

General, Organic, and Biological Chemistry

Structures of Life

Fifth Edition

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PEARSON

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Library of Congress Cataloging-in-Publication Data

Timberlake, Karen C., author.

General, organic, and biological chemistry : structures of life / Karen C. Timberlake.—Fifth edition.
pages cm

Includes bibliographical references and index.

ISBN 978-0-321-96746-6 (alk. paper)—ISBN 0-321-96746-1 (alk. paper)

1. Chemistry—Textbooks. I. Title.

QD33.2.T56 2016

540—dc23

2014032010

ISBN-10: 0-321-96746-1; ISBN-13: 978-0-321-96746-6

Printed in the United States of America

1 2 3 4 5 6 7 8 9 10—V011—18 17 16 15 14

PEARSON

www.pearsonhighered.com

ISBN-13: 978-0-321-96746-6
ISBN-10: 0-321-96746-1

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About the Author



Karen at the Natural History Museum where she is a supporter of children's environmental programs.

KAREN TIMBERLAKE is Professor Emerita of chemistry at Los Angeles Valley College, where **she taught chemistry for allied health and preparatory chemistry for 36 years.** She received her bachelor's degree in chemistry from the University of Washington and her master's degree in biochemistry from the University of California at Los Angeles.

Professor Timberlake has been writing chemistry textbooks for 40 years. During that time, her name **has become associated with the strategic use of pedagogical tools that promote student success in chemistry and the application of chemistry to real-life situations.** More than one million students have learned chemistry using texts, laboratory manuals, and study guides written by Karen Timberlake. In addition to *General, Organic, and Biological Chemistry: Structures of Life*, fifth edition, she is also the author of *Chemistry: An Introduction to General, Organic, and Biological Chemistry*, twelfth edition, with the accompanying *Study Guide and Selected Solutions Manual*, and *Basic Chemistry*, fourth edition, with the accompanying *Study Guide and Selected Solutions Manual*, *Laboratory Manual*, and *Essentials Laboratory Manual*.

Professor Timberlake belongs to numerous scientific and educational organizations including the American Chemical Society (ACS) and the National Science Teachers Association (NSTA). She has been the Western Regional Winner of Excellence in College

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When Professor Timberlake is not writing textbooks, she and her husband relax by playing tennis, ballroom dancing, traveling, trying new restaurants, cooking, and taking care of their grandchildren, Daniel and Emily.

DEDICATION

I dedicate this book to

- My husband, Bill, for his patience, loving support, and preparation of late meals
- My son, John, daughter-in-law, Cindy, grandson, Daniel, and granddaughter, Emily, for the precious things in life
- The wonderful students over many years whose hard work and commitment always motivated me and put purpose in my writing

FAVORITE QUOTES

The whole art of teaching is only the art of awakening the natural curiosity of young minds.

—Anatole France

One must learn by doing the thing; though you think you know it, you have no certainty until you try.

—Sophocles

Discovery consists of seeing what everybody has seen and thinking what nobody has thought.

—Albert Szent-Györgyi

I never teach my pupils; I only attempt to provide the conditions in which they can learn.

—Albert Einstein

Preface

Welcome to the fifth edition of *General, Organic, and Biological Chemistry: Structures of Life*. This chemistry text was written and designed to help you prepare for a career in a health-related profession, such as nursing, dietetics, respiratory therapy, and environmental and agricultural science. This text assumes no prior knowledge of chemistry. My main objective in writing this text is to make the study of chemistry an engaging and a positive experience for you by relating the structure and behavior of matter to its role in health and the environment.

It is my goal to help you become a critical thinker by understanding scientific concepts that will form a basis for making important decisions about issues concerning health and the environment. Thus, I have utilized materials that

- help you to learn and enjoy chemistry
- relate chemistry to clinical stories and careers that interest you
- develop problem-solving skills that lead to your success in chemistry
- promote learning and success in chemistry

New for the Fifth Edition

This new edition introduces chemistry in a clinical environment beginning with the stories of patients in the Chapter Openers and Clinical Updates that follow the diagnosis and treatment for the patients. New problem-solving strategies include Key Math Skills; Core Chemistry Skills; new Analyze the Problem features; more Guides to Problem Solving; and new Clinical Applications throughout each chapter that add clinical relevance to the chemistry content.

- **NEW AND UPDATED! Chapter Openers** now provide engaging clinical stories in which a metabolic or genetic condition introduces the content of each chapter.
- **NEW! Clinical Careers** include lipidology nurse, exercise physiologist, hepatology nurse, and public health nurse.
- **NEW! Clinical Updates** give a follow up of the diagnosis and treatment for each patient in the Chapter Openers.
- **NEW! Clinical Applications** are added to Questions and Problems sets that show the relevance between the chemistry content and the clinical story.
- **NEW! Biochemistry Chapters 19 to 24** contain new and expanded material on recent topics in biochemistry including **CH 19** Alzheimer's and beta-amyloid proteins that form plaques in the brain, **CH 20** lactose intolerance and breath hydrogen test, **CH 21** transcription factors, the estrogen receptor, and the impact of altered genes BRAC1 and BRAC2 in breast cancer, **CH 22** enzyme deficiencies in glycogen storage diseases, and **CH 23** malate-aspartate

pathway added, ATP energy values updated to 2.5 ATP for NADH and 1.5 ATP for FADH₂, and **CH 24** updated beta-oxidation and synthesis of fatty acids.

- **NEW! Ribbon Models** of proteins have been added including lactase with amino acids in the active site, transaminase, trypsin, chymotrypsin, carboxypeptidase, alanine amino transferase, estrogen receptor, cytochrome c, and aspartate transaminase.
- **NEW AND UPDATED! Diagrams** are updated using current models for allosteric enzymes, covalent modification including phosphorylation, 2- and 3-dimensional models of tRNA, DNA transcription, transcription factors in the promoter region, the sites in electron transport blocked by toxins, and urea cycle showing transport between the mitochondrial matrix and the cytosol.
- **NEW AND UPDATED! New biochemistry problems** include action of viruses, transcription and the estrogen receptor, energy diagram for the hydrolysis of ATP, defective enzymes that block the degradation of glycogen, and current values for ATP energy from NADH and FADH₂.
- **NEW! Interactive Videos** give students the experience of step-by-step problem solving for problems from the text.
- **NEW! Chapter Readiness** sections at the beginning of each chapter list the Key Math Skills and Core Chemistry Skills from the previous chapters, which provide the foundation for learning new chemistry principles in the current chapter.
- **NEW! Key Math Skills** review basic math relevant to the chemistry you are learning throughout the text. A **Key Math Skill Review** at the end of each chapter summarizes and gives additional examples.
- **NEW! Core Chemistry Skills** identify the key chemical principles in each chapter that are required for successfully learning chemistry. A **Core Chemistry Skill Review** at the end of each chapter helps reinforce the material and gives additional examples.
- **UPDATED! Analyze the Problem** features included in the solutions of the Sample Problems strengthen critical-thinking skills and illustrate the breakdown of a word problem into the components required to solve it.
- **UPDATED! Questions and Problems, Sample Problems, and art** are directly related to nursing and health applications to better demonstrate the connection between the chemistry being discussed and how these skills will be needed in professional experience.
- **UPDATED! Combining Ideas** features offer sets of integrated problems that test students' understanding by integrating topics from two or more previous chapters.

Chapter Organization of the Fifth Edition

In each textbook I write, I consider it essential to relate every chemical concept to real-life issues of health and environment. Because a chemistry course may be taught in different time frames, it may be difficult to cover all the chapters in this text. However, each chapter is a complete package, which allows some chapters to be skipped or the order of presentation to be changed.

Chapter 1, Chemistry in our Lives, now discusses the Scientific Method in everyday terms, guides students in developing a study plan for learning chemistry, and now has a new section of Key Math Skills that review the basic math including scientific notation needed in chemistry calculations.

- A new chapter opener tells the story of a murder and features the work and career of a forensic scientist.
- A new Clinical Update feature follows up with forensic scientists that help solve the murder and includes Clinical Applications related to the story.
- A new section, “Scientific Method: Thinking Like a Scientist,” has been added, which discusses the scientific method in everyday terms.
- A new section, “Key Math Skills,” reviews basic math required in chemistry, such as Identifying Place Values (1.4A), Using Positive and Negative Numbers in Calculations (1.4B) including a new feature Calculator Operations, Calculating Percentages (1.4C), Solving Equations (1.4D), Interpreting Graphs (1.4E), and Writing Numbers in Scientific Notation (1.4 F).
- New sample problems with nursing applications are added. New Sample Problem 1.5 requires the interpretation of a graph to determine the decrease in a child’s temperature when given Tylenol.
- New art includes a photo of a plastic strip thermometer placed on a baby’s forehead to determine body temperature.

Chapter 2, Chemistry and Measurements, looks at measurement and emphasizes the need to understand numerical relationships of the metric system. Significant numbers are discussed in the determination of final answers. Prefixes from the metric system are used to write equalities and conversion factors for problem-solving strategies. Density is discussed and used as a conversion factor.

- A new chapter opener tells the story of a patient with high blood pressure and features the work and career of a registered nurse.
- A new Clinical Update describes the patient’s follow-up visit with his doctor.
- New material is added that illustrates how to count significant figures in equalities and in conversion factors used in a problem setup.
- New abbreviation mcg for microgram is introduced as used in health and medicine.

- New Core Chemistry Skills are added: Counting Significant Figures (2.2), Using Significant Figures in Calculations (2.3), Using Prefixes (2.4), Writing Conversion Factors from Equalities (2.5), Using Conversion Factors (2.6), and Using Density as a Conversion Factor (2.7).
- New photos, including an endoscope, a urine dipstick, a pint of blood, Keflex capsules, and salmon for omega-3 fatty acids, are added to improve visual introduction to clinical applications of chemistry.
- Updated Guides to Problem Solving (GPS) use color blocks as visual guides through the solution pathway.
- Updated Sample Problems relate questions and problem solving to health-related topics such as the measurements that a nurse would make, blood volume, omega-3 fatty acids, radiological imaging, and medication orders.
- New Clinical Applications feature questions about health-related settings including measurements made by a nurse, daily values for minerals and vitamins, equalities and conversion factors for medications, and health questions related to the Clinical Update story.

Chapter 3, Matter and Energy, classifies matter and states of matter, describes temperature measurement, and discusses energy, specific heat, and energy in nutrition. Physical and chemical changes and physical and chemical properties are now discussed in more depth.

- A new chapter opener describes diet and exercise for an overweight child with type 2 diabetes and features the work and career of a dietitian. A new Clinical Update describes the new diet for weight loss.
- Chapter 3 has a new order of topics: 3.1 Classification of Matter, 3.2 States and Properties of Matter, 3.3 Temperature, 3.4 Energy, 3.5 Energy and Nutrition, 3.6 Specific Heat, and 3.7 Changes of State. Section 3.7 Changes of State now includes heat of fusion and vaporization, and combinations of energy calculations.
- New Core Chemistry Skills are added: Classifying Matter (3.1), Identifying Physical and Chemical Changes (3.2), Converting between Temperature Scales (3.3), Using Energy Units (3.4), and Using the Heat Equation (3.6).
- New Questions and Problems and Sample Problems now have more clinical applications to nursing and health, including Sample Problem 3.4, high temperatures used in cancer treatment; Sample Problem 3.5, the energy produced by a high-energy shock output of a defibrillator; Sample Problem 3.7, body temperature lowering using a cooling cap; and Sample Problem 3.8, ice bag therapy for muscle injury.
- The interchapter problem set, Combining Ideas from Chapters 1 to 3, completes the chapter.

Chapter 4, Atoms, introduces elements and atoms and the periodic table. The names and symbols of element 114, Flerovium, Fl, and 116, Livermorium, Lv, have been added to update the periodic table. Atomic numbers and mass number are determined for isotopes. Atomic mass is calculated

using the masses of the naturally occurring isotopes and their abundances. Electron arrangements are written using orbital diagrams, electron configurations, and abbreviated electron configurations. Trends in the properties of elements are discussed, including atomic size, Lewis symbols, ionization energy, and metallic character.

- A new chapter opener features chemistry in agriculture and the career of a farmer.
- A new Clinical Update describes the improvement in crop production by the farmer.
- New Core Chemistry Skills are added: Counting Protons and Neutrons (4.4), Writing Atomic Symbols for Isotopes (4.5), Writing Electron Configurations (4.7), Using the Periodic Table to Write Electron Configurations (4.7), Identifying Trends in Periodic Properties (4.8), and Drawing Lewis Symbols (4.8).
- A new weighted average analogy uses 8-lb and 14-lb bowling balls and the percent abundance of each to calculate weighted average of a bowling ball.
- New nursing and clinical applications are added to Sample Problems/Questions and Problems.
- Updated Chemistry Link to Health, “Biological Reactions to UV Light,” adds information on using light for neonatal jaundice.
- Updated photos and diagrams including a new diagram for the electromagnetic spectrum are added.

Chapter 5, Nuclear Chemistry, looks at the types of radiation emitted from the nuclei of radioactive atoms. Nuclear equations are written and balanced for both naturally occurring radioactivity and artificially produced radioactivity. The half-lives of radioisotopes are discussed, and the amount of time for a sample to decay is calculated. Radioisotopes important in the field of nuclear medicine are described.

- A new chapter opener about the work and career of a nuclear medicine technologist is added.
- A new Clinical Update discusses cardiac imaging using the radioisotope Tl-201.
- New Core Chemistry Skills are added: Writing Nuclear Equations (5.2) and Using Half-Lives (5.4).
- New Sample Problems and Questions and Problems use nursing and clinical examples, including Sample Problem 5.3 that describe the radioisotope yttrium-90 use in cancer and arthritis treatments. Sample Problem 5.6 that uses phosphorus-32 for the treatment of leukemia and Sample Problem 5.9 that uses titanium seeds containing a radioactive isotope implanted in the body to treat cancer.
- Clinical applications include radioisotopes in nuclear medicine, activity, half-lives, and dosage of radioisotopes.

Chapter 6, Ionic and Molecular Compounds, describes the formation of ionic and covalent bonds. Chemical formulas are written, and ionic compounds—including those with polyatomic ions—and molecular compounds are named. Section 6.2 is titled “Writing Formulas for Ionic Compounds,” 6.5 is

titled “Molecular Compounds: Sharing Electrons,” and 6.6 is titled “Lewis Structure for Molecules and Polyatomic Ions.”

- The chapter opener describes aspirin as a molecular compound and features the work and career of a pharmacy technician.
- A new Clinical Update describes several types of compounds at a pharmacy and includes Clinical Applications.
- “Ions: Transfer of Electrons” has been rewritten to emphasize the stability of the electron configuration of a noble gas.
- New Core Chemistry Skills are added: Writing Positive and Negative Ions (6.1), Writing Ionic Formulas (6.2), Naming Ionic Compounds (6.3), Writing the Names and Formulas for Molecular Compounds (6.5), Drawing Lewis Structures (6.6), Using Electronegativity (6.7), Predicting Shape (6.8), Identifying Polarity of Molecules (6.8), and Identifying Attractive Forces (6.9).
- A new art comparing the particles and bonding of ionic compounds and molecular compounds has been added.
- Bismuth was added to Table 6.5, Some Metals That Form More Than One Positive Ion.
- Analyze the Problem feature was updated for Sample Problems 6.4, 6.5, 6.6, 6.9, 6.10.
- The interchapter problem set, Combining Ideas from Chapters 4 to 6, completes the chapter.

Chapter 7, Chemical Reactions and Quantities, introduces moles and molar masses of compounds, which are used in calculations to determine the mass or number of particles in a given quantity. Students learn to balance chemical equations and to recognize the types of chemical reactions: combination, decomposition, single replacement, double replacement, and combustion reactions. Section 7.3 discusses Oxidation–Reduction Reactions using real-life examples, including biological reactions. Section 7.6, Mole Relationships in Chemical Equations, and Section 7.7, Mass Calculations for Reactions, prepare students for the quantitative relationships of reactants and products in reactions. Section 7.8, Limiting Reactants and Percent Yield, identifies limiting reactants and calculates percent yield, and Section 7.9, Energy in Chemical Reactions, calculates the energy in exothermic and endothermic chemical reactions.

- A chapter opener describes the chemical reaction that is used to whiten teeth and features the work and career of a dental hygienist.
- Sample Problems and problem sets include Clinical Applications for nursing.
- New Core Chemistry Skills are added: Balancing a Chemical Equation (7.1), Classifying Types of Chemical Reactions (7.2), Identifying Oxidized and Reduced Substances (7.3), Converting Particles to Moles (7.4), Calculating Molar Mass (7.5), Using Molar Mass as a Conversion Factor (7.5), Using Mole–Mole Factors (7.6), Converting Grams to Grams (7.7), Calculating Quantity of Product from a Limiting Reactant (7.8), Calculating Percent Yield (7.8), and Using the Heat of Reaction (7.9).

Chapter 8, Gases, discusses the properties of gases and calculates changes in gases using the gas laws: Boyle's, Charles's, Gay-Lussac's, Avogadro's, Dalton's, and the Ideal Gas Law. Problem-solving strategies enhance the discussion and calculations with gas laws including chemical reactions using the ideal gas law.

- The chapter opener describes a child with asthma and her treatment with oxygen and features the work and career of a respiratory therapist is added. A new Clinical Update describes exercises to prevent exercise-induced asthma. Clinical Applications are related to lung volume and gas laws.
- New Sample Problems and Challenge Problems use nursing and medical examples, including Sample Problem 8.3, calculating the volume of oxygen gas delivered through a face mask during oxygen therapy; and Sample Problem 8.12, preparing a heliox breathing mixture for a scuba diver.
- New Core Chemistry Skills are added: Using the Gas Laws (8.2, 8.3, 8.4, 8.5, 8.6), Using the Ideal Gas Law (8.7), Calculating Mass or Volume of a Gas in a Chemical Reaction (8.7), and Calculating Partial Pressure (8.8).
- Clinical applications includes calculations of mass or pressure of oxygen in uses of hyperbaric chambers.
- The interchapter problem set, Combining Ideas from Chapters 7 and 8, completes the chapter.

Chapter 9, Solutions, describes solutions, electrolytes, saturation and solubility, insoluble salts, concentrations, and osmosis. New problem-solving strategies clarify the use of concentrations to determine volume or mass of solute. The volumes and concentrations of solutions are used in calculations of dilutions, reactions, and titrations. Properties of solutions, osmosis in the body, and dialysis are discussed.

- The chapter opener describes a patient with kidney failure and dialysis treatment and features the work and career of a dialysis nurse.
- New Core Chemistry Skills are added: Using Solubility Rules (9.3), Calculating Concentration (9.4), Using Concentration as a Conversion Factor (9.4), Calculating the Quantity of a Reactant or Product (9.4), and Calculating the Boiling Point/Freezing Point of a Solution (9.6).
- Table 9.6 Electrolytes in Blood Plasma and Selected Intravenous Solutions is updated. Table 9.7 Solubility Rules for Ionic Solids in Water is updated.
- Molality is removed.
- New clinical applications include saline solutions, mass of solution in a mannitol, a lactated Ringer's solution, and a Pedialyte solution, solutions of medications, electrolytes in dialysis, and reactions of antacids.

Chapter 10, Reaction Rates and Chemical Equilibrium, looks at the rates of reactions and the equilibrium condition when forward and reverse rates for a reaction become equal. Equilibrium expressions for reactions are written and equilibrium constants are calculated. Le Châtelier's principle is used to evaluate the impact on concentrations when stress is placed on the system.

- A new chapter opener describes the symptoms of *infant respiratory distress syndrome* (IRDS) and discusses the career of a neonatal nurse.
- The Clinical Update describes a child with anemia, hemoglobin-oxygen equilibrium, and a diet that is high in iron-containing foods.
- New Core Chemistry Skills are added: Writing the Equilibrium Constant (10.3), Calculating an Equilibrium Constant (10.3), Calculating Equilibrium Concentrations (10.4), and Using Le Châtelier's Principle (10.5).
- New problems that visually represent equilibrium situations are added.
- Clinical applications include hemoglobin equilibrium and anemia.
- A new diagram represents the transport of O_2 by hemoglobin from the lungs to the tissues and muscles.
- Updates of Analyze the Problem include Sample Problems 10.4 and 10.5.

Chapter 11, Acids and Bases, discusses acids and bases and their strengths, conjugate acid-base pairs. The dissociation of strong and weak acids and bases is related to their strengths as acids or bases. The dissociation of water leads to the water dissociation constant expression, K_w , the pH scale, and the calculation of pH. Chemical equations for acids in reactions are balanced and titration of an acid is illustrated. Buffers are discussed along with their role in the blood. The pH of a buffer is calculated.

- A new chapter opener describes a blood sample for an emergency room patient sent to the clinical laboratory for analysis of blood pH and CO_2 gas and features the work and career of a clinical laboratory technician.
- Section 11.2 is now a discussion of Brønsted-Lowry Acids and Bases.
- A new Clinical Update discusses the symptoms and treatment of acid reflux disease.
- Analyze the Problem was updated in Sample Problems 11.3, 11.6, 11.8, 11.10, 11.12, and 11.13.
- Key Math Skills are added: Calculating pH from $[H_3O^+]$ (11.6) and Calculating $[H_3O^+]$ from pH (11.6).
- New Core Chemistry Skills are added: Identifying Conjugate Acid-Base Pairs (11.2), Calculating $[H_3O^+]$ and $[OH^-]$ in Solutions (11.5), Writing Equations for Reactions of Acids and Bases (11.7), Calculating Molarity or Volume of an Acid or Base in a Titration (11.8), and Calculating the pH of a Buffer (11.9).
- A new Guide to Writing Conjugate Acid-Base Pairs has been added. Guide to Calculating pH of an Aqueous Solutions, Calculating $[H_3O^+]$ from pH, Calculations for an Acid-Base Titration, and Calculating pH of a Buffer were updated.
- Clinical applications include calculating $[OH^-]$ or $[H_3O^+]$ of body fluids, foods, blood plasma, pH of body fluids, grams of antacids to neutralize stomach acid, and buffers for stomach acid.
- New visuals include the ionization of the weak acid hydrofluoric acid, a new photo of calcium hydroxide and information about its use in the food industry and

dentistry, as well as a new photo of sodium bicarbonate reacting with acetic acid.

- The interchapter problem set, Combining Ideas from Chapters 9 to 11, completes the chapter.

Chapter 12, Introduction to Organic Chemistry: Hydrocarbons, combines Chapters 11 and 12 of GOB, fourth edition. This new chapter compares inorganic and organic compounds, and describes the structures and naming of alkanes, alkenes including cis–trans isomers, alkynes, and aromatic compounds.

- A new chapter opener describes a fire victim and the search for traces of accelerants and fuel at the arson scene and features the work and career of a firefighter/emergency medical technician.
- A Clinical Update describes treatment for a burn patient and the identification of the fuels at the arson scene.
- Chapter 12 has a new order of topics: 12.1 Organic Compounds, 12.2 Alkanes, 12.3 Alkanes with Substituents, 12.4 Properties of Alkanes, 12.5 Alkenes and Alkynes, 12.6 Cis–Trans Isomers, 12.7 Addition Reactions, and 12.8 Aromatic Compounds.
- The wedge-dash models of methane and ethane have been added.
- New Core Chemistry Skills are added: Naming and Drawing Alkanes (12.2) and Writing Equations for Hydrogenation, Hydration, and Polymerization Hydration, and Polymerization of Alkenes (12.7).
- Line-angle structural formulas were added to Table 12.2.
- Guides to Drawing Structural Formulas for Alkanes, and Naming Alkanes with Substituents have been added.
- The Chemistry Link to Industry *Crude Oil* has been removed.
- Polymerization was added to Table 12.8, Summary of Addition Reactions.
- The Analyze the Problem features were updated in Sample Problem 12.7, 12.9, and 12.10.

Chapter 13, Alcohols, Phenols, Thiols, and Ethers, describes the functional groups and names of alcohols, phenols, thiols, and ethers.

- The chapter opener describes regional anesthetics for child birth and features the work and career of a nurse anesthetist.
- A Clinical Update describes some foods added to a diet plan including a comparison of their functional groups.
- New Core Chemistry Skills are added: Identifying Alcohols, Phenols, and Thiols (13.1), Naming Alcohols and Phenols (13.1), Writing Equations for the Dehydration of Alcohols (13.4), and Writing Equations for the Oxidation of Alcohols (13.4).
- New Guides to Naming Alcohols, and Phenols, and Writing IUPAC Names for Ethers have been added.
- The classification of alcohols has been moved to Section 13.3 “Physical Properties of Alcohols, Phenols, and Ethers.”

- New material on the use of phenol by Joseph Lister as the first surgical antiseptic is added.

Chapter 14, Aldehydes, Ketones, and Chiral Molecules, discusses the nomenclature, structures, and oxidation and reduction of aldehydes and ketones. The chapter discusses Fischer projections, chiral molecules, and mirror images to prepare students for the structures of carbohydrates in Chapter 15.

- A new chapter opener describes the risk factors for melanoma and discusses the career of a dermatology nurse.
- The Clinical Update discusses melanoma, skin protection, and functional groups of sunscreens.
- Line-angle structural formulas for aldehydes and ketones are added.
- New Core Chemistry Skills are added: Naming Aldehydes and Ketones (14.1), Identifying Chiral Molecules (14.5), and Identifying D- and L- Fischer Projections (14.5).
- New clinical applications include medicinal herbs, chiral carbon atoms in citronellol, alanine, amphetamine, and norepinephrine, and functional groups in sunscreens.
- The interchapter problem set, Combining Ideas from Chapters 12 to 14, completes the chapter.

Chapter 15, Carbohydrates, describes the carbohydrate molecules monosaccharides, disaccharides, and polysaccharides and their formation by photosynthesis. Monosaccharides are classified as aldo or keto pentoses or hexoses. Fischer projections and D and L notations are described. Carbohydrates used as sweeteners and carbohydrates used in blood typing are discussed. The formation of glycosidic bonds in disaccharides and polysaccharides is described.

- A new chapter opener describes a diabetes patient and her diet and the work and career of a diabetes nurse.
- New Core Chemistry Skills are added: Identifying D- and L-Fischer Projections (15.2) and Drawing Haworth Structures (15.3).
- Guide to Drawing Haworth Structures is updated.

Chapter 16, Carboxylic Acids and Esters, discusses the functional groups and naming of carboxylic acids and esters. Chemical reactions include esterification, amidation and acid and base hydrolysis of esters.

- A new chapter opener describes heart surgery and discusses the work and career of a surgical technician.
- A Clinical Update describes the use of liquid bandages.
- New Core Chemistry Skills are added: Naming Carboxylic Acids (16.1) and Hydrolyzing Esters (16.5).

Chapter 17, Lipids, discusses the alcohols and carboxylic acids found in fatty acids, and the formation of ester bonds in triacylglycerols and glycerophospholipids. Chemical properties of fatty acids and their melting points along with the hydrogenation of unsaturated triacylglycerols are discussed. Steroids, which are based on a group of connected multicyclic rings such as

cholesterol, bile salts, and steroid hormones, are described. Chemistry Links to Health include “Omega-3 Fatty Acids in Fish Oils,” “Converting Unsaturated Fats to Saturated Fats: Hydrogenation and Interesterification,” “Infant Respiratory Distress Syndrome (IRDS),” and “Anabolic Steroids.” The role of phospholipids in the lipid bilayer of cell membranes is discussed as well as the lipids that function as steroid hormones.

- A new chapter opener describes a patient with symptoms of familial hypercholesterolemia and features the work and career of a clinical lipid specialist.
- The Clinical Update describes changes in diet and exercise along with medications for treating high LDL-cholesterol levels.
- New Core Chemistry Skills are added: Identifying Fatty Acids (17.2), Drawing Structures for Triacylglycerols (17.3), Drawing the Products for the Hydrogenation, Hydrolysis, and Saponification of a Triacylglycerol (17.4), and Identifying the Steroid Nucleus (17.6).
- New notation for number of carbon atoms and double bonds in a fatty acid is added.
- New color-block diagrams for triacylglycerols, glycerophospholipids, and sphingolipids are added.
- New lipid panel for cholesterol, triglycerides, HDL, LDL, and cholesterol/HDL ratio is added.
- New photos include jojoba plant, use of triacylglycerols to thicken creams and lotions, and poisonous snake with venom that hydrolyzes phospholipids in red blood cells.
- New clinical applications include omega-3 fatty acids in fish oils, prostaglandins, drawing condensed and line-angle structure formulas for triacylglycerols and phospholipids in the body, cholesterol, bile salts, steroid hormones, and cell membranes.

Chapter 18, Amines and Amides, emphasizes the nitrogen atom in their functional groups and their names. Alkaloids are discussed as the naturally occurring amines in plants. Section 18.4 is now Neurotransmitters. Chemical reactions include amidation, and acid and base hydrolysis of amides.

- The chapter opener describes pesticides and pharmaceuticals used on a ranch and discusses the career of an environmental health practitioner.
- The Clinical Update describes the collection of soil and water samples for testing of insecticides and antibiotics.
- New art includes hemlock for coniine, crack cocaine, sedamine, structures of dicyclanil and enrofloxacin, and a soil collection bag.
- More line-angle structure formulas are drawn in the text and problem sections.
- New clinical applications include novocaine, lidocaine, ritalin, niacin, serotonin, histamine, acetylcholine, dose calculations of pesticides and antibiotics, enrofloxacin, and volataren.
- New Core Chemistry Skills are added: Forming Amides (18.5) and Hydrolyzing Amides (18.6).

- The interchapter problem set, Combining Ideas from Chapters 15 to 18, completes the chapter.

Chapter 19, Amino Acids and Proteins, discusses amino acids, formation of peptide bonds and proteins, and structural levels of proteins. Amino acids are drawn as zwitterions in physiological solutions. Section 19.4 describes the primary and secondary levels of protein structure. Section 19.5 describes the tertiary and quaternary levels of proteins.

- A new chapter opener describe some symptoms of Alzheimer’s disease and changes in brain proteins and discusses the career of a Radiology Technician.
- The Clinical Update describes a PET scan of the brain to determine the amount of plaque formation and cognitive decline, and the diagnosis and treatment for Alzheimer’s disease.
- The terms N-terminus and C-terminus are now used and the repeat backbone of a peptide is introduced.
- The updated Chemistry Link to Health, “Essential Amino Acids,” is moved to Section 19.1.
- Amino acids are drawn with the carboxyl or carboxylate groups showing single and double bonds to O atoms.
- Updates have been made in Analyze the Problem for Sample Problem 19.1, Sample Problem 19.3, and Sample Problem 19.4.
- New Core Chemical Skills are added: Drawing the Zwitterion for an Amino Acid (19.1) and Identifying the Primary, Secondary, Tertiary, and Quaternary Structures of Proteins (19.4, 19.5).
- New Chemistry Links to Health are added: “Protein Sequencing,” and “Protein Secondary Structures and Alzheimer’s Disease.”
- The use of electrophoresis to diagnose sickle-cell anemia was added to Chemistry Link to Health: Sickle-Cell Anemia.
- New ribbon models of beta-amyloid proteins in normal brain and an Alzheimer’s brain are added.
- A new diagram showing the separation of proteins by electrophoresis to diagnose sickle-cell anemia has been added.
- New clinical applications include essential amino acids, protein sequencing, proteins in Alzheimer’s, drawing peptides, and identifying the C-terminus and the N-terminus of peptides in health.
- The material on mad cow disease has been removed.

Chapter 20, Enzymes and Vitamins, relates the importance of the three-dimensional shape of proteins to their function as enzymes. The shape of an enzyme and its substrate are factors in enzyme regulation. End products of an enzyme-catalyzed sequence can increase or decrease the rate of an enzyme-catalyzed reaction. Other regulatory processes include allosteric enzymes, covalent modification and phosphorylation, and zymogens. Proteins change shape and lose function when subjected to pH changes and high temperatures. The important role of water-soluble vitamins as coenzymes is related to enzyme function.

- A new chapter opener discusses the symptoms of lactose intolerance and describes the career of a physician assistant.
- The Clinical Update describes the hydrogen breath test to confirm lactose intolerance and a diet that is free of lactose and use of Lactaid.
- Regulation of Enzyme Activity is now Section 20.4 and includes new are for positive and negative allosteric enzyme regulation.
- New material on covalent modification including phosphorylation and new ribbon models of chymotrypsin are added to Section 20.4.
- A new art shows the quaternary ribbon model of lactase and the amino acid residues in the active site.
- Clinical applications include isoenzymes, activity of pro-teases, prothrombin, amoxicillin, vitamins, and lactose intolerance.
- New art added illustrates the hydrolysis of lactose by lactase.
- New Core Chemistry Skills are added: Describing Enzyme Action (20.1), Classifying Enzymes (20.2), Identifying Factors Affecting Enzyme Activity (20.3), and Describing the Role of Cofactors (20.6).

Chapter 21, Nucleic Acids and Protein Synthesis,

describes the nucleic acids and their importance as biomolecules that store and direct information for the synthesis of cellular components. The role of complementary base pairing is discussed in both DNA replication and the formation of mRNA during protein synthesis. The role of RNA is discussed in the relationship of the genetic code to the sequence of amino acids in a protein. Mutations describe ways in which the nucleotide sequences are altered in genetic diseases. We also look at how DNA or RNA in viruses utilizes host cells to produce more viruses.

- A new chapter opener describes a patient diagnosis and treatment of breast cancer and discusses the work and career of a histology technician.
- The Clinical Update describes estrogen positive tumors, the impact of the altered genes BRCA1 and BRCA2 on the estrogen receptor, and medications to suppress tumor growth.
- Nucleotides in RNA and DNA are now named by adding monophosphate such as adenosine monophosphate.
- The synthesis of the lagging strand now include primers and single-strand binding proteins in a new Figure 21.8 and Table 21.24.
- Clinical applications include mRNA segments for human insulin, mutations in sickle-cell anemia, estrogen receptors, and segments of BRCA1 and BRCA2 genes.
- Entry inhibitors are added in inhibitors of reverse transcription.
- The discussion of the lactose operon was omitted.
- New problems are added for DNA cleavage by restriction enzymes.
- Transcription factors that bind RNA polymerase to DNA are now discussed as part of the regulation of transcription.

- One-letter abbreviations for amino acids were added to Table 21.6 Codons in mRNA: The Genetic Code for Amino Acids.
- Mutations are now named as point mutations, deletion mutations, and insertion mutations.
- New Core Chemical Skills are added: Writing the Complementary DNA Strand (21.3), Writing the mRNA Segment for a DNA Template (21.5), and Writing the Amino Acid for an mRNA Codon (21.6).
- The interchapter problem set, Combining Ideas from Chapters 19 to 21, completes the chapter.

Chapter 22, Metabolic Pathways for Carbohydrates,

describes the stages of metabolism and the digestion of carbohydrates, our most important fuel. The breakdown of glucose to pyruvate is described using glycolysis, which is followed under aerobic conditions by the decarboxylation of pyruvate to acetyl CoA. The synthesis of glycogen and the synthesis of glucose from noncarbohydrate sources are discussed.

- A new chapter opener describes the symptoms of a glycogen storage disease and discusses the career of a hepatology nurse.
- The Clinical Update describes medical treatment of frequent feedings of glucose for *von Gierke's disease*, in which a child has a defective glucose-6-phosphatase and cannot break down glucose-6-phosphate to glucose.
- New or updated diagrams were prepared for hydrolysis of ATP, ATP and muscle contraction, glycolysis, entry of galactose and fructose into glycolysis pathway, pathways for pyruvate, summary of glycogenesis and glycogenolysis, summary of glycolysis and gluconeogenesis, and the Cori cycle.
- New to this edition is material describing the *pentose phosphate pathway* for the oxidation of glucose that produces NADPH and pentoses.
- Chemistry Links to Health include “ATP Energy and Ca^{2+} Needed to Contract Muscles,” “Glycogen Storage Diseases (GSDs)”.
- New tables are added to summarize enzymes and coenzymes in metabolic reactions: “Characteristics of Oxidation and Reduction in Metabolic Pathways” (Table 22.2) and “Enzymes and Coenzymes in Metabolic Reactions” (Table 22.3).
- New color-coded art was added for structures of NAD and FAD in Figures 22.5 and 22.6.
- New art in Figure 22.12 adds glucose structures for reactions for glycogenesis.
- New Core Chemical Skills are added: Identifying Important Coenzymes in Metabolism (22.2), Identifying the Compounds in Glycolysis (22.4), Identifying the Compounds and Enzymes in Glycogenesis and Glycogenolysis (22.6).

Chapter 23, Metabolism and Energy Production,

looks at the entry of acetyl CoA into the citric acid cycle and the production of reduced coenzymes for electron transport, oxidative phosphorylation, and the synthesis of ATP. The malate-aspartate pathway was added to describe the transport of NADH from the cytosol into the mitochondrial matrix. Many diagrams were added or updated, including catalysis of lactose,

covalent modification, phosphorylation, formation of phosphonucleotides, DNA replication, recombinant DNA, muscle contraction, glycolysis, and galactose and fructose in glycolysis.

- The chapter opener describes the symptoms of pulmonary emphysema and discusses the career of an exercise physiologist.
- Clinical applications include enzyme deficiencies in the citric acid cycle, inhibitors of electron transport, low levels of O_2 and NADH production, and basal metabolic rate, kilocalories, and kilograms of ATP.
- The Clinical Update describes the exercise stress test and normal values of oximeter readings, and the exercises used to improve fitness and blood O_2 saturation.
- A new diagram (Figure 23.7) illustrates the malate-aspartate shuttle, which transfers energy stored in NADH in the cytosol into the mitochondrial matrix by regenerating NADH.
- The citric acid cycle was updated with enzyme names, identification of acetyl carbon group, and removal of ATP from electron transport system.
- The diagram of electron transport was updated and a new diagram of the sites in electron transport that are blocked by inhibitors was added.
- The details of ATP production by ATP synthase and its protein subunits were removed.
- The values for ATP production were adjusted to 2.5 ATP for NADH and 1.5 ATP for $FADH_2$.
- A new diagram emphasizes a mitochondrion and the product of NADH and $FADH_2$ from the citric acid cycle, and the formation of ATP from electron transport.
- New Core Chemistry Skills are added: Describing the Reactions in the Citric Acid Cycle (23.1), and Calculating the ATP Produced from Glucose (23.4).

Acknowledgments

The preparation of a new text is a continuous effort of many people. I am thankful for the support, encouragement, and dedication of many people who put in hours of tireless effort to produce a high-quality book that provides an outstanding learning package. I am extremely grateful to Dr. Laura Frost, who provided new and expanded material on current topics in the Biochemistry Chapters 19–24. The editorial team at Pearson has done an exceptional job. I want to thank Jeanne Zalesky, Editor-in-Chief, and Terry Haugen, Senior Acquisitions Editor who supported our vision of this fifth edition.

I appreciate all the wonderful work of Lisa Pierce, project manager, who skillfully brought together reviews, art, web site materials, and all the things it takes to prepare a book for production. I appreciate the work of Meeta Pendharkar and Jenna Vittorioso, project managers, and of Lumina Datamatics, Inc., who brilliantly coordinated all phases of the manuscript to the final pages of a beautiful book. Thanks to Mark Quirie,

Chapter 24, Metabolic Pathways for Lipids and Amino Acids, discusses the digestion of lipids and proteins and the metabolic pathways that convert fatty acids and amino acids into energy. Discussions include the conversion of excess carbohydrates to triacylglycerols in adipose tissue and how the intermediates of the citric acid cycle are converted to nonessential amino acids.

- A new chapter opener describes a liver profile with elevated levels of liver enzymes for a patient with chronic hepatitis C infection and discusses the career of a public health nurse.
- The Clinical Update describes interferon and ribavirin therapy for hepatitis C.
- The equations for the metabolism of glycerol were redrawn as two separate reactions.
- The diagram in Figure 24.3 was updated to include a transport region at the inner mitochondrial membrane for the transport of fatty acyl carnitine between the cytosol and the matrix.
- New ribbon model of aspartate transaminase is added to Sample Problem 24.8.
- Transport molecules are added to the urea cycle in Figure 24.9.
- New line-angle structural formulas replaced condensed structural formulas of fatty acyl CoA molecules.
- The Core Chemistry Skills are added: Calculating the ATP from Fatty Acid Oxidation (β Oxidation) (24.3), Describing How Ketone Bodies are Formed (24.4), and Distinguishing Anabolic and Catabolic Pathways (24.9).
- The interchapter problem set, Combining Ideas from Chapters 22 to 24, completes the chapter.

manuscript and accuracy reviewer, and Lumina Datamatics copy editor and proofreaders, who precisely analyzed and edited the initial and final manuscripts and pages to make sure the words and problems were correct to help students learn chemistry. Their keen eyes and thoughtful comments were extremely helpful in the development of this text.

I am especially proud of the art program in this text, which lends beauty and understanding to chemistry. I would like to thank Wynne Au Yeung, art specialist; Derek Bacchus, Design Manager, and Jerilyn Bockorick, interior and cover designers, whose creative ideas provided the outstanding design for the cover and pages of the book. Stephen Merland and Jen Simmons, photo researchers, were outstanding in researching and selecting vivid photos for the text so that students can see the beauty of chemistry, and to William Opaluch, text permissions manager for clearing third party content. Thanks also to *Bio-Rad Laboratories* for their courtesy and use of *Know-ItAll ChemWindows*, drawing software that helped us produce chemical structures for the manuscript. The macro-to-micro

illustrations designed by Imagineering give students visual impressions of the atomic and molecular organization of everyday things and are a fantastic learning tool. I also appreciate the hard work of Will Moore, Product Marketing Manager, and Chris Barker, Field Marketing Manager for their dedication in conveying the ideas of this revision through their marketing expertise.

I am extremely grateful to an incredible group of peers for their careful assessment of all the new ideas for the text; for their

suggested additions, corrections, changes, and deletions; and for providing an incredible amount of feedback about improvements for the book. I admire and appreciate every one of you.

If you would like to share your experience with chemistry, or have questions and comments about this text, I would appreciate hearing from you.

Karen Timberlake
Email: khemist@aol.com

Students learn chemistry using real-world examples

Feature	Description	Benefit	Page
<p>Chapter Opener</p> 	<p>Chapter Openers begin with Clinical Conditions and discuss careers in fields such as nursing, agriculture, exercise physiology, and anesthesia.</p>	<p>Connects a clinical situation with the chemistry in the chapter and show you how health professionals use chemistry every day.</p>	183
<p>Chemistry Link to Health</p>  <p>Chemistry Link to Health Losing and Gaining Weight</p> <p>The number of kilocalories or kilojoules needed in the daily diet of an adult depends on gender, age, and level of physical activity. Some typical levels of energy needs are given in Table 3.9. A person gains weight when food intake exceeds energy output.</p>	<p>Chemistry Links to Health apply chemical concepts to health and medicine such as weight loss and weight gain, trans fats, anabolic steroids, alcohol abuse, blood buffers, kidney dialysis, and cancer.</p>	<p>Provide you with connections that illustrate the importance of understanding chemistry in real-life health and medical situations.</p>	78
<p>Clinical Update</p>  <p>Clinical Update A Diet and Exercise Program for Charles</p> <p>It has been two weeks since Charles met with Daniel, a dietitian, who provided Charles with a menu for weight loss. Charles and his mother are going back to see Daniel again with a chart of the food Charles has eaten. The following is what Charles ate in one day:</p>	<p>Clinical Updates give a follow-up to the medical condition and treatment discussed in the chapter opener and include Clinical Application questions.</p>	<p>Continue a clinical theme through the entire chapter utilizing the chemistry content of the chapter.</p>	90
<p>Macro-to-Micro Art</p>  <p>Aspirin $C_9H_8O_4$</p>	<p>Macro-to-Micro Art utilizes photographs and drawings to illustrate the atomic structure of chemical phenomena.</p>	<p>Helps you connect the world of atoms and molecules to the macroscopic world.</p>	253
<p>Chemistry Link to the Environment</p>  <p>Chemistry Link to the Environment Carbon Dioxide and Climate Change</p> <p>The Earth's climate is a product of interactions between sunlight, the atmosphere, and the oceans. The Sun provides us with energy in the form of solar radiation. Some of this radiation is reflected back into space. The rest is absorbed by the clouds, atmospheric gases including carbon dioxide, and the Earth's surface. For millions of</p> 	<p>Chemistry Links to the Environment relate chemistry to environmental topics such as climate change, radon in our homes, and pheromones.</p>	<p>Helps you extend your understanding of the impact of chemistry on the environment</p>	75

Engage students in the world of chemistry

Feature	Description	Benefit	Page
<p>LEARNING GOAL</p> <p>Account for the ATP produced by the complete oxidation of glucose.</p>	<p>Learning Goals at the beginning and end of each section identify the key concepts for that section and provide a roadmap for your study.</p>	<p>Help you focus your studying by emphasizing what is most important in each section.</p>	851
<p>15.1 Carbohydrates</p> <p>Carbohydrates such as table sugar, lactose, and cellulose and oxygen. Simple sugars, which have formulas of $C_nH_{2n}O_n$, are hydrates of carbon, thus the name <i>carbohydrate</i>. In a series of reactions, energy from the Sun is used to combine the carbon</p>	<p>Timberlake's accessible Writing Style is based on careful development of chemical concepts suited to the skills and backgrounds of students in chemistry.</p>	<p>Helps you understand new terms and chemical concepts.</p>	551
	<p>Concept Maps at the end of each chapter show how all the key concepts fit together.</p>	<p>Encourage learning by providing a visual guide to the interrelationship among all the concepts in each chapter.</p>	859
<p>KEY MATH SKILL</p> <p>Interpreting Graphs</p>	<p>Key Math Skills review the basic math required needed for chemistry. Instructors can also assign these through MasteringChemistry.</p>	<p>Help you master the basic quantitative skills to succeed in chemistry.</p>	14
<p>CORE CHEMISTRY SKILL</p> <p>Describing the Reactions in the Citric Acid Cycle</p>	<p>Core Chemistry Skills identify content crucial to problem-solving strategies related to chemistry. Instructors can also assign these through MasteringChemistry.</p>	<p>Help you master the basic problem-solving skills needed to succeed in chemistry.</p>	837
 <p>FIGURE 15.3 ▶ Lactose, a disaccharid found in milk and milk products, contain galactose and glucose.</p>	<p>The Art and Photo Program is beautifully rendered, pedagogically effective, and includes questions with all the figures.</p>	<p>Helps you think critically using photos and illustrations.</p>	565
<p>CHAPTER REVIEW</p> <p>19.1 Proteins and Amino Acids</p> <p>LEARNING GOAL Classify proteins by their functions. Give the name and abbreviations for an amino acid, and draw its zwitterion.</p> <ul style="list-style-type: none"> Some proteins are enzymes or hormones, whereas others are important in structure, transport, protection, storage, and muscle contraction. 	<p>The Chapter Reviews include Learning Goals and visual thumbnails to summarize the key points in each section.</p>	<p>Help you determine your mastery of the chapter concepts and study for your tests.</p>	715
<p>Explore Your World</p> <p>Sugar and Sweeteners</p>	<p>Explore Your World features are hands-on activities that use everyday materials to encourage you to explore selected chemistry topics.</p>	<p>Helps you interact with chemistry, learn scientific method, and support critical thinking.</p>	580

Tools to engage students in chemistry and show them how to solve problems

Feature	Description	Benefit	Page						
<p>Clinical Applications</p> <p>3.19 a. A patient with hyperthermia has a temperature of 106 °F. What does this read on a Celsius thermometer?</p> <p>b. Because high fevers can cause convulsions in children, the doctor needs to be called if the child's temperature goes over 40.0 °C. Should the doctor be called if a child has a temperature of 103 °F?</p>	<p>Clinical Applications connect the chemistry in each section with health and clinical problems.</p>	<p>Shows you how the chemistry you are learning is related to health and medicine.</p>	73						
<p>Guide to Problem Solving Using Conversion Factors</p> <p>STEP 1 State the given and needed quantities.</p> <p>STEP 2 Write a plan to convert the</p>	<p>Guides to Problem Solving (GPS) illustrate the steps needed to solve problems.</p>	<p>Visually guide you step-by-step through each problem-solving strategy.</p>	44						
<table border="1"> <thead> <tr> <th>ANALYZE THE PROBLEM</th> <th>Given</th> <th>Need</th> </tr> </thead> <tbody> <tr> <td></td> <td>7.5 qt of blood, density of blood (1.06 g/mL)</td> <td>grams of blood</td> </tr> </tbody> </table>	ANALYZE THE PROBLEM	Given	Need		7.5 qt of blood, density of blood (1.06 g/mL)	grams of blood	<p>Analyze the Problems included in Sample Problem Solutions convert information in a word problem into components for problem solving.</p>	<p>Help you identify and utilize the components within a word problem to set up a solution strategy.</p>	51
ANALYZE THE PROBLEM	Given	Need							
	7.5 qt of blood, density of blood (1.06 g/mL)	grams of blood							
<p>QUESTIONS AND PROBLEMS</p> <p>15.1 Carbohydrates</p> <p>LEARNING GOAL Classify a monosaccharide as an aldose or a ketose, and indicate the number of carbon atoms.</p> <p>15.1 What reactants are needed for photosynthesis and respiration?</p> <p>15.2 What is the relationship between photosynthesis and respiration?</p>	<p>Questions and Problems are placed at the end of each section. Problems are paired and the Answers to the odd-numbered problems are given at the end of each chapter.</p>	<p>Encourage you to become involved immediately in the process of problem solving.</p>	554						
<p>SAMPLE PROBLEM 2.9 Problem Solving Using Conversion Factors</p> <p>Greg's doctor has ordered a PET scan of his liver. In radiological imaging such as PET or CT scans, dosages of pharmaceuticals are based on body mass. If Greg weighs 144 lb, what is his body mass in kilograms?</p> <p>SOLUTION</p> <p>STEP 1 State the given and needed quantities.</p> <table border="1"> <thead> <tr> <th>ANALYZE THE PROBLEM</th> <th>Given</th> <th>Need</th> </tr> </thead> <tbody> <tr> <td></td> <td>144 lb</td> <td>kilograms</td> </tr> </tbody> </table> <p>STEP 2 Write a plan to convert the given unit to the needed unit. The conversion factor relates the given unit to the U.S. system of measurement and the needed unit in the metric system.</p>	ANALYZE THE PROBLEM	Given	Need		144 lb	kilograms	<p>Sample Problems illustrate worked-out solutions with step-by-step explanations and required calculations. Study Checks associated with each Sample Problem allow you to check your problem solving strategies with the Answer.</p>	<p>Provide the intermediate steps to guide you successfully through each type of problem.</p>	44
ANALYZE THE PROBLEM	Given	Need							
	144 lb	kilograms							
<p>UNDERSTANDING THE CONCEPTS</p> <p>The chapter sections in review are shown in parentheses at the end of each question.</p> <p>1.31 A "chemical fire" shampoos include the following ingredients: water, carbonate, glycine, and citric acid. In the shampoos only "chemical fire" (1.1)</p> <p>1.32 A "thermal shock" camera includes the following components:</p> <p>1.33 Classify each of the following statements as an observation (O) or a hypothesis (H): (1.2)</p> <p>a. A patient breaks out in hives after receiving penicillin. b. Dinosaurs became extinct when a large meteorite struck and caused a large dust cloud that severely reduced the amount of light reaching the Earth. c. The 100-yd dash was run in 9.8 s.</p>	<p>Understanding the Concepts are questions with visual representations placed at the end of each chapter.</p>	<p>Build an understanding of newly learned chemical concepts.</p>	22						
<p>ADDITIONAL QUESTIONS AND PROBLEMS</p> <p>1.39 Identify each of the following as an observation (O), a hypothesis (H), an experiment (E), or a conclusion (C): (1.2)</p> <p>a. During an announcement in the emergency room, a nurse writes that the patient has a resting pulse of 90 beats/min. b. A nurse thinks that an infection from a recent surgery that he had and wonders is untreated. c. Repeated studies show that low-dose aspirin on the day leads to</p> <p>1.41 Select the correct phrase(s) to complete the following. If experimental results do not support your hypothesis (1.2)</p> <p>a. pretend that the experimental results support hypothesis b. modify your hypothesis c. do more experiments</p> <p>1.42 Select the correct phrase(s) to complete the following. A conclusion confirms a hypothesis when</p> <p>a. one experiment proves the hypothesis b. many experiments validate the hypothesis c. you think your hypothesis is correct</p>	<p>Additional Questions and Problems at the end of each chapter provide further study and application of the topics from the entire chapter. Problems are paired and the Answers to the odd-numbered problems are given at the end of each chapter.</p>	<p>Promote critical thinking.</p>	22						
<p>CHALLENGE QUESTIONS</p> <p>The following groups of questions are related to the topics in this chapter. However, they do not all follow the chapter order, and they require you to combine concepts and skills from several sections. These questions will help you increase your critical thinking skills and prepare for your next exam.</p> <p>1.51 Classify each of the following as an observation (O), a hypothesis (H), or an experiment (E): (1.2)</p> <p>a. The bicycle tire is flat. b. If I add air to the bicycle tire, it will expand to the proper size. c. When I added air to the bicycle tire, it was still flat. d. The bicycle tire must have a leak in it.</p> <p>1.52 Classify each of the following as an observation (O), a hypothesis (H), or an experiment (E): (1.2)</p> <p>Use the following graph for problem 1.53.</p>	<p>Challenge Questions at the end of each chapter provide complex questions.</p>	<p>Promote critical thinking, group work, and cooperative learning environments.</p>	23						
<p>COMBINING IDEAS FROM Chapters 7 and 8</p> <p>1.53 In the following diagram, blue spheres represent the element A and yellow spheres represent the element B. (6.5, 7.1, 7.2)</p> <p>a. Write the formulas for each of the reactants and products.</p> <p>b. If black spheres are carbon atoms, red spheres are oxygen atoms, and blue spheres are nitrogen atoms, what is the molecular formula of the reactant? c. How many moles of ethylene acid are contained in 100 g? d. How many capsules contain 75 mg?</p>	<p>Combining Ideas are sets of integrated problems placed after every 2 to 4 chapters that are useful as Practice exams.</p>	<p>Test your understanding of the concepts from previous chapters by integrating topics.</p>	322						

Resources

General, Organic, and Biological Chemistry: Structures of Life, fifth edition, provides an integrated teaching and learning package of support material for both students and professors.

Name of Supplement	Available in Print	Available Online	Instructor or Student Supplement	Description
Study Guide and Selected Solutions Manual (ISBN 0133891917)	✓		Resource for Students	The <i>Study Guide and Selected Solutions Manual</i> , by Karen Timberlake and Mark Quirie, promotes active learning through a variety of exercises with answers as well as practice tests that are connected directly to the learning goals of the textbook. Complete solutions to odd-numbered problems are included.
MasteringChemistry® (www.masteringchemistry.com) (ISBN 0133858375)		✓	Resource for Students and Instructors	MasteringChemistry® from Pearson is the leading online teaching and learning system designed to improve results by engaging students before, during, and after class with powerful content. Ensure that students arrive ready to learn by assigning educationally effective content before class, and encourage critical thinking and retention with in-class resources such as Learning Catalytics. Students can further master concepts after class through traditional homework assignments that provide hints and answer-specific feedback. The Mastering gradebook records scores for all automatically graded assignments while diagnostic tools give instructors access to rich data to assess student understanding and misconceptions.
MasteringChemistry with Pearson eText (ISBN 0133899306)		✓	Resource for Students	The fifth edition of <i>General, Organic, and Biological Chemistry: Structures of Life</i> features a Pearson eText enhanced with media within Mastering. In conjunction with Mastering assessment capabilities, Interactive Videos and 3D animations will improve student engagement and knowledge retention. Each chapter will contain a balance of interactive animations, videos, sample calculations, and self-assessments/quizzes embedded directly in the eText. Additionally, the Pearson eText offers students the power to create notes, highlight text in different colors, create bookmarks, zoom, and view single or multiple pages.
Instructor's Solutions Manual—Download Only (ISBN 0133891909)		✓	Resource for Instructors	Prepared by Mark Quirie, the solutions manual highlights chapter topics, and includes answers and solutions for all questions and problems in the text.
Instructor Resource Materials—Download Only (ISBN 0133891887)		✓	Resource for Instructors	Includes all the art, photos, and tables from the book in JPEG format for use in classroom projection or when creating study materials and tests. In addition, the instructors can access modifiable PowerPoint™ lecture outlines. Also available are downloadable files of the Instructor's Solutions Manual and a set of "clicker questions" designed for use with classroom-response systems. Also visit the Pearson Education catalog page for Timberlake's <i>General, Organic, and Biological Chemistry: Structures of Life</i> fifth Edition, at www.pearsonhighered.com to download available instructor supplements.
TestGen Test Bank—Download Only (ISBN 0133891895)		✓	Resource for Instructors	Prepared by William Timberlake, this resource includes more than 2000 questions in multiple-choice, matching, true/false, and short-answer format.
Laboratory Manual by Karen Timberlake (ISBN 0321811852)	✓		Resource for Students	This best-selling lab manual coordinates 35 experiments with the topics in <i>General, Organic, and Biological Chemistry: Structures of Life</i> fifth edition, uses laboratory investigations to explore chemical concepts, develop skills of manipulating equipment, reporting data, solving problems, making calculations, and drawing conclusions.
Online Instructor Manual for Laboratory Manual (ISBN 0321812859)		✓	Resource for Instructors	This manual contains answers to report sheet pages for the <i>Laboratory Manual</i> and a list of the materials needed for each experiment with amounts given for 20 students working in pairs, available for download at www.pearsonhighered.com .



Highlighting Relevancy and Clinical Applications

Designed to prepare students for health-related careers, **General, Organic, and Biological Chemistry: Structures of Life** breaks chemical concepts and problem solving into clear, manageable pieces, ensuring students follow along and stay motivated throughout their first, and often only, chemistry course. Timberlake's friendly writing style, student focus, strong problems, and engaging health-related applications continue to help students make connections between chemistry and their future careers as they develop problem-solving skills they'll need beyond the classroom.

Clinical Conditions, Applications, and Updates

Clinical features throughout the chapter connect chemistry to real life. Each chapter begins with an image and details of a Clinical Condition being addressed in the field by professionals from nursing, agriculture, exercise physiology, and anesthesia. **Clinical Updates** throughout the chapter follow the medical condition and treatment discussed in the chapter opener. **Clinical Applications** within the chapter and end-of-chapter show students how the chemistry they are learning applies specifically to health and medicine.

Clinical Update
Forensic Evidence Solves the Murder

Using a variety of laboratory tests, Sarah finds ethylene glycol in the victim's blood. The quantitative tests indicate that the victim had ingested 125 g of ethylene glycol. Sarah determines that the liquid in the glass found at the crime scene was ethylene glycol that had been added to an alcoholic beverage. Ethylene glycol is a clear, sweet-tasting, thick liquid that is colorless and mixes with water. It is easy to obtain since it is used as antifreeze in automobiles and in brake fluid. Because the initial symptoms of ethylene glycol poisoning are similar to being intoxicated, the victim is often unaware of its presence.


If ingestion of ethylene glycol occurs, it can cause depression of the central nervous system, cardiovascular damage, and kidney failure. If discovered quickly, hemodialysis may be used to remove ethylene glycol from the blood. A toxic amount of ethylene glycol is 1.5 g of ethylene glycol/kg of body mass. Thus, 75 g could be fatal for a 50-kg (110-lb) person.

Mark determines that a fingerprint on the glass found in the victim's home is a match to the victim's husband. This evidence along with the container of antifreeze found in the home led to the arrest and conviction of the husband for poisoning his wife.

Clinical Applications

1.29 A container was found in the home of the victim that contained 120 g of ethylene glycol in 450 g of liquid. What was the percentage of ethylene glycol? Express your answer to the ones place.

1.30 How many drinks, each containing 100 g of the liquid in problem 1.29, would a 50-kg victim need to consume to reach a toxic level of ethylene glycol?



1

Chemistry in Our Lives

A CALL CAME IN TO 911 FROM A MAN WHO FOUND

his wife lying on the floor of their home. When the police arrived at the home, they determined that the woman was dead. The husband said he had worked late, and just arrived at their home. The victim's body was lying on the floor of the living room. There was no blood at the scene, but the police did find a glass on the side table that contained a small amount of liquid. In an adjacent laundry room/garage, the police found a half-empty bottle of antifreeze. The bottle, glass, and liquid were bagged and sent to the forensic laboratory.

In another 911 call, a man was found lying on the grass outside his home. Blood was present on his body, and some bullet casings were found on the grass. Inside the victim's home, a weapon was recovered. The bullet casings and the weapon were bagged and sent to the forensic laboratory.

Sarah and Mark, forensic scientists, use scientific procedures and chemical tests to examine the evidence from law enforcement agencies. Sarah proceeds to analyze blood, stomach contents, and the unknown liquid from the first victim's home. She will look for the presence of drugs, poisons, and alcohol. Her lab partner Mark will analyze the fingerprints on the glass. He will also match the characteristics of the bullet casings to the weapon that was found at the second crime scene.



Evidence from a crime scene is sent to the forensic laboratory.

CAREER Forensic Scientist


Most forensic scientists work in crime laboratories that are part of city or county legal systems where they analyze bodily fluids and tissue samples collected by crime scene investigators. In analyzing these samples, forensic scientists identify the presence or absence of specific chemicals within the body to help solve the criminal case. Some of the chemicals they look for include alcohol, illegal or prescription drugs, poisons, arson debris, metals, and various gases such as carbon monoxide. In order to identify these substances, a variety of chemical instruments and highly specific methodologies are used. Forensic scientists also analyze samples from criminal suspects, athletes, and potential employees. They also work on cases involving environmental contamination and animal samples for wildlife crimes. Forensic scientists usually have a bachelor's degree that includes courses in math, chemistry, and biology.



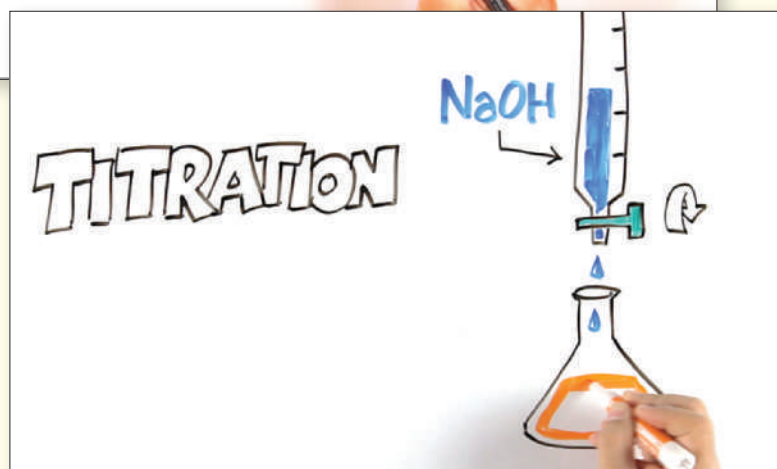
Interactive Videos

Interactive videos and demonstrations help students through some of the more challenging topics by showing how chemistry works in real life and introducing a bit of humor into chemical problem solving and demonstrations. Topics include Using Conversion Factors, Balancing Nuclear Equations, Chemical v. Physical Change, and Dehydration of Sucrose.

Sample Calculations walk students through the most challenging chemistry problems and provide a fresh perspective on how to approach individual problems and reach their solutions. Topics include Using Conversion Factors, Mass Calculations for Reactions, and Concentration of Solutions.

 **Green play button icons** appear in the margins throughout the text. In the eText, the icons link to new interactive videos that the student can use to clarify and reinforce important concepts. All Interactive Videos are available in web and mobile-friendly formats through the eText, and are assignable activities in MasteringChemistry.

ANALYZE THE PROBLEM
GIVEN: ALPHA PARTICLE BOMBARDMENT OF **Al-27** PRODUCES A RADIOACTIVE ISOTOPE & A NEUTRON
NEED: BALANCED NUCLEAR EQUATION



To obtain T_c by itself, we divide both sides by 1.8.

$$\frac{T_F - 32}{1.8} = \frac{1.8(T_c)}{1.8} = T_c$$

SAMPLE PROBLEM 1.4 Solving Equations

Solve the following equation for V_2 :

$$A_1V_1 = B_2V_2$$

SOLUTION

$$A_1V_1 = B_2V_2$$

To solve for V_2 , divide both sides by the symbol B_2 .

$$\frac{A_1V_1}{B_2} = \frac{B_2V_2}{B_2}$$

$$V_2 = \frac{A_1V_1}{B_2}$$

Interactive Video



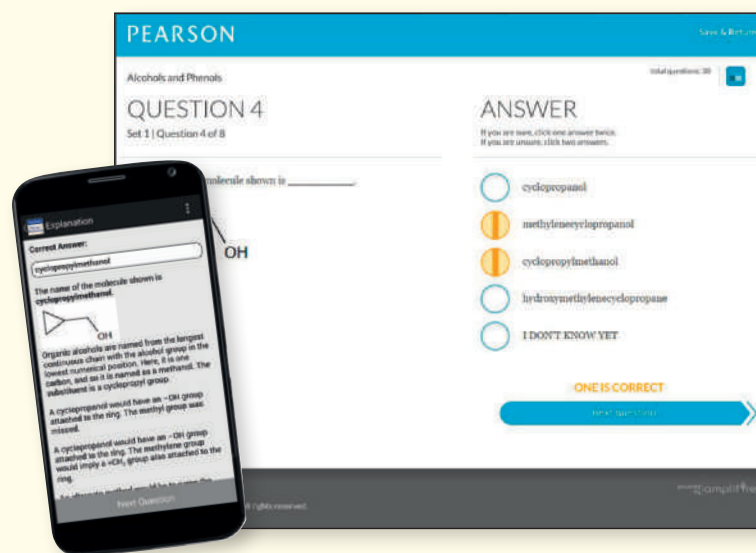
Solving Equations

MasteringChemistry®

MasteringChemistry® from Pearson is the leading online teaching and learning system designed to improve results by engaging students before, during, and after class with powerful content. Ensure that students arrive ready to learn by assigning educationally effective content before class, and encourage critical thinking and retention with in-class resources such as Learning Catalytics. Students can further master concepts after class through traditional homework assignments that provide hints and answer-specific feedback. The Mastering gradebook records scores for all automatically graded assignments while diagnostic tools give instructors access to rich data to assess student understanding and misconceptions.

Mastering brings learning full circle by continuously adapting to each student and making learning more personal than ever—before, during, and after class.

Before Class



The screenshot displays a Pearson MasteringChemistry interface. On the left, a smartphone shows a question explanation for cyclopropylmethanol, including a chemical structure and text explaining naming rules for alcohols. The main screen shows 'QUESTION 4' and 'ANSWER' for the question: 'The name of the molecule shown is _____'. The correct answer is 'cyclopropylmethanol', which is highlighted in blue. Other options include 'cyclopropanol', 'methylcyclopropylmethanol', 'cyclopropylmethanol', 'hydroxymethylcyclopropane', and 'I DON'T KNOW YET'. A 'ONE IS CORRECT' message is visible at the bottom.

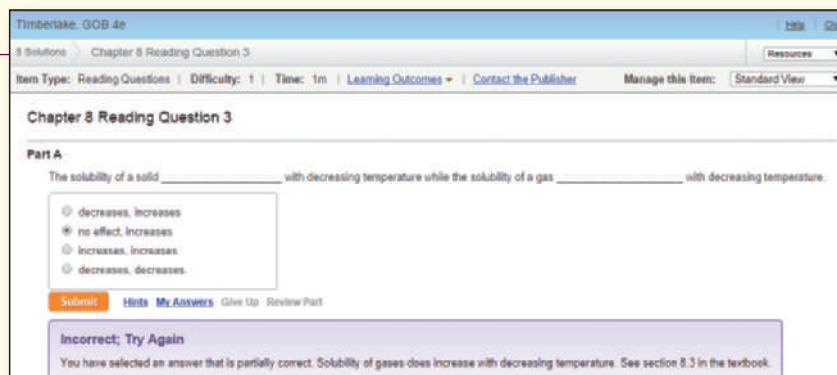
Dynamic Study Modules

Help students quickly learn chemistry!

Now assignable, Dynamic Study Modules (DSMs) enable your students to study on their own and be better prepared with the basic math and chemistry skills needed to succeed in the GOB course. The mobile app is available for iOS and Android devices for study on the go and results can be tracked in the MasteringChemistry gradebook.

Reading Quizzes

Reading Quizzes give instructors the opportunity to assign reading and test students on their comprehension of chapter content.



The screenshot shows a 'Chapter 8 Reading Question 3' interface. The question asks: 'The solubility of a solid _____ with decreasing temperature while the solubility of a gas _____ with decreasing temperature.' The options are: 'decreases, increases', 'no effect, increases', 'increases, increases', and 'decreases, decreases'. The 'no effect, increases' option is selected. Below the question, there are buttons for 'Submit', 'Hints', 'My Answers', 'Give Up', and 'Review Part'. A feedback message states: 'Incorrect; Try Again. You have selected an answer that is partially correct. Solubility of gases does increase with decreasing temperature. See section 8.3 in the textbook.'



During Class

Learning Catalytics

Learning Catalytics is a “bring your own device” student engagement, assessment, and classroom intelligence system. With Learning Catalytics you can:

- Assess students in real time, using open-ended tasks to probe student understanding.
- Understand immediately where students are and adjust your lecture accordingly.
- Manage student interactions with intelligent grouping and timing.

After Class

Factor	Name	Symbol
10^6	mega	M
10^3	kilo	k
10^2	hecto	h
10^1	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ

Tutorials and Coaching

Students learn chemistry by practicing chemistry.

Tutorials, featuring specific wrong-answer feedback, hints, and a wide variety of educationally effective content, guide your students through the toughest topics in General, Organic, and Biological chemistry.

Adaptive Follow-Ups

Mastering continuously adapts to each student, making learning more personal than ever.

Adaptive Follow-Ups are personalized assignments that pair Mastering’s powerful content with Knewton’s adaptive learning engine to provide personalized help to students before misconceptions take hold. These assignments are based on each student’s performance on homework assignments and on all work in the course to date, including core prerequisite topics.



