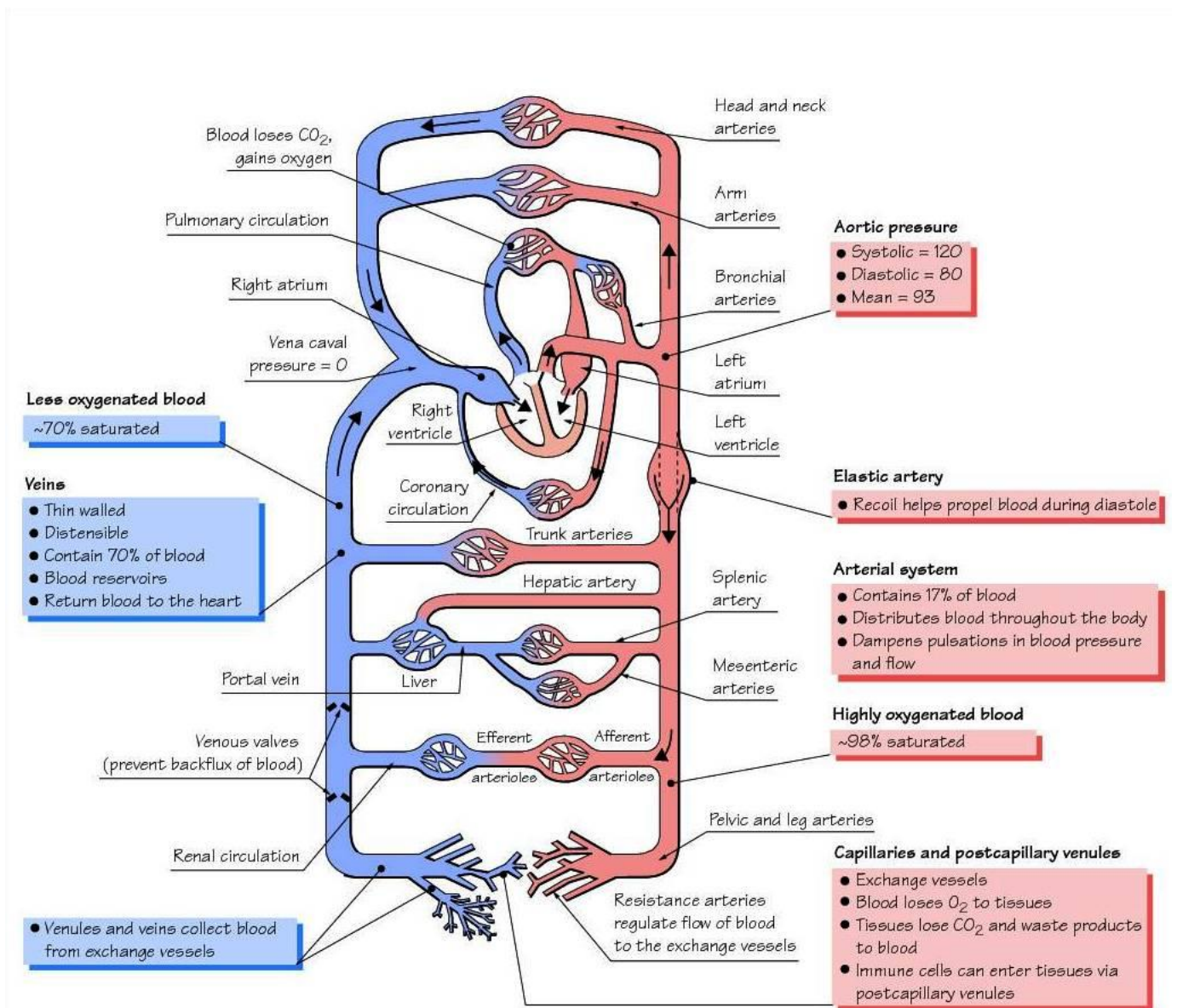


Cardiovascular System

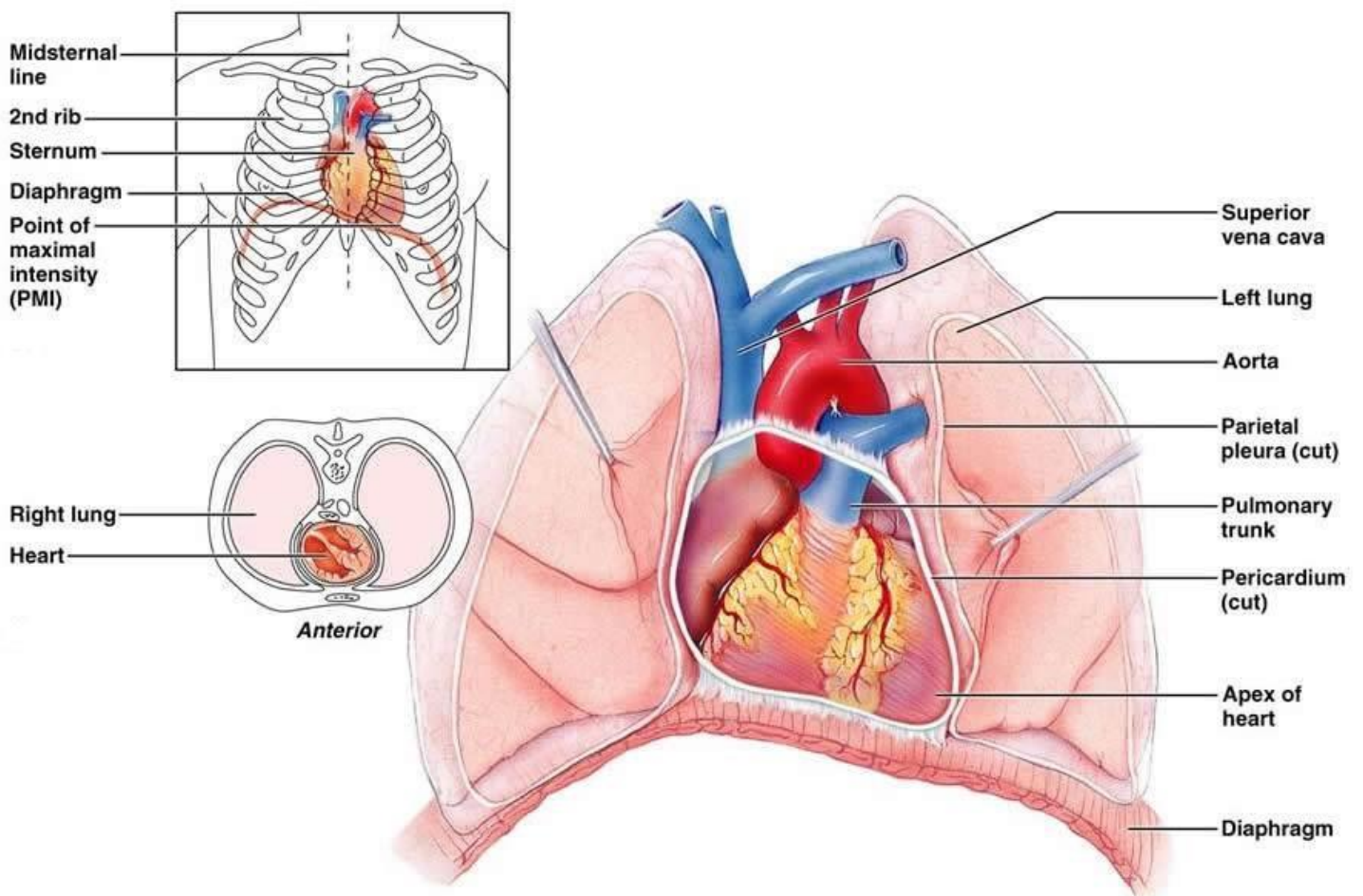
Components of the Cardiovascular System

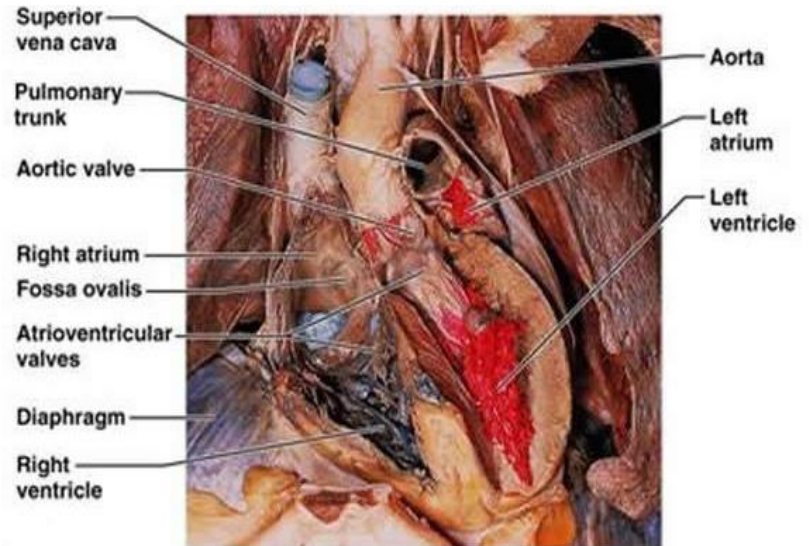
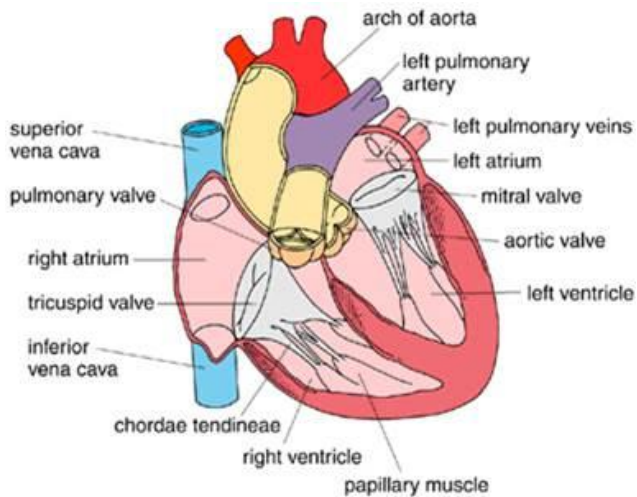
- consists of the heart plus all the blood vessels
- transports blood to all parts of the body in two 'circulations': pulmonary (lungs) & systemic (the rest of the body)
- responsible for the flow of blood, nutrients, oxygen and other gases, and hormones to and from cells
- about 2,000 gallons (7,572 liters) of blood travel daily through about 60,000 miles (96,560 kilometers) of blood vessels
- average adult has 5 to 6 quarts (4.7 to 5.6 liters) of blood, which is made up of plasma, red blood cells, white blood cells and platelets
- In addition to blood, it moves lymph, which is a clear fluid that helps rid the body of unwanted material



Anatomy of the Heart

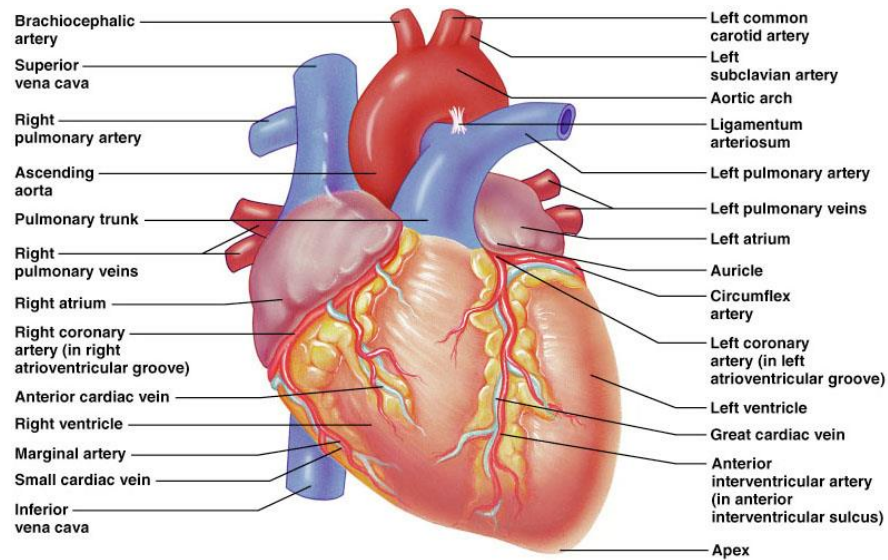
- The heart is a muscular organ a little larger than your fist weighing between 7 and 15 ounces (200 to 425 grams).
- It pumps blood through the blood vessels by repeated, rhythmic contractions. The average heart beats 100,000 times per day pumping about 2,000 gallons (7,571 liters) of blood.
- The average human heart beating at 72 BPM (beats per minute), will beat approximately 2.5 billion times during a lifetime of 66 years.
- The heart is usually situated in the middle of the thorax with the largest part of the heart slightly offset to the left underneath the breastbone or sternum and is surrounded by the lungs.
- The sac enclosing the heart is known as the pericardium.
- The right side of the heart is the pulmonary circuit pump.
- Pumps blood through the lungs, where CO₂ is unloaded and O₂ is picked up.
- The left side of the heart is the systemic circuit pump.
- Pumps blood to the tissues, delivering O₂ and nutrients and picking up CO₂ and wastes.



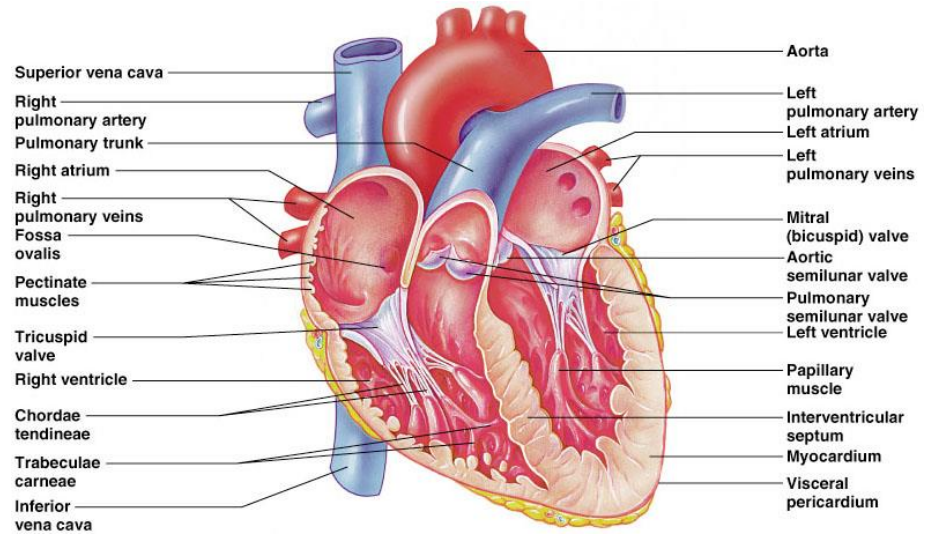


- **Right Atrium:** It collects deoxygenated blood returning from the body (through the vena cava) and then forces it into the right ventricle through the tricuspid valve.
- **Left Atrium:** It collects oxygenated blood returning from the lungs and then forces it into the left ventricle through the mitral valve.
- The **atrioventricular (AV) valves (Mitral & Tricuspid Valves)** prevent flow from the ventricles back into the atria.
- **Right Ventricle:** It collects deoxygenated blood from the right atrium and then forces it into the lungs through the pulmonary valve.
- **Left Ventricle:** It is the largest and the strongest chamber in the heart. It pushes blood through the aortic valve and into the body.
- The **pulmonary and aortic valves** prevent back flow from the pulmonary trunk into the right ventricle and from the aorta into the left ventricle.
- **Cardiac muscle cells** are joined by gap junctions that permit action potentials to be conducted from cell to cell.
- The **myocardium** also contains specialized muscle cells that constitute the conducting system of the heart, initiating the cardiac action potentials and speeding their spread through the heart.
- **Aorta:** It is the largest artery and carries oxygenated blood from the heart to the rest of the body.
- **Superior Vena Cava:** Deoxygenated blood from the upper parts of the body returns to the heart through the superior vena cava.
- **Inferior Vena Cava:** Deoxygenated blood from the lower parts of the body returns to the heart through the inferior vena cava.
- **Pulmonary Veins:** They carry oxygenated blood from the lungs back to the heart.
- **Pulmonary Arteries:** They carry blood from the heart to the lungs to pick up oxygen.

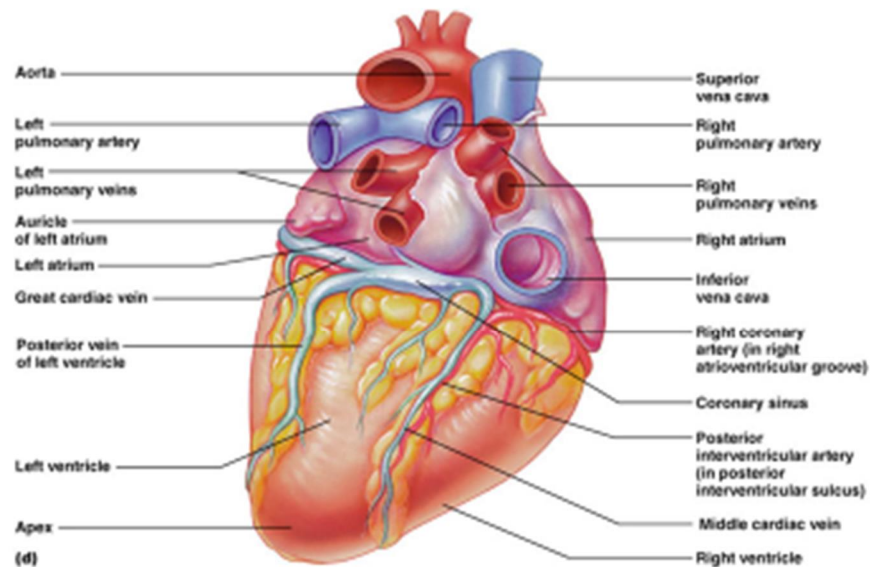
External Heart Anterior View



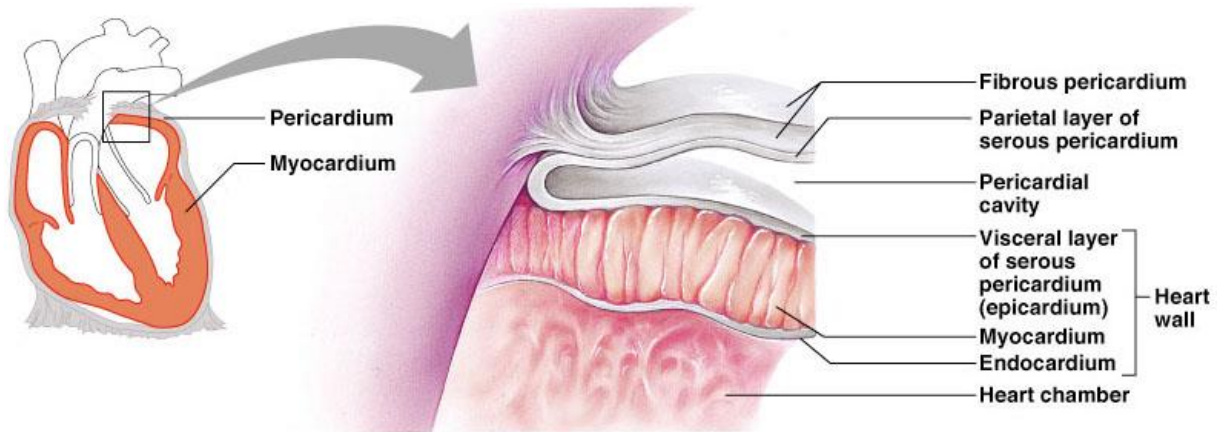
Frontal Section



External Heart Posterior View

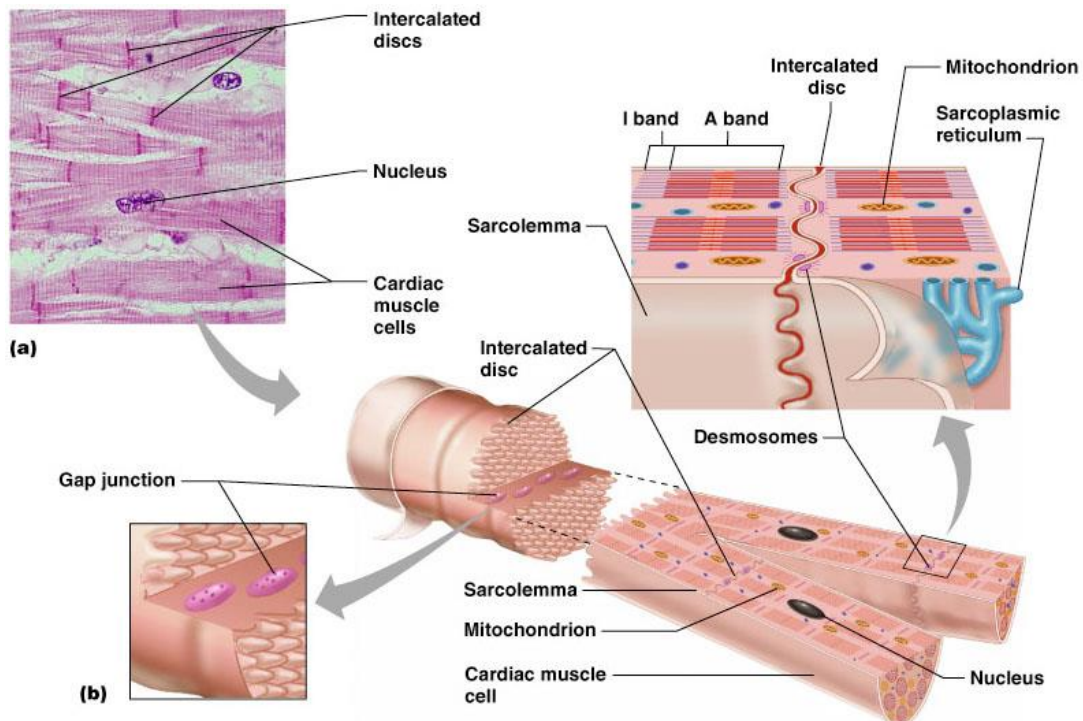


Pericardial Layers of the Heart Wall

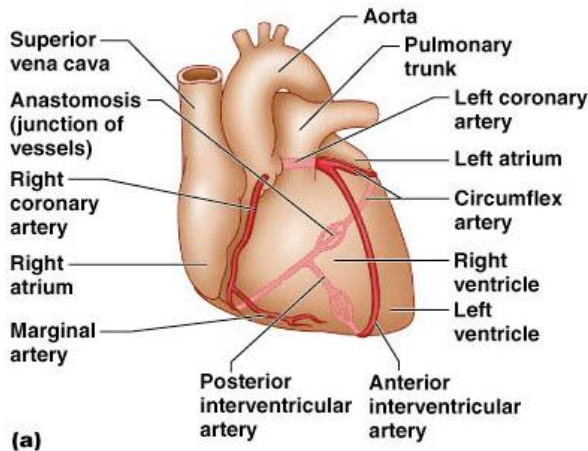


- **Epicardium** ó visceral layer of the serous pericardium
- **Myocardium** ó cardiac muscle layer forming the bulk of the heart
- **Fibrous skeleton of the heart** ó crisscrossing, interlacing layer of connective tissue
- **Endocardium** ó endothelial layer of the inner myocardial surface

Microscopic Anatomy of the Heart Muscle

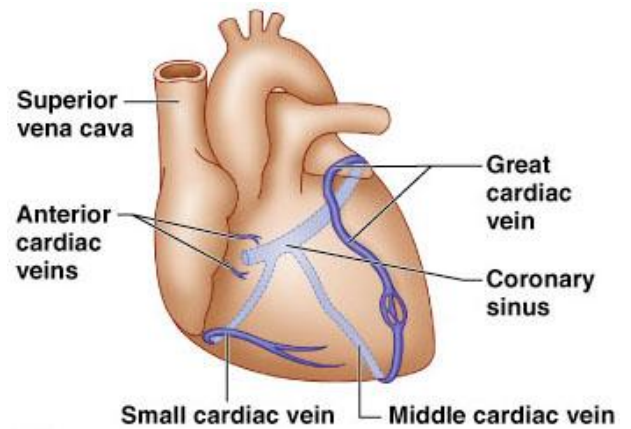


Coronary Circulation



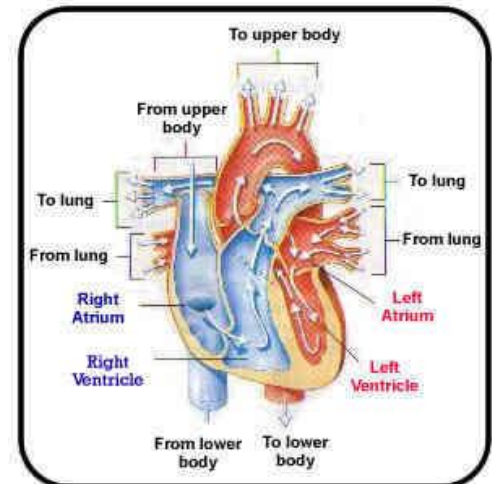
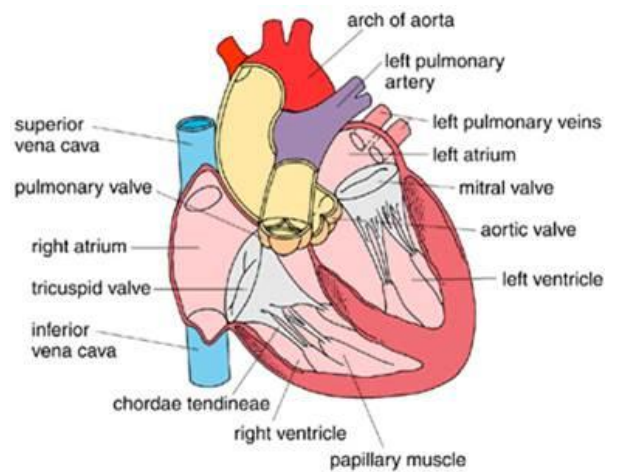
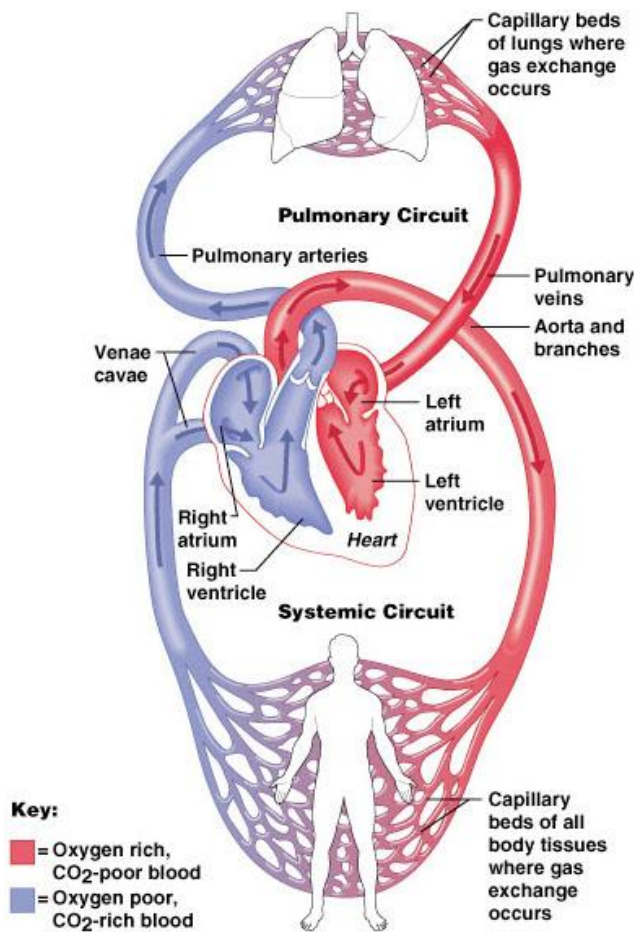
(a)

Arterial Supply

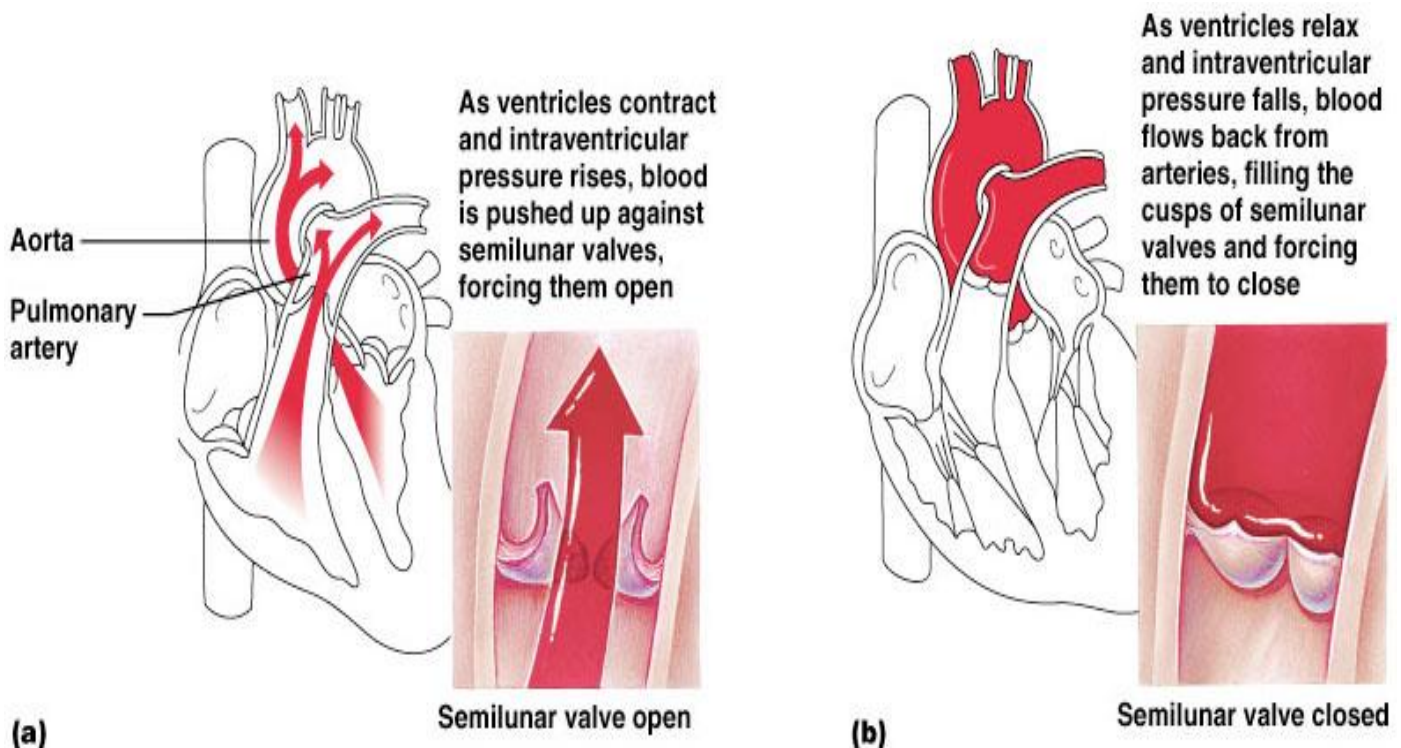
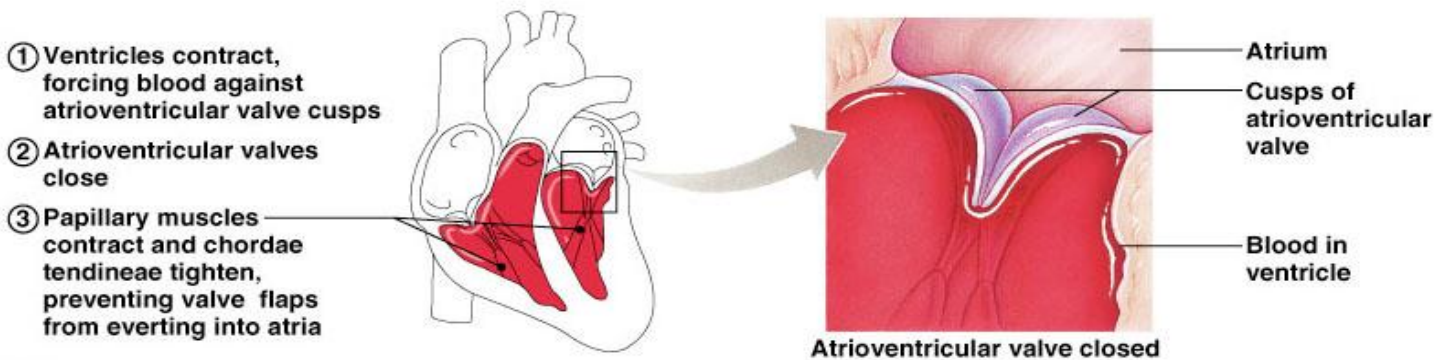
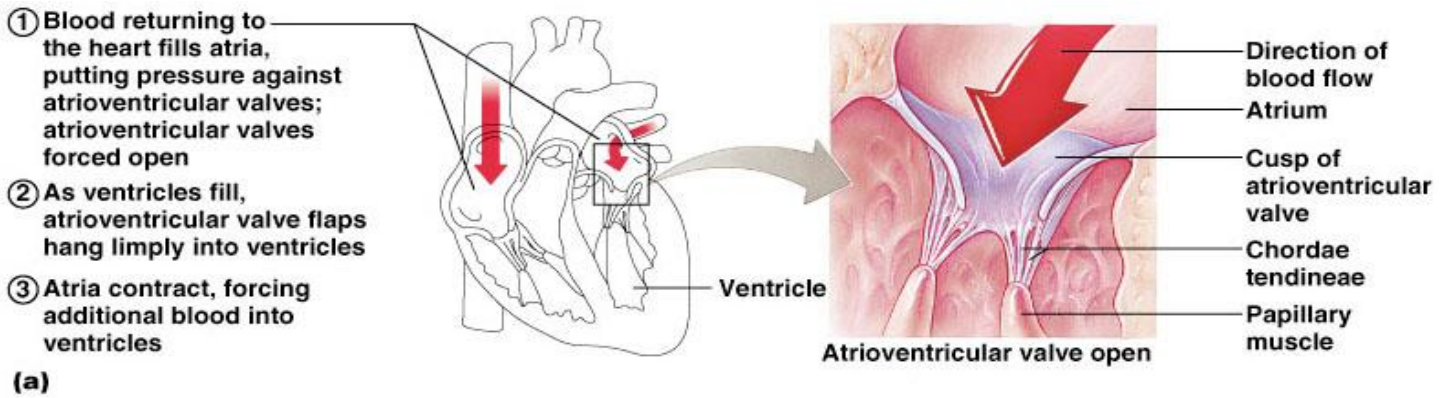


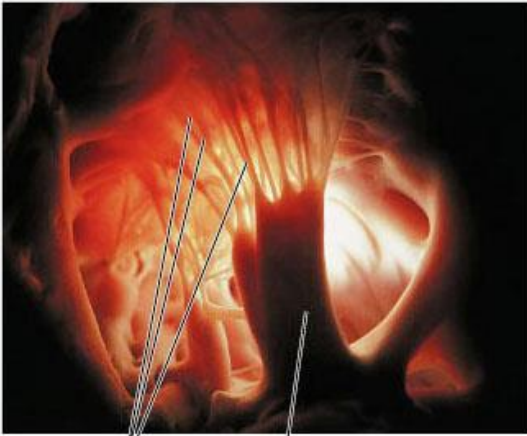
Venous Supply

Pathway of Blood through the Heart and Lungs



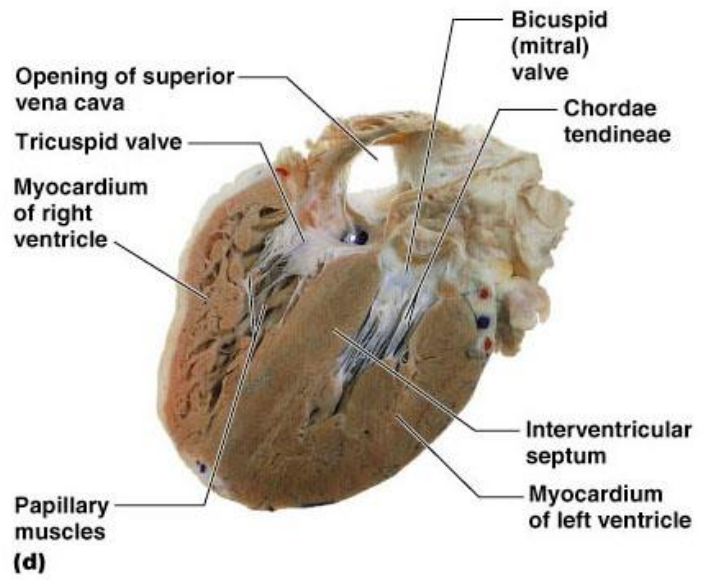
Heart Valves





Chordae tendineae attached to tricuspid valve flap (c)

Papillary muscle



Opening of superior vena cava

Tricuspid valve

Myocardium of right ventricle

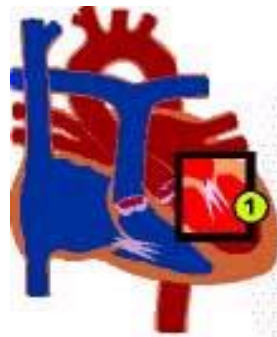
Papillary muscles (d)

Bicuspid (mitral) valve

Chordae tendineae

Interventricular septum

Myocardium of left ventricle



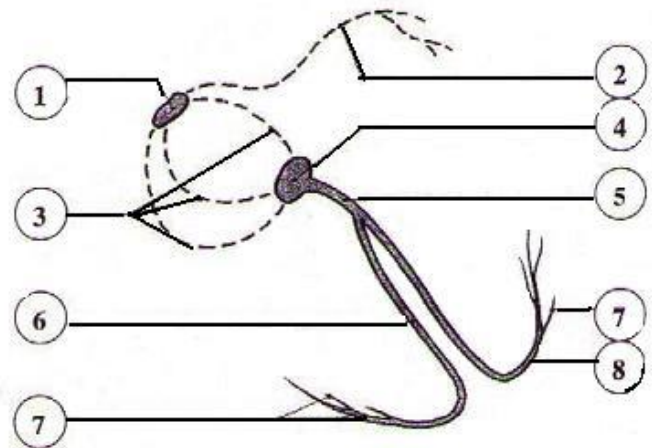
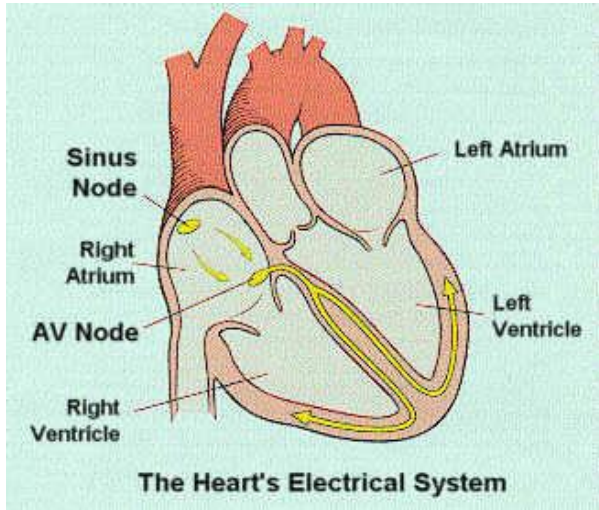
- 1 Mitral valve
- 2 Normal open mitral valve

Mitrial Valve Prolapse



- 3 Normal closed mitral valve
- 4 Prolapsed mitral valve; one leaflet does not close properly

Electrical System of the Heart

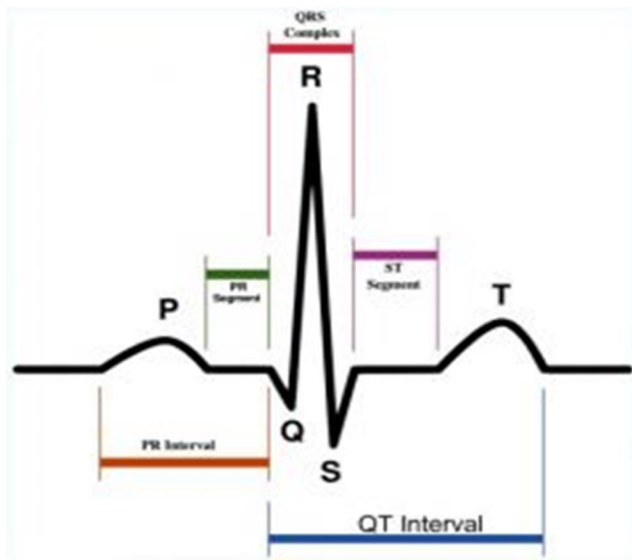


1. **Sinoatrial Node (SA Node)**-Pacemaker of the heart
2. **Intra-atrial Pathway**-carries electricity through atria
3. **Internodal Pathway**-carries electricity through atria
4. **Atrioventricular Node (AV Node)**-Back up pacemaker. Slows conduction
5. **Bundle of His**-last part of conduction in atria
6. **Right Bundle Branch**-carry electricity through R. Ventricle
7. **Purkinje Fibers**-distribute electrical energy to the myocardium
8. **Left Bundle Branch**-carries electricity through L. Ventricle

Heartbeat Coordination

- Cardiac muscle cells must undergo action potentials for contraction to occur.
 - The rapid depolarization of the action potential in atrial and ventricular cells (other than those in the conducting system) is due mainly to a positive feedback increase in sodium permeability.
 - Following the initial rapid depolarization, the membrane remains depolarized (the plateau phase) almost the entire duration of the contraction because of prolonged entry of calcium into the cell through slow plasma-membrane channels.
- The SA node generates the current that leads to depolarization of all other cardiac muscle cells.
 - The SA node manifests a pacemaker potential, which brings its membrane potential to threshold and initiates an action potential.
 - The impulse spreads from the SA node throughout both atria and to the AV node, where a small delay occurs. The impulse then passes in turn into the bundle of His, right and left bundle branches, Purkinje fibers, and nonconducting-system ventricular fibers.
- Calcium, mainly released from the sarcoplasmic reticulum (SR), functions as the excitation-contraction coupler in cardiac muscle, as in skeletal muscle, by combining with troponin.
 - The major signal for calcium release from the SR is calcium entering through voltage-gated calcium channels in the plasma membrane during the action potential.
 - The amount of calcium released does not usually saturate all troponin binding sites, and so the number of active cross bridges can be increased if cytosolic calcium is increased still further.
- Cardiac muscle cannot undergo summation of contractions because it has a very long refractory period.

Electrocardiogram (ECG or EKG) = record of spread of electrical activity through the heart

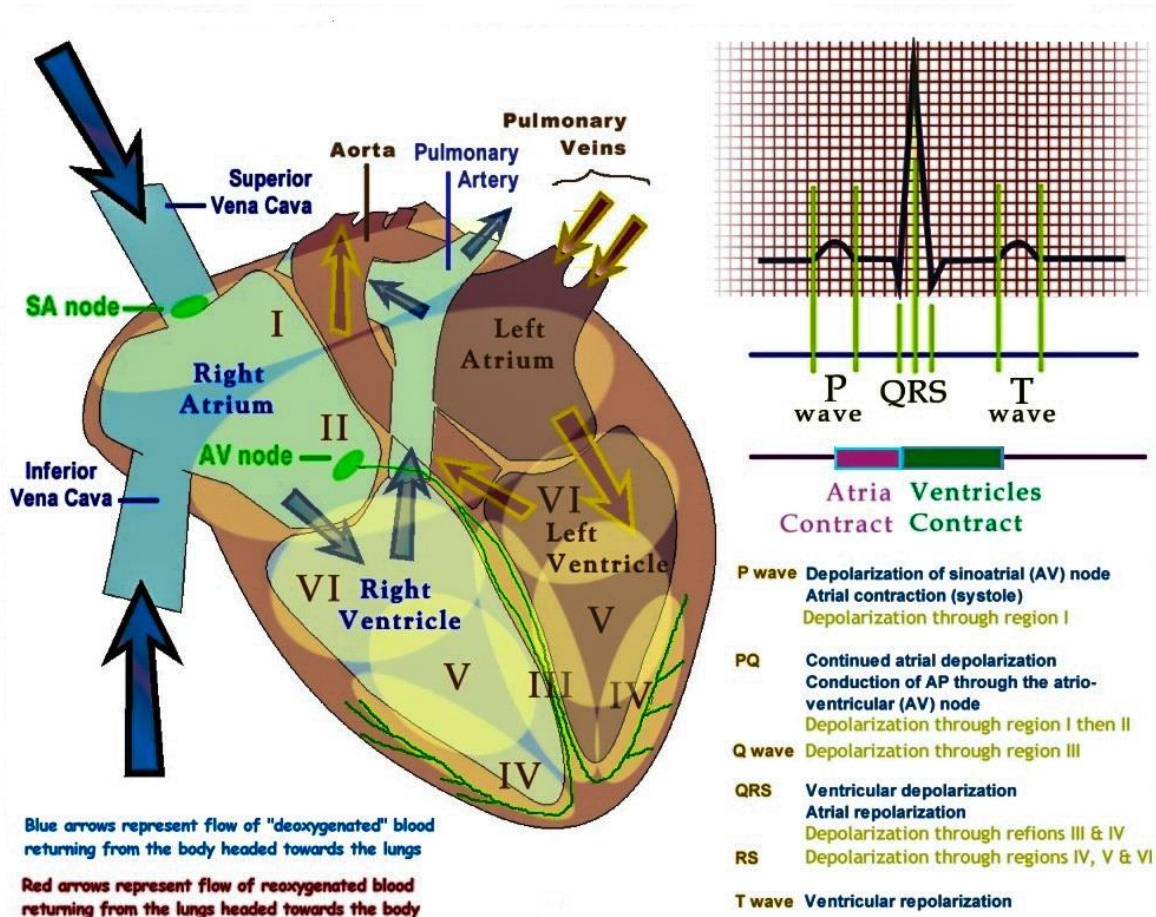


P wave = caused by atrial depolarization (contraction)

QRS complex = caused by ventricular depolarization (contraction) and atrial relaxation

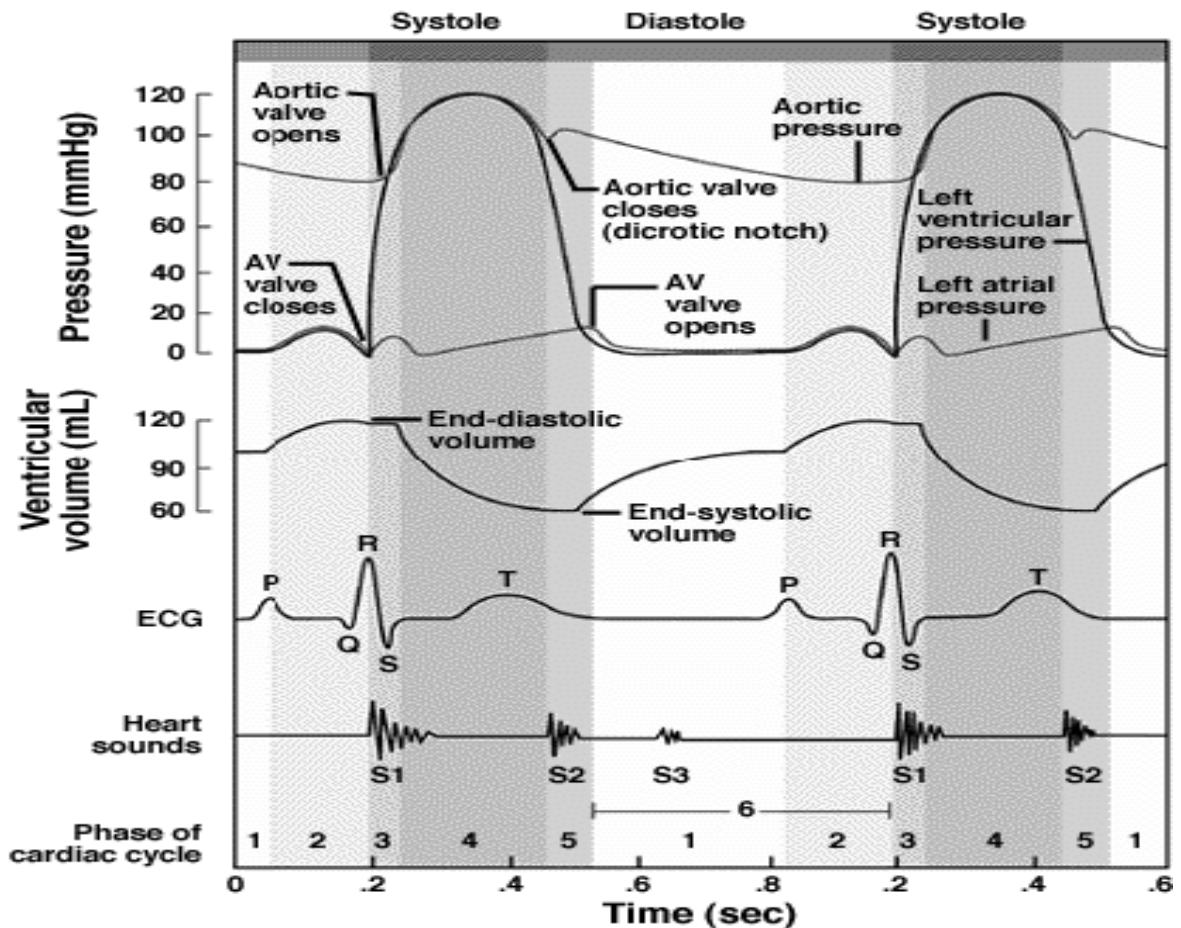
T wave = caused by ventricular repolarization (relaxation)

ECG = useful in diagnosing abnormal heart rates, arrhythmias, & damage of heart muscle



Mechanical Events of the Cardiac Cycle

- The cardiac cycle is divided into **systole** (ventricular contraction) and **diastole** (ventricular relaxation).
 - At the onset of **systole**, ventricular pressure rapidly exceeds atrial pressure, and the AV valves close. The aortic and pulmonary valves are not yet open, however, and so no ejection occurs during this isovolumetric ventricular contraction.
 - When ventricular pressures exceed aortic and pulmonary trunk pressures, the aortic and pulmonary valves open, and ventricular ejection of blood occurs.
 - When the ventricles relax at the beginning of diastole, the ventricular pressures fall significantly below those in the aorta and pulmonary trunk, and the aortic and pulmonary valves close. Because AV valves are also still closed, no change in ventricular volume occurs during this isovolumetric ventricular relaxation.
 - When ventricular pressures fall below the pressures in the right and the left atria, the AV valves open, and the ventricular filling phase of diastole begins.
 - Filling occurs very rapidly at first so that atrial contraction, which occurs at the very end of diastole, usually adds only a small amount of additional blood to the ventricles.
- The amount of blood in the ventricles just before systole is the end diastolic volume. The volume remaining after ejection is the end-systolic volume, and the volume ejected is the stroke volume.
- Pressure changes in the systemic and pulmonary circulations have similar patterns but the pulmonary pressures are much lower.
- The first heart sound is due to the closing of the AV valves, and the second to the closing of the aortic and pulmonary valves.



The Cardiac Output

- The cardiac output is the volume of blood pumped by each ventricle and equals the product of heart rate and stroke volume.
 1. Heart rate is increased by stimulation of the sympathetic nerves to the heart and by epinephrine; it is decreased by stimulation of the parasympathetic nerves to the heart.
 2. Stroke volume is increased by an increase in end-diastolic volume (the Frank-Starling mechanism) and by an increase in contractility due to sympathetic-nerve stimulation or to epinephrine.

Inherent rates for each of the three pacemaker sites

Sinus Node	60 to 100 beats per minute
AV Junction	40 to 60 beats per minute
Ventricles	20 to 40 beats per minute

Relevant Formulas

Stroke volume (SV) = milliliters of blood pumped per beat

Heart rate (HR) = number of beats per minute

Cardiac output (CO) = heart rate times stroke volume
 $CO = HR \times SV$

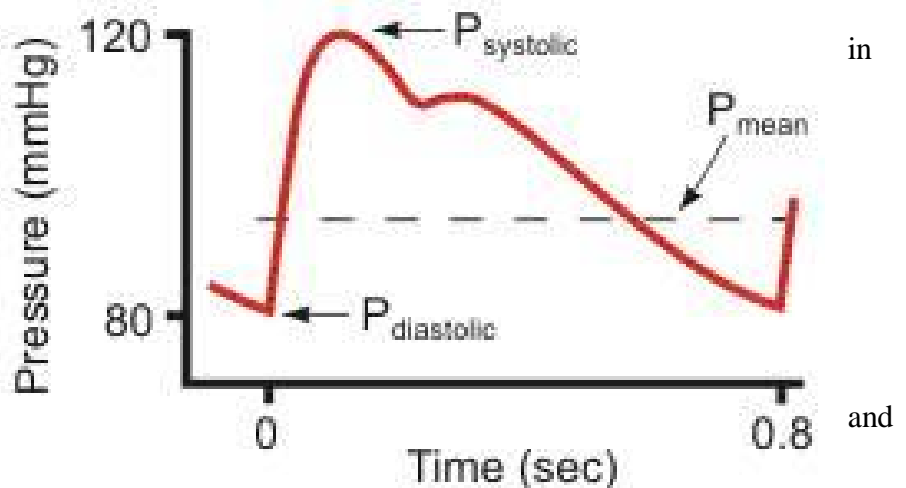
Pulse pressure (PP) = the difference between systolic pressure (SP) and diastolic pressure (DP)
 $PP = SP - DP$

Mean Arterial Pressure (MAP) (2 equations):

Formula 1: $MAP = \text{diastolic pressure} + 1/3 \text{ pulse pressure}$

Formula 2: $MAP = 2/3 \text{ diastolic pressure} + 1/3 \text{ systolic pressure}$

Mean arterial pressure, the primary regulated variable the cardiovascular system, equals the product of cardiac output and total peripheral resistance. The factors that determine cardiac output and total peripheral resistance are complex and include venous pressure, inspiration, stroke volume, nervous activity.

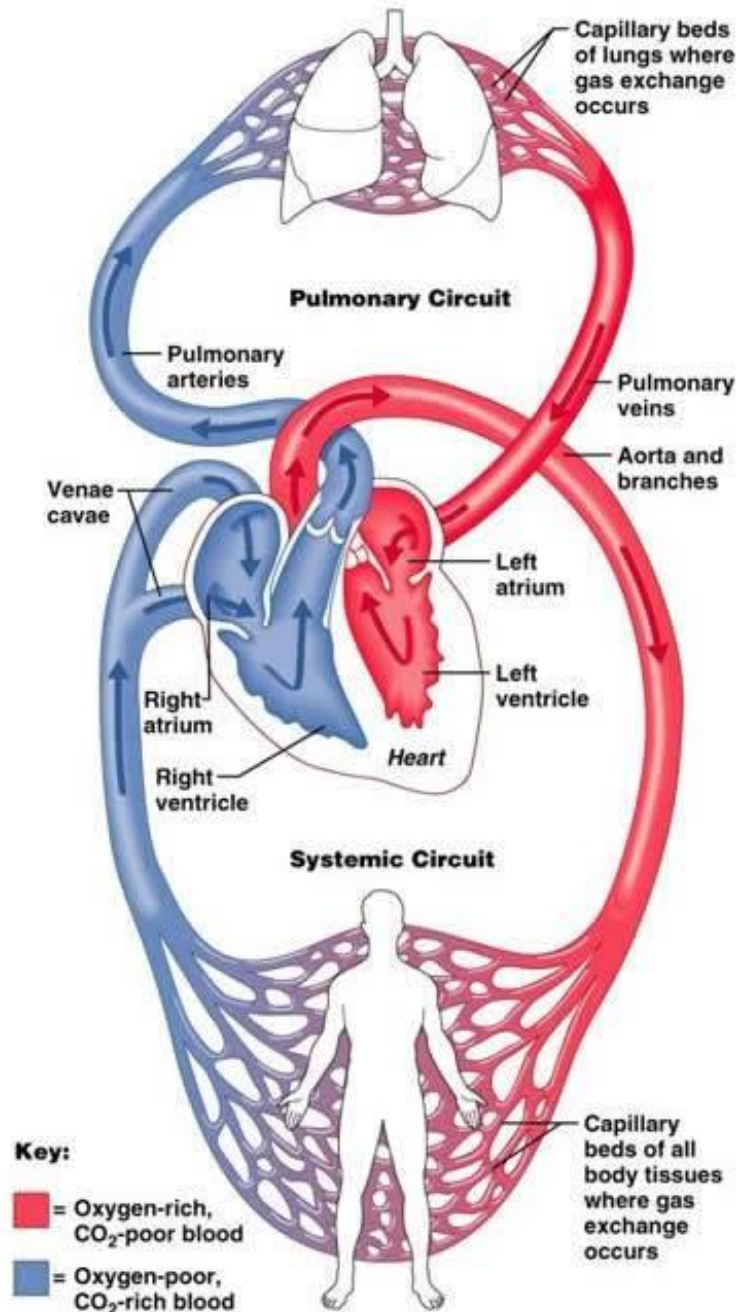


Flow of Blood through the Body:

vena cava → right atrium → tricuspid valve → right ventricle → pulmonary valve → pulmonary artery → pulmonary capillary bed → pulmonary veins → left atrium → bicuspid (mitral valve) → left ventricle → aortic valve → aorta → arteries → arterioles → tissue capillaries → venules → veins → vena cava

PRESSURE, FLOW, & RESISTANCE

- The cardiovascular system consists of two circuits: the pulmonary circulation, from the right ventricle to the lungs and then to the left atrium; and the systemic circulation, from the left ventricle to all peripheral organs and tissues and then to the right atrium
- Arteries carry blood away from the heart, and veins carry blood toward the heart
- In the systemic circuit, the large artery leaving the left heart is the aorta, and the large veins emptying into the right heart are the superior vena cava and inferior vena cava. The analogous vessels in the pulmonary circulation are the pulmonary trunk and the four pulmonary veins.
- The microcirculation consists of the vessels between arteries and veins: the arterioles, capillaries, and venules.
- Flow between two points in the cardiovascular system is directly proportional to the pressure difference between the points and inversely proportional to the resistance: $F = P/R$
- Resistance is directly proportional to the viscosity of a fluid and to the length of the tube. It is inversely proportional to the fourth power of the tube's radius, which is the major variable controlling changes in resistance.



Blood – Functions








- Transportation:
 - oxygen & carbon dioxide
 - nutrients
 - waste products (metabolic wastes, excessive water, & ions)
- Regulation - hormones & heat (to regulate body temperature)
- Protection - clotting mechanism protects against blood loss & leucocytes provide immunity against infection.

Blood types – A,B,O alleles - A and B genes are co-dominant and both dominant over the O gene which is recessive

<u>Phenotypes</u>	<u>Genotype</u>
A	$I^A I^A$ or $I^A i$
B	$I^B I^B$ or $I^B i$
AB	$I^A I^B$
O	ii

Blood Type	Genotype		Can Receive Blood From:
A	$I^A i$ $I^A I^A$	AA AO	A or O
B	$I^B i$ $I^B I^B$	BB BO	B or O
AB	$I^A I^B$	AB	A, B, AB, O
O	ii	oo	O

The ABO Blood System

Blood Type (genotype)	Type A (AA, AO)	Type B (BB, BO)	Type AB (AB)	Type O (OO)
Red Blood Cell Surface Proteins (phenotype)	 A agglutinogens only	 B agglutinogens only	 A and B agglutinogens	 No agglutinogens
Plasma Antibodies (phenotype)	 b agglutinin only	 a agglutinin only	NONE. No agglutinin	 a and b agglutinin

THE VASCULAR SYSTEM

Blood Vessels

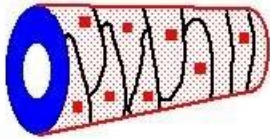
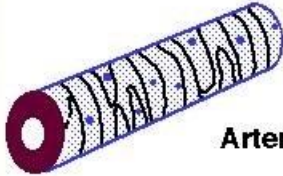
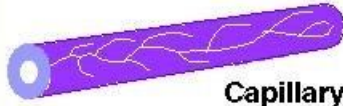


Arteries ó largest vessels ó carry blood from the heart.

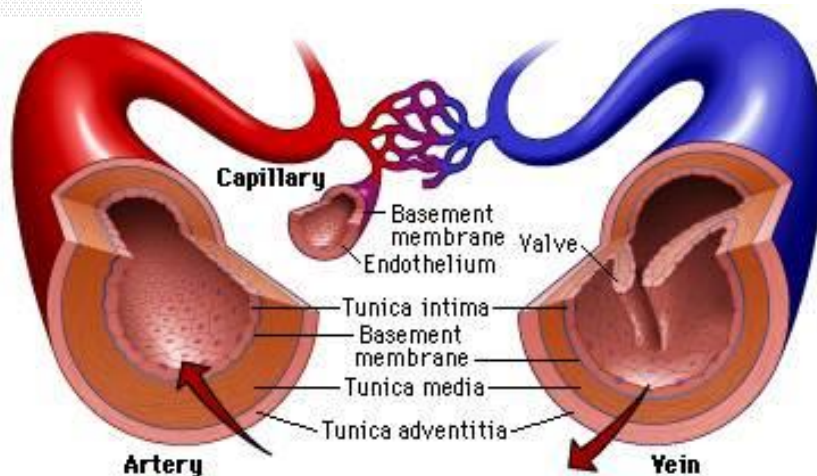
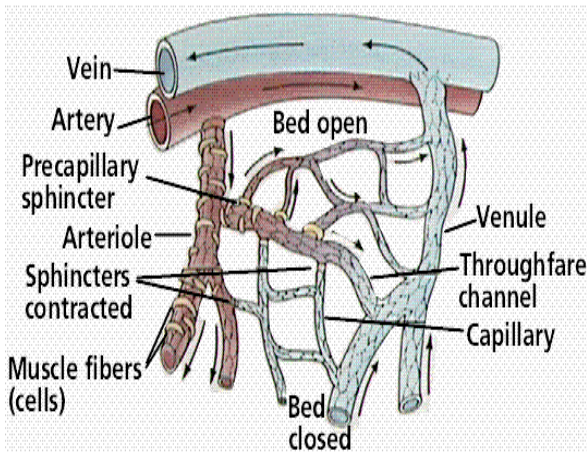
Arterioles- smaller version of arteries, carry blood to the capillaries

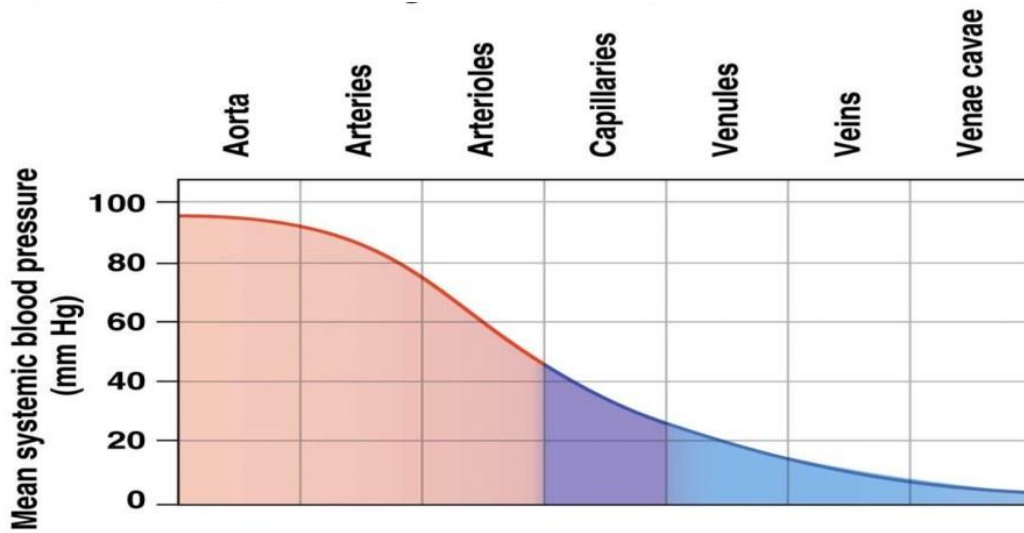
Capillaries ó smallest vessels, one cell thick, transfer materials to and from blood

Venules – small version of veins, carry blood from capillaries to veins

Veins – carry blood back to heart, have valves to stop backflow

APPEARANCE	DIMENSIONS	COMPOSITION OF VESSEL WALL
 <p style="text-align: center;">Artery</p>	<p>Vessel Diameter 25 mm Thickness 2 mm</p> <p style="text-align: center;">Aorta</p> <p style="text-align: center;">4 mm 1 mm</p> <p style="text-align: center;">Medium Sized Artery</p>	<p>Endothelium</p> <p>Elastic fibers</p> <p>Smooth muscle</p> <p>Collagen fibers</p>
 <p style="text-align: center;">Arteriole</p>	<p style="text-align: center;">30 µm 20 µm</p>	<p>Endothelium</p> <p>Elastic fibers</p> <p>Smooth muscle</p> <p>Collagen fibers</p>
 <p style="text-align: center;">Capillary</p>	<p style="text-align: center;">8 µm <1 µm</p>	<p>Endothelium</p> <p>No muscle or connective tissue</p>
 <p style="text-align: center;">Venule</p>	<p style="text-align: center;">20 µm 2 µm</p>	<p>Endothelium</p> <p>Small amount of Elastin and smooth muscle</p> <p>Collagen fibers</p>
 <p style="text-align: center;">Vein</p>	<p style="text-align: center;">20 mm 1 mm</p>	<p>Endothelium</p> <p>Elastic fibers</p> <p>Smooth muscle</p> <p>Collagen fibers</p> <p>have valves to stop backflow</p>





ARTERIES

- The arteries function as low-resistance conduits and as pressure reservoirs for maintaining blood flow to the tissues during ventricular relaxation.
- The difference between maximal arterial pressure (systolic pressure) and minimal arterial pressure (diastolic pressure) during a cardiac cycle is the pulse pressure.
- Mean arterial pressure can be estimated as diastolic pressure plus one-third pulse pressure.

ARTERIOLES

- Arterioles, the dominant site of resistance to flow in the vascular system, play major roles in determining mean arterial pressure and in distributing flows to the various organs and tissues.
- Arteriolar resistance is determined by local factors and by reflex neural and hormonal input.
 - Local factors that change with the degree of metabolic activity cause the arteriolar vasodilation and increased flow of active hyperemia.
 - Flow autoregulation, a change in resistance that maintains flow constant in the face of a change in arterial blood pressure, is due to local metabolic factors and to arteriolar myogenic responses to stretch.
 - The sympathetic nerves are the only innervation of most arterioles and cause vasoconstriction via alpha-adrenergic receptors. In certain cases noncholinergic, non-adrenergic neurons that release nitric oxide or other noncholinergic vasodilators also innervate blood vessels.
 - Epinephrine causes vasoconstriction or vasodilation, depending on the proportion of alpha- and beta-adrenergic receptors in the organ.
 - Angiotensin II and vasopressin cause vasoconstriction.
 - Some chemical inputs act by stimulating endothelial cells to release vasodilator or vasoconstrictor paracrine agents, which then act on adjacent smooth muscle. These paracrine agents include the vasodilators nitric oxide (endothelium-derived relaxing factor) and prostacyclin, and the vasoconstrictor endothelin-1.
- Arteriolar control in specific organs varies considerably, including influences from metabolic factors, physical forces, autoregulation, and sympathetic nerves.

VEINS

- Veins serve as low-resistance conduits for venous return.
- Veins are very compliant and contain most of the blood in the vascular system.
- Their diameters are reflexively altered by sympathetically-mediated vasoconstriction so as to maintain venous pressure and venous return.
- The skeletal-muscle pump and respiratory pump increase venous pressure locally and enhance venous return. Venous valves permit the pressure to produce only flow toward the heart.

VENUOLES

- Venules are small blood vessels that collect spent blood from capillary beds and transport it to the larger veins for transport back to the heart.
- Apart from their small size and narrow interior lumens, venules are structurally similar to veins, and several venules often merge together to form a vein.

CAPILLARIES

- Capillaries are the site of exchange of nutrients and waste products between blood and tissues.
- Blood flows through the capillaries more slowly than in any other part of the vascular system because of the huge cross-sectional area of the capillaries.
- Capillary blood flow is determined by the resistance of the arterioles supplying the capillaries and by the number of open precapillary sphincters.
- Diffusion is the mechanism by which nutrients and metabolic end-products exchange between capillary plasma and interstitial fluid.
 - Lipid-soluble substances move across the entire endothelial wall, whereas ions and polar molecules move through water-filled intercellular clefts or fused-vesicle channels.
 - Plasma proteins move across most capillaries only very slowly, either by diffusion through water-filled channels or by vesicle transport.
 - The diffusion gradient for a substance across capillaries arises as a result of cell utilization production of the substance. Increased metabolism increases the diffusion gradient and increases the rate of diffusion.
- Bulk flow of protein-free plasma or interstitial fluid across capillaries determines the distribution of extracellular fluid between these two fluid compartments.
 - Filtration from plasma to interstitial fluid is favored by the hydrostatic pressure difference between the capillary and the interstitial fluid. Absorption from interstitial fluid to plasma is favored by the plasma protein concentration difference between the plasma and the interstitial fluid.
 - Filtration and absorption do not change the concentrations of crystalloids in the plasma and interstitial fluid because these substances move together with water.
 - There is normally a small excess of filtration over absorption.

Capillary Exchange

capillary exchange - The movement of respiratory gases (oxygen and carbon dioxide) and nutrient and waste molecules between the plasma and the interstitial fluid by a variety of active and passive means; O₂ and nutrients tend to move to the interstitial fluid while CO₂ and wastes tend to move to the plasma.

diffusion - The movement of molecules or ions from a region of higher concentration to a region of lower concentration until equilibrium is reached; it is a passive transport process.

vesicular transport - The method of transport by which soluble proteins are packaged in membrane bound droplets which bud off from one compartment and fuse with the membrane of another; this transport sees the flow of protein out from the ER via the Golgi to the outside of the cell by a process known as exocytosis, or to lysosomes, or inwards from the cell membrane by endocytosis to endosomes and fusion with lysosomes; in addition to simple transport of these molecules, it presents the opportunity for modification of the proteins; it also provides opportunity for the recycling of membrane lipids.

bulk flow - The movement of a fluid from a region of higher pressure to one of lower pressure, e.g., filtration in the kidney nephron and absorption in the interstitial spaces of the tissues; it is a passive process.

Starling's law of the capillaries - The observations and mathematical relationships which explain how fluid and dissolved solutes either leave the capillaries ("filtration") for the tissue spaces or the reverse, leave the interstitial space for the plasma; these movements depend on a set of four forces: blood hydrostatic pressure (BHP), interstitial fluid hydrostatic pressure (IFHP), blood colloid osmotic pressure (BCOP), and interstitial fluid osmotic pressure (IFOP); see the details under "**net filtration pressure**" below.

blood hydrostatic pressure (BHP) - The hydrostatic force which is the mechanical pressure exerted on the fluid of plasma by the pumping of the heart during systole and by the elastic recoil and smooth muscle contraction in the walls of the arteries between heart beats during diastole, which tends to push water from the capillaries into the interstitial fluid; this pressure is a component variable of Starling's Law of the Capillaries.

interstitial fluid hydrostatic pressure (IFHP) - The hydrostatic force which is the mechanical pressure exerted on the interstitial fluid by the elastic recoil of the tissues in any region of the body, which tends to push water from the interstitial fluid back into the capillaries; this pressure is a component variable of Starling's Law of the Capillaries.

blood colloid osmotic pressure (BCOP) - The osmotic force (water concentration gradient) which is the result of differences in water concentration between plasma and interstitial fluid, which tends to pull water from the interstitial fluid and back into the plasma in the capillaries; this pressure is a component variable of Starling's Law of the Capillaries.

interstitial fluid osmotic pressure (IFOP) - The osmotic force (water concentration gradient) which is the result of differences in water concentration between plasma and interstitial fluid, which tends to pull water from the plasma in the capillaries into the interstitial fluid; this pressure is a component variable of Starling's Law of the Capillaries.

net filtration pressure - The dynamic equilibrium force which may be measured at any point along the capillaries from the arterial to the venous end; on the arterial side because the blood hydrostatic pressure (BHP) dominates, fluid moves from the capillary lumen into the tissue space; on the venous side because the blood colloidal osmotic pressure (BCOP) dominates, fluid moves from the tissue space back into the capillary lumen;

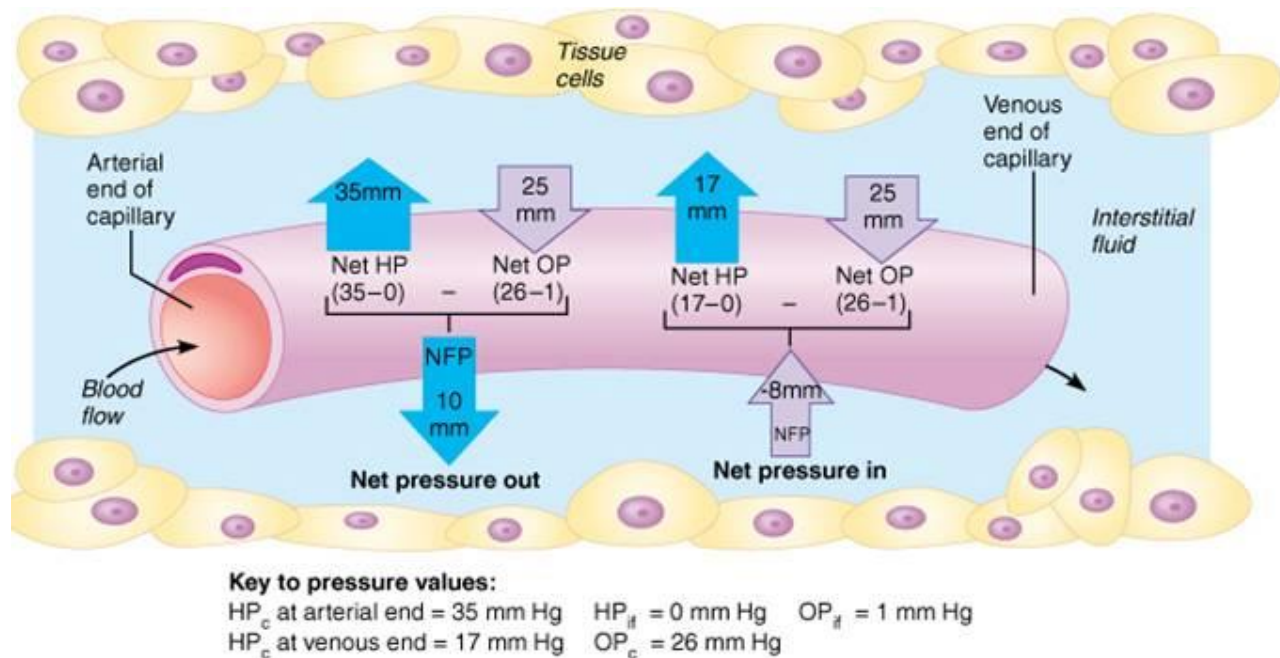
The net filtration pressure at any point is the sum of these four forces:

$$\text{NFP} = (\text{BHP} + \text{IFOP}) - (\text{BCOP} + \text{IFHP}) = \text{Pushing forces} - \text{Pulling forces}$$

This pressure is a component variable of Starling's Law of the Capillaries.

The BCOP and the IFOP are the same at both ends of the capillary; however, the BHP differs at the arterial and venous ends of the capillary (about 35 mmHg at arterial end, and 16 mmHg at venous end).

Any POSITIVE force is an OUTWARD, or pushing force, may be termed **CAPILLARY FILTRATION**. Any NEGATIVE force is an INWARD, or pulling force, may be termed **CAPILLARY REABSORPTION**.



oncotic pressure - The osmotic pressure created by colloids (mainly plasma proteins) which are normally retained within the vascular system; oncotic pressure nearly offsets the hydrostatic pressure which acts to drive fluid out of vessels into the extravascular space; the result is that small amounts of fluid cross the vascular barrier, which are then transported back to the blood via the lymphatics; a decrease in oncotic pressure can be a cause of non-inflammatory edema.

edema - Any excessive accumulation of serous fluid or interstitial fluid (lymph) in tissue spaces or a body cavity; significant edema will produce obvious swelling of the involved tissues; it may be localized, due to venous or lymphatic obstruction or to increased vascular permeability (e.g., in inflammation), or it may be systemic due to heart failure or renal disease.

CARDIOVASCULAR PATTERNS

HEMORRHAGE AND OTHER CAUSES OF HYPOTENSION

- Hypotension can be caused by loss of body fluids, by strong emotion, and by liberation of vasodilator chemicals.
- Shock is any situation in which blood flow to the tissues is low enough to cause damage to them.

THE UPRIGHT POSTURE

- In the upright posture, gravity acting upon unbroken columns of blood reduces venous return by increasing vascular pressures in the veins and capillaries in the limbs.
- The increased venous pressure distends the veins, causing venous pooling, and the increased capillary pressure causes increased filtration out of the capillaries.
- These effects are minimized by contraction of the skeletal muscles in the legs.

EXERCISE

- The changes are due to active hyperemia in the exercising skeletal muscles and heart, to increased sympathetic outflow to the heart, arterioles, and veins, and to decreased parasympathetic outflow to the heart.
- The increase in cardiac output depends not only on the autonomic influences on the heart but on factors that help increase venous return.
-
- Training can increase a person's maximal oxygen consumption by increasing maximal stroke volume and hence cardiac output.
- Exercise decreases the risk of atherosclerosis; it decreases BP or causes a slower rise in BP
- Exercise decreases LDLs, decreases cholesterol, and increases HDLs

HYPERTENSION

- Hypertension is usually due to increased total peripheral resistance resulting from increased arteriolar vasoconstriction.
- More than 95 percent of hypertension is termed primary in that the cause of the increased arteriolar vasoconstriction is unknown.

HEART FAILURE

- Heart failure can occur as a result of diastolic dysfunction or systolic dysfunction; in both cases cardiac output becomes inadequate.
- This leads to fluid retention by the kidneys and formation of edema because of increased capillary pressure.
- Pulmonary edema can occur when the left ventricle fails.

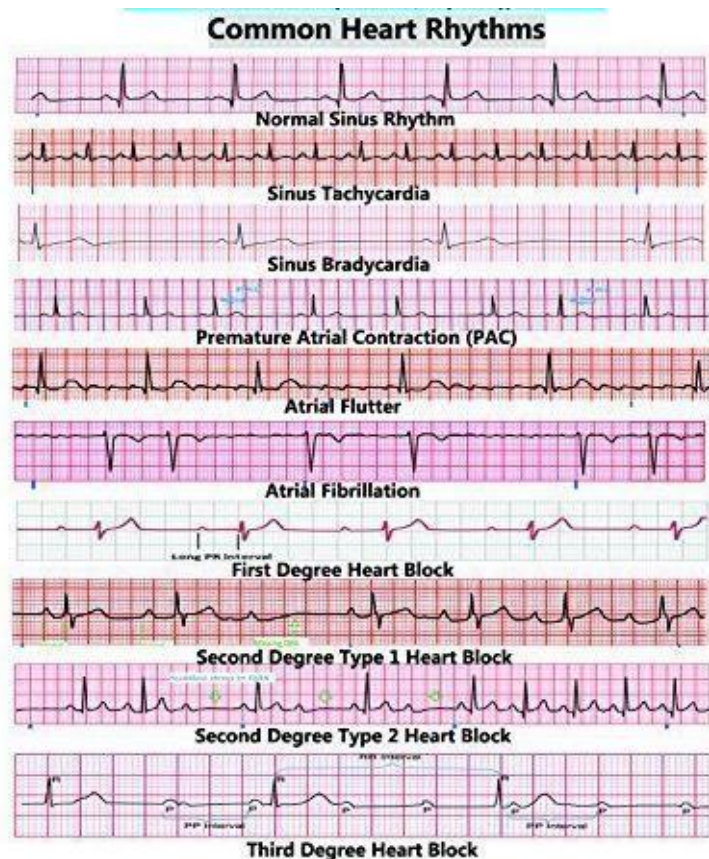
CORONARY ARTERY DISEASE

- Insufficient coronary blood flow can cause damage to the heart.
- Acute death from a heart attack is usually due to ventricular fibrillation.
- The major cause of reduced coronary blood flow is atherosclerosis, an occlusive disease of arteries.
- Persons may suffer intermittent attacks of angina pectoris without actually suffering a heart attack at the time of the pain.
- Atherosclerosis can also cause strokes and symptoms of inadequate blood flow in other areas.

DISORDERS OF THE VASCULAR SYSTEM

- **Arteriosclerosis** - a general term describing any hardening (and loss of elasticity) of medium or large arteries
- **Atherosclerosis**-Common form of arteriosclerosis-cholesterol, lipid, calcium deposits in the walls of the arteries
- **High Cholesterol**-elevated level of cholesterol. can cause deposits on walls of blood vessels
Increases risk of Coronary Heart Disease
high blood pressure – hypertension
- **Stroke**-Sudden loss of neurological function caused by vascular injury to the brain
- **Myocardial Infarction**-loss of living heart muscle as a result of coronary occlusion
- **Congestive Heart Failure** - the heart's function as a pump is inadequate to deliver oxygen rich blood to the body due to weakened heart muscle, stiffening of heart muscle or diseases that demand oxygen beyond the capacity of the heart to deliver oxygen-rich blood. It is treated with medications like ACE inhibitors, beta blockers, and diuretics as well as lifestyle changes. Surgery may also be used .
- **Bradycardia** – slowness of heart rate, usually fewer than 60 beats per minute in resting adults. Treatment vary based on the underlying cause of the condition. They may include medications, pacemaker, surgery, or even in severe cases a heart transplant
- **Tachycardia** – rapid resting heart rate, more than 100 beats per minute. Treatment varies based on underlying causes may include lifestyle changes, medications to slow heart, surgery for pacemaker or defibrillator

Lethal & nonlethal strip interpretation



Div. B:

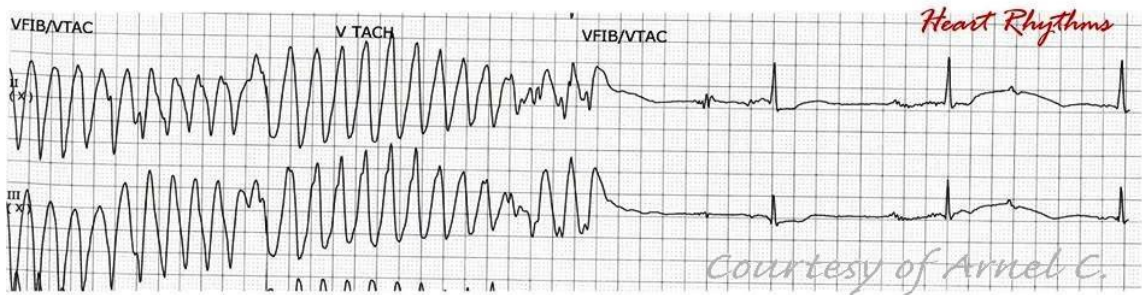
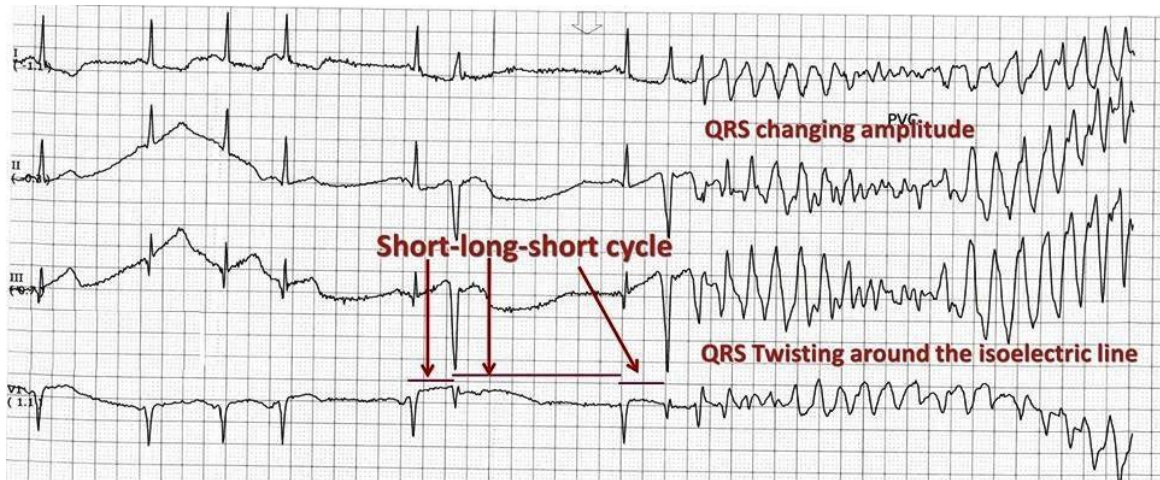
- **Atrial Fibrillation (A Fib)** Irregular and often rapid beats of the atria. Treatment involves medications to slow heart rate, restore and maintain normal rhythm, and prevent clot formation

Pulseless Electrical Activity (PEA) — heart rhythm is not creating a pulse. the heart rhythm will show up on the electrocardiogram demonstrating that the heart is beating and that there is electrical activity in the body, but holding your hand on the wrist or the side of the neck will not yield noticeable pulse.

Ventricular Tachycardia (V-tach) - a type of regular and fast heart rate that arises from improper electrical activity in the ventricles of the heart. Although a few seconds may not result in problems, longer periods are dangerous. Short periods may occur without symptoms or present with lightheadedness, palpitations, or chest pain. Ventricular tachycardia may result in cardiac arrest and turn into ventricular fibrillation

Div. C:

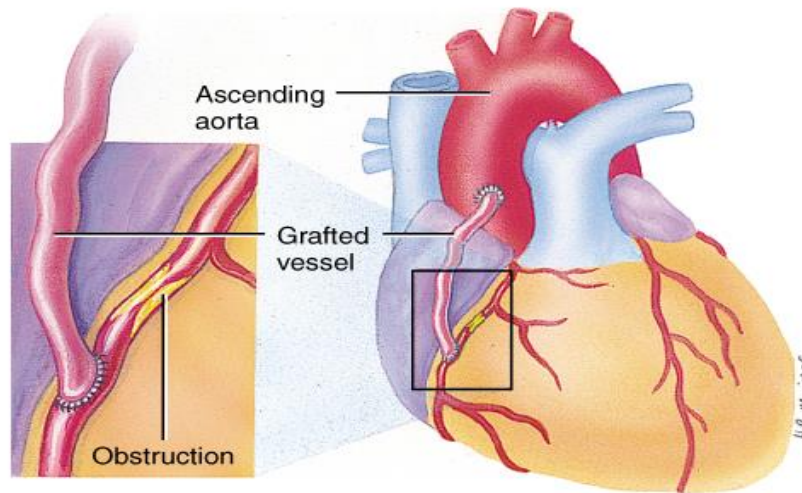
Torsades – abnormal heart rhythm that can lead to sudden cardiac death. It is a polymorphic ventricular tachycardia that exhibits distinct characteristics on EKG. It is characterized by a gradual change in the amplitude and twisting of QRS complexes around the isoelectric line.



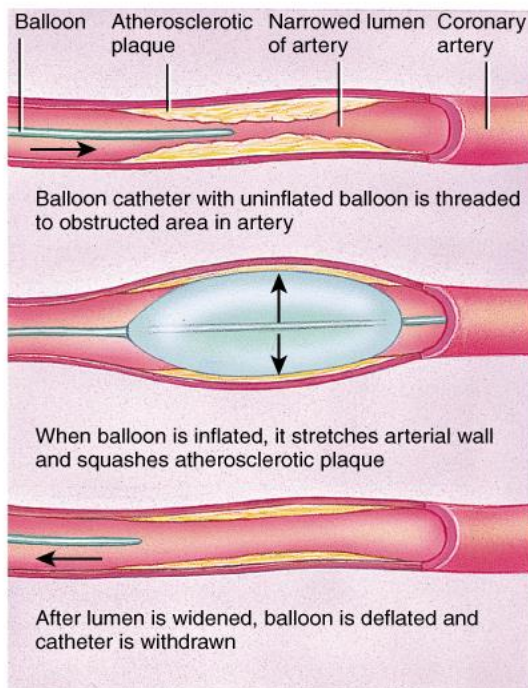
Premature Ventricular Contractions (PVCs) - depolarization that arises in either ventricle before the next expected sinus beat, and is therefore labeled "premature." Since PVCs originate in the ventricle, the normal sequence of ventricular depolarization is altered. For example, instead of the two ventricles depolarizing simultaneously, a PVC will cause the ventricles to depolarize at different times or sequentially.

Sustained Ventricular Tachycardia (SVT) - a rapid heart beat of more than 120 beats per minute (bpm) that arises from improper electrical activity of the heart presenting as a rapid heart rhythm, that starts in the bottom chambers of the heart or the ventricles and lasts more than 30 seconds.

Treatments



By-pass Graph



Angioplasty



Artificial Heart