

# Contents

*Preface*

*xiii*

## **SECTION I – INTRODUCTION TO BIOTECHNOLOGY** 1.1–1.7

### **1. Biotechnology: An Overview, Scope and Importance**

- 1.1 Definition of Biotechnology 1.3
- 1.2 Interdisciplinary Nature of Biotechnology 1.4
- 1.3 Applications of Biotechnology 1.5
- 1.4 Misuse of Biotechnology 1.6
- 1.5 International and National Organizations Related to Biotechnology 1.6

## **SECTION II – BIOCHEMISTRY** 2.1–2.38

### **2. Biomolecules**

- 2.1 Chemical Foundation of Biology 2.3
- 2.2 Nature of Biomolecules and their Functional Groups 2.4
- 2.3 Major Classes of Biomolecules 2.7
  - Summary* 2.37
  - Review Questions* 2.38

### **3. Biophysical Chemistry** 3.1–3.23

- 3.1 Principles of Thermodynamics 3.1
- 3.2 Molecular Interaction in Biological System 3.10
- 3.3 pH and Buffer 3.13
  - Summary* 3.22
  - Review Questions* 3.22

### **4. Metabolic Pathways and Regulation** 4.1–4.58

- 4.1 Introduction 4.1
- 4.2 Metabolism and Metabolic Pathways 4.6
- 4.3 Carbohydrate Metabolism 4.7
- 4.4 Protein Metabolism 4.33
- 4.5 Lipid Metabolism 4.44
- 4.6 Intermediary Metabolism 4.54
  - Summary* 4.57
  - Review Questions* 4.58

## **SECTION III – CELL BIOLOGY** 5.1–5.42

### **5. Cell Biology**

- 5.1 Introduction 5.3
- 5.2 Cell—Shape and Size 5.4

5.3	Prokaryotes and Eukaryotes	5.4	
5.4	General Structure and Organization of Prokaryotic Cell	5.6	
5.5	General Structure and Organization of an Eukaryotic Cell	5.6	
5.6	Plasma Membrane	5.6	
5.7	The Endomembrane System	5.13	
5.8	Mitochondria and Chloroplasts	5.18	
5.9	The Nucleus	5.23	
5.10	The Cell Cycle	5.26	
5.11	Cancer—Overview	5.31	
5.12	Apoptosis	5.35	
	<i>Summary</i>	5.41	
	<i>Review Questions</i>	5.41	
<b>6.</b>	<b>Microbial Physiology, Pathogenesis and Genetics</b>		<b>6.1–6.116</b>
6.1	Concepts and Methods of Microbiology	6.1	
6.2	Sterilization	6.7	
6.3	Prokaryotic Structure and Function	6.17	
6.4	Overview of Microbial Metabolism (Metabolism and Diversity among Microorganisms)	6.25	
6.5	Metabolic Diversity among Microorganisms	6.30	
6.6	Metabolism in Archaeobacteria	6.46	
6.7	Importance of N <sub>2</sub> Fixation	6.65	
6.8	Microbial Pathogenesis and Host—Parasite Relationship	6.70	
6.9	Microbial Genetics	6.89	
	<i>Summary</i>	6.113	
	<i>Review Questions</i>	6.115	
	<b>SECTION IV – MOLECULAR BIOLOGY</b>		<b>7.1–7.36</b>
<b>7.</b>	<b>DNA Replication, Repair and Recombination</b>		
7.1	DNA Replication	7.3	
7.2	Replication in Prokaryotes	7.8	
7.3	Replication in Eukaryotes	7.16	
7.4	DNA Repair	7.18	
7.5	DNA Recombination	7.28	
	<i>Summary</i>	7.34	
	<i>Review Questions</i>	7.35	
<b>8.</b>	<b>Transcription and Translation</b>		<b>8.1–8.20</b>
8.1	Transcription	8.1	
8.2	Translation	8.9	
8.3	The Mechanism of Protein Synthesis	8.12	
	<i>Summary</i>	8.19	
	<i>Review Questions</i>	8.20	
<b>9.</b>	<b>RNA Processing</b>		<b>9.1–9.9</b>
9.1	Introduction	9.1	
9.2	RNA Capping	9.2	

- 9.3 Poly (A) Tail Formation 9.3
- 9.4 RNA Splicing 9.4
- Summary* 9.8
- Review Questions* 9.9

## **10. Regulation of Gene Expression** **10.1–10.12**

- 10.1 Introduction 10.1
- 10.2 Gene Regulation in Prokaryotes 10.2
- 10.3 Gene Regulation in Eukaryotes 10.7
- Summary* 10.11
- Review Questions* 10.11

## **SECTION V – RECOMBINANT DNA TECHNOLOGY (GENETIC ENGINEERING)** **11.1–11.45**

### **11. Molecular Tools and Technology in Genetic Engineering**

- 11.1 Introduction 11.3
- 11.2 Isolation, Sequencing, Synthesis and Amplification of DNA 11.19
- 11.3 Cloning Strategies 11.32
- Summary* 11.40
- Review Questions* 11.42

### **12. Gene-Product Engineering** **12.1–12.4**

- 12.1 Introduction 12.1
- 12.2 Protein Engineering 12.1
- Summary* 12.4
- Review Questions* 12.4

### **13. Transgenic Technology** **13.1–13.11**

- 13.1 Introduction 13.1
- 13.2 Approach through Natural Methods 13.1
- 13.3 Artificial Method of DNA Transfer 13.4
- Summary* 13.10
- Review Questions* 13.10

## **SECTION VI – PLANT BIOTECHNOLOGY** **14.1–14.35**

### **14. Plant Biotechnology**

- 14.1 Introduction 14.3
- 14.2 Culture Media and Its Components 14.6
- 14.3 Culture Techniques 14.9
- 14.4 Isolation and Maintenance of Callus-Cell Suspension and Single-Cell Culture 14.12
- 14.5 Micropropagation and Somatic Embryogenesis 14.16
- 14.6 Organ Culture and Embryo Culture 14.22
- 14.7 Protoplast Isolation, Culture and Fusion 14.24
- 14.8 Applications of Plant-Tissue Culture 14.28
- 14.9 Gene-Transfer Technology in Plants and its Application 14.30
- Summary* 14.33
- Review Questions* 14.34

**SECTION VII – ANIMAL BIOTECHNOLOGY**

15.1–15.30

**15. Animal Biotechnology**

- 15.1 Introduction 15.3
- 15.2 Advantages of Tissue Culture 15.3
- 15.3 Laboratory Design and Equipment 15.4
- 15.4 Culture Environment 15.7
- 15.5 Media 15.8
- 15.6 Serum 15.8
- 15.7 Contamination 15.9
- 15.8 Sterilization 15.10
- 15.9 Primary Culture 15.10
- 15.10 Preservation of Cell Line 15.15
- 15.11 Transformation and Genetic Instability 15.15
- 15.12 Cell Freezing 15.15
- 15.13 Quantitation 15.19
- 15.14 Cytotoxicity and Survival 15.22
- 15.15 Organ Culture 15.23
- 15.16 The Stem Cell 15.23
- 15.17 Somatic-Cell Genetics 15.27
- 15.18 Fertilization in the Laboratory 15.28
- Summary* 15.29
- Review Questions* 15.29

**SECTION VIII – IMMUNOTECHNOLOGY**

16.1–16.41

**16. Basic Immunology**

- 16.1 Basic Immunology 16.3
- 16.2 Types of Immunity 16.5
- 16.3 Organs and Cells of the Immune System 16.11
- 16.4 Nature and Biology of Antigens and Super-Antigens 16.21
- 16.5 Antibody: Structure and Function 16.23
- 16.6 Major Histocompatibility Complex (MHC) 16.27
- 16.7 Immunological Tolerance 16.30
- 16.8 Hypersensitivity 16.31
- 16.9 Autoimmunity 16.36
- Summary* 16.39
- Review Questions* 16.40

**17. Immunotechnology**

17.1–17.9

- 17.1 Immunotechnology 17.1
- 17.2 Monoclonal Antibody 17.2
- 17.3 Hybridoma Technology 17.2
- 17.4 Advantages and Applications of Monoclonal Antibodies 17.5
- 17.5 Antibody Engineering 17.6
- 17.6 Human Antibodies 17.7
- Summary* 17.8
- Review Questions* 17.9

## **SECTION IX – HEALTH AND MEDICAL BIOTECHNOLOGY** **18.1–18.20**

### **18. Biotechnology in Human Welfare**

- 18.1 Introduction 18.3
- 18.2 Localisation of Human Gene Using Recombinant DNA Technology 18.4
- 18.3 The Detection of Genetic Disorders and Genetic Counselling 18.6
- 18.4 Gene Therapy 18.8
- 18.5 Gene–Transfer Technique 18.12
- 18.6 Fate of Transferred Gene in a Cell 18.13
- 18.7 Application of Gene Therapy 18.13
- 18.8 Sites of Gene Therapy 18.13
- 18.9 Ethics of Human Gene Therapy 18.14
- 18.10 Biodrugs 18.15
- 18.11 Assisted Reproductive Technologies (ARTS) 18.16
- 18.12 rDNA Based Therapeutic Agents 18.17
- 18.13 Vaccines 18.19
  - Summary* 18.19
  - Review Questions* 18.20

## **SECTION X – MOLECULAR GENOME MAPS** **19.1–19.15**

### **19. Molecular Markers and Genome Mapping**

- 19.1 Molecular Markers 19.3
- 19.2 Genome Mapping 19.8
- 19.3 Genome Mapping by Physical Technique 19.13
  - Summary* 19.15
  - Review Questions* 19.15

## **SECTION XI – INDUSTRIAL AND MICROBIAL BIOTECHNOLOGY** **20.1–20.56**

### **20. Basic Enzymology and Enzyme Biotechnology**

- 20.1 Introduction 20.3
- 20.2 Classification of Enzymes 20.9
- 20.3 Enzymes Lower Activation Energy 20.13
- 20.4 Enzyme Kinetics 20.14
- 20.5 Enzyme Inhibition 20.21
- 20.6 Regulation of Enzyme Activity in General 20.25
- 20.7 Mechanism of Enzyme Action 20.34
- 20.8 Introduction 20.48
- 20.9 Methods of Enzyme Production 20.48
- 20.10 Enzyme Immobilization 20.51
- 20.11 Enzyme Engineering 20.52
- 20.12 Applications of Enzymes 20.53
  - Summary* 20.55
  - Review Questions* 20.56

### **21. Industrial Microbiology** **21.1–21.22**

- 21.1 Introduction 21.1
- 21.2 Biotechnological Importance of Microorganisms 21.1

- 21.3 Microbial Products: Primary and Secondary Metabolites 21.12
- 21.4 Single-Cell Protein 21.15
- 21.5 Microbes and Biofertilizer 21.19
  - Summary 21.21
  - Review Questions 21.21

**22. Bioprocess Engineering and Technology**

**22.1–22.23**

- 22.1 Introduction 22.1
- 22.2 Fermentation Process 22.2
- 22.3 Bioreactors 22.5
- 22.4 Heat Transfer 22.7
- 22.5 Measurement and Control of Bioprocess Parameters 22.8
- 22.6 Isolation, Preservation and Maintenance of Industrial Microbes 22.8
- 22.7 Kinetics of Microbial Growth in STR 22.12
- 22.8 Downstream Processing 22.14
- 22.9 Whole Cell Immobilization and its Industrial Application 22.16
- 22.10 Food Technology 22.19
  - Summary 22.21
  - Review Questions 22.22

**SECTION XII – BIOTECHNOLOGY AND ENVIRONMENT**

**23.1–23.15**

**23. Environmental Biotechnology**

- 23.1 Introduction 23.3
- 23.2 Biological Production 23.4
- 23.3 Environmental Pollution and its Control through Biotechnology Strategy 23.5
- 23.4 Secondary Treatment Systems 23.7
- 23.5 Solid Waste Processing 23.8
- 23.6 Bioremediation 23.9
- 23.7 Biopesticides 23.11
- 23.8 Global Environmental Problems 23.13
  - Summary 23.14
  - Review Questions 23.14

**24. Bioenergy Technology**

**24.1–24.10**

- 24.1 Introduction 24.1
- 24.2 Sources of Energy (Renewable and Nonrenewable) 24.2
- 24.3 Bioenergy 24.4
- 24.4 Nonconventional Sources of Energy 24.6
- 24.5 Focus on the Future 24.9
  - Summary 24.9
  - Review Questions 24.9

<b>SECTION XIII – RULES, REGULATIONS AND ETHICAL ISSUES IN BIOTECHNOLOGY</b>	<b>25.1–25.9</b>
<b>25. Bioethics</b>	
25.1 Introduction	25.3
25.2 Biosafety Guideline and Regulations	25.4
25.3 Intellectual Property (IP)	25.5
25.4 Types of Intellectual Property Rights	25.5
<i>Summary</i>	25.8
<i>Review Questions</i>	25.9
<b>SECTION XIV – GENOMICS, PROTEOMICS AND BIOINFORMATICS</b>	<b>26.1–26.22</b>
<b>26. Genomics and Proteomics</b>	
26.1 Genomics	26.3
26.2 Sequencing and Genome Mapping	26.4
26.3 Construction of Genomic Libraries	26.5
26.4 New Vectors BACs and PACs and the Shotgun Approach	26.6
26.5 Location of Gene in a DNA Sequence	26.7
26.6 Gene Predicting and Gene Counting	26.8
26.7 Functional Genomics	26.9
26.8 DNA Chip (DNA Microarray) Technology	26.11
26.9 Comparative Genomics	26.15
26.10 Proteomics	26.16
<i>Summary</i>	26.21
<i>Review Questions</i>	26.22
<b>27. Bioinformatics</b>	<b>27.1–27.19</b>
27.1 Bioinformatics	27.1
27.2 Database Technology	27.2
27.3 Data Management and Retrieval Tools	27.6
27.4 Data Mining and Pattern Matching	27.8
27.5 Molecular Modeling	27.10
27.6 Drug Designing	27.12
27.7 Use of Bioinformatics Tools	27.17
<i>Summary</i>	27.18
<i>Review Questions</i>	27.18
<b>SECTION XV – PRACTICAL IN BIOTECHNOLOGY</b>	<b>28.1–28.33</b>
<b>28. Basic Experiments</b>	
28.1 List of Experiments	28.3
28.2 Experiment 1	28.4
28.3 Experiment 2	28.5
28.4 Experiment 3	28.7
28.5 Experiment 4	28.8

xii Contents

28.6	Experiment 5	28.10
28.7	Experiment 6	28.11
28.8	Experiment 7	28.13
28.9	Experiment 8	28.14
28.10	Experiment 9	28.16
28.11	Experiment 10	28.18
28.12	Experiment 11	28.19
28.13	Experiment 12	28.20
28.14	Experiment 13	28.22
28.15	Experiment 14	28.23
28.16	Experiment 15	28.24
28.17	Experiment 16	28.30
28.18	Experiment 17	28.32

*Glossary*

*G.1–G.10*

*Bibliography*

*B.1–B.3*

*Index*

*I.1–I.10*