The Circulatory System

Terminology

**Angina Pectoris**: Severe suffocation chest pain caused by brief lack of oxygen supply to the head muscle.

**Aorta**: Major systemic artery; arises from the left ventricle of the heart.

**Aortic Body**: Receptor in the aortic arch sensitive to changing oxygen, carbon dioxide, and pH levels of the blood.

**Arteries**: Blood vessels that conduct blood away from the heart and into the circulation. All but the pulmonary arteries carry oxygenated blood.

**Arteriole**: A minute artery, that carries the blood from the arteries to the capillaries.

**Arteriosclerosis**: Any of a number of proliferate and degenerative changes in the arteries leading to their decreased elasticity.

**Atherosclerosis**: Changes in the wall of the large arteries consisting of lipid deposits on the artery wall; the early stage of arteriosclerosis.

**Atria**: Paired, superiorly-located heart chambers that receive blood returning to the heart.

**Atrioventricular bundle (AV bundle)**: Bundle of specialized fibers that conduct impulses from the atrioventricular node (AV node) to the right and left ventricles; also called the bundle of His.

**Atrioventricular node (AV node)**: Specialized mass of conducting cells located at the atrioventricular junction of the heart.

**Baroreceptors**: Pressoreceptor; receptor that is stimulated by pressure changes. They are located in the Carotid artery and the aorta.

**Blood flow**: The amount of blood flowing through a vessel or organ at a particular time.

**Blood Pressure**: The force exerted by blood against a unit area of the blood vessel wall.

**Bradycardia**: Relatively slow heart rate (< 60 beats/minute).

**Capillaries**: The smallest of the blood vessels and the sites of exchange between the blood and tissue cells.

**Cardiac cycle**: Sequence of events encompassing one complete contraction and relaxation of the atria and ventricles of the heart.

**Cardiac muscle**: Specialized muscle of the heart.

**Cardiac output**: Amount of blood pumped out of a ventricle in one minute.

**Chemoreceptors**: Receptors sensitive to various chemicals, such as Hydrogen ions and Carbon dioxide, in the blood. They are located in the Carotid artery, the aorta and the Hypothalamus.

**Diastole**: Period when either the ventricles or the atria are relaxing.

**Electrocardiogram**: Graphic record of the electrical activity of the heart.

**Endocarditis**: Inflammation of the inner lining of the heart.
Endocardium: Endothelial membrane that lined the interior of the heart.
Edema: Abnormal accumulation of fluid in body parts or tissue; causing swelling.
Heart block: Impaired transmission of impulse from the atrium to the ventricle.
Heart murmur: Abnormal sound (usually resulting from valve problems).
Hypertension: High blood pressure.
Myocardial infarction: Condition characterized by dead tissue area in the myocardium; caused by interruption of blood supply to the area.
Myocardium: Layer of the heart wall composed by cardiac muscle.
Pulse: Rhythmic expansion and recoil of arteries resulting from heart contraction; can be felt from outside of the body.
Purkinje fibers: Modified cardiac muscle fibers of the conduction system of the heart.
Semilunar Valves: Valves that prevent blood return to the ventricles after contraction.
Sinoatrial (SA) node: specialized myocardial cells in the wall of the right atrium; pacemaker of the heart.
Stroke volume: Amount of blood pumped out of a ventricle during one contraction.
Systole: Period when either the ventricles or the atria are contracting.
Systolic pressure: Pressure generated by the left ventricle during systole.
Vasoconstriction: Narrowing of blood vessels.
Vasodilation: Relaxation of the smooth muscle of the blood vessels producing dilation.
Veins: Blood vessels that return blood toward the heart from circulation. Most carry deoxygenated blood, except pulmonary veins. Veins have thinner walls and valves within the vessels to prevent back flow.
Venules: Carry blood from the capillaries to the veins.
Ventricles: Paired, inferiorly located heart chambers that function as the major blood pumps.

Types of Circulation

1. Systemic: circulation between the heart and the rest of the body.
2. Pulmonary: circulation between the heart and the lungs.
3. Coronary: circulation within the heart.

Structure of the Heart

 Hearts have three layers:

♥ Layers of the Heart

1. Endocardium: is a thin smooth layer of cells that resembles squamous epithelium. This membrane lines the interior of the heart. The valves of the heart are formed by reinforced folds of this material.
2. Myocardium: The muscle of the heart, is the thickest layer. The structure cardiac muscle is unique. The cells are lightly striped (striated) and have specialized cell membranes (intercalated disks) that allow for rapid transfer of electric impulses between the cells.
3. Epicardium: Forms the thin, outermost layer of the heart wall and is continuous with the serous lining of the fibrous sac that encloses the heart. These membranes
together make up the **Pericardium**. The serous lining of the pericardial sac is separated from the epicardium on the heart surface by a thin film of fluid (decreases surface friction that is caused by the working heart).

♥ **Chambers of the Heart**

1. **Right Atrium:**
   - thin walled chamber
   - receives the deoxygenated blood returning from the body tissues
   - the blood enters via the Superior Vena Cava, Inferior Vena Cava, and Coronary Sinus.

2. **Right Ventricle:**
   - receives blood from the right atrium
   - pumps blood into the lungs via the pulmonary artery.

3. **Left Atrium:**
   - receives the oxygenated blood from the lungs via the pulmonary veins.

4. **Left Ventricle:**
   - thickest wall of all, pumps oxygenated blood to all parts of the body via the aorta.

♥ **Pathway of the Blood**

![Diagram of blood pathway](image)

**Conduction System of the Heart**

Components involved:

♥ **Sinoatrial (SA) node also called the Pacemaker.**
   - * depolarizes spontaneously at the rate of 70 to 80 times / minute
   - * initiates each depolarization
   - * characteristic rhythm, called the Sinus rhythm

♥ **Atrioventricular (AV) node**
   - * located in the inferior portion of the interatrial septum
   - * allows the atria to complete their contraction
Bundle of His
Right and Left Bundle branches
Purkinje Fibers

Pathway of Electrical Impulse

SA Node ⇒ AV Node ⇒ AV bundle ⇒ Bundle Branches ⇒ Purkinje Fibers

- Left ventricle is much larger than the right ventricle with Purkinje network being more elaborate
- Cardiac conduction system coordinates and synchronizes heart activity
- External nerve stimulation is not required for heart contraction
- Parasympathetic stimulation causes the heart rate to decrease, whereas the sympathetic stimulation causes the heart rate to increase.
- ANS (Autonomic Nerves System) controls, and or modifies the activity of the intrinsic conduction
  - defect in ANS can cause irregular heart rhythms or arrhythmias, or fibrillation

Regulation of the Heart

- Sensory receptors
  - Baroreceptors
  - Pressoreceptors

- Chemical Regulation
  - Hormones
    - Epinephrine - increases heart rate and contractility
    - Thyroxine - increases heart rate and slow contractility
  - Ions
    - Electrolyte imbalances

- Physical factors
  - Exercise ⇒ Sympathetic Nervous System (SNS) ⇒ increase heart rate
Heart

Review Questions

Multiple Choice Questions: Choose the best response.

1. When the semilunar valves are open, which of the following are occurring?
   a. 2, 3, 5, 6.
   b. 1, 2, 3, 7.
   c. 1, 3, 5, 6.
   d. 2, 4, 5, 7.

1. Coronary arteries fill  
2. AV valves are closed  
3. Ventricles are in systole  
4. Ventricles are in diastole  
5. Blood enters the Aorta  
6. Blood enters Pulmonary arteries  
7. Atria contract

2. The portion of the intrinsic conduction system located in the interventricular septum is the
   a. AV node
   b. SA node
   c. Bundle of His
   d. Purkinje fibers

3. The fact that the ventricular wall is thicker than the right reveals that it
   a. pumps a greater volume of blood
   b. pumps blood against greater resistance
   c. expands the thoracic cage
   d. pumps blood through a small valve

Fill in the Blanks for the following questions

1. The outermost layer is called ________________ pericardium and is made of ________________ tissue.
2. The serous membrane that lines the fibrous pericardium is called the __________________ pericardium.
3. The function of the serous fluid produced by the serous layers is to ________________ ________________ as the heart beats.
4. Which pair of chambers have the thicker wall? __________________
5. The wall of the myocardium between the two Atria is called __________________ and the __________________ is between the two Ventricles.

6. The heart is actually a double pump, and both pumps work simultaneously. The left side of the heart receives blood from the _______________ and pumps this blood to the _______________. Whereas the right side of the heart receives blood from the _______________ and pumps this blood to the _______________.

7. The smallest arteries are called ________________, and the smallest veins are called ________________

8. The blood vessel with the thickest wall in the body is ________________

9. The purpose of the Coronary vessel is to supply the __________ with blood.

10. The Cardiac conduction pathway is the pathway of the electrical ________ throughout the heart during each heart beat.

11. From the Atria to the Ventricles, most blood _________________ (flows passively or is pumped); from the Ventricles to arteries, all blood _________________ (flows passively or is pumped).

Define the Following:

1. Systole:
2. Diastole:
3. Capillaries:
4. Hypertension:
5. Myocardium:
6. Arteriosclerosis:

Number the events of one Cardiac cycle in the proper sequence. Two events have been properly numbered to get you started.

1. Blood continually flows into both Atria
2. Two thirds of the Atrial blood flows passively into the Ventricles
3. The right & left AV valves are closed, and the Aortic & Pulmonary Semilunar are opened.
4. The pressure of incoming blood open the right and left AV valves.
5. The Atria contract to pump the remaining blood into the Ventricles.
6. Ventricles contraction pumps blood into the arteries.
7. The atria relax, and the ventricles begin to contract.
8. The ventricles relax, and the Semilunar valves are closed.
Label the parts indicated.