Preface

This Instructor Guide to Text and Media for Stanfield and Germann’s *Principles of Human Physiology* is intended to assist first-time instructors and veteran physiology instructors alike in teaching their physiology course.

The Instructor’s Guide begins every chapter with a section covering links to media resources available through Benjamin Cummings. The Media for Instructors section includes a list of resources available via *The Physiology Place, IPweb (InterActive Physiology®), and PhysioEx™*. These references allow instructors to assign appropriate topics for each chapter to their students without spending a lot of time searching through the media themselves. In addition, the Web Site List (available at *The Physiology Place*) provides instructors with a quick list of Internet locations to which they may send students for further research on topics relevant to each text chapter.

Each chapter of the Instructor Guide contains a list of key terms, a chapter summary, chapter outline, a list of the tables in the chapter, cross references to associated topics in other chapters, and answers to all Quick Tests, Apply Your Knowledge, and End-of-Chapter questions. In addition, chapter-specific classroom demonstrations, activities, and helpful hints provide tips on relating material to students in a memorable fashion. The For Further Thought questions are intended as challenge questions for use either in class or on exams. Topics introduced in Toolboxes, Chemistry Reviews, Exercise Links, Discovery Boxes, and Clinical Connections features as well as equations given in the text, are addressed in the For Further Thought questions. The References section of each chapter list articles and texts that directly correspond to topics appearing in the features and/or For Further Thought questions.

The brand new Media Manager, a convenient chapter-by-chapter resource package on CD-ROM, provides a concise visual guide to all the art from the book. Larger images and labels, in JPEG and PowerPoint® formats, are provided in both labeled and unlabeled versions. Take advantage of the customizable PowerPoint lecture outlines with integrated links to specific *InterActive Physiology* pages, a selection of art offered as Label Edit art, with fully customizable labels, as well as Step Edit art that breaks down complex physiological processes into manageable multi-slide presentations. New *InterActive Physiology* (IP) Slides make it easy to incorporate specific IP pages into any PowerPoint presentation. This Instructor Guide, a test bank in Microsoft® Word format, and Personal Response System “clicker” questions are also included. Simply choose from a vast array of assets to easily create a shopping cart of your selections and quickly download it all onto your computer.
Writing this Instructor Guide has been both a pleasure and a challenge. I must thank the editorial team at Benjamin Cummings for their understanding and encouragement during this project. In addition, very special thanks go to my husband, Jim Stanfield, for his patience and support. I welcome comments and/or suggestions regarding this material. Please feel free to contact me in care of Benjamin Cummings, Applied Sciences, 1301 Sansome St., San Francisco, CA 94111. Best of luck to you and—happy teaching!

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This chapter is an introduction to the study of human physiology with an emphasis on homeostasis. The chapter begins with a discussion of the hierarchical organization of the body from cells to tissues to organs to organ systems. Characteristics of each of the four basic tissue types are discussed as well. This is followed by a discussion of the body’s external and internal environments and the exchange of materials between these environments. Next, the body’s fluid compartments and total body water are explained. This is followed by a discussion of homeostasis. Included in this discussion are the basic principles behind negative feedback control and positive feedback control systems. An example of homeostatic regulation using the thermoregulatory system is described. Within this example, mechanisms of heat exchange with the environment (including radiation, conduction, and evaporation) are defined. The concept of negative feedback is further explored within a discussion of the thermoregulatory response to a drop in temperature. The chapter ends by introducing a story about two runners involved in a marathon race. The story is meant to emphasize organ system integration via the study of exercise physiology. In each of the following chapters, the story will be revisited and students will be reminded of the correlations between the various organ systems of the body.
MEDIA FOR INSTRUCTORS

This section describes the media components available for your physiology course.

- **The Physiology Place, Instructor Resources** — Access these online tools at www.physiologyplace.com in developing your introduction to physiology and homeostasis:
  - Instructor Guide: an electronic version of this chapter.
  - Media Manager files: ready to use PowerPoint® slides and Step Edit art.

- **The Physiology Place, Student Resources** — Students can research topics and test their knowledge with the following chapter activities:
  - Chapter Objectives
  - Quizzes
  - Web Links
  - Challenge Yourself
  - Glossary
  - Flashcards
  - Ask the Authors
  - Answers to Quick Tests and Apply Your Knowledge questions
  - Links to *Get Ready for A&P, InterActive Physiology®, PhysioEx™*, and *Research Navigator™*

- **InterActive Physiology** — Detailed animations aid students in grasping these complex physiological processes:

CHAPTER BASICS

**Key Terms**

| cell | conduction | connective tissue cell | core temperature | convection | effector | endocrine gland | epithelia | evaporation | exocrine gland | extracellular fluid (ECF) | glands | homeostasis | hormone | hyperthermia | hypothermia | integrating center | internal environment | interstitial fluid (ISF) | intracellular fluid (ICF) | lumen | muscle fiber | negative feedback | neuron | organ | organ system | physiology | plasma | positive feedback | radiation | set point | thermoregulation | tissues | total body water (TBW) |
Chapter Outline

I. Organization of the Body
   A. Cells, Tissues, Organs, and Organ Systems
      1. Cells
         a. Nerve Cells
         b. Muscle Cells
         c. Epithelial Cells
         d. Connective Tissue Cells
      2. Tissues
      3. Organs and Organ Systems
   B. The Overall Body Plan: A Simplified View
      1. The Body’s External Environment
      2. The Body’s Internal Environment
         a. The Exchange of Materials Between the External and Internal Environment
         b. Body Fluid Compartments
            1) Total Body Water
            2) Intracellular Fluid (ICF)
            3) Extracellular Fluid (ECF)

II. Homeostasis: A Central Organizing Principle of Physiology
   A. Negative Feedback Control in Homeostasis
   B. Homeostasis in Action: Thermoregulation
      1. Mechanisms of Heat Transfer Between the Body and the External Environment
         a. Radiation
         b. Conduction
         c. Evaporation
         d. Convection
      2. The Components of the Body’s Thermoregulatory System
      3. The Thermoregulatory Response to a Drop in Temperature: A Negative Feedback System in Operation
         a. Decreased Sweat Production
         b. Decreased Blood Flow to Skin
         c. Stimulation of Shivering

III. Challenging Homeostasis: A Study in Organ System Integration During Exercise
   A. The Hierarchy of Resource Allocation in Response to Activity
   B. Bill and Jane’s Marathons
      1. Training
      2. Prelude to the Race
      3. The Race
Tables
1.1 Organ Systems, p. 6
1.2 Physical Characteristics of the Two Marathon Runners, p. 16
1.3 Anatomical and Functional Changes Resulting from Training, p. 17

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Clinical Connections: Heat Exhaustion and Heat Stroke, p. 10

Cross References
Chapter 3: Cell Metabolism—increased heat production from metabolism during exercise.
Chapter 6: The Endocrine System: Endocrine Glands and Hormone Actions—examples of feedback control.
Chapter 9: The Nervous System: Central Nervous System—role of the hypothalamus in controlling body temperature.
Chapter 14: The Cardiovascular System: Blood Vessels, Blood Flow, and Blood Pressure—body fluid balance
Chapter 21: The Endocrine System: Regulation of Energy Metabolism and Growth—blood glucose homeostasis.
Chapter 22: The Reproductive System—childbirth, an example of positive feedback.

Answers to Quick Tests
Quick Test 1.1 (p. 6)
1. A cell is the basic unit of life. It is composed of a plasma membrane, a membrane-bound nucleus, and several cellular organelles. There are hundreds of different specialized varieties of cells in the body. A tissue is a structure composed of hundreds of cells of the same type. There are four basic tissue types in the body: epithelial, connective, muscle, and nervous. An organ is a structure that is composed of several different types of tissues and has a specific functional role in the body. An example is the heart. An organ system is composed of several organs that work together to perform a homeostatic role in the body. For instance, the cardiovascular system is composed of the heart, blood, and blood vessels. All of these structures work together to deliver oxygen and nutrients to cells of the body and to remove wastes.
2. The four types of tissues in the body (made up of the corresponding four cell types) are epithelial, muscle, nervous, and connective tissue. **Epithelial tissues** make up body coverings and linings, and are characterized by being highly cellular with little extracellular material. Some functions of epithelial tissues are protection, transport, and secretion (for glandular epithelia). **Muscle tissue** is characterized by its ability to contract and generate force. **Nervous tissue** is characterized by its ability to generate electrical signals. **Connective tissues** are characterized as being composed primarily of extracellular materials with few cells. The extracellular matrix of connective tissues is composed of ground substance and fibers. Connective tissues generally function in support and protection.

**Quick Test 1.2 (p. 9)**

1. Extracellular fluid is all the fluid inside the body that is not contained within cells. It is considered the internal environment because it is not in contact with the outside world and because its composition is tightly controlled by internal factors. Namely, the composition of the extracellular fluid is directly controlled by the cells of the body, not directly by environmental conditions outside the body. Extracellular fluid is also the environment to which the body cells are exposed and have direct exchange.

2. a) All the water that is contained in the body is called **total body water**.
   b) Fluid that is contained within cells is called **intracellular fluid**.
   c) Fluid that is located outside of cells is called **extracellular fluid**.
   d) Fluid that is located outside of cells and is found in the blood is called **plasma**.
   e) Fluid that is located outside of cells and is found outside the blood is called **interstitial fluid**.

**Quick Test 1.3 (p. 12)**

1. **Homeostasis** is the maintenance of a stable internal environment in which the cells can survive. As environmental conditions change, homeostatic mechanisms at work within the body prevent those changes from altering the function of the body's cells. For instance, as the environmental temperature increases, homeostatic controls stimulate evaporative cooling mechanisms that allow the body to remove the excess heat. If the body did not make this attempt to control its internal environment, the body would heat up in concert with the environment. This would result in several tissues becoming badly damaged, enzymes denaturing, and ultimately, the death of the organism.

2. **Negative feedback** works to maintain homeostasis because the response of the system to a change in homeostatic levels is opposite in direction to the change that initiated the response in the first place. In a sense, negative feedback works by mediating the changes instituted by the body’s regulatory systems. When a change is instituted by the body (for example, when insulin is released in response to high levels of blood glucose), the end result of that change (lowered blood glucose in this example) acts to **turn off** the initial regulatory response (the release of insulin).
Quick Test 1.4 (p. 15)

1. The three mechanisms of heat loss are radiation, conduction, and evaporation.

2. In the thermoneutral zone, 25–30°C, thermoregulation occurs solely through alterations in blood flow to the skin. When temperature increases, blood flow to the skin increases to increase heat loss to the environment. When temperature decreases, blood flow to the skin decreases to minimize heat loss to the environment.

3. Some effectors that are important in thermoregulation are sweat glands, blood vessels in the skin, and skeletal muscles. Sweat glands respond to a drop in body temperature by decreasing their production of sweat such that evaporative cooling mechanisms are shut down and body heat is not lost. Blood vessels in the skin respond to a drop in body temperature by constricting, which decreases the amount of blood flowing to the surface of the body. This, in turn, decreases the amount of heat lost due to radiation and conduction. Skeletal muscles respond to a drop in body temperature by shivering. These contractions generate metabolic heat due to the fact that muscle contractions are not 100% efficient and any unused energy is given off as heat.

Answers to Apply Your Knowledge

Apply Your Knowledge (p. 9)

The body contains approximately 42 liters of water distributed into various compartments: intracellular fluid, plasma, and interstitial fluid. With a loss of plasma, water shifts first from the interstitial fluid to plasma, and if necessary, water can move out of cells into the extracellular fluid.

Answers to Multiple-Choice Questions

1. b
2. e
3. c
4. c
5. e
6. a

Answers to Objective Questions

1. extracellular fluid
2. homeostasis
3. true
4. sensor
5. false
6. below
7. false
8. raise
9. connective
10. false

Answers to Essay Questions

1. In the control of room temperature, the thermostat is the equivalent of an integrating center. In the control of body temperature, the hypothalamus is the body’s integrating
center, or thermostat. If the room thermostat is set to 21°C, this is the set point. In the
human body, the hypothalamus puts the set point at about 37°C. When the room temper-
ature drops to 18°C, there is an error signal of 3°. Mechanisms within the thermostat
sense this error signal and the thermostat turns on the heater. In this example, the heater is
the effector. After the heater has been on long enough to bring room temperature back to
21°C, the thermostat senses this and turns off the heater. This is an example of negative
feedback control. On a similar note, if body temperature drops below 37°C, central ther-
moreceptors in the brain and spinal cord feed to the hypothalamus, telling it that body
temperature has dropped. The hypothalamus then stimulates effector organs such as
sweat glands, blood vessels in the skin, and skeletal muscles (these are the body’s “heaters”).
Sweat production decreases, blood vessels in the skin constrict, and skeletal muscles shiver,
producing excess heat. Once body temperature has returned to normal, the central ther-
moreceptors sense this and once again feed back to the hypothalamus. The hypothalamus
responds by decreasing its output to the effector organs listed above.

2.

3. Glucose molecules first travel from the mouth to the esophagus, and then to the stomach.
As glucose travels through these organs, it is not absorbed because the epithelial cells
do not have transport mechanisms for glucose. In fact, the epithelia of the mouth and
esophagus are thick and protective, preventing substances from being absorbed. Once
the glucose molecules enter the small intestine, they are absorbed across the epithelial
cells of the small intestine and into the capillaries serving the villi of the small intestine.
They must pass through the epithelium and basement membrane of both the intestinal
epithelial cells and the intestinal capillaries before they are allowed into the blood-
stream. The glucose molecules travel through the bloodstream to capillaries within
skeletal muscles. Here, once again, glucose molecules must pass through the epithelium
lining the blood vessels and the associated basement membrane. After they move out of
the bloodstream into the interstitial spaces of the muscle tissue, they must cross the
plasma membrane of skeletal muscle cells to gain entry. Glucose is metabolized within
the cytosol and mitochondria of the muscle cell, and the carbons present in the initial
glucose molecules are now in the form of carbon dioxide. This carbon dioxide must pass
out through the sarcolemma of the muscle cell and into the interstitial spaces. Then it
must cross the basement membrane and epithelium of the muscle capillaries to gain
entry to the bloodstream. Once in the bloodstream, the carbon dioxide travels to the
lungs and into the lung capillaries. Once in the lung capillaries, the carbon dioxide must pass through the epithelium of the capillaries, the basement membrane, and the epithelium lining the alveoli of the lungs to gain entry into the alveolus. From here, carbon dioxide travels through the bronchioles, bronchi, and trachea before entering the pharynx and exiting the body through the nasal or oral cavities.

**Answer to Critical Thinking Question**

1. Differences between Bill and Jane’s behavioral patterns before, during, and after the marathon, and possible consequences of these behaviors are given in the table below.

<table>
<thead>
<tr>
<th>BILL</th>
<th>JANE</th>
<th>CONSEQUENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drank lots of coffee day of race</td>
<td>Drank less coffee day of race</td>
<td>Bill will lose more water during the race</td>
</tr>
<tr>
<td>Bill darts back and forth at beginning of race to escape crowd</td>
<td>Jane takes her time getting out of the pack</td>
<td>Bill uses up more energy reserves early in the race</td>
</tr>
<tr>
<td>Bill skips first drinking station and drinks only partial cup at second</td>
<td>Jane takes her time to obtain full drink at first two stations</td>
<td>Bill will be more dehydrated as the race progresses</td>
</tr>
<tr>
<td>Bill has watery diarrhea during race</td>
<td>Jane has no intestinal problems</td>
<td>Bill will be more dehydrated as the race progresses</td>
</tr>
<tr>
<td>Bill drinks a liter of water on completing race</td>
<td>Jane eats and drinks normally</td>
<td>Bill’s intake of a large volume of water without solutes creates an imbalance causing over-hydration</td>
</tr>
</tbody>
</table>

**IN THE CLASSROOM**

**Classroom Demonstrations/Activities**

1. Using a glass or cup as an example, demonstrate a structure/function relationship. Then give the students an object they are likely to be unfamiliar with and ask them to come up with possible functions of that object simply based on its structure.

2. As you are discussing negative feedback, use the function of a thermostat as a common example of negative feedback. If your classroom has a thermostat in an obvious location, use it as a “prop” for your discussion.

3. After introducing control systems, give your class a few minutes to brainstorm about what they think are regulated variables in the body.