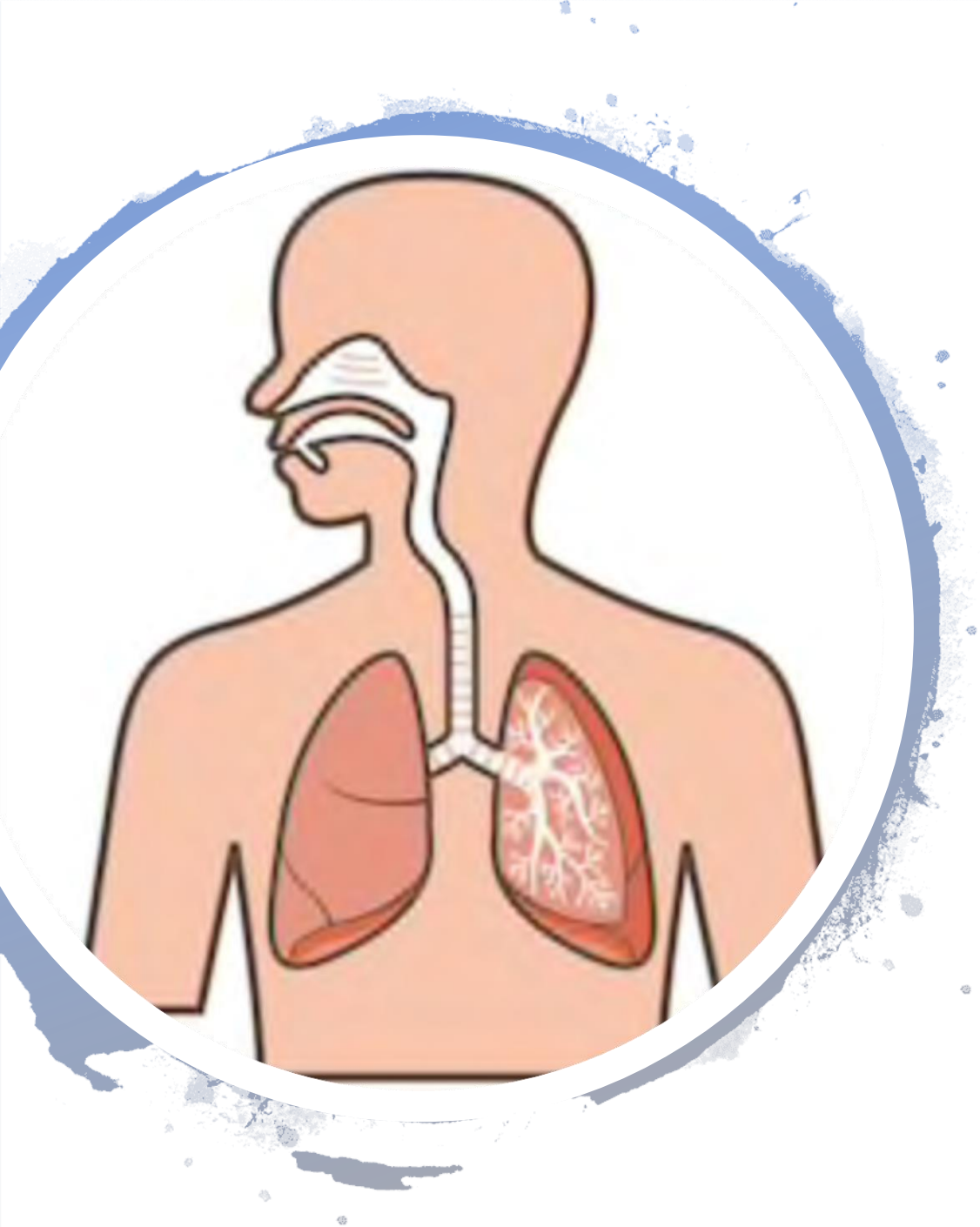

Basic structure and function of the respiratory system

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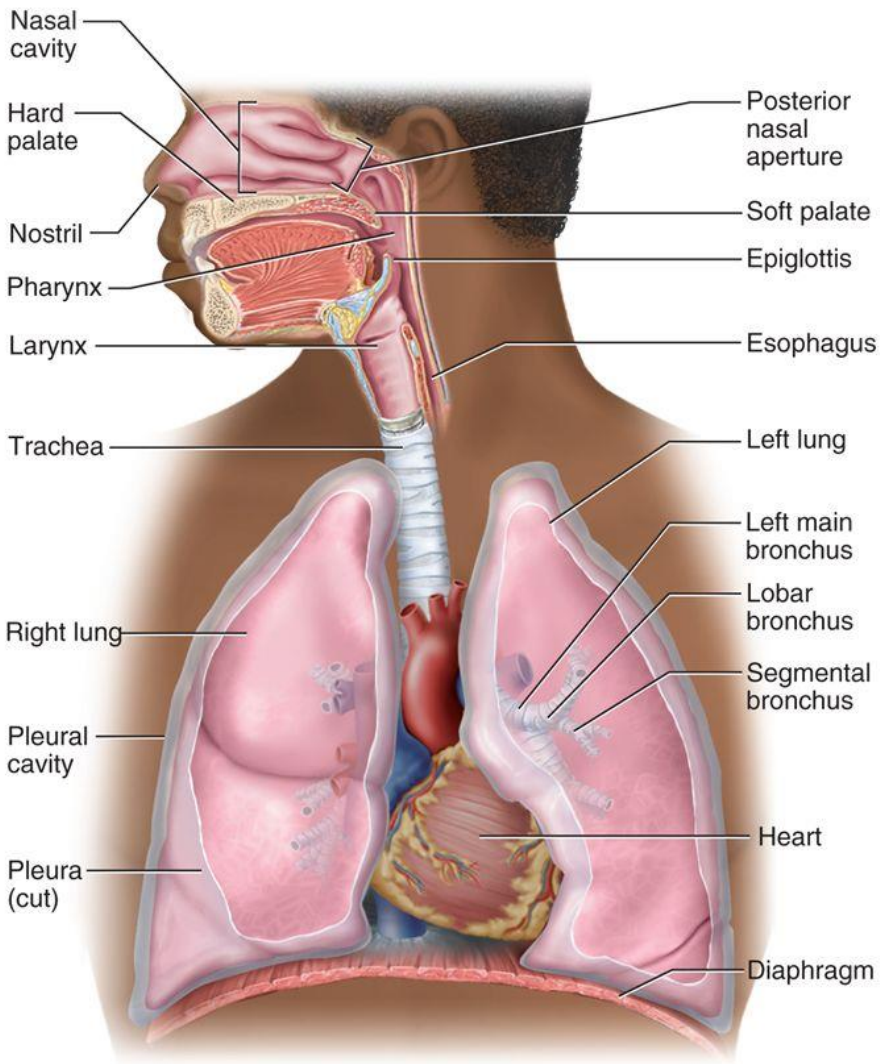
Learning Outcomes:

- Summarize the components of upper and lower respiratory tracts.
- Describe the anatomical structure of the tracheobronchial tree.
- Explain the general features and the neurovascular supply of lungs.
- Describe the anatomy of pleura and pleural cavity.
- Explain the hilum of the lung.
- Outline the anatomical structure of thoracic wall and neurovascular supply.
- List the muscles of respiration and interpret mechanism of respiration.

Respiratory system

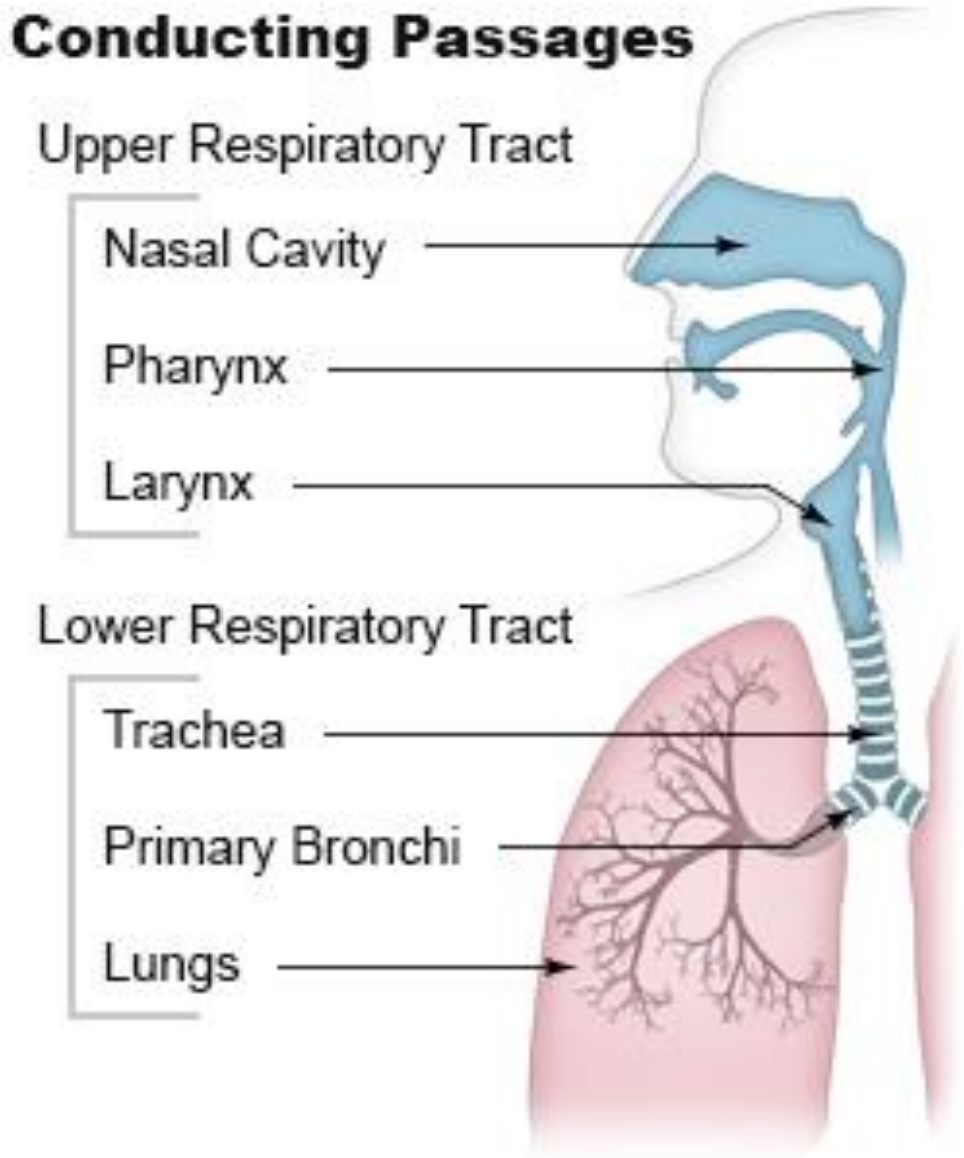


Functions of respiratory system:

- **gas exchange**
- **olfaction**
- **phonation**

Anatomically, it consists of 3 major parts:

- the respiratory tract
- the lungs
- the muscles of respiration



The respiratory tract

Anatomically, it is divided into:

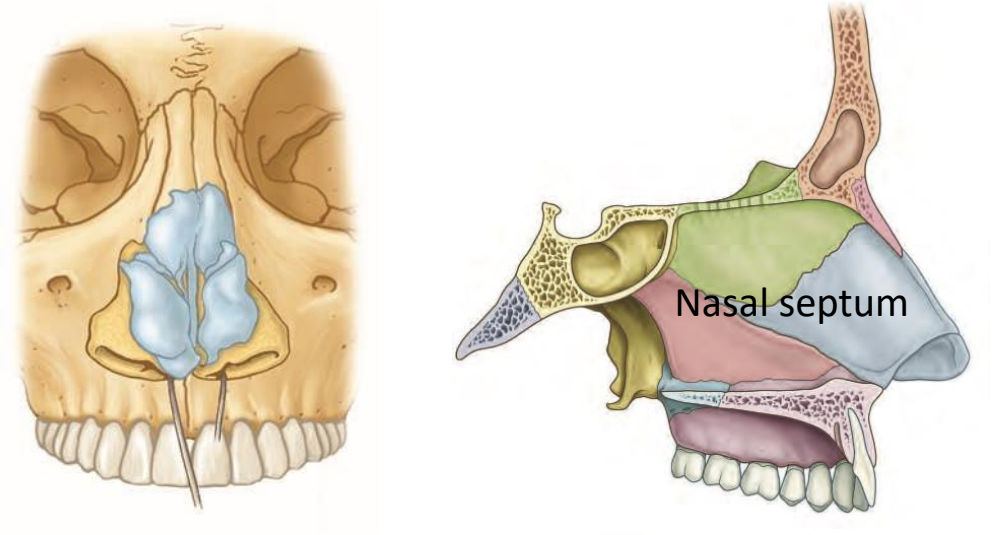
1. **Upper respiratory tract**:

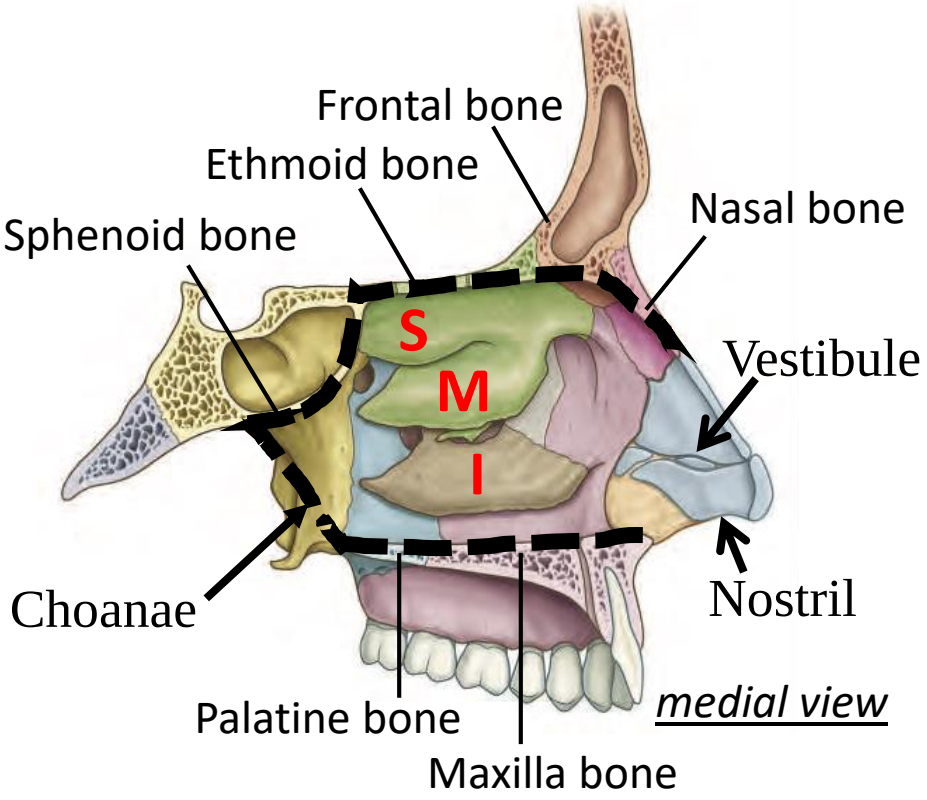
nasal cavity, paranasal sinuses, pharynx and larynx

2. **Lower respiratory tract**:

trachea, bronchi, bronchioles and lungs (alveoli)

The nose and nasal cavity





The nose is supported by:

- bones
- cartilages

The boundaries of nasal cavity:

- roof (nasal, frontal, ethmoid and sphenoid bones)
- floor (maxilla bone and palatine bone)
- medial wall (nasal septum)
- lateral wall

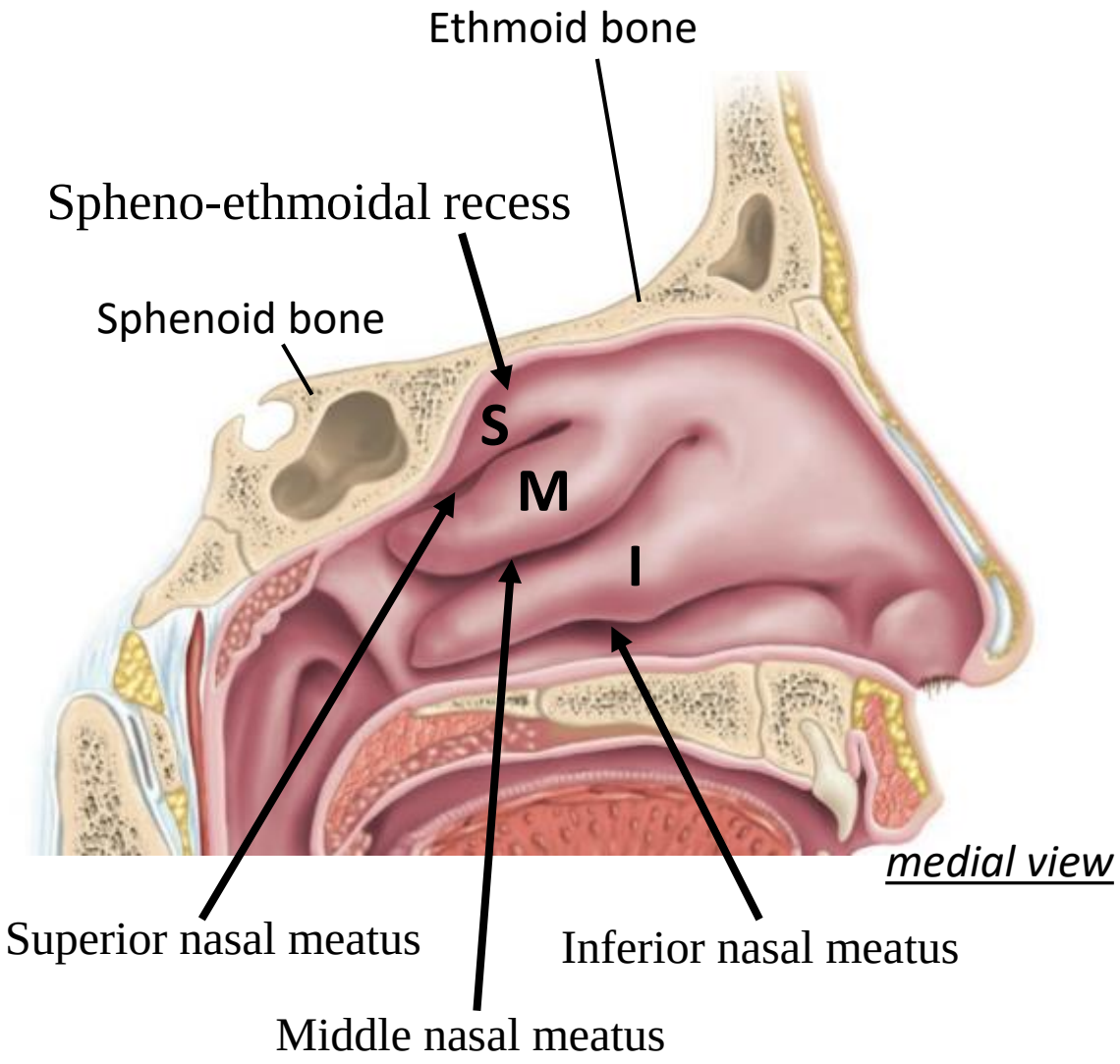
  - ethmoid bone

  → superior(S) and middle(M) nasal conchae

  - maxilla

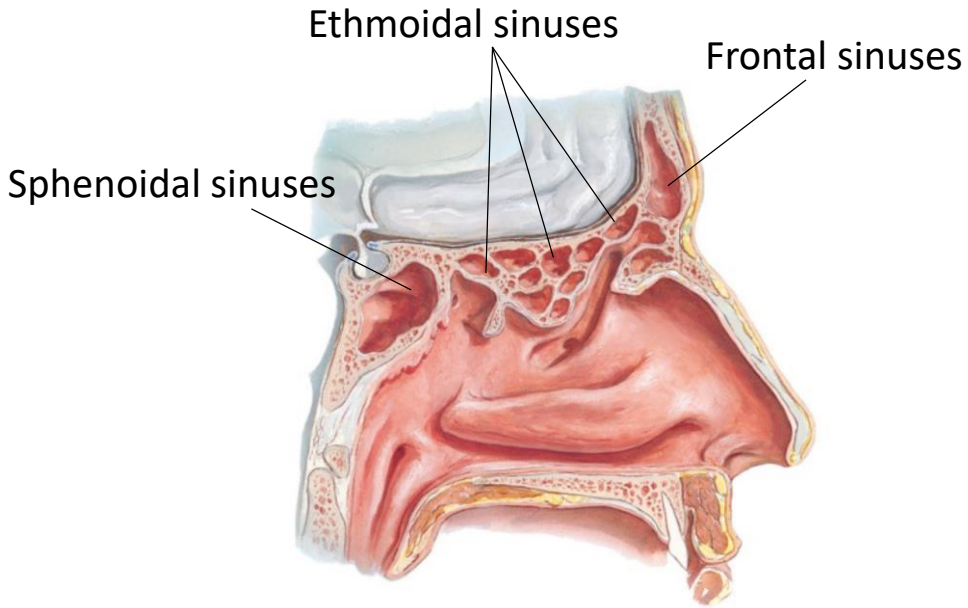
  → inferior(I) nasal conchae

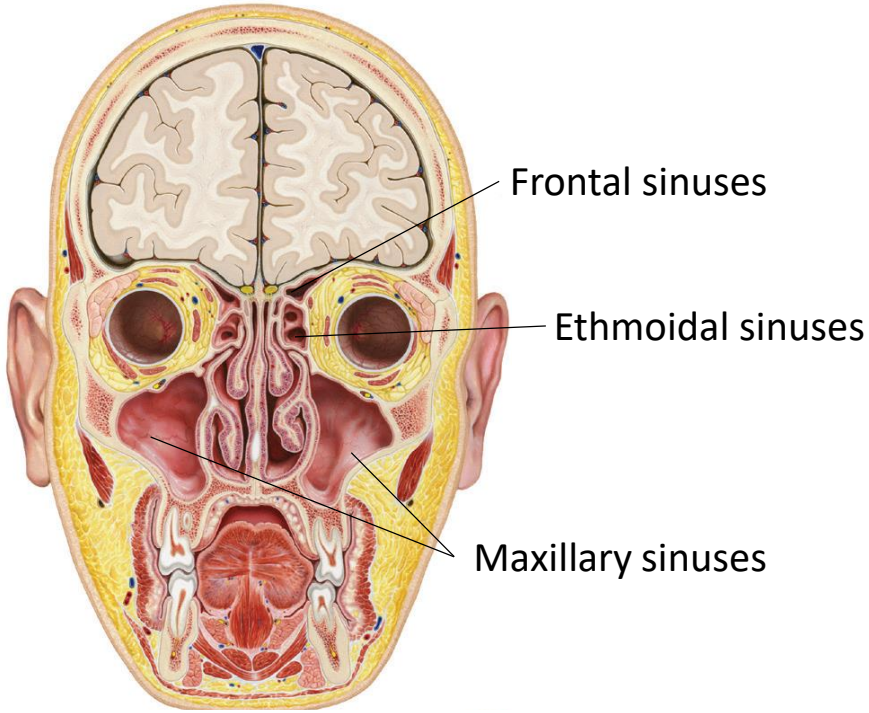
Nasal cavity



The nasal conchae divide the nasal cavity into four air passages:

- spheno-ethmoidal recess
- superior nasal meatus
- middle nasal meatus
- inferior nasal meatus



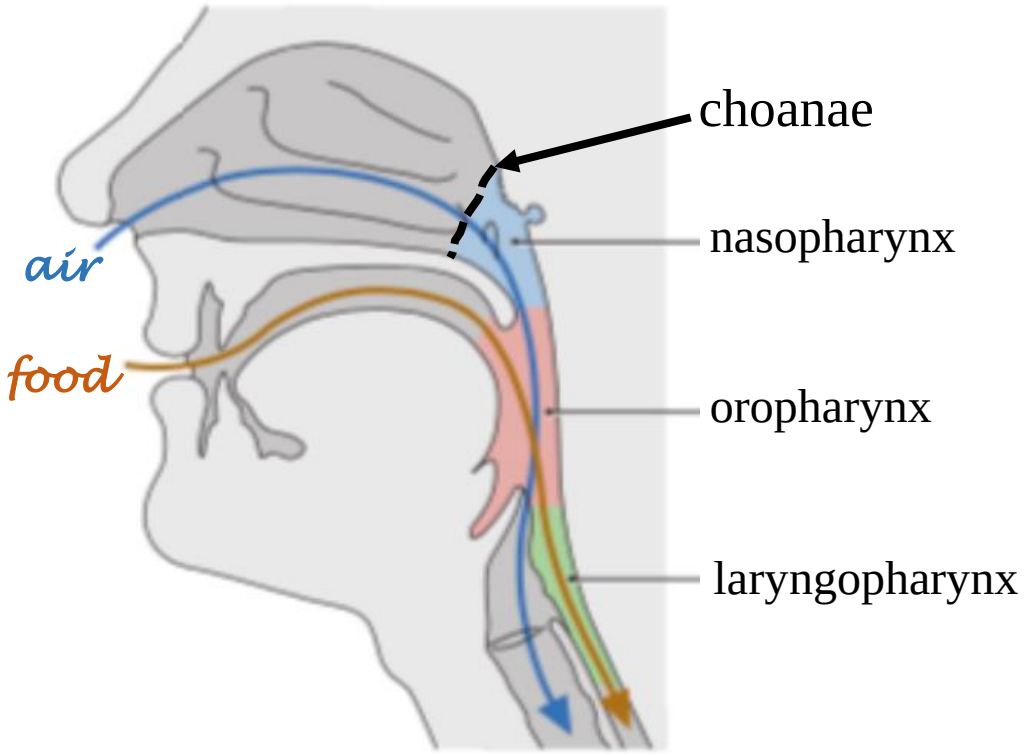


Paranasal sinus

The air-filled extensions of the nasal cavity into the cranial bones:

- **maxillary sinuses**
- **frontal sinuses**
- **ethmoidal sinuses**
- **sphenoidal sinuses**

Pharynx

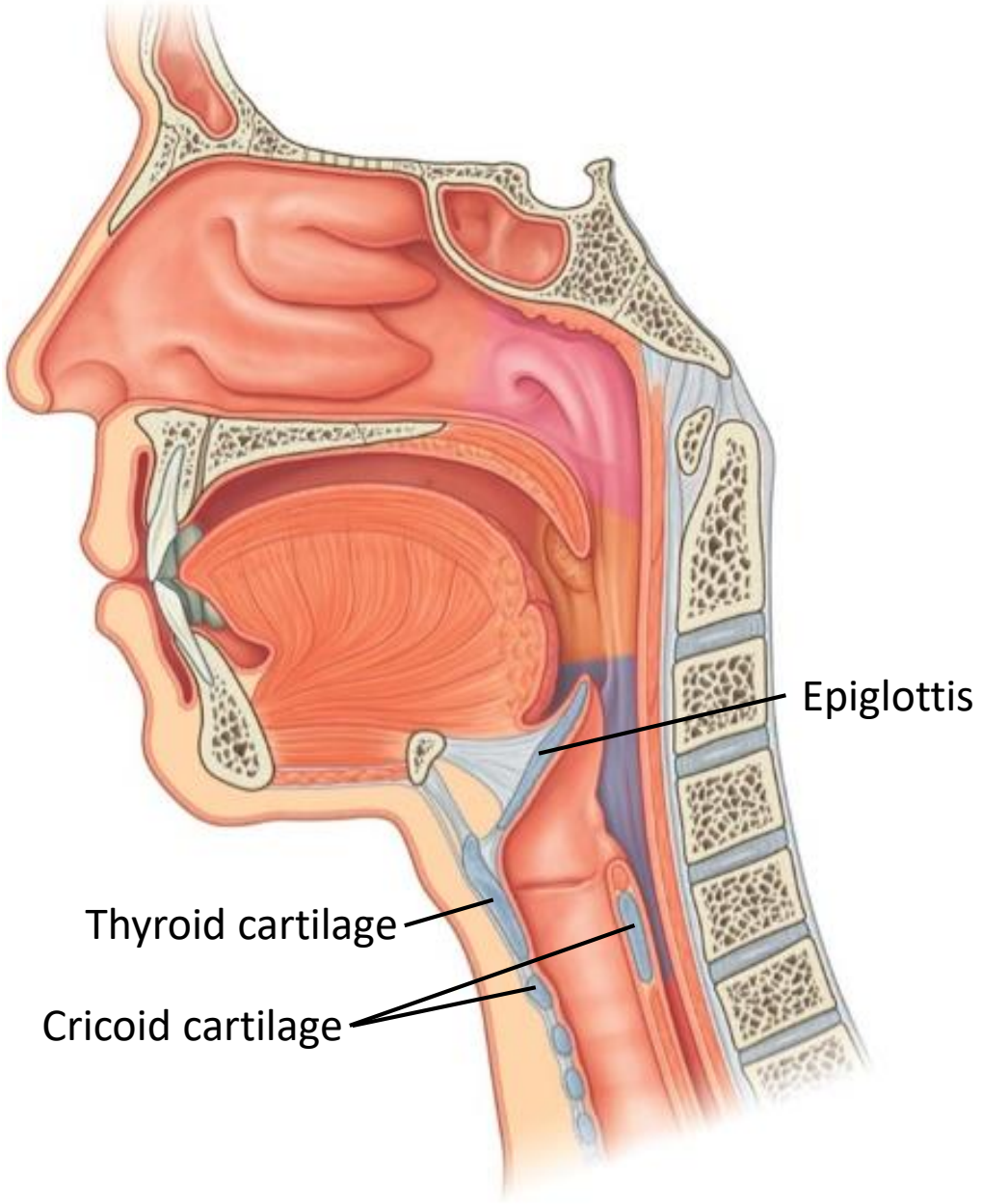


lateral view

The **muscular** funnel-shaped structure extending from choanae to the larynx

- nasopharynx (nasal cavity)
- oropharynx (oral cavity)
- laryngopharynx (larynx)

Larynx

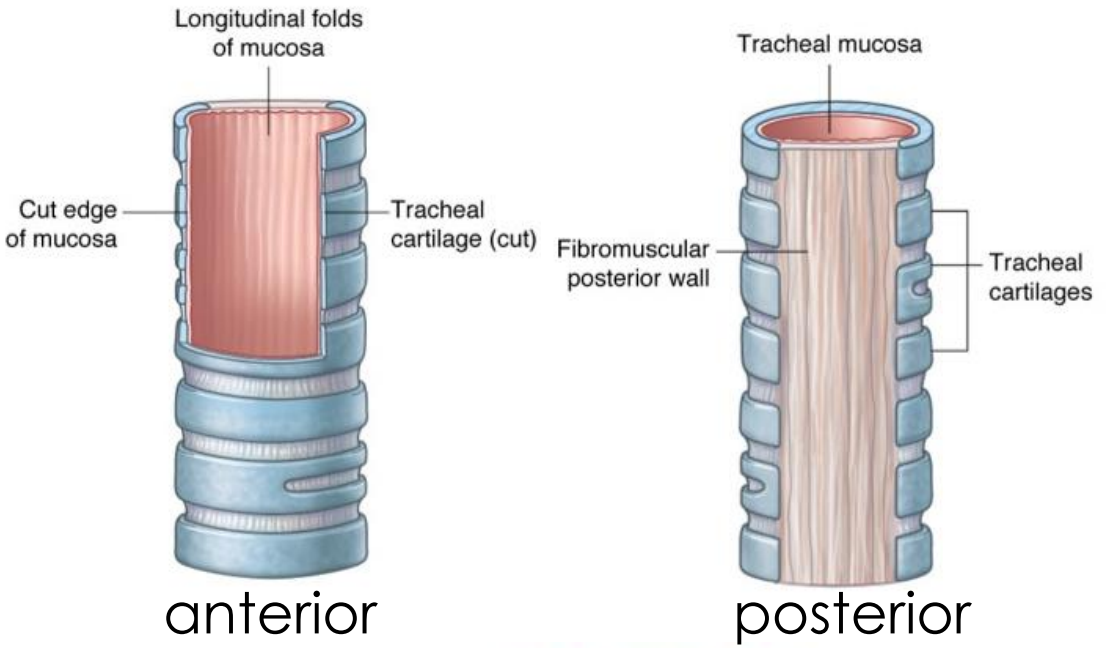


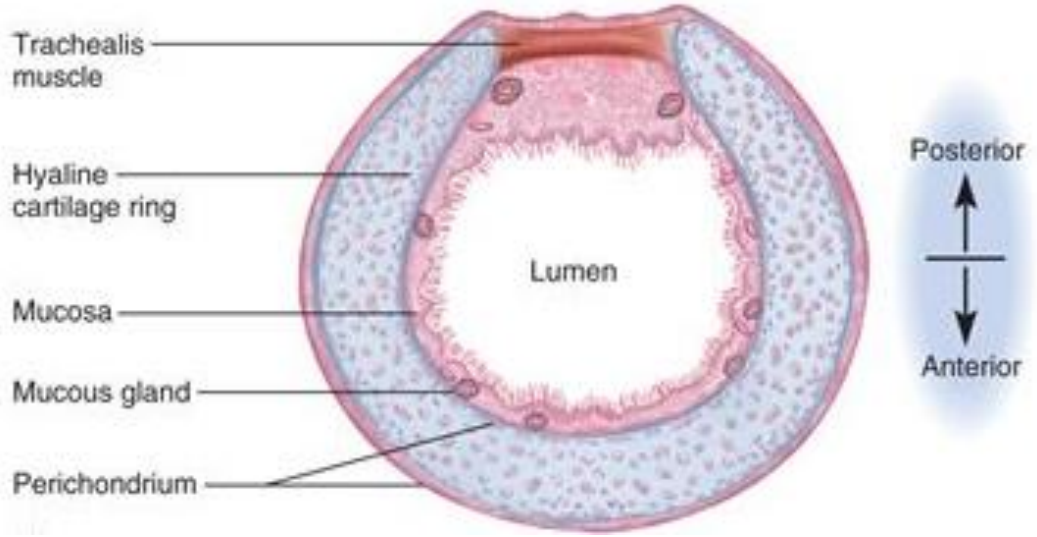
The hollow **musculoligamentous** structure with a **cartilaginous** framework (9 cartilages) that connects the laryngopharynx with the trachea

Functions

- respiration
- guard the air passage during swallowing (depression of epiglottis)
- phonation (vocal cords)

Tracheobronchial Tree





The **trachea** (windpipe) is supported by **C-shaped** rings of hyaline cartilage.

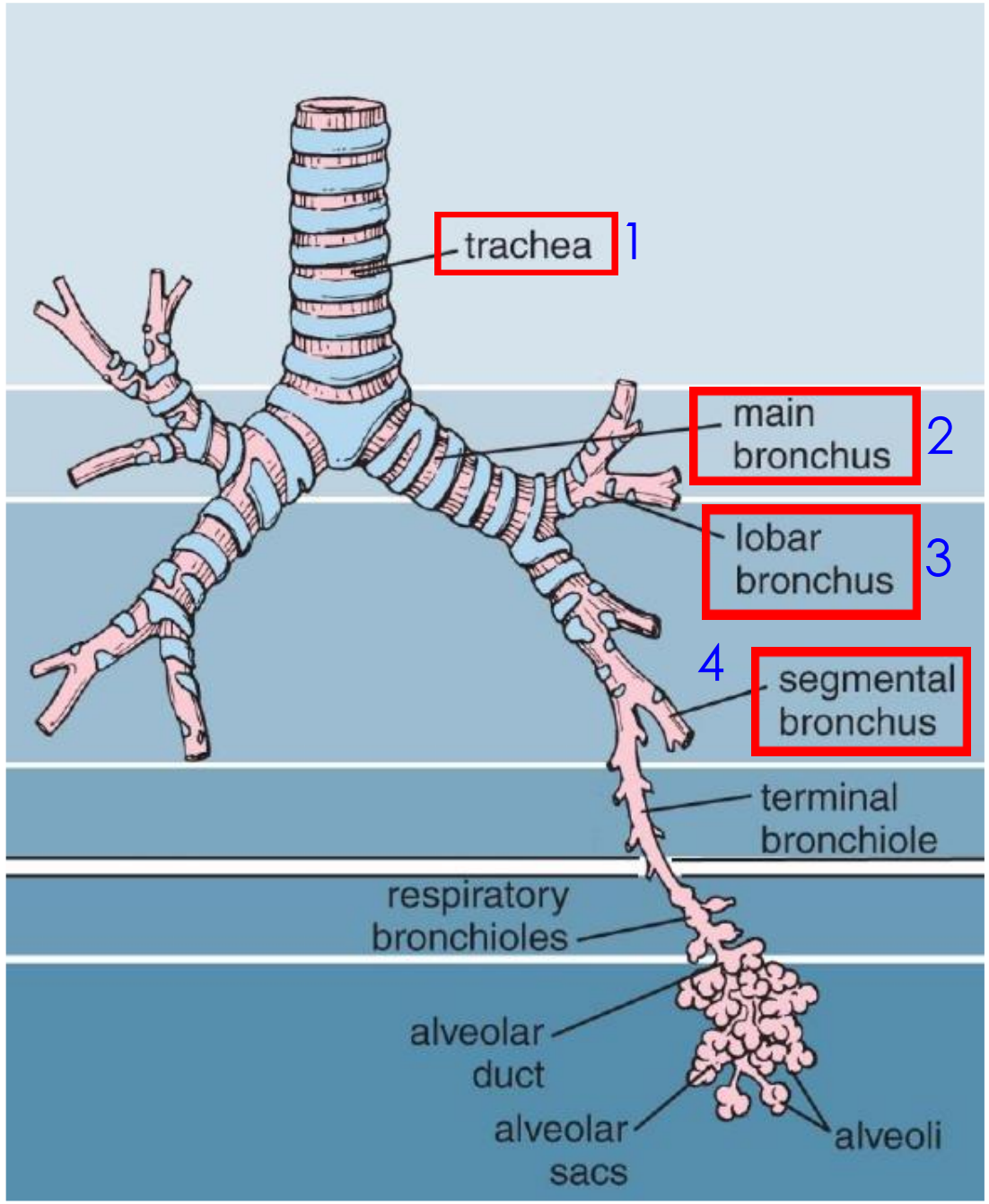
Histologically, the wall of trachea has 4 layers, from innermost to outermost:

- mucosa

  epithelium composed of mucus-secreting **goblet cells** and **ciliated cells**
- submucosa

  serous and mucous glands
- cartilage/muscle layer

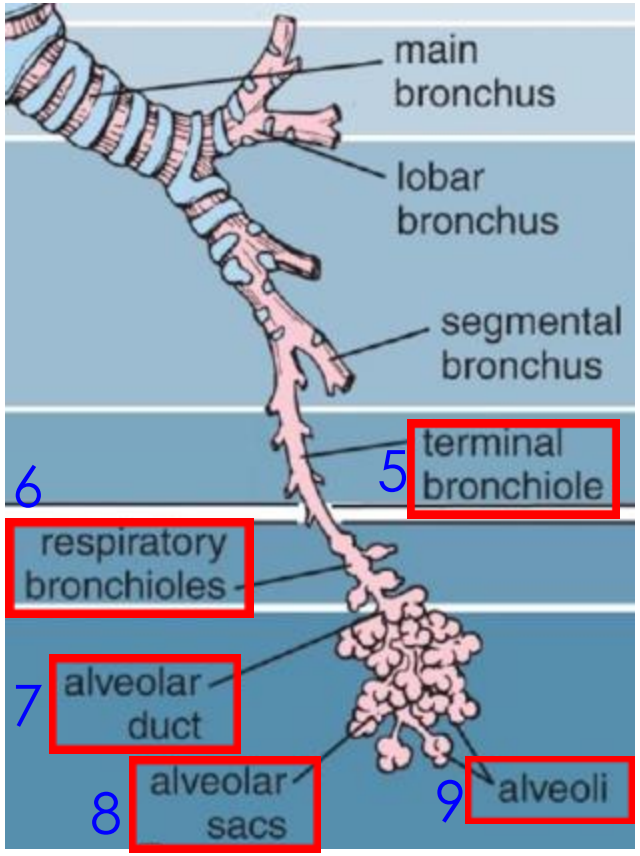
  hyaline cartilage/trachealis muscle
- adventitia

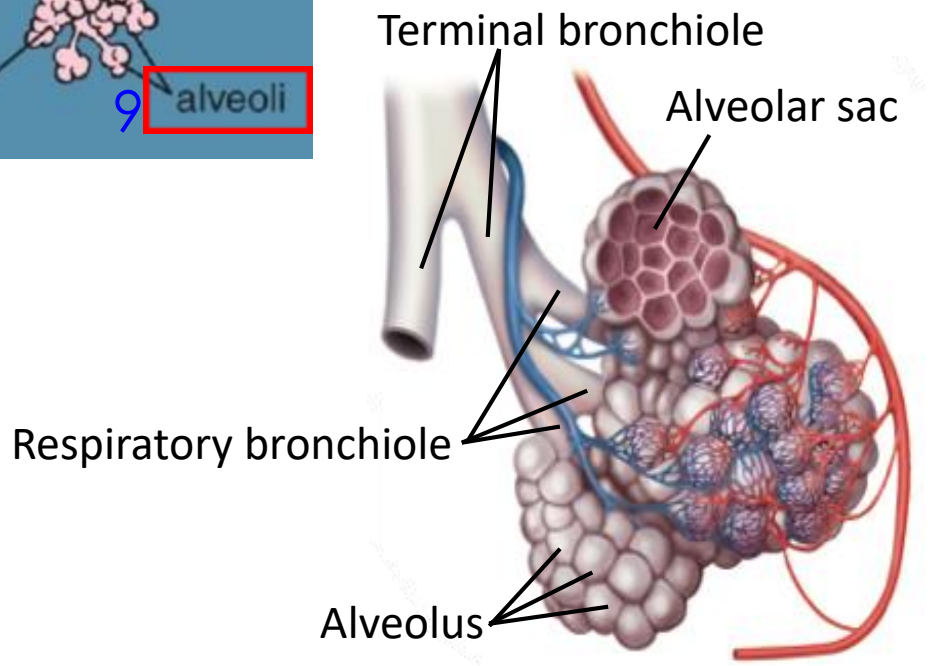


Tracheobronchial Tree

1. Trachea
   - trunk of the tree
2. Main bronchus (primary bronchus)
   - carina at the bifurcation
   - right and left main bronchi
3. Lobar bronchus (secondary bronchus)
   - each supplies a lobe of the lung
   - two on the left and three on the right
4. Segmental bronchus (tertiary bronchus)
   - each supplies a **bronchopulmonary segment**

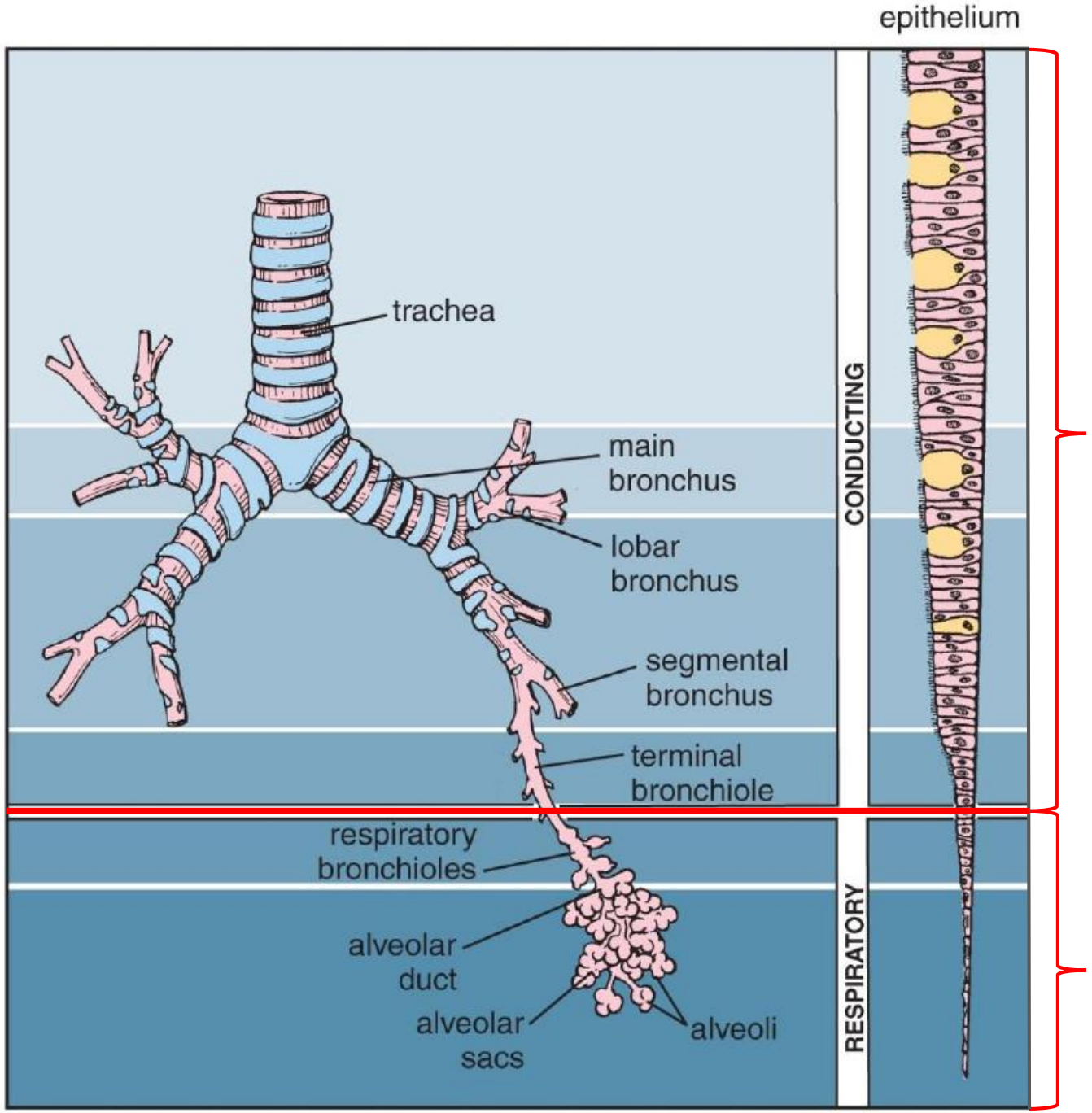
Tracheobronchial Tree





5. Terminal bronchiole
   - lack of cartilage or glands
   - transport air ONLY
6. Respiratory bronchioles
   - mark the start of the respiratory zone
7. Alveolar duct
   - elongated airways leading to the alveolar sacs (1:5-6)
8. Alveolar sacs
   - clusters of alveoli arrayed around a central space
9. Alveoli
   - place of gas exchange

Tracheobronchial Tree



Functionally, it is divided into:

Conducting zone (gas transport):

- from nasal cavity all the way to terminal bronchioles;

- lined by respiratory epithelium

(pseudostratified ciliated columnar epithelium)

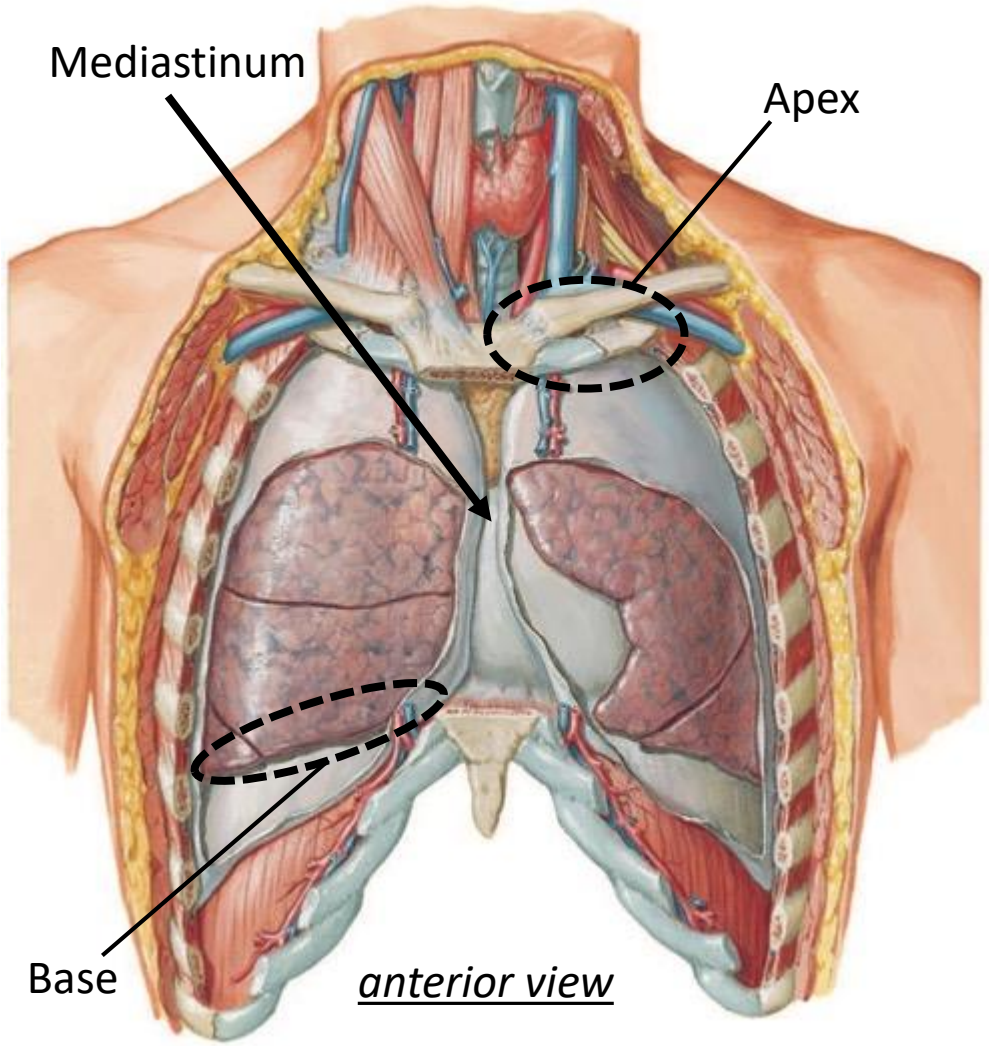
Respiratory zone (gas exchange):

- respiratory bronchioles, alveolar ducts, alveolar sacs and alveoli

- lining gradually changes to alveolar epithelium

(simple squamous epithelium)

Anatomy features of the lung



Apex

- above the level of the 1st rib, ascending into the root of the neck

Base

- the concave inferior surface, resting on the diaphragm

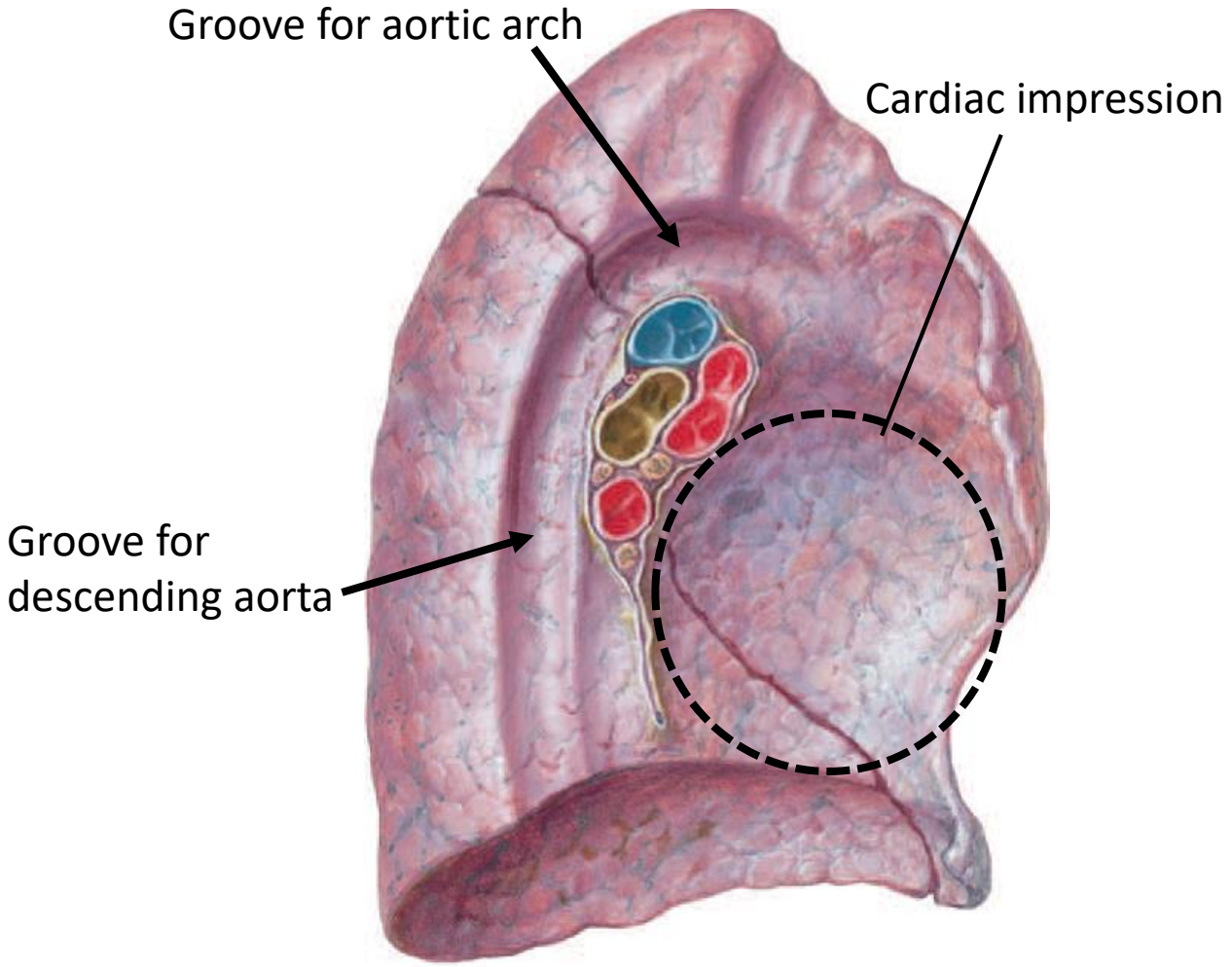
Cardiac impression

- a depression at mediastinal area for accommodating the heart

Groove for aortic arch/descending aorta

- an arched furrow caused by the impression of aortic arch and descending aorta

Anatomy features of the lung



medial view of the left lung

Apex

- above the level of the 1st rib, ascending into the root of the neck

Base

- the concave inferior surface, resting on the diaphragm

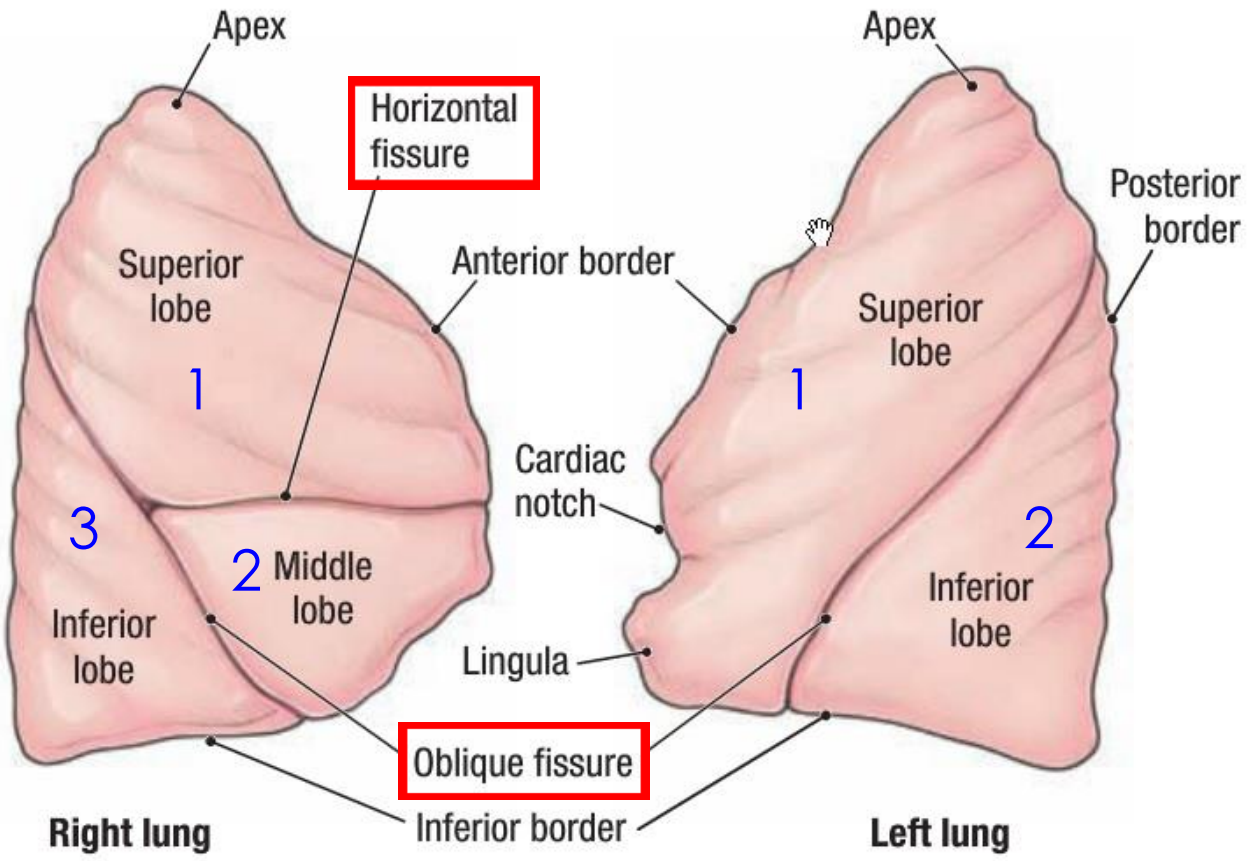
Cardiac impression

- a depression at mediastinal area for accommodating the heart

Groove for aortic arch/descending aorta

- an arched furrow caused by the impression of aortic arch and descending aorta

Lung



Lateral view

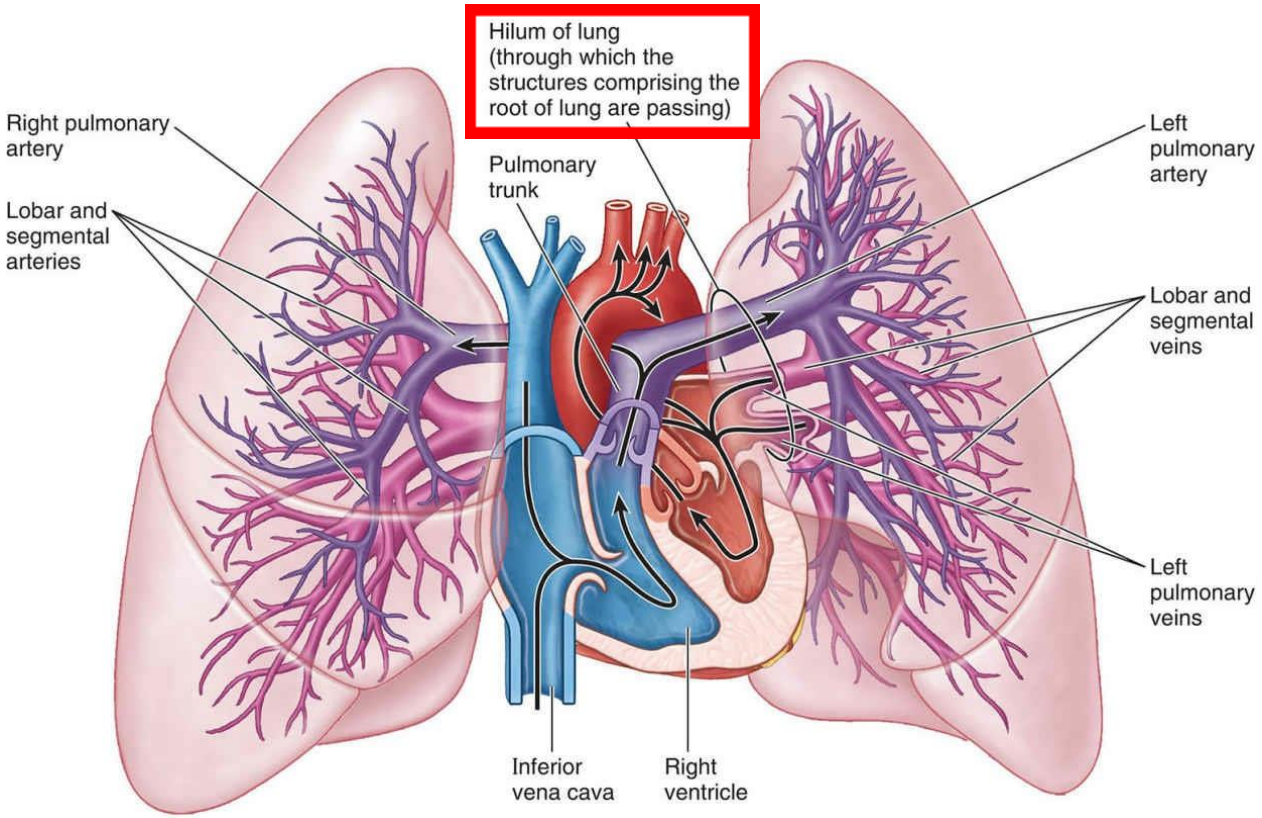
Fissures

- horizontal fissure
  - 4th rib
- oblique fissure
  - posterior → T4
  - anterior → 6th rib

Lobes

- left lung
  - superior and inferior
- right lung
  - superior, middle and inferior

Vasculature of Lungs



Each lung has:

- **One** pulmonary artery supplying deoxygenated blood to it

Each pulmonary artery divides into secondary lobar arteries and further tertiary segmental arteries running anteriorly along the corresponding bronchus.

- **Two** pulmonary veins draining oxygenated blood from it

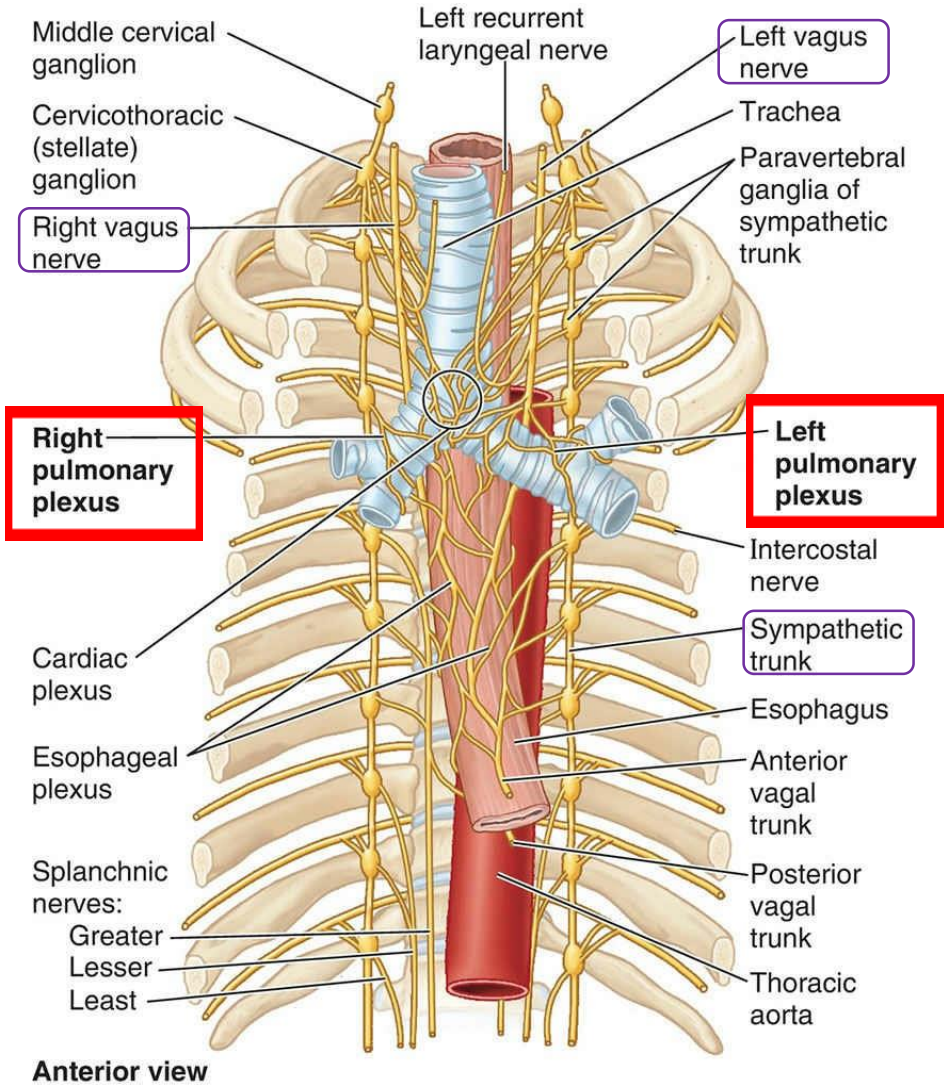
Pulmonary veins run **independently** of the arteries and bronchi coursing between the adjacent **bronchopulmonary segments**.

Innervation of the lungs

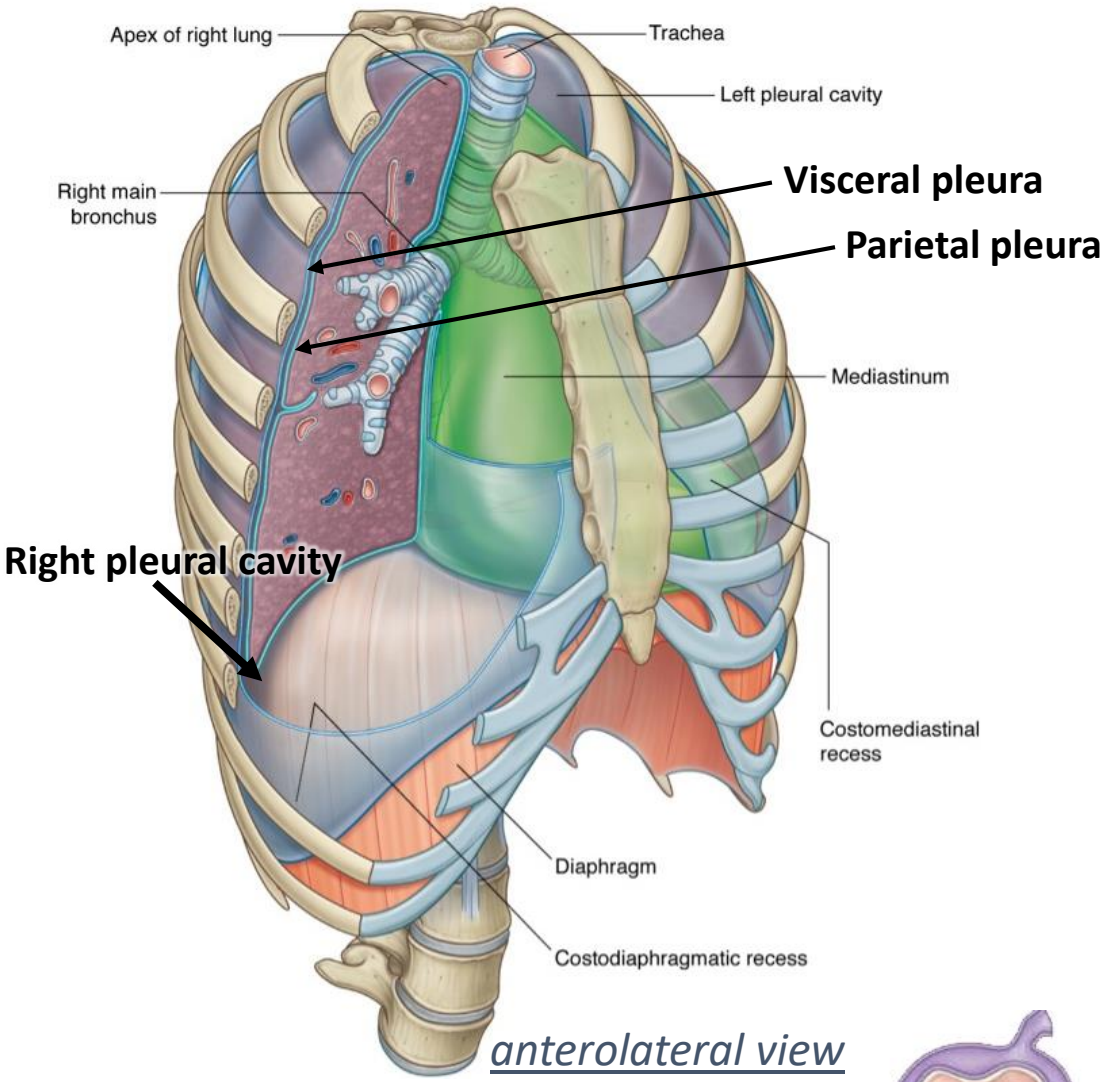
The lungs are supplied by pulmonary plexus formed of sympathetic and parasympathetic fibers, part of the autonomic nervous system.

- Sympathetic stimulation(sympathetic trunk):
  dilates bronchi
  reduces secretion

- Parasympathetic stimulation(vagus nerve):
  constricts bronchi
  promotes bronchial secretion



Pleura and Pleural Cavity



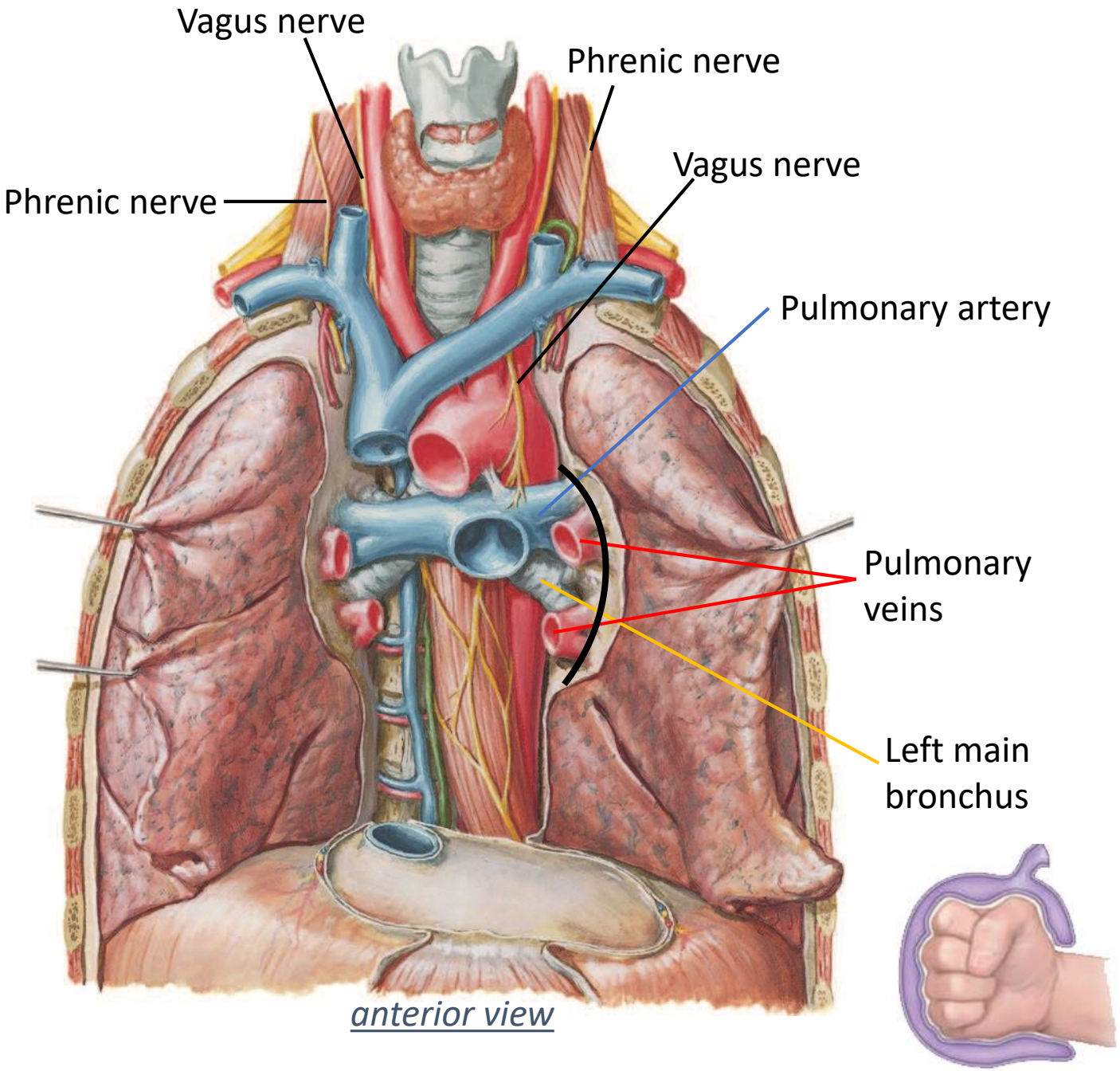
anterolateral view

Each lung is enclosed in a pleural sac that consists of two continuous membranes:

- **visceral pleura**(pulmonary pleura)
  - adherent to surfaces of the lungs
- **parietal pleura**
  - adherent to the thoracic wall, mediastinum and diaphragm

The potential space between the layers of pleura is **pleural cavity**, containing **serous pleural fluid**.

Costodiaphragmatic recesses is the lowest area in pleural cavity.

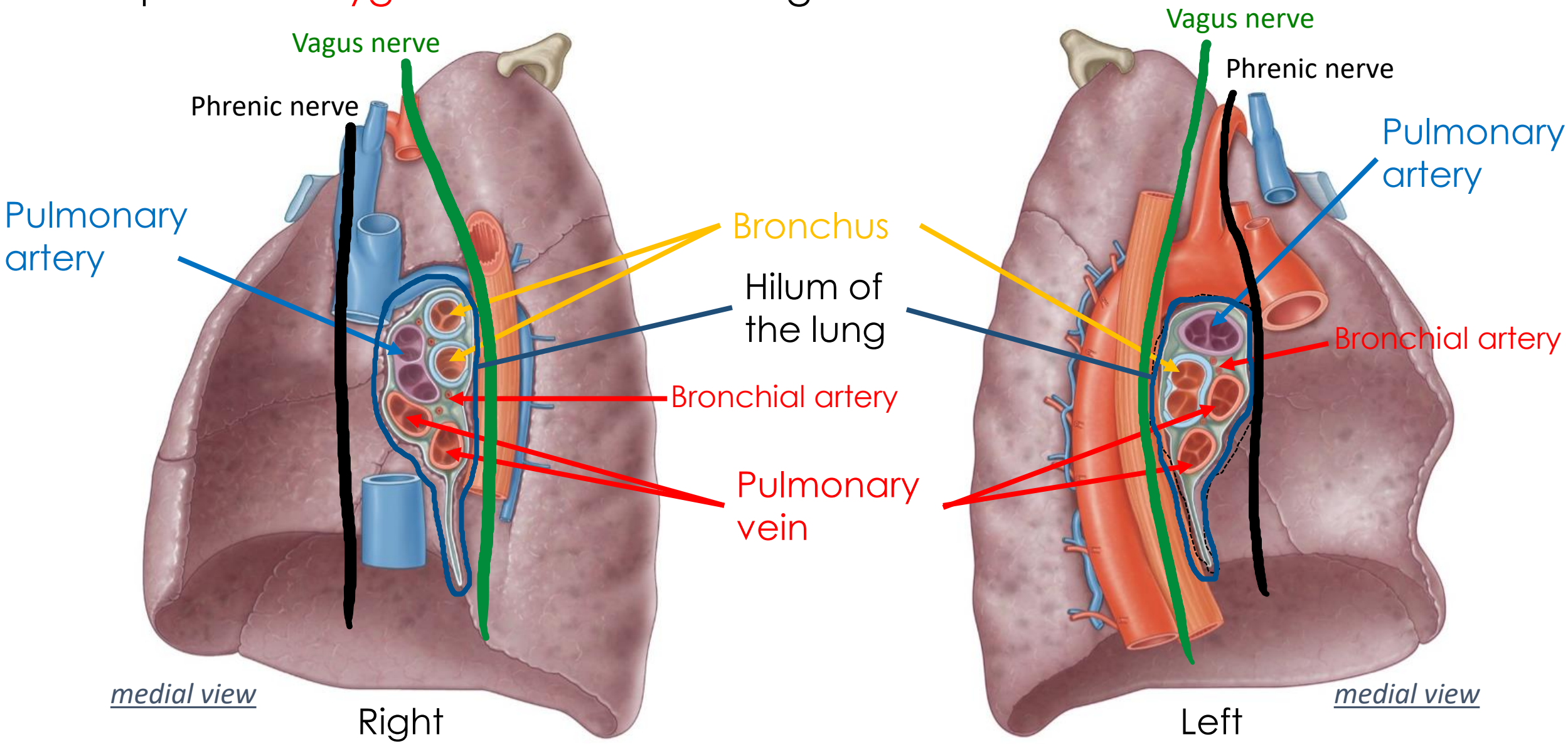


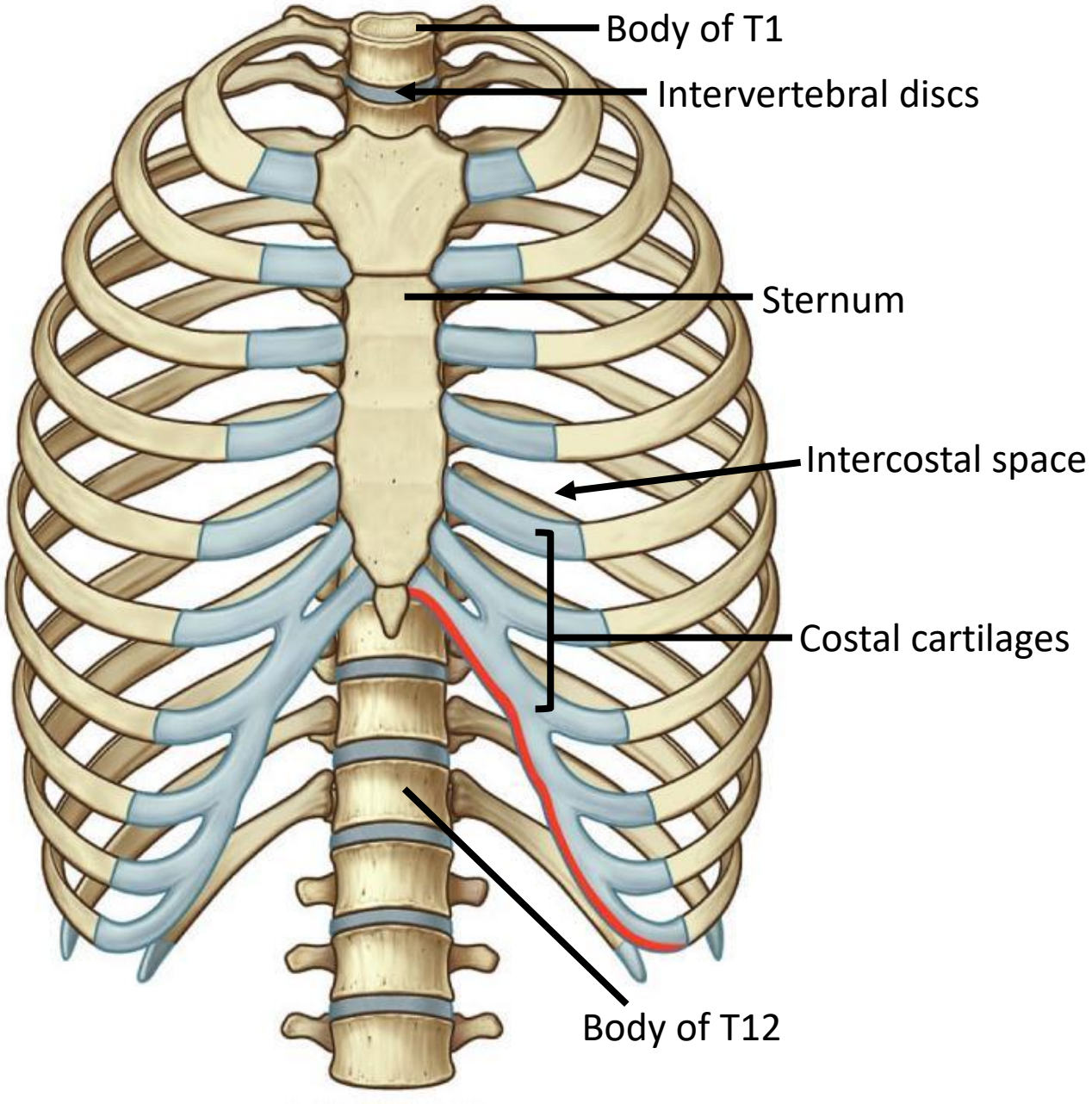
Hilum of the lung

The hilum of the lung is the area where the structures form **the root**, which connects the lung with the heart and trachea.

- **pulmonary artery**
- **superior** and **inferior pulmonary veins**
- **main bronchus** with **bronchial vessels** surrounding it
- lymphatic vessels and nerves

- The bronchial arteries supply the pleura near the hilum and provide oxygenated blood to lung tissues.





Thoracic cage

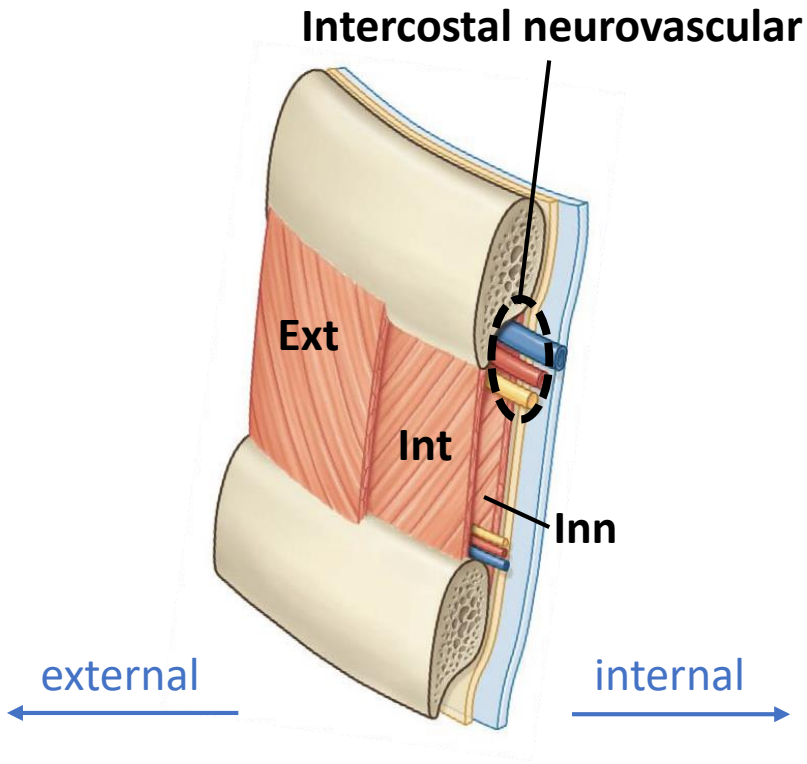
The thoracic skeleton forms the **thoracic cage**, including:

- the sternum
- 12 thoracic vertebrae and intervertebral discs
- 12 pairs of ribs and costal cartilages

Functions:

- To protect the heart and lungs
- To provide attachment for muscles

Intercostal space



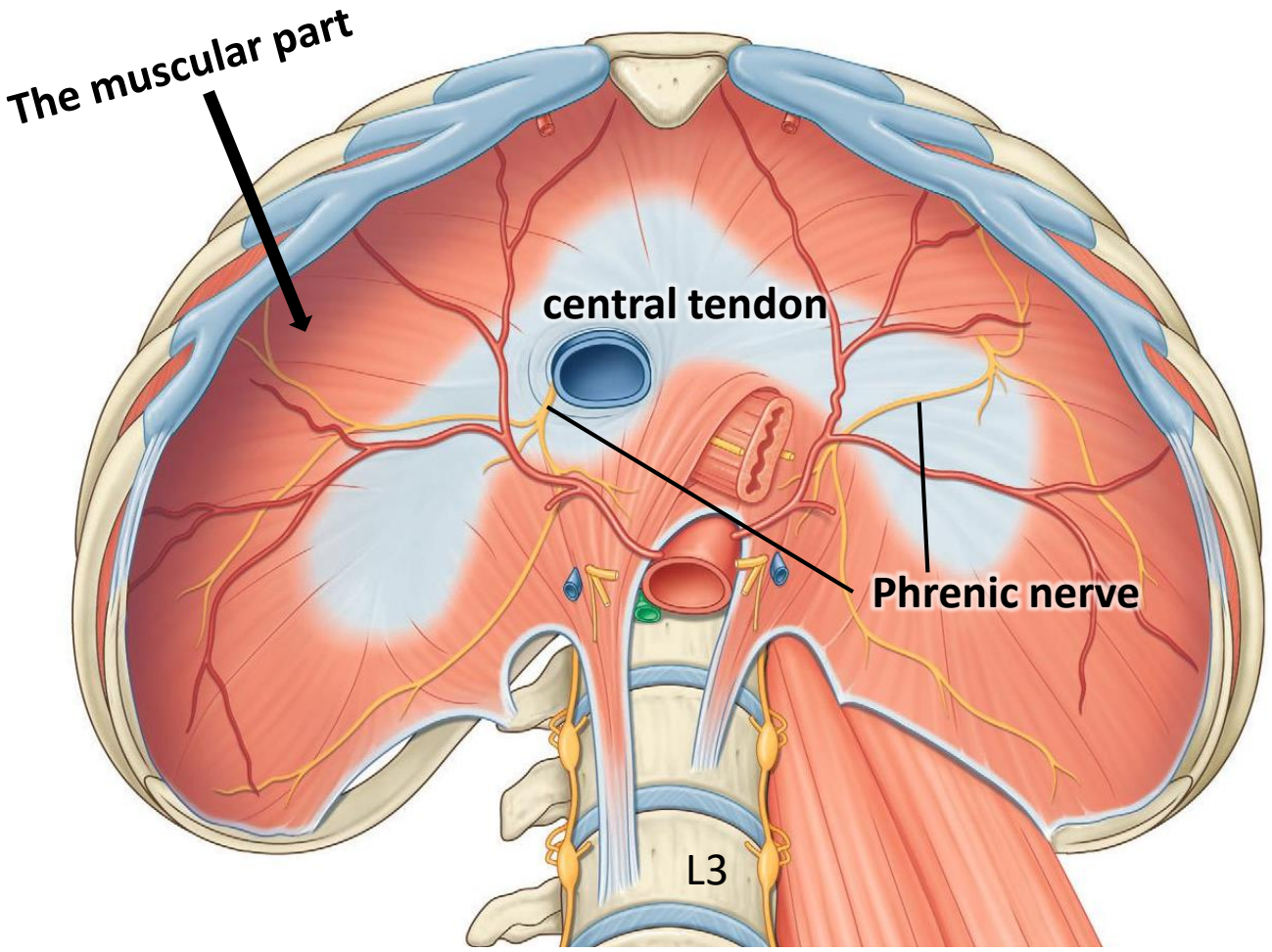
The **intercostal space** is occupied by **intercostal muscles**, from outmost to innermost:

- external intercostal muscle (**Ext**)
- internal intercostal muscle (**Int**)
- innermost intercostal muscle (**Inn**)

Intercostal neurovascular bundles are hidden in the **costal groove**, between internal and innermost intercostal muscles, from superior to inferior:

- intercostal **V**ein
- intercostal **A**rtery
- intercostal **N**erve

Diaphragm



inferior view

Diaphragm is a **musculotendinous** structure innervated by **phrenic nerve**.

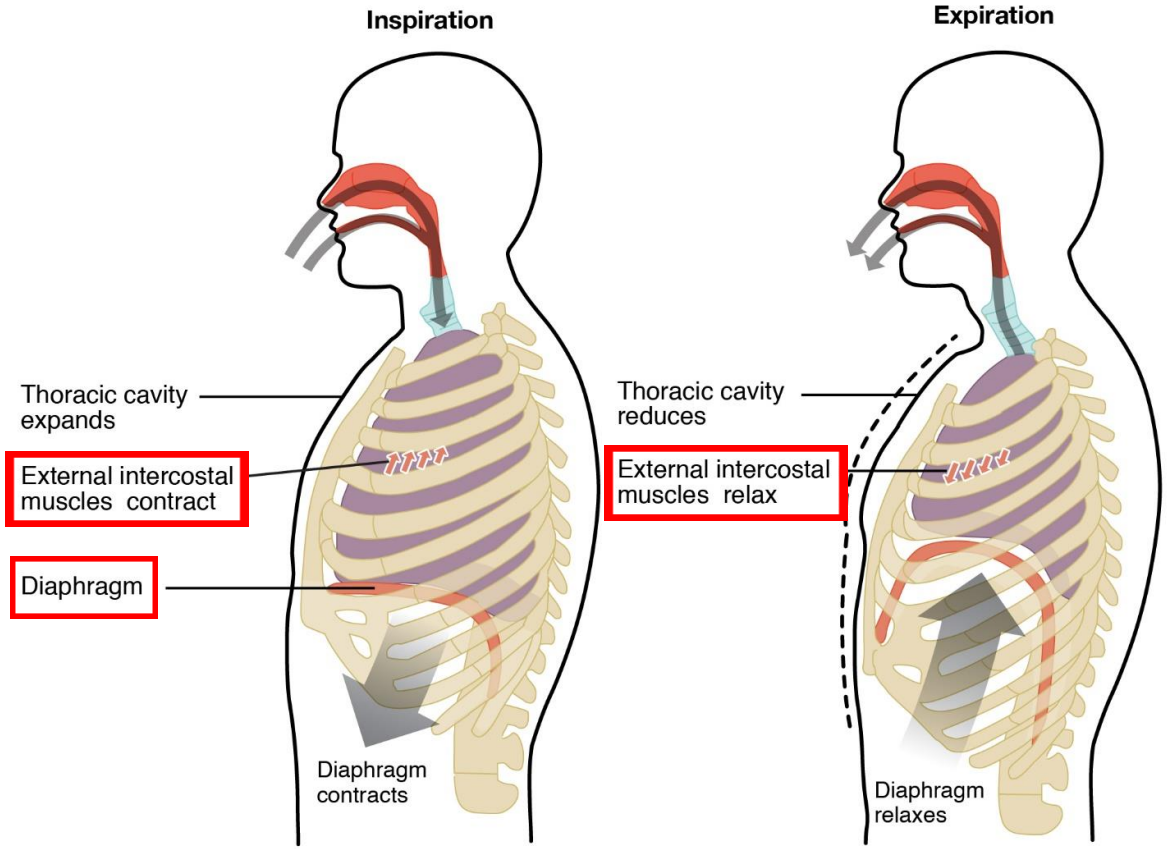
Composition of the diaphragm

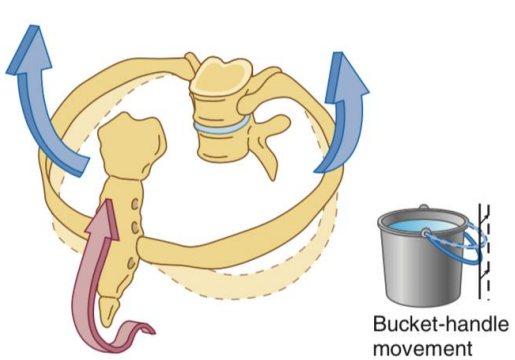
- the right dome
- the left dome
- the central aponeurotic part

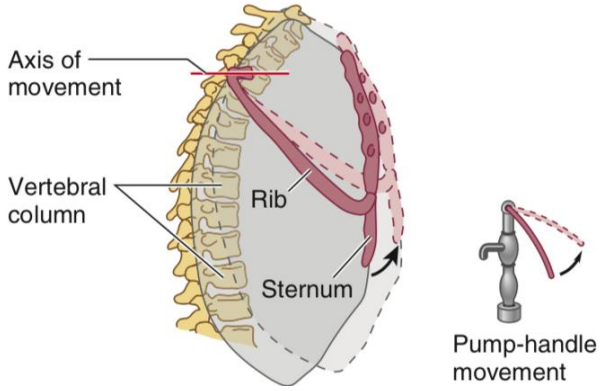
Function

- primary respiratory muscle

Mechanism of respiration







Quiet inspiration

- diaphragm contracts
  increase the vertical diameter
- external intercostal muscles contract
  increase the transverse and AP diameters

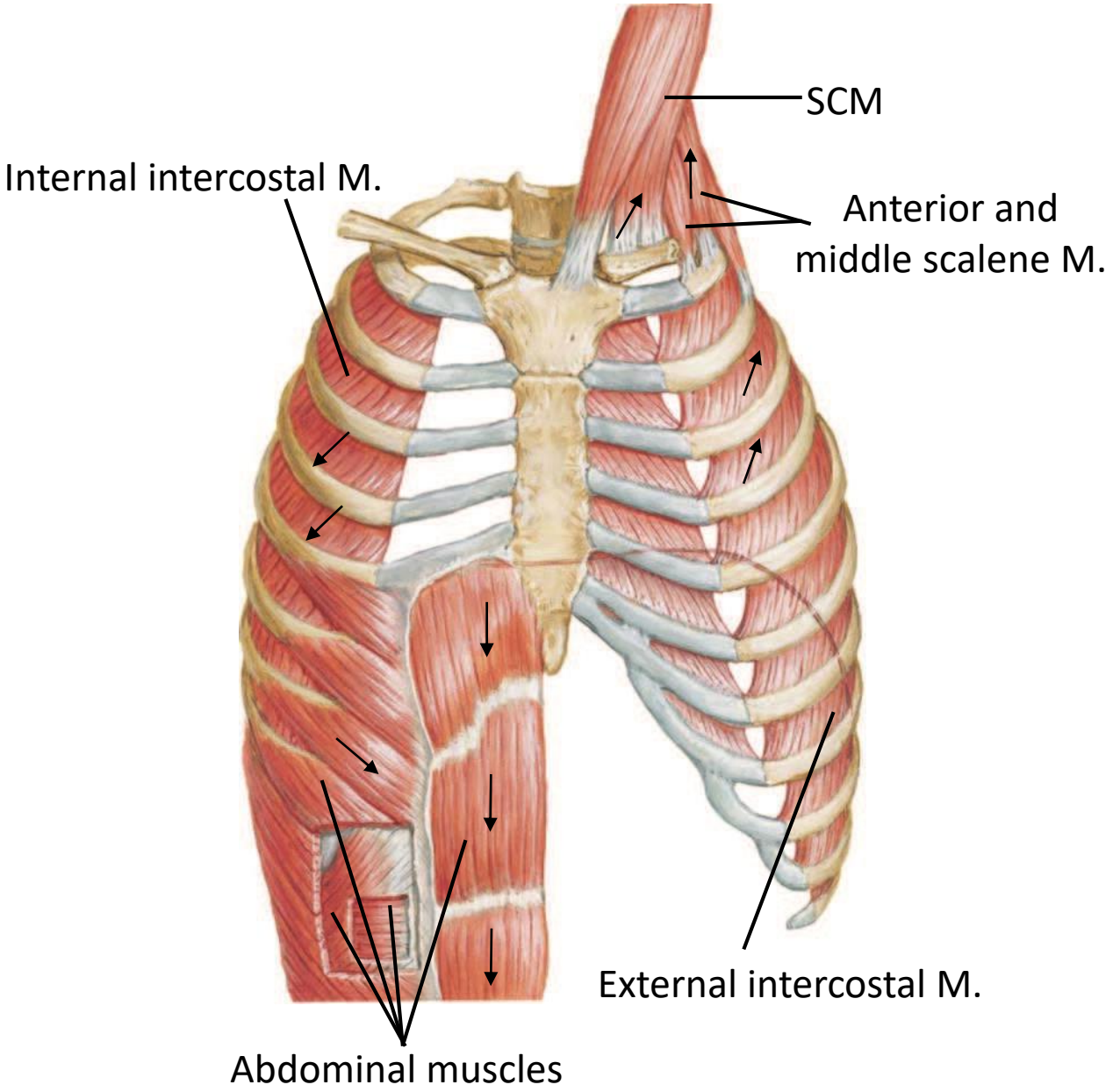
→ develops a negative intrathoracic pressure

Passive expiration

- diaphragm relaxes
  decrease the vertical diameter
- external intercostal muscles relax
  decrease the transverse and AP diameters

→ passive recoil of the lungs

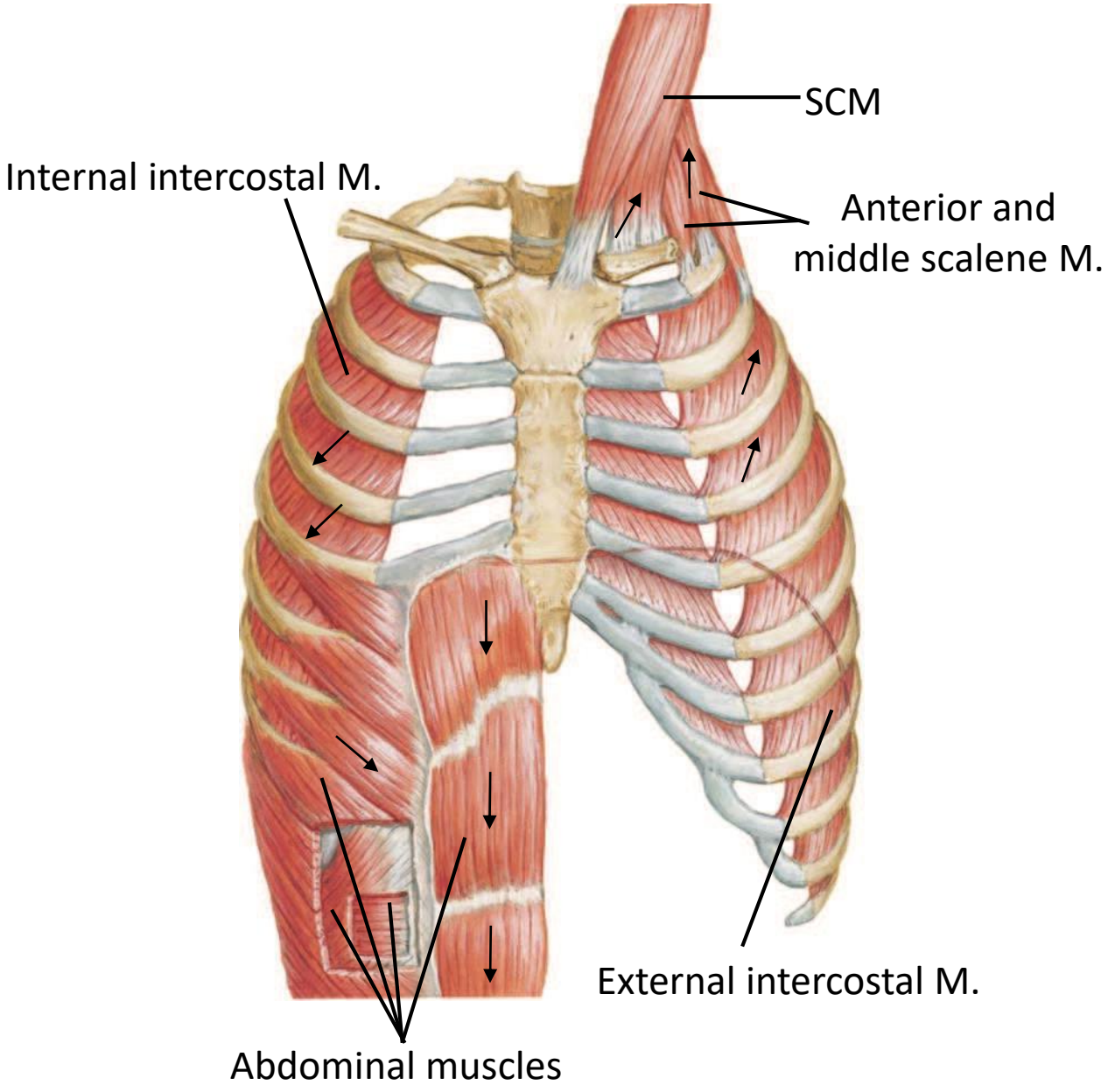
Mechanism of respiration



Forced (Active) inspiration

- anterior and middle scalene muscles
  - **lift** the 1st rib
- diaphragm and external intercostal muscles
  - increase the diameter
- pectoralis and sternocleidomastoid muscles (SCM)
  - further raise the ribs and sternum

→ allow additional increase in the AP and transverse diameters



Mechanism of respiration

Forced (Active) expiration

- internal and innermost intercostal muscles contract
  - depress ribs
  - decrease space in the thoracic cavity
- abdominal muscles contract
  - depress lower ribs
  - compress abdominal contents
  - push up respiratory diaphragm

→ allow further increased intrathoracic pressure

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