



FIFTH EDITION

GENERAL, ORGANIC, AND BIOLOGICAL
CHEMISTRY
Structures of Life

KAREN C. TIMBERLAKE

General, Organic, and Biological Chemistry

Structures of Life

Fifth Edition

Karen C. Timberlake

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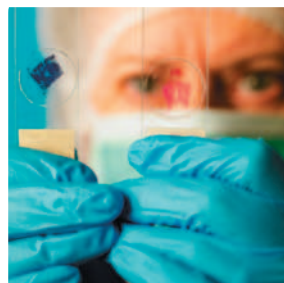
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About the Author



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 Pedalyte 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 proteases, 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).

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.

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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.

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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

Feature

Description

Benefit

Page

LEARNING GOAL

Account for the ATP produced by the complete oxidation of glucose.

Learning Goals at the beginning and end of each section identify the key concepts for that section and provide a roadmap for your study.

Help you focus your studying by emphasizing what is most important in each section.

851

15.1 Carbohydrates

Carbohydrates such as table sugar, lactose, and cellulose are hydrates of carbon, thus the name *carbohydrate*. In a series, energy from the Sun is used to combine the carbon

Timberlake's accessible **Writing Style** is based on careful development of chemical concepts suited to the skills and backgrounds of students in chemistry.

Helps you understand new terms and chemical concepts.

551



Concept Maps at the end of each chapter show how all the key concepts fit together.

Encourage learning by providing a visual guide to the interrelationship among all the concepts in each chapter.

859

KEY MATH SKILL

Interpreting Graphs

Key Math Skills review the basic math required needed for chemistry. Instructors can also assign these through MasteringChemistry.

Help you master the basic quantitative skills to succeed in chemistry.

14

CORE CHEMISTRY SKILL

Describing the Reactions in the Citric Acid Cycle

Core Chemistry Skills identify content crucial to problem-solving strategies related to chemistry. Instructors can also assign these through MasteringChemistry.

Help you master the basic problem-solving skills needed to succeed in chemistry.

837



FIGURE 15.3 ▶ Lactose, a disaccharid found in milk and milk products, contain galactose and glucose.

The **Art and Photo Program** is beautifully rendered, pedagogically effective, and includes questions with all the figures.

Helps you think critically using photos and illustrations.

565

CHAPTER REVIEW

19.1 Proteins and Amino Acids

LEARNING GOAL Classify proteins by their functions. Give the name and abbreviations for an amino acid, and draw its zwitterion.

- Some proteins are enzymes or hormones, whereas others are important in structure, transport, protection, storage, and muscle contraction.



The **Chapter Reviews** include Learning Goals and visual thumbnails to summarize the key points in each section.

Help you determine your mastery of the chapter concepts and study for your tests.

715



Explore Your World features are hands-on activities that use everyday materials to encourage you to explore selected chemistry topics.

Helps you interact with chemistry, learn scientific method, and support critical thinking.

580

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

Feature

Clinical Applications

- 3.19 a. A patient with hyperthermia has a temperature of 106 °F. What does this read on a Celsius thermometer?
 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?

Guide to Problem Solving
Using Conversion Factors

STEP 1
State the given and needed quantities.

STEP 2
Write a plan to convert the

ANALYZE THE PROBLEM	Given	Need
	7.5 qt of blood, density of blood (1.06 g/mL)	grams of blood

QUESTIONS AND PROBLEMS

15.1 Carbohydrates

LEARNING GOAL Classify a monosaccharide as an aldose or a ketose, and indicate the number of carbon atoms.

- 15.1 What reactants are needed for photosynthesis and respiration?
 15.2 What is the relationship between photosynthesis and respiration?

EXAMPLE PROBLEM 2.3 Problem Solving Using Conversion Factors

Greg's doctor has ordered a PET scan of his heart. 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?

STEP 1 State the given and needed quantities.

ANALYZE THE PROBLEM	Given	Need
	144 lb	kilograms

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.

UNDERSTANDING THE CONCEPTS

The chapter sections to review are shown in parentheses at the end of each question.

1.18 A "chemical-free" shampoo includes the following ingredients: water, sodium chloride, glycerin, and citric acid. In the shampoo only "chemical-free" (1.1, 1.2)

1.19 A "chemical-free" sunscreen includes the following ingredients: zinc oxide, titanium dioxide, and avobenzone. In the sunscreen only "chemical-free" (1.1, 1.2)

1.20 Classify each of the following statements as an observation (O) or a hypothesis (H): (1.2)

a. A patient breaks out in hives after receiving penicillin.
 b. Dinosaurs became extinct when a large meteorite struck Earth and caused a large dust cloud that severely reduced the amount of light reaching the Earth.
 c. The 1000th anniversary is 2000.

ADDITIONAL QUESTIONS AND PROBLEMS

1.21 Identify each of the following as an observation (O), a hypothesis (H), an experiment (E), or a conclusion (C): (1.2)

a. During an assessment in the emergency room, a nurse writes that the patient has a resting pulse of 50 beats/minute.
 b. A nurse thinks that an infection from a recent surgery that is not well swollen is infected.
 c. Repeated studies show that low-dose aspirin at the end leads to a decrease in risk.

1.22 Select the correct phrase(s) to complete the following. If experimental results do not support your hypothesis (1.2)

a. predict that the experimental results support hypothesis
 b. modify your hypothesis
 c. do more experiments

1.23 Select the correct phrase(s) to complete the following. A conclusion confirms a hypothesis when (1.2)

a. one experiment proves the hypothesis
 b. many experiments validate the hypothesis
 c. you think your hypothesis is correct

CHALLENGE QUESTIONS

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.

1.24 Classify each of the following as an observation (O), a hypothesis (H), or an experiment (E): (1.2)

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.

1.25 Classify each of the following as an observation (O), a hypothesis (H), or an experiment (E): (1.2)

Use the following graph for problem 1.25.

1.26 Classify each of the following as an observation (O), a hypothesis (H), or an experiment (E): (1.2)

a. Each capsule contains 250 mg of ibuprofen.
 b. If each capsule contains 250 mg of ibuprofen, and you take two capsules, you will get 500 mg of ibuprofen.
 c. How many capsules of ibuprofen will I need to take to get 500 mg of ibuprofen?
 d. How many capsules contain 250 mg of ibuprofen?

COMBINING IDEAS FROM Chapters 7 and 8

1.27 In the following diagram, blue spheres represent the element A and yellow spheres represent the element B. (6.5, 7.1, 7.2)

a. Write the formulas for each of the reactants and products.

Description

Clinical Applications connect the chemistry in each section with health and clinical problems.

Guides to Problem Solving (GPS) illustrate the steps needed to solve problems.

Analyze the Problems included in Sample Problem Solutions convert information in a word problem into components for problem solving.

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.

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**.

Understanding the Concepts are questions with visual representations placed at the end of each chapter.

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.

Challenge Questions at the end of each chapter provide complex questions.

Combining Ideas are sets of integrated problems placed after every 2 to 4 chapters that are useful as Practice exams.

Benefit

Shows you how the chemistry you are learning is related to health and medicine.

Visually guide you step-by-step through each problem-solving strategy.

Help you identify and utilize the components within a word problem to set up a solution strategy.

Encourage you to become involved immediately in the process of problem solving.

Provide the intermediate steps to guide you successfully through each type of problem.

Build an understanding of newly learned chemical concepts.

Promote critical thinking.

Promote critical thinking, group work, and cooperative learning environments.

Test your understanding of the concepts from previous chapters by integrating topics.

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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 127 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 in antifreeze in automobiles and in brake fluid. Because the initial symptoms of ethylene glycol poisoning are similar to those of alcohol, the victim is often unaware of its presence.

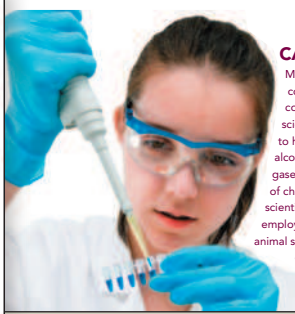
If ingestion of ethylene glycol occurs, it can cause depression of the central nervous system, cardiovascular damage, and kidney failure. If discovered quickly, hemodialysis may be used to remove ethylene glycol from the blood. A toxic amount of ethylene glycol is 1.5 g of ethylene glycol/kg of body 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 house 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 470 g of liquid. What was the percentage of ethylene glycol? Express your answer to the nearest percent.

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.

1

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

TITRATION

NaOH



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 :

$$P_1 V_1 = P_2 V_2$$

SOLUTION

$$P_1 V_1 = P_2 V_2$$

To solve for V_2 , divide both sides by the symbol P_2 .

$$\frac{P_1 V_1}{P_2} = \frac{P_2 V_2}{P_2}$$

$$V_2 = \frac{P_1 V_1}{P_2}$$

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 question titled "QUESTION 4" from the "Alcohols and Phenols" section. The question asks for the name of a molecule shown in a skeletal structure. The answer options are: cyclopropanol, methylmethylcyclopropanol, cyclopropylmethanol, hydroxymethylcyclopropane, and I DON'T KNOW YET. The correct answer is "cyclopropanol". A blue button labeled "ONE IS CORRECT" is visible at the bottom of the answer list. To the left, a smartphone displays the same question and answer, along with an explanation of the naming rules for cyclopropanol.

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" from a "Timed Take, GOB 4e" system. The question asks about the solubility of a solid and a gas with decreasing temperature. The options are: decreases, increases; no effect, increases; increases, increases; and decreases, decreases. The selected answer is "no effect, increases". 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
10^3	kilo	k
10^6	mega	M
10^9	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ

You can use these relationships to create equations and conversion factors. For example, the prefix centi is denoted with a c and is associated with a factor of 10^{-2} . If you were to apply this prefix to meter, you would obtain the equality $1 \text{ cm} = 10^{-2} \text{ m}$. This could be used to create two conversion factors.

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.

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1

Chemistry in Our Lives

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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.

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LOOKING AHEAD

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- 1.2 Scientific Method: Thinking Like a Scientist 4

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- 1.4 Key Math Skills for Chemistry 9
 - A. Identifying Place Values
 - B. Using Positive and Negative Numbers in Calculations
 - C. Calculating Percentages
 - D. Solving Equations
 - E. Interpreting Graphs
 - F. Writing Numbers in Scientific Notation

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 **Clinical Update** *Forensic Evidence Solves the Murder* 19



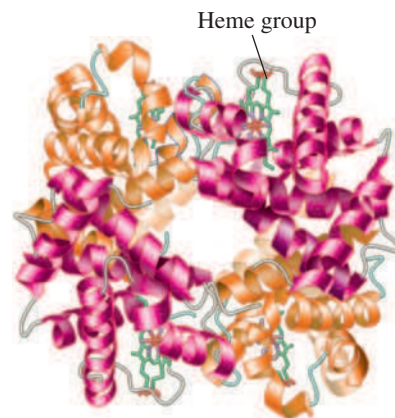
Chemists working in research laboratories test new products and develop new pharmaceuticals.

LEARNING GOAL

Define the term chemistry and identify substances as chemicals.

Now that you are in a chemistry class, you may be wondering what you will be learning. What questions in science have you been curious about? Perhaps you are interested in what hemoglobin does in the body or how aspirin relieves a headache. Just like you, chemists are curious about the world we live in.

- ▶ **What does hemoglobin do in the body?**
Hemoglobin consists of four polypeptide chains, each containing a heme group with an iron atom that binds to oxygen (O_2) in the lungs. From the lungs, hemoglobin transports oxygen to the tissues of the body where it is used to provide energy. Once the oxygen is released, hemoglobin binds to carbon dioxide (CO_2) for transport to the lungs where it is released.
- ▶ **Why does aspirin relieve a headache?**
When a part of the body is injured, substances called prostaglandins are produced, which cause inflammation and pain. Aspirin acts to block the production of prostaglandins, thereby reducing inflammation, pain, and fever.



Hemoglobin transports oxygen to the tissues and carbon dioxide to the lungs.

Chemists in the medical field develop new treatments for diabetes, genetic defects, cancer, AIDS, and other diseases. Researchers in the environmental field study the ways in which human development impacts the environment and develop processes that help reduce environmental degradation. For the chemist in the forensic laboratory, the nurse in the dialysis unit, the dietitian, or the agricultural scientist, chemistry plays a central role in understanding problems, assessing possible solutions, and making important decisions.

1.1 Chemistry and Chemicals

Chemistry is the study of the composition, structure, properties, and reactions of matter. *Matter* is another word for all the substances that make up our world. Perhaps you imagine that chemistry takes place only in a laboratory where a chemist is working in a white coat and goggles. Actually, chemistry happens all around you every day and has an impact on everything you use and do. You are doing chemistry when you cook food, add bleach to your laundry, or start your car. A chemical reaction has taken place when silver tarnishes or an antacid tablet fizzes when dropped into water. Plants grow because chemical reactions convert carbon dioxide, water, and energy to carbohydrates. Chemical reactions take place when you digest food and break it down into substances that you need for energy and health.



Antacid tablets undergo a chemical reaction when dropped into water.

Chemicals

A **chemical** is a substance that always has the same composition and properties wherever it is found. All the things you see around you are composed of one or more chemicals. Chemical processes take place in chemistry laboratories, manufacturing plants, and pharmaceutical labs as well as every day in nature and in our bodies. Often the terms *chemical* and *substance* are used interchangeably to describe a specific type of matter.

Every day, you use products containing substances that were developed and prepared by chemists. Soaps and shampoos contain chemicals that remove oils on your skin and scalp. When you brush your teeth, the substances in toothpaste clean your teeth, prevent plaque formation, and stop tooth decay. Some of the chemicals used to make toothpaste are listed in Table 1.1.

In cosmetics and lotions, chemicals are used to moisturize, prevent deterioration of the product, fight bacteria, and thicken the product. Your clothes may be made of natural materials such as cotton or synthetic substances such as nylon or polyester. Perhaps you wear a ring or watch made of gold, silver, or platinum. Your breakfast cereal is probably fortified with iron, calcium, and phosphorus, whereas the milk you drink is enriched with vitamins A and D. Antioxidants are chemicals added to food to prevent it from spoiling. Some of the chemicals you may encounter when you cook in the kitchen are shown in Figure 1.1.



Toothpaste is a combination of many chemicals.

TABLE 1.1 Chemicals Commonly Used in Toothpaste

Chemical	Function
Calcium carbonate	Used as an abrasive to remove plaque
Sorbitol	Prevents loss of water and hardening of toothpaste
Sodium lauryl sulfate	Used to loosen plaque
Titanium dioxide	Makes toothpaste white and opaque
Triclosan	Inhibits bacteria that cause plaque and gum disease
Sodium fluorophosphate	Prevents formation of cavities by strengthening tooth enamel with fluoride
Methyl salicylate	Gives toothpaste a pleasant wintergreen flavor



FIGURE 1.1 ► Many of the items found in a kitchen are chemicals or products of chemical reactions.

🔍 What are some other chemicals found in a kitchen?

QUESTIONS AND PROBLEMS

1.1 Chemistry and Chemicals

LEARNING GOAL Define the term chemistry and identify substances as chemicals.

In every chapter, odd-numbered exercises in the *Questions and Problems* are paired with even-numbered exercises. The answers for the magenta, odd-numbered *Questions and Problems* are given at the end of each chapter. The complete solutions to the odd-numbered *Questions and Problems* are in the *Student Solutions Manual*.

- 1.1 Write a one-sentence definition for each of the following:
 - a. chemistry
 - b. chemical
- 1.2 Ask two of your friends (not in this class) to define the terms in problem 1.1. Do their answers agree with the definitions you provided?

1.3 Obtain a bottle of multivitamins and read the list of ingredients. What are four chemicals from the list?

1.4 Obtain a box of breakfast cereal and read the list of ingredients. What are four chemicals from the list?

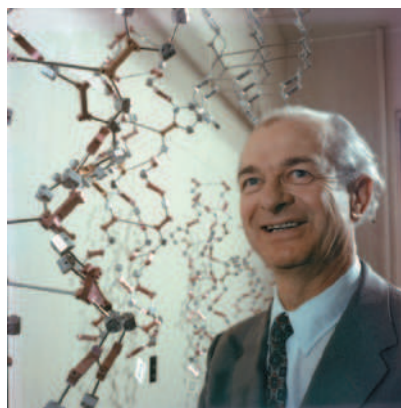
Clinical Applications

1.5 Read the labels on some items found in your medicine cabinet. What are the names of some chemicals contained in those items?

1.6 Read the labels on products used to wash your dishes. What are the names of some chemicals contained in those products?

LEARNING GOAL

Describe the activities that are part of the scientific method.



Linus Pauling won the Nobel Prize in Chemistry in 1954.

Explore Your World Nobel Prize Winners in Chemistry

Use the Internet to find information about each of the following:

1. Who won the latest Nobel Prize in Chemistry?
2. What was the area of research for question 1?

1.2 Scientific Method: Thinking Like a Scientist

When you were very young, you explored the things around you by touching and tasting. As you grew, you asked questions about the world in which you live. What is lightning? Where does a rainbow come from? Why is water blue? As an adult, you may have wondered how antibiotics work or why vitamins are important to your health. Every day, you ask questions and seek answers to organize and make sense of the world around you.

When the late Nobel Laureate Linus Pauling described his student life in Oregon, he recalled that he read many books on chemistry, mineralogy, and physics. “I mulled over the properties of materials: why are some substances colored and others not, why are some minerals or inorganic compounds hard and others soft?” He said, “I was building up this tremendous background of empirical knowledge and at the same time asking a great number of questions.” Linus Pauling won two Nobel Prizes: the first, in 1954, was in chemistry for his work on the nature of chemical bonds and the determination of the structures of complex substances; the second, in 1962, was the Peace Prize.

Scientific Method

Although the process of trying to understand nature is unique to each scientist, a set of general principles, called the **scientific method**, helps to describe how a scientist thinks.

1. **Observations** The first step in the scientific method is to make *observations* about nature and ask questions about what you observe.
2. **Hypothesis** Propose a *hypothesis*, which states a possible explanation of the observations. The hypothesis must be stated in such a way that it can be tested by experiments.
3. **Experiments** Several *experiments* may be done to test the hypothesis.
4. **Conclusion** When the results of the experiments are analyzed, a *conclusion* is made as to whether the hypothesis is *true* or *false*. When experiments give consistent results, the hypothesis may be confirmed. Even then, a hypothesis continues to be tested and, based on new experimental results, may need to be modified or replaced.



Chemistry Link to Health

Early Chemist: Paracelsus

Paracelsus (1493–1541) was a physician and an alchemist who thought that alchemy should be about preparing new medicines. Using observation and experimentation, he proposed that a healthy body was regulated by a series of chemical processes that could be unbalanced by certain chemical compounds and rebalanced by using minerals and medicines. For example, he determined that inhaled dust, not underground spirits, caused lung disease in miners. He also thought that goiter was a problem caused by contaminated water, and he treated syphilis with compounds of mercury. His opinion of medicines was that the right dose makes the difference between a poison and a cure. Paracelsus changed alchemy in ways that helped to establish modern medicine and chemistry.



Swiss physician and alchemist Paracelsus (1493–1541) believed that chemicals and minerals could be used as medicines.

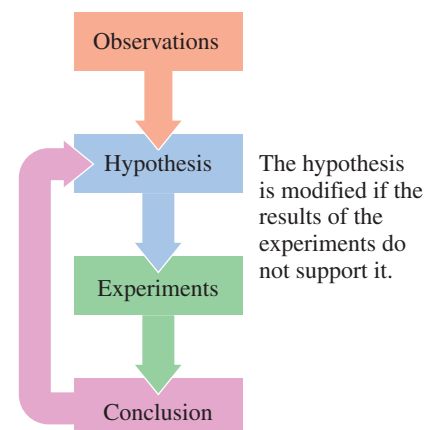
Using the Scientific Method in Everyday Life

You may be surprised to realize that you use the scientific method in your everyday life. Suppose you visit a friend in her home. Soon after you arrive, your eyes start to itch and you begin to sneeze. Then you observe that your friend has a new cat. Perhaps you ask yourself why you are sneezing and you form the hypothesis that you are allergic to cats. To test your hypothesis, you leave your friend's home. If the sneezing stops, perhaps your hypothesis is correct. You test your hypothesis further by visiting another friend who also has a cat. If you start to sneeze again, your experimental results support your hypothesis and you come to the conclusion that you are allergic to cats. However, if you continue sneezing after you leave your friend's home, your hypothesis is not supported. Now you need to form a new hypothesis, which could be that you have a cold.



Through observation you may determine that you are allergic to cat hair and dander.

Scientific Method



The scientific method develops conclusions using observations, hypotheses, and experiments.

QUESTIONS AND PROBLEMS

1.2 Scientific Method: Thinking Like a Scientist

LEARNING GOAL Describe the activities that are part of the scientific method.

1.7 Identify each activity, **a** to **f**, as an observation (O), a hypothesis (H), an experiment (E), or a conclusion (C).

At a popular restaurant, where Chang is the head chef, the following occurred:

- Chang determined that sales of the house salad had dropped.
- Chang decided that the house salad needed a new dressing.
- In a taste test, Chang prepared four bowls of lettuce, each with a new dressing: sesame seed, olive oil and balsamic vinegar, creamy Italian, and blue cheese.
- The tasters rated the sesame seed salad dressing as the favorite.
- After two weeks, Chang noted that the orders for the house salad with the new sesame seed dressing had doubled.
- Chang decided that the sesame seed dressing improved the sales of the house salad because the sesame seed dressing enhanced the taste.

1.8 Identify each activity, **a** to **f**, as an observation (O), a hypothesis (H), an experiment (E), or a conclusion (C).

Lucia wants to develop a process for dyeing shirts so that the color will not fade when the shirt is washed. She proceeds with the following activities:

- Lucia notices that the dye in a design fades when the shirt is washed.
- Lucia decides that the dye needs something to help it combine with the fabric.



Customers rated the sesame seed dressing as the best.

- She places a spot of dye on each of four shirts and then places each one separately in water, salt water, vinegar, and baking soda and water.
- After one hour, all the shirts are removed and washed with a detergent.
- Lucia notices that the dye has faded on the shirts in water, salt water, and baking soda, whereas the dye did not fade on the shirt soaked in vinegar.
- Lucia thinks that the vinegar binds with the dye so it does not fade when the shirt is washed.

Rx Clinical Applications

1.9 Identify each of the following as an observation (O), a hypothesis (H), an experiment (E), or a conclusion (C):

- One hour after drinking a glass of regular milk, Jim experienced stomach cramps.
- Jim thinks he may be lactose intolerant.
- Jim drinks a glass of lactose-free milk and does not have any stomach cramps.
- Jim drinks a glass of regular milk to which he has added lactase, an enzyme that breaks down lactose, and has no stomach cramps.

1.10 Identify each of the following as an observation (O), a hypothesis (H), an experiment (E), or a conclusion (C):

- Sally thinks she may be allergic to shrimp.
- Yesterday, one hour after Sally ate a shrimp salad, she broke out in hives.
- Today, Sally had some soup that contained shrimp, but she did not break out in hives.
- Sally realizes that she does not have an allergy to shrimp.

LEARNING GOAL

Develop a study plan for learning chemistry.

KEY MATH SKILL

CORE CHEMISTRY SKILL

1.3 Learning Chemistry: A Study Plan

Here you are taking chemistry, perhaps for the first time. Whatever your reasons for choosing to study chemistry, you can look forward to learning many new and exciting ideas.

Features in This Text Help You Study Chemistry

This text has been designed with study features to complement your individual learning style. On the inside of the front cover is a periodic table of the elements. On the inside of the back cover are tables that summarize useful information needed throughout your study of chemistry. Each chapter begins with *Looking Ahead*, which outlines the topics in the chapter. At the end of the text, there is a comprehensive *Glossary and Index*, which lists and defines key terms used in the text. *Key Math Skills* and *Core Chemistry Skills* that are critical to learning chemistry are indicated by icons in the margin, and summarized at the end of each chapter. In the *Chapter Readiness* list at the beginning of every chapter, the *Key Math Skills* and *Core Chemistry Skills* from previous chapters related to the current chapter concepts are highlighted for your review.

Before you begin reading, obtain an overview of a chapter by reviewing the topics in *Looking Ahead*. As you prepare to read a section of the chapter, look at the section title and turn it into a question. For example, for section 1.1, “Chemistry and Chemicals,” you could ask, “What is chemistry?” or “What are chemicals?” When you come to a *Sample Problem*, take the time to work it through and compare your solution to the one provided. Then try the

associated *Study Check*. Many *Sample Problems* are accompanied by a *Guide to Problem Solving*, which gives the steps needed to work the problem. In some *Sample Problems*, an *Analyze the Problem* feature shows how to organize the data in the word problem to obtain a solution. At the end of each chapter section, you will find a set of *Questions and Problems* that allows you to apply problem solving immediately to the new concepts.

Throughout each chapter, boxes titled “Chemistry Link to Health” and “Chemistry Link to the Environment” help you connect the chemical concepts you are learning to real-life situations. Many of the figures and diagrams use macro-to-micro illustrations to depict the atomic level of organization of ordinary objects. These visual models illustrate the concepts described in the text and allow you to “see” the world in a microscopic way. The *Explore Your World* features investigate concepts with materials found at home.

At the end of each chapter, you will find several study aids that complete the chapter. *Chapter Reviews* provide a summary in easy-to-read bullet points and *Concept Maps* visually show the connections between important topics. The *Key Terms*, which are in boldface type within the chapter, are listed with their definitions. *Understanding the Concepts*, a set of questions that use art and models, helps you visualize concepts. *Additional Questions and Problems* and *Challenge Problems* provide additional exercises to test your understanding of the topics in the chapter. The problems are paired, which means that each of the odd-numbered problems is matched to the following even-numbered problem. *Clinical Applications* are groups of problems that apply section content to health-related topics. The answers to all the *Study Checks* are included with the Sample Problems and the answers to all the odd-numbered problems are provided at the end of the chapter. If the answers provided match your answers, you most likely understand the topic; if not, you need to study the section again.

After some chapters, problem sets called *Combining Ideas* test your ability to solve problems containing material from more than one chapter.

Using Active Learning

A student who is an active learner continually interacts with the chemical ideas while reading the text, working problems, and attending lectures. Let’s see how this is done.

As you read and practice problem solving, you remain actively involved in studying, which enhances the learning process. In this way, you learn small bits of information at a time and establish the necessary foundation for understanding the next section. You may also note questions you have about the reading to discuss with your professor or laboratory instructor. Table 1.2 summarizes these steps for active learning. The time you spend in a lecture is also a useful learning time. By keeping track of the class schedule and reading the assigned material before a lecture, you become aware of the new terms and concepts you need to learn. Some questions that occur during your reading may be answered during the lecture. If not, you can ask your professor for further clarification.

Many students find that studying with a group can be beneficial to learning. In a group, students motivate each other to study, fill in gaps, and correct misunderstandings by teaching and learning together. Studying alone does not allow the process of peer correction. In a group, you can cover the ideas more thoroughly as you discuss the reading and problem solve with other students. You may find that it is easier to retain new material and new ideas if you study in short sessions throughout the week rather than all at once. Waiting to study until the night before an exam does not give you time to understand concepts and practice problem solving.

TABLE 1.2 Steps in Active Learning

1. Read each <i>Learning Goal</i> for an overview of the material.
2. Form a question from the title of the section you are going to read.
3. Read the section, looking for answers to your question.
4. Self-test by working <i>Sample Problems</i> and <i>Study Checks</i> .
5. Complete the <i>Questions and Problems</i> that follow that section, and check the answers for the magenta odd-numbered problems.
6. Proceed to the next section and repeat the steps.

ANALYZE THE PROBLEM	Given	Need
	165 lb	kilograms



Studying in a group can be beneficial to learning.

Making a Study Plan

As you embark on your journey into the world of chemistry, think about your approach to studying and learning chemistry. You might consider some of the ideas in the following list. Check those ideas that will help you successfully learn chemistry. Commit to them now. *Your success depends on you.*

My study plan for learning chemistry will include the following:

- _____ reading the chapter before lecture
- _____ going to lecture
- _____ reviewing the *Learning Goals*
- _____ keeping a problem notebook
- _____ reading the text as an active learner
- _____ working the *Questions and Problems* following each section and checking answers at the end of the chapter
- _____ being an active learner in lecture
- _____ organizing a study group
- _____ seeing the professor during office hours
- _____ reviewing *Key Math Skills* and *Core Chemistry Skills*
- _____ attending review sessions
- _____ organizing my own review sessions
- _____ studying as often as I can



Students discuss a chemistry problem with their professor during office hours.

SAMPLE PROBLEM 1.1 A Study Plan for Learning Chemistry

Which of the following activities would you include in your study plan for learning chemistry successfully?

- a. skipping lecture
- b. going to the professor's office hours
- c. keeping a problem notebook
- d. waiting to study until the night before the exam
- e. becoming an active learner

SOLUTION

Your success in chemistry can be improved by

- b. going to the professor's office hours
- c. keeping a problem notebook
- e. becoming an active learner

STUDY CHECK 1.1

Which of the following will help you learn chemistry?

- a. skipping review sessions
- b. working assigned problems
- c. staying up all night before an exam
- d. reading the assignment before a lecture

ANSWER

b and d

QUESTIONS AND PROBLEMS

1.3 Learning Chemistry: A Study Plan

LEARNING GOAL Develop a study plan for learning chemistry.

- 1.11** What are four things you can do to help yourself to succeed in chemistry?
- 1.12** What are four things that would make it difficult for you to learn chemistry?
- 1.13** A student in your class asks you for advice on learning chemistry. Which of the following might you suggest?
- forming a study group
 - skipping a lecture
 - visiting the professor during office hours
 - waiting until the night before an exam to study
 - being an active learner
- 1.14** A student in your class asks you for advice on learning chemistry. Which of the following might you suggest?
- doing the assigned problems
 - not reading the text; it's never on the test
 - attending review sessions
 - reading the assignment before a lecture
 - keeping a problem notebook

1.4 Key Math Skills for Chemistry

During your study of chemistry, you will work many problems that involve numbers. You will need various math skills and operations. We will review some of the key math skills that are particularly important for chemistry. As we move through the chapters, we will also reference the key math skills as they apply.

A. Identifying Place Values

For any number, we can identify the *place value* for each of the digits in that number. These place values have names such as the ones place (first place to the left of the decimal point) or the tens place (second place to the left of the decimal point). A premature baby has a mass of 2518 g. We can indicate the place values for the number 2518 as follows:

Digit	Place Value
2	thousands
5	hundreds
1	tens
8	ones

We also identify place values such as the tenths place (first place to the right of the decimal point) and the hundredths place (second place to the right of the decimal place). A silver coin has a mass of 6.407 g. We can indicate the place values for the number 6.407 as follows:

Digit	Place Value
6	ones
4	tenths
0	hundredths
7	thousandths

Note that place values ending with the suffix *ths* refer to the decimal places to the right of the decimal point.

LEARNING GOAL

Review math concepts used in chemistry: place values, positive and negative numbers, percentages, solving equations, interpreting graphs, and writing numbers in scientific notation.

KEY MATH SKILL

Identifying Place Values