

# Preface

## In Touch



## with Anatomy & Physiology Lab Courses

Author Terry Martin's forty years of teaching anatomy and physiology courses, authorship of three laboratory manuals, and active involvement in the Human Anatomy and Physiology Society (HAPS) drove his determination to create a laboratory manual with an innovative approach that would benefit students. The *Laboratory Manual for Human Anatomy & Physiology* includes a cat version, a fetal pig version, and for the first time, a rat version. Each of these versions includes sixty-one laboratory exercises, three supplemental labs found online, and six cat, fetal pig, or rat dissection labs. A main version with no dissection exercises is also available. All four versions are written to work well with any anatomy and physiology text.

### Martin Lab Manual Series . . .

### IN TOUCH with Anatomy & Physiology Lab Courses

- ▶ **NEW!** Available in **4 Versions:** main (no dissection), cat dissection, fetal pig dissection, and rat dissection.
- ▶ Incorporates **learning outcomes and assessments** to help students master important material!
- ▶ **NEW!** **Pre-Lab** assignments are printed in the lab manual. They will help students be more prepared for lab and save instructors time during lab.
- ▶ **Clear, concise** writing style facilitates more thorough understanding of lab exercises.
- ▶ **BIOPAC®** exercises use hardware and software for data acquisition, analysis, and recording.

Laboratory Exercise **12**

### Bone Structure and Classification

**Purpose of the Exercise**  
To review the way bones are classified and to examine the structure of a long bone and bone tissue.

**Materials Needed**

- Prepared microscope slide of ground compact bone
- Human bone specimens, including long-, short-, flat-, irregular-, and sesamoid types
- Human long bone, sectioned longitudinally
- Fresh animal bones, sectioned longitudinally and transversely
- Compound light microscope
- Dissecting microscope
- For Demonstration Aids: Fresh chicken bones (radius and ulna from wings)
- Vinegar or dilute hydrochloric acid

**Safety**

- Wear disposable gloves for handling fresh bones and for the demonstration of a bone soaked in vinegar or dilute hydrochloric acid.
- Wash your hands before leaving the laboratory.

**Learning Outcomes**

After completing this exercise, you should be able to

1. Arrange five groups of bones based on their shapes and identify an example for each group.
2. Locate the major structures of a long bone.
3. Distinguish between compact and spongy bone.
4. Differentiate the structural and functional characteristics of bone tissue.

**Pre-Lab**

Carefully read the introductory material and the entire lab. Be familiar with bone structure and bone tissue from lecture or the textbook. Visit [www.mhhe.com/anatomyseries2](http://www.mhhe.com/anatomyseries2) for LabCam videos. Answer the pre-lab questions.

**Pre-Lab Questions:** Select the correct answer for each of the following questions.

1. Which of the following tissues is not part of a bone as an organ?
  - a. dense connective
  - b. cartilage
  - c. muscle
  - d. blood
2. The organic matter of living bone includes
  - a. calcium phosphate
  - b. collagen fibers and cells
  - c. calcium carbonate
  - d. magnesium and fluoride
3. The \_\_\_\_\_ is an example of a sesamoid bone.
  - a. vertebra
  - b. femur
  - c. carpal
  - d. patella
4. The epiphyseal plate represents the
  - a. ends of the epiphyses
  - b. shaft between the epiphyses
  - c. growth zone of hyaline cartilage
  - d. membrane around a bone
5. The central canal of a bone tissue contains
  - a. blood vessels and nerves
  - b. osteocytes
  - c. red bone marrow
  - d. yellow bone marrow
6. A \_\_\_\_\_ is an example of an irregular bone.
  - a. femur
  - b. carpal
  - c. rib
  - d. vertebra
7. A femur includes both compact and spongy bone tissues.
 

True \_\_\_\_\_ False \_\_\_\_\_
8. Chicken bones, with both organic and inorganic components, possess the quality of tensile strength.
 

True \_\_\_\_\_ False \_\_\_\_\_
9. Trabeculae are structural characteristics of compact bone.
 

True \_\_\_\_\_ False \_\_\_\_\_

Laboratory Assessment **12**

### Bone Structure and Classification

Name \_\_\_\_\_  
Date \_\_\_\_\_  
Section \_\_\_\_\_

The \_\_\_\_\_ corresponds to the indicated osteon(s) found at the beginning of the laboratory exercise.

**Part A Assessments**

Complete the following statements: (Note: Questions 1-6 pertain to bone classification by shape.)

1. A bone that has a wide surface is classified as a(n) \_\_\_\_\_ bone. **A**
2. The bones of the wrist are examples of \_\_\_\_\_ bones. **A**
3. The bone of the thigh is an example of a(n) \_\_\_\_\_ bone. **A**
4. Vertebrae are examples of \_\_\_\_\_ bones. **A**
5. The patella (kneecap) is an example of a large \_\_\_\_\_ bone. **A**
6. The bones of the skull that form a protective covering for the brain are examples of \_\_\_\_\_ bones. **A**
7. Distinguish between the epiphyses and the diaphysis of a long bone. **A**
8. Describe where cartilage is found on the surface of a long bone. **A**
9. Describe where the periosteum is found on the surface of a long bone. **A**

**Part B Assessments**

Complete the following:

1. Distinguish the locations and tissues between the periosteum and the endosteum. **A**
2. What structural differences did you note between compact bone and spongy bone? **A**

**Ph.I.L.S. 4.0** METABOLISM v.2. Size and Basal Metabolic Rate. LAB 10. PRE-LAB. LABORATORY EXERCISE. PHOTOMOUNT AND SLIDE REPORT.

Time	Weight	Temp	Met
0:00	1.15		
0:15	1.30		
0:30	1.40		
0:45	1.50		
1:00			


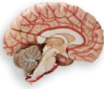
- ▶ **NEW! Ph.I.L.S. 4.0** included and physiology lab simulations interspersed throughout make otherwise difficult and expensive experiments a breeze through digital simulations.

External intercostals  
Teres major  
Latissimus dorsi (cut)  
1  
2  
3  
External oblique  
5  
Gluteus maximus

**Terms:**  
Erector spinae  
Iliocostalis  
Longissimus  
Quadratus lumborum  
Spinatus

- ▶ Cadaver images from **Anatomy & Physiology Revealed® (APR)** are incorporated throughout the lab. Cadaver images help students make the connection from specimen to cadaver.
- ▶ **Micrographs** incorporated throughout the lab aid students' visual understanding of difficult topics.
- ▶ **Instructor's Guide** is annotated for quick and easy use by adjuncts and is available online at [www.mhhe.com/martinseries2](http://www.mhhe.com/martinseries2).

## In Touch with Student Needs



- ▶ The procedures are clear, concise, and easy to follow. Relevant lists and summary tables present the contents efficiently. Histology micrographs and cadaver photos are incorporated in the appropriate locations within the associated labs.
- ▶  **NEW!** The pre-lab section now includes quiz questions. It also directs the student to carefully read the introductory material and the entire lab to become familiar with its contents. If necessary, a textbook or lecture notes might be needed to supplement the concepts. A visit to [www.mhhe.com/martinseries2](http://www.mhhe.com/martinseries2) will provide a list of animations from **Anatomy & Physiology Revealed® (APR)** and LabCam videos to review before answering five or more fundamental laboratory questions for that particular lab.
- ▶ **Terminologia Anatomica** is used as the source for universal terminology in this laboratory manual. Alternative names are included when a term is introduced for the first time.
- ▶ Laboratory assessments immediately follow each laboratory exercise.
- ▶ Histology photos are placed within the appropriate laboratory exercise.
- ▶ A section called “Study Skills for Anatomy and Physiology” is located in the front of this laboratory manual. This section was written by students enrolled in a Human Anatomy and Physiology course.
- ▶  Critical Thinking Activities are incorporated within most of the laboratory exercises to enhance valuable critical thinking skills that students need throughout their lives.
- ▶ Cadaver images are incorporated with dissection labs.

## In Touch with Instructor Needs



- ▶ The instructor will find digital assets for use in creating customized lectures, visually enhanced tests and quizzes, and other printed support material.
- ▶ A correlation guide for **Anatomy & Physiology Revealed® (APR)** and the entire lab manual is located on the lab manual’s website at [www.mhhe.com/martinseries2](http://www.mhhe.com/martinseries2). Cadaver images from APR are included within many of the laboratory exercises.

- ▶ Some unique labs included are “Scientific Method and Measurements,” “Chemistry of Life,” “Fetal Skeleton,” “Surface Anatomy,” “Diabetic Physiology,” and “Genetics.”
- ▶ The annotated instructor’s guide for *Laboratory Manual for Human Anatomy and Physiology* describes the purpose of the laboratory manual and its special features, provides suggestions for presenting the laboratory exercises to students, instructional approaches, a suggested time schedule, and annotated figures and assessments. It contains a “Student Safety Contract” and a “Student Informed Consent Form.”
- ▶ Each laboratory exercise can be completed during a single laboratory session.

## In Touch with Educational Needs

- ▶ Learning outcomes with icons  have matching assessments with icons  so students can be sure they have accomplished the laboratory exercise content. Outcomes and assessments include all levels of learning skills: remember, understand, apply, analyze, evaluate, and create.
- ▶ Assessment rubrics for entire laboratory assessments are included in Appendix 2.

## In Touch with Technology

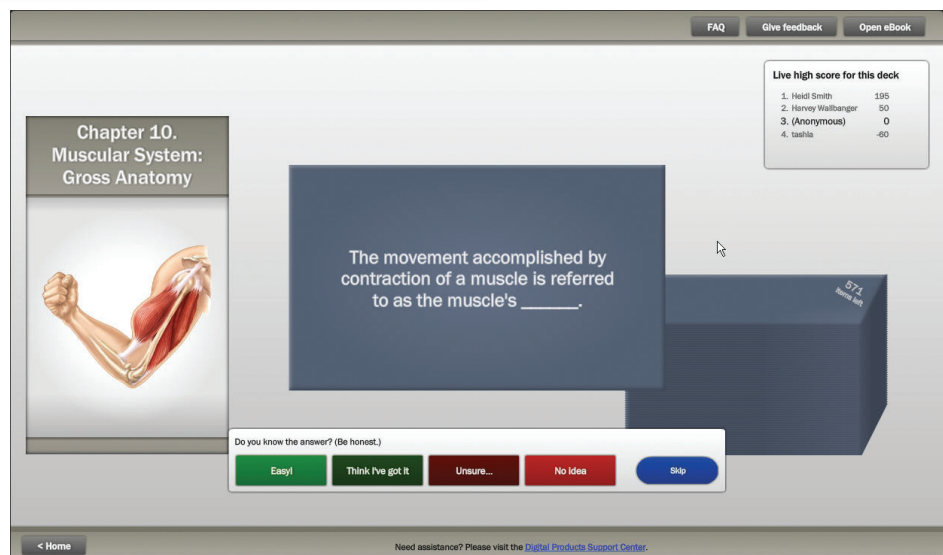
- ▶  Physiology Interactive Lab Simulations (Ph.I.L.S. 4.0) is included with the lab manual. Eleven lab simulations are interspersed throughout the lab manual. The correlation guide for all of the simulations is included in Appendix 3.
- ▶  BIOPAC® exercises are included on four different body systems. BIOPAC® systems use hardware and software for data acquisition, analysis, and recording of information for an individual.



# Engaging Presentation Materials for Lecture and Lab



**New!** All content in Connect is correlated to HAPS Learning Outcomes.



**McGraw-Hill ConnectPlus Anatomy & Physiology** is a web-based assignment and assessment platform that gives students the means to better connect with their coursework, with their instructors, and with the important concepts that they will need to know for success now and in the future. With Connect Anatomy & Physiology, instructors can deliver assignments, quizzes and tests easily online. Stu-

dents can practice important skills at their own pace and on their own schedule. With Connect Anatomy & Physiology Plus, students also get 24/7 online access to an eBook—an online edition of the text—to aid them in successfully completing their work, wherever and whenever they choose [www.mhhe.com/martinseries2](http://www.mhhe.com/martinseries2)

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Blackboard

## Do More



# Guided Tour Through A Lab Exercise

The laboratory exercises include a variety of special features that are designed to stimulate interest in the subject matter, to involve students in the learning process, and to guide them through the planned activities. These features include the following:

## Purpose of the Exercise

The purpose provides a statement about the intent of the exercise—that is, what will be accomplished.


## Materials Needed


This section lists the laboratory materials that are required to complete the exercise and to perform the demonstrations and learning extensions.

## Safety

A list of safety guidelines is included inside the front cover. Each lab session that requires special safety guidelines has a safety section. Your instructor might require some modifications of these guidelines.

## Learning Outcomes

The learning outcomes list what a student should be able to do after completing the exercise. Each learning outcome will have matching assessments indicated by the corresponding icon  in the laboratory exercise or the laboratory assessment.



# 12

## Laboratory Exercise

### Bone Structure and Classification

**Purpose of the Exercise**  
To review the way bones are classified and to examine the structure of a long bone and bone tissue.

**Materials Needed**

- Prepared microscope slide of ground compact bone
- Human bone specimens, including long, short, flat, irregular, and sesamoid types
- Human long bone, sectioned longitudinally
- Fresh animal bones, sectioned longitudinally and transversely
- Compound light microscope
- Dissecting microscope

**For Demonstration Activity:**  
Fresh chicken bones (radius and ulna from wings)  
Vinegar or dilute hydrochloric acid

**Safety**

- Wear disposable gloves for handling fresh bones and for the demonstration of a bone soaked in vinegar or dilute hydrochloric acid.
- Wash your hands before leaving the laboratory.

**Learning Outcomes**  
After completing this exercise, you should be able to

- 1 Arrange five groups of bones based on their shapes and identify an example for each group.
- 2 Locate the major structures of a long bone.
- 3 Distinguish between compact and spongy bone.
- 4 Differentiate the structural and functional characteristics of bone tissue.

**Pre-Lab**

Carefully read the introductory material and the entire lab. Be familiar with bone structure and bone tissue from lecture or the textbook. Visit [www.mhhe.com/martinseries2](http://www.mhhe.com/martinseries2) for LabCam videos. Answer the pre-lab questions.

**Pre-Lab Questions:** Select the correct answer for each of the following questions:

1. Which of the following tissues is *not* part of a bone as an organ?
  - a. dense connective
  - b. cartilage
  - c. muscle
  - d. blood
2. The organic matter of living bone includes
  - a. calcium phosphate.
  - b. collagen fibers and cells.
  - c. calcium carbonate.
  - d. magnesium and fluoride.
3. The \_\_\_\_\_ is an example of a sesamoid bone.
  - a. vertebra
  - b. femur
  - c. carpal
  - d. patella
4. The epiphyseal plate represents the
  - a. ends of the epiphyses.
  - b. shaft between the epiphyses.
  - c. growth zone of hyaline cartilage.
  - d. membrane around a bone.
5. The central canal of bone tissue contains
  - a. blood vessels and nerves.
  - b. osteocytes.
  - c. red bone marrow.
  - d. yellow bone marrow.
6. A \_\_\_\_\_ is an example of an irregular bone.
  - a. femur
  - b. carpal
  - c. rib
  - d. vertebra
7. A femur includes both compact and spongy bone tissues.  
True \_\_\_\_\_ False \_\_\_\_\_
8. Chicken bones, with both organic and inorganic components, possess the quality of tensile strength.  
True \_\_\_\_\_ False \_\_\_\_\_
9. Trabeculae are structural characteristics of compact bone.  
True \_\_\_\_\_ False \_\_\_\_\_

## Pre-Lab

The pre-lab includes quiz questions and directs the student to carefully read introductory material and examine the entire laboratory contents after becoming familiar with the topics from a textbook or lecture. Students will also be directed to visit [www.mhhe.com/martinseries2](http://www.mhhe.com/martinseries2) to obtain a list of correlated **Anatomy and Physiology Revealed®** animations and LabCam videos. After successfully answering the pre-lab questions, the student is prepared to become involved in the laboratory exercise.

**Introduction** The introduction describes the subject of the exercise or the ideas that will be investigated. It includes all of the information needed to perform the laboratory exercise.

**Procedure** The procedure provides a set of detailed instructions for accomplishing the planned laboratory activities. Usually these instructions are presented in outline form so that a student can proceed efficiently through the exercise in stepwise fashion.

The procedures include a wide variety of laboratory activities and, from time to time, direct the student to complete various tasks in the laboratory assessments.

There are also separate procedures in 11 labs that utilize Ph.I.L.S. 4.0.

**A bone represents an organ** of the skeletal system. As such, it is composed of a variety of tissues including bone tissue, cartilage, dense connective tissue, blood, and nervous tissue. Bones are not only alive, but also multifunctional. They support and protect softer tissues, provide points of attachment for muscles, house blood-producing cells, and store inorganic salts.

Living bone is a combination of about one-third organic matter and two-thirds inorganic matter. The organic matter consists mostly of embedded cells and collagen fibers. The inorganic matter is mostly complex salt crystals, hydroxyapatite, consisting of calcium phosphate. Lesser amounts of calcium carbonate and calcium magnesium fluoride, and sodium become incorporated into the inorganic crystals.

Bones are classified according to their shapes as long, short, flat, irregular, or sesamoid (round). Long bones are much longer than they are wide and have expanded ends. Short bones are somewhat cube shaped, with similar lengths and widths. Flat bones have wide surfaces, but they are sometimes curved, such as those of the cranium. Irregular bones have numerous shapes and often have articulations with more than one other bone. Sesamoid bones are small and embedded within a tendon near joints where compression often occurs. The patella is a sesamoid bone that is included in the total skeletal number of 206. Any additional sesamoid bones that may develop in compression areas of the hand or foot are not considered among the 206 bones of the adult skeleton. Although bones of the skeleton vary greatly in size and shape, they have much in common structurally and functionally.

**Procedure—Bone Structure and Classification**

During embryonic and fetal development, much of the supportive tissue is cartilage. Cartilage is retained in certain regions of the adult skeleton. Articular cartilage remains on the articulating surfaces of movable joints, costal cartilage connects the ribs to the sternum, and intervertebral discs are between the vertebrae. Hyaline cartilage composes the articular cartilage and the costal cartilage, while fibrocartilage is represented between the vertebrae.

Many bones contain compact and spongy bone components. The compact bone structure contains cylinder-shaped units called osteons. Each osteon contains a central canal that includes blood vessels and nerves in living bone. The cells or osteocytes are located in concentric circles within small spaces known as lacunae. The cellular processes of the osteocytes pass through microscopic canaliculi, which allow for the transport of nutrient and waste substances between cells and the central canal. The extracellular matrix occupies most of the area of an osteon.

Spongy bone does not possess the typical osteon units of compact bone. The osteocytes of spongy bone are located within a lattice of bony plates known as trabeculae. Canaliculi allow for diffusion of substances between the cells and the marrow that is positioned between the trabeculae.


1. Observe the individual bone specimens and arrange them into groups, according to the following shapes and examples (figs. 12.1 and 12.2).

**long**—femur; humerus; phalanges  
**short**—carpals; tarsals  
**flat**—ribs; scapula; most cranial bones  
**irregular**—vertebra; some facial bones as sphenoid  
**sesamoid (round)**—patella

**Critical Thinking Assessment**

Explain how bone cells embedded in a solid ground substance obtain nutrients and eliminate wastes.

**Demonstration Activities** Demonstration activities appear in separate boxes. They describe specimens, specialized laboratory equipment, or other materials of interest that an instructor may want to display to enrich the student's laboratory experience.




### Demonstration Activity

Examine a fresh chicken bone and a chicken bone that has been soaked for several days in vinegar or overnight in dilute hydrochloric acid. Wear disposable gloves for handling these bones. This acid treatment removes the inorganic salts from the bone extracellular matrix. Rinse the bones in water and note the texture and flexibility of each (fig. 12.7a). The bone becomes soft and flexible without the support of the inorganic salts with calcium.

Examine the specimen of chicken bone that has been exposed to high temperature (baked at 121°C/250°F for 2 hours). This treatment removes the \_\_\_\_\_ from the bone \_\_\_\_\_ bone comes \_\_\_\_\_ the collagen \_\_\_\_\_ of the quali- \_\_\_\_\_ provides ten- \_\_\_\_\_ the chicken

**Learning Extension Activities** Learning extension activities also appear in separate boxes. They encourage students to extend their laboratory experiences. Some of these activities are open-ended in that they suggest the student plan an investigation or experiment and carry it out after receiving approval from the laboratory instructor. Some of the figures are illustrated as line art or in grayscale. This will allow colored pencils to be used as a visual learning activity to distinguish various structures.



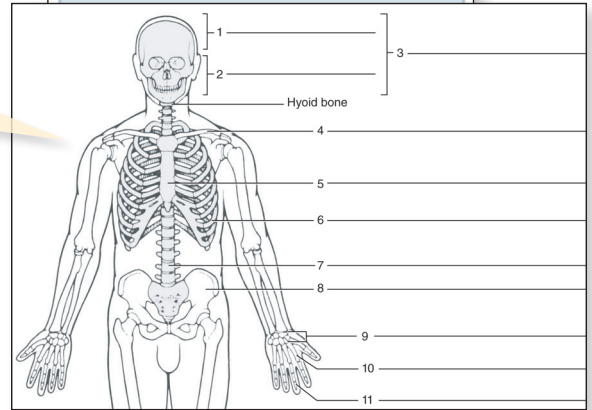
### Learning Extension Activity

Repeat the demonstration of diffusion using a petri dish filled with ice-cold water and a second dish filled with very hot water. At the same moment, add a crystal of potassium permanganate to each dish and observe the circle as before. What difference do you note in the rate of diffusion in the two dishes? How do you explain this difference?

\_\_\_\_\_

\_\_\_\_\_

**Illustrations** Diagrams similar to those in a textbook often are used as aids for reviewing subject matter. Other illustrations provide visual instructions for performing steps in procedures or are used to identify parts of instruments or specimens. Micrographs are included to help students identify microscopic structures or to evaluate student understanding of tissues.



In some exercises, the figures include line drawings suitable for students to color with colored pencils. This activity may motivate students to observe the illustrations more carefully and help them to locate the special features represented in the figures.

**Laboratory Assessments** A laboratory assessment form to be completed by the student immediately follows each exercise. These assessments include various types of review activities, spaces for sketches of microscopic objects, tables for recording observations and experimental results, and questions dealing with the analysis of such data.

**Laboratory Assessment**  
  
**12**

Name \_\_\_\_\_  
 Date \_\_\_\_\_  
 Section \_\_\_\_\_

The corresponds to the indicated outcome(s) found at the beginning of the laboratory exercise.

## Bone Structure and Classification

**Part A Assessments**

Complete the following statements: (Note: Questions 1–6 pertain to bone classification by shape.)

1. A bone that has a wide surface is classified as a(n) \_\_\_\_\_ bone.
2. The bones of the wrist are examples of \_\_\_\_\_ bones.
3. The bone of the thigh is an example of a(n) \_\_\_\_\_ bone.
4. Vertebrae are examples of \_\_\_\_\_ bones.
5. The patella (kneecap) is an example of a large \_\_\_\_\_ bone.
6. The bones of the skull that form a protective covering for the brain are examples of \_\_\_\_\_ bones.
7. Distinguish between the epiphysis and the diaphysis of a long bone.

\_\_\_\_\_

8. Describe where cartilage is found on the surface of a long bone.

\_\_\_\_\_

9. Describe where the periosteum is found on the surface of a long bone.

\_\_\_\_\_

Osteon \_\_\_\_\_

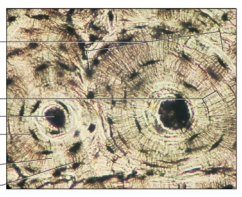
Lamella \_\_\_\_\_

Central canal \_\_\_\_\_

Lacuna (occupied by osteocyte in living bone) \_\_\_\_\_

Bone extracellular matrix \_\_\_\_\_

Canaliculus \_\_\_\_\_



\_\_\_\_\_ seen the periosteum and the endosteum.

\_\_\_\_\_ between compact bone and spongy bone?

**Histology** Histology photos placed within the appropriate exercise.



# Changes to This Edition

## Global Changes

- Introductory materials expanded; introductory material precedes most procedures.
- Pre-Lab questions expanded and placed in the laboratory manual rather than online.
- BIOPAC exercises rewritten.
- Ph.I.L.S. laboratory simulations updated.
- Ph.I.L.S. 4.0 online included with lab manual.
- Structural lists have functions and descriptions added.
- Muscle tables added with origins, insertions, and actions.
- New design and sequence of items placed on the introductory page of the laboratory exercise.
- Laboratory Reports changed to Laboratory Assessments.
- Matching assessments for the learning outcomes are all in the Laboratory Assessments.
- Laboratory exercises contain fully labeled figures.
- Laboratory Assessments expanded and contain figures to label.
- All micrographs contain magnifications.

Laboratory Exercise	Topic	Change
1	Laboratory Assessment	Improved directions
2	Procedures A, B, and C Structural lists Laboratory Assessment	Added introductory material Functions and descriptions added Added content
3	Fig. 3.1 (pH values) Procedure A	Improved depth Added introductory material
4	Fig. 4.3 (microscope) Laboratory Assessment	Added figure Added content; improved accuracy in Part B
5	Fig. 5.1 (composite cell) Introductory material Ph.I.L.S. Lesson 2	Improved depth Updated and expanded content Clarity added
6	Procedures B, C, and D Ph.I.L.S. Lesson 1	Added introductory material Clarity added
7	Fig. 7.2 (interphase) Fig. 7.5 (mitosis) Fig. 7.6a (human chromosomes) Introductory material	Added micrograph Improved depth New micrograph Improved depth
8	Fig. 8.1a, b, d, g, and h (epithelial tissues) Fig. 8.2 (sectional cuts) Table 8.1 (epithelial tissues)	New micrographs Added comparisons to body tube Added table with descriptions, functions, and locations
9	Fig. 9.1b and h (connective tissues) Table 9.1 (connective tissues) Table 9.2 (connective tissues) Introductory material	New micrographs Added table with descriptions and functions Improved design Improved depth
10	Fig. 10.1a and c (muscle tissues) Table 10.1 (muscle and nervous tissues)	New micrographs Added table with descriptions, functions, and locations
11	Fig. 11.1 (skin layers) Fig. 11.4b (skin structures) Table 11.1 (epidermal layers) Procedure	Added figure New micrograph Added table with locations and descriptions Reworked
12	Fig. 12.1 (bone classification) Fig. 12.4 (compact and spongy bone) Procedure Demonstration activity	Added figure Added figure Added introductory material Rewritten information
13	Fig. 13.1a–b (skeleton) Fig. 13.2a–h (bone features) Introductory material	Redrawn Added figure Improved depth
14	Figs. 14.1 and 14.2 (skulls) Fig. 14.7 (paranasal sinuses) Table 14.1 (skull passageways) Procedure	Redrawn Added figure Added table with locations and contents Expanded depth
15	Fig. 15.5 (rib) Procedures A and B Structural lists	Added figure Added introductory material Added functions and descriptions

Laboratory Exercise	Topic	Change
16	Fig. 16.2 <i>b</i> (scapula) Fig. 16.5 (hand bones) Procedures A and B Structural lists	Added figure New figure Added introductory material Added functions and descriptions
17	Fig. 17.2 <i>a</i> (hip bone) Fig. 17.2 <i>b</i> (hip bone) Fig. 17.5 (foot bones) Procedures A and B Table 17.1 (male and female pelvis) Critical Thinking Activities	Revised figure Added figure New figure Added introductory material Added comparison table Two added
18	Introductory material	Improved depth
19	Fig. 19.2 (synovial joint) Fig. 19.3 <i>b</i> (cadaver knee) Procedures A and B Critical Thinking Activity	New figure Added figure Added introductory material One added
20	Fig. 20.1 (neuromuscular junctions) Fig. 20.3 (fascicle) Fig. 20.5 (sarcomere) Table 20.1 (muscle descriptions) Structural list Ph.I.L.S. Lesson 5	Added micrograph Added micrograph Added micrograph Added table Functions and descriptions added Clarity added
21	BIOPAC Exercise (Electromyography)	Rewritten
22	Tables 22.1, 22.2, 22.3, and 22.4 (head and neck muscles)	Added tables with origins, insertions, and actions
23	Fig. 23.5 <i>a–b</i> (forearm muscles) Tables 23.1, 23.2, 23.3, and 23.4 (chest, shoulder, and upper limb muscles) Procedure	New figure Added tables with origins, insertions, and actions  Reworked
24	Title and two procedures Fig. 24.4 <i>a–c</i> (pelvic floor muscles) Tables 24.1, 24.2, and 24.3 (vertebral column, abdominal wall, and pelvic floor muscles)	Improved topics, clarity, and depth New figure Added tables with origins, insertions, and actions
25	Fig. 25.5 <i>b</i> (leg muscles) Fig. 25.7 (leg muscles) Tables 25.1, 25.2, and 25.3 (hip and lower limb muscles)	Added figure Added figure Added tables with origins, insertions, and actions
26	Procedure Laboratory Assessment Part C	Reworked sequence and clarity Improved design and directions
27	Procedures A and B Fig. 27.1 (structural neurons) Fig. 27.6 (neuroglia) Fig. 27.8 (Purkinje cell) Fig. 27.9 Tables 27.1 and 27.2 (neurons and neuroglia)	New organization Added figure Added figure Added micrograph Added figure Added tables with characteristics, locations, and functions
28	Title and three procedures Fig. 28.3 (spinal cord) Fig. 28.4 (spinal nerves) Fig. 28.7 (meninges) Fig. 28.8 (spinal cord)	Expanded topics, clarity, and depth Expanded content Added figure Added figure New micrograph
29	Fig. 29.1 (withdrawal reflex arc) Fig. 29.2 (stretch reflex arc) Laboratory Assessment Part A table	Expanded content Added figure Expanded components
30	Figs. 30.1 and 30.2 (ventricles of brain) Fig. 30.7 (cerebellum and brainstem) Tables 30.1, 30.2, and 30.3 (brain and cranial nerves) Procedure A	Added figures Added figure Added tables with descriptions and functions  Added introductory material



# Changes to This Edition

Laboratory Exercise	Topic	Change
31	BIOPAC (Electroencephalography)	Rewritten
32	Fig. 32.3 (sheep brain) Fig. 32.6 (sheep brain)	Redrawn figure Added figure
33	Fig. 33.3 (two-point test) Table 33.1 (skin receptors)	Added figure Added table
34	Fig. 34.1 (smell receptors) Fig. 34.4 (taste bud)	Revised figure Revised orientation
35	Fig. 35.1 (lacrimal apparatus) Fig. 35.6 (eye exam) Fig. 35.12 (sectioned eye) Table 35.1 (eye muscles) Structural list	New figure New figure New micrograph Added table with actions and nerves Descriptions and functions added
36	Fig. 36.1 (refractive defects) Procedure A	Added figure Clarified directions
37	Structural list	Descriptions and functions added
38	Laboratory exercise title	Better reflects content of lab
39	Fig. 39.1 (major endocrine glands) Fig. 39.6 (thyroid gland) Fig. 39.12 (pancreas) Ph.I.L.S. Lesson 19	New figure New micrograph New micrograph Clarity added
40	Procedure A	Added introductory material
41	Figs. 41.2 and 41.5 (blood cells) Table 41.1 (blood components) Introductory material	Added micrographs Updated and expanded content Improved depth
42	Procedure D (cholesterol test) Ph.I.L.S. Lesson 34 Introductory material	Added procedure Clarity added Improved depth
43	Fig. 43.4 (blood test results) Table 43.2 (blood typing reactions)	Added figure Updated
44	Fig. 44.3 (sectioned heart) Fig. 44.6 (blood circuits) Structural list Terminology	Added figure Added figure Added descriptions and functions Updated
45	Fig. 45.1 (heart sound locations) Fig. 45.4 (cardiac cycle) Procedure B	Updated Added figure Added introductory material
46	BIOPAC (Electrocardiography)	Rewritten
47	Fig. 47.1 (blood vessel wall structure) Fig. 47.2 (artery and vein) Fig. 47.6 (cerebral arterial circle) Introductory material Procedures A, C, and D	Added figure New micrograph Added figure Improved depth Added introductory material
48	Fig. 48.2 (taking pulse rate) Fig. 48.5 (taking blood pressure) Introductory material Procedure B Ph.I.L.S. Lesson 40	Added figure Added figure Improved depth Added introductory material Clarity added
49	Fig. 49.1 (fluid movements) Fig. 49.2 (lymph drainage areas) Fig. 49.6a (cadaver lymph node) Fig. 49.6c (lymph node) Fig. 49.7 (thymus) Fig. 49.8 (spleen) Introductory material	Added figure Added figure Added figure New micrograph New micrograph New micrograph Improved depth

Laboratory Exercise	Topic	Change
50	Fig. 50.1 (respiratory organs) Fig. 50.5 (respiratory organs) Fig. 50.6 (trachea wall) Structural list	New figure Added figure New micrograph Added descriptions and functions
51	Fig. 51.1 (respiratory muscles) Fig. 51.2 (model for air movements) Procedure A Ph.I.L.S. Lesson 38	Added figure Added figure Added introductory material Clarity added
52	BIOPAC (Spirometry)	Rewritten
53	Figs. 53.1 and 53.2 (respiratory organs) Fig. 53.3 (peripheral chemoreceptors) Introductory material	New figures Added figure Updated and improved depth
54	Fig. 54.7 (stomach wall) Structural lists	New micrograph Added descriptions and functions
55	Fig. 55.1 (lock-and-key model) Introductory material	Added figure Improved depth
56	Laboratory exercise title Fig. 56.2 (kidney section) Fig. 56.6 (urethra of female and male) Fig. 56.9 (urethra) Procedure C Structural lists	Reflects expanded content Revised labels Added figure Added micrograph Added introductory material and urethra Added descriptions and functions
57	Procedures A and B	Reflects new organization of contents
58	Fig. 58.1 (male reproductive system) Fig. 58.2 (testis of cadaver) Fig. 58.3 (testis) Fig. 58.4 (seminiferous tubule) Fig. 58.5 (epididymis) Fig. 58.6 (ductus deferens) Structural lists Laboratory Assessments Part B	New figure Added figure Expanded labels New figure New figure Added figure Added descriptions and functions New content arrangement
59	Fig. 59.3 (female cadaver organs) Fig. 59.8 (uterine tube) Fig. 59.9 (uterine wall) Structural lists Laboratory Assessments Part B	Added figure New micrograph New micrograph Added descriptions and functions New content arrangement
60	Structural list	Added descriptions and functions
61	Introductory material	Improved depth