

Table of contents

Preface xii

Acknowledgments xv

PART I INTRODUCTION

1 Life, Cell and Thermodynamics 1

1 The Origin of Life 2

2 Cellular Architecture 5

3 Thermodynamics 11

2 Physical and Chemical Properties of Water 23

1 Physical Properties of Water 24

2 Chemical Properties of Water 31

PART II BIOMOLECULES

3 Overview of DNA Structure, Function, and Engineering 42

1 Nucleotides 43

2 Introduction to Nucleic Acid Structure 46

3 Overview of Nucleic Acid Function 50

4 Nucleic Acid Sequencing 53

5 Manipulating DNA 66

4 Amino Acids 80

1 Amino Acid Structure 81

2 Stereochemistry 88

3 Amino Acid Derivatives 91

5 Polypeptide Analysis, Sequencing and Evolution 97

1 Polypeptide Diversity 98

2 Protein Purification and Analysis 99

3 Protein Sequencing 110

4 Protein Evolution 119

6 Proteins: Structure and Folding 131

1 Secondary Structure 132

2 Tertiary Structure 145

3 Quaternary Structure and Symmetry 158

4 Protein Stability 160

5 Protein Folding 165

7 Physiological Activities of Proteins 180

1 Oxygen Binding to Myoglobin and Hemoglobin 181

2 Muscle Contraction 200

3 Antibodies 212

8 Saccharide Chemistry 221

1 Monosaccharides 222

2 Polysaccharides 228

3 Glycoproteins 234

9 Lipids, Bilayer and Membranes 245

1 Lipid Classification 246

2 Lipid Bilayers 259

3 Membrane Proteins 262

4 Membrane Structure and Assembly 269

10 Passive and Active Transport 293

1 Thermodynamics of Transport 294

2 Passive-Mediated Transport 295

3 Active Transport 309

PART III ENZYMES

11 Mechanisms of Enzyme Action 322

- 1 General Properties of Enzymes 323
- 2 Activation Energy and the Reaction Coordinate 327
- 3 Catalytic Mechanisms 330
- 4 Lysozyme 339
- 5 Serine Proteases 345

12 Properties of Enzymes 361

- 1 Reaction Kinetics 362
- 2 Enzyme Inhibition 374
- 3 Control of Enzyme Activity 382
- 4 Drug Design 391

13 Hormones and Signal Transduction 402

- 1 Hormones 403
- 2 Receptor Tyrosine Kinases 408
- 3 Heterotrimeric G Proteins 423
- 4 The Phosphoinositide Pathway 432

PART IV METABOLISM

14 Bioenergetics 442

- 1 Overview of Metabolism 443
- 2 “High-Energy” Compounds 452
- 3 Oxidation–Reduction Reactions 462
- 4 Experimental Approaches to the Study of Metabolism 468

15 Glycolysis and the Pentose Phosphate Pathway 478

- 1 Overview of Glycolysis 479

- 2 The Reactions of Glycolysis 481
- 3 Fermentation: The Anaerobic Fate of Pyruvate 497
- 4 Regulation of Glycolysis 502
- 5 Metabolism of Hexoses Other than Glucose 508
- 6 The Pentose Phosphate Pathway 512

16 Additional Pathways in Carbohydrate Metabolism 523

- 1 Glycogen Breakdown 524
- 2 Glycogen Synthesis 532
- 3 Control of Glycogen Metabolism 536
- 4 Gluconeogenesis 544
- 5 Other Carbohydrate Biosynthetic Pathways 551

17 The Citric Acid Cycle 558

- 1 Overview of the Citric Acid Cycle 559
- 2 Synthesis of Acetyl-Coenzyme A 562
- 3 Enzymes of the Citric Acid Cycle 568
- 4 Regulation of the Citric Acid Cycle 575
- 5 Reactions Related to the Citric Acid Cycle 579

18 Mitochondrial ATP Synthesis 588

- 1 The Mitochondrion 589
- 2 Electron Transport 593
- 3 Oxidative Phosphorylation 609
- 4 Control of Oxidative Metabolism 620

19 Photosynthesis 630

- 1 Chloroplasts 631
- 2 The Light Reactions 635

3 The Dark Reactions 651

20 Synthesis and Degradation of lipids 664

1 Lipid Digestion, Absorption, and Transport 664

2 Fatty Acid Oxidation 671

3 Ketone Bodies 685

4 Fatty Acid Biosynthesis 686

5 Regulation of Fatty Acid Metabolism 697

6 Synthesis of Other Lipids 700

7 Cholesterol Metabolism 706

21 Synthesis and Degradation of Amino Acids 718

1 Protein Degradation 719

2 Amino Acid Deamination 724

3 The Urea Cycle 728

4 Breakdown of Amino Acids 733

5 Amino Acid Biosynthesis 746

6 Other Products of Amino Acid Metabolism 758

7 Nitrogen Fixation 764

22 Regulation of Fuel Metabolism 773

1 Organ Specialization 774

2 Hormonal Control of Fuel Metabolism 781

3 Metabolic Homeostasis: The Regulation of Energy Metabolism, Appetite, and Body Weight 786

4 Disturbances in Fuel Metabolism 790

PART V GENE EXPRESSION AND REPLICATION

23 Nucleotide Synthesis and Degradation 802

1 Synthesis of Purine Ribonucleotides 802

2 Synthesis of Pyrimidine Ribonucleotides 809

3 Formation of Deoxyribonucleotides 812

4 Nucleotide Degradation 820

24 DNA structure and Interactions with Proteins 831

1 The DNA Helix 832

2 Forces Stabilizing Nucleic Acid Structures 848

3 Fractionation of Nucleic Acids 856

4 DNA–Protein Interactions 859

5 Eukaryotic Chromosome Structure 868

25 DNA Synthesis and Repair 879

1 Overview of DNA Replication 880

2 Prokaryotic DNA Replication 882

3 Eukaryotic DNA Replication 898

4 DNA Damage 904

5 DNA Repair 909

6 Recombination 916

26 RNA Metabolism 938

1 Prokaryotic RNA Transcription 939

2 Transcription in Eukaryotes 948

3 Posttranscriptional Processing 961

27 The Genetic Code and Translation 982

1 The Genetic Code 983

2 Transfer RNA and Its Aminoacylation 988

3 Ribosomes 996

4 Translation 1004

5 Posttranslational Processing 1024

28 Gene Expression in Prokaryotes and Eukaryotes 1033

1 Genome Organization 1034

2 Regulation of Prokaryotic Gene Expression 1043

3 Regulation of Eukaryotic Gene Expression 1052

4 The Cell Cycle, Cancer, Apoptosis, and Development 1080

Glossary G-1 Index I-1

SOLUTIONS to Odd-Numbered Problems SP-1