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Structural studies of nanosystems based on zwitterionic sugar-based surfactants as innovative gene delivery systems

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One of the most important advantages of synthetic non-viral drug delivery systems is the improved transfection efficiency [1]. Broad range of amphiphilic dicationic surfactants, known as gemini surfactants, is currently studied for gene delivery purposes [2]. Unfortunately the disadvantage of these systems is their cytotoxicity.

The presented here studies indicated, that an effective complexation between DNA or RNA and zwitterionic sugar-based surfactants leads to the compaction of the nucleic acids. This effect has potential applications for preparation of gene delivery systems with reduced toxicity and improved transfection efficiency. Such systems can protect the genetic material against the degeneration by intracellular nucleases and also can promote the penetration of nucleic acid into the target cell.

The influence of various concentrations of selected surfactants on different structural forms of DNA (single strand DNA, double strand DNA and RNA oligomers) was investigated using circular dichroism (CD) spectroscopy and gel electrophoresis.

The small angle scattering of synchrotron radiation (SR-SAXS) studies were also performed on selected lipoplexes based on short DNA and RNA double stranded oligomers (21 bp), single strand DNA (23-mer) and sugar-based surfactants. The SAXS data for nanosystems studied were collected on P12 beam line of EMBL Hamburg Outstation at PETRA III storage ring (DESY).

A series of toxicity and transfection tests of these lipoplexes were performed using HeLa and fibroblasts (GM04033 and GM07492 line).

The results obtained revealed the unique properties of such designed systems. Even small amounts of lactose-based surfactants, that bind strongly to DNA or RNA, can cause a change of nucleic acid from one conformation to another.

We can conclude, that sugar-based surfactants could be useful as potential vectors for transfer genetic material into mammalian cells during non-viral gene therapy. Thanks to their construction these carriers can be able to deliver the genes of various sizes to the cells, which is difficult using viral gene delivery systems.

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