After studying this chapter, you will be able to:

12.1 Name the parts of the blood system and discuss the function of each part
12.2 Define combining forms used in building words that relate to the blood system
12.3 Identify the meaning of related abbreviations
12.4 Name the common diagnoses, clinical procedures, and laboratory tests used in treating disorders of the blood system
12.5 List and define the major pathological conditions of the blood system
12.6 Explain the meaning of surgical terms related to the blood system
12.7 Recognize common pharmacological agents used in treating disorders of the blood system

Structure and Function

Blood is a complex mixture of cells, water, and various biochemical agents, such as proteins and sugars. It transports life-sustaining nutrients, oxygen, and hormones to all parts of the body. As a transport medium for waste products from cells of the body, it prevents toxic buildup. It helps maintain the stability of the fluid volume that exists within body tissues (a form of homeostasis, the maintaining of a balance), and it helps regulate body temperature. Without blood, human life is not possible. Figure 12-1a illustrates the blood system, with arteries shown in red and veins shown in blue. Figure 12-1b is a schematic showing the path of blood through the body.

An average adult has about 5 liters of blood circulating within the body. The volume of blood changes with body size, usually equaling about 8 percent of body weight. If a person loses blood, either through bleeding or by donating blood, most of the blood volume is replaced within 24 hours. If bleeding is extensive, blood transfusions may be necessary.

Blood is a thick liquid made up of a fluid part, plasma, and a solid part containing red blood cells, white blood cells, and platelets. Plasma (the liquid portion of unclotted blood) consists of water, proteins, salts, nutrients, vitamins, and hormones. If some proteins and blood cells are removed from plasma, as happens during coagulation (clotting), the resulting fluid is called serum. Serum is the liquid portion of clotted blood. Serology is the science that deals with the properties of serum, such as the presence of immunity-provoking agents.
Plasma

When blood is separated, the plasma (about 55 percent of the blood) is the clear liquid made up of 92 percent water and 8 percent organic and inorganic chemicals. The 8 percent consists of proteins, nutrients, gases, electrolytes, and other substances.

The main groups of plasma proteins are albumin, globulin, fibrinogen, and prothrombin. Albumin helps regulate water movement between blood and tissue. Plasma proteins cannot pass through capillaries, and, in order to maintain a balance of fluids on both sides of the capillary walls, they create pressure that forces water into the bloodstream. Leakage of water out of the bloodstream can cause edema. An injury can upset the balance of water in the blood and, if too much water is lost, can eventually lead to shock.

Globulins have different functions, depending on their type. The alpha and beta globulins, which are joined in the liver, transport lipids and fat-soluble vitamins. Gamma globulins arise in the lymphatic tissues and function as part of the immune system. Globulins can be separated from each other when plasma is placed in a special solution and electrical currents attract the different proteins to move in the direction of the electricity through a process called electrophoresis. Blood may also be centrifuged, put in a device that separates blood elements by spinning. Plasmapheresis is a process that uses centrifuging to take a patient’s blood and return only red cells to that patient.

Fibrinogen and prothrombin are essential for blood coagulation, the process of clotting. The clot is formed by platelets that rush to the site of an

FIGURE 12-1  (a) The blood system transports life-sustaining nutrients to all parts of the body; (b) a schematic showing the path of blood through the body.
They clump at the site and release a protein, thromboplastin, which combines with calcium and various clotting factors (I-V and VII-XIII) to form the fibrin clot (Figure 12-2). Thrombin, an enzyme, helps in formation of the clot. The clot tightens while releasing serum, a clear liquid. Blood clotting at the site of a wound is essential. Without it, one would bleed to death. Blood clotting inside blood vessels, however, can cause major cardiovascular problems. Some elements of the blood, such as heparin, prevent clots from forming during normal circulation.

Blood Cells
The solid part of the blood that is suspended in the plasma consists of the red blood cells (RBCs), also called erythrocytes, white blood cells (WBCs), also called leukocytes, and platelets, also referred to as thrombocytes. These cells or the solids in the blood make up about 45 percent of the blood. The measurement of the percentage of packed red blood cells is known as the hematocrit. Most blood cells are formed as stem cells (hematocytoblasts) or immature blood cells in the bone marrow. Stem cells mature in the bone marrow before entering the bloodstream and becoming differentiated, specialized in their purpose. Figure 12-3 shows the stages of

Stem cells can be gotten from umbilical cord blood. To find out about how to donate cord blood once a baby is born, go to the NIH website on stem cells (http://stemcells.nih.gov).
blood cell development. The term differential, which you will see on written orders for blood tests, refers to the percentage of each type of white blood cell in the bloodstream.

**MORE ABOUT...**

**Stem Cells**

Stem cells are the foundation cells for all other cells in the body. As a new individual develops, the process of differentiation begins by designating certain cells to become specific cell types within the body. It is the stem cell’s ability to be manipulated that is believed to hold the key to engineering new tissues to repair diseases or injuries. There are two types of stem cells that are at the center of this bioethical debate; embryonic and adult stem cells. Embryonic stem cells tend to be the preferred cell due to their genetic ability to easily divide and develop into all types of cells within the body. An adult stem cell found in a person or umbilical cord has a limited ability to form only certain types of cells.

Controversy about the use of embryonic stem cells arises because an embryo is used in the process. Some individuals who believe that human life begins at conception are strongly opposed to using embryos in research and development. Others counter that these cells are harvested for the purpose of reproduction by artificial means and unused embryos will be destroyed if not used. Why not use them for the benefit of those individuals whose disease processes could be treated or possibly cured?
FIGURE 12-3 Development of blood cells from a hemocytoblast.
**Erythrocytes or Red Blood Cells**

A hormone produced in the kidneys, **erythropoietin**, stimulates the production of red blood cells in the bone marrow. When stem cells mature into erythrocytes, they lose their nucleus and become bi-concave.

A protein within red blood cells, **hemoglobin**, aids in the transport of oxygen to the cells of the body. Oxygen molecules have the ability to bond with hemoglobin molecules. When a red blood cell has oxygen on board, it becomes bright red in color. Oxygen-poor red blood cells are a deep burgundy color.

About one-third of each red blood cell is made up of hemoglobin. Hemoglobin is composed of **heme**, a pigment containing iron, and **globin**, a protein. Erythrocytes live for about 120 days. Some are removed from circulation each day to maintain a steady concentration of red blood cells. **Macrophages** are cells formed from stem cells that consume damaged or aged cells. The average number of red blood cells in a cubic millimeter of blood is 4.6 to 6.4 million for adult males and 4.2 to 5.4 million for adult females. This measurement is known as the **red blood cell count**. Figure 12-4 tracks the life cycle of a **red blood cell**.

**FIGURE 12-4** Life cycle of a red blood cell. Nutrients taken into the small intestine are then supplied to the bone marrow where red blood cells are produced. These cells then circulate in the body for approximately 120 days.

**Erythropoietin** is used in the treatment of AIDS patients to encourage red blood cell production.
Leukocytes

Leukocytes, or white blood cells, protect against disease in various ways—for example, by destroying foreign substances. Leukocytes are transported in the bloodstream to the site of an infection. There are two main groups of leukocytes—granulocytes and agranulocytes.

The first group, granulocytes, have a granular cytoplasm and have nuclei with several lobes when viewed under a microscope and when stain is used. There are three types of granulocytes:

1. Neutrophils are the most plentiful leukocytes (over half of the white blood cells in the bloodstream). They do not stain distinctly with either an acidic or an alkaline dye. Their purpose is to remove small particles of unwanted material from the bloodstream.

2. Eosinophils are only about 1 to 3 percent of the leukocytes in the bloodstream. Their granules stain bright red in the presence of an acidic red dye called eosin. Their purpose is to kill parasites and to help control inflammations and allergic reactions.

3. Basophils are less than 1 percent of the leukocytes in the bloodstream. Their granules stain dark purple in the presence of alkaline dyes. They release heparin, an anticoagulating factor, and histamine, a substance involved in allergic reactions.

The second group of leukocytes, agranulocytes, have cytoplasm with no granules. Their single nucleus does not have the dark-staining elements of granulocytes. There are two types of agranulocytes:

1. Monocytes, the largest blood cells, make up about 3 to 9 percent of the leukocytes in the bloodstream. They destroy large particles of unwanted material (such as old red blood cells) in the bloodstream.

2. Lymphocytes make up about 25 to 33 percent of the leukocytes in the bloodstream. They are essential to the immune system, discussed in Chapter 13.

Table 12-1 lists the types of white blood cells.

Platelets

Platelets, or thrombocytes, are fragments that break off from large cells in red bone marrow called megakaryocytes. Platelets live for about 10 days and...
help in blood clotting. Platelets adhere to damaged tissue and to each other and group together to control blood loss from a blood vessel. Figure 12-5 shows platelets clumping together.

**Blood Types**

When blood is needed for transfusion, the blood being donated is tested for type and put into one of four human blood types or groups. The donated blood...
CHAPTER 12 The Blood System

Blood must be tested since an incompatible blood type from a donor can cause adverse reactions. Blood typing is based on the antigens (substances that promote an immune response) and antibodies (special proteins in the blood) present in the blood. (Chapter 13 describes the work of antigens and antibodies in the immune system.) The most common type of blood in the population is O, followed by A, B, and AB in descending order. Table 12-2 lists the four blood types and their characteristics.

The danger in transfusing blood of a different type is that agglutination or clumping of the antigens stops the flow of blood, which can be fatal. People with type O blood have no antigens, so people with type O can donate to all other types and are, therefore, called universal donors. People with AB blood are called universal recipients because they can receive blood from people with all the other types and not experience clotting.

In addition to the four human blood types, there is a positive or negative element in the blood. Rh factor is a type of antigen first identified in rhesus monkeys. Rh-positive blood contains this factor and Rh-negative blood does not. The factor contains any of more than 30 types of agglutinogens, substances that cause agglutination, and can be fatal to anyone who receives blood with a factor different from the donor.

Rh factor is particularly important during pregnancy. The fetus of parents with different Rh factors could be harmed by a fatal disease or a type of anemia if preventive measures are not taken prior to birth. The problem arises

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Antigen</th>
<th>Antibody</th>
<th>Percent of Population with This Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>Anti-B</td>
<td>41</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>Anti-A</td>
<td>10</td>
</tr>
<tr>
<td>AB</td>
<td>A and B</td>
<td>Neither anti-A nor anti-B</td>
<td>4</td>
</tr>
<tr>
<td>O</td>
<td>Neither A nor B</td>
<td>Both anti-A and anti-B</td>
<td>45</td>
</tr>
</tbody>
</table>

The lives of some animals are saved by blood transfusions. Go to www.cvm.uiuc.edu/petcolumns/showarticle.cfm?id=1114 and search the term “transfusions” to read about the similarities between human and some pet transfusions.

FIGURE 12-6 How the Rh factor affects pregnancy.
when the mother is Rh-negative and produces antibodies to the father’s Rh-positive factor present in the fetus. When the Rh-negative mother becomes exposed to the Rh-positive blood, usually during childbirth, antibodies are formed by the mother. The problem does not arise during a first pregnancy but will arise in each subsequent pregnancy because the antibodies that arise after the first birth would carry a risk for an Rh-positive fetus. Treatment with Rho-gam, a gamma globulin, during each pregnancy usually prevents the problem. Figure 12-6 shows how a combination of Rh factors affects pregnancy.

Vocabulary Review

In the previous section, you learned terms relating to the blood system. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>agglutination</td>
<td>Clumping of cells and particles in blood.</td>
</tr>
<tr>
<td>agglutinogen</td>
<td>Substance that causes agglutination.</td>
</tr>
<tr>
<td>agranulocyte</td>
<td>Leukocyte with nongranular cytoplasm.</td>
</tr>
<tr>
<td>albumin</td>
<td>Simple protein found in plasma.</td>
</tr>
<tr>
<td>basophil</td>
<td>Leukocyte containing heparin and histamine.</td>
</tr>
<tr>
<td>blood</td>
<td>Fluid (containing plasma, red blood cells, white blood cells, and platelets) circulated throughout the arteries, veins, capillaries, and heart.</td>
</tr>
<tr>
<td>blood types or groups</td>
<td>Classification of blood according to its antigen and antibody qualities.</td>
</tr>
<tr>
<td>coagulation</td>
<td>Changing of a liquid, especially blood, into a semi-solid.</td>
</tr>
<tr>
<td>electrophoresis</td>
<td>Process of separating particles in a solution by passing electricity through the liquid.</td>
</tr>
<tr>
<td>eosinophil</td>
<td>Type of granulocyte.</td>
</tr>
<tr>
<td>erythrocyte</td>
<td>Mature red blood cell.</td>
</tr>
<tr>
<td>erythropoietin</td>
<td>Hormone released by the kidneys to stimulate red blood cell production.</td>
</tr>
<tr>
<td>fibrin</td>
<td>Clot-forming threads formed at the site of an injury during coagulation where platelets clump together with various other substances.</td>
</tr>
<tr>
<td>fibrinogen</td>
<td>Protein in plasma that aids in clotting.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>gamma globulin</td>
<td>Globulin that arises in lymphatic tissue and functions as part of the immune system.</td>
</tr>
<tr>
<td>globin [GLÔ-bîn]</td>
<td>Protein molecule in the blood, a part of hemoglobin.</td>
</tr>
<tr>
<td>granulocyte [GRÂN-yû-lô-sît]</td>
<td>Leukocyte with granular cytoplasm.</td>
</tr>
<tr>
<td>hematocrit [HÈ-má-tô-krit, HÈM-ä-tô-krit]</td>
<td>Measure of the percentage of red blood cells in a blood sample.</td>
</tr>
<tr>
<td>heme [hêm] Greek kaima, blood</td>
<td>Pigment containing iron in hemoglobin.</td>
</tr>
<tr>
<td>hemoglobin [hé-mô-GLÔ-bîn]</td>
<td>Protein in red blood cells essential to the transport of oxygen.</td>
</tr>
<tr>
<td>heparin [HĔP-à-rîn] Greek hep, liver</td>
<td>Substance in blood that prevents clotting.</td>
</tr>
<tr>
<td>histamine [HĬS-tă-mên]</td>
<td>Substance released by basophils and eosinophils; involved in allergic reactions.</td>
</tr>
<tr>
<td>leukocyte [LŬ-kô-sît] leuko-, white + -cyte</td>
<td>Mature white blood cell.</td>
</tr>
<tr>
<td>lymphocyte [LĬM-fô-sît] lympho-, lymph + -cyte</td>
<td>Type of agranulocyte.</td>
</tr>
<tr>
<td>megakaryocyte [mêg-ă-KÂR-ē-ŏ-sît]</td>
<td>Large cells in red bone marrow that form platelets.</td>
</tr>
<tr>
<td>monocyte [MŎN-ŏ-sît] mono-, one + -cyte</td>
<td>Type of agranulocyte.</td>
</tr>
<tr>
<td>neutrophil [NŬ-trô-fîl] neutro-, neutral + -phil</td>
<td>Type of leukocyte; granulocyte.</td>
</tr>
<tr>
<td>plasma [PLÂZ-mâ] Greek</td>
<td>Liquid portion of unclotted blood.</td>
</tr>
<tr>
<td>plasmapheresis [PLÂZ-mâ-fê-RÊ-sîs] plasma + -pheresis, removal</td>
<td>Process of removing blood from a person, centrifuging it, and returning only red blood cells to that person.</td>
</tr>
<tr>
<td>platelet [PLÄT-lêt] plate + -let, small</td>
<td>Thrombocyte; part of a megakaryocyte that initiates clotting.</td>
</tr>
<tr>
<td>prothrombin [prô-THRÔM-bîn]</td>
<td>Type of plasma protein that aids in clotting.</td>
</tr>
<tr>
<td>red blood cell</td>
<td>One of the solid parts of blood formed from stem cells and having hemoglobin within; erythrocyte.</td>
</tr>
<tr>
<td>red blood cell count</td>
<td>Measurement of red blood cells in a cubic millimeter of blood.</td>
</tr>
<tr>
<td>Rh factor rh(esus monkey)</td>
<td>Type of antigen in blood that can cause a transfusion reaction.</td>
</tr>
<tr>
<td>Rh-negative</td>
<td>Lacking Rh factor on surface of blood cells.</td>
</tr>
<tr>
<td>Rh-positive</td>
<td>Having Rh factor on surface of blood cells.</td>
</tr>
</tbody>
</table>
Check Your Knowledge

After each of the following, write the letter of the component of blood that is most closely related to either a, b, or c.

a. red blood cell       b. white blood cell       c. component of plasma

1. albumin ____________
2. hemoglobin __________
3. leukocyte __________
4. eosinophils __________
5. gamma globulin __________
6. fibrinogen __________
7. basophils __________
8. beta globulin __________
9. monocyte __________
10. neutrophils __________
11. histamine __________
12. alpha globulin __________
13. lymphocytes __________

Find the Type

Write the correct blood type, A, B, AB, or O, in the space following each phrase.

14. Has A and B antigens ____________
15. Has neither A nor B antigens ____________
16. Has only B antigens ____________
17. Has only A antigens ____________
18. Has both anti-A and anti-B antibodies ____________
19. Has neither anti-A nor anti-B antibodies ____________
20. Has only anti-A antibodies ____________
21. Has only anti-B antibodies ____________

Find a Match

Match the term in the left column with its correct definition in the right column.

22. _____ coagulation    a. type of leukocyte
23. ___ heparin  
24. ___ neutrophil  
25. ___ albumin  
26. ___ agglutination  
27. ___ Rh factor  
28. ___ erythrocyte  
29. ___ platelet

b. a blood protein  
c. clumping of incompatible blood cells  
d. process of clotting  
e. antigen  
f. cell that activates clotting  
g. an anticoagulant  
h. red blood cell

CASE STUDY

Getting Treatment

John Maynard was admitted to the hospital on April 2, 2XXX, complaining of respiratory problems and left-sided lower abdominal pain. The doctor on call ordered blood tests, and Mr. Maynard was found to be anemic. Because of Mr. Maynard’s multiple medical problems, a hematologist was called in to consult about the disease and treatment of this patient. The history as written in his medical record is as follows:

**HISTORY OF PRESENT ILLNESS:** John Maynard is an 83-year-old man who was admitted on April 2, 2XXX, with acute exacerbation of chronic obstructive pulmonary disease and left-sided lower abdominal pain. He has been admitted in the past with a similar kind of pain but on the right side. He was evaluated by Dr. Evans in the past, but no obvious additional problem was identified. During this present admission, he was also found to be anemic.

On direct interviewing: Mr. Maynard denies any acute blood loss. His stool and urine color are normal. He has a history of a stroke and has not been ambulatory. He lives with his nephew, who takes care of him. He denies any night sweats. He did not notice any new lumps or bruising anywhere. No new bone pain. He feels short of breath with minimal activity. He denies any chest pain or palpitations. He feels dizzy at times.

Critical Thinking

30. Blood tests can reveal problems almost anywhere in the body. Why are the elements in blood a good measure of many bodily functions?

31. Does Mr. Maynard’s blood type (O positive) make him more susceptible to illnesses? Why or why not?

Combining Forms and Abbreviations

The lists below include combining forms and abbreviations that relate specifically to the blood system. Pronunciations are provided for the examples.

<table>
<thead>
<tr>
<th>Combining Form</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>agglutin(o)</td>
<td>agglutinin</td>
<td>agglutinogenic [ä-GLU-tin-ō-JÊN-ik], causing the production of agglutinin</td>
</tr>
<tr>
<td>eosino</td>
<td>eosinophil</td>
<td>eosinopenia [Ē-ō-sin-ō-PĒ-nē-ā], abnormally low count of eosinophils</td>
</tr>
</tbody>
</table>
**COMBINING FORM** | **MEANING** | **EXAMPLE**
---|---|---
erythr(o) | red | erythrocyte [ˌɛ-rɪ-θro-sɪt], red blood cell
hemo, hemat(o) | blood | hemodialysis [ˌhɛ-mō-dī-ˈāl-ə-sis], external dialysis performed by separating solid substances and water from the blood
leuk(o) | white | leukoblast [ˈlu-kō-blast], immature white blood cell
phag(o) | eating, devouring | phagocyte [ˈfæ-gō-sɪt], cell that consumes other substances, such as bacteria
thromb(o) | blood clot | thrombocyte [ˈθrōm-bō-sɪt], cell involved in blood clotting

**ABBREVIATION** | **MEANING** | **ABBREVIATION** | **MEANING**
---|---|---|---
APTT | activated partial thromboplastin time | MCHC | mean corpuscular hemoglobin concentration
baso | basophil | MCV | mean corpuscular volume
BCP | biochemistry panel | mono | monocyte
BMT | bone marrow transplant | PCV | packed cell volume
CBC | complete blood count | PLT | platelet count
diff | differential blood count | PMN, poly | polymorphonuclear neutrophil
eos | eosinophils | PT | prothrombin time
ESR | erythrocyte sedimentation rate | PTT | partial thromboplastin time
G-CSF | granulocyte colony-stimulating factor | RBC | red blood cell count
GM-CSF | granulocyte macrophage colony-stimulating factor | SR, sed. rate | sedimentation rate
HCT, Hct | hematocrit | seg | segmented mature white blood cells
HGB, Hgb, HB | hemoglobin | WBC | white blood cell count
MCH | mean corpuscular hemoglobin

**COMBINING FORMS AND ABBREVIATIONS EXERCISES**

**Find a Match**
Match the terms on the left that contain blood system combining forms with the correct definition on the right. You will be using the combining forms, suffixes, or prefixes you have learned in this chapter and in Chapters 1, 2, and 3.

32. ___ leukocytolysis  
 a. development of white blood cells
33. ___ hemotoxin  
 b. instrument for counting red blood cells
34. ___ thrombogenic  
 c. destruction of a clot
35. ___ hemostasis
d. painful skin redness
36. ___ eosinopenia
e. destruction of white blood cells
37. ___ erythrocytometer
f. substance that causes blood poisoning
38. ___ hemanalysis
g. causing blood coagulation
39. ___ thrombolysis
h. stoppage of bleeding
40. ___ erythralgia
i. blood analysis
41. ___ leukopoiesis
j. low number of eosinophils

Build Your Medical Vocabulary
Define the following words using the list of blood system combining forms above and the prefixes, suffixes, and combining forms in Chapters 1, 2, and 3.

42. agglutinophilic
43. thrombectomy
44. erythroblast
45. hematopathology
46. eosinotaxis
47. lymphoblast
48. phagosome
49. polycythemia
50. cytology
51. leukocyte
52. leukemia
53. thrombocytopenia
54. hematoma
55. erythrocytosis

CASE STUDY
Interpreting Results
The laboratory data on Mr. Maynard's record is as follows.

April 2, 2XXX: PSA 1.8
April 2, 2XXX: BUN 6, creatinine .7, calcium 8.3, uric acid 8.7, SGOT 42, SGPT 38, alkaline phosphatase 86, total bilirubin 0.7.
April 2, 2XXX: White blood cell count 5.8, hemoglobin 10.4, HCT 31.1, platelet count 275,000.
December 4, 2XXX: vitamin B12 1,230, folate 16.1.
December 6, 2XXX: HCT 38.9.
December 10, 2XXX: HCT 32.3.

Critical Thinking
56. What procedure is used to obtain the blood samples needed in Mr. Maynard's case? Is it safe to take several blood samples at once? Why or why not?
57. What is the difference between an RBC and a WBC?

Diagnostic, Procedural, and Laboratory Terms

Phlebotomy or venipuncture, the withdrawal of blood for examination, is probably the most frequently used diagnostic tool in medicine (Figure 12-7). Various measurements provide a clue as to someone's general health and aid in diagnosing specific conditions. Table 12-3 lists common blood analyses, and Figure 12-8 shows laboratory results for specific blood tests.
Most of the blood tests described in Table 12-3 are performed in a laboratory. Names of tests may vary according to the region of the country or the practice of a particular doctor. For example, a biochemistry panel is sometimes called a **chemistry profile**, and a blood chemistry is sometimes
<table>
<thead>
<tr>
<th>Test or Procedure</th>
<th>Purpose of Test</th>
<th>Common Diseases/Disorders That May Be Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>complete blood count (CBC)</td>
<td>common screen for basic medical checkup (Figure 12-8)</td>
<td>iron-deficiency anemia, bacterial or viral infection, internal bleeding, dehydration, aplastic anemia, impaired renal function, liver disease, circulatory disorder</td>
</tr>
<tr>
<td>blood chemistry</td>
<td>test of plasma for presence of most substances, such as glucose, cholesterol, uric acid, and electrolytes</td>
<td>diabetes, hyperlipidemia, gout, circulatory disorders, impaired renal function, liver diseases, general metabolic disorder</td>
</tr>
<tr>
<td>biochemistry panel</td>
<td>group of automated tests for various common diseases or disorders</td>
<td>same as blood chemistry</td>
</tr>
<tr>
<td>blood indices</td>
<td>measurement of size, volume, and content of red blood cells</td>
<td>classification of anemias</td>
</tr>
<tr>
<td>blood culture</td>
<td>test of a blood specimen in a culture in which microorganisms are observed; test for infections</td>
<td>septicemia, bacterial infections</td>
</tr>
<tr>
<td>erythrocyte sedimentation rate (ESR); sedimentation rate (SR)</td>
<td>test for rate at which red blood cells fall through plasma; indicator of inflammation and/or tissue injury</td>
<td>infections, joint inflammation, sickle cell anemia, liver and kidney disorders</td>
</tr>
<tr>
<td>white blood cell differential and red blood cell morphology</td>
<td>test for number of types of leukocytes and shape of red blood cells</td>
<td>infection, anemia, leukemia, poikilocytosis, anisocytosis</td>
</tr>
<tr>
<td>platelet count (PLT)</td>
<td>test for number of thrombocytes in a blood sample</td>
<td>hemorrhage, infections, malignancy, hypersplenism, aplastic anemia, thrombocytopenia</td>
</tr>
<tr>
<td>partial thromboplastin time (PTT)</td>
<td>test for coagulation defects</td>
<td>vitamin K deficiency, hepatic disease, hemophilia, hemorrhagic disorders</td>
</tr>
<tr>
<td>prothrombin time (PT)</td>
<td>test for coagulation defects</td>
<td>vitamin K deficiency, hepatic disease, hemorrhagic disorders, hemophilia</td>
</tr>
</tbody>
</table>
TABLE 12-3  Common Blood Analyses (see Appendix D for Normal Laboratory Values) (cont.)

<table>
<thead>
<tr>
<th>Test or Procedure</th>
<th>Purpose of Test</th>
<th>Common Diseases/Disorders That May Be Indicated</th>
</tr>
</thead>
<tbody>
<tr>
<td>antiglobulin test; Coombs’ test</td>
<td>test for antibodies on red blood cells</td>
<td>Rh factor and anemia</td>
</tr>
<tr>
<td>white blood count (WBC)</td>
<td>number of white blood cells in a sample (usually done as part of complete blood count)</td>
<td>bacterial or viral infection, aplastic anemia, leukemia, leukocytosis</td>
</tr>
<tr>
<td>red blood count (RBC)</td>
<td>number of red blood cells in a sample (usually done as part of complete blood count)</td>
<td>polycythemia, dehydration, iron-deficiency anemia, blood loss, erythropoiesis</td>
</tr>
<tr>
<td>hemoglobin (HGB, Hgb)</td>
<td>level of hemoglobin in blood (usually done as part of complete blood count)</td>
<td>polycythemia, dehydration, anemia, sickle cell anemia, recent hemorrhage</td>
</tr>
<tr>
<td>hematocrit (HCT, Hct)</td>
<td>measure of packed red blood cells in a sample (usually done as part of complete blood count). This shows the percent of red blood cells.</td>
<td>polycythemia, dehydration, blood loss, anemia</td>
</tr>
<tr>
<td>mean corpuscular volume (MCV)</td>
<td>volume of individual cells (usually part of blood indices)</td>
<td>microcytic or macrocytic anemia</td>
</tr>
<tr>
<td>mean corpuscular hemoglobin (MCH)</td>
<td>weight of hemoglobin in average red blood cell (usually part of blood indices)</td>
<td>classification of anemia</td>
</tr>
<tr>
<td>mean corpuscular hemoglobin</td>
<td>concentration of hemoglobin in a red blood cell (usually part of blood indices)</td>
<td>hyperchromic or hypochromic anemia</td>
</tr>
<tr>
<td>concentration (MCHC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

known as an SMA (sequential multiple analyzer), the name of the first machine used to analyze blood chemistries.

**VOCABULARY REVIEW**

In the previous section, you learned diagnostic, procedural, and laboratory terms. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>antiglobulin test</td>
<td>Test for antibodies on red blood cells.</td>
</tr>
<tr>
<td>anti(body) + globulin</td>
<td></td>
</tr>
<tr>
<td>biochemistry panel</td>
<td>Common group of automated tests run on one blood sample.</td>
</tr>
</tbody>
</table>
### Term Definition

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>blood chemistry</td>
<td>Test of plasma for presence of a particular substance such as glucose.</td>
</tr>
<tr>
<td>blood culture</td>
<td>Test of a blood specimen in a culture medium to observe for particular microorganisms.</td>
</tr>
<tr>
<td>blood indices [ˌɪn-dɪ-sēz]</td>
<td>Measurement of the characteristics of red blood cells.</td>
</tr>
<tr>
<td>chemistry profile</td>
<td>See blood chemistry.</td>
</tr>
<tr>
<td>complete blood count (CBC)</td>
<td>Most common blood test for a number of factors.</td>
</tr>
<tr>
<td>erythrocyte sedimentation rate (ESR)</td>
<td>Test for rate at which red blood cells fall through plasma.</td>
</tr>
<tr>
<td>partial thromboplastin time (PTT)</td>
<td>Test for ability of blood to coagulate.</td>
</tr>
<tr>
<td>phlebotomy [flē-bōt-ō-mē] phleo-, vein + -tom,y, a cutting</td>
<td>See venipuncture.</td>
</tr>
<tr>
<td>platelet count (PLT)</td>
<td>Measurement of number of platelets in a blood sample.</td>
</tr>
<tr>
<td>prothrombin time (PT)</td>
<td>Test for ability of blood to coagulate.</td>
</tr>
<tr>
<td>red blood cell morphology</td>
<td>Observation of shape of red blood cells.</td>
</tr>
<tr>
<td>sedimentation rate (SR)</td>
<td>See erythrocyte sedimentation rate.</td>
</tr>
<tr>
<td>SMA (sequential multiple analyzer)</td>
<td>Original blood chemistry machine; now a synonym for blood chemistry.</td>
</tr>
<tr>
<td>venipuncture [vĕn-i-pŭnk-chŭr, Vĕ-nĭ-pŭnk-chŭr] veni-, vein + puncture</td>
<td>Insertion of a needle into a vein, usually for the purpose of extracting a blood sample.</td>
</tr>
</tbody>
</table>

---

**CASE STUDY**

**Evaluating the Tests**

Mr. Maynard’s record has the following notes from the hematologist’s evaluation.

**ASSESSMENT:** Mr. Maynard has multiple medical problems. He has recently been admitted with abdominal discomfort, the etiology of which is unclear at this point. He was also found to have anemia. A review of his laboratory data shows that his hematocrit has been fluctuating between 27 and 38. His hematocrit on December 6 was 38.9, but within four days it dropped to 32.3. Since then there have also been several incidences in which his hematocrit dropped further, but then improved. This variation in the hematocrit is suggestive of some ongoing blood loss.

**Critical Thinking**

58. Other than blood loss, name at least two other conditions the HCT results might indicate.

59. What is the name of a test for leukocytes?
Match the Test

Match the name of the test in the column on the left to its correct description in the column on the right.

60. ____ blood culture  a. average red blood cell volume
61. ____ hematocrit  b. antibodies on red blood cells
62. ____ sedimentation rate  c. rate at which red blood cells fall
63. ____ white blood count  d. group of automated tests
64. ____ antiglobulin test  e. most common blood test
65. ____ mean corpuscular hemoglobin concentration  f. clotting factors test
66. ____ mean corpuscular volume  g. number of white blood cells
67. ____ complete blood count  h. measure of packed red blood cells
68. ____ prothrombin time  i. concentration of hemoglobin in red blood cells
69. ____ biochemistry panel  j. growing of microorganisms in a culture

Find the Value

Give the expected (normal) range for each of the following laboratory measurements.

70. cholesterol _____________  75. PLT _____________
71. sodium _____________  76. HCT _____________
72. iron _____________  77. RBC _____________
73. thyroid (T4) _____________  78. WBC _____________
74. MCV _____________  79. MCHC _____________

Pathological Terms

Many diseases and disorders have some effect on the blood, but they are really diseases of other body systems. For example, diabetes is a disorder of the endocrine system, but its diagnosis includes an analysis of blood glucose levels.

Actual diseases of the blood are characterized by changes in the supply or characteristics of blood cells, presence of microorganisms affecting the blood, or presence or lack of certain substances in the blood. Dyscrasia is a general term for any disease of the blood with abnormal material present.

Anemia is a general term for a condition in which the red blood cells do not transport enough oxygen to the tissues due to a deficiency in number or quality of red blood cells. The most common types of anemia include:

- Iron-deficiency anemia, a lack of enough iron in the blood that affects the production of hemoglobin
- Aplastic anemia, a failure of the bone marrow to produce enough red blood cells
- Pernicious anemia, a condition in which the shape and number of the red blood cells changes due to a lack of sufficient vitamin B₁₂
• Sickle cell anemia, a hereditary condition (usually in persons of African-American ancestry) characterized by sickle-shaped red blood cells and a breakdown in red blood cell membranes
• Hemolytic anemia, a disorder characterized by destruction of red blood cells
• Posthemorrhagic anemia, a disorder resulting from a sudden, dramatic loss of blood
• Thalassemia, an inherited disorder (usually in people of Mediterranean origin) resulting in an inability to produce sufficient hemoglobin (the most severe form of which is Cooley’s anemia).

Figure 12-9 shows blood cell characteristics for some anemias.

Von Willebrand’s disease is a hemorrhagic disorder in which there is a greater tendency to bleed due to the lack of a clotting factor called Factor VIII. Common symptoms are bruising and nosebleeds. Two other disorders of the blood that involve excessive bleeding are hemophilia and thrombocytopenia. Hemophilia is a hereditary lack of clotting Factor VIII (or, in 15 percent of the cases, a different clotting factor, Factor IX). Hemophiliacs can be treated with medications and transfusions. Thrombocytopenia is a bleeding disorder with insufficient platelets to aid in the clotting process. Thrombocytopenia is present in purpura, a condition with multiple tiny hemorrhages under the skin (Figure 12-10).

Small, flat, red spots called petechiae may indicate a deficiency in the number of platelets. There are a number of disorders of the blood cells or related substances in the blood. Pancytopenia is a condition with a low number of all blood cell components (red blood cells, white blood cells, and thrombocytes). The blood must be supplemented with transfusions. Erythropenia (also called erythrocytopenia) is a disorder with an abnormally low number of red blood cells. Hemochromatosis is a hereditary disorder leading to excessive buildup of iron in the blood. Because excessive iron in the blood can ultimately cause heart failure, people with this disorder have to limit their iron intake.

Polycythemia is a disease that causes an abnormal increase in red blood cells and hemoglobin. Various forms of the disease are associated with conditions such as hypertension and emphysema. Anisocytosis is characterized by red blood cells of differing sizes and shapes, a characteristic that prevents them from functioning normally. Macrocytosis is a disorder with abnormally large red blood cells present, and microcytosis is a disorder with abnormally small red blood cells present. Poikilocytosis is a disorder with irregularly-shaped red blood cells present. Reticulocytosis is a disorder with an abnormal number of immature erythrocytes present. Hemolysis is a disorder with breakdowns in the red blood cell membrane.

There are also disorders of white blood cells. The major disease involving white blood cells is leukemia. Leukemia is a general term for a disorder with an excessive increase in white blood cells in the bone marrow and bloodstream. People with leukemia may experience remissions (disappearances of the disease) and relapses (recurrences of the disease). Some leukemias (acute lymphocytic leukemia and chronic lymphocytic leukemia) occur in the lymph system.

The two most common leukemias of the bone marrow and bloodstream are AML and CML. Acute myelogenous leukemia (AML) is a disorder in which immature granulocytes (or myeloblasts) invade the bone marrow. Chronic
myelogenous leukemia (CML) or chronic granulocytic leukemia is a disorder in which mature and immature myeloblasts are present in the bloodstream and marrow. It is usually a slowly developing illness with a reasonably good prognosis. Acute lymphocytic leukemia (ALL) is a disorder with an abnormal number of immature lymphocytes. It is usually a disease of childhood and adolescence. The prognosis for recovery is very good. Chronic lymphocytic leukemia (CLL) appears mainly in adults and includes an abnormal number of mature lymphocytes.

Another disorder of the white blood cells is granulocytosis, an abnormal increase in granulocytes in the bloodstream, such as neutrophils during infection. Granulocytosis can also occur in combination with allergic conditions or certain infections, in which case it is called eosinophilia, an abnormal increase in eosinophilic granulocytes. Basophilia is an increase in basophilic granulocytes that is found in some types of leukemia. Neutropenia is a disorder with an abnormally low number of neutrophils in the bloodstream. Neutrophilia is a disorder with an abnormal increase in neutrophils.

Erythroblastosis fetalis, or Rh factor incompatibility between the mother and a fetus, can cause death to the fetus or a type of fetal anemia. A blood transfusion or treatment with medication can sometimes save the fetus.

Multiple myeloma is a malignant tumor of the bone marrow. It involves overproduction of certain white blood cells that produce immunoglobulins. The myeloma cells then migrate to different areas of the body where they cause tumors and destroy bony structures.

At www.multiplemyeloma.org, you can learn about the treatment options for multiple myeloma.

In the previous section, you learned terms relating to pathology. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>anemia [æ-NÉ-mé-ä]</td>
<td>Condition in which red blood cells do not transport enough oxygen to the tissues.</td>
</tr>
<tr>
<td>anisocytosis [än-Ī-sō-sī-TŌ-sēs]</td>
<td>Condition with abnormal variation in the size of red blood cells.</td>
</tr>
<tr>
<td>basophilia [bä-sō-FĪL-e-ä]</td>
<td>Condition with an increased number of basophils in the blood.</td>
</tr>
<tr>
<td>eosinophilia [Ē-o-sīn-ō-FĪL-e-ä]</td>
<td>Condition with an abnormal number of eosinophils in the blood.</td>
</tr>
<tr>
<td>erythroblastosis fetalis [ē-RĪTH-rō-blās-TŌ-sīs fē-TĀL-īs]</td>
<td>Incompatibility disorder between a mother with Rh negative and a fetus with Rh positive.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td><strong>erythropenia</strong></td>
<td>Disorder with abnormally low number of red blood cells.</td>
</tr>
<tr>
<td><strong>granulocytosis</strong></td>
<td>Condition with an abnormal number of granulocytes in the bloodstream.</td>
</tr>
<tr>
<td><strong>hemochromatosis</strong></td>
<td>Hereditary condition with excessive iron buildup in the blood.</td>
</tr>
<tr>
<td><strong>hemolysis</strong></td>
<td>Disorder with breakdown of red blood cell membranes.</td>
</tr>
<tr>
<td><strong>hemophilia</strong></td>
<td>Hereditary disorder with lack of clotting factor in the blood.</td>
</tr>
<tr>
<td><strong>leukemia</strong></td>
<td>General term for a number of disorders with excessive white blood cells in the bloodstream and bone marrow.</td>
</tr>
<tr>
<td><strong>macrocytosis</strong></td>
<td>Disorder with abnormally large red blood cells.</td>
</tr>
<tr>
<td><strong>microcytosis</strong></td>
<td>Disorder with abnormally small red blood cells.</td>
</tr>
<tr>
<td><strong>multiple myeloma</strong></td>
<td>Malignant tumor of the bone marrow.</td>
</tr>
<tr>
<td><strong>myeloblast</strong></td>
<td>Immature granulocytes.</td>
</tr>
<tr>
<td><strong>pancytopenia</strong></td>
<td>Condition with a low number of blood components.</td>
</tr>
<tr>
<td><strong>poikilocytosis</strong></td>
<td>Disorder with irregularly shaped red blood cells.</td>
</tr>
<tr>
<td><strong>polycythemia</strong></td>
<td>Disorder with an abnormal increase in red blood cells and hemoglobin.</td>
</tr>
<tr>
<td><strong>purpura</strong></td>
<td>Condition with multiple tiny hemorrhages under the skin.</td>
</tr>
<tr>
<td><strong>reticulocytosis</strong></td>
<td>Disorder with an abnormal number of immature erythrocytes.</td>
</tr>
<tr>
<td><strong>thalassemia</strong></td>
<td>Hereditary disorder characterized by inability to produce sufficient hemoglobin.</td>
</tr>
<tr>
<td><strong>thrombocytopenia</strong></td>
<td>Bleeding condition with insufficient production of platelets.</td>
</tr>
<tr>
<td><strong>von Willebrand's disease</strong></td>
<td>Hemorrhagic disorder with tendency to bleed from mucous membranes.</td>
</tr>
</tbody>
</table>
CASE STUDY

Reading the X-Rays
Next, the radiology report is added to Mr. Maynard's record, and the hematologist adds notes.

Critical Thinking
80. Does a CBC provide enough information for a diagnosis of anemia or chronic blood loss?
81. Is Rh factor important for an 83-year-old man? Why or why not?

RADIOLOGY: Abdomen: Adynamic ileus.
April 2, 2XXX: Chest; bibasilar changes compatible with a small pleural effusion. Increased density in the right lung and small localized density because of rotation.
December 4, 2XXX: Abdominal ultrasound; normal biliary examination. Bilateral multiple renal cysts. Liver; fatty texture.

In summary, I have initiated more workup for anemia. The possibilities include anemia of chronic disease, myelodysplasia, or chronic blood loss. If his workup is inconclusive, then he might require bone marrow aspiration and biopsy to establish the diagnosis.

PATHOLOGICAL TERMS EXERCISES

Spell It Correctly
The following terms are either spelled correctly or incorrectly. Put C in the space following correctly spelled words. Put the correct spelling in the space following incorrectly spelled words.

82. hemophilia _____________
83. pancypenia _____________
84. macrocytosis _____________
85. anemia _____________
86. aplastic anemia _____________
87. eosinophilia _____________
88. pupura _____________
89. reticulocytosis _____________
90. thrombocytopenia _____________
91. poikilocytosis _____________

Check Your Knowledge
Circle T for true or F for false.

92. Sickle cell anemia is found primarily in people of Mediterranean origin. T F
93. All red blood cell disorders are inherited. T F
94. A sudden loss of blood can cause anemia. T F
95. Multiple myeloma is a form of cancer. T F
96. Rh factor incompatibility can cause hemochromatosis. T F
97. Pernicious anemia may result from a deficiency of vitamin B12. T F
98. Leukemia and anemia are types of cancer. T F
99. Too many red blood cells can be a symptom of a disorder. T F

**Find the Meaning**
Describe the cause of each of the following forms of anemia.

100. aplastic anemia
101. iron-deficiency anemia
102. pernicious anemia
103. thalassemia
104. sickle cell anemia

**CASE STUDY**

**Getting Confirmation**
In addition to his other problems, Mr. Maynard has prostate cancer. His PSA has remained normal for a few years, so the cancer is thought to be in remission. However, the cause of the anemia was not confirmed. His diagnosis is also not confirmed, so a bone marrow biopsy is ordered. The bone marrow biopsy confirms aplastic anemia.

**Critical Thinking**
105. Describe the abnormality that the bone marrow biopsy reveals.
106. Does Mr. Maynard’s condition require treatment before he has any surgery?

**Surgical Terms**
Surgery is not generally performed on the blood system. Sometimes venipuncture is considered a minor surgical procedure. (In this text, we have classified it as a diagnostic procedure.) The exceptions are bone marrow biopsy and bone marrow transplant.

A bone marrow biopsy is used in the diagnosis of various blood disorders, such as anemia and leukemia. A needle is introduced into the bone marrow cavity and marrow is extracted for examination.

A bone marrow transplant is performed for serious ailments, such as leukemia and cancer. In this procedure, a donor’s marrow is introduced into the bone marrow of the patient. First, all the diseased cells are killed through extensive radiation and chemotherapy. After the donor’s marrow is introduced, successful transplants result in healthy cells taking over the patient’s marrow. Unsuccessful transplants may result in rejection of the marrow or a recurrence of the disease.

**Vocabulary Review**
In the previous section, you learned terms relating to surgery. Before going to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes
Pharmacological Terms

Medications that directly affect the work of the blood system are anticoagulants (to prevent blood clotting); thrombolytics (to dissolve blood clots); coagulants or clotting agents (to aid in blood clotting); and hemostatics (to stop bleeding, such as vitamin K). Anticoagulants are administered before most types of surgeries to prevent emboli. Blood flow is affected by vasoconstrictors and vasodilators, two medications given for cardiovascular problems.

Chemotherapy, therapy that uses drugs, is used to cause a remission (disappearance of the disease) in leukemia. Sometimes more treatment is needed when a relapse (recurrence of the disease) occurs. Table 12-4 lists common pharmaceutical agents used in treating blood disorders.

TABLE 12-4 Some Pharmaceutical Agents Used to Treat Blood Disorders

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Purpose</th>
<th>Generic</th>
<th>Trade Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>anticoagulant</td>
<td>dissolves blood clots</td>
<td>warfarin, heparin,</td>
<td>Coumadin, various</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dipyrimadole, enoxaparin</td>
<td>Persantine, Lovenox, Mephyton</td>
</tr>
<tr>
<td>clotting agent; coagulant</td>
<td>aids in clotting blood</td>
<td>phytonadione, vitamin K</td>
<td></td>
</tr>
<tr>
<td>hemostatic</td>
<td>stops bleeding</td>
<td>aminocaproic acid,</td>
<td>Amicar, NovoSeven</td>
</tr>
<tr>
<td></td>
<td></td>
<td>recombinant factor VIIa</td>
<td></td>
</tr>
<tr>
<td>thrombolytic</td>
<td>dissolves blood clots</td>
<td>streptokinase, urokinase</td>
<td>Streptase, Abbokinase, Activase</td>
</tr>
</tbody>
</table>
In the previous section, you learned terms relating to pharmacology. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. These etymologies (word histories) are for your information only. You do not need to memorize them.

**Term** | **Definition**
--- | ---
**anticoagulant** [ÃN-tē-kō-ÃG-yū-lēnt] anti-, against + coagulant | Agent that prevents formation of blood clots.
**coagulant** [kō-ÃG-yū-lēnt] Latin coagulo, to curdle | Clotting agent.
**hemostatic** [hē-mō-STÂT-ik] hemo-, blood + -static, maintaining a state | Agent that stops bleeding.
**relapse** [RĒ-lāps] From Latin relabor, to slide back | Recurrence of a disease.
**remission** [rē-MĪSH-ūn] Latin remissio, a relaxation | Disappearance of a disease for a time.
**thrombolytic** [thrōm-bō-LĪT-ik] thrombo-, thrombus + -lytic, a loosening | Agent that dissolves blood clots.

**CASE STUDY**

**Coordinating Prescription Medication**

Mr. Maynard’s medication list at admission is:

Cardura 4 mg. p.o. q.h.s.
Ventolin unit does t.i.d.
Atrovent unit does t.i.d.
Ceftin 250 mg. b.i.d. prior to admission.
Magnesium citrate b.i.d.
Lactulose 30 cc p.o. b.i.d.

Cardura is for his high blood pressure and prostate problems. Ventolin and Atrovent are prescribed for his respiratory symptoms. Ceftin is an antibiotic for a urinary tract infection. Magnesium citrate and lactulose are laxatives.

**Critical Thinking**

107. Aspirin is known to promote some bleeding. Should Mr. Maynard use aspirin for pain?
108. What vitamin might improve Mr. Maynard’s condition?

**PHARMACOLOGICAL TERMS EXERCISES**

**Check Your Knowledge**

Fill in the blanks.

109. Hemophiliacs require _______ and _______ to control bleeding.

110. A prescription for someone with coronary artery disease might include a(n) _______.

404 Chapter 12 The Blood System
111. If medication is not taken regularly, a(n) ________ of a disease might occur.

112. Sometimes the temporary disappearance of a disease, called a(n) ________, is unexplained.

**Challenge Section**

The form shown in Figure 12-8 gives results for a patient and expected ranges for lab tests done in a large lab service.

**Critical Thinking**

113. What tests, if any, are abnormal?

114. The laboratory was instructed to do a T3 and T4 uptake test. What was the patient’s physician trying to determine?

**Terminology in Action**

Alicia Minot is a 21-year-old student who is prone to migraine headaches. Her latest visit to her family doctor included a general physical and a CBC as well as a urinalysis. All test results were normal except for a low hemoglobin count. Alicia complains that Tylenol does not relieve her headaches and she wants to use her mother’s aspirin. Do you think the doctor will recommend aspirin? Why or why not? What are some steps Alicia can take in her daily life to raise her hemoglobin count?

**Using the Internet**

Go to the Web site of the Aplastic Anemia Association (www.aplastic.org). Choose one of their online articles and write a paragraph summarizing its content.
CHAPTER REVIEW

The material that follows is to help you review all the material in this chapter.

Matching
Write the letter of the meaning of the term in the space provided.

115. ___________ erythropoietin
    a. Protein in the plasma that aids in clotting.
116. ___________ fibrinogen
    b. Substance released by basophils and eosinophils; involved in allergic reactions.
117. ___________ gamma globulin
    c. Protein that aids in forming a fibrin clot.
118. ___________ histamine
    d. Hormone released by the kidneys to stimulate red blood cell production.
119. ___________ plasmapheresis
    e. A protein that arises in lymphatic tissue and functions as part of the immune system.
120. ___________ thromboplastin
    f. Process of removing blood from a person, centrifuging it, and returning only red blood cells to that person.

Complete the Sentence
Circle the term that best describes the italicized description of the correct answer

121. Mrs. Sommers is lacking the Rh factor on the surface of her red blood cells, therefore she is (Rh-negative, Rh-neutral, Rh-positive).

122. Mr. Martinez has an increase in his platelet count or (thrombocytes, granulocytes, megakaryocytes).

123. The liquid portion of unclotted blood is called (serum, plasma, albumin).

124. The physician informed Mrs. Larkin that the protein in the red cells essential to the transport of oxygen was low. He was referring to her (red blood cell, hematocrit, hemoglobin) level.

125. Basophils, eosinophils and neutrophils are all considered (granulocytes, agranulocytes, hematocystoblasts).

126. The process of infusing donor blood into a person needing blood is known as: (plasmapheresis, agglutination, transfusion).

Root Out the Meaning
Separate the following terms into word parts; define each word part.

127. eosinophilic     ______________________________________________________________________________
128. hemolysis ___________________________________________________________________________________
129. hemocytometer ______________________________________________________________________________
130. pancytopenia ________________________________________________________________________________
131. phlebitis __________________________________________________________________________________
132. phlebotomy _________________________________________________________________________________
133. phlebectomy ______________________________________________________________________________
134. hematoma __________________________________________________________________________________
135. anisocytosis _________________________________________________________________________________
136. thrombophlebitis ____________________________________________________________________________
137. hemostatic

138. venospasm

139. hemogram

140. hemolytic

141. anemia

142. phlebography

143. phlebectasia

144. hemorrhage

145. hemopathy

146. hematopoiesis

147. hematology

148. plasmapheresis

149. sideropenia

150. basophil

**Complete the Sentence**

Circle the term that best describes the *italicized* description of the correct answer.

151. A disorder in which there are *excessive red blood cells* is known as: (erythrocytopenia, polycythemia, leukemia).

152. This test measures the amount of *protein essential to the transport of oxygen*. (hematocrit, hemogram, hemoglobin).

153. A *blood disorder with a tendency to hemorrhage* is known as (hemophilia, anemia, dyscrasia).

154. The test results indicated a *fragmentation of red blood cells* or (eosinosis, erythroclasis, erytholysis).

155. The term *hemocytoblasts* refers to (red cells, stem cells, white cells).

156. The *largest of the white blood cells* is called a (neutrophil, basophil, monocyte).

157. These cells *break off from larger cells in the red bone marrow* and assist in blood clotting (megakaryocytes, agranulocytes, proerythoblasts).

158. A MCV test can indicate (microcytic or macrocytic, hyperchromic or hypochromic) anemia.

**Building Your Medical Vocabulary**

Construct a word with each of the following meanings. Some of the word parts you need to use are in Chapters 1 and 2.

159. An immature white blood cell _____________

160. Dissolution of red blood cells _____________

161. The study of the structure of red blood cells _____________

162. A normal (red) blood cell _____________

163. A cell that ingests bacteria and other particles _____________

164. Irregularly shaped red blood cells _____________

165. A spherical red blood cell _____________

166. White blood cell cancer _____________
167. Removal of white blood cells from drawn blood _____________
168. Forming new blood cells _____________

Matching
Indicate whether the abbreviation refers to red cells, white cells or platelets.
R = red cells
W = white cells
P = platelets

169. ___ APTT 174. ___ ESR
170. ___ seg 175. ___ diff
171. ___ SR 176. ___ mono
172. ___ PLT 177. ___ MCHC
173. ___ HCT 178. ___ PMN, poly

Matching
Place the letter of the pharmaceutical agents used to treat blood disorders to the left in the blank and then state the drugs purpose in the blank after the drug class.

179. Thrombolytic: _____________ a. heparin
180. Coagulant: _____________ b. streptokinase
181. Hemostatic: _____________ c. vitamin K
182. Anticoagulant: _____________ d. aminocaproic acid

True or False
Indicate in the blank whether the statement is true or false.

183. The disappearance of a disease for a time is known as submission _____________.
184. A bone marrow transplant is the extraction of bone marrow, by means of a needle, for observation _____________.
185. A malignant tumor of the bone marrow is referred to as multiple myeloma _____________.
186. Erythroblastosis fetalis is the a condition in which a fetus forms new red blood cells _____________.
187. Purpura is a condition in which multiple tiny hemorrhages form under the skin _____________.
188. Aplastic anemia is the failure of the bone marrow to produce enough red blood cells _____________.
189. Hemodialysis is the internal dialysis performed by separating solid substances and water from the blood _____________.
190. Agglutination is the clumping of cells and particles in the blood _____________.
191. Plasma is the liquid portion of clotted blood _____________.
192. A hereditary condition with excessive iron buildup in the blood is known as sickle cell anemia _____________.

Check Your Spelling
If the word is spelled correctly place a C in the blank. If the term is not spelled correctly, place the correct spelling in the blank.

193. miloblast _____________ 195. neutralphil _____________
194. hematoglobin _____________ 196. granulocytosis _____________
**Definitions**

Define the following terms and combining forms. Review the chapter before starting. Make sure you know how to pronounce each term as you define it. The blue words in curly brackets are references to the Spanish Glossary available online at www.mhhe.com/medterm3e.

### Word

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>205. agglutin(o)</td>
<td>agglutination [á-glū-ti-NÁ-shún] [aglutinación]</td>
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<tr>
<td>206. agglutination</td>
<td>agglutination [á-glū-ti-NÁ-shún] [aglutinación]</td>
</tr>
<tr>
<td>207. agglutinogen [á-glū-TÍN-o-jén]</td>
<td>agglutinogen [á-glū-TÍN-o-jén] [aglutinógeno]</td>
</tr>
<tr>
<td>208.агранулоцит [á-GRÂN-yú-lo-sít]</td>
<td>agranulocyte [á-GRÂN-yú-lo-sít] [agranulocito]</td>
</tr>
<tr>
<td>209. альбумин [ál-BYÚ-min]</td>
<td>albumin [ál-BYÚ-min] [albúmina]</td>
</tr>
<tr>
<td>210. анемия [á-NÊ-mé-á]</td>
<td>anemia [á-NÊ-mé-á] [anemia]</td>
</tr>
<tr>
<td>211. анизоцитозис [án-Í-só-sí-TÓ-sís]</td>
<td>anisocytosis [án-Í-só-sí-TÓ-sís]</td>
</tr>
<tr>
<td>214. базофило [BÁ-so-fíl]</td>
<td>basophil [BÁ-so-fíl] [basófilo]</td>
</tr>
<tr>
<td>215. базофилия [bā-so-FÍL-e-á]</td>
<td>basophilia [bā-so-FÍL-e-á] [basofilia]</td>
</tr>
<tr>
<td>216. биохимический анализ</td>
<td>biochemistry panel</td>
</tr>
<tr>
<td>217. кровь [blúd]</td>
<td>blood [blúd] [sangre]</td>
</tr>
<tr>
<td>218. химия крови</td>
<td>blood chemistry</td>
</tr>
<tr>
<td>219. кровь</td>
<td>blood culture</td>
</tr>
<tr>
<td>220. индексы крови</td>
<td>blood indices [ÍN-dí-sèz]</td>
</tr>
<tr>
<td>221. кровь или группы</td>
<td>blood types or groups</td>
</tr>
<tr>
<td>222. костный мозгная биопсия</td>
<td>bone marrow biopsy</td>
</tr>
<tr>
<td>223. костный мозгный трансплантат</td>
<td>bone marrow transplant</td>
</tr>
<tr>
<td>224. химический анализ</td>
<td>chemistry profile</td>
</tr>
<tr>
<td>225. коагулянт [ko-ÅG-yú-lênt]</td>
<td>coagulant [ko-ÅG-yú-lênt]</td>
</tr>
<tr>
<td>226. коагуляция [kō-åg-yú-LÁ-shún]</td>
<td>coagulation [kō-åg-yú-LÁ-shún] [coagulación]</td>
</tr>
<tr>
<td>227. полное число крови</td>
<td>complete blood count (CBC)</td>
</tr>
<tr>
<td>228. диссемиация [díš-KRÁ-zhe-á]</td>
<td>dyscrasia [díš-KRÁ-zhe-á] [dyscrasia]</td>
</tr>
<tr>
<td>230. эозинофил [é-ös-SÍN-o-fíl]</td>
<td>eosinophil [é-ös-SÍN-o-fíl] [eosinófilo]</td>
</tr>
<tr>
<td>232. еритрой [e-riTÒ-sís]</td>
<td>erythroblastosis fetalis [é-riTÒ-sís]</td>
</tr>
<tr>
<td>233. еритроцит [é-riTÒ-sís]</td>
<td>erythrocyte [é-riTÒ-sís] [eritrocito]</td>
</tr>
<tr>
<td>234. еритромедицина</td>
<td>erythrocyte sedimentation rate (ESR)</td>
</tr>
<tr>
<td>235. еритропения [é-riTÒ-sís]</td>
<td>erythropenia [é-riTÒ-sís] [eritropenia]</td>
</tr>
<tr>
<td>236. еритропоэтина</td>
<td>erythropoietin [é-riTÒ-sís] [eritropoetina]</td>
</tr>
<tr>
<td>237. еритромедицина [é-riTÒ-sís]</td>
<td>erythrocyte sedimentation rate (ESR)</td>
</tr>
<tr>
<td>238. еритропения [é-riTÒ-sís]</td>
<td>erythropenia [é-riTÒ-sís] [eritropenia]</td>
</tr>
<tr>
<td>239. фибрин [fí-brín]</td>
<td>fibrinogen [fí-GRÍN-o-jén] [fibrinógeno]</td>
</tr>
<tr>
<td>240. фибриноген [fí-GRÍN-o-jén]</td>
<td>fibrinogen [fí-GRÍN-o-jén] [fibrinógeno]</td>
</tr>
<tr>
<td>241. гамма глобулин [GÁ-má GLÖB-yú-lín]</td>
<td>gamma globulin [GÁ-má GLÖB-yú-lín]</td>
</tr>
<tr>
<td>242. глобин [GLÖB-yú-lín]</td>
<td>globin [GLÖB-yú-lín] [globina]</td>
</tr>
<tr>
<td>243. глобулин [GLÖB-yú-lín]</td>
<td>globulin [GLÖB-yú-lín]</td>
</tr>
<tr>
<td>244. гранулоцит [GRÂN-yú-lo-sít]</td>
<td>granulocyte [GRÂN-yú-lo-sít]</td>
</tr>
<tr>
<td>245. гранулоцитозис [GRÂN-yú-lo-sít]</td>
<td>granulocytosis [GRÂN-yú-lo-sít]</td>
</tr>
<tr>
<td>246. гематокрит [HÉ-má-tô-křít]</td>
<td>hematocrit [HÉ-má-tô-křít]</td>
</tr>
<tr>
<td>247. гематоцитобласт [HÉ-má-tô-SÍ-tô-blást]</td>
<td>hemocytoblast [HÉ-má-tô-SÍ-tô-blást]</td>
</tr>
<tr>
<td>248. гем [hêm]</td>
<td>heme [hêm]</td>
</tr>
<tr>
<td>249. гемо, гемато (o)</td>
<td>hemo, hemat(o)</td>
</tr>
<tr>
<td>250. гемохроматозис</td>
<td>hemochromatosis [HÉ-mó-křo-má-TÓ-sís]</td>
</tr>
<tr>
<td>251. гемоглобин [hê-mô-GLÖ-bín]</td>
<td>hemoglobin [hê-mô-GLÖ-bín]</td>
</tr>
<tr>
<td>252. гемолизис [he-MÔL-i-sís]</td>
<td>hemolysis [he-MÔL-i-sís]</td>
</tr>
<tr>
<td>253. гемофилия [hê-mô-FLÈ-ę]</td>
<td>hemophilia [hê-mô-FLÈ-ę]</td>
</tr>
<tr>
<td>254. гемостатический [hê-mô-STÀ-Tík]</td>
<td>hemostatic [hê-mô-STÀ-Tík]</td>
</tr>
<tr>
<td>255. гепарин [HÉP-à-řín]</td>
<td>heparin [HÉP-à-řín] [heparina]</td>
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<tr>
<td>256. гистамин [HÍS-tà-mén]</td>
<td>histamine [HÍS-tà-mén] [histamina]</td>
</tr>
<tr>
<td>257. лук (o)</td>
<td>leuk(o)</td>
</tr>
<tr>
<td>258. лейкоцит [LÚ-kó-sít]</td>
<td>leukocyte [LÚ-kó-sít] [leucócit]</td>
</tr>
<tr>
<td>259. лейкемия [lú-KÊ-mé-ä]</td>
<td>leukemia [lú-KÊ-mé-ä] [leucemia]</td>
</tr>
</tbody>
</table>
Abbreviations

Write the full meaning of each abbreviation.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>APTT</td>
<td>partial thromboplastin time (PTT)</td>
</tr>
<tr>
<td>baso</td>
<td>basophil</td>
</tr>
<tr>
<td>BMT</td>
<td>bone marrow transplant (BMT)</td>
</tr>
<tr>
<td>CBC</td>
<td>complete blood count (CBC)</td>
</tr>
<tr>
<td>diff</td>
<td>differential cell count</td>
</tr>
<tr>
<td>eos</td>
<td>eosinophil</td>
</tr>
<tr>
<td>ESR</td>
<td>erythrocyte sedimentation rate (ESR)</td>
</tr>
<tr>
<td>G-CSF</td>
<td>granulocyte colony-stimulating factor (G-CSF)</td>
</tr>
<tr>
<td>GM-CSF</td>
<td>granulocyte-macrophage colony-stimulating factor (GM-CSF)</td>
</tr>
<tr>
<td>HCT, Hct</td>
<td>hematocrit</td>
</tr>
<tr>
<td>HGB, Hgb, HB</td>
<td>hemoglobin</td>
</tr>
<tr>
<td>MCH</td>
<td>mean corpuscular hemoglobin</td>
</tr>
<tr>
<td>MCHC</td>
<td>mean corpuscular hemoglobin concentration</td>
</tr>
<tr>
<td>MCV</td>
<td>mean corpuscular volume</td>
</tr>
<tr>
<td>mono</td>
<td>monocyte</td>
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<tr>
<td>PCV</td>
<td>platelet count (PCV)</td>
</tr>
<tr>
<td>PLT</td>
<td>platelet (PLT)</td>
</tr>
<tr>
<td>PMN, poly</td>
<td>polymorphonuclear leukocyte (PMN)</td>
</tr>
<tr>
<td>PT</td>
<td>prothrombin time (PT)</td>
</tr>
<tr>
<td>PTT</td>
<td>partial thromboplastin time (PTT)</td>
</tr>
<tr>
<td>RBC</td>
<td>red blood cell (RBC)</td>
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<tr>
<td>Rh-negative</td>
<td>Rh-negative leukocytes</td>
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<tr>
<td>Rh-positive</td>
<td>Rh-positive leukocytes</td>
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<tr>
<td>SR</td>
<td>sedimentation rate (SR)</td>
</tr>
<tr>
<td>SMA</td>
<td>sequential multiple analyzer (SMA)</td>
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<tr>
<td>SR, sed. rate</td>
<td>sedimentation rate (SR)</td>
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<tr>
<td>seg</td>
<td>segmented neutrophil</td>
</tr>
<tr>
<td>WBC</td>
<td>white blood cell (WBC)</td>
</tr>
<tr>
<td>WBC, white blood cell</td>
<td></td>
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</table>
Answers to Chapter Exercises

1. c
2. a
3. b
4. b
5. c
6. c
7. b
8. c
9. b
10. b
11. b
12. c
13. b
14. AB
15. O
16. B
17. A
18. O
19. AB
20. B
21. A
22. d
23. g
24. a
25. b
26. c
27. e
28. h
29. f
30. Blood circulates throughout the body and exchanges substances with most of the body's cells.
31. No; blood type does not make one more susceptible.
32. e
33. f
34. g
35. h
36. j
37. b
38. i
39. c
40. d
41. a
42. tending to clump together
43. removal of a thrombus
44. immature red blood cell
45. study of diseases of the blood
46. movement of eosinophils
47. immature white blood cell
48. part of the cell that aids a cell in digesting unwanted particles
49. disease with increased red blood cells
50. study of cells
51. white blood cell
52. disease (type of cancer) with abnormal number of white blood cells
53. abnormally small amount of platelets in the blood
54. blood-filled mass
55. disease with increased red blood cell counts
56. Venipuncture; Yes; small amounts of blood are replaced within a day or so.
57. RBC measures red blood cells and WBC measures white blood cells.
58. anemia; dehydration; polycythemia
59. white blood count (WBC)
60. j
61. h
62. c
63. g
64. b
65. i
66. a
67. e
68. f
69. d
70. 120–199
71. 135–145
72. 30–150
73. 4.5–12.8
74. 80.0–98.0
75. 150–400
76. 34.0–47.0
77. 3.80–5.20
78. 3.9–11.1
79. 32.0–36.0
80. Yes. Anemia and chronic blood loss are indicated by the percentage of red blood cells noted in a CBC.
81. Yes; it is important for everybody who might need a transfusion.
82. hemophilia
83. pancytopenia
84. C
85. C
86. aplastic anemia
87. eosinophilia
88. purpura
89. C
90. thrombocytopenia
91. C
92. F
93. F
94. T
95. T
96. F
97. T
98. T
99. T
100. failure in production of red blood cells
101. lack of enough iron either in diet or absorption, which causes insufficient production of hemoglobin
102. insufficient vitamin B₁₂, which causes abnormal red blood cell shape
103. hereditary blood disorder with insufficient hemoglobin production
104. hereditary red blood cell disorder with misshapen cells and breakdown in cell membranes that creates problems with carrying oxygen to the tissues
105. aplastic anemia, a failure of the bone marrow to produce enough red blood cells
106. Yes; anemia is a complication that should be dealt with first because of the probability of further blood loss during surgery.
107. No. He cannot afford to lose more blood.
108. Vitamin B₁₂
109. coagulants; hemostatics
110. anticoagulant
111. relapse
112. remission
113. cholesterol; HDL; LDL;
114. thyroid function
115. d
116. a
117. e
118. b
119. f
120. c
Chapter 12 The Blood System

121. Rh-negative
122. thrombocytes
123. plasma
124. hemoglobin
125. granulocytes
126. transfusion
127. eosin(o), red (stain) + phil(o), affinity for + -ic, pertaining to
128. hem(o), blood + -lysis, destruction
129. hem(o), blood + cyt(o), cell + -meter, instrument used to measure
130. pan-, all + cyt(o), cells + -penia, deficiency
131. phleb(o), vein + -itis, inflammation
132. phleb(o), vein + -ectomy, incision into
133. phleb(o), vein + -ectomy, excision
134. hemat(o), blood + -oma, tumor
135. an-, without + is(o), equal + cyt(o), cell + -osis, condition
136. thromb(o), clot + phleb(o), vein + -itis, inflammation
137. hem(o), blood + -static, stopping, maintaining
138. ven(o), vein + -spasm, contraction
139. hem(o), blood (tests) + -gram, a record
140. hem(o), blood + -lytic, destroying
141. an- without + -emia, blood
142. phleb(o), vein + -graphy, process of recording
143. phleb(o), vein + -ectasia, dilation
144. hem(o), blood + -rrhage, heavy discharge
145. hem(o), blood + -pathy, disease
146. hemat(o), blood + -poiesis, formation
147. hem(o), blood + -ology, study of
148. plasma, fluid part of blood + -pheresis, removal
149. sider(o), iron + penia, deficiency
150. bas(o), base (blue dye) + -phil, affinity for
151. polycythemia
152. hemoglobin
153. hemophilia
154. erythroclasis
155. stem cells
156. monocyte
157. megakaryocytes
158. microcytic or macrocytic
159. leukoblast
160. lysemia
161. red cell morphology
162. normocyte
163. phagocyte
164. poikilocytes
165. spherocyte
166. leukemia
167. leukopheresis
168. hemoplastic
169. P
170. W
171. W
172. P
173. R
174. R
175. W
176. W
177. R
178. W
179. b; dissolves blood clots
180. c; aids in clotting blood
181. d; stops bleeding
182. a; dissolves blood clots
183. F
184. F
185. T
186. F
187. T
188. T
189. F
190. T
191. F
192. F
193. myeloblast
194. hemoglobin
195. neutrophil
196. C
197. histamine
198. C
199. C
200. C
201. aniscytosis
202. reticulocytosis
203. venipuncture
204. phlebotomy
205–329. Answers are available in the vocabulary reviews in this chapter.