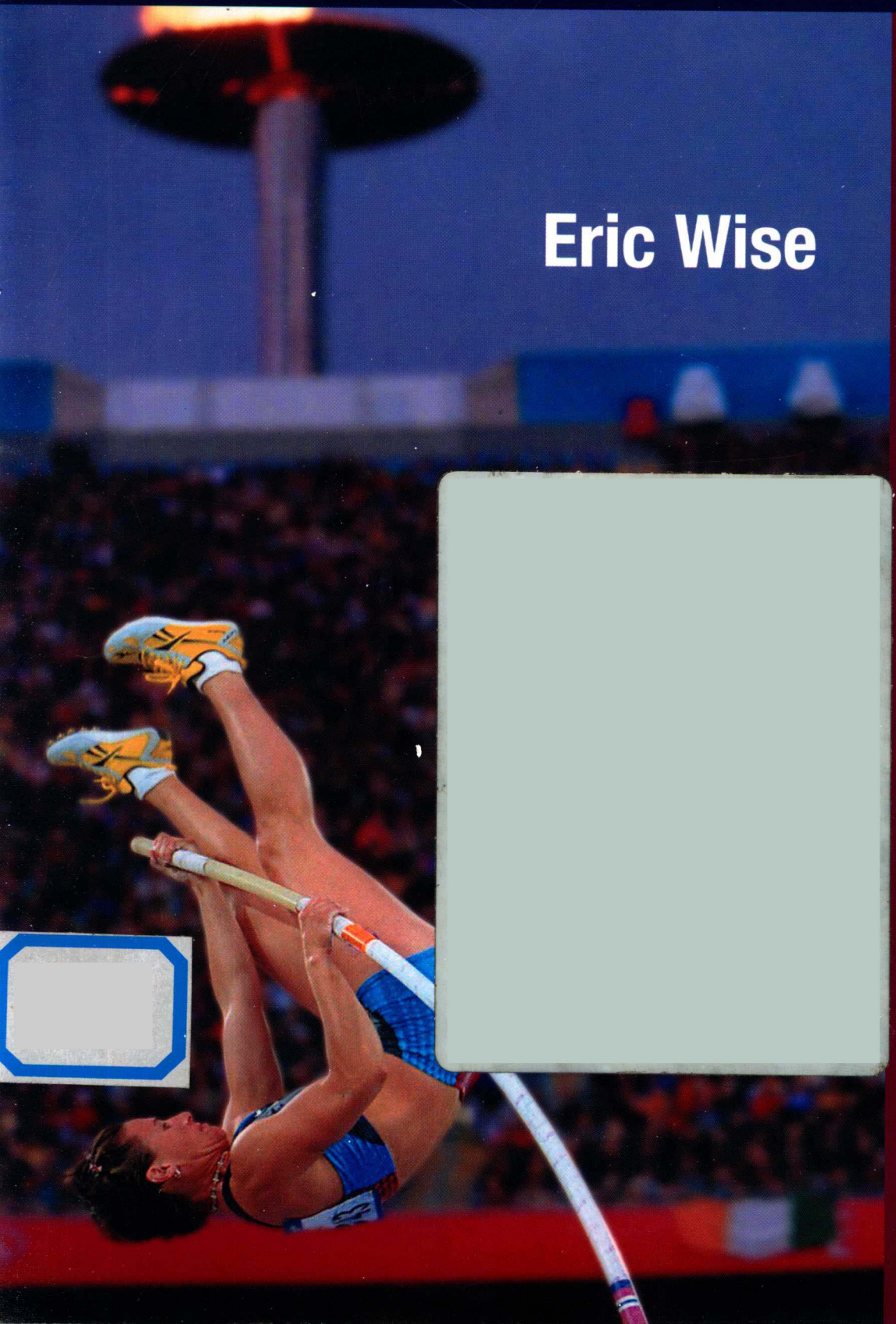
sixth edition

Anatomy & Physiology

SEELEY STEPHENS TATE



Eric Wise

Laboratory Manual

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sixth edition

Anatomy & Physiology

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McGraw-Hill Higher Education
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LABORATORY MANUAL TO ACCOMPANY ANATOMY AND PHYSIOLOGY
SIXTH EDITION

This book is printed on acid-free paper.

4 5 6 7 8 9 0 VNH/VNH 0 9 8 7 6 5 4

ISBN 0–07–235114–4

Publisher: *Martin J. Lange*
Developmental editor: *Kristine A. Queck*
Senior development manager: *Kristine Tibbetts*
Senior marketing manager: *Michelle Watnick*
Project manager: *Joyce Watters*
Senior production supervisor: *Laura Fuller*
Designer: *K. Wayne Harms*
Cover photo: © *Rick Rickman/Newsport*
Senior photo research coordinator: *John C. Leland*
Senior media project manager: *Stacy A. Patch*
Media technology senior producer: *Barbara R. Block*
Compositor: *GTS Graphics, Inc.*
Typeface: *10/12 Minion*
Printer: *Von Hoffmann Press, Inc.*

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Laboratory Safety Guidelines

The following is a brief list of safety guidelines for you to follow in the anatomy and physiology lab. More complete descriptions of safety procedures are found throughout the manual.

1. Read all of the lab material prior to coming to class. This is a safety issue. Failure to read or understand the lab can result in hazards. Unauthorized experiments are not allowed in the lab.
2. Locate the first aid kit, eyewash station, shower station, fire blanket, fire extinguisher, and other safety areas in the lab prior to beginning the first lab. Be familiar with how to use the equipment in the event of an emergency.
3. Clean up spills. Inform your instructor of any spill in the lab. Be careful if the material is toxic or caustic. If you are not sure if the material is hazardous, ask your instructor for the proper procedure for the cleanup.
4. Assume all bodily fluids in the lab are infectious. Follow precautions when handling bodily fluids, such as wearing latex gloves, lab coats, and protective eyewear. Never use any instrument twice that comes into contact with bodily fluid! Once the instrument is used, dispose of it in either a biohazard bag or in a container of 10% bleach. Clean all lab surfaces with a bleach solution at the end of a lab involving bodily fluids, even if you think no fluid has come in contact with the table surface.
5. Keep the lab clean and free of clutter. Place all backpacks, purses, and umbrellas in safe areas and not on the lab tables.
6. Do not eat, smoke, or chew gum in the lab. Many reagents in the lab are toxic, so do not drink them. Never pipette anything by mouth. Use a pipette bulb or pipette pump when pipetting.
7. Keep your hair secured so it does not catch fire or dip into beakers containing solutions. Never heat volatile material over an open flame. An explosion might occur.
8. Do *not* wear contact lenses in the lab. Notify your instructor if you wear contact lenses.
9. Do *not* throw sharp material such as glass or cutting blades in the normal trash containers in the lab. They are to be disposed of in an appropriate container such as a "sharps" container. Report any glassware breakage to your instructor, and dispose of it in the appropriate container.
10. Never point a test tube that is heating over a Bunsen burner in the direction of someone else. Never walk away from anything that is being heated. Pay attention to material on hot plates and remove material with appropriate mitts or tongs. Heat material only in appropriate heat-resistant containers. Turn off and unplug hot plates immediately after use.
11. Dissect with the blade cutting away from you and your lab partners. If you do cut yourself, make sure you wash the wound well with soap and water and notify your instructor.
12. If you have an allergic reaction to the preserving fluid (usually restricted breathing, a flushed feeling, or a skin rash), notify your instructor immediately. Notify your instructor if you are pregnant or have any medical condition.
13. Do *not* apply cosmetics in lab.
14. Wear closed-toed shoes in lab, not sandals.
15. Wash your hands after lab, especially before eating or going to the restroom.

Laboratory Manual

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Anatomy & Physiology

Instructor Preface

Anatomy and physiology can be the crown jewel in our students' education or the bane of their college career. As an instructor of anatomy and physiology for many years, I decided to write a lab manual that was student-friendly and with a singular focus on the lab portion of the course. This lab manual was written for the undergraduate student of anatomy and physiology, and it consists of 43 exercises designed to help students learn basic human anatomy and the practical lab applications in physiology.

The diversity of interests in today's anatomy and physiology students is due, in part, to the number of majors that either require or recommend the subject. This lab manual provides a framework for understanding anatomy and physiology for students interested in nursing, radiology, physical or occupational therapy, physical education, dental hygiene, or other allied health majors.

This manual was written to be used with Seeley, Stephens and Tate, sixth edition. The illustrations are labeled, therefore students do not need to bring their lecture text to the lab. The lab manual accompanies the lecture text and lecture portion of the course and can be used in either a one-term or full-year course. The illustrations are outstanding, and the balanced combination of line art and photographs provides effective coverage of material. The amount of lecture material in the manual is limited so there is little material included that is not part of the lab experience.

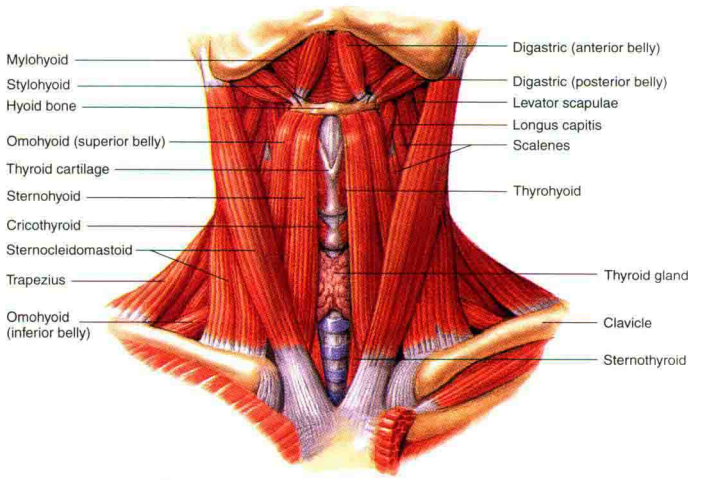
Practical lab experience is an invaluable opportunity to reinforce lecture concepts, enrich students' understanding of anatomy and physiology, and allow them to explore new dimensions in the subject area. The educational benefit of reinforcing lecture material with hands-on experiments and acquiring knowledge with a learn-by-doing philosophy makes the anatomy and physiology lab a very special educational environment. Many of us use lab experiences to present conceptually difficult material in physiology and to provide students with different learning styles another avenue for learning.

The 43 exercises in this lab manual provide a comprehensive overview of the human body. Each exercise presents the core elements of the subject matter. You can tailor this manual to match your own vision of the course or use it in its entirety. There are significant differences among anatomy and physiology laboratories, and the advances in physiology equipment, especially computer modules, are numerous and continually evolving. The materials section in each lab is designed for a lab of 24 students and includes the amounts and types of reagents to be used. The labs generally take between 2 and 3 hours to complete.

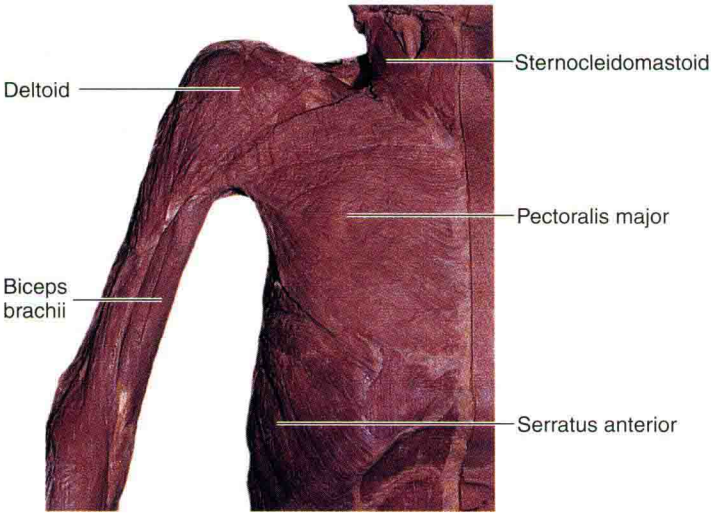
This lab manual was written for three types of anatomy and physiology courses. For those courses that use the cat as the primary dissection animal, cat dissections or mammalian organ dissections follow the material on humans. For those courses that use models or charts, numerous cadaver photographs are included so students can see the representative structures as they exist in the cadaver material. Finally, for those courses that use cadavers, this lab manual can be used by studying the human material and omitting the cat dissection sections.

Key Features

1. **Dynamic Art Program.** The figures in this laboratory manual have been carefully rendered to convey realistic, three-dimensional detail.



2. **Instructional Photographs.** Numerous full-color photomicrographs and dissection images prepare students for what they will encounter in the lab, or can supplement discussions when hands-on labs are not available. These labeled, photographic references also preserve a record of the lab experience long after it has passed.



3. **Labels.** Illustrations are labeled for students to learn the names and terminology by looking at real-life examples or models and by referring to the illustrations in the manual.
4. **Focus on the Laboratory.** This manual focuses primarily on the material necessary for the laboratory and does not repeat the material presented in the lecture text, with the expectation that students can look up material in the lecture text when necessary.
5. **Integrated Use of the Cat for Dissection Specimen.** The cat is used as the dissection animal; however, it is integrated with material on human anatomy, so that animals do not have to be relied upon as dissection specimens if so desired.
6. **Safety.** Safety guidelines appear in the inside front cover for reference. The international symbol for caution ( ) is used throughout the manual to identify material that the reader should pay close and special attention to when preparing for or performing the laboratory exercise.
7. **Clean Up.** At the end of many laboratory exercises an icon for clean up ( ) reminds the student to clean up the laboratory. Special instructions are given where appropriate.
8. **Data Collection.** Collection of data is imbedded within each exercise as opposed to in a separate table at the back of the manual.
9. **User-Friendly Format.** Each exercise begins on a right-hand page, and the pages are perforated to allow students to more easily remove the exercises to turn them in and later store them.
10. **Key Terms.** Current anatomical terminology is used throughout the laboratory manual. Key terms are boldfaced.
11. **Multimedia Tie-Ins.** A CD-ROM icon ( ) appears in several of the exercises after the materials section. This icon represents "The Virtual Physiology Lab" CD-ROM and signals the reader that a supplemental laboratory exercise can be found on the CD-ROM. "The Virtual Physiology Lab" CD-ROM can be packaged with *Anatomy and Physiology Laboratory Manual* for a minimal fee or can be bought separately.

Teaching and Learning Supplements

In addition to this laboratory manual, an extensive array of supplemental materials is available for use in conjunction with *Anatomy and Physiology,* Sixth Edition, by Seeley, Stephens, and Tate. Students can order supplemental study materials by contacting the McGraw-Hill Customer Service Department at 800-338-3987. Instructors can obtain teaching aids by calling the Customer Service Department, visiting our A&P website at www.mhhe.com/ap, or contacting your local McGraw-Hill sales representative.

Online Learning Center

The *Anatomy and Physiology* Online Learning Center (OLC) at www.mhhe.com/seeley6 offers an extensive array of learning and teaching tools.

Essential Study Partner A collection of interactive study modules that contains hundreds of animations, learning activities, and quizzes designed to help students grasp complex concepts.

PowerWeb An online supplement that offers access to course-specific current articles refereed by content experts, course-specific real-time news, weekly course updates, refereed and updated research links, daily news, and the Northernlight.com Special Collection™ of journals and articles.

Online Tutoring A 24-hour tutorial service moderated by qualified instructors. Help with difficult concepts is only an email away.

Along with these outstanding online tools, the OLC features specialized content for both students and instructors using the sixth edition of *Anatomy and Physiology.* The Student Center of the OLC features quizzes, interactive learning games, and study tools tailored to coincide with each chapter of the textbook. The Instructor Center is an online repository for teaching aids. It houses downloadable and printable versions of traditional ancillaries plus a wealth of online content.

Instructor's Manual for the Laboratory Manual

Accessed via the Online Learning Center, this helpful preparation guide includes suggestions for coordinating lab exercises with the textbook, set-up instructions and materials lists, and answers to the laboratory review questions at the end of each exercise.

Other Offerings

In addition to the materials specifically designed to accompany *Anatomy and Physiology,* McGraw-Hill offers the following supplemental resources to enrich the study and instruction of anatomy and physiology.

GradeSummit GradeSummit, found at www.gradesummit.com, is an Internet-based self-assessment service that provides students and faculty with diagnostic information about subject strengths and weaknesses. This detailed feedback and direction enables learners and teachers to focus study time on areas where they will be most effective. GradeSummit also enables instructors to measure their students' progress and assess that progress relative to others in their classes and worldwide.

MediaPhys A new interactive CD-ROM tutorial that guides students through each body system, with quizzing and learning exercises along the way.

Virtual Physiology Lab CD-ROM A CD featuring 10 simulations of common animal-based physiology experiments that allow students to repeat experiments for improved mastery. A great alternative when animal specimens are not available or not preferred.

Dynamic Human Version 2.0 A set of two interactive CD-ROMs that cover each body system and demonstrate clinical concepts, histology, and physiology with animated three-dimensional and other images.

Web-Based Cat Dissection Review for Human Anatomy and Physiology, by John Waters, Pennsylvania State University. An online multimedia program containing vivid, high-quality labeled cat dissection photographs that is designed to help students easily identify and review the corresponding structures and functions between the cat and the human body.

Interactive Histology CD-ROM, by Bruce Wingerd and Paul Paolini, San Diego State University. An electronic histology atlas featuring 135 full-color, high-resolution LM images and 35 SEM images of selected tissue sections typically studied in A&P. Each image has labels that can be clicked on or off, has full explanatory legends, offers views at two magnifications, and has links to study questions. The CD also has a glossary with pronunciation guides.

Case Histories in Human Physiology, third edition, by Donna Van Wynsberghe and Gregory Cooley (print *or* Internet-based). Stimulate analytical thinking using case studies and problem solving. Includes an instructor's answer key.

Life Science Animations Library CD-ROM More than 400 animations in an easy-to-use program that enables instructors to quickly view the animations and import them into multimedia classroom presentations or web-based course materials.

Atlas of Skeletal Muscles, fourth edition, by Robert and Judith Stone, Suffolk County Community College. A straightforward guide to the structure and function of human skeletal muscles that pairs clear and precise illustrations with a listing of the origin, insertion, action, and innervation of each muscle.

Laboratory Atlas of Anatomy and Physiology, third edition by Eder et al. A comprehensive full-color atlas that covers histology, human skeletal anatomy, and human muscular anatomy using dissections and reference tables.

Regional Human Anatomy: A Laboratory Workbook for use with Models and Prosections, by Frederick E. Grine, State University of New York—Stony Brook. A regionally organized workbook that utilizes coloring and labeling activities to simplify the learning of anatomy. Brief text descriptions of key anatomical structures are grouped with detailed illustrations that can be colored and labeled to reinforce the material presented.

Coloring Guide to Anatomy and Physiology, by Robert and Judith Stone, Suffolk County Community College. A thorough review of anatomical and physiological concepts that emphasizes learning through the process of color association.

Human Anatomy and Physiology Study Cards, by Kent Van De Graaff, R. Ward Rhees, and Christopher Creek. A set of 300 3 × 5" cards with terminology, pronunciation guides, word origins, diagrams, and concise descriptions of anatomical and physiological concepts.

Acknowledgements

Many people have been involved in the development and production of this lab manual. I would like to thank the editorial and marketing staff at McGraw-Hill—Marty Lange, Kris Queck, Michelle Watnick, and Darlene Schueller—for their input and encouragement. Thanks also go to the McGraw-Hill production team—Joyce Watters, John Leland, and Wayne Harms—for a job well done.

I would like to dedicate this book to my parents, Lew and Helen Wise.

Please feel free to write me or email me with your comments, suggestions, and criticisms. I value your input and hope that your comments will lead to an even better revision of this laboratory manual.

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Reviewers

The writing of a laboratory manual is a collaborative effort and I was impressed by the dedication and insight given to me by the reviewers. I would like to gratefully acknowledge them as they made significant contributions regarding improving the content and clarity of the manual. I appreciate their time and energy in making this a better lab manual, however I alone take responsibility for any remaining errors.

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Duquesne University

Student Preface

This laboratory manual was written to help you gain experience in the lab as you learn human anatomy and physiology. The 43 exercises explore and explain the structure and function of the human body. You will be asked to study the structure of the body using the materials available in your lab, which may consist of models, charts, mammal study specimens such as cats, preserved or fresh internal organs of sheep or cows, and possibly cadaver specimens. You may also examine microscopic sections from various organs of the body. You should familiarize yourself with the microscopes in your lab very early so you can take the best advantage of the information they can provide.

The physiology portion of the course involves experiments that you will perform on yourself or your lab partner. They may also involve the mixing of various chemicals and the study of the functions of live specimens. Because the use of animals in experiments is of concern to many students, a significant attempt has been made to reduce (but unfortunately not eliminate) the number of live experiments in this manual. Until there is an effective replacement for live animals, their use will continue to be part of the college physiology lab. Your instructor may have alternatives to live animal experimentation exercises, such as computer simulations. It is important to get the most out of what live specimen experimentation there is. Coming to the lab unprepared and then sacrificing a lab animal while gaining little or no information is an unacceptable waste of life. Use the animals with care. Needless use or inhumane treatment of lab animals is not acceptable or tolerated.

As a student of anatomy and physiology you will be exposed to new and detailed information. The time it takes to learn the information will involve *more* than just time spent in the lab. You should maximize your time in the lab by reading the assigned lab exercises before you come to class. You will be doing complex experiments, and if you are not familiar with the procedure, equipment, and time involved you could end up ruining the experiment for yourself and/or your lab group. The exercises in physiology are written so you can fill in the data as you proceed with the experiment. At the end of each exercise are review sheets that your instructor may wish to collect to evaluate the data and conclusions of your experiments. The illustrations are labeled except on the review pages. All review materials can be used as study guides for lab exams or they may be handed in to the instructor.

The anatomy exercises are written for cat and human study, though these exercises can be used with or without cats or cadavers. Get *involved* in your lab experience. Don't let your lab partner do all of the dissections or all of the experimentation; likewise, don't insist on doing everything yourself. Share the responsibility and you will learn more.

Safety

Safety guidelines appear in the inside front cover for reference. The international symbol for caution () is used throughout the manual to identify material that you should pay close and special attention to when preparing for or performing laboratory exercises.

Clean Up

Special instructions are provided for cleanup at the end of appropriate laboratory exercises and are identified by this unique icon ().

How to Study for This Course

Some people learn best by concentrating on the visual, some by repeating what they have learned, and others by writing what they know over and over again. In this course, you will have to adapt your particular learning style to different study methods. You may use one study method to learn the muscles of the body and a completely different method for understanding the function of the nervous system. Some students need only a few hours per week to succeed in this course, while others seem to study far longer with a much less satisfactory performance.

You need to come to class. Come to lab on time. The beginning of the lab is when most instructors go over the material and point out what material to omit, what to change, and how to proceed. If you do not attend lab, you do not get the necessary information.

Read the material ahead of time. The subject matter is very visual, and you will find an abundance of illustrations in this manual. Record on your calendar all of the lab quizzes and exams listed on the syllabus provided by your instructor. Budget your time so you study accordingly.

Work hard! There is absolutely no substitute for hard work to achieve success in a class. Some people do math easier than others, some people remember things easier, and some people express themselves better. Most students succeed because they work hard at learning the material. It is a rare student who gets a bad grade because of a lack of intelligence. Working at your studies will get you much farther than worrying about your studies.

Be *actively* involved with the material and you will learn it better. Outline the material after you study it for a while. Read your notes, go over the material in your mind, and then make the information your own. There are several ways that you can get actively involved.

Draw and doodle a lot. Anatomy is a visual science, and drawing helps. You do not have to be a great illustrator. Visualize the material in the same way you would draw a map to your house for a friend. You do not draw every bush and tree, but rather create a *schematic* illustration that your friend could use to get the *pertinent* information. As you know, there are differences in maps. Some people need more practice than others, but anyone can do it. The head can be a circle, which can be divided into pieces representing the bones of the skull. Draw and label the illustration after you have studied the material and without the use of your text! Check yourself against the text to see if you really know the material. Correct the illustration with a colored pen so you highlight the areas you need work on. Go back and do it again until you get it perfect. This does take some time, but not as much as you might think.

Write an outline of the material. Take the mass of information to be learned and go from the general to the specific. Let's use the skeletal system as an example. You may wish to use these categories:

1. Bone composition and general structure
2. Bone formation
3. Parts of the skeleton
   - **a.** Appendicular skeleton
     - (1) Pectoral girdle
     - (2) Upper extremity
     - (3) Pelvic girdle
     - (4) Lower extremity
   - **b.** Axial skeleton
     - (1) Skull
     - (2) Hyoid
     - (3) Ribs
     - (4) Vertebral column
     - (5) Sternum

An outline helps you organize the material in your mind and lets you sort the information into areas of focus. If you do not have an organizational system, then this course is a jumble of terms with no interrelationships. The outline can get more detailed as you progress, so you eventually know that the specific nasal bone is one of the facial bones and the facial bones are skull bones, which are part of the axial skeleton, which belongs to the skeletal system!

Test yourself before the exam or quiz. If you have practiced answering questions about the material you have studied, then you should do better on the real exam. As you go over the material, jot down possible questions to be answered later, after you study. If you compile a list of questions as you review your notes, then you can answer them later to see if you have learned the material well. You can also enlist the help of friends, study partners, or family (if they are willing to do this for you). You can also study alone. Some people make flash cards for the anatomy portion of the course. It is a good idea to do this for the muscle section of the class, but you may be able to get most of the information down by using the preceding technique. Flash cards take time to fill out, so use them carefully.

Use memory devices for complex material. A mnemonic device is a memory phrase that has some relationship to the study material. For example, there are two bones in the wrist right next to one another, the trapezium and the trapezoid. The mnemonic device used by one student was that trapez*ium* rhymes with th*umb* and it is the one under the thumb.

Use your study group as a support group. A good study group is very effective in helping you do your best in class. Hang out with people who will push you to do your best. If you get discouraged, your study partners can be invaluable support people. A good group can help you improve your test scores, develop study hints, encourage you to do your best, and let you know that you are not the *only* one living, eating, and breathing anatomy and physiology.

Just as a good study group can really help, a bad group can drag you down farther than you might go on your own. If you are in a group that constantly complains about the instructor, that the class is too hard, that there is too much work, that the tests are not fair, and that you don't really need to know this much anatomy and physiology for your own field of study and that this isn't medical school, then get yourself out of that group and into one that is excited by the information. Don't listen to people who complain constantly and make up excuses instead of studying. There is a tendency to start believing the complaints, and that begins a cycle of failure. Get out of a bad situation early and get with a group that will move forward.

Do well in the class and you will feel good about the experience. If you set up a study time with a group of people and they spend most of the time talking about parties, sports, or personal problems, then you aren't studying. There is nothing wrong with parties, sports, or helping someone with personal problems, but you need to address the task at hand, which is learning anatomy and physiology. Don't feel bad if you must get out of your study group. It is *your* education, and if your partners don't want to study, then they don't really care about your academic well-being. A good study partner is one who pays attention in class, who is prepared ahead of the study time session, and who can explain information that you may have gotten wrong in your notes. You may want to get the phone number of two or three such classmates.

Supplemental Materials

A variety of materials can be purchased separately to supplement this laboratory manual. Please see the instructor's preface for a list and description of these items, or call the McGraw-Hill Customer Service Department at 800-338-3987.

Test-Taking

Finally, you need to take quizzes and exams in a successful manner. By doing practice tests, you can develop confidence. Do well early in the semester. Study extra hard early (there is no such thing as overstudying!). If you fail the first test or quiz, then you must work yourself out of an emotional ditch. Study early and consistently, and then spend the evening before the exam going over the material in a general way and solving those last few problems. Some people do succeed under pressure and cram before exams; however, the information is stored in short-term memory and does not serve you well in your major field! If you study on a routine basis, then you can get up on the morning of a test, have a good breakfast, listen to some encouraging music, maybe review a

bit, and be ready for the exam. I love the morning. It is a great time to study.

Your instructor is there to help you learn anatomy and physiology, and this laboratory manual was written with you in mind. Relate as much of the material as you can to your own body and keep an optimistic attitude.

Please feel free to write me or email me with your comments, suggestions, and criticisms. I value your input and hope that your comments will lead to an even better revision of this laboratory manual.

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Working in the Lab

The lab is a busy place, and your first priority in lab is to have a safe laboratory experience. You should read the Laboratory Safety Guidelines on the inside front cover of your lab manual and follow all of the safety directions that your instructor provides you. Know where the closest phone is in the event of an emergency, and make sure that you understand any specific emergency procedures for your lab.

Working in the science lab requires you to focus on the procedures and materials at hand. You may work as part of a group in some labs, and it is important that you read your lab material before coming into the lab. Some of the materials you work with may be dangerous, and a thorough prior knowledge of the lab exercise will ensure a safer lab.

Pay attention to the experiment and what is to be done and when. Casual observation and carelessness may lead to incorrect results. Establish a procedure for conducting experiments. If you are working with one or more lab partners, divide up responsibilities before the experiment begins. If you are responsible for a particular portion of the experiment, make sure your lab partners see the results. Make a careful record of the results of your experiment.

Be honest. Fudging data is not tolerated in the scientific community. Record your data as you measure it. If your results do not seem to be what they should, then discuss this with your instructor. Never record data that you think you should get; instead, record the observed data.

Measurement in Science

Members of the scientific community and people of many nations of the world use the metric system to record quantities such as length, volume, mass (weight), and time. This is because the metric system is based on units of 10, and conversion to higher or lower values is relatively easy when compared to using the U.S. customary system. For example, assume you are working on a bicycle and are using a 1/2-inch wrench. If you need to go up in size you move to a 9/16-inch, then a 5/8-inch, then an 11/16-inch, or perhaps as large as a 3/4-inch wrench. This requires a bit of computation as you move from one size to the next. On the other hand, if you are using the metric system and a 12 millimeter (mm) wrench is too small, you progressively move to a 13 mm, 14 mm, or 15 mm wrench.

The same idea can be applied to volume or weight. In the case of volume, there are 8 ounces per cup, and 128 ounces per gallon. The calculation for the number of ounces in 7 gallons is a little cumbersome (7 gallons × 128 ounces). In the metric system, there are 1000 milliliters in 1 liter, so there are 7000 milliliters in 7 liters. The conversions are much easier. Medical dosages are given frequently in milliliters or cubic centimeters (cc). Under standard conditions, one milliliter occupies one cubic centimeter, and so these values are interchangeable.

You can use the metric system to measure four quantities—length, volume, mass, or time. Examine table 1 and compare the quantity, base unit, and U.S. equivalent.

If the quantity measured is much larger or smaller than the base unit, then the base unit can be expressed in multiples or fractions of 10. For example, if you had one thousand grams (1000 grams),

Table 1 Metric System and Equivalents

Quantity	Base Unit	U.S. Equivalent
Length	Meter (m)	1.09 yards (39.4 inches)
Volume	Liter (L)	1.06 quarts
Mass	Gram (g)	.036 ounces (1/454 of a pound)
Time	Second (s)	Second

then you would have a **kilo**gram. If you had one thousandth of a gram (1/1000 gram), you would have a **milli**gram. Examine table 2 as you answer the following questions:

What is 1/100 gram? _____

What is 1000 seconds? _____

What is 10 meters? _____

What is 1/1,000,000,000 liter? _____

Table 2 Decimals of the Metric System

Name	Description	Multiple/Fraction	
Kilo	One thousand times greater	1000	
Deca	Ten times greater	10	
Base Unit			
Deci	One-tenth as much	1/10	0.1
Centi	One-hundredth as much	1/100	0.01
Milli	One-thousandth as much	1/1000	0.001
Micro	One-millionth as much	1/1,000,000	0.000001
Nano	One-billionth as much	1/1,000,000,000	0.000000001

The extremes of measurement represent the **range** of the measurements. In the case of height these would be the smallest to the tallest. In terms of weight the range would represent the lightest to the heaviest.

The **mean** is the average for the group. To obtain the mean for a set of data, take the sum of all the individual measurements and divide by the total number of individuals in the group.

Scientific Notation

As you can see from table 2, some measurements in science are very small. The amounts of hormones circulating in the blood are very minute indeed. To provide a shortened notation for numbers that are very large or small, we use scientific notation. A number such as 60,000 is written as 6×10^4. You move the decimal point four places to the left and thus the superscript above the 10 is a 4. Write 6000 in scientific notation _____. For very small numbers, the superscript is written as a negative number. 0.00006 is written as 6×10^{-5}, as you move the decimal point five places to the right. Convert the following numbers into scientific notation:

4,300,000 _____

0.000034 _____

2200 _____

0.0019 _____

Graphing

By graphing data you can more easily see trends in a sample size. Some graphs are simple line graphs, others are bar graphs or pie charts. One problem in sampling is that you need to have a large enough number to have a valid sample. Let's suppose that you wish to graph the height of everyone in class, and one-half of the basketball team is enrolled in your lab section. This might have a rather unusual effect on your graph (see figure 1). On the other hand, if you can sample your entire school, the effects of the basketball players' sizes in the sample size would be minimized (see figure 2).

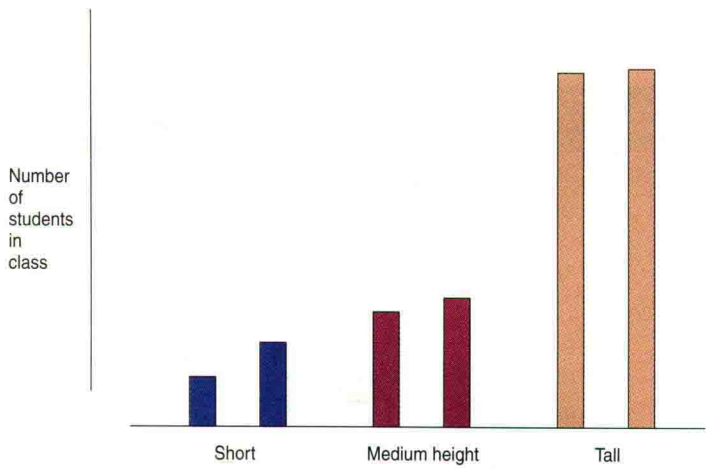

Figure 1

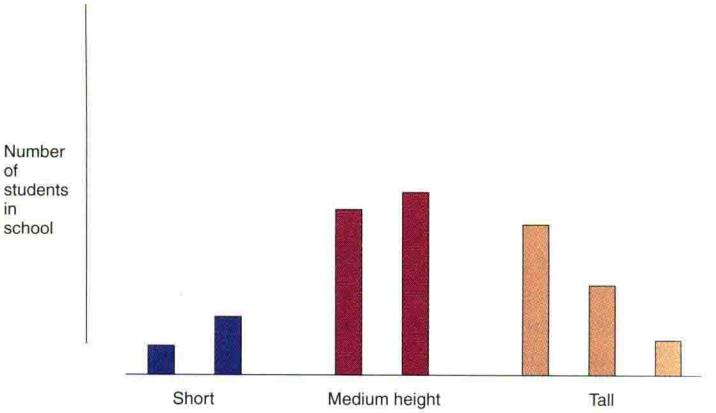

Figure 2

Lab Reports

Your instructor may ask you to write up your results for specific experiments. This process is valuable in that you evaluate your experimental data and form an understanding of the process that comes from the results of your experiment. Writing up scientific experiments generally follows a very specific process, and this is described in appendix D at the back of the lab manual. You should refer to it before you begin your lab write-ups.

Practical Problems

You should make sure that you understand the concepts presented previously by working on the following problems.

1. In terms of base units
   a. What is the base unit of length in the metric system?
   b. What is the base unit of volume in the metric system?
2. How many cubic centimeters are there in 200 mL?
3. Assume a pill has a dosage of 350 mg of medication. How much medication is this in grams?
4. How would you write 0.000345 liters in scientific notation?
5. How many milligrams are there in 4.5 kilograms?
6. How many meters is 250 millimeters?
7. If given a length of 1/10,000 of a meter:
   convert this number into a decimal.
   convert it into scientific notation.
8. Use a word to describe:
   a. one-thousandth of a second
   b. one thousand liters
   c. one-hundredth of a meter

Contents

Exercise 1

Organs, Systems, and Organization of the Body

Introduction

Science is the study of natural phenomena **and follows** specific guidelines that **make** it **unique** from other disciplines. **Anatomy** is the scientific study of the structure of the human body, and **physiology** is the study of the function of the body. Anatomy and physiology are two closely related fields, and they are well suited for study together.

The study of the human body requires you to understand both how the body or organ is oriented and how it is presented in terms of body regions. In this exercise, you examine the major organ systems of the body, the directional terms, and the levels of organization of the body, from the subatomic level to the whole organism. You also describe the major regions of the body. These topics are discussed in text chapter 1, "The Human Organism."

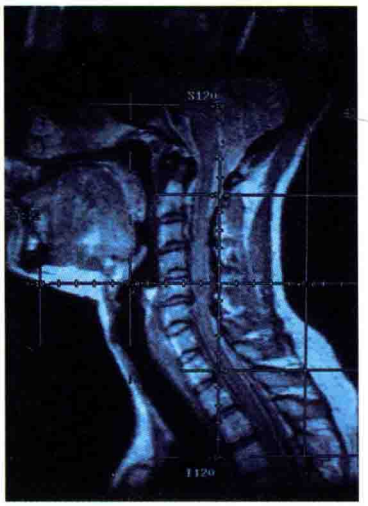

Figure 1.1 MRI of the Neck

Objectives

At the end of this exercise you should be able to

1. list the levels of structural hierarchy from smallest to largest;
2. list the 11 organ systems of the body;
3. place major organs such as the heart, lungs, and stomach in the proper organ system;
4. explain what is meant by *anatomic position;*
5. give directional terms that are equivalent to up, down, front, back, toward the midline, and toward the surface of the body;
6. determine from an illustration whether a section is in the frontal, transverse, or sagittal plane;
7. identify the four major body cavities;
8. identify the quadrants and nine regions of the abdomen.

Materials

Models of human torso
Charts of human torso

Procedure

Levels of Organization

The human body can be studied from a number of perspectives. The earliest study involved **gross anatomy,** or cutting up part or all of the body and examining its details. As more sophisticated equipment was developed, other levels of organization became apparent. Today, the manipulation of atomic nuclei under magnetic fields has led to magnetic resonance imaging (MRI) studies that do not depend on dissection of the body (figure 1.1). The following list shows the levels of organization along with examples of each:

Level	Examples
Chemical	Oxygen, carbohydrates
Organelle	Mitochondrion, ribosome
Cellular	Fibrocytes, squamous epithelium
Tissue	Epithelial, muscular
Organ	Stomach, kidney
Organ system	Digestive system, urinary system
Organism	*Homo sapiens*

Organ Systems

Anatomy can be studied in many ways. **Regional anatomy** is the study of particular areas of the body such as the head or leg. Most undergraduate college courses in anatomy and physiology (and the format of this lab manual) involve **systemic anatomy,** which is the study of **organ systems** such as the skeletal system and the nervous system. Although organ systems are studied separately, it is important to realize the intimate connections between the systems. If the heart fails to pump blood as part of the cardiovascular system, then the lungs do not receive blood for oxygenation and the intestines do not transfer nutrients to the blood as fuel. The brain is no longer capable of functioning, and the result is death. From a clinical standpoint, the failure of one system has impacts on many other organ systems.

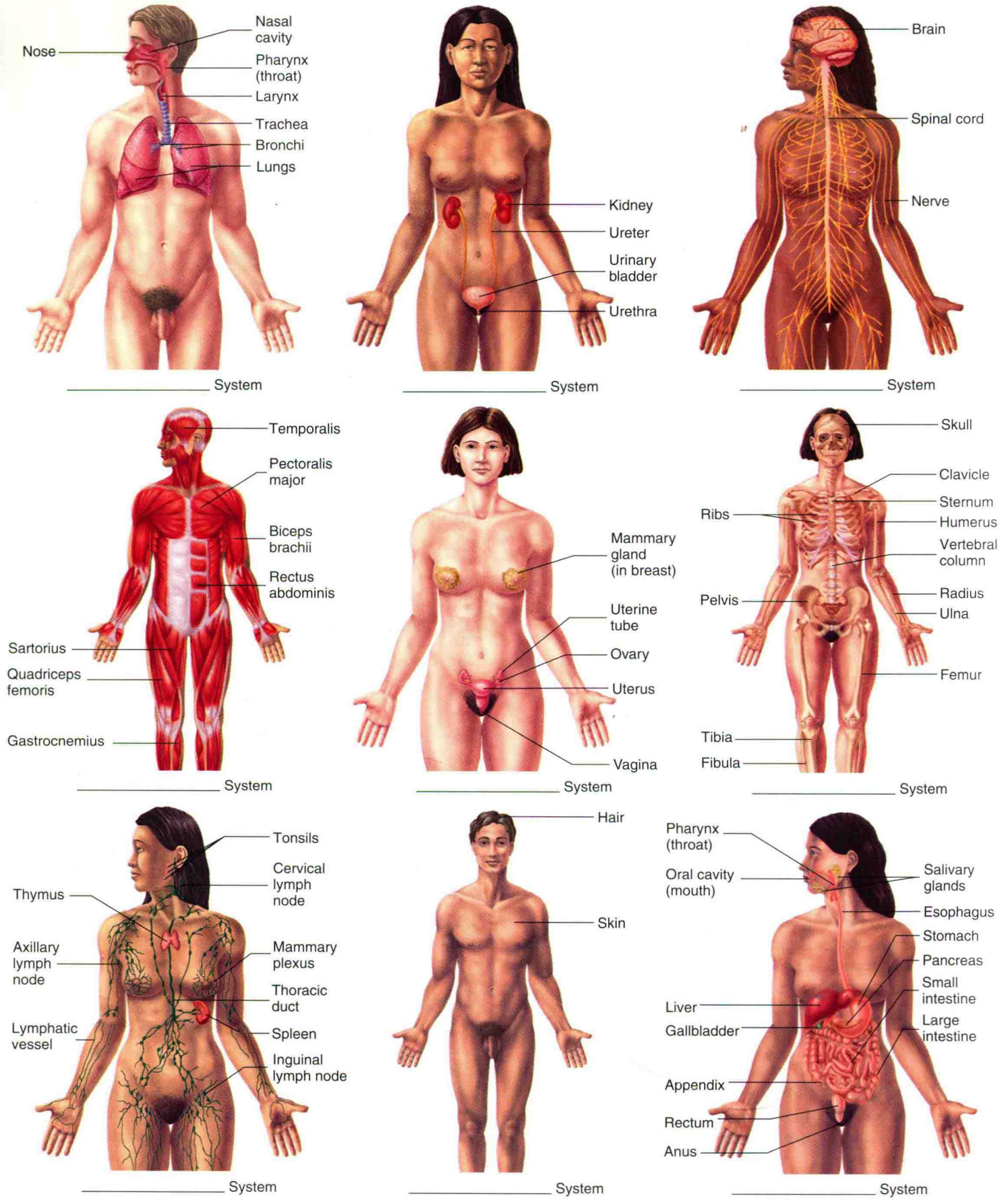

Figure 1.2 Organ Systems of the Human Body