INTERNATIONAL SUPPORT OF UKRAINIAN SCIENCE

https://doi.org/10.15407/exp-oncology.2024.02.179

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EXPERIENCE OF CREATIVE INTERNATIONAL COOPERATION WITHIN THE FRAMEWORK OF THE UKRAINE-AUSTRALIA RESEARCH FUND

Background — Geopolitical

Science and politics have always gone together. This is what happened in our days when Russia's military aggression against Ukraine, which began in 2014, turned into a full-scale military invasion in 2022 and a war of liberation for the independence and freedom of Ukraine. These events dramatically affected not only the fate of millions of citizens but also brought the destruction of fields of science and technology important for the existence of the country.

The reduction of funding for fundamental and applied science led to a dramatic outflow of highly qualified scientific personnel and young scientists, as well as the partial destruction of the infrastructure and equipment in scientific institutions, especially where hostilities took place. Ukrainian science was in a critical situation and especially needed international support. One of the examples of such assistance is discussed in this paper. Financial support came from the Australian Academy of Science, which partnered with the Breakthrough Prize Foundation and created the Ukraine-Australia Research Fund to support Ukrainian researchers in eligible fields of science that have been impacted by the war. The donation is being used to fund two different activities, each offering practical support to enable the continuation of research and technology activities by Ukrainian scientists. In 2024, a total of A$405,000 was awarded to Ukrainian researchers impacted by the war with Russia.

Background — Australian contribution

The first activity supports Ukrainian researchers to participate in short-term visits to Australia (4 to 12 weeks in duration) to engage in project research at a host institution, or to participate in conferences and site visit programs. The Australian host organization is responsible for applying for funding and administering the grant to cover the direct costs to support the visit. Applying hosts are encouraged

Citation: Mikhailenko V, Kuchel P. Experience of creative international cooperation within the framework of the Ukraine-Australia research fund. *Exp Oncol.* 2024; 46(2): 179-182. https://doi.org/10.15407/exp-oncology.2024.02.179

Fig. 1. Left, the logo of the research fund; right, from the left Dr. Victor Mikhailenko, Philip Kuchel, Emeritus Professor of Biochemistry, and Dr. Biswarajan Mohanty, NMR Facility Manager for the 'Sydney Analytical' network in The School of Life and Environmental Sciences. In front of the 800 MHz NMR spectrometer, a key instrument used in our studies of phospholipase D, as it operates *in situ* in cells

to seek co-contribution support from their institute or the conference organizing committee to maximize the opportunities available to the visiting Ukrainian researchers. Funded short-term visits are designed to enable ongoing research activities to continue and provide opportunities for long-term collaborations between Australian and Ukrainian researchers. In 2024, a total of A$205,000 was awarded to support 15 Ukrainian visitors.

The Australian host institutions are Monash University, University of Queensland, University of Sydney, University of Technology Sydney, Australian National University, and University of Melbourne. The visitors are from the National Academy of Sciences of Ukraine (D.K. Zabolotny Institute of Microbiology and Virology, Institute for Evolutionary Ecology, R.E. Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology, and the Institute of Physics) and Ukrainian universities (the Taras Shevchenko National University of Kyiv, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Simon Kuznets Kharkiv National University of Economics, Institute of Astronomy of V.N. Karazin Kharkiv National University, and Lutsk National Technical University).

The second activity provides practical support for research in Ukraine that has been impacted by the current war. Under this activity, Ukrainian researchers can access leading infrastructure capabilities in Australia, such as supercomputing facilities, microscopy and microanalysis, and telescopes. Ukrainian researchers can send their samples to facilities for analysis, such as those under the National Collaborative Research Infrastructure Strategy (NCRIS), with the results returned to Uk-

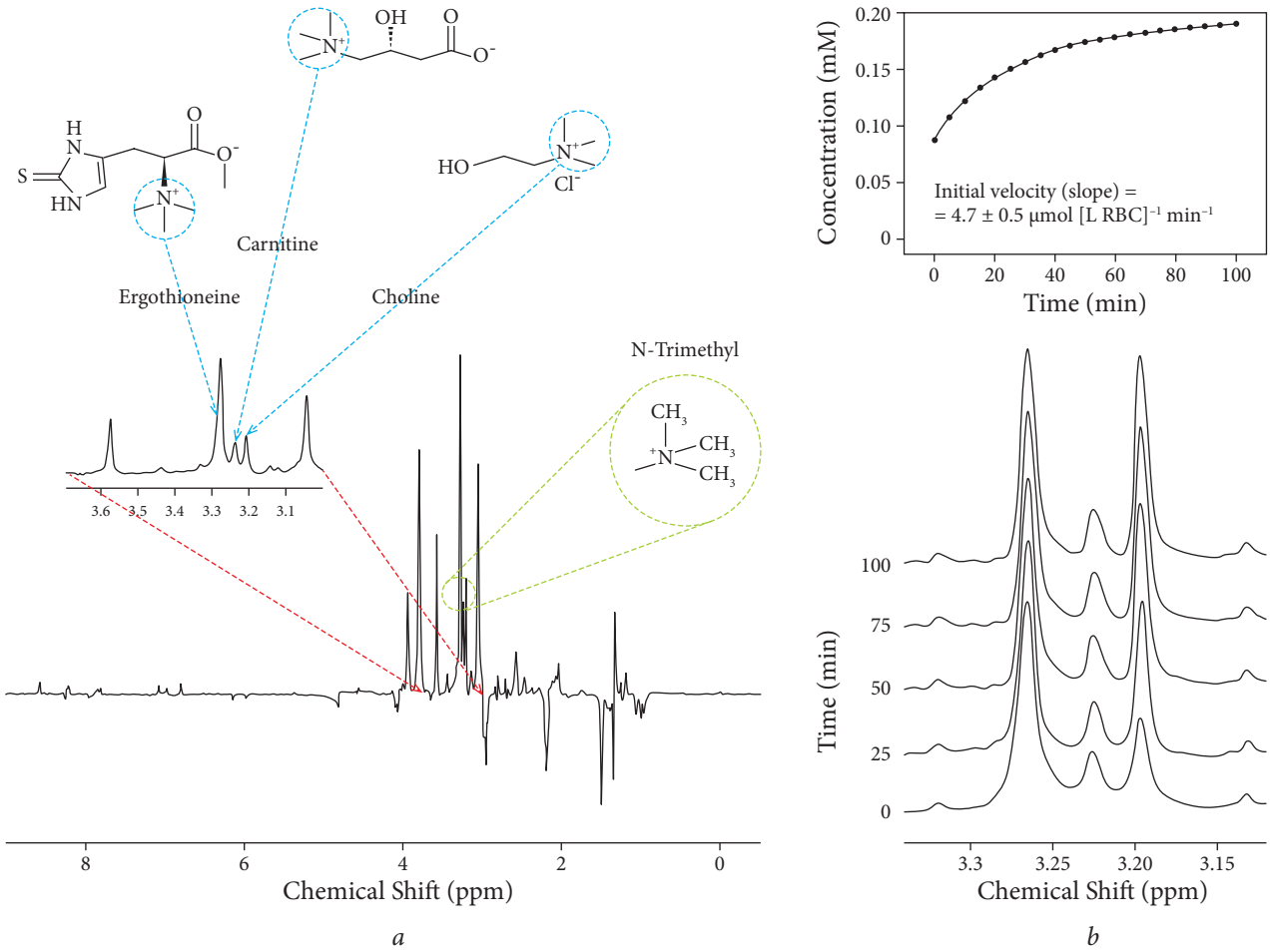

Fig. 2. An 800 MHz ^{1}H NMR spin-echo spectrum of a human hemolysate (*a*) and spectral time course of choline release from membrane L-α-phosphatidylcholine in human hemolysate (*b*). Hematocrit 86%; temperature 25 °C

raine. Funding covers the cost of sending samples between Ukraine and the Australian testing facility and the cost of testing and analyzing the samples. This activity will keep Ukrainian researchers productive and publishing at their institutes in Ukraine while also engaging in international collaborations.

The total amount awarded was over A$200,000. The collaborating Australian facilities are Astronomy Australia and the Australian National University, AGRF, Australian National University RSES SHRIMP, Australian Proteome Analysis Facility, Bioplatforms Australia and the Royal Botanic Gardens Victoria, Curtin University.

Background — Ukrainian participants

The Ukrainian institutes-participants are the National Antarctic Scientific Center of Ukraine, the National Science Center "Kharkiv Institute of Physics and Technology", M.P. Semenenko Institute of Geochemistry, Mineralogy and Ore Formation. From the National Academy of Sciences of Ukraine: the Main Astronomical Observatory, Palladin Institute of Biochemistry, Institute for Nuclear Research, M.G. Kholodny Institute of Botany, Institute of Geological Sciences, and The National Museum of Natural History.

Background — Rigorous selection

Applications were evaluated by an assessment committee of Academy Fellows and relevant subject matter experts. The final decision on approvals and allocations was made by the Ukraine-Australia Research Fund Working Group, chaired by Academy President Professor Chennupati Jagadish.

Those activities are supposed to provide immediate impact by enabling ongoing research as well as the long-term benefit of increasing collaborations between Ukrainian researchers and interna-

tional research communities. One of the positive and already successful examples of such international scientific cooperation is described below.

The story began with an invitation letter from Nancy Pritchard, Director of the International Programs and National Committees for Science of the Australian Academy of Science to participate in a short-term visit as part of the Ukraine-Australia Research Fund, hosted by Prof. Philip Kuchel from the University of Sydney.

The project titled "NMR of phospholipase-D in erythrocytes: cell distortion-activation and ethanol exchange" was approved for application by Prof. Philip Kuchel in collaboration with Dr. Victor Mikhailenko (the Visitor) from the R.E. Kavetsky Institute for Experimental Pathology, Oncology and Radiobiology, NAS of Ukraine (Fig. 1). The period of the visit agreed by the parties was from March 1 to May 31, 2024.

Our Project — Phospholipase D in cells

The aim of this project is to investigate phospholipase D (PLD) kinetics and its correlation with the discocyte-echinocyte-spherocyte (DEST) morphological transition. It includes the study of the hydrolysis and transphosphatidylation reactions in hemolysates of red blood cells (RBCs) mediated by PLD, using ^{1}H spin-echo and ^{13}C NMR spectroscopy and microscopy (Fig. 2).

In our study, we used new ways of studying biochemical reactions and membrane transport in intact cells, non-invasively and uniquely with NMR spectroscopy and advanced light microscopy. NMR studies were carried out on 600 and 800 MHz spectrometers, each with cryoprobe, and light microscopy on a Zeiss Axiovert 200M light microscope with differential interference contrast (DIC) imaging and fluorescence capabilities.

RBC hemolysates incubated at 25 °C in the presence of calcium showed the rapid formation of free choline peak (Fig. 2, *a*), while those assigned to the methyls of two other quaternary ammonium compounds, ergothioneine and carnitine, remained essentially stationary (Fig. 2, *b*). The choline concentration reached an apparent plateau after incubation for 80 min with an initial velocity of $v_i = 4.7 \pm 0.5$ μM [L RBC]$^{-1}$ min^{-1}. In other words, we can quantify PLD activity and correlate it with time courses of the discocyte-echinocyte-spherocyte shape transition, captured by DIC light microscopy. Also, this facile (in the sense of requiring little sample manipulation like forming cell extracts) NMR-based assay paves the way for studying effectors (drugs and reagents) of the activity of the enzyme.

Research of PLD activity has become a "hot topic" in cell signaling studies, as the enzyme involvement in membrane turnover and nuclear signaling (via phosphatidic acid) is implicated in cancer progression, infection, invasion, and neurodegenerative disease. The role of PLD in cell development is now a major area of interest for cancer researchers and clinicians. A growing body of research shows that PLD activity is significantly increased in cancer cells, indicating that it plays a critical role in signal transduction, cell proliferation, and anti-apoptosis. The elevated total PLD activity, as well as an overexpression, is present in a wide variety of cancers including gastric, colorectal, renal, stomach, esophagus, lung, and breast. PLD overexpression increases cancer cell migration, invasion, and metastasis and plays a distinct role during chemotherapy including its anti-apoptotic function, noted above.

Conclusions

The Ukraine-Australia Fund Grant was used to a very good effect: the proposed experimental outcomes were largely realized; and a plausible way forward, using collaborations with Australian scientists, seems likely for Ukraine as it recovers its scientific capabilities.

The choice of PLD as a focus for the collaboration was apposite: Prof. Kuchel has a wide breadth of experience with NMR spectroscopy of cellular systems, especially erythrocytes, and Dr. Mikhailenko previously ran a high-field NMR spectrometer with a focus on cancer-cells and toxicology. The emerging interest in PLD in both fields made for a good level of exchange of basic ideas in biochemistry and cell biology. In other words, we spoke the same scientific language.

Overall, this was a very rewarding collaborative connection with valuable scientific and personal outcomes.