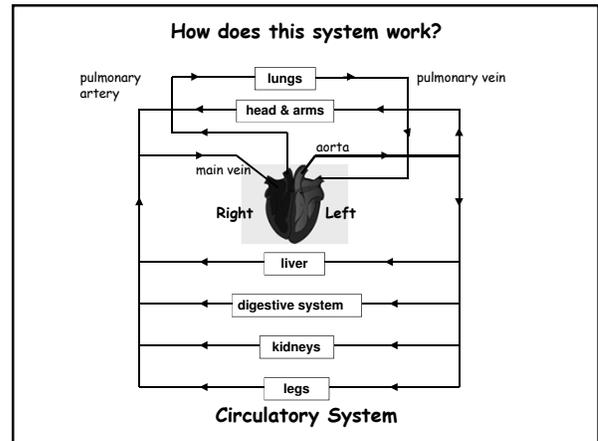


What is the CARDIOVASCULAR system?

- The cardiovascular system carries blood and dissolved substances to and from different places in the body.
- The Heart has the job of pumping these things around the body.
- The Heart pumps blood and substances around the body in tubes called blood vessels.

➤ 3 Elements of the Cardiovascular System:

- BLOOD
- HEART
- BLOOD VESSELS



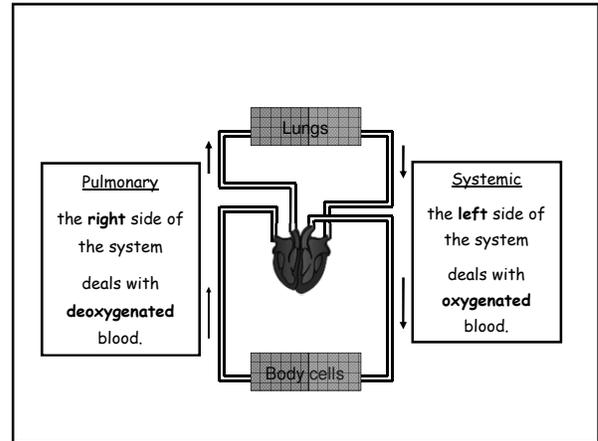
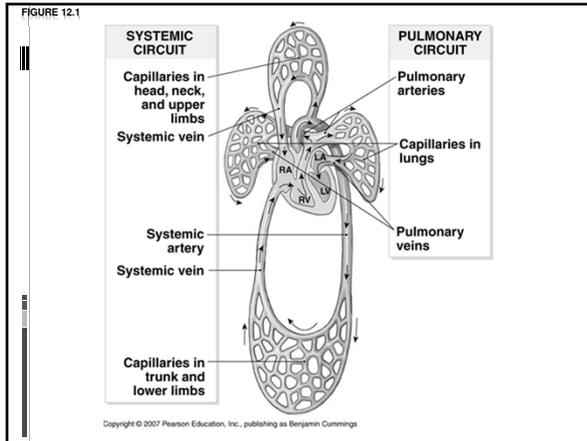
Blood must *move!*

- Cells rely on interstitial fluid for O₂, nutrients, and waste disposal
- Without circulating blood, these resources would be quickly exhausted or filled up
- Fun Facts
 - Beats approx. 100,000 /day
 - Pumps roughly 8,000 liters of blood/day

Heart Basics

Our circulatory system is a double circulatory system.
This means it has two parts.

- **Pulmonary Circuit:**
 - Carries blood between the **right** side of the heart, to the **lungs**, and back to the **left** side of the heart.
- **Systemic Circuit:**
 - Carries blood between the **left** side of the heart and the **rest of the body**.
 - Each begins/ends at heart, and blood travels thru in sequence



Double Circuit System

Heart: Anatomy & Organization

- In the **mediastinum**
 - Mass of connective tissue b/t 2 pleural cavities
- Surrounded by **pericardial cavity**
- Pericardial cavity lined with **pericardium** (serous membrane)
 - Visceral peric.
 - Parietal peric.
 - Pericardial fluid in cavity

Heart Basics, ctd.

- Small organ
- **Four** chambers
 - **Right atrium** – receives blood from systemic circ.
 - **Right ventricle** – discharges into pulmonary circ.
 - **Left atrium** – receives blood from pulmonary circ.
 - **Left ventricle** – discharges into systemic circ.
- **Atria** contract simultaneously **first**, then ventricles

Structural Differences between Atria & Ventricles

- Based on demand
 - Job of right & left atria?
 - Job of right & left ventricles?

Heart Basics

Blood from the heart gets around the body through blood vessels

- **Arteries** – larger; carry blood **away** from the heart
- **Veins** – smaller than arteries; carry blood back **toward** the heart
- **Capillaries**
 - Smallest, thin walled vessels b/t the smallest arteries and veins
 - Nutrient exchange between blood and surrounding tissues

The ARTERY

Arteries carry blood away from the heart.

the **elastic fibres** allow the artery to **stretch** under pressure

thick muscle and elastic fibres

the thick muscle can contract to **push** the blood along.

The VEIN

Veins carry blood toward the heart.

veins have **valves** which act to stop the blood from going in the **wrong direction**.

thin muscle and elastic fibres

body muscles surround the veins so that when they contract to move the body, they also squeeze the veins and push the blood along the vessel.

The CAPILLARY

Capillaries link Arteries with Veins

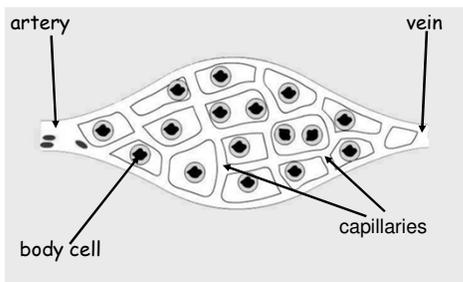
they **exchange materials** between the blood and other body cells.

the wall of a capillary is only one cell thick

The exchange of materials between the blood and the body can only occur through **capillaries**.

The CAPILLARY

A collection of capillaries is known as a **capillary bed**.



The Heart

This is a **vein**. It brings blood from the body, except the lungs.

These are **arteries**. They carry blood away from the heart.

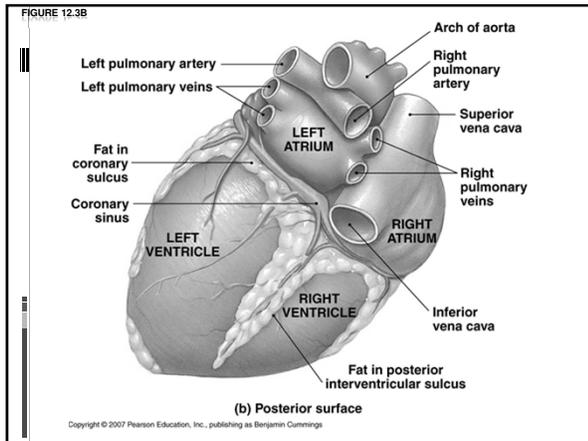
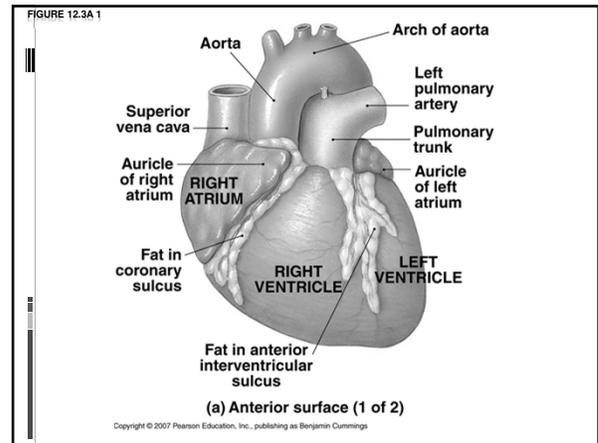
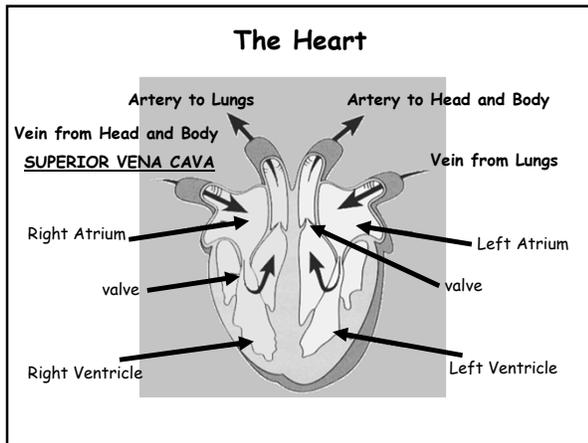
2 atria

2 ventricles

Coronary arteries, the heart's own blood supply

The heart has four chambers

now lets look inside the heart



The Heart Valves

- The **Atrioventricular Valves** (open during relaxation & closed when ventricles contract)
 - Between atria & ventricles on each side
 - Prevent **backflow (regurgitation)** into atria
 - LEFT AV = **bicuspid valve**
 - RIGHT AV = **tricuspid valve**
 - Small amt of backflow = **heart murmur**

- The **Semilunar Valves** (closed during relaxation & open when ventricles contract)
 - At the base of each main artery leaving the ventricles
 - **Pulmonary semilunar valve**
 - **Aortic semilunar valve**

How does the Heart work?

STEP ONE

blood from the body

blood from the lungs

The heart beat begins when the heart muscles **relax** and blood flows into the atria.

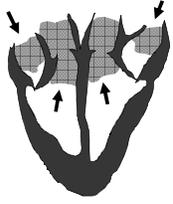
How does the Heart work?

STEP TWO

The atria then **contract** and the valves **open** to allow blood into the ventricles.

How does the Heart work?

STEP THREE



The valves **close** to stop blood flowing **backwards**.

The **ventricles** contract forcing the blood to **leave** the heart.

At the same time, the **atria** are relaxing and once again **filling** with blood.

The cycle then repeats itself.

Pathway of the blood

Blood comes into the heart on **RIGHT** side through the

- Superior /Inferior Vena Cava
- Right Atrium
- AV Valve- tricuspid
- Right ventricle
- Pulmonary semilunar valve
- Pulmonary artery

- Lungs
- Pulmonary vein
- Left atrium
- Bicuspid valve
- Left ventricle
- Aortic semilunar valve
- Aorta
- Out to body

The Cardiac Cycle

- Cardiac Cycle
 - Period between start of one heartbeat and the start of the next is one cycle
 - Includes:
 - Contraction (**systole**) – chamber squeezes blood where it needs to go
 - Relaxation (**diastole**) – chamber fills with blood and prepares for next cardiac cycle

HEART SOUNDS - OPENING AND CLOSING OF VALVES, "L"

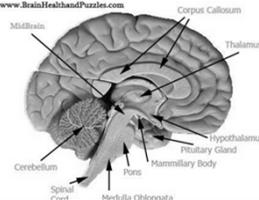


Stethoscope - instrument to listen and measure heart sounds

REGULATION OF CARDIAC CYCLE

controlled by the **cardiac center** within the **medulla oblongata**. The cardiac center signals heart to increase or decrease its rate according to many factors that the brain constantly monitors.

Muscle Activity
Body Temperature
Blood ion levels (potassium & calcium)



CARDIAC OUTPUT

Cardiac Output = Stroke Volume x Heart Rate



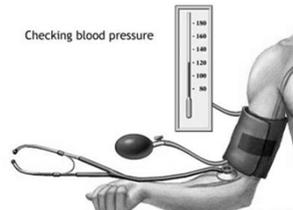
Heart Dynamics

- **Stroke Volume (SV)**
 - The amount of **blood** ejected by a **ventricle** during a **single beat**

Factors affecting blood pressure:

1. **Cardiac Output**
2. **Blood volume (5 liters for avg adult)**
3. **Blood Viscosity**
4. **Peripheral Resistance**

Average=120/80
(higher number is the **systolic** pressure)



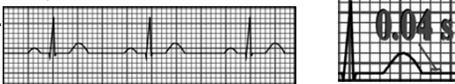
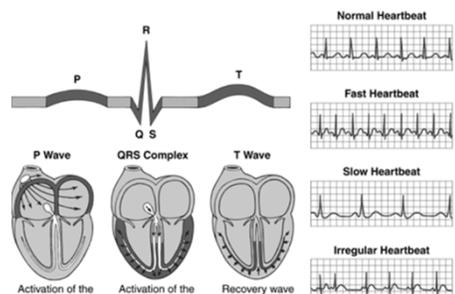
Checking blood pressure

#ADAM

Interpreting ECGs

An ECG is printed on paper covered with a grid of squares. Notice that five small squares on the paper form a larger square. The width of a single small square on ECG paper represents 0.04 seconds.

A common length of an ECG printout is 6 seconds; this is known as a "six second strip."

Normal Heartbeat

Fast Heartbeat

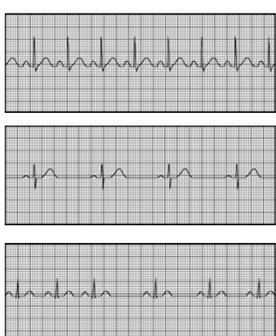
Slow Heartbeat

Irregular Heartbeat

P Wave QRS Complex T Wave

Activation of the atria Activation of the ventricles Recovery wave

Analyze an ECG



Each one of the figures represents an ECG pattern displaying three types of abnormal rhythms: **Tachycardia, Bradycardia, and Arrhythmia.**

Identify each.

Defibrillator

common treatment for life-threatening cardiac arrhythmia

The device shocks the heart and allows it to re-establish its normal rhythm

The device can also be used to start a heart that has stopped.



Disorders of the Circulatory System

1. **MVP - mitral valve prolapse.** The mitral valve does not close all the way; this creates a clicking sound at the end of a contraction.
2. **Heart Murmurs** – valves do not **close** completely, causing an (often) harmless murmur sound. Sometimes holes can occur in the **septum** of the heart which can also cause a murmur
3. **Myocardial Infarction (MI)** - a **blood clot** obstructs a coronary **artery**, commonly called a “**heart attack**”

4. **Atherosclerosis** – deposits of **fatty** materials such as cholesterol form a “**plaque**” in the arteries which **reduces** blood flow. Advanced forms are called **arteriosclerosis**.

▫ **Treatment:**

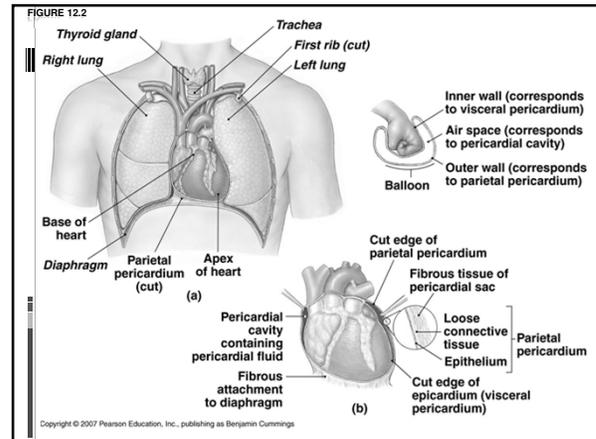
- **Angioplasty**—a catheter is inserted into the artery and a **balloon** is used to stretch the walls open. A **bypass** can also treat clogged arteries. A **vein** is used to replace a clogged **artery**. **Coronary bypass** refers to a procedure where the **coronary artery** is bypassed to supply blood to the **heart**. (The phrase “quadruple bypass” means that **4** arteries were bypassed.)

5. **Hypertension** – **high blood pressure**, the **force** within the arteries is too high. A **sphygmomanometer** can be used to diagnose hypertension

6. **Hypotension**—**low** blood pressure

Blood Supply to the Heart

- Coronary circulation
 - Provides blood to the muscle of heart
- Coronary arteries (l & r)
 - Begin at base of aorta
- Infarction
 - Area of dead tissue caused by interruption in blood flow
 - Myocardial infarction (MI)



Anatomy & Organization, ctd.

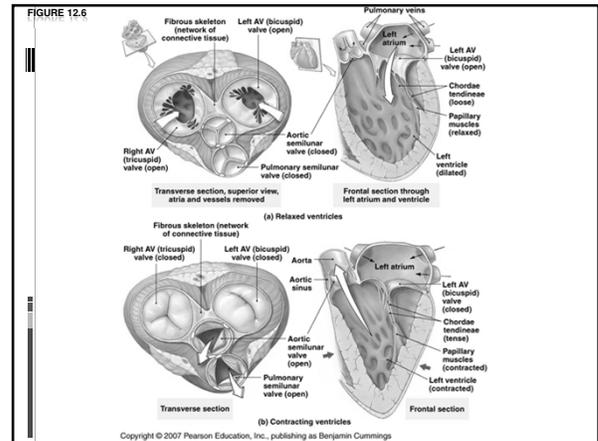
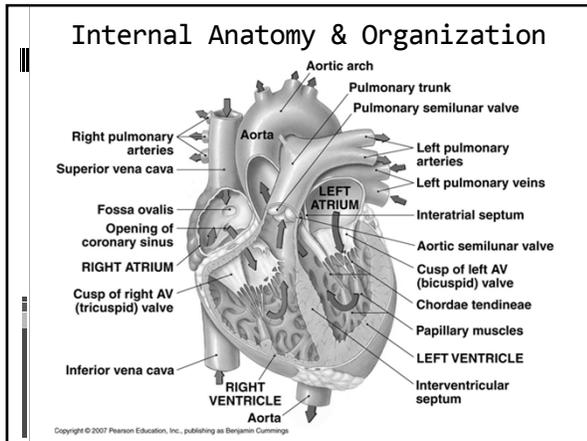
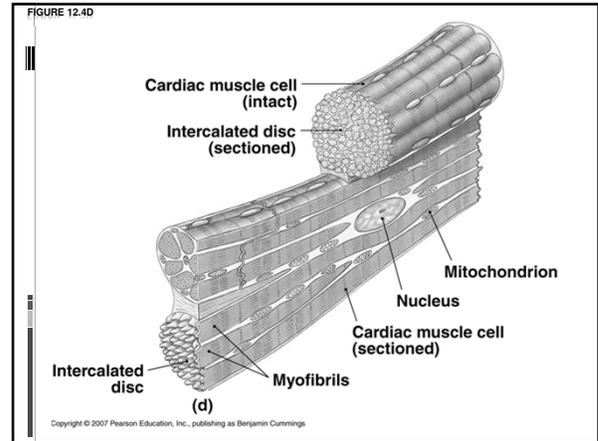
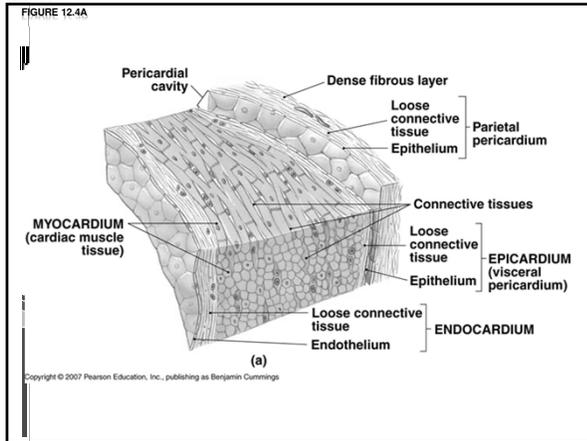
Heart Wall

- Epicardium
- Myocardium
 - Muscular wall
- Endocardium

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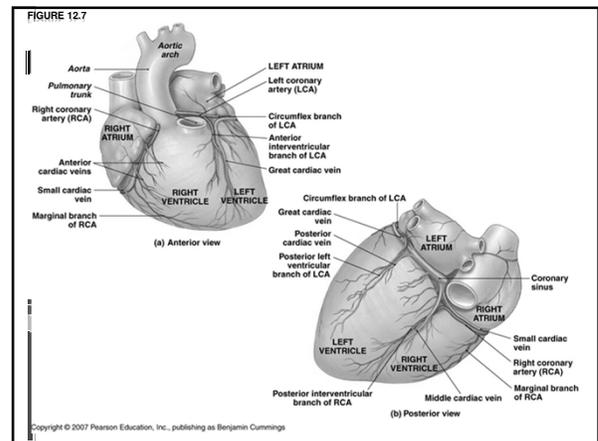
Cardiac muscle cells

- Many mitochondria
- Myofibrils and sarcomeres
- Lots of myoglobin to store O₂
- Intercalated discs
 - Hold together adjacent membranes
 - Desmosomes and gap junctions
 - Action potentials can therefore travel quickly



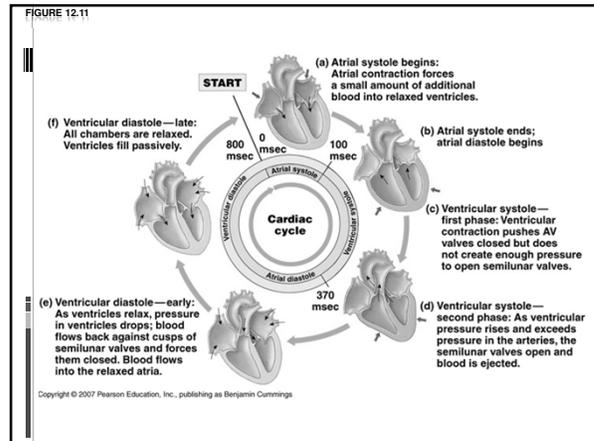
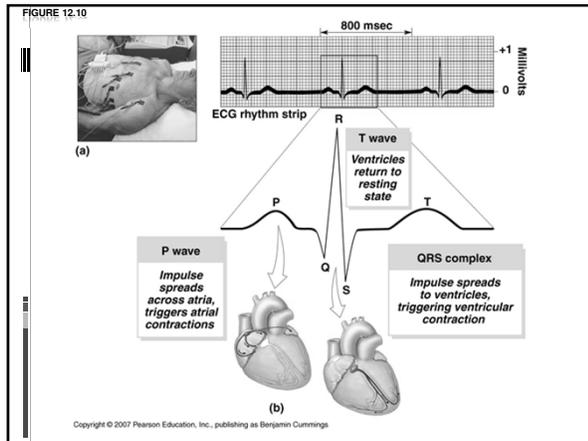
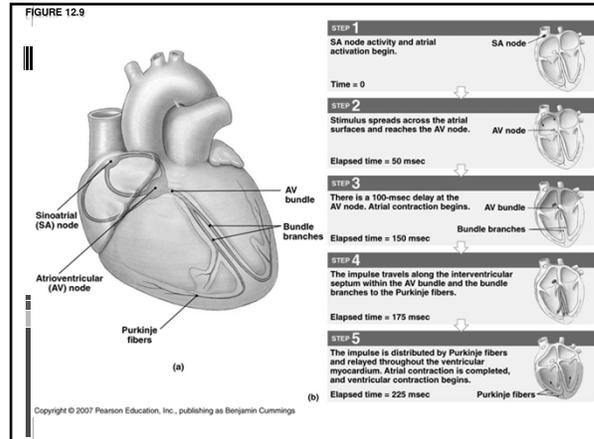
The Fibrous Skeleton

- Dense bands of connective tissue encircling bases of pulmonary trunk and aorta & valves
 - Stabilizes position of valves
 - Isolates atrial musc. tissue from ventricular musc. Tissue
 - Isolation allows for more control of contraction timing



The Heartbeat

- Contractile cells
 - Produce contraction
- Noncontractile cells
 - Control and coordinate actions of contractile cells
 - Ex: Pacemaker cells
- Electrocardiogram (ECG or EKG)
 - Record of electrical events in the heart



Control of Cardiac Output

- Blood Volume Reflexes
 - **Atrial reflex:** adjusts heart rate based on how much blood is coming in thru veins
 - **Filling time:** amt. of blood pumped out depts on amt. of time blood can flow into ventricles (heart rate dependent)
- Autonomic Innervation
 - ACh (parasympathetic/lowers HR)
 - NE (sympathetic/increases HR)
 - E (sympathetic/sustains increased HR)
 - Also, ACh, NE, E affect force of contractions and therefore SV

Control of Cardiac Output

- Cardiac ctr. of medulla oblongata
 - Control of symp/parasymp motor neurons (respond to sensory info like decline in BP or increase in CO₂ levels)
- Higher centers influencing Cardiac Centers
 - Changes in emotional state...rage, fear, arousal...affect HR
- Hormones