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Novel biomimetic systems based on polyethylene glycols and amphiphilic phosphonium salt. Self-organization and solubilization of hydrophobic guest

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ABSTRACT

The solution behavior of single and binary systems based on biorelevant building blocks, i.e., polyethylene glycol (PEG) of different molecular weight, and a cationic surfactant, cetyltriphenylphosphonium bromide (TPPB), has been studied. Tensiometry data for PEG–water solutions provide critical aggregation concentrations which decrease with an increase of molecular weight of the polymer. Large particles of $\geqslant$200 nm occur in the PEG-1000 solution along with the smaller ones, while in the PEG-400 and PEG-20000 samples only populations coinciding with the size of the polymer coils are found. The dye solubilization study reveals that some hydrophobic domains occur in the PEG solution. The binary PEG-TPPB systems demonstrate a synergetic behavior, i.e. a decrease in critical micelle concentration and much higher solubilization power as compared to single TPPB micelles. The data obtained reveal that PEG-TPPB assemblies present soft nanocontainers, which (i) are composed of biorelevant components; (ii) are formed at low concentrations; (iii) are characterized by nanoscale dimension; (iv) exhibit high binding capacity toward water insoluble guest. Based on these features they may be considered as candidates for the drug delivery formulations.

1. Introduction

A majority of biotechnological applications is based on the strategies of polymer and colloid chemistry [1–5]. One of the challenging tasks in this sphere is the design of nanocontainers for bioactive substrates, including drugs. Importantly, the growing numbers of drugs are water insoluble, and therefore the lipid based formulations including liposomes, micelles, emulsions, microemulsions are of importance [6–10]. They provide the possibility of the encapsulation of hydrophobic guests into nonpolar domain of aggregates, i.e. vesicle bilayer or micellar core. Additional profit of these carriers is their nanoscale dimension, which meets biorelevant size criteria [11]. The sphere of our interest is the design of biomimetic systems based on amphiphiles and polymers, which can be used as nanocontainers and nanoreactors [12–15]. In our studies, we focus on the development of the effective synthetic equivalents of natural carriers, such as liposome, and viral vectors. While the latter are highly effective and biocompatible, they are problematic from the viewpoint of the expensiveness, the scaling up of the technology, immune response. Therefore, alternative synthetic formulations relevant to biocriteria are required, which in turn entails the design of novel biocompatible building blocks. Herein we suggest biomimetic system based on well known biocompatible polymer, polyethylene glycol (PEG), and a much

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