The description of optical spectra of photosynthetic pigment-protein complexes faces several difficulties. Two major ones are (i) to include both the pigment-protein and the pigment-pigment coupling, that give rise to vibrational sidebands, dissipation of excitation excess energy, delocalization of excited states, redistribution of oscillator strength, into a dynamical theory of optical spectra, and (ii) to determine the parameters of the pigment-protein Hamiltonian, i.e. the excitonic couplings, the local transition energies of the pigments, and the spectral density of the pigment-protein coupling. The first part of the talk will describe methods that we have developed to solve the above problems and the second part will contain applications that allow to draw conclusions about structure-function relationships of these systems, as, for example, how the proteins direct the excitation energy flow.