CONTENTS

PART I—CELL BIOLOGY AND CHEMISTRY

1. The cell 3
- 1.1. Organization and composition of cells 3
- 1.2. Subcellular organelles 8
- 1.3. Plasma membrane 15
- 1.4. Plasma membrane transport mechanisms 20
- 1.5. Cell-to-cell communication 28
- 1.6. Cytoskeletal proteins 32

2. Chemistry of Carbohydrates 35
- 2.1. Classification and biomedical importance of carbohydrates 35
- 2.2. Structure and biomedical importance of monosaccharides 38
- 2.3. Isomers of monosaccharides 42
- 2.4. Reactions and separation of carbohydrates 46
- 2.5. Monosaccharide derivatives 50
- 2.6. Disaccharides 55
- 2.7. Homopolysaccharides 58
- 2.8. Heteropolysaccharides 61
- 2.9. Glycosylated proteins 64

3. Chemistry of Lipids 70
- 3.1. Classification and biomedical importance of lipids 70
- 3.2. Simple lipids 73
- 3.3. Complex lipids 78
- 3.4. Derived lipids 86
- 3.5 Amphipathic lipids 95
- 3.6. Separation and analysis of lipids 97
- 3.7. Surface tension 99

4. Chemistry of Amino Acids, Peptides and Proteins 101
- 4.1. Classification and biomedical importance of amino acids 101
- 4.2. Reactions and separation of amino acids 106
- 4.3. Peptides 112
- 4.4. Classification and biomedical importance of proteins 115
- 4.5. Structural organization of proteins 119
- 4.6. Physiochemical properties and reactions of proteins 124
- 4.7. Quantitation of proteins 128
- 4.8. Separation and purification of proteins 134
- 4.9. Characterization of proteins 139

5. Enzymes 144
- 5.1 Properties of enzymes 144
- 5.2. Classification of enzymes 146
- 5.3. Mechanisms of enzyme catalyzed reactions 149
- 5.4. Factors affecting enzyme catalyzed reaction 153
- 5.5 Enzyme regulation 164
- 5.6. Isoenzymes 171
- 5.7. Clinically important enzymes 174
- 5.8. Enzymes as diagnostic reagents 181
- 5.9. Enzymes as therapeutic agents 183

PART II—METABOLISM AND NUTRITION

6. Introduction to Intermediary Metabolism 187
- 6.1. Metabolic reactions 187
- 6.2. Regulation of metabolism 189
- 6.3. Approaches to the study of metabolism 192

7. Digestion and Absorption 195
- 7.1. Digestion and absorption of carbohydrates 195
- 7.2. Digestion and absorption of lipids 199
- 7.3. Digestion and absorption of proteins 203

8. Biological Oxidations 210
- 8.1. Bioenergetics 210
- 8.2. Oxidation-reduction reactions 214
- 8.3. Electron transport 218
- 8.4. Oxidative phosphorylation 222
- 8.5. Reactive oxygen species and antioxidants 228

9. Carbohydrate Metabolism 234
9.1. Overview of carbohydrate metabolism 234
9.2. Glycolysis 237
9.3. Pyruvate oxidation 244
9.4. Pyruvate metabolism and acetyl CoA metabolism 247
9.5. Citric acid cycle 248
9.6. Pentose phosphate pathway 253
9.7. Uronic acid pathway 257
9.8. Gluconeogenesis 259
9.9. Glycogen metabolism 264
9.10. Galactose metabolism 271
9.11. Fructose metabolism 273
9.12. Regulation of blood glucose 276
9.13. Glucose tolerance test 280
9.14. Reducing substances in urine 283

10. Lipid Metabolism 286
10.1. Lipolysis-mobilization of fatty acids 286
10.2. Oxidation of fatty acids 288
10.3. Ketone bodies 294
10.4. Synthesis of fatty acids 297
10.5. Triacylglycerol synthesis 303
10.6. Metabolism of phospholipids 306
10.7. Metabolism of glycolipids 309
10.8. Metabolism of lipoproteins 311
10.9. Biosynthesis of cholesterol 321
10.10. Cholesterol derivatives 325
10.11. Cholesterol transport and plasma cholesterol 329
10.12. Eicosanoids 331

11. Amino Acid Metabolism 336
11.1. Overview of amino acid metabolism 336
11.2. Reactions of amino acids in amino acid metabolism 340
11.3. Ammonia metabolism 342
11.4. Urea cycle (Krebs-Henseleit cycle) 346
11.5. Glycine 350
11.6. Sulfur containing amino acids: Methionine 354
11.7. Sulfur containing amino acids: Cysteine 359
11.8. Serine and threonine 362
11.9. Glutamic acid, aspartic acid and alanine 365
11.10. Branched chain amino acids 369
11.11. Histidine, arginine and lysine 371
11.12. Metabolism of proline 379
11.13. Phenylalanine and tyrosine 380
11.14. Tryptophan 389

12. Integration of Metabolism 394
12.1. Metabolic interactions 394
12.2. Regulation of metabolism 395
12.3. Metabolic pathways in different tissues 398
12.4. Metabolic adaptations in fed and fasted states 400
12.5. Metabolic changes in diabetes mellitus 403

13. Vitamins 406
13.1. Overview of vitamins 406
13.2. Vitamin A 411
13.3. Vitamin D 418
13.4. Vitamin E 423
13.5. Vitamin K 425
13.6. Thiamin 428
13.7. Riboflavin 431
13.8. Niacin 434
13.9. Pantothenic acid 440
13.10. Pyridoxine 444
13.11. Biotin 448
13.12. Folic acid 450
13.13. Vitamin B_{12} 455
13.14. Vitamin C (Ascorbic acid) 459
13.15. Vitamin like compounds 462

14. Minerals 465
14.1. Calcium 465
14.2. Phosphorus 474
14.3. Magnesium 478
14.4. Sulfur 480
14.5. Iron 480
14.6. Copper 486
14.7. Zinc 488
14.8. Manganese, iodine, fluorine, selenium, chromium and molybdenum 490

15. Nutrition 496
15.1. Nutrients 496
15.2. Energy aspects of foods 503
15.3. Balanced diet 507
15.4. Disorders of nutrition 509
15.5. Diet therapy 513

PART III—MOLECULAR BIOLOGY AND GENETICS

16. Chemistry of Nucleotides 519
16.1. Purines, pyrimidines and nucleosides 519
16.2. Nucleotides 522

17. Metabolism of Nucleotides 526
17.1. Synthesis of purine nucleotides 526
17.2. Degradation of purine nucleotides 532
17.3. Metabolism of pyrimidine nucleotides 536

18. Chemistry of Nucleic Acids 543
18.1. Ribonucleic acid (RNA) 543
18.2. Deoxyribonucleic acid (DNA) 547

19. DNA Metabolism 556
19.1. DNA replication 556
19.2. DNA damage and repair 564
19.3. DNA recombination 569

20. RNA Metabolism 573
20.1. Transcription 573
20.2. Post-transcriptional processing of RNA 576
20.3. Reverse transcription 579

21. Protein Metabolism 582
21.1. Genetic code and mutations 582
21.2. Translation: Process of protein synthesis 586
21.3. Post-translational modifications, protein folding and protein targeting 595

22. Regulation of Gene Expression
22.1. Regulation of gene expression in eukaryotes 602
22.2. Regulation of gene expression in prokaryotes 609

23. Cancer
23.1. Cell cycle 612
23.2. Apoptosis 617
23.3. Causes of cancer 620
23.4. Tumor markers 624

24. Genetic Diseases
24.1. Genetic disorders 628
24.2. Inborn errors of metabolism: Inherited metabolic disorders 633

25. Molecular Biology Technology
25.1. Tools for molecular biology technology 638
25.2. Techniques in molecular biology 642
25.3. Medical applications of molecular biology techniques 654

PART IV—SPECIALIZED TISSUES AND CLINICAL BIOCHEMISTRY

26. Blood 663
26.1. Plasma proteins 663
26.2. Erythrocytes 669
26.3. Metabolism of heme 671
26.4. Hemoglobin 680
26.5. Red cell metabolism 693
26.6. Hemostasis and thrombosis 694

27. Immune System 699
27.1. The immune response 699
27.2. Innate immune response 700
27.3. Humoral immunity and immunoglobulins 705
27.4. T-lymphocytes and cell mediated immunity 713
27.5. Immunologic mechanisms of tissue injury 716

28. Kidneys and Lungs 719
28.1. Renal function tests 719
28.2. Urine analysis 726
28.3. Functions of lungs 727
28.4. Pleural effusion and pleural fluid analysis 729

29. Water, Electrolytes and Acid-base Balance 730
29.1. Water metabolism 730
29.2. Sodium metabolism 736
29.3. Potassium metabolism 741
29.4. Chloride and bicarbonate 745

30. Acid-base Balance
30.1. Acids, bases and buffers 748
30.2. Acid-base balance 752
30.3. Disorders of acid-base balance 755

31. Liver 758
31.1. Liver function tests 758

32. Gastrointestinal System
32.1. Stomach 768
32.2. Small intestine 771
32.3. Pancreas (Exocrine function) 774
32.4. Malabsorption syndromes 776

33. Musculoskeletal System 779
33.1. Skeletal muscle 779
33.2. Bone 783
33.3. Joints 786
33.4. The extracellular matrix 787

34. Cardiovascular System 791
34.1. Vascular cells 791
34.2. Cardiac muscle 795

35. Endocrine System 799
35.1. Overview of endocrine function 799
35.2. Pituitary function 805
35.3. The thyroid function 813
35.4. Parathyroid function 816
35.5. Adrenal gland: Adrenal cortex 818
35.6. Adrenal gland: Adrenal medulla 822
35.7. Pancreatic hormones 824
35.8. Male reproductive system 829
35.9. Female reproductive system 831
35.10. Pregnancy 833
35.11. Gastrointestinal hormones 836
35.12. Multiple endocrine neoplasia 838

36. Nervous System 839
36.1. Cells of the nervous system 839
36.2. Neurotransmitters 841
36.3. Metabolism in the brain 844
36.4. Biochemical investigations in disorders of nervous system 845

37. Visual Function 853
37.1. Biochemistry of vision 853
37.2. Cataract formation 854

38. Differentiation, Growth, Development and Aging 856
38.1. Sexual differentiation 856
38.2. Growth 858
38.3. Puberty 861
38.4. Aging 863

39. Toxicology 866
39.1. Biotransformation: Detoxification 866
39.2. Drug toxicology 869
39.3. Alcohol 872
39.4. Environmental toxicology 874

40. Instrumentation and Techniques 877
40.1. Photometry spectrophotometry, and mass spectrometry 877
40.2. Electrochemical techniques 881
40.3. Radioactive isotopes 882
40.4. Laboratory automation 885

41. Biochemical Investigations in Laboratory Medicine 888
41.1. Utility of biochemical tests in clinical practice 888
41.2. Types of biochemical investigations 889
41.3. Quality control 890
41.4. Interpretation of biochemical tests 892

Index *895*