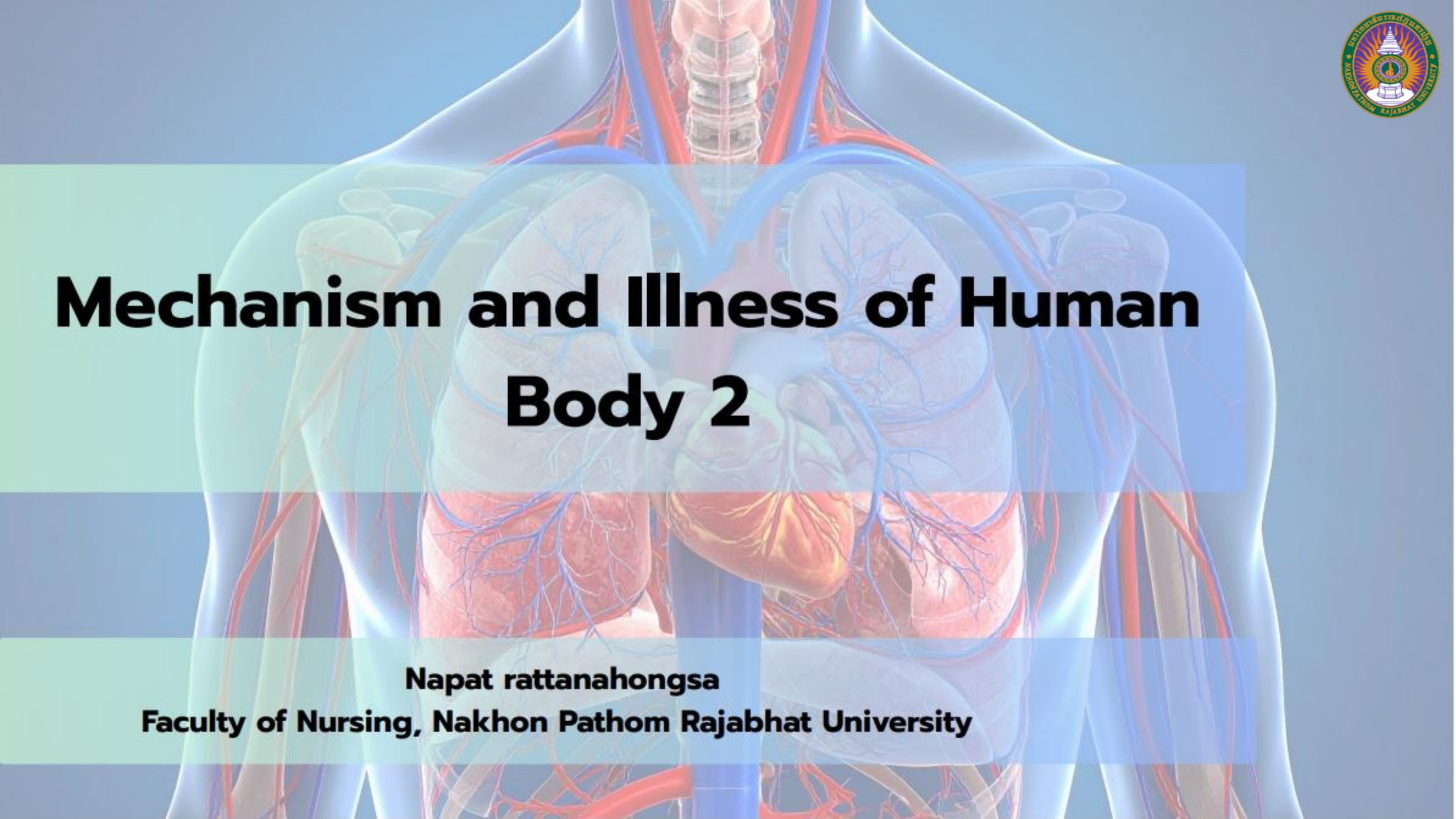

# มหาวิทยาลัยราชภัฏนครปฐม



# Mechanism and Illness of Human Body 2

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# Disorders of the Respiratory System

## Pulmonary function test

- FEV1 (forced expiratory volume in 1 second) measures flow that is exhaled forcefully in a one second period. If low, indicates limited or obstructed airflow
- FVC (forced vital capacity) measures the amount of air that is forcibly exhaled and is the volume plateau or maximum achieved after 3-6 seconds exhalation

if FEV1/FVC < 90%, indicates limited airflow (obstructive lung disease)

if FVC < 80%, suggests restrictive lung disease

if FEF25-75 < 70%, may indicate small airway disease


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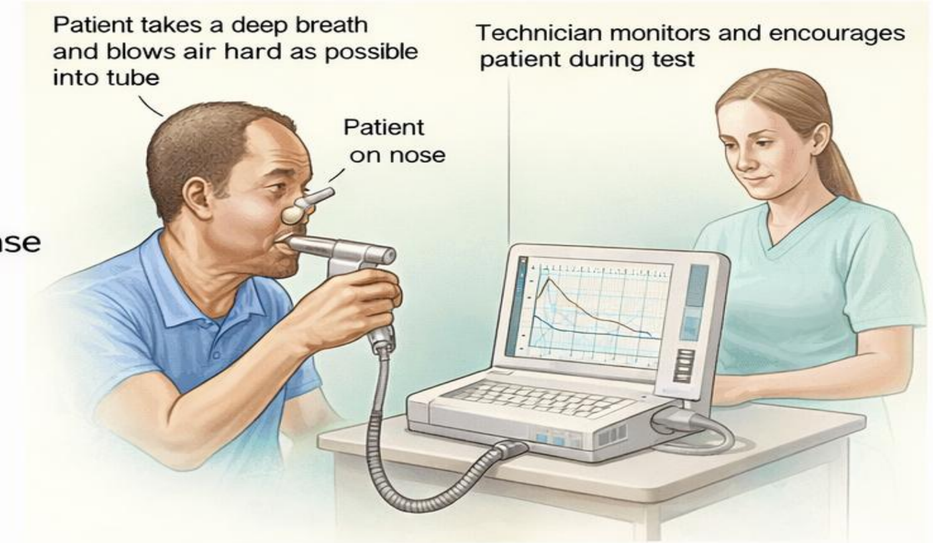
- if FEF25-75 < 70%, may indicate small airway disease


Spirometry

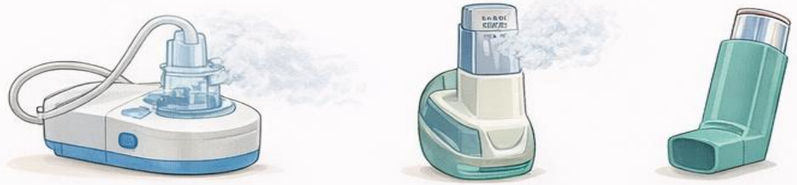
# Disorders of the Respiratory System

## Pulmonary function test

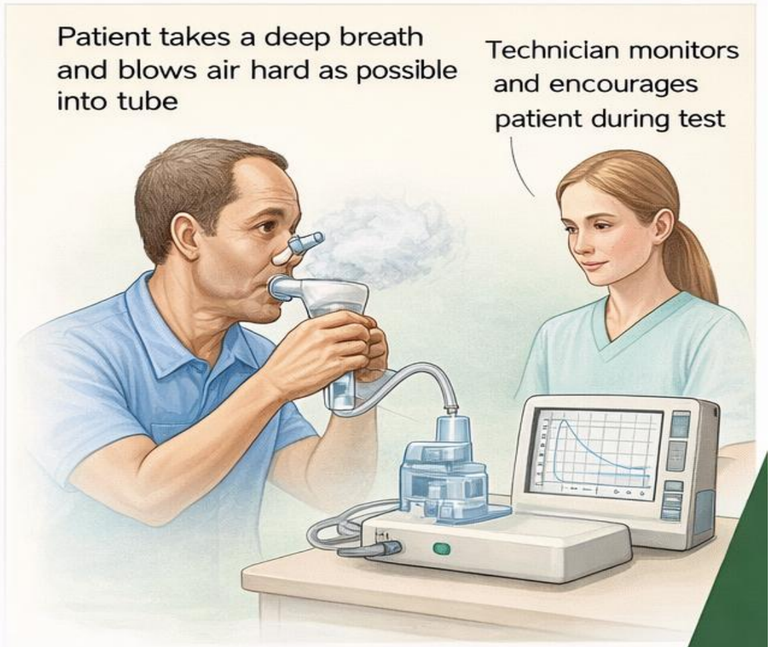
- PEFR (peak expiratory flow rate) measures “peak flow” which is the highest flow achieved during forced exhalation. Often tested in Asthma

## Bronchodilator (BD) response test

- Perform spirometry (pre-BD) 1st
- Then administer bronchodilator in nebulizer/ DPI / MDI
- Wait 15-30 minutes, then perform post-BD
- Check FEV1 or PEFR, often tested in COPD



Nebulizer DPI MDI



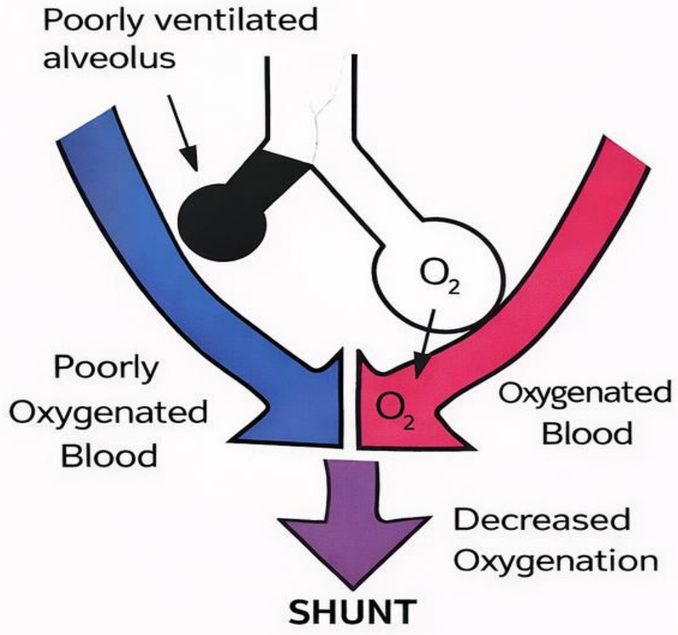
# Disorders of the Respiratory System

## V/Q mismatch

- Ventilation perfusion mismatch (V/Q mismatch) is a condition involving an imbalance between the air (ventilation; V) and blood flow (perfusion; Q) around the alveoli.

Normal V/Q ratio should be > 0.8–1.0

- Low V/Q ratio: Inadequate oxygenation of the body's cells




Causes of low V/Q ratio: Ventilation: V

1. Lung compliance (c)
2. Surface tension (s)
3. Constriction of respiratory muscles

Causes of low V/Q ratio: Ventilation : V

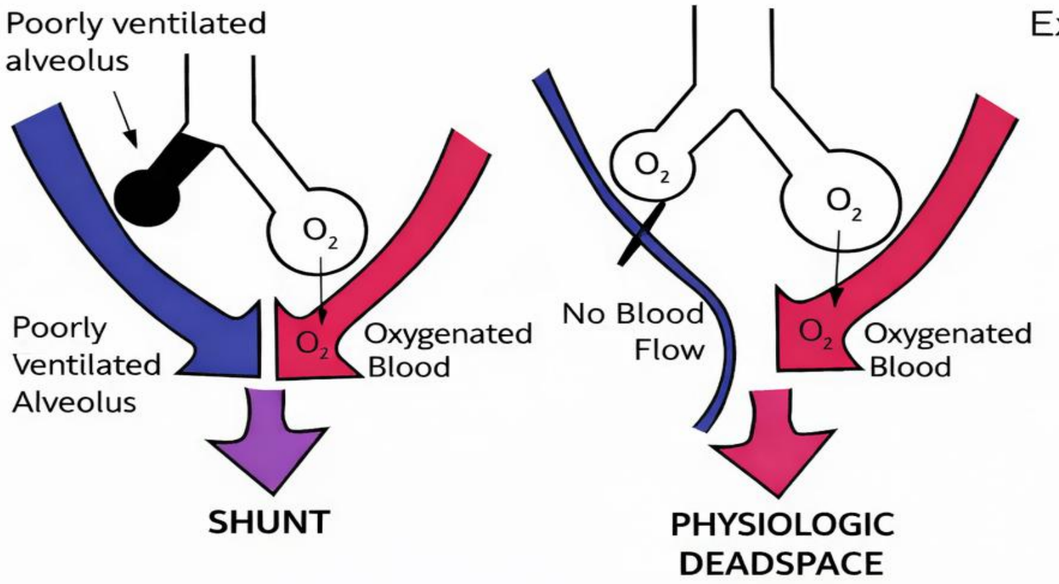
1. Lung compliance (c)
2. Surface tension (s)

# Disorders of the Respiratory System

## V/Q mismatch

Normal resting V/Q should be approximately ~ 5,000 mL/min.

- V/Q < 0.8 is V/Q mismatch characteristic of a shunt effect
- V/Q > 1 is V/Q mismatch characteristic of a dead space effect




Examples of V/Q > 1 include:

- Decreased perfusion due to dehydration, blood loss or low cardiac output
- Increased ventilation from tachypnea, rapid breathing or high tidal volumes

# Disorders of the Respiratory System

## Diffusion impairment

Diffusion impairment occurs when the surface area for gas exchange is reduced or thickened, increasing diffusion time.

1. Differences between $O_2$ concentration in capillary blood and air in alveoli lead to faster diffusion
2. Alveolar Capillary Membrane thickens, slowing diffusion rate
3. Thickening of gas exchange tissue, reduces oxygen diffusion
4. Characteristics of diffusion impairment:
   - $O_2$ diffuses into capillary blood longer than 0.25 sec, averaging about 20 sec averaging about 20 sec
   - $CO_2$ diffuses from capillary blood into alveoli faster than $O_2$ due to higher solubility
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# Disorders of the Respiratory System

## Dead space

A region where Ventiiation (V) occurs but Perfusion (Q) does not, resulting in no gas exchange (no function).

1. Anatomical dead space:

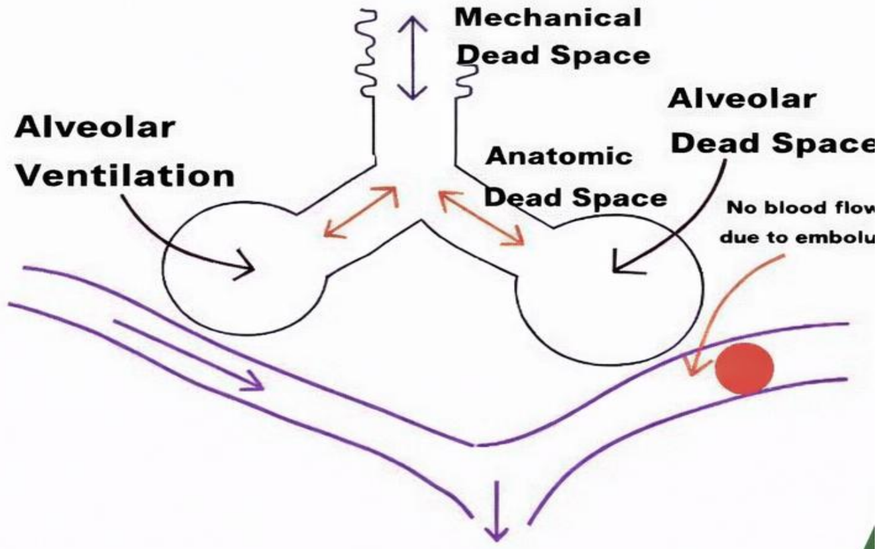
   Air within the airway that does not participate in gas exchange

2. Alveolar dead space:

   Air within the alveolus that does not participate in gas exchange

3. Mechanical dead space:

   Air that is within ventilated mechanical conduits.



# Disorders of the Respiratory System

## Shunting

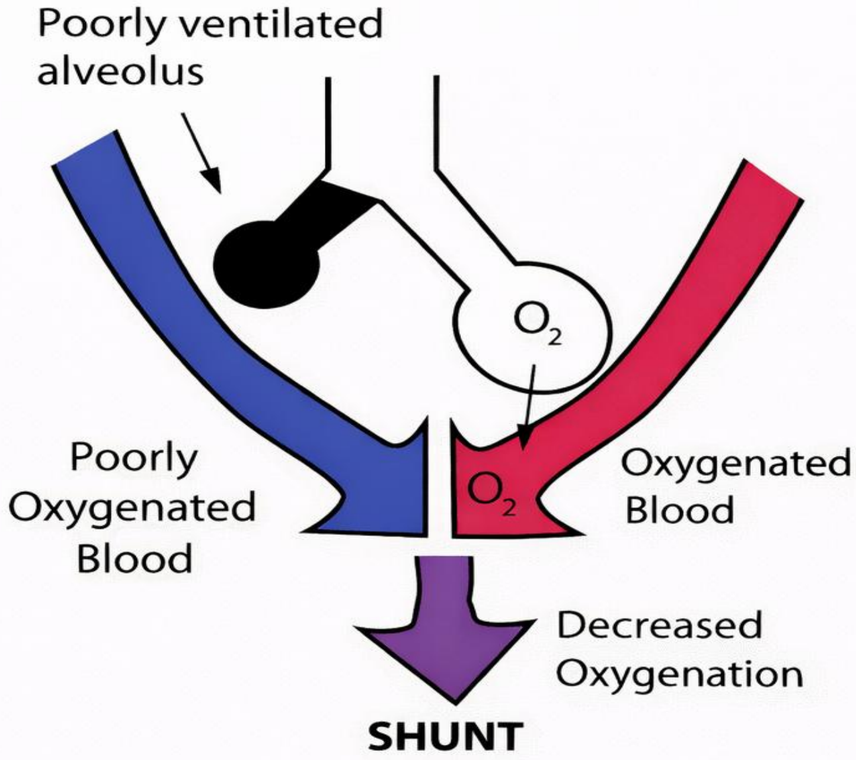
- Right Distress
  - Right to Left shunt

    in ISD, VSD, PDA
  - Left to Right shunt

    Pulmonary stenosis

- Capillary shunt

  Atelectasis, ARDS (acute respiratory distress syndrome)



# Disorders of the Respiratory System

## Type of Hypoxia

Hypoxia is a condition where tissues have inadequate oxygen ($O_2$).

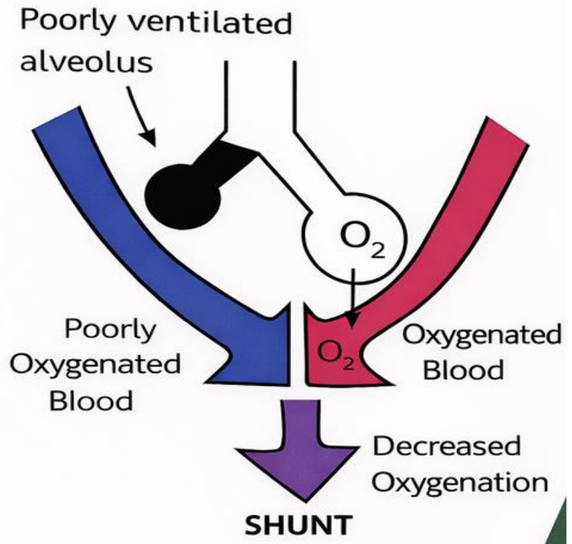
Hypoxemia is a condition where the blood has lower than normal $O_2$ levels.

- **Histotoxic hypoxia or Cellular hypoxia:**

  Anemia decreases Hb, releasing $O_2$ in hemoglobin (Hb).
  Toxins or poisons like CO (which binds to hemoglobin more than 200-250 times greater than $O_2$), sulfanilamide, Cyanide, Carbon Monoxide can prevent tissue from using oxygen

- **Hypoxemic hypoxia**

  1. Low inspired partial presure of $O_2$
  2. Alveolar hypoventilation
  3. Intrapulmonary shunt
  4. Dead space ventilation
  5. Ventilation – Perfusion mismatch
  6. Diffusion defect



# Disorders of the Respiratory System

## Type of Hypoxia

- **Circulatory hypoxia or Stagnant hypoxia:**

  This is hypoxia resulting from **decreased flow** of blood toward tissues due to:

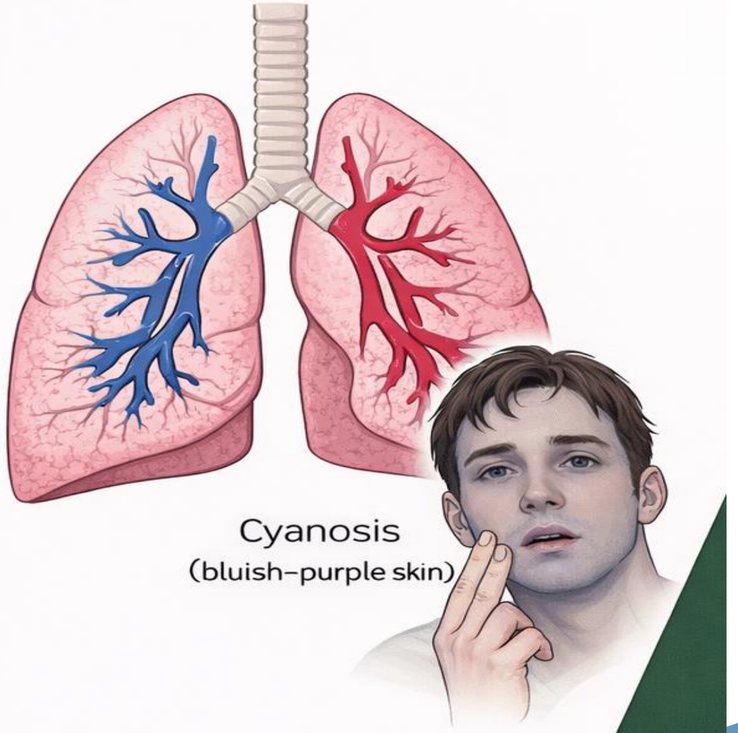
  - Hypovolemic shock
  - Distributive shock
  - Cardiogenic shock or Obstructive shock

- **Histotoxic hypoxia or Cellular hypoxia:**

  This is hypoxia caused by cells that receive $O_2$ but cannot use it due to disruption of cellular oxidative processes by:

  - Cyanide poisoning
  - Sulfanilamide
  - Carbon monoxide

**Cyanosis** can be easily observed in hypoxic hypoxemic hypoxia and Circulatory hypoxia.



Cyanosis
(bluish-purple skin)

# Disorders of the Respiratory System

## Signs of Hypoxia

### Nervous System

- Accounts for basal oxygen consumptin (20%). Uses $O_2$ 45 mL/min to produce ATP needed for control of Na-K pump, neurotransmitter synthesis, synapse signaling
- if $PaO_2 < 40$–45 mmHg → acidosis increases cerebral cortex permeability → cerebral edema occurs.

Mild hypoxemia: $PaO_2$ 60 - 80 mmHg
Moderate hypoxemia: $PaO_2$ 40–60 mmHg
Severe hypoxemia: $PaO_2 < 40$ mmHg

### Cardiovascular System

- Sympathetic stimulation increases cardiac output (SV, HR).
- Vasodilation increases blood flow to essential organs: function of heart increases blood flow, oxygen demand and heart rate.
- Metabolic acidosi leads to clubbing finger, 2,3-diphospho-glycerate (2,3-DPG) rises $O_2$ delivery increases.

### Respiratory System

- Low $O_2$ + lactic acidosis stimulates carotid body to send signals to speed up rapid, forceful breathing. May use accessory muscles e.g. belly muscles.
- $PaO_2 < 30$ mmHg → medullary center depressed → Cheyne-Stokes breathing → apnea in severe cases.

### Kidneys & Muscle System

- Low $O_2$ + lactic acidosis ↓ blood flow to kidneys.
- Renin erythropoietin factor (REF) stimulates erythropoietin (EPO) to stimulate excessive RBC formation leading to high viscocity blood, ↑ pulmonary hypertension risk.
- Low $O_2$ leads to centrilobular fibrosis.
- Muscle tissue breaks down stored ATP (creatinine phosphate) leading to glycolyis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