PTA 106
Unit 2 Lecture 5

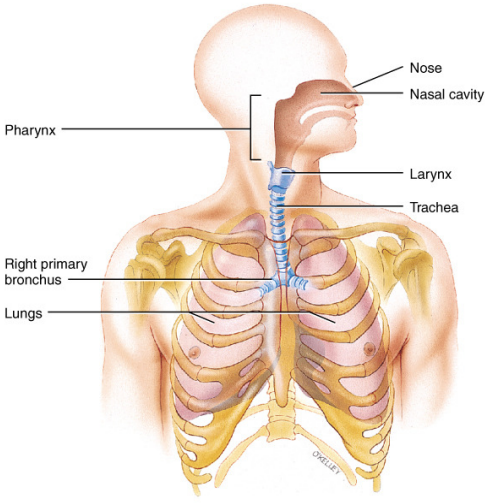
Processes of the Respiratory System

- **Pulmonary ventilation**

  mechanical flow of air into and out of the lungs
- **External Respiration**

  exchange of gases between the pulmonary air spaces and the blood
- **Internal Respiration**

  exchange of gases between blood and tissues



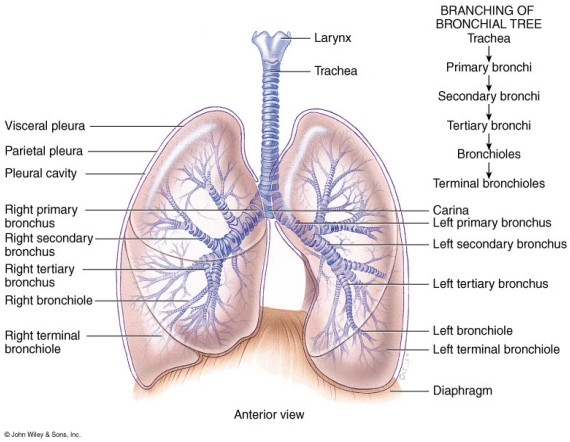
(a) Anterior view showing organs of respiration

Structural Portions of the Respiratory System

- **Lower Respiratory System:**

  Contains a set off conducting ducts that carry air to the exchange surfaces.

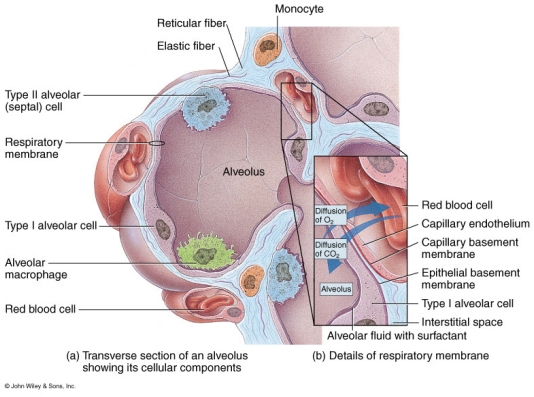
Know order from largest to smallest.

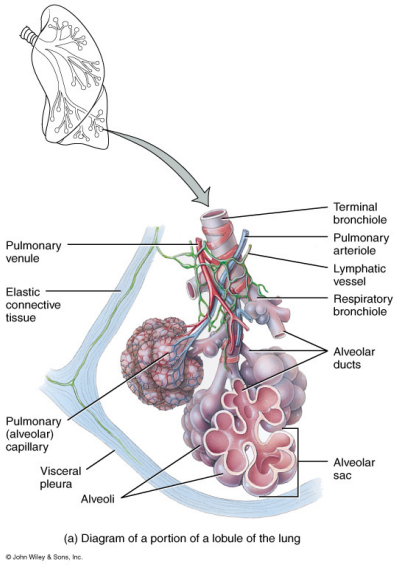


Structural Portions of the Respiratory System

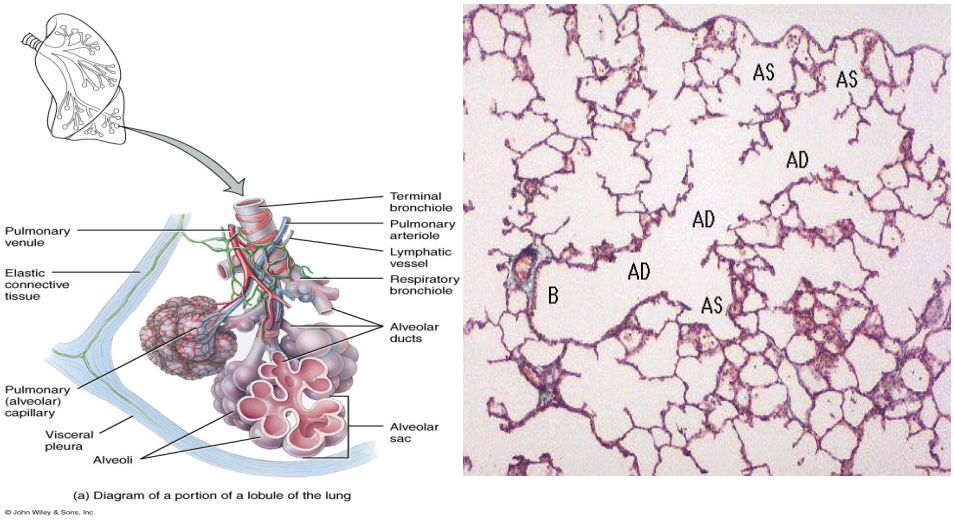
- **Lower Respiratory System**

  Respiratory Portion





Microscopic Anatomy of a Lobule



Pulmonary Ventilation
Inspiration

- **Muscles of Inspiration**

  Primary Muscle

  Diaphragm – only muscle active during normal breathing or eupnea

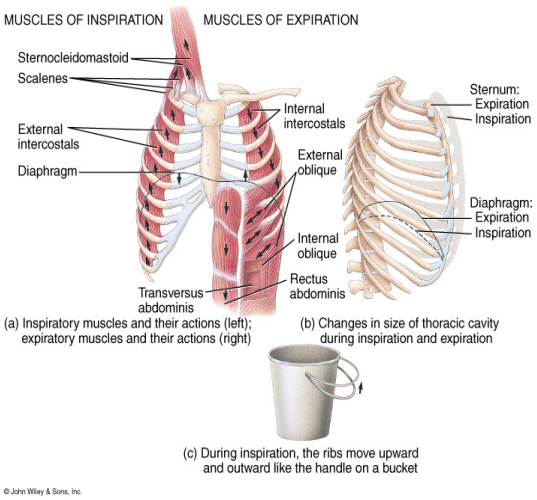
  Secondary Muscles

  Active during deep breathing

  Sternocleidomastoid

  Scalenes

  External Intercostals



Pulmonary Ventilation
Expiration

- **Muscles of Expiration**

  Primary Muscle

  Diaphragm is inactive

  Secondary Muscles Active during deep breathing

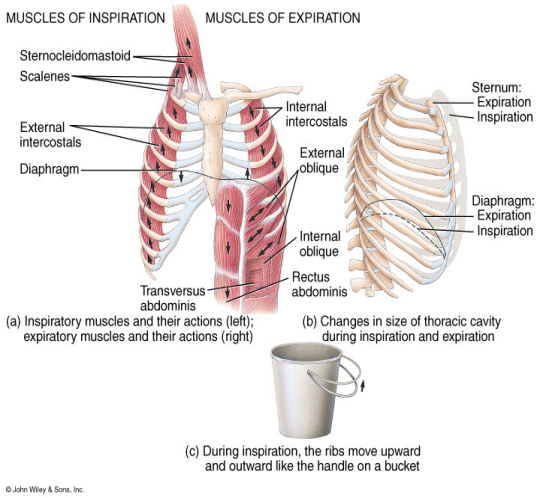
  Internal intercostals

  External Oblique

  Internal Oblique

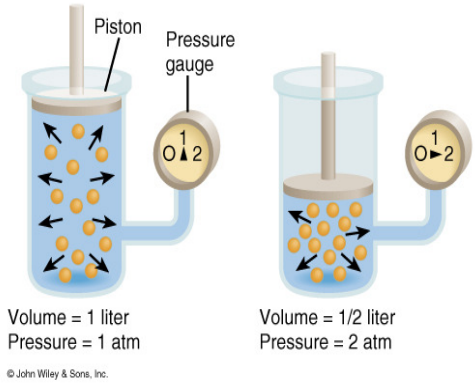
  Transversus Abdominis

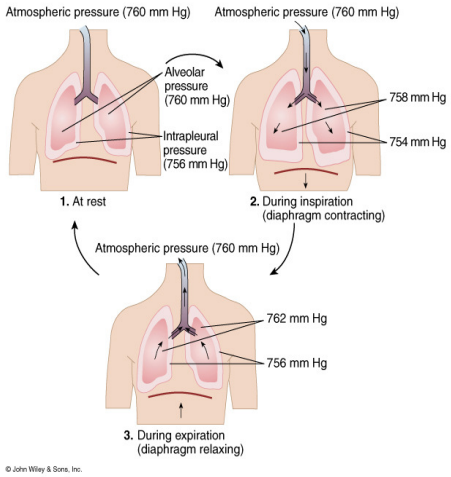
  Rectus Abdominis



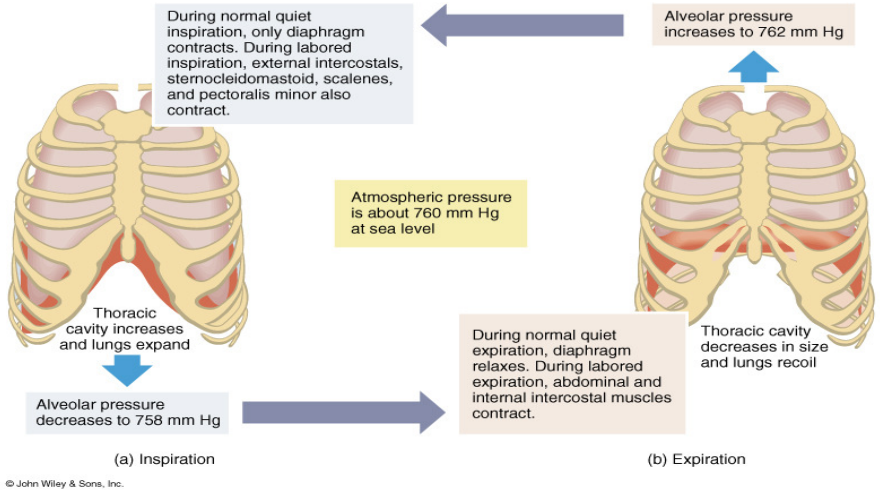
Pressure Changes in Pulmonary Ventilation and Boyle's Law

Pressure is inversely related to Volume





Summary of Inspiratory and Expiratory Events



Factors Affecting Pulmonary Ventilation

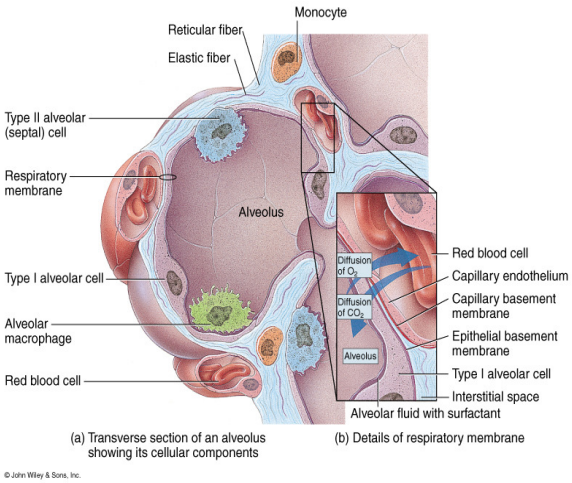
- **Surface Tension**

  Surfactant decreases surface tension thus preventing alveolar collapse

- **Compliance**

  High compliance means the lungs and thoracic wall expand easily

  Low compliance means that they resist expansion



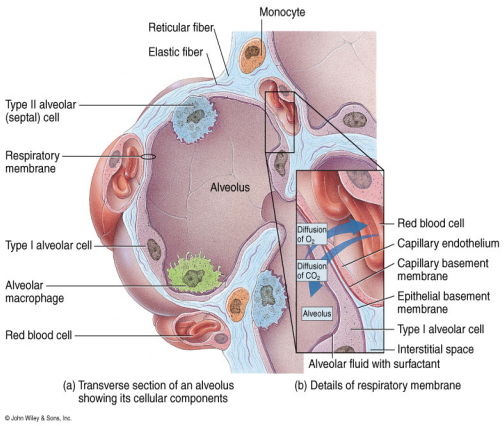
Factors Affecting Pulmonary Ventilation

- **Decreased Compliance**

1. **Tuberculosis – scarring of the lungs**
2. **Pulmonary edema - Retention of fluid in lung tissue**
3. **Respiratory distress Syndrome – Lack of surfactant in premature infants**
4. **Paralysis of respiratory muscles**

- **Increased Compliance**

1. **Emphysema – destruction of elastic fibers in alveolar walls**



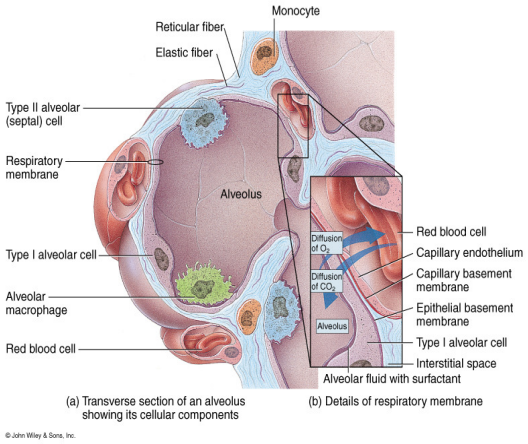
Factors Affecting Pulmonary Ventilation

- **Airway Resistance**

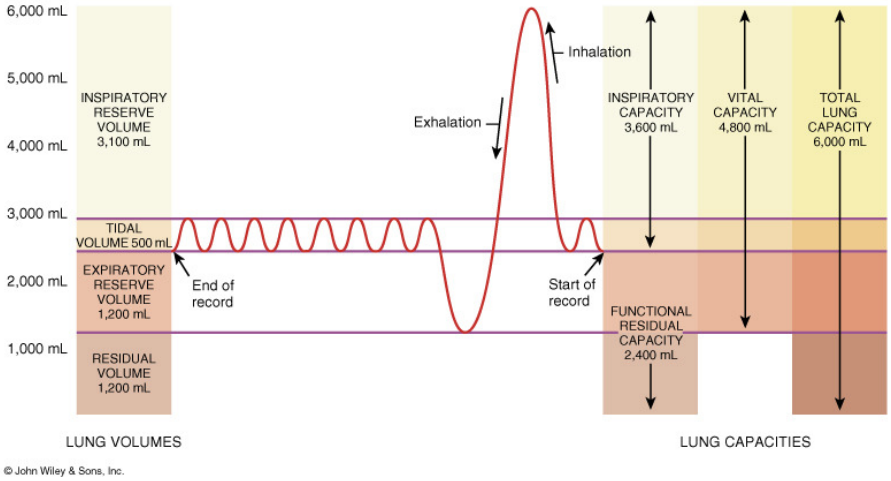
Any condition or obstruction of airways that increases resistance.

Chronic Obstructive Pulmonary Disease (COPD) asthma

Chronic Bronchitis

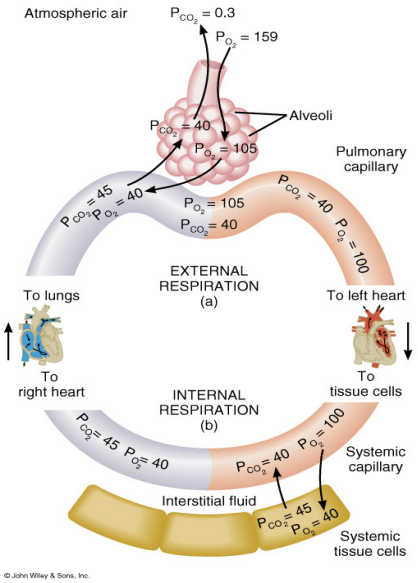


Lung Volumes and Capacities



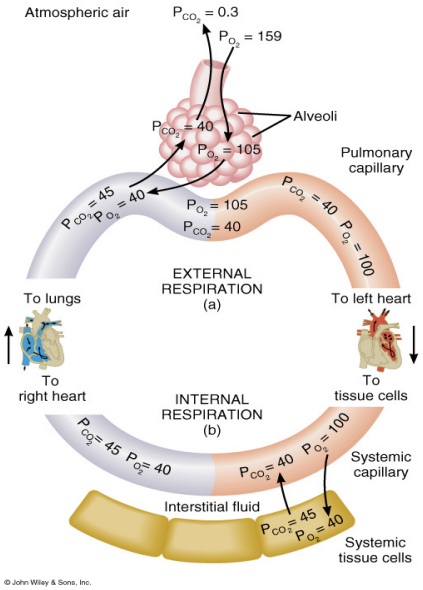
Factors affecting External Respiration

1. **Partial Pressure of gases**
2. **Alveolar surface area**
3. **Diffusion rate and distance**
4. **Solubility of each gas and molecular weight of the gas**
5. **Hemoglobin affinity**



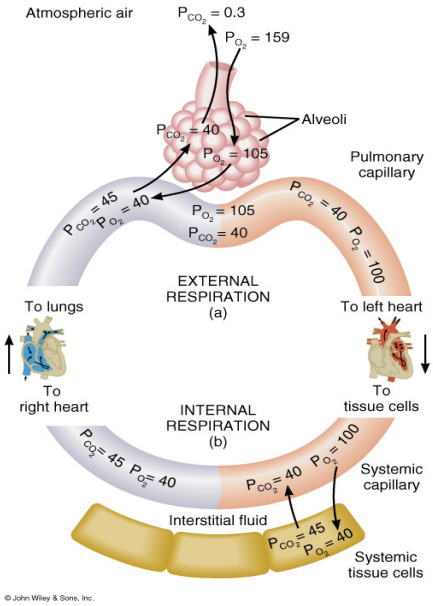
Factors affecting External Respiration

- **Dalton's Law – Atmospheric pressure is the sum total of all partial pressures of all gases in the atmosphere**
- **N2 78% 597.4mmHg**
- **02 21% 158.8mmHg**
- **CO2 >1% .3mmHg**



Factors affecting External Respiration

- **Dalton's Law and High Altitude sickness**
- **Sea Level: pO2 160mmHg**
- **10,000ft.: pO2 110mmHg**
- **20,000ft.: pO2 73mmHg**
- **50,000ft.: pO2 18mmHg**



Factors affecting External Respiration

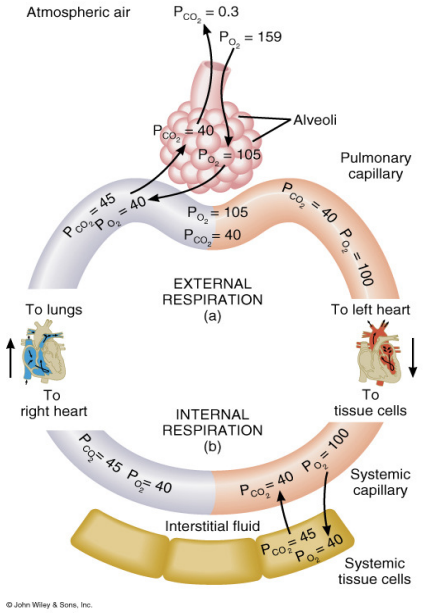
- **Henry's Law**

  Quantity of a gas that will dissolve in solution is proportional to the partial pressure and the solubility coefficient (SC) of the gas.

  SC CO2 = .57

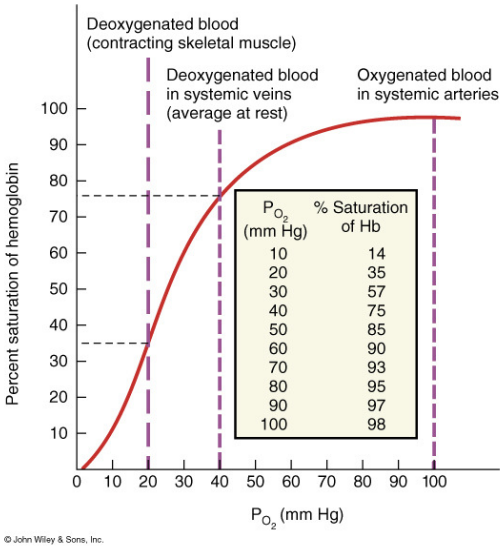
  SC O2 = .024

  SC N2 = .012



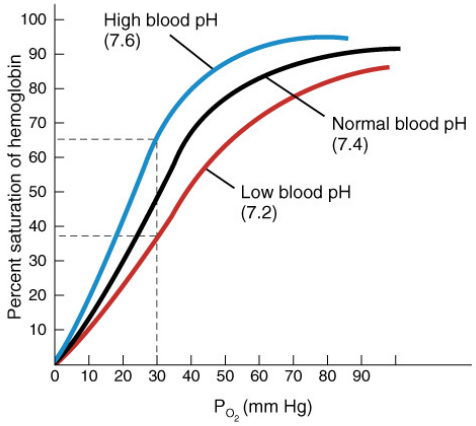
Factors that effect Oxygen Transportation by Hemoglobin

1. **pH (blood acidity)**
2. **Partial pressure of CO2**
3. **Blood Temperature**
4. **2,3-bisphosphoglycerate (BPG)**



The Effect of Blood pH on the Affinity of Hemoglobin for O2

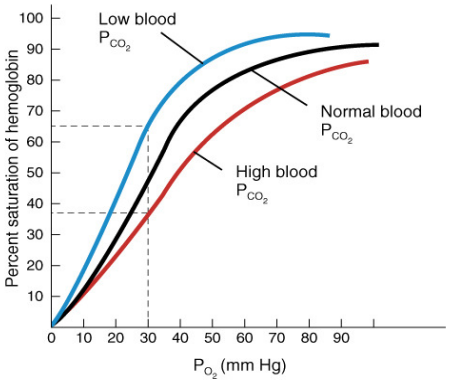
- **Increased pH of blood (more basic) the greater the affinity**
- **Decreased pH of blood (more acidic) the lower the affinity**



(a) Effect of pH on affinity of hemoglobin for oxygen

The Effect of pCO2 on the Affinity of Hemoglobin for O2

- Low pCO2 the higher the affinity
- High pCO2 the lower the affinity
- H2O + CO2
- Bohr Effect

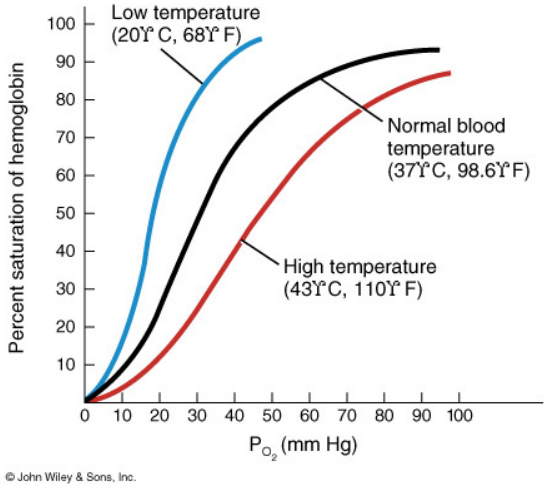


(b) Effect of P_{CO_2} on affinity of hemoglobin for oxygen

H20 + CO2 ⟹ Carbonic Acid (H2CO3) ⟹ H+ + HCO3

The Effect of Blood Temperature on the Affinity of Hemoglobin for O2

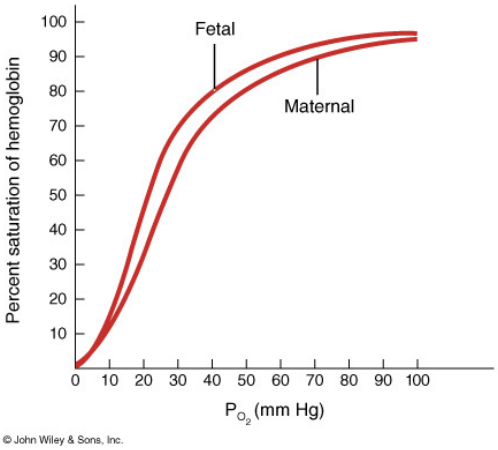
- **Lower the temperature the greater the affinity**
- **Higher the temperature the lower the affinity**



The Difference between Fetal and Maternal Hemoglobin for O2 Affinity

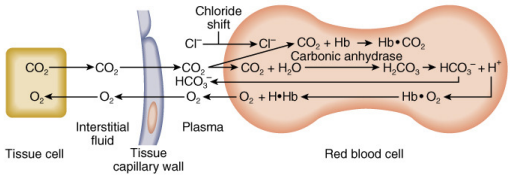
- **For efficient gas exchange between a fetus and it's mother,**

  Fetal hemoglobin has a higher affinity for O2 then maternal hemoglobin.

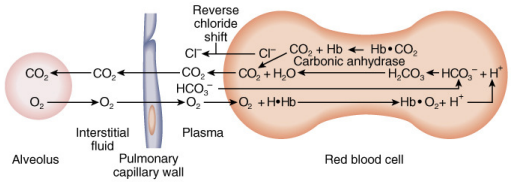


Summary of gas Exchange during both external and Internal Respiration

- **O2 is carried on hemoglobin forming Oxyhemoglobin.**
- **7% of CO2 is carried as dissolved CO2**
- **25% of CO2 is carried as carbaminohemoglobin**
- **70% of CO2 is carried as bicarbonate ions**



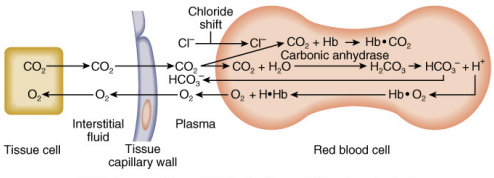
(a) Exchange of O_2 and CO_2 in the tissues (internal respiration)



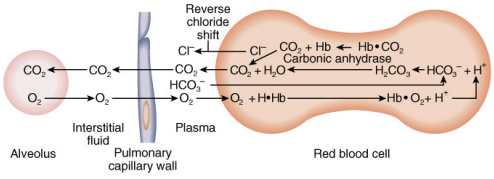
(b) Exchange of O_2 and CO_2 in the lungs (external respiration)

Summary of gas Exchange during both external and Internal Respiration

- **Haldane effect: The lower the oxyhemoglobin, the higher the CO2-carrying capacity of the blood.**
- **Deoxyhemoglobin binds more readily with CO2**
- **Deoxyhemoglobin also acts as a better buffer absorbing more H+, causing more bicarbonate to form.**



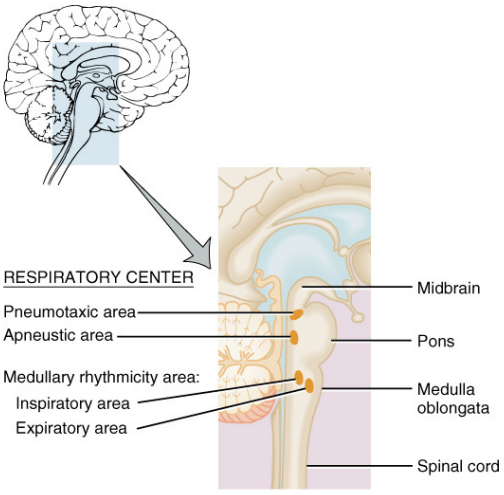
(a) Exchange of O_2 and CO_2 in the tissues (internal respiration)



(b) Exchange of O_2 and CO_2 in the lungs (external respiration)

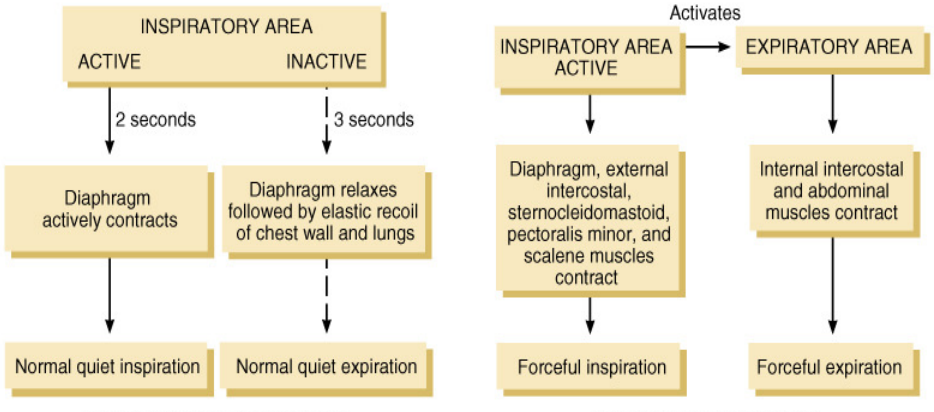
Nervous Control of Pulmonary Ventilation and the of respiratory centers

- **MRA: Controls the basic rhythm of ventilation**
- **PA: transmits inhibitory impulses to the inspiratory area**
- **AA: Transmits stimulatory impulses to the inspiratory area**



Sagittal section of brain stem

Proposed mechanism of ventilation control



(a) During normal quiet breathing

(b) During labored breathing

Chemical Regulation of Respiration

- **Aortic Body: Cluster of chemoreceptors located in the wall of the aortic arch that respond to H+**
- **Carotid Bodies: Cluster of chemoreceptors located in the walls of the L & R Carotid arteries that respond to H+**
- **Central Chemoreceptors: located in the Medulla Oblongata also respond to H+**

Clinical Terms

- **Hypercapnia: Arterial Blood PCO2 above 40mmHg**
- **Hypocapnia: Arterial Blood PCO2 below 40mmHg**
- **Hyperventilation: Rapid/deep breathing**
- **Hypoventilation: Slow/shallow breathing**
- **Hypoxia: O2 deficiency at the tissues**
- **Hypoxic hypoxia: due to high altitude, airway obstruction, or fluid**
- **Anemic hypoxia: deficiency fo hemoglobin**
- **Ischemic hypoxia: decreased blood flow**
- **Histotoxic hypoxia: Caused by toxic agent such as cyanide which prevents tissues from using O2**