Fluorescent Conjugated Polyelectrolytes for the Potential Detection of Bacterial Infections.

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Abstract

Conjugated polyelectrolytes (CPEs) constitute an interesting class of fluorescent materials with a wide range of properties. They are π-conjugated polymers, their rigid backbone consisting of an alternation of simple and double bonds with water soluble side chains containing cationic or anionic groups. Electron delocalization facilitates rapid intra and interchain exciton migration, conferring collective optical responses and amplified signals when comparing to conventional fluorophores. During the past decades, CPEs have received great attention in biomedical applications, especially for developing biosensing schemes and sensing devices for biomolecules and more recently have been employed as novel fluorescent probes for bioimaging.

Our group has synthesized two fluorene-based cationic CPEs emitting at different wavelength (figure 1): HTMA-PFP (blue emission) and HTMA-PFNT (red emission). Recently we have explored the ability of these compounds to interact with anionic and zwitterionic lipid vesicles [1]. From these works we concluded that the polyelectrolytes rapidly interact with both membranes, increasing their fluorescence intensity, showing higher affinity by the anionic system. Additional experiments showed that the polyelectrolytes label the lipid bilayer without altering the morphology of the vesicles and allowing their visualization. These results confirm the use of HTMA-PFP and HTMA-PFNT as fluorescent markers in membrane studies. On the other hand, the high affinity of these CPEs to anionic lipids, the dominant lipid component in bacterial membranes, as well as its high fluorescence quantum yield and photostability makes it a suitable candidate to be used for selective recognition and imaging of bacteria over mammalian cells. In the present work we have evaluated this possibility exploring the interaction of these two cationic CPEs, first with model membranes of E.coli (DOPE:DOPG:CA) and mammalian (DOPC:Col) through steady-state fluorescence spectroscopy and fluorescence microscopy experiments, and second with bacteria E.coli and HeLa cells.

Results confirm the interaction between the CPEs and both model membranes and indicate a higher affinity towards to the E.coli than to mammalian model membranes, which was specially observed for the red emission polymer HTMA-PFNT. In addition, the fluorescence microscopy studies showed the ability of the two polyelectrolytes to label and visualize bacteria E.coli in blue and in red color. Finally, the microscopy results obtained for the HeLa cells were very interesting because these cells were labeled with HTMA-PFP but not with HTMA-PFNT. It suggests that the red conjugated polyelectrolyte could be used to detect bacterial infection in living animals by selectively targeting the bacterial membrane over the membrane surfaces of healthy mammalian cells.

Reference

[1] Kahveci, Z.; Martínez-Tomé, M.J.; Esquembre,R.; Mallavia and R.; Mateo, C.R. Materials **7** (2014) 2120-40.

Figure 1: Chemical structural of HTMA-PFP (left) and PTDANF($NMe_3Br)_2$ (right).