MAR07-2006-000597

Abstract for an Invited Paper
for the MAR07 Meeting of
the American Physical Society

Ligand-receptor binding in the presence of polymeric spacers

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Ligand-receptor binding is of fundamental importance in many biological processes. Examples include cell-cell adhesion and cell-surface interactions among others. In several biomimetic materials as well as in some biological systems the ligand is attached to the surface by a spacer. In this talk we address the role that spacers play in ligand-receptor binding. More specifically, we present a series of theoretical studies in which we systematic study the role of polymeric spacers on the efficiency of ligand-receptor binding. The systems of interest correspond to the ligand chemically bound at the free end of polymers tethered to the surface, while the receptor is part of proteins free to move in the solution. Our theoretical approach is based on a molecular theory that has been shown to predict thermodynamic and structural information for tethered polymer layers in excellent agreement with experimental observations. We have generalized the theory to include the equilibrium between the bound and unbound species. We find that the presence of spacers increases the amount of binding as compared to the case in which the ligands are directly on the surface. The maximal binding is obtained at a relatively low surface coverage of spacer and it increases as the spacer chain length increases. The maximal binding is found to correspond to the cases in which the bound proteins can accommodate at different distances from the surface while bound to the ligand. We will show how the binding depends upon the size of the protein, the free energy of binding of the bare ligand-receptor pair, the polymer surface coverage and molecular weight. The predictions of the theory will be compared with recent experimental observations on the interactions between protein coated surfaces and surfaces with ligands at the end of polyethylene oxide spacers. Finally, we will show the use of mixed tethered layers to optimize ligand- receptor binding and at the same time to minimize non-specific adsorption of proteins. Throughout the presentation the interplay between different interactions in determining the binding will be discussed.