Lecture 5

Pulmonary circulation

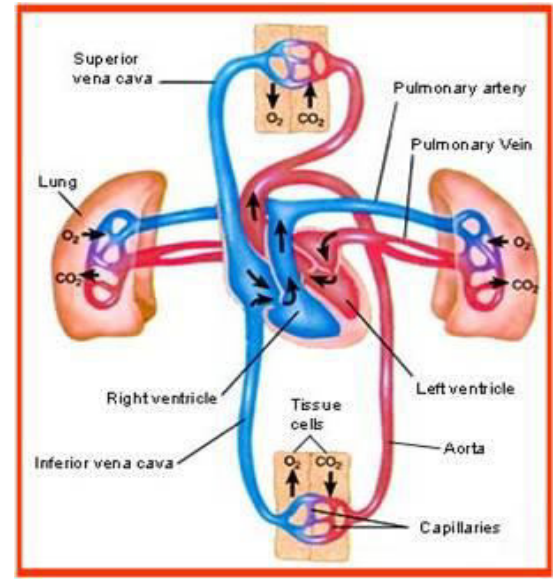
Objectives

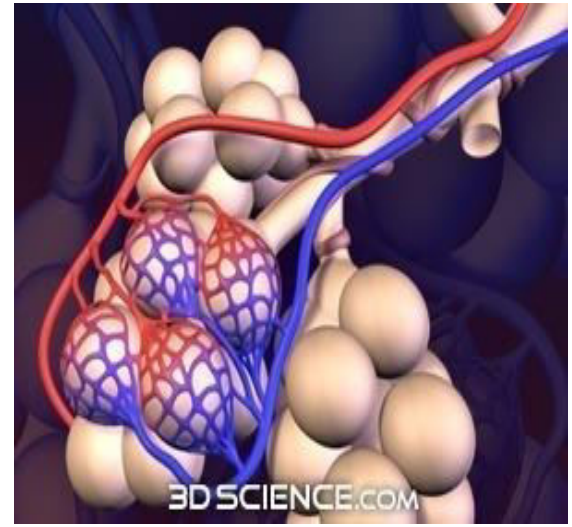
- Features of the pulmonary circulation
- Factors affecting pulmonary blood flow
- The differences in ventilation & perfusion in different parts of the lung

PULMONARY CIRCULATION

Features of pulmonary circulation

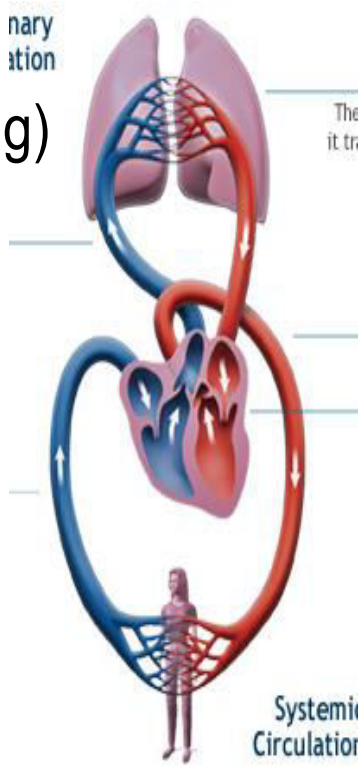
1) Lung is the only organ receiving the entire CO
2) Less affected by gravitational forces
3) Pulmonary blood vessels:
   - Pul arteries: thin walled (30% as thick as the wall of the aorta) little SM and elastic tissue and have larger diameter
   - Pul capillaries: larger than systemic capillaries and denser with multiple anastomoses
   - Pul veins: highly dispensable and act a blood reservoir

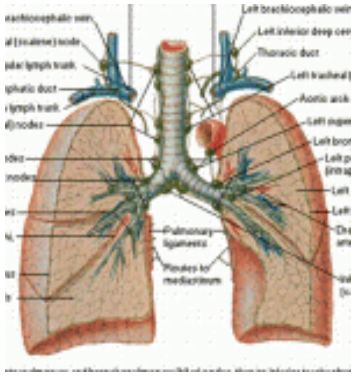




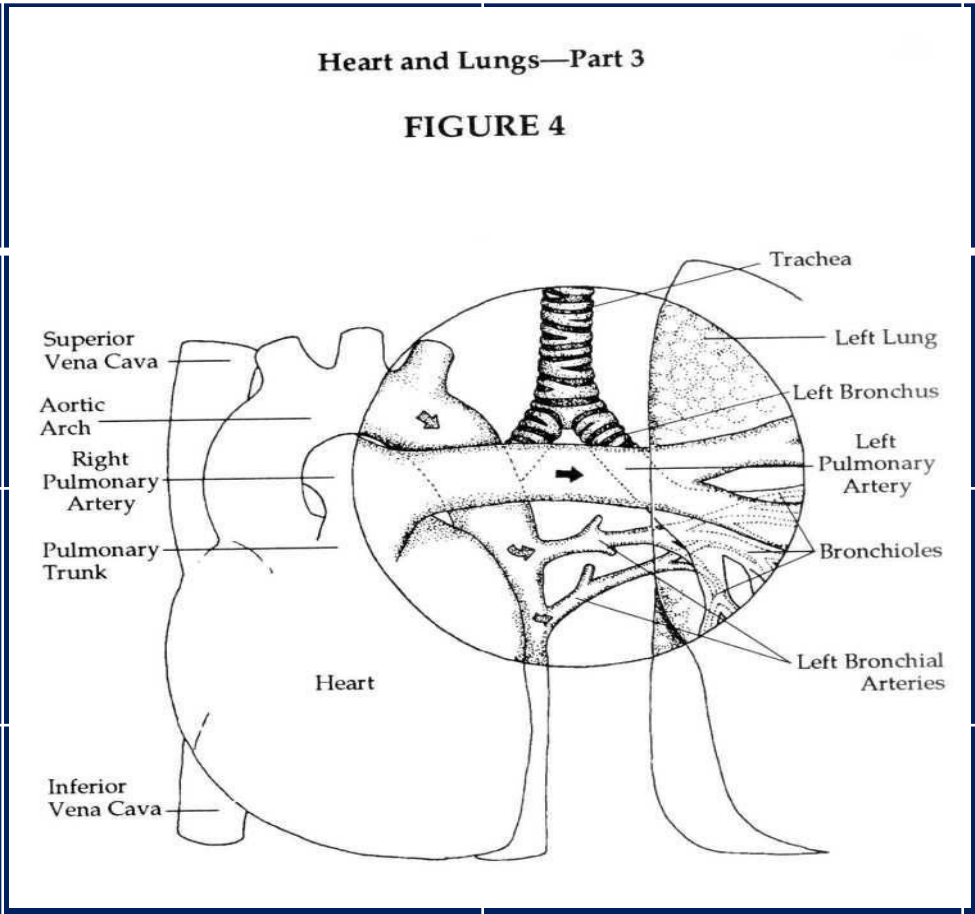
4) Pulmonary blood pressure
   - Pul circulation (low-pr) (24/9mmHg): Systemic (120/80mmHg)
   - Pul capillary pr is 10mmHg (systemic=30mmHg)

5) Pulmonary blood flow is influenced by intrapleural pr.
6) Pulmonary circulation acts as a filter which prevents emboli from reaching the systemic circulation (fibrinolytic system)
7) The pulmonary arteries are the only postnatal arteries that carry deoxygenated blood, and pulmonary veins are the only postnatal veins that carry oxygenated blood.
8) Lymphatic channels are abundant in lungs (keep alveoli dry and maintain -ve intrapleural pressure)
9) ACE produced by endothelial cells of pulmonary vessels → maintaining blood pr



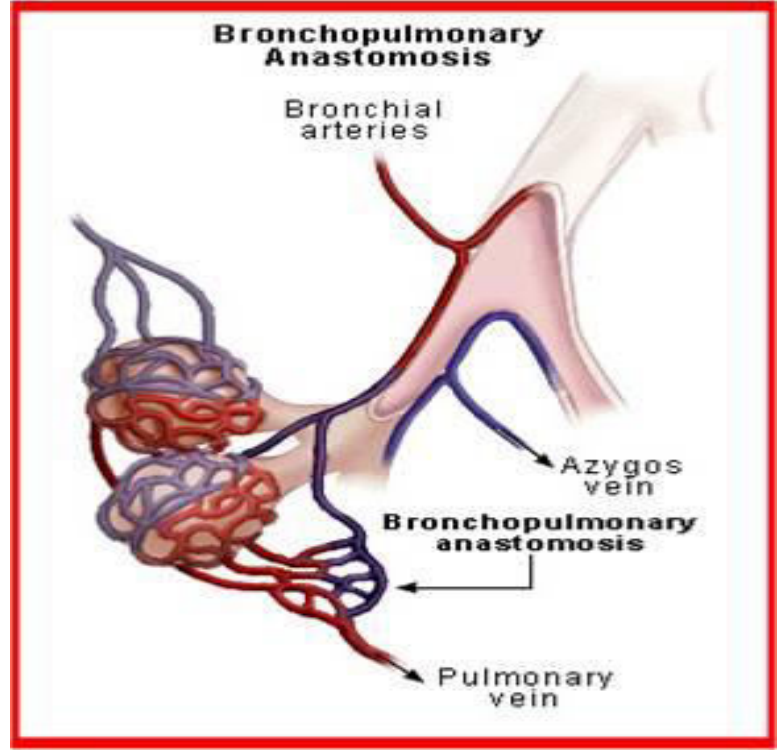


10) Blood vessels of lung consist of two sets originating from two different sources, performing different functions.

Pulmonary artery		**Bronchial arteries**
Pulmonary circulation		Systemic circulation
Deoxygenated blood		Oxygenated blood
Gas exchange		To the respiratory tree up to the terminal bronchioles

11) Physiologic shunt

- Shunt: blood that has not been oxygenated in the lungs is added to systemic circulation
- Lung: Bronchopulmonary anastomosis.
  - Some bronchial venous blood (de-oxygenated blood) enters pulmonary veins (oxygenated blood) bypassing the right ventricle and returns to left side of heart.
  - This constitutes 2% of blood in systemic circulation.



Regulation of pulmonary blood flow:

1) Cardiac out put:

- ↑CO ⟶ ↑ pulmonary blood flow

2) Pulmonary vascular resistance:

- Pulmonary perfusion is inversely proportional to pulmonary vascular resistance

3) Nervous factors:

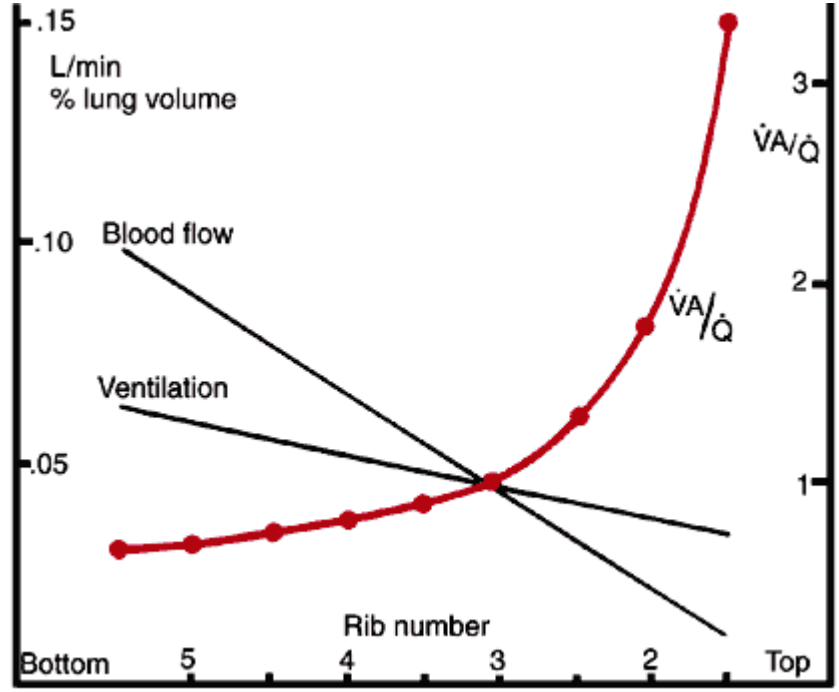
- Sympathetic ⟶ vasoconstriction ⟶ ↓pulmonary perfusion
- Parasympathetic⟶ vasodilatation ⟶ ↑pulmonary perfusion

4) Chemical factors:

- Hypoxia, hypercapnia, and acidosis ⟶ vasoconstriction ⟶↑ pulmonary arterial pressure (pul hypertension)
  - ☞ In all others areas other than lung, hypoxia produces vasodilatation
  - ☞ COPD⟶ hypoxia ⟶ vasoconstriction ⟶ pulmonary hypertension ⟶ RHF

5) Effects of gravity:

- In the erect posture (Apex of lung above the level of heart, base below) ⟶ linear ↑ in pulmonary blood flow from the apex to the base of the lung.



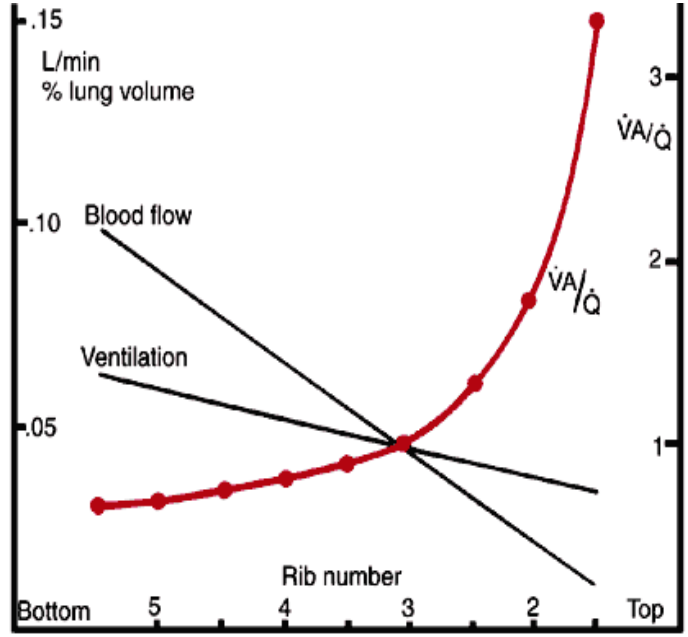
6) Hormonal factors:

- Pulmonary arteriolar vasoconstriction (angiotensin II, epinephrine, norepinephrine, PGF2α)
- Vasodilator (Ach, NO)

7) Phases of respiration:

- Inspiration ⟶pulmonary vasodilatation ⟶↑ pul. perfusion
- Expiration ⟶ vasoconstriction ⟶ ↓ pul. perfusion.

Ventilation perfusion ration (V/Q):



- **Definition:** alveolar ventilation (4L/min) / pulmonary blood flow (CO) 5L/min
- **Difference** in different parts of the lung
- **Normal value**
  - At the apex of the lung (V/Q =3)
  - at the middle of the lung (V/Q=0.8)
  - At the base of the lung (V/Q=0.6)
- **For proper** O_2 and CO_2 exchange in the lungs, ventilation and perfusion must be matched.
  - In the upright posture, ventilation and perfusion are less at the apex and more towards the base (gravity)
  - In lying down posture, the posterior part of the lung is well ventilated and perfused than the anterior part.

- Gravity dependent reduction in perfusion is more marked at the apex than reduction for ventilation → V/Q is highest at the apex and lowest at the base in upright posture.

	Alveolar pressure cmH_2O	Pleural pressure cmH_2O	Trans-pulmonary cmH_2O	Lung expansion	V	Q	V/Q
Apex	0	-10	10	More	↓	↓	↑3
							0.8
Base	0	-2.5	2.5	Less	↑	↑	↓ 0.6

Clinical Importance:

- If one lung is not functioning, the patient is advised to lie on the side in which the lung is functioning so that this lung will be well ventilated and perfused.
- Pulmonary tuberculosis affects apex of the lung first:
  - High V/Q at the apex of the lung → more O_2 is available at the apex of lung → favorable environment for the growth of tubercle bacilli (aerobic bacteria)
  - Poor perfusion at the apex. Antibodies in the blood do not reach the apex satisfactorily. So, apex of the lung is more vulnerable to bacterial attack.