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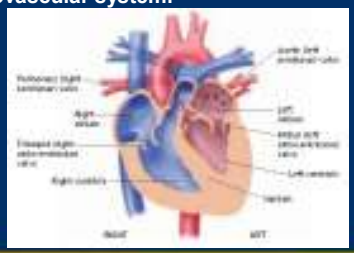
The Heart

- The *circulatory system* is made up of the cardiovascular system and the lymphatic system.
  - The **cardiovascular system** is made up of the blood, heart, and blood vessels.
  - The **lymphatic system** is made up of the lymph, lymph nodes, and the lymph vessels.

The Heart, *continued*

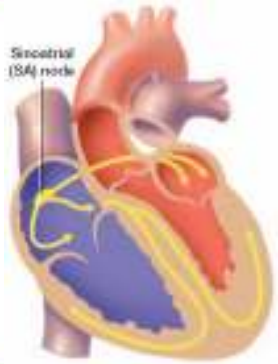
- The heart is the central organ of the cardiovascular system.



The Heart, *continued*

- **Control of the Heartbeat**
  - Pacemaker of the Heart
    - The **sinoatrial (SA) node** is a group of specialized heart-muscle cells that lies at the junction of the superior vena cava and the right atrium and regulates the contraction of the heart.

Electrical Regulation of the Heart



The Heart, *continued*

- **Control of the Heartbeat,** *continued*
  - A series of pressure waves are caused by the contractions of the left ventricle when it forces blood through the arteries. This is called a **pulse.**

Blood Vessels, *continued*

- **Arteries and Blood Pressure**
  - The large, muscular vessels that carry blood away from the heart and to the body are called **arteries.**

Blood Vessels, *continued*

- **Arteries and Blood Pressure,** *continued*
  - As the heart moves the blood through the arteries, it produces a great force against the inside walls of a blood vessel. This force is known as **blood pressure.**
  - High blood pressure, or **hypertension,** can place a strain on the walls of the arteries and could cause that artery to burst.

Blood Vessels, *continued*

- **Arteries and Blood Pressure,** *continued*
  - In order to measure blood pressure, systolic pressure and diastolic pressure must be measured.
  - ***Systolic pressure***, measured first, is the pressure of the blood when the ventricles contract.
  - ***Diastolic pressure,*** measured second, indicates the steady flow of blood through the artery.

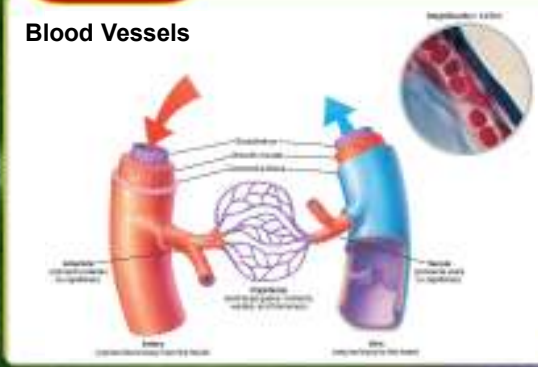
Blood Vessels, *continued*

- **Capillaries and Veins**
  - From the artery, a series of smaller vessels called ***arterioles*** carry the blood to capillaries.
  - The **capillaries** are a vast network of tiny vessels that allow an exchange between the blood and the cells to occur.

Blood Vessels, *continued*

- **Capillaries and Veins,** *continued*
  - After cells interact with the blood, the blood goes back to the heart. To do this, capillaries merge to form ***venules.***
  - These venules are connected to a vein. A **vein** is a bundle of vascular tissue that transports fluids and nutrients back to the heart.

Blood Vessels



Lymphatic System-Immune System

- The circulatory system also includes the lymphatic system.
- The lymphatic system returns fluids that have collected in the tissues to the bloodstream.
- Excess fluid in the tissues, called **lymph**, moves into the tiny vessels of the lymphatic system by diffusion.

Lymphatic System, *continued*

- Lymph vessels are similar to blood vessels but are also different in many ways.
- Lymph is filtered through small organs known as lymph nodes to trap tissue debris and other foreign particles.
  - Lymph nodes also store ***lymphocytes***, white blood cells that are specialized to fight disease.

Composition of Blood

- Blood is composed of a liquid medium—plasma—and blood solids–red and white blood cells and platelets.
- **Plasma**
  - **Plasma** is a sticky, straw-colored fluid that is about 90 percent water and includes metabolites, nutrients, wastes, salts, and proteins.
  - Plasma provides cells with nourishment and carries various proteins.

Composition of Blood, *continued*

- **Red Blood Cells**
  - A **red blood cell** is a disc-shaped cell that has no nucleus and transports oxygen to cells in all parts of the body.
  - Immature red blood cells synthesize large amounts of an iron-containing protein called hemoglobin. **Hemoglobin** is the molecule that transports oxygen.

Composition of Blood, *continued*

- **White Blood Cells**
  - **White blood cells** are cells in the blood that destroy bacteria, viruses, and toxic proteins and helps the body develop immunities.
  - In addition to different functions, white blood cells also have a different structure and life span than red blood cells.

Composition of Blood, *continued*

- **White Blood Cells, continued**
  - There are several types of white blood cells, including phagocytes and antibodies.
    - **Phagocytes** are cells that engulf and digest foreign matter or microorganisms.
    - **Antibodies** are proteins that react to a specific type of invader or inactivate or destroy toxins.

Composition of Blood

Components of Blood	Function
Plasma portion (60% of total blood volume)	
Water	Acts as solvent
Metabolites and wastes, salts and ions, proteins	Play diverse roles (nourish cells, catalyze chemical reactions, act as chemical messengers, maintain blood volume, fight infection, etc.)
Cellular portion (40% of total blood volume)	
Red blood cells	$O_2 + CO_2$ transport
White blood cells	Produce antibodies, ingest foreign materials
Platelets	Aid in clotting blood

Blood Types

- Red blood cells have surface proteins that are used to classify a person's blood. The type of surface protein determines a person's **blood type.**
- The surface proteins on a red blood cell or on an invading pathogen are called **antigens.**
- The most important human antigens are A, B, and Rh. They form two systems of blood typing: the A-B-O system and the Rh system.