Hemoglobin & O₂ Transport:

- Total Blood O₂ = 20 mls O₂/100 mls
  - 0.3 mls dissolved
  - 19.7 mls carried on Hemoglobin
- ~98% O₂ carried on Hemoglobin

Indicates importance of Hemoglobin
- Majority of oxygen can NOT be carried dissolved in the blood
- Oxygen MUST be transported on hemoglobin due to low solubility
% Hemoglobin Saturation:
* Dependent upon 2 factors:
  1. **Blood PO\textsubscript{2} (concentration)**
  2. **Hemoglobin O\textsubscript{2} Affinity**

  ~ **Variable affinity**

PARTIAL PRESSURE OF OXYGEN (PO\textsubscript{2})
* High PO\textsubscript{2} (concentration)
  * Favors: *Hemoglobin Loading Reaction*
  * Forms: **Oxyhemoglobin**

\( \text{Hb} + 4\text{O}_2 \rightarrow \text{Hb(O}_2\text{)_4} \)

% Hemoglobin Saturation: Related to PO\textsubscript{2}
* Greater the PO\textsubscript{2} the higher the saturation

* **Oxyhemoglobin Dissociation Curve**
\[ \text{PO}_2 = 100 \text{ mm Hg (Arterial PO}_2) \]
\[ \% \text{ saturation} = \sim 98 \% \]

\[ \text{BLOOD } \text{O}_2: \text{ 20 mls O}_2/100 \text{ mls blood} \]

\[ \text{PO}_2 = 40 \text{ mm Hg (Venous PO}_2) \]
\[ \% \text{ saturation is} = \sim 75 \% \]

\[ \text{BLOOD } \text{O}_2: \text{ 15 mls O}_2/100 \text{ mls blood} \]

\[ \text{O}_2 \text{ delivered: 5 mls O}_2 / 100 \text{ mls blood} \]

✓ **Significance:** Even in low partial pressures, Hemoglobin still has HIGH Oxygen saturation

Ensures a significant blood oxygen reservoir
1. **High O₂ Affinity**: Bind O₂ tightly
   - **LUNGS**: *Carry* O₂ to tissue
   - **Hemoglobin loading**

2. **Low O₂ Affinity**: Release O₂
   - **TISSUES**: *Release* O₂ to tissue
   - **Hemoglobin Unloading**

![Hemoglobin Dual Affinity Diagram](image)

**Diagram Descriptions**:
- **Tissue cells**: Where O₂ is released.
- **Loading of CO₂**: The process of CO₂ being absorbed into the blood.
- **Unloading of O₂**: The release of O₂ from hemoglobin.
- **CO₂ + H₂O → H₂CO₃ → H⁺ + HCO₃⁻**: Water and Carbonic acid reactions.
- **Plasma**: The liquid part of blood.
- **Systemic capillary**: The capillary bed where gas exchange occurs.
- **Red blood cell**: The primary site of O₂ transport and release.
Hemoglobin Affinity Changes: Caused by changes in CO₂ concentration (PCO₂)

CO₂ Diffusing from Tissues

- 7% dissolves in the blood
- 22% combines with hemoglobin
- 77% is converted to bicarbonate ions

Carbon Dioxide Transport:
Carried in blood in 3 forms:
1. Dissolved in plasma (~10%)
   ✓ Very soluble
2. Bound to Hemoglobin (~20%)
   ✓ Carbaminohemoglobin
3. Bicarbonate: HCO₃⁻ (~70%)

Bicarbonate Formation:
• PRIMARY form of CO₂ transport
1. CO₂ combines with H₂O
   ➜ Facilitated by RBC enzyme: Carbonic Anhydrase
2. Forms Carbonic Acid
   ➜ CO₂ + H₂O → H₂CO₃
3. Carbonic Acid dissociates into Bicarbonate & H⁺ Ions
   ➜ H₂CO₃ → H⁺ + HCO₃⁻
Significance: $H^+$ by-product $\rightarrow$ Blood Acidity

Effects of $\uparrow H^+$:

1. $H^+$ Binds Hemoglobin
   - RBCs: Positively charged due to "HYDROGEN TRAPPING"

2. Increased Hemoglobin Acidity
   - Low pH reduces Hemoglobin affinity
   - FUNCTIONALLY DENATURES Hemoglobin
   - Promotes: “Hemoglobin Unloading”
Physiological Correlation:

* Anaerobic Exercise: Lactic Acid
  
  - Decreases hemoglobin oxygen affinity
  - Increases Oxygen unloading to TISSUES
**TISSUES:** Hemoglobin Affinity: LOW

- **CO₂ plasma concentrations HIGH**
  - \( H^+ \) concentrations increase
  - \( H^+ \) binds hemoglobin

\[ \Downarrow \text{Hemoglobin Affinity: } \text{Unload O₂ to tissues} \]

**LUNGS:** Hemoglobin O₂ Affinity HIGH

- **Low Alveolar \text{PCO₂}** drives \text{CO₂ diffusion}

\[ \Downarrow \text{Reactions occur in reverse} \]

- **Carbonic Acid** converted into back into: \text{CO₂ & H₂O}
  - Facilitated by: \text{Carbonic anhydrase}
  - \text{CO₂ exhaled}

- **Hemoglobin’s affinity increases** as \( H^+ \) concentration decreases
  - \( H^+ \) is combined with bicarbonate
1. MOST Oxygen carried on Hemoglobin = ~98%
2. O₂ delivered to tissues = 5 ml (≈25%)

3. Venous blood maintains a HIGH O₂ concentration
   ✓ Hemoglobin saturation = ~ 70-75%

4. Hemoglobin affinity directly affected by: pCO₂ and pH
5. Primary stimuli for controlling breathing are pCO₂ and pH