Diffusion

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Objectives

- Identify type of transport the cell membrane
- Identify passive transport
- Identify diffusion
- The difference between diffusion and osmosis

TRANSPORT MECHANISMS

TRANSPORT

Active process

- Primary Transport
- Secondary Transport

Passive process

- Simple diffusion
- Facilitated diffusion
- Osmosis

Passive Transport

- Cytoplasm, extracellular fluid and cell membrane vary in concentrations and pressure gradients.
- Concentration refers to the overall POPULATION of molecules as well as the RATIO in that location compared to another.
- Net Movement
- Kinetic energy

Passive transport includes

- **Simple Diffusion**
  - **Tendency of molecules of any substance to spread out into the available space. Substances will diffuse down their concentration gradient.**
- **Osmosis**
  - **The diffusion of water molecules across a selectively permeable membrane.**
  - **Hypertonic = solution with higher [conc.] of solutes**
  - **Hypotonic = solution with lower [conc.] of solutes**
  - **Isotonic = solutions are equal in solute concentration**
- **Facilitative Diffusion**

-Transport proteins are helping molecules to cross membrane, but still diffusion (lowering overall free energy) thus doesn't require energy from cell.

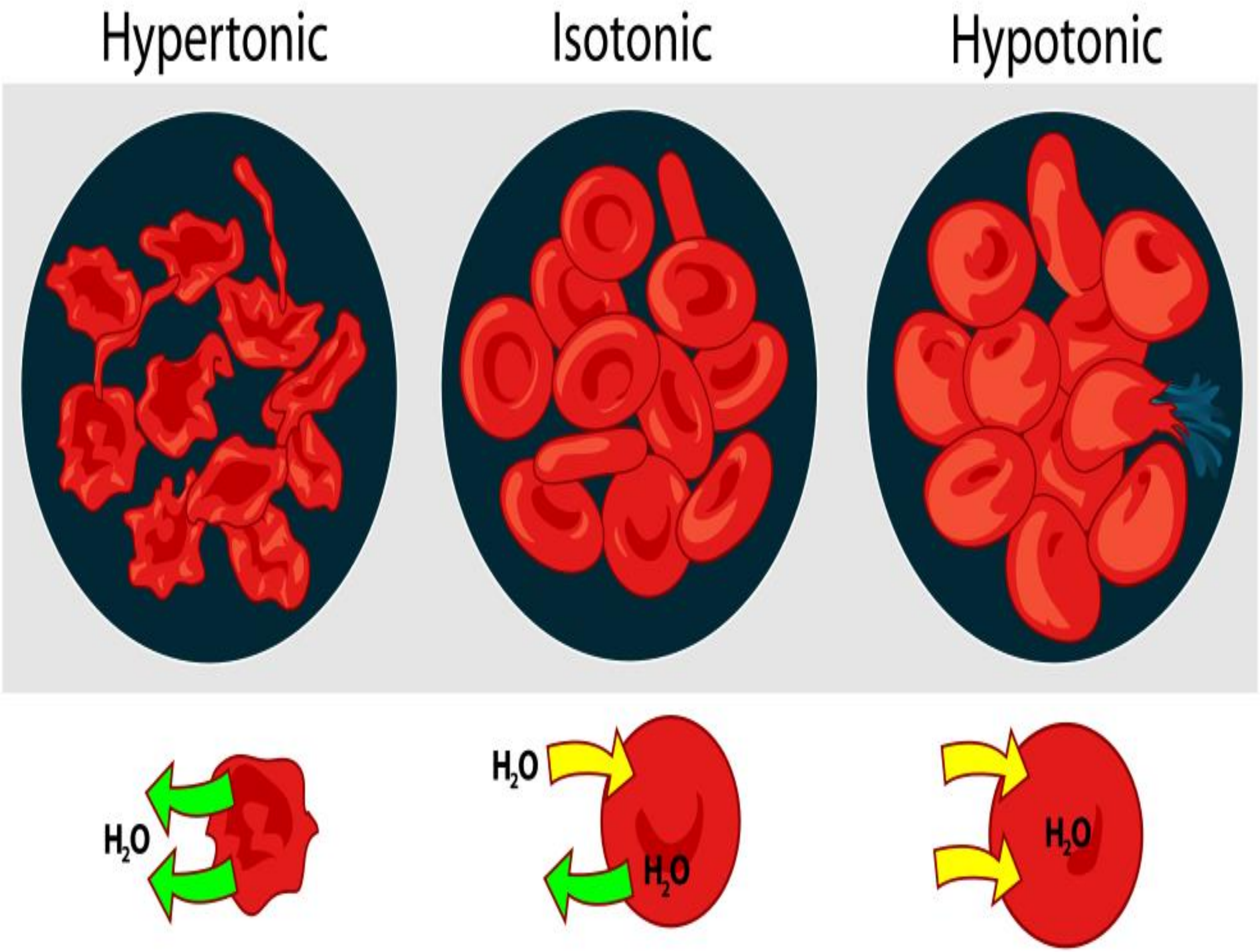
How to quantify numerically the tonicity of solution?

- A 3% sodium chloride (NaCl) solution is hypertonic and when infused intravenously would increase extracellular fluid volume and osmolarity, thereby causing water to flow out of the cell. This would decrease intracellular fluid volume and further increase extracellular fluid volume.

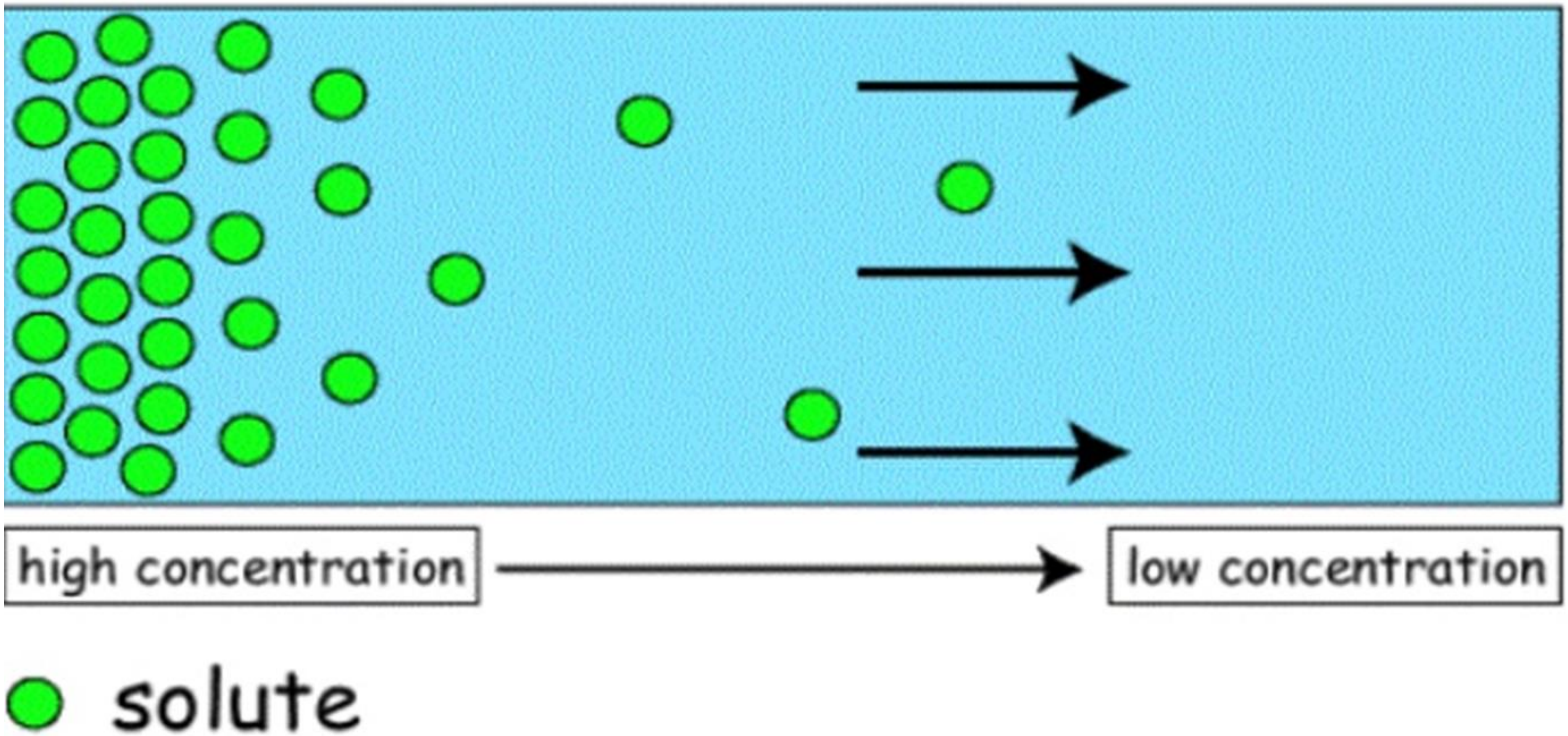
- The 0.9% NaCl solution and 5% dextrose solution are isotonic, and therefore would not reduce intracellular fluid volume.

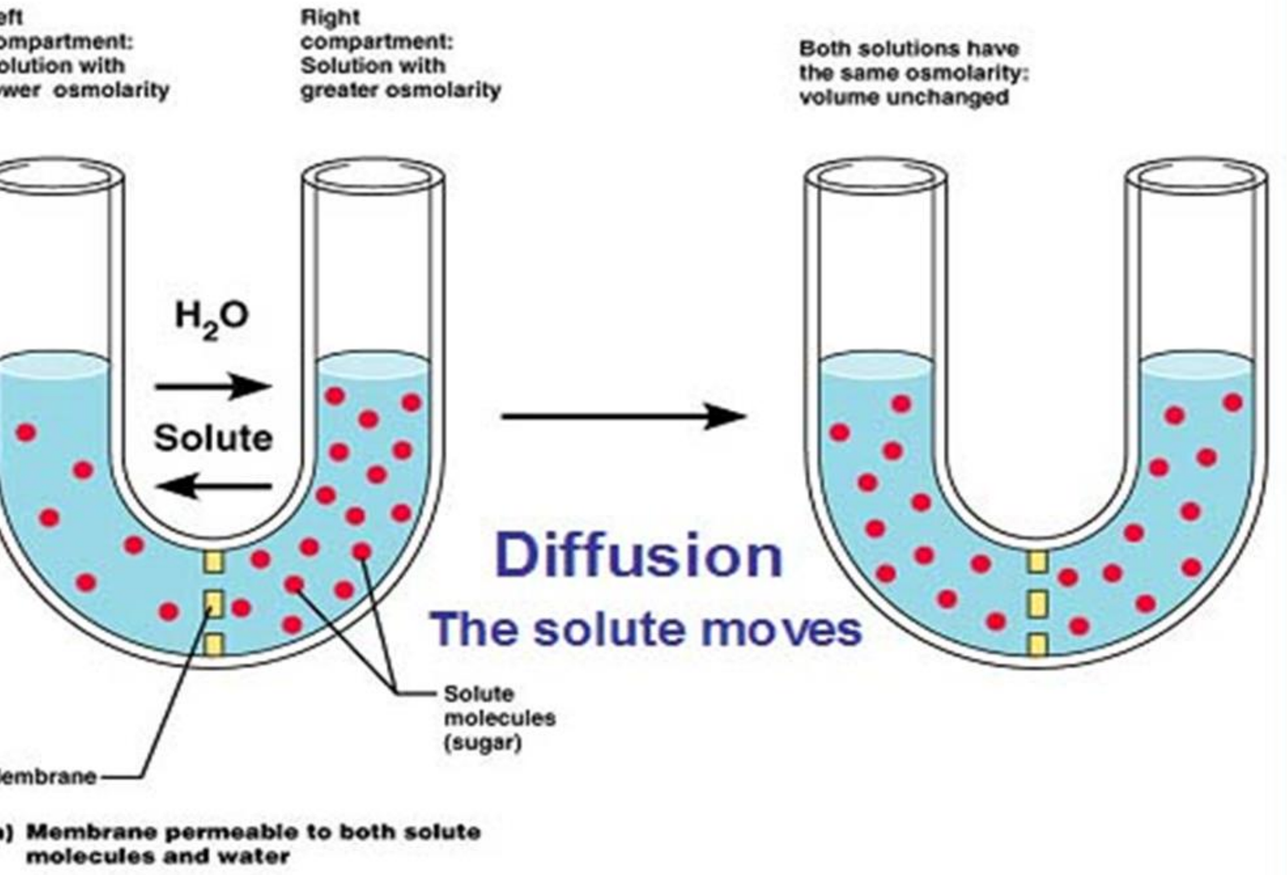
- Pure water and the 0.45% NaCl solution are hypotonic, and when infused would increase both intracellular and extracellular fluid volumes

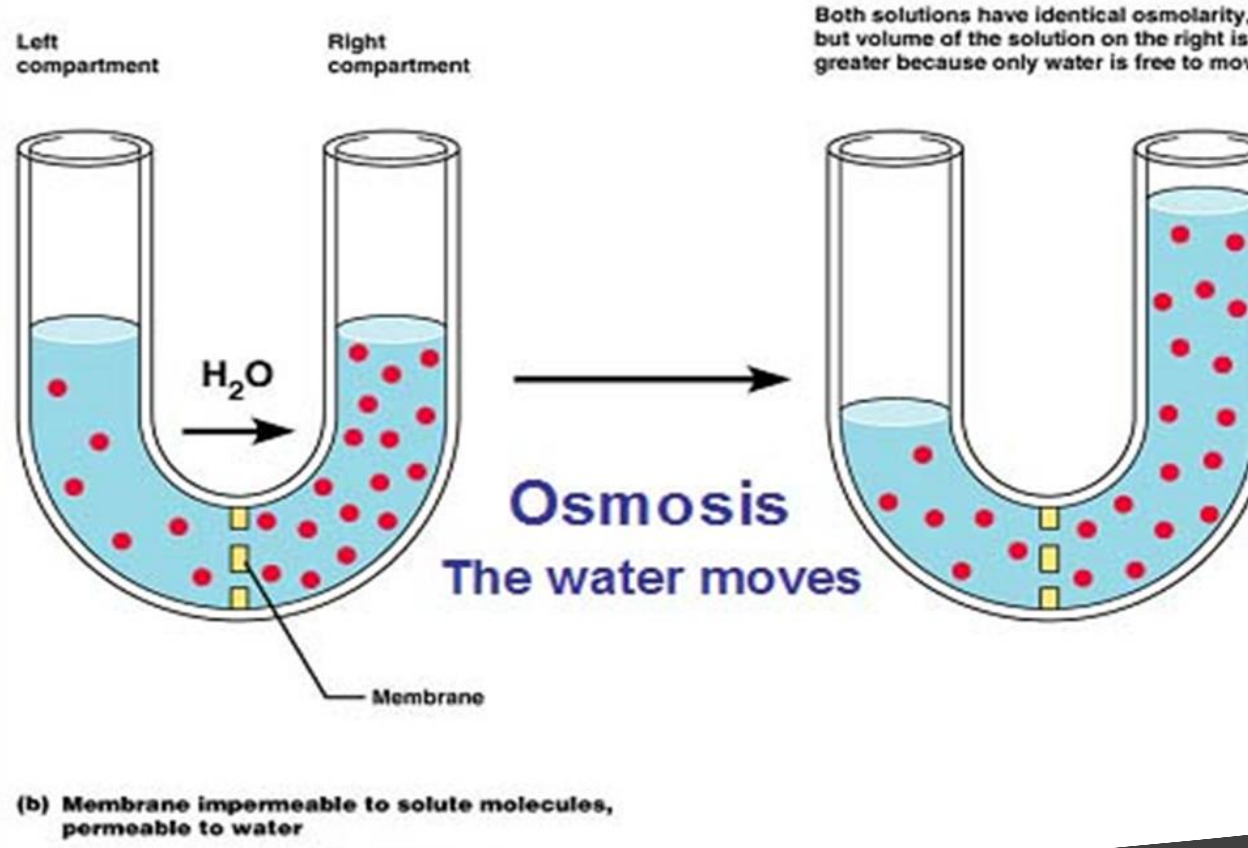
Tonicity of solution



Diffusion







Diffusion Vs. Osmosis

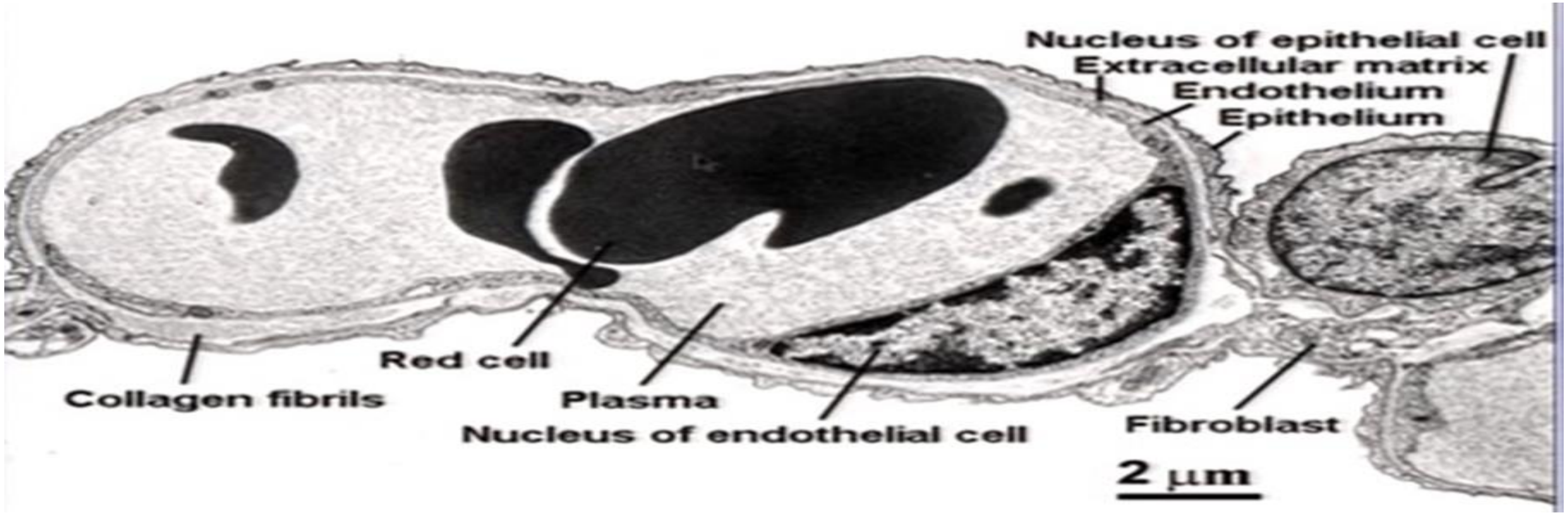
FACTORS AFFECTING NET RATE OF DIFFUSION

FICK'S LAW OF DIFFUSION:

$$J = -\frac{DA \times (C1 - C2)}{T}$$ at particular temperature.

D = Diffusion coefficient.
A = Surface area.
C1&C2 = Concentrations on either sides.

Electron micrograph of Pulmonary Capillary



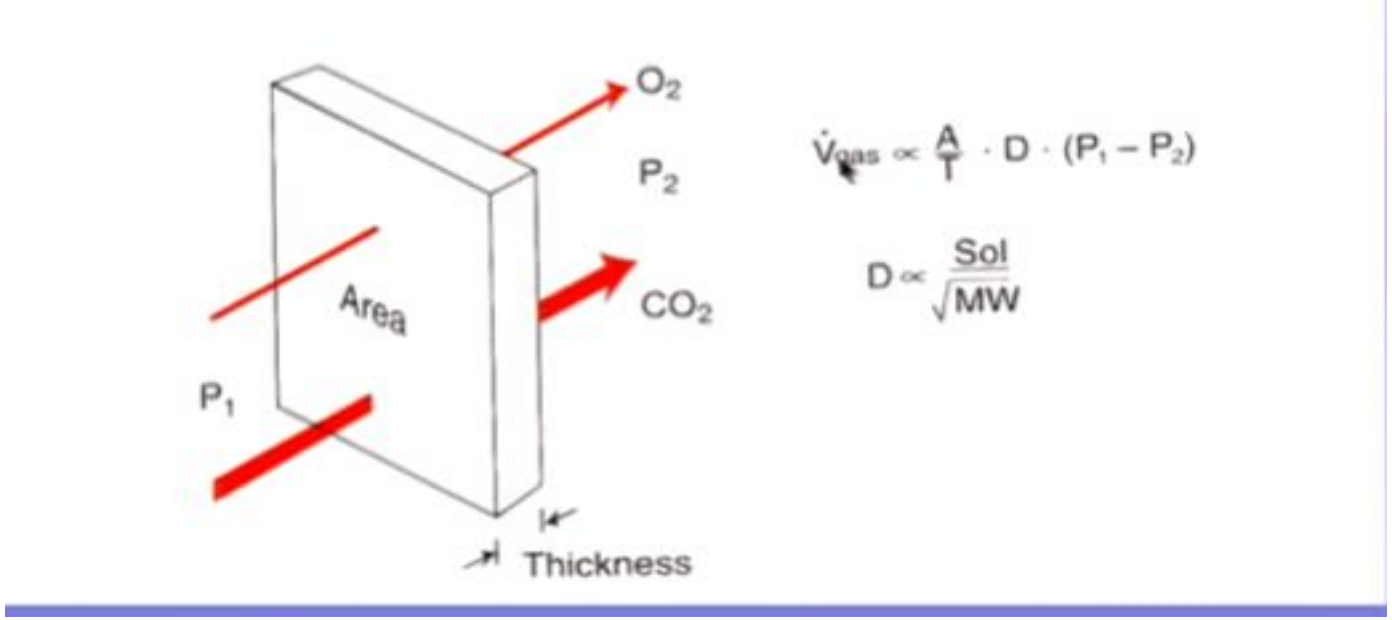
- the capillary and alveolar wall which is running across the slide here
- Alveolar gas on both side of the capillary
- Inside the capillary red blood cells and plasma
- the wall of the capillary is the blood gas barrier blood from one side and gas on the other
- The scale of the blood gas barrier is one third of micron

One micron= millionth of meter or thousandth of millimeter

Red blood cells =seven micron in diameter ; visible on light microscope less than one micron we need micrograph

- The blood gas barrier is polarized so on side ; the capillary side is thinner than the alveolar side
- A barrier that is thin is rather fragile and of the pressure in the capillary rises to abnormally high levels you can get ultrastructure changes and leak fluid into alveolar spaces and that’s situation is called stress failure

Ficks law of diffusion through a tissue sheet



❑ if you have a tissue sheet like a postage stamp then the volume of gas which moves a cross the sheet is proportional to the area of the sheet and proportional to the constant which is called the diffusion constant and the difference of partial pressure between one side of the sheet and the other

❑Inversely proportional to the thickness of sheet

❑So we need thin sheet as possible and large area as possible
The blood gas barrier is phenomenally thin and the area is about 50 to 100 square meters enormous area that is generated by 500 million alveoli and in each walls of the alveoli you get these capillaries with their blood gas barrier

Factors that Influence Diffusion Rates

- Distance -
  - The shorter the distance, the more quickly [ ] gradients are eliminated
  - Few cells are father than 125 microns from a blood vessel
- Molecular Size
  - Ions and small molecules diffuse more rapidly
- Temperature -
  - ↑ temp., ↑ motion of particles
- Steepness of concentrated gradient -
  - The larger the [ ] gradient, the faster diffusion proceeds
- Membrane surface area -
  - The larger the area, the faster diffusion proceed

Diffusion Across Membranes

- **Simple Diffusion**
  - Lipophilic substances can enter cells easily because they diffuse through the lipid portion of the membrane
    - Examples are fatty acids, steroids, alcohol, oxygen, carbon dioxide, and urea,
- **Channel-Mediated Diffusion**
  - Membrane channels are transmembrane proteins
  - Used by ions, very small water-soluble compounds
  - Much more complex than simple diffusion

Diffusion through the cell membrane