Everything started in 1780 when Joseph Priestley, an English chemist, enclosed a mint plant and a burning candle in a glass jar. Surprisingly, the candle burned without interruption, even though in earlier experiments it was extinguished quickly when no plant was present in the jar. Now, 230 years later, we know a lot more about photosynthesis, but still many details, like the origin of the functional asymmetry in bacterial reaction centers, remain unknown. Thus, the work presented in this dissertation focuses on the functional asymmetry and the role of bacteriochlorophylls α-protein interactions in the bacterial reaction center and light-harvesting complex II. A detailed understanding of those processes may provide a significant insight as to the nature and functioning mechanism of the solar energy conversion machinery. This knowledge will be beneficial for the development of artificial photosynthetic devices, which would facilitate the solution of the global energy problem.