

~ PREFACE ~

The field of molecular biology continues to be the most exciting and dynamic area of science and is predicted to dominate the 21st century. Only by investigating biological phenomena at the molecular level is it possible to understand them in detail. Such understanding is vital for advances in medicine, and the pharmaceutical industry that produces new drugs and cures is greatly dependent upon molecular biology. But molecular biology also contributes to the understanding of what human beings are and how they fit into this universe.

This volume builds on its companion volume, *The Physical and Chemical Basis of Molecular Biology*. It will be most intelligible and useful if the reader is aware of the information in that volume.

Proteins and nucleic acids are the primary subjects of molecular biology. They carry, transmit, and express the genetic information that defines each living organism. It is vital to understand how these molecules function.

The first chapter is an introduction to the covalent structures and conformations of macromolecules. The next four chapters deal with the nucleic acids. The structural and chemical properties of DNA are the basis of its central role in storing and transmitting the genetic information (Chapter 2). DNA molecules tend to be immensely long, equivalent to a rope that is many kilometers long, which gives them special topological properties that must be accommodated (Chapter 3). The structure of RNA differs from DNA only very slightly, but this gives it remarkably different properties and functions (Chapter 4). The abilities of individual strands of DNA and RNA to base-pair with other strands with complementary nucleotide sequences are central to many techniques of molecular biology and increasingly to molecular medicine (Chapter 5). The ability to manipulate nucleic acids is central to molecular biology and described in Chapter 6.

The next six chapters deal with proteins, starting with the chemical properties of polypeptide chains and the implications of their covalent structures (Chapter 7). The conformational properties of polypeptides determine the structures that proteins can adopt (Chapter 8), to produce three-dimensional structures of incredible diversity and amazing functional properties (Chapter 9). Proteins in solution have very important dynamic properties that are crucial for their biological activities (Chapter 10). They also have a propensity to lose their folded structures and unfold, and how proteins do this and how they manage to fold to their native three-dimensional structure remains a major question (Chapter 11).

The final four chapters describe the most fundamental functional properties of proteins and nucleic acids. Central to the functions of proteins is their interactions with other molecules (Chapter 12).

Some of the physiologically most important interactions are those between proteins and nucleic acids (Chapter 13). The most impressive and important property of proteins and nucleic acids is their ability to catalyze the rates of chemical reactions by many orders of magnitude, and usually incredibly specifically (Chapter 14). Such potent chemical capabilities must be controlled very closely (Chapter 15).

The references listed were chosen to be those that would best provide the interested reader with entry to the literature. They should not be assumed to be those most important for the subject.

No one person can be expert in all the areas of molecular biology, so I have made ample use of the work of many others more expert than me, but too numerous to specify. Very special thanks are due to Eric Martz of the University of Massachusetts for making available the program Firstglance in Jmol (<http://firstglance.jmol.org>). It is incredibly useful for examining protein structures and, at least as important, is very easy to use.

Of course, shortcomings and errors in this volume are totally my responsibility, for which I apologize in advance. Criticisms and suggestions would be welcome and can be sent to me at HelvetianPress@gmail.com.

Thomas E. Creighton