

Twenty-One Amino Acids

⊕ Positive

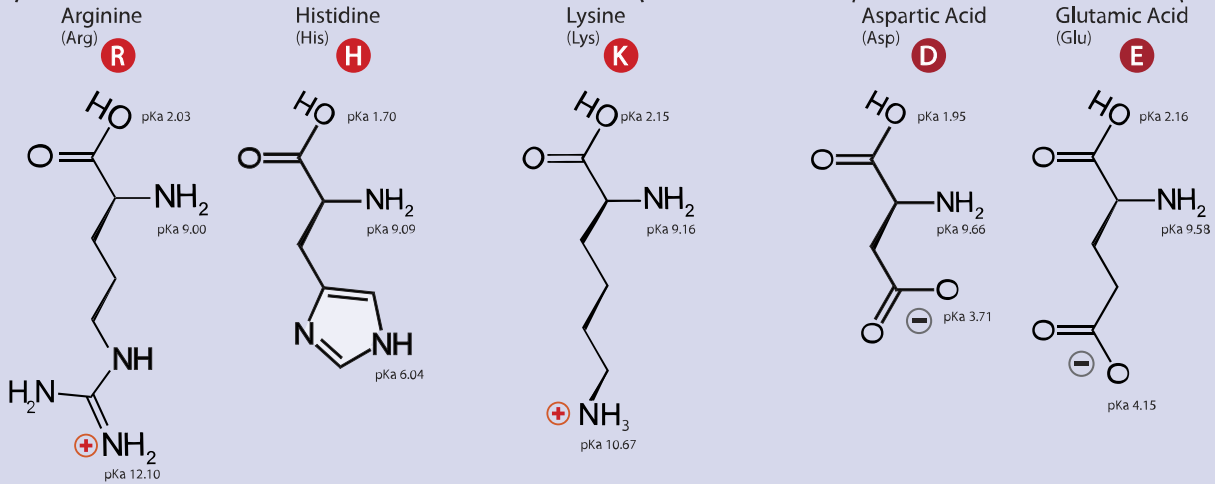
⊖ Negative

• Side chain charge at physiological pH 7.4

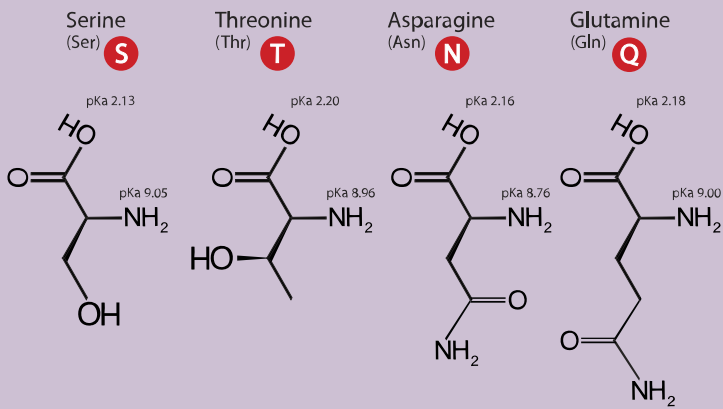
A. Amino Acids with Electrically Charged Side Chains

Positive

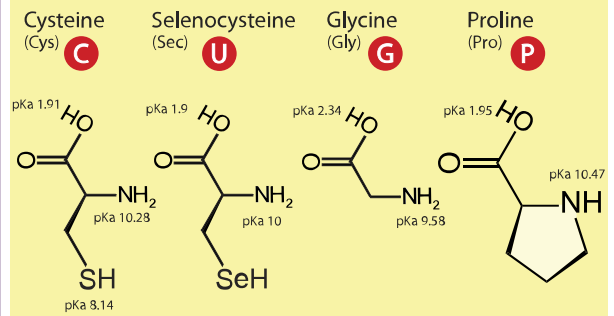
Negative



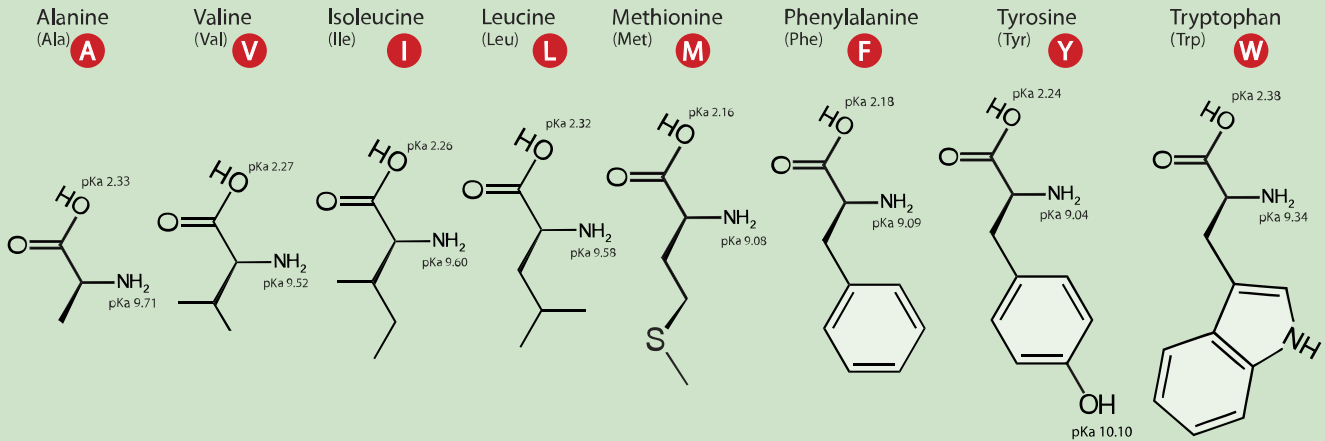
B. Amino Acids with Polar Uncharged Side Chains

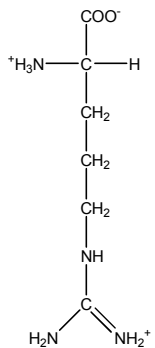
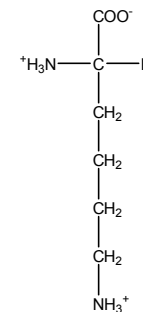
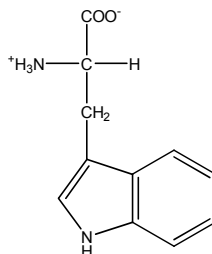
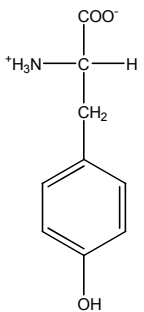
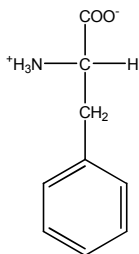
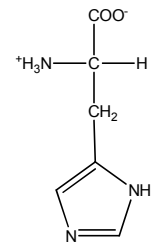
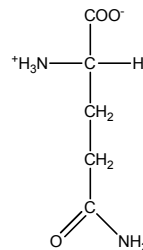
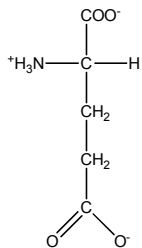
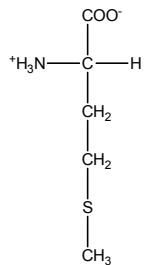
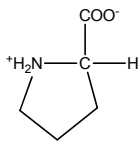
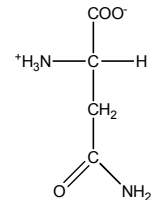
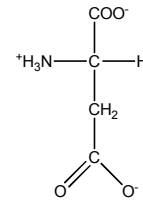
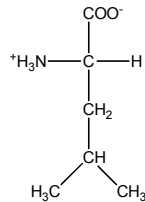
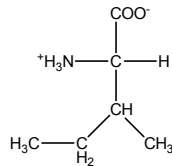
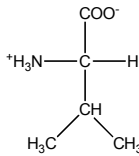
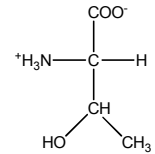
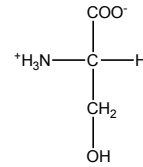
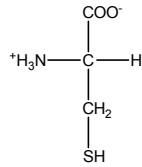
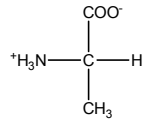
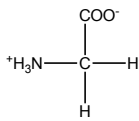


C. Special Cases



D. Amino Acids with Hydrophobic Side Chain

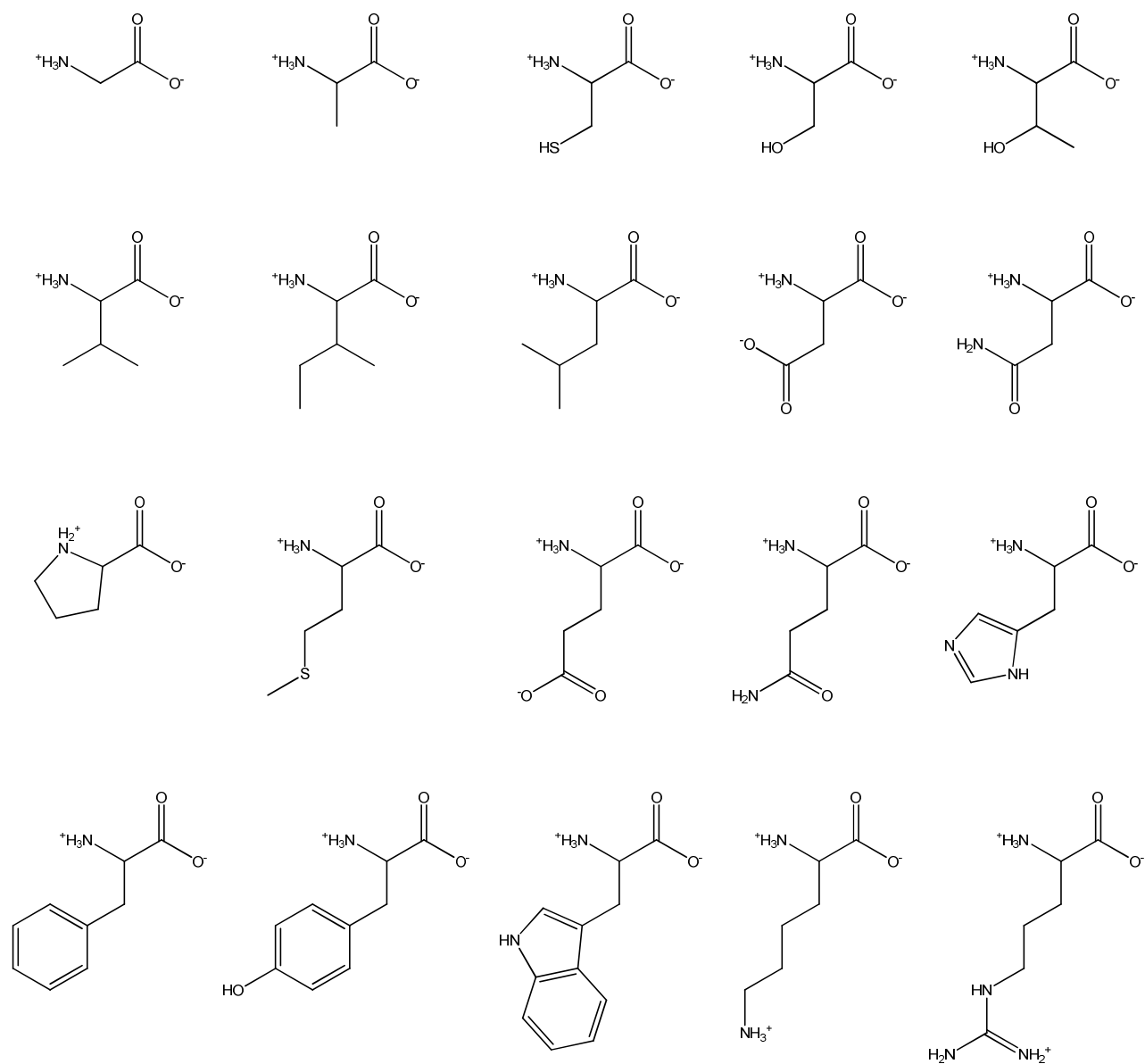




Approximate pK_a values of ionizable groups of amino acids and peptides
(side chains listed unless otherwise noted):

Aspartate (carboxyl): 4
 Glutamate (carboxyl): 4
 Histidine (imidazole): 6
 Cysteine (sulfhydryl): 8.5
 Tyrosine (hydroxyl): 10.5
 Lysine (amino): 10.5
 Arginine (guanidino): 12.5

Serine (hydroxyl): 13
 Threonine (hydroxyl): 13
 α-carboxyl of free amino acid: 2
 α-amino of free amino acid: 9.5
 C-terminal carboxyl of peptide: 3
 N-terminal amino of peptide: 8



Hydropathy values

These numbers are taken from one of many scales that describe the hydrophobicity of the amino acids. The more positive the value, the more hydrophobic the aa. (Likewise, the more negative the value, the more hydrophilic the aa.) In other scales, the order of amino acids (from most to least hydrophobic) may vary, but the general progression is similar.

(from J. Kyte & R. F. Doolittle. A simple method for displaying the hydropathic character of a protein. *J Mol Biol*, 157, 105-132):

Isoleucine	4.50	Methionine	1.90	Tryptophan	-0.90	Glutamic acid	-3.50
Valine	4.20	Alanine	1.80	Tyrosine	-1.30	Asparagine	-3.50
Leucine	3.80	Glycine	-0.40	Proline	-1.60	Glutamine	-3.50
Phenylalanine	2.80	Threonine	-0.70	Histidine	-3.20	Lysine	-3.90
Cysteine	2.50	Serine	-0.80	Aspartic acid	-3.50	Arginine	-4.50