Pulmonary Pathophysiology
Reduction of Pulmonary Function

1. Inadequate blood flow to the lungs – **hypoperfusion**
2. Inadequate air flow to the alveoli - **hypoventilation**
Signs and Symptoms of Pulmonary Disease

• Dyspnea – subjective sensation of uncomfortable breathing, feeling “short of breath”

• Ranges from mild discomfort after exertion to extreme difficulty breathing at rest.

• Usually caused by diffuse and extensive rather than focal pulmonary disease.
Dyspnea cont.

• Due to:
  – Airway obstruction
    • Greater force needed to provide adequate ventilation
    • Wheezing sound due to air being forced through airways narrowed due to constriction or fluid accumulation
  – Decreased compliance of lung tissue
Signs of dyspnea:

- Flaring nostrils
- Use of accessory muscles in breathing
- Retraction (pulling back) of intercostal spaces
Cough

• Attempt to clear the lower respiratory passages by abrupt and forceful expulsion of air

• Most common when fluid accumulates in lower airways
Cough may result from:

- Inflammation of lung tissue
- Increased secretion in response to mucosal irritation
  - Inhalation of irritants
  - Intrinsic source of mucosal disruption – such as tumor invasion of bronchial wall
- Excessive blood hydrostatic pressure in pulmonary capillaries
  - Pulmonary edema – excess fluid passes into airways
• When cough can raise fluid into pharynx, the cough is described as a **productive cough**, and the fluid is **sputum**.
  – Production of bloody sputum is called **hemoptysis**
    • Usually involves only a small amount of blood loss
    • Not threatening, but can indicate a serious pulmonary disease
      – Tuberculosis, lung abscess, cancer, pulmonary infarction.
• If sputum is purulent, and infection of lung or airway is indicated.

• Cough that does not produce sputum is called a dry, **nonproductive** or hacking cough.

• Acute cough is one that resolves in 2-3 weeks from onset of illness or treatment of underlying condition.
  – Us. caused by URT infections, allergic rhinitis, acute bronchitis, pneumonia, congestive heart failure, pulmonary embolus, or aspiration.
• A chronic cough is one that persists for more than 3 weeks.
• In nonsmokers, almost always due to postnasal drainage syndrome, asthma, or gastroesophageal reflux disease
• In smokers, chronic bronchitis is the most common cause, although lung cancer should be considered.
Cyanosis

- When blood contains a large amount of unoxygenated hemoglobin, it has a dark red-blue color which gives skin a characteristic bluish appearance.
- Most cases arise as a result of peripheral vasoconstriction – result is reduced blood flow, which allows hemoglobin to give up more of its oxygen to tissues- peripheral cyanosis.
- Best seen in nail beds
- Due to cold environment, anxiety, etc.
• **Central cyanosis** can be due to:
  – Abnormalities of the respiratory membrane
  – Mismatch between air flow and blood flow
  – Expressed as a ratio of change in ventilation (V) to perfusion (Q): V/Q ratio
    • Pulmonary thromboembolus - reduced blood flow
    • Airway obstruction – reduced ventilation

• In persons with dark skin can be seen in the whites of the eyes and mucous membranes.
Pain

• Originates in pleurae, airways or chest wall
• Inflammation of the parietal pleura causes sharp or stabbing pain when pleura stretches during inspiration
  – Usually localized to an area of the chest wall, where a **pleural friction rub** can be heard
  – Laughing or coughing makes pain worse
  – Common with pulmonary infarction due to embolism
Tests of Pulmonary Function
Chest radiographs are among the most common examinations of the pulmonary system.

**Chest x-ray**

Heart size
Lung mass
Pleural effusion
Fibrosis
Pneumonia
Pneumothorax
CT SCAN
Spirometry
The diagnosis of COPD is confirmed by spirometry, a test that measures breathing. Spirometry measures the forced expiratory volume in one second (FEV$_1$) which is the greatest volume of air that can be breathed out in the first second of a large breath and the forced vital capacity (FVC) which is the greatest volume of air that can be breathed out in a whole large breath. Normally at least 70% of the FVC comes out in the first second (i.e. the FEV$_1$/FVC ratio is >70%).
In COPD, this ratio is less than normal, (i.e. FEV$_1$/FVC ratio is <70%) even after a bronchodilator medication has been given. Spirometry can help to determine the severity of COPD. The FEV$_1$ (measured post-bronchodilator) is expressed as a percent of a predicted "normal" value based on a person's age, gender, height and weight:
<table>
<thead>
<tr>
<th>Severity of COPD</th>
<th>FEV₁ % predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>≥80</td>
</tr>
<tr>
<td>Moderate</td>
<td>50-69</td>
</tr>
<tr>
<td>Severe</td>
<td>30-49</td>
</tr>
<tr>
<td>Very severe</td>
<td>&lt;30 or Chronic respiratory failure symptoms</td>
</tr>
</tbody>
</table>
A  NORMAL

Maximum inspiration

FEV₁

FEV₁/FVC% = 80%

FVC

Lung volume change (liters)

Seconds

B  AIRWAY OBSTRUCTION

FEV₁

FEV₁/FVC% = 47%

FVC

Lung volume change (liters)

Seconds
**Ventilation/perfusion ratio (or V/Q ratio)**: It is defined as: the ratio of the amount of air reaching the alveoli to the amount of blood reaching the alveoli.

"V" - **ventilation** - the **air** which reaches the **alveoli**

"Q" - **perfusion** - the **blood** which reaches the alveoli

These two variables constitute the main determinants of the blood oxygen concentration. In fact since V determines the quantity of oxygen mass reaching the alveoli per minute (g/min) and Q expresses the flow of blood in the lungs (l/min), the V/Q ratio refers to a concentration (g/l).

Nuclear study
Pathophysiology
A lower V/Q ratio usually seen in chronic bronchitis, asthma and acute pulmonary edema.
A high V/Q ratio increases paO2 and decreases paCO2. This finding is typically associated with pulmonary embolism (where blood circulation is impaired by an embolus).
Pulmonary angiography
Laryngoscopy
Bronchoscopy
Skin test (TB)
Microbiological (Sputum, Pleural fluid, Throat swab)
Histopathological and cytological
**Sputum**: It is usually in air passages in diseased lungs, bronchi, pneumonia. It can be associated with blood (hemoptysis) if a chronic cough is present, possibly from severe cases of tuberculosis.
ABG – Arterial blood gas analysis – commonly performed for individuals with suggested or diagnosed pulmonary disease. Provides valuable information about an individual’s gas exchange & acid-base status.
• Inflammation of trachea or bronchi produce a central chest pain that is pronounced after coughing  
  – Must be differentiated from cardiac pain
• High blood pressure in the pulmonary circulation can cause pain during exercise that often mistaken for cardiac pain (angina pectoris)
Respiratory Failure

• The inability of the lungs to adequately oxygenate the blood and to clear it of carbon dioxide.

• Can be acute:
  – ARDS or pulmonary embolism
  – Direct injury to the lungs, airways or chest wall
  – Indirect due to injury of another body system, such as the brain or spinal cord.
• Chronic respiratory failure
  – Due to progressive hypoventilation from airway obstruction or restrictive disease
• Respiratory failure always presents a serious threat
  – Dyspnea always present, but may be difficult to detect a change in a chronic patient
  – Since nervous tissue is highly oxygen-dependent, see CNS signs and symptoms
  – Memory loss, visual impairment, drowsiness
  – Headache due to increased intracranial pressure due to cerebral vasodilation
Obstructive Pulmonary Disease

• Characterized by airway obstruction that is worse with expiration. More force is required to expire a given volume of air, or emptying of lungs is slowed, or both.

• The most common obstructive diseases are asthma, chronic bronchitis, and emphysema.

• Many people have both chronic bronchitis and emphysema, and together these are often called chronic obstructive pulmonary disease - COPD
• Major symptom of obstructive pulmonary disease is dyspnea, and the unifying sign is wheezing.

• Individuals have increased work of breathing, V/Q mismatching, and a decreased forced expiratory volume.
COPD

• Pathological changes that cause reduced expiratory air flow
• Does not change markedly over time
• Does not show major reversibility in response to pharmacological agents
• Progressive
• Associated with abnormal inflammatory response of the lungs to noxious particles or gases.
• Fourth leading cause of death in U.S.
• Increasing in incidence over the past 30 years
• Primary cause is cigarette smoking
• Both active and passive smoking have been implicated
• Other risks are occupational exposures and air pollution
• Genetic susceptibilities identified
Infection of respiratory system
1-Upper resp tract inf
2-Pneumonia
3-TB
4-Fungal inf
5-Tumour and carcinoma