GAS EXCHANGE AND GAS TRANSFER

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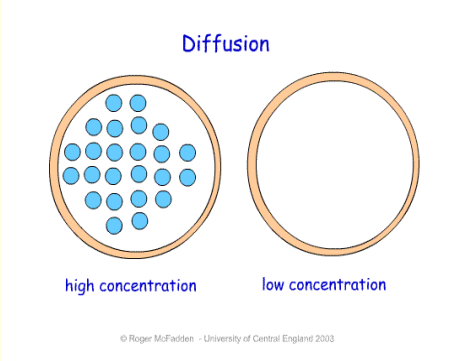
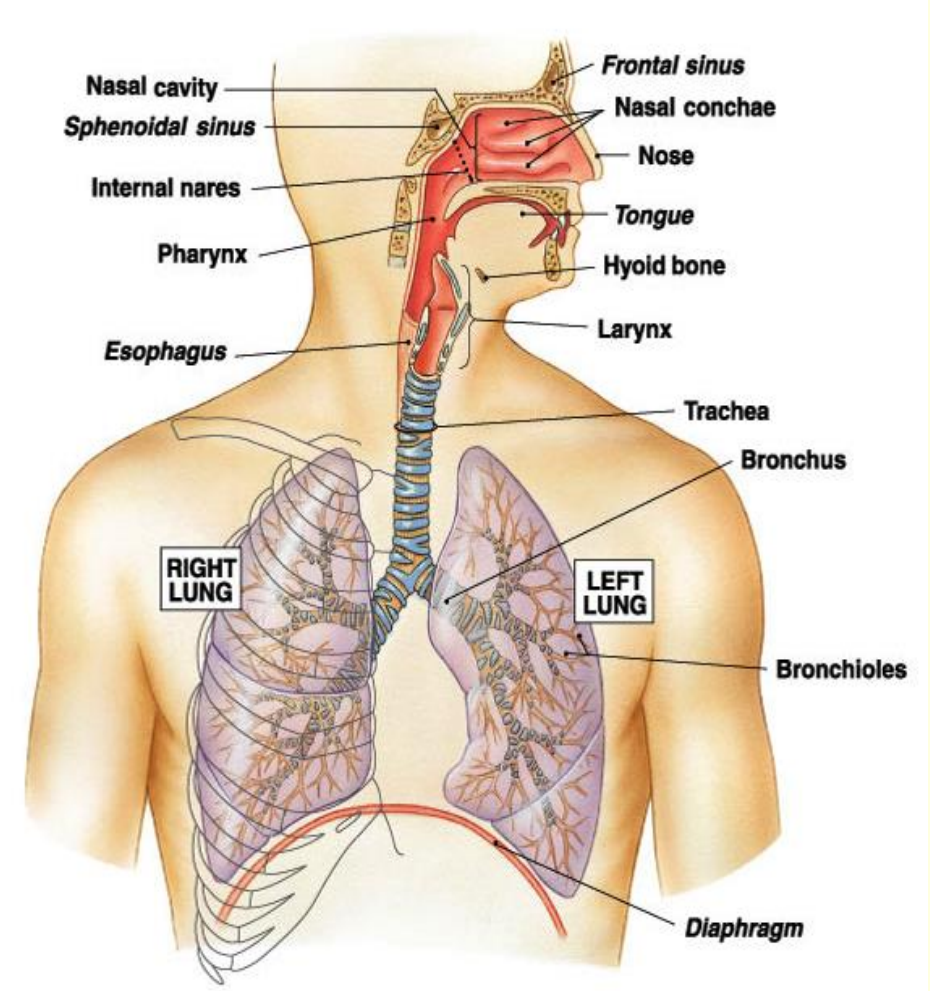
DIFFUSION OF GASES AND LAWS

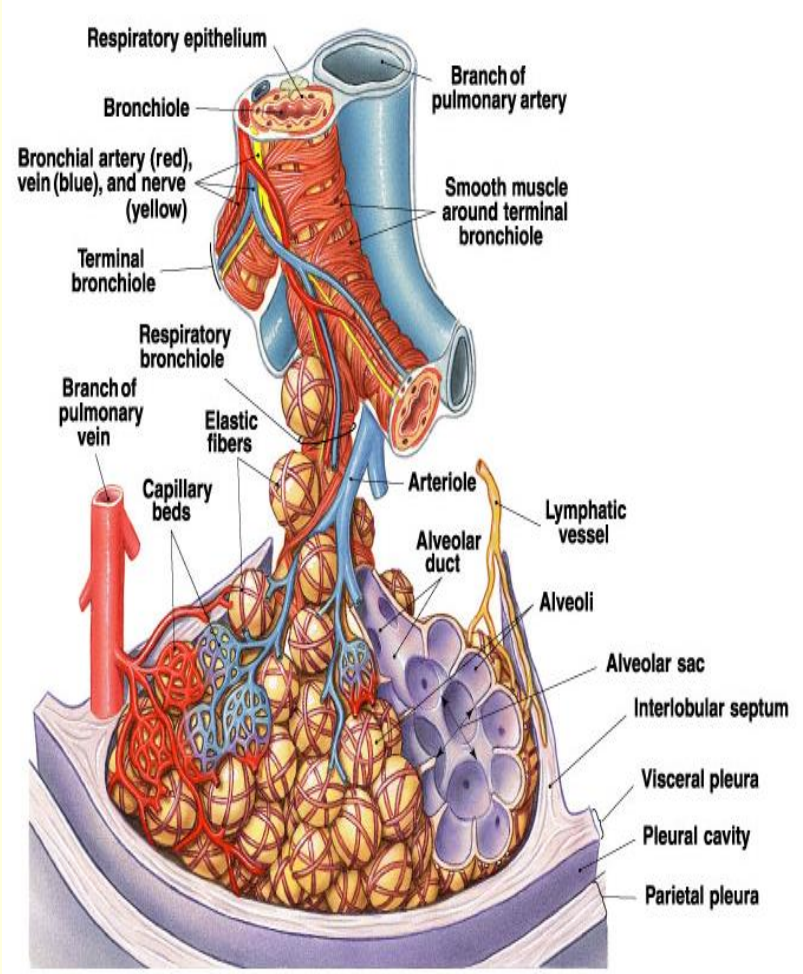
- Henry's law
  - Gases diffuse from high pressure to low pressure.
- Diffusion rate depends upon
  - Pressure difference
  - Solubility of the gas
  - The difference in the pressure of specific gases from the capillary blood to the alveoli dictates the direction of diffusion.



Ref. Guyton and Hall

DIFFUSION OF THE GASES





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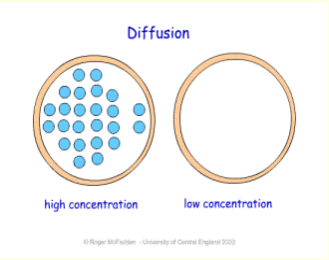
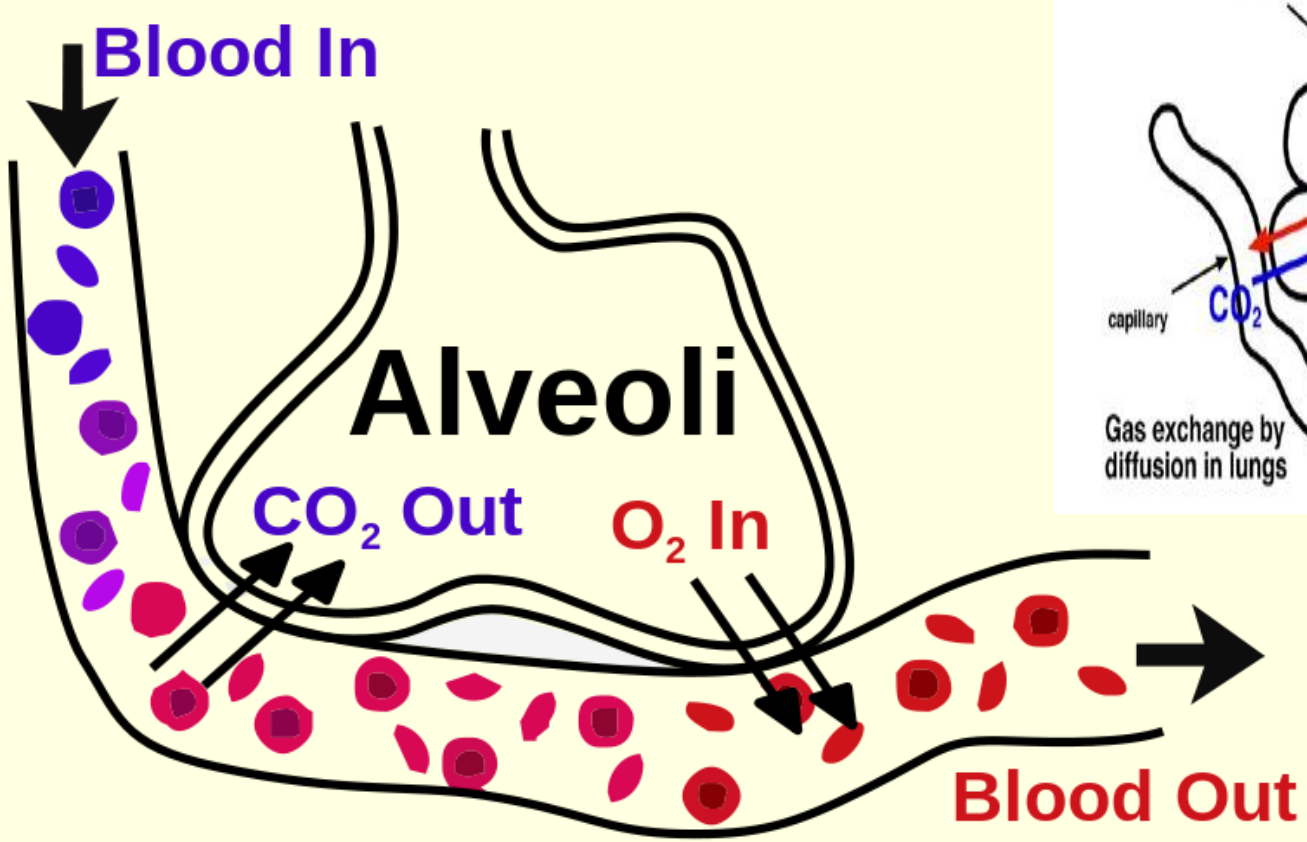
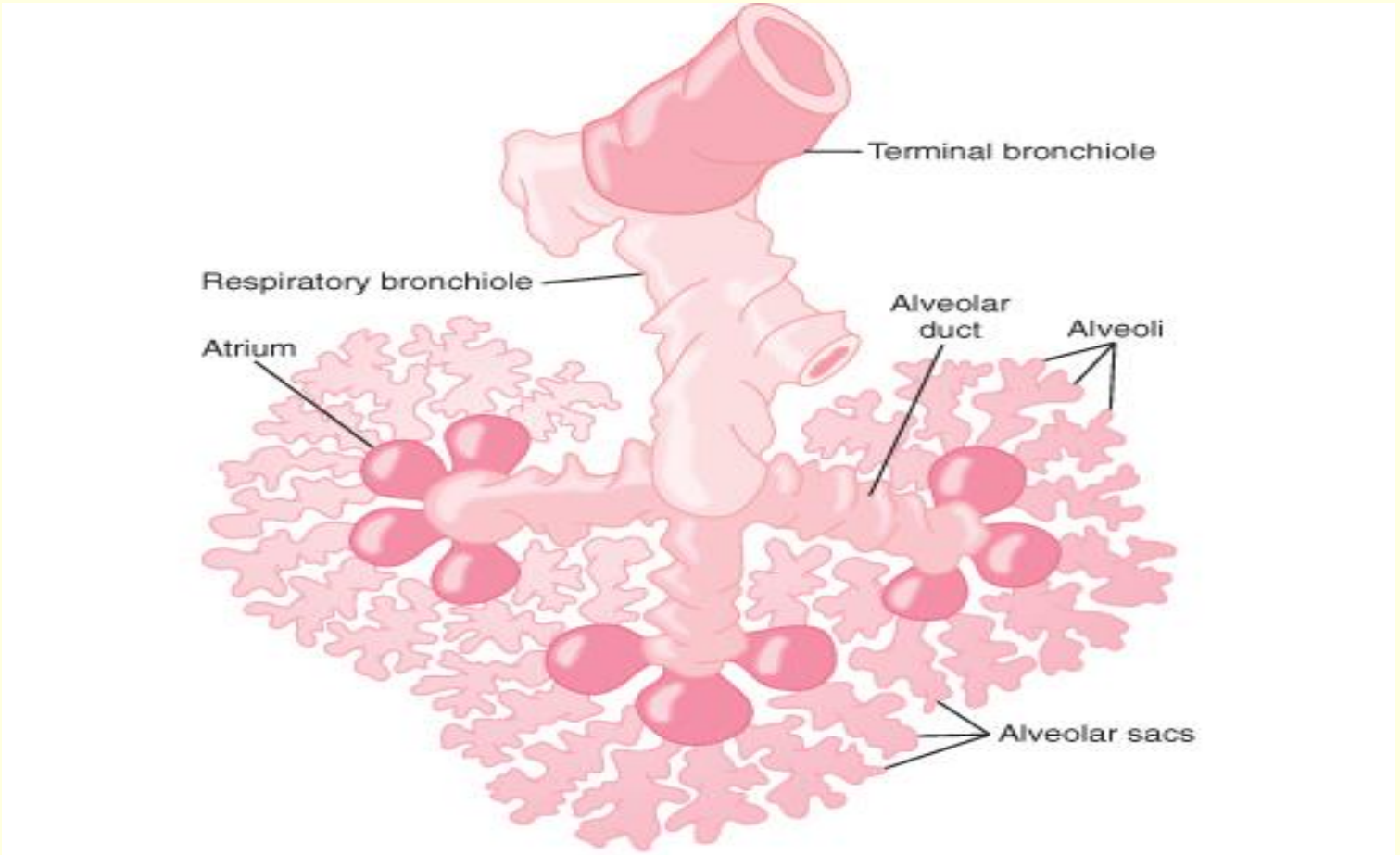




RESPIRATORY UNIT



Ref. Guyton and Hall

RESPIRATORY UNIT

Respiratory Unit: Also called "respiratory lobule", which is composed of a respiratory bronchiole, alveolar ducts, atria, and alveoli.

- There are about 300 million alveoli in the two lungs
- Each alveolus has an average diameter of 0.2 millimeters
- The overall thickness of the respiratory membrane in some areas is as little as 0.2 micrometer and averages is 0.6 micrometer
- Surface area of the respiratory membrane is about 70 square meters in the normal adult human male. Equivalent to the floor area of a 25–by-30–foot room.
- The total quantity of blood in the capillaries of the lungs at any given instant is 60 to 140 milliliters.

Ref. Guyton and Hall

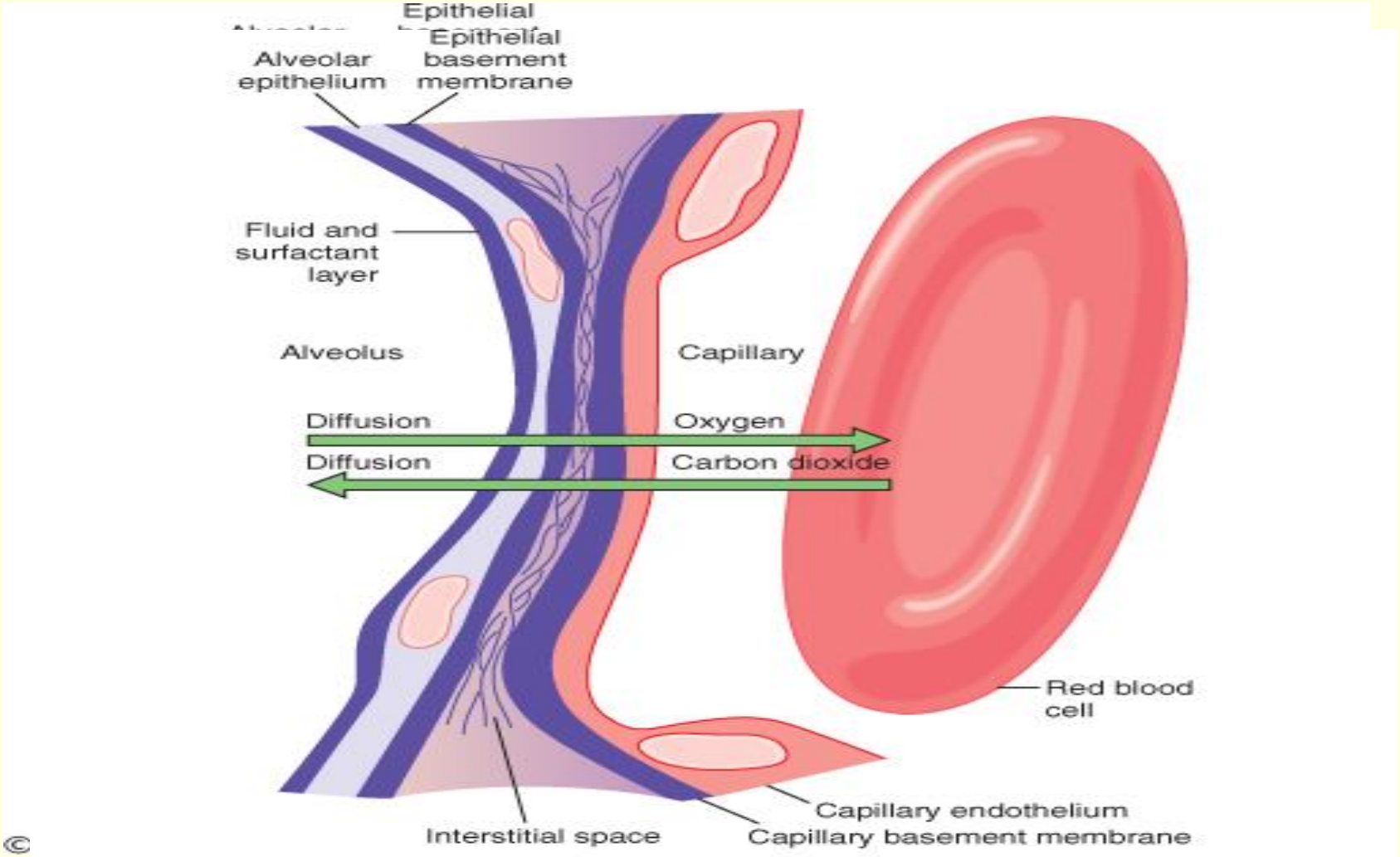
LAYERS OF THE RESPIRATORY MEMBRANE

Diffusion of oxygen from the alveolus into the red blood cell and diffusion of carbon dioxide in the opposite direction. Note the following different layers of the respiratory membrane:

1. A layer of fluid lining the alveolus
2. The alveolar epithelium
3. An epithelial basement membrane
4. Interstitial space
5. Capillary basement membrane
6. The capillary endothelial membrane

Ref. Guyton and Hall

LAYERS OF THE RESPIRATORY MEMBRANE



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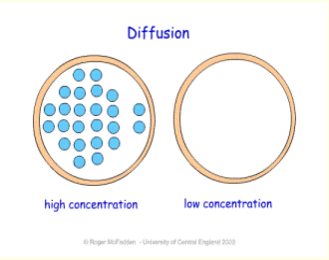
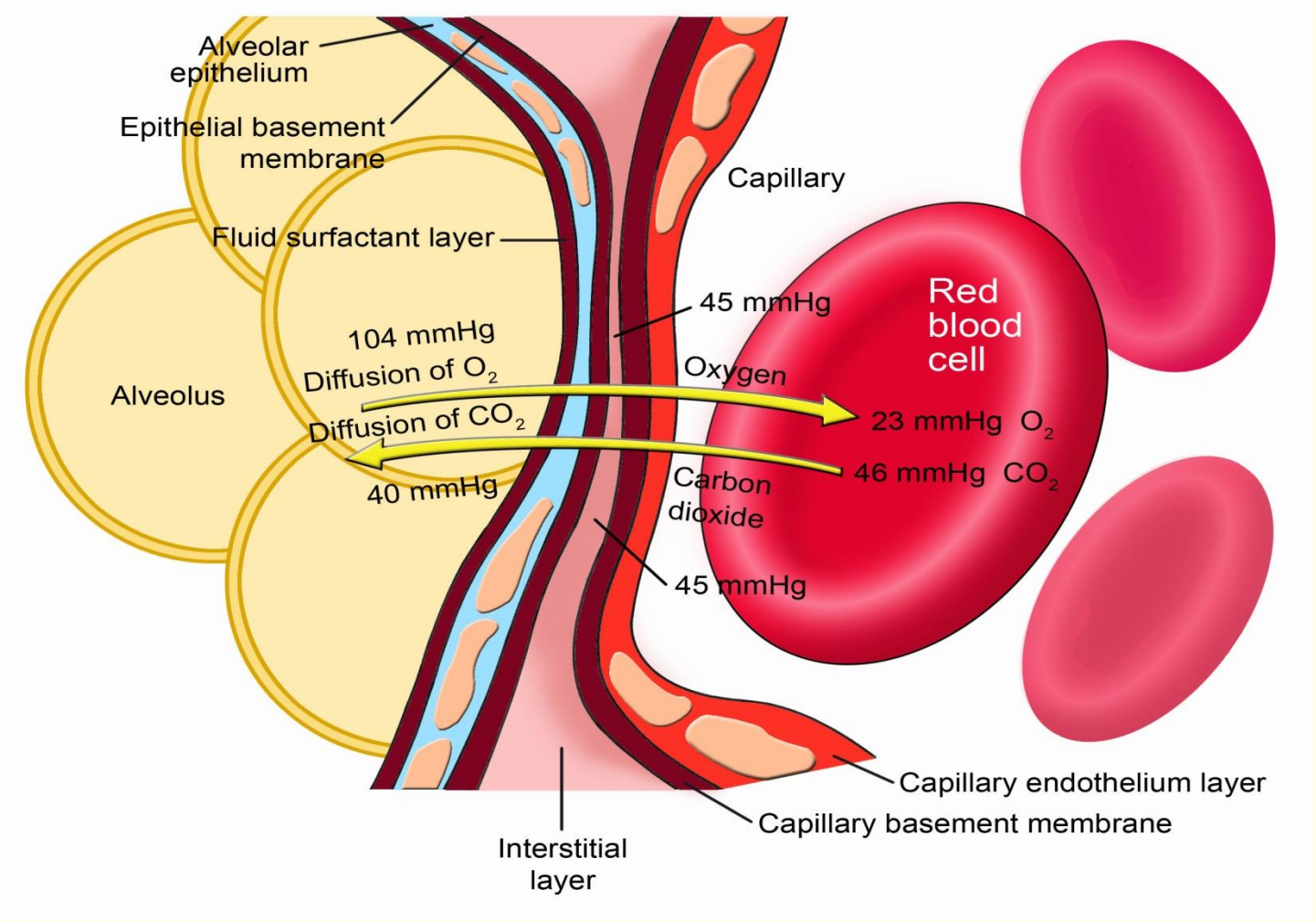




PARTIAL PRESSURE OF GASES

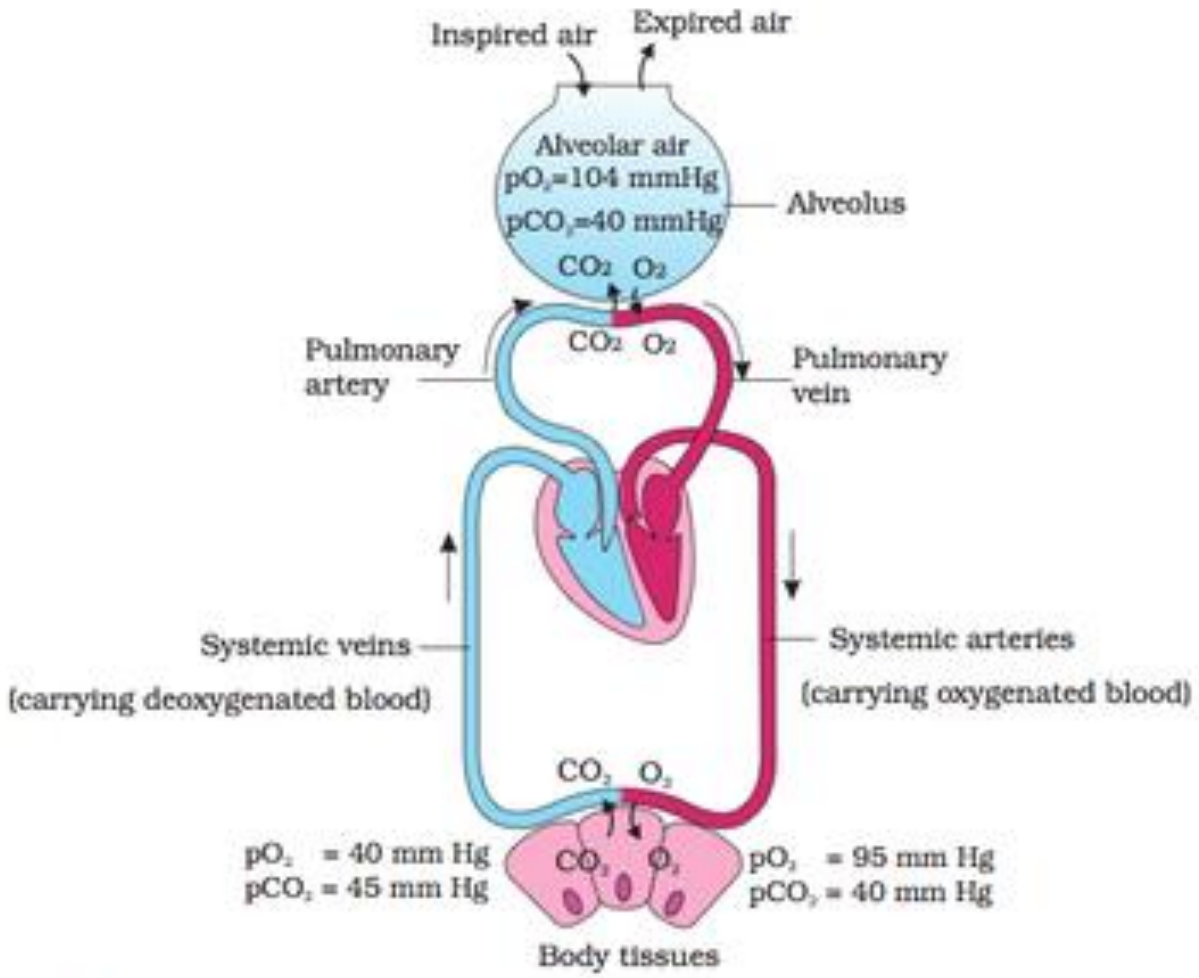
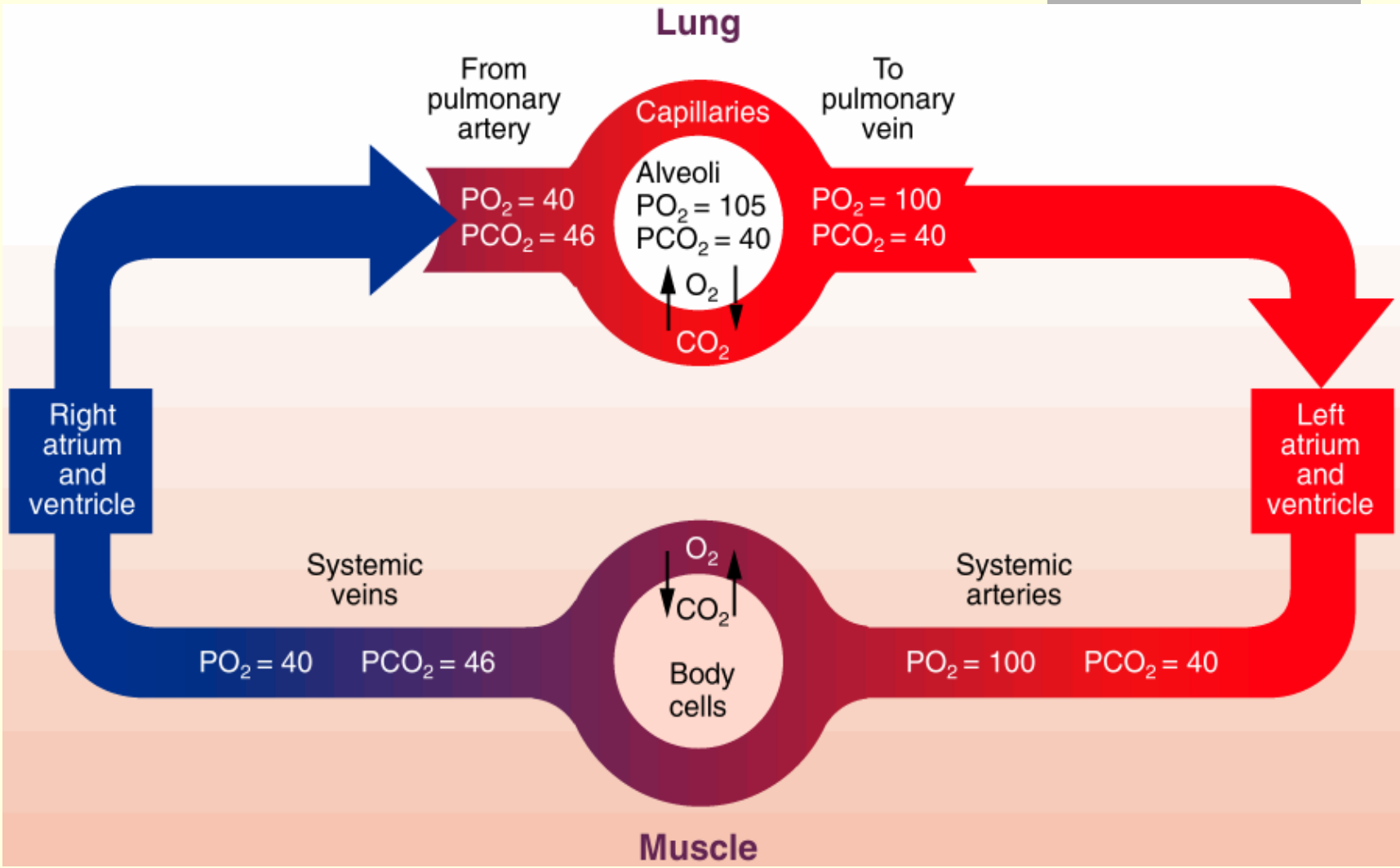
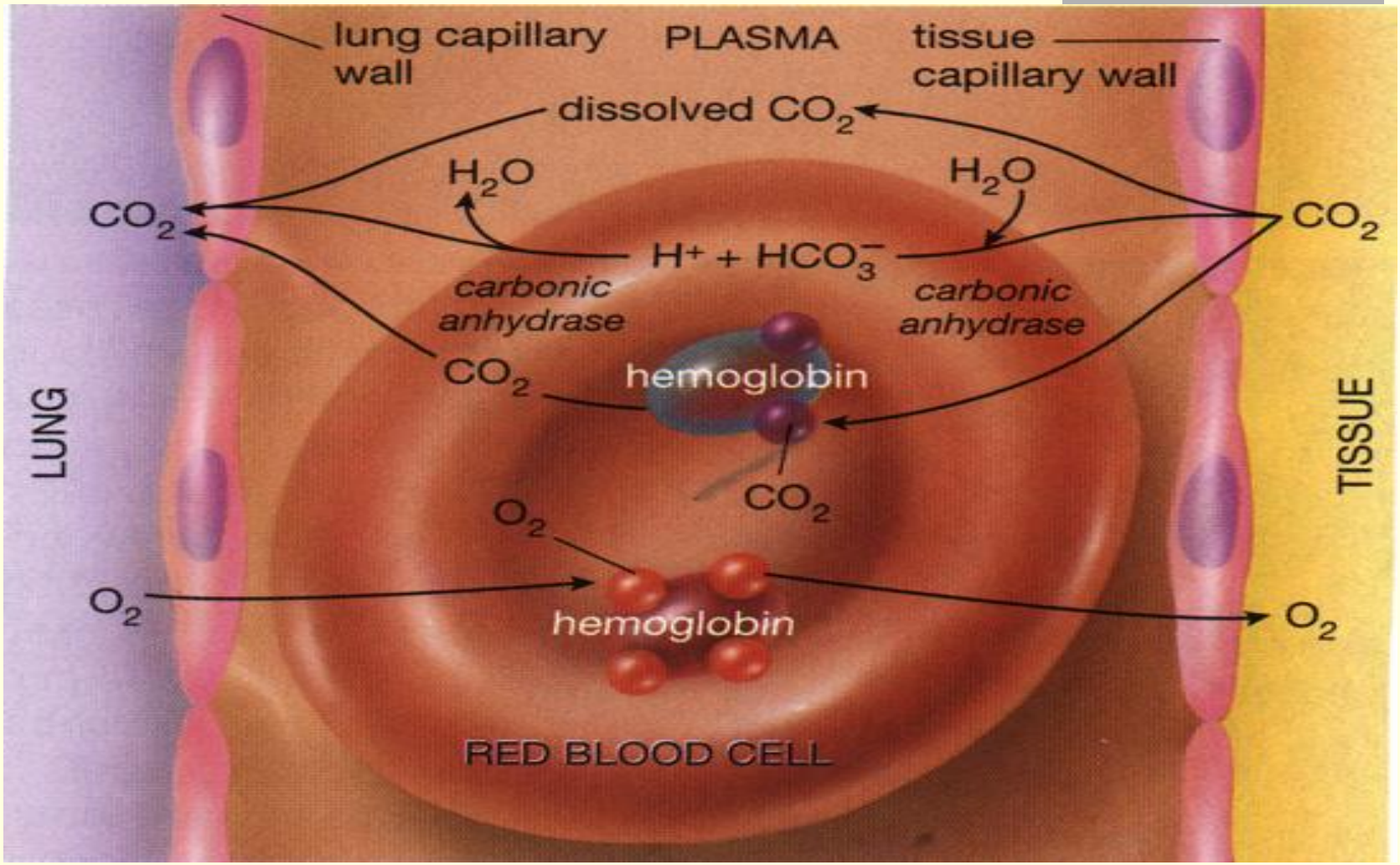


Figure 17.3 Diagrammatic representation of exchange of gases at the alveolus and the body tissues with blood and transport of oxygen and carbon dioxide

PARTIAL PRESSURE OF GASES



DIFFUSION OF OXYGEN AND CO2



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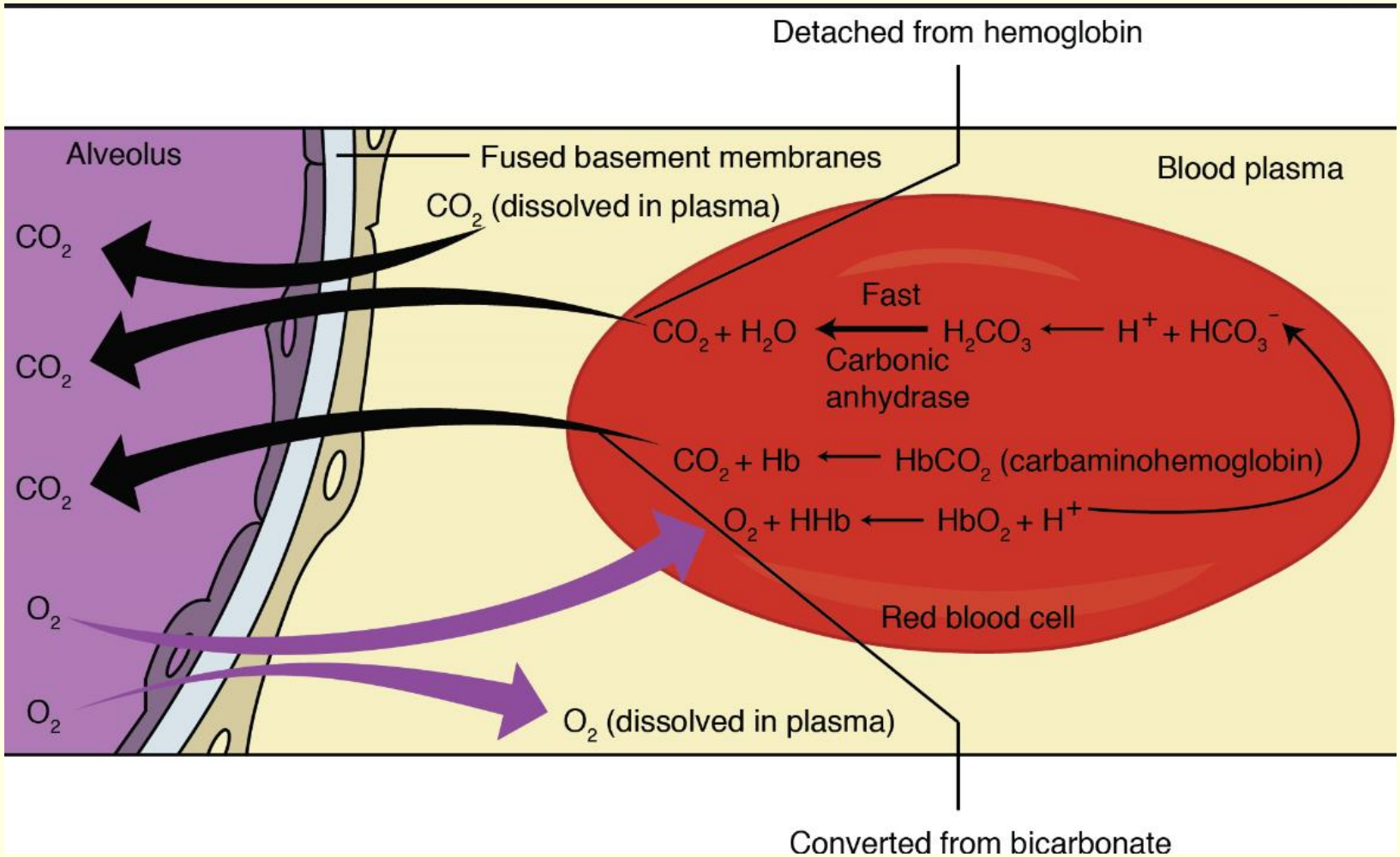


DIFFUSION OF OXYGEN

Diffusion of oxygen from alveolus into pulmonary blood:

Partial pressure of oxygen in the alveolus is 104 mm Hg, whereas the PO_2 of the venous blood entering the capillary is an average 40 mm Hg since a large amount of O_2 has been removed from blood as it passes through the peripheral Pulmonary capillary is 104-40 = 64 mm Hg.

Ref. Guyton and Hall

DIFFUSION OF OXYGEN

Diffusion of O_2 from capillaries into interstitial fluid

Partial pressure of O_2 in the arterial end of the capillaries is 95 mm Hg while in interstitial fluid it is 40 mm Hg. Therefore O_2 diffuses from arterial end of capillary into the interstitial fluid

Diffusion of O_2 from interstitial fluid into cells

The partial pressure of O_2 in interstitial fluid is 40 mm Hg, while that in the cells is 23 mm Hg therefore O_2 diffuses from interstitial fluid into the cells

Ref. Guyton and Hall

DIFFUSION OF CO2

The diffusion of CO_2 occurs in the opposite direction of oxygen. It diffuses from the cells to the interstitial fluid and to alveoli

i. Diffusion of CO_2 from cells to interstitial fluid: Partial pressure of CO_2 within the cell is 46 mm Hg while its pressure in the interstitial fluid is 45 mm Hg. Thus it diffuses from the cells to the interstitial fluid

ii. Diffusion of CO_2 from interstitial fluid into capillaries: Partial pressure of CO_2 in interstitial fluid is 45 mm Hg while in the arterial end of the capillaries, is 40 mm Hg. Therefore, CO_2 diffuses from interstitial fluid into the capillaries.

Ref. Guyton and Hall

DIFFUSION OF CO2

Diffusion of CO_2 from pulmonary blood into alveoli

Partial pressure of CO_2 in pulmonary blood is 45 mm Hg while in the alveolus, it is 40 mm Hg. So CO_2 diffuses from pulmonary blood into the alveoli.

Ref. Guyton and Hall

FACTORS EFFECTING THE DIFFUSION OF GASES

Temperature	• Higher temperature → Diffuse Faster
Surface Area	• Larger surface → Diffuse Faster
Concentration Gradient	• Higher Gradient → Diffuse faster
Size of Particles	• Smaller particles → Diffuse faster
Diffusion Medium	• Solid → Slowest • Liquid → Faster • Gas → Fastest

FACTORS EFFECTING THE DIFFUSION OF GASES

- **Thickness of the respiratory membrane** (inversely proportional)
- **Surface area of the respiratory membrane** (directly proportional)
- **Diffusion coefficient of gas** (directly proportional)
- **Pressure difference** (directly proportional)

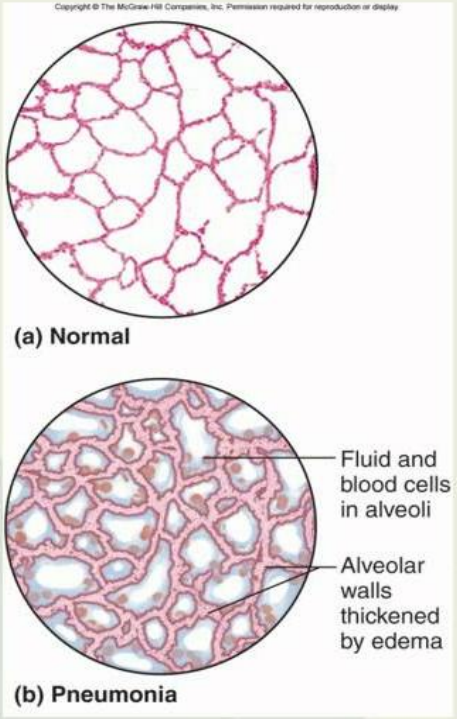
Ref. Guyton and Hall

FACTORS EFFECTING THE DIFFUSION OF GASES

Factors Affecting Gas Exchange

membrane thickness – the respiratory membrane is very thin (only 0.5 μm) and presents little obstacle to diffusion

- If the membrane thickens, diffusion will take more time and gas exchange is inhibited
  - In pulmonary edema & pneumonia – fluid in the alveoli thickens the respiratory membrane



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Ref. Guyton and Hall

THANK YOU