Circulatory System

The circulatory system is divided into 2 systems:

1. Cardiovascular system - the heart and blood vessels

2. Lymphatic system - lymph vessels and lymph nodes

Heart – The heart is covered in a separate lecture.

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 or 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 known as the 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 also called metarterioles. These allow blood to pass from arterioles to venules without passing through capillaries.

Capillaries - the smallest blood vessels (7 to 10 micrometers in diameter)
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 central nervous system where they are important in forming part of the blood-brain barrier

2. fenestrated - have wide pores in the cell wall. These pores are 80 to 100 nanometers in diameter. The pores are covered by a mucoprotein. This type of capillary is seen in kidneys, endocrine glands, and small intestines.

3. discontinuous or sinusoidal - have gaps between endothelial cells. These gaps appear as little cavities or sinusoids. This type of capillary is 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, around 2 to 4 mmHg. 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 – is produced by the heart and the vessels

Systolic blood pressure - is generated by blood being ejected from the heart. Normal systolic blood pressure is considered to be 120 mmHg. It is basically the pressure to which the elastic aorta gets "inflated"

Diastolic blood pressure - is generated contraction of arterial walls, mainly the aorta. Normal diastolic blood pressure is considered to be 80 mmHg. It is basically the pressure in the aorta when the aorta is not being stretched by the blood surging through it.

the difference between the systolic blood pressure and diastolic blood pressure is called the pulse pressure. Ideally the pulse pressure should be 40 mmHg or slightly higher. Pulse pressure lower than 40 mmHg may indicate a condition in which the aorta is losing its elasticity, most likely due to plaque buildup.

Several factors can affect blood pressure

1. blood pressure decreases as the distance from the heart increases

2.an increase in cardiac output. Stroke volume times heart rate

3. Blood volume and viscosity

a. lower blood volume results in a lower blood pressure

b. high blood viscosity causes higher blood pressure

Lymphatic system

The 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 in their wall, 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 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 indicate the presence of an infection

note that there are aggregations of lymph 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)