PREFACE

One of our most fascinating intellectual endeavors has been to study the molecular workings of the very cells of which we ourselves are composed. This selection of readings from *Scientific American* unfolds the miracle of life by developing the structural hierarchy of living cells and showing how they are assembled from relatively simple small molecules. Beginning with a successful origin-of-life "event" in the prebiotic milieu 3 billion years ago, the course of evolution on earth has led to the existence of self-reproducing multicellular beings that include a unique species called Human. That highly developed species has now learned enough about the molecular architecture of life that some of its members have begun to manipulate it at very basic levels. The implications of this recently acquired and developing technology are awesome, perhaps terrifying to some. Furthermore, we humans are constantly "enriching" our environment with new chemical combinations that are incompatible with most living forms. Biology no longer should be the specialized domain of a few professional biologists, since we are all called upon to register opinions and make decisions that may affect the future of life on earth. It is incumbent upon all of us to be "biologists" to the extent that we try to understand the possible consequences of our actions on the future of the biosphere. We need to learn how the exercise of our intelligence may enable us to survive even though many other life forms have become extinct. As a start we should all gain some appreciation of the way in which living systems are put together and how they proliferate.

The articles in this collection span the broad field of molecular biology between two other recent *Scientific American* readers on specialized topics—*Life: Origin and Evolution* and *Recombinant DNA*. The emphasis here is upon molecular structures, their interactions in forming supramolecular structures, and the genetic control of their synthesis in the growing cells that constitute life. The story develops from George Wald's thoughtful speculations on the probability of life's origin as a chance occurrence and it leads to Stanley Cohen's discussion of the new technology of gene manipulation in which the element of chance has been minimized if not eliminated.

This is not a text, yet it is definitely intended for use in the classroom. It does not include an essay on each important topic in the field of molecular biology, even though most of those topics have in fact been documented through the years in *Scientific American* articles. To include most of them would have resulted in an unwieldy and costly volume. The articles that are included were selected to highlight material that I consider to be important but which is not normally emphasized in textbooks. I have selected many articles that are much more current and detailed than any textbook in print. Others have been selected for their historical value and because they enable the student to ap-

preciate the perceptiveness of some of the early researchers in the field of molecular biology. Students will learn how the classic experiments were done from the scientists who performed them. My choice of articles has been guided by the experience that my colleagues and I have had in the teaching of molecular and cellular biology at Stanford University and by our use of *Scientific American* readers for many years. Many of my colleagues have been of help, and I particularly wish to acknowledge the counsel of Robert Simoni and Charles Yanofsky in assembling this collection. The collection includes ten articles usually assigned to our students from an earlier reader, *The Chemical Basis of Life*, which I assembled in collaboration with Robert Haynes six years ago. The present volume includes the classic article on the gene by George Beadle, written five years before the proposal of the DNA structure by Watson and Crick. The other selections are all more recent, and they include 12 articles from the past six-year period, of which seven are from the past three years. The earlier articles have been updated and placed in current perspective through my commentary in the Introductions. Some of the authors contributed to the updating task, and I particularly want to thank Harold Morowitz, Daniel Mazia, David C. Phillips, William B. Wood, Masayasu Nomura, Charles Yanofsky, and Arthur Kornberg for their help. A list of references cited and suggested sources for additional reading (including *Scientific American* Offprints) has been provided at the end of each Introduction.

The 26 articles in this volume have been assembled in five sections. Section I considers the origin of life on the barren earth and the present-day range in complexity of cellular types from the simplest free-living cells to the component cells of mammals. Section II describes the structure and function of proteins—the principal building blocks of living organisms and the catalysts that regulate most biological activity. The assembly of subcellular organelles and those ultimate parasites, the viruses, from proteins and nucleic acids is also described. Section III deals with the boundary of the cell—that is, the membrane—and its role in compartmentalization as well as in the organization of certain essential cellular functions, such as the energy transducing systems. In Section IV, an historical flavor is intended through descriptions of classic experiments that elucidate the way in which information is transferred from the primary genetic blueprint to the synthesis of proteins and its expression in the visible properties of organisms. Finally, Section V deals with the nature of the primary genetic material, the DNA, and its transactions. The DNA is replicated, repaired, and manipulated by living cells. These same processes are now carried out in sterile glassware in the laboratories of scientists.

If the five Introductions are read first, that will be helpful in providing an overview as well as an understanding of the rationale for the arrangement of the articles selected for this volume. In the Introductions, I have tried to strike a balance between simplifying background information for the articles and commenting on current developments not discussed otherwise. I suggest that each Introduction be read as though it were the menu in a fine international restaurant, for the articles that follow are indeed delicacies from some of the great scientific "chefs" of the world.

I wish to thank my secretary, Maria Kent, for typing endless revisions and for her enlightened proofreading skill, which included worthwhile editorial suggestions. I thank Dr. Evelyn Parker for preparing the index. My father, J. Donald Hanawalt, has been a continuing source of encouragement, and my wife, Graciela, a source of inspiration.

I wish to dedicate this volume in loving memory of my mother, Lenore Smith Hanawalt, 1902–1978. She taught me to look for the beauty beyond the facts.

February 1980 *Philip C. Hanawalt*