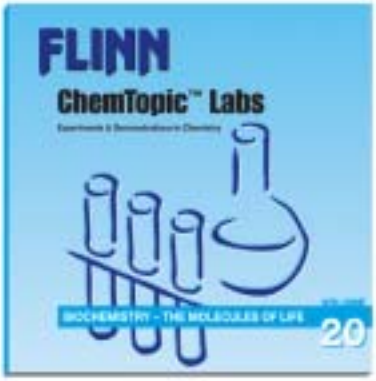
Biochemistry–The Molecules of Life—Preface



Carbohydrates, proteins, lipids, and nucleic acids—these are the molecules of life. From the smallest microbe to the largest mammal, all life depends on the properties and reactions of these four classes of organic compounds. Carbohydrates provide energy for metabolism. Proteins catalyze the reactions that allow an organism to live and grow. Lipids build cell membranes that regulate the internal structure and function of cells. Nucleic acids supply the blueprint for the synthesis of proteins and the function of life itself. Biochemistry is the study of the structure, properties, and reactions of these compounds. The purpose of *Biochemistry,* Volume 20 in the Flinn ChemTopic™ Labs series, is to bring together a selection of biochemistry lab activities for the high school science classroom. Four experiments and five demonstrations allow students to explore the physical and chemical properties of biological compounds and build vital connections between biology and chemistry.

Carbohydrates

Carbohydrates are the most abundant biological compounds. Although all carbohydrates are related structurally, they also have essential differences that give them characteristic chemical properties. In "Introduction to Carbohydrates," students perform a sequence of classification tests to unscramble the identities of five unknown carbohydrates. How are monosaccharides related to di- and polysaccharides? What is the difference between a reducing and nonreducing sugar? Each classification test addresses a key question concerning the structure and properties of carbohydrates and provides a single clue that will reveal the identity of an unknown. Three demonstrations illustrate the connection between the physical and chemical properties of carbohydrates and their biological roles. "Membrane Diffusion" compares the diffusion of small and large molecules across a semipermeable membrane to mimic the process of diffusion in cells. "Glucose Fermentation" uses an acid–base indicator and a redox indicator to demonstrate the chemistry involved in fermentation. Finally, the role of enzymes in carbohydrate digestion is explored in "Lactose Intolerance."

Amino acids and proteins

Starting with only 20 different amino acids, a single cell may synthesize more than 3,000 different proteins. The question naturally arises—what are the similarities and differences among all these different proteins? In "Identifying Proteins and Amino Acids," students perform a series of chemical tests to investigate the structure and composition of proteins and amino acids. The similarities among different proteins—albumin, casein, and gelatin—are first revealed using the biuret test. Their differences are then explored using chemical tests for three specific amino acid residues. The identification of amino acids and proteins is also the basis of an applications-oriented demonstration in "Amino Acid Fingerprints," which looks at the forensic use of the ninhydrin reaction to detect latent fingerprints. In a second experiment, "Physical Properties of Proteins," students identify possible physiological and environmental factors that lead to protein denaturation and loss of protein activity. The effect of pH on the structure and properties of proteins is further illustrated in "pH and Protein Solubility—A Reversible Demonstration."

Lipids

The chemistry of lipids is more varied than that of either carbohydrates or proteins. Lipids are related to each other not by a common structure but by a common physical property—they are insoluble in water. In "Properties of Lipids," students study the real-life processes that are used to obtain and characterize lipids. Students also perform a test for unsaturation on a variety of seed oils to learn more about the vital role of saturated versus unsaturated fats in nutrition and health. By comparing their results with the information provided on the nutritional labels of different foods, students gain personal insight into the connections between biology, chemistry, and nutrition.

Building connections

The selection of experiments and demonstrations in *Biochemistry—The Molecules of Life* provides an excellent introduction to the chemical basis of life. Building connections between the sciences and integrating all aspects of science content are important goals of science education, and indeed these goals are formally embedded in the National Science Education Standards. The experiments in this book allow students to build essential connections linking previous knowledge in biology, chemistry, and nutrition. The demonstrations add further perspective to tie together the biological and chemical properties of organic compounds. Each experiment and demonstration in *Biochemistry—The Molecules of Life* has been thoroughly tested and retested to assure success. Use the experiment summaries and concepts on the following pages to locate the concepts you want to teach and to choose experiments and demonstrations that will help you meet your goals.