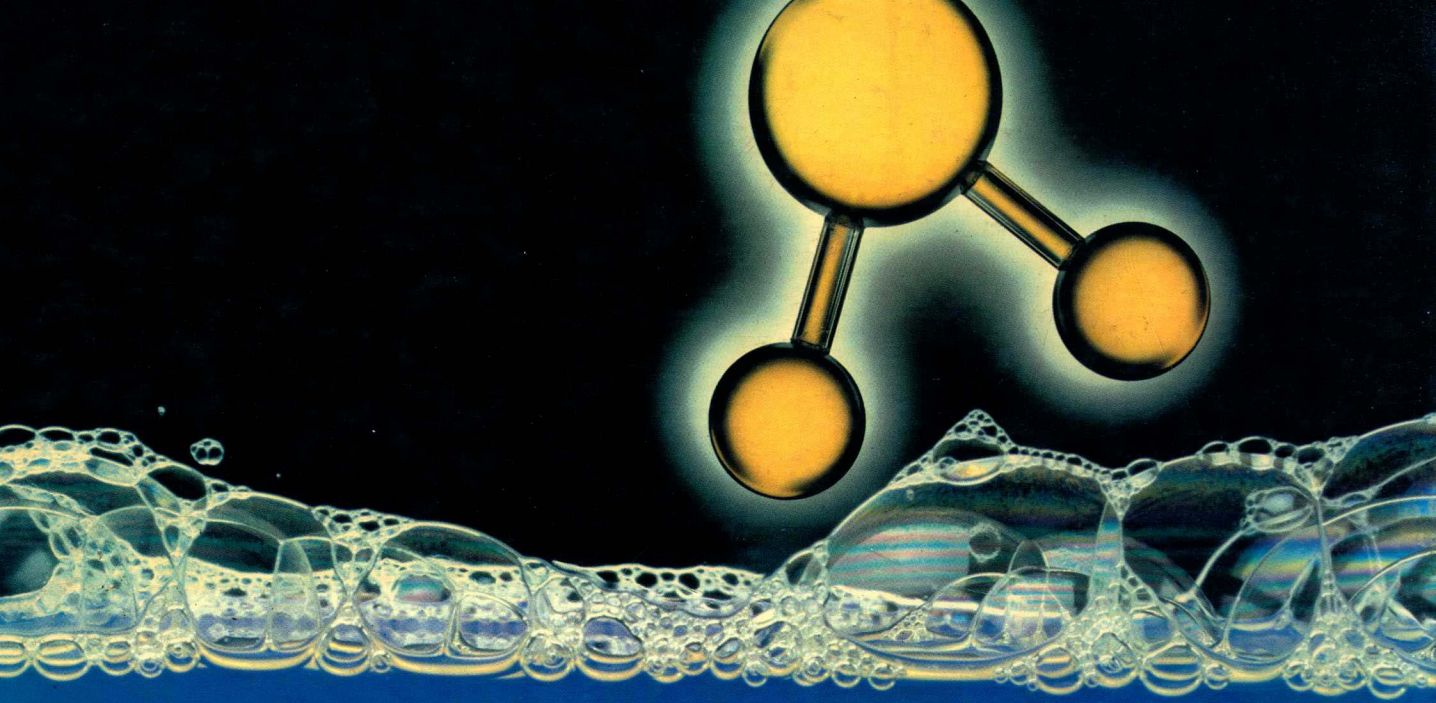

# ESSENTIALS OF GENERAL, ORGANIC, AND BIOLOGICAL CHEMISTRY

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# Essentials of General, Organic, and Biological Chemistry

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# *Essentials of General, Organic, and Biological Chemistry*



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*To Cynthia and Natasha*

# ·PREFACE·

*Essentials of General, Organic, and Biological Chemistry* is a textbook for courses that introduce beginning chemistry students to the most fundamental principles of general chemistry, organic chemistry, biological chemistry, and physiological chemistry. The principal goal of the text is to provide students with a solid chemistry background that will support them in their study of biology, allied health sciences, and future chemistry courses. To accomplish this goal, I have integrated biological and health science applications into many chemistry discussions. However, I have not omitted discussions of important chemical principles in favor of biological applications. *Essentials of General, Organic, and Biological Chemistry* is a chemistry textbook.

A question that faces the author of an allied health chemistry textbook is how much information to include. No textbook of reasonable length can present all of the significant topics in general, organic, and biochemistry. Instead, many compromises must be made. In some cases the inclusion of one important topic means the exclusion or deemphasis of another. But with the help of my excellent reviewers I believe that I have reached the balance of topics that most chemistry professors prefer.

For those chemistry programs that require a more comprehensive textbook, a longer version of this textbook, *General, Organic, and Biological Chemistry*, is available. The longer version contains two additional chapters. One of these chapters is devoted to the elements of life. This chapter discusses properties, reactions, and the biogeochemical cycles of carbon, hydrogen, nitrogen, and oxygen. It also explores the properties of important minerals found in living systems. The other additional chapter is devoted to human digestion and nutrition, containing discussions of nutritional requirements, macromineral nutrients, trace minerals, and vitamins. The longer version also contains expanded discussions of measurement uncertainty, polyatomic ions, stoichiometry, inorganic reactions, normality, diagnosis using nuclear magnetic resonance (NMR), terpenes, thioalcohols, drugs, cell membranes, enzyme deficiency diseases, virus, and many others. In addition, this book contains more figures, questions, and problems.

## ORGANIZATION OF CHAPTERS

General chemistry topics are covered in Chaps. 1 through 10. The fundamental principles of chemistry that support the remaining chapters in the book are found in Chaps. 1 to 5. I have minimized the biological applications in these five chapters because I have found that too many complex biological applications in the early stages of the course can

frustrate rather than excite students. In Chaps. 6 through 10, however, I have included many more health science applications to help students see the importance of learning basic chemical principles.

Chapters 1 to 10 were the last to be written. I was therefore able to delete or deemphasize chemistry topics that did not support either organic or biological chemistry discussions in the remaining chapters of the book. The order of the first seven chapters is standard. Reaction Rates and Chemical Equilibria (Chap. 8) is placed before Acids and Bases (Chap. 9) to support the concepts of aqueous equilibria. Nuclear and Radiation Chemistry (Chap. 10) is a self-contained chapter that can be presented at any point after Chap. 3, Elements, Atoms, and the Periodic Table.

Organic chemistry is discussed in Chaps. 11 through 17. Chapter 11 is an introduction to organic chemistry in which I have attempted to make as easy a transition from inorganic to organic chemistry as possible. In addition to the usual topics found in such a chapter, I have included a discussion of condensed molecular formulas and functional groups. An early knowledge of condensed formulas and functional groups helps students to better understand the remaining chapters in the book.

I have omitted synthetic organic reactions and classic name organic reactions that do not support the material in the sections on biochemistry and physiological chemistry, not because these reactions are unimportant, but so that a more complete discussion of biochemistry might be presented. Each of the organic chemistry chapters is sprinkled liberally with biological and medical applications. For example, Amines and Amides (Chap. 17) contains a section on important heterocyclic amines and amides that are found in living systems, and those that are contained in medicines and drugs. Stereochemistry is not included in the organic chemistry chapters, but is presented along with carbohydrates and other optically active biochemicals.

Descriptive biochemistry is found in Chaps. 18 through 22. The discussions of carbohydrates, lipids, proteins, enzymes, and nucleic acids are separated from the final four chapters, which cover physiological chemistry. I believe that students should learn the fundamental properties and reactions of the major classes of biochemicals before tackling the complex interconnected metabolic pathways. The first biochemistry chapter, Carbohydrates (Chap. 18), contains an introduction to biochemistry and a discussion of stereochemistry in addition to the topics typically found in such a chapter. Because of their importance in physiological chemistry and in the world of medicine, enzymes are given an entire chapter (Chap. 21).

Physiological chemistry is discussed in the final four chapters of the book—Chaps. 23 through 26. Chapter 23 is a discussion of the principal body fluids. If time does not permit, Chapter 23 can be omitted or assigned as independent reading. Production of Biological Energy (Chap. 24) begins by providing the students with an introduction to bioenergetics and concludes with discussions of the electron-transport system and the citric acid cycle. Thus, students are free to concentrate on the specific metabolic pathways of carbohydrates, lipids, and proteins in the final two chapters with the knowledge that catabolic pathways provide many of the precursors for the electron-transport system and citric acid cycle.

## CHAPTER FEATURES

Each chapter begins with **Study Guidelines** that outline what is most important within the chapter. All chapters contain many **figures** and **photographs** to help students visual-

ize the abstract concepts of chemistry. When appropriate, mnemonics, flowcharts, and calculation maps are included. Informative **margin notes** amplify the topics presented in the body of the text. Within the chapters that contain numerical problems, **Example Problems** are presented that completely solve illustrative problems using a four-step procedure that incorporates the factor-label method (unit-conversion method). *Throughout the book students are encouraged to express their answers to the correct number of significant figures with the correct units.* **Review Questions** are found at the end of each section in a chapter, and can be used by students to test their understanding of the section before proceeding to the next section. A complete **Summary** of the most important topics in the chapter, and from 50 to 80 **Questions and Problems** conclude each chapter. The questions and problems range from factual recall to very challenging questions.

## APPENDIXES AND GLOSSARY

Much valuable information is found in the appendixes of *Essentials of General, Organic, and Biological Chemistry*. Appendix 1, Review of Math Skills, discusses basic algebraic operations, scientific notation, and graphing. Appendix 2, Measurement Uncertainty and Significant Figures, is a discussion of precision of measurements and significant figure operations. Appendix 3, Vitamins, is a table that includes the names, structures, solubilities, dietary sources, and deficiency symptoms of all vitamins. Appendix 4 contains the answers to most of the odd-numbered problems and questions in the text. All the answers can be found in the Instructor's Guide. The book concludes with an extensive Glossary, which contains all important terms that are introduced in the text.

## SUPPLEMENTAL MATERIALS

*Essentials of General, Organic, and Biological Chemistry* has a complete set of ancillary materials. A student **Study Guide** written by Daniel Pantaleo and Wayne Anderson of Bloomsburg University contains added explanations of the most important topics, additional example problems, self-tests, and answers to some of the questions at the end of the chapters. *Chemistry in Action* by Erwin Boschmann and Norman Wells is the laboratory manual to accompany the text. *Chemistry in Action* contains tested experiments in general, organic, and biological chemistry. All experiments are carefully written and contain safety warnings when needed. The **Instructor's Manual** has four sections. One section contains the answers to all of the questions and problems in the book. Another section contains a test bank that includes over 1200 multiple choice questions. A computerized test bank of these questions, Microexaminer, is available on diskettes for use with most popular microcomputers. The final two sections of the Instructor's Manual contain a guide to the laboratory manual and a set of transparency masters for selected figures in the text.

## ACKNOWLEDGMENTS

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*Drew H. Wolfe*

# Essentials of General, Organic, and Biological Chemistry

# CONTENTS

# · CHAPTER 1 ·

# Matter and Energy

## Study Guidelines

After completing Chapter 1, you should be able to

1. Write a simple definition of chemistry
2. Define and give examples of physical properties and chemical properties
3. Distinguish between and give examples of physical changes and chemical changes
4. List the fundamental properties of substances and mixtures
5. Distinguish between the composition and the structure of matter
6. Describe and give examples of elements, compounds, homogeneous mixtures, and heterogeneous mixtures
7. Write symbols for common elements and write the names of elements given their symbols
8. Describe the composition of a compound given its formula
9. Define energy in terms of work
10. Distinguish between potential and kinetic energy
11. Describe the different types of potential energies and kinetic energies
12. State the conservation laws of matter and energy