Chapter 13-Cardiovascular System

http://www2.nbc17.com/lifestyles/2012/jan/24/north-carolina-boy-makes-heart-history-duke-ar-1848342/
I. Structure of the Heart

A. Coverings of the heart *Peri=*  
   1. **fibrous pericardium** - outer, though, protective sac composed largely of white fibrous connective tissue  
   2. **visceral pericardium** (epicardium) - inner layer covering the heart *shrinkwrap*  
   3. **parietal pericardium** - inner lining of fibrous pericardium  
   4. **pericardial cavity** - between parietal and visceral pericardium, contains serous fluid to reduce friction between membranes as the heart moves

Functions to *move blood* between body cells and organs of integumentary, digestive, and urinary systems.
B. Wall of the heart

1. **outer epicardium**- (visceral pericardium) functions as a protective layer
2. **middle myocardium**- thick, composed of cardiac muscle, functions to force blood out of heart chambers
3. **inner endocardium**- epithelium and connective tissue with many elastic and collagenous fibers (include purkinje fibers- function discussed later)
C. Heart Chambers and Valves

- 4 chambers
  - 2 atria: Upper receiving chambers. Thin walls
  - 2 ventricles: lower pumping chambers. Thick walls

A-V valves between

Semilunar valves prevent backflow into ventricles

Vena cava: Inferior and superior. Large veins that empty into the right atrium. The coronary sinus also empties into the right atrium.
D. Path of the blood through the heart
1. Superior and inferior vena cavae
2.
3.
4.
5.
6.
7.
8. Lungs
9.
10.
11.
12.
13.
14.
15. Body
D. Path of the blood through the heart
1. Superior and inferior vena cavae
2. Right atrium
3. Tricuspid valve
4. Right ventricle
5. Pulmonary trunk
6. Pulmonary semilunar valve
7. Pulmonary arteries
8. Lungs
9. Pulmonary veins
10. Left atrium
11. Bicuspid (mitral) valve
12. Left ventricle
13. Aorta
14. Aortic semilunar valve
15. Body
Pathways of Blood

• The ___1___ and ___2___ bring deoxygenated blood from the body to the heart. This blood enters the ___3___ of the heart. From there it is pumped through the ___4___ valve and into the ___5___. From there it is pumped into the lungs by way of the ___6___ which branches into smaller ___7___. Once oxygenated in the lungs, the blood returns to the heart by way of the right and left ___8___. These vessels deliver blood to the ___9___ of the heart. Upon contraction of this chamber blood will be sent through the ___10___ valve and into the ___11___. This muscular chamber will send blood out to the body via the ___12___. When the ventricles relax, blood does not flow back into the heart because the ___13___ valves close, ensuring unidirectional flow.
E. Blood supply to the heart

1. left and right coronary arteries- 1st two branches of aorta *branch directly into capillaries*

2. cardiac veins collect blood from capillaries and join to form *coronary sinus* which returns the blood to the right atrium
Ischemia = lack of oxygen
II. Actions of the heart
A. 1 Cardiac Cycle

_Atria contract while the ventricles relax_

_And_

_The ventricles contract while the atria relax_

_Contraction= systole_

_Relaxation= diastole_
II. Actions of the heart

A. 1 Cardiac Cycle

Atria contract while the ventricles relax
And
The ventricles contract while the atria relax

Contraction = systole
Relaxation = diastole

B. Heart Sounds-
sounds produced by blood flow and mostly the opening and closing of the valves

1. lub- ventricles contract
   A-V valves close

2. dub- (dup) ventricles relax
   Semilunar valves close
C. Cardiac Muscle Fibers- *act like nerve fibers*

-interconnected networks that spread in all directions through the heart, stimulation of any fiber will send an impulse in all directions

-**functional syncytium**- a mass of merging cells that act as a unit (2 in the heart)

one in the atrial walls- *atrial syncytium*

one in the ventricle walls- *ventricular syncytium*
D. Cardiac Conduction System

clumps and strands of specialized cardiac muscle tissue that functions to initiate and distribute impulses
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- S-A node
- A-v node
- Bundle of His
- Purkinje fibers
1. Sinoatrial Node

- Self-excitatory - Myogenic
- Initiate impulse in atria (atrial syncytium)
- Rhythmic – one impulse after another. 70-80x/min
- Pacemaker
- Wave does not spread into ventricles (they’re insulated)
- Contraction forces blood into the ventricles

2. Atrioventricular Node

- Impulse passes into A-V node, provides only normal conduction between atrial and ventricular syncytia
- Impulse is delayed b/c fibers are small. Gives time for atria to empty
- Impulse travels down bundles of His and continues on Purkinje fibers
- When impulse reaches the ends of the Purkinje fibers the cells around them contract
- Contraction starts at the bottom and moves upward
- Forces blood into arteries
E. Electrocardiogram

- A recording of the electrical changes that occur in the myocardium during a cardiac cycle (changes result from depolarization and repolarization of muscle fibers during contraction)

P wave - depolarization of atria (for contraction)

QRS - depolarization of ventricles (for contraction)

T wave - repolarization of ventricles

No wave seen for repolarization of atria, covered up by depolarization of ventricles
F. Regulation of Cardiac Cycle

**CAC** – cardioaccelerator center
- sympathetic nervous system
- secretes *norepinephrine*
Increases rate and force of myocardial contractions

**CIC** – cardioinhibitory center
- parasympathetic nervous system
- secretes *acetylcholine*
Impose a braking action on the heart
Factors Influencing Cardiac Center

1. **Pressoreceptors** (baroreceptors) – stretch receptors in arteries that detect changes in blood pressure
2. Impulses from **cerebrum** (thinking) or hypothalamus (fainting, anxiety, etc.)
3. **Temperature change** – temp. increase, heart rate increase; temp. decrease, heart rate decrease
4. Presence of **ions**
   - Excess of K+ - heart rate decrease
   - Low of K+ - heart rate increase
   - Excess of Ca++ - heart rate increase
   - Low Ca++ - heart rate decrease
• Review with a partner:
• Name the pacemaker.
• What are Purkinje fibers and the AV bundle (bundle of His)?
• What is an SA node?
• How do the CAC and CIC affect heart rate?
• Name 4 other factors that affect heart rate.
• On an electrocardiogram what does the P wave represent?
III. Blood Vessels

Vessels named according to the direction in which they carry blood.
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Vessels:
- **artery**
- **venule**
- **Capillary bed**
- **arteriole**
- **veins**
III. Blood Vessels

Vessels named according to the direction in which they carry blood:

- Artery
- Arteriole
- Venule
- Capillary bed
- Veins
- Precapillary sphincters
- Valves

O₂, H₂O, nutrients, hormones, electrolytes, CO₂, wastes
A. Arteries and Arterioles

**ARTERY WALLS** – 3 layers

1. Inner simple squamous epithelium (endothelium) with a connective tissue membrane
2. Middle smooth muscle fibers and a thick layer of elastic connective tissue
3. Outer thin layer of connective tissue (elastic and collagenous fibers)

**Vasoconstriction** – nerve fibers from sympathetic division cause smooth muscle to contract and reduce diameter of vessels

**Vasodilation** – nerve impulses inhibited, smooth muscle relaxes and diameter of vessels increase

**ARTERIOLES** – walls have 3 layers but they get thinner and thinner as they approach capillaries
Extra info- add in where you have room

- Atherosclerosis- plaque in arteries
- Arteriosclerosis- hardening of the arteries
B. Capillaries – smallest blood vessels

1. Walls – a single layer of squamous epithelium *one cell thick*

2. Some tissues have more capillaries b/c they need more oxygen and food  
   *muscles vs cartilage vs cornea*

1. Patterns of capillary arrangement- special branching allows blood to follow different pathways; some cells need more nutrients at special times *capillaries lie in beds*

2. Precapillary sphincters-regulate distribution of blood *opens and closes beds when needed*
Exchanges in capillaries

- **Diffusion**: molecules move from an area of high concentration to an area of low concentration
- **Filtration**: large molecules are pushed through pores by blood pressure (hydrostatic pressure)
- Pressure drops as you move away from the heart so filtration occurs more at the arteriole ends of the capillaries
- **Osmosis**: water moves from high pressure to low pressure across a semi-permeable membrane. Water is forced out of the blood vessels into the tissues at the arteriole end of capillaries. Some water is returned to the blood at the venule end of the capillaries
- *** more water leaves the capillaries than is returned to the capillaries. The excess fluid is collected by lymphatic vessels and returned to the blood stream.
Capillary Exchange

- Blood pressure = 40 mm Hg
- Osmotic pressure = 25 mm
- Net blood pressure = 15 mm

Water (H₂O)
Oxygen (O₂)
Glucose (C₆H₁₂O₆)
Carbon dioxide (CO₂)
Amino acids

From arteriole to venule:

Red blood cell
Plasma proteins
Tissue cell
Waste molecules
D. Venules and veins

1. Walls: 3 layers - same as arteries, but they are much thinner and contain less elastic tissue and smooth muscle.

2. Valves: usually 2 leaflets.

3. Contain 70% of blood volume.

4. Functions as blood reservoirs: sympathetic nerve impulses cause smooth muscle to contract, decreasing diameter of venules and veins thereby raising blood pressure and ensuring a nearly normal blood flow even when as much as 25% blood volume is lost.
Article: What’s that noise in her?

• When you have finished reading the article you should be able to tell me:
  – What was causing the noise?!! Where was the source of the noise?
  – How was it diagnosed?
  – Why did the doctor question what he was hearing?
  – What could have happened if the condition was not corrected?

Any other lessons to be learned here?
Any questions?
IV. Blood Pressure- Average blood pressure is 120/80. It is a measure of the force of blood against the arterial walls

- A. Arterial Blood Pressure
  - Systolic Pressure- ventricles contract filling arteries with blood. The elastic walls swell and the pressure rises (120)
  - Diastolic Pressure- ventricles relax and the arteries relax therefore blood pressure falls (80)
  - Pulse- the expansion and contraction of artery walls
How much blood does your heart pump in a minute?

• Heart rate (pulse)________/min
• Avg. of 80ml with each pump

• Ml/minute at rest=

  80 ml/ beat X 72 beats/ min = 5560ml = 5.56 L
B. Factors that Influence Arterial Blood Pressure

1. heart action
2. blood volume
3. peripheral resistance
4. viscosity
5. Vessel diameter
B. Factors that Influence Arterial Blood Pressure

• 1. heart action
• Stroke volume - volume of blood discharged from the ventricle with each contraction
• Cardiac output - volume discharged from the ventricle with each minute

\[ \text{Cardiac output} = \text{stroke volume} \times \text{pulse} \]

• 2. blood volume - blood pressure is directly proportional to volume of blood
• Changes in blood volume are accompanied by changes in blood pressure
• Ex: salty foods \(\rightarrow\) water retention \(\rightarrow\) \(\uparrow\) in blood pressure
• 3. peripheral resistance
• 4. viscosity
• 5. Vessel diameter
B. Factors that Influence Arterial Blood Pressure

1. heart action
2. blood volume- blood pressure is directly proportional to volume of blood
3. Changes in blood volume are accompanied by changes in blood pressure
   Ex: salty foods → water retention → ↑ in blood pressure
4. peripheral resistance friction between blood and walls of the blood vessels hinders blood flow. Example: plaque
5. viscosity- a fluid with high viscosity tends to be thick like syrup, a fluid with low viscosity flows easily like water
6. Vessel diameter- the larger the vessel lumen the lower the blood pressure. Nicotine in cigarettes causes vasoconstriction. Cholesterol also causes a smaller lumen

Add in
C. Venus Blood Flow - due to low blood pressure the veins need help in returning blood to the heart

3 methods

1. Muscle pump
2. Respiratory movements
3. Vasoconstriction
C. Venus Blood Flow- due to low blood pressure the veins need help in returning blood to the heart

3 methods

1. **Muscle pump**- during contraction skeletal muscles squeeze veins. The blood cannot move backwards due to the valves so it will move forward toward the heart.

2. **Respiratory movements**- inhalation- diaphragm presses downward on the abdominal viscera squeezing blood out of abdominal veins and into thoracic veins

3. **Vasoconstriction**- low blood pressure in veins causes the sympathetic division to stimulate smooth muscle to contract and raise blood pressure. This forces blood towards the heart.
Getting Your Blood Pressure:

1. Put cuff on your upper left arm
2. Inflate cuff no higher than 180
3. Wait for it to give you a reading

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<thead>
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<th>Systolic (mm Hg)</th>
<th>Diastolic (mm Hg)</th>
<th>Blood Pressure Range</th>
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<td>High / Normal Blood Pressure</td>
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<td>40</td>
<td>Too Low Blood Pressure</td>
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<td>50</td>
<td>33</td>
<td>Dangerously Low Blood Pressure</td>
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What is the Average Blood Pressure Range for Your Age?

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• What Causes Hypertension?
• Most blood pressure doesn't have a cause and is called essential or primary hypertension. In cases where the cause of high blood pressure is known (called secondary hypertension), it is usually the result of kidney problems, hormonal disorders, abnormalities of the aorta (the main artery that carries oxygenated blood to the body), or a narrowing of certain smaller arteries. Doctors screen teens with high blood pressure for secondary causes with physical examination and laboratory testing.
• Some teens may inherit the tendency toward higher blood pressure from one or both parents. Although hypertension often runs in families, some people with a strong family history of high blood pressure may never develop it.
• Kids and teens who are obese are at a higher risk for hypertension. Lack of exercise makes it easier to become overweight and increases the chance of high blood pressure. People who drink a lot of alcohol or take illegal drugs like amphetamines and cocaine are also at risk of developing the condition. In some cases, medications like steroids or birth control pills can cause high blood pressure.
How Do Doctors Diagnose High Blood Pressure?

For most teens, the only way to know if you have high blood pressure is to get your blood pressure checked. It's painless and fast.

A single reading showing high blood pressure doesn't necessarily mean that you have hypertension, but it is an indication that it should be watched carefully. Some people have what's called "white coat hypertension," meaning that their blood pressure rises at a doctor's office because they are anxious. When they feel more relaxed, their blood pressure usually decreases. Ambulatory blood pressure monitoring, a test where your blood pressure is measured over a whole day, helps in separating white coat hypertension from true hypertension.

Someone may need to get his or her blood pressure checked several times over a period of days or weeks to determine if they have hypertension. A doctor should recommend how to go about this.

Doctors usually ask for the following information to help determine what might cause someone's high blood pressure:

- a complete medical history, including questions about a person's present and past health and the health of family members
- whether that person is taking any medications
- whether that person smokes or drinks alcohol
- eating and exercise habits
- The doctor will probably take weight and height measurements, and might perform urine or blood tests to check for other physical problems, such as a kidney problem or a thyroid disorder that sometimes can be the underlying cause of high blood pressure. A doctor may also test for high blood cholesterol and other conditions that can increase someone's risk for developing heart disease or stroke.
V. Paths of Circulation

1. Pulmonary circuit - To lungs

2. Systemic circuit - to body
V. Paths of Circulation

3. Fetal circulation:
   • Blood goes from the right atrium to the left atrium through the foramen ovale
   • The ductus arteriosus connects the pulmonary artery to the aorta
V. Paths of Circulation

4. The Circle of Willis (cerebral arterial circle) is a vital route of blood vessels in the brain that helps to ensure oxygenation in the brain.