Circulatory System

is divided into 2 systems:

1. **Cardiovascular system** - the heart and blood vessels
2. **Lymphatic system** - lymph vessels and lymph nodes

**Heart** – already talked about

**EKG**

- **P wave** - depolarization of atrial fibers
- **P-R interval** - indicates the time it takes for the SA depolarization to reach the ventricles
- **QRS complex** - heart in systole, blood being ejected
- **ST segment** - time between ventricular depolarization and the initiation of repolarization
- **T wave** - ventricular repolarization

**Blood vessels**

- **Arteries** - carry blood away from the heart chambers.
  - smaller = arterioles
  - smaller yet = capillaries - the capillaries join the arteries to the veins and are the level where all exchange occurs (gases, nutrients, and wastes)

- Blood returning to the heart passes from the capillaries to venules and then to veins

- Both arteries and veins have walls made up of three layers (tunics)
  1. **Tunica externa** - outermost layer made of loose fibrous connective tissue
  2. **Tunica media** - made of smooth muscle
  3. **Tunica interna** - innermost layer
     - has two parts
     - a. a layer of elastic fibers
     - b. simple squamous epithelium (endothelium)

Arteries differ from veins in the amount of muscle they have in relation to their diameter. Also MOST peripheral veins have valves.

- **Elastic arteries** - (Large arteries) have many fibers of elastin in their tunica media. This allows the vessel to expand with higher blood pressure and then recoil as the pressure drops. This serves two functions:
  1. aids the heart in pumping blood
  2. provides for a smoother flow of blood through the smaller arteries and arterioles

- **Muscular arteries** – do not alter their diameter with changes in blood pressure and blood flow thus they provide great resistance to blood flow. The smaller muscular arteries branch to form arterioles. At the level of arterioles we may see arteriovenous anastomoses (metarterioles). These allow blood to pass from arterioles to venules without passing through capillaries.

- **Capillaries** - the smallest blood vessels (7-10 µm)
  Capillaries are referred to as the functional unit of the circulatory system. This is where the exchange of nutrients and gases between blood and tissue occurs. There are over 40 billion capillaries in the body providing a surface area of 1000 square miles. There are three types of capillaries, but regardless of the type they are all only one cell thick.
1. **continuous** - found in muscles, lungs, adipose tissue, and most importantly in the CNS (blood-brain barrier)
2. **fenestrated** - have wide pores in the cell wall (800-1000 ) covered by a mucoprotein. Seen in kidneys, endocrine glands, intestines.
3. **discontinuous** - have gaps between endothelial cells. These gaps appear as little cavities (sinusoids). Seen in bone marrow, liver, and spleen.

**Veins** - are usually not round like arteries, but rather appear flatter, this is due to the low blood pressure (2mm Hg). This pressure is too low to assure venous return to the heart, thus we have two mechanisms to aid in venous return,
1. valves
2. skeletal muscle pump

**Blood Pressure** - produced by the heart and the vessels

- **systolic** = 120 - blood ejected from the heart
- **diastolic** = 80 - contraction of arterial walls

The difference between the systolic and diastolic is called the **pulse pressure**

Several factors can affect blood pressure
1. BP decreases as the distance from the heart increases
2. increase cardiac output (stroke volume X heart rate)
3. Blood volume and viscosity
   a. lower volume = lower pressure
   b. high viscosity = higher pressure

**Lymphatic system**

Has three functions
1. it transports excess interstitial fluid (tissue fluid) back to the bloodstream
2. carries fat absorbed from the intestine to the blood.
3. helps provide immunological defenses against disease causing agents

**Lymph vessels** - begin as small closed end tubes found in the intercellular spaces within tissue. Once the interstitial fluid enters the lymph capillaries it is referred to as lymph.

Lymph capillaries merge to form lymph ducts. Lymph ducts resemble veins in having the same three layers as well as valves to prevent lymph backflow.

The lymph ducts merge to form two principal lymph vessels,
1. **thoracic duct** - drains the left side of the head, neck, and body as well as both upper and lower extremities on the left and the right lower extremity. It drains into the left subclavian vein
2. **Right lymphatic duct** - drains the right side of the head and neck, the right upper extremity, and the right side of the thorax. It drains into the right subclavian vein

Along lymph vessels we find lymph nodes. These filter the blood and contain (as well as produce) lymphocytes and phagocytes which fight infection.

Swollen nodes = infection
note that there are aggregations of nodes in specific areas.

**Lymph organs** - the spleen and thymus

**Spleen** - filters blood, produces lymphocytes as well as produces and destroys old erythrocytes (RBCs)

**Thymus** - activates immune cells, is located in the anterior thorax (anterior mediastinum)