

Gas Uptake & Exchange

Overall process of gas exchange & transport

- **Oxygen** (O_2) enters blood at lungs & leaves at tissues
- **Carbon dioxide** (CO_2) enters blood at tissues & leaves at lungs

External respiration

Site: alveoli (at respiratory zone)

- Account for most of lungs volume
- Provide tremendous surface area for gas exchange
- Surrounded by fine elastic fibers
- Densely covered with a cobweb of pulmonary capillaries

Cell types of alveoli

- Type I cells: Single layer of squamous epithelial cells that form alveolar wall
- Type II cells: Secrete surfactant that coats the alveolar surfaces exposed to gas
- Macrophages: Keep alveolar surfaces sterile

Respiratory membrane

- Barrier across which gases are exchanged between alveolar air & blood
- Consists of alveolar epithelium, capillary endothelium & joined basement membranes

Factors affecting gas movement across respiratory membrane

- Partial pressure gradients & gas solubilities
- Structural characteristics of respiratory membrane
- Matching of alveolar ventilation & pulmonary blood perfusion
- Pressure gradients promote gas exchange across respiratory membrane in **lungs**
 - PO_2 in alveoli $>$ PO_2 in pulmonary artery
 - PCO_2 in pulmonary artery $>$ PCO_2 in alveoli

Internal respiration

- Pressure gradients promote gas exchange across systemic capillary membranes in **body tissues**
 - PO_2 in systemic arterial blood $>$ PO_2 in tissue
 - PCO_2 in tissue $>$ PCO_2 in systemic arterial blood

Oxygen transport

- (1) Dissolved in plasma
- (2) Bound to hemoglobin (Hb) within RBCs (each Hb molecule binds 4 O_2 molecules)
 - Affinity between Hb & O_2 molecules is regulated by:
 - PO_2 , PCO_2 , temperature, blood pH, concentration of 2,3-bisphosphoglycerate (BPG)

Influence of PO_2 on Hb saturation

- In lungs: PO_2 in arterial blood is high (100 mmHg)
- At tissue cells: PO_2 in capillaries decreases (to 40 mmHg)
 - 5 mL O_2 (per 100 mL of blood) is released to tissues (only 75% saturation of Hb)

Bohr effect

- Blood pH declines \rightarrow weaken hemoglobin-oxygen bond \rightarrow faster oxygen unloading

Carbon dioxide transport

- (1) Dissolved in plasma
- (2) Bound to hemoglobin (carbaminohemoglobin)
- (3) Bicarbonate ions in plasma (70%)