Cardiovascular System

Anatomy:

- Heart
  - Dual pump
  - Left and right sides are divided by a septum
  - Valves (made of endothelium):
    - Pulmonary semilunar
    - Aortic semilunar
    - Tricuspid
    - Mitral (Bicuspid)
  - Chordate Tendinae and the papillary muscles anchor the valves
  - Myocardium
  - Epicardium
  - Muscle fibers:
    - Connected by intercalculated discs which form functional syncytia
    - Within these are desmosomes (mechanically) and gap junctions (electrically)
- Blood
- Blood Vessel
- Circulation:
  - Pulmonary: from heart to the lungs (low pressure because low distance)
  - Systemic: from heart to the body (high pressure because farther distance)

Electrical Activity of the Heart:

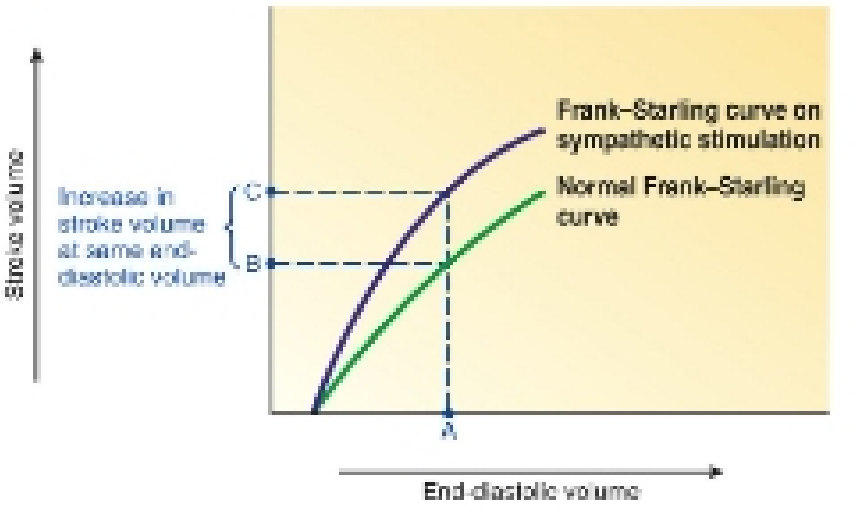
- Auto rhythmicity: there are no nerves that innervate the heart
- Cells are either contractile or autorhythmic
  - Contractile: 99% of cells
    - Do the actual contraction
  - Autorhythmic:
    - Don't contract
    - Initiate action potentials
    - Ie. SA node, AV node, bundle of His, purkinje fibers
- Action potentials exhibit a prolonged positive phase with a prolonged period of contraction
  - Ensures adequate ejection time
  - Plateau due to activation of slow L-type Ca channels
  - Ca entry through L-type channels in T-tubules cause a larger release of Ca from sarcoplasmic reticulum→ regular contraction
  - Long refractory period + prolonged plateau phase = impossible summation and tetanus
- EEG: record of overall spread of electrical activity through the heart

Cardiac output: the volume of blood ejected by each ventricle *per minute*

- Heart rate x stroke volume(volume of blood ejected by either ven2tricle *per heart beat*)
- Stoke volume is determined by venous return (intrinsic) and sympathetic activity (extrinsic)
  - Causes an increase in strength of heart contraction
  - Stroke volume = end diastolic volume – end systolic volume

Frank Starling Law:

- States that the heart normally pumps out during systole, the volume of blood returned to it during diastole



- End diastolic volume and stoke volume relationship

Nourishing the Heart:

- Nourished with oxygen and nutrients via the coronary artiers
- Heart is the first to receive the blood supply that occurs during diastole
    - Not systole because the coronary arteries are compressed during contraction
    - The blood flow varies to keep pace with cardiac oxygen needs

Coronary Artery Disease:

- Pathological changes cause diminished blood flow
- Leading cause of death
- Can cause myocardial ischemia and acute myocardial infarction (heart attack)
    - Profound Vascular spasm of coronary arteries
    - Formation of atherosclerotic plaques
    - Thromboembolism
- Regular vascular spasms
    - Abnormal spastic constriction
    - Early stages of CAD
    - Caused by cold, physical exertion, anxiety
    - Is reversible
- Atherosclerosis
    - Progressive, degenerative artery disease
    - Gradual blockage of vessels
    - Serious in heart and brain
    - Angina pectoria, thromboembolism, heart attack

Blood Vessels:

Flow:

- Blood is constantly being reconditioned
- Organs that recondition blood receive more blood than those organs with metabolic needs
    - Digestive organs, kidney, skin
    - Adjust the blood to achieve homeostasis
- Blood flow to other organs can be adjusted
- Brain cannot tolerate disrupted supply
- Rate:
    - Directly proportional to pressure gradient (pressure difference from beginning to end)
    - Inversely proportional to vascular resistance

Resistance:

- Blood viscosity
- Vessel length
- Vessel radius→ major determinant
    - Slight change produces significant change in blood flow
        - Radius is proportional to 1/r4

Vascular Tree:

- Arteries: rapid transit passageways
    - Because large lumen and little resistance
    - Act as reservoir to provide driving force for blood when heart is relaxing
    - Contains collagen and elastin fibers
    - Resistance vessels
    - Radius supplying individual organs can be adjusted independently to:

        - Distribute cardiac output among systemic organs
        - Help regulate arterial BP
    - Vasoconstriction: increased O2 and sympathetic stimulation
    - Vasodilation
        - Decreased resistance and increased flow through that vessel
        - Decreased O2 and other local chemical changed that need increased blood flow
        - Decreased sympathetic stimulation
    - Vasoactive mediators:
        - Endothelial cells
        - Nitric oxide: vasodilator
    - Medulla controls cardiovascular system
    - Hormones:
        - Epinephrine & norepinephrine
        - Vasopressin and angrio tension 2→ fluid balance
- Capillaries
    - Thin walled, small radius, extensively branched
    - Exchange happens here
        - Large surface area
        - Small distance to diffuse
        - Diffusion and bulk flow
    - Allow water soluble substances
    - Filtration
- Lymphatic system:
    - Network of 1 way vessels
    - Provides accessory route by which fluid can be returned from interstitial to the blood
    - Small lymphatics
        - Blind-ended terminal lymph vessels
    - Lymph: interstitial fluid that enters a lymph vessel
    - Lymph vessels: formed from convergence of initial lymphatics
        - Empty into venous system
        - 1 way valves push lymph to veins
    - Functions:
        - Return of excess filtered fluid
        - Defense against disease
        - Transport of absorbed fat
        - Return of filtered protein
    - Edema can be a result of too much interstitial fluid
        - Caused by decreased plasma proteins
        - Increased venous pressure
        - Blockage of lymph nodes
- Veins:
    - Bring the blood to the heart
    - Capillaries drain into venules
    - Little resistance to blood flow
    - Factors that enhance return of blood:
        - Cardiac contraction
        - Sympathetic induced vasoconstriction