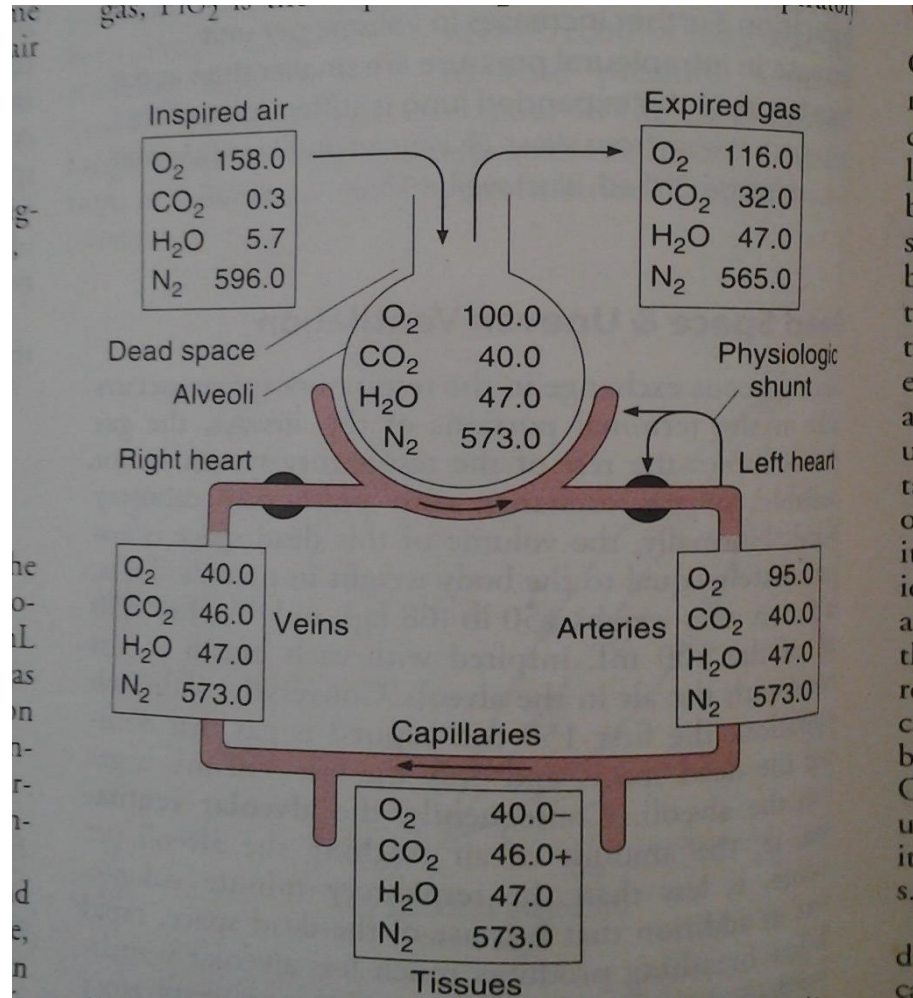


# TRANSPORT OF OXYGEN

# PARTIAL PRESSURE OF GASES



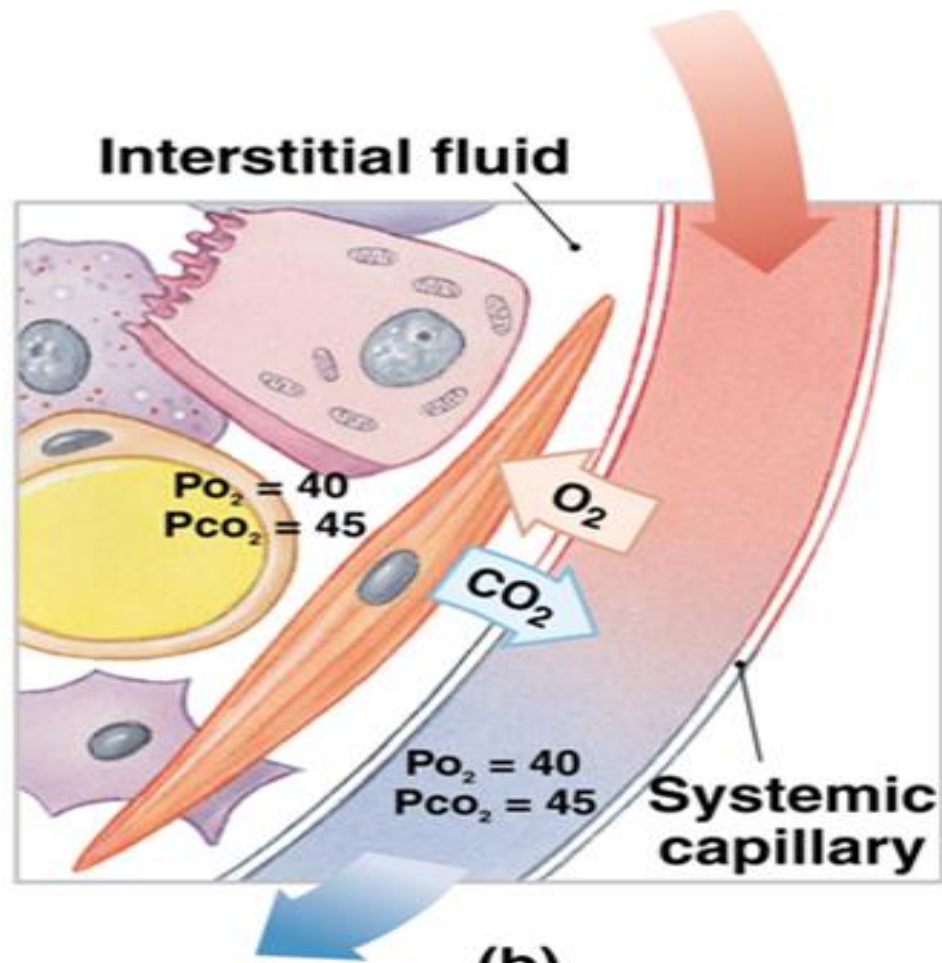
**Figure 34-18.** Partial pressures of gases (mm Hg) in various parts of the respiratory system and in the circulatory system.

# OXYGEN DELIVERY TO THE TISSUE

- Depends on
  - 1. Amount of oxygen entering the lungs
  - 2. Adequacy of pulmonary gas exchange
  - 3. Blood flow to the tissues
  - 4. The capacity of blood to carry oxygen

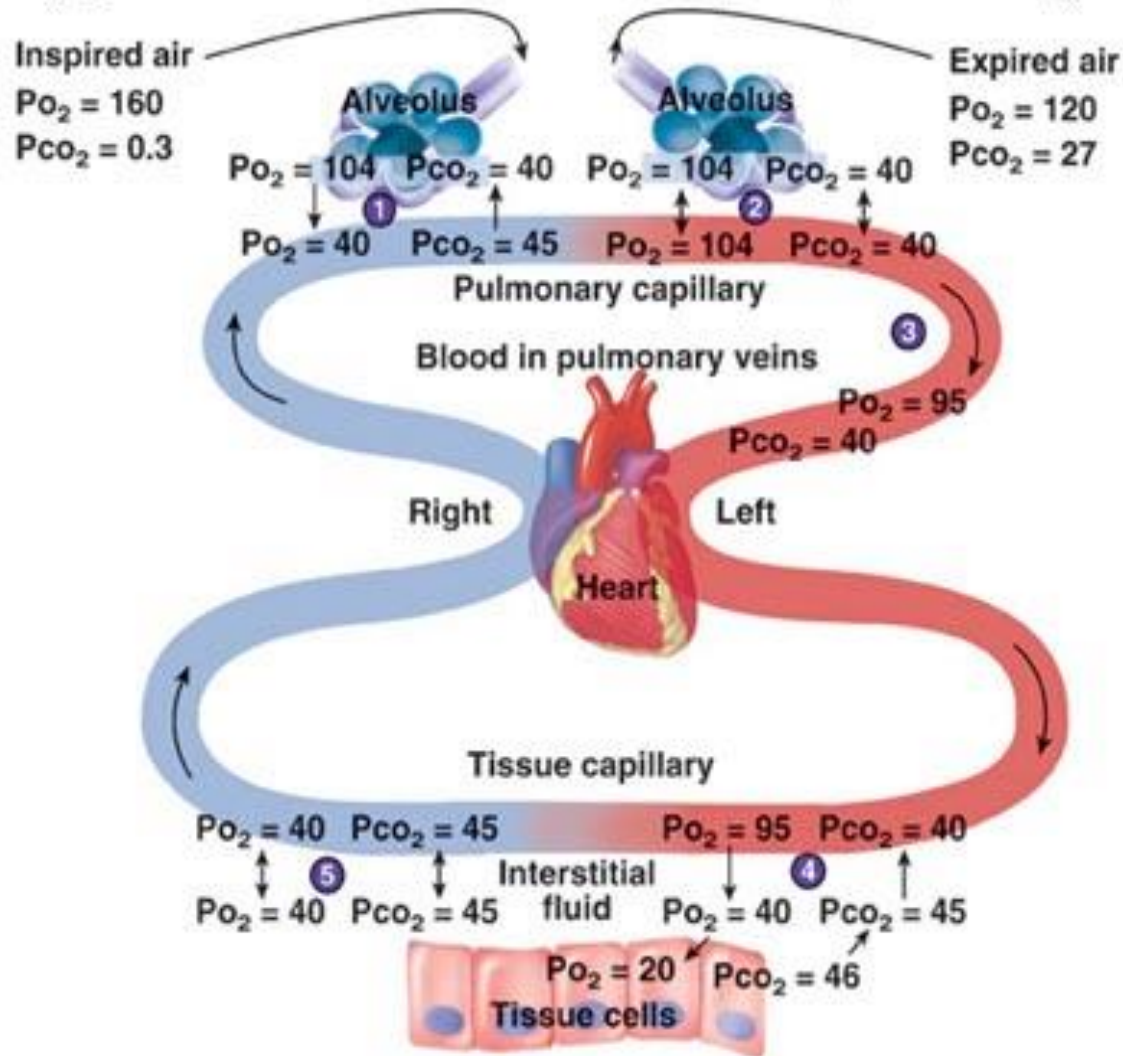
# Difference in the partial pressures

- Why the arterial  $PO_2$  is less than alveolar  $PO_2$ ?



# DIFFUSION AT TISSUE LEVEL

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# METHODS OF OXYGEN TRANSPORT

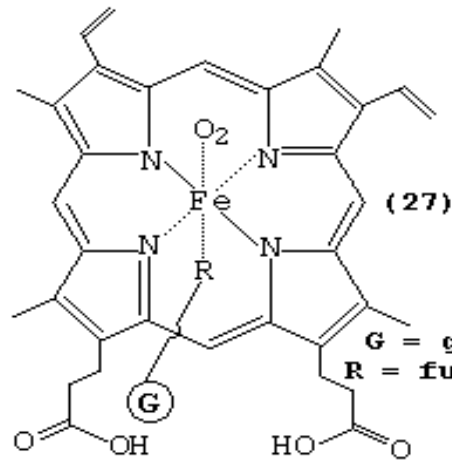
- 1. Combined with Hemoglobin- 97%
- 2. Dissolved in the plasma- 3%
  - 0.3ml of Oxygen/ 100 ml of blood ( considering an arterial PO<sub>2</sub> of 100 mmHg

# REVERSIBLE COMBINATION WITH Hb

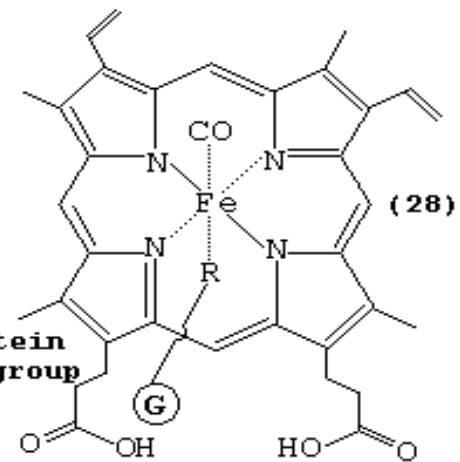
- Oxygen molecule combines loosely & reversibly with hemoglobin when  $PO_2$  is high (pulmonary capillaries)
- When  $PO_2$  is low, Oxygen is released from Hb (Tissue capillaries)
- **This is the basis of Oxygen transport from lungs to the tissues**



# OXYHEMOGLOBIN

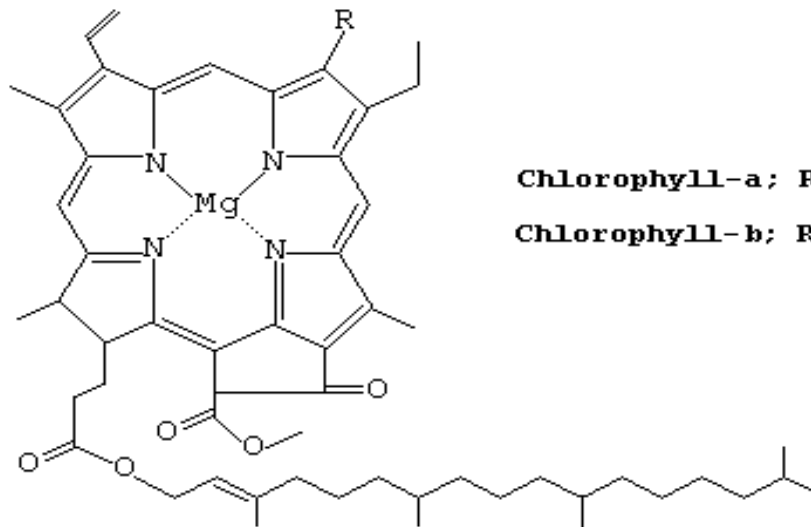


**Oxyhaemoglobin**



**Carboxyhaemoglobin**

**G = globin protein**  
**R = functional group**



**Chlorophyll-a; R = H (29)**

**Chlorophyll-b; R = CH<sub>3</sub> (30)**

# ROLE OF Hb IN OXYGEN TRANSPORT

- Reversible combination of Oxygen with Hb
- Reaction of Hb & Oxygen- Oxygenation
- $\text{Hb}_4 + \text{O}_2 \leftrightarrow \text{Hb}_4\text{O}_2$
- $\text{Hb}_4\text{O}_2 + \text{O}_2 \leftrightarrow \text{Hb}_4\text{O}_4$
- $\text{Hb}_4\text{O}_4 + \text{O}_2 \leftrightarrow \text{Hb}_4\text{O}_6$
- $\text{Hb}_4\text{O}_6 + \text{O}_2 \leftrightarrow \text{Hb}_4\text{O}_8$

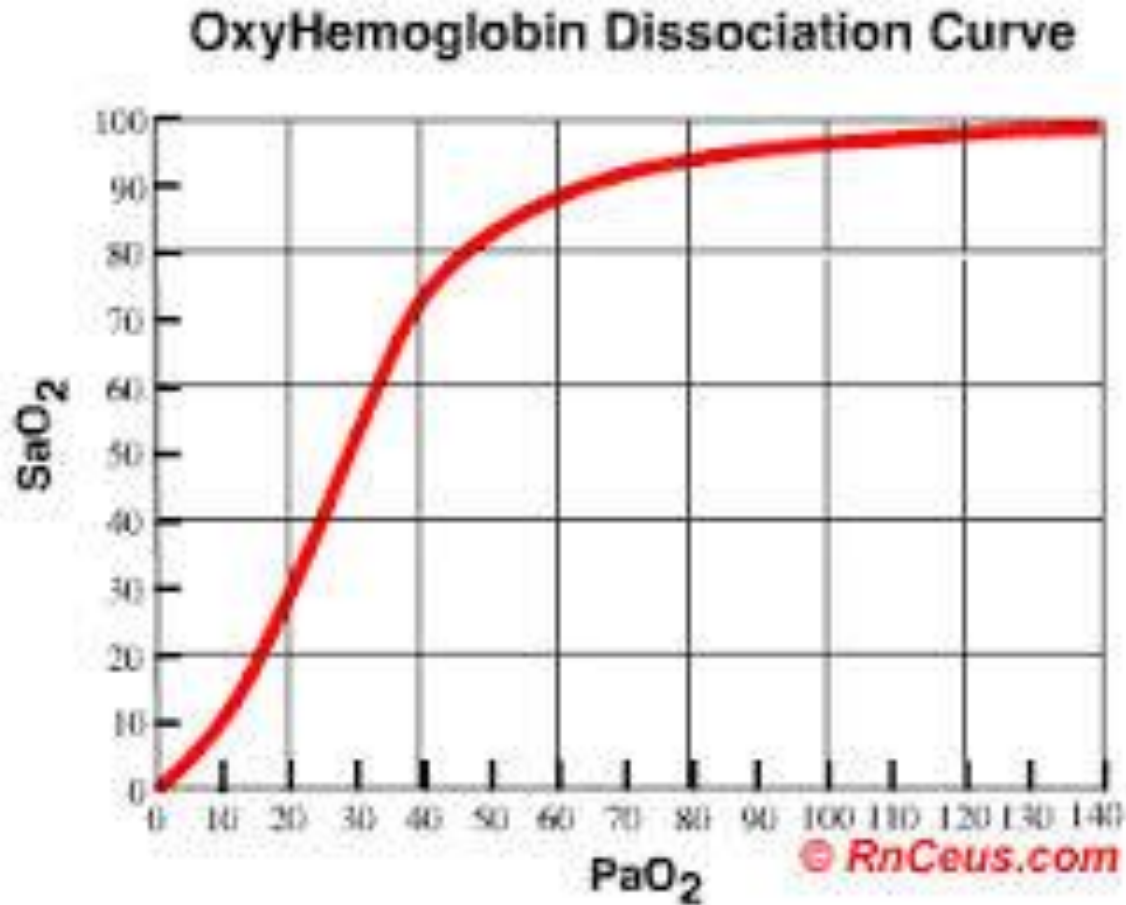
Oxygenation is rapid requiring  $< 0.01$  sec.

Deoxygenation is also rapid

# OXYGEN HEMOGLOBIN DISSOCIATION CURVE

- The curve relating the percentage saturation of oxygen carrying of hemoglobin to  $PO_2$ .
- Sigmoid in shape

# OXYGEN HEMOGLOBIN DISSOCIATION CURVE



# MOLECULAR BASIS OF SIGMOID CURVE

- T-R interconversion
- In deoxyHb, globin units are tightly bound in a **tense 'T' configuration**- Reduced affinity for Oxygen
- Binding with first molecule of Oxygen, bonds holding , globin units are released producing **relaxed – Relaxed (R) configuration**- exposes more oxygen binding state.
- Binding of First molecule of oxygen make the binding of second molecule easier and so on

# MOLECULAR BASIS OF SIGMOID CURVE

- Saturation rises steeply between 15 mm Hg and 40mm Hg
- Beyond 60 mm Hg- Plateau- Most of the binding sites are already occupied by Oxygen

# ADVANTAGES OF SIGMOID SHAPE

- Amount of Oxygen carried by hemoglobin does not change much If  $PO_2$  drops from 100 to 60%- Beneficial at high altitude
- Steep portion of curve- Between 15 and 40mm Hg- Any small increase in  $PO_2$  – Oxygen carrying capacity of blood is increased markedly.

# OXYGEN CARRYING CAPACITY OF HEMOGLOBIN

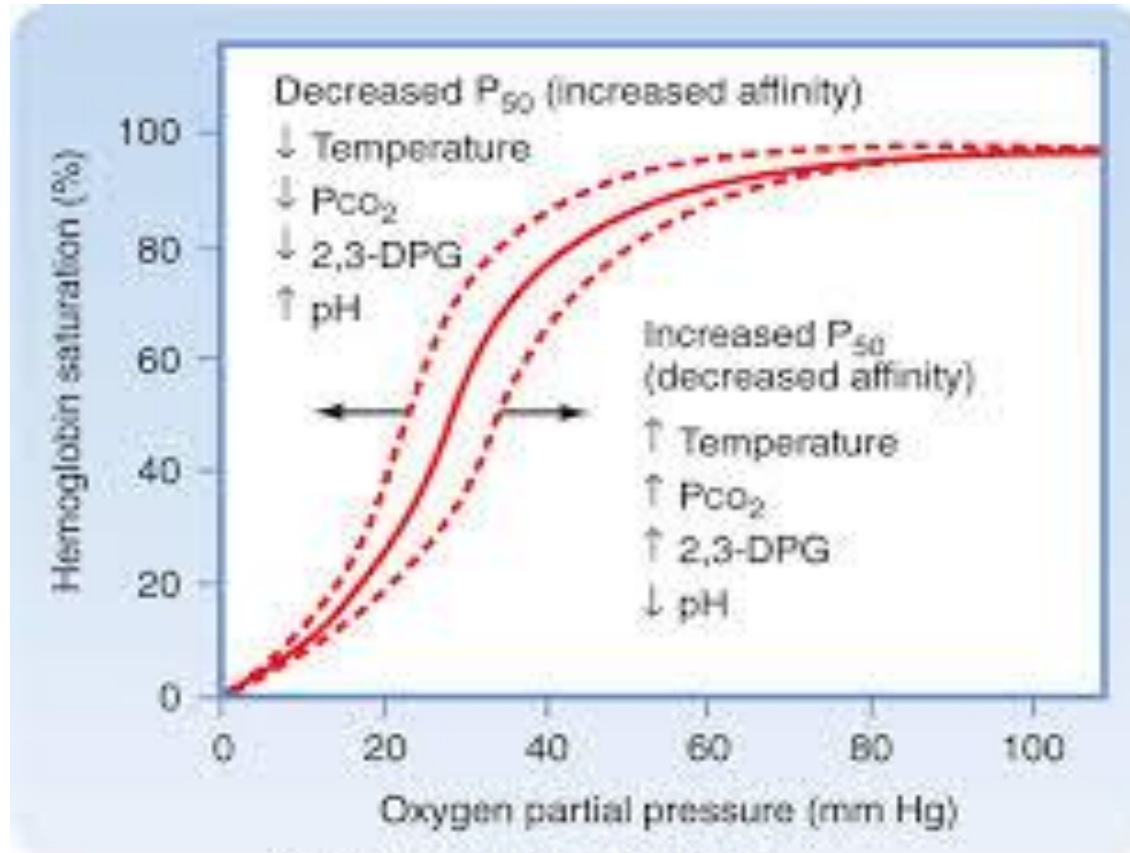
- 1 g of fully saturated normal Hb-  
Contain **1.39 ml** of oxygen
- As blood normally contains small amount of inactive derivatives, measured value is lower  
– **1.34 ml of Oxygen**
- Hb conc. In blood of Hb.  $15\text{g/dl} = 20.1\text{l/dL}$ -  
when Hb is 100% saturarted.
- Dissolved Oxygen – linear function of  $\text{PO}_2$ -  
 $0.003\text{ml/dl blood/mm Hg}$

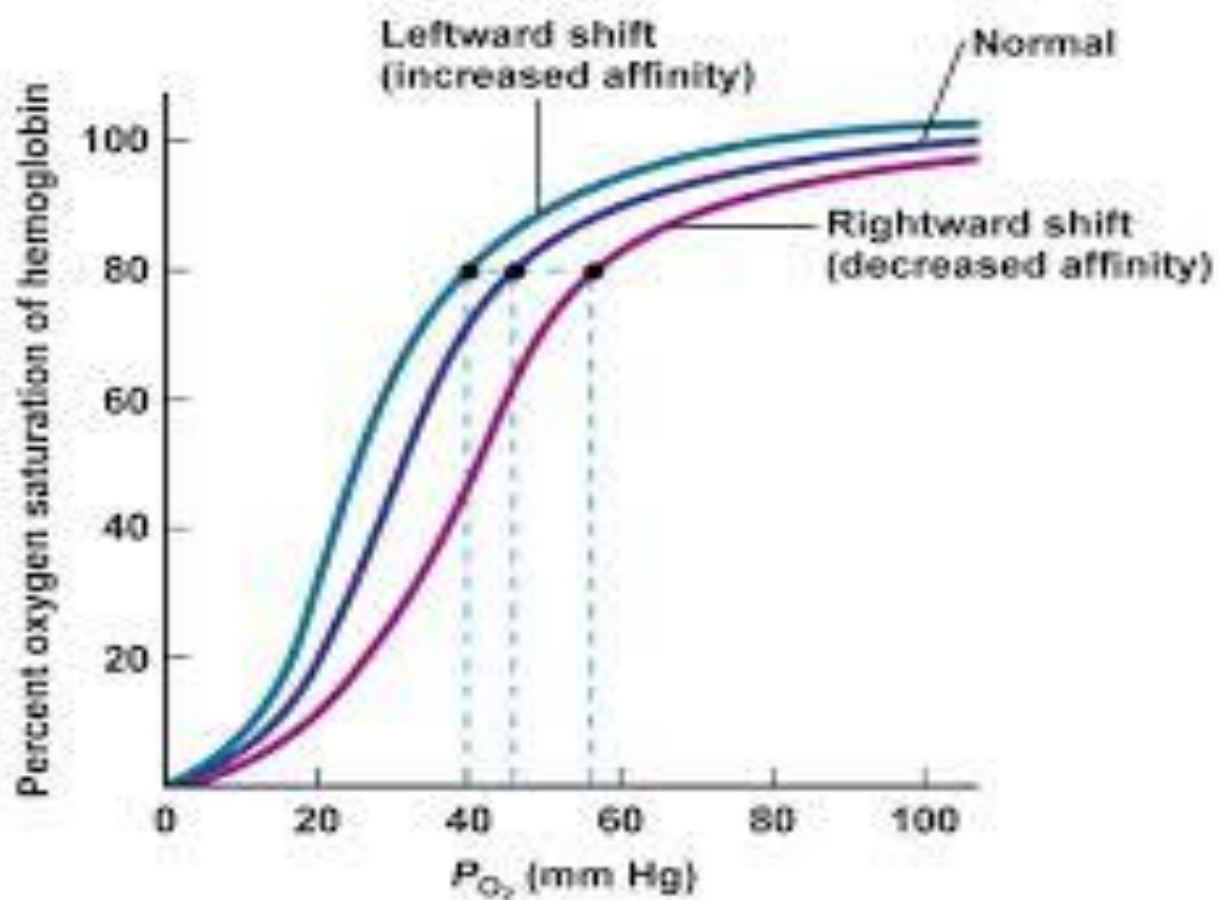


# AMOUNT OF OXYGEN RELEASED

- Oxygen content of normal **systemic arterial blood** (97.5 percent saturated) is **19.8ml/100ml of blood**
- ( 19.5 ml bound to Hb & 0.29 ml in solution)
- **Venous blood** - ( PO<sub>2</sub> – 40mm Hg- 75 percent saturated) – **15.2 ml/ 100ml**
- ( 15.1 ml bound to Hb & 0.12 ml in solution)
- Amount of Oxygen removed at tissue- **4.6ml/dl**

# OXYGEN TRANSFER





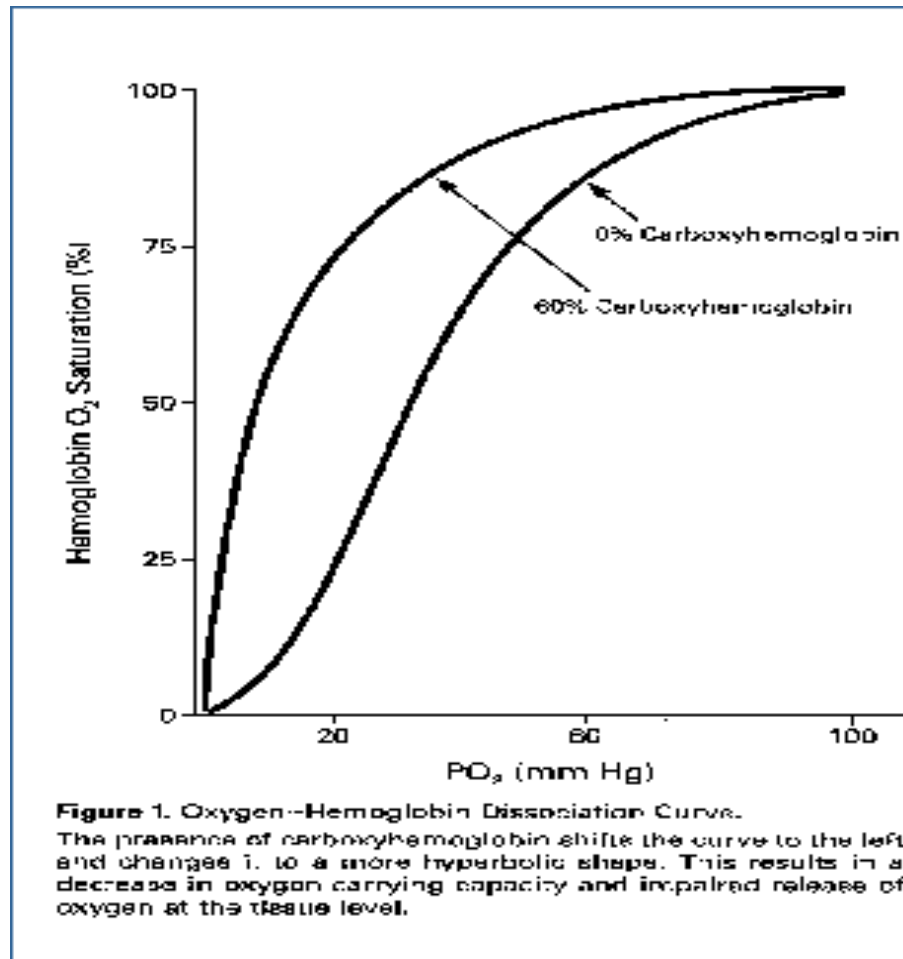
# BOHR EFFECT

- The right shift of oxygen hemoglobin dissociation curve brought about by an increase in  $\text{PCO}_2$  is called Bohr effect
- Possibly mediated by an increase in  $\text{H}^+$  concentration
- When  $\text{H}^+$  binds with Hb  $\rightarrow$  Configurational change in Hb  $\rightarrow$  Accessibility of Oxygen to heme group is reduced

# $P_{50}$

- $P_{50}$  is the  $PO_2$  at which Hemoglobin is 50% saturated
- Normal value about 26.6mm Hg at  $pCO_2$ , pH 7.4 and temperature  $37^{\circ}C$
- Significance of  $P_{50}$ - Helps to determine Hb affinity for oxygen
- Hb affinity for Oxygen is an inverse function of  $P_{50}$  value- Higher the  $P_{50}$ , lower the affinity for Hb to Oxygen

# CARBON MONOXIDE POISONING

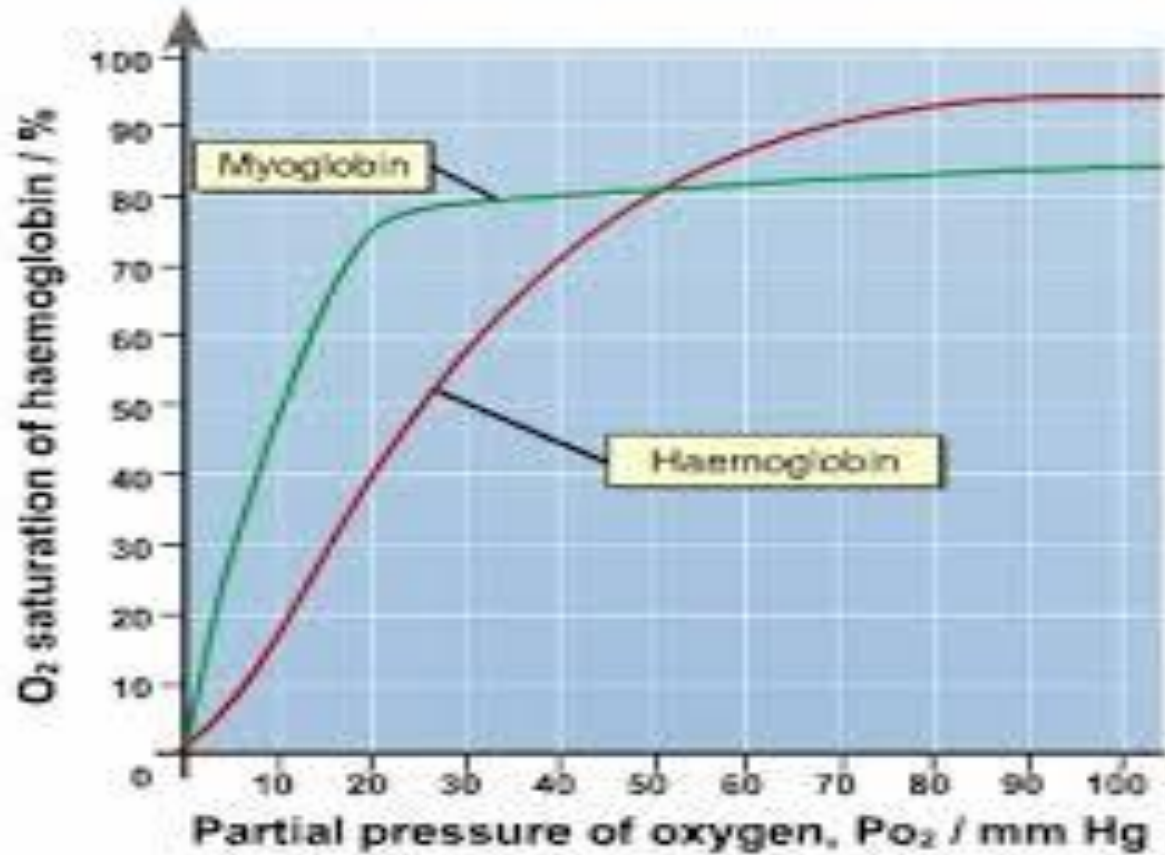


# CARBONMONOXIDE POISONING

- CO has more affinity for Hb than Oxygen ( 210) times
- So even at low conc. Of CO, it can displace Oxygen.
- Oxygen delivery to the tissue is also affected.
- Lethal conc. Of CO in air is 0.1%
- Treatment Of CO poisoning-
  - 100% Oxygen
  - Hyperbaric Oxygen therapy

# MYOGLOBIN

Oxygen dissociation curve

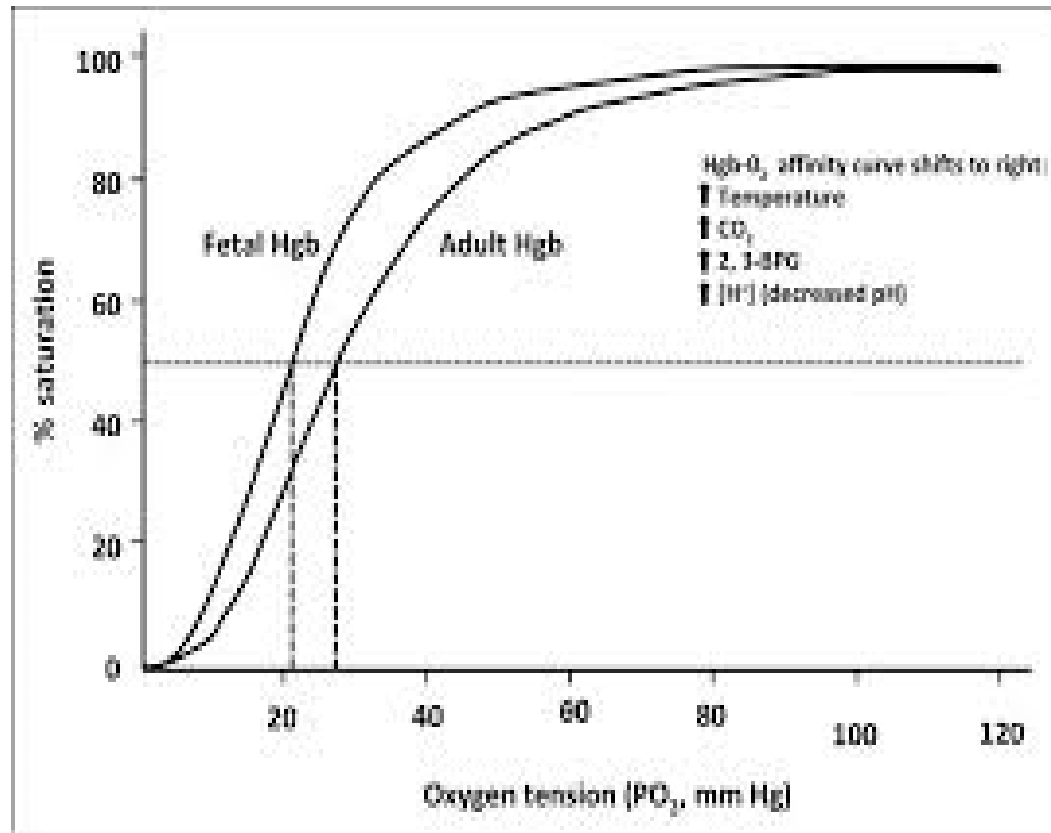




# MYOGLOBIN

- Shape of dissociation curve is rectangular hyperbola
- As the curve is left to Oxygen Hb curve, it takes up oxygen from Hb in the blood.
- Releases Oxygen only at low  $PO_2$

# FETAL HEMOGLOBIN



# FOETAL HEMOGLOBIN

- The greater affinity of Hb F than adult Hb for Oxygen facilitate movement of Oxygen from mother to fetus

# DISSOLVED FORM

- At normal arterial  $PO_2$ , 95 mm Hg- Dissolved Oxygen is 0.29ml/100ml
- At  $PO_2$ , 40mm Hg – 0.12ml
- Oxygen transported in dissolved Oxygen – 0.17 ml/ 100ml arterial blood flow

# FUNCTIONS OF HEMOGLOBIN

- 1. Facilitate oxygen transport
- 2. Facilitate carbon dioxide transport
- 3. Buffer
- 4. Transport of Nitric oxide