Design of Novel Supramolecular Nanoparticles: Spherical Nucleic Acids with Polymeric and Liposomal Cores

Financing organization: National Science Fund
Contract No DN 19/8, 10.12.2017
Duration: 2017-2020
Affiliation organization: Institute of polymers, BAS (Scientific team of Prof. St. Rangelov)
Partner organization: Sofia University "St. Kliment Ohridski "
Funds: 36 000 BGN (total 120 000 BGN)

Team members of partner organization:
Assc. Prof. Dr. Jordan Doumanov, Sofia University, Faculty of Biology, Coordinator
Prof. Dr. Svetla Petrova, BF, SU
Assoc. Prof. Dr. T. Topouzova-Hristova, BF, SU
Assoc. Prof. Dr. Veselina Moskova-Doumanova, BF, SU
Major assistant prof. Dr. Kirilka Mladenova, BF, SU
Chemist Denitsa Melnishka

Summary:
The project proposed for funding is interdisciplinary. It is related with a number of areas in polymer science, organic chemistry, physical chemistry, colloid science, nanoscience and nanotechnology, cell biology and nanomedicine, biochemistry and biophysics. In accordance to its interdisciplinary character and specificity, the research team is composed of researchers with complementary knowledge and experience from leading in their areas, internationally recognized research organizations – the Institute of Polymers, Bulgarian Academy of Sciences and Faculty of Biology, Sofia University.
The aim of the present project proposal is preparation of specific supramolecular nanoparticles, called spherical nucleic acids (SNAs). These will be composed of polymeric or liposomal cores to which highly oriented oligonucleotides are densely attached thus forming a shell. The focus of the research will be placed on the development of novel polymeric or liposomal cores aiming at diversifying the existing ones and producing novel properties. The research goals will be accomplished by synthesizing various polymer-oligonucleotide conjugates that are able to self-assemble or co-assemble with rationally designed copolymers and phospholipids to form the title supramolecular nanoparticles. A variety of synthetic, preparation, and loading techniques (from methods for controlled polymerization to “click” or other highly effective reactions and specific approaches for preparation of self-assembled/co-assembled structures) will be employed to design and construct the SNAs. After full physicochemical characterization of the resulting SNAs in terms of size, size distribution, molar mass, dimensions of the cores, thickness of the oligonucleotide shell, surface potential, etc., detailed investigation of the biological properties will follow. In particular, investigation of the interactions with and penetration through biological membranes of the novel

SNAs, evaluation of their biological compatibility, transfection efficiency and potential to transfer enzymes, small molecules, therapeutic and diagnostic agents will be performed.
The implementation of the research program will bring to accumulation of knowledge as well as experimental data and findings, which are applicable for solving health problems with significant social importance such as treatment of cancer and genetic diseases, vaccine development, regenerative medicine, development of diagnostic and theranostic platforms. Whereas the research planned in the project is highly fundamental, an essential part of it has an innovation character and potential. The implementation of the project will contribute to improvement of the skills and qualification of the team members and enhancement of competitiveness of the partnering organizations.
Key words: spherical nucleic acids, polymeric nuclei, self-association