

	NONPOLAR, HYDROPHOBIC	R GROUPS	POLAR, UNCHARGED	
Alanine Ala A	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}_3$		$\text{H}-\text{CH}(\text{COOH})-\text{NH}_2$	Glycine Gly G
Valine Val V	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}(\text{CH}_3)_2$		$\text{HO}-\text{CH}_2-\text{CH}(\text{COOH})-\text{NH}_2$	Serine Ser S
Leucine Leu L	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}_2-\text{CH}(\text{CH}_3)_2$		$\text{OH}-\text{CH}(\text{CH}_3)-\text{CH}(\text{COOH})-\text{NH}_2$	Threonine Thr T
Isoleucine Ile I	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}(\text{CH}_3)-\text{CH}_2-\text{CH}_3$		$\text{HS}-\text{CH}_2-\text{CH}(\text{COOH})-\text{NH}_2$	Cysteine Cys C
Phenylalanine Phe F	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}_2-\text{C}_6\text{H}_5$		$\text{HO}-\text{C}_6\text{H}_4-\text{CH}_2-\text{CH}(\text{COOH})-\text{NH}_2$	Tyrosine Tyr Y
Tryptophan Trp W	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}_2-\text{C}_8\text{H}_6\text{N}_2$		$\text{NH}_2-\text{C}(=\text{O})-\text{CH}_2-\text{CH}(\text{COOH})-\text{NH}_2$	Asparagine Asn N
Methionine Met M	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}_2-\text{CH}_2-\text{S}-\text{CH}_3$		$\text{NH}_2-\text{C}(=\text{O})-\text{CH}_2-\text{CH}_2-\text{CH}(\text{COOH})-\text{NH}_2$	Glutamine Gln Q
Proline Pro P	$\text{HOOC}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH}-\text{CH}_2$		$\text{NH}_2-\text{CH}(\text{COOH})-(\text{CH}_2)_4-\text{NH}_2$	Lysine Lys K
Aspartic acid Asp D	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}_2-\text{C}(=\text{O})\text{OH}$	POLAR ACIDIC	$\text{NH}_2-\text{CH}(\text{COOH})-(\text{CH}_2)_3-\text{CH}(\text{NH}_2)-\text{C}(=\text{O})\text{NH}_2$	Arginine Arg R
Glutamic acid Glu E	$\text{HOOC}-\text{CH}(\text{NH}_2)-\text{CH}_2-\text{CH}_2-\text{C}(=\text{O})\text{OH}$		$\text{C}_6\text{H}_7\text{N}_3^+ - \text{CH}(\text{COOH})-\text{NH}_2$	Histidine His H

Figure 2.3 The 20 Amino Acids found in Living Organisms

in the Maillard reaction, forming a brown tar around Miller's apparatus (see Figure 2.4). Ultimately, Miller was producing large

quantities of a brown-coloured compound called melanoidin.

2.5 Wrong Forms of Amino Acids

But there is a more fundamental problem with this scenario, which can easily be overlooked. Amino acids, like all chemicals, are three-dimensional structures. The arrangement of

the central carbon atom is tetrahedral⁴ (see Figure 2.2). However, in Figure 2.5 you can see two versions of this. Unless you are used to studying these sorts of arrangements, you