Purpose of the Respiratory System

- The respiratory system is responsible for moving air in and out of the airways (ventilation).
- The upper respiratory system = warms and filters air.
  - Traps particulate matter in the mucus of the airways and propels it toward the mouth for elimination by coughing or swallowing.
- The lower respiratory tract/lungs = gas exchange.
  - The lungs, in conjunction with the circulatory system, deliver oxygen to and expel carbon dioxide from the cells of the body.

Structures of the Upper Respiratory Tract

- Nose
- Sinuses and nasal passages
- Pharynx
- Tonsils and adenoids
- Larynx: epiglottis, glottis, vocal cords, and cartilages
- Trachea
Upper Respiratory System

Paranasal Sinuses

Cross-Section of Nasal Cavity
Functions of upper respiratory system structures

• **Nose**
  - Secrets mucous through goblet cells
  - Moves mucous using cilia
  - Filters impurities and humidifies and warms the air
  - Responsible for smell = olfactory receptors
  - This diminishes with age.

• **Sinuses**
  - Bony cavities lined with mucosa and ciliated epithelium
  - Connected to drain in the nasal cavity
  - Resonating chamber for speech
  - Common site of infection

• **Turbinates (Conchae)**
  - Curved surface allows inhaled air to meet a larger membrane surface and thus traps unwanted dust and organisms.
  - Moistens, warms, and aids in smell and sneezing.

• **Pharynx**
  - Pharynx connects the nose and oral cavities to the larynx
  - Divided into nasal, oral, and laryngeal.
  - Epiglottis is the entrance to the larynx

• **Tonsils and Adenoids**
  - Tissue that encircles the throat
  - Important in protecting the body from organisms entering through the nose

• **Larynx**
  - "voice box"
  - Connects what?
  - Functions: vocalization, protection of lower airways, and facilitates coughing
  - Structures
    - Epiglottis (covers larynx during swallowing).
    - Glottis, Thyroid cartilage, cricoid cartilage, vocal cords.

• **Trachea**
  - "windpipe"
  - Smooth muscle with rings of cartilage
  - Connect larynx to the bronchi
Structures of the Lower Respiratory System

- **Lungs**
  - Pleura-serous membrane lining
  - Mediastinum-middle of thorax that contains thoracic tissue outside the lungs
  - Lobes of the lungs:
    - Left: upper and lower
    - Right: upper, middle, and lower
- **Bronchi and bronchioles-see Figure 21-4**
- **Alveoli**
  - Type I – epithelial cells that form the walls
  - Type II-secrete surfactant that line the inner surface and prevent collapse
  - Type III – macrophages that ingest foreign matter and act as a defense.
**Functions of the Respiratory System**

- **Oxygen Transport**
  - $O_2$ from the blood to the cells
  - $CO_2$ from the cells to the blood
- **Respiration**
- **Ventilation**
- **Diffusion**
- **Ventilation and Perfusion Balance**
- **Gas Exchange**
- **$CO_2$ transport**
- **Neurological control of ventilation**

**Respiration**

- The process of gas exchange between atmospheric air and the blood at the alveoli, and between the blood cells and the cells of the body.
- Exchange of gases occurs because of differences in partial pressures and to match the elimination of $CO_2$ and supply of oxygen to meet metabolic needs.
  - An increase in PCO2 causes acidosis. Receptors in the brain and structures adjacent to blood vessels respond to this and stimulate ventilation.
- Oxygen diffuses from the air into the blood at the alveoli to be transported to the cells of the body.
- Carbon dioxide diffuses from the blood into the air at the alveoli to be removed from the body.
Respiration Continued

- Respiration is controlled by:
  - the Central Nervous System, specifically the_________.
  - The stimulation of receptors from inhaled irritants and mucus stimulates the cough reflex.
  - Changes in partial pressures of oxygen and carbon dioxide affect respiration as mentioned earlier.

Ventilation: the movement of air in and out of the airways.

- The thoracic cavity is an airtight chamber. The floor of this chamber is the diaphragm.

- Things that affect ventilation:
  - Compliance: the ease with which the lung expands
    - Diseases that cause fibrosis of the lungs result in "stiff" lungs with low compliance. These require high inspiratory pressures to achieve a set volume of gas. (atelectasis & CF)
    - Diseases that damage the elastic structure of the walls cause "floppy" lungs with greater compliance. Low pressures can achieve the same volume of air during inspiration, but passive exhalation is impaired. (emphysema)

Ventilation Continued

- Surface tension
  - Is the result of the air-liquid interface at each alveolus.
  - Type II Cells in the alveolar lining produce surfactant that lowers surface tension and thus increase compliance and aid ventilation. A deficiency of surfactant result in stiff/noncompliant lungs.

- Muscle effort
  - Muscle contraction enlarges the thorax on inspiration causing alveolar pressure to become lower than the atmospheric pressure, and air flows into the lungs.
  - Muscle contraction on expiration resists lung tissue and increases alveolar pressure above atmospheric pressure and causes air to move out of the lungs.
  - Forced expiration and coughing use accessory muscles to decrease the size of the thoracic space and cause expiration.

- Airway Resistance
  - This will impede air flow and change ventilation
Ventilation Overview

- Inspiration: contraction of the diaphragm (movement of this chamber floor downward) and contraction of the external intercostal muscles increases the space in this chamber. Lowered intrathoracic pressure causes air to enter through the airways and inflate the lungs.
-Expiration: with relaxation, the diaphragm moves up and intrathoracic pressure increases. This increased pressure pushes air out of the lungs.Expiration requires the elastic recoil of the lungs.
- Inspiration normally is 1/3 of the respiratory cycle and expiration is 2/3.

Gas Exchange and Respiratory Function

- Ventilation is the movement of air in and out of the lungs.
- Perfusion is the filling of the pulmonary capillaries with blood.
- Adequate gas exchange depends upon an adequate V/Q ratio, a match of ventilation and perfusion.
- Air must reach the alveoli to be available for gas exchange.
- Shunting occurs when there is an imbalance of ventilation and perfusion. This results in hypoxia.
Ventilation-Perfusion Ratios:
A- Normal Ratio
B- Shunts
C- Dead Space
D- Silent Unit

Regulation of Acid-Base Balance
- Gas exchange helps maintain the acid-base balance of the body.
- Changes in the CO2 level in the blood result in either respiratory acidosis or alkalosis.
  - Insufficient ventilation causes a buildup of CO2, respiratory acidemia, called __________.
  - Hyperventilation causes low amounts of CO2 and respiratory alkalemia, called ___________.
- Thus, the effectiveness of ventilation can be measured by the amount of PCO2 in the arterial blood.
  - Normal PCO2=35-45 mm Hg
  - If this number is >45 what does this indicate?
  - What factors might increase this number?

Neurologic control of breathing
- The phrenic nerve stimulates respiratory cells.
- The medulla and pons control the rate and depth of ventilation.
  - Apneustic center = responsible for deep, prolonged inspirations.
  - Pneumotaxic center = controls the patterns of respiration.
Lung Capacities:

- Tidal volume (TV): air volume of each breath
- Inspiratory reserve volume (IRV): maximum volume that can be inhaled after a normal inhalation
- Expiratory reserve volume (ERV): maximum volume exhaled after a normal exhalation.
- Vital capacity (VC): the maximum volume of air exhaled from a maximal inspiration, VC = TV + IRV + ERV
- Forced expiratory volume (FEV): volume exhaled forcefully over time in seconds. Time is indicated as a subscript, usually 1 second.

Measurement of Volume and Inspiratory Force

- A spirometer measures volumes of air exhaled and is used to assess lung capacities.
- When assessing TV, measure several breaths. TV varies from breath to breath.
- Pulmonary function tests (PFTs) assess respiratory function and determine the extent of dysfunction.
- Peak flow rate reflects maximal expiratory flow and is frequently done by patients using a home spirometer.

Inspiratory Force

- Evaluates the effort of the patient in making an inspiration.
- A manometer that measures inspiratory effort can be attached to a mask or endotracheal tube to occlude the airway and measure pressure.
- Normal inspiratory pressure is approximately 100 cm H2O.
- Force of less than 25 cm usually requires mechanical ventilation.
Effects of Aging

- Most changes occur in the lower airway.
- Movement of cilia in the upper airway slows and becomes less effective
  - This predisposes older adults to increased respiratory infections.
- Lungs become rounder and alveolar air decreases.*
- Alveolar walls lose elasticity.
  - This decreases lung function
- There is an increased incidence of true emphysema and a greater prevalence of chronic cough and sputum production. This suggests that environmental or occupational pollutants, in addition to the normal aging process, may be a component in the decline of lung function.

Assessment

Respiratory History

- Need information about present condition and previous respiratory problems
- Detail and time taken depend on the client's condition
- Ask questions in the context of the client's daily activities.
  - Example?
Respiratory History

- Biographical and demographic data
- Current health
  - Chief complaint: common = dyspnea, cough, sputum production, hemoptysis, wheezing, stridor, and chest pain.
- Symptom Analysis
- OLDCART
- Past health history
  - Childhood and infectious diseases
  - Immunizations
  - Major illnesses and hospitalizations
  - Medications
  - Allergies

Respiratory History

- Family Health history
- Psychosocial History
  - Occupation
  - Geographic location
  - Environment
  - Habits
  - Exercise
  - nutrition

Physical Exam review

- Utilize the techniques of inspection, palpation, percussion, and auscultation.
- Always compare findings on one side to those on the other side.
- INSPECTION
  - s/r respiratory distress
  - 1:2 ration normal length of inspiration is half that of expiration, normal ratio is 1:2
  - Observe the speech pattern/LOC/orientation
  - Condition and color of skin
  - Head and neck (nose, nasopharynx, sinuses, smell)
  - Chest wall configuration
    - AP diameter
    - Barrel chest, pigeon chest, funnel chest, thoracic kyphoscoliosis, and chest movement
    - Fingers and toes*
Physical Exam Review

- PALPATION
  - Trachea
  - Chest wall
  - Thoracic excursion
  - Tactile fremitus

- PERCUSSION (types of sounds) Table 21-4 pg. 574
  - Resonant
  - Hyperresonant
  - Dull
  - Flat
tympanic

Physical Exam Review

- AUSCULTATION
  - On bare chest
  - For a full respiratory cycle at each location
  - Normal sounds: Table 21-5 p. 575
    - Vesicular
    - Bronchial
    - Bronchovesicular
    - Absent/diminished

- AUSCULTATION CONT'
  - Adventitious sounds (Table 21-6)
    - Crackle
    - Rhonchi
    - Wheezes
    - Pleural friction rubs
  - Voice Sounds
    - Bronchophony
    - Egophony
    - Whispered pectoriloquy
Diagnostic Tests

- Pulse Oximetry
- Pulmonary function tests
- Arterial blood gases
- V/P Lung Scan
- Chest x-ray
- Fluoroscopic studies and angiography
- Computed tomography (CT)
- Magnetic resonance imaging (MRI)
- Ultrasonography
- Gallium Scans
- Sputum tests

Diagnostic Tests

- Bronchoscopy
- Laryngoscopy
- Alveolar Lavage
- Thoracotomy
- Thoracentesis
- Pleural Biopsies
- Lung Biopsies

Diagnostic Test Worksheets