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# PATHOPHYSIOLOGY of **Heart Disease**

A Collaborative  
Project of  
Medical Students  
and Faculty

**SIXTH EDITION**

**Leonard S. Lilly**

EDITION

6

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A COLLABORATIVE PROJECT  
OF MEDICAL STUDENTS  
AND FACULTY

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**A COLLABORATIVE PROJECT  
OF MEDICAL STUDENTS AND  
FACULTY**

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Dedicated to

**Carolyn, Jonathan,  
Rebecca, Douglas, Deborah,  
Norma and David Lilly**

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# Foreword

It is axiomatic that when designing any product or service, the needs of the prospective user must receive primary consideration. Regrettably, this is rarely the case with medical textbooks, which play a vital role in the education of students, residents, fellows, practicing physicians, and paramedical professionals. Most books are written for a wide audience so as to attract as many readers (and buyers) as possible. Most medical textbooks are tomes written either for the specialist or advanced trainee or they are technical “how to” manuals.

Medical educators appreciate that the needs of medical students exposed to a subject for the first time differ importantly from those of practicing physicians who wish to review an area learned previously or to be updated on new developments in a field with which they already have some familiarity. The lack of textbooks designed specifically for students leads faculty at schools around the country to spend countless hours preparing and duplicating voluminous lecture notes, and providing students with custom-designed “camels” (a camel is a cow created by a committee!).

*Pathophysiology of Heart Disease: A Collaborative Project of Medical Students and Faculty* represents a refreshing and innovative departure in the preparation of a medical text. Students—the intended user—dissatisfied with currently available textbooks on cardiology, made their needs clear. They need to understand the pathophysiology of cardiovascular disorders, and how the pathophysiology leads to key clinical and laboratory findings and to the rationale for management. Fortunately, their pleas fell on receptive ears. Dr. Leonard Lilly, a Professor of Medicine at Harvard Medical School, who is a brilliant teacher and a respected cardiologist at the Brigham and Women’s and Faulkner Hospitals, has served as the senior editor of this project. He has brought together a group of talented Harvard medical students and faculty who have collaborated closely to produce this superb introductory text specifically designed to meet the needs of medical students during their initial encounters with patients with heart disease. Dr. Lilly, who was a co-author of most of the chapters made certain that there were no repetitions or major gaps, as so often occurs with multi-authored texts. While *Pathophysiology of Heart Disease* is not meant to be encyclopedic or all inclusive, it is remarkably thorough.

The first five editions of this fine book were received enthusiastically, and *Pathophysiology of Heart Disease* is now a required or recommended text at many medical schools not only in the United States and Canada, but in other countries as well. It has been translated into several languages, has received two awards of excellence from the American Medical Writers Association, and has inspired other student–faculty collaborative book projects at Harvard and at other medical schools. This sixth edition is completely updated, as is required by a field as dynamic as cardiology. The figures have been upgraded, are now in full color, and they display complex concepts in uncomplicated ways. This edition will prove to be even more valuable than its predecessors.

Dr. Lilly and his colleagues—both faculty and students—have made a significant and unique contribution in preparing this important book. Future generations of medical educators and students, and ultimately the patients that they serve, will be indebted to them for

**Eugene Braunwald, MD**  
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# Preface

This textbook is a comprehensive introduction to diseases of the cardiovascular system. Although excellent cardiology reference books are available, their encyclopedic content can overwhelm the beginning student. Therefore, this text was created to serve as a simplified bridge between courses in basic physiology and the care of patients in clinical settings. It is intended to help medical students and physicians-in-training form a solid foundation of knowledge of diseases of the heart and circulation and is designed to be read in its entirety during standard courses in cardiovascular pathophysiology. Emphasis has been placed on the basic mechanisms by which cardiac illnesses develop, in order to facilitate subsequent in-depth study of clinical diagnosis and therapy.

The original motivation for writing this book was the need for such a text voiced by our medical students, as well as their desire to participate in its creation and direction. Consequently, the book's development is unusual in that it represents a close collaboration between Harvard medical students and cardiology faculty, who shared in the writing and editing of the manuscript. The goal of this pairing was to focus the subject matter on the needs of the student, while providing the expertise of our faculty members. In this updated and rewritten sixth edition of *Pathophysiology of Heart Disease*, the collaborative effort has continued between a new generation of medical students and our cardiovascular faculty.

The introductory chapters of the book review basic cardiac anatomy and physiology and describe the tools needed for understanding clinical aspects of subsequently presented material. The remainder of the text addresses the major groups of cardiovascular diseases. The chapters are designed and edited to be read in sequence but are sufficiently cross-referenced so that they can also be used out of order. The final chapter describes the major classes of cardiovascular drugs and explains the physiologic rationale for their uses.

It has been a great privilege for me to collaborate with the 106 talented and creative medical students who have contributed to the six editions of this book. Their intelligence, enthusiasm, energy, and dedication have made the production of each manuscript enjoyable and intellectually stimulating. I particularly recognize David Fischer, who stepped forward as the main student author liaison for this edition and was instrumental in facilitating organization of this project.

I am indebted to my faculty colleague coauthors for their time, their expertise, and their continued commitment to this book. I especially acknowledge Professor Gary Strichartz, who has been an essential contributor to this project since 1996, and whose input into future editions I will greatly miss as he transitions to retirement and new pursuits.

I sincerely appreciate the thoughtful and constructive comments received from faculty and students around the globe pertaining to previous editions of this book. These communications have been very helpful in directing the current revision, and the many warm remarks and have been an important source of encouragement. I also acknowledge with gratitude several individuals who provided material, detailed comments and reviews, or other support to this edition: Suhny Abbara, Lauren Bayer, Marcelo DiCarli, Sharmila Dorbala, Marie Gerhard-Herman, Andetta Hunsaker, Raymond Kwong, Gillian Lieberman, Robert Padera,

Lippincott Williams & Wilkins. In particular, I thank Amy Weintraub, Crystal Taylor, Marian Bellus, Holly McLaughlin, and Leslie Jebaraj for their skill and professionalism in bringing this edition to completion.

Finally, a project of this magnitude could not be undertaken without the support and patience of my family, and for that, I am very grateful.

On behalf of the contributors, I hope that this book enhances your understanding of cardiovascular diseases and provides a solid foundation for further learning and clinical care of your patients.

**Leonard S. Lilly, MD**  
Boston, Massachusetts

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