

HUMAN ANATOMY

THE CARDIOVASCULAR SYSTEM

AYDIN ÇÖL

The Cardiovascular System

1-Blood 2-Heart 3-Blood Vessels

Blood is a liquid **connective** tissue that consists of cells surrounded by a **liquid** extracellular **matrix**.

The extracellular matrix is called **blood plasma**, and it suspends various **cells** and cell **fragments**.

Interstitial fluid is the fluid that bathes body cells and is constantly renewed by the blood.

Blood **transports oxygen** from the lungs and **nutrients** from the gastrointestinal tract, which diffuse from the blood into the interstitial fluid and then into body cells.

Carbon dioxide and other **wastes** move in the reverse direction, from body cells to interstitial fluid to blood.

Blood then transports the wastes to various organs—the lungs, kidneys, and skin—for elimination from the body.

Blood, continued

Functions of Blood

Blood has three general functions:

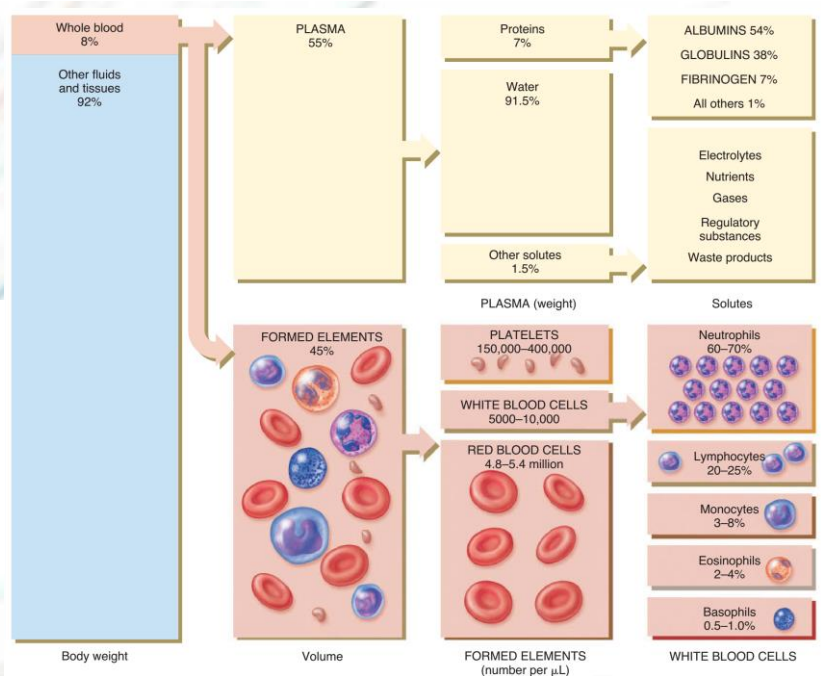
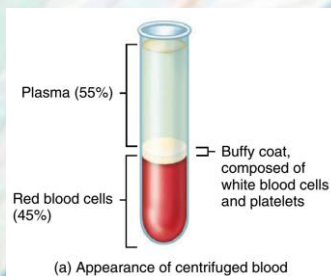
1. Transportation. Blood transports **oxygen** from the lungs to the cells of the body and **carbon dioxide** from the body cells to the lungs for exhalation. It carries **nutrients** from the gastrointestinal tract to body cells and **hormones** from endocrine glands to other body cells. Blood also transports **heat** and **waste products** to various organs for elimination from the body.

2. Regulation. Circulating blood helps maintain homeostasis of all body fluids. Blood helps regulate **pH** through the use of buffers (chemicals that convert strong acids or bases into weak ones). It also helps adjust **body temperature** through the heat absorbing and coolant properties of the water in blood plasma and its variable rate of flow through the skin, where excess heat can be lost from the blood to the environment. In addition, blood osmotic pressure influences the **water content of cells**, mainly through interactions of dissolved ions and proteins.

3. Protection. Blood can **clot** (become gel-like), which protects against its excessive loss from the cardiovascular system after an injury. In addition, its white blood cells protect against disease by carrying on **phagocytosis**. Several types of **blood proteins**, including **antibodies**, **interferons**, and **complement**, help protect against disease in a variety of ways.

Blood, continued

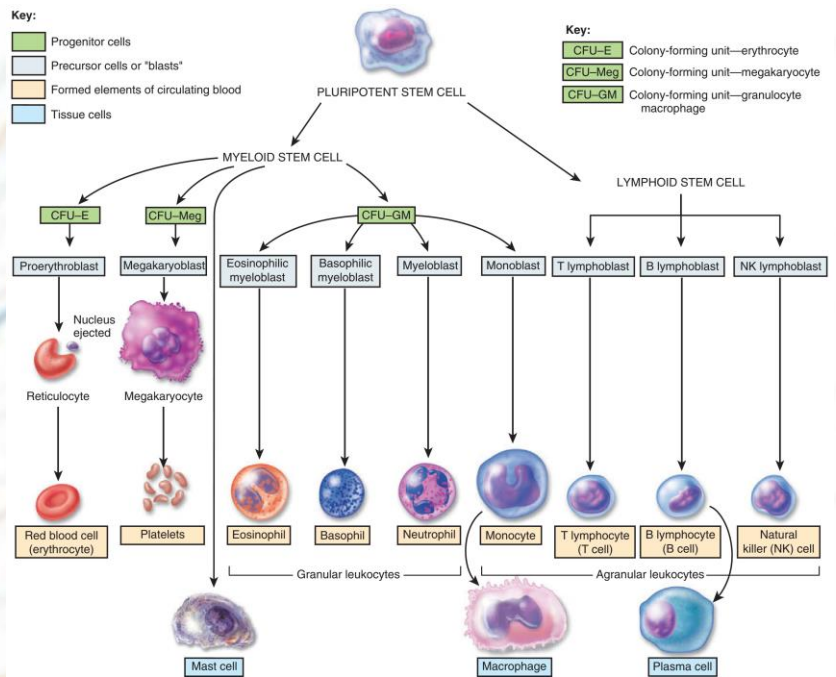
Components of Blood





Substances in Blood Plasma

CONSTITUENT	DESCRIPTION	FUNCTION
Water (91.5%)	Liquid portion of blood.	Solvent and suspending medium. Absorbs, transports, and releases heat.
Plasma proteins (7%)	Most produced by liver.	Responsible for colloid osmotic pressure. Major contributors to blood viscosity. Transport hormones (steroid), fatty acids, and calcium. Help regulate blood pH.
Albumins	Smallest and most numerous plasma proteins.	Help maintain osmotic pressure, an important factor in the exchange of fluids across blood capillary walls.
Globulins	Large proteins (plasma cells produce immunoglobulins).	Immunoglobulins help attack viruses and bacteria. Alpha and beta globulins transport iron, lipids, and fat-soluble vitamins.
Fibrinogen	Large protein.	Plays essential role in blood clotting.
Other solutes (1.5%)		
Electrolytes	Inorganic salts; positively charged (cations) Na^+ , K^+ , Ca^{2+} , Mg^{2+} ; negatively charged (anions) Cl^- , HPO_4^{2-} , SO_4^{2-} , HCO_3^- .	Help maintain osmotic pressure and play essential roles in cell functions.
Nutrients	Products of digestion, such as amino acids, glucose, fatty acids, glycerol, vitamins, and minerals.	Essential roles in cell functions, growth, and development.
Gases	Oxygen (O_2). Carbon dioxide (CO_2). Nitrogen (N_2).	Important in many cellular functions. Involved in the regulation of blood pH. No known function.
Regulatory substances	Enzymes. Hormones. Vitamins.	Catalyze chemical reactions. Regulate metabolism, growth, and development. Cofactors for enzymatic reactions.
Waste products	Urea, uric acid, creatine, creatinine, bilirubin, ammonia.	Most are breakdown products of protein metabolism that are carried by the blood to organs of excretion.

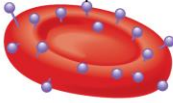
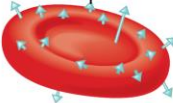
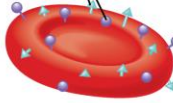




Origin, development, and structure of blood cells.



Summary of Formed Elements in Blood

NAME AND APPEARANCE	NUMBER	CHARACTERISTICS*	FUNCTIONS
RED BLOOD CELLS (RBCS) OR ERYTHROCYTES 	4.8 million/ μL in females; 5.4 million/ μL in males.	7–8 μm diameter, biconcave discs, without nuclei; live for about 120 days.	Hemoglobin within RBCs transports most oxygen and part of carbon dioxide in blood.
WHITE BLOOD CELLS (WBCS) OR LEUKOCYTES	5000–10,000/ μL .	Most live for a few hours to a few days. ⁷	Combat pathogens and other foreign substances that enter body.
Granular leukocytes			
Neutrophils 	60–70% of all WBCs.	10–12 μm diameter; nucleus has 2–5 lobes connected by thin strands of chromatin; cytoplasm has very fine, pale lilac granules.	Phagocytosis. Destruction of bacteria with lysozyme, defensins, and strong oxidants, such as superoxide anion, hydrogen peroxide, and hypochlorite anion.
Eosinophils 	2–4% of all WBCs.	10–12 μm diameter; nucleus usually has 2 lobes connected by thick strand of chromatin; large, red-orange granules fill cytoplasm.	Combat effects of histamine in allergic reactions, phagocytize antigen–antibody complexes, and destroy certain parasitic worms.
Basophils 	0.5–1% of all WBCs.	8–10 μm diameter; nucleus has 2 lobes; large cytoplasmic granules appear deep blue-purple.	Liberate heparin, histamine, and serotonin in allergic reactions that intensify overall inflammatory response.
Agranular leukocytes			
Lymphocytes (T cells, B cells, and natural killer cells) 	20–25% of all WBCs.	Small lymphocytes are 6–9 μm in diameter; large lymphocytes are 10–14 μm in diameter; nucleus is round or slightly indented; cytoplasm forms rim around nucleus that looks sky blue; the larger the cell, the more cytoplasm is visible.	Mediate immune responses, including antigen–antibody reactions. B cells develop into plasma cells, which secrete antibodies. T cells attack invading viruses, cancer cells, and transplanted tissue cells. Natural killer cells attack wide variety of infectious microbes and certain spontaneously arising tumor cells.
Monocytes 	3–8% of all WBCs.	12–20 μm diameter; nucleus is kidney- or horseshoe-shaped; cytoplasm is blue-gray and appears foamy.	Phagocytosis (after transforming into fixed or wandering macrophages).
PLATELETS 	150,000–400,000/ μL .	2–4 μm diameter cell fragments that live for 5–9 days; contain many vesicles but no nucleus.	Form platelet plug in hemostasis; release chemicals that promote vascular spasm and blood clotting.

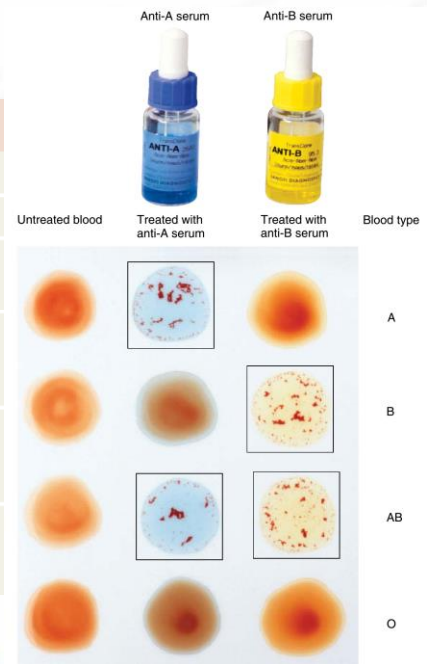
ABO Blood Group

BLOOD TYPE	TYPE A	TYPE B	TYPE AB	TYPE O
	A antigen	B antigen	Both A and B antigens	Neither A nor B antigen
Red blood cells				
Plasma	 Anti-B antibody	 Anti-A antibody	Neither antibody	 Both anti-A and anti-B antibodies

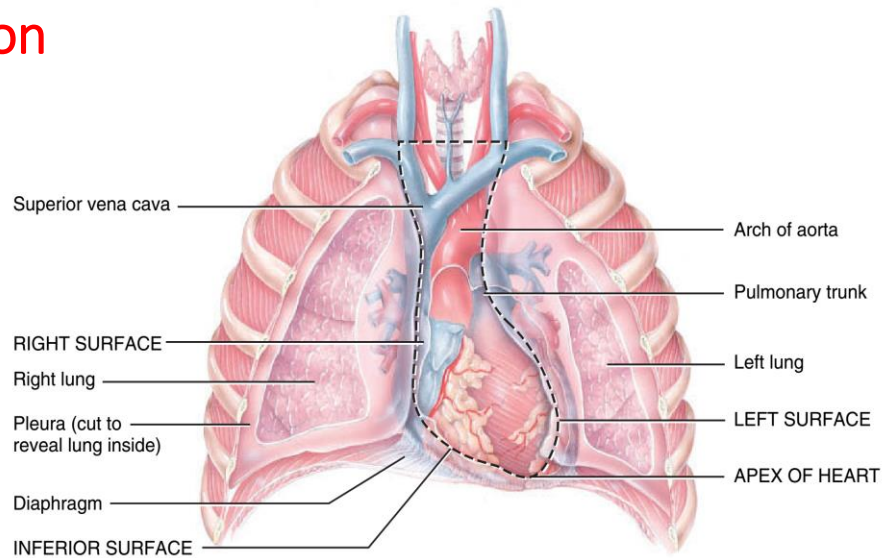
ABO and Rh Blood Group

Summary of ABO Blood Group Interactions

CHARACTERISTIC	BLOOD TYPE			
	A	B	AB	O
Agglutinin (antigen) on RBCs	A	B	Both A and B	Neither A nor B
Agglutinin (antibody) in plasma	Anti-B	Anti-A	Neither anti-A nor anti-B	Both anti-A and anti-B
Compatible donor blood types (no hemolysis)	A, O	B, O	A, B, AB, O	O
Incompatible donor blood types (hemolysis)	B, AB	A, AB	—	A, B, AB

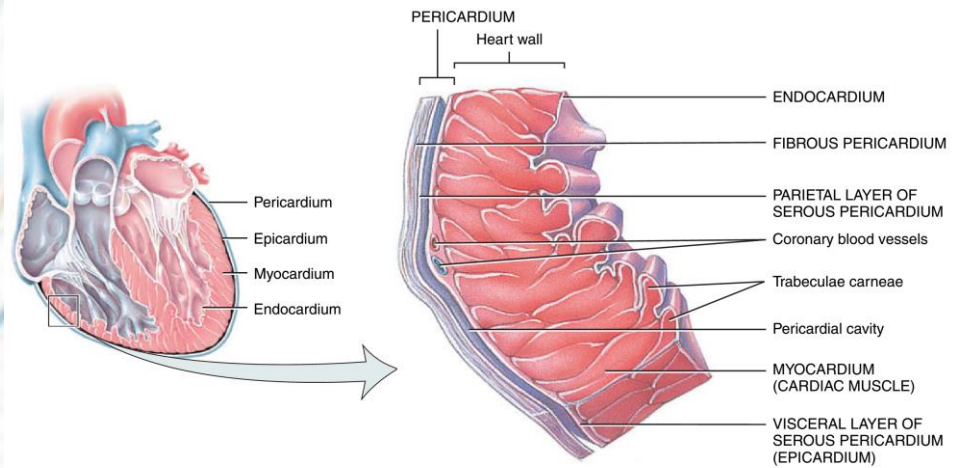


Location of the Heart



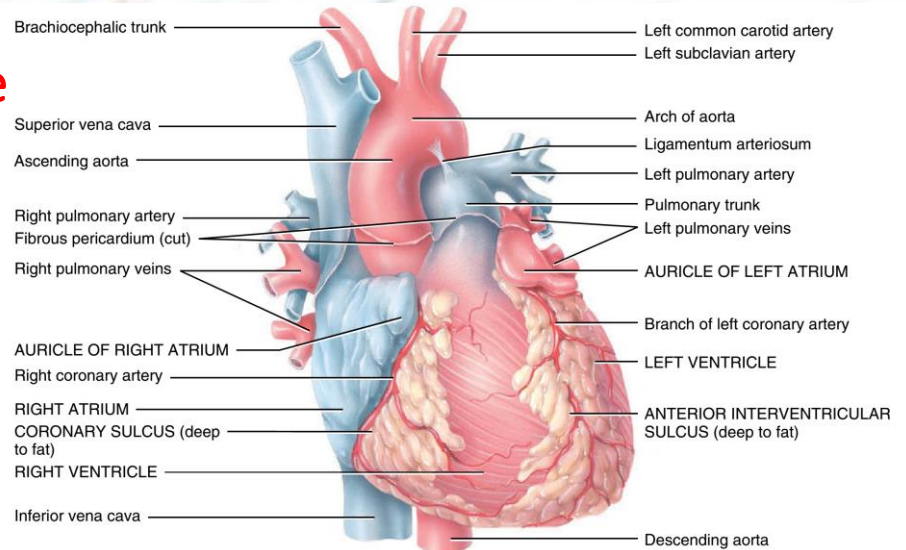
(b) Anterior view of the heart in the thoracic cavity

Anatomy of the Heart



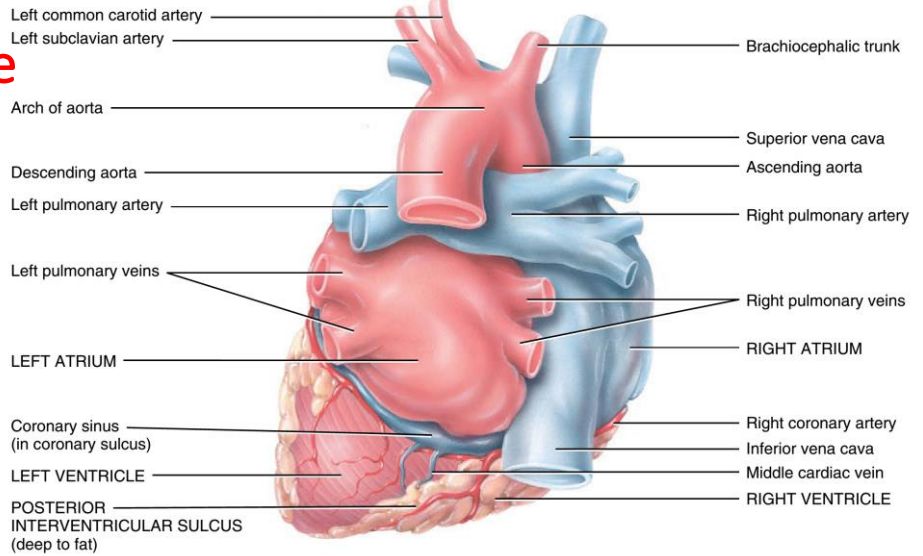
(a) Portion of pericardium and right ventricular heart wall showing divisions of pericardium and layers of heart wall

Surface Structure of the Heart



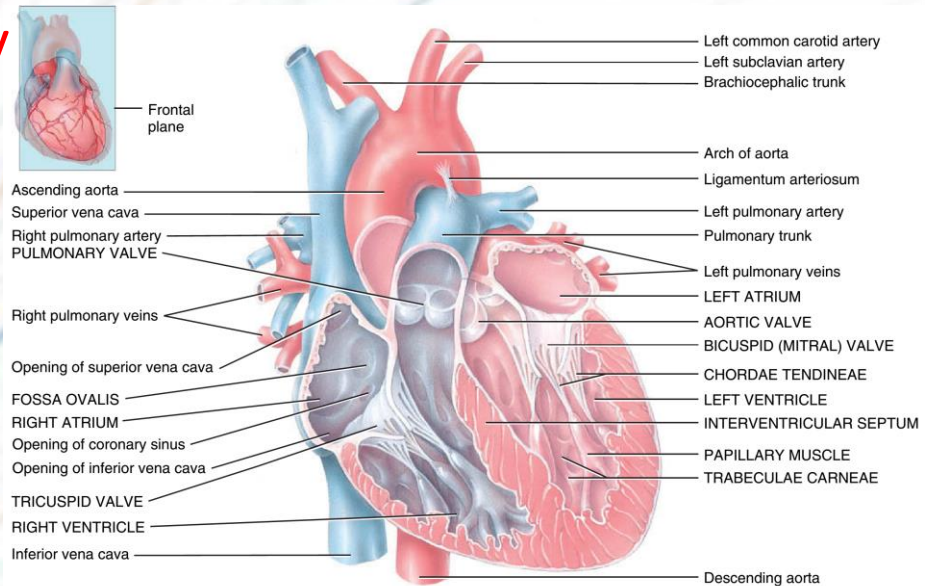
(a) Anterior external view showing surface features

Surface Structure of the Heart



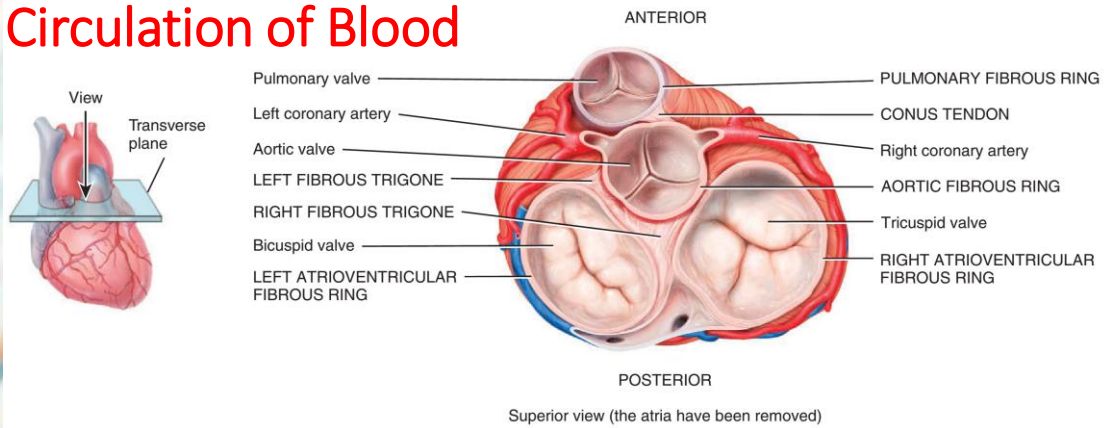
(c) Posterior external view showing surface features

Anatomy of the Heart



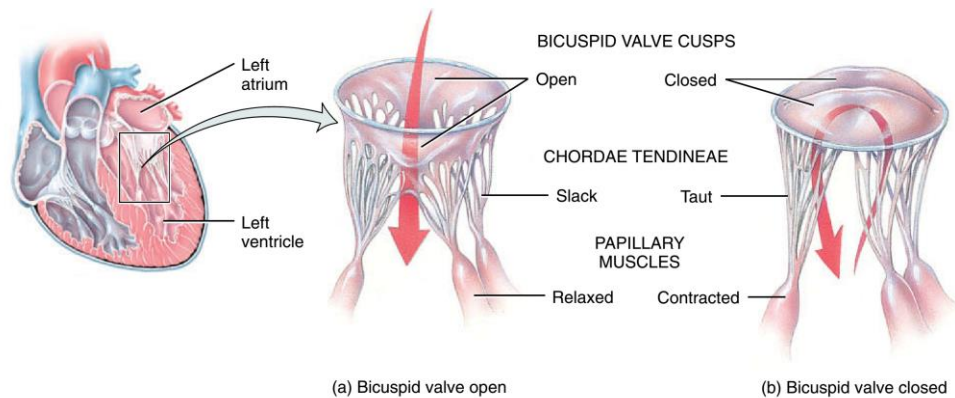
(a) Anterior view of frontal section showing internal anatomy

Heart Valves and Circulation of Blood

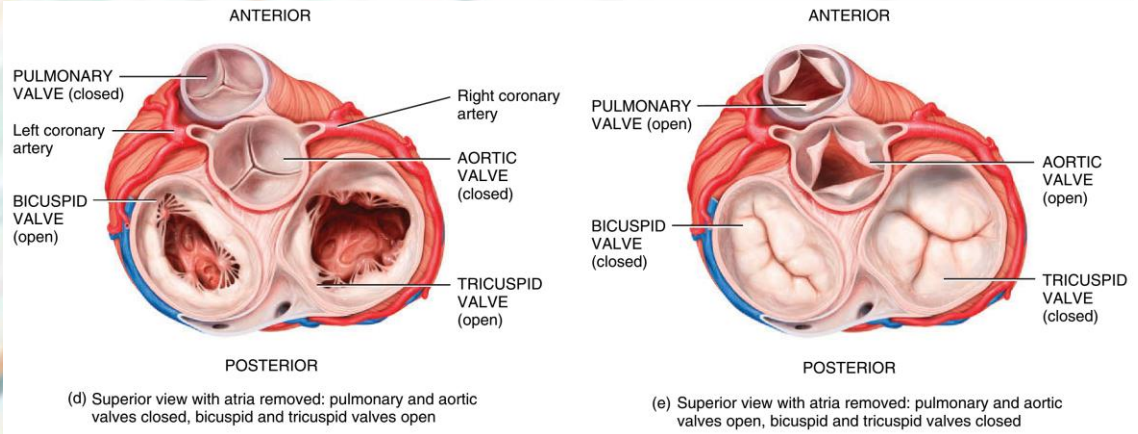


Heart Valves and Circulation of Blood

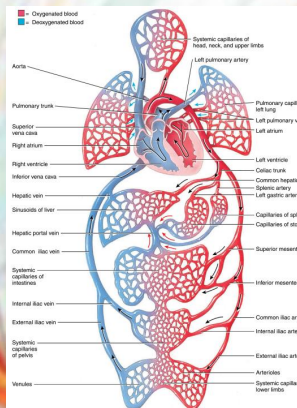
Heart valves prevent the backflow of blood.



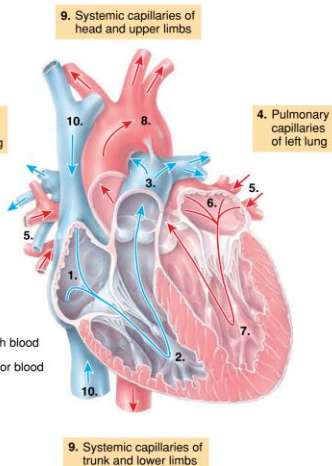
Heart Valves and Circulation of Blood



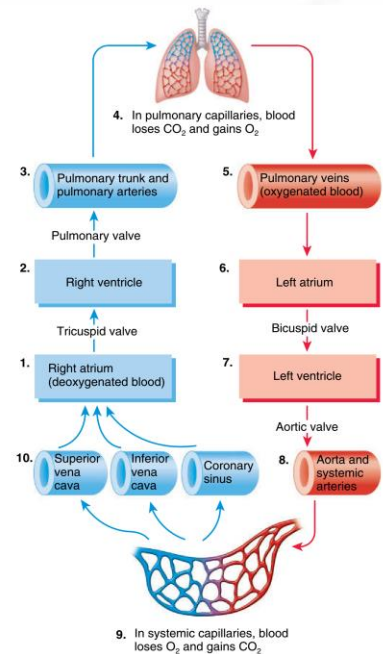
Circulation of Blood



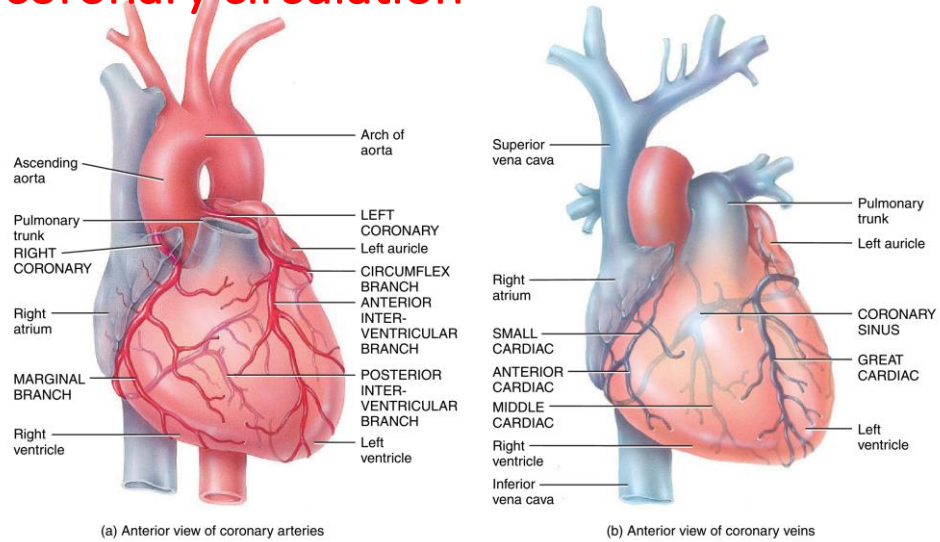
The left side of the heart pumps oxygenated blood into the systemic circulation to all tissues of the body except the air sacs (alveoli) of the lungs. The right side of the heart pumps deoxygenated blood into the pulmonary circulation to the air sacs.



(a) Path of blood flow through heart



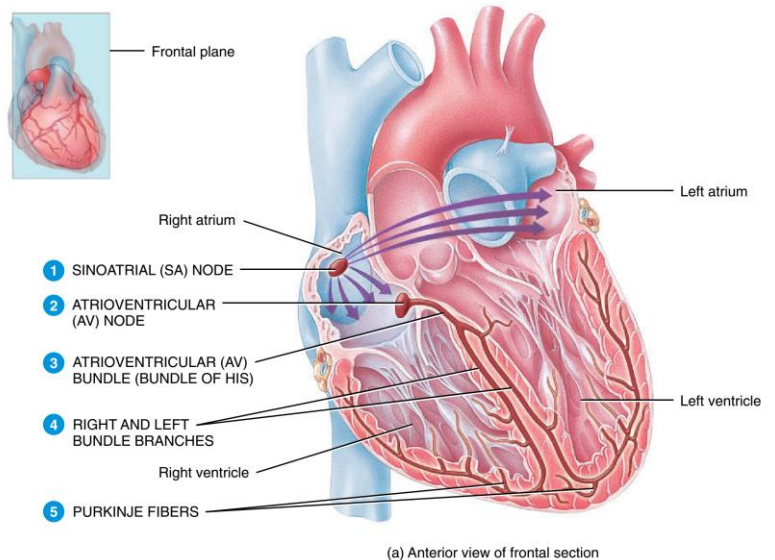
The coronary circulation



The conduction system of the heart

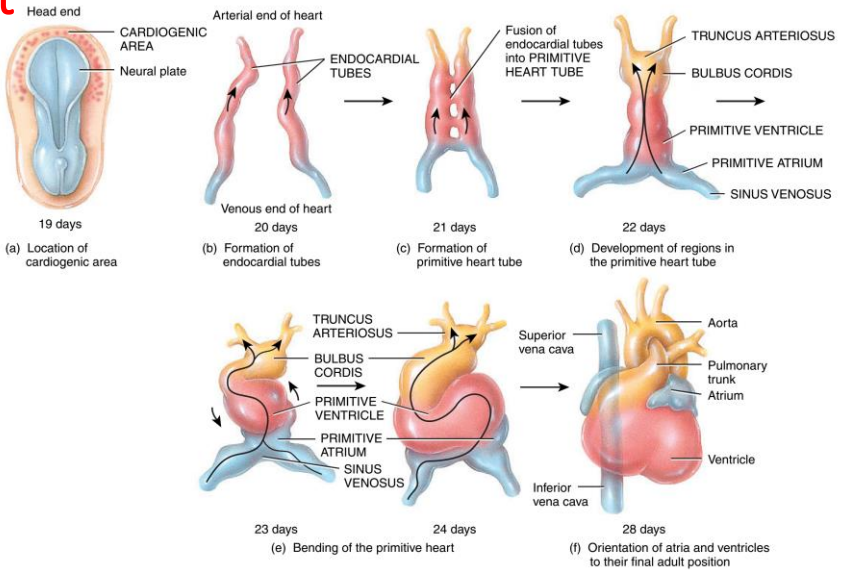
The conduction system ensures that the chambers of the heart contract in a coordinated manner.

The cardiovascular center in the medulla oblongata controls both **sympathetic** and **parasympathetic** nerves that innervate the heart.



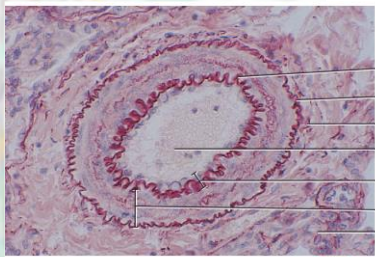
Development of the Heart

The heart begins its development from a group of mesodermal cells called the cardiogenic area during the third week after fertilization.



Blood Vessels

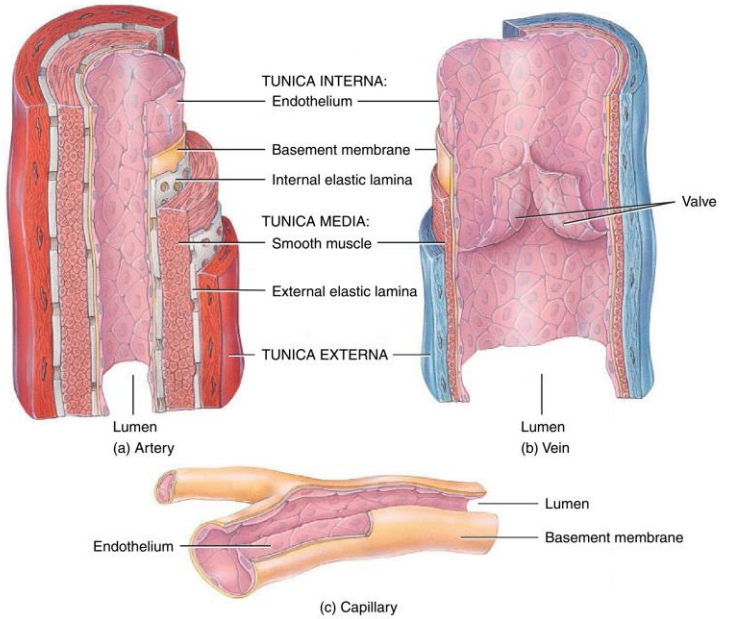
Arteries carry blood from the heart to tissues; veins carry blood from tissues to the heart.



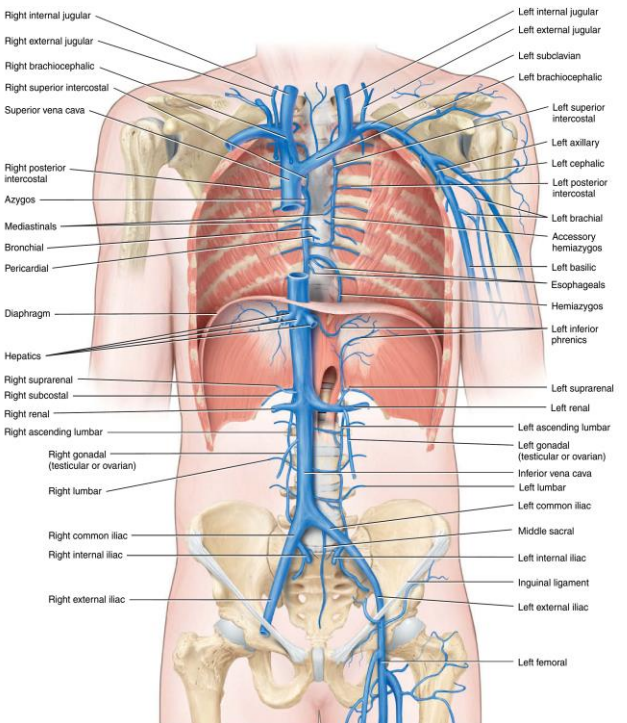
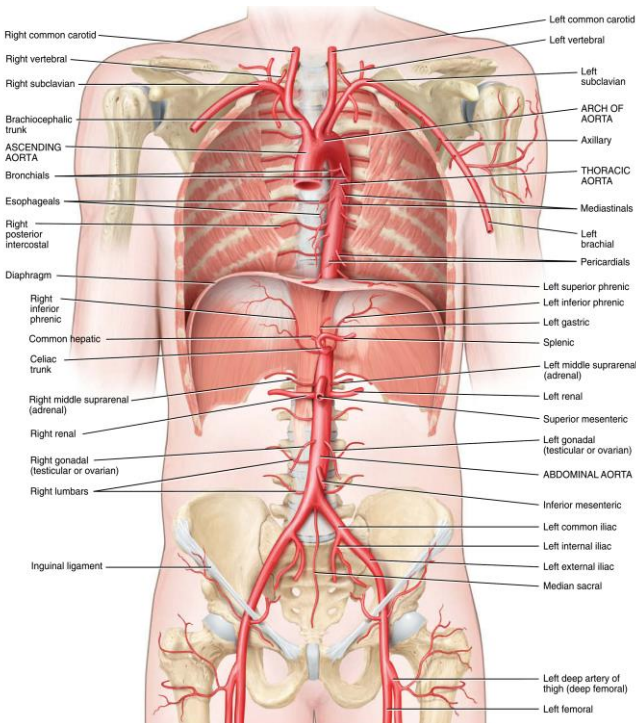
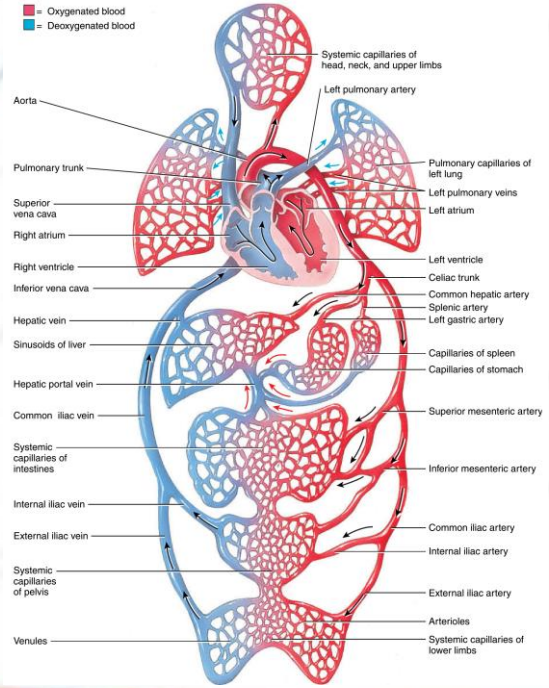
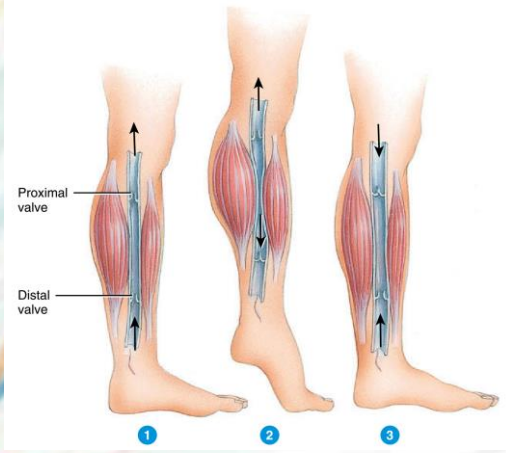
(d) Transverse section through an artery

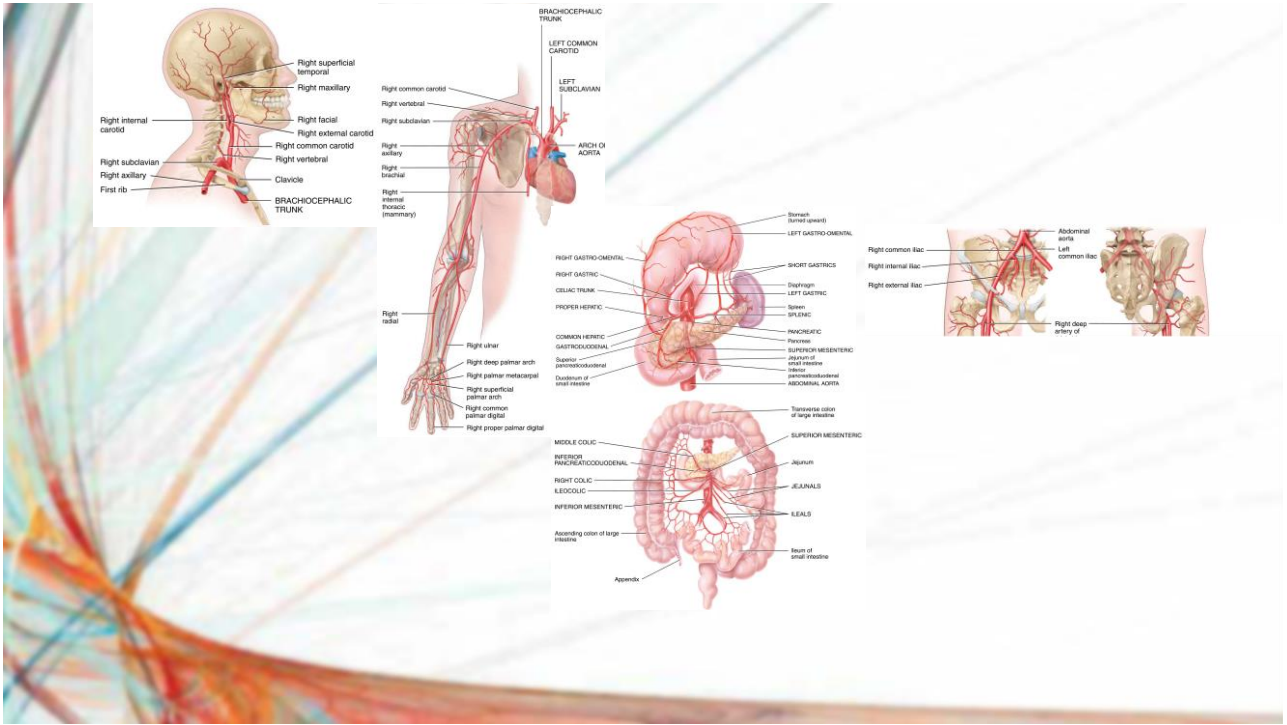


(e) Red blood cells passing through a capillary

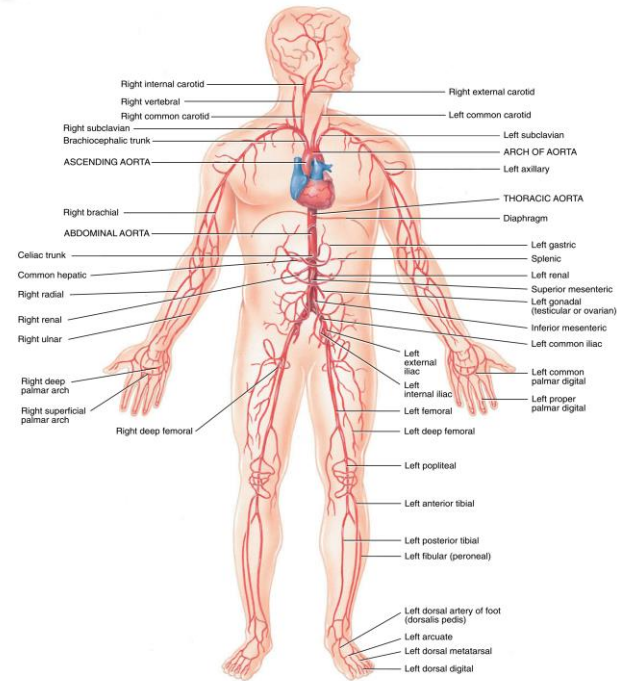


Blood Vessels, continue



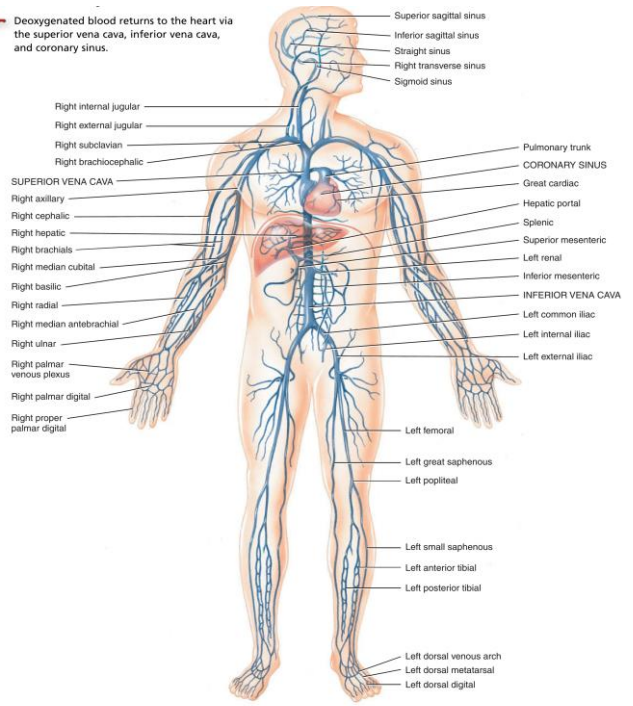


All systemic arteries branch from the aorta.



(a) Overall anterior view of the principal branches of the aorta

Deoxygenated blood returns to the heart via the superior vena cava, inferior vena cava, and coronary sinus.



Overall anterior view of the principal veins

An abstract background featuring a dense network of thin, overlapping lines in various colors including light blue, teal, orange, and yellow. The lines radiate from the bottom-left corner towards the top-right, creating a sense of movement and depth.

QUESTIONS?

An abstract background featuring a dense network of thin, overlapping lines in various colors including light blue, teal, orange, and yellow. The lines radiate from the bottom-left corner towards the top-right, creating a sense of movement and depth.

**HAVE A
WONDERFUL
DAY**

Thank you for being my students!