

CH 12 The Cardiovascular and Lymphatic Systems

The Cardiovascular and Lymphatic Systems

OUTLINE:

- Cardiovascular System
- Blood Vessels
- Heart
- Blood Pressure
- Lymphatic System

Cardiovascular System

- The cardiovascular system is composed of
 - Blood vessels
 - Heart
- This system distributes blood, delivers nutrients, and removes wastes

Blood Vessels

- Blood passes through the following loop of vessels moving away from the heart
 - Arteries
 - Arterioles
 - Capillaries
 - Venules
 - Veins
- Blood returns to the heart from the venules and veins

Blood Vessels

- Common features
 - Lumen—the hollow interior through which blood flows
 - Endothelium—the inner lining consisting of simple squamous epithelium
- Special features
 - Each type of blood vessel has traits that reflect its particular function

Arteries

- Thick, muscular vessels that carry blood away from the heart to body tissues
- Layers
 - Inner—endothelium
 - Middle
 - Elastic fibers—allow the artery to stretch and return to its original shape
 - Smooth muscle—allows the artery to contract
 - Outer—connective tissue

Arteries

- Pulse
 - Pressure wave created by the alternate expansion and contraction of the arteries
 - Moves along the arteries with each heartbeat
 - The pulse rate is the same as the heart rate

Arteries

- Vasoconstriction
 - Smooth muscle of the middle layer contracts and the diameter of the lumen narrows, reducing blood flow
- Vasodilation
 - Smooth muscle of the middle layer relaxes and the diameter of the lumen increases,

increasing blood flow

Arteries

- Aneurysm
 - Occurs when the wall of an artery is weakened and swells outward
 - The primary risk is that it will burst, causing blood loss
 - If it does not burst, then it can form life-threatening clots

Arteries

- Arterioles
 - Smallest arteries
 - The prime controllers of blood pressure (pressure of blood against vessel walls)
 - Serve as gatekeepers to the capillary networks, keeping them open or closed

Capillaries

- Microscopic blood vessels connecting arterioles and venules
- Sites of exchange of materials between the blood and the body cells
 - Have walls that are one cell thick
 - Provide enormous surface area for exchange
 - Exchange occurs through endothelial cells (across the plasma membranes) or through slits between these cells
 - Blood flows very slowly, allowing more time for the exchange of materials
 - Capillary bed is a network of capillaries servicing a particular area
 - Precapillary sphincter regulates blood flow into it

Veins

- Venules
 - Capillaries merge to form venules, the smallest kind of vein
 - Venules join to form larger veins
- Veins
 - Carry blood back to the heart
 - Walls have the same three layers as arteries, but they are thinner; also have larger lumens
 - Serve as reservoirs for blood volume

Veins

- Three mechanisms move blood (against gravity) from the lower parts of the body to the heart
- Contraction of skeletal muscles
- Pressure differences caused by breathing
 - Expansion of the thoracic cavity during inhalation
 - Lowers pressure and pulls blood toward the heart
 - Increases pressure in the abdominal cavity, which squeezes veins, and moves blood toward the heart
- Valves in veins
 - Prevent backflow of blood

Heart

- Structure
 - Three layers of the heart
 - Myocardium
 - The wall of the heart
 - Mostly cardiac muscle tissue

- Endocardium
 - Thin lining of the cavities of the heart
 - Reduces resistance to blood flow through the heart
- Pericardium
 - Thick fibrous sac that holds the heart

Heart

- The septum separates the two halves of the heart
- Each half has two chambers
 - Atrium—smaller and thin-walled
 - Ventricle—larger and more muscular

Heart

- Valves (two pairs)
 - Atrioventricular (AV) valves: separate the atria from the ventricles
 - Semilunar valves: separate the ventricles from the exit vessels
- Heart's “lub-dup” sounds come from the valves
 - “Lub”—closing of the AV valves
 - “Dup”—closing of the semilunar valves

Heart

- AV valves
 - Tricuspid valve
 - On the right side of the heart, has three flaps
 - Bicuspid (or mitral) valve
 - On the left side of the heart, has two flaps

Heart

- Semilunar valves
 - Aortic semilunar valve: between left ventricle and aorta
 - Pulmonary semilunar valve: between right ventricle and pulmonary artery
 - Prevent the backflow of blood into the ventricles

Two Circuits of Blood Flow

- The right side of the heart
 - Contains blood low in oxygen
 - Pumps blood through the pulmonary circuit
 - Transports blood to and from the lungs
- The left side of the heart
 - Contains blood rich in oxygen
 - Pumps blood through the systemic circuit
 - Transports blood to and from body tissues

Coronary Circulation

- Coronary circulation nourishes the heart muscle
 - Coronary arteries
 - The first two arteries that branch off the aorta and branch extensively
 - Bring oxygen and nutrients to the heart muscle
 - Coronary veins
 - Blood passes through capillary beds, enters coronary veins, and flows into the right atrium

Cardiac Cycle

- All chambers relax and blood passes through atria into ventricles
 - Atria contract
 - Ventricles contract
 - Heart relaxes, and the cycle begins again
- Contraction is called systole
- Relaxation is called diastole

Internal Conduction System

- Sinoatrial (SA) node (pacemaker)
 - Located in the right atrium
 - Causes atria to contract
 - Generates an electrical signal that sets the tempo of the heartbeat

Internal Conduction System

- Atrioventricular (AV) node
 - Located between the two atria
 - Receives the signal from the SA node
 - Transmits the signal by way of the **atrioventricular bundle** (located along the wall between the two ventricles) to **Purkinje fibers** that penetrate the walls of the ventricles, causing the ventricles to contract

Internal Conduction System

- Problems with the internal conduction system can result in ventricular fibrillation (irregular contraction of the ventricles)
- Electric shock may induce the SA node to function normally
- Implantable defibrillators can be used in the long term

Internal Conduction System

Electrocardiogram

- A powerful tool recording of the electrical events associated with the heartbeat
 - Abnormal patterns can indicate heart problems
- Three distinguishable deflection waves
 - P wave
 - Signals from SA node spread across the atria and cause them to contract
 - QRS wave
 - Spread of signals through ventricles and ventricular contraction
 - T wave
 - Return of the ventricles to the electrical state before contraction

Blood Pressure

- The force exerted by the blood against the walls of the blood vessels (e.g., 120/80)
- Can be measured using a sphygmomanometer
 - Measures pressure in the brachial artery of the arm

Blood Pressure

- Systolic pressure
 - Highest pressure in the artery during each heartbeat (ventricles are contracting)
 - About 120 mm Hg in a healthy adult
- Diastolic pressure

- Lowest pressure in the artery during each heartbeat (ventricles are relaxing)
- About 80 mm Hg in a healthy adult

Lymphatic System

- Components of the lymphatic system
 - Lymph: fluid identical to interstitial fluid
 - Lymphatic vessels
 - Vessels through which lymph flows
 - Have one-way valves to prevent backflow
 - Lymphoid tissues and organs

Lymphatic System

- Functions of the lymphatic system
 - Return excess interstitial fluid to the bloodstream
 - Transport products of fat digestion from the small intestine to the bloodstream
 - Defend the body against disease-causing organisms and abnormal cells

Lymphatic System

- Elephantiasis
 - A condition in which parasites block lymphatic vessels, preventing the return of fluid to blood
 - Results in massive swelling, darkening, and thickening of the skin in the affected area

Lymphatic System

- Lymphatic capillaries
 - Extra fluid enters these microscopic tubules
 - Differ from blood capillaries
 - End blindly
 - More permeable
 - Drain into larger lymphatic vessels
 - Lymph eventually enters ducts that join with large veins at the base of the neck

Lymphatic System

- Lymph nodes
 - Bean-shaped structures
 - Filter lymph as it flows through them
 - Contain macrophages and lymphocytes that defend against disease-causing organisms

Lymphatic System

- Lymphoid organs include
 - Tonsils
 - Thymus gland
 - Spleen
 - Peyer's patches (nodules along the small intestine)
 - Red bone marrow

You Should Now Be Able To:

- Describe the organs of the cardiovascular system
- Know the structure and function of blood vessels:

- Arteries
- Capillaries
- Veins
- Know the detailed anatomy of the heart
- Explain blood circulation
- Understand the heart's internal conduction system
- Understand blood pressure and how to measure it
- Describe the lymphatic system with its organs and its circulation