Ch13 – Cardiovascular System

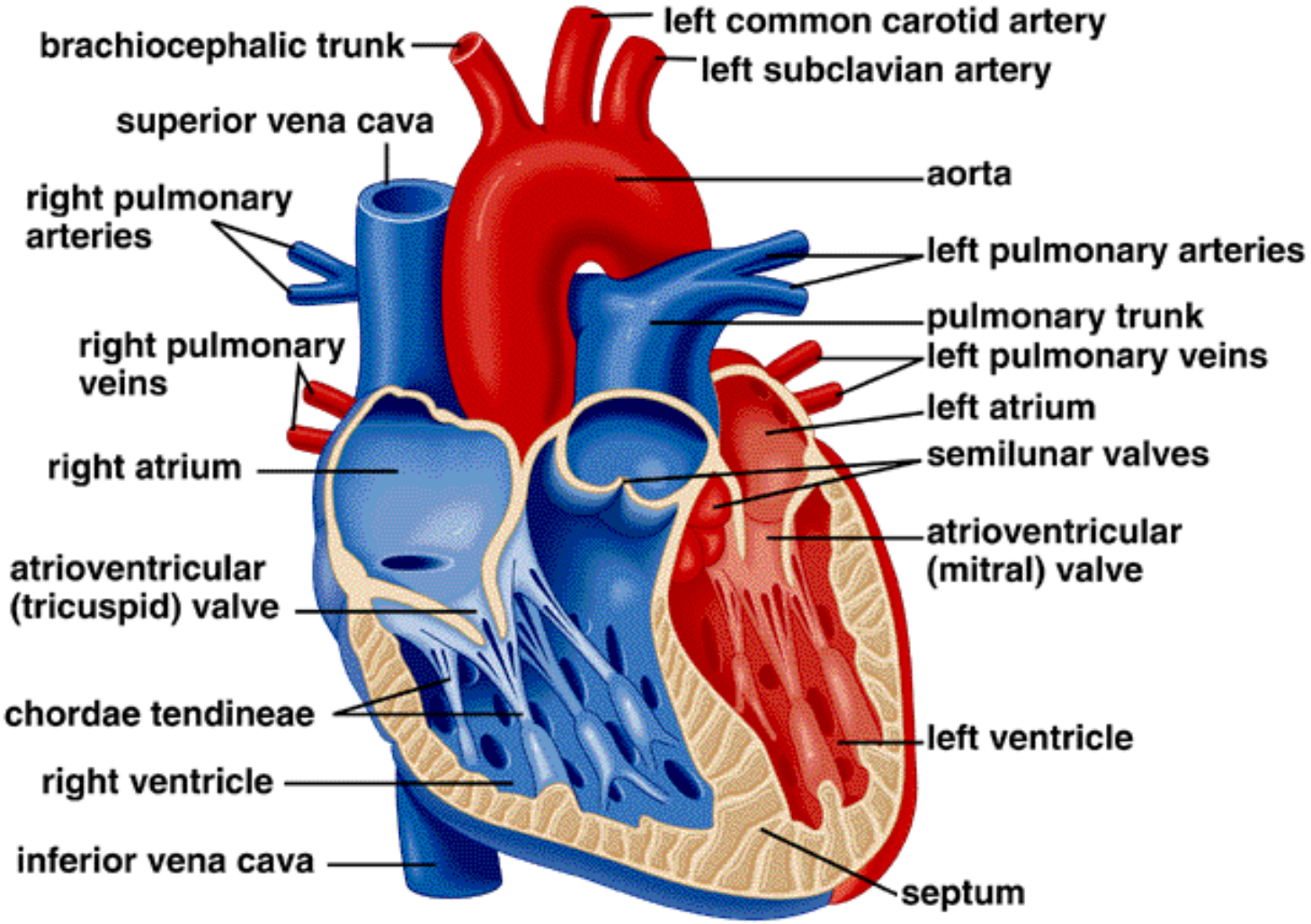
Cardiovascular system = circulatory system

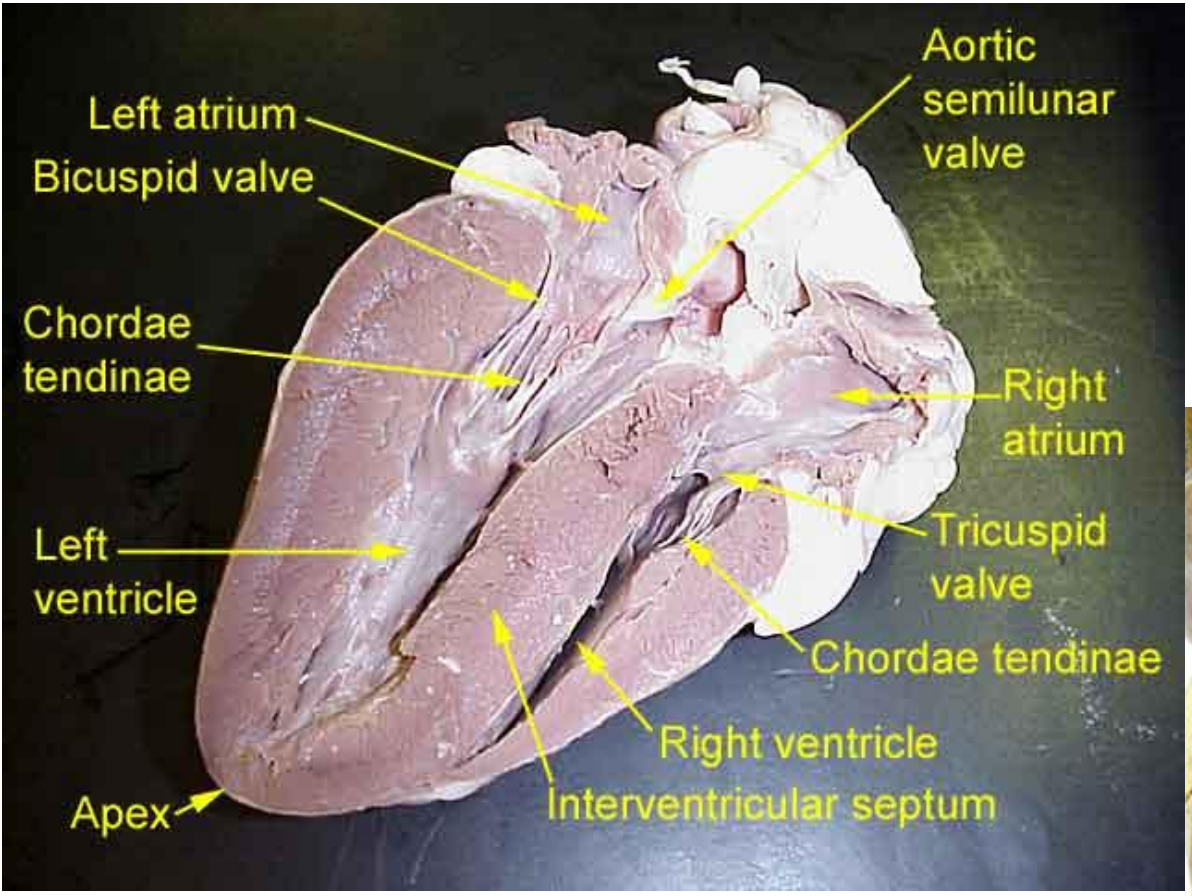
- Function: transportation to and from cells
- Structure: Heart, blood vessels, and blood

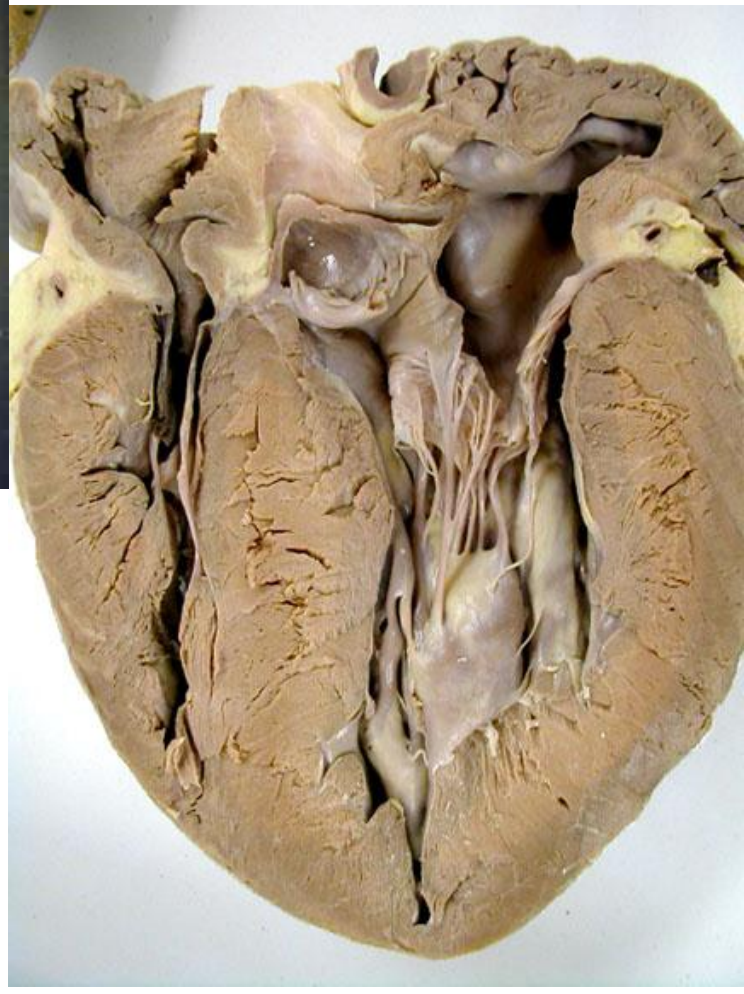
Heart Anatomy

- Size: person's fist
- Location: within thorax and medial to lungs
- Parts:
  - Apex (pointed part of heart that rests on diaphragm)
  - Base (posterosuperior aspect of heart)
- Chambers:
  - Atria (atrium) – receiving chambers
  - Interatrial septum – separates artia
  - Ventricles – discharging, contracting chambers
  - Interventricular septum – separates ventricles

Internal View of Heart




Left atrium
Bicuspid valve
Aortic semilunar valve
Chordae tendinae
Right atrium
Left ventricle
Tricuspid valve
Chordae tendinae
Right ventricle
Interventricular septum
Apex



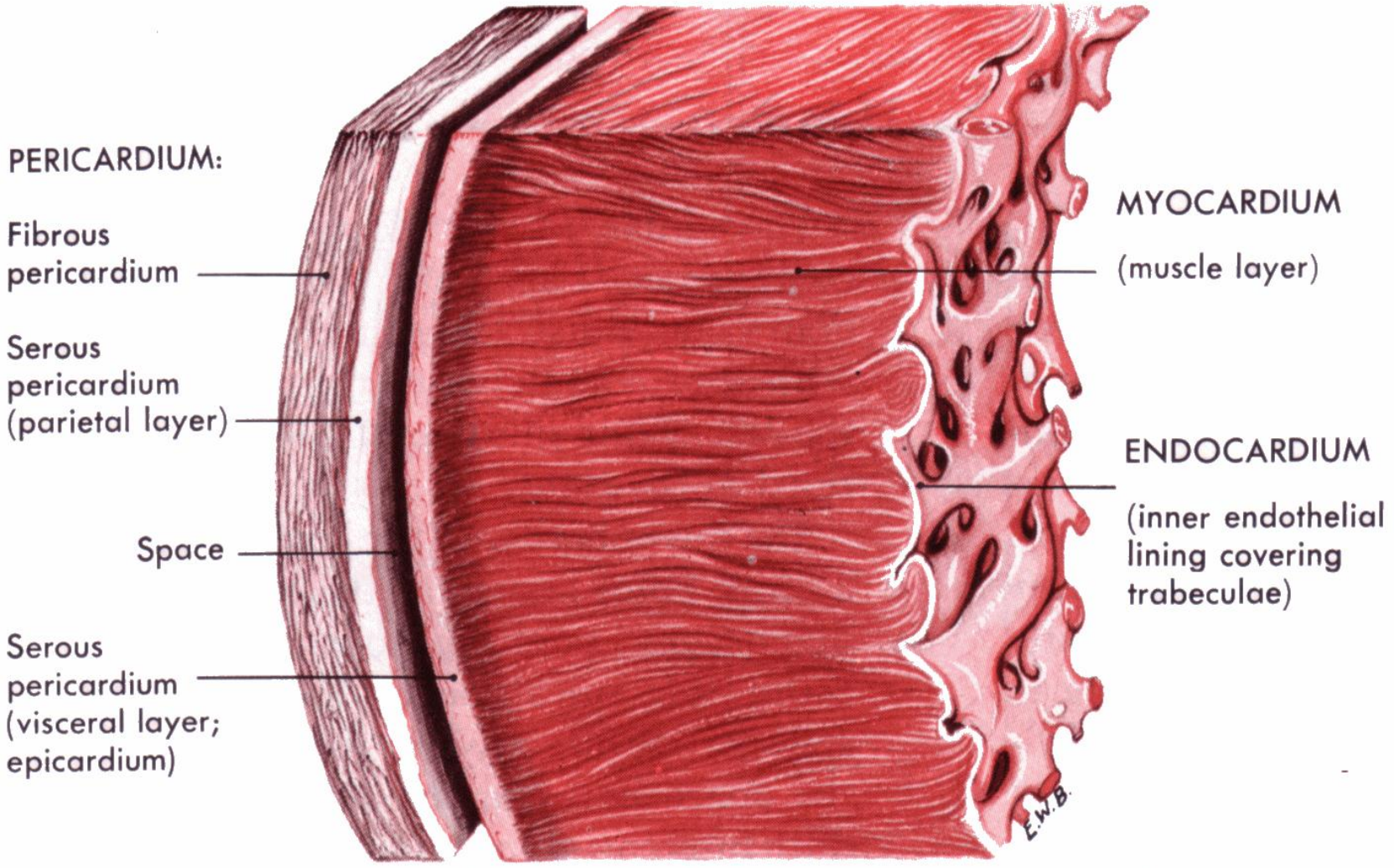
Videos

- How the heart works
- Heart Song
- Beating Heart
- Heart Bypass Surgery

Heart Anatomy

- Serous Membranes:
  - Visceral Pericardium (epicardium) – touches external surface of heart
  - Parietal Pericardium – attaches to surrounding cavity

- Heart Walls:
  - Epicardium – outer layer of heart
  - Myocardium – layer that is made up of muscle and contracts
  - Endocardium - inner layer that lines chambers of heart and is continuous with walls of blood vessels



Section of the heart wall showing the components of the outer pericardium (heart sac), muscle layer (myocardium), and inner lining (endocardium).

Blood Vessel Anatomy

- Layers (outside to inside): tunica externa, tunica media (smooth muscle), tunica interna

- Arteries
  - Function: carries blood away from the heart
  - Structure: has large layer of smooth muscle to withstand high pressures and lacks valves

Blood Vessel Anatomy

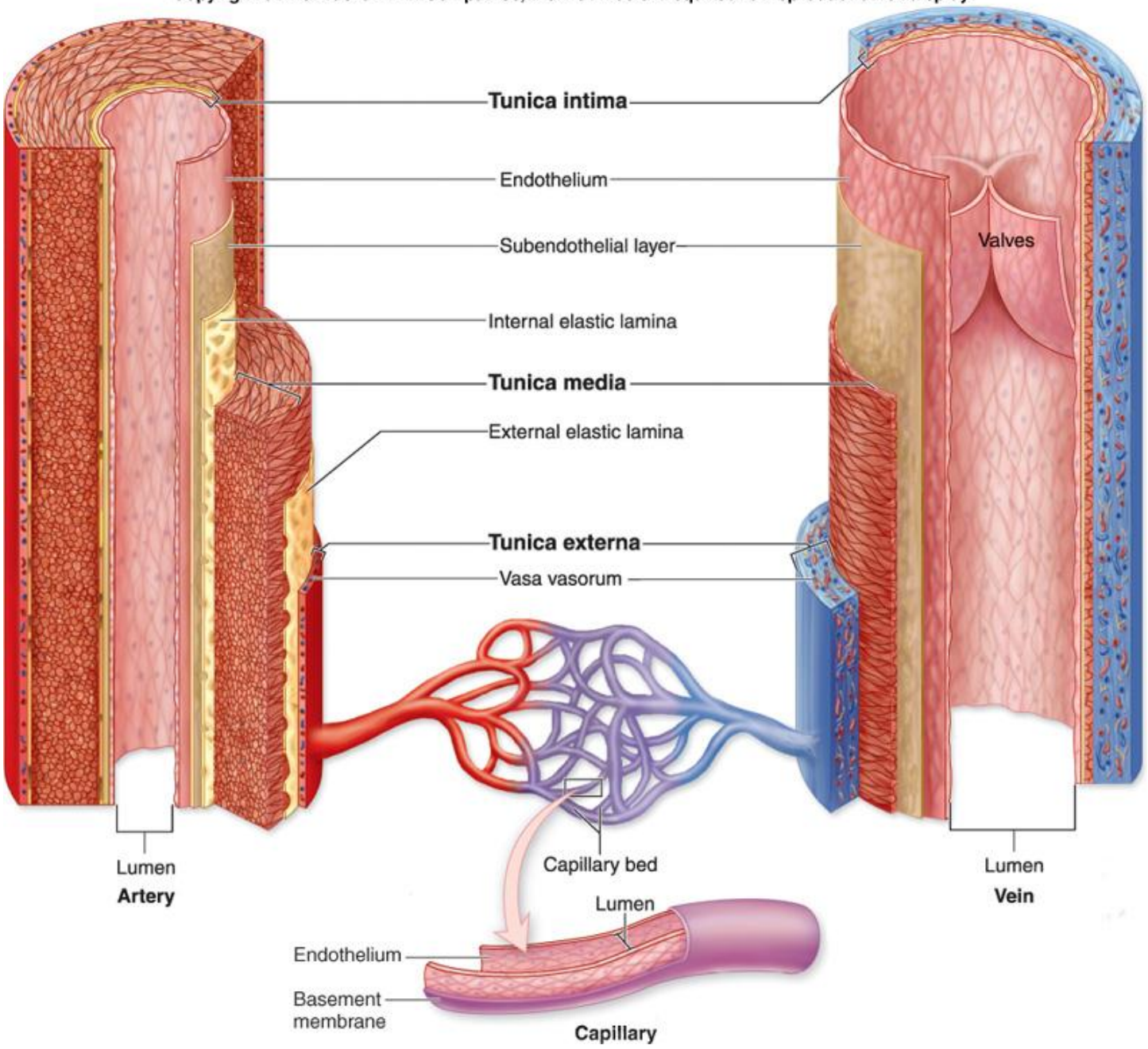
- Arterioles
  - Smaller and thinner than arteries

- Capillaries
  - Function: site of gas exchange from blood to body cells
  - Structure: smallest diameter blood vessel, one cell layer thick, large surface area because they are the most numerous blood vessel

Blood Vessel Anatomy

- Venules
  - Smaller and thinner than veins

- Veins
  - Function: carries blood towards the heart
  - Structure: thin layer of smooth muscle because they are low pressure vessels, contains valves for movement back to heart,
  - Skeletal muscle contractions help with venous return



Heart is a Double Pump

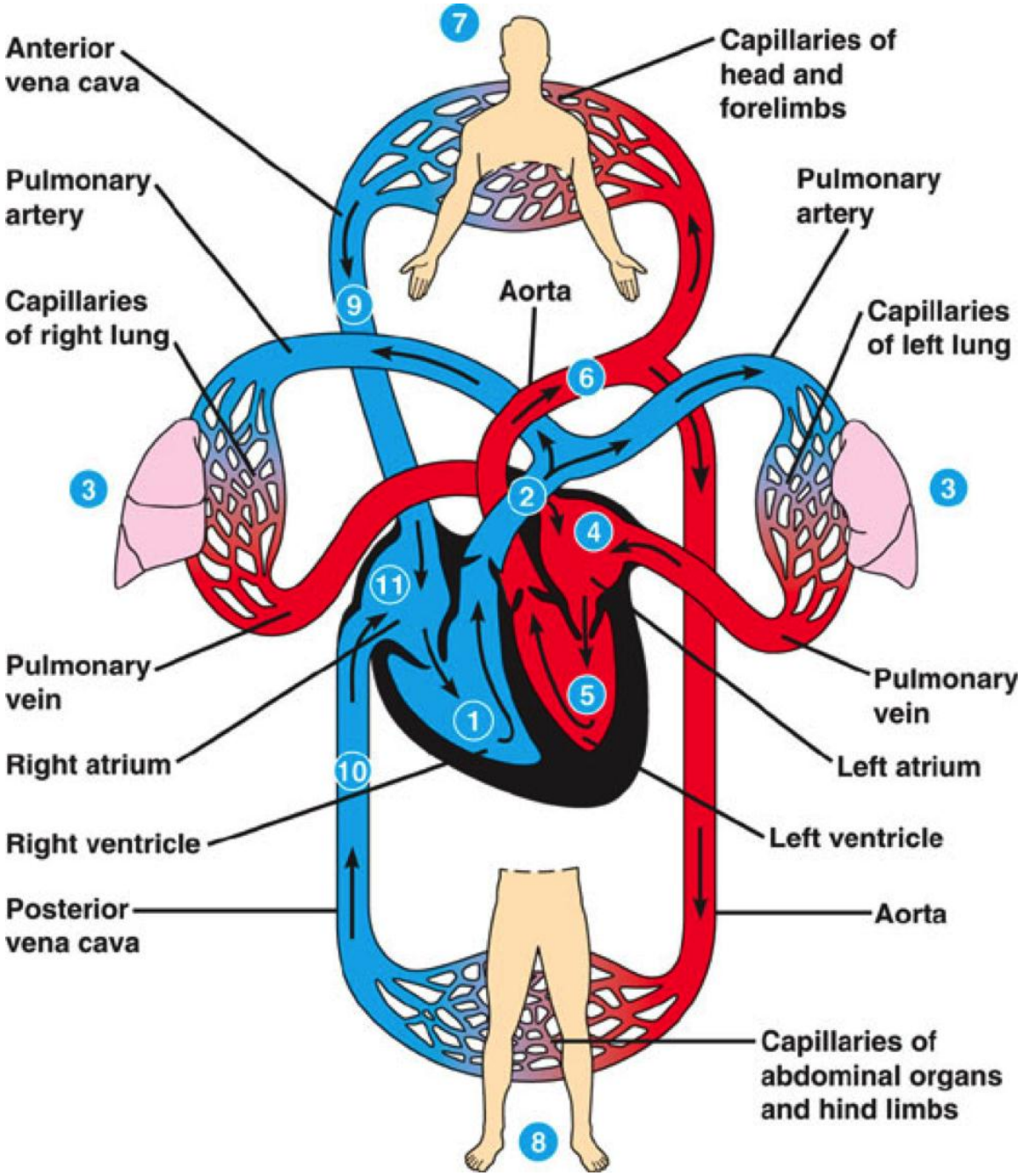
Pulmonary Circuit Steps

- Right side of heart works as pulmonary (lung) circuit pump
- Right atria receives oxygen poor blood from superior and inferior vena cava
- Blood spills into right ventricle and atria contracts
- Blood is pumped out through the right and left pulmonary arteries, then through arterioles
- Blood is carried to the capillaries of the lungs where they receive oxygen and unload carbon dioxide
- Oxygen rich blood drains into venules and then to the left atria through the pulmonary veins

Heart is a Double Pump

Systemic Circulation Steps

- Left atria receives oxygen rich blood from the lungs
- Blood spills into the left ventricle and atria contracts
- Blood is pumped out through the aorta when the ventricle contracts
- Blood travels from aorta to a series of smaller arteries, then to arterioles
- When arterioles reach the outermost tissues of the body they form capillaries
- Capillaries connect arteries (arterioles) and veins (venules) and this is where oxygen is released from the blood
- Venules and then veins carry oxygen poor blood from the bodies tissues back to the heart through the superior and inferior vena cava


7
Anterior vena cava
Capillaries of head and forelimbs
Pulmonary artery
Pulmonary artery
Capillaries of right lung
Aorta
Capillaries of left lung
9
6
3
2
3
4
11
Pulmonary vein
5
Pulmonary vein
1
Right atrium
Left atrium
10
Right ventricle
Left ventricle
Posterior vena cava
Aorta
Capillaries of abdominal organs and hind limbs
8

Four Valves of Heart

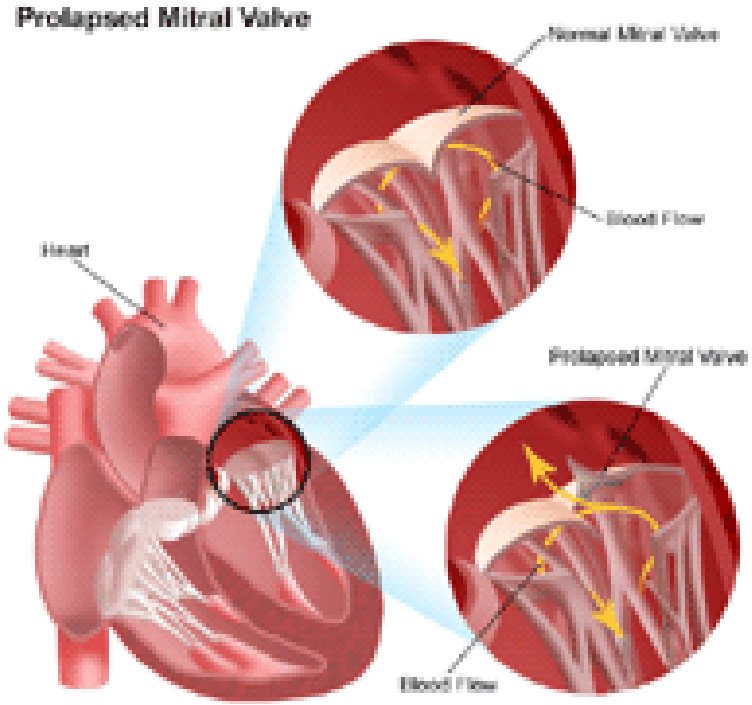
- Allows blood to flow in only one direction through the heart

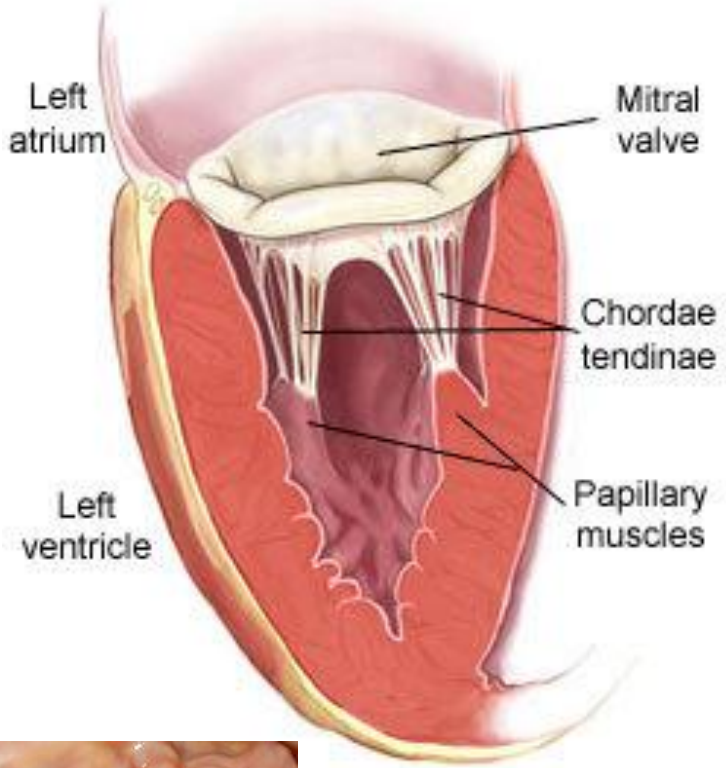
- Atrioventricular (AV) valves – between atria and ventricle on each side
  - Prevent backflow into atria when ventricles contract
  - Left AV valve – bicuspid (mitral) valve
    - 2 flaps of endocardium
  - Right AV valve – tricuspid valve
    - 3 flaps

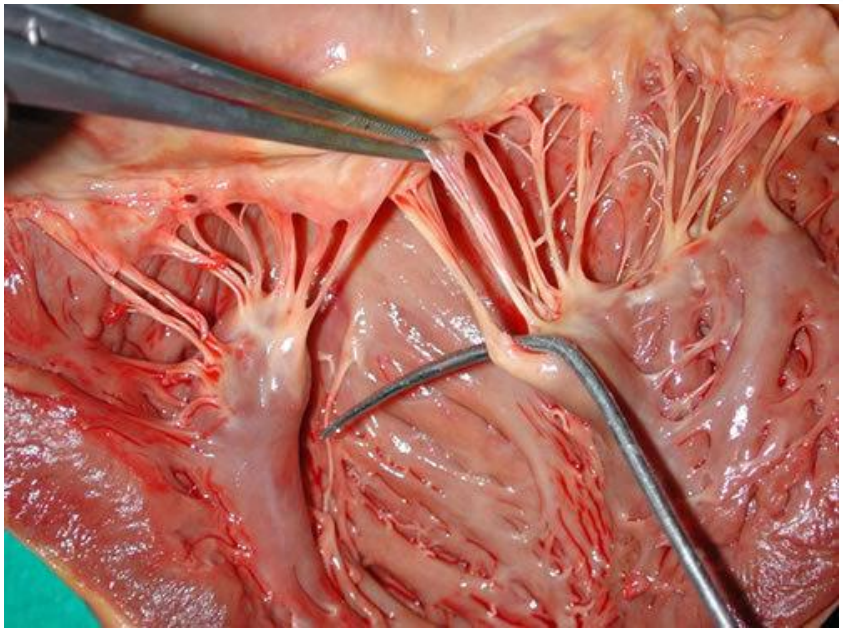
- Chordae tendineae – “heart strings”
  - Anchor cusps or flaps to walls of ventricles
  - Tighten when valve closes

- Semilunar valves – guards bases of two large arteries leaving ventricular chambers
  - Pulmonary and Aortic semilunar valves
  - 3 cusps or flaps
  - Open when ventricles contract and close when ventricles relax to prevent backflow into the heart

- Difference between valves
  - AV valves open during heart relaxation and semilunar are closed curing relaxation


Prolapsed Mitral Valve
Normal Mitral Valve
Blood Flow
Heart
Prolapsed Mitral Valve
Blood Flow


Left atrium
Mitral valve
Chordae tendinae
Papillary muscles
Left ventricle



Disorders

- Angina pectoris – chest pain
  - Heart beats at a rapid rate, myocardium does not receive adequate supply of oxygen
  - Heart cells can become deprived of oxygen resulting in a crushing chest pain
- Angina pectoris can lead to a myocardial infarction (heart attack or coronary) – part of cardiac muscle dies off and no longer functions

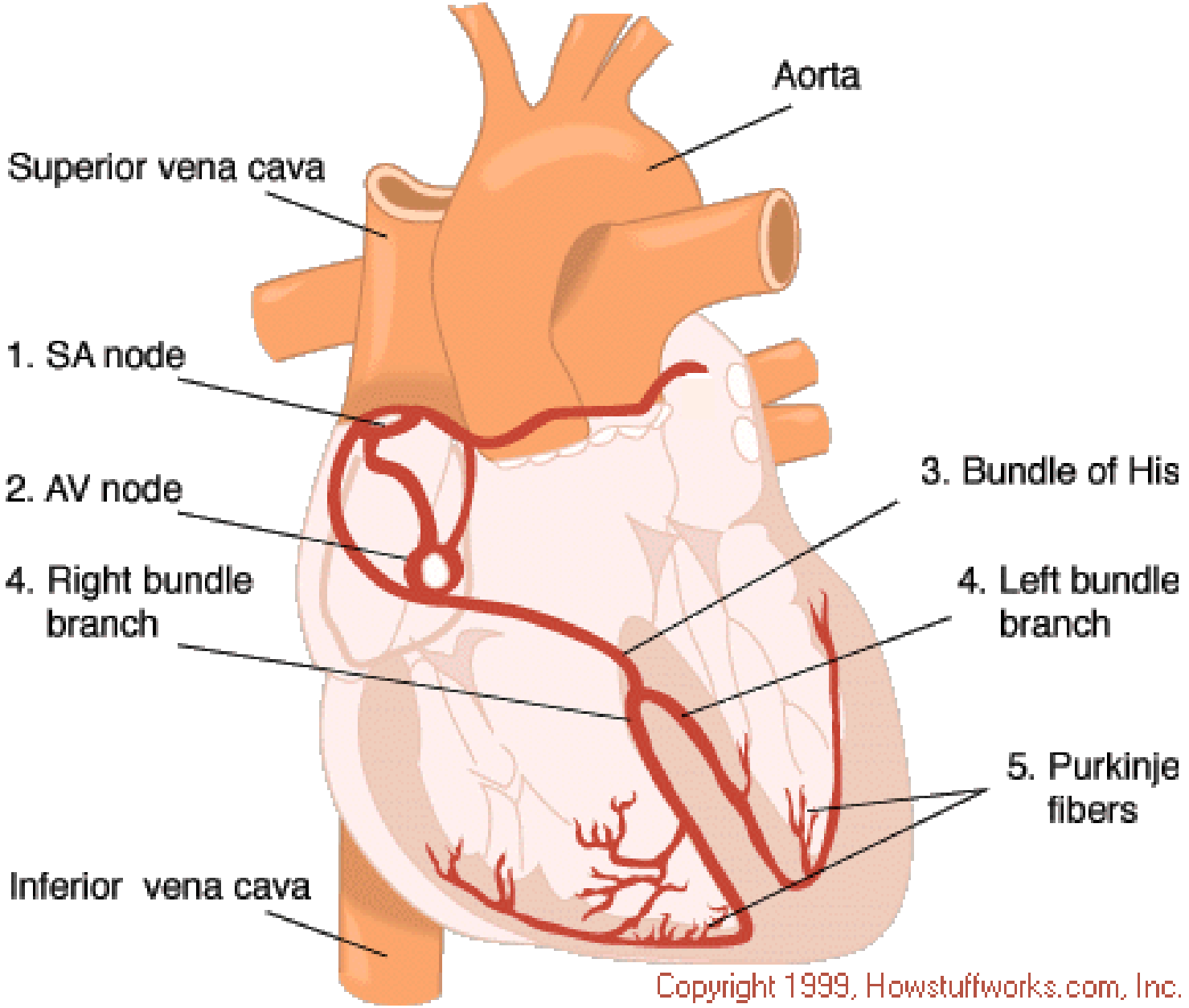
Physiology of the Heart

- Conduction System = pathway that electrical signals take to stimulate the contraction of the cardiac muscle
  - Contract spontaneously and independently

- Two types of controlling systems
  - Autonomic nervous system – acts as the brakes and accelerators to increase or decrease the heart rate
  - Intrinsic conduction system – built into the heart tissue

Intrinsic conduction system

- Sinoatrial node (SA) – located in right atrium
  - Pacemaker – starts each heartbeat
  - Sends signal to AV node and to left atrium
- Atrioventricular node (AV) – located at junction between of the atria and ventricles
- Atrioventricular bundle (bundle of His) – located in Interventricular septum
- Purkinji fibers – located within in the muscle of the ventricle walls


Aorta
Superior vena cava
1. SA node
2. AV node
4. Right bundle branch
3. Bundle of His
4. Left bundle branch
5. Purkinje fibers
Inferior vena cava
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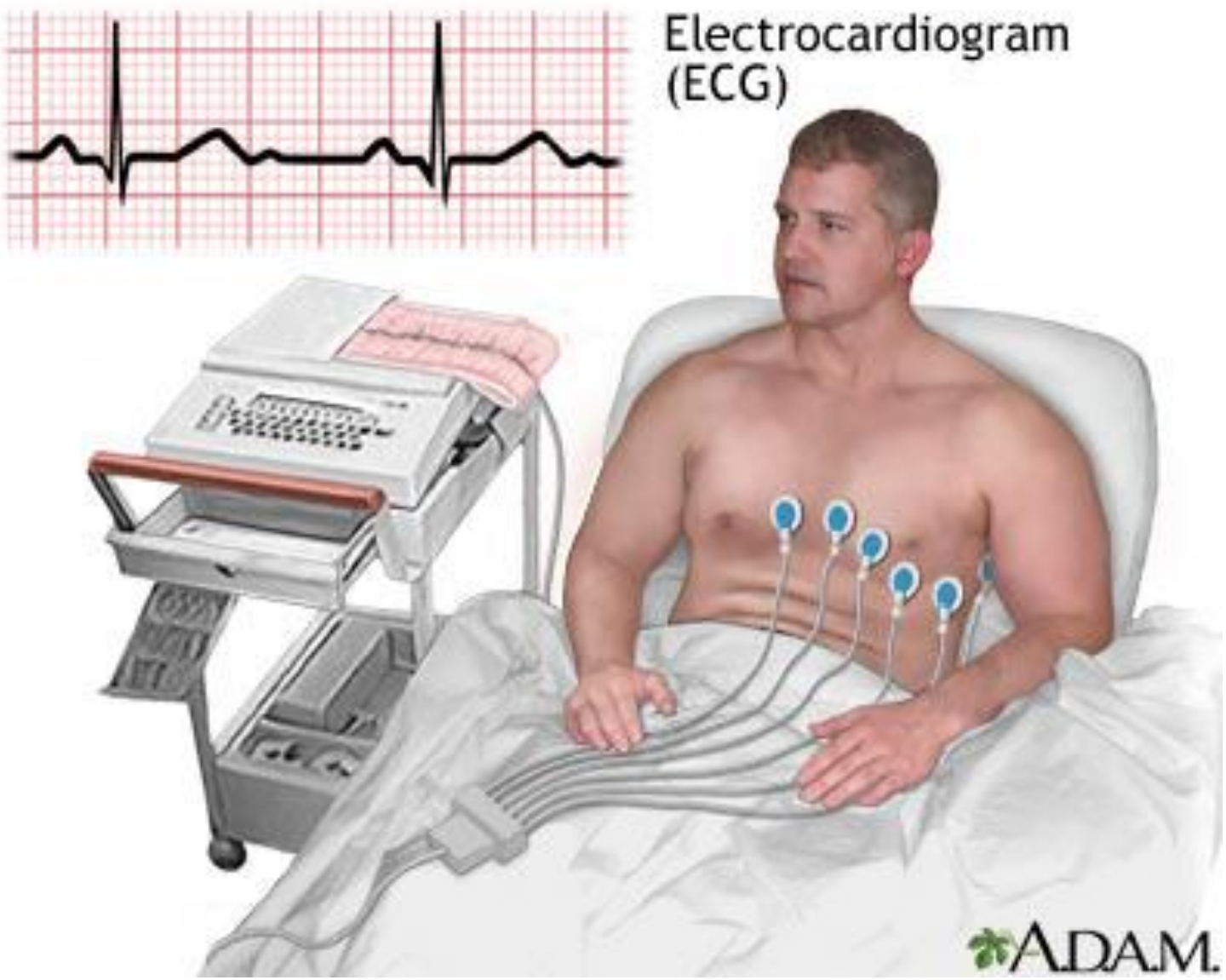
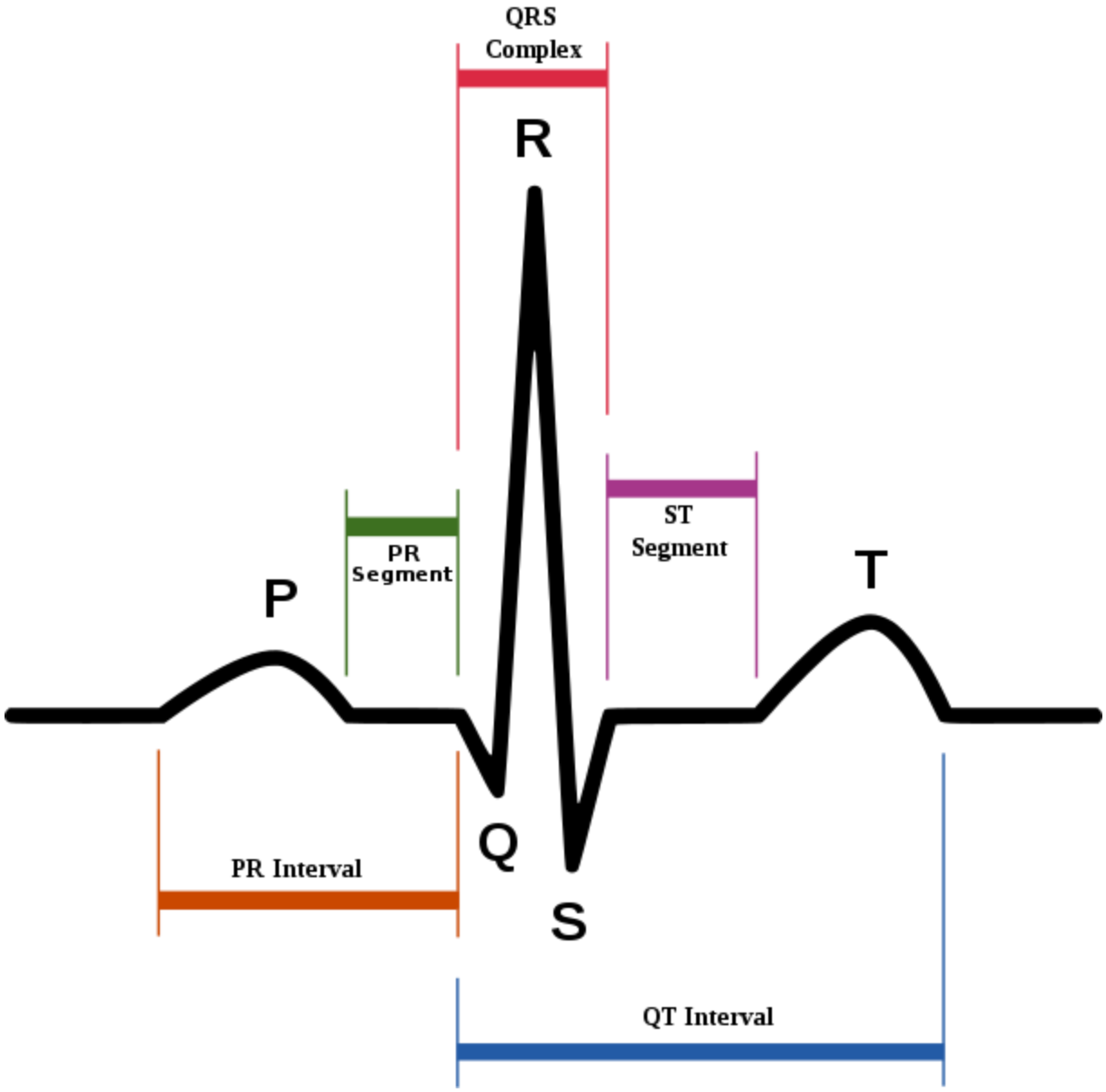
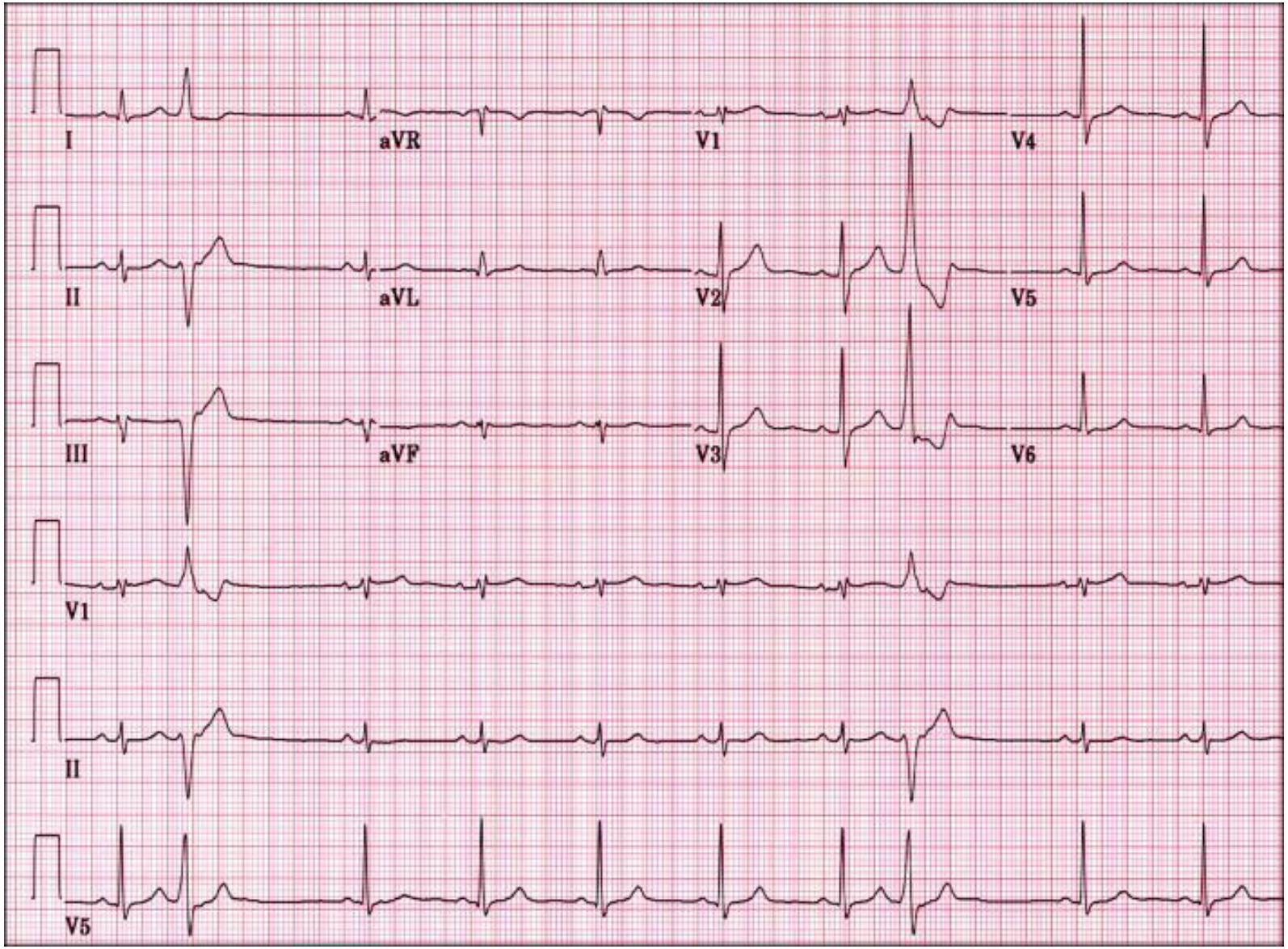
Intrinsic conduction system

- Electrocardiography – clinical procedure for mapping the electrical signal of the heart
  - P wave – atrial depolarization
  - QRS complex – ventricular depolarization and atrial repolarization (hidden by big wave)
  - T wave – ventricular repolarization


Electrocardiogram
(ECG)
A.D.A.M.


QRS
Complex
R
PR
Segment
ST
Segment
P
T
Q
S
PR Interval
QT Interval


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5

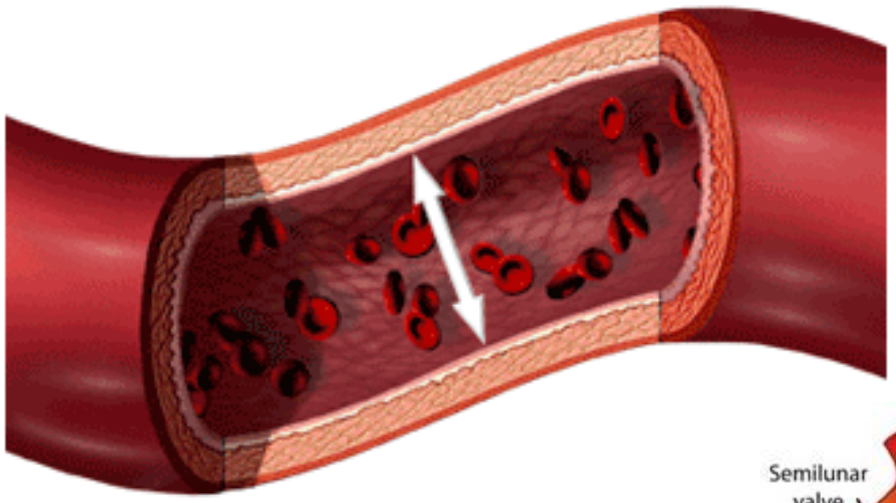
Cardiac Cycle

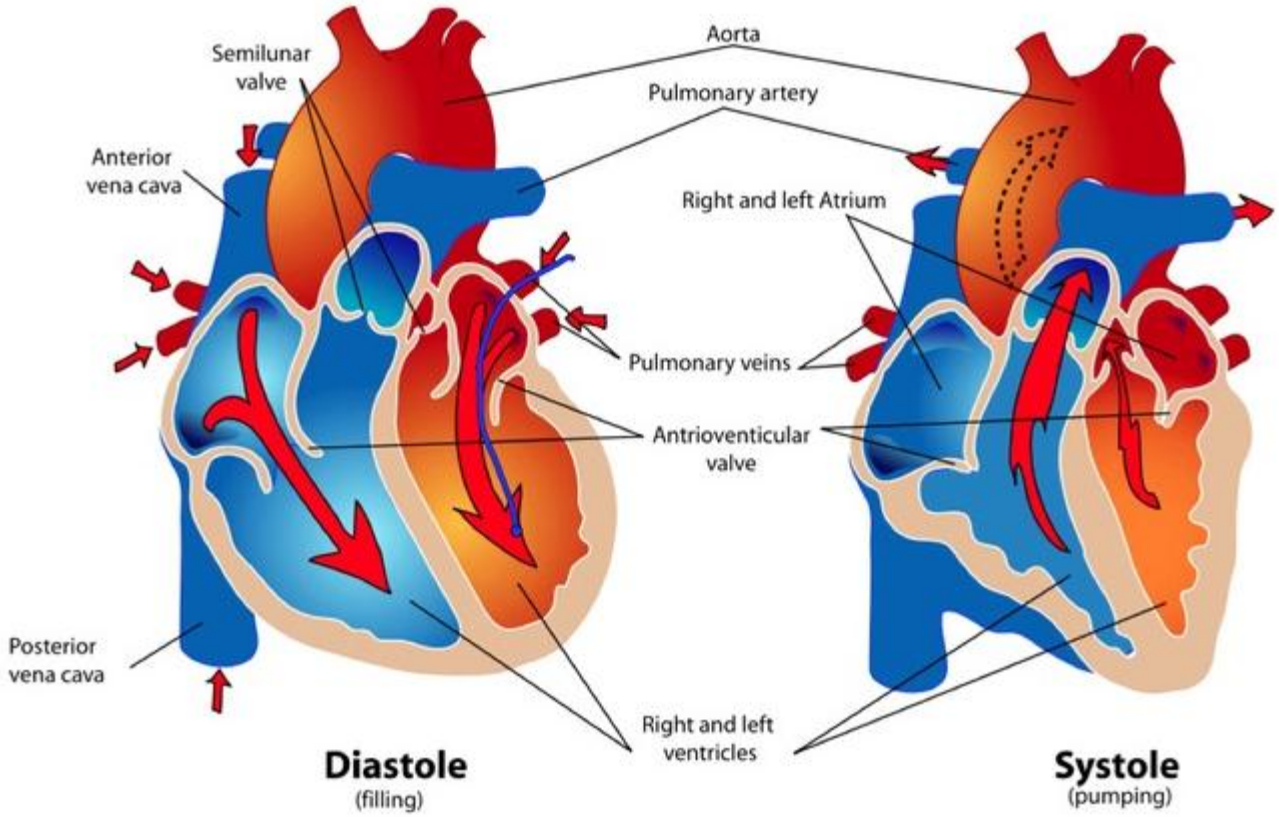
- Cardiac Cycle = events of one complete heartbeat in which both atria and ventricles contract and relax
  - Heart beats about 75 times per minutes – each cycle is 0.8 seconds

- Blood pressure (BP) – pressure blood exerts against inner walls of blood vessels
  - Systolic – pressure of contraction of ventricles
  - Diastolic – pressure of relaxation of ventricles

  - Typical BP for a healthy person is 120/80 mmHg

Blood pressure is the measurement of force applied to artery walls





- Pulse – the expansion and recoil of the arteries as blood passes
  - Typical resting pulse is 60-100 beats per minute (BPM)

- Heart Sounds
  - Lub-Dup
  - Lub = closing of AV valve
    - Louder and longer
  - Dup = closing of semilunar valve
    - Short and sharp

Cardiac Output (CO)

- Cardiac Output = amount of blood pumped out by each side of the heart in 1 minute
  - CO = Heart rate and Stroke volume
  - CO = HR (75 beats/min) X SV (70 mL/beat)

- Stroke volume – volume of blood pumped out by a ventricle with each heartbeat
  - Entire blood supply passes through heart about once per minute

CARDIAC OUTPUT

CO = HR X Stroke Volume

Cardiac Output — Heart Rate

Regulation of Stroke Volume

- SV rises or falls with volume of venous return
- About 60% of blood that enters the heart is pumped out
- SV = how much the heart muscles are stretched before contraction

Regulation of Heart Rate

- HR influenced by:
  - Nerves of autonomic nervous system
  - Nerves of parasympathetic nervous system
  - Drugs and other chemicals
  - Ion levels in blood

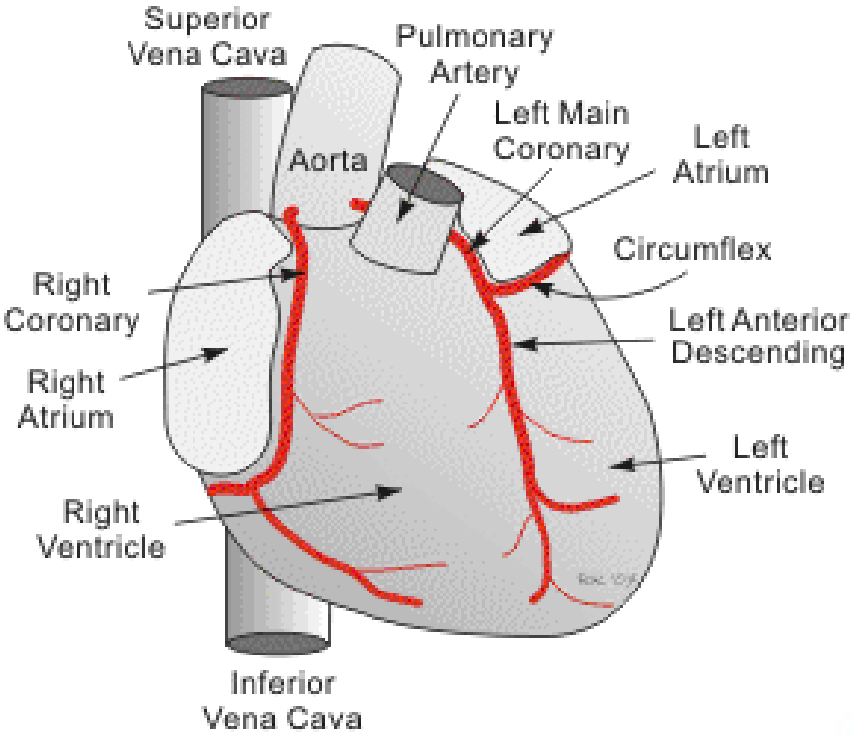
Disorder

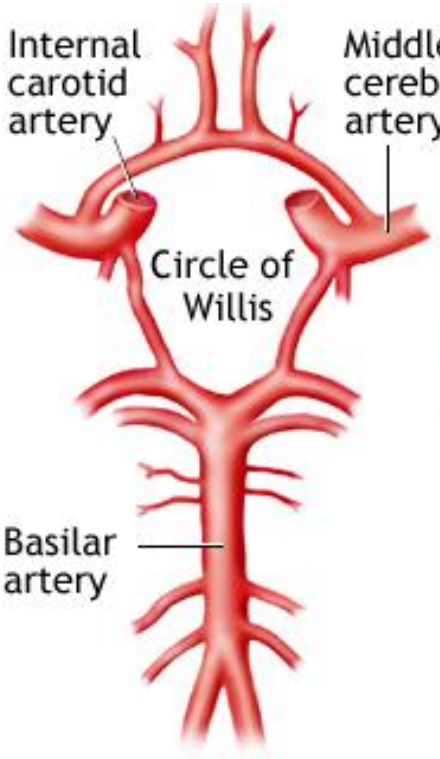
- Congestive heart failure – when pumping efficiency of heart is depressed so that circulation can not meet tissue needs
  - Caused by coronary atherosclerosis (clogging of coronary vessels), high blood pressure, or multiple myocardial infarctions

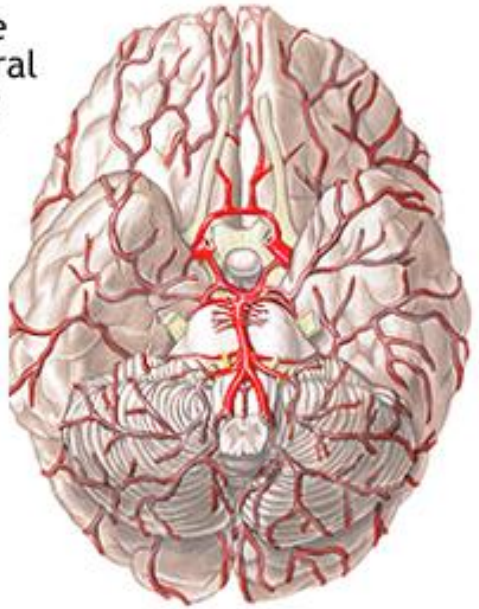
Special Types of Circulation

- Coronary Circulation – how heart gets blood
  - Right and left coronary arteries branch from aorta and encircle heart
  - Brings oxygen and nutrients to heart cells
  - Myocardium drained by cardiac veins, which dumps the oxygen poor blood directly into the right atrium

- Circle of Willis
  - Two arteries connect to form a ring in the brain
    - Allows for blood to continue to circulate when there are blockages and helps regulate blood pressure in the brain







Bottom view of brain