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Cardiac Anatomy & Physiology

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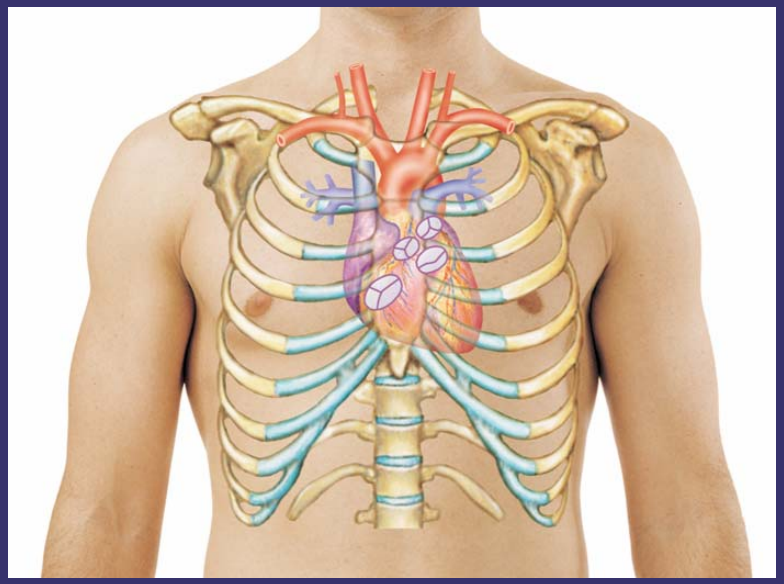
Location of the Heart

- Hollow muscular organ
- Located in the middle of the thoracic cavity
- Surrounded by pericardium
- Attached to thorax via great vessels



Location of the Heart

- Apex (bottom)
  - Formed by tip of left ventricle
- Base (top)
  - Approximately 2nd intercostal space
- Anterior surface
  - Consists primarily of right ventricle
- Inferior (diaphragmatic) surface
  - Formed by right and left ventricles, predominantly left

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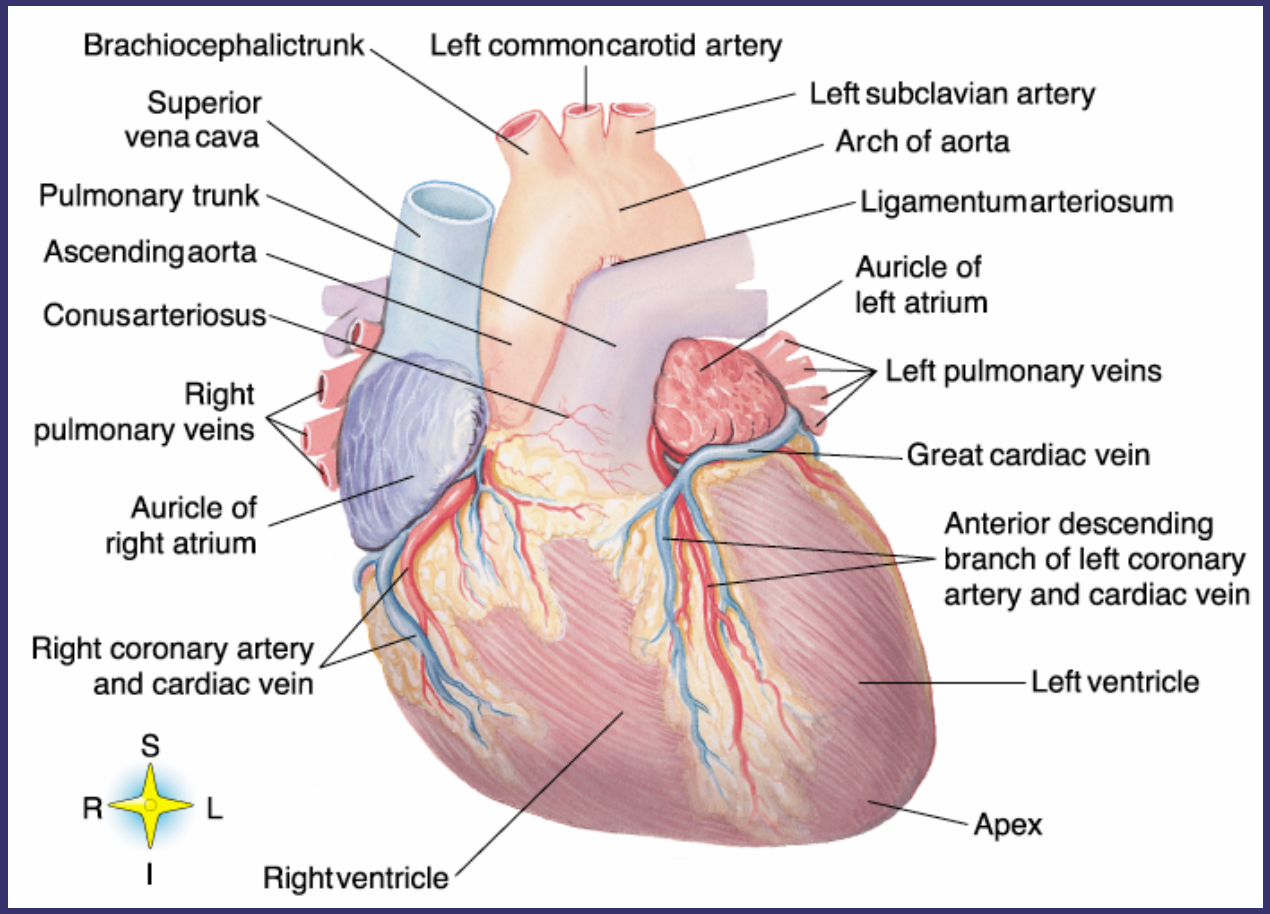
Location of the Heart



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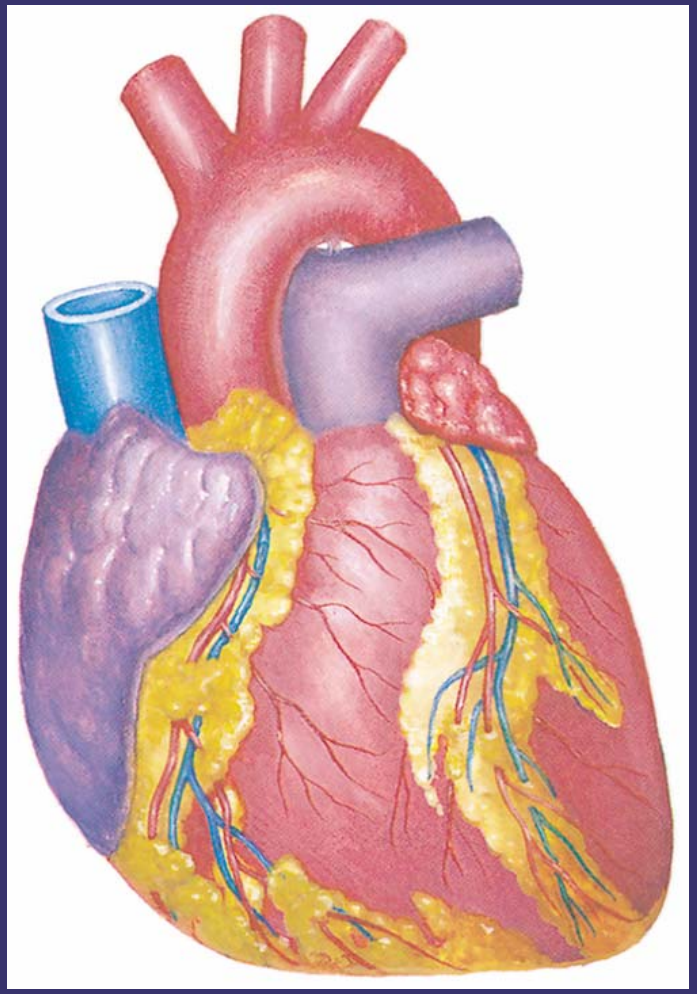
Size and Shape of the Heart

- Cone-shaped muscular organ
- Adult heart is approximately:
  - 5 inches (12 cm) long
  - 3.5 inches (9 cm) wide
  - 2.5 inches (6 cm) thick
  - About the size of a man's fist



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Size and Shape of the Heart

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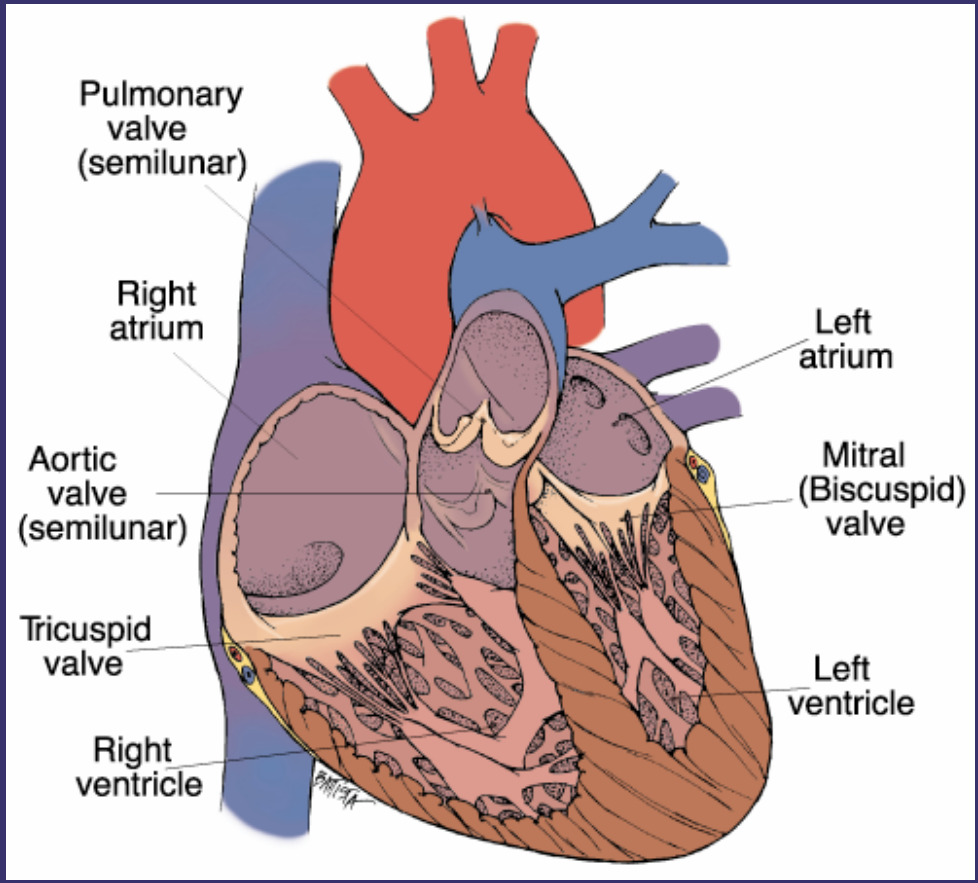
Heart Chambers

- The heart is divided into four cavities or chambers
- Functions as a two-sided pump
  - Two upper chambers = right and left atria
  - Two lower chambers = right and left ventricles



Heart Chambers

- Right side of the heart
  - Low-pressure system
  - Pumps venous blood to the lungs
- Left side of the heart
  - High-pressure system
  - Pumps arterial blood into the systemic circulation

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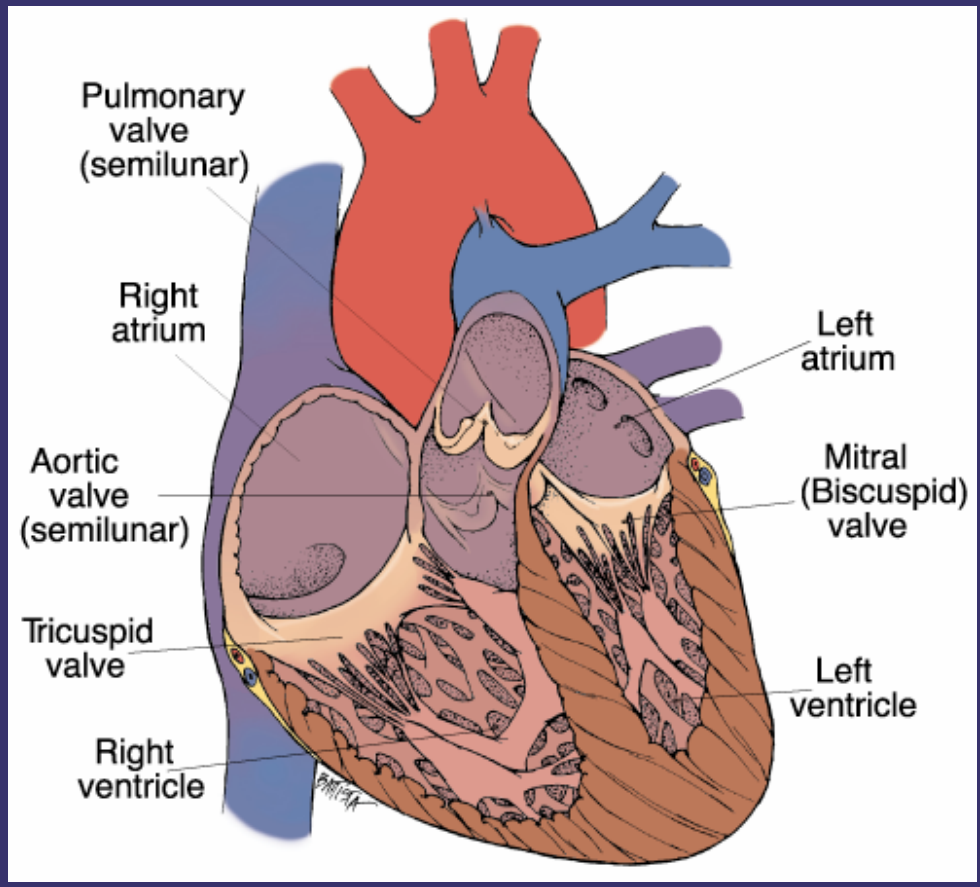
Atria

- Thin-walled, low-pressure chambers that receive blood
- Interatrial septum separates right and left atria
- “Atrial kick”



Ventricles

- Pump blood to lungs and systemic circulation
- Interventricular septum separates right and left ventricles
- Left ventricle
  - High-pressure chamber

Layers of the Heart

- The heart wall is made up of three tissue layers:
  - Endocardium
  - Myocardium
  - Epicardium

Layers of the Heart

- Endocardium
  - Innermost layer
  - Lines inner chambers, valves, chordae tendineae, and papillary muscles
  - Continuous with innermost layer of arteries, veins, and capillaries

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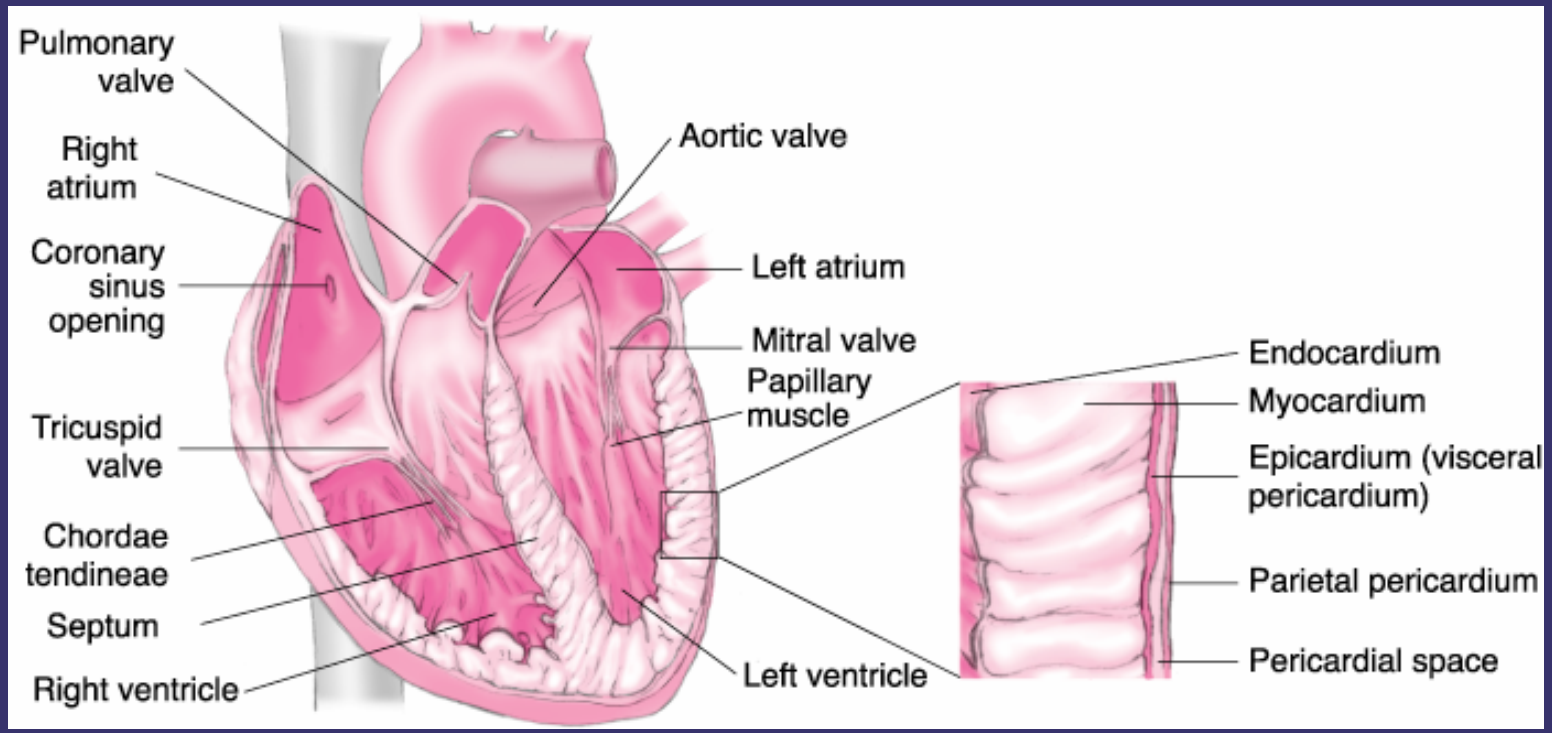
Layers of the Heart



Layers of the Heart

- Myocardium
  - Middle layer
  - Thick, muscular layer
  - Responsible for pumping action

Layers of the Heart

- Epicardium
  - Also called the visceral layer of the serous pericardium
  - External layer of the heart
  - Includes blood capillaries, lymph capillaries, nerve fibers, and fat

Layers of the Heart

- Pericardium
  - Double-walled sac that encloses the heart
  - Fibrous parietal pericardium
    - Rough outer layer of the pericardial sac
  - Serous pericardium
  - Pericardial space
    - Contains approximately 10 mL of serous fluid

Cardiac Muscle

- Walls of the heart are formed by cardiac muscle fibers
  - Sarcolemma
  - Myofibrils

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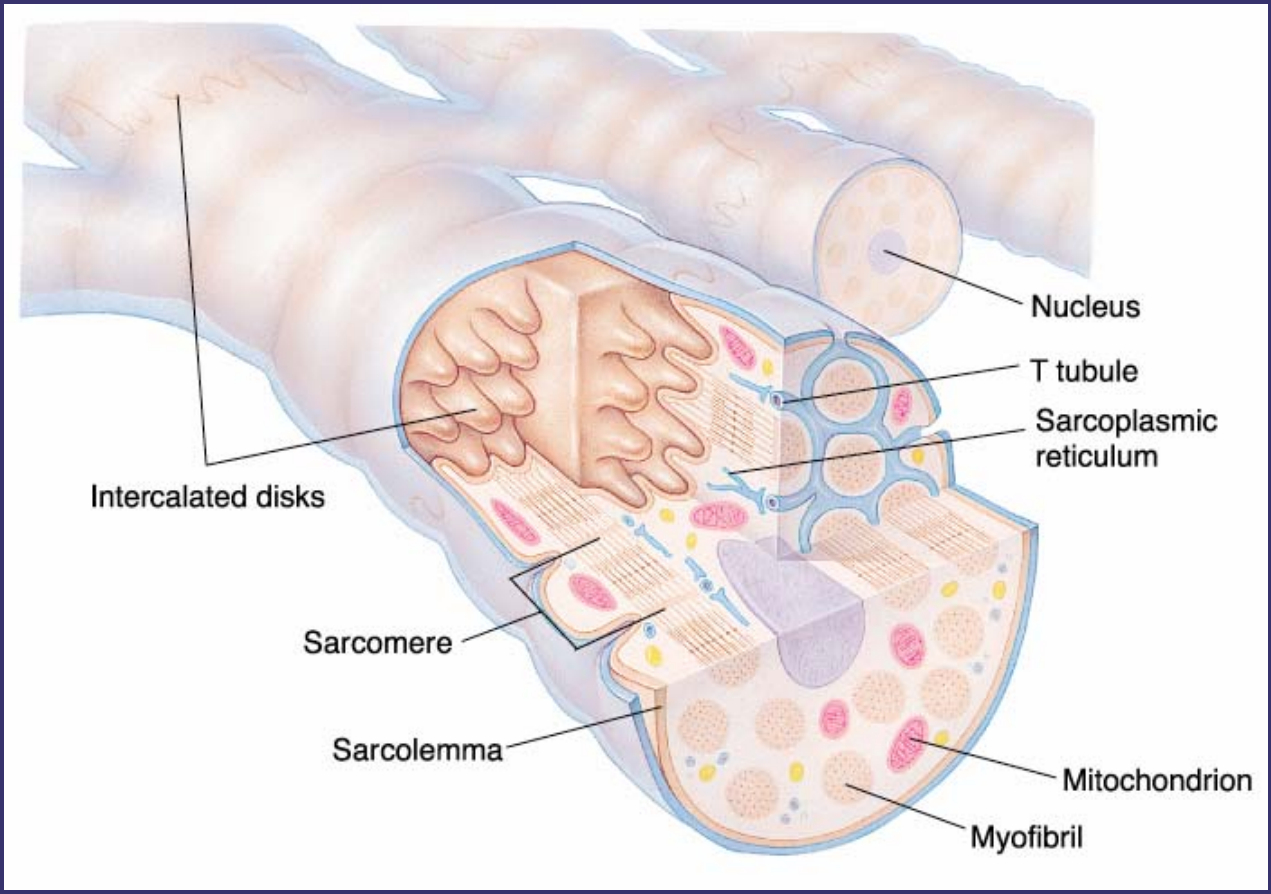
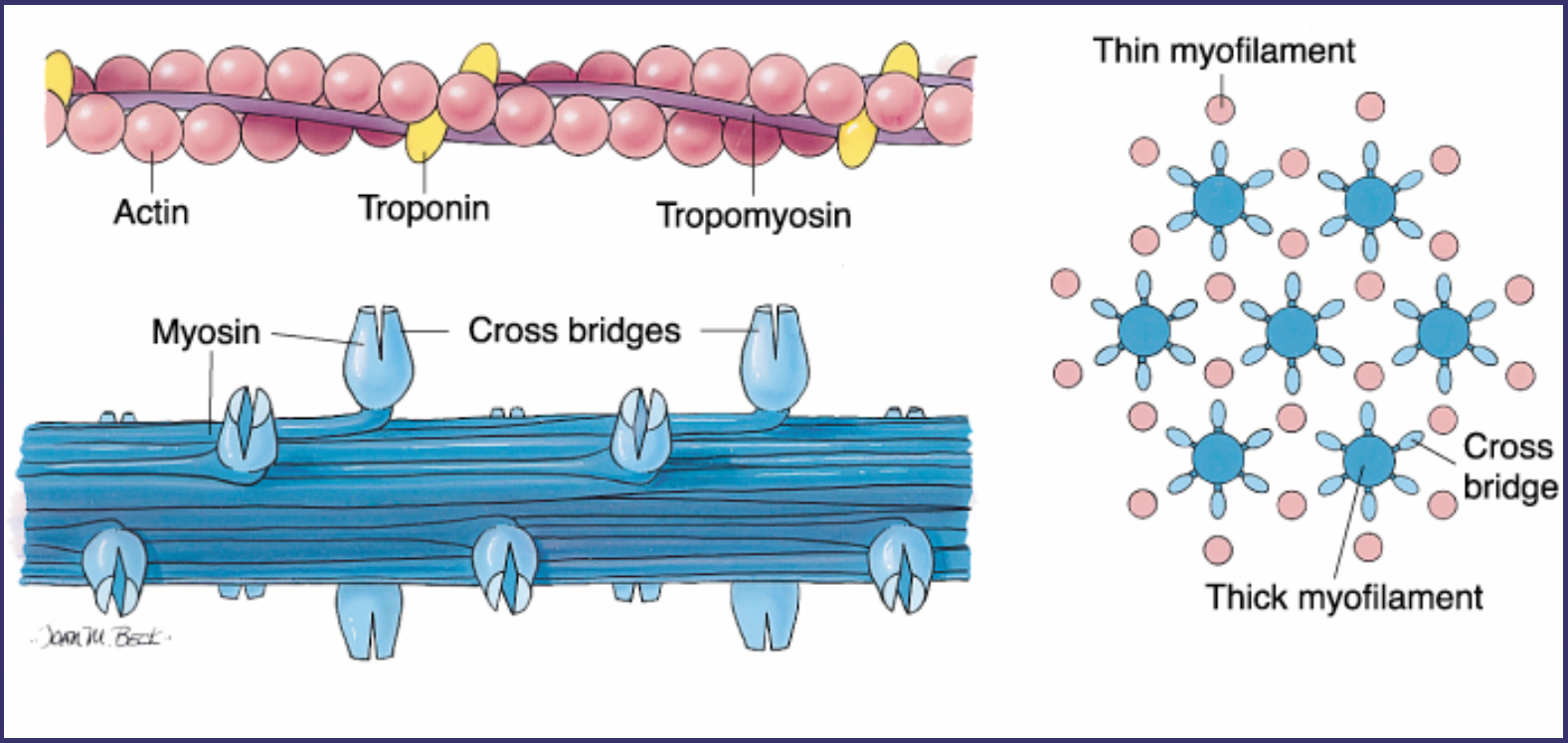
Cardiac Muscle



Cardiac Muscle

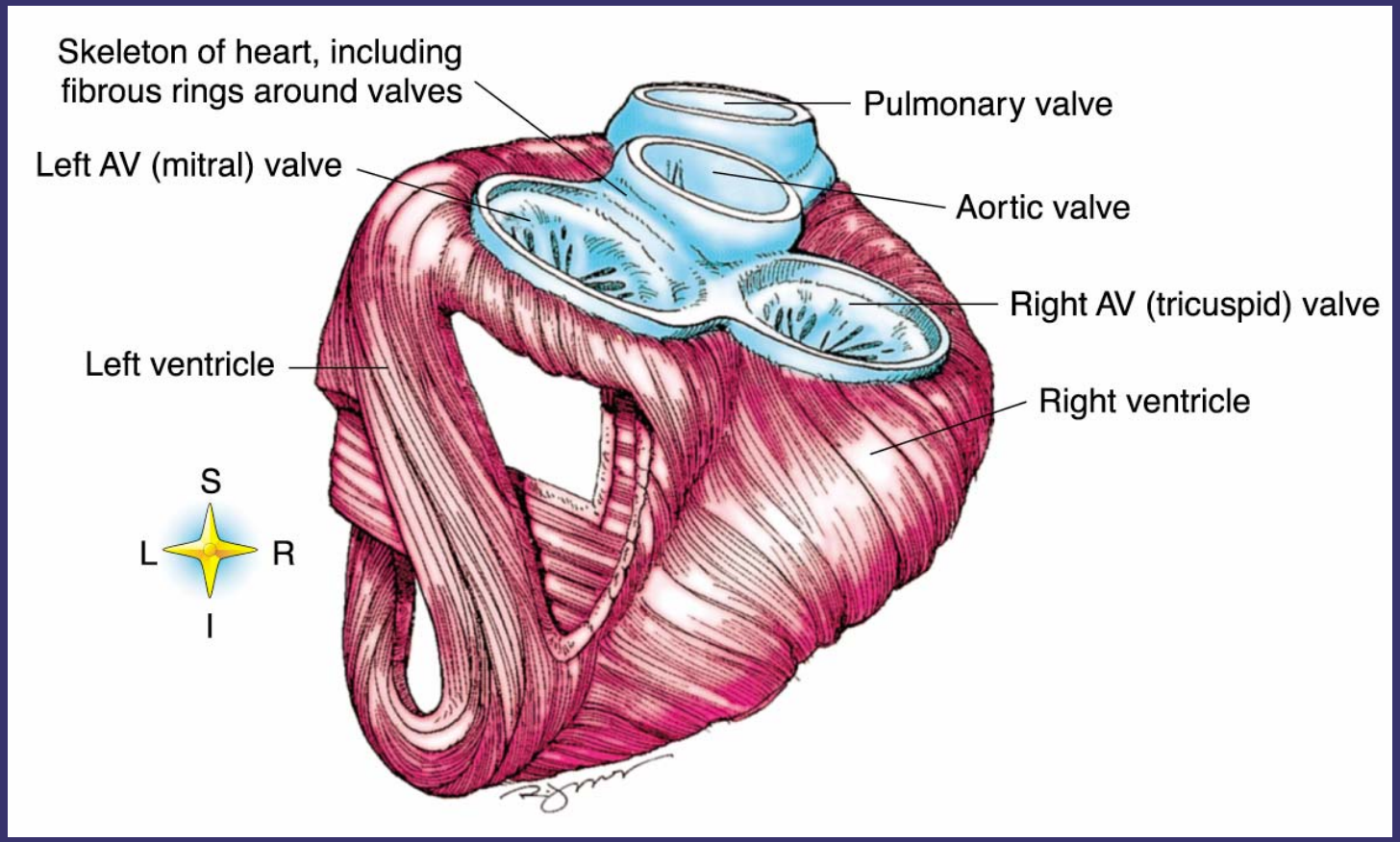
- Each sarcomere contains two types of protein filaments: actin and myosin



Cardiac Muscle

- Cardiac muscle fibers fit together tightly at junctions called intercalated disks
  - Intercalated disks form gap junctions
    - Function as electrical connections
    - Allow cells to conduct electrical impulses rapidly

Valves of the Heart

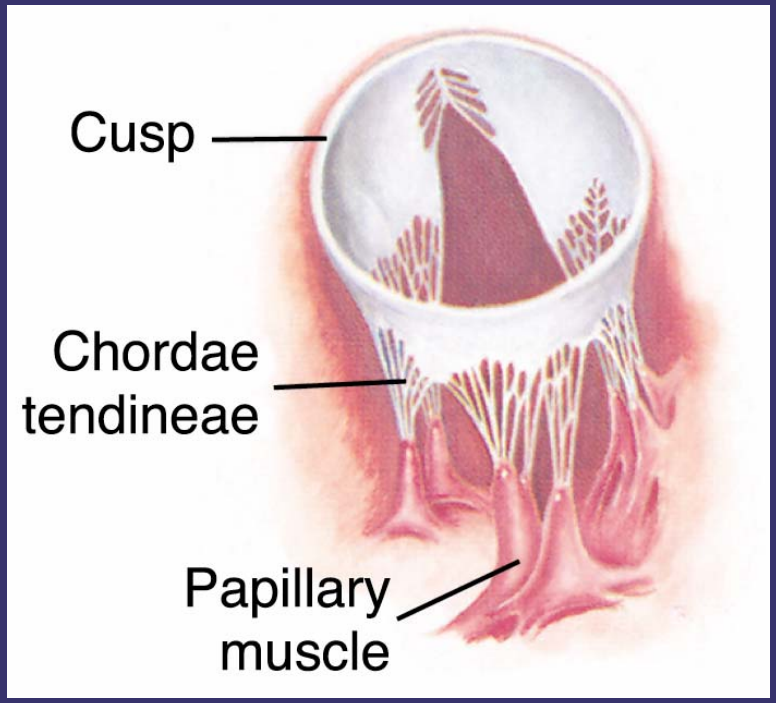


Heart Valves

- Heart contains four valves
  - Two sets of atrioventricular (AV) valves
  - Two sets of semilunar valves
- Function
  - Ensure blood flows in one direction through heart chambers
  - Prevent backflow of blood

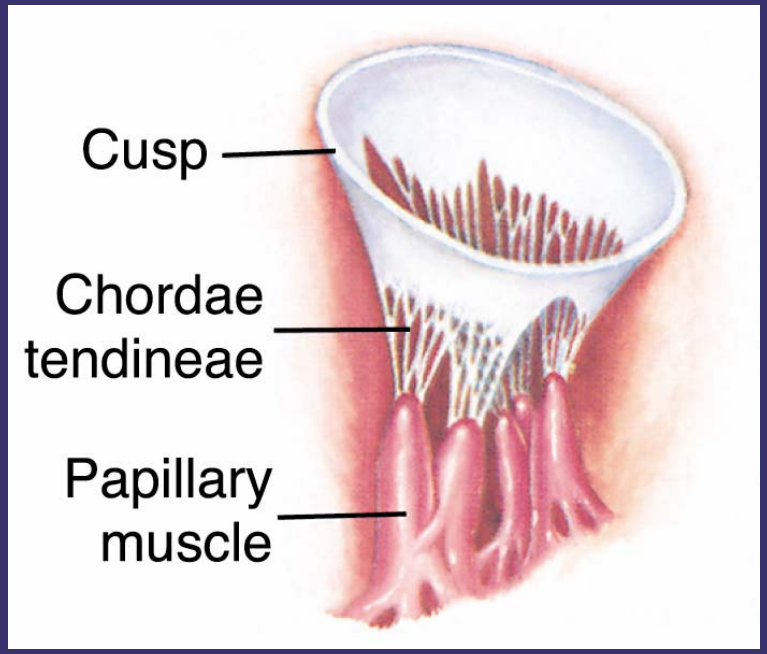
Atrioventricular (AV) Valves

- AV valves separate atria from ventricles
- Tricuspid valve
  - Lies between right atrium and right ventricle
  - Consists of three separate leaflets
  - Larger in diameter and thinner than mitral valve



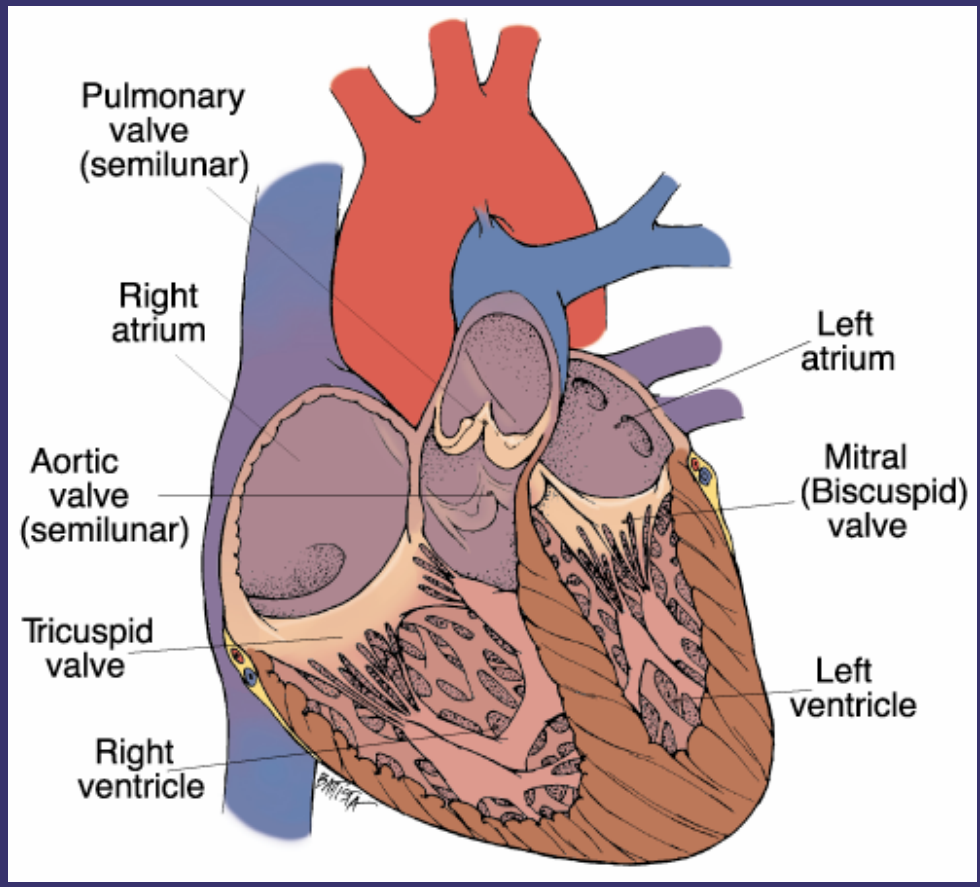
Atrioventricular (AV) Valves

- Mitral (bicuspid) valve
  - Has only two cusps
  - Lies between left atrium and left ventricle



Atrioventricular (AV) Valves

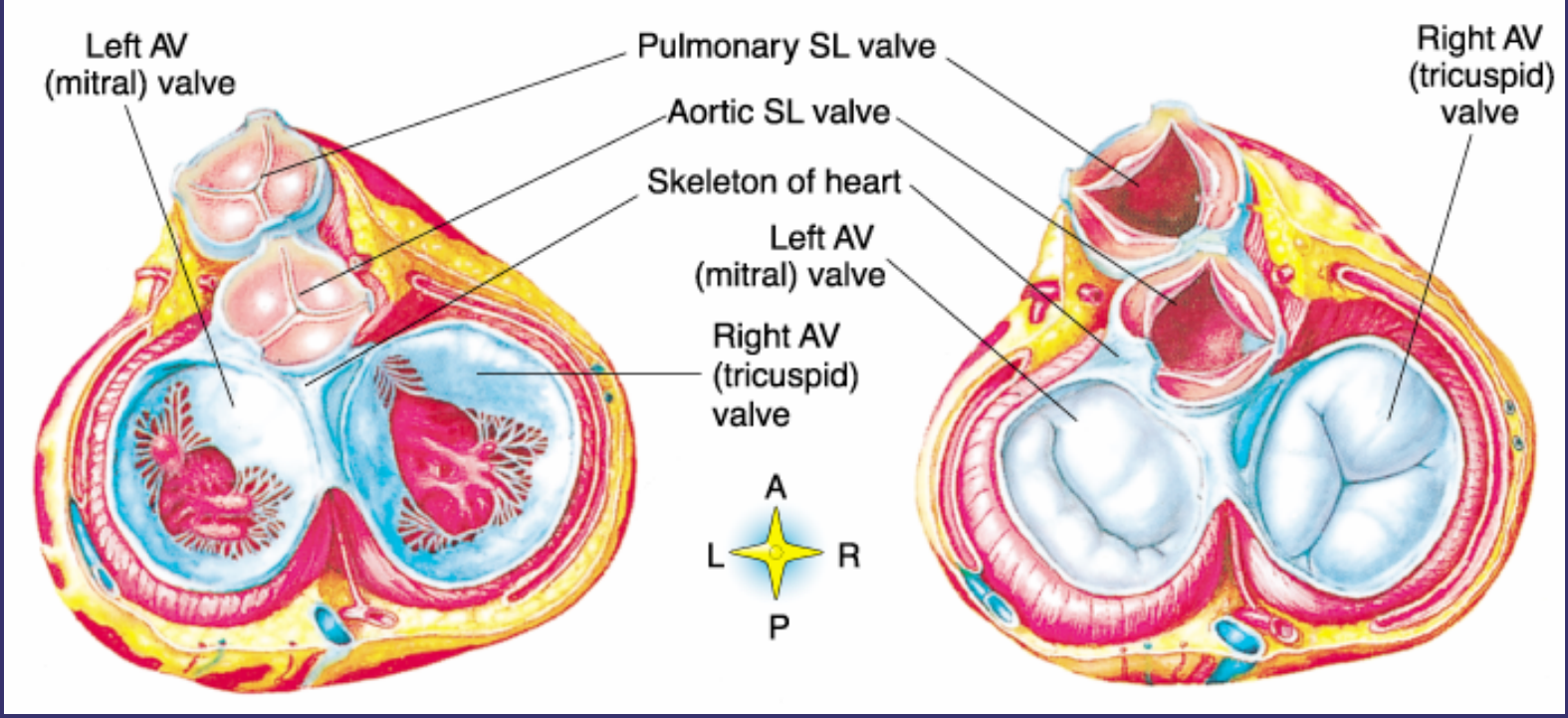
- Cusps of AV valves are attached to chordae tendineae
  - "Heart strings"
  - Originate from papillary muscles
  - Serve as anchors



Semilunar Valves

- Prevent backflow of blood from the aorta and pulmonary arteries into the ventricles during diastole
  - Pulmonic valve
  - Aortic valve

Semilunar Valves



Semilunar Valves

- Pulmonic valve
  - Prevents backflow of blood into right ventricle
- Aortic valve
  - Prevents backflow of blood into left ventricle

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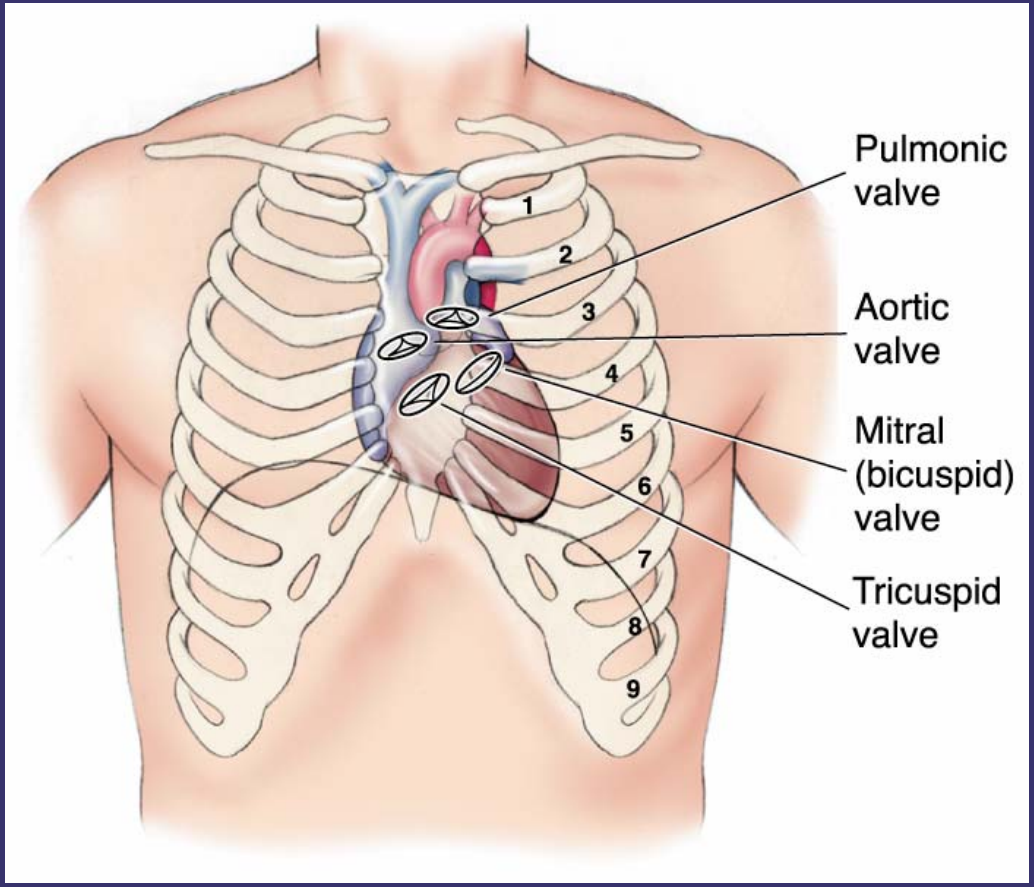
Semilunar Valves



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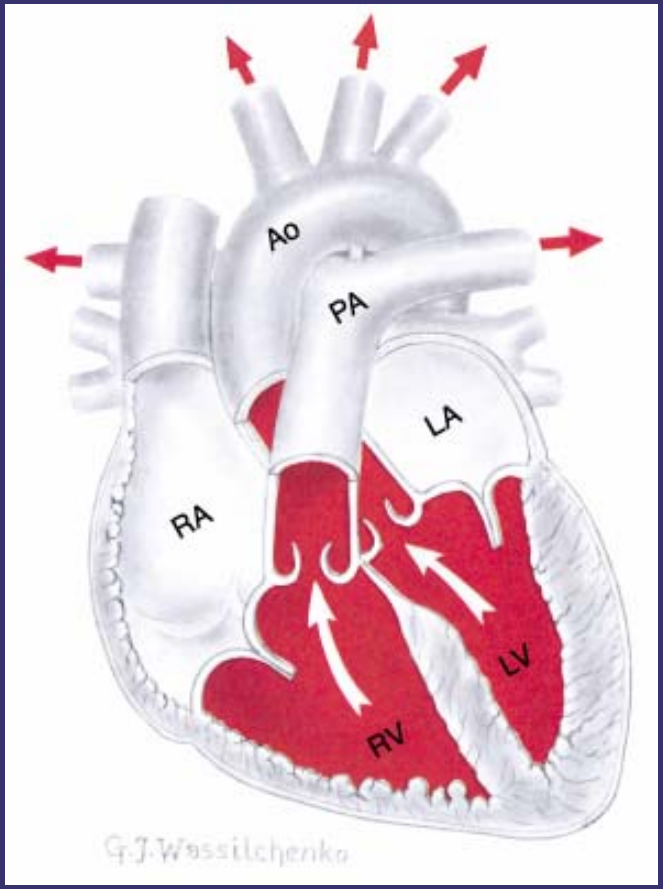
Blood Flow Through the Heart



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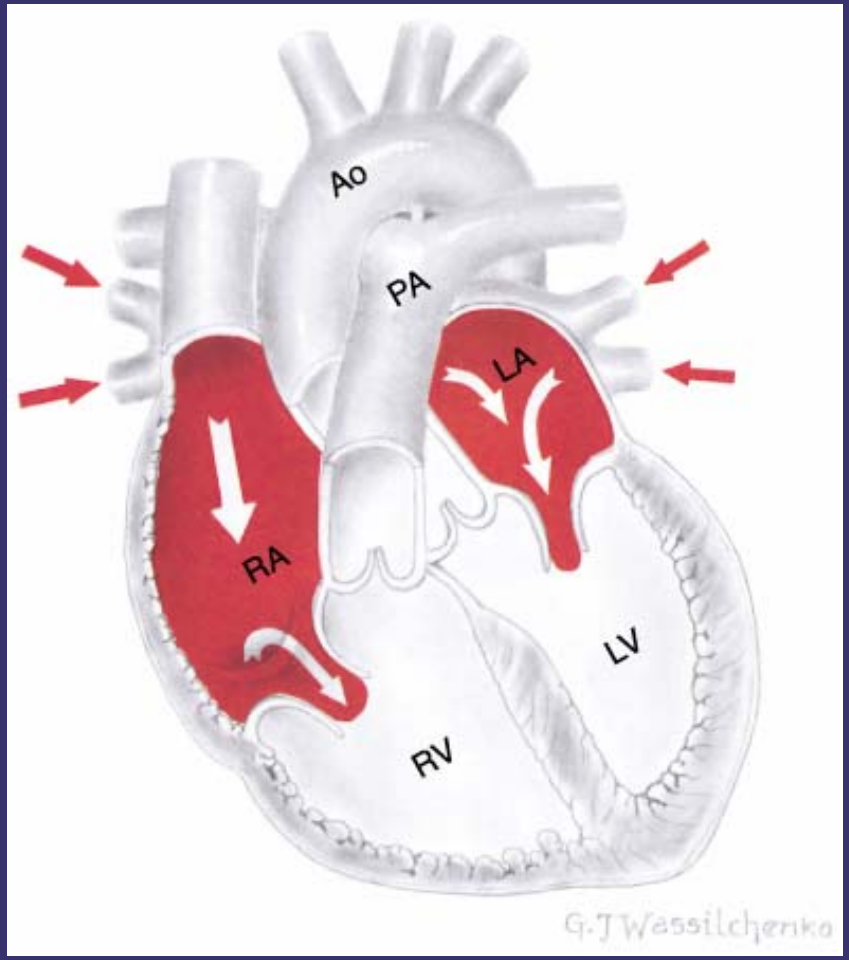
Cardiac Cycle

- Systole -

  Period during which the chamber is contracting and blood is being ejected



Cardiac Cycle

- Diastole
  - Period of relaxation during which the chamber is filling

The Heart as a Pump

- Venous return
  - Most important factor determining amount of blood pumped by heart

Cardiac Output

- Cardiac output is the volume of blood ejected from the heart over 1 minute
  - Because the ventricles contract almost simultaneously, their cardiac outputs are normally equal

Cardiac Output

- Cardiac output (CO) equals stroke volume (SV) multiplied by heart rate (HR)
  - CO = SV □ HR
- Cardiac output is affected by a change in heart rate *OR* stroke volume

Decreased Cardiac Output

- Cold, clammy skin
- Color changes in skin/mucous membranes
- Dyspnea
- Orthopnea
- Crackles (rales)
- Changes in mental status
- Changes in blood pressure
- Dysrhythmias
- JVD
- Fatigue
- Restlessness

Stroke Volume

- Amount of blood ejected during one contraction
- Dependent on:
  - Preload
  - Afterload
  - Myocardial contractility

Preload

- Preload is the force exerted by the walls of the ventricles at the end of diastole
- The volume of blood returning to the heart (venous return) influences preload
  - Hypovolemia = decreases preload
  - Heart failure = increases preload

Frank-Starling Law of the Heart

- Up to a limit, the more a myocardial muscle is stretched, the greater the force of contraction (and stroke volume)
  - Influenced by preload and afterload

Afterload

- Afterload is the pressure or resistance against which the ventricles must pump to eject blood
  - Increased afterload usually means an increase in the work of the heart

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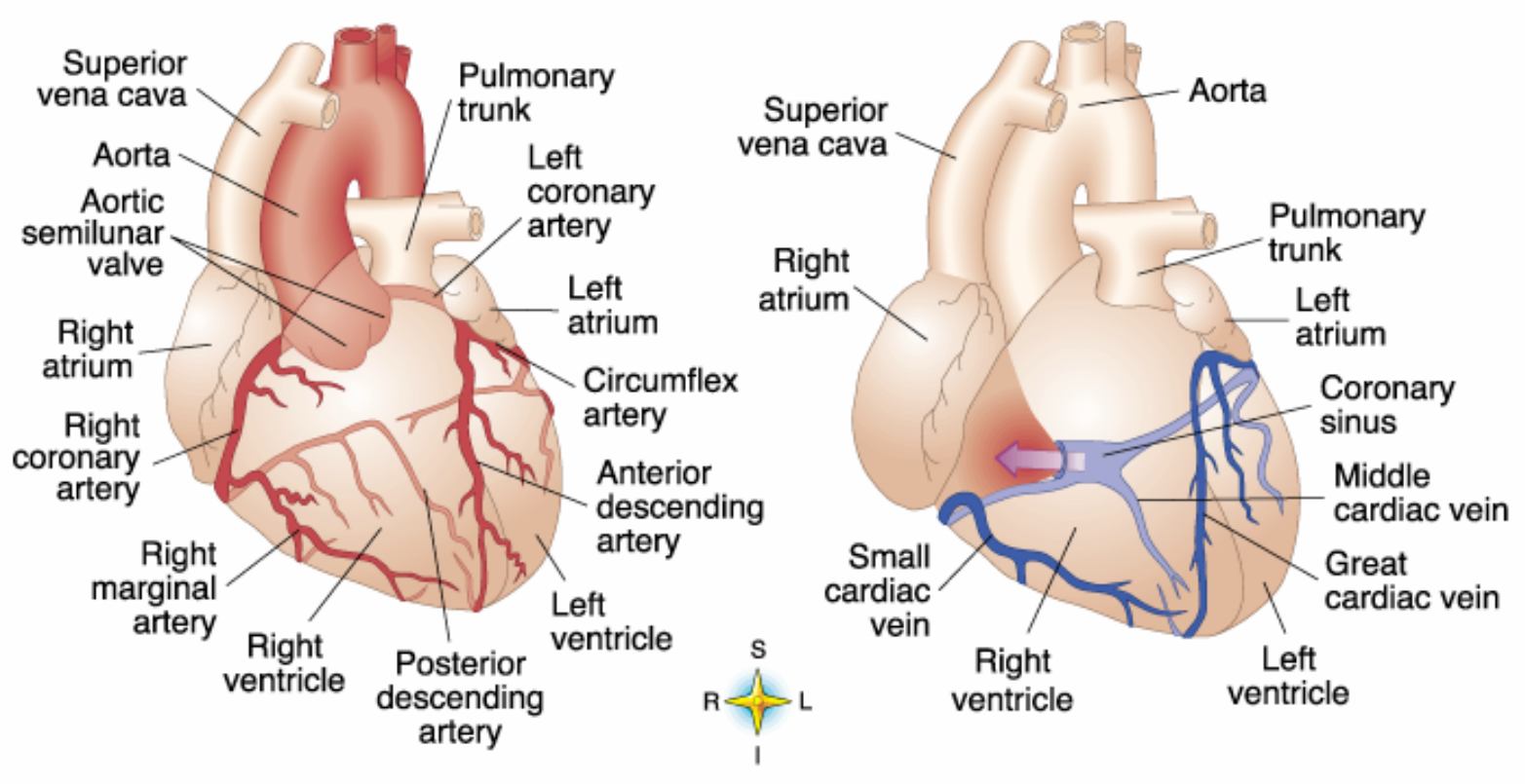
Coronary Circulation



Coronary Arteries

- Supply heart with oxygenated blood
- Primary arteries: right and left coronary arteries
  - Coronary artery filling occurs during ventricular relaxation (diastole)

Right Coronary Artery

Coronary Artery and its Branches	Portion of Myocardium Supplied	Portion of Conduction System Supplied
• Posterior descending • Right marginal	• Right atrium • Right ventricle • Inferior wall of left ventricle • Posterior wall of left ventricle • Posterior 1/3 of interventricular septum	• SA node (50% to 60% of population) • AV node (85% to 90%) • Proximal portion of bundle of His • Posterior-inferior fascicle of left bundle branch

Left Coronary Artery

Coronary Artery and its Branches	Portion of Myocardium Supplied	Portion of Conduction System Supplied
Left anterior descending	• Anterior and part of the lateral surface of the left ventricle • Anterior 2/3 of interventricular septum	• Majority of right bundle branch • Anterior-superior fascicle of left bundle branch • Portion of the posterior-inferior fascicle of the left bundle branch
Circumflex	• Left atrium • Anterolateral and posterolateral walls of left ventricle • Posterior wall of left ventricle	•SA node (40% to 50% of population) •AV node (10% to 15%)

Coronary Veins

- Run parallel to coronary arteries
- Drain myocardial blood into right atrium
  - Thebesian veins
  - Anterior cardiac veins
  - Coronary sinus
- Thebesian and anterior cardiac veins are tributaries of coronary sinus