

CONTENTS

ACKNOWLEDGMENT

XI

PREFACE

XIII

CHAPTER 1: INTRODUCTION TO BIOCHEMISTRY

1

1.1 WHAT IS BIOCHEMISTRY?

2

1.2 ORIGIN OF LIFE FROM THE BIOCHEMICAL ASPECT

4

1.2.1 The RNA Concept in the Origin of Life

5

1.2.2 Hypothetical Scenario of Origin of Life

6

1.2.3 Meaning of Life

6

1.3 EVOLUTION OF CELLS

6

1.3.1 Similarities between Eukaryotes and Prokaryotes

7

1.3.2 Differences between Eukaryotes and Prokaryotes

7

1.3.3 Important Biochemical Cell Organelles (components)

8

1.3.4 Common Unifying Topics in Biochemistry

9

1.3.5 Types of Biochemical Reactions

10

SUMMARY

13

REVIEW QUESTIONS

15

REFERENCES

16

CHAPTER 2: WATER – SOURCE OF LIFE ON EARTH

17

2.1 INTRODUCTION

18

2.2 MOLECULAR AND PHYSICAL PROPERTIES OF WATER

18

2.3 NONCOVALENT BONDING

19

2.3.1 Ionic Interactions

19

2.3.2 Hydrogen Bonds

19

2.3.3 Van der Waals Forces

20

2.4 THERMAL PROPERTIES OF WATER

20

2.5 SOLVENT PROPERTIES OF WATER

21

2.5.1 Hydrophilic Molecules

21

2.5.2 Hydrophobic Molecules

22

2.6 AMPHIPATHIC MOLECULES

22

2.7 OSMOTIC PRESSURE

23

2.8 IONIZATION OF WATER	23
SUMMARY	27
REVIEW QUESTIONS	28
REFERENCES	28
CHAPTER 3: CARBOHYDRATES	29
3.1 OVERVIEW	30
3.2 ROLE OF CARBOHYDRATES	30
3.3 HOW ARE CARBOHYDRATE NAMED?	30
3.4 MONOSACCHARIDES	31
3.4.1 Properties and Classification	31
3.4.2 Monosaccharides Stereoisomers	32
3.4.3 Cyclic Structure of Monosaccharides	32
3.5 IMPORTANT REACTION IN MONOSACCHARIDES	34
3.5.1 Important Monosaccharides	36
3.5.2 Monosaccharides Derrivatives	36
3.6 OLIGOSACCHARIDES AND DISACCHARIDES	38
3.6.1 Important Sugar of Dissaccharides	38
3.7 OLIGOSACCHARIDES SUGAR	40
3.8 POLYSACCHARIDES	40
3.8.1 Homopolysaccharides	41
3.8.2 Heteropolysaccharides	44
SUMMARY	45
QUESTION REVIEW	46
REFERENCES	46
CHAPTER 4: LIPIDS	47
4.1 INTRODUCTION	48
4.2 LIPID CLASSES	48
4.2.1 Fatty Acid (FA) and Its Derivatives	48
4.2.2 Triacylglycerol (TAG)	51
4.2.3 Wax Ester	52
4.2.4 Phospholipids	53
4.2.5 Sphingolipid	55
4.2.6 Isoprenoids	56
4.2.7 Lipoprotiens	56

4.3 PLASMA MEMBRANES	57
4.3.1 Membrane Structure	58
4.3.2 The Fluid Mosaic Model	58
4.3.3 Membrane Proteins	59
4.3.4 Basics of Selective Permeability	62
4.3.5 Types of Transport across Cell Membranes	62
4.3.6 Bulk transport	65
4.4 LIPID TECHNOLOGY: SEPARATION OF PLASMA LIPOPROTEINS	67
4.4.1 Ultra-centrifugation	67
4.4.2 Electrophoresis	67
SUMMARY	67
REVIEW QUESTIONS	68
REFERENCES	69
CHAPTER 5: AMINO ACIDS	71
5.1 GENERAL PROPERTIES OF AMINO ACIDS	72
5.2 CLASSIFICATION AND NOMENCLATURE OF AMINO ACIDS	73
5.2.1 Basic Amino Acid	74
5.2.2 Acidic Amino acid	74
5.2.3 Neutral Polar Amino Acid	75
5.2.4 Neutral Non Polar Amino Acids	76
5.3 CONFIGURATION OF AMINO ACIDS	76
5.4 TITRATION OF AMINO ACIDS	76
5.5 FUNCTION OF AMINO ACIDS	79
5.6 AMINO ACID REACTIONS	79
5.7 PEPTIDE BOND FORMATION	79
5.8 CYSTEIN OXIDATION	81
5.9 AMINO ACID TECHNOLOGY	81
SUMMARY	82
REVIEW QUESTIONS	83
REFERENCES	84
CHAPTER 6: PROTEIN	85
6.1 INTRODUCTION	86
6.2 FOUR LEVEL OF PROTEIN STRUCTURE	86
6.2.1 Primary Structure	86

6.2.2	Secondary Structure	86
6.2.3	Tertiary Structure	87
6.2.4	Quaternary Structure	88
6.3	LOSS OF PROTEIN STRUCTURE	89
6.4	FIBROUS PROTEINS	91
6.4.1	α -keratin	91
6.4.2	Collagen	91
6.4.3	Silk Fibroin	91
6.5	GLOBULAR PROTEIN	92
6.5.1	Myoglobin	92
6.5.2	Hemoglobin	92
6.5.3	Enzyme	93
6.6	PROTEIN TECHNOLOGY	99
6.6.1	Introduction	99
6.6.2	Step to Isolate Protein	99
SUMMARY		103
REVIEW QUESTIONS		103
REFERENCES		104
 CHAPTER 7: NUCLEIC ACIDS		 105
7.1	INTRODUCTION	106
7.2	THE STRUCTURE OF NUCLEIC ACIDS	107
7.2.1	DNA	108
7.2.2	RNA	109
7.3	THE FUNCTIONS OF NUCLEIC ACIDS	109
7.3.1	DNA	109
7.3.2	RNA	110
7.4	THE STABILITY OF DNA	110
7.5	TECHNIQUES IN DNA TECHNOLOGY	111
7.5.1	Chromatography	111
7.5.2	Electrophoresis	112
7.5.3	Southern Blot	112
7.5.4	Polymerase Chain Reaction	114
7.5.5	DNA Microarrays	114
SUMMARY		116
REVIEW QUESTIONS		117
REFERENCES		117

CHAPTER 8: GENETIC INFORMATION	119
8.1 INTRODUCTION	120
8.2 DNA REPLICATION	120
8.2.1 Semiconservative Replication	120
8.2.2 DNA Replication System	121
8.3 DNA TRANSCRIPTION	123
8.3.1 Transcription Initiation	125
8.3.2 Chain Elongation	125
8.3.3 Chain Termination	126
8.4 TRANSLATION	126
8.4.1 Initiation of Translation	127
8.4.2 Translation Elongation	128
8.4.3 Translation Termination	130
8.5 THE GENETIC CODE	130
8.6 MUTATIONS	131
8.6.1 Types of Mutations	131
8.7 RECOMBINANT DNA TECHNOLOGY	135
8.7.1 Restriction Endonuclease	135
8.7.2 General Formation of Recombinant DNAs	135
SUMMARY	137
REVIEW QUESTIONS	138
REFERENCES	140
CHAPTER 9: METABOLISM	141
9.1 INTRODUCTION TO METABOLISM	142
9.2 OVERVIEW OF METABOLISM	143
9.2.1 Trophic Strategies	143
9.2.2 Metabolic Pathways	143
9.2.3 Thermodynamic Considerations	143
9.2.4 High-energy Compounds	144
9.2.5 Oxidation-reduction Reaction: Coupling via NAD	147
9.3 GLUCOSE CATABOLISM	147
9.3.1 The Reactions of Glycolysis	148
9.4 CITRIC ACID CYCLE	151
9.5 FERMENTATION: ANAEROBIC FATE OF PYRUVATE	153

9.6 ELECTRON TRANSPORT AND OXIDATIVE PHOSPHORYLATION	154
9.6.1 Electron Transport Chain	155
9.7 OXIDATIVE PHOSPHORYLATION	163
9.7.1 Definition	163
9.7.2 Mechanism	163
SUMMARY	167
REVIEW QUESTIONS	168
REFERENCES	170
CHAPTER 10: PHOTOSYNTHESIS	171
10.1 WHAT IS PHOTOSYNTHESIS?	172
10.2 CHLOROPHYLL AND CHLOROPLASTS	172
10.3 LIGHT REACTIONS	174
10.3.1 Photosystem II and Oxygen Generation	175
10.3.2 Photosystem I and NADPH Synthesis	176
10.4 LIGHT-INDEPENDENT REACTIONS (DARK REACTIONS)	176
10.4.1 The Calvin Cycle	176
10.4.2 Photorespiration	177
10.4.3 C ₄ Metabolism	178
PHOTOSYNTHESIS AND APPLICATIONS	178
SUMMARY	180
REVIEW QUESTIONS	181
REFERENCES	182
GLOSSARY	183
INDEX	211