Summary

- Upper Respiratory System
- Lower Respiratory System
- Gross Anatomy of the Lungs
- Ventilation/Respiration
- Respiratory Muscles
- Resistance/Compliance
- Gas Exchange

Understanding respiratory mechanics concepts

- Starts with understanding of the individual components that support the act of breathing
- Understanding the differences between the spontaneous and mechanical ventilation.

Upper Respiratory System

- Three major categories
  - Nose and Nasal Cavity
  - Pharynx
  - Larynx

Pharynx:
- Nasal Pharynx
- Oropharynx
- Laryngopharynx

Larynx:
- "Voice Box"
- Ciliated Mucous Membrane
- Filters & Humidifies

Epiglottis
- Moves up & down during swallowing to prevent food or liquid from entering the trachea

Vocal Cords
- Vibrate to create phonation

Lower Respiratory System

Trachea:

Bronchi:
- 2 mainstem bronchi
- bronchioles (5-19)
- terminal bronchioles
  - Cartilage is present down to approx. 1.0 mm in diameter (terminal bronchi)

Lungs:
- Large enough to fill pleural division of thoracic cavity
- Cone shaped organs
- Location: Extends from base, on diaphragm, to apex located slightly above the clavicles

Alveolar ductus and alveolar sacs:

Alveolar walls:
- Major area of gas exchange
- Gas exchange is via passive diffusion from areas of a higher to lower pressure, what it depends on is the partial pressure of the different gases
- Two types of cells (Pneumocytes) that make up the alveolar walls:
  1. Type I cell - Squamous
  2. Type II cell - Granular

Bronchioles:
- Its hallmark is the absence of cartilage
- Terminal bronchioles = approx. 0.5mm diameter
- Anatomical dead space - No gas exchange
- Terminal bronchioles divide into Respiratory bronchioles (12-19) (transitional zone, conducting gas exchange alveolar sacs).
Pneumocytes - Alveoli

Squamous Pneumocytes
- Very thin & flat cells
- Alveolar Macrophages
  - Arise from bone marrow
  - Phagocytic

Granular Pneumocytes
- More cuboidal cells
- Proliferate in case of injury & give rise to new Type I cells
- Origin of Surfactant

Surfactant
- Reduces surface tension
- Helps prevent alveolar collapse

Macrophages
- Scavenger cells
- Protect against bacteria & other infective organisms that bypass the upper respiratory tract

Capillaries
- Surround each alveolus
- Center of gas exchange

Lung Divisions

- Three lobes in right, two in left
- Root consist of primary bronchus & pulmonary artery & veins, bound together by connective tissue
- Hilum is vertical slit on medial surface, through which root structures enter the lung
- Covering - visceral pleura

- Furnish place where large amounts of air and blood can come in close enough contact for rapid exchange of gases to occur.

Chest anatomy:

- 3 main component groups:
  - Tissue that supports (structure) - ribs, cage structures. Pleura (protects lung tissue from frictional damage during breathing)
  - Tissue that acts (muscle group, diaphragm) - generate pressure changes for moving gas in/out
  - Tissue that react (lung, heart) - mechanisms of gas exchange

Rib cage dynamics

- Rib cage - configuration that is constantly tensioned to spring outward
- Balance preventing collapse
- Isolated lung tissue, left unsupported, tends to contract due to the elastic forces

Spontaneous Breathing

When the diaphragm contracts, the area in the chest cavity is enlarged — drop in pressure — air moves through the tracheobronchial tree — alveoli (enhancement of venous return to heart)

Expiration: passive action — diaphragm relaxes — returns to its resting position — reduces the volume of the chest — increase pressure — forces the gas out of the lung

Respiration

Exchange of oxygen and carbon dioxide between the organism and the external environment:
- Can be defined as: The exchange of oxygen and carbon dioxide in the lung and at the body cell
- Can be classified as: *External Respiration* - exchange at the alveolus
  *Internal Respiration* - exchange at the cellular level
Mechanically assisted ventilation

- Ventilator generates a rise in chest pressure forcing gas into lungs by mechanical means.
- Opposite of normal course of inspiration.
- Increased chest pressure may act on the heart, circulation, decrease venous return.
- Increased pressure reduces normal efficiency of pulmonary circulation.

Mechanical-Spontaneous breath

- Pressure Difference
- Volume Change
- Gas Flow
- Pressure Difference

Compliance

\[ C = \frac{\Delta V}{\Delta P} \]

Airway Resistance

- “The Feature of the Tube”

\[ R = \frac{dP}{dF} \]

Arterial Blood Gases

- Arterial sampling has proven to be a very important diagnostic tool.
- Obtained from the Radial, Brachial, or Femoral arteries.
- Arterial Blood - vessels that carry oxygenated blood away from the heart, except pulmonary artery.
- Venous Blood - vessels that carry deoxygenated blood towards the heart, except pulmonary veins.
- pH reflects the degree of acidity or alkalinity.
- PaCO2 reflects the respiratory system.
- HCO3 reflects the metabolic system.
### Normal Blood Gas Parameters

<table>
<thead>
<tr>
<th></th>
<th>Arterial</th>
<th>Mixed Venous</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pH, units</strong></td>
<td>Normal: 7.40</td>
<td>Normal: 7.36</td>
</tr>
<tr>
<td></td>
<td>Range: 7.35-7.45</td>
<td>Range: 7.31-7.41</td>
</tr>
<tr>
<td><strong>PCO2, mmHg</strong></td>
<td>Normal: 40</td>
<td>Normal: 46</td>
</tr>
<tr>
<td></td>
<td>Range: 35-45</td>
<td>Range: 41-51</td>
</tr>
<tr>
<td><strong>PO2, mmHg</strong></td>
<td>Normal: 97</td>
<td>Normal: 40</td>
</tr>
<tr>
<td></td>
<td>Range: 80-100</td>
<td>Range: 35-40</td>
</tr>
<tr>
<td><strong>O2Sat, %</strong></td>
<td>Normal: 97</td>
<td>Normal: 75</td>
</tr>
<tr>
<td></td>
<td>Range: 95-100</td>
<td>Range: 70-75</td>
</tr>
<tr>
<td><strong>HCO3, mEq/L</strong></td>
<td>Normal: 24</td>
<td>Normal: 24</td>
</tr>
<tr>
<td></td>
<td>Range: 22-26</td>
<td>Range: 22-26</td>
</tr>
<tr>
<td><strong>BE, mEq/L</strong></td>
<td>Normal: 0</td>
<td>Normal: 0</td>
</tr>
<tr>
<td></td>
<td>Range: +2</td>
<td>Range: +2</td>
</tr>
</tbody>
</table>

### Interpretation

- **pH:**
  - Elevated = alkalosis (> 7.45)
  - Reduced = acidosis (< 7.35)

- **PO2:**
  - High = hyperoxemia (>100 mmHg)
  - Low = hypoxemia (<80 mmHg)

- **PCO2:**
  - Elevated = hypercapnia (>45mmHg)
  - Reduced = hypocapnia (<35mmHg)

- **BE:**
  - Elevated = alkalosis (> +2 mEq/L)
  - Reduced = acidosis (< -2 mEq/L)