

TABLE 1.1 The 20 Classical Amino Acids

Amino Acid	One-Letter Abbreviation	Three-Letter Abbreviation
AMINO ACIDS WITH CHARGED SIDE GROUP		
Glutamic acid	E	Glu
Aspartic acid	D	Asp
Lysine	K	Lys
Histidine	H	His
Arginine	R	Arg
Asparagine	N	Asn
Glutamine	Q	Gln
AMINO ACIDS WITH LIPOPHILIC (HYDROPHOBIC) SIDE CHAIN		
Phenylalanine	F	Phe
Tyrosine	Y	Tyr
Leucine	L	Leu
Isoleucine	I	Ileu
Valine	V	Val
Tryptophan	W	Trp
AMINO ACID WITH HYDROXYL GROUP		
Serine	S	Ser
Threonine	T	Thr
AMINO ACIDS WITH SULFUR ATOM		
Cysteine	C	Cys
Methionine	M	Met
OTHER AMINO ACIDS		
Glycine	G	Gly
Alanine	A	Ala
Proline	P	Pro

polymer of amino acids, typically about 100–500 amino acids in length. The term *oligopeptide* refers to shorter polymers of amino acids in the range of about 10–50 amino acids. Some nonclassical amino acids, such as homocysteine, exist only in the free state, and do not become incorporated into any polypeptide. But other nonclassical amino acids, such as GLA and phosphotyrosine, occur in naturally occurring proteins because of a process called *post-translational modification*.

Table 1.1 identifies which amino acids have a side chain that is charged, and thus interact well with water, and amino acids with an uncharged side chain, and thus do not much interact with water. The terms hydrophilic and hydrophobic are used to refer to chemicals, or to regions of chemicals, that are charged and that are uncharged, respectively. Hydrophilic groups include carboxyl groups, amino groups, and hydroxyl groups. Hydrophobic groups include alkane chains and aromatic rings. Although the term “hydrophobic” is in common use, it has been pointed out that there does not exist any force or interaction in nature that is a hydrophobic force or interaction (61).

A knowledge of the amino acids is needed to understand:

- drug stability during manufacturing and storage,
- point of attachment of polyethylene glycol (PEG) to the drug, where relevant,
- unwanted immunogenicity,
- immunogenicity that is desired and essential for drug efficacy.

This concerns in vitro stability. For drugs that are oligopeptides or proteins, stability

⁶¹Hildebrand JH. Is there a “hydrophobic effect”? Proc. Natl Acad. Sci. 1979;76:194.