

## Kirk's Amino Acids Chart

Note: an amino acid may be considered to belong to more than one category. For charge state, consider physiological condition (~pH 7). The range of pKa for  $\alpha$ -COOH (1.7-2.6) and for  $\alpha$ -NH<sub>3</sub><sup>+</sup> (8.8 to 10.8).

| Name          | Letter Codes | Chemical Structure of Side Chain R                             | Hydrophobic | Polar | Charged | Aromatic | Side Chain pKa |
|---------------|--------------|--|-------------|-------|---------|----------|----------------|
| Alanine       | Ala<br>A     | —CH <sub>3</sub>   | Y           | N     | N       | N        |                |
| Arginine      | Arg<br>R     | —(CH <sub>2</sub> ) <sub>3</sub> NH-C(NH)NH <sub>2</sub>       | Y           | Y/N   | Y(+)    | N        | 12.5           |
| Asparagine    | Asn<br>N     | —CH <sub>2</sub> CONH <sub>2</sub>                             | N           | Y/N   | N       | N        |                |
| Aspartic acid | Asp<br>D     | —CH <sub>2</sub> COOH  | N           | Y/N   | Y(-)    | N        | 3.9            |
| Cysteine      | Cys<br>C     | —CH <sub>2</sub> SH  | Y/N         | Y/N   | N       | N        | 8.3            |
| Glutamine     | Gln<br>Q     | —CH <sub>2</sub> CH <sub>2</sub> CONH <sub>2</sub>             | N           | Y/N   | N       | N        |                |
| Glutamic acid | Glu<br>E     | —CH <sub>2</sub> CH <sub>2</sub> COOH                          | N           | Y/N   | Y(-)    | N        | 4.3            |
| Glycine       | Gly<br>G     | —H   | Y/N         | Y/N** | N       | N        |                |
| Histidine     | His<br>H     | —CH <sub>2</sub> -C <sub>3</sub> H <sub>3</sub> N <sub>2</sub> | Y           | Y/N   | Y(+)    | Y        | 6.0            |
| Isoleucine    | Ile<br>I     | —CH(CH <sub>3</sub> )CH <sub>2</sub> CH <sub>3</sub>           | Y           | N     | N       | N        |                |
| Leucine       | Leu<br>L     | —CH <sub>2</sub> CH(CH <sub>3</sub> ) <sub>2</sub>             | Y           | N     | N       | N        |                |
| Lysine        | Lys<br>K     | —(CH <sub>2</sub> ) <sub>4</sub> NH <sub>2</sub>               | Y           | Y/N   | Y(+)    | N        | 10.5           |
| Methionine    | Met<br>M     | —CH <sub>2</sub> CH <sub>2</sub> SCH <sub>3</sub>              | Y           | N     | N       | N        |                |
| Phenylalanine | Phe<br>F     | —CH <sub>2</sub> C <sub>6</sub> H <sub>5</sub>                 | Y           | N     | N       | Y        |                |
| Proline       | Pro<br>P     | —CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> -             | Y           | N     | N       | N        |                |
| Serine        | Ser<br>S     | —CH <sub>2</sub> OH  | Y/N         | Y/N   | N       | N        | 13             |
| Threonine     | Thr<br>T     | —CH(OH)CH <sub>3</sub>   | Y           | Y/N   | N       | N        | 13             |
| Tryptophan    | Trp<br>W     | —CH <sub>2</sub> C <sub>8</sub> H <sub>6</sub> N               | Y           | Y/N*  | N       | Y        |                |
| Tyrosine      | Tyr<br>Y     | —CH <sub>2</sub> -C <sub>6</sub> H <sub>4</sub> OH             | Y           | Y/N*  | N       | Y        | 10.1           |
| Valine        | Val<br>V     | —CH(CH <sub>3</sub> ) <sub>2</sub>                             | Y           | N     | N       | N        |                |

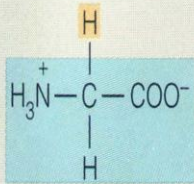
AVLIPMF have entirely nonpolar R groups. The rest are amphiphilic (varying amounts of polar and nonpolar parts).

\*Y and W have the smallest polar portion.

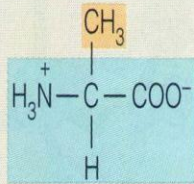
\*\*Glycine with only H as its R group can be accommodated in both polar and nonpolar environments. As such, it is found both inside and on the surface of proteins. Its polar peptide linkages are the major determinant of its property.

## 20 Standard Amino Acids

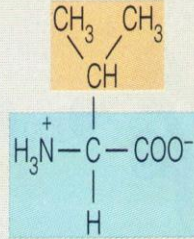
### ALIPHATIC AMINO ACIDS



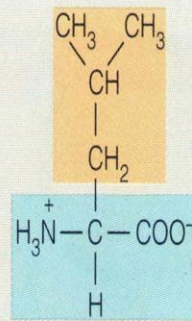
Glycine (Gly) G



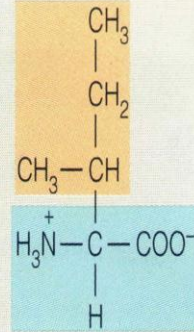
Alanine (Ala) A



Valine (Val) V

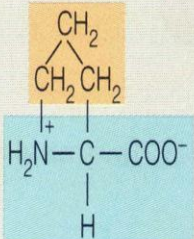


Leucine (Leu) L



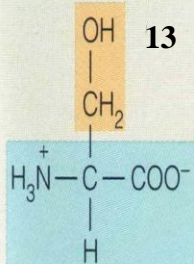
Isoleucine (Ile) I

### CYCLIC AMINO ACID

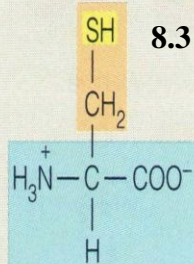


Proline (Pro) P

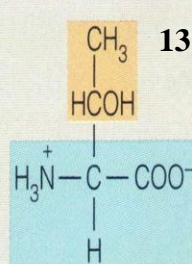
### AMINO ACIDS WITH HYDROXYL- OR SULFUR-CONTAINING SIDE CHAINS



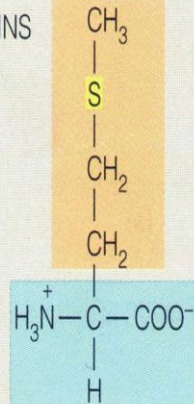
Serine (Ser) S



Cysteine (Cys) C

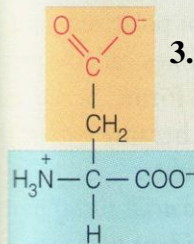


Threonine (Thr) T

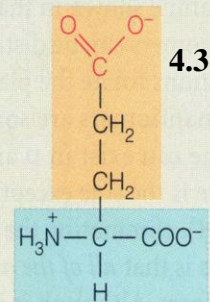


Methionine (Met) M

### ACIDIC AMINO ACIDS AND THEIR AMIDES

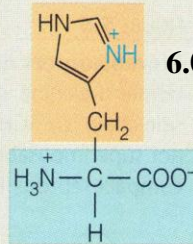


Aspartic acid (Asp) D

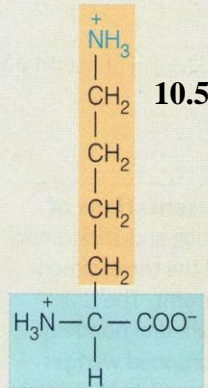


Glutamic acid (Glu) E

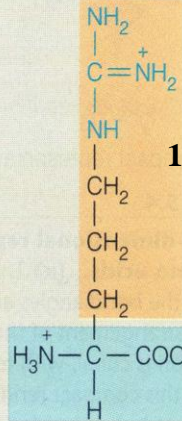
### BASIC AMINO ACIDS



Histidine (His) H

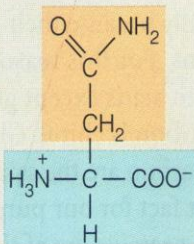


Lysine (Lys) K

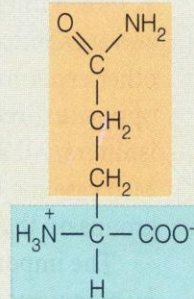


Arginine (Arg) R

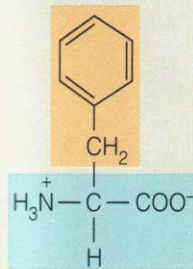
### AROMATIC AMINO ACIDS



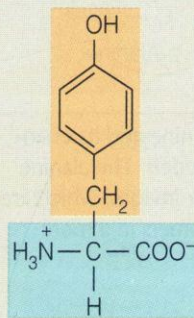
Asparagine (Asn) N



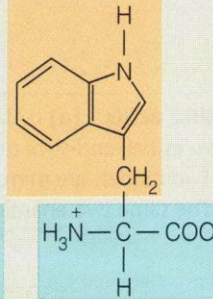
Glutamine (Gln) Q



Phenylalanine (Phe) F



Tyrosine (Tyr) Y



Tryptophan (Trp) W