

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 laminae...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
 - P_{pul} rises above P_{atm} (+1mm) causing air to leave the lungs (hence why expiration) -> gas flows out of the lungs until P_{pul} 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 (P_{atm})
 - Atmospheric pressure (P_{atm}) = 760mm at sea level

- this is the pressure exerted by the air surrounding the body
 - negative respiratory pressure = less than P_{atm}
 - 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 P_{atm}
 - leads to exhalation so that air can go from high pressure (inside the body) to low pressure (outside the body)
 - P_{pul} = intrapulmonary pressure and P_{ip} = intrapleural pressure
 - “pul” = PULmonary
 - P_{pul} and P_{ip} fluctuate with the phases of breathing
 - P_{pul} always will eventually equalize with P_{atm}
 - P_{ip} is always LESS than P_{pul} and P_{atm}
 - if the pressure INSIDE falls -> air flows IN (inhalation)
 - volume increases
 - NEED a difference of 3mm (-3mm) compared to P_{atm} in order to inhale
 - ex. Outside = 760mmInside = ~757mm
 - if the pressure INSIDE rises -> air flows OUT (exhalation)
 - volume decreases
 - NEED a positive difference of 3mm (+3mm) compared to P_{atm} 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 P_{ip} with the P_{pul}
 - Transpulmonary pressure keeps the airways open
 - Transpulmonary pressure- difference btwn the intrapulmonary and intrapleural pressures ($P_{pul} - P_{ip}$)
- 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 (ΔP)
 - ΔP = 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