A review of the project "Research on the Biological Effect of Heavy Charged Particles with Different Energies" proposed for realization at the Joint Institute for Nuclear Research in 2018—2020

The project aims to continue the studies performed at JINR's Laboratory of Radiation Biology (LRB). In the course of radiation genetics research, regularities and mechanisms have been studied of molecular disorders in genetic structures of mammalian and human cells, regularities in the formation of mutations of different types in lower and higher eukaryote cells, and mechanisms of the initiation of radiation damage in structures of the organ of vision and central nervous system after exposure to ionizing radiations of different quality.

In particular, regularities in the formation of DNA double-strand breaks and the kinetics of their repair have been studied for the action of accelerated ions of different energy and linear energy transfer (LET). Significant differences have been found in the spatial distribution of damage in human cells after exposure to gamma-rays and accelerated heavy ions. Research has been performed on the kinetics of DNA damage induction and repair in normal and tumor cells after exposure to gamma rays, protons of different energies, and accelerated neon ions. Regularities have been studied in the mutation process in mammalian cells for radiations in a wide LET range at different times after exposure. It has been found that the time of the maximal yield of mutant subclones depends on accelerated ions' LET. At higher LET, the mutant yield maximum shifts towards longer times of irradiated cell expression.

An efficient technique of clustered DNA DSB analysis designed and implemented at the LRB will allow studying the induction of the most serious damage of the genetic apparatus by heavy ions and will make it possible to study the formation and repair of genetic damage both in proliferating tissues and in highly differentiated elements of the nervous system. The use of cells of different organisms in experiments will allow evaluation of the yield of gene and structural mutations induced by radiations in a wide LET range and studying formation of cytogenetic disorders for different doses of irradiation with charged particles of different energies. The approaches developed at the LRB to the problem of chromosome instability will allow clearing up the mechanisms behind these reactions and evaluating the contribution of physicochemical processes and inducible repair mechanisms to their realization.

Elucidation of these fundamental cell processes as responses to exposure to charged particles of different energies can be the basis for understanding the tissue response of highly differentiated cell systems — the eye retina and CNS structures — to irradiation. In turn, these studies will allow the assessment of the system's integrity violation: cognitive and behavioral disorders. The practical value of this type of complex research for different activity areas is absolutely obvious.

Based on the above, I consider the research planned within the framework of this project to be of a fundamental character and urgent for solving a wide range of practical tasks.

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