

A microscopic image showing a cross-section of a blood vessel. The vessel lumen is the central white area. The vessel wall is composed of several layers: an innermost layer of simple cuboidal endothelium, a thick middle layer of smooth muscle (intima and media) stained pink, and an outer layer of connective tissue (adventitia).

Cardiovascular (Circulatory) System

Circulatory System

Heart

Blood Vessels

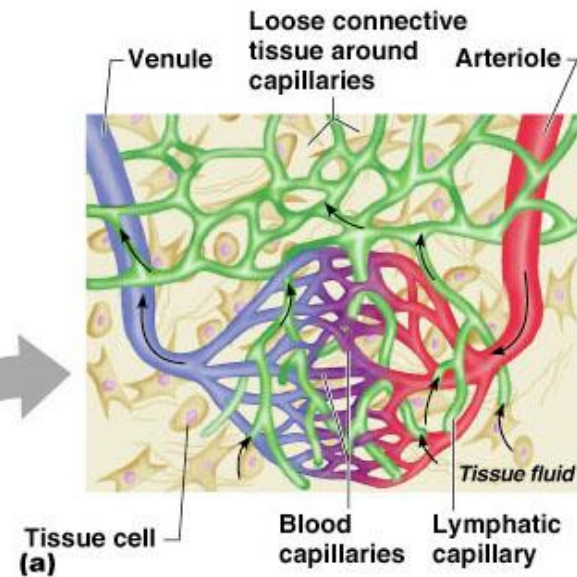
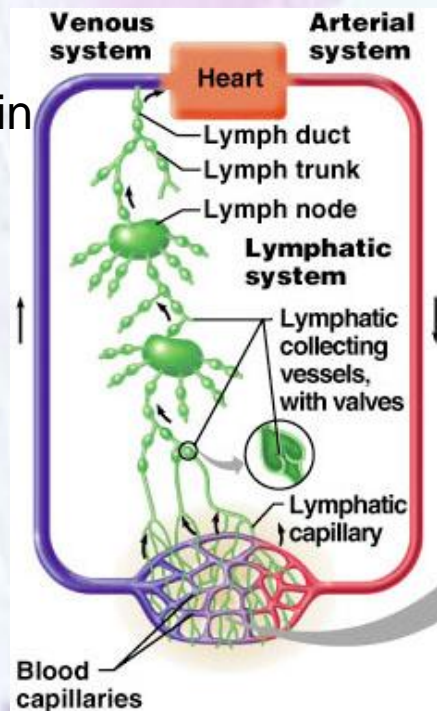
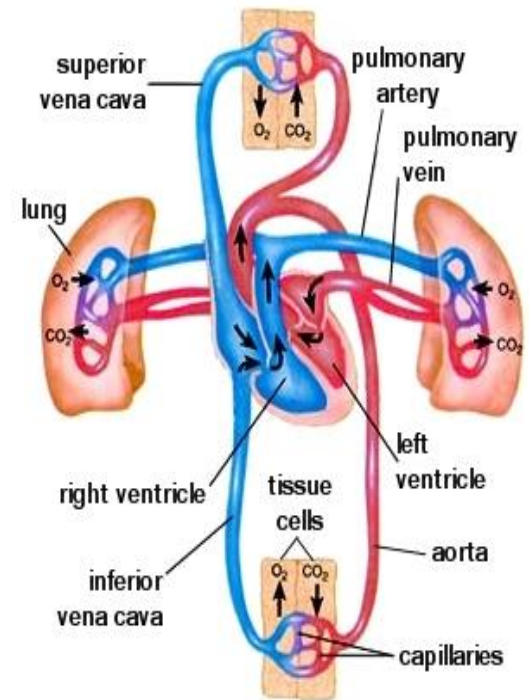
Macrovasculature (More than 0.1mm)

- Elastic Artery
- Muscular (Distributing) Artery
- Large Arteriol
- Small Vein
- Muscular (Medium) Vein
- Large Vein

Microvasculature

- Arteriol
- Capillary
- Post Capillary Venule

Lymph Vessels



Structure of Vessels

- Tunica Intima
 - Endothelium
 - Subendothelium
 - Loose CT
 - Scattered Smooth Muscle

Internal Elastic Lamina

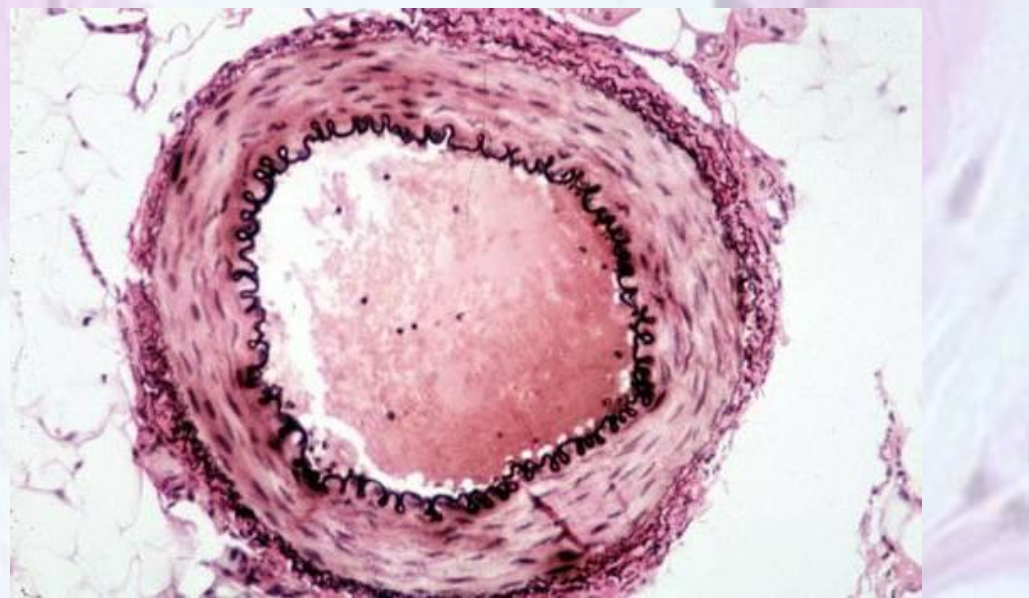
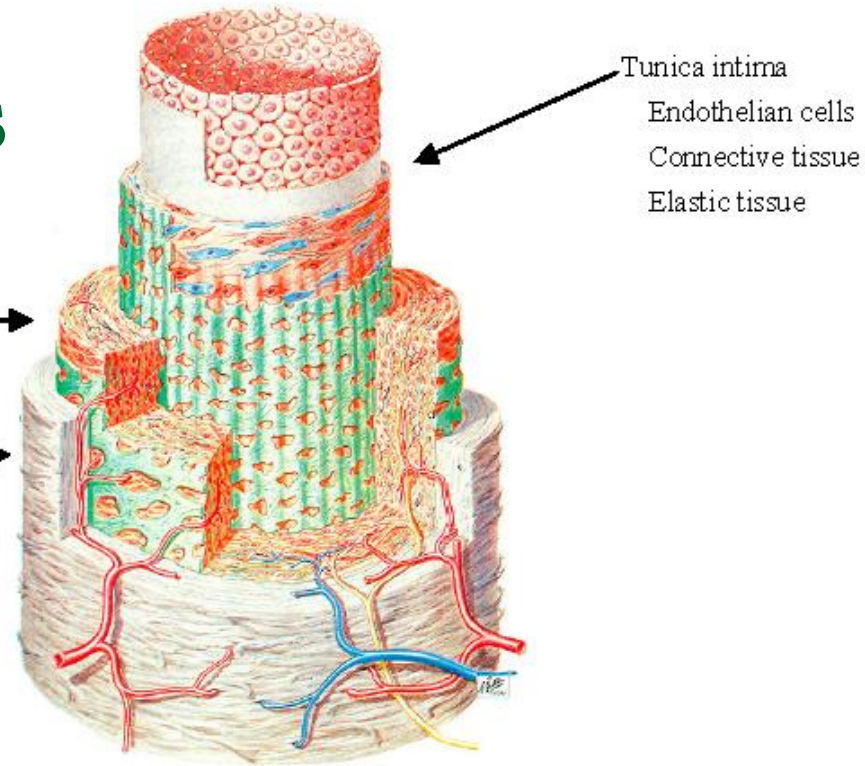
- Tunica Media
 - Circular Smooth Muscle
 - Elastic Fibers & Lamina

External Elastic Lamina

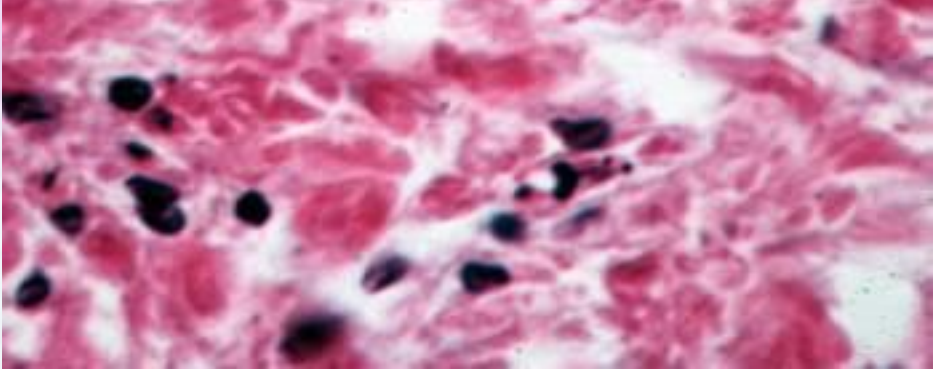
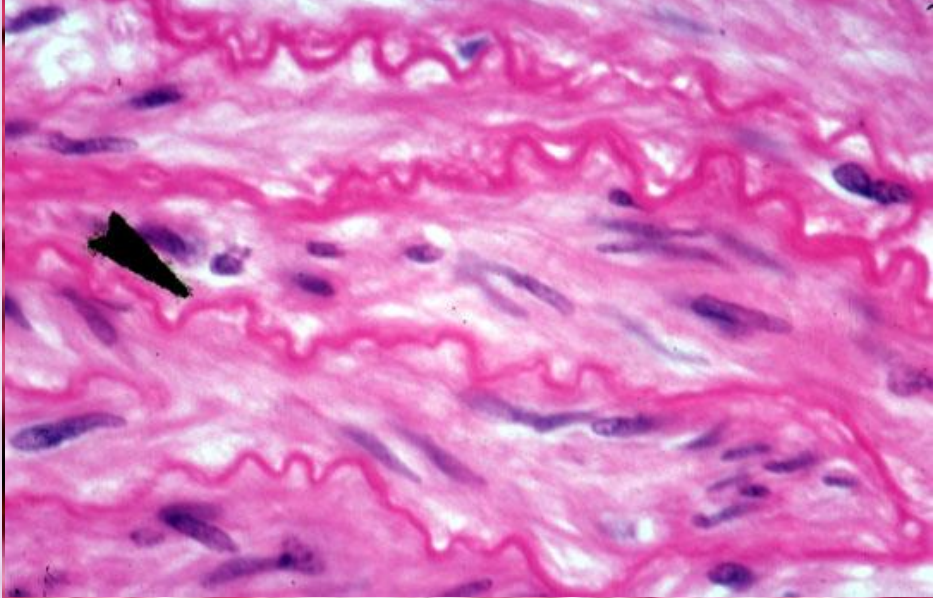
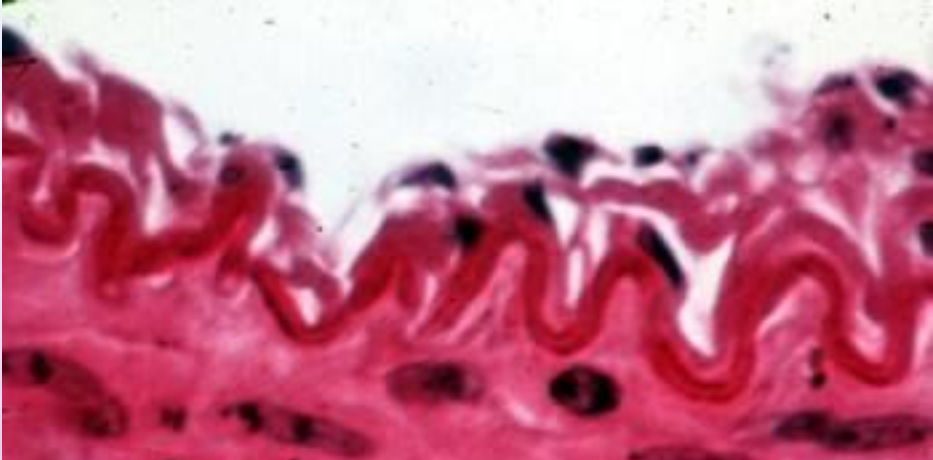
- Tunica Adventitia
 - Connective Tissue
 - Collagen I & Elastic Fibers

Tunica media

Tunica adventitia



Structure of Vessels



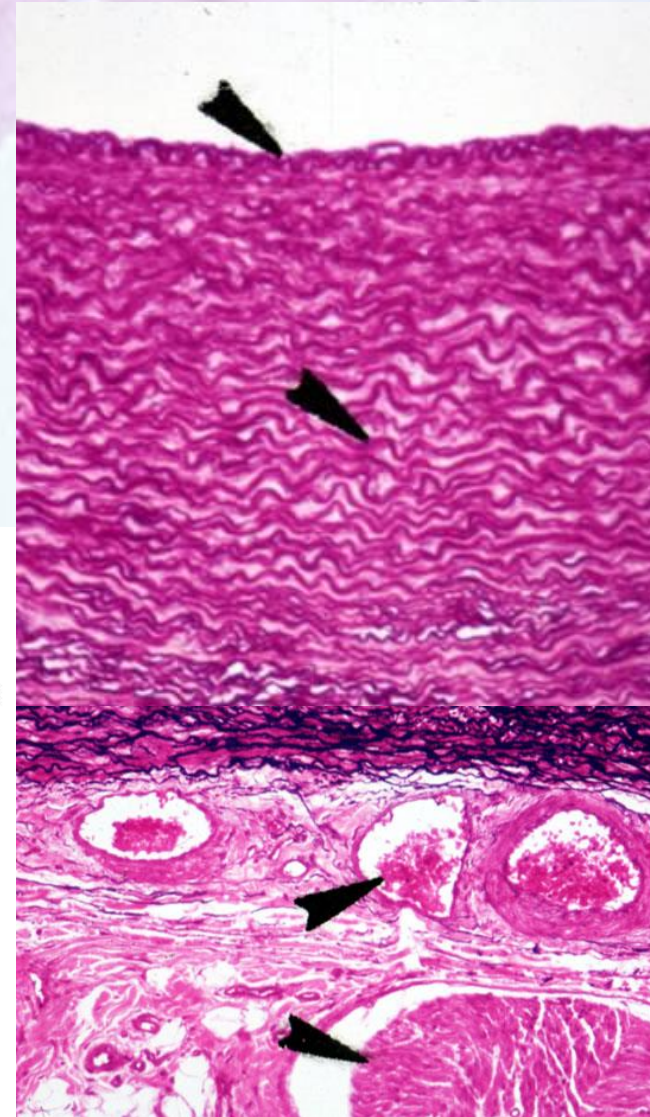
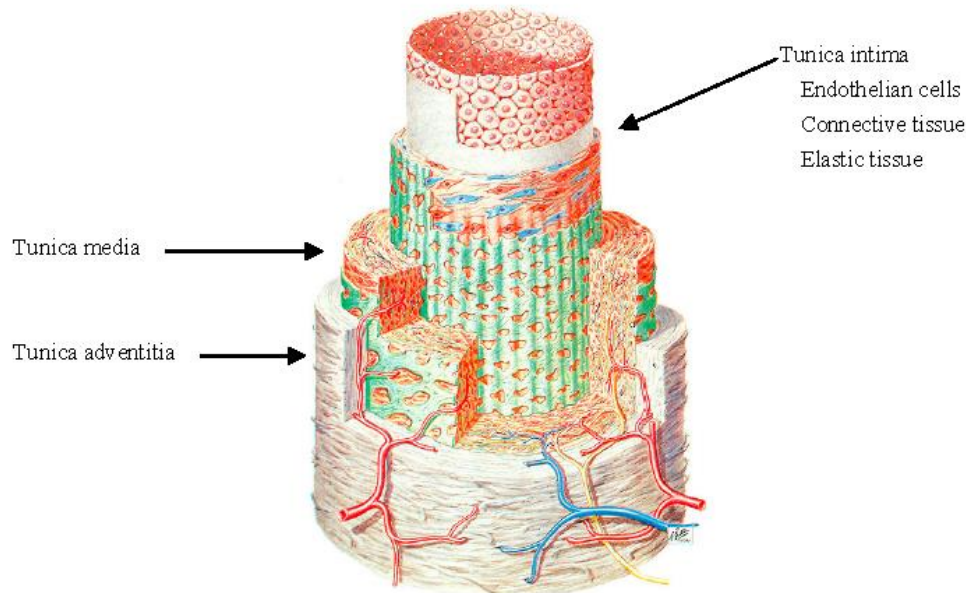
Vasa Vasorum & Vessels Innervation

■ Vasa Vasorum

- Large Vessels
- Adventitia & Outer Media

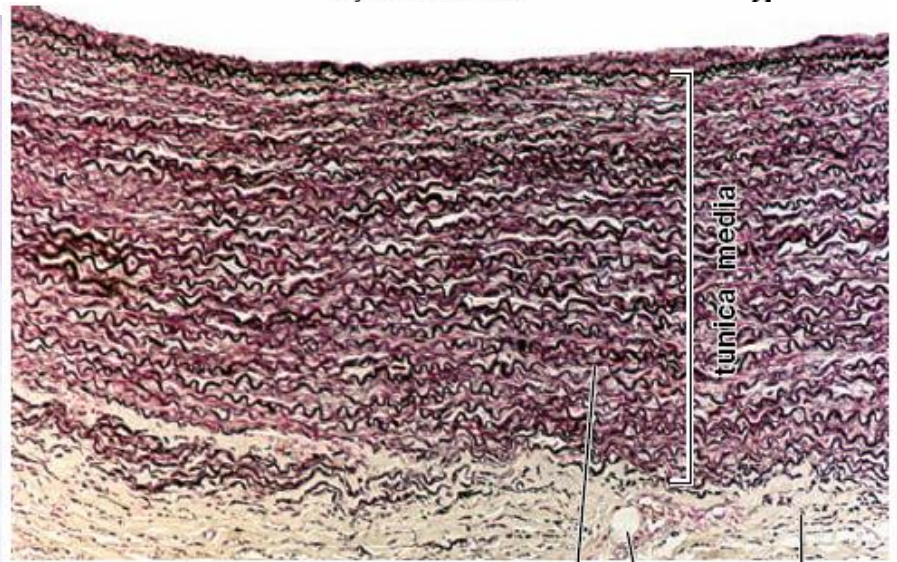
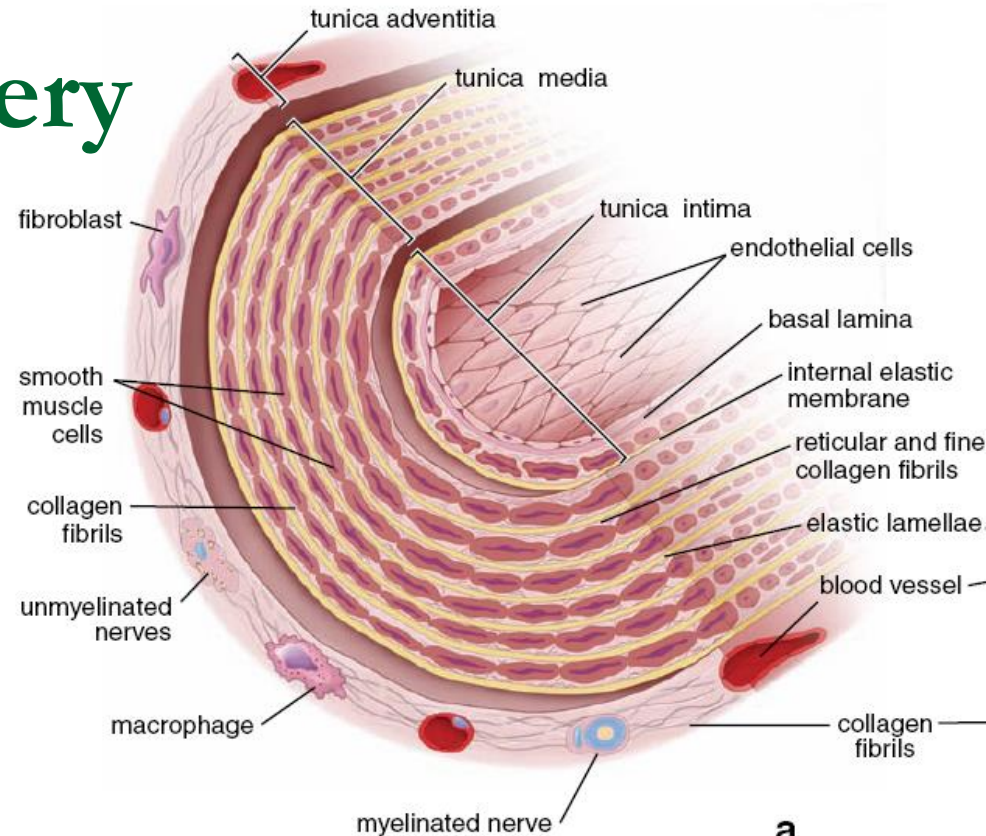
■ Innervation

- Vasomotor (Adrenergic) Nerves
- Vasodilator (Cholinergic) Nerves
 - Skeletal Muscle Vessels



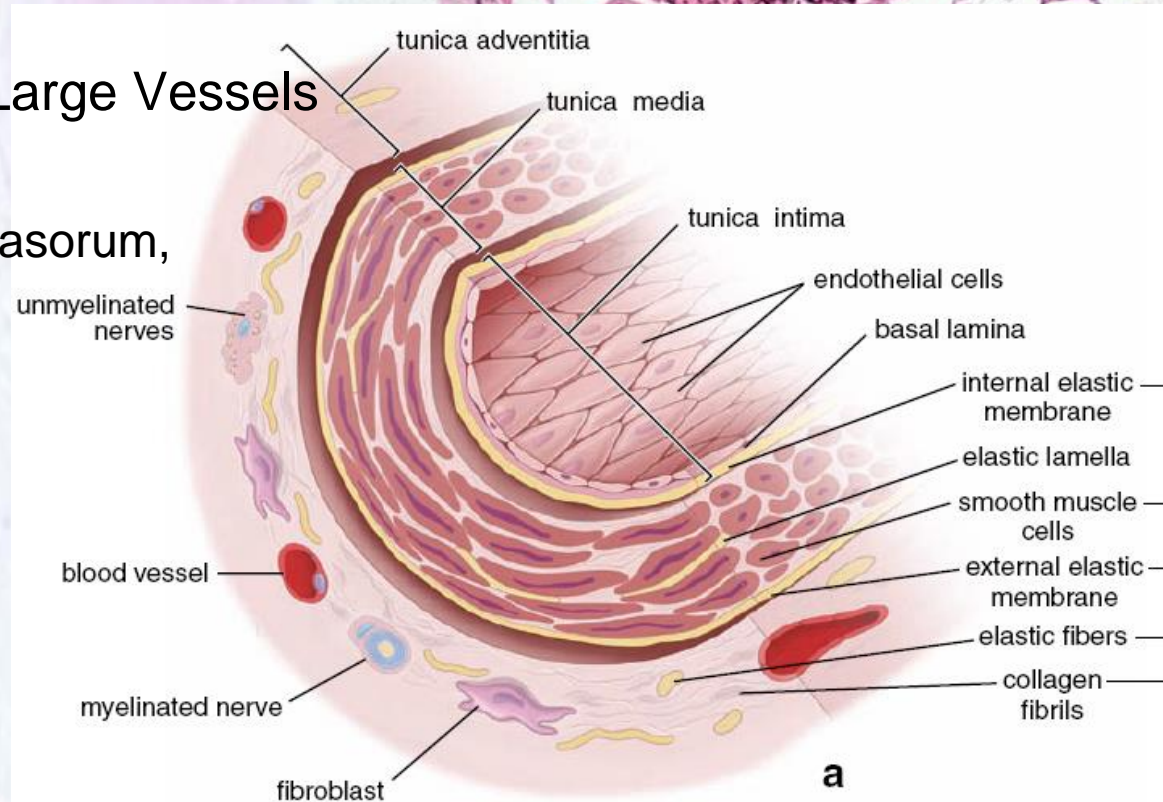
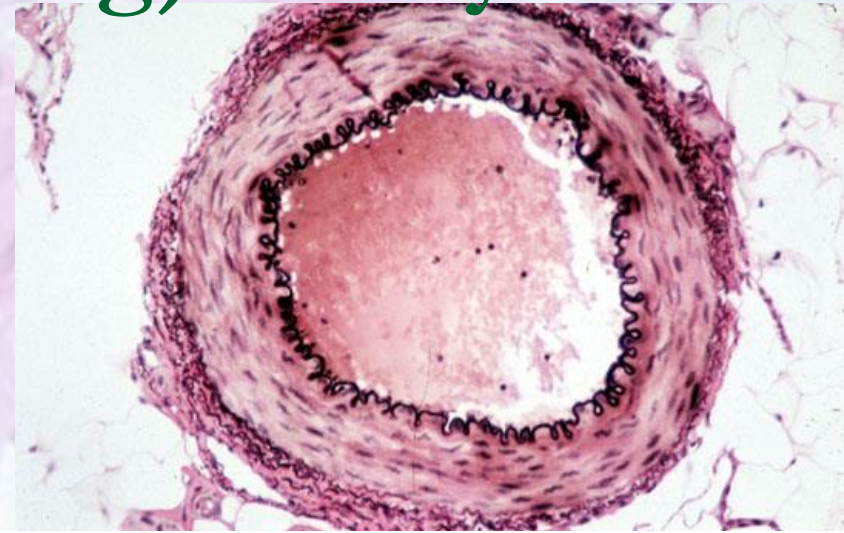
Large Elastic Artery

- Aorta & its Main Branches
- Thick Intima
- Media
 - Plenty of Elastic Fibers & Lamina (40-70 Layer)
 - Smooth Muscles
- Rudimentary Adventitia
- Indistinct Internal & External Elastic Lamina
- Help to Continuous Blood Flow



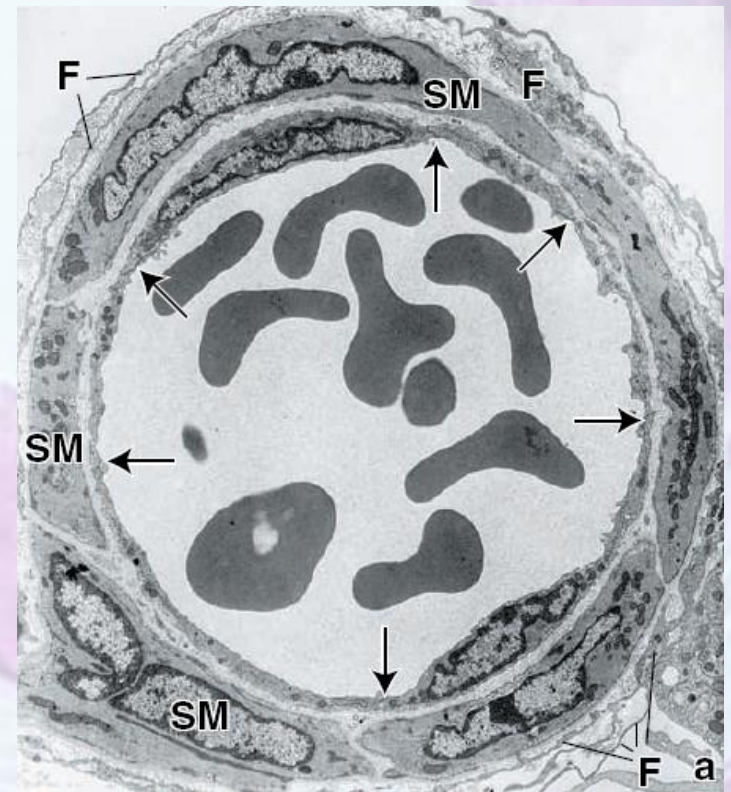
Muscular (Distributing) Artery

- Intima
 - Relatively Thick
- Clear Internal Elastic Lamina
- Media
 - Up to 40 Smooth Muscle Layers
 - Elastic Lamina
- External Elastic Lamina in Large Vessels
- Adventitia
 - Connective Tissue, Vasa Vasorum, Lymphatics, Nerves



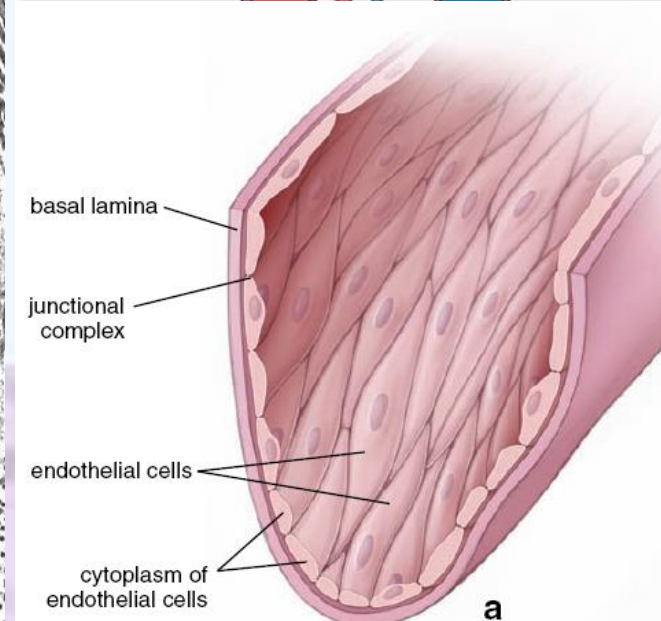
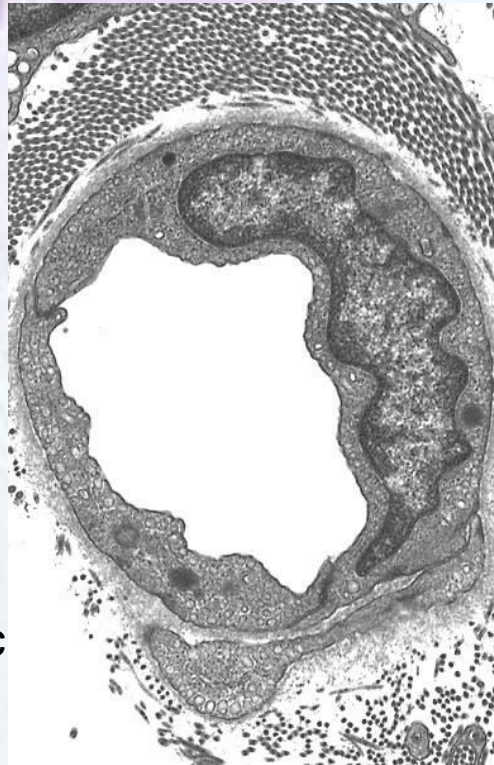
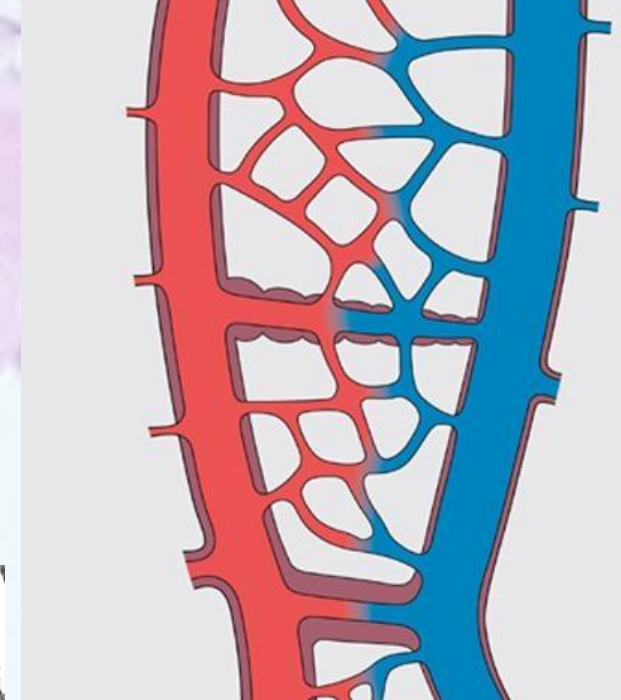
Arteriole

- Diameter Less than 0.5mm
- Thin Intima
- Internal Elastic Lamina Absent in Small Arteriol
- Media
 - 1 or 2 Circular Smooth Muscles
- No External Elastic Lamina
- Thin Adventitia



Capillary

- Exchange Vessels
- Diameter 7-9 μm
- Length: <50 μm
- Capillary Structure
 - Endothelium & BL
 - Simple Squamous
 - Nuclear Bulging
 - Tight Junction
 - Pinocytotic Vesicles
 - Pericytes
 - Contractile Properties
 - Repair Roles
- Exchange Pathways
 - Simple Diffusion (Gas)
 - Paracellular Pathway (Water & Small Hydrophilic Substances)
 - Pinocytotic Vesicles



Types of Capillary

Continuous (Somatic)

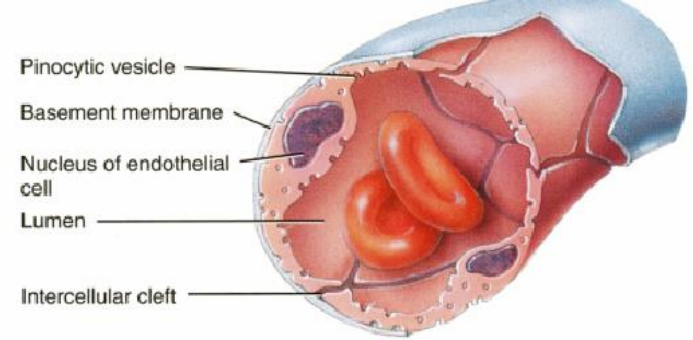
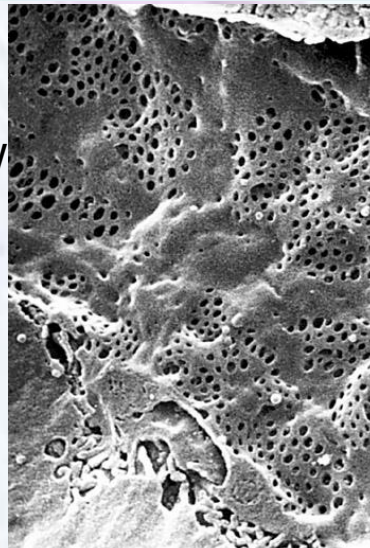
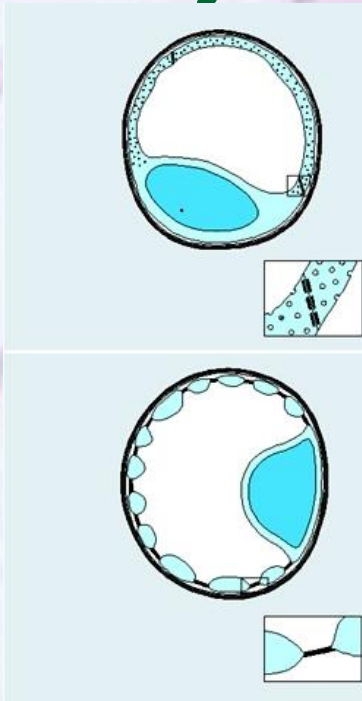
- ❑ Connective Tissue
- ❑ Muscular Tissue
- ❑ Exocrine Gland
- ❑ Nervous System
 - No Pinocytic Vesicles

Fenestrated (Visceral)

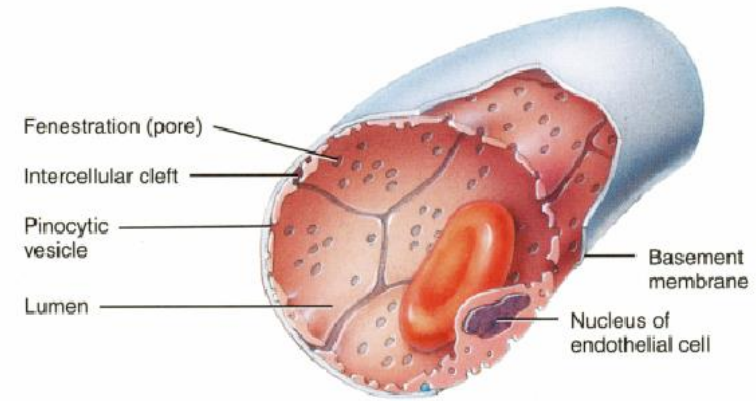
- ❑ **With Diaphragm**
 - Kidney
 - Intestine
 - Endocrine gland
- ❑ **Without Diaphragm**
 - Kidney Glomeruli

Sinusoidal

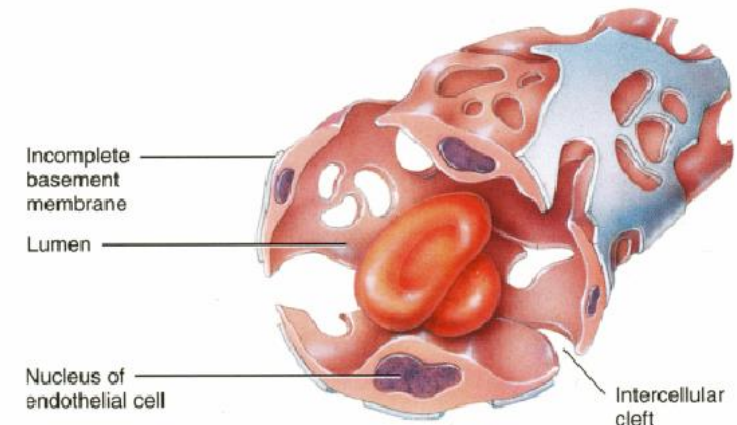
- ❑ Liver, Spleen & Bone Marrow
- ❑ Diameter 30-40 μ m
- ❑ Non-continuous Endothelium & BL
- ❑ Numerous Endothelial Pore
- ❑ Macrophages



(a) Continuous capillary formed by endothelial cells



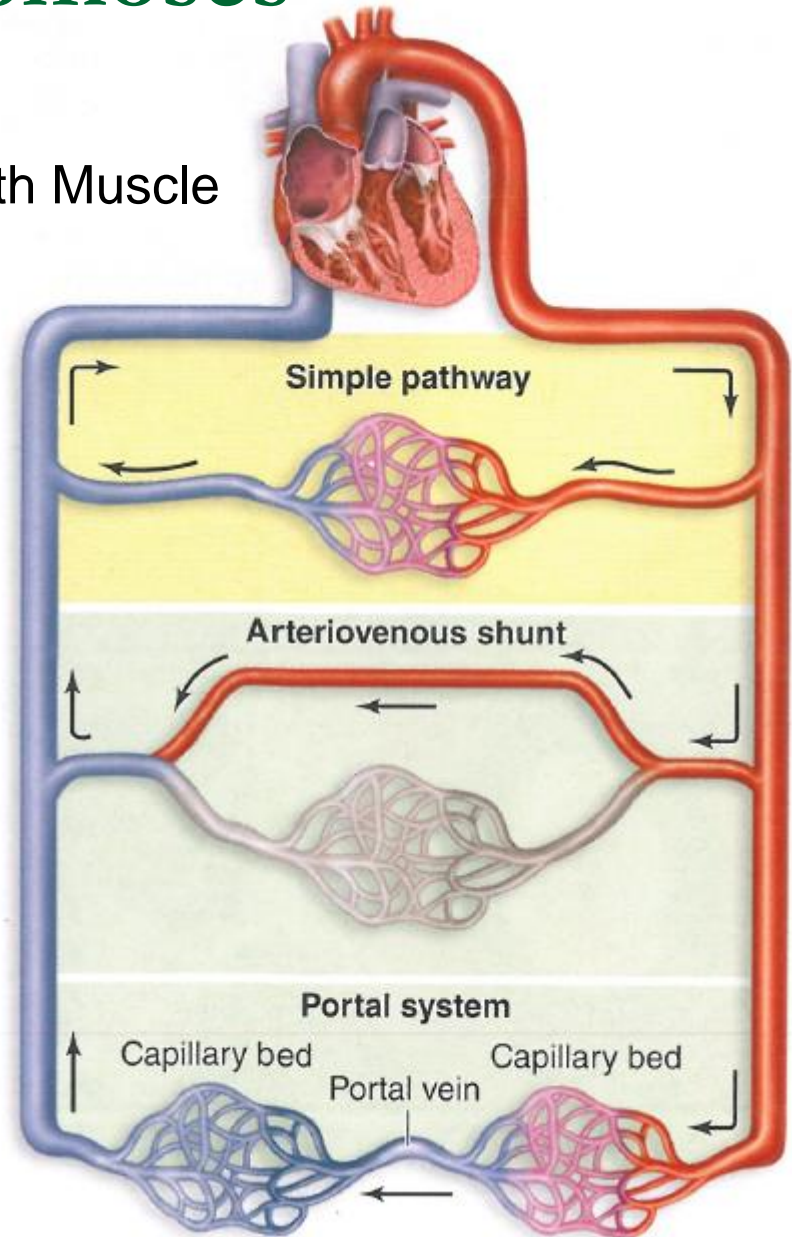
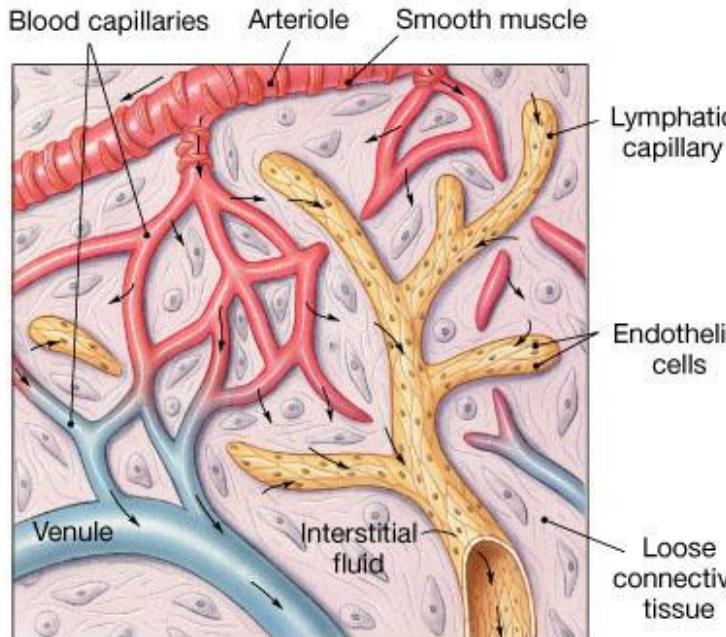
(b) Fenestrated capillary



(c) Sinusoid

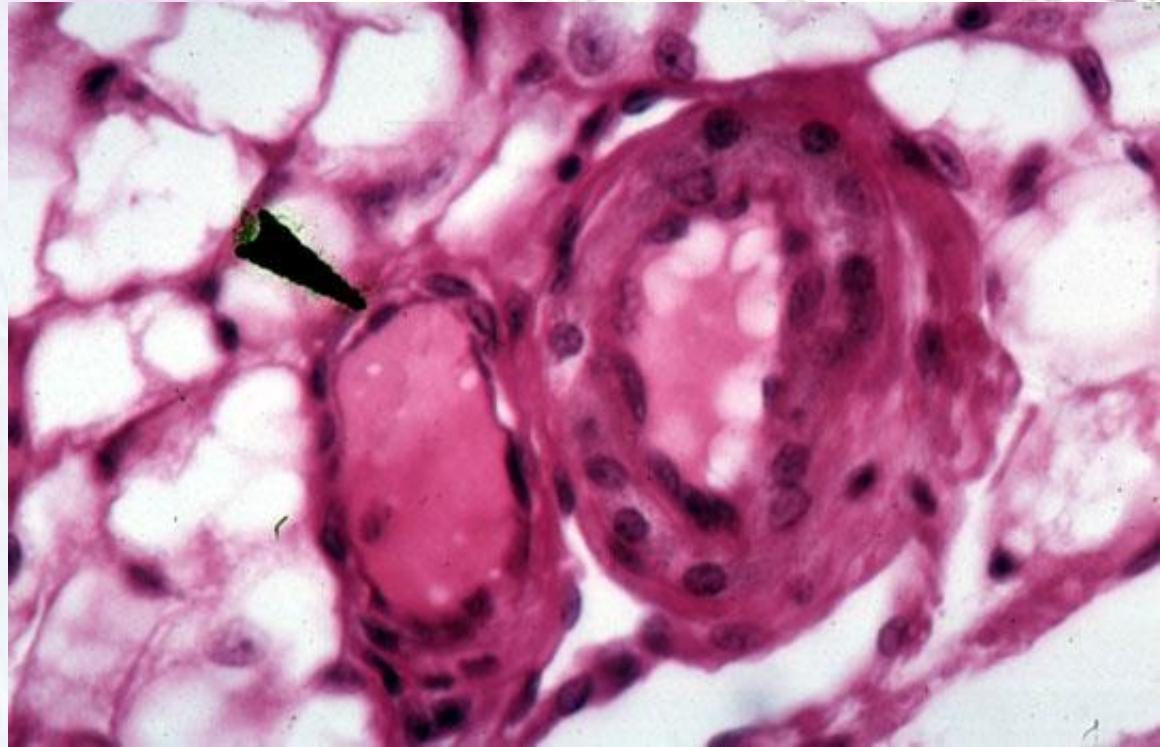
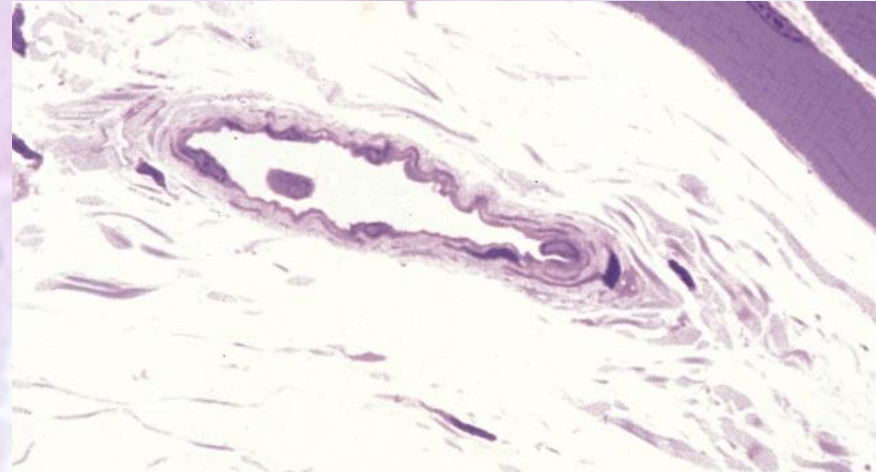
Metarteriole, Capillary Network & Arterio-Venous Anastomoses

- Metarteriole
 - Sphincteric Non-continuous Smooth Muscle
- Arterio-Venous Anastomoses
 - Regional Blood Flow Regulation
 - Blood Pressure Regulation
 - Body temperature Regulation



Post Capillary Venules

- Diameter: 0.2-1 mm
- Intima
 - Endothelium (Cuboidal)
 - Thin Subendothelium
- Media
 - Pericytes (Small Venule)
 - Smooth Muscles
- Functions
 - Metabolite Exchange
 - Diapdesis



Veins

■ Small or Medium Veins

□ Intima

- Thin Subendothelium

□ Media

- Less Smooth Muscle
- Reticular & Elastic Fibers

□ Adventitia

- Well Developed Collagenous Layer

■ Large Veins

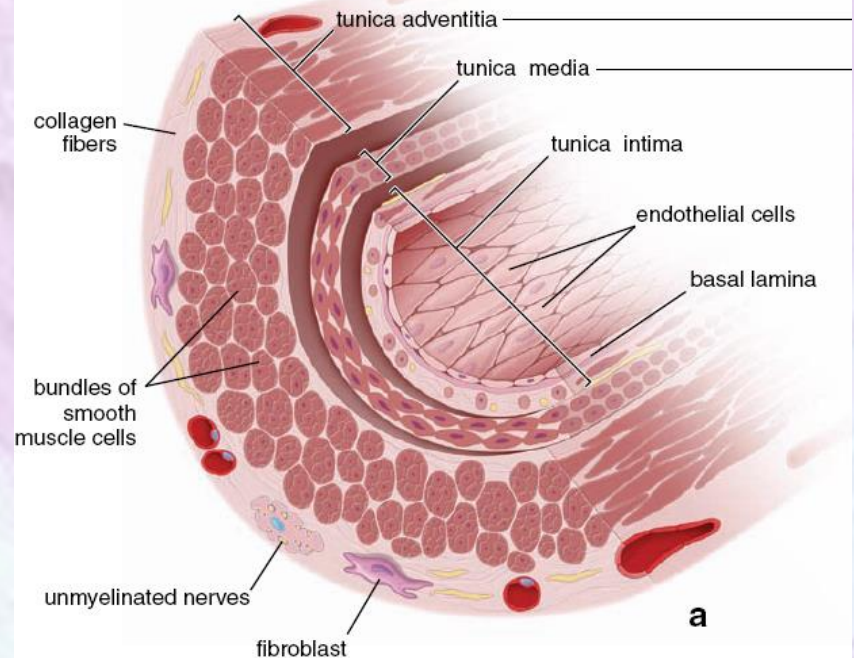
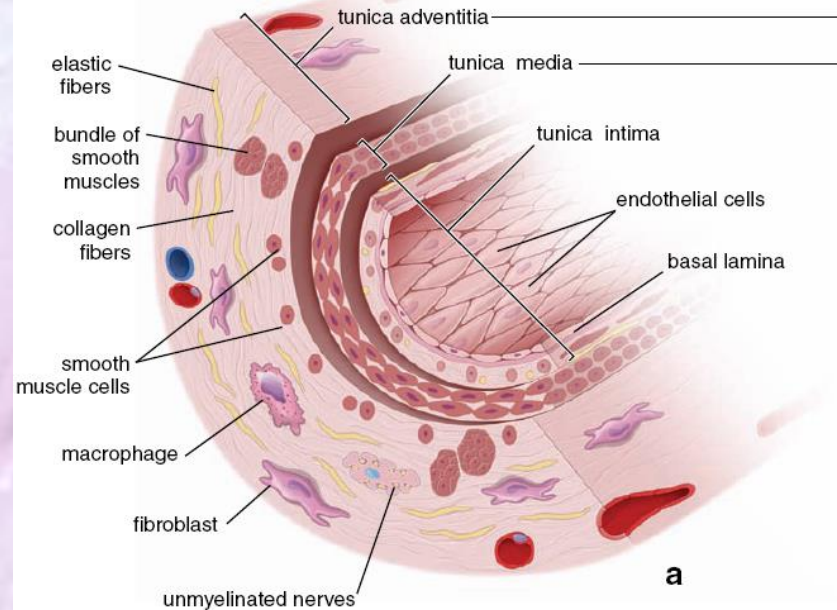
□ Well Developed Intima

- Vein Valves

□ Thin Media

□ Thick Adventitia

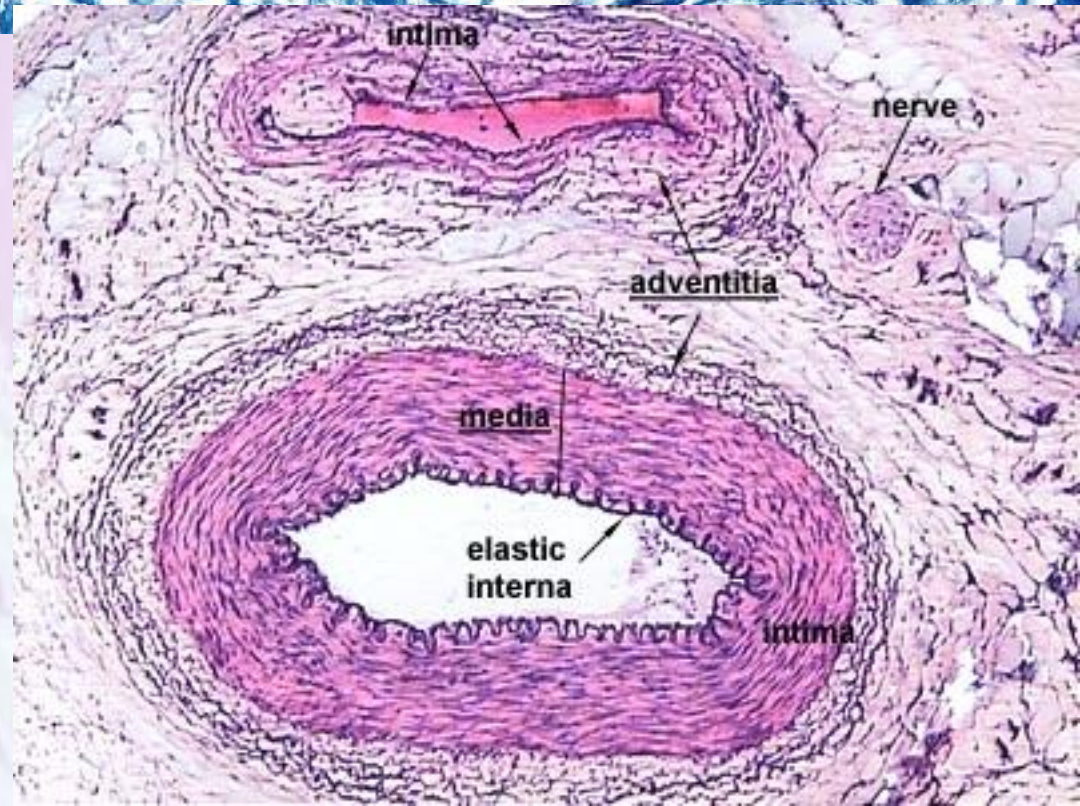
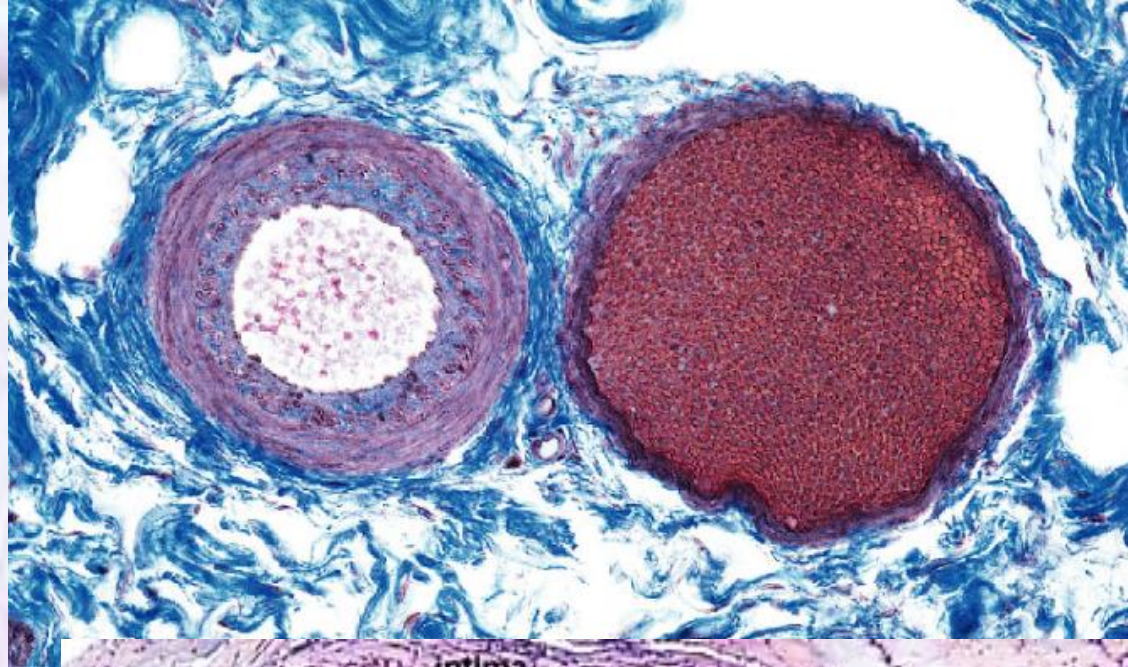
- Longitudinal Smooth Muscles



LARGE VEIN

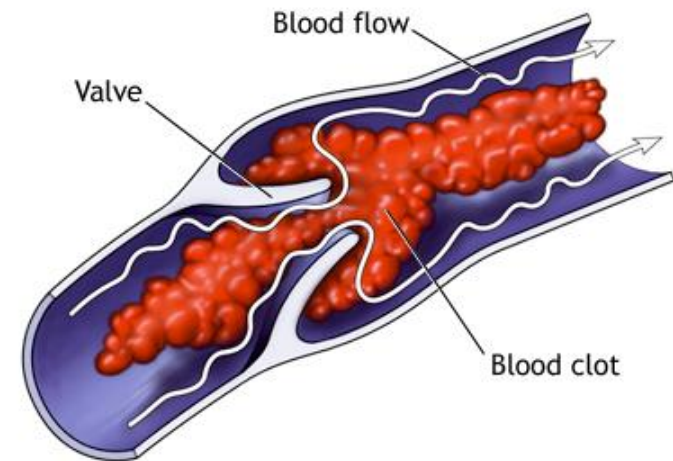
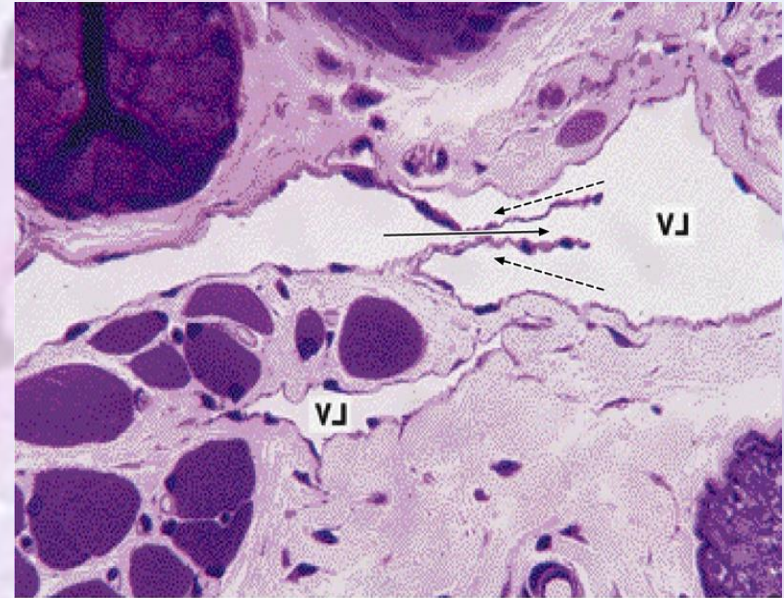
Veins

- Small or Medium Veins
 - Intima
 - Thin Subendothelium
 - Media
 - Less Smooth Muscle
 - Reticular & Elastic Fibers
 - Adventitia
 - Well Developed Collagenous Layer
- Large Veins
 - Well Developed Intima
 - Vein Valves
 - Thin Media
 - Thick Adventitia
 - Longitudinal Smooth Muscles



Valves of Veins

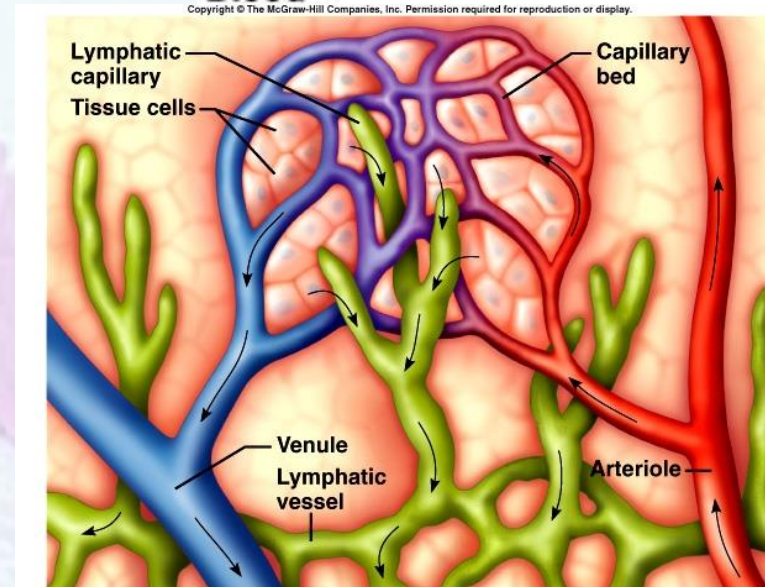
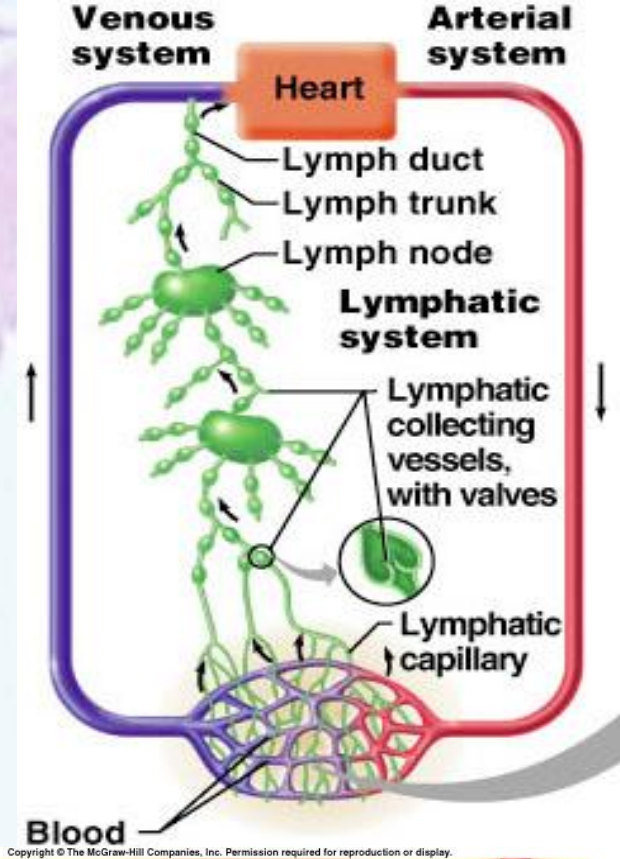
- In Many Medium-Sized Veins
- Folds of Intima
 - Endothelium
 - Thin layer of Collagen
 - Elastic Network
- Valve Sinus
 - Thinner & Expanded Wall



Lymphatic System

Return Tissue Fluid to Blood

- Dead End Capillary
 - Endothelium
 - Non-Continuous BL
- Medium lymph Vessels
 - Similar to Veins
 - Thin Tunics
 - More Valves
- Large Lymph Vessels
 - Media
 - Longitudinal & Circular
 - Vasa Vasorum
 - Nerve Plexus



Arterial Degenerative Changes

■ Atherosclerosis

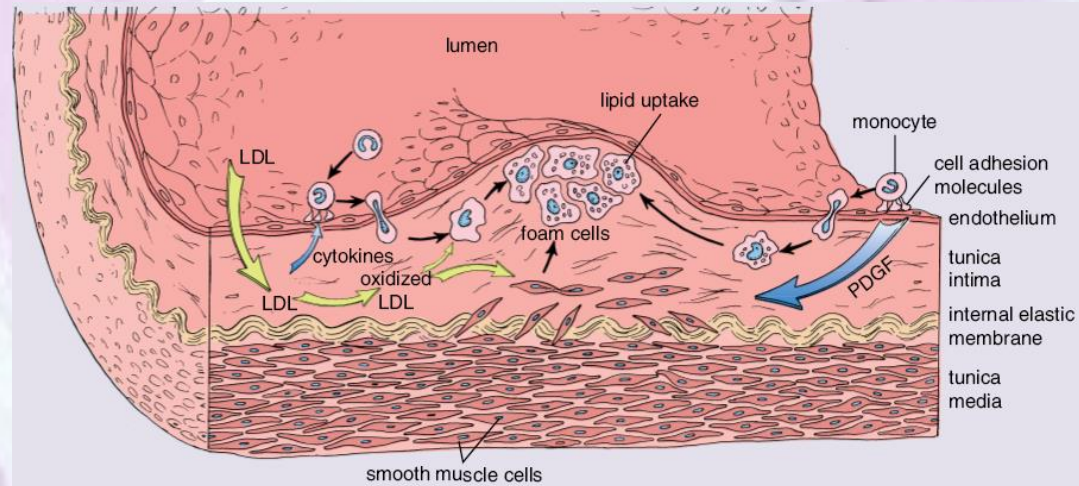
- Local Thickening of Intima
- Smooth Muscle Aggregation
- Extracellular Matrix Aggregation
- Cholesterol Deposition (Foam Cells)
 - Smooth Muscle Cells
 - Macrophages

■ Aneurysm

- Weakening of Media

■ Infarcts

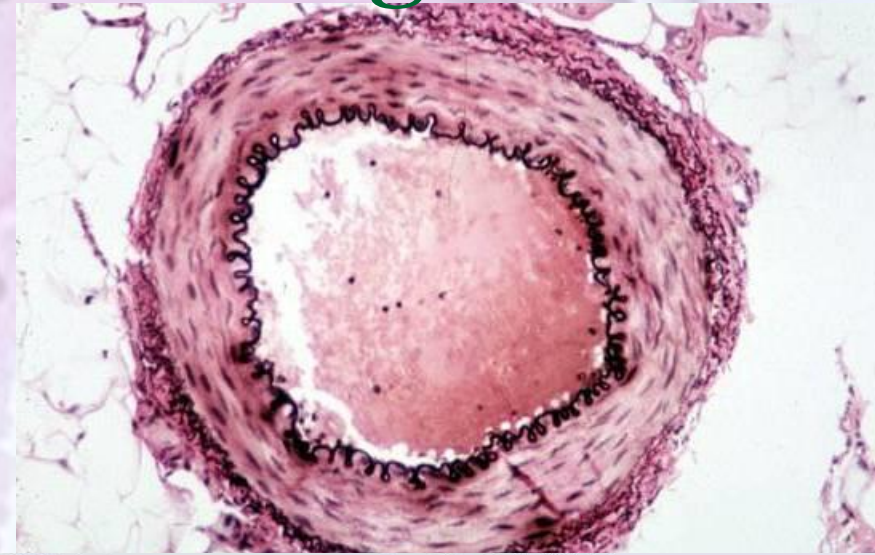
- In Non-Anastomoses Area
 - Heart
 - Brain
 - Kidney



Arterial Degenerative Changes

■ Atherosclerosis

- Local Thickening of Intima
- Smooth Muscle Aggregation
- Extracellular Matrix Aggregation
- Cholesterol Deposition (Foam Cells)
 - Smooth Muscle Cells
 - Macrophages

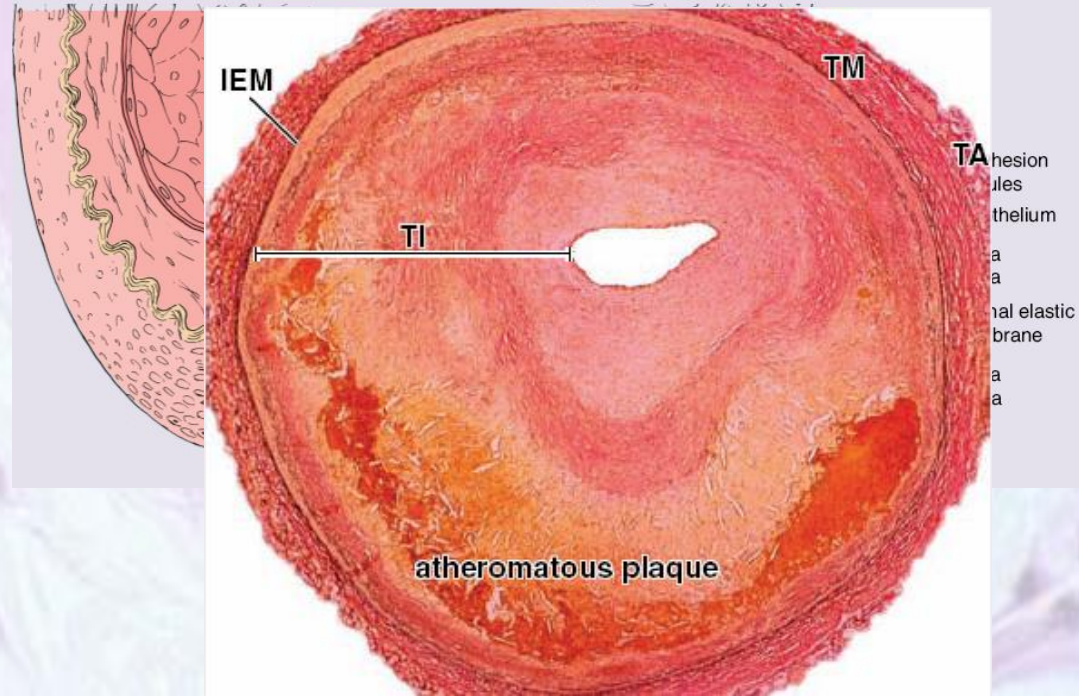


■ Aneurysm

- Weakening of Media

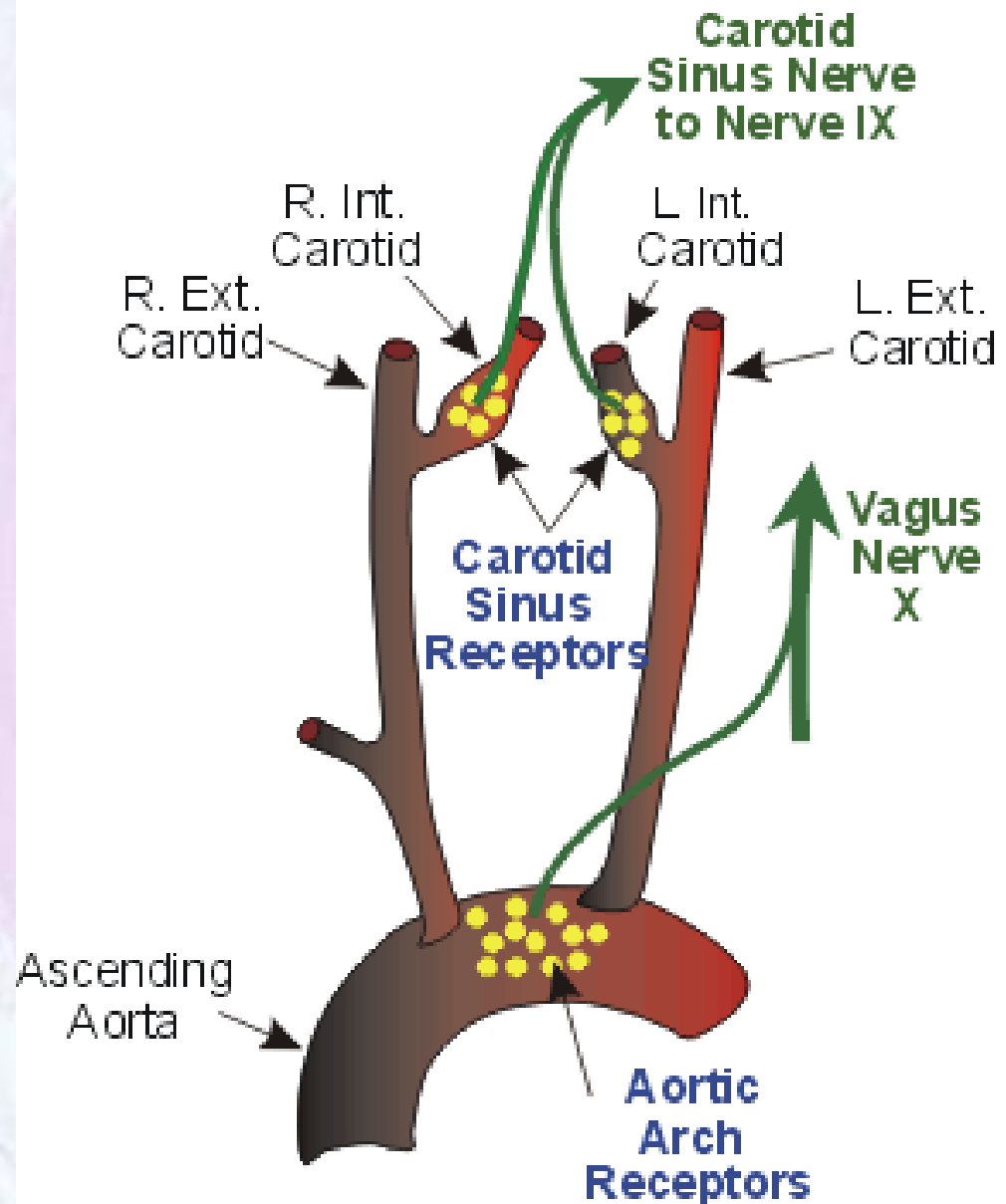
■ Infarcts

- In Non-Anastomoses Area
 - Heart
 - Brain
 - Kidney



Sensory Organs

- Carotid Body
 - Chemoreceptor
 - Type I Cells (Receptor)
 - Dopamine
 - Serotonin
 - Adrenalin
 - Type II Cells (Supporting)
 - CO_2 , O_2 & pH
- Carotid Sinus
 - Baroreceptor
- Aortic Body
 - Similar to Carotid Body



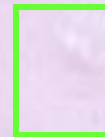
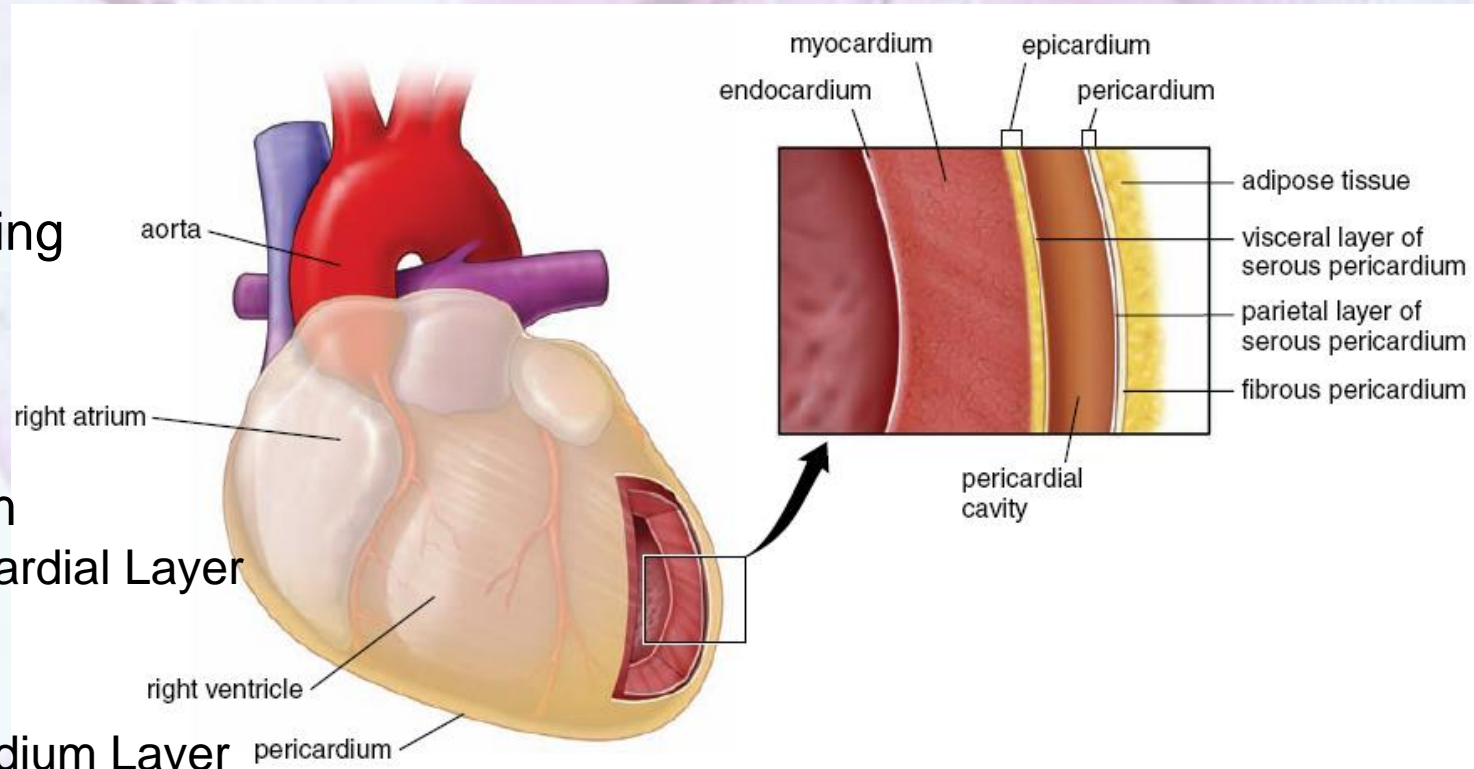
Heart

Function

- Blood Pump
- ANF Producing

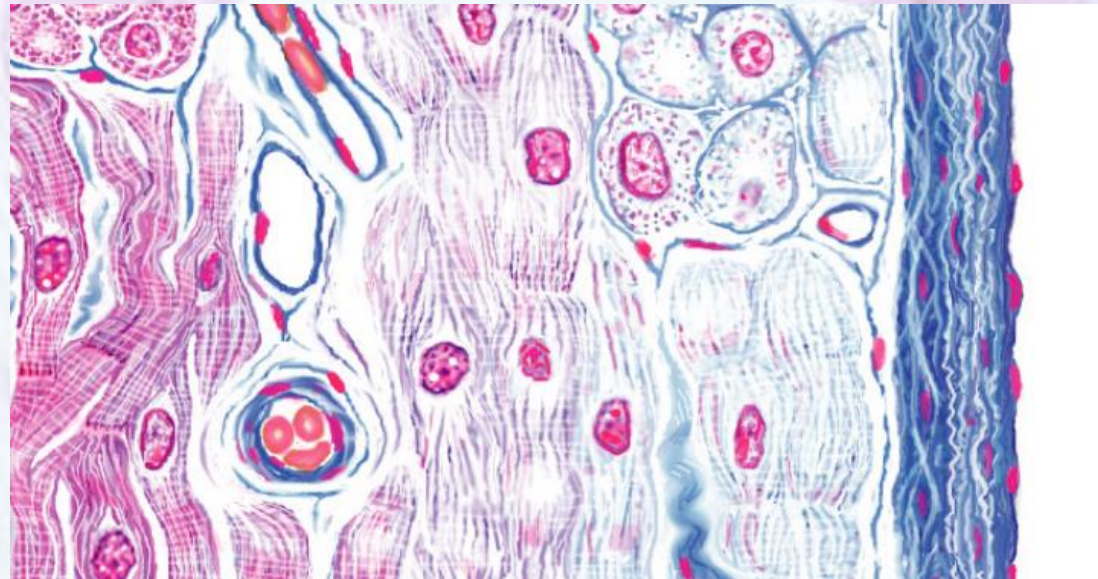
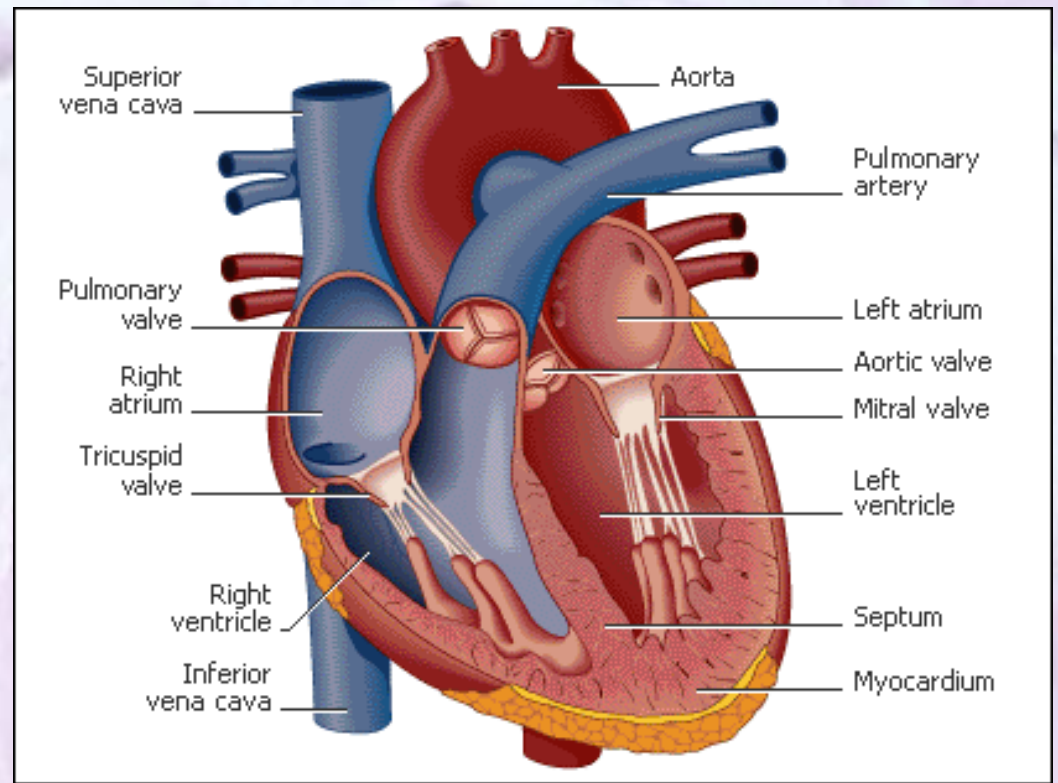
Structure

- Endocardium
 - Subendocardial Layer
- Myocardium
- Epicardium
 - Subepicardium Layer



Heart

- Endocardium
 - Endothelium
 - Subendothelium
- Subendocardial Layer
 - Veins
 - Nerves
 - Purkinje Fibers of Conducting System



Heart

Myocardium

Cardiac Muscle

Intercalated Disks

- Fascia Adherents
- Desmosome
- Gap Junction

T-Tubule & Diad

Mitochondrion (Up to 40%)

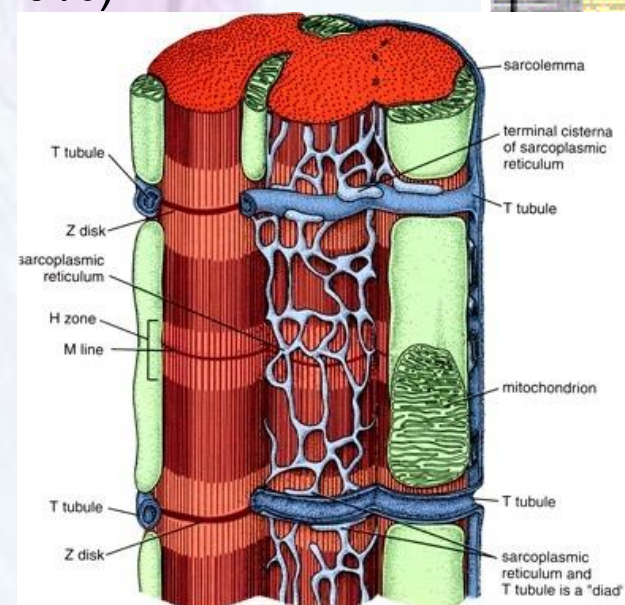
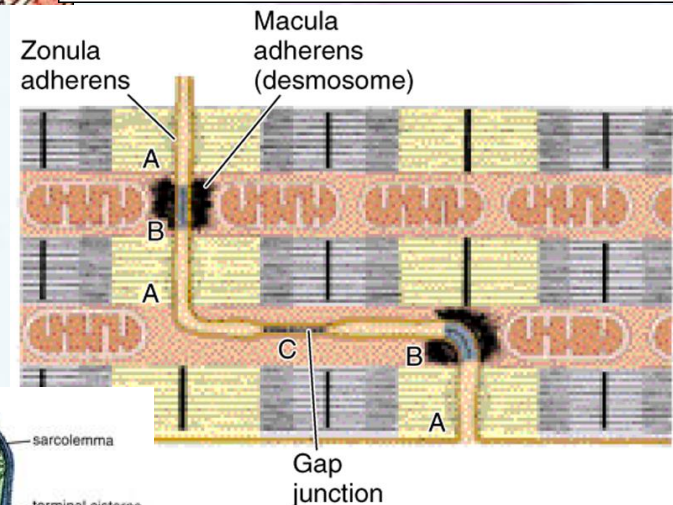
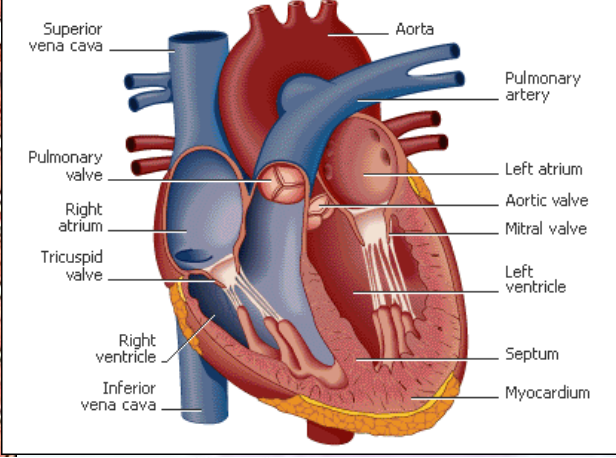
Lipid Droplet

Less Glycogen

ANF Granules

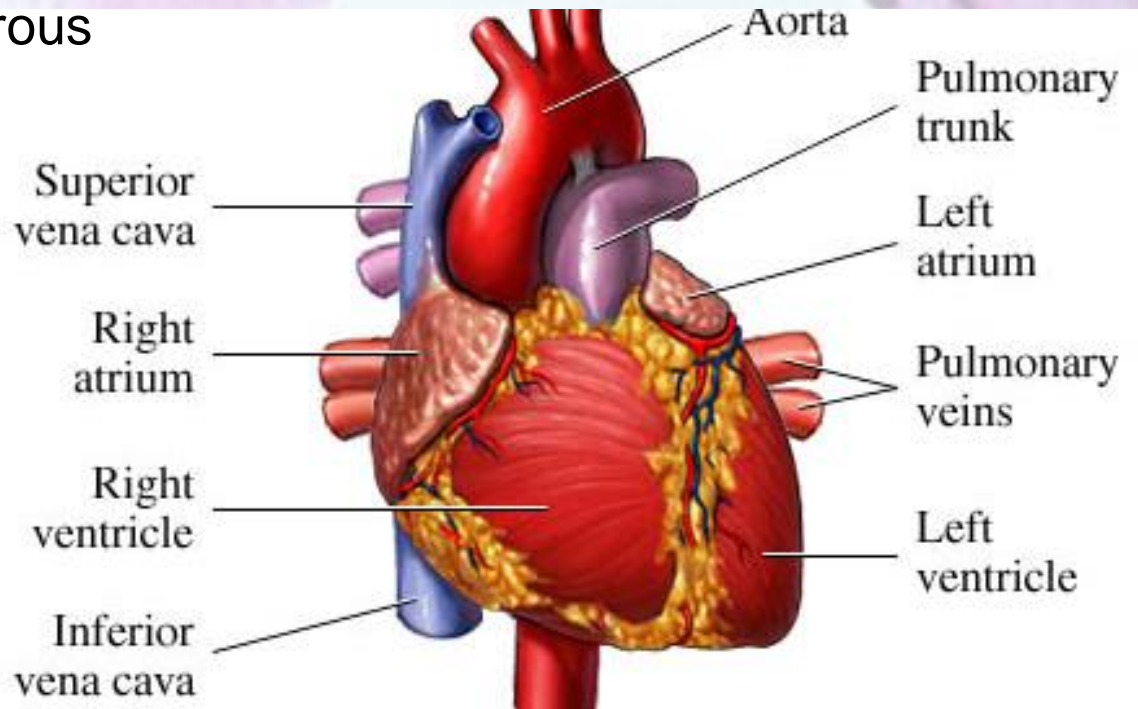
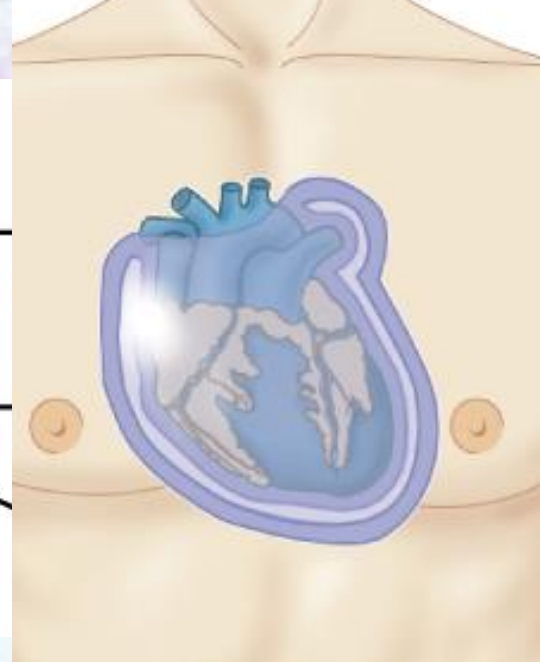
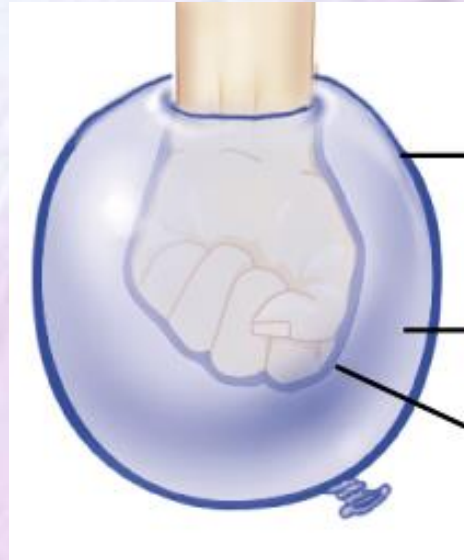
Endomysium

Highly Vascularized



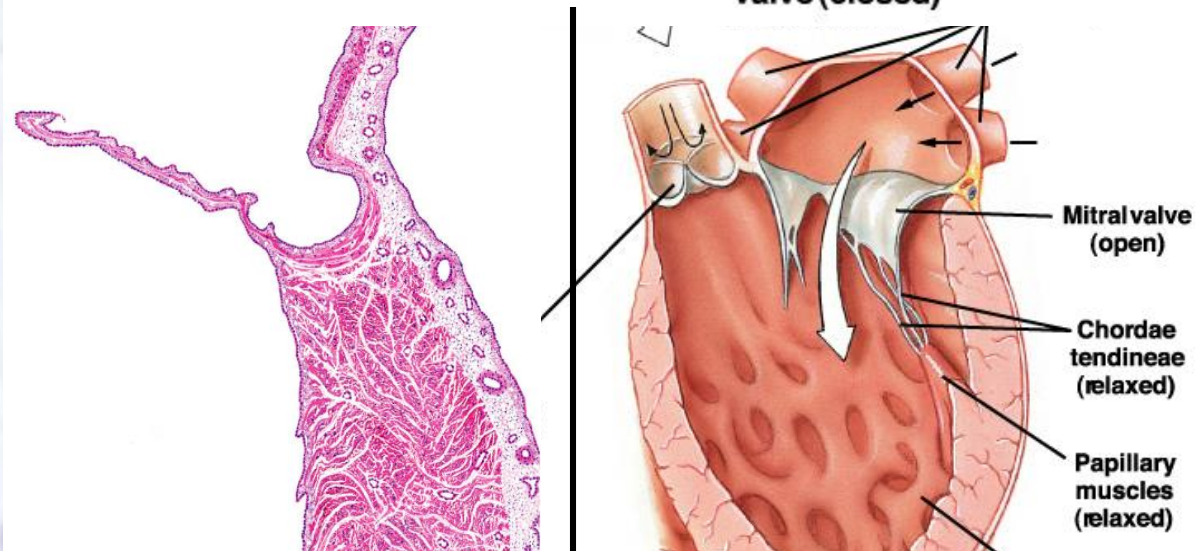
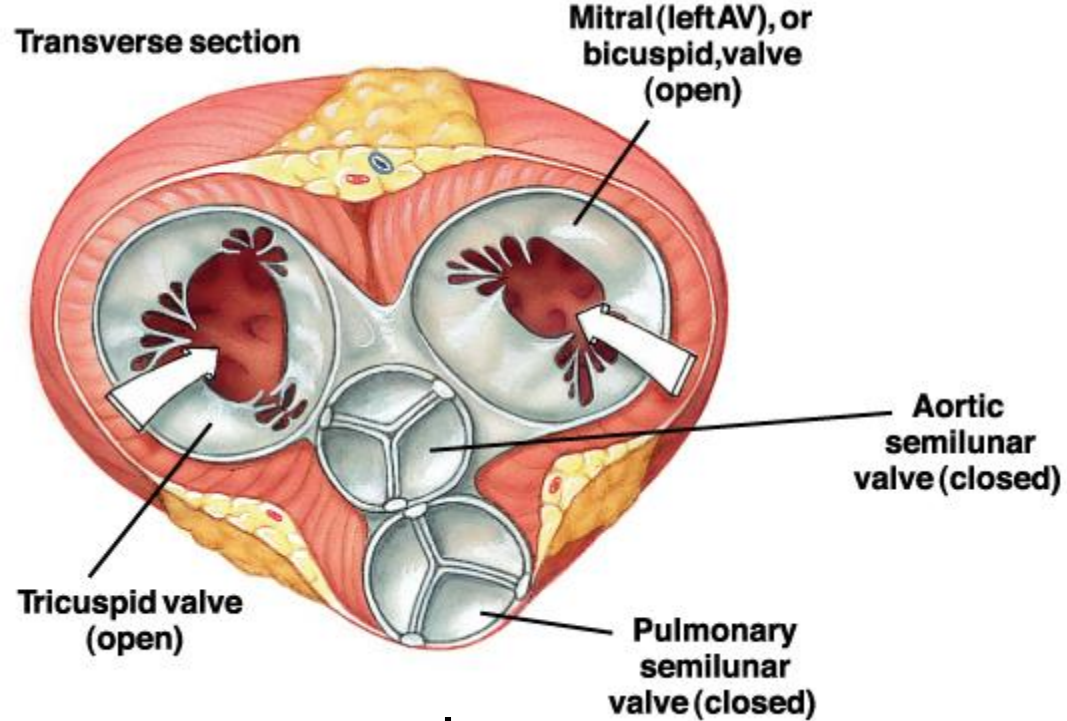
Heart

- Epicardium
 - Visceral Layer of serous Pericardium
 - Mesothelium
 - Thin CT
- Subepicardium
 - Loose CT
 - Veins
 - Nerves
 - Neural Ganglia



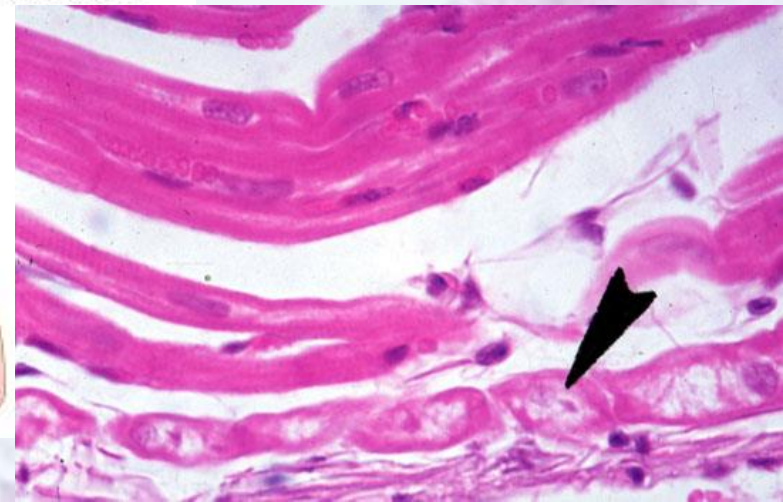
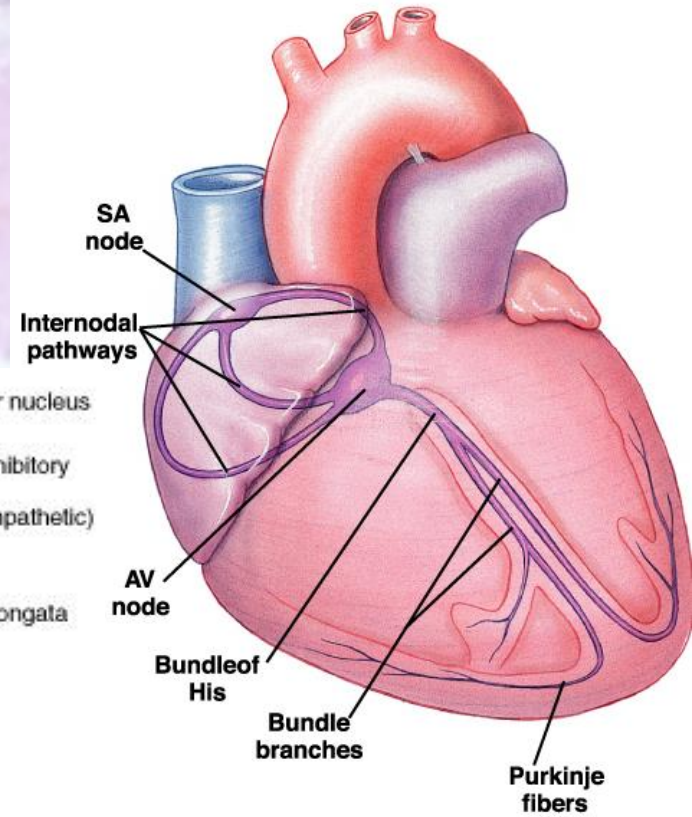
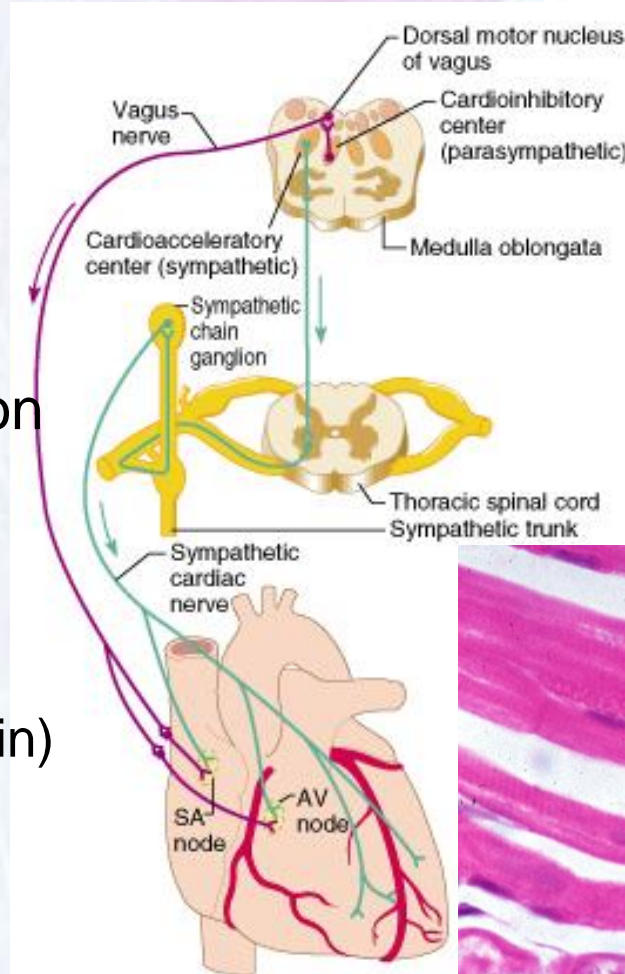
Fibrous Skeleton of Heart & Cardiac Valves

- Dense CT
 - Membranous septum
 - Fibrous Trigoni
 - Fibrous Rings
- Cardiac Valves
 - Dense Fibrous CT
 - Endothelium

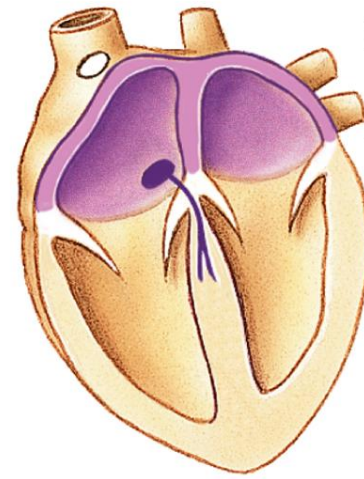


Conducting System

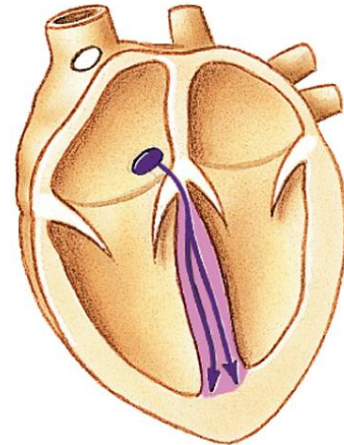
- Sino-Atrial (SA) Node
 - Pacemaker
 - Atrio-Ventricular Node
 - Atrio-Ventricular Bundle
 - Right & Left Branches
 - Purkinje Cells
-
- Pulse Rhythm Regulation
 - Sympathetic
 - Parasympathetic
 - Sensory Nerves
 - Free Nerve Ending (Pain)



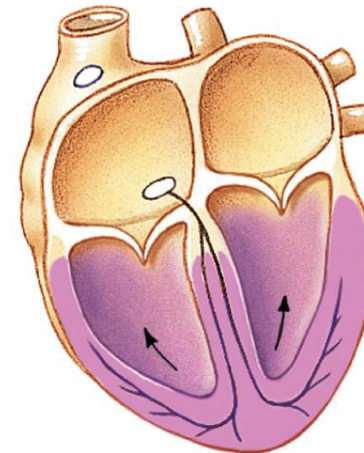
Conducting System



Depolarization spreads more slowly across atria. Conduction slows through AV node.



Depolarization moves rapidly through ventricular conducting system to the apex of the heart.



Depolarization wave spreads upward from the apex.

Endothelial Functions

- Metabolites & Gas Exchange
- Anti Thrombosis
- Activation
 - Angiotensin I to Angiotensin II in Pulmonary Endothelium
- Inactivation
 - Bradikinin
 - Serotonin
 - Prostaglandins
 - Norepinephrine
 - Thrombin
- Lipolysis
- Vasoactive Substance Production
 - Endothelin
 - NO

- Angiogenesis (VEGF)