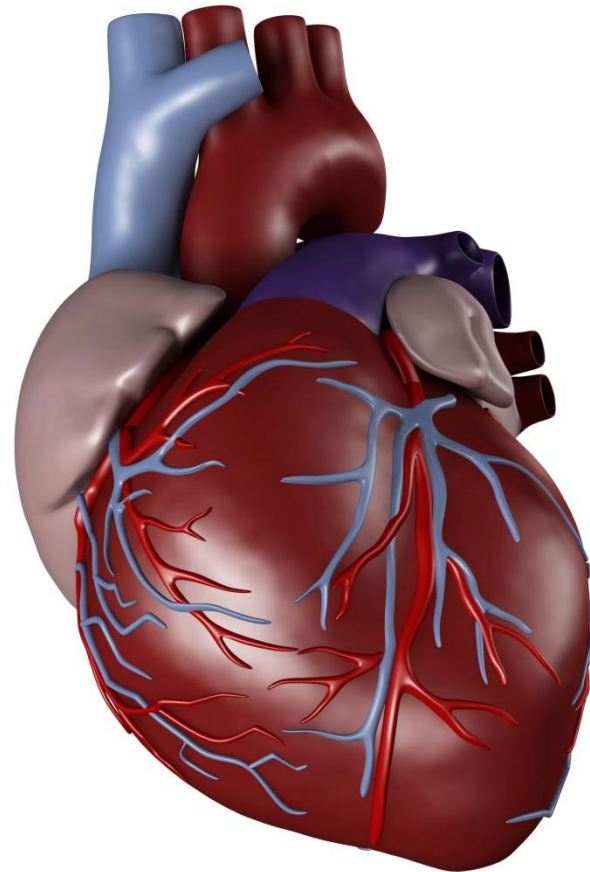


# Lecture 8

## **The Cardiovascular System**

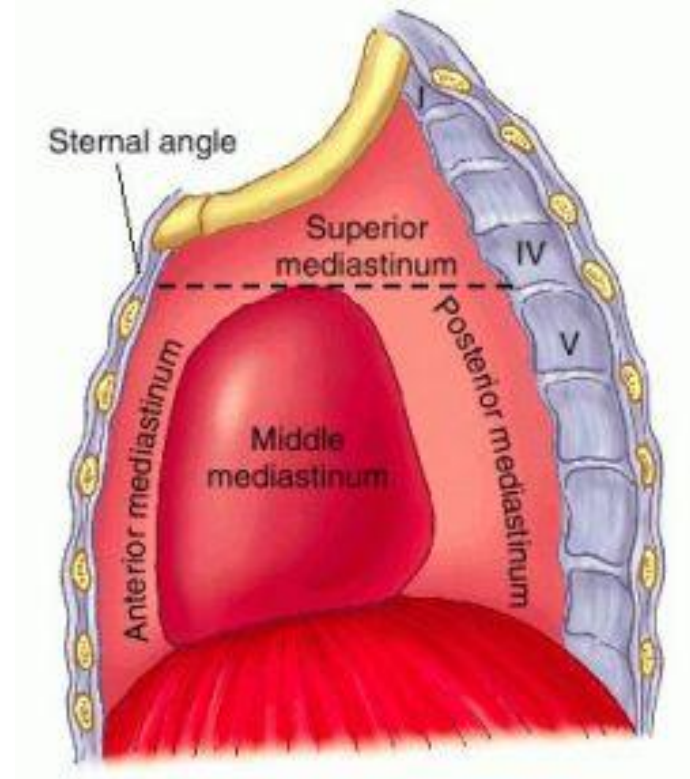


# The Cardiovascular System

- The cardiovascular system delivers oxygen, nutrients, and hormones to various tissues of the body
- The CV system also transports waste products to the appropriate waste removal system
- The CV system is also referred to as the circulatory system

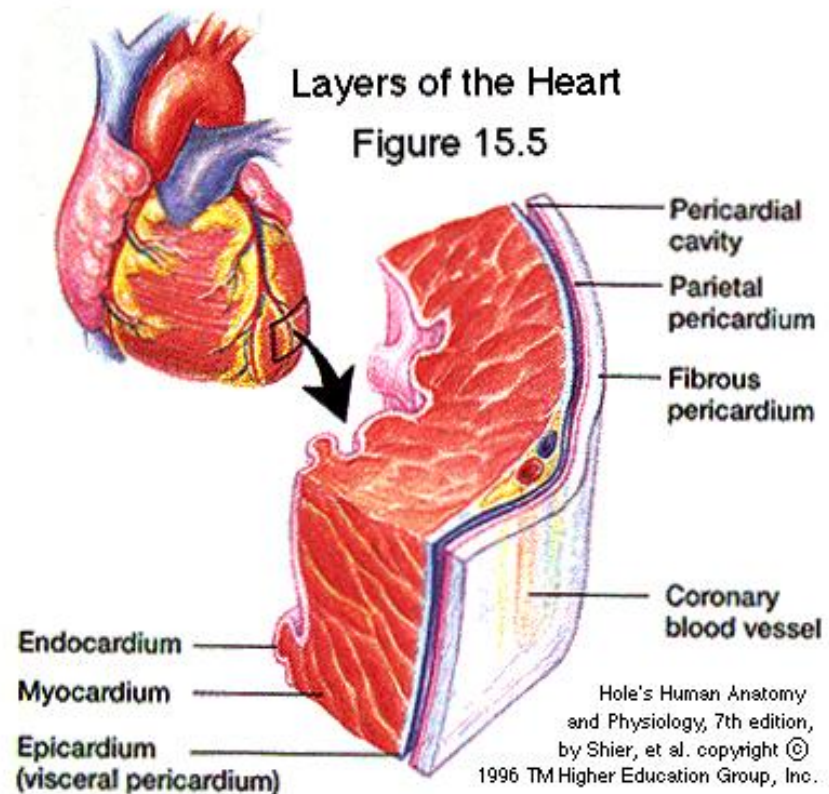
# The Cardiovascular System

- Cardiovascular means pertaining to the heart and blood vessels
- The heart is a hollow muscular organ that provides the power to move blood through the body (like a pump)
- The heart is located in the mediastinum, which is a space in the thoracic cavity between the lungs



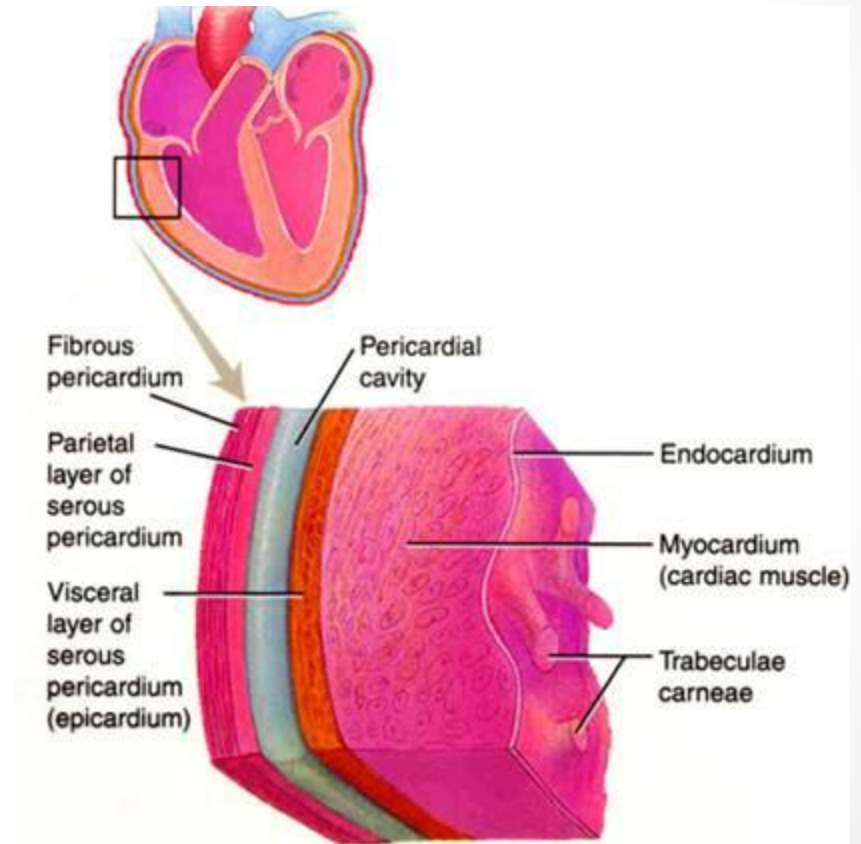
# The Structures Surrounding the Heart

- The pericardium is a double-walled membrane that surrounds the heart
  - Peri- means around
- There are two layers of the pericardium:
  - the fibrous layer
  - the serous layer
    - parietal layer
    - visceral layer



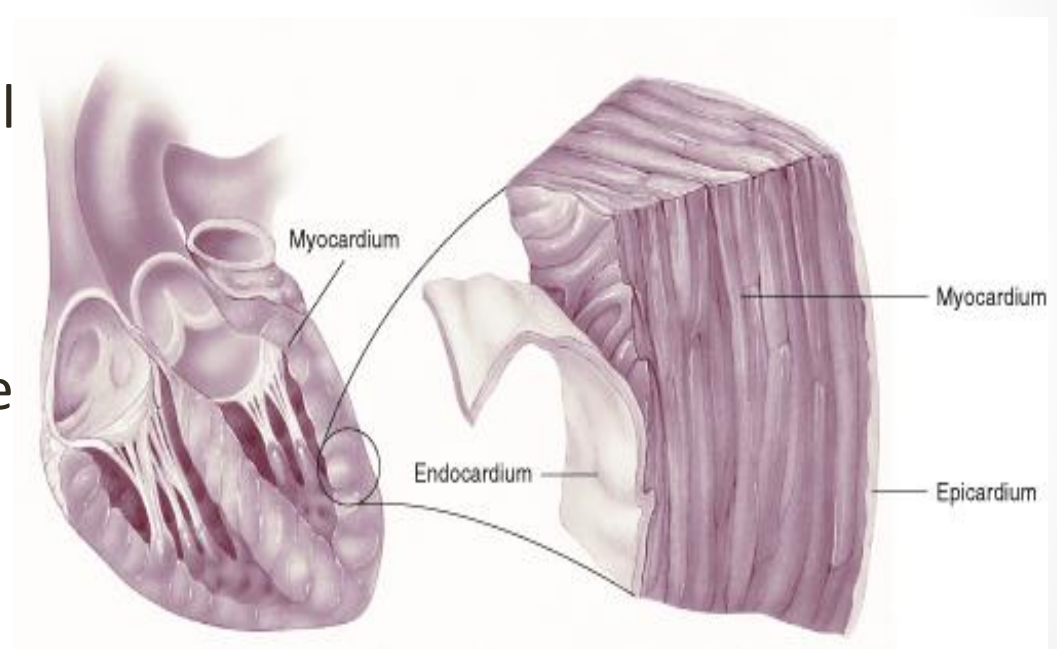
# The Structures Surrounding the Heart

- The pericardial space is the space between the two serous layers of the pericardium
  - This space contains pericardial fluid
    - Pericardial fluid prevents friction between the heart and the pericardium when the heart beats



# The Heart Walls

- The heart is made up of three walls:
  - epicardium = external layer
    - epi- means upper/outer
  - myocardium = middle layer
    - my/o means muscle
  - endocardium = inner layer
    - endo- means within

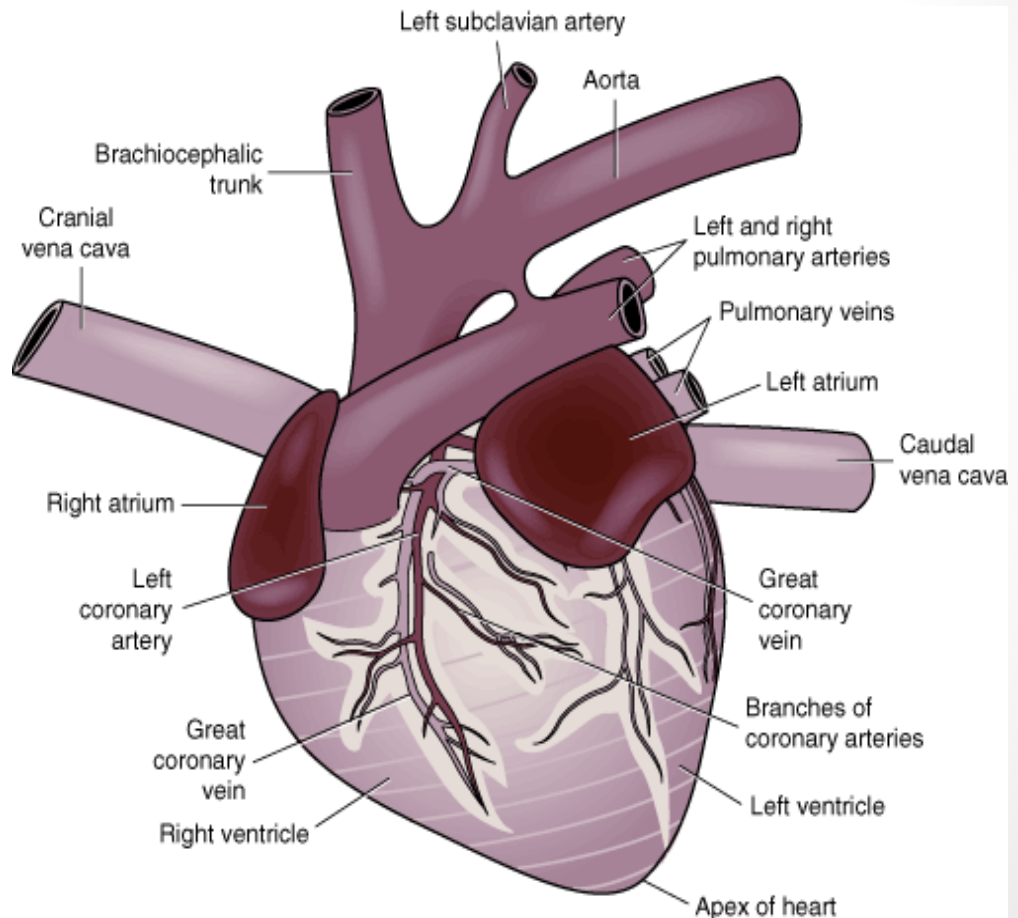




# Blood Supply to the Heart

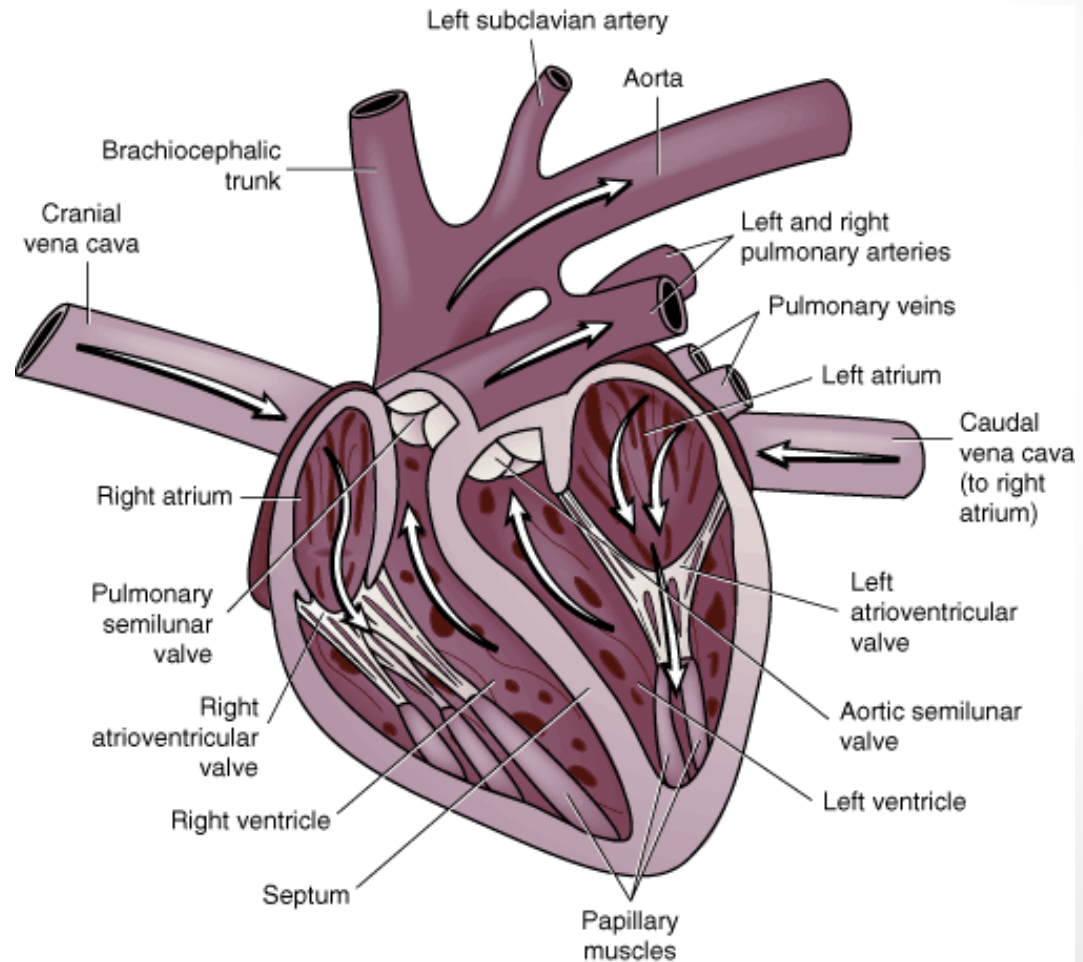
- The blood vessels that deliver blood to and take blood away from the heart are known as coronary vessels

- Coronary occlusion means blockage of the coronary vessels
- Coronary occlusion may lead to ischemia
  - Ischemia is a deficiency in the blood supply to an area
- Ischemia may lead to necrosis
- An area of necrosis caused by an interrupted blood supply is called an infarct



# The Heart Chambers

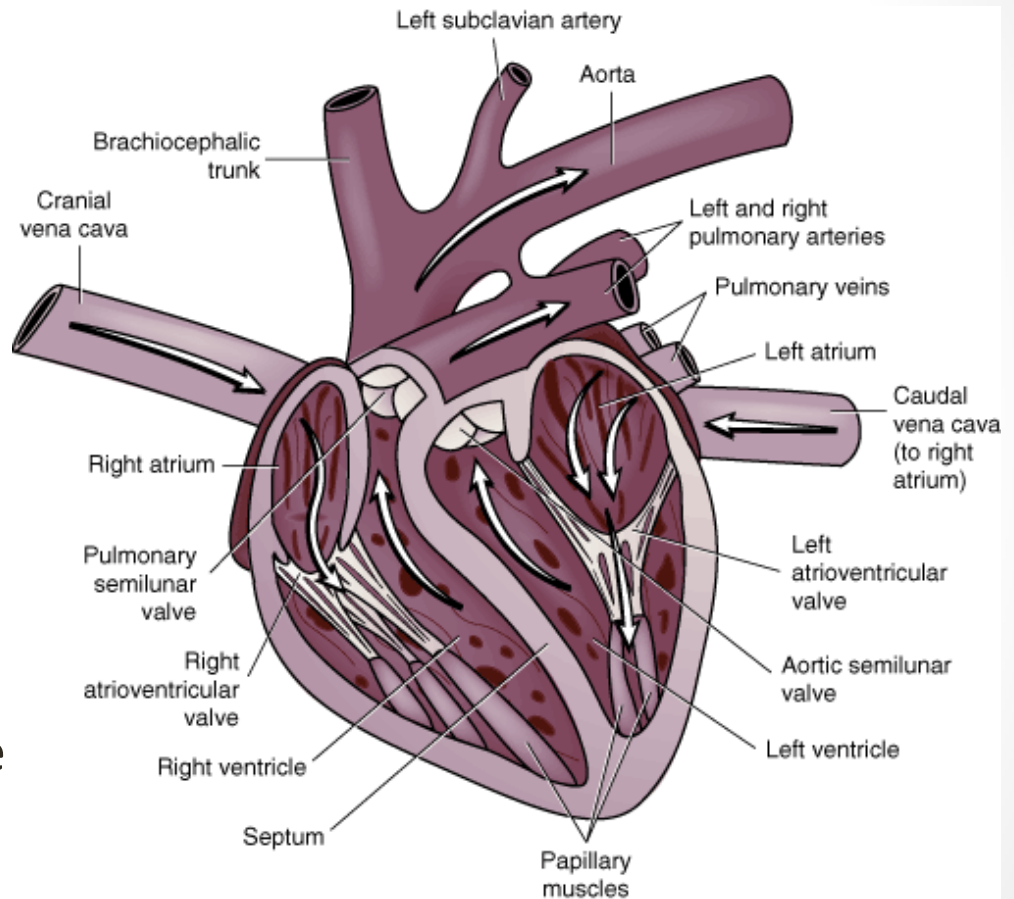
- The superior chambers of the heart are known as atria (singular is atrium)
  - atri/o = atria
- The inferior chambers of the heart are known as ventricles
  - ventricul/o = ventricles
- A septum is a separating wall
- The apex is the tip of the heart





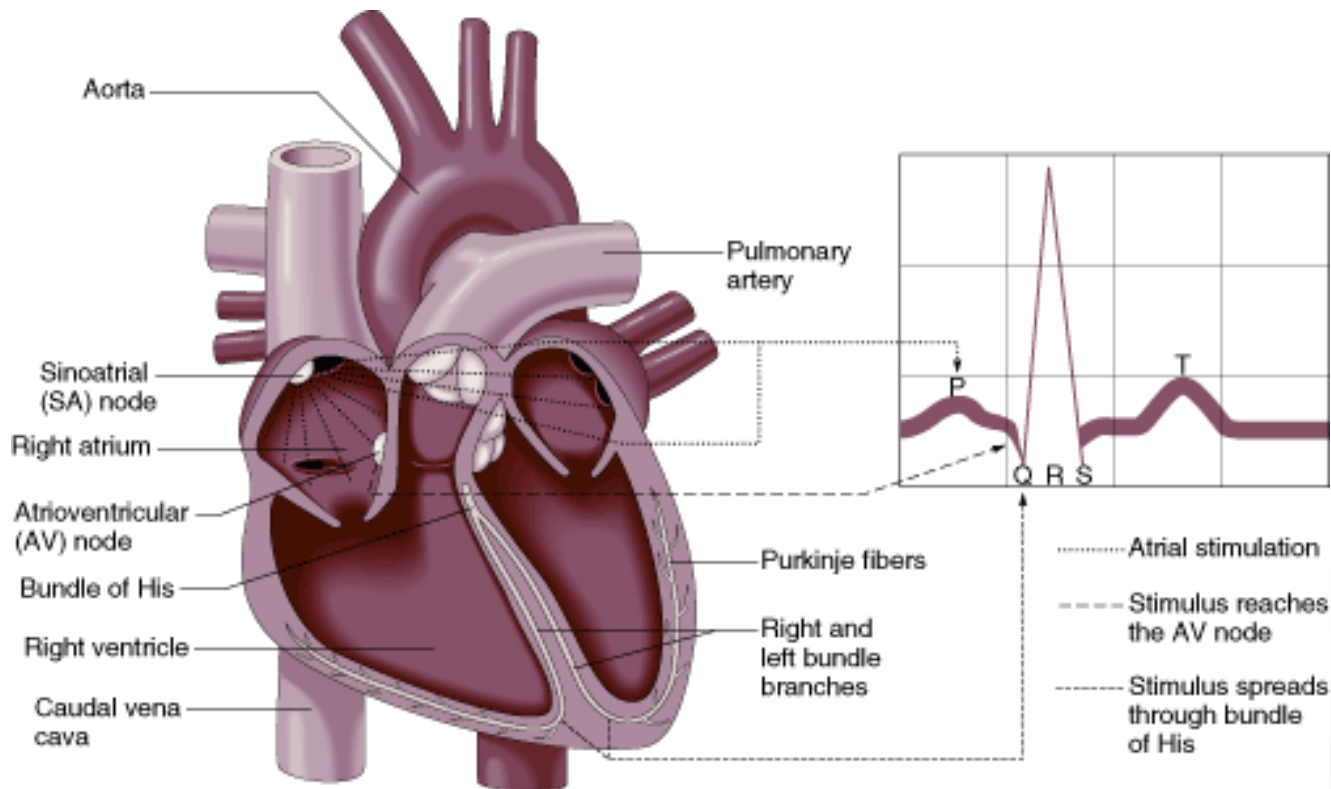
# The Heart Valves

- A valve is a membranous fold
- The heart valves control the flow of blood through the heart
  - valv/o and valvul/o = valve
- Right atrioventricular valve
  - aka tricuspid valve
- Pulmonary semilunar valve
- Left atrioventricular valve
  - aka mitral valve
  - aka bicuspid valve
- Aortic semilunar valve



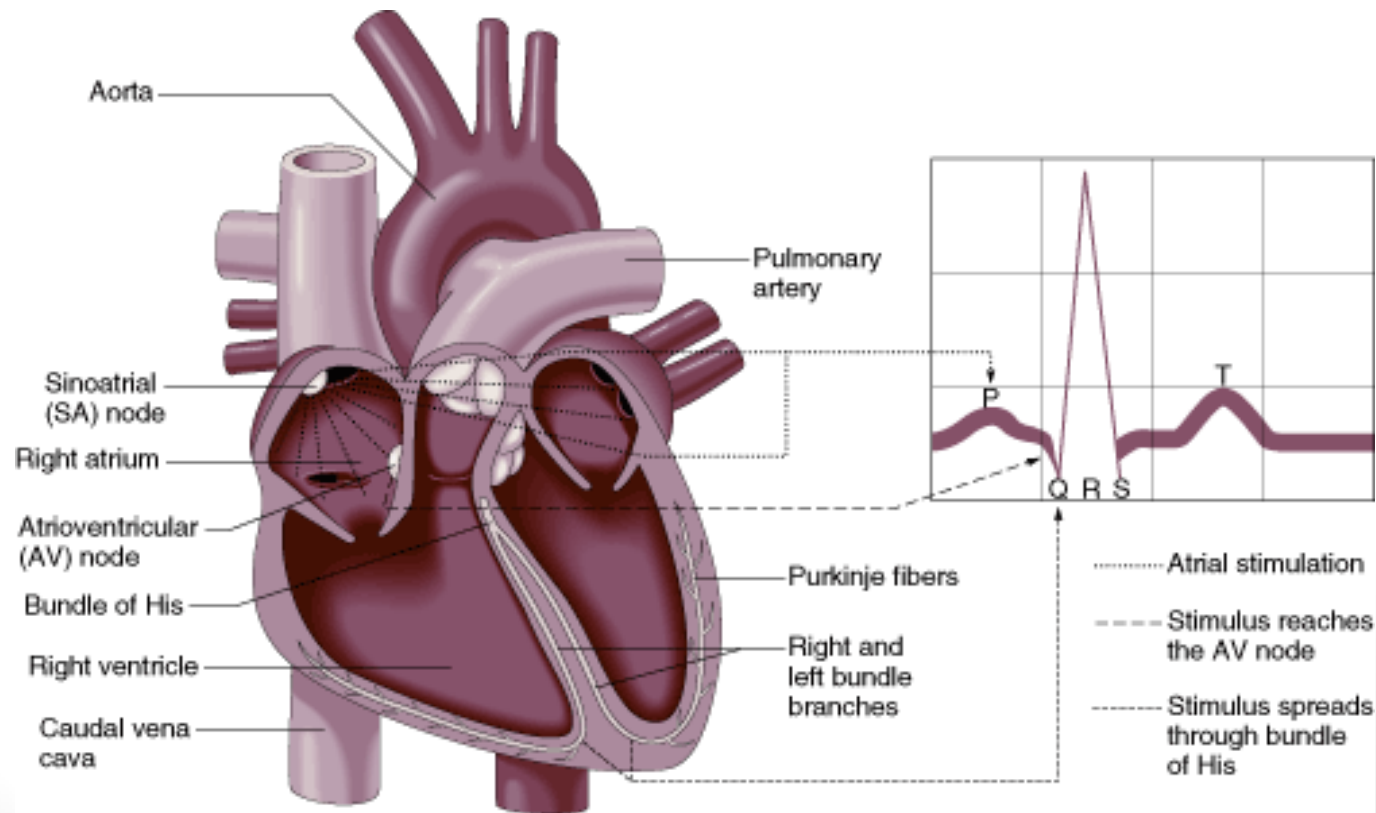
# Heart Rate

- The rate and regularity of the heart rhythm is termed the heartbeat
- The heartbeat is influenced by the electrical impulses from nerves that stimulate the myocardium
- Cardiac output is the volume of blood pumped by the heart per unit time



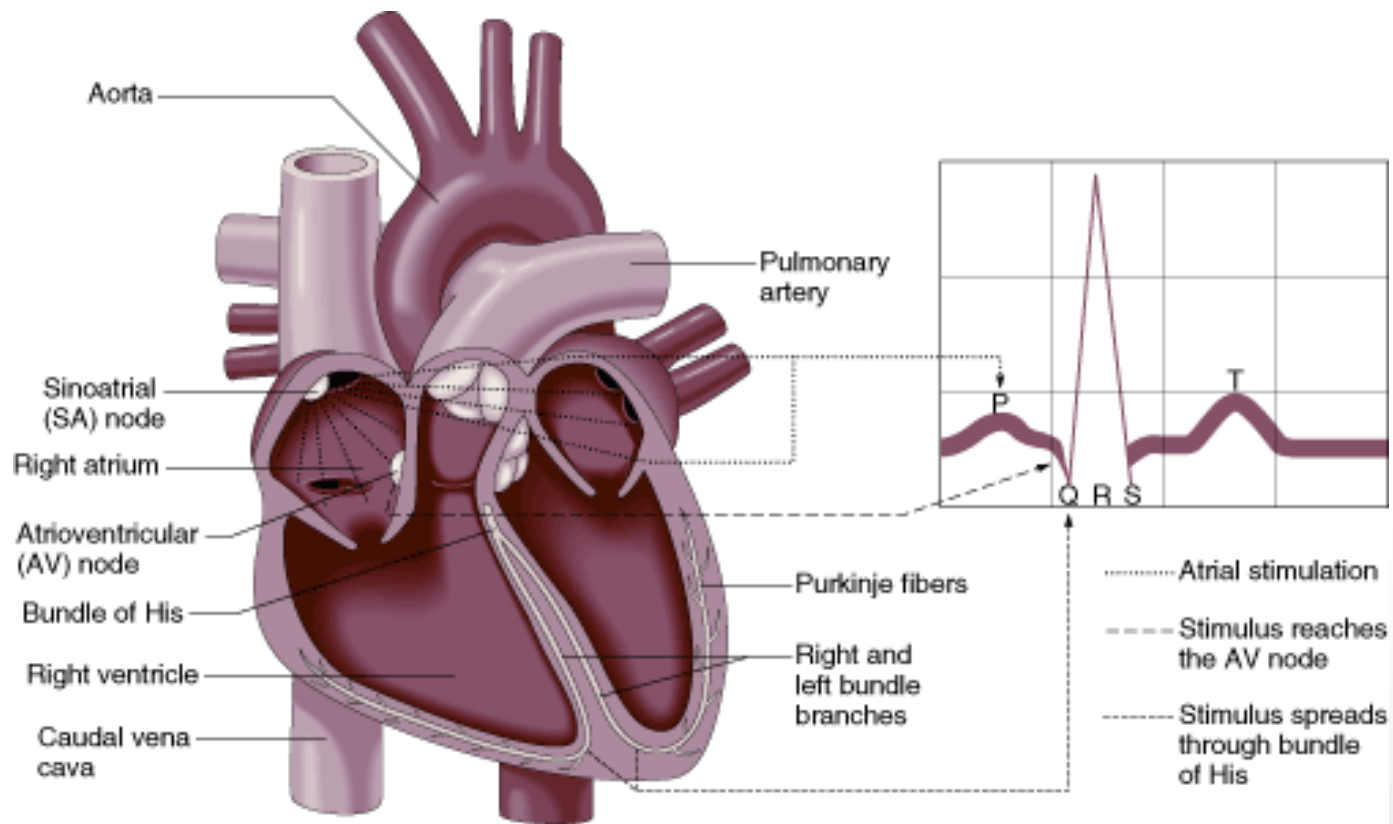
# The Conduction System of the Heart

- Sinoatrial node (SA node) is located in the right atrial wall and initiates the heart rhythm
  - is termed the pacemaker of the heart
- Atrioventricular node (AV node) is located in the interatrial septum and receives impulses from the SA node
  - sends impulses to the bundle of His



# The Conduction System of the Heart

- The bundle of His is located within the interventricular septum and continues through the ventricle as the ventricular Purkinje fibers
  - Purkinje fibers carry impulses through the ventricular muscle causing the ventricles to contract



# Heart Rate Terms

- Systole: contraction
  - asystole = without contraction
- Diastole: relaxation
- Arrhythmia: abnormal heart rhythm (also known as dysrhythmia)
- Bradycardia: abnormally slow heartbeat
- Tachycardia: abnormally fast heartbeat

# Electrocardiography

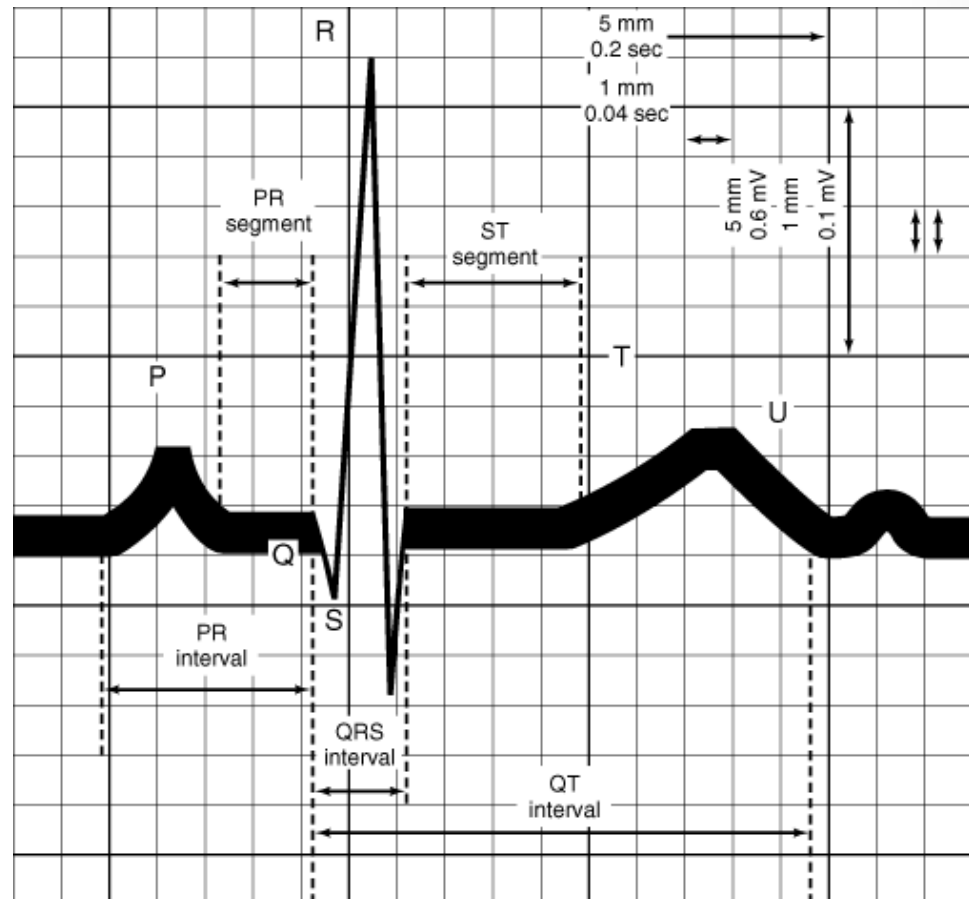
- An electrocardiogram (ECG or EKG) is the record of the electrical activity of the myocardium
  - ECG or EKG is a tracing that shows the changes in voltage and polarity of the heart over time
- Electrocardiography is the process of recording electrical activity of the heart





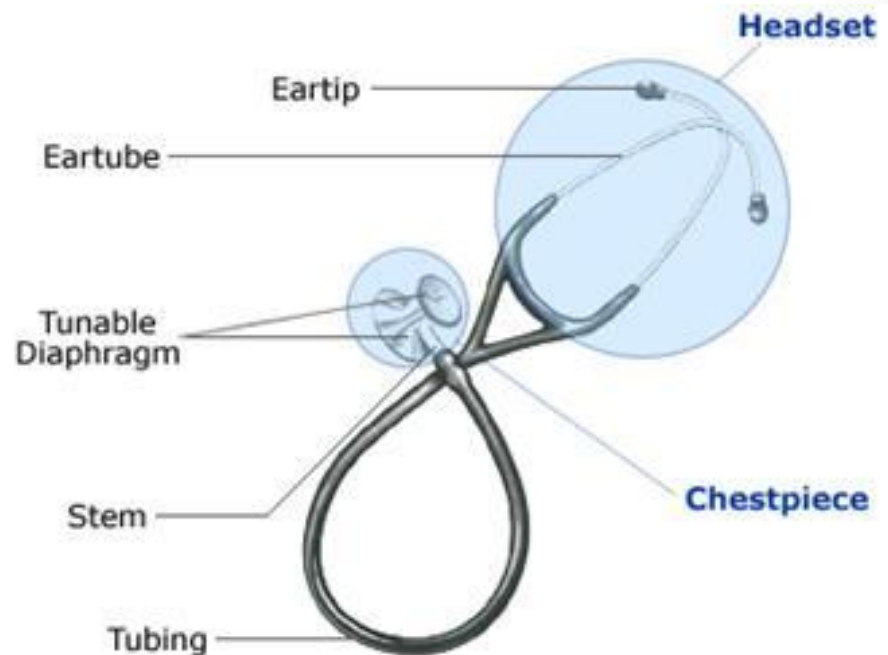
# Electrocardiography

- The electrical activity of the heart can be visualized as wave movements on the ECG or EKG
  - P wave = depolarization (excitation) of the atria
  - QRS complex = depolarization (excitation) of the ventricles
  - T wave = repolarization (recovery) of the ventricles



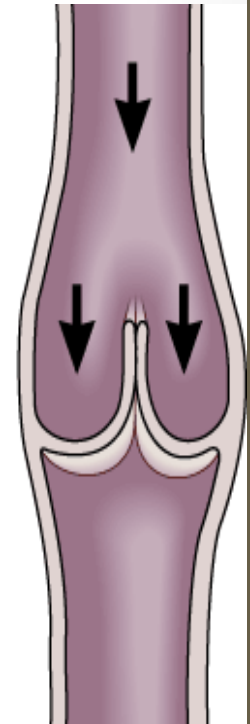
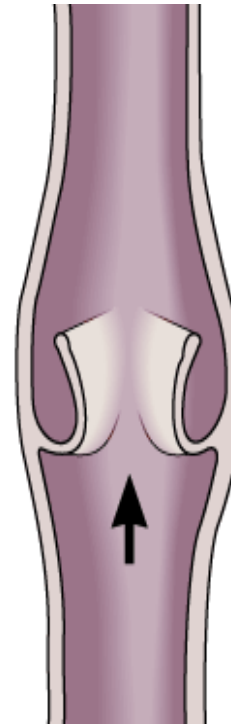
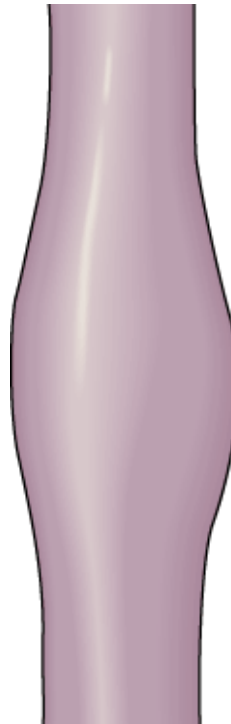
# Heart Sounds

- Auscultation is listening to body sounds with a stethoscope
- When auscultating the heart, a lubb/dubb sound heard
  - lubb = closing of the atrioventricular valves
  - dubb = closing of the semilunar valves
  - murmur = abnormal sound associated with turbulent blood flow



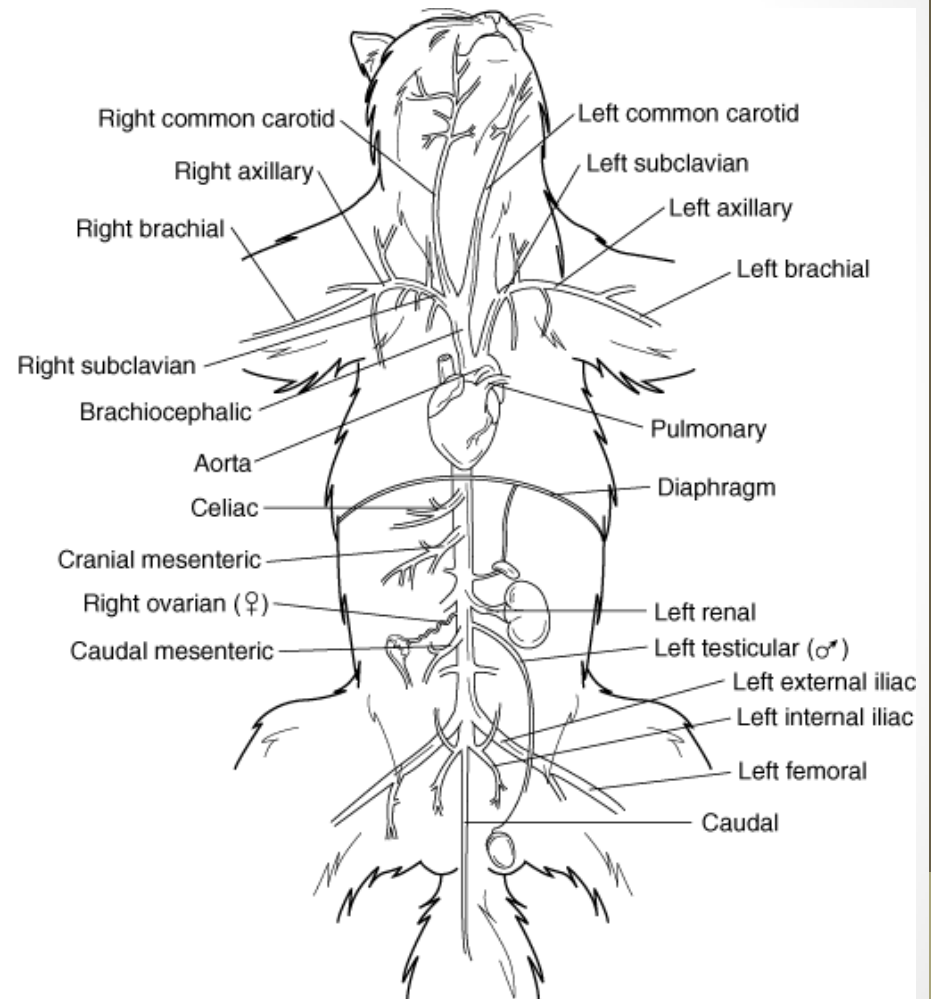
# Blood Vessels

- There are three major types of blood vessels in animals
  - arteries
  - capillaries
  - veins
- The lumen is the opening within these vessels through which the blood flows
  - Constriction is narrowing of the lumen
  - Dilation is widening of the lumen



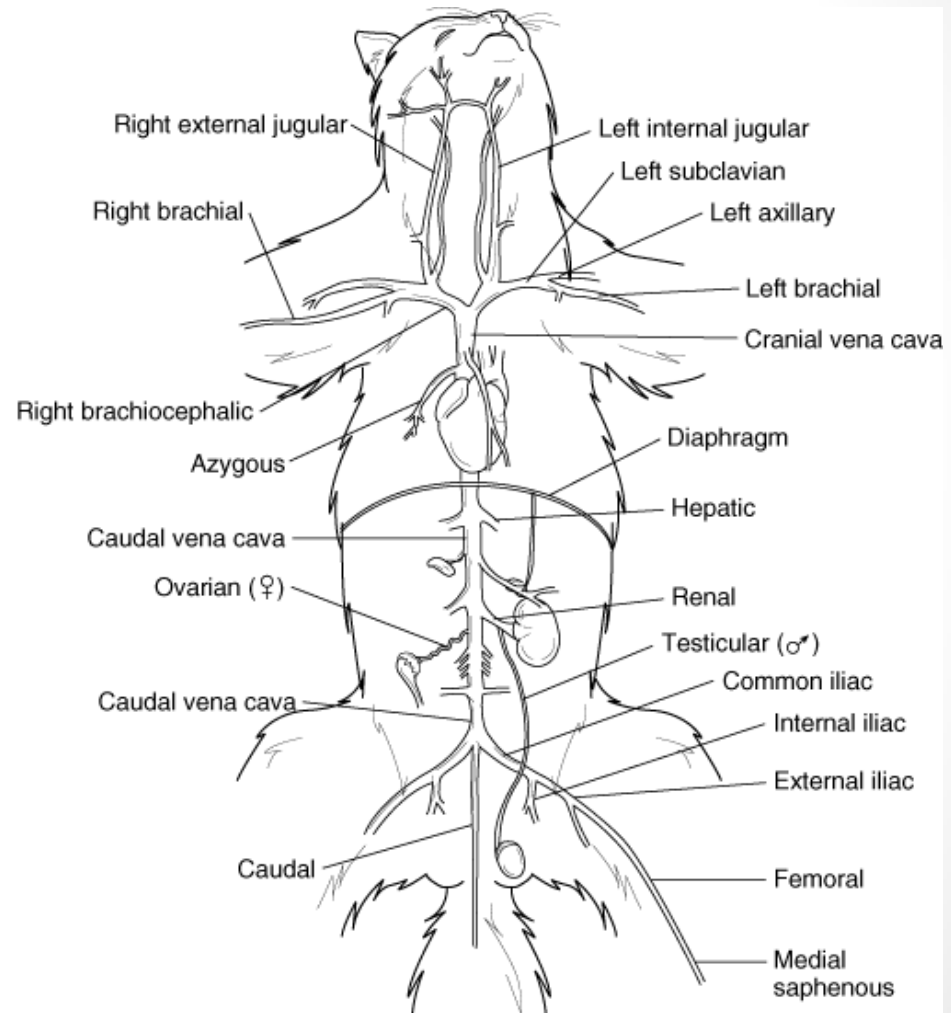
# Blood Vessels

- Combining forms for a vessel are angi/o and vas/o
- Arteries are blood vessels that carry blood away from the heart
  - Combining form is arteri/o
  - Smaller arteries are arterioles



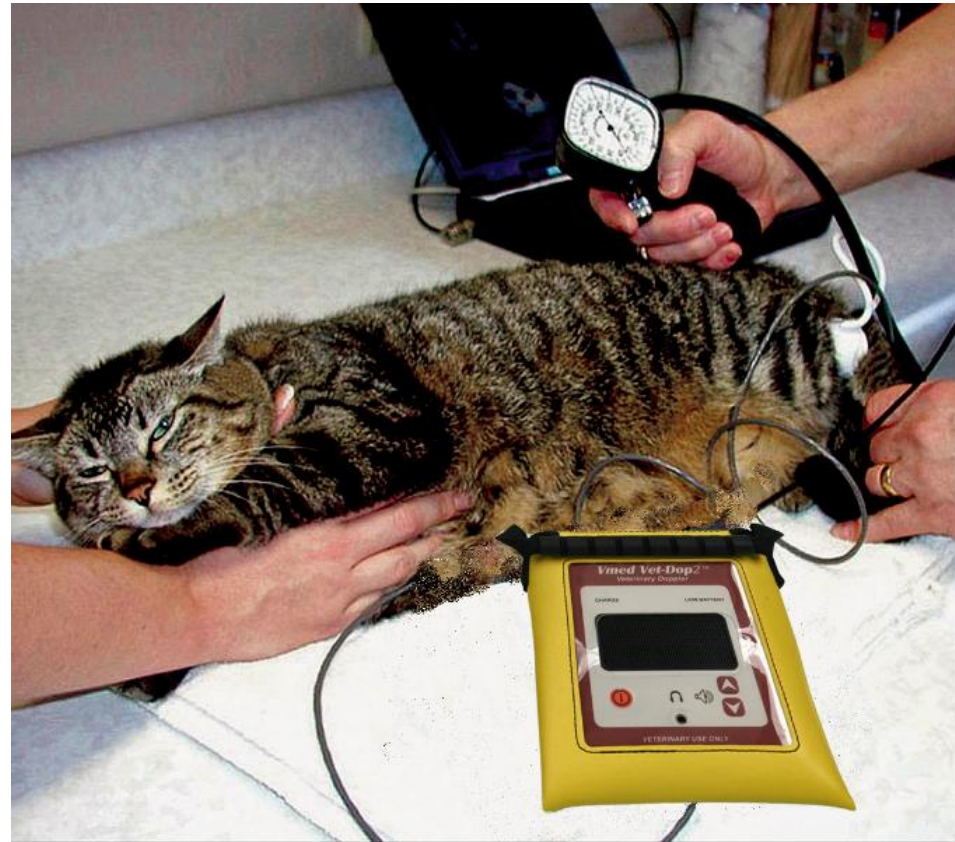
# Blood Vessels

- Capillaries are single-cell thick vessels that connect the arterial and venous systems
- Veins are blood vessels that carry blood toward the heart
  - Combining forms for vein are ven/o and phleb/o



# Blood Pressure

- Blood pressure is the tension exerted by blood on the arterial walls
  - The combining form for pressure or tension is tensi/o
- A pulse is the rhythmic expansion and contraction of an artery produced by pressure
- Blood pressure is measured by a sphygmomanometer





# CIRCULATORY SYSTEM

- 4-chambered Heart - necessary to pump blood rapidly through vessels to meet high metabolic demands.
- Bird hearts are 50-100% larger than hearts of mammals of similar body size.
- Resting heart rates of birds are generally lower than those of similar-sized mammals; birds have higher stroke volume (amount of blood pumped per heart beat) than similar-sized mammals, so total cardiac output (amount of blood pumped per time) is generally similar.

# Bird Hearts (cont.)

- Blood pressure is generally somewhat higher in birds than in mammals.
- Bird heart also differs from mammal heart in that the left ventricle pumps blood to the body via the right systemic arch (left arch drops out during embryonic development); in mammals the left systemic arch persists and the right drops out.

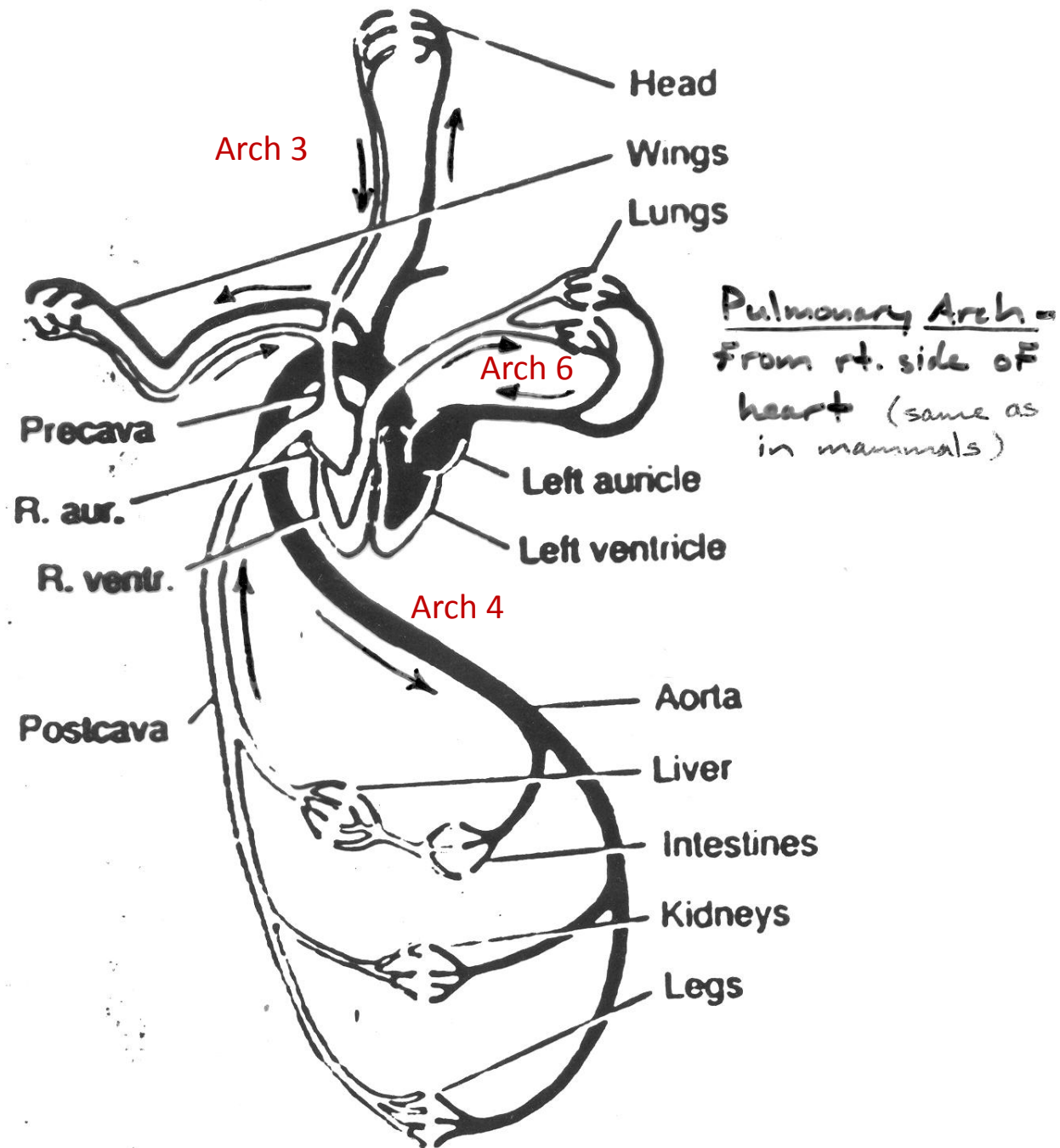
# Blood Vessels

- Similar pattern to mammals and reptiles
- Aortic Arches - 6 in early embryo; 1, 2, & 5 drop out.
  - #3 → Carotid Arteries to head
  - #4 → Only right 4th persists as systemic arch
  - #6 → Pulmonary arteries
- Large brachial and pectoral arteries which supply blood to flight musculature

# Blood Vessels

- Renal Portal Vein persists (present in jawed fish, amphibians, reptiles, but drops out in mammals).
- These veins drain the posterior part of the body trunk and enter the capillary bed surrounding the kidney tubules.
- Plays a role in reabsorption of fluid from kidney tubule.

## General Pattern of Avian Circulation



# Bird Blood

- Consists of plasma and formed elements (cells)
- Plasma = 80% water, 0.9% NaCl, glucose concentration is 2X higher than in mammals (adaptive for support of high metabolic rates).
- RBCs = nucleated as in all vertebrates except mammals
  - Hematocrit (packed cell volume) averages about 40% but varies among species, sexes, seasons, altitude, etc. - **generally higher when energy demands are higher.**
  - *Dark-eyed Juncos*: Hc = 47% in summer, 53% in winter





# Bird Blood

- Hemoglobin concentration lower (slightly) than in mammals; oxygen affinity (how tightly oxygen is bound) is generally lower in birds than in similar-sized mammals, and this enhances unloading of oxygen to tissues.
- WBCs = main function is defense against foreign pathogens, immune response; similar types and functions to mammals.
- Thrombocytes = cells involved in clotting, functional analogues to mammalian platelets.

# Medical Terms

- **ACE inhibitor**
  - blocks the action of the enzyme that causes the blood vessels to contract resulting in hypertension
- **Anemia**
  - a lower than normal number of erythrocytes in the blood
- **Aneurysm**
  - a localized weak spot, or balloon-like enlargement, of the wall of an artery
- **Aneurysmectomy**
  - the surgical removal of an aneurysm
- **Angitis**
  - the inflammation of a blood or lymph vessel
- **Angina**
  - a condition of episodes of severe chest pain due to inadequate blood flow to the myocardium
- **Angiography**
  - a radiographic study of the blood vessels after the injection of a contrast medium
- **Angina**
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- **Angiostenosis**
  - the abnormal narrowing of a blood vessels
- **Anticoagulant**
  - slows coagulation and prevents new clots from forming
- **Aplastic anemia**
  - characterized by an absence of all formed blood elements caused by the failure of blood cell production in the bone marrow
- **Arrhythmia**
  - describes an abnormality, or the loss of the normal rhythm, of the heart
- **Arteriectomy**
  - the surgical removal of part of an artery

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- **Arteriectomy**
- the surgical removal of part of an artery
- **Angioplasty**
- a procedure in which a small balloon is used to open a partially blocked coronary artery by flattening the plaque deposit and stretching the lumen
- **Arteriosclerosis**
- any of a group of diseases characterized by thickening and the loss of elasticity of arterial walls

- **Artificial pacemaker**
- used primarily as treatment for bradycardia or atrial fibrillation
- **Aspirin**
- recommended to reduce the risk of a heart attack or stroke by slightly reducing the ability of the blood to clot
- **Atherosclerosis**
- hardening and narrowing of the arteries caused by a buildup of cholesterol plaque on the interior walls of the arteries
- **Atrial fibrillation**
- occurs when the normal rhythmic contractions of the atria are replaced by rapid irregular twitching of the muscular heart wall
- **Beta-blocker**
- reduces the workload of the heart by slowing the rate of the heart beat
- **Bradycardia**
- an abnormally slow resting heart rate

- **Cardiac arrest**
- an event in which the heart abruptly stops or develops a very abnormal arrhythmia that prevents it from pumping blood
- **Cardiomyopathy**
- the term used to describe all diseases of the heart muscle
- **Cardiopulmonary resuscitation**
- an emergency procedure for life support consisting of artificial respiration and manual external cardiac compression
- **Carditis**
- an inflammation of the heart
- **Congenital heart defects**
- structural abnormalities caused by the failure of the heart to develop normally before birth
- **Coronary thrombosis**
- damage to the heart muscle caused by a thrombus blocking a coronary artery
- **Defibrillation**
- the use of electrical shock to restore the heart's normal rhythm

- **Digitalis**
- strengthens the contraction of the heart muscle, slows the heart rate, and helps eliminate fluid from body tissues
- **Embolism**
- the sudden blockage of a blood vessel by an embolus
- **Hemorrhage**
- the loss of a large amount of blood in a short time
- **Hemostasis**
- to stop or control bleeding
- **Hyperlipidemia**
- the general term used to describe elevated levels of cholesterol and other fatty substances in the blood
- **Hypertension**
- the elevation of arterial blood pressure to a level that is likely to cause damage to the cardiovascular system
- **Hypotension**
- lower than normal arterial blood pressure

- **Ischemia**
- a condition in which there is an insufficient oxygen supply due to a restricted blood flow to a part of the body
- **Ischemic heart disease**
- a group of cardiac disabilities resulting from an insufficient supply of oxygenated blood to the heart
- **Leukemia**
- a type of cancer characterized by a progressive increase in the number of abnormal leukocytes found in blood forming tissues, other organs, and in the circulating blood
- **Leukopenia**
- describes any situation in which the total number of leukocytes in the circulating blood is less than normal
- **Myocardial infarction**
- the occlusion of one or more coronary arteries caused by plaque buildup (heart attack)
- **Myocarditis**
- an inflammation of the myocardium

- **Nitroglycerin**
- a vasodilator that is prescribed to prevent or relieve the pain of angina by dilating the blood vessels to the heart
- **Palpitation**
- a pounding or racing heart with or without irregularity in rhythm
- 
- **Pericarditis**
- an inflammation of the pericardium that causes an accumulation of fluid within the pericardial sac
- 
- **Phlebitis**
- the inflammation of a vein
- 
- **Plaque**
- a fatty deposit that is similar to the buildup of rust inside a pipe
- 
- **Plasma**
- a straw-colored fluid that contains nutrients, hormones, and waste products
- **Polycythemia**
- an abnormal increase in the number of red cells in the blood due to excess production of these cells by the bone marrow

- **Stent**
- a wire-mesh tube that is commonly placed after the artery has been opened
- **Systolic pressure**
- occurs when the ventricles contract; the highest pressure against the walls of an artery
- **Tachycardia**
- an abnormally rapid resting heart rate
- **Thrombosis**
- the abnormal condition of having a thrombus
- **Thrombus**
- a blood clot attached to the interior wall of an artery or vein
- **Valvoplasty**
- the surgical repair or replacement of a heart valve
- **Valvulitis**
- an inflammation of a heart valve
- **Varicose veins**
- abnormally swollen veins, usually occurring in the superficial veins of the legs
- **Vasoconstrictor**
- causes blood vessels to narrow
- **Vasodilator**
- causes blood vessels to expand
- **Ventricular fibrillation**
- the rapid, irregular, and useless contractions of the ventricles
- **ventricular tachycardia**
- a very rapid heartbeat that begins within the ventricles