

Preface

This book is based on the results of experimental and theoretical studies presented in articles and in conferences.

Initially, the research was focused on the processes accompanying the pulsed electric discharges in water. These processes include: shock waves, UV-irradiation, generation of nanoparticles (as a result of thermoelectric erosion of metal electrodes), photolysis which is accompanied by generation of hydrogen peroxide (H_2O_2), reactive OH radicals, and hydrated electrons. These studies were intended to justify the use of these discharges for the decontamination of mineral and sewage water, as well as an alternative to traditional methods of disinfection for potable water. It was confirmed that pulsed electrical discharges in water destroy the whole spectrum of pathogens and the spores of opportunistic to human fungi.

Particular interest evoked the phenomenon of prolonged microbial resistance of water treated by electric discharges, i.e., the ability of water to kill the bacteria for a long time. There are two groups of factors cause bactericidal action of pulsed electric discharges in water:

- UV-irradiation and shock waves (factors of current action)
- Hydrated electrons, OH radicals, H_2O_2 , nanoparticles, and positive ions of metal electrodes (factors of post action).

Since the lifetime of hydrated electrons, OH radicals, and H_2O_2 is no more than several days, it is evident that only the nanoparticles and positive ions are responsible for prolonged microbial resistance of water.

Based on the obtained results, a study was performed on the impact of water dispersions of nanoparticles on bacterial medium in vivo. Local use of water dispersion of nanoparticles in treatment of purulent wounds with chronic constituent elements was used, which showed that the bacterial contamination had disappeared by the 7th day. At the same time, the signs of cellular atypia are absent.

In addition, there have been studies conducted on the antitumor effects of silver nanoparticles on Pliss lymphosarcoma. As a result, it was found that intravenous injection of the water dispersions of silver nanoparticles leads to a significant

reduction in the growth rate of Pliss lymphosarcoma. One possible antitumor mechanism is the restoration of the equilibrium of the silver concentration in the DNA of the tumor cells. Another mechanism is an impact of nanoparticles' surface electric charge on the electronic processes of cell homeostasis.

Another application of nanoparticles in medicine is used in stomatology. It was shown that during the treatment, the periodontal pocket depth had decreased by 2.5 mm, bleeding index was 1 point, and PCR-RT data appeared within normal values in 3 weeks that coincided with absence of exudates from periodontal pockets.

Particular object of the medical study was the identification of mutagenicity and genotoxicity of nanoparticles. Experiments *in vivo* have shown that the nanoparticles are not genotoxic or mutagenic.

The goal of the biological investigations was to determine the connection between the properties of the nanoparticles and peculiarities of their interaction with the human blood serum, as highly concentrated solutions of macromolecules. It was found that albuminous and lipoprotein structures of HBS are agglutinated on the surface of the nanoparticles, forming supramolecular complexes. Thus, the higher the concentration of nanoparticles in dispersion is, the larger complexes are formed. At early stages of the process rather small complexes of albuminous and immunoglobulins are formed, then lipoproteins are agglutinated, and finally, complexes of large (more than 2 μm) hydrodynamic radius are formed. Interactions of the nanoparticles with blood serum are of the same type and have differed only quantitatively. These distinctions are connected with the sizes of nanostructure aggregates in the dispersions. Known correlation between patients' state and blood properties allows us to suppose potential diagnostic significance of new integral characteristics of patient state, characteristic radii of nanoparticles-serum components complex formed. Obtained results, taken together with data available from the literature, lead us to the possibility of using such nanostructures for diagnosis of some conformational diseases such as Alzheimer disease.

Studying the "soft" damaging effects of intensive shock waves generated by pulse electric discharges on the shell of the virus showed that this method could be a novel one for preparing antiviral vaccines.

The statement above shows the potential use of pulsed electrical discharges and water dispersions of nanoparticles in various fields of medicine, biology, and ecology.

The book may be of interest to both undergraduate and graduate students in related disciplines, and to professionals employed in other fields of studies who would want to further explore this subject in-depth.

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