Contents

Preface ...(v) Acknowledgement ...(vii)

UNIT – 1 : BIOMOLECULES AND BIOENERGETICS

Biomolecules or Macromolecules ...1

Carbohydrates ...1

Classification of carbohydrates ...2 Chemical nature of carbohydrates ...6 Biological significance of carbohydrates ...9

Lipids ...10

Classification of lipids ...11 Biological significance of lipids ...13

Fatty Acids ...14

Classification of fatty acids ...14 Nomenclature of fatty acids ...15 Biological significance of fatty acids ...16

Nucleic Acids ...17

Classification or types of nucleic acids ...17 Chemical nature of nucleic acids ...17 Nitrogen bases ...18 Sugars ...20 Nomenclature of nucleotides ...21 Biological significance of nucleic acids ...22

Proteins 23

Classification of proteins ...24 Biological significance of proteins ...28

Amino Acids ...29

Classification of amino acids ...29 Nomenclature of amino acids ...34 Biological significance of amino acids ...34

Bioenergetics or Biochemical Thermodynamics ...35

Exergonic reaction ...35

Endergonic reaction ...35 Terms used in Bioenergetics ...36 Free energy ...36 Enthalpy ...37 Entropy ...37 Relationship between the change of free energy, enthalpy and entropy ...37

Redox Potential ...37

Energy Rich Compounds ...38

Classification of high energy compounds ...39 Adenosine triphosphate (ATP) ...40 Biological significance of ATP ...41 Cyclic adenosine monophosphate (cAMP) ...42 Biological significance of cAMP ...43

Probable Questions ...43

Part-A: Multiple choice questions ...43 Key for multiple choice questions ...49
Part-B: Short answers ...50
Part-C: Long answers ...50

UNIT - 2 : CARBOHYDRATE METABOLISM AND BIOLOGICAL OXIDATION

Carbohydrate Metabolism ...53 Transport of glucose ...53 Glycolysis ...56 Definition ...56 Types ...56 Pathway ...56 Regulation ...61 Importance / Significance ...61 Energetics ...61 Metabolic disorders ...61 Conversion of Pyruvate to Acetyl CoA ...62

Citric Acid Cycle ...62

Definition ...62 Pathway ...63 Importance / Significance ...66 Regulation ...66 Energetic ...66 Energetic of Glucose Oxidation ...66 Aerobic condition ...66 Anaerobic condition ...66 Gluconeogenesis ...67 Definition ...67 Pathway ...67 List of glucogenic amino acids ...73 Significance ...73 Regulation ...73 Hexose Mono Phosphate (HMP) Shunt ...73 Definition ...73 Pathway ...73 Significance ...76 Metabolic disorder ...77 Glucose-6-phosphate dehydrogenase deficiency ...77 Wernicke-Korsakoff syndrome ...77 Regulation ...77 Glycogen metabolism 77 Glycogen ...77 Glycogenesis ...78 Definition ...78 Pathway ...78 Glycogenolysis 81 Definition81 Pathway ...81 Glycogen Storage Diseases ...83 Von-Gierke's disease ...84 Diabetes Mellitus ...86 Classification ...87 Regulation of Carbohydrate Metabolism or Regulation of Blood Glucose Level ...87 Allosteric regulation ...87 Hormonal regulation ...88 Effect of calcium ...90 Biological Oxidation ...90 Co-enzyme system involved in biological oxidation ...90

Substrate Level Phosphorylation ...91 Oxidative Phosphorylation ...92 Phosphorous oxygen ratio ...92 Site of oxidative phosphorylation in ETC ...92 Energetic of oxidative phosphorylation ...92 Mechanism of oxidative phosphorylation ...93 Inhibitors of oxidative phosphorylation ...95

Synthesis of ATP91

Electron Transport Chain (ETC) or Respiratory Chain or Electron Transport System (ETS) ...96

Mitochondria ...96 Mechanism of ETC ...97 Components of ETC ...97 Inhibitors of ETC ...99

Probable Questions ...101

Part-A: Multiple choice questions ...101 Key for Multiple choice questions ...107 Part-B: Short answers ...107 Part-C: Long answers ...107

UNIT - 3: LIPID METABOLISM AND AMINO ACID METABOLISM

Lipid Metabolism ...109

Fatty Acid Oxidation ...109

β-Oxidation of Fatty Acids ...109

Definition ...109 Stages involved ...109 Oxidation of palmitic acid ...115 Energetic of palmitic acid β -oxidation ...116 Metabolic disorder ...117

Ketone Bodies Metabolism ...117

Ketogenesis ...117

Definition ...117 Pathway ...117 Regulation of ketogenesis ...120

Ketolysis ...120

Definition ...120 Pathway ...120 Metabolic Disorders of Ketone Bodies Metabolism ...120

Ketonemia ...120 Ketonuria ...120 Ketosis ...120 Ketoacidosis ...122

Denovo Synthesis of Fatty Acids ...122

Components required ...122 Stages involved ...122

Cholesterol ...127

Biological significance of cholesterol ...128 Degradation of cholesterol ...128 Conversion of cholesterol into bile acids ...128 Conversion of cholesterol into steroid hormones ...130 Conversion of cholesterol into vitamin-D ...135

Metabolic Disorders of Lipid Metabolism ...137

Hypercholesterolemia ...137 Atherosclerosis ...138 Fatty liver ...139 Obesity ...140

Amino Acid Metabolism ...141

General Reactions of Amino Acid Metabolism ...141

Transamination ...142 Definition ...142 Most important features ...142 Deamination ...143 Oxidative deamination ...143 Non-oxidative deamination ...144 Decarboxylation ...144

Urea Cycle or kreb's-Henseleit Cycle ...145

Pathway ...146 Metabolic disorders of urea cycle ...148

Phenylalanine and Tyrosine ...149

Catabolism of phenylalanine & tyrosine ...149 Biosynthesis of Catecholamines ...152 Biological significance of catecholamines ...153

Biosynthesis of 5-Hyroxytryptamine (5-HT)

or Serotonin and Melatonin ...154

Biological significance of serotonin ...155 Biological significance of melatonin ...156 Metabolic disorders of amino acid metabolism ...157

Phenylketonuria (PKU) ...158 Albinism ...158 Alkaptonuria ...159 Tyrosinemia ...159 Tyrosinemia type – I or Tyrosinosis ...160 Tyrosinemia type – II or Hanhart syndrome ...160 Hyperbilirubinemia ...160 Jaundice ...160 Hemolytic jaundice ...160 Hepatic jaundice or hepatocellular jaundice ...161 Obstructive jaundice or regurgitation jaundice ...161

Catabolism of Heme 161

Probable Questions ...164

Part-A: Multiple choice questions ...164 Key for multiple choice questions ...167 Part-B: Short answers ...167 Part-C: Long answers ...168

UNIT - 4 : NUCLEIC ACID METABOLISM

Nucleic Acid Metabolism ...169

Biosynthesis of Purine Nucleotides ...169

Pathway ...170 Inhibitors of purine nucleotide synthesis ...173 Synthesis of AMP and GMP from IMP ...173

Degradation of Purine Nucleotides ...176

Metabolic Disorders of Purine Metabolism ...178

Hyperuricemia ...178 Uricosuria ...178 Gout ...178 Pseudogout ...179

Biosynthesis of Pyrimidine Nucleotides ...179

Pathway ...180

Structure of DNA ...184

Composition ...185 Schematic representation ...185 Chargaff's rule ...185 DNA double helix ...186 Other types of DNA structure ...188

Organization of Mammalian Genome or Organization of DNA in the Cell ...188

Organization of prokaryotic DNA ...188 Organization of eukaryotic DNA ...188

Structure of RNA ...189 Composition ...189 Comparison between DNA and RNA ...189 Types of RNA ...190 Messenger RNA (mRNA) ...190 Transfer RNA (tRNA) ...191 Ribosomal RNA (rRNA) ...191 Ribozymes (Catalytic RNA) ...191 The Central Dogma of Life ... 192 DNA Replication ...192 Definition ... 192 Replication in prokaryotes ...192 Inhibitors of DNA replication ...196 Transcription ... 196 Definition ... 196 Transcription in prokaryotes ...196 Stage - 1 or Initiation stage ... 196 Stage - 2 or Elongation stage ... 197 Stage – 3 or Termination stage ... 198 Inhibitors of transcription ...198

Genetic Code ...198

Protein Biosynthesis ...200

Components requirement ...200 Amino acids activation ...201 Proper protein synthesis ...201 Chaperones and protein folding ...203 Post-translational modifications of proteins ...203 Inhibitors of protein synthesis ...203

Probable Questions ...204

Part-A: Multiple choice questions ...204 Key for multiple choice questions ...208 Part-B: Short answers ...208 Part-C: Long answers ...209

UNIT - 5 : ENZYMES

Properties of Enzymes ...211

Nomenclature of Enzymes ...212

Classification of Enzymes ...213

IUB classification ...213 Classification based on place of action ...214 Classification based upon the number of Polypeptide chains ...214

Classification based upon the Number of enzymes ...214 Mechanism of Enzyme Action ...214 Enzyme decreases activation energy ...214 Formation of enzyme-substrate complex ...215 Lock and key model or Fischer's template theory ...215 Induced fit theory or Koshland's model ...215 Substrate strain theory ...215 Enzyme Kinetics ...216 Michaelis Plot ...216 Lineweaver–Burk Double Reciprocal Plot ...218 Enzyme Inhibition ...219 Reversible enzyme inhibition (REI) ...219 Irreversible enzyme inhibition ...222 Allosteric enzyme inhibition ...222 Enzyme Regulation ...223 Allosteric regulation ...223 Latent enzyme activation ...225 Metabolic pathways compartmentation ...226 Enzyme synthesis control ...226 Induction ...226 Repression ...226 Enzyme degradation ...226 Iso-enzyme ...227 Co-enzymes ...227 Types of co-enzymes ...227 Vitamin co-enzymes ...227 Non-vitamin co-enzymes ...227 Nucleotide co-enzymes ...233 Protein co-enzymes ...233 Iso-enzymes ...233 Therapeutic & diagnostic applications of iso-enzyme ...233 Applications of Enzymes ...234 Therapeutic applications ...234 Analytical applications ...235 Applications in genetic manipulation ...235 Industrial applications ...235 Diagnostic applications ...235 Probable Questions ...237 Part-A: Multiple choice guestions ...237 Key for multiple choice questions ...241 Part-B: Short answers ...241

Part-C: Long answers ...241