AMINO ACIDS AND PEPTIDES

Knowing something about proton transfer changes how we look at some important biomolecules. Amino acids are the fundamental building blocks of peptides and proteins. Peptides, which are chains of amino acids, are frequently used as signaling molecules within the body (some hormones are peptides). Proteins, which are very large peptides, have a variety of uses. They form the key components of muscles, for instance, and they also form enzymes that carry out a multitude of chemical reactions necessary for life.

Amino acids are so called because they all contain two common components. One is an amine, or a tetrahedral nitrogen attached to a carbon. The other is a carboxylic acid, which is a carbon that is double bonded to an oxygen and also attached to an OH or hydroxyl group.

We have seen that carboxylic acids are moderately acidic. Most of them have pKa's of 3 to 5. That means a small fraction of the OH groups are ionized in a large group of carboxylic acids.

Figure AB15.1. A carboxylic acid in water.

We have also seen that tetrahedral nitrogens are somewhat Lewis basic. The nitrogen can donate its lone pair to Lewis acidic atoms. Protons are good Lewis acids. Amines are easily protonated if protons are available.

Figure AB15.2. An amine in a proton-rich environment.

Because the carboxylic acid is a pretty good source of protons and because protons bind to amines pretty well, it seems reasonable that a proton transfer may occur from one site to the other.

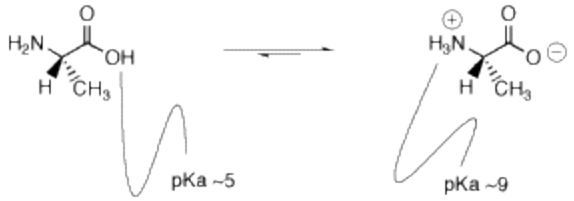

Figure AB15.3. Two forms of an amino acid, related by proton transfer.

Does one of these forms dominate the equilibrium? Compare the pKa's. The pKa of the acid is near 5, and the pKa of the ammonium is near 9. The ammonium holds the proton more tightly than does the acid. The proton stays on the nitrogen.

Amino acids are zwitterionic. A zwitterion is a compound that has no overall charge but that has charge separation within it. The zwitterionic nature of amino acids has an effect on their properties. For example, they are usually pretty soluble in water and other polar solvents.

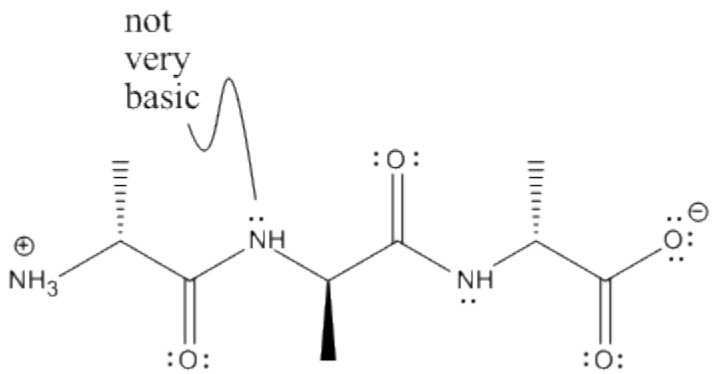

Figure AB15.4. A peptide.

Amino acids are joined together via "amide linkages" to form peptides and proteins. In these structures, the individual amino acids no longer have the same acidic carboxylic acid group; the carbonyl (or C=O) no longer has a hydroxyl group attached. The amino acids no longer contain amines, either; a nitrogen attached to a C=O has very different properties than a regular nitrogen attached to carbon. Only the "N-terminus" and "C-terminus" are ionic. The nitrogens along the chain are not very basic and are not protonated.

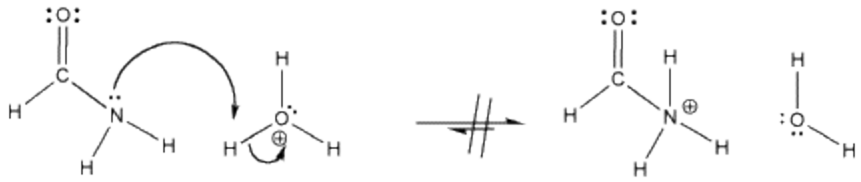

Figure AB15.5. An amide, and the unfavourable protonation of an amide.

Source : http://employees.csbsju.edu/cschaller/Principles%20Chem/acidity/acid%20amino.htm