Biology 224
Human Anatomy and Physiology II
Week 3; Lecture 2; Monday
Dr. Stuart S. Sumida

Structure of the Lung

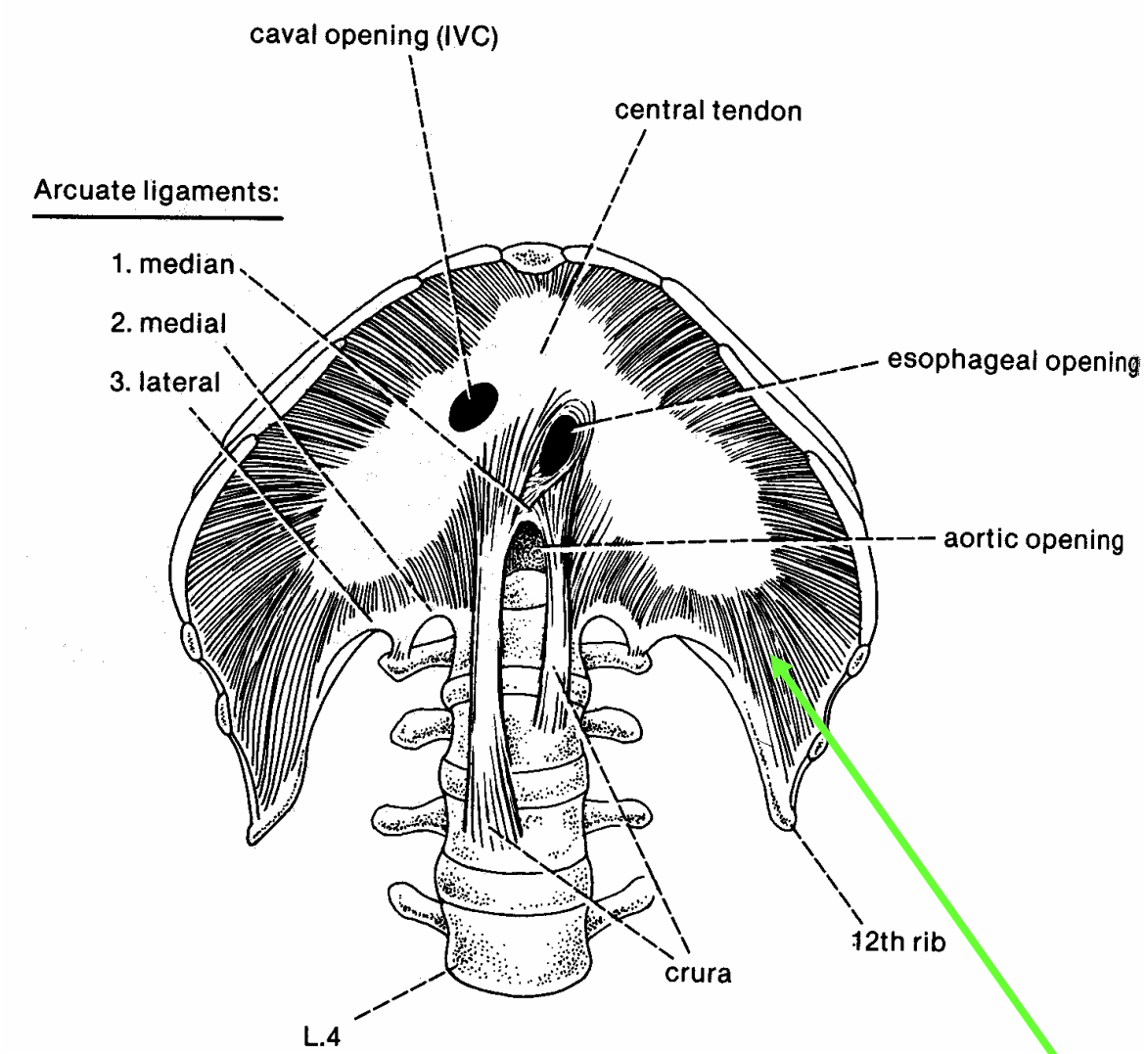
Biomechanics of Breathing

Diaphragm:

•Derived from hypaxial musculature of cervical segments.

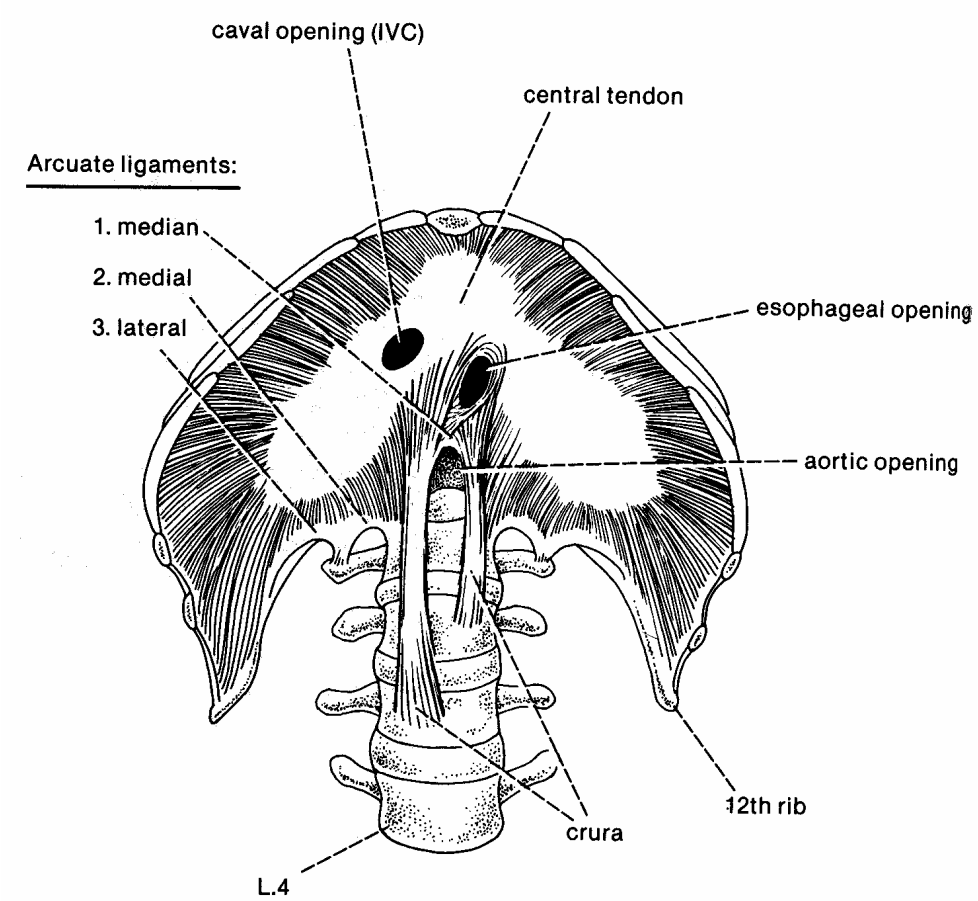
•So motor innervation is from cervical segmental nerves: right and left phrenic nerves (C3,4,5).

•Diaphragm is a muscular dome-shaped structure.



- Derived from hypaxial musculature of cervical segments.
- So motor innervation is from cervical segmental nerves: right and left phrenic nerves (C3,4,5).
- Diaphragm is a muscular dome-shaped structure.

Connective tissue structures of the diaphragm



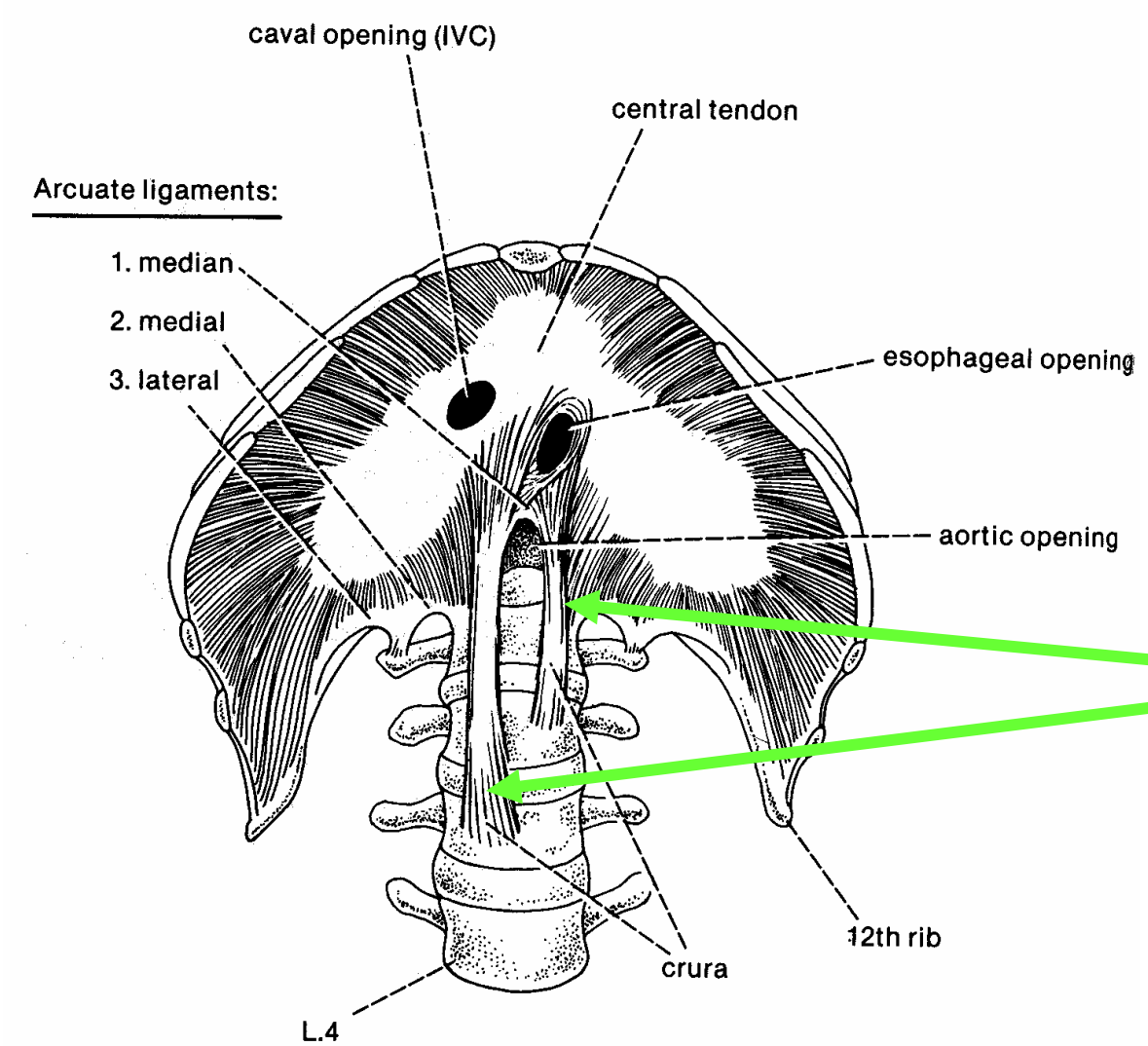
Three TYPES of ligaments, (five total).

Called ARCUATE LIGAMENTS.

(1) Median ligament.

(2) (Right and Left) Medial Ligaments

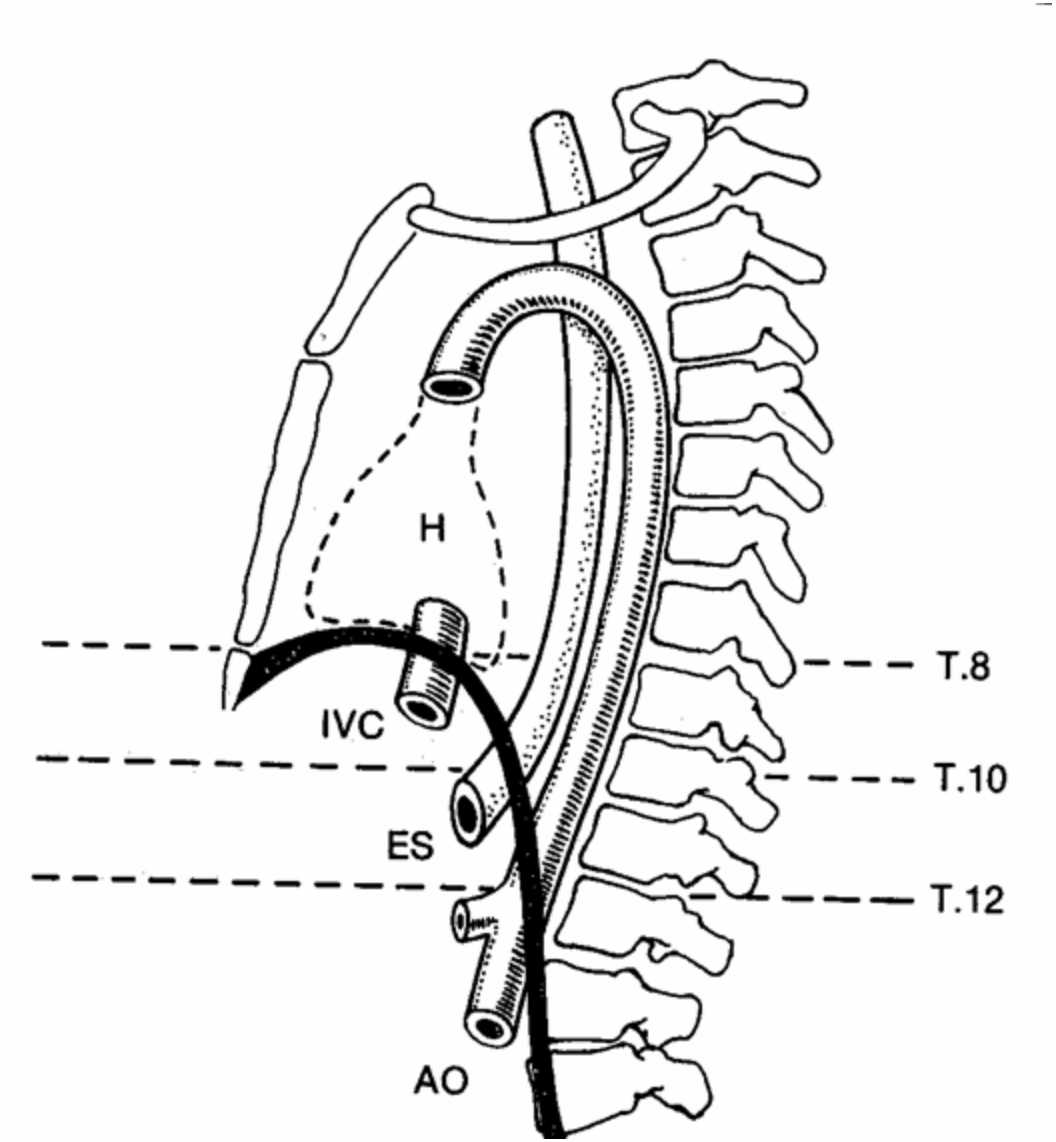
(2) (Right and Left) Lateral Ligaments



Muscular Structures of the Diaphragm:

Right and left Crura (muscular columns that help attach diaphragm.

Side view to see curvature of diaphragm…



RESPIRATORY TREE

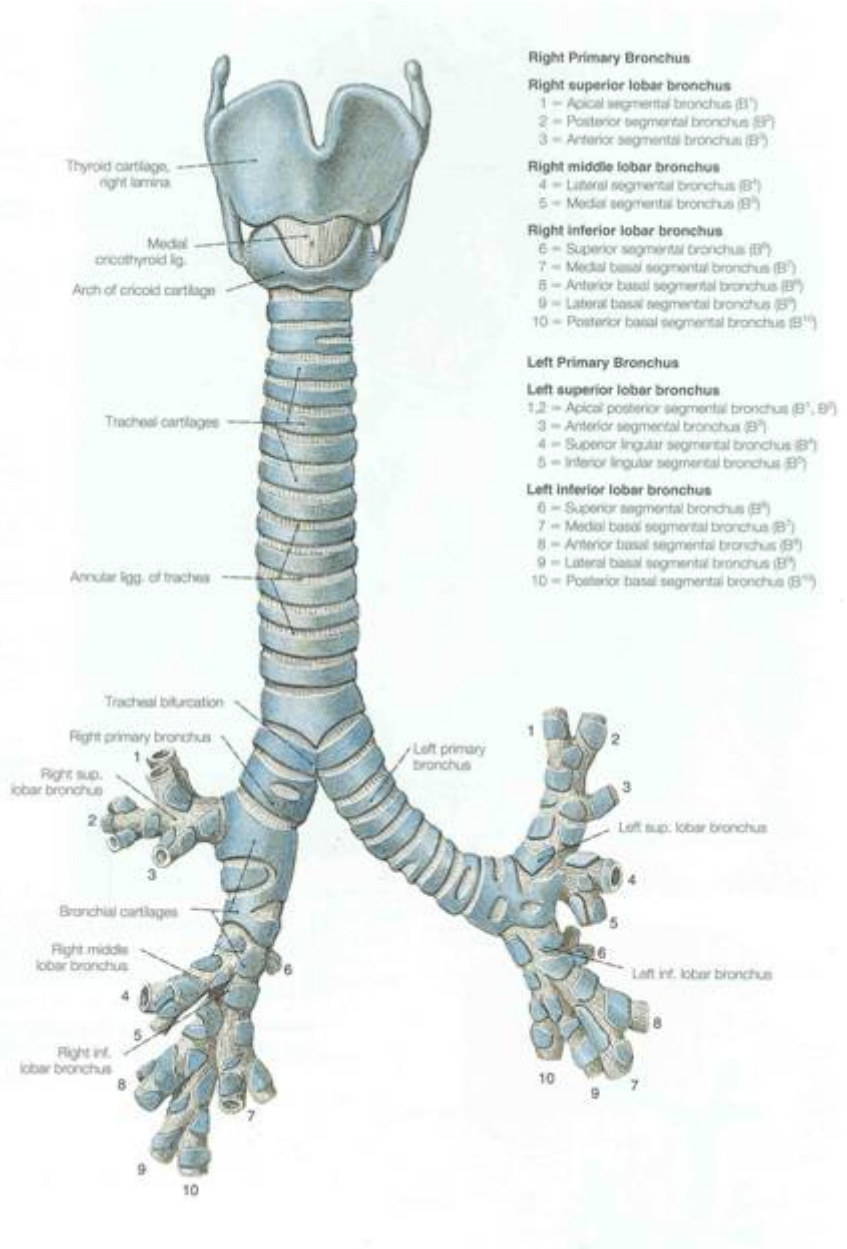
Trachea ⮙ 2 Primary Bronchi (right and left)

Each Primary Bronchus ⮙ to many Secondary Bronchi

Each Secondary Bronchus ⮙ to many Tertiary Bronchi

Tertiary bronchi ⮙ to many Bronchioles

Bronchioles ⮙ to “Alveoli”



RESPIRATORY TREE

Trachea ⮜ 2 Primary Bronchi (right and left)

Each Primary Bronchus ⮜ to many Secondary Bronchi

Each Secondary Bronchus ⮜ to many Tertiary Bronchi

BLOOD VESSELS

Lung highly vascularized.

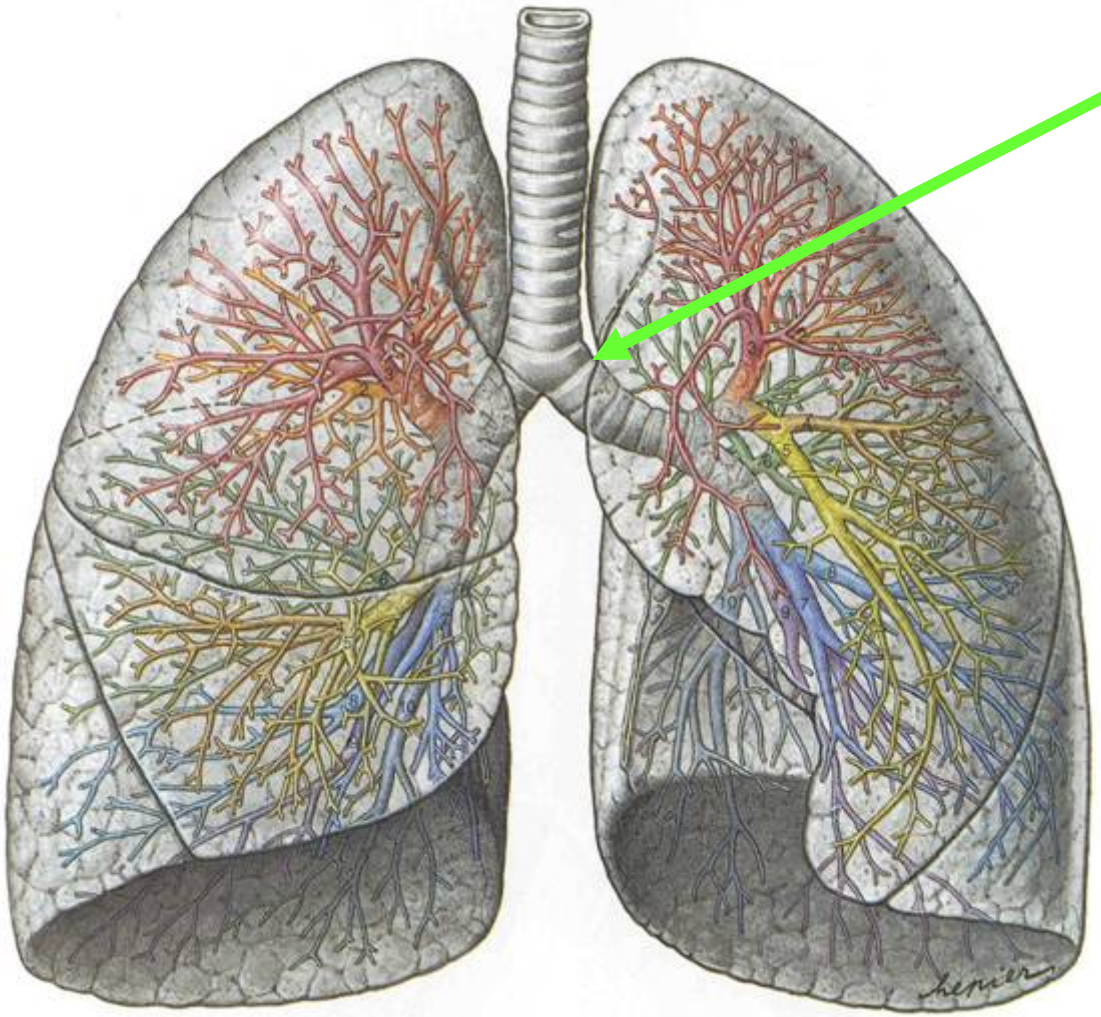
Vessels from mesoderm.

Arteries tend to run ventral to branches of bronchial tree.

Veins more variable in pattern.

Wheer bronchi and vessels disappear into tissue of lung: called ROOT OF THE LUNG.

LUNG STRUCTURE



Root of Lung

Note!
Because heart is displaced to left, left lung smaller (only two lobes).

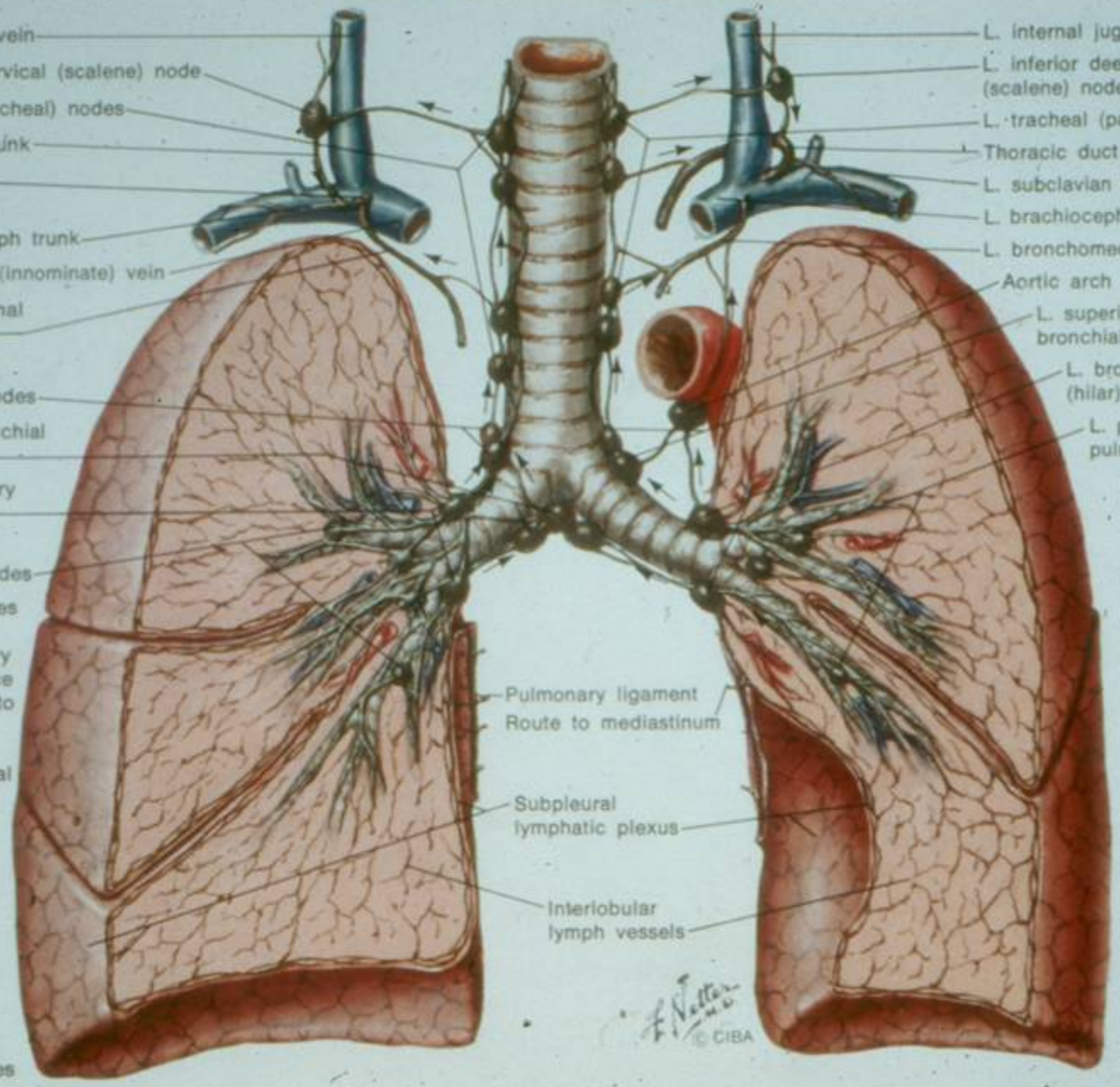
Right lung has three lobes.

(Smaller sections are called BRONCIOPULMONARY SEGMENTS)

Right lung (3 lobes)

Left lung (2 lobes)

Routes of Lymphatic Drainage of Lungs



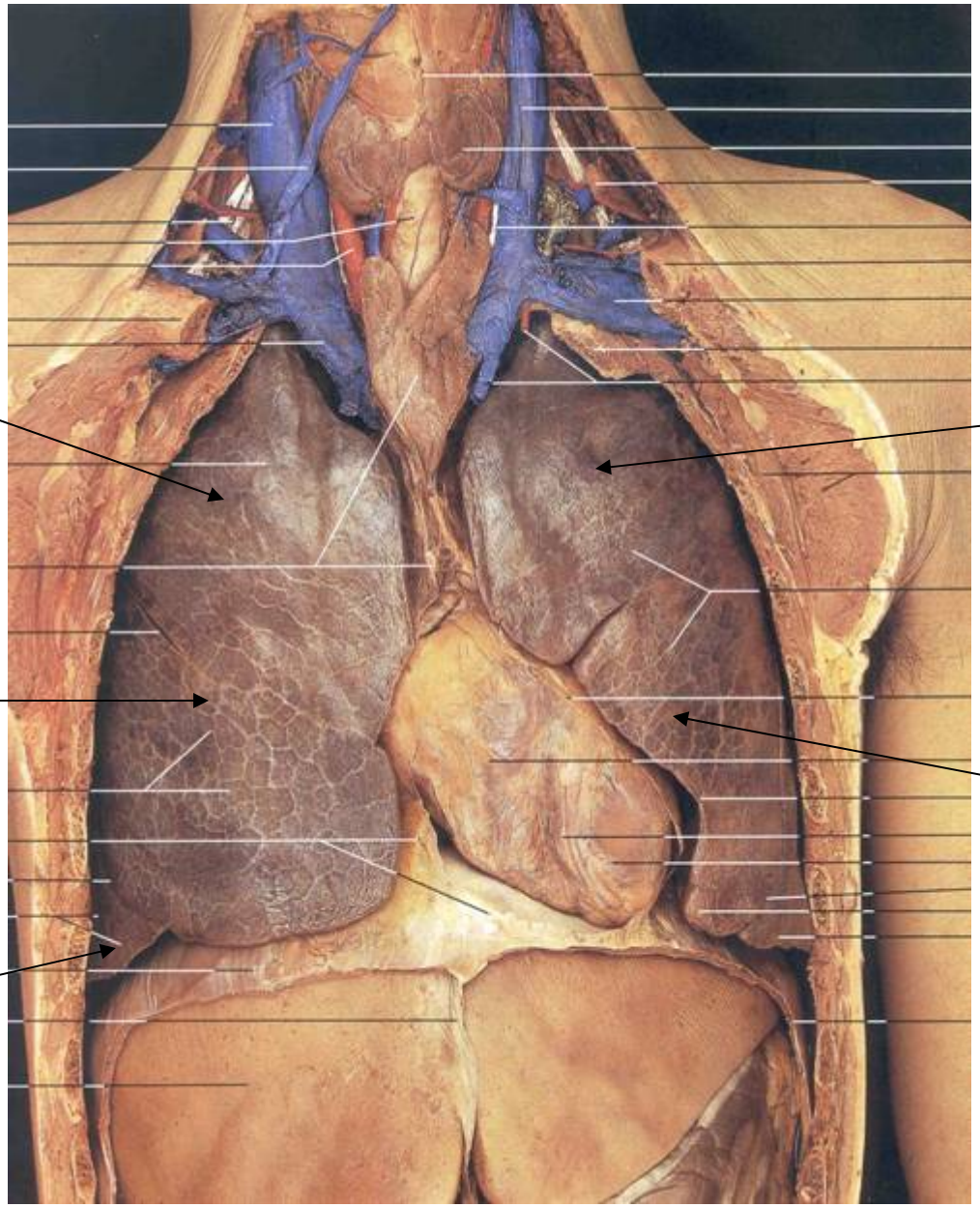
Right lung:

Larger (3 lobes)

Superior lobe

Middle lobe

Inferior lobe



Left lung:

Smaller (2 lobes)

Superior lobe

Inferior lobe

PLUERAL CAVITY

Subdivisions (2, right and left) of the coelom.

Peritoneal material is here called “pleura.”

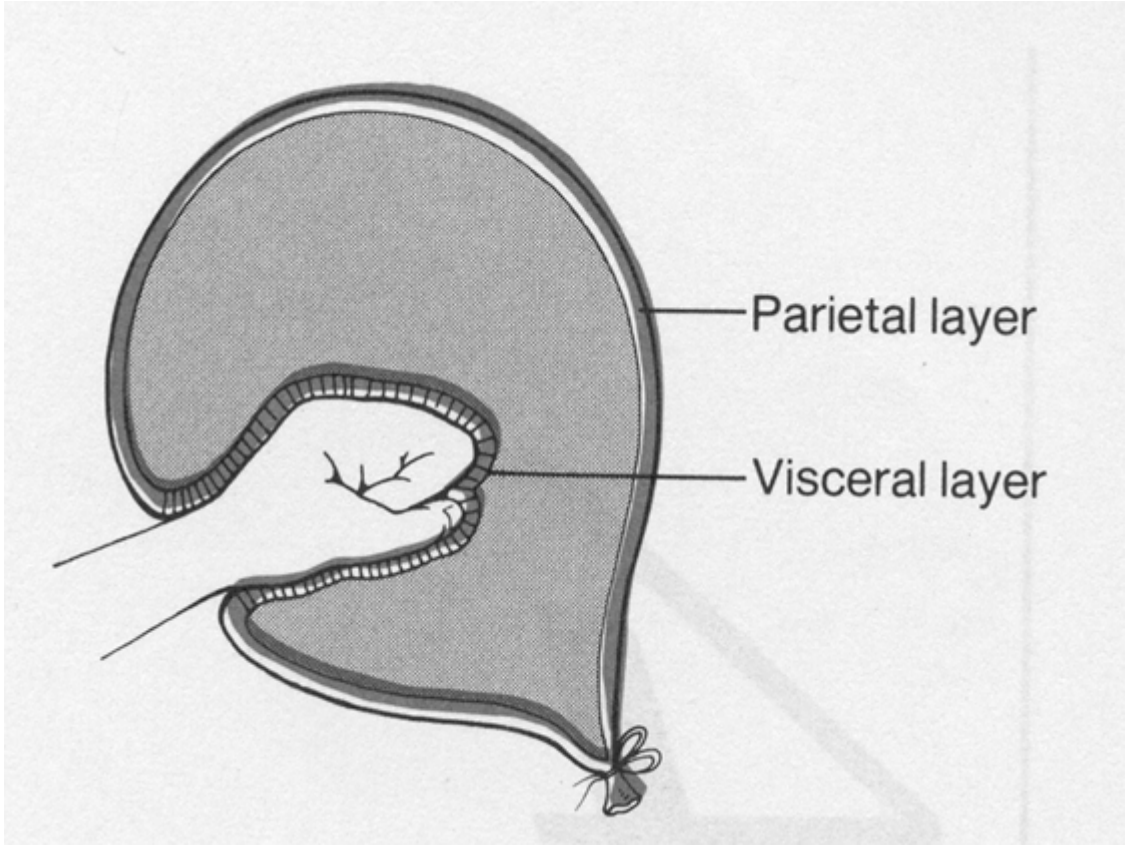
Visceral Pleura – on lungs

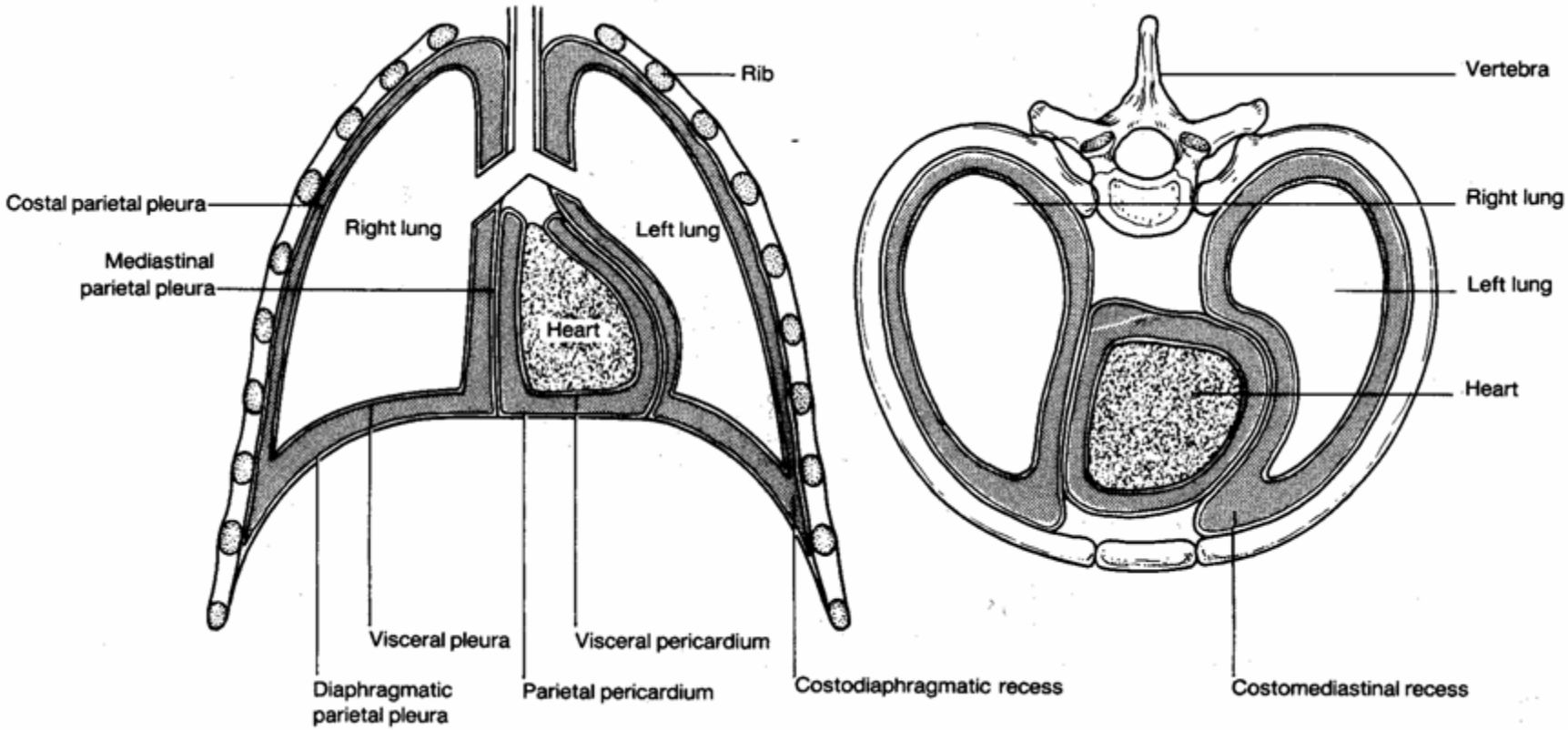
Parietal Pleura – on inside of body wall and diaphragm.

- Costal
- Diaphragmatic
- Mediastinal
- Cupola
- Costodiaphragmatic Recess

Remember…

Coelom is wraped around lungs as if the lungs were pushed into a mesodermally constructed space

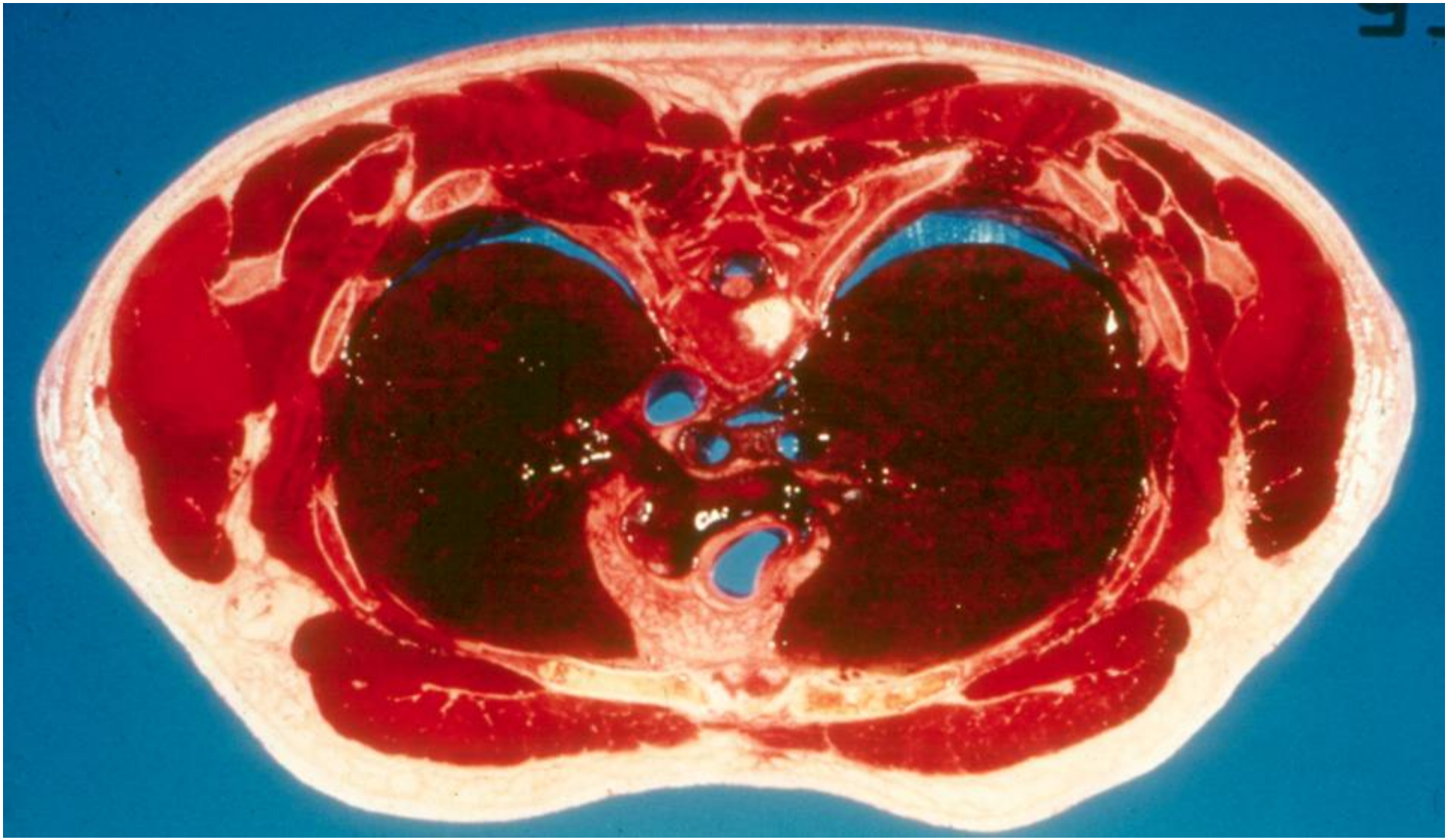




Visceral Pleura – on lungs

Parietal Pleura – on inside of body wall and diaphragm.

- Costal, Diaphragmatic, Mediastinal, Cupola
- Costodiaphragmatic Recess



Functional Considerations for the Pleura…

Lung does not expand up into cupola.

Expands downward toward pleural recess (the inferior space between ribs and diaphragm.

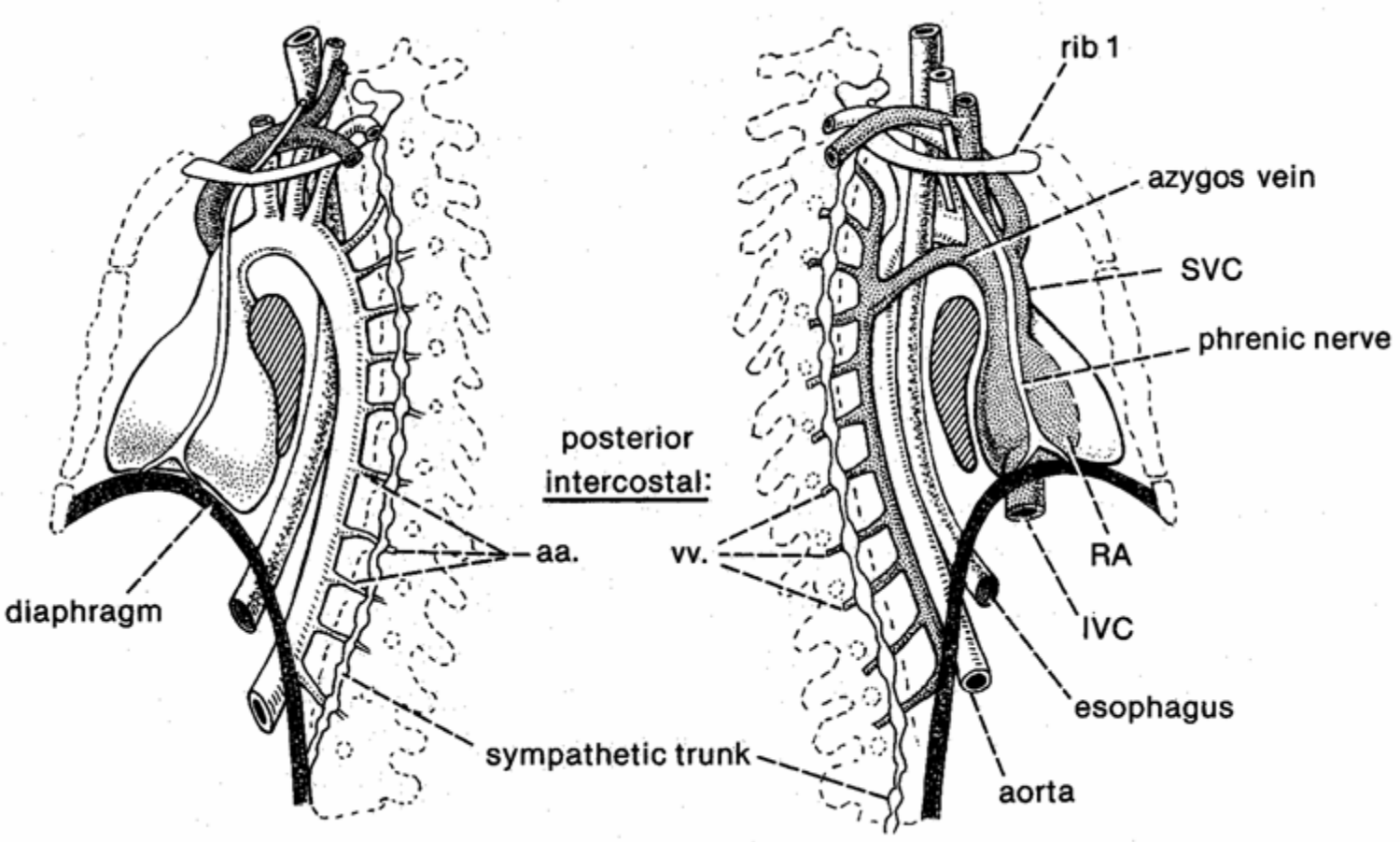
Pleura secretes coelomic fluid (for lubrication and to pull lungs when body wall moves).

“Pleurisy” is the painful chaffing between visceral and parietal pleura.

The “MEDIASTINUM” is the partition between the right and left pleura and the enclosed lungs.

Exercise: What is in the mediastinum? (Look at the pictures in your lab manual and in the Cartmill text.

Here’s a hint for what to look for…



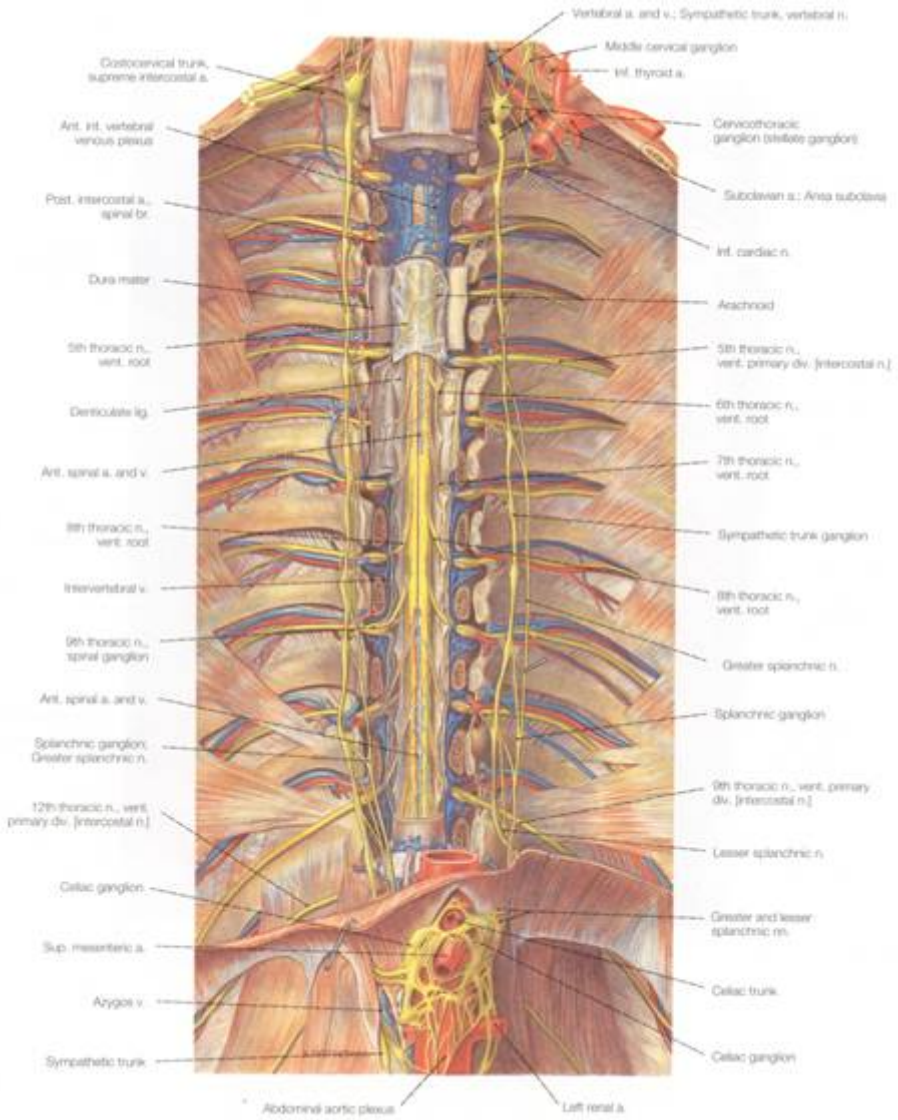
LUNG FUNCTION AND BREATHING

Smooth Muscle and Nervous Supply of Lung

- Smooth muscle can constrict or open respiratory tree.
- CONSTICTION: Parasympathetic nervous control is by VAGUS NERVE (X).
- Ganglia between pre- and post-ganglionic neurons right on target organ.

Smooth Muscle and Nervous Supply of Lung

- Smooth muscle can constrict or open respiratory tree.
- OPENING: Sympathetic fibers.
- Pre- and postganglionic sympathetic fibers synapse in thoracic region of sympathetic trunk.
- Then, they go up into the neck (cervical sympathetic trunk) and back down to lungs.
- WHY?



Pre- and postganglionic sympathetic fibers synapse in thoracic region of sympathetic trunk.

Then, they go up into the neck (cervical sympathetic trunk) and back down to lungs.

WHY?

BECAUSE! Remember: Lungs started out in the neck, and then moved down. The nerves were simply following!

BIOMECHANICS AND NERVOUS CONTROL OF BREATHING

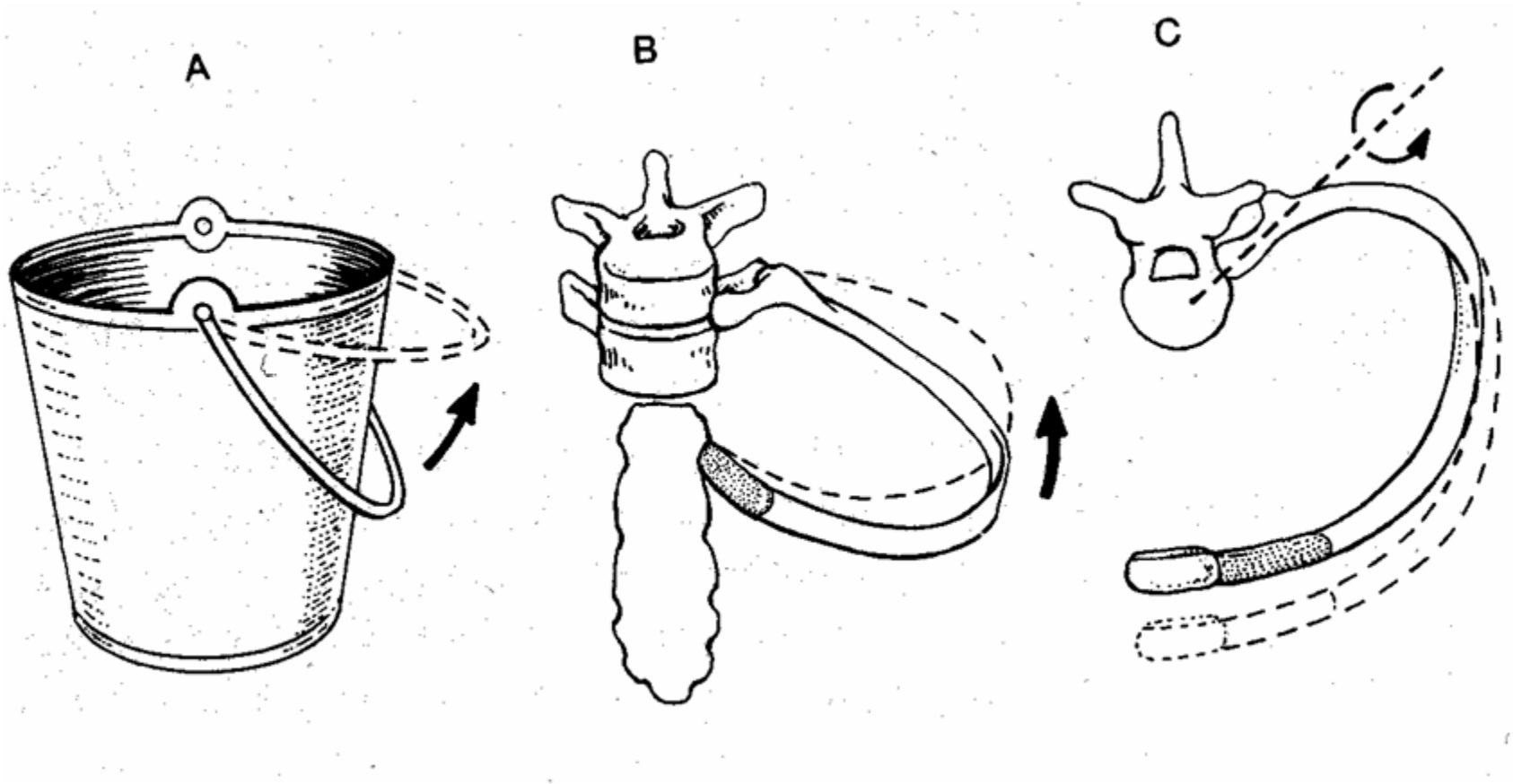
THORACIC BREATHING

Based on RIB MOVEMENTS:

- Scalene muscles pull cranially (up) on 1st and 2nd ribs.
- Ribs move like bucket handles.
- Each successive rib pulls on the next via intercostal muscles.
- When ribs/bucket handles move up and out, **VOLUME OF THORACIC CAVITY INCREASES**.

Scalene muscles pull cranially (up) on 1st and 2nd ribs.

(Scalenes are segmentally innervated: C2-7.)



Ribs move like bucket handles.

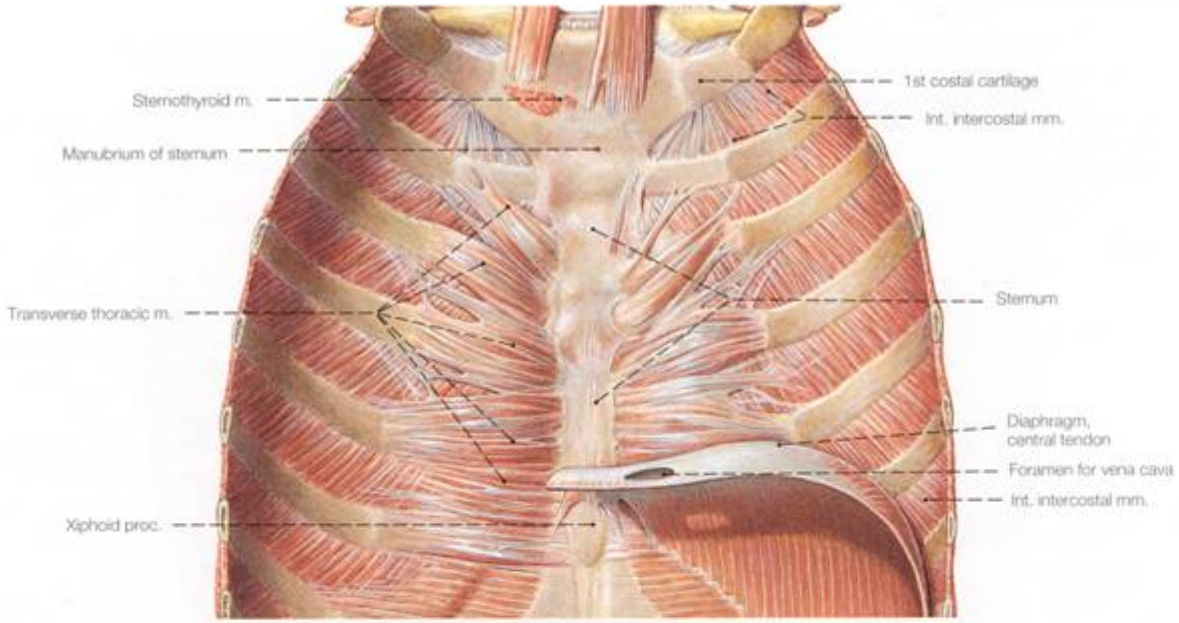
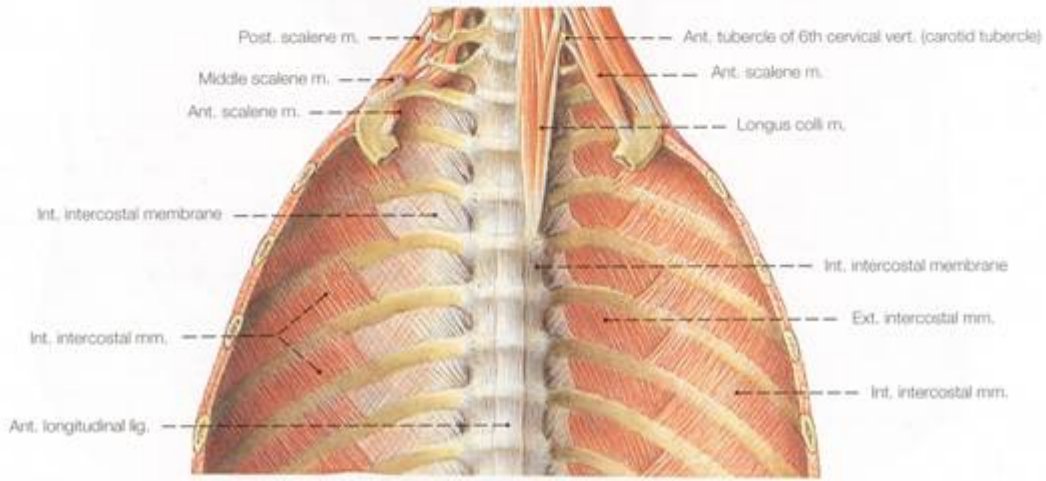


Fig. 796 Thoracic cage, viewed from behind. Internal aspect of the anterior thoracic wall with the diaphragm in place on the right side.



Each successive rib pulls on the next via intercostal muscles.

When ribs/bucket handles move up and out, **VOLUME OF THORACIC CAVITY INCREASES**.

So what happens when volume increases?

PRESSURE DECREASES...

When **PRESSURE DECREASES…**

Air gets SUCKED IN.

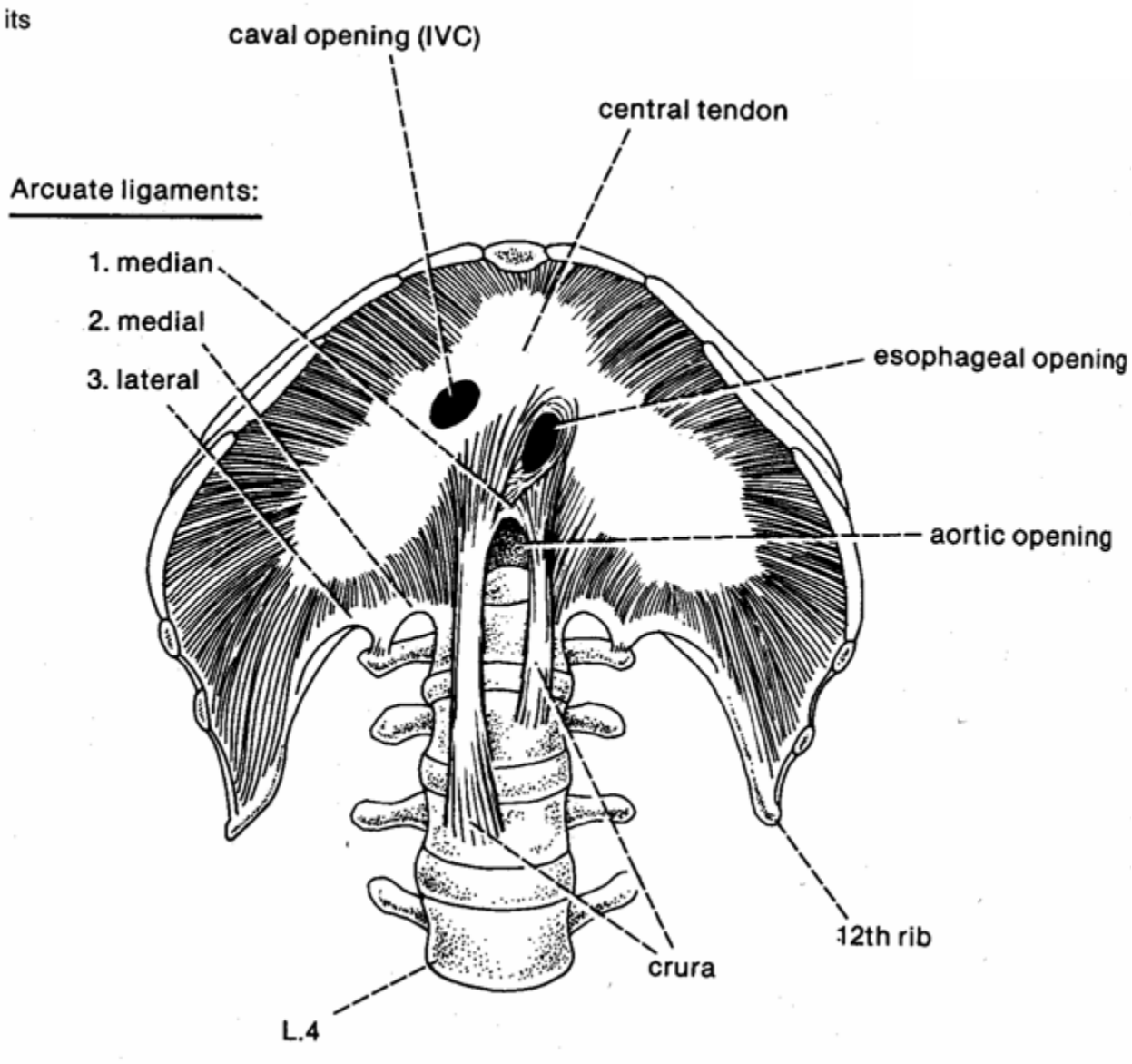
(All amniotes do this. In other words, amniotes (including humans as mammals)...

…SUCK.

ABDOMINAL BREATHING

(Use of the Diaphragm)

Remember the shape and structure of the diaphragm!!!



ABDOMINAL BREATHING

- Diaphragm is “dome-shaped.”
- When it contracts, the dome flattens out.
- This INCREASES THORACIC VOLUME.

- Where have you heard this before…?

So, when diaphragm contracts, **VOLUME OF THORACIC CAVITY INCREASES**.

So what happens when volume increases?

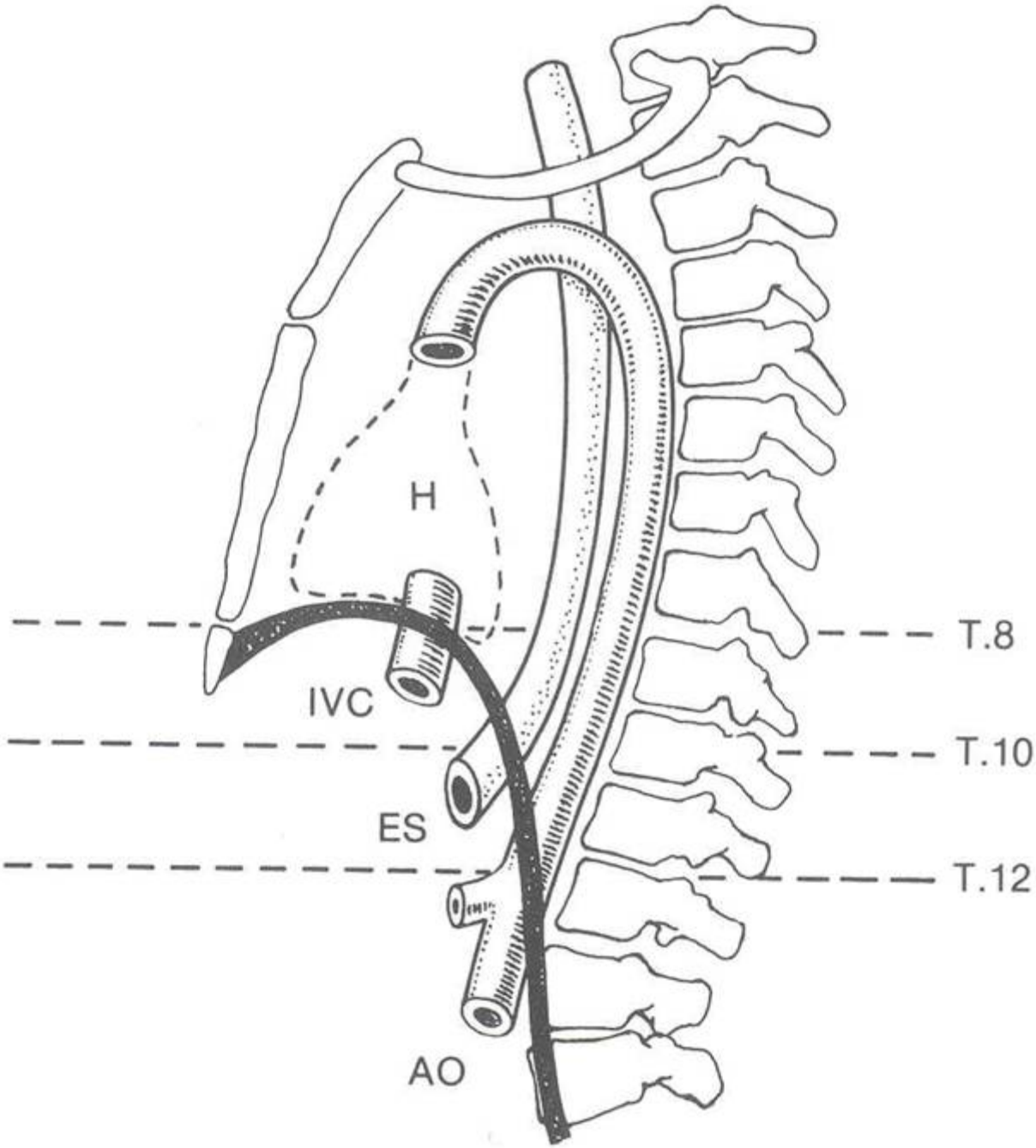
PRESSURE DECREASES...

When **PRESSURE DECREASES…**

Air gets SUCKED IN.

Only mammals (including humans) have a diaphragm.

So, humans SUCK really well.


H
IVC
ES
AO
T.8
T.10
T.12

FORCED BREATHING

- Inhalation can be increased by increasing the amplitude of the movements we just discussed.

- Forced Exhalation -- facilitated by all the muscles of the ribcage, pressurizing coelom, and contracting limb muscles around the axial body wall.

Forced Exhalation

Muscles of the ribcage (bucket handles move down).

Pressurizing coelom (pushes diaphragm back up into dome-shape)** -- decreases thoracic volume to push air out.

Contracting limb muscles around the axial body wall can help compress thoracic cavity.

NOTE:

Pressurizing coelom (pushes diaphragm back up into dome-shape)** -- decreases thoracic volume to push air out.

In other words, mammals (including humans) also BLOW**.

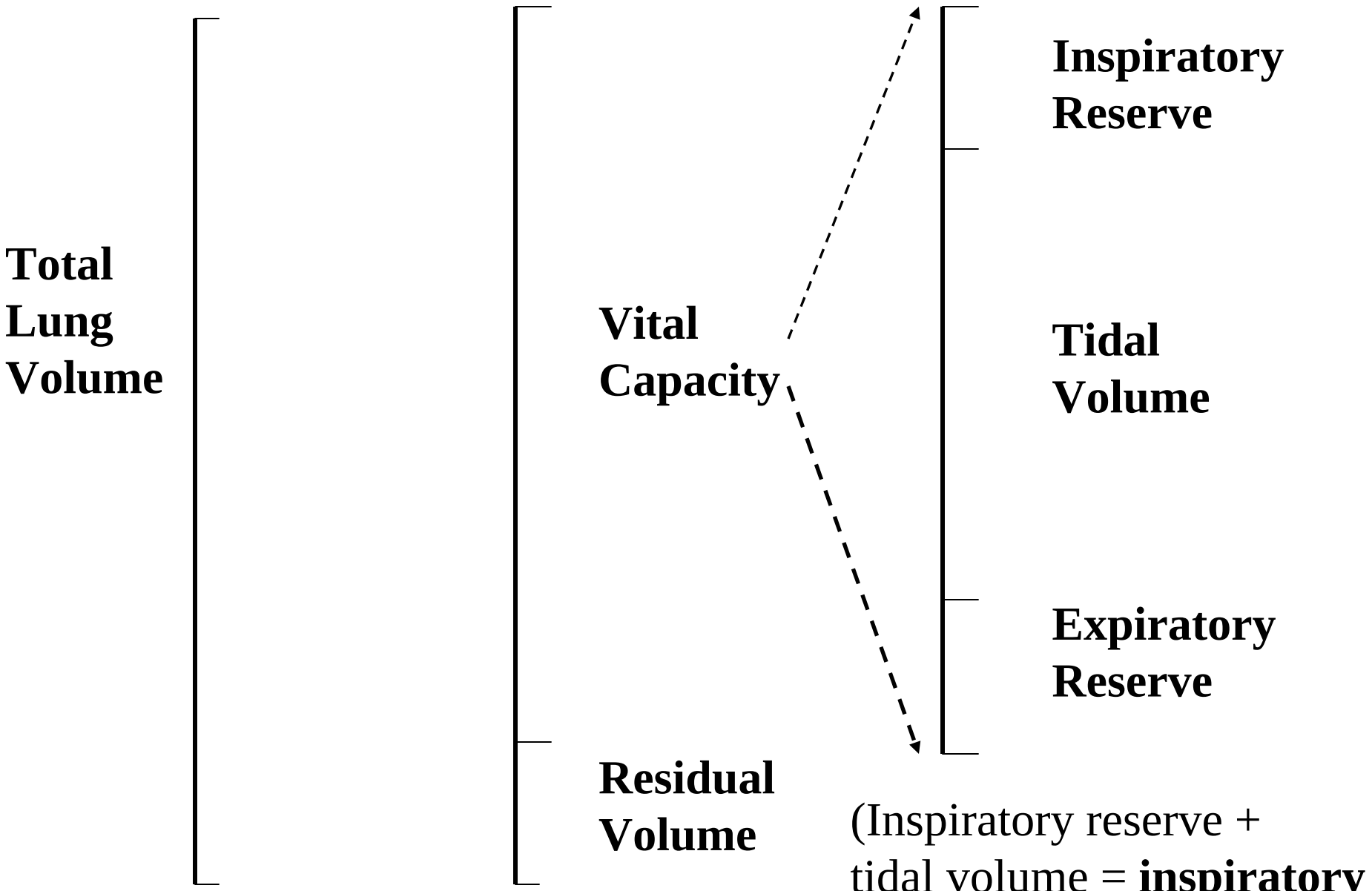
HUMANS BOTH SUCK AND BLOW.

(**I’m quoting Bart Simpson here.)

VOLUMES OF AIR IN LUNGS

- Normal Breathing: about half a liter per breath.

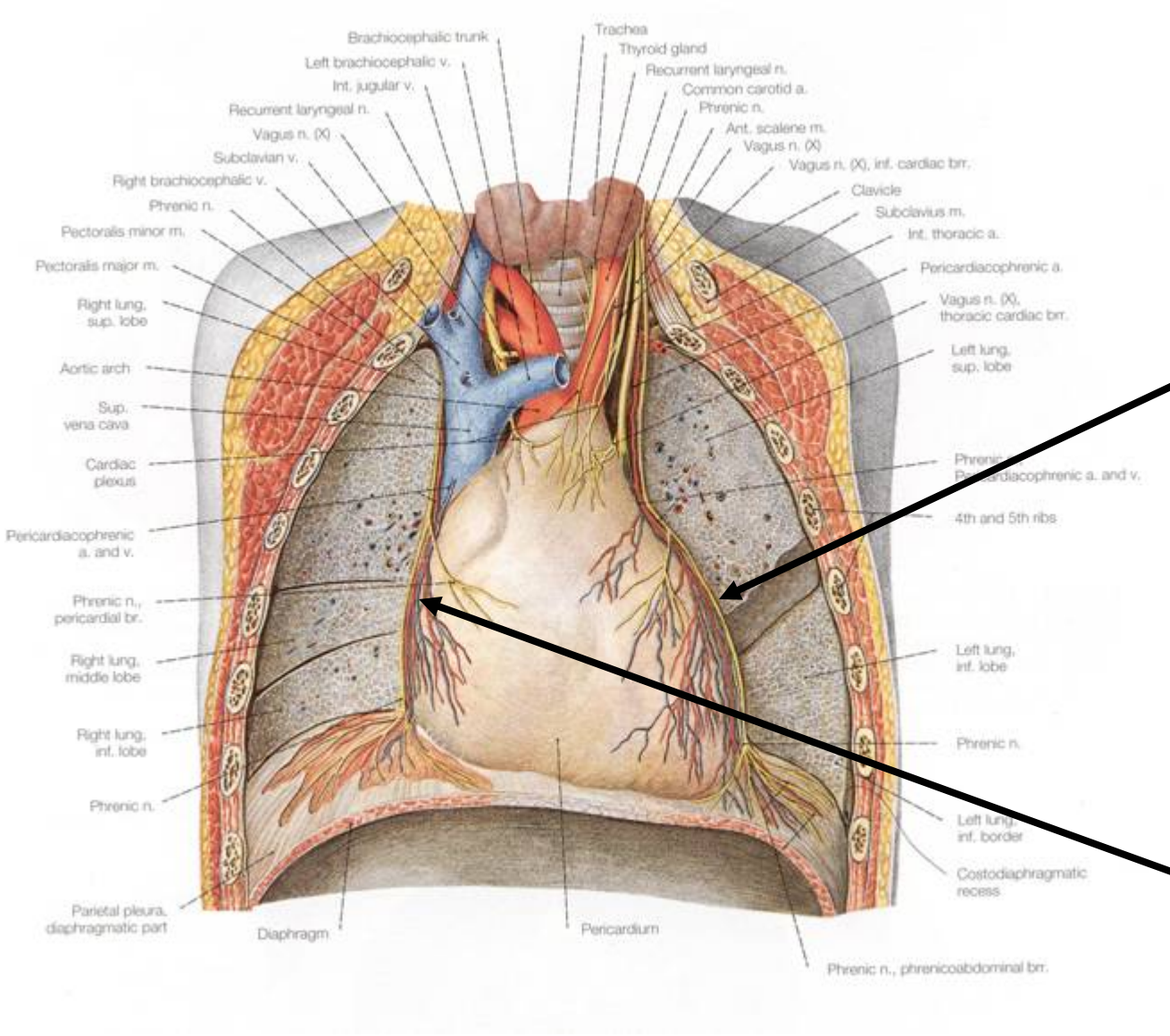
- This is known as **“TIDAL VOLUME.”**



(Inspiratory reserve + tidal volume = **inspiratory capacity.**

INNERVATIONS

- Diaphragm: PHRENIC NERVES (right and left)
- Scalenes: C2-7.
- Breathing is “involuntary behavior powered by voluntary muscles.”



Phrenic nerves pierce diaphragm near apex; send branches across inferior (abdominal) surface of diaphragm.

Diaphragm: PHRENIC NERVES (right and left)

CENTRAL NERVOUS CONTROL OF BREATHING

- Normal Breathing: known as “EUPNEA”
- Main controls in pons and medulla oblongata.

- In Pons:
- APNEUSTIC AREA - causes strong inhalation, weak exhalation.
- PNEUMOTAXIC AREA - causes strong inhalation, weak exhalation.

CHEMICAL CONTROLS OF BREATHING

- CO_2 in blood dissociates into CARBONIC ACID.
- More carbonic acid means lower pH.
- CAROTID BODIES (at junction of internal and external carotid): Sense pH and communicate with medulla.
- AORTIC BODY (on arch of aorta): Sense pH and communicate with medulla.

RHYMICITY CENTERS OF MEDULLA OBLONGATA

- Increased CO_2 (in form of carbonic acid) or increased blood pressure signals from carotid and aortic bodies.
- Carotid bodies and arotic body tell medullary rhymicity centers.
- Medullary rhymicity centers can then increase activity of apneustic area (deeper breathing.)

RHYMICITY CENTERS OF MEDULLA OBLONGATA

- Decreased CO_2 is called RESPIRATORY ALKALOSIS (higher pH).
- Carotid bodies and aortic body tell medullary rhymicity centers.
- Medullary rhymicity centers can then increase activity of pneumotaxic area (shallower breathing.)

MICROSCOPIC DETAIL OF RESPIRATORY TREE

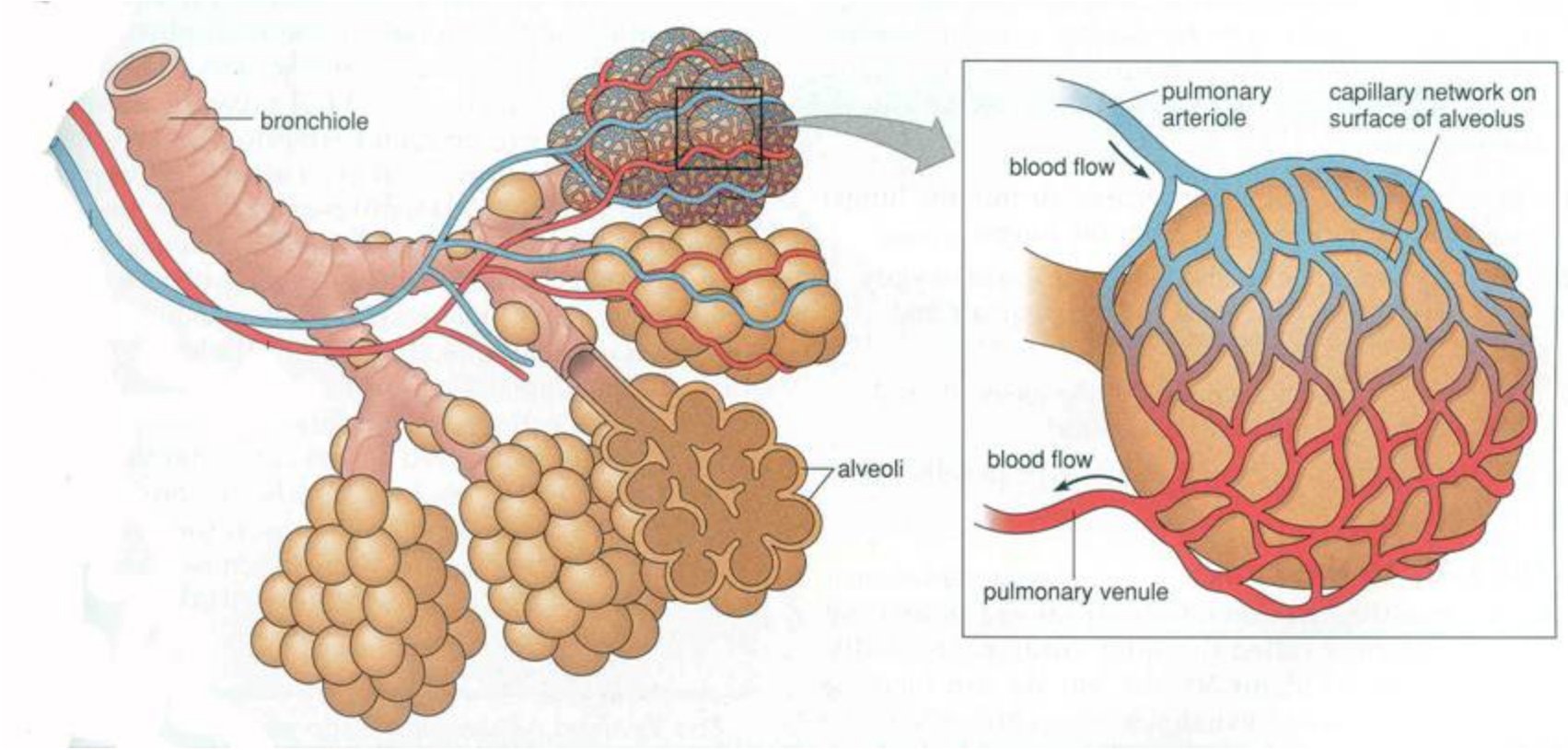
ALVEOLI:

Terminal “Grape-like Lobes of Respiratory Tree.

Microscopic airsacs, thin enough for gas to pass across.

Each alveolus is surrounded by capillary plexus (deoxygenated blood from pulmonary artery, oxygenated blood returned via pulmonary vein).

Note! Only at this microscopic level is lung “hollow.”



Terminal “Grape-like Lobes of Respiratory Tree.

Microscopic airsacs, thin enough for gas to pass across.

Each alveolus is surrounded by capillary plexus (deoxygenated blood from pulmonary artery, oxygenated blood returned via pulmonary vein).

GAS EXCHANGE

Alveolar and capillary membranes: extremely thin. (Capillaries only one red blood cell wide.)

Thus, hemoglobin in RBCs maximally exposed to fresh oxygen.

Remember, oxygen BINDS TO HEMOGLOBIN in regions of high oxygen concentration.

Carbon dioxide dumped.

SURFACTANTS

Specialized cells of alveolar lining secrete thse chemicals.

They reduce “surface tension” – prevents fluid from beading up on alveolar surface.

Prevents collapse of alveoli due to concentrated fluid weight.

Thinner layer of fluid makes gas diffusion easier.

OTHER DEFENSES

Alveoli contain lots of phagocytic cells: ALVEOLAR MACROPHAGES.

- Ingest and destroy microorganisms and other foreign substances (from breathing them in…)

Cilia can transport small bits of foreign material and mucous back up.

Coughing

Foreign material can be carried into lymphatic system.

Smooth Muscle and Nervous Supply:

Bronchial segments include smooth muscle—can expand or constrict tree.

PARASYMPATHETIC:

- Vagus Nerve – signals cause smooth muscle to contract and constrict bronchioles.
- Ganglia between pre- and postganglionic neurons right on target organ (on bronchioles themselves).

SYMPATHETIC:

- Pre- and post-ganglionic neurons synapse in thoracic part of sympathetic chain.
- Go up to cervical region, then go back down sympathetic chain to lungs.
- Why? Because lungs started out in neck.
- Cause dilation of bronchi.