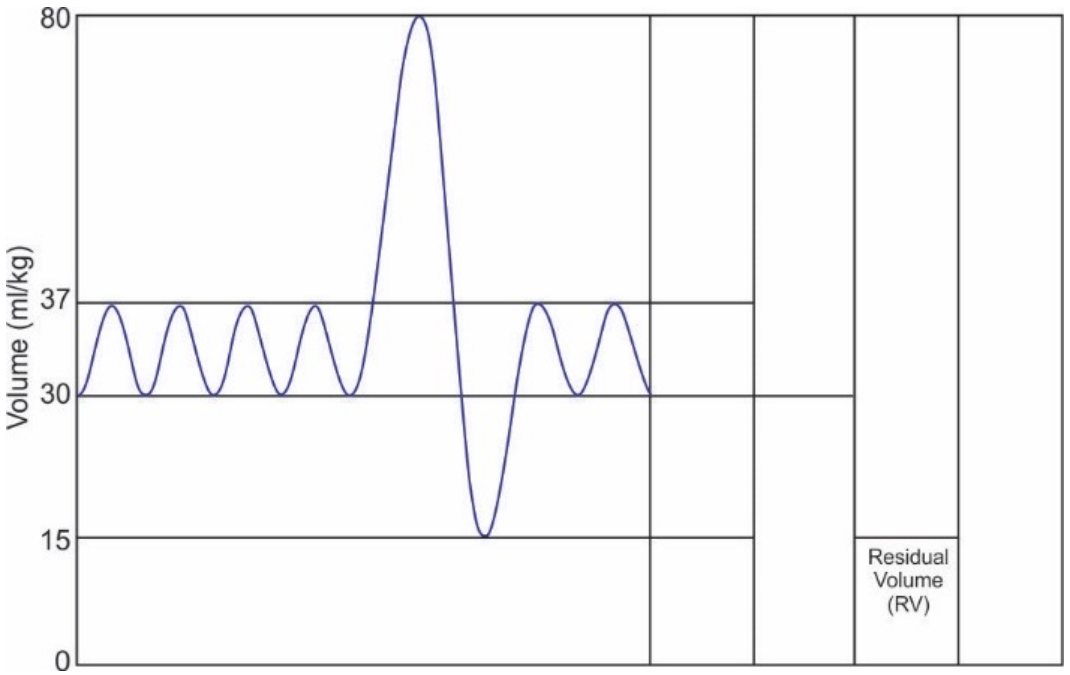
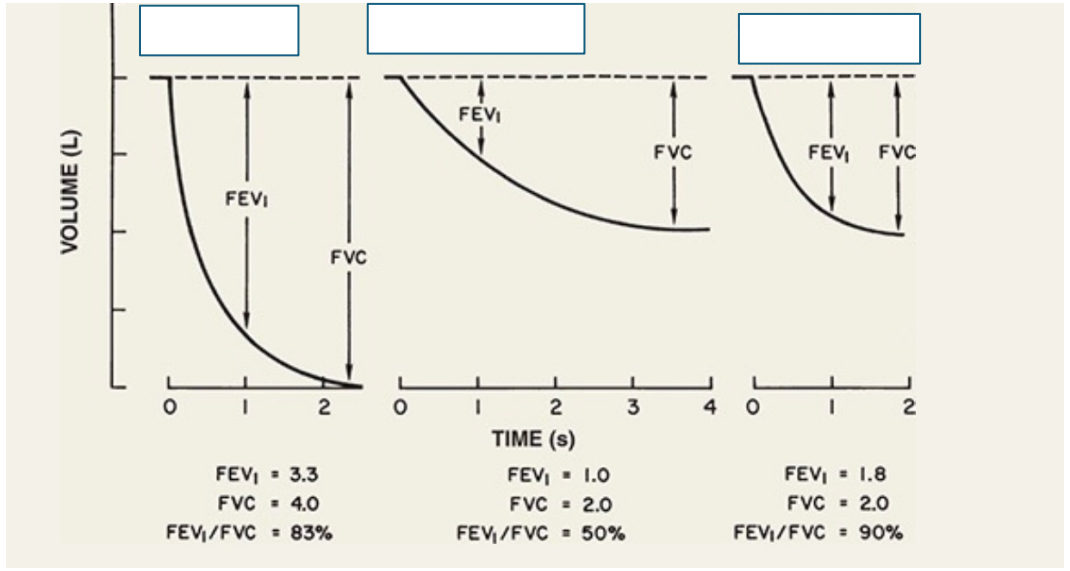
INTEGRATED RESPIRATORY SYSTEM

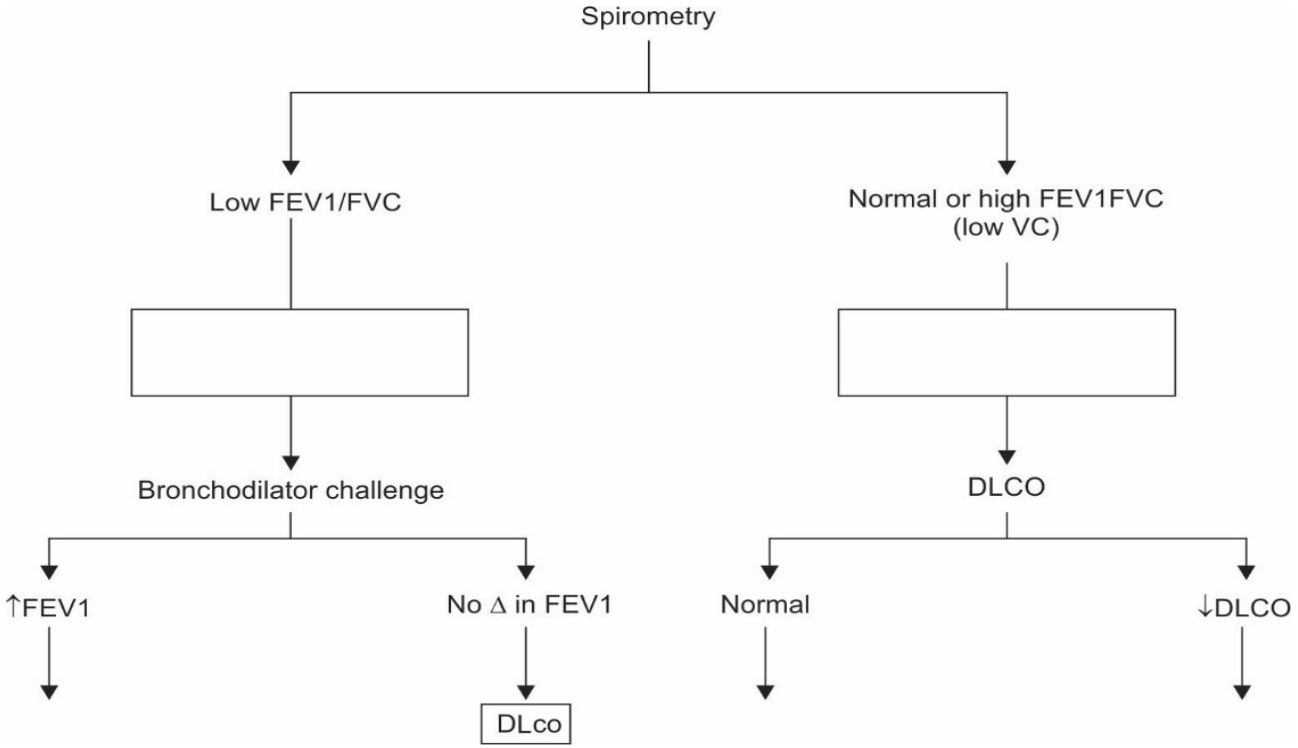
SPIROMETRY

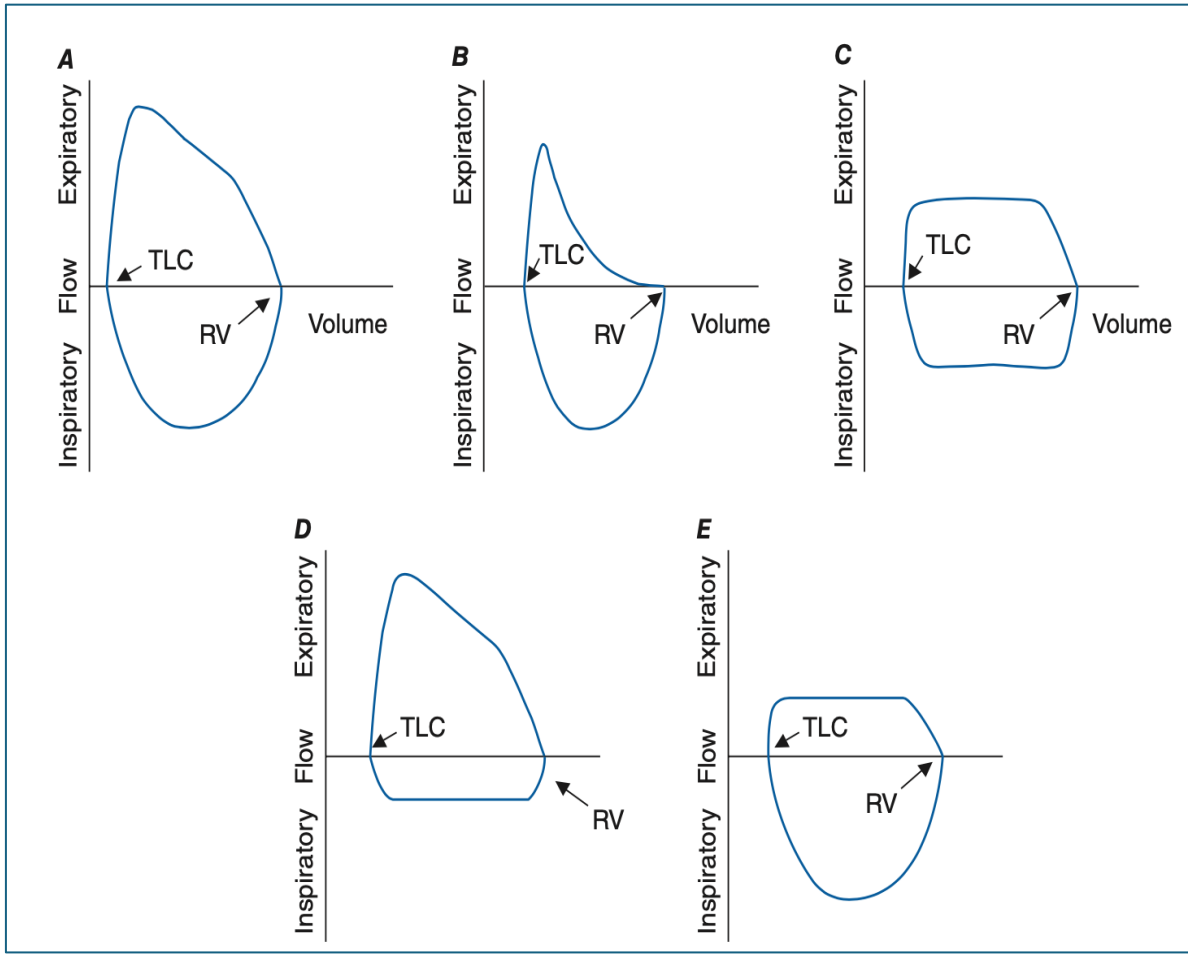




Parameter	Obstructive Lung Disease	Restrictive Lung Disease
RV		
FRC		
TLC		
FEV_1 (N:>80%)		
FVC(N:>80%)		
FEV_1/FVC (N:>70%) (Tiffeneau–Pinelli index)		

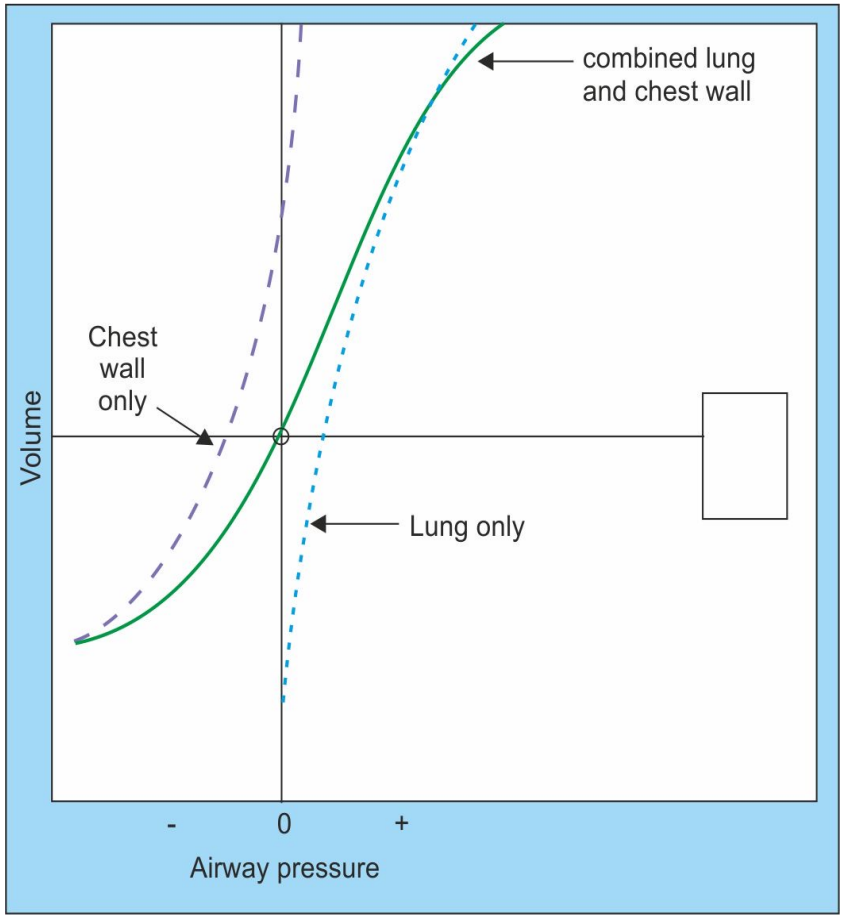
Helium dilution/ Nitrogen washout /Body plethysmography

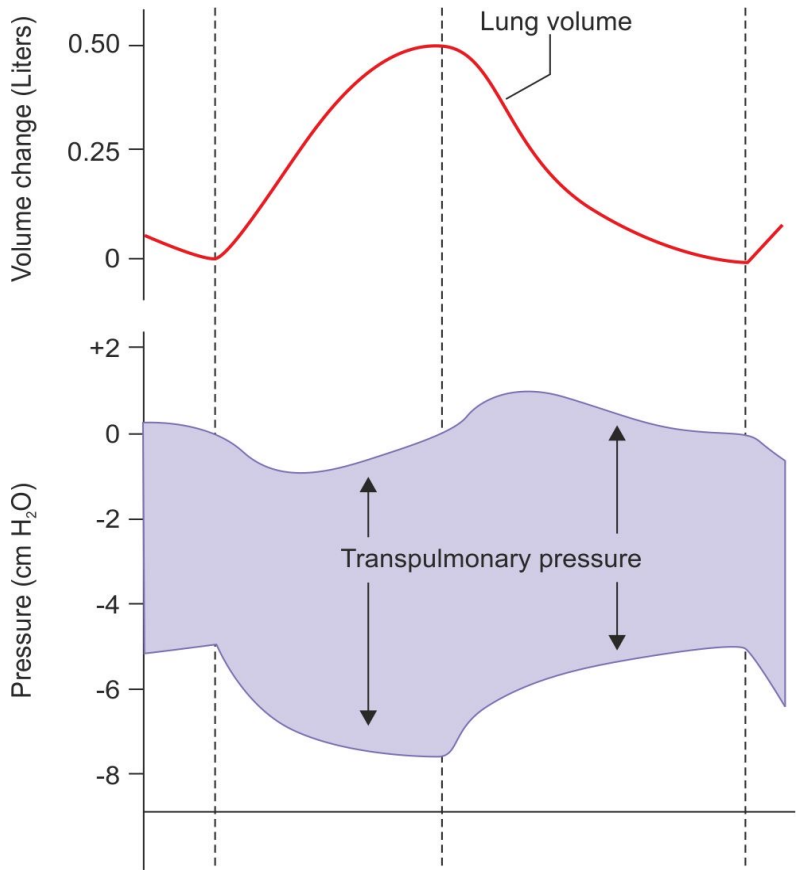




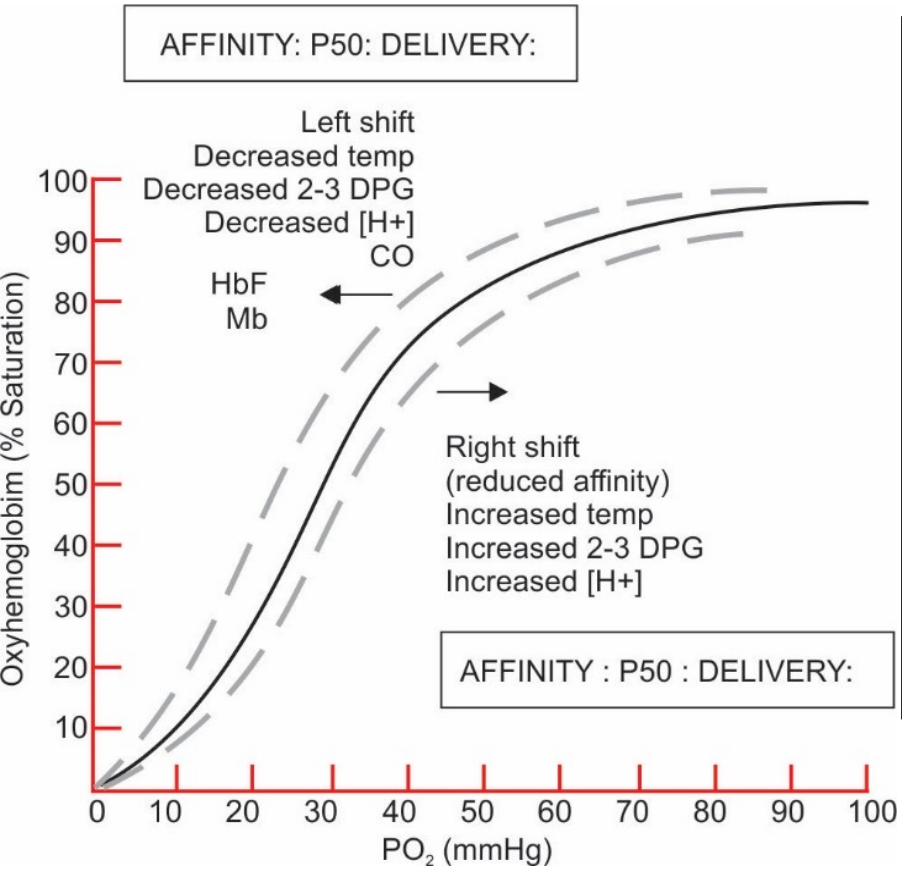
Low MIP / MEP:
High DLco:
Low Dlco with normal FEV1/FVC:

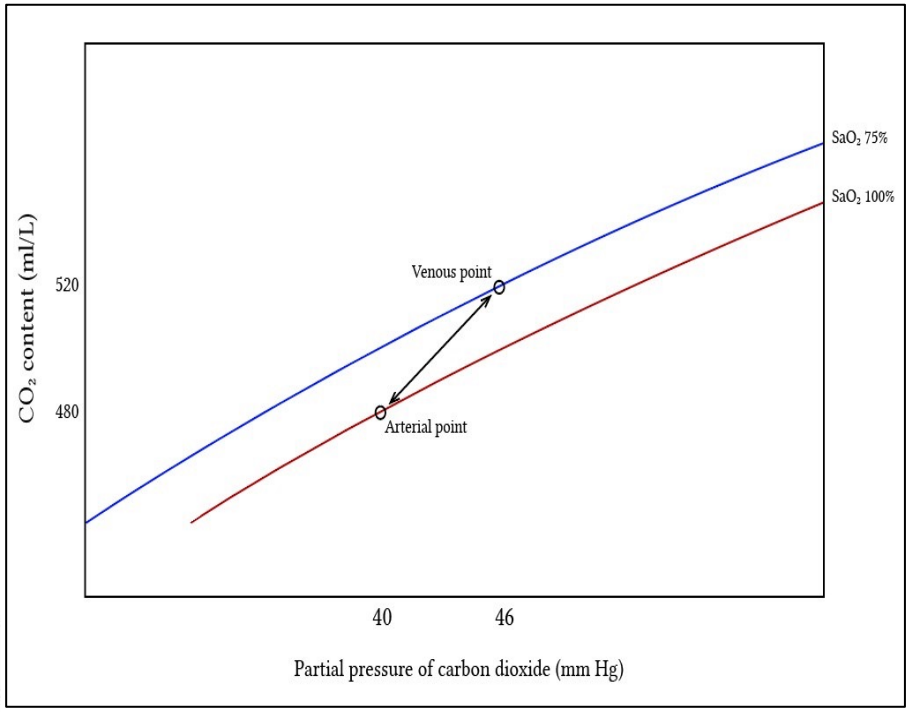
Respiratory physiology graphs

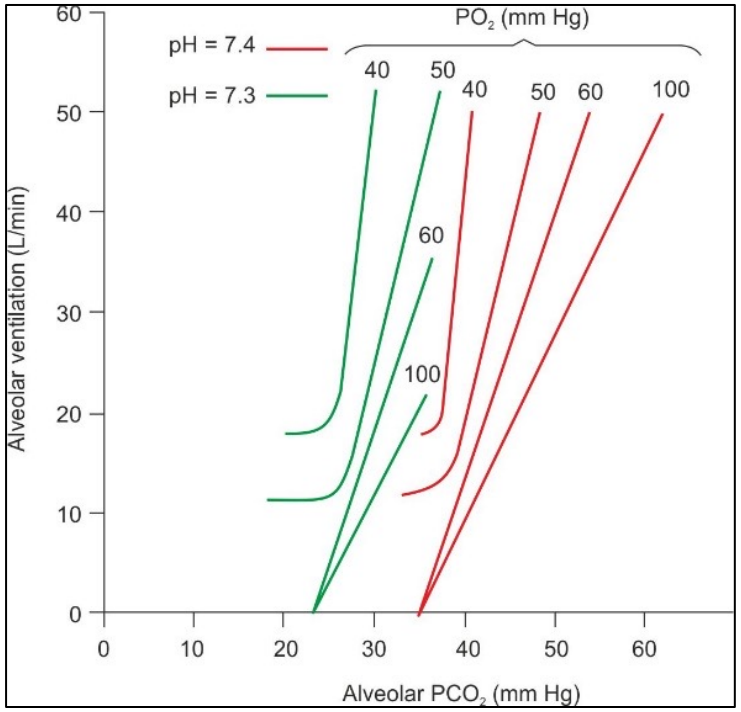




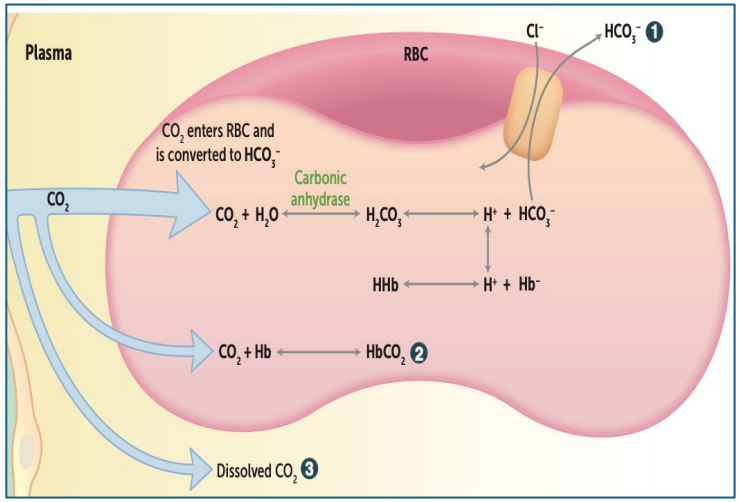
Closing volume (CV): lung volume where small airways in the lower lungs begin to close during expiration
Increased in:
Closing Capacity:

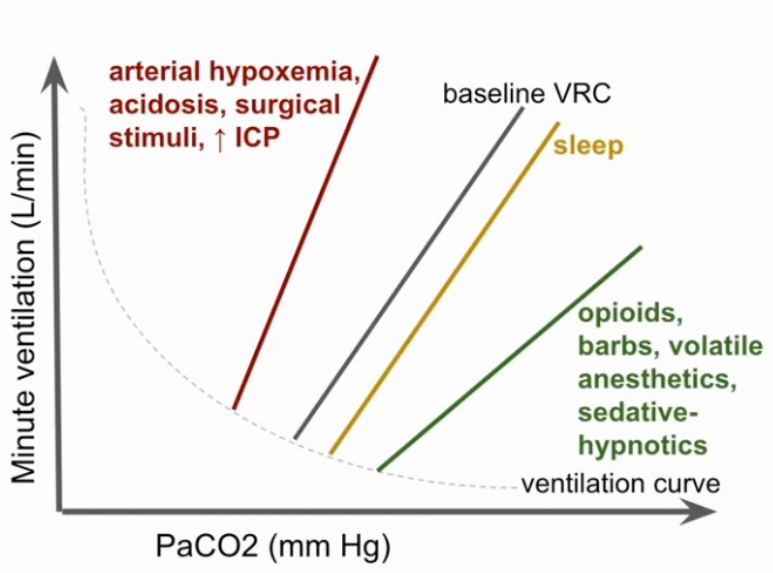




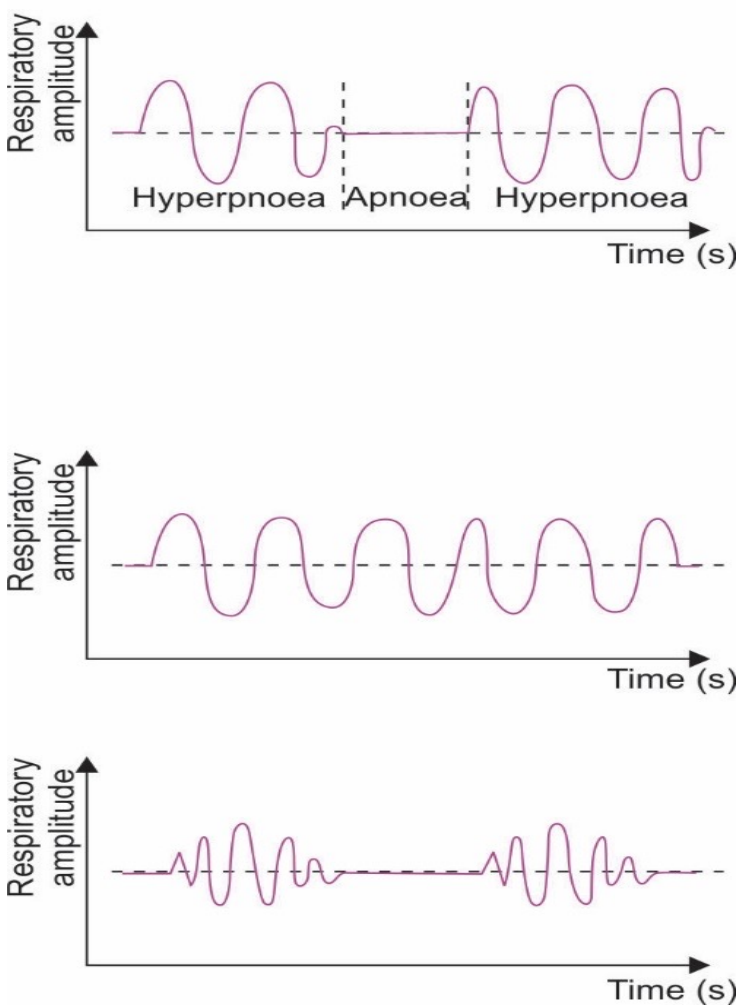


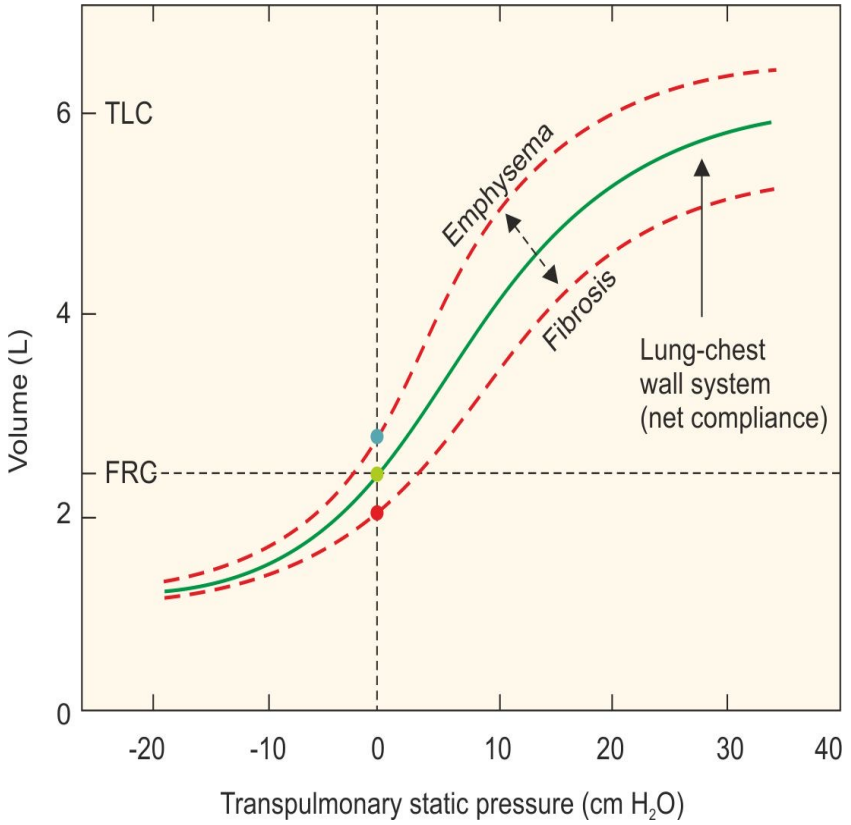
Shape:
Positive co-operativity
P50:
2,3 DPG binds to:



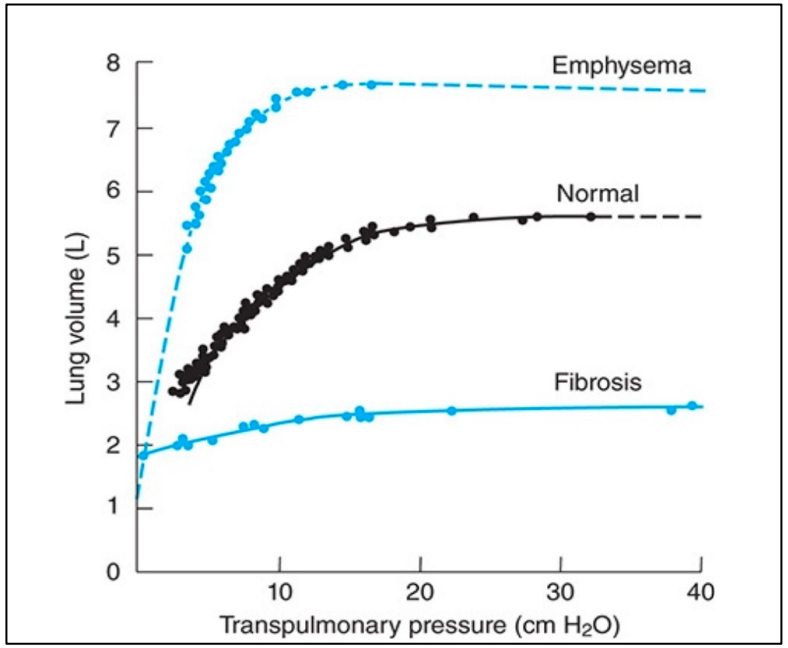


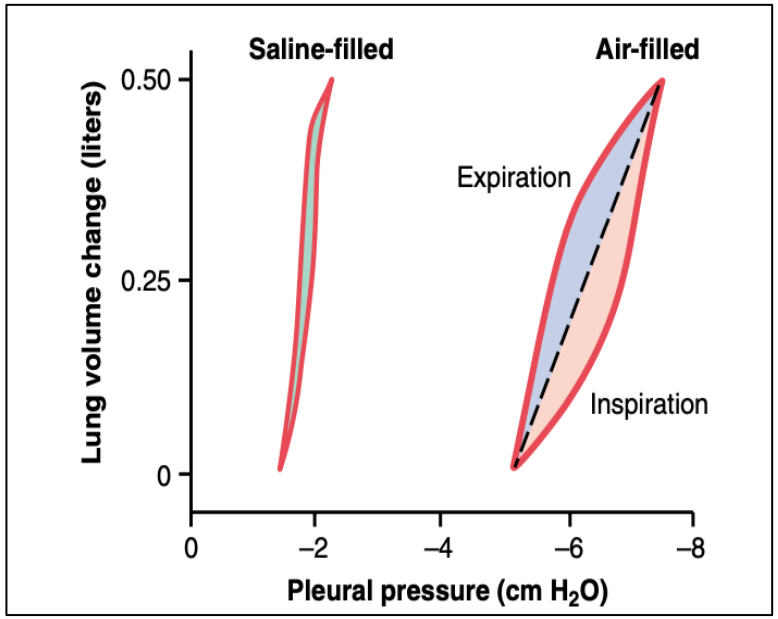
Partial pressure of carbon dioxide increases-Reduced affinity of O2

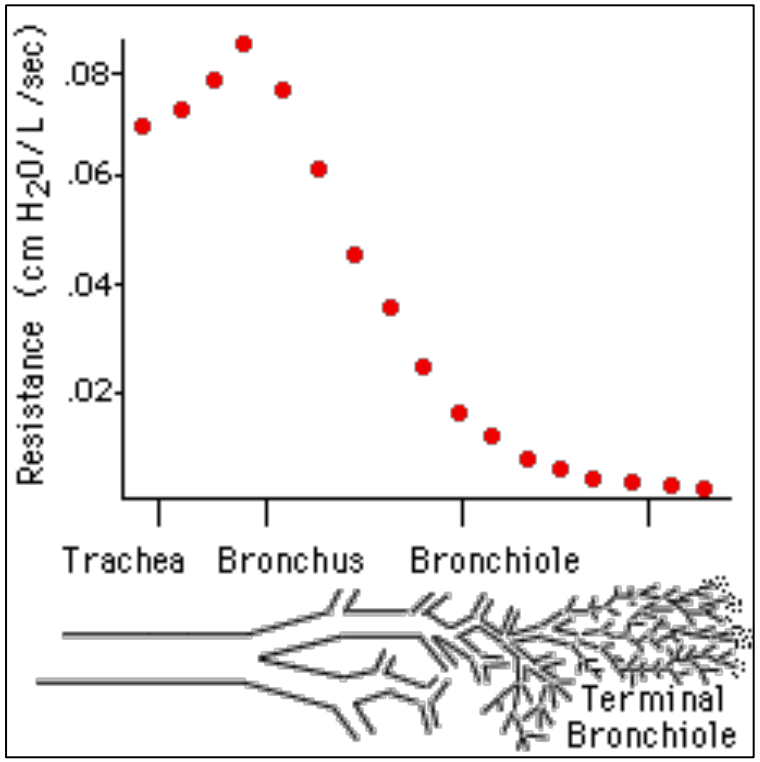


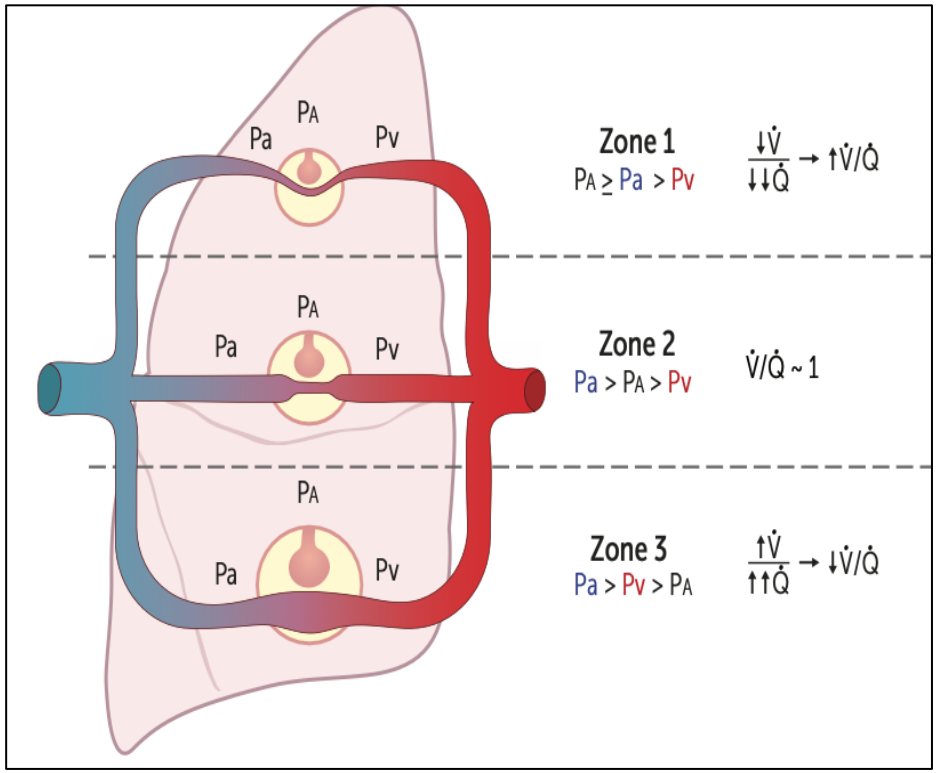


Surfactant: Compliance
Surface tension





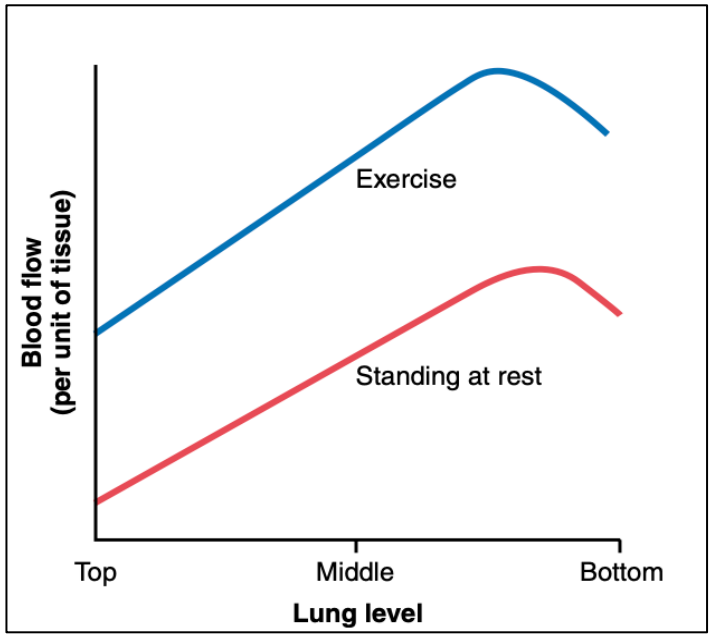


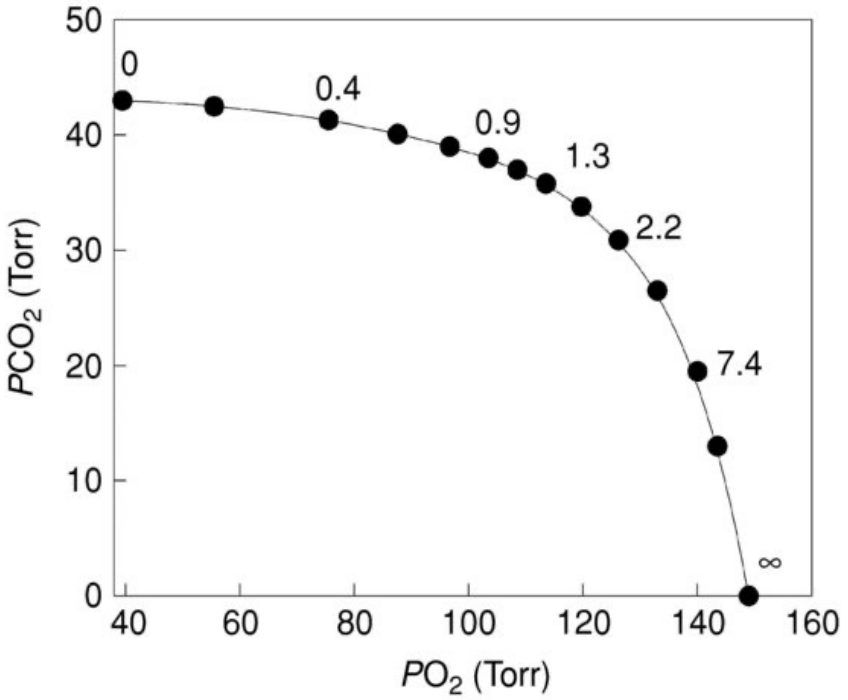


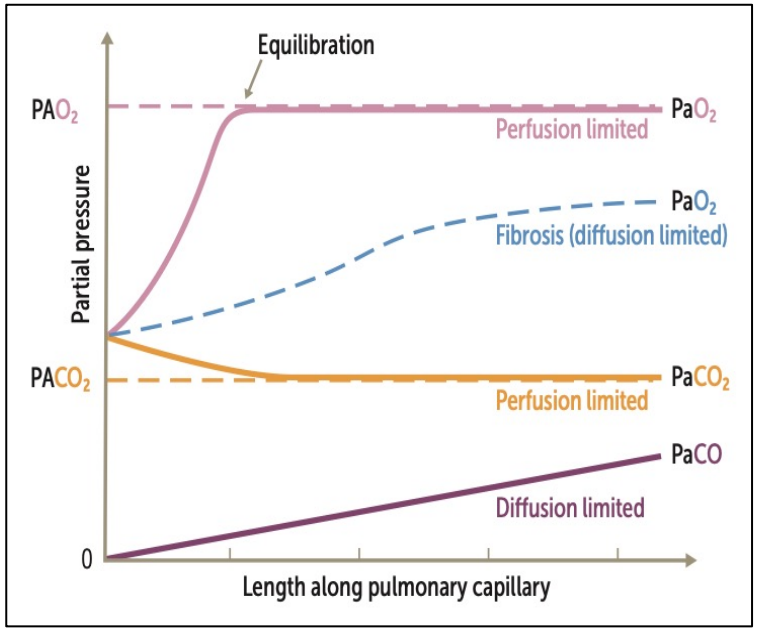
PPV / Hypovolemia: Zone 1

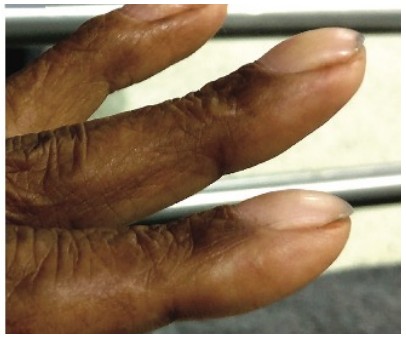
Exercise: Zone 3

Supine, exercise: V/Q matching









HYPOXIA

A–a gradient: Normal

↓ Inspired Oxygen Tension (P_iO_2)

$P_iO_2 = F_iO_2 \times (P^B - P^{H}{}_2O)$

Hypoventilation (↑ $PaCO_2$)

A–a gradient: Increased

Diffusion Limitation

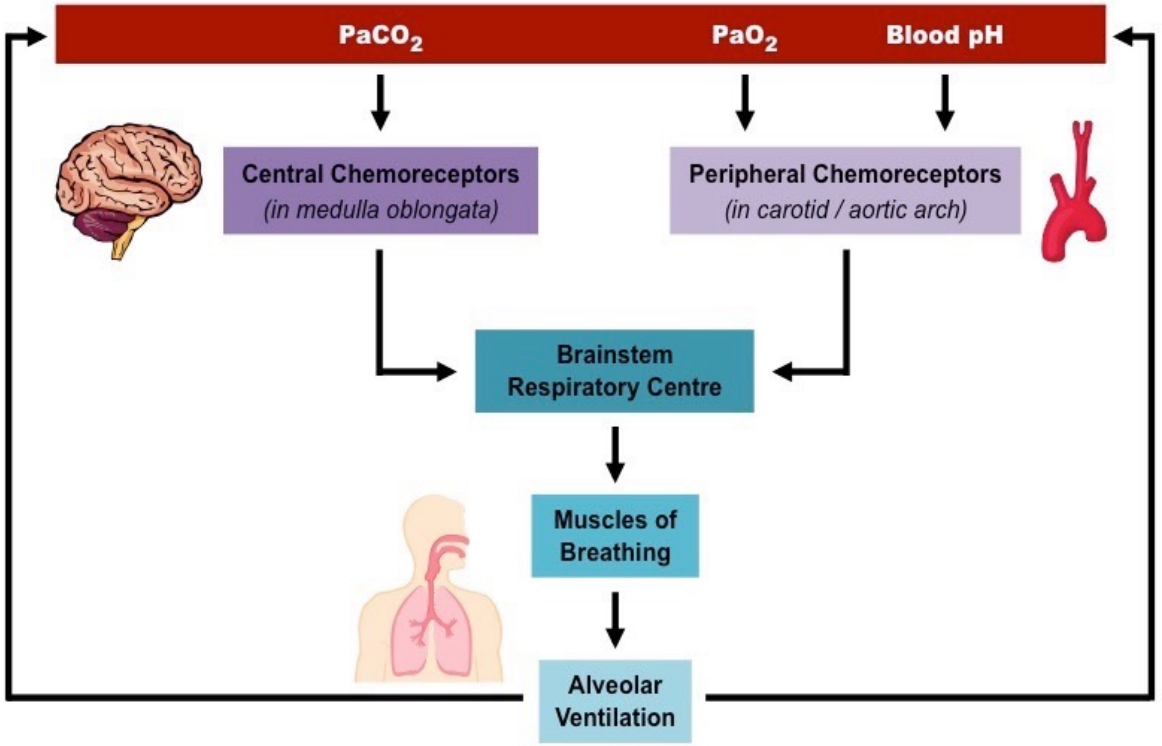
- Pulmonary fibrosis

V/Q Mismatch

- Pulmonary edema
- Pulmonary embolism

Right-to-Left Shunt

- Anatomic shunt (cardiac)
- Physiologic shunt (e.g., ARDS)
- Does not correct fully with 100% oxygen



Altitude physiology:
Acid-base:
Kidney compensation 48-72hrs
Rx of acute mountain sickness:

2,3BPG/ EPO/ VEGF:
PVR:
02 sensitive K channels (VS ATP-sn in systemic)
HAPE:
Rx:
HACE:
Rx :

LUNG REFLEXES
Hering–Breuer inflation reflex Prolonged inspiration (TV ≈ 1500 mL) -> Myelinated vagal fibres (slow-adapting)
Head's paradoxical reflex Prolonged inspiration ->
J reflex Raised capillary pressure -> Unmyelinated vagal C fibres

Space physiology
Positive G: VR/Cerebral perfusion
"Blackout"
Negative G VR/Cerebral perfusion
"Red eyes"

Decompression sickness / Caisson's disease

Bends/ chokes/ Hemoconcentration
Rx:

FORMULAE

MINUTE VENTILATION

ALVEOLAR VENTILATION

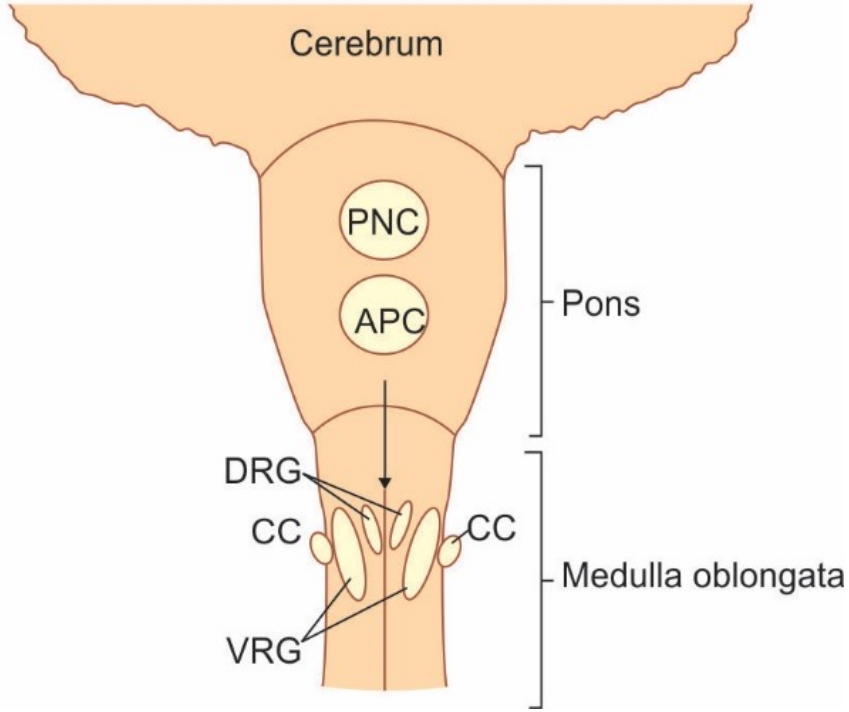
$$V_D = V_T \times \frac{PaCO_2 - PECO_2}{PaCO_2}$$

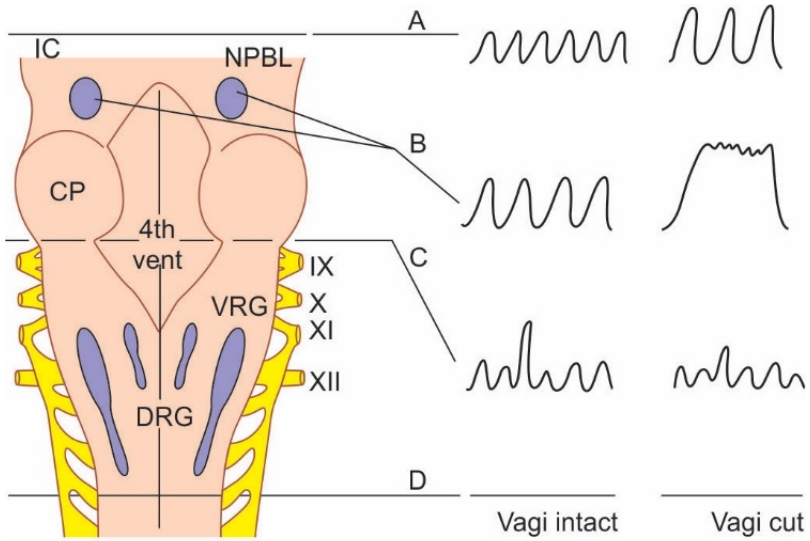
OXYGEN CARRYING CAPACITY OF BLOOD

C_aO_2 = Hb-bound O_2 + Dissolved O_2
$C_aO_2 = (O_2 \text{ carrying capacity} \times S_aO_2) + (P_aO_2 \times 0.0031)$

	Hb CONCENTRATION	Sao_2	Pao_2	TOTAL O_2 CONTENT
CO poisoning / MethHb				
Anaemia				
Polycythaemia				
Cyanide toxicity				

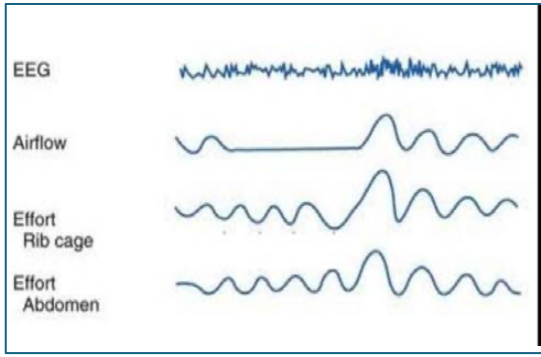
RESPIRATORY REGULATION





Transection	Effect
ABOVE PONS	X intact: X cut:
MID-PONS	X intact: X cut:
PONS-MEDULLA	
BELOW MEDULLA	

PaO2 normal during day



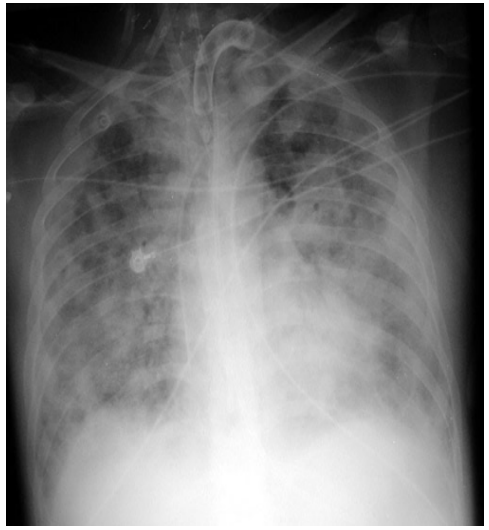
Obesity
Hypoventilation
PaCo2 high during day and night

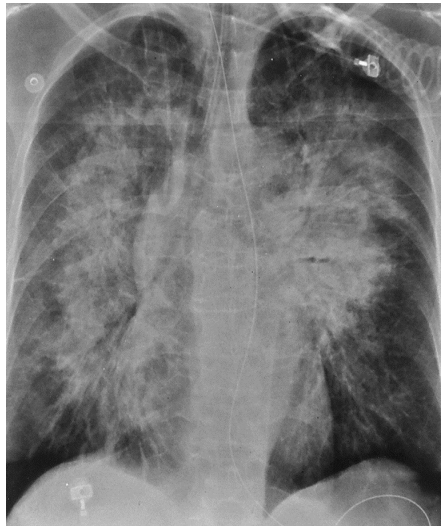
RESPIRATORY FAILURE

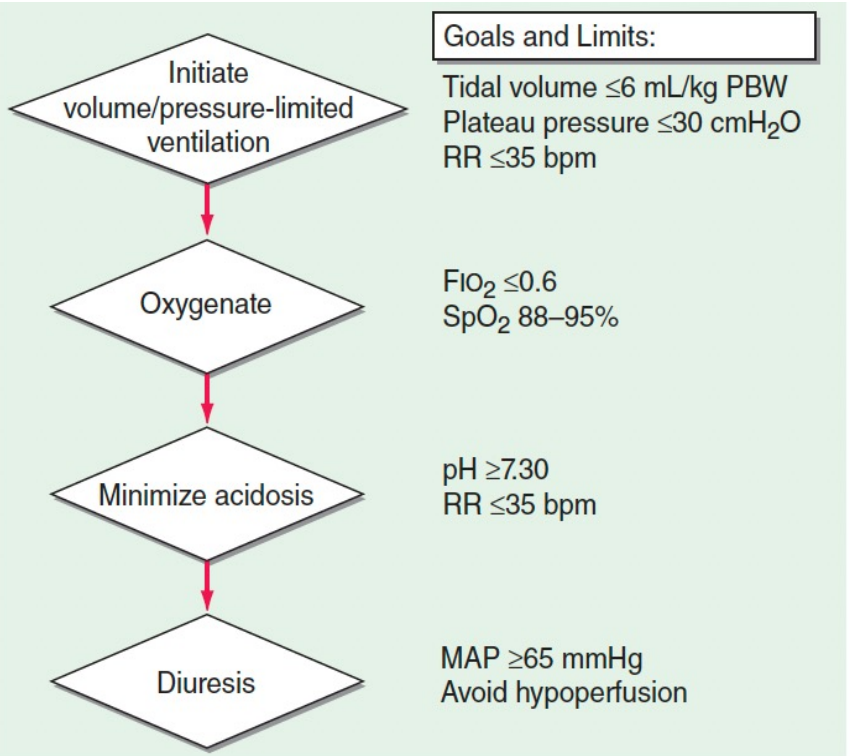
TYPE 1 HYPOXEMIC	TYPE 2 HYPERCAPNIC	TYPE 3: PERI-OPERATIVE	TYPE 4 SHOCK WITH HYPOPERFUSION

ARDS

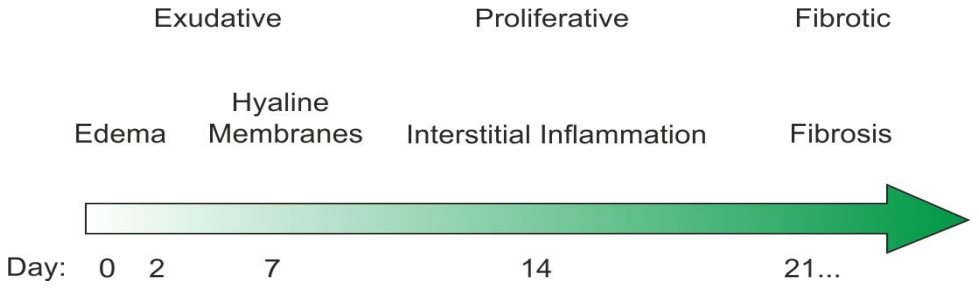
DIAGNOSTIC CITERIA FOR ARDS			
OXYGENATION **PA02/ FI02**	**ONSET**	**CHEST RADIOGRAPH**	**ABSENCE E OF LEFT ARTRIAL HYPERTENSION**
Mild: **Moderate:** **Severe:**	**Acute: within 1 week of clinical insult or new or worsening respiratory symptoms**	**Bilateral opacities consistent with pulmonary edema not fully explain by effusions, lobar/lung collapse or nodules**	







PRONE VENTILATION



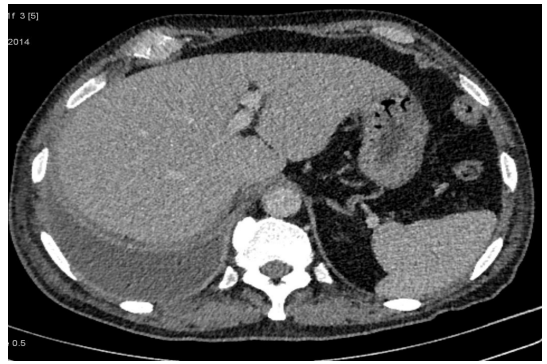
PLEURAL EFFUSION

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		

Low glucose:

High Amylase:

Indications of drainage of effusion:

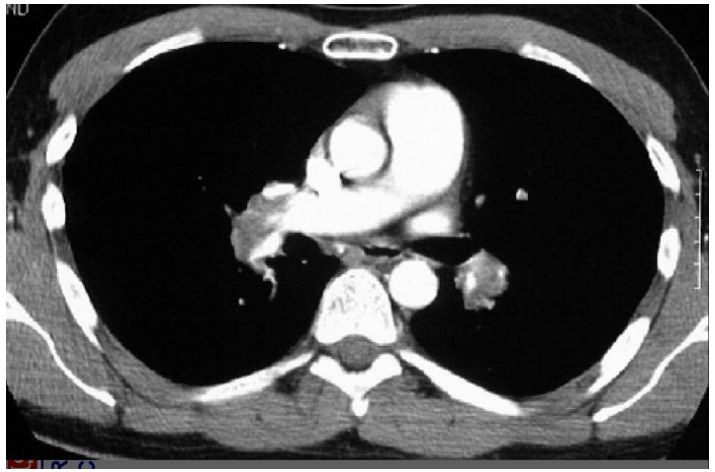


Pulmonary embolism

Virchow triad:

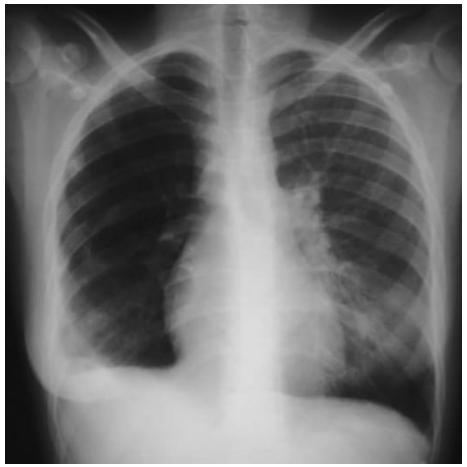
Diagnostic algorithm:

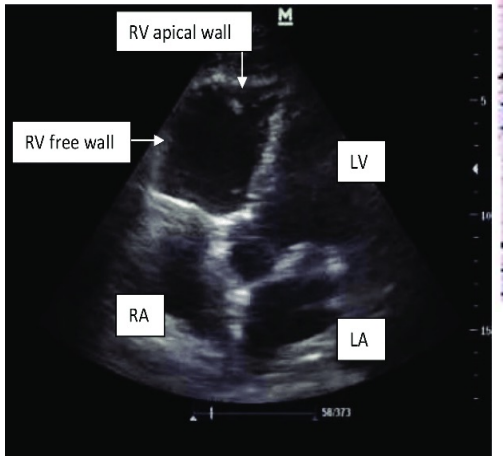
Clinical Variable	PE Score
C/F of DVT	3.0
Alternative diagnosis less likely than PE	3.0
Heart rate >100/min	1.5
Immobilization >3d; surgery within 4wks	1.5
Prior PE or DVT	1.5
Hemoptysis	1.0
Cancer	1.0

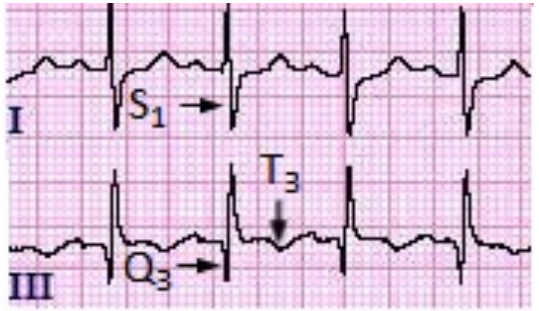


V/Q scan:

Treatment algorithm:

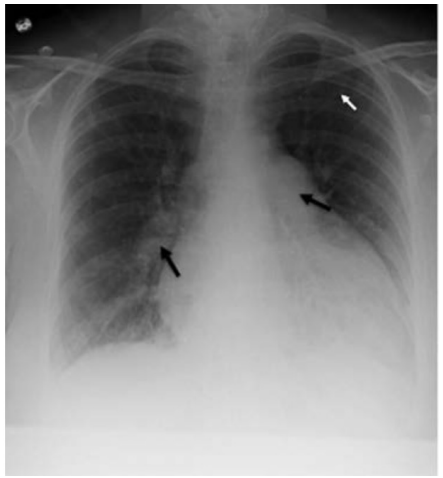


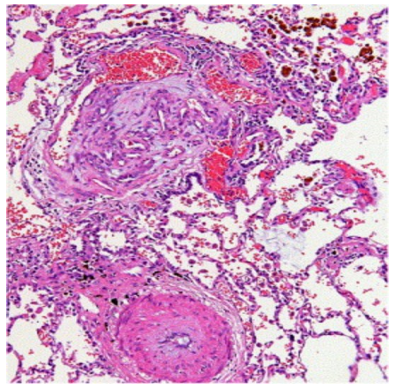


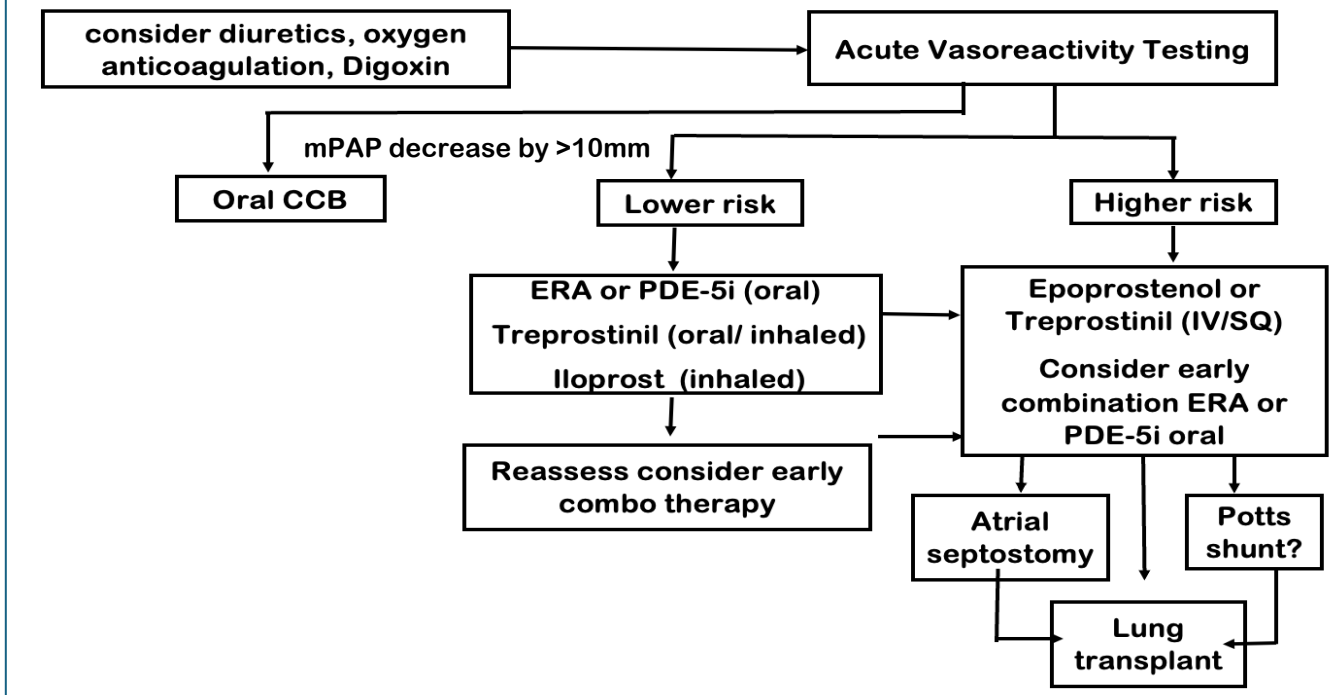


PAH

	DEFINITION:
GROUP	DANA-POINT CLASSIFICATION
1.	Idiopathic/ Hereditary: BMPR2 Associated with CREST/ HIV / Portal Hypertension/ Schistosomiasis/Eisenmenger
2.	Left heart disease (Post capillary)
3.	PAH owing to lung disease/ hypoxia
4.	Chronic thromboembolic pulmonary hypertension
5.	Sarcoid/ Glycogen storage D



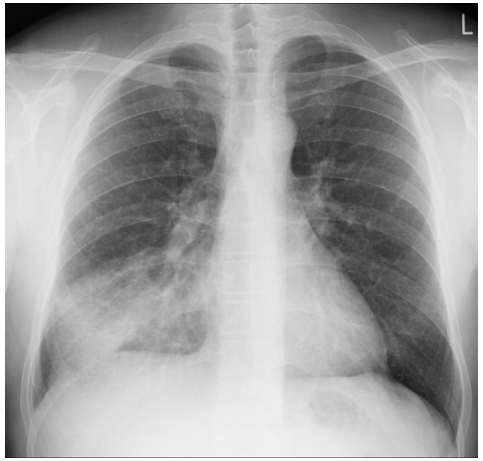


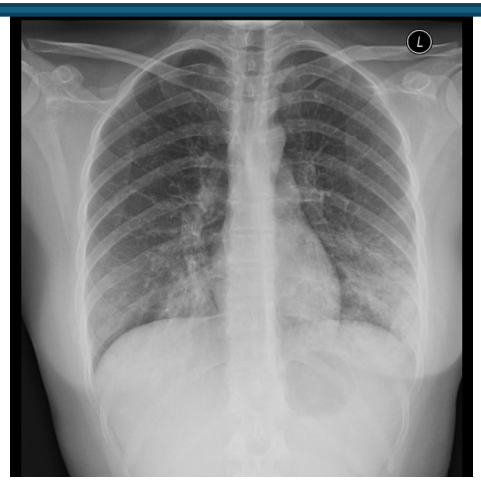


ERA: Bosentan, Macitentan, Ambrisentan
s/e:
PDE5i-: Sildenafil, Tadalafil
Guanylate cyclase +: Riociguat
Beraprost
Selexipag

Chest infections

MCC of typical CAP:
MCC of atypical CAP:
MCC of HAP (>48hrs of admission):
MCC of VAP (>48hrs of ventilation):





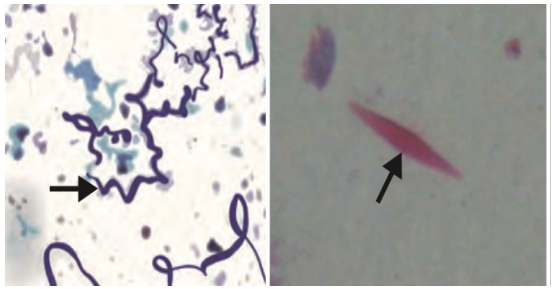
CURB-65 Scoring	
Confusion	1
Urea: BUN>19 mg/dL (>7 mmol/L)	1
Respiratory rate>30 breaths /min	1
Systolic BP <90 mm Hg or diastolic BP <60 mm Hg	1
Age> 65 years	1

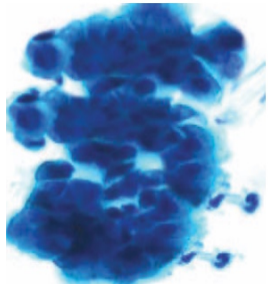
OP: 0-1	Amoxicillin +/- Macrolides / Doxycycline
IP: 2	FQ / BL+ Azithral/Doxy
ICU: 3-5	BL+ FQ/ Azithral

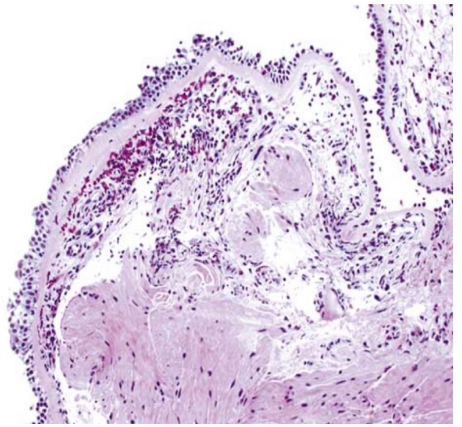
Aspiration:
- Supine position
- Lying on right side or prone
- Upright position

Asthma

- Airway hyper-responsiveness
- Variability-Diurnal PEFR
- Reversibility-Bronchodilator:
- Methacholine:
- Exercise:







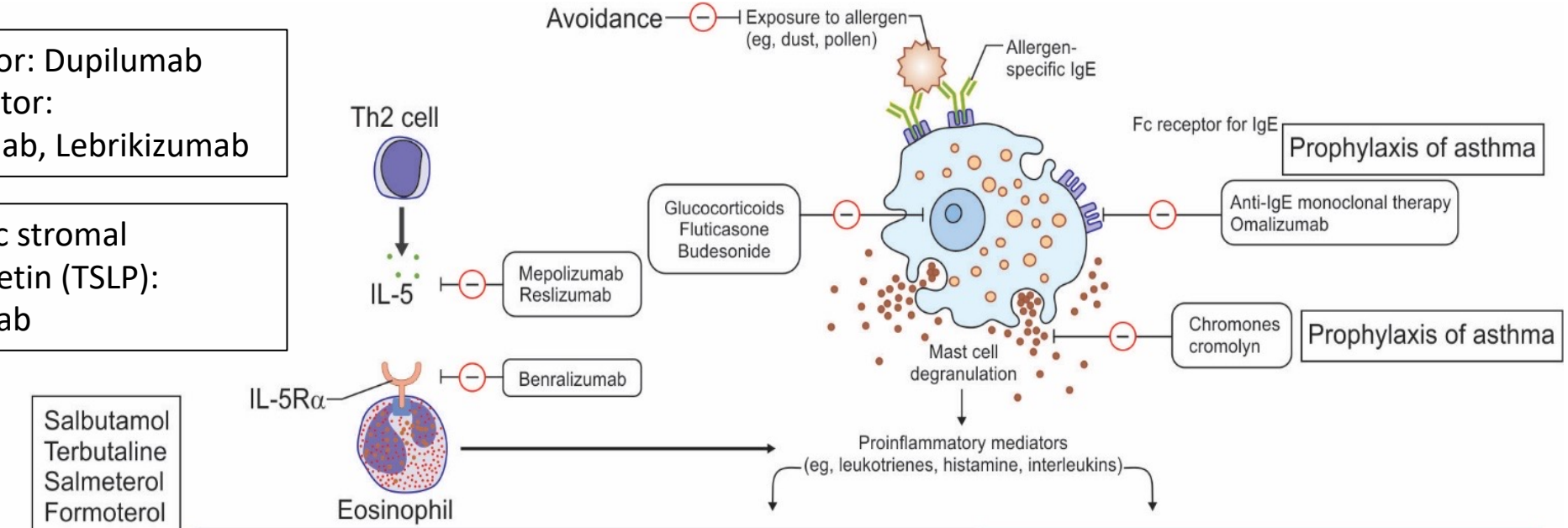
Step1,2: Symptoms <5d/week:
LD-ICS-Formoterol as needed
Step 3: Most days/ >1/week nighttime:
LD-ICS-Formoterol MART
Step 4: Low lung function:
MD-ICS-Formoterol
Step 5: Add LAMA + HD-ICS + Anti-IgE/IL5

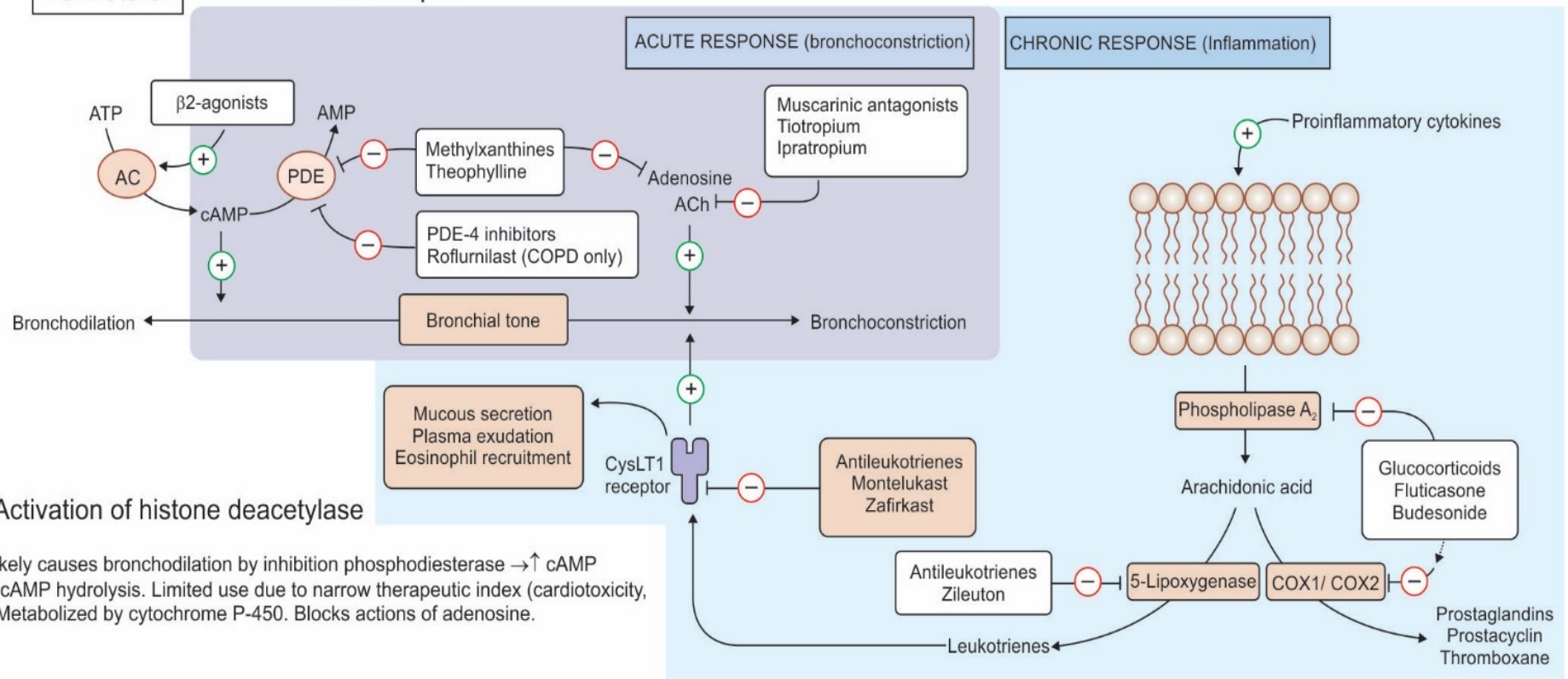
Rx of exacerbation of asthma
1.O2 (>94%)
2.Bronchodilatation: SABA ± SAMA
3.Corticosteroids (Systemic)
4.Adjuvant Therapy-IV Magnesium sulfate 1–2 g

<u>Severe Asthma</u>
PEFR ≤ 50%
Pulsus paradoxus
Unable to speak / complete sentences in one breath
<u>Signs of Impending Respiratory Arrest – PPV</u>
Silent chest
Bradycardia / hypotension/ Altered sensorium
Cyanosis
$PaCO_2$ >42mm

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

Anti-thymic stromal lymphopoietin (TSLP):
Tezepelumab



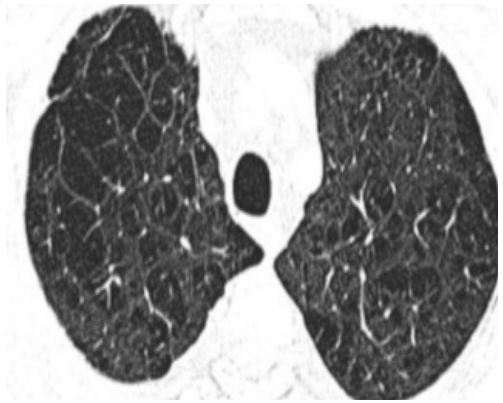


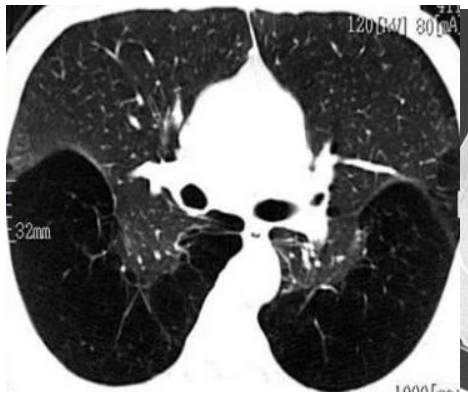
Theophylline–likely causes bronchodilation by inhibition phosphodiesterase →↑ cAMP levels due to ↓ cAMP hydrolysis. Limited use due to narrow therapeutic index (cardiotoxicity, neurotoxicity); Metabolized by cytochrome P-450. Blocks actions of adenosine.

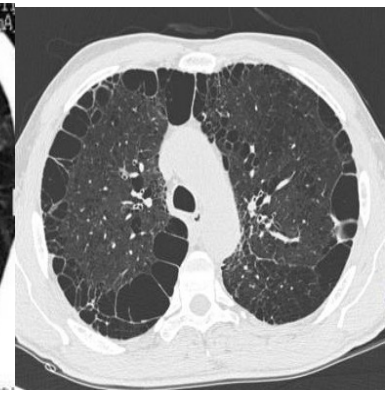
COPD

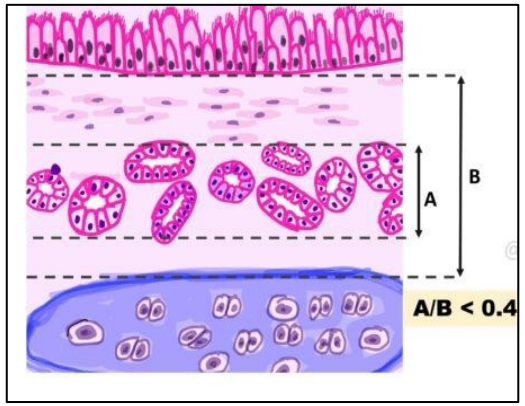
Chronic bronchitis:
Cough with sputum ≥ 3 months/yr for ≥ 2 years
Type 2 RF
Hypoxic Pulmonary VC-> PAH – cor pulmonale
BLUE BLOATERS
Reid index:

Emphysema
PINK puffers
Type 1 RF







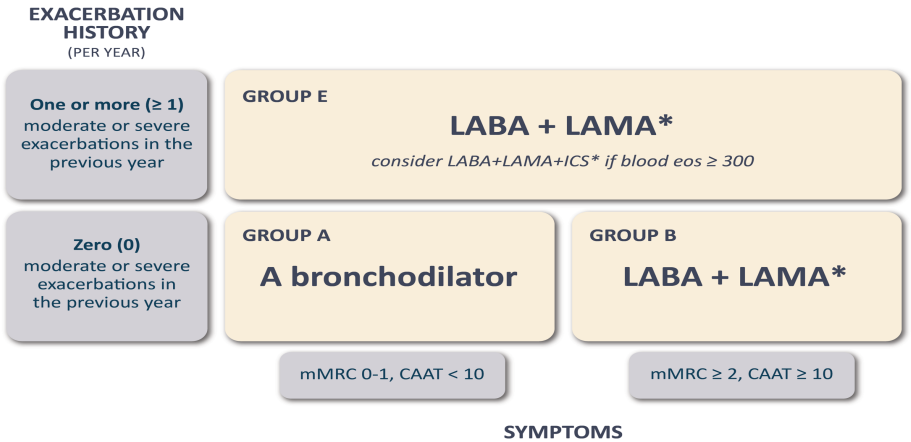


FEV_1 / FVC < 0.7
GOLD 1 – Mild
- $FEV_1 \geq 80\%$ predicted

GOLD 2 – Moderate
- $50\% \leq FEV_1 < 80\%$ predicted

GOLD 3 – Severe
- $30\% \leq FEV_1 < 50\%$ predicted

GOLD 4 – Very Severe
- $FEV_1 < 30\%$ predicted



Management of COPD: GOLD 25
- **Smoking cessation**
- **Long-term O2 - $PaO_2 \leq 55$ mmHg or $SpO_2 \leq 88\%$**
- **Acute Exacerbation: MCC:**
- **O2 + Antibiotics**
- **SAMA +/- SABA**
- **Steroids only for severe**

Modified MRC (mMRC) Dyspnea Scale

mMRC Grade 0-breathless with strenuous exercise

mMRC Grade 1-when hurrying on level ground or walking up a slight hill

mMRC Grade 2

•I walk slower than people of the same age on level ground because of breathlessness

•I have to stop for breath when walking at my own pace on level ground

mMRC Grade 3

•I stop for breath after walking about 100 meters or after a few minutes on level ground

mMRC Grade 4

•I am too breathless to leave the house

I am breathless when dressing or undressing

5 A's Strategy for Smoking Cessation

ASK

ADVISE

ASSESS

ASSIST

ARRANGE

BODE Index (Prognosis in COPD)

B – BMI $\leq$ 21

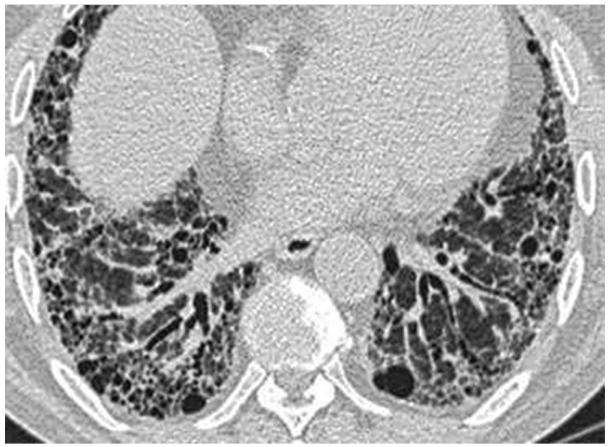
O – Obstruction-FEV_1 < 50% predicted

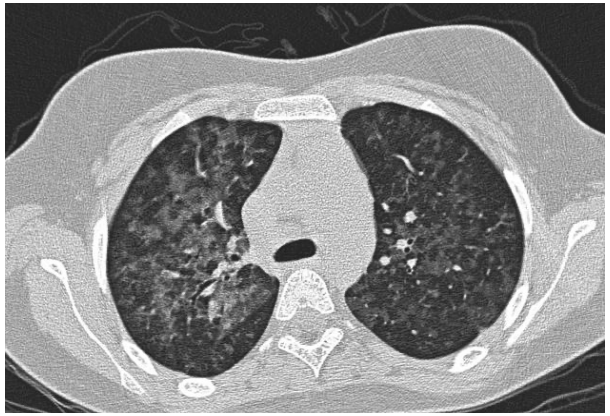
D – Dyspnea-mMRC $\geq$ 2

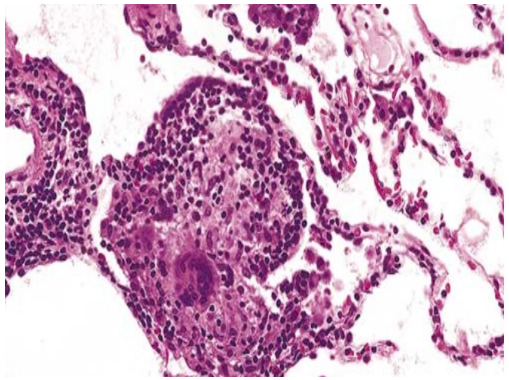
E – Exercise capacity 6-minute walk distance < 350m

ILD

Chronic Fibrosing
•Idiopathic pulmonary fibrosis (IPF)
•Non-specific interstitial pneumonia (NSIP)
ii. Smoking-Related
•Desquamative interstitial pneumonia (DIP)
•Respiratory bronchiolitis–associated ILD (RB-ILD)
•Pulmonary Langerhans cell histiocytosis
iv. Others
Lymphangioleiomyomatosis (LAM)
Cryptogenic organizing pneumonia (COP)
Hypersensitivity pneumonitis
MC:





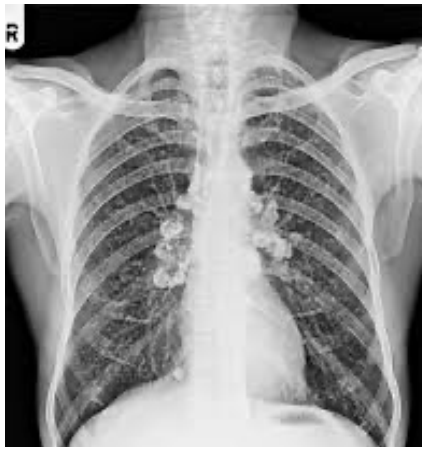


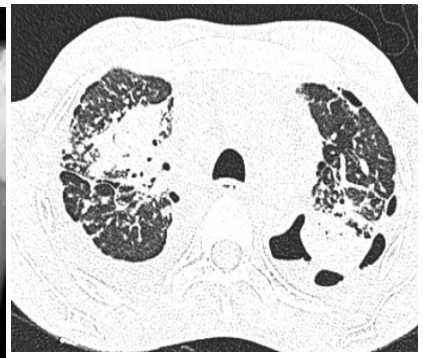
Upper Zone Predominance
•Sarcoidosis
•Silicosis, CWP
•Centrilobular emphysema
•Langerhans cell histiocytosis
•Hypersensitivity pneumonitis

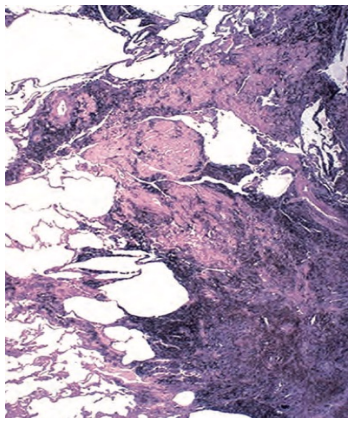
Lower Zone Predominance
•Panlobular emphysema
•UIP
•Asbestosis
•Pulmonary edema

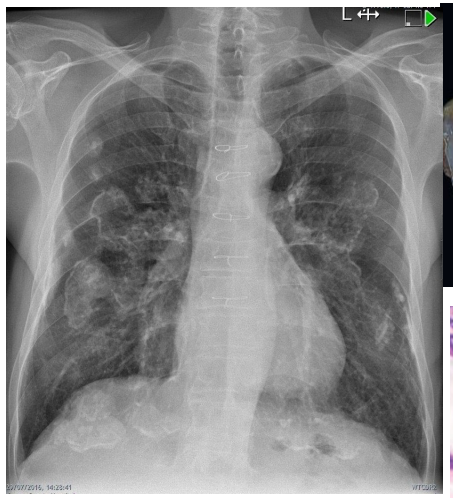
Pirfenidone:
Nintendanib:

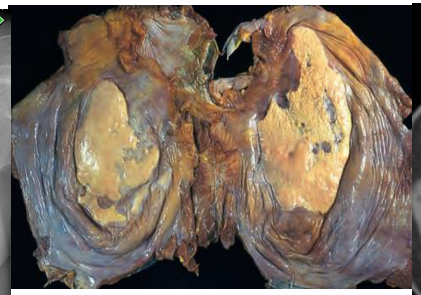
OCCUPATIONAL LUNG DISEASES

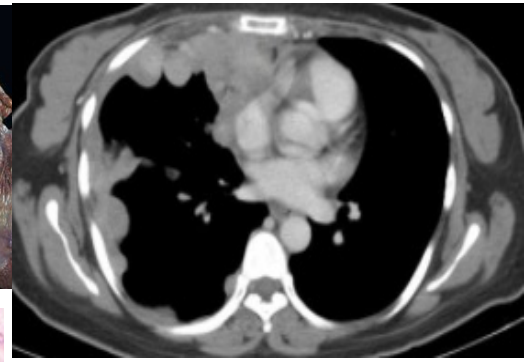


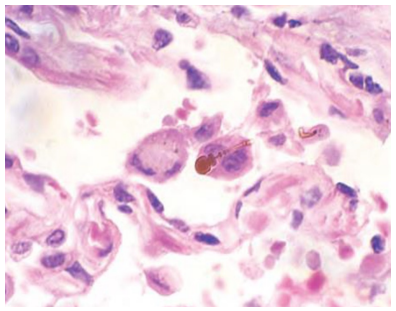








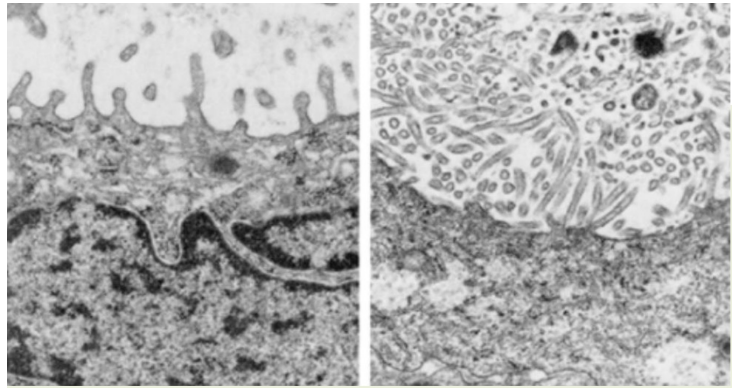




Caplan syndrome

Erasmus syndrome

Serpentine/ Crysolite
Amphibole/ Crocidolite

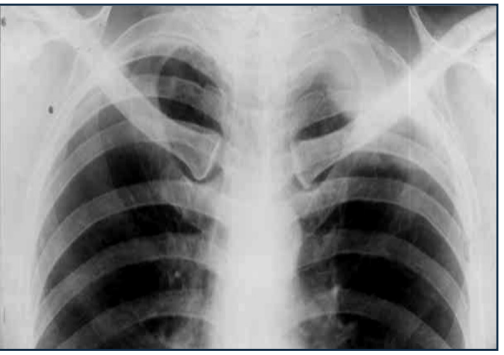


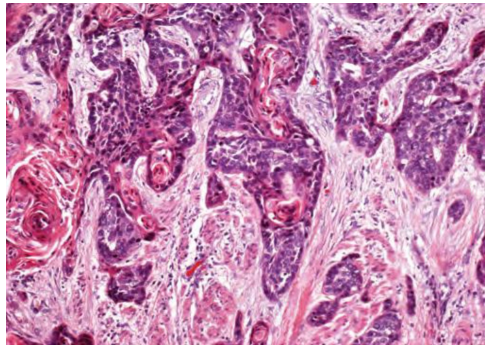
Jewellery /dental alloy
Granulomatosis
BeLPT

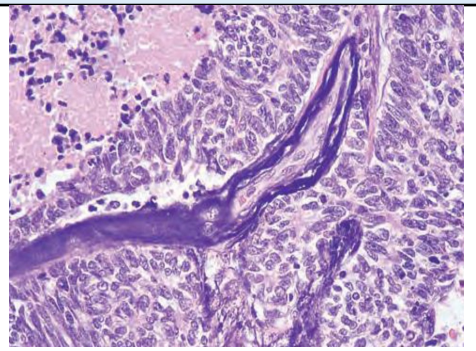
Diamond industry
Giant cell interstitial pneumonitis

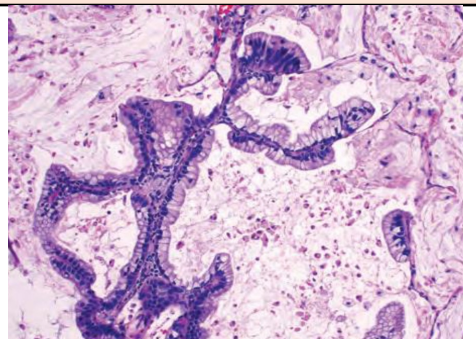
Carcinoma lung

	Squamous cell ca	Small cell ca	Adenoca	Large cell ca
Smoker?				
Location?				
GENES				
H/P				
IHC				
Paraneoplastic				









Stage	Criteria
T1	Tumor ≤ **3 cm**, surrounded by lung/visceral pleura or located in lobar/peripheral bronchus
T2	Tumor **3-5cm** OR invasion of **main bronchus (not carina)** OR **visceral pleura invasion** OR **crossing fissure into adjacent lobe**
T3	Tumor **5-7cm** OR invasion of **parietal pleura, chest wall, pericardium, phrenic nerve, azygos vein, thoracic nerve roots (T1–T2), stellate ganglion**
	Separate tumor nodules in same lobe
T4	Tumor **>7 cm** OR invasion of **mediastinum, thymus, trachea, carina, recurrent laryngeal nerve, vagus nerve, esophagus, diaphragm**
	Invasion of **heart, great vessels, intrapericardial pulmonary arteries/veins, supra-aortic arteries, brachiocephalic veins, subclavian vessels, vertebral body, lamina, spinal canal, cervical nerve roots, brachial plexus**
	Separate tumor nodules in different ipsilateral lobe

Stage	Criteria
N1	Metastasis in **ipsilateral peribronchial and/or ipsilateral hilar nodes** and **intrapulmonary nodes**, including direct extension
N2	Metastasis in **ipsilateral mediastinal or subcarinal nodes**
N3	Metastasis in **contralateral mediastinal/hilar nodes** OR **ipsilateral/contralateral scalene or supraclavicular nodes**

M1a	Pleural or pericardial nodules OR **malignant pleural/pericardial effusion** OR **separate tumor nodule(s) in contralateral lobe**

Miscellaneous

Screening :
Age 50-80 years
≥ 20 pack years

Haemoptysis
Massive:
MCC:
1st step:
Unstable:
Diagnostic approach:

Antitussive

First-Generation H_1 Antihistamines

Diphenhydramine, Dimenhydrinate, Chlorpheniramine, Doxylamine

Second-Generation H_1 Antihistamines

Loratadine, Fexofenadine, Desloratadine, Cetirizine

Dextromethorphan

Antagonizes NMDA glutamate/ Synthetic codeine analogue
May cause serotonin syndrome

Mucolytic

N-acetyl cysteine, ambroxol/ bromhexine