Ch. 14 Lecture 1

Cardiac Output

- Volume of blood pumped each minute by each ventricle
- Cardiac output=Stroke volume x heart rate
    - Stroke volume: Amount of blood squirted out every contraction
        - mL/beat
    - Heart rate
        - Beats/min
    - Avg heart rate=70 bpm
    - Avg Stroke volume= 70-80
    - Avg Cardiac output = 5500mL/min
        - Pretty much entire volume of blood
- Regulation of cardiac rate
    - Spontaneouds depolarization occurs at SA node
        - HCN channels open allowing Na+ in
    - Sympathetic Norepinepherine and epinephrine produce cAMP which targets the CN part of the HCN channels.
        - cAMP increases the rate of depolarization, increasing heartrate
        - Anything that increases epinephrine/norepinephrine will raise HR
        - Called a Chronotropic effect
    - Parasympathetic acetylcholine will open K+ Channels
        - Slows heart rate
- Regulation of Stroke Volume
    - 3 Variables
    - End diastolic volume
        - Volume of blood in the ventricles at the end of diastole
        - Sometimes called **preload**
        - Stroke volume increases with increased EDV
    - Arterial blood pressure
        - **Afterload**
        - Affected by total peripheral resistance: Frictional resistance in the arteries
    - Contractility
        - Strength of ventricular contraction
        - Stroke volume increases along with contractility
    - **Ejection Fraction**
        - SV/EDV
        - Normally about 60%
    - Frank Starling Law
        - Increased EDV results in an increased contractility and thus increased stroke volume

        - The increased stretch of the ventricles increases the stroke volume
- Intrinsic Control of Contraction Strength
    - Intrinsic to the muscles
    - Due to myocardial stretch
- Extrinsic Control
    - Regulated by the sympathetic nervous system
        - Increases in contraction due to making more Ca2+ available to sarcomeres
- Venous Return
    - Effects end diastolic volume
    - Factors that affect venous return
        - Total blood volume
        - Venous pressure
        - Veins are **compliant**. Streetch at a given pressure. They hold more blood than arteries but maintain lower pressure
    - More factors in venous return
        - Highest pressure in venules vs. lowest pressure in veins closest to heart
        - Sympathetic nerve activity to stimulate smooth muscles and lower compliance
        - Skeletal muscle pumps
        - Pressure difference between abdominal and thoracic cavities
        - Blood volume

Ch. 14 Lecture 2

Blood Volume

- Body Water Distribution
    - 2/3 of our body water is found in cells
    - Of the remaining third, 80% is in interstial fluid and 20% in plasma
    - Controlled by osmotic forces and hydrostatic pressure
    - Water intake and urine formation also play role in regulation of blood volume
    - Water loss:
        - Urine formation
        - Lungs
        - Skin (sweat glands)
        - Feces
- Tissue/Capillary Fluid exchange
    - Filtration
        - Has to do with blood pressure (hydrostatic pressure) in capillaries that dictates whether fluid will move in/out of capillaries/interstitial space
        - Pressure is higher on arterial side than on veinous side

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        - 36mmHg at arteriole end vs 16 at veinous
    - Colloid osmotic pressure
        - Due to proteins dissolved in fluid
            - Colloid = stuff that is not totally dissolved/undissolved (like milk)
        - Blood plasma has a higher colloid osmotic pressure than interstitial fluid
            - Difference is known as oncotic pressure
            - Oncotic pressure=25mmHg
        - Fluid would preferably move into the capillaries
    - Starling Forces
        - Combination of hydrostatic pressure and oncotic pressure which will predict movement of fluids across capillary membranes
        - Movement is proportional to (fluid out)-(fluid in)
        - (Hydrostatic pressure in capillary + Colloid osmotic pressure in IF) – (Hydrostatic pressure of IF + Colloid pressure in capillary)
        - Colloid osmotic pressure is usually constant, so the hydrostatic pressure is what is changing.
            - **Example**: 37-26=11mmHg, which means 11mmHg pushing fluids out of the capillaries (arteriol)
            - On venule side it was negative, (-9), means that 9mmHg pushing into vein.
            - The fact that it's 2mmHg different means that a little fluid gets pushed out of the capillaries to be absorbed by the cells and/or picked up by the lymphatic system
    - Edema
        - Excessive accumulations of interstitial fluids
        - "swelling"
        - Result of
            - High arterial blood pressure
            - Venous obstruction
            - Leakage of plasma proteins into Interstitial space
            - Decreased plasma protein concentration
            - Obstruction of lymphatic drainage
        - Then he showed us a scary example: Elephantitis. ☹
- Regulation of blood Volume
    - Kidneys
        - Formation of urine begins with filtration of fluid through capillaries in the kidneys known as **glomeruli**
            - 180L of Filtrate is filtered through them daily, but only 1.5L is taken out for urine
            - Remainder is reabsorbed into the blood