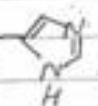


Three letter Symbol and One letter Symbol	Structural formula	pK_1 $\alpha\text{-COOH}$	pK_2 $\alpha\text{-NH}_3^+$	pK_R Side Chains	pI Isoelectric point.

Amino acids with charged polar side chains.

Lysine *	COO^-	2.16	9.06	10.54	9.8
Lys K	$\text{HC}(\text{NH}_3^+)(\text{CH}_2)_4\text{NH}_3^+$			($\epsilon\text{-NH}_3^+$)	
Arginine *	COO^-	1.82	8.99	12.48	10.74
Arg R	$\text{HC}(\text{NH}_3^+)(\text{CH}_2)_3\text{NH}-\text{C}(=\text{NH}_2^+)\text{NH}_2$			(guanidino)	
Histidine *	COO^-	1.80	9.33	6.04	7.68
His H	$\text{HC}(\text{NH}_3^+)=\text{CH}_2$ 			(imidazole)	
Aspartic acid	COO^-	1.99	9.90	3.90	2.94
Asp D	$\text{HC}(\text{NH}_3^+)=\text{CH}_2-\text{C}(=\text{O})\text{O}^-$			($\beta\text{-COOH}$)	
Glutamic acid	COO^-	2.10	9.47	4.07	3.08
Glu E	$\text{HC}(\text{NH}_3^+)=\text{CH}_2-\text{CH}_2-\text{C}(=\text{O})\text{O}^-$			($\gamma\text{-COOH}$)	

Amino acids with non polar side chains .

Glycine Gly G	$\begin{array}{c} \text{COO}^- \\ \\ \text{CH}_2 \\ \\ \text{NH}_3^+ \end{array}$	2.35	9.78	6.06
Alanine Ala A	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_3 \\ \\ \text{NH}_3^+ \end{array}$	2.35	9.87	6.11
Valine * Val V	$\begin{array}{c} \text{COO}^- \quad \text{CH}_3 \\ \quad \quad \\ \text{H}-\text{C}-\text{CH} \\ \quad \quad \\ \text{NH}_3^+ \quad \text{CH}_3 \end{array}$	2.29	9.74	6.02
Leucine * Leu L	$\begin{array}{c} \text{COO}^- \quad \quad \text{CH}_3 \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{CH}_2-\text{CH} \\ \quad \quad \quad \\ \text{NH}_3^+ \quad \quad \text{CH}_3 \end{array}$	2.33	9.74	6.04
Isoleucine * Ile I	$\begin{array}{c} \text{COO}^- \quad \text{CH}_3 \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{CH}_2-\text{CH}_3 \\ \quad \quad \\ \text{NH}_3^+ \quad \text{H} \end{array}$	2.32	9.76	6.04

Methionine * Met M	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_2-\text{CH}_2-\text{SCH}_3 \\ \\ \text{NH}_3^+ \end{array}$	2.13	9.28	5.70
Proline Pro P	$\begin{array}{c} \text{H}_2 \\ \\ \text{COO}^- \text{C} \\ / \quad \backslash \\ \text{C} \quad \text{CH}_2 \\ \quad \quad \\ \text{H} \quad \text{N}^+ \quad \text{CH}_2 \\ \quad \quad \\ \quad \quad \text{H}_2 \end{array}$	1.95	10.64	6.30
Phenylalanine * Phe F	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_2-\text{C}_6\text{H}_5 \\ \\ \text{NH}_3^+ \end{array}$	2.20	9.31	5.76
Tryptophan * Trp W	$\begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_2-\text{C}_8\text{H}_6\text{N} \\ \\ \text{NH}_3^+ \end{array}$	2.46	9.41	5.94

Amino acids with uncharged polar side chains.

Serine Ser S	$ \begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_2\text{OH} \\ \\ \text{NH}_3^+ \end{array} $	2.19	9.21		5.7
Threonine* Thr T	$ \begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{C}-\text{CH}_3 \\ \quad \\ \text{NH}_3^+ \text{OH} \end{array} $	2.09	9.10		5.60
Asparagine Asn N	$ \begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_2-\text{C}(=\text{O})\text{NH}_2 \\ \\ \text{NH}_3^+ \end{array} $	2.14	8.72		5.43
Glutamine Gln Q	$ \begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_2-\text{CH}_2-\text{C}(=\text{O})\text{NH}_2 \\ \\ \text{NH}_3^+ \end{array} $	2.17	9.13		5.65
Tyrosine Tyr Y	$ \begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_2-\text{C}_6\text{H}_4-\text{OH} \\ \\ \text{NH}_3^+ \end{array} $	2.20	9.21	10.46 (phenol)	6.33
Cysteine Cys C	$ \begin{array}{c} \text{COO}^- \\ \\ \text{H}-\text{C}-\text{CH}_2\text{SH} \\ \\ \text{NH}_3^+ \end{array} $	1.92	10.70	8.37 (sulfhydryl)	5.14