Ventilation Management

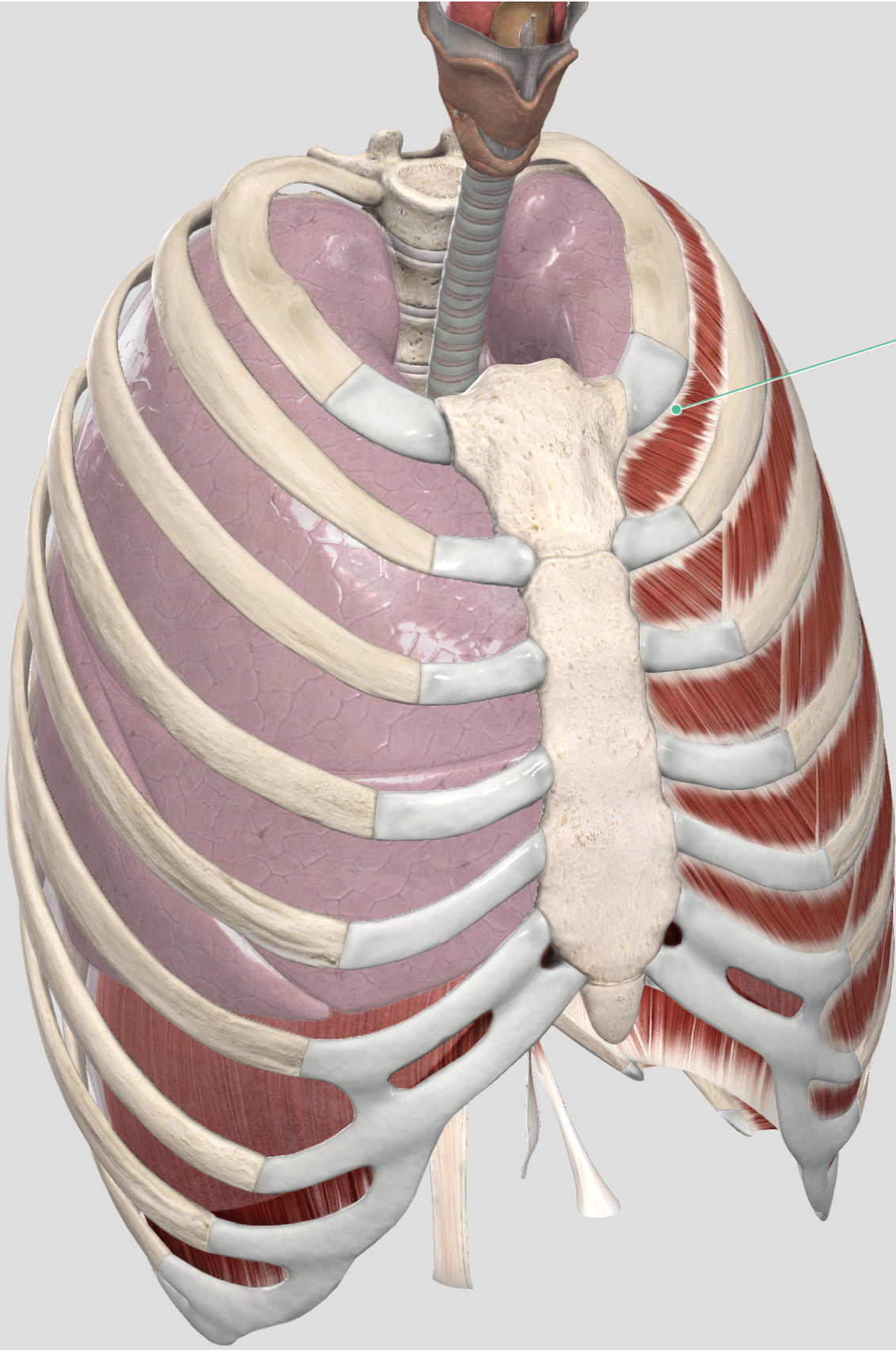
for the

Pre-Hospital Provider

Course Objectives

- Identify respiratory anatomy
- Identify three gas laws that are involved in breathing
- Describe the physiological process of breathing
- Identify compliance and resistance of the airway
- Describe how to ventilate for compliance or resistance issues

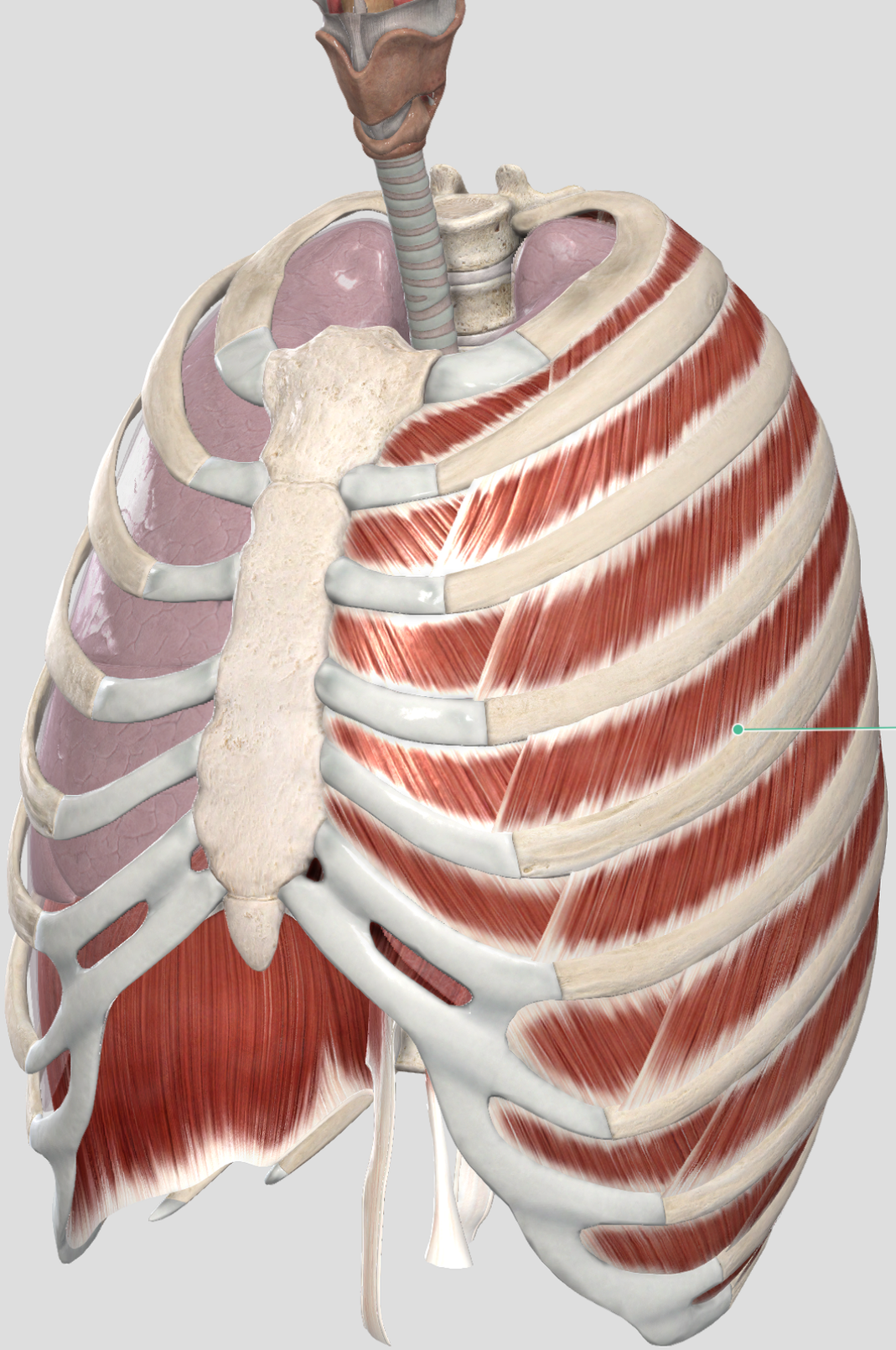
Let’s Look At The Chest Wall



Internal Intercostal Muscles

External Intercostal Muscles

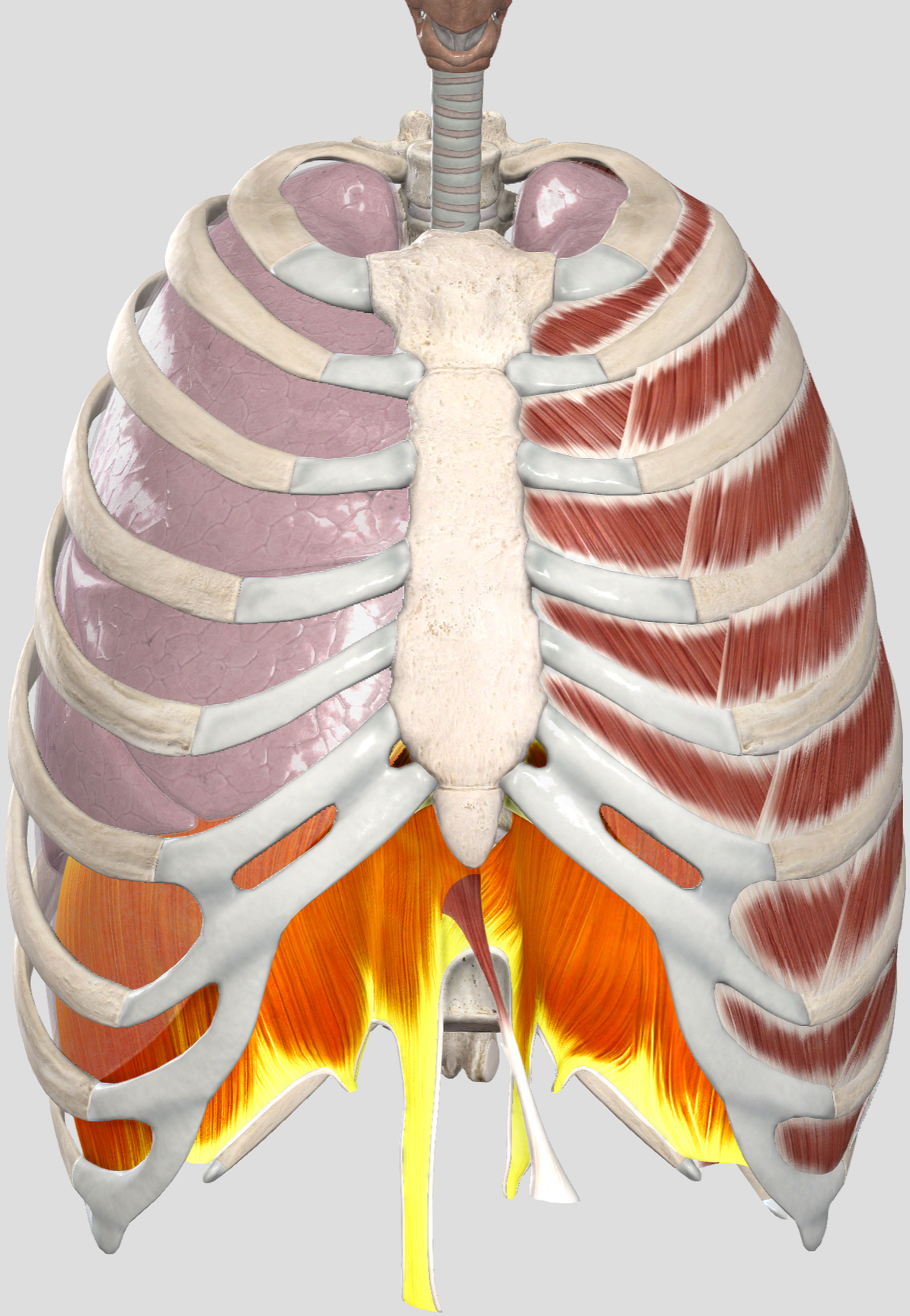
Diaphragm



Internal Intercostal Muscles

External Intercostal Muscles

Diaphragm

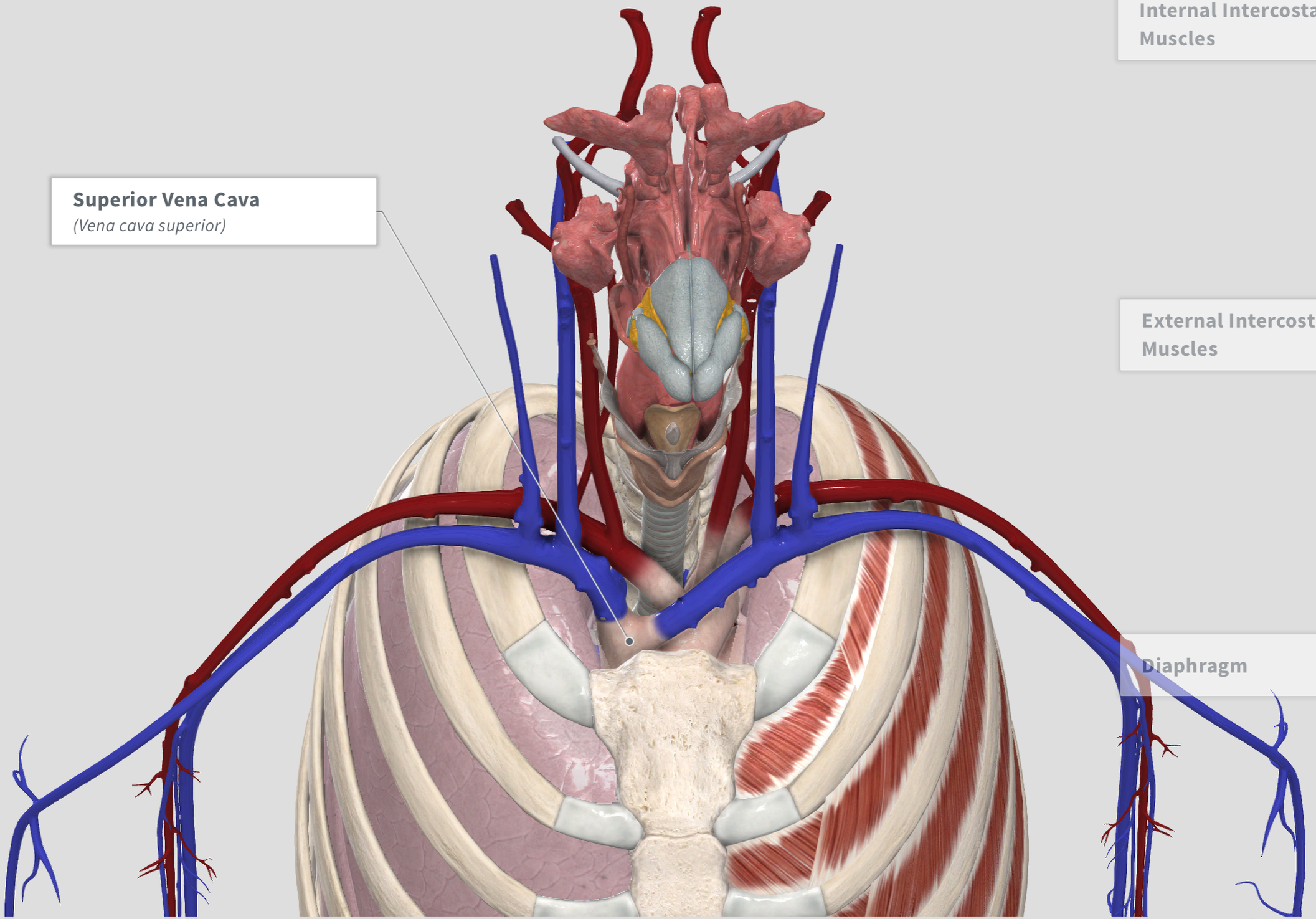


Internal Intercostal Muscles

External Intercostal Muscles

Diaphragm

Superior Vena Cava
(Vena cava superior)

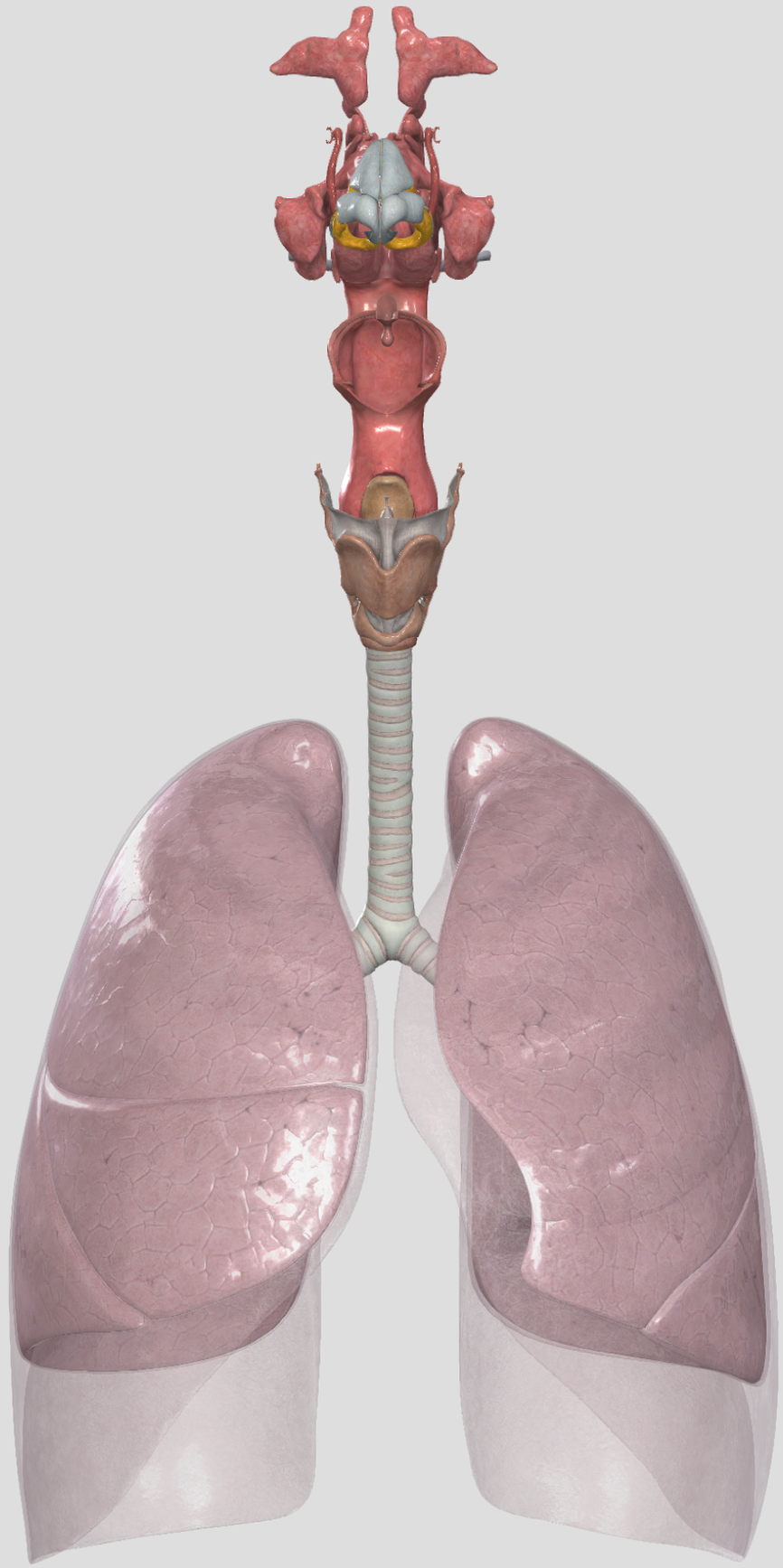


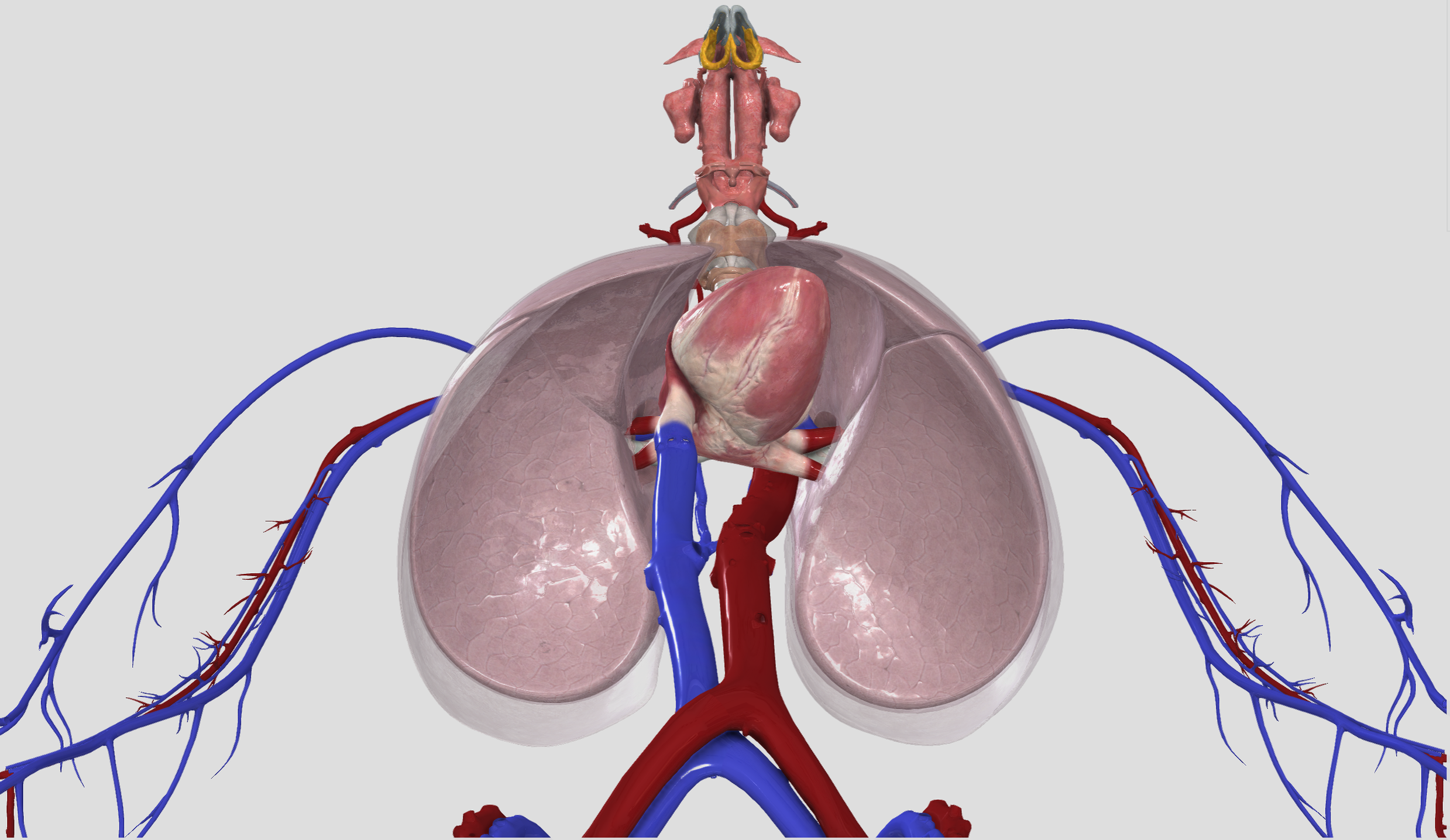
Internal Intercostal Muscles

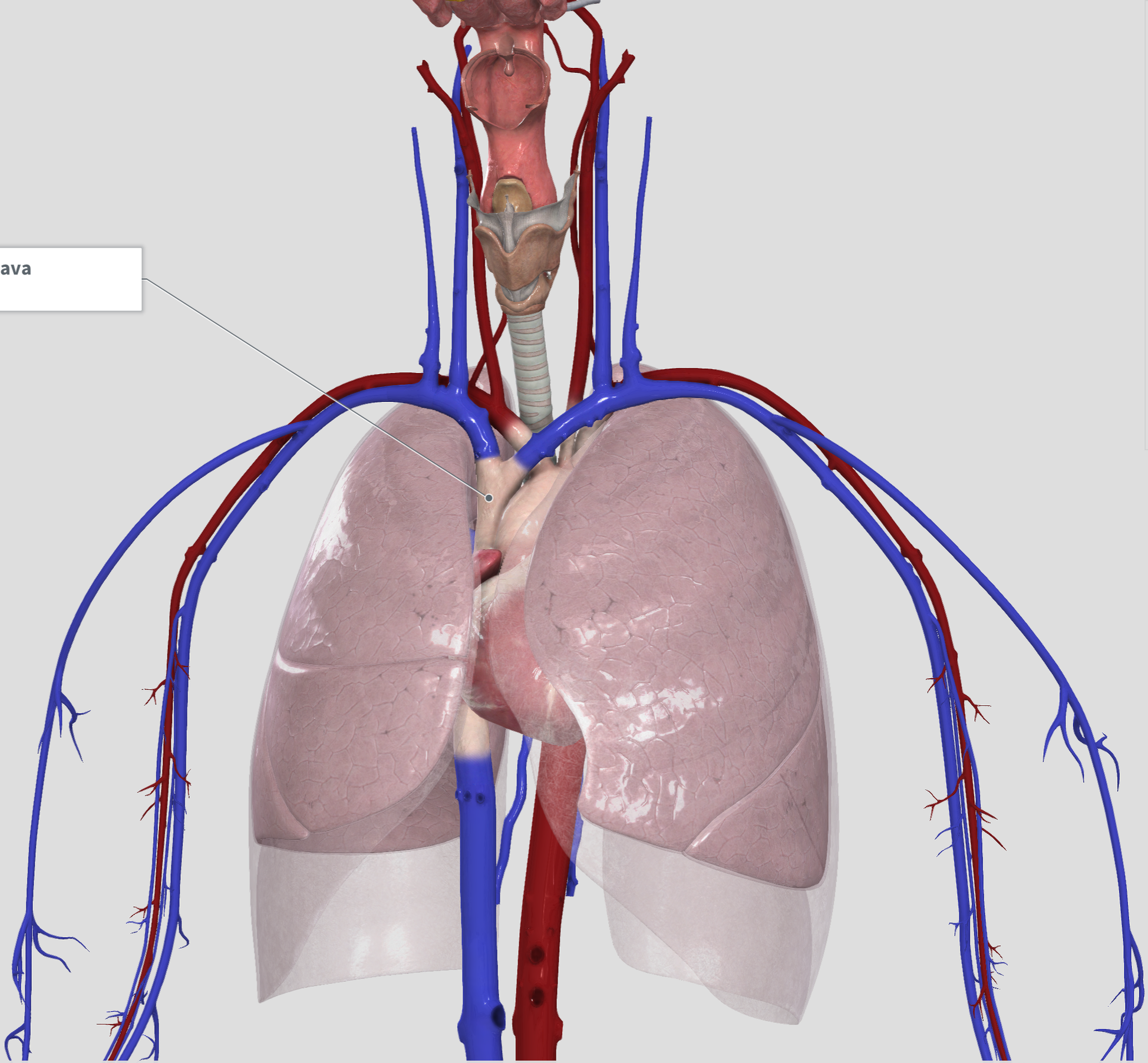
External Intercostal Muscles

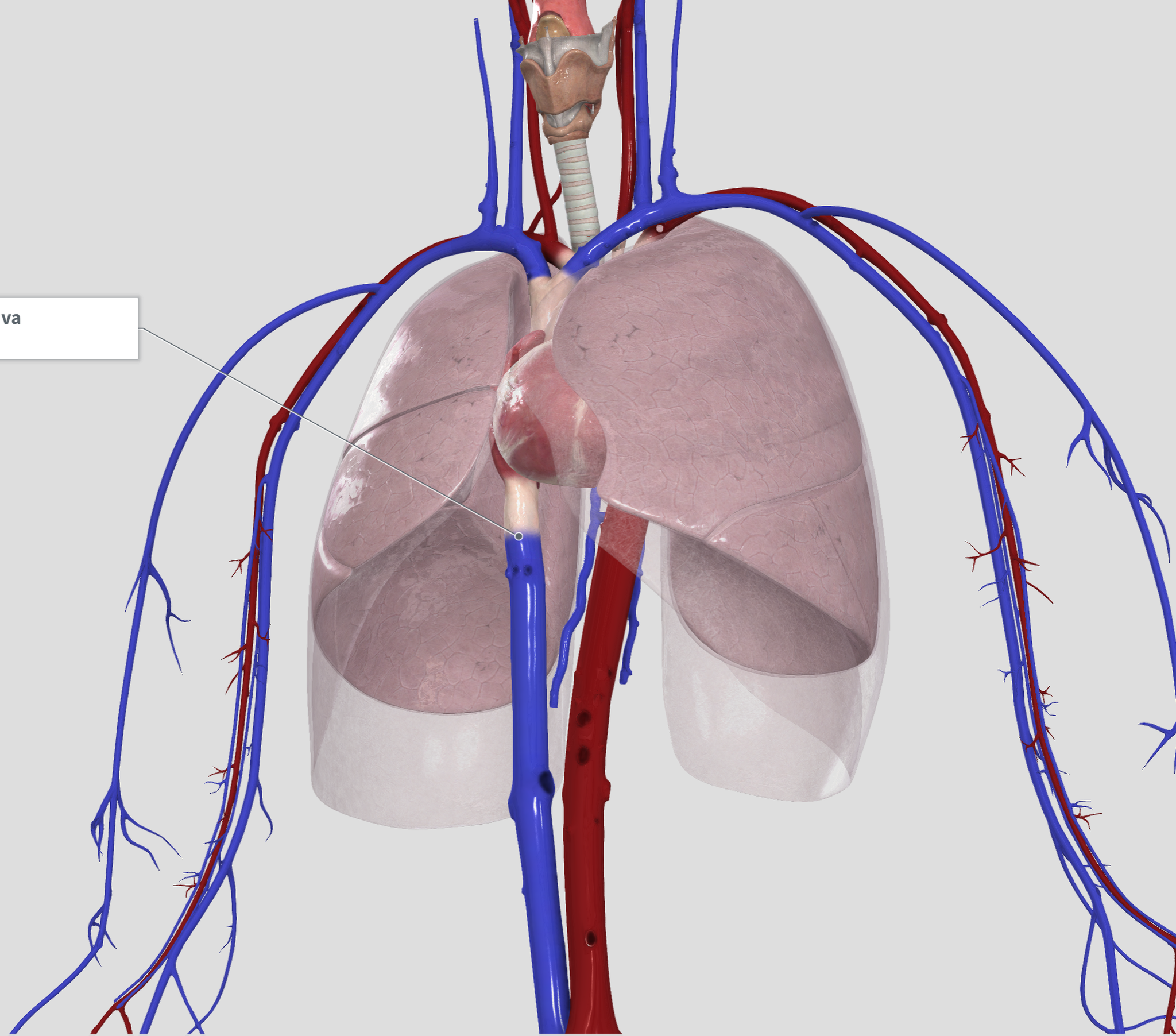
Diaphragm

Let’s Look In The Chest Cavity

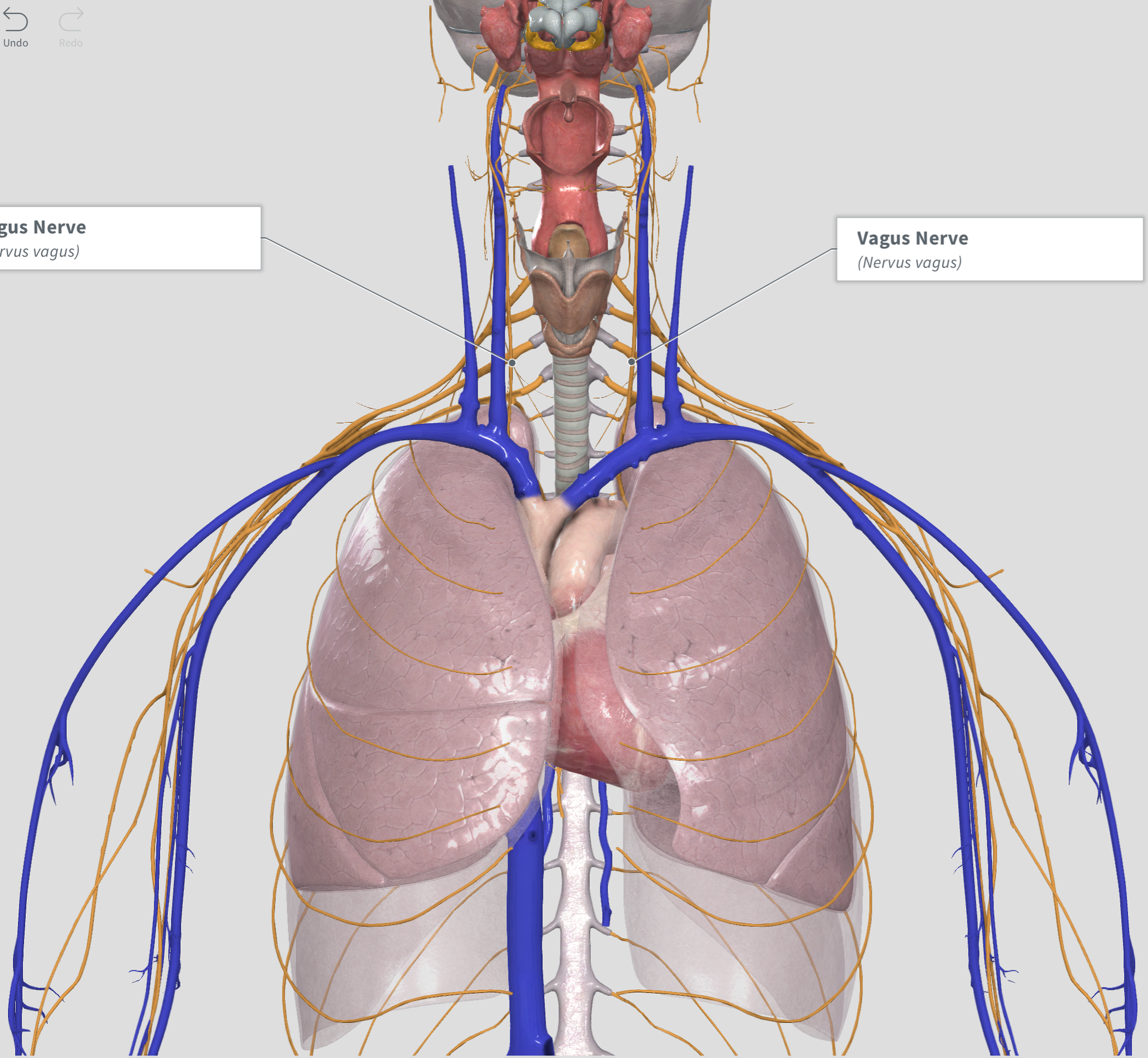





Superior Vena Cava
(Vena cava superior)


Inferior Vena Cava
(Vena cava inferior)

Let’s look At The Nerves


Vagus Nerve
(Nervus vagus)
Vagus Nerve
(Nervus vagus)

Back
Origin Mode

TAB
+

Vagus Nerve (Right)

(Nervus vagus)

...

Info

Origin Path

Isolate Origin Path

Highlight Origin Path

Back
Origin Mode

TAB
+

Vagus Nerve (Left)

(Nervus vagus)

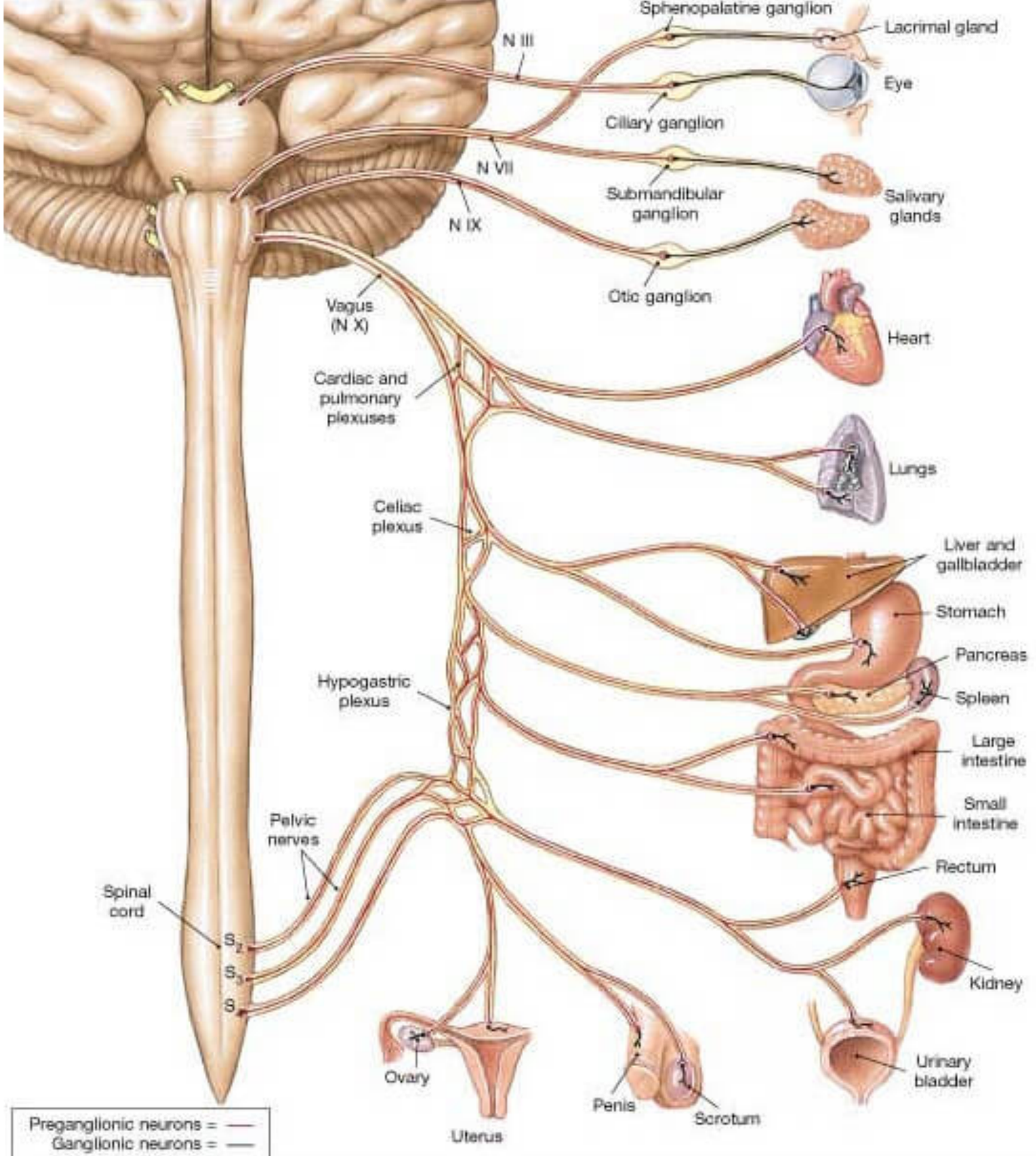
...

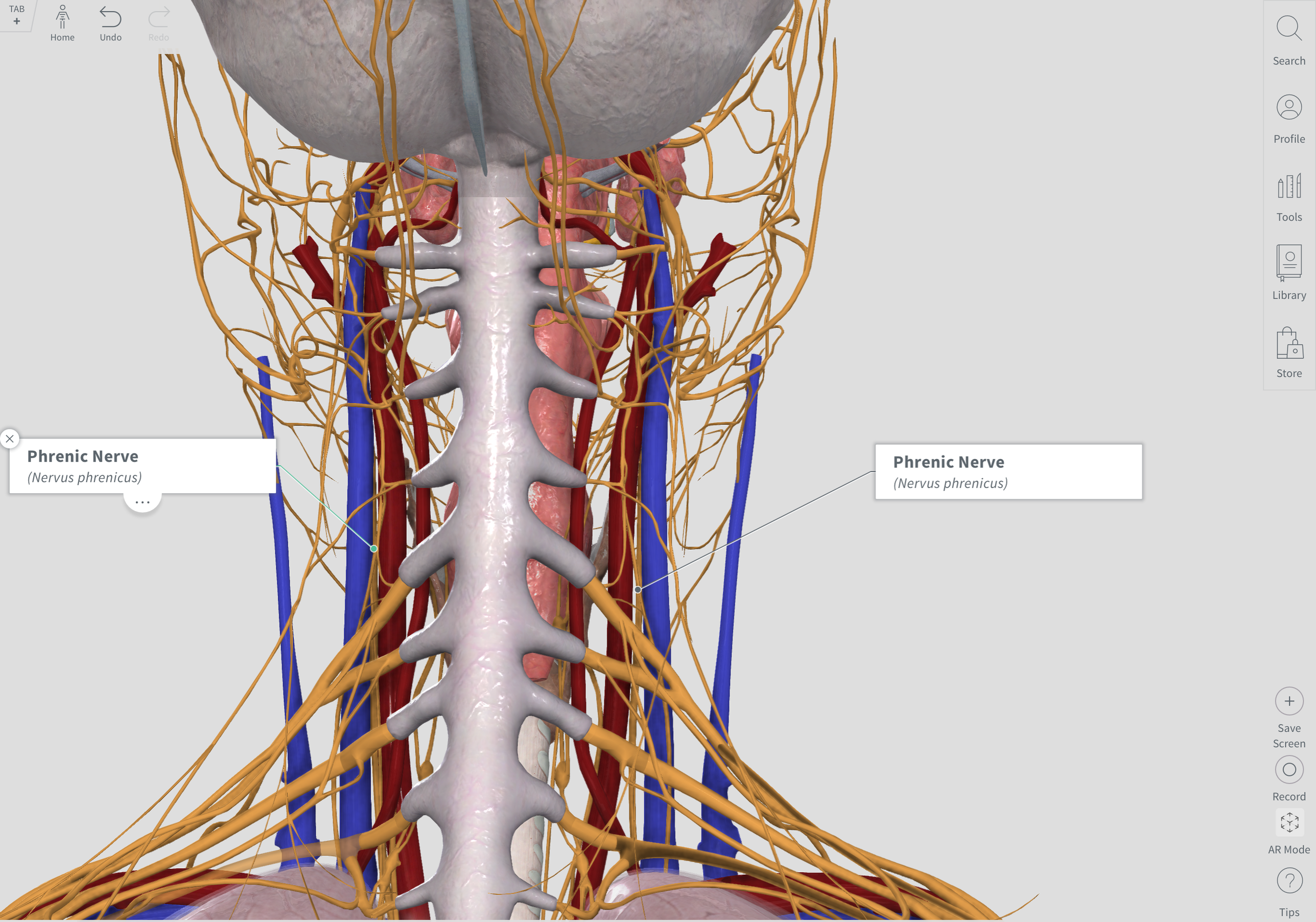
Info

Origin Path

Isolate Origin Path

Highlight Origin Path


Sphenopalatine ganglion
Lacrimal gland
N III
Eye
Ciliary ganglion
N VII
Submandibular ganglion
Salivary glands
N IX
Otic ganglion
Vagus (N X)
Heart
Cardiac and pulmonary plexuses
Lungs
Celiac plexus
Liver and gallbladder
Stomach
Pancreas
Spleen
Hypogastric plexus
Large intestine
Small intestine
Pelvic nerves
Rectum
Spinal cord
S2
S3
S4
Kidney
Urinary bladder
Ovary
Penis
Scrotum
Uterus
Preganglionic neurons =
Ganglionic neurons =


Phrenic Nerve
(Nervus phrenicus)
Phrenic Nerve
(Nervus phrenicus)

Phrenic Nerve (Right)

(Nervus phrenicus)

...

Info

Origin Path

Isolate Origin Path

Highlight Origin Path

Phrenic Nerve (Left)

(Nervus phrenicus)

...

Info | Origin Path

Isolate Origin Path

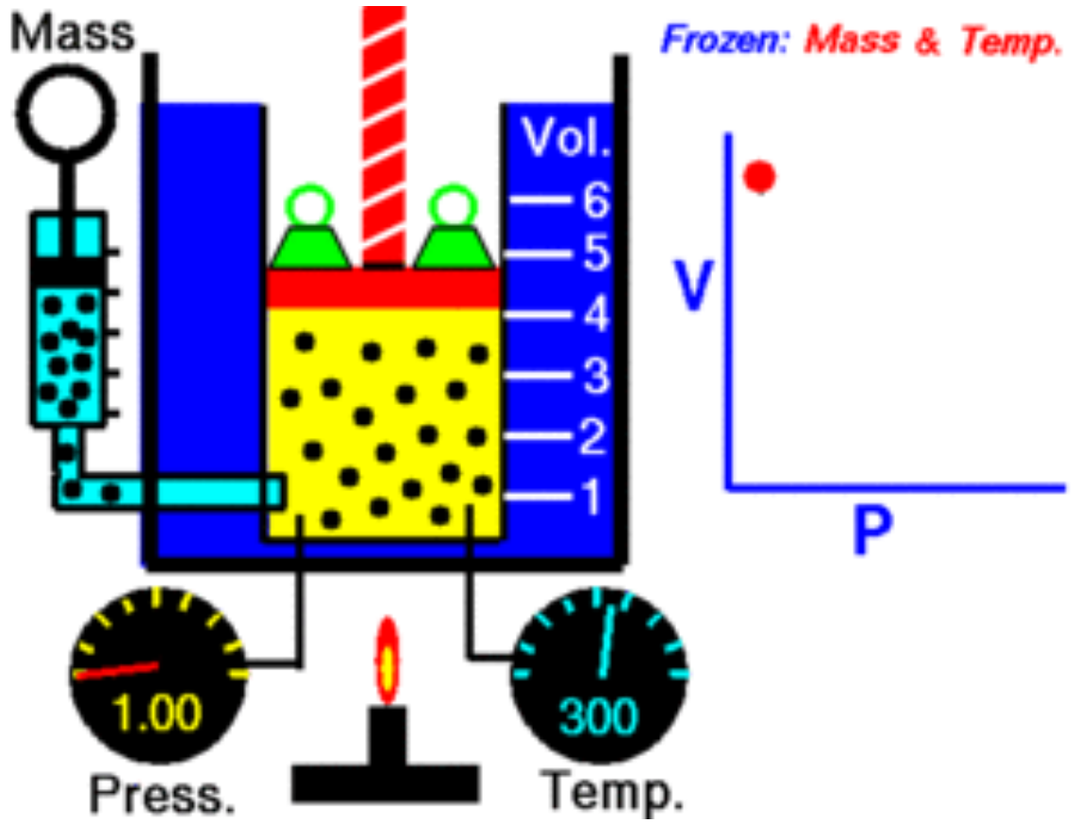
Highlight Origin Path

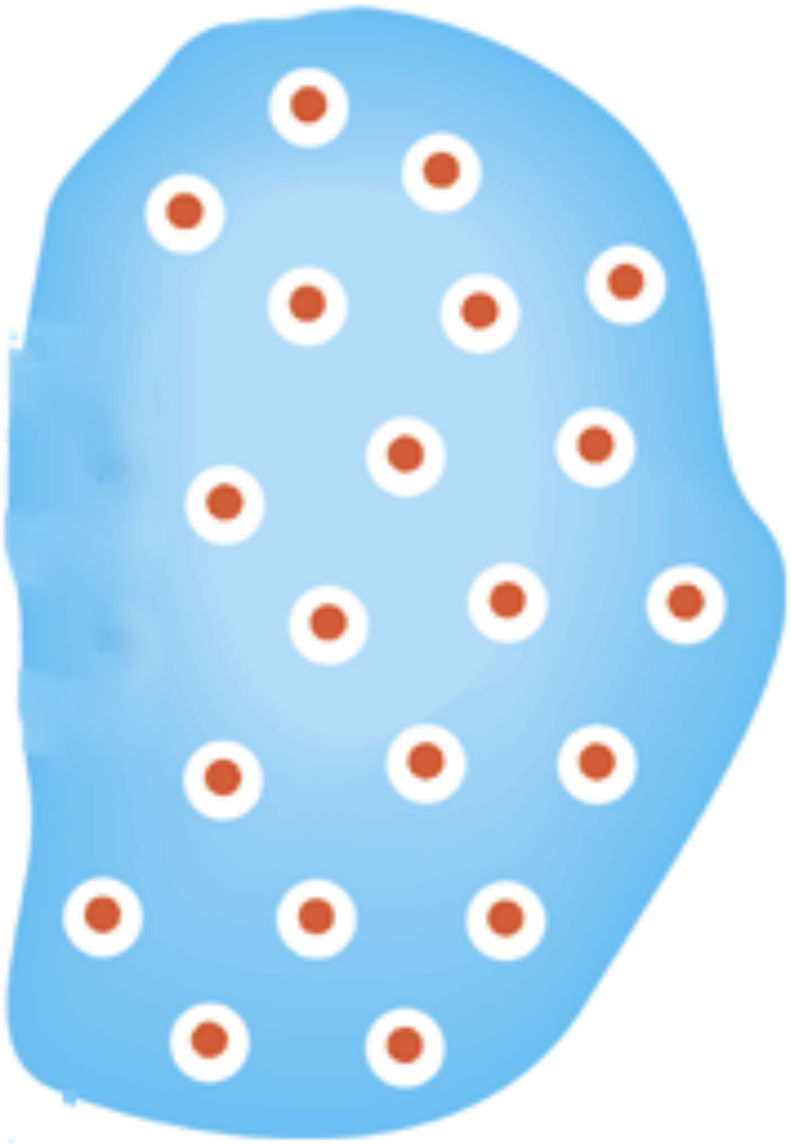
The Laws of Gases

Boyle’s-Henry’s-Charles’s

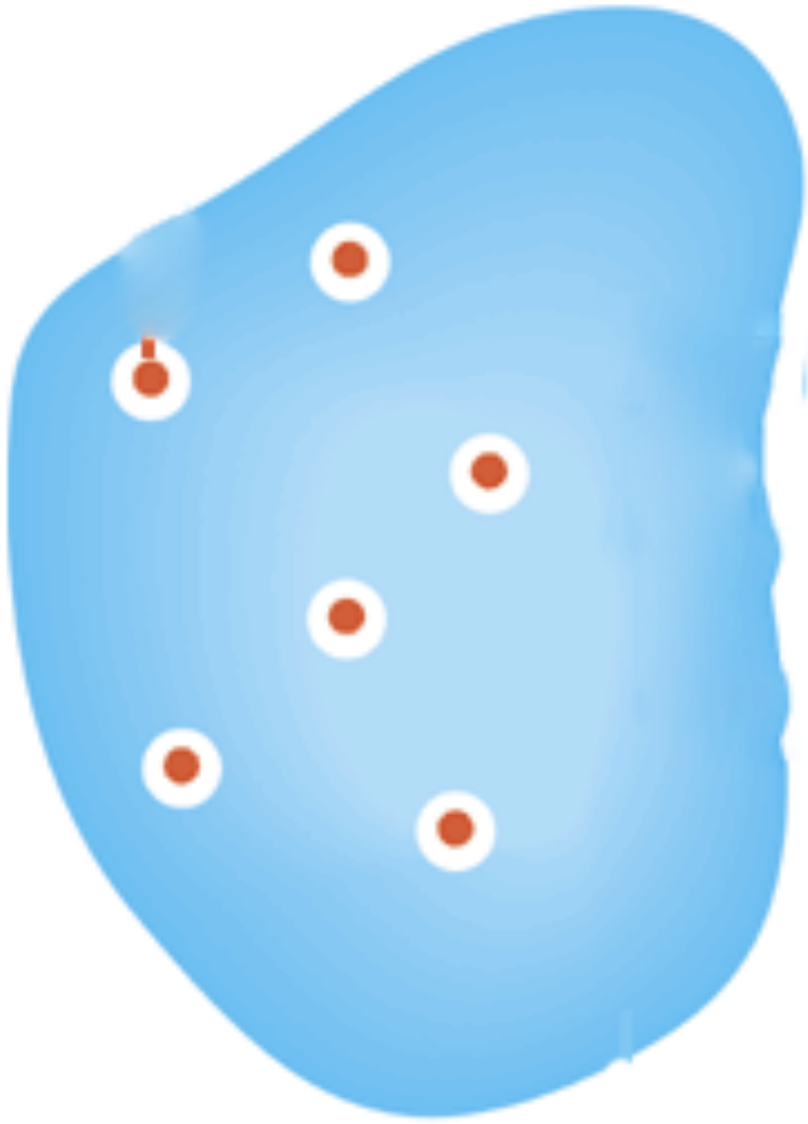
Robert Boyle's Law

- At a constant temperature
- Volume is inversely proportionate to pressure
- As pressure increases, volume decreases
- As pressure decreases, volume increases

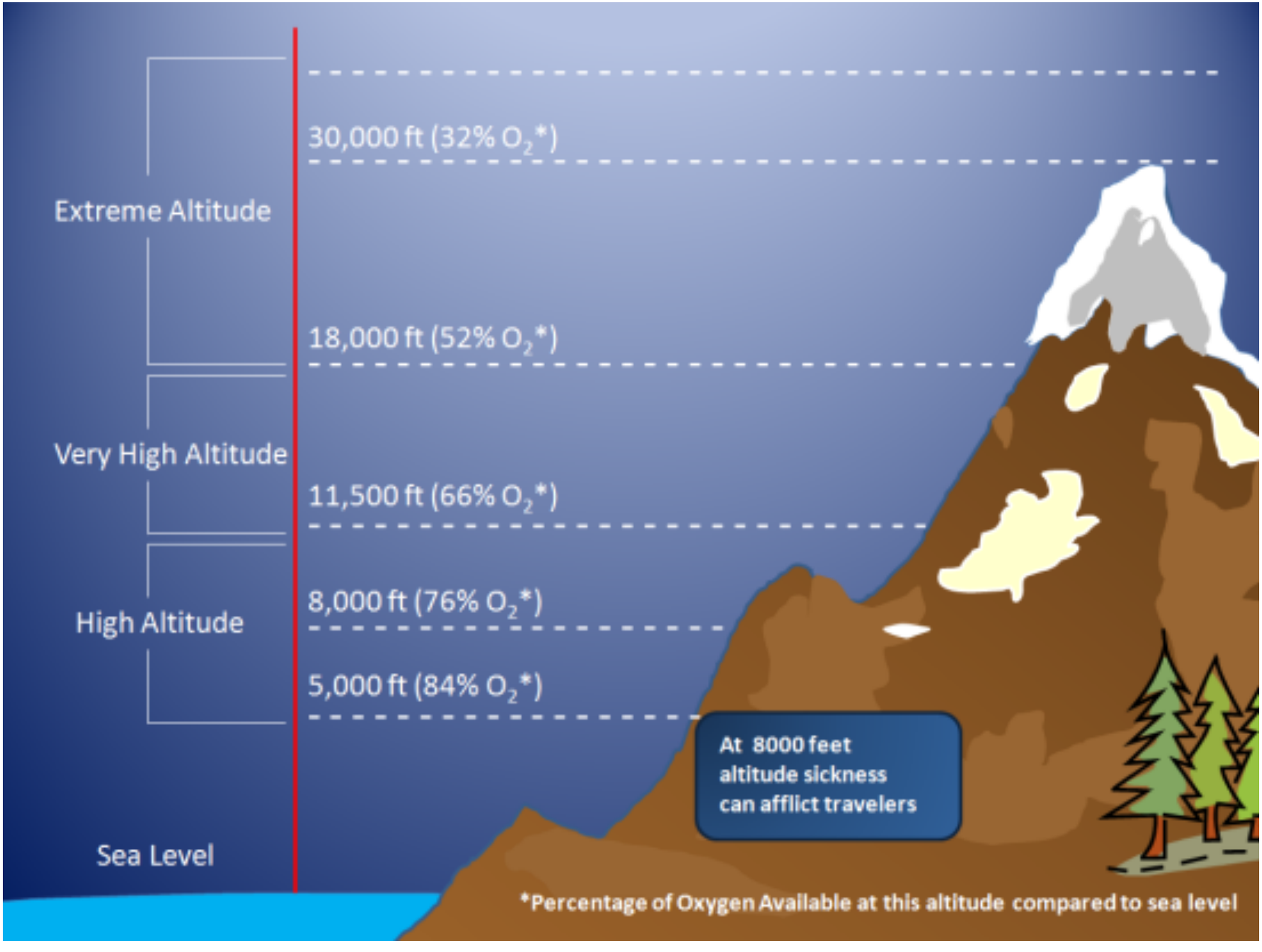




# of Oxygen in air at sea level



# of Oxygen in air at altitude


30,000 ft (32% O_2*)
Extreme Altitude
18,000 ft (52% O_2*)
Very High Altitude
11,500 ft (66% O_2*)
8,000 ft (76% O_2*)
High Altitude
5,000 ft (84% O_2*)
At 8000 feet altitude sickness can afflict travelers
Sea Level
*Percentage of Oxygen Available at this altitude compared to sea level

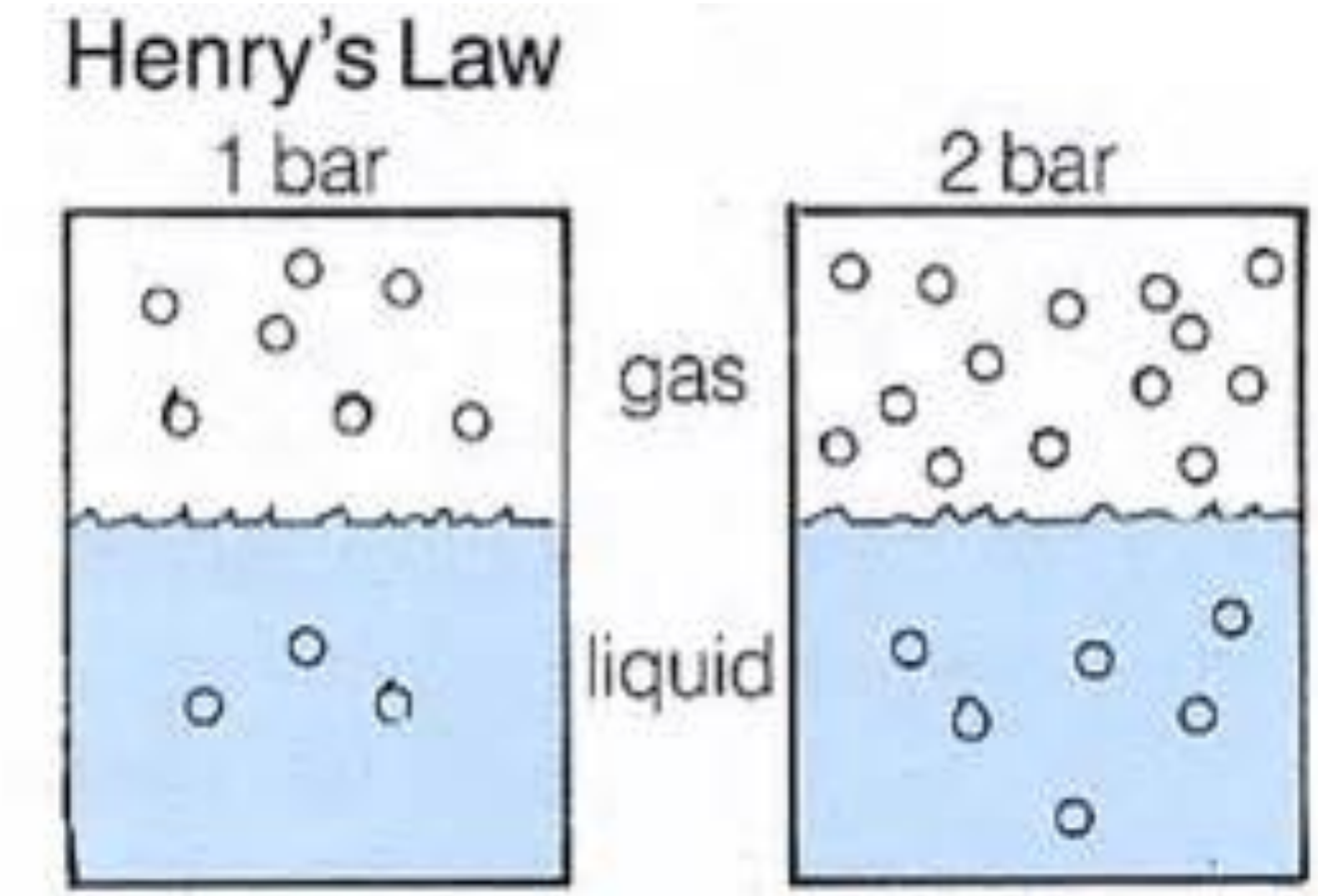
William Henry's Law

- The pressure of a gas above a liquid is proportional to the pressure dissolved in liquid at a constant temperature

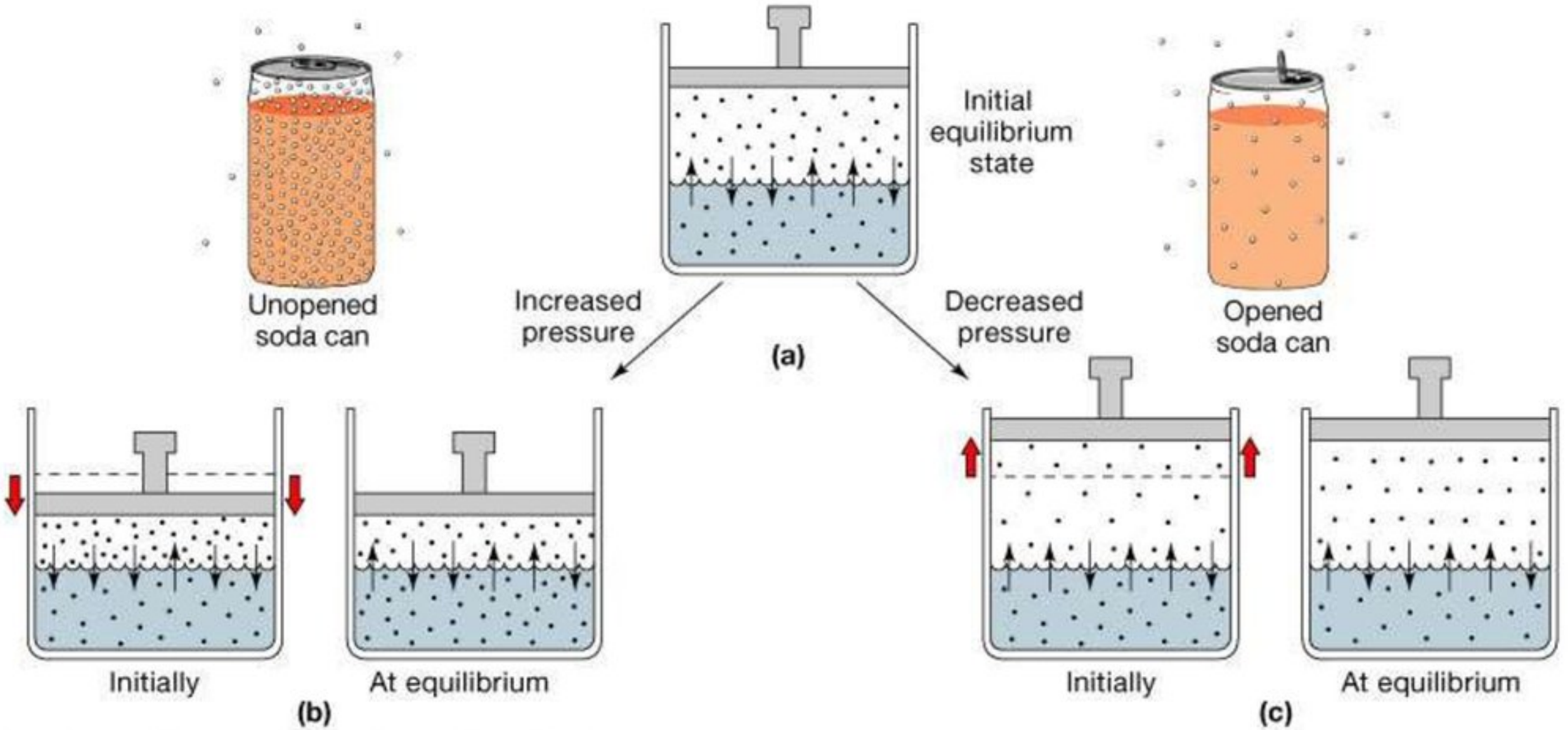
- Huh? The more pressure applied. The more gas dissolves in liquid

- Think of a can of soda

- Before the can is open the air above the soda is almost pure CO_2 until the can is opened



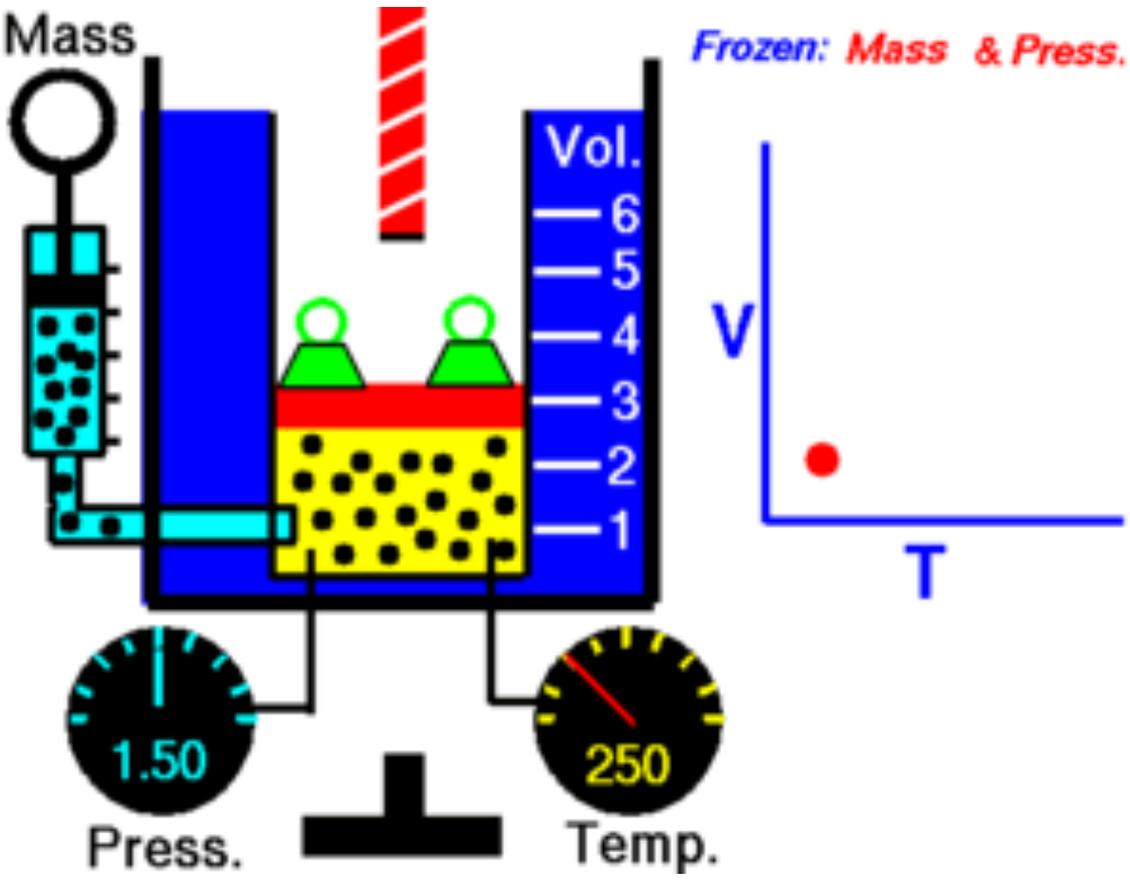
Henry's Law and the Relationship between Solubility and Pressure

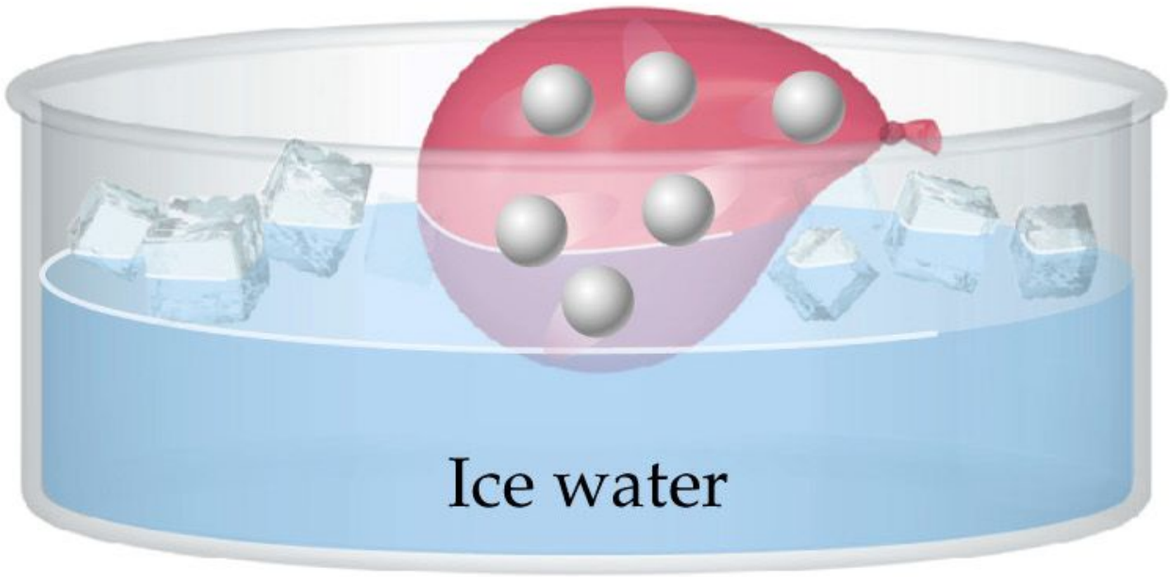


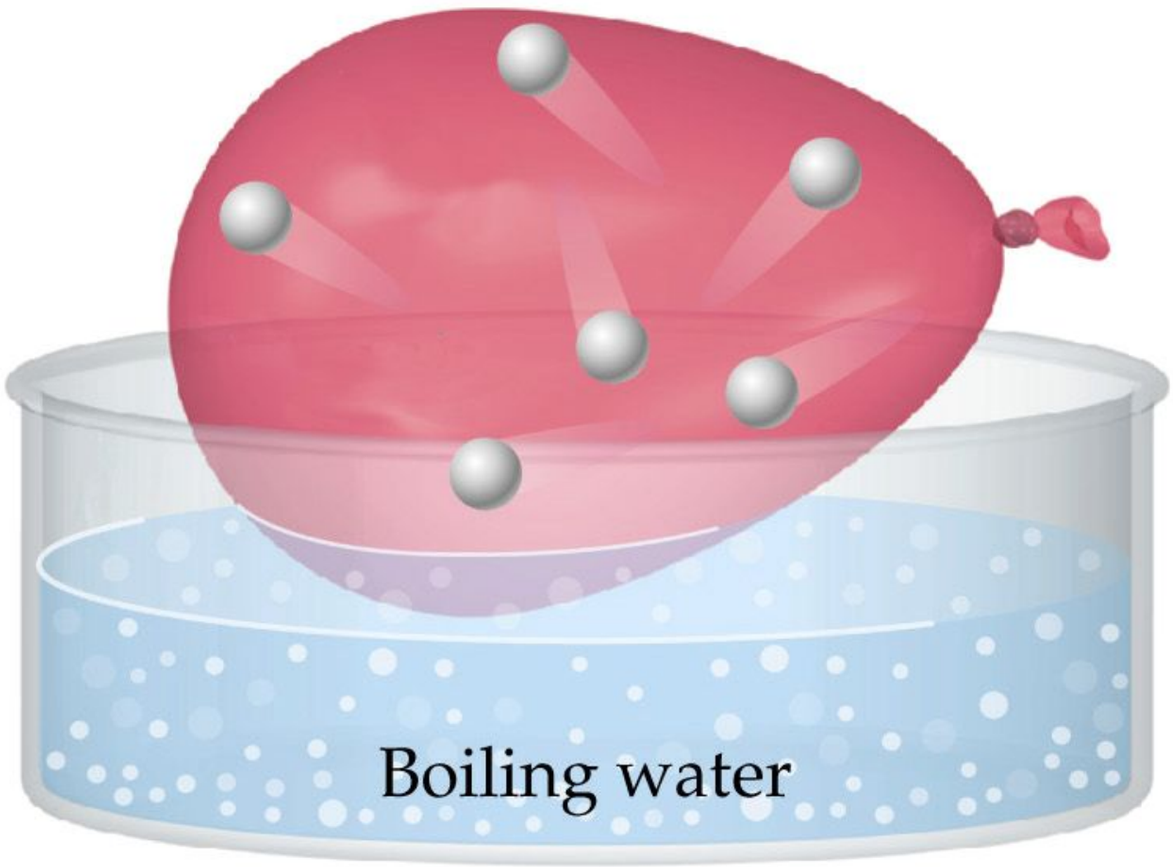
Jacques Charles's Law

- At a constant pressure, a gas volume increases as temperature increases

- Conversely, a gas volume decreases as temperature decreases



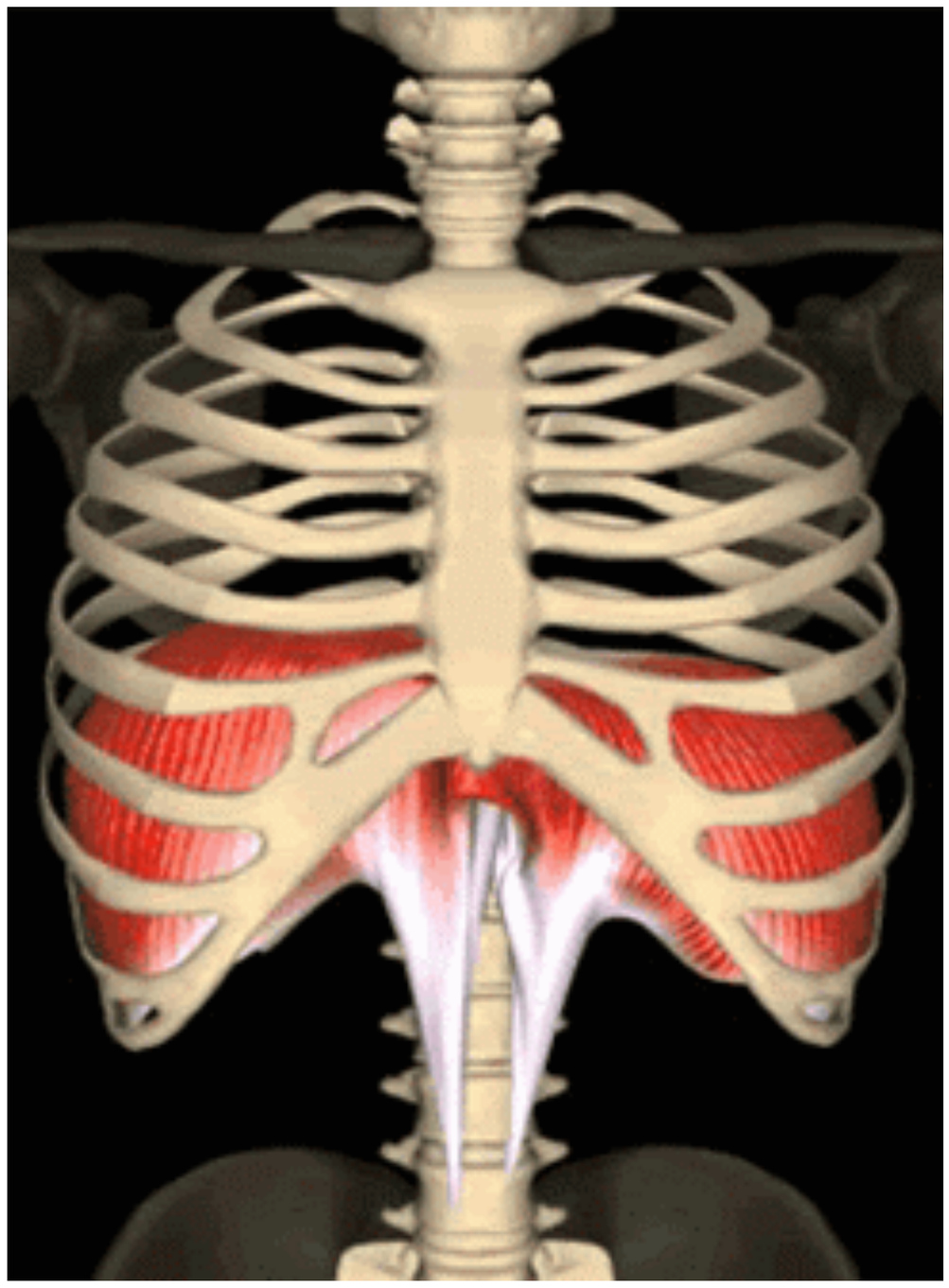

Ice water


Boiling water

BREATHE

How We Breathe

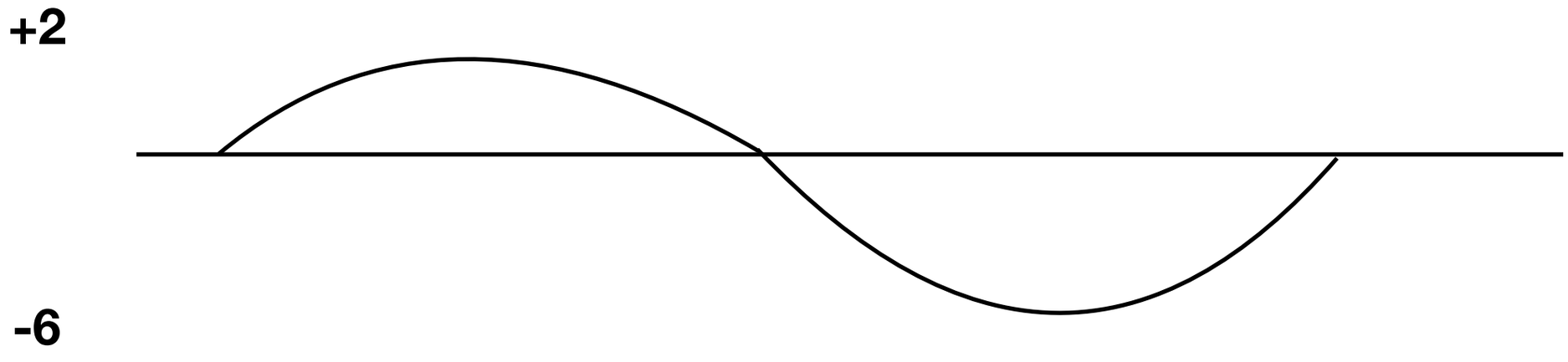
- Diaphragm contracts
- Negative pressure created
- Normal breathing is 1-2 mmHg difference from thoracic to atmospheric pressure
- Creates normal sinus dysrhythmia



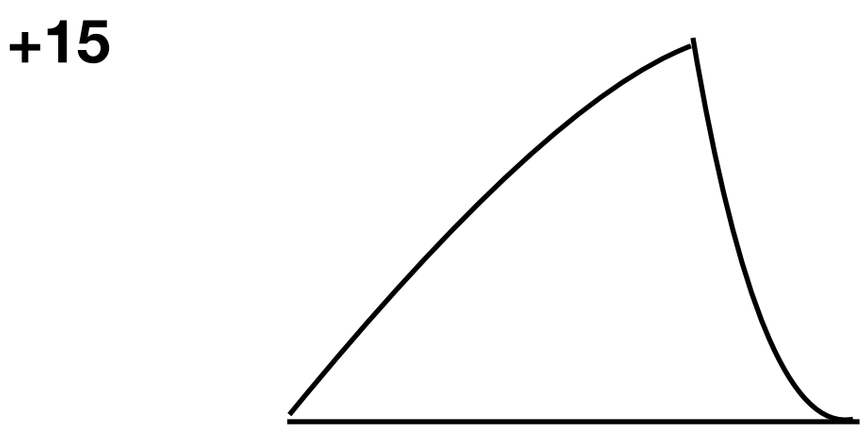
Positive Pressure

Ventilation

Normal Ventilation (mm Hg)



Positive Pressure Ventilation (mm Hg)



Compliance & Resistance

Compliance

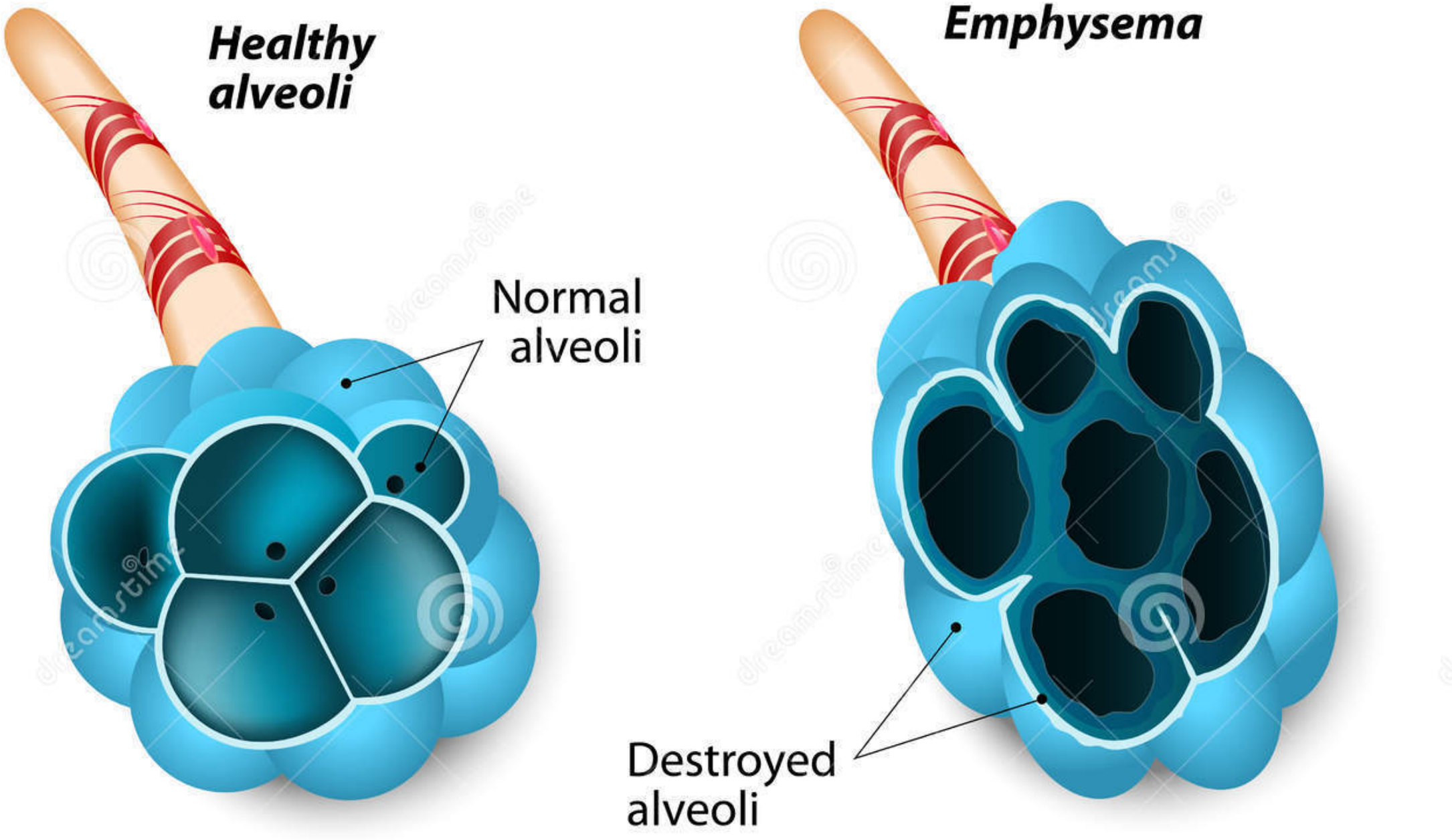
Problem with the alveoli

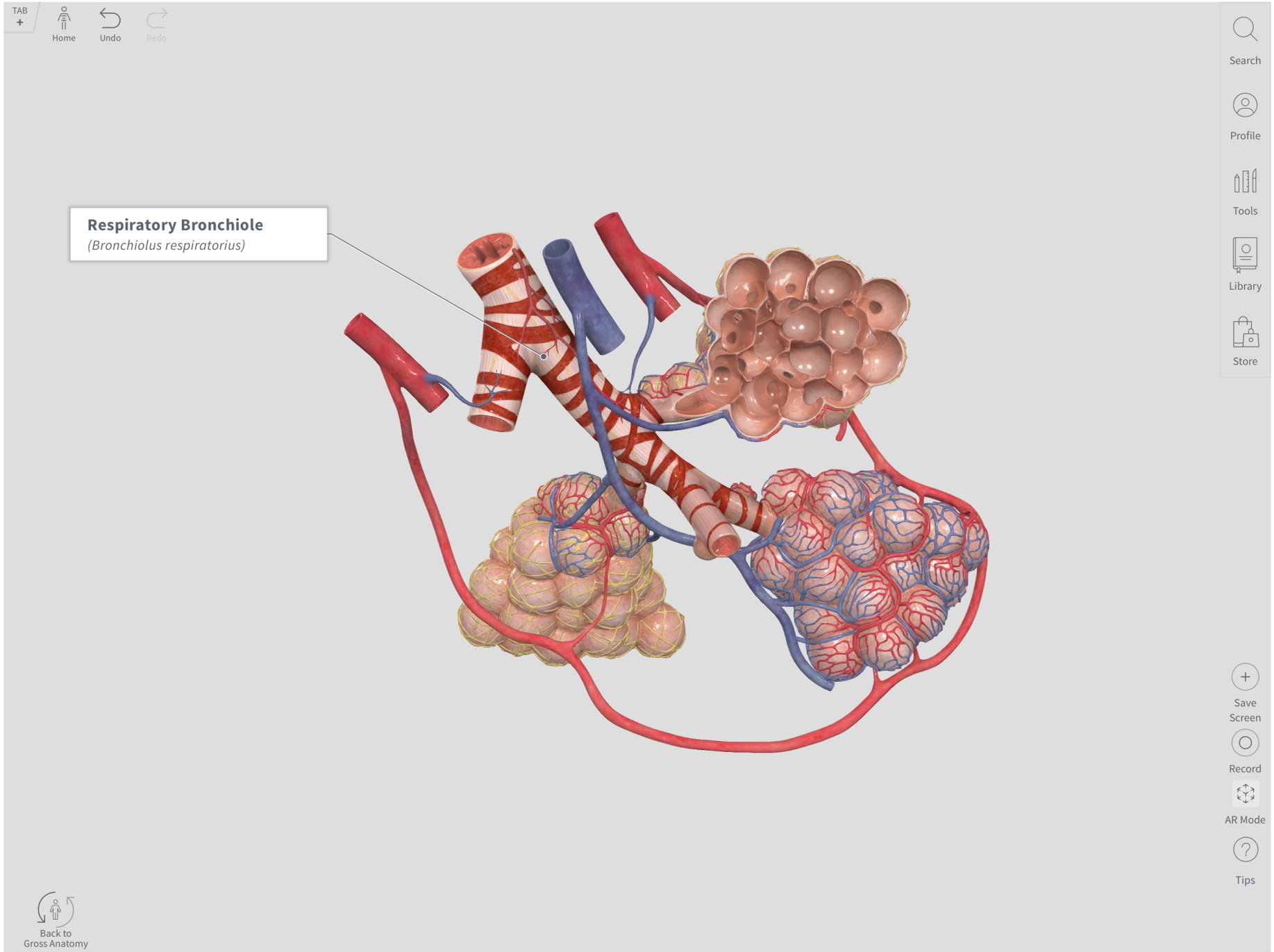
Causes of poor compliance

- Emphysema/COPD
- Pulmonary Edema
- Fibrosis
- Supine Position
- Any condition that looses elasticity

Compliance issues can get air out but have a hard time getting air in

EMPHYSEMA





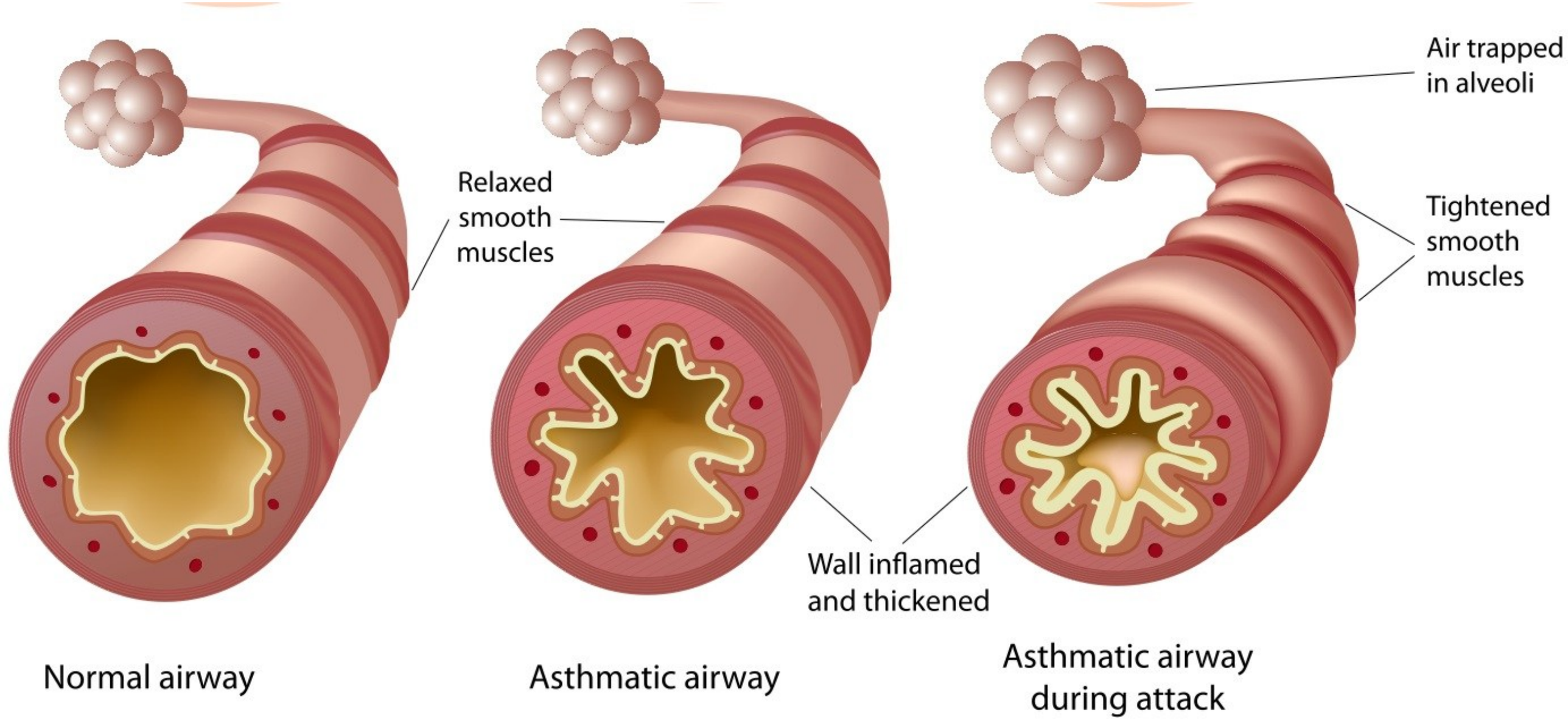
Resistance

Problem with the tract

Causes of restriction

- Bronchoconstriction
- Emphysema on expiration
- Tracheal stenosis
- Mucous buildup

Restrictive tracts can get air in but harder to get air out


Relaxed
smooth
muscles
Air trapped
in alveoli
Tightened
smooth
muscles
Wall inflamed
and thickened
Normal airway
Asthmatic airway
Asthmatic airway
during attack

Ventilation

“Ventilation is the profound secret of existence ”

–Peter Sloterdijk

Important Reminders

- Respiratory Rate (RR) & Tidal Volume (Tv)= Controls CO2
- I:E Ratios help control pressure with BVM
- Keep Peak Inspiratory Pressures Below 40 mm Hg
- Use Manometer or Pressure Relief Valve


SPHYGMOMANOMETER
120
140
160
180
200
100
220
80
240
60
260
40
280
20
300
mmHg

Ventilation for Poor Compliance

- Increase inspiratory times with shorter to normal expiratory times.
- Example: normal I:E 1:2, Compliance 1-4:1-2
- Poor Compliance will feel easy to bag at first then become increasingly harder and Peak Inspiratory Pressures (PIP) will tend to increase gradually.

Ventilation for Restriction of the Tract

- Inverse I:E ratios. Quick inspiratory long expiratory phase
- Example: normal I:E 1:2, Restrictive Tract 1 or less:2-5
- Restrictive Tract will feel difficult to ventilate from initial squeeze of the bag and have high initial Peak Inspiratory Pressures (PIP)

Questions?