

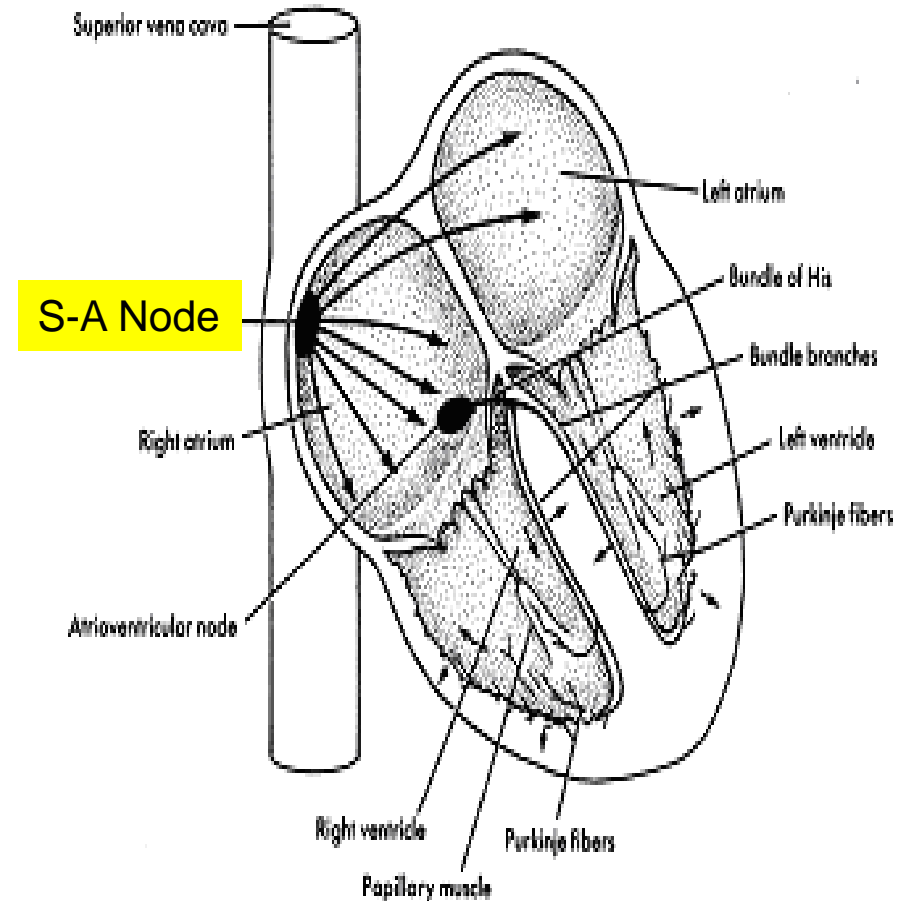
# Cardiac Conduction System

# What causes the Heart to Beat?

- Heart contracts by electrical signals!
- Cardiac muscle tissue contracts on its own
  - an electrical signal is sent out by the heart so that all cells beat together

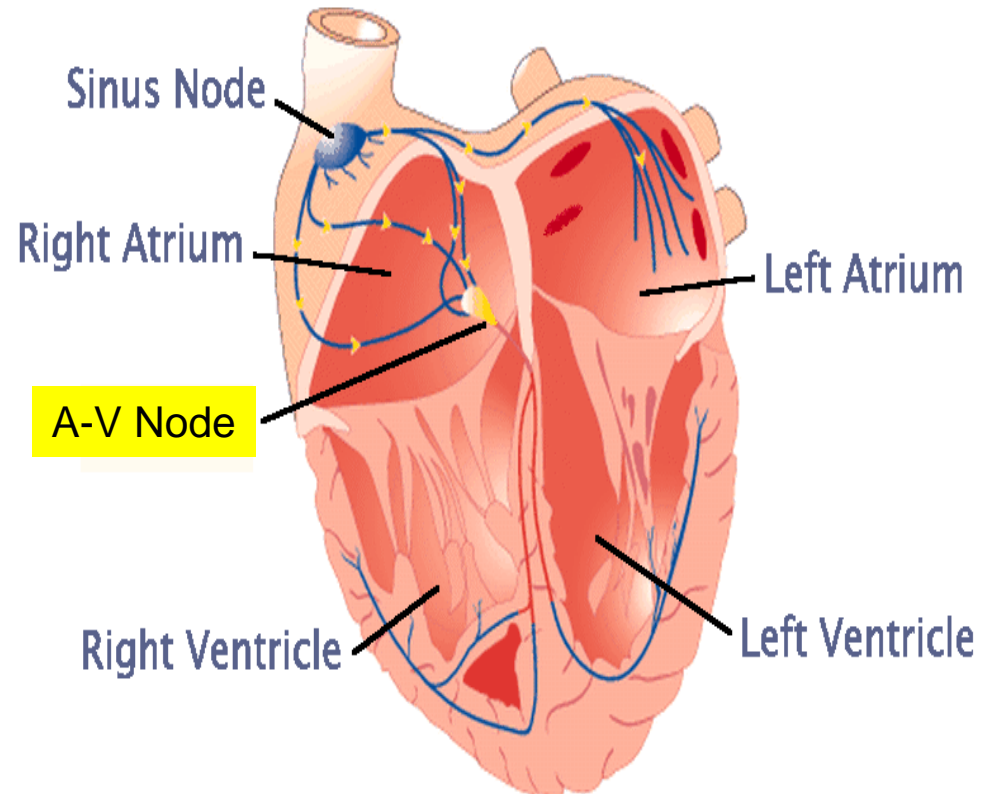
# Parts of the Conducting System

- **Sinoatrial Node (S-A node)**
- Aka the pacemaker
  - Located in the wall of the right atrium.
  - Initiates the impulse.
    - Generates the hearts rhythmic contractions
  - Generates about 75 impulses a minute



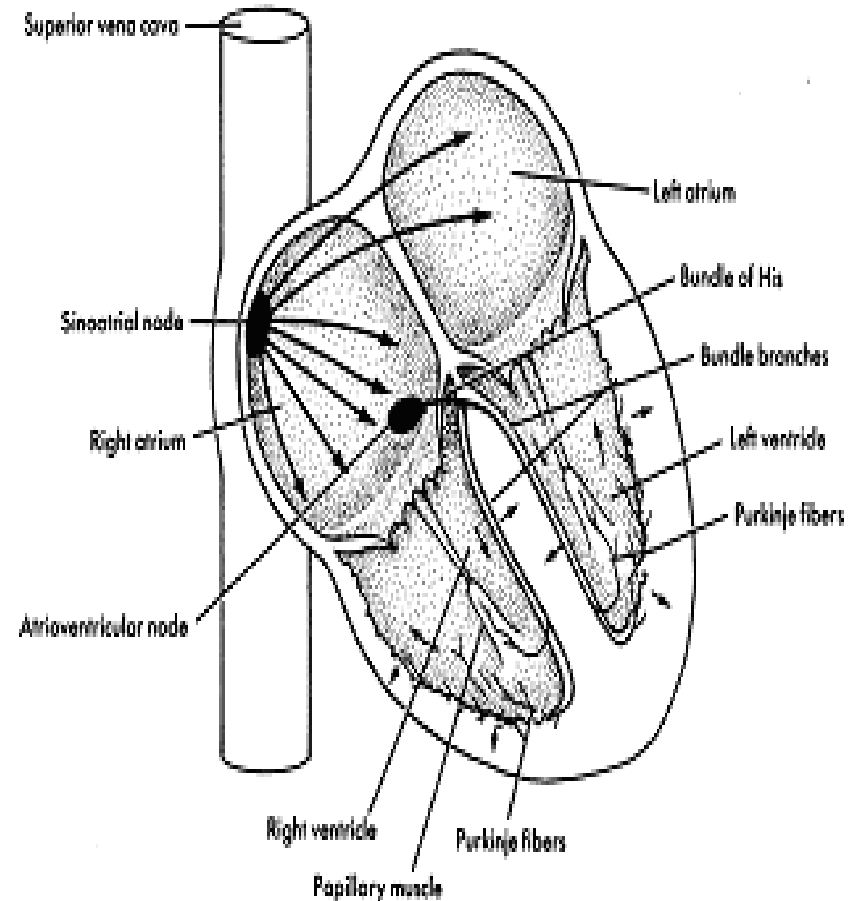
# Parts of the Conducting System

- **Atrioventricular Node (A-V Node)**
  - Located between the atria near the bottom, just beneath the endocardium.
  - Provides the only normal conduction pathway between the atria and ventricles



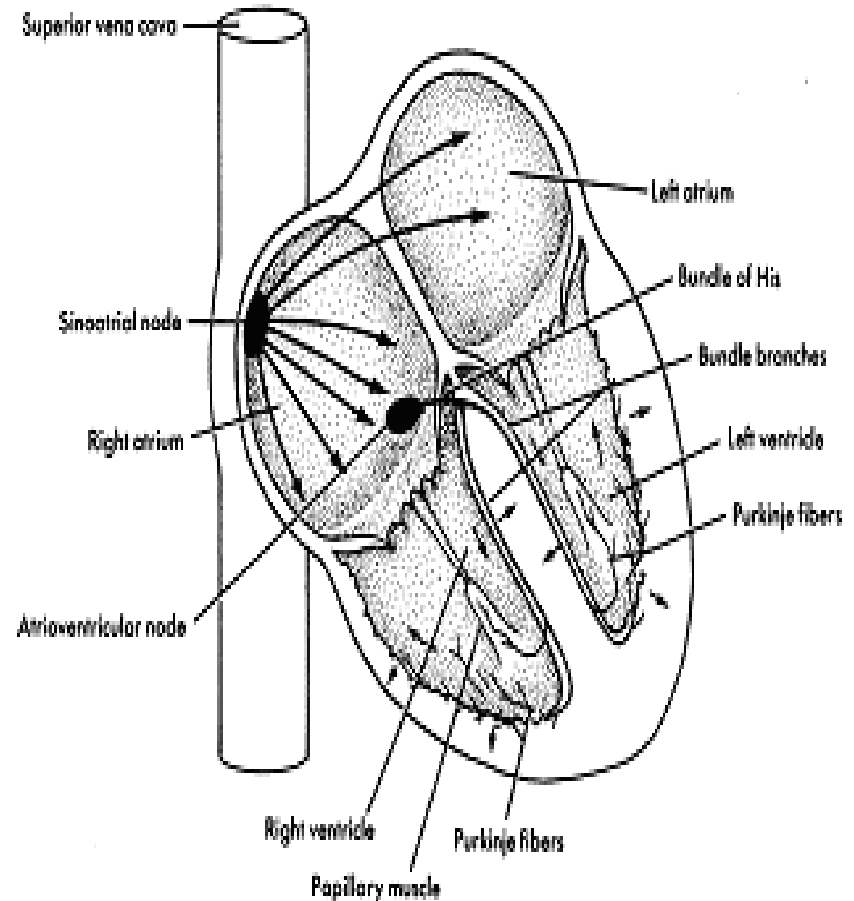
# Parts of the Conducting System

- A-V Bundle (Bundle of His)
  - A-V Bundle enter the upper part of the interventricular septum and divides into right and left branches.
  - Conducts the impulse to the Purkinje fibers



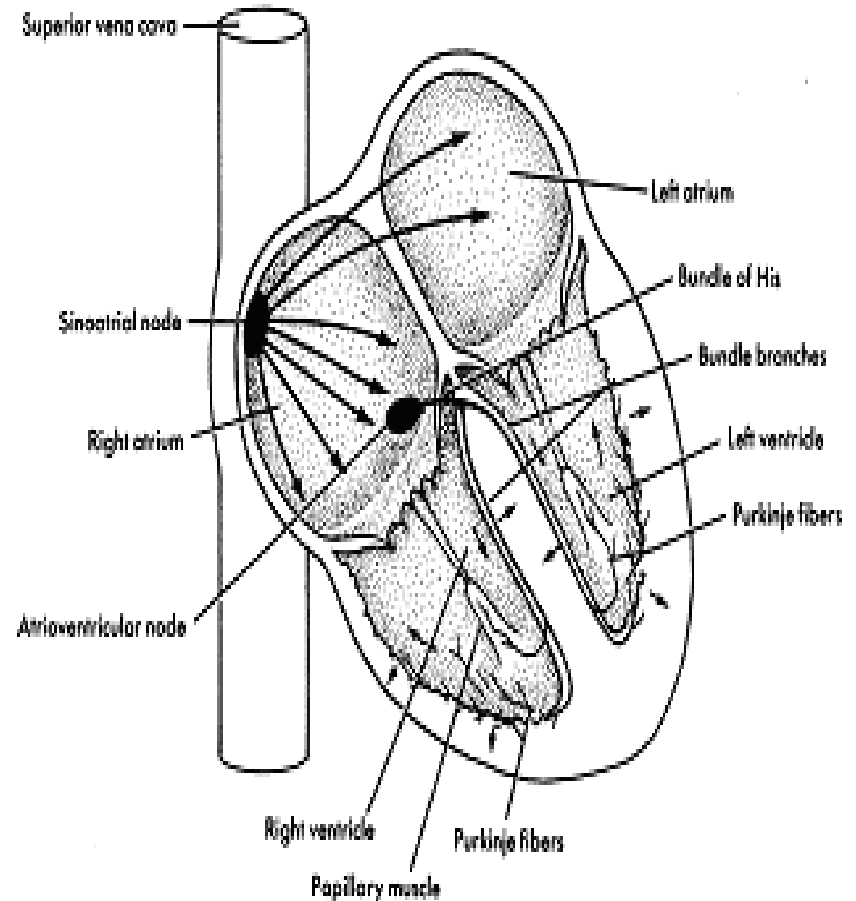
# Parts of the Conducting System

- Purkinje Fibers
  - Spread out from the interventricular septum into the papillary muscles and then continue downward to the apex of the heart. There they curve around the tips of the ventricles and pass upward over the lateral walls of these chambers.
  - Distribute the stimulus to the myocardium
  - Causes the ventricles to contract!!



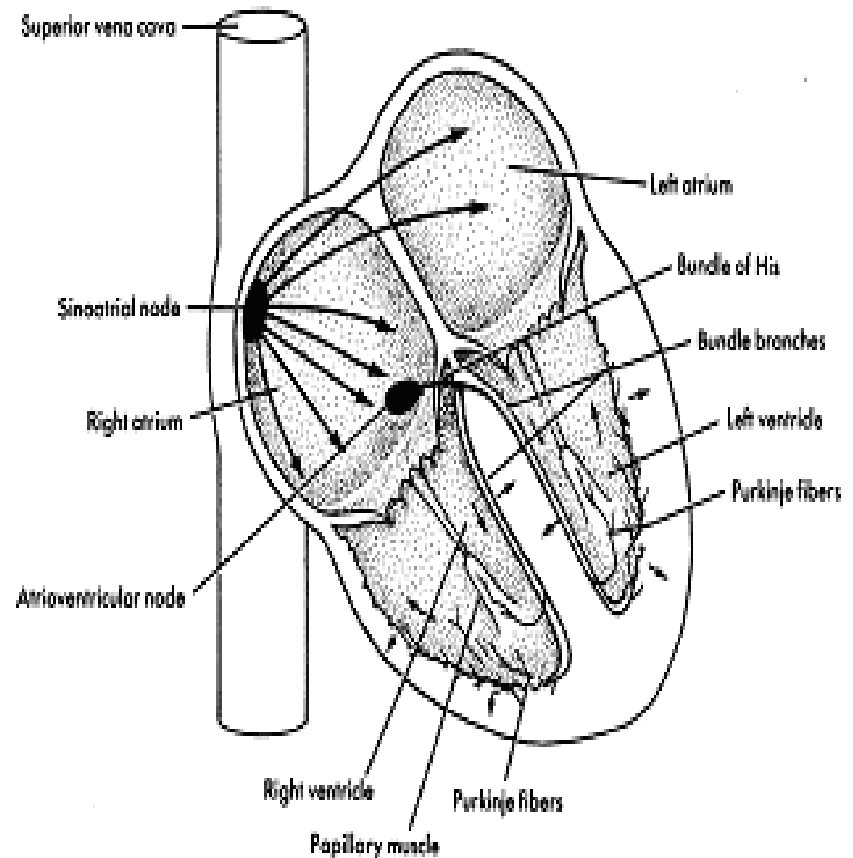
# The Conducting System

- S-A node sends out the signal
  - Impulse is sent along fibers in both right and left atria
- Atria Contract



# The Conducting System

- Impulse reaches the A-V node.
- Impulse slightly delayed (0.01s) – Allows the atria to finish contracting before the ventricles contract.

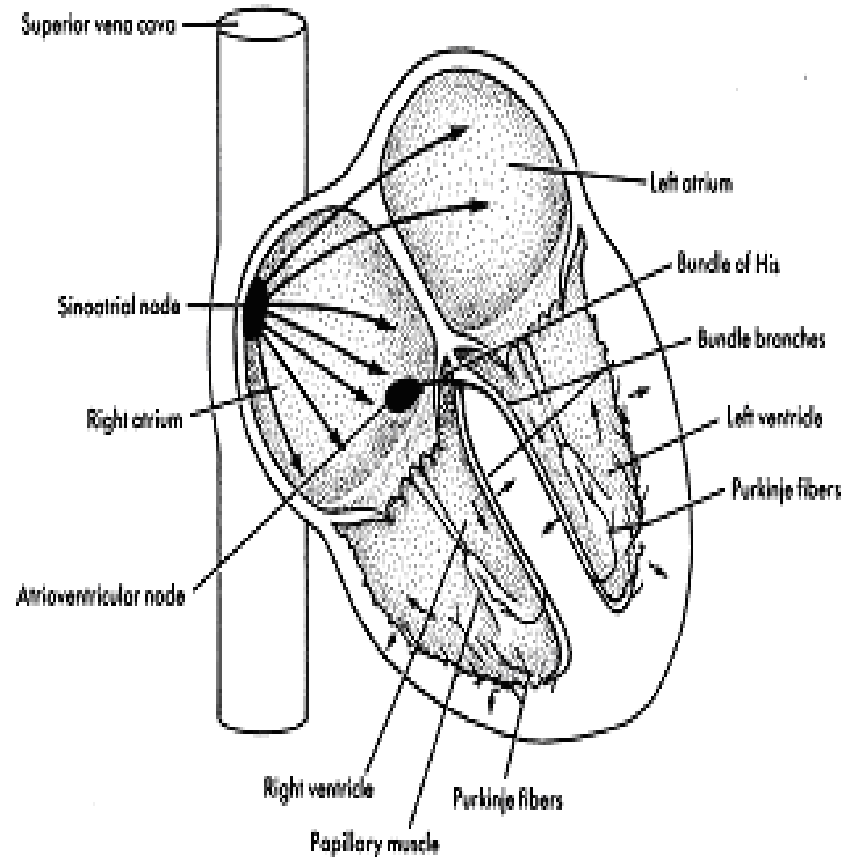


# The Conducting System

- Why do the atria need to finish contracting before the ventricles can contract??
- Once the ventricles start to contract, the AV valves close. If all chambers contracted at the same time, then the AV valves would prevent blood flow from the atria and into the ventricles. In essence the blood would be “stuck” inside the heart!

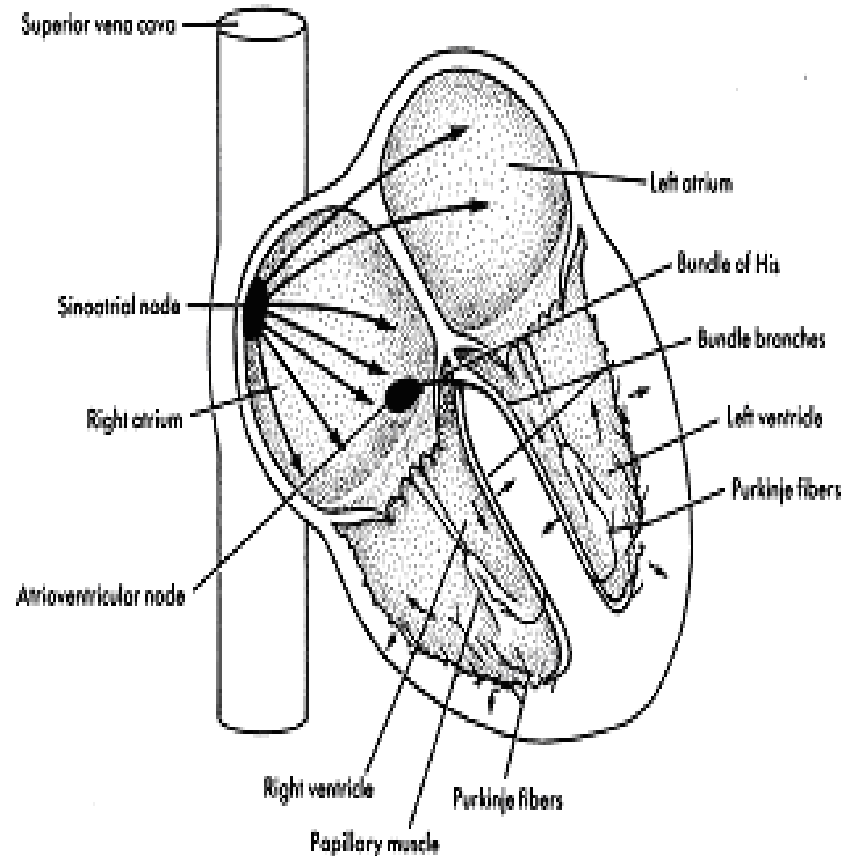
# The Conducting System

- Impulse travels down the A-V bundle towards the Purkinje fibers.
- Impulse is distributed by the Purkinje fibers and relayed throughout the ventricular myocardium.



# The Conducting System

- Ventricular contraction begins.
- Blood is squeezed out of the ventricles



# The Cardiac Cycle

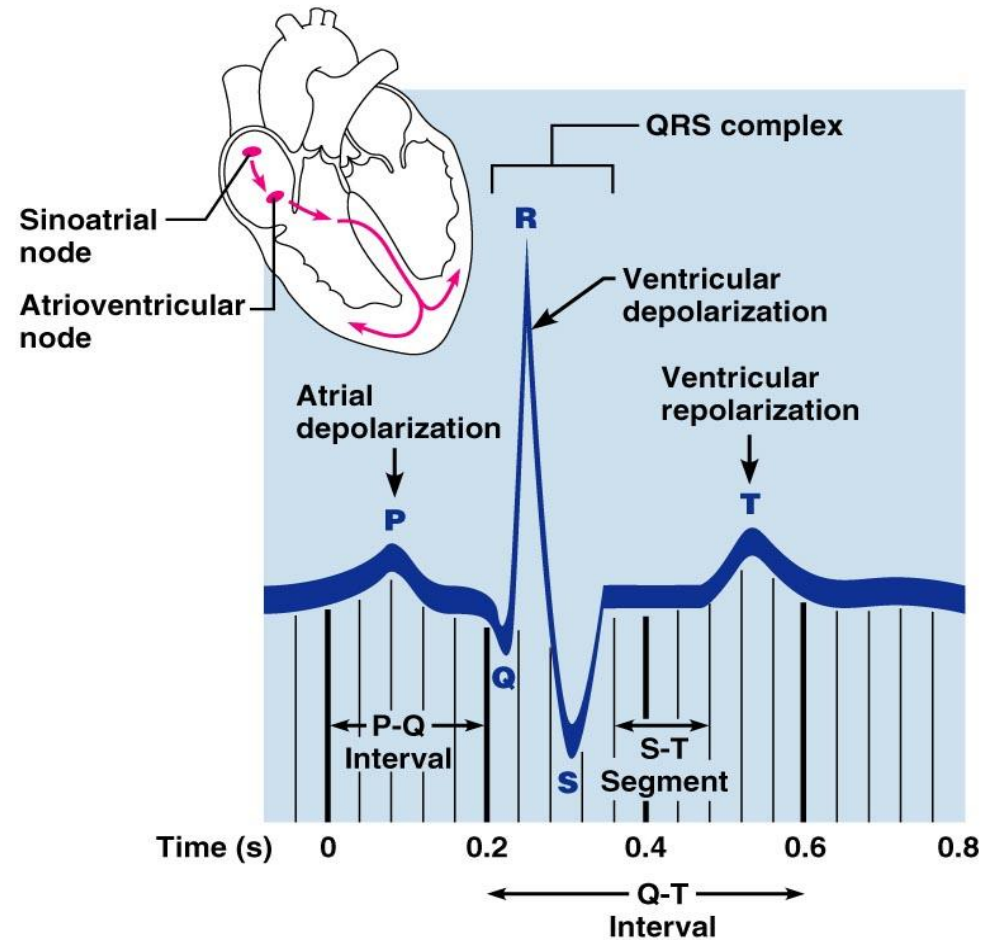
- The period between the start of one heartbeat and the start of the next heartbeat.
- Includes periods of contraction and relaxation.
- **Systole**
  - Contraction – pushing blood into adjacent chamber or artery
- **Diastole**
  - Relaxation – chamber filling with blood
- Atrial and ventricular systole and diastole must occur at opposite times or the blood would not flow!!

# Electrocardiogram

- EKG – recording of electrical changes that occur in the myocardium during a cardiac cycle.
- Used to monitor the electrical activity of the heart.
  - The electrical activity of the heart can be measured by placing electrodes at different locations
  - If an area has been damaged, the affected muscles will no longer conduct electricity and contract.

# Electrocardiogram

- P Wave
  - Atria contract
- QRS complex
  - Ventricles contract
- T Wave
  - Ventricles relax



# Blood Vessels

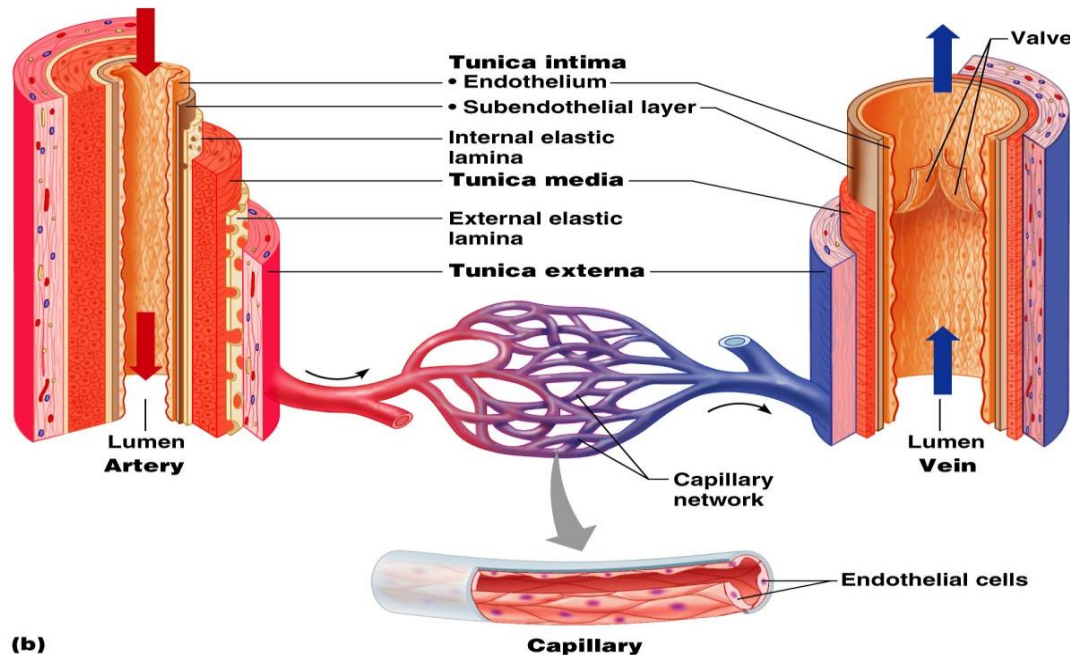
- Arteries
  - carry blood away from the heart.
  - Branch, diverge, fork, etc.
  - Form smaller and smaller divisions
- Veins
  - Carry blood towards the heart
  - Join, merge, converge, etc.
  - Form larger and larger vessels
- Heart → arteries → arterioles → capillary beds  
→ venules → veins

# Structure of Blood Vessel Walls

- Veins and arteries are made up of three layers:
- Inner layer – tunica intima
- Middle layer – tunica media
- Outer layer – tunica externa

# Structure of Blood Vessel Walls

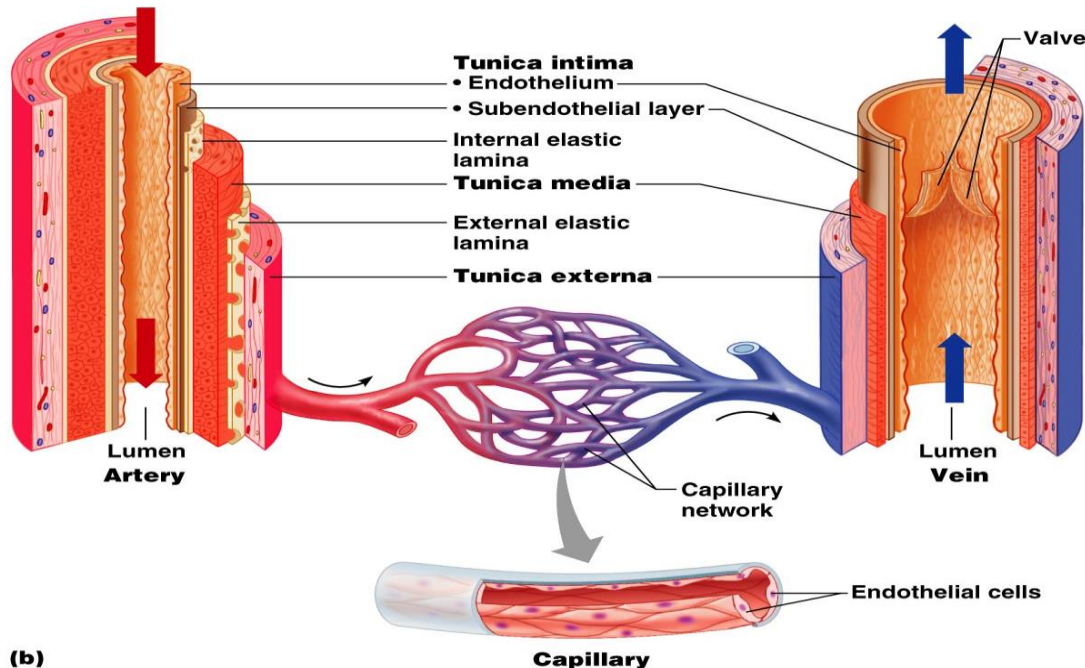
- Inner layer – tunica intima
  - Composed of simple squamous epithelium (endothelium)
  - Helps to prevent blood clotting by providing a smooth surface that allows blood cells and platelets to flow through without being damaged



(b)

# Structure of Blood Vessel Walls

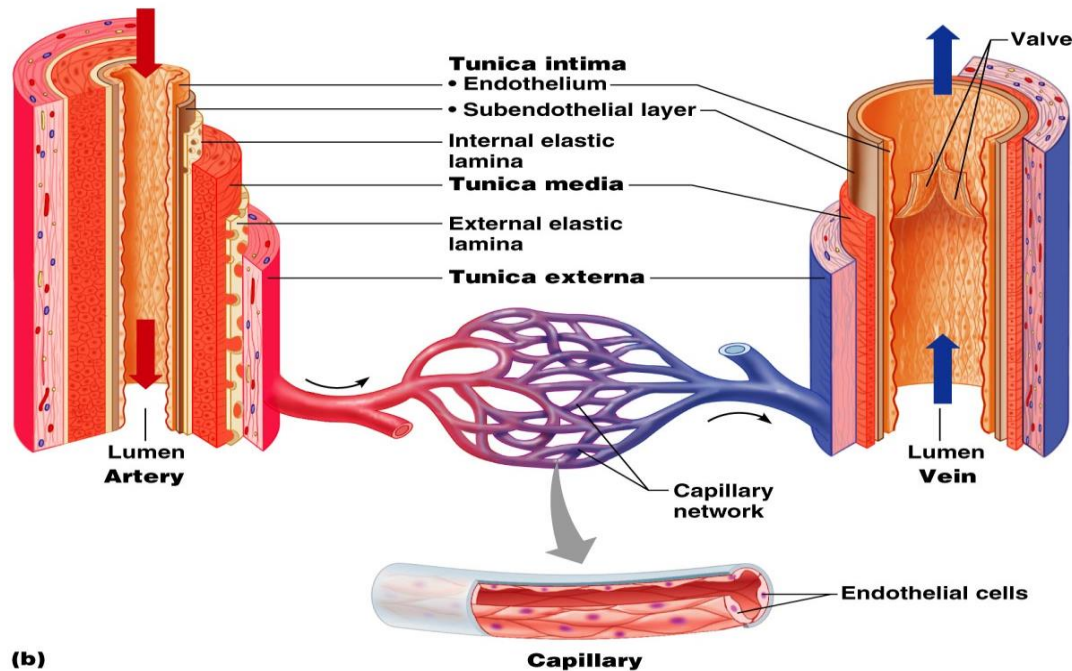
- Middle Layer – tunica media
  - Smooth muscle fibers encircle the tube and a thick layer of elastic connective tissue.



(b)

# Structure of Blood Vessel Walls

- Outer Layer – tunica externa
  - Relatively thin; consists of connective tissue.
  - Attaches blood vessel to surrounding tissues



# Arteries

- Arteries
- Have all three layers
  - Endothelial lining does not contract – so it appears wavy
- Very developed middle layer – thick strong walls
  - Allows vessel diameter to change
  - Vasoconstriction – artery contracted (smaller)
  - Vasodilation – artery relaxes (larger)
- Lumens (middle holes) are smaller than arteries
- Thick strong walls

# Veins

- Has the same three layers as arteries
  - Endothelial lining appears smooth
- Middle layer is poorly developed – thin walls
  - Contain less smooth muscle and elastic tissue
  - Appears wavy
- Lumens (middle holes) are larger than arteries
  - Allows blood to flow!!!
- Have valves → stops the blood from flowing backwards
- Blood flows slowly – low pressure

# Capillaries

- Smallest-diameter blood vessel
  - Only slightly larger than a RBC
- Single layer of simple squamous tissue (endothelium)
  - Allows for filtration, diffusion, osmosis
- Only place where gas exchange and substances are exchanged
- Blood flows slowly to allow gas exchange
- Connect arterioles and venules

