

# PULMONARY CIRCULATION

## High yield



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### Summary

This lecture covers the physiology of the pulmonary circulation, a low-pressure, high-compliance system. Its primary functions are gas exchange (arterialization of blood), acting as a blood reservoir, and filtering emboli.

Key characteristics include low pulmonary vascular resistance (PVR) and unique pressure values (e.g., mean pulmonary arterial pressure is 15 mmHg).

PVR is regulated by factors like oxygen tension (hypoxia causes vasoconstriction, unlike in systemic circulation) and is affected by gravity, creating zones of different blood flow in the upright lung.

Pulmonary blood flow is regulated overall by cardiac output and regionally by local alveolar gas levels. Factors affecting pulmonary arterial pressure include PVR, left atrial pressure, and cardiac output.

### Highlighted Content

#### 1. Functions of Pulmonary Circulation:

- Conduction of blood from the right heart to the left heart.
- Blood oxygenation and CO<sub>2</sub> removal (arterialization).
- Filtration of emboli via a fibrinolytic system.
- Blood reservoir (volume increases by up to 400 ml when lying down).

#### 2. Characteristics of Pulmonary Vasculature:

- Thin-walled, highly compliant arteries with little smooth muscle.
- Short, compliant veins.
- Anastomoses between pulmonary and bronchial arteries; most bronchial blood drains into pulmonary veins.
- Extensive, large, and permeable capillary network around alveoli.
- Rich lymphatic supply.

#### 3. Normal Pressures:

- Right Ventricle: Systolic ~25 mmHg, Diastolic ~0 mmHg.
- Pulmonary Artery: Systolic ~25 mmHg, Diastolic ~8 mmHg, Mean ~15 mmHg.
- Pulmonary Capillary: ~7 mmHg (lowest in the body).
- Left Atrium: 1-5 mmHg (avg. 2 mmHg).

#### 4. Pulmonary Vascular Resistance (PVR):

- Normally very low (1/6 of systemic resistance).
- Increased by (Vasoconstriction): Hypoxia, Acidosis (low pH), Sympathetic stimulation, Catecholamines, Angiotensin II, Thromboxane A<sub>2</sub>.
- Decreased by (Vasodilation): Vagal stimulation, Acetylcholine, Atrial Natriuretic Peptide (ANP), Prostacyclin.
- Increased in diseases like: Emphysema, Pulmonary fibrosis; Pulmonary embolism.

#### 5. Regulation of Pulmonary Blood Flow (PBF):

- Overall Regulation: Passive; increased cardiac output (e.g., exercise) dilates vessels, drops PVR, and increases PBF.
- Regional Regulation:
  - O<sub>2</sub> Tension: Local hypoxia and hypercapnia (via low pH) cause local vasoconstriction to redirect blood to well-ventilated areas.
  - Gravity: In an upright person, blood flow is highest at the lung bases and lowest at the apices.

## 6. Zones of Pulmonary Blood Flow (in upright lung):

- Zone 1 (Apex): No blood flow if alveolar pressure  $>$  capillary pressure (not normally present).
- Zone 2 (Mid-lung): Intermittent blood flow (systole only).
- Zone 3 (Bases): Continuous blood flow.

## 7. Factors Affecting Pulmonary Arterial Pressure:

- Pulmonary Vascular Resistance (PVR): Increased by sympathetic stimulation, hypoxia, acidosis, and certain lung diseases.
- Left Atrial Pressure: Increased pressure (e.g., from left heart failure) causes a back-pressure rise. Pressure  $>30$  mmHg risks pulmonary edema.
- Cardiac Output: Large increases (e.g., exercise) cause only a small pressure rise due to vessel distension and recruitment of capillaries.

## 8. Functional Characteristics:

- Distensible, low-pressure, high-flow system.
- High compliance (blood reservoir).
- Rapid capillary flow (0.75 sec at rest,  $<0.3$  sec during exercise).
- Unique response to hypoxia and acidosis (vasoconstriction).
- Affected by gravity.

## 9. Physiological Shunts:

- Cause: Drainage of deoxygenated blood from bronchial and coronary veins into the pulmonary veins/left heart.
- Effect: Systemic arterial  $O_2$  is slightly less than pulmonary venous  $O_2$ .

## 10. Diseases:

- Pulmonary Hypertension: Caused by increased PVR from factors like hypoxia, drugs, or genetic mutations. Leads to right heart failure. Treated with vasodilators (e.g., prostacyclin).