The Circulatory System

- **Function of the circulatory system**

- The cardiovascular system of land vertebrates has two circuits
  
  The pulmonary circuit

  The systemic circuit
  
  Carries blood between the heart and the rest of the body.

  Figure 23.5

  The human heart and cardiovascular system typify those of mammals
  - The mammalian heart has two thin-walled atria that receive

  - The thick-walled ventricles pump blood

  Figure 23.4

  Figure 23.6
  
  The heart contracts and relaxes rhythmically
  - **Diastole**

  Systole
  
  - The atria briefly contract and fill the ventricles with blood
  - Then the ventricles contract and propel blood out

  - Heart valves prevent backflow

  Cardiac output
The pacemaker sets the tempo of the heartbeat

- The SA node (pacemaker) generates electrical signals that trigger the contraction of the atria
- The AV node then relays these signals to the ventricles

Control of the heartbeat

- The heart's pumping rhythm is controlled by the pacemaker or sinoatrial (S-A) node
  
  - Generates an electrical signal that spreads through the atria causing them to contract

  - Signal spreads rapidly over both ventricles and they contract

Control of the Heartbeat

- The brain also influences heart rate
  
  - Control centers in the brain
  
  - Send signals to SA node or AV node

What is a heart attack?

- A heart attack is

Blood Vessels

Arteries

- Thick, muscular walls
- Greater blood pressure

Veins

- Less muscular and thicker than arteries
- Less blood pressure
- Many have valves
Figure 23.9a - The circulatory system associates intimately with all body tissues
• Capillaries are microscopic blood vessels
  – They form an intricate network among the tissue cells

Figure 23.9b
  – No substance has to diffuse far to enter or leave a cell

Capillaries allow the transfer of substances through their walls

• The transfer of materials between the blood and interstitial fluid can occur by

Composition of Blood

Blood is composed of
• Plasma – liquid composed of water (90%) and dissolved salts, proteins, and other substances
• Cellular elements –

Figure 23.12a - Red blood cells transport oxygen
• Red blood cells contain hemoglobin

White blood cells help defend the body
• White blood cells function both inside and outside the circulatory system

Figure 23.12c  Blood clots plug leaks when blood vessels are injured
• When a blood vessel is damaged, platelets respond
  – They help trigger the formation of an insoluble fibrin clot that plugs the leak

Blood transports the respiratory gases, with hemoglobin carrying the oxygen
• The heart pumps oxygen-poor blood to the lungs
  – In the lungs it picks up $O_2$ and drops off $CO_2$
In the tissues, cells pick up CO₂ and drop off O₂. Gases diffuse down pressure gradients in the lungs and the tissues.

- Hemoglobin is a protein in red blood cells
  - It helps buffer the pH of blood and carries some CO₂

- Most CO₂ in the blood combines with water to form carbonic acid
  - The carbonic acid breaks down to form H⁺ ions and bicarbonate ions

- Most CO₂ is transported to the lungs in the form of bicarbonate ions

Blood exerts pressure on vessel walls
- Blood pressure depends on resistance of vessels

Connection: Measuring blood pressure can reveal cardiovascular problems
- Blood pressure is measured as systolic and diastolic pressures

- Hypertension is persistent systolic pressure higher than 140 mm Hg and/or diastolic pressure higher than 90 mm Hg
  - It is a serious cardiovascular problem