PREFACE

Biotechnology has made the world a different place. Biotechnology has made it possible to identify the genetic causes behind many different inherited diseases. Biotechnology has made it possible for people to survive to a much higher population density by providing more food per acre. The advent of modern molecular biology and genetics has advanced our understanding of the genomes of a wide range of organisms from viruses and bacteria to trees and humans. The application of this knowledge has revolutionized the sciences, changing them from a descriptive nature to a variety of disciplines that provide new products such as drugs, vaccines, and foods.

Biotechnology has opened doors to making proteins with new functions, and even new biochemical pathways with altered products. With new proteins and new biochemical pathways, it seems only logical to find ways to incorporate the new functions into crops, into animals, and, it is hoped, into people with genetically based illnesses. Only a short time ago, agriculturists largely relied on green fingers to get good yields; today they use green fluorescent protein to assess gene expression in transgenic crops. The ability to make such direct changes will result in major changes for the future. Will biotechnology find the proverbial fountain of youth by identifying the molecular changes that cause us to age or develop cancer? Will it change the way we treat diseases? Will the way we wage war change with the development of new biological agents?

Biotechnology: Applying the Genetic Revolution explains how the information from the genetic revolution is being used to answer some of these questions. It informs the reader about the many avenues where biotechnology has changed the original field of study. The first few chapters provide a clear and concise review of the basics of molecular biology. These topics are explained in more detail in the first book of this series, entitled *Molecular Biology: Understanding the Genetic Revolution*. This review will take the student through the basics, including DNA structure, gene expression, and protein synthesis, as well as survey the variety of organisms used in biotechnology research. The student is then presented with the basic methodologies used in biotechnology research. Chapter 3 explains how nucleic acids are isolated, cloned into humanmade genetic vehicles, and then reinserted into one of the model organisms for in-depth analysis. The next two chapters discuss in more detail various techniques that have been developed to investigate the function of genes. Chapter 4 focuses on DNA, dealing with both *in vivo* and *in vitro* synthesis of DNA and the polymerase chain reaction. Chapter 5 focuses on RNA, explaining antisense technology, RNA interference, and ribozymes. Familiarity with these chapters is critical to understanding the rest of the textbook.

The remaining chapters focus on different fields of research, presenting some of the ways the genetic revolution has irreversibly changed these areas. Chapter 6 begins this approach by presenting newer techniques to generate antibodies for genetic research and for creating new vaccines. Chapter 7 delves into a different realm, one based on the nanoscale. This chapter evaluates how molecular biology will be changed by the ability of scientists to work in the nanoscale world. It discusses how scientists are using novel nanoscale structures to deliver drugs, identify biological molecules *in situ*, and manufacture antibacterial materials. The chapter illustrates how nanobiotechnology exploits the self-assembly property of DNA to create nanodevices. It shows how DNA can physically control the shape of proteins. This new field of research is intimately intertwined with molecular biology and will only become a stronger component of molecular biology courses in the future.

The next section returns to the more familiar world of genomics and proteomics. These chapters emphasize the applied aspect of these topics and discuss the medical applications of advances in genomics and proteomics. The proteomics chapter includes a variety of techniques used to isolate and characterize proteins, including the more recent developments in mass spectrometry. Proteomics provides a nice segue to the next chapter, which surveys how proteins are studied by expressing them in various organisms and cultured cells. The creation of proteins with novel properties by protein engineering follows.

Because single genetically modified proteins have their limitations, Chapter 12 moves from the lab to the environment and presents the emerging field of metagenomics. This approach bypasses the traditional method of identifying new genes one at a time from model organisms in the laboratory. Instead, metagenomics skips directly to isolating genomic sequences from the environment without identifying the organism from which they originate. The investigation of novel gene functions continues in Chapter 13. Biochemical pathways may be altered using recombinant DNA technology, and this chapter presents a few of these novel pathways. Construction of novel proteins and biochemical pathways is pointless unless they can be inserted into plants and animals. So the next two chapters present the student with the latest advances in creating transgenic plants and animals.

The next block of chapters focuses on the medical arena. First, in Chapter 16, the molecular basis for inherited defects is examined. This leads into the following chapter on gene therapy. Several chapters then present the molecular basis of cancer, a selection of noninfectious diseases, such as erectile dysfunction, diabetes, and obesity, and then aging. Last, molecular biology has made huge strides in our understanding of bacterial and viral diseases. In Chapter 21 and Chapter 22, the student will learn how bacteria and viruses exploit our cellular machinery to cause disease. The latest research on the unusual prion diseases, such as mad cow disease and Creutzfeldt-Jakob disease, is also covered. Chapter 23 builds on the knowledge of bacterial and viral pathogenesis to present a survey of biowarfare and bioterrorism.

Chapter 24 surveys how the field of forensics has been altered by the genetic revolution. The way criminals are identified via molecular biology has changed the penal system irreversibly. New cases, old cases, and unsolved cases are all now examined with DNA testing which is more accurate and reliable than previous identification methods. The use of DNA in criminal investigation has even spawned popular television series that showcase these advances and their effect on society. As the book comes to a close in Chapter 25, the subject of bioethics is presented. Rather than discussing scientific methodology, this chapter asks questions about the role of these methodologies in society. Should we use the genetic revolution to clone a human, create transgenic crops, do research on human stem cells? Should our genetic identity be open to the public domain?

Biotechnology: Applying the Genetic Revolution demonstrates many different ways in which advances in technology and the revolution in molecular biology have merged. The combined ability to process large volumes of information along with analyzing our bodies and other organisms with infinitesimal precision has and will continue to change our society, our ethics, and our personal surroundings. This book gives the student a basic knowledge of some of those changes that have already occurred, with the hope that they will be able to apply this knowledge toward future advances.