

Amino Acids Reference Chart

Hydrophobic - aliphatic

Hydrophobic - aromatic

Neutral - polar side chains

Acidic

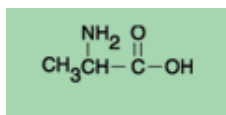
Basic

Unique

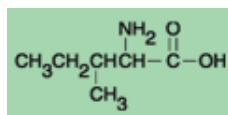
Properties of Common Amino Acids

Hydrophobicity Index

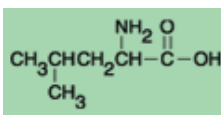
Amino Acids with Hydrophobic Side Chain - Aliphatic



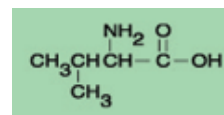
Alanine, Ala, A



Isoleucine, Ile, I



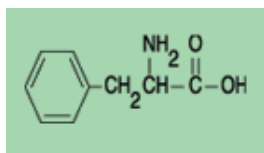
Leucine, Leu, L



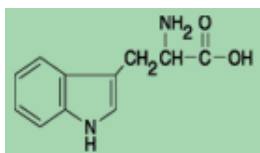
Valine, Val, V

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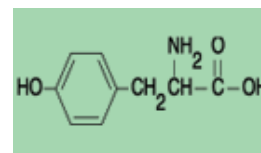
Amino Acids with Hydrophobic Side Chain - Aromatic



Phenylalanine, Phe, F



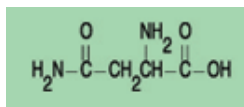
Tryptophan, Trp, W



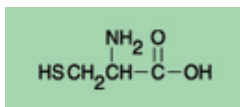
Tyrosine, Tyr, Y

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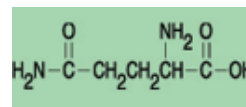
Amino Acids with Polar Neutral Side Chains



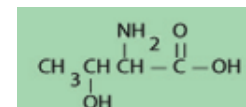
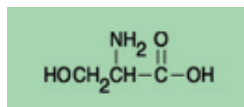
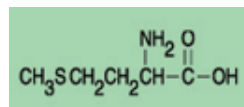
Asparagine, Asn, N



Cysteine, Cys, C



Glutamine, Gln, Q



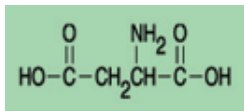
Methionine, Met, M

Serine, Ser, S

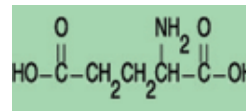
Threonine, Thr, T

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Amino Acids with Electrically Charged Side Chains - Acidic



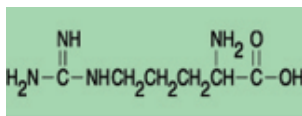
Aspartic acid, Asp, D



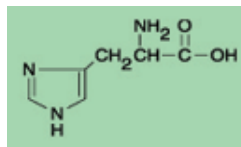
Glutamic acid, Glu, E

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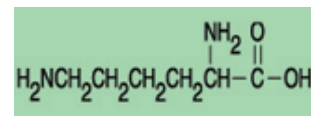
Amino Acids with Electrically Charged Side Chains - Basic



Arginine, Arg, R



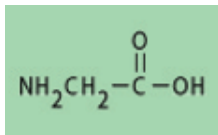
Histidine, His, H



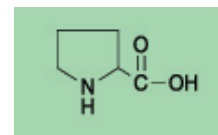
Lysine, Lys, K

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Unique Amino Acids



Glycine, Gly, G



Proline, Pro, P

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Properties of Common Amino Acids

Name	3-Letter Symbol	1-Letter Symbol	Molecular weight	Molecular Formula	Residue Formula	Residue Weight (-H ₂ O)	pK _a ¹	pK _b ²	pK _x ³	pI ⁴
Alanine	Ala	A	89.10	C ₃ H ₇ NO ₂	C ₃ H ₅ NO	71.08	2.34	9.69	—	6.00
Arginine	Arg	R	174.20	C ₆ H ₁₄ N ₄ O ₂	C ₆ H ₁₂ N ₄ O	156.19	2.17	9.04	12.48	10.76
Asparagine	Asn	N	132.12	C ₄ H ₈ N ₂ O ₃	C ₄ H ₆ N ₂ O ₂	114.11	2.02	8.80	—	5.41
Aspartic acid	Asp	D	133.11	C ₄ H ₇ NO ₄	C ₄ H ₅ NO ₃	115.09	1.88	9.60	3.65	2.77
Cysteine	Cys	C	121.16	C ₃ H ₇ NO ₂ S	C ₃ H ₅ NO ₂	103.15	1.96	10.28	8.18	5.07
Glutamic acid	Glu	E	147.13	C ₅ H ₉ NO ₄	C ₅ H ₇ NO ₃	129.12	2.19	9.67	4.25	3.22
Glutamine	Gln	Q	146.15	C ₅ H ₁₀ N ₂ O ₃	C ₅ H ₈ N ₂ O ₂	128.13	2.17	9.13	—	5.65
Glycine	Gly	G	75.07	C ₂ H ₅ NO ₂	C ₂ H ₃ NO	57.05	2.34	9.60	—	5.97
Histidine	His	H	155.16	C ₆ H ₉ N ₃ O ₂	C ₆ H ₇ N ₃ O	137.14	1.82	9.17	6.00	7.59
Hydroxyproline	Hyp	O	131.13	C ₅ H ₉ NO ₃	C ₅ H ₇ NO ₂	113.11	1.82	9.65	—	—
Isoleucine	Ile	I	131.18	C ₆ H ₁₃ NO ₂	C ₆ H ₁₁ NO	113.16	2.36	9.60	—	6.02
Leucine	Leu	L	131.18	C ₆ H ₁₃ NO ₂	C ₆ H ₁₁ NO	113.16	2.36	9.60	—	5.98
Lysine	Lys	K	146.19	C ₆ H ₁₄ N ₂ O ₂	C ₆ H ₁₂ N ₂ O	128.18	2.18	8.95	10.53	9.74
Methionine	Met	M	149.21	C ₅ H ₁₁ NO ₂ S	C ₅ H ₉ NO ₂	131.20	2.28	9.21	—	5.74
Phenylalanine	Phe	F	165.19	C ₉ H ₁₁ NO ₂	C ₉ H ₉ NO	147.18	1.83	9.13	—	5.48
Proline	Pro	P	115.13	C ₅ H ₉ NO ₂	C ₅ H ₇ NO	97.12	1.99	10.60	—	6.30
Pyroglutamic	Glp	U	139.11	C ₅ H ₇ NO ₃	C ₅ H ₅ NO ₂	121.09	—	—	—	5.68
Serine	Ser	S	105.09	C ₃ H ₇ NO ₃	C ₃ H ₅ NO ₂	87.08	2.21	9.15	—	5.68
Threonine	Thr	T	119.12	C ₄ H ₉ NO ₃	C ₄ H ₇ NO ₂	101.11	2.09	9.10	—	5.60
Tryptophan	Trp	W	204.23	C ₁₁ H ₁₂ N ₂ O ₂	C ₁₁ H ₁₀ N ₂ O	186.22	2.83	9.39	—	5.89
Tyrosine	Tyr	Y	181.19	C ₉ H ₁₁ NO ₃	C ₉ H ₉ NO ₂	163.18	2.20	9.11	10.07	5.66
Valine	Val	V	117.15	C ₅ H ₁₁ NO ₂	C ₅ H ₉ NO	99.13	2.32	9.62	—	5.96

¹ pK_a is the negative of the logarithm of the dissociation constant for the -COOH group
² pK_b is the negative of the logarithm of the dissociation constant for the -NH₃⁺ group
³ pK_x is the negative of the logarithm of the dissociation constant for any other group in the molecule
⁴ pI is the pH at the isoelectric point

References: D. R. Lide, *Handbook of Chemistry and Physics*, 72nd Edition, CRC Press, Boca Raton, FL, 1991.

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Hydrophobicity Index for Common Amino Acids

The hydrophobicity index is a measure of the relative hydrophobicity, or how soluble an amino acid is in water. In a protein, hydrophobic amino acids are likely to be found in the interior, whereas hydrophilic amino acids are likely to be in contact with the aqueous environment.

The values in the table below are normalized so that the most hydrophobic residue is given a value of 100 relative to glycine, which is considered neutral (0 value). The scales were extrapolated to residues which are more hydrophilic than glycine.

At pH 2 [^]		At pH 7 [^]	
Very Hydrophobic			
Leu	100	Phe	100
Ile	100	Ile	99
Phe	92	Trp	97
Trp	84	Leu	97
Val	79	Val	76
Met	74	Met	74
Hydrophobic			
Cys	52	Tyr	63
Tyr	49	Cys	49
Ala	47	Ala	41
Neutral			
Thr	13	Thr	13
Glu	8	His	8
Gly	0	Gly	0
Ser	-7	Ser	-5
Gln	-18	Gln	-10
Asp	-18		
Hydrophilic			
Arg	-26	Arg	-14
Lys	-37	Lys	-23
Asn	-41	Asn	-28
His	-42	Glu	-31
Pro	-46	Pro	-46 (used pH 2)
		Asp	-55

[^]pH 2 values: Normalized from Sereda et al., J. Chrom. 676: 139-153 (1994).

[^]pH 7 values: Monera et al., J. Protein Sci. 1: 319-329 (1995).

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