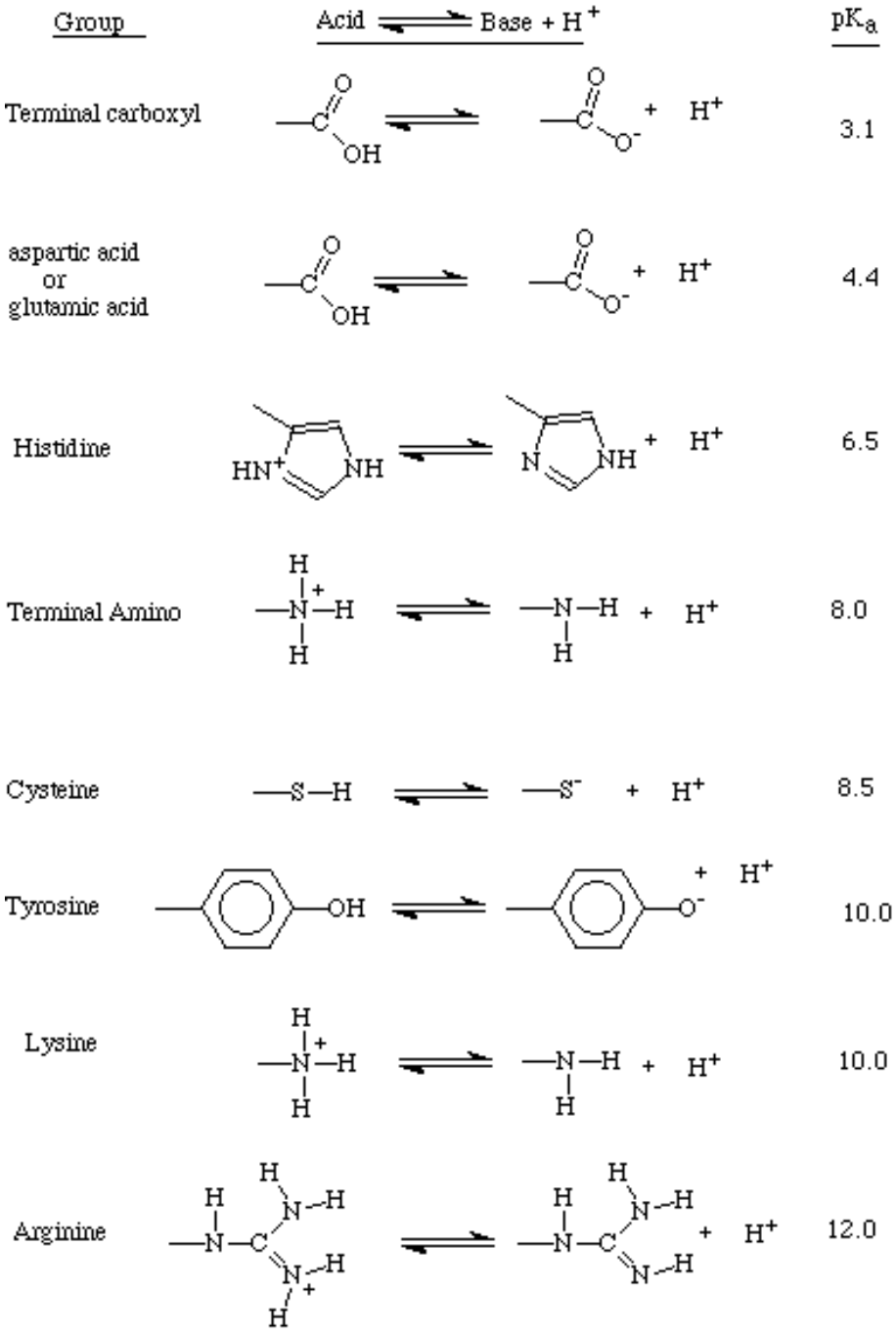
Chemistry 201

Polypeptides as buffers

NC State University

Amino acid side chain pK_a

Proteins are made of up of a number of “titratable” amino acids. At pH 7 the terminal carboxyl, aspartate and glutamate have a negative charge. Terminal amino, lysine and arginine are positively charged. Others are neutral, but can be charged due to interactions within the protein. The pKa of any of these groups may be altered by the protein.



The isoelectric point of a protein pI

Proteins have many titratable groups on their surface. It is not possible to define a single pKa since all of the groups have different pKa values. However, we can define the point at which protein is neutral in charge: the isoelectric point. At the isoelectric point the protein has 0 net charge, which means that there as many positive as negative groups on the surface.

The isoelectric point concept applies to polymers, nanoparticles etc. Any macromolecule can be described in terms of its overall charge.

IMPORTANT: When pH = pI a macromolecule has a neutral surface. This is the minimum stability point. Macromolecules tend to precipitate at this point.

Hemoglobin as a buffer

Hemoglobin is the most abundant protein inside of red blood cells and accounts for one-third of the mass of the cell. During the conversion of CO_2 into HCO_3^-, H^+ liberated in the reaction are buffered by hemoglobin, which is reduced by the dissociation of oxygen. This buffering helps maintain normal pH. The process is reversed in the pulmonary capillaries to re-form CO_2, which then can diffuse into the air sacs to be exhaled into the atmosphere.