Team publishes roadmap to enhance radioresistance for space colonization

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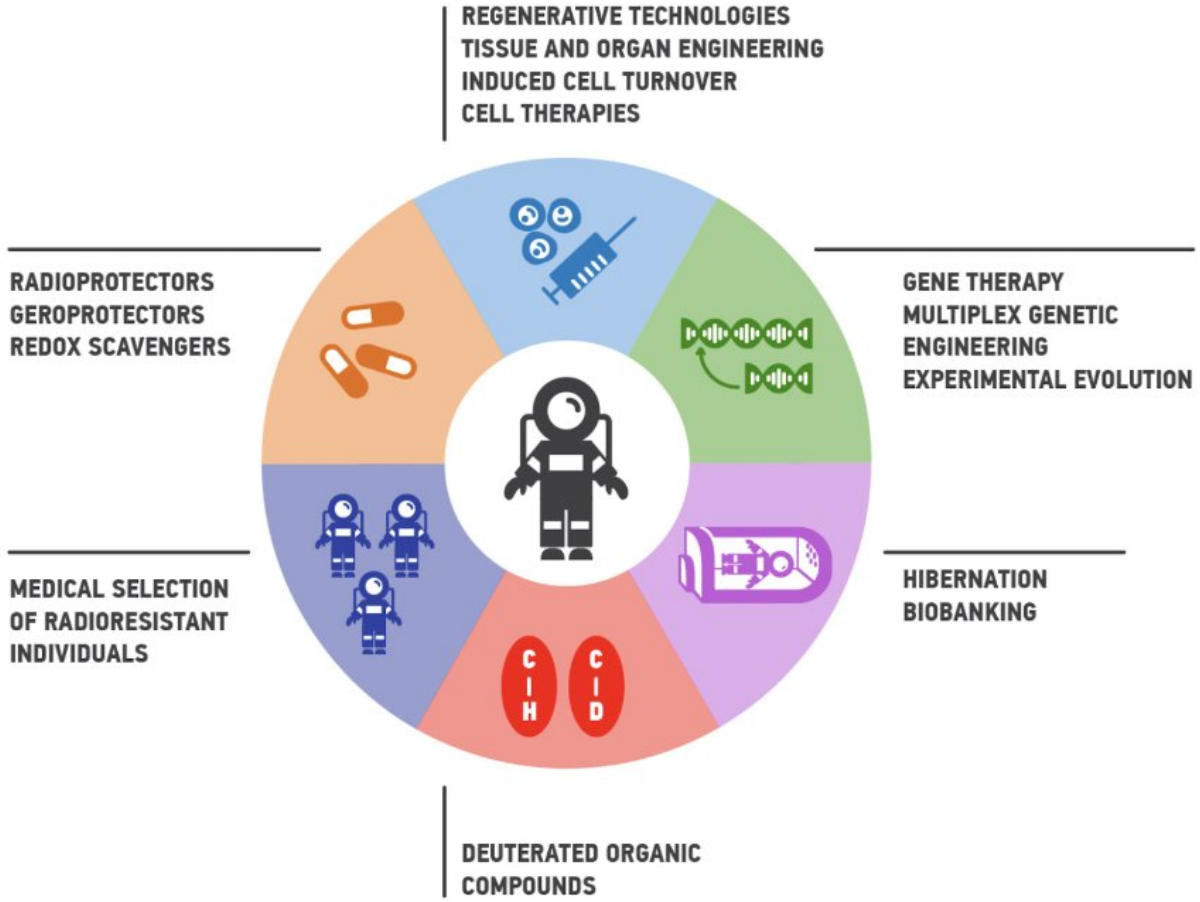

Ways to reduce health risks from space radiation during deep space travels. Multiple approaches from medical selection of radioresistant individuals to gene therapy may be proposed. Credit: Biogerontology Research Foundation, NASA Ames Research Center, Environmental and Radiation Health Sciences Directorate at Health Canada, Canadian Nuclear Laboratories, Belgian Nuclear Research Centre, Oxford University, Insilico Medicine, Insilico Medicine

Taiwan, Boston University, Johns Hopkins University, University of Lethbridge, Ghent University, Center for Healthy Aging

An international team of researchers from NASA Ames Research Center, Environmental and Radiation Health Sciences Directorate at Health Canada, Oxford University, Canadian Nuclear Laboratories, Belgian Nuclear Research Centre, Insilico Medicine, the Biogerontology Research Center, Boston University, Johns Hopkins University, University of Lethbridge, Ghent University, Center for Healthy Aging and many others have published a roadmap toward enhancing human radioresistance for space exploration and colonization in the peer-reviewed journal *Oncotarget*.

"Our recent manuscript provides a comprehensive review of radioresistance for space radiation. Currently there is minimal research being done for radioresistance against HZE irradiation. The importance of these types of studies will be to reduce the associated health risks for long-term space exploration and allow for the development of potential countermeasures against space radiation. In addition, the synergy between understanding aging with radioresistance will allow for further benefits for humans in long-term space missions and allow for reduced health risk. This review sets the stage for the potential research the scientific community can do to allow for safe long term space exploration" said Afshin Beheshti, an author of the paper and a Bioinformatician at NASA Ames Research Center.

The roadmap outlines future research directions toward the goal of enhancing human radioresistance, including upregulation of endogenous repair and radioprotective mechanisms, possible leeways into gene therapy in order to enhance radioresistance via the translation of exogenous and engineered DNA repair and radioprotective mechanisms,

the substitution of organic molecules with fortified isoforms, the coordination of regenerative and ablative technologies, and methods of slowing metabolic activity while preserving cognitive function. The paper concludes by presenting the known associations between radioresistance and longevity, and articulating the position that enhancing human radioresistance is likely to extend the healthspan of human spacefarers as well.

"This paper explores the foreseeable means by which human radioresistance could be biomedically enhanced for the purposes of space exploration and colonization. It also aims to elucidate the links between aging, longevity and radioresistance, and the ways in which research into enhancing human radioresistance could synergistically enable human healthspan extension, ultimately highlighting how ongoing research into the very well-funded sphere of aerospace research could galvinate progress in biomedical gerontology, a massively under-funded area of research despite the grave economic burden posed by demographic aging" said Franco Cortese, an author of the paper and Deputy Director of the Biogerontology Research Foundation.

The publication of the paper in *Oncotarget* this week is timely, given the test launch of the Falcon Heavy, SpaceX's largest rocket to date, just last week. Interest into space exploration and even colonisation has been mounting for a number of years. Less than one year ago Elon Musk, CEO of SpaceX, unveiled a roadmap toward colonizing Mars, outlining the ambitious goal of placing a million people on Mars within the next 40 to 100 years. If interest in space colonization continues apace, research into methods of enhancing radioresistance to protect against the various forms of space radiation that spacefarers would be subjected to needs to be accelerated accordingly.

"In linking ageing and radioresistance and tying together research into enhancing the radioresistance of astronauts with the extension of healthy

longevity, we hope to have shown how aerospace research could be used to leapfrog the massive funding deficit surrounding the clinical translation of healthspan-extending interventions, in order to brave the storm of the oncoming Silver Tsunami and prevent the looming economic crisis posed by demographic aging" said Dmitry Kaminskiy, an author of the paper and Managing Trustee of the Biogerontology Research Foundation.

The roadmap highlights the need to converge and accelerate research in radiobiology, biogerontology and AI to enable spacefarers to address both the healthcare challenges that we are already aware of, as well as those that we are not.

"Sooner or later we'll have to do it - leave Earth and wander into deep space. Such travel, taking one or more years outside the Earth's magnetosphere, would take a high toll on astronauts' health due to exposure to cosmic radiation. So it's better to start thinking now about how we are going to cope with that challenge. Luckily, current knowledge from such fields as radiobiology, aging research and biotechnology in general, with the wealth of recent advances in gene editing and regenerative medicine, allow for the drafting of conceptual roadmaps to enhance human resistance to cosmic radiation. This is exactly what this work is all about. It was fun and a pleasure to partake in this theoretical project with such a diverse international team. We were just throwing ideas on the table, some being quite ambitious and futuristic, and then examining them carefully for feasibility and assessing their potential. The work laid out several interesting directions and concepts that can eventually pay off. Last but not least, I think it is also very important to attract widespread attention and interest to this topic" said Dmitry Klokov, an author of the paper and Section Head of the Radiobiology & Health section at Canadian Nuclear Laboratories.

Furthermore, given the massive amount of funding allocated to research

into facilitating and optimizing space exploration and optimization, the researchers hope to have shown how research into enhancing radioresistance for space exploration could galvanize progress in human healthspan extension, an area of research that is still massively underfunded despite its potential to prevent the massive economic burden posed by the future healthcare costs associated with demographic aging.

"This roadmap sets the stage for enhancing human biology beyond our natural limits in ways that will confer not only longevity and disease resistance but will be essential for future space exploration" said João Pedro de Magalhães, an author of the paper and a Trustee of the Biogerontology Research Foundation.

More information: Franco Cortese et al, Vive la radiorésistance!: converging research in radiobiology and biogerontology to enhance human radioresistance for deep space exploration and colonization, *Oncotarget* (2018). DOI: 10.18632/oncotarget.24461

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