Anatomy and Physiology 1 Final Exam - Figueroa

Respiratory System

- Major Functions:
  - provide blood with oxygen (O2) and to get rid of/ dispose of carbon dioxide (CO2)
  - gas exchange is simple diffusion
  - In order for respiration to occur, 4 processes must happen
    - 1) Pulmonary ventilation (aka breathing)- the moving of air into and out of the lungs
      - see "pulmonary" think "lungs"
    - 2) External respiration- gas exchange between the lungs and blood
    - 3) Transport of respiratory gases
    - 4) Internal respirations- movement of O2 from the blood to the tissue cells AND the movement of CO2 from the tissue cells to the blood
- Respiratory membrane has 3 main parts
  - 1) wall of the capillary
  - 2) wall of the alveolus
  - 3) the space between these two walls

- Conducting Zone (the function is to conduct air to the respiratory zone)
  - considered "conducting zone" because NO alveoli (so no actual gas exchange occurs in the conducting zone)
  - Bronchi
    - subdivided into Secondary Bronchi, each supplying a lobe of the lungs
    - there are 23 orders of branching in the lungs that air must pass through
    - contain cartilage
  - Bronchial Tree
    - Bronchi split into Bronchioles
    - bronchioles contain a layer of smooth muscle and lack cartilage support
  - NOTE: big tubes of the conducting zone contain cartilage, small tubes lack cartilage
  - Bronchi -> Secondary Bronchi -> Tertiary Bronchi -> Bronchioles -> Terminal Bronchioles
- Respiratory Zone
  - begins as the terminal bronchioles feed into Respiratory bronchioles
  - **alveoli are present**
  - Terminal bronchioles -(start)-> Respiratory bronchioles -> Alveolar ducts -> Alveolar sacs -> Alveoli
  - alveoli are the smallest, alveolar sacs are made up of alveoli, etc
  - O2 goes from high -> low, so if take a deep breath, have high O2 in lungs/tubes, which then travels to the blood where O2 levels are low
    - hence: simple diffusion
  - There are ~ 300 million alveoli
    - this makes up most of the lungs' volume
    - there are tiny sacs on alveoli (don't confuse with with alveolar sacs) which account for a greater surface area for gas exchange
    - **capillaries cover alveoli**
      - 6 capillaries cover the alveoli
  - Air-Blood Barrier

- The Alveolar walls and Capillary walls are fused at their basal laminas...making the Air-Blood Barrier
- there is fluid between the lungs and the blood capillaries
- O2 diffuses into the cells and CO2 diffuses out of the cells
- Alveolar wall:
  - made up of a single layer epithelial cells
  - allows gas exchange to occur via simple diffusion
  - secretes ACE (angiotensin converting enzyme)

- Blood Circulations to the Lungs
  - two circulations: Pulmonary and Bronchial
  - Pulmonary arteries- supply systemic blood to be oxygenated
  - Pulmonary veins- carry oxygenated blood from respiratory zones to the heart

- Breathing (aka Pulmonary Ventilation)
  - *** different than respiration
    - Ventilation = breathing
    - Respiration = the gas exchange aspect
  - two phases
  - 1) Inspiration : air flows into the lungs
    - aka inhalation
  - 2) Expiration: gases exit the lungs
    - exhalation
  - Mechanical process that depends on volume changes in the thoracic cavity
  - by moving the diaphragm, the pressure in the cavity changes
  - the lower the volume = higher pressure
    - pressure and volume are INVERSELY related
  - Inspiration (diaphragm)
    - diaphragm contracts (moves DOWN) during inspiration
    - changes in the anterior- posterior and superior-inferior dimensions
      - ribs elevated and sternum expands as external intercostals contract
  - diaphragm and abdomen contract at OPPOSITE times
  - Expiration (abdominal muscle)
    - abdomen contracts during expiration
    - diaphragm relaxes (moves UP) and the rib cage descends due to gravity
    - Thoracic cavity volume decreases
    - lungs recoil passively and intrapulmonary volume decreases
    - Ppul rises above Patm (+1mm) causing air to leave the lungs (hence why expiration) -> gas flows out of the lungs until Ppul is ZERO (0)
  - During normal quiet inhalation: the diaphragm and external intercostals contract
  - During labored inhalation: sternocleidomastoid, scalenes, and pectoralis minor ALSO contract
  - During normal exhalation: the diaphragm and external intercostals relax
  - During forceful exhalation : abdominal and internal intercostal muscles contract

- Pressure Relationships
  - Respiratory pressure is measured relative to Atmospheric pressure (Patm)
  - Atmospheric pressure (Patm) = 760mm at sea level

- this is the pressure exerted by the air surrounding the body
- negative respiratory pressure = less than Patm
  - leads to inhalation so that air can go from high pressure (outside the body) to low pressure (inside the body)
- positive respiratory pressure = greater than Patm
  - leads to exhalation so that air can go from high pressure (inside the body) to low pressure (outside the body)

- Ppul = intrapulmonary pressure and Pip = intrapleural pressure
  - "pul" = PULmonary
  - Ppul and Pip fluctuate with the phases of breathing
  - Ppul always will eventually equalize with Patm
  - Pip is always LESS than Ppul and Patm
- if the pressure INSIDE falls -> air flows IN (inhalation)
  - volume increases
  - NEED a difference of 3mm (-3mm) compared to Patm in order to inhale
  - ex. Outside = 760mm .....Inside = ~757mm
- if the pressure INSIDE rises -> air flows OUT (exhalation)
  - volume decreases
  - NEED a positive difference of 3mm (+3mm) compared to Patm in order to exhale
  - ex. Outside = 760mm ..... Inside = ~763mm
- Two forces act to pull lungs away from the thoracic wall, promoting the lung collapse
  - Elasticity of the lungs causes them to assume smallest possible size
  - Surface tension of alveolar fluid draws alveoli to their smallest size possible
- Opposing force- elasticity of the chest wall pulls the thorax outward to enlarge the lungs

- Lung Collapse
- caused by the equalization of the Pip with the Ppul
- Transpulmonary pressure keeps the airways open
  - Transpulmonary pressure- difference btwn the intrapulmonary and intrapleural pressures (Ppul - Pip)

- Physical Factors Influencing Ventilation: Airway Resistance
- Air flow is directly related to the difference in pressure
- Air flow is inversely related to the tube resistance (diameter accounts for this)
  - the smaller the diameter = the bigger the resistance
    - can NOT change the diameter of the BIG tubes with cartilage
    - SMALLER tubes have smooth muscle so you CAN change the diameter of those tubes
      - bronchial dilation
- Friction is the major NONelastic source of resistance to airflow
- F = (delta P) / R
  - F = flow
  - P = pressure
  - R = resistance
- the amount of gas flowing into and out of the alveoli is directly proportional to the (delta P)
  - delta P = the pressure gradient btwn the atmosphere and alveoli
- ** the greatest resistance is in the medium-sized bronchi **
- as airway resistance increases, breathing becomes more strenuous