Circulatory System: Blood and Gas Exchange

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Functions!

The cardiovascular system has three major functions: transportation of materials, protection from pathogens, and regulation of the body's homeostasis.

- ***Transportation***: The cardiovascular system transports blood to almost all of the body's tissues. The blood delivers essential nutrients and oxygen and removes wastes and carbon dioxide to be processed or removed from the body. Hormones are transported throughout the body via the blood's liquid plasma.

- ***Protection***: The cardiovascular system protects the body through its white blood cells. White blood cells clean up cellular debris and fight pathogens that have entered the body. Platelets and red blood cells form scabs to seal wounds and prevent pathogens from entering the body and liquids from leaking out. Blood also carries antibodies that provide specific immunity to pathogens that the body has previously been exposed to or has been vaccinated against.

- ***Regulation***: The cardiovascular system is instrumental in the body's ability to maintain homeostatic control of several internal conditions. Blood vessels help maintain a stable body temperature by controlling the blood flow to the surface of the skin. Blood vessels near the skin's surface open during times of overheating to allow hot blood to dump its heat into the body's surroundings. In the case of hypothermia, these blood vessels constrict to keep blood flowing only to vital organs in the body's core. Blood also helps balance the body's pH due to the presence of bicarbonate ions, which act as a buffer solution. Finally, the albumins in blood plasma help to balance the osmotic concentration of the body's cells by maintaining an isotonic environment.

Importance of a Circulatory System

- Nutrients can only diffuse across a small distance
- Organization
- A Highway for nutrients and gases necessary for the survival of our cells.
- Postal Service!!

Connection to Other Systems

- Respiratory
  - Gas Exchange via lungs
- Digestive
  - Diffusion of nutrients like sugar and salt into blood stream
- Muscular
  - Nutrients like ATP fuel muscles for exercise

Cool Fact: Blood leaves the digestive tract to go to the muscles....this means indigestion if you exercise after a meal...oops.

- Endocrine and Nervous
  - signals regulate blood flow
    ex. histamine released from wound causing smooth muscles to relax, blood vessels dilate so more white blood cells coat wound

Cont.

- Immune System
  - White blood cells!
- Osmoregulation
  - blood is filtered through the kidneys
- Development System
  - Stem cell turn to blood cells!

Differing Circulatory Systems

Open System

- Arthropods and mollusks (snails, clams, crabs..)
- less energy used
- “blood” consists of hemolymph
- no actual veins
- blood vessels merge into a sinus region which directly coats the cells
- imagine a bucket with two hoses attached to a squeeze bulb
- less efficient

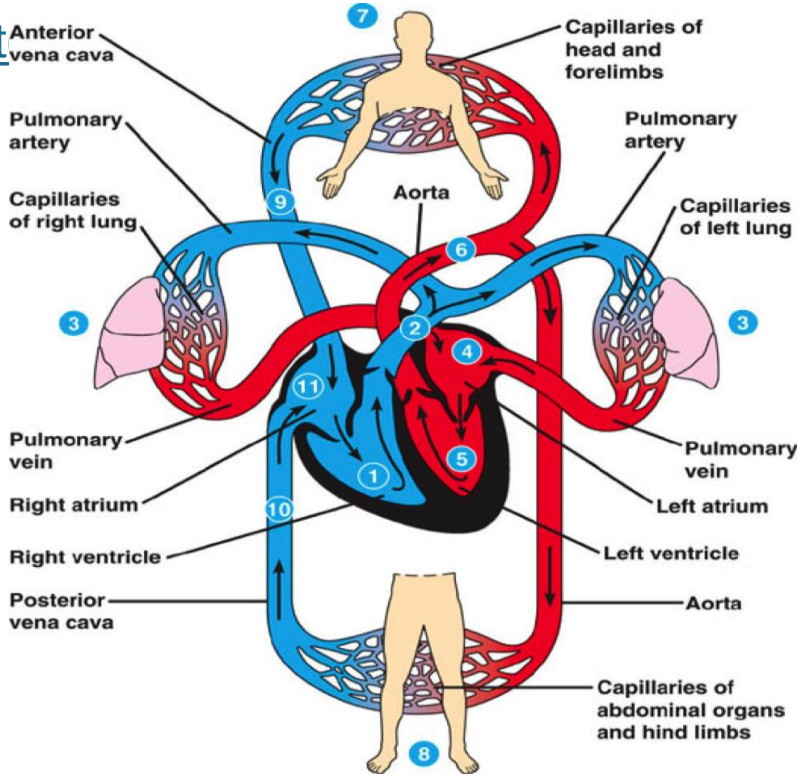
Closed System

- Mammals, better for bigger animals
- more energy
- blood confined to veins
- nutrients diffuse through capillaries to the cells, not directly connected to cells

Double Circulation in the Human

https://www.youtube.com/watch?v=oHMmt

- Pulmonary Circuit: oxygen-poor blood to lungs
  - called pulmocutaneous circuit in amphi--bians because gas exchanges in lungs *AND* skin.
- System Circuit: oxygen-rich blood goes to body

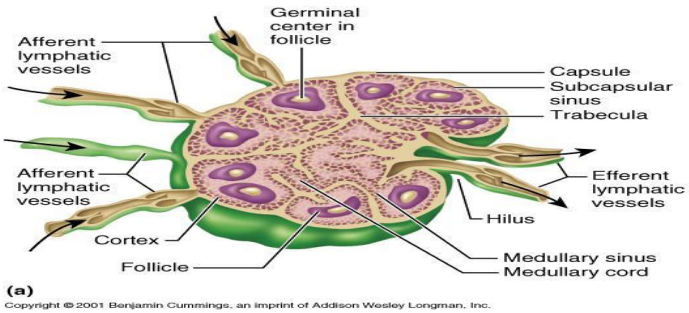


Respiratory working with Circulatory

- ★ Tracheal systems in insects branch throughout body
- Lungs are not directly connected to all parts of the body (wut?)
- alveoli touch the capillaries
- *Pneumonia & Emphysema*: caused by infection to alveoli
- Respiratory Pigments: assist in the transfer of oxygen through blood
  - **without** 4.5 mL of O2: 1 L of blood
  - **with** 200 mL of O2: 1 L of blood
    ex: hemoglobin
- Bohr Shift: CO2 triggers release of O2

Lymphatic System

- Fluid and proteins leak out during diffusion across capillaries
- Filters lymph(fluid) back into the circulatory system
- tiny vessels regroup with the veins of circ system (neck)
- lymph nodes: contain white blood cells and assist in filtering the lymph
- Edema and Elephantiasis: Diseases from accumulation or blocking of lymph...possibly from parasitic worms in vessels...heehee



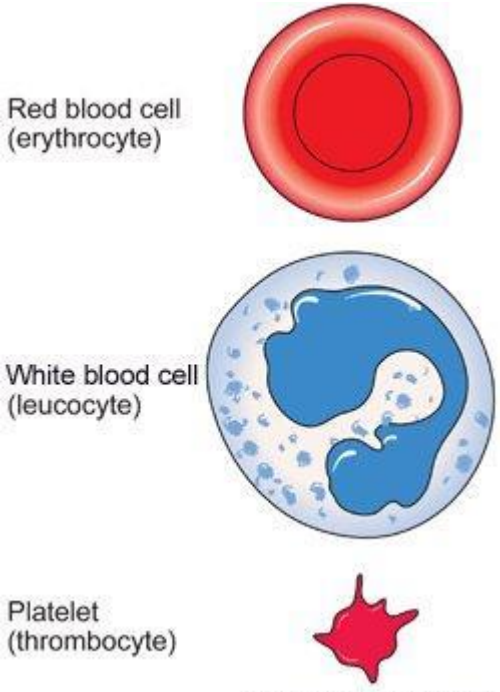
Evolution.

A four chambered heart, and two independent circuit systems, are key adaptations to the endothermic way of life (mammals and birds, although evolved independently of each other). Endotherms use about 10x as much energy as ectotherms, so their circulatory systems must deliver 10x as much fuel to tissues, and remove 10x as much waste. The closed system also provides evolutionary benefits energy wise- higher blood pressure= more oxygen delivered, and they better distribute blood to organs.

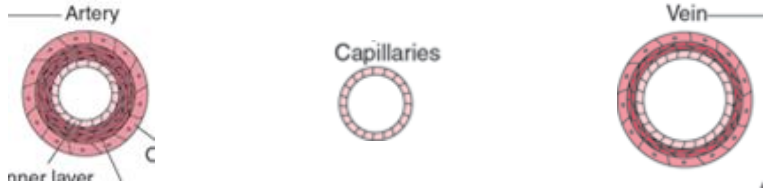
Blood!

The average human body contains about 4 to 5 liters of blood. It transports many substances through the body and helps to maintain homeostasis of nutrients, wastes, and gases.

- **Red Blood Cells** transport oxygen in the blood through the red pigment hemoglobin. Hemoglobin contains iron and proteins joined to greatly increase the oxygen carrying capacity. They pick up oxygen in the lungs and transport it to all the body cells. After delivering the oxygen to the cells they gather up the carbon dioxide and transport it back to the lungs where it is removed from the body when we exhale.
- **White Blood Cells** make up about 1% of total blood volume. They are a major part of the immune system and function as the body's defense to bacteria and viruses.
- **Platelets** help to stop bleeding by sticking to damaged blood vessels (clotting) and forming scabs.
- White and Red Blood cells and Platelets are all formed in bone marrow.
- **Plasma** is the liquid portion of blood, and makes up approximately half the total volume. It is made up of water, proteins and dissolved substances. It carries blood cells and other components throughout the body. Plasma is produced in the liver. Salts dissolve into ions and buffer blood/keep pH stable.



Blood Vessels!



Blood vessels are hollow tubes that circulate blood throughout the body. There are three types of blood vessels :

- **Arteries** “muscular”, carry oxygen rich blood AWAY from the heart, and are used to measure pulse. The contractions of arteries occur in time with heartbeats, and are near enough to the surface of our skin to be felt.
- **Capillaries** are tiny- as thin or thinner than the hairs on your head. Capillaries connect arteries to veins. Food substances(nutrients), oxygen and wastes pass in and out of your blood through the capillary walls.
- **Veins** carry blood back TOWARDS your heart.

(If you took all of the blood vessels out of an average child, and laid them out in one line, the line would be over 60,000 miles long, an adult's vessels would be closer to 100,000 miles long)

Blood Pressure! (Blood Flow)

- **Blood Pressure** is measured using blood flowing through arteries because it has a higher pressure than blood flowing through veins.
- Your blood pressure is measured using two numbers.
  - The first number, which is higher, is taken when the heart *beats* (the systole phase).
  - The second number is taken when the heart *relaxes* (the diastole phase).
- Those two numbers stand for millimeters. A column of mercury rises and falls with the beat of the heart. The height of the column is measured in millimeters.
- Certain hormones along with autonomic nerve signals from the brain affect the rate and strength of heart contractions .
- Blood vessels also affect blood pressure. Vasoconstriction decreases the diameter of an artery by contracting the smooth muscle in the arterial wall. The sympathetic (fight or flight) division of the autonomic nervous system causes vasoconstriction, which leads to increases in blood pressure and decreases in blood flow in the constricted region
- The volume of blood in the body also affects blood pressure. A higher volume of blood in the body raises blood pressure by increasing the amount of blood pumped by each heartbeat. Thicker, more viscous blood from clotting disorders can also raise blood pressure.

Hypertension (High Blood Pressure)

- In as many as 95% of reported high blood pressure cases in the U.S., the underlying cause cannot be determined. This type of high blood pressure is called essential hypertension.
  - High blood pressure tends to run in families and is more likely to affect men than women. Age and race also play a role. Other risk factors include; smoking, obesity, diets high in salt, excessive drinking, stress
- When a direct cause for high blood pressure can be identified, the condition is described as secondary hypertension. Among the known causes of secondary hypertension, kidney disease ranks highest. Hypertension can also be triggered by tumors or other abnormalities that cause the adrenal glands (small glands that sit atop the kidneys) to secrete excess amounts of the hormones that elevate blood pressure.
- Hypertension can lead to damaged organs, as well as several illnesses, such as kidney failure, aneurysm, heart failure, stroke, or heart attack. (blood pressure is I M P O R T A NT to the proper functioning of your entire body!!)
- More than 73 million American adults, or one out of three, have high blood pressure.
- Can be treated with medication or lifestyle changes- usually both. Goal is to lower it to less than 140/90; 120/80 or less is healthy.

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