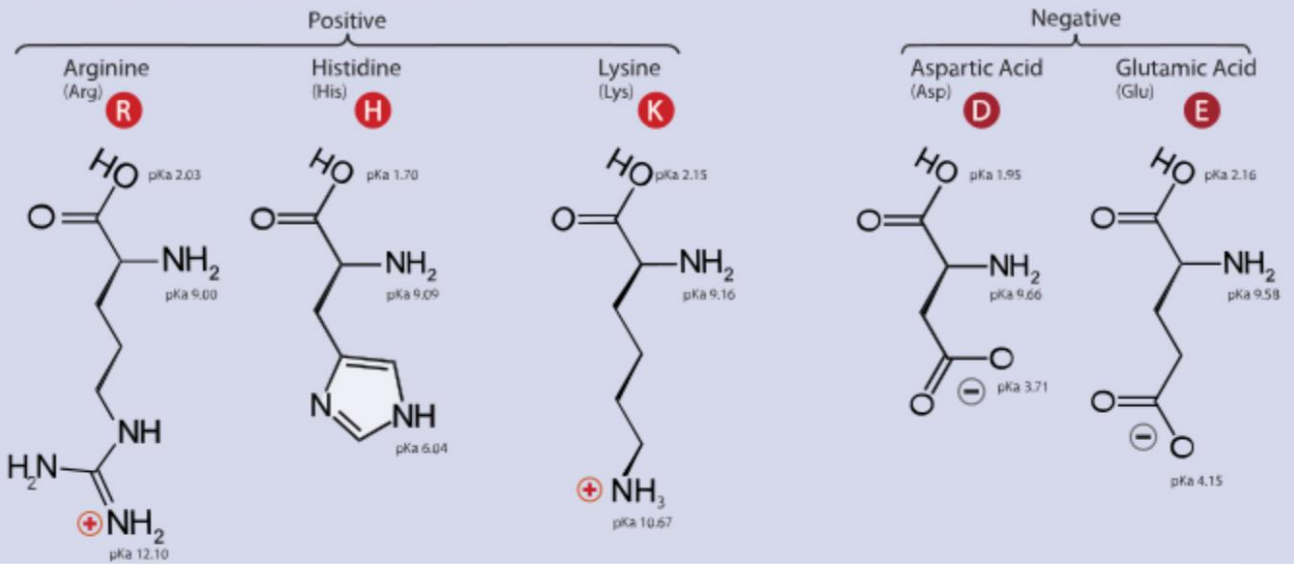


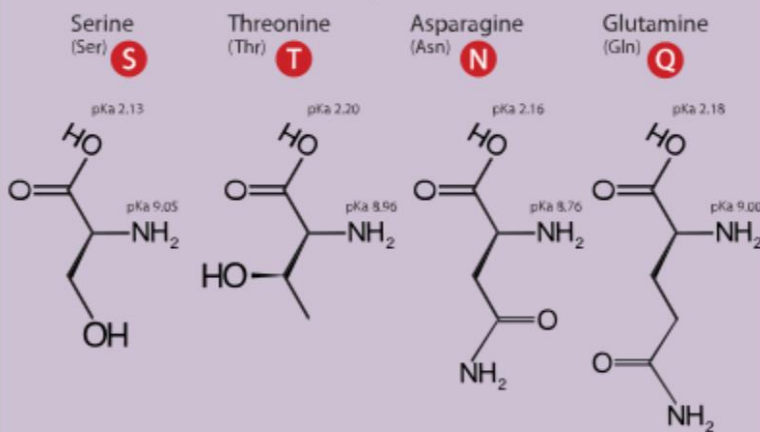
Twenty-One Amino Acids

⊕ Positive ⊖ Negative
 • Side chain charge at physiological pH 7.4

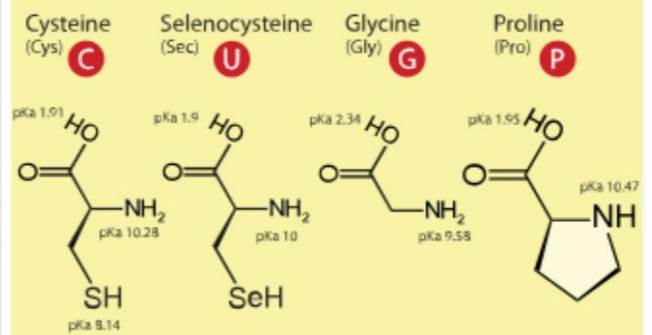
A. Amino Acids with Electrically Charged Side Chains



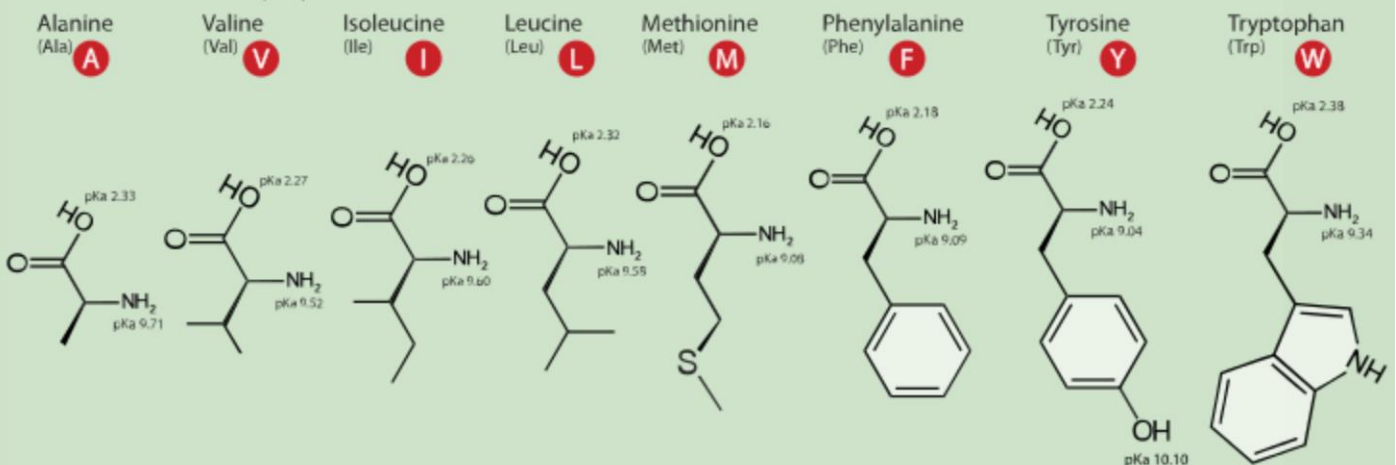
B. Amino Acids with Polar Uncharged Side Chains

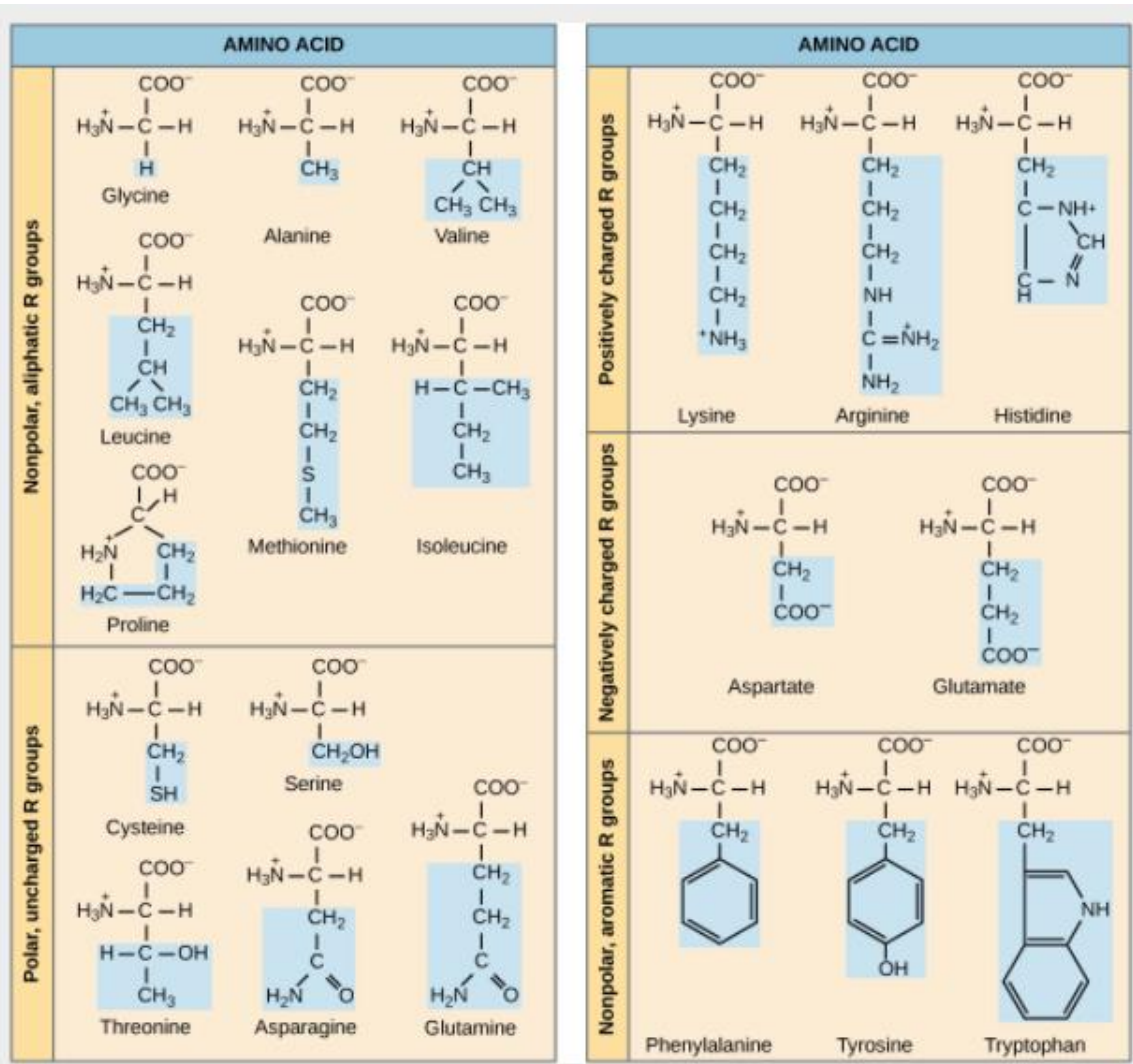


C. Special Cases



D. Amino Acids with Hydrophobic Side Chain





Functional Group	Structure	Properties
Hydroxyl	$\text{R}-\text{O}-\text{H}$	Polar
Methyl	$\text{R}-\text{CH}_3$	Nonpolar
Carbonyl	$\text{R}-\text{C}(=\text{O})-\text{R}'$	Polar
Carboxyl	$\text{R}-\text{C}(=\text{O})\text{OH}$	Charged, ionizes to release H^+ . Since carboxyl groups can release H^+ ions into solution, they are considered acidic.
Amino	$\text{R}-\text{N}(\text{H})_2$	Charged, accepts H^+ to form NH_3^+ . Since amino groups can remove H^+ from solution, they are considered basic.
Phosphate	$\text{R}-\text{O}-\text{P}(=\text{O})(\text{OH})_2$	Charged, ionizes to release H^+ . Since phosphate groups can release H^+ ions into solution, they are considered acidic.
Sulfhydryl	$\text{R}-\text{S}-\text{H}$	Polar

Figure 2.29 The functional groups shown here are found in many different biological molecules.