C7 roots
- Function: motor — Serratus anterior

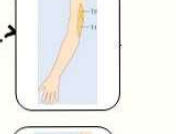
## Suprascapular
- Origin: Superior trunk
- Spinal segments: C5,C6
- Function: motor — Supraspinatus, infraspinatus

## Nerve to subclavius
- Origin: Superior trunk
- Spinal segments: C5,C6
- Function: motor — Subclavius

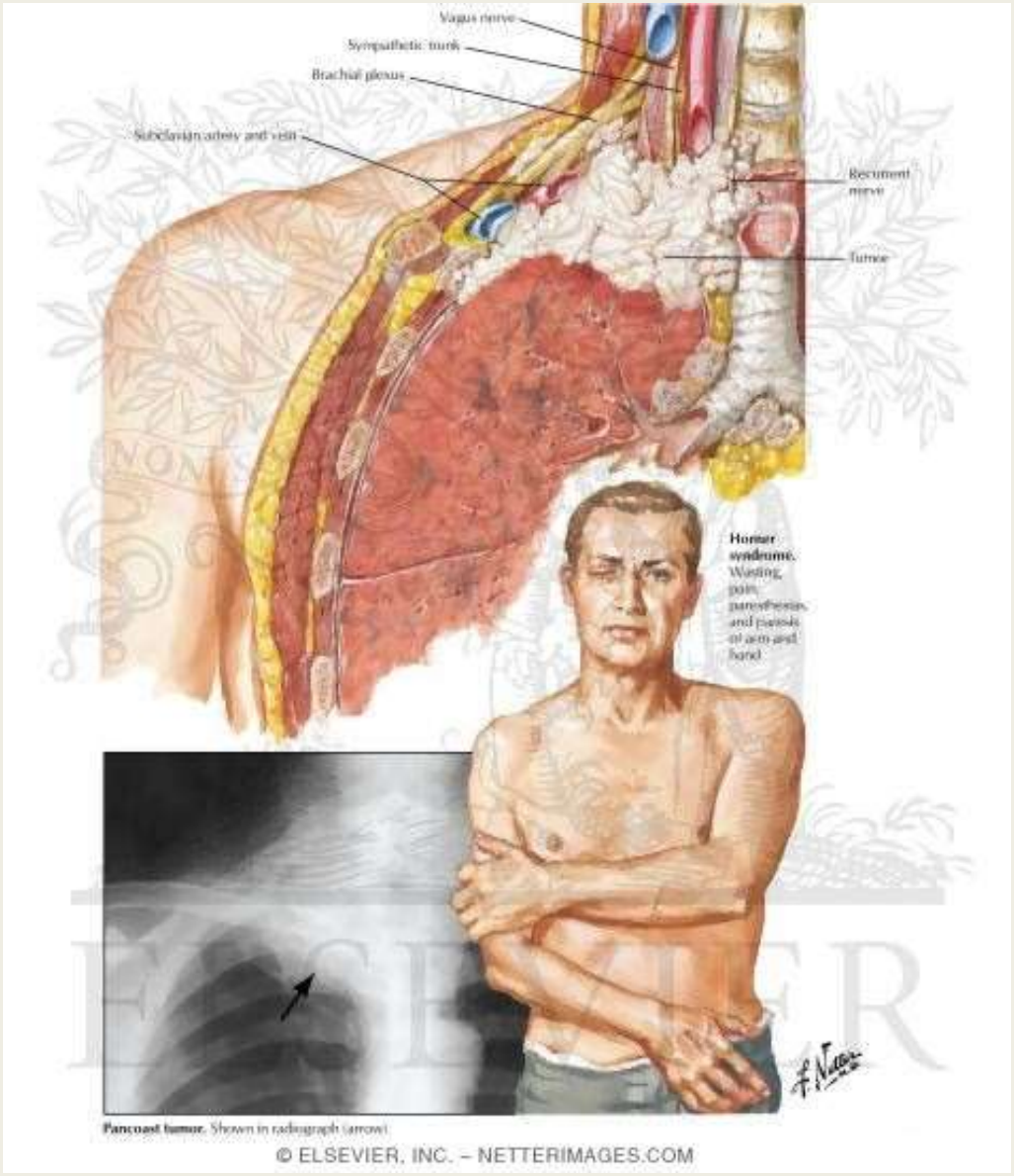
## Lateral pectoral
- Origin: Lateral cord
- Spinal segments: C5 to C7
- Function: motor — Pectoralis major

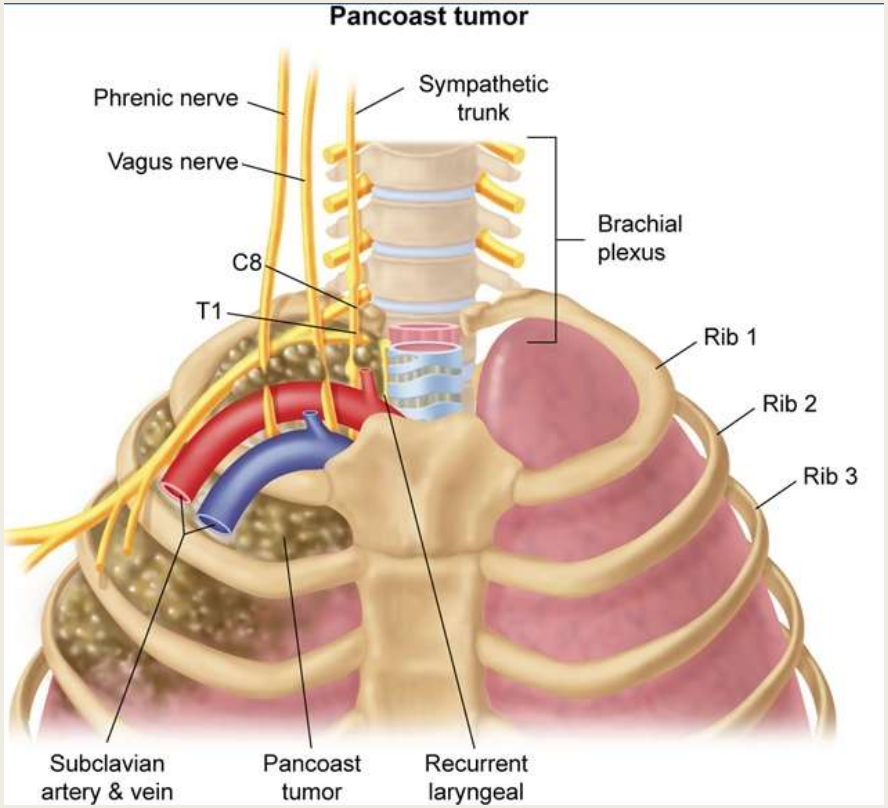
## Medial cutaneous of forearm
- Origin: Medial cord
- Spinal segments: C8,T1
- Function: sensory — Skin on medial side of forearm

## Superior subscapular
- Origin: Posterior cord
- Spinal segments: C5,C6
- Function: motor — Subscapularis



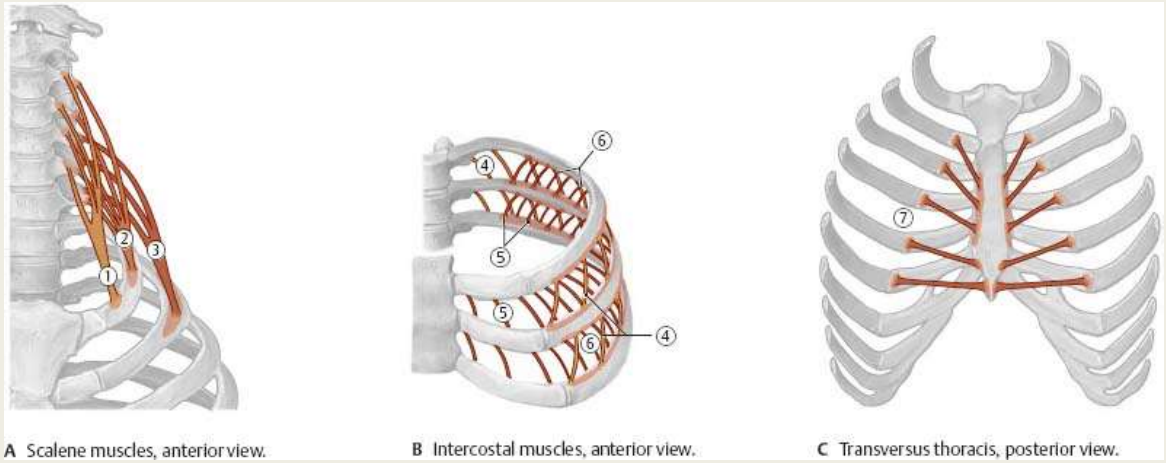
## Median
- Origin: Medial and lateral cords
- Spinal segments: (C5),C6 to T1
- Function: motor — All muscles in the anterior compartment of the forearm (except flexor carpi ulnaris and medial half of flexor digitorum profundus), three thenar muscles of the thumb and two lateral lumbrical muscles




# Pancoast TUMORS

# Intrinsic muscles of chest wall




A Scalene muscles, anterior view. B Intercostal muscles, anterior view. C Transversus thoracis, posterior view.

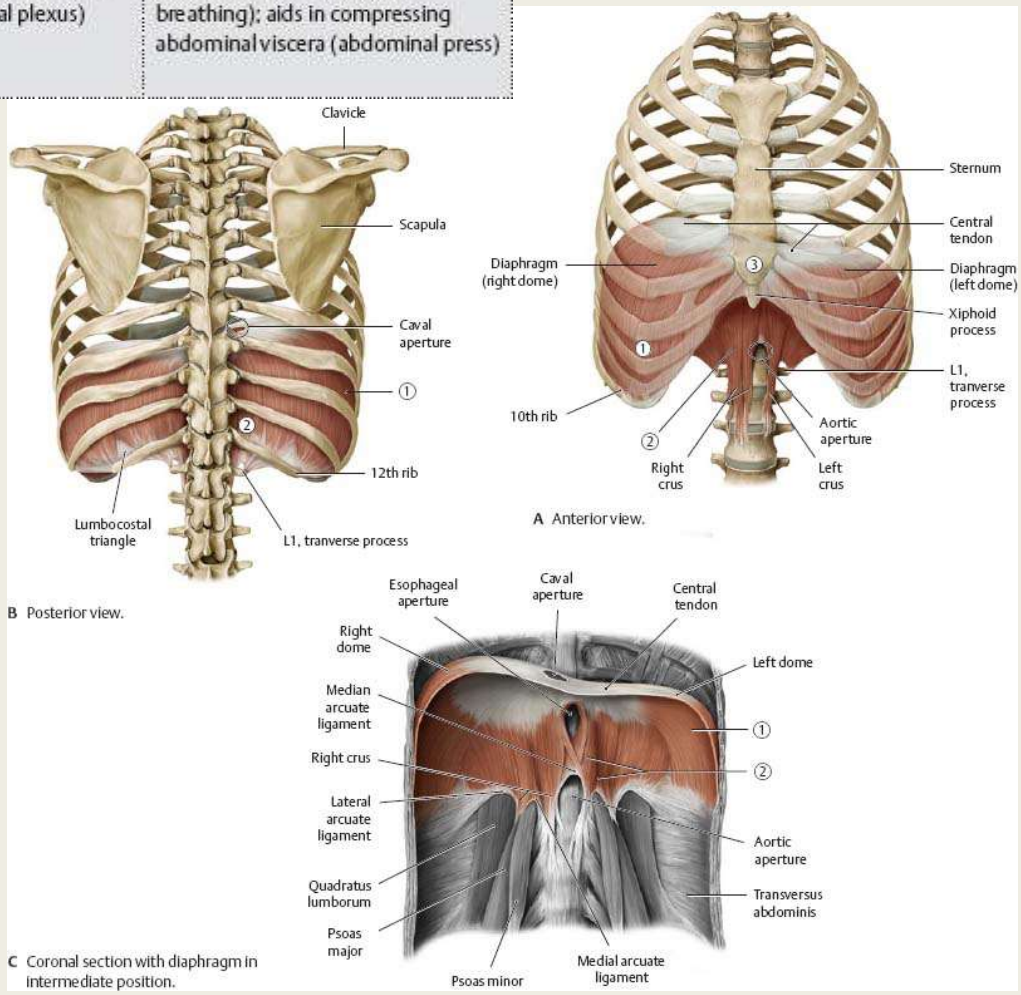
**Table 5.2 Muscles of the thoracic wall**

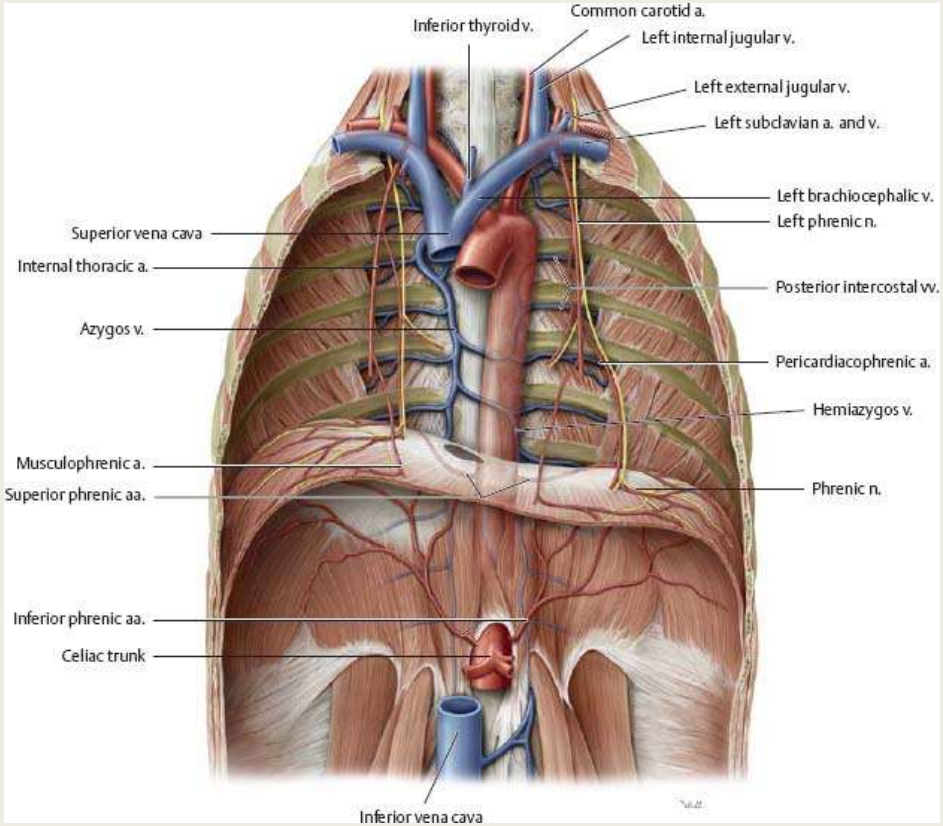
| Muscle | | Origin | Insertion | Innervation | Action |
|---|---|---|---|---|---|
| Scalene | ① Anterior scalene | C3–C6 (transverse processes, anterior tubercles) | 1st rib (scalene tubercle) | Direct branches from cervical and brachial plexus (C3–C6) | *With ribs mobile*: Raises upper ribs (inspiration)<br>*With ribs fixed*: Bends cervical spine to same side (unilateral); flexes neck (bilateral) |
| | ② Middle scalene | C4–C6 (transverse processes, posterior tubercles) | 1st rib (posterior to groove for subclavian a.) | | |
| | ③ Posterior scalene | | 2nd rib (outer surface) | | |
| Intercostal | ④ External intercostal | Lower margin of rib to upper margin of next lower rib (courses obliquely forward and downward from costal tubercle to chondro-osseous junction) | | 1st to 11th intercostal nn. | Raises ribs (inspiration); supports intercostal spaces; stabilizes chest wall |
| | ⑤ Internal intercostal | Lower margin of rib to lower margin of next lower rib (courses obliquely forward and upward from costal angle to sternum) | | | Lowers ribs (expiration); supports intercostal spaces, stabilizes chest wall |
| | ⑥ Innermost intercostal | | | | |
| Subcostal | | Lower margin of lower ribs to inner surface of ribs two to three ribs below | | Variable lower intercostal nn. | Raises ribs (inspiration) |
| ⑦ Transversus thoracis | | Sternum and xiphoid process (inner surface) | 2nd to 6th ribs (costal cartilage, inner surface) | 2nd to 7th intercostal nn. | Weakly lowers ribs (expiration) |

**Table 5.3 Diaphragm**

| Muscle | | Origin | Insertion | Innervation | Action |
|---|---|---|---|---|---|
| Diaphragm | ① Costal part | 7th to 12th ribs (inner surface; lower margin of costal arch) | Central tendon | Phrenic n. (C3–C5, cervical plexus) | Principal muscle of respiration (diaphragmatic and thoracic breathing); aids in compressing abdominal viscera (abdominal press) |
| | ② Lumbar part | Medial part: L1–L3 vertebral bodies, intervertebral disks, and anterior longitudinal ligament as right and left crura | | | |
| | | Lateral parts: lateral and medial arcuate ligaments | | | |
| | ③ Sternal part | Xiphoid process (posterior surface) | | | |

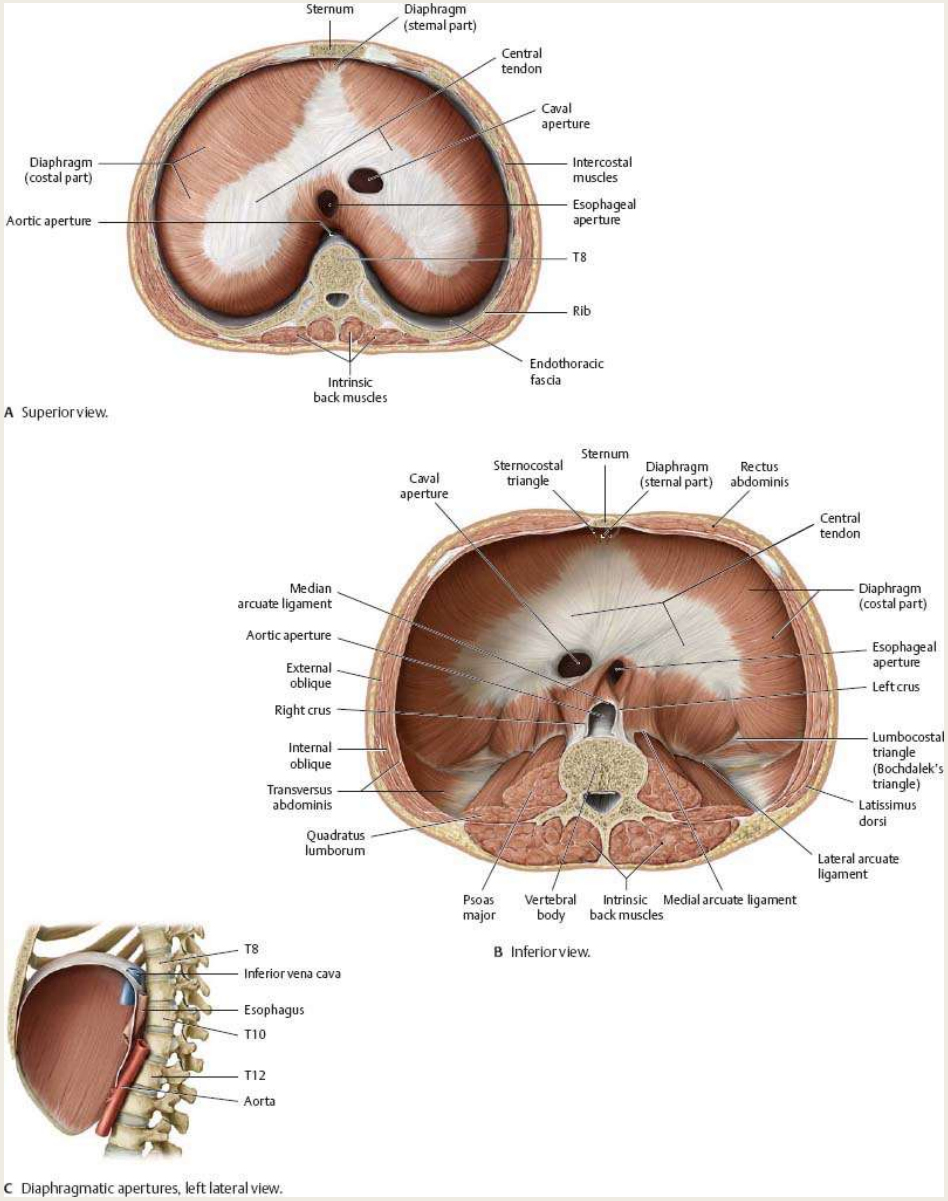
# Diagphram structure



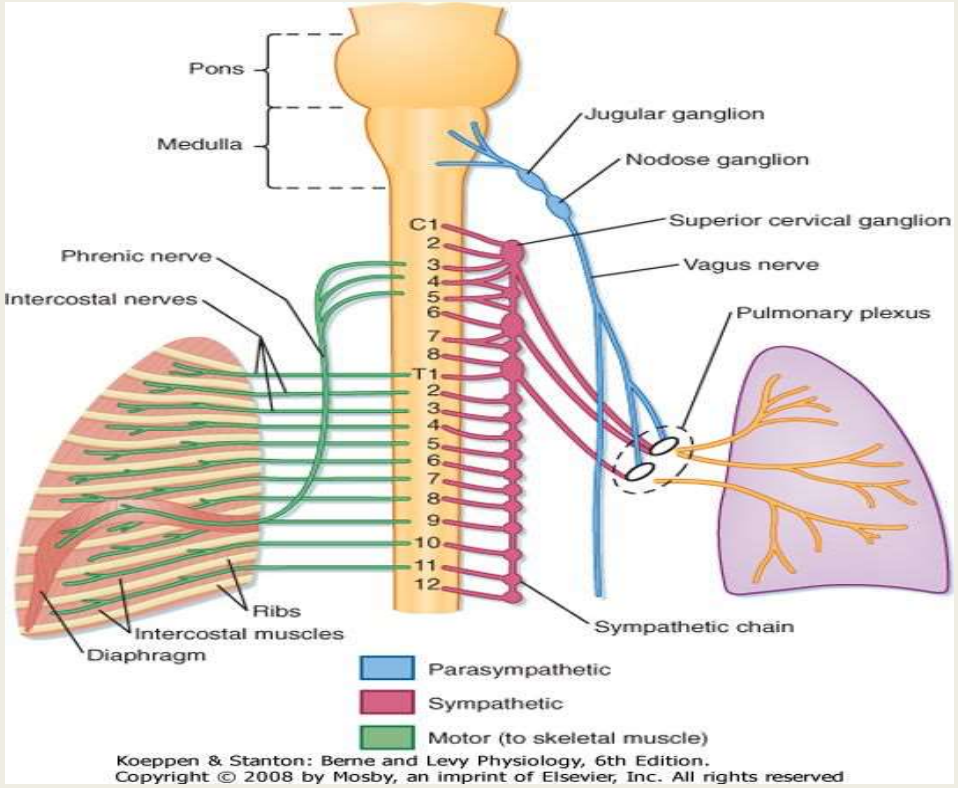


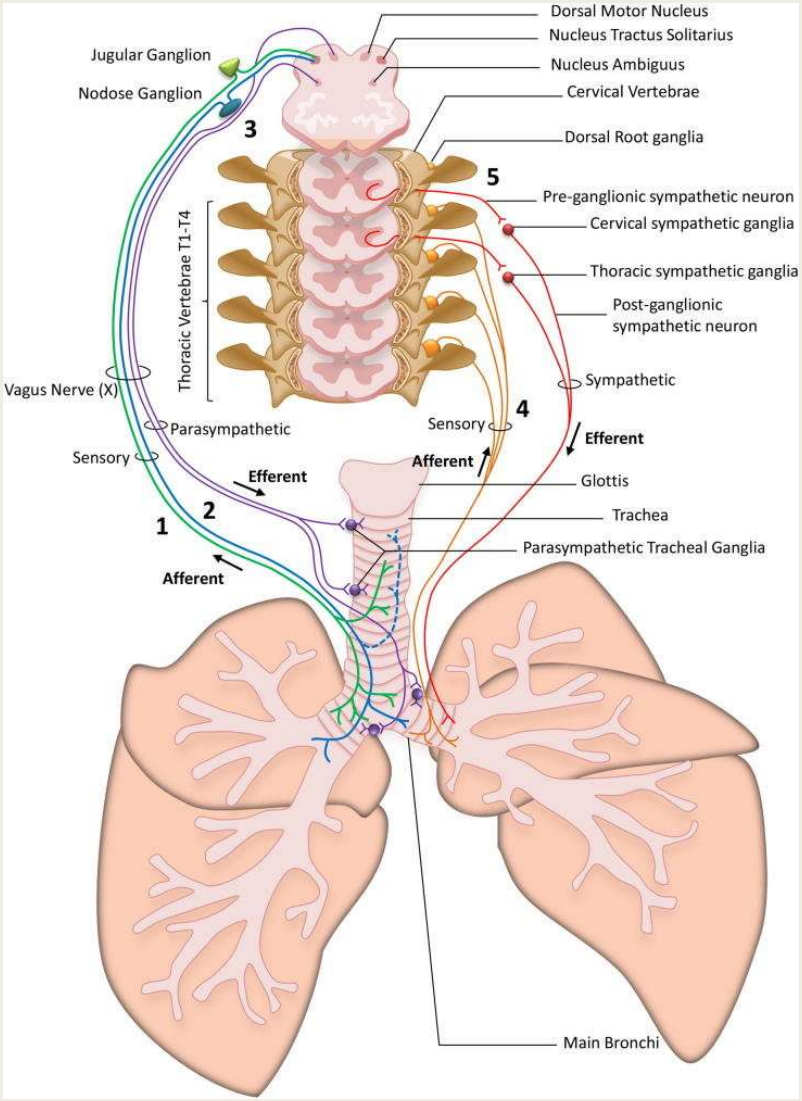

# Diagphram

Vessel supply and apertures



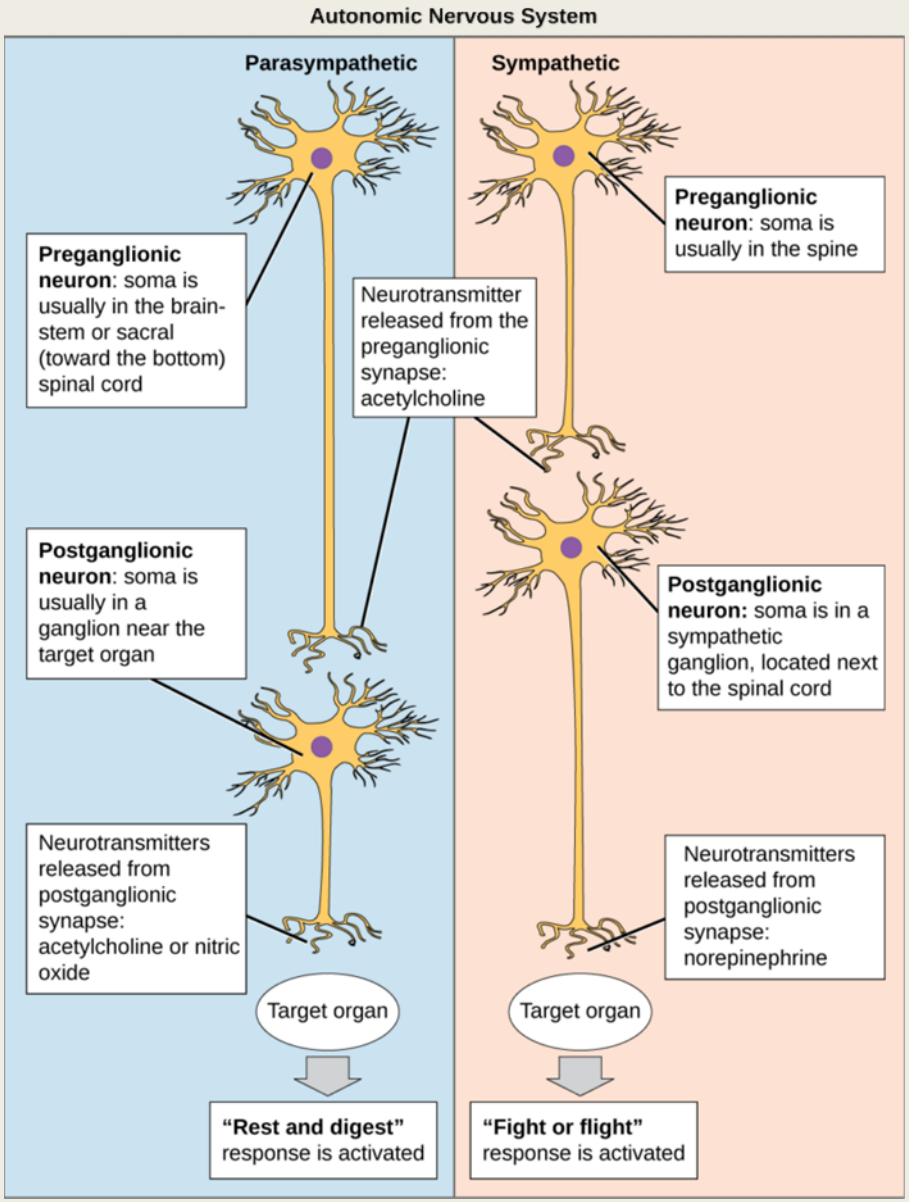
# The airways are innervated by a dual system of afferent sensory neurons and efferent neurons



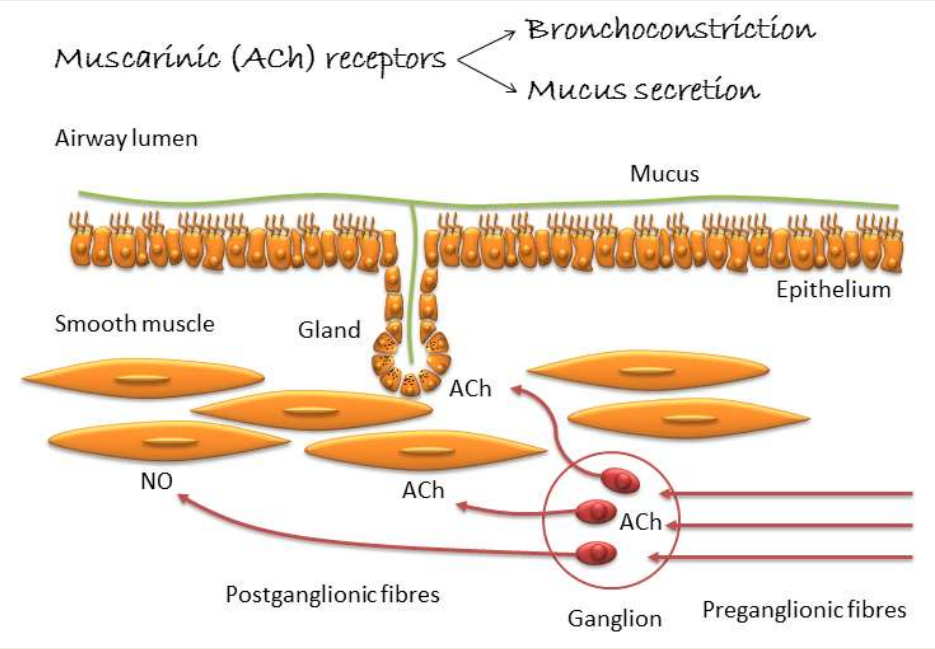



**Vagus nerve** (X) contains:

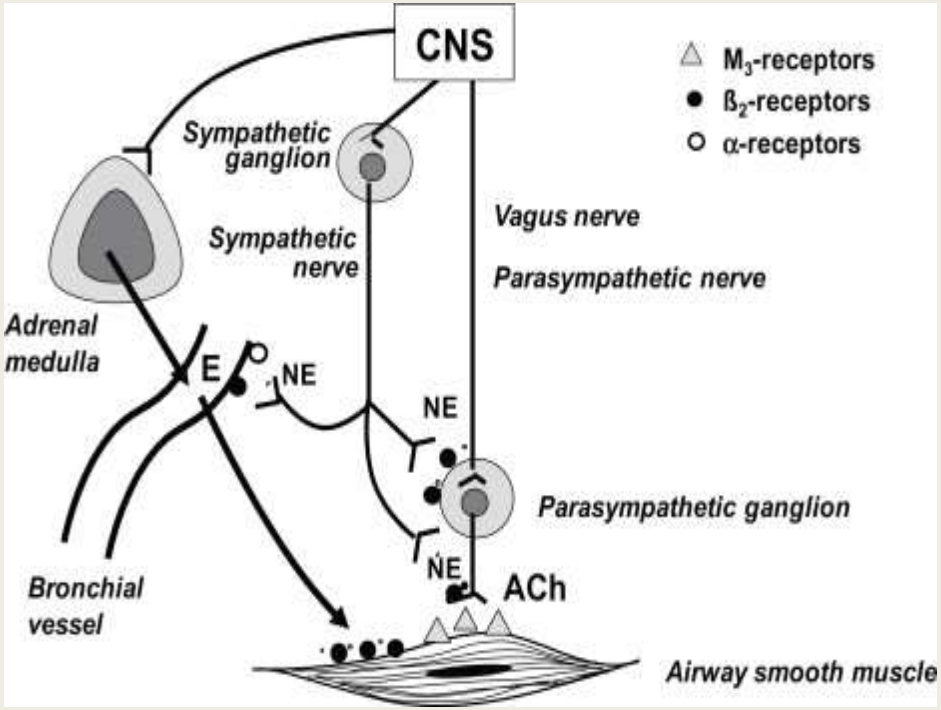
1. Sensory neurons (green line) originating from the sub-cerebral jugular ganglion which innervate the upper and lower airways and project into the nucleus tractus solitarius and
2. Neurons originating from the sub-cerebral nodose ganglia which innervate the lower airway and bronchi (blue line) and 'cough receptor' mechano-sensitive Aδ fibres which innervate the upper airway (dashed blue line) and project to the nucleus tractus solitarius.
3. Two different parasympathetic pathways run alongside the sensory fibres nerves in the vagus nerve (X)


Autonomic Nervous System
Parasympathetic
Sympathetic
Preganglionic neuron: soma is usually in the brain-stem or sacral (toward the bottom) spinal cord
Neurotransmitter released from the preganglionic synapse: acetylcholine
Postganglionic neuron: soma is usually in a ganglion near the target organ
Neurotransmitters released from postganglionic synapse: acetylcholine or nitric oxide
Target organ
"Rest and digest" response is activated
Preganglionic neuron: soma is usually in the spine
Postganglionic neuron: soma is in a sympathetic ganglion, located next to the spinal cord
Neurotransmitters released from postganglionic synapse: norepinephrine
Target organ
"Fight or flight" response is activated

Pre-ganglionic Parasympathetic neurons originating from the nucleus ambiguous and the dorsal motor nucleus in the brainstem respectively innervate postganglionic cholinergic neurons located in tracheal parasympathetic ganglia. These parasympathetic ganglia regulate bronchial tone and mucus secretion.

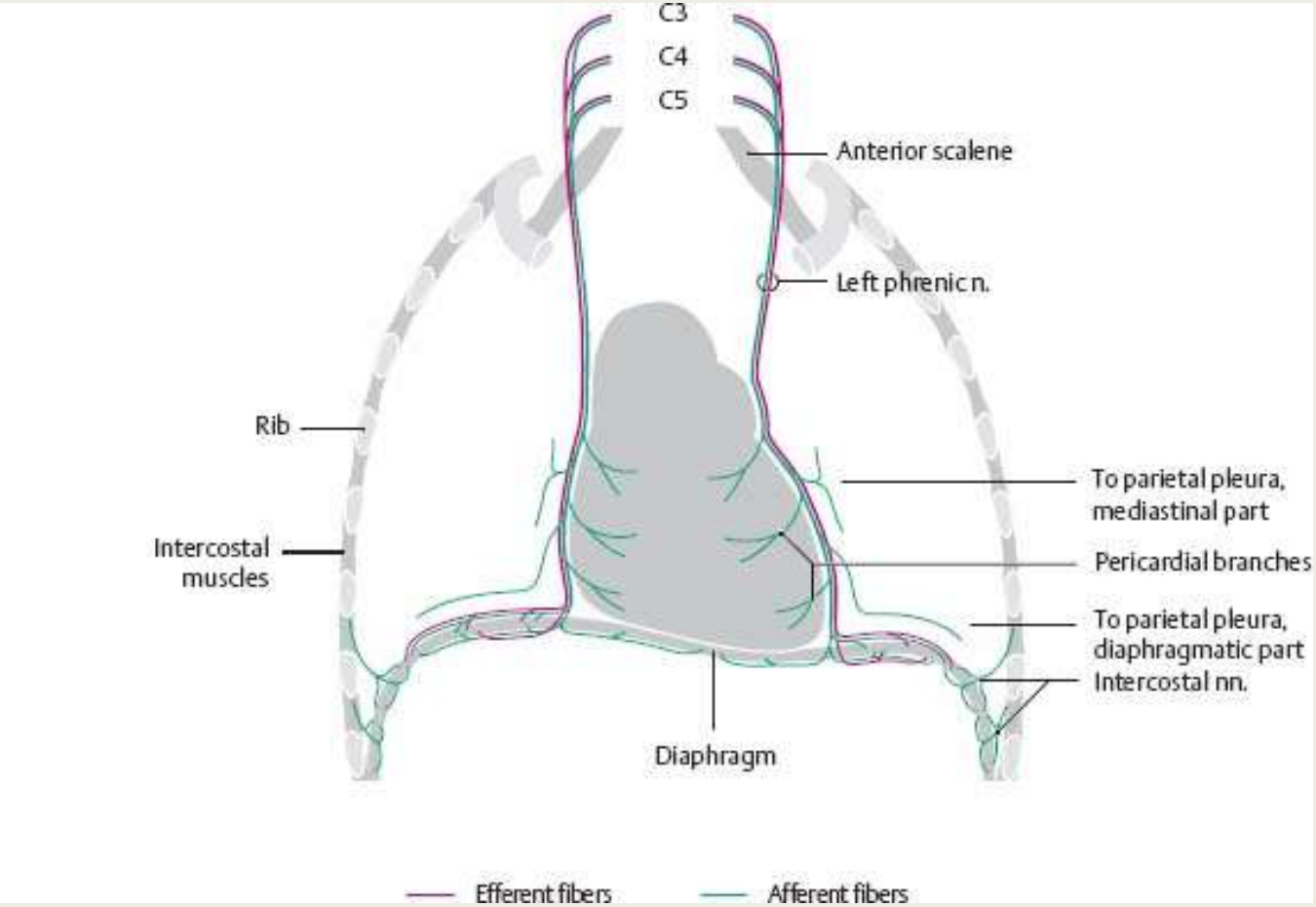


Nerves originating from the spinal cord also innervate the airways with (4) sensory neurons originating from the dorsal root ganglia in thoracic vertebrae T1 to T4 which innervate the lower airways and bronchi




**Sympathetic neurons** derived from the cervical and thoracic spinal cord respectively project to sympathetic neurones located in the cervical and thoracic ganglia. These sympathetic neurons innervate airways controlling blood vasculature but non directly smooth muscles tone.

The **Phrenic nerve** lies on the lateral surface of the fibrous pericardium together with the pericardiacophrenic arteries and veins.



# Phrenic nerve

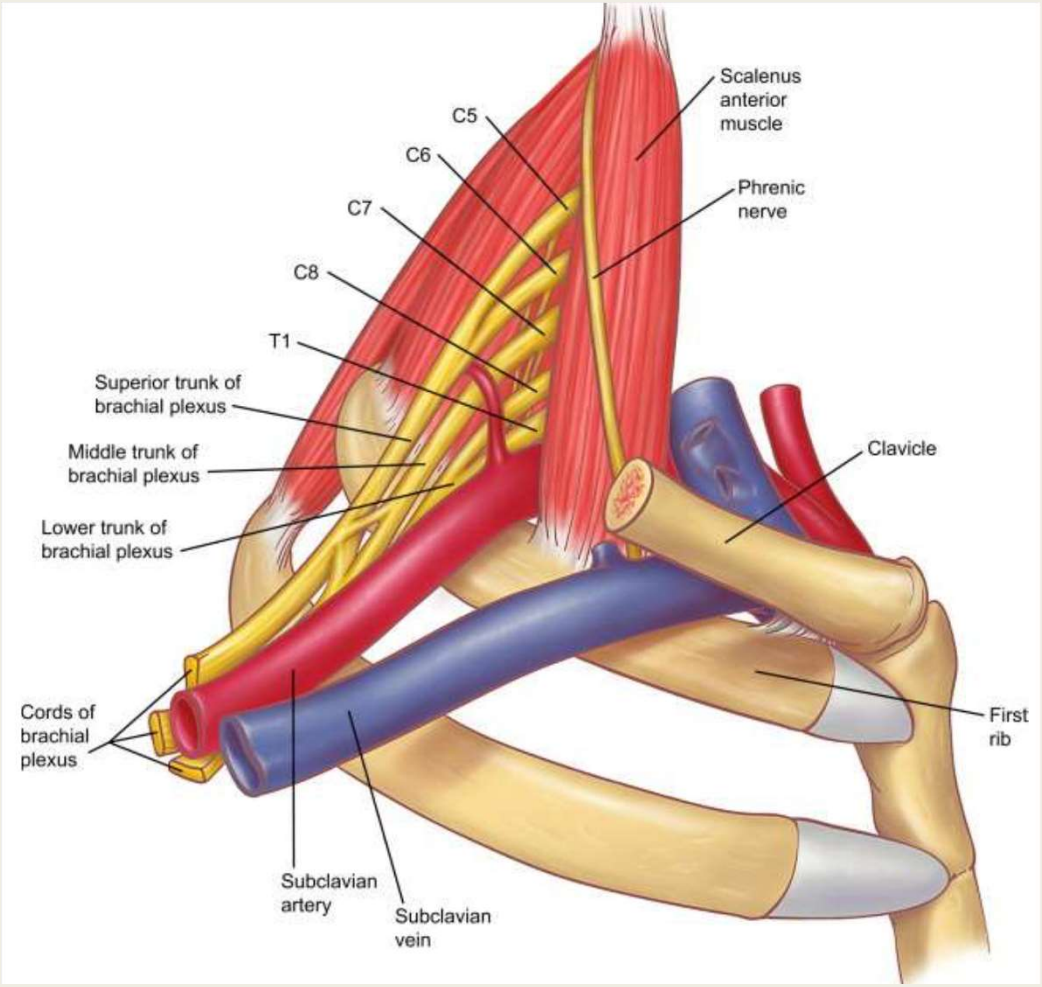
- **Motor Functions**
- The phrenic nerve provides motor innervation to the **diaphragm**; the main muscle of respiration.
- As the phrenic nerve is a bilateral structure, each nerve supplies the **ipsilateral side** of the diaphragm (i.e. the hemi-diaphragm on the same side as itself).

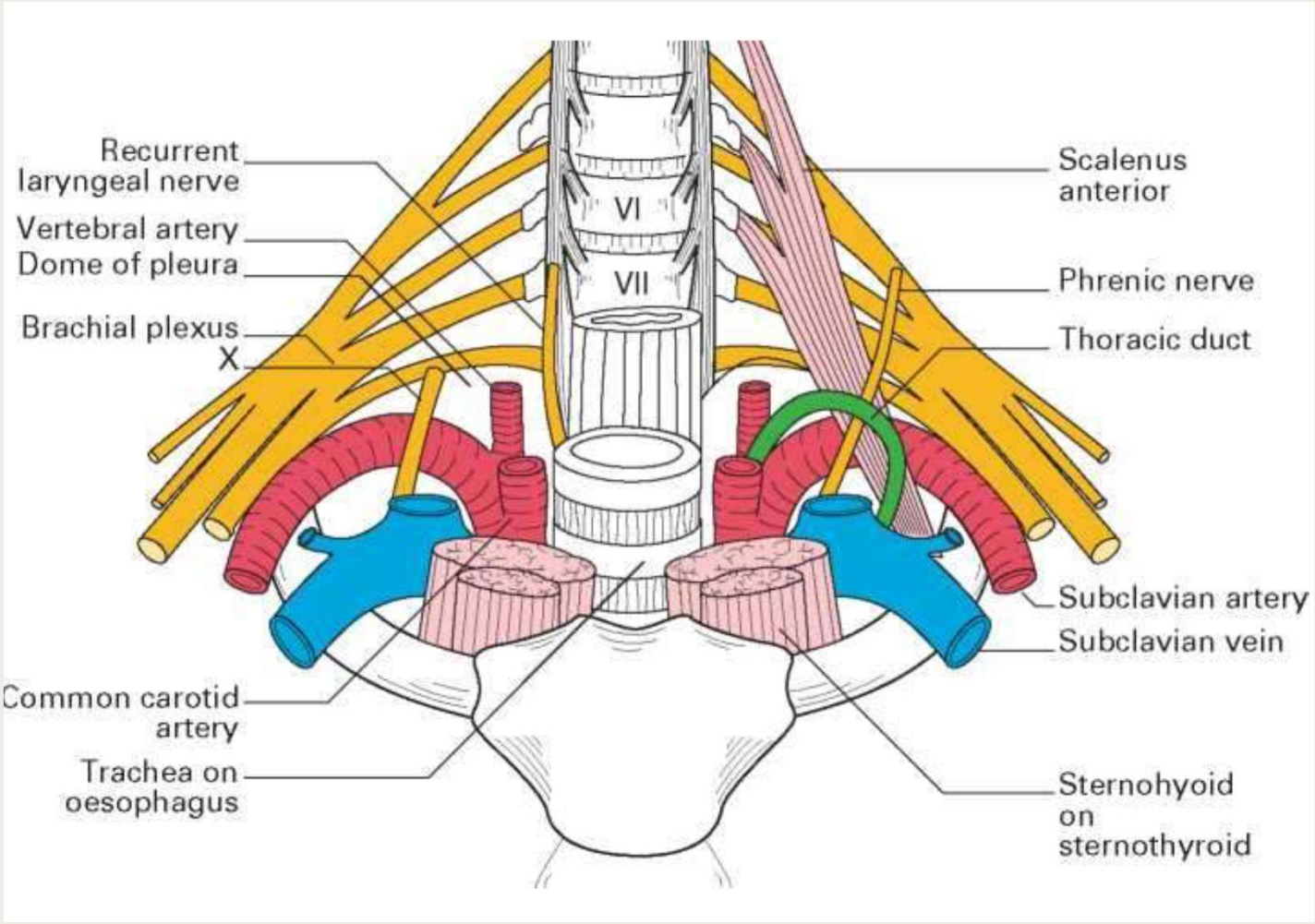
# Phrenic nerve

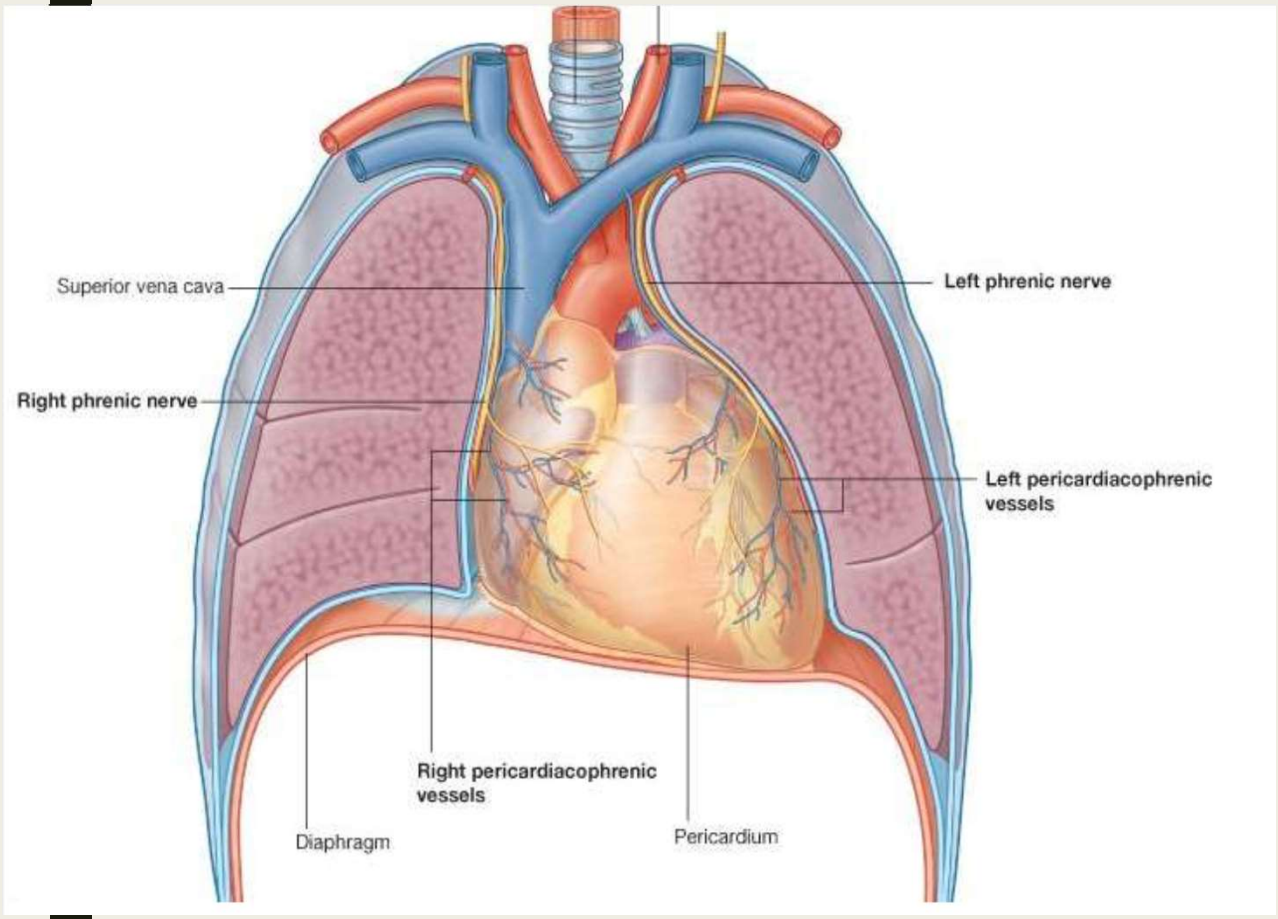
- **Sensory Functions**
- Sensory fibres from the phrenic nerve supply the central part of the diaphragm, including the (diaphragmatic) **pleura** and **peritoneum**.
- The nerve also supplies sensation to:
  - The **mediastinal pleura** and
  - The **pericardium.**

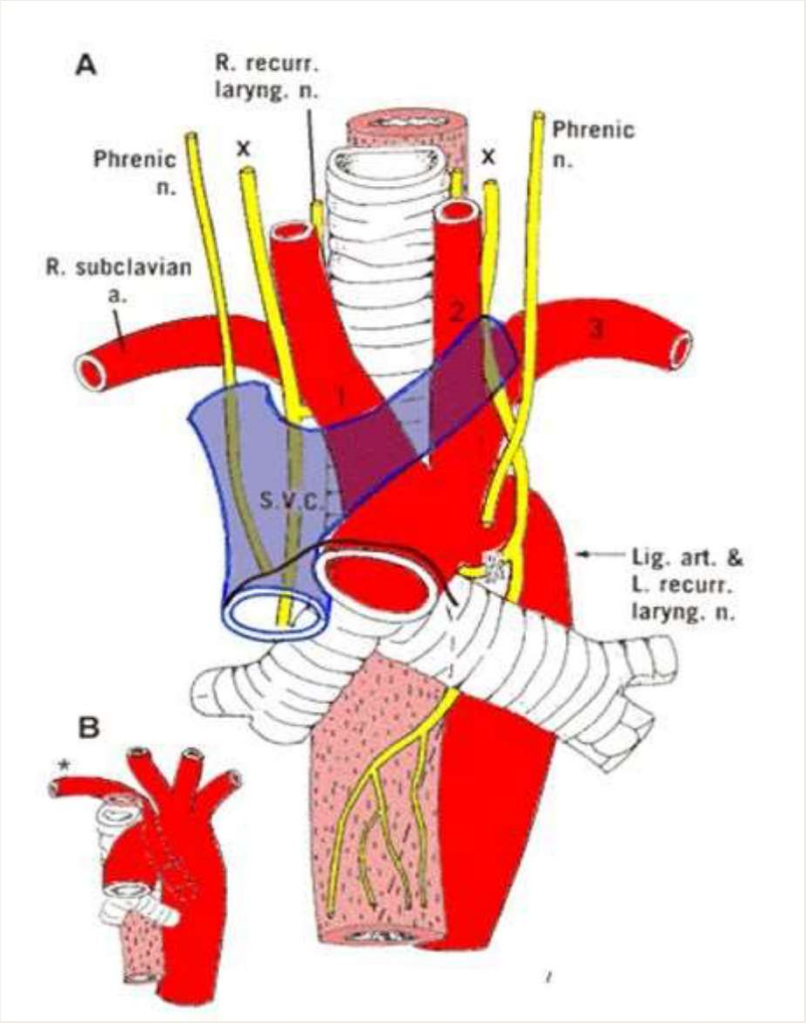
# Phrenic nerve

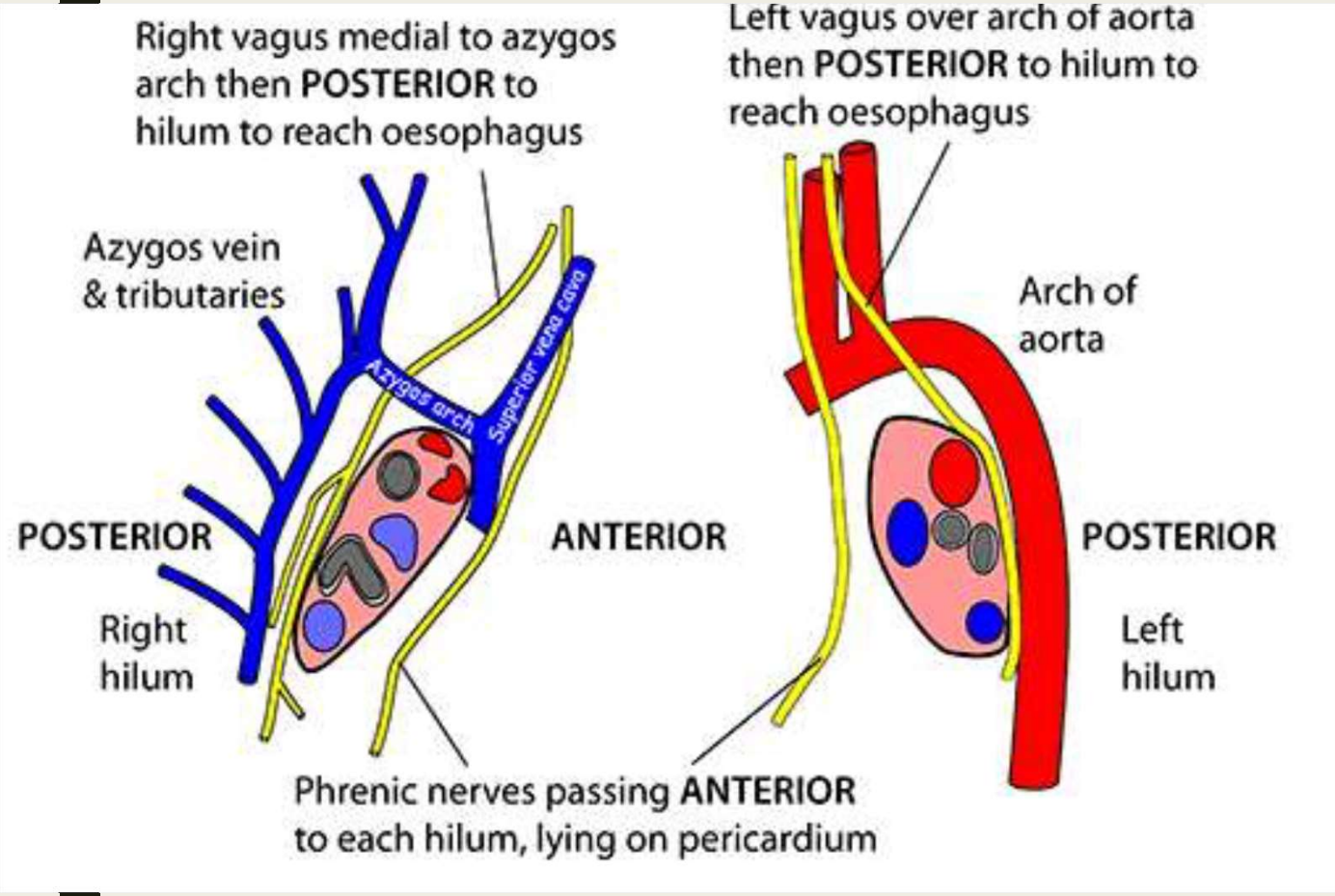
- **ORIGIN**
- The point of origin is from **ventral rami** of C3, C4 and C5 but primarily from C4.
- (the root from C5 may reach the phrenic nerve directly or from the nerve to subclavius muscle)
- **COURSE**
- It runs vertically downwards on the anterior surface of the scalenus anterior, which it crosses obliquely from lateral to medial side.
- Afterward it runs downwards on the **cervical pleura** to go into the **thorax** behind first costal cartilage.


Scalenus anterior muscle
C5
C6
C7
C8
T1
Phrenic nerve
Superior trunk of brachial plexus
Middle trunk of brachial plexus
Lower trunk of brachial plexus
Clavicle
Cords of brachial plexus
First rib
Subclavian artery
Subclavian vein


Recurrent laryngeal nerve
Vertebral artery
Dome of pleura
Brachial plexus
X
VI
VII
Scalenus anterior
Phrenic nerve
Thoracic duct
Subclavian artery
Subclavian vein
Common carotid artery
Trachea on oesophagus
Sternohyoid on sternothyroid

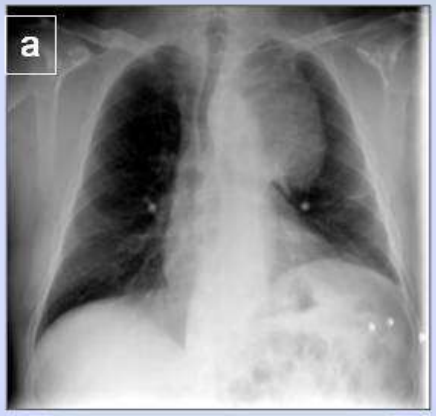

Superior vena cava
Left phrenic nerve
Right phrenic nerve
Left pericardiacophrenic vessels
Right pericardiacophrenic vessels
Diaphragm
Pericardium


A
R. recurr. laryng. n.
Phrenic n.
X
X
Phrenic n.
R. subclavian a.
1
2
3
S.V.C.
Lig. art. & L. recurr. laryng. n.
B


Right vagus medial to azygos arch then POSTERIOR to hilum to reach oesophagus
Left vagus over arch of aorta then POSTERIOR to hilum to reach oesophagus
Azygos vein & tributaries
Azygos arch
Superior vena cava
Arch of aorta
POSTERIOR
ANTERIOR
POSTERIOR
Right hilum
Left hilum
Phrenic nerves passing ANTERIOR to each hilum, lying on pericardium

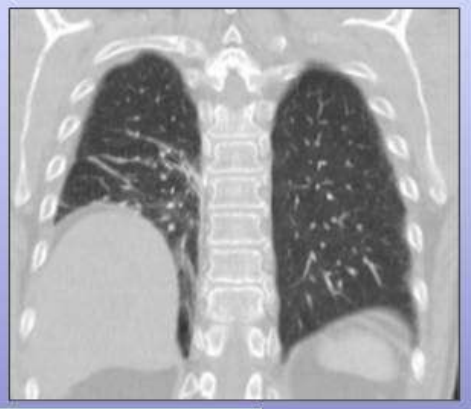
- **Diaphragmatic Paralysis**
- The phrenic nerve provides motor innervation to the diaphragm. If the nerve becomes damaged, paralysis of the diaphragm will result. Causes of phrenic nerve palsy include:
- **Mechanical trauma** – ligation or damage to the nerve during surgery.
- **Compression** – due to a tumour within the chest cavity.
- **Neuropathies** – such diabetic neuropathy.
- Paralysis of the diaphragm produces a **paradoxical movement**. The affected side of the diaphragm moves upwards during inspiration, and downwards during expiration.

Fig. 12 **Unilateral paralysis of diaphragm**




Mediastinal mass


Diaphragmatic paralysis by cardiac surgery

Diaphragmatic dysfunction due to laryngeal surgery

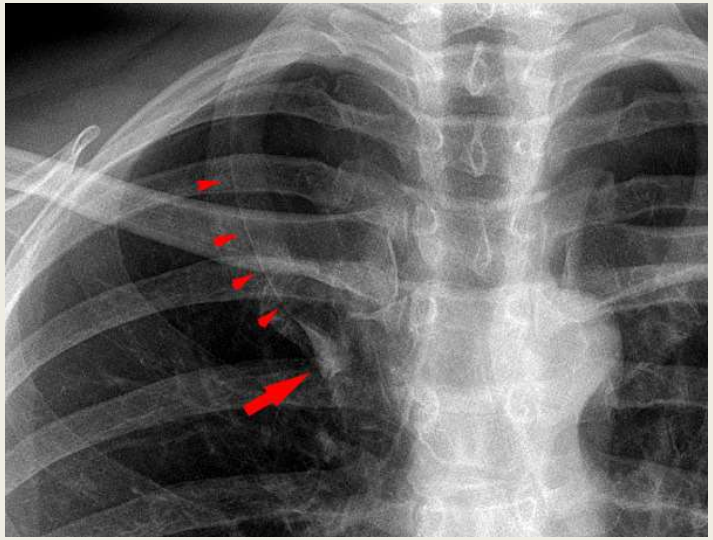
# Anatomical variants

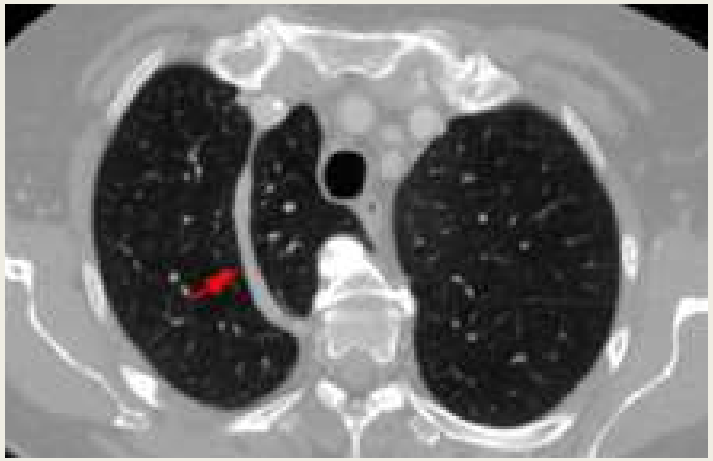
An **Azygos lobe** is a rare, anatomical variant of the upper lobe of the right lung found in approximately 1% of anatomic specimens and 0.4% of chest radiographs

It forms during embryological development when the posterior cardinal vein, the precursor of the upper thoracic segment of the azygos vein, erroneously migrates through the upper lobe of the lung

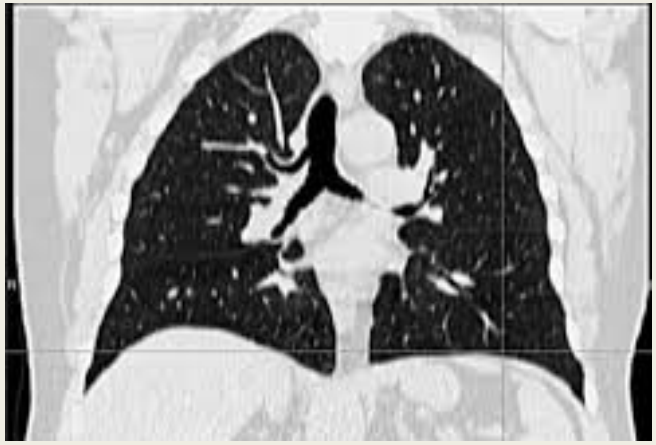
As a result, two pleural layers are carried through the right upper lobe creating a fissure known as the azygos fissure

An azygos lobe is not a true accessory lobe as it does not have a unique bronchus or blood supply

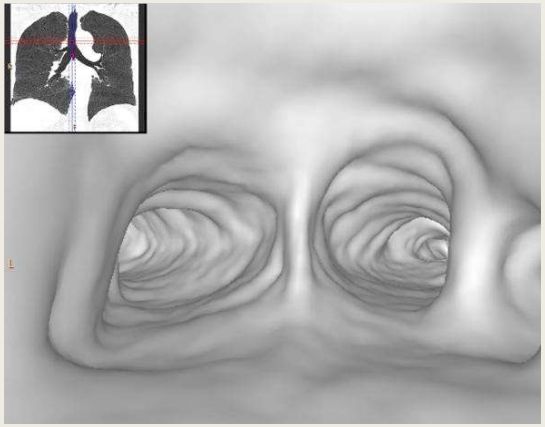


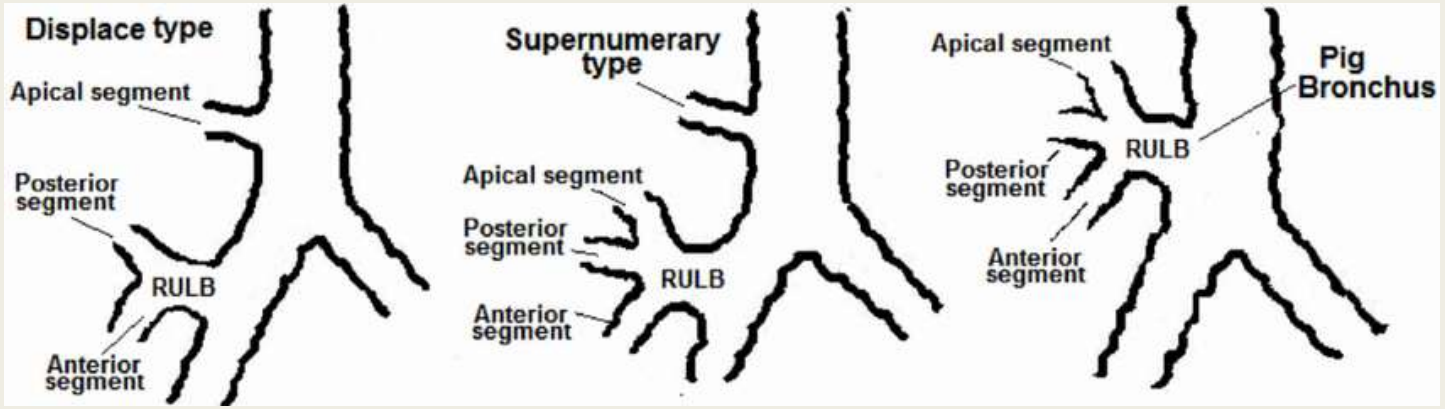


# Tracheal bronchus



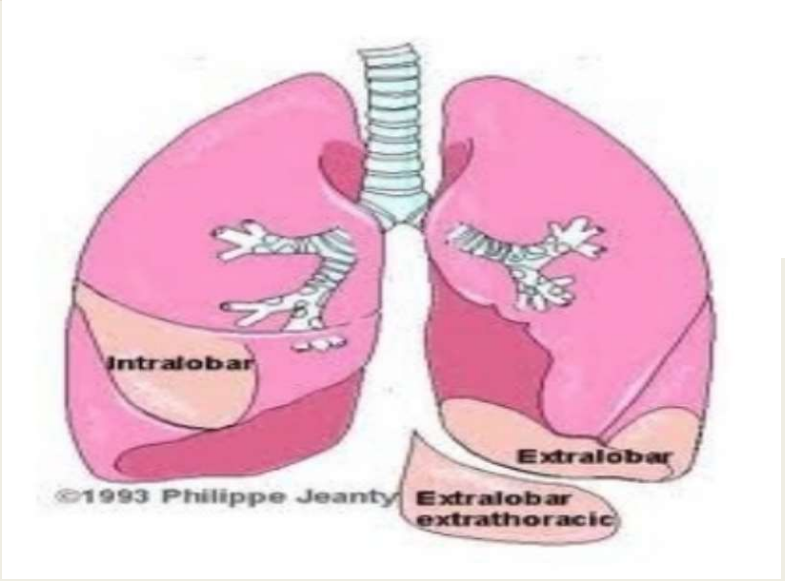
The right upper lobe bronchus with its segmental and subsegmental bronchus originating from the trachea is very rare (0.1 - 2%) and in that case tracheal bronchus is defined as "pig bronchus"





# Congenital lung abnormalities

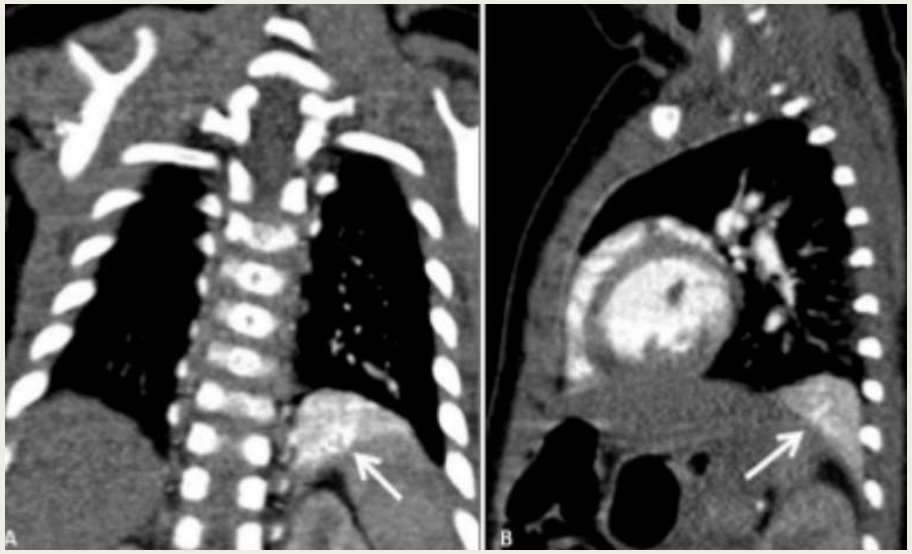
- Pulmonary sequestration is defined as an **aberrant lung tissue mass that has no normal connection with the bronchial tree or with the pulmonary arteries**.
- The arterial blood supply arises from the systemic arteries, usually the **thoracic or abdominal aorta, and its venous drainage is via the azygous system, the pulmonary veins, or the inferior vena cava**.
- Sequestration is divided into **two types**:
  - **Extralobar and Intrapulmonary**

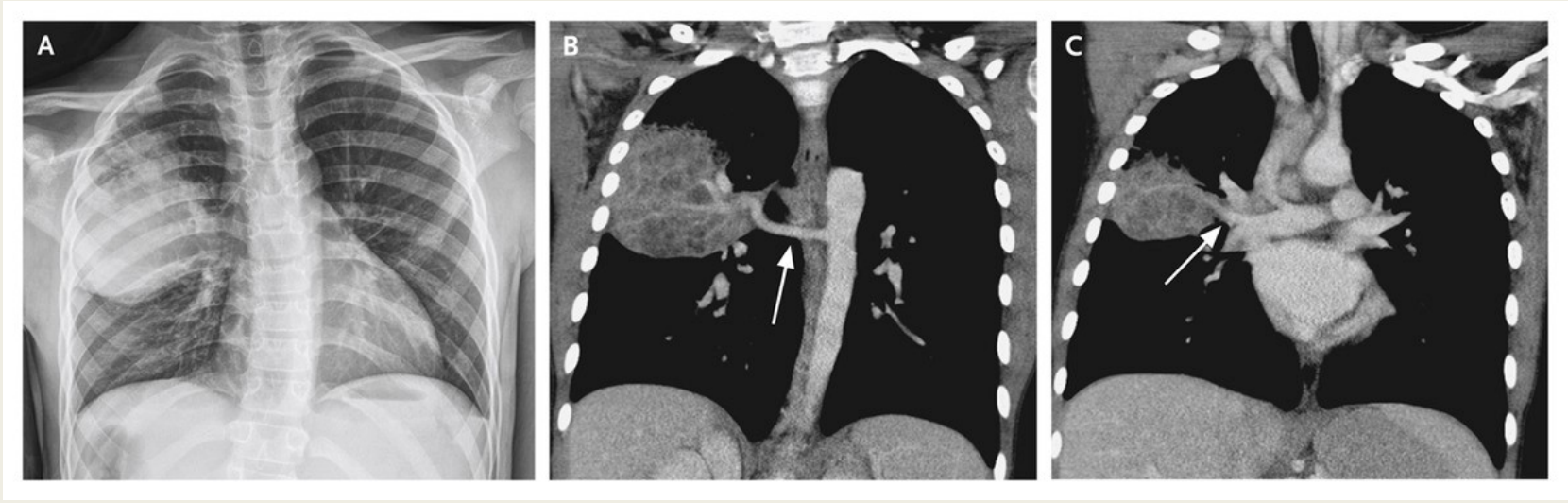



## Bronchopulmonary Sequestration

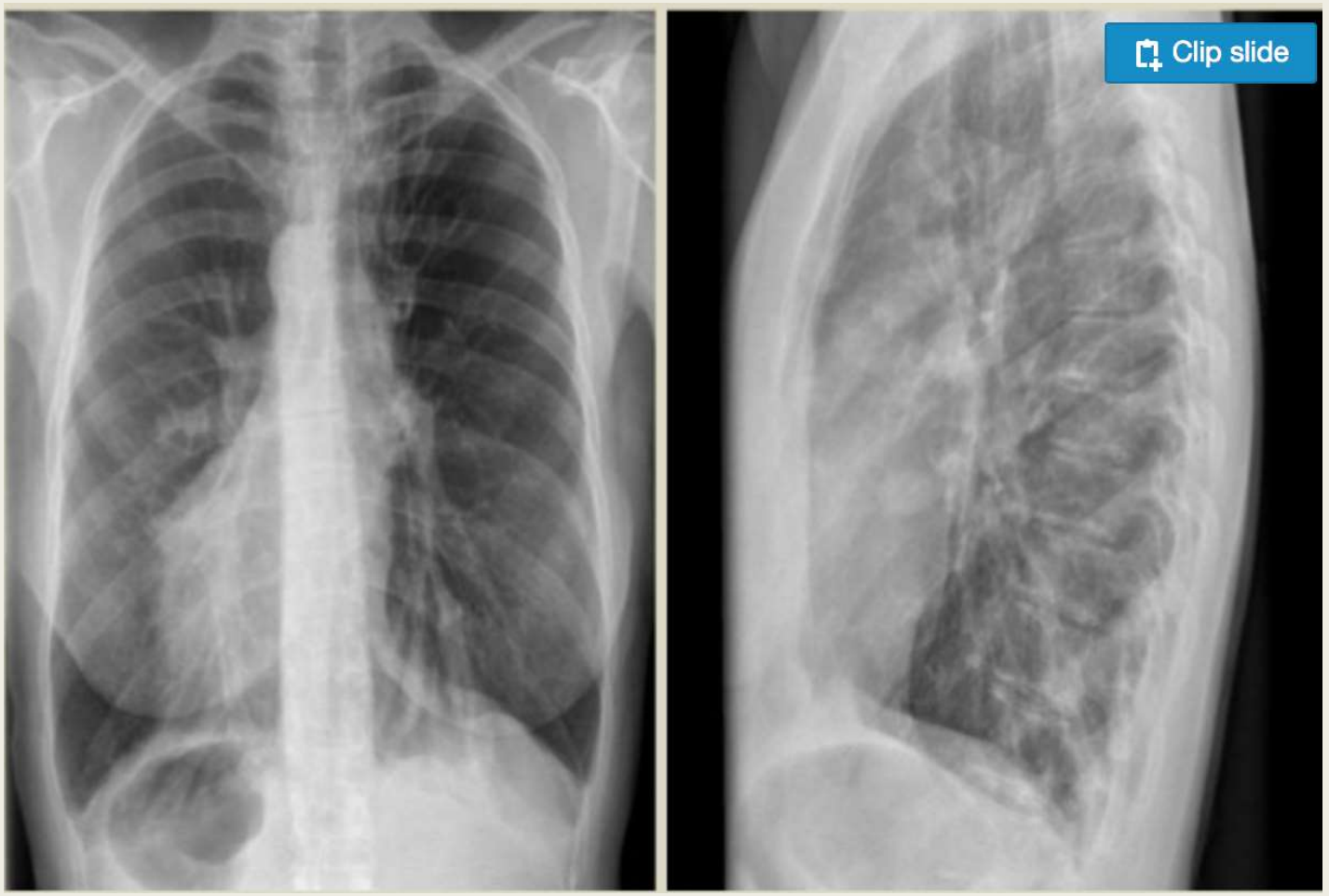
Dysplastic, disorganized and nonfunctioning pulmonary parenchyma without a normal arterial or bronchial connection

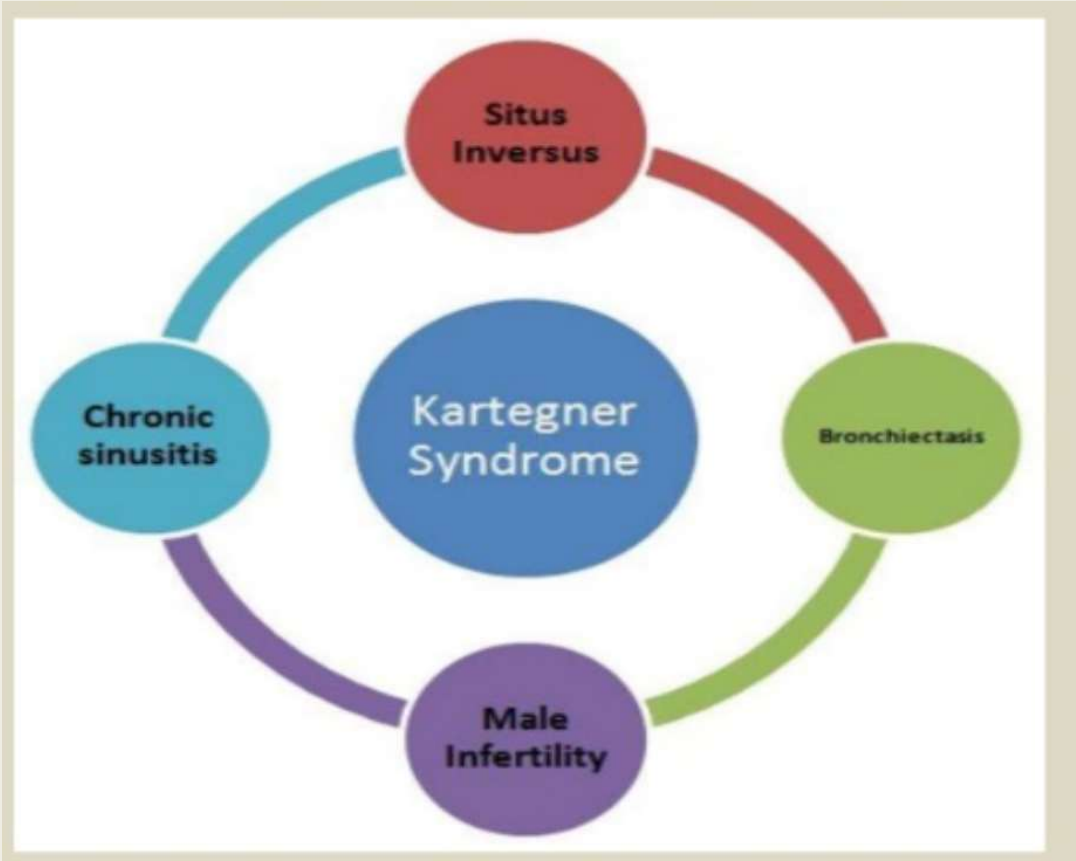
| | |
|---|---|
| **Intralobar sequestration** | Shared pleura with one of the lobes |
| **Extralobar sequestration** | Invested in its own pleura |




A
B
C

## Situs viscerum inversus






Prevalence of diagnosis ranged from 1:10.000 to 1:20.000 live-born children
Median age at diagnosis is 5.3 years