Blood and the Cardiovascular System

Blood Functions

- Distribution
  - Delivery of oxygen and nutrients to all body cells; Transport of wastes to lungs and excretory organs; Transport of hormones
- Regulation
  - Maintenance of body temperature, pH, and adequate fluid volume
- Protection
  - Prevention of blood loss via clotting; prevention of infection with the immune system

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Blood

- Parts of the blood
  - Plasma (~55%)
  - Erythrocytes (~42-45%)- Red Blood Cells
  - Leukocytes (~1%)- White Blood Cells
  - Platelets

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Plasma

- Composed largely of water (90%), but also has over 100 dissolved solutes (gases, nutrients, wastes, proteins, etc.)

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Erythrocytes (RBCs)

- Shaped like flattened disks with depressed centers giving it a high surface area good for gas exchange
  - Have no nucleus and very few organelles
  - Contains proteins such as hemoglobin that aid in carrying oxygen (do not go through aerobic respiration so none of this oxygen is consumed by the RBC)

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Erythrocytes (RBCs)

- Functions in oxygen and carbon dioxide gas exchange
- Production of RBCs occurs in the red bone marrow

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Erythrocyte Disorders

- Anemia
  - An insufficient number of red blood cells
    - Possibly due to blood loss, bone marrow failure, excessive RBC destruction
  - Low hemoglobin content
    - Often related to nutrition (may be diet or inability of the body to absorb certain nutrients)
  - Abnormal hemoglobin
    - Globin is misshaped due to genetic variation

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Erythrocyte Disorders

- Polycythemia is an excess of RBC's that increases blood viscosity
  - Polycythemia vera – often caused by bone marrow cancer
  - Secondary polycythemia – often caused by prolonged exposure to high altitudes and is a response by the body to get more oxygen
    - Can be treated with blood dilution
- Some athletes do this on purpose (called blood doping) to increase oxygen carrying capabilities

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Leukocytes (WBCs)

- Are complete cells who function in the bodies defense system
- The circulatory system is their highway and means of transportation to where they are needed
- The body speeds up WBC production when needed; therefore, having a WBC count over 11,000 tends to signify an infection

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Leukocyte Disorders

- Leukemias – a group of cancerous conditions involving WBCs
  - The type of cancer will depend on the type of WBC involved
  - The bone marrow becomes occupied by cancerous leukocytes and immature WBCs flood into the bloodstream
    - This in turn can cause anemia and bleeding problems
- Infectious Mononucleosis (Mono) – caused by the Epstein-Barr virus
  - Typically runs its course in a few weeks

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Platelets

- Cytoplasmic fragments of large cells called megakarocytes
- Function in the clotting process by sticking to the damaged site and creating a temporary seal
  - This process is called hemostasis and involves 3 phases
    - Vascular spasms (vasoconstriction)
    - Platelet plug formation
    - Coagulation or blood clotting

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ABO Blood Groups

- Based on the presence or absence of the agglutinogens A and B
  - Their presence or absence gives rise to A, B, AB and O blood
  - O which means neither is present is the most common blood type
  - Preformed antibodies called agglutinins will form against those antigens not present
    - A person with type O blood will have both anti-A and anti-B antibodies

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ABO Blood Groups

TYPE	YOU CAN GIVE BLOOD TO	YOU CAN RECEIVE BLOOD FROM
A+	A+, AB+	A+, A-, O+, O-
O+	O+, A+, B+, AB+	O+, O-
B+	B+, AB+	B+, B-, O+,O-
AB+	AB+	EVERYONE
A-	A+, A-, AB+, AB-	A-, O-
O-	EVERYONE	O-
B-	B+, B-, AB+, AB-	B-, O-
AB-	AB+, AB-	AB-, A-, B-, O-

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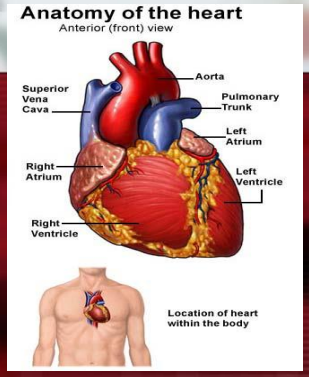

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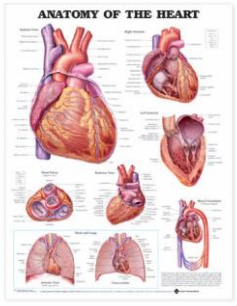
The Heart

- Is about the size of a fist and generally weighs 250-350 grams
- Is located more centrally in the chest between the lungs above the diaphragm. The sternum sits in front of the heart.



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The Cardiovascular System (cont

- **The Heart**
  - **Covered by the pericardium.**
  - **Has two sides with two chambers.**
  - **Blood flows through the heart in one direction.**
  - **Valves control the blood flow.**
  - **The cardiac conduction system controls the electrical impulses that cause the heart to contract.**

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Layers of the Heart Wall

- The heart wall is composed of 3 layers:
  - Epicardium: the visceral layer of the serous pericardium
    - Often becomes fatty in older people
  - Myocardium: the contracting layer of the heart which is composed mainly of cardiac muscle
  - Endocardium: endothelium cells that line the inner myocardial surfaces (chambers of the heart and valves)

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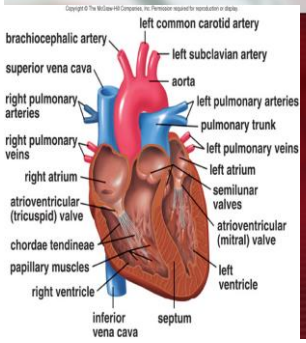
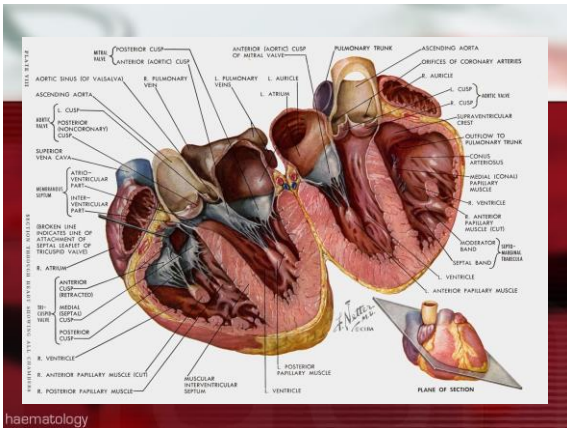
Chambers



- The heart has 4 chambers
  - 2 superior atria
  - 2 inferior ventricle



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Atria

- The atria are receiving chambers for blood returning to the heart
- Relatively small, thin-walled chambers and responsible for very little pumping (blood moves from atria to ventricle)
- Blood enters the R. atrium via
  - Superior vena cava: returns blood from areas superior to the diaphragm
  - Inferior vena cava: returns blood from below the diaphragm
  - Coronary sinus: collects blood draining from the myocardium
- Blood enters the L. atrium via 4 veins from the lungs

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Ventricles

- Make up the bulk of the heart
- These are the discharging chambers. When the ventricles contract, blood is propelled out of the heart.
- The R. ventricle pumps blood to the pulmonary trunk which sends blood to the lungs where gas exchange occurs
- The L. ventricle ejects blood into the aorta which sends blood out to the body

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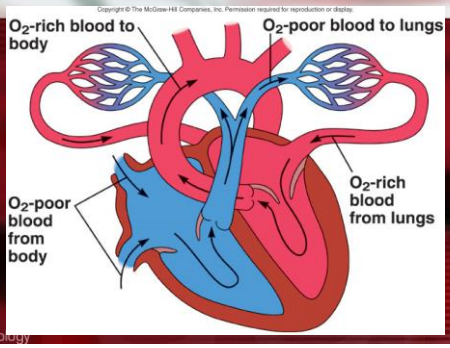
Path of blood through the heart



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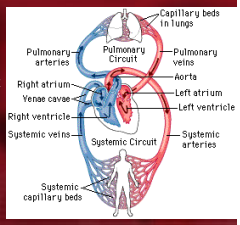
Pathway of Blood

- The heart consists of two circuits
  - Pulmonary circuit – the blood vessels that carry blood to and from the heart
    - The pump is the right side of the heart
  - Systemic circuit – the blood vessels that carry blood to and from the body
    - The pump is the left side of the heart
- Deoxygenated blood returning from the body will enter the R. atrium, enters the R. ventricle where it pumps to the lungs via the pulmonary arteries. Oxygenated blood then returns to the L. atrium via the pulmonary veins, enters the L. ventricle where it pumps to the body via the aorta.



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The Cardiovascular System (cont.)

- **Circulation**
  - **Coronary circulation – the circulation of blood within the heart.**
  - **Pulmonary circulation – the flow of blood between the heart and lungs.**
  - **Systemic circulation – the flow of blood between the heart and the cells of the body.**

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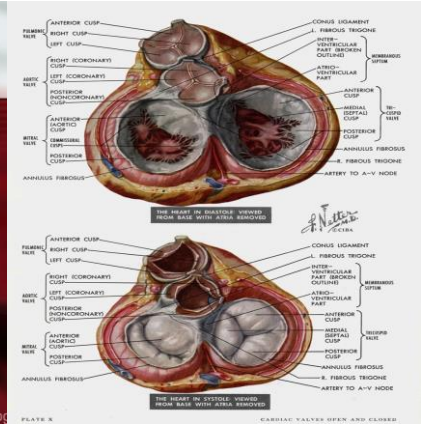
The Heartbeat

- Each heartbeat is called a *cardiac cycle*.
- When the heart beats, the two atria contract together, then the two ventricles contract; then the whole heart relaxes.
- *Systole* is the contraction of heart chambers; *diastole* is their relaxation.
- The *heart sounds*, lub-dup, are due to the closing of the atrioventricular valves, followed by the closing of the semilunar valves.

Heart Valves

- Blood flows through the heart in one direction enforced by 4 valves
  - 2 atrioventricular (AV) valves located at each atrial-ventricular junction
    - R. AV valve (tricuspid valve)
    - L. AV valve (bicuspid or mitral valve)
  - 2 semilunar (SL) valves
    - Aortic SL valve located at junction between L. ventricle and aorta
    - Pulmonary SL valve located at junction between R. ventricle and pulmonary trunk



Heart Sounds

- During each heartbeat, 2 sounds can be distinguished
  - Described as lub-dup, pause, lub-dup, pause, etc.
  - Sounds associated with closing of heart valves
  - 1st sound – AV valves close
  - 2nd sound – SL valves close (generally do not close at the same time making this sound less defined)

Heart Sound Link

- http://www.med.ucla.edu/wilkes/intro.html

- Normal Sounds
- Murmurs
- Wheezing
- Crackles

Disorders of the Heart

- Heart palpitation – a heartbeat that is unusually strong, fast, or irregular
  - Can be caused by drugs, emotional pressures or heart disorders
- Hypertrophic cardiomyopathy (HCM) – cardiac muscle cells enlarge, thickening the heart wall. The heart pumps well, but doesn't relax well during diastole when the heart is filling
  - Leading cause of death among young athletes

Disorders of the Heart

- Mitral valve prolapse – the mitral valve does not close properly, allowing blood regurgitation.
  - Affects up to 10% of the population; often seen in young women; may be genetic
  - Often treated with valve replacement
- Myocarditis – inflammation of the myocardium; may weaken the heart and its ability to pump
  - Often caused by untreated strep infection

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Diseases and Disorders (cont.)

- **Diseases and Disorders**
  - **Hypertension.**
  - **Stroke.**
  - **Arteriosclerosis.**
  - **Aneurysm.**
  - **Coronary artery disease (CAD).**
  - **Heart attack (Myocardial Infarction)**
  - **Congestive heart failure (CHF).**
  - **Anemia, hemophilia, and leukemia.**

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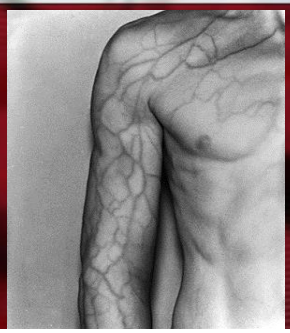
BLOOD VESSELS



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ARTERIES

FUNCTION – CARRY BLOOD AWAY FROM THE HEART

CHARACTERISTICS

•VERY THICK, MUSCULAR WALLS (WHY).

•VERY HIGH BLOOD PRESSURE

•CARRIES OXYGENATED BLOOD

•EXAMPLES – CORONARY, AORTA, CAROTID, FEMORAL

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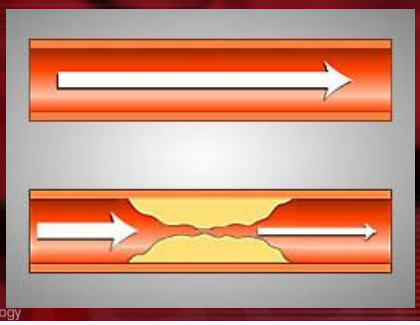
ATHEROSCLEROSIS



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ARTERIES

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CORONARY ARTERIES

Coronary arteries are the network of blood vessels that supply the heart. In this photograph, the left coronary artery has been injected with a red dye, and the right coronary artery with white.

ARTERIES IN BRAIN

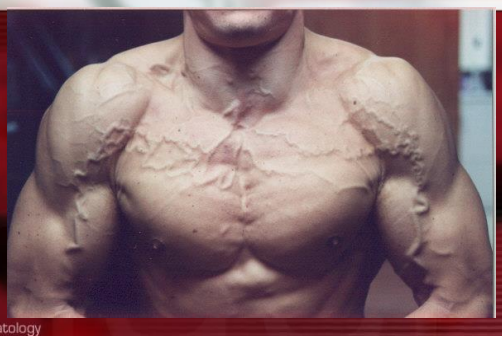
VEINS

FUNCTION – AFTER BLOOD MOVES THROUGH THE ARTERIES IT ENTERS BLOOD VESSELS CALLED VEINS, WHICH CARRY BLOOD BACK TO THE HEART.

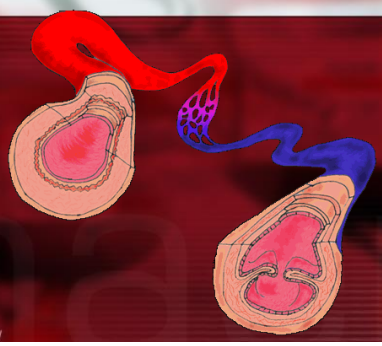
CHARACTERISTICS

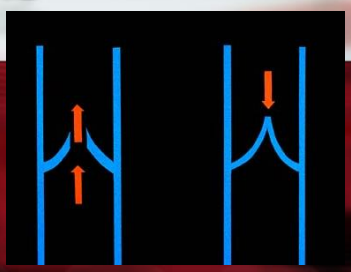
- THINNER WALLS WITH LESS MUSCLE
- HAVE VALVES
- CARRIES DEOXYGENATED BLOOD (1 EXCEPTION)
- EXAMPLES – VENA CAVA, JUGULAR,
- LOCATION – NEAR MUSCLES

VEINS



VEINS VS. ARTERIES





Vein Valves

Allows flow of blood in only ONE DIRECTION

VEINS

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SPIDER VEINS

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RETICULAR VEINS

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VERICOSE VEINS

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VERICOSE VEINS

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CAPILLARIES

FUNCTION: WHERE MATERIAL (OXYGEN, NUTRIENTS, CARBON DIOXIDE, ENERGY) IS EXCHANGED BETWEEN BLOOD AND CELLS

CHARACTERISTICS

- VERY SMALL
- WALLS ARE ONLY ONE CELL THICK
- DIFFUSION TAKES PLACE
- MOST ABUNDANT
- FOUND NEAR MUSCLE CELLS, ORGANS, ETC.

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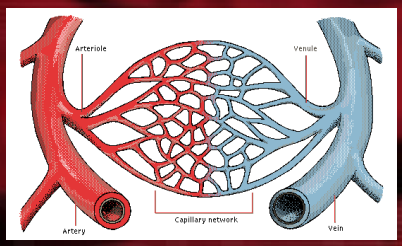
CAPILLARIES



http://www.innerbody.com/htm/body.html

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