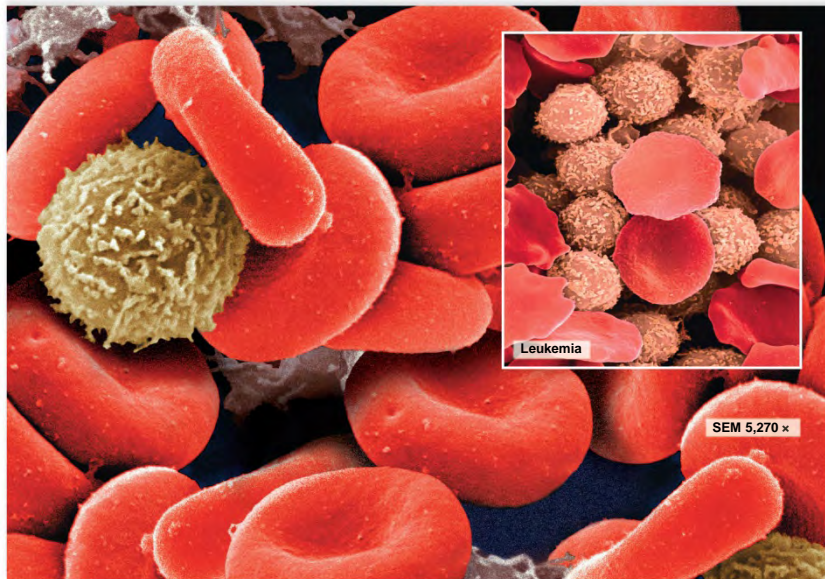


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Circulation & Cardiovascular Systems

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Outline

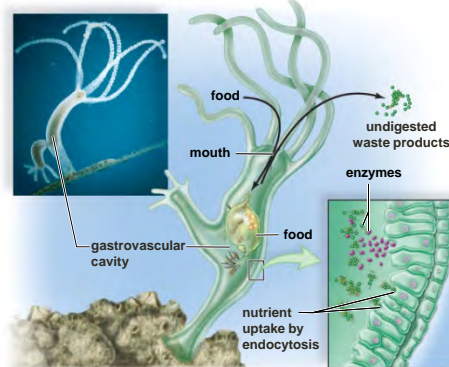
- Transport in Invertebrates
 - Open versus Closed Circulatory Systems
- Transport in Vertebrates
- Transport in Humans
 - Heartbeat
 - Vascular Pathways
 - Blood Pressure
- Cardiovascular Disorders
- Blood
 - Components
 - Clotting

Transport in Invertebrates

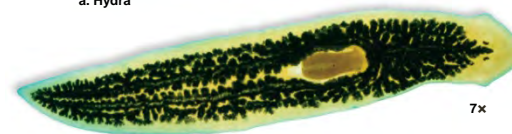
- Small aquatic animals with no circulatory system
 - May rely on external water in gastrovascular cavity to service cells
- Roundworms and other pseudocoelomates
 - Use a fluid-filled body cavity as a means of transporting substances
 - Fluid-filled cavity can also act as a hydrostatic skeleton
- Animals that have a rigid skeleton
 - May still rely on body fluids for the purpose of locomotion
 - Bivalves pump hemolymph into the foot for digging into mud

Aquatic Organisms Without a Circulatory System

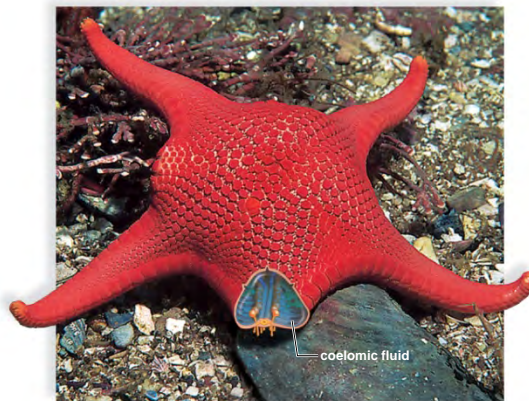
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a. Hydra



b. Flatworm



c. Red sea star, Mediastar

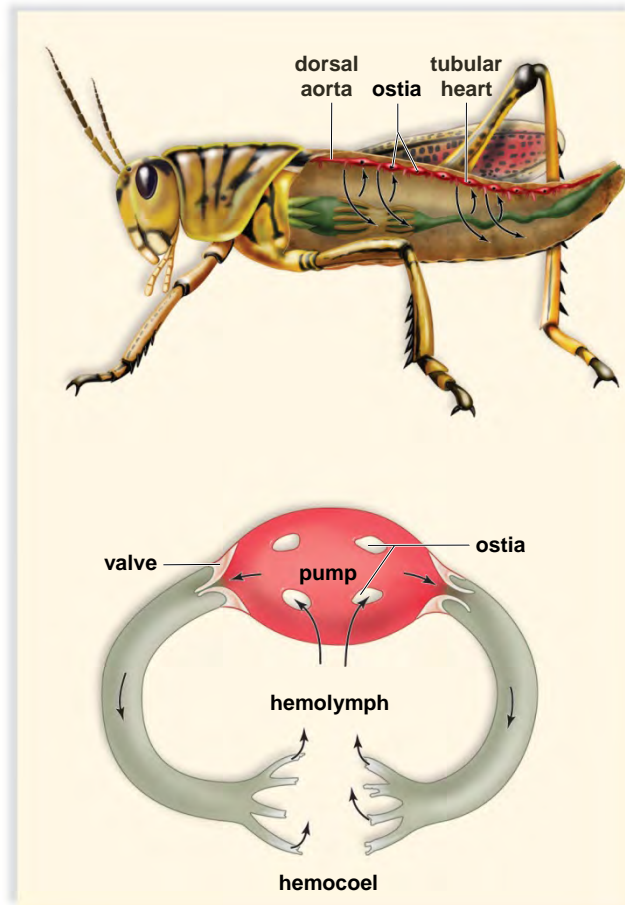
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Open vs. Closed Invertebrate Circulation

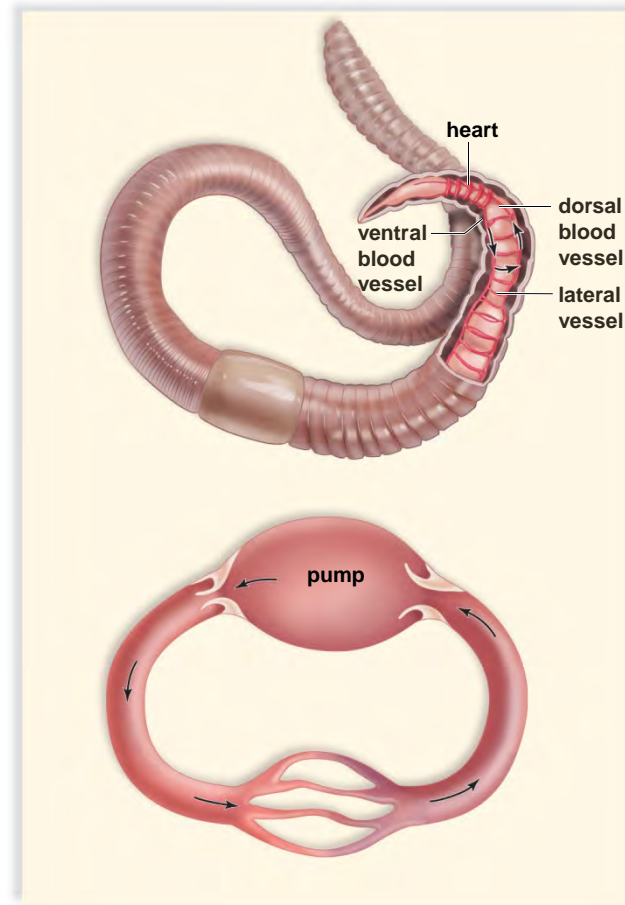
- Two types of circulatory fluids:
 - Blood - contained within blood vessels
 - Hemolymph - flows into hemocoel
- Open Circulatory System
 - Heart pumps hemolymph via vessels
 - Vessels empty into tissue spaces
- Closed Circulatory System
 - Heart pumps blood to capillaries
 - Gases and materials diffuse to and from nearby cells
 - Vessels return blood to heart without it contacting tissues

Open vs. Closed Circulatory Systems

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a. Open circulatory system



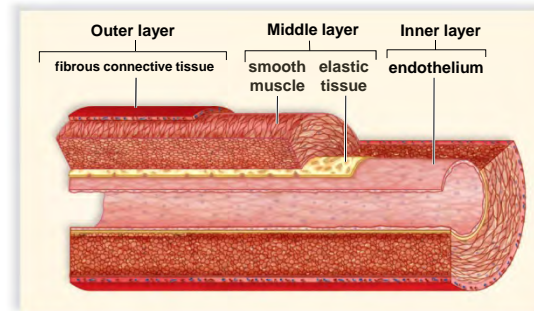
b. Closed circulatory system

Transport in the Vertebrates

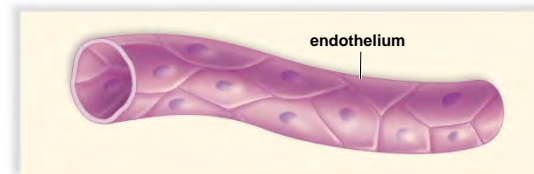
- All vertebrates have a closed cardiovascular system
- Vertebrate heart:
 - Atrial chamber(s) of heart receive blood from general circulation
 - Ventricle chamber(s) of heart pump blood out through blood vessels
- Vertebrate vessels:
 - Arteries - Carry blood away from heart
 - Arterioles – Lead to capillaries
 - Capillaries - Exchange materials with tissue fluid
 - Venules - Lead to veins
 - Veins - Return blood to heart

Transport in Vertebrates

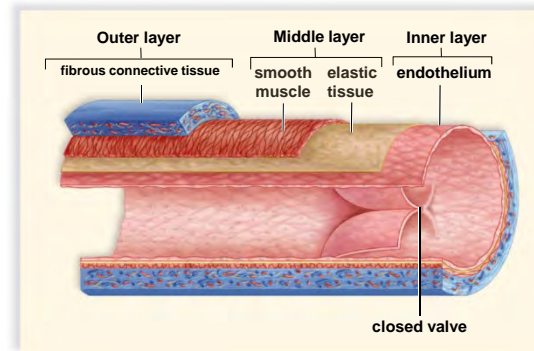
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a. Artery



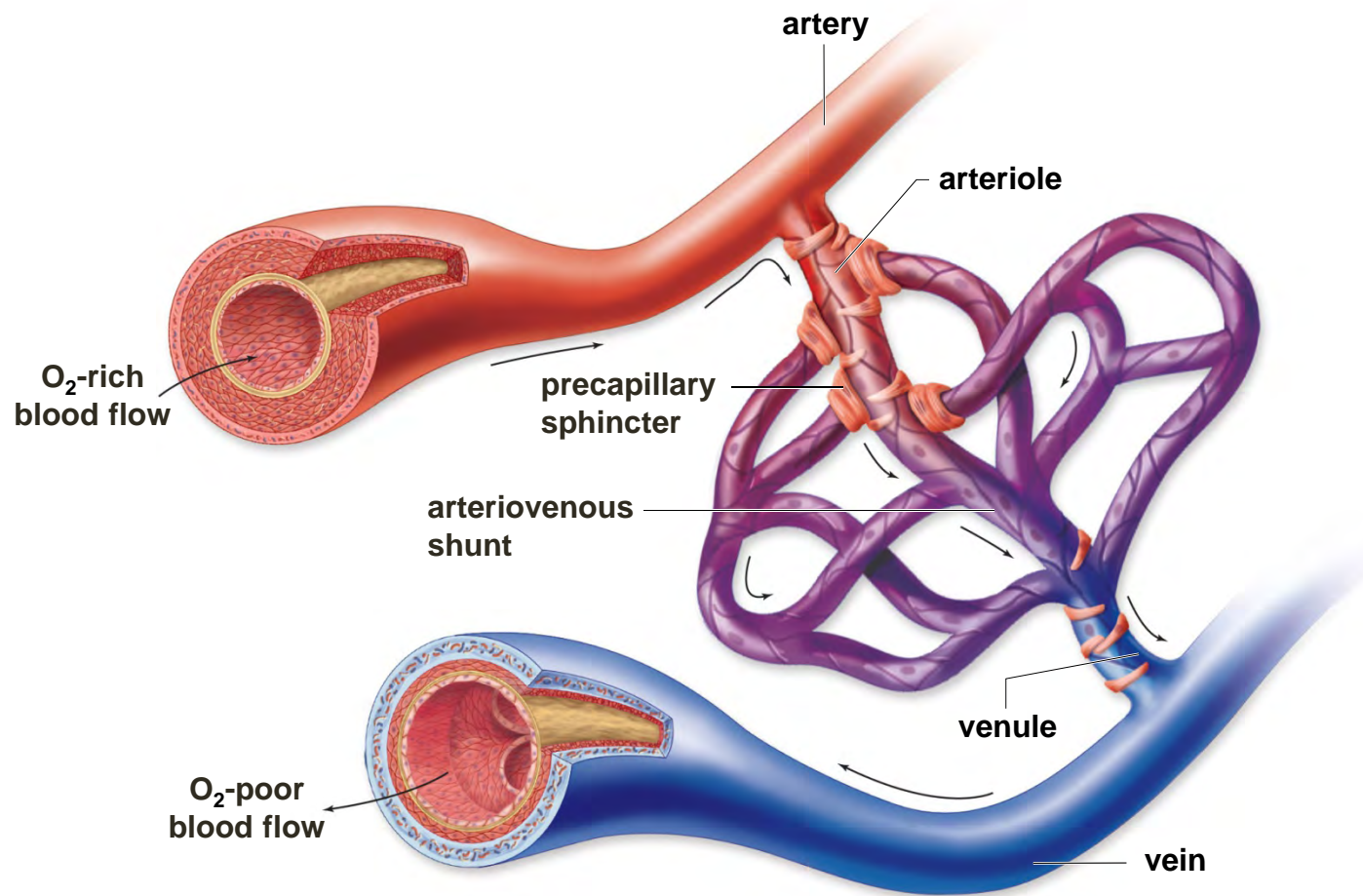
b. Capillary



c. Vein

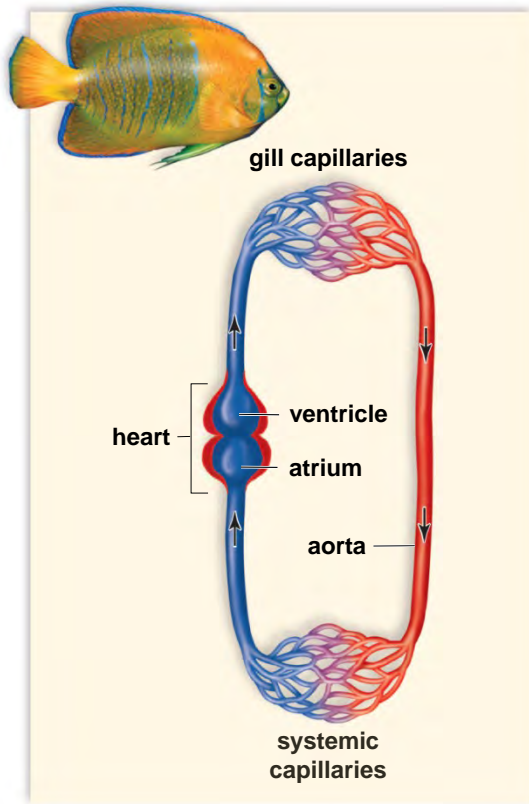
Anatomy of a Capillary Bed

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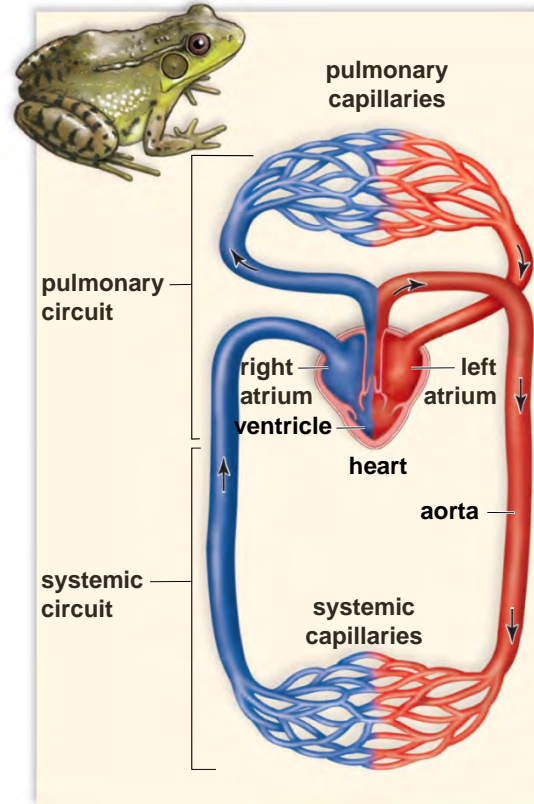


Comparison of Circulatory Circuits in Vertebrates

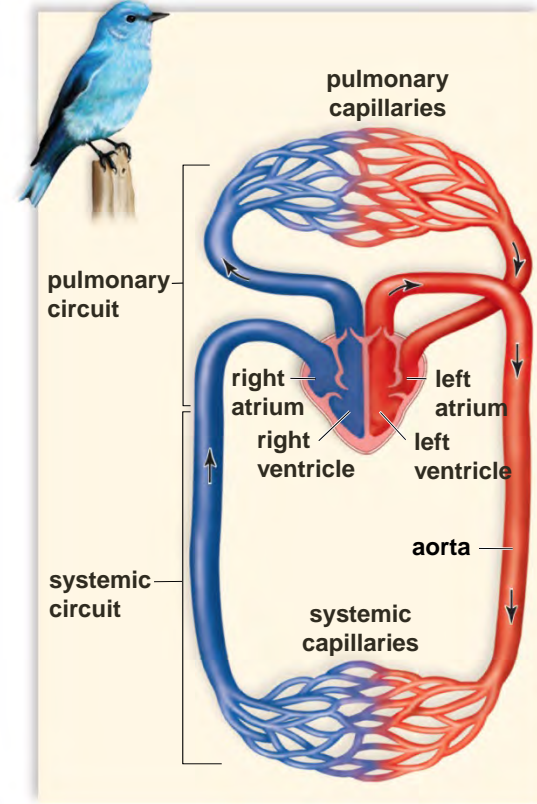
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a.



b.



c.

Comparison of Circulatory Pathways

- Fish - Blood flows in single loop
 - Single atrium and single ventricle
- Amphibians - Blood flows in double loop
 - Two atria with single ventricle
- Other vertebrates - Blood flows in a double loop
 - Heart divided by septum into separate sides

Transport in Humans

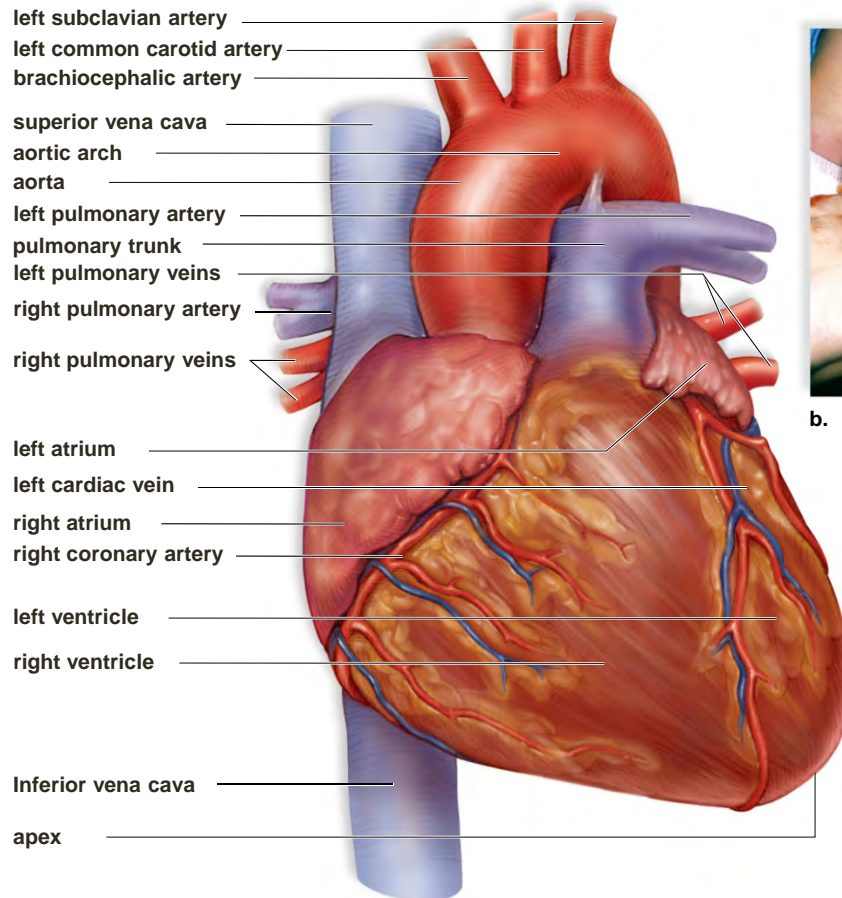
- Human Heart
 - Fist-sized
 - Cone-shaped
 - Very muscular organ (special cardiac fibers)
 - Lies within a fluid-filled sac (the pericardium)

Human Heart: Gross Anatomy

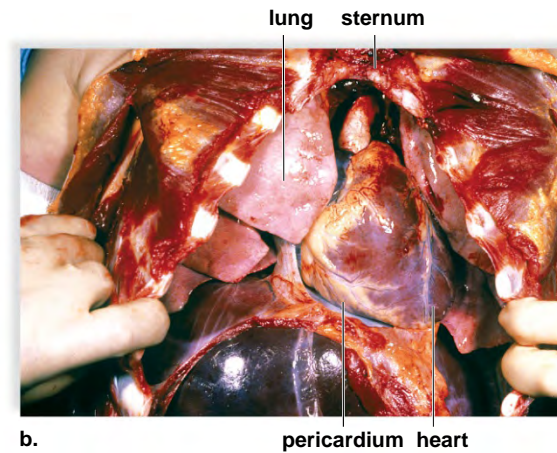
- Septum separates heart into left & right halves
- Each half has two chambers
 - Upper two chambers are the atria
 - Thin-walled
 - Receive blood from circulation
 - Lower two chambers are the ventricles
 - Thick-walled
 - Pump blood away from heart

External Heart Anatomy

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a.

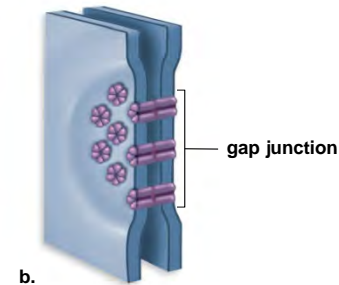
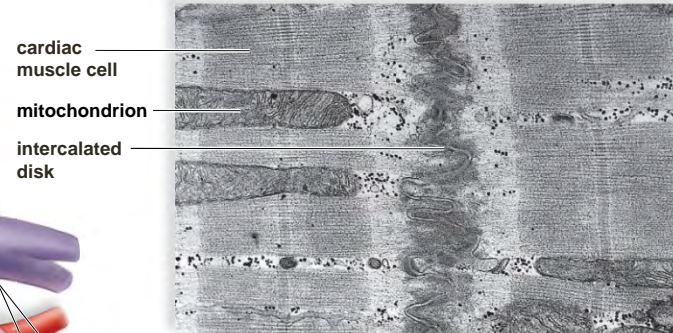
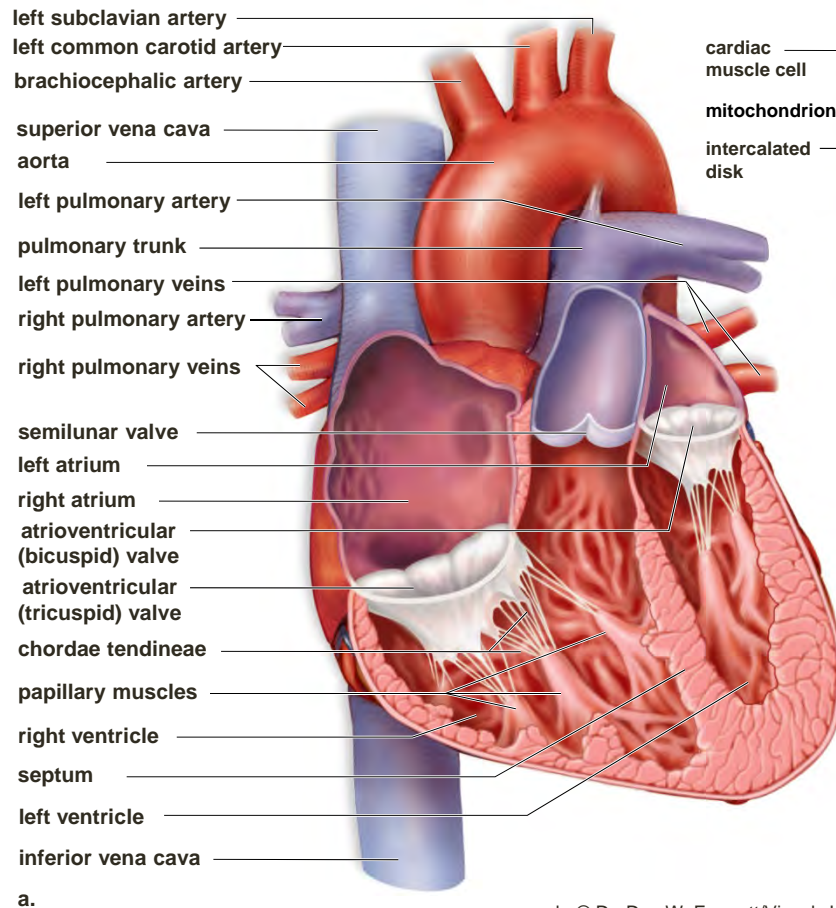


b.

b: © SIU/Visuals Unlimited

Internal View of the Heart

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Human Heart: Valves

- Valves open and close to control blood flow through heart
 - Atrioventricular valves
 - Tricuspid
 - Bicuspid
 - Semilunar valves
 - Pulmonary
 - Aortic

Transport in Humans

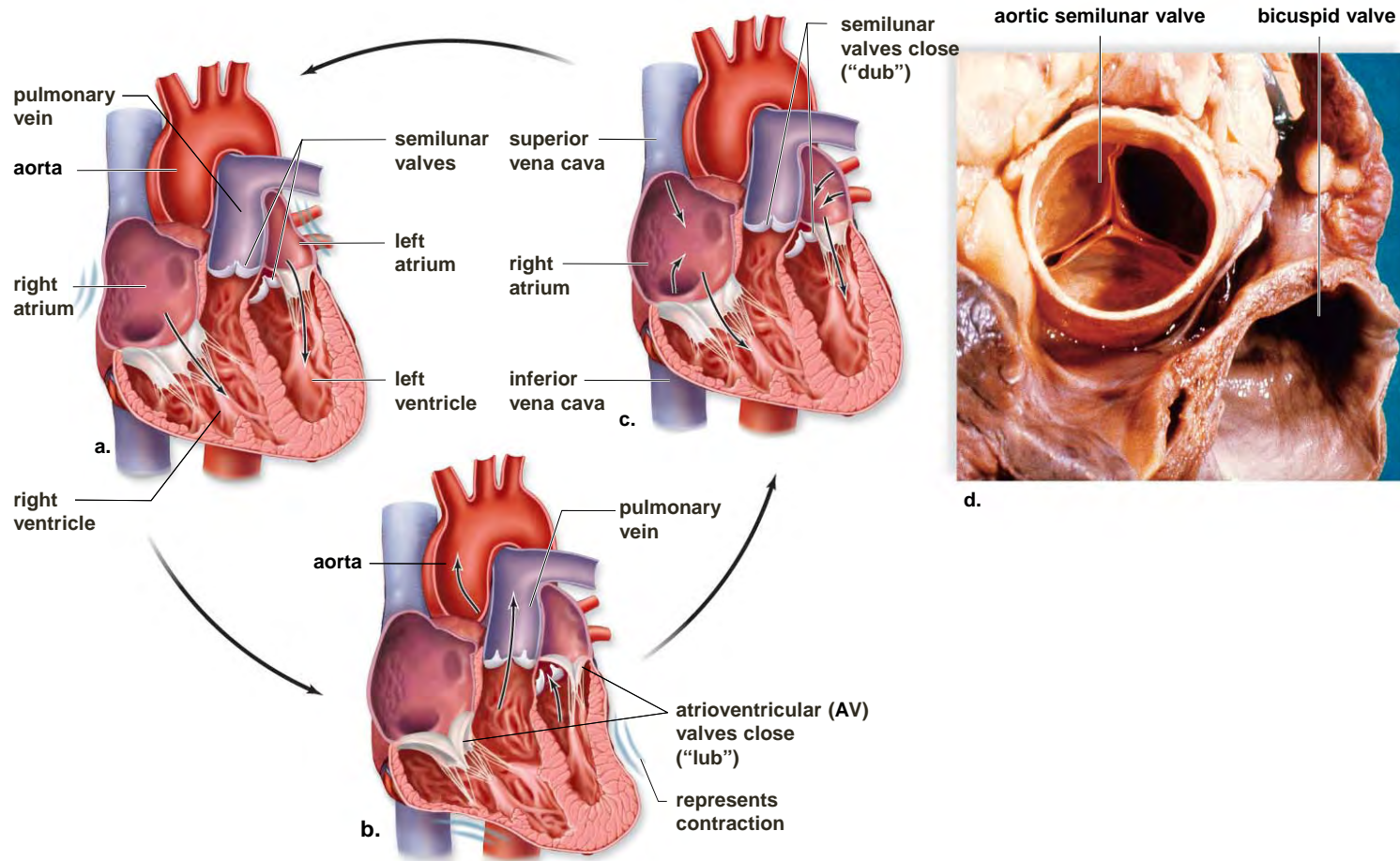
- Blood returning to heart from systemic circuit
 - Enters right atrium
 - Right atrium pumps through tricuspid valve to right ventricle
 - Right ventricle pumps blood through pulmonary valve to the pulmonary circuit
- Blood returning to heart from pulmonary circuit
 - Enters left atrium
 - Left atrium pumps through mitral valve to left ventricle
 - Left ventricle pumps blood through aortic valve to the systemic circuit
- Oxygen-poor blood never mixes with oxygen-rich blood (in humans)

Heartbeat

- Systole - Contraction of heart chambers
- Diastole - Relaxation of heart chambers
- Pulse - Two-part pumping action that takes about a second
 - Blood collects in atria, the atria contract
 - Pushes blood through tricuspid and mitral valves into the resting lower ventricles
 - This phase (the longer of the two) is called the diastole
 - Second part begins when ventricles fill
 - Ventricles contract
 - This is called systole
 - After blood moves into the pulmonary artery and aorta, the ventricles relax

Stages in the Cardiac Cycle


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Animation

McGraw Hill **The Cardiac Cycle**



Play Pause Audio Text

Ventricular contraction causes the atrioventricular (AV) valves to close, which signals the beginning of ventricular systole. The semilunar valves were closed during the previous diastole and remain closed during this period.

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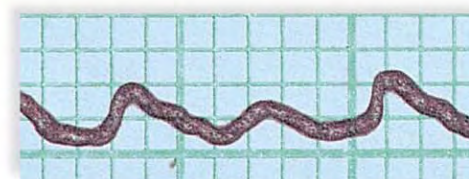
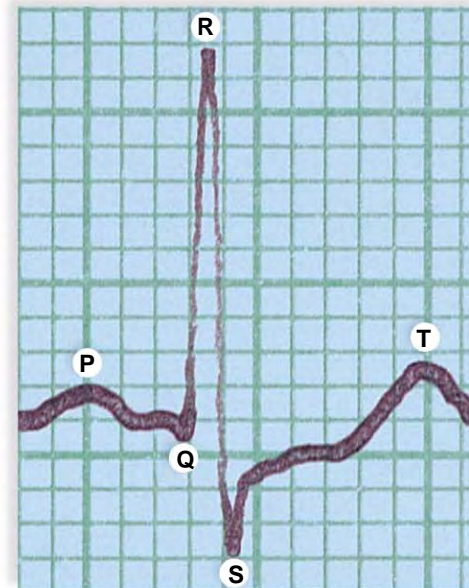
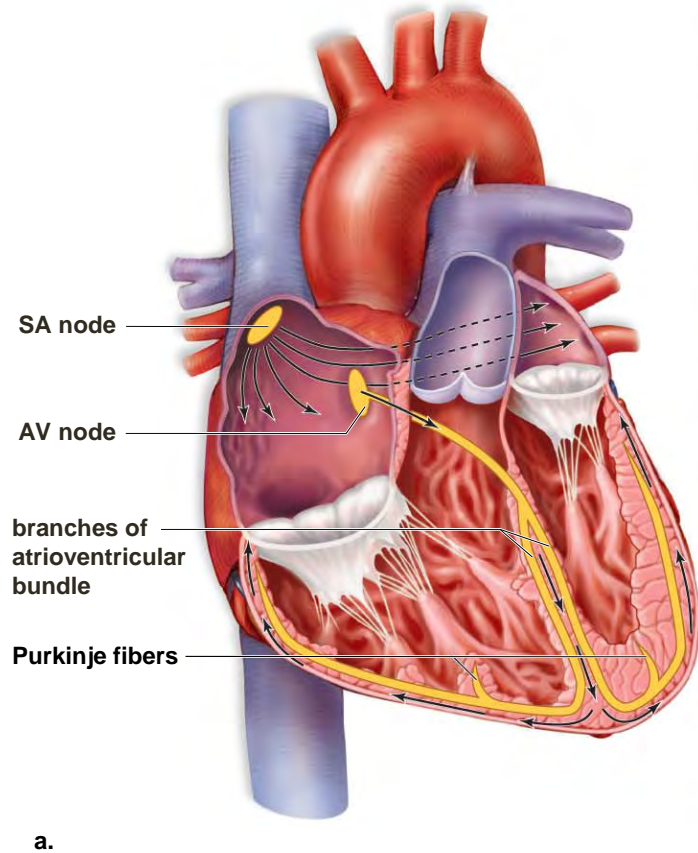
Animation

Mechanical Events of the Cardiac Cycle

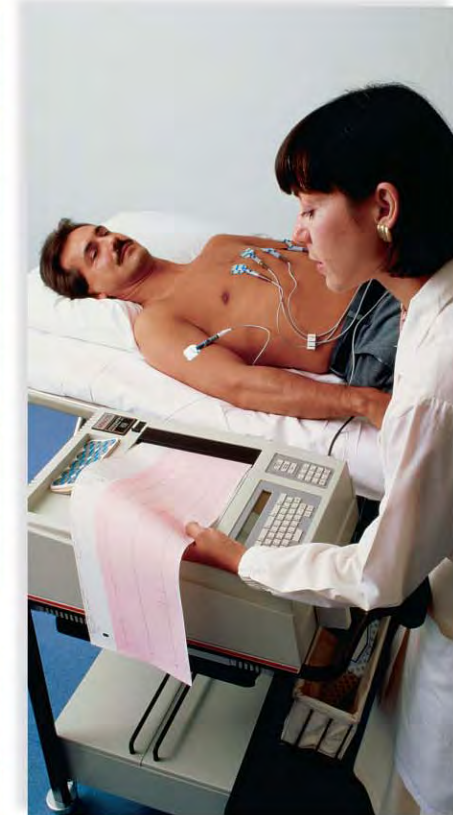


Conduction System of the Heart

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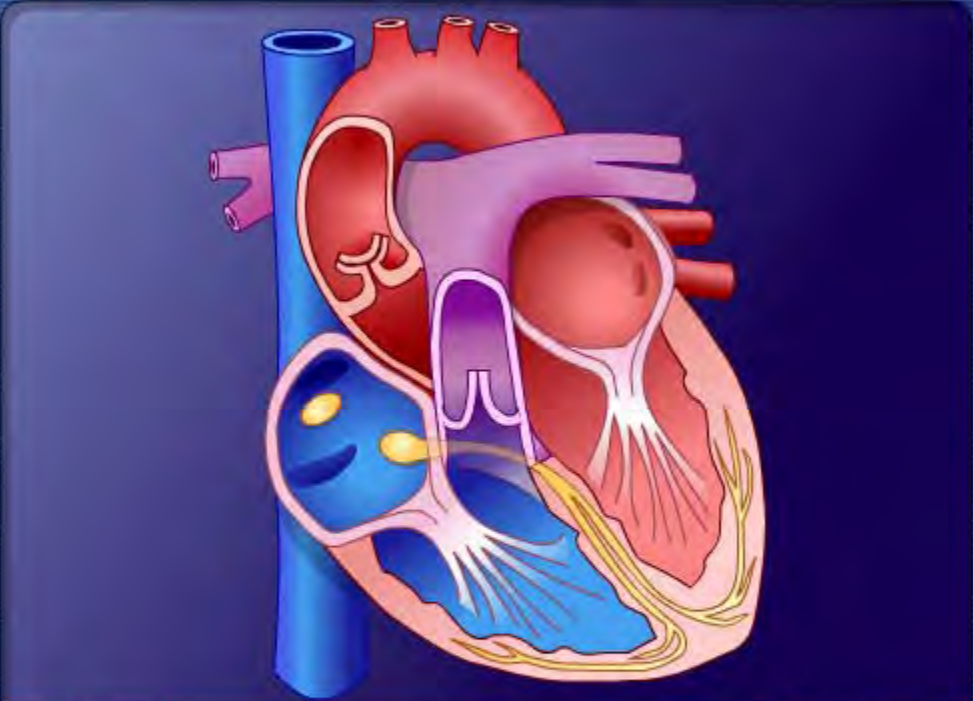


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Animation

McGraw Hill **Conducting System of the Heart**



▶ Play ⏸ Pause ◀ ▶ Audio 📄 Text

Action potentials originate in the sinoatrial (SA) node and travel across the wall of the atrium from the sinoatrial node to the atrioventricular (AV) node.

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Heartbeat

- Rhythmic contraction due to cardiac conduction system
 - Sinoatrial node (SA) keeps the heartbeat regular
 - Atrioventricular node (AV) signals ventricles to contract - Purkinje Fibers
- Electrocardiogram (ECG)
- A recording of electrical changes that occurring in myocardium during cardiac cycle
 - When SA node triggers an impulse, the atrial fibers produce an electrical charge (P wave)

Animation

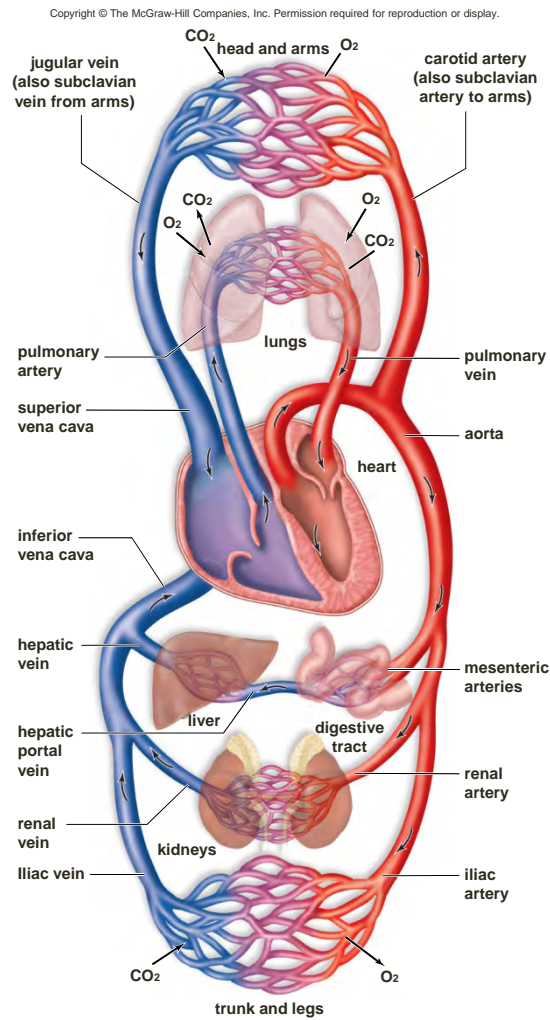
Action Potentials in the Sinoatrial (SA) Node



Vascular Pathways

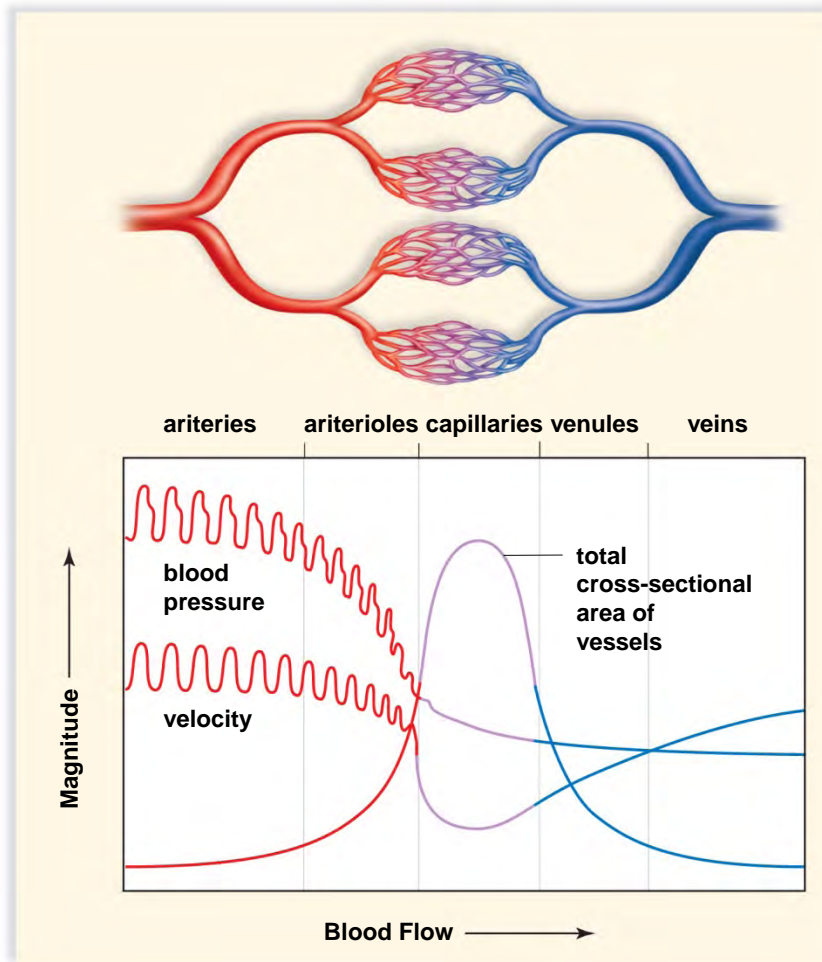
- Human cardiovascular system includes two major circular pathways:
 - Pulmonary Circuit
 - Takes oxygen-poor blood to the lungs and returns oxygen-rich blood to the heart
 - Systemic Circuit
 - Takes blood throughout the body from the aorta to the vena cava

Path of Blood



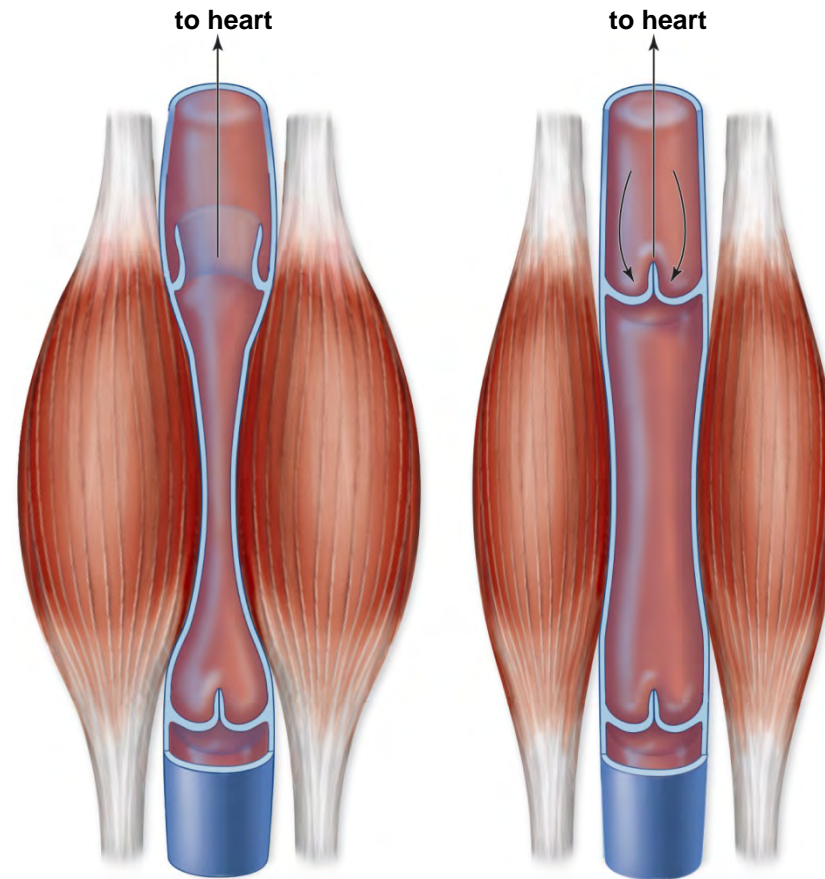
Velocity and Blood Pressure

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Cross Section of a Valve in a Vein

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a. Contracted skeletal muscle pushes blood past open valve.

b. Closed valve prevents backward flow of blood.

Blood Pressure

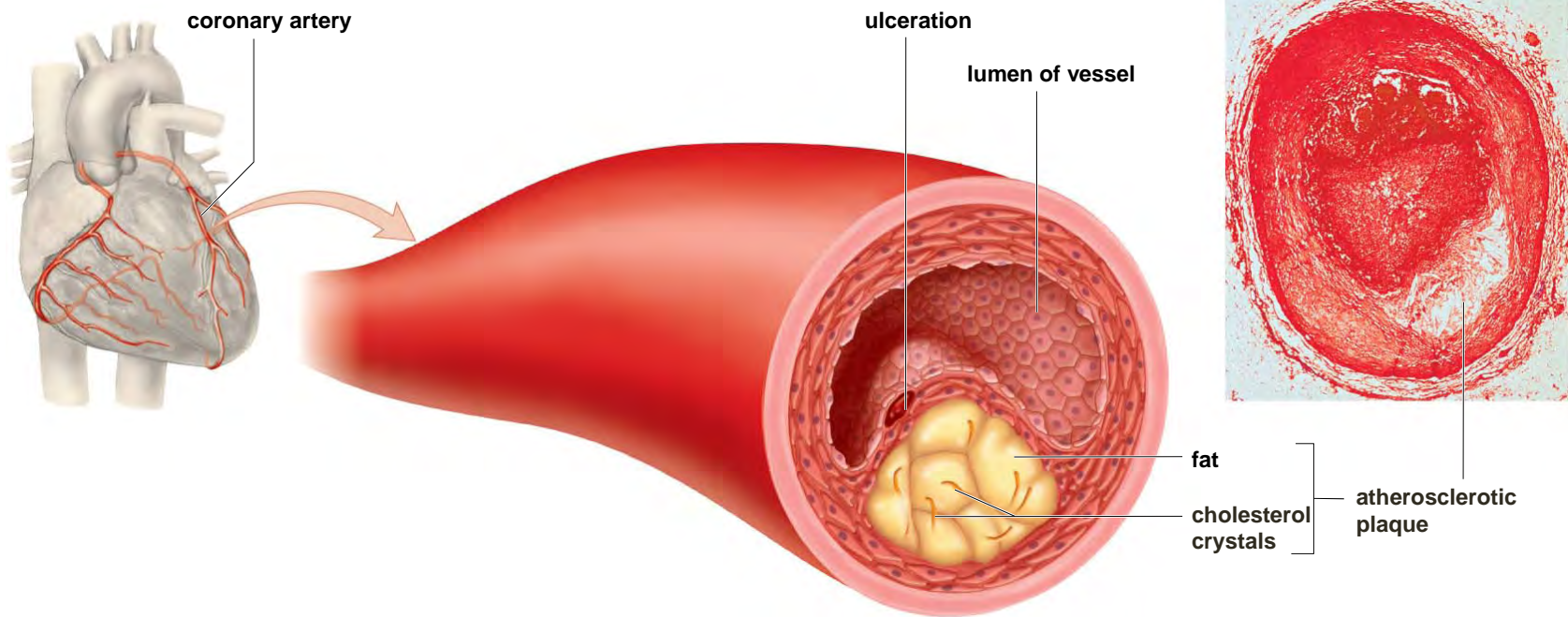
- The beat of the heart supplies pressure that keeps blood moving in the arteries
 - Systolic Pressure results from blood forced into the arteries during ventricular systole
 - Diastolic Pressure is the pressure in the arteries during during ventricular diastole
- Skeletal muscle contraction pushes blood in the veins toward the heart
- Blood pressure
 - Normally measured with a sphygmomanometer on the brachial artery
 - Expressed in the form: Systolic “over” Diastolic

Cardiovascular Disorders

- Hypertension - High blood pressure
- Atherosclerosis - Accumulation of fatty materials in inner linings of arteries
- Stroke - Cranial arteriole bursts or is blocked by an embolus
- Heart attack – (Myocardial infarction) Coronary artery becomes partially blocked
- Angina pectoris – Painful squeezing sensation from myocardial oxygen insufficiency

Coronary Arteries and Plaque

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Blood: Homeostasis Functions

- Transports substances to and from capillaries for exchange with tissue fluid
- Guards against pathogen invasion
- Regulates body temperature
- Buffers body pH
- Maintain osmotic pressure
- Clots prevent blood/fluid loss

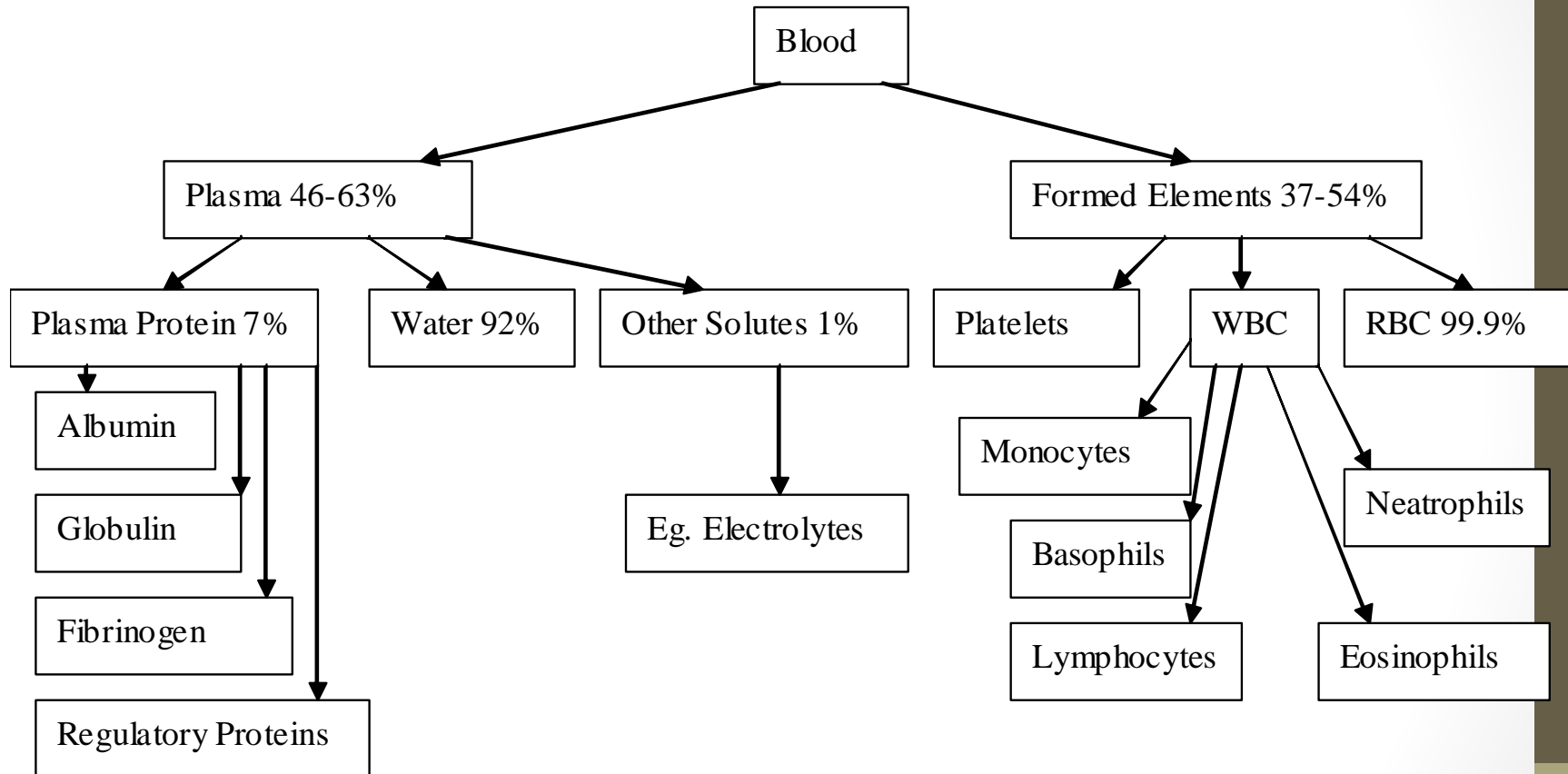
Red Blood Cells

- Small, biconcave disks
- Lack a nucleus and contain hemoglobin
 - Hemoglobin contains
 - Four globin protein chains
 - Each associated with an iron-containing heme
 - Manufactured continuously in bone marrow of skull, ribs, vertebrae, and ends of long bones

White Blood Cells

- Most types larger than red blood cells
- Contain a nucleus and lack hemoglobin
- Important in inflammatory response
 - Neutrophils enter tissue fluid and phagocytize foreign material
 - Lymphocytes (T Cells) attack infected cells
 - Antigens cause body to produce antibodies

Composition of Blood



Platelets

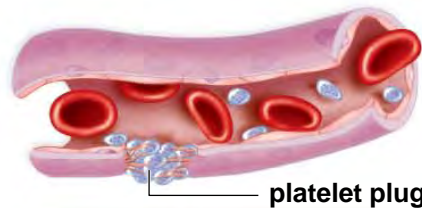
- Platelets
 - Result from fragmentation of megakaryocytes
 - Involved in coagulation
- Blood clot consists of:
 - Platelets
 - Red blood cells
 - All entangled within fibrin threads

Blood Clotting

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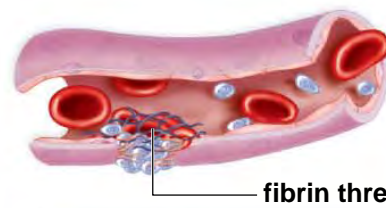


1. Blood vessel is punctured.



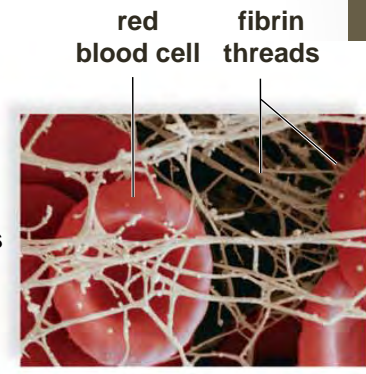
platelet plug

2. Platelets congregate and form a plug.



fibrin threads

3. Fibrin threads form and trap red blood cells.



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Capillary Exchange

- Capillaries very narrow – Tiny RBCs must go through single file
- Wall of capillaries very thin to facilitate diffusion of nutrients, gases, and wastes
 - Oxygen and nutrients exit a capillary near the arterial end
 - Carbon dioxide and waste molecules enter a capillary near the venous end

Blood Type

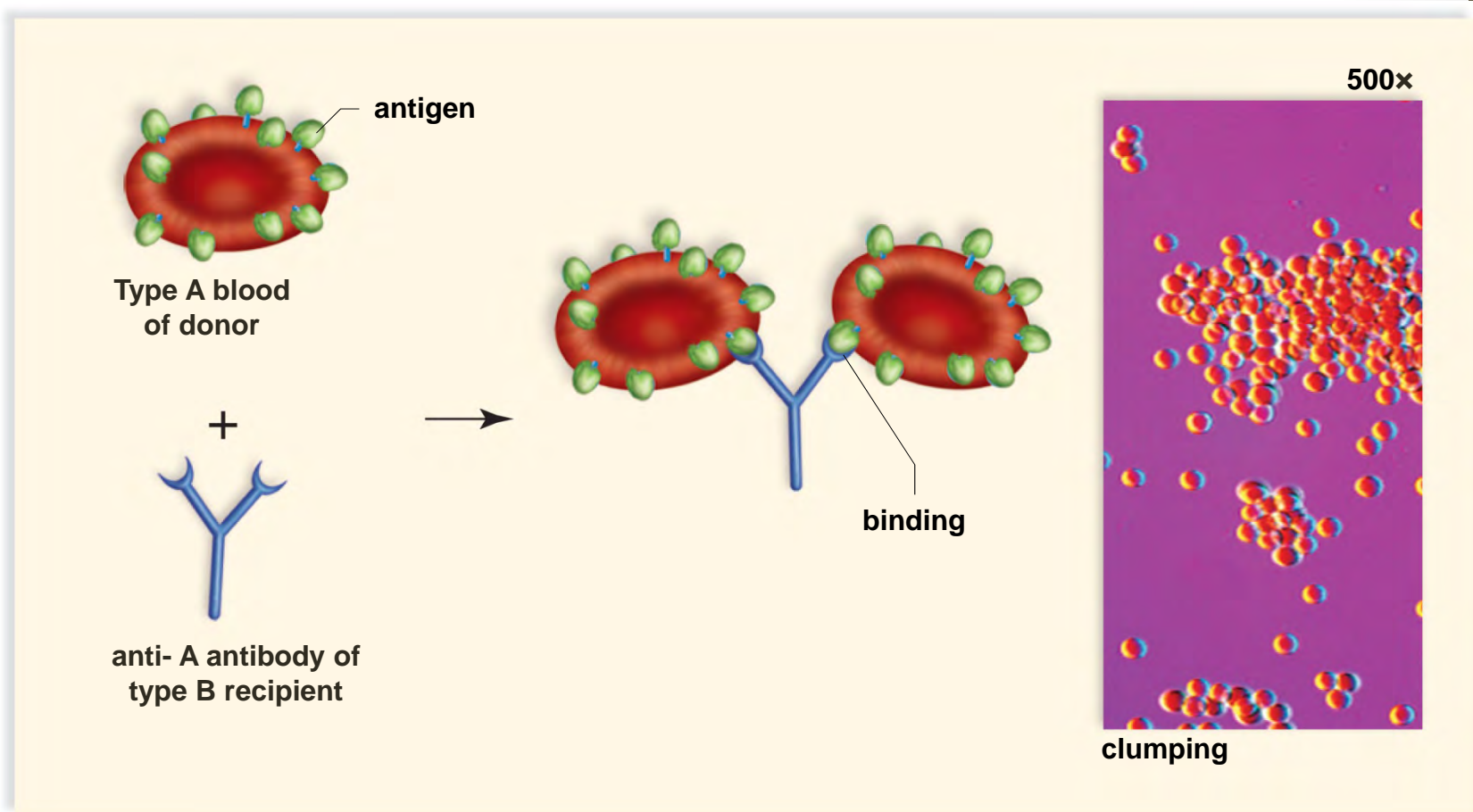
- Determined by the presence or absence of surface antigens (agglutinogens)
 - Antigens A, B and Rh (D)
- Antibodies in the plasma (agglutinins)
- Cross-reactions occur when antigens meet antibodies

Blood Type

Blood Type	Antigen on Red Blood Cells	Antibody In Plasma
A	A	Anti-B
B	B	Anti-A
AB	A, B	None
O	None	Anti-A and anti-B

Agglutination

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Agglutination

Blood Type

- During pregnancy, if the mother is Rh negative and the father is Rh positive, the child may be Rh positive.
 - Rh-positive red blood cells may leak across the placenta
 - The mother will produce anti-Rh antibodies.
 - Antibodies may attack the embryo in a subsequent pregnancy

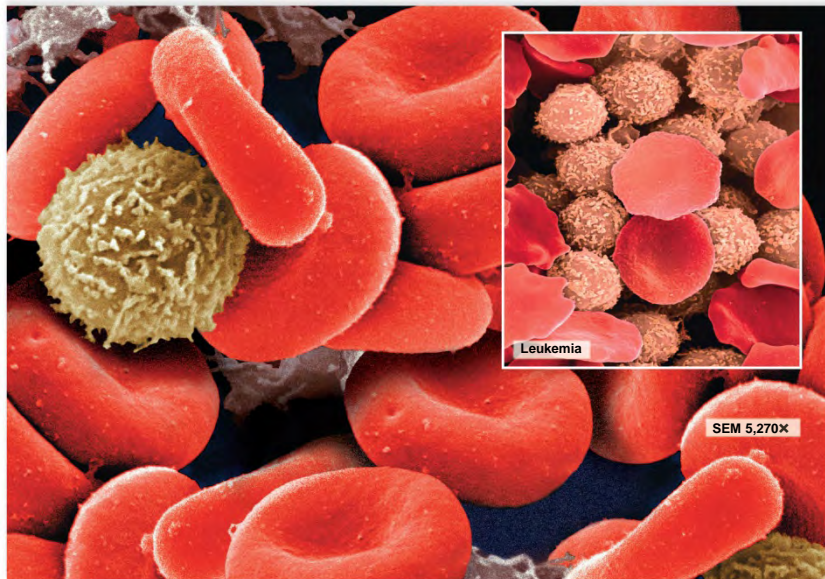
Review

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