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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.

1. 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

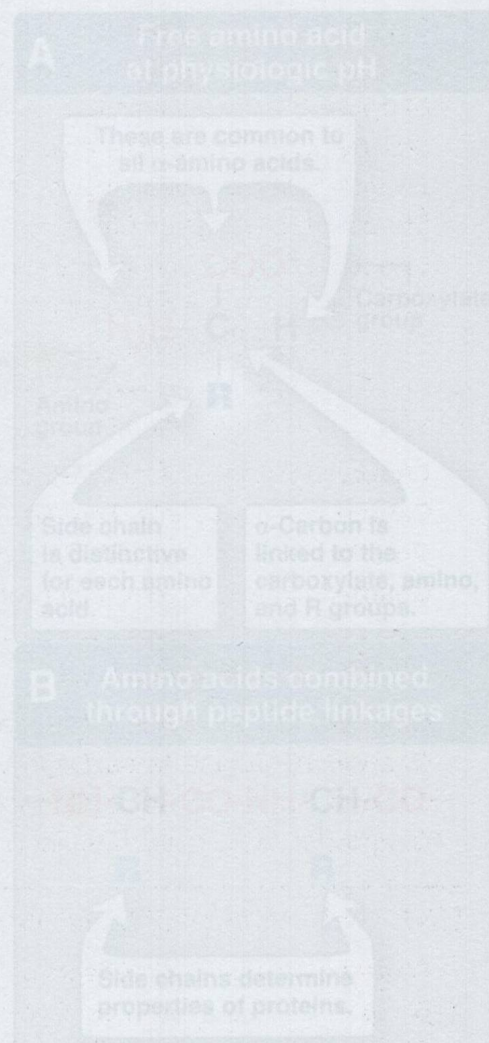


Figure 1.1

A, B: Structural features of amino acids.