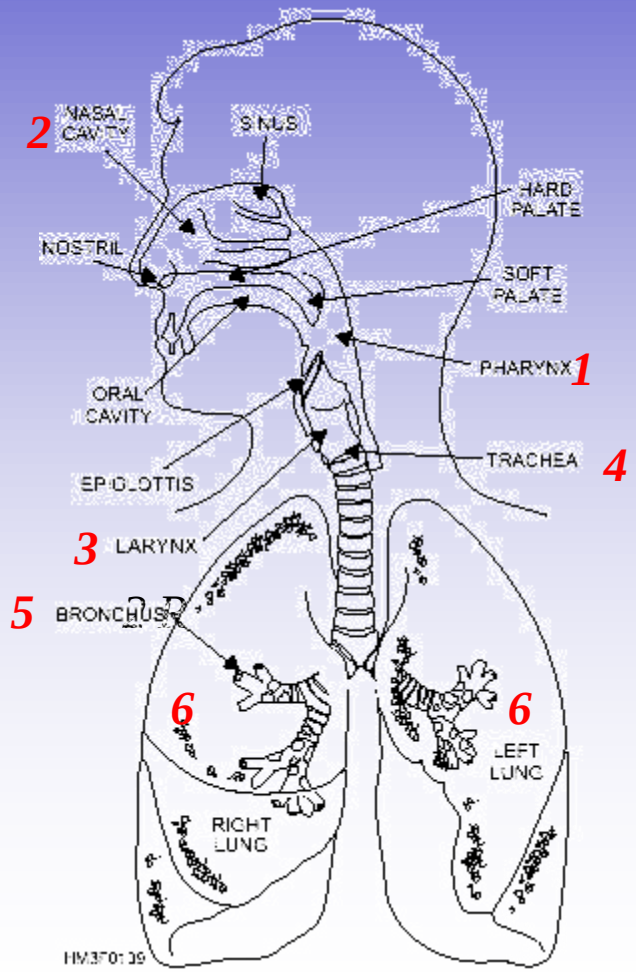
RESPIRATORY SYSTEM

It is responsible for gas exchange between the blood and atmospheric air. It consists of:

AIRWAYS

- *2 Nasal cavities*
- *1 Pharynx*
- *3 Larynx*
- *4 Trachea*
- *5 Bronchi*

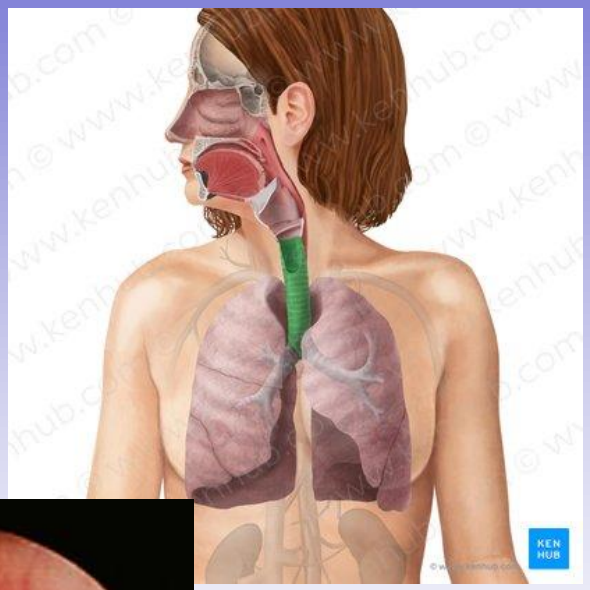


LUNGS

6 The lungs represent the site of hematosis (gas exchange)..

RESPIRATORY SYSTEM
TRACHEA

The trachea is an unpaired cylindrical duct that is kept permanently open by a supporting framework made up of a series of ***cartilaginous rings****.*



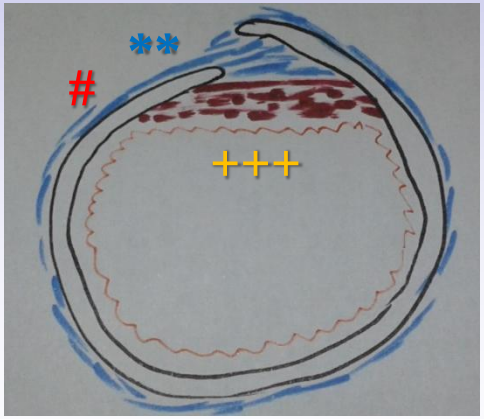
The trachea is a 10–13 cm fibrocartilaginous tube extending from the larynx (C6 vertebra) to the bronchi (T4-T5 vertebra).

Key anatomical parts include:
-16–20 C-shaped hyaline cartilage rings for support,
-the posterior trachealis muscle for elasticity,
-and the carina, which is the internal ridge at the bifurcation

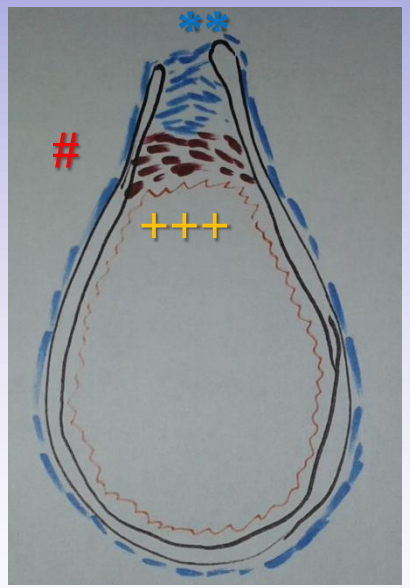
RESPIRATORY SYSTEM
TRACHEA

In different species, each cartilaginous ring may be dorsally closed in different ways by a ligament or by a muscular component.

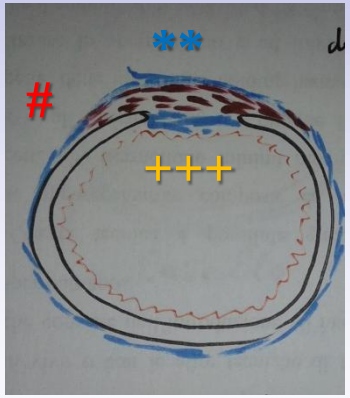
TRACHEAL MUSCLE #
FIBROELASTIC MEMBRANE**
CARNIVORES +++



Horse



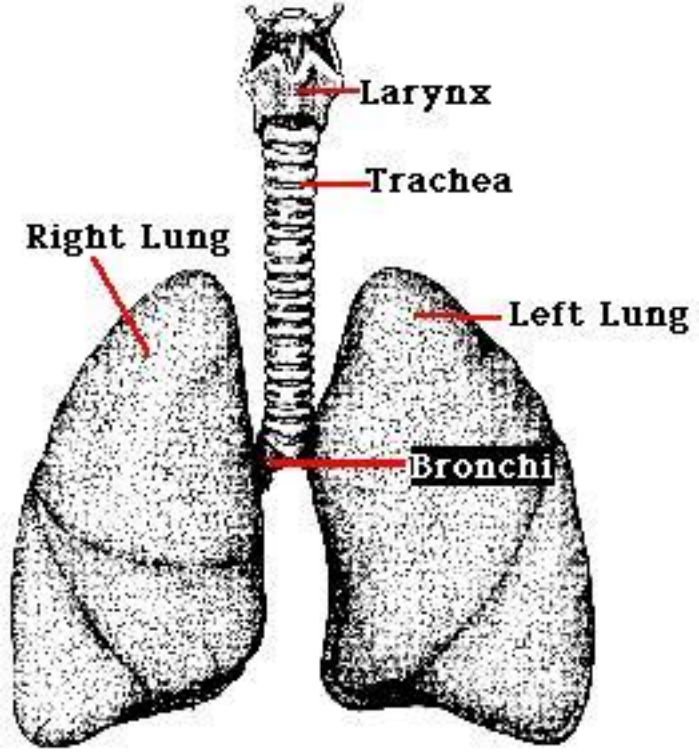
Bovine



Carnivores
Primates

RESPIRATORY SYSTEM
TRACHEA

The first cartilaginous ring of the trachea is connected to the cricoid cartilage by the ***cricotracheal ligament****..*

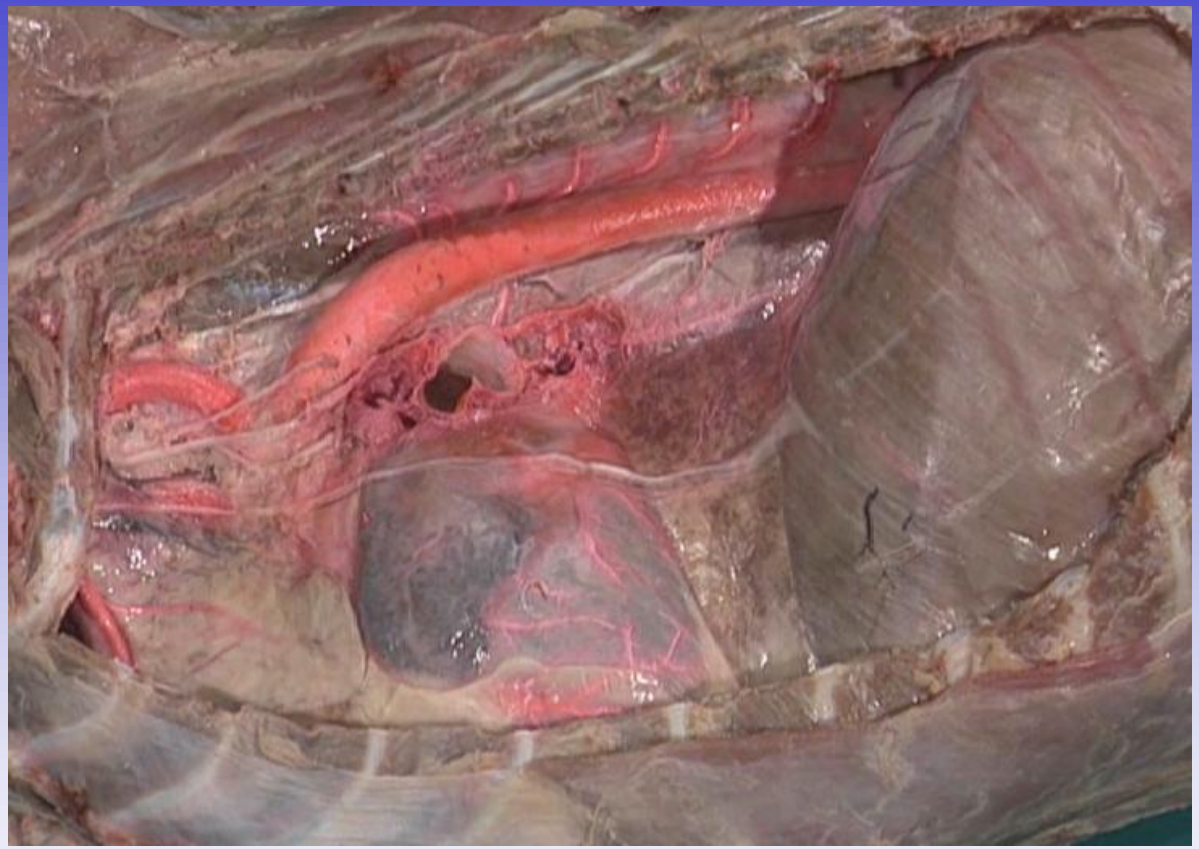


The trachea ends in the thoracic cavity by dividing into two ***bronchi****, one for each lung..*

RESPIRATORY SYSTEM
TRACHEAL BIFURCATION

The trachea ends by bifurcating, just after the aorta, into the two main bronchi, right and left.

RESPIRATORY SYSTEM
TRACHEA



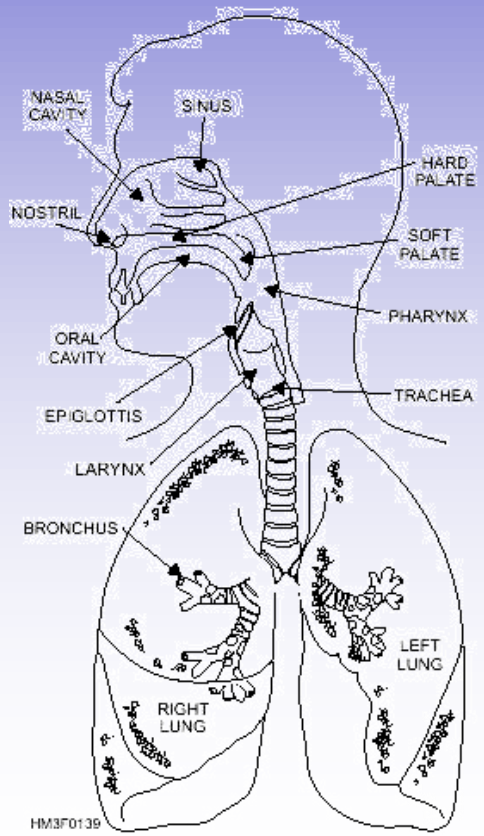
*The right and left main bronchi enter the **hilum** of their respective lungs.*

RESPIRATORY SYSTEM
TRACHEA

The trachea consists of:

Cervical part, *located in the visceral space of the neck.*

Thoracic part, *located within the cranial and middle mediastinum.*

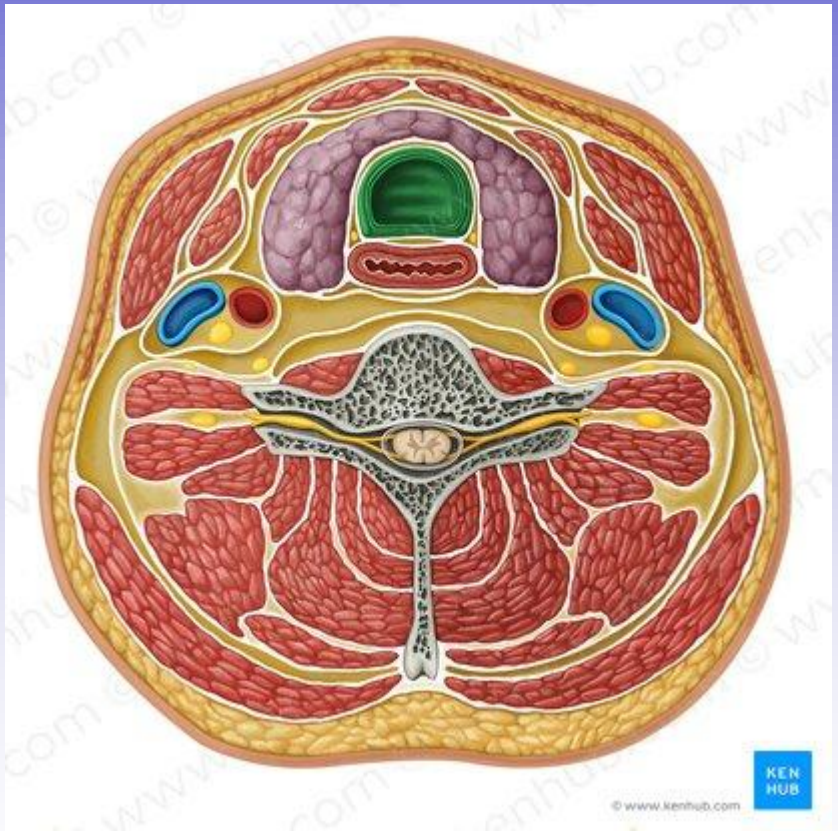


RESPIRATORY SYSTEM
TRACHEA

Cervical part, *located in the visceral space of the neck.*

The cervical part of trachea is covered anteriorly by several structures, from deep to superficial;

-The visceral cervical fascia
-The isthmus of thyroid gland.
-Pretracheal lymph nodes
-The sternohyoid and sternothyroid muscles
-The jugular venous arch



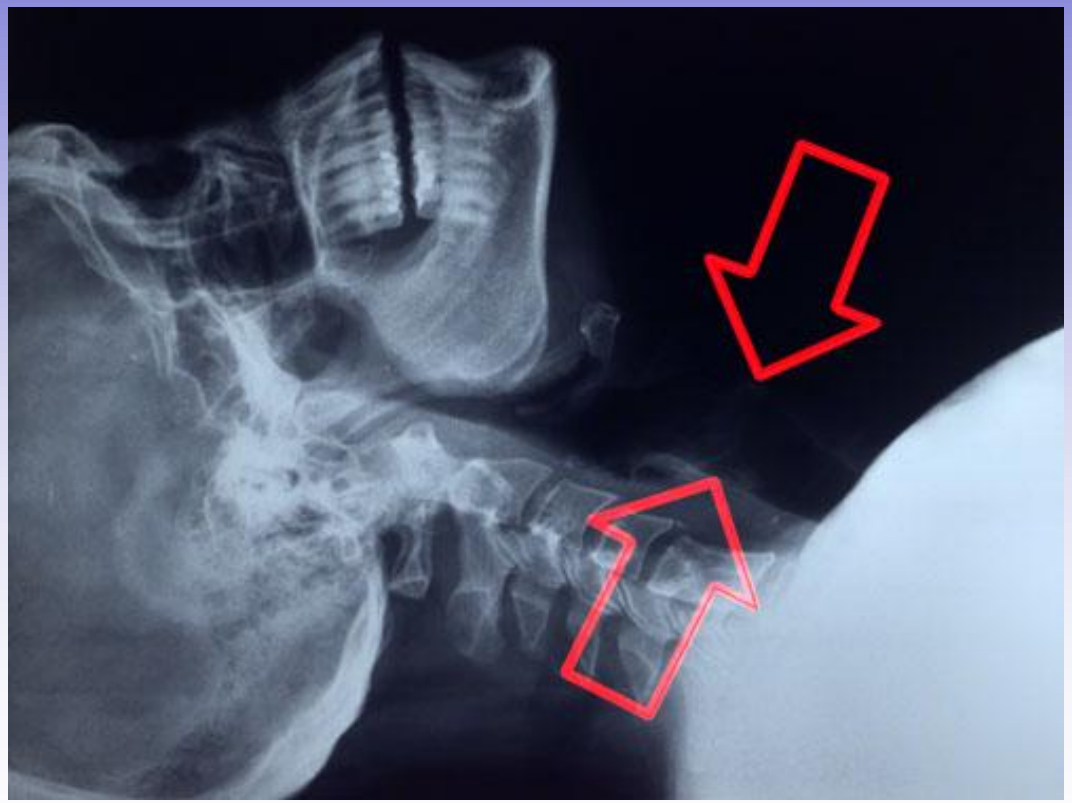
RESPIRATORY SYSTEM
TRACHEA

Cervical part

RESPIRATORY SYSTEM
TRACHEA

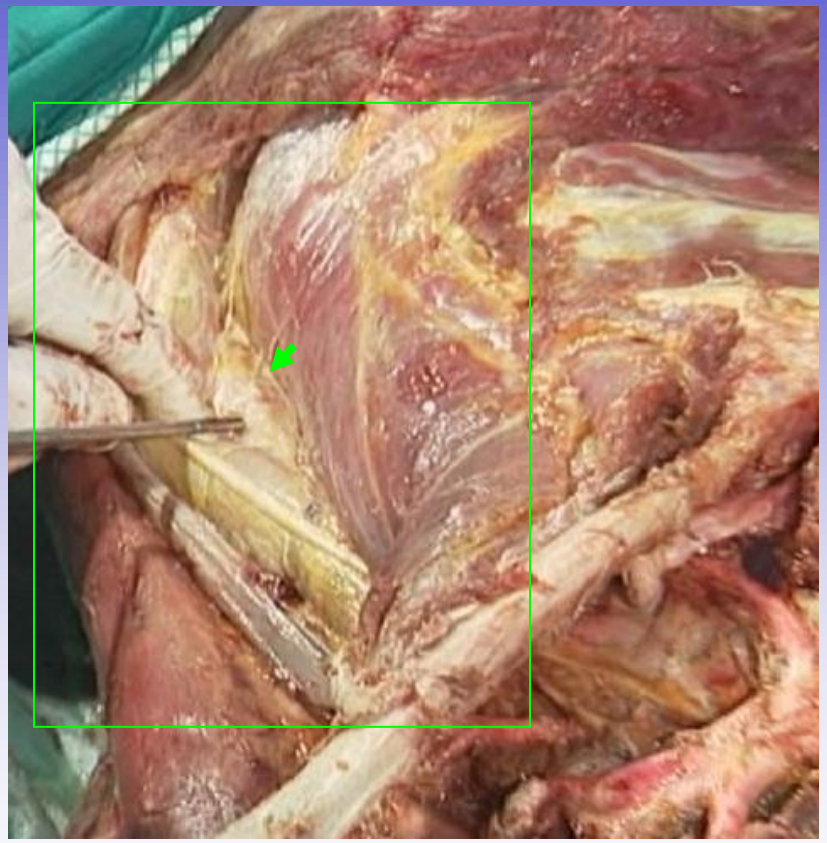
Cervical part

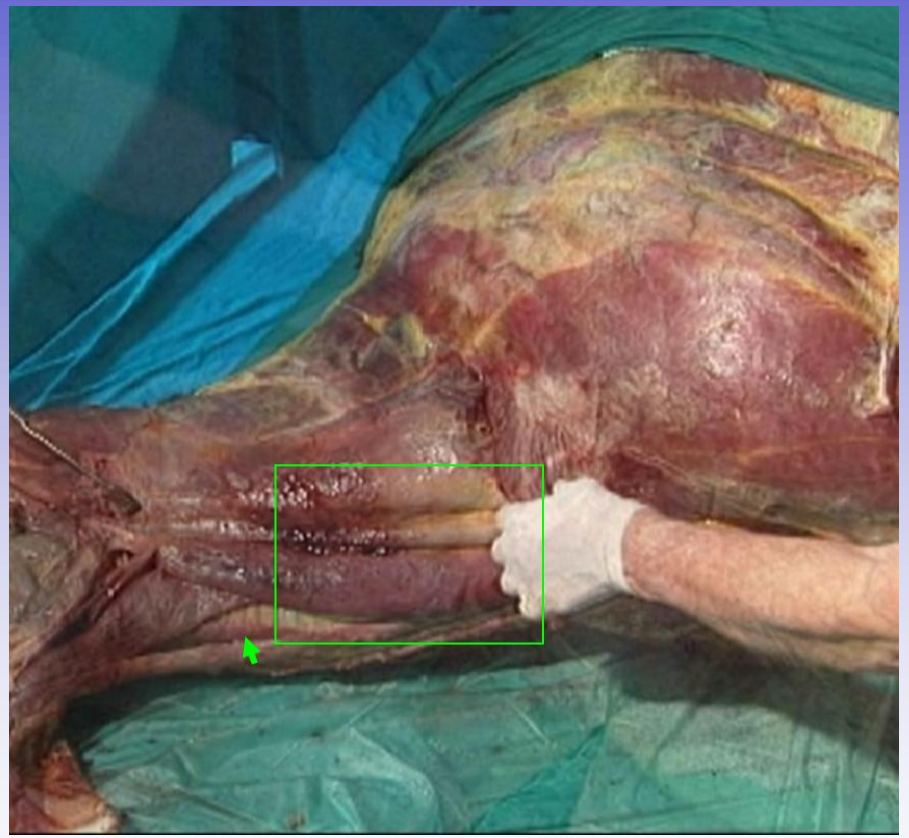
"The dorsal surface is related to the esophagus, which deviates to the left in the lower half of the cervical region.



RESPIRATORY SYSTEM
TRACHEA

Cervical part



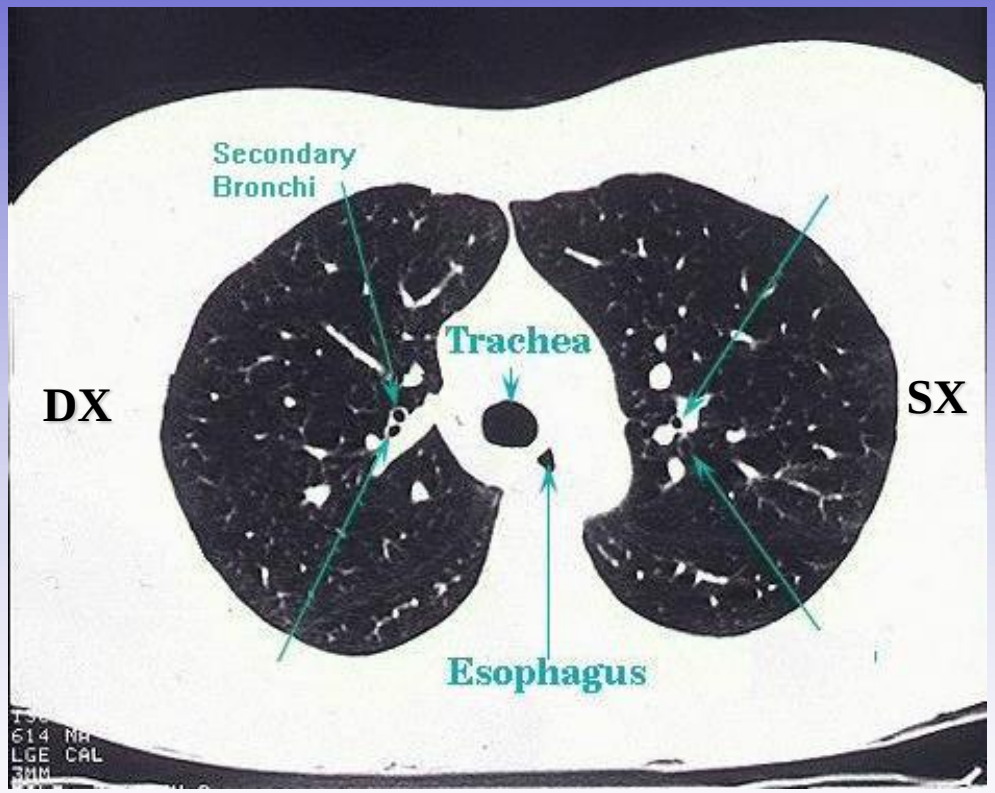


*At the base of the neck it is also related, first laterally and then ventrally, to the neurovascular bundle (**common carotid artery, vagosympathetic trunk**, and in the bovine the **external jugular vein**)*

RESPIRATORY SYSTEMTRACHEA

Thoracic part

*At the entrance of the thorax, the trachea is still related laterally on the left side to the **esophagus** and ventrally to the neurovascular bundle..*

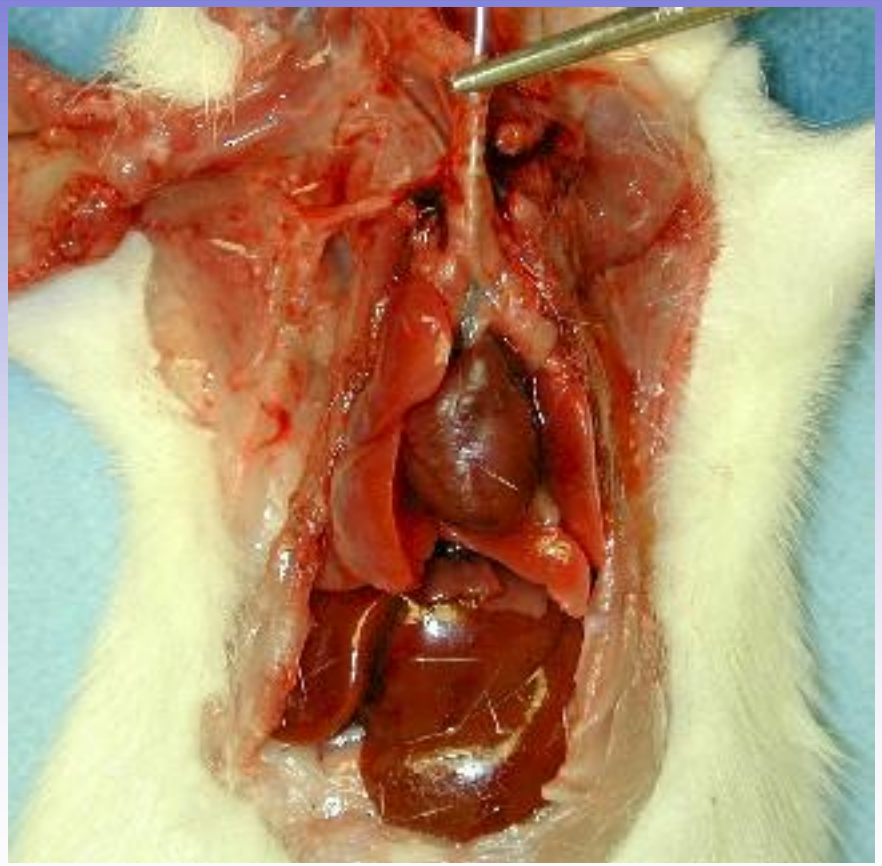


In the <u>cranial mediastinum</u>, the esophagus resumes its dorsal position..

RESPIRATORY SYSTEMTRACHEA

Thoracic part

*In the **middle mediastinum**, the trachea lies dorsal to the base of the heart and, just beyond the aorta, bifurcates into the right and left main bronchi*

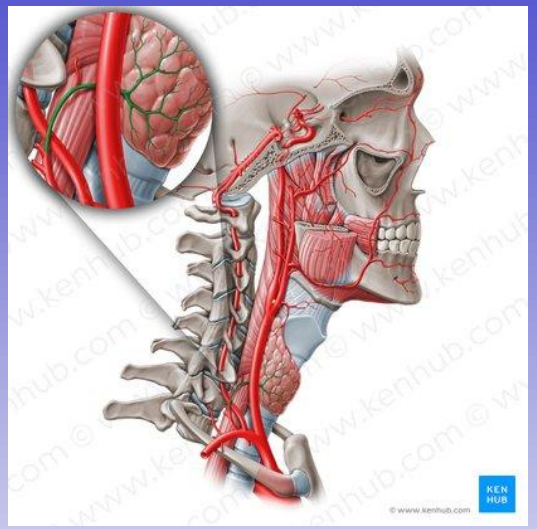


RESPIRATORY SYSTEM
TRACHEA AND BRONCHIAL BRANCHES

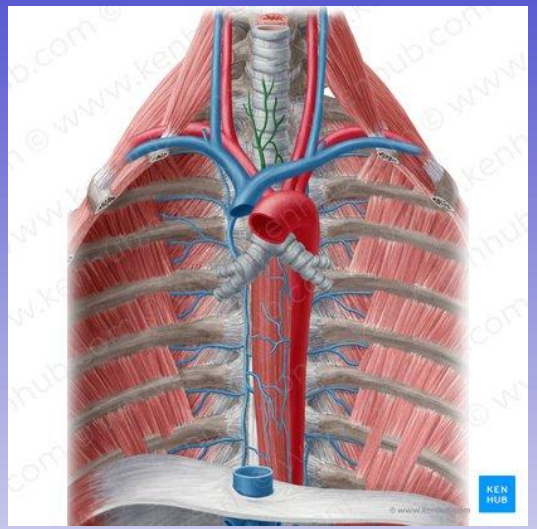
In ruminants and in the pig, a few centimeters before the bifurcation the trachea gives rise to the ***tracheal bronchus****, destined for the cranial lobe of the right lung.*

In carnivores, the bronchus destined for the cranial lobe of the right lung originates at the level of the origin of the right main bronchus; therefore, it is referred to as ***bronchial trifurcation****..*

RESPIRATORY SYSTEM
TRACHEA: BLOOD SUPPLY AND INNERVATION



Inferior thyroid artery



Inferior thyroid vein

The trachea is supplied with arterial blood by tracheal branches of inferior thyroid arteries, that stem from the thyrocervical trunk.

Venous blood is drained to the inferior thyroid venous plexus, which empties into the brachiocephalic veins.

Lymphatic drainage is to the pretracheal and paratracheal (cervical, thoracic) lymph nodes that empty into the deep cervical lymph nodes.

The trachea receives innervation from the pulmonary plexus.
Parasympathetic supply originates from the recurrent laryngeal nerves, branches of the vagus nerve.
Sympathetic supply is provided by the sympathetic trunks.

RESPIRATORY SYSTEM
TRACHEA: MICROSCOPIC ANATOMY

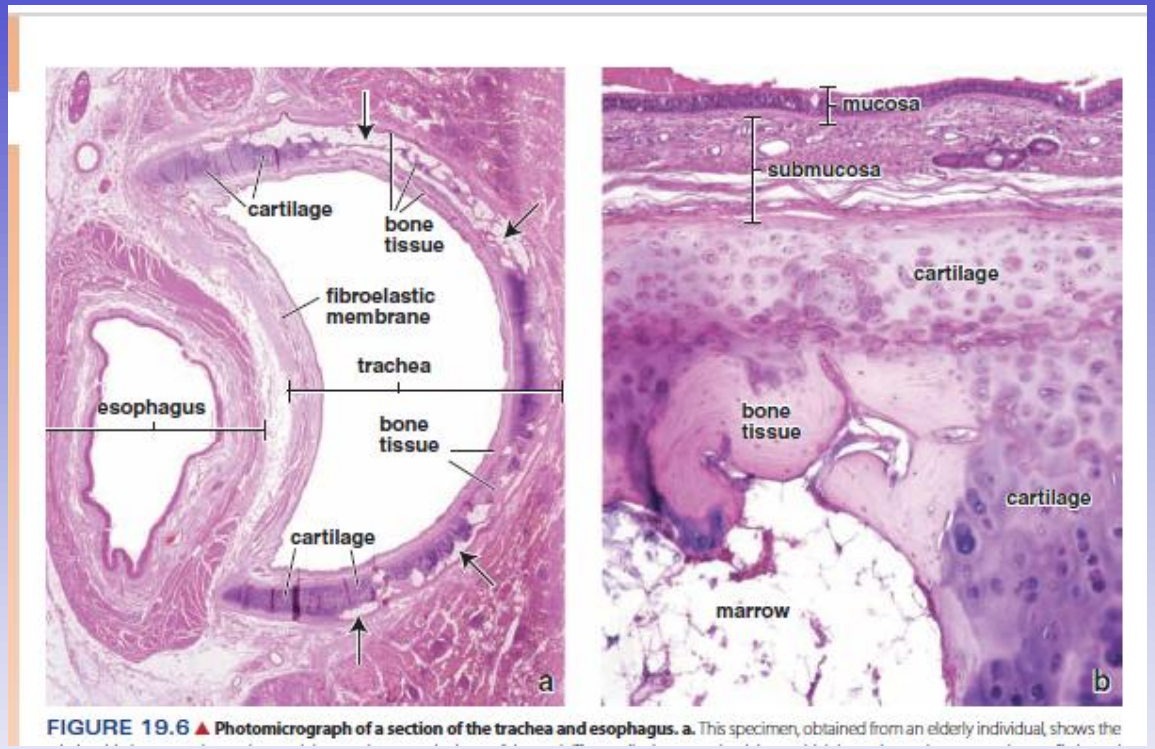
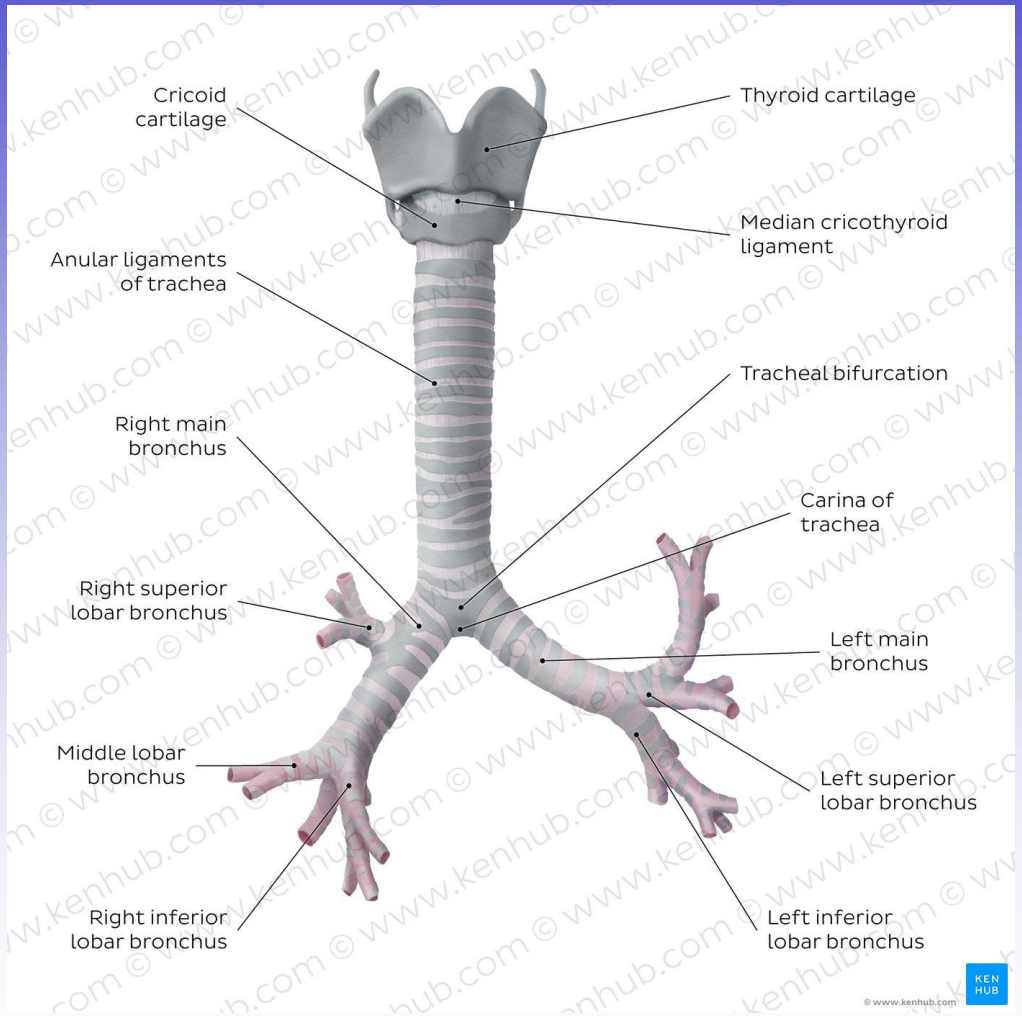


FIGURE 19.6 ▲ **Photomicrograph of a section of the trachea and esophagus. a.** This specimen, obtained from an elderly individual, shows the

The wall of the trachea consists of four layers:

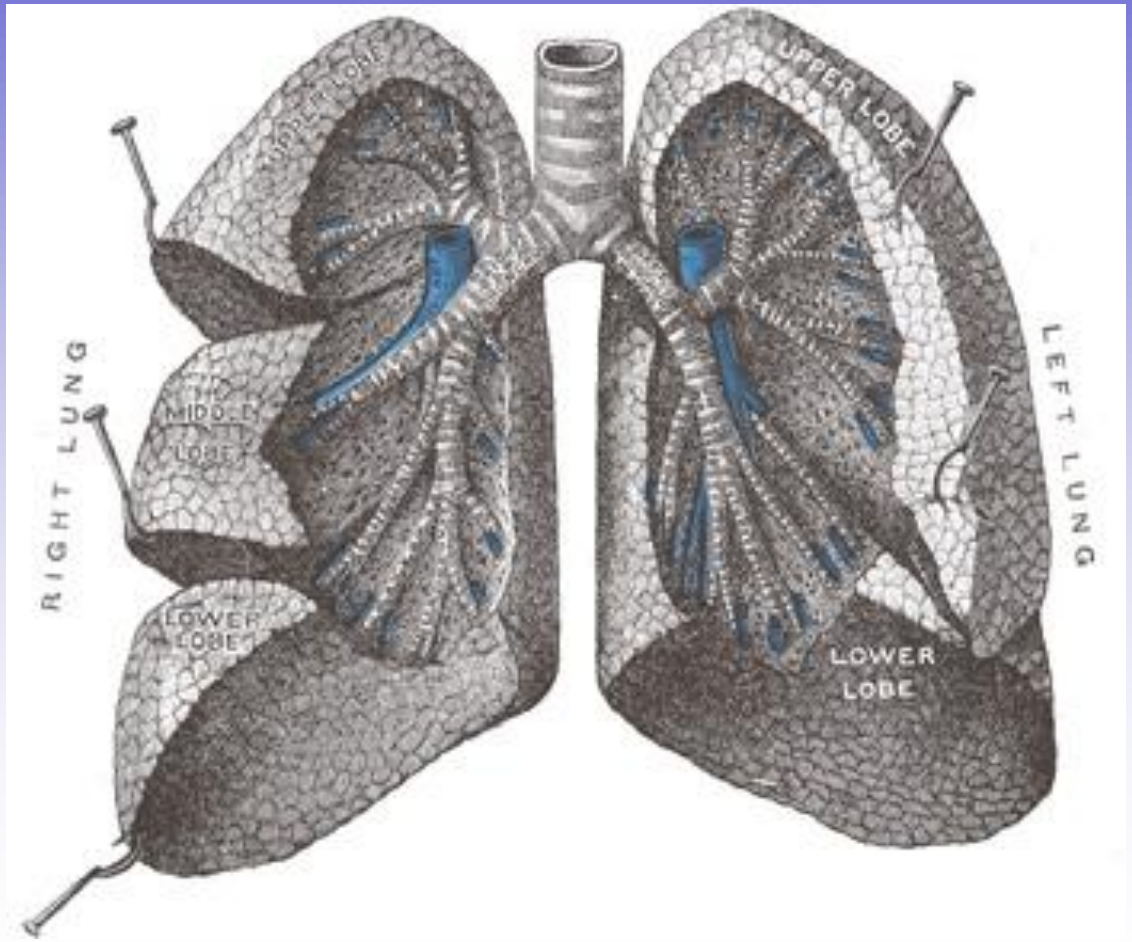
- **Mucosa**, composed of a ciliated, pseudostratifi ed epithelium and an elastic, fi ber-rich lamina propria
- **Submucosa**, composed of a slightly denser connective tissue than the lamina propria
- **Cartilaginous layer**, composed of C-shaped hyaline cartilages
- **Adventitia**, composed of connective tissue that binds the trachea to adjacent structures

RESPIRATORY SYSTEM
TRACHEA AND BRONCHIAL BRANCHES



RESPIRATORY SYSTEM
BRONCHI

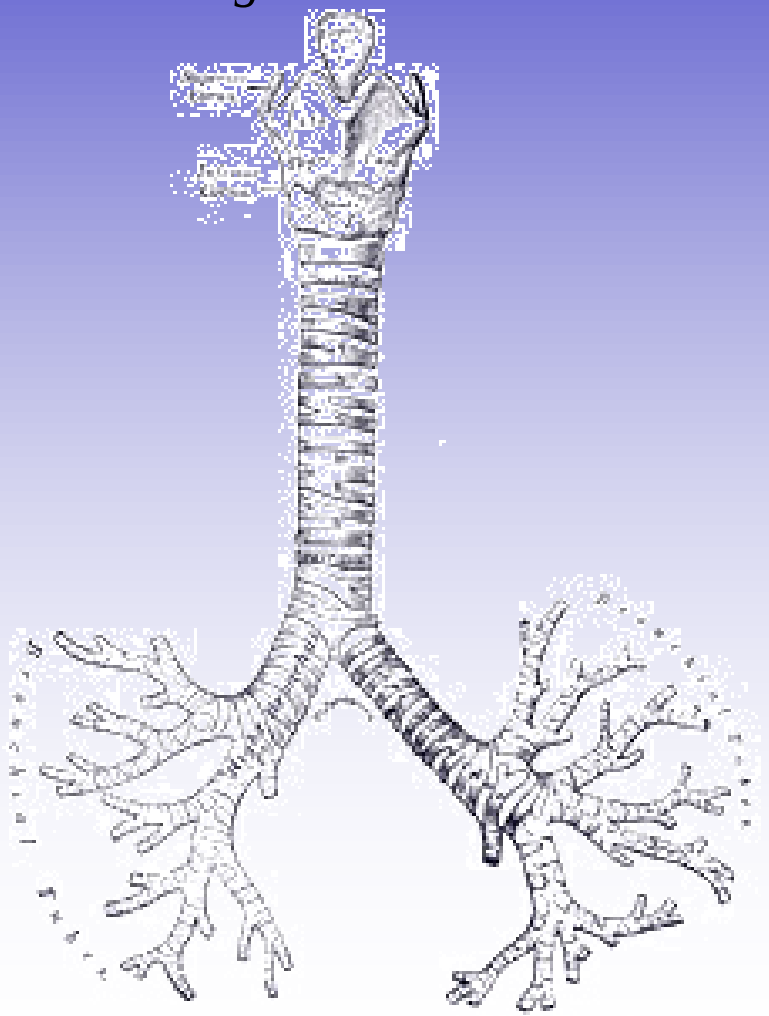
*Each main bronchus presents a short **extrapulmonary segment** that is related to the tracheobronchial lymph nodes.*



RESPIRATORY SYSTEM
BRONCHI

RESPIRATORY SYSTEM
BRONCHI

After entering the lung, the main bronchus gives rise to the bronchial tree through successive branching.

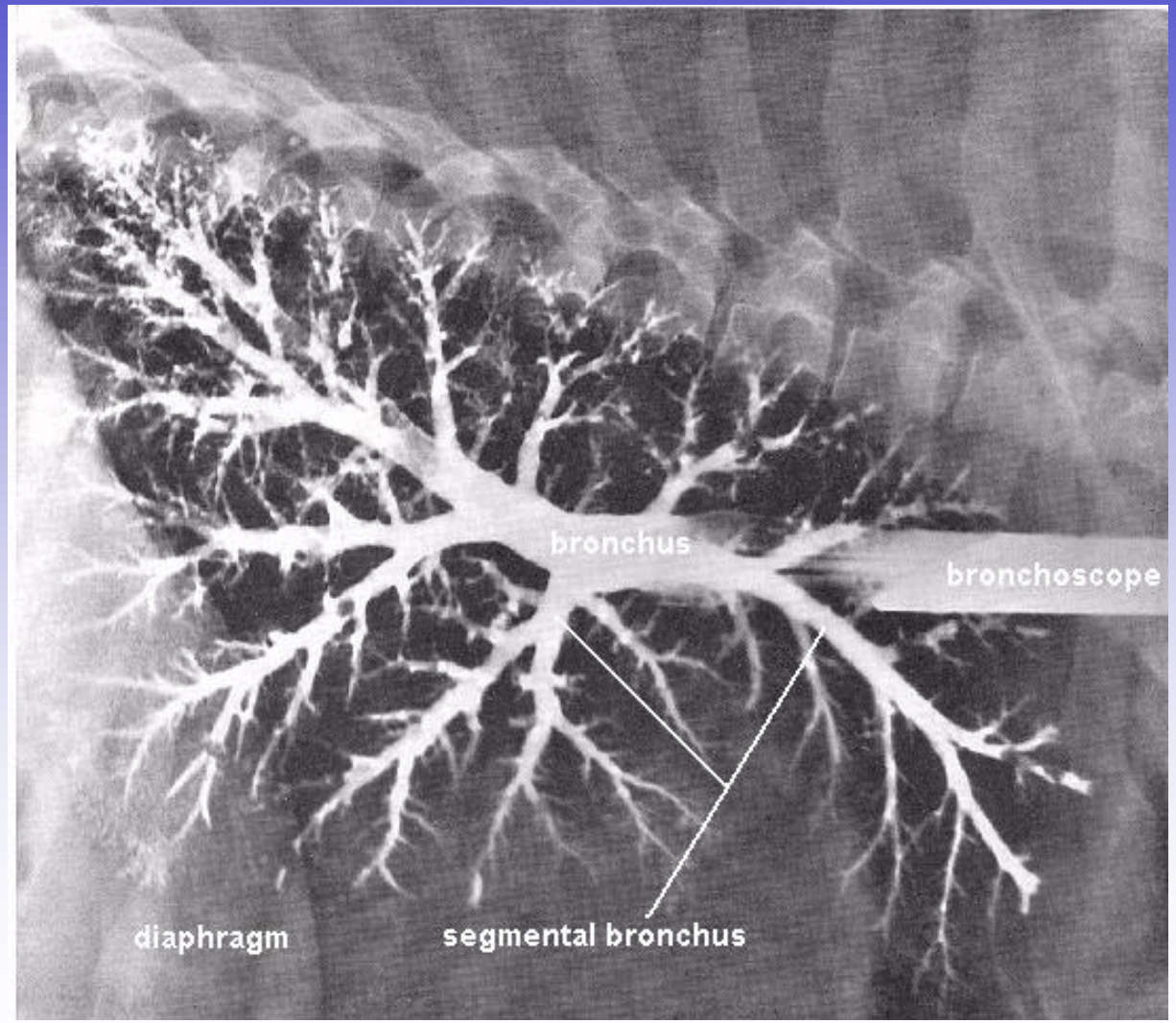


RESPIRATORY SYSTEM
BRONCHI

BRONCHIAL TREE

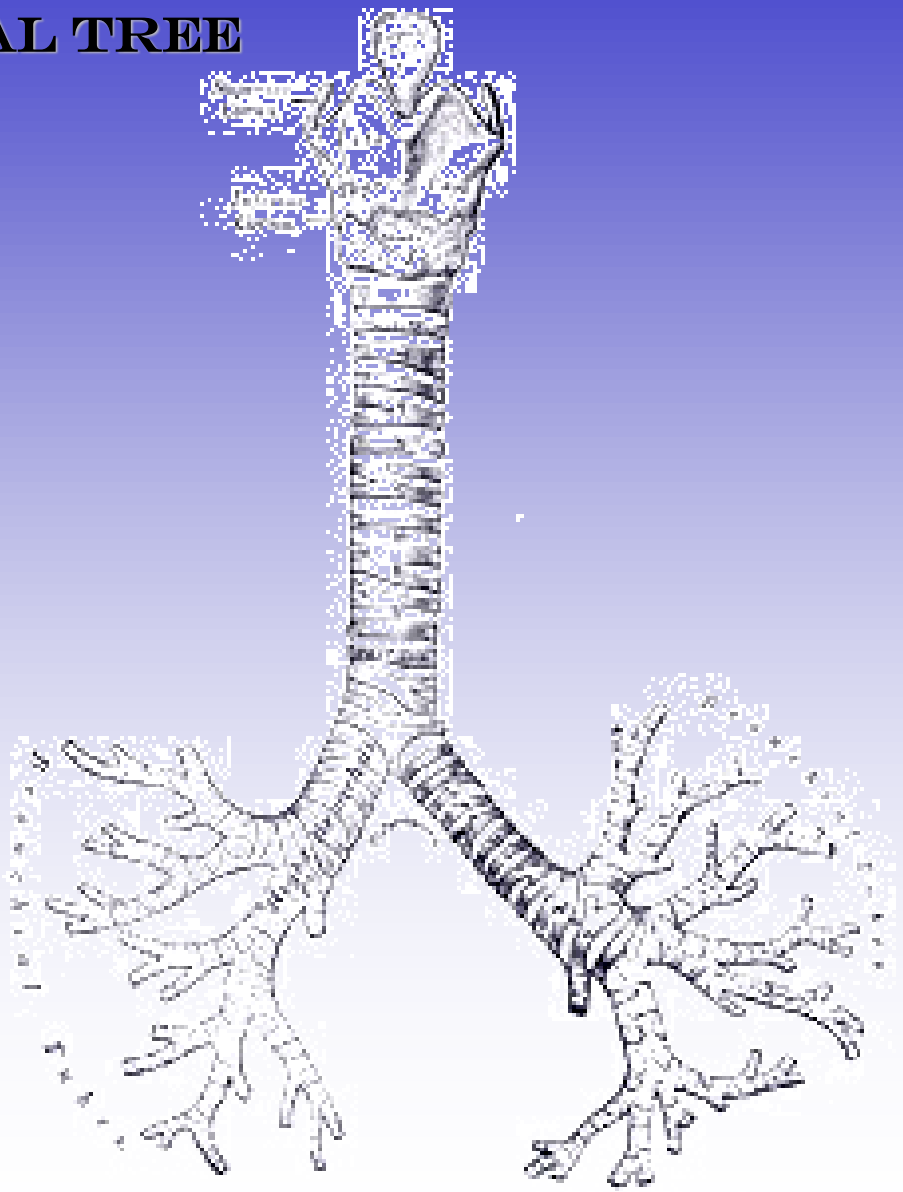
RESPIRATORY SYSTEM
BRONCHI

BRONCHIAL TREE



RESPIRATORY SYSTEM
BRONCHI

BRONCHIAL TREE

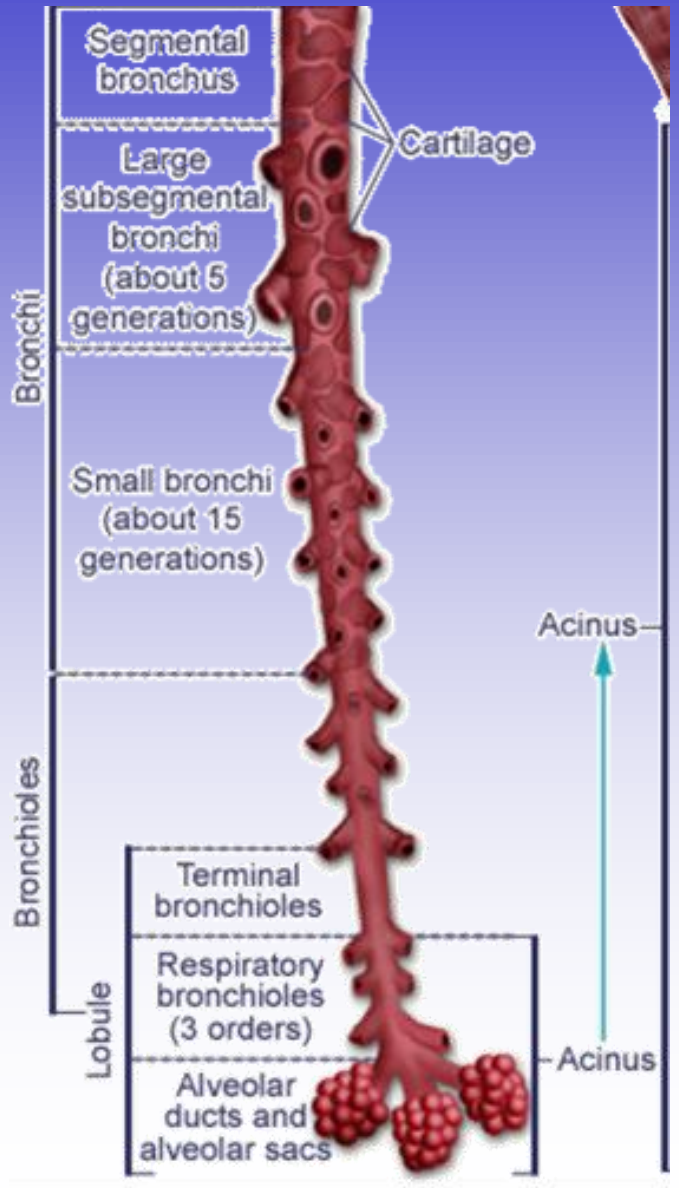


CRANIAL LOBAR BRONCHUS
CAUDAL LOBAR BRONCHUS

SEGMENTAL BRONCHI

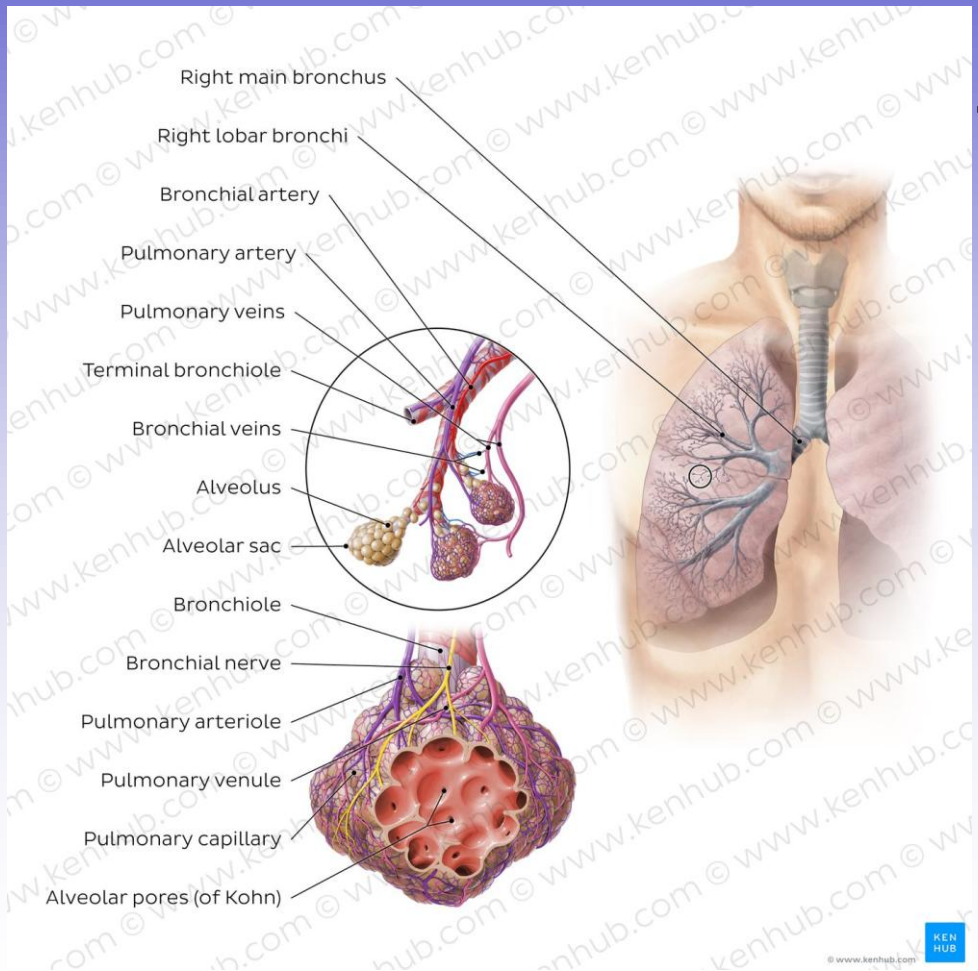
SUBSEGMENTAL BRONCHI

RESPIRATORY SYSTEM
BRONCHIAL ARBORIZATION
BRONCHIOLES



RESPIRATORY SYSTEM
BRONCHIOLES AND ALVEOLI

*The **bronchioles** are part of conducting zone of the respiratory system.*
*The conducting zone allows air to travel from the trachea into the **alveoli**, where gaseous exchange occurs.*



There are **two types of bronchioles**:

Conducting bronchioles: conduct air but they lack glands or alveoli

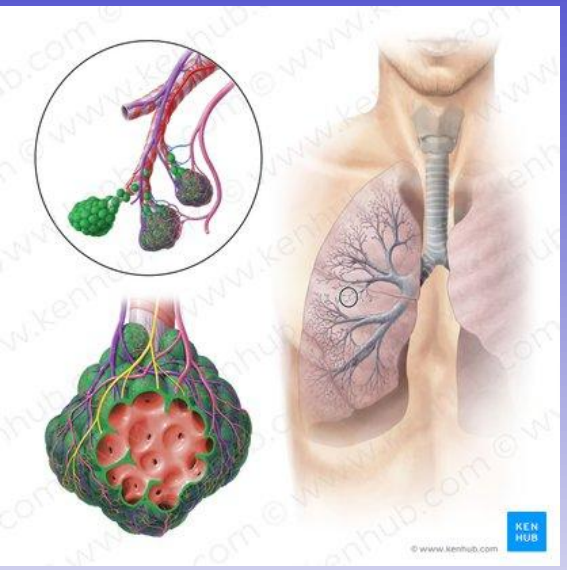
Respiratory bronchioles: conduct air and also contain alevoli that extend from their lumens

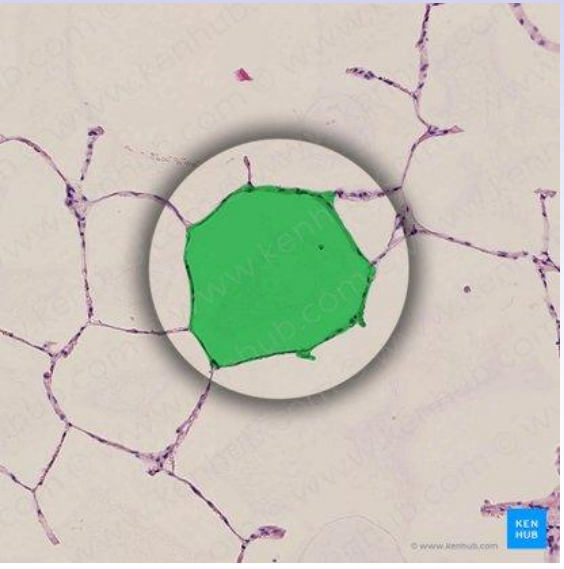
RESPIRATORY SYSTEM

BRONCHI ** - BRONCHIOLES

RESPIRATORY SYSTEM
ALVEOLI

Alveoli *are the basic unit for gaseous exchange in the lungs*





The lung alveoli are the balloon-like air sacs loacted at the distal ends of the bronchial tree

Each alveolus is a thin-walled polyhedral chamber approximately 0.2 mm in diameter that is confluent with an alveolar sac

- **Alveolar ducts** are elongated airways that have almost no walls, only alveoli, as their peripheral boundary. Rings of smooth muscle are present in the knob-like interalveolar septa
- **Alveolar sacs** are spaces surrounded by clusters of alveoli. The surrounding alveoli open into these spaces.

RESPIRATORY SYSTEM
ALVEOLI: MICROSCOPIC ANATOMY

Alveolar epithelium is composed of type I and II alveolar cells and occasional brush cells.

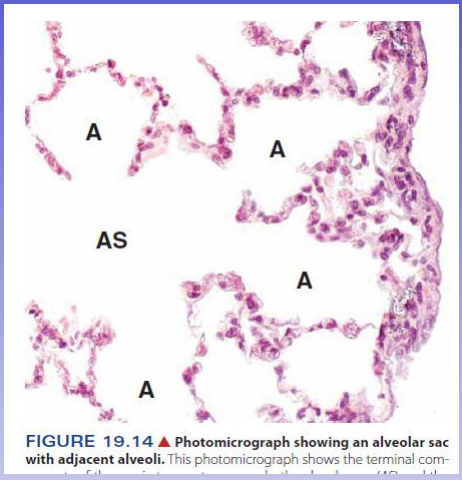


FIGURE 19.14 ▲ **Photomicrograph showing an alveolar sac with adjacent alveoli.** This photomicrograph shows the terminal com-

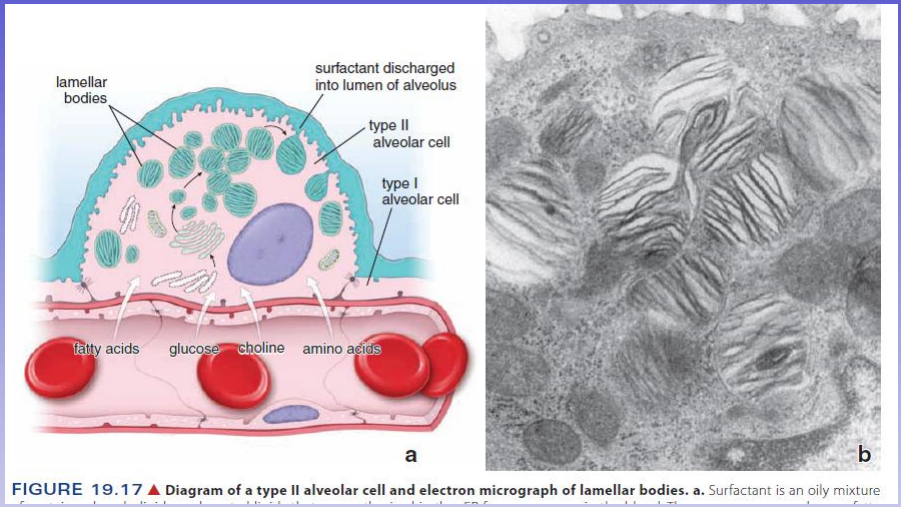


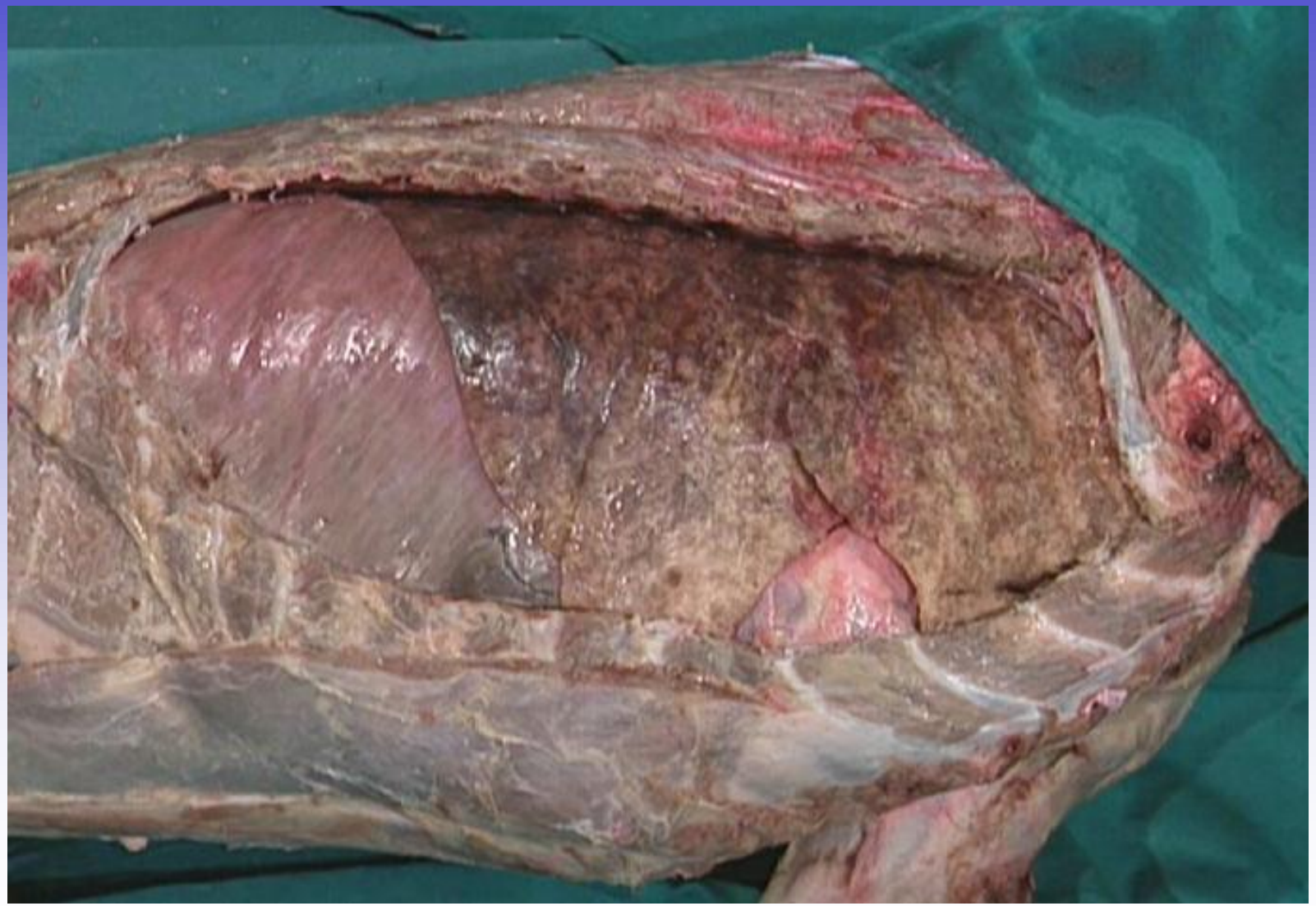
FIGURE 19.17 ▲ **Diagram of a type II alveolar cell and electron micrograph of lamellar bodies. a.** Surfactant is an oily mixture

•**Type I alveolar cells (type I pneumocytes):** very thin squamous cells that cover about **95% of the alveolar surface**. They form tight (occluding) junctions that create a barrier between air and the septal wall. These cells do not divide.

•**Type II alveolar cells (type II pneumocytes or septal cells): cuboidal secretory cells**. They contain **lamellar bodies** that secrete **pulmonary surfactant** (a mixture of lipids and proteins) by exocytosis. They also act as **progenitor cells**, capable of proliferating and replacing both type I and type II cells after lung injury.

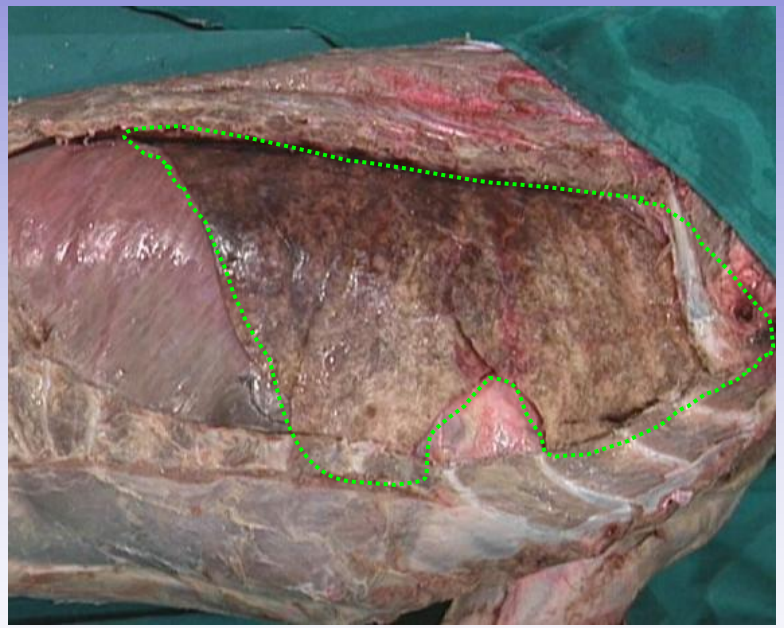
•**Brush cells: rare cells** in the alveolar wall that likely function as **sensory receptors monitoring air quality**.

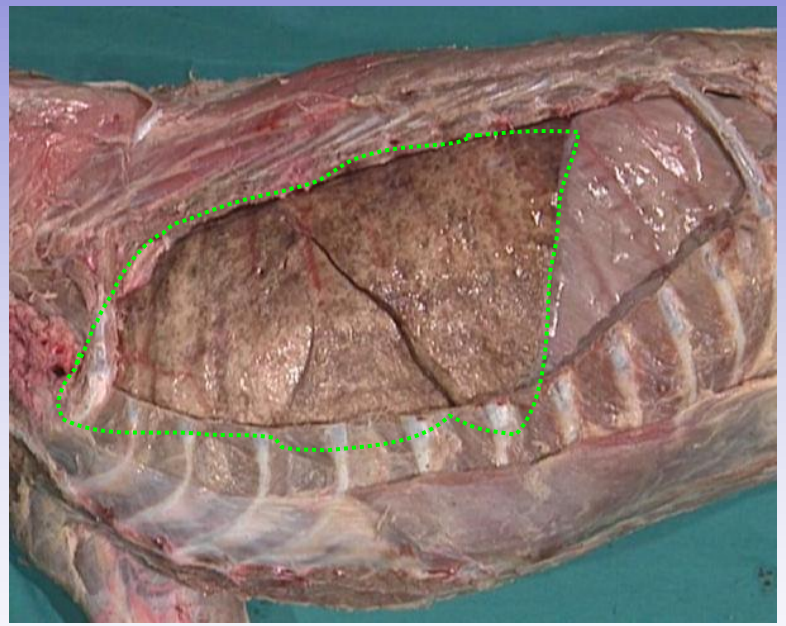
RESPIRATORY SYSTEM
LUNGS



RESPIRATORY SYSTEM
LUNGS

The lungs are located within the thoracic cavity and are divided into two organs: ***the right lung*** *and* ***the left lung****..*

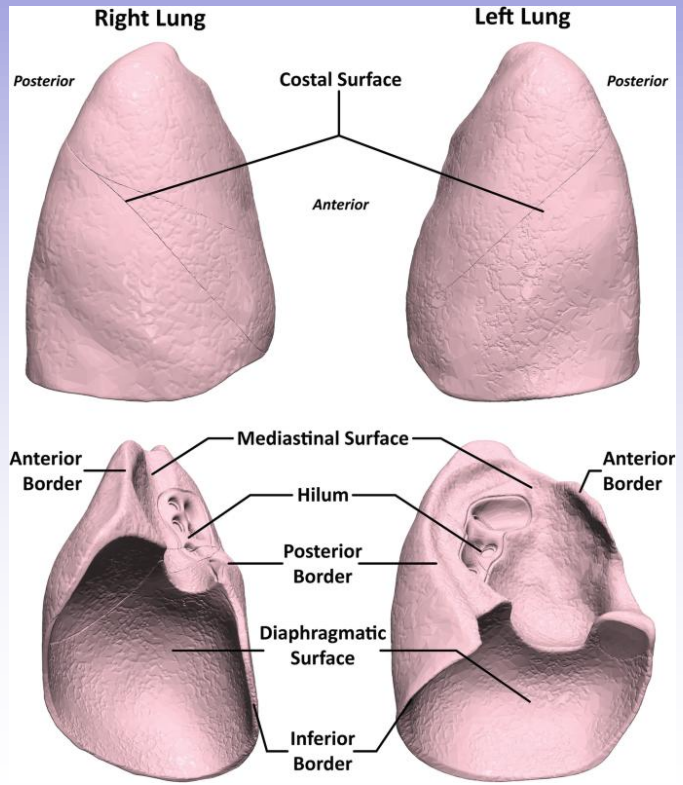




RESPIRATORY SYSTEM
LUNGS

The lungs are elastic organs that, in the closed thorax, conform to the thoracic walls and mediastinal organs due to the negative pressure within the pleural cavity.

RESPIRATORY SYSTEM
LUNGS

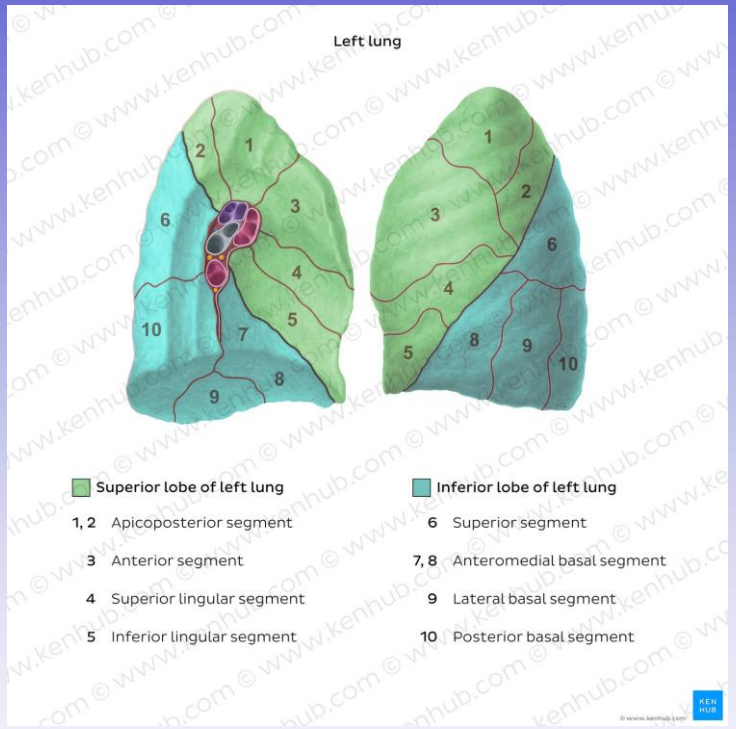


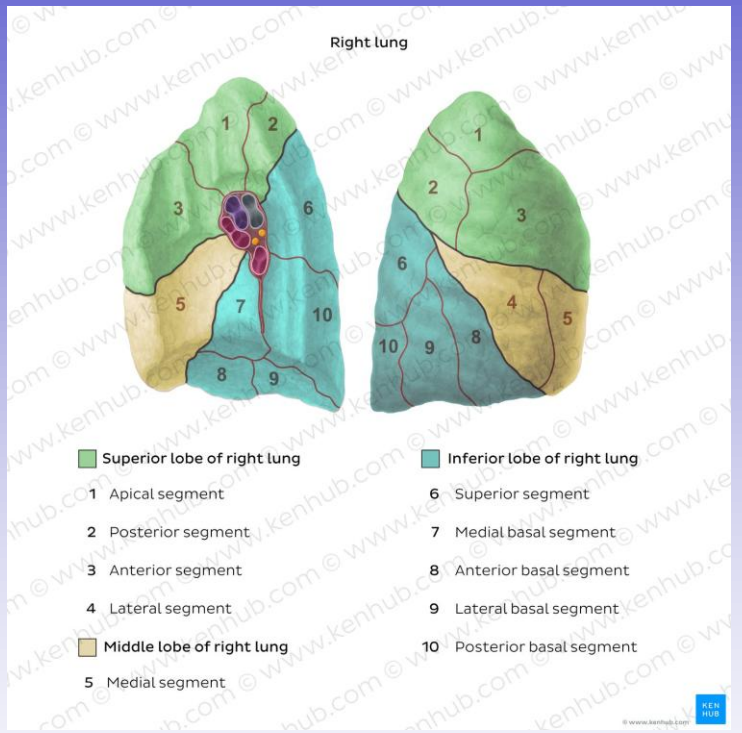
Each lung presents:

- **Three surfaces:**
  - **Costal surface** (lateral)
  - **Mediastinal surface** (medial)
  - **Diaphragmatic surface** (inferior)
- **Two borders:**
  - **Anterior border**
  - **Posterior border**
- **A base** *(diaphragmatic surface)*
- **An apex**

RESPIRATORY SYSTEM
LUNGS

The organs are roughly conical in shape and are divided by **fissures** into **lobes**.

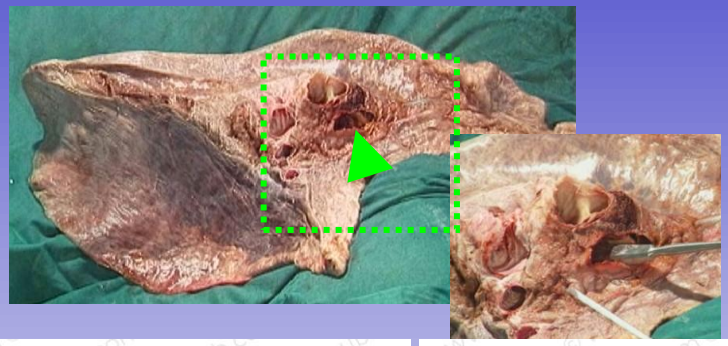


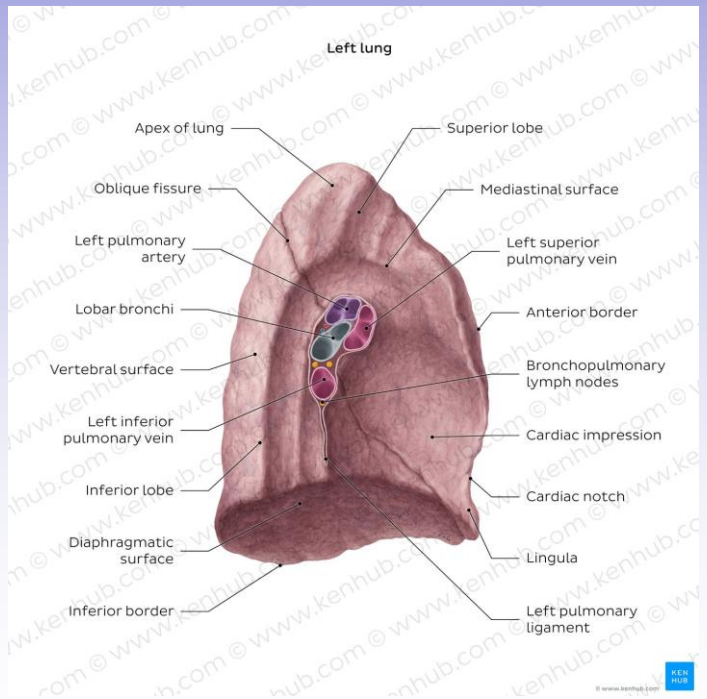


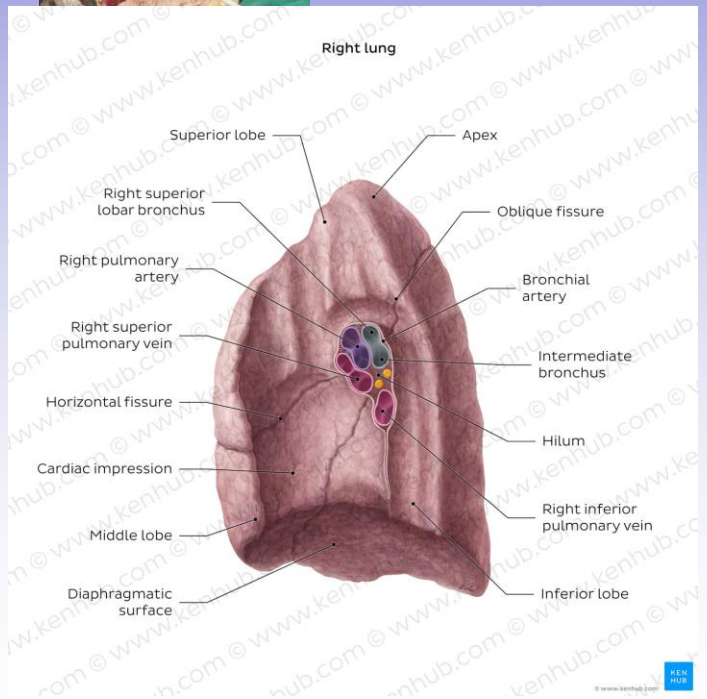
The left lung has two lobes and one fissure; while the right lung has three lobes and two fissures. The lobes are then further subdivided into bronchopulmonary segments; such that the left lung has 9 – 10 segments, while the right lung has 10. Between lobes are interlobar surfaces of lungs which are separated by fissures of the lungs.

RESPIRATORY SYSTEM
LUNGS: LATERAL SURFACE

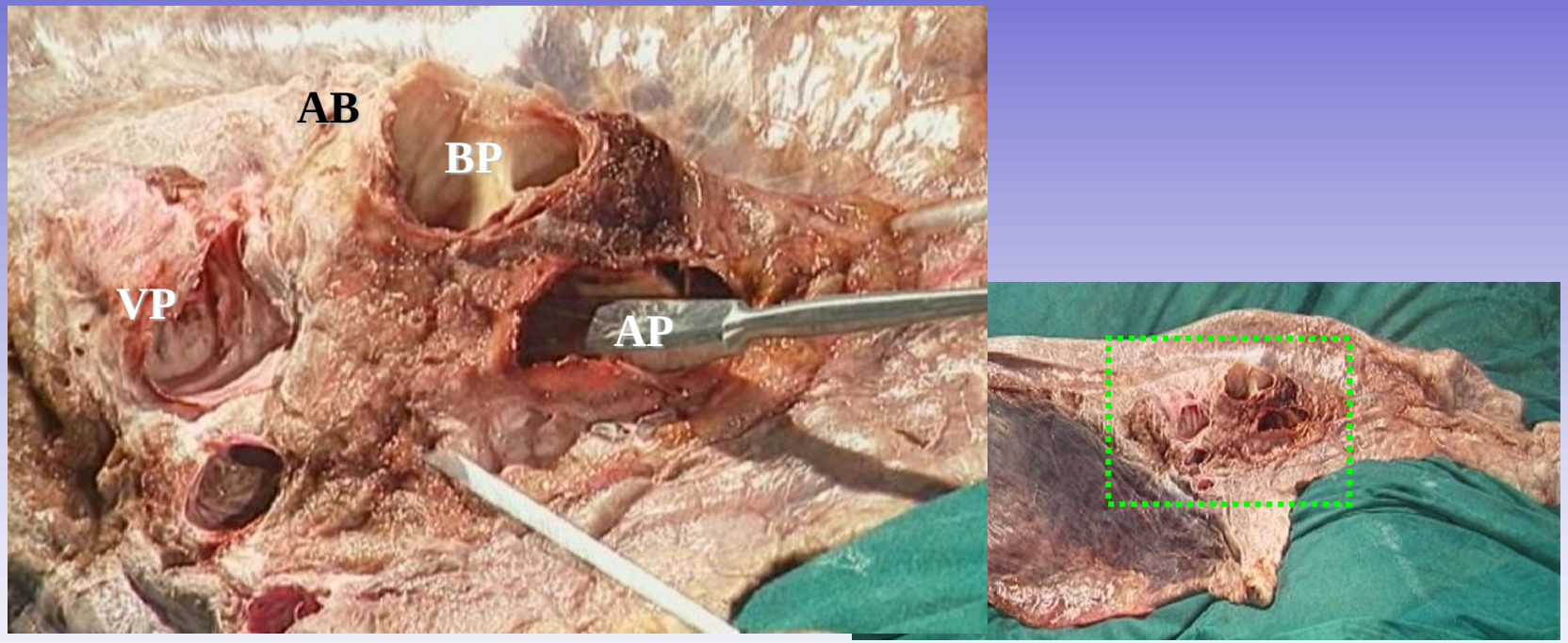
RESPIRATORY SYSTEM
LUNGS: MEDIAL SURFACE





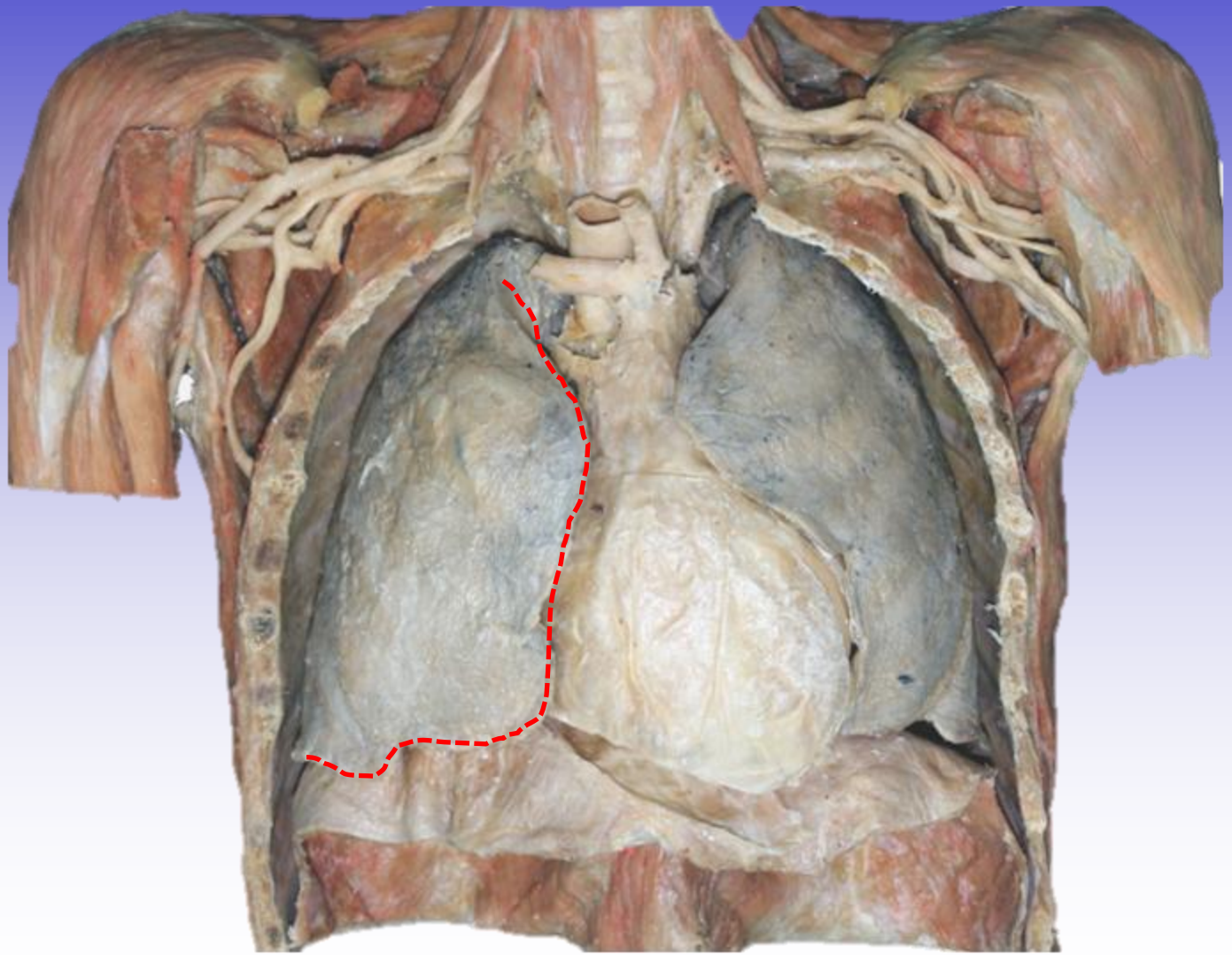


RESPIRATORY SYSTEM
MEDIASTINAL SURFACEAND ROOT OF THE LUNG

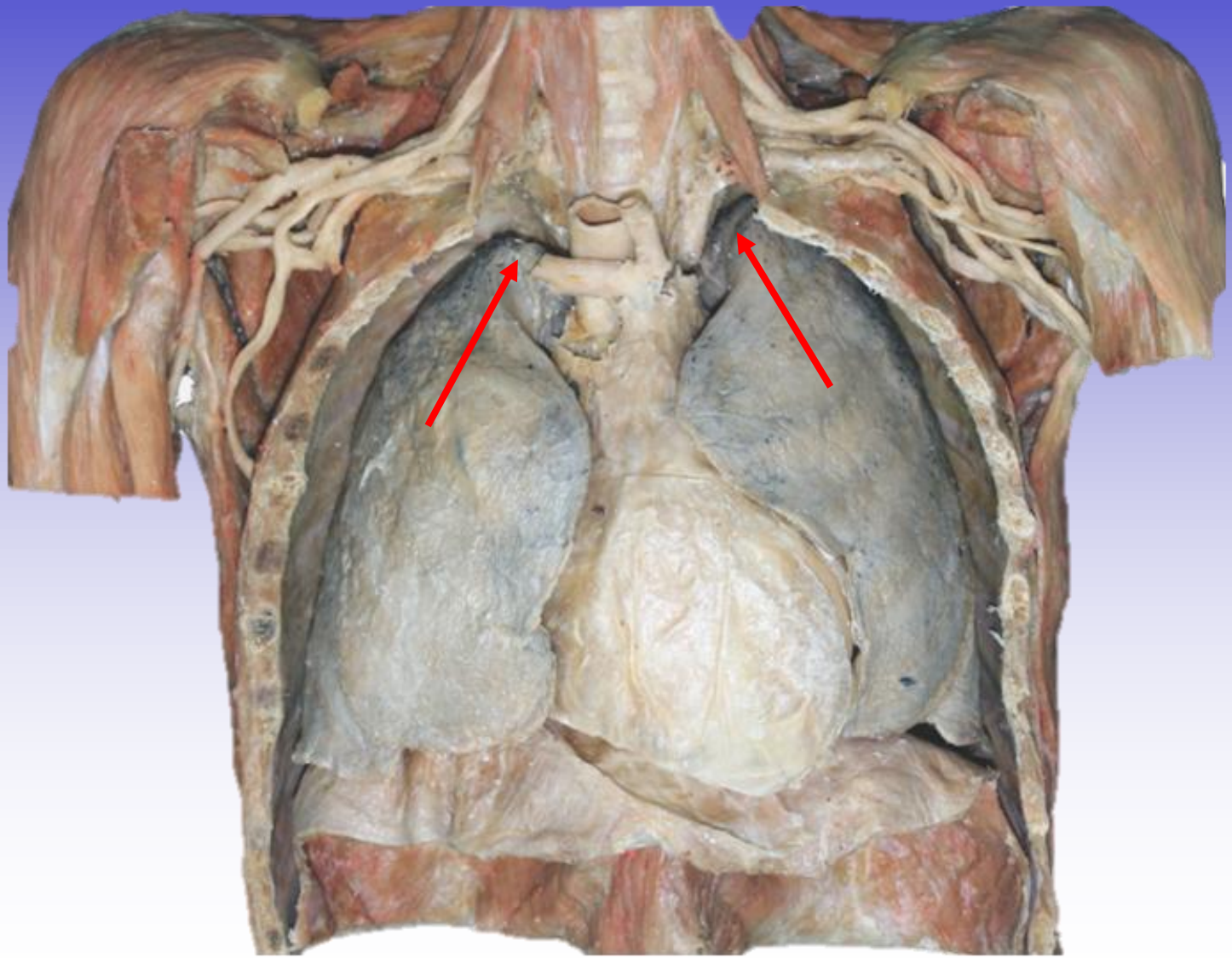


RESPIRATORY SYSTEM
LUNGS: BASE OR DIAPHRAGMATIC SURFACE

RESPIRATORY SYSTEM
LUNGS ANTERIOR AND POSTERIOR BORDERS

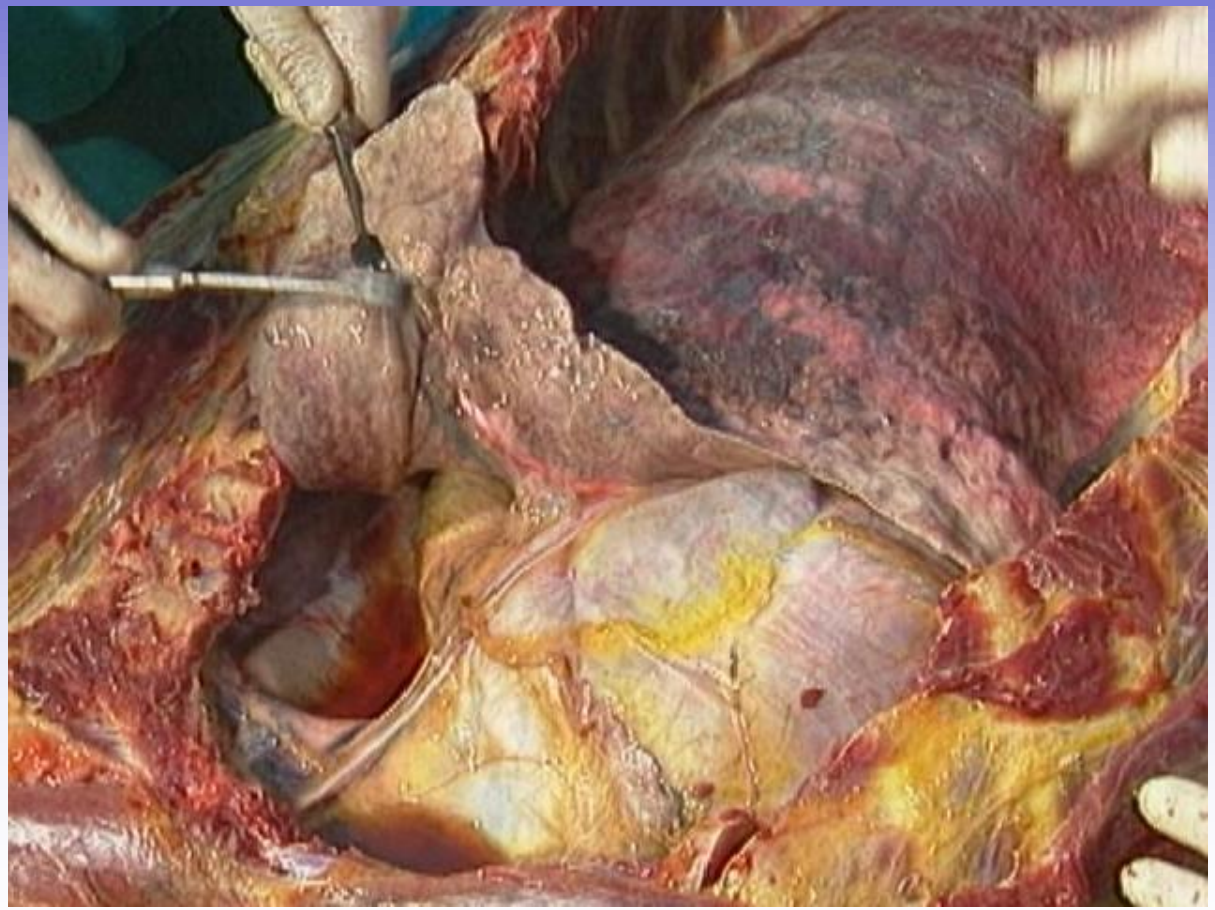


RESPIRATORY SYSTEM
LUNGS: APEX

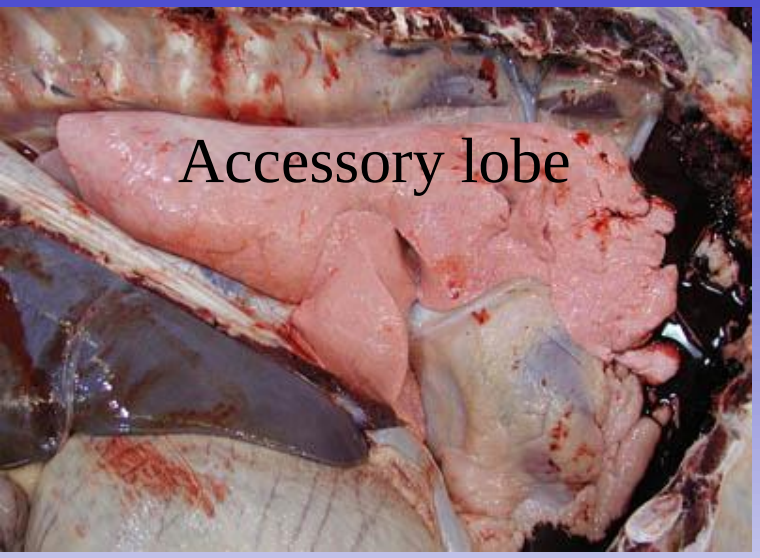


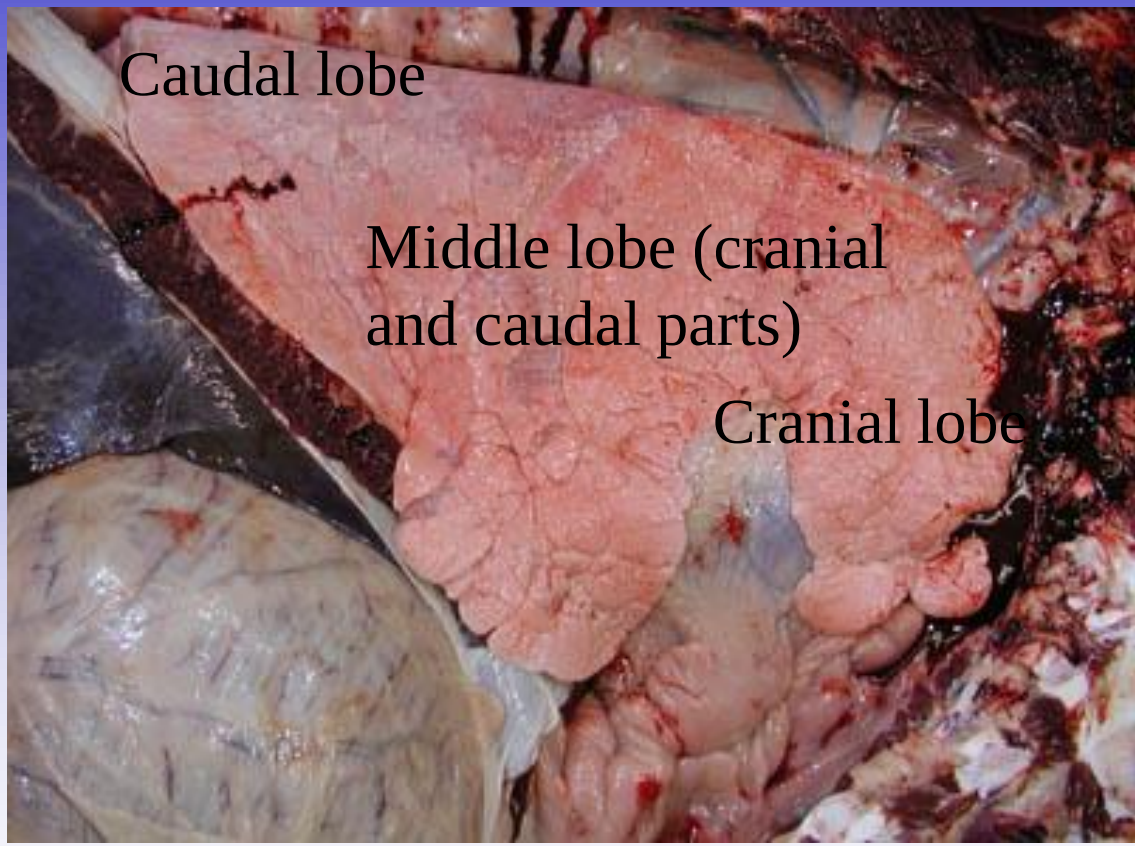
RESPIRATORY SYSTEM
LUNGS: APEX

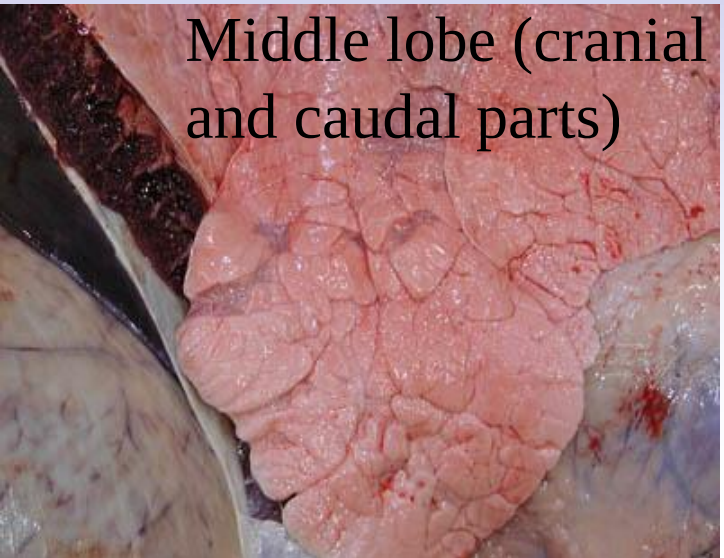
The apex and the cranial portion of the lung are very mobile within the thoracic cavity, unlike the caudal portions, which are held in place by the pulmonary ligament



RESPIRATORY SYSTEM
RIGHT LUNG OF THE BOVINE







RESPIRATORY SYSTEM
LUNG

BLOOD SUPPLY, INNERVATION, AND LYMPHATIC DRAINAGE

- The lung has both pulmonary and bronchial circulations.
- **Pulmonary circulation** delivers blood via branches of the pulmonary artery to the capillary network surrounding the alveoli for oxygenation. Blood is collected by pulmonary venous capillaries that eventually form the pulmonary veins.
- **Bronchial circulation**, via bronchial arteries, supplies the walls of the bronchi, bronchioles, and the remaining connective tissue of the lung.
- **Autonomic nerves** follow the branches of pulmonary arteries and innervate the smooth muscle of blood vessels, the bronchial tree, and the respiratory mucosa.
- A dual **lymphatic drainage** of the lungs parallels the dual blood supply. Accumulation of the bronchus-associated lymphatic tissue **(BALT)** and lymph nodes are frequently found near large bronchi.