Interaction of Magnetic Nanorods Coated by Dopamine with Anionic Liposomes as Revealed by FTIR Spectroscopy

I. M. Le-Deygen, E. D. Kutsenok, M. V. Efremova, P. G. Rudakovskaya, A. G. Majouga, Y. I. Golovin, E. V. Kudryashova, A. V. Kabanov, N. L. Klyachko

Lomonosov Moscow State University, 119991 Russia, Moscow, Leninskie gory 1, 3
i.m.deygen@gmail.com

Liposomes are almost ideal carriers for delivery of both hydrophobic and hydrophilic drugs and genes. Nowadays one of the key problems is the cargo loading and controlled release. It is accepted based on the results of recent studies that radio frequency, low frequency, and extremely low frequency magnetic fields penetrate easily through the body providing great promise for internal therapy. However, the molecular mechanism of effects observed in magnetoliposomes is not entirely understood yet. Local bilayer disordering, which presumably can be achieved by oscillation of membrane-bound magnetic nanoparticles, may also result in the liposome cargo release.

A direct evidence of liposomal membrane loosening by alternating extremely low frequency magnetic field (ELF MF)-mediated nanorods oscillation is presented in this work and physical model of this process is suggested. We have studied a system based on anionic liposomes containing 20 wt % of anionic lipid cardiolipin (CL) and 80 wt % of dipalmitoylphosphatidylcholine (DPPC) and magnetic nanorods coated with positively charged dopamine (f-MNPs). f-MNPs and liposomes were characterized by DLS and NTA methods to estimate hydrodynamic radius r_{HD} and concentration of particles. The process of membrane loosening under magnetic field was demonstrated by a novel technique based on Attenuated Total Reflection Fourier Transform IR spectroscopy (ATR-FTIR) about 50% of hydrophobic chains became highly mobile under the action of magnetic field. These results are corroborated by classic label-based fluorescence spectroscopy. Using sodium chloride as an example we show that the phenomenon of membrane fluidity increase is accompanied by the increase of membrane permeability causing the release of liposome cargo.

This work is supported by RSF 14-13-00731 and RFBR 17-54-33027grants.