

#### **Function of Blood:**

#### Transport of Materials: Oxygen, Carbon Dioxide, nutrients, wastes, and hormones.

### **Regulation of Processes:** pH, body temperature, water content.

### **Protection:** blood clotting, disease.

#### **Characteristics of Blood**

- 4-6 liters in the average adult. Males slightly more than females.
- 45% Formed Elements (blood cells) 55% Plasma



#### Plasma

Is a straw colored liquid that makes up about 55% of your blood volume. Almost 92% of the plasma is water. Dissolved in the water are proteins, electrolytes, nutrients=amino acids, monosaccharides, and glycerol and fatty acids; gases, vitamins, wastes, and regulatory substances like hormones.

Plasma proteins include albumins, which help maintain proper osmotic pressure. Globulins are antibodies which are produced by lymphocytes (white blood cells) and attack and destroy foreign antigens. Fibrinogen is a plasma protein that is important in the formation of blood clots.

#### **Formed Elements**

**Erythrocytes (Red Blood Cells=RBC)** Composed of hemoglobin, responsible for transporting oxygen. Some carbon dioxide is carried by the RBC.

The surface of the RBC's contain proteins (antigens) that give blood different characteristics.



RBC's last for about 120 days. They don't reproduce because they lack nuclei. They are produced in bone marrow by a process called erythrpoiesis. Anemia is a condition where there is a lower than normal number of RBC. Worn out RBC's are removed by the liver, spleen, and bone marrow.



#### Red Blood Cells Shape of a Red Blood Cell

Surface

8 µ m

Sectioned

lof 2

## red blood cells

#### Leucocytes (White Blood Cells=WBC)

There are many different kinds of WBC based on their appearance. WBC are involved in defending the body against foreign material.

Some WBC are phagocytic, they ingest bacteria and dead cells. Some WBC release specific enzymes that fight inflammation and allergic reactions.

Some WBC produce proteins called antibodies that react with foreign proteins on the surfaces of microorganisms called antigens. This antigen-antibody response helps to destroy these micro-organisms.



#### Inflammatory response-

When cells are damaged by bacteria, viruses or injury, inflammation occurs.

It consists of : pain redness heat swelling The three stages of inflammation are: 1. vasodilation-an increase in the flow of blood to the area which allows phagocytes, antibodies, and clot forming chemicals to enter the injured area. Histamine and prostaglandin are some of the chemicals responsible for vasodilation. Prostaglandin stimulates pain receptors. This increase in blood flow causes heat, swelling and redness. 2. Phagocyte migration-in about an hour neutrophils begin to accumulate in the area to begin destroying bacteria and viruses.

3. Repair- As mitosis occurs to replace damaged cells, some living and many dead white blood cells can accumulate at the infected area. This thick white fluid is pus. Pus build up in a confined space is called an abscess. Pimples and boils are examples.

#### Immune response-

Immunity is a specific response to disease. Special cells are responsible for destroying specific antigens ( substances found on microbes, pollen etc...) The following leucocytes are resposible for various activities during an immune response:



Neutrophils -Engulf bacteria and cellular debris 37-77%



**Basophils -**Hypersensitivity, Release histamine 0-1.6%



Eosinophils -Parasitic infections, Allergic response 1-7%

### White Blood Cells

Lymphocytes -Produce antibodies, regulate the immune response 10-44%





Monocytes -Engulf cellular debris, antigen processing 2-10% \*neutrophils(have a nucleus with two to four lobes connected by thin filaments), most common wbc, 55-60% of wbc

-they phagocytize microorganisms

# Neutrophil

### Neutrophil

**basophils**(nucleus with two distinct lobes), distinct dark blue to black granules in cytoplasm, very few, only 0.5% of wbc

-they release histamines which promote inflammation of tissues

eosinophils(nucleus that is bilobed) very few, only 1-3% of wbc,orange to red granules in cytoplasm -they release chemicals that reduce inflammation of tissues

### Eosinophil

\*monocytes(irregular cell with indented or "U" shaped nucleus) third most common wbc, 3-7% of wbc -phagocytic cell, forms macrophages

### monocyte

\***lymphocytes**(round cells with a round nucleus) second most common wbc, 20-35% of wbc.

## lymphocyte

#### Two types of cells: T-cells and B-cells.

Killer T-cells can directly attack cell antigens.

Memory T-cells stay in the body and can remember the antigen for a faster response next time. B-cells produce antibodies(proteins, immunoglobulins, that can destroy antigens)

Memory B-cells remain in the body for years and can respond rapidly to the next exposure.


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All blood cells are produced by a process known as <u>hemopoiesis</u>. Red bone marrow contains stem cells that have the capacity to develop into different types of cells.

#### Myeloid stem cells develop into:

RBC, Platelets, Eosinophils, Basophils, Neutrophils, Monocytes

Lymphoid stem cells develop into T and B lymphocytes.

### **Stages of Blood Clot Formation**

I. An injury stimulates the release of thromboplastin (TF=Tissue Factor) in two ways:

1.Platelets attracted to the area can release the thromboplastin (TF) directly.

2. The injured tissues can release thromboplastin (TF)

Thromboplastin can combine with calcium ions to form prothrombinase which in turn reacts with a blood protein called prothrombin. This combination of thromboplastin, calcium ions, and prothrombin form thrombin. Thromboplastin + Ca+ = prothrombinase(which converts prothrombin to thrombin)

III. Another blood protein called fibrinogen reacts with thrombin to form fibrin. Fibrin is an insoluble threadlike protein that forms a network of fibers over the break in the blood vessel which stops the flow of blood.

This network of fibrin is called a clot (thrombosis) . A blood clot that dislodges and moves within the vascular system is called an embolism.

## The following is a summary of the blood clotting process:



Hemophelia is an inherited condition in which an essential clotting protein (factor) is missing and the clotting process can't be completed.

Hemorrhage is an excessive loss of blood from the circulatory system. If 40% of the total volume of blood is lost, the heart can't pump the blood effectively. Blood pressure decreases and body tissues soon suffer from lack of oxygen. A 50 % blood loss is usually fatal.

#### Human Blood Types

Blood types are determined by the presence of antigens on the surface of red blood cells. Antigens are proteins on the cell membrane. Inherited genes determine the type of antigen present on the red blood cells.



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ABO Blood Types						
Erythrocytes	Antigen A	Antigen B	Antigens A and B	Neither antigen A nor B		
Plasma	Anti-B antibodies	Anti-A antibodies	Neither anti-A nor anti-B antibodies	Both anti-A and anti-B antibodies		
Blood type	<b>Type A</b> Erythrocytes with type A surface antigens and plasma with anti-B antibodies	<b>Type B</b> Erythrocytes with type B surface antigens and plasma with anti-A antibodies	<b>Type AB</b> Erythrocytes with both type A and type B surface antigens, and plasma with neither anti-A nor anti-B antibodies	<b>Type O</b> Erythrocytes with neither type A nor type B surface antigens, but plasma with both anti-A and anti-B antibodies		

Blood Type	Genotype		Can Receive Blood From:
Α	i <sup>^</sup> i i <sup>^</sup> i <sup>^</sup>	АА АО	A or O
В	i <sup>B</sup> i i <sup>B</sup> i <sup>B</sup>	BB BO	B or O
AB	i <sup>^</sup> i <sup>B</sup>	АВ	А, В, АВ, О
0	i i	00	О

There are several other factors in the blood, one of which is called the Rh factor.

About 85% of the population in the United States have this factor and are called (Rh+). The other 15% lack the protein and are considered (Rh-) During transfusions, mixing of noncompatible blood (different blood) causes a reaction between the antigens and antibodies called agglutination. Careful testing of the blood called typing or crossmatching must take place before a transfusion can be done.

#### Structure of the Heart Pericardium-

Tough protective sac called pericardium, surrounds the heart. The outermost layer is called the fibrous pericardium and it anchors the heart in the mediastinum, the space between the lobes of the lungs.

The serous pericardium has two layers: 1.the parietal layer lies just beneath the fibrous pericardium. 2.The visceral layer or epicardium lies

on the surface of the heart itself.

The space between these layers is the pericardial cavity and is filled with the pericardial fluid to reduce friction.



#### Heart Muscle-

The wall of the heart is composed of three layers: 1.epicardium-The external surface of the heart.

## 2.myocardium-The thick muscular layer composed of cardiac muscle tissue.

## 3.endocardium-The thin inner layer composed of epithelium cells.



Chambers: The heart contains four hollow regions called chambers. The two upper chambers are called the atria, and the two lower chambers are called the ventricles.



The walls that divide the heart into right and left halves are called the interatrial septum, and the interventricular septum. The right and left sides of the heart function as two completely seperate pumps.





Blood Vessels attached to the heart: Blood is carried back to the heart from the head and arms by the superior vena cava. The inferior vena cava carries blood back from the body organs and legs. The pulmonary artery carries blood to the lungs from the right ventricle. The pulmonary veins return blood from the lungs to the left atrium.

Blood leaves the left ventricle from the aorta which has three parts: 1.
ascending aorta 2. arch of the aorta 3. descending aorta



#### **Heart Valves**

Valves allow blood to flow in only one direction preventing blood from backing up.

The valve on the right side between the atrium and ventricle is called the TRICUSPID VALVE.

# The valve on the left side between the atrium and ventricle is the BICUSPID, or MITRAL VALVE.

Both of these valves have chordae tendinae, tough strands of connective tissue, that prevent the valve from bending backwards into the atria.
Another set of one-way valves, called the SEMILUNAR VALVES, seperate the right and left ventricles from the pulmonary arteries and the aorta where blood is pumped out of the heart.



## Blood Supply to the Heart

The heart itself receives blood from the coronary arteries. The right and left coronary arteries branch off the ascending aorta and supply the heart with blood. A large vein on the back of the heart called the coronary sinus collects blood and returns it to the right atrium.





A myocardial infarction (heart attack) is death of the heart muscle. This is commonly caused by blockage of blood flow through the coronary arteries. How does cholesterol cause heart disease?







### **Heart Conduction System**

-Controls the impulses that coordinate the heart beat 1. The Sinoatrial node (SA node) A mass of specialized myocardial cells in the right atrium near the superior vena cava that initiates each heart beat and sets the pace of the heart.

# 2. Atrioventricular node (AV node)

- Is stimulated by the impulse from the SA node.
- There is a .1 sec delay before the contraction of the ventricles

Atrioventricular Bundle (Bundle of His)

Group of specialized muscle fibers that aid in conducting the contraction impulse through the ventricles. The bundle of His divides into a network called the Purkinje fibers.

The atrioventricular bundle divides into the right and left bundle branches which carry the impulse to the bottom of the ventricles. The Purkinje fibers (conduction myofibers) carry the impulse upward through the rest of the ventricles.



**Cardiac Conduction System** 

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## Cardiac Cycle-

Systole-contraction of the myocardium

Diastole-Relaxation of the myocardium The cardiac cycle consists of atrial systole and atrial diastole, ventricular systole and ventricular diastole.



## **Blood Vessel Structure**

- Large blood vessels consist of 3 primary layers.
- 1. <u>Tunica intima-(inner layer)</u> a layer of endothelium consisting of simple squamous cells.
- 2.<u>Tunica media-(middle layer) layers of</u> smooth muscle surrounded by elastic connective tissue.

#### <u>Tunica adventitia-(outer layer) an outer</u> layer of dense connective tissue

## Three types of Blood Vessels

A. Arteries-blood is transported away from the heart by the arteries. They have a thicker elastic connective tissue layer to aloow stritching as the heart pumps and pressure increases and decreases.

Veins- blood is transported toward the heart by the veins. Veins have thinner walls. Pressure is less in veins. There are small folds in the endothelium of veins forming valves to prevent the backflow of blood.

<u>**Capillaries</u>**- Very thin walled vessels consisting of only a layer of epithelium. Materials are transported between the blood and the body cells through the capillaries.</u>





