

Preface

Astronauts in orbit above the Earth have a unique and special perspective. The problems and issues concerning the world from this broad perspective may seem to be much different than those concerning the average person, especially a student studying physical chemistry. The laws of thermodynamics that were developed over 100 years ago may seem to have a limited significance compared to the issues that can alter the Earth on a large scale, such as the hydrogen economy and global climate change. The goal of this book is to provide an understanding of physical chemistry that is needed for a firm scientific understanding of such problems. It is my hope that the extensive reference to current issues will give students the opportunity to discuss relevant issues from a scientific standpoint. These sections, which are identified as Research directions, present not only the background on specific issues but also ask what the unanswered questions are and how they are being addressed by scientists.

Chapters 2–8 of the book present thermodynamics and kinetics, with biological applications ranging from global climate change and nitrogen fixation to drug design and proton transfer. Chapters 9–16 focus on quantum mechanics and spectroscopy. In this section, issues of biology are presented with an emphasis on understanding the function of proteins at a molecular level.

The last part of the book (Chapters 17–20) is written with the hope that the ideas of thermodynamics, kinetics, quantum mechanics, and spectroscopy can be integrated to understand biology on a broad scale, with the specific examples being signal transduction, ion channels, molecular imaging, and photosynthesis. These chapters are independent of each other and can be presented in any combination. The intention of these chapters is to provide the instructor with the opportunity to teach biology from a physical-chemistry viewpoint and show how the concepts of the course can be used in an integrative fashion rather than simple parts.

One of the balances in organizing this text is to present a rigorous treatment of the material without expecting an unrealistic understanding of mathematical concepts. The text has two mechanisms to maintain a proper balance. First, students have often been taught a high level of mathematics but have not used such concepts in their recent courses. Throughout the

text are short math concept boxes that will remind the students of how to complete a specific step (for example, the derivative of an exponential). Second, formal derivations of expressions are included but highlighted, for example Schrödinger's equation for the hydrogen atom is solved explicitly. By providing the derivation, students can gain an appreciation of the mathematical concepts behind the expression. However, the text is written such that the derivation can be skipped without disruption. Thus, the instructor can decide on which derivations to present in class, while students can always work through the derivations as they wish.

This book was developed from a course taught by the author that is targeted primarily towards undergraduate biochemistry students but also intended for students in physics, biology, and engineering. I wish to thank those students for their comments, which helped shape this textbook. I would also like to thank my colleagues who have commented on the chapters, especially Wei-Jen Lee, who read the chapters very carefully. The reviewers and editors have all been very helpful, with special acknowledgment to Elizabeth Frank, Nancy Whilton, and Haze Humbert. The notes of Neal Woodbury served as the initial basis for several chapters, and many figures represent artwork designed by Aileen Taguchi; both of these proved to be invaluable in writing this book. Finally, I wish to thank my family, JoAnn, Hannah, and Celeste, for their love and support.

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