

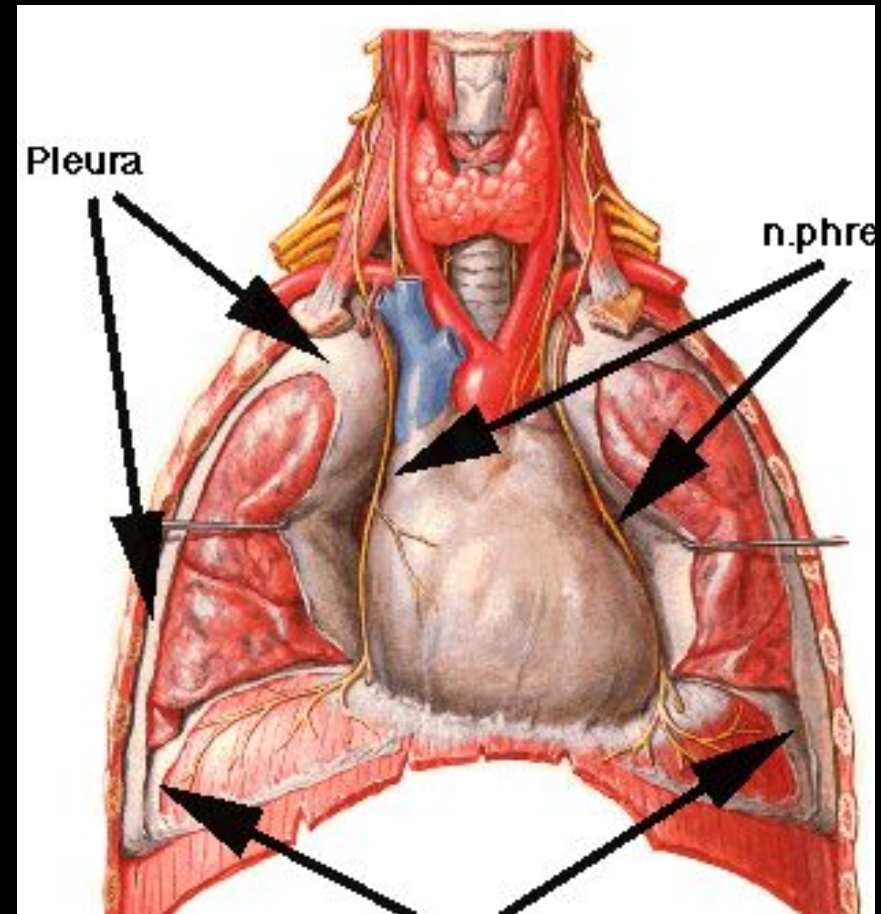
# Heart's Anatomy and Physiology

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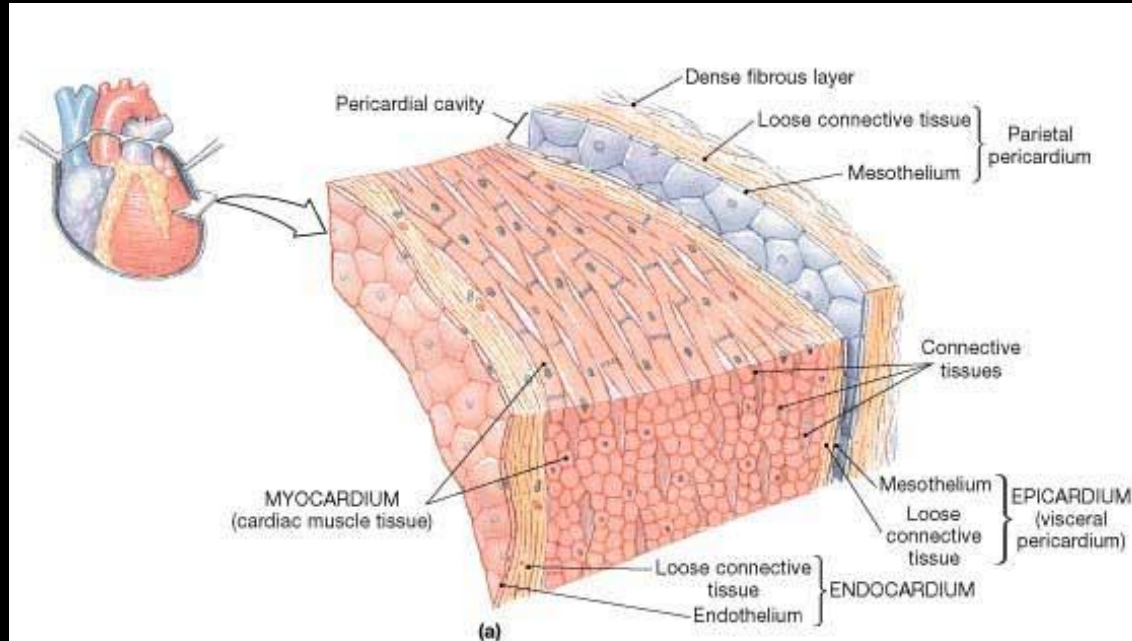
# Heart

- 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

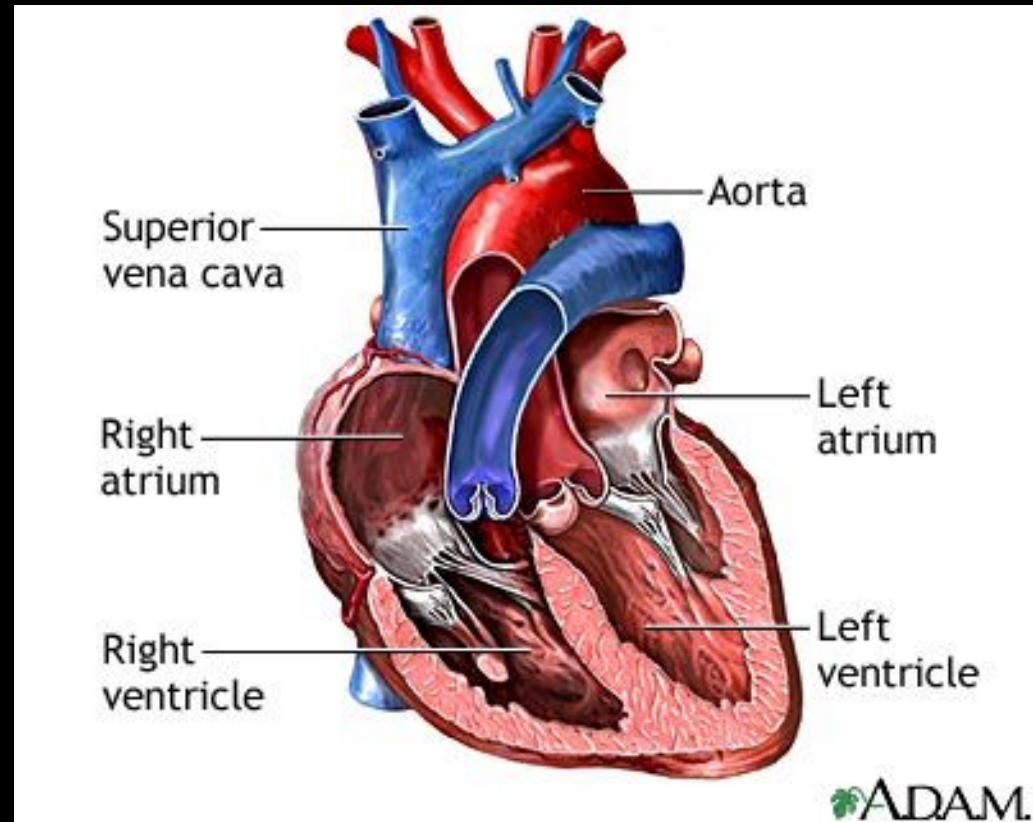
- Muscle tissue layers
  - epicardium (visceral pericardium)
    - > thin & transparent
  - myocardium (cardiac muscle tissue)
    - > striated muscle fibers
  - endocardium (smooth endothelial tissue)



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

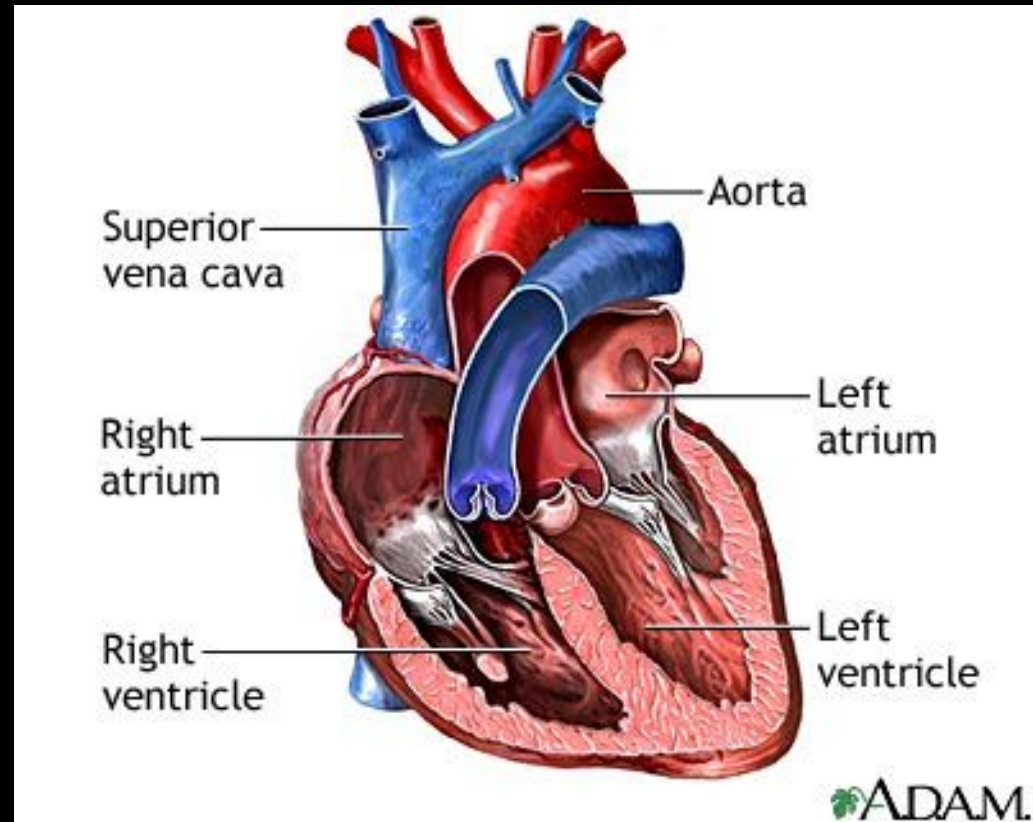
# Chambers of the Heart

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



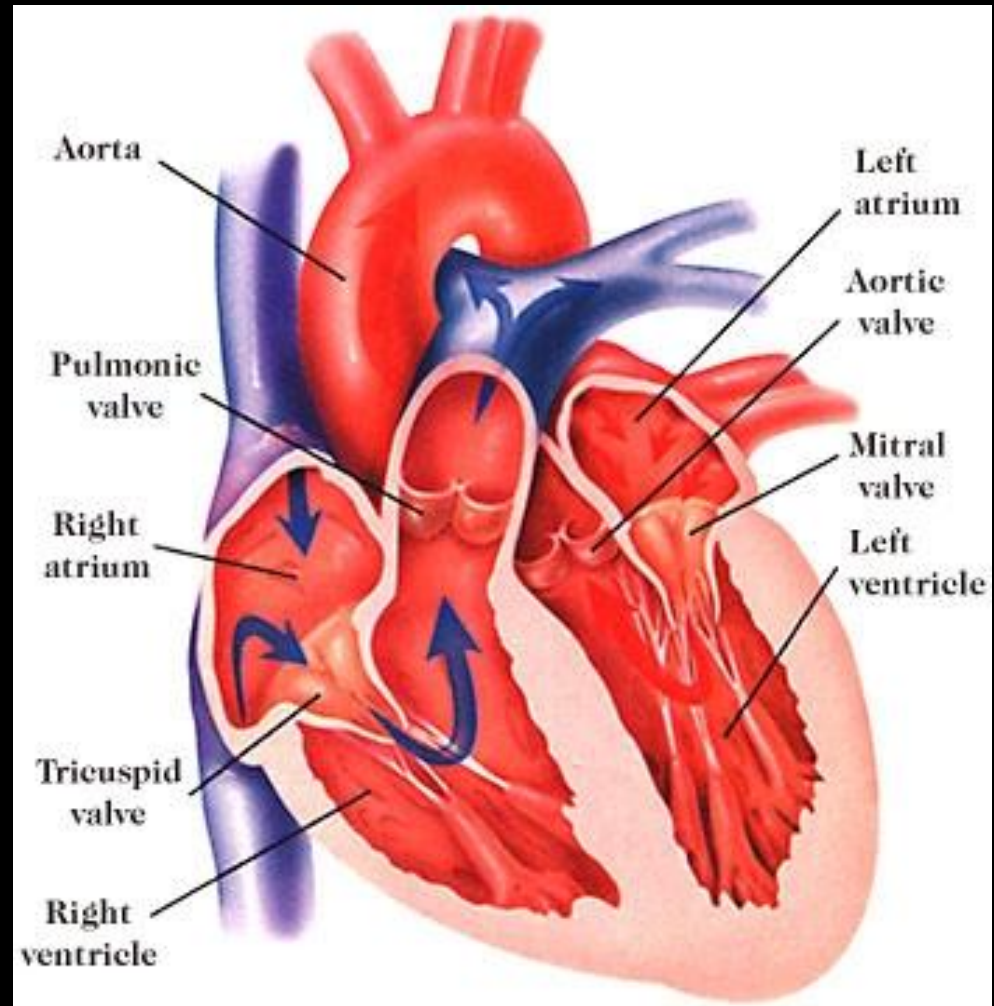
# Chambers of the Heart

- 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



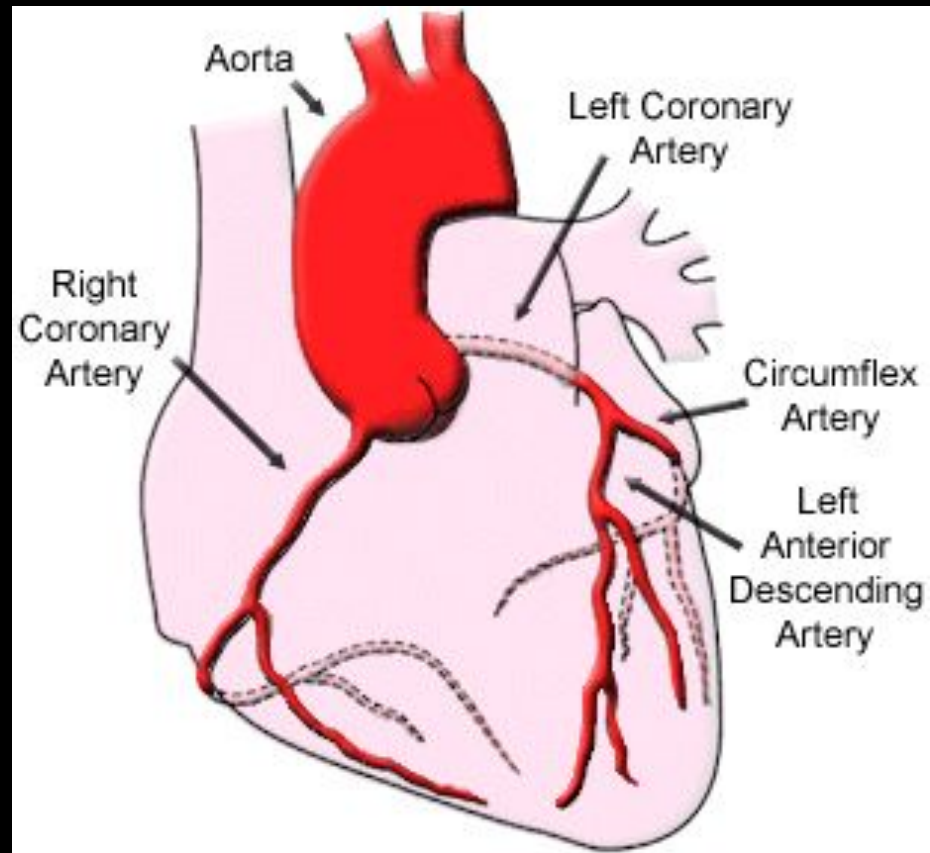
# Heart Valves

- 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



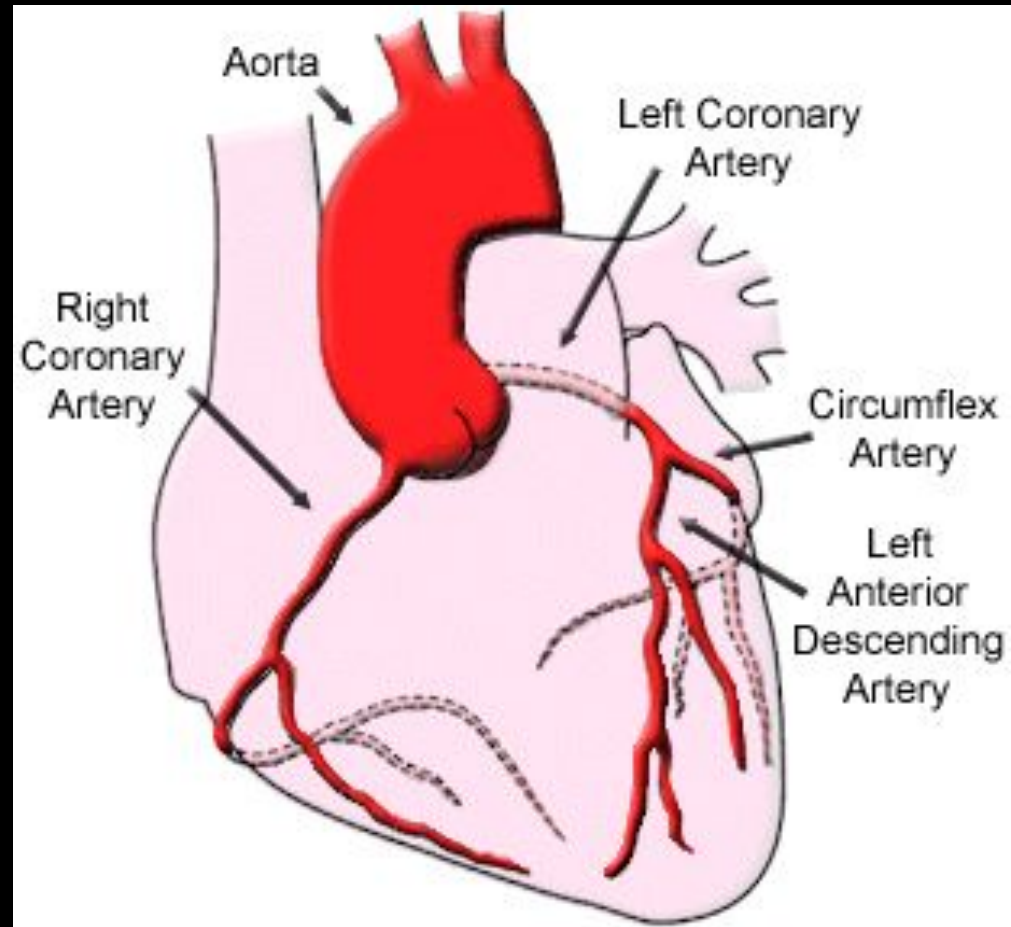
# Coronary Arteries

- 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

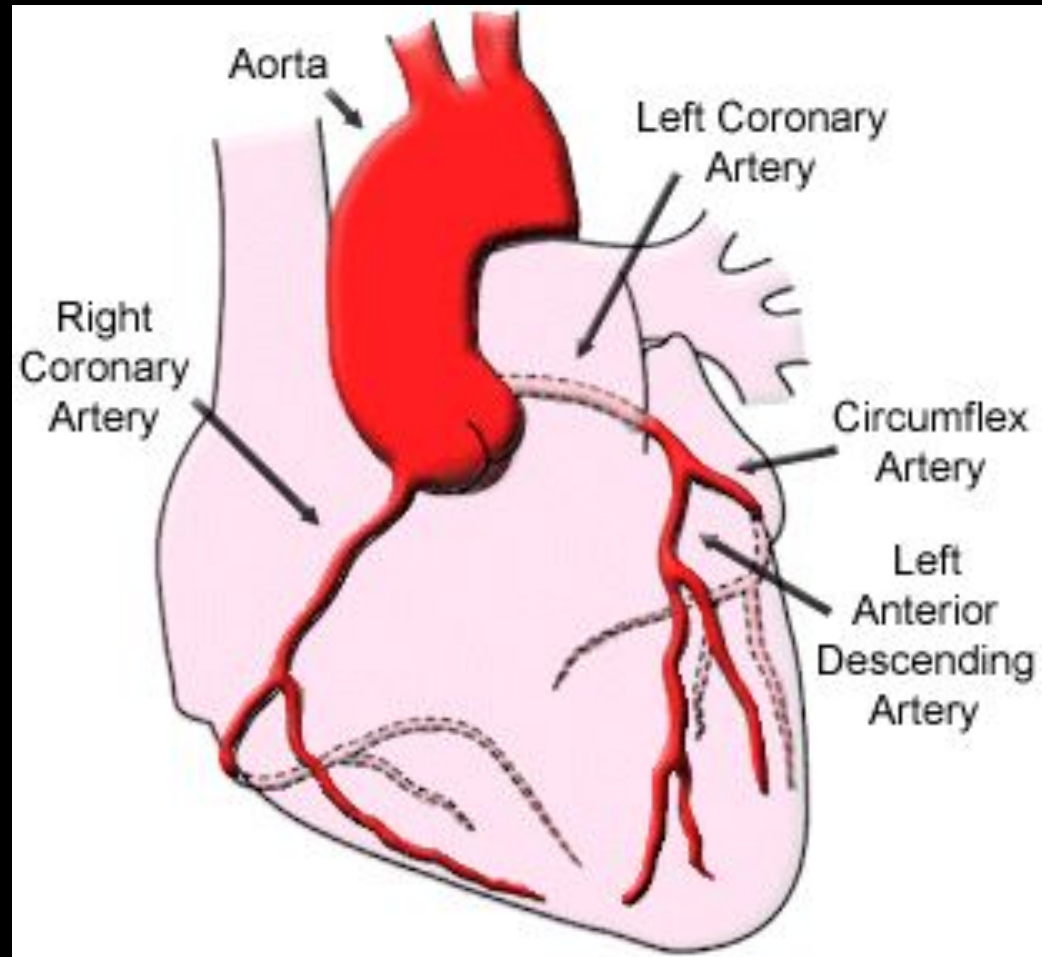
- Left main coronary artery (LCA)
  - Left anterior descending artery (LAD)
    - > descends toward the anterior wall & apex of LV
    - > supplies LV, ventricular septum, chordae, papillary muscle & RV
  - Left circumflex artery (LXA)
    - > descends toward the lateral wall of LV & apex
    - > supplies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



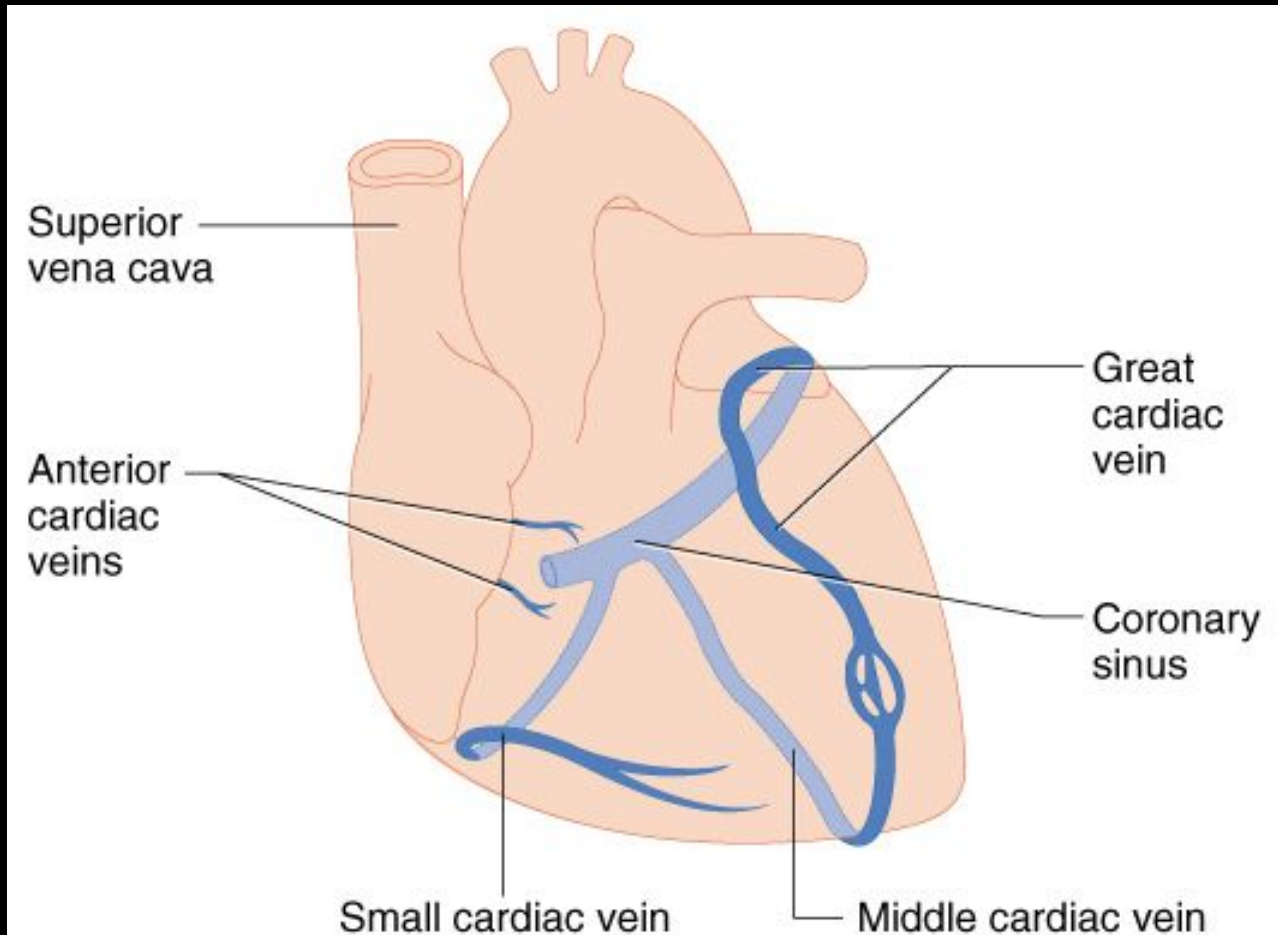


# Coronary Arteries

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



# Coronary Veins



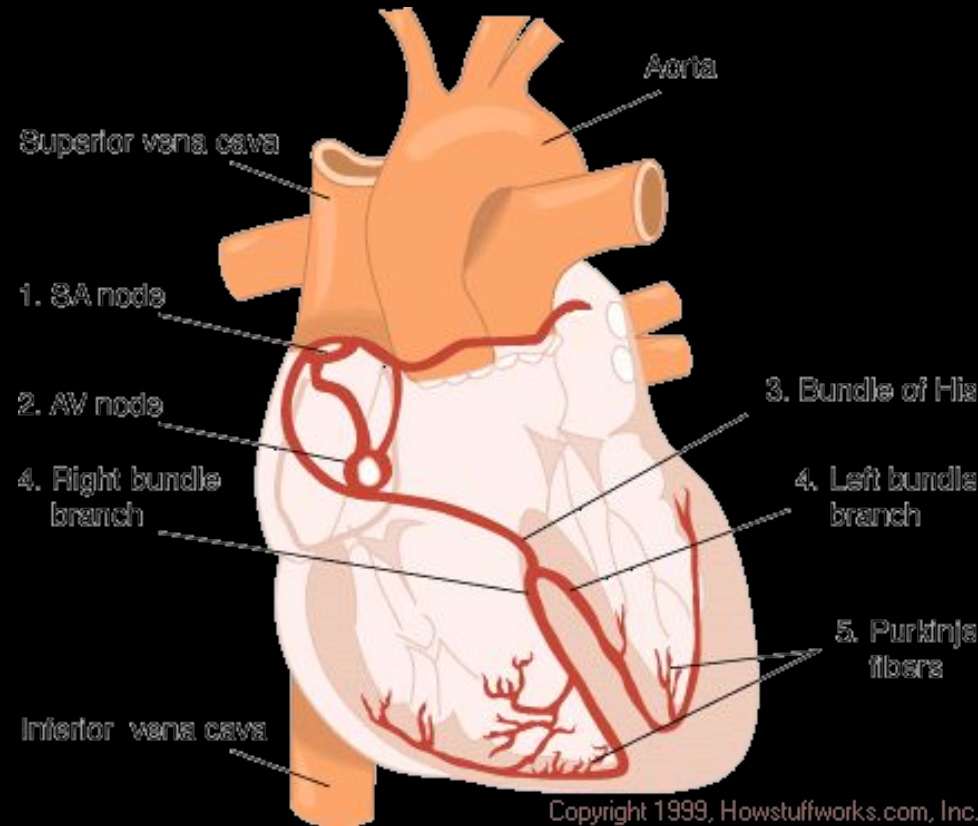
**(b)**

# 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)

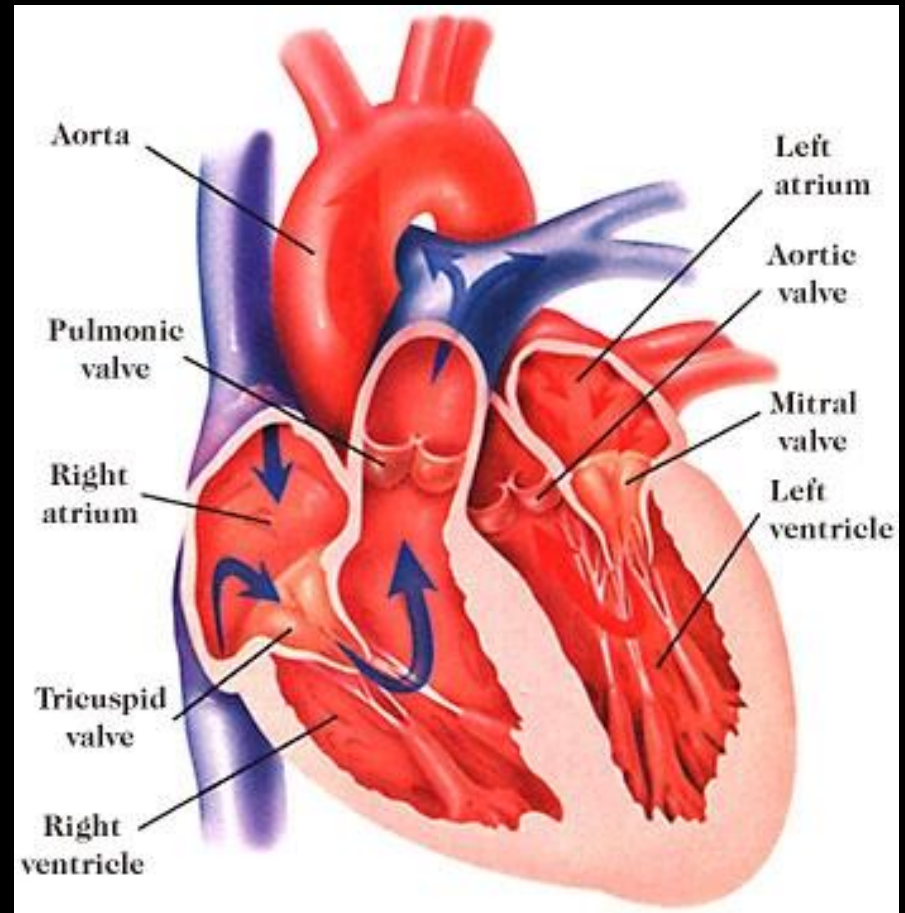
# Conduction System of the Heart

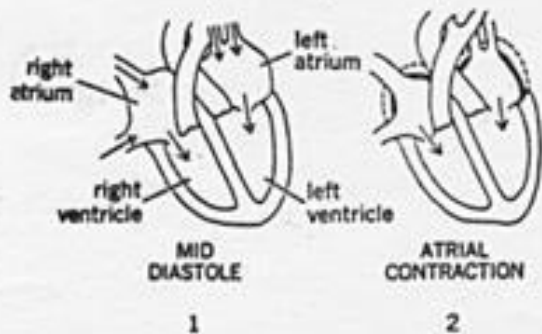
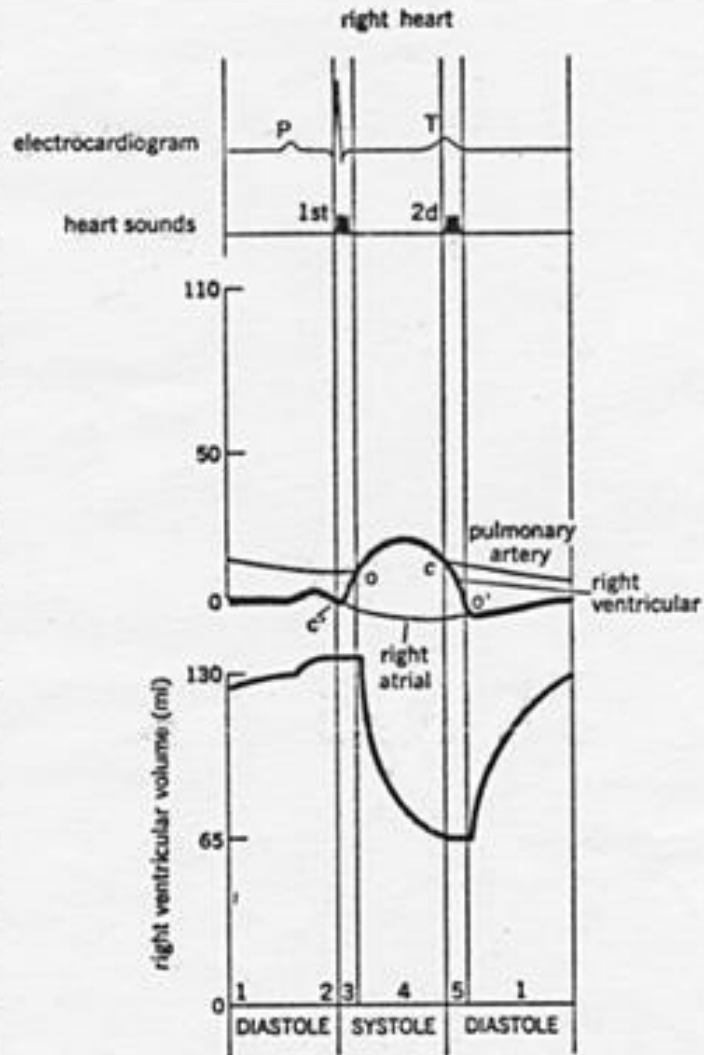
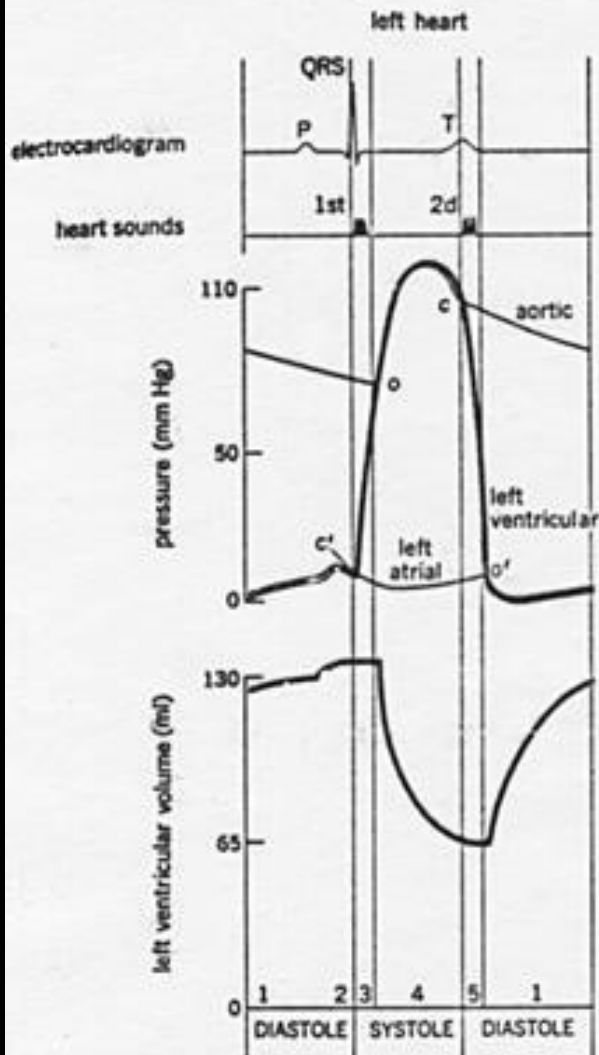
- Sinoatrial node (SA node)
  - pacemaker cells initiate impulses at 60 – 100 beats/min
- Atrioventricular node (AV node)
  - located in the junctional area
  - normal delay (allows the atria to contract completely before the ventricles are stimulated to contract)
  - 40 – 60 beats/min
- Bundle of His
  - 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

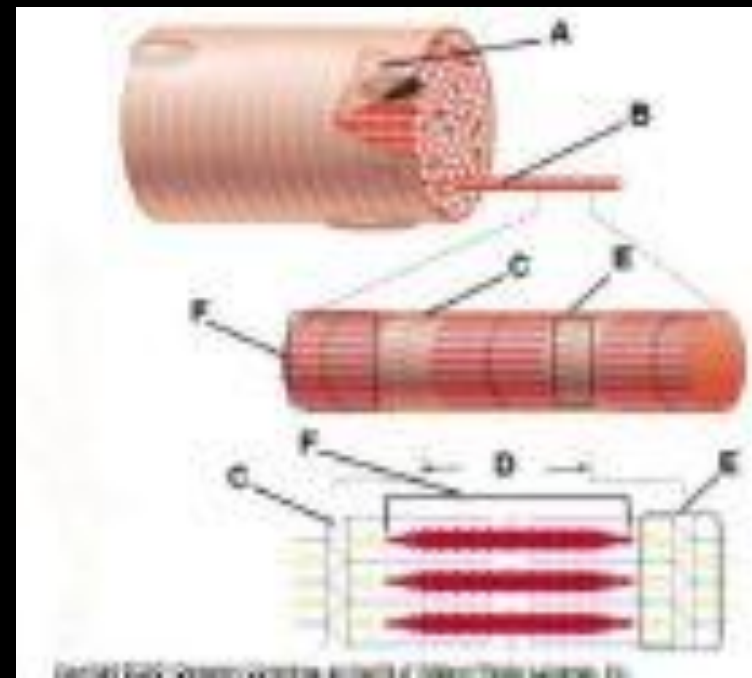
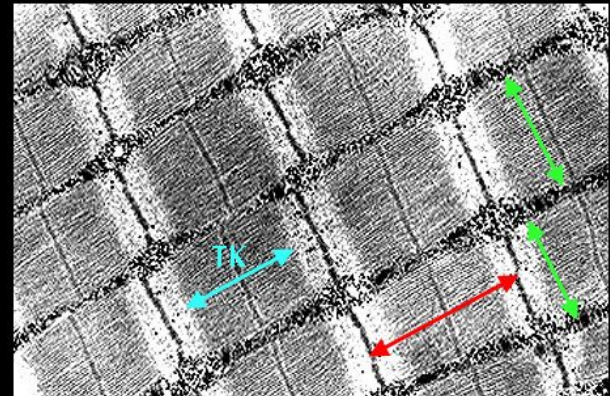
- Diastole
  - relaxation and filling of the atria and ventricles
  - “dub”
- Systole
  - contraction and emptying of the atria & ventricles
  - “lubb”





# 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

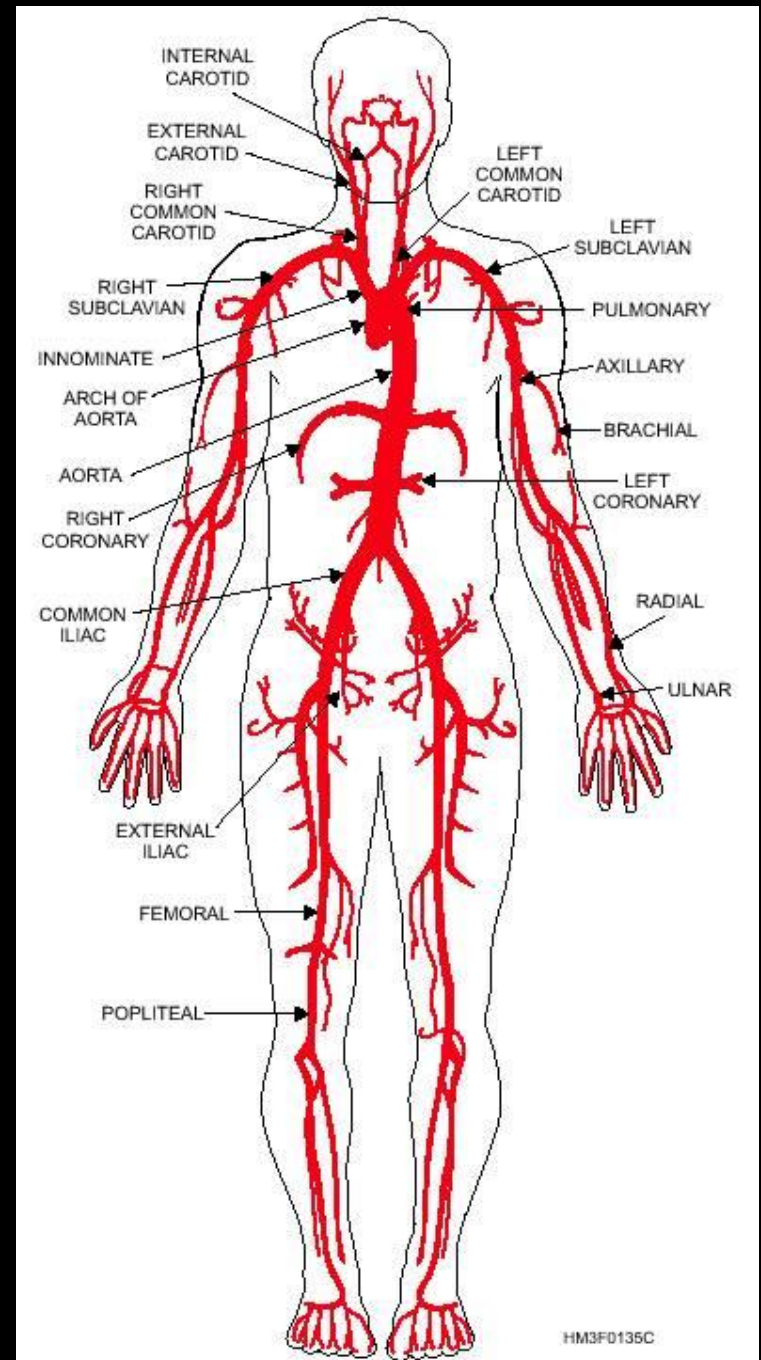
- Myocardial contractility
  - force of cardiac contraction independent of preload
  - increased by sympathetic nervous stimulation, calcium release & positive inotropic drugs
  - decreased by hypoxemia & acidemia

# 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

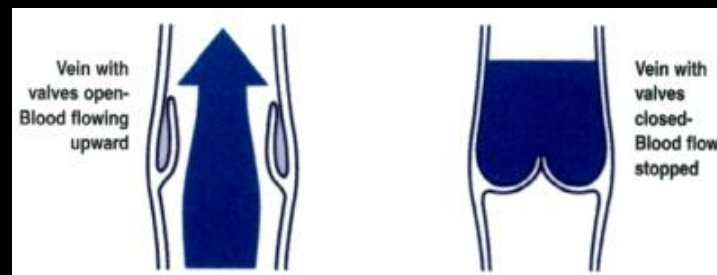
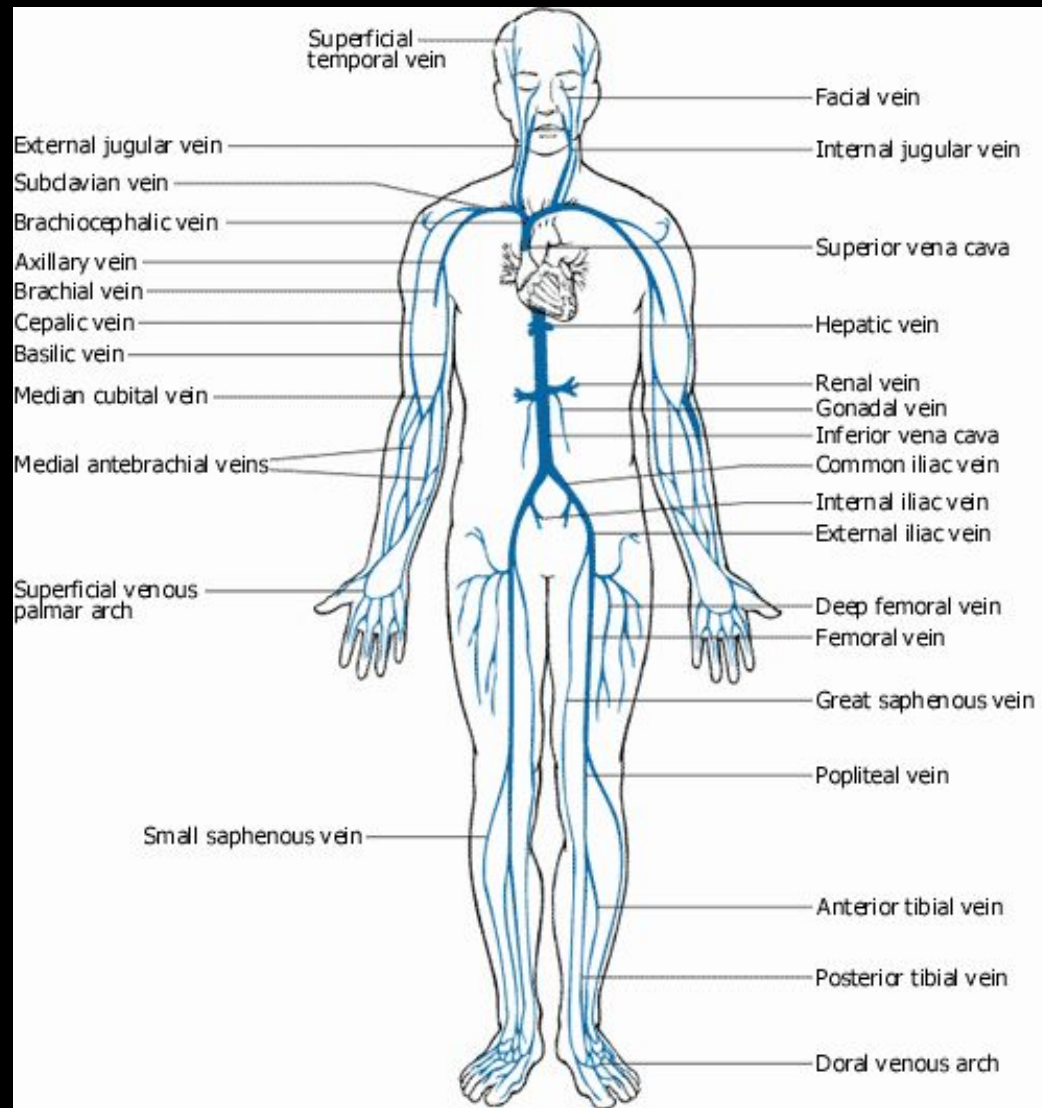
- Autonomic Nervous System
  - Baroreceptors (arch of aorta & origin of internal carotid arteries)
    - > stimulated when arterial walls are stretched by increased BP
    - > inhibit vasomotor center (pons & medulla or brainstem)
  - Chemoreceptors (bifurcation of carotid arteries & aortic arch)
  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

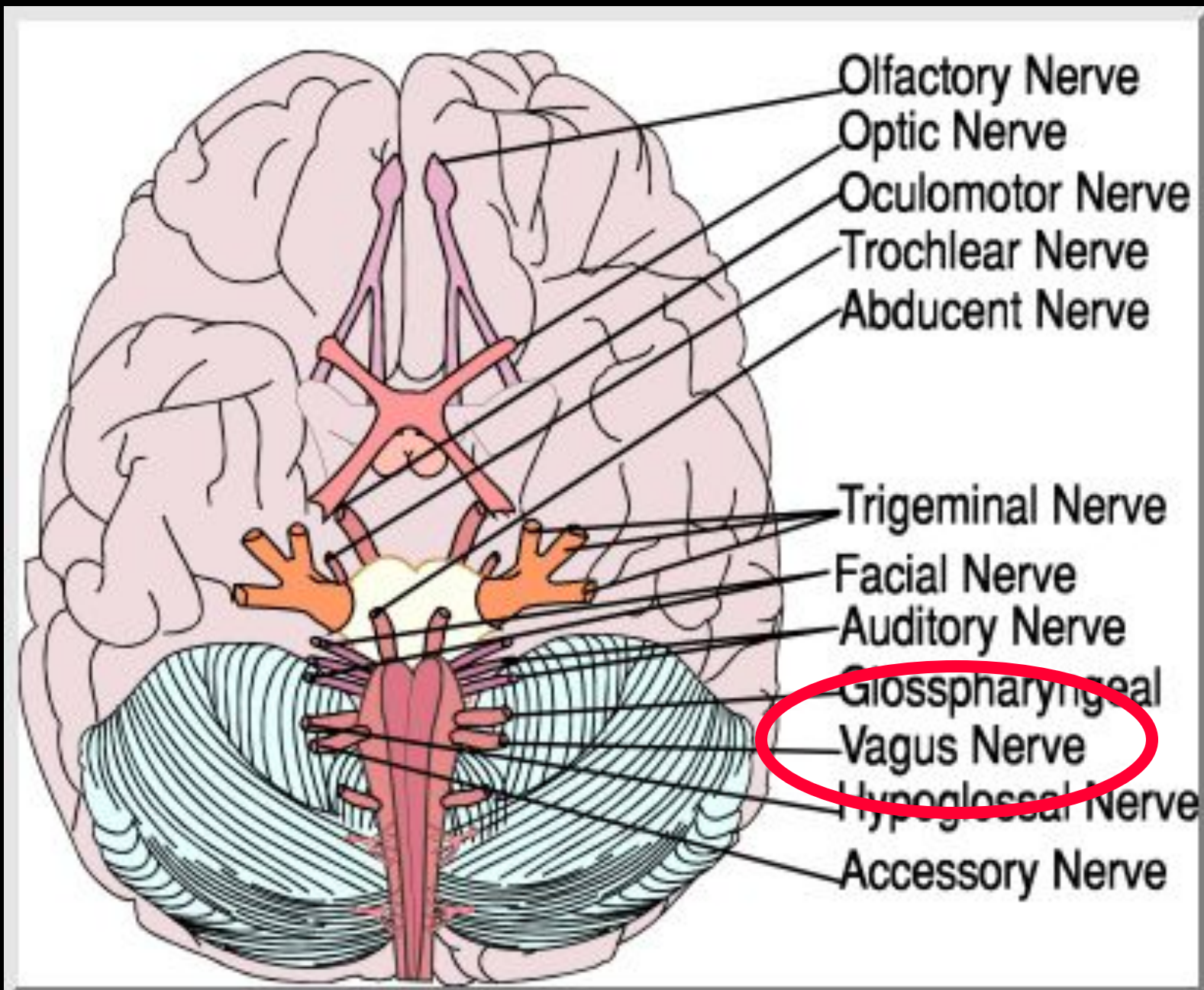




# Venous System

- 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)

