Title:	A simple quantitative method to study protein-lipopolysaccharide interactions by using liquid crystals
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Abstract:	The interaction of proteins with endotoxins has divergent effects on lipopolysaccharide (LPS)-induced responses, which serve as a basis for many clinical and therapeutic applications. It is, therefore, important to understand these interactions from both theoretical and practical points of view. This paper advances the design of liquid crystal (LC)-based stimuli-responsive soft materials for quantitative measurements of LPS-protein binding events through interfacial ordering transition. Micrometer-thick films of LCs undergo easily visualized ordering transitions in response to proteins at LPS-aqueous interfaces of the LCs. The optical response of the LC changes from dark to bright after aqueous solutions of hemoglobin (Hb), bovine serum albumin (BSA), and lysozyme proteins (LZM) are in contact with a LPS-laden aqueous-LC interface. The effects of interactions of different proteins with LPS are also observed to cause the response of the LC to vary significantly from one to another; this indicates that manipulation of the protein-LPS binding affinity can provide the basis for a general, facile method to tune the LPS-induced responses of the LCs to interfacial phenomena. By measuring the optical retardation of the 4′-pentyl-4-cyanobiphenyl (5CB) LC, the binding affinity of the proteins (Hb, BSA, and LZM) towards LPS that leads to different orientational behavior at the aqueous interfaces of the LCs can be determined. The interaction of proteins with the LPS-laden monolayer is highest for LPS-Hb, followed by LPS-BSA, and least for LPS-LZM; this is in correlation with their increasing order of binding constants (LPS-Hb>LPS-BSA>LPS-LZM). The results presented herein pave the way for quantitative and multiplexed measurements of LPS-protein binding events and reveal the potential of the LC system to be used as quantitative LC-based, stimuli-responsive soft materials.
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