Unit Seven – Blood and Immunity

I. Introduction

A. Definition – Blood is a sticky fluid that is heavier and thicker than water. Blood is a type of __________ ____________, whose cells and suspended in a liquid intercellular material. It functions in transportation of substances throughout the body and provides a ________________ mechanism to protect the body.

B. The blood is composed of two portions:

1. ________percent of blood is plasma (liquid)

    A. Plasma is a clear liquid containing mostly water, amino acids, proteins, carbohydrates, lipids, vitamins, hormones, electrolytes and waste from cells.

2. ________percent of blood is made up of formed elements (solids)

    A. The formed elements are mostly made in the bone marrow and consist of red blood cells, white blood cells and cellular fragments called platelets.

    B. An outline of the formed elements:

        I. Erythrocytes (red blood cells)
        II. Leukocytes (white blood cells)
            a. Granular leukocytes (granulocytes)
                1. Neutrophils
                2. Eosinophils
                3. Basophils
            b. Agranular leukocytes (agranulocytes)
        III. Platelets

3. Diagram of a blood sample:

   ![Diagram of a blood sample](image)
C. Facts about Blood

1. Volume of body weight is about _________ percent blood.

2. The average human has about _____________ of blood.

3. In one drop of blood (1 cubic milliliter) there are about 5 million red blood cells, 8,000 _________, and 250,000 platelets.

4. The process of forming new blood cells is called ___________________________. Hemopoiesis takes place in the marrow of the humerus and femur; flat bones such as the sternum, ribs and cranial bones; the vertebrae and the pelvis.

5. All blood cells originate from hemocytoblasts, ____________ cells that undergo differentiation into the major types of blood cells.

6. pH Range: ________________________.

7. Percentage of water in blood: ________________________.
II. Functions of the Blood

A. Transportation

1. Blood transports oxygen \((O_2)\) from the _____________ to the cells of the body and carries carbon dioxide \((CO_2)\) from the cells of the body to the lungs.

2. Blood carries _____________ (food) from the ___________________________ tract (stomach and intestines) to the cells and carries heat and waste away from the cells.

3. Blood is used to carry ________________ from the endocrine glands to target cells throughout the body.

B. Regulation

1. Blood regulates __________ through buffers.

   What is a buffer?

2. Blood regulates ___________ _______________ by varying the rate of blood flow to the skin; excess heat can be given off from increased surface area of vessels near the skin’s surface.

C. Protection

1. White blood cells (WBCs) protect the body against microbes and other foreign ________________.

2. Platelets protect the body against ________________ ____________ through clotting.

III. Erythrocytes (Red Blood Cells)

A. Structure of Erythrocytes

1. Tiny, ________________ disks, which are thin near the center and thicker around their edges.

2. Mature cells are very simple in structure and they do not have a _______________ and have few organelles.

3. Hemoglobin gives the RBC its red color and is responsible for binding with oxygen. It makes up about one-third of a RBC.

   a. Oxyhemoglobin - when oxygen is combined with _______ giving the blood a bright _____________ color.
b. Deoxyhemoglobin - when the __________ is released to the cells giving the blood a ___________ red or burgundy color.

4. Certain proteins called ________________ on the surface of red blood cells are responsible for creating the different blood types: ____________, ____________, ____________, ____________ and RH __________ or ________.

<table>
<thead>
<tr>
<th>Red Blood Cell Type</th>
<th>Group A</th>
<th>Group B</th>
<th>Group AB</th>
<th>Group O</th>
<th>RH +</th>
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<tr>
<td>Antigens Present</td>
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B. Function of Erythrocytes

1. ________________ on the surface of RBCs combines with O₂ by diffusion at the lungs and is carried to all the cells of the body. The oxygen is used by the ________________ of the cell in the process of ________________ ________________ to create ATP.
2. RBCs pick up some CO₂ created by the cells during cellular respiration and bring it back to the lungs, but most of the CO₂ is carried back to the lungs in the blood plasma and leaves the lungs due to ________________.

3. RBCs have ______ nucleus, which increases their capacity to carry hemoglobin and hence O₂.

4. RBCs do not have ________________ and have to generate ATP anaerobically, thus they do not need to use any of the O₂ they are transporting.

C. Life Span and Destruction of Erythrocytes

1. RBCs only live about _______ days because of damage on their membranes as they squeeze through capillaries.

2. Worn out RBCs are phagocytized by macrophages (phagocytes) in the spleen and liver.

3. Hemoglobin from the worn out RBC is broken down into heme (iron portion) and globin (a protein).

4. The __________ is broken down into iron and biliverdin.

5. The iron is stored in the liver until it is released from storage, then sent to the bone marrow to make new hemoglobin for new erythrocytes.

6. _________________ is converted to bile in the liver and is excreted into the small intestine eventually to be removed in the feces, giving it the characteristic brown color.

Flow Chart of Erythrocyte Breakdown:
D. Formation of Erythrocytes

1. Erythropoiesis - the process by which __________________ are formed.

2. The number of red cells destroyed must be equaled by the new cells produced. The body must produce about 2 million new RBCs per second.

3. Erythropoietin - when oxygen levels become low the kidneys increase the release of the hormone erythropoietin which circulates to the bone marrow increasing erythropoiesis.

IV. Leukocytes (White Blood Cells)

A. General Information about Leukocytes

1. Leukocytes combat microbes by _______________ or antibody production.

2. WBCs do most of their work outside the circulatory system, but use the blood for transportation.

3. Leukocytes are produced in______________________________.

4. There are ___________ types of leukocytes (see introduction).

B. Granular Leukocytes

1. There are ___________ kinds of granular leukocytes, they are about twice the size of a RBC, have a short life span (about twelve hours), and are identified on the basis of how their granules stain.

   a. Neutrophils - combat invaders by__________________________, they are small phagocytes, usually respond first to bacterial invasion and make up a little more than half of all WBCs.

   b. Eosinophils - release enzymes such as _______________ to combat inflammation and allergic reaction. Make up only 1 to 3 percent of all WBCs.

   c. Basophils - involved in ______________ and __________________ reactions, make up less than 1 percent of all WBCs.
C. Nongranular Leukocytes

1. Monocytes (macrophages) - can ______________ disposing of dead cells; they clean up cellular debris following an infection.
   a. 3 to 9 percent of all WBCs
   b. live for several weeks to months

2. Lymphocytes - found in lymphatic system (housed in lymph nodes), overall responsible for immune responses.
   a. 25 to 33 percent of all __________
   b. long life spans (some many years)
      i. T Lymphocytes can be ____________ cells or ____________ cells activated by antigens.
      ii. B Lymphocytes make ______________ to be released and attack foreign antigens.

D. Differential white blood cell counts:

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<th>Cell</th>
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<th>Absolute #</th>
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<td>Eosinophil</td>
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<td>Basophil</td>
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**Blood Donations are Based on Safe Antigen/Antibody Interactions:**

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**Summary of Reactions:**

**V. Thrombocytes (Platelets)**

**A. Structure of Thrombocytes**

1. Platelets are _____________ complete cells; they are fragments of cytoplasm developed from large cells called megakaryocytes.

2. Platelets are disc-shaped and do not contain a nucleus.

3. Platelets have short life spans, only five to nine _____________.

**B. Function of Thrombocytes**

1. Platelets prevent blood loss by initiating a chain of reactions that results in blood clotting with the use of ________________ protein in the blood.
VI. Blood Plasma

A. Blood plasma is the part of blood left when RBCs, WBCs and platelets are removed. It is a clear _______________ liquid. It is _______ percent water and contains plasma proteins, nutrients (amino acids, glucose, and various lipids) gases (O₂ and CO₂), electrolytes (sodium and chloride ions amount others), waste products of metabolism (urea), enzymes, and hormones.

VII. Disorders and Development

A. Sickle Cell –

B. Hemophilia –

C. Anemia –

D. Thrombus –

E. Leukemia –