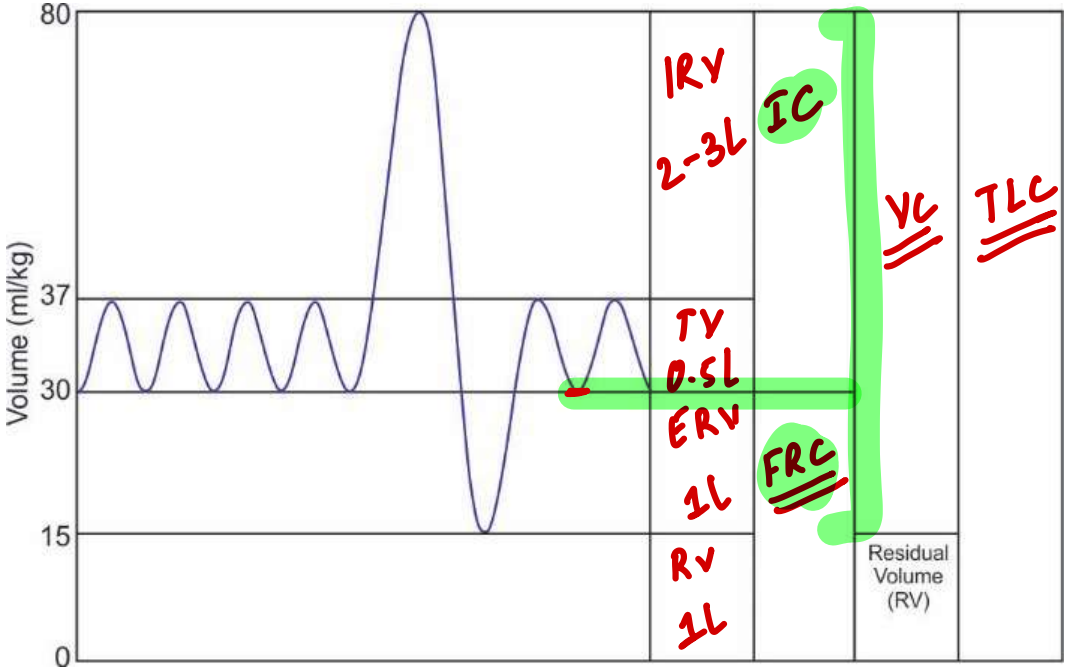
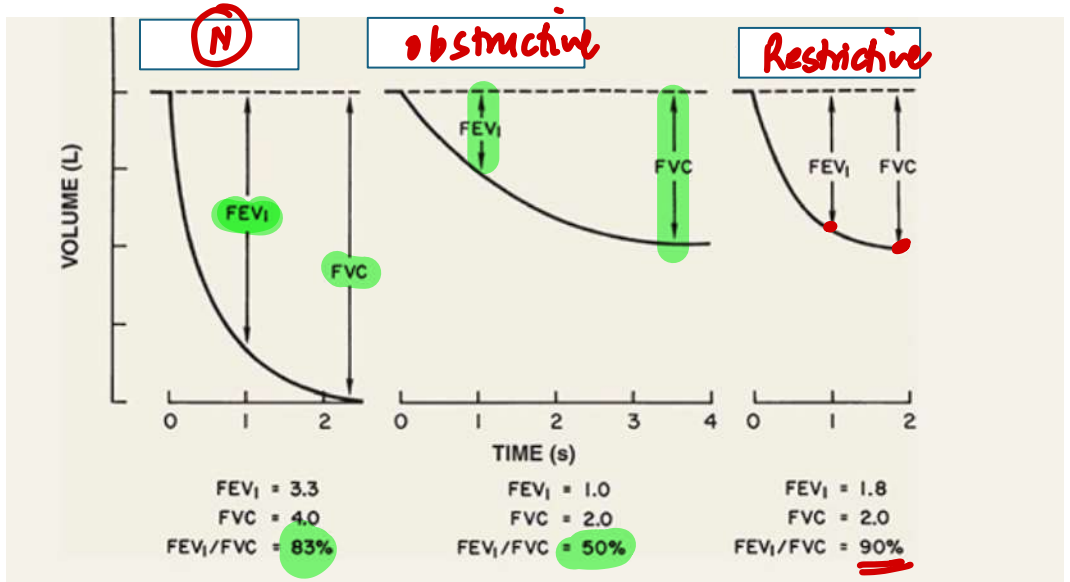
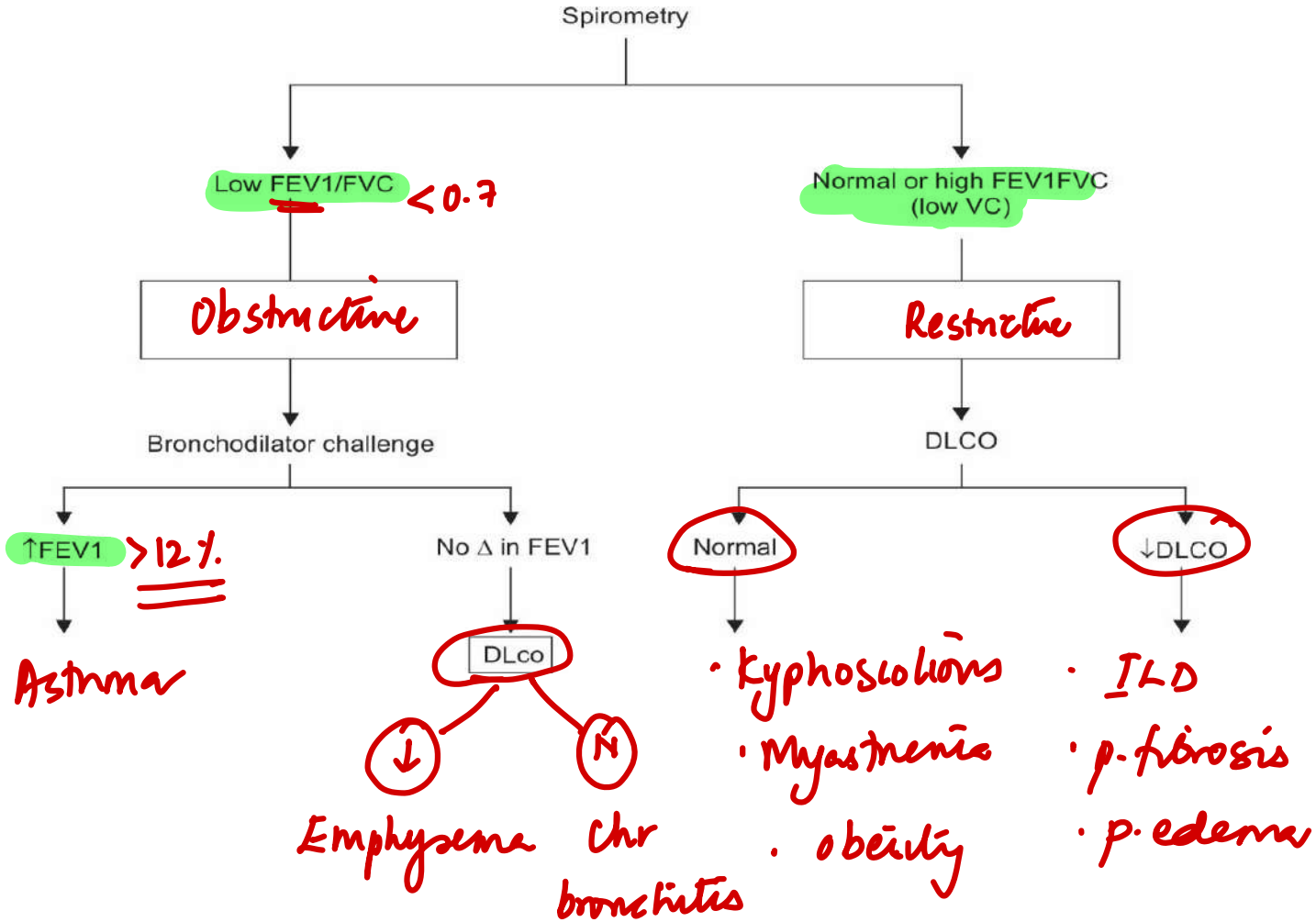
INTEGRATED RESPIRATORY SYSTEM

SPIROMETRY

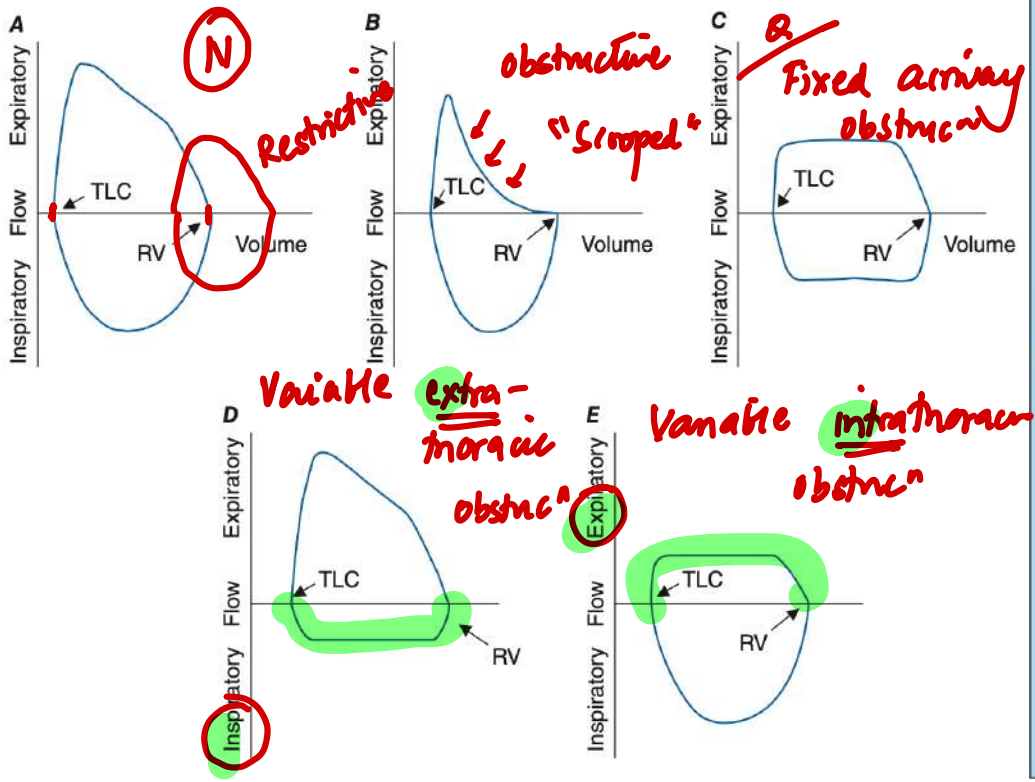


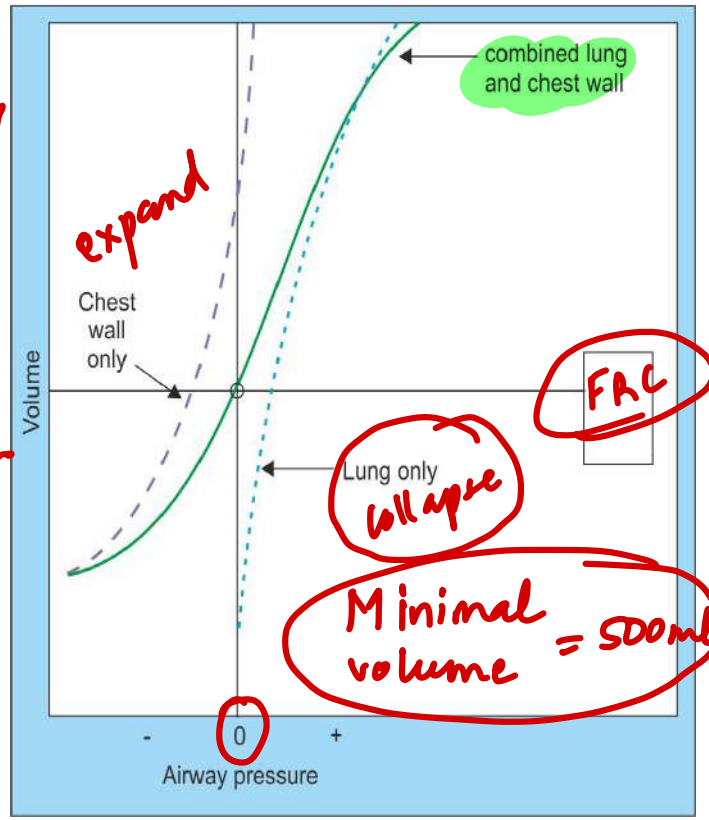


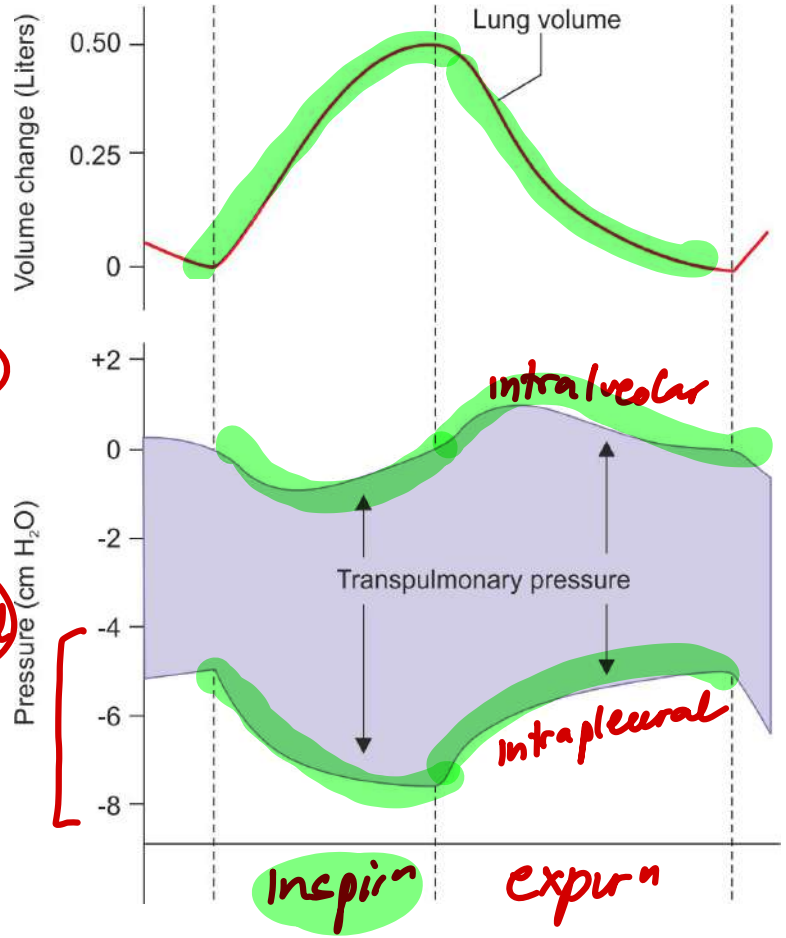


Helium dilution
Nitrogen washout
Body plethysmography – best

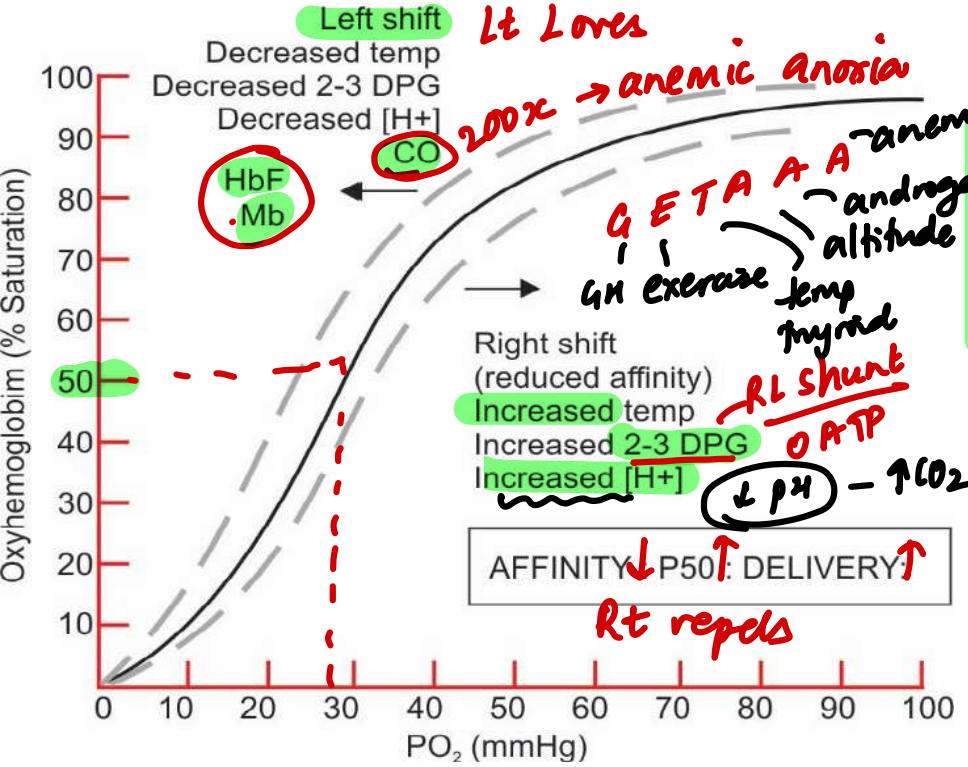
RV


A
Expiratory
Flow
Inspiratory
TLC
RV
Volume
N
Restrictive
B
obstructive
"Scooped"
C
Fixed airway obstruction
D
Variable extra-thoracic obstruction
E
Variable intrathoracic obstruction


combined lung and chest wall
expand
Chest wall only
Volume
FRC
Lung only
collapse
Minimal volume = 500ml
-
0
+
Airway pressure


Lung volume
Volume change (Liters)
0.50
0.25
0
+2
0
-2
-4
-6
-8
Pressure (cm H2O)
intralveolar
Transpulmonary pressure
intrapleural
Inspir
expir

AFFINITY↑ P50↓ DELIVERY↓



Lt Loves

200x → anemic anoxia

GETAA – anemia, androgens, altitude

GH exercise, temp, thyroid

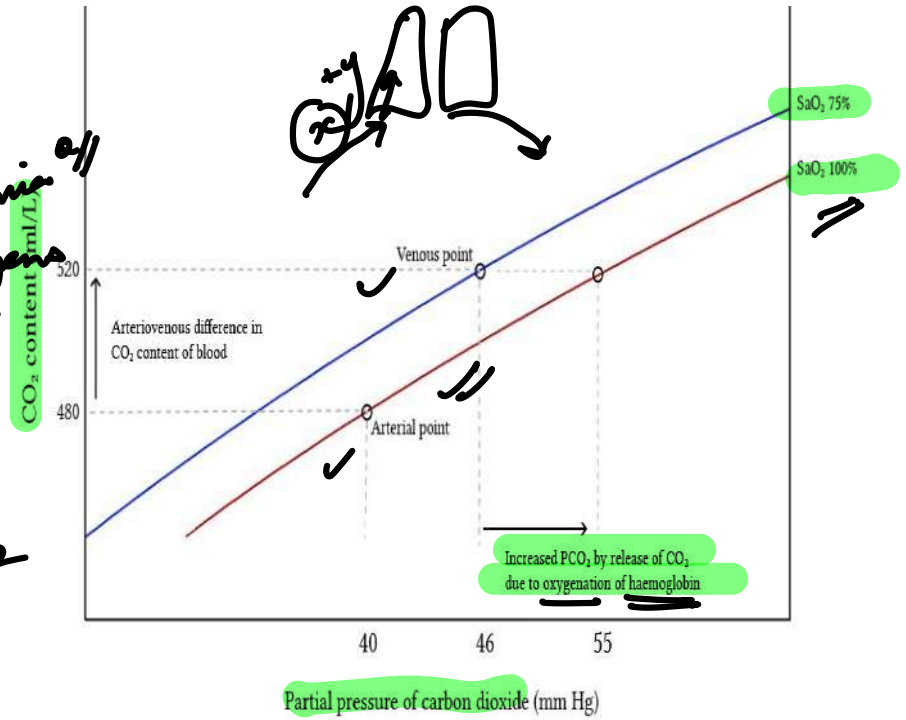
RL shunt

↓ ATP

↓ pH – ↑ CO_2

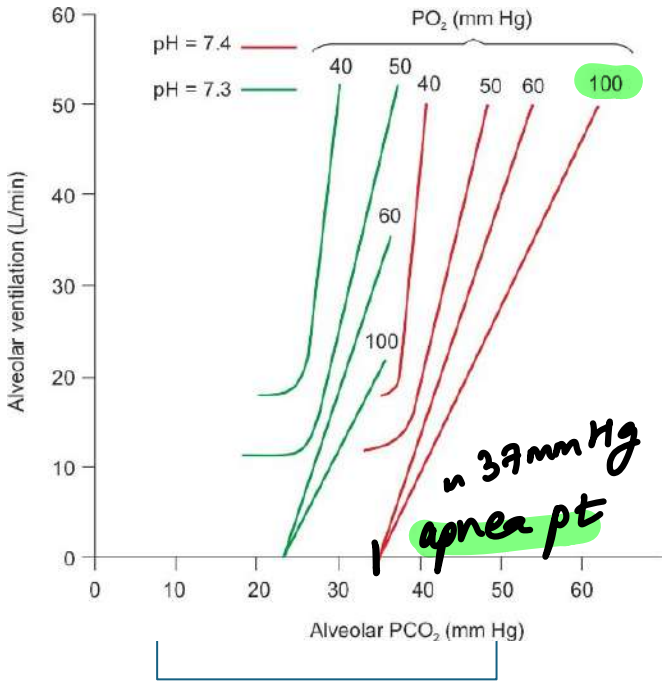
AFFINITY↓ P50↑ DELIVERY↑

Rt repels



Haldane effect

O_2 ↑ → CO_2 ↑



≈ 37 mm Hg

apnea pt

Chemoreceptors

Peripheral

Central

↓ pO_2 ↑ pCO_2 ↓ pH

pCO_2

pH

Shape: Sigmoidal

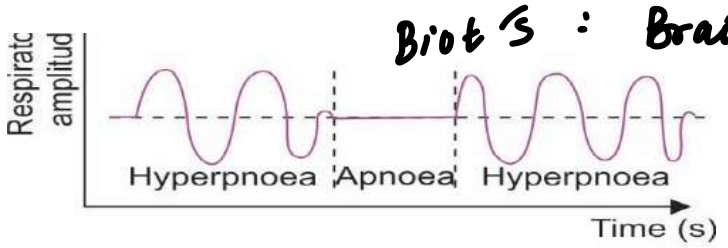
Positive co-operativity

P50: 27mm Hg

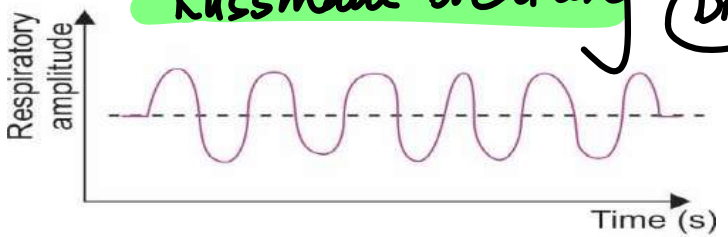
2,3 DPG binds to: Globin (B)

BOHR effect

Partial pressure of carbon dioxide increases-Reduced affinity of O2



Biot's : Brain dysfn

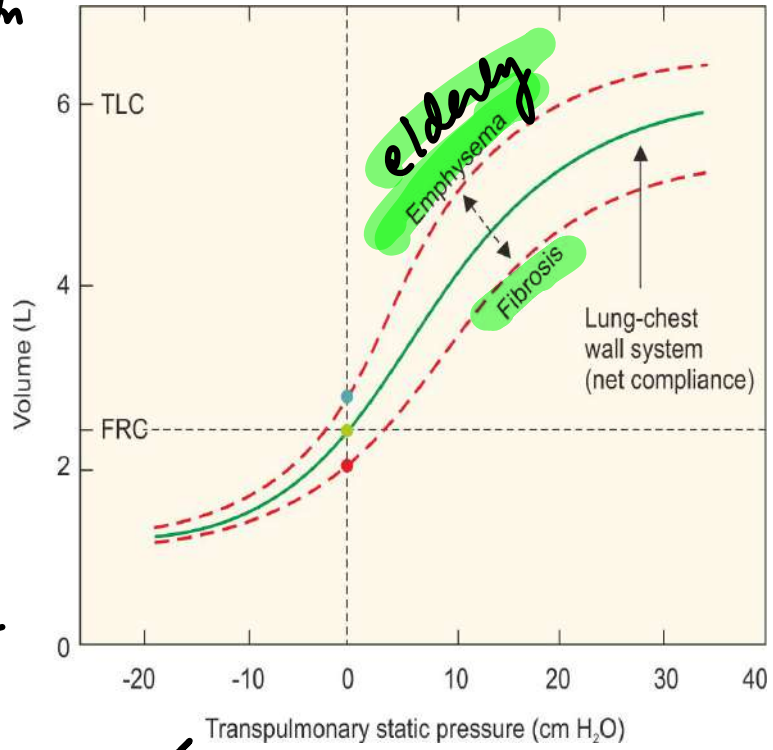


HAGMA

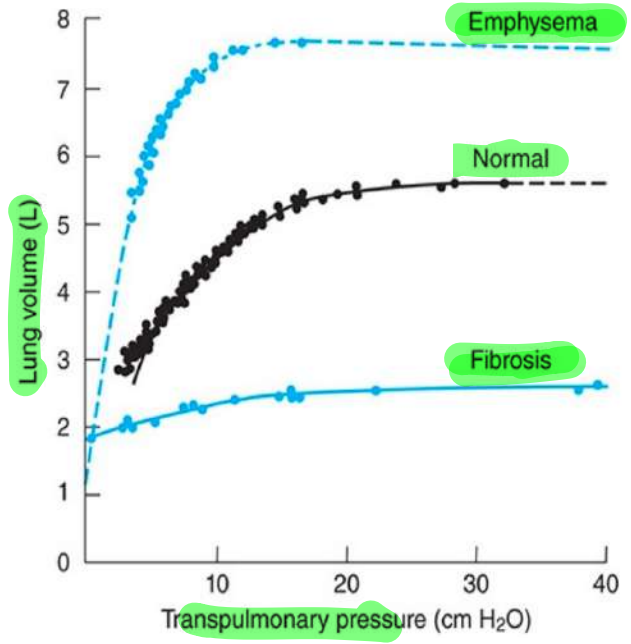
Kussmaul breathing

DKA

Chynes Stokes - CVS arrest



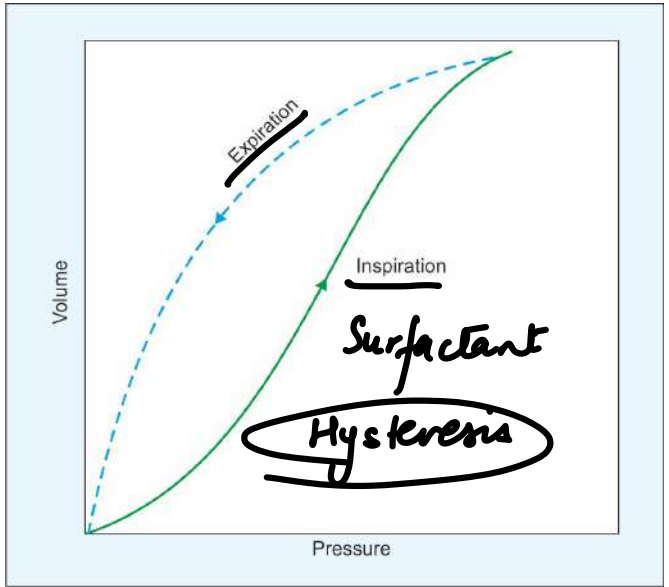
elderly

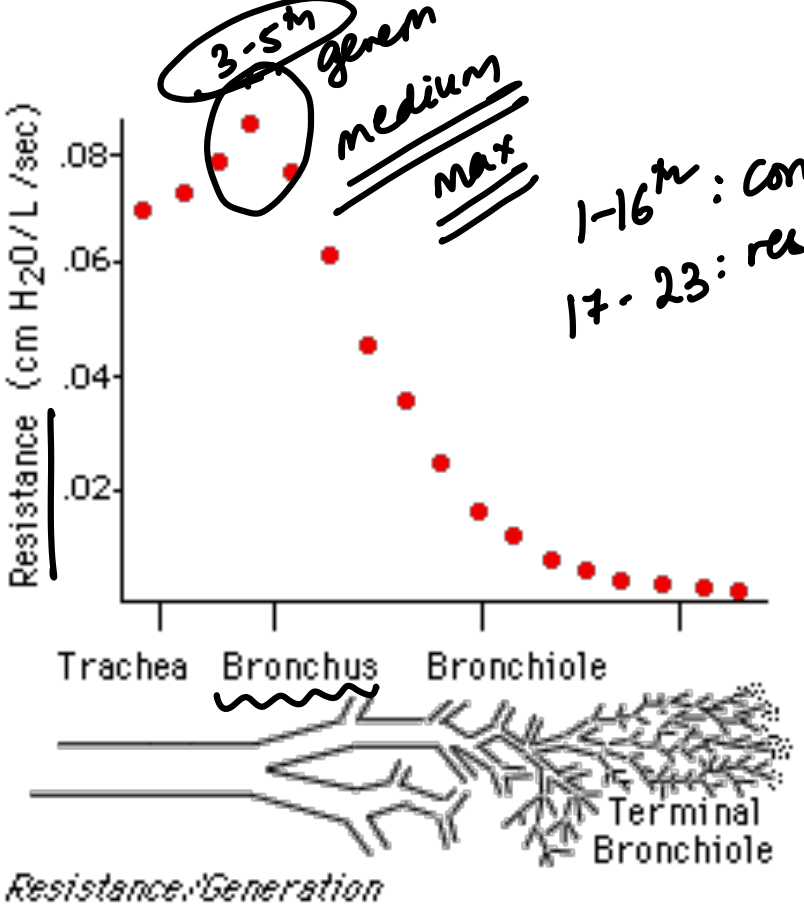


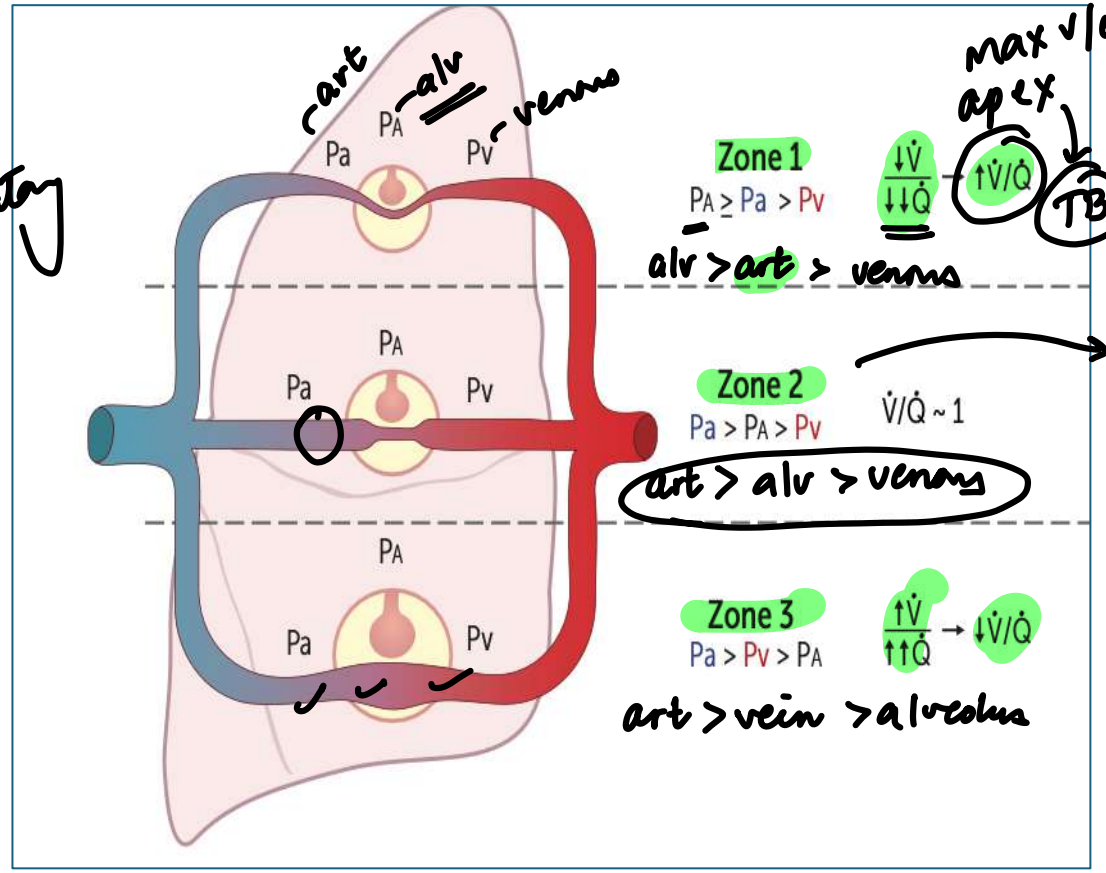
Q/

Surfactant: Compliance ↑
Surface tension ↓

Compliance: $\Delta V / \Delta P$







PPV / Hypovolemia: Zone 1

SLUICE/waterfall effect

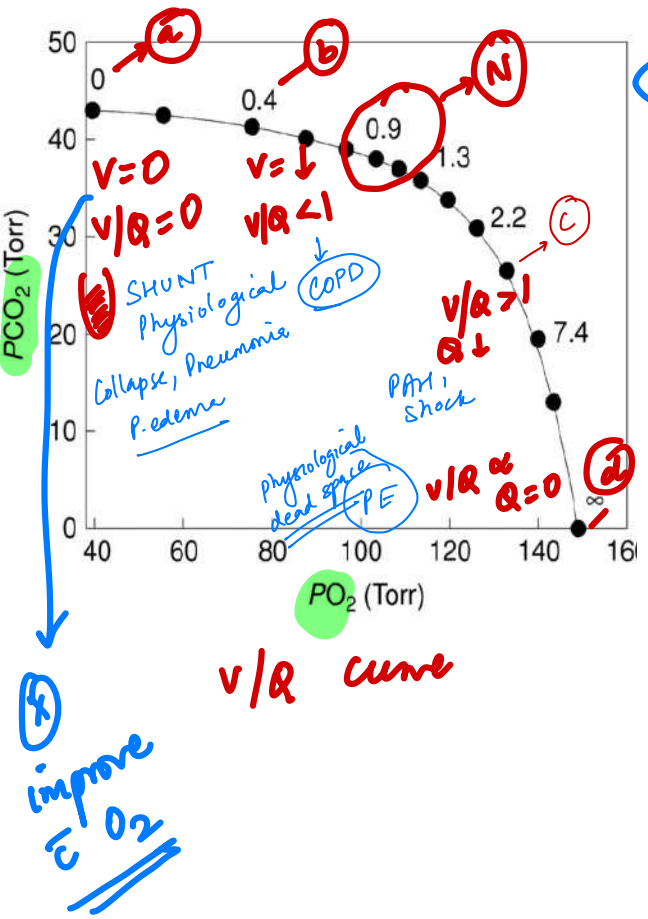
Exercise: Zone 3

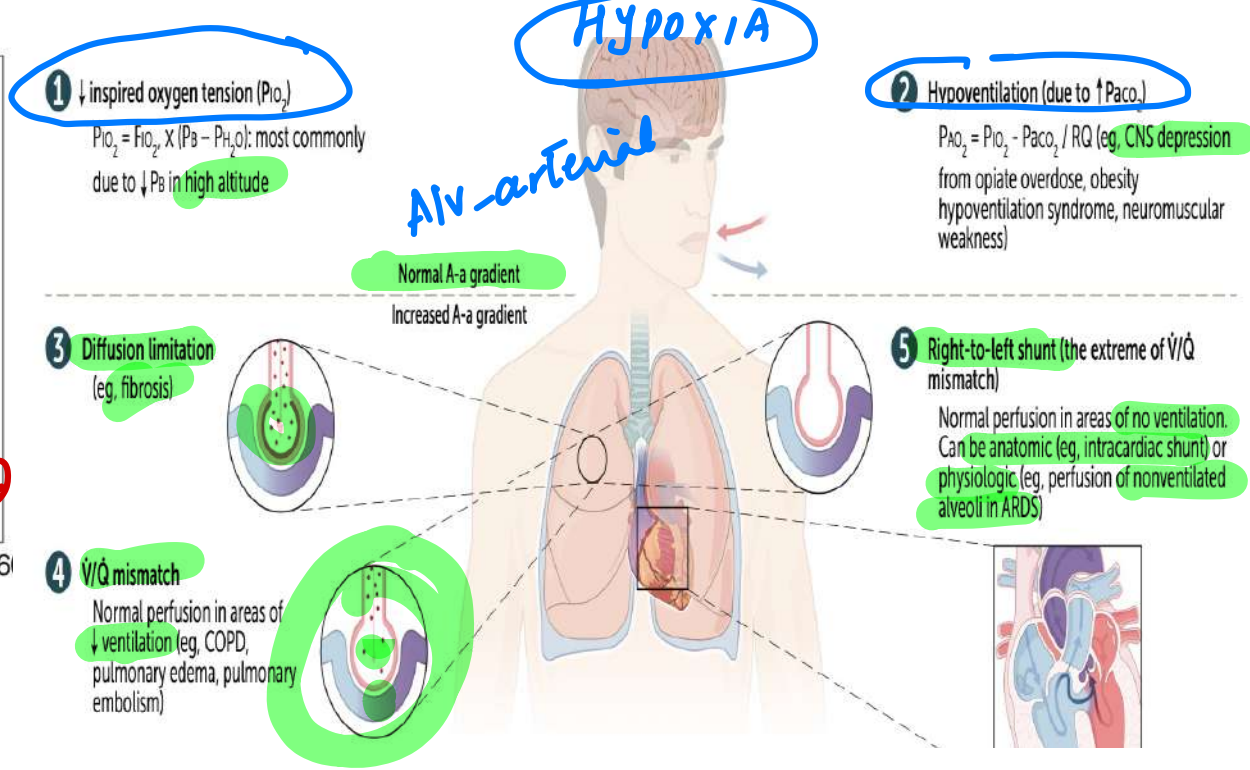
Zone 4

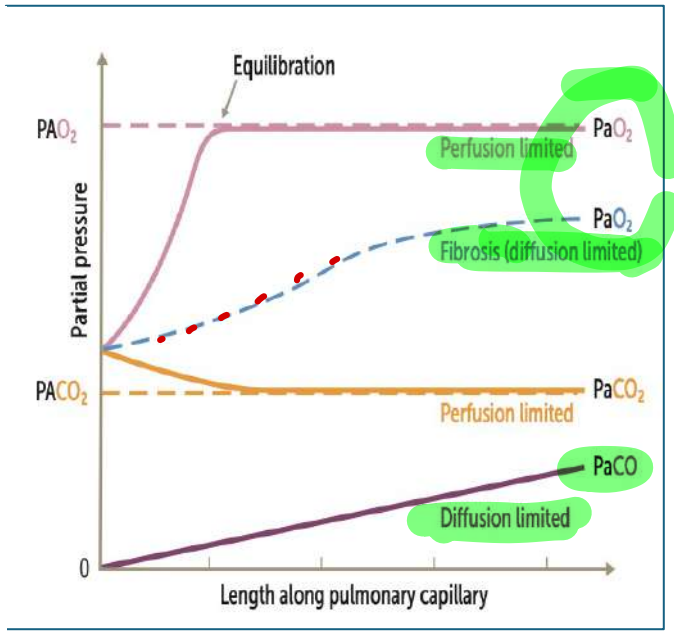
↑ Interstitial pressure

$P_{art} > P_{int} > P_{vein}$

Supine, exercise: V/Q matching - all lung


50
40
30
20
10
0
0
0.4
0.9
1.3
2.2
7.4
∞
40
60
80
100
120
140
160
PCO_2 (Torr)
PO_2 (Torr)
a
b
N
c
d
V=0
V/Q=0
V=↓
V/Q<1
SHUNT
Physiological
COPD
Collapse, Pneumonia
P.edema
V/Q>1
Q↓
PAH, Shock
physiological dead space
PE
V/Q ∞
Q=0
V/Q curve
improve
O2


Hypoxia
A|v-arterial
1 ↓ inspired oxygen tension (P_{IO_2})
$P_{IO_2} = F_{IO_2} \times (P_B - P_{H_2O})$: most commonly due to ↓ P_B in high altitude
2 Hypoventilation (due to ↑ P_{aCO_2})
$P_{AO_2} = P_{IO_2} - P_{aCO_2} / RQ$ (eg, CNS depression from opiate overdose, obesity hypoventilation syndrome, neuromuscular weakness)
Normal A-a gradient
Increased A-a gradient
3 Diffusion limitation (eg, fibrosis)
4 V̇/Q̇ mismatch
Normal perfusion in areas of ↓ ventilation (eg, COPD, pulmonary edema, pulmonary embolism)
5 Right-to-left shunt (the extreme of V̇/Q̇ mismatch)
Normal perfusion in areas of no ventilation. Can be anatomic (eg, intracardiac shunt) or physiologic (eg, perfusion of nonventilated alveoli in ARDS)


Equilibration
PA_{O_2}
Pa_{O_2}
Perfusion limited
Pa_{O_2}
Fibrosis (diffusion limited)
Partial pressure
PA_{CO_2}
Pa_{CO_2}
Perfusion limited
PaCO
Diffusion limited
0
Length along pulmonary capillary

FORMULAE

MINUTE VENTILATION — RR × TV

ALVEOLAR VENTILATION — $RR \times (T_V - T_D)$

$$V_D = V_T \times \frac{PaCO_2 - PECO_2}{PaCO_2}$$

(arterial – expired)

OXYGEN CARRYING CAPACITY OF BLOOD

C_aO_2 = Hb-bound O_2 + dissolved O_2

C_aO_2 = (O_2 carrying capacity × S_aO_2) + (P_aO_2 × 0.0031)

$1.34 \times Hb \times SaO_2$

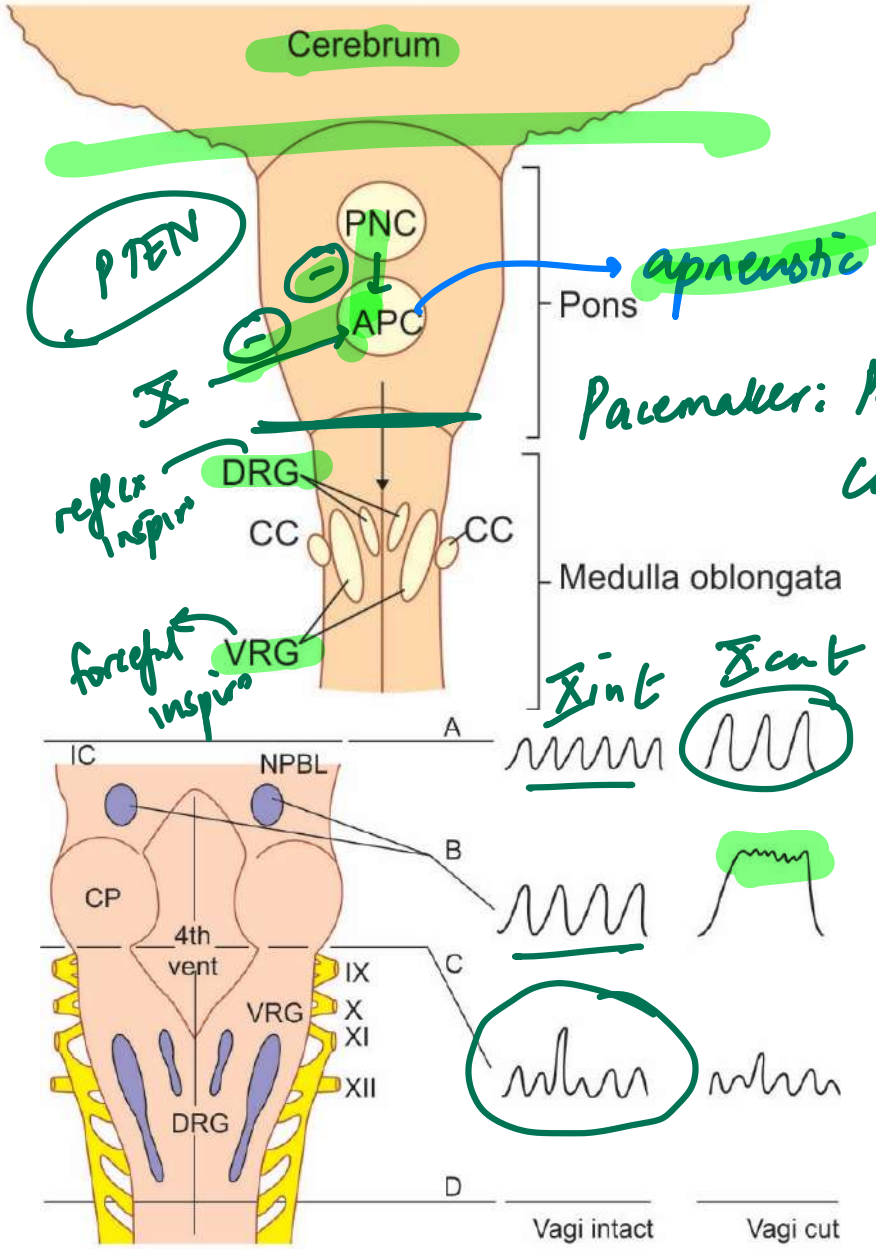
	Hb CONCENTRATION	Sao_2	Pao_2	TOTAL O_2 CONTENT
CO poisoning / MethHb	—	↓	—	↓
Anaemia	↓	—	—	↓
Polycythaemia	↑	—	—	↑
Cyanide toxicity	N	N	N	N

Anemic anoxia

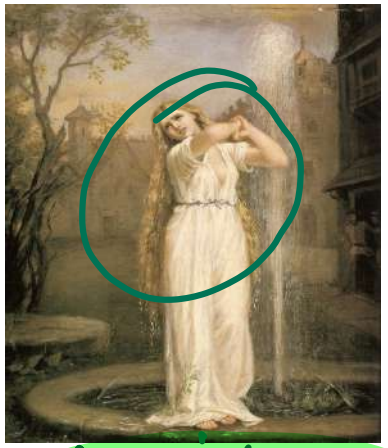
Fe^{3+} : Dapsone / Prilocaine* / Benzocaine / Nitrites

Histotoxic anoxia

RESPIRATORY REGULATION



Transection	Effect
ABOVE PONS	X intact: vol control X cut: ↑ depth
MID-PONS	X intact: ↑ depth X cut: apneusis
PONS-MEDULLA	irregular
BELOW MEDULLA	dead ceases



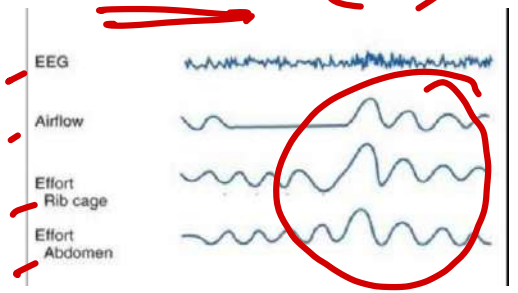
Ondine's curse

Cortical control ✓ of breathing

PaO2 normal during day : SLEEP APNEA

Central (CSA) — Brain depth

Obstructive (OSA)



Obesity BMI > 30

Hypoventilation

PaCo2 high during day and night

Obesity-hypoventil° = Pickwickian S/

RESPIRATORY FAILURE

TYPE 1 HYPOXEMIC	TYPE 2 HYPERCAPNIC	TYPE 3: PERI-OPERATIVE	TYPE 4 SHOCK WITH HYPOPERFUSION

$PO_2 \downarrow$

ILD / p. edema

$PCO_2 \uparrow$

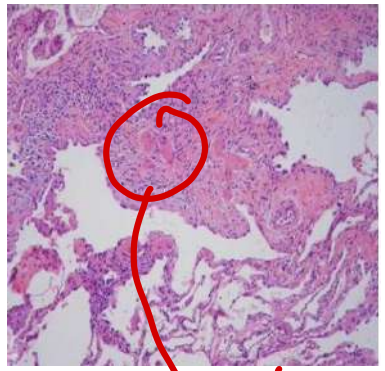
Hypoventilation

OSA / CSA / COPD

Honey combing (+)

UIP = IPF

Steroids ✗✗



fibroblastic foci

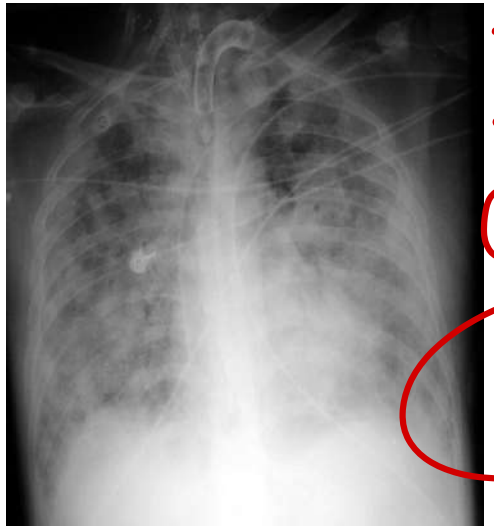
. temporal / spatial heterogeneity

Pirfenidone : anti TGF B

Nintedanib : anti PDGF

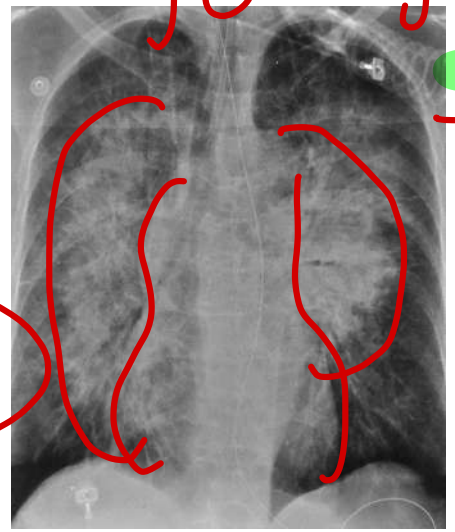
ARDS : sepsis / pancreatitis / toxins

DIAGNOSTIC CITERIA FOR ARDS (Berlin's)			
SEVERITY: OXYGENATION PA02/ FI02 <300	**ONSET**	**CHEST RADIOGRAPH**	**ABSENCE E OF LEFT ARTRIAL HYPERTENSION** ↓ PCWP (N)
Mild: 200 - 300 Moderate: 100 - 200 Severe: <100	Acute: within 1 week of clinical insult or new or worsening respiratory symptoms	Bilateral opacities consistent with pulmonary edema not fully explain by effusions, lobar/lung collapse or nodules	

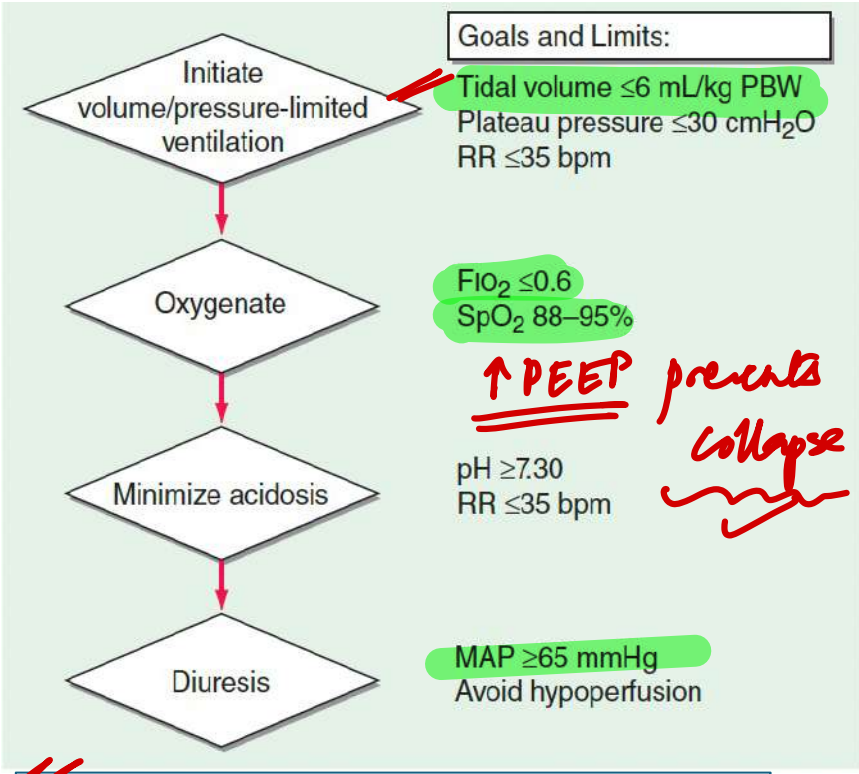


- peripheral
- patchy
- (x) pl effusion

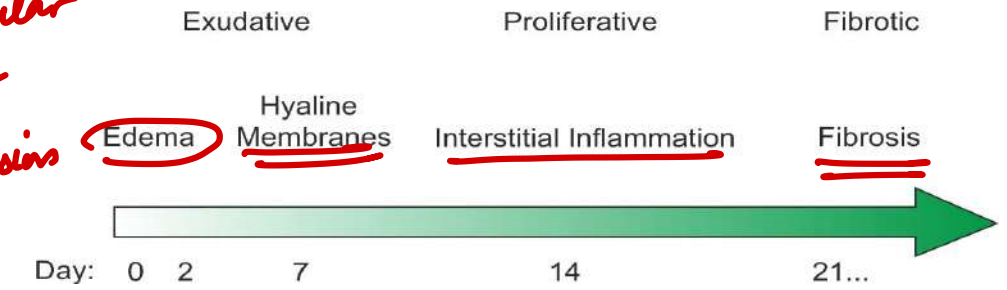
NC p.edema
ARDS ✓



batwing (+) ♡megaly
♡ p.edema
- Kerley lines
- interlobular septal
- Pl effusion (+)



PRONE VENTILATION



PLEURAL EFFUSION

Light's criteria for pleural effusions		
	Transudate	Exudate
Protein (pleural/ serum	< 0.5	>0.5
LDH (Pleural/serum)	<0.6	>0.6
	Pleural LDH <two-thirds upper limit of normal serum LDH	Pleural LDH> two-thirds upper limit of normal serum LDH
Causes	· Cirrhosis / CHF / NS	Inflammⁿ / malignancy

Low glucose: 'REM'
RA, Empyema, Malignancy

High Amylase: Malignancy
Pancreatitis / Esoph rupture

Indications of drainage of effusion:
1. Split pleura sign
2. pH < 7.2
3. Glc ↓
4. GS/ culture ⊕
5. Loculations

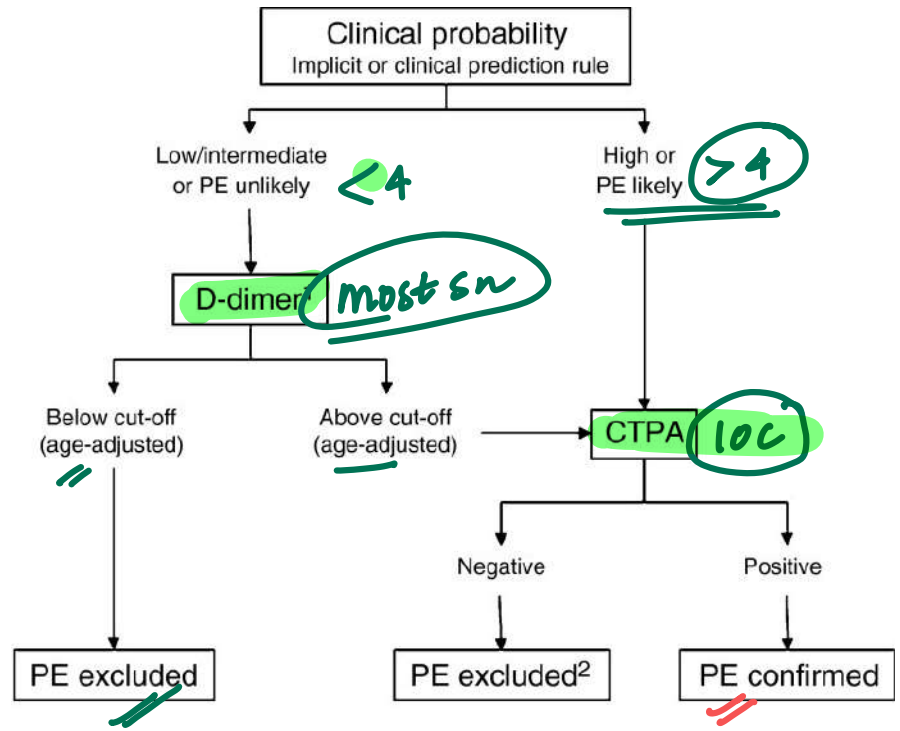
CHYLOTHORAX
· lymphatic leaks
· Tg > 110mg/dl

Pseudo-chylothorax : RA
Cholesterol

Empyema (pigtail)

Split pleura sign

Pulmonary embolism

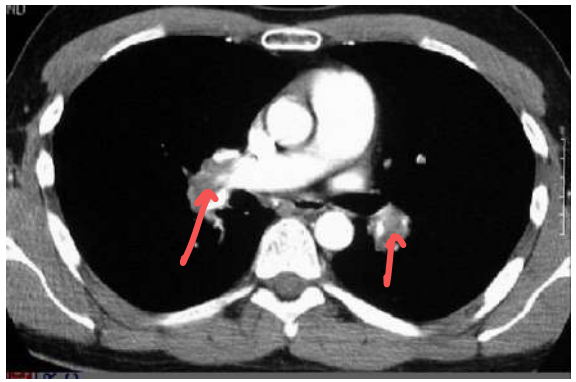


Treatment algorithm:

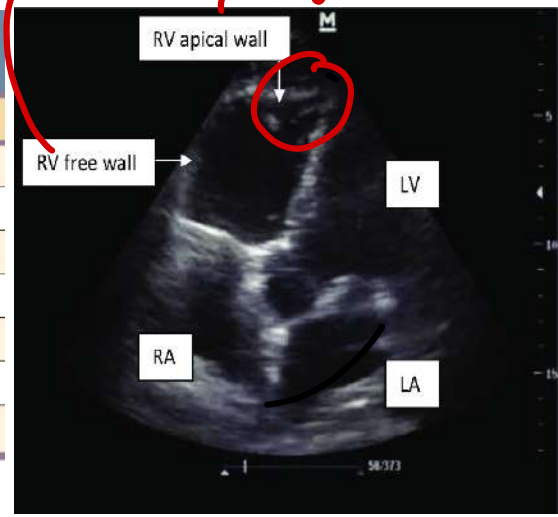
unstable → fibrinolytic → CI → embolectomy

stable → LMWH anticoagulation → CI → IVC filter

High Clinical Likelihood of Pulmonary Embolism (PE) if Point Score Exceeds 4	
CLINICAL VARIABLE	SCORE
Signs and symptoms of DVT	3.0
Alternative diagnosis less likely than PE	3.0
Heart rate >100/min	1.5
Immobilization >3 days; surgery within 4 weeks	1.5
Prior PE or DVT	1.5
Hemoptysis	1.0
Cancer	1.0



(Infrarenal IVC)



RV strain = McConnel sign

Virchow's Δ : DVT

- Hypercoagulability — Factor V (mc)
- Stasis
- Endothelial injury

ECG

mc: Sinus tachy

Most sp: S1Q3T3

Xray specific:

- Westermark – oligemia
- Hampton's hump
- Palla's : PA prominent

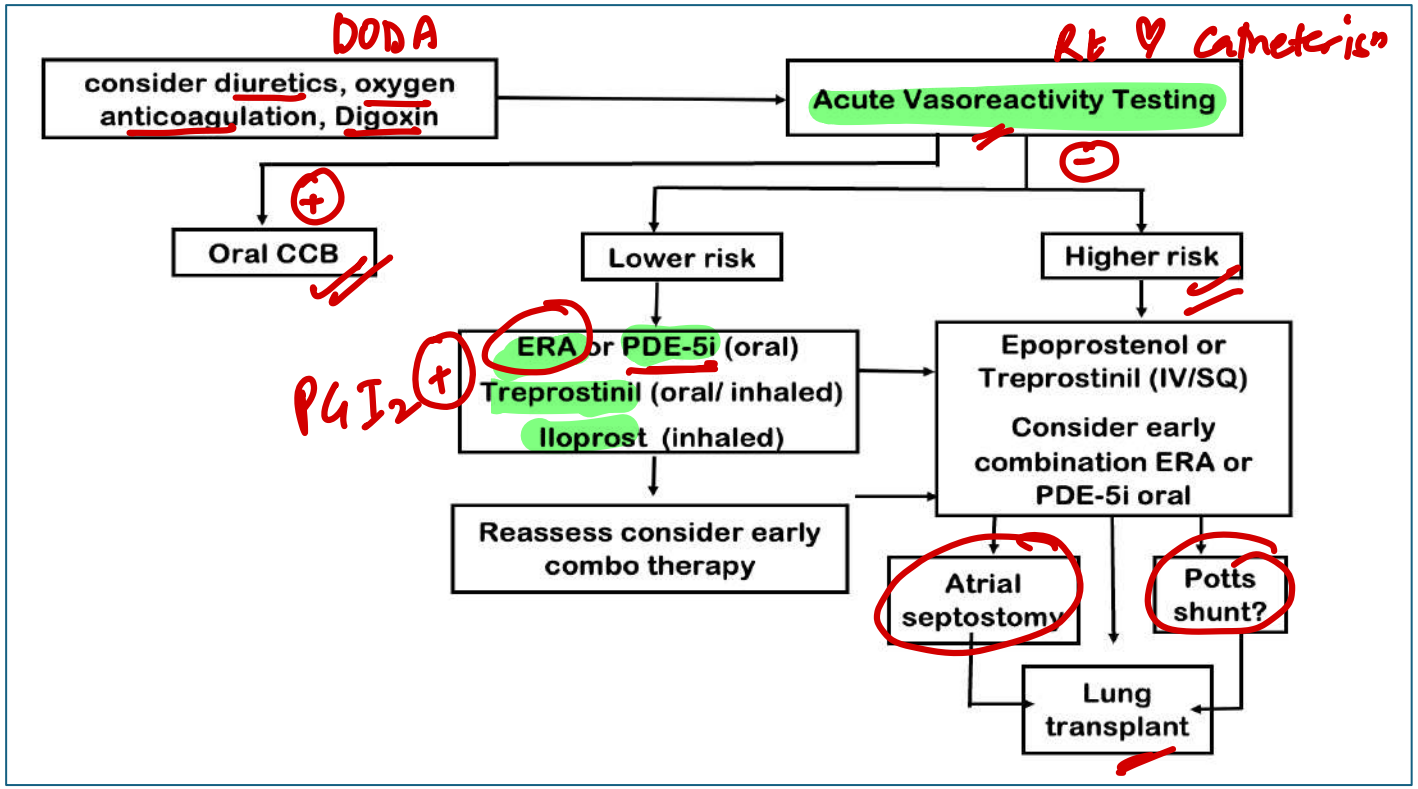
PAH

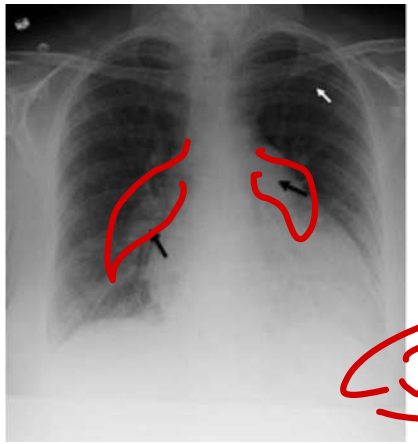
GROUP	DESCRIPTION
1.	Idiopathic Hereditary: BMPR2 Associated with Connective tissue diseases HIV infection Portal Hypertension Congenital heart disease Schistosomiasis Chronic haemolytic anaemia
2.	PAH owing to left heart disease
3.	PAH owing to lung disease and /or hypoxia
4.	Chronic thromboembolic pulmonary hypertension
5.	PH with unclear multifactorial mechanism

Dana Point

CREST (mc)

plexiform arteriopathy





Jug handle

ERA: Bosentan, Macitentan, Ambrisentan → s/e: hepatotoxic

PDE5i-: Sildenafil, Tasalafil : ⊗ use in nitrates

Guanylate cyclase +: Riociguat

Chest infections

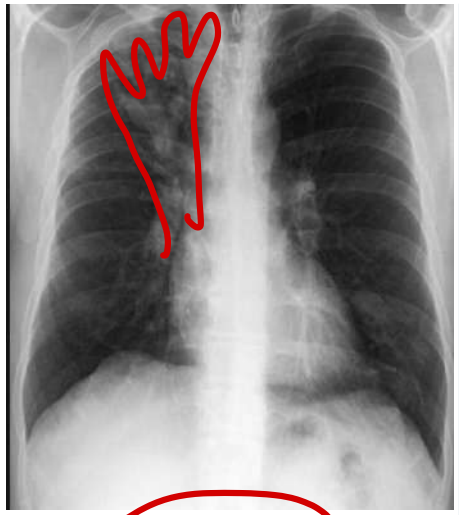
MCC of typical CAP: S.pneumoniae
MCC of atypical CAP: Mycoplasma
MCC of HAP (>48hrs of admission): Gram -ve
MCC of VAP (>48hrs of ventilation):

early : S.pneumoniae
late : Pseudomonas
Acinetobacter

CURB-65 Scoring	
Symptom	**Points**
Confusion	1
~~Urea: BUN>19 mg/dL (>7 mmol/L)~~	~~1~~
Respiratory rate≥30 breaths /min	1
Systolic BP <90 mm Hg or diastolic BP ≤60 mm Hg	1
Age≥ 65 years	1

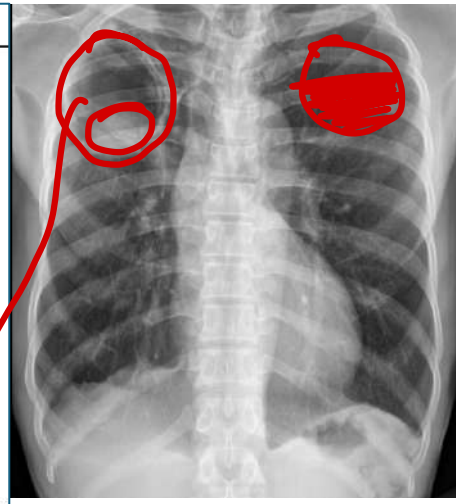
OP: 0-1	Amoxicillin +/- Macrolides / Doxycycline
IP: 2	FQ / BL+ Azithral/Doxy
ICU: 3-5	BL+ FQ/ Azithral

OP:0
IP: 1-2
ICU: 3-4

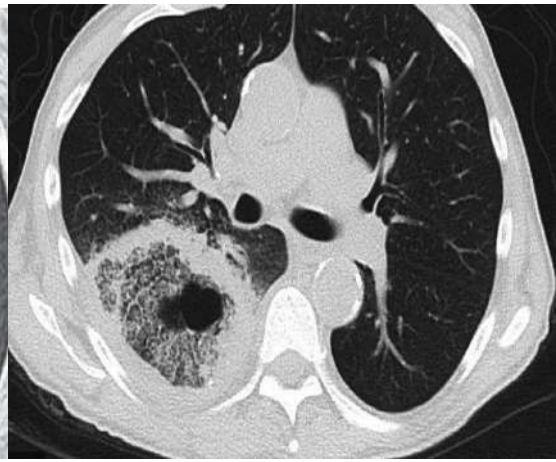


ABPA
Hand-in-glove

Primary criteria (1–6 suggestive, +7 definite)
1. Episodic bronchial obstruction
2. Peripheral eosinophilia
3. Positive immediate skin test to *Aspergillus*
4. Positive precipitin test to *Aspergillus*
5. Increased total serum IgE
6. History of transient or fixed lung infiltrates
7. Proximal bronchiectasis
Secondary (supportive) criteria
1. Brown plugs/flecks in sputum
2. Positive late (6–12 h/Arthus) skin test to *Aspergillus*



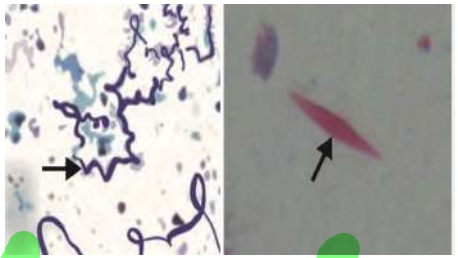
Monad
Fungal ball = Aspergilloma
Rx: Symptomatic



← ic /neutropenia
Halo sign
Invasive aspergillosis
Rx: VORICONAZOLE

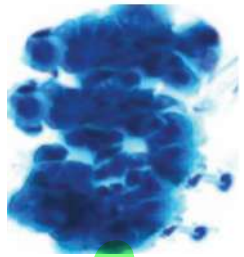
Reverse halo / Bird's nest
MUCOR

Asthma



Cruschmann spirals

C-L Crystals galectin-10 (eosinophils)

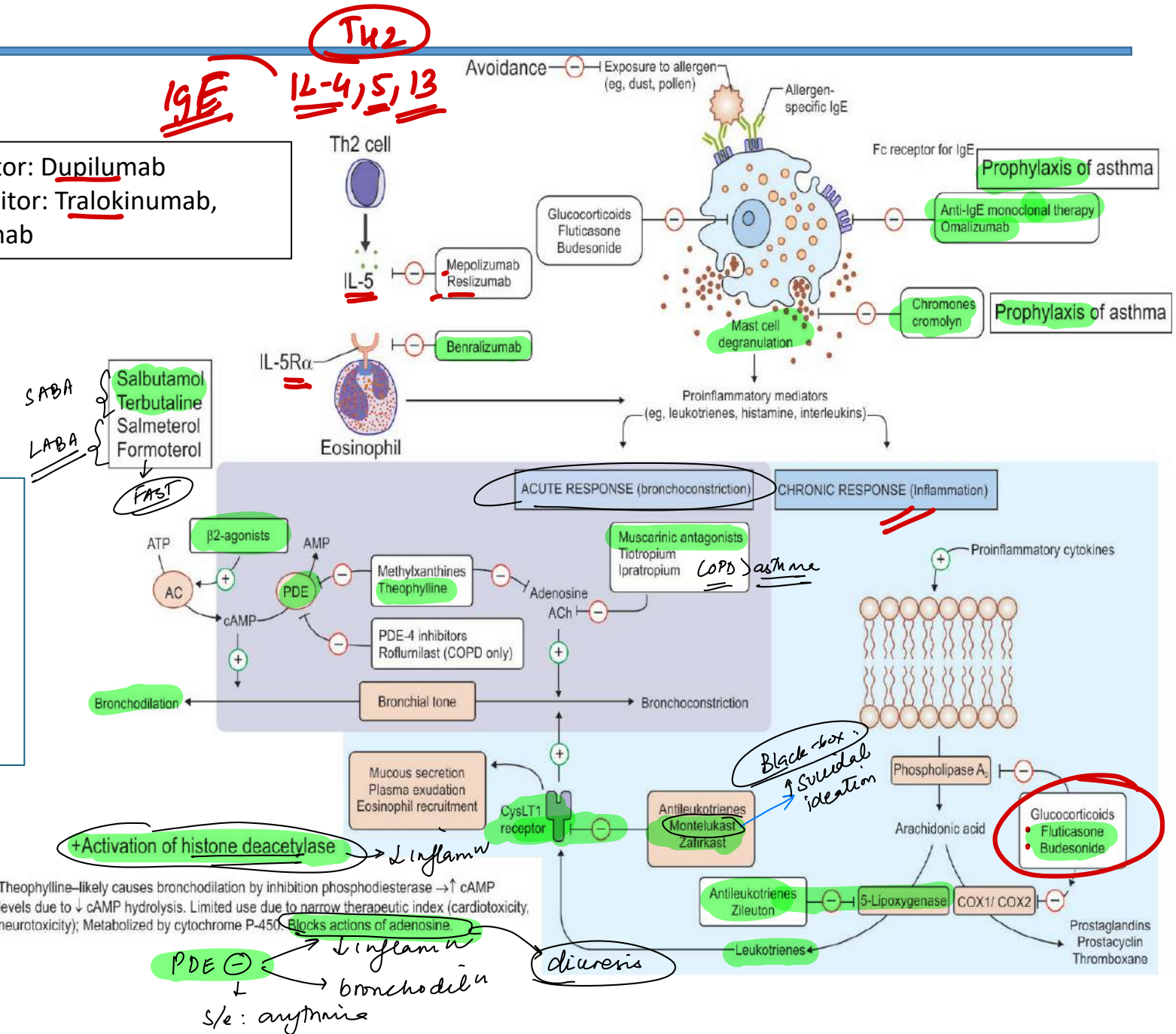


Creola bodies

GINA

Step1,2: Symptoms <5d/week:
LD-ICS-Formoterol as needed
Step 3: Most days/ >1/week nighttime:
LD-ICS-Formoterol
Step 4: Low lung function:
MD-ICS-Formoterol
Step 5: Add LAMA + HD-ICS + Anti-IgE/IL5

IL-4 inhibitor: Dupilumab
IL-13 inhibitor: Tralokinumab, Lebrikizumab



COPD-GOLD Criteria-2023

GOLD ABE Assessment Tool

Spirometrically confirmed diagnosis → Assessment of airflow obstruction → Assessment of symptoms/risk of exacerbations

Post-bronchodilator FEV1/FVC < 0.7

GRADE	FEV1 (% predicted)
GOLD 1	≥ 80
GOLD 2	50-79
GOLD 3	30-49
GOLD 4	< 30

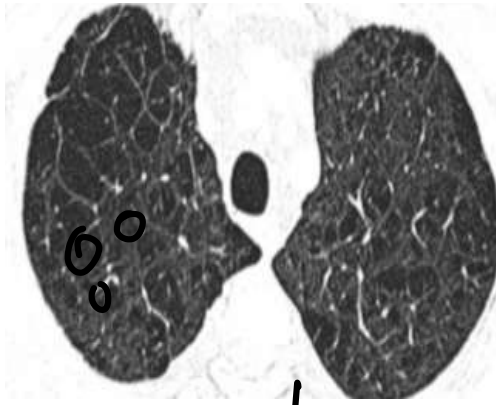
30 + 50 = 80

EXACERBATION HISTORY (PER YEAR)	SYMPTOMS: mMRC 0-1, CAT < 10	SYMPTOMS: mMRC ≥ 2, CAT ≥ 10
≥ 2 moderate exacerbations or ≥ 1 leading to hospitalization	E	E
0 or 1 moderate exacerbations (not leading to hospitalization)	A	B

E: LABA + LAMA + ICS

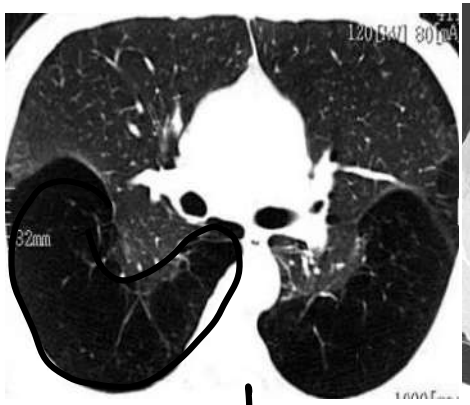
A: SABA / SAMA

B: LABA / LAMA



- Smokers
- U/L

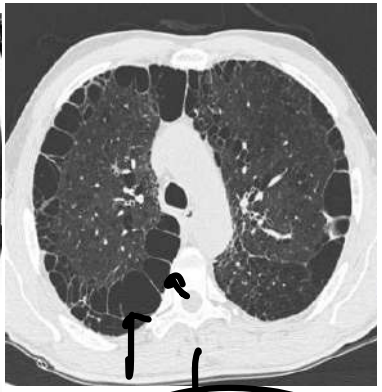
Centrilobular



α1AT def

LL

Panlobular



Paraseptal

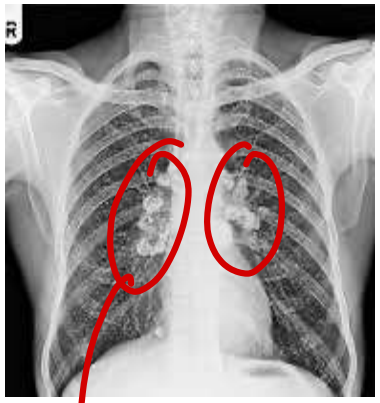
mc: Smokers

Reid index = Mucous gland / BM-cartilage

Chronic bronchitis : ≥ 40%

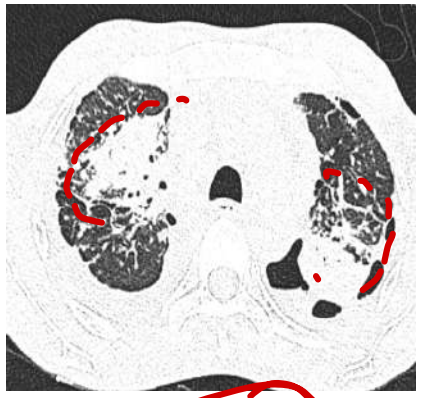
OCCUPATIONAL LUNG DISEASES

U/L exc Asbestosis



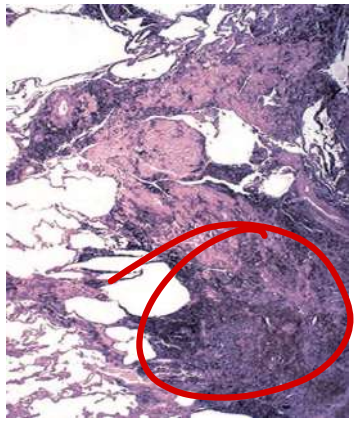
egg shell Ca^{2+}

SILICOSIS



PMF

progressive massive fibrosis



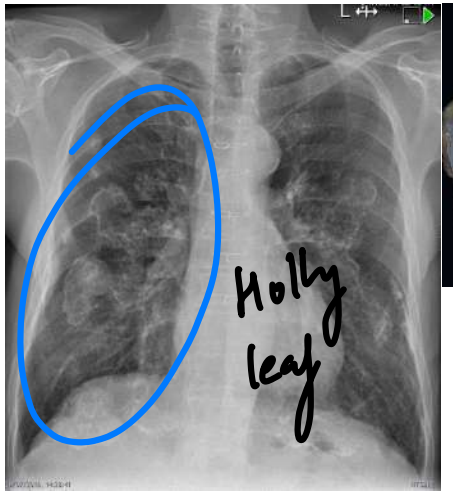
Caplan syndrome

CWP + RA

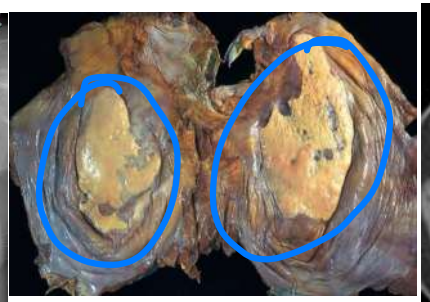
Erasmus syndrome

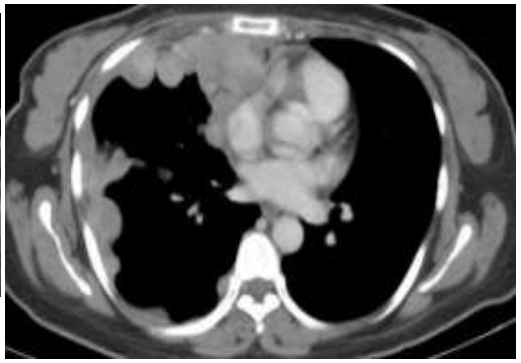
CWP + SSc

CWP



Pleural plaques Ca^{2+}





Dumbell

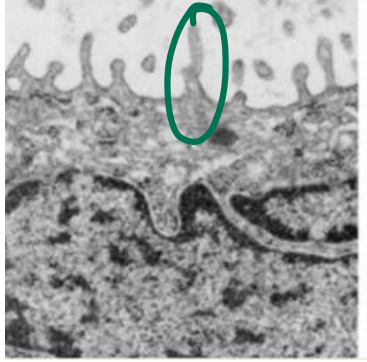
mc: adeno ca

Most fp: Mesothelioma

FROZEN HEMITHORAX

Serpentine/ Crysolite

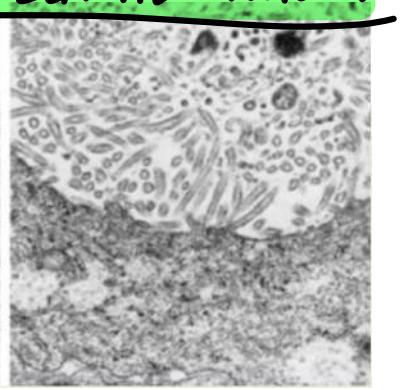
Amphibole/ Crocidolite



Short, stubby villi

adca

TTF1 / Napsin A



long, slender villi

Mesothelioma

Calretinin / CK5/6

Berilyosis

Jewellery /dental alloy

Granulomatosis

BeLPT

HLA-DP

mimics Sarcoidosis

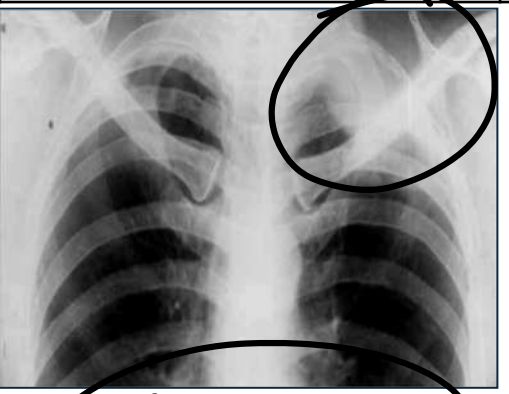
Cobalt

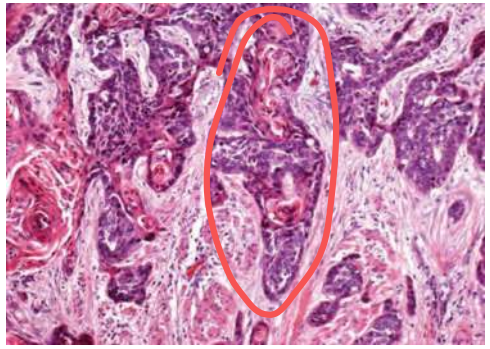
Diamond industry

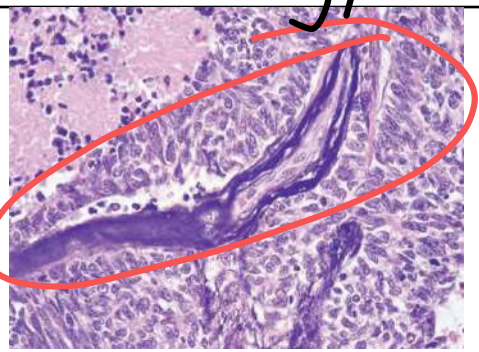
Giant cell interstitial pneumonitis

CARCINOMA LUNG

	Squamous cell ca	Small cell ca	Adenoca (mc)	Large cell ~~sea~~
Smoker?	✓	✓	(–)	
Location?	Central	central	peripheral	
GENES	p53	L-myc	EGFR / ALK / KRAS	—
H/P	Keratin pearls	Azzopardi / salt & pepper chromatin	Lepidic Spread	
IHC	p40 / p63	Synaptophysin / Chromogranin NSE / Bombesin	TTF1 / NapsinA	
Paraneoplastic	↑Ca2+ : PTHrp	SIADH / Cushing / LEMS	Trosseau Sx / HPOA	Gynecomastia

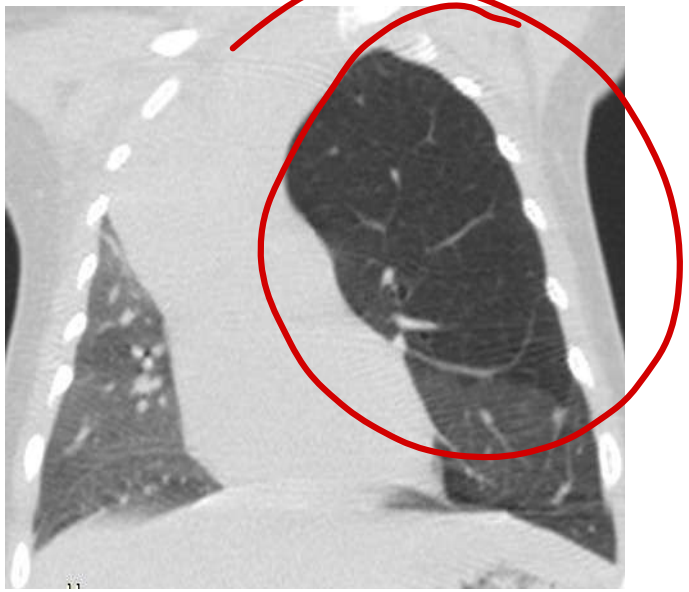






PANCOAST → Sq cc > small IOC: MRI

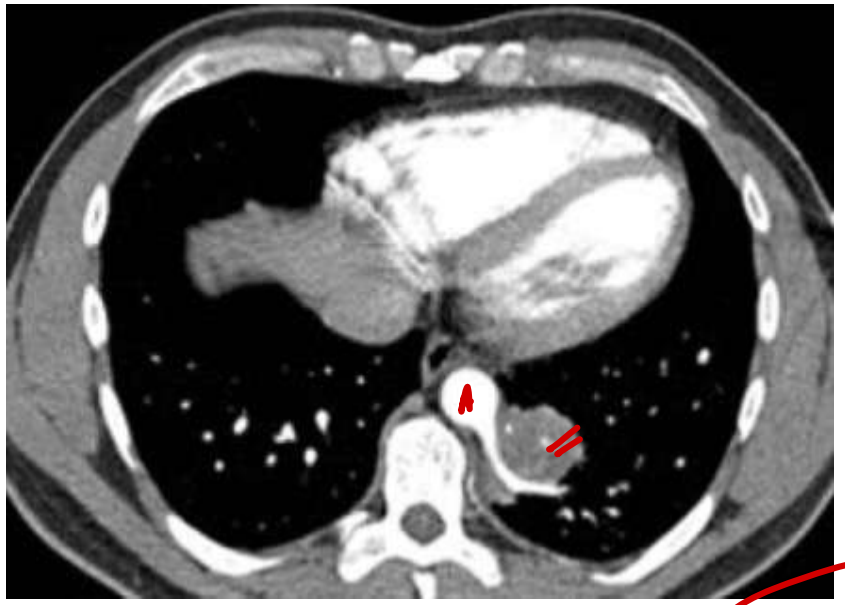
Congenital pulmonary malformations



Cong Lobar overinflation

CLO

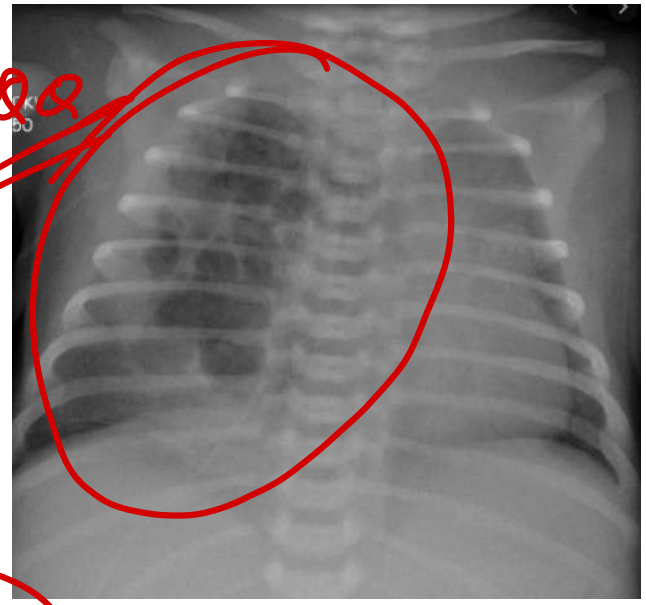
mc: LUL



Sequestration

EXTRALOBAR	INTRALOBAR
Own visceral pleura	Shares pleura with parent lobe
Systemic venous drainage	Pulmonary venous drainage
Foregut communication, CDH	Associated anomalies rare
Presentation: Perinatal or infancy	Adolescence

systemic arterial



CPAM

Cong pulm airway malform