

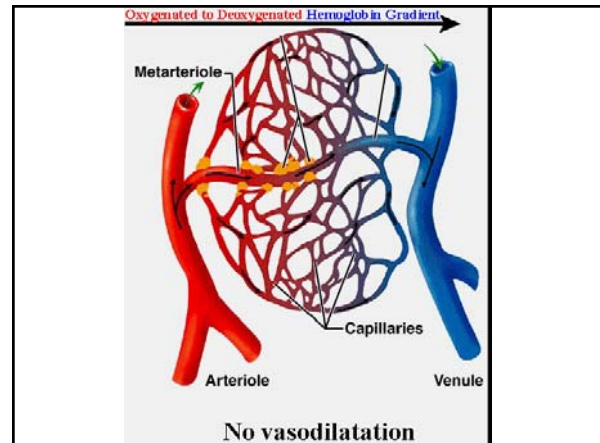
# Heart

## INTRODUCTORY REMARKS:

- The circulatory system provides a way for the blood to be transported throughout the body. This provides nutrients to the cells and allows wastes to be removed.
- Open vs. Closed Circulatory System

## Review the essential roles of the following blood vessels:

- Arteries -
- Arterioles -
- Veins -
- Venules -
- Capillaries -



## THE HEART

- A heart is a hollow muscular pump.
- Hearts consist of two chamber types separated by valves and or septa.
  1. **Atrium** - This type of chamber receives blood into the heart.
  2. **Ventricle** - This type of chamber is the pumping chamber.

## The Heart services 2 circuits

**Systemic circuit** (whole body other than lungs)  
[bring oxygenated blood to the rest of the body]

**Pulmonary circuit** (lungs) [re-oxygenates blood]  
\*heart beats  $\approx 100,000$  times/day ( $\approx 8000$  liters of blood)

## Main Heart Anatomy

•Right heart is concerned with pulmonary circulation

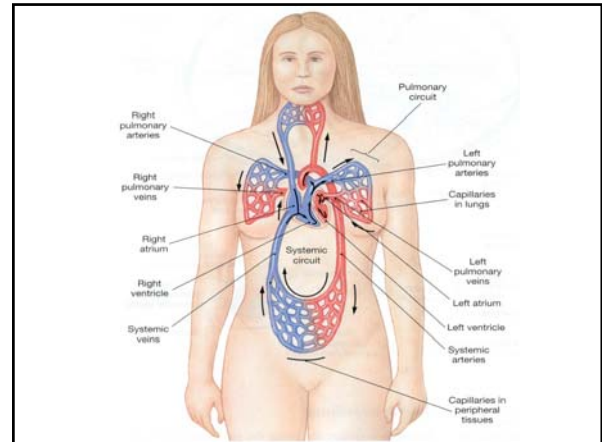
•Left heart is concerned with systemic circulation

**RA-** Vena Cavae

**RV-** Pulmonary Artery

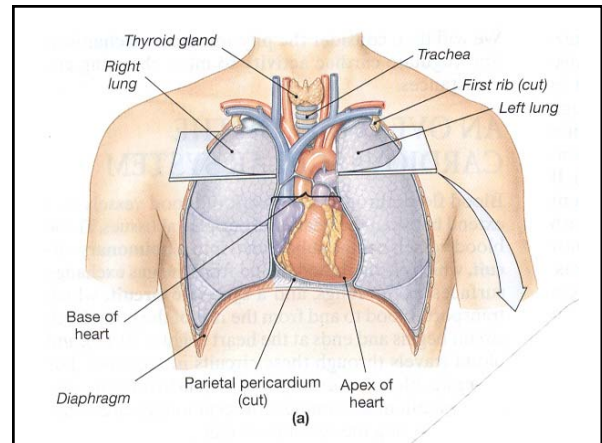
**LA-** Pulmonary Veins

**LV-** Aorta



•The heart is located in the anterior chest, directly posterior to the sternum

(**peri** / around; **cardium** / refers to the heart)



## 1. Pericardium

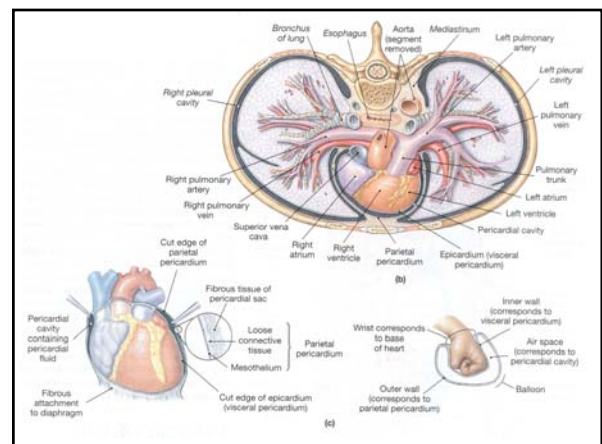
•Serous membrane sac around the heart

•Formed like a balloon around a fist.  
Fist= heart  
Balloon= pericardial sac

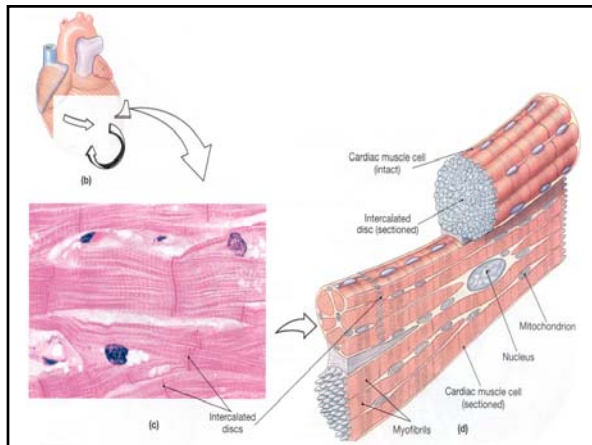
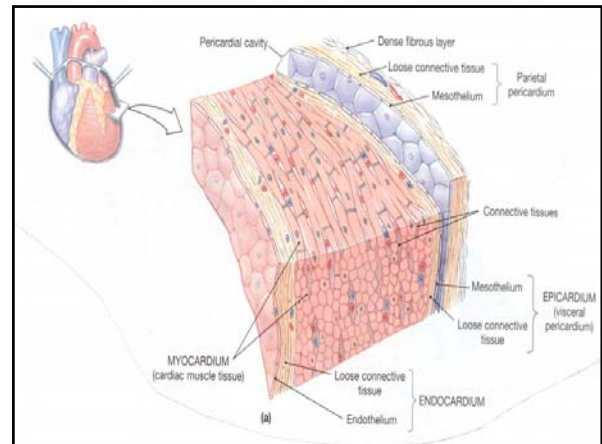
•Visceral pericardium covers the outer surface of the heart

•Parietal pericardium lines the inner surface of the pericardial cavity

•The pericardial space is filled with pericardial fluid (≈10-20 ml) acts as a lubricant during heart beats



**2. Myocardium** - The heart muscle tissue itself. The inner myocardial surface is lined with an endothelial sheet of tissue called the *endocardium*. Cardiac muscle cells act as a single unit called a *functional syncytium*. There is an *atrial syncytium* and a *ventricular syncytium*.



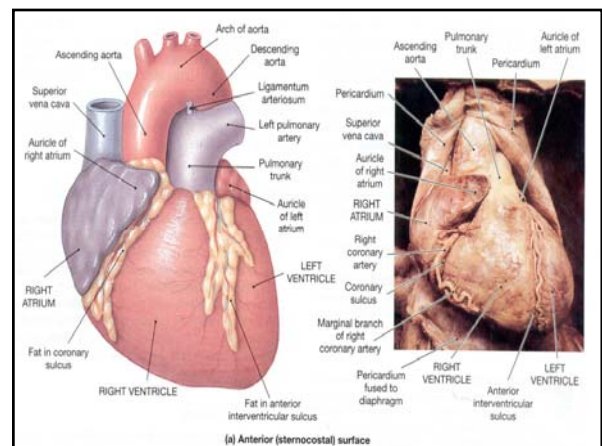
**3. Chambers** - (4 of them. 2 atria and 2 ventricles)

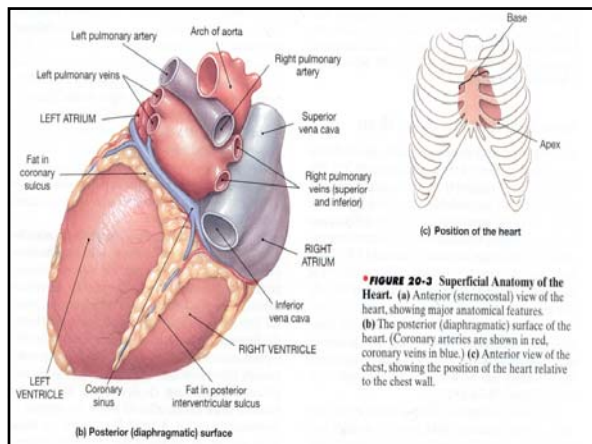
- a. *Right atrium* - Receives deoxygenated blood from the vena cava.
- b. *Right ventricle* - Receives blood from the right atrium and then pumps it to the lungs.
- c. *Left atrium* - Receives oxygenated blood from the lungs.
- d. *Left ventricle* - Receives blood from the left atrium and pumps it via the systemic circuit.

**Coronary sulcus:** a deep groove which marks the border b/n. the atria and ventricles

**Interventricular sulci:** shallow groove b/n. ventricles

- The tissue in these sulci generally contains large amounts of fat
- This fat is the hearts supply for energy
- The sulci also contain the veins and arteries that supply the cardiac muscle of the heart itself





**NOTES:** The left ventricle walls are thicker due to the greater resistance of the systemic circuit. Also note the **auricles** which expand the capacity of the atria. The interatrial septum has a fetal remnant called the *fossa ovalis*. Also found in the atria are found parallel bundles called *pectinate muscles*.

#### 4. Heart valves

**a. Atrioventricular valves** - These have cusps that hang limply into ventricular chambers when the heart is relaxing.

- 1) **Tricuspid valve** - Between the right atrium & right ventricle.
- 2) **Bicuspid valve** - Between the left atrium & left ventricle.

**NOTE:** The bicuspid valve is AKA **mitral valve**. When closing, the mitral valve closes slightly before the tricuspid.

**b. Semilunar valves** - These valves act like baskets that catch the blood preventing backflow into the ventricles.

- 1) **Pulmonary SL (Pulmonic) valve** - From right ventricle to pulmonary trunk.
- 2) **Aortic SL valve** - From the left ventricle to the aorta. The aortic valve normally snaps shut slightly before the pulmonic valve.

**5. Interventricular septum** - The wall between the ventricles. There is a *muscular portion* and a *membranous portion*.

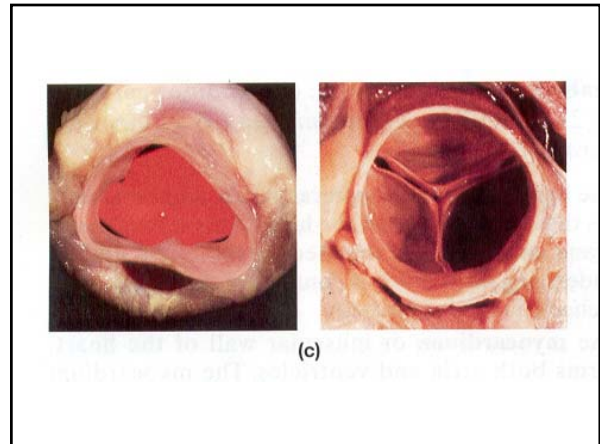
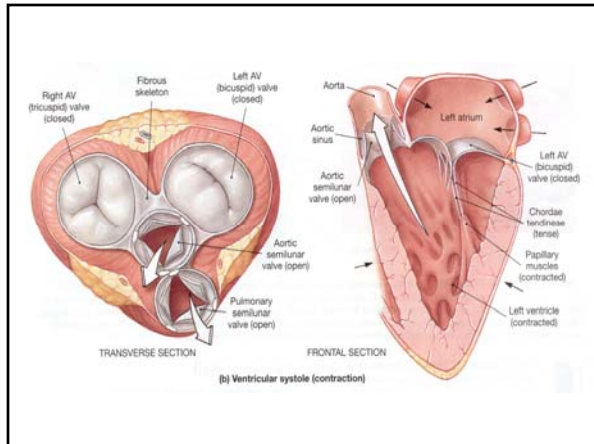
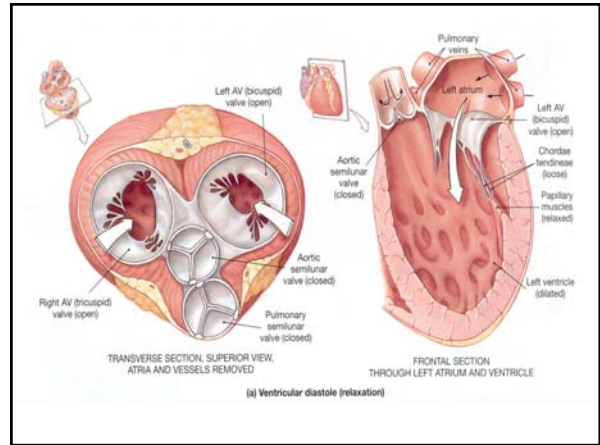
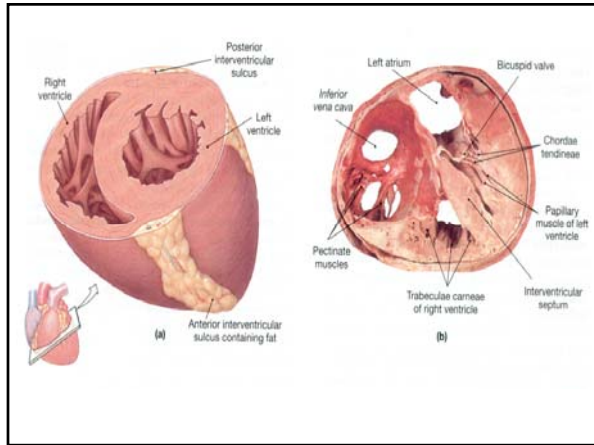
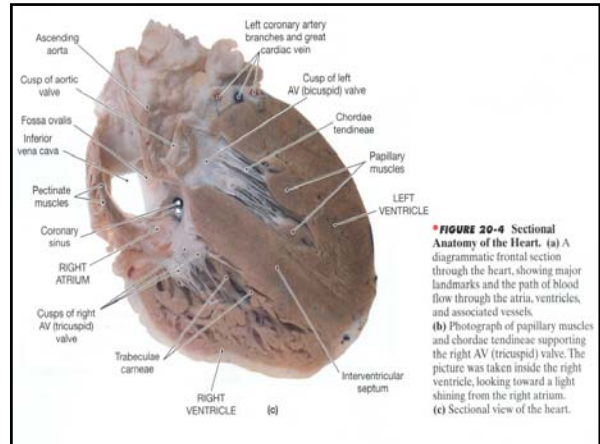
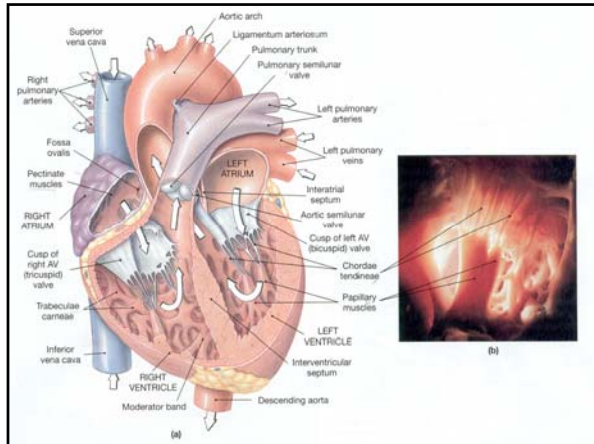
**6. Trabeculae carneae** - "Crossbars of flesh." Irregular bands of heart muscle which project from the inner surface of the ventricles. There are several types.

- a. *Ridges*: Run along the ventricular walls.
- b. *Bridges*: Muscle strands that cross the hollow portion. (blood surrounds these)

**7. Papillary muscles** - Attachment point for the chordae tendineae.

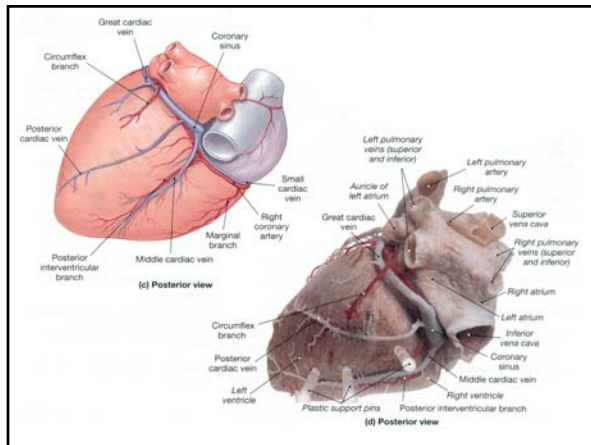
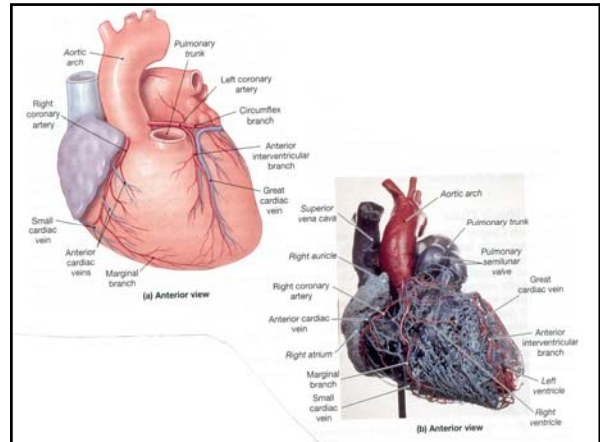
**8. Chordae tendineae** - Strong fibers that attach to the papillary muscles and the valve cusps. They keep the valves from opening into the atria during ventricular contraction.





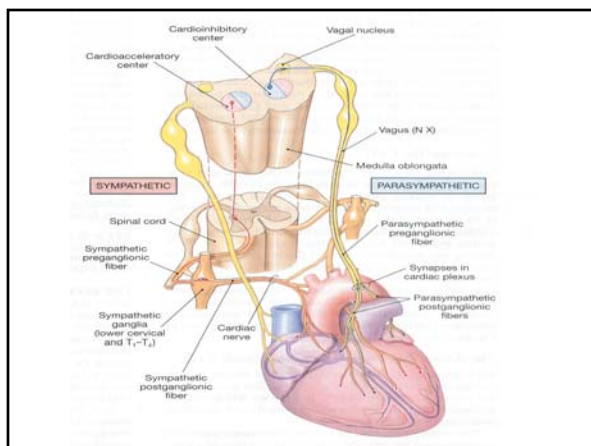
Be able to locate the following blood vessels associated with the heart.

- |                       |   |
|-----------------------|---|
| a. Aorta              | f. Inferior vena cava   |
| b. Pulmonary trunk    | g. Right coronary artery  |
| c. Pulmonary arteries | h. Left coronary artery & its two major branches the Circumflex and the Anterior interventricular |
| d. Pulmonary veins    | i. Great cardiac vein & coronary sinus  |
| e. Superior vena cava |   |



### Innervation of the Heart

- The ANS innervates the heart through the cardiac plexus
- The cardiac plexus is a series of nerves and receptors which give the ANS information it needs, and the ability to adjust heart rate



### Conducting System:

**Nodal tissue** - (Cardiac conduction system)  
A specialized tissue that is unique to the heart. Found throughout the heart, this tissue contains only a few myofibrils and can also conduct impulses like a neuron.

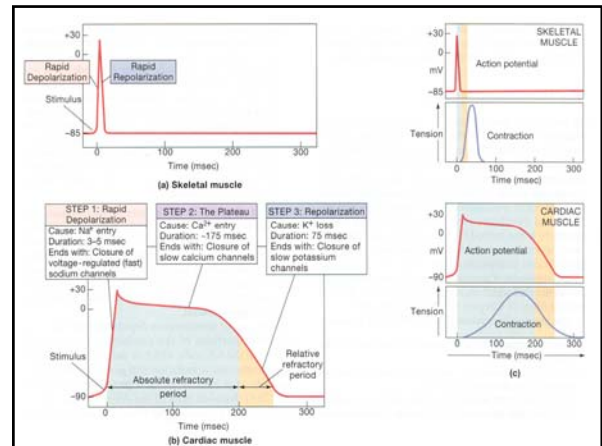
Key portions of this system include...

**a) Sinoatrial Node** - (S-A node) Often called the pacemaker of the heart. It is located in the posterior wall of the right atrium. S-A node cells are able to excite themselves, initiating impulses that travel from the S-A node into the atrial syncytium. The result is the almost simultaneous contraction of the atria.

**b) Atrioventricular Node - (A-V node)** Impulses are now passed to this second node which is located in the floor of the right atrium near the interatrial septum. Acts as a conduction pathway between the atria and the ventricular syncytium.

**c) Bundle of His - (A-V bundle)** A bundle of fibers that takes impulses from the A-V node into the interventricular septum where it branches to form structures called *Purkinje fibers*.

**d) Purkinje fibers** - These fibers of nodal tissue spread from the interventricular septum into the papillary muscles and to the rest of the myocardium resulting in ventricular contraction

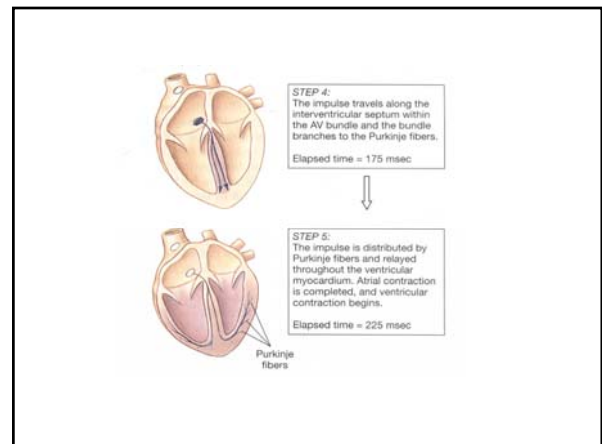
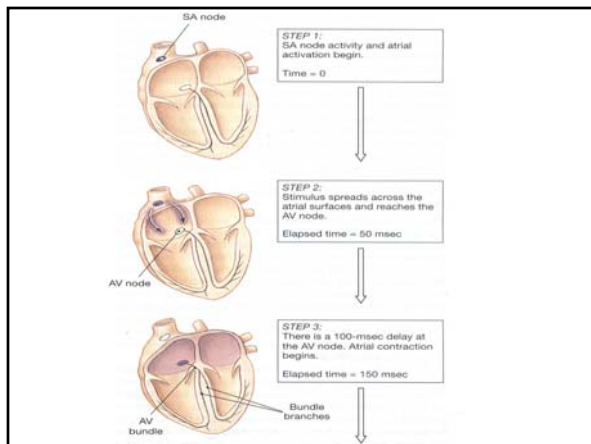
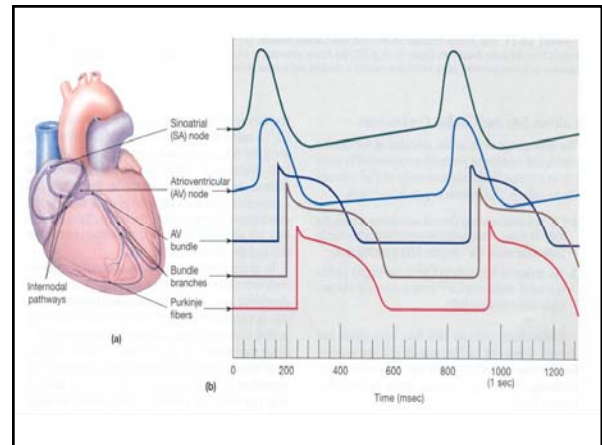


### Ion Permeability & Concentration

Na<sup>+</sup>

Ca<sup>2+</sup>

K<sup>+</sup>

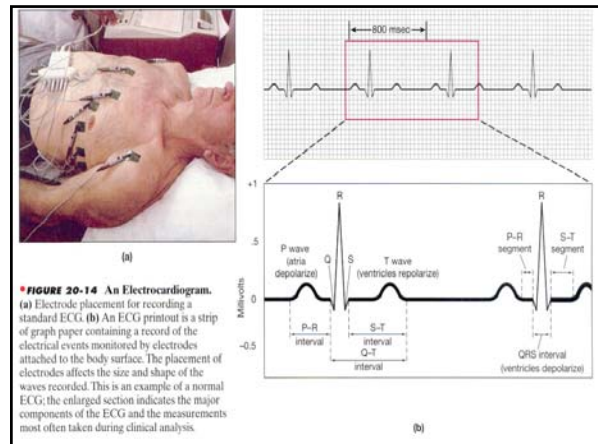


**Electrocardiogram (ECG or EKG)**-Looks at depolarization & re-polarization of the heart

**P-wave:** depolarization of the atria

**QRS complex:** depolarization of the ventricles {so where is the atrial re-polarization?}

**T-waves:** re-polarization of the ventricles



Heart rate is **inversely** related to body size.

Elephant = 30 beats/min.

Human = 70 beats/min.

Shrew = 780 beats/min.

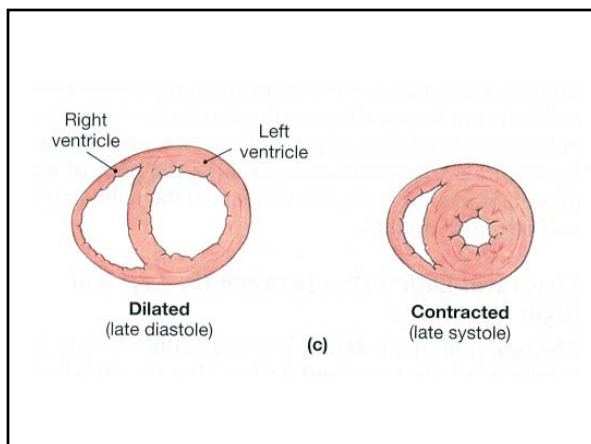
### Cardiac Cycle

•The time bwn. the start of one heart beat, and the start of the next

So...the cardiac cycle consists of periods of

**Systole:** the heart muscle contracting {high pressure}

**Diastole:** the heart muscle relaxing {low pressure}



### That is why BP has 2 numbers

Systolic → high is somewhat tolerated

Diastolic → too high is very worrisome

•A cycle begins w/ atrial systole (ventricles remain in diastole) when atria finish contracting they go into diastole (ventricles start to contract)

•When ventricles are in systole, the atria are in diastole. When ventricles enter diastole the heart beat is over, and the atria & ventricles will remain in diastole until the next cycle begins



120	<b>Normal</b>
80	
140	<b>&gt; High</b>
90	

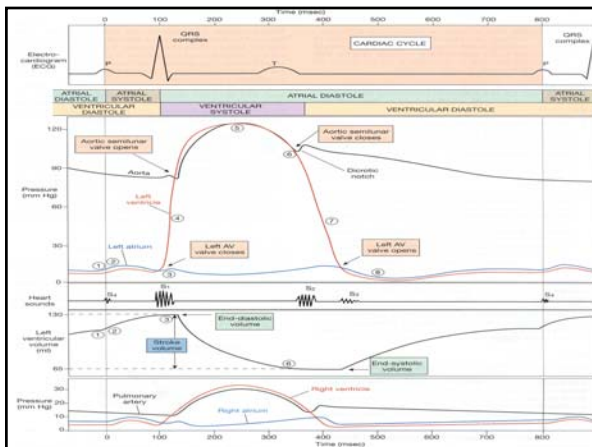
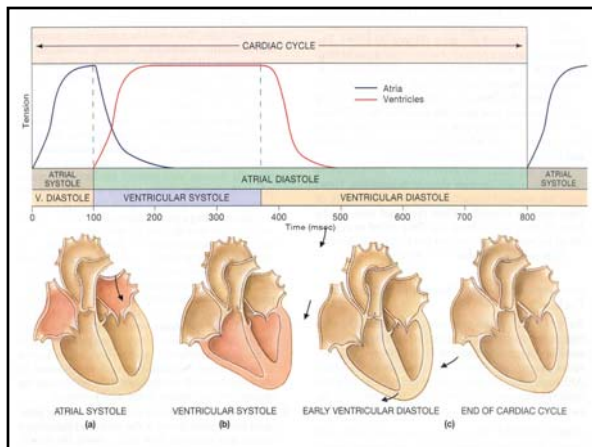
- High blood pressure can lead to:**
- an enlarged and weakened heart
  - Heart attack
  - Stroke
  - Kidney failure.

**MEASUREMENT OF ARTERIAL PRESSURE:**

•When we refer to "blood pressure" we refer to the mean arterial pressure in the brachial artery. Traditionally, the pressure is measured in millimeters of mercury with an instrument called a **sphygmomanometer**.

**HOW TO USE A SPHYGMOMANOMETER**

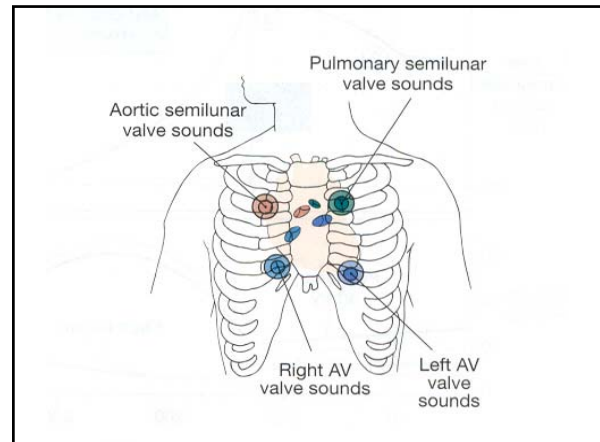
•The blood flow distal to the cuff is detected with a stethoscope placed over the brachial artery, near the elbow. When the pressure in the cuff is greater than in the artery, the vessel is occluded and there is no blood flow. When the pressure in the cuff is reduced to less than in the artery, the artery is open and blood flow is uninterrupted. However, when the pressure in the cuff is between the systolic and diastolic pressures, the flow is intermittent and the spurts can be heard with the stethoscope. The highest pressure (in mm Hg) at which blood passes under the cuff is the systolic pressure and the pressure at which the blood begins to flow continuously is the diastolic pressure. The results are given in fractional form. For example 120/80. Sounds heard with the stethoscope are called "Sounds of Korotkoff"



### Heart sounds: "Lub-dup"

The heart sounds heard with a stethoscope are a result of valves opening and closing.

- In addition, ventricular vibrations add to the sound.
- The **lub** occurs during ventricular contraction as both AV valves are closing.
- The **dup** occurs during ventricular diastole as both SL valves are snapping shut.



### SOME CIRCULATORY DISORDERS:

1. **Atherosclerosis:** Deposition of material (lipids like saturated fats) in the lumen of arteries. In time calcium builds on the deposits to form hard plates. The condition is now called. . .
2. **Arteriosclerosis:** Excessive rigidity and loss of elasticity in the arteries. Since the elasticity is gone, hypertension results.
3. **Heart murmurs:** Caused by defective valves. Two major types.
  - a. *Incompetence* AKA *insufficiency* - cusps don't provide a secure seal when closed.
  - b. *Stenosis* - The valve cusps don't open all of the way.

4. **Circulatory shock:** This condition can be defined as a bout of acute hypotension, or inadequate cardiac output. There is a decrease in blood volume which may be. . .

- a. Real - due to actual fluid loss.
- b. Apparent - due to vasodilation.

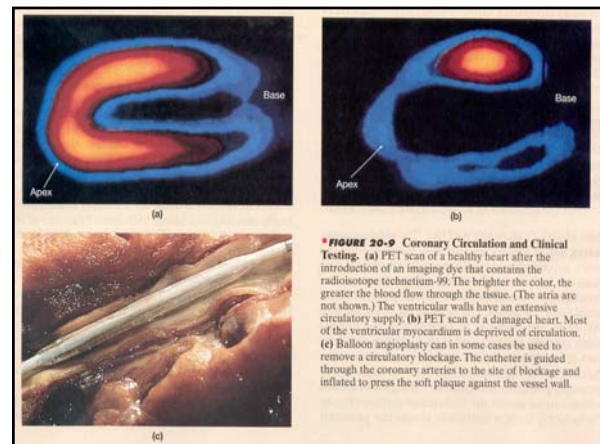
- Try to keep the person warm and elevate the feet in order to allow gravity to help in the flow of blood to the heart and brain.

5. **Cardiac arrest:** This is a term which simply means that the heart stops.

6. **Myocardial infarction:** A thrombus or embolus cuts off blood to an area of the myocardium. *Necrosis* occurs in a localized area. In many cases the patient already suffers from atherosclerosis, and the reduced lumen size makes it easier for the clot to get stuck. It should be obvious that the larger the artery involved, the more dangerous the infarction in terms of survival.

Unblocking the artery - Some of the procedures include

- a. Severe diet modification/exercise/meditation, etc.
- b. Coronary bypass operation.
- c. Balloon angioplasty.



**7. Arrhythmia:** An unusual heart rate. Several types.

- a. *Tachycardia* - The rate is too rapid. Usually over 100 bpm.
- b. *Bradycardia* - The rate is slow. Under 60 bpm.
- c. *Fibrillation* - Areas of the heart are beating weakly and in an uncoordinated mode.

**8. Congestive Heart Failure** - Blood backs up into the heart and lungs. Ventricular hypertrophy is one of the most common causes.