

# Human Biology

## Cardiovascular System

The cardiovascular system is vital for providing oxygen and nutrients to tissues, and for removing wastes.

### Structure of the Heart

1. Size & location of the heart
  - a. The heart is about 14 centimeters long and 9 centimeters wide.
  - b. It is located within the mediastinum and rests on the diaphragm.
2. Covering of the heart
  - a. The heart is enclosed in a layered pericardium.
  - b. The pericardial cavity is a potential space between the visceral and parietal layers of the pericardium.
3. Wall of the heart
  - a. The wall of the heart is composed of three layers.
  - b. These layers include an epicardium, a myocardium and an endocardium.
4. Heart chambers and valves
  - a. The heart is divided into four chambers - two atria and two ventricles - that communicate through atrioventricular orifices on each side.
  - b. Right chambers and valves
    - i. The right atrium receives blood from the venae cavae and coronary sinus.
    - ii. The right atrioventricular orifice is guarded by the tricuspid valve.
    - iii. The right ventricle pumps blood into the pulmonary trunk.
    - iv. The base of the pulmonary trunk is guarded by the pulmonary valve.
  - c. Left chambers and valves
    - i. The left atrium receives blood from the pulmonary veins.
    - ii. The left atrioventricular orifice is guarded by the bicuspid valve.
    - iii. The left ventricle pumps blood into the aorta
    - iv. The base of the aorta is guarded by an aortic valve.
5. Skeleton of the heart
  - a. The skeleton of the heart consists of fibrous rings that enclose the bases of the pulmonary artery, aorta, and atrioventricular orifices.
6. Path of the blood through the heart
  - a. Blood that is relatively low in oxygen concentration and high in carbon dioxide concentration enters the right side of the heart and is pumped into the pulmonary circulation.

- b. After the blood is oxygenated in the lungs and some of its carbon dioxide is removed, it returns to the left side of the heart.
7. Blood supply to the heart
- a. Blood is supplied to the myocardium through the coronary arteries.
  - b. It is returned to the right atrium through the cardiac veins and coronary sinus.

### **Actions of the Heart**

1. Cardiac cycle
  - a. The atria contract while the ventricles relax; the ventricles contract while the atria relax.
  - b. This series of events constitutes a cardiac cycle.
2. Heart sounds
  - a. Heart sounds are due to the vibrations produced by the blood and valve movements.
3. Cardiac muscle fibers
  - a. Cardiac muscle fibers are interconnected to form a functional syncytium.
  - b. If any part of the syncytium is stimulated, the whole structure contracts as a unit.
4. Cardiac conduction system
  - a. This system functions to initiate and conduct impulses through the myocardium.
  - b. Impulses from the sino-atrial (S-A) node pass slowly to the atrio-ventricular (A-V) node; impulses travel rapidly along the A-V bundle and Purkinje fibers.
5. Electrocardiogram (ECG)
  - a. An ECG is a recording of the electrical changes occurring in the myocardium during a cardiac cycle.
  - b. The pattern contains several waves:
    - i. The P wave represents an atrial depolarization.
    - ii. The QRS complex represents a ventricular depolarization.
    - iii. The T wave represents a ventricular repolarization.
6. Regulation of the cardiac cycle
  - a. The heartbeat is affected by physical exercise, body temperature, and the concentration of various ions.
  - b. The S-A and A-V nodes are innervated by branches of sympathetic and parasympathetic nerve fibers.
  - c. Autonomic impulses are regulated by the cardiac center in the medulla oblongata.

## **Blood Vessels**

The blood vessels form a closed circuit of tubes.

1. Arteries and arterioles
  - a. The arteries are adapted to carry high pressure blood away from the heart.
  - b. The walls of the arteries and arterioles consist of endothelium, smooth muscle, and connective tissue.
  - c. The smooth muscles are innervated by autonomic fibers.
2. Capillaries
  - a. The capillary wall consists of a single layer of epithelial cells.
  - b. The openings in capillary walls, where adjacent endothelial cells overlap, vary in size and are responsible for the permeability of these walls.
  - c. The blood flow into a capillary is controlled by a precapillary sphincter.
  - d. Exchanges in the capillaries:
    - i. Gases, nutrients, and metabolic by-products are exchanged between the capillary blood and tissue fluid.
    - ii. Diffusion provides the most important means of transport.
    - iii. Filtration causes a net outward movement of fluid at the arterial end of a capillary.
    - iv. Osmosis causes a net inward movement of fluid at the venule end of a capillary.
3. Venules and veins
  - a. Venules continue from capillaries and merge to form veins.
  - b. Veins carry blood to the heart.
  - c. Venous walls are similar to arterial walls, but they are thinner and contain less muscle and elastic tissue.

## **Blood Pressure**

Blood pressure is the force exerted by the blood against the inside of the blood vessels.

1. Arterial blood pressure
  - a. The arterial blood pressure is created primarily by heart action.
  - b. The systolic pressure occurs when the ventricle contracts; the diastolic pressure occurs when the ventricle relaxes.
2. Factors that influence arterial blood pressure
  - a. The arterial pressure increases as the cardiac output, blood volume, peripheral resistance, or blood viscosity increases.
3. Control of blood pressure
  - a. Blood pressure is controlled in part by the mechanisms that regulate cardiac output and peripheral resistance.

- b. The more blood that enters the heart, the stronger the ventricular contraction, the greater the stroke volume, the greater the cardiac output.
  - c. Regulation of the heart rate and peripheral resistance involves the cardiac and vasomotor centers of the medulla oblongata.
4. Venous blood flow
- a. Venous blood flow depends on skeletal muscle contraction and breathing movements.
  - b. Many veins contain flap-like valves that prevent blood from flowing backwards.
  - c. Ven constriction can increase venous pressure and blood flow.

### **Paths of Circulation**

1. Pulmonary circuit
  - a. The pulmonary circuit is composed of vessels that carry blood back from the right ventricle to the lungs and back to the left atrium.
2. Systemic circuit
  - a. The systemic circuit is composed of vessels that lead from the heart to the body and back to the heart.
  - b. It includes the aorta and its branches.

### **Arterial System**

1. Principal branches of the aorta
  - a. The aorta is the largest artery.
  - b. Its branches include the coronary, brachiocephalic, left common carotid, and left subclavian arteries.
  - c. The branches of the descending aorta include the thoracic and abdominal groups.
  - d. The abdominal aorta terminates by dividing into the right and left common iliac arteries.
2. Arteries to the neck, head, and brain
  - a. These include the branches of the subclavian and common carotid arteries.
3. Arteries to the thoracic and abdominal walls
  - a. The thoracic wall is supplied by branches of the subclavian artery and thoracic aorta.
  - b. The abdominal wall is supplied by branches of the abdominal aorta and other arteries.

4. Arteries to the shoulder and arm
  - a. The subclavian artery passes into the upper arm and in various regions is called the axillary and the brachial artery.
  - b. The branches of the brachial artery include the ulnar and radial arteries.
5. Arteries to the pelvis and leg
  - a. The common iliac artery supplies the pelvic organs, gluteal region, and leg.

### **Venous System**

1. Characteristics of venous pathways
  - a. Veins are responsible for returning blood to the heart.
  - b. The larger veins usually parallel the paths of major arteries.
2. Veins from the brain, head, and neck
  - a. These regions are drained by the jugular veins.
  - b. The jugular veins unite with the subclavian veins to form the brachiocephalic veins.
3. Veins from the abdominal and thoracic walls
  - a. These walls are drained by tributaries of the brachiocephalic and azygos vein.
4. Veins from the abdominal viscera
  - a. The blood from the abdominal viscera generally enters the hepatic portal system and is carried to the liver.
  - b. From the liver, the blood is carried to the hepatic portal veins to the inferior vena cava.
5. Veins from the arm and shoulder
  - a. The arm is drained by sets of superficial and deep veins.
  - b. The deep veins parallel arteries with similar names.
6. Veins from the leg and pelvis
  - a. These regions are drained by sets of deep and superficial veins.
  - b. The deep veins include the tibial veins, and the superficial veins include the saphenous veins.