

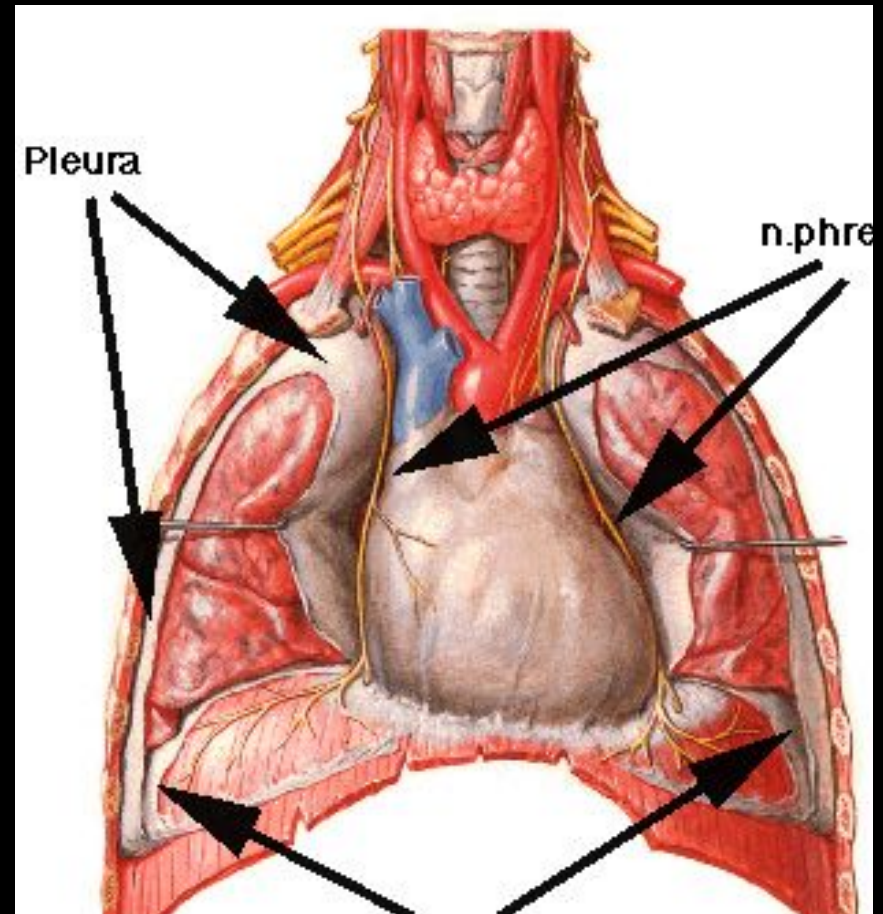
Heart's Anatomy and Physiology

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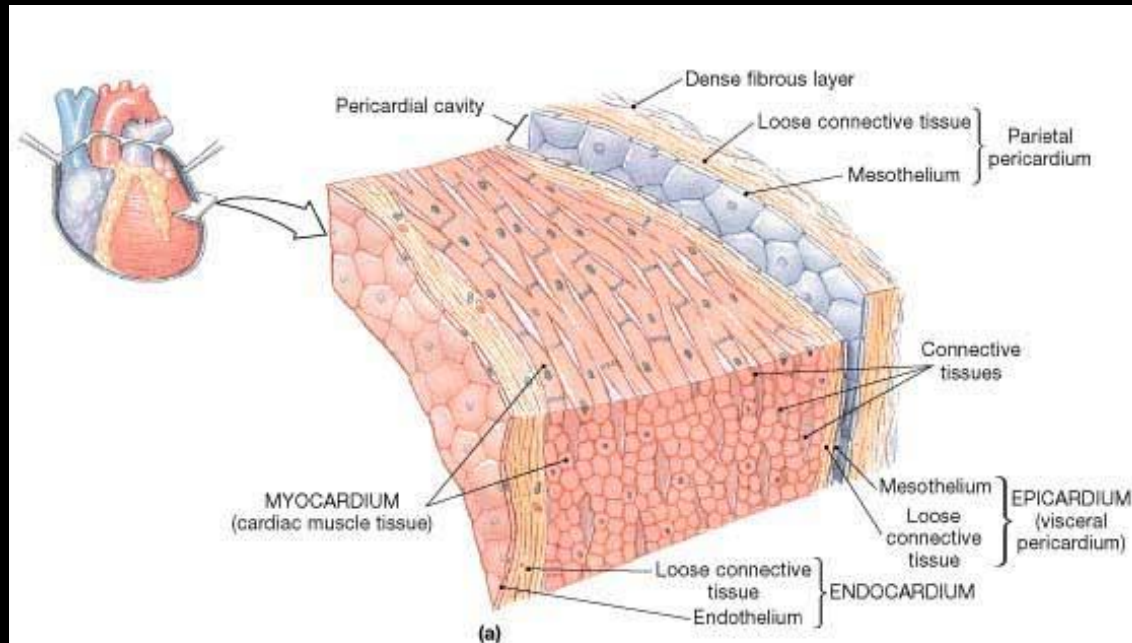
Heart

- Hollow, muscular organ
- Mediastinum between the lungs resting on the diaphragm, tilting forward and to the left
- Pumps 60mL of blood (5 L/min)
- Encapsulated by pericardium



Heart

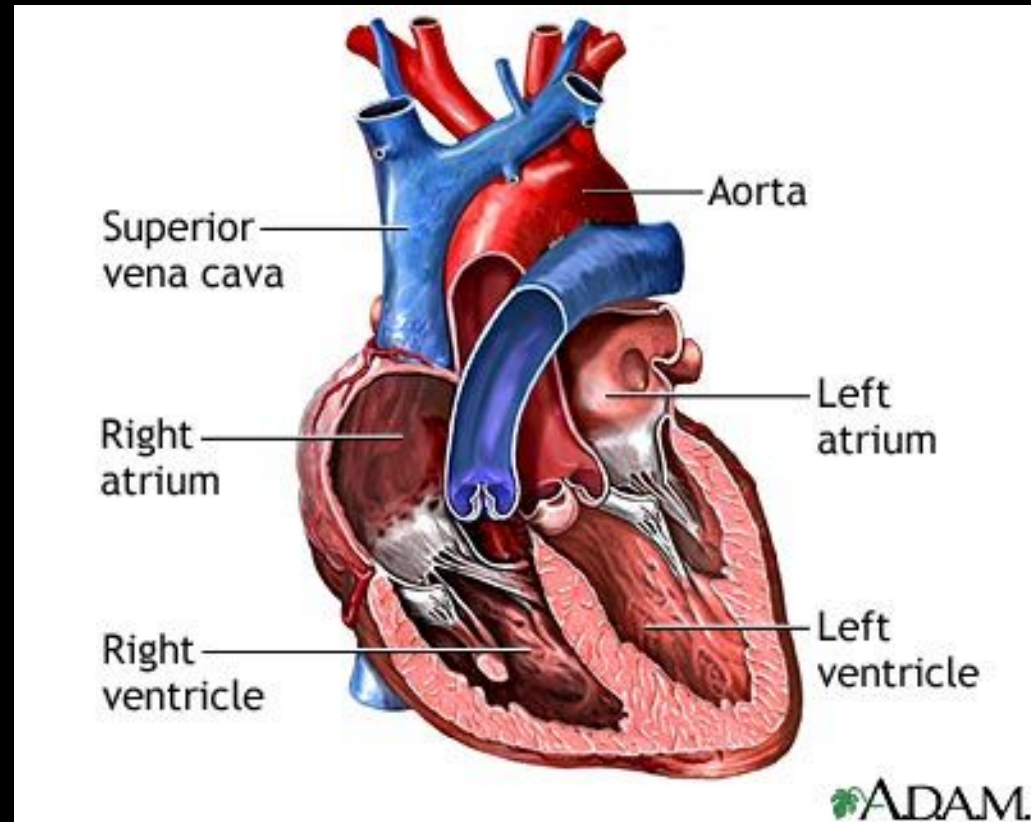
- Muscle tissue layers
 - epicardium (visceral pericardium)
 - > thin & transparent
 - myocardium (cardiac muscle tissue)
 - > striated muscle fibers
 - endocardium (smooth endothelial tissue)



• **FIGURE 20-7** The Heart Wall. (a) A diagrammatic section through the heart wall, showing the relative positions of the epicardium, myocardium, and endocardium.

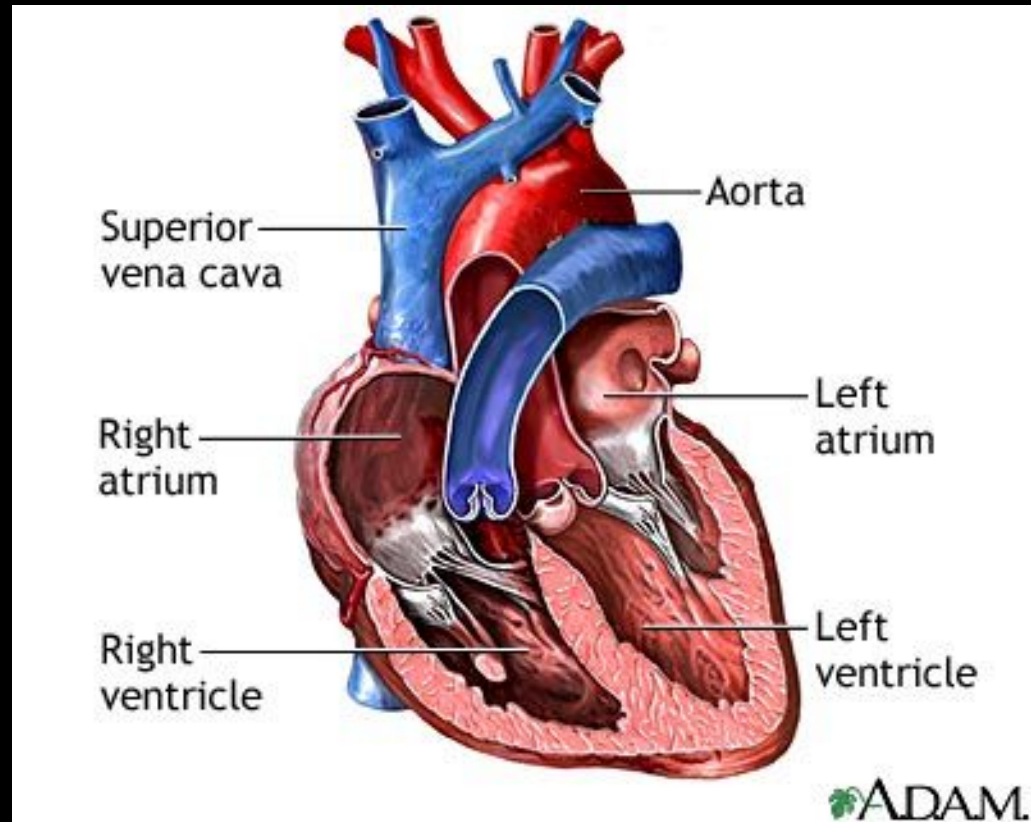
Chambers of the Heart

- Right atrium
 - receives unoxygenated blood from peripheral tissues through SVC and IVC
- Right ventricle
 - propels blood into the pulmonary artery & lungs
 - low-pressure system



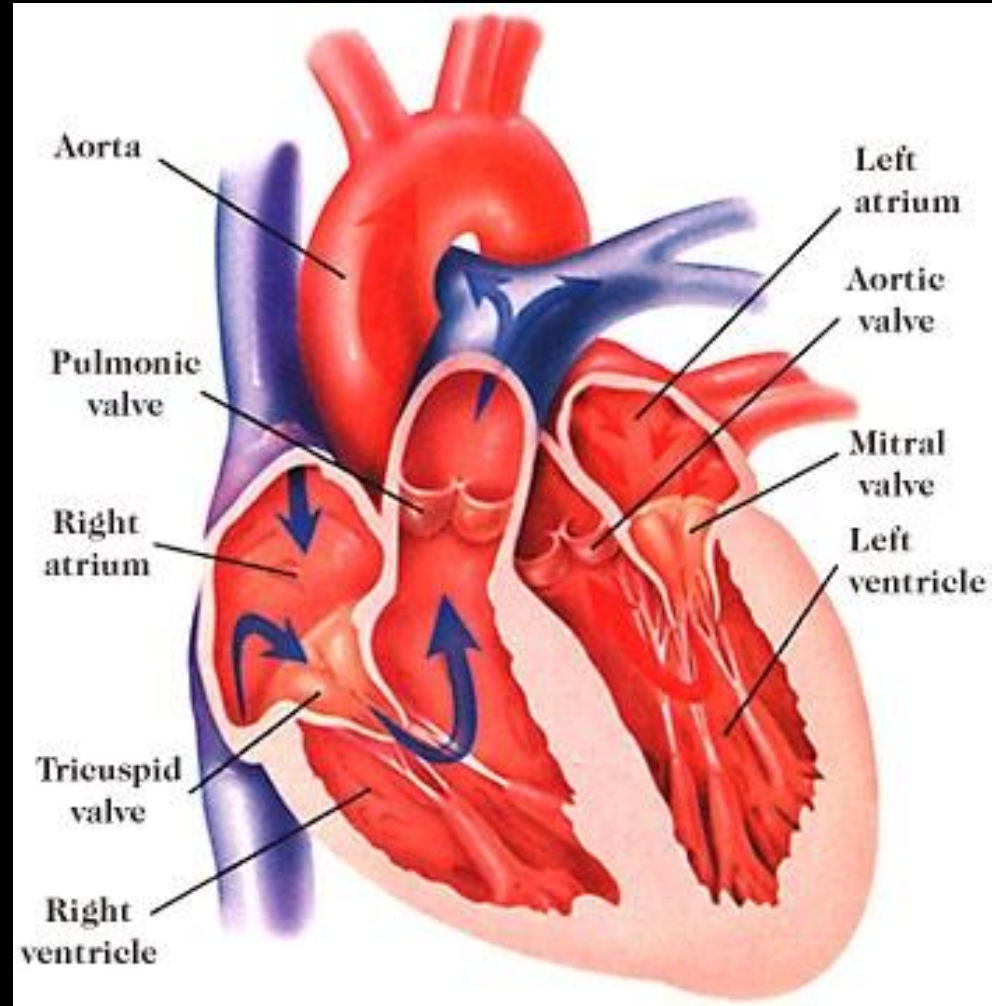
Chambers of the Heart

- Left atrium
 - receives oxygenated blood from the 4 pulmonary veins
- Left ventricle
 - largest & most muscular chamber
 - high pressure system
 - propels blood through the aorta to the periphery



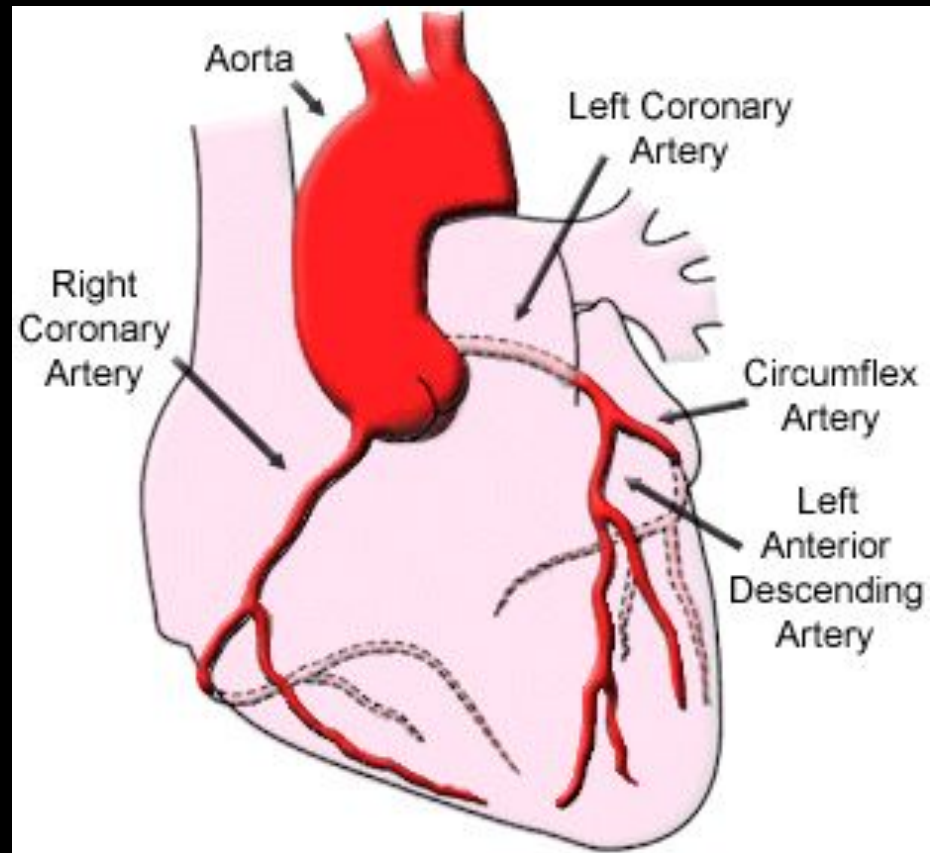
Heart Valves

- Atrioventricular valves
 - Tricuspid valve (3 leaflets)
 - > separates RA from RV
 - Bicuspid valve (mitral valve)
 - > separates LA from LV
- Semilunar valves
 - Pulmonic valve
 - > separates RV from the pulmonary artery
 - Aortic valve
 - > separates LV from the aorta



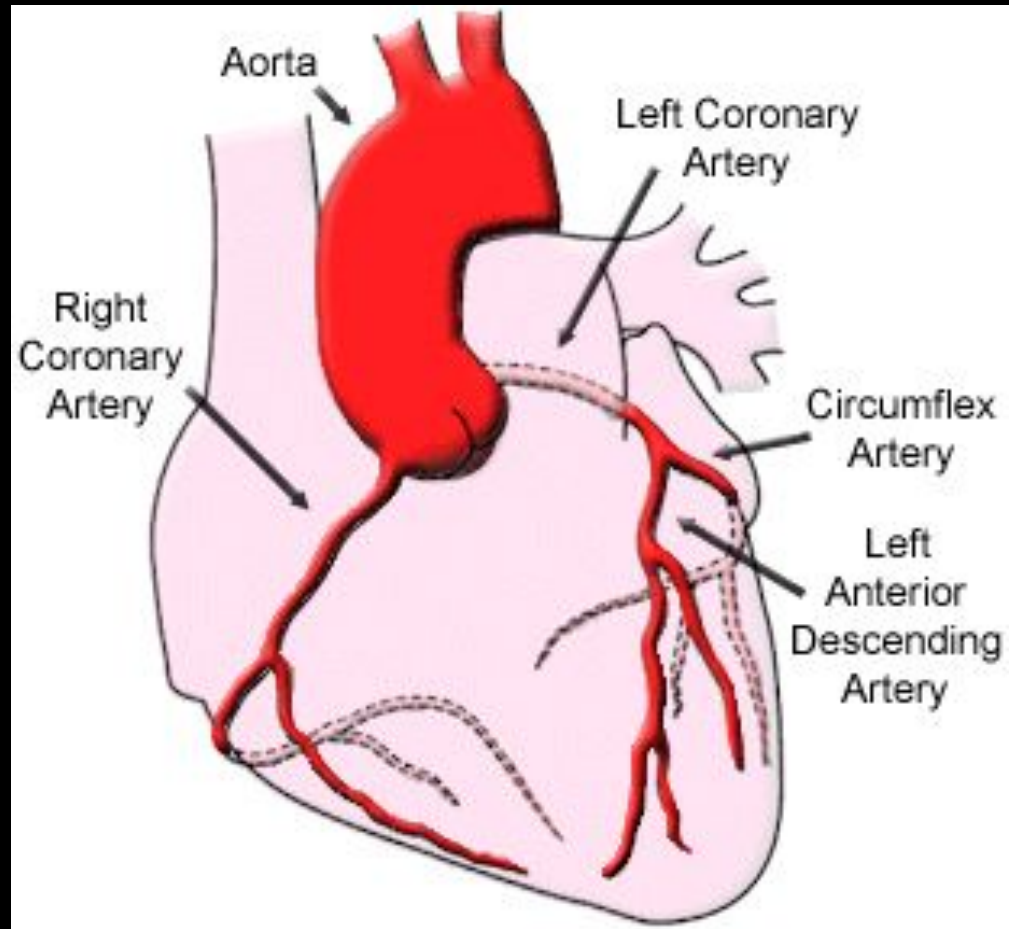
Coronary Arteries

- Originates from the aorta just beyond the aortic valve
- Coronary blood flow to the myocardium occurs primarily during diastole
- * To maintain adequate blood flow through the coronaries, *mean arterial pressure* (MAP) must be at least 60 mmHg



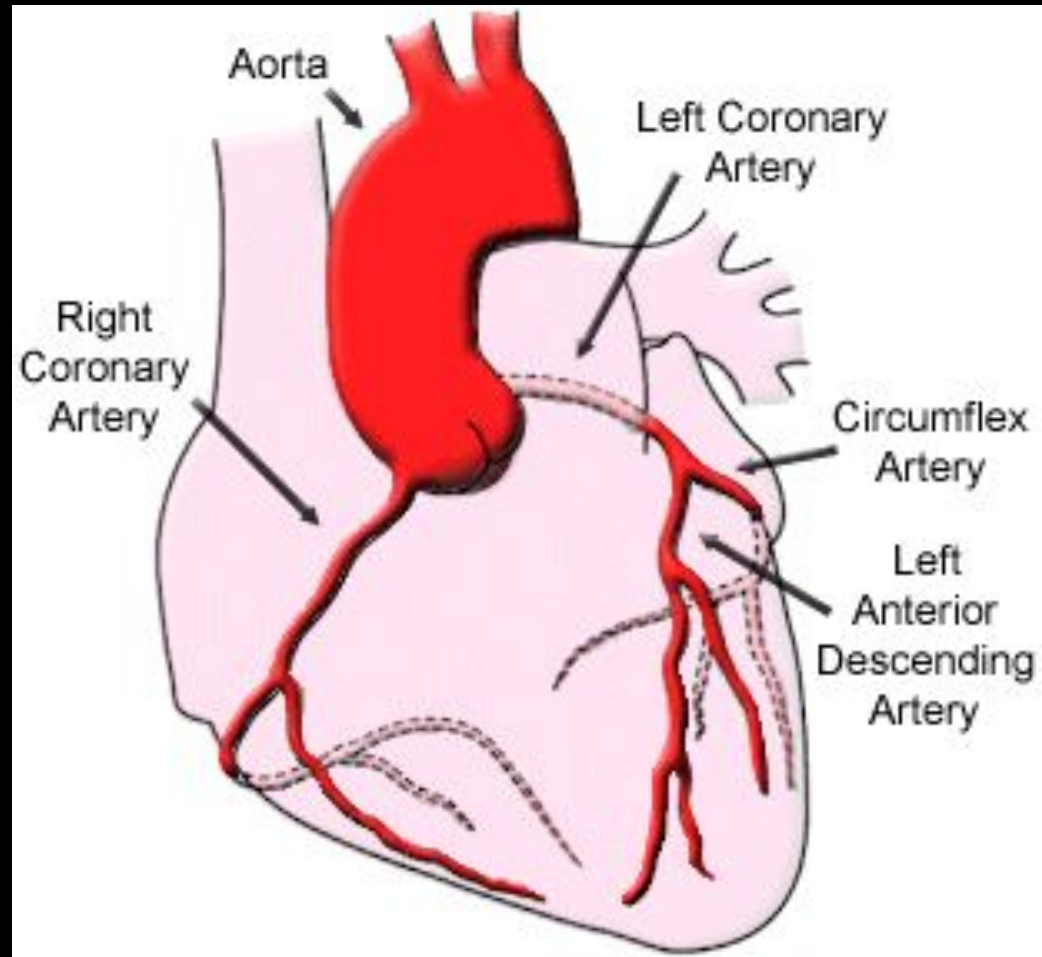
Coronary Arteries

- Left main coronary artery (LCA)
 - Left anterior descending artery (LAD)
 - > descends toward the anterior wall & apex of LV
 - > supplies LV, ventricular septum, chordae, papillary muscle & RV
 - Left circumflex artery (LXA)
 - > descends toward the lateral wall of LV & apex
 - > supplies LA, lateral & posterior LV surfaces
 - *45% supplies SA node

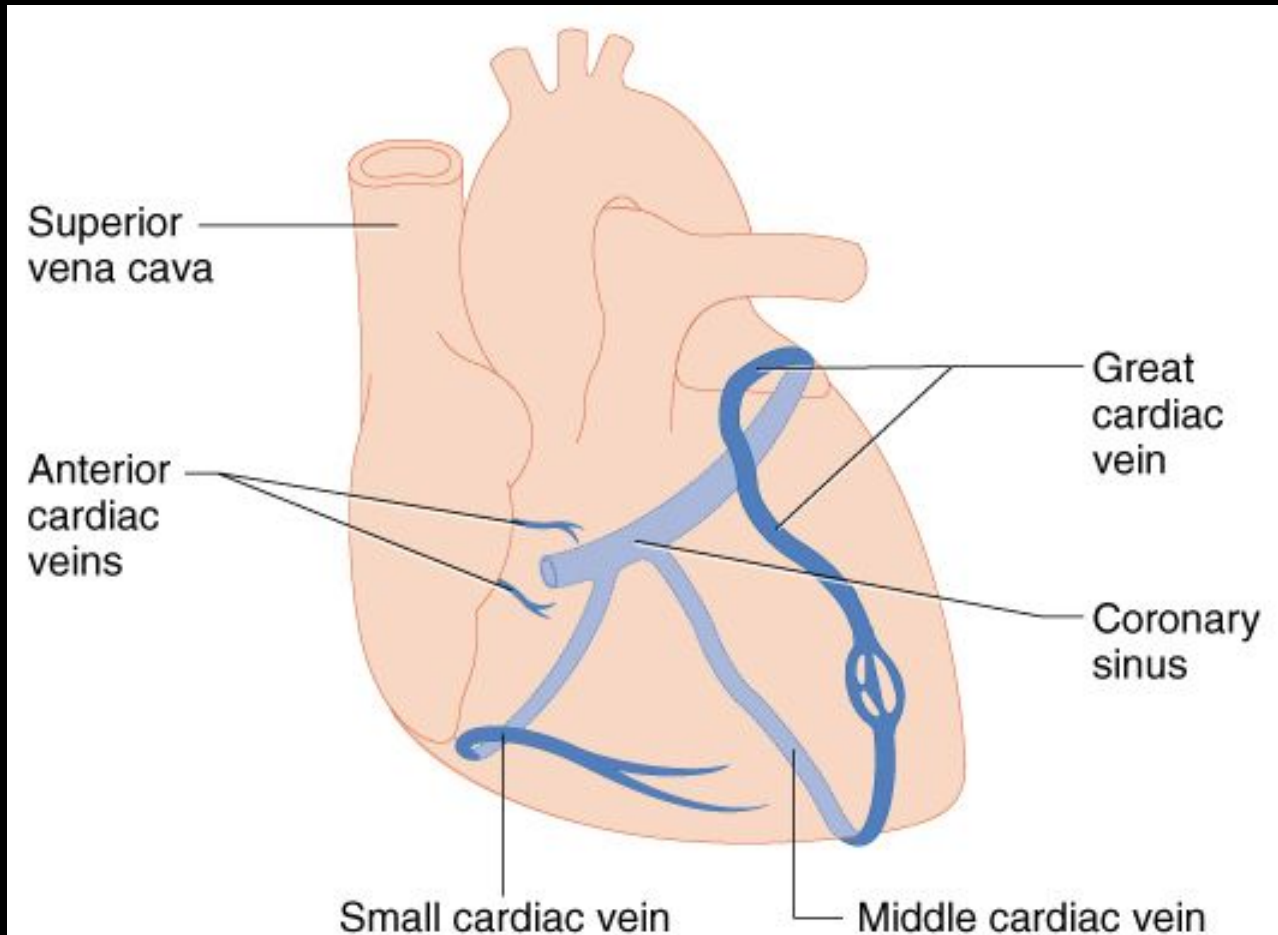


Coronary Arteries

- Right main coronary artery (RCA)
 - descends toward the apex of RV
 - supplies the RA, RV, & inferior portions of LV



Coronary Veins



(b)

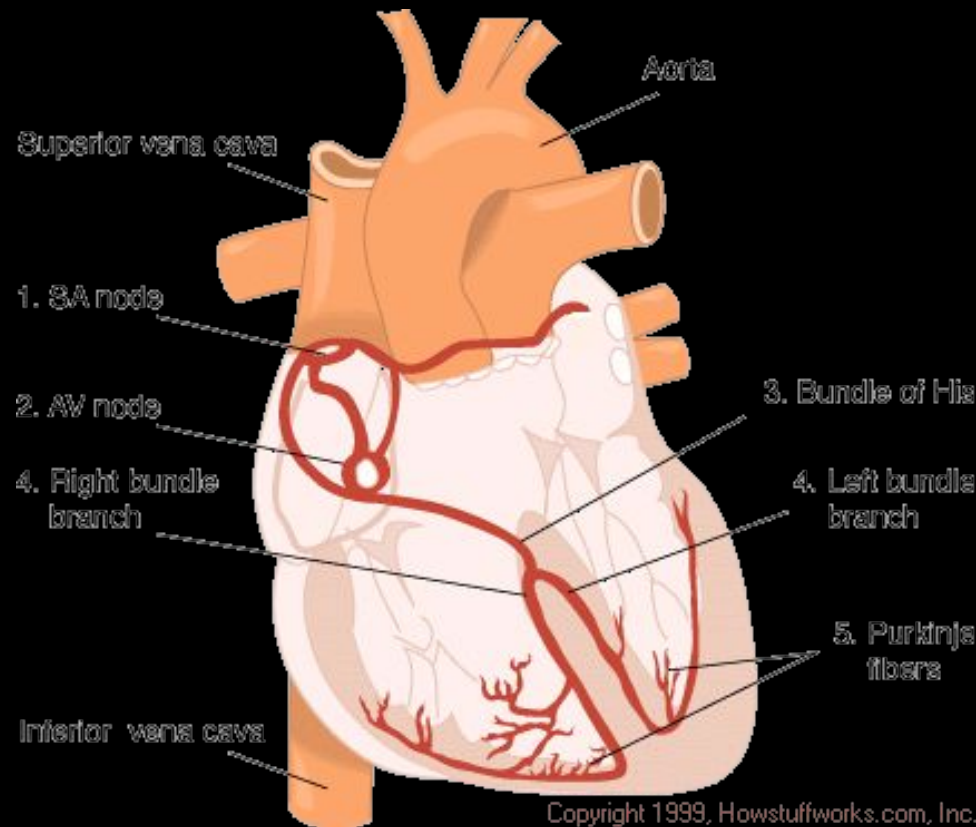
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Physiology of the Heart

- Electrophysiologic properties (regulates heart rate & rhythm)
 - Automaticity – ability of all cardiac cells to initiate an impulse spontaneously & repetitively
 - Excitability – ability of cardiac cells to respond to stimulus by initiating an impulse (depolarization)
 - Conductivity – cardiac cells transmit the electrical impulses they receive
 - Contractility – cardiac cells contract in response to an impulse
 - Refractoriness – cardiac cells are unable to respond to a stimulus until they've recovered (repolarized)

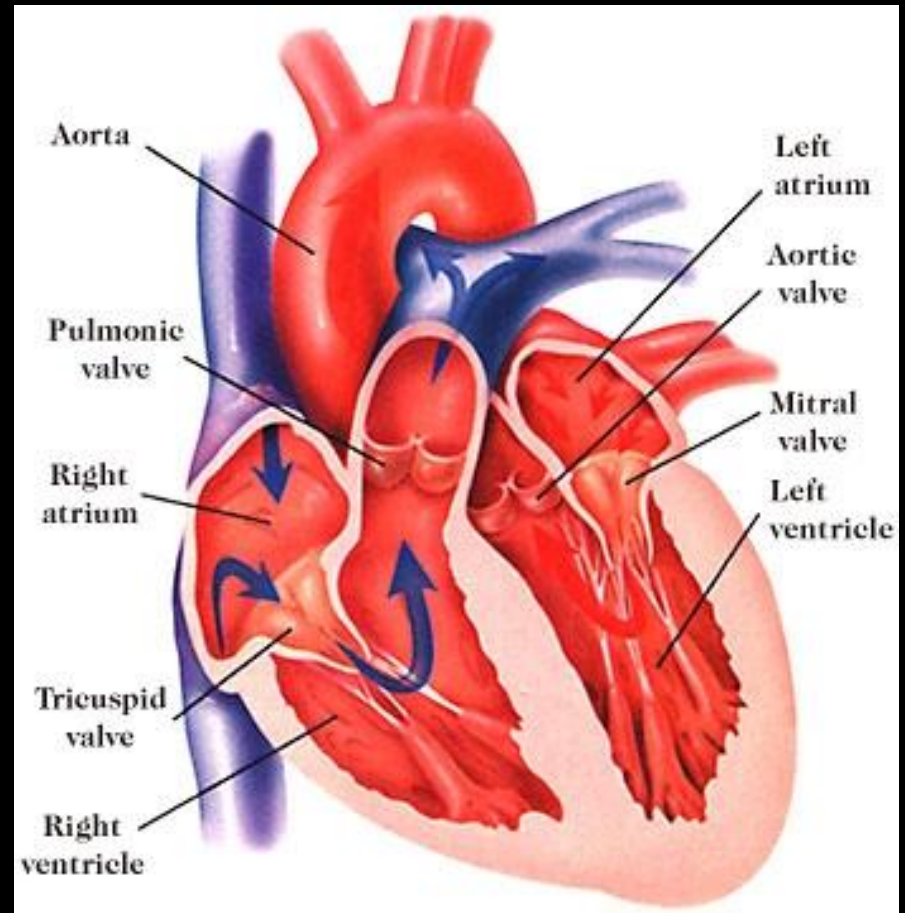
Conduction System of the Heart

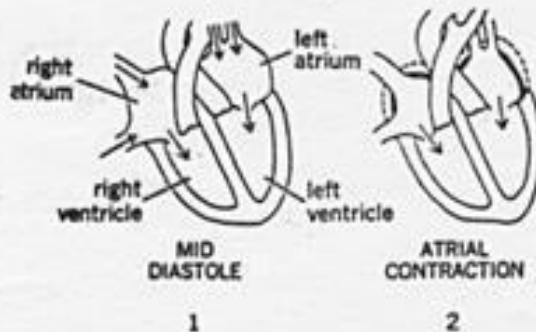
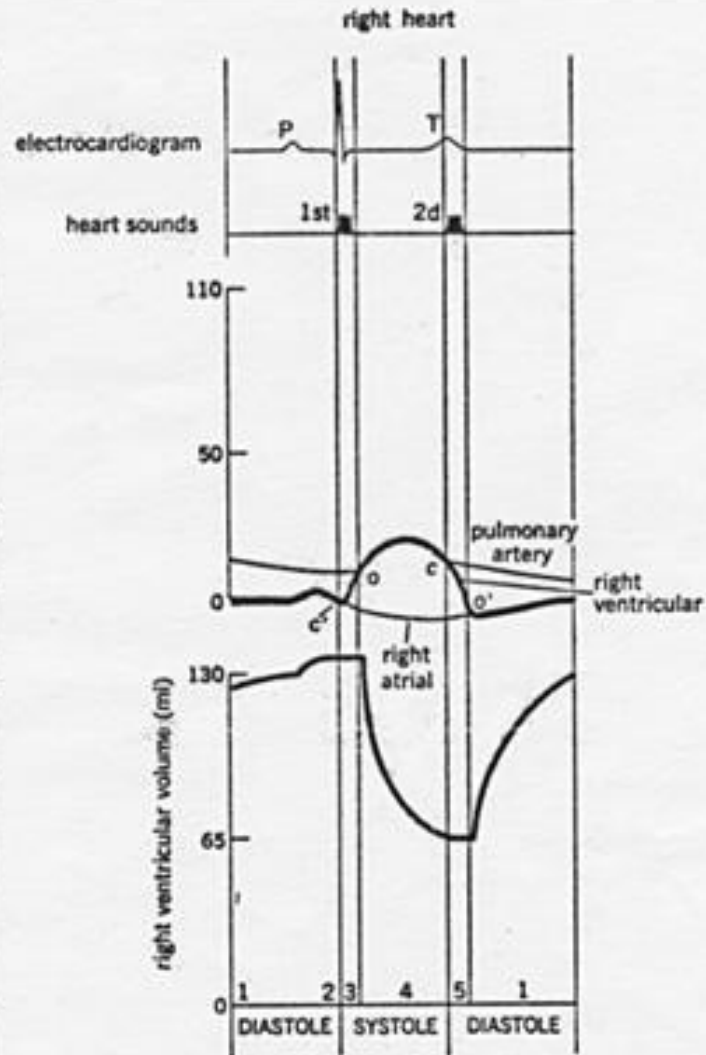
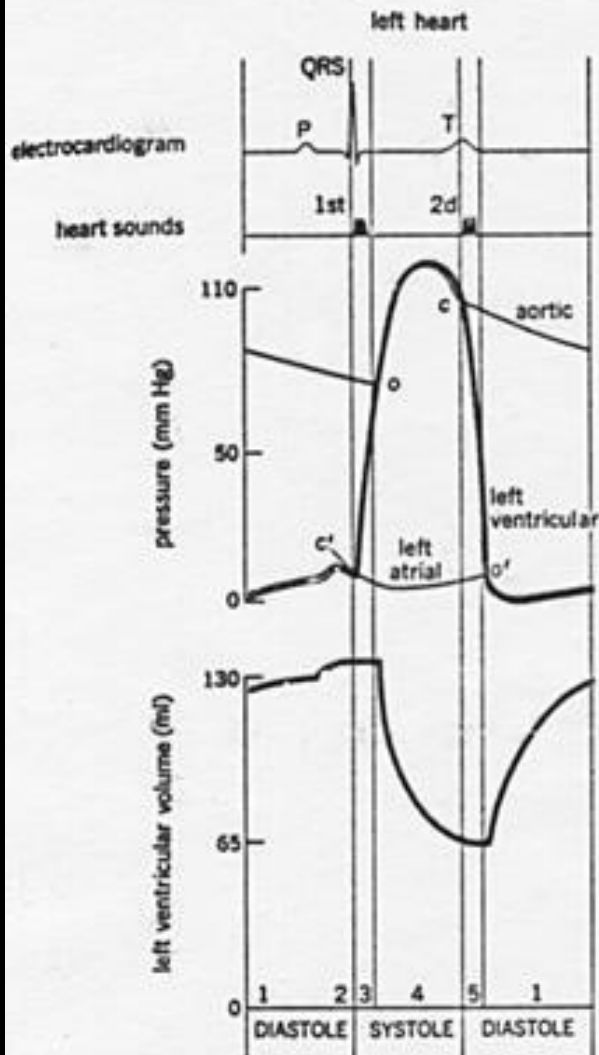
- Sinoatrial node (SA node)
 - pacemaker cells initiate impulses at 60 – 100 beats/min
- Atrioventricular node (AV node)
 - located in the junctional area
 - normal delay (allows the atria to contract completely before the ventricles are stimulated to contract)
 - 40 – 60 beats/min
- Bundle of His
 - located in the interventricular septum
 - Left and Right bundle branches
- Purkinje fibers
 - terminal branches that carry the impulse to RV & LV
 - 20 – 40 beats/min



Cardiac Cycle

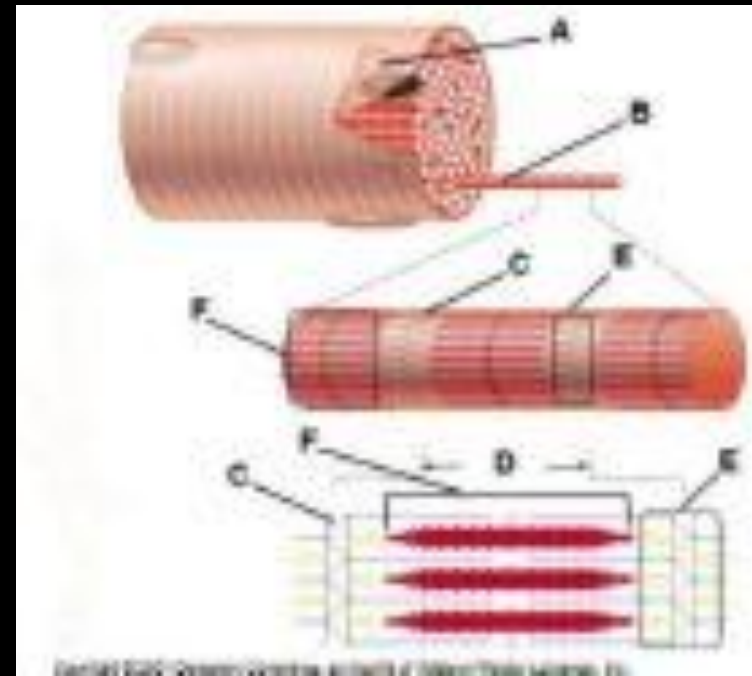
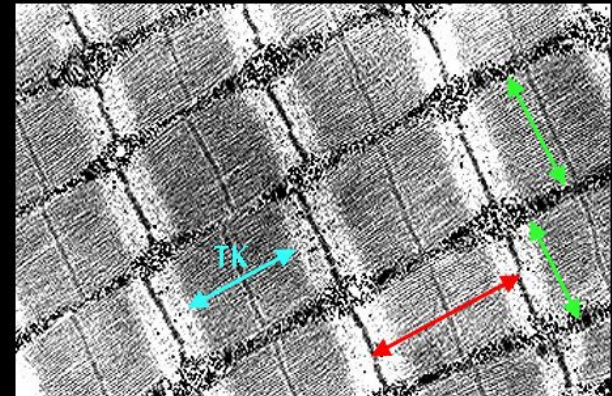
- Diastole
 - relaxation and filling of the atria and ventricles
 - “dub”
- Systole
 - contraction and emptying of the atria & ventricles
 - “lubb”





Cardiac Muscle Contraction

- Release of large amounts of Calcium ions from the sarcoplasmic reticulum of myocardial cells
- Ca ions diffuse into the myofibril sarcomere (basic contractile unit of the myocardial cell)
- Ca ions promote interaction of actin & myosin protein filaments causing the filaments to link & overlap (cross-bridges or linkages)
- Sliding of protein filaments shortens sarcomere producing contraction



Mechanical Properties of the Heart

- Cardiac output
 - volume of blood (liters) ejected by the heart each minute
 - 4 – 7 L/min
 - heart rate x stroke volume
- Heart rate
 - number of times the ventricles contract each minute
 - 60 – 100 beats/min
 - controlled by the ANS via the vagus nerve
- Stroke volume
 - amount of blood ejected by the LV during each systole

Mechanical Properties of the Heart

- Preload
 - degree of myocardial stretch at the end of diastole & just before contraction
 - determined by the amount of blood returning to the heart from the venous (R) & pulmonary system (L) – LVED
- *Starling's law – the more the heart is filled during diastole, the more forcefully it contracts

Mechanical Properties of the Heart

- Afterload
 - pressure or resistance that the ventricles must overcome to eject blood through the semilunar valves & into the peripheral blood vessels
 - directly proportional to the BP & diameter of blood vessels
- Impedance (peripheral component of afterload)
 - pressure that the heart must overcome to open the aortic valve
 - depends on aortic compliance, blood viscosity & arteriolar constriction

Mechanical Properties of the Heart

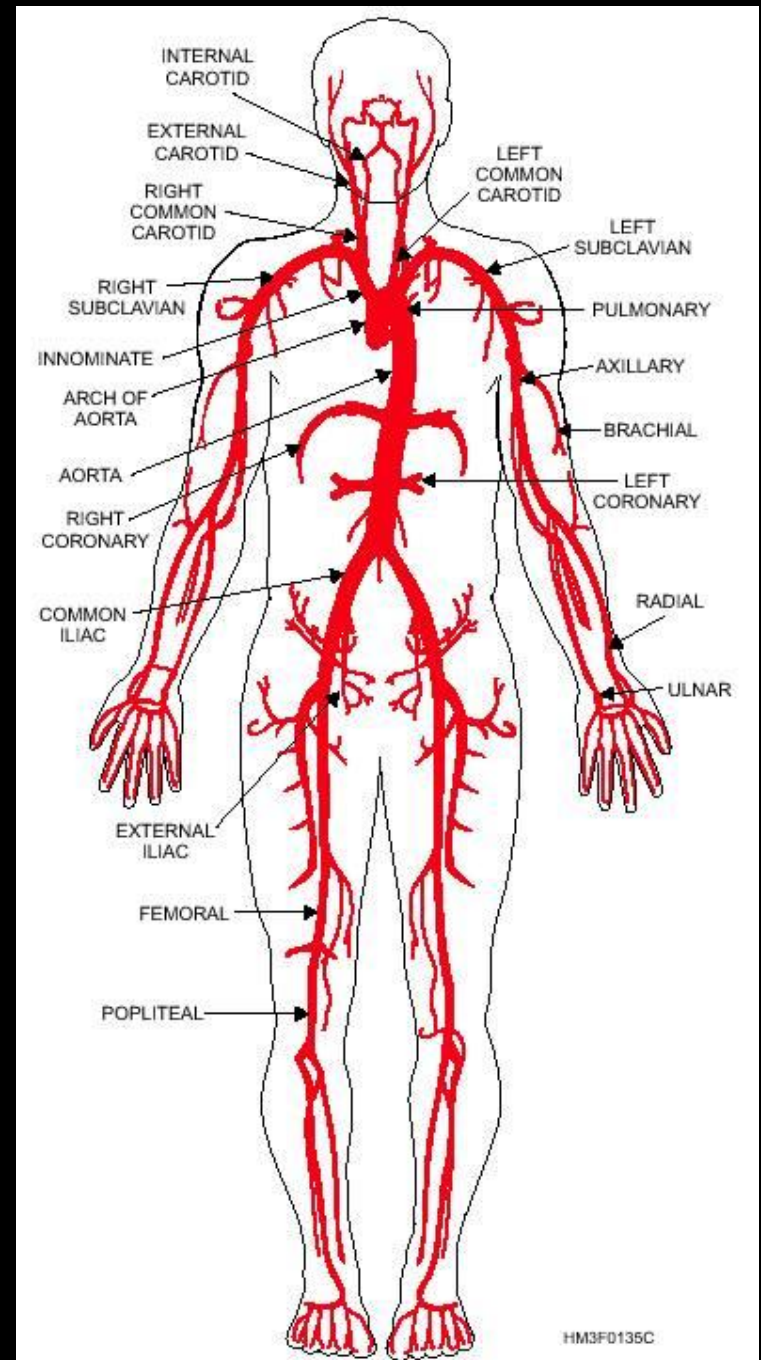
- Myocardial contractility
 - force of cardiac contraction independent of preload
 - increased by sympathetic nervous stimulation, calcium release & positive inotropic drugs
 - decreased by hypoxemia & acidemia

Vascular System

- Provide conduits for blood to travel from the heart to nourish the body
- Carry cellular wastes to the excretory organs
- Allow lymphatic flow to drain tissue fluid back to the circulation
- Return blood to the heart for recirculation

Arterial System

- Delivers blood to various tissues for nourishment
- Transport of cellular wastes
- Contribute to thermal regulation



Arterial System

- Blood pressure
 - force of blood exerted against the vessel walls
 - = $CO \times \text{peripheral vascular resistance}$
 - regulated by:
 - > autonomic nervous system (ANS)
 - > kidneys (renin-angiotensin-aldosterone)
 - > endocrine system (catecholamines, kinins, serotonin, histamine)

Blood Pressure

- Systolic:
 - amount of pressure/force generated by LV to distribute blood into the aorta w/ each contraction of the heart
 - 90 – 135 mmHg (120)
 - affected by CO and arterial distention
- Diastolic:
 - amount of pressure/force sustained by the arteries during the relaxation phase of the heart
 - ability of the heart to rest while filling with blood
 - affected by peripheral vascular resistance
 - 60 – 85 mmHg (80)



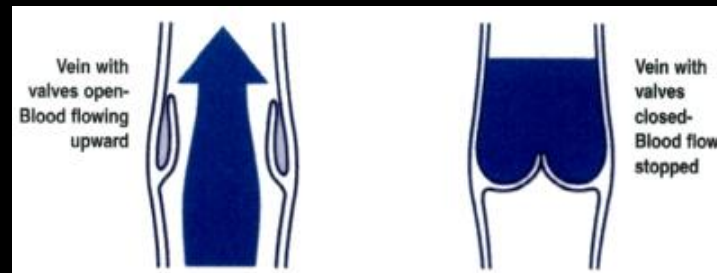
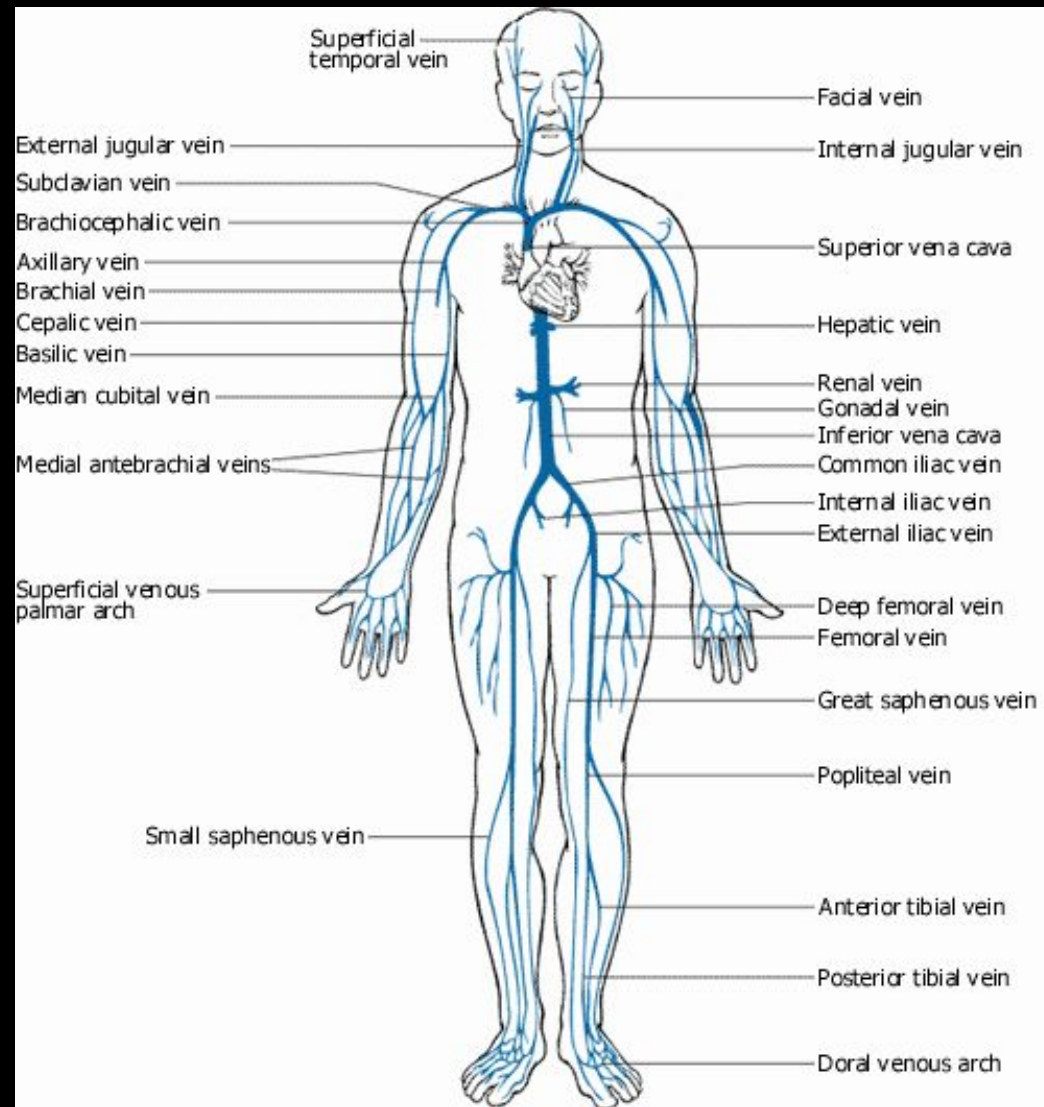
Regulation of BP

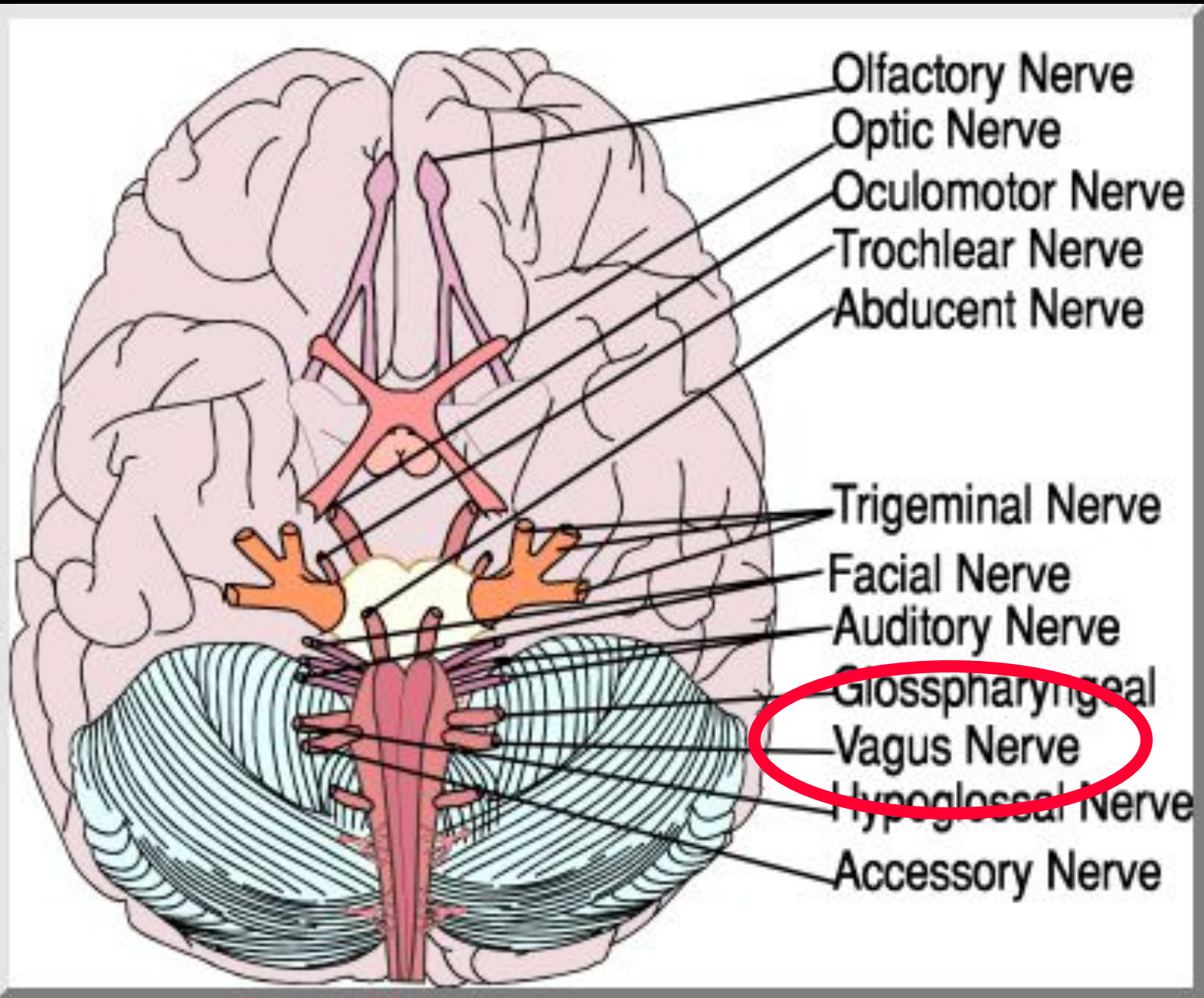
- Autonomic Nervous System
 - Baroreceptors (arch of aorta & origin of internal carotid arteries)
 - > stimulated when arterial walls are stretched by increased BP
 - > inhibit vasomotor center (pons & medulla or brainstem)
 - Chemoreceptors (bifurcation of carotid arteries & aortic arch)
 - > sensitive to hypoxemia, hypercapnia



Venous System

- Series of veins located adjacent to arterial system
- Veins collect blood from the capillaries & terminal arterioles
- Acts as reservoir for blood
- Low-pressure, collapsible system that work against effects of gravity





Great Arteries (Human)

