Student Workbook

Silverthorn • Hill

Human Physiology

An Integrated Approach

Second Edition

Silverthorn

STUDENT WORKBOOK

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HUMAN PHYSIOLOGY

AN INTEGRATED APPROACH

SECOND EDITION

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OWNER'S MANUAL

Welcome! Please take a moment to look through this material to familiarize yourself with the features contained in your workbook. The workbook is divided into the following sections to help you effectively study the chapters in the text.

Summary
For each chapter in the textbook, you will find a brief list that points out the key learning tasks for the chapter, along with a short narrative summary.

Teach Yourself the Basics
This section is organized using the section headers from the chapter. *Teach Yourself the Basics* has a series of questions about each section, with figure numbers and cross-references so that you can refer back to the book for pertinent material. There are two ways to use *Teach Yourself the Basics*. You can fill it in as you read, using the workbook to actively direct your reading and notetaking. This is an excellent method for making sure that you are getting the important information out of each section of the chapter. Or, you can wait until you have studied the chapter, then see if you can answer the questions without referring to the textbook.

∫ This symbol marks cross-referenced information that can be integrated into the current chapter.

☛ These POINTERS give you interesting facts or helpful ways to remember information.

Talk the Talk is a vocabulary list of the important terms from the chapter. Use this list to quiz yourself.

Quantitative Thinking includes quantitative problems and shows you how to think about them and how to go about solving them.

Practice Makes Perfect is a set of questions that deal with material in the chapter. They range from simple "memorization" questions to difficult "application" questions. The answers to these questions are contained in an appendix at the back of the workbook.

Beyond the Pages contains additional material that is related to the chapter.

Running Problem sections provide additional information about the Running Problem in the text chapter.
Try It sections include activities that you may want to try, such as mini-experiments and demonstrations or interesting web sites
MediaLabs in the workbook are similar to those in the text. These sections provide additional Web exercises beyond the MediaLabs found in the book.
Reading sections include books or articles that relate to material covered in the chapter.
Viewing sections suggest movies and videos of interest.

A Note on Conventions Used in the Workbook
Ions in the workbook are written in the following format: Na^+, Ca^{2+}, Cl^-, K^+, P_i, and PO_4^{3-}. If you are not familiar with the concept of ions, read pg. 24 in Chapter 2.
Body fluid compartments are abbreviated as follows:

ICF = intracellular fluid
ECF = extracellular fluid
IF = interstitial fluid

Study Hints for Physiology Students

There are several differences you will notice when studying and learning science:

- ✓ There is a large volume of unfamiliar and frequently intimidating vocabulary.
- ✓ Science textbooks have a different writing style and need to be read differently than textbooks in the humanities.
- ✓ The thought process for science requires linear thinking and the ability to trace a process in some detail from beginning to end. Humanities students are used to analyzing interrelationships and tend to think too broadly.

Here are some suggestions to use in class and when studying physiology.

♦ Notetaking

Do not try to write down every word the instructor says. Listen particularly for vocabulary, concepts, points the instructor emphasizes. Develop your own shorthand so that you can get down more information. *Example*: Use up and down arrows for "increase" and "decrease."

Stop the instructor when a major point is unclear, or if the instructor has gone too fast.

If you can't ask a question about something or if you get behind in your notetaking, put a ? in the margin so that you know that your notes in that section are lacking. Check with a friend or the instructor to clear up what you missed.

Develop one or two "study buddies" with whom you can compare your notes. If you have to miss class, try to get notes from more than one person. Notes are a memory aid rather than a verbatim copy of the lecture, so two different sets of notes are more likely to give you a complete overview of the lecture.

♦ Vocabulary

Most scientific words sound terribly complicated and difficult to remember. However, you can learn some common prefixes, suffixes, and roots that will help you to remember the words. In the textbook after some vocabulary words, there will be a note in [ ] that shows the roots and their meanings. In this workbook, there is a list of some of the most common roots you will encounter in physiology. You can also use a dictionary to find out the origin of a word. Start a list in your own notebook of other suffixes, prefixes, and roots.

♦ Reading the Textbook

Find out from your instructor if you are responsible for material that is in the text but has not been covered in lecture. If you are, you will need to add the extra information from the text to the information in your class notes. If you are not, then you need to be familiar with your notes so that you can pay less attention to material in the text that is not relevant.

Science texts are written with important facts in every sentence. You cannot speed-read a science text. Go slowly and analyze each sentence as you read it. Ask yourself if you understand the concepts in that sentence, and how that sentence relates to the facts presented in previous sentences.

Use the charts and diagrams in the book. Read the captions to the figures as they will frequently explain what is in the diagram. Sometimes the figures in a physiology text provide a summary of material in a section.

♦ Organizing Your Studying

As soon as possible after class, you should glance over your notes and mark the points that are unclear or where your notes may be lacking.

Some students sit down and spend a lot of time rewriting their notes. Usually there are other, more profitable ways of spending your study time. You will still be writing down the information in your notes, but you will also be reorganizing it into study notes of a form that you can remember. The following are some possible ways to do this. You probably won't have time to do all of them, so experiment until you find the method that works best for the way you learn.

1. Mark up your original notes with colored pens.

Use colored pens to see if you can divide the notes into levels and sublevels for an outline. Assign a different color to each level of organization. Underline or draw a box around the word(s) that fits into that heading. For example:

SUBJECT HEADING: Purple
I. Major topic = red
    A. Secondary topic = green
        1. Facts under that topic = turquoise

Give vocabulary words and concepts their own color, such as yellow.

Once you have marked your notes this way, go back and make a skeleton outline using the words you marked. It probably won't be a perfect outline (Topic I may have A but not B), but don't let that worry you. Use this outline to give yourself an overview of the material covered and the progression of the ideas or concepts covered.

2. Make a working vocabulary list.

- Take a sheet of lined notebook paper and fold it in half lengthwise.
- Down the left-hand side, list all the words and concepts you have marked in yellow in your notes.
- Down the right-hand side (on the other side of the fold), list an abbreviated definition.
- Study with the paper open so that you can see both sides. When you think you have learned the material, fold the paper in half so that you see only the list of words. Test yourself by going down the list and saying the definitions to yourself. If you don't know a definition, keep going. When you reach the end of the list, go back and look at the definitions of the words you missed.
- Now turn the paper over so that you are looking at the definitions. Read the definitions and see if you can say and spell the word that fits each definition.

3. **Get the big picture as well as the details.**

In physiology, for each system studied, you should make an outline, study sheet, or chart that answers the following questions:

- What is the anatomical structure of the system? Can you trace a molecule involved in the system through all the parts? Example: trace a drop of blood from the aorta to various parts and back through the heart. What kinds of tissues or cells make up this system? What kind of muscle? Is there some structural entity that we can call the "functional unit?"

- What is the function(s) of the system? Which parts carry out which function? How are the functions carried out?

- How is the system regulated? Consider control by the nervous system and the endocrine system. Are there any reflexes? Know where any pertinent hormones are secreted and what controls their release.

- How is the circulatory system involved with this system?

- Certain themes will keep popping up throughout the chapters. Make note of them. They include:

  Movement of molecules across membranes
  Pressure and flow
  Biomolecules: carbohydrates, fats, proteins. Their roles, transport, and metabolism.
  Ions: Na^+, K^+, H^+, HCO_3-
  Gases: oxygen and carbon dioxide
  Energy use and storage

4. **Make charts, diagrams, flow charts, and concept maps**

One advantage of a chart is that it also allows you to compare and contrast different concepts that at first glance may not seem to have much relationship.

To make a chart:

Divide your paper into columns and rows. Across the top, write the topics you want to compare (Example: male and female reproduction). Down the left side, label the rows or blocks with the points you want to compare (Example: name of gamete, name of gonad, hormones). Go back and fill in the chart.

One technique some students have used is to try to condense everything they have learned about a system onto a piece of poster paper. One effective way to do this is to make a giant drawing of the structure (anatomy) of the system and then add in all the physiological processes at or near the appropriate structure.

Example: Make a poster of the respiratory system.

On the board you might draw a large upper body with the upper and lower respiratory systems drawn in and labeled. In the head you would also include the neurological control of ventilation. Add an enlarged cluster of alveoli just below the lung, and draw in the circulatory system going to a single cell.

5. **Practice higher level thinking**

One objective of many physiology courses is to teach students how to use what are called higher level **cognitive** (factual knowledge) processes. The table below* shows one scheme for classifying the types of learning that people do. How many levels do you usually use when you study?

Lowest

1. Knowledge	Requires that you recognize or recall information
2. Comprehension	Requires that you think on a low level such that the knowledge can be reproduced or communicated without a verbatim repetition
3. Application	Requires that you solve or explain a problem by applying what you have learned to other situations and learning tasks
4. Analysis	Requires that you solve a problem through the systematic examination of facts or information
5. Synthesis	Requires that you find a solution to a problem through the use of original, creative thinking
6. Evaluation	Requires that you make an assessment of good or not so good, according to some standards

Highest

To use the higher thinking skills, you must master the first two levels; in other words, you must have a memorized database of information upon which to act. Once that background information is in place, you can begin to analyze and apply it.

You can recognize questions that require use of higher level thinking by the following phrases:

How would you (solve some problem)?	[synthesis]
Predict what would happen if...?	[application]
What inference would you make?	[synthesis]
What is more important...?	[analysis]
Compare and contrast...	[analysis]

* *A Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook I: Cognitive Domain.* Benjamin S. Bloom, editor. McKay Publishers, New York, 1956.

Ten Tasks for Students in Classes That Use Active Learning

Written by Marilla Svinicki, Ph.D.
Director, University of Texas Center for Teaching Effectiveness

1. Make the switch from an "authority-based" conception of learning to a "self-regulated" conception of learning. Recognize and accept your own responsibility for learning.

2. Be willing to take risks and go beyond what is presented in class or the text.

3. Be able to tolerate ambiguity and frustration in the interest of understanding.

4. See errors as opportunities to learn rather than failures. Be willing to make mistakes in class or in study groups so that you can learn from them.

5. Engage in **active** listening to what's happening in class.

6. Trust the instructor's experience in designing class activities and participate willingly, if not enthusiastically.

7. Be willing to express an opinion or hazard a guess.

8. Accept feedback in the spirit of learning rather than as a reflection of you as a person.

9. Prepare for class physically, mentally, and materially (do the reading, work the problems, etc.).

10. Provide support for your classmate's attempts to learn. The best way to learn something well is to teach it to someone who doesn't understand.

Dr. Dee's Eleventh Rule

DON'T PANIC! Pushing yourself beyond the comfort zone is scary but you have to do it in order to improve.

Word Roots for Physiology

a- or **an-**	without; absence
anti-	against
-ase	signifies an enzyme
auto-	self
bi-	two
brady-	slow
cardio-	heart
cephalo-	head
cerebro-	brain
contra-	against
-crine	a secretion
crypt-	hidden
cutan-	skin
-cyte or **cyto-**	cell
de-	without, lacking
di-	two
dys-	difficult, faulty
-elle	small
endo-	inside or within
exo-	outside
extra-	outside
-emia	blood
epi-	over
erythro-	red
gastro-	stomach
-gen, -genic	produce
gluco-, glyco-	sugar or sweet
hemo-	blood
hemi-	half
hepato-	liver
homo-	same
hydro-	water
hyper-	above or excess
hypo-	beneath or deficient
inter-	between
intra-	within
-itis	inflammation of
kali-	potassium
leuko-	white
lipo-	fat
lumen	inside of a hollow tube
-lysis	split apart or rupture
macro-	large
micro-	small
mono-	one
multi-	many
myo-	muscle
oligo-	little, few
patho-, -pathy	related to disease
para-	near, close
peri-	around
poly-	many
post-	after
pre-	before
pro-	before
pseudo-	false
re-	again
retro-	backward or behind
semi-	half
sub-	below
super-	above, beyond
supra-	above, on top of
tachy-	rapid
trans-	across, through

MAPPING STRATEGIES FOR PHYSIOLOGY

Introduction

Mapping is a technique to improve a student's understanding and retention of subject material. It is based on the theory that each person has a memory bank of knowledge organized in a unique way based on prior experience. Learning occurs when you attach new ideas to your preexisting framework. By actively interacting with the information and by organizing it in your own way before you load it into memory, you will find that you remember the information longer and can recall it more easily.

Mapping is a non-linear way of organizing material, closely related to the flow charts used to explain many physiological processes. A map can take a variety of forms but usually consists of terms or concepts linked by explanatory arrows. The map may include diagrams or figures. The connecting arrows can be labeled to explain the type of linkage between the terms (structure/function, cause/effect) or may be labeled with explanatory phrases ("is composed of").

You will find a number of maps in the text that you can simply memorize, but the real benefit from using maps occurs when you create the maps yourselves. By organizing the material yourself, you question the relationships between terms, organize concepts into a hierarchial structure, and look for similarities and differences between items. Such interaction with the material ensures that you process it into long-term memory instead of simply memorizing it for a test. Teaching you how to map is an important part of the process, as you may not know where to begin.

Key Elements of Maps

A map has only two parts: the concepts and the linkages between them. A concept is an idea, event or object. Concepts do not exist in isolation; they have associations to other relevant concepts. An example is the sentence "The heart pumps blood." Heart and blood are two concepts related by the verb pumps. A map consists of a group of related terms that are hierarchically ranked and linked by explanatory arrows. In this Student Workbook, we have provided some groups of words to be mapped. You will probably want to develop your own groups of words to fit the material you are studying.

How to make a map

1. Choose the concepts to map. Begin at either the top or the center with the most general, important, or overriding concept from which all the others naturally stem. If this is a reflex pathway, you would start with the stimulus. Next, use the other concepts to break down this one idea into progressively more specific parts or to follow the reflex pathway. Use horizontal cross-links to tie branches together. The downward development of the map may reflect the passage of time if the map represents a process or increasing levels of complexity if the map represents something like a cell.

If you are trying to map a large number of terms, you might try writing each term on a small piece of paper. You can then lay out the papers on a table and rearrange them until you are satisfied with your map. Even an experienced physiologist may draw a map several times before being satisfied that it is the best representation of the information.

2. Think about the type of association between two concepts. Arrows will point the direction of the linkage, but you should also label the kind of linkage. You may label the line with linking words or by the type of link, such as CE (cause or effect). Color is very effective on maps. You can use colors for different types of links or for different sections.

3. Once you have your map, sit back and think about it. Are all the items in the right place? You may want to move them around once you see the big picture. Revise your map to expand the picture with new concepts or to correct wrong linkages. Review the information in the map by beginning with recall of the main concept and then moving to the more specific details. Ask yourself questions like, "What is the cause? effect? parts involved? main characteristics?" to jog your memory.

4. The best way to study with a map is to trade maps with your study partner and see if you can understand each other's maps. You may want to find an empty classroom, put your maps on the blackboards, then step back and compare them. Did one of you put in something the other forgot? Did one of you have an incorrect relationship between two items?

Practice making maps. The study questions in each chapter of your textbook will give you some ideas of what you should be mapping. Your instructor can help you if you do not know how to get started.

LIBRARY RESEARCH

Resources in the library come in two forms: books and journals. Books are the best resource for general background information. If you are trying to learn about a new subject, they can be an excellent place to start, especially older books that have simpler background information. However, unless the book has a recent publication date, it may not be the most up-to-date source of information. One exception is the book that is a compilation of published papers from a **symposium** [a meeting or conference held to discuss a certain topic]. An effort is made to see that these books are published with a minimum of delay.

JOURNALS: Scientific journals are usually sponsored by a scientific organization and consist of contributed papers that describe the **original scientific research** of an individual or group. When a scientist speaks of writing "a paper," he/she is usually referring to the scientific paper published in a journal. Many journals will publish **review articles**. A review article is a synopsis of recent research on a particular topic and is an excellent place to begin a search for information, since it usually contains more up-to-date information than a book on the same topic.

CITATION FORMAT: Citation formats for papers will vary but will usually include the following elements somewhere:

Title. [Brackets around the title indicate an English translation of a foreign language paper.]

Year the paper was published.

Name of author(s). Within a body of work, a multiauthor paper is usually cited as **first author, et al.** Et al. is the abbreviation for the Latin *et alii* meaning "and others," and indicates that there are additional authors.

Journal abbreviation, **volume (issue)**: inclusive **pages.** A **volume** number is usually given to all issues published in one calendar year (six months for weekly journals). **Issue** 1 would be the first issue published in a volume, Issue 2 would be the second, etc.

Example: Horiuchi M., Nishiyama H., and Katori R. Aldosterone-specific membrane receptors and related rapid non-genomic effects. [Review] Trends Pharmacol Sci 14(1):1-4, 1993.

In many citations, the name of a journal is abbreviated. Here is a list of commonly used abbreviations.

Adv	advances	**Am**	American
Ann	annals	**Annu**	annual
Appl	applied	**Arch**	archives
Assoc	association	**Behav**	behavior
Biochem	biochemistry	**Biol***	biology or biological
Biophys	biophysics	**Br**	British
Can	Canadian	**Chem**	chemistry or chemical
Clin	clinical	**Commun**	communications
Curr	current	**Dev**	developmental
Dis	disease	**Eur**	European
Exp	experimental	**Gen**	general
Hum	human	**Int**	internal
Intl	international	**J**	journal
Med	medicine or medical	**Monogr**	monograph
Nat	natural	**Natl**	national
Pharm	pharmacy	**Physiol***	physiology or physiological
Proc	proceedings	**Q**	quarterly
Res	research	**Rev**	review
Sci	science	**Soc**	society or social
Surg	surgery or surgical	**Symp**	symposium
Ther	therapy		

* Most words ending with -ology or -ological will be abbreviated by stopping after the "l". Titles of one word such as "Nature" are never abbreviated.

Citing Sources Published on the World Wide Web

Searching the World Wide Web has become a standard method for gathering information. However, a word of caution is in order. Most articles published in scientific journals have gone through a screening process known as peer review, in which the article is read and critiqued by other specialists in a particular field. In some cases, articles that are submitted are rejected by the journal editor, and in many cases the authors must make revisions to the article before it can be published. This process acts as a safeguard against the publication of poorly done research. However, anyone can create a web page and publish information on the Web. There is no screening process, so the reader must decide how valid the information is. Web sites that are published by recognized universities and not-for-profit organizations are likely to have good information. But an article in vitamins on the web page of a health food store should be viewed with a skeptical eye unless the article cites published research.

Citing sources from the Web requires a different format. Here is one suggested format:

Author (year; month and day if appropriate) Title. Source name [online]. Available: (electronic address sufficient for retrieval)

Examples:

Long, Chris. (1995, August 14) Teachers hope to use 'Net to make science fun. *Austin American Statesman* [online], City/State section, p. B2. Available: NEXIS: News NEXIS File:AAS.

English, Peter. (1997 Nov 10) Birds of the Ecuadorian Rainforest. Internet. http://www.utexas.edu/depts/grg/gstudent/grg394k/spring97/english/english.html

RESOURCES: Online and Otherwise

- Grey's Anatomy is now online. You can find it at the following URL: http://www.bartleby.com/107

- A bimonthly magazine that has many articles of interest is Science & Medicine. Regular features include short articles on Gene Therapy, Tissue Engineering, and A Is For ... [some current concept, such as epitope spreading]. For subscription information, call (800) 888-0029.

- A great (and free) Web site for those pursuing a field within the health profession is Medscape. Once you register, you can receive weekly newsletters with current research in areas you pick. You also have access to a host of other medical information. Check it out at www.medscape.com.

- Many major publications have Web sites now. Try using a search engine to find Web sites for reputable publications. In the query box, type "American Medical Association," another organization, or a specific journal/magazine title. You'll probably come up with a number of good resources. As always, however, check out the quality of the site before relying too heavily on it. If you have questions about a site's accuracy, ask your professor or teaching assistant.

- Take some time to familiarize yourself with all the publications out there. Go to your library and look through the plethora of scientific journals, magazines, newsletters, etc.

1

CHAPTER 1
INTRODUCTION TO PHYSIOLOGY

SUMMARY

What should you take away from this chapter?

- What are the different levels of organization for living organisms?
- Be able to name the physiological systems of the human body.
- What is the difference between a teleological and mechanistic approach to science?
- List six key themes in physiology.
- Be able to describe how scientists design and execute experiments.

Physiology is the study of how organisms function and adapt to a constantly changing environment.

The human body is comprised of ten organ systems. However, these organ systems do not act as isolated units. Instead they communicate and cooperate to maintain homeostasis, a relatively stable internal environment composed of the extracellular fluid that bathes the cells. Physiologists use a wide variety of techniques to study how the human body operates. Some of these techniques examine the activities of molecules and cells, while others focus on the response of entire organ systems. Physiology is usually approached from a functional, or mechanistic, viewpoint. Physiological events can also be explained in terms of their significance, which is considered a teleological approach to physiology. Scientific experimentation includes formulation of a hypothesis, observation and experimentation, and data collection and analysis. Experiments using human subjects are difficult to perform and analyze because of tremendous variability within human populations and because of ethical problems.

TEACH YOURSELF THE BASICS

LEVELS OF ORGANIZATION

1. List the ten levels of organization, starting with atoms and ending with the biosphere.

_____

2. List the ten human organ systems. (Table 1-1)

_____

_____

PHYSIOLOGY IS AN INTEGRATIVE SCIENCE

3. What do we mean when we say that physiology is an integrative science?

FUNCTION AND PROCESS

4. What is the difference between a teleological approach to physiology and a mechanistic approach? Use the pumping of blood by the heart as an example.

THE EVOLUTION OF PHYSIOLOGICAL SYSTEMS

5. Humans are animals adapted to a terrestrial environment. What is the primary challenge of life on land?

6. Name some mechanisms terrestrial animals have evolved to cope with their environment.

HOMEOSTASIS

7. What is the "external environment" for the individual cells of the body?

8. Define homeostasis.

9. What happens when the body is unable to maintain homeostasis? What are some factors that might contribute to a failure of homeostasis?

THEMES IN PHYSIOLOGY

10. List 6 key themes of physiology in addition to homeostasis.

THE SCIENCE OF PHYSIOLOGY

11. List the key steps a scientist goes through in a scientific inquiry.

12. In an experiment, which are independent variables and which are dependent variables?

13. Why should every experiment have a control?

14. How does a scientific theory differ from a hypothesis?

15. Why is a crossover study better than a study in which the experimental and control groups are composed of different organisms?

16. What advantage is gained by having a blind study? A double-blind study?

TALK THE TALK: (important vocabulary in this chapter)

Aristotle	blind study	cell-to-cell communication
cell	circulatory system	concept map
control	crossover study	data
dependent variable	digestive system	double-blind crossover study
double-blind study	endocrine system	energy
external environment	extracellular fluid	fertilization
fetal development	Hippocrates	homeostasis
hypothesis	immune system	independent variable
integration of body systems	integumentary system	internal environment
law of mass balance	lumen	mass flow
mechanistic approach	musculoskeletal system	nervous system
organ system	pH	physiology
placebo	placebo effect	reproductive system
respiratory system	salinity	scientific method
skin	teleological approach	temperature regulation
tissue	urinary system	