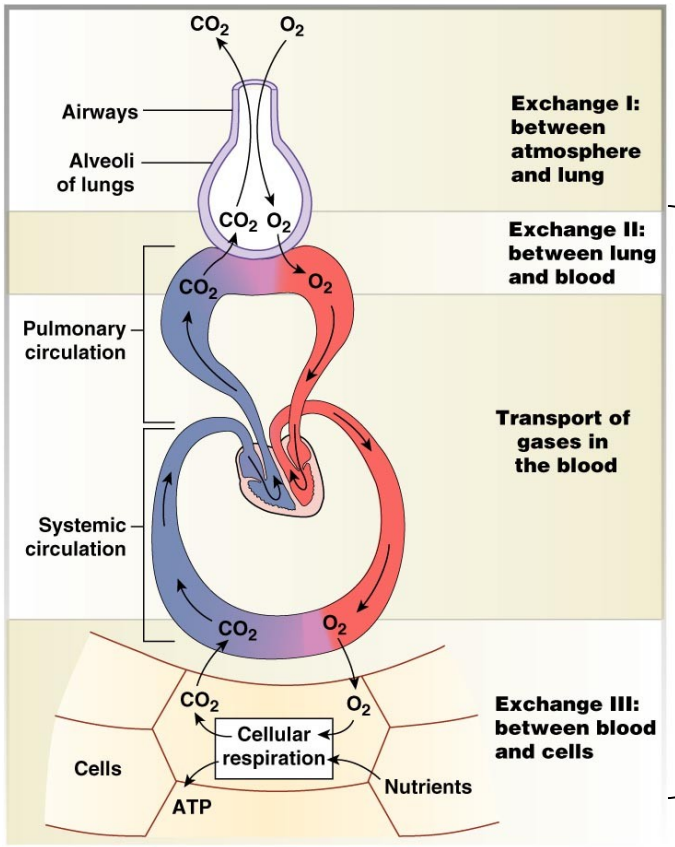
Respiratory Physiology



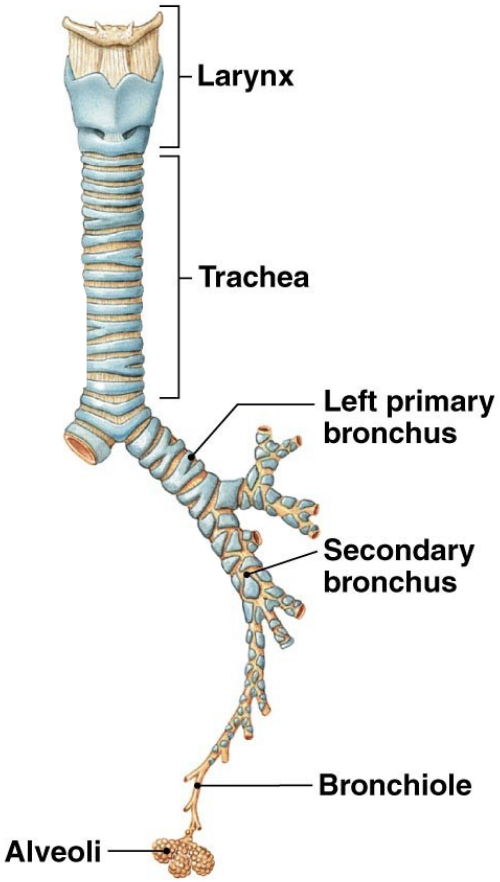
1) Mostly covered in Lab; Control of Air Flow

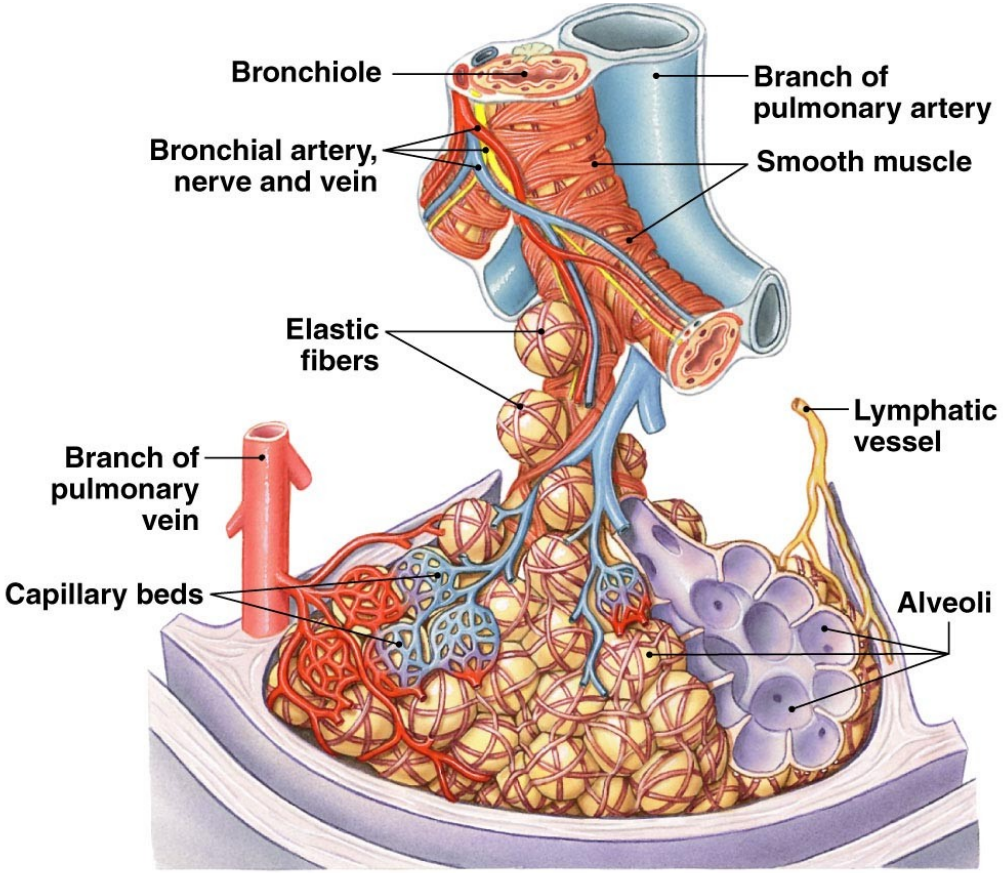
Gas exchange (2,4) and Transport (3)

Oxygen & Carbon Dioxide

The primary function of the respiratory system is to exchange O2 and CO2 between blood and air

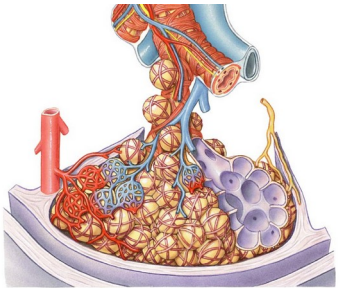
*Air must **FLOW** through airways to **Alveoli***





***veoli** are where **gas exchange** between **air** & **blood** occurs*

Factors affecting air flow



Costs Energy > Diaphragm Contraction!

1) Pressure needed to expand sphere (alveoli)

Name	Division	Diameter (mm)
Trachea	0	15–22
Primary bronchi	1	10–15
Smaller bronchi	2	1–10
	3	
	4	
	5	
	6–11	
Bronchioles	1–23	0.5–1
Alveoli	24	0.3

Pulmonary Surfactant – decreases ST required to expand alveoli during inspiration

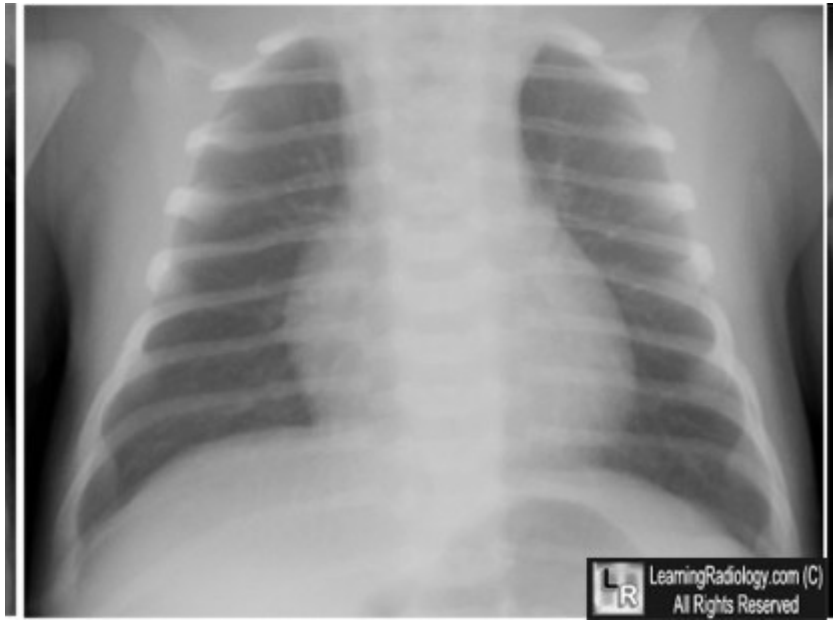
Pressure Tension = **Surface**

Alveolar Radius

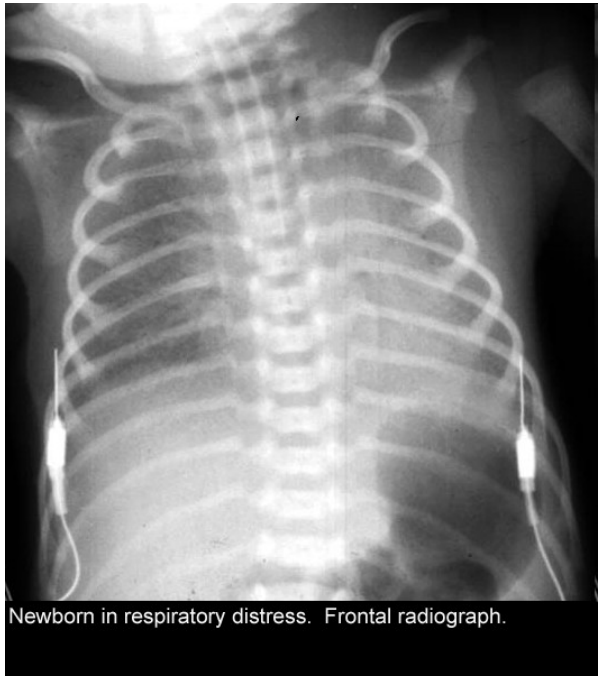
Very Small>>>>>Huge Pressure Need

Medical Relevance of Surfactant

Normal Infant



Infant Respiratory Distress Syndrome (IRDS)



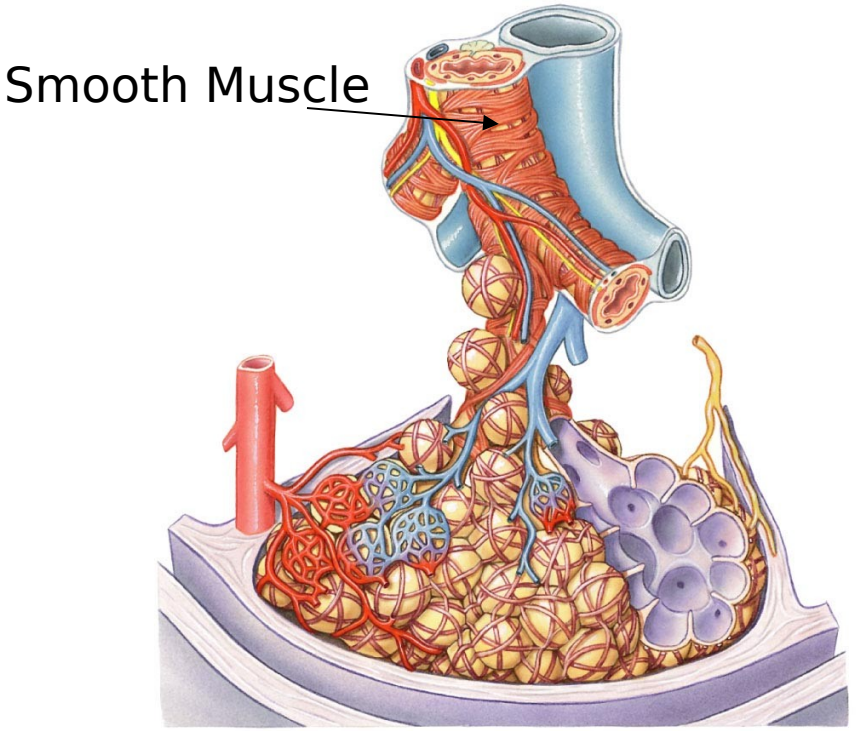
Premature infants (< 32 weeks), leading cause of infant mortality in

Factors affecting Airflow

2) Airway Resistance = 1/ airway diameter

Resistance increases as airway diameter decreases

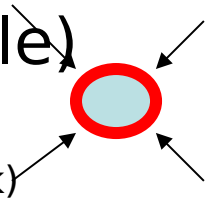
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Alveoli	24	0.3



Smooth Muscle control: ANS, Hormones & Local Chemicals

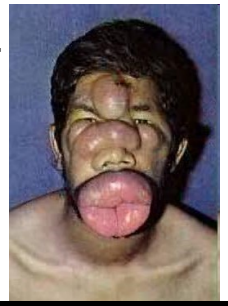
ooth Muscle control: ANS, Hormones & Local Chemic

Bronchoconstriction (contraction of smooth muscle)



ANS – Parasympathetic > acetylcholine > muscarinic receptors (weak)

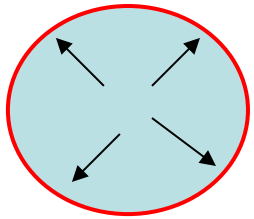
Local – **Histamines** due to irritation or



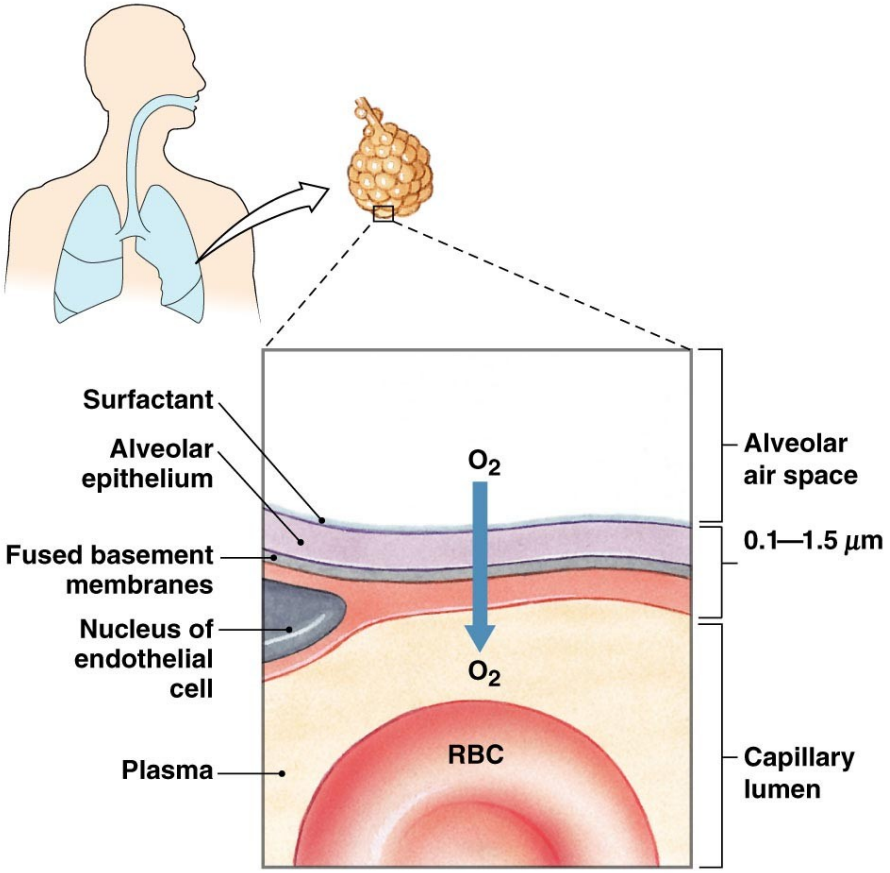
Bronchodilation (relaxation of smooth muscle)

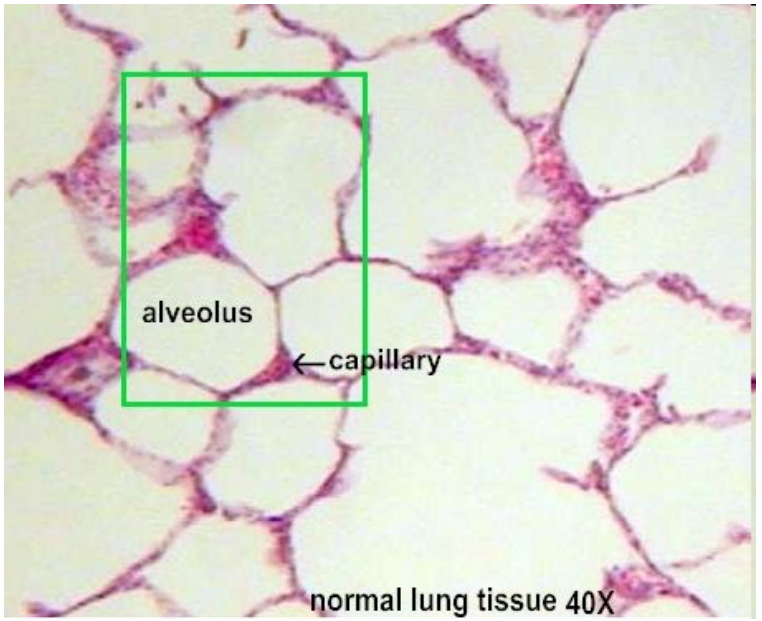
Hormonal - Epinephrine (adrenal) > β_2 receptors (Epi-Pen for bee sting!)

Local – high CO2 during expiration



Alveolar-Blood Interface





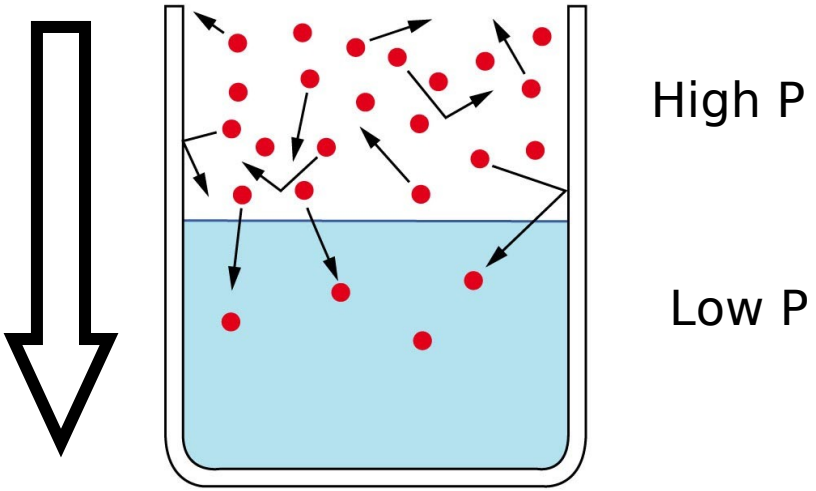
Membrane between Alveoli & Capillary is VERY VERY THIN

.....increases diffusion rate

Simple Diffusion & Partial Pressures

<u>Rate of Diffusion = Concentration Gradient</u>

Gas Concentrations are represented by **Partial Pressures**!

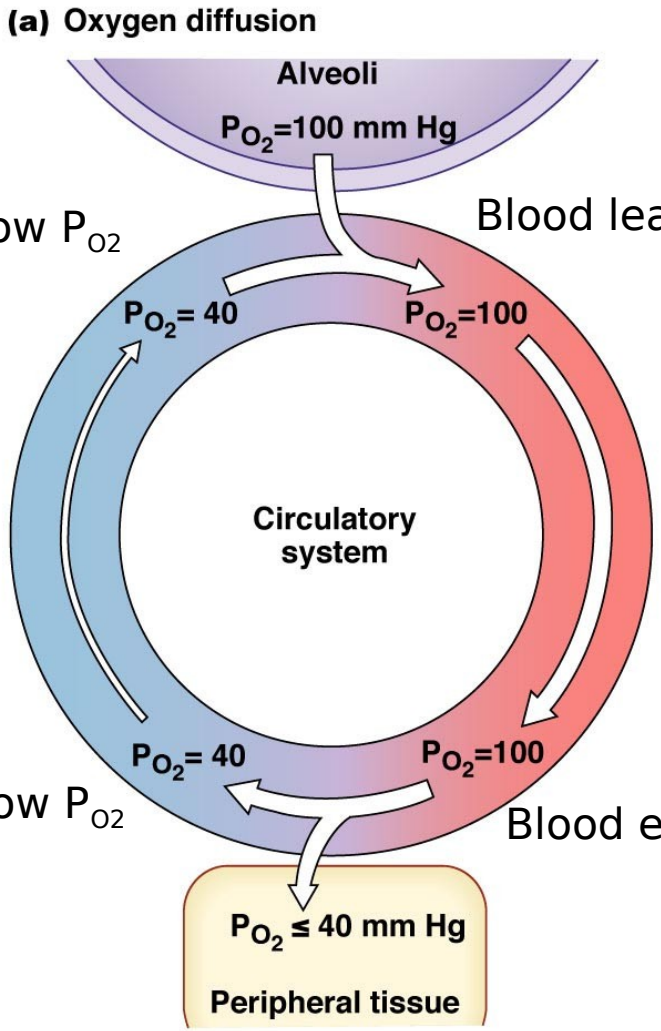


ffusion is best over VERY VERY short distances…..that is why alveoli-blood interface is so th

Diffusion between Alveoli & Blood: OXYGEN

Blood entering Lungs has Low P_{O2}

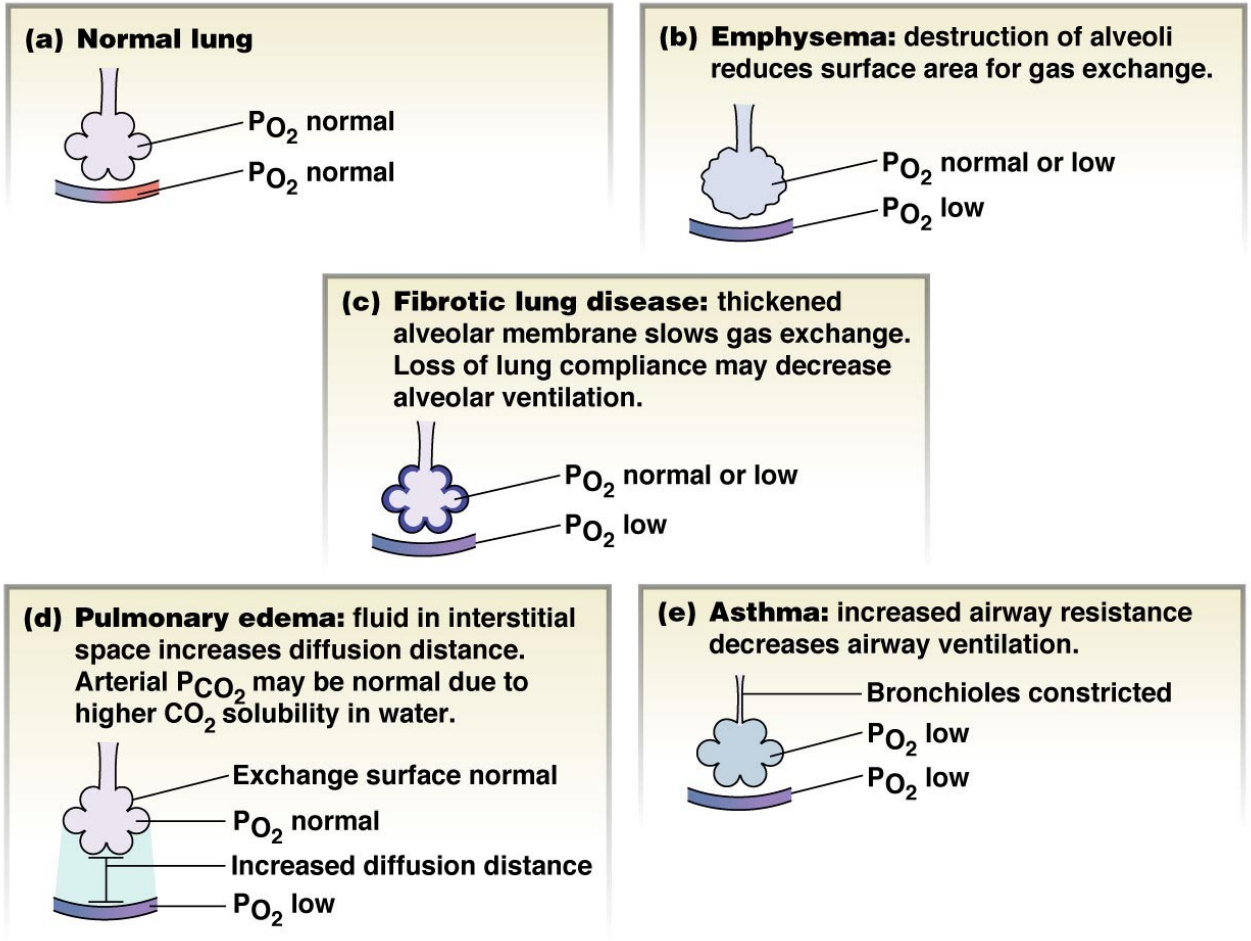
Blood leaving Lungs has High P_{O2}



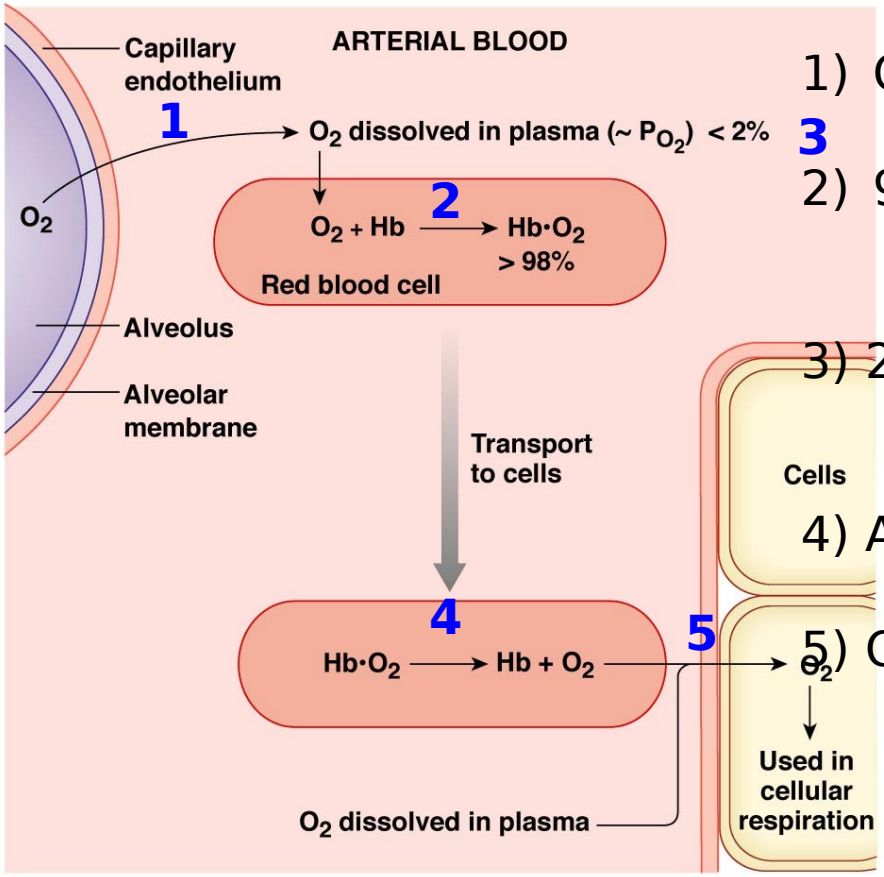
Blood leaving Tissue has Low P_{O2}

Blood entering Tissue has High P_{O2}

Diseases affecting O2 Diffusion



Oxygen Transport in Blood



1) O2 diffuses into blood from Alveoli

2) 98% of diffused oxygen enter RBC binds to Hemoglobin (Hb)

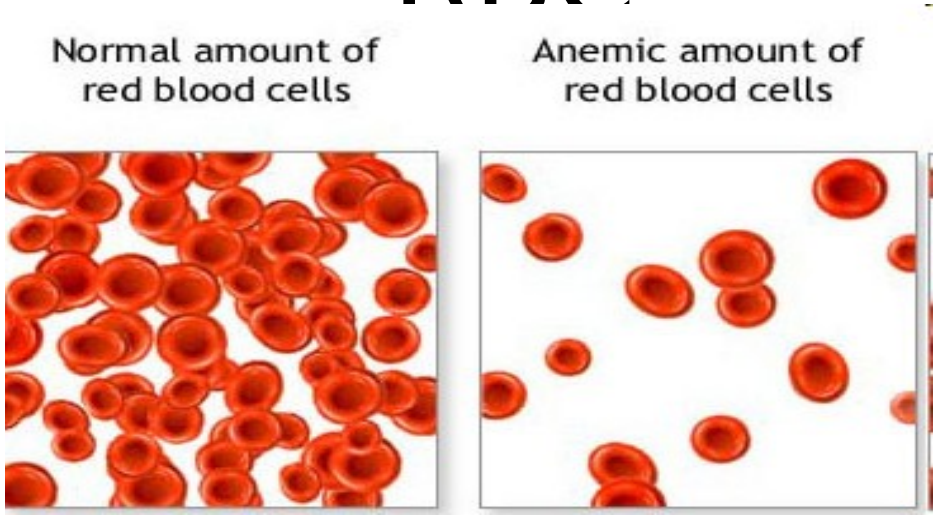
3) 2% of oxygen remains in plasma

4) At tissue, Hb + O2 dissociate

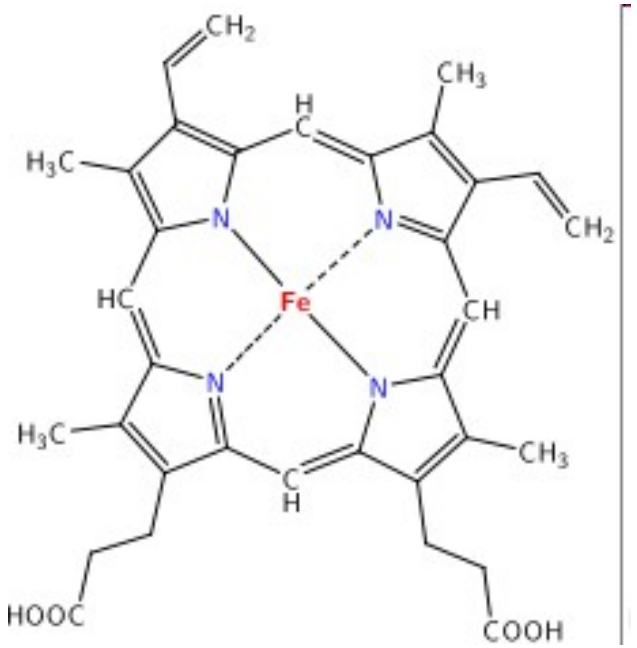
5) O2 dissolves through plasma into ISF

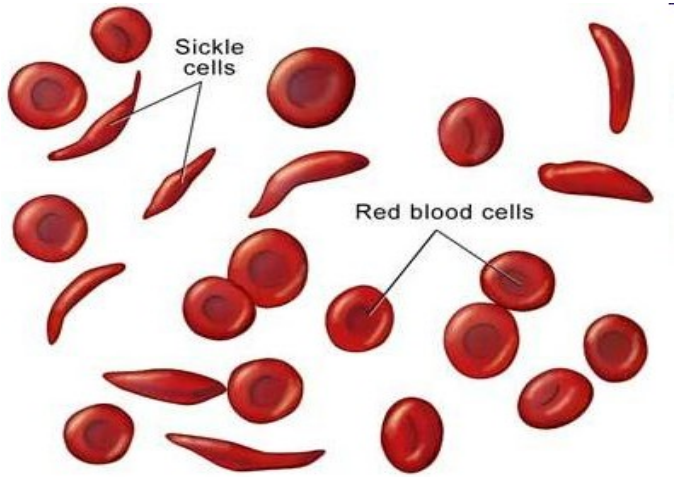
Hemoglobin in RBC allows blood to carry 5000% more oxygen!

Anemia: too few RBC



1) Iron Deficiency = no heme

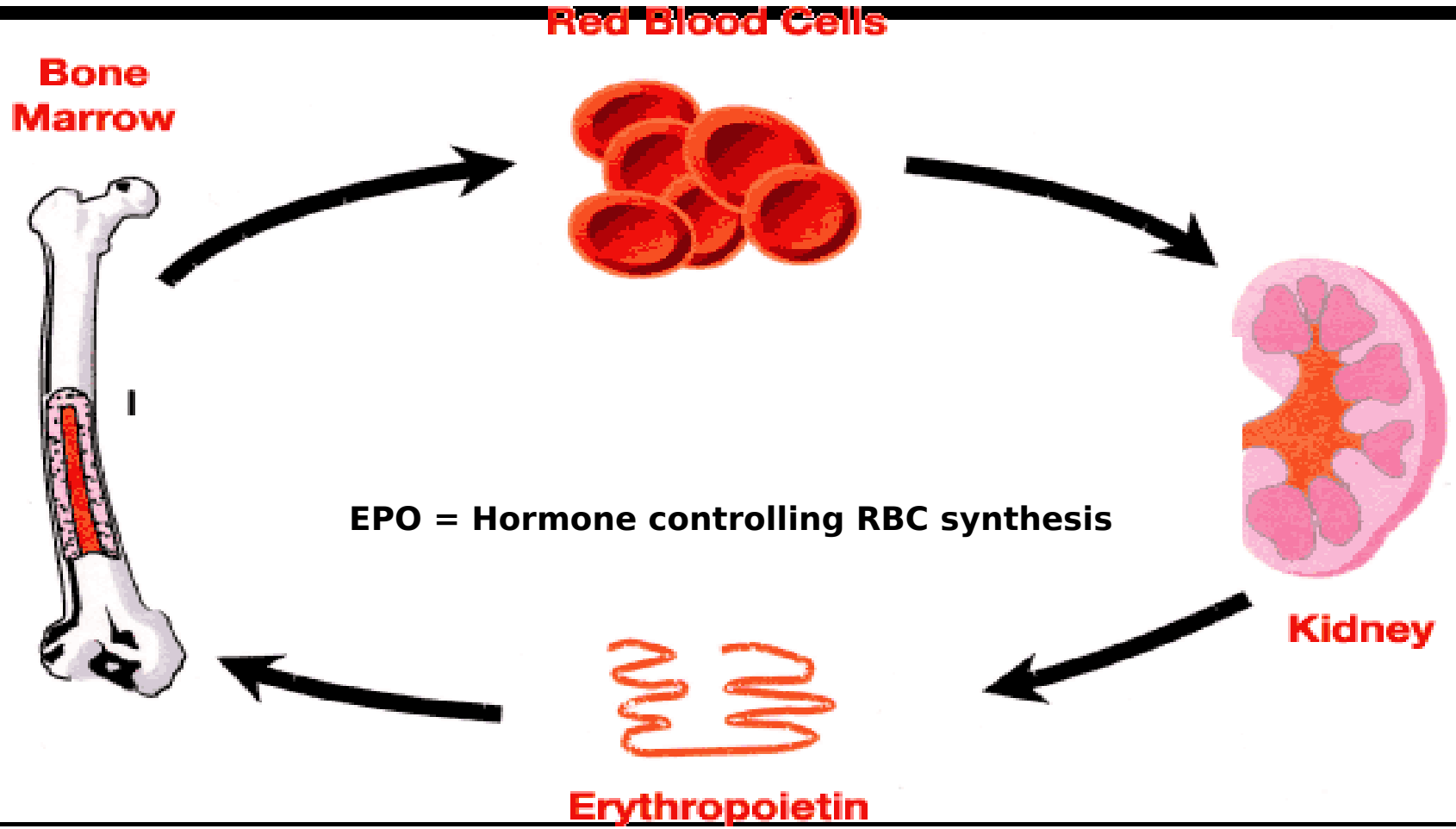




3) Sickle Cell: hereditary

2) B_{12} or Folate Deficiency = reduced DNA synthesis

Erythropoetin (EPO)



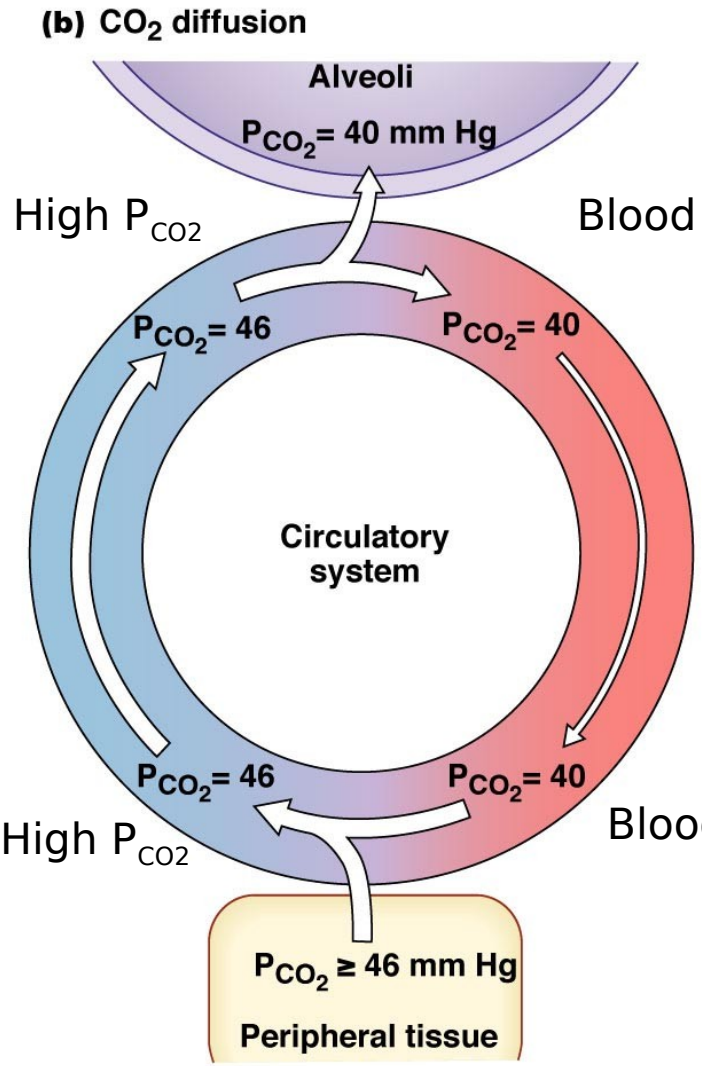
Blood Doping = synthetic EPO supplement

= more RBC = more O_2 carrying capacity

Diffusion between Alveoli & Blood: CO2

Blood entering Lungs has High P_{CO2}

Blood leaving Lungs has Low P_{CO2}

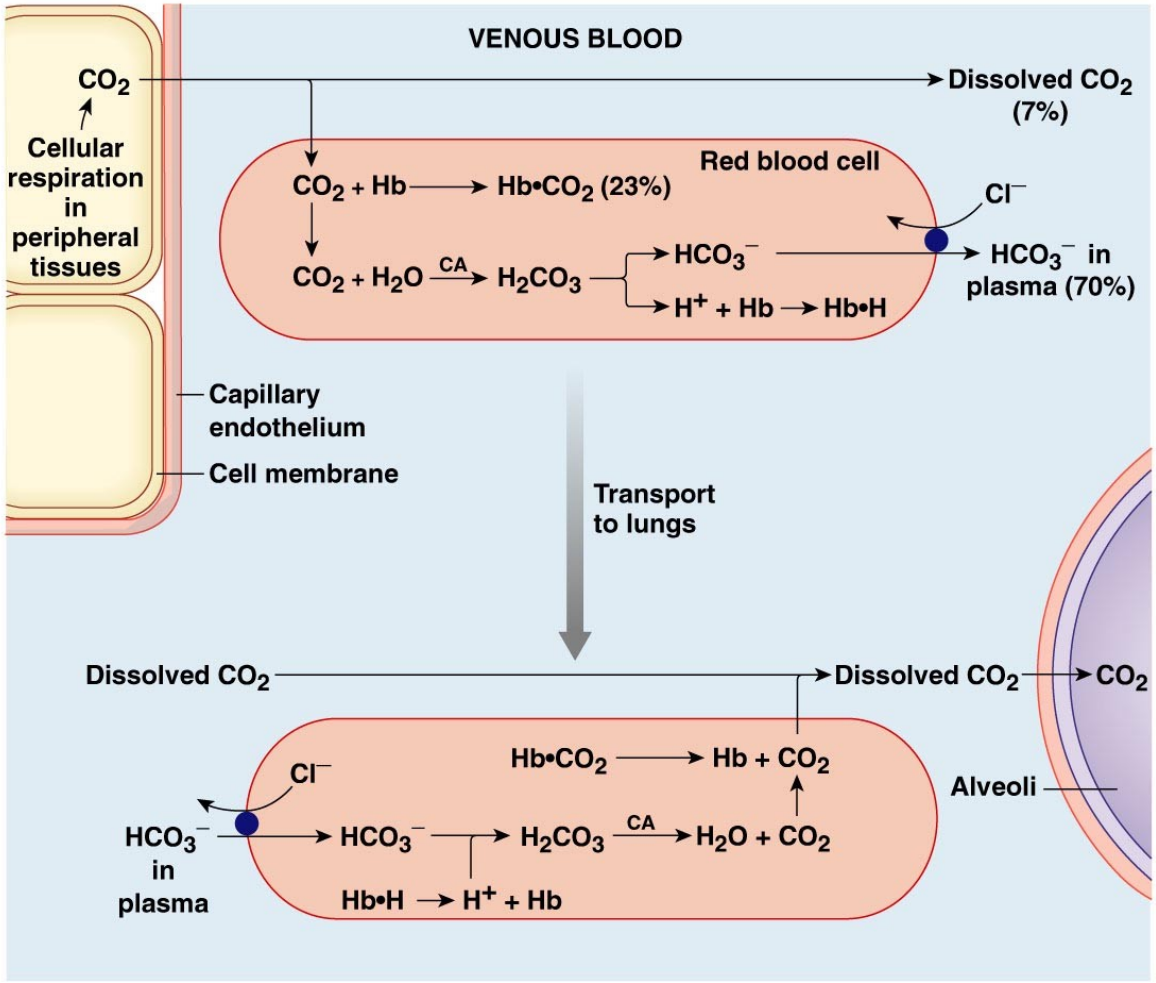


Blood leaving Tissue has High P_{CO2}

Blood entering Tissue has Low P_{CO2}

Carbon Dioxide Transport in Blood

1) Dissolved CO_2 ~ 7%

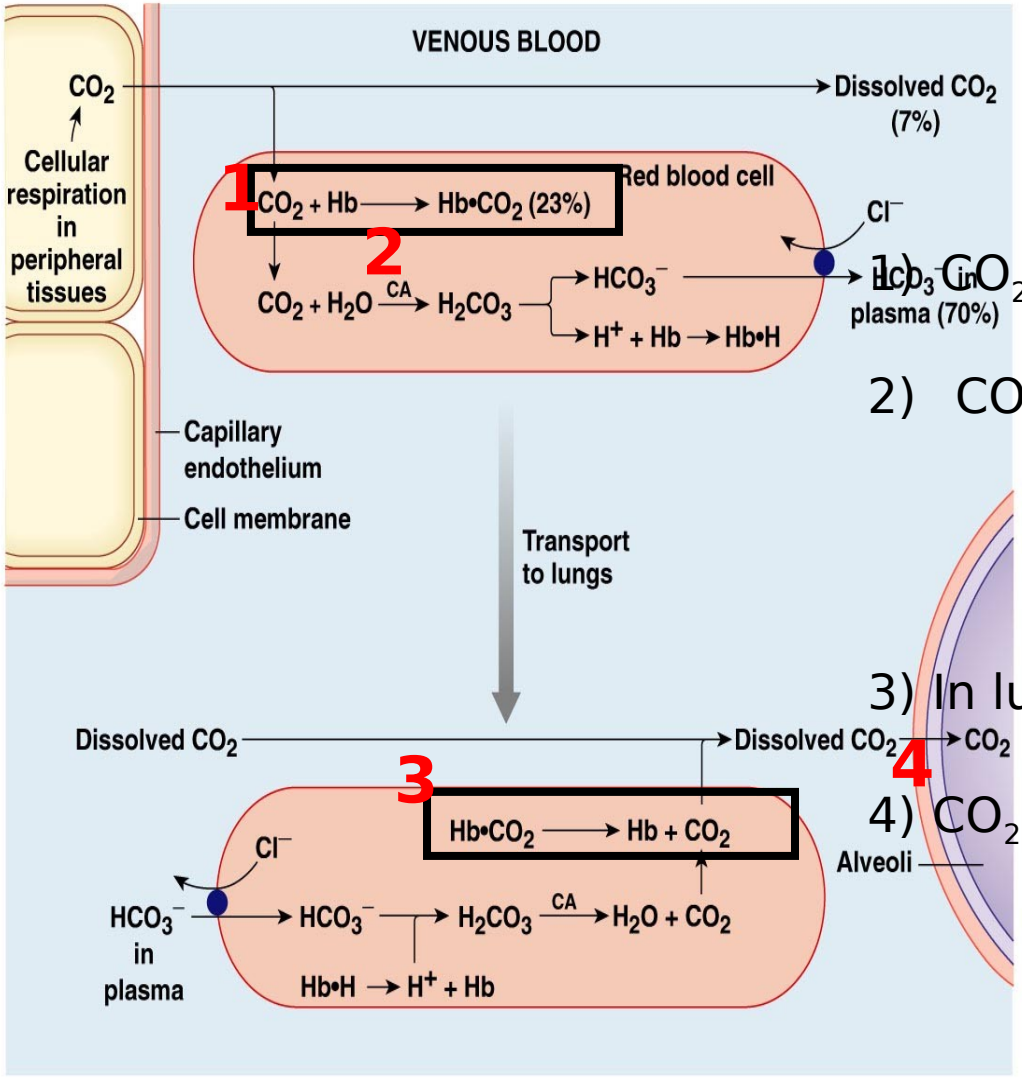


1) Diffusion from tissues to capillaries

2) Diffusion from venous blood to alveolar air

Carbon Dioxide Transport in Blood

2) Hemoglobin transport ~ 23%



1) CO_2 diffuses into blood from tissues

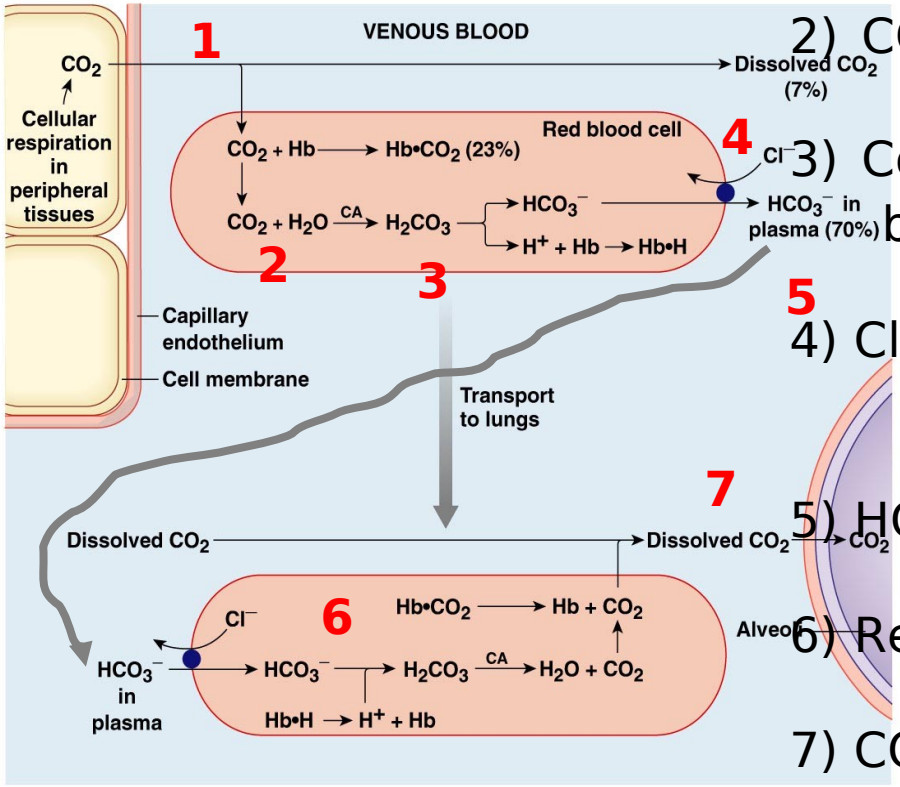
2) CO_2 binds to Hemoglobin (Hb)

3) In lungs, Hb + CO_2 dissociate

4) CO_2 dissolves into plasma and diffuses to air in alveoli

Carbon Dioxide Transport in Blood

3) Bicarbonate Ion ~ 70%



1) CO_2 dissolves into plasma

2) CO_2 enters RBC and combines with water

3) Converted to HCO_3^- & $Hb\text{-}H^+$ by CARBONIC ANHYDRASE (CA)

4) Cl^- ion is exchanged for HCO_3^- in CHLORIDE SHIFT

5) HCO3- is carried in plasma to lungs

6) Reverse of 3 & 4

7) CO_2 dissolves in plasma and diffuses to alveolar air

HCO_3^- (Bicarbonate) is the most important pH buffer in blood

Chloride Shift maintains RBC membrane electrical neutrality

$Hb\text{-}H^+$ helps maintain pH by using extra H^+ ion from 2)

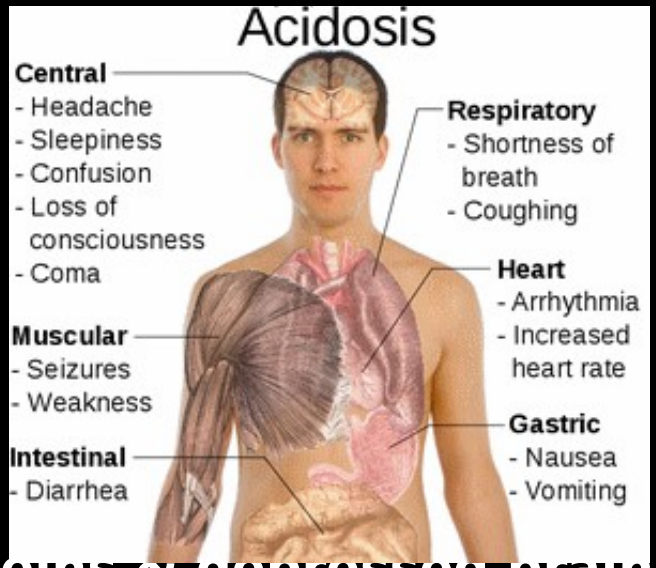
Poor CO2 elimination – Respiratory dysfunction

Why is removing CO_2 important?

$$CO_2 + H_2O \xrightarrow{CA} H_2CO_3 \rightarrow HCO_3^- + H^+$$

Elevated H+ leads to acidic blood

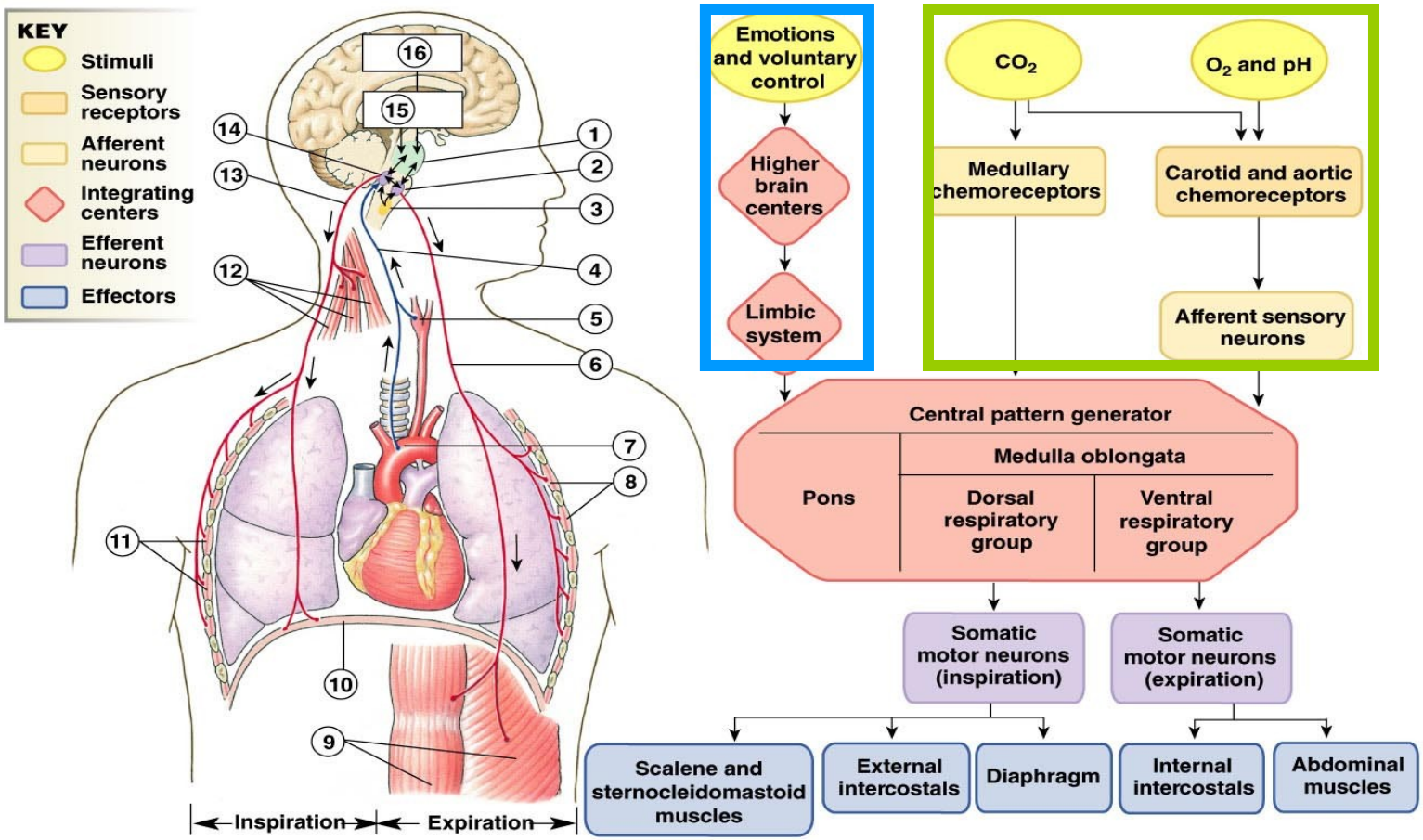
Elevated CO_2 = Hypercapnia



Acidosis leads to denatured proteins & depressed brain function

Causes of Resp. Dys.: COPD, Emphysema, Musc Dystrophy, Asthma, Alcohol Use

Control of Ventilation



Chemoreceptor pathways ALWAYS override **Voluntary pathways**

You can't hold you breath until you die!

This is why you drown!!!!