Physiology

1. **Ohm's law: J O2 (flow)= DF (driving force)/R (resistance).**

2. **K (permeability)= (A area/ dx thickness)*(S solubility/√mm).**

- The least important factor among the four is the molecular weight because we take the square root of it.

- Permeability is how easy to cross the membrane . In the context of ions we refer to it as conductance which is the opposite of resistance. So, K=1/R so --> J=DF*K.

3. **Combine solubility and molecular weight into a single value called the diffusion coefficient (D).**

4. **RMV (respiratory minute ventilation) = tidal volume*respiratory rate.**

- Alveolar ventilation = 350*12=4.2L and anatomic dead space ventilation=150*12=1.8L

5. **PO2 mixed expired= (150ml*150) + (350ml*100))/500ml=116**

6. **Poiseuille's Law: R=8 η l/ πr^4 (Direct Measurement of Resistance) which requires:**

o Laminar flow (not turbulent).

o Homogeneous fluid (e.g., water) not heterogeneous as the blood (contains

plasma and RBCs).

o Steady, non-pulsatile flow (steady flow with respect to time).

- These conditions are not typically met in physiological systems.

- The radius is the most important factor affecting R.

7. **Work is how much ATP is utilized to support the respiratory system**

- W= ΔP × ΔV.

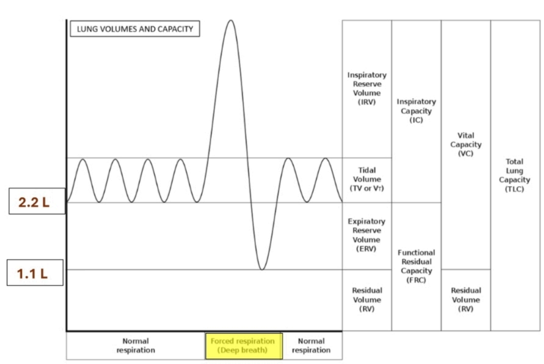
8. **Inspiratory capacity: IC=IRV+VT=3.5 L**

7. **Functional residual capacity: FRC=ERV + RV = 2.2L**

8. **Vital capacity: VC= ERV+IRV+VT = 4.6L**

9. **TLC= VT+ ERV+IRV+RV=5.7 L**

important



10. Helium dilution technique to measure Functional Residual Capacity (FRC):

C1V1=C2V2

C1V1=C2 ($V1+FRC$)

$$FRC = \frac{V1(C1-C2)}{C2}$$

11. V/Q ratio: alveolar ventilation/ pulmonary blood flow

12. PDS= ADS + wasted volume

$$PDSV = \frac{VT\ X\ (P_A CO2 - P_{\hat{E}} CO2)}{P_A CO2}$$

PDSV= Physiological Dead Space Volume.

VT=Tidal Volume.

PACO2= Partial pressure of CO2 in the alveoli.

PE` CO2= Partial pressure of CO2 in the expired air.

$$PDSV = \frac{VT\ X\ (P_A CO2 - P_{\hat{E}} CO2)}{P_A CO2} = 500\ X\ \frac{40-28}{40} = 150$$

Extra: How did we measure 28?

$P_{\hat{E}}CO2$ is the expired Co2 from the lungs, contains 350 ml aleovli + 150 ml ADS:

$$P_{\hat{E}}CO2 = \frac{Alev\ X\ P_A CO2 + ADS\ X\ atm\ Co2}{VT} = \frac{350\ X\ 40 + (150\ X\ 0)}{500} = \mathbf{28}$$

13. compliance= ΔV/ΔP

14. Law of Laplace: P=2T/r

😊 الارقام المطلوب حفظها:

1. At sea level, Patm is equal to 760 mmHg.

2. Percent of O_2 in the outside air is 21%.

3. Outside air --> PO_2 = 21%*760 = 159 ≈ 160mmHg, PN_2≈600mmHg and PCO_2 = 0.3 which is considered as≈ zero.

4. Every time we ascend approximately 5.5 km above sea level, both the atmospheric pressure (Patm) and the partial pressure of oxygen (PO_2) decrease by half.

5. Divisions 0–16: conductive zone, Divisions 17–23: respiratory (exchange) zone.

6. Division 0: Trachea, Division 1: Primary (main or mother) bronchus, Division 16: terminal bronchiole and Division 23: alveolus.

7. The anatomic dead space volume (ADSV) = 2 mL/kg.

- For example, a person weighing 75 kg has an ADSV of approximately 150 mL, which is often cited in textbooks as the typical adult ADSV.

8. When dry air is inhaled it contains O_2 and N_2, with $PH_2O = 0$.

The conductive zone adds a third gas: H_2O vapor. At body temperature (37°C), PH_2O = 47 mmHg, meaning atmospheric air becomes 100% saturated with water vapor.

So in the anatomic dead space, PO_2 =(760−47)×21%=149≈150$mmHg$ and PCO_2 remains at zero.

9. In Alveolar Air, PO_2 (PAO_2) = 100 mmHg and PCO_2=40mmHg.

10. O_2: Diffusion coefficient = 1, CO_2 Diffusion coefficient = 20 and CO: Diffusion coefficient = 0.8.

11. Tidal volume= 500 ml (the volume of air inhaled or exhaled with each breath).

12. The volume of air in the lungs at rest is 2.2L

13. PO_2 mixed expired=116mmHg

14. The blood volume forms 7% of the body's weight in males (if body weight was 70 kg), and 6% in females.

- This approximates 5000ml which is distributed throughout the CVS as follows: 3000ml in systemic veins (60%), 750ml in systemic arteries (15%), 450ml in pulmonary

circulation (9%), 350ml in the cardiac chambers (7%), and 350ml in systemic capillaries (7%).

- In the lung, blood is found in 3 regions, 190ml in pulmonary arteries, 190ml in pulmonary veins, and 70ml in pulmonary capillaries and the alveoli have about 2500ml inside.

15. Systemic capillaries comprise 60% TBW in males (and 55% in females – because they have more fat so there is less water => fat hates water). So: 60% x 70 kg (body weight) = 42L.

The 42L are divided into:

a. 2/3 represent 28L that go to the intracellular fluid.

b. 1/3 represent 14L that is divided into <u>2 further parts in the extracellular fluid:</u>

i. interstitial fluid taking 11L (this what we care about)

ii. plasma taking 3L

16. Intrapleural pressure= -4.

17. Normally: R is small and negligible [ΔP of 1 mmHg is enough to overcome it].

18. Initial pulmonary artery pressure: 14 mmHg (calculated as 2/3 of 8 + 1/3 of 25).

- The pulmonary arterial pressure is mean pressure of systolic (25mmHg) and diastolic (8mmHg). Since the heart spends more time in diastole, the formula to calculate the mean pressure is 1/3 *systolic pressure + 2/3 * diastolic pressure).

19. Pulmonary hypertension: >20 mmHg.

20. Inspiratory Reserve Volume IRV= 3L

21. Expiratory Reserve Volume ERV=1.1

22. Residual volume RV=1.1 (more in elderly)

23. Normal V/Q ratio = 1

24. If the V/Q is infinity, the PAO2 would be = 150 (same as the ADS)

25. Physiological dead space (PDS =ADS + wasted volume)

- In healthy individuals, PDSV is equal to ADS=150

- If there is wasted volume, the partial pressure of carbon dioxide (PCO2) would be zero, which reduces $P\hat{E}CO2$ and thus increases PDSV.

26. FEV1/FVC:

- normally it equals 80%

- In obstructive lung disease it decreases and can be as low as 20-30% in severe obstructive airway disease.

- In restrictive disorders have a near normal FEV1/FVC or sometimes more than normal.

27. surfactant-to-albumin (S/A) ratio in amniotic fluid is measured:

[مش متأكدة اذا حفظ بس احتياط]

- >55 mg: Lungs are mature.

- 35–55 mg: Intermediate maturity.

- <35 mg: Lungs are immature.

28. Diagnosis of ARDS: The key diagnostic criterion for ARDS is when the PaO2/FiO2 ratio is <200.

o FiO2 (Fraction of Inspired Oxygen)

o PaO2 (Partial Pressure of Oxygen in Arterial Blood)

- Example:
    - In a healthy individual:
      FiO2 = 21%, PaO2 = 100 mmHg
      100/0.21 = 500
      while inhaling pure oxygen **(FiO2 = 100%), PaO2 =** **(500-600) mmHg** **very high**
      600/1 = 600
    - In ARDS patient,the ratio will NEVER exceed 200 (always < 200)
      Even When inhaling pure oxygen (FiO2 = 100%)
      For example: FiO2 = 100% ,PaO2 = 100 mmHg (100/1=100)

This low ratio is a hallmark of ARDS.

29.

Lining Type	Surface Tension	Cause (This column is additional for ur better understanding)	Pressure Required
Water	High	Strong hydrogen bonding between water molecules at the air-water interface	-23
Interstitial Fluid	Lower than water	Presence of proteins and solutes reduces intermolecular attraction compared to water	-13
Surfactant	Minimal	Surfactant disrupts cohesive forces between water molecules, reducing surface tension	-4

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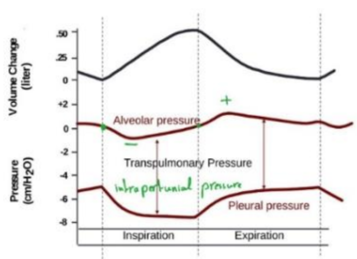
Extra table (Helpful for exam purposes):

Intrapleural Pressure (Ppl) - This is the pressure within the pleural cavity, the space between the lung and the chest wall. It is always negative (subatmospheric) during normal breathing.

Intrapulmonary Pressure (Ppul) - This is the pressure within the lungs (or the alveoli). It is also known as alveolar pressure.



Respiratory Stage	Intrapleural Pressure (Ppl)	Intrapulmonary Pressure (Ppul)
During Inspiration	**More negative** (subatmospheric) as the chest expands	**Negative** (lower than atmospheric) to draw air in
At the End of Inspiration	**Most negative** (subatmospheric) due to full lung expansion	**Equal to atmospheric pressure** (no airflow)
During Expiration	**Less negative** (subatmospheric), or slightly positive during forced expiration	**Positive** (greater than atmospheric) to push air out
At the End of Expiration	**Less negative** (subatmospheric) or slightly positive during forced expiration	**Equal to atmospheric pressure** (no airflow)

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