CARDIOVASCULAR SYSTEM:

Introduction

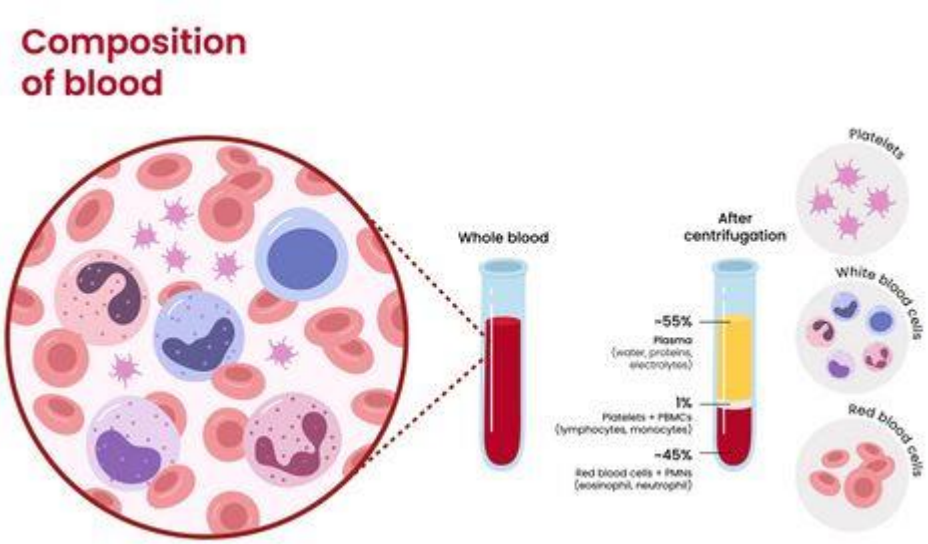
The cardiovascular system, also known as the circulatory system, acts as a transportation system to supply the body with oxygenated blood and nutrients and remove waste products, such as carbon dioxide and metabolites from the body's cells. In essence, it is a sophisticated system of vessels (arteries, capillaries, and veins) powered by a strong muscular pump (the heart).

Many mechanisms regulate the cardiovascular system, including changes in blood volume, hormonal factors, changes in electrolytes and osmolarity, various medications, the kidneys, etc. Both the parasympathetic and sympathetic divisions of the autonomic nervous system also play important roles in regulating the cardiovascular system.

This article explores the cardiovascular system, covering the major anatomical structures and components, heart physiology and function and circulatory pathways. It also includes links to information on commonly encountered cardiovascular diagnoses.

Cardiovascular System Components and Function

Blood



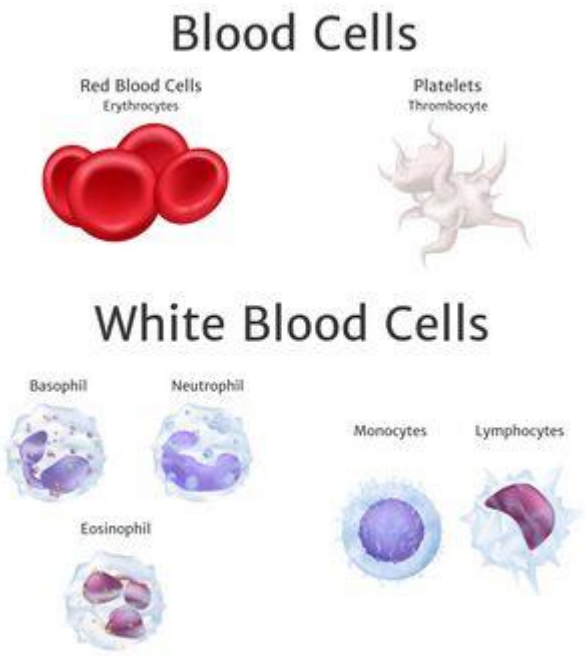
There are three layers found in a centrifugal blood sample: the top layer contains blood plasma, the thin middle layer (known as the buffy coat) contains white blood cells and platelets, and the bottom layer contains red blood cells.

Blood is a specialised connective tissue that carries nutrients, oxygen, hormones, and water to the cells and carbon dioxide and waste products away from the cells. Blood is involved in regulating body temperature and pH and has a role in immunological functions and inflammatory responses. It is also responsible for blood clot formation to prevent excess blood loss.

Blood is made up of four main components: (1) plasma, (2) red blood cells, (3) white blood cells, and (4) platelets. Plasma makes up approximately 55-60% of a person's total blood volume, red blood cells make up approximately 40-45%, and white blood cells and platelets make up less than 1%.

Plasma

Plasma is the liquid component of blood. It is a mixture of water, sugar, fat, protein, and salts. The primary function of plasma is to transport blood cells throughout the body along with nutrients, waste products, antibodies, clotting proteins, chemical messengers (eg. hormones), and proteins that help maintain the body's fluid balance.



Red blood cells

Red blood cells (RBCs, also known as erythrocytes) are biconcave, disc-shaped cells that are specialised for oxygen transport throughout the body. Red blood cells lack a nucleus and organelles. This maximises space for haemoglobin, the iron-containing protein that binds oxygen. Each red blood cell contains approximately 270 million haemoglobin molecules and can carry over a billion oxygen molecules. Red blood cells pick up oxygen in the lungs where high oxygen levels promote haemoglobin saturation, then release it in tissues where lower oxygen and higher carbon dioxide concentrations facilitate unloading (Bohr effect, please see additional resources for more information). They also help transport carbon dioxide back to the lungs for elimination.

White blood cells

White blood cells (WBCs, also known as leukocytes) are immune system cells that defend the body against infections, foreign substances, and abnormal cells. There are several specialised types of white blood cells, each with distinct

functions. Neutrophils are the most abundant white blood cell. They act as first responders to bacterial infections, engulfing pathogens through phagocytosis and releasing antimicrobial substances. Lymphocytes (includes B cells that produce antibodies and T cells) coordinate immune responses by killing infected cells or regulating immunity. Monocytes circulate in blood and become tissue macrophages that consume pathogens and debris while presenting antigens to other immune cells. Eosinophils combat parasites and mediate allergic reactions, while basophils release histamine during inflammation. White blood cells can migrate from blood vessels into tissues and circulate through both blood and lymphatic systems to provide comprehensive immune surveillance and protection.

Platelets

Platelets (also known as thrombocytes), are essential for blood clotting and haemostasis. These disc-shaped structures circulate for 8-10 days and contain granules filled with clotting factors, growth factors, and vasoactive substances. When blood vessels are injured, platelets rapidly adhere to exposed collagen through surface receptors. They then undergo activation and shape changes. This triggers platelet aggregation, resulting in an initial haemostatic plug that seals the vessel breach. Platelets also promote fibrin formation, stable clot development, aid wound healing, and participate in inflammatory responses.

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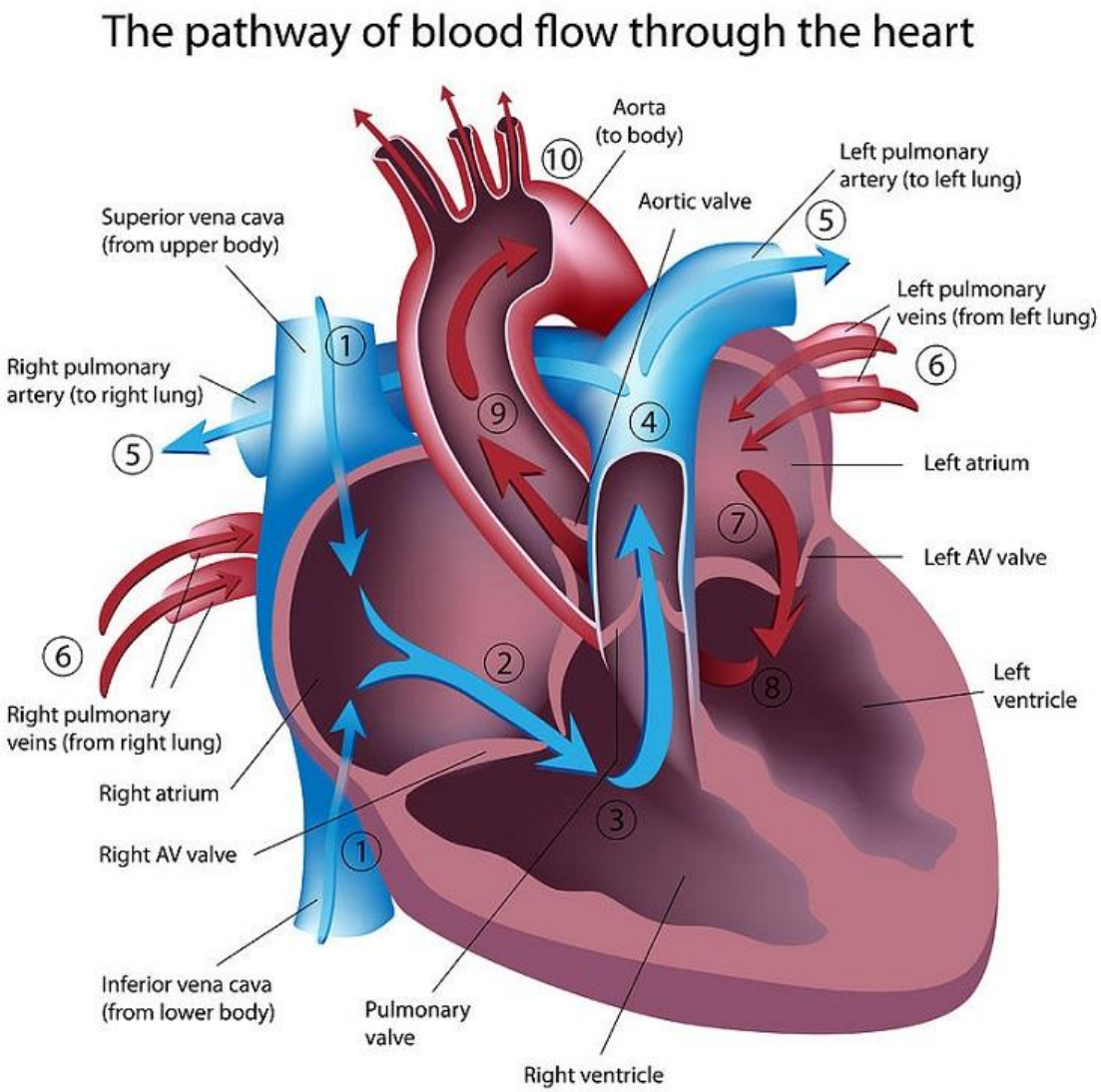
Heart

The heart is a strong, muscular organ that beats regularly to pump oxygenated blood to the systemic system and deoxygenated blood to the pulmonary system. It is located in the thoracic cavity, behind the sternum. The heart and its great vessels are suspended in a fibrous fluid-filled sac called the pericardium, which stabilises the heart, supports cardiac contractions, and separates it from other structures in the thorax.

The wall of the heart has three layers. From innermost to outermost, these layers are the: endocardium, myocardium, and epicardium.

Conduction System of heart

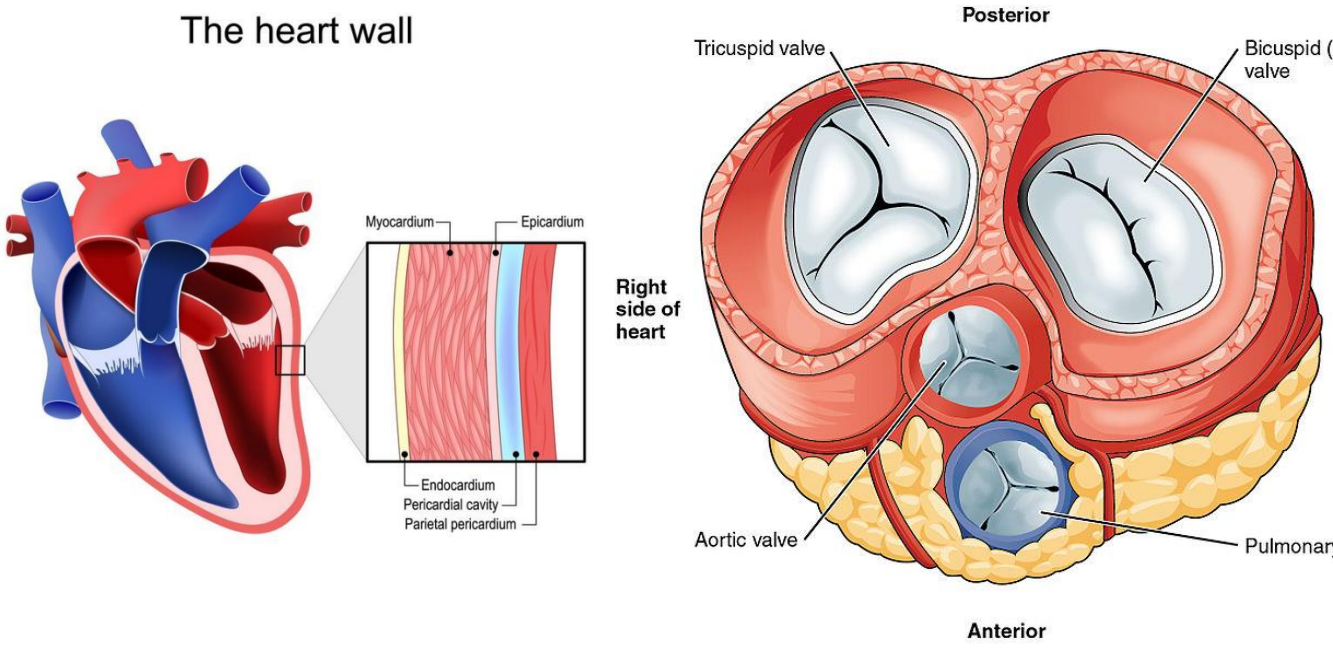


Structure of the Heart

The heart contains four chambers (right atrium, right ventricle, left atrium, left ventricle) that are divided by a muscular septum into a right and left pump. Each pump has an atrium and a ventricle. The four valves of the heart ensure a constant flow of blood in the right direction through the heart's chambers. The two atrioventricular valves direct blood from the atria to the ventricles and the semilunar valves direct blood flow from the ventricles to the outgoing arteries.

The right atrium receives deoxygenated blood from the body (via the inferior and superior vena cavae) and the heart itself and sends it through the right atrioventricular valve (also known as the tricuspid valve) into the right ventricle. The right ventricle then pumps this blood through the pulmonary valve into the lungs via the pulmonary trunk. After gas exchange occurs in the lungs, the left atrium receives oxygenated blood via the pulmonary veins and sends it through the left atrioventricular valve (also

known as the bicuspid or mitral valve) into the left ventricle. The left ventricle then pumps this blood through the aortic valve to the entire body via the aorta.

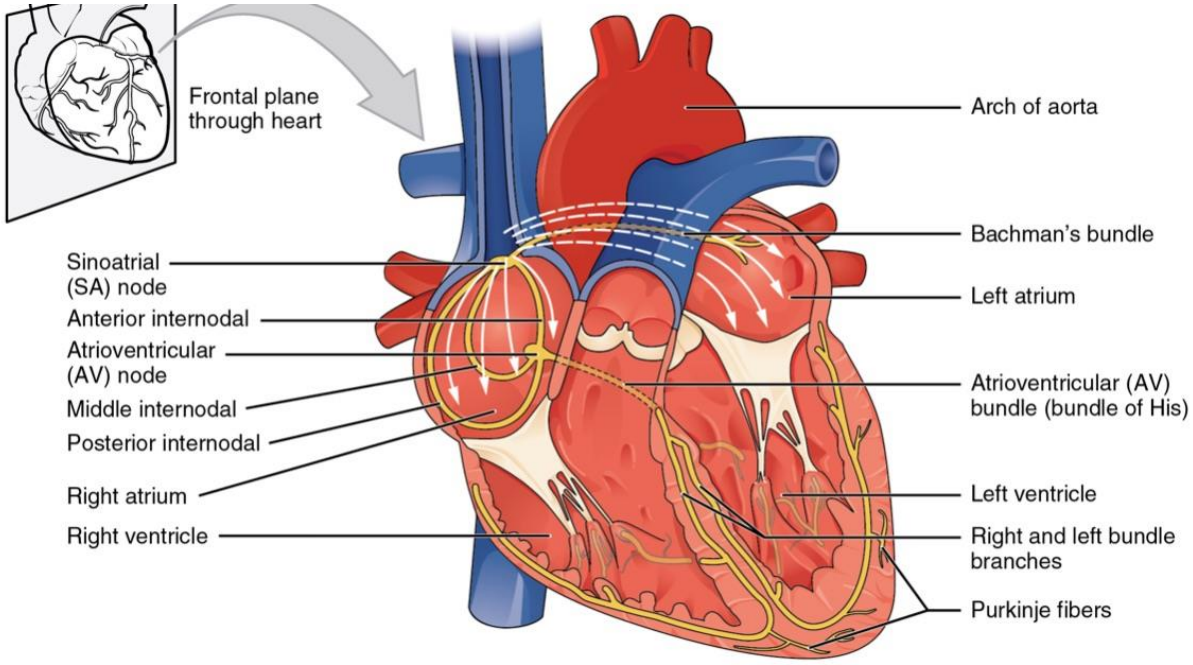


Circulatory Systems

The cardiovascular system consists of two main circulatory systems: (1) pulmonary and (2) systemic circulation systems. The pulmonary circulation, powered by the right ventricle, holds around 10% of the total blood volume at any given time. It is responsible for the oxygenation of blood via the lungs. It is a low-pressure system, with lower intravascular pressure compared to the systemic circulation. The systemic circulation, powered by the left ventricle, contains approximately 85% of the total blood volume at any given time. It provides oxygenated blood and nutrients to the body. It involves high intravascular pressure. The remaining 5% of the blood volume is within the heart chambers themselves.

Sinoatrial Node

The heart has its own pacemaker, called the sinoatrial (SA) node. The electrical signals generated here get carried through the left atrium, via the Bachmann’s bundle, and trigger atrial contraction. The signal then travels to the atrioventricular (AV) node; to the atrioventricular bundle (also known as the bundle of His) and finally through Purkinje fibres, which trigger ventricular contraction. Because our heart rate must be able to adapt to our body's changing physiological demands, it is also regulated by the endocrine and autonomic systems—for example, parasympathetic nervous system action decreases heart rate while sympathetic nervous system action increases heart rate. Without these extrinsic regulatory influences, the sinoatrial node would establish a resting heart rate of around 100 beats per minute.



Supply to the Heart

The heart has its own blood supply. 80% of blood to the heart comes from the left coronary artery, which divides into the left anterior descending artery and the circumflex coronary artery. The right coronary artery supplies the remaining 20% of blood to the heart.