The Cardiovascular System
Part # 1

Fall 2008
Function

- To provide blood rich in nutrients, oxygen, electrolytes, vitamins and minerals to cells
- To carry waste away to be eliminated
- Type of waste?
- Urea to kidneys, CO2 to lungs
- To exchange Oxygenated (O2) blood for deoxygenated (CO2) blood
Vessels

- Arteries: carry blood away from a reference point - Heart
  - Usually oxygenated
  - Two exceptions – one is?
  - Symbolized with red
- Veins: carry blood to reference point - Heart; contain valves; why?
  - Usually deoxygenated
  - Two exceptions – one is?
  - Symbolized with blue
- Capillaries: form an intricate network throughout the body for the interchange of various substances, between blood and tissue cells; single cell layer thick
  - How does the exchange take place?
Chambers of the Heart

- Four chambered heart
- Two upper chambers called atria (atrium) covered by flaps called auricles
- Two lower chambers called ventricles
- Septum (Septa) “wall” separates the chambers
- Interatrial septum?
- Interventricular septum?
- Atrioventricular septum?
Circulation Pathways

- Two circulation pathways
  
  **A. Pulmonary** = lungs
  Blood pumped from right side of heart to lungs (drops off CO2, picks up O2) and back to the left side of heart

  **B. Systemic** = body systems
  Blood pumped from left side of heart out to the body (drops off O2, picks up CO2) and back to the right side of heart
Valves of the Heart

• **Type 1: Flap Valves**
  • Found between the atria and ventricles
    – Atrio-Ventricular Valve (AV valves)
  • A. Right side: **Tricuspid Valve** – 3 flaps
  • B. Left side: **Bicuspid Valve (Mitral Valve)** – 2 flaps

• Prevent backflow of blood from ventricles into atria when ventricles contract
• Held together by strings attached to bumps of muscle
  – Strings- **Chordae Tendinae**
  – Muscles- **Papillary muscles**
Chordae Tendinae and Papillary Muscle
Valves Viewed from Top
Valves of the Heart

- **Type 2: Semilunar Valves**
  - Found at the base of two major arteries leaving the heart
  - Shaped like “half moons”
  - Catch the blood that is pulled back by gravity
  - A. Right side: base of pulmonary artery headed to lungs – pulmonary semilunar
  - B. Left side: base of aorta headed to body – aortic semilunar
Semilunar Valves
Valves Viewed from Top
Blood Flow Pathway

1. Superior/Inferior Vena Cava
2. Right atrium
3. Through Tricuspid Valve
4. Right Ventricle
5. Through Pulmonary Semi-lunar valve
6. Pulmonary trunk (artery)* branches into
7. Pulmonary arteries*- travel to both lungs
8. Branch into smaller arteries*
9. Branch into “baby” arteries (arterioles)*
10. Branch into capillaries – inside lungs (loss of CO2)

* Are these arteries the typical color?
Blood Flow Pathway

11. Pick up O2 into capillaries
12. Merge into “baby” veins called venules*
13. Merge into small veins*
14. Merge into pulmonary veins*
   * Are these veins the typical color?
15. Dump into left atrium
16. Through Bicuspid Valve
17. Into left ventricle
18. Through aortic semi-lunar valve
19. Into aorta
20. Out to systemic circulation to the body
Capillary Gas Exchange
Pulmonary and Systemic Circulation

The systemic circuit delivers oxygen to all body cells and carries away wastes.

The pulmonary circuit eliminates carbon dioxide via the lungs and oxygenates the blood.

Oxygenated blood returns to heart via pulmonary veins.

Deoxygenated blood returns to heart via venae cavae.
Circulation

AO = Aorta
PA = Pulmonary Artery
LA = Left Atrium
RA = Right Atrium
LV = Left Ventricle
RV = Right Ventricle

Oxygen-rich Blood

Oxygen-poor Blood
Major Arteries

Right common carotid a.
Left common carotid a
Right subclavian a.
Left subclavian a.
Brachiocephalic a.
Aortic arch
Ascending aorta
Right coronary a.
Left coronary a.
Abdominal aorta
Left gastric a.
Splenic a.
Celiac a.
Hepatic a.
Right gastric a.
Suprarenal a.
Right renal a.
Gonadal a.
Superior mesenteric a
Lumbar a.
Inferior mesenteric a.
Middle sacral a.
Left common iliac a.
Aortic Arch
Systemic Blood Flow Pathway

Aorta- 3 arteries branch off of Aortic Arch headed upward
A. Left Subclavian – goes under collarbone (clavicle) to left arm
B. Left Carotid – up to left side of brain
C. Brachiocephalic – (“arm/head”) Alternative name: Innominate artery
   Branches into:
   I. Right Carotid – up to right side of brain
   II. Right Subclavian – under collarbone to right arm
Aortic arch curves downward with two portions
Thoracic and Abdominal – in respective cavities
Branch into smaller arteries – ex. Hepatic? Gastric? Renal?
Branch into “baby” arteries- arterioles
Branch into capillaries inside the organs and muscles (loss of O2)
Gain of CO2 from organs and muscles
Merge into “baby” veins- venules
Merge into smaller veins exiting the organs and muscles – ex. Gastric? Renal?
   Superior mesenteric?
Merge into superior/inferior vena cavae
Two large veins drain the arm/head – names?
Rt. And Left Brachiocephalic
Major Arteries

- Right common carotid a.
- Left common carotid a.
- Right subclavian a.
- Left subclavian a.
- Brachiocephalic a.
- Aortic arch
- Ascending aorta
- Right coronary a.
- Left coronary a.
- Abdominal aorta
- Left gastric a.
- Splenic a.
- Celiac a.
- Hepatic a.
- Right gastric a.
- Splanic a.
- Suprarenal a.
- Superior mesenteric a.
- Right renal a.
- Lumbar a.
- Gonadal a.
- Inferior mesenteric a.
- Middle sacral a.
- Left common iliac a.
- Right common iliac a.
Systemic Circulation

- cranial vena cava
- caudal vena cava
- hepatic portal vein
- liver
- intestines
- kidneys
- hindlegs & tail
- aorta
- head & forelimbs
- lung
- Alveolar capillaries
- Systemic capillaries
- Tissue cells
- Pulmonary veins
- Pulmonary capillaries
- Alveolus
- Right atrium
- Tricuspid valve
- Pulmonary valve
- Right ventricle
- Inferior vena cava
- Left atrium
- Mitral valve
- Left ventricle
- Aortic valve
- Aorta
- Systemic capillaries
- Tissue cells
Aortic Arch Differences in the Pig

• Only 2 branches
• 1. Left Subclavian – goes where?
• 2. Right brachiocephalic – goes where?
  – Branches into:
  – Right subclavian – Goes where?
  – Right carotid – Goes where?
  – Left carotid - Goes where?
Major Veins from the Upper Body

Rt. And Left
Brachiocephalic

Jugular Veins
drain into these
from brain

Subclavian Veins
drain into these
from the arms
Heart Beat Sequence and Sounds

- Two part heart beat
- Two atria fill at the same time
- Contract and blood flows into both ventricles
- A-V Valves close = “lub” sound
- Two ventricles contract at the same time
- Blood flows into pulmonary and aortic arteries
- Semi-lunar valves close = “dub” sound
- Heart murmur = “leaky” valve

Mitral Regurgitation - Sound
“Exceptional” Veins and Arteries

- **Pulmonary arteries** - carry blood from the heart (right ventricle) to the lungs
  - Carry deoxygenated blood

- **Pulmonary veins** - carry oxygen-rich blood from the lungs to the left atrium of the heart
  - Carry oxygenated blood.

What are the other two exceptions we know?

Umbilical arteries and vein
Cardiovascular System
Part # 2
Review of Fetal System

- Umbilical Cord contains blood vessels:
  - Arteries transport deoxygenated blood away from the fetal system to the placenta
  - Vein transports oxygenated blood to the fetal system from the placenta
  - Allantoic duct used to be used to carry waste out to sac for storage; collapsed and vestigial
  - 2 umbilical arteries and 1 umbilical vein
Fetal Blood Characteristic

- Oxygenated fetal blood enters the body thru the umbilical vein and enters the liver
- Blood that was oxygenated leaves fetal liver and joins the inferior vena cava to enter the right atrium of heart
- Result?
- Mixing of oxygenated and deoxygenated blood
- Why can the fetus survive this?
Unique Fetal Cardiovascular Structures –
Goal: Blood Skips Fetal Lungs

- Why skip the lungs?
- A. **Foramen Ovale** – hole like flap between two atria
- Allows blood to move from right atrium to left atrium
- Skips right ventricle and pulmonary artery
- Instead goes directly to left ventricle and out to body
- Seals shortly before/after birth
- Patent Foramen Ovale – fails to close after birth
- What would be the effect of this?
- May need to be surgically repaired
Foramen Ovale
• B. Ductus Arteriosus
• What if some blood goes from Rt. Atrium into the Rt. Ventricle anyway?
• Blood is pumped up and out pulmonary trunk headed to lungs
• Instead, enters Ductus Arteriosus
• Temporary “bridge” vessel linking the pulmonary artery to the aorta
• Blood “jumps” over to aorta
• Seals shortly before/after birth
Ductus Arteriosus
Fetal Circulation Summary
Fetal Circulation Changes and Birth

- Umbilical cord is cut, inverted to form navel
- 1. Foramen Ovale seals
- 2. Ductus Arteriosus seals off
- Result of both?
- Blood travels to the lungs; not mixed
- How do we duplicate the liver functions with blood related to toxins and glucose storage?
Hepatic Portal System

- Special blood flow system that takes blood from digestive organs to the liver before it enters the heart to be pumped to the body
- What organs should it drain?
  - Stomach, Intestines, Spleen, Pancreas
- Liver can detoxify
- Can also store glucose as glycogen
Hepatic Portal System
Hepatic Portal System
Hepatic Portal System
Coronary Vessels

- Left coronary artery
- Right coronary artery
- Anterior interventricular artery
Coronary Circulation

Heart muscle receives blood to “feed” itself through 2 coronary arteries that branch off aortic semilunar valve.
Cardiac/Coronary Veins
Cardiovascular Conditions

• Thrombo- clot
  – Thrombocytes - platelets

• Coronary Thrombosis
  – Atherosclerosis = cholesterol/ fatty plaque with calcium deposits
  – Platelets attracted to “roughness”
  – Clot forms in a coronary artery
  – May lead to myocardial infarction
  – Heart muscle/tissue death
  – Heart attack
Heart Attack Symptoms?

• Due to **ischemia** = restricted blood flow
• If to heart muscle leads to: **Angina Pectoris** – squeezing chest pain
• Can occur prior to a heart attack; “warning sign”
• May radiate down left arm
• Shortness of breath
Diagnosis of Coronary Blockage

Angiogram

• Enter the coronary vessels
  • Usually via femoral or subclavian artery
  • Inject dye and watch for blockage
Angioplasty and Stents

- Often follows an angiogram
- Insert a small catheter
- Inflate a “balloon” to compress plaque and widen the artery
- Can insert a stent to hold it open

**Coronary Artery Angioplasty (Heart Stent)**

[Diagram of angioplasty and stent placement]
Coronary Bypass

- Major surgery
- Heart usually shocked to stop it
- Remove a piece of a leg vein called Great Saphenous
- Must turn upside down; why?
- Sew in a “detour” around the blockage in one or more places
- Heart shocked again to restart
Major Veins from the Upper Body

- External jugular v.
- Subclavian v.
- Superior vena cava
- Inferior vena cava
- Arterial v.
- Hepatic v.
- Interosseus v.
- Median cubital v.
- Radial v.
- Renal v.
- Ulnar v.
- Common iliac v.
- External iliac v.
- Femoral v.
- Great saphenous v.
- Popliteal v.
- Posterior tibial v.
- Small saphenous v.
- Anterior tibial v.
More Cardiac Bypass

- Heart below has three “detour” vessels
- Called what?

Coronary Artery Bypass
Conference: Stroke

- Interruption of blood flow to the brain
- Causes:
  A. Ischemic = blockage of flow due to clot in a major vessel – ie. carotid
  B. Hemorrhagic = loss of flow due to rupture of a major brain vessel
- Similar symptoms – speech problems, paralysis – often unilateral, loss of memory
- Can be fatal; can cause long-term disability
- Can recover “somewhat” through therapy – brain “rewires” itself
- Importance of rapid diagnosis and treatment
Contributing Factors for Strokes

- Atherosclerosis
- Smoking
- Some medications – ex. Older women taking birth control pills
- Heart arrhythmias ex. Atrial Fibrillation (A-fib)
Possible Stroke Diagnosis

- **FAST**
- Face – Ask to smile; drooping on one side
- Arms – Raise both; may have difficulty with one
- Speech – Ask to repeat simple sentence; may have difficulty
- **TIME!!** – Any of above – get treatment!!