Nanochemistry and biotechnology

Block/comb-like copolymers of perfluorochemical and dimethyl amino ethyl methacrylates as vectors for DNA delivery

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Literature describes perspective of using F-containing micelles and dendrimers for marking and detection of biological objects [1,2]. Unique lyophobic and hydrophobic properties of F-containing carriers prevent their interaction with proteins and improve carrier affinity to cell membrane. In addition, the fluorination of polymers for DNA delivery enhances the cellular uptake of polyplex [3].

Polymer chains consisting of poly(fluorine-methacrylate) (block A) and poly((2-dimethylamino)ethyl methacrylate) (block B) polymeric blocks were synthesized via two-stage radical polymerization. First, comb-like polymeric block A of variable backbone and side perfluorochemical chain lengths was obtained via polymerization of corresponding fluorine–containing methacrylate in the presence of peroxide containing chain transfer agent (MP). Using MP during polymerization provided not only controlling polymer chain length and narrowing MWD but also the formation of polymers with end peroxide moiety. At the second stage block-copolymers were synthesized via polymerization of DMAEMA initiated by such macroinitiators. General structure of copolymers is presented on the Fig 1.

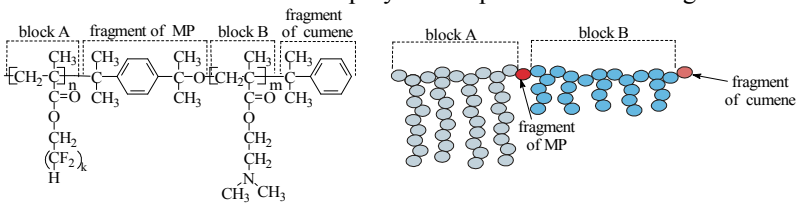

Fig.1. General structures of block-branched copolymers

All the synthesized block-copolymers are water soluble surface-active

substances, forming micelles of controlled size of depending on pH value, the lengths of the blocks and side fluorine-containing chains. The structural, molecular-weight and colloidal – chemical characteristics of the block/branched copolymers were studied using IR-, NMR- spectroscopy, gel-penetration chromatography, elementary and functional analyses techniques, dynamic and static light scattering methods respectively.

As a result of interaction of polycationite block poly(DMAEMA), included in the structure of the block-copolymer, and negatively charged plasmid DNA (pDNA) forming supramolecular structures, polyplexes. Their formation was confirmed by electrophoretic technique. DLS study revealed strong decrease of the size and strong change of the pDNA charge from negative to positive in a result of polyplex formation. Novel non-viral vectors deliver pDNA surely protected from enzyme damage during transportation to the cancer cells, bacteria and plant cells providing efficient transfection activity. The most crucial factors defining the efficiency of gene delivery were lengths of poly(DMAEMA) block and the length of side fluorine-containing chains determining hydrodynamic size of polymer/pDNA complex in the solution. Their formation was confirmed by electrophoretic technique. DLS study revealed strong decrease of the size and strong change of the pDNA charge from negative to positive in a result of polyplex formation. Novel non-viral vectors deliver pDNA surely protected from enzyme damage during transportation to the cancer cells, bacteria and plant cells providing efficient transfection activity. The most crucial factors defining the efficiency of gene delivery were lengths of poly(DMAEMA) block and the length of side fluorine-containing chains determining hydrodynamic size of polymer/pDNA complex in the solution.

1. *Knight J. C., Edwards P. G., Paisey S. J.* Fluorinated contrast agents for magnetic resonance imaging; a review of recent developments // RSC Advances.-2011.-**1**.-P. 1415 – 1325.

2. *Lu H., Su F., Mei Q., Tian Ya., Tian W., Johnsona R. H. and Meldrum D. R.* Using fluorine-containing amphiphilic random copolymers to manipulate the quantum yields of aggregation-induced emission fluorophores in aqueous solutions and the use of these polymers for fluorescent bioimaging // Journal of materials chemistry.-2012.-22.-P. 9890-9900.

3. *Wang M.*, Liu H., Li L., Cheng Yi. A fluorinated dendriner achieves excellent gene transfecrion efficacy at extremely low nitrogen to phosphorus ratios // Nature communications.-2014.-5.-P.3053.