Dedication

To our wives
and children:
Maria, Ricky, and Carrie
Judy and Jonathan
Jake and Amy, and in
loving memory of LeeAnn
Meet the Authors

ERIC P. WIDMAIER received his Ph.D. in 1984 in Endocrinology from the University of California at San Francisco. His postdoctoral training was in endocrinology and physiology at the Worcester Foundation for Experimental Biology, and The Salk Institute in La Jolla, California. His research is focused on the control of body mass and metabolism in mammals, the mechanisms of hormone action, and the postnatal development of adrenal gland function. He is currently Professor of Biology at Boston University, where he teaches Systems Physiology and Comparative Physiology, and has been recognized with the Gitner Award for Distinguished Teaching by the College of Arts and Sciences, and the Metcalf Prize for Excellence in Teaching by Boston University. He is the author of numerous scientific and lay publications, including books about physiology for the general reader. He lives outside Boston with his wife, Maria, and children, Carrie and Ricky.

HERSHEL RAFF received his Ph.D. in Environmental Physiology from the Johns Hopkins University in 1981 and did postdoctoral training in Endocrinology at the University of California at San Francisco. He is now a Professor of Medicine (Endocrinology, Metabolism and Clinical Nutrition) and Physiology at the Medical College of Wisconsin and Director of the Endocrine Research Laboratory at Aurora St. Luke’s Medical Center. At the Medical College of Wisconsin, he teaches systems physiology, neuroendocrinology, and endocrine pharmacology to medical and graduate students. He was an inaugural inductee into the Society of Teaching Scholars, and he has received the Beckman Basic Science Teaching Award from the Senior Class and the Outstanding Teacher Award from the Graduate Student Association. He is also an Adjunct Professor of Biomedical Sciences at Marquette University. He recently completed terms as Secretary-Treasurer of The Endocrine Society and as Associate Editor of Advances in Physiology Education. Dr. Raff’s basic research focuses on the effects of low oxygen (hypoxia) at the organismal, cellular, and molecular levels. His clinical interest focuses on pituitary and adrenal diseases, with a special focus on Cushing’s syndrome. His hobby is playing the piano and guitar. He resides outside Milwaukee with his wife, Judy, and son, Jonathan.

KEVIN T. STRANG received his Master’s degree in Zoology (1988) and his Ph.D. in Physiology (1994) from the University of Wisconsin at Madison. His research area is cellular mechanisms of contractility modulation in cardiac muscle. He teaches a large undergraduate systems physiology course as well as first-year medical physiology in the UW-Madison School of Medicine and Public Health. He was elected to UW-Madison’s Teaching Academy and serves on the steering committee of the Institute for Cross-college Biology Education (ICBE). Teaching awards include the UW Medical Alumni Association’s Distinguished Teaching Award for Basic Sciences, and the University of Wisconsin System’s Underkofler/Alliant Energy Excellence in Teaching Award. Interested in teaching technology, Dr. Strang has created an interactive CD-ROM tutorial called “Anatomy of a Heart Attack,” and has produced numerous animations for teaching physiology. He lives in Madison with his children, Jake and Amy.
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From the Authors

We are very pleased to launch the 11th edition of *Vander’s Human Physiology*. The current authors have attempted to maintain the highest standards of excellence, accuracy, and pedagogy developed by Arthur Vander, James Sherman, and Dorothy Luciano over the many years in which they educated countless thousands of students worldwide with this textbook. At the same time, we have been very attuned to the evolving needs of instructors and students in physiology, particularly those interested in a career in the health sciences. Thus, in addition to the usual updates of scientific material reflecting recent advances in physiology, this edition builds on the pedagogy that was expanded in the 10th edition. A new feature, called *Physiological Inquiries*, has been added to each chapter beginning with Chapter 4. These inquiries are associated with key figures throughout the chapters, encouraging students to stop and think about the broader implications of what they have just learned. In some cases, this may entail quantitative analyses, while in other cases it may involve understanding the material in an evolutionary context. We think that such exercises will further encourage students to think about what they are learning in new and more profound ways.

Similarly, a new chapter has been added to the end of the textbook (Chapter 19), called *Medical Physiology: Integration Using Clinical Cases*. Three case studies, adapted from real-life scenarios, are presented to the student in a way that requires the student to think critically and apply what has been learned throughout the semester to novel clinical situations. Along the way, students are asked to *Reflect and Review* the material as the case unfolds, providing them with a step-by-step interactive learning experience. We hope that users of the book will agree that the increased emphasis on pedagogy has enhanced the utility of the textbook as a learning tool.

We are as always deeply grateful for the many helpful insights, suggestions, and reviews from colleagues and students around the world. We remain indebted to Drs. Vander, Sherman, and Luciano for their trust and guidance, and to the wonderful staff at McGraw-Hill Higher Education for their support and professionalism.

New Case Study Chapter!

**CASE 19-3**

**A Man with Abdominal Pain, Fever, and Circulatory Failure**

*Case Presentation*

A 25-year-old healthy college student was consulting with his family physician about a problem he had been having for 2 days. One day, he had returned home from a long-distance run and complained of abdominal pain. While he ate a small meal, he began to feel faint and went to bed. He woke up with a fever and chills the following day. Over the next 2 days, his symptoms worsened and he was admitted to the hospital. On admission, he was found to be pale, clammy, and extremely short of breath. His blood pressure was测得 to be 70/40 mm Hg, and his heart rate was测得 to be 140 beats per minute. The attending physician was concerned about the patient’s critical condition and ordered immediate medical intervention.

*Physical Examination*

On arrival at the hospital, the young man was restless and lucid. He was restless and agitated, with a heart rate of 150 beats per minute. Blood pressure was测得 to be 75/40 mm Hg, and his temperature was测得 to be 101.2°F. Laboratory tests revealed a white blood cell count of测得 to be 12,000 cells/mm³, and a hematocrit of测得 to be 30%. The attending physician was concerned about the patient’s critical condition and ordered immediate medical intervention.

*Laboratory Tests*

Additional measurements were then performed, and the results are测得 in Table 19-3. The attending physician was concerned about the patient’s critical condition and ordered immediate medical intervention.

**Table 19-3**

<table>
<thead>
<tr>
<th>Blood Parameter</th>
<th>Value</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hgb (g/dL)</td>
<td>12</td>
<td>13-18</td>
</tr>
<tr>
<td>WBC (cells/mm³)</td>
<td>12,000</td>
<td>4000-10,000</td>
</tr>
<tr>
<td>Platelets (×10³)</td>
<td>200</td>
<td>150-400</td>
</tr>
<tr>
<td>MCH (pg)</td>
<td>25</td>
<td>27-35</td>
</tr>
<tr>
<td>MCHC (%)</td>
<td>33</td>
<td>32-36</td>
</tr>
<tr>
<td>Red blood cells</td>
<td>4.6</td>
<td>4.4-5.7</td>
</tr>
<tr>
<td>Hematocrit (%)</td>
<td>30</td>
<td>32-42</td>
</tr>
</tbody>
</table>

*Diagnosis*

An evaluation of the case revealed that the patient was at risk of developing a severe complication. The attending physician was concerned about the patient’s critical condition and ordered immediate medical intervention. A computed tomography (CT) scan of the abdomen was performed, which revealed a large amount of fluid in the abdomen. The patient was immediately transferred to the intensive care unit, where he was intubated and ventilated. Further studies revealed a bacterial infection, and the patient was started on antibiotics. The attending physician was concerned about the patient’s critical condition and ordered immediate medical intervention.

*Medical Physiology: Integration Using Clinical Cases*