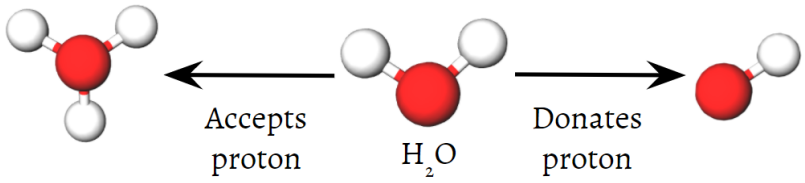
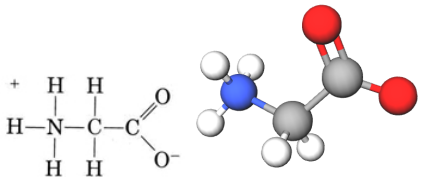
11.12: Amphiprotic Species

Molecules or ions which can either donate or accept a proton, depending on their circumstances, are called **amphiprotic species**. The most important amphiprotic species is water itself. When an acid donates a proton to water, the water molecule is a proton acceptor, and hence a base. Conversely, when a base reacts with water, a water molecule donates a proton, and hence acts as an acid.



Another important group of amphiprotic species is the amino acids. Each amino acid molecule contains an acidic carboxyl group and a basic amino group. In fact the amino acids usually exist in *zwitterion* (German for "double ion") form, where the proton has transferred from the carboxyl to the amino group. In the case of glycine, for example, the zwitterion is



The zwitterion can donate one of the protons from the N, just as an NH_4^+ ion can donate a proton. On the other hand, its COO^- end can accept a proton, just as a CH_3COO^- ion can. Other common amphiprotic species are HCO_3^-, $H_2PO_4^-$, HPO_4^{2-}, and other anions derived from diprotic or triprotic acids.

Example 11.12.1 : Equations

Write equations to show the amphiprotic behavior of (a) $H_2PO_4^-$ and (b) H_2O.

Solution

To make an amphiprotic species behave as an acid requires a fairly good proton acceptor. Conversely, to make it behave as a base requires a proton donor.

a)

Acid: $H_2PO_4^- + OH^- \rightarrow HPO_4^{2-} + H_2O$

Base: $H_2PO_4^- + H_3O^+ \rightarrow H_3PO_4 + H_2O$

b)

Acid: $H_2O + S^{2-} \rightarrow OH^- + HS^-$

Base: $H_2O + H_2SO_4 \rightarrow H_3O^+ + HSO_4^-$