Unit L Notes #3 - Gas Exchange

- When carbon dioxide diffuses from tissue cells into the blood, only a small amount of it (9%) reaching the blood is held in simple solution. (this portion is carried as dissolved carbon dioxide CO_2 in the plasma)

- Another 27 % attaches directly to the Hemoglobin to form Carbaminohemoglobin ($HbCO_2$)

- The majority, the remaining 64%, combines with water to form bicarbonate ions (HCO_3^-) and hydrogen ions (H^+).

- Each time blood passes through the tissues; it picks up large quantities of carbon dioxide. This then reacts with water to form Bicarbonate (HCO_3^-) and Hydrogen Ions (H^+).

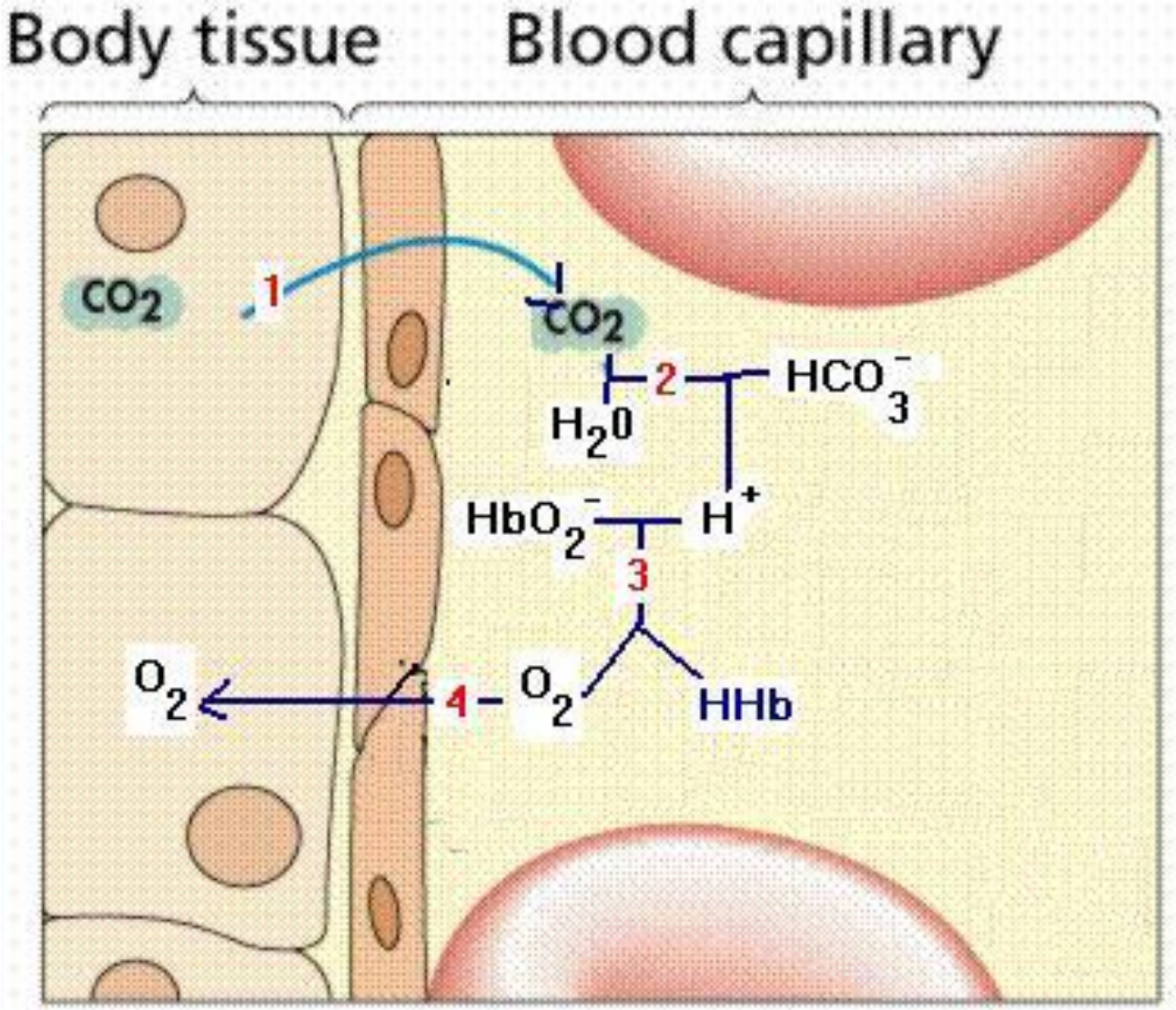
Ex. $H_2O + CO_2 \rightarrow H_2CO_3 \rightarrow HCO_3^- + H^+$

*** The reaction above takes place within erythrocytes with the help of an enzyme**

called "Carbonic Anhydrase" – This reaction can be reversed by the same enzyme as blood enters the pulmonary capillaries of the lungs.

- There are many substances in the blood capable of binding to the excess free hydrogen ions. Hemoglobin is one of the most important of these substances. When Hydrogen (H^+) combines with the hemoglobin (Hb), the Hb releases some of the oxygen attached to it. The (Hb) binds with the H^+ to make (HHb) or "Reduced Hemoglobin"

A) Gas Exchange in Tissues : Internal Respiration



1. CO_2 diffuses into the blood from the cells

2. CO_2 joins with water to make Bicarbonate and Hydrogen Ions thanks to Carbonic Anhydrase

$$CO_2 + H_20 \rightarrow H^+ + HCO_3^-$$

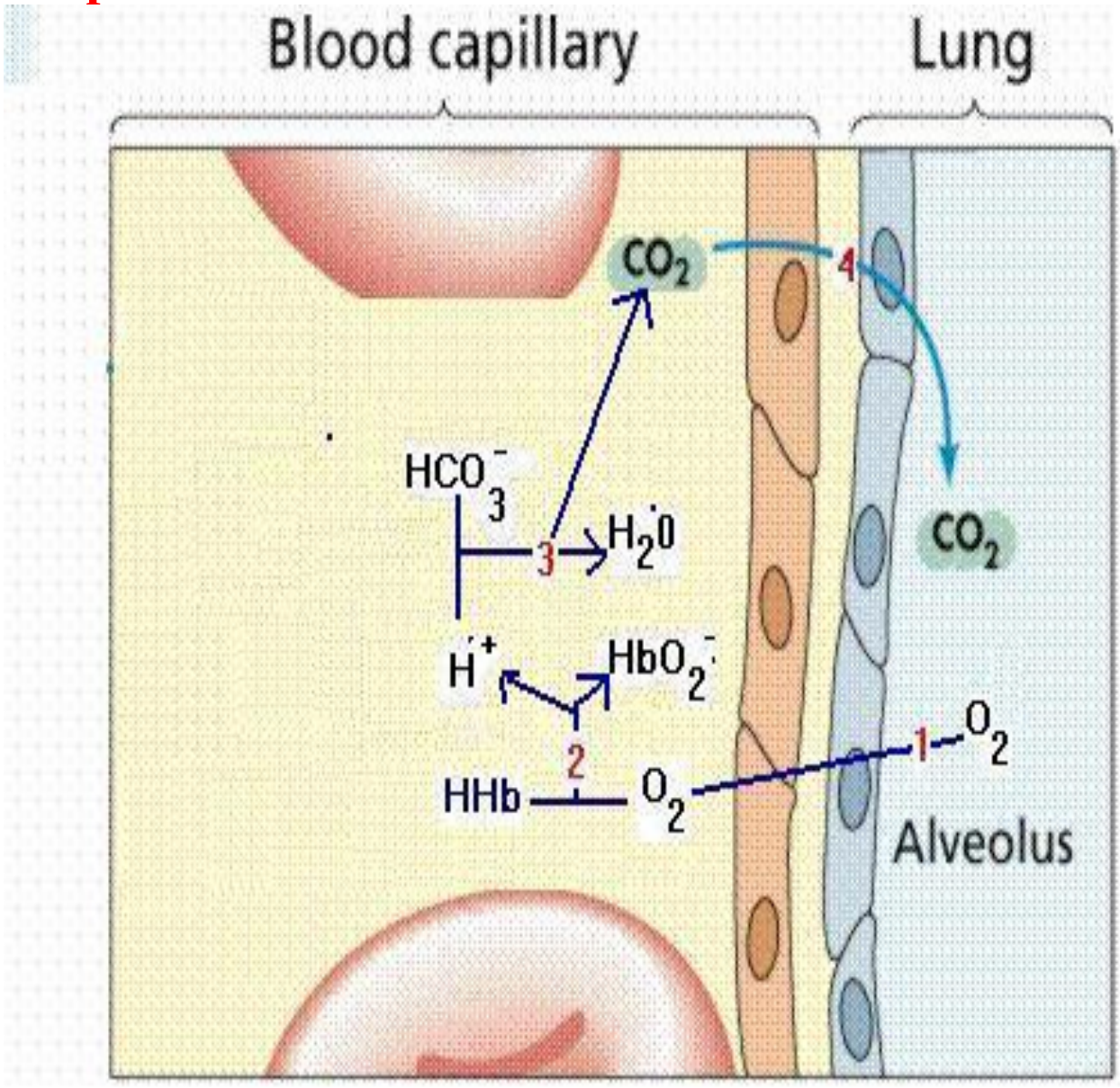
3. Most of the released H^+ is picked up by the combined from of O_2 and hemoglobin (Oxy-hemoglobin - HbO_2) The taking up of H^+ by HbO_2 (produces HHb), causing the HbO_2 to release its oxygen.

- The H^+ concentration (more acidic near tissue) and the slight increase in temperature alters the hemoglobin structure (Slight Denaturation) causing it to release its oxygen easily.

4. Oxygen then enters the tissue moving from an area of high concentration to an area of low concentration.

- **The blood leaving the tissues now contains large quantities of hemoglobin which is free of oxygen but carrying H+ ions, at this point these Hb's are called <u>Reduced Hemoglobins</u> (HHb) The blood also contains large amounts of <u>bicarbonate ions</u> (HCO_3^-). No further changes occur until the blood reaches the lungs.**

B) Gas Exchange in the Lungs **– External Respiration**



*** The environment near the lungs is different than near the tissues, the capillaries near the lungs are at a <u>cooler</u> temperature and at a <u>higher pH</u> (more basic)**

1. High concentration of Oxygen in lungs. Allows oxygen to diffuses into blood.

2. The reduced hemoglobin (HHb) changes shape causing it to lose its H^+ to become Deoxyhemoglobin (Hb). This Deoxyhemoglobin readily picks up oxygen to form Oxyhemoglobin (HbO_2)

Ex. $HHb \rightarrow H^+ + Hb \rightarrow Hb + O_2 \rightarrow HbO_2$

3. H^+ is then picked up by a Bicarbonate ion (HCO_3^-) to break down to produce CO_2 + H_2O

Ex. $H^+ + HCO_3^- \rightarrow H_2CO_3 \rightarrow H_2O + CO_2$

4. The CO_2 then diffuses into the lung alveoli where it is expelled by normal breathing.

*****NOTE: H^+ does not accumulate because as soon as it is released from HHB, it combines with HCO_3^- to release Carbon dioxide.**

- Hemoglobin is essential in the blood because it serves as a carrier for oxygen, carbon dioxide, and hydrogen ions (acts like a <u>buffer</u>).***

- **Use the diagram below to see the role of Carbonic Anhydrase:**