Study Guide Answers:

Blood and the Cardiovascular System
A) Composition and Functions of Blood

1. Describe the composition and volume of whole blood.

~ 6 Liters
45% Formed Elements
55% Plasma

2. Describe the composition of plasma and discuss its importance in the body.

Plasma is comprised of:

- 90% water
- proteins (albumin)
- nutrients- minerals
- salts
- hormones
- gases
- antibodies
- waste

Importance = It serves as a transport matrix for the body and distributes body heat.
3) List the cell types making up the formed elements and describe the major functions of each type - PART I

**Erythrocytes! (Red Blood Cells or RBCs)**

- biconcave disc shape
- contain hemoglobin, binds $O_2$ & $CO_2$
- has no nucleus or organelles
- 100-120 day life span
- rate of production is controlled by the hormone *erythropoietin*
- low oxygen prompts increase in RBC production
3) List the cell types making up the formed elements and describe the major functions of each type - (Part II)

**Granular**

**Basophil**
- highly granular
- the least common WBC (0.5%)
- secretes histamine – creates inflammation in allergic reactions

**Eosinophil**
- has small granules and often dyes red
- usually seen in higher numbers when an individual has parasites

**Neutrophils**
- often look like they have multiple nuclei
- makes up 60% of WBCs
- granules are very small, contain digestive enzymes
- phagocytize & destroy bacteria
- First cells to respond to infection
- secrete antibacterial chemicals

**Leukocytes** or White Blood Cells (WBCs)

preferred term

**Agranular**

**Lymphocytes**
- produce antibodies
- image is mostly nucleus

**Monocytes**
- the largest of the white blood cells.
- characteristic U-shaped nuclei
- become macrophages

**Platelets (Thrombocytes):**
- form from megakaryocytes
- involved in blood clotting
- Made in bone marrow(red)
- count = 250-500,000/mm$^3$
thrombocyte
basophil
erythrocytes
lymphocytes
neutrophil
eosinophil
monocyte
4) **Hemocytoblast**  
- the stem cell that is the precursor for all blood cells  
- found in red bone marrow

**B) Hemostasis**

1. **What is hemostasis?**  
   Stoppage of blood flow

2. **Name some factors that may inhibit or enhance the blood-clotting process.**
   **Inhibit:**  
   1. platelet deficiency inhibits blood clotting  
   2. deficit of clotting factors (proteins)
   
   **Enhance:**  
   1. applying pressure to trigger the release of binding enzymes/proteins  
   2. sterile gauze to provide a place for platelets to adhere
C) Blood Groups and Transfusions

1. Describe the ABO and Rh blood groups.

**ABO Groups**

There are 4 blood types
a) A - has A antigens
b) B - has B antigens
c) AB - has A & B antigens
d) O - has no antigens

2) you **cannot** receive blood that has an antigen you don't already have

3) if a mismatch occurs, agglutination (clumping of the blood) can occur

4) **O - universal donor type**-- because no antigen's on RBC surface

5) **AB - universal recipient type**
**Rh factors**

a) a variety of antigens that may or may not be present in your blood
b) **if Rh is present**, you have **Rh+ blood**
c) if it is absent, you have Rh- blood

d) With the first pregnancy, an Rh- mother carries an Rh+ baby with no problems.
e) *Danger can occur when an Rh- mother is carrying her SECOND Rh+ baby!*

f) Mother's immune system will make anti-Rh antibodies unless she receives RhoGAM after the first birth to block immune response.
   i) antibodies in the mother's blood can get into the baby's system and damage the baby
   ii) transfusions of the baby's blood are required to prevent anemia and hypoxia
   iii) **if untreated, brain damage and even death may occur**
Rh - ve
Mother

Rh + ve
Fetus
(First exposure)

Mother's immune system recognizes the new antigen as non self.

That cell doesn't look familiar!

Looks like a trespasser...
We better catch it next time!

Mother's white blood cells produces IgM antibodies.
IgM does not cross the placenta.
First baby is safe.

Rh - ve
Mother

Rh + ve
Fetus
(Second exposure)

Mother's immune system rapidly recognizes the new antigen and produces large number of IgG antibodies.

Same antigen again

Rh antibody attaches to fetal RBCs and marks them for destruction

IgG antibodies can cross the placenta.
Fetal red cells are susceptible to destruction.
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2. Explain the basis for a transfusion reaction.

Erythrocytes mixed with an antibody directed against their blood type will cause an immune reaction. Antibodies attach to the newly transfused cells and **agglutination** occurs.

**Agglutination** is clumping that occurs because the blood has reacted with a certain antibody.
- It indicates the blood is not compatible with blood containing that kind of antibody.
- If the blood does not agglutinate, it indicates that the blood does not have the antigens for that protein.
Pulmonary edema (fluid in the lungs) is an example of a transfusion reaction.
D) Homeostatic Imbalances

(see the homeostatic imbalances document)
A) Describe the location of the heart in the body and identify its major anatomical areas on an appropriate model or diagram.

Location
- Mediastinum (in the thorax, between the lungs);
- Superior to the diaphragm;
- The pointed apex is directed toward your left hip
1) Trace the pathway of blood through the heart.

The Pathway of Blood to and from the Heart

- Deoxygenated blood from the body enters through the superior and inferior vena cava into the right atrium.
- It passes through the tricuspid valve into the right ventricle.
- The blood leaves through the pulmonary semi-lunar valves and flows into the pulmonary trunk into the pulmonary artery.
- The blood flows to the lungs, where CO₂ is dropped off and O₂ is acquired.
- The oxygenated blood re-enters the heart through the pulmonary veins.
- The blood flows into the left atrium, then through the bicuspid (mitral) valve.
- The blood enters the left ventricle, where it is pumped out through the aortic semilunar valve.
- The blood enters the aortic arch and then the aorta, where it is sent out into the body.
2) Compare the pulmonary and systemic circuits.

The **pulmonary circuit** starts in the right ventricle with the deoxygenated blood that is being pumped to the lungs and **ends** in the left atrium.

The **systemic circuit** starts in the left ventricle with the oxygenated blood that is pumped out to the body, and **ends** in the right atrium.
3. Explain the operation of the heart valves

**AV or Atrioventricular Valves**
- Flexible barriers, prevent backward flow of blood between the atria and ventricles
- Consist of fibrous connective tissue flaps attached by chordae tendinae.
- Papillary muscles pull the chordae tendinae to keep the valves shut.

**Semilunar Valves**
- Flexible barriers, prevent backward flow of blood between the blood vessels and the ventricles.
- Backward flow of blood fills the half-moon (semilunar) valve cups, holding it shut.
B. Name the elements of the intrinsic conduction system of the heart and describe the pathway of impulses through this system.

1. Define systole, diastole, and cardiac cycle

   Systole – contraction of the heart chambers
   Diastole – relaxation of the heart chambers

Cardiac cycle - sequence of events that occurs when the heart beats.

One cardiac cycle = heart fills with blood and that blood is pumped out of the heart.

Two phases:

Diastole: the ventricles are relaxed and the blood flows from the atria into the ventricles.

Systole: the AV valves close, ventricles contract, blood is pumped out to the arteries. During this phase the atria are re-filling.
B) Name the elements of the intrinsic conduction system of the heart and describe the pathway of impulses through this system.

Try this link for a step-by-step animation of this process.


2) Intrinsic Conduction System (Cardiac Conduction)

1) Electrical impulse sent from the **Sinoatrial (SA) node** (the "pacemaker")
2) The impulse causes the atria to contract;
3) The electric signal arrives at the **Atrioventricular (AV) node**
4) The signal continues to the **Bundle of His** (also known as the **AV bundle**);
5) It moves into the left and right **bundle branches** (located in the septum);
6) The signal proceeds to the **Purkinje fibers**, causing the ventricles to contract.
3) Explain what information can be gained from an electrocardiogram (ECG).

The following information may be obtained through use of an ECG:

- Evidence of damage or changes to the heart muscle;
- Changes in the structure or function of the valves;
- Fluid or swelling in the sac around the heart;
- Inflammation of the heart (myocarditis);
- Past or current heart attack;
- Poor blood supply to the heart arteries;
- Abnormal heart rhythms (arrhythmias);
- A change in pressure in the blood within the heart chambers.

This question may be used - but ONLY for Extra Credit!
C) Blood Vessels

1) Compare and contrast the structure and function of arteries, veins, and capillaries

**Arteries:**
Take blood *away from the heart*
Layered with muscle and connective tissue; muscle is thicker than veins.
Blood in arteries is under much higher pressure than in veins.
**Veins:**
Bring blood *to the heart.*
Layered with muscle and connective tissue; much less muscle, much thinner walls than arteries.
Blood in vein is under much less pressure (*passive blood flow*).
Valves in the veins help prevent backflow.

**Capillaries:**
Smallest blood vessels
Delivers nutrients & oxygen to interstitial fluid
Removes CO₂ and waste through diffusion and active transport
2) Identify the body's major arteries and veins entering or leaving the heart and name the body region supplied by each.

*Five major blood vessels enter and leave the heart:*

- **superior vena cava** carries deoxygenated blood from the upper half of the body to the heart.
- **inferior vena cava** carries deoxygenated blood from the lower half of the body to the heart.
- **pulmonary artery** carries deoxygenated blood from the heart to the lungs for gas exchange.
- **pulmonary vein** carries oxygenated blood from the lungs back to the heart.
- **the aorta** splits into the **ascending aorta**, which supplies the head, neck, arms and the heart muscle, and the **descending aorta**, which supplies the chest cavity, the abdominal and pelvic organs and the legs.