

biomembranes '18

@MIPT - OCTOBER 1st - 5th



Moscow Institute of Physics and Technology
(State University)

BIOMEMBRANES 2018

International Conference

1 – 5 October 2018
Book of Abstracts

Dolgoprudny
MIPT
2018

УДК 577.352(082)
ББК 28.071я43

BIOMEMBRANES 2018. International Conference.
01.10.18-05.10.18: Book of Abstracts. Dolgoprudny: MIPT, 2018.

*These proceedings will be published online in the Journal of Bioenergetics
and Biomembranes (Springer)*

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ATR-FTIR spectroscopy reveals spectral features of exosomal membrane valuable for drug delivery systems development

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Exosomes are naturally produced membrane-derived vesicles; they may be found almost in any biological fluids therefore their toxicity is minor. Nowadays, exosomes have begun to be explored for use as drug delivery systems able to increase circulation time in blood and biocompatibility of compounds [1]. Due to their structure they can transfer both hydrophobic, hydrophilic and amphiphilic drugs. Additionally, exosomes could facilitate drug targeting and help to avoid immune response.

The aim of this work is to study spectral properties of exosomal membrane in order to find out any unusual features able to become an analytical valuable. FTIR-spectroscopy seems to be an adequate and useful method for exosomal structure investigation. As a model for first studies we used so-called synthetic exosomes. These are liposomal vesicles with addition of BSA protein. We have successfully obtained linear dependence between protein-lipid content of synthetic exosomes and peaks integral intensity in IR-spectra. Utilizing the dependence, it is possible to determine protein-to-lipid ratio in natural exosomes. In the next step, we studied a trigger drug release in low frequency alternative magnetic field, using complexes of exosomes with magnetic nanoparticles. These particles, being attached to the surface of lipid membrane, can oscillate in magnetic field changing its permeability; thus, the drug incorporated in the exosome can easily be released. Such an effect has been already demonstrated for liposomal complexes with magnetic nanoparticles [2]. We have investigated changes in bilayer fluidity using the combination of FTIR-spectroscopy and classical fluorescent spectroscopy. BODIPY-fluorescent label B9PPC was added into exosomes in advance. It is known that lipid membrane loosening could be evidenced by decrease of fluorescent polarization signal. We have obtained complex dependence between fluorescent polarization signal and exposure time in magnetic field. We are able to claim for sure that exosomes membrane could be loosed by magnetic nanoparticles after exposure in magnetic field.

This research is supported in part by RSF-14-13-00731 grant.

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