Bio 2341 Study Aid to Accompany Chapter 22: Respiratory System

Respiratory system anatomy is being covered in lecture and lab. Lecture focuses on histology and histologic changes in the conducting passages starting with the nasal cavity and following the passageways to the respiratory bronchioles. Lab focuses on mainly on macroscopic anatomy. Table 22.1 provides a list of the Principal Organs of the Respiratory System.

The next major concept is the function of the alveoli in gas exchange including their high surface area, surfactant production to prevent them from collapsing, and their protection via macrophages.

The gas laws are introduced to offer understanding of how lungs inflate, deflate, and perform gas exchange. The body uses air pressure differences and gas partial pressure differences to move air through passageways and gases across membranes. Figure 22.13. Changes in thoracic volume and sequence of events during inspiration and expiration clearly demonstrates why lungs inflate and deflate. Figure 22.17. Partial pressure gradients promoting gas movements in the body helps you understand the movements of gases from blood to tissues and vice-versa based on an analysis of partial pressures.

Oxygen transport is accomplished by hemoglobin but the binding of oxygen to hemoglobin varies based on local pO$_2$, blood pH, and local tissue temperatures. CO$_2$ has a direct impact on blood pH and a key role in the stimulation of respiratory reflexes. Blood pO$_2$ has less of a role than you might think, only really affecting respiratory reflexes when values are very low. Hemoglobin saturation curves demonstrate that function of the proteins in hemoglobin is altered by surrounding chemistry, pH and temperature. See the Focus explanation, Figure 22.20.

The chemistry of CO$_2$ in blood is presented. CO$_2$ is carried in the blood three ways. pCO$_2$ also has a direct effect on the ability of hemoglobin to carry O$_2$. Therefore, tissues where pCO$_2$ is high will be perfused with O$_2$ more readily (in addition to pH decrease, heat, and low pO$_2$. See Figure 22.22 Transport and exchange of CO$_2$ and O$_2$.

The role of the autonomic and conscious brain in respiratory movements is presented. Note that the autonomic system is the controller over normal rates and depths of respiration. However, the cerebrum can alter normal rates via conscious control and anticipation. The hypothalamus will modify rates in response to pain and emotional events. Chemoreceptors in brain and elsewhere will respond into increasing CO$_2$ waste by stimulating changes in the pontine and medullary pace setting centers. Stretch receptors and irritant receptors will also alter respiratory function by controlling depth of breathing and efforts to clear respiratory passages of irritants.

Finally, the respiratory volumes and capacities are presented.

Vocabulary is needed to understand and explain concepts. Sample vocabulary includes:

- cellular respiration
- internal respiration
- external respiration
- ventilation
- olfaction
- conducting zone
- respiratory zone
- pharynx
- carina
- bronchus
- parietal pleura
- visceral pleura
- cardiac notch
- lobe
- segment
- lobule
- mediastinum
- apex
- base
- hilum
- vibrissae
- Eustachian
tube/pharyngotympanic tube
- epiglottis
- laryngeal prominence
- thyrohyoid membrane
- vocal folds
- glottis
- trachealis
- trachea
- pseudostratified ciliated
- epithelium
- goblet cells
- seromucous glands
- hyaline cartilage
- stroma
- alveolus
- Type I alveolar (pneumocyte) cell
- Type II alveolar (pneumocyte) cell
- alveolar pores
- pleural cavity
- transpulmonary
- intrapleural
- intrapulmonary
- inspiration
- expiration
- partial pressure
- hemoglobin
- oxyhemoglobin
- deoxyhemoglobin
Major concepts that you must remember and understand include:

- Students must understand the difference between respiration and ventilation.
- The anatomical and functional differences of the upper and lower respiratory systems.
- The three areas of the pharynx.
- Orientation and location of lungs in the thorax including number of lobes.
- Function of the nasal conchae and nasal meatuses and overall function of the nasal cavity.
- Description of defenses against particulates and infectious agents in the nasal cavity.
- Function of the eustachian tubes.
- Organization of the larynx.
- Protection of the larynx from entry of food or drink.
- The difference between vocal folds and vestibular folds.
- Layers of trachea and respiratory tubes: mucosa, submucosa, adventitia.
- Organization of the conducting zone passages; histologic changes as the passages get smaller and highly branched. Names of each of these passageways.
- Thickness of the blood-air barrier = 0.5 µm
- Composition of an alveolus: cell types
- Function of surfactant released by Type II cells.
- Pressures acting on the lungs in the thoracic cavity.
- The aspect of lung function that Boyle’s law applies to. The relationship between Boyle’s law, thoracic volume changes, and contraction of respiratory muscles.
- Muscles of inspiration: diaphragm, scalenes, sternocleidomastoid, pectoralis minor, erector spinae.
- Application of Dalton’s law of partial pressure to respiratory physiology.
- Application of Henry’s law to gas exchange; partial pressure gradients and movement of gasses dissolved in liquids.
- Hemoglobin is nearly saturated with oxygen at the lungs where pO₂ is high, blood is cooler and the blood pH more normal. Hemoglobin has reduced ability to bind oxygen at the tissues where the pO₂ is lower, blood is warmer, and blood pH is lower. AKA blood comes to near saturation at the lungs but loses much oxygen in working muscle.
- Physiology and locations of CO₂ transport in blood, conversions, binding, loading, unloading.
- Pulmonary reserve capacity.
- Location and function of autonomic respiratory centers in the brain.
- Location of central and peripheral chemoreceptors monitoring blood pH, pCO₂, and pO₂.
- Effect of anticipation, emotion, and pain on respiratory rate and depth.
- Understanding and explanation of respiratory volumes including residual volume and inspiratory and expiratory reserves.

Concepts you should learn on your own:
- Homeostatic imbalances of the respiratory system.
- Hypocapnia and hypercapnia.
- Respiratory adjustments to high altitude

Concepts you can skip:
- Developmental aspects of the respiratory system.