

CHAPTER SCOPE

This first chapter presents an introduction to the *scientific method* as an approach to the study of **physiology** and a basic review of human organs, tissues, and their underlying control systems. Also featured here is a description of the physiological methods the body uses to communicate among and within its various, tissues, organs, and systems. The four primary **tissues** of the body — muscle, nerve, epithelium, and connective tissues — are all present in skin, an example of an **organ**. As you read the descriptions of how these tissues function independently, remember that they also perform in concert with other tissues in the body as smoothly operating **systems**. Most of these systems will be presented individually as separate concepts in the chapters that follow.

The underlying theme of any physiology course is summed up in the critical, but difficult-to-describe term **homeostasis**. Homeostasis can be defined as the unique ability of the body to keep almost all internal body processes such as temperature within normal limits, despite the many wide variety of forces and stresses that interfere with these vital processes.

Each subsequent chapter will allude to, if not directly demonstrate, homeostasis at work. Operating through *negative feedback* mechanisms, homeostasis processes act to oppose the initial stress on the body and to initiate changes that will return conditions toward normal. Here, you will be introduced to the concept of homeostasis featuring important demonstrations of the **nervous** system (electrical signals and neurotransmitter chemicals) and the **endocrine** system (hormone chemicals and receptor proteins) working smoothly and efficiently to regulate body function.

I. INTRODUCTION TO PHYSIOLOGY

Human physiology is the study of how the human body functions, with emphasis on specific cause-and-effect mechanisms. Knowledge of these mechanisms has been obtained experimentally through applications of the scientific method.

A. Multiple Choice

You will find multiple-choice questions in each section of this study guide. Select the letter of the **best** choice to answer each of the following questions or to complete each phrase. Write that letter in the space provided. Answer all of the questions in each section, then check your work with the correct answers provided at the end of this chapter. Remember, if you are having difficulty, be sure to reread the corresponding section in your textbook before going on to the next set of questions. These exercises will help prepare you for similar questions you may see on “scantron”-type examinations. Good luck!

- ___ 1. Physiology is the study of
- biological function.
 - how the body works.
 - cause-and-effect sequences in the body.
 - observations that overlap many other sciences.
 - All of these are correct.
- ___ 2. Which of the following statements about physiology is *not* correct?
- The ultimate objective is to understand the normal functioning of the human body.
 - Pathophysiology is a related science that complements normal physiology.
 - The study of disease processes has helped our understanding of physiology.
 - Because animals are so different from humans, the study of comparative physiology has very little direct application to human physiology.
 - All of these statements are correct.

- ___ 3. According to *scientific theory*, all observations must be
 - a. published.
 - b. reproducible.
 - c. clinical.
 - d. predictable.
 - e. None of these is correct.
- ___ 4. Which of the following is *not* considered to be an important criterion when testing the hypothesis that a regular exercise program causes people to have a lowered resting heart rate?
 - a. gathering of quantitative measurements
 - b. collecting an experimental group of individuals
 - c. comparisons with a control group of individuals
 - d. removing any investigation bias by taking blind measurements
 - e. All of these are important investigation criteria.
- ___ 5. During an investigation, scientists will often apply mathematical tools of statistics to demonstrate that the observed differences between groups of data are *not* due to random chance – such a test is known as the
 - a. rejection of chance hypothesis.
 - b. null hypothesis.
 - c. scientific method.
 - d. blind measurement.
 - e. peer-review method.
- ___ 6. In the development of new pharmaceutical drugs, in which phase of human or clinical trials is the drug tested on the *target* human population (for example, those with hypertension)?
 - a. phase I clinical trials
 - b. phase II clinical trials
 - c. phase III clinical trials
 - d. phase IV clinical trials

B. True or False/Edit

For each of the following statements, decide whether the statement is true or false. In the space provided write “**T**” if the statement is true or “**F**” if the statement is false. For statements that are **false, edit** (rewrite) the statement so that it now becomes **true**. As an example, the first statement below is false and is edited for you. Notice that there are many ways to “edit” or rewrite the false statement to make it true. The edit should be simple and clear. Remember that the answers and sample “edits” are provided for you at the end of each chapter.

- ___ 7. *Physiology* is the study of disease processes in the body.
 (**False/Edit:** Physiology is the study of how the body works normally at tasks essential for life [to maintain homeostasis].)
- ___ 8. The *scientific method* is based on a confidence in our rational ability, honesty, and humility.
- ___ 9. *Fact:* All athletes have lower resting pulse rates than other people.
- ___ 10. In biomedical research, subjects that are part of an experimental group could also serve as their own control group.
- ___ 11. In biomedical research, scientists attempt to test the hypothesis that observed differences in their data is due to chance by applying mathematical tools that will reject the null hypothesis.
- ___ 12. Peer-reviewed journals are important because scientists that work in other fields of endeavor can critically review original research articles.
- ___ 13. Animal models of particular diseases have served as critically important tools, leading to better understanding of similar human diseases.
- ___ 14. Only 10% of all newly developed drugs are considered safe enough to advance from preliminary testing in experimental animals to human/clinical trials.

II. HOMEOSTASIS AND FEEDBACK CONTROL

The regulatory mechanisms of the body can be understood in terms of a single, shared function: that of maintaining constancy of the internal environment. A state of relative constancy of the internal environment is known as homeostasis, and it is maintained by effectors that are regulated by sensory information from the internal environment.

A. Multiple Choice

- ___ 15. In homeostasis, the critical concept describing the body's response to any deviation from some particular set point (such as temperature rising when exercising), which results the activation of mechanisms to oppose that deviation (return temperature toward normal), is known as
- negative feedback.
 - the integrating center.
 - positive feedback.
 - milieu interior.
- ___ 16. Which of the following mechanisms of homeostasis is analogous to the house thermostat setting that operates to regulate the temperature in the house?
- sensor
 - the set point
 - effector
 - integrating center
- ___ 17. Arrange the following terms in the sequence that best reflects how the body maintains homeostasis (for example, during a fever). (1) effector activated; (2) integrating center process; (3) negative feedback loops activated; (4) sensor activated; (5) return to set point
- 2 4 3 1 5
 - 5 3 2 4 1
 - 4 3 1 5 2
 - 4 2 1 3 5
 - 1 2 4 5 3
- ___ 18. During homeostasis, increasing or decreasing the activity of particular effectors is the primary role of the
- integrating center.
 - sensor.
 - muscle or gland.
 - positive feedback loops.
 - negative feedback loops.
- ___ 19. The term, *innervate* means to
- activate glands to release hormones.
 - inactivate glands.
 - produce nerve impulses in nerve fibers.
 - inactivate nerve fibers.
 - inactivate both glands and nerve fibers.
- ___ 20. Hormone secretion can result from the stimulation of endocrine glands by
- nerve stimulation (releasing neurotransmitter chemicals).
 - other specific body chemicals.
 - other hormones.
 - Only A and C are correct.
 - All of these are correct.

B. True or False/Edit

- ___ 21. Most of our present knowledge of human physiology in the twentieth century has been gained through the expansion in the fields of biotechnology and molecular genetics.
- ___ 22. In medicine, illness occurs when the body is unable to maintain constancy within the internal environment.
- ___ 23. In homeostasis, the activation of effectors generally refers to the specific activation of muscles or bones.
- ___ 24. An initial rise in blood glucose level followed by a subsequent further increase in blood glucose is an example of negative feedback.
- ___ 25. Bleeding from a cut activates a positive feedback "cascade," whereas the subsequent formation of a blood clot represents the completion of a negative feedback loop.
- ___ 26. The regulation of homeostasis by messages sent from the nervous and endocrine systems to a target organs somewhere else in the body, is an example of intrinsic control.

- ___ 27. The brain uses glucose molecules in the blood as its primary source of energy.
- ___ 28. During fasting the blood glucose levels will fall, causing blood insulin hormone levels to rise and blood glucagon hormone levels to fall in a negative feedback response.

III. THE PRIMARY TISSUES

The organs of the body are composed of four different primary tissues each of which has its own characteristic structure and function. The activities and interactions of these tissues determine the physiology of the organs.

A. Multiple Choice

- ___ 29. Which primary tissue features *intercalated discs*?
- epithelial
 - nervous
 - muscle
 - connective
 - None of these is correct.
- ___ 30. Which of the following is *not* considered epithelial tissue?
- simple membranes
 - exocrine glands
 - endocrine glands
 - brain and spinal cord
 - All of these are considered epithelial tissue.
- ___ 31. The type of epithelium best adapted for rapid passage of oxygen and carbon dioxide between the air and blood, is
- simple squamous.
 - simple cuboidal.
 - columnar.
 - ciliated columnar.
- ___ 32. The type of epithelium that allows digestion products in the small intestine to pass from the intestinal lumen to the blood, is
- simple squamous.
 - simple columnar.
 - cuboidal.
 - ciliated columnar.
- ___ 33. Which of the following is *not* characteristic of epithelium?
- It may be simple or stratified.
 - It may contain goblet cells.
 - It may be keratinized (or cornified).
 - It is constantly lost (exfoliated) and replaced.
 - All of these are characteristic of epithelium.
- ___ 34. Which of the following is *not* an exocrine gland?
- liver
 - pancreas
 - spleen
 - prostate
 - sebaceous gland
- ___ 35. Tendons (muscle to bone) and ligaments (bone to bone) are examples of
- dense irregular connective tissue.
 - dense regular connective tissue.
 - loose (areolar) connective tissue.
 - cartilage.
- ___ 36. Lamellae, lacunae, and canaliculi are characteristic of
- connective tissue proper.
 - cartilage.
 - bone.
 - Blood

- ___ 37. Cells that have similar function are grouped into categories, called
 - a. systems.
 - b. organs.
 - c. primary tissues.
 - d. tissues.
- ___ 38. Organs that work together, performing functions in common, may be grouped into
 - a. systems.
 - b. organisms.
 - c. primary tissues.
 - d. tissues.
- ___ 39. Which of the following is *not* a primary tissue?
 - a. muscle tissue
 - b. bone tissue
 - c. nervous tissue
 - d. epithelial tissue
 - e. e. connective tissue
- ___ 40. Which of the following cell types is actually a *syncytium*, that is, a multinucleate mass formed from the union of separate cells during embryonic development?
 - a. myofibers
 - b. osteocytes
 - c. adipocytes
 - d. neurons

B. True or False/Edit

- ___ 41. Histology is the study of microscopic anatomy.
- ___ 42. Smooth and cardiac muscles are voluntarily controlled.
- ___ 43. Each skeletal muscle cell or fiber (myofiber) is controlled individually by nerve fibers so that the overall muscle strength of contraction can be varied or “graded.”
- ___ 44. Intercalated discs couple myocardial cells mechanically and electrically.
- ___ 45. Heart muscle (myocardial) cells can be stimulated to contract individually, like skeletal muscle fibers.
- ___ 46. Peristalsis is a process requiring skeletal muscle contractions.
- ___ 47. Supporting glial cells in the brain and spinal cord are more numerous than neurons, do not conduct impulses, and are able to divide by mitosis throughout life.
- ___ 48. Columnar epithelial cells with projecting cilia are located in many respiratory passages and in the uterine (fallopian) tubes of females.
- ___ 49. Structures collectively called junctional complexes and the basement membrane are also features of epithelial tissues.
- ___ 50. The digestive tract is considered an outside or external body surface; so that it’s lumen (center space) is part of the external environment.
- ___ 51. The numerous eccrine (or merocrine) sweat glands secrete a dilute salt solution that evaporates and cools the skin during thermoregulation.
- ___ 52. Epithelial tissue consists of cells that form membranes, that cover and line the body surfaces, and consists of glands that are derived from these membranes.
- ___ 53. Endocrine glands secrete chemicals through a duct that leads to the outside of a membrane and thus, leads to the outside of a body surface.
- ___ 54. Endothelium is a unique single layer of squamous epithelial cells that forms a thin membrane lining found along the lumen of all blood vessels.
- ___ 55. The characteristic body odor of the axillae (underarms) and pubic regions is due to the presence of bacteria that thrives on a protein-rich fluid secreted by local apocrine sweat glands.
- ___ 56. Bile is an exocrine secretion of the pancreas.
- ___ 57. Adipose tissue is a specialized type of loose connective tissue, composed of cells known as adipocytes.
- ___ 58. Basement membranes, located between the outer epithelial membranes and the underlying connective tissue, are primarily composed of collagen proteins and polysaccharides.

IV. ORGANS AND SYSTEMS

Organs are composed of two or more primary tissues that serve the different functions of the organ. The skin is an organ that has numerous functions provided by its constituent tissues.

A. Multiple Choice

- ___ 59. Which of the following glands is *not* exocrine?
a. hair follicle
b. apocrine sweat gland
c. eccrine sweat gland
d. sebaceous gland
e. All of these are exocrine.
- ___ 60. The largest organ in the body in terms of its surface area, is the
a. liver.
b. stomach.
c. skin.
d. brain.
e. heart.
- ___ 61. Which of the following is *not* a cutaneous sensation?
a. pain
b. pressure
c. heat/cold
d. taste
e. touch
- ___ 62. Which substance is a hormone secreted by the endocrine glands of the skin into the bloodstream?
a. melanin
b. vitamin D
c. hemoglobin
d. keratin
e. collagen
- ___ 63. Which of the following organ systems of the body primarily functions in the regulation of blood volume and composition?
a. endocrine system
b. circulatory system
c. urinary system
d. digestive system
e. reproductive system
- ___ 64. Which of the following organ systems of the body primarily functions in defense of the body against invading pathogens?
a. immune system
b. circulatory system
c. integumentary system
d. digestive system
e. respiratory system
- ___ 65. Tissue fluid, or interstitial fluid, is an aqueous compartment that belongs to the
a. intracellular compartment
b. extracellular compartment

B. True or False/Edit

- ___ 66. Sebaceous glands secrete oily sebum into hair follicles, which transport the sebum to the cornified surface of the skin to aid in lubrication.
- ___ 67. Both sensory and motor nerve fibers (neurons) are found in the skin.
- ___ 68. Blood flow to the skin is partially controlled by motor nerve fibers to smooth muscle in the walls of cutaneous blood vessels that regulate the degree of constriction or dilation.

- ___ 69. The connective tissue found in most organs is an ideal location for blood vessels, nerve endings, scattered cells for fighting infection, and possibly glandular tissue as well.
- ___ 70. As major organs of the circulatory system, bone marrow and lymphoid organs function primarily in the defense of the body against invading pathogens.
- ___ 71. Within the two major aqueous compartments that can be identified in tissues, organs, and systems, only the extracellular compartment is subdivided into blood plasma and tissue (interstitial) fluid.

C. Label the Figure and Application—An Organ: The Skin

The skin is an excellent example of an **organ** that is composed of the four tissue types. Figure 1.1 below is a diagram of the skin with structures numbered 72—84. Identify each structure and *write* the correct term in the space that follows the number in the figure. If you need help, see figure 1.21 in the text.

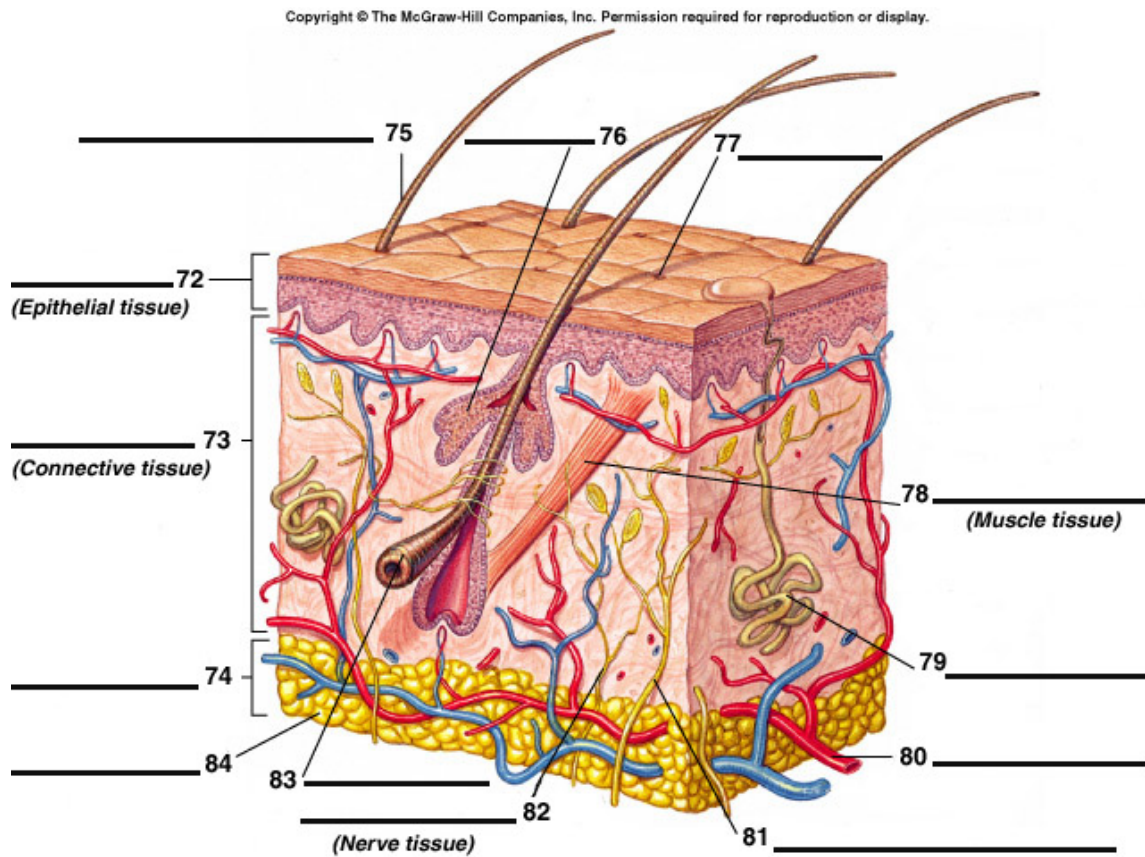


Figure 1.21 Diagram of skin. The skin is an organ that contains all four types of primary tissues.

Using Figure 1.1 as a reference, read questions 85-89 that follow and fill in the blanks with the correct word or phrase that applies to the skin.

- 85. Two examples of exocrine glands are the _____ gland that secretes sebum; and the _____ gland whose watery secretion cools the skin.
- 86. The blood supply to skin arrives from the _____ tissue level, then branches into the _____ layer, but does not enter the _____ layer of the skin, that is fed by diffusion.
- 87. Notice the ideal location of the Pacinian corpuscle for the sensation of _____.
- 88. The subcutaneous tissue, which contains adipose or _____ cells, nerves, and blood vessels, is also known as the _____.
- 89. Adipose tissue is a type of _____ (primary) tissue.

CHAPTER REVIEW

A. Completion

90. Physiology is the study of how the body works - from _____ to _____, to _____, to systems.
91. By asking questions beginning with “_____,” scientists studying physiology discover answers that involve _____-and-_____ sequences during experiments.
92. The four primary tissues are _____, _____, _____, and _____.
93. The three types of muscle tissue are _____, _____, and _____; of which only _____ muscle is not striated.
94. Epithelial membranes provide a protective barrier of cells tightly joined by _____ (two words), as they cover and line the body surfaces. These membranes may be simple or _____; and consist of _____, _____, or _____ cell shapes.
95. Invaginated epithelial tissue may form exocrine glands with _____, or form endocrine glands secreting _____ into the bloodstream.
96. Four types of connective tissue are _____, _____, _____, and _____.
97. Skin is a good example of a (an) _____.
98. Three exocrine glands found in the dermis of the skin are _____, _____, and _____.
99. Also in the dermis of the skin are the _____ pili muscles and muscles constricting and dilating the walls of _____; both of these muscles are composed of _____ muscle fiber type.
100. Homeostasis is maintained through _____ feedback loops involving sensors, integrating centers, and _____, which communicate extrinsically through messengers of the _____ and _____ systems.
101. Both neurotransmitters and hormones bind with unique membrane _____ proteins and control specific _____ organs.

B. Crossword Puzzle — Tissues, Organs, and Control Systems

Across

- | | |
|--|---|
| <ol style="list-style-type: none">1. Dense, regular type of connective tissue connecting muscle to bone6. Maintaining a constant internal environment9. Opposing a rise or fall in body temperature or blood glucose during homeostasis (2 words)12. 37°C is an example of _____ point in homeostasis13. Homeostasis strives to maintain all values at their _____ (2 words)15. Adipose tissue of the hypodermis16. Fibrous protein common to most connective tissue19. Nerve fiber control over muscle or gland effector activity21. Property of muscle in which the strength of its contraction can vary from weak to strong22. The muscle or gland cell that receives nerve impulses | <ol style="list-style-type: none">23. Single cytoplasmic extension of the neuron cell body24. Connective tissue containing lamellae, lacunae, and canaliculi25. Study of biological function emphasizing body mechanisms that involve cause-and-effect26. Clusters of secretory ducts in exocrine glands that are squeezed by myoepithelial cells sequences27. Rhythmic contractions of circular and longitudinal muscle, pushing food through the digestive tract28. Oily secretion on hair follicles and cornified skin—prevents drying and cracking |
|--|---|

Down

1. Watery secretion from lacrimal (exocrine) gland
2. The largest organ in the body
3. Homeostatic process that supports and worsens body changes rather than opposes and returns to normal
4. Cells of stomach or intestine that secrete mucus
5. Receiver of relayed sensory information to process and help maintain homeostasis (examples: brain and spinal cord)
7. Characteristic of exocrine glands
8. Water-resistant protein in dead cells of the cornified epidermis of the skin

10. Physiology seeks answers to help explain cause-and-_____ sequences
11. Study of microscopic anatomy
14. Physiology typically asks the question _____?
17. Cavity or space within an organ or structure—like the inner space within blood vessels or the stomach
18. Simple squamous membrane lining blood vessels; specifically adapted for diffusion and filtration
20. Cells (fibers) of the nervous system that conduct impulses

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C. Essay

Essay Tutorial

This essay tutorial will answer the first essay question found in the “**Test Your Understanding of Concepts and Principles**” section located at the end of each chapter in your *Human Physiology* textbook. Please read the question below carefully, and let me guide you through one possible answer in this section. Watch for helpful tips and general suggestions on writing the essay or short-answer questions. Learn to spot key words in the questions such as those that I indicate in **bold-face** type, and to outline your ideas quickly on a separate piece of paper. This will help you organize your thoughts, express yourself clearly, and — since it will be easier to read — result in better scores! Using similar techniques, try the bonus essay questions I have written that follow. Enjoy!

103. Describe the **structure** of various **epithelial membranes**, and explain how their structures relate to their **functions**.

Answer. First, write the bold-faced key words as column headings. Next, list the membranes separately and then complete the descriptions of structure and function. Study Table 1.3 in your textbook for a sample table format.

Epithelial	Membranes	Structure-Function
Simple squamous	Flat	Diffusion and filtration (endothelium)
Simple cuboidal	Cube	Line exocrine ducts and kidney tubules; → transport
Simple columnar	Tall	Stomach and intestinal lining (goblet cells); → barrier
Ciliated columnar	“Oars”	Uterine (fallopian) tubes and respiratory passages; → movement and filtration
Stratified squamous (many layers)	Esophagus (nonkeratinized) Skin (keratinized)	→ protection → protection
Glandular, exocrine	Ducts	Secretions to outside
Glandular, endocrine	No ducts	Hormone release into the blood

Note: Don’t be frustrated if your answer didn’t look like this at first. Be patient — and with practice, your skills will improve. Now, refer to the text for help in answering the remainder of these bonus essay questions, organize your thoughts based on key words in the question, then write your answer clearly and concisely. Good luck!

104. List and describe the structures of the skin that represent the four primary tissues. Include the function of each structure.

105. Blood levels of calcium are held constant (at a set point) by hormones. Parathyroid hormone is one hormone that helps raise the blood calcium concentration. Draw a flow diagram that shows how this hormone would act after you consumed a tall, frothy glass of calcium-rich milk (*hint*: similar to the glucose-insulin figure).

106. Draw a flow diagram showing how the parasympathetic nerve stimulation to the heart slows the average heart rate of 70 beats per minute (bpm), while sympathetic nerve stimulation speeds up the average heart rate (*hint*: see figure 1.4 for help).

Answers — Chapter 1

- I. Introduction
 A. 1. e, 2. d, 3. b, 4. e, 5. b, 6. b
 B. 7. F, 8. T, 9. F—Replace “fact” with “hypothesis,” 10. T, 11. T, 12. F—Replace “other” with “the same,” 13. T, 14. T
- II. Homeostasis and Feedback Control
 A. 15. a, 16. b, 17. d, 18. a, 19. c, 20. e
 B. 21. T, 22. T, 23. F—Replace “bone” with “glands,” 24. F—Replace “negative” with “positive,” 25. T, 26. F—Replace “intrinsic” with “extrinsic,” 27. T, 28. F—Switch “rise” with “fall”
- III. The Primary Tissues
 A. 29. c, 30. d, 31. a, 32. b, 33. e, 34. c, 35. b, 36. c, 37. d, 38. a, 39. b, 40. a
 B. 41. T, 42. F—Replace “voluntarily” with “involuntarily,” 43. T, 44. T, 45. F—Replace “can be” with “cannot be,” 46. F—Replace “skeletal” with “smooth,” 47. T, 48. T, 49. T, 50. T, 51. T, 52. T, 53. F—Replace “Endocrine” with “Exocrine,” 54. T, 55. T, 56. F—Replace “pancreas” with “liver,” 57. T, 58. T
- IV. Organs and Systems
 A. 59. e, 60. c, 61. d, 62. b, 63. c, 64. a, 65. b
 B. 66. T, 67. T, 68. T, 69. T, 70. F—Replace “circulatory” with “immune,” 71. T
 C. 72. epidermis, 73. dermis, 74. hypodermis, 75. hair, 76. sebaceous gland, 77. sweat pore, 78. arrector pili muscle, 79. sweat gland, 80. blood vessel (arteriole), 81. sensory nerve, 82. motor nerve, 83. hair bulb, 84. adipose tissue, 85. sebaceous; sweat, 86. subcutaneous; dermis; epidermis, 87. pressure, 88. fat; hypodermis, 89. connective
- Chapter Review
 A. 90. cells; tissues; organs, 91. how?; cause; effect, 92. connective; epithelial; nervous; muscle, 93. smooth; skeletal; cardiac; smooth, 94. junctional complexes; stratified, squamous; cuboidal; columnar, 95. ducts; hormones, 96. connective tissue proper; cartilage; bone; blood, 97. organ, 98. hair follicles; sweat glands; sebaceous glands, 99. arrector; blood vessels; smooth, 100. negative; effectors; endocrine; nervous, 101. receptor; target

