Physio Equations

lec 1 :

1) Ohm's law → $flow = \frac{DF}{R} = \frac{\Delta P}{R}$

DF: driving force, R: Resistance

2) Oxygen flow $= \Delta P_{O_2} * k$

k: permeability

3) $k = \underbrace{\left(\frac{A}{dx}\right)}_{\text{Respiratory Membrane}} * \underbrace{\left(\frac{S}{\sqrt{MW}}\right)}_{\text{Gas}}$ ⟹ $\frac{S}{\sqrt{MW}}$ = diffusion coefficient

•A: Surface Area, •dx: Thickness, •S: Gas Solubility, •MW: Gas molecular weight

lec 2 :

1) Total Body Water = 60% * Body Weight

2) Gas pressures in Expired air

$$P_{expired} = \frac{(V_A * P_A) + (V_D * P_D)}{V_T}$$

V_A (350): Alveolar volume, P_A: Partial pressure in Alveolar air

V_D (150): dead-space volume, P_D: 〃 〃 in dead-space air

V_T: Tidal volume

So for example :

$$P_{\bar{E}}O_2 = \frac{350\,ml * 100\,mmHg + 150\,ml * 150\,mmHg}{500\,ml} = 116\,mmHg$$

$$P_{\bar{E}}CO_2 = \frac{350\,ml * 40\,mmHg + 150\,ml * 0\,mmHg}{500\,ml} = 28\,mmHg$$

$\bar{E}$: Mixed Expired • : Alveolar contents • : Dead space contents

3) $P = \frac{Force}{Area}$

4) Boyle's law (The pressure & volume of a gas are inversely proportional, provided Temp & mass are kept constant).

$$P_1 V_1 = P_2 V_2 = constant$$

lec 3:

1) Cardiac output (Q) = Stroke volume * Heart Rate

2) Respiratory minute ventilation (RMV) = V_T * RR

V_T : Tidal volume , RR : Respiratory Rate

3) $R = \frac{8\eta l}{\pi r^4}$

R : Resistance , η : viscosity , l : length , r : radius

$R \propto \frac{1}{A^2}$ $\left(R \propto \frac{1}{r^4}\right)$

4) velocity $\left(\frac{d}{t}\right) = \frac{\text{flow}\left(\frac{d^3}{t}\right)}{\text{Area}\,(d^2)}$

5) Work = $\Delta P * \Delta V$

ΔP : DF , ΔV : Tidal volume

6)

- Inspiratory capacity (IC) = Tidal Volume (V_T) + Inspiratory Reserve Volume (IRV)
- Functional Residual Capacity (FRC) = Expiratory Reserve volume (ERV) + Residual volume (RV)
- Vital Capacity (VC) = IRV + V_T + ERV (All volumes except RV)
- Total Lung Capacity (TLC) = VC + RV (All 4 Volumes)

7) Initial amount of He = Final amount of He

$$C_1 * V_1 = C_2 * (V_1 + FRC)$$

final equation :

$$FRC = V_1\left(\frac{C_1}{C_2} - 1\right)$$

FRC : functional Residual capacity , V_1 : known gas volume , C_1 & C_2 : (He) concentration

lec 4:

1) $PDSV = ADSV + AWV$

PDSV: physiological dead space volume, ADSV: Anatomical dead space volume, AWV: Alveolar wasted volume

2) $PDSV = V_T * \left(\frac{P_aCO_2 - P_{\bar{E}}CO_2}{P_aCO_2}\right)$

V_T: Tidal volume, P_aCO_2: Arterial CO_2 partial pressure, $P_{\bar{E}}CO_2$: Mixed Expired Air CO_2 partial pressure

lec 5:

1) for (Lung volume – Intrapleural pressure curve)

$$Compliance = Slope = \frac{\Delta V}{\Delta P} = \tan\theta$$

2) $P = \frac{2T}{r}$ (Laplace's law)

P: inflation pressure, T: Surface Tension, r: radius

lec 6:

1) Mean (systemic or pulmonary) Arterial pressure $= \frac{2}{3}$ dias. BP $+ \frac{1}{3}$ syst. BP

2) $\underbrace{R_p}_{\text{pulmonary Resistance}} \approx \frac{1}{7} * TPR$ $\left(\frac{14}{100} * TPR\right)$

3) $NFP = \overbrace{(P_c + \pi_i)}^{\text{filtration}} - \overbrace{(P_i + \pi_c)}^{\text{Reabsorption}}$

NFP: Net filtration pressure, P_c: capillary hydrostatic pressure, π_i: Interstitial oncotic pressure

P_i: Interstitial hydrostatic pressure, π_c: capillary oncotic pressure

Quick Revision for the "Zones of pulmonary blood flow"

$P_A > P_s > P_d$ → No Blood flow → Zone 1 Blood flow

$P_s > P_A > P_d$ → Only during systole (Intermittent) → Zone 2 Blood flow

$P_s > P_d > P_A$ → Continuous flow → Zone 3 Blood flow

P_A : Alveolar pressure, P_s : systolic pressure, P_d : diastolic pressure