# The 20 amino acids

Codes, side-chain classes, dietary status, side-chain pKa, formulas and molecular weights

| 1-letter | Name | 3-letter | Side chain | Dietary | Side-chain pKa | Formula | MW (g/mol) |
|---|---|---|---|---|---|---|---|
| G | **Glycine** | Gly | Gly / Pro | Cond. essential | — | $C_2H_5NO_2$ | 75.07 |
| A | **Alanine** | Ala | Hydrophobic | Nonessential | — | $C_3H_7NO_2$ | 89.09 |
| V | **Valine** | Val | Hydrophobic | Essential | — | $C_5H_{11}NO_2$ | 117.15 |
| L | **Leucine** | Leu | Hydrophobic | Essential | — | $C_6H_{13}NO_2$ | 131.17 |
| I | **Isoleucine** | Ile | Hydrophobic | Essential | — | $C_6H_{13}NO_2$ | 131.17 |
| P | **Proline** | Pro | Gly / Pro | Cond. essential | — | $C_5H_9NO_2$ | 115.13 |
| F | **Phenylalanine** | Phe | Hydrophobic | Essential | — | $C_9H_{11}NO_2$ | 165.19 |
| W | **Tryptophan** | Trp | Hydrophobic | Essential | — | $C_{11}H_{12}N_2O_2$ | 204.23 |
| M | **Methionine** | Met | Hydrophobic | Essential | — | $C_5H_{11}NO_2S$ | 149.21 |
| S | **Serine** | Ser | Polar | Nonessential | — | $C_3H_7NO_3$ | 105.09 |
| T | **Threonine** | Thr | Polar | Essential | — | $C_4H_9NO_3$ | 119.12 |
| C | **Cysteine** | Cys | Polar | Cond. essential | 8.18 | $C_3H_7NO_2S$ | 121.16 |
| Y | **Tyrosine** | Tyr | Polar | Cond. essential | 10.07 | $C_9H_{11}NO_3$ | 181.19 |
| N | **Asparagine** | Asn | Polar | Nonessential | — | $C_4H_8N_2O_3$ | 132.12 |
| Q | **Glutamine** | Gln | Polar | Cond. essential | — | $C_5H_{10}N_2O_3$ | 146.15 |
| D | **Aspartic acid** | Asp | Negative | Nonessential | 3.65 | $C_4H_7NO_4$ | 133.10 |
| E | **Glutamic acid** | Glu | Negative | Nonessential | 4.25 | $C_5H_9NO_4$ | 147.13 |
| K | **Lysine** | Lys | Positive | Essential | 10.53 | $C_6H_{14}N_2O_2$ | 146.19 |
| R | **Arginine** | Arg | Positive | Cond. essential | 12.48 | $C_6H_{14}N_4O_2$ | 174.20 |
| H | **Histidine** | His | Positive | Essential | 6.00 | $C_6H_9N_3O_2$ | 155.16 |

Side-chain pKa values are approximate values for the free amino acid (Lehninger, *Principles of Biochemistry*); values in proteins vary with environment. Typical α-carboxyl pKa ≈ 2.0–2.4 and α-amino pKa ≈ 9.0–10.0. Molecular weights are average values for the free amino acid. "Cond. essential" amino acids are normally made by the body but may be needed from the diet during growth, illness or injury; classifications vary slightly between textbooks.