MATHEMATICAL MODELS OF THE DYNAMICS OF THE HEMATOPOIETIC SYSTEM IN ACUTELY/CHRONICALLY IRRADIATED HUMANS

Smirnova O.A.

Federal State Unitary Enterprise Research and Technical Center of Radiation-Chemical Safety and Hygiene, Shchukinskaya st. 40, Moscow, 123182, Russia
OlgaAndreevnaSmirnova@gmail.com

Biologically motivated mathematical models of the human hematopoietic system, which form an universal tool for the study of the dynamics of this vital body system under various irradiation scenarios, are developed. The models are implemented as the systems of nonlinear differential equations, which variables and constant parameters have clear biological meaning. It is shown that the models of the major hematopoietic lineages (the thrombopoietic, granulopoietic, lymphopoietic, and erythropoietic systems) are capable of predicting the dynamics of blood cells and their bone marrow precursor cells in humans exposed to acute and chronic irradiation in wide ranges of doses and dose rates. The obtained modeling findings demonstrate that the developed model of the human hematopoiesis can be applied for the radiation risk assessment for health of astronauts during long-term space missions (e.g., voyages to Mars or Lunar colonies), for health of people exposed to radiation due to environmental radiological events, and for health of patients treated with radiotherapy. As an example, the mathematical model of human granulopoietic system was applied to simulate the dynamics of this vital body system in astronauts engaged in long-term interplanetary space missions (voyage to Mars). The dependence of the dynamics of the system on hand on several parameters of space radiation exposure, such as the dose equivalent rates of galactic cosmic rays (GCR) and large solar particle events (SPEs) and the time interval between SPEs, is examined. Such modeling predictions would provide a better understanding of the risks to health from the space radiation environment and enable one to evaluate the need for operational applications of countermeasures for astronauts.

References

1. *Smirnova O.A.* Environmental Radiation Effects on Mammals: A Dynamical Modeling Approach (2nd ed.). – Springer, Switzerland, 2017, 359p.
2. *Smirnova O.A., Hu S., Cucinotta F.A.* Analysis of the Lymphocytopoiesis Dynamics in Nonirradiated and Irradiated Humans: A Modeling Approach // Radiation Research, **Vol. 181**, p.240-250, 2014.
3. *Smirnova O.A.* Comparative analysis of the dynamics of thrombocytopoietic, granulocytopoietic, and erythropoietic systems in irradiated humans: A modeling approach // Health Physics, **Vol. 103**, p.787-801, 2012.