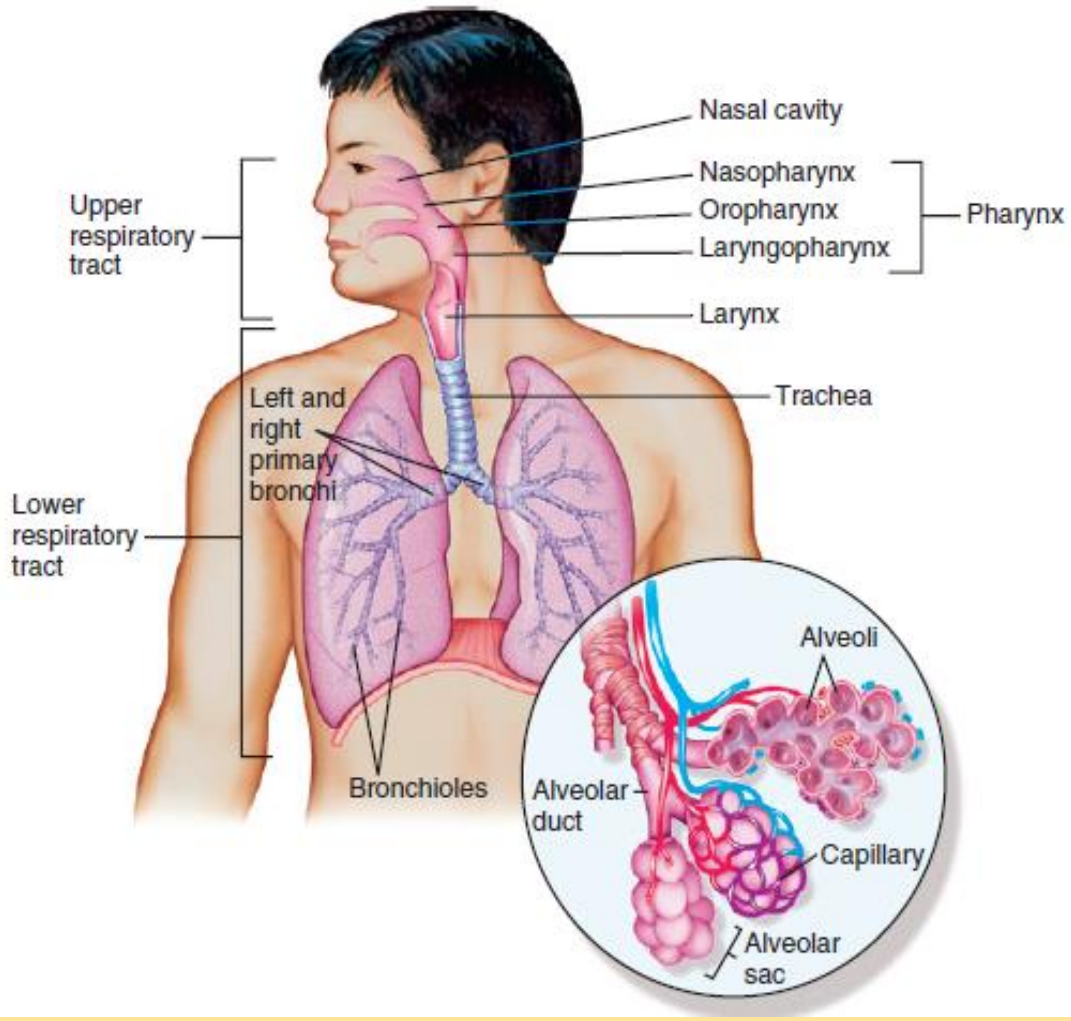

FIG. Structures of the pulmonary system

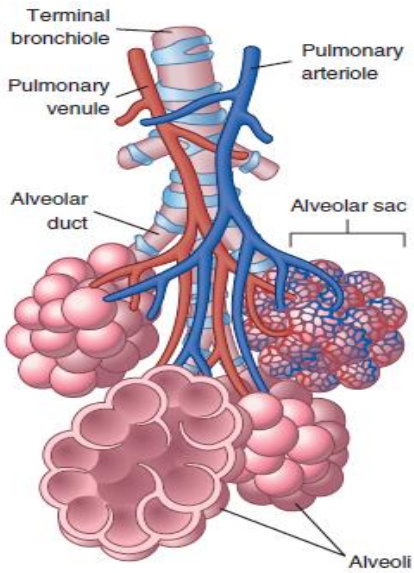

FIG. Alveoli at the terminal end of the lower airway.

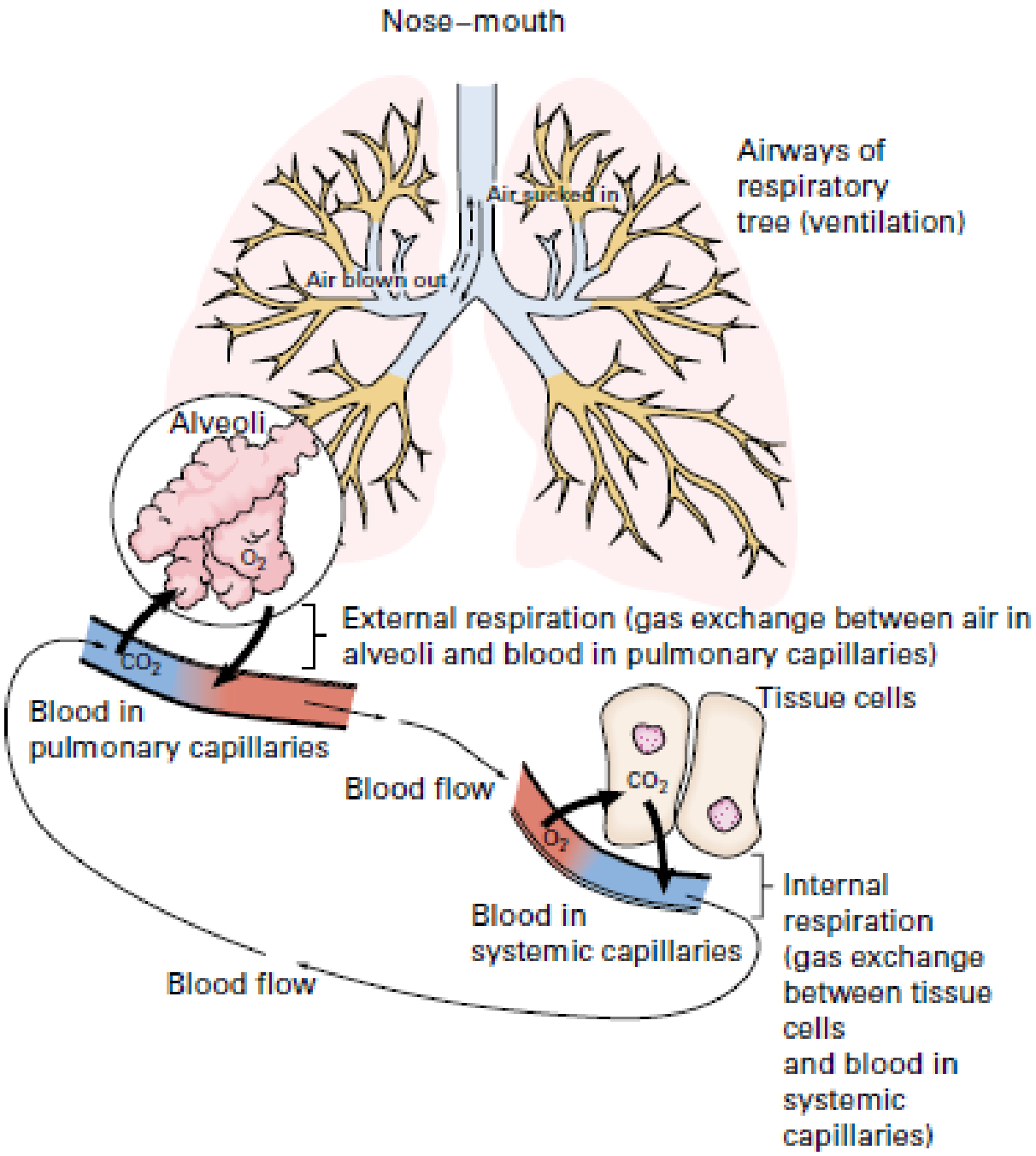

Figure 32-2 Elements of Oxygenation of the Pulmonary and Hematologic Systems

Dr. Ihab Habeb

1. Introduction to Oxygenation

Oxygenation refers to the process of delivering oxygen to the tissues and cells of the body. Oxygen is essential for maintaining life because every cell in the body requires oxygen to produce energy. This energy is necessary for cellular metabolism, growth, repair, and normal physiological functions.

The process of oxygenation depends on the proper functioning of several body systems, primarily the respiratory, cardiovascular, and hematologic systems. These systems work together to ensure that oxygen from the air is transported to the cells and that carbon dioxide, the waste product of metabolism, is removed from the body.

Importance of Oxygenation in Nursing

Adequate oxygenation is vital for cellular metabolism, energy production, and proper function of organs such as the brain, heart, and kidneys. Even brief interruptions can lead to serious complications, particularly in oxygen-dependent organs like the brain. In clinical settings, nurses care for patients with conditions affecting oxygen delivery, such as respiratory and cardiac diseases, trauma, and infections. Therefore, understanding oxygenation and recognizing early signs of deficiency are essential to prevent complications like hypoxia, respiratory failure, and organ damage.

Overview of the Respiratory System

The respiratory system enables the exchange of oxygen and carbon dioxide. Air travels from the nose or mouth through the pharynx, larynx, trachea, bronchi, and bronchioles to reach the alveoli.

Alveoli are tiny air sacs surrounded by capillaries where oxygen enters the blood and carbon dioxide is removed. Their large number provides a wide surface area, ensuring efficient gas exchange and oxygenation of the blood.

Components of Oxygenation

The oxygenation process includes several important physiological steps. These steps work together to ensure that oxygen reaches the body cells efficiently. The major components of oxygenation include:

1. **Ventilation**
2. **Alveolar gas exchange**
3. **Oxygen transport in the blood**
4. **Circulation**
5. **Cellular respiration**

Each of these components plays a critical role in maintaining adequate oxygen levels in the body.

Dr. Ihab Habeb

Physiology of Oxygenation

The physiology of oxygenation refers to the processes that move oxygen from the environment to body cells, relying on the coordinated function of the respiratory, cardiovascular, and hematologic systems.

Oxygenation involves ventilation, alveolar gas exchange, oxygen transport in the blood, circulation, and cellular respiration. Disruption in any of these steps can impair tissue oxygen delivery and cause serious health problems.

- **Ventilation**

Ventilation is the movement of air into and out of the lungs. It is the first step in the oxygenation process. During inhalation, air containing oxygen enters the lungs, while during exhalation, carbon dioxide leaves the body.

Ventilation is regulated by respiratory control centers in the pons and medulla oblongata, which are located in the brain stem. The rate and depth of ventilation are constantly adjusted in response to changes in the concentrations of hydrogen ion (pH) and carbon dioxide (CO_2) in the body's fluids.

Mechanism of Inspiration and Expiration

Breathing has two main phases: inspiration and expiration.

Inspiration: The diaphragm contracts and moves downward, and the external intercostal muscles lift the ribs. This expands the thoracic cavity, lowers intrathoracic pressure, and draws air into the lungs.

Expiration: Usually passive, as respiratory muscles relax, the thoracic cavity shrinks, pressure rises, and air is expelled.

During respiratory distress or exercise, accessory muscles help in breathing.

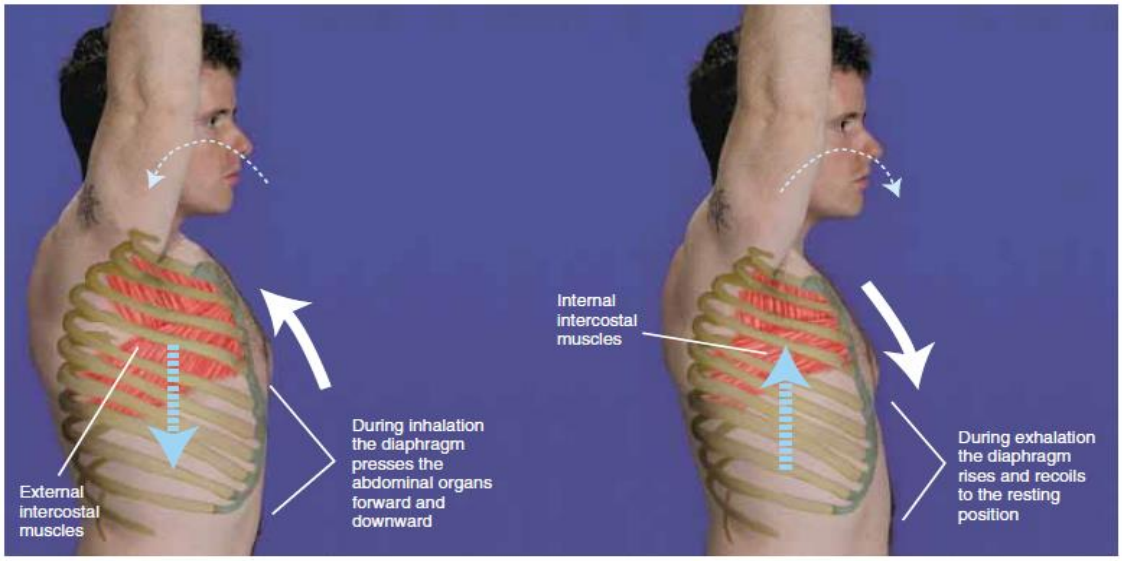

Figure 32-3 Mechanics of breathing. Inhalation increases the volume of the thorax by diaphragmatic excursion and elevation of the sternum. Exhalation is normally accomplished by passive elastic recoil.

- **Alveolar Gas Exchange**

Once air reaches t

he alveoli, gas exchange occurs between the alveoli and the pulmonary capillaries. This process is called external respiration.

Oxygen moves from the alveoli into the blood through diffusion. Diffusion occurs because oxygen concentration is higher in the alveoli than in the blood within the pulmonary capillaries.

At the same time, carbon dioxide diffuses from the blood into the alveoli because its concentration is higher in the blood than in the alveolar air.

This exchange allows oxygen to enter the bloodstream while carbon dioxide is removed from the body during exhalation.

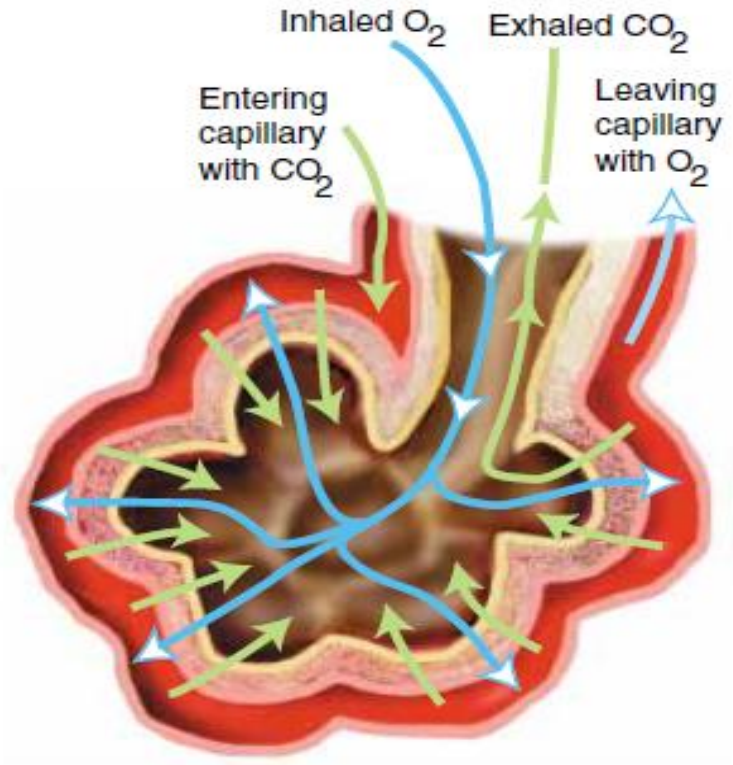

Figure 32-4 Alveolar Gas Exchange

- **Oxygen Transport in the Blood**

After oxygen diffuses into the pulmonary capillaries, it is transported through the bloodstream to body tissues. Oxygen is carried in the blood in two forms.

A small amount of oxygen dissolves directly in the plasma. However, most oxygen is transported by binding to hemoglobin molecules inside red blood cells.

Hemoglobin has a high affinity for oxygen and forms a reversible bond with oxygen molecules. This allows hemoglobin to pick up oxygen in the lungs and release it in the body tissues where it is needed.

The amount of oxygen bound to hemoglobin is measured as oxygen saturation (SaO_2), while the oxygen dissolved in plasma is measured as the partial pressure of oxygen (PaO_2).

- **Circulation**

Circulation is responsible for delivering oxygenated blood from the lungs to the body tissues. The heart acts as a pump that moves blood through the blood vessels.

The right side of the heart receives deoxygenated blood from the body and pumps it to the lungs through the pulmonary arteries. In the lungs, carbon dioxide is removed and oxygen enters the blood.

The oxygenated blood then returns to the left side of the heart through the pulmonary veins. The left ventricle pumps this oxygen-rich blood to the entire body through the aorta and systemic circulation.

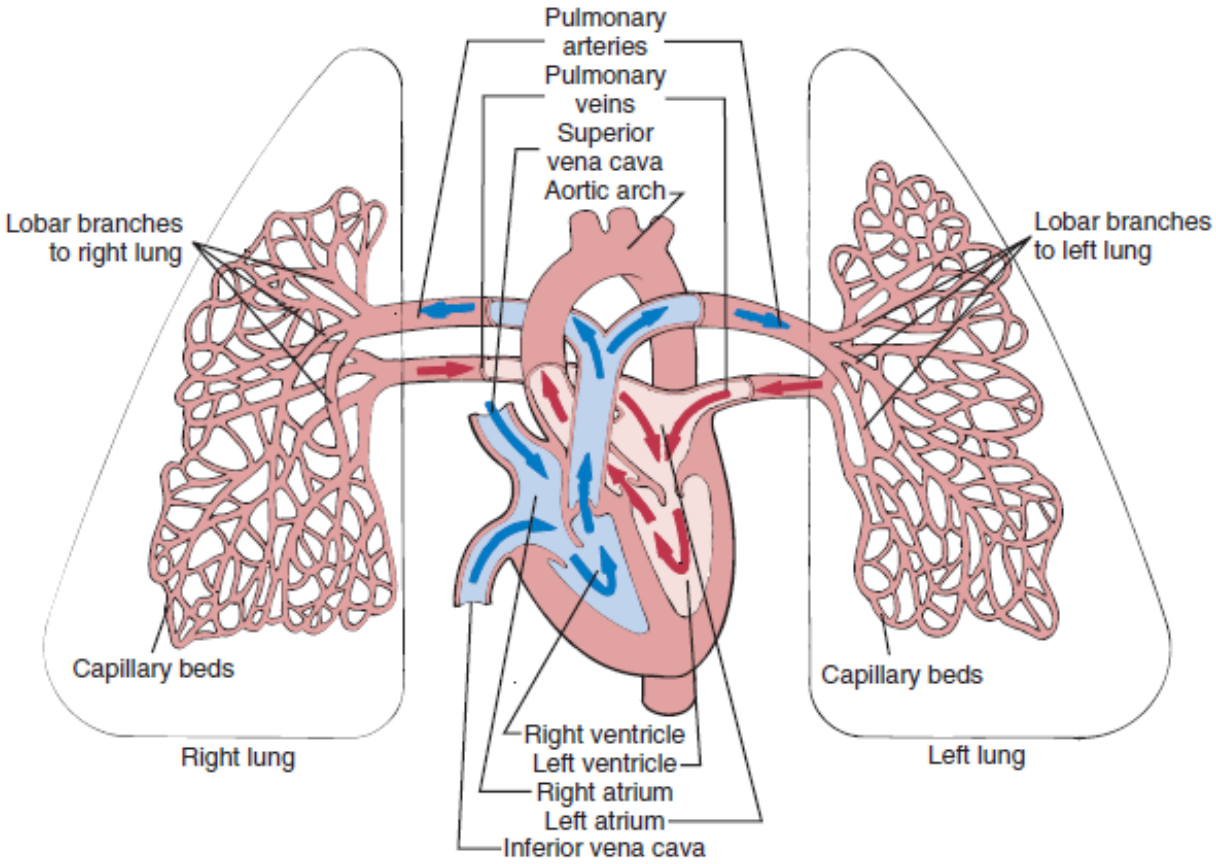

FIG. Schematic representation of blood flow through the heart. Arrows indicate direction of flow and pulmonary circulation.

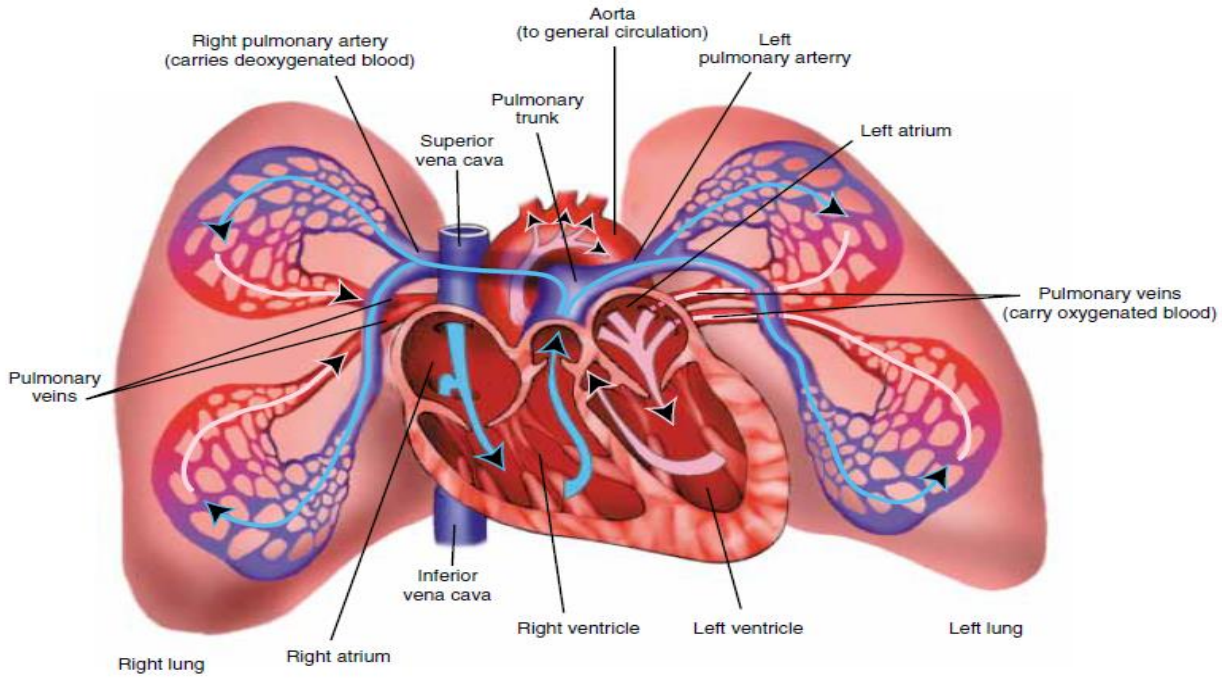

Figure 32-6 Major Structures of the Heart and Pulmonary Circulation

- **Cellular Respiration**

Gas exchange at the cellular level, like that at the alveolar level, takes place via diffusion in response to concentration gradients. Oxygen diffuses from the blood to the tissues, while carbon dioxide moves from the tissues to the blood; the blood is then reoxygenated by the heart. This process is referred to as internal respiration.

Normal Respiratory Values

The main goal of ventilation is to maintain normal levels of respiratory gases in arterial blood.

- **Arterial Carbon Dioxide ($PaCO_2$):** Normal range: **35–45 mmHg**
- **Arterial Oxygen (PaO_2):** Normal range: **80–100 mmHg**

These values are measured using **Arterial Blood Gas (ABG) analysis**.
Another important indicator is **oxygen saturation (SpO_2)** measured by a **pulse oximeter**.

- **Normal SpO_2: ≥ 95%**

Factors Affecting Oxygenation

1. Age

Age is an important factor that influences the efficiency of oxygenation. As individuals grow older, several physiological changes occur in the respiratory system. In older adults, the chest wall becomes less elastic and the thoracic cage may develop a **barrel-shaped appearance**, which requires greater effort during breathing. Additionally, the alveoli lose part of their elasticity, leading to reduced efficiency of gas exchange and a decrease in the partial pressure of oxygen in arterial blood.

Another important change with aging is the **reduced activity of the cilia** in the respiratory tract. Cilia normally help remove mucus, microorganisms, and foreign particles from the airway. When their activity decreases, older adults become more susceptible to respiratory infections such as pneumonia and **bronchitis**.

2. Environmental and Lifestyle Factors

Environmental conditions and lifestyle habits can significantly influence oxygenation status. Exposure to pollutants such as **dust, animal dander, asbestos, and toxic chemicals** in homes or workplaces can damage the respiratory tract and impair lung function.

Lifestyle factors also play an important role. Individuals experiencing **severe physical or emotional stress** may have altered breathing patterns that affect oxygenation. In addition, **obesity or being underweight** can influence respiratory efficiency. Obesity restricts chest expansion, while severe undernutrition may weaken respiratory muscles.

Smoking is one of the most important lifestyle factors affecting oxygenation. Cigarette smoke damages lung tissue, reduces ciliary activity, and increases mucus production. Therefore, healthcare providers should always assess **smoking history**, including the type of tobacco used, the number of cigarettes per day, and the duration of smoking exposure.

3. Increased Metabolic Rate

An increased metabolic rate raises the body's demand for oxygen.

This occurs during:

- Pregnancy
- Exercise
- Wound healing

Normally the body can meet these demands, but when it cannot, oxygen levels decline.

Fever

Fever increases:

- Tissue oxygen consumption
- Carbon dioxide production

If fever continues for a long period, the metabolic rate remains high and the body begins to break down protein stores. This leads to **muscle wasting**, including respiratory muscles such as the diaphragm and intercostal muscles.

To compensate, the body increases the **rate and depth of breathing**, which increases the **work of breathing (WOB)**. Eventually, symptoms of **hypoxemia** may appear, especially in patients with lung disease.

4. **Musculoskeletal Abnormalities**

Musculoskeletal disorders affecting the thoracic region reduce oxygenation by limiting chest expansion.

Examples include abnormalities of the rib cage or spine such as:

- Pectus excavatum
- Kyphosis
- Lordosis
- Scoliosis.

5. **Disease Processes**

Many disease processes can interfere with normal oxygenation. These diseases may affect one or more components of the oxygenation process, including ventilation, gas exchange in the alveoli, oxygen transport in the blood, or tissue perfusion.

Some of the most common disease conditions affecting oxygenation include:

- Obstructive pulmonary diseases
- Restrictive pulmonary diseases
- Diffusion defects
- Ventilation–perfusion mismatch
- Cardiovascular disorders
- Blood disorders such as anemia
- Atherosclerosis
- Heart failure
- alterations in oxygen uptake

Each of these conditions interferes with the body's ability to deliver sufficient oxygen to tissues.

- **Obstructive Pulmonary Disease**

Obstructive pulmonary diseases occur when airflow is partially or completely blocked, reducing the lungs' ability to expel air and causing air trapping. This limits fresh air from reaching the alveoli, impairing gas exchange.

Mechanism:

- Narrowing or obstruction of airways
- Loss of lung elasticity
- Air trapping in alveoli

Common Examples:

- Asthma
- Emphysema
- Chronic bronchitis

These conditions are collectively called **Chronic Obstructive Pulmonary Disease (COPD).**

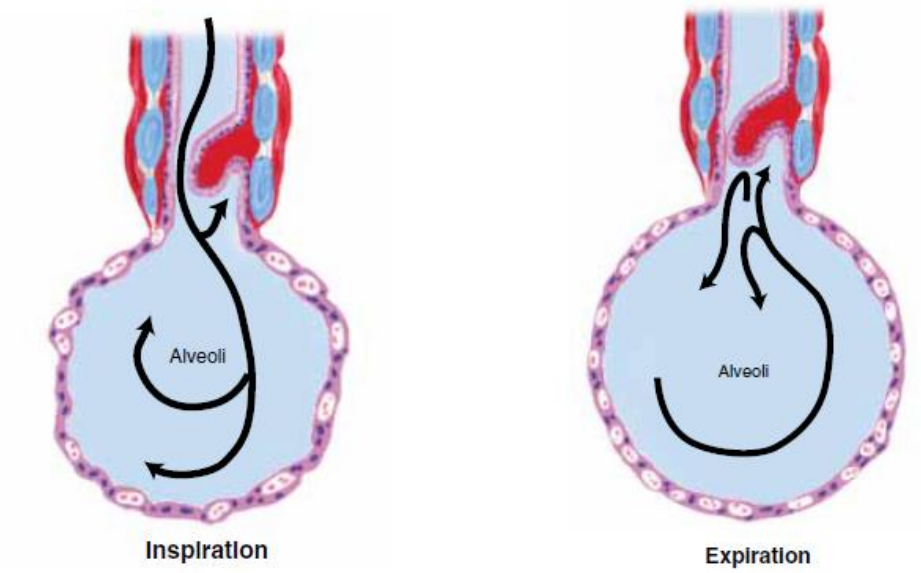

Figure 32-9 One mechanism of air trapping in COPD. During inspiration, the airway widens and opens. During exhalation, the airway closes, trapping air distal to the obstruction and preventing fresh air from entering the alveoli.

- **Restrictive Pulmonary Disease**

Restrictive pulmonary diseases limit the lungs' or chest wall's ability to expand during inspiration, decreasing lung volume and increasing the work of breathing.

Mechanism:

- Reduced lung compliance
- Increased effort required to breathe
- Decreased airflow into alveoli

Examples:

- Pneumonia
- Pulmonary fibrosis
- Thoracic injuries
- Pleural disorders

These conditions reduce air reaching the alveoli, impairing oxygenation.

Common Pleural Defects

Pleural Defect	Description
Pleural effusion	Collection of fluid between the pleural layers. May consist of serous fluid (hydrothorax), purulent fluid (empyema), or chyle (chylothorax).
Hemothorax	Collection of blood between the pleural layers.
Pneumothorax	A collection of air between the pleural layers caused by a hole in one or both layers of the pleural membrane. May be classified as *open* (communicating with a chest wall wound) or *closed* (no exterior wound).
Tension pneumothorax	A pneumothorax that rapidly expands with each respiratory cycle, compressing the lungs and heart and pushing the great vessels and trachea toward the opposite side of the chest. *A tension pneumothorax is a medical emergency requiring immediate intervention.*

- **Anemia and Circulatory Disorders**

  Oxygen transport depends on hemoglobin in red blood cells, which carries oxygen to tissues. Low hemoglobin levels, as seen in anemia, reduce the blood's oxygen-carrying capacity.

  Even with normal oxygen saturation, tissues may still receive insufficient oxygen if hemoglobin is inadequate.

- **Diffusion Defects**

  Diffusion defects occur when the transfer of oxygen from the alveoli into pulmonary capillary blood becomes impaired.

  Causes:
  - Thickening of alveolar-capillary membrane
  - Pulmonary edema
  - Pulmonary fibrosis

- **Ventilation–Perfusion Mismatch**

  Ventilation-perfusion mismatch occurs when the amount of air reaching the alveoli does not match the amount of blood flowing through the pulmonary capillaries.

- **Cardiovascular Disorders**

  Cardiovascular diseases may reduce oxygen delivery to body tissues due to impaired blood circulation.

- **Atherosclerosis**

  Atherosclerosis is the narrowing of arteries due to the accumulation of lipid and calcium deposits.

- **Heart Failure**

  Heart failure occurs when the heart cannot pump sufficient blood to meet the body's metabolic needs.

  Effects:
  - Reduced cardiac output
  - Pulmonary congestion
  - Pulmonary edema

- **Alterations in Oxygen Uptake**

  Some conditions impair the ability of body cells to utilize oxygen effectively.

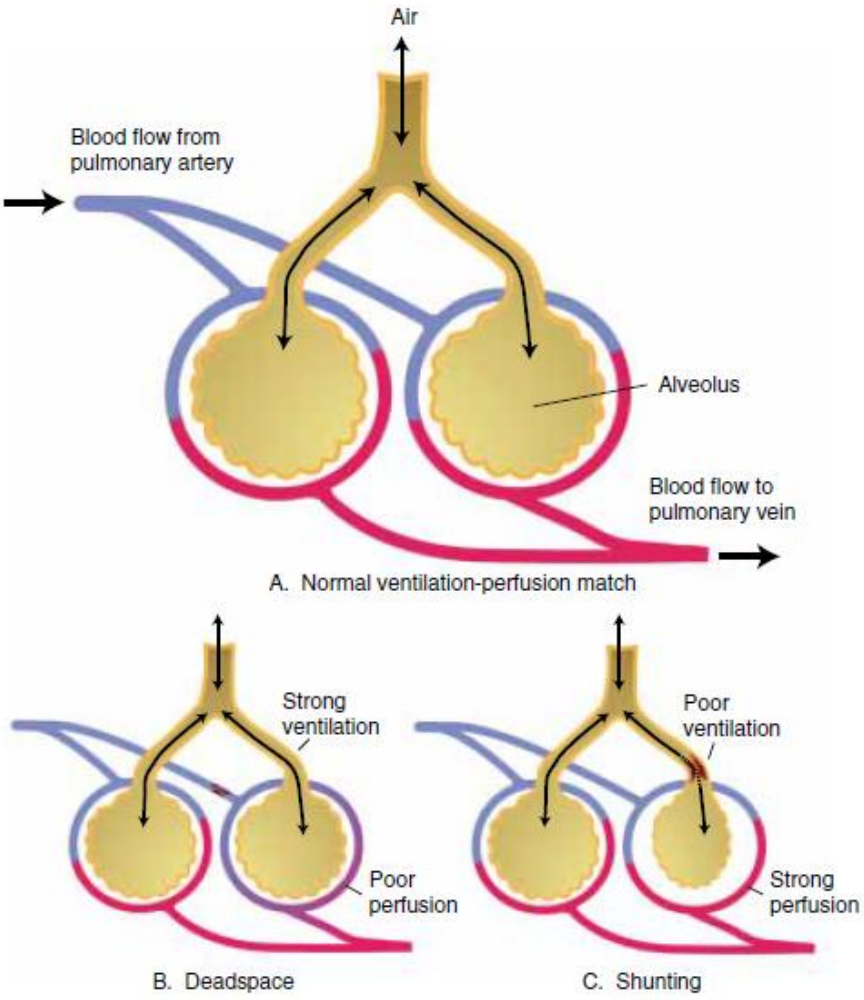

Figure 32-10 Types of Ventilation-Perfusion Abnormalities

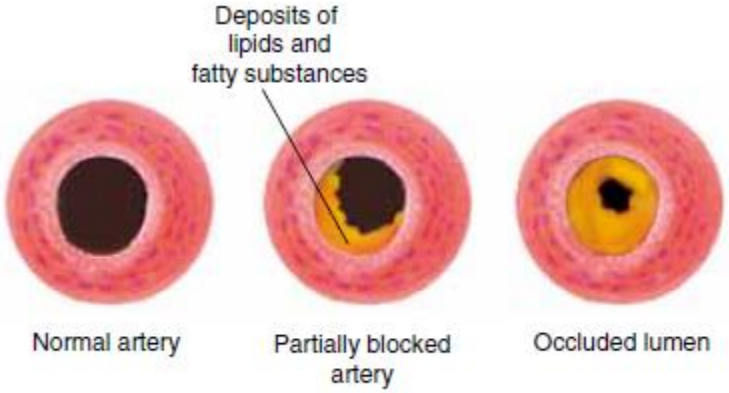

Figure 32-11 Progression of Atherosclerosis

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Physiological Responses to Reduced Oxygenation

When oxygen delivery to tissues becomes insufficient to meet metabolic needs, the body initiates several compensatory mechanisms to maintain cellular function and survival. These responses include:

- Increased oxygen extraction
- Shift to anaerobic metabolism
- Tissue ischemia and cell death if hypoxia persists

1. Increased Oxygen Extraction

Under normal conditions, body tissues do not use all the oxygen carried by arterial blood. Venous blood returning to the heart typically has about **75% oxygen saturation**.

When oxygen delivery decreases or tissue demand increases, cells compensate by extracting a greater proportion of oxygen from circulating blood.

Clinical significance: This is an early compensatory response to hypoxia.

2. Anaerobic Metabolism

Cells normally produce energy through **aerobic metabolism**, which requires oxygen.

When oxygen is insufficient, cells temporarily switch to **anaerobic metabolism**, producing energy without oxygen.

Limitations of Anaerobic Metabolism

1. **Not all cells can perform anaerobic metabolism**, especially brain cells.
2. **Produces less ATP** compared to aerobic metabolism.
3. **Accumulation of acidic byproducts**, such as lactic acid, disrupts the cell's chemical environment and triggers the release of lysosomal enzymes, which can damage cells.

3. Tissue Ischemia and Cell Death

Prolonged oxygen deprivation leads to failure of cellular metabolism. Reduced ATP production causes:

- Impaired cellular functions
- Cell membrane damage
- Cellular swelling
- Organelle destruction

Ultimately, cells die. Tissue death due to prolonged hypoxia is called **infarction**.

Examples:

- Myocardial infarction
- Cerebral infarction (stroke)

Severe and prolonged oxygen deprivation can lead to **multiple organ system failure**, a life-threatening condition.

Carbon Dioxide Transport and Excretion

Carbon dioxide (CO_2) is a natural byproduct of cellular metabolism, particularly glucose metabolism.

It is transported in the blood in three forms:

1. Dissolved in plasma
2. Bound to hemoglobin
3. As bicarbonate ions in plasma

In the lungs, CO_2 diffuses from blood into the alveoli and is exhaled from the body.

Role of Carbon Dioxide in Respiratory Regulation

CO_2 regulates breathing by combining with water to form **carbonic acid**, releasing hydrogen ions.

These hydrogen ions stimulate respiratory centers in the **medulla oblongata** and **pons**, increasing the rate and depth of breathing.

Increased CO_2 production, such as during fever or exercise, also increases ventilation.

Hypercapnia, or elevated blood CO_2, indicates **inadequate alveolar ventilation**.

Nursing Assessment of Oxygenation

Nursing assessment of oxygenation is a systematic process used to evaluate a patient's respiratory and cardiovascular status. The goal is to identify early signs of impaired oxygenation and prevent complications.

Assessment includes health history, physical examination, and diagnostic data.

Health History

Collecting a detailed health history is essential in identifying risk factors affecting oxygenation.

Key areas include:

- Respiratory conditions (asthma, COPD, infections)
- Cardiovascular diseases
- Smoking history
- Occupational exposure (dust, chemicals)
- Current medications
- Symptoms such as dyspnea, cough, chest pain

Common Symptoms of Oxygenation Problems

Patients with impaired oxygenation may present with:

- Dyspnea (shortness of breath)
- Orthopnea (difficulty breathing when lying down)
- Cough
- Wheezing
- Chest pain
- Fatigue

Health History Related to Oxygenation	
Presenting Problem	**Qualifiers**
Cough	Onset: sudden or gradual, how long ago Nature: dry, moist, barking, hacking, productive, nonproductive Pattern: continuous, occasional, related to time of day, position or activity, weather severity Associated symptoms: pain, shortness of breath, wheezing Alleviating factors: vaporizers, OTC medications
sputum	Amount, color, odor Presence of blood in sputum
Shortness of breath	Onset: sudden or gradual Nature: precipitated by choking or gagging Pattern: associated with activity or position; continuous or intermittent Associated symptoms: pain, cough, diaphoresis Alleviating factors
Pain	Location/radiation Nature: stabbing, dull, aching, burning, squeezing, crushing Associated symptoms: dizziness, nausea, diaphoresis, palpitations Aggravating factors Alleviating factors

Physical Examination

Inspection

Inspection involves observing the patient's general appearance and breathing pattern.

Key observations include:

- Respiratory rate and rhythm
- Use of accessory muscles
- Chest shape and symmetry
- Skin color (cyanosis, pallor)
- Level of consciousness

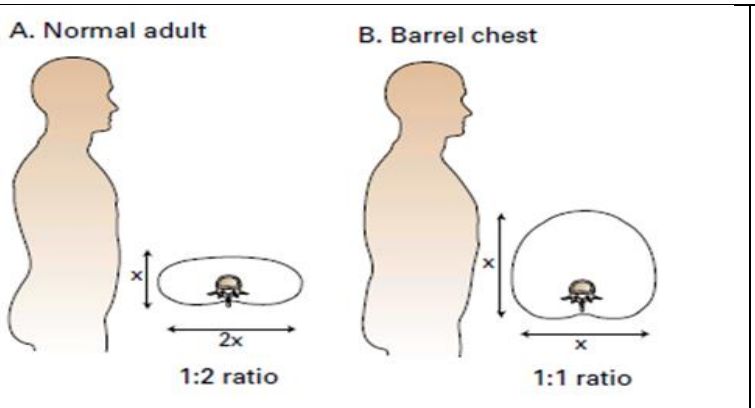

Figure 32-12 Changes in chest configuration and posture. The normal ratio of the anterior posterior diameter to the lateral diameter is 1:2. With a barrel chest, the ratio between the diameters is 1:1.

Figure 32-14 Clubbing of the Fingers as a Result of Chronic Hypoxia (Courtesy of Robert A. Silverman, M.D., Clinical Associate Professor, Department of Pediatrics, Georgetown University.)

Palpation

Palpation is used to assess chest expansion and detect abnormalities.
The nurse evaluates:

- Symmetry of chest movement
- Presence of tenderness
- Tactile fremitus (vibration during speech)

Percussion

Percussion helps assess underlying lung tissue.
Findings include:

- Resonance (normal lung)
- Dullness (fluid or consolidation)
- Hyperresonance (air trapping)

Auscultation

Auscultation involves listening to breath sounds using a stethoscope.

Normal breath sounds:

1. Vesicular
   - Description: Soft, low-pitched, rustling sounds.
   - **Location:** Heard over most of the lung fields, especially the peripheral (outer) areas.
   - Duration: Inspiration is longer than expiration.
   - Clinical Note: These are the most common normal lung sounds.
2. Bronchial
   - Description: Loud, high-pitched, hollow sounds.
   - **Location:** Heard over the trachea and large bronchi.
   - Duration: Expiration is longer than inspiration.
   - Clinical Note: Normally heard only over central airways. If heard elsewhere, it may indicate lung consolidation.
3. Bronchovesicular
   - Description: Medium-pitched, intermediate intensity sounds.
   - **Location:** Heard over the mid-chest area anteriorly and between the scapulae posteriorly.
   - Duration: Inspiration and expiration are about equal.
   - Clinical Note: These sounds are normal in the central chest regions.

Abnormal sounds:

Crackles (Rales)

- Sound: Fine or coarse popping, bubbling sounds.
- Timing: Usually during inspiration.
- Cause/Significance: Fluid in alveoli; may indicate pneumonia, heart failure, or pulmonary edema.

Wheezes

- Sound: Continuous, high-pitched, musical sound.
- Timing: Often expiration, sometimes inspiration.
- Cause/Significance: Narrowed airways; seen in asthma, COPD, or bronchospasm.

Rhonchi

- Sound: Low-pitched, snoring or gurgling quality.
- Timing: Usually during expiration.
- Cause/Significance: Secretions or obstruction in larger airways; may clear with coughing.

Pleural Friction Rub

- Sound: Harsh, grating, or squeaking.
- Timing: Both inspiration and expiration.
- Cause/Significance: Inflamed pleural surfaces rubbing; seen in pleuritis or pneumonia involving the pleura.

Vital Signs

Vital signs provide important information about oxygenation status:

- Respiratory rate
- Heart rate
- Blood pressure
- Temperature
- Oxygen saturation (SpO_2)

Pulse Oximetry

Pulse oximetry is a noninvasive method to measure oxygen saturation (SpO_2). Normal values typically range from 95% to 100%.
Values below normal indicate hypoxemia and require further evaluation.

Arterial Blood Gases (ABGs)

ABGs provide detailed information about oxygenation, ventilation, and acid-base balance.

Normal values:

- PaO_2: 80–100 mmHg
- $PaCO_2$: 35–45 mmHg
- pH: 7.35–7.45

Diagnostic Tests

Additional tests may include:

- Chest X-ray
- Pulmonary function tests
- CT scan

- Hemoglobin levels

Nursing Diagnosis

Nursing care of the client experiencing oxygenation problems should be prioritized based on the A-B-C format used in basic life support

1. Ineffective Airway Clearance
2. Ineffective Breathing Patterns
3. Impaired Gas Exchange
4. Decreased Cardiac Output
5. Ineffective Tissue Perfusion

Planning

Outcome identification and planning are essential steps in the nursing process for clients with oxygenation disorders. Goals should be **individualized according to the client's condition, abilities, and limitations**.

Expected outcomes are often achieved **gradually in small steps**, helping the client progress from one level of functioning to another without feeling overwhelmed.

Outcomes may be based on:

- **Physiological indicators** (respiratory rate, oxygen saturation, arterial blood gases)
- **Activity tolerance**
- **Client comfort**
- **Learning needs**

Outcomes should be directly related to the **assessment findings and nursing diagnosis**.

For example, if a client has a respiratory rate of **30 breaths per minute with shallow breathing**, the desired outcome may be a **respiratory rate of 20 breaths per minute or less with normal breathing and no retractions**, indicating improvement in the client's breathing pattern.

Nursing Interventions for Oxygenation

Nursing interventions for oxygenation aim to maintain or improve a patient's oxygen status, ensure adequate ventilation, and prevent complications such as hypoxia. These interventions include independent nursing actions, collaborative care, and patient education.

Positioning the Patient

Proper positioning enhances lung expansion and improves oxygenation.

Common positions include:

- Fowler's position
- Semi-Fowler's position

- Orthopneic position

Airway Management

Maintaining a patent airway is essential for effective oxygenation.
Interventions include:

- Proper head positioning
- Suctioning secretions when necessary
- Encouraging effective coughing

Breathing Exercises

Breathing exercises promote lung expansion and improve ventilation.
Types include:

- Deep breathing exercises
- Diaphragmatic breathing
- Pursed-lip breathing

Incentive Spirometry

- An incentive spirometer encourages deep breathing and prevents atelectasis, especially after surgery.
- Patients are instructed to inhale slowly and deeply using the device.

Oxygen Therapy

Oxygen therapy increases oxygen availability in the body.
Common delivery systems:

- Nasal cannula
- Face mask
- Venturi mask

Nurses must monitor oxygen saturation and ensure safe administration.

Hydration

Adequate hydration helps liquefy respiratory secretions, making them easier to expectorate.

Chest Physiotherapy

Chest physiotherapy facilitates the removal of secretions.
It includes:

- Postural drainage
- Chest percussion
- Vibration

Medication Administration

Medications used to improve oxygenation include:

- Bronchodilators
- Corticosteroids
- Antibiotics

Nurses should monitor therapeutic effects and potential side effects.

Monitoring and Evaluation

Continuous monitoring is essential to assess patient response.

Includes:

- Respiratory rate and pattern
- Oxygen saturation (SpO_2)
- Level of consciousness
- Arterial blood gases (ABGs)

Patient Education

Patient education is essential for long-term management.

Key topics:

- Smoking cessation
- Adherence to medications
- Breathing techniques
- Recognizing warning signs

Hypoxia

Hypoxia is **inadequate oxygen supply to tissues at the cellular level**. It is a **life-threatening condition** and can cause serious cardiac complications.

Causes of Hypoxia

Major causes include:

1. **Decreased hemoglobin level:** e.g., anemia
2. **Low concentration of inspired oxygen**: e.g., high altitude
3. **Inability of tissues to use oxygen**: e.g., cyanide poisoning
4. **Impaired diffusion of oxygen**: e.g., pneumonia
5. **Poor tissue perfusion**: e.g., shock
6. **Impaired ventilation**: e.g., rib fractures or chest trauma

Early Signs and Symptoms

- Apprehension
- Restlessness
- Difficulty concentrating
- Decreased level of consciousness
- Dizziness
- Behavioural changes
- Fatigue and agitation

Vital Sign Changes

- Increased **pulse rate**

- Increased **respiratory rate and depth**
- Blood pressure may initially **increase**

As hypoxia worsens:

- Respiratory rate may **decline due to respiratory muscle fatigue**

Cyanosis

Cyanosis is a **bluish discoloration of the skin and mucous membranes** caused by the presence of **deoxygenated hemoglobin**. It is considered a **late sign of hypoxia**.

Types of Cyanosis

Central Cyanosis

Seen in areas with high blood flow such as:

- Tongue
- Soft palate
- Conjunctiva of the eye

This indicates **true hypoxemia**.

Peripheral Cyanosis

Seen in:

- Extremities
- Nail beds
- Earlobes

Usually caused by **vasoconstriction or slow blood circulation** rather than true oxygen deficiency.

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Figure 32-27 Oxygen Delivery Systems: A. Nasal cannula; B. Single face mask; C. Open face tent; D. Reservior mask; E. Venturi mask.

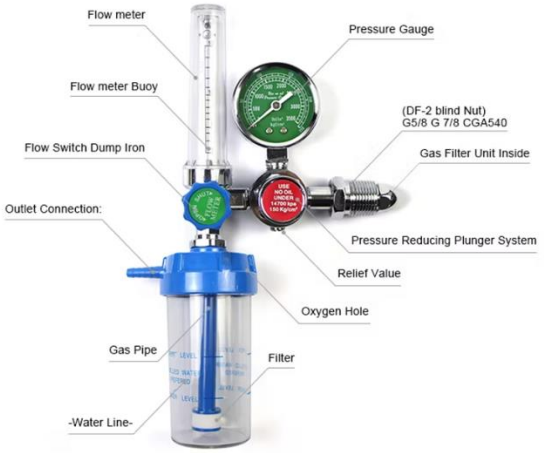

FIGURE 41-13 Volume-oriented incentive spirometer.

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TABLE 41-6 Positions for Postural Drainage—cont'd

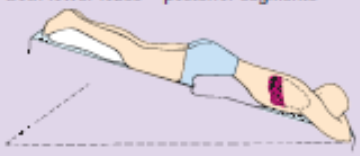
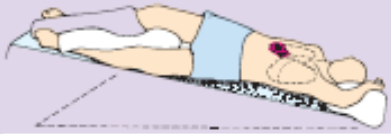
Lung Segment	Position of Patient	Lung Segment	Position of Patient
Left upper lobe—posterior segment 	Side-lying with left side of chest elevated on pillows	Both lower lobes—posterior segments 	Prone in Trendelenburg's position
Right middle lobe—anterior segment 	Three-fourths supine position with dependent lung in Trendelenburg's position		
Child			
Bilateral—apical segments 	Sitting on nurse's lap, leaning slightly forward flexed over pillow	Bilateral lobes—anterior segments 	Lying supine on nurse's lap, back supported with pillow
Bilateral—middle anterior segments 	Sitting on nurse's lap, leaning against nurse		

FIGURE 41-9 Chest wall percussion, alternating hand clapping against patient's chest wall.

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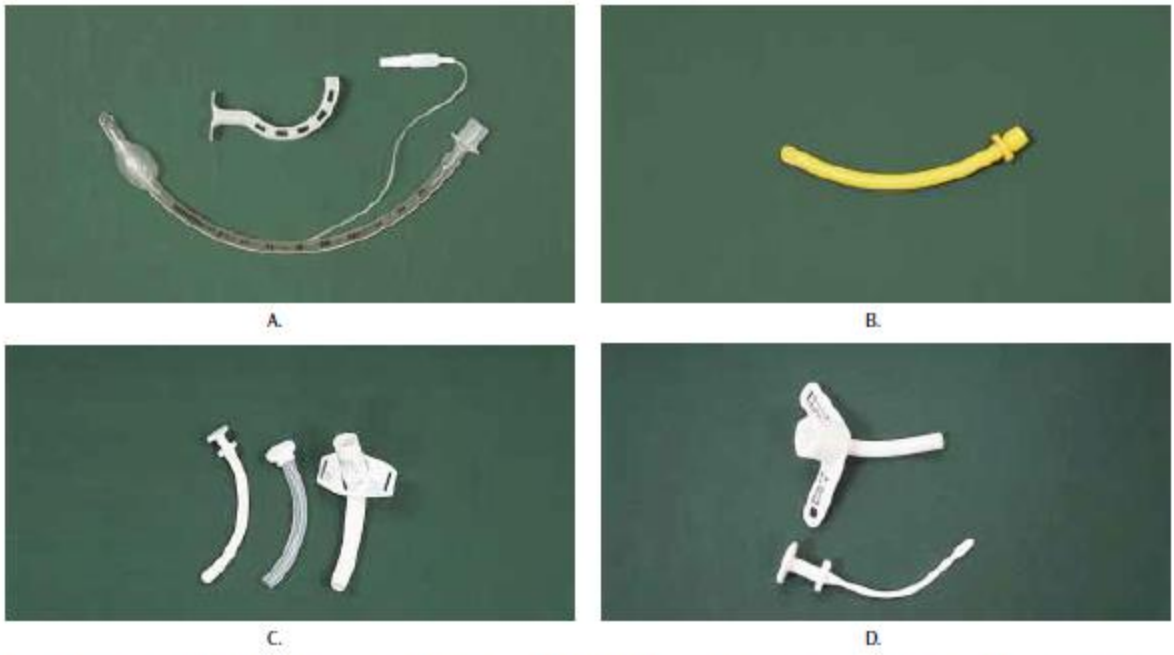

Figure 32-19 Types of Artificial Airways: A. Oral airway and endotracheal tube; B. Nasal trumpet; C. Tracheostomy tube; D. Pediatric tracheostomy tube.

FIGURE 41-11 Artificial oral airways.

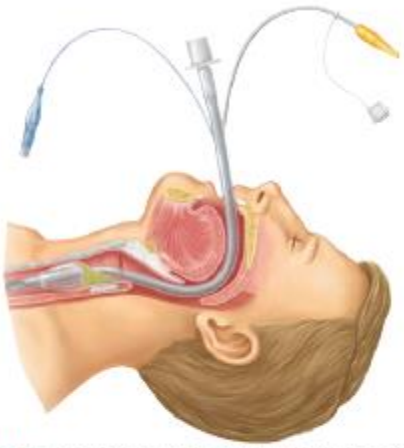

FIGURE 41-12 Endotracheal tube inserted into trachea. Cuff inflated to maintain position. (Copyright © 2015 Medtronic. All rights reserved. Used with the permission of Medtronic.)

FIGURE 41-14 CPAP mask.

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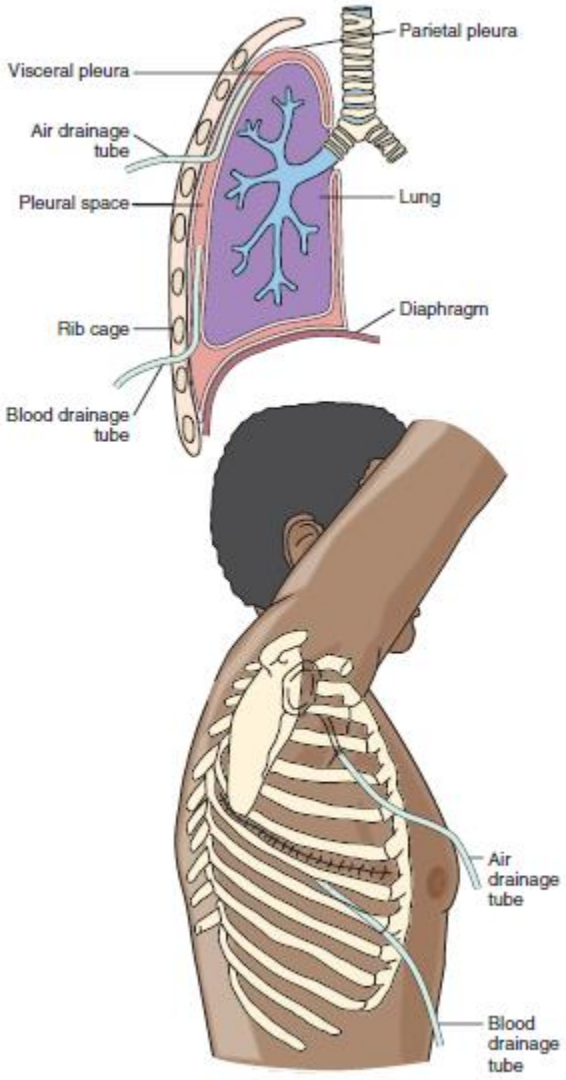

FIGURE 41-15 Chest tube placement.

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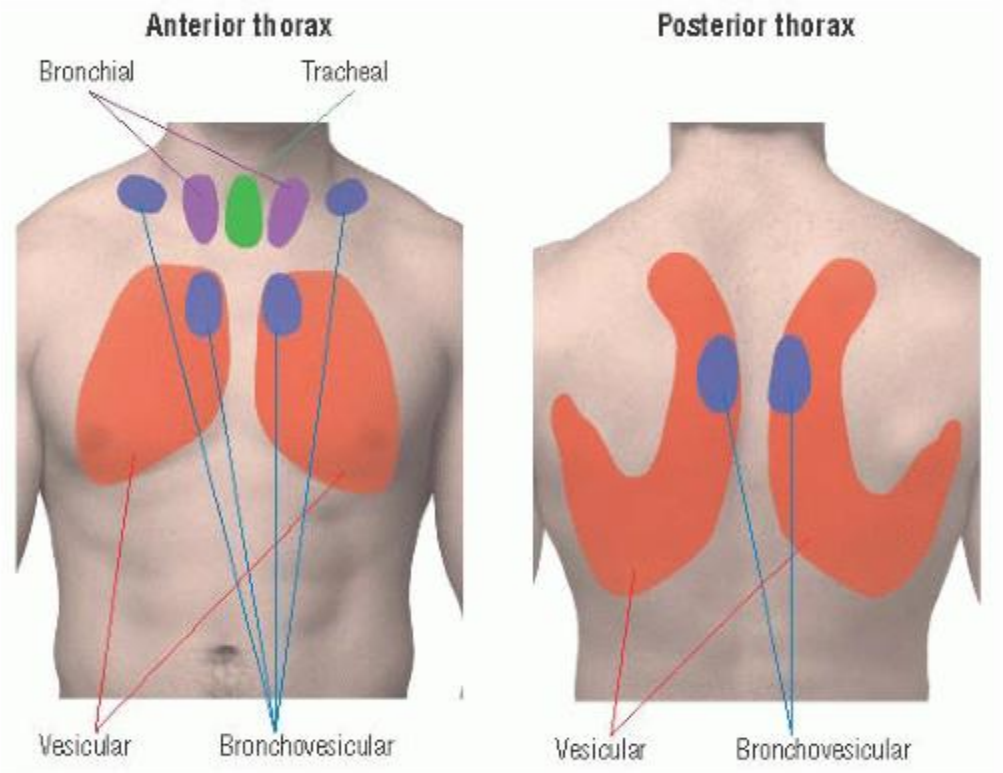

Auscultatory sites for normal breath sounds heard over other chest wall areas