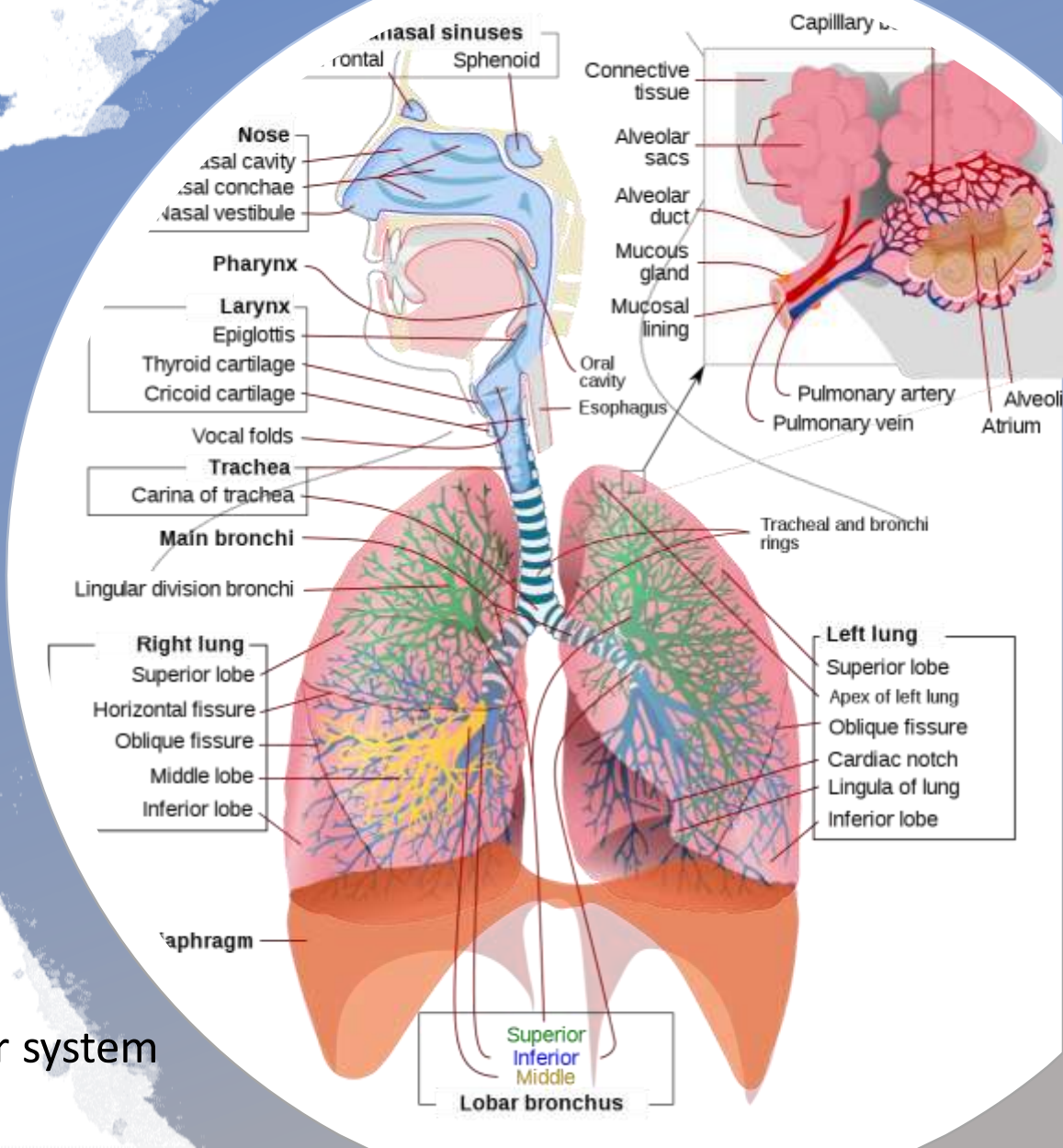
OVERVIEW OF RESPIRATORY SYSTEM

- Pulmonary ventilation
  - Air moves in and out of lungs
  - Continuous replacement of gases in alveoli (air sacs)

- External respiration
- Gas exchange between blood and air at alveoli
- O2 (oxygen) in air diffuses into blood
- CO2 (carbon dioxide) in blood diffuses into alveoli

- Internal respiration
- Gas exchange in capillaries between blood and tissue cells
- O2 in blood diffuses into tissues
- CO2 waste in tissues diffuses into blood

- Cellular respiration
  - Oxygen (O2) is used by the cells
  - O2 needed in conversion of glucose to cellular energy (ATP)
  - Carbon dioxide (CO2) is produced as a waste product
  - The body's cells die if either the respiratory or cardiovascular system fails



Branches of the airways :

Airways consist of 2 important pathways :

1) Conducting zone :only responsible for air transport to respiratory zone

2) Respiratory zone : Gas exchange in capillaries between blood and tissue cells :

O_2 in blood diffuses into tissues

CO_2 waste in tissues diffuses into blood

Conducting zone

- Respiratory passages that carry air to the site of gas exchange
- Filters : any foreign bodies
- Humidifies
- and warms air : if your body intake any cold air it will be warmed in this zone

Respiratory zone

- Site of gas exchange
- Composed of
  - Respiratory bronchioles
  - Alveolar ducts
  - Alveolar sacs

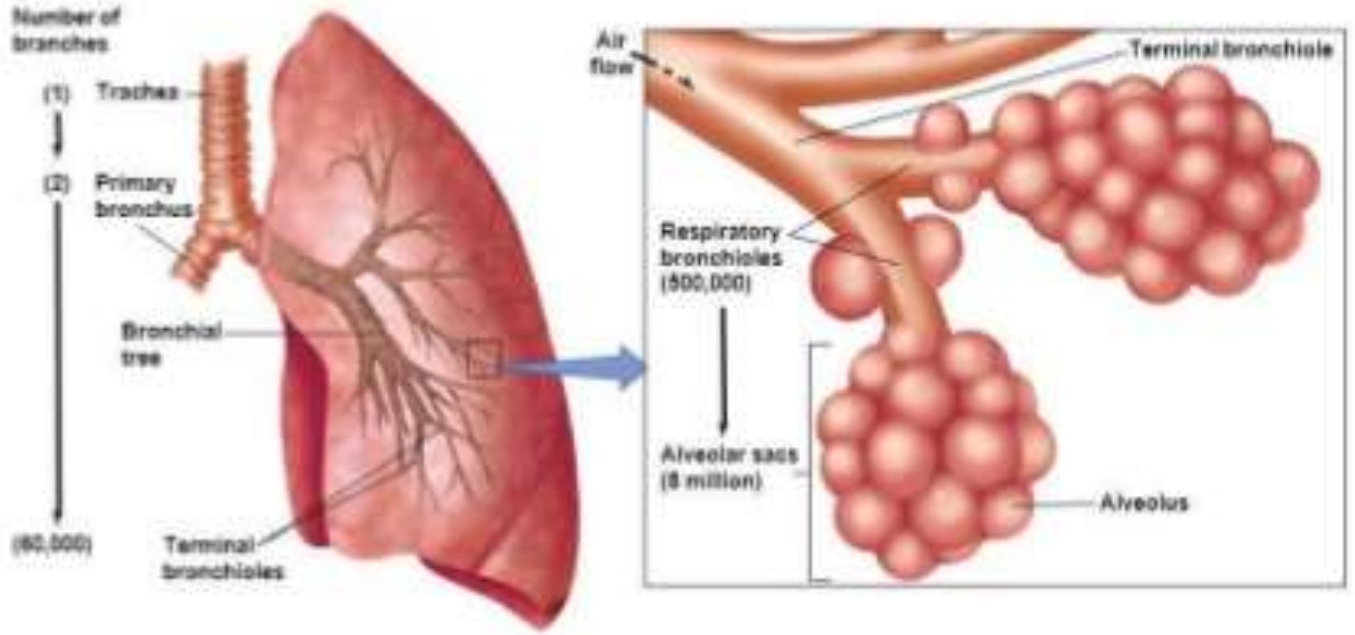
Organs of the Respiratory System

Conducting zone

- carries, filters, humidifies and warms incoming air.

Respiratory zone

- is the site where the actual gas exchange occurs.

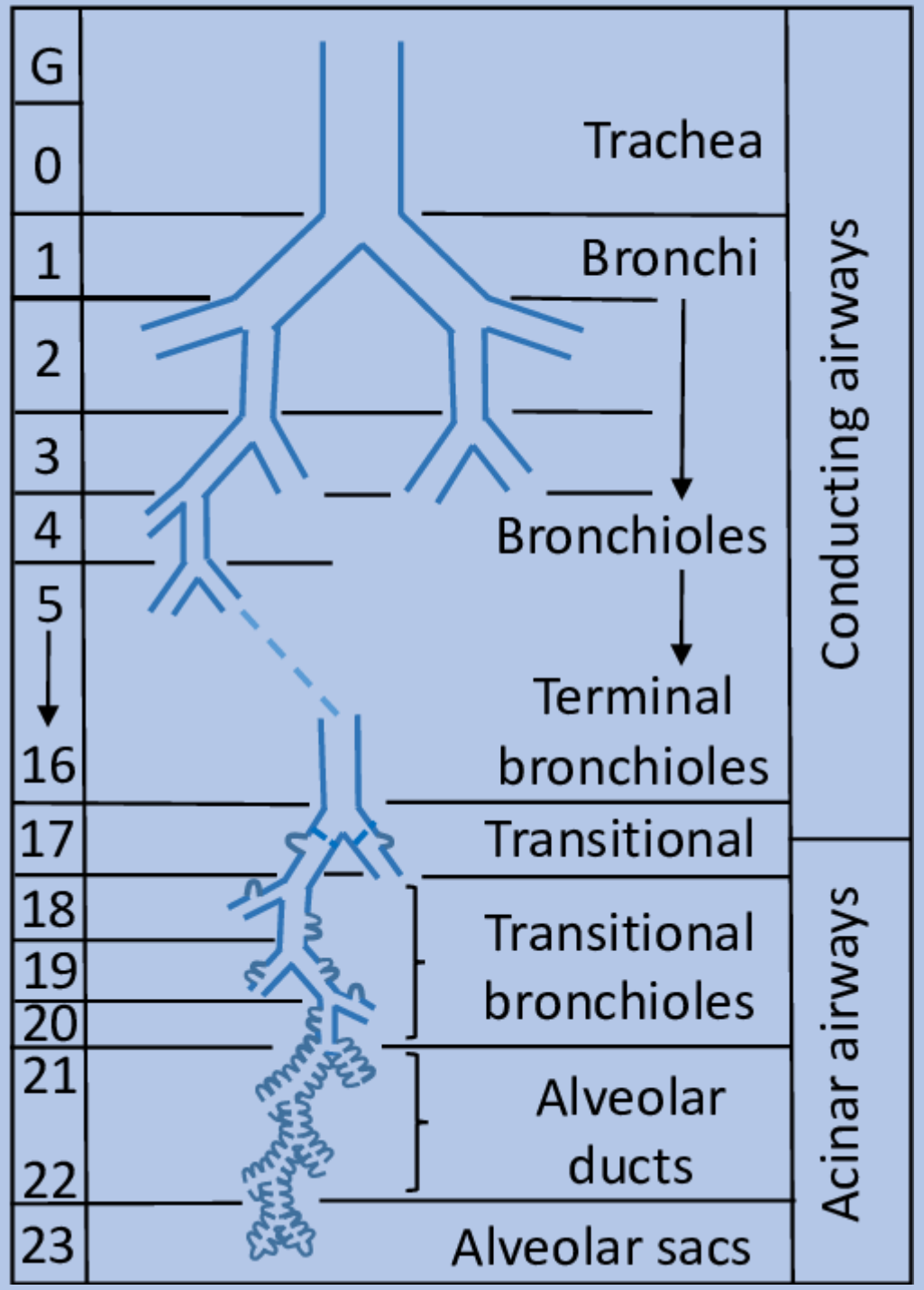


FACTS OF VENTILATION

- Swiss anatomist dr. weibel counted the air ways in the lung and measures their sizes and he came up with idealized airway model called weibel model

Scientist Weibel did autopsy for the hung ….. Then then counted the airways and measured their size according to the cross section of them …… then he produced idealized model called Weibel Model

Any pathology condition in respiratory taking in or taking out that's indicates problems in blood gas exchange

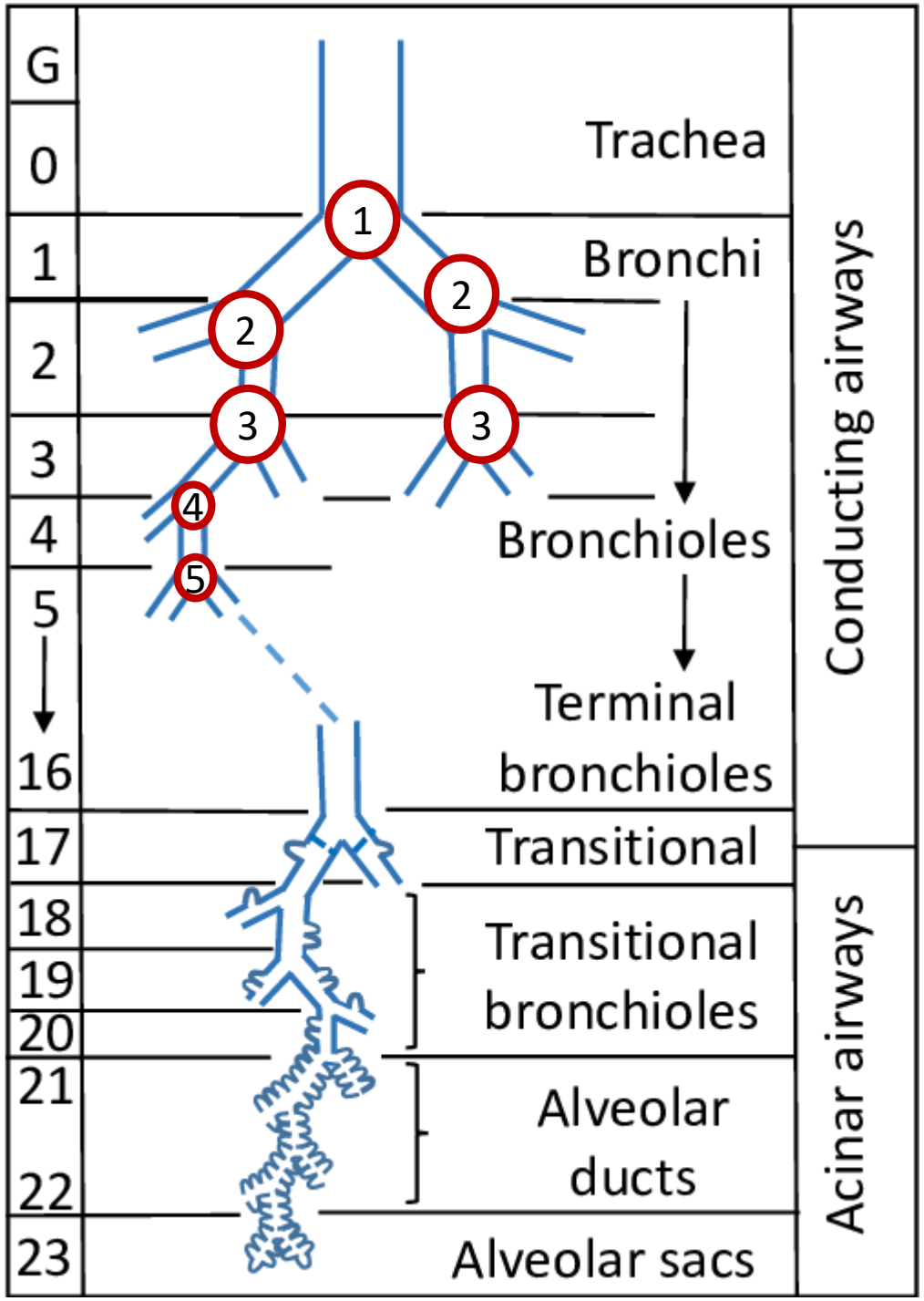


WEIBEL MODEL :

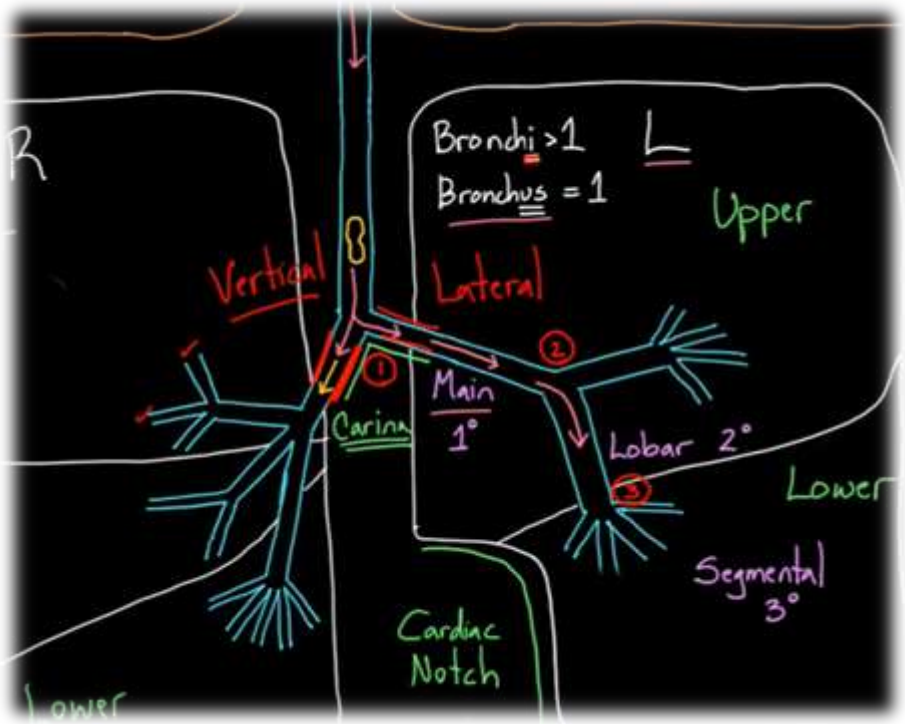
1) Divided the airways into generations (Z. 0.1.2……etc.) up to 23 generation
2) From generation (z-16) conducting zone
3) From generation (17-23) respiratory zone

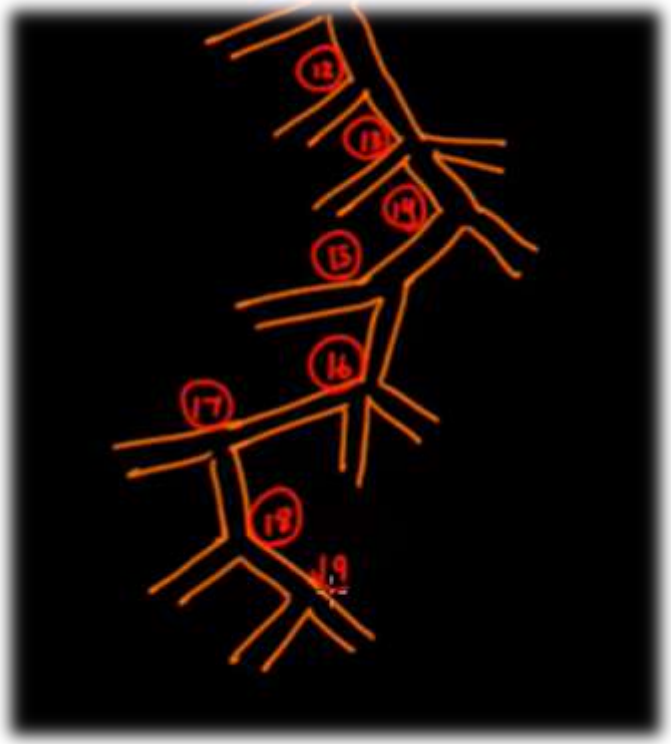
Generation number = to location of branch point
أي كل رقم في الجدول يمثل رقم موقع نقطة التفرع

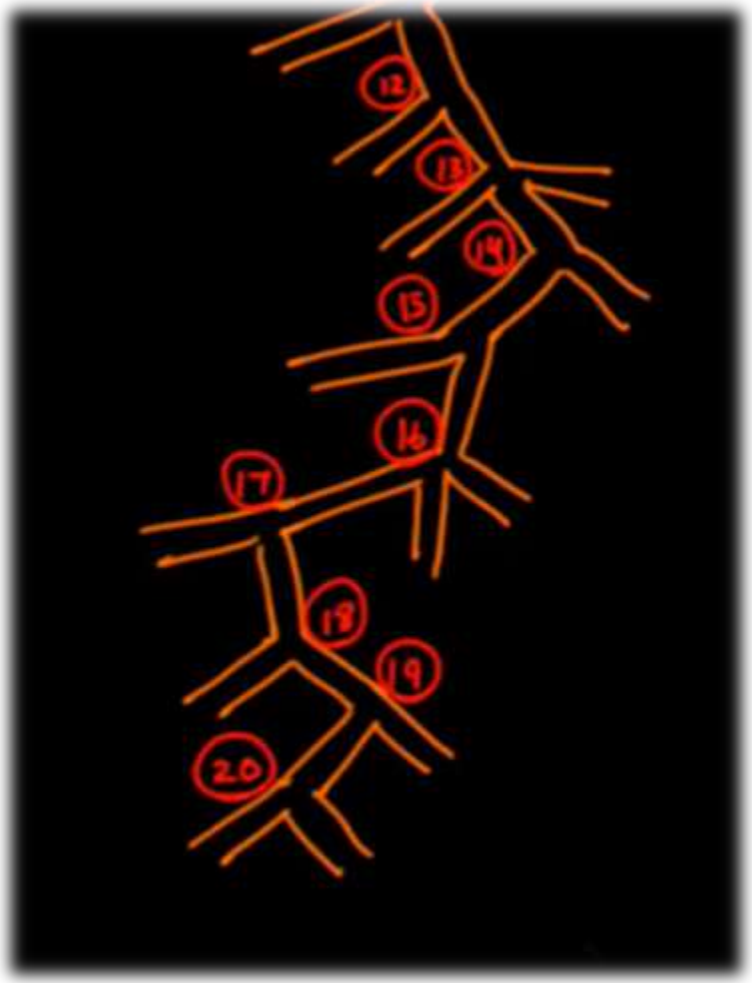
1) Started with trachea which divided into 2 divisions called bronchi
2) Each bronchi divided into 2 divisions called bronchioles located in generation 2



For clarification







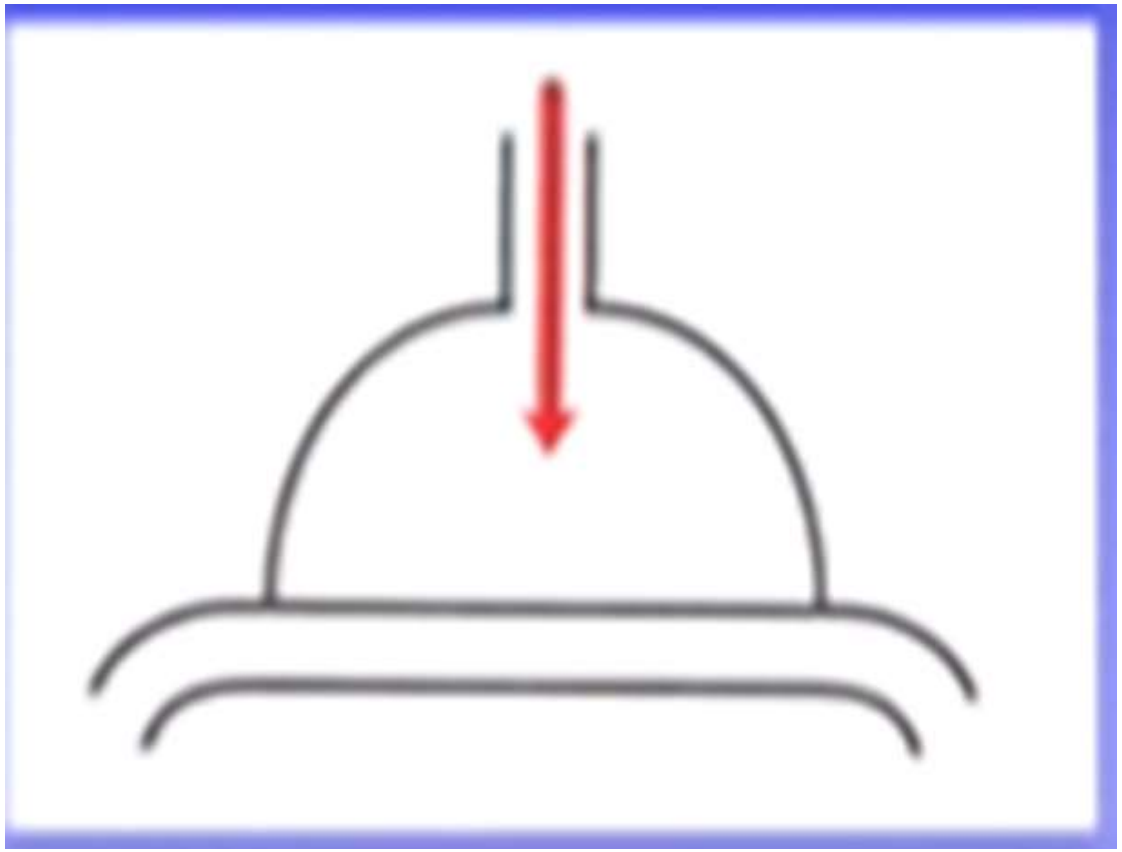
Think of lung as symmetrical organ with the blood gas barrier in the middle air coming from one side by ventilation and blood coming to the other side by pulmonary circulation

We are going to look at the two sytems the airway and the blood system in turn

Weibel Model clinically applications :

A- Systemic circulation (between heart and body cells).
- Carries oxygenated blood away from left side of heart to body and deoxygenated blood from body to right side of heart.

B- Pulmonary circulation (between heart and lungs).
- Carries deoxygenated blood away from right side of heart to lungs and oxygenated blood from lungs to left side of heart

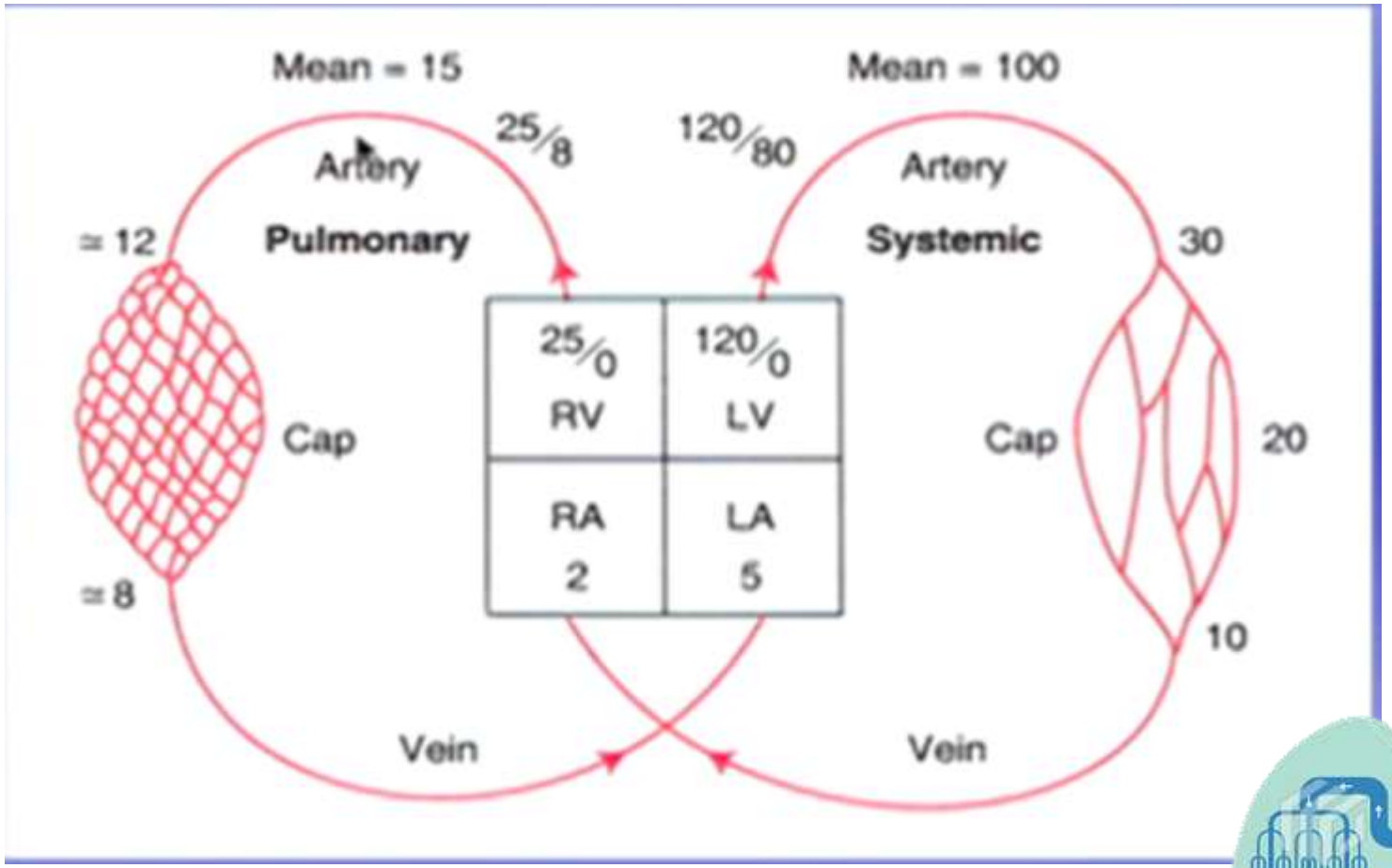


Heart :

1) Left side (oxygenated blood)
2) Right side (deoxygenated blood)

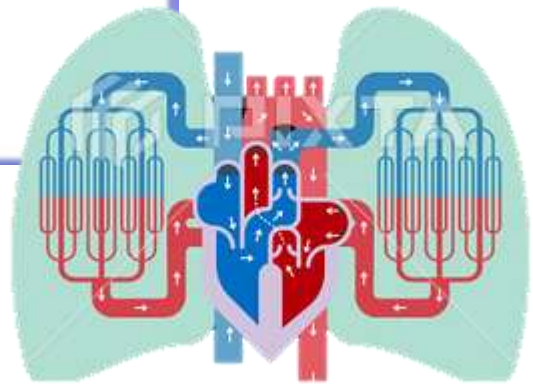
1) RV (DEOXY) …..through pulmonary artery (the only one which carry deoxy blood) to the lung

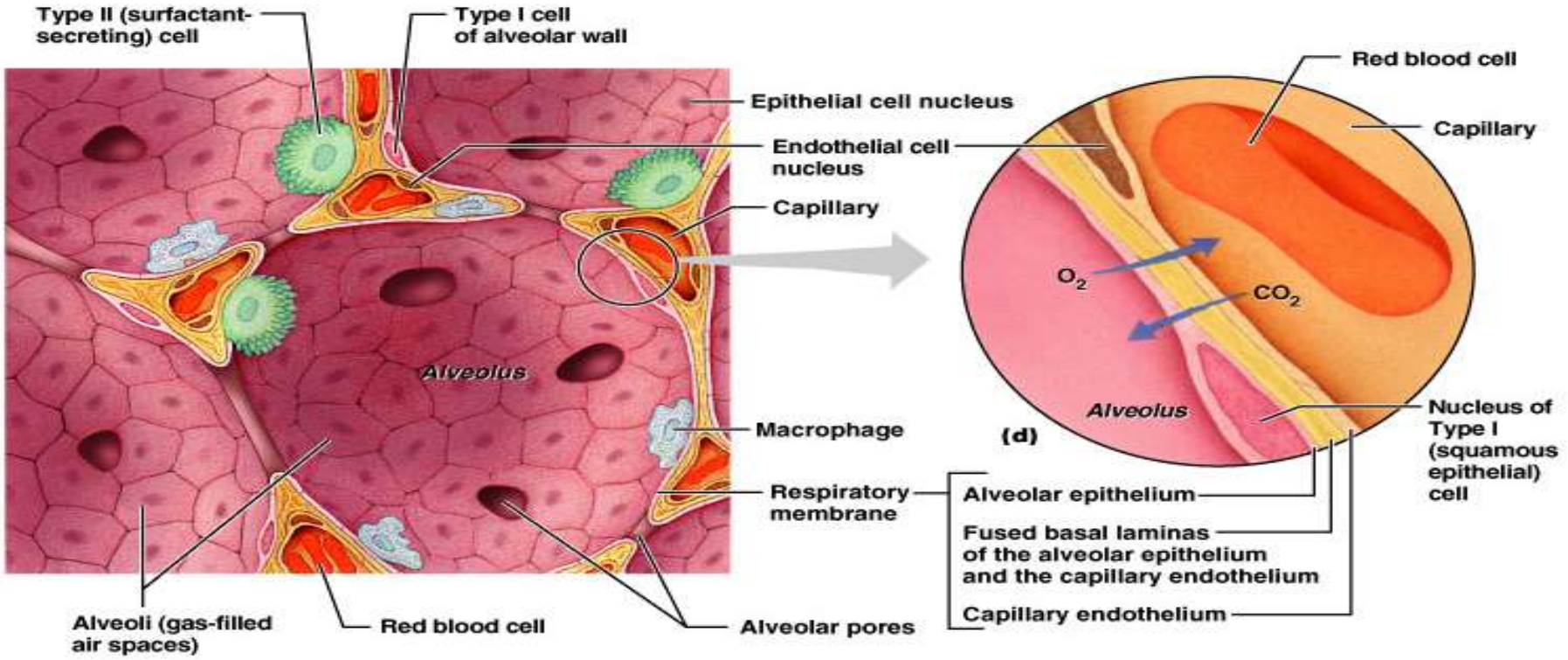
2) Through the capillaries in the lung …….then through pulmonary vein ……> to the LA



3) From the LA to the LV …… hen through the aorta (OXYGENATED)

4) Internal respiration and cellular respiration



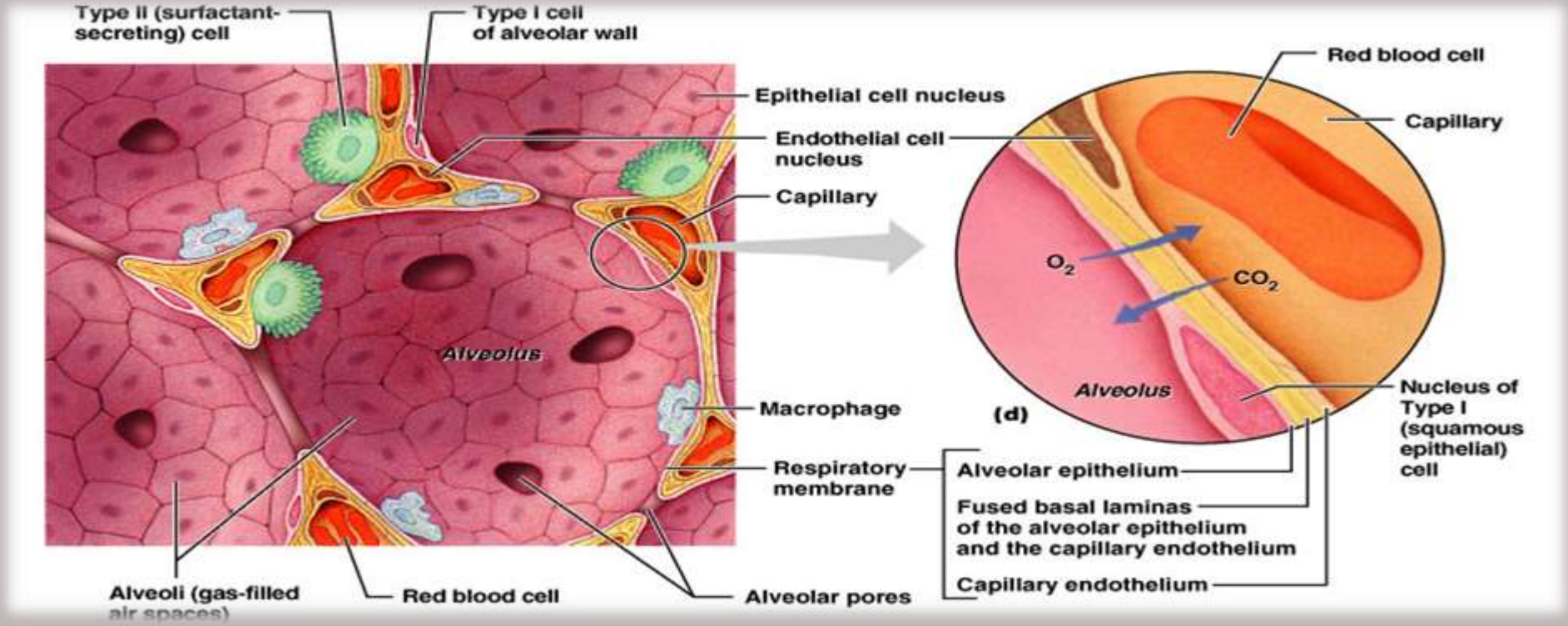


- Alveoli surrounded by fine elastic fibers
- Alveolar macrophages – free floating "dust cells"
- Note type I and type II cells and joint membrane
- Type 4 collagen responsible for the strength of basement membrane

- air-blood barrier (the respiratory membrane)

  is where gas exchange occurs

  Oxygen diffuses from air in alveolus (singular of alveoli) to blood in capillary.Carbon dioxide diffuses from the blood in the capillary into the air in the alveolus

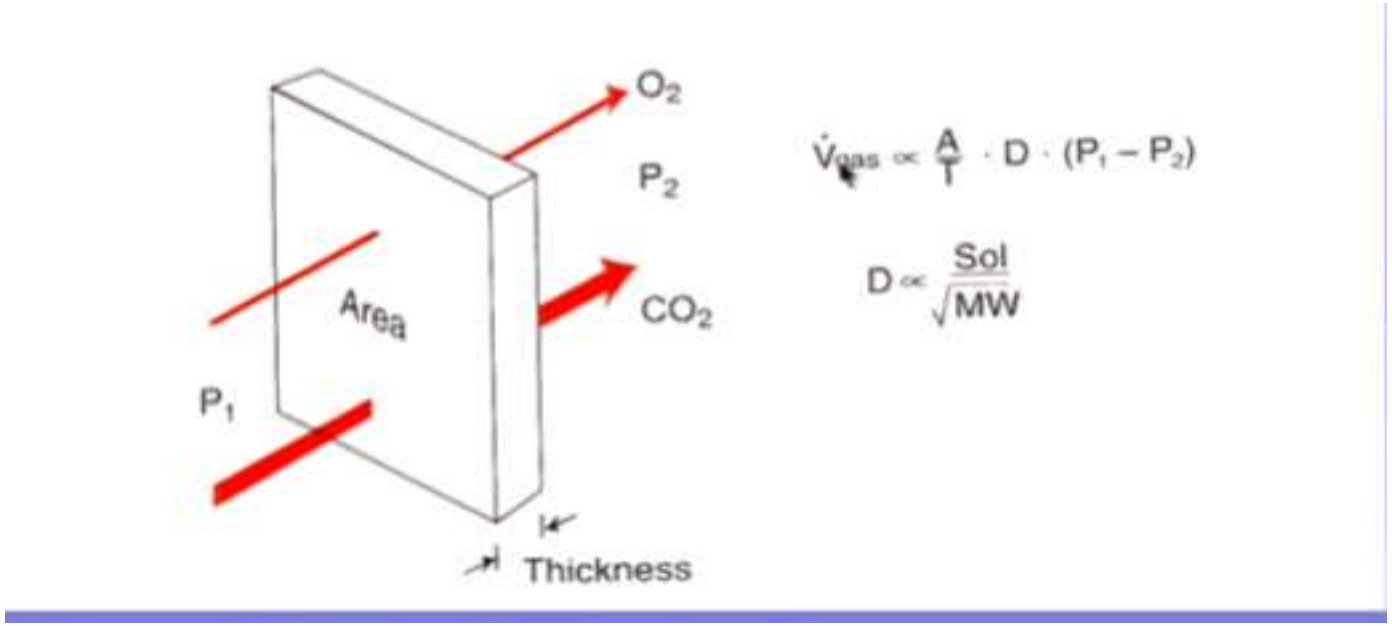


Macrophages : kind of WBCS… located on the surface of alveoli ..the first line of defense …any foreign body inside the alveoli this cell phages or destroys it by endocytosis

Type 2 cells : responsible for reducing the surface tension (releasing for surfactant)

Gas exchange through a barrier which separates the alveoli from the blood through down hill diffusion

Ficks law of diffusion through a tissue sheet

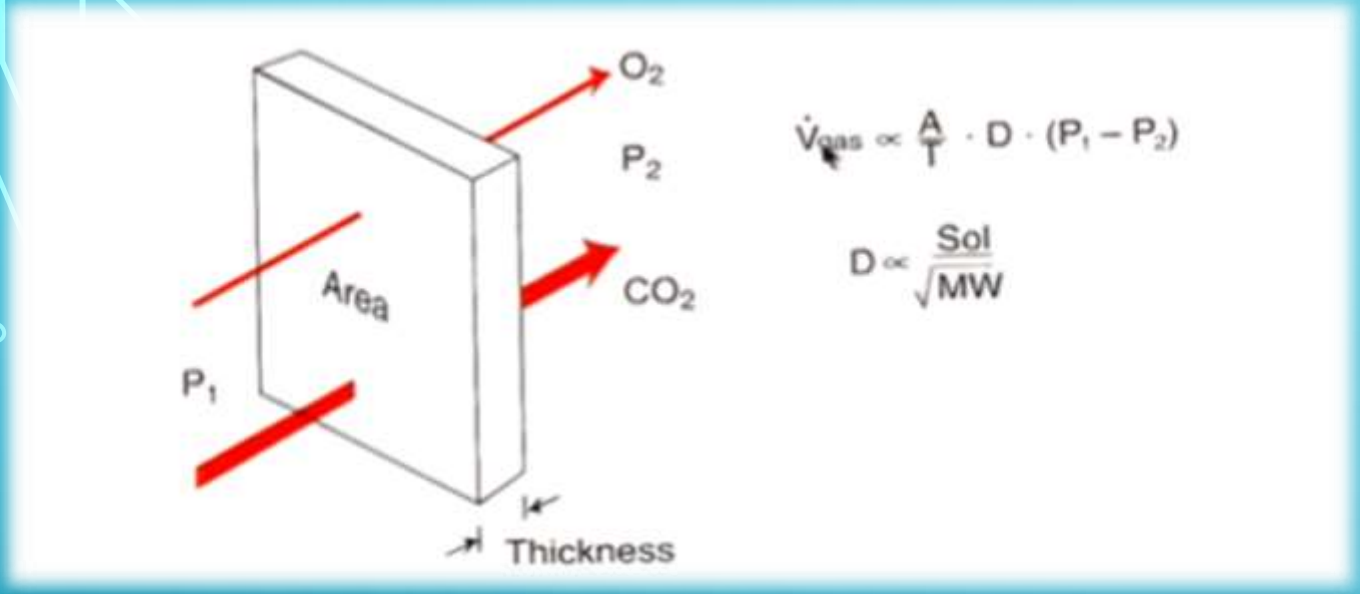


❑ if you have a tissue sheet like a postage stamp then the volume of gas which moves a cross the sheet is proportional to the area of the sheet and proportional to the constant which is called the diffusion constant and the difference of partial pressure between one side of the sheet and the other

❑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



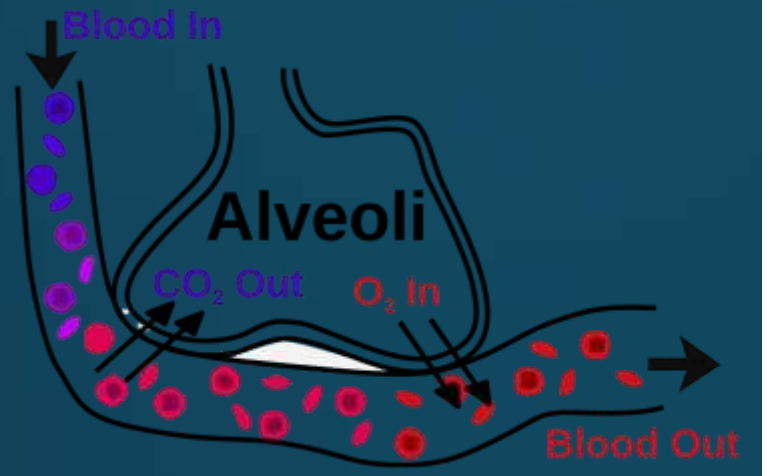
The barrier of the blood gad exchange is very thin and small (about 2mmicrons diameter) so it can't be seen through LM (because not used for less than 1microns)
But it can be seen through EM (used for less than 1 microns)

In Fick's law equation here :
(p) Is expressing the partial pressure

1) Partial pressure : is the concentration of specific gas to the other gases
2) For example : partial pressure of O2 is 50 mmHg (this means concentration of O2 to the other gases like CO2 AND N)

Blood gas barrier is very this so doesn't allow any substance to pass (except gases) through it and gases passes through diffusion
If there are other small particles (like dust and smoking particles) they wont pass because in very large amount so require other transport mechanisms not in blood

Applications in lungs :
The very thin barrier (dramatically very thin 2mmicrons) and the numerus area of diffusion allows more gases diffusion between the blood and the alveoli



Thick (T) → Blood gas barrier very thin 2mmicrons → According to the equation more diffusion

Surface area (A) → Very numerous area f respiratory zone → According to the equation more diffusion

Fick's Law

✓ Diffusion Equation

$$\dot{V}_{gas} = \frac{D * (P_1 - P_2) * A}{T}$$

- Diffusion Coefficient (D)
- Partial pressure gradient ($P_1 - P_2$)
- Surface area (A)
- Thickness of barrier (T)