MAIN VERSION

Laboratory Manual for

HUMAN ANATOMY & PHYSIOLOGY

Fourth Edition

TERRY R. MARTIN | CYNTHIA PRENTICE-CRAVER

Mc Graw Hill Education

MAIN VERSION

LABORATORY MANUAL FOR

HUMAN ANATOMY & PHYSIOLOGY

FOURTH EDITION

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LABORATORY MANUAL FOR HUMAN ANATOMY & PHYSIOLOGY: MAIN VERSION, FOURTH EDITION

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Some of the laboratory experiments included in this text may be hazardous if materials are handled improperly or if procedures are conducted incorrectly. Safety precautions are necessary when you are working with chemicals, glass test tubes, hot water baths, sharp instruments, and the like, or for any procedures that generally require caution. Your school may have set regulations regarding safety procedures that your instructor will explain to you. Should you have any problems with materials or procedures, please ask your instructor for help.

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Endocrine System

Cardiovascular System

Lymphatic System

Respiratory System

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Supplemental Laboratory Exercises*

*These exercises are available in the eBook via Connect Anatomy & Physiology and also online for instructor distribution; see Instructor Resources via Connect Library tab.

PREFACE

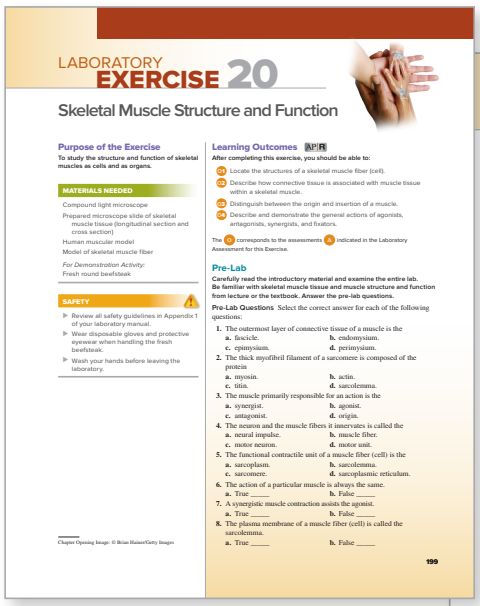
InTOUCH | WITH Anatomy & Physiology Lab Courses

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. Author Cynthia Prentice-Craver's twenty-two years of passion for and experience in teaching human anatomy and physiology, and her commitment to developing curriculum that stimulates student curiosity and enthusiasm, steered her cultivation of this laboratory manual. The *Laboratory Manual for Human Anatomy & Physiology* includes a main version, a cat version, and a fetal pig version. Each of these versions includes sixty-three laboratory exercises, three supplemental labs found online, and six cat, or fetal pig, dissection labs in the corresponding versions. All versions are written to work well with any anatomy and physiology text.

Martin Lab Manual Series . . .

InTOUCH WITH Anatomy & Physiology Lab Courses

- Anatomy and Physiology REVEALED® icons are found in figure legends. These icons indicate that there is a direct link to APR available in the eBook provided with Connect® for this title.
- Incorporates **learning outcomes and assessments** to help students master important material.
- **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.


LABORATORY EXERCISE 20

Skeletal Muscle Structure and Function

Purpose of the Exercise

To study the structure and function of skeletal muscles as cells and as organs.

Learning Outcomes

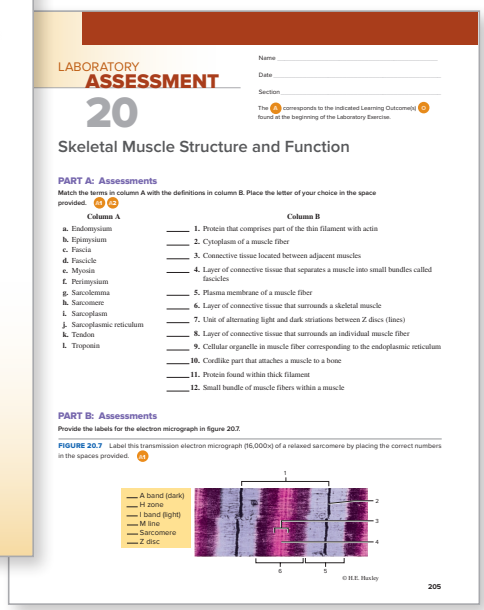
After completing this exercise, you should be able to:

MATERIALS NEEDED

SAFETY

Pre-Lab

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


LABORATORY ASSESSMENT 20

Skeletal Muscle Structure and Function

PART A: Assessments

Match the terms in column A with the definitions in column B. Place the letter of your choice in the space provided.

Column A

a. Endomysium
b. Epimysium
c. Fascia
d. Fascicle
e. Myosin
f. Perimysium
g. Sarcolemma
h. Sarcomere
i. Sarcoplasm
j. Sarcoplasmic reticulum
k. Tendon
l. Troponin

Column B

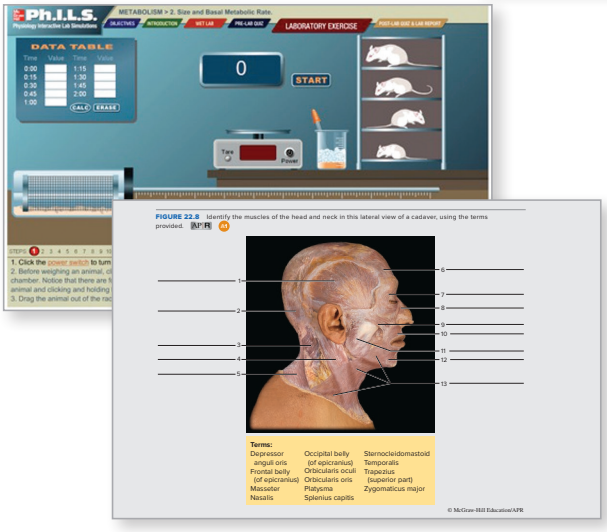
1. Protein that comprises part of the thin filament with actin
2. Cytoplasm of a muscle fiber
3. Connective tissue located between adjacent muscles
4. Layer of connective tissue that separates a muscle into small bundles called fascicles
5. Plasma membrane of a muscle fiber
6. Layer of connective tissue that surrounds a skeletal muscle
7. Unit of alternating light and dark striations between Z discs (lines)
8. Layer of connective tissue that surrounds an individual muscle fiber
9. Cellular organelle in muscle fiber corresponding to the endoplasmic reticulum
10. Cordlike part that attaches a muscle to a bone
11. Protein found within thick filament
12. Small bundle of muscle fibers within a muscle

PART B: Assessments

Provide the labels for the electron micrograph in figure 20.7.

FIGURE 20.7 Label this transmission electron micrograph (16,000×) of a relaxed sarcomere by placing the correct numbers in the spaces provided.

A band (dark)
H zone
I band (light)
M line
Sarcomere
Z disc



- **BIOPAC®** exercises use hardware and software for data acquisition, analysis, and recording.
- **NEW!** Exercise 56 Metabolism. This new lab will explore metabolism, how it can be measured, and conditions that influence it.
- **Ph.I.L.S. 4.0** physiology lab simulations, available in Appendix 4, make otherwise difficult and expensive experiments a breeze through digital simulations.
- 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 instructors and is available online.

FEATURES OF THIS LABORATORY MANUAL

InTOUCH 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.
- The pre-lab section 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.
- **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 and Assessments 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.

InTOUCH 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 available. Contact your McGraw-Hill Learning Technology Representative. 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," "Metabolism," 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.

InTOUCH WITH Educational Needs

- Learning outcomes with icons O have matching assessments with icons A 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 3.

InTOUCH WITH Technology

- Anatomy & Physiology REVEALED® 3.2

  Detailed cadaver photographs blended together with a state-of-the-art layering technique provide a uniquely interactive dissection experience. Cat and fetal pig versions are also available.

- 

Physiology Interactive Lab Simulations (Ph.I.L.S. 4.0) is included with the Connect website for this laboratory manual. Eleven lab simulations are located in Appendix 4, including a correlation guide.

- BIOPAC Systems, Inc. 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.

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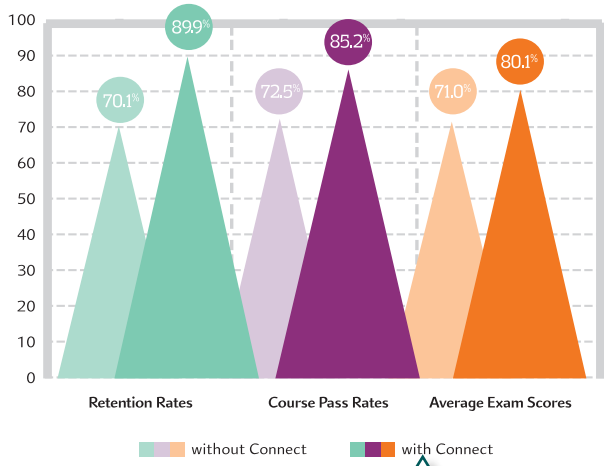

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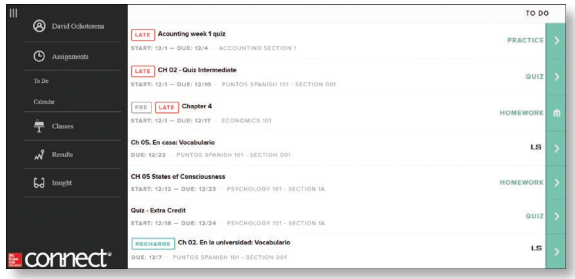

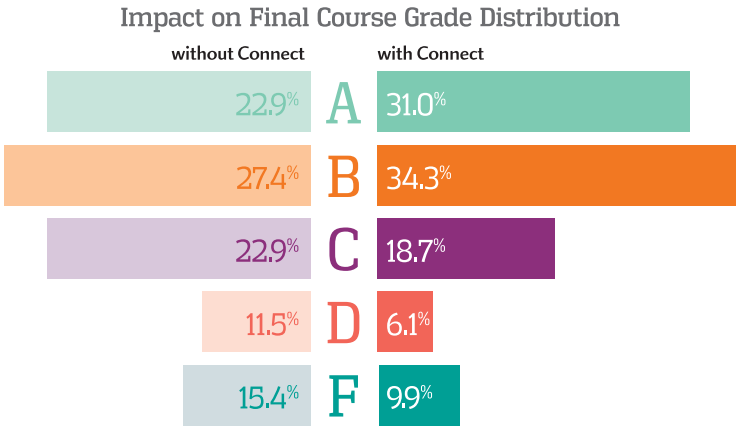

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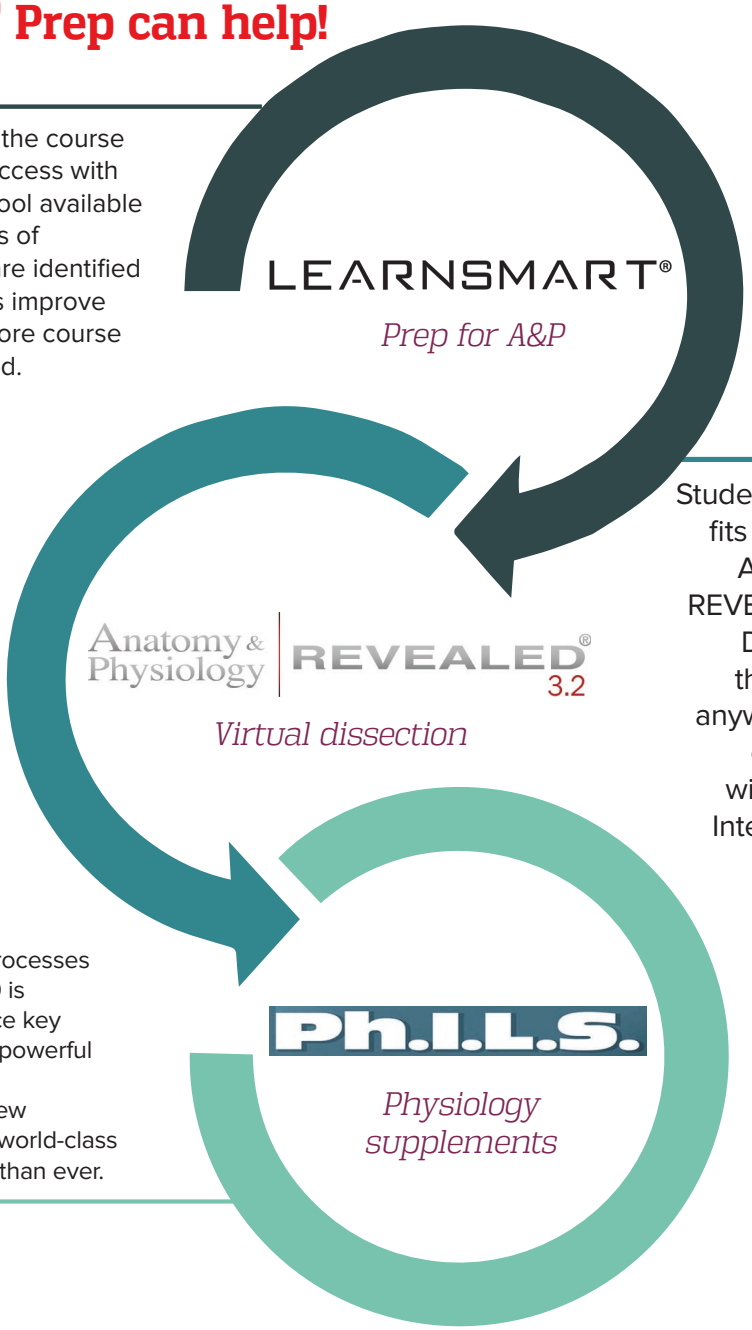

Students seek lab time that fits their busy schedules. Anatomy & Physiology REVEALED 3.2, our Virtual Dissection tool, allows them practice anytime, anywhere. Now featuring enhanced physiology with Concept Overview Interactives (COVI's) and 3D animations!

Bringing to life complex processes is a challenge. Ph.I.L.S. 4.0 is the perfect way to reinforce key physiology concepts with powerful lab experiments.
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GUIDED TOUR THROUGH AN 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.

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 A in the laboratory exercise or the laboratory assessment.

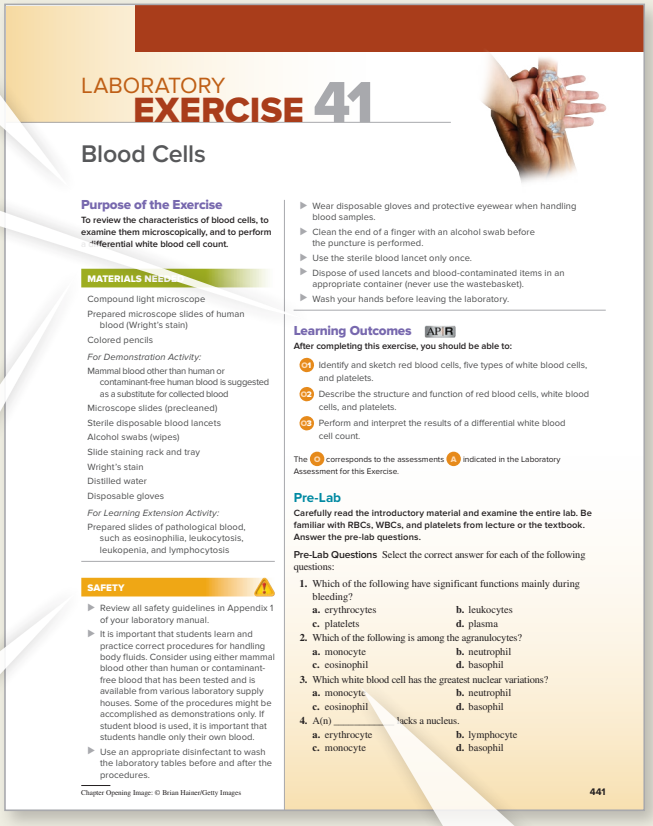
Materials Needed This section lists the laboratory materials that are required to complete the exercise and to perform the demonstrations and learning extensions.

Safety A list of laboratory safety guidelines is located in Appendix 1 of your laboratory manual. Each lab session that requires special safety guidelines has a safety section. Your instructor might require some modifications of these guidelines.

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



LABORATORY EXERCISE 41

Blood Cells

Purpose of the Exercise

To review the characteristics of blood cells, to examine them microscopically, and to perform differential white blood cell count.

MATERIALS NEEDED

- Compound light microscope
- Prepared microscope slides of human blood (Wright's stain)
- Colored pencils

For Demonstration Activity:

- Mammal blood other than human or contaminant-free human blood is suggested as a substitute for collected blood
- Microscope slides (precleaned)
- Sterile disposable blood lancets
- Alcohol swabs (wipes)
- Slide staining rack and tray
- Wright's stain
- Distilled water
- Disposable gloves

For Learning Extension Activity:

- Prepared slides of pathological blood, such as eosinophilia, leukocytosis, leukopenia, and lymphocytosis

SAFETY

- Review all safety guidelines in Appendix 1 of your laboratory manual.
- It is important that students learn and practice correct procedures for handling body fluids. Consider using either mammal blood other than human or contaminant-free blood that has been tested and is available from various laboratory supply houses. Some of the procedures might be accomplished as demonstrations only. If student blood is used, it is important that students handle only their own blood.
- Use an appropriate disinfectant to wash the laboratory tables before and after the procedures.
- Wear disposable gloves and protective eyewear when handling blood samples.
- Clean the end of a finger with an alcohol swab before the puncture is performed.
- Use the sterile blood lancet only once.
- Dispose of used lancets and blood-contaminated items in an appropriate container (never use the wastebasket).
- Wash your hands before leaving the laboratory.

Learning Outcomes A P R

After completing this exercise, you should be able to:

- LO1 Identify and sketch red blood cells, five types of white blood cells, and platelets.
- LO2 Describe the structure and function of red blood cells, white blood cells, and platelets.
- LO3 Perform and interpret the results of a differential white blood cell count.

The LO corresponds to the assessments A indicated in the Laboratory Assessment for this Exercise.

Pre-Lab

Carefully read the introductory material and examine the entire lab. Be familiar with RBCs, WBCs, and platelets from lecture or the textbook. Answer the pre-lab questions.

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

1. Which of the following have significant functions mainly during bleeding?
   a. erythrocytes b. leukocytes
   c. platelets d. plasma
2. Which of the following is among the agranulocytes?
   a. monocyte b. neutrophil
   c. eosinophil d. basophil
3. Which white blood cell has the greatest nuclear variations?
   a. monocyte b. neutrophil
   c. eosinophil d. basophil
4. A(n) _____ lacks a nucleus.
   a. erythrocyte b. lymphocyte
   c. monocyte d. basophil

Chapter Opening Image: © Brian Haiser/Getty Images

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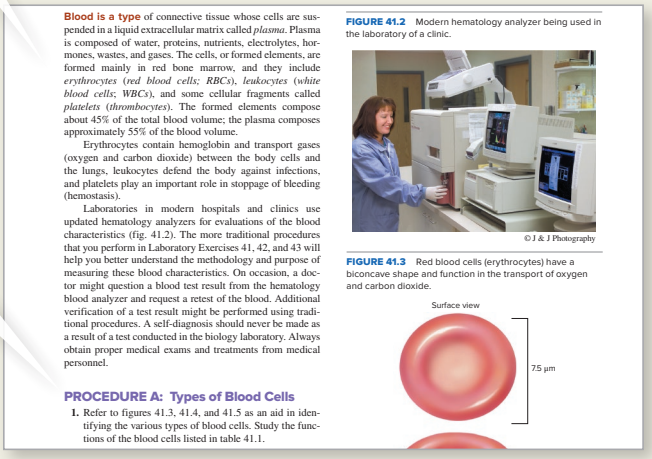
Pre-Lab The pre-lab includes quiz questions and directs the student to carefully read introductory material and examine the entire laboratory contents after becoming familiar with the topics from a textbook or lecture. After successfully answering the pre-lab questions, the student is prepared to become involved in the laboratory exercise.



Blood is a type of connective tissue whose cells are suspended in a liquid extracellular matrix called *plasma*. Plasma is composed of water, proteins, nutrients, electrolytes, hormones, wastes, and gases. The cells, or formed elements, are formed mainly in red bone marrow, and they include *erythrocytes* (*red blood cells; RBCs*), *leukocytes* (*white blood cells*; *WBCs*), and some cellular fragments called *platelets* (*thrombocytes*). The formed elements compose about 45% of the total blood volume; the plasma composes approximately 55% of the blood volume.

Erythrocytes contain hemoglobin and transport gases (oxygen and carbon dioxide) between the body cells and the lungs, leukocytes defend the body against infections, and platelets play an important role in stoppage of bleeding (hemostasis).

Laboratories in modern hospitals and clinics use updated hematology analyzers for evaluations of the blood characteristics (fig. 41.2). The more traditional procedures that you perform in Laboratory Exercises 41, 42, and 43 will help you better understand the methodology and purpose of measuring these blood characteristics. On occasion, a doctor might question a blood test result from the hematology blood analyzer and request a retest of the blood. Additional verification of a test result might be performed using traditional procedures. A self-diagnosis should never be made as a result of a test conducted in the biology laboratory. Always obtain proper medical exams and treatments from medical personnel.

PROCEDURE A: Types of Blood Cells

1. Refer to figures 41.3, 41.4, and 41.5 as an aid in identifying the various types of blood cells. Study the functions of the blood cells listed in table 41.1.

FIGURE 41.2 Modern hematology analyzer being used in the laboratory of a clinic.

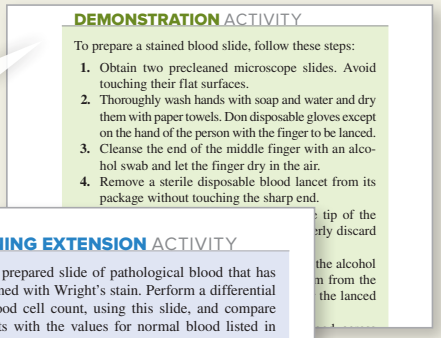
© J & J Photography

FIGURE 41.3 Red blood cells (erythrocytes) have a biconcave shape and function in the transport of oxygen and carbon dioxide.

Surface view

7.5 µm

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.

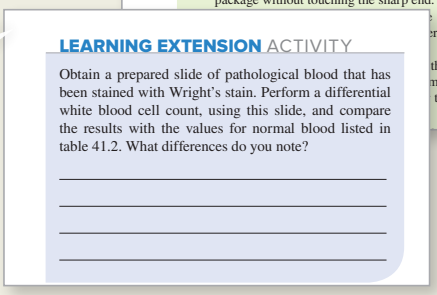


DEMONSTRATION ACTIVITY

To prepare a stained blood slide, follow these steps:

1. Obtain two precleaned microscope slides. Avoid touching their flat surfaces.
2. Thoroughly wash hands with soap and water and dry them with paper towels. Don disposable gloves except on the hand of the person with the finger to be lanced.
3. Cleanse the end of the middle finger with an alcohol swab and let the finger dry in the air.
4. Remove a sterile disposable blood lancet from its package without touching the sharp end.

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

Obtain a prepared slide of pathological blood that has been stained with Wright's stain. Perform a differential white blood cell count, using this slide, and compare the results with the values for normal blood listed in table 41.2. What differences do you note?

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.

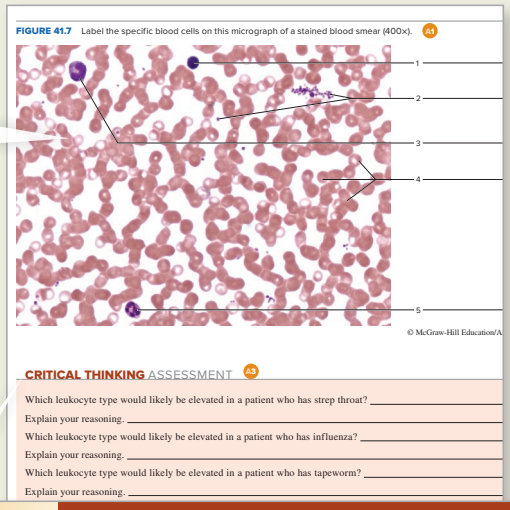


FIGURE 41.7 Label the specific blood cells on this micrograph of a stained blood smear (400×). A1

1 2 3 4 5

© McGraw-Hill Education/A

CRITICAL THINKING ASSESSMENT A3

Which leukocyte type would likely be elevated in a patient who has strep throat? _____

Explain your reasoning. _____

Which leukocyte type would likely be elevated in a patient who has influenza? _____

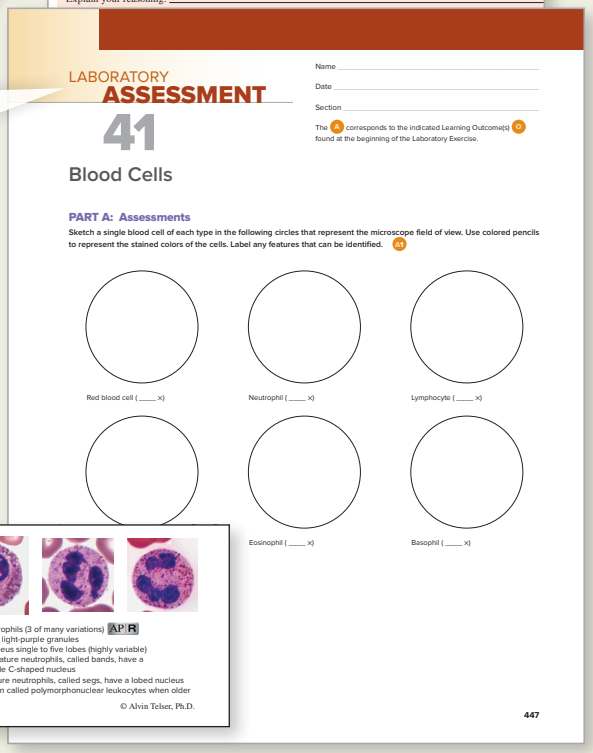
Explain your reasoning. _____

Which leukocyte type would likely be elevated in a patient who has tapeworm? _____

Explain your reasoning. _____

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. Critical Thinking Assessments enhance higher-order thinking skills.

As a result of these activities, students will develop a better understanding of the structural and functional characteristics of their bodies and will increase their skills in gathering information by observation and experimentation. By completing all of the assessments, students will be able to determine if they were able to accomplish all of the learning outcomes.



LABORATORY **ASSESSMENT**

41

Blood Cells

Name _____

Date _____

Section _____

The A corresponds to the indicated Learning Outcome(s) O found at the beginning of the Laboratory Exercise.

PART A: Assessments

Sketch a single blood cell of each type in the following circles that represent the microscope field of view. Use colored pencils to represent the stained colors of the cells. Label any features that can be identified. A1

Red blood cell (____ ×) Neutrophil (____ ×) Lymphocyte (____ ×)

Eosinophil (____ ×) Basophil (____ ×)

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Histology Histology photos placed within the appropriate exercise.

Neutrophils (3 of many variations) AP R

- Fine light-purple granules
- Nucleus single to five lobes (highly variable)
- Immature neutrophils, called bands, have a single C-shaped nucleus
- Mature neutrophils, called segs, have a lobed nucleus
- Often called polymorphonuclear leukocytes when older

© Alvin Telser, Ph.D.

CHANGES TO THIS FOURTH EDITION

Global Changes

- Renumbering of many exercise figures
- Safety guidelines moved to Appendices
- Ph.I.L.S. 4.0 laboratory lessons moved to Appendices
- Added APR icons.
- Replaced squares for histology drawings with circles to represent microscope field of view

LABORATORY EXERCISE	TOPIC	CHANGE
1	Pre-Lab	Added question
2	Pre-Lab Introductory material Procedure A (body cavities and membranes) Fig. 2.2a and 2.2b (thoracic membranes) Fig. 2.3 (serous membranes) Fig. 2.4 (other body cavities) Procedure C (positions, planes, regions) Fig. 2.6 (directional terms) Table 2.1 (directional terms meaning) Fig. 2.7 (planes) Fig. 2.9 (body surface regions) Fig. 2.11 (serous membranes of heart) Assessments: Part C Fig. 2.13b (body surface regions—posterior)	Added question Revised components and improved depth of membranes and other body cavities Improved depth Expanded labels Revised and improved labels New figure Improved depth Revised labels New table Revised label Added labels New figure Added questions New figure
3	Pre-Lab Procedure A (pH scale) Procedure B (slide preparation) Assessments: Part A	Added question Improved depth Revised components and step lettering Added question
4	Fig. 4.1 (microscope) Table 4.1 (microscope parts and their function) Assessments: Part C Assessments: Part E	Revised labels and expanded legend New table Added letter *e* Revised field of view circles for drawings
5	Materials Needed Introductory material Assessments: Part C Fig. 5.5 (cellular components)	Suggestion for prepared slides Revised and improved depth of plasma membrane structure and transport Revised field of view circles for drawings; added question Revised components
6	Procedure B (osmosis) Procedure C (hyper-, hypo-, iso- tonic) Fig. 6.3 (apparatus for alternative activity) Procedure D (filtration) Assessments: Part D	Improved depth New Alternate Activity New drawing Improved depth Expanded Critical Thinking
7	Pre-Lab Introductory material Procedure (cell cycle) Fig. 7.2, 7.3, 7.4, 7.5 (cell cycle) Fig. 7.6 (onion root tip cells) Fig. 7.7 (human chromosomes) Assessments: Part B	Added questions Revised and improved depth Revised components; new Learning Extension Activity Revised legends and labels New figure Revised and improved legend Revised field of view circles for drawings
8	Pre-Lab Introductory material Procedure (epithelial tissues) Figure 8.1d and 8.1e Assessments: Part A Assessments: Part B and Part C	Added question Revised and improved depth of epithelial tissue characteristics Expanded directions Revised leader lines Revised field of view circles for drawings Added questions

LABORATORY EXERCISE	TOPIC	CHANGE
9	Introductory material Procedure (connective tissues) Figure 9.1a (areolar connective tissue) Figure 9.1c (reticular connective tissue) and Figure 9.1k (blood) Figure 9.1f (elastic connective tissue) Table 9.1 (connective tissues and function) Table 9.3 (cells in connective tissues) Assessments: Part A Assessments: Part C	Expanded to include embryonic tissue Expanded directions Added label Updated labels Replaced micrograph and revised labels Expanded components New table Revised field of view circles for drawings Revised components and added question
10	Introductory material Figure 10.1c (cardiac muscle) Figure 10.2 (nervous tissue) Assessments: Part A Assessments: Part B	Improved depth for each muscle type Added label and revised leader lines Revised labels and leader lines Revised field of view circles for drawings Added question
11	Introductory material Procedure (integumentary system) Figure 11.5e (base of two hair structures) Assessments: Part A and Part E	Revised components Expanded components Replaced micrograph Revised and expanded components
12	Introductory material Procedure (bone structure and classification) Figure 12.3 (long bone structures) Figure 12.5 and Figure 12.11 (anatomy of bone) Figure 12.6b (spongy bone) and Figure 12.12 (compact bone) Assessments: Part A	Improved depth of function, matrix, cells Revised components and improved depth of cartilages and compact bone and long bone structures Expanded legend Revised and added leader lines and labels New figures Revised and expanded components
13	Pre-Lab Figure 13.2 (bone features)	Added questions Added labels
14	Pre-Lab Procedure (skull) Figure 14.1, 14.2, 14.4, 14.5, 14.11 (skull) Figure 14.3 (mandible) Figure 14.11 (lateral view of skull) Assessments: Part A and Part D	Added questions Revised and added components Added labels New figure Added term to label Added questions
15	Introductory material Procedure A (vertebral column) Figure 15.3 (articulation of atlas and axis) Figure 15.4 (vertebrae features) and Figure 15.5 (sacrum and coccyx) Assessments: Part B and Figure 15.10 Figure 15.11 (thoracic cage)	Improved clarity on axial skeleton Expanded components New figure Added labels Added question and new figure Added labels
16	Figure 16.8 (elbow) and Figure 16.9 (shoulder)	Added labels
17	Pre-Lab Introductory material Procedure A (pelvic girdle) and Procedure B (lower limb) Figure 17.2 (hip bone) and Figure 17.3 (femur) Figure 17.11 (coxal bone)	Added question Expanded components Added components Added labels New figure
19	Introductory material Figure 19.1 (joint classification)	Revised and expanded component on cartilaginous joints New figure
20	Introductory material Procedure (skeletal muscle) Figure 20.1 (skeletal muscle arrangement)	Improved depth on origin, insertion, action, shape Expanded and added components Revised leader lines for endomysium
21	Figure 21.1 (student lab system setup) and Figure 21.2 (display window setup) Table 21.1 (display tools for analysis) and Figure 21.5 (dynamometers or pump bulb)	Replaced figures Revised and updated components

LABORATORY EXERCISE	TOPIC	CHANGE
22	Pre-Lab Procedure (head and neck) Figure 22.1 (facial expression) Table 22.1 (facial expression), Table 22.2 (mastication), Table 22.3 (head and neck), Table 22.4 (hyoid and larynx) Figure 22.7 (anterior head) and Figure 22.8 (lateral head) Assessments: Part B Assessments: Part C	Added question Added muscles Added labels Expanded components; include innervation of muscles Added labels Added questions and updated numbering Added column for innervation and added question
23	Figure 23.2 (anterior chest, shoulder, arm) and Figure 23.3 (posterior chest, shoulder, arm) Table 23.1 (respiration), Table 23.2 (pectoral girdle), Table 23.3 (arm), Table 23.4 (forearm), table 23.5 (hand) Assessments: Part A and Part E Assessments: Part D	Added labels and revised components Expanded components; innervation of muscles Added questions Added column for innervation
24	Pre-Lab Table 24.1 (vertebral column), Table 24.2 (abdominal wall), Table 24.3 (pelvic floor) Figure 24.2 (abdominal wall)	Added question Expanded components; innervation of muscles Added labels
25	Figure 25.1 (hip and thigh) Procedure (hip and lower limb) Figure 25.3 (posterior hip and thigh) Figure 25.4 (deep hip) and Figure 25.7 (posterior right leg) Table 25.1 (thigh), Table 25.2 (leg), Table 25.3 (foot) Figure 25.5 (anterior thigh) Figure 25.10 (posterior hip and thigh) and Figure 25.11 (leg) Assessments: Part C Assessments: Part D	Revised (a) and added figure (b) Expanded components Revised and added labels Added labels Expanded components; innervation of muscles Replaced figure Added labels Added column for innervation Added question
26	Learning Outcomes Pre-Lab Figure 26.1 (posterior torso) and Figure 26.4 (lateral shoulder and upper limb), Figure 26.3b (anterior lower torso) Figure 26.2b (lateral head and neck), Figure 26.2c (posterior head and neck), Figure 26.3 (anterior torso), Figure 26.9 (anterior view) Assessments: Part C	Added Learning Outcome O4 Added question Replaced images and updated terminology Updated terminology Added question
27	Procedure A (nervous tissue), Figure 27.5 (ganglion and sensory neurons), Figure 27.9 (peripheral nerve) Assessments: Part C and Part D	Updated terminology Revised field of view circles for drawings
28	Introductory material and Procedure B (structure of spinal cord) Figure 28.1 (meninges of spinal cord), Figure 28.2 (cadaver cervical spinal cord), Figure 28.3 (spinal cord cross section), Figure 28.4 (spinal cord tracts), Figure 28.6 (transverse view spinal cord) Table 28.1 (nerve plexuses) Figure 28.7 (cervical plexus), Figure 28.11 (lumbar plexus), Figure 28.12 (sacral plexus), Figure 28.14 (micrograph spinal cord) Assessments: Part C and Part D	Updated terminology Updated and expanded components Expanded components Added labels Added questions
30	Procedure A: Cranial meninges Figure 30.4 (transverse section of brain) and Figure 30.6 (median section of brain) Table 30.1 (brain regions and functions)	Expanded components Added labels Expanded components
31B	Figure 31B.2 (electrode placement)	Revised component

LABORATORY EXERCISE	TOPIC	CHANGE
32	Procedure (dissection of sheep brain) Figure 32.5 (median section sheep brain), Figure 32.7 (frontal section human brain), Figure 32.8 (median section sheep brain)	Expanded components to improve depth Revised and added labels
33	Learning Outcomes Pre-Lab Procedure B (tactile localization) Assessments: Part B (tactile localization) and Part C (two-point threshold) Assessments: Part D	Revised Learning Outcome O2; added Learning Outcome O4 Added question Revised and replaced material Added table for organization and revised and added components Updated Learning Outcome connection
34	Figure 34.2 (smell structures)	Revised label and leader lines
35	Procedure A (structure and function of eye) Figure 35.3 (eye structures) Procedure B (eye dissection) Figure 35.8 (cow eye dissection) and Figure 35.14 (cow eye dissection)	Expanded components and added depth Added label Expanded components New figures
37	Figure 37.11 (spiral organ structures)	Replaced micrograph and revised labeling
38	Figure 38.4 (dynamic equilibrium structures) Figure 38.6 (crista ampullaris)	Revised components Replaced micrograph and revised labeling
39	Learning Outcomes Introductory material Procedure (endocrine gland histology) Table 39.1 (endocrine hormones and functions) Figure 39.3 (anterior lobe), Figure 39.4 (posterior lobe), Figure 39.6 (thyroid gland), Figure 39.12 (pancreas) Figure 39.13 (ovary structure), Figure 39.14 (ovary), Figure 39.15 (testes structure) Assessments: Part A Assessments: Part B and Part C Assessments: Part D	Revised Learning Outcome O2 and added Learning Outcome O4 Revised and improved depth of relationship between hypothalamus-pituitary-thyroid Expanded and improved depth New table Replaced micrographs and revised labeling New figures and micrographs Revised field of view circles for drawings Revised components New assessment and questions
40	Figure 40.1 (normal stained pancreas) and Figure 40.4 (pancreas with diabetes mellitus) Assessment: Part C	Replaced micrographs and revised labeling Revised field of view circles for drawings
41	Pre-Lab and introductory material Table 41.1 (cellular components of blood) Assessment: Part C	Updated terminology Revised component Added question
42	Learning Outcomes Pre-Lab Introductory material Figure 42.1 (oxyhemoglobin dissociation) Assessments: Part A and Part B	Added new Learning Outcome O4 Added question Revised and improved depth New figure Added questions
43	Pre-Lab Introductory material Figure 43.2 (agglutination reaction)	Added question Improved depth Revised legend and label
44	Procedure A (human heart) and Procedure B (dissection of sheep heart)	Revised and expanded components
45	Pre-Lab Introductory material Table 45.1 (ECG components) and Figure 45.3 (ECG components) Assessments: Part C and Part E	Added question Revised components Expanded components Added questions
47	Introductory material Figure 47.2 (neurovascular bundle) Procedure C (arterial system) Figure 47.10a, 47.10c, 47.10d (arteries), 47.13 (thoracic wall veins), Figure 47.15a (veins) Procedure D (venous system) Assessments: Part A Assessments: Part D	Improved depth on characteristics of arteries and veins New figure and micrograph Added and expanded components New figures Added and expanded components Revised field of view circles for drawings Added question

LABORATORY EXERCISE	TOPIC	CHANGE
49	Introductory material Figure 49.5 (lymphatic vessels, nodes, organs) Figure 49.11a (tonsils) Assessments: Part B Assessments: Part D	Improved depth on pharyngeal tonsils Revised figure New figure Revised field of view circles for drawings Added questions
50	Pre-Lab Introductory material Procedure A (respiratory organs) Figure 50.3 (larynx) and Figure 50.5 (lower respiratory system) Procedure B (respiratory tissues) Figure 50.9 (human lung tissue) Figure 50.10 (human lung tissue) Assessments: Part B	Added question Expanded components Added and expanded components Revised and added labels Expanded components Replaced micrograph and labels Revised label Revised field of view circles for drawings
51	Introductory material Table 51.1 (muscles of respiration) Assessments: Part C	Revised and improved depth on respiratory passages Revised for distinction Added question
52	Figure 52.1 (spirogram), Figure 52.2 (sample recording first calibration), Figure 52.3 (setup second calibration), Figure 52.5 (recording setup), Figure 52.6 (sample recording spirometry), Figures 52.7–52.10 (proper selection areas) Procedure B (calibration) and Procedure C (recording)	Replaced figures Revised and updated components
53	Pre-Lab Table 53.1 (muscles of respiration) Assessments: Part B	Added question Revised for distinction Added question
54	Procedure A (oral cavity and salivary glands) and Procedure D (pancreas and liver) Figure 54.1 (oral cavity) Assessment: Part A Assessments: Part D	Revised and added components Added labels Revised field of view circles for drawings Moved and added questions
55	Pre-Lab Introductory material Figure 55.1 (lock-and-key model) Figure 55.2 (amylase on starch digestion) Assessments: Part A	Added questions Revised and improved depth Revised to identify the key and the lock Revised legend Added question
56	Laboratory Exercise	New exercise
57	Procedure B (renal blood vessels and nephrons) Assessments: Part B and Part D Assessments: Part C	Revised and added components Revised field of view circles for drawings Added question
58	Pre-Lab Procedure A (physical and chemical analysis) and Procedure B (microscopic sediment analysis) Assessments: Part A	Added question Improved depth Expanded table to included column for abnormal simulated urine results
59	Introductory material Procedure A (male reproductive organs) Figure 59.1b (cadaver male reproductive) Assessments: Part A Assessments: Part B	Revised components Expanded components New figure Added question Revised field of view circles for drawings
60	Figure 60.1b (cadaver female reproductive) Procedure B (microscopic anatomy) Figure 60.6 (ovary) Assessments: Part B	New figure Improved depth on mature follicle Added labels and revised leader line Revised field of view circles for drawings
61	Introductory material Procedure A (meiosis and fertilization) Figure 61.3 (sea urchin stages) Assessments: Part A	Revised components and improved depth Expanded components New figure Revised field of view circles for drawings

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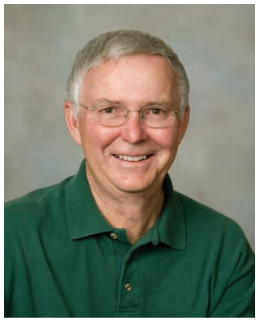

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This laboratory manual series was created by now-coauthor **TERRY R. MARTIN** of Kishwaukee College. Terry's teaching experience of over forty years, his interest in students and love for college instruction, and his innovative attitude and use of technology-based learning enhance the solid tradition of his other well-established laboratory manuals. Among Terry's awards are the Kishwaukee College Outstanding Educator, Phi Theta Kappa Outstanding Instructor Award, Kishwaukee College ICCTA Outstanding Educator Award, Who's Who Among America's Teachers, Kishwaukee College Faculty Board of Trustees Award of Excellence, Continued Excellence Award for Phi Theta Kappa Advisors, and John C. Roberts Community Service Award. Terry's professional memberships include the National Association of Biology Teachers (NABT), Illinois Association of Community College Biologists, Human Anatomy and Physiology Society (HAPS), former Chicago Area Anatomy and Physiology Society (founding member), Phi Theta Kappa (honorary member), and The Nature Conservancy. Terry revised the *Laboratory Manual to Accompany Hole's Human Anatomy and Physiology,* Fifteenth Edition, and revised the *Laboratory Manual to Accompany Hole's Essentials of Human Anatomy and Physiology,* Thirteenth Edition. Terry teaches lecture and cadaver portions of EMT and paramedic classes. Terry has also been a faculty exchange member in Ireland. The author locally supports historical preservation, natural areas, scouting, and scholarship. Through an established endowment to the Kishwaukee College Foundation, the "Terry & Sherrie Martin Health Careers Wing" was designated in 2014.

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Photo: Kelley Dulcich

CYNTHIA PRENTICE-CRAVER, coauthor of this fourth-edition laboratory manual, has been teaching anatomy and physiology at Chemeketa Community College for twenty-two years and is a member of the Human Anatomy and Physiology Society (HAPS). Prior to teaching community college, Cynthia taught middle-school sciences for seven years. Her experience as a contributing author in the third edition, and her observations and engagement with students who use this laboratory manual, continually reinforce her excitement and passion for authoring. Teaching anatomy and physiology in many formats, including fully online, hybrid, and traditional on-campus, has allowed Cynthia to explore and use different methods of content delivery that promote student involvement and confidence building. Her M.S. in Curriculum and Instruction, along with undergraduate and graduate coursework in biological sciences, have been instrumental in achieving the effective results in these courses. She is thrilled to be using the human cadaver lab at Chemeketa Community College in her teaching. Cynthia's professional experiences include serving as program chair in the Life Sciences program for eight years, serving on committees, and being a reviewer and advisor of textbooks and digital products. Beyond her professional pursuits, Cynthia's passions include reading, attending exercise classes, hiking and taking long walks, listening to music and going to concerts, traveling, and spending time with her family.

TO THE STUDENT

The exercises in this laboratory manual will provide you with opportunities to observe various anatomical structures and to investigate certain physiological phenomena. Such experiences should help you relate specimens, models, microscope slides, and your body to what you have learned in the lecture and read about in the textbook.

Frequent variations exist in anatomical structures among humans. The illustrations in the laboratory manual represent normal (normal means the most common variation) anatomy. Variations from normal anatomy do not represent abnormal anatomy unless some function is impaired.

The following list of suggestions and study skills may make your laboratory activities more effective and profitable.

1. Prepare yourself before attending the laboratory session by reading the assigned exercise and reviewing the related sections of the textbook and lecture notes as indicated in the pre-lab section of the laboratory exercise. Answer the pre-lab questions. It is important to have some understanding of what will be done in the lab before you come to class.
2. Be on time. During the first few minutes of the laboratory meeting, the instructor often will provide verbal instructions. Make special note of any changes in materials to be used or procedures to be followed. Also listen carefully for information about special techniques to be used and precautions to be taken.
3. Keep your work area clean and your materials neatly arranged so that you can locate needed items. This will enable you to proceed efficiently and will reduce the chances of making mistakes.
4. Pay particular attention to the purpose of the exercise, which states what you are to accomplish in general terms, and to the learning outcomes, which list what you should be able to do as a result of the laboratory experience. Then, before you leave the class, review the outcomes and make sure that you can perform all of the assessments.
5. Precisely follow the directions in the procedure and proceed only when you understand them clearly. Do not improvise procedures unless you have the approval of the laboratory instructor. Ask questions if you do not understand exactly what you are supposed to do and why you are doing it.
6. Handle all laboratory materials with care. Some of the materials are fragile and expensive to replace. Whenever you have questions about the proper treatment of equipment, ask the instructor.
7. Treat all living specimens humanely and try to minimize any discomfort they might experience.
8. Although at times you might work with a laboratory partner or a small group, try to remain independent when you are making observations, drawing conclusions, and completing the activities in the laboratory reports.
9. Record your observations immediately after making them. In most cases, such data can be entered in spaces provided in the laboratory assessments.
10. Read the instructions for each section of the laboratory assessment before you begin to complete it. Think about the questions before you answer them. Your responses should be based on logical reasoning and phrased in clear and concise language.
11. At the end of each laboratory period, clean your work area and the instruments you have used. Return all materials to their proper places and dispose of wastes, including glassware or microscope slides that have become contaminated with human blood or body fluids, as directed by the laboratory instructor. Wash your hands thoroughly before leaving the laboratory.

Study Skills for Anatomy and Physiology

Students have found that certain study skills worked well for them while enrolled in Human Anatomy and Physiology. Although everyone has his or her learning style, there are techniques that work well for most students. Using some of the skills listed here can make your course more enjoyable and rewarding.

1. **Time management:** Prepare monthly, weekly, and daily schedules. Include dates of quizzes, exams, and projects on the calendar. On your daily schedule, budget several short study periods. Daily repetition alleviates cramming. Prioritize your tasks so that you still have time for work and leisure activities. Find an appropriate study atmosphere with minimum distractions.
2. **Note taking:** Look for the main ideas and briefly express them in your own words. Organize, edit, and review your notes soon after the lecture. Add textbook information to your notes as you reorganize them. Underline or highlight with different colors the important points, major headings, and key terms. Study your notes daily, as they provide sequential building blocks of the course content.
3. **Chunking:** Organize information into logical groups or categories. Study and master one chunk of information at

a time. For example, study the bones of the upper limb, lower limb, trunk, and head as separate study tasks.

4. **Mnemonic devices:** An *acrostic* is a combination of association and imagery to aid your memory. It is often in the form of a poem, rhyme, or jingle in which the first letter of each word corresponds to the first letters of the words you need to remember. **S**o **L**ong **T**op **P**art, **H**ere **C**omes **T**he **T**humb is an example of such a mnemonic device for remembering the eight carpals in a correct sequence. *Acronyms* are words formed by the first letters of the items to remember. *IPMAT* is an example of this type of mnemonic device to help you remember the phases of the cell cycle in the correct sequence. Try to create some of your own.
5. **Note cards/flash cards:** Make your own. Add labels and colors to enhance the material. Keep them with you; study them often and for short periods. Concentrate on a small number of cards at one time. Shuffle your cards and have someone quiz you on their content. As you become familiar with the material, you can set aside cards that don't require additional mastery.
6. **Recording and recitation:** An auditory learner can benefit by recording lectures and review sessions with a cassette recorder. Many students listen to the taped sessions as they drive or just before going to bed. Reading your notes aloud can help also. Explain the material to anyone (even if there are no listeners). Talk about anatomy and physiology in everyday conversations.
7. **Study groups:** Small study groups that meet periodically to review course material and compare notes have helped and encouraged many students. However, keep the group on the task at hand. Work as a team and alternate leaders. This group often becomes a support group.

Practice sound study skills during your anatomy and physiology endeavor.

The Use of Animals in Biology Education*

The National Association of Biology Teachers (NABT) believes that the study of organisms, including nonhuman animals, is essential to the understanding of life on Earth. NABT recommends the prudent and responsible use of animals in the life science classroom. NABT believes that biology teachers should foster a respect for life. Biology teachers also should teach about the interrelationship and interdependency of all things.

Classroom experiences that involve nonhuman animals range from observation to dissection. NABT supports these experiences so long as they are conducted within the long-established guidelines of proper care and use of animals, as developed by the scientific and educational community.

As with any instructional activity, the use of nonhuman animals in the biology classroom must have sound educational objectives. Any use of animals, whether for observation or dissection, must convey substantive knowledge of biology. NABT believes that biology teachers are in the best position to make this determination for their students.

NABT acknowledges that no alternative can substitute for the actual experience of dissection or other use of animals and urges teachers to be aware of the limitations of alternatives. When the teacher determines that the most effective means to meet the objectives of the class do not require dissection, NABT accepts the use of alternatives to dissection, including models and the various forms of multimedia. The Association encourages teachers to be sensitive to substantive student objections to dissection and to consider providing appropriate lessons for those students where necessary.

To implement this policy, NABT endorses and adopts the "Principles and Guidelines for the Use of Animals in Precollege Education" of the Institute of Laboratory Animals Resources (National Research Council). Copies of the "Principles and Guidelines" may be obtained from the ILAR (2101 Constitution Avenue, NW, Washington, DC 20418; 202-334-2590).

*Adopted by the Board of Directors in October 1995. This policy supersedes and replaces all previous NABT statements regarding animals in biology education.

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LABORATORY
EXERCISE 1

Scientific Method and Measurements

Purpose of the Exercise

To become familiar with the scientific method of investigation, learn how to formulate sound conclusions, and provide opportunities to use the metric system of measurements.

MATERIALS NEEDED

Meterstick
Calculator
Human skeleton

Learning Outcomes AP|R

After completing this exercise, you should be able to:

- O1 Convert English measurements to the metric system, and vice versa.
- O2 Calculate expected upper limb length and actual percentage of height from recorded upper limb lengths and heights.
- O3 Apply the scientific method to test the validity of a hypothesis concerning the direct, linear relationship between human upper limb length and height.
- O4 Design an experiment, formulate a hypothesis, and test it using the scientific method.

The O corresponds to the assessments A indicated in the Laboratory Assessment for this Exercise.

Pre-Lab

Carefully read the introductory material and examine the entire lab. Be familiar with the scientific method from lecture or the textbook. Answer the pre-lab questions.

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

1. To explain biological phenomena, scientists use a technique called
   a. the scientific method. **b.** the scientific law.
   c. conclusions. **d.** measurements.
2. Which of the following represents the correct sequence of the scientific method?
   a. analysis of data, conclusions, observations, experiment, hypothesis
   b. conclusions, experiment, hypothesis, analysis of data, observations
   c. observations, hypothesis, experiment, analysis of data, conclusions
   d. hypothesis, observations, experiment, analysis of data, conclusions
3. A hypothesis, verified continuously from experiments by many investigators, can become known as a
   a. control. **b.** variable.
   c. valid result. **d.** theory.
4. The most likely scientific unit for measuring the height of a person would be
   a. feet. **b.** centimeters.
   c. inches. **d.** kilometers.
5. Which of the following is *not* a unit of the metric system of measurements?
   a. centimeters **b.** liters
   c. inches **d.** millimeters

6. The variable that can be changed and is determined before the experiment starts is the
   a. dependent variable. **b.** hypothesis.
   c. independent variable. **d.** analysis.
7. The hypothesis is formulated from the results of the experiment.
   a. True _____ **b.** False _____
8. A centimeter represents an example of a metric unit of length.
   a. True _____ **b.** False _____

Scientific investigation involves a series of logical steps to arrive at explanations for various biological phenomena. It reflects a long history of asking questions and searching for knowledge. This technique, called the *scientific method,* is used in all disciplines of science. It allows scientists to draw logical and reliable conclusions.

The scientific method begins with making *observations* related to the topic under investigation. This step commonly involves the accumulation of previously acquired information and/or your observations of the phenomenon. These observations are used to formulate a tentative explanation known as the *hypothesis.* An important attribute of a hypothesis is that it must be testable. The testing of the proposed hypothesis involves designing and performing a carefully controlled *experiment* to obtain data that can be used to support, reject, or modify the hypothesis. During the experiment to test the proposed hypothesis, it is important to be able to examine only a single changeable factor, known as a *variable.* An *independent variable* is one that can be changed, but is determined before the experiment occurs; a *dependent variable* is determined from the results of the experiment.

An *analysis of data* is conducted using sufficient information collected during the experiment. Data analysis may include organization and presentation of data as tables, graphs, and drawings. From the interpretation of the data analysis, *conclusions* are drawn. (If the data do not support the hypothesis, you must reexamine the experimental design and the data, and if needed develop a new hypothesis.) The final presentation of the information is made from the conclusions. Results and conclusions are presented to the scientific community for evaluation through peer reviews, presentations at professional meetings, and published articles. If many investigators working independently can validate the hypothesis by arriving at the same conclusions, the explanation can become a *theory.* A theory serves as the explanation from a summary of known experiments and supporting evidence unless it is disproved by new information. The five components of the scientific method are summarized as

Observations
↓
Hypothesis
↓
Experiment
↓
Analysis of data
↓
Conclusions

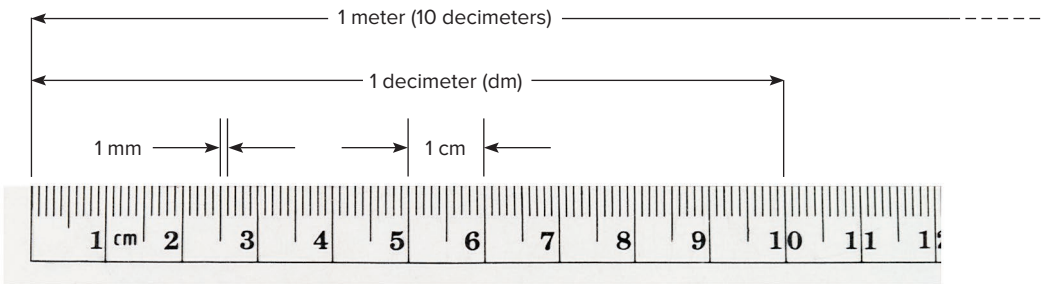
Metric measurements are characteristic tools of scientific investigations. The English system of measurements is often used in the United States, so the investigator must make conversions from the English system to the metric system. Table 1.1 provides the conversion factors necessary to change from English to metric units.

PROCEDURE A: Using the Steps of the Scientific Method

This procedure represents a specific example of the order of the steps utilized in the scientific method. Each of the steps for this procedure will guide you through the proper sequence in an efficient pathway.

1. A correlation exists between the length of the upper and lower limbs and the height (stature) of an individual. For example, a person who has long upper limbs (the arm, forearm, and hand combined) tends to be tall. Make some visual observations of other people in your class to observe a possible correlation.
2. From such observations, the following hypothesis can be formulated: The length of a person's upper limb is equal to 0.4 (40%) of the height of the person. To test this hypothesis, perform the following experiment.
3. Use a meterstick (fig. 1.1) to measure an upper limb length of ten subjects. Place the meterstick in the axilla (armpit) and record the length in centimeters to the end of the longest finger (fig. 1.2). Obtain the height of

FIGURE 1.1 Metric ruler with metric lengths indicated. A meterstick length would be 100 centimeters (10 decimeters). (The image size is approximately to scale.)



Metric ruler

Table 1.1 Metric Measurement System and Conversions

Measurement	Unit & Abbreviation	Metric Equivalent	Conversion Factor Metric to English (approximate)	Conversion Factor English to Metric (approximate)
Length	1 kilometer (km)	1,000 (10^3) m	1 km = 0.62 mile	1 mile = 1.61 km
	1 meter (m)	100 (10^2) cm 1,000 (10^3) mm	1 m = 1.1 yards = 3.3 feet = 39.4 inches	1 yard = 0.9 m 1 foot = 0.3 m
	1 decimeter (dm)	0.1 (10^{-1}) m	1 dm = 3.94 inches	1 inch = 0.25 dm
	1 centimeter (cm)	0.01 (10^{-2}) m	1 cm = 0.4 inches	1 foot = 30.5 cm 1 inch = 2.54 cm
	1 millimeter (mm)	0.001 (10^{-3}) m 0.1 (10^{-1}) cm	1 mm = 0.04 inches	
	1 micrometer (μm)	0.000001 (10^{-6}) m 0.001 (10^{-3}) mm		
Mass	1 metric ton (t)	1,000 (10^3) kg	1 t = 1.1 ton	1 ton = 0.91 t
	1 kilogram (kg)	1,000 (10^3) g	1 kg = 2.2 pounds	1 pound = 0.45 kg
	1 gram (g)	1,000 (10^3) mg	1 g = 0.04 ounce	1 pound = 454 g 1 ounce = 28.35 g
	1 milligram (mg)	0.001 (10^{-3}) g		
Volume (liquids and gases)	1 liter (L)	1,000 (10^3) mL	1 L = 1.06 quarts	1 gallon = 3.78 L 1 quart = 0.95 L
	1 milliliter (mL)	0.001 (10^{-3}) L 1 cubic centimeter (cc or cm^3)	1 mL = 0.03 fluid ounce 1 mL = 1⁄5 teaspoon 1 mL = 15–16 drops	1 quart = 946 mL 1 fluid ounce = 29.6 mL 1 teaspoon = 5 mL
Time	1 second (s)	1⁄60 minute	same	same
	1 millisecond (ms)	0.001 (10^{-3}) s	same	same
Temperature	Degrees Celsius (°C)		°F = 9⁄5 °C + 32	°C = 5⁄9 (°F – 32)

FIGURE 1.2 Measurement of upper limb length.

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each person in centimeters by measuring them without shoes against a wall (fig. 1.3). The height of each person can also be calculated by multiplying each individual's height in inches by 2.54 to obtain his/her height in centimeters. Record all your measurements in Part A of Laboratory Assessment 1.

4. The data collected from all of the measurements can now be analyzed. The expected (predicted) correlation between upper limb length and height is determined using the following equation:

   Height × 0.4 = expected upper limb length

   The observed (actual) correlation to be used to test the hypothesis is determined by

   Length of upper limb/height = actual % of height

5. A graph is an excellent way to display a visual representation of the data. Plot the subjects' data in Part A of the laboratory assessment. Plot the upper limb length of each subject on the x-axis (independent variable) and the height of each person on the y-axis (dependent variable). A line is already located on the graph that represents a hypothetical relationship of 0.4 (40%) upper limb length compared to height. This is a graphic representation of the original hypothesis.
6. Compare the distribution of all of the points (actual height and upper limb length) that you placed on the graph with the distribution of the expected correlation represented by the hypothesis.
7. Complete Part A of the laboratory assessment.

FIGURE 1.3 Measurement of height.

PROCEDURE B: Design an Experiment

You have completed the steps of the scientific method with guidance directions in Procedure A. This procedure will allow for less guidance and more flexibility using the scientific method.

CRITICAL THINKING ACTIVITY

You have probably concluded that there is some correlation of the length of body parts to height. Often, when a skeleton is found, it is not complete. It is occasionally feasible to use the length of a single bone to estimate the height of an individual. Observe human skeletons and locate the humerus bone in an upper limb or the femur bone in a lower limb. Use your observations to identify a mathematical relationship between the length of the humerus or femur and height. Formulate a hypothesis that can be tested. Make measurements, analyze data, and develop a conclusion from your experiment. Complete Part B of the laboratory assessment.

LABORATORY
ASSESSMENT
1

Name _____

Date _____

Section _____

The A corresponds to the indicated Learning Outcome(s) O found at the beginning of the Laboratory Exercise.

Scientific Method and Measurements

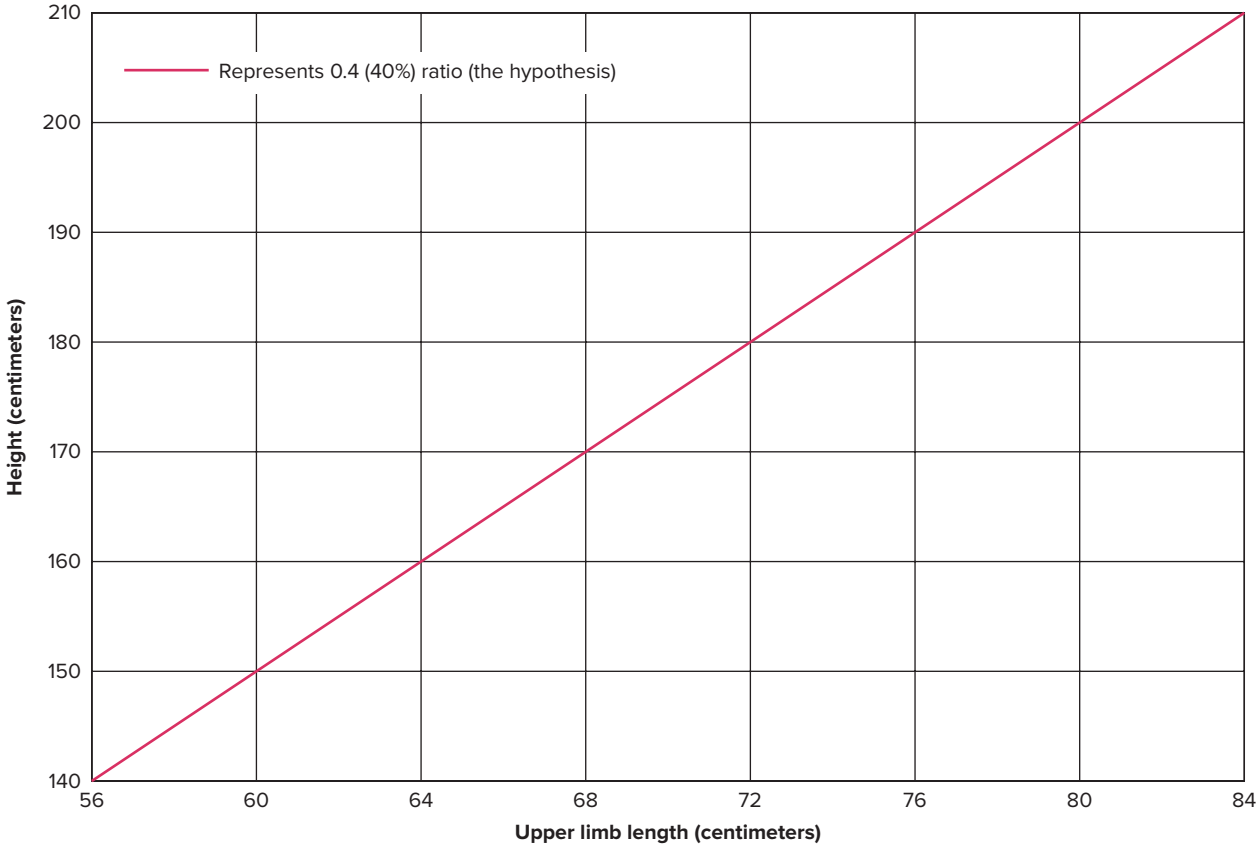
PART A: Assessments

1. Record measurements for the upper limb length and height of ten subjects. Use a calculator to determine the expected upper limb length and the actual percentage (as a decimal or a percentage) of the height for the ten subjects. Record your results in the following table. A2

Subject	Measured Upper Limb Length (cm)	Height* (cm)	Height × 0.4 = Expected Upper Limb Length (cm)	Actual % of Height = Measured Upper Limb Length (cm)/Height (cm)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

*The height of each person can be calculated by multiplying each individual's height in inches by 2.54 to obtain his/her height in centimeters. A1

2. Plot the distribution of data (upper limb length and height) collected for the ten subjects on the following graph. The line located on the graph represents the *expected* 0.4 (40%) ratio of upper limb length to measured height (the original hypothesis). (The x-axis represents upper limb length, and the y-axis represents height.) Draw a line of *best fit* through the distribution of points of the plotted data of the ten subjects. Compare the two distributions (expected line and the distribution line drawn for the ten subjects). A3



3. Does the distribution of the ten subjects' measured upper limb lengths support or reject the original hypothesis? _____ Explain your answer. A3

PART B: Assessments

1. Describe your observations of a possible correlation between the humerus or femur length and height. A4

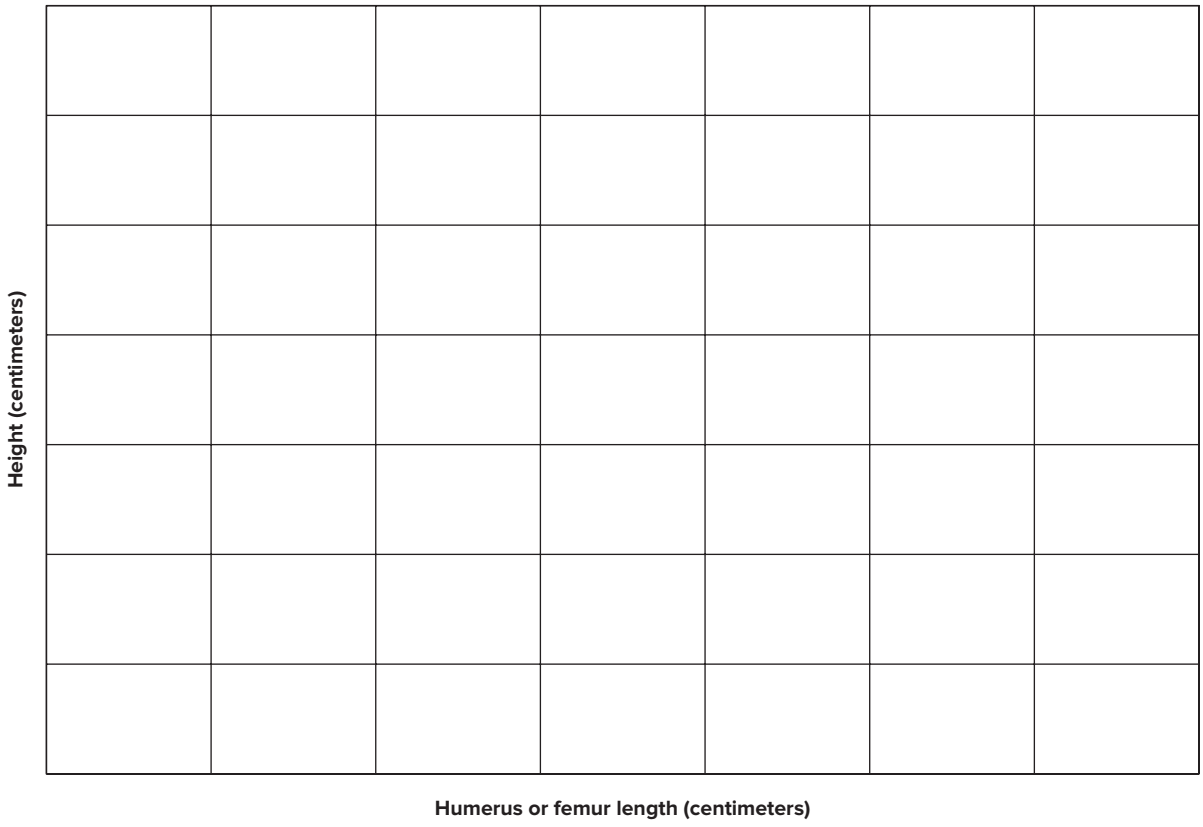
2. Write a hypothesis based on your observations. A4

3. Describe the design of the experiment that you devised to test your hypothesis. A4

4. Place your analysis of the data in this space in the form of a table and a graph. A4

a. Table:

b. Graph:



5. Based on an analysis of your data, what can you conclude? Did these conclusions confirm or refute your original hypothesis? A4

6. Discuss your results and conclusions with classmates. What common conclusion can the class formulate about the correlation between the humerus or femur length and height? A4

LABORATORY
EXERCISE 2

Body Organization, Membranes, and Terminology

Purpose of the Exercise

To review the organizational pattern of the human body, to review its organ systems and the organs included in each system, and to become acquainted with the terms used to describe the relative position of body parts, body sections, and body regions.

MATERIALS NEEDED

Dissectible human torso model (manikin)
Variety of specimens or models sectioned along various planes

Learning Outcomes AP|R

After completing this exercise, you should be able to:

- O1 Locate and name the major body cavities and identify the membranes associated with each cavity.
- O2 Associate the organs and functions included within each organ system and locate the organs in a dissectible human torso model.
- O3 Select the terms used to describe the relative positions of body parts.
- O4 Differentiate the terms used to identify body sections and identify the plane along which a particular specimen is cut.
- O5 Label body regions and associate the terms used to identify body regions.

The O corresponds to the assessments A indicated in the Laboratory Assessment for this Exercise.

Pre-Lab

Carefully read the introductory material and examine the entire lab. Be familiar with body cavities, membranes, organ systems, and body regions from lecture or the textbook. Answer the pre-lab questions.

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

1. The basis for communication in anatomy and physiology assumes
   a. the person is lying down. **b.** relative positions.
   c. anatomical position. **d.** the person is sleeping.
2. Which of the following is *not* a body cavity?
   a. diaphragm **b.** thoracic
   c. cranial **d.** abdominopelvic
3. The pericardium is associated with the
   a. lung. **b.** intestine.
   c. liver. **d.** heart.
4. The _____ plane divides the body into left and right sides.
   a. frontal **b.** cranial
   c. sagittal **d.** transverse
5. The abdominopelvic cavity can be subdivided into
   a. pleural cavities. **b.** pericardial cavities.
   c. quadrants. **d.** vertebral canals.
6. The larynx is part of the _____ system.
   a. urinary **b.** respiratory
   c. lymphatic **d.** nervous

Chapter Opening Image: © Bryan Hainer/Getty Images

7. The epigastric region is a portion of the _____ cavity.
   a. pelvic **b.** pleural
   c. vertebral **d.** abdominal
8. In the posterior view, the cubital region is _____ to the carpal region.
   a. distal **b.** medial
   c. superficial **d.** proximal
9. The brachial surface region pertains to the wrist.
   a. True _____ **b.** False _____
10. A frontal plane divides the body into anterior and posterior parts.
   a. True _____ **b.** False _____

The major features of the organization of the human body include certain body cavities. A body cavity may contain an organ and/or a specific fluid. The *posterior body cavity* includes a cranial cavity containing the brain and a vertebral canal (spinal cavity) containing the spinal cord. These posterior body cavities also contain cerebrospinal fluid (CSF). The *anterior body cavity* includes the *thoracic cavity,* which is subdivided into a mediastinum containing primarily the heart, esophagus, and trachea, with the lungs located on either side of the mediastinum. Also included in the anterior body cavity is the *abdominopelvic cavity,* composed of an abdominal cavity and pelvic cavity. The entire abdominopelvic cavity is further subdivided into either nine regions or four quadrants. The large size of the abdominopelvic cavity, with its many visceral organs, warrants these further subdivisions into regions or quadrants for convenience and for accuracy in describing organ locations, injury sites, and pain locations.

Located within the anterior body cavities are thin double-layered serous membranes that include the *pericardium, pleura,* and *peritoneum.* Each serous membrane has an outer parietal layer that forms the outer cavity wall and an inner visceral layer that covers the surface of an organ. Between each serous membrane is a space called a cavity that is filled with serous fluid. In the thoracic cavity, the pericardium surrounds the heart. Between its parietal pericardium and visceral pericardium is the pericardial cavity that is filled with pericardial fluid. The thoracic cavity also includes a parietal pleura and visceral pleura surrounding each lung, each with a pleural cavity that contains pleural fluid. Within the abdominopelvic cavity is the parietal peritoneum and visceral peritoneum with a peritoneal cavity containing peritoneal fluid. Several abdominopelvic organs, such as the kidneys, are located just behind (are retroperitoneal to) the parietal peritoneum, thus lacking a mesentery (visceral peritoneum).

Some other body cavities include the orbital cavity of the eye, nasal cavity of the nose, oral cavity of the mouth, cavity of the middle ear, and synovial cavity of a movable joint such as the knee or elbow.

Although the human body functions as one entire unit, it is customary to divide the body into eleven body organ systems. In order to communicate effectively with each other about the body, scientists have devised anatomical terminology. Foremost in this task we use *anatomical position* as our basis for communication, including directional terms, body regions, and planes of the body. A person in anatomical position is standing erect, facing forward, with upper limbs at the sides and palms forward. This standard position allows us to describe relative positions of various body parts using such directional terms as left-right, anterior (ventral)-posterior (dorsal), proximal-distal, medial-lateral, and superior-inferior. Body regions include certain surface areas, portions of limbs, and portions of body cavities. In order to study internal structures, often the body is depicted as sectioned into a sagittal plane, frontal plane, or transverse plane.

PROCEDURE A: Body Cavities and Membranes

This procedure outlines the body cavities by location. Certain cavities contain thin layers of cells, called membranes, that line the cavity and cover the organs within the cavity. The figures included in Procedure A will allow you to locate and identify the associated membrane location and name appropriate for the cavity and the organs involved.

1. Study figures 2.1, 2.2, 2.3, 2.4, and 2.5 to become familiar with body cavities and associated membranes.
2. Locate as many of the following features as you can on a dissectible human torso model (fig. 2.5):

body cavities

- cranial cavity—houses brain
- vertebral canal (spinal cavity)—houses spinal cord
- thoracic cavity
  - mediastinum—region between the lungs; includes pericardial cavity
  - pleural cavities (2)
- abdominopelvic cavity
  - abdominal cavity
  - pelvic cavity

diaphragm—separates thoracic and abdominopelvic cavities; functions in respiration

smaller cavities within the head

- oral cavity (mouth)
- nasal cavity with connected sinuses
- orbital cavity—houses eye and associated structures
- middle ear cavity (tympanic cavity)—air-filled and contains auditory ossicles

membranes and cavities

- pleural cavity—associated with lungs; contains pleural (serous) fluid
  - parietal pleura—lines cavity wall
  - visceral pleura—covers lungs

FIGURE 2.1 Major body cavities: (a) left lateral view; (b) anterior view. AP|R

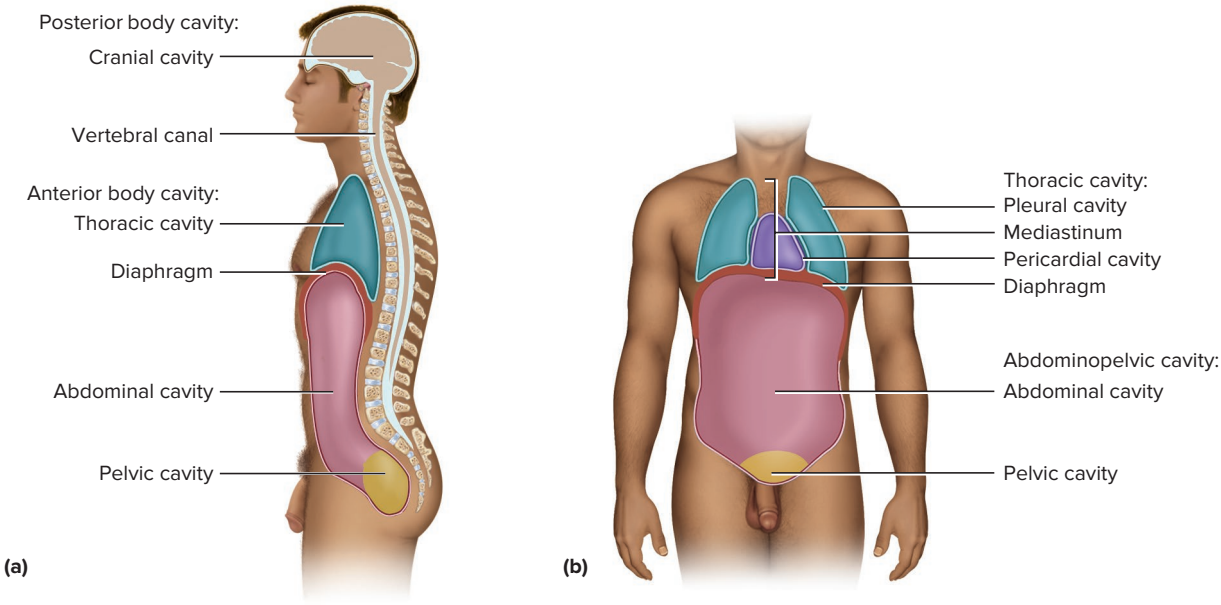


FIGURE 2.2 Thoracic membranes and cavities associated with (a) the lungs and (b) the heart. AP|R

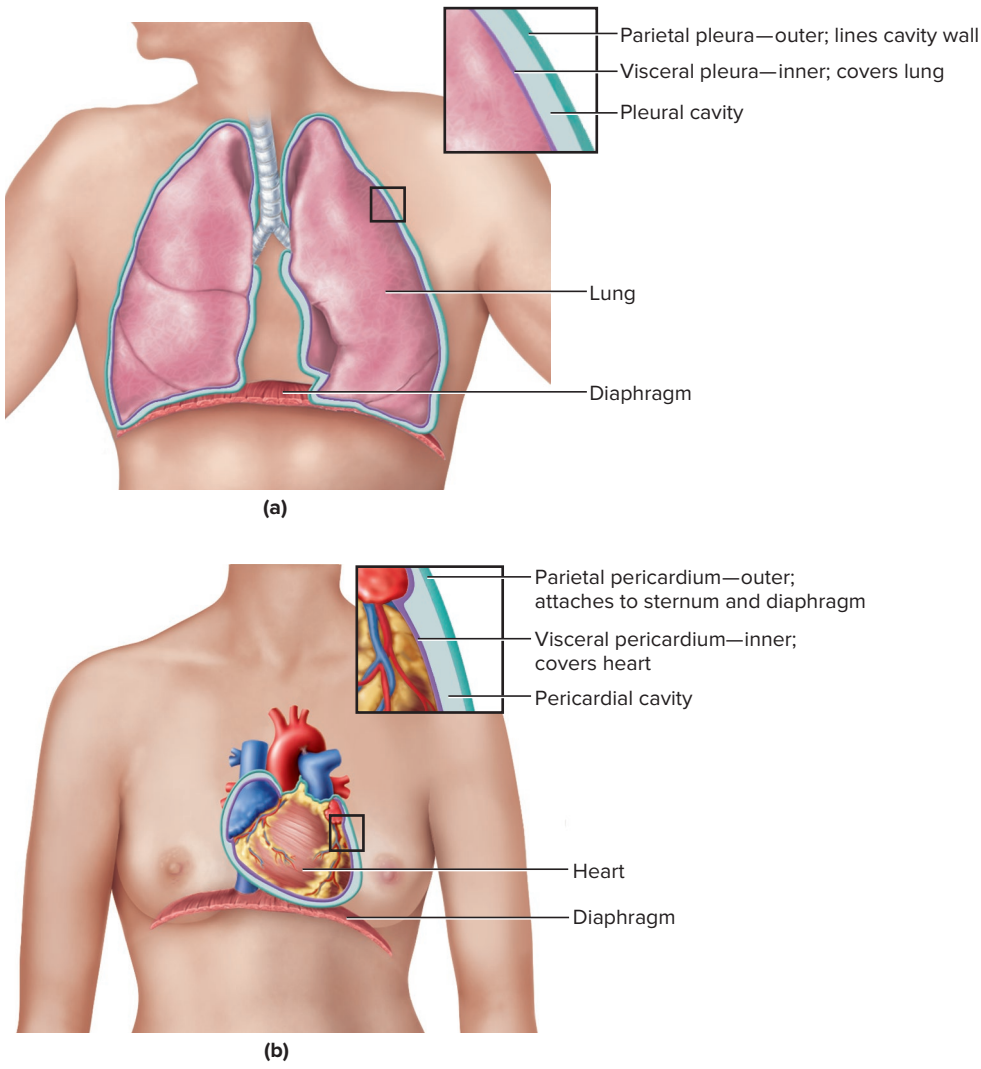
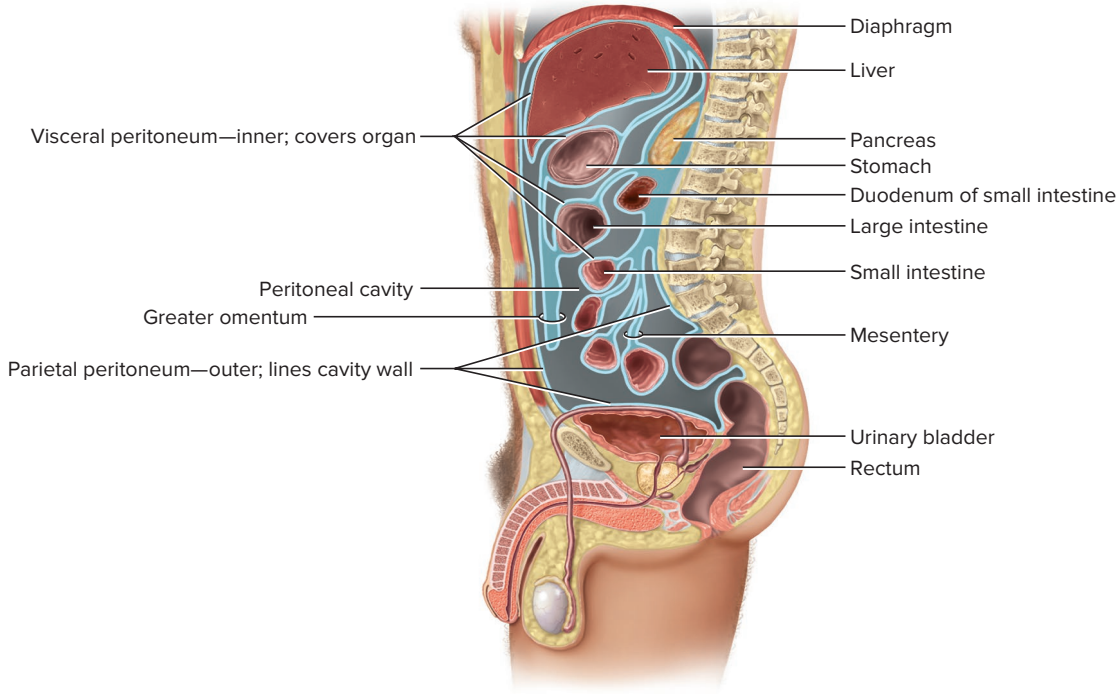
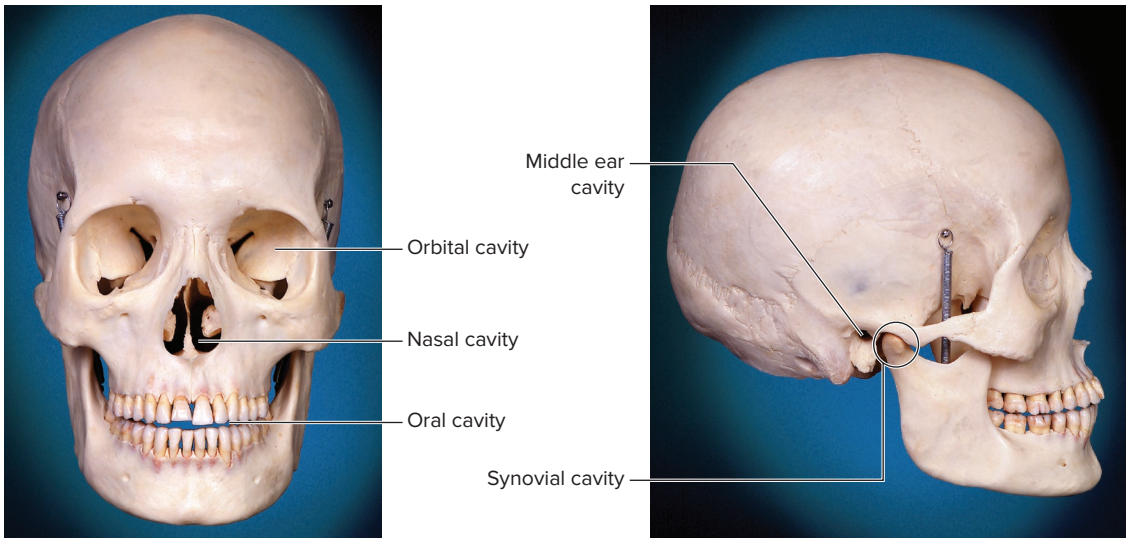


FIGURE 2.3 Serous membranes of the abdominal cavity are shown in this left lateral view. AP|R



Sagittal plane

FIGURE 2.4 Other body cavities include the orbital, nasal, oral, middle ear, and synovial cavities, indicated in these images of the (a) anterior view and (b) lateral view of the skull.



(a)

(b)

- pericardial cavity—associated with heart; contains pericardial (serous) fluid
  - parietal pericardium—covered by fibrous pericardium
  - visceral pericardium (epicardium)—covers heart
- peritoneal cavity—associated with abdominal organs; contains peritoneal (serous) fluid
  - parietal peritoneum—lines cavity wall
  - visceral peritoneum—covers organs

3. Complete Part A of Laboratory Assessment 2.