

## INTRODUCTION

We live in a troubled, but wonderful time. It is our good fortune to witness and benefit from scientific advances that would have been literally unimaginable to our grandparents. However, there are dark clouds on the horizon. The rate of growth of scientific knowledge has been so great as to outstrip the ability of our society to assimilate it, the capacity of the educational system to teach it properly, and the wisdom of government adequately to sustain and apply it. There is growing indifference to science among the young. Even medical science, which touches the lives of us all, is generally left to the practitioners. Whatever the reason for this disparity between the importance of science and the lack of general public understanding, it is important to address it.

In this book we try to take a few steps in this direction. Specifically, the pages to follow tell the tales of many molecules that can qualify as miracles of modernity. These relatively small, highly-structured clusters of atoms, the principal therapeutic agents of modern medicine, can perform in a way that would have been considered miraculous to our ancestors. Such "miracle molecules" can save countless human lives, prolong human life, alleviate pain and suffering, control cells, tissues and organs millions of times their size, and bring enormous material gains through commercial sales of billions of dollars per year. Such molecules also can serve as tools to probe the molecular nature of life processes and disease states and pave the way for the discovery of other effective medicines.

The molecules at the core of this book have been carefully selected from several thousand therapeutic agents that have been used in medicine at one time or another. The development of each of them, arduous and costly though it might have been, represents an enormously valuable investment with very large and ongoing benefits. In the course of discovering all these wonderfully useful molecules, we have learned more about the discovery process itself and have developed an ever expanding set of new discovery tools. The invention of these new platforms for innovation is being powered by dramatic advances in technology, computing and the underlying chemical and biomedical sciences.

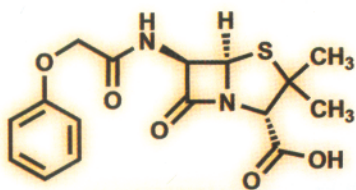
The very next section of this book provides a step-by-step introduction to the understanding of the architecture of organic molecules and the general principles that govern structures of molecules. In addition, we explore the fundamental forces that hold molecules together and that allow them to recognize and bind to one another. The affinity of molecules for one another is central to the biological activity of therapeutic agents and to life itself. The section on how to read the chemical diagrams of small molecules is followed by another tutorial on understanding much larger structures, the proteins of life.

It seems quite possible that, in the next century or so, effective treatments for most illnesses will emerge. Disease, premature death, suffering and pain may no longer be a part of the human condition. Humans will as a matter of course live out a full and healthy lifespan, and then depart with grace and dignity. The famous poem of Lady Gio in "The Tale of the Heike" describes the life process and its end in an eloquent and happy way:

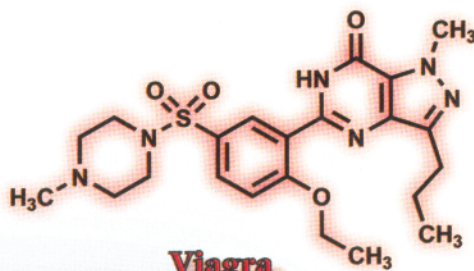
*Grasses of the plain,  
Springing up and withering,  
They all fare alike.  
Indeed the lot of all things  
Is but to wait for autumn.*

An impossible dream? Perhaps, but the immense effort required will be well worthwhile, because the gain will be incalculable. The achievements of modern science and technology provide both encouragement and inspiration.

For instance, we now can trace our universe back some 14 billion years to an unbelievably hot object, with a temperature of about  $10^{32}$  Kelvin (10 followed by 32 zeros), and more than a million times smaller than the period at the end of this sentence. From this inferno of exceedingly small and simple objects, the first elements, hydrogen and helium, formed about a million years later, to be followed by all the other objects of the universe – the chemical elements, stars and galaxies, and an unknown collection of other forms of matter and energy, and finally the earth and life upon it. Surely, a time will come when our knowledge of life, intelligence, disease and health will dwarf that of the present.

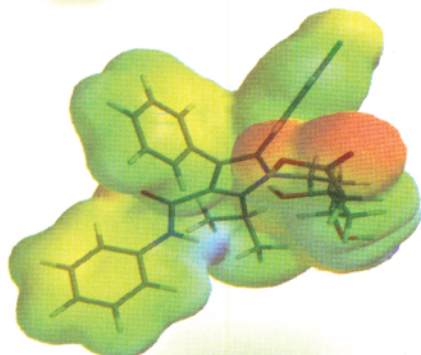
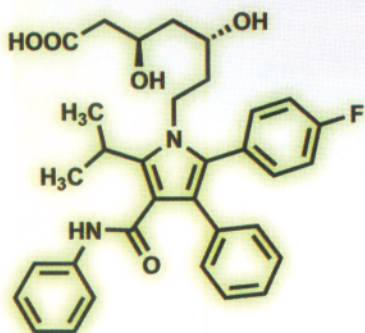


**Penicillin V**

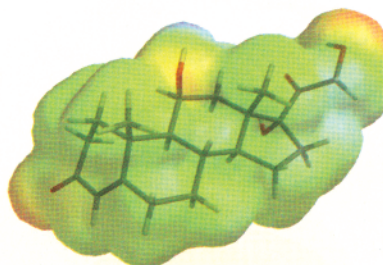
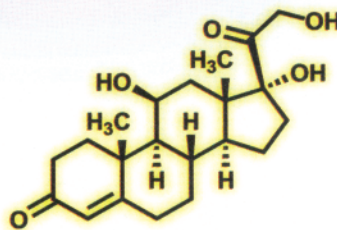


**Viagra**

# MIRACLE MOLECULES



**Lipitor**



**Cortisol**