Cardiovascular System

Major Function of the Cardiovascular System

Transportation

Structures of the Cardiovascular System

- Heart
  - muscular pump
- Blood vessels
  - network of tubes
- Blood
  - liquid transport vehicle
Heart

- Size
- Weight
- Location

Anatomy of the Heart

- Covering
  - Pericardium - double connective tissue sac
- Wall
  - Epicardium - external layer
  - Myocardium - thick bundles of cardiac muscle
  - Endocardium - thin lining of heart chambers

External Heart Anatomy

- brachiocephalic trunk
- superior vena cava
- right pulmonary arteries
- right pulmonary veins
- right atrium
- right coronary artery
- right ventricle
- inferior vena cava
- left common carotid artery
- left subclavian artery
- aorta
- left pulmonary arteries
- pulmonary trunk
- left pulmonary veins
- left atrium
- left cardiac vein
- left ventricle
Chambers of the Heart

- Four chambers
  - lined with endocardium
  - 2 atria - right atrium & left atrium
    - superior receiving chambers
  - 2 ventricles - right ventricle & left ventricle
    - inferior discharging chambers

Path of Blood Through Heart

- Oxygenated blood to body
- Deoxygenated blood to lungs
- Oxygenated blood from lungs
- Deoxygenated blood from body
Heart is a Double Pump

- **Pulmonary circulation**
  - Right side of heart pumps blood to lungs
    - returns to left atrium
  - Systemic circulation
    - Left side of heart pumps blood to all body organs
    - Returns to right atrium

Heart Valves

- **Function:**
  - allow blood to flow in only one direction through heart chambers
- **Atrioventricular valves**
  - between atria and ventricles on each side
- **Semilunar valves**
  - base of arteries leaving ventricles
- **Sounds**
- **Sequence of operation**

Internal View of Heart

- right atrium
- atrioventricular (tricuspid) valve
- right ventricle
- left atrium
- semilunar valves
- atrioventricular (mitral) valve
- left ventricle
Conduction System of the Heart

- Sinoatrial (SA) node
  - Located in right atrium
- Atrioventricular (AV) node
  - Located at junction of atria & ventricles
- Atrioventricular (AV) bundle (of His)
  - Located in interventricular septum
- Purkinje fibers
  - Within muscles of ventricle walls

Cardiac Cycle

- One complete heartbeat
  - Both atria & ventricles contract and then relax
- Length of cardiac cycle = 0.8 second
  - Average heart beats 75 times per minute
- Both atria contract simultaneously
- Both ventricles contract simultaneously
  - Systole - ventricles contract, blood pressure increases
  - Diastole - ventricles relax, blood pressure decreases
Heart Sounds
Made during each cardiac cycle
- “lub-dup” sound
- “lub”
  - Sound caused by closing of AV valves
- “dup”
  - Sound caused by closing of semilunar valves

Regulation of Heart Rate
- Pacemaker <SA node> controls heart rate
- Other factors that can modify heart rate
  - During stress - sympathetic nervous system
  - Hormones
    - epinephrine & thyroxine - increases heart rate
  - Age, gender, exercise, and body temperature
Blood Vessels

- Arteries - take away blood from the heart
  - Arterioles - small arteries
- Veins - return blood to the heart
  - Venules - small veins
- Capillaries - connect arteries and veins
  - exchange

Anatomy of Blood Vessels

- Tunica interna
  - Innermost layer - single layer of endothelium
    - squamous epithelial cells
- Tunica media
  - Middle layer - mostly smooth muscle and elastic tissue
- Tunica externa
  - Outermost layer - mostly fibrous connective tissue
Structural Differences between Arteries and Veins

Veins have:
- thinner walls
- tunica media
- larger lumen
- valves
Venous Blood Flow

Problems:
- Low venous blood pressure
- gravity

Solutions:
- larger lumen
- valves
- milking activity
  - skeletal muscle
  - respiratory pump

Anatomy of Capillary Bed

Exchange Across Capillary Wall

blood pressure = 40 mm Hg
- osmotic pressure = 25 mm
  - net blood pressure = 15 mm

osmotic pressure = 25 mm Hg
- blood pressure = 10 mm
  - net osmotic pressure = 15 mm
Capillary Exchange

- Direct diffusion
- Vesicles - endocytosis & exocytosis
- Diffusion through intercellular clefts
- Diffusion through pores

Circulatory System (Major Arteries)

- Carotid artery
- Subclavian artery
- Pulmonary artery
- Aorta
- Mesenteric artery
- Common iliac artery
- Renal artery
- Femoral artery

Major Arteries

Pulmonary artery

Aorta

- Ascending aorta
  - Coronary arteries
  - Brachiocephalic artery
  - Left common carotid artery
  - Left subclavian artery
- Descending aorta
  - Hepatic artery
  - Renal artery
Circulatory System (Major Veins)

jugular vein
superior vena cava
inferior vena cava
common iliac vein
subclavian vein
renal vein
mesenteric vein
femoral vein
great saphenous vein

Major Veins

Most deep veins follow course of companion artery
- often named for body region or organ served (arteries)

- Superior Vena Cava
  - Jugular vein
- Inferior Vena Cava
  - Hepatic vein
  - Renal vein

View of Coronary Arteries and Cardiac Veins

superior vena cava
aorta
pulmonary trunk
right cardiac vein
right coronary artery
inferior vena cava
left coronary artery
left cardiac vein
Physiology of Circulation

4 Vital Signs

1. Arterial pulse
2. Blood pressure
3. Respiratory rate
4. Body temperature

Arterial Pulse

Pulse
- caused by alternating expansion and recoil of an artery
- occurs with each beat of left ventricle
  - travels throughout arterial system
- Pulse rate
  - pulse rate = heart rate

Blood Pressure

The pressure the blood exerts against the inner walls of the blood vessels
- Force that keeps blood circulating between heartbeats
- Decreases further along pathway
  - at vena cavae
“Normal” Blood Pressure

“Normal” Adults
Systolic 140-110
Diastolic 80-75

BP varies with:
- age
- weight
- race
- mood, etc

Variations in Blood Pressure

- Hypotension
  - Systolic blood pressure below 100 mm Hg
- Hypertension
  - Sustained elevated arterial pressure of 140/90 mm Hg

Blood Pressure Check

Sphygmomanometer

column of mercury indicating pressure in mm Hg
inflatable rubber cuff

squeezael bulb inflates cuff with air

sounds are heard with stethoscope

artery

air valve
**Sphygmomanometer Readings**

- **Auscultatory Method**
  - BP measured at brachial artery
  - No sounds (artery is closed)
  - Sounds heard (artery is opening and closing)
  - No sounds (artery is open)

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**Plaque**

- Smooth muscle cells
- Lumen of vessel
- Ulceration
- Endothelium
- Cholesterol crystals
- Fat

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**Atherosclerosis**

- **Narrowing of BV lumen** (clogging)
  - Inner wall of BV thickens and protrudes into lumen

**Causes:**

- Endothelial damage
- Platelets stick
- Chemicals from damaged endothelium
  - Fatty plaque
Arteriosclerosis 1

- Loss of elasticity of BV walls
  - “hardening of the arteries”
- End stage of atherosclerosis

Physiology:
- Plaques hinder movement of nutrients from blood to outer BV walls
  - Smooth muscle of tunica media dies
  - Elastic fibers of tunica media deteriorate
  - Replaced by inflexible (hard) scar tissue

Arteriosclerosis 2

Due to loss of elasticity:
- Arterial walls fray and ulcerate
- Potential for thrombus/embolus formation
  - heart attack
  - stroke
  - kidney failure
- Blood pressure increases

Twins organization saddened by death of Kirby Puckett

By Kelly Thesier / MLB.com 03/06/2006 8:04 PM ET

FORT MYERS, Fla.-- Hall of Fame outfielder Kirby Puckett, 45, one of the most beloved players to ever don a Twins uniform, passed away this afternoon due to complications resulting from a stroke, suffered on Sunday (March 5) morning at his Scottsdale, Ariz., home.

Puckett had surgery to drain blood and relieve pressure resulting from bleeding in the brain, the Star-Tribune of Minneapolis reported.

The Twins' first-round draft pick in 1982, Puckett spent 12 years in Minnesota before his career was cut short in 1996 when glaucoma caused him to lose sight in his right eye. He was a first ballot Hall of Fame inductee in 2001.

There had been concerns for Puckett’s health over the past few years. The former slugger continued to put on weight since retiring. The weight gain was especially alarming considering Puckett’s family history of heart disease. The player has lost many of his family members before the age of 50 to various health problems.

Kirby Puckett, who led the Minnesota Twins to World Series titles in 1987 and 1991, wished to be an organ donor.
Coronary Bypass Operation

grafted veins

blocked vessels

The End