Module 1 Circulatory System

1. Circulatory System [1]

The human Circulatory system is an intricate system which passes nutrients to and from cells in the body to help fight diseases and help stabilize body temperature and pH to maintain homeostasis.

The system is comprised of the cardiovascular system which is further comprised of the heart, blood and blood vessels and the lymphatic system which distributes lymph and is comprised of the lymph, lymph nodes and lymph vessels.

2. The System Circulatory System [2]

Via the systemic circulatory system, blood circulates through blood vessels which form a closed transport system. Like a system of roads, the systemic circulatory system has freeways, secondary roads and alleys. As the heart beats blood is propelled into larger arteries leaving the heart. It then moves into successively smaller and smaller arteries and then into arterioles which feed the capillary beds. Capillary beds are drained by venules which in turn empty into veins that finally return and empty blood back into the heart. Thus the arteries carry blood away from the heart and the veins which drain tissues and return the blood to the heart are simply conducting vessels-the freeways and secondary roads. The tiny hairlike capillaries which extend and branch through the tissues and connect the small arteries (arterioles) to the smallest veins (venules) directly serve the needs of the body cells. It is through their walls that exchanges between the tissue cells and blood occur. Arteries are generally located deep in well protected areas whereas veins are more superficial and generally can easily be seen and palpated. Most deep veins run the course of major arteries and the veins with a few exceptions are named as that of their companion arteries.

2.1 Vessels [2]

Artery walls are much thicker than the walls of veins. Arteries are closer to the pumping action of the heart and must be able to expand as blood is passed through and recoil as blood passes through. Their walls must be both strong and elastic to withstand the continuous change in pressure

Veins, with thinner walls, are distant from the heart and are subject to constant low pressure. The lumen (inside of the vein) is larger than that of an artery and larger veins have valves to prevent backflow. Skeletal muscle enhances venous return. As the muscles surrounding the veins contract and relax the blood is “milked” through the veins toward the heart.

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Except for capillaries whose are wall are one layer thick, the walls of blood vessels have three coats aka tunics.

- Tunica intima: lines the lumen or interior of the vessel
- Tunica media: the bulky middle coat comprised mainly of smooth muscle and elastic tissue
- Tunica externa: the outer layer composed primarily of fibrous connective tissue

2.1.1 Capillaries [2]

As stated previously, capillaries fulfill a very distinct role in the circulatory system. It is only through the walls of capillaries that the exchange between tissue cells and blood can occur

2.1.2 Major Arteries

The aorta is the body's largest artery with different parts of the aorta are named for their location and shape. The aorta branches into four branches: ascending aorta; aortic arch; thoracic aorta and abdominal aorta.

Major aortic branches into arterials branches

1. Ascending Aorta
   Right and left coronary arteries
2. Aortic Arch
   Brachiocephalic
   Left common carotid artery
   Left subclavian artery
3. Thoracic Aorta
   Intercostals arteries (10 pairs) supply the muscles of the thorax wall. Outer branches supply the lungs, esophagus and diaphragm.
4. Abdominal Aorta
   Celiac trunk
   Superior mesenteric artery
   Renal arteries
   Gonadal arteries
   Lumbar arteries
   Inferior mesenteric artery
   Common iliac arteries

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2.1.3 Major Veins [2]

These enter the vena cava. Those draining the head and arms empty into the superior vena cava and those draining the lower body empty into the inferior vena cava.

Superior vena cava [2]

Veins draining into the superior vena cava are named in a distal/proximal direction meaning in the same direction that the blood flows into the superior vena cava.

1. Radial and ulnar veins
2. Cephalic vein
3. Basilic vein
4. Subclavian vein
5. Vertebral vein
6. Internal jugular vein
7. Brachiocephalic vein
8. Azygos vein

Inferior vena cava [2]

Veins draining into the inferior vena cava are named in a distal/proximal direction meaning in the same direction that the blood flows into the inferior vena cava.

1. Anterior and posterior tibial veins
2. Great saphenous vein
3. Common iliac vein
4. R. gonadal vein
5. Renal vein
6. Hepatic portal vein
7. Hepatic veins

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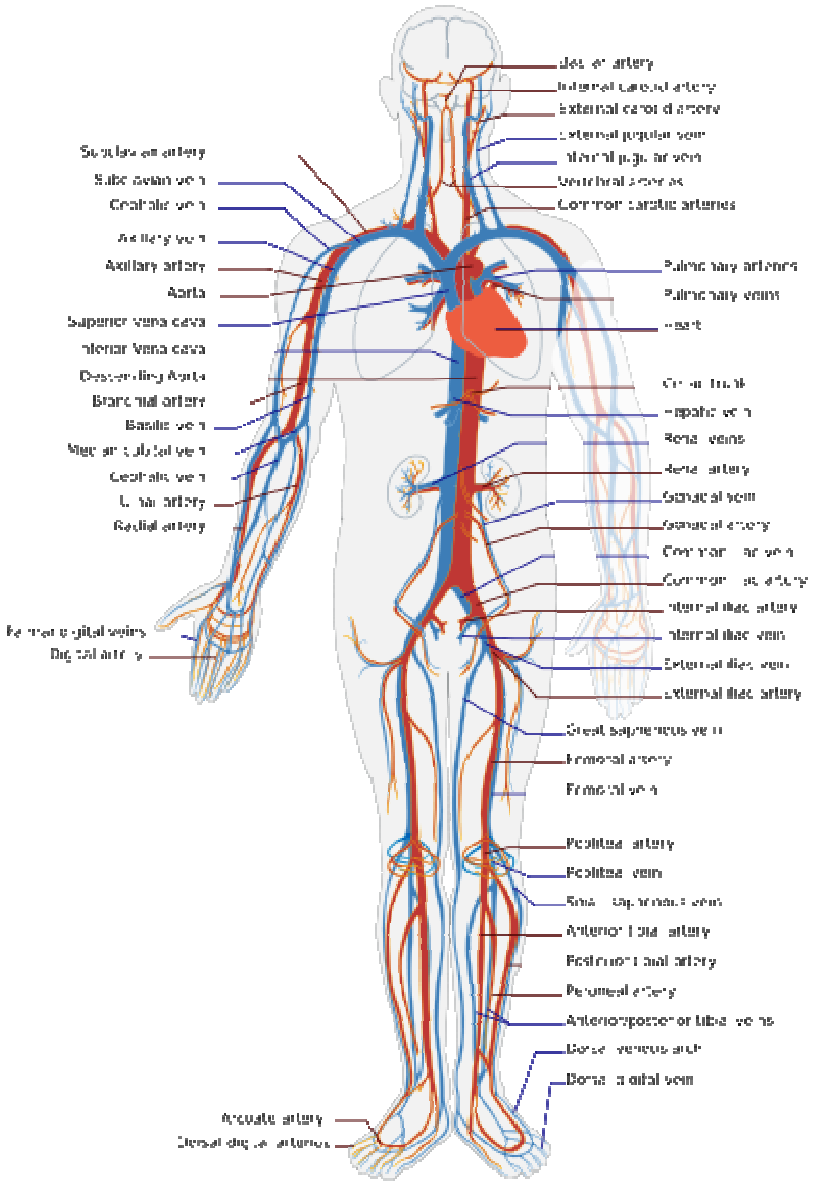

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3. Perfusion

Perfusion is the process of nutritive delivery of arterial blood to a capillary bed in the biological tissue.

Tests of adequate perfusion are a part of a patient assessment performed many numerous medical personnel. The most commons methods of measurement include skin color, temperature, condition and capillary refill. [3]

Tissue perfusion is often confused with blood flow. Tissue perfusion is an actual measurement of the volume of blood that flows through capillaries in a tissue. It is generally measured in milliliters of blood per 100 grams of tissue. This measurement is carried out to determine the health of a particular tissue since impaired or reduced perfusion can indicate a medical condition which may require care. [4]

Insufficient tissue perfusion may cause reduced nutritional supply to the cells in the region which can be problematic if continue over a prolonged period. Altered tissue perfusion can also cause a reduction in oxygen supply to the affected region. [4]

Blood is responsible for the delivery of nutrients and removal of waste products through the body. Critical blood nutrients include red blood cells with transport oxygen and carbon dioxide to tissues, white blood cells which are responsible for delivery cells and substances to support the body's immunity and defense against disease and foreign body's as well as platelets which are responsible for blood clotting. [2]

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Ischemia is a restriction in blood supply generally due to factors in the blood vessels. Ischemia can lead to damage or dysfunction in the tissue. [5]

Ischemia differs from hypoxia which is a term that denotes a more general lack of breathing oxygen. Ischemia is "an absolute or relative shortage of the blood supply to an organ, i.e. a shortage of oxygen, glucose and other blood-borne fuels. A relative shortage means the mismatch of blood supply (oxygen/fuel delivery) and blood request for adequate metabolism of tissue. Ischemia results in tissue damage because of a lack of oxygen and nutrients. Ultimately, this can cause severe damage because of the potential for a build-up of metabolic wastes." [5]

Cutaneous ischemia a reduced blood flow to skin layers can be characterized by uneven and patchy discoloration of the skin as well as cool temperature. Arterial ischemia can be characterized by a pale color and venous ischemia will appear as a bluish skin discoloration. [5]

Critical considerations of reduced tissue perfusion are the surgical clinical outcomes linked to tissues that receive a reduced lack of oxygen and white blood cells. As stated before, ischemia is a lack of oxygen to tissue layers. This lack of oxygen may ultimately lead to tissue necrosis. A lack of white blood cells in blood and surrounding tissues may inhibit the body from properly fight local bacteria potentially leading to bacterial colonization and subsequent wound infection.

In considering the role and impact of ischemia on infection, it is important to understand the following has been demonstrated in studies of ischemia and infection.

- ischemia increases the incidence of infection [6,7]
- infections that occur in the presence of ischemia have significant worse outcomes than those that occur in the well perfused tissues [8,9]

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