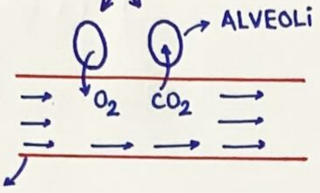
RESPIRATORY PHYSIOLOGY

RESPIRATION

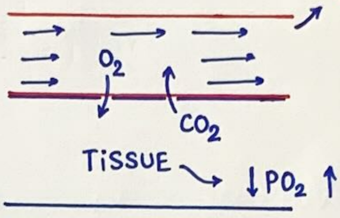
EXTERNAL

INTERNAL → Tissues



PULMONARY CAPILLARY
↓
↑PO_2 ↓PCO_2

SYSTEMIC CAPILLARY
[↑PO_2]



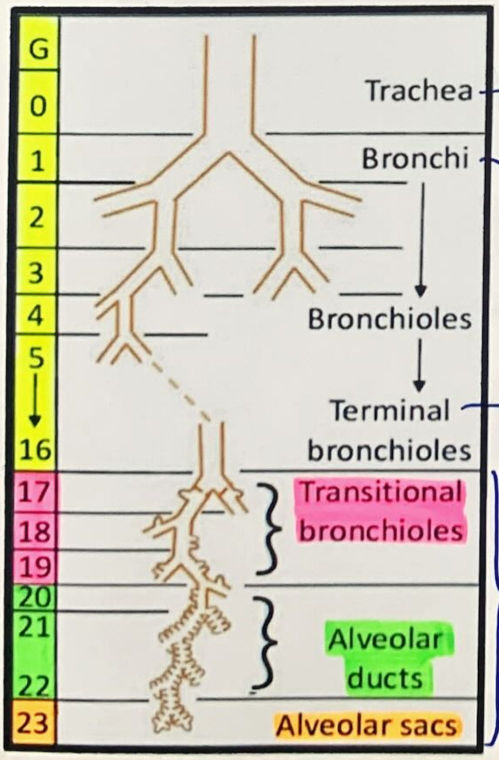
TISSUE → ↓PO_2 ↑PCO_2

UPPER RESPIRATORY TRACT → NASAL PASSAGES → PHARYNX → LARYNX

LOWER RESPIRATORY TRACT → WEIBEL CLASSIFICATION → 0-23 generations

↓

between TRACHEOBRONCHIAL TREE & LUNG PARENCHYMA ...



Trachea → 0

Bronchi → 1-10

Terminal bronchioles → 11-16

→ CONDUCTING ZONE / ANATOMICAL DEAD SPACE
↓
NO EXCHANGE

→ RESPIRATORY | EXCHANGE | TRANSITIONAL ZONE
↓
17-23

MEDIUM SIZE AIRWAYS	FEATURES	SMALL SIZE AIRWAYS
Less	CSA	More
↑↑	VELOCITY	↓↓
↑↑	REYNOLD's No.	↓↓
↑↑	TURBULENCE	↓ (Laminar)
Maximum Resistance	RESISTANCE	Minimum Resistance

ACCORDING TO VOLUME - RESISTANCE
is Minimum @ TLC and
Maximum @ RV

INNERVATION OF THE RESPIRATORY TRACT

PARASYMPATHETIC
(VAGAL)
↓
Ach
↓
BRONCHOCONSTRICTION

SYMPATHETIC
↓
NANC
(Non-Adrenergic Non-cholinergic)
↓
BRONCHODILATION

(VIP)
↳ Vasoactive Intestinal Peptide

- * β_2- RECEPTORS are in plenty in BRONCHI & BRONCHIOLES ...
- * CARTILAGE & SUBMUCOSAL GLANDS → BRONCHI
- * SMOOTH MUSCLES is ⊕ maximum in BRONCHIOLES

1. **CLARA CELLS / CLUB CELLS**

↓

release SURFACTANT PROTEIN → i.e. SP - A, B, C, D

↓

maintains the STABILITY of the SURFACTANT...

2. **PNEUMOCYTES**
   - I → 90-95% Surface Area → GASEOUS EXCHANGE
   - II → 5% Surface Area but constitute 60% of Total Pneumocytes
     ↓
     SURFACTANT
   - III → have MICROVILLI (non-specific)
     ↓
     K|a BRUSH CELLS

DYNEIN - CILIA → muco-ciliary escalator

DYNEIN ↓ motor

↓

IMMOBILE CILIA (non-functioning)

- DYNEIN ⊕
  ↓
  CFTR gene #
  ↓
  CYSTIC FIBROSIS
- DYNEIN ⊖
  ↓
  IMMOBILE CILIA SYNDROME
  ↓
  KARTAGENER SYNDROME

MECHANICS OF RESPIRATION

↓

* BOYLE's LAW : $P \propto \frac{1}{\text{Volume}}$

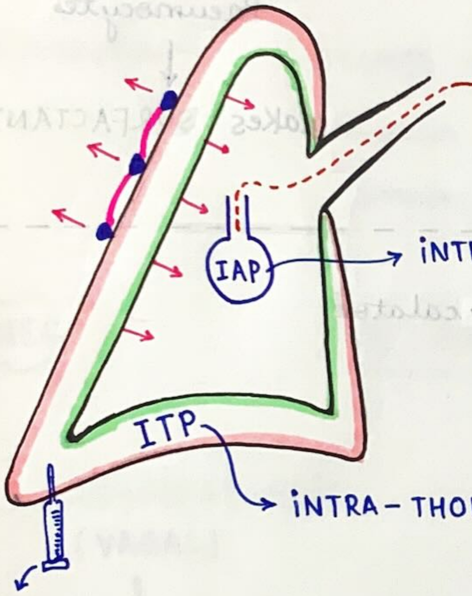
* INSPIRATION : SUCTION PRESSURE → -ve pressure

* EXPIRATION : +ve pressure

↓↓ chest cavity volume

↓

↑↑ Pressure



→ OPEN SYSTEM ≈ ATMOSPHERIC PRESSURE

(760 | 0 mm Hg)

absolute relative

IAP → INTRA-ALVEOLAR PRESSURE / INTRA-PULMONARY PRESSURE

ITP → INTRA-THORACIC PRESSURE / INTRA-PLEURAL PRESSURE

↓

CLOSED SYSTEM (can be any pressure)

Pressure Gauze → MANOMETER

Ⓝ INSPIRATION

↓

i) ↑ in VERTICAL DIAMETER
d/t DESCENT OF DIAPHRAGM → 75 % of Total Inspiration

ii) ↑ in AP DIAMETER
d/t ELEVATION OF EXTERNAL ICM → Pump Handle Movement
(2-6 Rib)

iii) ↑ in TRANSVERSE DIAMETER
d/t ELEVATION OF EXTERNAL ICM (7-10 Rib) → Bucket Handle Movement

Ⓝ EXPIRATION : Passive Process d/t ELASTIC RECOIL OF LUNG and CHEST WALL ...

* MUSCLES INVOLVED IN DEEP INSPIRATION : PS_3

↓

Pectoralis Minor
SCM
Serratus Anterior
Scalenius

* MUSCLES INVOLVED IN FORCED EXPIRATION

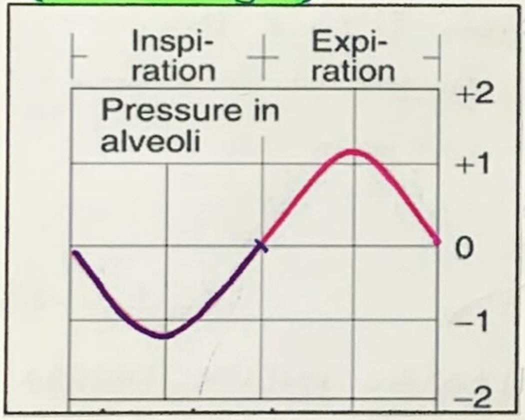
↓

INTERNAL ICM + ANTERO-LATERAL ABDOMINAL MUSCLES

↓

- External Oblique
- Internal Oblique
- Transversus Abdominis
- Rectus Abdominis

IAP Changes



* During Inspiration → −1

* During Expiration → +1

* @ beginning or @ end of ↗ inspiration ↘ expiration

↓

'0'

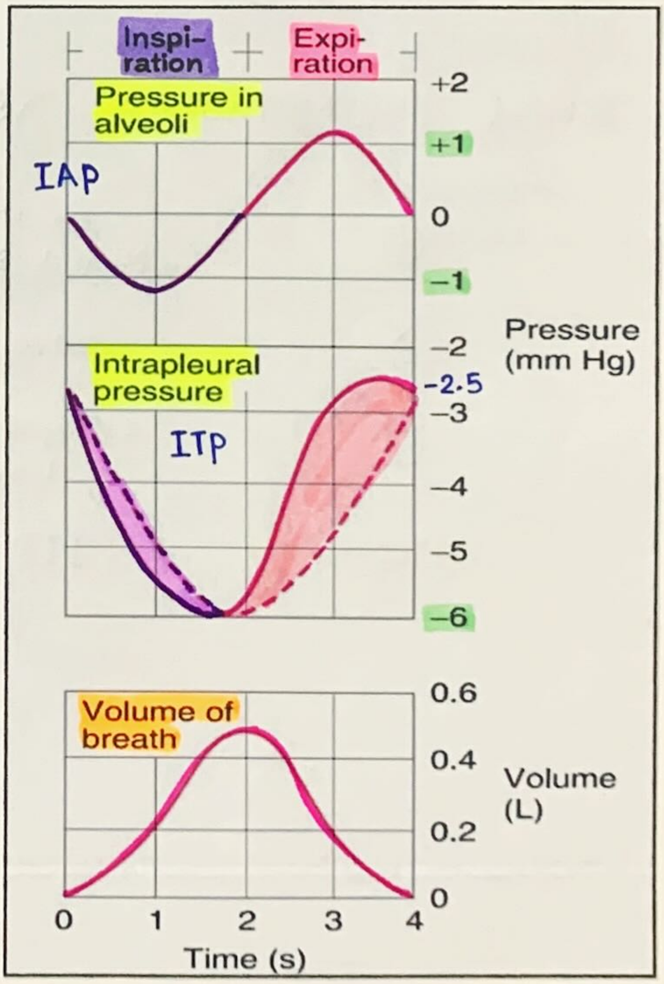
ITP / IPP Changes

↓

* At Rest → −2.5 mm Hg

* During Inspiration → −6 mm Hg

* At the end of Expiration → −2.5 mm Hg



Q: Why ITP is Negative ?

↓

because Chest Wall has natural tendency to SPRING OUTWARD & Lung wants to RECOIL INWARD ...

↓

Visceral & Parietal Pleura ⟶ stretch in opposite direction + close cavity

↓

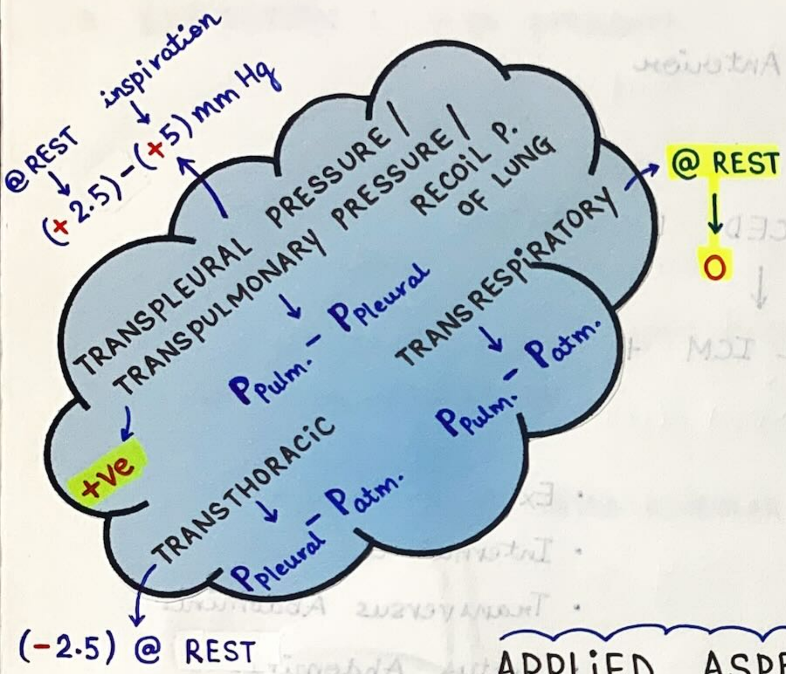
-ve pressure

↓

it is d/t LYMPHATIC DRAINAGE OF PLEURA

↓

drain ↑↑ fluid than it is secreted in pleura ...

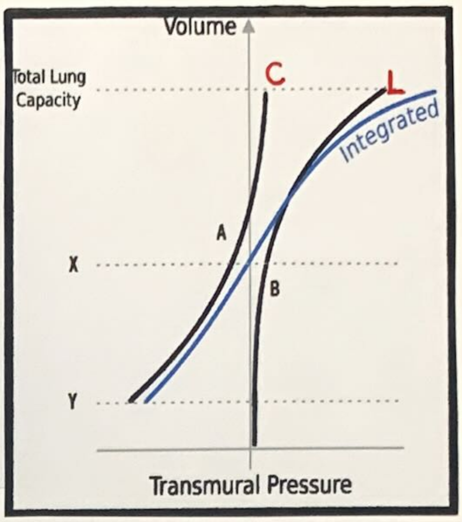


APPLIED ASPECTS

SIMPLE PNEUMOTHORAX	VS	TENSION PNEUMOTHORAX
⊕	Air in Pleural Space	⊕
×	Valve	✓
⊕	Collapse of Lung	⊕⊕⊕ ⟶ quick
0/760 mm Hg	ITP	+ve

Q. The graph below represents the relationship of chest, lung and both together w.r.t. the transmural pressure.

- **a.** A= Curve for chest wall; B= Curve for Lung; X= Residual Volume
- **b.** A= Curve for Lung; B= Curve for Chest wall; X= Residual Volume
- **c.** A= Curve for chest wall; B= Curve for Lung; X= Functional Residual Capacity
- **d.** A= Curve for Lung; B= Curve for Chest wall; X= Functional Residual Capacity



COMPLIANCE
↓
means Distensibility / Stretchability

$$\text{ELASTASE} \propto \frac{1}{\text{COMPLIANCE}}$$

TYPES OF TISSUE (COMPLIANCE) → 3 Types

HEALTHY
↓
GOOD
↙ ↘
Compliance Recoil

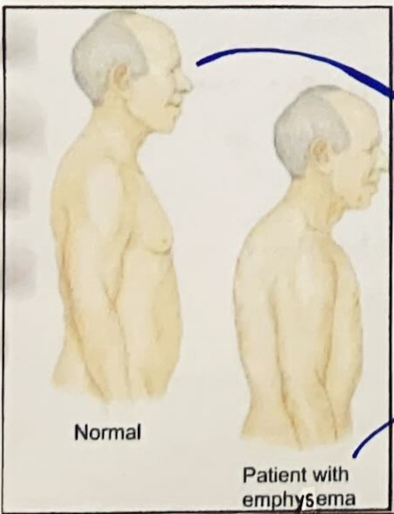
GOOD COMPLIANCE
POOR RECOIL
↓
EMPHYSEMA

POOR ↗ Compliance
POOR ↘ Recoil
↓
ELASTIN protein is replaced by FIBROBLAST...

eg. FIBROSIS
PARENCHYMAL DISEASE (except Emphysema)

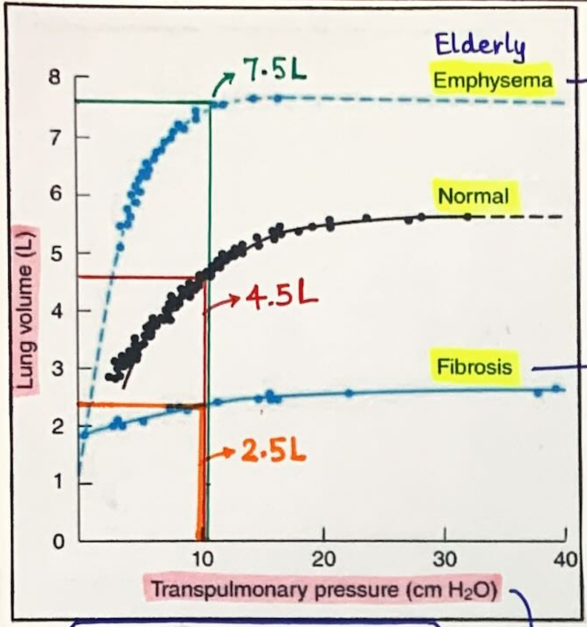
α_1-AT DEFICIENCY
↓
Air Trapping

~~α~~ ↓
ELASTASE
↘
↑ Elastic Tissue Breakdown



Normal → Transverse : AP Diameter
7 : 5

Patient with emphysema → Transverse : AP Diameter → 1 : 1 or it may be ↑↑



Emphysema → ↑ Compliance

Fibrosis → ↓ Compliance → All Parenchymal Disease except EMPHYSEMA

Transpulmonary pressure → always +ve

$$\boxed{\text{COMPLIANCE} = \frac{\Delta V}{\Delta P}}$$

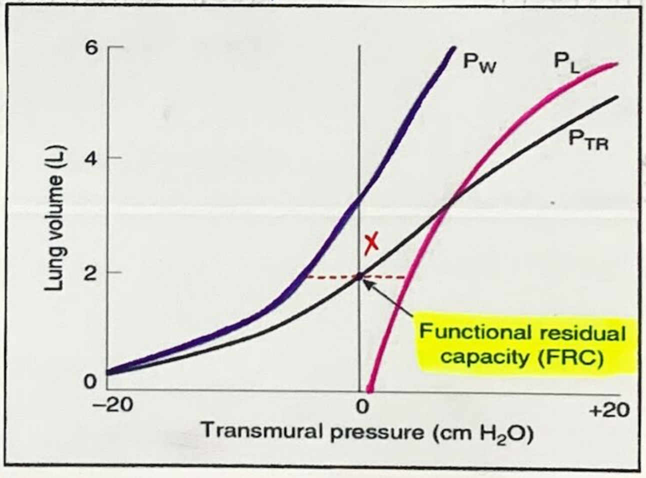
↓

c̄ change in PRESSURE, how much VOLUME change takes place in LUNG

COMPLIANCE CURVE

Q

↓



TRANSRESPIRATORY (P_{TR})

↓

Average of Both

↙ ↘

P_W P_L

P_L ↓ always +ve

FRC

↓

intersection point of P_{TR} & '0' pressure ...

■ : TRANSPULMONARY PRESSURE → P_L

P_W : TRANSTHORACIC PRESSURE / TRANSMURAL PRESSURE ACROSS CHEST WALL

P_{TR} : TRANSRESPIRATORY PRESSURE

X : point where P_W & P_L are same & in opposite direction ...

↓

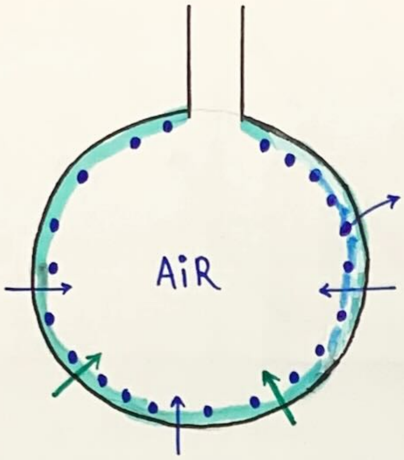
- * No Muscle is contracting
- * No entry or exit of air

↓

FRC

SURFACE TENSION → inward force ⊕ in ALVEOLI

MAXIMUM @ Air - Water Interface



SURFACTANT → Lipids
↓
PHOSPHOLIPID
↙ ↘
DPPC | LECITHIN (DiPalmitoyl Phosphatidyl Choline)
SPHINGOMYELIN (+nt in Neurons also)

$\longleftrightarrow$

Ⓝ : $\frac{L}{C}$ Ratio ⇒ ≥2

if $\frac{L}{C} < 2$ → Fetal Lung Immature

SURFACTANT → secreted by Type II Pneumocytes >> Clara cells
↓ SP-A,B,C,D

↓
Composition → Max. : Lipid
↓
MC → Phospholipid
↓
MC → DPPC >> Phosphatidyl choline

* WORK OF BREATHING → mainly depends upon Surface Tension (>40%)

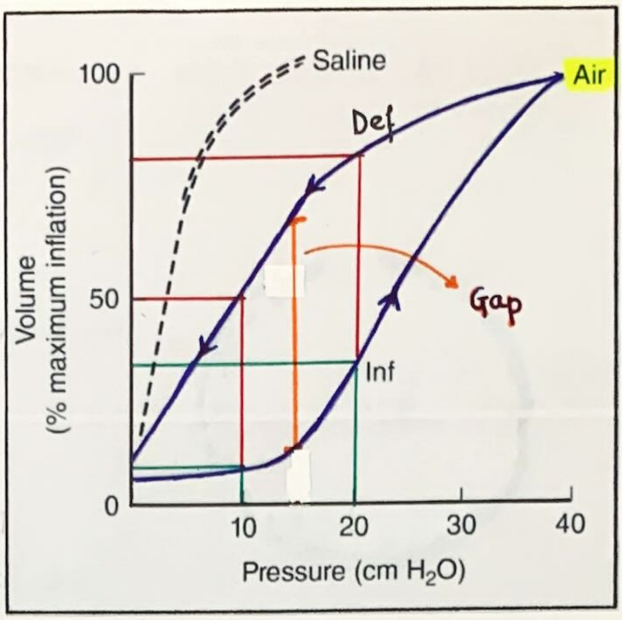
Q : FACTORS that ↓↓ SURFACE TENSION → ST
↙ ↘
Steroid Thyroid
↓
used in RDS in preterm babies

HYSTERESIS LOOP

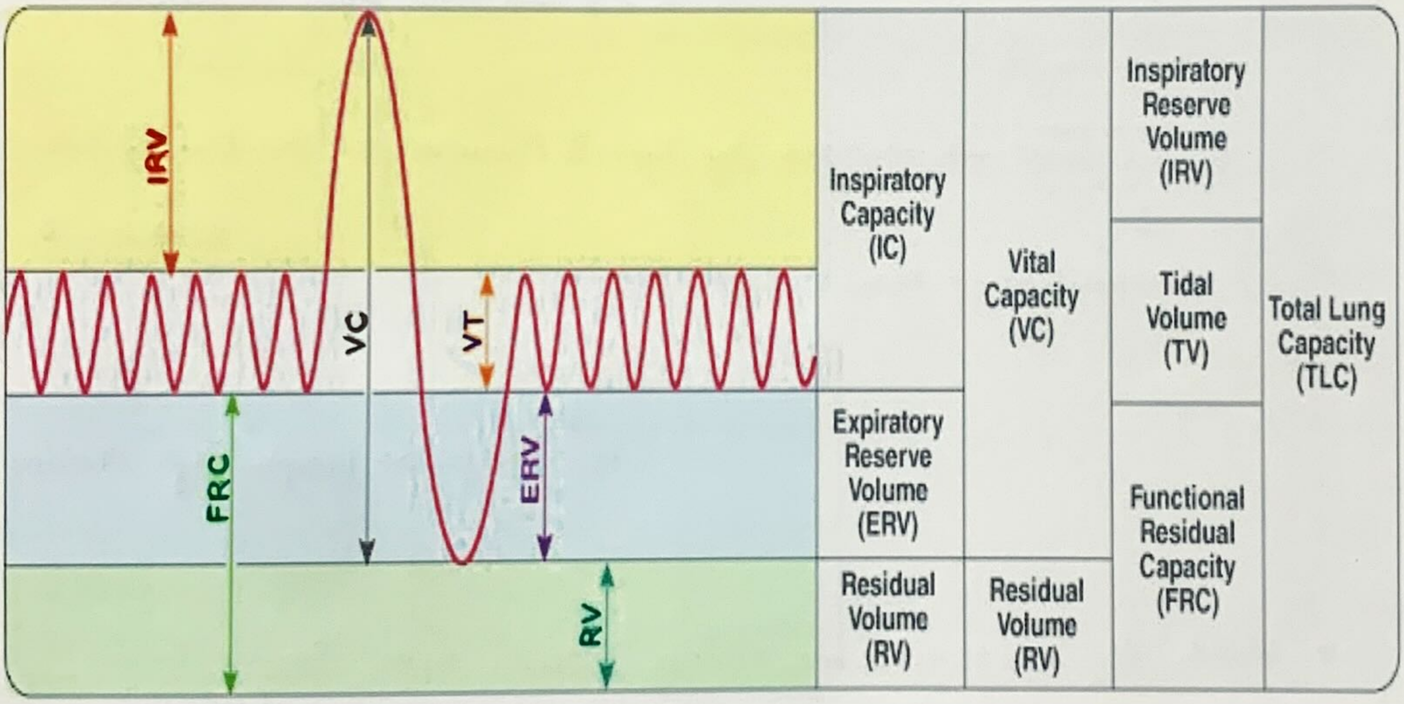
Hysteresis mean GAP and it is d/t AIR - WATER INTERFACE (Surface Tension)

↓ LEAF like graph ↓ present in Ⓝ Lung c̄ Air

↓ d/t SURFACTANT



LUNG'S VOLUMES AND CAPACITIES



CLOSING VOLUME : amount of air coming out of the Lung after CLOSURE OF ALVEOLI in the dependent parts of the alveoli ...

CV + RV ⟶ CLOSING CAPACITY (CC)

- * TV = 500 mL
- * IRV = 2-3 L
- * ERV = 1.2 L
- * RV = 1.3 L

- * IC = TV + IRV
- * EC = TV + ERV
- * FRC = RV + ERV
- * VC = IRV + TV + ERV = TLC - RV

★ VC → ♂ : 4.2 – 4.8 L
→ ♀ : 3.2 – 3.4 L

Physiological ↓ VC →
- ♀
- Pregnant ♀
- Children , Old Age
- Supine position

ESTIMATION OF FRC (Relaxing Volume)

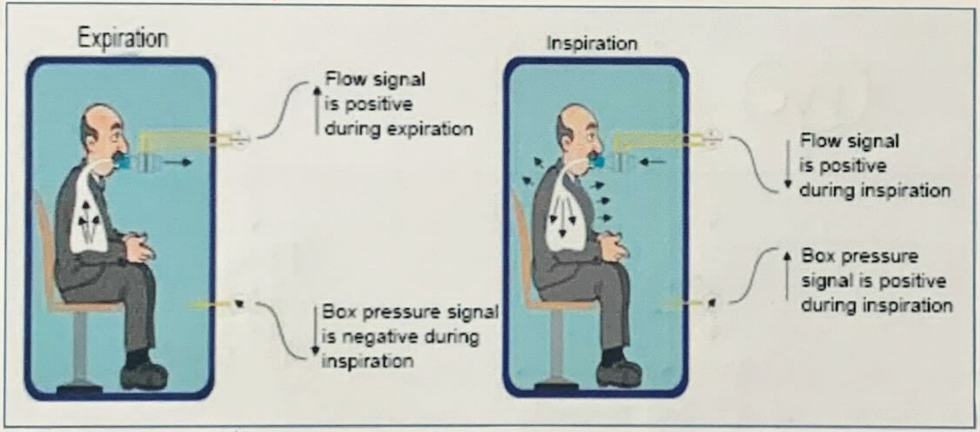
↓

① Helium Dilution Method / Closed Circuit Spirometry

② Nitrogen Washout Method / Open Circuit Spirometry / Fowler's Method → Anatomical Dead Space can also be measured

③ Whole Body Plethysmography (BEST)

↓



Q_1 - Ⓝ Person → b)

Q_2 - COPD Patient → c)

a) EVC > IVC
b) EVC = IVC
c) EVC < IVC
d) NONE

Q_3 - Volumes which can't be measured by SPIROMETER ?

i) RV
ii) FRC
iii) TLC
iv) CC

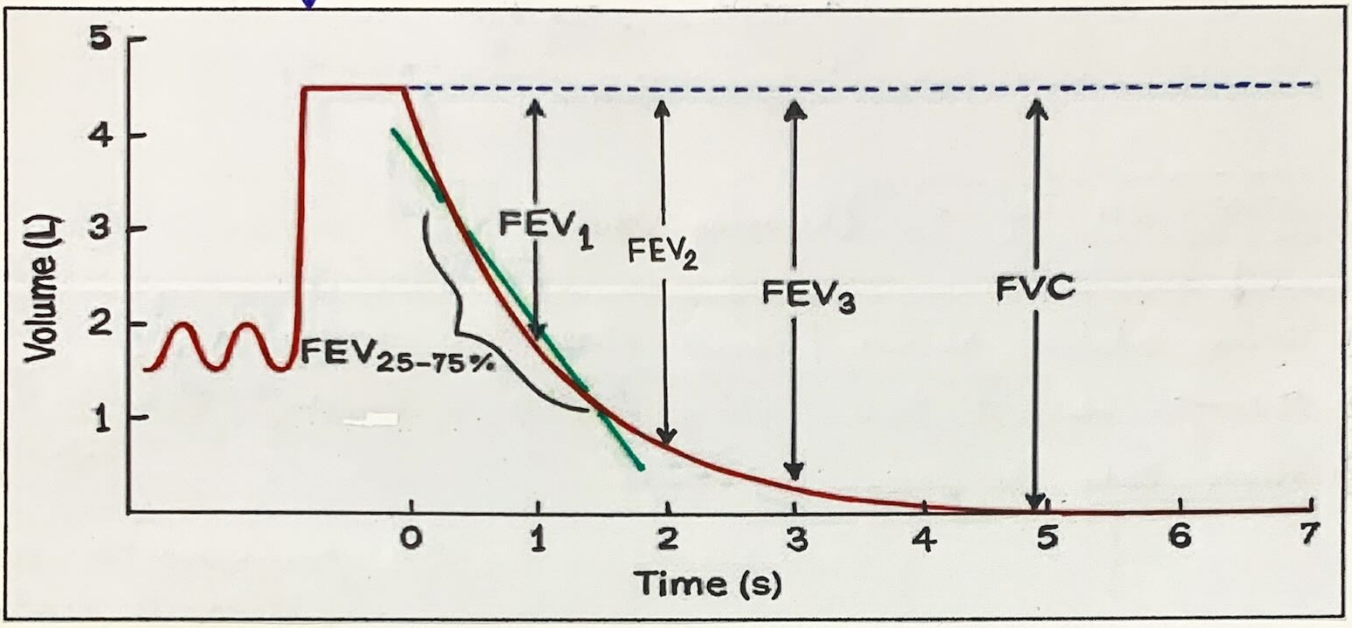
* RESTING MINUTE VENTILATION : amount of air inspired or expired out of the Lungs in 1 minute ...

↓

TV X RR → RMV
500 mL 12/mint. 6L/mint.

DYNAMIC VOLUMES & CAPACITIES

TIME is considered and patient is asked to hold BREATH for a moment and asked to exhale forcefully c̄ full speed possible...

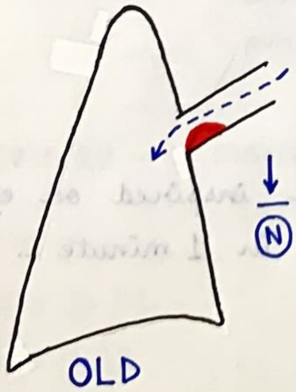


FVC

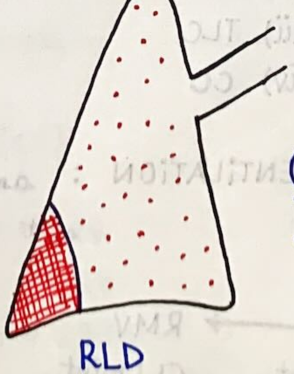
- FEV$_1$ → 75–80% in 1st Second
- FEV$_2$ → 90–95% in 1st TWO Seconds
- FEV$_3$ → 98–100% in 1st THREE seconds...

TIFFENEAU – PINELLI INDEX → FEV$_1$ %

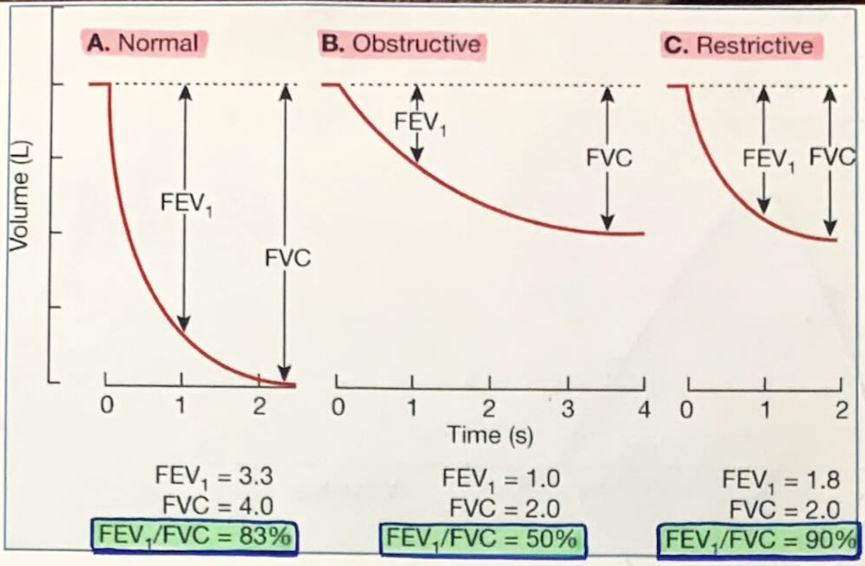
$$\frac{FEV_1}{FVC} \times 100 = 75-80\% \rightarrow \textcircled{N}$$

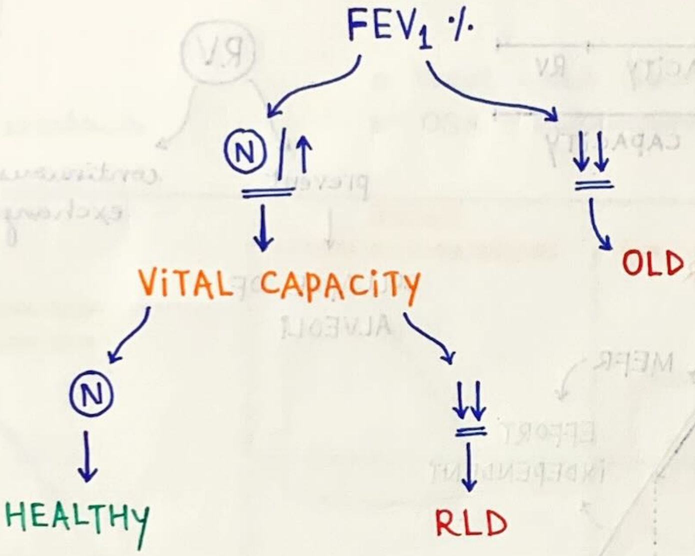


$$\frac{\downarrow}{\textcircled{N}} = \downarrow$$



$$\frac{\textcircled{N}/\downarrow}{\downarrow\downarrow\downarrow\downarrow} = \textcircled{N}/\uparrow\uparrow$$



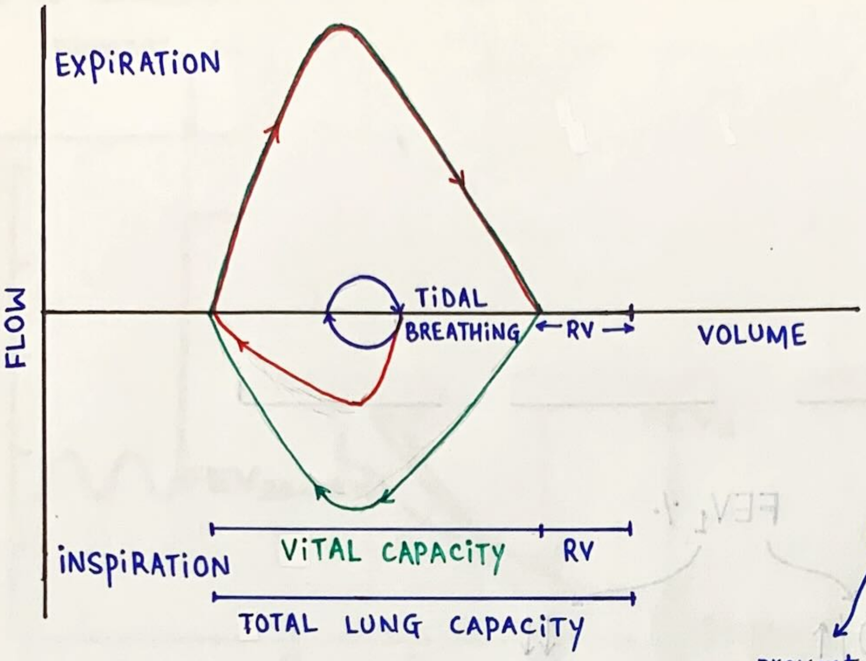


Q. A 58-year-old male patient visits to the OPD for follow up of his pulmonary function test. He had history of smoking for 15 years and a known case of COPD. Which of the following pulmonary assessments shows most appropriate results of the patient?

OLD

- **a. FEV1/FVC < 0.7; FEV1< 80%**
- **b. FEV1/FVC > 0.75; FEV1 > 85%**
- **c. FEV1/FVC > 0.7; FEV1 < 80 %**
- **d. FEV1/FVC < 0.75; FEV1 > 80 %**

FLOW - VOLUME CURVE



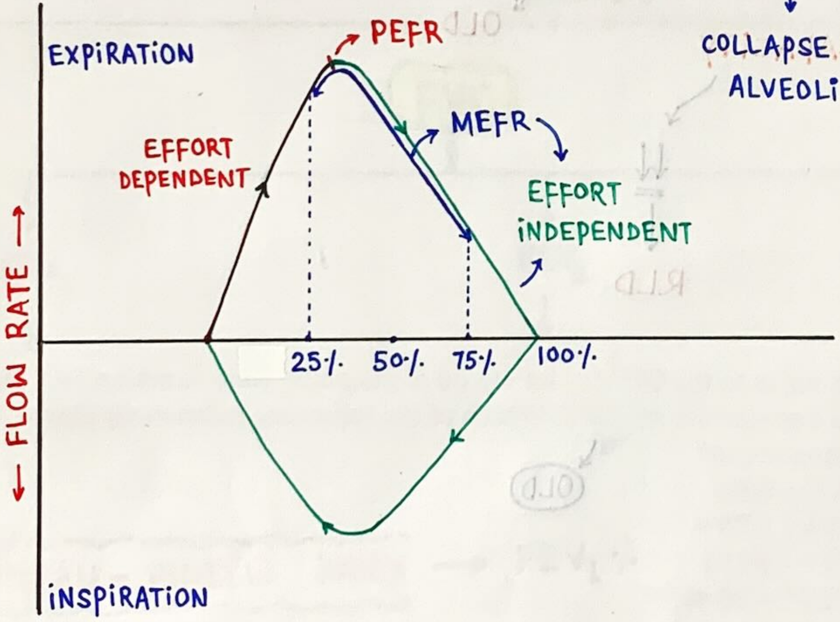
RV

↓ prevent

↓

COLLAPSE OF ALVEOLI

↓ continuous gas exchange ...



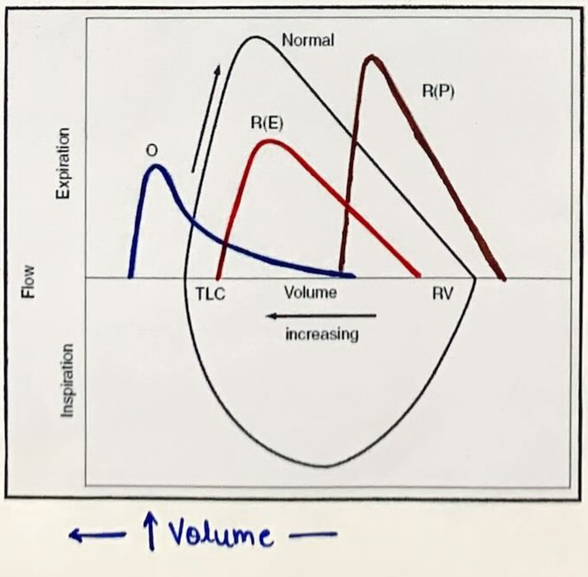
OLD

↓

* Left Shift
* Scooped out pattern

↓

eg. in Emphysema



RLD

↓

Right shift

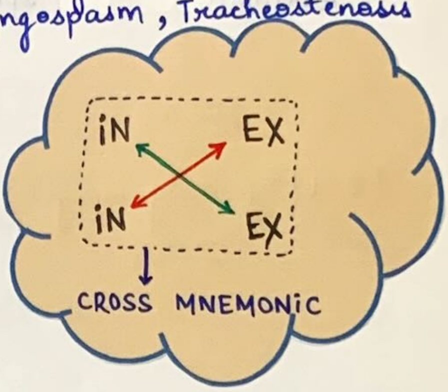
OLD

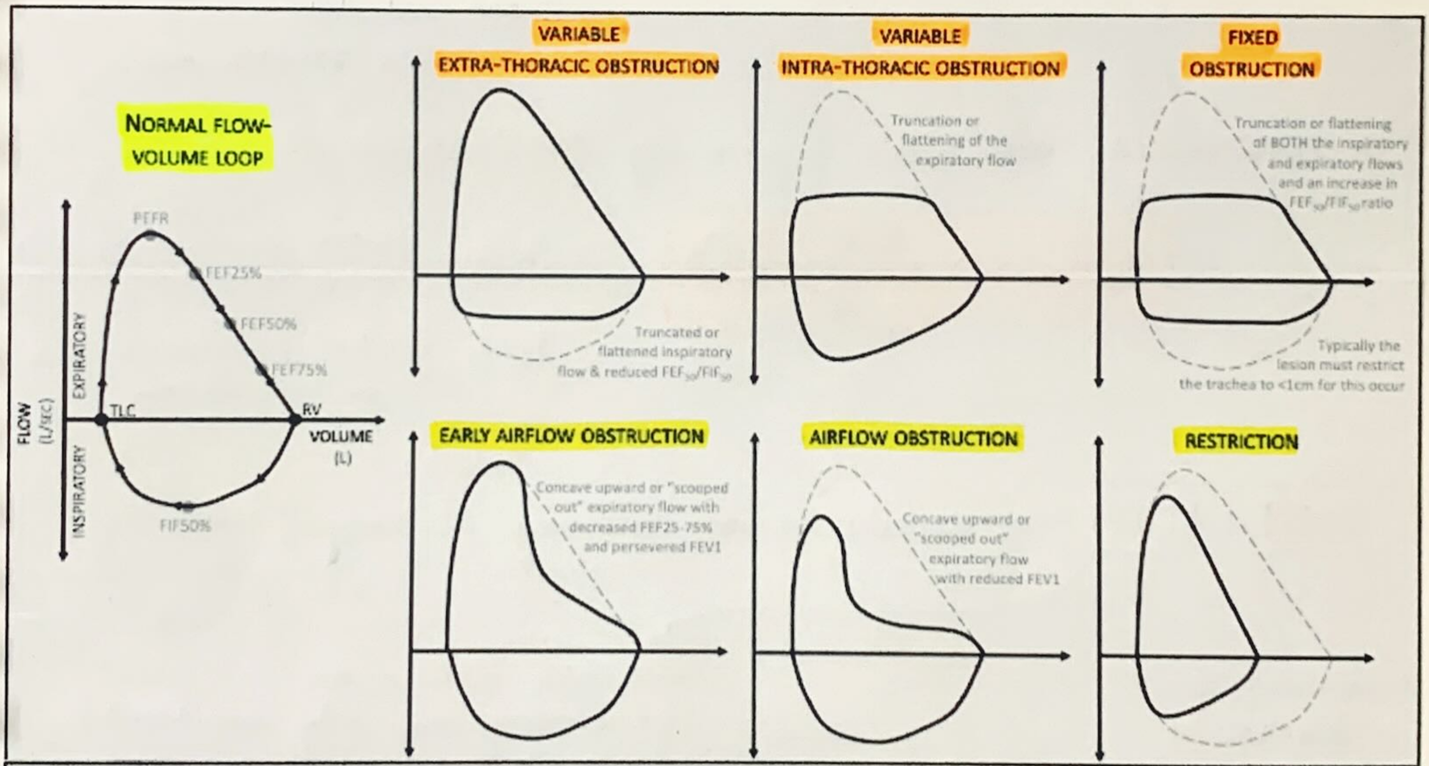
VARIABLE OBSTRUCTION

INTRA-THORACIC OBSTRUCTION
↓
problem in Expiration
↓
- * Tumor
- * Tracheomalacia

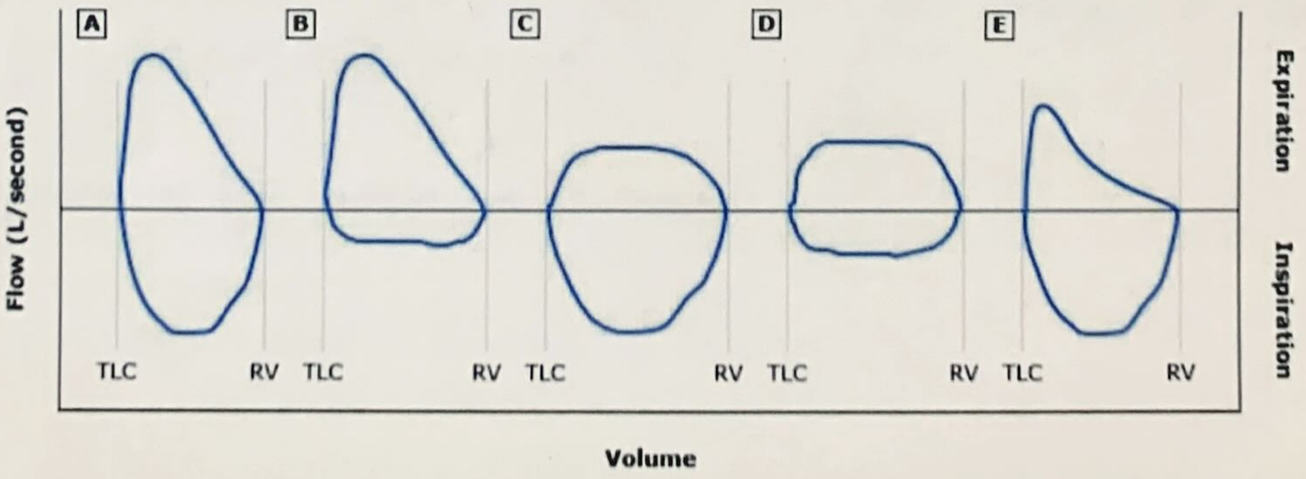
EXTRA-THORACIC OBSTRUCTION
↓
problem in Inspiration
↓
- * Vocal Cord Paralysis
- * OSA (Obstructive Sleep Apnea)

FIXED OBSTRUCTION
↓
eg. Foreign Body, Scarring (Fibrosis) Laryngospasm, Tracheostenosis





Flow-volume loops in upper airway obstruction



DEAD SPACE : amount of air → not getting exchanged

↓

PHYSIOLOGICAL DEAD SPACE

ANATOMICAL DEAD SPACE
↓
150 mL

(2mL/Kg Body Weight)

ALVEOLAR DEAD SPACE
↓
amount of air not getting exchanged from RESPIRATORY ZONE ...
(17-23)
↓
Ⓝ → ZERO

* Anatomical Dead Space : given by **FOWLER's METHOD**
→ can calculate CLOSING VOLUME also...

* PHYSIOLOGICAL DEAD SPACE : given by **BOHR's EQUATION**

$$\boxed{V_D = T.V \times \frac{P_ACO_2 - P_ECO_2}{P_ACO_2}}$$

P_ACO_2 : partial pressure of CO_2 in ALVEOLi

P_ECO_2 : partial pressure of CO_2 in expired air

VENTiLATiON → amount of air entering in Lungs | mint.

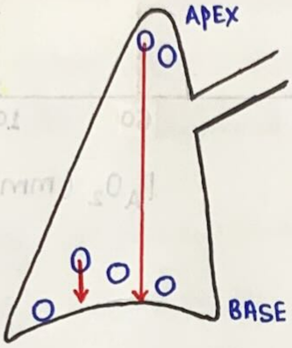
PULMONARY / MiNUTE VENTiLATiON
↓
TV X RR
500 X 12 = 6000 mL = 6L

ALVEOLAR VENTiLATiON
(Respiratory zone only considered)
↓
(TV - DS) X RR
(500 - 150) X 12
350 X 12 = 4200 mL = 4.2L
↓
amount of air reaching lung for exchange...

VENTILATION – PERFUSION RELATIONSHIP

$$\frac{V}{Q} = \frac{\text{amount of AIR coming in Lung for Exchange}}{\text{amount of BLOOD coming in Lung for Exchange}} = \frac{4.2L}{5L} \simeq 0.8$$

Ⓝ $\frac{V}{Q} \simeq 0.8$



* PO_2 max → Apex

* PCO_2 max → Base

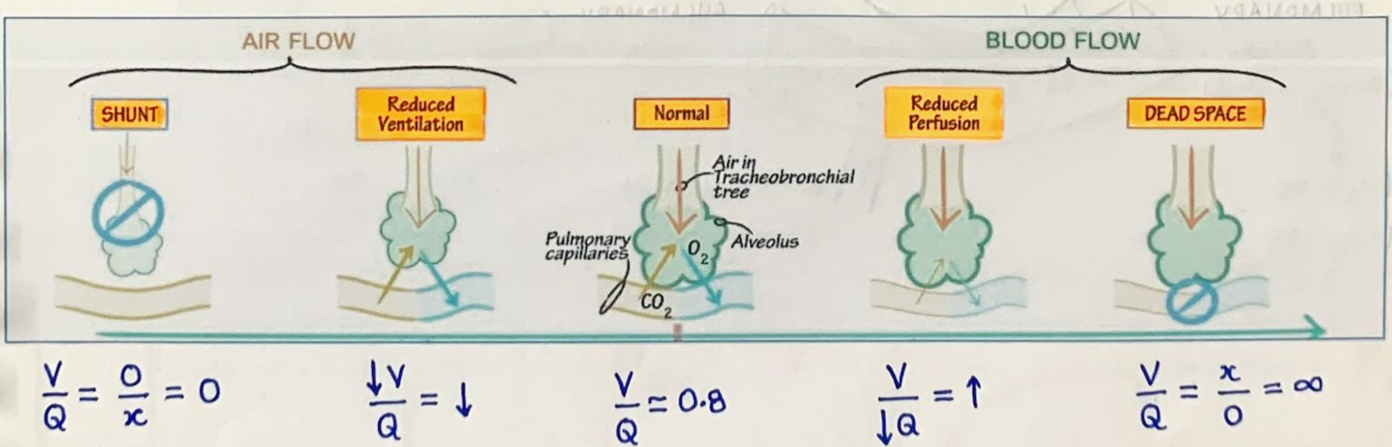
EFFECT OF GRAVITY

Apical Alveoli
↓
OVERSTRETCHED
↓
UNDER VENTILATED
UNDER PERFUSED
↓
$\frac{\downarrow V}{\downarrow\downarrow\downarrow Q}$
↓
$\frac{V}{Q} = 3.3$
(Maximum)

Basal Alveoli
↓
UNDERSTRETCHED
↓
OVER VENTILATED
OVER PERFUSED
↓
$\frac{\uparrow V}{\uparrow\uparrow\uparrow Q}$
↓
$\frac{V}{Q} = 0.6$
(Minimum)

Q: Why Min. $\frac{V}{Q}$ @ Base ?

a) Minimum Perfusion
[✓ b) Maximum Perfusion]
c) Minimum Ventilation
d) Maximum Ventilation



$\frac{V}{Q} = \frac{0}{x} = 0$
↓
WASTED PERFUSION

$\frac{\downarrow V}{Q} = \downarrow$

$\frac{V}{Q} \simeq 0.8$

$\frac{V}{\downarrow Q} = \uparrow$

$\frac{V}{Q} = \frac{x}{0} = \infty$
↓
WASTED VENTILATION

★ ↑ PO_2 → Apex → predispose to infection (TB)

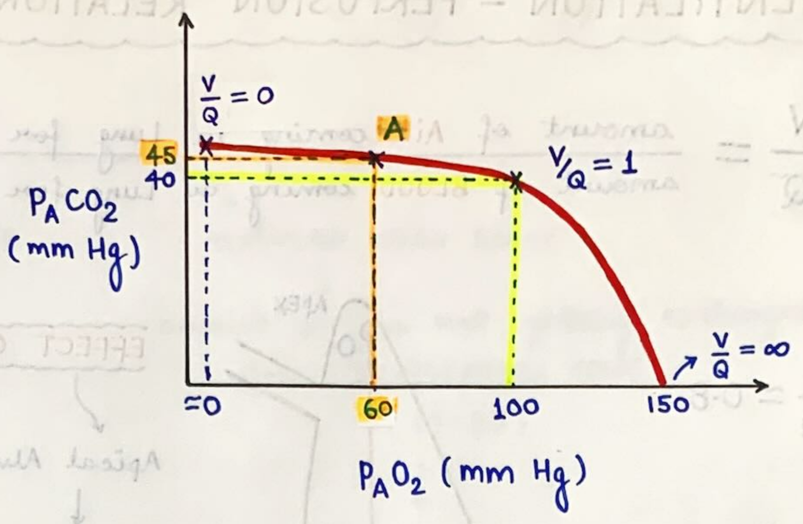
$\frac{V}{Q}$ CURVE

↓

* if Ventilation is hampered

↓

Point on Graph lies towards LEFT of Ⓝ V/Q point → ↓ $\frac{V}{Q}$

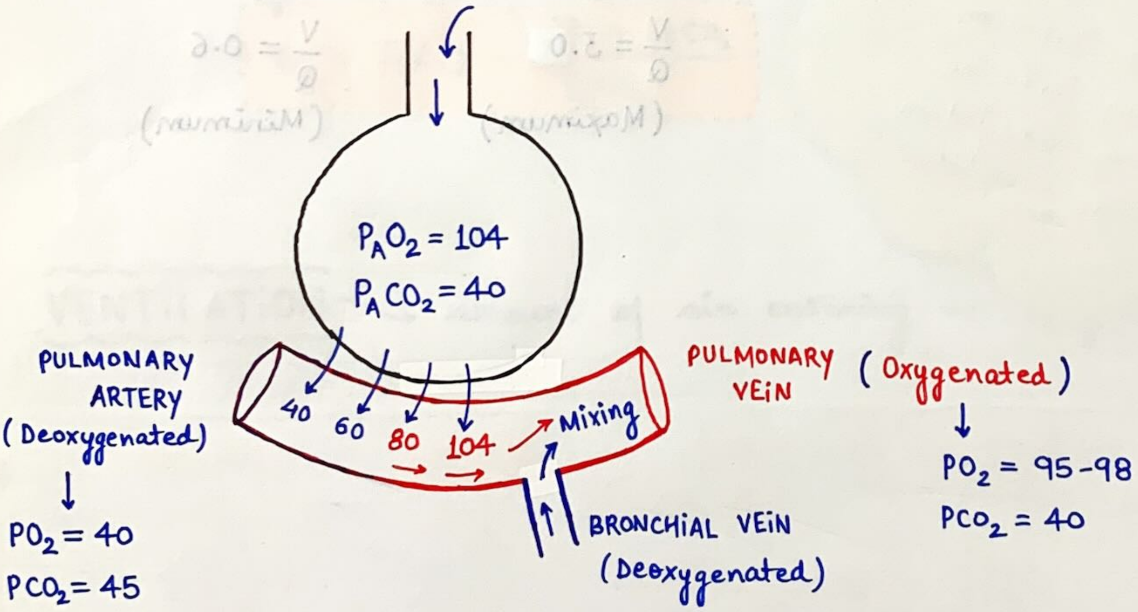


* if Perfusion is hampered

↓

Point on Graph lies towards RIGHT of Ⓝ V/Q point ... → ↑ $\frac{V}{Q}$

PHYSIOLOGICAL SHUNT → BRONCHIAL VEIN

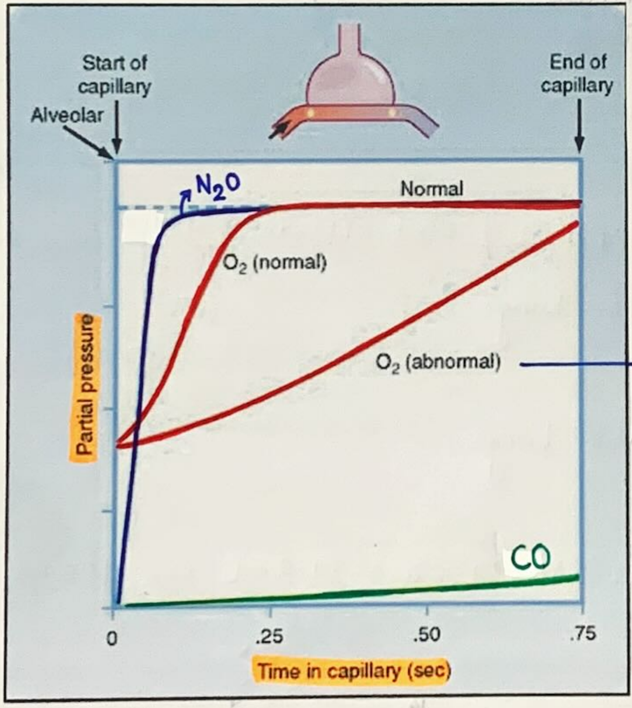


TRANSIT TIME AT PULMONARY CAPILLARY → 0.75 second

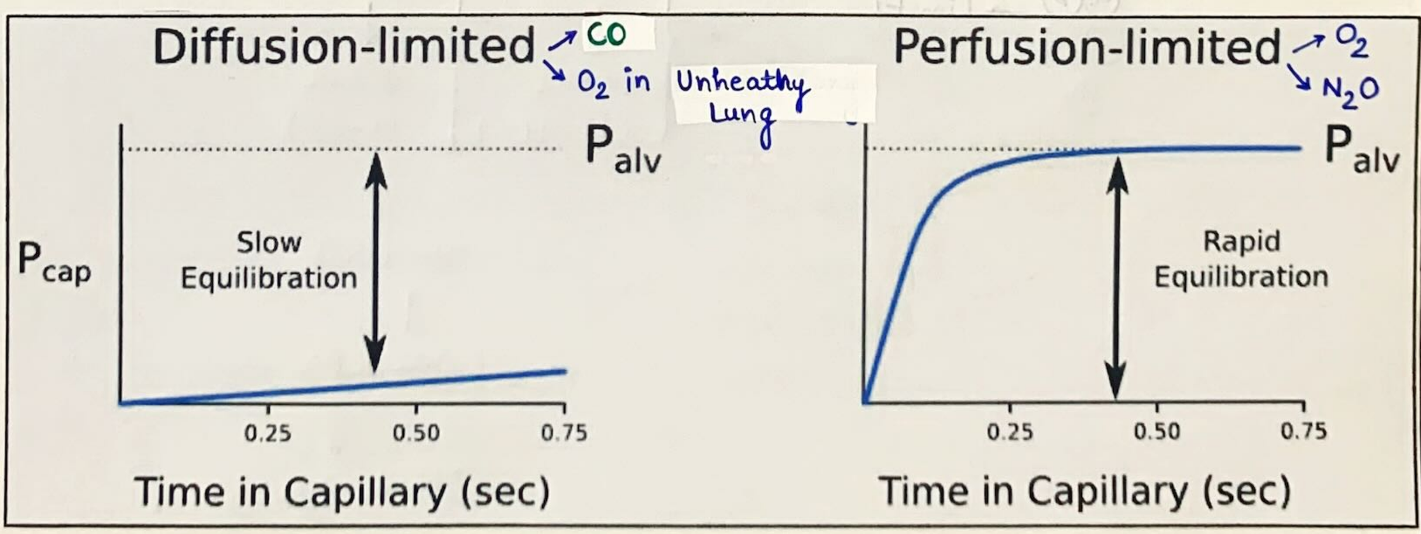
how much time does it take for the Blood to get transported in the pulmonary capillary ...

- * Diffusion Equilibrium reached O_2 and CO_2 in 0.25 second
- * **HENRY's LAW** states that partial pressure of gas depends only on the dissolved form of that gas in Blood ...

- * Gas which only dissolves → N_2O (Max. Partial pressure)
- * Gas which only binds to Hb & doesn't dissolve at all } → CO



→ Perfusion related

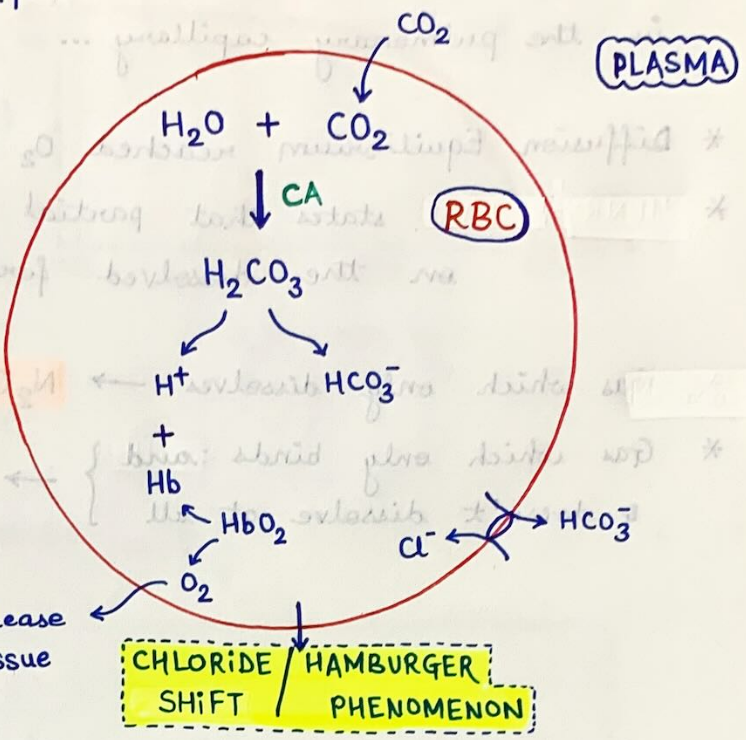


TRANSPORT OF CO_2 : VENOUS BLOOD = 52 mL per 100 mL
ARTERIAL BLOOD = 48 mL per 100 mL

↓

Ⓝ : 4 mL % or 4 mL / 100 mL or 4 mL / dL

FORMS
↓
- **Bicarbonate** → 70% (Maximum)
- **Carb-amino** (Hb, Albumin) → 20%
- **Dissolved** → 10%



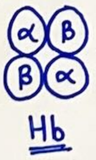
O_2 release @ Tissue → BOHR's EFFECT

HALDANE EFFECT
↓
- * Christian Douglas Haldane Effect / CDH Effect
- * in the presence of ↑ PO_2 in Lungs

↓

↑ CO_2 is released to the Lungs...

TRANSPORT OF O_2 : ARTERIAL BLOOD = 19.8 mL per 100 mL



→ Limit / Saturation

O_2-Hb → 19.5 mL (98-99%)

Dissolved → 0.3 mL (1-2%) → No Limit → $0.003 \times PO_2$ → ↑↑↑ in Hyperbaric O_2

★ **BOHR's EFFECT** : Right shift of the Curve in presence of ↑ PCO_2...

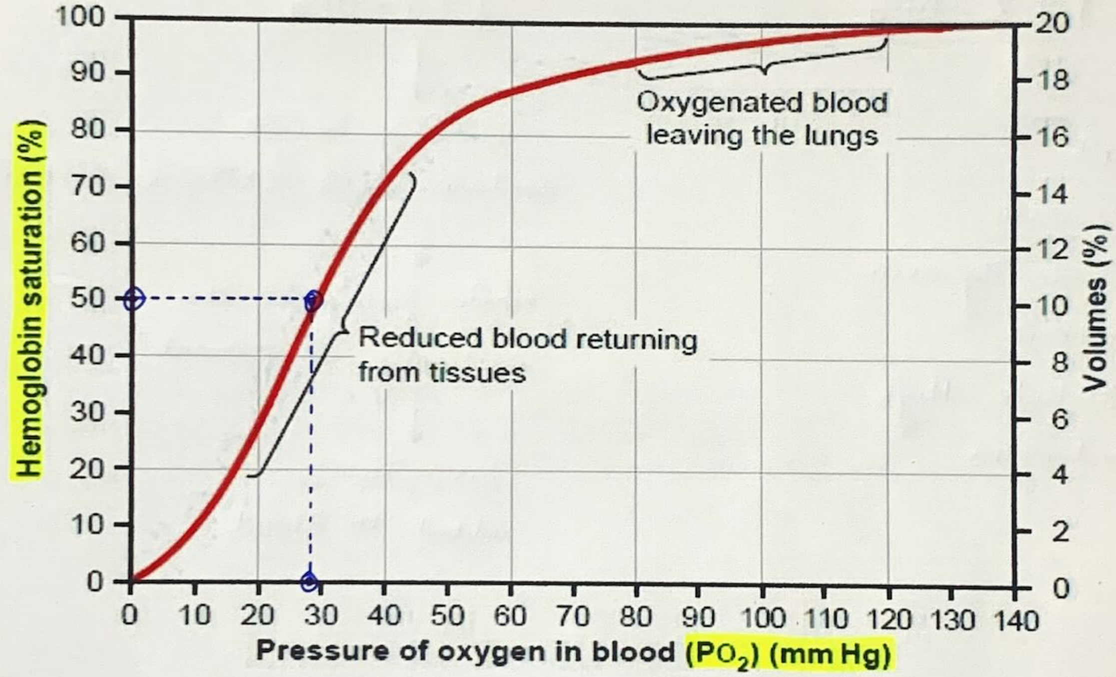
↓

release of O_2 → @ Tissues

O_2 – Hb DISSOCIATION CURVE

↓

Sigmoid Shape d/t Cooperative Binding Theory...



P_{50} → 27 mm Hg

LEFT SHIFT

(↑ affinity for O_2, but O_2 Delivery ↓)

- ↓ PCO_2
- ↓ H^+ / ↑ pH^+
- ↓ 2,3-DPG
- ↓ Temperature (Blood Bank)
- HbF
- CO Poisoning
- Hb RANJER, Hb CHESAPEAKE

RIGHT SHIFT [Right CADET]

(↓ affinity for O_2, but O_2 Delivery ↑)

↓

C → CO_2

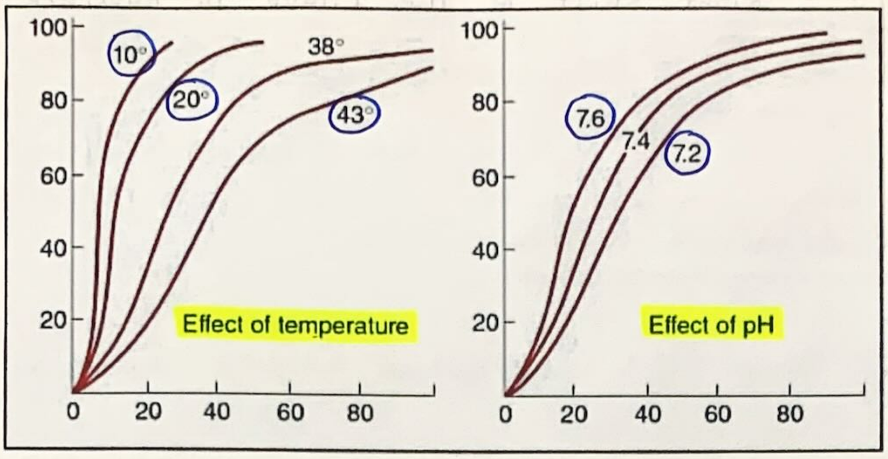
A → Acid (↑ H^+ / ↓ pH), Anemia (HbS, HbM)

D → 2,3 DPG

E → Exercise

T → Temperature

HORMONES (GH, Thyroid Hormone)



↑ 2,3 - DPG

↓

G → GH

E → Exercise

T → Tissue Hypoxia

A → Anemia

A → Altitude : High

A → Androgens

↓ 2,3 - DPG

↓

STORED BLOOD

contains ACID DEXTROSE CITRATE

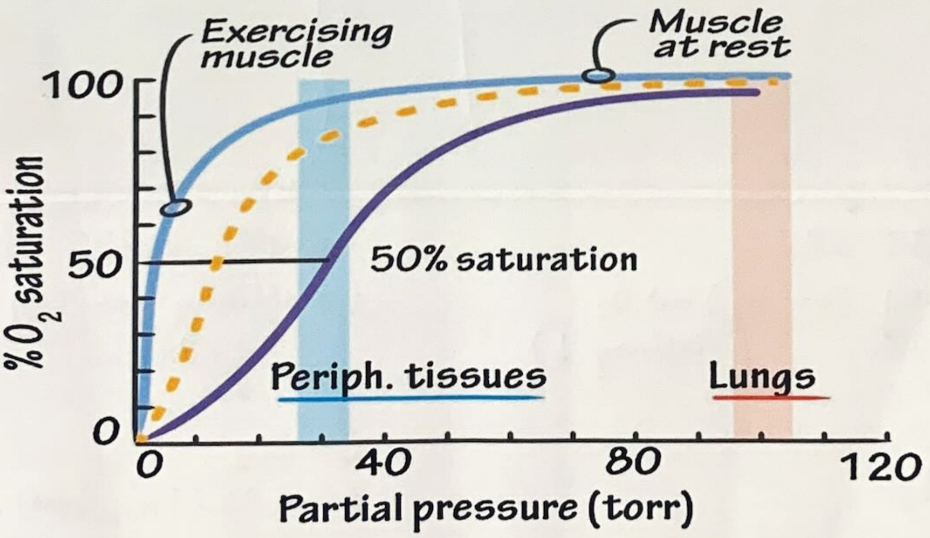
↓

While giving to the critically ill patient

↓

IONOSINE is added to Blood

Dissociation Curves



Myoglobin
- Higher O_2 affinity
- Responds to muscle's O_2 needs

Hemoglobin
- Cooperative binding = sigmoidal curve
- Responds to O_2 availability

Fetal Hemoglobin

Greater O_2 affinity: facilitates O_2 transfer from mother to fetus.

★ 1 gm Hb – Oxygen carrying capacity = 1.34 mL O_2 / 100 mL of Blood...

Q : Total amount of O_2 carried by Blood, when Hb is 75% saturated and Hb = 16 gm/dL and PO_2 = 90 mm Hg.

↓

$$\left(16 \times 1.34 \times \frac{75}{100}\right) + (0.0031 \times 90)$$

↓ O_2 – Hb ↓ ↓ Dissolved

$$\Rightarrow \frac{1608\cancel{00}}{100\cancel{00}} + 0.27 = 16.08 + 0.27$$

$$\Rightarrow 16.35 \text{ L } O_2$$

REGULATION OF RESPIRATION

NEURAL CHEMICAL REFLEX

NEURAL

↓

* Pneumotaxic Centre in upper pons regulates RR

↓ ⊖

* Apneustic Centre in lower pons

↓ ⊕

* DRG Neurons in Medulla

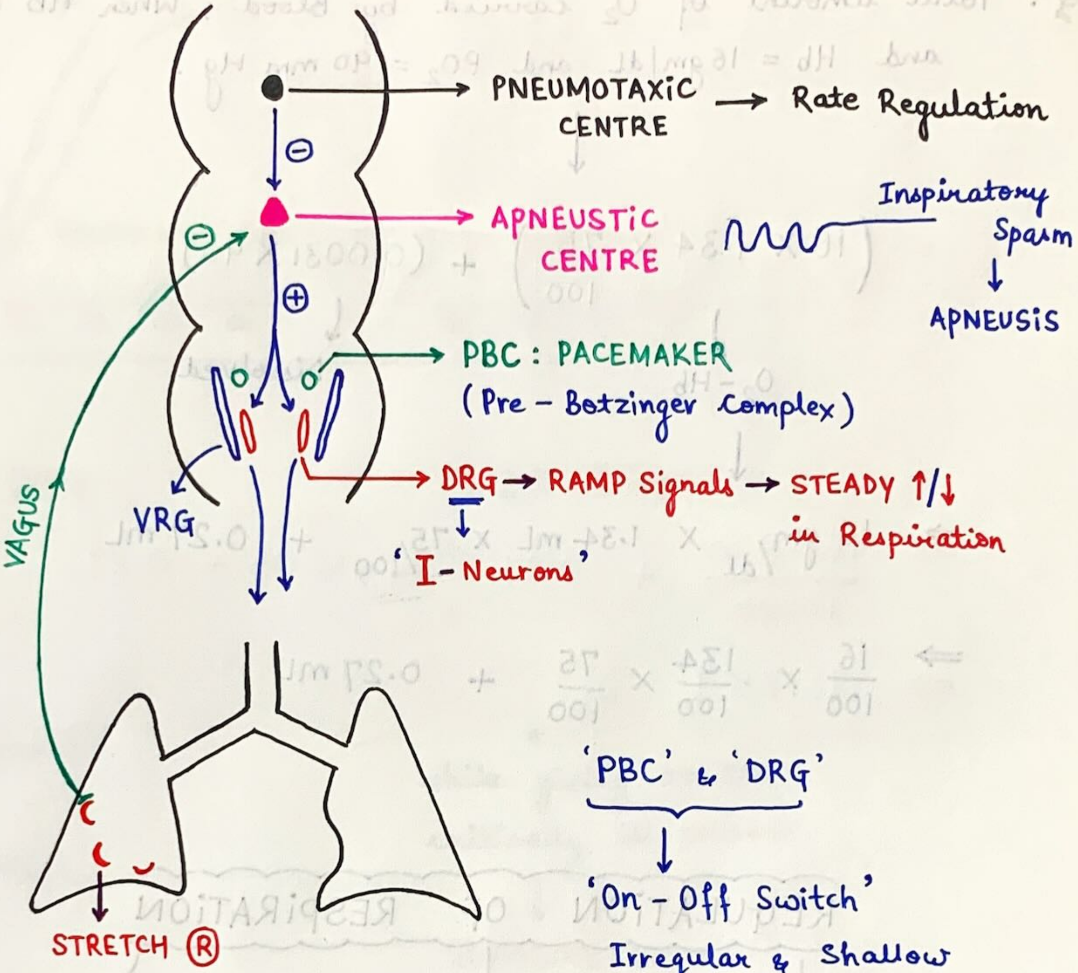
* STRETCH Ⓡ on Lungs → VAGUS ⊖ → Apneustic Centre

* VRG has Inspiratory and Expiratory Neurons

↓

only activate in FORCEFUL RESPIRATION...

I. NEURAL REGULATION OF RESPIRATION



'PBC' & 'DRG'

↓

'On - Off Switch'

Irregular & Shallow

↓

to make it

Smooth & Deep

↓

APNEUSTIC CENTRE
is responsible

VRG

↓

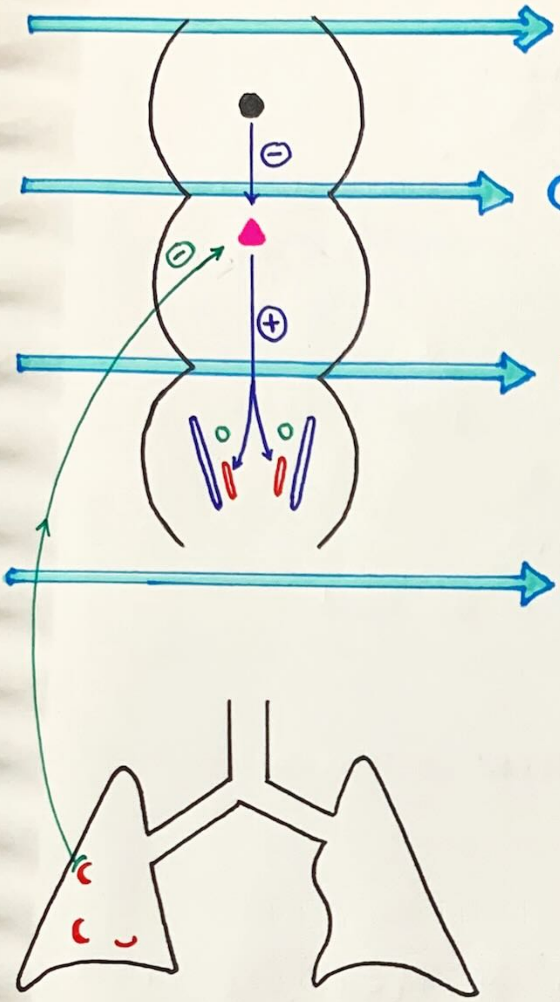
- * has both 'I' & 'E' Neurons
- * only activate EXTRA - RESPIRATORY DRIVE
  i.e. during forceful respiration
- * eg. Exercise

★ **ROLE OF VAGAL FIBRES** : they act similar to PNEUMOTAXIC CENTRE

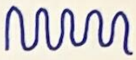
↓

- Afferent from PULMONARY STRETCH RECEPTORS in Vagal Fibres inhibit DRG via ⊖ of APNEUSTIC CENTRE ...
- it is a preventive reflex to prevent Rupture of Alveoli ...

TRANSECTIONS / LESIONS



D : ABOVE UPPER PONS
- → c̄ VAGi intact : Ⓝ
- → c̄ VAGi CUT → ↑TV



Deep & Slow

C : MID-PONTINE LESION
- → c̄ VAGi intact → Deep & Slow
- ↓ B/L VAGOTOMY → APNEUSIS

B : PONTO-MEDULLARY JUNCTION

↓

IRREGULAR & SHALLOW

A : LOWER | CAUDAL MEDULLA

↓

RESPIRATORY ARREST

★ if VAGi is cut → DEEP & SLOW RESPIRATION

★ **ONDINE's CURSE** → patient has to breathe VOLUNTARILY

↓

- * CORTEX : intact
- * BRAINSTEM : damaged → ~~PONS~~ ~~MEDULLA~~
- * eg. BULBAR POLIO

REFLEXES

HEAD's PARADOXICAL REFLEX

↓

1st few breaths in Newborn

↓

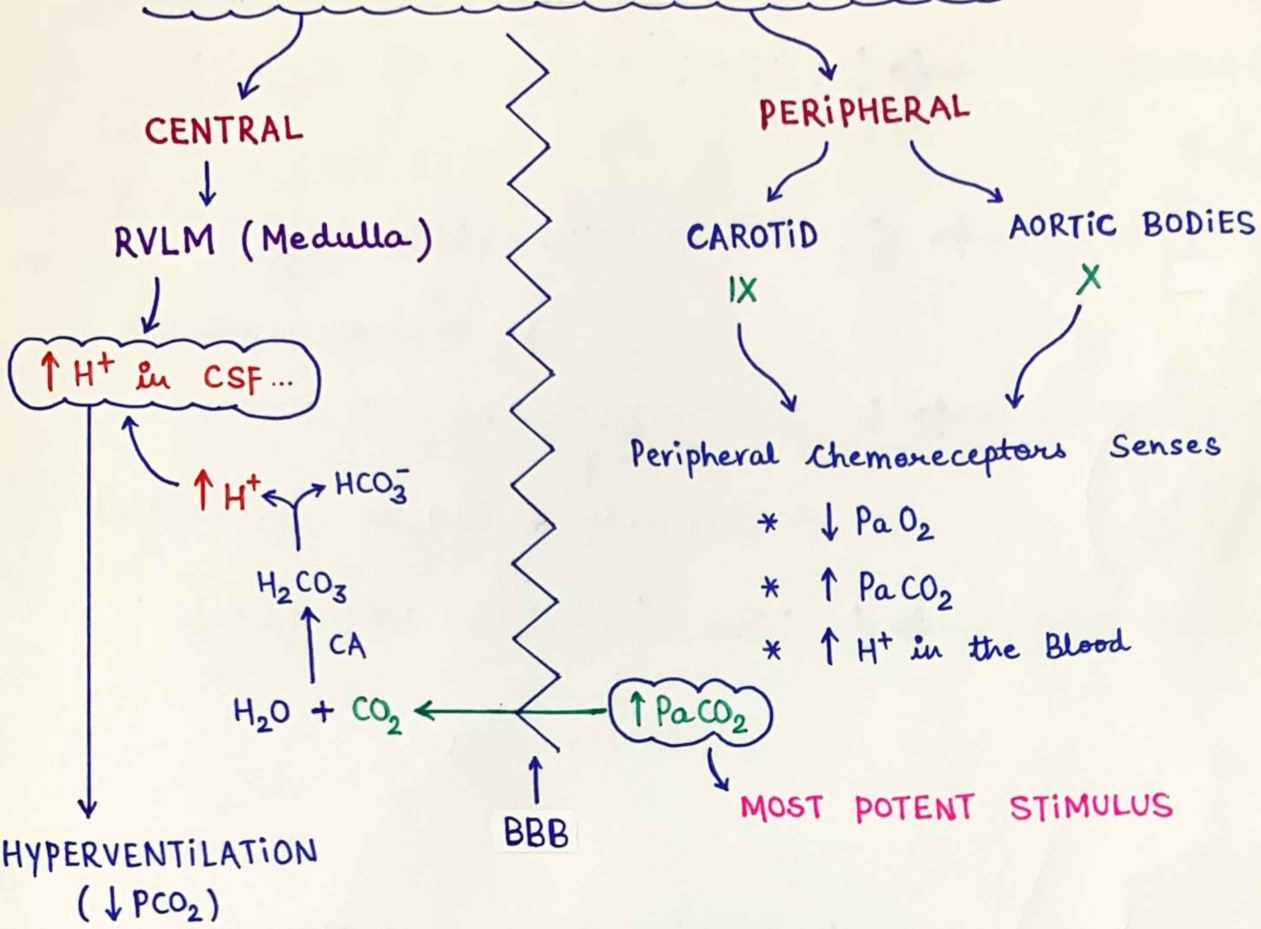
$\text{inflation} \xrightarrow[\oplus]{} \text{inflation}$

HERiNG BREURER REFLEX (Adults)

↓

- * $\text{inflation} \xrightarrow{\ominus} \text{further inflation}$
- * $\text{deflation} \xrightarrow{\ominus} \text{further deflation}$

II. CHEMICAL CONTROL OF RESPIRATION : CHEMORECEPTORS



CENTRAL

↓

RVLM (Medulla)

↓

↑ H^+ in CSF...

↓

HYPERVENTILATION ($\downarrow PCO_2$)

$H_2O + CO_2 \xrightarrow{CA} H_2CO_3 \rightarrow \uparrow H^+ + HCO_3^-$

↑ $PaCO_2$ → $H_2O + CO_2$ (across the BBB)

↑ $PaCO_2$ → MOST POTENT STIMULUS

BBB

PERIPHERAL

CAROTID — IX

AORTIC BODIES — X

Peripheral Chemoreceptors Senses

- * ↓ PaO_2
- * ↑ $PaCO_2$
- * ↑ H^+ in the Blood

MECHANISM OF STIMULATION OF PERIPHERAL CR

↓

Type I : GLOMUS CELL → O_2 Sensitive K^+ channels

↓

- * ↑ O_2 : Open
- * ↓ O_2 : Close

Type II : SUPPORTING CELL

HYPOXIA

↓

stimulation of Peripheral CR

↓

O_2 Sensitive K^+ channels CLOSE

↓

↑ K^+ accumulation inside cell

↓

DEPOLARISATION

↓

opening of VG- Ca^{2+} channels

↓

↑ intracellular Ca^{2+} → Release of DA Vesicles → Afferent IX & X

↓

↑ stimulation of medullary ventilatory centre

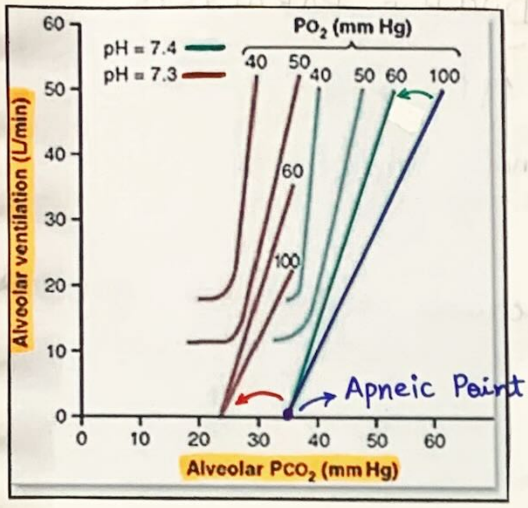
↓

HYPERVENTILATION

↓

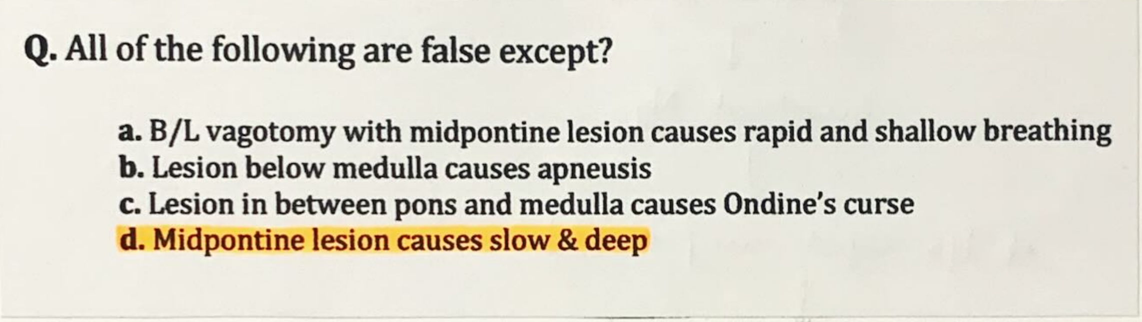
↑ PO_2 ⊖ → HYPOXIA

HYPOXIA & VENTILATION



→ Apneic Point

* ↑ PCO_2 → ↑ Ventilation
* ↑ PCO_2 & ↓ O_2 → Steeper Curve (Left Shift)
* ↑ PCO_2, ↓ O_2 & ↓ pH → Shift of Apneic Point



Q. All of the following are false except?

a. B/L vagotomy with midpontine lesion causes rapid and shallow breathing
b. Lesion below medulla causes apneusis
c. Lesion in between pons and medulla causes Ondine's curse
d. Midpontine lesion causes slow & deep

HYPOXIA

Content Arterial O_2

Reduced Hb > 5gm %

	PaO_2	$Hb\text{-}O_2$	CaO_2	CvO_2	$(A\text{-}V)\ O_2\ \Delta$	CYANOSIS	EXAMPLE
HYPOXIC	↓	↓	↓	↓	Ⓝ	⊕	HIGH ALTITUDE, FIBROSIS, DIFFUSION D/o
ANAEMIC	Ⓝ	↓	↓	↓	Ⓝ	⊖	ANEMIA, METHHb-emia, CO POISONING
STAGNANT (♡ genic)	Ⓝ	Ⓝ	Ⓝ	↓	↑	⊕	HEMORRHAGE, CHF, SHOCK
HISTOTOXIC	Ⓝ			↑	↓		CYANIDE POISONING, BERI-BERI

blocks O_2 utilisation

DECOMPRESSION SICKNESS / CAISSON's DISEASE / DYSBARISM / DIVER's PARALYSIS

↓

1. **SNORKELLING** : Anatomical Dead Space ↑↑↑ → air in tube

∴ it act as an extension of ADS...

2. **SCUBA DIVING** : ↑ Work of Breathing causes undesirable symptoms

↓

Deep Sea : ↑↑↑ Atmospheric Pressure

↓

gases start to compress

↓

Dissolved N_2

↓

if f/b rapid rise / ascend

↓

Decompression of gases → N_2 Bubble formation

↓

EMBOLI ⊕

↓

- * STROKES → 85-90%
- * BENDS → 2-5%
- * CHOKES → 10%

℞ : i) HYPERBARIC CHAMBER

ii) PROMPT RECOMPRESSION f/b gradual slow decompression

↓

N_2 is exhaled before it forms emboli...

HIGH ALTITUDE PHYSIOLOGY

1. TRANSIENT MOUNTAIN SICKNESS (6-24 Hours)

- Headache, Nausea, Vomiting
- Hyperventilation ← ↓ PO_2 (++) Peripheral CR
- Tachycardia, ↑ CO, Palpitation ← ↓ PO_2 (++) VMC

2. ACUTE MOUNTAIN SICKNESS (starts c̄ 1 Day and lasts upto 1 WK)

- Headache, Nausea, Vomiting
- Oliguria → ∵ of diversion of Blood Flow to Hypoxic Muscles
- CEREBRAL EDEMA → ↓ PO_2

↓

Cerebral VD

↓

↑ pressure in cerebral capillaries

↓

BROKEN capillaries & fluid transudation

- Rx : i) Hyperbaric O_2
  - ii) DIAMOX (CA ⊖)
  - iii) Halting Descent

3. HIGH ALTITUDE PULMONARY EDEMA (HAPE)

↓

↓ PO_2

↓

VC

↓

↑ PA Pressure

↓

PAH

↓

↑ Pulmonary capillary hydrostatic pressure

↓

PULMONARY EDEMA

Rx : i) Immediate Descent
ii) O_2 Therapy
iii) CCB

4. ACCLIMATIZATION

- seen in the people who live in high altitude from long time ...
- COMPENSATORY RESPONSE to ↓ PO_2 to enhance survival and ↑ metabolic performance

↓

↓ PO_2

↓

stimulation of Peripheral - CR

↓

HYPERVENTILATION

↓

CO_2 Washout

↙

BRAKING EFFECT

↓

STOP VENTILATION

↓

KIDNEY (2-3 Days)

↓

compensate via excretion of HCO_3^-

↓

BRAIN

↓

HCO_3^- pump pushes HCO_3^- out of Brain and l/t Acidic pH

↓

(++) Central - CR

↘ ALKALOSIS

immediate shift of O_2-Hb Dissociation Curve to LEFT ...

PERIODIC BREATHING

CHEYNE - STOKES BREATHING

↓

* High Altitude
* Sleep Apnea
* CHF

↓

CRESCENDO – DECRESCENDO BREATHING PATTERN

BIOT's BREATHING

↓

BRAINSTEM LESION

↓

irregular

KUSSMAUL's BREATHING
AIR HUNGER

↓

DKA

(↑ Rate & ↑ Depth)

Q. Conducting zone of airway extends from

a. Nose to respiratory bronchioles
b. Nose to terminal bronchioles
c. Nose to bronchi
d. Nose to alveolar ducts

Q. During a quite inspiration, alveolar pressure is normally:

a. -2.5 mm Hg **b.** -1 mm Hg **c.** 0 mm Hg **d.** +1 mm Hg

Q. Which one of following value depict normal V/Q ratio in healthy individual:

a. 0.8 **b.** 1.5 **c.** 2 **d.** 3

Q. Which of the following is higher at the apex of the lung than at the base when a person is standing?

a. V/Q ratio **b.** Blood flow **c.** Ventilation **d.** PaCO2

Q. Surfactant Deficiency is seen in ?

* IRDS | HMD
* ARDS
* Patient c̄ 100% O_2
* Chronic Smokers

PYT's

Q_1. Maximum airflow resistance is seen in:

- **A.** Respiratory bronchioles
- **B. Bronchus**
- **C.** Alveolar duct
- **D.** Terminal bronchioles

Q_2. What would be the lung volume if the lung was allowed to recoil without the chest wall in expiration?

- **A.** Residual volume
- **B.** FRC
- **C.** Minimal volume
- **D.** Zero

Q_3. In children with respiratory distress syndrome, there is a deficiency of which of the following lipids:

- **A.** Dipalmitoyl phosphatidylcholine
- **B.** Sphingomyelin
- **C.** Cardiolipin
- **D.** Leukotrienes

Q_4. Which of the following cells are deficient in a premature infant with RDS?

- **A.** Alveolar capillary endothelial cells
- **B.** Type I alveolar cells
- **C.** Type II alveolar cells
- **D.** Alveolar macrophages

Q_5. Va/Q = Infinity when:

- **A.** Pressure of oxygens in the alveolar air is less than dead space
- **B.** Partial pressure of oxygen and carbon dioxide are equal
- **C.** When PaO_2 is 159 mmHg and $PaCO_2$ is 40 mmHg
- **D.** No exchange of CO_2 and O_2 occur

Q$_6$. All the following will shift the oxygen haemoglobin curve to the right except?

- **A.** Increase in H+ concentration
- **B.** Increase in pCO_2
- **C.** Increase in HbF
- **D.** Increase in 2, 3 DPG

Q$_7$. Citrate-phosphate-dextrose stored blood is better for hypoxic patients than acid – citrate dextrose blood because it is.

- **A.** Less acidic
- **B.** There is less decrease in 2, 3-dpg
- **C.** It has a low P50
- **D.** None of the above

Q$_8$. During exercise, rapid breathing is possible by which center?

- **A.** Pneumotaxic center
- **B.** Apneustic center
- **C.** VRG
- **D.** DRG

Q$_9$. A person complains of breathlessness at a high altitude of 3000m. All of the following can be used in managing this person except

- **A.** Oxygen supplementation
- **B.** Immediate rapid descent
- **C.** Acetazolamide
- **D.** Intravenous digoxin