USRA Was Founded in 1969

“I would like to propose that the Academy take initiative in convening the representatives of a number of appropriate universities to discuss the formation of such a consortium.”

In his 1965 letter to Frederick Seitz, President of the National Academy of Sciences

“To constitute an entity by means of which universities and other research organizations may cooperate with one another, with the governments of the United States and other nations, and with other organizations toward the development and application of space-related science, technology, and engineering.”

From the USRA Articles of Incorporation
USRA Is Driven by Its Mission and Values

OUR MISSION

- Advance the space- and aeronautics-related sciences and exploration through innovative research, technology, and education programs;
- Promote space and aeronautics policy; and
- Develop and operate premier facilities and programs by involving universities, governments, and the private sector for the benefit of humanity.

OUR VALUES

- **Passion**—for science, technology, and education.
- **Partnerships**—with universities, governments, and the private sector.
- **Professionalism**—through excellence, accountability, and respect for others.
Today, USRA’s Core Competencies Span a Broad Range of Space- and Aeronautics-Related Disciplines

What We Do:

- Astronomy and Astrophysics
- Planetary Science
- Earth Sciences
- Space Life Sciences
- Materials Science
- Fluid Physics
- Space Nuclear Power and Propulsion
- Computational Sciences
- Advanced Technology Development
- Facility Management and Operation
- Education and STEM Workforce Development
...From California to Puerto Rico
SYNTHEtic Biology

USRA has partnered with the Synthetic Biology Lab at NASA’s Ames Research Center, to conduct collaborative research in synthetic biology focusing on application for human space exploration and astrobiology. The goal is to harness engineered biological systems to further space exploration and science, to search for life beyond Earth, and to improve life on Earth.

Research is accomplished through lab and field work including instrument development, as well as missions such as the Eu:CROPIS mission which is planned to demonstrate synthetic biology technology in space.

http://www.riacs.edu/
Dr. Ivan Paulino-Lima

- Development, delivery and ground controls for the PowerCell payload on the DLR Eu:CROPIS mission

- Continuation of my NPP work on extremophiles and radiation
<table>
<thead>
<tr>
<th>Factor</th>
<th>Class</th>
<th>Defining Growth Condition</th>
<th>Example Organisms</th>
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<tbody>
<tr>
<td>High Temperature</td>
<td>Hyperthermophile</td>
<td>&gt; 80°C</td>
<td>Pyrolobus fumarii</td>
</tr>
<tr>
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<td>Thermophile</td>
<td>60 to 80°C</td>
<td></td>
</tr>
<tr>
<td>Low Temperature</td>
<td>Psychrophile</td>
<td>&lt; 15°C</td>
<td>Synechococcus lividis</td>
</tr>
<tr>
<td>High pH</td>
<td>Alkaliphile</td>
<td>pH &gt; 9</td>
<td>Psychrobacter, Vibrio, Anthrobacter</td>
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<td>Barophile</td>
<td>High weight</td>
<td>Unknown</td>
</tr>
<tr>
<td></td>
<td>Piezophile</td>
<td>High pressure</td>
<td>Pyrococcus sp.</td>
</tr>
<tr>
<td>Salinity</td>
<td>Halophile</td>
<td>2 to 5 M NaCl</td>
<td>Halobacteriaceae, Dunaliella salina</td>
</tr>
<tr>
<td>Low Nutrients</td>
<td>Oligotroph</td>
<td>e.g., &lt;1 mg L⁻¹ dissolved organic carbon</td>
<td>Sphingomonas alaskensis, Caulobacter spp.</td>
</tr>
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<td>Oxygen Tension</td>
<td>Anaerobe</td>
<td>Cannot tolerate O₂</td>
<td>Methanococcus jannaschii</td>
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<tr>
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<td>Microaerophile</td>
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<td>Clostridium</td>
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<td>−</td>
<td>Tolerates high concentrations of metal (e.g., Cu, As, Cd, Zn)</td>
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Why the study of radiation and its effects on materials and biology is important?

http://www.esa.int/Our_Activities/Space_Engineering_Technology/Proba_Missions/Detecting_radiation
Extremely high UV-C radiation resistant microorganisms from desert environments with different manganese concentrations

Ivan Glaucio Paulino-Lima a,1,*, Kosuke Fujishima b,1, Jesica Urbina Navarrete b, Douglas Galante c, Fabio Rodrigues d, Armando Azua-Bustos e, Lynn Justine Rothshild f

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Microbial diversity

ABSTRACT

Desiccation resistance and a high intracellular Mn/Fe ratio contribute to ionizing radiation resistance of Deinococcus radiodurans. We hypothesized that this was a general phenomenon and thus developed a strategy to search for highly radiation-resistant organisms based on their natural environment. While desiccation is a typical feature of deserts, the correlation between radiation resistance and the intracellular Mn/Fe ratio of indigenous microorganisms or the Mn/Fe ratio of the environment, has not yet been described. UV-C radiation is highly damaging to biomolecules including DNA. It was used in this study as a selective tool because of its relevance to early life on earth, high altitude atmosphere and the search for life beyond Earth. Surface soil samples were collected from the Sonoran Desert, Arizona (USA), from the Atacama Desert in Chile and from a manganese mine in northern Argentina. Microbial isolates were selected after exposure to UV-C irradiation and growth. The isolates comprised 28 genera grouped within six phyla, which we ranked according to their resistance to UV-C irradiation. Survival curves were performed for the most resistant isolates and correlated with their intracellular Mn/Fe ratio, which was determined by ICP-MS. Five percent of the isolates were highly resistant, including one more resistant than D. radiodurans, a bacterium generally considered the most radiation-resistant organism, thus used as a model for radiation resistance studies. No correlation was observed between the occurrence of resistant microorganisms and the Mn/Fe ratio in the soil samples. However, all resistant isolates showed an intracellular Mn/Fe ratio much higher than the sensitive isolates. Our findings could represent a new front in efforts to harness mechanisms of UV-C radiation resistance from extreme environments.

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Surface biosignatures of exo-Earths: Remote detection of extraterrestrial life

Siddharth Hegde\textsuperscript{a,1}, Ivan G. Paulino-Lima\textsuperscript{b}, Ryan Kent\textsuperscript{c}, Lisa Kaltenegger\textsuperscript{a,d}, and Lynn Rothschild\textsuperscript{a}

\textsuperscript{a}Max Planck Institute for Astronomy, Heidelberg 69117, Germany; \textsuperscript{b}National Aeronautics and Space Administration Postdoctoral Program Fellow, National Aeronautics and Space Administration Ames Research Center, Moffett Field, CA 94035; \textsuperscript{c}University of California, Santa Cruz University Affiliated Research Center, National Aeronautics and Space Administration Ames Research Center, Moffett Field, CA 94035; \textsuperscript{d}Institute for Pale Blue Dots, Department of Astronomy, Cornell University, Ithaca, NY 14853; and \textsuperscript{a}National Aeronautics and Space Administration Ames Research Center, Moffett Field, CA 94035

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Hegde et al. (2015) PNAS, 112(13), 3886-3891.
Cyprien et al. *Int. J. Astrobiology* (2016)
PowerCells on Eu:CROPIS: A demonstration of synthetic biology technology and biology in space

Eu:CROPIS: A DLR satellite mission scheduled to launch in March 2017
- Euglena
- Combined Regenerative
- Organic Food Production
- In Space

PI: Lynn J. Rothschild, Ph.D.
Biology: Ryan Kent, Griffin McCutcheon, Evie Pless & Ivan Paulino-Lima, Ph.D.

How does variable gravity impact synthetic biology?

PowerCell:
- Co-culture
- Transformation

Power Cell
- Produces fixed carbon
Producer cells
- Uses PowerCell sugar to grow; produces useful products
Material
- Food, fuel, clothes, drugs, bricks, etc.
“The Earth is the cradle of humanity, but one can not live in a cradle forever”

Konstantin E. Tsiolkovsky
Thank you!