Gas Exchange

I. **External Respiration**

A. **Gas exchange between AIR (at alveoli) and BLOOD (in pulmonary capillaries).**

B. **Both alveoli walls and capillary walls are one cell layer thick.**

C. **This exchange of gases is by diffusion alone**

D. Law of diffusion states that material will flow from area of high concentration to area of low concentration

E. High CO_2 → Low CO_2 = conc. gradient

(blood) (air – 0.5%)

High O_2 → Low O_2

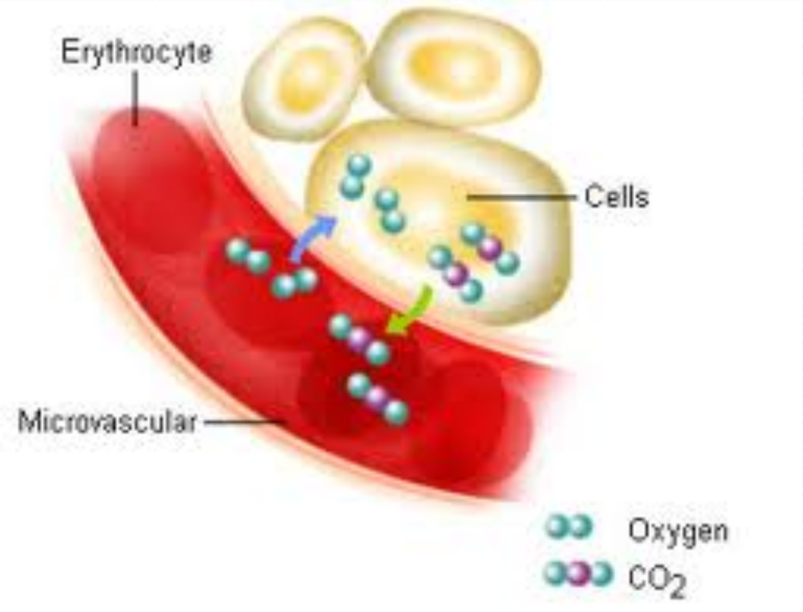
(air – 18%) (blood)

II. Internal Respiration

A. **Gas exchange of O_2 and CO_2 between BLOOD and TISSUE FLUID**

B. **Oxygen diffuses from the systemic capillaries (blood) into tissue fluid**

HbO_2 -----> $Hb + O_2$



C. Tissue fluid is low in O_2, high in CO_2, due to constant cellular respiration

D. CO_2 therefore diffuses into the blood.

E. High CO_2 (tissues) → Low CO_2 (blood)

High O_2 (blood) → Low O_2 (tissues)

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Transport of CO_2 and O_2 in the Blood

I. <u>Oxygen</u>

A. 5% is dissolved in plasma

B. 95% of blood O_2 volume is oxyhaemoglobin (HbO_2)

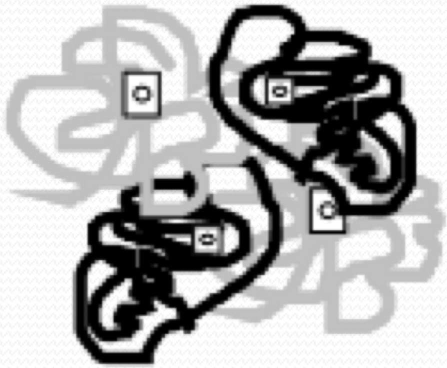
II. <u>Hemoglobin</u>

A. Hemoglobin is an iron-containing respiratory pigment found within red blood cells

B. There are about 200 million hemoglobin molecules per RBC.

C. Hemoglobin increases the oxygen carrying capacity of blood by 60X

D. Hemoglobin is composed of 4 polypeptide chains (a "tetramer") connected to 4 heme groups (contain iron)



E. The iron portion forms a loose association with O_2

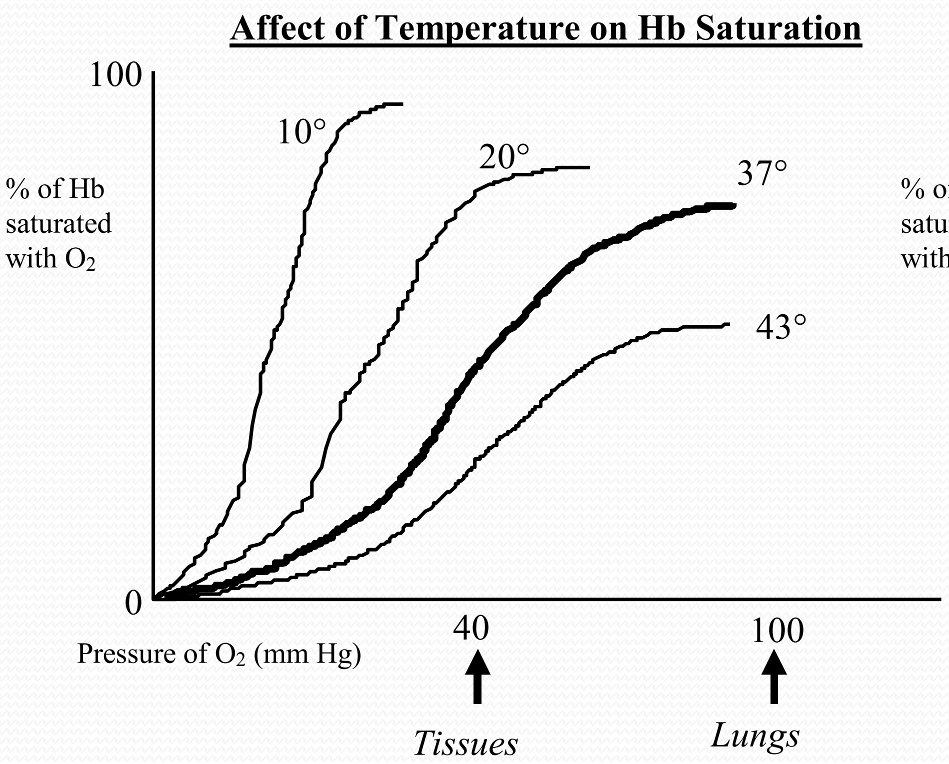
F. Four O_2 bind per hemoglobin molecule

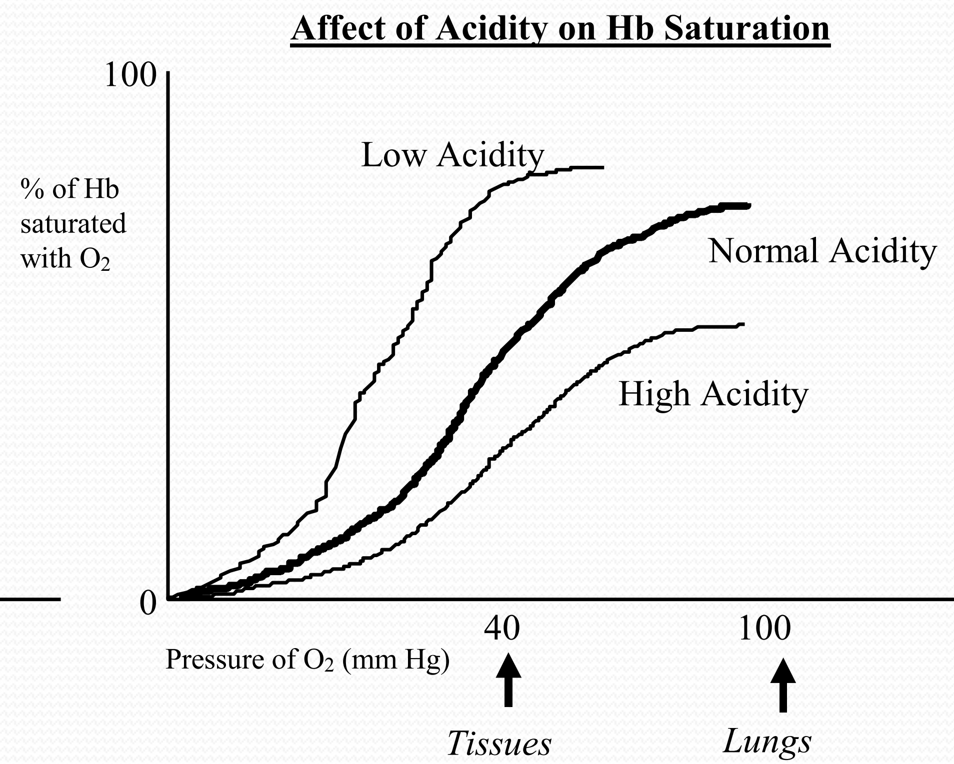
G. How does hemoglobin work?

1. Hb will bind O_2 in the lungs, and release it in tissues.

	LUNGS	
Hb + O_2	----------->	HbO_2
reduced hemoglobin (dark purple)	<----------- TISSUES	oxyhemoglobin (bright red)

2. Hb accepts O_2 more easily at cooler, more basic or neutral pH environment of lungs
3. Hb gives up O_2 at warmer, more acidic environment of the tissues


Affect of Temperature on Hb Saturation
100
0
% of Hb saturated with O_2
10°
20°
37°
43°
Pressure of O_2 (mm Hg)
40
100
Tissues
Lungs


Affect of Acidity on Hb Saturation
100
0
% of Hb saturated with O_2
Low Acidity
Normal Acidity
High Acidity
Pressure of O_2 (mm Hg)
40
100
Tissues
Lungs

III. CO_2

A. **9% dissolved in plasma**

B. **27% is carbaminohemoglobin ($HbCO_2$)**

	TISSUES	
$Hb + CO_2$	----------->	$HbCO_2$
	<----------- LUNGS	carbamino- hemoglobin

C. **64% combines with H_2O to form carbonic acid, which dissociates in to bicarbonate ion (HCO_3^-) & hydrogen ions (H^+)**

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

(to Hb) **(to Plasma)**

D. As CO_2 levels rise due to cellular respiration, so does the H^+ concentration of blood (pH drops)

1. Hemoglobin combines with the excess H+ that this reaction produces
2. Blood pH remains constant
3. Hemoglobin acts like a buffer!

E. Carbonic anhydrase in RBC

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

(in blood) ← (to alveoli)

The above reaction is driven to the right as CO_2 leaves the blood, and is sped up by the enzyme carbonic anhydrase in red blood cells