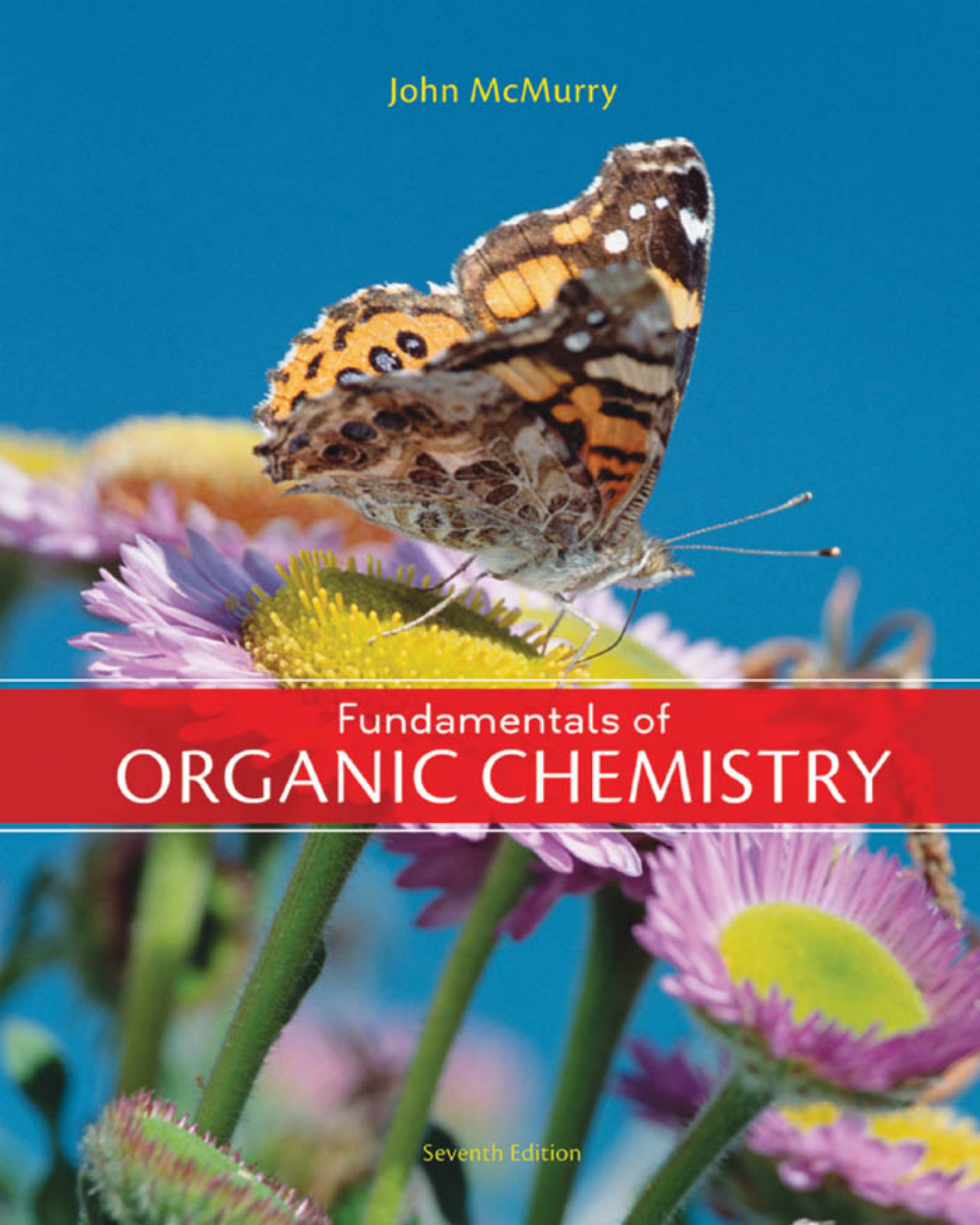
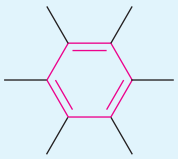
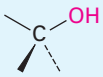
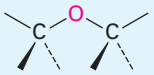
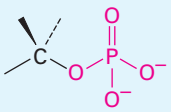
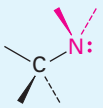
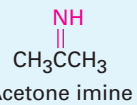
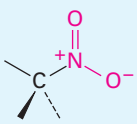
John McMurry



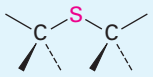
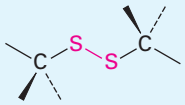
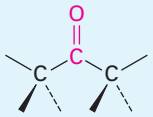
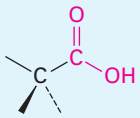
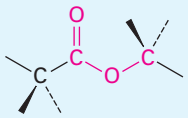
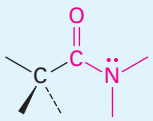
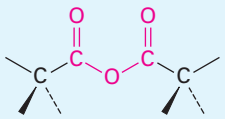
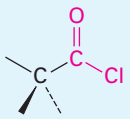
Fundamentals of ORGANIC CHEMISTRY

Seventh Edition

Structures of Some Common Functional Groups

Name	Structure*	Name ending	Example
Alkene (double bond)		*-ene*	$H_2C{=}CH_2$ Ethene
Alkyne (triple bond)	—C≡C—	*-yne*	HC≡CH Ethyne
Arene (aromatic ring)		None	 Benzene
Halide	 (X = F, Cl, Br, I)	None	CH_3Cl Chloromethane
Alcohol		*-ol*	CH_3OH Methanol
Ether		*ether*	CH_3OCH_3 Dimethyl ether
Monophosphate		*phosphate*	$CH_3OPO_3^{2-}$ Methyl phosphate
Amine		*-amine*	CH_3NH_2 Methylamine
Imine (Schiff base)		None	 Acetone imine
Nitrile	—C≡N	*-nitrile*	$CH_3C{\equiv}N$ Ethanenitrile
Nitro		None	CH_3NO_2 Nitromethane
Thiol		*-thiol*	CH_3SH Methanethiol

*The bonds whose connections aren't specified are assumed to be attached to carbon or hydrogen atoms in the rest of the molecule.

Name	Structure*	Name ending	Example
Sulfide		*sulfide*	CH_3SCH_3 Dimethyl sulfide
Disulfide		*disulfide*	CH_3SSCH_3 Dimethyl disulfide
Carbonyl			
Aldehyde		*-al*	CH_3CH Ethanal
Ketone		*-one*	CH_3CCH_3 Propanone
Carboxylic acid		*-oic acid*	CH_3COH Ethanoic acid
Ester		*-oate*	CH_3COCH_3 Methyl ethanoate
Amide		*-amide*	CH_3CNH_2 Ethanamide
Carboxylic acid anhydride		*-oic anhydride*	CH_3COCCH_3 Ethanoic anhydride
Carboxylic acid chloride		*-oyl chloride*	CH_3CCl Ethanoyl chloride

*The bonds whose connections aren't specified are assumed to be attached to carbon or hydrogen atoms in the rest of the molecule.

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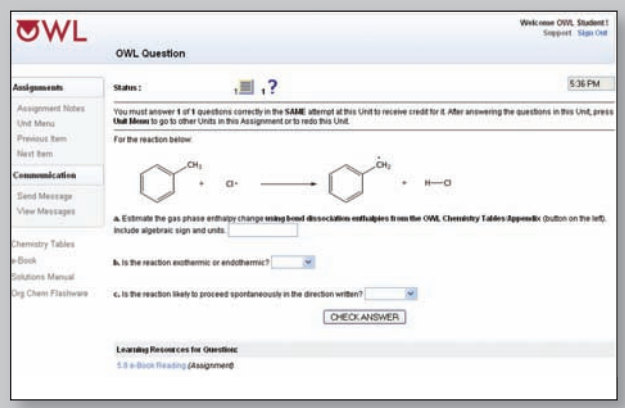

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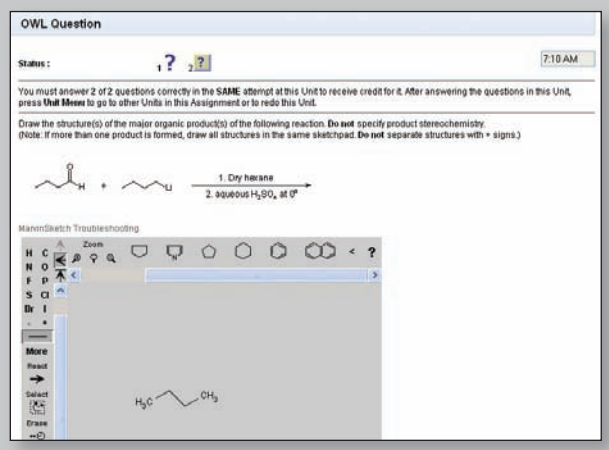

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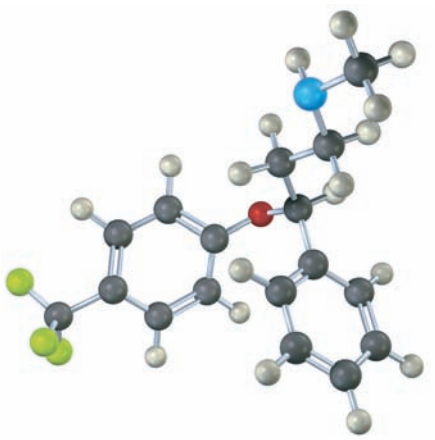

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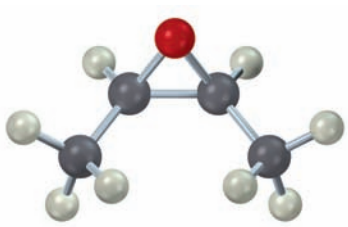

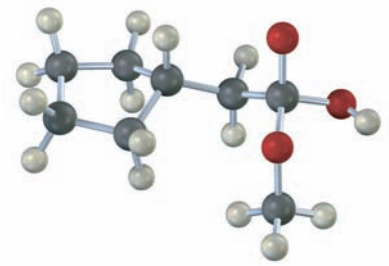

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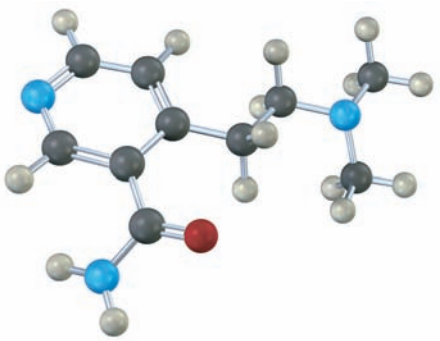

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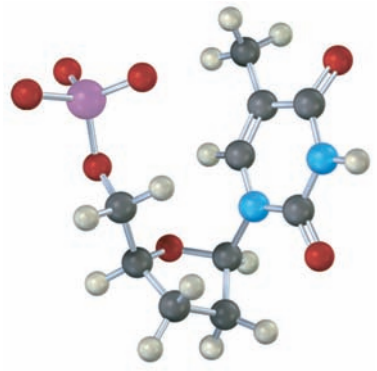

17 The Organic Chemistry of Metabolic Pathways

PREFACE

Organic chemistry is changing rapidly. From its early days dealing primarily with soaps and dyes, organic chemistry has moved to center stage in many fields, from molecular biology to medicine and from agriculture to advanced electronics. Today's organic chemists are learning new languages—particularly those of medicine and molecular biology—to shape the world we live in, and practitioners in many other fields are finding themselves having to learn something of organic chemistry. More than ever before, a fundamental understanding of organic chemistry is critical to addressing complex, interdisciplinary problems.

This seventh edition of *Fundamentals of Organic Chemistry* addresses some of the changes that are occurring by placing a greater emphasis on the applications of organic chemistry, especially applications to medicine and agriculture. Many new examples of biological organic reactions have been added in this edition; *Interlude* boxes at the end of each chapter are rich in the chemistry of drugs and agrochemicals; and problem categories such as "In the Field" and "In the Medicine Cabinet" reinforce the emphasis on applications.

This book is written for a one-semester course in organic chemistry, where content must be comprehensive but to the point. Only those topics needed for a brief course are covered, yet the important pedagogical tools commonly found in larger books are also maintained. In this seventh edition, *Fundamentals of Organic Chemistry* continues its clear explanations, thought-provoking examples and problems, and the trademark vertical format for explaining reaction mechanisms.

The primary organization of this book is by functional group, beginning with the simple (alkanes) and progressing to the more complex. Within the primary organization, there is also an emphasis on explaining the fundamental mechanistic similarities of reactions, and several chapters even have a dual title: Chapter 7 (Organohalides: Nucleophilic Substitutions and Eliminations), Chapter 9 (Aldehydes and Ketones: Nucleophilic Addition Reactions), and Chapter 10 (Carboxylic Acids and Derivatives: Nucleophilic Acyl Substitution Reactions), for instance. Through this approach, memorization is minimized and understanding is maximized.

The first six editions of this text were widely regarded as the clearest and most readable treatments of introductory organic chemistry available. I hope you will find that this seventh edition of *Fundamentals of Organic Chemistry* builds on the strengths of the first six and serves students even better. I have made every effort to make this seventh edition as effective, clear, and readable as possible; to show the beauty, logic, and relevance of organic chemistry; and to make the subject interesting to learn. I welcome all comments on this new edition as well as recommendations for future editions.

FEATURES CONTINUED FROM THE SIXTH EDITION

- Trademarked **vertical reaction mechanisms** give students easy-to-follow descriptions of each step in a reaction pathway. The number of these vertical mechanisms has increased in every edition; see Figure 11.1 on page 375, for example, where the mechanisms of enol formation under both acid-catalyzed and base-catalyzed conditions are compared.

- **Full color** throughout the text highlights the reacting parts of molecules to make it easier to focus on the main parts of a reaction.
- Nearly 100 **electrostatic potential maps** display the polarity patterns in molecules and the importance of these patterns in determining chemical reactivity.
- More than 100 **Visualizing Chemistry problems** challenge students to make the connection between typical line-bond drawings and molecular models.
- Each chapter contains many **Worked Examples** that illustrate how problems can be solved, followed by a similar problem for the student to solve. Each worked-out problem begins with a Strategy discussion that shows how to approach the problem.
- More than 900 **Problems** are included both within the text and at the end of every chapter.
- Current **IUPAC nomenclature** rules, as updated in 1993, are used to name compounds in this text.

CHANGES AND ADDITIONS FOR THE SEVENTH EDITION

The primary reason for preparing a new edition is to keep the book up-to-date, both in its scientific coverage and in its pedagogy. Global changes to the text for this new edition include:

- Writing has been revised at the sentence level.
- Chemical structures have been redrawn.
- Titles have been added to Worked Examples.
- Brief paragraphs titled "Why This Chapter" have been added to chapter introductions to explain the relevance of the chapter material to students.
- Many biologically oriented problems and examples have been added.

Specific changes and additions in individual chapters include:

- **Chapter 1:** A new Section 1.11, Organic Acids and Organic Bases, has been added.
- **Chapter 4:** Coverage of epoxide formation and cleavage has been added to Section 4.6.
- **Chapter 5:** A new *Interlude,* Aspirin, NSAIDs, and COX-2 Inhibitors, has been added.
  Coverage of biologically important aromatic heterocycles has been added to Section 5.9.
- **Chapter 7:** Coverage of alkyl fluoride preparation from alcohols has been added to Section 7.2.
  Coverage of the biologically important E1cB reaction has been added to Section 7.8.
- **Chapter 8:** Coverage of the Grignard reaction has been added to Section 8.3.
  Periodinane oxidation of alcohols has been added to Section 8.4.
  A new *Interlude,* Epoxy Resins and Adhesives, has been added.
- **Chapter 9:** The former Sections 9.6 and 9.11 have been combined in a new Section 9.6, Nucleophilic Addition of Hydride and Grignard Reagents: Alcohol Formation.
  A new *Interlude,* Vitamin C, has been added.

- **Chapter 10:** Coverage of the DCC method of amide synthesis has been added to Section 10.10.
  A new Section 10.12, Biological Carboxylic Acid Derivatives: Thioesters and Acyl Phosphates, has been added.
  Coverage of biodegradable polymers has been added to Section 10.13.
- **Chapter 11:** A new *Interlude,* Barbiturates, has been added.
- **Chapter 12:** Coverage of the azide synthesis of amines has been added to Section 12.4.
  A new *Interlude,* Green Chemistry, has been added.
- **Chapter 13:** The chapter has been reorganized to cover IR before UV.
- **Chapter 14:** A new subsection, Biological Ester Formation: Phosphorylation, has been added to Section 14.7.
  A new Section 14.8, The Eight Essential Monosaccharides, has been added.
- **Chapter 15:** Coverage of major coenzymes has been added to Section 15.9.
  A new *Interlude,* X-Ray Crystallography, has been added.
- **Chapter 16:** All material on nucleic acid chemistry has been updated.
- **Chapter 17:** A new *Interlude,* Statin Drugs, has been added.

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