

# Preface

Imagine that we had some way to look directly at the molecules in a living organism. An x-ray microscope would do the trick, or since we're dreaming, perhaps an Asimov-style nanosubmarine (unfortunately, neither is currently feasible). Think of the wonders we could witness firsthand: antibodies attacking a virus, electrical signals racing down nerve fibers, proteins building new strands of DNA. Many of the questions puzzling the current cadre of scientists would be answered at a glance. But the nanoscale world of molecules is separated from our everyday world of experience by a daunting million-fold difference in size, so the world of molecules is completely invisible.

I created the illustrations in this book to help bridge this gulf and allow us to see the molecular structure of cells, if not directly, then in an artistic rendition. I have included two types of illustrations with this goal in mind: watercolor paintings which magnify a small portion of a living cell by one million times, showing the arrangement of molecules inside, and computer-generated pictures, which show the atomic details of individual molecules. In this second edition of *The Machinery of Life*, these illustrations are presented in full color, and they incorporate many of the exciting scientific advances of the 15 years since the first edition.

As with the first edition, I have used several themes to tie the pictures together. One is that of scale. Most of us do not have a good concept of the relative sizes of water molecules, proteins, ribosomes, bacteria, and people. To assist with this understanding, I have drawn the illustrations at a few consistent magnifications. The views showing the interiors of living cells, as in the Frontispiece and scattered through the last half of the book, are all drawn at one million times magnification. Because of this consistent scale, you can flip between pages in these chapters and compare the sizes of DNA, lipid membranes, nuclear pores, and all of the other molecular machinery of living cells. The computer-generated figures of individual molecules are also drawn at a few consistent scales to allow easy comparison.

I have also drawn the illustrations using a consistent style, again to allow easy comparison. A space-filling representation that shows each atom as a sphere is used for all the illustrations of molecules. The shapes of the

molecules in the cellular pictures are simplified versions of these space-filling pictures, capturing the overall form of the molecule without showing the location of every atom. The colors, of course, are completely arbitrary since most of these molecules are colorless. I have chosen them to highlight the functional features of the molecules and cellular environments.

In the drawings of cellular interiors, I have made every effort to include the proper number of molecules, in the proper place, and having the proper size and shape. In the 15 years since publication of the first edition, a remarkable variety of new data have become available to support these pictures, but the published data on the distribution and concentration of the molecules are still far from complete. As a result, the cellular pictures are subject to some personal interpretation, especially the illustrations of human cells in Chapters 5 and 6.

As in the first edition, I have written the text with the nonscientist reader in mind, and I have drawn the illustrations at a level of scientific rigor meant to satisfy readers who are scientists. For the lay reader, this book is an introduction to molecular biology—a pictorial overview of the molecules that orchestrate the processes of life. The new edition includes many new results from the study of molecular biology, and includes a new chapter on life, aging and death.

Please note, however, that this book is not meant to be comprehensive—I have chosen a series of subjects that capture the aspects of molecular biology that I find most salient, and most fascinating. The reader is referred to the excellent textbooks listed at the end of the book for more detailed and comprehensive information. In particular, *Molecular Biology of the Cell* will point the way to further study of nearly any subject in cell or molecular biology. For the scientist, it is my hope that this book will continue to provide a touchstone for intuition. Please use the illustrations, as I have, to help imagine biological molecules in their proper context: packed into living cells.

I thank the people who have been instrumental in seeing this project from concept to conclusion. Arthur Olson has continued to provide useful comments at every stage, as well as providing an amazing working environment in the Molecular Graphics Laboratory at the Scripps Research Institute in La Jolla. Much of the material from this book draws on my Molecule of the Month series at the RCSB Protein Data Bank, which has kindly supported my illustration and writing for the past 8 years. I also thank the Fondation Scientifique Fourmentin-Guilbert for their kind support of this project. The computer-generated illustrations were produced with methods that I developed under the auspices of the Daymon Runyon-Walter Winchell Cancer Research Fund, the National Institutes of Health, and the National Science Foundation. Finally, I would like to thank Bill Grimm for his support and confidence.

La Jolla, CA

D.S. Goodsell



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Goodsell, D.S.

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