

Contents

Dedication...v

Acknowledgments...v

Contributing Editor, Online Unit Review Questions...v

Reviewers...vi

Preface...viii

UNIT I: Protein Structure and Function

Chapter 1: Amino Acids and the Role of pH...1

Chapter 2: Protein Structure...14

Chapter 3: Globular Proteins...26

Chapter 4: Fibrous Proteins...45

Chapter 5: Enzymes...57

UNIT II: Bioenergetics and Carbohydrate Metabolism

Chapter 6: Bioenergetics and Oxidative Phosphorylation...77

Chapter 7: Introduction to Carbohydrates...92

Chapter 8: Introduction to Metabolism and Glycolysis...100

Chapter 9: Tricarboxylic Acid Cycle and Pyruvate Dehydrogenase Complex...120

Chapter 10: Gluconeogenesis...128

Chapter 11: Glycogen Metabolism...137

Chapter 12: Monosaccharide and Disaccharide Metabolism...151

Chapter 13: Pentose Phosphate Pathway and Nicotinamide Adenine Dinucleotide Phosphate...160

Chapter 14: Glycosaminoglycans, Proteoglycans, and Glycoproteins...173

UNIT III: Lipid Metabolism

Chapter 15: Dietary Lipid Metabolism...191

Chapter 16: Fatty Acid, Triacylglycerol, and Ketone Body Metabolism...201

Chapter 17: Phospholipid, Glycosphingolipid, and Eicosanoid Metabolism...223

Chapter 18: Cholesterol, Lipoprotein, and Steroid Metabolism...243

UNIT IV: Nitrogen Metabolism

Chapter 19: Amino Acids: Nitrogen Disposal...271

Chapter 20: Amino Acids: Degradation and Synthesis...290

Chapter 21: Amino Acids: Conversion to Specialized Products...308

Chapter 22: Nucleotide Metabolism...324

UNIT V: Integration of Metabolism

Chapter 23: Metabolic Effects of Insulin and Glucagon...341

Chapter 24: The Feed-Fast Cycle...357

Chapter 25: Diabetes Mellitus...375

Chapter 26: Obesity...390

UNIT VI: Medical Nutrition

Chapter 27: Nutrition: Overview and Macronutrients...401

Chapter 28: Micronutrients: Vitamins...423

Chapter 29: Micronutrients: Minerals...446

UNIT VII: Storage and Expression of Genetic Information

Chapter 30: DNA Structure, Replication, and Repair...459

Chapter 31: RNA Structure, Synthesis, and Processing...482

Chapter 32: Protein Synthesis...496


Chapter 33: Regulation of Gene Expression...515

Chapter 34: Biotechnology and Human Disease...532

Chapter 35: Blood Clotting...558

Appendix...575

Index...607

Figure Sources...625 

Proteins are among the most abundant and functionally diverse molecules in living systems. Virtually every life process depends on this class of macromolecules. For example, enzymes and polypeptide hormones direct and regulate metabolism in the body, whereas contractile proteins in muscle permit movement. In bone, the protein collagen forms a framework for the deposition of calcium phosphate crystals, acting like the steel cables in reinforced concrete. In the bloodstream, proteins, such as hemoglobin and albumin, transport molecules essential to life, whereas immunoglobulins fight infectious bacteria and viruses. In short, proteins display an incredible diversity of functions, yet all share the common structural feature of being linear polymers of amino acids. This chapter describes the properties of amino acids and the importance of pH to normal protein and body function. Chapter 2 explores how these simple building blocks are joined to form proteins that have unique three-dimensional structures, making them capable of performing specific biologic functions.

II. STRUCTURE

Although more than 300 different amino acids have been described in nature, only 20 are commonly found as constituents of mammalian proteins. These 20 standard amino acids are the only amino acids that are encoded by DNA, the genetic material in the cell. Nonstandard amino acids are produced by chemical modification of standard amino acids. Each amino acid has a carboxyl group, a primary amino group (except for proline, which has a secondary amino group), and a distinctive side chain or R group bonded to the α -carbon atom.

At physiologic pH (~ 7.4), the carboxyl group of an amino acid is dissociated, forming the negatively charged carboxylate ion ($-\text{COO}^-$), and the amino group is protonated ($-\text{NH}_3^+$) (Fig. 1.1A). In proteins, almost all of these carboxyl and amino groups are combined through peptide linkage and, in general, are not available for chemical reaction except for hydrogen bond or ionic bond formation (Fig. 1.1B). Amino acids within proteins are referred to as *residues* in reference to the residual structure remaining after peptide bond formation between consecutive amino

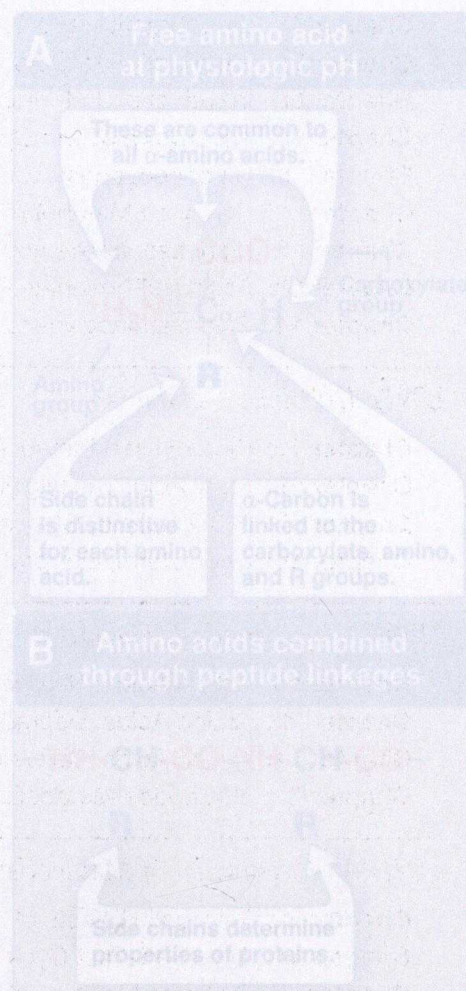


Figure 1.1

A, B: Structural features of amino acids.