PRESENTING OUR

GKTEACH

STAGE 1 SERIES

MSA Education

~~FMS - CELL BIOLOGY AND SIGNALLING~~	~~MONDAY 13TH NOV 6PM~~
~~FMS - MOLECULAR AND CELL GENETICS~~	~~THURSDAY 16TH NOV 6PM~~
~~FMS - NUTRITION AND METABOLISM~~	~~TUESDAY 21ST NOV 6PM~~
~~ANATOMY OF RESPIRATORY AND CARDIOVASCULAR SYSTEMS~~	~~WEDNESDAY 29TH NOV 13:30PM~~
~~PHYSIOLOGY OF RESPIRATORY AND CARDIOVASCULAR SYSTEMS~~	~~WEDNESDAY 29TH NOV 4PM~~
~~FPP - PHARMACOLOGY~~	~~MONDAY 4TH DEC 6PM~~
RESPIRATORY PHYSIOLOGY	MONDAY 11TH DEC 6PM
RESPIRATORY ANATOMY	THURSDAY 14TH DEC 6PM

MAKE SURE TO COME ALONG!

PCRS Resp Physiology

Yathavi Charavanamuttu - Year 2

MSA Education Officer

GKTeach Stage 1 - December 2023

Restrictive or Obstructive?

- Emphysema
- COPD
- Lung fibrosis
- Asthma
- Respiratory muscle weakness

What are we covering?

We will be focusing on: **Lung Mechanics 1 + 2**

We will NOT be covering: V/Q mismatch, alveolar and gas 1 and 2

(except DLCO because I found that super confusing in first year!)

But feel free to ask questions about any of these topics at the end!

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The basics - muscles in inspiration and expiration

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inspiration

- diaphragm contracts
- ↑ chest vol
- ↓ pressure

QUIET BREATHING
- diaphragm contracts

FORCED
- pec. major
- scalene
- sternocleidomastoid

expiration

- diaphragm relaxes
- ↓ chest vol
- ↑ pressure

- diaphragm relaxes + passive recoil

- abdominals
- internal intercostals

Transmural pressures

Transmural pressures

- **Transpulmonary pressure = alveolar pressure - Intrapleural pressure**
- Trans chest wall pressure = Intrapleural pressure - barometric pressure
- Trans total system pressure = alveolar pressure - barometric pressure

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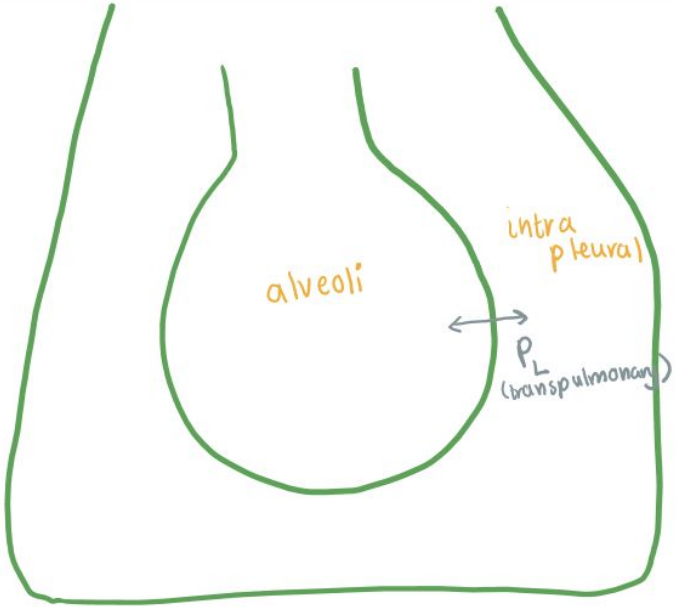
transpulmonary pressure



- Inward alveolar recoil
- Outward recoil of chest wall

- transpulmonary pressure (PL) drives inflation of lungs
  - Negative intrapleural pressure

diagram shows transpulmonary pressure

! inside − outside = ΔP

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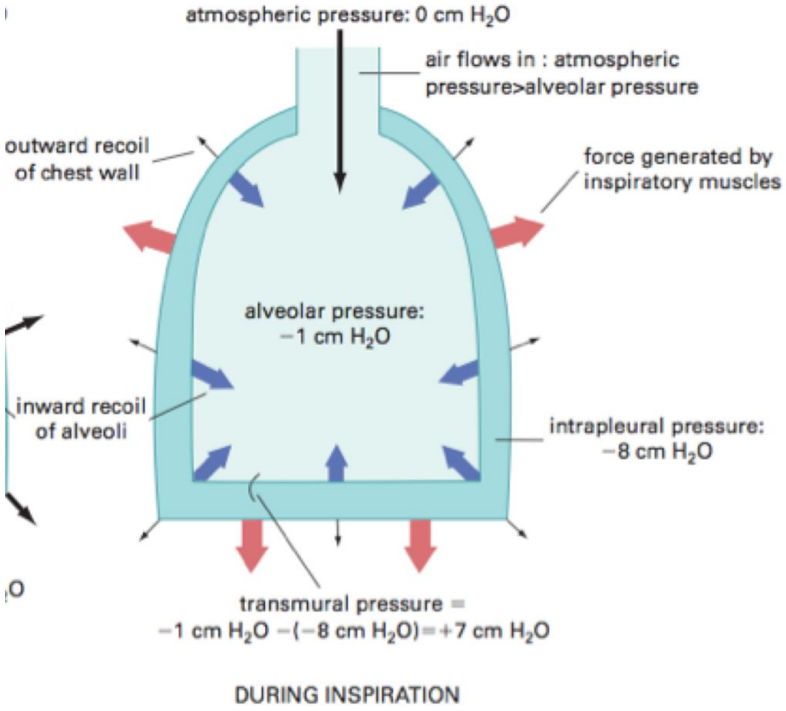


- More negative intrapulmonary pressure + surface tension causes inflation
  - = decreased alveolar pressure = air flows in
- Negative intrapleural pressure opposes elastic recoil = prevents lungs collapsing

Which of the following would be seen in a pneumothorax?

A more negative intrapleural pressure

B intrapleural pressure = atmospheric pressure

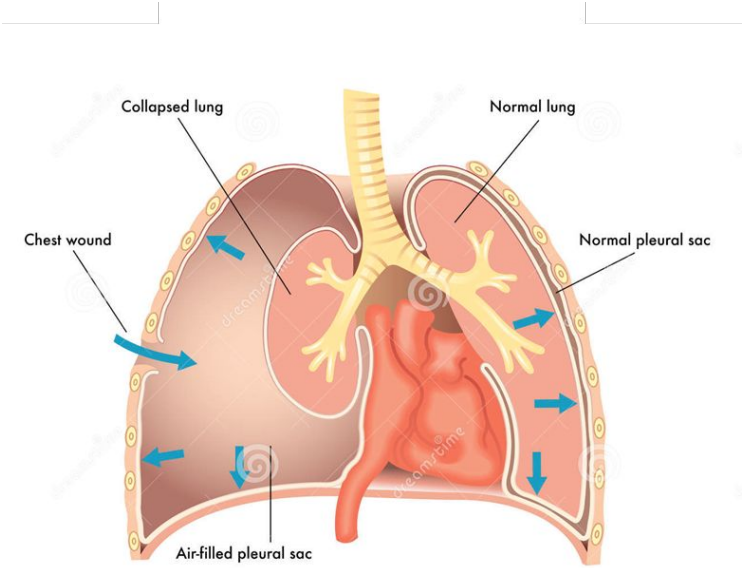
C atmospheric pressure increases

D alveolar recoil increases

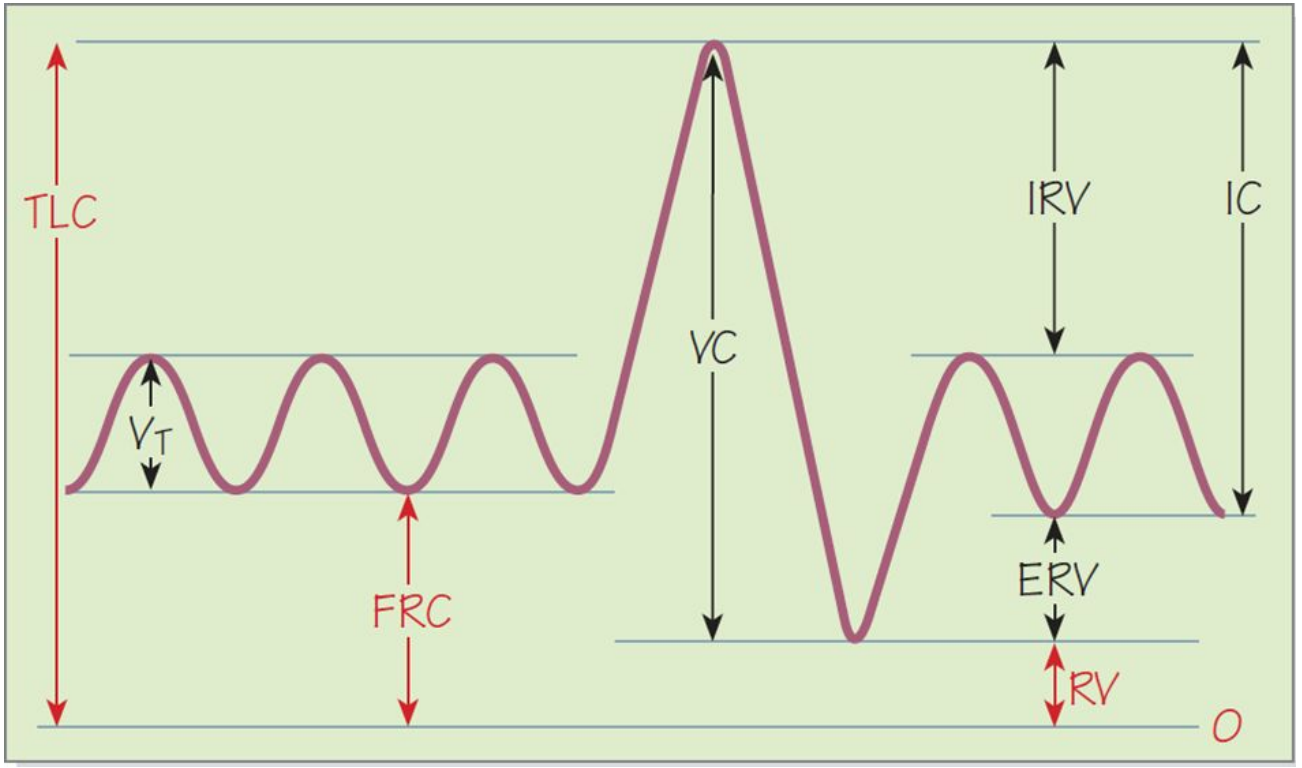
E chest wall compresses

B) intrapleural pressure = atmospheric pressure

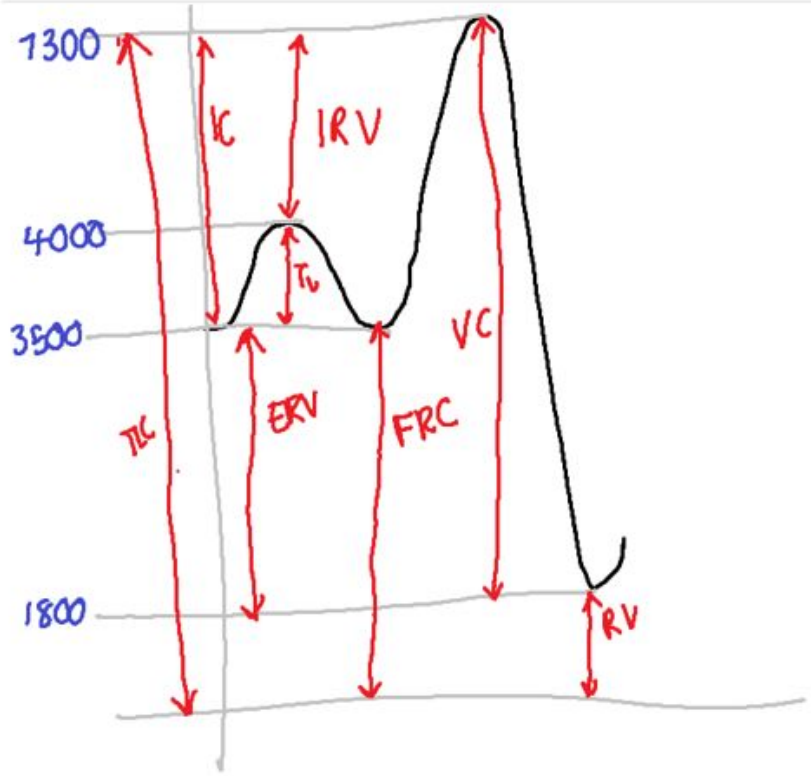
- Air is sucked into pleural space until pressure equilibrates
  - Leads to collapsed lung
  - Caused by inward elastic recoil
  - Chest wall will expand due to outward recoil
    - Not opposed by inward elastic recoil



Lung volumes



how i remembered the typical volumes



Tidal volume (V_T) rest	500 mL
Vital capacity (VC)	5500 mL
Inspiratory reserve volume (IRV)	3300 mL
Expiratory reserve volume (ERV)	1700 mL
Inspiratory capacity (IC)	3800 mL
Total lung capacity (TLC)	7300 mL
Functional residual capacity (FRC)	3500 mL
Residual volume (RV)	1800 mL

Resistance and flow

Formulas for ventilation

Minute ventilation = breathing rate x tidal volume

Physiological dead space = anatomical dead space + alveolar dead space

Alveolar ventilation = minute ventilation - dead space ventilation

Formulas for resistance and flow

$$\text{Flow} = \Delta P / R$$

$$R = \frac{8VL}{\pi r^4} \quad \text{Poiseuille's Law}$$

$$\text{Flow} = \frac{(P_1 - P_2)}{R} = \frac{(P_1 - P_2)\,\pi r^4}{8VL}$$

Which of the below has the greatest RAW?

A bronchioles

B trachea

C medium bronchi

D small bronchi

E alveoli

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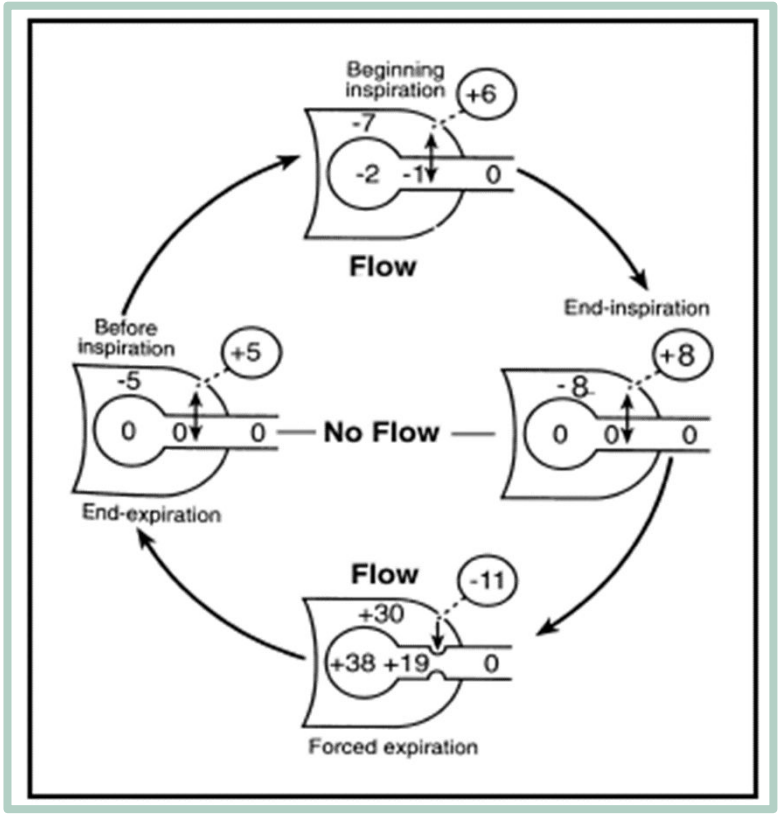
C) medium bronchi

- Medium-sized bronchi (gen 3-5) = most contribution to RAW
  - Smaller airways have higher individual resistance
  - But are in parallel so less overall

What happens in high RAW?

- Slow expiration
  - Air trapping
    - airways collapse
      - Because greater force applied to expire against higher resistance
  - Expiratory wheezes

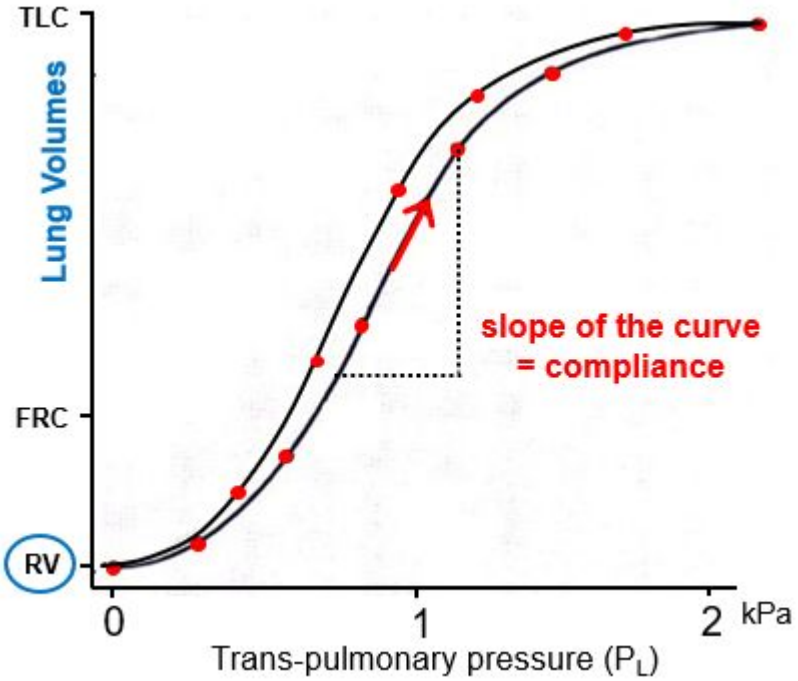


Static pressure volume loops

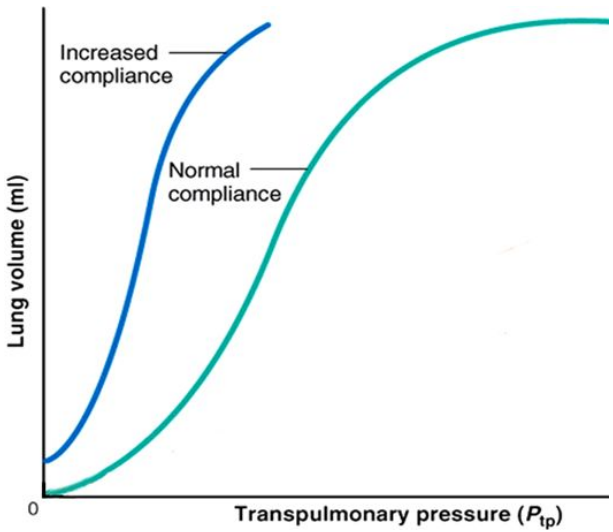
Compliance is highest around the normal tidal volume

Lung compliance calculated as:

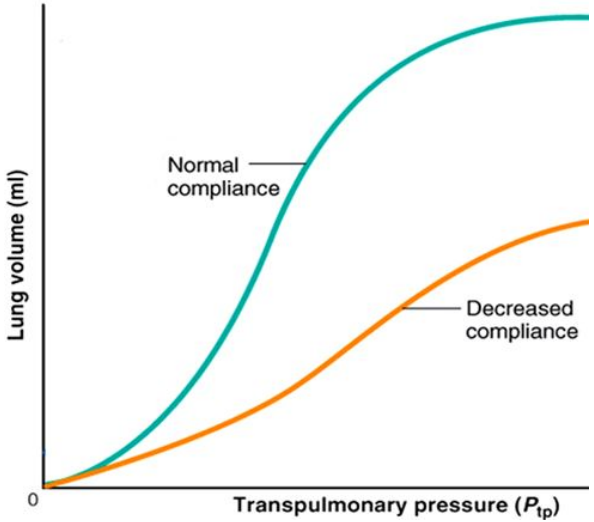
$$\frac{\text{change in lung volume}}{\text{change in trans-pulmonary pressure}}$$



emphysema



lung fibrosis



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Restrictive and Obstructive

How do you define obstructive and restrictive diseases?

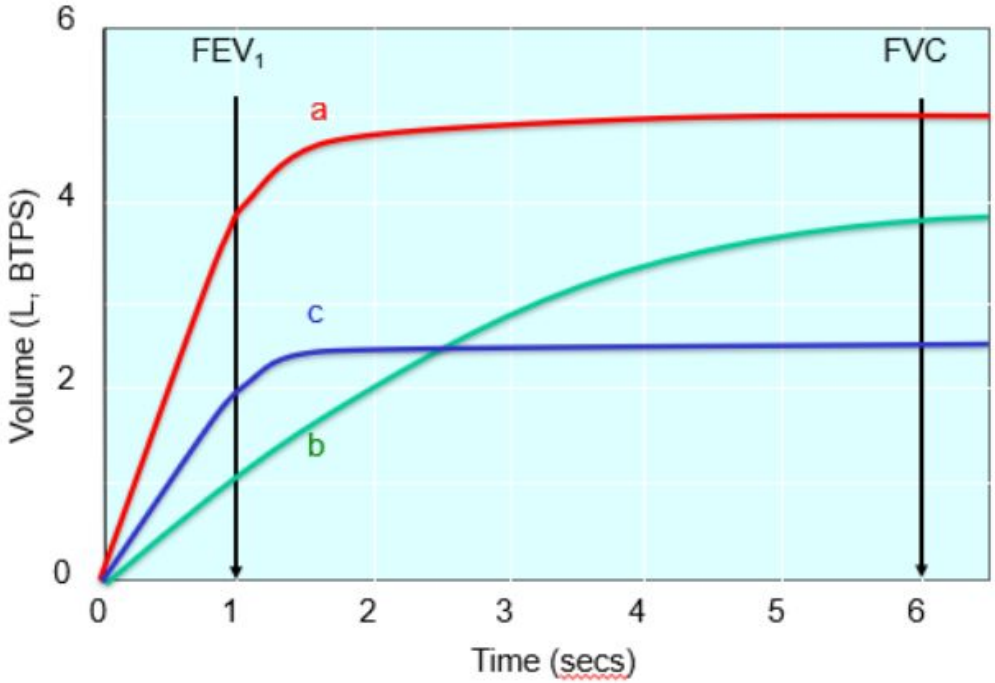
restrictive

- Decreased FEV1 and FVC
- Normal FEV1/FVC ratio

obstructive

- Decreased FVC and VERY decreased FEV1
- Decreased FEV1/FVC ratio (< 0.7)

restrictive or obstructive?



BTPS – body temperature and pressure saturated

Examples of obstructive and restrictive diseases

obstructive

- asthma
  - ↳ reversible
- COPD
  - emphysema
  - chronic bronchitis

restrictive

- lung fibrosis
- NMD / resp muscle weakness

A patient presents to clinic with a chronic cough and shortness of breath. Their FEV1/FVC ratio = 0.6. They are prescribed Salbutamol. What is the mechanism of this drug?

A steroid

B beta 2 receptor agonist

C beta 1 receptor agonist

D beta 2 receptor antagonist

E beta 1 receptor antagonist

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B) beta 2 receptor agonist

A patient presents to clinic with a chronic cough and shortness of breath. Their FEV1/FVC ratio = 0.6. The patient is given salbutamol before having another spirometry reading. Their FEV1, FVC, and FEV1/FVC ratio does not improve. What is the most likely cause of their symptoms?

A lung fibrosis

B poorly managed asthma

C COPD

D pneumonia

E pneumothroax

C) COPD

- The condition is chronic and obstructive
  - Obstructive as FEV1/FVC <0.7
  - Chronic, as explained by the chronic cough (symptom)
- There was no marked improvement on giving salbutamol
  - Meaning that it is not reversible
- Therefore that leaves us with COPD being the most likely cuase

DLCO

$$VO_2 = D_LO_2 \times (P_nO_2 - P_cO_2)$$

- VO_2: rate of O_2 uptake into blood
- D_LO_2: area + thickness (how easy to diffuse across membrane)
- $(P_nO_2 - P_cO_2)$: difference in O_2 between alveoli + capillary (diffusion gradient)

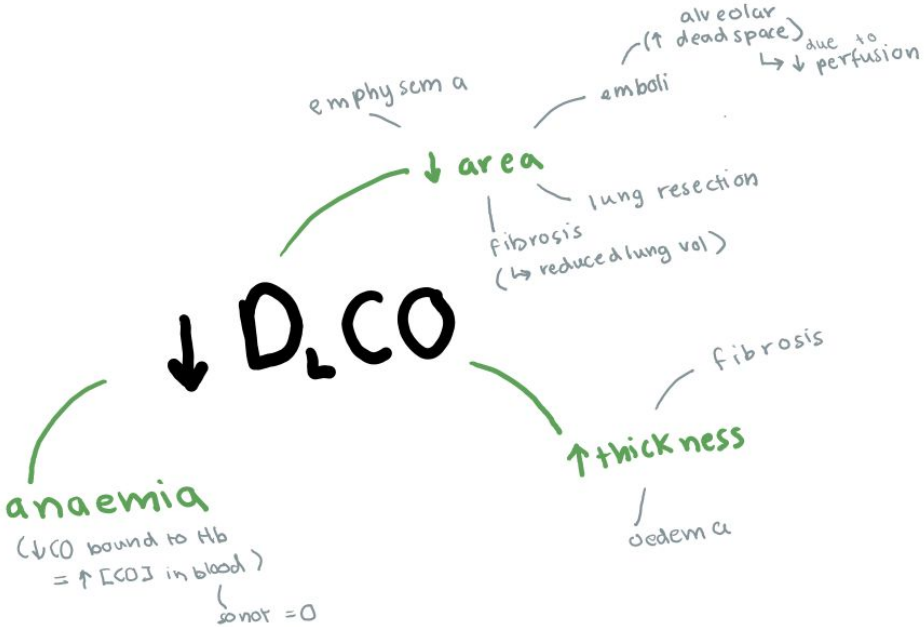
$$D_LCO = \frac{VCO}{P_ACO}$$

why?

D_LCO= CO uptake from the lungs (VCO)
$P_ACO - P_{\cancel{E}}CO$

assume [CO] = 0 in blood

Causes of increased/decreased DLCO?


↓ D_LCO
↓ area
emphysema
embolism
(↑ alveolar dead space) due to ↓ perfusion
lung resection
fibrosis
(↳ reduced lung vol)
anaemia
(↓CO bound to Hb = ↑ [CO] in blood)
so not = 0
↑ thickness
fibrosis
oedema

A patient is admitted to hospital with shortness of breath. Their VCO is found to be 5ml/min/mmHg, and there PACO is found to be 40mmHg. What is a possible cause for their symptoms?

A pulmonary fibrosis

B alveolar haemorrhage

C hyperventillation

D asthma

E neuromuscular disease

A) Pulmonary fibrosis

- (For reference, normal DLCO is 25-30ml/min/mmHg)
- DLCO is reduced = decreased transfer of gases across alveolar surface
- Fibrosis = increased thickness and decreased area (due to inability to inflate)
    - So less transfer of gas

Which of the following conditions is most likely to cause a V/Q mismatch?

A pulmonary fibrosis

B pulmonary embolism

C hyperventillation

D asthma

E pneumothorax

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B) Pulmonary embolism

- (PE = clot in the lungs)
- So alveoli are not supplied by blood = low perfusion
    - So have a higher V/Q ratio

Which of the following statements are correct?

A pleural oedema is associated with an increased V/Q ratio

B V/Q ratio is higher at the top of the lungs

C ventilation is higher at the top of the lungs

D COPD is a type of restrictive lung disease

E pulmonary arteries vasodilate in hypopxia

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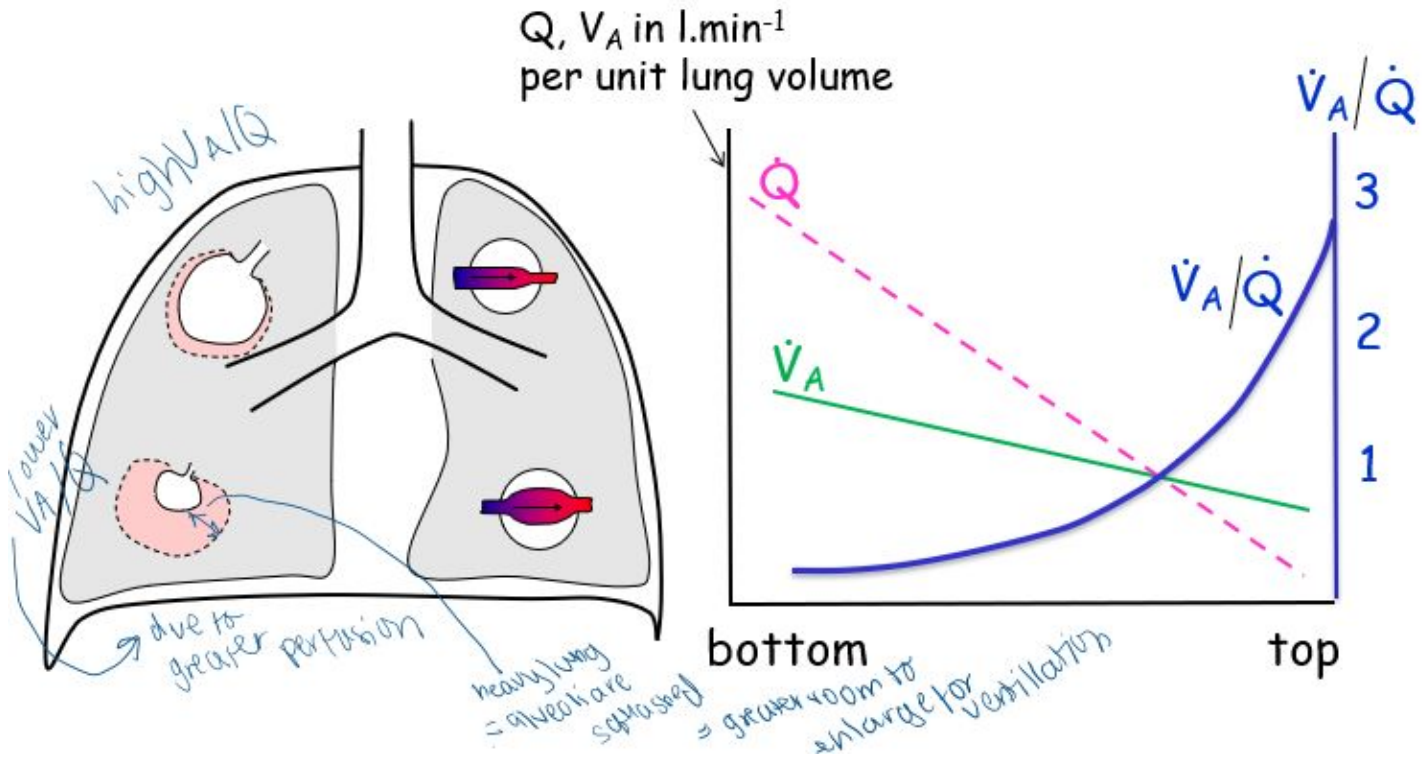
B) V/Q ratio is higher at the top of the lungs



B) V/Q ratio is higher at the top of the lungs

Why are the others wrong?

- A) pleural oedema is associated with an increased V/Q ratio
  - V/Q would be decreased (as oedema = less ventilation in alveoli)
- C) ventilation is higher at the top of the lungs
  - Ventilation is higher at the bottom (as expand more during inspiration)
- D) COPD is a type of restrictive lung disease
  - COPD is a non-reversible obstructive lung disease
- E pulmonary arteries vasodilate in hypopxia
  - Arteries vasoconstrict in hypoxia

V/Q

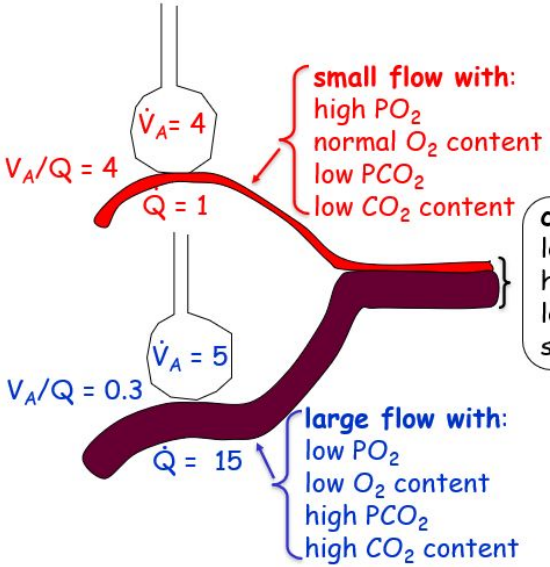
V/Q key points:

IF V/Q>1

- Dead space effect
  - under-perfused
- Decreased pCO2, increased pO2 (in that area of the lungs)
  - But not O2 content as Hb is saturated

IF V/Q<1

- Shunt effect
  - under ventilated
- Increased pCO2, decreased pO2
  - Causes an increase in ventilation (as hypercapnic)



Questions?

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Thank you for attending the session -

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