Anatomy of The Respiratory System & Partial Pressures

(Text Pg 120 – 124)

The respiratory system is composed of structures that allow the **passage of air** from outside the body to the lungs as well as structures that allow for **gas exchange** to occur.

3 Main Functions of the Respiratory System

1. Supply O_2
2. Remove CO_2
3. Regulate blood pH

The structures of the respiratory system are divided into two main zones:

A) Conductive Zone:

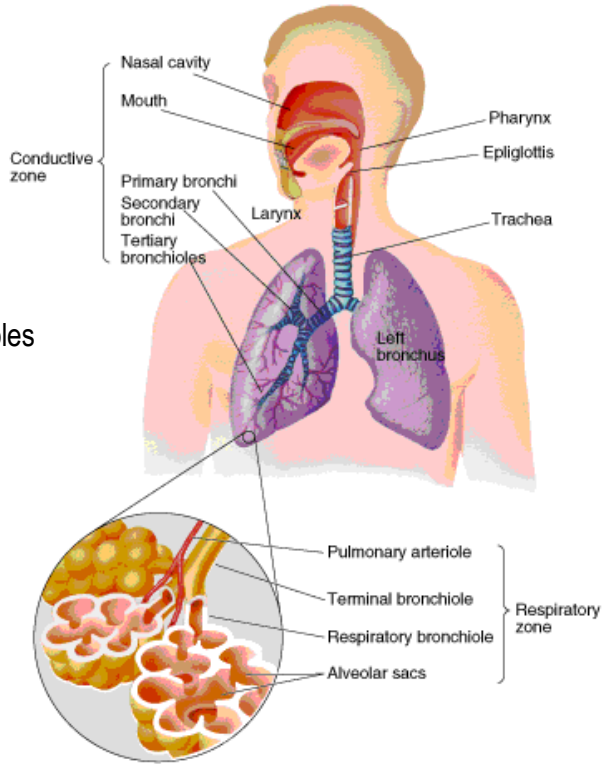
The combination of all the structures that convey air from the outside of the body to the lungs

Purpose:

- Transport air to the respiratory zone
  - ***Filter*** incoming air
  - ***Humidify*** incoming air
  - ***Warm*** the inspired air

Structures include:

- Mouth & Nose
- Pharynx
- Larynx
- Trachea
- Bronchi
- Bronchioles



B) Respiratory Zone

The structures that are involved with the exchange of gases between inspired air and the blood

- Terminal Bronchiole
- Respiratory Bronchioles
- Alveolar ducts
- Alveoli

Purpose:

- Rapid Gas exchange (O_2 & CO_2) via diffusion
  - Alveoli = functional unit (1 cell thick membrane)
  - 300 million = ~ 2800 square feet of surface area
  - Alveoli are covered with capillaries (1 cell thick membrane)

DEMO: Holding Your Breath

- Lets Hold Our Breath for as long as we can!
  - How were you feeling when you had to stop? What makes us want to take our next breath?

Physiology of Respiration (Respiratory Control Centres**)**

- The main stimulus to breathe is the level of CO_2 in the blood. As CO_2 levels rise, the ***Medulla Oblongata*** (respiratory control center in the brain) triggers:
  - An increase in the breathing ***Frequency (F)***
  - An increase in the ***DEPTH*** of each breath know as the **Tidal Volume *(V_T)***
    - ✓ Both remain elevated until the level of CO_2 returns to acceptable levels.
- The ***Pons*** fine tunes our breathing rate (smoothes out the transition between inhalation and exhalation)

Atmospheric air is a mixture of three key gases

- Oxygen (O_2) = 20.93% pO2 = 159.1 mmHg
- Carbon Dioxide (CO_2) = 0.03% pCO2 = 0.23 mmHg
- Nitrogen (N_2) = 79.04% pN2 = 600.7 mmHg

Three Rules That Determine Gas Movements For Breathing

1. Gasses move from high to low **pressure** (Law of partial pressures).
2. Gasses move from **high concentration** to **low concentration.**
3. Gasses move within the body by means of **diffusion.** (as the concentration gradient increases, greater rates of diffusion are observed)

Henry's Law

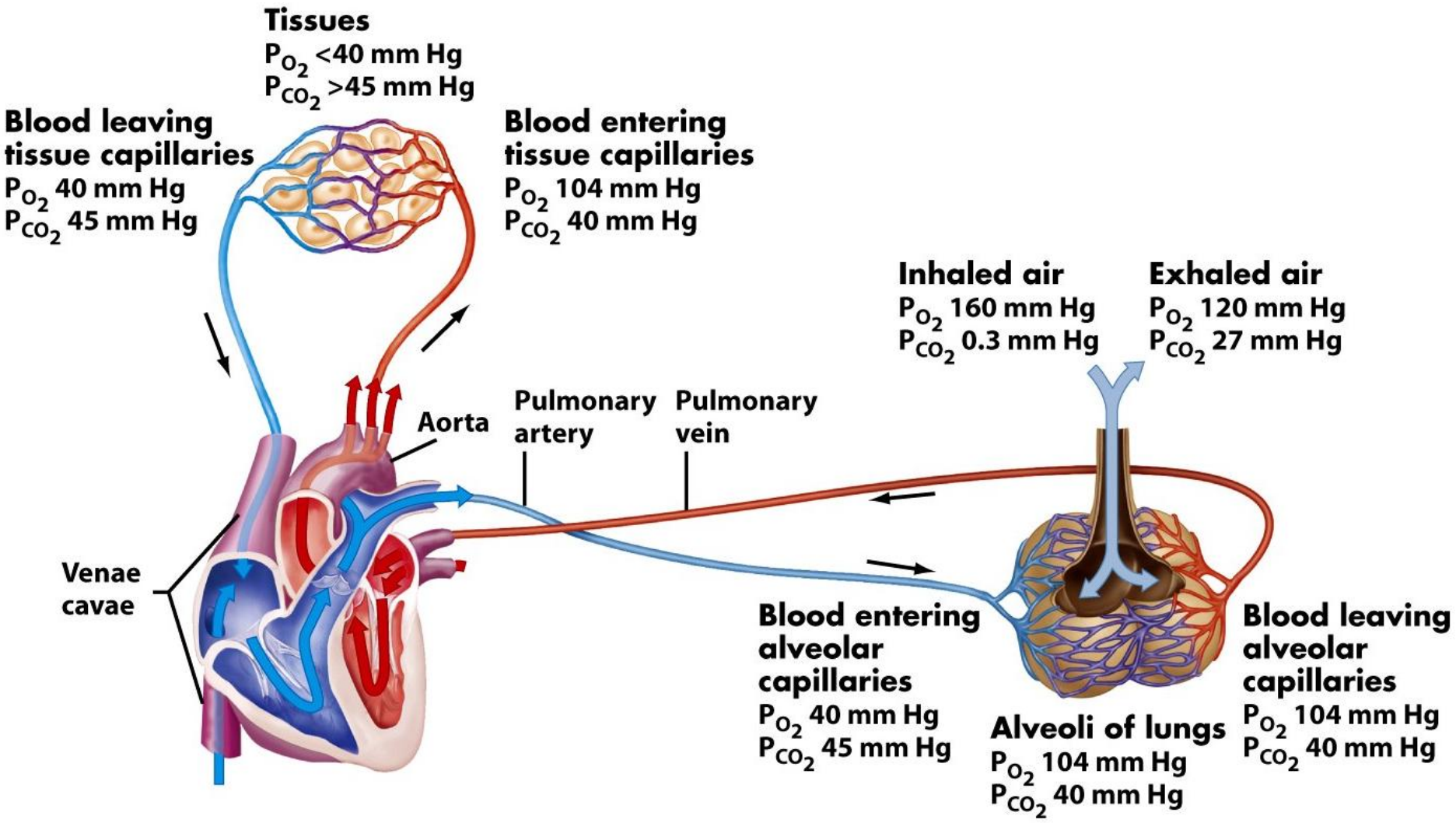
- The amount of gas that will dissolve/diffuse into a liquid is proportional to the partial pressure of the gas and the solubility of the gas.
- A gas will continue to dissolve into solution until equilibrium is reached.

The Partial Pressure of a Gas Determines Its Movement Between:

- The atmosphere and our lungs
- Our lungs and our blood
- Our blood and our cells
- As PO_2 ↓'s **or** PCO_2 ↑'s, it becomes harder to breath

What Happens When Altitude Changes?

• % of gas remains constant.
• The Partial pressures change.
o **Up** a mountain: Partial Pressure **drops** which limits O_2 delivery to the blood (e.g. PO_2 = 104 mmHg)
o **Below** sea level: Partial Pressure **rises** which increases O_2 delivery to the blood (e.g. PO2 = 180 mmHg)


Tissues
P_{O_2} <40 mm Hg
P_{CO_2} >45 mm Hg
Blood leaving tissue capillaries
P_{O_2} 40 mm Hg
P_{CO_2} 45 mm Hg
Blood entering tissue capillaries
P_{O_2} 104 mm Hg
P_{CO_2} 40 mm Hg
Inhaled air
P_{O_2} 160 mm Hg
P_{CO_2} 0.3 mm Hg
Exhaled air
P_{O_2} 120 mm Hg
P_{CO_2} 27 mm Hg
Aorta
Pulmonary artery
Pulmonary vein
Venae cavae
Blood entering alveolar capillaries
P_{O_2} 40 mm Hg
P_{CO_2} 45 mm Hg
Alveoli of lungs
P_{O_2} 104 mm Hg
P_{CO_2} 40 mm Hg
Blood leaving alveolar capillaries
P_{O_2} 104 mm Hg
P_{CO_2} 40 mm Hg