3. 07. 2025

YAKEEN NEET 2.0

2026

BREATHING AND EXHANGE OF GASES

ZOOLOGY | **Lecture – 4**

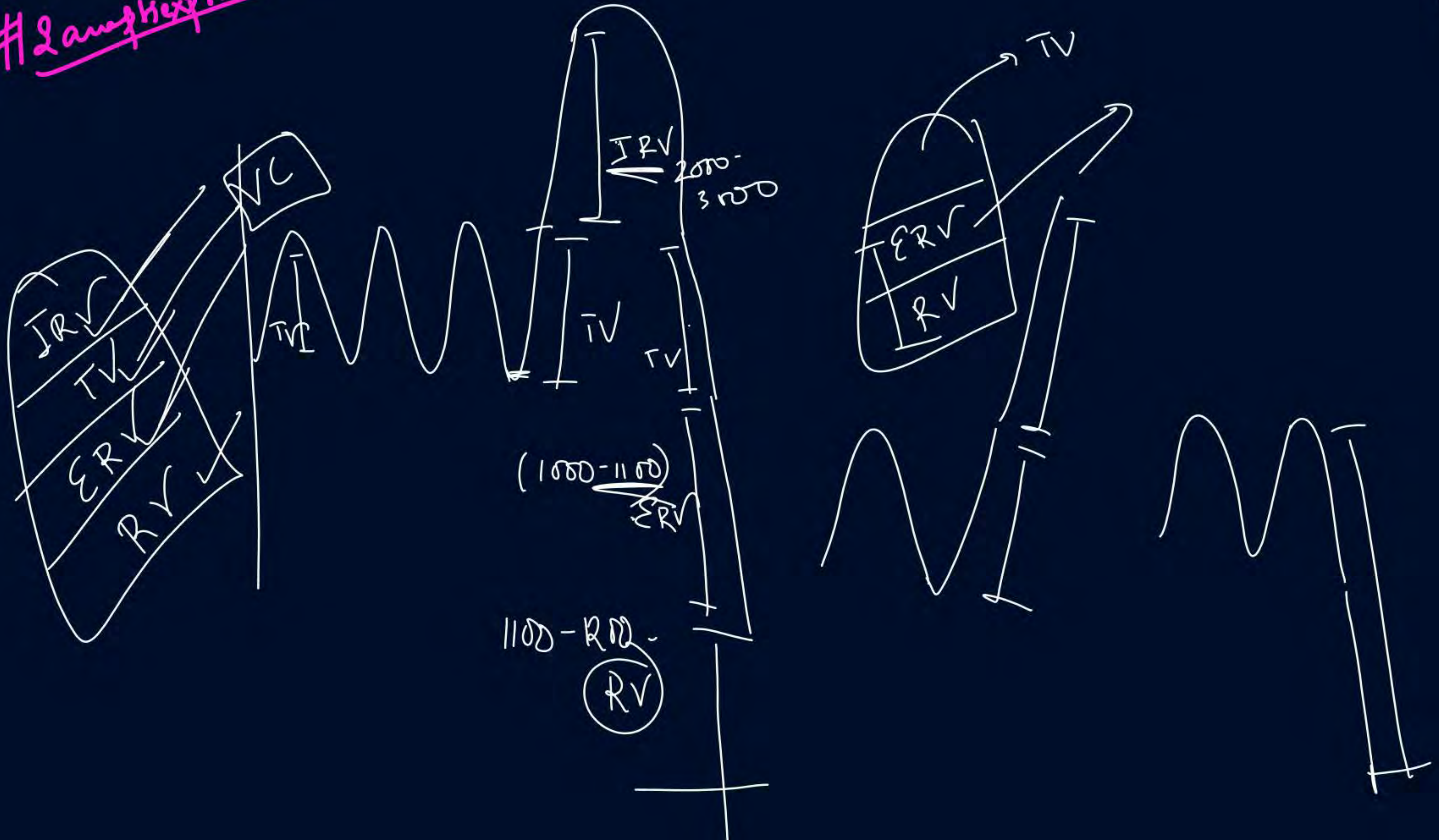
By- SAMAPTI MAM

Topics to be covered

1. EXCHANGE OF GASES, TRANSPORT OF GASES
2.
3.
4.

MY TELEGRAM

#Lungsexpress



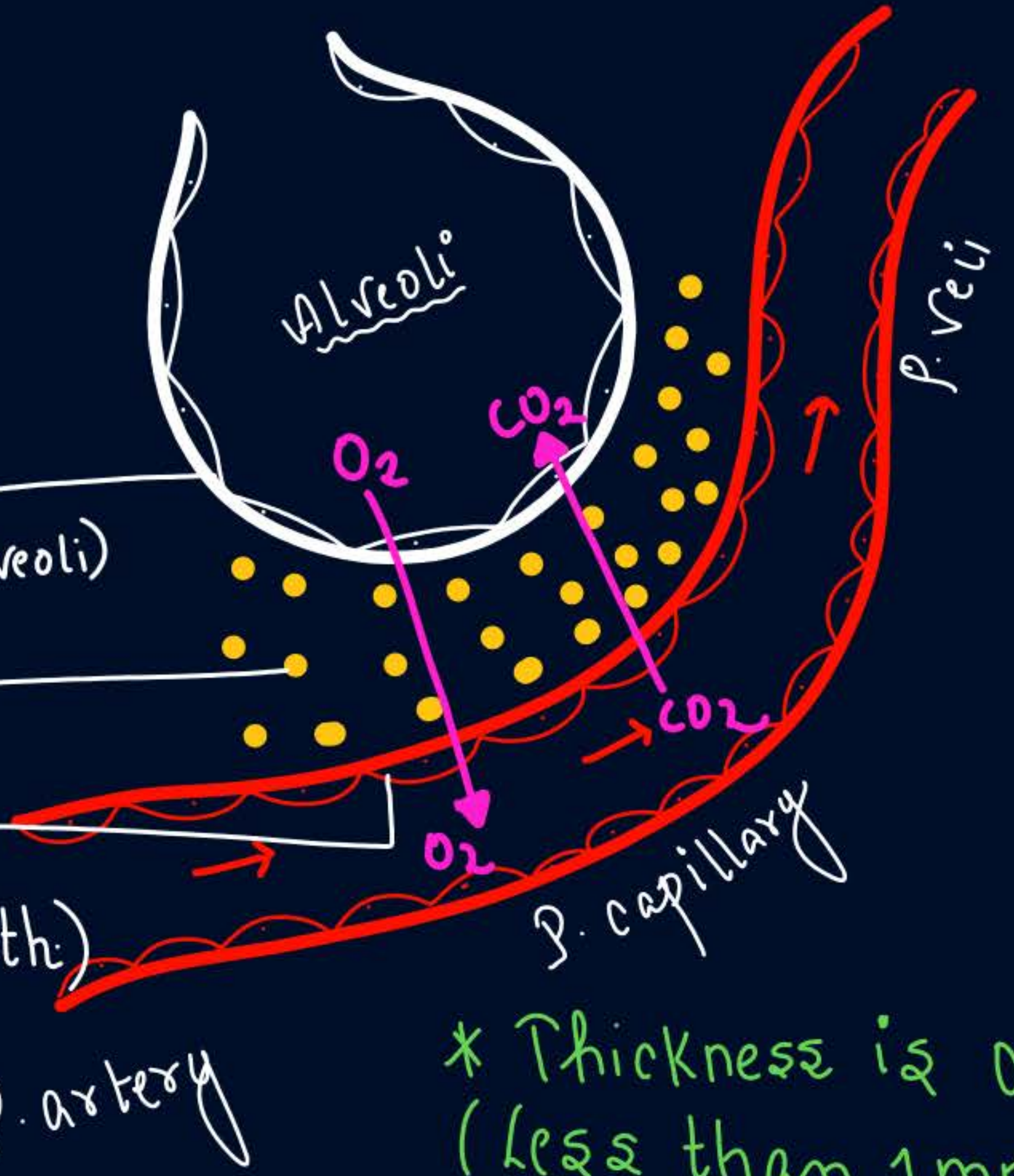
Exchange of gases: Alveoli are PRIMARY SITE for Exchange of gases.

Factors affecting Exchange of gases:

1. Thickness of Diffusion membrane:

Diffusion membrane
↓
3 Layered
↓
2 cellular, 1 Non-cellular (Basement Substance)
↓
formed by Basement membrane of Epithelium of Alveoli & p. capillary.

1. Simple sq. epithelium (Alveoli)
2. Basement substance
3. Endothelium (Simple sq. epith.)



* Thickness is 0.2 mm (less than 1mm).

(2) Partial Pressure: Air always moves from a region of high partial pressure to low partial pressure.

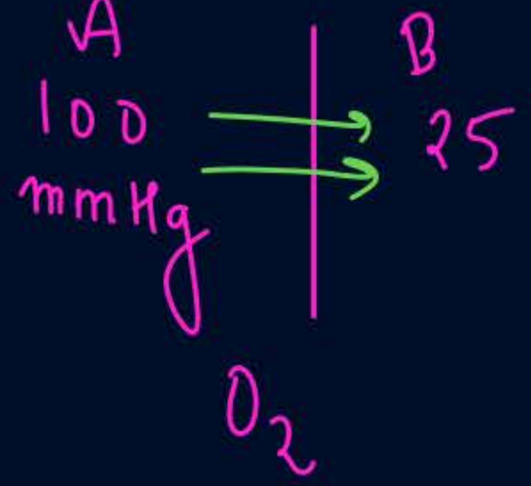
(Atmospheric pressure)

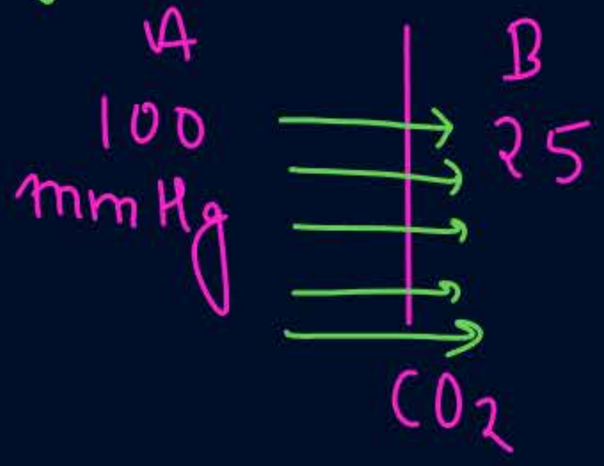
pO_2 : 159 mm Hg (Atmosphere) : $760 \times \frac{21}{100}$ (21% = % of O_2 in atmosphere)

pCO_2 : 0.3 mm Hg (Atmosphere) : $760 \times \frac{0.03}{100}$] Extra gyaan

(3) Solubility: ↑ Solubility means faster diffusion: CO_2 is 20-25 times more soluble than O_2.

$\boxed{\text{NOTE}}$: The diffusion of CO_2 accross the diffusion membrane per unit difference in partial pressure is much higher than O_2





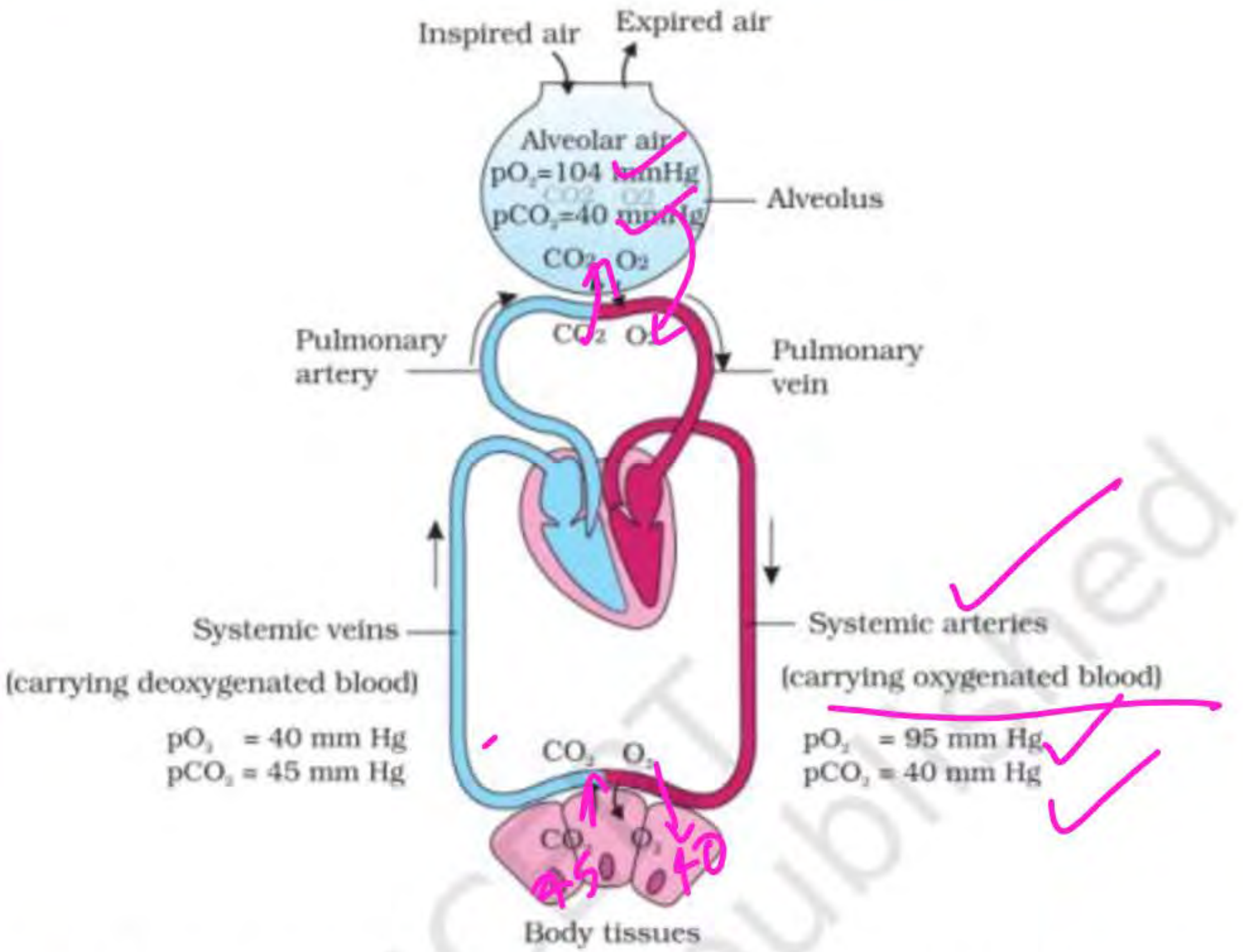
14.3 Exchange of Gases

Alveoli are the primary sites of exchange of gases. Exchange of gases also occur between blood and tissues. O_2 and CO_2 are exchanged in these sites by simple diffusion mainly based on pressure/concentration gradient. Solubility of the gases as well as the thickness of the membranes involved in diffusion are also some important factors that can affect the rate of diffusion.

Pressure contributed by an individual gas in a mixture of gases is called partial pressure and is represented as pO_2 for oxygen and pCO_2 for carbon dioxide. Partial pressures of these two gases in the atmospheric air and the two sites of diffusion are given in Table 14.1 and in Figure 14.3. The data given in the table clearly indicates a concentration gradient for oxygen from alveoli to blood and blood to tissues. Similarly,

Table 14.1 Partial Pressures (in mm Hg) of Oxygen and Carbon dioxide at Different Parts Involved in Diffusion in Comparison to those in Atmosphere

Respiratory Gas	Atmospheric Air	Alveoli	Blood (Deoxygenated)	Blood (Oxygenated)	Tissues
O_2	159	104	40	95	40
CO_2	0.3	40	45	40	45



igure 14.3 Diagrammatic representation of exchange of gases at the alveolus and the body tissues with blood and transport of oxygen and carbon dioxide

a gradient is present for CO_2 in the opposite direction, i.e., from tissues to blood and blood to alveoli. As the solubility of CO_2 is 20-25 times higher than that of O_2, the amount of CO_2 that can diffuse through the diffusion membrane per unit difference in partial pressure is much higher compared to that of O_2. The diffusion membrane is made up of three major layers (Figure 14.4) namely, the thin squamous epithelium of alveoli, the endothelium of alveolar capillaries and the basement substance (composed of a thin basement membrane supporting the squamous epithelium and the basement membrane surrounding the single layer endothelial cells of capillaries) in between them. However, its total thickness is much less than a millimetre. Therefore, all the factors in our body are favourable for diffusion of O_2 from alveoli to tissues and that of CO_2 from tissues to alveoli.

A/R

02

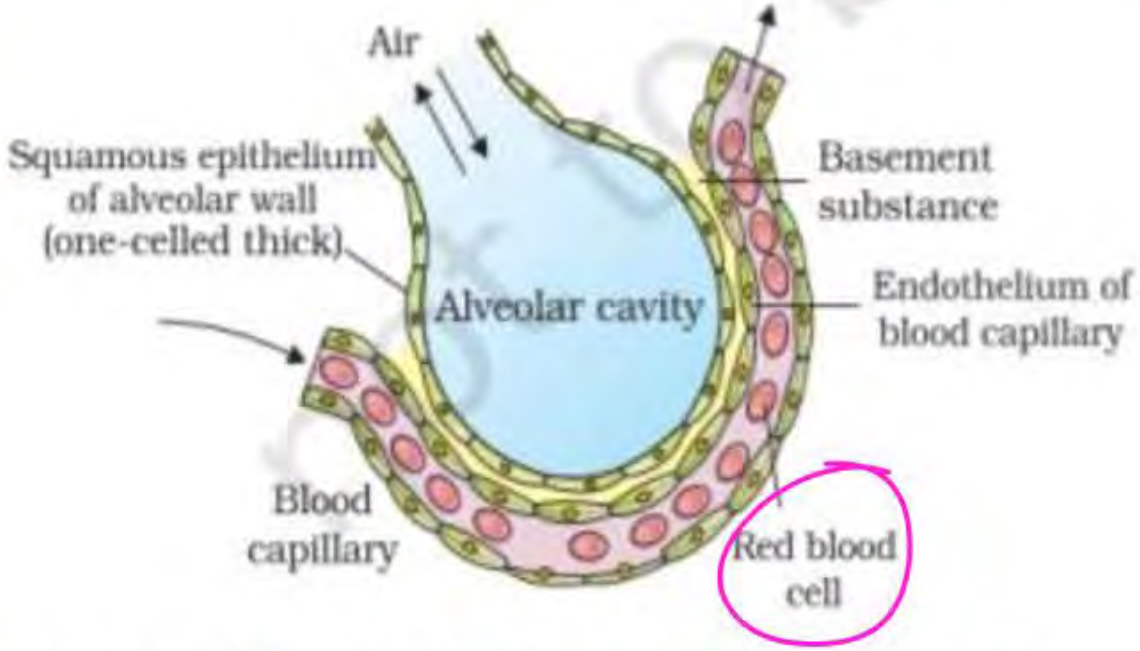
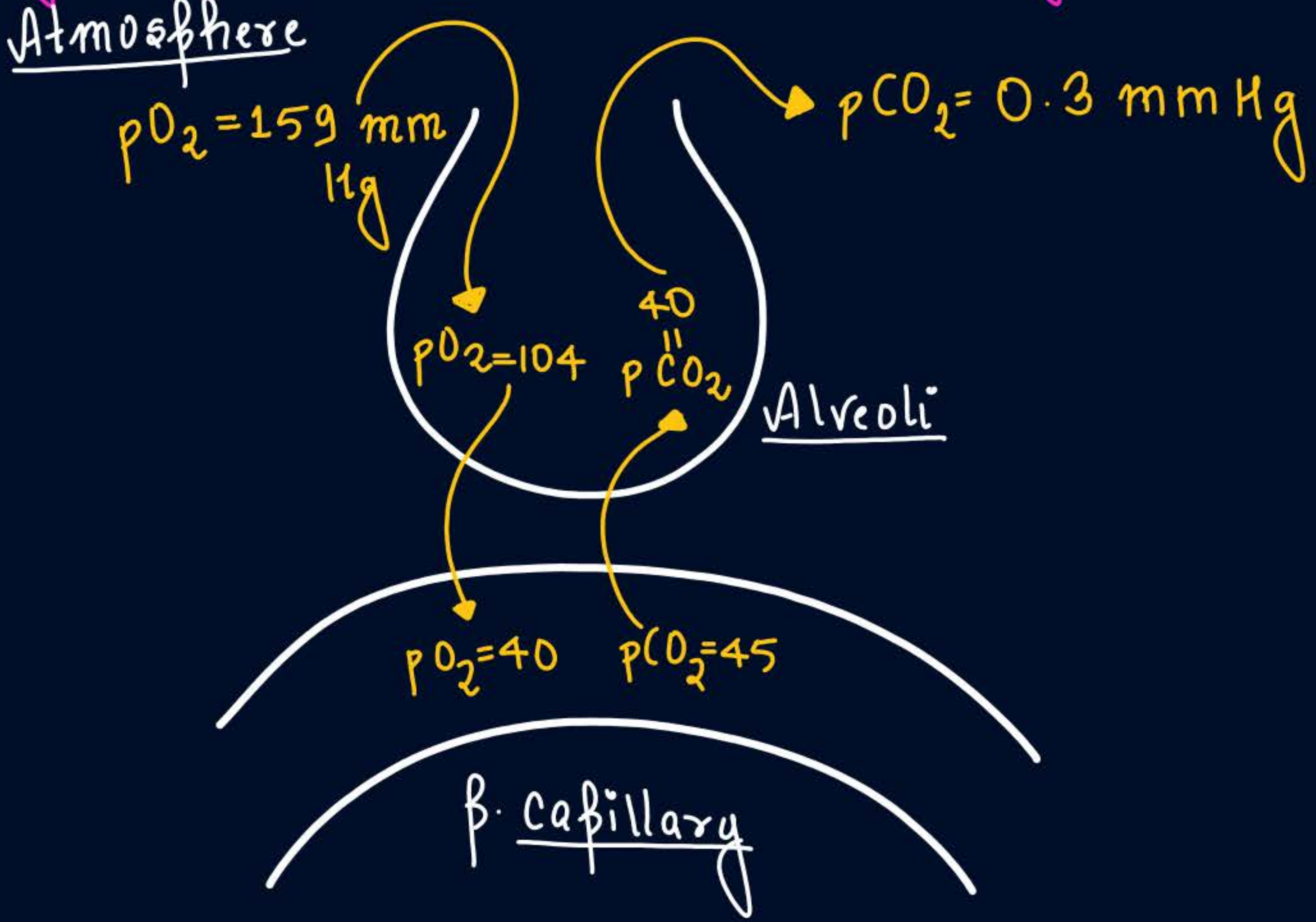
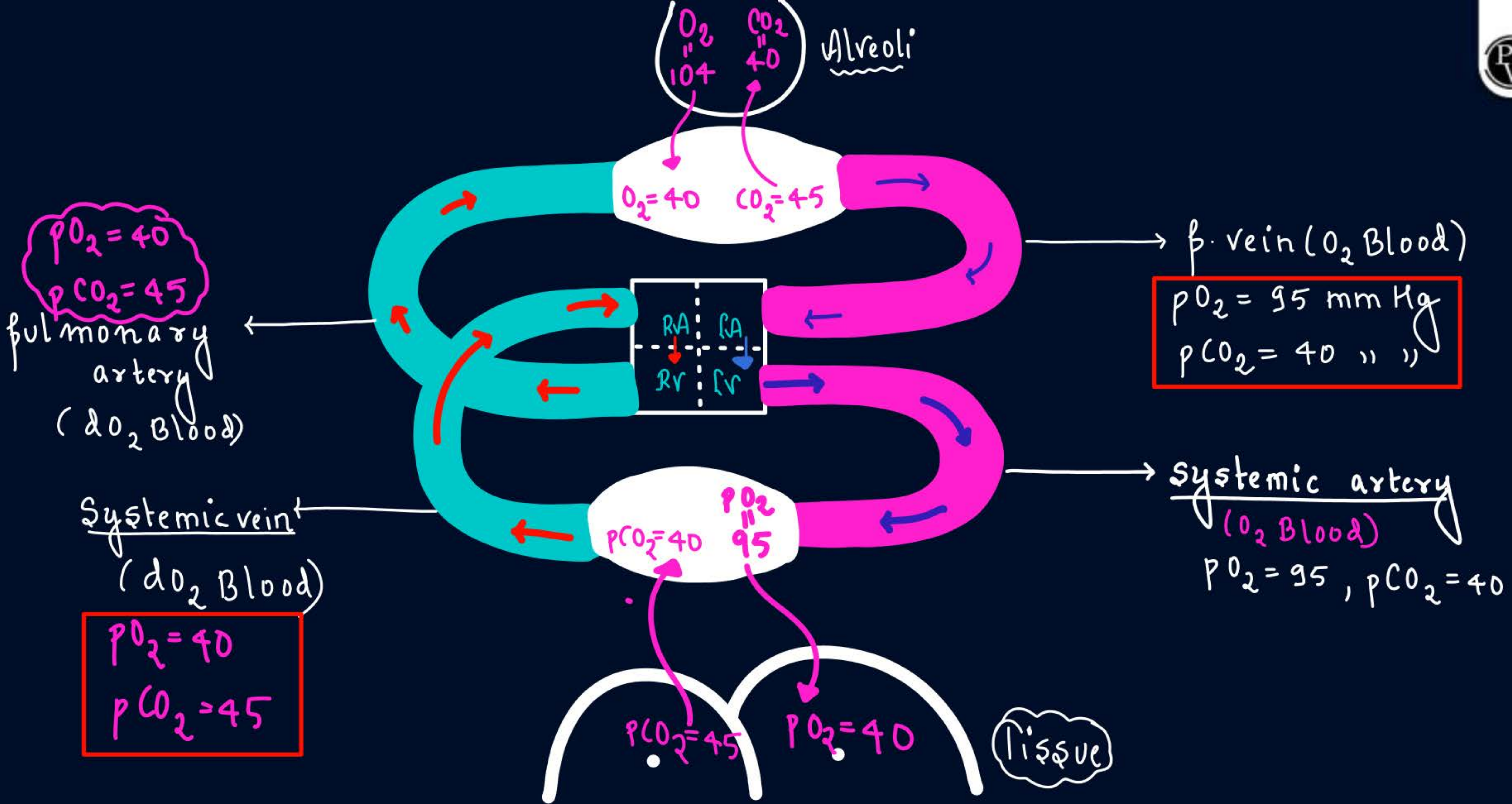


Figure 14.4 A Diagram of a section of an alveolus with a pulmonary capillary.

(I) Exchange of gases b/w Alveoli & P. capillary:



(ii) Exchange b/w $\underbrace{\text{Systemic}}_{\text{(tissue)}}$ capillary & Tissue:



O2 = 104
CO2 = 40
Alveoli
O2 = 40
CO2 = 45
pO2 = 40
pCO2 = 45
pulmonary artery
(dO2 Blood)
RA
LA
RV
LV
P. vein (O2 Blood)
pO2 = 95 mm Hg
pCO2 = 40 " "
systemic artery
(O2 Blood)
pO2 = 95, pCO2 = 40
Systemic vein
(dO2 Blood)
pO2 = 40
pCO2 = 45
pCO2 = 40
pO2 = 95
pCO2 = 45
pO2 = 40
Tissue

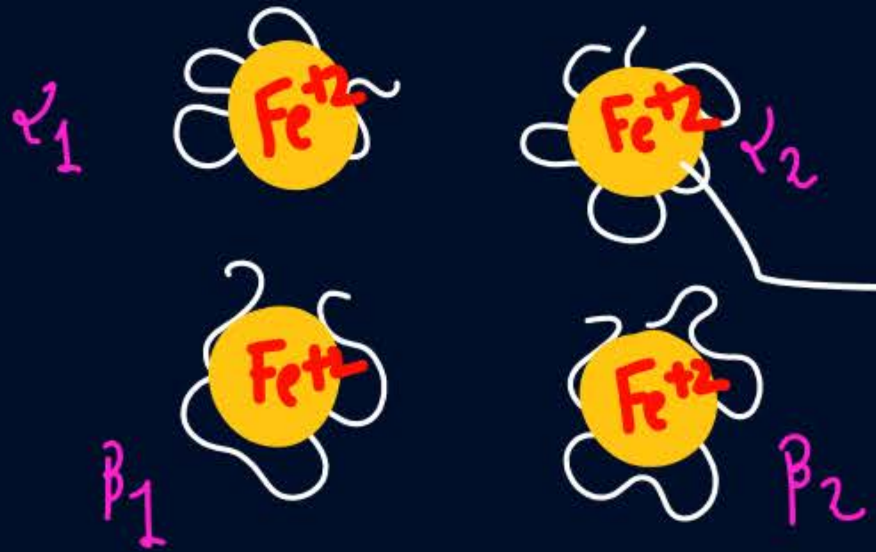
Transport of Gases:

① **Transport of O_2:** Through Blood
- i) Dissolved in Plasma (3%)
- ii) Bound with 'Hb' (97%)

Blood
- Plasma
- formed element
  - Blood cell
    - RBC
    - WBC
  - Platelets

→ RBC : Enucleated with 'Hb' : RED COLORED PIGMENT

1 Hb
- 4 Haem (Non protein)
- 4 Globin (protein chain)
  - 2 → α chain
  - 2 β-chain

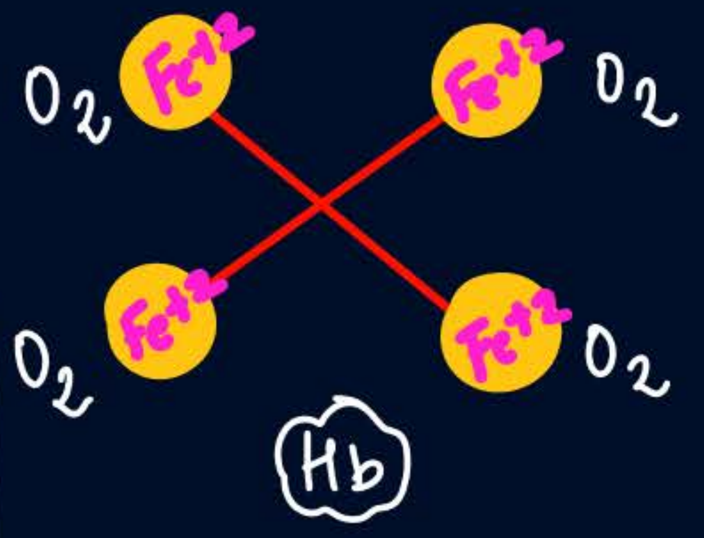


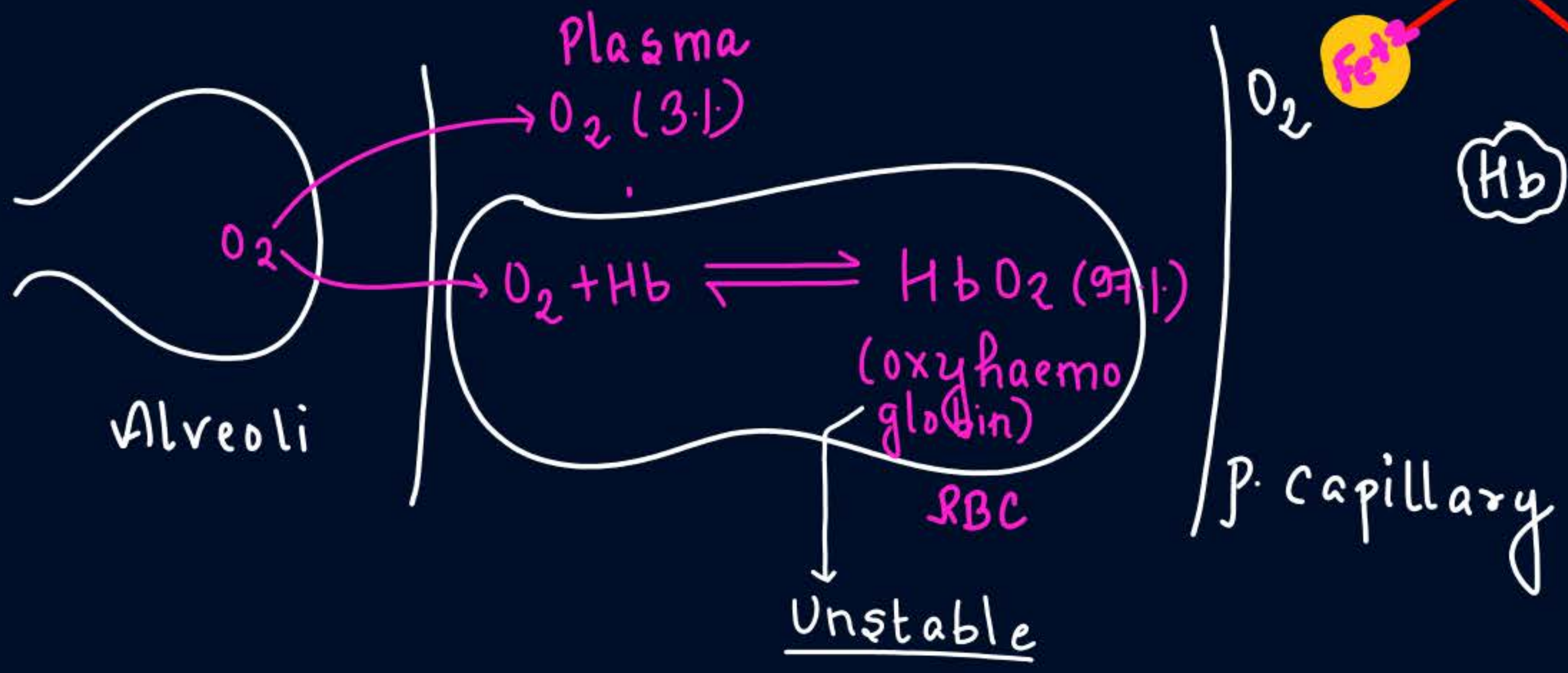
'Haem' : has 'Fe^{+2}'

4 haem = 4 Fe^{+2}

→ O_2 binds to 'Fe^{+2}' part of 'Haem'

→ 1 Hb carries ⇝ 4 O_2 molecules





$$O_2 + Hb \underset{\text{Tissue}}{\overset{\text{Alveoli}}{\rightleftharpoons}} HbO_2$$

Some Imp. Points:

1) 100 ml Blood $\simeq$ 15 gm Hb (12-16 gm)

2) 1 gm Hb can carry $\simeq$ 1.34 ml O_2

3) 100 ml oxygenated Blood = 15 gm Hb × 1.34 ml O_2 = 20 ml O_2 (At $\underbrace{\text{Lungs}}_{\text{site}}$)

4)* At normal physiological condition (temp = 37°C, pH = 7.4, CO_2, H^+ normal), every 100 ml of oxygenated Blood transports/delivers 5 ml O_2 to tissue.

14.4 Transport of Gases

Blood is the medium of transport for O_2 and CO_2. About 97 per cent of O_2 is transported by RBCs in the blood. The remaining 3 per cent of O_2 is carried in a dissolved state through the plasma. Nearly 20-25 per cent of CO_2 is transported by RBCs whereas 70 per cent of it is carried as bicarbonate. About 7 per cent of CO_2 is carried in a dissolved state through plasma.

14.4.1 Transport of Oxygen

Haemoglobin is a red coloured iron containing pigment present in the RBCs. O_2 can bind with haemoglobin in a reversible manner to form **oxyhaemoglobin**. Each haemoglobin molecule can carry a maximum of four molecules of O_2. Binding of oxygen with haemoglobin is primarily related to partial pressure of O_2. Partial pressure of CO_2, hydrogen ion concentration and temperature are the other factors which can interfere with this binding. A sigmoid curve is obtained when percentage saturation of haemoglobin with O_2 is plotted against the of haemoglobin with O_2 is plotted against the pO_2. This curve is called the Oxygen dissociation curve (Figure 14.5) and is highly useful in studying the effect of factors like pCO_2, H^+ concentration, etc., on binding of O_2 with haemoglobin. In the alveoli, where there is high pO_2, low pCO_2, lesser H^+ concentration and lower temperature, the factors are all favourable for the formation of oxyhaemoglobin, whereas in the tissues, where low pO_2, high pCO_2, high H^+ concentration and higher temperature exist, the conditions are favourable for dissociation of oxygen from the oxyhaemoglobin. This clearly indicates that O_2 gets bound to haemoglobin in the lung surface and gets dissociated at the tissues. Every 100 ml of oxygenated blood can deliver around 5 ml of O_2 to the tissues under normal physiological conditions.

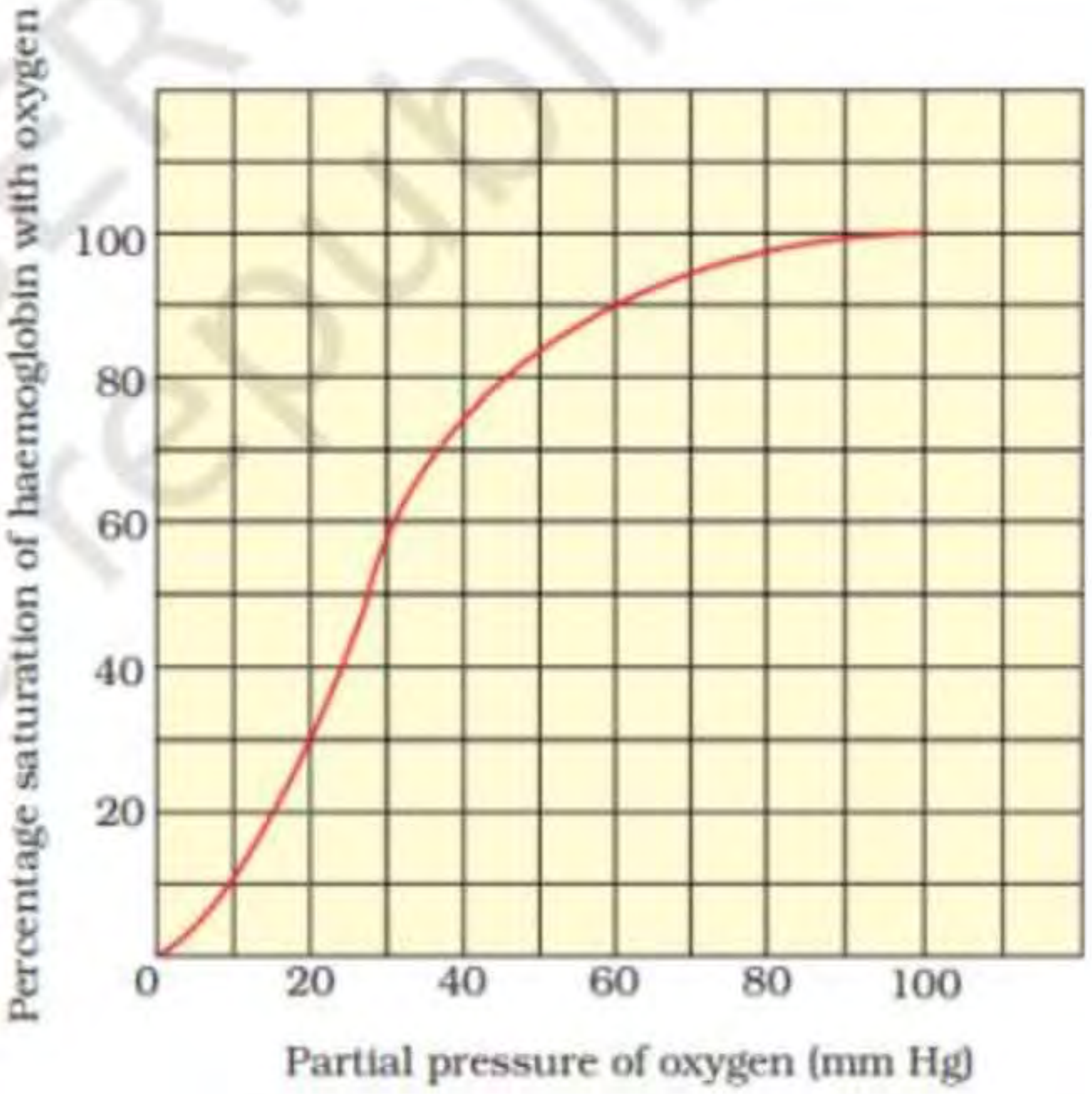


Figure 14.5 Oxygen dissociation curve

14.4.2 Transport of Carbon dioxide

CO_2 is carried by haemoglobin as **carbamino-haemoglobin** (about 20-25 per cent). This binding is related to the partial pressure of CO_2. pO_2 is a major factor which could affect this binding. When pCO_2 is high and pO_2 is low as in the tissues, more binding of carbon dioxide occurs whereas, when the pCO_2 is low and pO_2 is high as in the alveoli, dissociation

of CO_2 from carbamino-haemoglobin takes place, i.e., CO_2 which is bound to haemoglobin from the tissues is delivered at the alveoli. RBCs contain a very high concentration of the enzyme, carbonic anhydrase and minute quantities of the same is present in the plasma too. This enzyme facilitates the following reaction in both directions.

$$CO_2 + H_2O \underset{}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} H_2CO_3 \underset{}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} HCO_3^- + H^+$$

At the tissue site where partial pressure of CO_2 is high due to catabolism, CO_2 diffuses into blood (RBCs and plasma) and forms HCO_3^- and H^+.. At the alveolar site where pCO_2 is low, the reaction proceeds in the opposite direction leading to the formation of CO_2 and H_2O. Thus, CO_2 trapped as bicarbonate at the tissue level and transported to the alveoli is released out as CO_2 (Figure 14.4). Every 100 ml of deoxygenated blood delivers approximately 4 ml of CO_2 to the alveoli.

H.W discussions

QUESTION

Q-1

Arrange the following in the order of increasing volume.

(A) Tidal volume

(B) Residual volume

(C) Inspiratory reserve volume

(D) Vital capacity

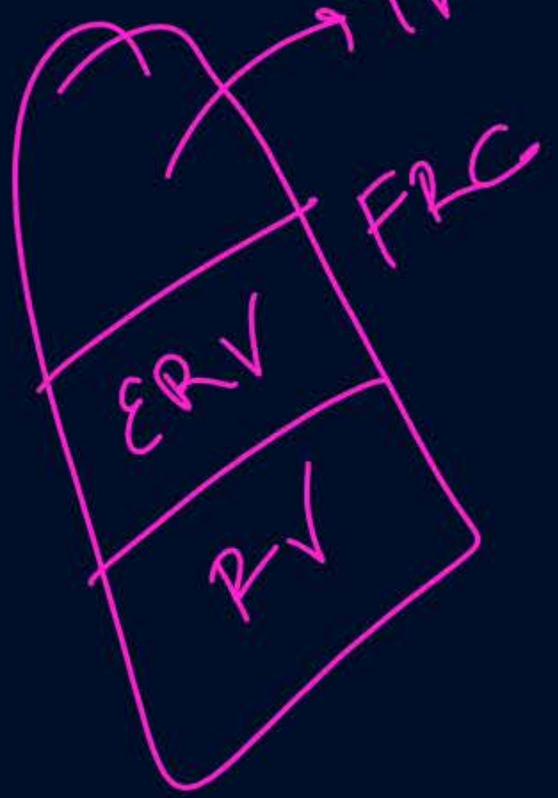
1

1. A < B < C < D TV < RV < IRV < VC
2. A < C < B < D
3. A < D < C < B
4. A < D < B < C

QUESTION

The volume of air remaining in the lungs even after a normal expiration is called:

1. tidal volume (TV).
2. residual volume (RV).
3. functional residual capacity (FRC).
4. vital capacity (VC).



Q-2

3

QUESTION

Statement-I: Measurement of various respiratory volumes using spirometer is of no clinical assessment in pulmonary function

F

Statement-II: All the respiratory volumes can be measured using a spirometer

F

Q-3

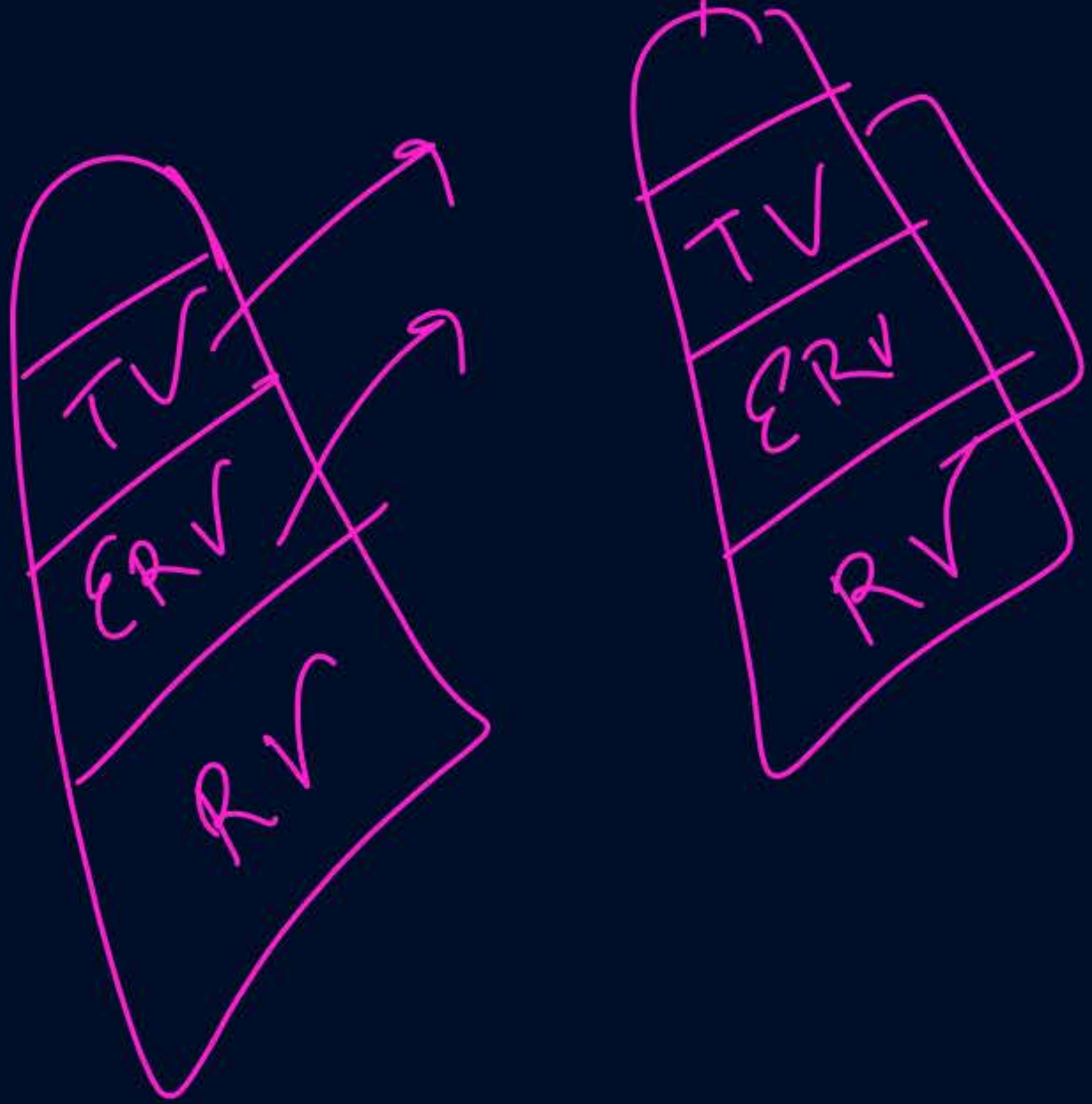
4

1. Statement I and Statement II both are correct.
2. Statement I is correct, but Statement II is incorrect.
3. Statement I is incorrect, but Statement II is correct.
4. Statement I and Statement II both are incorrect.

QUESTION

What is the pulmonary volume of air inhaled by a person under normal condition after he forcefully exhales out?

1. TV
2. TV+IRV+ERV
3. TV+ERV
4. TV+IRV



Q-4

3

QUESTION

Statement-I: The partial pressure of gases, solubility, and the thickness of diffusion membrane are essential factors for exchange of gases T

Alveoli

Statement-II: All the factors in our body are favourable for diffusion of O_2 from tissue to alveoli and that of CO_2 from alveoli to tissue. F

Alveoli

Q-5

1. Statement I and Statement II both are correct.
2. Statement I is correct, but Statement II is incorrect.
3. Statement I is incorrect, but Statement II is correct.
4. Statement I and Statement II both are incorrect.

2

Homework

- REVISE CLAASNOTES / ZOOLOGY MED EASY

MODULE HW
Module -1
Prarambh exercise 1- 7-26

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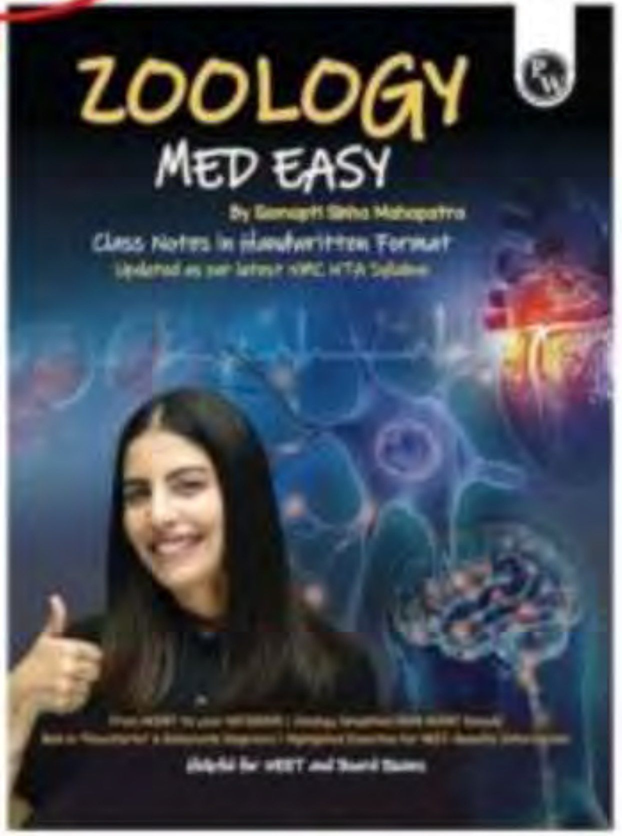

THANK
YOU