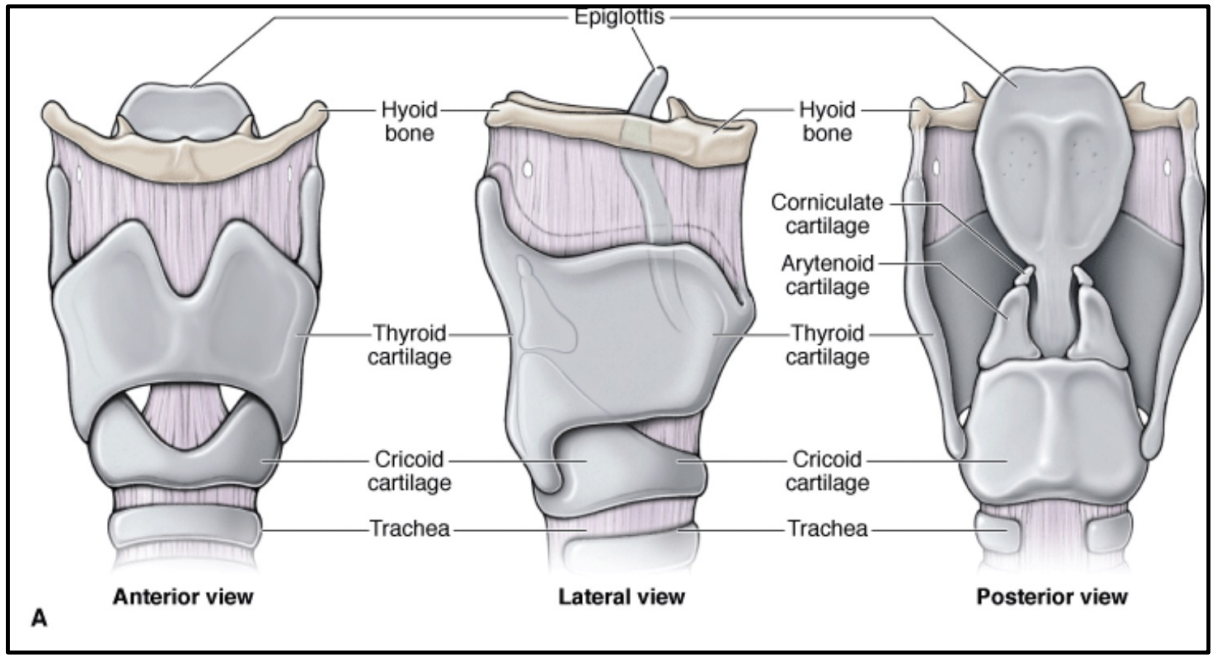
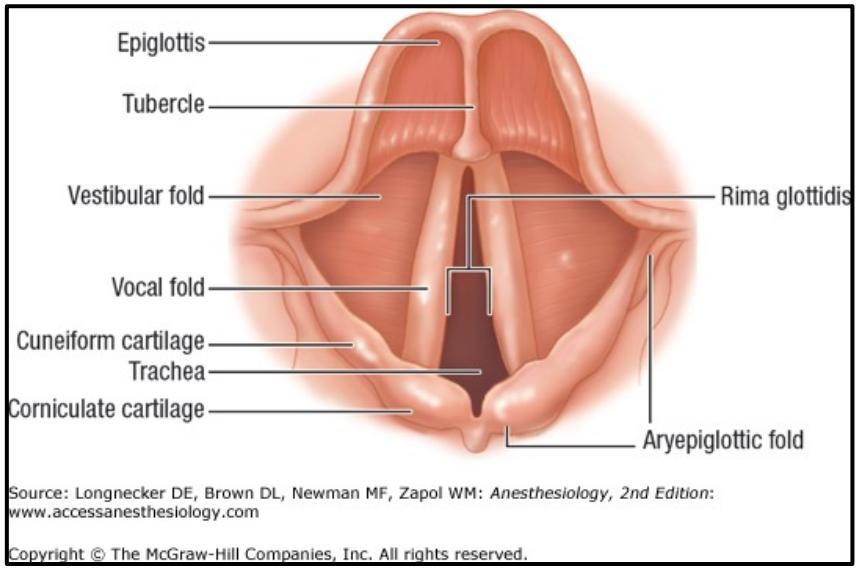
PowerPoint Handout: Lab 3, Thorax

Larynx: Introduction (Review MBB)

- The **larynx** is an air passageway that connects the laryngopharynx to the trachea.
- Its main functions are to maintain a patent airway, phonation, and to prevent food from entering the air passageways.
- It is composed of nine cartilages (3 paired and 3 unpaired) connected by ligaments and membranes.
  - The **thyroid cartilage** is the largest cartilage forming the larynx. It is unpaired and is composed of two large plates that are joined anteriorly to form a protrusion called the **laryngeal prominence** (Adam's apple).
  - The **cricoid cartilage** is an unpaired cartilage inferior to thyroid cartilage. It forms a complete ring around the larynx and is connected by ligaments to both the thyroid cartilage and the trachea. It is located at the level of the C6 vertebra. Its inferior edge delineates the boundary between the larynx and the trachea of the respiratory tract, and between the pharynx and the esophagus of the digestive tract.



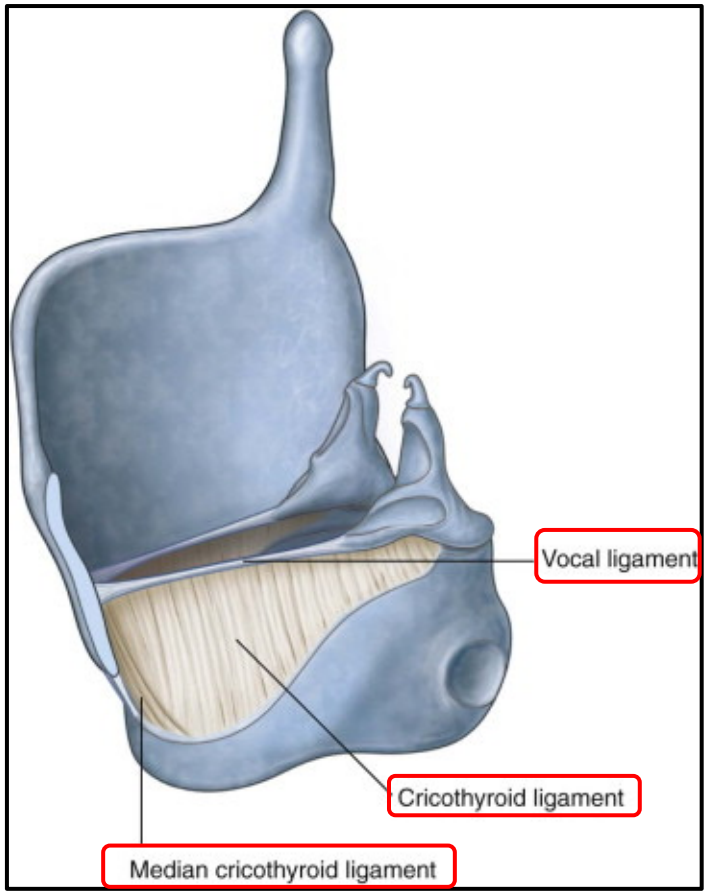
- The **arytenoid cartilages** are paired pyramidal-shaped cartilages that rest on the superior side of the posterior portion of the cricoid cartilage.
- Attached to the apex of each arytenoid cartilage are the **corniculate cartilages**.
- The cuneiform cartilages are 2 small, club-shaped cartilages that lie anterior to the corniculate cartilages in the aryepiglottic folds. They form small, whitish elevations on the surface of the mucous membrane just anterior of the arytenoid cartilages.
- The **epiglottis** is an unpaired cartilage of the larynx composed of elastic cartilage, which allows it to be flexible. During swallowing, the epiglottis covers the laryngeal inlet. When not actively swallowing, the unattached end projects superiorly from the larynx and extends into the oropharynx.

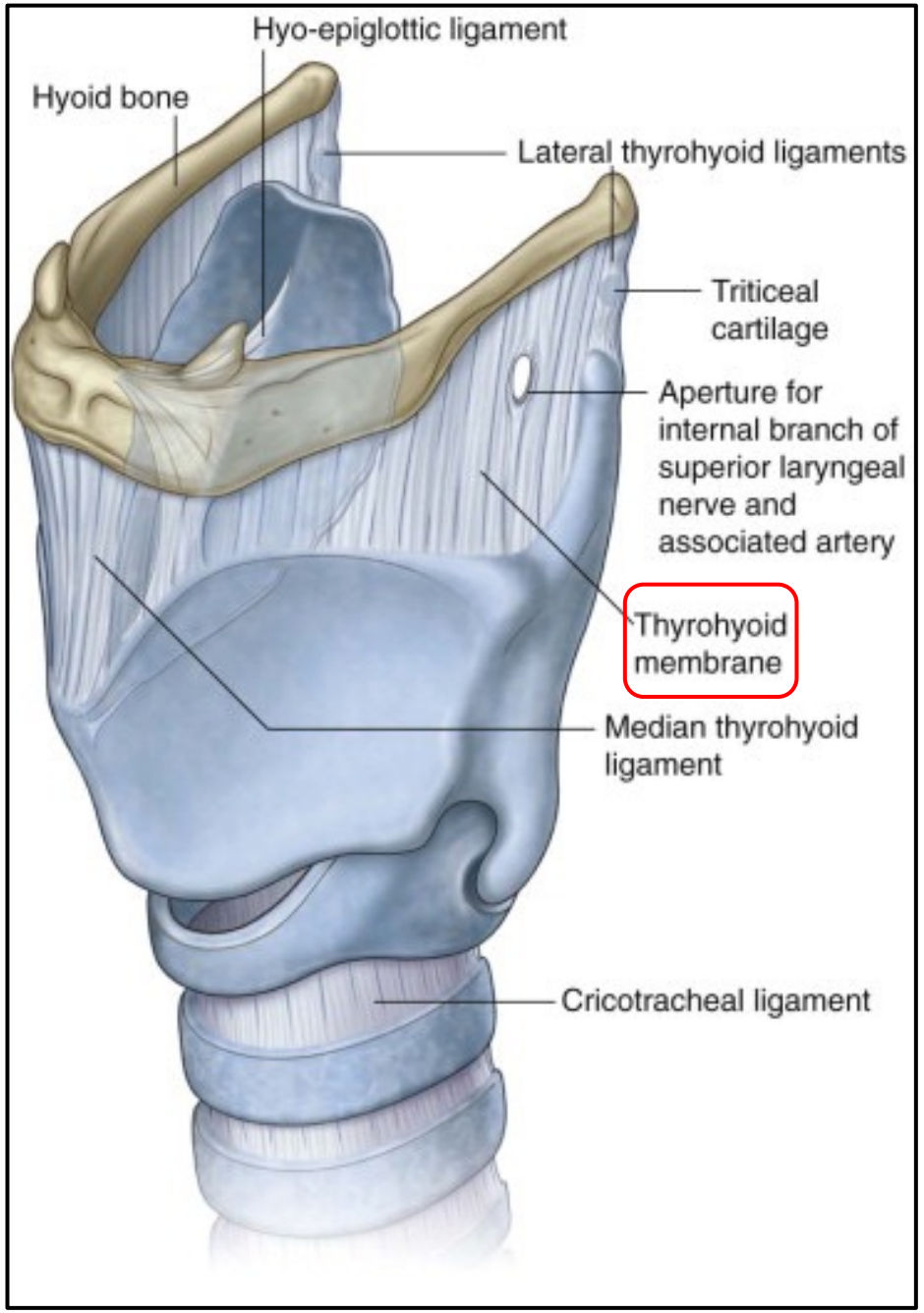


Source: Longnecker DE, Brown DL, Newman MF, Zapol WM: *Anesthesiology, 2nd Edition*: www.accessanesthesiology.com

Larynx: Ligaments (Review MBB)

- The **cricothyroid ligament (membrane)** is thickened anteriorly in the midline to form the median cricothyroid ligament (Figure 2).
- **Thyrohyoid membrane** spans the space between the thyroid cartilage and hyoid bone
- The **vocal ligaments** extend from the posterior side of the junction between the plates of the thyroid cartilage to the base of the arytenoid cartilages. They are involved in the production of sound. We will explore the muscles involved in phonation in the next PowerPoint Handout.





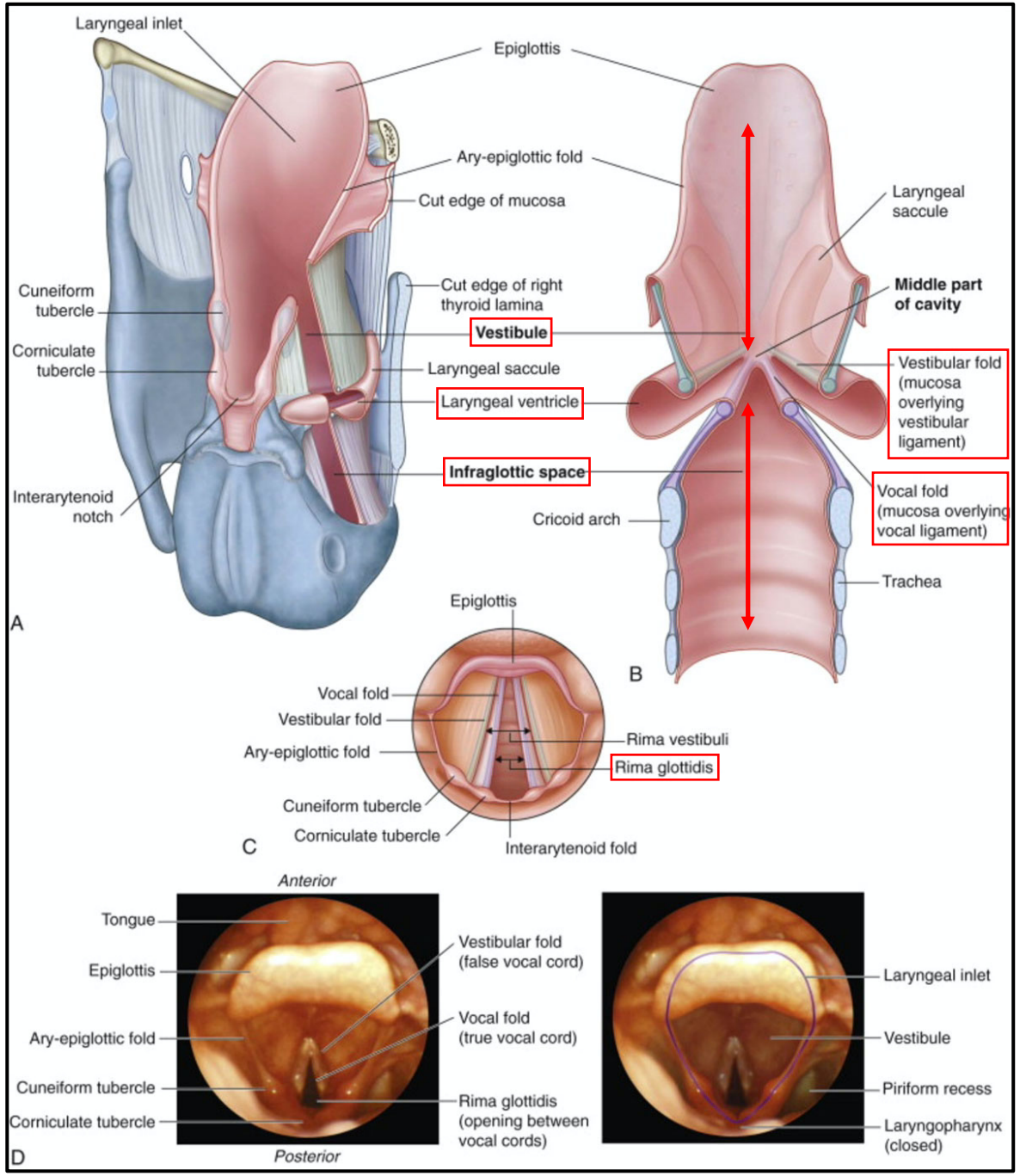
Larynx: Folds and Spaces (Review MBB)

- The **laryngeal inlet** is formed by the following boundaries.
  - The free, curved edge of the epiglottis forms the anterior boundary.
  - The interartytenoid fold (mucous membrane between the arytenoid cartilages) forms the posterior wall.
  - The aryepiglottic fold, spanning between the epiglottis anteriorly and the arytenoid cartilage posteriorly, forms the lateral border.

- The **vocal fold** is a mucosal fold created by the underling **vocal ligament**.
- The **false vocal fold (vestibular or ventricular fold)** is a fold of tissue superior to the true vocal fold that is not involved in the production of sound.
- The **laryngeal ventricle** is a recessed region within each lateral wall of the larynx located between the false vocal fold superiorly and the true vocal fold inferiorly.
- The space between the vocal folds is called rima glottidis.
  - The term **glottis** refers to the paired vocal folds (true vocal fold/cord) AND the space between them (rima glottidis) .

Spaces separated by the ventricle

- The region of the laryngeal cavity between the laryngeal inlet and the ventricle is the **laryngeal vestibule**.
- The region of the larynx inferior to the vocal folds is the **infraglottic space**.

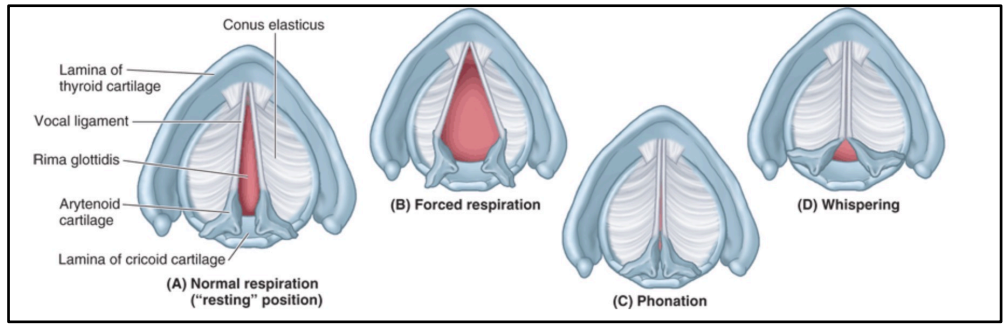


Laryngeal Muscles (Review MBB)

Muscles the move the larynx are categorized as extrinsic or intrinsic.

- Extrinsic laryngeal muscles move the entire larynx superiorly or inferiorly (swallowing). Suprahyoid muscles, infrahyoid muscles, and stylopharyngeus are examples of extrinsic laryngeal muscles.
- **Intrinsic laryngeal muscles** move individual components of the larynx, which leads to altering the shape of the rima glottidis, length of vocal ligament, and/or tension on the vocal ligament.
    - Note: All intrinsic laryngeal muscles are innervated by the **recurrent laryngeal nerve** EXCEPT for the **cricothyroid muscle**, which is innervated by the **external branch of the superior laryngeal nerve**.

FUNCTIONAL ANATOMY: Variation in the tension and length of the vocal ligaments, in the width of the rima glottidis, and the intensity of the expiratory effort produces changes in the pitch of the voice. The lower range of pitch in postpubescent males results from the greater length of the vocal ligaments.

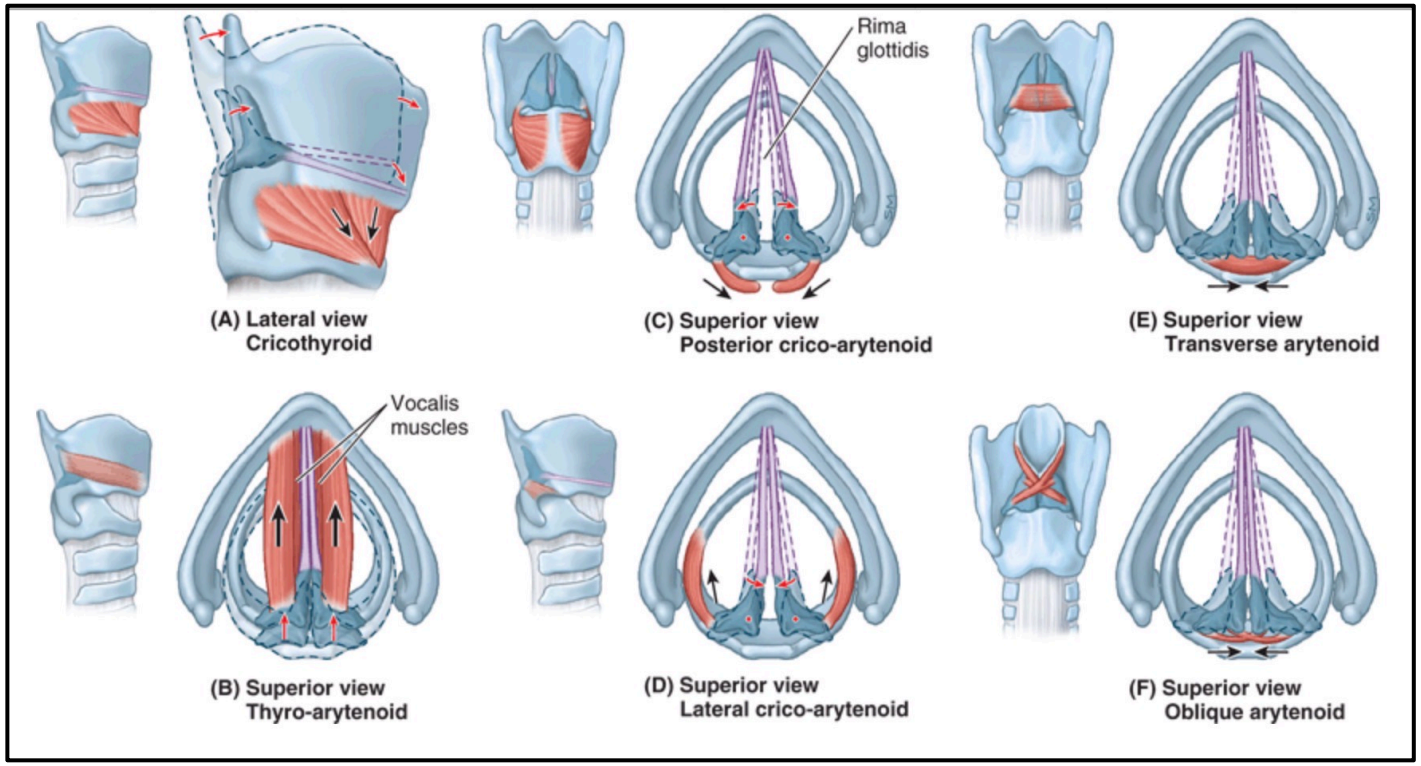


CLINICAL ANATOMY: Bilateral loss of the posterior cricoarytenoid muscles causes adduction of the vocal cords, which results in a risk of asphyxiation.

TABLE 8.9 MUSCLES OF LARYNX

	Muscle	*Origin*	*Insertion*	*Innervation*	*Main Action(s)*
*	Cricothyroid	Anterolateral part of cricoid cartilage	Inferior margin and inferior horn of thyroid cartilage	External branch of superior laryngeal nerve (CN X)	Tenses vocal fold
*	Posterior crico-arytenoid	Posterior surface of laminae of cricoid cartilage	Muscular process of arytenoid cartilage	Recurrent laryngeal nerve (CN X)	Abducts vocal fold
	Lateral crico-arytenoid	Arch of cricoid cartilage			Adducts vocal fold
	Thyro-arytenoid[a]	Posterior surface of thyroid cartilage			Relaxes vocal fold
	Transverse and oblique arytenoids[b]	One arytenoid cartilage	Opposite arytenoid cartilage		Close inlet of larynx by approximating arytenoid cartilages
	Vocalis[c]	Angle between laminae of thyroid cartilage	Vocal ligament, between origin and vocal process of arytenoid cartilage		Alters vocal fold during phonation

[a]Superior fibers of the thyro-arytenoid muscle pass into the ary-epiglottic fold, and some of them reach the epiglottic cartilage. These fibers constitute the thyro-epiglottic muscle, which widens the inlet of the larynx.
[b]Some fibers of the oblique arytenoid muscle continue as the ary-epiglottic muscle.
[c]This slender muscular slip is derived from inferior deeper fibers of the thyro-arytenoid muscle.



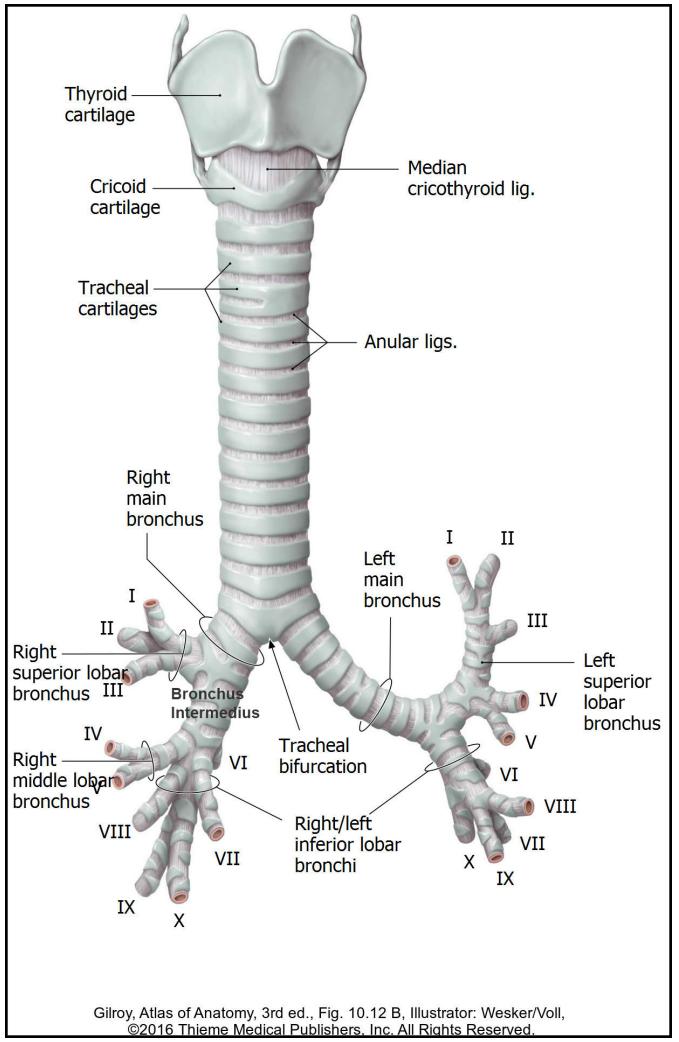
Trachea

The **trachea** (windpipe) extends from the inferior end of the larynx into the mediastinum of the thoracic cavity where it bifurcates (divides) into a right and left main bronchus.

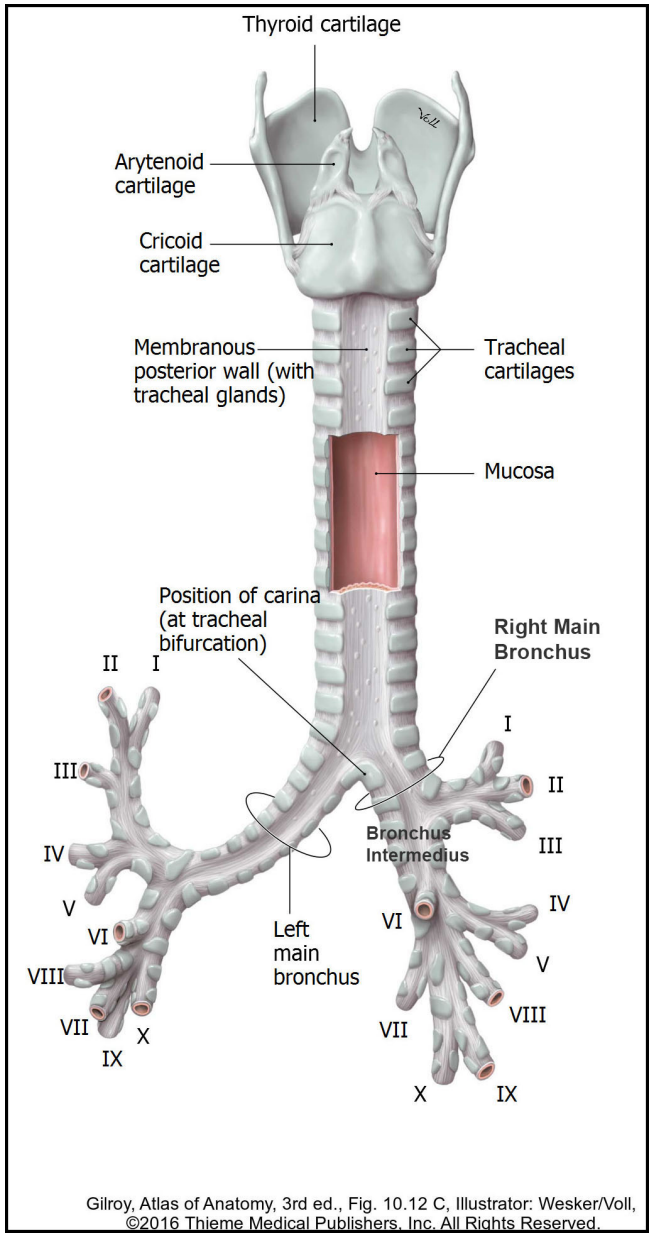
- The termination point of the trachea is at the level of the body where the manubrium meets the body of the sternum.

- The tracheal wall consists of **"C" shaped cartilaginous rings** of hyaline cartilage that maintain the trachea as a patent tube (an open passageway). The function of the tracheal rings (and the cricoid cartilage as well) is to keep the airway patent during inspiration.

- The ends of the cartilage in the wall of the trachea are joined by smooth muscle called the **trachealis muscle**. The trachealis muscle contracts during coughing to decrease the lumenal diameter, which increases the velocity of air moving through the trachea to assist with movement of mucus or a foreign substance toward the throat.



Gilroy, Atlas of Anatomy, 3rd ed., Fig. 10.12 B, Illustrator: Wesker/Voll, ©2016 Thieme Medical Publishers, Inc. All Rights Reserved.



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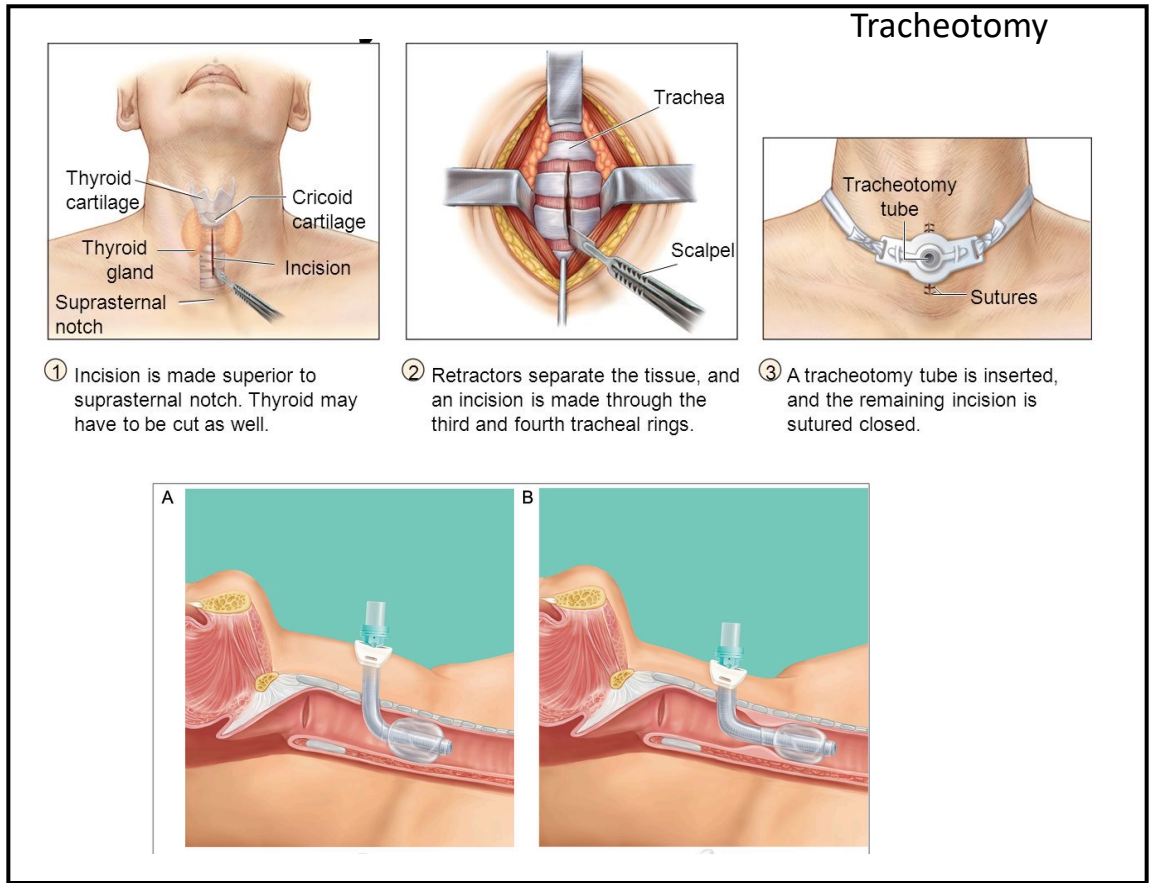
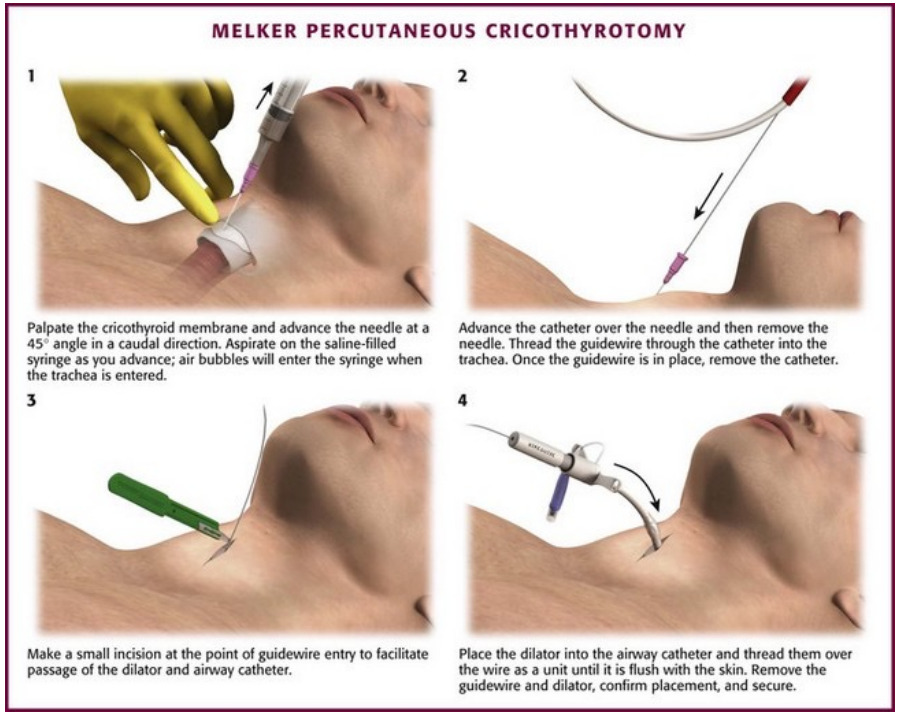
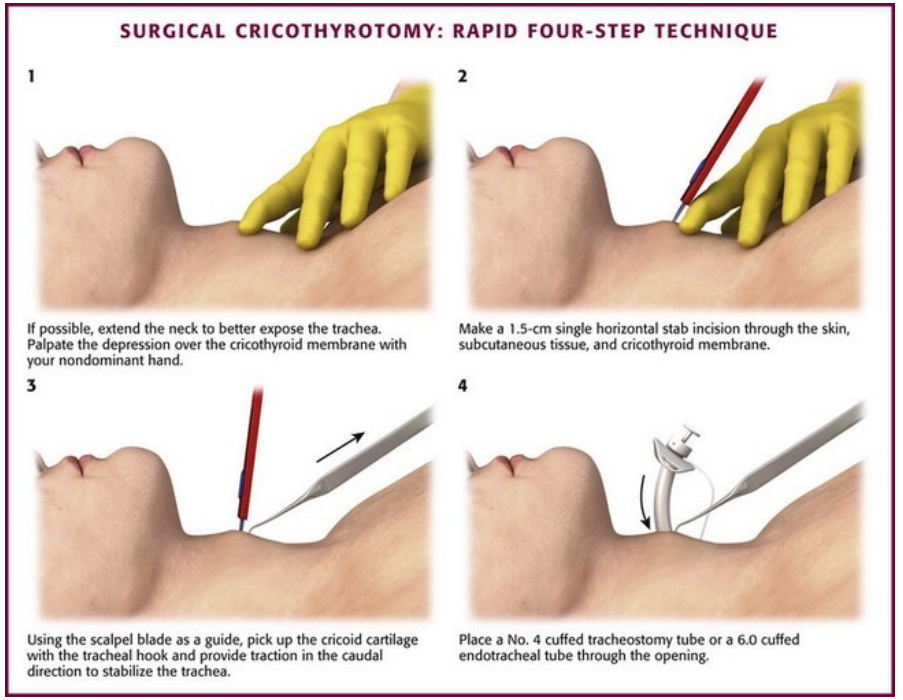
CLINICAL ANATOMY: **Cricothyrotomy** and **Tracheotomy**

Surgical airway management is performed as a last resort in cases where orotracheal and nasotracheal intubation are impossible or contraindicated.

- In an emergency, an incision can be made in the median cricothyroid ligament (a cricothyrotomy) to quickly establish a temporary airway due to the absence of major vessels in this location. However, an incision at this location can potentially injure the vocal folds.
- A tracheotomy is a surgically created opening through the skin and tracheal wall. A tracheostomy tube is then inserted into the trachea and secured. A tracheotomy may be created when a patient needs to be placed on a mechanical ventilator for a long period of time.







Carina and Main (Primary) Bronchi

When looking inferiorly into the **trachea**, a cartilaginous ridge called the **carina** is located at the trachea's point of bifurcation into the mainstem bronchi.

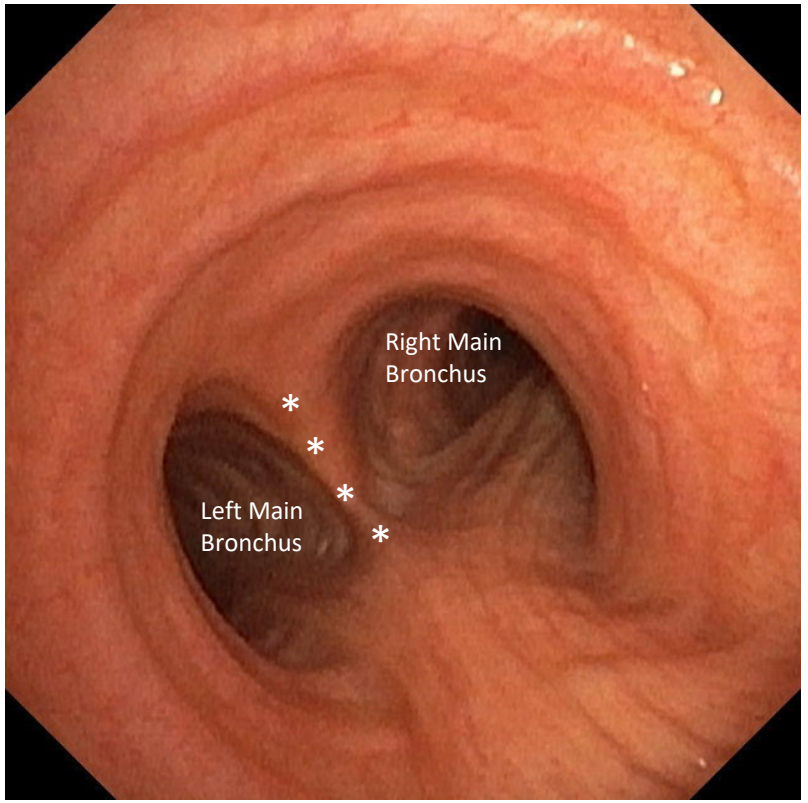
- The term “carina” is often used to simply describe the location of the trachea’s point bifurcation.
- The tracheal bifurcation is usually located at the T4-T5 vertebral level (T4 in the embalmed cadaver), which is in the same horizontal plane as the sternal angle. However, due to breathing, the vertebral level that aligns with the bifurcaton can change by as many as two vertebral levels, which is why the bifurcation is sometimes described as aligning to a range of vertebral levels (T4-T7).

The trachea bifurcates into right and left main bronchi. Relative to the *left* main bronchus, the *right* main bronchus is:

- More vertically oriented
- Wider
- Shorter

CLINICAL ANATOMY: The right main bronchus is wider, shorter, and runs more vertically than the left main bronchus. By virtue of this variation, **aspirated foreign objects** are more likely to pass to the right and lodge somewhere in the right bronchial tree.

* = Carina



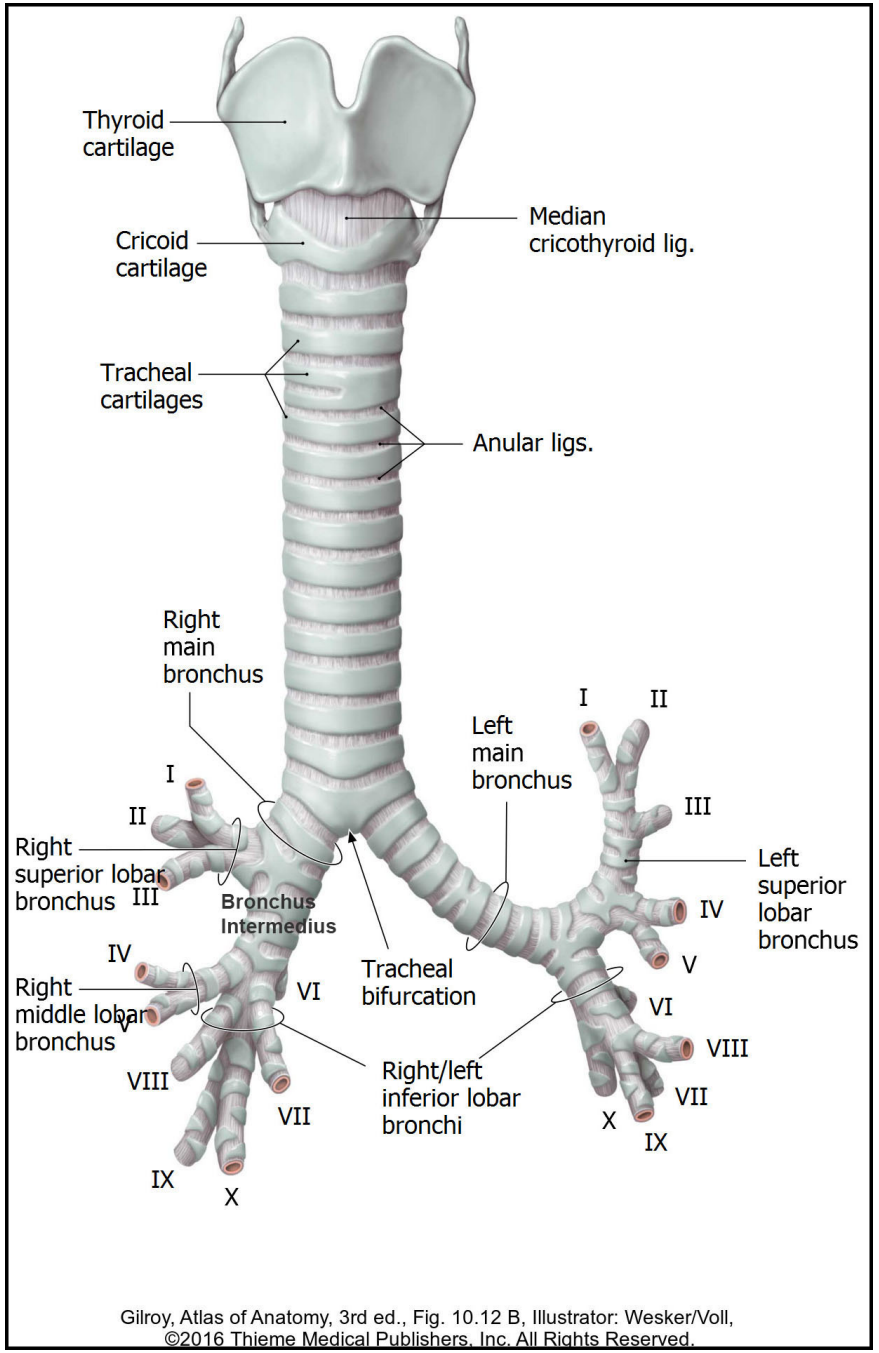
Bronchial Tree

The right bronchial tree consists of the following branches.

- **Main (primary) bronchus**
- **Superior (upper) lobar (secondary) bronchus**
- **The intermediate bronchus (bronchus intermedius)** is the region of the main (primary) bronchus between the origin of the superior lobar bronchus and the origins of the middle/inferior lobar bronchi.
  - **Middle lobar (secondary) bronchus → Segmental (tertiary)**
  - **Inferior (lower) lobar (secondary) bronchus → Segmental (tertiary) bronchi**

The left bronchial tree consists of the following branches.

- **Main (primary) bronchus**
- **Superior (upper) lobar (secondary) bronchus → Segmental (tertiary) bronchi**
- **Inferior (lower) lobar (secondary) bronchus → Segmental (tertiary) bronchi**



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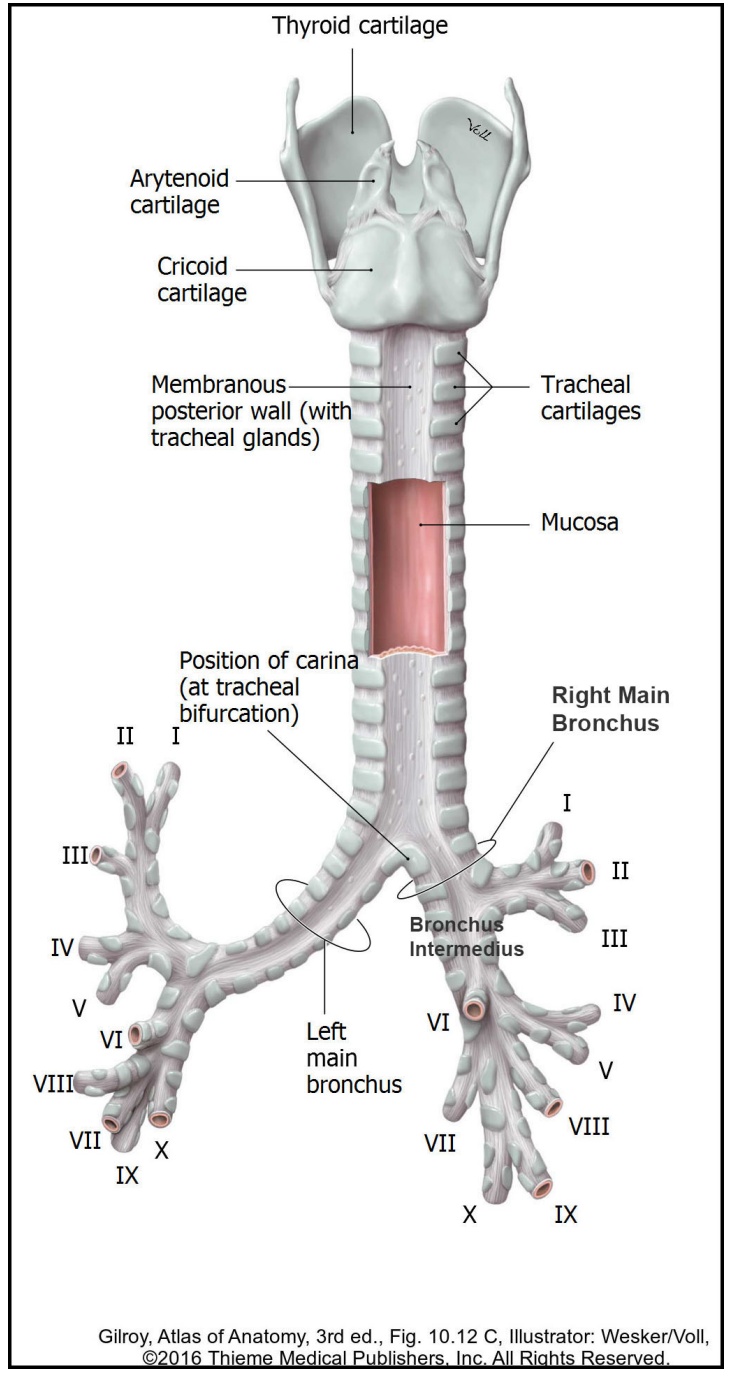

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Segmental Bronchi & Bronchopulmonary Segments

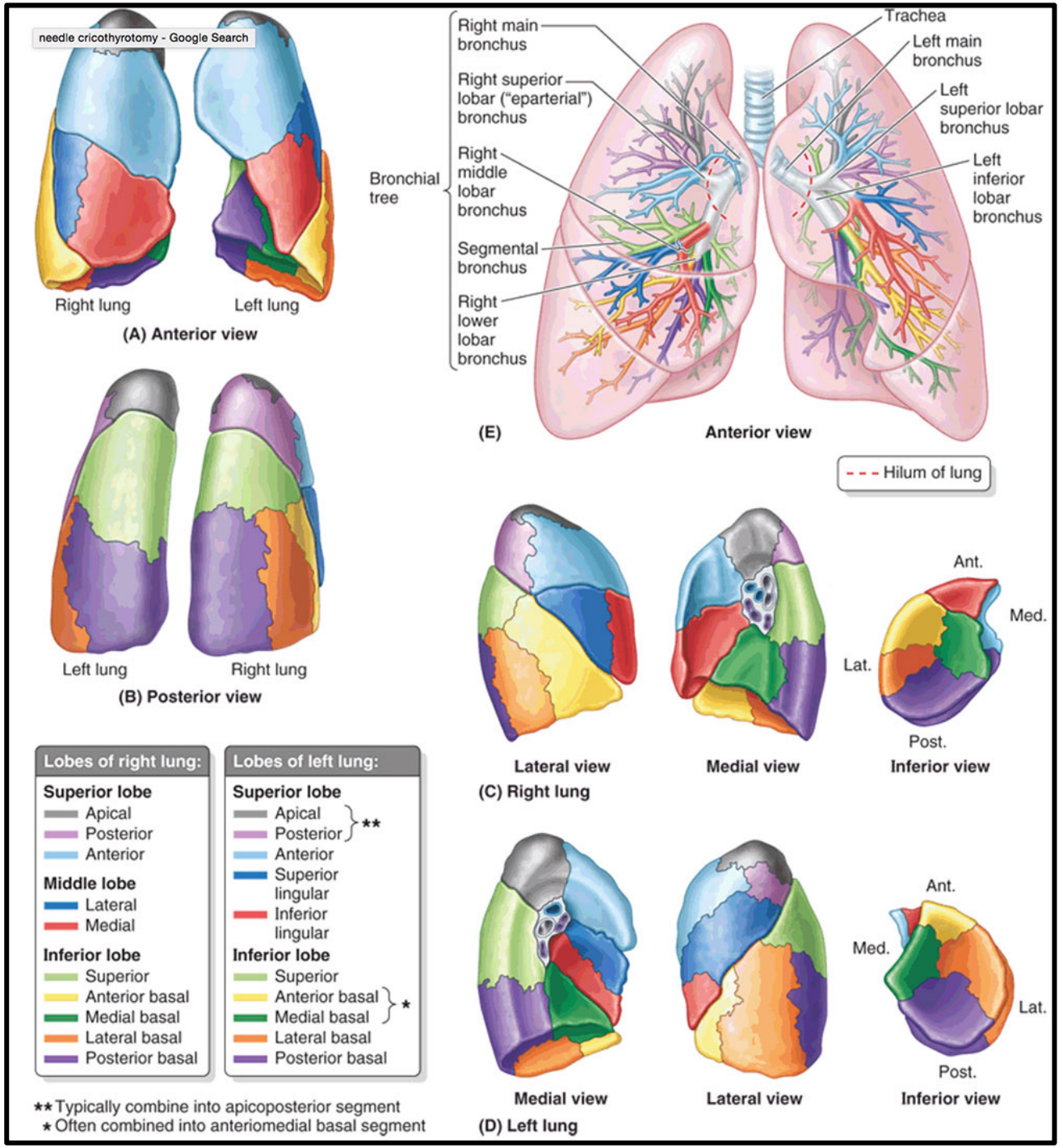
Each **segmental bronchus**, along with a branch of the pulmonary artery, supplies a bronchopulmonary segment. Each lung consists of 10 bronchopulmonary segments. However, it is common for segmental bronchi in the left lung to be fused, which results in 8-9 segments.

CLINICAL ANATOMY: Bronchopulmonary Segmentectomy

Each **bronchopulmonary segment** is the largest subdivision of a lobe. Each segment is an anatomically and functionally discrete structure. This is possible because each segment is surrounded by a small amount of connective tissue, it receives its own tertiary bronchus, and receives its own branch (tertiary branch) of the pulmonary artery. This anatomical and functional separation allows for surgical resection (segmentectomy) of a segment without adversely affecting adjacent segments. In addition, tumors and abscesses often localize in bronchopulmonary segments.

CLINICAL ANATOMY: Surgical procedures to remove a lung or a portion of a lung receive different names.

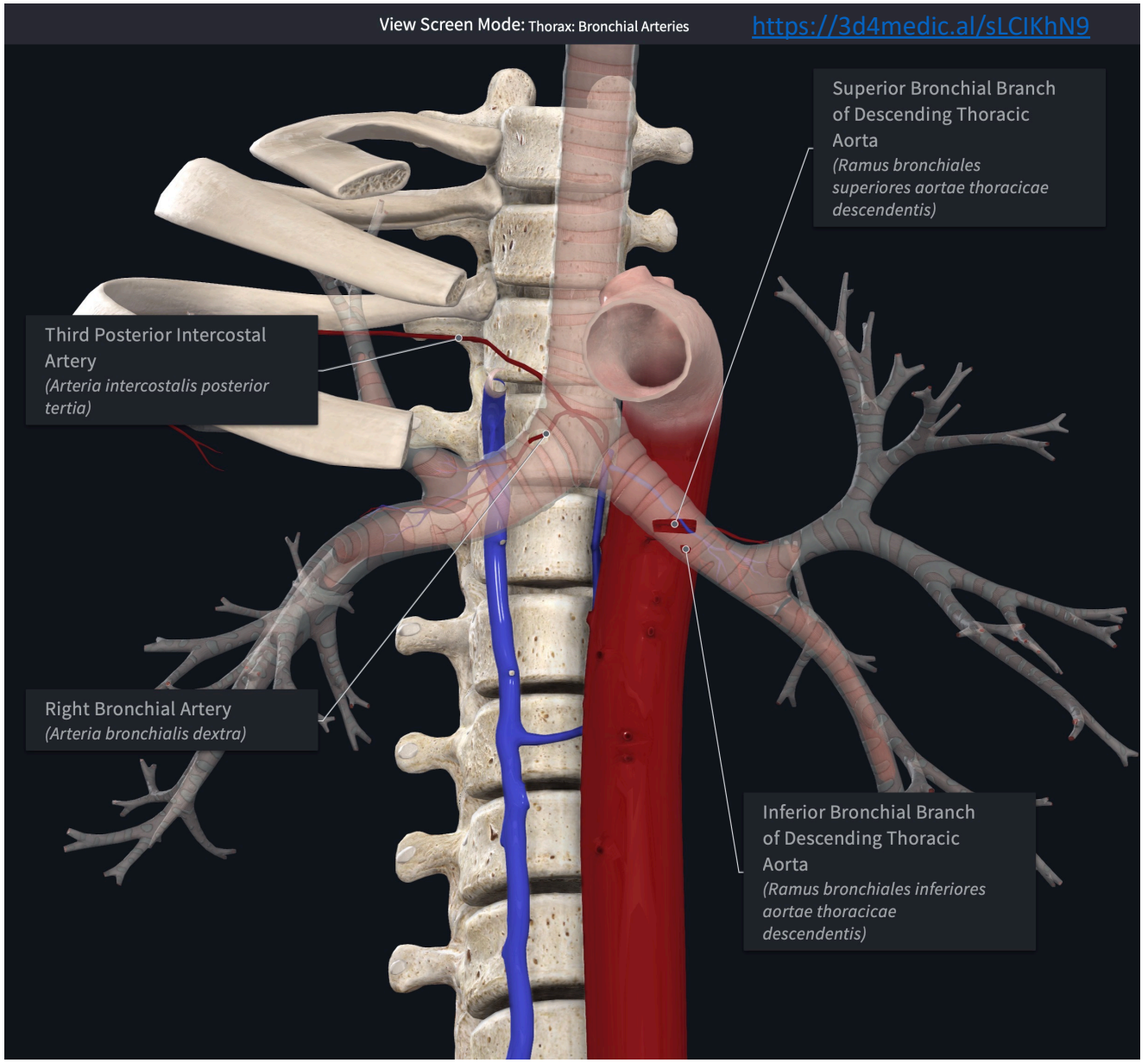
- **Pneumonectomy** is the removal of an entire lung.
- **Lobectomy** is the removal of a lobe.
- **Segmentectomy** is the removal of a bronchopulmonary segment.



Bronchial Arteries

The **bronchial arteries** supply oxygenated blood to the bronchial tree to the level of terminal bronchioles. In addition to supplying the conduction portion of the airway, they also supply nearby lymph nodes and visceral pleura with oxygenated blood.

- The right bronchial artery branches from a posterior intercostal artery (usually 3rd).
- The two left bronchial arteries (superior and inferior) arise directly from the thoracic aorta.

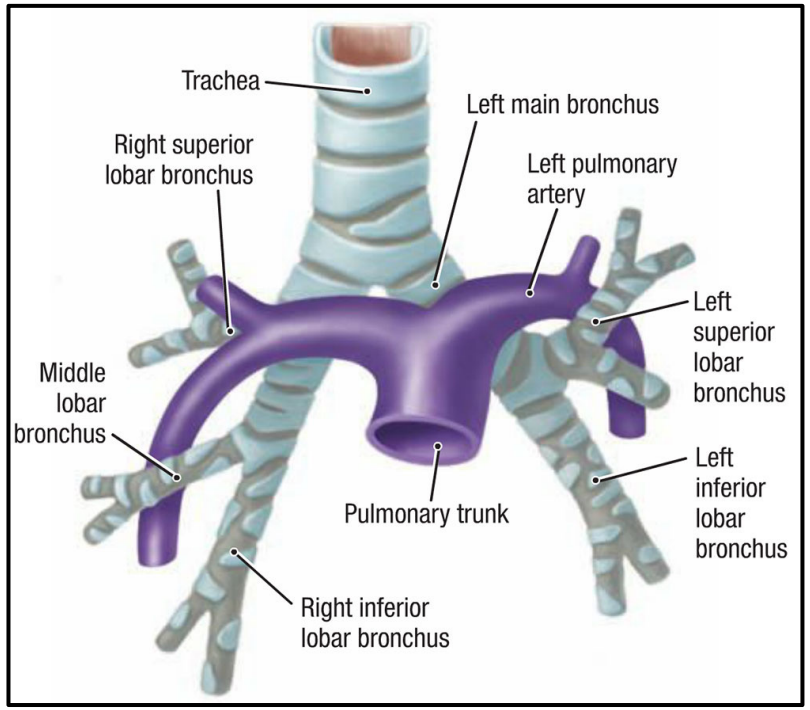


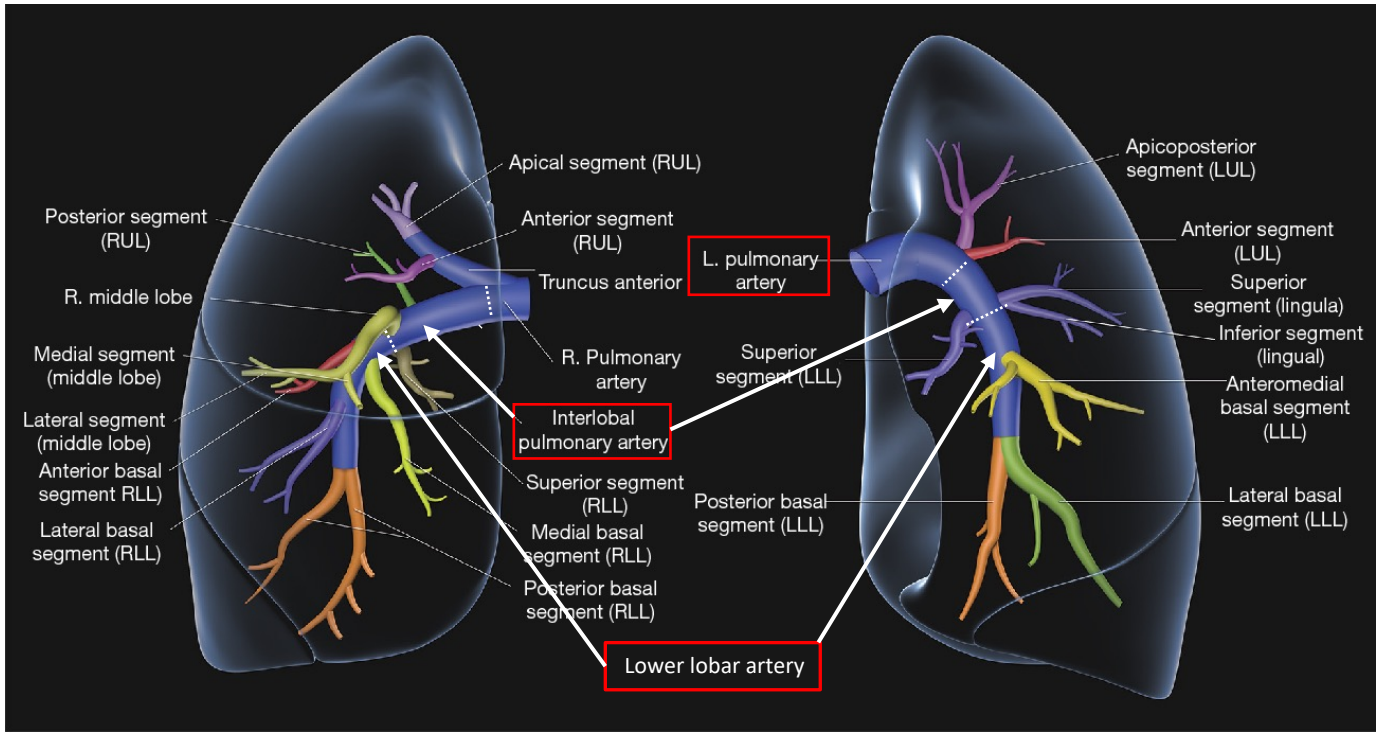
Pulmonary Arterial System: Right Pulmonary Artery

The **pulmonary trunk** is a short vessel (2 inches) that transports *deoxygenated* blood away from the right ventricle. It branches to form the right and left pulmonary arteries that supply each lung with *deoxygenated* blood.

Path of the ***right*** **pulmonary artery (RPA)**

- The RPA branches in a *perpendicular* direction from the right side of the pulmonary trunk.
- It Passes posterior to the *ascending* aorta and the superior vena cava.
- It then courses *anterior and slightly inferior* to the right mainstem bronchus on its path to enter lung via the hilum.
- Branches
  - The **superior lobar artery (truncus anterior)** often branches from the RPA before entering the hilum. The superior lobar artery courses alongside the superior lobar bronchus on its path to supply blood to the right upper lobe.
  - The interlobar (descending) artery courses in an inferior direction alongside the bronchus intermedius. The interlobar artery branches to form the following vessels.
    - The middle lobar artery (may be more than one) branches from the interlobar artery to supply blood to the middle lobe.
    - The interlobar artery becomes the right lower lobar artery after the branch point of the middle lobar artery (arteries). The right lower lobar artery forms branches that supply blood to the right lower lobe.

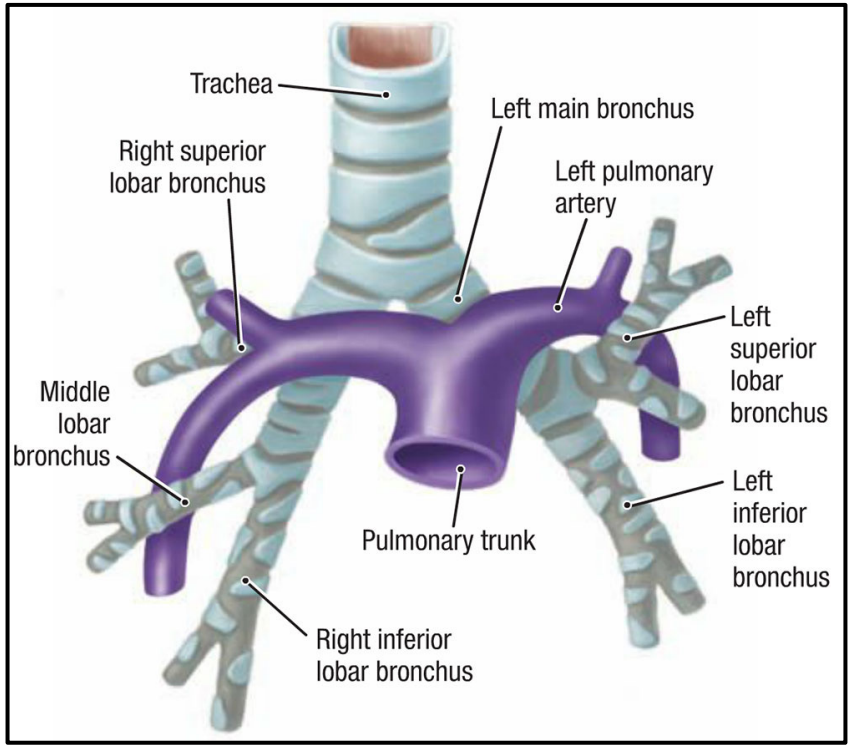


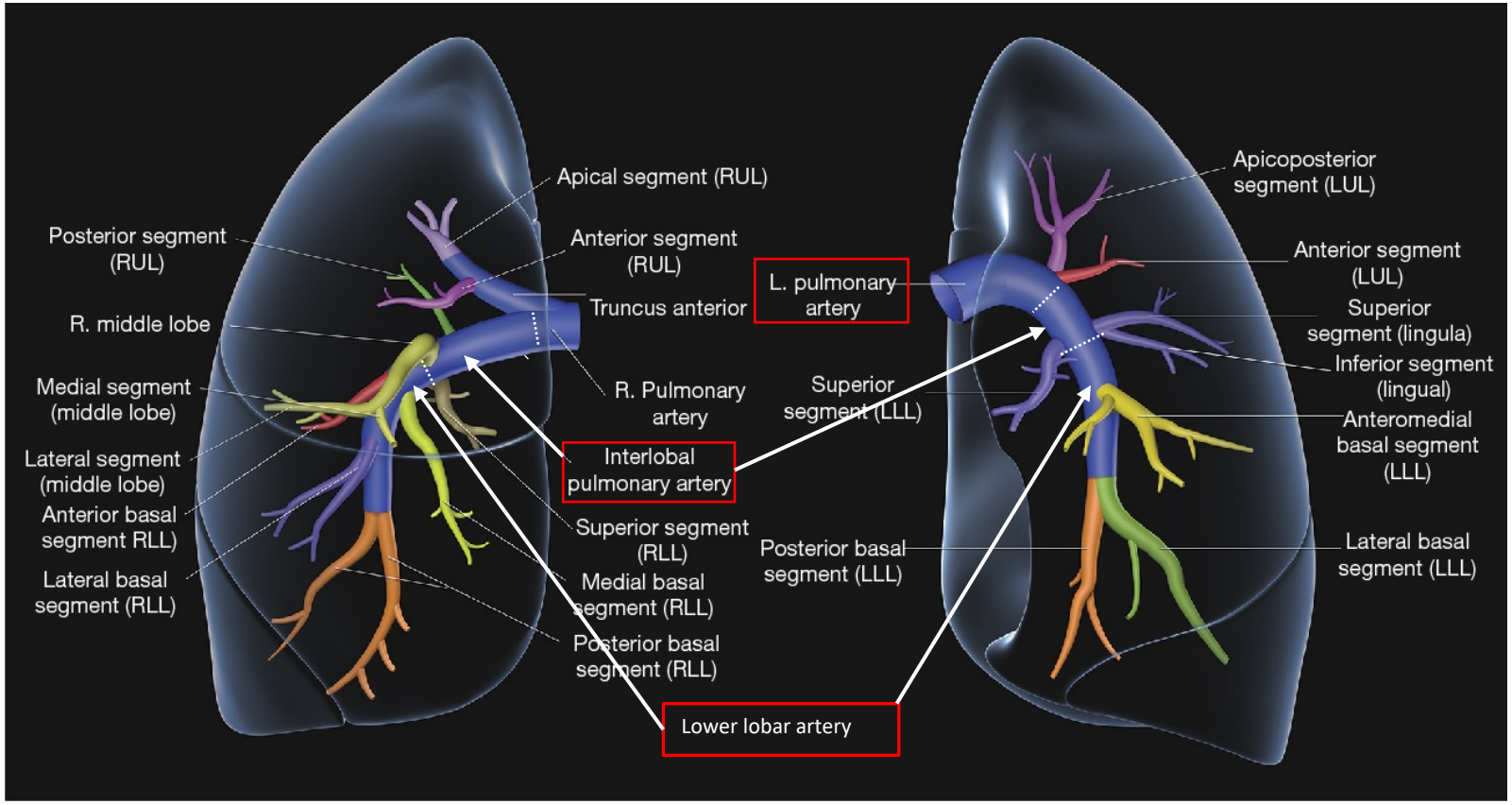


Pulmonary Arterial System: Left Pulmonary Artery

Path of the ***left*** **pulmonary artery (LPA)**

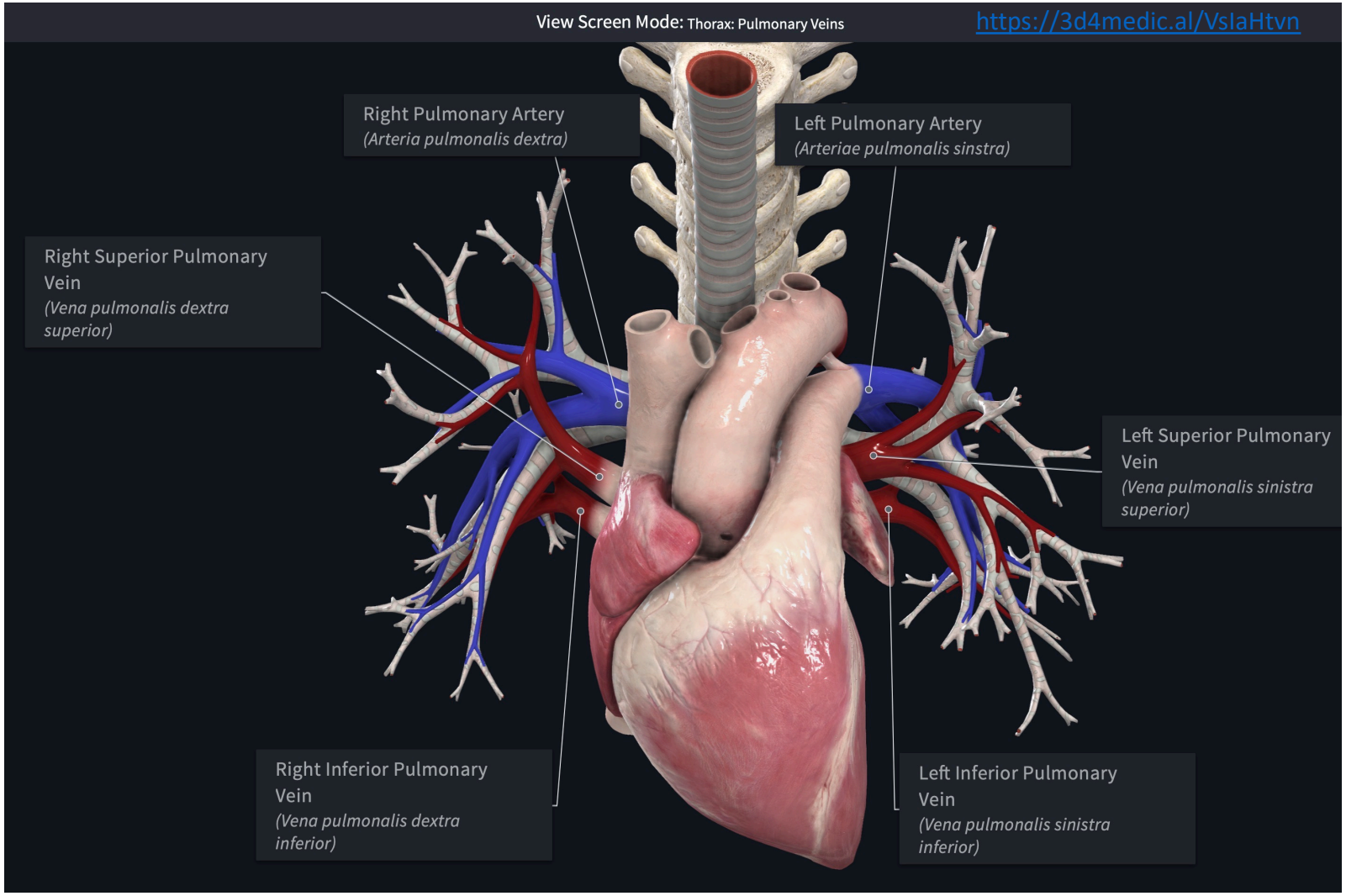
- Beyond the branch point of the right pulmonary artery, it continues *posterior and slightly lateral toward the left side of the body*.
- Passes anterior to the *descending* aorta
- Arches *over* the left mainstem bronchus
- Enters the left lung at the hilum *posterior* to the mainstem bronchus
- Branches: The branching pattern of the left pulmonary artery is more variable than the right pulmonary artery
  - Unlike the RPA with one branch supplying the upper lobe, 3-5 branches from the LPA supply the left upper lobe in various configurations.
  - The interlobar artery spans the distance between the upper lobe branches and branches to form the following vessels.
    - The lingula artery branches from the interlobar artery to supply blood to the region of the lingula.
    - The interlobar artery becomes the left lower lobar artery after the branch point of the lingula artery. The left lower lobar artery continues inferiorly along the posterolateral aspect of the inferior lobar bronchus forming branches that supply blood to the inferior lobe.





Pulmonary Venous System

- The pulmonary veins don't follow the branching of the bronchial airways.
- Each lung's pulmonary venous system ultimately drains into the left atrium of the heart by two vessels.
  - **(Left and Right) superior pulmonary vein**
  - **(Left and Right) Inferior pulmonary vein**

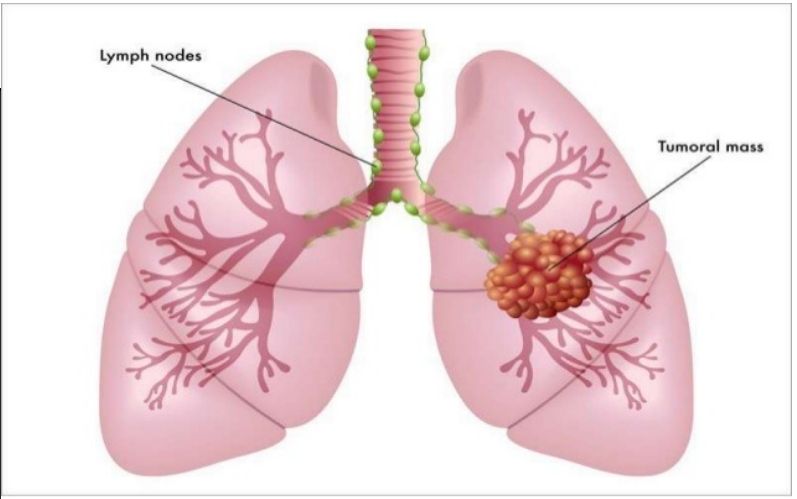


Bronchogenic Carcinoma

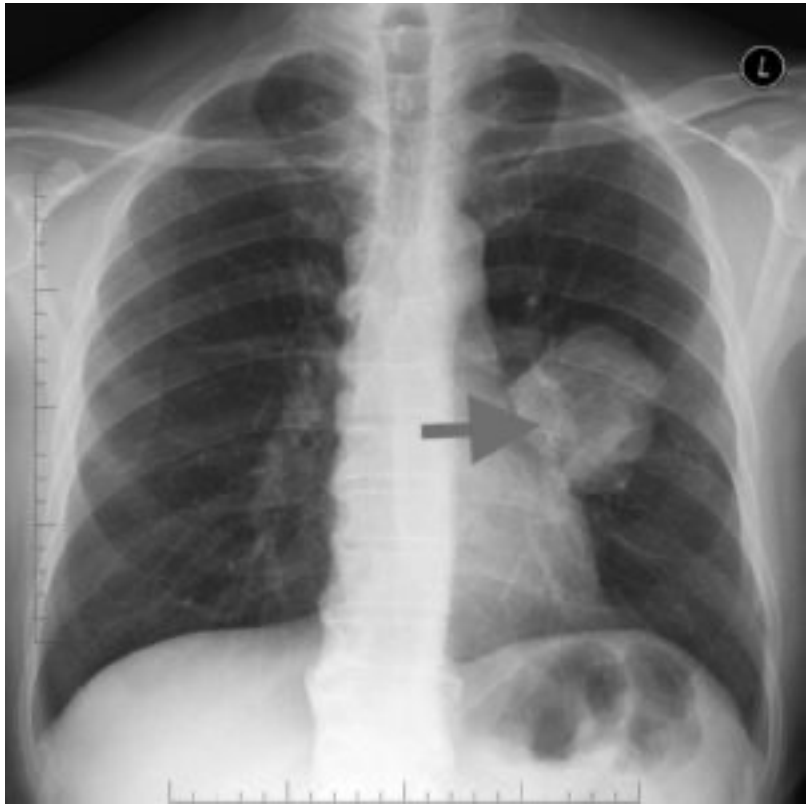
CLINICAL ANATOMY: Bronchogenic carcinoma is a malignant neoplasm of the lung arising from the epithelium of the bronchus or bronchiole. They can occur almost anywhere within the lung tissue, but are most frequently located in the hilus of the lung. Approximately two thirds of the lesions originate in the primary, secondary and tertiary bronchi. Adenocarcinomas (type of bronchogenic carcinoma) typically arise in the peripheral lung tissue from the alveolar septal cells or from terminal bronchioles.

Bronchogenic carcinomas may arise as intraluminal masses, invade the bronchial mucosa, or form large bulky masses pushing into adjacent lung parenchyma and may continue to proliferate along the following different pathways.

- It may grow into the lumen of the bronchi becoming an intraluminal mass.
- It may extend to the pleural surface and into the pleural cavity or into the pericardium.
- As the tumor grows, it may metastasize to other regions of the body.
- It may penetrate the wall of a bronchus and infiltrate along the peribronchial tissue into the adjacent region of the carina or mediastinum. Due to their proximity, the following structures can be involved:
    - Growth and impingement upon the sympathetic chain can result in **Horner's syndrome**
    - Esophageal intrusion can result in difficulty swallowing.
    - Compression of the superior vena cava can result in **SVC syndrome**: (dilation of head and neck veins, facial swelling, and cyanosis)
    - Compression of the recurrent laryngeal nerve can result in a **hoarse voice**
    - Impingement of the phrenic nerve can lead to **paralysis of the diaphragm**.
    - A **pancoast tumor** is a carcinoma that arises at the level of the superior sulcus and is limited to the apical segment of either lung. It principally involves chest wall structures rather than the underlying lung tissue and may invade areas such as lymph nodes, nerves, ribs, and spine. Common symptoms are: shoulder/elbow/arm pain or paresthesia due to invasion of the brachial plexus. In addition, a pancoast tumor may invade the sympathetic trunk leading to Horner's syndrome.



BRONCHOGENIC CARCINOMA



Lung Lymph Drainage

All lymph from the lungs drains to the **bronchopulmonary (hilar) nodes**. From the bronchopulmonary nodes, lymph drains by the following pathway:

- **Inferior (carinal)** and **superior tracheobronchial nodes,** located inferiorly and superiorly to the tracheal bifurcation
  - The right lung primarily drains by the pathway of hilar to tracheobronchial nodes on the right side.
  - The left *upper* lobe primarily drains by the pathway of hilar to tracheobronchial nodes on the on the left side.
  - Much (not all) of the lymph from the ***left*** lower lobe drains from left hilar nodes into tracheobronchial nodes on the ***right***. This occurs because lymph can cross the midline where right and left inferior tracheobronchial nodes communicate.
  - **(Para)tracheal nodes** are located on either side of the trachea
- Right and left **bronchiomediastinal trunks** drain lymph into the venous circulation.
  - The left bronchomediastinal trunk drains into the left venous angle or joins with the thoracic duct prior to where it joins with the left venous angle.
  - The right bronchomediastinal trunk drains into the right venous angle.

CLINICAL ANATOMY: When the inferior tracheobronchial lymph nodes (a.k.a. **"carinal" nodes**) enlarge the carina becomes distorted. Therefore, the appearance of the carina (normal vs. abnormal) is a useful diagnostic sign of bronchogenic carcinoma.

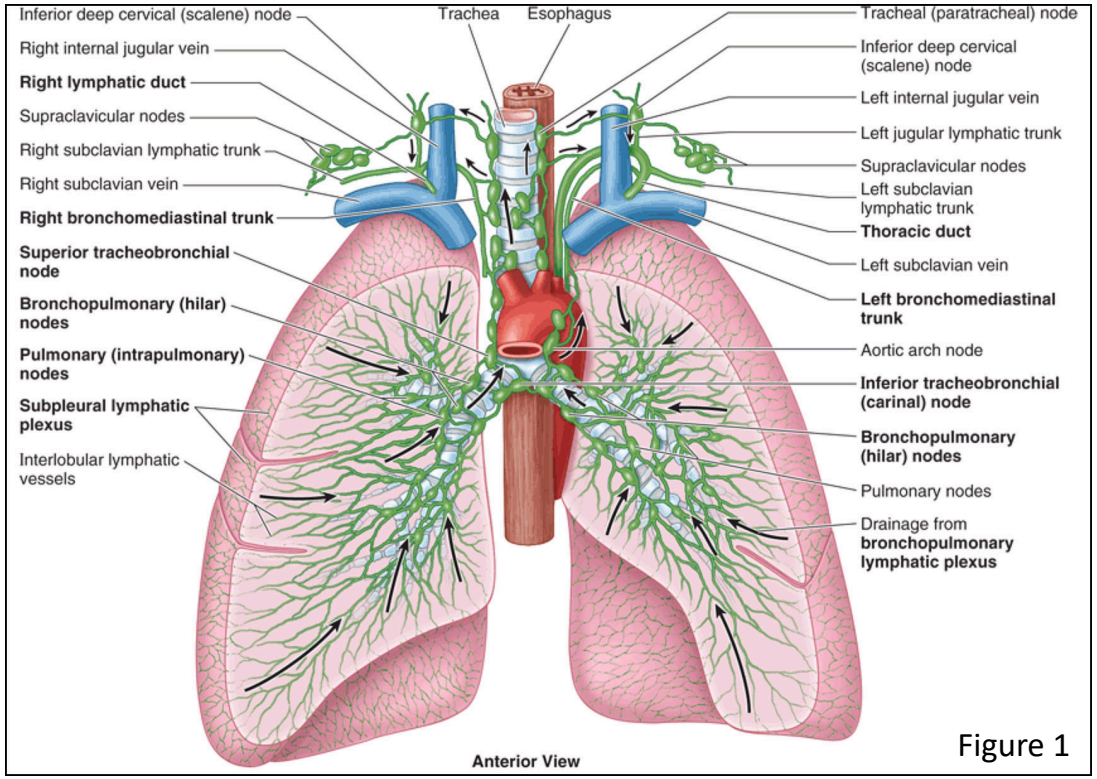


Figure 1

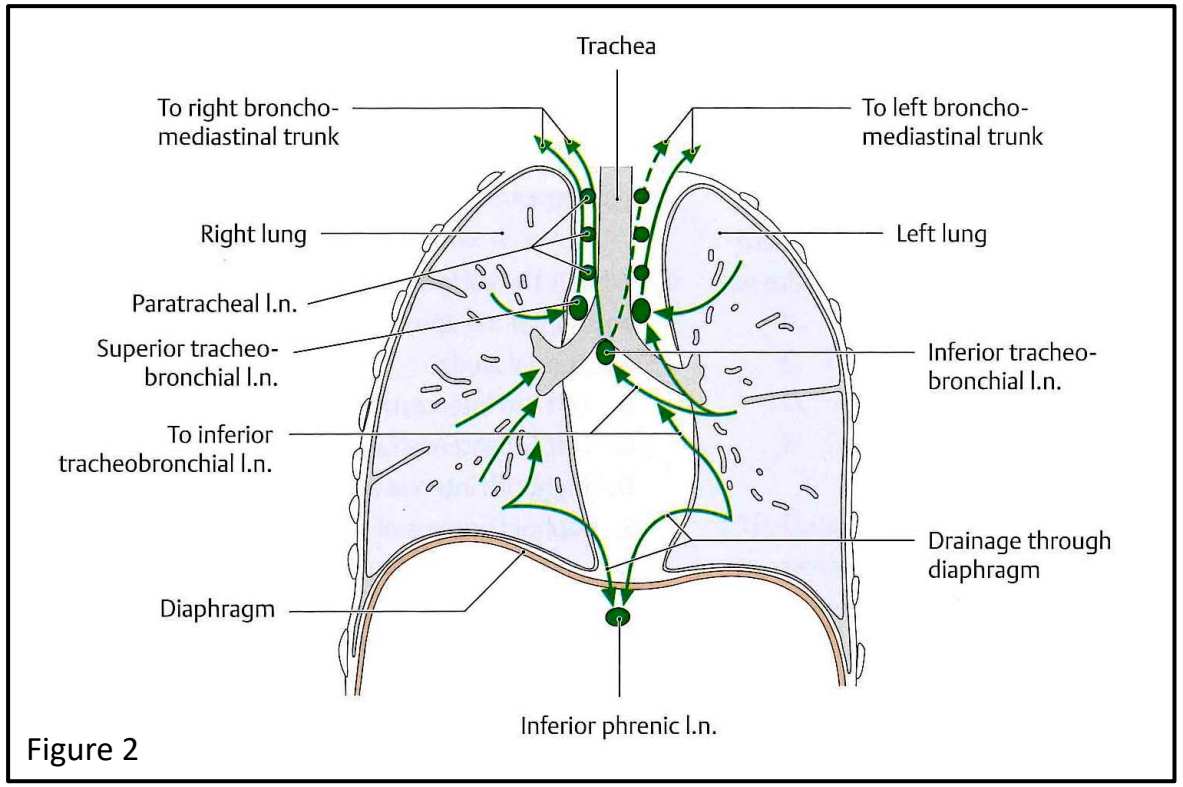
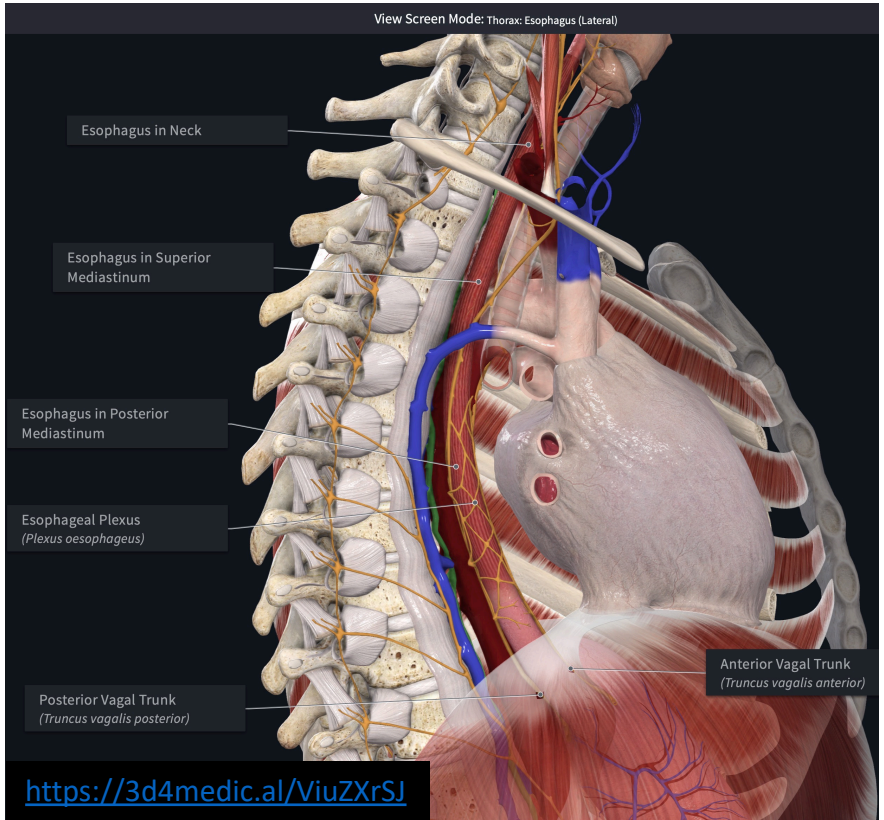


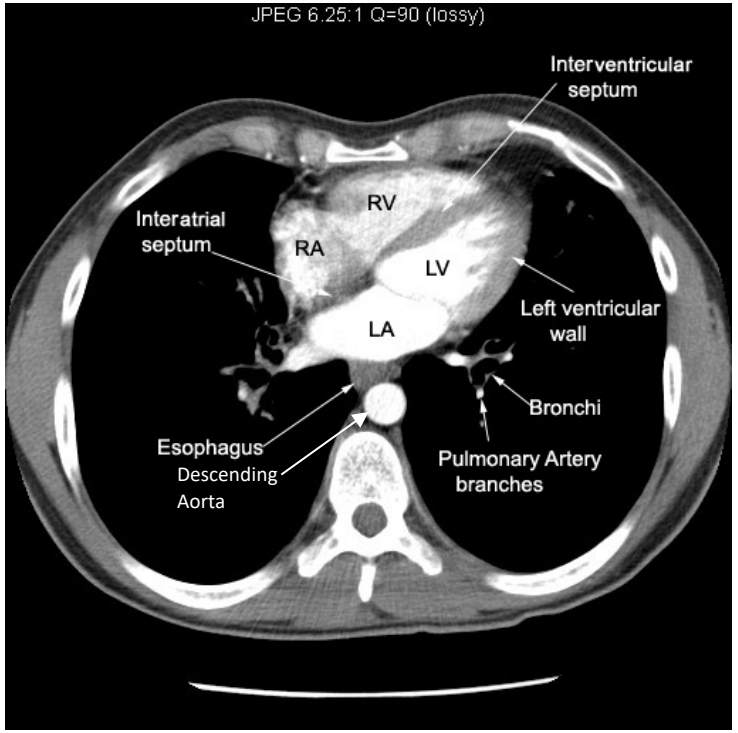
Figure 2

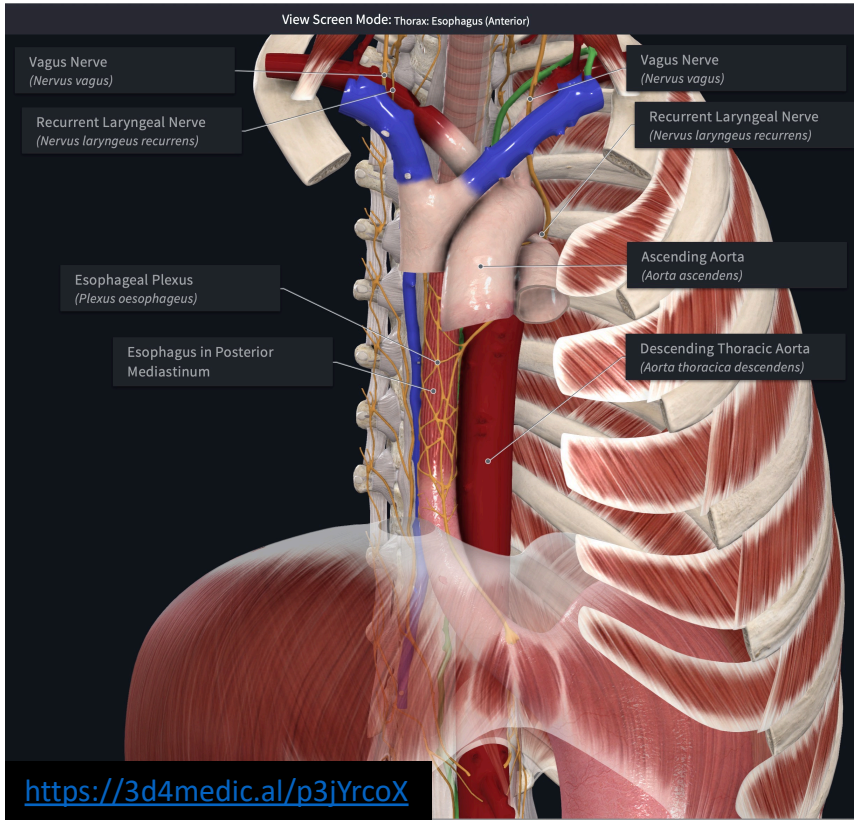
Posterior Mediastinum: Esophagus (Review GI)

The **esophagus** is a flattened muscular tube about 18–26 cm long that begins in the neck as a continuation of the pharynx at its upper sphincter.

- It traverses the superior mediastinum and the posterior mediastinum to pass through the diaphragm at the esophageal hiatus where it joins with the stomach.
  - In the superior mediastinum, the esophagus is posterior to the trachea and the ascending aortic arch.
  - In the (inferior) posterior mediastinum, the anatomical relationship of the esophagus to other structures is as follows.
    - It is posterior to the pericardium.
    - It is posterior to the left atrium and small portion of the left ventricle
    - it is located to the right and slightly anterior to the to the thoracic aorta
    - As the esophagus continues its descent through the thorax, it progressively becomes anterior to the aorta.
    - It enters the abdomen anterior to the aorta by passing through the esophageal hiatus in the diaphragm (**T10 vertebral level)**.
    - Upon entering the abdomen, it is called the abdominal part of the esophagus, which empties into stomach at the gastroesophageal junction (GEJ). The GEJ is the location of the cardiac sphincter (lower esophageal sphincter).



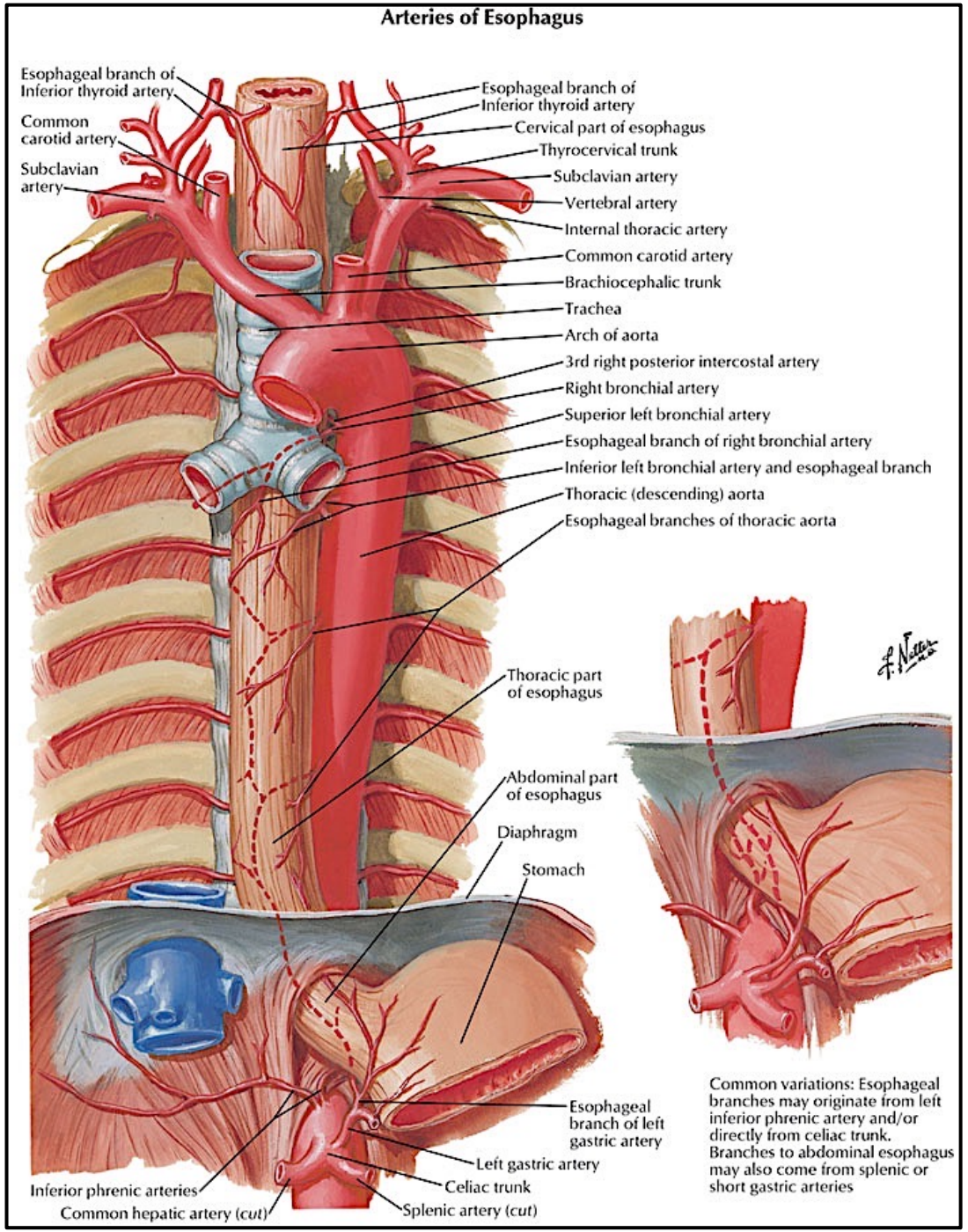




Esophagus: Arterial Supply (Review GI)

The arterial supply to the esophagus involves many vessels and can be separated into three areas.

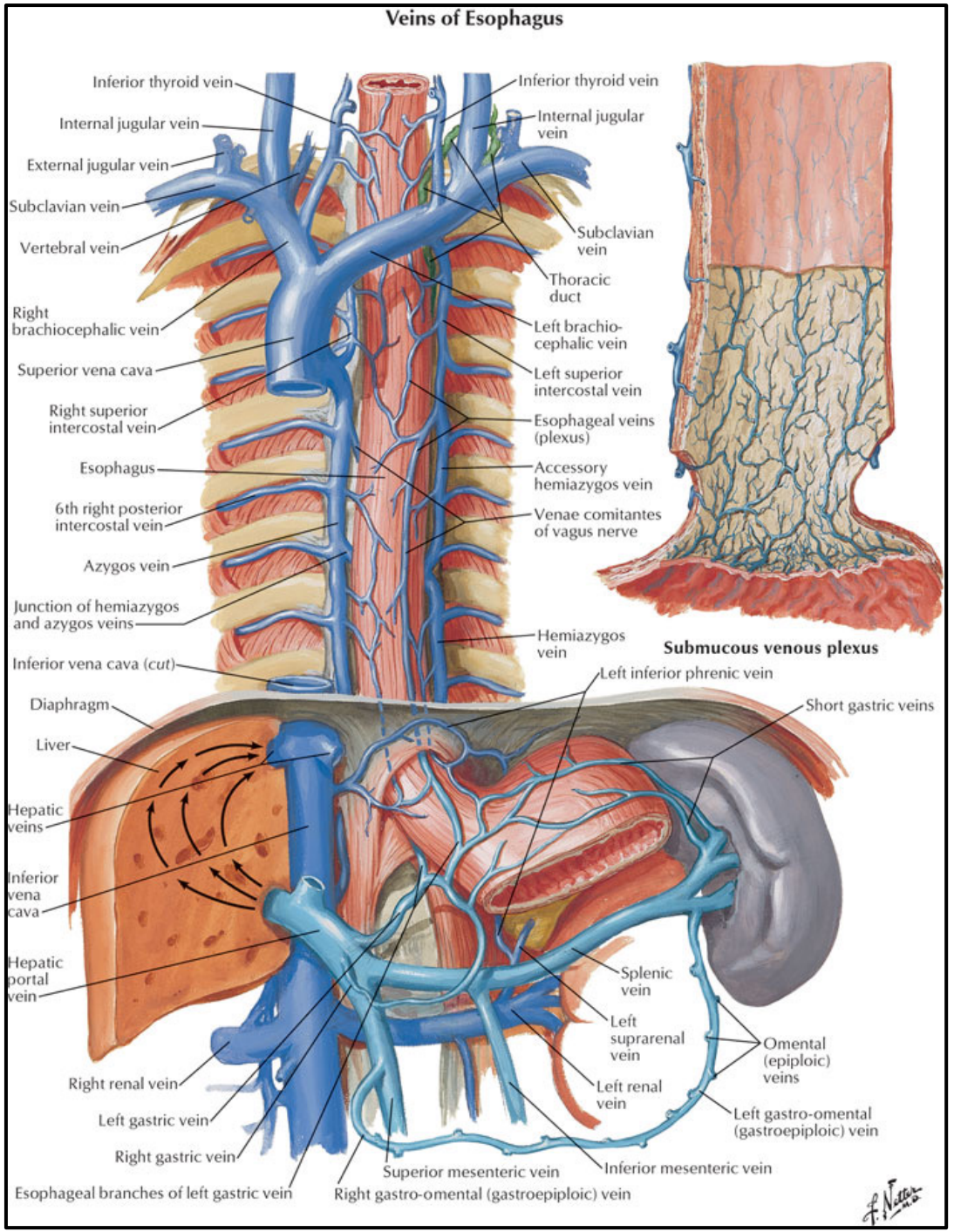
- Upper 1/3 (Upper esophageal sphincter, cervical esophagus)
  - Inferior thyroid artery
- Middle 1/3 (thoracic esophagus)
  - Esophageal branches of the thoracic aorta
  - Terminal branches of bronchial arteries
- Lower 1/3 (abdominal esophagus)
  - Branches from left gastric artery
  - Branches of left phrenic artery



Esophagus: Venous Drainage (Review GI)

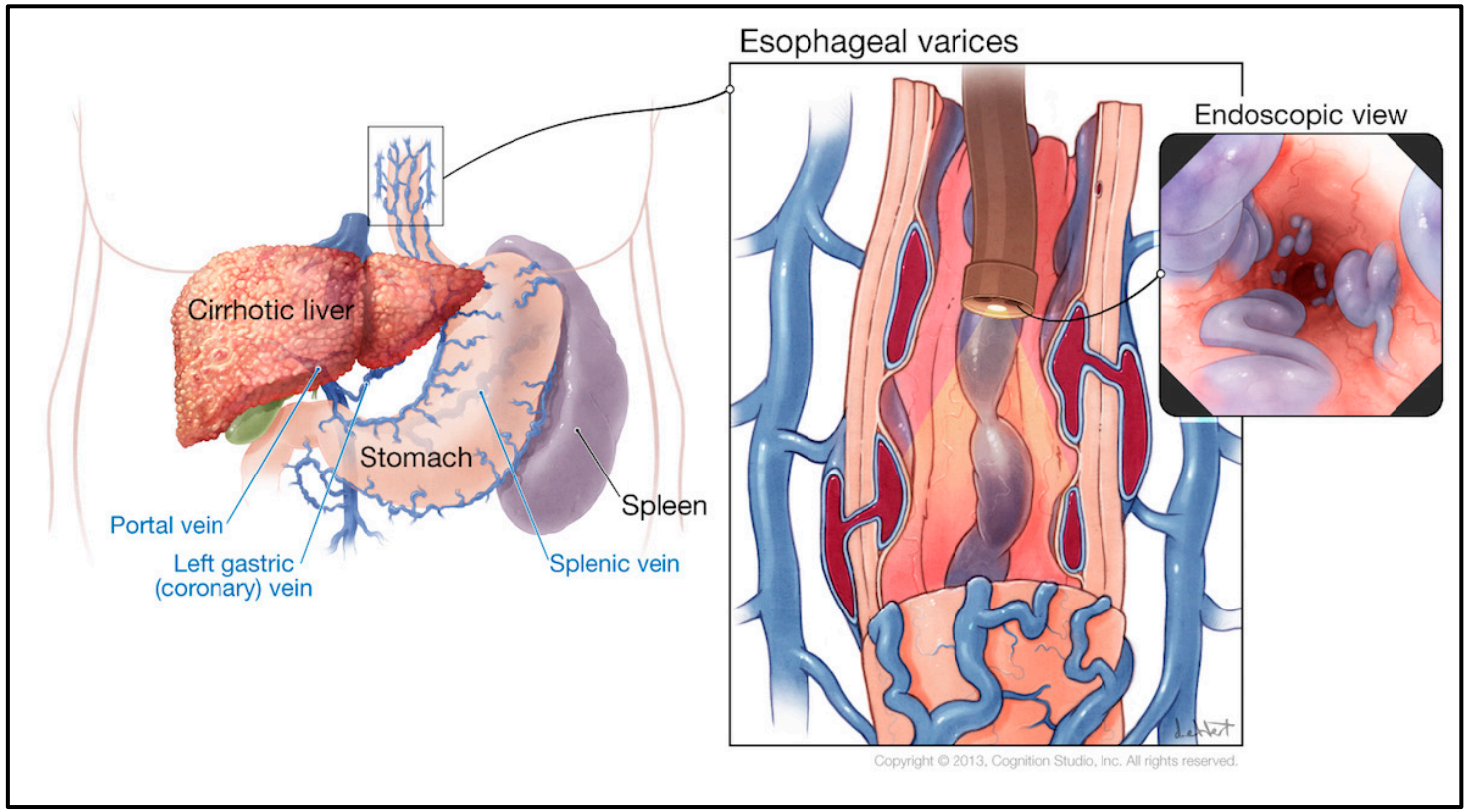
The venous drainage of the esophagus involves many vessels and can be separated into three areas.

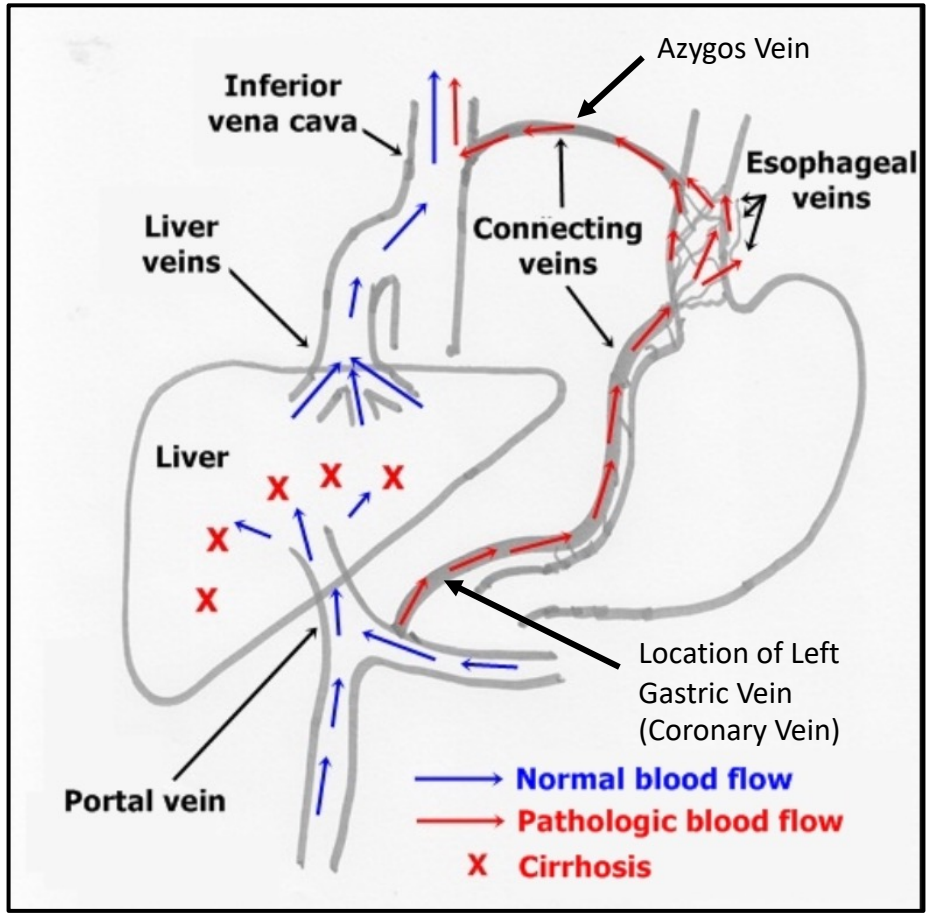
- Upper 1/3 (Upper esophageal sphincter, cervical esophagus)
  - Inferior thyroid veins
- Middle 1/3 (thoracic esophagus)
  - Azygos vein
  - Hemiazygos vein
  - *Bronchial veins (to a lesser extent)*
- Lower 1/3 (abdominal esophagus)
  Left gastric vein (also called coronary vein)



Esophageal Varices (Review GI)

CLINICAL ANATOMY: Esophageal varices are a manifestation of portal hypertension which is usually caused by cirrhosis. Normally, blood in the lower 1/3rd of the esophagus drains via the left gastric vein (coronary vein) into the portal vein to be filtered by the liver. If portal hypertension is present, then blood flow through the portal system is impeded; this increased pressure is transmitted back to the veins of the lower esophagus which causes these thin walled esophageal veins to dilate, forming esophageal varices. Because the blood from the lower esophagus cannot adequately drain through the portal system, it is redirected through collaterals that develop to the azygos vein and ultimately the inferior vena cava.

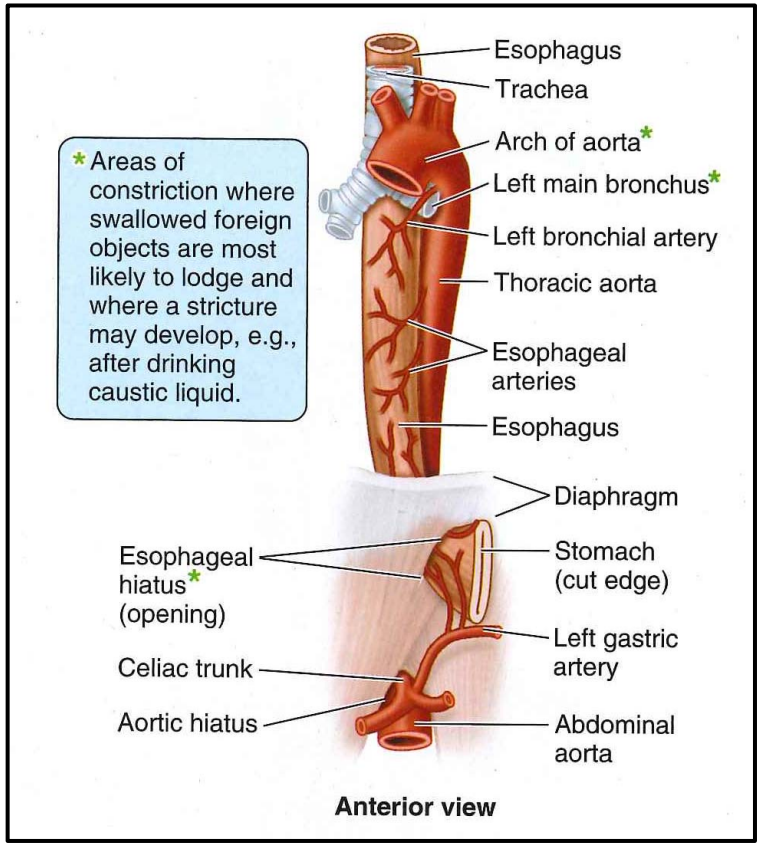


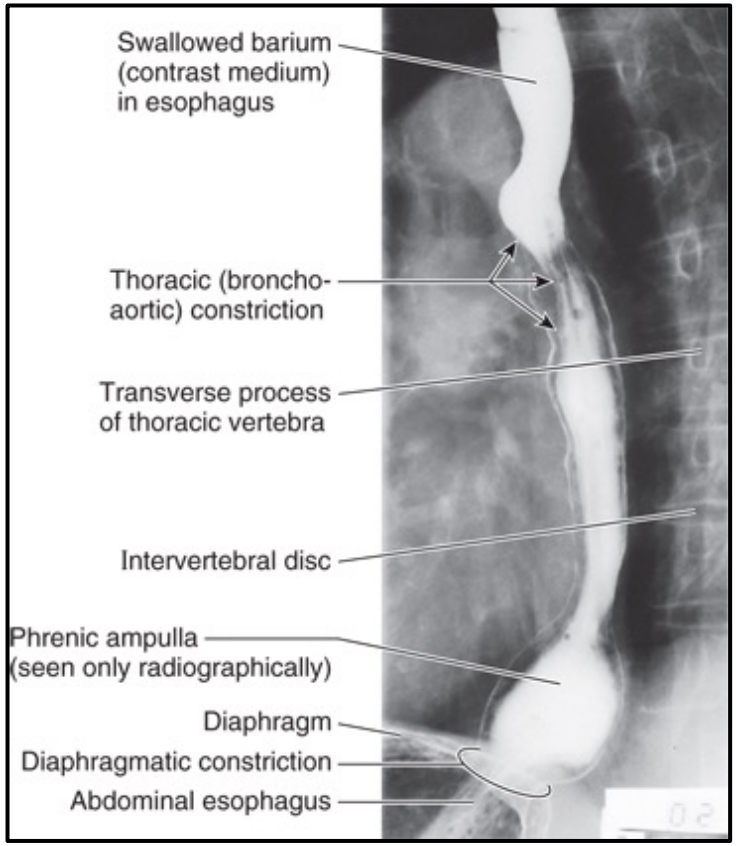


Posterior Mediastinum: Esophageal Constrictions (Review GI)

CLINICAL ANATOMY: The esophagus has three natural "constrictions," where adjacent structures press into the esophageal wall. These may be observed as narrowed regions of the lumen in oblique chest radiographs that are taken as barium is swallowed. The esophagus is compressed in the following three regions.

1. A cervical constriction occurs at the level of the cricoid cartilage by the cricopharyngeus muscle (upper esophageal sphincter)
2. A thoracic constriction occurs where the arch of the aorta and left main bronchus cross the esophagus. Sometimes these are considered as separate constrictions. When considered together, this impression is called the broncho-aortic constriction. The aortic arch compression is most evident in a postero-anterior (PA) radiograph after a barium swallow, and the bronchial impression is more evident in lateral views. No constrictions are visible in the empty esophagus; however, as it expands during filling, the structures noted above compress its walls.
3. A constriction occurs as the esophagus passes through the esophageal hiatus to enter the abdominal cavity. The aortic arch compression is most evident in a postero-anterior (PA) radiograph after a barium swallow, and the bronchial impression is more evident in lateral views. No constrictions are visible in the empty esophagus; however, as it expands during filling, the structures noted above compress its walls.



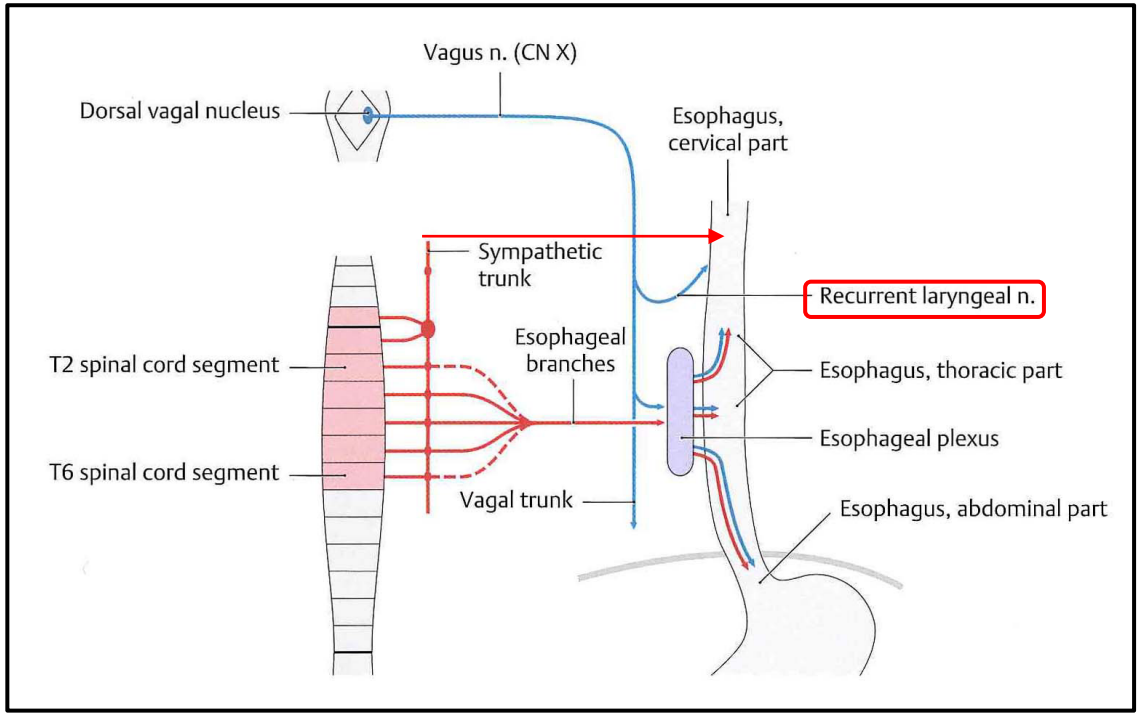


Posterior Mediastinum: Esophageal Innervation (Review GI)

Innervation of the **esophagus** is complex as it receives neuron fibers from both the sympathetic and parasympathetic divisions of the ANS. In addition, the cervical esophagus is innervated separately from the thoracic esophagus.

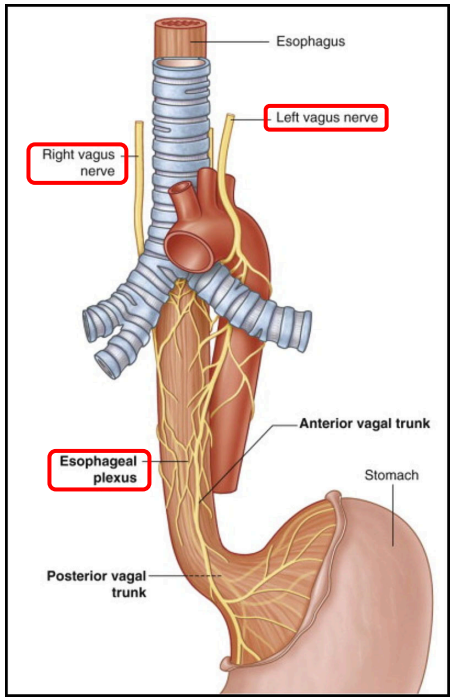
Upper 1/3: Cervical Esophagus

- Parasympathetic innervation is via the **recurrent laryngeal branch of the vagus nerve.**
  - Branchial efferent to skeletal muscle
  - Preganglionic visceral efferent fibers to myenteric plexus supplying glands
- *Sympathetic innervation from branches of sympathetic trunk are primarily vasomotor
  - Postganglionic fibers arise from cervical and T1 region of sympathetic trunk.
- Sensory:
  - Mechanosensation and chemosensation for reflexes: **recurrent laryngeal branch of vagus**
  - Pain: **axons follow path of sympathetic neurons**



Lower 2/3: Thoracic Esophagus

- A mesh-like network of neurons called the **esophageal plexus** innervates smooth muscle and glands of the inferior two-thirds of the esophagus. This network is formed by sympathetic and parasympathetic fibers.
  - Parasympathetic: **left and right vagus nerve**
    - Preganglionic visceral efferent fibers via to smooth muscle and glands.
  - *Sympathetic innervation from branches of sympathetic trunk are primarily vasomotor
    - Postganglionic fibers arise from the T2-T5(6) ganglia of the sympathetic trunk.
  - Sensory:
    - Mechanosensation and chemosensation for reflexes: **right and left vagus nerve**
    - Pain: **axons follow path of sympathetic neurons** with many synapsing on the T1-T6 spinal cord levels, which means referred pain is “felt” in these dermatomes.



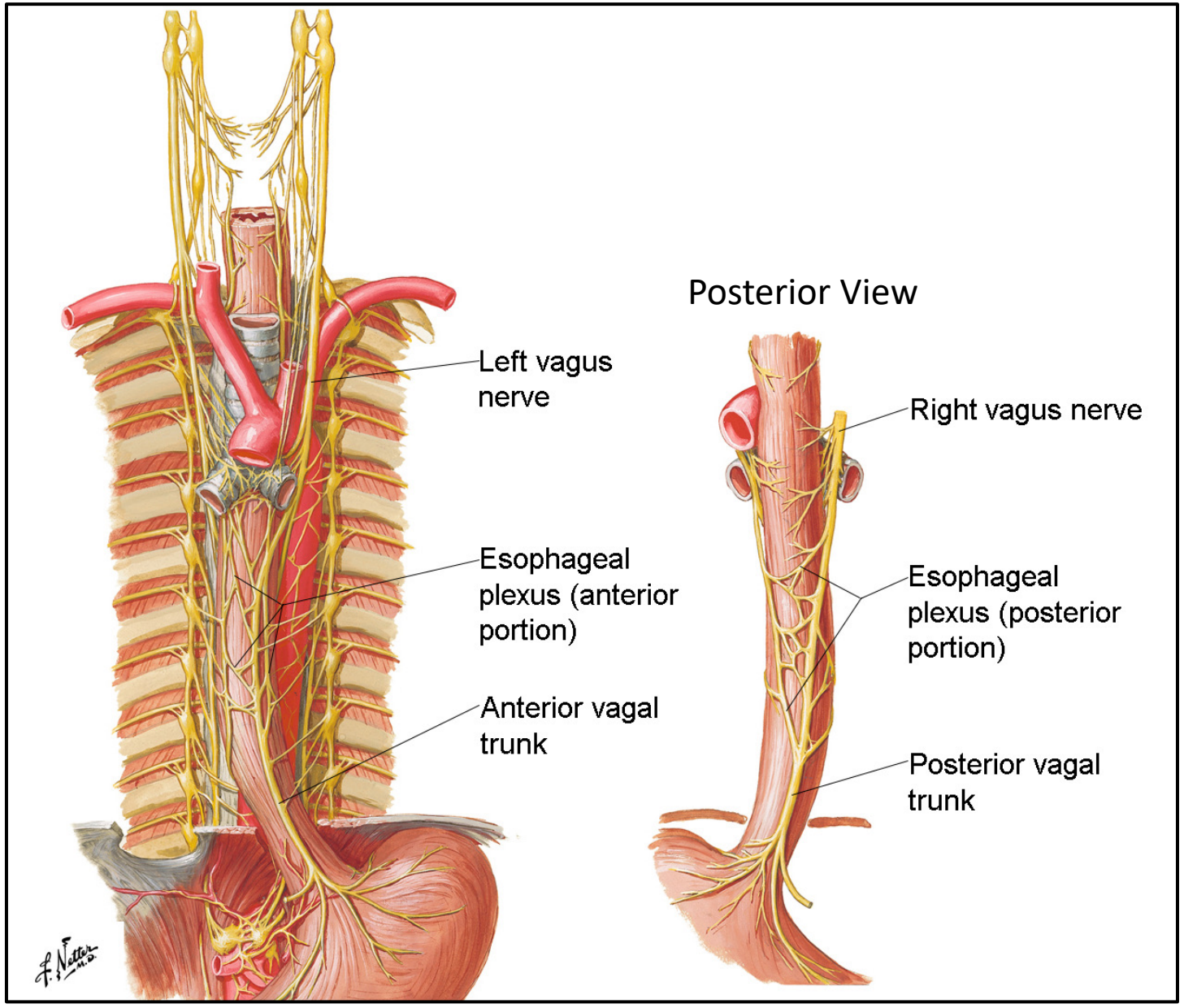
* Sympathetic preganglionic fibers to the esophagus arise from T1-T10 intermediolateral column (lateral horn) of the spinal cord.

Posterior Mediastinum: Esophageal Plexus & Vagal Trunks (Review GI)

FUNCTIONAL ANATOMY: Neurons upon which the parasympathetic fibers synapse within the esophageal wall are contained within the myenteric and submucosal plexuses. These plexuses give rise to autonomous esophageal contraction even when vagal and sympathetic fibers are severed. A peristaltic wave of contraction is initiated in the esophagus by the voluntary act of swallowing. Unlike other portions of the alimentary canal, the esophagus does not engage in spontaneous peristaltic contractions.

Just superior to the diaphragm, fibers in the esophageal plexus coalesce to form the **anterior and posterior vagal trunks**. These pass through the esophageal hiatus with the esophagus to innervate portions of the gastrointestinal tract.

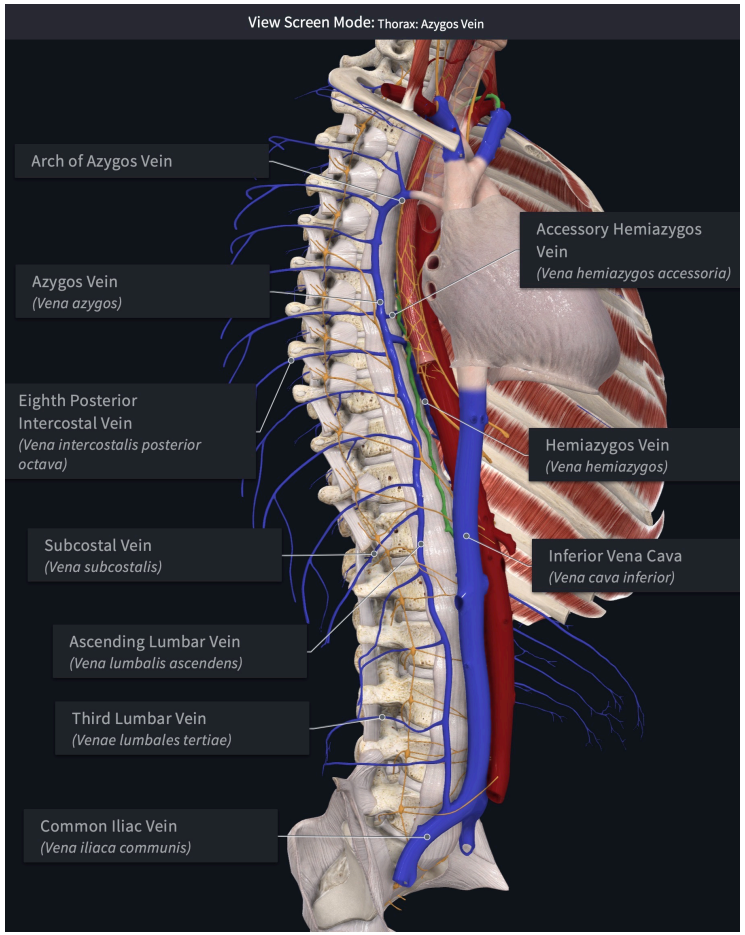
- Fibers from the left vagus n. enter the anterior aspect of the esophageal plexus and typically predominate in the **anterior vagal trunk**.
- Fibers from the right vagus n. pass to the posterior aspect of the esophageal plexus and predominate in the **posterior vagal trunk**.
- A commonly used mnemonic to remember this relationship is LARP
  - Left = Anterior
  - Right = Posterior



Posterior Mediastinum: Azygos Venous System

In general, the **azygos system** of veins is responsible for draining venous blood from the thorax, back, vertebrae/vertebral canal, and posterior wall of the abdomen.

- **Azygos vein**
  - Begins at the L1/L2 vertebral level at the junction between the *right* ascending lumbar vein and the *right* subcostal vein.
  - Ascends through the posterior and superior mediastinum receiving blood directly from posterior intercostal veins on the right (as high as 3rd posterior intercostal vein), the hemiazygos vein, and accessory hemiazygos vein.
  - Empties into the superior vena cava after forming the **arch of the azygos vein** over the root of the right lung.
- **Hemiazygos vein**
  - Formed by the junction of the left subcostal vein and the left ascending lumbar veins.
  - Typically receives blood from the 9th, 10th, and 11th posterior intercostal veins.
  - Crosses the midline to empty into the azygos vein.
- **Accessory hemiazygos vein**
  - Begins at the 4th intercostal vein on the left
  - Descends to the 8th or 9th intercostal space receiving blood from the veins in the intercostal spaces it crosses.
  - Crosses the midline where it drains into the azygos vein or into the hemiazygos vein



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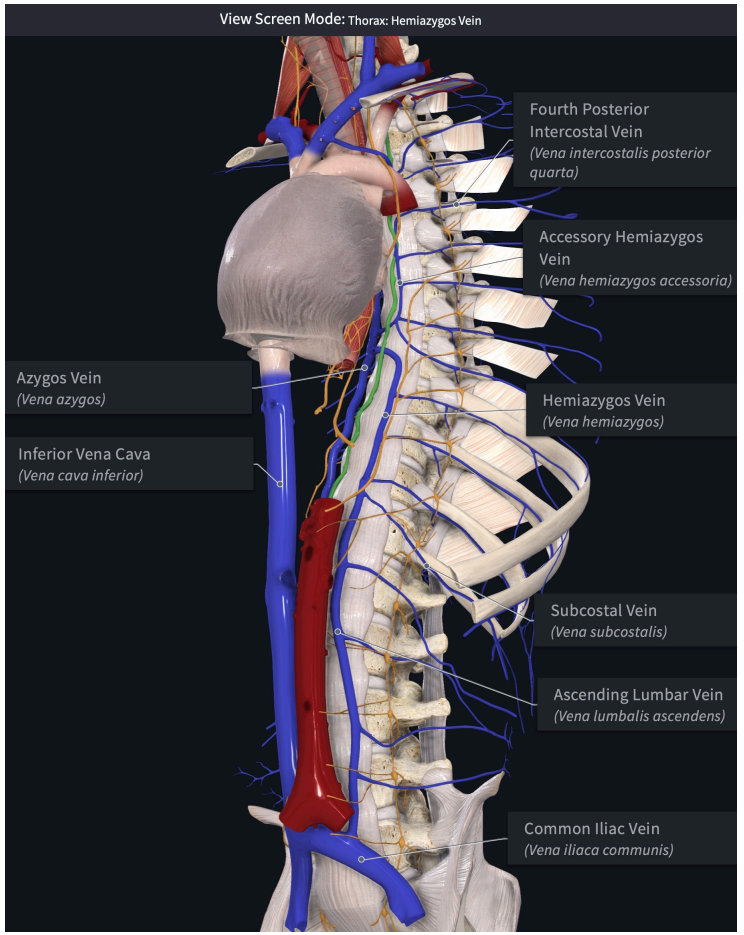

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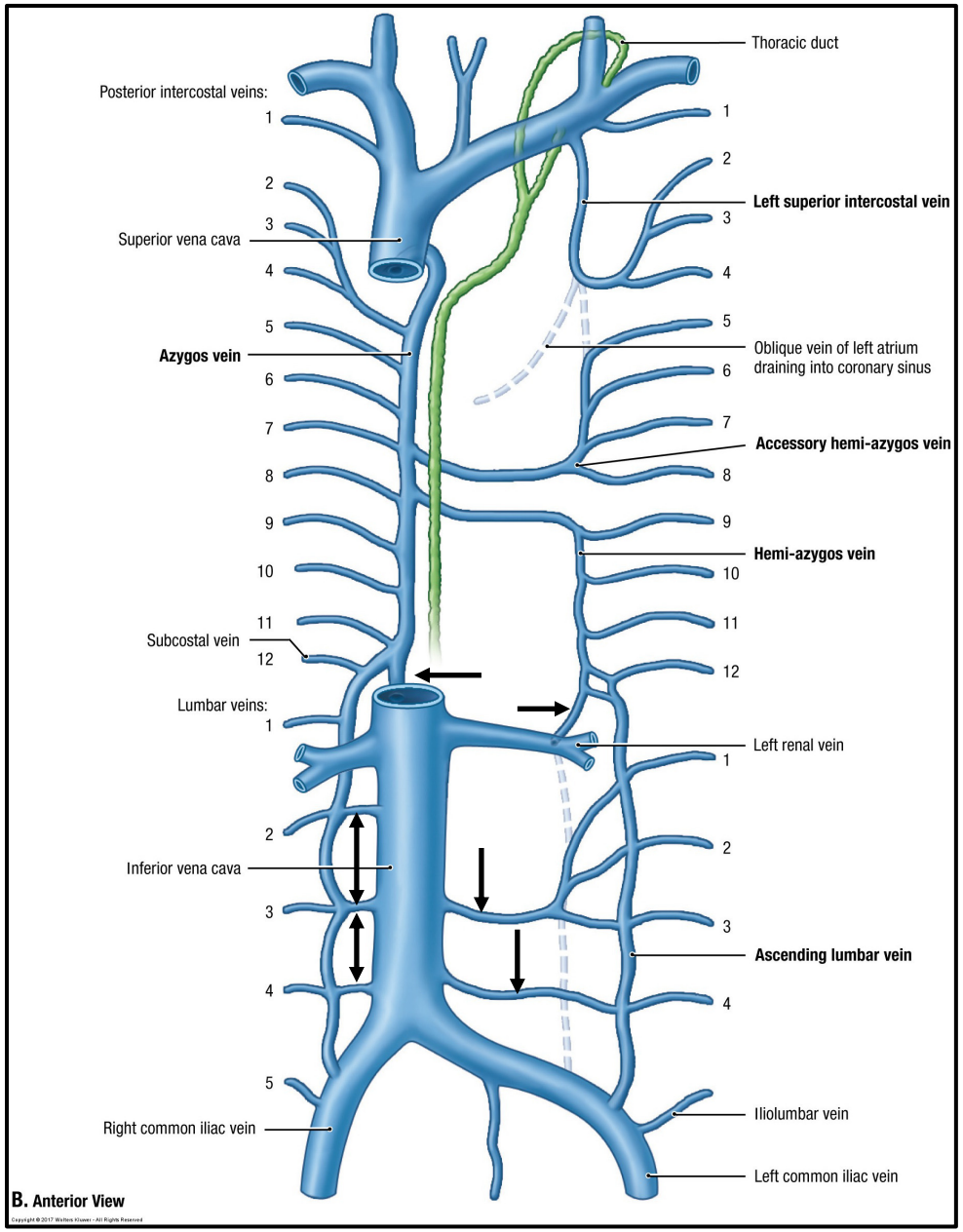
Posterior Mediastinum: Azygos Venous System (Continued)

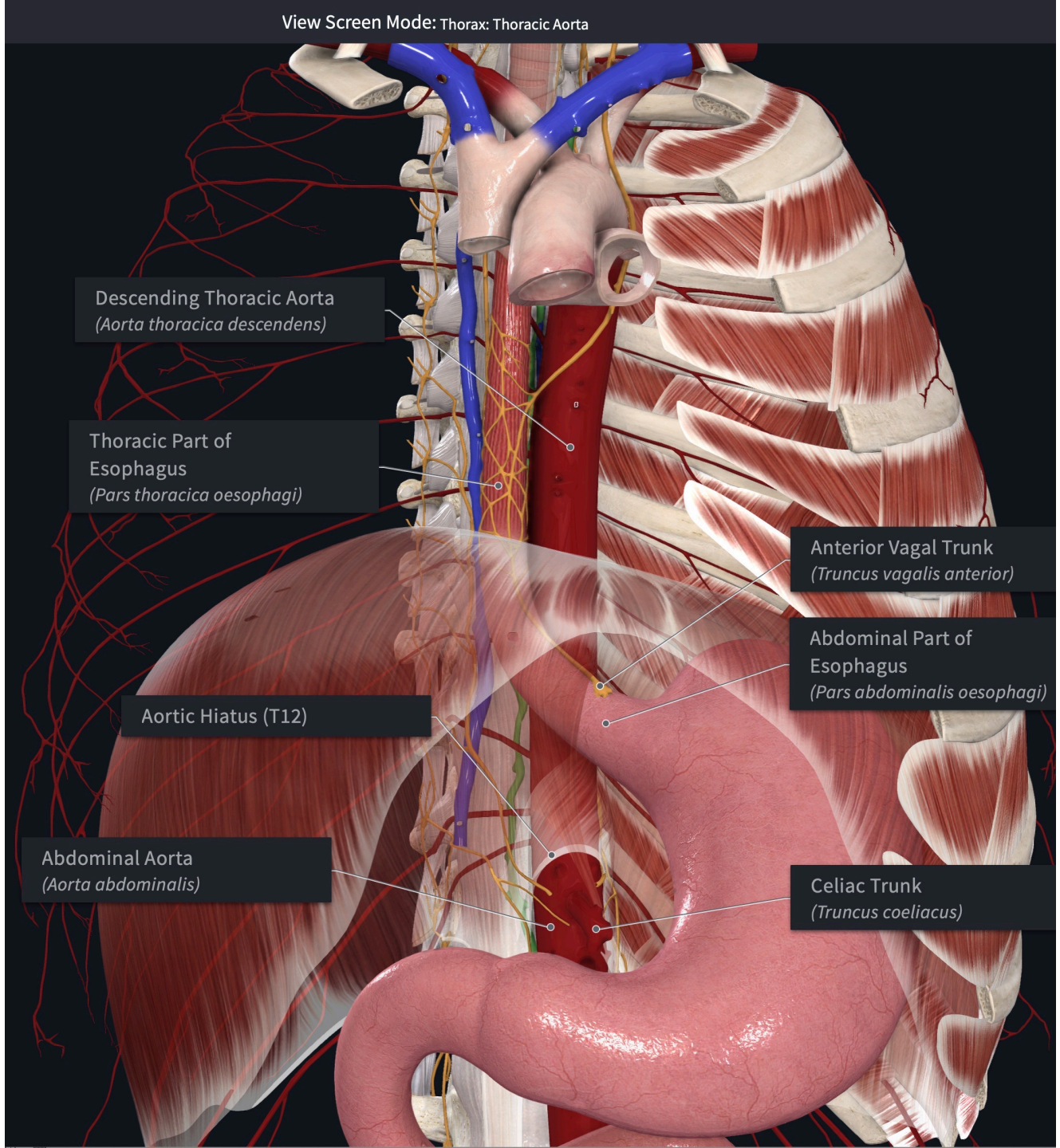
CLINICAL ANATOMY: The azygos venous system has connections with the **inferior vena cava** in the abdomen. Consequently, the azygos system provides an alternate route of venous drainage from the thorax, abdomen, and back when obstruction of the inferior vena cava occurs. The black arrows in the figure indicate connections between the azygos system and the IVC, which can be alternative routes for venous drainage..

Note: The connection sites between the IVC and the azygos system weren't shown in the CA images on the previous slide.



Posterior Mediastinum: Thoracic Aorta

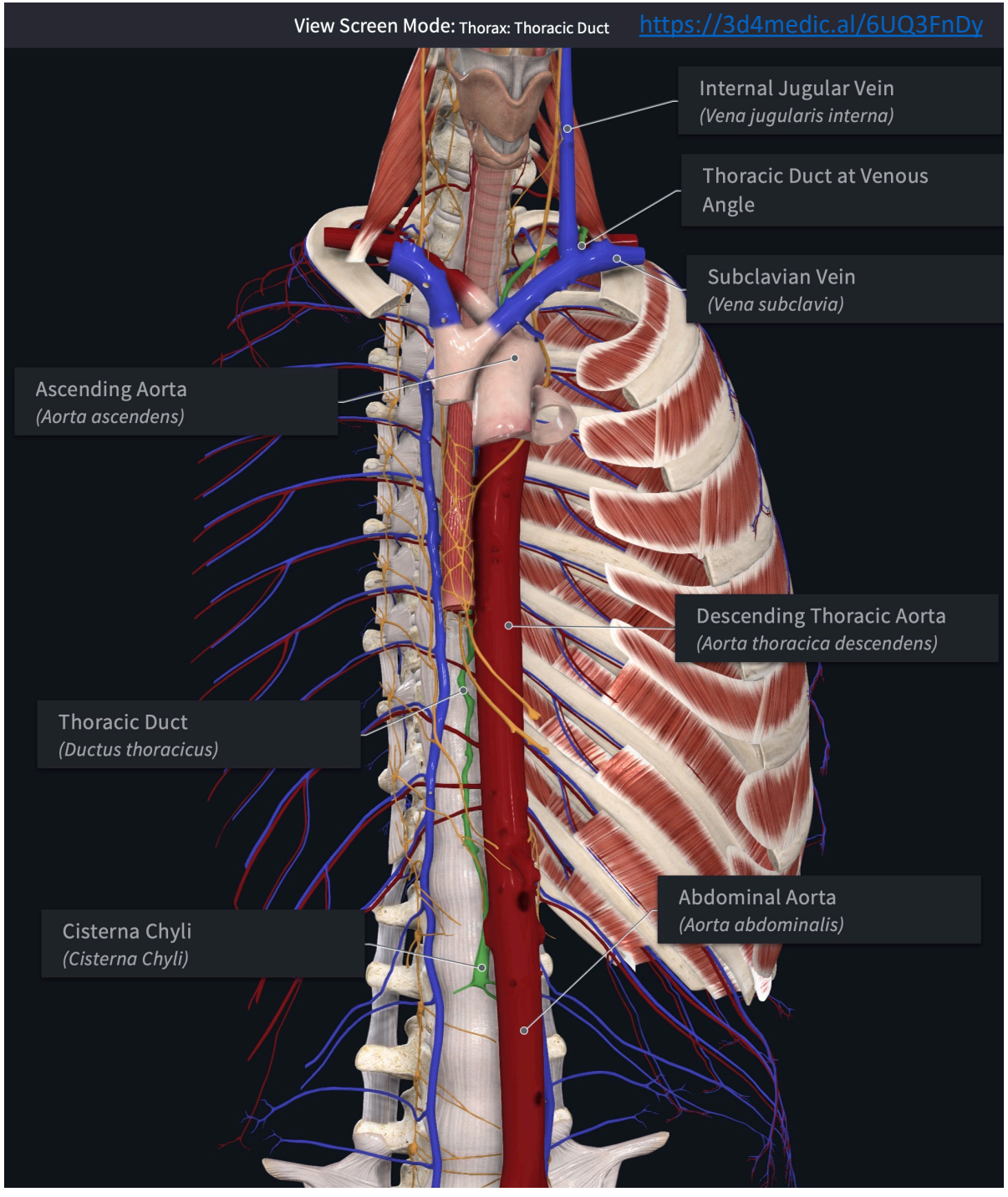
The **thoracic aorta** is the superior portion of the descending aorta and is located to the left and posterior of the esophagus. The thoracic aorta passes into the abdomen through the aortic hiatus at the T12 vertebral level.



Posterior Mediastinum: Thoracic Duct

Posterior to the esophagus, the **thoracic duct** is located in the connective tissue between the thoracic aorta and azygos vein.

- The thoracic duct is a thin-walled and easily torn lymphatic duct. In the lab on an embalmed cadaver, it will look similar to a small vein.
- The thoracic duct originates in the abdomen from a saccular dilation called the **cisterna chyli**, which receives lymph from the abdominal walls, abdominal viscera, pelvis, perineum, and lower limbs. The thoracic duct passes through the aortic hiatus in the diaphragm to enter the thoracic cavity.
- It courses through both the posterior mediastinum and superior mediastinum to ultimately terminate at the **left venous angle**, which is the junction of the left internal jugular and left subclavian veins. The thoracic duct is the principal channel that transports lymph from the majority of the body to the venous circulation.



Posterior Mediastinum: Sympathetic Trunk

The **sympathetic trunk (chain)** is located at the lateral aspect of the vertebral column and consists of a series of (paravertebral) ganglia. It extends from the superior cervical ganglion at the base of the skull to the ganglion impar at the coccyx. Recall that the ganglia have connections to other structures.

- Connections between paravertebral ganglia: Ganglia connect to each other superiorly and inferiorly via ascending/descending preganglionic sympathetic axons.
- Connections to the anterior ramus of spinal nerves
  - From T1-L2, ganglia connect to anterior rami by two connections
    - White ramus communicantes
    - Gray ramus communicantes
  - In regions other than T1-L2, ganglia connect to anterior rami by only gray rami
- Connections to prevertebral (preaortic) ganglia: Projecting anteriorly from the paravertebral ganglia are splanchnic nerves that contain sympathetic efferent axons and visceral afferent axons that innervate viscera of body cavities (thorax and abdominopelvic cavities).
  - Cardiopulmonary (splanchnic) nerves (postganglionic) branch from cervical and thoracic paravertebral ganglia.
  - Thoracic splanchnic nerves (preganglionic) (T5-T12) branch from thoracic paravertebral ganglia
    - Greater splanchnic n.
    - Lesser splanchnic n.
    - Least splanchnic n.
  - Lumbar splanchnic nerves (preganglionic) (L1-L2) branch from lumbar paravertebral ganglia.
  - Sacral splanchnic nerves (Preganglionic) branch from sacral paravertebral ganglia.