Detection of Biomolecular Interactions at a Phospholipid Interface Using a Liquid Crystal Read-Out

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The detection of molecular recognition events, such as DNA hybridization, is at the heart of molecular diagnostics and continues to enable the genomic and proteomic revolutions. Detection typically involves biomolecular "probes" with a fluorescent "label" and expensive and bulky laser scanners. The elimination of these labels would not only decrease the cost of detection, but also permit new applications that require real-time and portable detection. Recent work has shown that the anchoring of liquid crystal molecules can be modified by the adsorption of amphiphiles at a liquid crystal/aqueous interface; such modifications are easily visualized using polarized light. Using this technique, we have demonstrated a simple method for detecting protein-phospholipid interactions at an adsorbed phospholipid interface. Both specific protein-phospholipid interactions between neutravidin and biotinylated phospholipids, as well as nonspecific protein-phospholipid interactions between neutravidin, bovine serum albumin, beta-casein and phosphaditylcholines were probed. In general, nonspecific protein interactions had a greater effect on the adsorbed phospholipid monolayer as visualized by changes in the polarization of the light passing through the adjacent liquid crystal layer. A number of factors are responsible for these nonspecific interactions due to the complex nature of proteins. Electrostatic interactions between proteins and the phospholipids were investigated by altering the pH and ionic strength of the aqueous phase and shown to have substantial effects on the interactions. Additionally, electrostatic effects were demonstrated by the extent of interactions between charged proteins and the charged phospholipid headgroups. This simple technique for sensing protein-phospholipid interactions can allow researchers to better understand interactions between proteins, cells, and membrane-bound organelles.