CONTENT

ESSAYS ON NANOMEDICINE

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This monograph is devoted to nanomedicine, a sub-category of nanotechnology. **Chapter 1** provides an explanation of the term “nano” and a definition of nanotechnology. It is argued that the transition from bulk materials to nanomaterials is determined not only and not primarily by the size of the particles, but by the appearance of a new properties of material.

Everybody seems to know what nanotechnology is, but even within the scientific community the meaning of this word is not yet well established. In fact, nanotechnology has apparently has different meanings in different fields of science. In this book it is discussed (in **Chapter 2**) what nanoscience and nanotechnology mean for biology. Based on the fact that the transition to nanolevel means a change of properties, in biological systems there are three levels and two border-crossings where a change of object properties takes place. The first boundary devotes to the World of Molecules and the World of Supramolecular Structures (NanoWorld). The change during the transition of this boundary lies in the fact that there emerge supramolecular complexes are not only able to mediate some biological response, but also to create new supramolecular structures. However, they are not self-sufficient enough to be able to reproduce themselves. The second boundary devotes to the NanoWorld and the World of Life. The transition of this boundary is defined by the formation of complicated self-organizing systems capable for selfreproduction, i.e. these structures are already quite self-sufficient to reproduce their own kind. However, this new property is responsible for a complete dependence on energy supply, without which they cannot exist.

Based on this classification, in **Chapter 3** we formulate a definition of nanomedicine as “the application for the treatment and/or diagnosis of the supramolecular complexes, which include molecules of the active principle and vehicles. It has dimensions which are in the range of 1 — 1000 nm, and used in therapeutic or prophylactic purposes nanoscaled or nanostructured materials with highly developed surface”. It is emphasized that the aims of “conventional” medicine and nanomedicine are the same, and the difference lies only in the fact that nanomedicine uses other tools, that are closer to what Nature uses in living organisms.

In **Chapter 4** we discuss the roots and origins of nanomedicine, the occurrence which was due to all the development of medicinal chemistry and pharmacology in the second part of the 20-th century, and the need to eliminate the side effects of drugs and reduce their toxicity. At the same time new drugs (peptide and nucleotide nature) appeared, the molecules of which are not stable in physiological media. Therefore, the use of such drugs in therapy requires the “protective coating” of the molecules, which allows to deliver the active molecule to its target. Therefore, the tools of nanomedicine are, on the one hand, particles with a highly developed surface, and on the other — supramolecular complexes consisting of at least two components, one of which is the active principle that defines the overall therapeutic effect. Components of such nanoparticles that determine the pharmacokinetic parameters of the whole composition are classified as vehicles.

Chapter 5 provides an overview of the classification of the nanoparticles, their properties and their behavior in biological systems.

Chapter 6 is devoted to the description of vehicles and tools used in nanomedicine: lipid nanoparticles (liposomes and micelles), polymeric nanoparticles, protein-based nanoparticles (including protein cages), dendrimers, inorganic nanoparticles, carbon nanostructures (fullerenes, carbon nanotubes, nanohorns and nanodiamonds), silica, quantum dots, ferrofluids, gold and silver.

Chapter 7 describes the use of nanomedicinals for drug delivery and diagnostics in vivo and in vitro, and nanosized drugs, which include products based on fullerenes and dendrimers. In the same chapter data on new therapies based on the use of nanoparticles (eg, hyperthermia), biomaterials and implants are presented. A separate section describes theranostics drugs, which are the combination of therapeutic

and imaging agents in one particle.
In most papers that can be attributed as nanomedicine works, the creations of delivery systems are described. Therefore, **Chapter 8** is entirely devoted to discussing why drug delivery systems are needed as well as the various types of drug delivery systems (target drug delivery, passive target delivery and active target delivery systems).
The supramolecular complexes are the basic for nanomedicine preparations. Nature for long ago easily started to use such structures and their ensembles for regulation of the functions of alive organisms. However, we are still studying, and that is why nanomedicine is facing many challenges and in **Chapter 9** discusses the development of such new field as nanomedicine is facing a lot of challenges. They include standardization, nanotoxicology, comparison of the data of in vitro and in vivo, as well as the problems that arose when both passive and active targeted delivery systems were designed.
Chapter 10 shows the published data on the presence of nanomedicinals on the market.
The emergence and development of nanotechnologies and nanomedicine, accompanied by a great number of fantastic ideas, is discussed and described in the **Chapter 11**.
For better understanding the problems discussed in this book, several supplementary discussion were included, namely: Biocompatibility and toxicity, High-throughput screening and synthesis, Surface plasmon resonance, Differences between compounds and materials, Chemical bonds and intermolecular forces, Supramolecular chemistry etc.

Nanomedicine should not be opposed to conventional medicine. Its objectives, as well as medicine in general, are diagnostics, treating, and preventing disease and traumatic injury, relieving pain, and preserving and improving human health. The only difference is that nanomedicine uses methods similar to those used by Nature.
This is well expressed by the words of Leonardo da Vinci: “Where Nature finishes producing its own species, man begins, using natural things and with the help of this nature, to create an infinity of species”.
This book is intended not only for professionals. I hope that it can be useful to anyone interested in the problems of nanotechnologies and nanomedicine. At least that was the aim of my writing, whether I succeeded the readers are to judge.