Learning to Care for Those in Harm's Way

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Release No. 17-10-17
October 17, 2017
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New Study Redefines How Radiation Kills Cells, Could Help Target Cancer Treatment

Bethesda, Md. – Scientists have discovered for the first time how to accurately predict cellular radiation resistance without actually irradiating cells, instead measuring their internal 'manganese-complexes' responsible for resistance. This surprising discovery applies not only to the champion of radiation resistance, Deinococcus radiodurans - aka Conan the Bacterium, but also to other cells - bacteria, yeasts, and human cells, which contain the same elixir of antioxidant manganese-complexes: the more of these complexes a cell has, the more resistant to gamma-rays it becomes. This new broad measure of radiation resistance opens exciting scientific possibilities such as: allowing for more personalized cancer treatments, development of radioprotectors needed for astronauts to get to Mars and back, all while minimizing the need for animals in radiation studies, according to "Across the Tree of Life, Radiation Resistance is Governed by Antioxidant Mn(II), Gauged by Paramagnetic Resonance" published in the October 17 online issue of the Proceedings of the National Academy of Sciences USA (PNAS), http://www.pnas.org/content/early/2017/10/16/1713608114.

The collaborative study was led by Michael J. Daly, Ph.D., professor at the Uniformed Services University of the Health Sciences (USU), Department of Pathology, and Brian Hoffman, Ph.D., professor at Northwestern University, Department of Chemistry, who together applied an advanced spectroscopy technique called EPR, short for 'electron paramagnetic resonance'. They showed that radiation resistance can be accurately measured by EPR and without exposing cells to dangerous radiation. Daly's team previously reported that D. radiodurans accomplishes its astonishing survival feats in an unexpected way – by shielding its protein enzymes, not its DNA genes, from radiation damage with Mn antioxidants. In cells, these Mn antioxidants spare all proteins, including repair enzymes, from radiation damage, and this allows the cells to reassemble broken DNA with great efficiency. Previously, resistance could be measured only by testing how deadly the radiation itself was. Now, resistance can be predicted in cells without applying radiation.

"Don't forget, this EPR work was built on over a decade of research on Deinococcus Mn(II) complexes, the same complexes now used in making irradiated vaccines and protecting animals. It may take some more time, but EPR spectroscopy may also overturn the way scientists view other biological phenomena, like aging," Daly said.

This project was supported by a National Institutes of Health (NIH) grant to Dr. Hoffman, and a Defense Threat Reduction Agency (DTRA) grant to Dr. Daly. The team included scientists at the National High Magnetic Field Laboratory in Tallahassee, Florida, funded by the National Science Foundation; Dr. Jocelyne DiRuggiero at Johns Hopkins, Baltimore, MD; Dr. Igor Shuryak, Center for Radiological Research at Columbia University, New York, NY; and international collaborators including Dr. Cene Gostinčar at the University of Ljubljana, Slovenia, funded by a bilateral US/Slovenia grant to Drs. Gunde-Cimerman and Daly; and Isabel H. Conze at the University of Bielefeld, Germany. For more information on Deinococcus research see, http://www.usuhs.mil/pat/deinococcus/index_20.htm.

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