Anatomy and Physiology

Cardiovascular System

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IMPORTANT TERMS TO REMEMBER

Aorta: The largest artery in the body, the aorta originates from the left ventricle of the heart and extends down to the abdomen, where it branches off.

Aortic arch: The second section of the aorta; it branches into the brachiocephalic trunk, left common carotid artery, and left subclavian artery.

Aortic valve: Located at the base of the aorta, the aortic valve has three cusps and opens to allow blood to leave the left ventricle during contraction.

Arteries: Elastic vessels able to carry blood away from the heart under high pressure.

Arterioles: Subdivisions of arteries; they are thinner and have muscles that are innervated by the sympathetic nervous system. **Atria:** The upper chambers of the heart; they receive blood returning to the heart.

Atrioventricular node (AV node): A mass of specialized tissue located in the inferior interatrial septum beneath the endocardium; it provides the only normal conduction pathway between the atrial and ventricular syncytia.

AV bundle: The bundle of His; a large structure that receives the cardiac impulse from the distal AV node. It enters the upper part of the interventricular septum.

Blood volume: The sum of formed elements and plasma volumes in the vascular system; most adults have about 5 L of blood.

Capillaries: The smallest-diameter blood vessels, which connect the smallest arterioles to the smallest venules.

Cardiac conduction system: The initiation and distribution of impulses through the myocardium that coordinates the cardiac cycle.

Cardiac cycle: A heartbeat; it consists of a complete series of systolic and diastolic events.

Cardiac output: The volume discharged from the ventricle per minute, calculated by multiplying stroke volume by heart rate, in beats per minute.

Cardiac veins: Those veins that branch out and drain blood from the myocardial capillaries to join the coronary sinus.

Carotid sinuses: Enlargements near the base of the carotid arteries that contain baroreceptors and help to control blood pressure.

Cerebral arterial circle: The circle of Willis; it connects the vertebral artery and internal carotid artery systems.

Chordae tendineae: Strong fibers originating from the papillary muscles that attach to the cusps of the tricuspid valve.

Coronary arteries: The first two aortic branches, which supply blood to the heart tissues.

Coronary sinus: An enlarged vein joining the cardiac veins; it empties into the right atrium.

Diastole: The relaxation of a heart structure.

Diastolic pressure: The lowest pressure that remains in the arteries before the next ventricular contraction.

Electrocardiogram (EKG): The recording of electrical changes in the myocardium during the cardiac cycle. The EKG machine works by placing nodes on the skin that connect via wires and respond to weak electrical changes of the heart. The abbreviation EKG is more commonly used than ECG.

Endocardium: The inner layer of the heart wall.

Epicardium: The outer layer of the heart wall.

Functional syncytium: A mass of merging cells that functions as a unit.

Hepatic portal system: The veins that drain the abdominal viscera, originating in the stomach, intestines, pancreas, and spleen, to carry blood through a hepatic portal vein to the liver.

Inferior vena cava: Along with the superior vena cava, one of the two largest veins in the body; it is formed by the joining of the common iliac veins.

Mitral valve: The bicuspid valve; it lies between the left atrium and left ventricle, preventing blood from flowing back into the left atrium from the ventricle.

Myocardium: The thick middle layer of the heart wall that is mostly made of cardiac tissue.

Pacemaker: The term used to refer to the sinoatrial node (SA node).

Papillary muscles: Those muscles that contract as the heart's ventricles contract, pulling on the chordae tendineae to prevent the cusps from swinging back into the atrium.

Pericardium: A membranous structure that encloses the heart and proximal ends of the large blood vessels and that consists of double layers.

Peripheral resistance: A force produced by friction between blood and blood vessel walls.

Pulmonary circuit: The venules and veins, which send deoxygenated blood to the lungs to receive oxygen and unload carbon dioxide.

Pulmonary valve: Lying at the base of the pulmonary trunk, this valve has three cusps and allows blood to leave the right ventricle while preventing backflow into the ventricular chamber.

Purkinje fibers: Consisting of branches of the AV bundle that spread and enlarge, these fibers are located near the papillary muscles; they continue to the heart's apex and cause the ventricular walls to contract in a twisting motion.

Septum: A solid, wall-like structure that separates the left atria and ventricle from the right atria and ventricle.

Sinoatrial node (SA node): A small mass of specialized tissue just beneath the epicardium in the right atrium that initiates impulses through the myocardium to stimulate contraction of cardiac muscle fibers.

Stroke volume: The volume of blood discharged from the ventricle with each contraction; it is usually about 70 mL.

Superior vena cava: Along with the inferior vena cava, one of the two largest veins in the body; the superior vena cava is formed by the joining of the brachiocephalic veins.

Systemic circuit: The arteries and arterioles, which send oxygenated blood and nutrients to the body cells while removing wastes.

Systole: The contraction of a heart structure.

Systolic pressure: The maximum pressuring during ventricular contraction.

Thyrocervical arteries: Those that branch off to the thyroid and parathyroid glands, larynx, trachea, esophagus, pharynx, and muscles of the neck, shoulder, and back.

Tricuspid valve: Lying between the right atrium and ventricle, this valve allows blood to move from the right atrium into the right ventricle while preventing backflow.

Vasoconstriction: The contraction of blood vessels, which reduces their diameter.

Vasodilation: The relaxation of blood vessels, which increases their diameter.

Veins: Blood vessels that carry blood back to the atria; they are less elastic than arteries.

Ventricles: The lower chambers of the heart; they receive blood from the atria, which they pump out into the arteries.

Venules: Microscopic vessels that link capillaries to veins.

Vertebral arteries: One of the main divisions of the subclavian and common carotid arteries; the vertebral arteries run upward through the cervical vertebrae into the skull and supply blood to the vertebrae, their ligaments, and their muscles.

Viscosity: Thickness or stickiness; the resistance of fluid to flow. In a biologic fluid, viscosity is caused by the attraction of cells to one another.

Introduction

The cardiovascular system, therefore, consists of a closed circuit: the heart, arteries, arterioles, capillaries, venules, and veins.

The Blood Vessels

- The blood vessels of the human body carry blood to every type of tissue and organ.
- Vessels decrease in size as they move away from the heart (arteries and arterioles), ending in the capillaries, and then increase in size as they move toward the heart (venules and veins).
- The largest artery in the body is the aorta, with the largest veins being the venae cava.

There are five general classes of blood vessels in the cardiovascular system:

1. Arteries
2. Arterioles
3. Capillaries
4. Venules
5. Veins

1. **Arteries** are elastic vessels that are very strong, able to carry blood away from the heart under high pressure.
   Arteries subdivide into thinner tubes that give rise to branched, finer **arterioles**.

An artery's wall consists of three distinct layers.

- The innermost tunica interna is made up of a layer of simple squamous epithelium known as endothelium. It rests on a connective tissue membrane with many elastic, collagenous fibers. The endothelium helps prevent blood clotting and may also help in regulating blood flow.
- The middle tunica media makes up most of an arterial wall, including smooth muscle fibers and a thick elastic connective tissue layer.
- The outer tunica externa (tunica adventitia) is thinner, mostly made up of connective tissue with irregular fibers—it is attached to the surrounding tissues.

Nerve supply to Arteries: Smooth artery and arteriole muscles are innervated by the sympathetic nervous system. Vasomotor fibers receive impulses to contract and reduce blood vessel diameter (**vasoconstriction**). When inhibited, the muscle fibers relax and the vessel's diameter increases (**vasodilation**). Changes in artery and arteriole diameters greatly affect blood flow and pressure.

Blood supply:

- Outer layer of the BV receives supply from VASAVASORUM.
- Internal layers from the diffusion from vessels itself.
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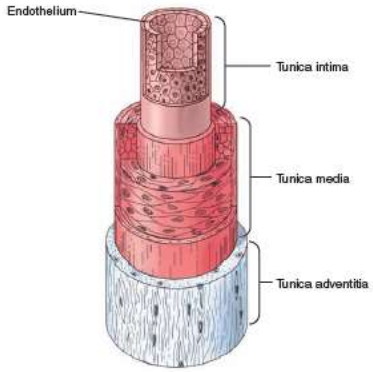
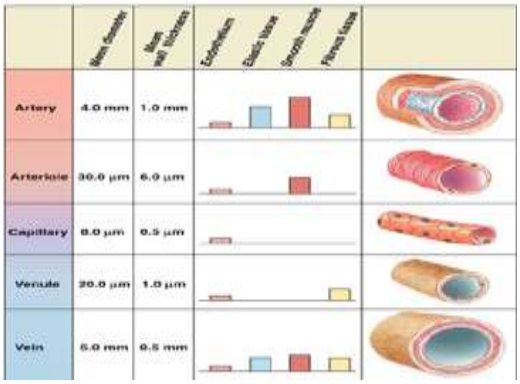
2. **Arterioles** also have three layers in their walls, which get thinner as arterioles lead to capillaries. Very small arteriole walls only have an endothelial lining and some smooth muscle fibers, with a small amount of surrounding connective tissue.
3. **Capillaries** are smallest-diameter blood vessels, which connect the smallest arterioles to the smallest venules.

- The walls of capillaries are also composed of endothelium and form the semipermeable layer through which substances in blood are exchanged with substances in tissue fluids surrounding cells of the body.
- Gases, metabolic by-products, and nutrients are exchanged between capillaries and the tissue fluid surrounding body.

4. **Venules** are microscopic vessels that link capillaries.
5. **Veins** are similar to arteries but have poorly developed middle layers. Because they have thinner walls that are less elastic than arteries,
    - Lumens of veins have a greater diameter.
    - Many veins have flaplike *valves* projecting inward from their linings.
    - Valves help in returning blood to the heart, opening if blood flow is toward the heart, but closing if it reverses.
    - Therefore, a major structural difference between veins and arteries is that arteries do not have valves.



Structure of the Blood Vessels



Blood Vessels difference