Role of blood:

1) Transport
   - $O_2$ from lungs to cells
   - nutrients from digestive system to cells
   - wastes from excretory system from cells
   - heat (38°C)
     ex: hormones & enzymes to and from cells

2) Regulates pH (**7.35** - **7.45**)
   - carbonate-bicarbonate buffering system

3) Prevents fluid loss by clotting

4) Combats toxins & foreign invaders
   - through phagocytosis

5) Maintains homeostasis
• **Plasma**
  
  - liquid part of blood
  - straw color 55% of blood volume
  - mostly water (>90% of plasma)
  - carries organic & inorganic molecules

**Plasma Proteins:**

- albumins (55-65%)
  - regulates blood volume & pressure
- globulins (~ 15%)
  - antibodies
- fibrinogen (~4%)
  - clotting factor

**Non-protein nitrogenous substances**

- urea; creatine; ammonia

**Gases**

- oxygen
- carbon-dioxide

**Electrolytes**

- cations & anions
Blood Histology:
A Specialized Connective Tissue Comprised of

- **Formed elements:**
  - ~45% of blood volume
  - blood "cells"

1) **Erythrocytes (RBC)**
   - biconcave discs
   - lacks nucleus at maturity
   - carries hemoglobin molecule (quaternary structure of protein)
     - iron carrier --> heme + globin

   **RBC Function**

2) **Leukocytes (WBC)**
   - 3 types of granular leukocytes (produced by bone marrow)
     1) basophils
     2) eosinophils
     3) neutrophils
   - 2 types of agranular leukocytes (produced by lymph tissue)
     1) lymphocytes
     2) monocytes: antigen -antibody response

   **WBC Types/Functions**

3) **Thromocytes (platelets)**
   - cell fragments
   - assists in clotting
   - clot formation (thrombus)
     - insoluble network of fiber that traps cells
       - fibrinogen --> fibrin
       - prothrombin --> thrombin

   **Khan Academy: How do we make blood clots?**
• Besides the four blood groups, we also have a factor called the Rh factor in the blood.

• It’s named after the Rhesus monkey (animal they conducted they study on)

• Have it (+)    Don’t have it (-)

Bozeman Blood Typing
Hemolytic disease of the newborn

- Anti-Rh antibodies can develop in the mother -they can cross the placenta, destroying the Rh-positive fetus’s RBCs
- the baby may die or be very anemic
- **RhoGAM**
  - A serum containing antibodies against the Rh antigens
    - given to an Rh-negative mother to destroy any Rh-positive fetal cells in her circulation and thereby prevent her production of anti-Rh antibodies

Hemolytic Disease/RhoGAM
Histology of the Heart:

Pericardial sac (parietal pericardium)
- membrane surrounding heart

3 tissue layers:

1) Epicardium (visceral pericardium)
   - outer tissue layer
   - serous membrane that covers the muscular part of the heart
   - secretes a watery fluid (pericardial fluid)
   - lubricates membrane surfaces
   - reduces friction during contractions & relaxations

2) Myocardium
   - middle layer
   - cardiac muscle
   - thick; 3/4 heart's bulk
   - cardiac muscles are branched & connected by intercalated disc's
   - free flowing ions across disc's
   - action potentials easily move from cell to cell

3) Endocardium
   - inner tissue layer
   - glistening membrane lining cavities of the heart
Anatomy of the Heart and vessels

Heart
- cone-shaped
- muscular organ about the size of your fist
- located behind the sternum between lungs
- apex of heart points to left

4 Chambers:
  2 Atria
- upper chambers
  - right atrium & left atrium
  - right atrium is larger than left

  2 Ventricles
- lower chambers
  - right ventricle & left ventricle
  - left ventricle is larger than right

  Septa
- dividing wall of tissue

Interventricular septum
- separates rt. & left ventricles

Interatrial septum
- separates rt. & left atria
Venous & Arterial Connections within the Heart:
- Superior & inferior vena cava to right atrium
- Pulmonary veins to left atrium
- Pulmonary arteries from left ventricle
- Aorta from left ventricle
- Coronary vessels supply cardiac muscle
• **Atrio-ventricular Valves:**
  - prevent backflow of blood at strategic points in heart
  - supported by chordae tendineae (strong fibrous strings)
  - papillary muscles open & close valves
    - **Tricuspid valve:**
      - between right atrium & right ventricle = *deoxygenated blood*
    - **Bicuspid valve (mitral valve):**
      - between left atrium & left ventricle = *oxygenated blood*

• **Semilunar Valves**
  - **Pulmonary semilunar valve:**
    - between right ventricle & pulmonary artery = *deoxygenated blood*
  - **Aortic semilunar valve:**
    - between left ventricle & aorta = *oxygenated blood*
Pathway of blood through the Heart

- Deoxygenated blood enters the atrium from both superior & inferior vena cava.

- Blood is pumped into the ventricle through tricuspid valve.

- Right ventricle pumps blood through semilunar valve into pulmonary artery into lungs.

- From lungs through pulmonary veins (oxygenated blood) into left atrium.

- Blood is pumped into left ventricle through bicuspid valve.

- Left ventricle pumps blood through semilunar valve into aorta to the rest of the body.
**Vascular Pathways**
-cardiovascular system is divided into two circuits with the heart in between

**Pulmonary circulation**
-right ventricle of heart through pulmonary artery
-deoxygenated blood is pumped from the body to the lungs
-w/in the lungs C0₂ is released and O₂ is picked up
-oxygenated blood returns from the lungs & enters left atrium

**Systemic circulation**
-left ventricle of heart through aorta carrying oxygenated blood
-arteries branching from aorta supply blood to major organs & body regions
**Coronary circulation**

*Coronary arteries/veins*
- part of systemic circulation
- supply blood to heart itself
- first branch off aortic arch
Conduction system
- provides stimulus of cardiac muscle innervation

• Sinoatrial Node (S-A node):
  - wall of the right atrium near where superior vena cava enters
  - (sinus venous)
  - pacemaker
    - ability to depolarize spontaneously & rhythmically
      - S-A node cells RMP -55 to -60 mV
      - heart cells RMP -80 to -90 mV

• Atrio-ventricular Node (A-V node):
  - located on the side of interatrial septum
  - receives impulses from S-A node
  - relays impulses to specialized cells (Bundle of His) & ultimately into Purkinje fibers which stimulate the muscle cells of the ventricles to depolarize & contract
Physiology of Cardiovascular Circulation

Cardiac Cycle
-one heart beat
-(lub-dub) sounds are heart valves closing
-the first is atrioventricular valves closing
-the second is semilunar valves closing
-2 atria contract at same time
-atrial systole
-2 ventricles contract at same time
-ventricular systole-all 4 chambers relax
-atrial & ventricle diastole

Alila Medical Medial video: Conduction Sytem of the Heart
Blood passes through the following loop of vessels moving away from the heart:

- Arteries
- Arterioles
- Capillaries
- Venules
- Veins

Blood returns to the heart from venules and veins

Blood Vessel Overview
Blood Vessel Features

- **Common features**
  - **Lumen**: the hollow interior through which blood flows
  - **Endothelium**: the inner lining consisting of simple squamous epithelium

- **Unique features**
  Each type of blood vessel has traits that reflect its particular function

List three structural differences between arteries and veins

Structural Differences in Blood Vessels
Veins
- Carry blood back to the heart
  
**Superior vena cava**
- Carries blood from the upper body back to the heart
  
**Jugular veins**
- Carry blood from head to the heart

**Pulmonary veins**
- Carry oxygenated blood from the lungs to the heart

**Renal vein**
- Carries blood from the kidney to the heart

**Inferior vena cava**
- Carries blood from the lower body back to the heart

**Radial vein**
- Carries blood from the hand back to the heart

**Femoral vein**
- Carries blood from the thigh and inner knee back to the heart

**Iliac vein**
- Carries blood from the pelvic organs and abdominal wall back to the heart