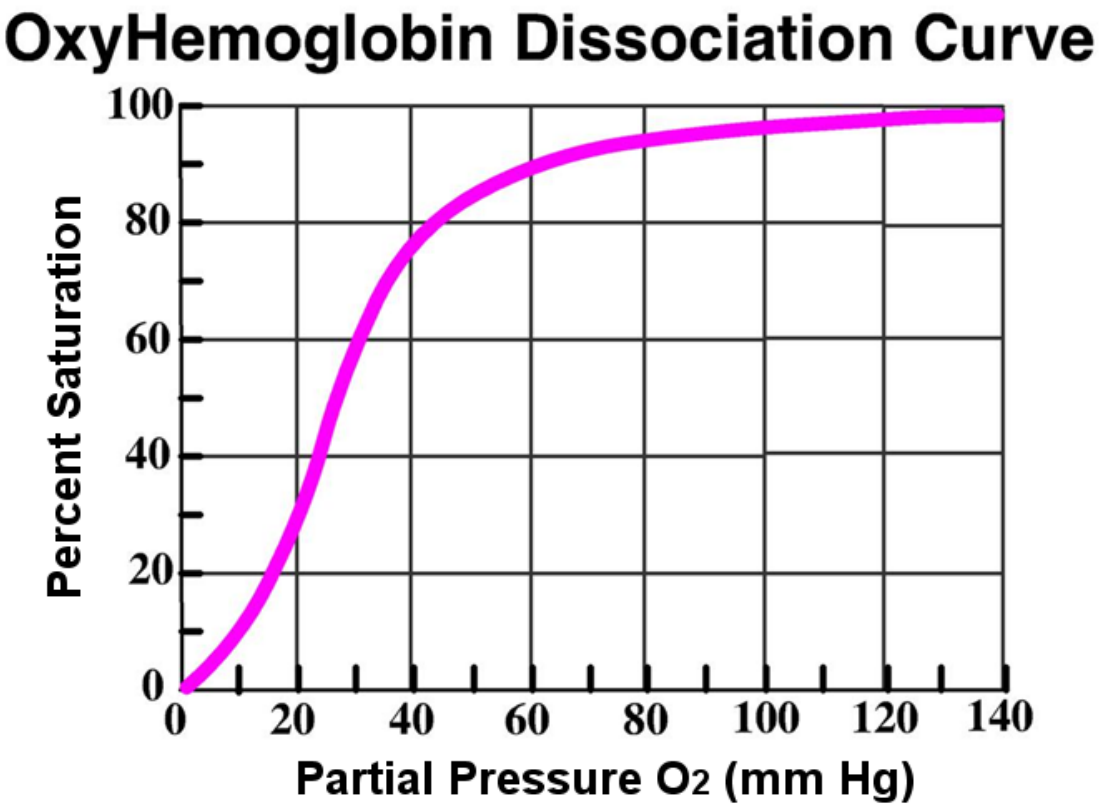

Hemoglobin binds oxygen in the blood.

Air pressure at sealevel is 760 mm. Oxygen pressure is 21% of air pressure. The lungs, however, quickly remove oxygen into the blood.

Hemoglobin can bind O_2 at each of its four protein subunits. The O_2 molecule binds an iron atom (Fe) in the "heme" portion of each subunit.

The "S curve" of O_2 binding means that the binding of each O_2 increases the likelihood of another subunit binding O_2.

Other small molecules such as cyanide (CN^-) and carbon monoxide (CO) compete for oxygen biding sites on hemoglobin. Smoking releases CO. A person smoking may release enough CO to decrease oxygen binding by 20%.

Another protein, **myoglobin**, stores oxygen in the muscle. When oxygen pressure is low (below 40 mm), myoglobin starts to release its oxygen in the blood.

Questions

1. What is the partial pressure of oxygen in fresh air at sealevel?

2. At 40 mm oxygen in the lungs, what percent of hemes are binding O2?

3. At what oxygen pressure (approximately) does oxygen reach 100% saturation of hemoglobin?

Carbon dioxide acts as a pH buffer in the blood.

What is pH? Acid? Base?

An acid releases H^+ ions.

Strong acid: HCl (hydrochloric acid) releases all its H^+

$HCl \rightarrow H^+ + Cl^-$

Weak acid: Carbonic acid releases some of its H^+

$H_2CO_3 <===> H^+ + HCO_3^-$

A base removes H^+ ions by releasing OH^- to react, generating water (H_2O).

Strong base: NaOH (sodium hydroxide)

$NaOH \rightarrow Na^+ + OH^-$

pH = negative $\log_{10}$ of H^+ concentration.

pH range = 0 to 14. H^+ range = 1 Molar to 10^{-14} Molar (Molarity = Moles per liter)
Neutral pH = pH 7
Below pH 7 means acid.
Above pH 7 means base.

CO_2 is an essential pH buffer in the blood.

CO_2 is released from respiration on organic foods. As CO_2 enters the blood, it combines with H_2O to make carbonic acid, H_2CO_3.

$CO_2 + H_2O <===> H_2CO_3 <===> H^+ + HCO_3^-$

Too much **CO_2** builds up → carbonic acid → more H^+, pH too low, acidosis
Die in coma

Breath too fast → **CO_2** pulled out of blood → H^+ low, pH too high, alkalosis
Die of convulsions

The Henderson-Hasselbalch Equation:

$pH = 6.1 + \log_{10} (HCO_3^- / CO_2)$

Questions

1. Your stomach contains hydrochloric acid (HCl) to kill most bacteria. If the stomach acidity is pH 2, what is the hydrogen ion concentration?

2. Your normal blood pH equals pH 7.4. What fraction of the total CO2 (including ionized forms) is in the form of bicarbonate ion (HCO3-)?

3. Your bicarbonate:CO2 ratio is 15:1. What is your blood pH? Are you dying of coma or of convulsions?