LUBLIN SCIENCE AND TECHNOLOGY PARK S.A.

International research and practice conference

INNOVATIVE TECHNOLOGY IN MEDICINE: EXPERIENCE OF POLAND AND UKRAINE

April 28–29, 2017

Lublin, Republic of Poland

2017

International research and practice conference “Innovative technology in medicine: experience of Poland and Ukraine” : Conference Proceedings, April 28–29, 2017. Lublin. 196 pages.

Each author is responsible for content and formation of his/her materials.

The reference is mandatory in case of republishing or citation.

NANOTRANSPORTER OF TARGETED DELIVERY OF NUCLEIC ACIDS INTO CELLS

Chovpan H. O.
PhD in Physics,
Associate Professor at the Department of Medical and Biological Physics and Medical Informatics

Batiuk L. V.
PhD in Biology,
Associate Professor at the Department of Medical and Biological Physics and Medical Informatics

Bezeha Ye. V.
Student
Kharkiv National Medical University
Kharkiv, Ukraine

Relevance. The key issue, which depends on the successful development of nanotechnology is the creation of an effective nanotransport systems drug delivery into cells. The solution of this problem will allow to increase the duration of action of medications, minimize side effects and, consequently, to increase the effectiveness of therapeutic treatment and to promote the development of environmentally friendly processes. Unique features of nucleic acids (NK) such as the ability to self-organization, self-reproduction, molecular recognition of the target, and the possibility of integration into the cellular genome lie at the core of gene therapy. Since the first works on gene therapy to create methods and systems for delivery of exogenous genetic material in certain organs, tissues or cells has been and remains a major problem, the solution of which depends on the successful use of gene therapy [1, p. 808]. The main objective of the research in this area is the development of vectors, i.e. targeted delivery systems of genes in localized areas of tissues and in specific cell types, providing a high level of expression of therapeutic genes in the body.

The most effective means to deliver genetic constructions into cells until premenopausal vectors based on viruses [2, p. 249; 3, p. 901; 4, p. 858]. To create gene therapy vectors are the most promising retro-viruses – RNA-genomic viruses that are easy to integrate into the genome of the host cell, thereby providing long-term expression of the required gene. Unlike retroviral vectors, adenoviral vectors, constructed on the basis of DNA-containing viruses of vertebrates, can tolerate long enough genes (encoding a transgene capacity up to 37,000 base pairs). Also,

currently being developed vector system based on herpes simplex virus [5, p. 91]. A unique feature of this virus is its pronounced tropism for cells of the nervous system, making herpes simplex virus a promising vector for the treatment of brain tumors, Parkinson's disease and many others [6, p. 502].

The alternative for viral vectors are non-viral delivery systems, which include the introduction of genetic constructs in the composition of the liposomes [7, p. 299] or packaged using molecular conjugates of the oligopeptides, a modified chitosan, glycosamine lipid, carbohydrate vectors. These carriers are largely excluded the disadvantages of viral vectors, however, the ability to transform most of them is lower than that of viral vectors. As vectors for delivery of therapeutic drugs to tumor cells has been used for some hormones, oncofetal proteins, in particular alpha-fetoprotein and growth factors, the receptors of which are tumor proteins that are located mainly on the surface of cancer cells. Polymer nanomaterials have a number of advantages that determine the effectiveness of their use in technologies of delivery, biocompatibility, ability to biodegradation, functional compatibility. Typical compounds which represent the basis for creating polymer nanoparticles are polyethylenimine, polyamidoamine, and are polyglycolic acid, polyethylene glycol, polycaprolactone, and others, and their various copolymers. Controlled sizes and surface properties and stability of dendrimers make them very promising for use as a means of delivery of nucleic acids into cells. Carbon nanotubes have a high affinity for lipid structures. They are also able to form stable complexes with peptides and nucleic acids and to encapsulate these molecules. This determines their use in creating effective systems of delivery of vaccines and genetic material. Gold nanoparticles, nanospheres, nanorods, formed by the molecules of gold and Nickel, iron nanoparticles with magnetic properties, and other nanostructure that contains metals, currently used effectively for the delivery of oligonucleotides and nucleic acids in cells [8, p. 957; 9, p. 3818]. The main disadvantage of nucleic acids as biomedical drugs is their degradation in the cell under the action of cellular nucleases. To protect from nuclease degradation was engineered multilayered nanoparticles calcium phosphate/DNA, in which DNA is located inside the particle formed of several layers of calcium phosphate and its. Inorganic nanoparticles have several advantages compared to organic. They can be easily prepared, can be stored for a long period of time without losing transfairusa activity, many of them have good ability to biodegrade, have low toxicity and are biocompatible with the tissues of the body.

Research opportunities targeted delivery of therapeutic and diagnostic products, including nucleic acids in single cells, organs and tissues of the body are at the forefront of science, and the introduction of nanotechnology in the medical sector will be able to significantly improve the quality of medical services. Using

nanotransport systems will allow us to deliver these drugs to a certain point-the target organism to ensure its accumulation, effective protection from degradation and release in a certain time in the necessary doses, thus prolonging their action and providing a more reliable and controlled treatment of diseases.

References:

1. Anderson W.F. // Human gene therapy. Science. 1992. V. 256. № 5058. P. 808–813.

2. Walther W., Stein U. // Viral vectors for gene transfer: a review of their use in the treatment of human diseases. Drugs. 2000. V. 60. № 2. P. 249–271.

3. Mah C., Byrne B.J., Flotte T.R. // Virus-based gene delivery systems. Clin. Pharmacokinet. 2002. V. 41. № 12. P. 901–911.

4. Mancheño-Corvo P., Martín-Duque P. // Viral gene therapy. Clin. Transl. Oncol. 2006. V. 8. № 12. P. 858–867.

5. Marconi P., Argnani R., Berto E., Epstein A.L., Manservigi R. // HSV as a vector in vaccine development and gene therapy. Hum Vaccin. 2008. V. 4. № 2. – P. 91–105.

6. Yeomans D.C., Wilson S.P. // Herpes virus-based recombinant herpes vectors: gene therapy for pain and molecular tool for pain science. Gene Ther. 2009. V. 16, P. 502–508.

7. Kaneda Y., Morishita R., Dzau V.J. // Prevention of restenosis by gene therapy. Ann. N. Y. Acad. Sci. 1997. V. 811. № 15. P. 299–308.

8. Rosi N.L., Giljohann D.A., Thaxton C.S., Lytton-Jean A.K., Han M.S., Mirkin C.A. // Oligonucleotide-modified gold nanoparticles for intracellular gene regulation. Science. 2006. V. 312. № 5776. P. 1027–1030.

9. Giljohann D.A., Seferos D.S., Patel P.C., Millstone J.E., Rosi N.L., Mirkin C.A. // Oligonucleotide loading determines cellular uptake of DNA-modified gold nanoparticles. Nano Lett. 2007. V. 7. № 12. P. 3818–3821.