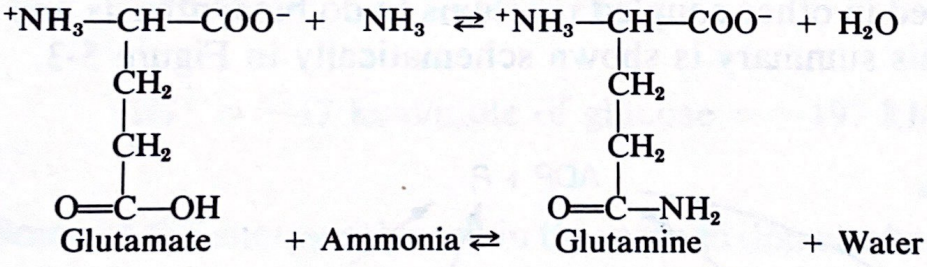
5–3 *Coupled Reactions and Group Transfer Potentials: Endergonic Reactions are Coupled to Exergonic Reactions by an Enzyme*

We noted in the preceding section that if the free energy released from one process (say, the oxidation of glucose) is to be utilized for another process (say, biosynthesis of an amino acid), there must be some means by which the two processes are coupled. In the absence of coupling, the energy released in the first process would not be harnessed for biosynthesis and would eventually appear as heat.

Let us consider a specific example of coupling: the synthesis of the amino acid glutamine and the simultaneous hydrolysis of ATP to ADP. This is one of many examples that could be chosen. It shares three characteristics with others: (a) an endergonic (free-energy requiring) reaction is coupled with an exergonic (free-energy yielding) reaction so that the combined coupled reaction is exergonic overall and therefore spontaneous; (b) the exergonic reaction is the hydrolysis of ATP to ADP and phosphate; and (c) an enzyme is the coupling factor which unites the two reactions into one so that the exergonic part drives the endergonic part.

The amino acid glutamine is a source of nitrogen in the biosynthesis of many compounds, including amino acids, nucleic acids, and amino sugars. Glutamine is formed by the condensation of NH_3 with glutamate:



$\Delta G^* = +3.4\ \text{kcal mol}^{-1} = +14\ \text{kJ mol}^{-1}$ (5-5)

The positive sign of ΔG^* shows that the reaction is endergonic.