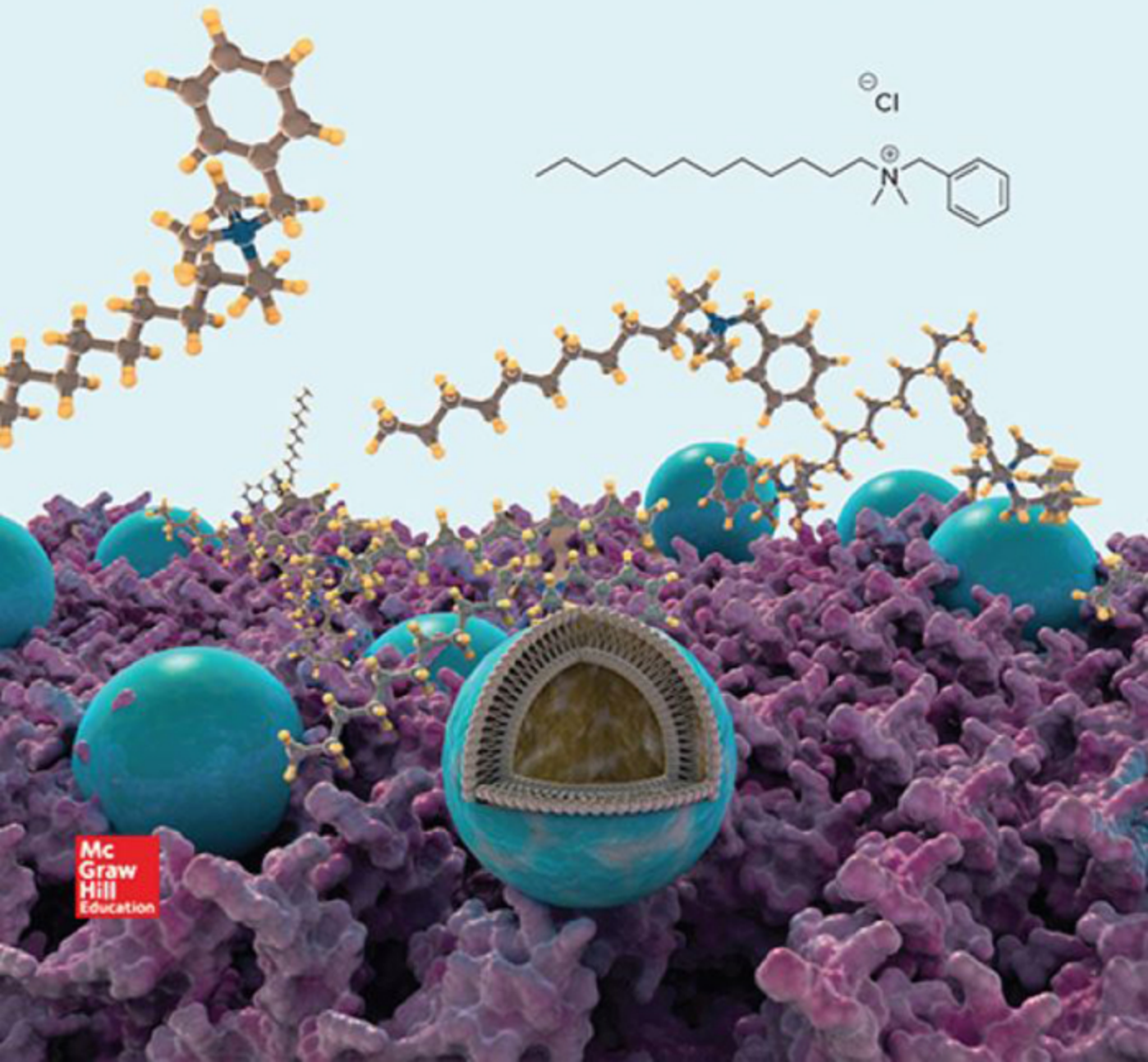
Francis A. Carey | Robert M. Giuliano | Neil T. Allison | Susan L. Bane

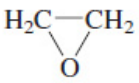
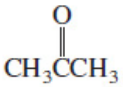
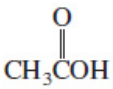
Eleventh Edition

ORGANIC CHEMISTRY

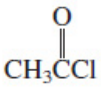
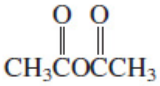
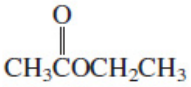
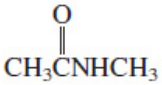


Mc Graw Hill Education

THE PRINCIPAL FUNCTIONAL GROUPS OF ORGANIC CHEMISTRY

	Example	*Acceptable Name(s) of Example*	*Characteristic Reaction Type*
Hydrocarbons			
Alkanes	CH_3CH_3	Ethane	Free-radical substitution of hydrogen by halogen
Alkenes	$H_2C{=}CH_2$	Ethene or ethylene	Electrophilic addition to double bond
Alkynes	$HC{\equiv}CH$	Ethyne or acetylene	Electrophilic addition to triple bond
Dienes	$H_2C{=}CHCH{=}CH_2$	1,3-Butadiene	Electrophilic addition to double bonds
Arenes		Benzene	Electrophilic aromatic substitution
Halogen-substituted derivatives of hydrocarbons			
Alkyl halides	CH_3CH_2Cl	Chloroethane or ethyl chloride	Nucleophilic substitution; elimination
Alkenyl halides	$H_2C{=}CHCl$	Chloroethene or vinyl chloride	Electrophilic addition to double bond; elimination
Aryl halides	C_6H_5Cl	Chlorobenzene	Electrophilic aromatic substitution; nucleophilic aromatic substitution
Oxygen-containing organic compounds			
Alcohols	CH_3CH_2OH	Ethanol or ethyl alcohol	Dehydration; conversion to alkyl halides; esterification
Phenols	C_6H_5OH	Phenol	Electrophilic aromatic substitution
Ethers	$CH_3CH_2OCH_2CH_3$	Ethoxyethane or diethyl ether	Cleavage by hydrogen halides
Epoxides		Epoxyethane or ethylene oxide or oxirane	Nucleophilic ring opening
Aldehydes		Ethanal or acetaldehyde	Nucleophilic addition to carbonyl group
Ketones		2-Propanone or acetone	Nucleophilic addition to carbonyl group
Carboxylic acids		Ethanoic acid or	Ionization of carboxyl;

THE PRINCIPAL FUNCTIONAL GROUPS OF ORGANIC CHEMISTRY

	Example	*Acceptable Name(s) of Example*	*Characteristic Reaction Type*
Carboxylic acid derivatives			
Acyl halides		Ethanoyl chloride or acetyl chloride	Nucleophilic acyl substitution
Acid anhydrides		Ethanoic anhydride or acetic anhydride	Nucleophilic acyl substitution
Esters		Ethyl ethanoate or ethyl acetate	Nucleophilic acyl substitution
Amides		*N*-Methylethanamide or *N*-methylacetamide	Nucleophilic acyl substitution
Nitrogen-containing organic compounds			
Amines	$CH_3CH_2NH_2$	Ethanamine or ethylamine	Nitrogen acts as a base or as a nucleophile
Nitriles	$CH_3C{\equiv}N$	Ethanenitrile or acetonitrile	Nucleophilic addition to carbon–nitrogen triple bond
Nitro compounds	$C_6H_5NO_2$	Nitrobenzene	Reduction of nitro group to amine
Sulfur-containing organic compounds			
Thiols	CH_3CH_2SH	Ethanethiol	Oxidation to a sulfenic, sulfinic, or sulfonic acid or to a disulfide
Sulfides	$CH_3CH_2SCH_2CH_3$	Diethyl sulfide	Alkylation to a sulfonium salt; oxidation to a sulfoxide or sulfone

Organic Chemistry

ELEVENTH EDITION

Francis A. Carey
University of Virginia

Robert M. Giuliano
Villanova University

Neil T. Allison
University of Arkansas

Susan L. Bane
Binghamton University

ORGANIC CHEMISTRY, ELEVENTH EDITION

This book is printed on acid-free paper.

1 2 3 4 5 6 7 8 9 LWI 21 20 19

ISBN 978-1-260-14892-3
MHID 1-260-14892-0

Portfolio Manager: Michelle Hentz
Product Developers: Mary E. Hurley & Megan Platt
Marketing Manager: Tamara Hodge
Content Project Managers: Laura Bies, Rachael Hillebrand & Sandra Schnee
Buyer: Sandy Ludovissy
Design: Daivd W. Hash
Content Licensing Specialists: Lorraine Buczek
Cover Image: ©Ella Maru Studio
Compositor: Aptara, Inc.

All credits appearing on page or at the end of the book are considered to be an extension of the copyright page.

Library of Congress Cataloging-in-Publication Data

Names: Carey, Francis A., 1937- author. | Giuliano, Robert M., 1954- author. | Allison, Neil T. (Neil Thomas), 1953- author. | Tuttle, Susan L. Bane, author.
Title: Organic chemistry / Francis A. Carey (University of Virginia), Robert M. Giuliano (Villanova University), Neil T. Allison (University of Arkansas), Susan L. Bane Tuttle (Binghamton University).
Description: Eleventh edition. | New York, NY: McGraw-Hill Education, 2018. | Includes index.
Identifiers: LCCN 2018024902| ISBN 9781260148923 (alk. paper) | ISBN 1260148920 (alk. paper)
Subjects: LCSH: Chemistry, Organic. | Chemistry, Organic—Textbooks

Classification: LCC QD251.3 .C37 2018 | DDC 547—dc23 LC record available at https://lccn.loc.gov/2018024902

mheducation.com/highered

Each of the eleven editions of this text has benefited from the individual and collective contributions of the staff at McGraw-Hill. They are the ones who make it all possible. We appreciate their professionalism and thank them for their continuing support.

About the Authors

Before **Frank Carey** retired in 2000, his career teaching chemistry was spent entirely at the University of Virginia.

In addition to this text, he is coauthor (with Robert C. Atkins) of *Organic Chemistry: A Brief Course* and (with Richard J. Sundberg) of *Advanced Organic Chemistry,* a two-volume treatment designed for graduate students and advanced undergraduates.

Frank and his wife Jill are the parents of Andy, Bob, and Bill and the grandparents of Riyad, Ava, Juliana, Miles, Wynne, and Sawyer.

Robert M. Giuliano was born in Altoona, Pennsylvania, and attended Penn State (B.S. in chemistry) and the University of Virginia (Ph.D., under the direction of Francis Carey). Following postdoctoral studies with Bert Fraser-Reid at the University of Maryland, he joined the chemistry department faculty of Villanova University in 1982, where he is currently Professor. His research interests are in synthetic organic and carbohydrate chemistry.

Bob and his wife Margot, an elementary school teacher he met while attending UVa, are the parents of Michael, Ellen, and Christopher and the grandparents of Carina, Aurelia, Serafina, Lucia, and Francesca.

Neil T. Allison was born in Athens, Georgia, and attended Georgia College (B.S., 1975, in chemistry) and the University of Florida (Ph.D., 1978, under the direction of W. M. Jones). Following postdoctoral studies with Emanuel Vogel at the University of Cologne, Germany, and Peter Vollhardt at the University of California, Berkeley, he joined the faculty of the Department of Chemistry and Biochemistry, University of Arkansas in 1980. His research interests are in physical organometallic chemistry and physical organic chemistry.

Neil and his wife Amelia met while attending GC, and are the parents of Betsy, Joseph, and Alyse and the grandparents of Beau.

Susan L. Bane was raised in Spartanburg, South Carolina, and attended Davidson College (B.S., 1980, in chemistry) and Vanderbilt University (Ph.D., 1983, in biochemistry under the direction of J. David Puett and Robley C. Williams, Jr.). Following postdoctoral studies in bioorganic chemistry with Timothy L. Macdonald at the University of Virginia, she joined the faculty of the Department of Chemistry of Binghamton University, State University of New York, in 1985. She is currently Professor of Chemistry and director of the Biochemistry Program. Her research interests are in bioorganic and biophysical chemistry.

Susan is married to David Tuttle and is the mother of Bryant, Lauren, and Lesley.

Brief Contents

Contents

CHAPTER 4

Chirality 134

CHAPTER 5

Alcohols and Alkyl Halides: Introduction to Reaction Mechanisms 172

CHAPTER 6

Nucleophilic Substitution 210

CHAPTER 7

Structure and Preparation of Alkenes: Elimination Reactions 244

CHAPTER 10

Introduction to Free Radicals 356

CHAPTER 11

Conjugation in Alkadienes and Allylic Systems 384

CHAPTER 12

Arenes and Aromaticity 426

CHAPTER 13

Electrophilic and Nucleophilic Aromatic Substitution 476

CHAPTER 16

Alcohols, Diols, and Thiols 638

CHAPTER 17

Ethers, Epoxides, and Sulfides 676

CHAPTER 19

Carboxylic Acids 764

CHAPTER 20

Carboxylic Acid Derivatives: Nucleophilic Acyl Substitution 800

CHAPTER 24

Lipids 996

List of Important Features

Mechanisms