Transport of Carbon Dioxide in the Blood

Carbon dioxide molecules are transported in the blood from body tissues to the lungs by one of three methods:

1. Dissolution directly into the blood (as a gas)
2. Binding to hemoglobin (forming carboaminohemoglobin)
3. Carried as a bicarbonate ion (as a solid)

- Several properties of carbon dioxide in the blood affect its transport.
- First, carbon dioxide is more soluble in blood than is oxygen. About 5 to 7 percent of all carbon dioxide is dissolved in the plasma.
- Second, carbon dioxide can bind to plasma proteins or can enter red blood cells and bind to hemoglobin. This form transports about 10-20% of the carbon dioxide. When carbon dioxide binds to hemoglobin, a molecule called ***carbaminohemoglobin*** is formed.
    - Binding of carbon dioxide to hemoglobin is reversible. Therefore, when it reaches the lungs, the carbon dioxide can freely dissociate from the hemoglobin and be expelled from the body.
- Third, the majority of carbon dioxide molecules (70-85%) are carried as bicarbonate.
    - In this system, carbon dioxide diffuses into the red blood cells.
    - Carbonic anhydrase (CA) within the red blood cells quickly converts the carbon dioxide into carbonic acid (H_2CO_3). Carbonic acid is unstable, and immediately changes into bicarbonate ions (HCO_3^-) and hydrogen (H^+) ions.
    - **Since carbon dioxide is quickly converted into bicarbonate ions, this reaction allows for the continued uptake of carbon dioxide into the blood, down its concentration gradient.**
    - It also results in the production of H^+ ions. If too much H^+ is produced, it can alter blood pH. However, hemoglobin binds to the free H^+ ions, limiting shifts in pH.
    - When the blood reaches the lungs, this process is reverser and the carbon dioxide produced is expelled through the lungs during exhalation.

The benefit of the bicarbonate system is that carbon dioxide is “soaked up” into the blood with little change to the pH of the system. This is important because it takes only a small change in the overall pH of the body for severe injury or death to result. The presence of this bicarbonate buffer system also allows for people to travel and live at high altitudes. When the partial pressure of oxygen and carbon dioxide change at high altitudes, the bicarbonate buffer system adjusts to regulate carbon dioxide while maintaining the correct pH in the body.