Transport of Gases-I

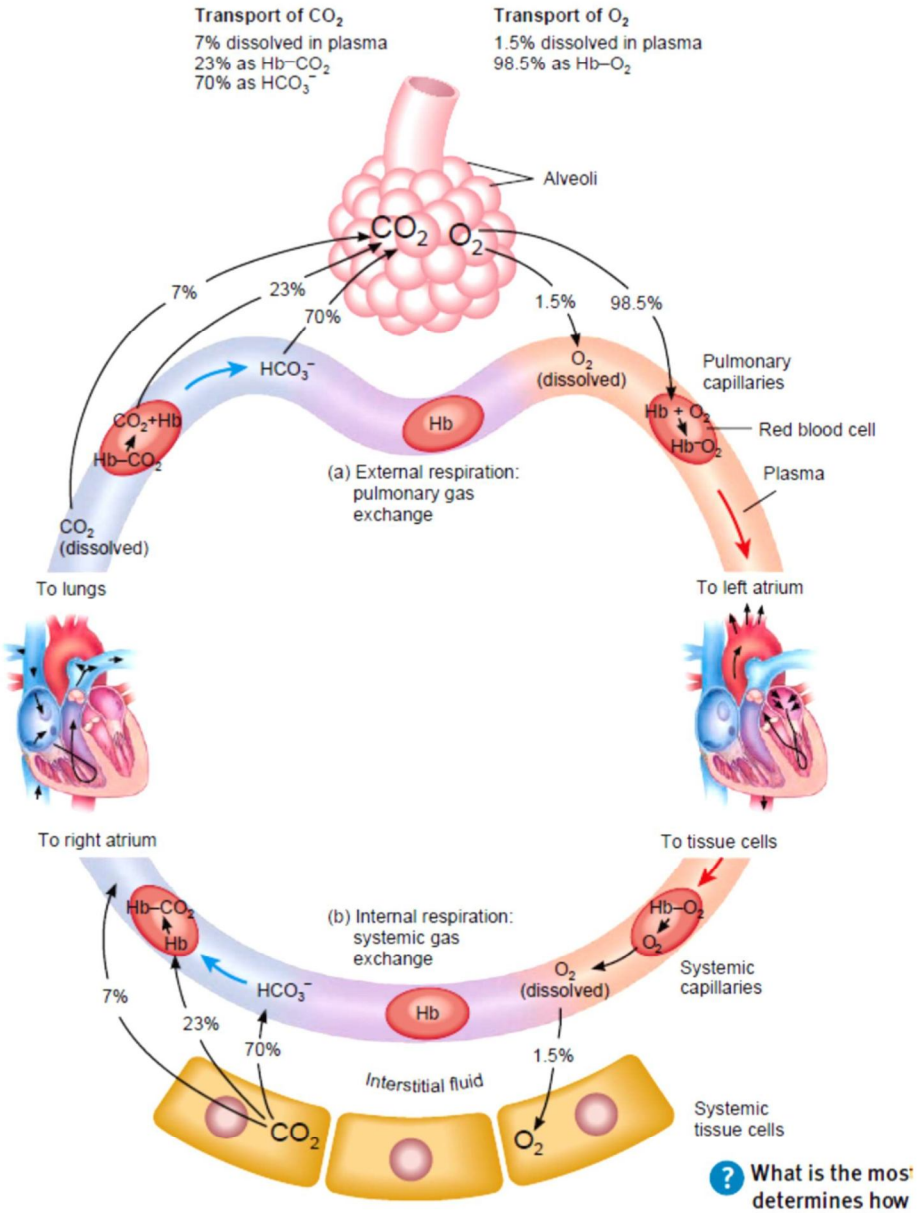
Transports of Gases

The blood transports gases between the lungs and body tissues. When O2 and CO2 enter the blood, certain chemical reactions occur that aid in gas transport and gas exchange.

Oxygen Transport

Oxygen does not dissolve easily in water, so only about 1.5% of inhaled O_2 is dissolved in blood plasma, which is mostly water. About 98.5% of blood O_2 is bound to hemoglobin in red blood cells.

Most O_2 is transported by hemoglobin as oxyhemoglobin ($Hb–O_2$) within red blood cells; most CO_2 is in blood plasma as bicarbonate ions (HCO_3^-).



Each 100 mL of oxygenated blood contains the equivalent of 20 mL of gaseous O2. Using the percentages just given, the amount dissolved in the plasma is 0.3 mL and the amount bound to hemoglobin is 19.7 mL. The heme portion of hemoglobin contains four atoms of iron, each capable of binding to a molecule of O2. Oxygen and hemoglobin bind in an easily reversible reaction to form **oxyhemoglobin:**

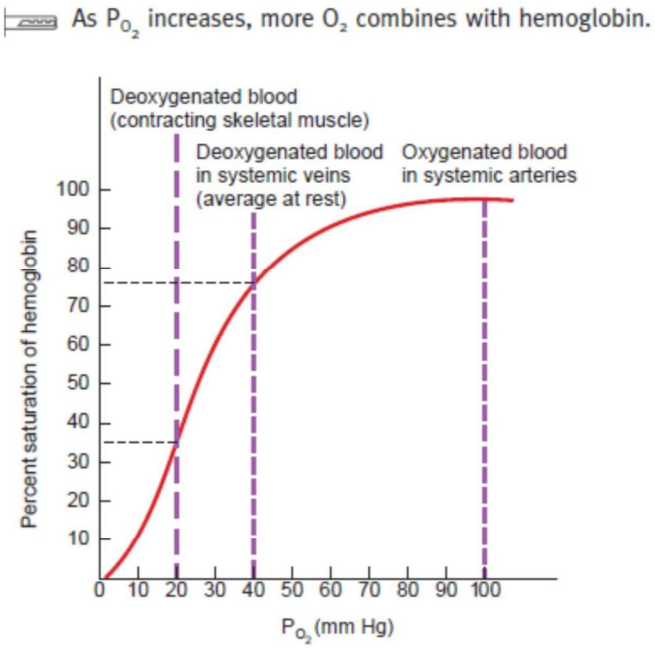
$$\underset{\text{Reduced hemoglobin (deoxyhemoglobin)}}{Hb} + \underset{\text{Oxygen}}{O_2} \underset{\text{Dissociation of } O_2}{\overset{\text{Binding of } O_2}{\rightleftharpoons}} \underset{\text{Oxyhemoglobin}}{Hb{-}O_2}$$

The 98.5% of the O2 that is bound to hemoglobin is trapped inside RBCs, so only the dissolved O2 (1.5%) can diffuse out of tissue capillaries into tissue cells. Thus, it is important to understand the factors that promote O2 binding to and dissociation (separation) from hemoglobin.

The Relationship Between Hemoglobin and Oxygen Partial Pressure

The most important factor that determines how much O2 binds to hemoglobin is the PO2; the higher the PO2, the more O2 combines with Hb. When reduced hemoglobin (Hb) is completely converted to oxyhemoglobin (Hb–O2), the hemoglobin is said to be **fully saturated;** when hemoglobin consists of a mixture of Hb and Hb–O2, it is **partially saturated.** The **percent saturation of hemoglobin** expresses the average saturation of hemoglobin with oxygen. For instance, if each hemoglobin molecule has bound two O2 molecules, then the hemoglobin is 50% saturated because each Hb can bind a maximum of four O_2.

When the PO_2 is high, hemoglobin binds with large amounts of O_2 and is almost 100% saturated. When PO_2 is low, hemoglobin is only partially saturated. In other words, the greater the PO_2, the more O_2 will bind to hemoglobin, until all the available hemoglobin molecules are saturated. Therefore, in pulmonary capillaries, where PO_2 is high, a lot of O_2 binds to hemoglobin. In tissue capillaries, where the PO_2 is lower, hemoglobin does not hold as much O_2, and the dissolved O_2 is unloaded via diffusion into tissue cells. That hemoglobin is still 75% saturated with O_2 at a PO_2 of 40 mmHg, the average PO_2 of tissue cells in a person at rest. This is the basis for the earlier statement that only 25% of the available O_2 unloads from hemoglobin and is used by tissue cells under resting conditions.



When the PO2 is between 60 and 100 mmHg, hemoglobin is