Respiratory Physiology

Respiration

- _____ – breathing – air movement
- _____ – gas exchange between pulmonary blood and alveoli
- Respiratory _____ – transport via bloodstream
- _____ – gas exchange between capillary blood and tissue cells

- _____ = process by which gases flow between the atmosphere and the pulmonary alveoli (breathing)
  - Consists of inhalation and subsequent exhalation.
- _____ ***Breathing*** = normal, unforced breathing
- **Mechanism of Breathing:**
  - Depends on _____ changes in thoracic cavity
  - Volume changes lead to _____ changes, which lead to flow of gases to equalize the pressure

Inspiration

- During quiet breathing, inspiration is driven by:
  - Diaphragm contracts by flattening and moves _____
  - External intercostals (between the ribs): _____ and moves sternum forward

- During deep inhalations, the scalene, sternocleidomastoid, and pectoralis minor muscles become involved
  - this gets the rib cage to expand further than normal

- Thoracic cavity _____ in size and since lungs are attached to walls it too increases in size

- Intrapulmonary _____ increases as gas within lungs spreads out

- _____ in gas pressure in lungs (lower than atmosphere pressure) causes air to be _____ the lungs to _____ the pressure

Expiration

- *Passive process* during quiet breathing: requires _____
  - The elastic recoil of the chest wall and the return of the diaphragm to its resting position are enough to drive it.

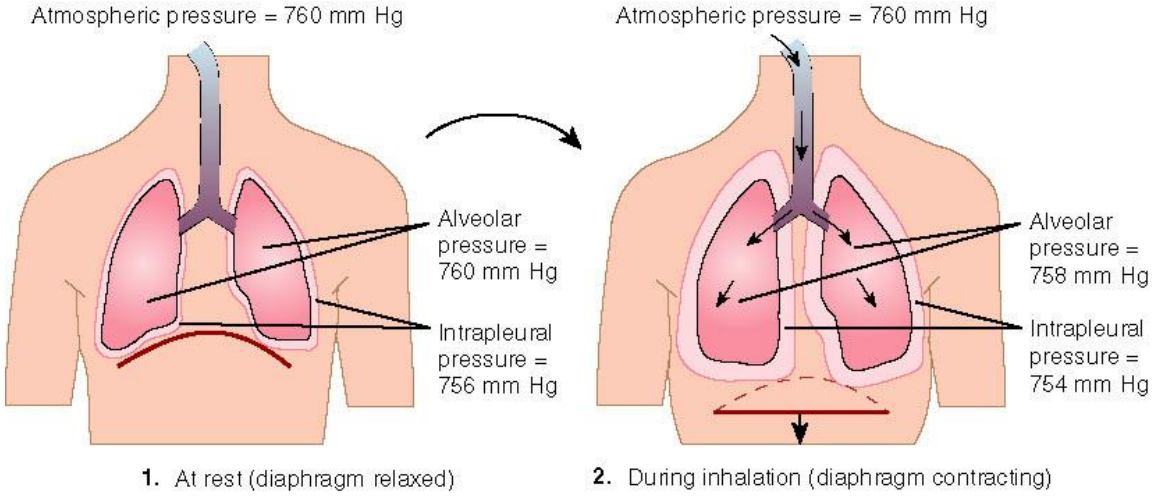
- Alveoli also have natural recoil, but the *surfactant* that is lining the inner walls keeps it from collapsing.

- Intrapulmonary _____ _____ to higher than atmospheric pressure and gases flow out to equalize the pressure

- If bronchioles become narrowed or clogged (asthma or pneumonia), expiration becomes _____
  - During forced exhalation (sneezes, coughs, exercise) the internal intercostals, obliques, and rectus abdominis contract to compress the rib cage and force the diaphragm upwards.

Pressure Changes During Breathing:

As inhalation and exhalation occur, pressure differences between the body and the atmosphere drive air either _____ of the lungs.



Note: The pleural cavity maintains pressure about 4 mmHg LOWER than atmospheric pressure. This is to ensure that the alveoli, even after exhalation, are

_____

_____

Gas Exchange

- Based on the laws of _____ _____ – gases will diffuse according to the pressure that they alone are exerting within a mixture.

- **External respiration:** exchange between the lungs and bloodstream
  - Converts deoxygenated blood arriving through the pulmonary arteries to _____ blood
  - Blood dumps off carbon dioxide at the same time.
  - Each of these processes occurs _____ – it is not truly an exchange as it is labeled.

- **Internal respiration:** exchange of gases between the _____ and the systemic _____.

- Both processes are driven by the *partial pressures* of oxygen and carbon dioxide in their respective locations.
  - The diffusion of _____ does not influence the diffusion of _____, and vice versa.

Factors that affect external respiration:

1) ***Partial pressure (concentration) of gases*** – if the partial pressure of the gases on the outside of the body changes, the _____ of gas exchange will be affected.

   – Ex: *altitude changes* – as altitude increases, the _____ decreases, as do the partial pressures.

   – The partial pressure of oxygen, though it remains 20.9% of the inhaled air, sinks from 159 mmHG at sea level to 110 mmHg at 10,000 ft. and 73 mmHg at 20,000 ft.

2)***Surface area*** – if surface area of alveoli decreases, then _____ _____ will take place.

- This is why emphysema, smoking, and respiratory diseases are so dangerous. Emphysema, for example, causes alveolar walls to disintegrate.

normal 

 emphysema

3) ***Diffusion distance*** – the _____ the gases have to diffuse, the slower they'll go.

- Buildup of the alveolar wall or pulmonary fluid (edema) can significantly increase this distance.

Transport of gases in the blood:

- **Oxygen transport:** carried out by both _____ and blood plasma…
  - Oxygen dissolves very poorly in water, so only about 1.5% of the oxygen that blood carries is in the plasma
  - The remaining 98.5% is bound to hemoglobin

$$Hb + O_2 \rightleftharpoons HbO_2$$

**Remember that each hemoglobin has four iron atoms, and can therefore bind four oxygen molecules.

- Binding of oxygen with hemoglobin is dependent on the partial pressure of oxygen
  - The _____ the pressure, the more _____ oxygen binds.
  - If the oxygen pressure is low, Hb will _____ oxygen (happens in the systemic capillaries)

- Other factors also effect the release of oxygen by hemoglobin:
  - **Carbon dioxide levels** – higher CO_2 levels promote the _____
    - Tissues outputting a large amount of CO_2 will receive more oxygen from bloodstream
  - **Acidity** – _____ causes hemoglobin to release oxygen more readily
    - Active muscles produce lactic acid therefore blood will release more oxygen into the tissue
  - **Temperature** – _____ temperature means higher oxygen release
    - Active tissues generate heat → more oxygen to active tissues

- **Carbon Dioxide Transport:** CO_2 makes its way through the bloodstream in three forms:
  - **Dissolved in plasma** - about 9% is directly dissolved into blood plasma. In the alveolar capillaries it passes straight into the alveoli and is exhaled
  - **Bound to hemoglobin** - about 13% binds to the amino groups of proteins in the blood; hemoglobin is the most abundant of these.
  - _____ - most CO_2 is transported as bicarbonate (HCO_3^-), which is a result of carbon dioxide combining with a water molecule in solution

Respiratory Sounds

- _____

  _____

- Bronchial sounds – air through large passageways (trachea and bronchi)
- Vesicular sounds – air filling the alveoli (muffled breeze)
- Blocked airways can lead to rasping sounds or wheezing

Non-respiratory Air Movements

- Cough – taking a deep breath, closing glottis (space between vocal folds), and forcing air superiorly from lungs against glottis. Then, glottis opens suddenly and a blast of air rushes upward. Coughs clear _____ respiratory passageways
- Sneeze – similar to cough, except air is directed through nasal cavity. _____ closes oral cavity. Sneezes clear _____ respiratory passages.
- Crying – inspiration followed by release of air in a number of short breathes. Emotionally induced

- Laughing – same as crying in terms of air movements. Emotionally induced
- Hiccups – sudden inspirations resulting from _____.

  Initiated by irritation of diaphragm or phrenic nerve. Sound occurs when inspired air hits vocal cords of closed glottis.
- Yawn – very deep inspiration. Formerly believed to be triggered by need for more oxygen, but this theory is now being questioned.

  _____

Lung Volumes and Capacities

- _____ **Volume:** volume of a normal breath during quiet breathing.

- _____ **Ventilation:** total volume of air inhaled and exhaled per minute - (breathing rate X tidal volume)
  - Only about 70% of each inhaled breath actually makes it into the alveoli. The rest is ***anatomic dead space***, as there is no gain from having fresh air in these areas

- _____ **Volume:** the extra volume inspired if you take a “deep breath”

- _____ **Volume:** the extra volume expired if you try to push all the air out of your lungs.

- _____ **Volume:** remains in the lungs even after you've breathed "all the way out".

- _____ **:** the max amount of air that can be exhaled after maximum inhalation

- _____ **:** total volume lungs can hold. Averages about 6 liters.

Control of Respiration:

The Respiratory Center: consists of groups of neurons in the medulla and the pons (brain stem)

- **Phrenic and intercostal nerves –** transmit impulses from brain to diaphragm and other muscles
- _____ **–** self-exciting inspiratory center sets basic rhythm of breathing
- _____– smoothes out basic rhythm that medulla sets

- At rest, the tissues use about 200 mL of oxygen each minute. During exercise, this consumption rate can increase 20 to 30 fold.

- **Eupnea** – normal respiratory _____ respirations per minute

- Point when inspiration stops and expiration starts in due to stretch receptors in alveoli
  - Respond to _____

- During exercise – we breathe faster and deeper because of increase in signals from the brain
  - After strenuous exercise, expiration becomes active

Regulation of the Respiration:

1. _____ **Factors –** talking, coughing, and exercise
2. **Volition (_____ Control)** –This is the voluntary control which you have over your breathing rate such as singing,
   - This is NOT absolute, you can't hold your breath, or breathe too deeply, forever. Influences of the chemical receptors become to powerful and overtake the voluntary controls.
3. _____ ***factors*** – anticipation or anxiety may stimulate the limbic system, which will cause an increase in rate and depth of ventilation

4. _____ – receptors in the body monitor levels of three quantities within the bloodstream: the partial pressures of oxygen and carbon dioxide, and the pH

- A low pH or O2 level, or a high CO2 level (*hypercapnia*), will result in ***hyperventilation***
  - an increase in the breathing rate.

5. _____ – higher body temp will increase respiratory rate.

- Also, sudden cold stimulus will temporarily cause breathing to cease (apnea)

6. _____ – as soon as vigorous activity starts, breathing rate increases BEFORE levels of O2, CO2, or pH change.
   - This is because proprioceptors notice the activity in joints and muscles, and stimulate the inspiratory area.
7. _____ – Sudden, severe pain causes brief apnea
8. _____ ***of the airways*** – will, obviously, cause breathing to stop, or significantly decrease.
   - Usually triggers coughing/sneezing as well.

Disorders

- Cleft palate – genetic defect in which bones forming _____ fail to fuse and leads to difficulty with breathing and chewing
- _____ – inflammation of nasal mucosa due to cold viruses
- _____ – inflamed sinuses and can lead to sinus headaches
- Tonsillitis – inflammation of the tonsils
- Tracheostomy – surgical opening of trachea to aid in breathing

- Pleurisy – inflammation of the pleura which causes a decrease in pleura fluid and leads to _____ and pain with breathing
- Atelectasis – _____
- Pneumothorax – presence of _____ in intrapleural space
- _____ – cessation of breathing
- _____– difficulty or labored breathing
- Cyanosis – insufficient oxygen in the blood
- Asthma – chronically inflamed, hypersensitive bronchial passageways; responds to irritation

- Chronic obstructive pulmonary disease (COPD)
  - _____ – alveoli enlarge and break; lungs become less elastic and airways become blocked; hard to exhale (uses a lot of energy)
  - _____– mucosa in lower respiratory tract becomes inflamed and pooled mucus impairs ventilation
- Lung Cancer – _____ of all cancer deaths in US
  - Squamous cell carcinoma – in larger bronchi and form masses that hollow out and bleed
  - Adenocarcinoma – peripheral areas of lungs
  - Small cell carcinoma – starts in primary bronchi and grow into clusters in mediastinum

- Cystic Fibrosis – genetic disorder that over secretes _____ that clogs passageways; can lead to death in children (every day 2 children die from CF)

- Sudden Infant Death Syndrome (SIDS) – some cases result from problems with _____, but 1/3 is due to heart rhythm abnormality