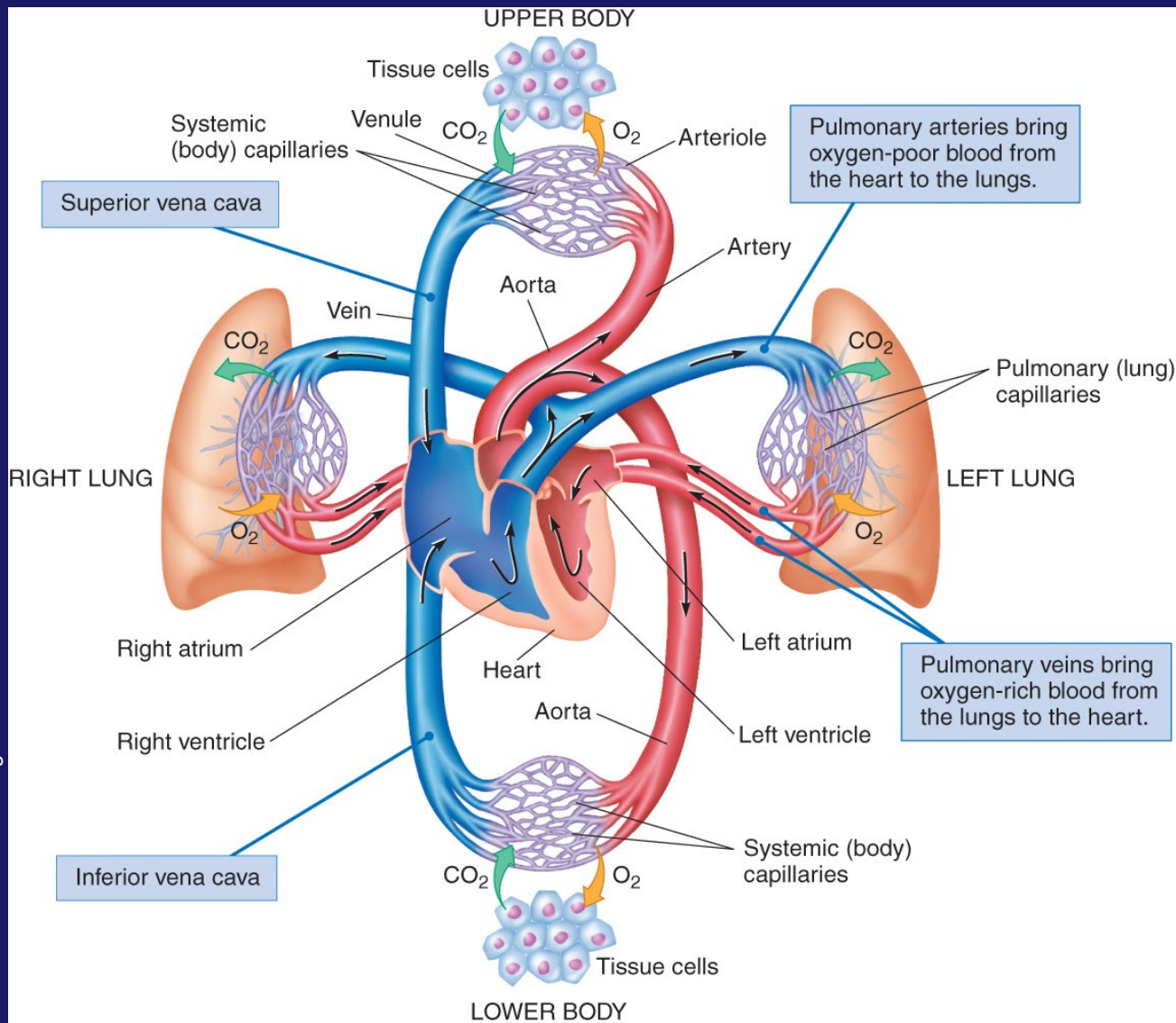


The Circulatory System



Pea Ridge Fire Department EMS refresher



Blood

- Created through hematopoiesis
- Cell production:
 - Bone marrow (primary site)
 - Lymphoid tissues (thymus, lymph nodes, spleen)

Spleen

- Filters and breaks down RBCs
- Assists with production of lymphocytes
- Has an important role in homeostasis and infection control

Functions of Blood

- Respiratory
- Nutritional
- Excretory
- Regulatory
- Defensive

Blood Composition

- Blood consists of plasma (55%) and formed cellular fragments (45%).
- Plasma
 - Water (92%)
 - Proteins (7%)
 - Albumins
 - Globulins
 - Fibrinogen
 - Remainder: oxygen, carbon dioxide, nitrogen, electrolytes, nutrients, and wastes

Hematopoietic Stem Cells

- Have the ability to change into multiple different types of cells
 - Created through hematopoiesis
 - Begin in bone marrow
 - Formation of hematocytoblasts that gradually differentiate into one of the blood components

Red Blood Cells

- Carry oxygen to tissues
- Most numerous formed elements
- Contain hemoglobin, which carries oxygen by binding to it
- Constantly being made by erythropoiesis
 - Finite lifespan of 120 days

Red Blood Cells

- Common laboratory tests on blood:
 - RBC count
 - Hemoglobin level
 - Measurement of hematocrit

White Blood Cells

- Move through capillary walls and into tissues
- Elevated count during inflammatory response, immune response, or both
- Types
 - Neutrophils, eosinophils, basophils, lymphocytes, monocytes

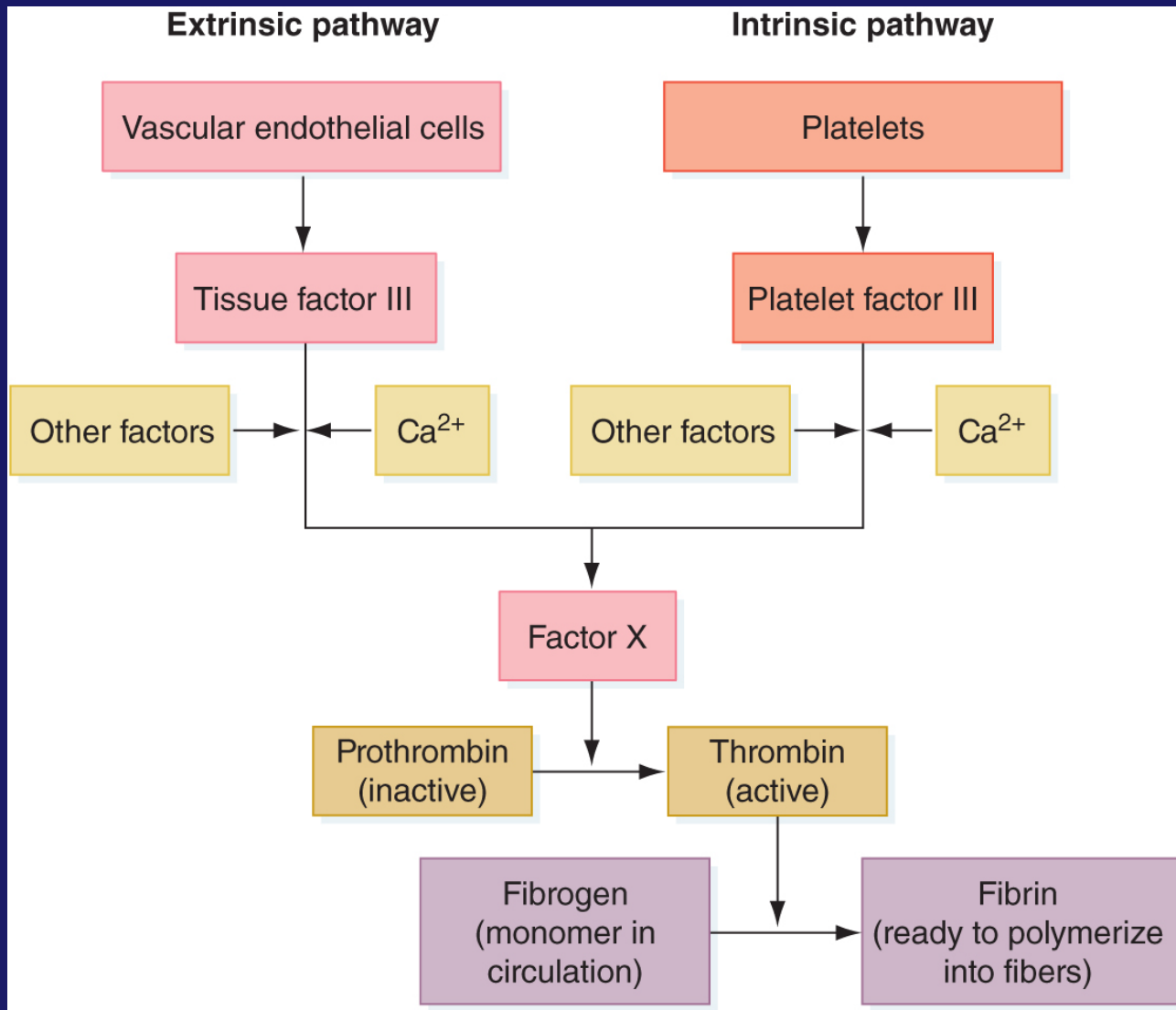
Platelets

- Production is controlled by thrombopoietin, a protein hormone.
- Platelets circulate in the blood for 7 to 10 days.

Platelets and Blood Clotting

- Platelets help form blood clots.
 - Clotting is a chain reaction stimulated by the release of thromboplastin from injured cells lining damaged blood vessels.
 - During fibrinolysis, the enzyme plasminogen is converted to plasmin, which dissolves the fibrin fibers of the clot.

Platelets and Blood Clotting



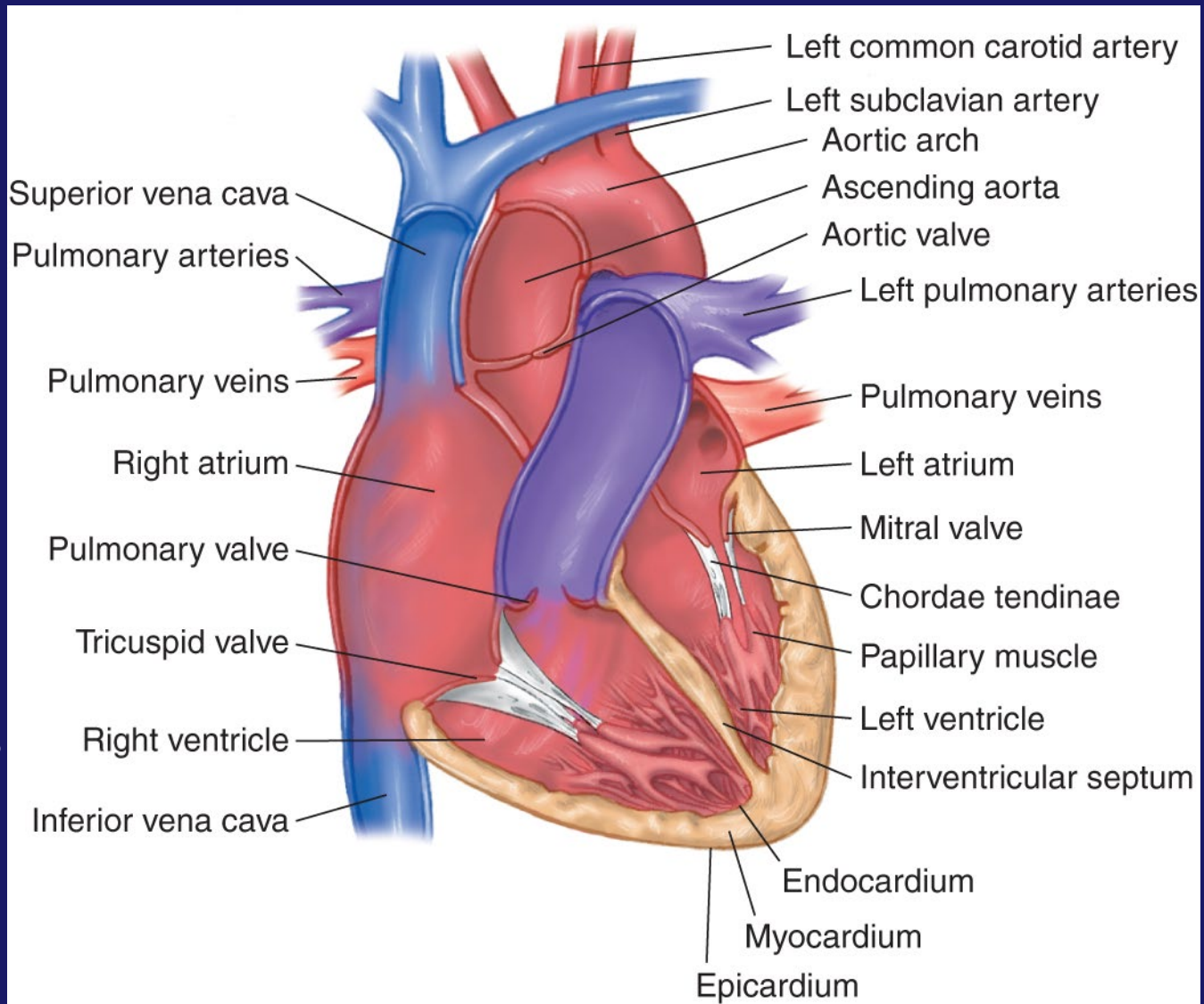
ABO and Rh Blood Groups

- Blood types are classified based on presence or absence of specific antigens.
- The ABO system identifies blood types O, A, B, and AB.
 - Type O: universal donor
 - Type AB: universal recipient
- Rh factor is present in Rh-positive blood.
- Rh factor is not present in Rh-negative blood.

The Heart

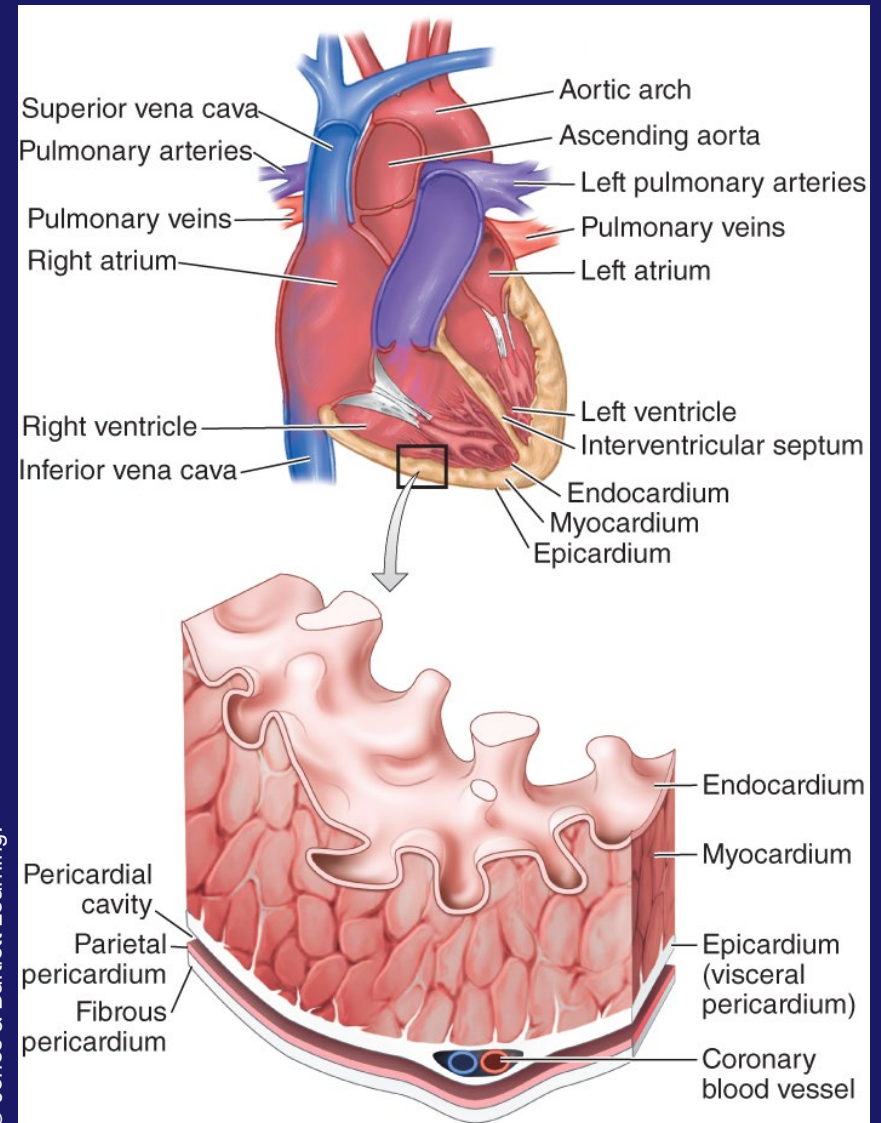
- The heart is a muscular organ that pumps blood throughout the body.
- Venae cavae return venous blood from the upper and lower parts of the body to the right atrium.
- The aorta and pulmonary arteries carry blood away from the heart.

The Heart



The Heart

- Three layers compose the wall of the heart:
 - Epicardium (outer)
 - Myocardium (middle)
 - Endocardium (inner)



The Heart

- The heart has four chambers:
 - Two atria
 - Two ventricles
- Atria receive blood returned to the heart.
- Ventricles pump blood out of the heart.

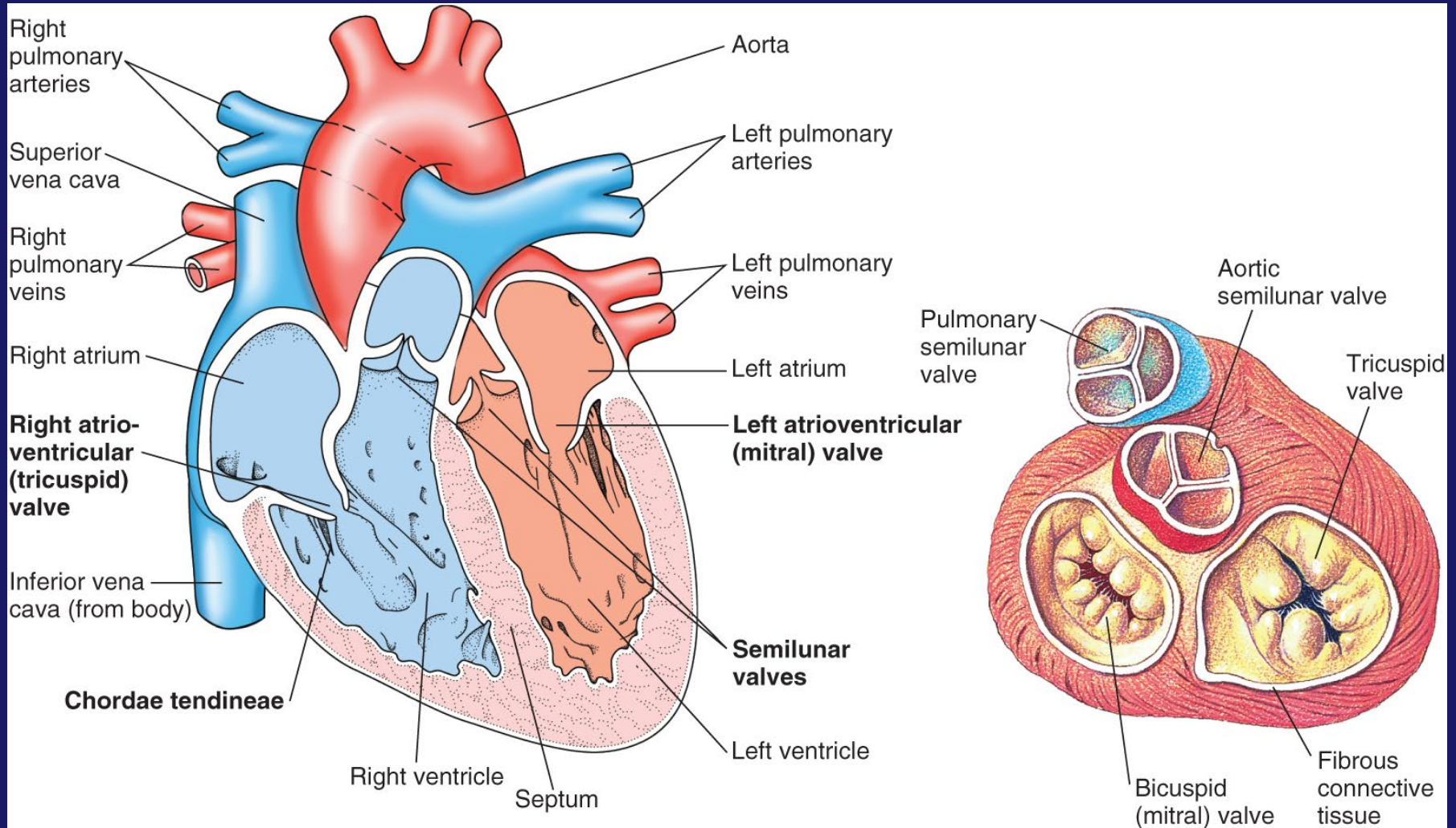
Cardiac Muscle

- Cardiac muscle is unique to the heart.
- Contraction occurs when calcium interferes with troponin and tropomyosin.
- Muscle fibers are long, branching cells that fit together at intercalated disks.
 - Allows the walls of the atria (and ventricles) to contract almost at the same time

Heart Valves

- The heart has four valves:
 - Two atrioventricular valves
 - Two Semilunar valves
- These valves do the following:
 - Direct the flow of blood between the chambers
 - Prevent backward flow during ventricular contraction (regurgitation)

Heart Valves



Blood Flow Through the Cardiovascular System

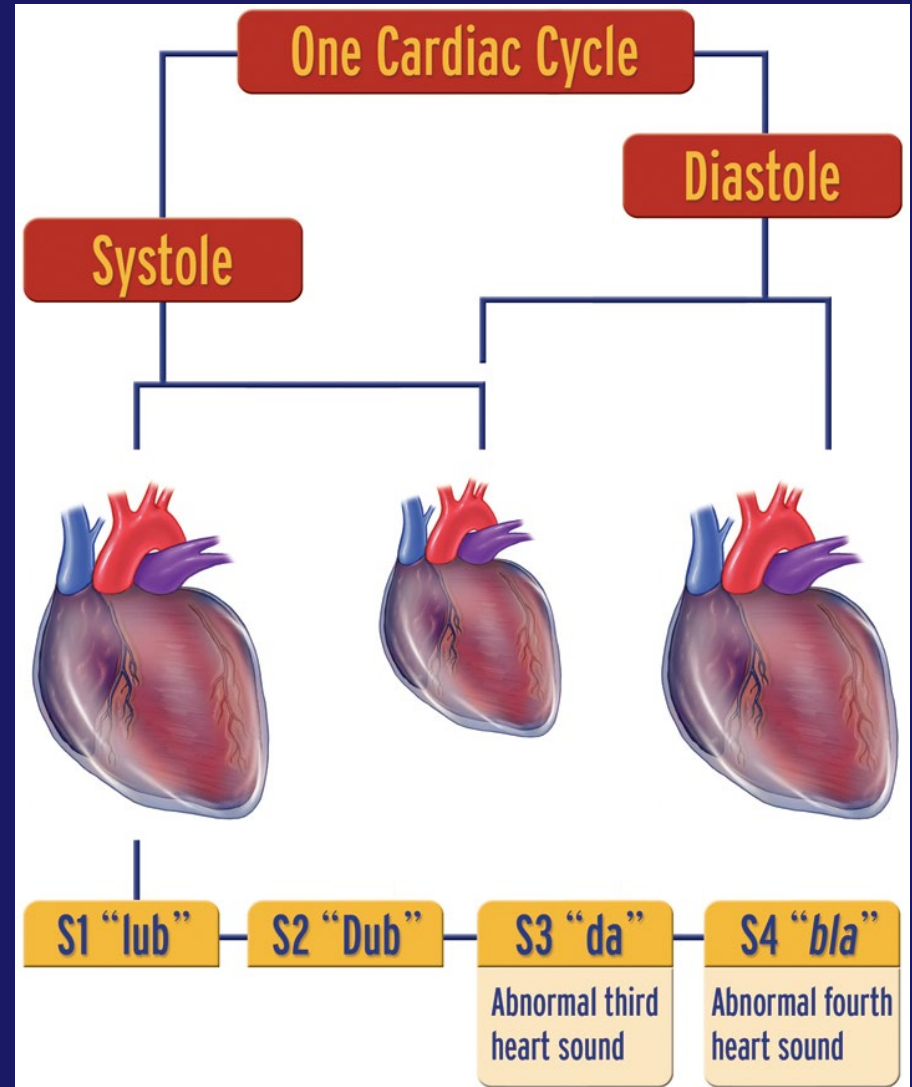
- The body's total blood volume can be divided into:
 - Systemic circulation (85%)
 - Pulmonary circulation (about 10%)
 - Heart chambers (about 5%)

The Cardiac Cycle

- Creates the pumping of the heart
- Systole
 - Contraction of ventricular mass
 - Pumping of blood into systemic circulation
- Diastole
 - Relaxation phase of cycle

Heart Sounds

- Created by contraction and relaxation of heart and flow of blood
 - Heard during auscultation with stethoscope
- S_1 and S_2 are normal sounds.
 - S_3 and S_4 are not



Cardiac Output

- Cardiac output = stroke volume $\times$ heart rate
- Stroke volume: amount of blood ejected per contraction
- Heart rate: number of cardiac contractions/minute (pulse rate)
- Ejection fraction: percentage of blood that leaves the heart each time it contracts

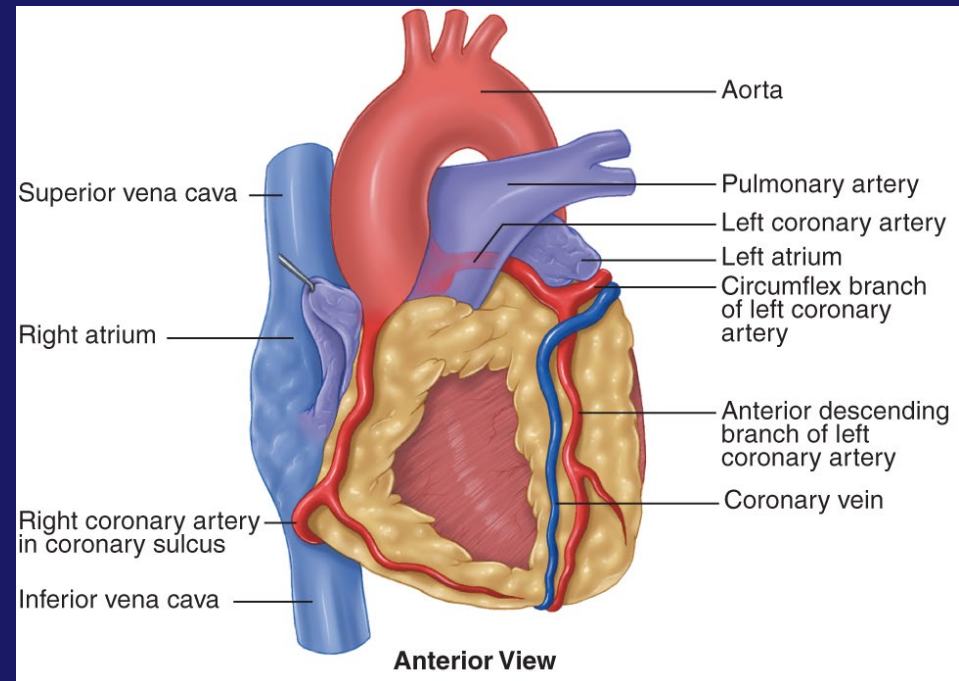
Cardiac Output

- Preload: volume of blood in the ventricle at the end of diastole; reflection of venous return
- Afterload: force against which the ventricles must contract to eject blood
- Several ways of increasing SV

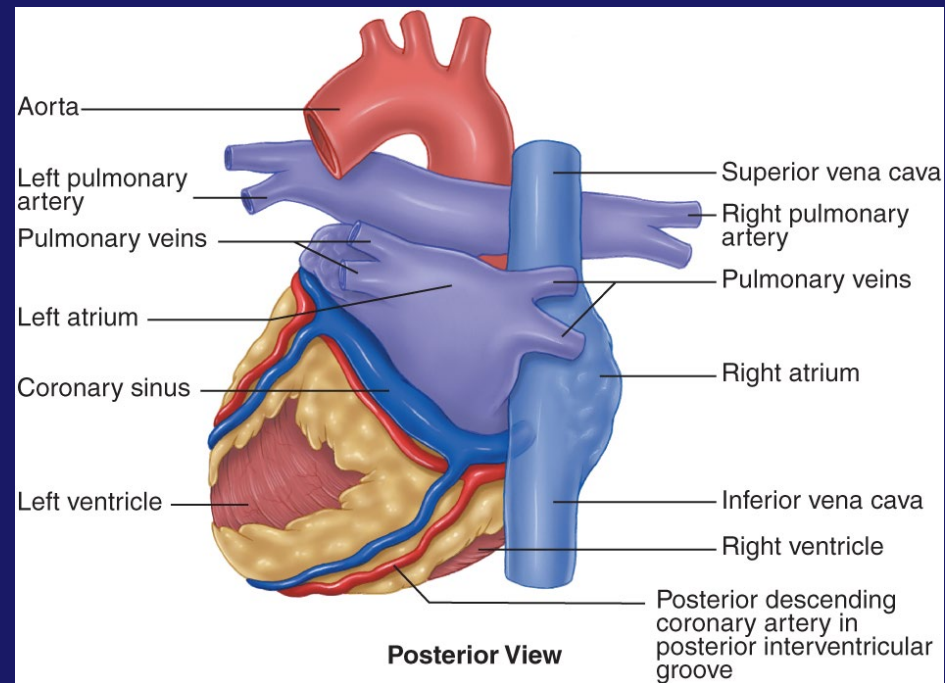
Coronary Circulation

- Oxygenated blood reaches the heart through the coronary arteries.
 - The left coronary artery supplies the left ventricle, interventricular septum, and part of the right ventricle.
 - The right coronary artery supplies blood to the walls of the right atrium and ventricle, left ventricle, and portions of the conduction system.

Coronary Circulation



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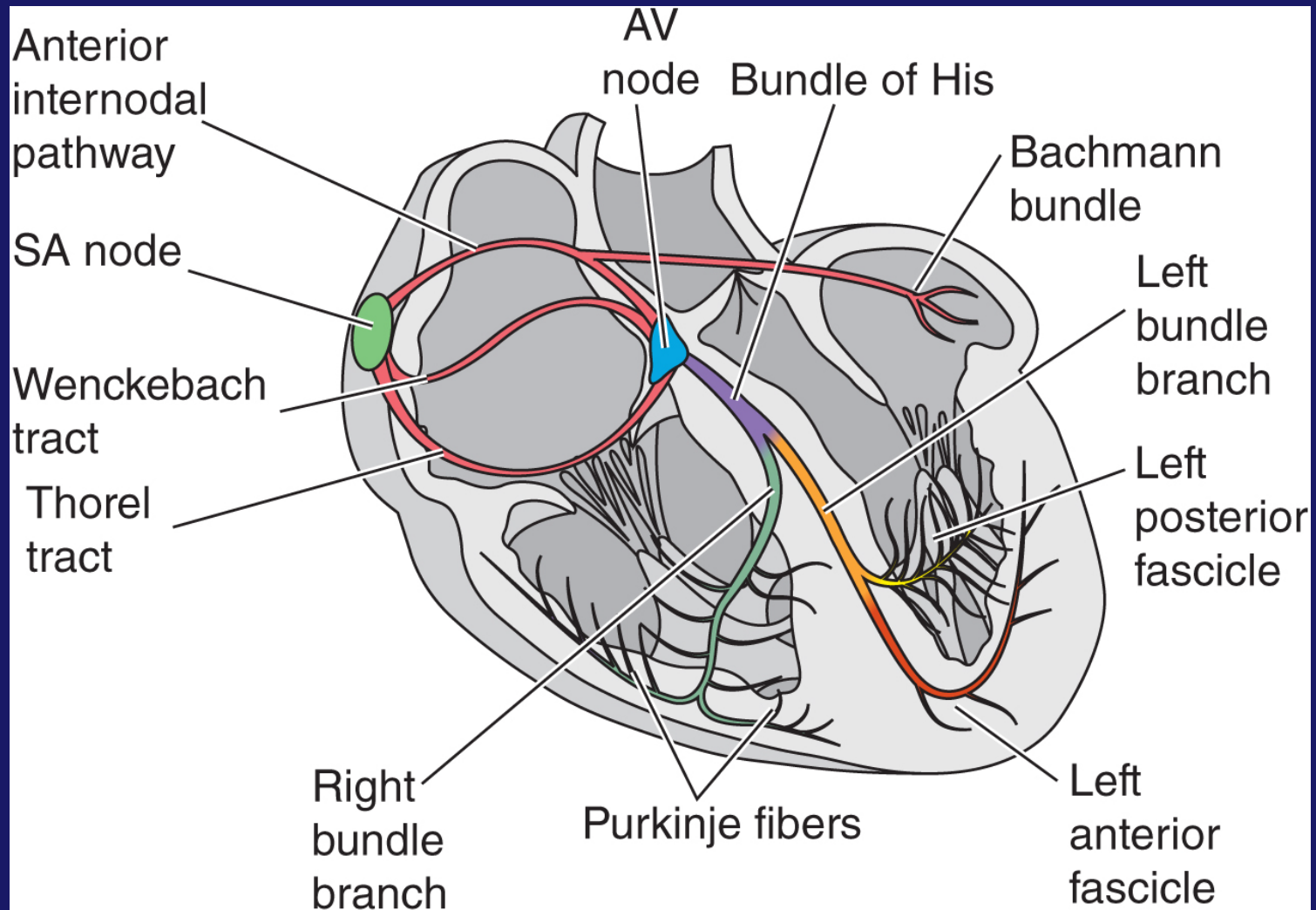


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The Electrical Conduction System

- Electrical stimuli control mechanical pumping action.
- Conduction system components include:
 - Sinoatrial (SA) node
 - Atrioventricular (AV) node
 - Bundle of His
 - Right and left bundle branches
 - Purkinje fibers

The Electrical Conduction System



Regulation of Heart Function

- The ANS innervates the heart by means of cardiac nerves.
- Branches of the vagus nerves provide parasympathetic innervation.
- Networks of sympathetic and parasympathetic fibers perform various functions.

Regulation of Heart Function

- Factors that influence heart rate:
 - Stimulation of sympathetic nerves
 - Electrolyte and hormone levels
 - Metabolic rate
 - Medications
 - Stress, anxiety, fear
 - Body temperature

Blood Vessels and Circulation

- The vasculature can be divided into:
 - Arterial system
 - Venous system
 - Microcirculation

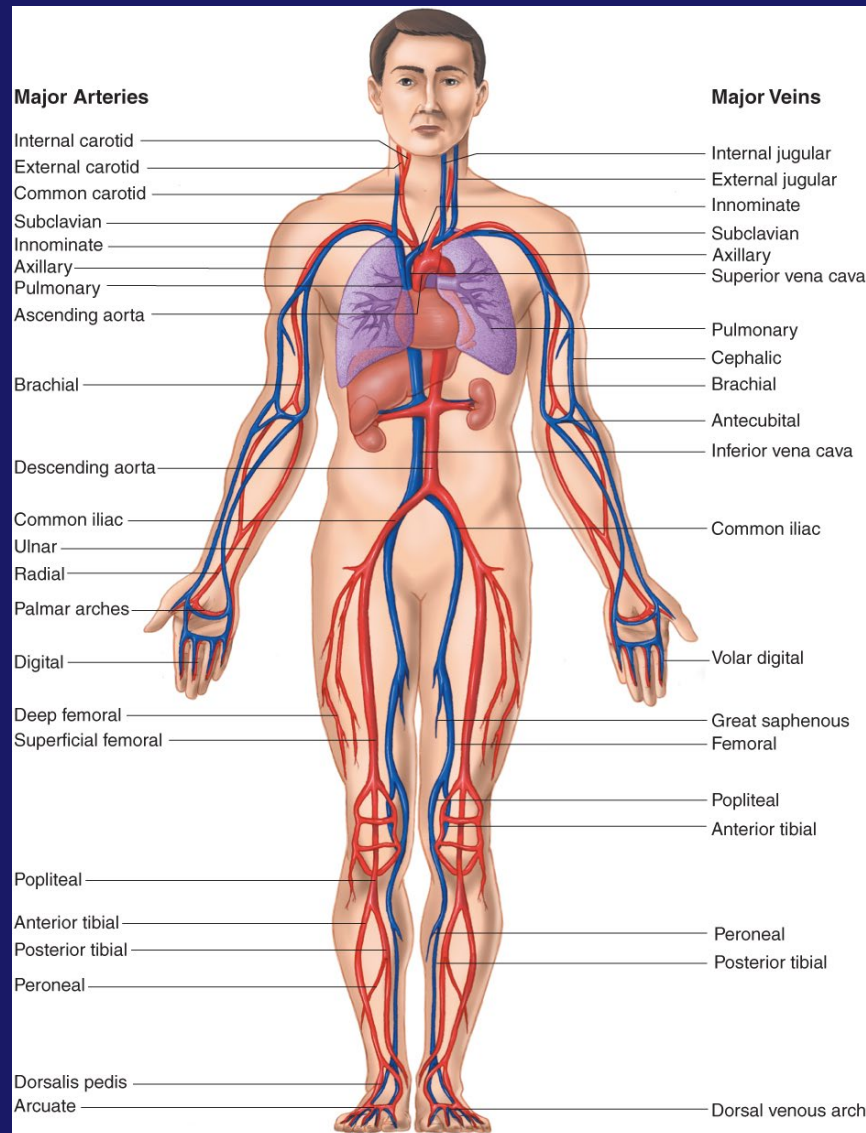
Arterial System

- Ascending aorta
 - originates from the base of the heart and terminates by becoming the arch of the aorta
- Descending aorta
 - named according to its location within the body cavities
- Aortic arch

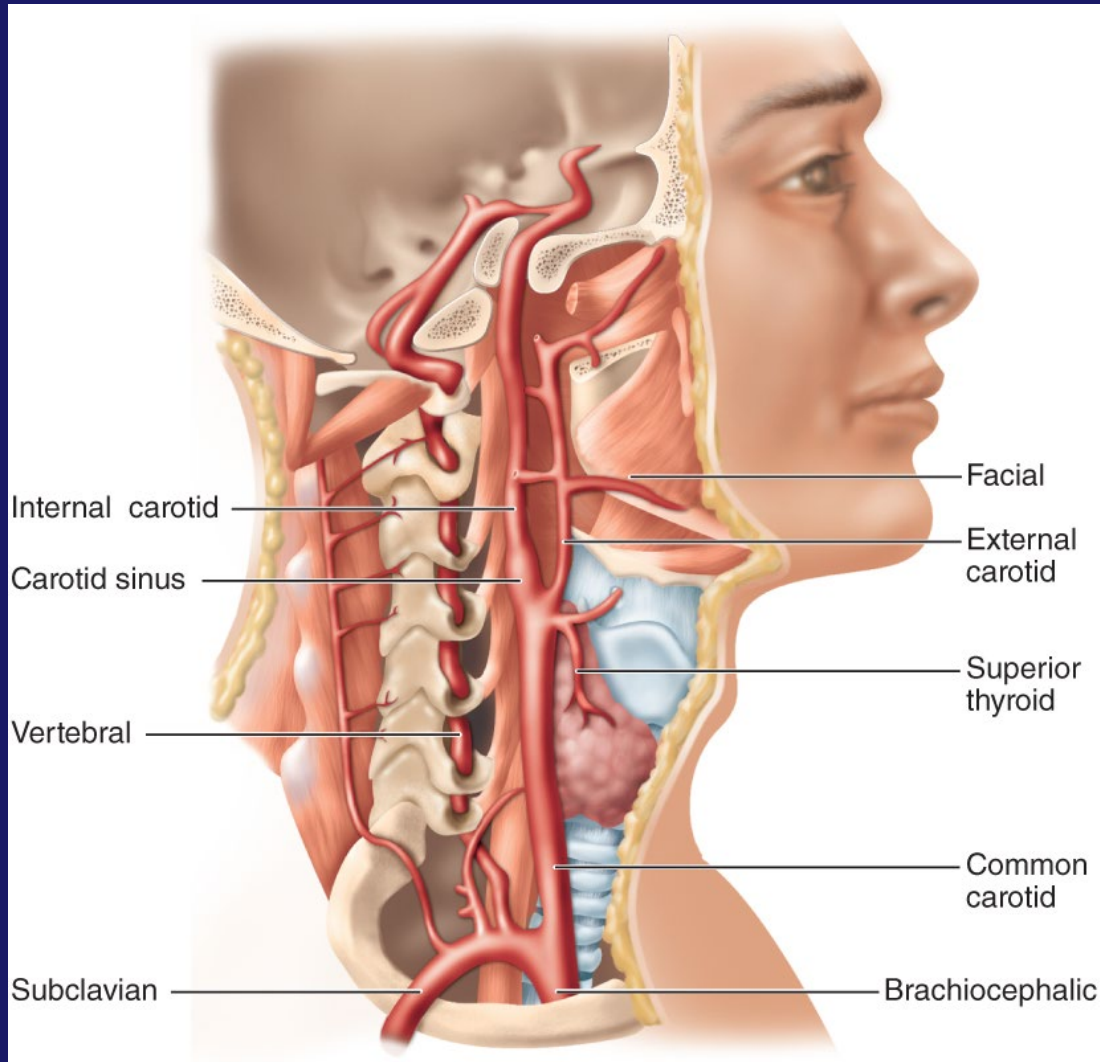
Arterial System

- Types of arteries
 - Conducting arteries
 - Distributing arteries
 - Arterioles

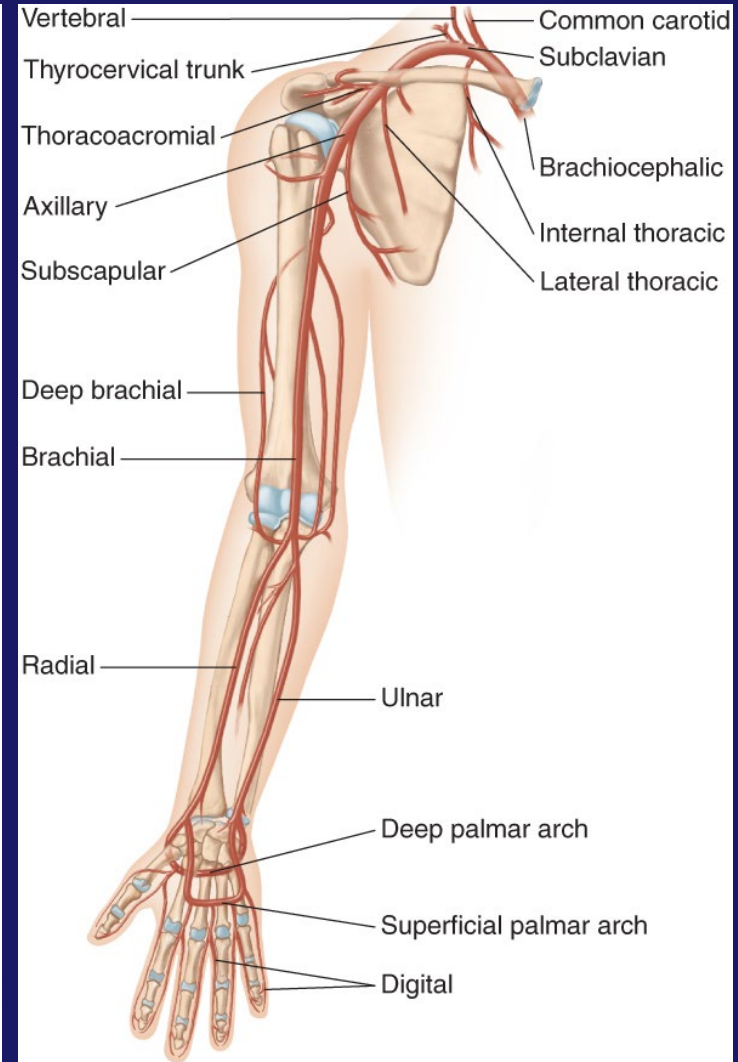
Arterial System



Arterial System



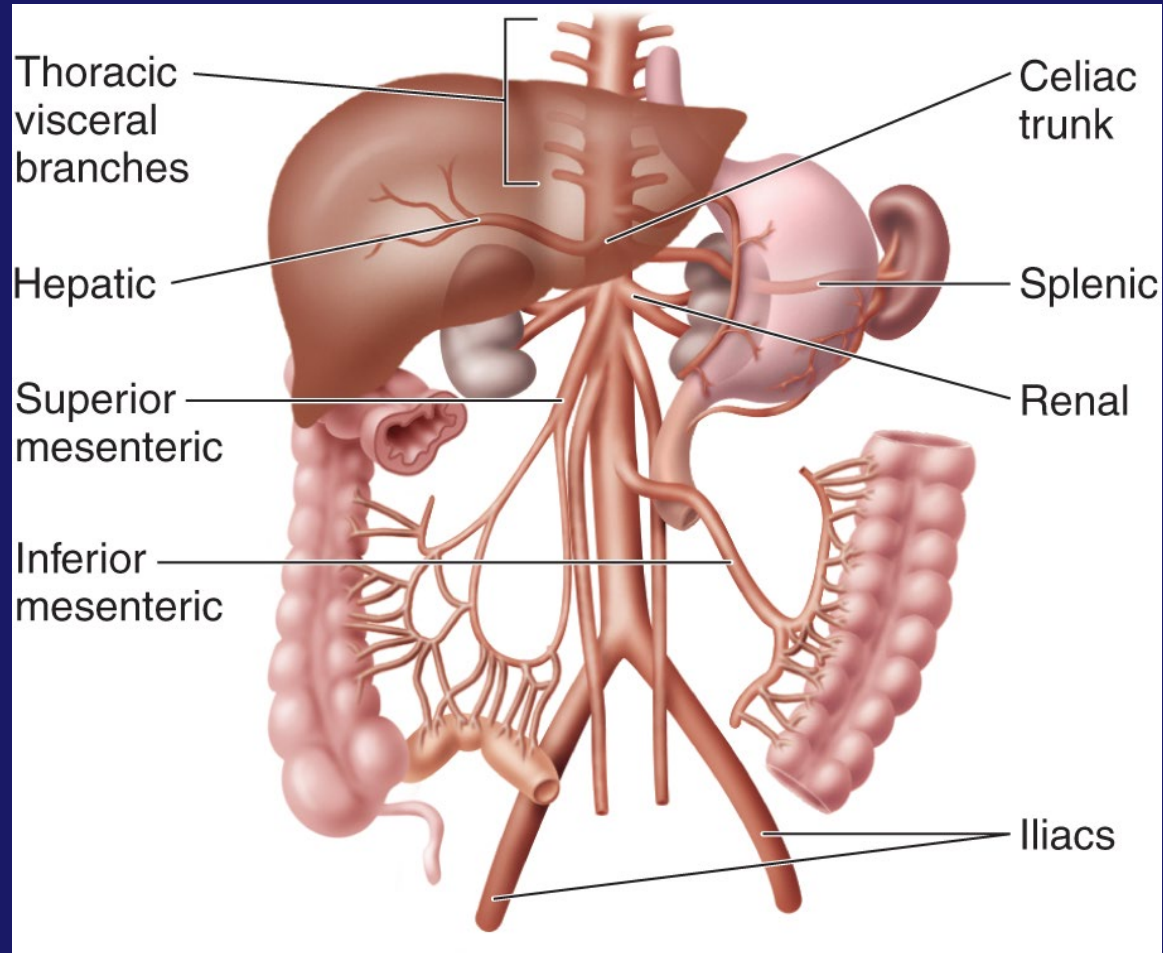
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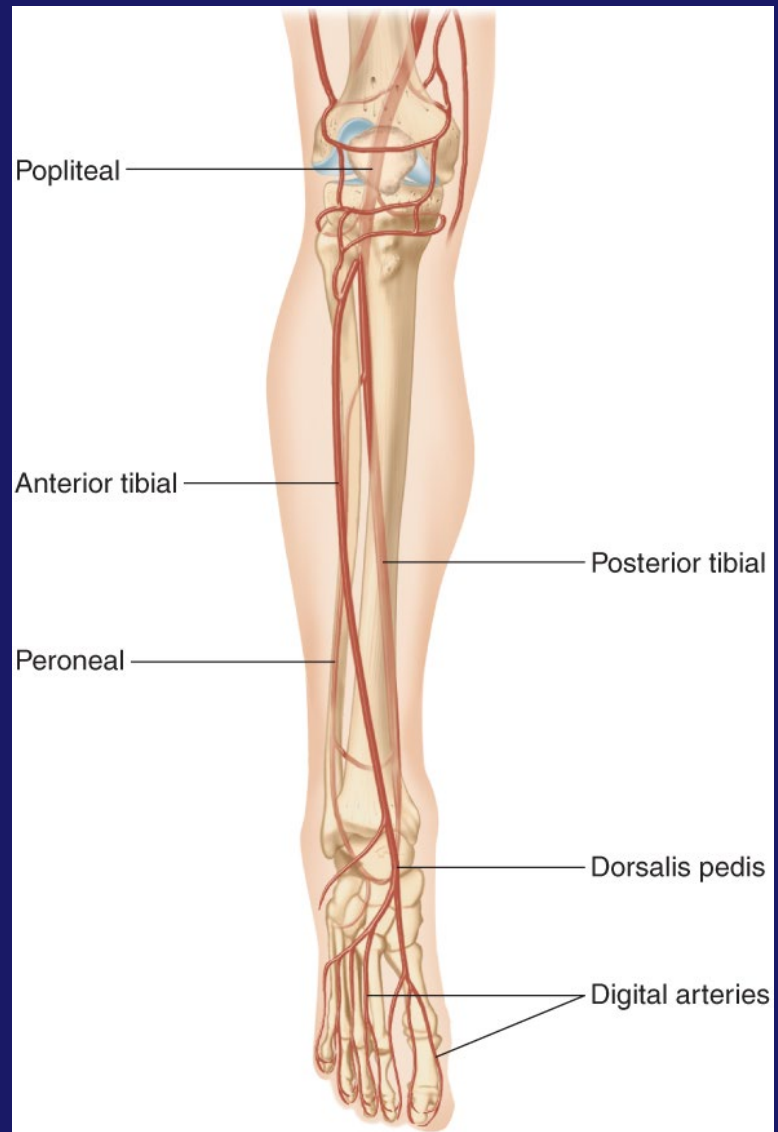
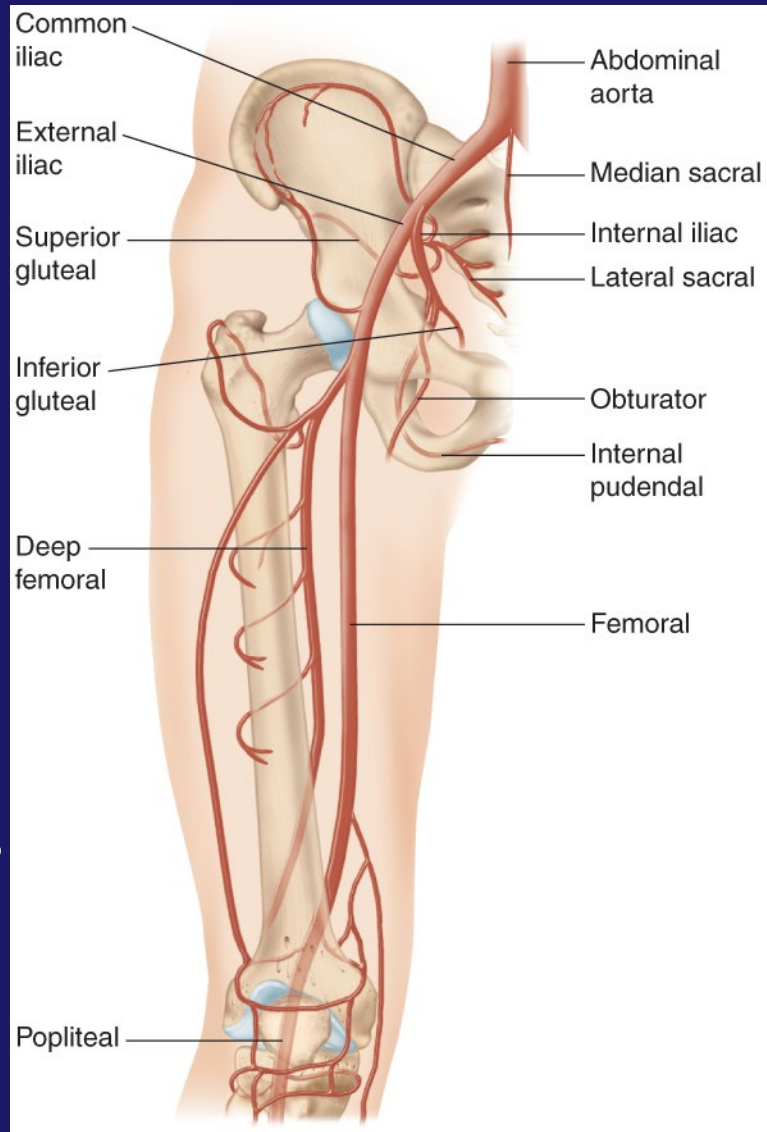
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Arterial System

- Branches of the abdominal aorta



Arterial System

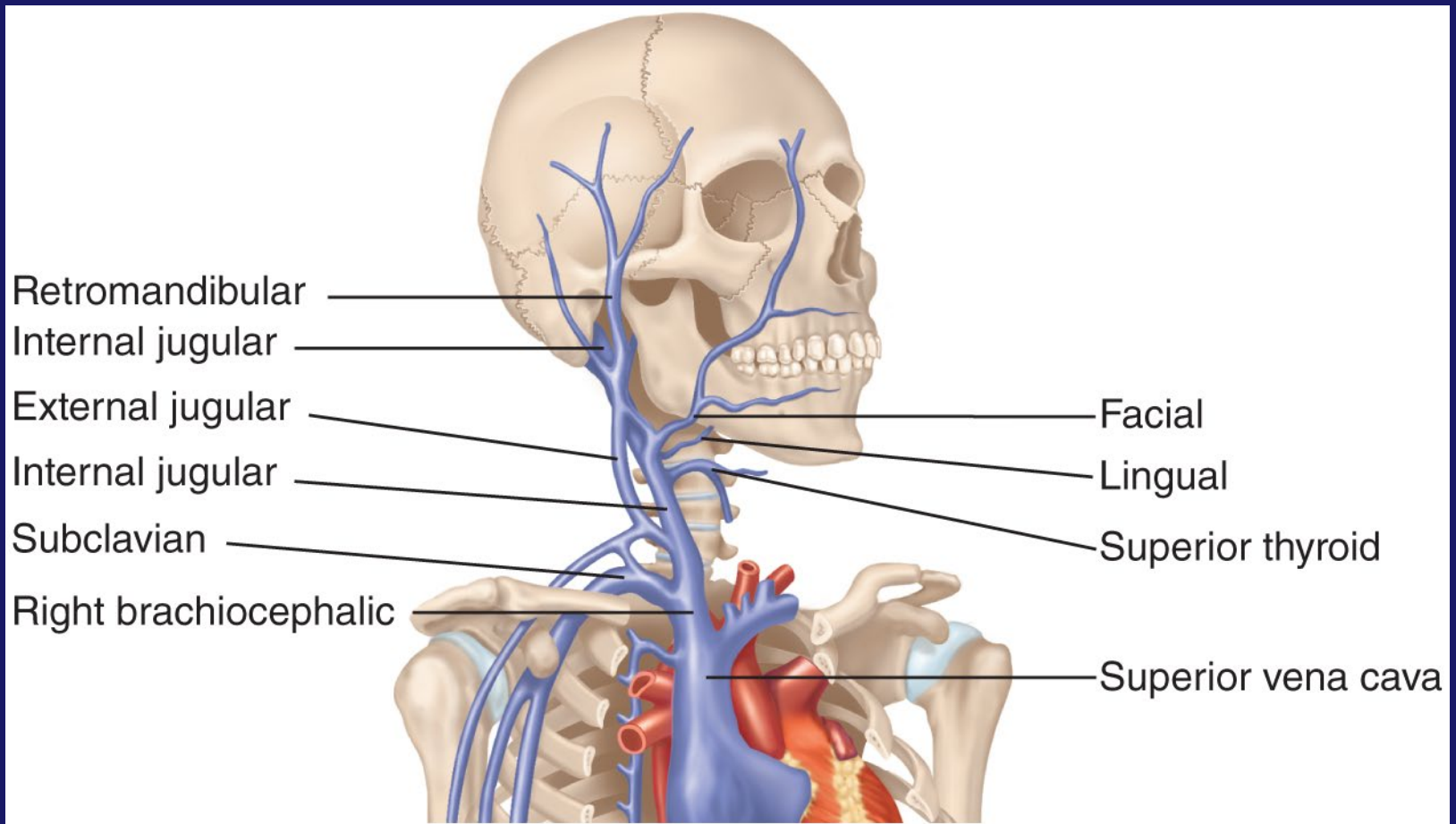


Venous System

- Collection system
 - Venules: smallest venous vessels
 - Medium-sized vessels
 - Superior vena cava and inferior vena cava
- Pulmonary circulation
- Systemic circulation

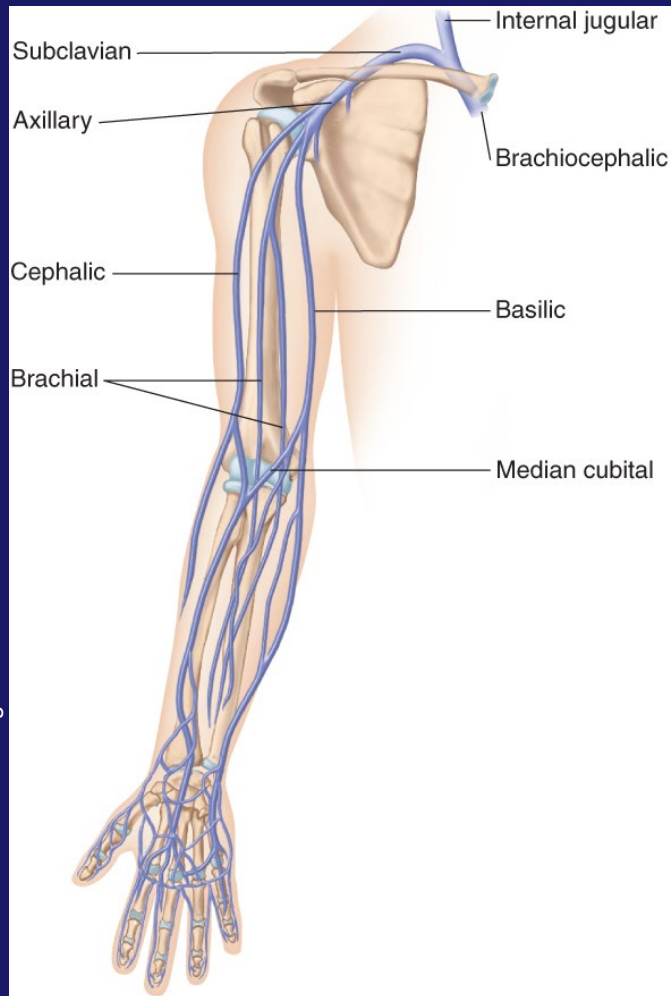
Venous System

- Veins of the head and neck

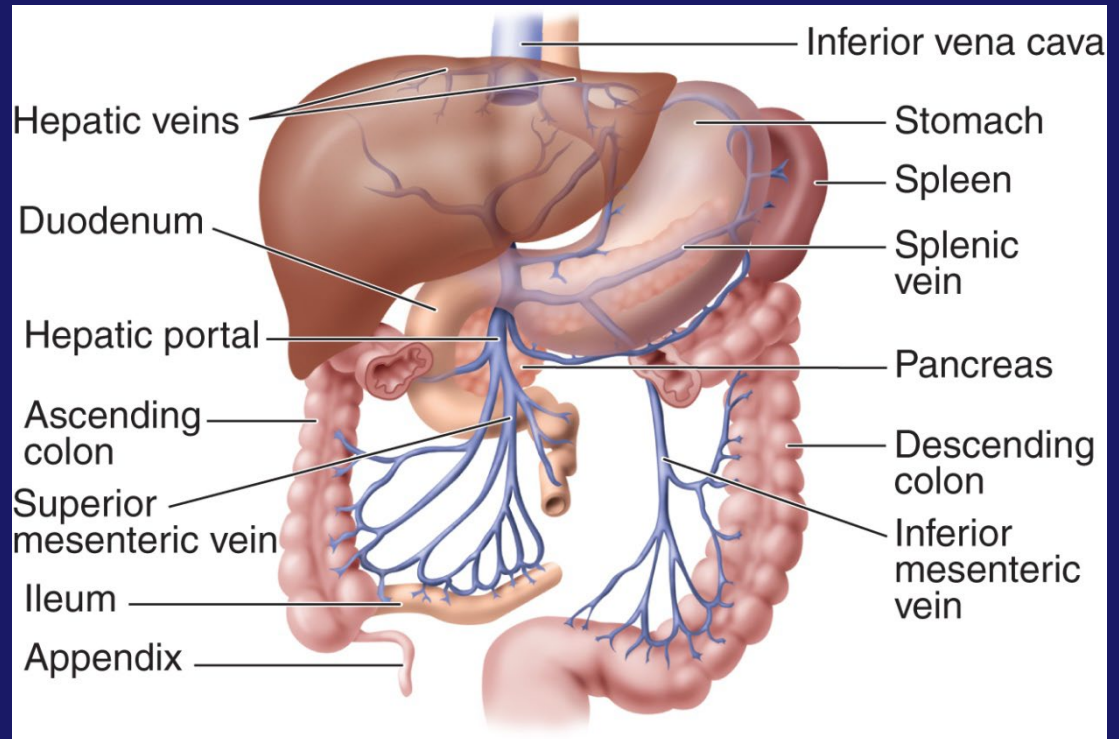


Venous System

- Veins of the upper extremity

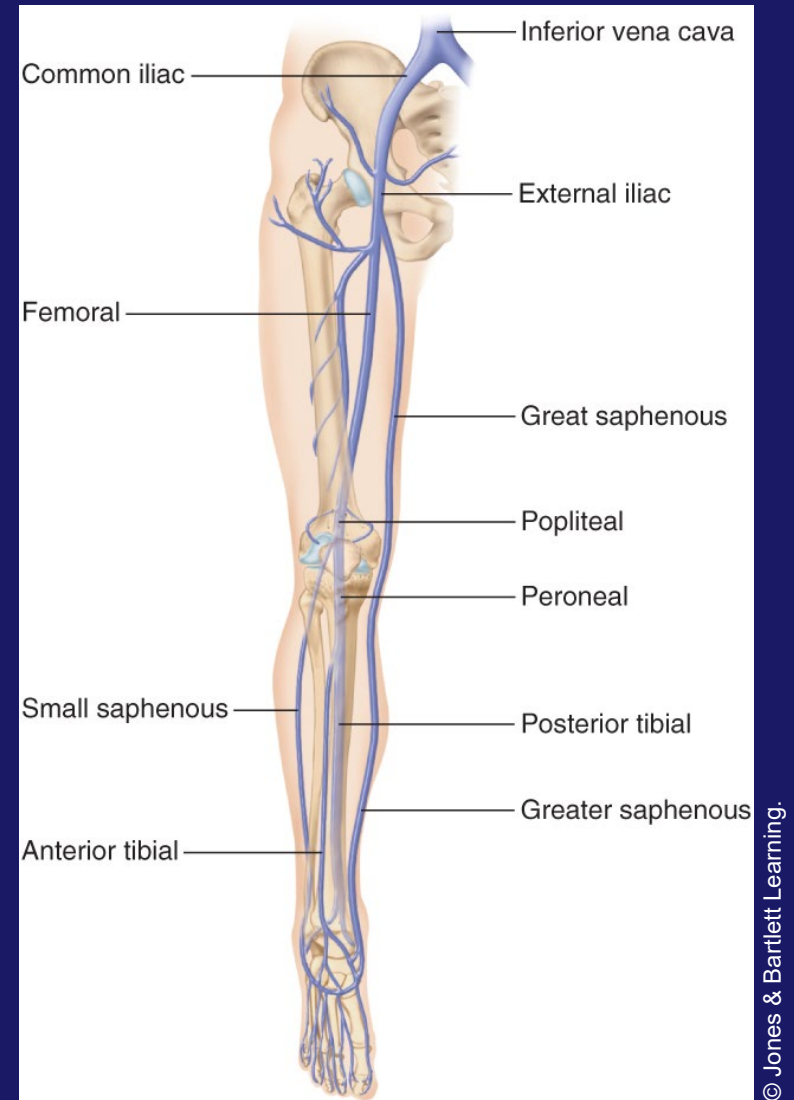


- Hepatic portal system



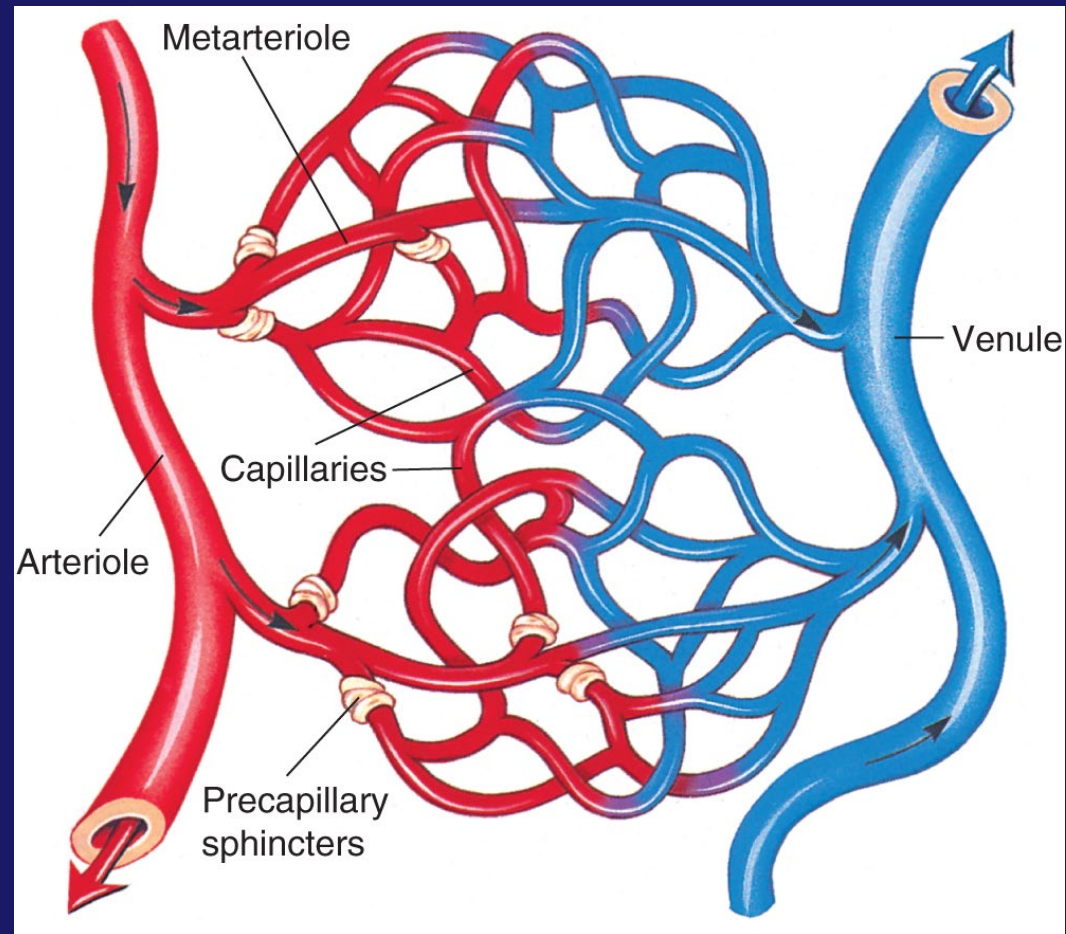
Venous System

- Veins of the lower extremity



Microcirculation

- Portion of the vasculature consisting of the arterioles, capillaries, and venules



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Microcirculation

- Most important functions are:
 - Transport of nutrients to the tissues
 - Removal of cellular waste

Microcirculation

- Capillary filtration
 - Depends on three factors
 - Capillary membrane permeability
 - Arterial hydrostatic pressure
 - Venous oncotic pressure
 - No sharing of the same membrane permeability

Microcirculation

- Movement of water between the plasma in intravascular compartment and interstitial space is a result of pressure.
 - Hydrostatic pressure
 - Oncotic pressure
 - Balance of pressure by precapillary and postcapillary sphincters

Thank You



Please move to the next section