CIRCULATORY SYSTEM

2.01, 2.02
2.01 Essential Questions

- What are the structures of blood?
- What are the structures of the circulatory system?
2.01 Essential Questions

Understand the functions and disorders of the circulatory system

What are the functions of blood?
What are some disorders of the blood?
How are blood disorders treated?
How do you relate the body's use of nutrients to the blood?

What are the functions of the circulatory system?
What are some disorders of the circulatory system?
How are disorders of the circulatory system treated?
How do you relate the body's use of nutrients to the circulatory system?
Hematology

Interesting facts

- Average adult - 8-10 pints
- One gtt -
  - 5 million RBCs
  - 250,000 - 500,000 platelets
  - 7,500 WBCs
- RBCs live 120 days
- Make news cells 2 million/sec
Hematology

Average adult - ? Pints of blood

Fx's:

Transport
   - Nutrients - $O_2$, cellular wastes, hormones
   - Aids distribution of heat
   - Regulates acid-base
   - Helps against infections
Hematology

Composition:
- Plasma - liquid portion of blood, no cellular components
- Serum - plasma after a blood clot is formed
- Cellular elements are RBCs, WBCs, & platelets
Hematology

Plasma - straw colored
- Water
- Bld proteins
- Plasma proteins
  - Fibrinogen - clotting
    - Synthesized in the liver
  - Albumin - maintains osmotic pressure & volume
    - From liver
  - Prothrombin - helps with bld coagulation
    - Vit K - necessary for prothrombin synthesis

Nutrients
- Electrolytes
- Hormones, vitamins, enzymes
- Metabolic waste products
Hematology

- Erythrocytes - RBC
  - Shape - biconcave
  - Hemoglobin (Hgb) - gives red color
    - Hemi - iron globin - protein
  - FX - transport $O_2$ to tissue / $CO_2$ away from cells

- Lab values - ♂ 14-18 gm; ♀ 12-16 gm
Hematology

FXs of Hgb

- RBCs → lungs $O_2$ is picked up → tissues & released, $CO_2$ picked up → lungs for exchange
- Arterial bld - ↑ $O_2$/bright red
- Venous bld - ↑ $CO_2$/ dark crimson

What is $CO_2$ poisoning????
Hematology

🧫 Erythropoiesis 😤😤

🧫 Manufactures RBCs

🧫 Where? (think of skeletal system)

🧫 Bone marrow

🧫 Live 120 days

🧫 Broken down - spleen & liver

🧫 Hemolysis - rupture/bursting of RBCs

🧫 How? Bld transfusions or disease
Hematology

**Leukocytes - WBCs**
- Larger than RBCs
- Normal count - 3,200-9,800
- 5 types
  - **Neutrophils** - immune defenses
  - **Eosinophils** - defense against parasites
  - **Basophils** - inflammatory response, produce heparin, anticoagulant
  - **Lymphocytes** - antibody production/cellular immune response
  - **Monocytes** - immune surveillance
**Hematology**

※ Phagocytosis

※ WBCs surround, engulf, digest harmful bacteria
Hematology

Diapedesis

The process when leukocytes move through the capillary wall to neighboring tissue

Inflammation

What is it?

Body’s reaction to chemical or physical trauma
Pathogenic - disease producing
S&S - redness, local heat, edema, pain

WHY??????

Bacterial toxin.↑ Bld flow, edema
Hematology

INFLAMMATION

Continue:

- **Histamine** - ↑ bld flow → injured area
- **Pus** - combination of dead tissue, dead & living bacteria, dead WBCs & plasma
- **Abscess** - pus filled cavity
- **Pyrexia** - ↑ body temp by hypothalamus, response to pathogenic invasion
- **Leukocytosis** - ↑ WBCs in response to infection
- **Leukopenia** - ↓ in WBCs to chemo or radiation
Hematology

- Thrombocytes -(Platelets)
  - Smallest of bld components
  - Synthesized in red marrow
  - Fragments of megakaryocytes, not cells
  - Needed for bld clotting process
Hematology

Phagocytosis

Process when WBCs surround, engulf & digest harmful bacteria
Blood Types - where do we get it?

What are the types of blood????

How much do you know about bld typing?

Who was the immunologist that discovered blood types?

Karl Steiner
Blood Types

Type A antigens has B antibodies
Type B antigens has A antibodies
Type AB antigens has no antibodies
Type O antigens has A & B antibodies
Hematology

What are antigens & antibodies?????

Antigen: a protein marker on the surface of a cell

Antibodies: an immunoglobulin produced by B lymphocytes in response to a unique antigen

Immunoglobulin - diverse grp plasma proteins for protection against organism
Hematology

Rh factor
- an inherited trait
- a specific protein on RBC
- called - antigen

Blood Transfusions
- must match donors for
- for Rh status & ABO bld type

Rh factor can affect pregnancy, not pt’s health
1940 Rhesus monkey study
- Bld clotted when injected into guinea pigs
Hematology

- Rh Factor
- Rh protein = Rh+
- No Rh protein = Rh−
Hematology

Erythroblastosis fetalis

- develops in an unborn infant - mother & baby have different blood types. Mom produces substances called antibodies that attack the developing baby's RBCs.

The most common form of erythroblastosis fetalis is ABO incompatibility.

- ABO incompatibility is a reaction of the immune system that occurs if two different and not compatible blood types are mixed together.

The less common form is called Rh incompatibility, which can cause very severe anemia in the baby.

- Rh incompatibility is a condition that develops when a pregnant woman has Rh-negative blood and the baby in her womb has Rh-positive blood.
• **Erythroblastosis fetalis**

• During pregnancy, RBCs from the unborn baby can cross into the mother's bloodstream via the placenta.

• If the mother is Rh-negative, her immune system treats Rh-positive fetal cells as if they were a foreign substance and makes antibodies against the fetal blood cells.

• These anti-Rh antibodies may cross back through the placenta into the developing baby and destroy the baby's circulating red blood cells.
**Hematology**

**Erythroblastosis fetalis (EF)**

- When RBCs are broken down, they make bilirubin
  - causes an infant to become jaundiced
- It takes time for the mother to develop antibodies
  - Firstborn infants are often not affected unless the mother had past miscarriages or abortions
  - That sensitized her immune system
  - All children she has afterwards who are also Rh-positive may be affected
- Rh incompatibility develops only when the mother is Rh-negative and the infant is Rh-positive
- With use of immune globulins called RhoGHAM, EF has become uncommon in the United States and other places that provide access to good prenatal care.
Hematology
Pathophysiology

Anemia

- inability of bld to carry sufficient $O_2$ from lungs to tissues

TYPES

- Aplastic - idiopathic
  - Most result from bone marrow damage - toxic chemicals, drugs, radiation

- Pernicious
  - dietary deficiency of $B_{12}$, can be fatal if not tx

- Folate-deficient anemia
  - vit deficiency of $B_9$
Hematology

Patho - continue

- Hemolytic Anemia - inherited
  - Bld disorder, characterized by abnormal types of hgb
    (hemolytic - pertaining to bld breakage)
  - Often RBCs become distorted & easily broken
    - ie: Sickle cell - severe, hereditary, sometimes fatal
  - One defective gene, Pt carry the sickle trait
  - Two genes - full blown sickle cell
  - SC & malaria - in endemic regions of malaria said to be resistant to malaria
Patho - continue

**Polycythemia** -
- Too many RBCs
- At high altitudes, less O2, ↑ thickening of bld

**Thrombus**
- Bld clot that does not move
- Condition: thrombosis

**Embolus**
- Bld clot that dislodges
- Condition - embolism

**DVT**
- Blood clot that forms in a vein deep inside a part of the body
- Mainly affects the large veins in the lower leg and thigh.
Patho – continue

- Septicemia
  - Pathogenic organism in the bld

- Hematoma
  - Localized clotted mass of bld in tissues space

- Anticoagulants
  - Bld thinners for clots – can be life long tx
  - Heparin, Coumadin – different but the same in their basic fx
Hematology

Patho - continue

👩‍⚕️ Hemophilia - inherited

👩‍⚕️ Failure of bld to clot

👨‍⚕️ Sex linked - carried on the X chromosome of the male which produces a female, thereby giving the female the disease. The male has the disease with the X chromosome. This thereby makes the female a carrier of the disease
Circulatory System

How big is your heart?
What do you know about the HEART????????

Where is it?
- thoracic cavity

Structures of the Circulatory System
Circulatory System

Can you identify the structures of the heart???

- Atria
- Ventricles
- Valves
- Aorta
- Veins
- Arteries
- Septum
- Cordae tendonae
Circulatory System

- Superior vena cava (from upper body)
- Right pulmonary arteries (to right lungs)
- Aortic valve
- Right pulmonary veins (from right lungs)
- Tricuspid valve
- Inferior vena cava (from lower body)
- Pulmonary valve
- Direction of blood flow
- Right ventricle
- Septum
- Left atrium
- Left pulmonary veins (from left lung)
- Left pulmonary arteries (to left lung)
- Mitral valve
- Left ventricle
- Aorta (body)
Anatomy

4 chambers/cavities

2 upper - atria

smaller

walls thinner

often called receiving chambers

bld enters the hrt thru veins that open into those upper cavities
Circulatory System

Blood eventually pumped from arteries to ventricles

"septum" separates atria → interatrial septum

2 lower - ventricles - discharging chambers

Septum → interventricular septum
Circulatory System

Layers of the Heart

Right atrium

Right ventricle

Left atrium

Myocardium

Endocardium

Pericardium

Left ventricle
Circulatory System

Layers of the Heart

Cardiac tissue

Myocardium

Inner lining - smooth tissue

Endocardium

Endo - inside/within; epi - upon/on

Surrounding hrt - fibrous tissue

Inner layer

Pericardium/epicardium
Circulatory System

- Superior vena cava
- Inferior vena cava
- Right atrium
- Tricuspid valve
- Right ventricle
- Septum
- Aortic semilunar valve
- Pulmonary artery
- Pulmonary vein
- Left atrium
- Bicuspid (mitral) valve
- Pulmonary semilunar valve
- Left ventricle
- Apex
Circulatory System

The 2 pumps

it first beats → atria contract simultaneously
  Called atrial systole

the ventricles fill with bld & contract → ventricle systole

Rhythmic, repetitive
  Lup dup

Abnormal hrt sounds
  Hrt murmurs
Circulatory System

Heart Sounds

Tachycardia - very fast

Normal Heart Sound

Tachycardia - fast

http://www.youtube.com/watch?v=Pes9O5z8efk&feature=player_detailpage
First heart sound → longer in duration, lower in pitch

*Cause* - AV valves closing
- Prevents blood into atria during contraction of ventricle
- Called systole
- Active phase of cardiac cycle

Second heart sound → shorter

*Caused* - semilunar valves closing
- Ventricles relax
- Called diastole
Circulatory System

Cardiac cycle
- One complete hrt beat

Stroke volume
- Amt bld ejected $\rightarrow$ ventricle/beat

Cardiac output
- vol bld pumped $\rightarrow$ ventricle/min

Valve disorders, coronary artery blockage or MI $\rightarrow$ stroke vol
Circulatory System

Types of Circulation

Coronary

- Heart - movement of blood right ventricle → lungs
- Systemic - general circ - throughout the entire body - movement of blood left ventricle → body
Circulatory System

Blood Vessels

Arteries -
- Largest bld vessels → veins → capillaries
- 3 layers
- Thick
- Elastic
- Connective tissue
- Muscular layer (most muscular)
- Endothelethial layer
- Strength required to support pressure
Coronary arteries
- Located outer surface hrt
- \( O_2 \)
- Arterioles
  - Smaller, contain highest \( O_2 \)
  - Bld pump bld away from hrt
  - Bld contain \( O_2 \) (except in the pulmonary artery)
Blood Circulation of the Heart

#1_______________________

#2_____________________________________________________

#3__________________________

#4_____________________________________________________

#5__________________________
Circulatory System

Veins
- 3 layers
- Thinner
- Muscular
- Valves prevent backflow of blood

Capillaries
- Single layer
- Suitable for gas & nutrient exchange
- Collapse easily filled with blood
Circulatory System

- Right atrium
- Tricuspid valve
- Right ventricle
- Pulmonary artery
- Lungs $O_2$ & $CO_2$ exchange
- Pulmonary veins
- Left atrium
- Mitral valve
- Left ventricle
- Aortic Valve
- Aorta
- Body
- Arteries
- Arterioles
- Capillaries $O_2$ & $CO_2$ exchange
- Venules
- Veins
- Superior/Inferior vena cava
- Right atrium
Circulatory System

Cardiac Actions

Cardiac Cycle
- Systole = contraction
- Diastole = relaxation
The cusps (flaps) of the bicuspid and tricuspid valves are anchored to the ventricle walls by fibrous “cords” called chordae tendineae, which attach to the wall by papillary muscles. This prevents the valves from being pushed up into the atria during ventricular systole.
1. Right Atrium
2. Right Atrioventricular Valve (Tricuspid Valve)
3. Right Ventricle
4. Left Atrioventricular Valve (Mitral Valve)
5. Left Atrium
6. Left Ventricle
7. Papillary Muscle
8. Chordae Tendinae
9. Mitral Valve cusps
Pathway of Cardiac Conductions

- Sinoatrial (S-A) node (pacemaker) → Junctional fibers → Atrioventricular (A-V) node → A-V bundle → Perkinje fibers
Circulatory System

Cardiac Conduction System. Figure 15.19

Interatrial septum

S-A node

A-V node

A-V bundle

Left bundle branch

Purkinje fibers

Interventricular septum
Circulatory System

Can you identify these parts?
1. Sinoatrial node (Pacemaker)
2. Atrioventricular node
3. Atrioventricular Bundle (Bundle of HIS)
4. Left & Right Bundle Branches
5. Bundle Branches (Perkinje Fibers)
Circulatory System

ECG - electrocardiogram - a recording of the electrical events during a cardiac cycle

P Wave - depolarization of the atria (atrial contraction - systole)

QRS Complex - depolarization of the ventricles (ventricular contraction, systole)

T Wave - Repolarization of the ventricles

Heart Sounds - opening and closing of the valves, flow of blood into and out of the chambers, vibrations in muscle
Pulses

- Bradycardia
  - Pulse < 60 beats/min
- Tachycardia
  - Pulse > 100 beats/min
- Arrhythmia
  - Uneven pulse rate
Circulatory System

Pulse Sites

A. Carotid
B. Radial
C. Brachial
D. Dorsalis Pedis
E. Posterior Tibial
F. Femoral
Circulatory System

Blood pressure
- is the surge of blood when heart pumps creates pressure against the walls of the arteries

SYSTOLIC PRESSURE
- Measured during the contraction phase

DIASTOLIC PRESSURE
- Measured when the ventricles are relaxed
Circulatory System

Factors affecting blood pressure:
- Average is 120/80 (higher number is the systolic pressure)
- Normal systolic = 100 - 140 mm Hg
- Normal diastolic = 60 - 90 mm Hg
Circulatory System

Pathophysiology

Aneurysm

Section of artery becomes abnormally widened due to weakening of arterial wall.
Circulatory System

- Coronary artery disease
Circulatory System

Hypertension

What is hypertension?
What factors influence the development of hypertension?
How is it treated?
Why is it called the “silent killer?”
Circulatory System

• Heart Failure
Circulatory System

- Murmurs

What is the most common instrument used to detect murmurs?
Circulatory System

Myocardial infarction

- Chest discomfort
- Arm or back discomfort
- Neck or jaw discomfort
- Trouble breathing, with or without chest discomfort
- Feeling light-headed or breaking into a cold sweat
- Feeling sick or discomfort in your stomach
Circulatory System

Peripheral vascular disease

How can PVD be prevented?
Circulatory System

Pulmonary Edema

Accumulation of fluid in the air sacs (alveoli) in the lungs
Circulatory System

Transient ischemic Attack

Thrombus lodges in the cerebral artery causing a stroke

Thrombus in the carotid artery breaks off and travels to the cerebral artery in the brain

Diseased carotid artery

Normal carotid artery

Learn these signs of stroke.

Face
Does the face look uneven? Ask the person to smile.

Arm
Does one arm drift down? Ask the person to raise both arms.

Speech
Does their speech sound strange? Ask the person to repeat a simple phrase, for example, "The sky is blue."

Time
If you observe any of these signs, it's time to call 9-1-1.

Call 9-1-1

Be a hero. Save a life.
Circulatory System

Varicose Veins

• **Prevention**
  - Wear sunscreen
  - Elevate legs when resting
  - Wear elastic support stockings
  - Eating fiber diets
  - Exercise
  - Weight control
Circulatory System

- Leading Causes of Death:
- The Impact of Circulatory Disorders
Circulatory System

Relevance of nutrients to the blood and circulatory system
The circulatory system plays a vital role in homeostasis
Absorption and transport of nutrients to cells, tissues, organs, and systems

Did you know???

Vitamin K - prevents hemorrhage
Vitamin B12 - prevents anemia
Vitamin E - prevents hemolysis