J Nanomed Nanotechnol 2013, 4:6
http://dx.doi.org/10.4172/2157-7439.S1.015

OMICS Group Conferences
Accelerating Scientific Discovery
3rd International Conference on
Nanotek & Expo
December 02-04, 2013 Hampton Inn Tropicana, Las Vegas, NV, USA

Structural DNA nanotechnology: Liquid-crystalline approach

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The investigation of DNA-based materials attracts attention of scientists from various laboratories because this is definitely an emerging area in physics, molecular biology, biotechnology, biosensorics, nanobiotechnology as well as in material science.

1. Two different approaches in the structural DNA nanotechnology, i.e. "hybridization" approach and "liquid-crystalline approach" are compared.
2. The state-of-the art in the fundamental studies of liquid-crystalline state of double-stranded (ds) DNA molecules appeared as a result of their phase exclusion from polymer-containing water-salt solutions is described in detail.
3. The fundamental data obtained when studying the physico-chemical properties of ds DNA cholesteric liquid-crystalline dispersions (CLCD) were used as a background for the design of a few types of "rigid" DNA nanoconstructions (NaCs). Two versions of liquid-crystalline approach to structural DNA nanotechnology, i.e. design of "rigid" NaCs, using ds DNA molecules fixed within quasinematic layers of CLCD particles as building blocks, are considered. To realize the first version of liquid-crystalline approach, formation of artificial nanobridges in the "free" space between ds DNA molecules was used. Second version of liquid-crystalline approach is based on the directed decrease in solubility of DNA molecules fixed within quasinematic layers of CLCD particles. The unique properties of the formed NaCs are demonstrated. The AFM studies of the various "rigid" DNA NaCs allow one to draw some important evaluations.
4. Practical application of "rigid" DNA NaCs carrying various "guest" molecules is outlined.

Biography

Yevdokimov Yuri. Mikhailovich Graduated from M. V. Lomonossov Moscow State University and was invited by Academician V. A. Engelhardt to Institute of Physico-Chemical and Radiation Biology of the RAS (former name for Institute of Molecular Biology). He did his Ph.D. in 1967 (Chemistry), attained a doctoral degree in 1991 (Chemistry), 1992 he became a Professor of Molecular Biology. He is the Head of the Laboratory "Condensed State of Nucleic Acids" at Engelhardt Institute of Molecular Biology of the RAS. He is author and co-author more then 300 papers in the area of physical chemistry of nucleic acids, liquid crystals of nucleic acids and nanotechnology of nucleic acids published in the Russian and International journals. He is an Editorial Board Member of "Open NanoScience" and "Sensory Systems" (Russia) journals.

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Diagnostics, healing and the development of artificial organs based on nanostructures

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Errors in our DNA that programs our destiny can produce subsequently several kinds of illnesses such as cancer. Today, nanotechnology's role in medicine is at the top of people's minds. We need to begin by improving diagnosis of a particular ailment. In nearly every disease for which we have a treatment, early diagnose vastly increases our chances of extending life. Once a disease is diagnosed, it can be treated. Treatments have to be very specific. If we are treating cancer, then we need to only attack the cancer cells while preserving absolutely the healthy cells. Nowadays, chemotherapy is used to treat cancer but this treatment produces side effects such as lose of finger nails and hair. A third goal in medicine would be to replace failing organs with new ones before the situation reaches a crisis. Today, organ transplantation is a predictable, successful science. The problem: there are not enough organs available. What if, instead of waiting for donors to come along, we could grow organs outside the body? Nanotechnologists are disseminating the seeds of medical revolutions.

To perform targeted measurements, nanodevices containing medicines and drugs are used to first detect the cancer cells (target cells) and then release the medicines at regular doses, thus avoiding side effects to be produced. The detection of target compounds is done by means of highly sensitive nanosensors thanks to the use of nanomaterials presenting a huge surface to volume ratio. Nanocantilevers, carbon nanotubes, and nanowires have been used to construct miniaturized sensor probes due to their unique physical properties. Their large surface area promotes interaction between the target cells and nanomaterials.

The performance of theses nanosensors combined with different receptors such as molecularly imprinted polymers (MIPs) and antibodies will be presented. These nanosensors are very promising and can be applied in almost all fields such as health, food safety, and environmental pollution.

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