



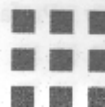
# Preface to the second edition

A number of changes have been introduced in this second edition. First, clearer guidance is provided regarding the mathematical prerequisites in order to achieve the maximum benefit from the material, particularly in the later chapters. The basic structure of the book remains unchanged, while a number of the chapters providing details of the basic approaches to modeling have been enhanced. In the light of developments over recent years, the range of case study material included in this book has been substantially increased, including two new extensive examples drawn from recent research experience.

Our thanks go to Martina Negretto for assistance with preparation of the manuscript.

We would also like to thank members of the Elsevier team who have encouraged and helped us in bringing this second edition into fruition, particularly Leticia Lima and Mara Conner.

Claudio Cobelli and Ewart Carson  
*Padova, Italy and Ludlow, United Kingdom*  
August 2019



# Preface to the first edition

Mathematical modeling is now widely applied in physiology and medicine to support life scientists and clinical workers. Our aim in writing this book is to provide an introduction to this topic, presenting the underlying principles of good modeling methodology together with numerous examples, indicating the way in which such modeling is finding application in physiology and medicine.

Mathematical modeling finds application in medical research, in education, and in supporting clinical practice. In the research context, the use of models can, for example, yield quantitative insights into the manner in which physiological systems are controlled. In the educational setting, medical students can use computer model simulation to explore the dynamic effects of pathophysiological processes or of drug therapy. In the clinical arena, mathematical models can enable estimates to be made of physiological parameters that are not directly measurable—useful for example in diagnosis, as well as enabling predictions to be made as to how changes in drug therapy will impact on variables of clinical importance, such as blood pressure or blood glucose concentration.

This book is directed at a broad readership across a wide range of student and practitioner backgrounds. In terms of the student readership, it is designed to appeal to biomedical engineers and to those studying physical and engineering sciences, and biological and life sciences. It should also appeal to medical students who wish to enhance their quantitative understanding of the physical and chemical processes that underpin physiology and medicine. Further, this book should be of interest to practitioners of all professions who have an interest in quantitative aspects of physiology and medicine.

This book begins by exploring some of the complexities of physiology that lend themselves to modeling in order that their quantitative features may be better understood. The concepts of mathematical modeling are then introduced, showing that models can be used for a wide range of purposes: to gain insights, to support processes of measurement, to make predictions of future behavior, and in a variety of ways assist in enhancing clinical research and practice. A number of approaches to developing mathematical models are then considered, with each being illustrated by a range of examples. The remainder of the text then focuses on issues associated with making estimates of model parameters and addressing the problem of ensuring that a mathematical model is valid; that is to say fit for its intended purpose. The final chapter comprises a number of case studies which demonstrate, in detail, how the modeling concepts, methods, and techniques that have been described and discussed earlier can be applied to real-world problems in physiology and medicine.

Lastly, we wish to express our thanks to a number of our colleagues who have worked with us in developing the examples and case studies, including: Alessandra Bertoldo, Chiara Dalla Man, Giovanni Sparacino, Gianna Toffolo, and Peter Weller; and to Andy Morrison for

his assistance in the preparation of the figures. We are also indebted to those who over many years have offered us encouragement and support in our modeling ventures, including Riccardo Bonadonna, Derek Cramp, Ludwik Finkelstein, Roman Hovorka, David Kelley, Antonio Lepschy, Robert Rizza, Abdul Roudsari, and Peter Sönksen. Finally, we should like to express our gratitude to Jonathan Simpson and all his colleagues at Academic Press/Elsevier for their encouragement, support, and tolerance during the lengthy gestation of this book.

Claudio Cobelli, Ewart Carson