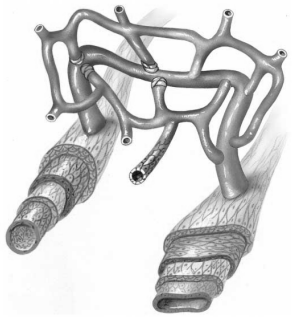
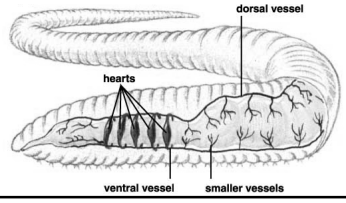
Chapter 32:
Circulation



Types of Circulatory Systems:

1) Open Circulatory System:
   - Open space present (hemocoel); blood bathes organs
   - Arthropods (e.g. insects, crabs); mollusks (e.g. snails, clams)

2) Closed Circulatory System:
   - Blood confined to heart / vessels
   - Invertebrates (e.g. earthworms); vertebrates (e.g. humans)

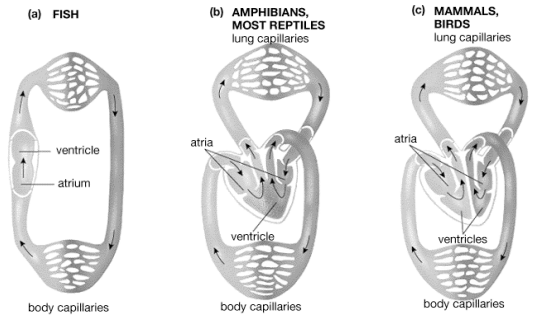


Benefits:
1) Efficient transport
2) ↑ blood pressure

(Figure 32.1)

Heart: Pump propelling blood through vessels

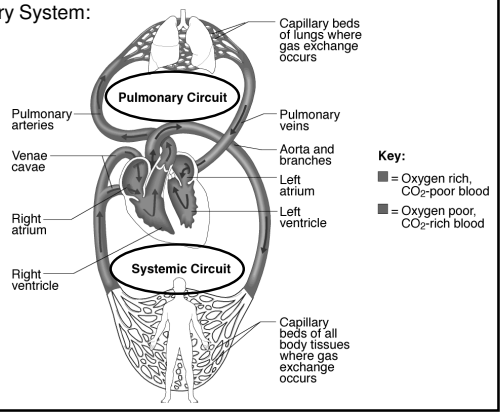
More effecient transfer of oxygenated blood



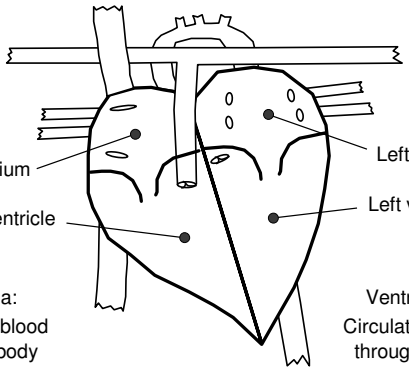
2 chambered heart | 3 chambered heart | 4 chambered heart

(Figure 32.2)

Circuits of the Circulatory System:



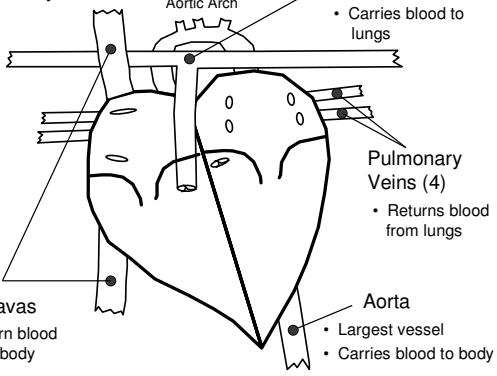
Heart Anatomy: always from the perspective of the person the heart is in!



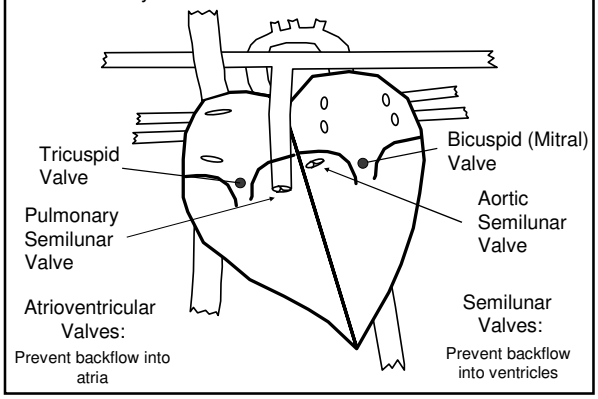
Atria:
Collect blood from body

Ventricles:
Circulate blood through body

Heart Anatomy:



Heart Anatomy:



Tricuspid Valve

Bicuspid (Mitral) Valve

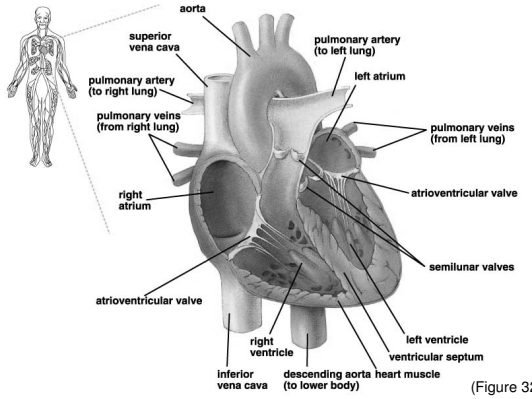
Pulmonary Semilunar Valve

Aortic Semilunar Valve

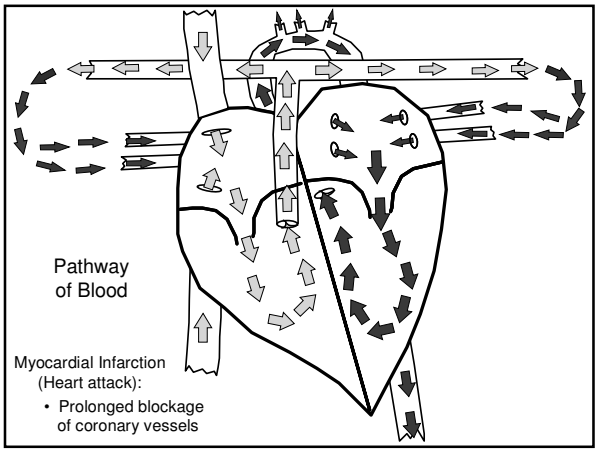
Atrioventricular Valves:
Prevent backflow into atria

Semilunar Valves:
Prevent backflow into ventricles

Heart Anatomy:



(Figure 32.3)



Pathway of Blood

Myocardial Infarction (Heart attack):

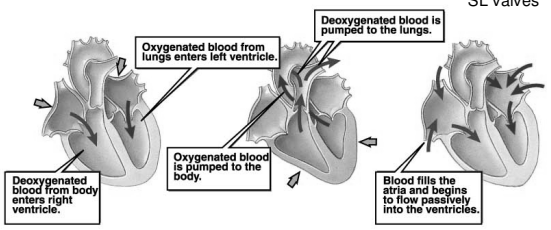
- Prolonged blockage of coronary vessels

Cardiac Cycle:

- Heart beats ~ 100,000 times / day

"Lub" = closing of AV valves

"Dub" = closing of SL valves



1) Atria contract; blood pushed into ventricles

2) Ventricles contract; blood pushed to lungs / body

3) Heart relaxes; blood flows passively into chambers

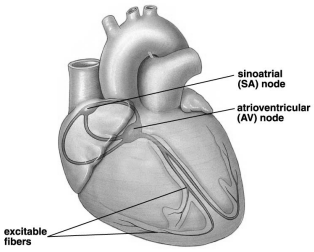
(Figure 32.5)

(Figure 32.7)

Coordination of Heart Contraction:

- Gap junctions allow cardiac muscles to synchronize contraction

1) Sinoatrial Node (SA Node) initiates contraction:
   - Pacemaker cells
   - Located in wall of right atrium



2) Atria contract
3) Signal delayed at Atrioventricular Node (AV Node)
   - Allows for atria to finish contraction
4) Ventricles contract

➢ Fibrillation
   - Uncoordinated, irregular contractions of heart

Nervous System / Hormones Influence Heart Rate:

- SA Node = 100 beats / min
- Nervous System:
  - Parasympathetic System = Decreased heart rate
    - Usually in control
  - Sympathetic System = Increased heart rate
    - Exercise; stress
- Endocrine System
  - Epinephrine = Increased heart rate

Other effects on heart rate

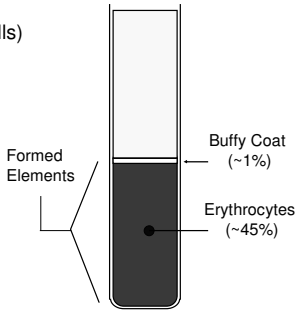
- **Fitness**
  - **Athletes have a slower heart rate at rest than those who are out of shape.**
  - **Drugs can also affect heart rate**
    - **Amphetamines**
    - **Cocaine**

Len Bias learned that cocaine doesn't do a heart good.

Blood ("River of Life"):

Components:

1) Formed Elements (living cells)
   - Erythrocytes (RBC's)
     - Carry oxygen
     - Produced in bone marrow
     - Lifespan = ~120 days
   - Leukocytes (WBC's)
     - Immune function
     - Produced in bone marrow
     - Lifespan = days - years
   - Platelets
     - Blood clotting
     - Produced in bone marrow
     - Lifespan = 10 - 12 days

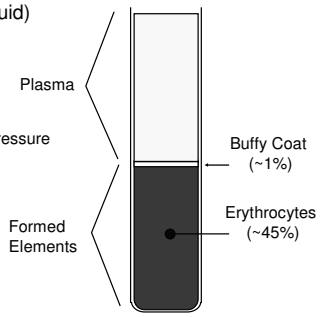


Volume = 5 - 6 L

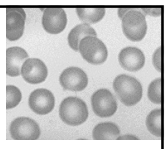
Blood ("River of Life"):

Components:

2) Plasma (Non-cellular - Fluid)
   - 50 - 60% blood volume
   - Composition:
     1) Water (90%)
     2) Proteins (8%)
        - Regulate osmotic pressure
        - Transport nutrients
        - Clot blood
     3) Other solutes (2%)
        - Nutrients, Gases
        - Wastes
        - Hormones



Erythrocyte = Red blood cell



- Biconcave shape ("certs")
  - Increased surface area for gas exchange
- No nucleus (anucleate)
- Contains Hemoglobin
  - Iron-containing protein which binds oxygen
    - 4 O_2 molecules / hemoglobin
- RBC production regulated by erythropoietin (hormone)
  - Produced in kidney; targets bone marrow
  - ↑ erythropoietin = ↑ RBC count
- Contain unique proteins on cell surface
  - A and B proteins (Type A, B, AB, O)
  - Rh factor (Type + or -)

Blood types

ABO Blood Types

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

(a)

Genetics of blood types

- **Blood type A & B are codominant**
- **Blood type O is recessive.**
- **But to make things really confusing…**

❖**The Bombay gene can make a Type A person appear to be type O!**

hh AO = type A

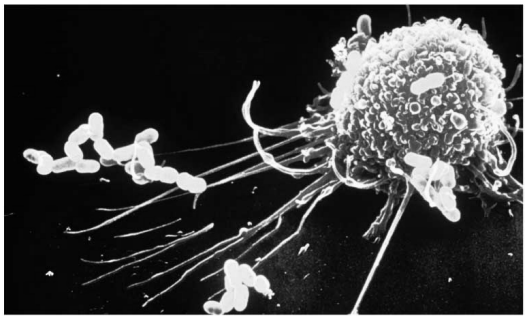
Hh AO = type O

What about the R factor?

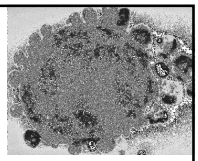
- **Different gene from ABO gene.**
- ❖ **Dominant is type R+**
- ❖ **Recessive is type R-**
  - ➢ **Rh- is a relatively recent mutation that occurred in Europe.**
  - ➢ **35% of Basques are Rh-**
  - ➢ **16-17% of Europeans are Rh-**
  - ➢ **Less than 1% of all other human populations are Rh-**

Leukocyte = White blood cell

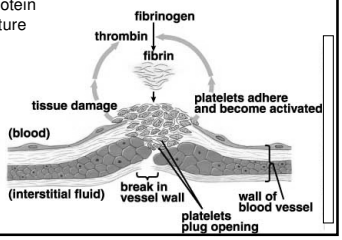
- Protect body against foreign invaders (e.g. bacteria)
  - Utilize blood for transport

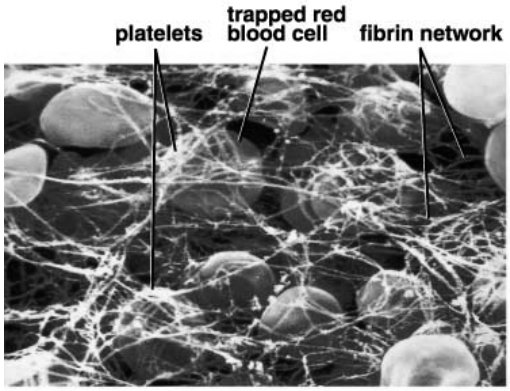


Platelets:

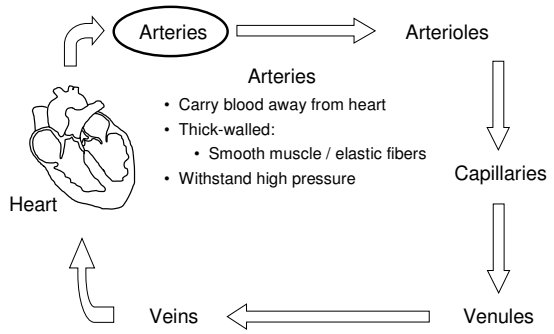


- Formed from fragmenting megakaryoctyes (bone marrow)
- Initiate blood clotting:
  1) Platelets stick to ruptured surface (plug)
  2) Platelets initiate production of thrombin (enzyme)
     - Thrombin constructs protein web (fibrin) to seal rupture

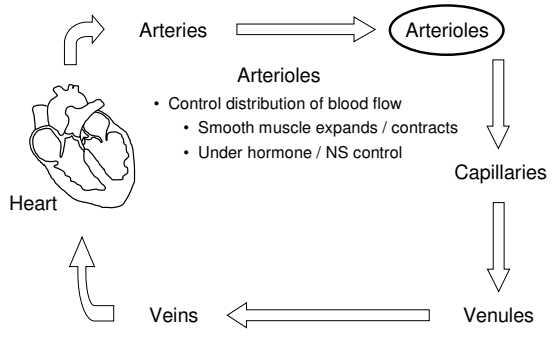




Blood Vessels:



Blood Vessels:



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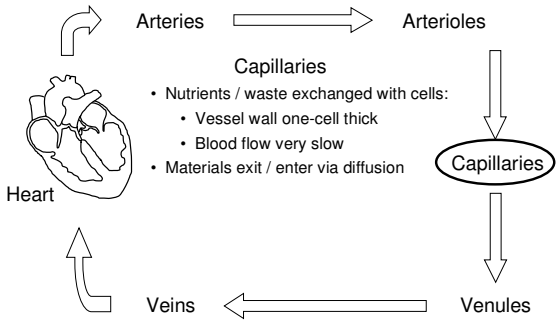

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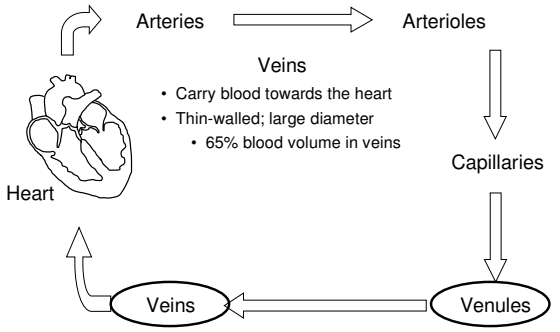
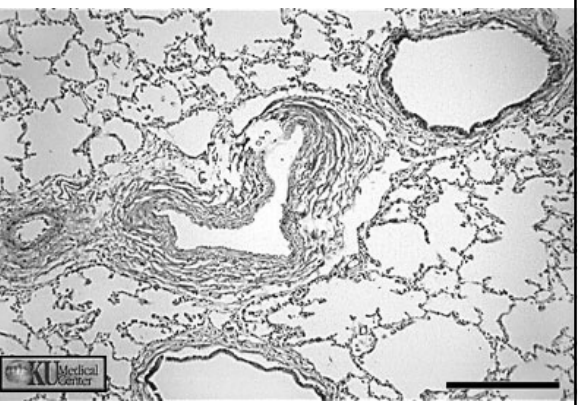
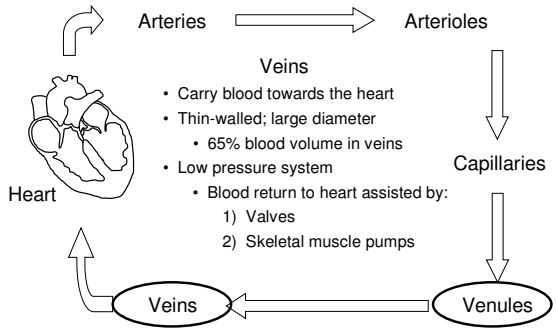
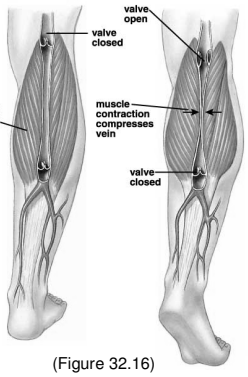




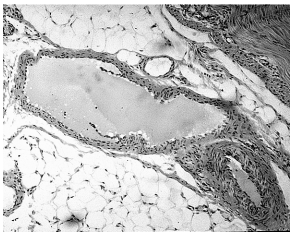
Blood Vessels:



Skeletal Muscle Pump:



Vein Valve:



(Figure 32.16)

Cardiovascular Disorders:

- Leading cause of death in the United States
  1) Hypertension = High blood pressure
     - ↑ Resistance in vessels = ↑ work for heart
       - Angina = Chest pain (heart lacks O_2)
       - Stroke = Vessel ruptures in brain
  2) Atherosclerosis = Deposits (plaques) collect in vessels

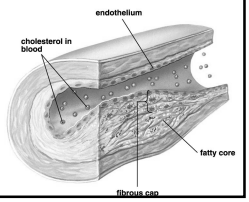
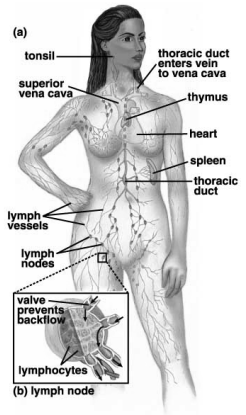


Figure E32-2

Lymph System:

- Vascular system closely associated with circulatory system
- Function:
  - Return fluids to blood (lymph)
  - Transport fats (small intestine → blood)
  - Defend body against bacteria / viruses (store leukocytes)
- Components:
  - Lymph vessels (capillaries → large vessels)
    - Empty into circulatory system near heart
  - Lymph nodes / tonsils (house leukocytes)
  - Thymus: Gland which activates leukocytes
  - Spleen: Filters blood / houses leukocytes



Elephantiasis

elephantiasis

- Elephantiasis is caused by a small round worm
  - ❖Transmitted by mosquitoes.
  - ❖Unclear whether it is caused by the blocked lymphatic tissues or an allergic reaction to the worm.
  - ❖Affects mostly lower limbs and male genitals.