Gas Exchange & Transport

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**
  - P_{O_2} in alveoli > P_{O_2} in pulmonary artery
  - P_{CO_2} in pulmonary artery > P_{CO_2} in alveoli

Internal respiration

- Pressure gradients promote gas exchange across systemic capillary membranes in **body tissues**
  - P_{O_2} in systemic arterial blood > P_{O_2} in tissue
  - P_{CO_2} in tissue > P_{CO_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:
  - P_{O_2}, P_{CO_2}, temperature, blood pH, concentration of 2,3-bisphosphoglycerate (BPG)

Influence of P_{O_2} on Hb saturation

- In lungs: P_{O_2} in arterial blood is high (100 mmHg)
- At tissue cells: P_{O_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 → weaken hemoglobin-oxygen bond → faster oxygen unloading

Carbon dioxide transport

(1) Dissolved in plasma

(2) Bound to hemoglobin (carbaminohemoglobin)

(3) Bicarbonate ions in plasma (70%)