

Biological research at Baksan Neutrino Observatory in the field of low background radiobiology, deep underground microbiology and astrobiology

Zarubin Mikhail¹, Kravchenko Elena¹, Tarasov Kirill¹, Yakhnenko Alena¹, Gangapshev Albert²

¹Joint Institute for Nuclear Research, Dubna, Russia

²Institute of Nuclear Research, Moscow, Russia

Baksan Neutrino Observatory (BNO INR RAS) and deep underground low radiation background laboratory (DULB-4900), located in the Elbrus region (North Caucasus, Russia) beneath the peak of Andyrchy mountain, were founded on purposes of nuclear physics and astrophysics, but possess a unique potential for interdisciplinary research. Molecular genetics group of DLNP JINR initiated cooperative studies at BNO facility, those link tasks of biophysics, radiobiology, astrobiology, microbiology and medicine.

Studies of effects of low background radiation on biological systems is a rapidly evolving field of radiobiology in 2010s. In our work [1,2], we aimed to register for the first time the response to reduced radiation background of DULB-4900 of complex multicellular organism (*D. melanogaster*) at the transcriptome level by RNA-seq profiling and to analyze obtained results in terms of the impact of different types of stress including radiation treatment. Obtained data indicates non-specificity of biological response in DULB-4900 conditions, which involves down-regulation of primary metabolic processes, up-regulation both of the immune system process and the response to stimuli.

Another branch of our studies is devoted to investigation of extremophile organisms and deep underground microbiome of saline warm springs at unused part of BNO tunnel, emerged due to high hydrothermal activity of Elbrus volcanic region. In recent work [3], we present the characterization of the novel bacterium *Cytobacillus pseudoceanisediminis* sp. nov. isolated from the deep underground spring at the depth ~2.5 km. We obtained complete bacterial genome at Oxford Nanopore MinION, analyzed the metabolism, performed chemotaxonomic characterization and approved methylotrophy of the organism and it's high heavy metal resistance. Currently ongoing experiment will enable to validate one of few deep underground metagenomes of the North Caucasus and Elbrus region, isolated from deep underground saline spring.

In this report, the potential of deep underground facilities of Baksan Neutrino Observatory INR RAS for biological studies will be discussed and ongoing cooperative experiments of JINR and INR RAS will be reviewed.

1. Zarubin, M. P., Kuldoshina, O. A., & Kravchenko, E. V. (2021). Biological effects of low background radiation: prospects for future research in the low-background laboratory DULB-4900 of Baksan Neutrino Observatory INR RAS. *Physics of Particles and Nuclei*, 52, 19-30.
2. Zarubin, M., Gangapshev, A., Gavriljuk, Y., Kazalov, V., & Kravchenko, E. (2021). First transcriptome profiling of *D. melanogaster* after development in a deep underground low radiation background laboratory. *PLoS One*, 16(8), e0255066
3. Tarasov, K., Yakhnenko, A., Zarubin, M., Gangapshev, A., Potekhina, N. V., Avtukh, A. N., & Kravchenko, E. (2023). *Cytobacillus pseudoceanisediminis* sp. nov., A Novel Facultative Methylotrophic Bacterium with High Heavy Metal Resistance Isolated from the Deep Underground Saline Spring. *Current Microbiology*, 80(1), 31.