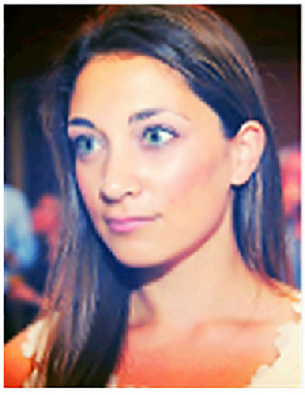
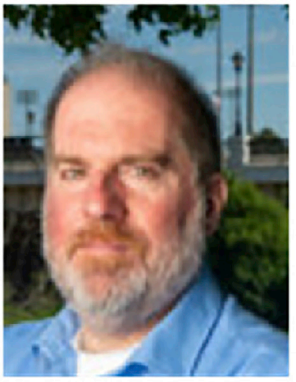
Space Omics
An esa funded Topical Team
https://issop.space/space-omics-topical-team/







Backstory

Building the Space Omics Topical Team to boost European space researchers' role in the international consortia redefining spaceflight-generated datasets

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Key members in the Space Omics Topical Team funded by ESA (grant/contract 4000131202/20/NL/PG/pt "Space Omics: Toward an integrated ESA/NASA –omics database for spaceflight and ground facilities experiments").From left to right, Dr. Raúl Herranz, Dr. Willian da Silveira, Dr. Daniela Bezdan, Dr. Stefania Giacomello, and Prof. Nathaniel Szewczyk.

In a broadening and more competitive space exploration landscape, playing at scale is necessary to obtain results. European researchers share their lessons learned on growing a research program where omics techniques can feed new knowledge, both fundamental and practical, for space exploration. Sending people to new space destinations will require interdisciplinary research centered around omics and personalized medicine, with added constraints of low-gravity and high-radiation environments.

Why build this consortium?

Humans were explorers from the beginning and the European Space Agency (ESA) takes pride in the continent's history of important voyages and how they helped shape the modern technological world we currently live in. To continue our explorer's journey, we have to go farther than ever into a space exploration competition with new players, not only our usual partners NASA and Roscosmos but also growing economies in Asia and South America. In this context, Europe risks becoming a minority partner in upcoming endeavors. Our group aims to increase the importance of European Researchers in Space Biology in general and Space Omics in particular.

Our particular research focus is learning how to live in extreme environments facing radiation exposure threat, with a different gravity, different air composition, extremely limited biodiversity, difficult access to water and oxygen, and the mental and health effects generated by all these factors. As scurvy was once a major threat in the age of Earth exploration, we are now faced with muscle and bone density loss, potentially increased mutation rate and cancer risk, vision loss, and more. Spaceflight exposure effects are diverse in scope and varied in intensity, affecting different people, and organisms, in different ways. To cover such a range of biological questions, we need to gather as many researchers as possible into our consortium.

For planned long-term space missions to be successful, we have to extract the maximum amount of biological information from the limited number of astronauts and other organisms in space. This enables discovery and production of efficient countermeasures. For humans, this is personalized medicine, and Omics technologies are an essential part of such an endeavor. A number of discoveries in space can later be used to solve problems here on Earth. The use of Omics allows access to all the information of our biological molecules at same time. Genomics allows us to look at all the 4.2 billion pair-bases in our genomes. Transcriptomics allows us to estimate the levels of all the ~25,000 coding genes at once, with similar approaches for proteins and metabolites.

The Space Omics Topical Team was created as a forum for integration of Biologists and Omics researchers from ESA member states to support new and ongoing ESA scientific community activities in the field.

Who were the players in this project, and how did you bring everyone together?

This Topical Team started as an offshoot of a successful NASA initiative called GeneLab. GeneLab is a repository for spaceflight and analog environment Omics data. As part of GeneLab's activities, they supported the creation of Analysis Working Groups (AWG). At the GeneLab AWG symposium in 2018, we realized there were a considerable number of members based in Europe. This continued to be the case at the second symposium in 2019, so we organized talks between each other as we thought there was a strong potential for coalescing space Omics research within the ESA member states. In one of those talks, Dr Raúl Herranz (Spanish National Research Council – CSIC in Spanish) proposed the idea to channel those efforts through a Topical Team funded by ESA. As a space biologist since 1999, Dr. Herranz participated in seven space experiments with ESA (Plant and Animal models), coordinated three ground-based facilities projects, and was a full member in a previous Topical Team, so he was aware of how to approach ESA with such a proposal. We immediately recruited Dr. Willian da Silveira, a very active Brazilian member in GeneLab working teams, who was eager to develop a career in Europe, and Professor Nathaniel Szewczyk, a senior researcher in the University of Nottingham, UK, who has extensive experience in spaceflight research with nematodes and who was partnering with Dr. Herranz in some ESA scientific roadmap advisory boards. This core started the elaboration of the Topical Team proposal and the gathering of the rest of European members from GeneLab AWGs in a first step. To complete the core structure of the Topical Team,

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considering geographical distribution of the research institutions in Europe, gender and ethnic balance, and replicating the AWG organization at that moment, four contacts points were designed; Dr Herranz as co-head for Plants, Dr Daniela Bezdan – at the University of Tübingen, Germany – for Microbes, Dr Willian da Silveira – then at Queen's University Belfast (now in Staffordshire Univ., also in the UK) – for Multi-Omics and Systems Biology, and Dr Stefania Giacomello (Stockholm Univ., Sweden) – for Animals. Note that Dr Nathaniel Szewczyk was the initial Animal contact but requested to be replaced to improve geographic, career stage, and gender balance.

One consortium to rule them all, and in the standards bind them

All European-based members of the AWG joined the Topical Team and we have continued to work on expanding the group, including additional members from the cited countries and adding members from Sweden, France, Belgium, and Malta. The strengthening of these links have created conditions that impact the European scientific community and beyond. We co-organized a Master's Student module on Space Omics with the International Space University, and we helped establish and continue to contribute to the international consortium International Standards for Space Omics Processing (ISSOP). The ISSOP, headed by Dr. Giacomello and Dr. Bezdan together with Dr. Rutter (located in Japan), is a consortium of scientists who develop, share, and encourage sample processing standardization and metadata normalization of spaceflight "omics" experiments as a complement to GeneLab AWG. Our Topical Team members collaborate to optimize the conditions for scientists and the general public to derive valid hypotheses from these precious data by reducing confounding factors and increasing interoperability at the global level. Our standardization efforts are crucial for understanding the effects of spaceflight on biological organisms and preparing the international community toward developing safe and effective crewed space exploration beyond Low Earth Orbit.

"The strengthening of these links have created conditions that impact the European scientific community and beyond"

In the last couple of years, the combined efforts of GeneLab AWG (NASA), Space Omics TT (ESA), and ISSOP produced two dozen publications in The Biology of Spaceflight collection in Cell Press journals in 2020, and now the particular contribution from Europe is represented in the present collection (European Space Omics collection). Omics and Bioinformatics were added as part of the ESA Life Sciences strategy on the "Roadmaps for Future Research" by recommendation of the members of the Topical Team. Our final goal is to elaborate recommendations that could be used to improve our research capabilities in Europe to keep pace in the context of international collaboration.

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Final goals and expectations from our team

Translational Omics is pivotal for the development of new personalized medicine tests and treatments, and it counts as ~30% of new registrations in the FDA in the last 5 years. The COVID-19 Pandemic highlighted the importance of the European Pharmaceutical R&D to the world, with the German Pfizer/BioNTech and the UK Oxford/AstraZeneca vaccines helping to fight the virus. Europe concentrates 20% of the pharmaceutical market worldwide and is home of the second largest space industry in the world. The Space research environment in Europe is well positioned to be a leader in the development of spaceflight-derived therapeutics having Omics at its core.

Omics are also at the center of new developments in agriculture and other kinds of biotechnology. This makes a natural development of the Topical Team members to contribute to the ESA's "Business in Space Growth Network" dedicated to Life Sciences. This initiative aspires to link Academia and Space Industry to accelerate and multiply the development of spaceflight-derived biotech and to secure European leadership in the field. Scurvy was once solved by Europeans, and European researchers using the Omics approach will without doubt

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be invaluable in guaranteeing the success of this new age of space exploration.

Our expectation is that the group of scientists gathered into this Topical Team will lead new proposals to European and International funding bodies to perform new spaceflight experiments to be performed with a European signature, but also to promote spin-off working groups to be shaped into new Topical Teams as deemed necessary by ESA.