

Blood

Objectives

Overview: Blood Composition and Functions

1. Describe the components of blood and their relative proportions. Define the blood hematocrit.
2. List the physical characteristics of blood. Indicate the normal volumes for males and females.
3. Discuss the functions of blood.

Blood Plasma

4. Define blood plasma and list the components and their functions.

Formed Elements

5. Indicate the formed elements of the blood, their structure, function, and development.
6. Explain the fate and destruction of erythrocytes.
7. Examine the disorders of too many and too few of each type of formed element.

Hemostasis

8. Define hemostasis.
9. Identify the events of platelet plug formation.
10. List the events of the coagulation phase of hemostasis. Differentiate between the intrinsic and extrinsic pathways of prothrombin formation.
11. Explain the mechanism and function of clot retraction and tissue repair.
12. Discuss the factors that limit clot formation.

Transfusion and Blood Replacement

13. List the reasons for transfusion of whole blood, plasma, and blood volume expanders.
14. Discuss the basis for human blood groups. Identify what factor determines each blood group.
15. Explain the results of a transfusion reaction, and how blood typing is used to avoid such a problem.

Diagnostic Blood Tests

16. Indicate how the various types of diagnostic blood tests are used.

Developmental Aspects of Blood

17. List the structures involved in formation of fetal blood.
18. Compare fetal and adult hemoglobin.

Suggested Lecture Outline

I. Overview: Blood Composition and Functions (pp. 647–648; Fig. 17.1)

- A. Components (pp. 647–648; Fig. 17.1)
 1. Blood is a specialized connective tissue consisting of living cells, called formed elements, suspended in a nonliving fluid matrix, blood plasma.
 2. Blood that has been centrifuged separates into three layers: erythrocytes, the buffy coat, and plasma.

3. The blood hematocrit represents the percentage of erythrocytes in whole blood.
- B. Physical Characteristics and Volume (p. 648)
1. Blood is a slightly basic (pH = 7.35–7.45) fluid that has a higher density and viscosity than water, due to the presence of formed elements.
 2. Normal blood volume in males is 5–6 liters, and 4–5 liters for females.
- C. Functions (p. 648)
1. Blood is the medium for delivery of oxygen and nutrients, removal of metabolic wastes to elimination sites, and distribution of hormones.
 2. Blood aids in regulating body temperature, body fluid pH, and fluid volume within fluid compartments.
 3. Blood protects against excessive blood loss through the clotting mechanism, and from infection through the immune system.

II. Blood Plasma (pp. 648–649; Table 17.1)

- A. Blood plasma consists of mostly water (90%), and solutes including nutrients, gases, hormones, wastes, products of cell activity, ions, and proteins.
- B. Plasma proteins account for 8% of plasma solutes, mostly albumin, which function as carriers.

III. Formed Elements (pp. 649–662; Figs. 17.2–17.12; Table 17.2)

- A. Erythrocytes (pp. 649–656; Figs. 17.3–17.8)
1. Erythrocytes, or red blood cells, are small cells that are biconcave in shape. They lack nuclei and most organelles, and contain mostly hemoglobin.
 - a. Hemoglobin is an oxygen-binding pigment that is responsible for the transport of most of the oxygen in the blood.
 - b. Hemoglobin is made up of the protein globin bound to the red heme pigment.
 2. Production of Erythrocytes
 - a. Hematopoiesis, or blood cell formation, occurs in the red bone marrow.
 - b. Erythropoiesis, the formation of erythrocytes, begins when a myeloid stem cell is transformed to a proerythroblast, which develops into mature erythrocytes.
 - c. Erythrocyte production is controlled by the hormone erythropoietin.
 - d. Dietary requirements for erythrocyte formation include iron, vitamin B₁₂ and folic acid, as well as proteins, lipids, and carbohydrates.
 - e. Blood cells have a short life span due to the lack of nuclei and organelles; destruction of dead or dying blood cells is accomplished by macrophages.
 3. Erythrocyte Disorders
 - a. Anemias are characterized by a deficiency in RBCs.
 - b. Polycythemia is characterized by an abnormal excess of RBCs.
- B. Leukocytes (pp. 656–662; Figs. 17.9–17.11)
1. Leukocytes, or white blood cells, are the only formed elements that are complete cells and make up less than 1% of total blood volume.
 2. Leukocytes are critical to our defense against disease.
 3. Granulocytes are a main group of leukocytes characterized as large cells with lobed nuclei and visibly staining granules; all are phagocytic.
 - a. Neutrophils are the most numerous type of leukocyte. They are chemically attracted to sites of inflammation and are active phagocytes.

- b. Eosinophils are relatively uncommon and attack parasitic worms.
 - c. Basophils are the least numerous leukocyte and release histamine to promote inflammation.
- 4. Agranulocytes are a main group of lymphocytes that lack visibly staining granules.
 - a. T lymphocytes directly attack viral-infected and tumor cells; B lymphocytes produce antibody cells.
 - b. Monocytes become macrophages and activate T lymphocytes.
- 5. Production and Life Span of Leukocytes
 - a. Leukopoiesis, the formation of white blood cells, is regulated by the production of interleukins and colony-stimulating factors (CSF).
 - b. Leukopoiesis involves differentiation of hemocytoblasts along two pathways: lymphoid and myeloid stem cells.
- 6. Leukocyte Disorders
 - a. Leukopenia is an abnormally low white blood cell count.
 - b. Leukemias are clones of a single white blood cell that remain unspecialized and divide out of control.
 - c. Infectious mononucleosis is a disease caused by the Epstein-Barr virus.
- C. Platelets (p. 662; Fig. 17.12)
 - 1. Platelets are not complete cells, but fragments of large cells called megakaryocytes.
 - 2. Platelets are critical to the clotting process, forming the temporary seal when a blood vessel breaks.
 - 3. Formation of platelets involves repeated mitoses of megakaryocytes without cytokinesis.

IV. Hemostasis (pp. 663–668; Figs. 17.13–17.14; Table 17.3)

- A. A break in a blood vessel stimulates hemostasis, a fast, localized response to reduce blood loss through clotting. (p. 663)
- B. Vascular spasms are the immediate vasoconstriction response to blood vessel injury. (pp. 663–665)
- C. Platelet Plug Formation (p. 665; Fig. 17.13)
 - 1. When endothelium is damaged, platelets become sticky and spiky, adhering to each other and the damaged vessel wall.
 - 2. Once attached, other platelets are attracted to the site of injury, activating a positive feedback loop for clot formation.
- D. Coagulation, or blood clotting, is a multi-step process in which blood is transformed from a liquid to a gel. (pp. 665–666; Figs. 17.13–17.14)
 - 1. Factors that promote clotting are called clotting factors, or procoagulants; those that inhibit clot formation are called anticoagulants.
 - 2. The clotting process involves: formation of prothrombin activator, conversion of prothrombin to thrombin, and the formation of fibrin mesh from fibrinogen in the plasma.
- E. Clot Retraction and Repair (p. 666)
 - 1. Clot retraction is a process in which the contractile proteins within platelets contract and pull on neighboring fibrin strands, squeezing plasma from the clot and pulling damaged tissue edges together.
 - 2. Repair is stimulated by platelet-derived growth factor (PDGF).

- F. Fibrinolysis removes unneeded clots through the action of the fibrin-digesting enzyme plasmin. (p. 666)
- G. Factors Limiting Clot Growth or Formation (pp. 666–667)
 - 1. Rapidly moving blood disseminates clotting factors before they can initiate a clotting cascade.
 - 2. Thrombin that is not bound to fibrin is inactivated by antithrombin III and protein C, as well as heparin.
- H. Disorders of Hemostasis (pp. 667–668)
 - 1. Thromboembolytic disorders result from conditions that cause undesirable clotting, such as roughening of vessel endothelium, slow-flowing blood, or blood stasis.
 - 2. Disseminated intravascular coagulation is a situation leading to widespread clotting throughout intact vessels, and may occur as a complication of pregnancy, septicemia, or incompatible blood transfusions.
 - 3. Bleeding disorders arise from abnormalities that prevent normal clot formation, such as a deficiency in circulating platelets, lack of synthesis of procoagulants, or hemophilia.

V. Transfusion and Blood Replacement (pp. 668–671; Fig. 17.15; Table 17.4)

- A. Transfusion of whole blood is routine when blood loss is substantial, or when treating thrombocytopenia. (pp. 668–670; Fig. 17.15; Table 17.4)
 - 1. Humans have different blood types based on specific antigens on RBC membranes.
 - 2. ABO blood groups are based on the presence or absence of two types of agglutinogens.
 - 3. Preformed antibodies (agglutinins) are present in blood plasma and do not match the individual's blood.
 - 4. The Rh factor is a group of RBC antigens that are either present in Rh⁺ blood, or absent in Rh⁻ blood.
 - 5. A transfusion reaction occurs if the infused donor blood type is attacked by the recipient's blood plasma agglutinins, resulting in agglutination and hemolysis of the donor cells.
- B. Plasma and blood volume expanders are given in cases of extremely low blood volume. (p. 671)

VI. Diagnostic Blood Tests (pp. 671–672)

- A. Changes in some of the visual properties of blood can signal diseases such as anemia, heart disease, and diabetes.
- B. Differential white blood cell counts are used to detect differences in relative amounts of specific blood cell types.
- C. Prothrombin time, which measures the amount of prothrombin in the blood, and platelet counts evaluate the status of the hemostasis system.
- D. SMAC, SMA12–60, and complete blood count (CBC) give comprehensive values of the condition of the blood.

VII. Developmental Aspects of Blood (pp. 672–673)

- A. Prior to birth, blood cell formation occurs within the fetal yolk sac, liver, and spleen, but by the seventh month, red bone marrow is the primary site of hematopoiesis.
- B. Fetal blood cells form hemoglobin-F, which has a higher affinity for oxygen than adult hemoglobin, hemoglobin-A.

Cross References

Additional information on topics covered in Chapter 17 can be found in the chapters listed below.

1. Chapter 3: Diffusion; osmosis
2. Chapter 4: Tissue repair
3. Chapter 6: Hematopoietic tissue
4. Chapter 18: Role of the heart in blood delivery
5. Chapter 19: Vasoconstriction as a mechanism of blood flow control; general overview of arteries, capillaries, and veins
6. Chapter 20: Role of the spleen in the removal of old red blood cells; macrophages
7. Chapter 21: Granulocyte function in nonspecific resistance; lymphocyte function (T and B cells) in specific immune response; role of monocytes (macrophages) in the immune response; AIDS; antigen-antibody interaction; diapedesis; chemotaxis
8. Chapter 22: Gas exchange between blood, lungs, and tissues; respiratory gas transport
9. Chapter 23: Vitamin B₁₂ absorbance; production of vitamin K in the large intestine
10. Chapter 24: Role of blood in body temperature regulation
11. Chapter 25: Erythropoietin related to renal function; plasma filtration
12. Chapter 26: Control of water and ion balance; acid-base balance

Laboratory Correlations

1. Marieb, E. N. *Human Anatomy & Physiology Laboratory Manual: Cat and Fetal Pig Versions*. Eighth Edition Updates. Benjamin Cummings, 2006.
Exercise 29: Blood
2. Marieb, E. N. *Human Anatomy & Physiology Laboratory Manual: Main Version*. Seventh Edition Update. Benjamin Cummings, 2006.
Exercise 29: Blood

Histology Slides for the Life Sciences

Available through Benjamin Cummings, an imprint of Pearson Education, Inc. To order, contact your local Benjamin Cummings sales representative.

- Slide 86 Red Blood Cells, White Blood Cells, Platelets—Blood (Vascular).
Slide 95 Monocyte.
Slide 96 Neutrophils.
Slide 97 Eosinophil.
Slide 98 Lymphocyte.
Slide 99 Basophil.

Lecture Hints

1. Emphasize that the hematocrit is an indirect measurement of the O₂ carrying capacity of the blood. More red blood cells mean more O₂ carried by the same volume of blood.
2. Emphasize that simple diffusion gradients cause the loading and unloading of respiratory gases and other substances. It may be of benefit to ask the students pointed questions about respiratory gas diffusion during the lecture to be sure the class has mastered this concept.
3. As a point of interest, mention that well-oxygenated blood is bright red; normal deoxygenated blood (at the tissue level) is dark red; and that under hypoxic conditions, hemoglobin becomes blue.

4. Spend some time with the feedback loop involved in erythropoiesis. This is a typical negative feedback mechanism that allows the application of critical thought processes.
5. Mention that serum is essentially plasma without clotting proteins.
6. Point out the delicate balance between clotting and prevention of unwanted clotting. We want to be sure that hemorrhage is arrested, but at the same time, we need to prevent clot formation in unbroken blood vessels.
7. Emphasize that ABO incompatibility does not require sensitization by a previous blood transfusion, while Rh incompatibility does.
8. The regulation of hemostasis is often difficult for students. Areas to clarify include: the continuous presence of various clotting factors circulating in the blood in an inactive form; the production of activating and inhibiting stimuli; and the importance of rapid blood flow in the prevention of spontaneous clot formation.
9. Students often have difficulty with the concepts of blood antigens and antibodies, and relating them to the terms agglutinogens and agglutinins. Stress the location of each in the blood.

Activities/Demonstrations

1. Audio-visual materials listed under Multimedia in the Classroom and Lab.
2. Display equipment used to perform a hematocrit, sedimentation rate, and cell counts. Describe how these tests are performed and the information they yield. Run a hematocrit so that students can see the difference in volume of plasma and formed elements.
3. Provide blood-typing sera and have the students type their own blood. All lancets and disposable items are to be placed immediately in a disposable autoclave bag after use, and used slides should be placed in a solution of freshly prepared 10% bleach and soaked for at least two hours. Both the autoclave bag and the slides are to be autoclaved for 15 min. at 121°C, 15 lbs. pressure to ensure sterility. After autoclaving, the autoclave bag may be discarded in any disposable container; the glass slides may be washed with laboratory detergent and reprepared for use.
4. Provide a sample of centrifuged animal blood so that students can examine consistency, texture, and color of plasma. Have pH paper available so that students can determine its pH. Use this activity as a lead-in to a discussion about the composition and importance of plasma.
5. Use models to exhibit blood cells.
6. Set up a stained blood smear to illustrate as many types of white blood cells as possible.

Critical Thinking/Discussion Topics

1. Discuss the fears and facts associated with blood donation, transfusion, and AIDS.
2. Explore the problems associated with IV drug use (i.e., hepatitis, AIDS, necrosis of tissue, and other blood-related disorders).
3. Discuss the procedure of autologous transfusion.
4. Discuss why gamma globulin injections are painful.
5. Why do red blood cells lack a nucleus? Why is this an advantage?
6. How can you explain that an incompatible ABO blood group will generate a transfusion reaction the first time a transfusion is given, while Rh incompatibility creates a problem the second time a transfusion is given?

Library Research Topics

1. Research the blood disorders associated with IV street drug use.
2. Study the role of blood in the AIDS epidemic.
3. Investigate inherited blood disorders.
4. Explore the blood antigens other than A, B, and Rh.
5. Research the various blood immunoglobulins, their functions, and how they are made (i.e., stimulus required).
6. Examine the various uses of donated blood; i.e., packed red cells, platelets, etc.
7. Research which diseases are transmitted by blood and why these diseases are increasing in incidence. Why is careful handling of blood in the clinical agency vitally important?

Multimedia in the Classroom and Lab

Online Resources for Students

www.anatomyandphysiology.com

www.myaandp.com

The following shows the organization of the Chapter Guide page in both the Anatomy & Physiology Place and MyA&P™. The Chapter Guide organizes all the chapter-specific online media resources for Chapter 17 in one convenient location, with e-book links to each section of the textbook. Please note that both sites also give you access to other general A&P resources, like InterActive Physiology®, PhysioEx 6.0™, Anatomy 360°, Flashcards, a Glossary, a Histology Tutorial, and much more.

Objectives

Section 17.1 Overview: Blood Composition and Functions (pp. 647–648)

Section 17.2 Blood Plasma (pp. 648–649)

Memory: Blood Cells

Section 17.3 Formed Elements (pp. 649–662)

InterActive Physiology® : Respiratory System: Gas Transport

Memory: Identifying the Formed Elements of Blood

Case Study: Iron Deficiency Anemia

Case Study: Sickle Cell Anemia

Section 17.4 Hemostasis (pp. 663–668)

Section 17.5 Transfusion and Blood Replacement (pp. 668–671)

Section 17.6 Diagnostic Blood Tests (pp. 671–672)

Section 17.7 Developmental Aspects of Blood (pp. 672–673)

Chapter Summary

Self-Study Quizzes

Art Labeling Quiz

Matching Quiz

Multiple-Choice Quiz (Level I)

Multiple-Choice Quiz (Level II)

True-False Quiz

Crossword Puzzles

Crossword Puzzle 17.1

Media

See *Guide to Audio-Visual Resources in Appendix A* for key to AV distributors.

Slides

1. *Human Blood Smear, Wright's Stain* (FSE). Slide clearly differentiates between erythrocytes and leukocytes.

Video

1. *Bleeding and Coagulation* (FHS; 31 min., 2000). Scrutinizes the body's mechanism of coagulation through the use of case studies.
2. *Blood* (FHS; 20 min., 1995). From *The New Living Body* series, this video explains blood and circulation through the story of a sickle-cell sufferer.
3. *Blood is Life* (FHS; 45 min., 1995). Award-winning video that provides a thorough introduction to human blood.
4. *Diseases of the Blood: Issues and Answers* (FHS; 24 min., 2001). Explores breakthroughs in treatments for multiple myeloma and chronic lymphocytic leukemia.

Software

1. *Blood and Immunity* (CE, LP; Win/Mac). Teaches the components of blood, blood types, and the processes of blood. Includes information on HIV.
2. *Blood and the Circulatory System NEO/LAB* (LP; Win/Mac). Provides interactive exercises on blood typing, morphology, and genetics.
3. *InterActive Physiology[®] 9-System Suite CD-ROM* (BC; Win/Mac). Interactive software that explores the physiology of the cardiovascular system.

Lecture Enhancement Material

To view thumbnails of all of the illustrations for Chapter 17, see Appendix B.

Transparencies Index/Media Manager

| | |
|--------------|--|
| Figure 17.1 | The major components of whole blood. |
| Figure 17.2 | Photomicrograph of a human blood smear stained with Wright's stain. |
| Figure 17.3 | Structure of erythrocytes. |
| Figure 17.4 | Structure of hemoglobin. |
| Figure 17.5 | Erythropoiesis: genesis of red blood cells. |
| Figure 17.6 | Erythropoietin mechanism for regulating erythropoiesis. |
| Figure 17.7 | Life cycle of red blood cells. |
| Figure 17.8 | Comparison of (a) a normal erythrocyte to (b) a sickled erythrocyte. |
| Figure 17.9 | Types and relative percentages of leukocytes in normal blood. |
| Figure 17.10 | Leukocytes. |
| Figure 17.11 | Leukocyte formation. |
| Figure 17.12 | Genesis of platelets. |
| Figure 17.13 | Events of hemostasis. |
| Figure 17.14 | Scanning electron micrograph of erythrocytes trapped in a fibrin mesh. |
| Figure 17.15 | Blood typing of ABO blood types. |
| Table 17.1 | Composition of Plasma |
| Table 17.2 | Summary of Formed Elements of the Blood |
| Table 17.3 | Blood Clotting Factors (Procoagulants) |

Table 17.4 ABO Blood Groups
A Closer Look Concocting Blood: Artificial Blood Substitutes*
*Indicates images that are on the Media Manager only.

Answers to End-of-Chapter Questions

Multiple Choice and Matching Question answers appear in Appendix G of the main text.

Short Answer Essay Questions

11. a. -The formed elements are living blood cells. The major categories of formed elements are erythrocytes, leukocytes, and platelets.
b. The least numerous of the formed elements are the leukocytes.
c. The buffy coat in a hematocrit tube comprises the white blood cells and platelets. (pp. 647–648)
12. Hemoglobin is made up of the protein globin bound to the pigment heme. Each molecule contains four polypeptide chains (globins) and four heme groups, each bearing an atom of iron in its center. Its function is to bind oxygen to each iron atom. When oxygen is loaded (bound to hemoglobin), the hemoglobin becomes bright red. When oxygen is unloaded from the iron, the hemoglobin becomes dark red. (p. 650)
13. With a high hematocrit, you would expect the hemoglobin determination to be high, since the hematocrit is the percent of blood made up of RBCs. (p. 648)
14. In addition to carbohydrates for energy and amino acids needed for protein synthesis, the nutrients needed for erythropoiesis are iron and certain B vitamins. (p. 652)
15. a. -In the process of erythropoiesis, a hemocytoblast is transformed into a pro-erythroblast, which gives rise to early, then late erythroblasts, normoblasts, and reticulocytes.
b. The immature cell type released to the circulation is the reticulocyte.
c. The reticulocyte differs from a mature erythrocyte in that it still contains some rough ER. (pp. 651–652)
16. The physiological attributes which contribute to the function of white blood cells in the body include the ability to move by amoeboid action, exhibition of positive chemotaxis enabling them to pinpoint areas of tissue damage, diapedesis (moving through capillary walls), and the ability to participate in phagocytosis. (p. 657)
17. a. With a severe infection, the WBC count would be closest to $15,000 \text{ WBC}/\text{mm}^3$ of blood.
b. This condition is called leukocytosis. (p. 657)
18. a. Platelets appear as small discoid fragments of large, multinucleated cells called megakaryocytes. They are essential for the clotting process and work by clumping together to form a temporary plug to prevent blood loss.
b. Platelets should not be called “cells” because they are only fragments of cells. (p. 662)
19. a. Literally, hemostasis is “blood standing still” because it refers to clotted blood. It encompasses the steps that prevent blood loss from blood vessels. (p. 663)
b. The three major steps of coagulation include the formation of prothrombin activator by a cascade of activated procoagulants, the use of prothrombin activator enzymatically to release the active enzyme thrombin from prothrombin, and the use of thrombin to cause fibrinogen to form fibrin strands. (pp. 663–665)
c. The intrinsic pathway depends on substances present in (intrinsic to) blood. It has many more steps and intermediates, and is slower. The extrinsic mechanism bypasses the early steps of the intrinsic mechanism and is triggered by tissue factor (thromboplastin) released by injured cells in the vessel wall or in surrounding tissues. (pp. 665–666)

- d. Calcium is essential to virtually all stages of coagulation. (p. 664)
- 20. a. Fibrinolysis is the disposal of clots when healing has occurred.
b. The importance of this process is that without it, blood vessels would gradually become occluded by clots that are no longer necessary. (p. 666)
- 21. a. Clot overgrowth is usually prevented by rapid removal of coagulation factors and inhibition of activated clotting factors. (pp. 666–667)
b. Two conditions that may lead to unnecessary (and undesirable) clot formation are roughening of the vessel wall endothelium and blood stasis. (p. 667)
- 22. Bleeding disorders occur when the liver cannot synthesize its usual supply of procoagulants. (p. 668)
- 23. a. A transfusion reaction involves agglutination of foreign RBCs, leading to clogging of small blood vessels, and lysis of the donated RBCs. It occurs when mismatched blood is transfused.
b. Possible consequences include disruption of oxygen-carrying capacity, fever, chills, nausea, vomiting, general toxicity, and renal failure. (pp. 669–670)
- 24. Among other things, poor nutrition can cause iron-deficiency anemia due to inadequate intake of iron-containing foods or to pernicious anemia due to deficiency of vitamin B₁₂. (p. 655)
- 25. The most common blood-related problems for the aged include chronic types of leukemias, anemias, and thromboembolytic disease. (p. 672)

Critical Thinking and Clinical Application Questions

1. Hemopoiesis is a process involving fairly rapid cell production. Since chemotherapeutics simply target cells exhibiting rapid turnover (rather than other specific properties of cancer cells), hemopoiesis is a target of chemotherapeutic drugs and must be carefully monitored. (pp. 651–652)
2. a. The woman would probably be given a whole blood transfusion. It is essential that she maintain sufficient O₂ carrying capacity to serve fetal needs and blood volume to maintain circulation.
b. The blood tests that would be performed include tests for ABO and Rh group antigen and cross matching. (pp. 669–670)
3. a. Polycythemia accounts for his higher erythrocyte count because of the need to produce more RBCs to increase his O₂ binding and transport ability in the high altitude (thinner air) environment of the Alps. Enhanced production of RBCs was prompted by an increased production of erythropoietin.
b. His RBC count will not stay higher than normal because the excess production of RBCs will depress erythropoietin production by the kidneys when adequate levels of O₂ are being transported in the blood. (p. 656)
4. Janie's leukocytes are immature or abnormal and are incapable of defending her body in the usual way. (p. 660)
5. Red bone marrow is the site of hemopoiesis, and if it is destroyed by benzene, hemocytoblasts will not be produced, which will reduce the production of megakaryocytes (the progenitor cells of platelets, which are involved in clotting). (p. 651)
6. Tyler is turning out a high rate of reticulocytes (immature red blood cells), which accounts for his high hematocrit. (p. 652)
7. An analysis of the clotting process described in the text should reveal that the two blood proteins are thrombin and fibrinogen. (p. 665)
8. An elevated RBC count could be related to smoking, due to the frequent hypoxia that results from inhalation of oxygen-poor cigarette smoke. (p. 652)
9. Aspirin is a mild anticoagulant, which could cause excessive bleeding during or after surgery. (p. 667)

Suggested Readings

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