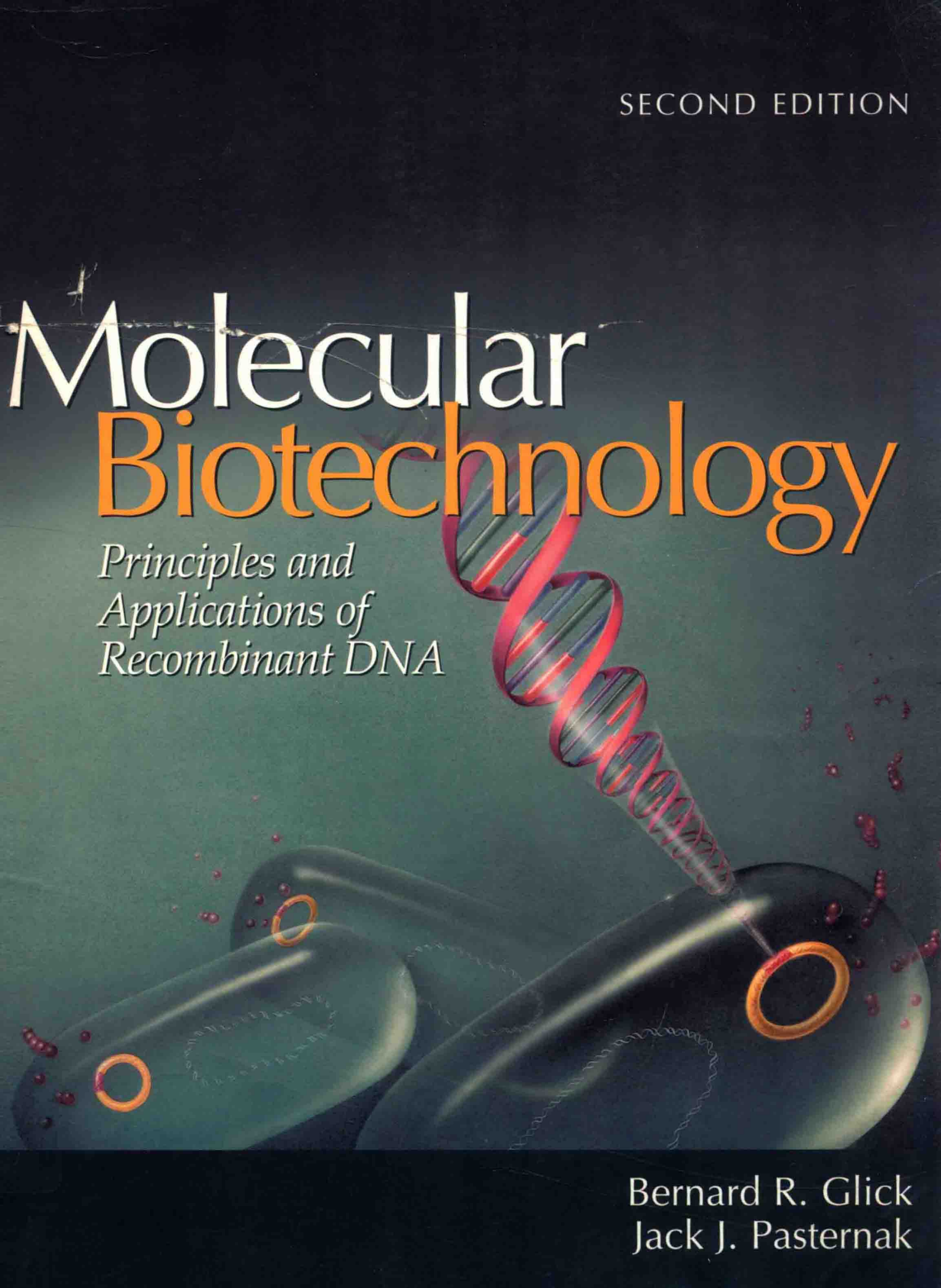


SECOND EDITION

Molecular Biotechnology



*Principles and
Applications of
Recombinant DNA*

Bernard R. Glick
Jack J. Pasternak

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of Recombinant DNA*

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Jack J. Pasternak**

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SECOND EDITION

Molecular Biotechnology

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of Recombinant DNA*

To Marcia, for being Marcia
BRG

To Lili, for everything
JJP

Preface

In the past 4 years, since the publication of the first edition of *Molecular Biotechnology: Principles and Applications of Recombinant DNA*, there has been an outpouring of new discoveries from biotechnology laboratories, and many gene-based innovations have been introduced into the marketplace. For example, human pharmaceuticals that are the products of cloned genes have been commercialized, while many other promising biotechnology drugs are being tested; immunological and PCR-based diagnostic assays for several disease-causing organisms and human disorders have become the standard feature of clinical testing procedures; novel recombinant vaccines that are based on gene products and cloned genes have been developed; many human disease genes have been identified and characterized; the number of human gene therapy clinical trials has increased 10-fold; detailed genetic and physical maps of human chromosomes have been constructed; the first mammal has been cloned from a differentiated somatic cell; and the first commercial transgenic plants have been used on a large scale.

In the first edition, we presented the principles and applications of molecular biotechnology, in a broad biological context, in a way that would be interesting and informative. Since then, we have received many helpful comments from colleagues, graduate students, and undergraduates from many different institutions around the world. With our original objectives in mind and taking into consideration the advice of a number of readers, we have updated, expanded, and reorganized *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. We hope that the second edition conveys the excitement of molecular biotechnology, the scientific underpinnings of this area of study, the significance of recent discoveries, and how this information will be used to create "goods and services." Specifically, a new chapter that discusses the organisms that are commonly used by molecular biotechnologists has been added. As well, there is a complete chapter that describes the fundamental principles of molecular biology. The chapters dealing with human molecular genetics, human gene therapy, and

plant biotechnology have been extensively expanded to account for the recent advances in these areas. The chapters pertaining to diagnostic assays and vaccines have been thoroughly reorganized. The coverage of material has been updated throughout the book. In addition to these extensive changes, the numbers of figures and tables have been increased by approximately 50% to facilitate the understanding of both experimental strategies and important theoretical concepts. The glossary has also been updated and expanded. Notwithstanding all of the revising and reorganization, we have tried to preserve the same jargon-free and “reader-friendly” style that made the first edition popular with students.

We thank the crew at ASM Press, including Ken April, Susan Birch, Greg Payne, and Jeff Holtmeier for their support and encouragement. Susan Schmidler, as usual, did an excellent job with design of the book. Special thanks to Ken April, who handled the manuscript with diligence and thoroughness and us with patience.

Bernard R. Glick
Jack J. Pasternak

Preface to the First Edition

Molecular biotechnology emerged as a new research field that arose as a result of the fusion in the late 1970s of recombinant DNA technology and traditional industrial microbiology. Whether one goes to the movies to see *Jurassic Park* with its ingenious but scientifically untenable plot of cloning dinosaurs, reads in the newspaper about the commercialization of a new “biotech” tomato that has an extended shelf life, or hears one of the critics of molecular biotechnology talking about the possibility of dire consequences from genetic engineering, there is a significant public awareness about recombinant DNA technology. In this book, we introduce and explain what molecular biotechnology actually is as a scientific discipline, how the research in the area is conducted, and how this technology may realistically impact on our lives in the future.

We have written *Molecular Biotechnology: Principles and Applications of Recombinant DNA* to serve as a text for courses in biotechnology, recombinant DNA technology, and genetic engineering or for any course introducing both the principles and the applications of contemporary molecular biology methods. The book is based on the biotechnology course we have offered for the past 12 years to advanced undergraduate and graduate studies from the biological and engineering sciences at the University of Waterloo. We have written this text for students who have an understanding of basic ideas from biochemistry, molecular genetics, and microbiology. We are aware that it is unlikely that students will have had all of these courses before taking a course on biotechnology. Thus, we have tried to develop the topics in this text by explaining their broader biological context before delving into molecular details.

This text emphasizes how recombinant DNA technology can be used to create various useful products. We have, wherever possible, used experimental results and actual methodological strategies to illustrate basic concepts, and we have tried to capture the flavor and feel of how molecular biotechnology operates as a scientific venture. The examples that we have selected—from a vast and rapidly growing literature—were chosen as case studies that not only illustrate particular points but also provide the reader with a solid basis for understanding current research in specialized areas of

molecular biotechnology. Nevertheless, we expect that some of our examples will be out of date by the time the book is published, because molecular biotechnology is such a rapidly changing discipline.

For the ease of the day-to-day practitioners, scientific disciplines often develop specialized terms and nomenclature. We have tried to minimize the use of technical jargon and, in many instances, have deliberately used a simple phrase to describe a phenomenon or process that might otherwise have been expressed more succinctly with technical jargon. In any field of study, synonymous terms that describe the same phenomenon exist. In molecular biotechnology, for example, recombinant DNA technology, gene cloning, and genetic engineering, in a broad sense, have the same meaning. When an important term or concept appears for the first time in this text, it is followed in parentheses with a synonym or equivalent expression. An extensive glossary can be found at the end of the book to help the reader with the terminology of molecular biotechnology.

Each chapter opens with an outline of topics and concludes with a detailed summary and list of review questions to sharpen students' critical thinking skills. All of the key ideas in the book are carefully illustrated by the more than 200 full-color diagrams in the pedagogical belief that a picture is indeed worth a thousand words. After introducing molecular biotechnology as a scientific and economic venture in Chapter 1, the next five chapters (2 to 6) deal with the methodologies of molecular biotechnology. The chapters of Part I act as a stepping-stone for the remainder of the book. Chapters 7 to 12 in Part II present examples of microbial molecular biotechnology covering such topics as the production of metabolites, vaccines, therapeutics, diagnostics, bioremediation, biomass utilization, bacterial fertilizers, and microbial pesticides. Chapter 13 describes some of the key components of large-scale fermentation processes using genetically engineered (recombinant) microorganisms. In Part III, we deal with the molecular biotechnology of plants and animals (Chapters 14 and 15). The isolation of human disease-causing genes by using recombinant DNA technology and how, although it is in its early stages, genetic manipulation is being currently contemplated for the treatment of human diseases are presented in Chapters 16 and 17. The book concludes with coverage of the regulation of molecular biotechnology and patents in Part IV.

A brief mention should be made about the reference sections that follow each chapter. Within many of the chapters we have relied upon the published work of various researchers. In all cases, although not cited directly in the body of a chapter, the original published articles are noted in the reference section of the appropriate chapter. In some cases, we have taken "pedagogic license" and either extracted or reformulated data from the original publications. Clearly, we are responsible for any distortions or misrepresentations from these simplifications, although we hope that none has occurred. The reference sections also contain other sources that we used in a general way, which might, if consulted, bring the readers closer to a particular subject.

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*Bernard R. Glick
Jack J. Pasternak*

Contents

Preface xix

Preface to the First Edition xxi

PART ONE

Fundamentals of Molecular Biotechnology 1

CHAPTER 1

The Molecular Biotechnology Revolution 3

Recombinant DNA Technology 3

Emergence of Molecular Biotechnology 4

Commercialization of Molecular Biotechnology 8

Concerns and Consequences 10

SUMMARY 11

REFERENCES 12

REVIEW QUESTIONS 12

CHAPTER 2

Molecular Biotechnology Biological Systems 13

Prokaryotic and Eukaryotic Organisms 13

Escherichia coli 14

Saccharomyces cerevisiae 16

Eukaryotic Cells in Culture 17

SUMMARY 17

REFERENCES 17

REVIEW QUESTIONS 18

CHAPTER 3

DNA, RNA, and Protein Synthesis 19

Structure of DNA 19

DNA Replication 22

Decoding Genetic Information: RNA and Protein 23

Translation 30

Regulation of mRNA Transcription in Bacteria 35

Regulation of mRNA Transcription in Eukaryotes 39

SUMMARY 42

REFERENCES 44

REVIEW QUESTIONS 44

CHAPTER 4

Recombinant DNA Technology 45

Restriction Endonucleases 45

Plasmid Cloning Vectors 51

Plasmid Cloning Vector pBR322 53

Transformation and Selection 54

Other Plasmid Cloning Vectors 56

Creating and Screening a Library 59

Making a Gene Library 59

Screening by DNA Hybridization 59

Screening by Immunological Assay 65

Screening by Protein Activity 65

Cloning DNA Sequences That Encode Eukaryotic Proteins 66

Vectors for Cloning Large Pieces of DNA 68

Bacteriophage λ Vectors 68

Cosmids 70

Very-Large-Insert Bacterial Vector Systems 72

Genetic Transformation of Prokaryotes 74

Transferring DNA into *E. coli* 74

Electroporation 74

Conjugation 75

SUMMARY 76

REFERENCES 76

REVIEW QUESTIONS 77

CHAPTER 5

Chemical Synthesis, Sequencing, and Amplification of DNA 79

Chemical Synthesis of DNA 79

The Phosphoramidite Method 80

Uses of Synthesized Oligonucleotides 84

Synthesis of Genes 85

DNA Sequencing Techniques 89

- Dideoxynucleotide Procedure for Sequencing DNA 89
- Using Bacteriophage M13 To Obtain Single-Stranded DNA 92
- Primer Walking 93

PCR 96

- Cloning cDNA Ends by PCR 98
- Gene Synthesis by PCR 102
- SUMMARY 106
- REFERENCES 107
- REVIEW QUESTIONS 107

CHAPTER 6

Manipulation of Gene Expression in Prokaryotes 109**Gene Expression from Strong and Regulatable Promoters 110**

- Regulatable Promoters 110
- Increasing Protein Production 113
- Large-Scale Systems 114
- Expression in Other Microorganisms 115

Fusion Proteins 117

- Cleavage of Fusion Proteins 118
- Uses of Fusion Proteins 118
- Surface Display 122

Unidirectional Tandem Gene Arrays 124**Translation Expression Vectors 127****Increasing Protein Stability 128****Overcoming Oxygen Limitation 129**

- Use of Protease-Deficient Host Strains 129
- Bacterial Hemoglobin 129

DNA Integration into the Host Chromosome 130**Increasing Secretion 134****Metabolic Load 135**

- SUMMARY 138
- REFERENCES 140
- REVIEW QUESTIONS 143

CHAPTER 7

Recombinant Protein Production in Eukaryotic Cells 145***Saccharomyces cerevisiae* Expression Systems 146**

- S. cerevisiae* Vectors 147
- Direct Expression in *S. cerevisiae* 147
- Secretion of Heterologous Proteins by *S. cerevisiae* 150

Other Yeast Expression Systems 151

- Expression of Hepatitis B Virus Surface Antigen 151
- Expression of Bovine Lysozyme C2 153

Cultured Insect Cell Expression Systems 154

- Baculovirus Expression Vector System 155

- Production of Recombinant Baculovirus 156
 Construction of an *E. coli*-Insect Cell Baculovirus Shuttle Vector 158
 Selective Purification of Recombinant Protein from Insect Cells by Affinity
 Tagging 160

Mammalian Cell Expression Vectors 161

- Selectable Marker Systems for Mammalian Expression Vectors 162
 Expression of Two Cloned Genes in One Mammalian Cell 163
 SUMMARY 166
 REFERENCES 168
 REVIEW QUESTIONS 169

CHAPTER 8

Directed Mutagenesis and Protein Engineering 171

Directed Mutagenesis Procedures 172

- Oligonucleotide-Directed Mutagenesis with M13 DNA 173
 Oligonucleotide-Directed Mutagenesis with Plasmid DNA 176
 PCR-Amplified Oligonucleotide-Directed Mutagenesis 176
 Random Mutagenesis with Degenerate Oligonucleotide Primers 179
 Random Mutagenesis with Nucleotide Analogs 182

Protein Engineering 182

- Adding Disulfide Bonds 184
 Changing Asparagine to Other Amino Acids 186
 Reducing the Number of Free Sulfhydryl Residues 187
 Increasing Enzymatic Activity 187
 Modifying Metal Cofactor Requirements 189
 Modifying Enzyme Specificity 191
 Increasing Enzyme Stability and Specificity 192
 SUMMARY 192
 REFERENCES 193
 REVIEW QUESTIONS 194

PART TWO

Molecular Biotechnology of Microbial Systems 197

CHAPTER 9

Molecular Diagnostics 199

Immunological Diagnostic Procedures 200

- Enzyme-Linked Immunosorbent Assay 201

Monoclonal Antibodies 201

- Formation and Selection of Hybrid Cells 203
 Identification of Specific Antibody-Producing Hybrid Cell Lines 205

DNA Diagnostic Systems 206

- Hybridization Probes 206
 Diagnosis of Malaria 207
 Detection of *Trypanosoma cruzi* 207

Nonradioactive Hybridization Procedures	208
DNA Fingerprinting	212
Random Amplified Polymorphic DNA	212
Molecular Diagnosis of Genetic Disease	215
Sickle-Cell Anemia	215
The PCR/OLA Procedure	216
Genotyping with Fluorescence-Labeled PCR Primers	219
Mutation at Different Sites within One Gene	219

Prospects 222

SUMMARY	222
REFERENCES	223
REVIEW QUESTIONS	224

CHAPTER 10

Microbial Production of Therapeutic Agents 227**Pharmaceuticals 228**

Isolation of Interferon cDNAs	228
Engineering Human Interferons	230
Engineering Human Growth Hormone	231
Optimizing Gene Expression	232

Enzymes 233

DNase I	233
Alginate Lyase	233

Monoclonal Antibodies as Therapeutic Agents 235

Structure and Function of Antibodies	235
Preventing Rejection of Transplanted Organs	237
Chemically Linked Monoclonal Antibodies	237
Human Monoclonal Antibodies	238
Hybrid Human-Mouse Monoclonal Antibodies	240

Production of Antibodies in *E. coli* 243**HIV Therapeutic Agents 247**

SUMMARY	249
REFERENCES	250
REVIEW QUESTIONS	252

CHAPTER 11

Vaccines 253**Subunit Vaccines 255**

Herpes Simplex Virus	256
Foot-and-Mouth Disease	257
Tuberculosis	258
Peptide Vaccines	259
Genetic Immunization	260

Attenuated Vaccines 263

Cholera	263
<i>Salmonella</i> Species	265
<i>Leishmania</i> Species	265

Vector Vaccines 267

- Vaccines Directed against Viruses 267
- Vaccines Directed against Bacteria 272
- Bacteria as Antigen Delivery Systems 272
- SUMMARY 273
- REFERENCES 274
- REVIEW QUESTIONS 276

CHAPTER 12

Synthesis of Commercial Products by Recombinant Microorganisms 277

Restriction Endonucleases 277

Small Biological Molecules 280

- Synthesis of L-Ascorbic Acid 280
- Microbial Synthesis of Indigo 284
- Synthesis of Amino Acids 286

Antibiotics 289

- Cloning Antibiotic Biosynthesis Genes 290
- Synthesis of Novel Antibiotics 292
- Engineering Polyketide Antibiotics 294
- Improving Antibiotic Production 296

Biopolymers 299

- Engineering *Xanthomonas campestris* for Inexpensive Xanthan Gum Production 300
- Isolation of Melanin Biosynthesis Genes 301
- Synthesis of an Animal Adhesive Biopolymer in Microbial Cells 302
- Microbial Synthesis of Rubber 304
- Microbial Production of Polyhydroxyalkanoates 304
- SUMMARY 306
- REFERENCES 307
- REVIEW QUESTIONS 309

CHAPTER 13

Bioremediation and Biomass Utilization 311

Microbial Degradation of Xenobiotics 311

Genetic Engineering of Biodegradative Pathways 316

- Manipulation by Transfer of Plasmids 318
- Manipulation by Gene Alteration 318

Utilization of Starch and Sugars 324

- Commercial Production of Fructose and Alcohol 324
- Improving Fructose and Alcohol Production 326
- Zymomonas mobilis* 330
- Silage Fermentation 332

Utilization of Cellulose 333

- Components of Lignocellulose 334
- Isolation of Prokaryotic Cellulase Genes 336
- Isolation of Eukaryotic Cellulase Genes 338
- Manipulation of Cellulase Genes 339

Production of Single-Cell Protein 341

SUMMARY 342

REFERENCES 343

REVIEW QUESTIONS 345

CHAPTER 14

Plant Growth-Promoting Bacteria 347**Nitrogen Fixation 348****Nitrogenase 350**

Components of Nitrogenase 350

Genetic Engineering of the Nitrogenase Gene Cluster 352

Hydrogenase 356

Hydrogen Metabolism 356

Genetic Engineering of Hydrogenase Genes 357

Nodulation 359

Competition among Nodulating Organisms 359

Genetic Engineering of Nodulation Genes 359

Biocontrol of Pathogens 364

Siderophores 364

Antibiotics 366

Enzymes 367

Ice Nucleation and Antifreeze Proteins 369

Growth Promotion by Free-Living Bacteria 370

SUMMARY 372

REFERENCES 373

REVIEW QUESTIONS 374

CHAPTER 15

Microbial Insecticides 377**Insecticidal Toxin of *Bacillus thuringiensis* 378**

Mode of Action and Use 378

Toxin Gene Isolation 382

Engineering of *B. thuringiensis* Toxin Genes 383**Baculoviruses as Biocontrol Agents 391**

Mode of Action 391

Genetic Engineering for Improved Biocontrol 392

SUMMARY 394

REFERENCES 395

REVIEW QUESTIONS 397

CHAPTER 16

Large-Scale Production of Proteins from Recombinant Microorganisms 399**Principles of Microbial Growth 401**

Batch Fermentation 401

Fed-Batch Fermentation 403