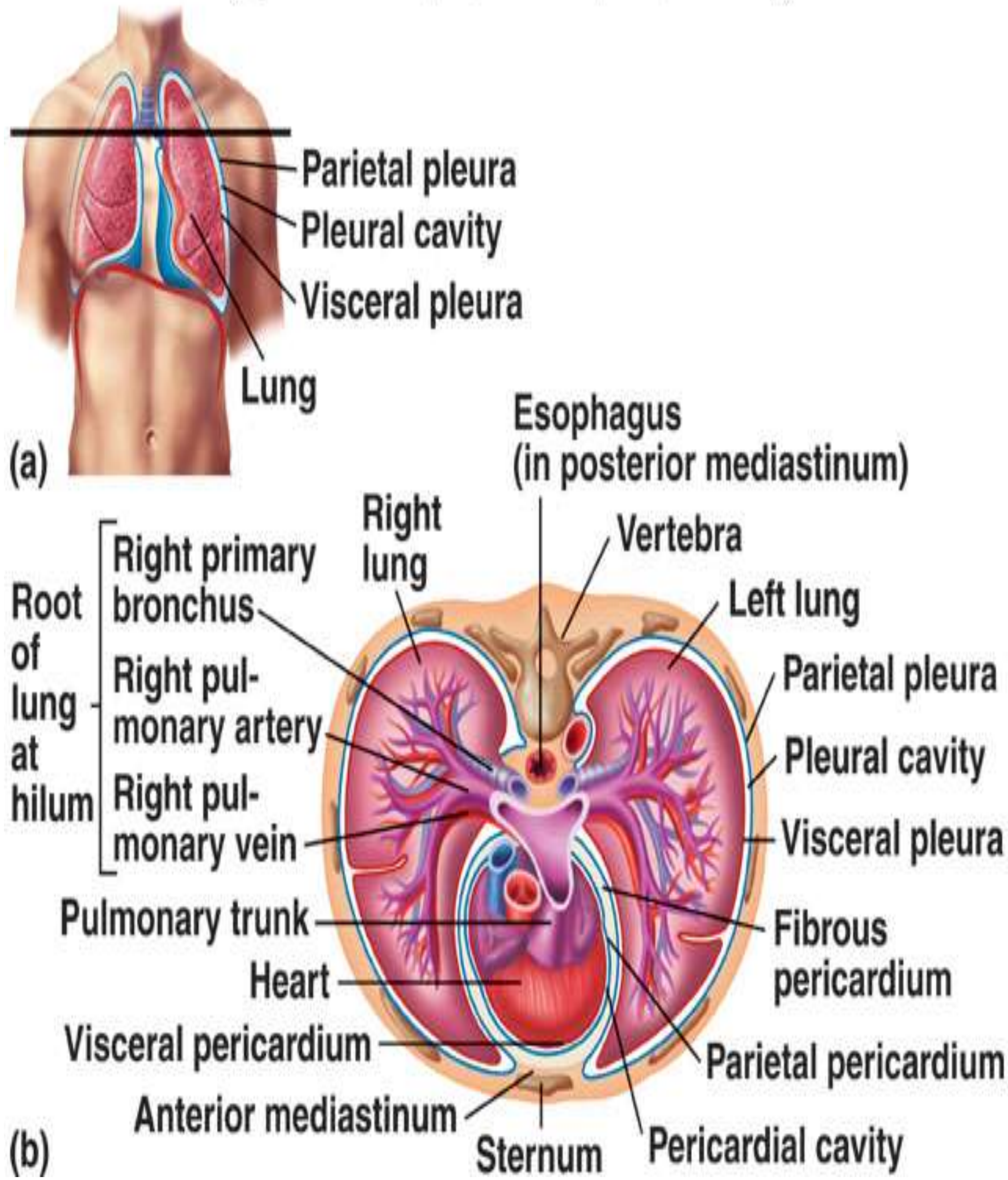
College of science , Biology Department .

Animal physiology, Respiratory Physiology.

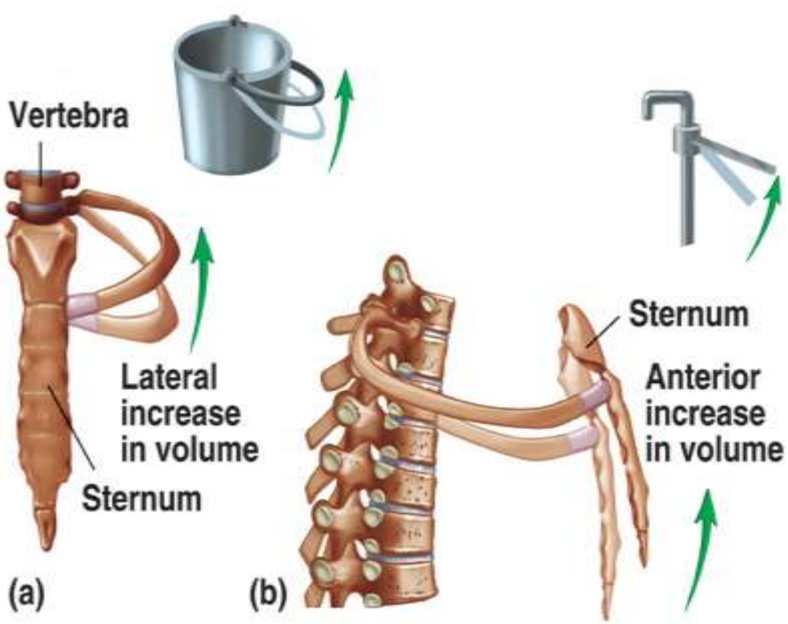
Dr. Sanaa Jameel Thamer

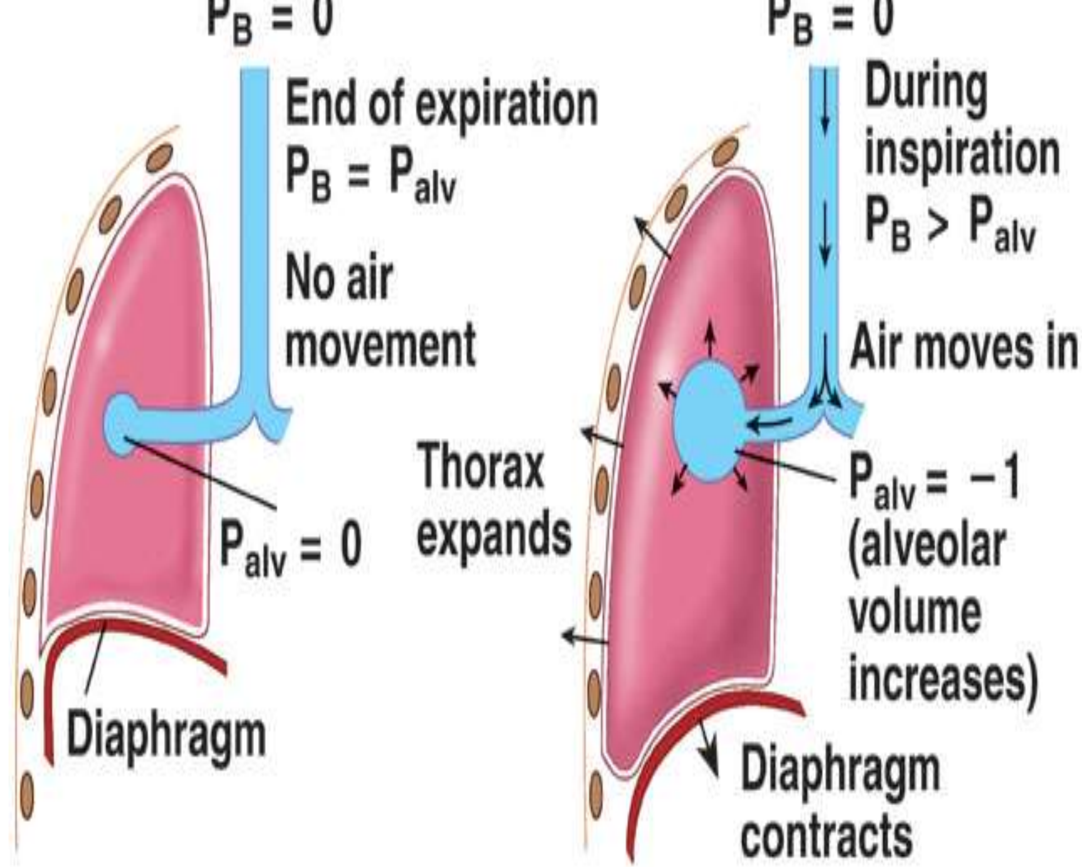
- Overall function
- Movement of gases
- Gas exchange
- Transport of gas (oxygen and carbon dioxide).
- PULMONARY VENTILATION:
- BOYLE'S LAW
- Gas pressure in closed container is inversely proportional to volume of container.
- Pressure differences and Air flow.
- Pressures
- Atmospheric pressure – 760 mm Hg, 630 mm Hg here
- Intrapleural pressure – 756 mm Hg – pressure between pleural layers
- Intrapulmonary pressure – varies, pressure inside lungs



Inspiration/Inhalation

- Diaphragm & Intercostal muscles
- Increases volume in thoracic cavity as muscles contract
- Volume of lungs increases
- Intrapulmonary pressure decreases (758 mm Hg)

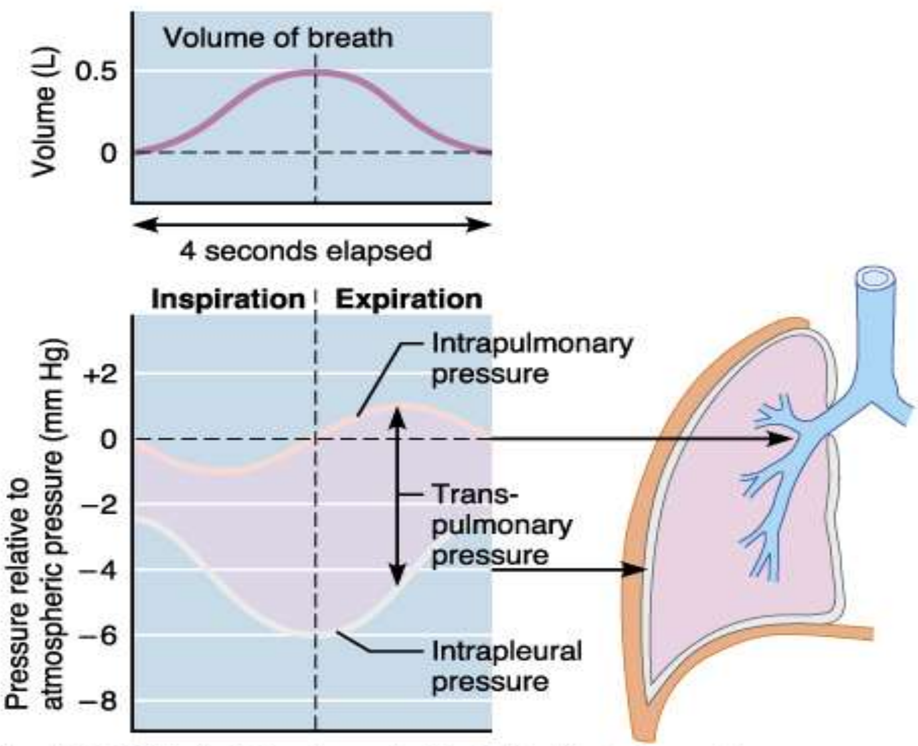


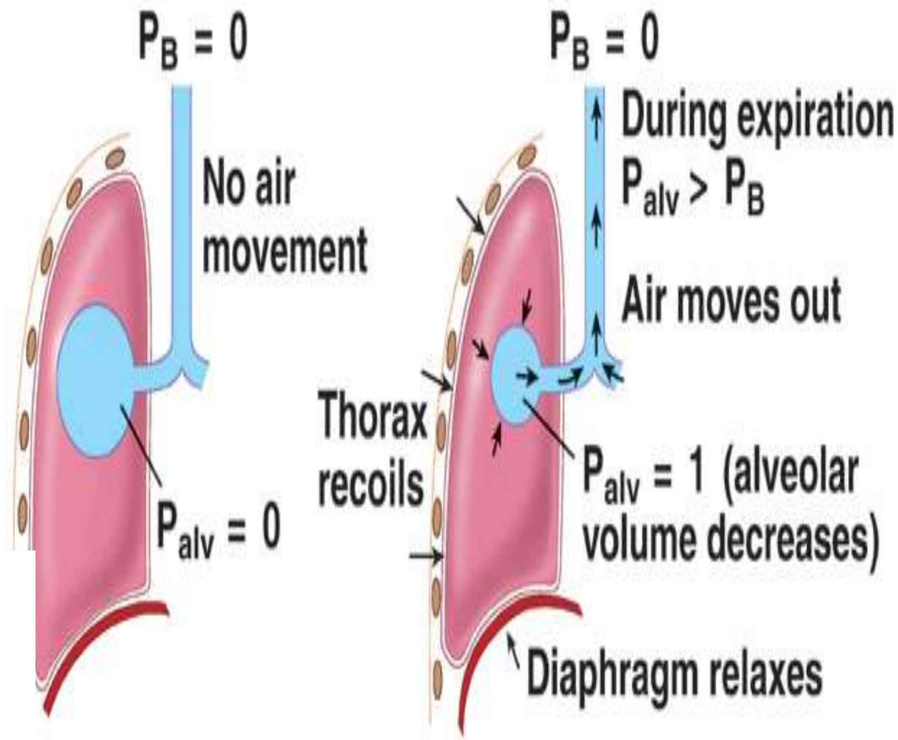


1. Barometric air pressure (P_B) is equal to alveolar pressure (P_{alv}) and there is no air movement.
2. Increased thoracic volume results in increased alveolar volume and decreased alveolar pressure. Barometric air pressure is greater than alveolar pressure, and air moves into the lungs.

Expiration/Exhalation

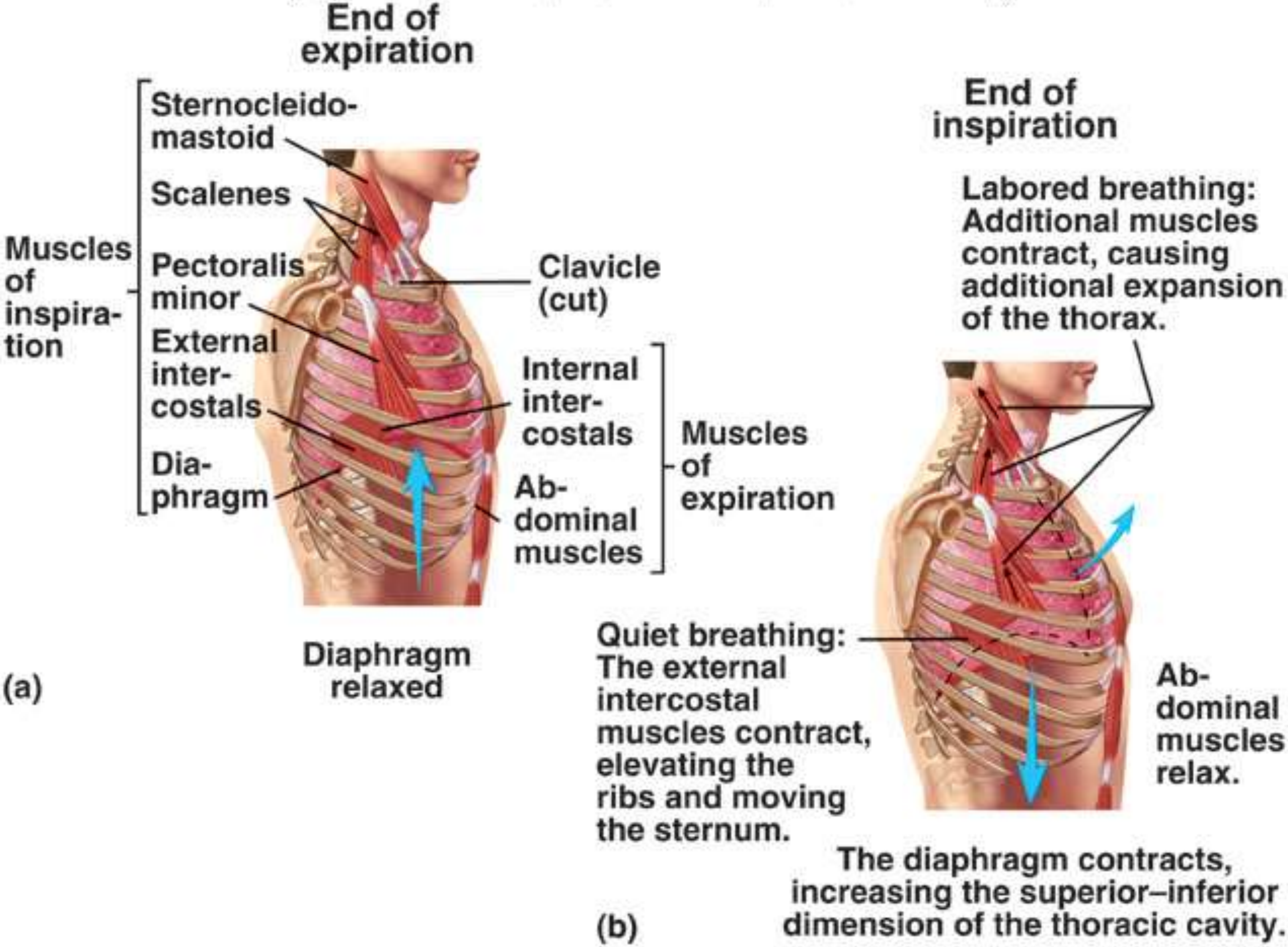
- Muscles relax
- Volume of thoracic cavity decreases
- Volume of lungs decreases
- Intrapulmonary pressure increases (763 mm Hg)
- Forced expiration is active



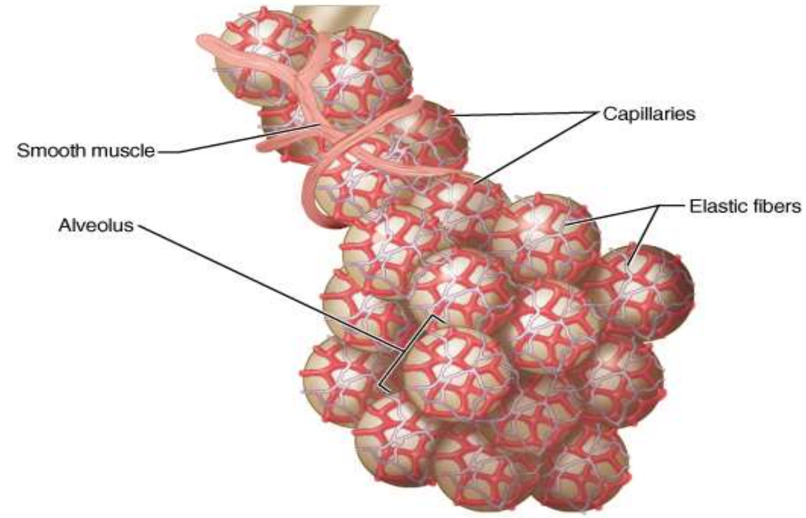


. End of inspiration.

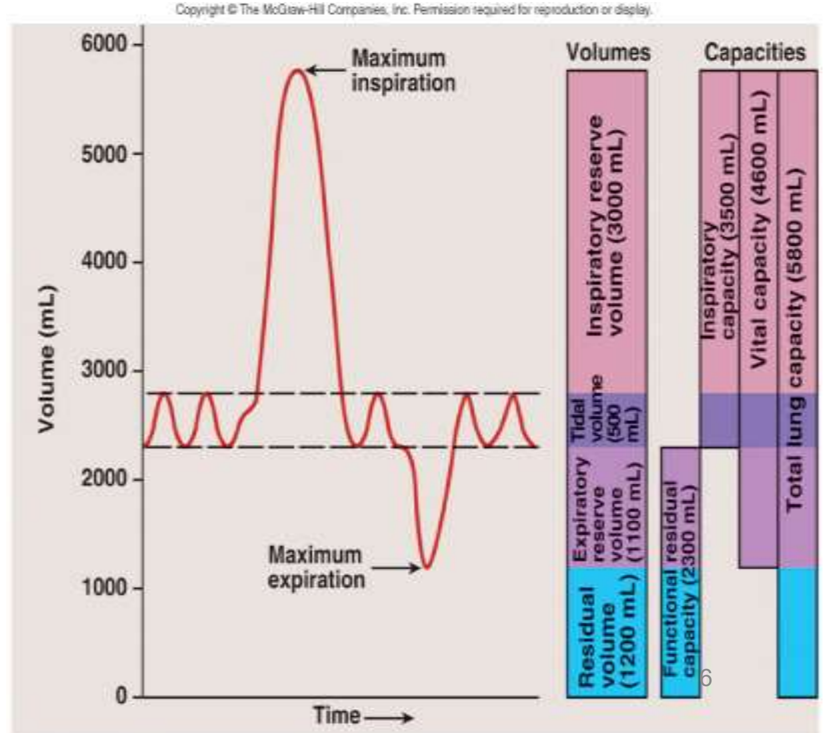
4. Decreased thoracic volume results in decreased alveolar volume and increased alveolar pressure. Alveolar pressure is greater than barometric air pressure, and air moves out of the lungs.


End of expiration
Muscles of inspiration
Sternocleido-mastoid
Scalenes
Pectoralis minor
External inter-costals
Dia-phragm
Clavicle (cut)
Internal inter-costals
Ab-dominal muscles
Muscles of expiration
Diaphragm relaxed
(a)
End of inspiration
Labored breathing: Additional muscles contract, causing additional expansion of the thorax.
Quiet breathing: The external intercostal muscles contract, elevating the ribs and moving the sternum.
Ab-dominal muscles relax.
(b)
The diaphragm contracts, increasing the superior–inferior dimension of the thoracic cavity.

- Factors that influence pulmonary air flow
- Diameter of airways, esp. bronchioles
- Sympathetic & Parasympathetic NS.
- Lung collapse.
- Surface Tension:
- Surface tension tends to oppose alveoli expansion
- Pulmonary surfactant reduces surface tension.
- Lung Volumes & Capacities
- Tidal Volume (500 mls)
- Respiratory Rate (12 breaths/minute)
- Minute Respiratory Volume (6000 mls/min).
- Inspiratory Reserve Volume (3000, 2100 mls)
- Inspiratory Capacity (TV + IRV).
- Expiratory Reserve Volume (1200, 800 mls)
- Residual Volume (1200 mls)
- Air left in lungs after exhaling the tidal volume quietly

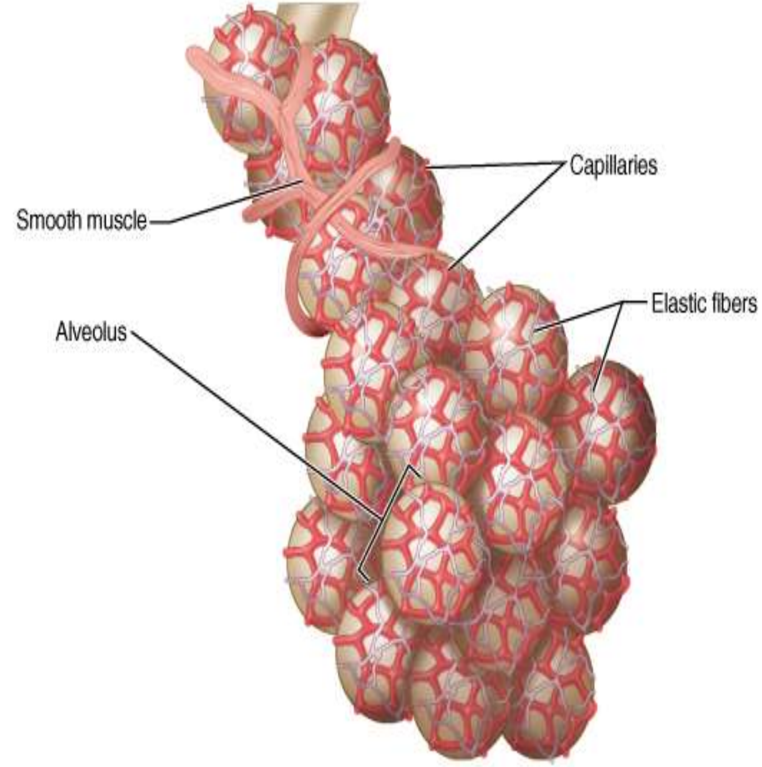


(b)



Alveolar Ventilation Efficiency

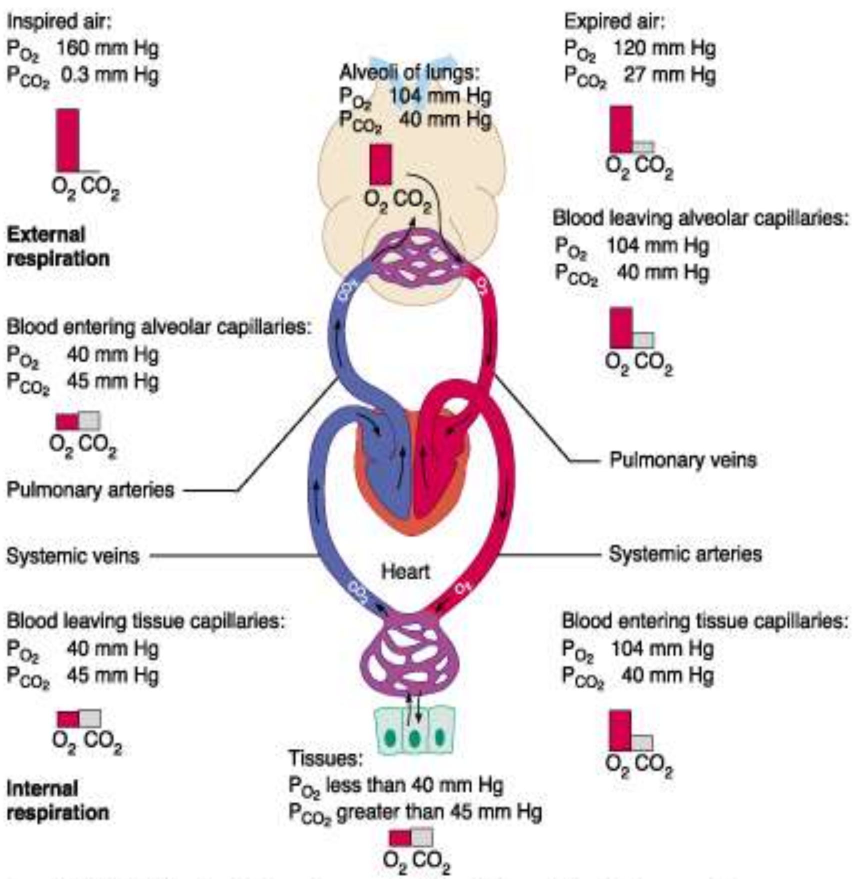
- Matching Alveolar air flow with blood flow
- Pulmonary vessels
- Vessels can constrict in areas where oxygen flow is low
- Respiratory passageways
- Airways can dilate where carbon dioxide levels are high.
- Gas Exchange.
- Partial Pressure
- Each gas in atmosphere contributes to the entire atmospheric pressure, denoted as P
- Gases in liquid
- Gas enters liquid and dissolves in proportion to its partial pressure
- O2 and CO2 Exchange by DIFFUSION
- PO2 is 105 mmHg in alveoli and 40 in alveolar capillaries
- PCO2 is 45 in alveolar capillaries and 40 in alveoli

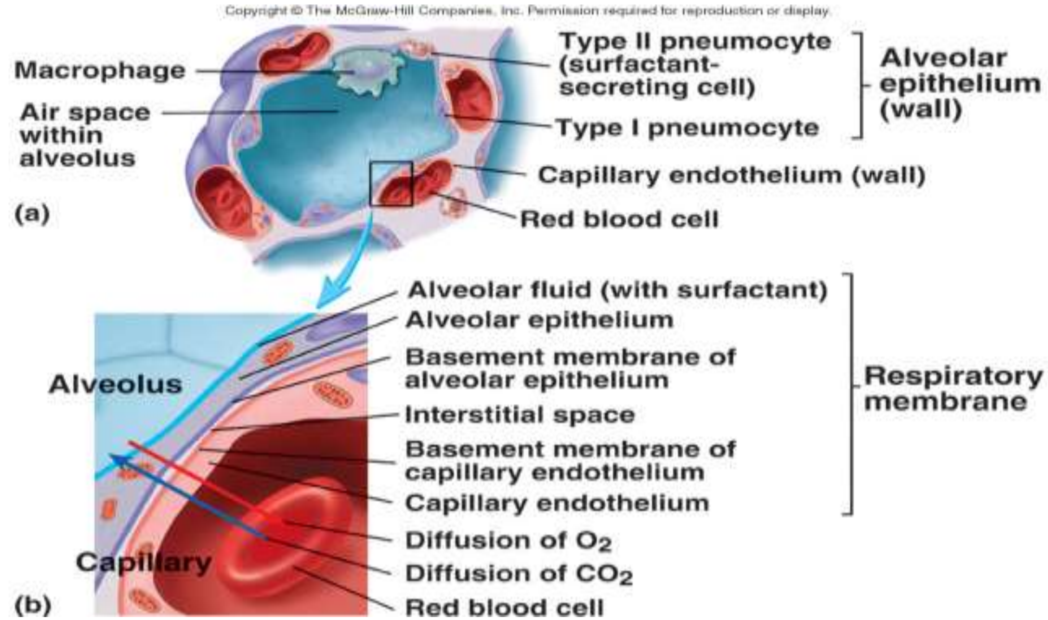


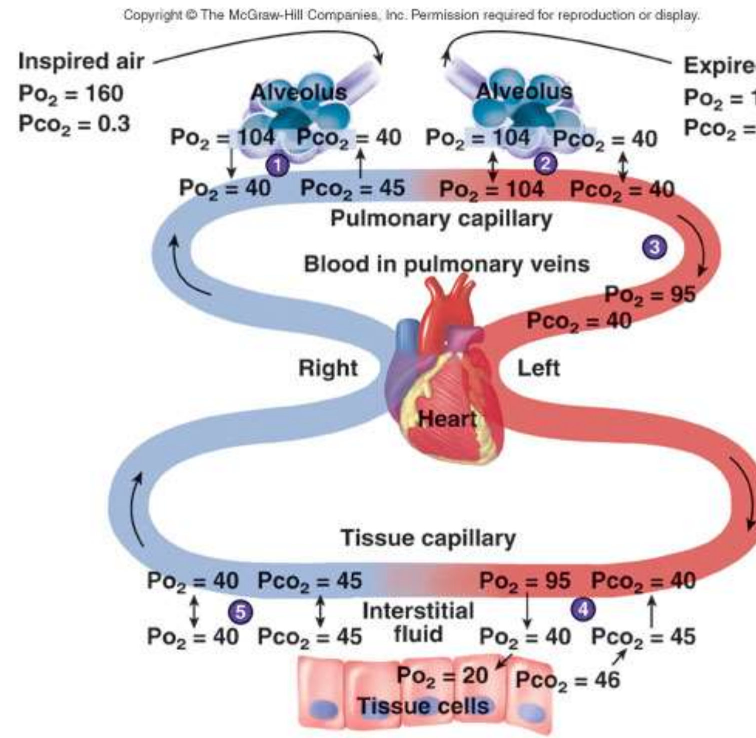
(b)

Partial Pressures

- Oxygen is 21% of atmosphere
- 760 mmHg x .21 = 160 mmHg PO2
- This mixes with “old” air already in alveolus to arrive at PO2 of 105 mmHg
- Carbon dioxide is .04% of atmosphere
- 760 mmHg x .0004 = .3 mm Hg PCO2
- This mixes with high CO2 levels from residual volume in the alveoli to arrive at PCO2 of 40 mmHg

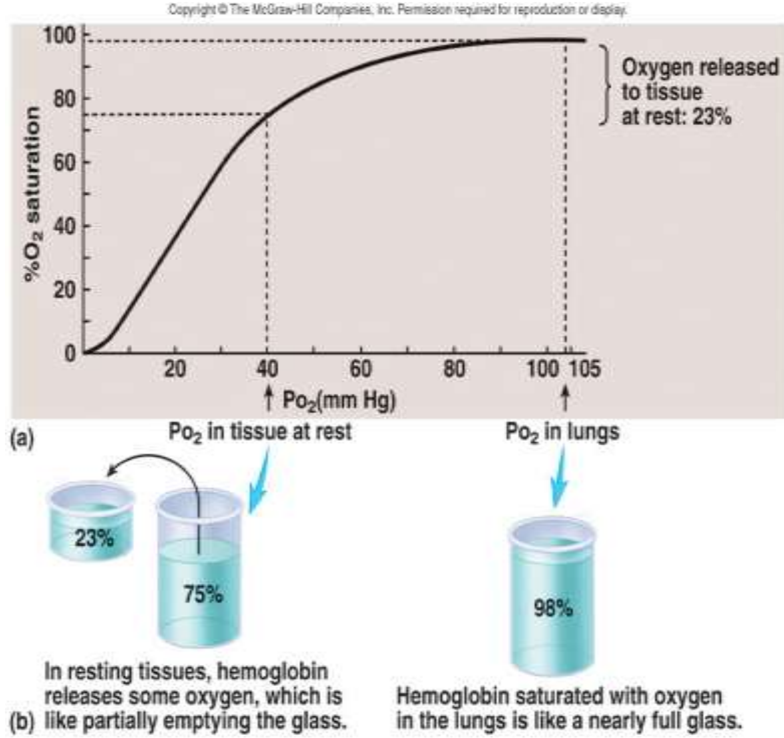


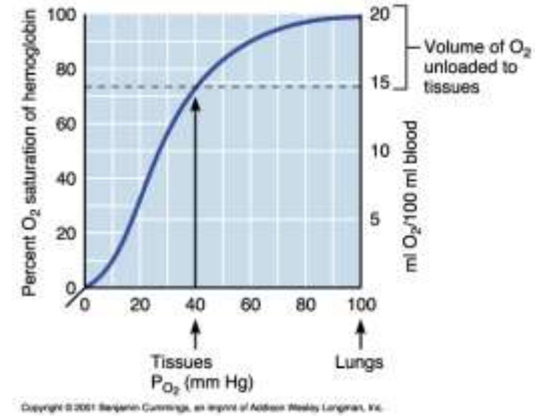


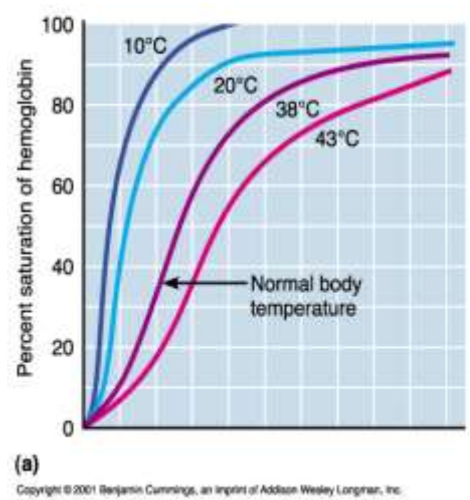


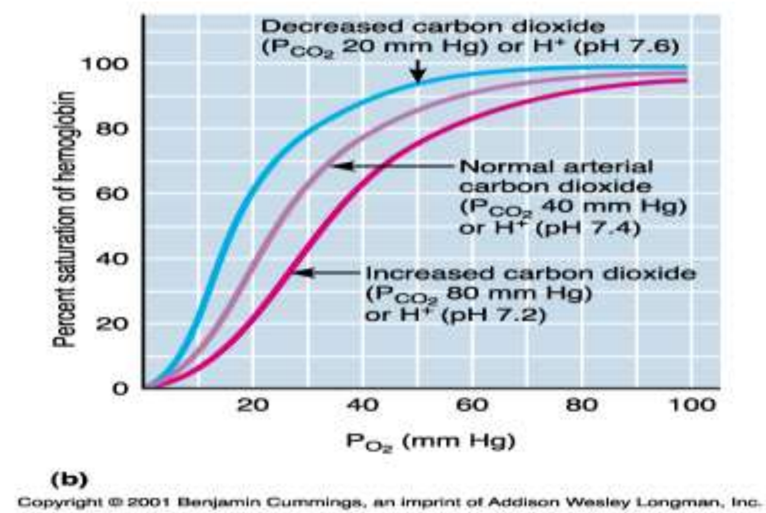
Gas Transport

- **O2 transport in blood**
- Hemoglobin – O2 binds to the heme group on hemoglobin, with 4 oxygens/Hb
- PO2
- PO2 is the most important factor determining whether O2 and Hb combine or dissociate
- O2-Hb Dissociation curve.
- pH
- CO2
- Temperature
- DPG
- CO2 transport
- 7% in plasma
- 23% in carbamino compounds (bound to globin part of Hb)
- 70% as Bicarbonate



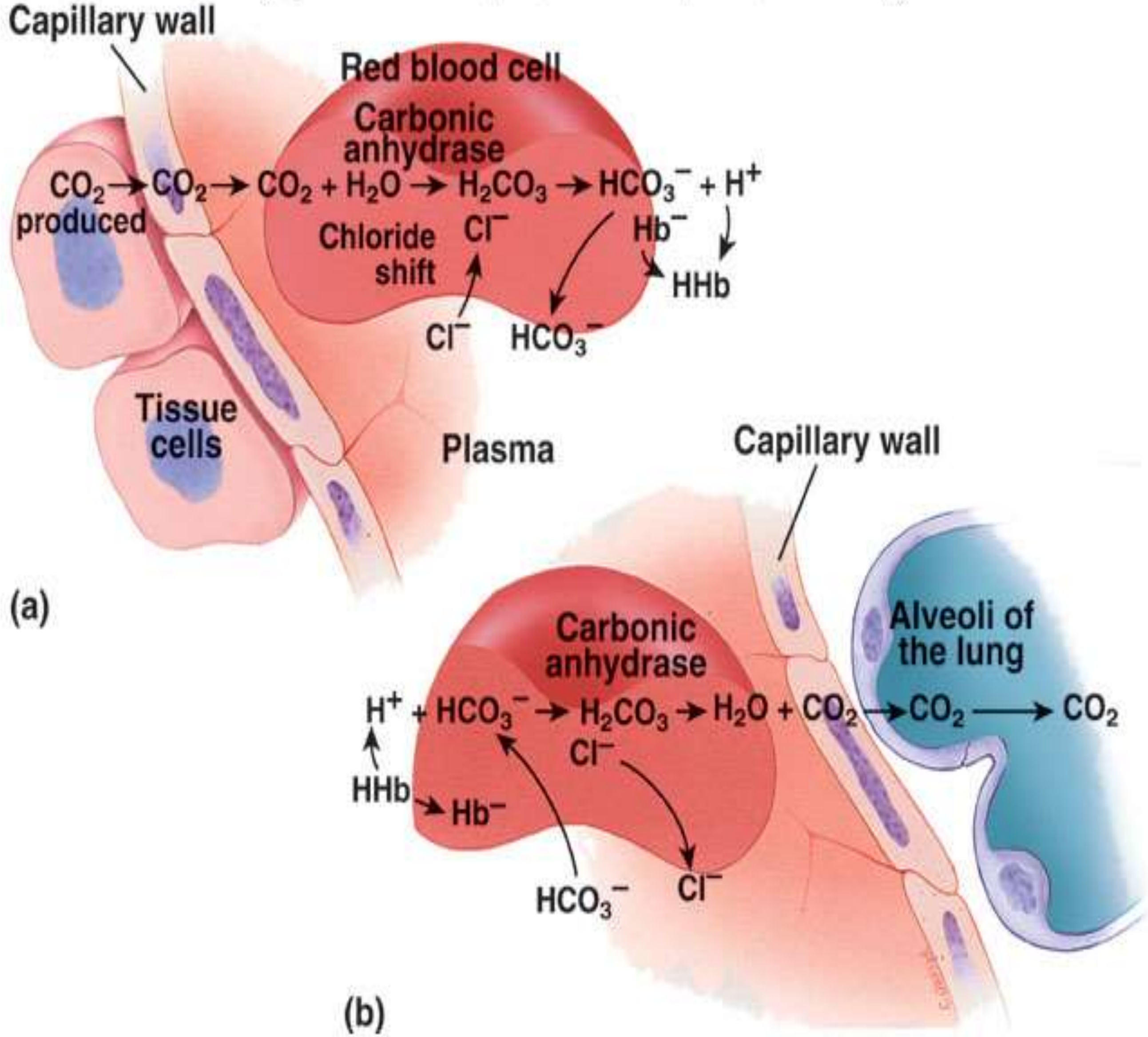






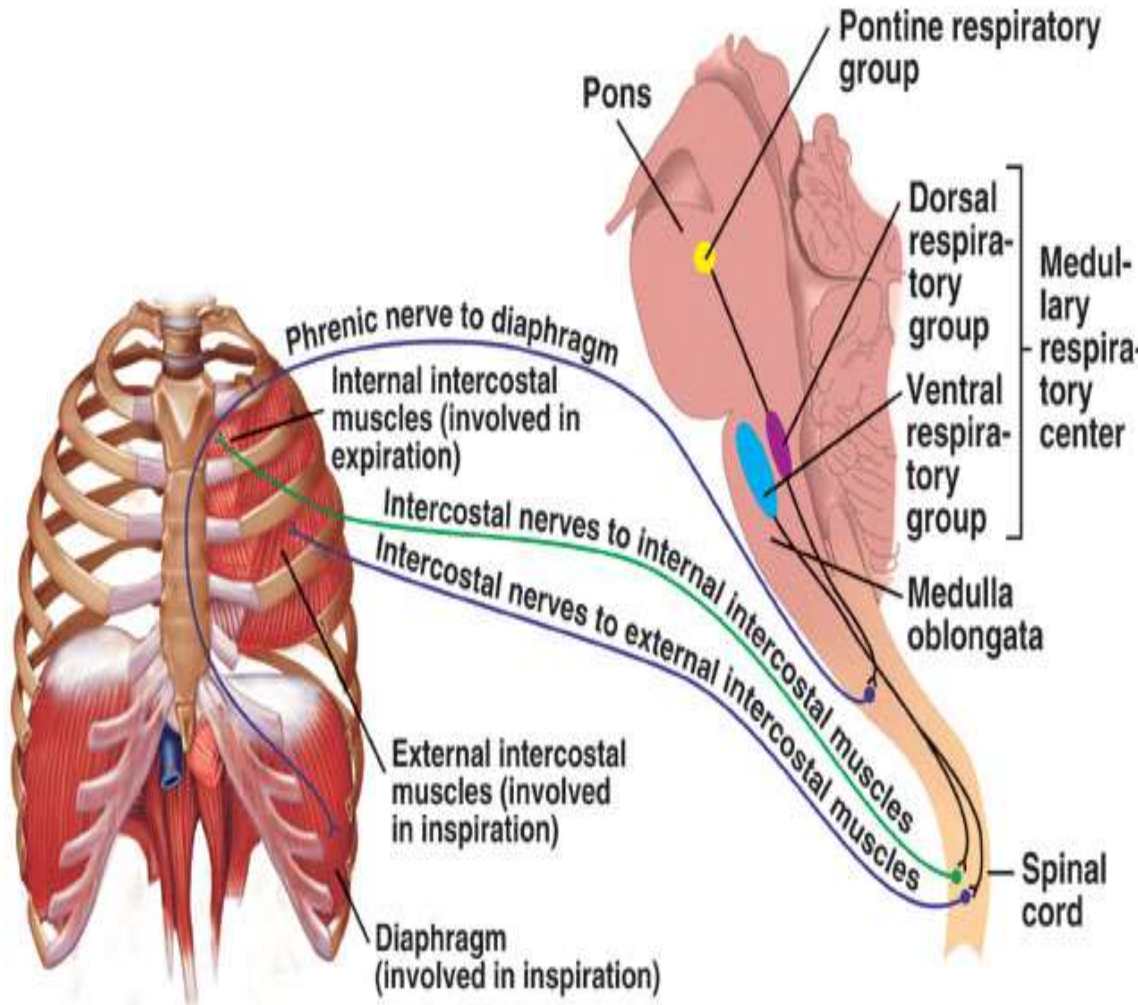
Carbon Dioxide

- $CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$
- Enzyme is Carbonic Anhydrase
- Chloride shift to compensate for bicarbonate moving in and out of RBC



Controls of Respiration

- Medullary Rhythmicity Area
- Medullary Inspiratory Neurons are main control of breathing
- Pons neurons influence inspiration, with Pneumotaxic area limiting inspiration and Apneustic area prolonging inspiration.
- Lung stretch receptors limit inspiration from being too deep.
- Medullary Rhythmicity Area
- Medullary Expiratory Neurons
- Only active with exercise and forced expiration



Controls of rate and depth of respiration

- Arterial PO_2
  - When PO_2 is VERY low, ventilation increases
- Arterial PCO_2
  - The most important regulator of ventilation, small increases in PCO_2, greatly increases ventilation
- Arterial pH
  - As hydrogen ions increase, alveolar ventilation increases, but hydrogen ions cannot diffuse into CSF as well as CO_2